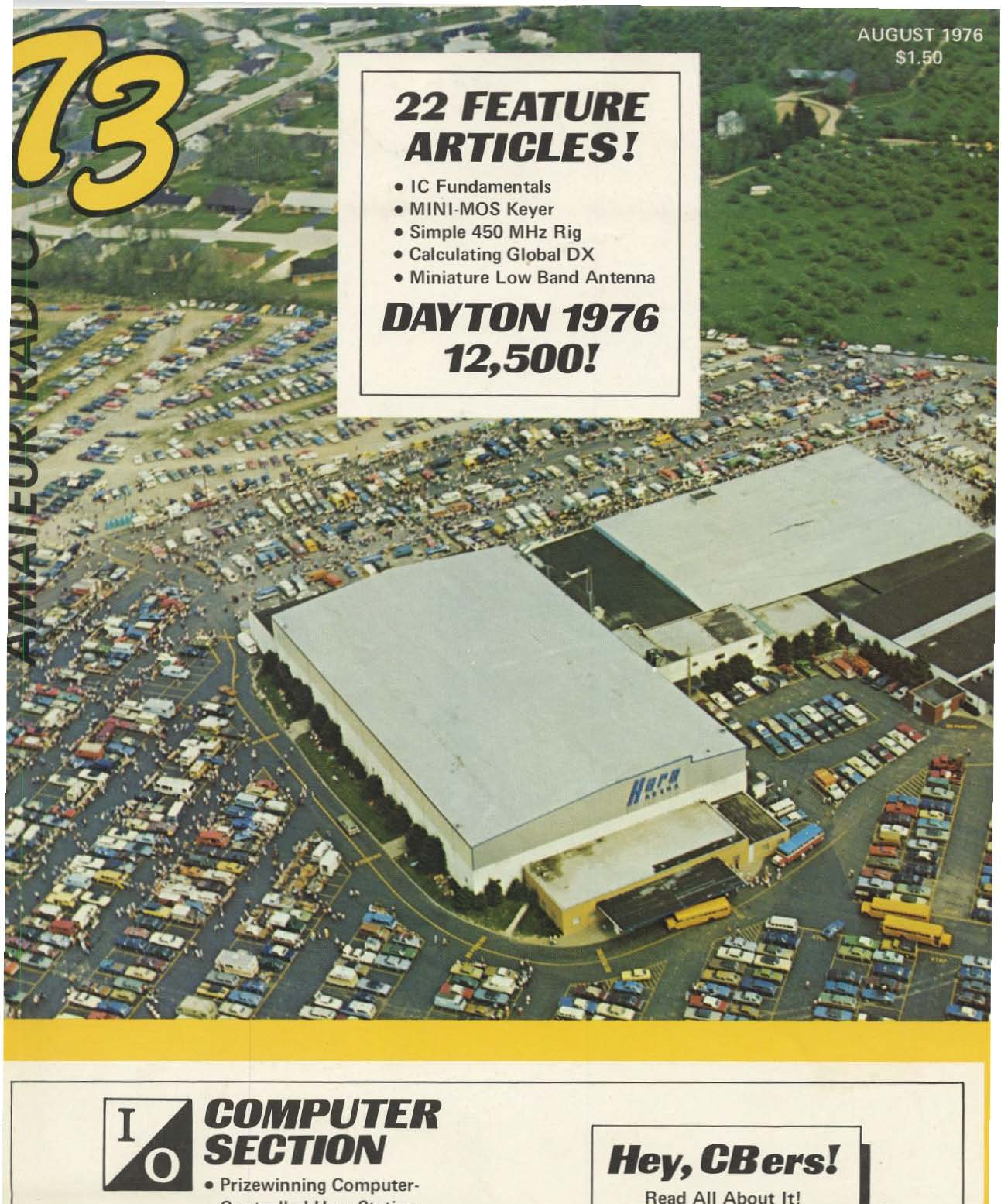
73

AMATEUR RADIO

AUGUST 1976
$1.50



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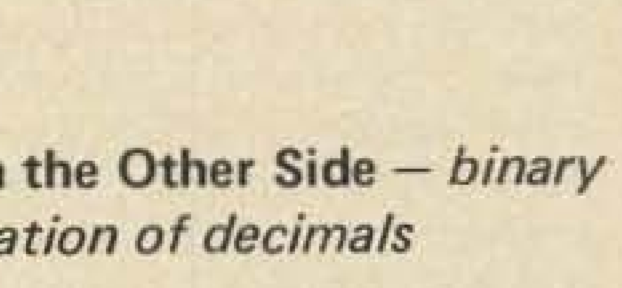

#190 AUG 1976

COVER: Aerial photo of the Dayton Hamvention by New Hampshire Air Photo, Marlow NH 03456.

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NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

DAYTON . . . BIG

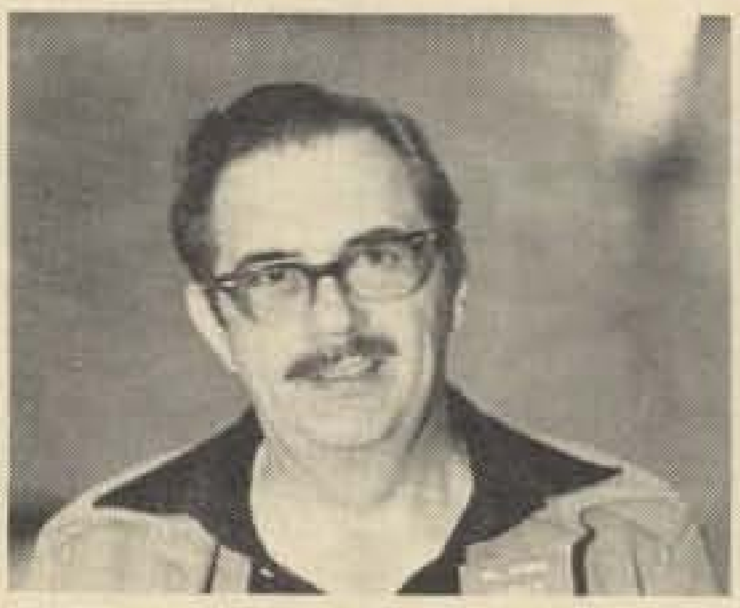
Everyone was grousing about Dayton this year, so presumably everyone was having a good time. Flea marketers lined up late Friday night to get the hot spots for Saturday . . . only to get aced out by later comers. Manufacturers arriving Thursday evening found the doors locked, and their exhibits had to be parked out overnight with fingers crossed that the usual Hamvention rip-off artists wouldn't get busy until Friday. Then there was the setting up of exhibits while being jammed with hamfesters wanting to buy stuff on Friday . . . some exhibitors never did get a chance to unpack everything!

All these are things that will probably be cured next year . . . and all have little to do with the average hamfest goer . . . who had a good deal. With over 12,500 in attendance, everything was busy . . . the flea market ran out of fleas quickly and latecomers had to settle for pawing over hundreds of tons of ham gear . . . much of it choice vintage stuff. The inside exhibits wore out their people taking in the money . . . over 100 exhibits and probably an average of $20,000 taken in per booth . . . about $2 million inside and certainly not much less outside.

The talks were for the most part well attended . . . and just about everyone who is anyone in amateur radio was there. Here are some pictures of people who stopped by the *73* booth and said hello . . . people you probably know, or should.

Johnny Johnston, FCC.

Don Payne.



Bill DuBord, Ham Radio Center.

Bill Sanders, Data Engineering.

Clarence Munsey, Robot.

Fred Huft, Optoelectronics.

Tom Caudle, Bullet Electronics.

George Perrine, HAL Communications Corp.

IS NOVICE A KICK IN THE HEAD?

Perhaps we have become so used to starting everyone off in amateur radio with a Novice ticket that we haven't given the whole situation a lot of thought. Let's think about it together for a moment and see what comes of it.

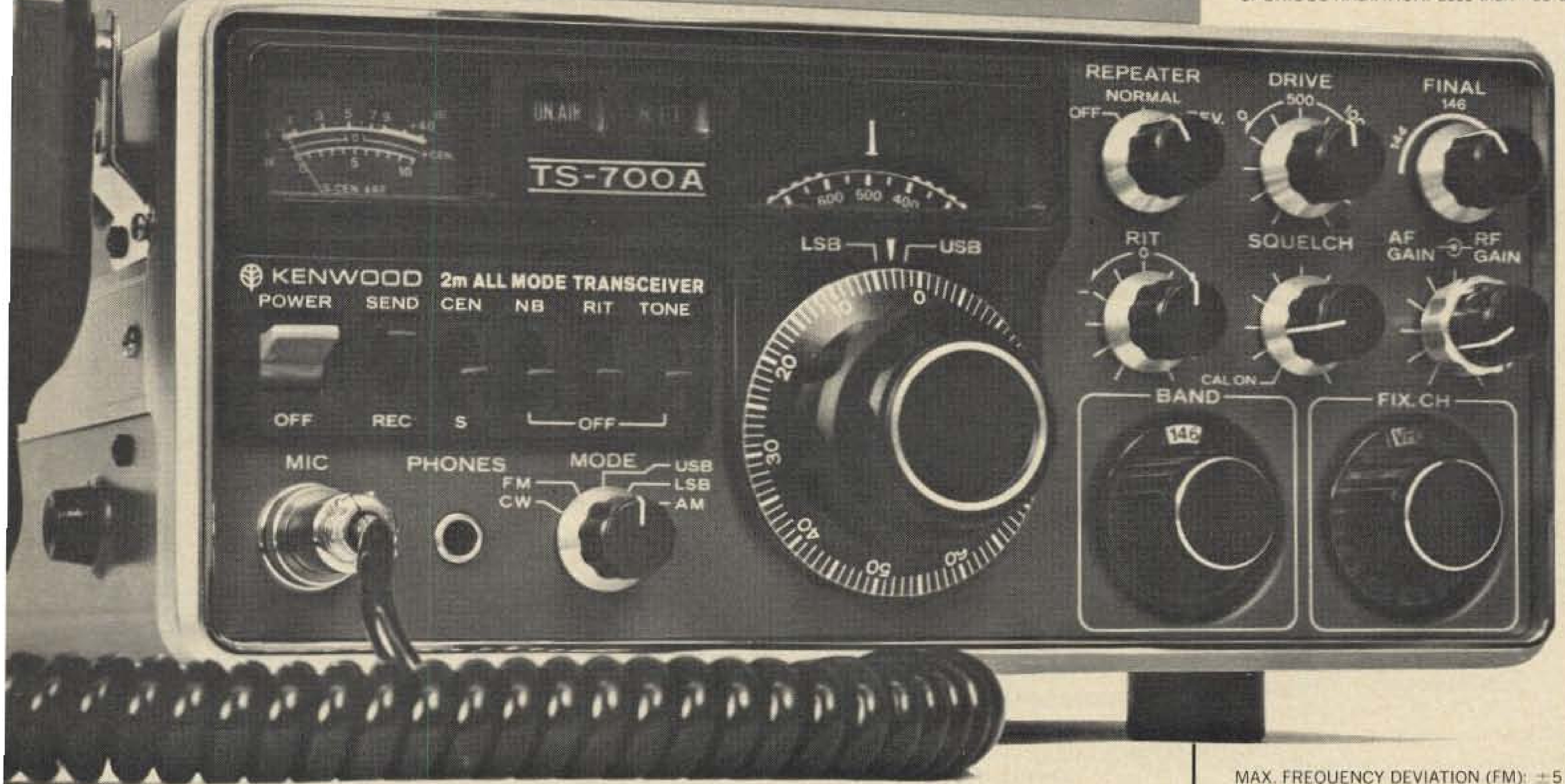
The Novice license has a couple great benefits . . . for one it is so easy to get that it is almost ridiculous. The code can be mastered in a matter of five to ten hours . . . more like five. The theory takes about the same length of time. My code cassette teaches 75% of the users the letters and numbers of Morse code in one hour. By the way, although you do better when practicing code to keep sessions to a half hour, you do much better at first to sit for the full hour and learn all the characters . . . and one hour should about do it.

The theory required is on the high school science level and is covered totally on three one hour cassettes I've prepared. Add to that one more hour of discussing questions and answers from recent FCC Novice exams and you have a four hour course which should allow most people to pass the test easily.

Okay, so the Novice test is simple and it only takes a few days to bone up for it. The other side of the coin is what this license permits you to do.

Continued on page 14

When you get tired of compromises...



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CARRIER SUPPRESSION: Better than 40 dB
SIDE-BAND SUPPRESSION: Better than 40 dB
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MAX. FREQUENCY DEVIATION (FM): ±5 kHz
REPEATER FREQUENCY SHIFT WIDTH: 600 kHz
TONE BURST TIME: 0.5-1.0 sec.
MODULATION: Balanced modulation for SSB. Variable reactance frequency shift for FM. Low power modulation for AM.
MICROPHONE: Dynamic microphone, 500Ω
AUDIO FREQUENCY RESPONSE: 400-2600 Hz, within −9 db
RECEIVING SYSTEM: SSB, CW, AM: Single-superheterodyne. FM: Double-superheterodyne.
INTERMEDIATE FREQUENCY: SSB, CW, AM: 10.7 MHz. FM: 1st IF: ... 10.7 MHz. 2nd IF: ... 455 kHz.
RECEIVING SENSITIVITY: SSB, CW: S/N = 10 dB or better at 0.25μV. 20 dB noise quieting = Less than 0.4μV. AM: S/N = 10 dB or better at 1μV.
IMAGE RATIO: Better than 60 dB
IF REJECTION: Better than 60dB
PASS-BANDWIDTH: SSB, CW, AM: More than 2.4 kHz at −6 dB. FM: More than 12 kHz at −6 dB.
RECEIVER SELECTIVITY: SSB, CW, AM: Less than 4.8 kHz at −60 dB. FM: Less than 24 kHz at −60 dB.
SQUELCH SENSITIVITY: 0.25μV
AUDIO OUTPUT: More than 2W at 8Ω load (10% distortion)
RECEIVER LOAD IMPEDANCE: 8Ω
FREQUENCY STABILITY: Within ±2 kHz during one hour after one minute of warm-up, and within 150 Hz during any 30 minute period thereafter.
POWER CONSUMPTION: Transmit mode: 95W (AC 120/220V), 4A (DC 13.8V), max. Receive mode (no signal): 45W (AC 120/220V), 0.8A (DC 13.8V).
POWER REQUIREMENTS: AC 120/220V, 50/60 Hz. DC 12-16V (13.8V as reference).
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LETTERS

BUGGED

You should tell it like it is. Re your I/O Editorial, page 81, June, 1976, *73.*

The *Bugbooks* are relatively useless unless either you purchase the kits from E&L around which they are written, or you know enough about the devices to deduce what's in the kits and start from there, in which case you probably don't need the *Bugbooks* anyway.

I know; I have the whole set and have spent a good many hours with them. I also have been in design work with TTL for some time and am studying up applications.

The *Bugbooks* don't stand alone: They need to be used with the E&L TTL kit or Micro-designer kit. There is not sufficient data to build your own kit easily, so unless you wish to purchase theirs, beware.

I will acknowledge that, if used with the E&L kits, the *Bugbooks* are probably excellent.

Joseph Naber K9AMI
Marengo IL

A very good point, Joe. I've added up the cost of the kits which go with the Bugbooks, *and they come to over $700! That puts a different light on the value of the books . . . and never mind reader complaints about the kits. – Wayne.*

MORE CARDIAC CLUES

I read in the June issue about the reader in Michigan with his pacemaker and its troubles.

My partner and I implant about 100-125 cardiac pacemakers per year. Using the Medtronic line of pacemakers exclusively, we have not had any problems with rf interference. The circuitry in the Medtronic model number 5950 demand pulse generator is such that in the presence of high rf the generator is activated rather than suppressed. On top of that, the generator is exceptionally well shielded.

Should rf activate the generator and the patient be in a paced rhythm, obviously nothing is going to happen. Should his generator be functioning in the demand mode and then be activated, he will run a competing rhythm which has some very slight danger, popularly referred to as the "one on one phenomenon," where the heart's own stimulus and the generator's stimulus fall at the same time in the cardiac cycle. The mathematical probability of this happening is extremely small, but, nevertheless, it is possible. In this rare instance it is possible to get an arrhythmia. It is also extremely unlikely that the rf field is going to be continuous for any significant period of time.

We are fortunate here in Lancaster to have a major electronics industry, the Radio Corporation of America; one of its engineers, George Gadbois W3FEY, has done considerable testing on this generator. I will ask him to comment on his thoughts and findings.

By copy of this letter, I will ask the Medtronic Corporation to voice their feelings.

In summary, I think the patient today with a good demand pulse generator has little to fear from rf, and should be permitted to enjoy the things that he is accustomed to. If there is any question, it is a very simple procedure to make a field check of an individual patient.

G. Gary Kirchner, M.D. WA3YES
Lancaster PA

BLOWING OFF STEAM

A good example of the crap that goes on when two groups of stupid people buck heads can be found in the evenings about 2100 MST most anytime that you need a laugh (or a good laxative). Just tune around 3.900-.935 kHz and listen to one group get jammed by talk, singing, tuning up, and CW on "their freq." Then this group will retaliate by turning the airwaves blue (even Nixon would blush!). The name calling, etc., is a great example of what we as communicators should not tolerate.

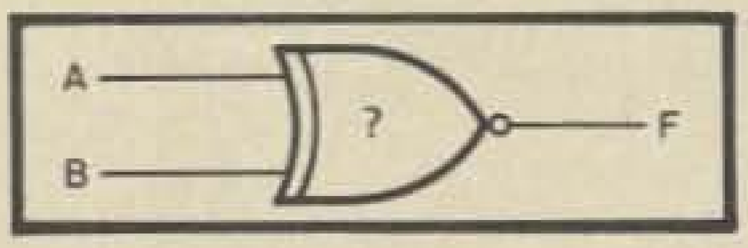
You see, CB and hams do have much in common. It doesn't pay to have such a "holier than thou" attitude such as some hams continue to have with the dirty laundry still to be washed. Of course, CB has quite a way to go yet, also. It's a shame that both couldn't work together.

Thanks for letting me blow off steam.

James L. Griffin
Seattle WA

P.S. Why do large advertisers continue to advertise rigs they do not have in stock?

Ham gear is selling extremely well these days and not much stays in stock on a dealer's shelf for long. Ads, which are expensive, are run only when the equipment has been promised by the manufacturer to back up the ads. It takes about two months for an ad to be prepared, published, and reach the reader via the mail. Many dealers have found that the promised rigs never arrive . . . that they've been sold instead to one of the larger dealers who is converting them to CB and selling them for $100 or so above list price. The promises continue, but no equipment ever comes, so money has to be refunded, a most painful process. Perhaps, if you pretend you are a CBer and pay the extra "conversion fee," you can get a ham rig. – Wayne.



A new device in the "feminine logic" family has recently become available to experimenters. It is called the "Maybe" gate, and is shown by the logic symbol above. The device functions as follows: (a) inputs 1 and/or 2 "high" may cause the output to go "high" (but maybe not); (b) if the output does go "high" it will remain "high" unless it goes "low"; (c) if the output is "high" and either input 1 or 2 goes "low," the device will probably go "low."

I'm certain you can see the potential for the "Maybe" gate in such items as "household computers," "computer-piloted automobiles," etc. A second version, with steering gates "we can't afford it" and "threats of physical violence" (on the drawing board now), should make the device more predictable.

Don Simon W6PQS
Covina CA

COUNTERATTACK

Over the years, various state legislatures have either opposed amateur radio call plates for cars or have attempted to treat them as any other form of personalized or vanity plate – and have attempted to charge substantially extra.

For many years, California has issued call plates without extra charge. Assembly Bill 4271, recently introduced before the California Legislature, is an attempt to rewrite California laws relating to license plates. As part of this bill, amateur radio call plates would be treated as vanity plates with a $25 initial fee, $10 per year continuing extra fee and a $12 transfer charge if the plates are shifted to another car.

After talking to several local amateurs, I have agreed to coordinate, at least for Southern California, a counterattack in an attempt to prove to the Department of Motor Vehicles and the State Legislature that call plates serve a valid purpose and should not be lumped in with vanity, personalized plates.

The first step in the counterattack will be to gather information from amateurs throughout the country, and not just in California, as to as many specific instances as possible where callsign plates have assisted amateurs in performing a public service function. These instances could range from occurrences in which an individual needing emergency communications has stopped a ham because he has ham radio plates and has asked that message traffic be passed, through facilitating participation in community activities or entering into closed areas during emergencies for the purpose of handling authorized emergency traffic. I do wish to stress that I need hard information as to actual instances in which call plates have been helpful, as opposed to mere statements of opinion.

Not only will this information be utilized to oppose the pending California legislation, but I will be happy to make the information available to attorneys and radio clubs throughout the country that may have to oppose similar anti-call plate legislation in their states.

Any publicity which you could give this effort would be appreciated.

All information should be sent to Jon Gallo WA6PTM, Suite 2000, 1900 Avenue of the Stars, Los Angeles CA 90067.

Jon J. Gallo WA6PTM
Los Angeles CA

FIGHTING DIABETES

It was certainly a great pleasure meeting and speaking with Wayne at the Trenton State College Computer Fair. I have been reading *73* for about 2 years now, and enjoy it immensely.

At Trenton, I heard comments concerning *73*'s proliferation of microprocessor articles. I have to comment that I cannot agree with those who feel that microprocessors have no place in an amateur radio magazine. Well, contrary to this popular belief, most of the *real* applications for the microprocessor have come from hams. Hams have accessed computers via satellite. Hams are using computers as tools around the shack, for keeping logs, keeping track of equipment, controlling antennas, and for scoring and duping during contests. The list could continue *ad infinitum.*

As it stands, most avid amateur computerists have been able to use their machinery for such mammoth tasks as playing the game of Life or Star Trek – great fun, but isn't a kilobuck awfully expensive for a game?

Granted, computers are and should be fun, but don't you agree that each of us should have *one* serious application in mind for these tools *before* we dedicate them to games?

I am a diabetic of 24 years, on insulin from the onset of my condition at age 4. My 21 month old daughter is also diabetic. I have an idea that could well benefit her and all other diabetics, provided that it gets the developmental support that it deserves. My theory is that the new electronic marvel, the microprocessor, provides us with the extremely accurate basis needed for an artificial pancreas.

Although slow by the standards of the huge electronic brains, the microprocessor is quite fast enough to take the digitally coded output from an analog device that would constantly test blood glucose levels. This would be compared by the processor against a pre-established glucose level for the individual patient. The digital result would then be used to establish the need for insulin, as well as determine the dosage required. This digital figure would then be used to control the analog amount of insulin administered.

This would have been impossible 6 months ago, but the state of the art in microprocessor technology has advanced so rapidly that such a device, with all of its speed and accuracy, should be available to the diabetic within the year, for less than $100.00.

I will be working on such a theory, developing whatever portions of such a unit that I can, with the hope of presenting this theory at the Personal Computing '76 Consumer Trade Fair (Atlantic City NJ, Aug. 28-29, 1976), so that its development can be advanced by the experts of the microprocessor field who will be in attendance at this show. My hope is that some of the expertise used to develop such games as Life and Star Trek can be enlisted in the development of something that will serve, rather than only amuse, mankind.

John David Jones, Jr. WA2AML
Co-Chairman, PC '76
Somers Point NJ

5 APES WHIP

Enclosed is a photo of an antenna I've been experimenting with. It's called a "5 Apes Whip." You will note that the "traps" are actually 5 apes and the second from the bottom is a small ape used as a matching stub. Thought you might be interested.

Mike Berlin WB2FIG
Brooklyn NY

ALL IS NOT ROSES

All is not roses in the mail order business. We, like every other reputable mail order house, try to satisfy our customers to the best of our ability. However, there are many pitfalls to scuttle our endeavors. The customer can help a great deal just by doing things such as making sure his address (and name) are on his order blank or letter — as well as on the envelope. (If one Peter C. Johnson would send his address along to us we would be happy to reply to his request for our catalog.) Another important thing is to *type* or *print*. So far we've managed to decipher all orders, but it has not been easy. Oh yes — don't forget your check or money order.

Not having a crystal ball, we cannot predict what items will be selling the most. In April it was 2N6081s — it seemed every order was for them. We did run out, and of course it took us six weeks to get our order from the factory. If we do run out, we try to get word to our customers that we'll be late. We would appreciate their understanding of this problem.

Last but not least is our great mail service. A lost package sent out and a lost letter stating the package wasn't received garnered us a letter of complaint from one state's Attorney General. We used to worry about how long it took a package to get to a destination (and most of our stuff goes out First Class) — now we worry about whether it will arrive at all.

But on top of it all we're still going to hang in there.

Al Smith WA2TAQ
Aldelco Semi-Conductor
Supermarket
Lynbrook NY

VERY SMART

I got some issues of *73 Magazine* and I like them very much. I am not a ham operator but a ham DXer. I do shortwave listening as a hobby. I enjoy listening to ham operators. They are very smart at the hobby. I don't understand a thing they talk about.

I am going to try my hand at ham radio and get my Novice license. I am so thankful for other ham operators who can help me. They are all so willing to give me their time and help. I am greatful to Dudley WA3JXW, who got me interested in ham radio by sending me a radiogram. He is trying to find a class for me so I can learn code and theory. It will take me a long time before I get on the air. So until I get on the air I will say "73" to all ham operators.

Larry McKinney
424 Grant Road
Adamstown PA 19501

GOOD WORK

Keep up the good work on computer theory and construction.

T. D. Miller III W4SWB
Burlington NC

ANYONE FOR DVORAK?

I have a suggestion for you (and especially your readers) to consider: I would like to see an idea swapping feature each month.

Every one of your readers has creative talent and I think that it should be shared. Maybe someone has a neat idea for a piece of equipment or a plan for using a different mode. Perhaps they have thought up a useful computer program or fun game, but they don't have the computer to run it. Maybe they just aren't any good at building things and they would like to pass the idea along to someone else.

The thing that would probably be the best feature of such a idea swap would be idea hitchhiking. The actual suggestions might not work out, but they might start someone else thinking about how to make it work.

I have seen plenty of idea generation material in the "Letters" column, and I've only had a subscription for five months. I think that ideas, even half baked ones, should be encouraged. The world and ham radio needs creative thinking.

Also, I have an idea that I would like to see passed along to microprocessor and RTTY enthusiasts (keyboard Morse types as well). The "standard" typewriter keyboard is an awkward, difficult thing to learn and use. It was developed over a half a century ago to *slow down* the typist, because the early typewriters were slow, cumbersome pieces of machinery that jammed up if the typist had even moderate skill. In the early '30s, A. Dvorak developed a keyboard that doubled the average person's typing speed and reduced learning time, as well as reduced fatigue and frustration for the beginner. The concept was to put the most used keys on the "home" row of keys, put the most used keys under the strongest fingers, and put the vowels together. The last was done because most words alternate between vowels and consonants, which leads to alternate hand rhythm.

It seems to me that if you are building or working with a keyboard that you can re-wire, the Dvorak system is worth considering.

"Standard"
qwertyuiop
asdfghjkl;
zxcvbnm,./
"Dvorak"
/,.pyfgcrl
aoeuidhtns
;qjkxbmwvz

James Whitfield
PSC Box 3204
Edwards AFB CA 93523

ANOTHER SHOOTING VICTIM

I received my first copy of *73* for May and I sure do like it. But it sure upset me about one thing. That is about Trigger Electronics, with which Larry S. Lawhorn WA4MJA had trouble. I myself ordered $47.20 of amateur gear from them on April 6th and sent a cashier's check by bank draft. I have written them once and

called them long distance twice. I have not got the order or my money. I am trying my best to get it and if I don't I want all hams and *73* to know it also. I have been a ham since 1961 and would not do any of my fellow hams that way. I want to warn all fellow hams. I will let you know the results. I am retired and Social Security is my only income and I cannot afford many losses like this. Keep up the good work. I look forward to the next issue.

Horace M. Lewey, Sr. WA4CUD
Greensboro NC

WHAT DOES THIS MEAN?

I have received on this day, the third of May, all at the same time, *73 Magazine* for June, 1976, *QST* for May, 1976, and *CQ* for April, 1976. What does all this mean? Cheers!

Paul G. Stecker
Westwood NJ

THICK IRISH SKULL

Your *73* article ("Those Exciting Memory Chips," June, page 96) was very good. I'm trying to get some of this new solid state down, but my thick Irish skull can't seem to absorb it. Anyway, thanks for the fine article.

Jim Sullivan W1PSW
Woburn MA

BICENTENNIAL PLATES

The Missouri Department of Revenue will honor all requests for bicentennial call letter plates. All requests must be written and should contain the applicant's name, address, type of vehicle, current call letters, bicentennial call letters which they are requesting, and must be received before July 1, 1976. The requests should be mailed to the Motor Vehicle Bureau, Box 100, Jefferson City MO 65101, Attention: Special License Unit. The fee for all Amateur Radio plates, regular or bicentennial, is an additional $5.00 over the normal cost of license plates.

C. A. Jurgens, Jr. WAØCMO
Jefferson City MO

LITTLE PARIS

This is a report on the operation of FKØKG, a YASME DXpedition to Noumea, New Caledonia.

The first QSO was with JA1AB on 30 March 1976, and the last QSO was with FG7AQ on 28 April 1976. Some 7,500 QSOs were made, operating on 28 MHz, 21 MHz, 14 MHz, 7 MHz and 3.5 MHz. Operation on all bands was made on both CW and SSB (approx. 50% each mode).

On 16 April 1976, all continents (WAC) were worked on 7 MHz CW in two hours and 5 minutes. QSOs were F9YZ (0605 Z), K6HMO (0608 Z), ZL2AMP (0625 Z), PY1ARS/4 (0630 Z), EA8BF (0808 Z), and JA1ABU (0809 Z).

We were amazed to discover Noumea to be the largest and most modern town that we have visited in the Pacific Ocean areas (excluding Honolulu). It is a "little Paris," with many beautiful homes, apartment buildings, modern department stores, traffic jams, etc. Some of the local city buses have true hi-fi stereo sound on them for the enjoyment of the passengers. Speakers on one side of the bus are on one channel and speakers on the other side are on another channel. The only problem with Noumea is that everyone speaks *French*. We know a little French but could have enjoyed the city more if our French was better.

The taking of radio gear in and out of New Caledonia was easy, and our licenses to operate were obtained rapidly. All in all, it was a great place for a DXpedition. We had a good time, and band conditions, although erratic, were good.

Lloyd Colvin W6KG
Iris Colvin W6DOD
Noumea, New Caledonia

COLOMBIAN MOONBOUNCE

The Mount Airy VHF Radio Club (The Pack Rats) is pleased to announce that it has received permission from the Colombian Minister of Communications to conduct a moonbounce experiment from South America on 432 MHz.

As of April 27, no South American continent stations had been available for 432 MHz EME work. The station will be located near Barranquilla and will be operated by S. William Olson W3HQT, Walter Bolman K3BPP, and Anthony Souza W3HMU. Arrangements for the trip are being made by Bolmar Aguilar WB3AOP, Elliott Weisman K3JJZ, and Socrates Martinez WB3AFY.

Colombian liaison is being handled by Dr. Atenogenes Blanco HK1BYM, who has coordinated a group of radio amateurs in Colombia representing all of the active radio clubs in Barranquilla (HK1RCB, HK1EE, HK1LR). Dr. Blanco's address is Apartado Aereo 15-020, Barranquilla, Colombia, South America.

Operation will be on 432.040 MHz, using a portable 16 yagi array especially constructed for this project. Liaison during the South American operation will be maintained with Pack Rat stations stateside. Those wishing to convey information to the expeditionary force should contact Ernie Kenas W3KKN or Bertha Kenas W3TNP, 2823 Old Welsh Road, Willow Grove PA 19090, (215)-659-3485.

Communications with the expeditionary force in Colombia may be obtained via Dr. Blanco, whose address is listed above.

It is our intent to work as many of the 432 moonbounce stations as possible from this location, and schedules have been made with all of the 432 EME stations known to be active at this time. Anyone requiring additional information with regard to the expedition may contact me.

Elliott T. Weisman K3JJZ
8533 Algon Ave.
Philadelphia PA 19152
(212)-742-3525

ALL-STAR ALTAJ

I recently placed an order with Altaj Electronics, for the miserly sum of $3.79. Although Altaj is Texas-based, and I live in Mass., I received the order (in perfect condition) in less than five full days. Furthermore, the shipping cost, for which Altaj picked up the full tab, came to $1.40.

I wonder if all of your readers are aware of the fact that this outfit has no minimum order, and absolutely does not charge for postage or handling.

Malcolm Leonard
New Bedford MA

LIKE IT!

Received my MAY issue of *73* today in *March* — uh, but, you see, er — that is to say, uh, how — I've *never* — *no one* — er, not even — no! it's just *not* — uh, especially since — and then too, there's, uh — son of a gun! Great! F.B. articles, too! Like it!

Bud Resch WØFTD
Independence MO

VERADA 214

I feel I should write you in regard to one of your advertisers in *73*.

In April I saw an ad from Verada 214 and ordered an amplifier from there. It was to be complete with face plate and knobs. The order came by mail (postpaid) in less than a week. Really pleased me with their prompt service. But, it was missing the knobs. A little disappointment, but knobs are cheap, no sweat. Tuesday of the next week, before I had a chance to either rewrite them or buy knobs, another package comes from Verada 214: not only the knobs for the tuner, but a short note from J. Rutherford, apologizing for the mistake.

I certainly would recommend them to any of your readers. Add Verada 214 to the long list of people that are F.B.

Thanks for a fine mag (lifetime subscriber to *73*), and for your dedication to allowing only reliable companies to place ads in your mag.

Harry Mitchell WB2SFZ
Baldwinsville NY

DOWN UNDER

Just a little note to let you know about VHF activity in VK. Plenty of FM activity — repeaters in all capital cities and big towns. Mostly commercial gear — ICOM 22s, TR10s, etc. The advent of the YAESU 620 and 220 VHF SSB gear has given it a big boost. Since the commencement of the year, the new ICOM IC-202 and IC-502 low power portable 6 and 2m SSB gear has made VHF even more popular. Some surprising QSOs over amazing distances with the little units. Everyone is making solid state linears run 10 W and 40 W PEP. OSCAR 6 and OSCAR 7 are accessible with the units and the linears and a moderate beam. ZLs and P29s are some of the DX.

S. J. Mahony VK5ZIM
Elizabeth Downs
South Australia

DIGESTING

After the customary six week incubation period following each and every subscription application, I received the May '76 copy of *73* and have spent about a month memorizing every page. This done, I eagerly anticipated the next month's copy. Yesterday I received the April '76 copy, which I am likewise digesting, and I'm sure I will be equally anxious for the March '76 copy. Keep up the good work!

Lyle Ross W5UPD
Richardson TX

P.S. Please don't bother to send the January '76 issue because a fellow ham who received six copies gave one to me.

Ham Help

I need Ham Help!

Gregory L. Smith
5604 West Overland Pass
Peoria IL 61607
(309)-697-3324

Keep up the very good work on your magazine. It's the best in my book. Love everything in the issues, even the advertising.

Would like to get in touch with someone owning a Kenwood TS-511S transceiver. I have been on the air for a year now and still haven't heard anyone with this kind of set. Would like to compare notes and iron out a few problems I have with the set. Thank you.

Leo Patin WB9PCO
1800 North Timber Trail Lane
Oconomowoc WI 53066

SPEEDY SERVICE

Just a few words along with my Reader Service requests to say that your code tapes are great! I just listened to the five words per minute tape every now and then, and after a couple of weeks I had passed my Novice code test with ease. I'm now awaiting my Novice license, and looking forward to getting on the air.

Gary E. Szatkowski
Sault Ste. Marie MI

P.S. I also compliment your Reader Service and its speedy replies — and the overall magazine. Keep it up!

WHY NOT?

I hereby submit my first letter to your honorable publication, which I was introduced to by Ken Cole W7IDF, and have anxiously awaited receipt of each and every month.

Just read your May letters column, and agree with Steve Uhrig WA3SWS. How about a "White House" type article on *73*, Inc.? We *must know* what the people who run the magazine look, act, and operate like. Pictures, especially, would help. Let's hear it . . . and see it!

Excellent magazine you've got there, and keep up the good work, including subversive activities in an attempt to overthrow the ARRL regime, if that's what you're after. F.B.

As a CBer and ham, I can appreciate all of what both titles stand for. Being KDZ-9707 has its advantages over WN7AVF, and vice versa. Personally, I think the CB situation is and/or will get better. 10-4?

More basic logic articles like you had last year. F.B. on your new I/O section. Only wish I could afford a microprocessor.

New format is good. All good things must come to an end, and the old minisize did. Big size offers more room, detail, and ease of reading. I give my full approval.

Before you get too carried away with this computer bit, as I said before, include more basic explanations for us Novices and equally uninformed Extras, if there are any.

Have one of your tapes, the 14 per one. Will say I listened a *total of 3 hours* to be able to pass the General. Great tape(s) . . . used it twice, since I failed the written part the first time. F.B.

Have been receiving *QST*, and your magazine is far more interesting, informative, humorous, etc. Speaking of humor, why not put in a few cartoons with a technical or ham-political theme? We need a laugh in these times of trouble, etc., etc., etc. Your editorials are also very good, and I also like the "Autobiography of an Ancient Aviator."

Let's have lots of ATV, repeater stuff, HF-CW, SSB, SSTV, and computers and computer technology. You'll undoubtedly kill *HR, CQ, QST*, or anybody else, with a lot of new, bright stuff.

As for increasing membership (in ham radio), CB offers the ideal source.

There's hope for "conversion." Amen. Ham conventions and hamfests should be open to CBers, without any ill feelings (or at least just a grit-your-teeth smile). Here CBers could become interested and could be welcomed by hamdom. Of course, generally (in the real world), they would not be welcomed, but they could be. Why not????

Robert B. Barnard WN7AVF
Seattle WA

MORE MAPLE HILLERS

WB2YCR, the radio voice of Maple Hill High School, Castleton, New York, is proud to announce the licensing of four new amateur radio operators. The four young men recently completed an intense six week course taught by WA2UON at Maple Hill, and successfully completed FCC tests showing both their ability to send and receive the international Morse code and their mastery of basic radio theory and regulations.

The new radio men are: Al Ferreira WN2EQP, Geoff Schad WN2EQN, Robert Porter WN2EQO, and Scott VanNederynen WN2EQQ. All four are part of the Maple Hill High School Amateur Radio Club (WB2YCR) and are also members of the high school's audio-visual special team, "The Media Men."

John Kienzle WA2UON
Castleton NY

NEVER MATCH 2M FM

I have been buying your great magazine, and this was the deciding factor which has made me start learning that famous Morse code.

I plan to get the General license during the month of September. Hopefully, before this year is over I will be on the air.

I am a computer programming major at Florida International University, and I think that your computer section is great — but please don't cut the amount of articles and construction projects about 2 meter FM.

Keep up the good work.

Rene A. Nunez
Miami FL

P.S. I have a CB license, even if I don't have a transceiver right now. On the road it's a great help, but it will never be able to match 2m FM.

Repeater Update

Fred Goldstein WA1WDS

A — Addition; C — Change; D — Deletion

A	MA	WR1AFO	Belmont	147.315
A	MA	WR1AAA	Malden (29.685)	29.52
A	MA	WR1AFP	Fitchburg	224.34
A	MA	WR1AGJ	Saugus P	147.015
C	MA	WR1AFG	Worcester	146.325
A	MA	WR1ACO	Malden	449.40
A	MA	WR1AFO	Belmont	448.10
A	RI	WR1AFY	Newport	147.36
C	VT	WR1AAK	Killington	146.88
A	NJ	WR2AHV	Sussex	147.30
A	NJ	WR2AFL	Atlantic City	146.94
C	NJ	WR2ACQ	Northfield	146.745
C	NJ	WR2AHM	Pine Hill	146.865
A	NY	WR2	Buffalo (52.05)	53.05
C	PA	WR3AGB	Carnegie (147.63)	147.03
C	PA	WR3AGU	Mahouponoy	147.21
A	PA	WR3AEV	Wilkes-Barre	146.88
A	PA	WR3AGV	DuBois	146.73
D	PA	WR3	Hazleton	146.76
C	PA	WR3PHL	Valley Forge	146.76
A	KY	WR4	Ashland	146.82
C	KY	WR4ALH	Ashland	147.24
A	KY	WR4	Falmouth	146.73
A	KY	WR4	Louisville	146.64
A	KY	WR4	Louisville	146.94
A	TN	WR4ANW	Cookeville	146.67
C	VA	WR4ABR	Vienna	146.91
A	VA	WR4APE	Winchester PL	147.30
C	LA	WR5AFJ	Baton Rouge	146.94
C	LA	WR5AKA	New Orleans T1.8	146.76
A	LA	WR5	Jonesboro	146.88
A	NM	WR5AJS	Roswell	146.76
C	NM	WR5AHA	Las Cruces	146.76
A	NM	WR5ABG	Las Cruces	146.64
A	NM	WR5AEQ	Sandia Crest	444.00
A	OK	WR5	Oklahoma City	147.36
C	OK	WR5AJP	Oklahoma City	146.94
C	OK	WR5ADF	Oklahoma City	146.76
A	OK	WR5	Oklahoma City (147.63)	147.03
C	OK	WR5AJP	Oklahoma City	444.10
A	OK	WR5ACB	Oklahoma City	147.21
A	OK	WR5ACB	Oklahoma City	447.80
A	CA	WR6AMZ	Inyokern	146.64
A	CA	WR6AEP	Ventura	447.325
A	CA	WR6ANW	Santa Barbara	146.79
A	ID	WR7AFH	Burley-Mt. Harrison (146.40)	147.00
A	ID	WR7	Pocatello	146.88
A	NV	WR7	Reno	146.79
C	OR	WR7AGX	Roseburg-Scott Mt.	146.76
C	MI	WR8AIJ	South Lyons	147.21
A	OH	WR8AHJ	Cincinnati (147.60)	147.00
C	OH	WR8AGO	Hillsboro	147.21
A	OH	WR8	Louisville	147.12
C	OH	WR8ACQ	Mansfield TT34	146.94
A	OH	WR8AIW	Youngstown	147.915
A	OH	WR8AED	Uniontown	147.09
A	OH	WR8ACV	Lancaster	146.025
A	OH	WR8	Dayton	146.175
A	OH	WR8	Dayton	147.855
A	OH	WR8	Troy	147.015
A	OH	WR8	Mainville	147.315
A	OH	WR8AHE	Cincinnati	147.285
A	OH	WR8AHL	Cincinnati	147.945
A	OH	WR8ADZ	Cincinnati PL	147.975
A	OH	WR8AED	Uniontown	223.98
A	OH	WR8ACV	Dayton	444.25
A	WV	WR8	Parsons	146.73
A	IN	WR9AEB	Vincennes	147.67
A	KS	WRØAKL	Derby	146.79
A	KS	WRØAJH	Emporia	146.91
A	KS	WRØAJI	Herrington	146.61
A	KS	WRØAJZ	Topeka	146.67
C	KS	WRØAIP	Salina (147.63)	147.03
C	KS	WRØAGP	Wilson	146.97
C	KS	WRØAJW	Coffeyville	146.61
			Kansas Coordinator:	
			R. D. "Slim" Cummings WAØEDA	
			510 W. Fifth St.	
			Pittsburg KS 66762	
A	PQ	VE2KPG	Hull-Ottawa	147.36
A	ON	VE3RRR	Windsor (RTTY, SSTV)	147.30
A	ON	VE3SVR	Morrisburg	146.76
A	ON	VE3TFM	Toronto	223.98
A	ON	VE3MGB	Midland	147.18
A	ON	VE3LSP	Montreal River (146.46)	147.06
C	SA	VE5ESK	Jansen	146.76
C	SA	VE5SCR	Swift Current	146.61
A	SA	VE5MMR	Arcola	146.82
D	SA	VE5	Weyburn/Carlisle	146.82
A	SA	VE5	Melville	146.88
C	BC	VE7ELK	Chilliwack (146.40)	147.00
C	AUS	VK2RWI	Sydney N.	147.00
C	AUS	VK2RLE	Sydney S.	146.80
D	AUS	VK2	Ulladulla	146.90
C	AUS	VK2RAW	Wollongong	146.85

Editor:
Robert Baker WA1SCX
34 White Pine Drive
Littleton MA 01460

CONTESTS

VENEZUELAN INDEPENDENCE CONTEST

Phone
Starts: 0000 GMT July 3
Ends: 2400 GMT July 4
CW
Starts: 0000 GMT July 31
Ends: 2400 GMT August 1

Contacts with stations in the same country are permitted on all bands for country multiplier credit, but have zero point value. There are 4 classes of competition:

Single operator – single band; Single operator – all bands; Single transmitter – multi-operator; Multi-transmitter – multi-operator (only 1 xmtr per band).

Use all bands 80 to 10 meters.

EXCHANGE:
RS(T) and progressive QSO number starting with 001.

SCORING:
QSOs with stations in different country count 2 points, while with stations in same country count zero points. Venezuelan stations may, however, contact each other on 40 and 80 meters for 1 point per QSO but will score zero points for contacts with other YVs on 10, 15, and 20 meters. The final score is the total QSO points multiplied by the sum of YV zone call areas and countries on each band.

AWARDS:
A trophy will be awarded to first place in each category. Medals will be given to the highest scoring station in: N. America, Central America, S. America, Caribbean, Europe, Asia, Oceania, and SWLs. No station can be awarded more than once! Certificates will be issued to all stations having made the following contacts: Caribbean and N., Central, and S. America (except YV) – 20 YVs plus 10 different countries for SSB and 15 YVs plus 10 different countries for CW; Europe and Africa – 10 YVs and 10 different countries; Asia and Oceania – 5 YVs and 10 different countries; YV stations only – 30 YVs on 40 and 80 mtrs, 10 different countries (including YV), and 50 QSOs with foreign stations *for SSB; On CW* – 15 YVs on any band plus 10 different countries (including YV), and 50 QSOs with foreign stations; SWLs – 50 complete QSOs, including a minimum of 10 YVs. Both exchanged numbers must be shown in the log for credit. Medal to the SWL with the maximum QSOs.

ENTRIES:
Each entry must be accompanied by a summary sheet showing all scoring information, category of competition, mode, name, callsign, address in *block letters*, and a signed declaration that all contest rules and regulations for amateur radio in the country have been observed. A remittance of $2 or equivalent IRCs is requested with each entry to cover awards and handling. All entries must be postmarked no later than Sept. 15, 1976, for the phone section and October 15, 1976, for the CW section. SWL deadline is December 15, 1976. Mail logs to: Radio Club Venezolano, P.O. Box 2285, Caracas 101, Venezuela. Logs must show all times in GMT. Indicate YV zone call area and country multiplier only the first time it is worked on each band. *Use a separate sheet for each band!*

CALENDAR

July 3-4	Venezuelan Indep. Contest – Phone
July 17-19	CW County Hunters Contest*
July 24-25	ARRL Bicentennial Celebration
July 31-Aug 1	Venezuelan Indep. Contest – CW
Aug 7-8	10-10 Net Summer QSO Party
Aug 14-15	European DX Contest – CW
Aug 21-22	SARTG Worldwide RTTY Contest
Aug 21-23	New Jersey QSO Party
Aug 28-29	Arizona QSO Party
Aug 28-30	All Asian DX Contest – CW
Sept 4-5	ARRL VHF QSO Party
Sept 4-5	Albatros SSTV Contest
Sept 11-12	European DX Contest – Phone
Sept 11-12	Washington State QSO Party
Sept 18-19	Scandinavian Activity Contest – CW
Sept 25-26	Scandinavian Activity Contest – Phone
Sept 25-27	Delta QSO Party
Oct 2-3	VK/ZL/Oceania Jubilee DX Contest – Phone
Oct 8-10	CD Party – Phone
Oct 9-10	RSGB 21-28 MHz Contest – Phone
Oct 9-10	VK/ZL/Oceania Jubilee DX Contest – CW
Oct 16-17	RSGB 7 MHz Contest – CW
Oct 16-18	CD Party – CW
Oct 17-18	Manitoba QSO Party
Oct 30-31	CQ Worldwide DX Contest – Phone
Nov 5-8	IARS-CHC-FHC-HTH QSO Party
Nov 6-7	RSGB 7 MHz Contest – SSB
Nov 6-8	ARRL Sweepstakes – CW
Nov 13-14	European DX Contest – RTTY
Nov 14	OK DX Contest
Nov 20-22	ARRL Sweepstakes – Phone
Nov 27-28	CQ Worldwide DX Contest – CW
Dec 4-5	ARRL 160 Meter Contest
Dec 11-12	ARRL 10 Meter Contest
Dec 31	Straight Key Night

* = described in last issue

VK7 USA BICENTENNIAL CONTEST

Starts: 1400 GMT, Saturday, July 3
Ends: 1400 GMT, Sunday, July 4

RULES:
There will be two sections to the contest: a) single band, transmitting open (single operator); b) multiband, transmitting open (single operator). All U.S.A. and VK7 amateurs may enter the contest, whether their stations are fixed, portable or mobile. Amateurs may use all modes, and crossmode contacts are permitted. All amateur bands may be used, but crossband contacts are not permitted. Skeds for other bands are allowed.

SCORING:
VK7 stations: 1 point per contact per band and, in addition, 5 bonus points for each new state worked on each band. U.S.A. stations: 1 point for the first contact, 2 points for the second, 3 points for the third, etc. A station may be contacted once only per band for scoring purposes.

NUMBERS:
Before points may be claimed for a contact, numbers must be exchanged and acknowledged. The number will be made up of RS (phone) or RST (CW) reports, plus the year in which the operator first received his license. U.S.A. stations must also give the state they are in.

LOGS:
Logs must show date and time in GMT, band, callsign of station contacted, number sent, number received, and score. VK7 stations must also underline and show each new state worked.

SUMMARY SHEET:
Summary sheet must show callsign, name and address (in block letters), details of equipment and power used, whether single or multiband log (entry), and score.

ENTRIES:
All logs should be sent to: The Contest Manager, P.O. Box 1010 Launceston, Tasmania 7250, Australia. They must be in the hands of the contest manager before 1 November 1976.

ARRL BICENTENNIAL CELEBRATION

Starts: 0000 GMT Saturday, July 24
Ends: 2359 GMT Sunday, July 25

Object of the contest is for US stations to work as many stations as possible, while non-US stations will try to work as many US stations as possible. US to US contacts are permitted. US entries must be single operator while non-US entries may be either single or multi-operator. Multi-transmitter, however, is not permitted. No more than 36 hours of the contest period may be operated, with time-outs not less than 15 minutes long and no more than 8 time-outs total. Each station may be worked once on voice and once on any other mode. No repeater contacts, except through OSCAR, are allowed. A station may not be worked with a regular call followed by a contact with a bicentennial call; only one contact per mode.

EXCHANGE:
US stations send RS(T), state, and state entry number into the Union (see list below). Non-US stations send RS(T) and consecutive serial number starting with 001.

SCORING:
Simple: Final score equals number of QSOs; *no multipliers.*

AWARDS:
US stations: 1776 or more QSOs, 200 or more QSOs, 50 or more QSOs on or above 50 MHz, ARRL section high score, WAS, 200 or more QSOs with non-US stations. Non-US stations: 1776 or more QSOs, 200 or more QSOs, 50 or more QSOs on or above 50 MHz, country high score, WAS, and worked 13 original colonies.

ENTRIES:
A summary sheet, log sheets, and check sheets are required from all US entries. Summary sheet and log sheets required from all non-US entries.

Special summary and log sheets will be available from ARRL headquarters if an SASE is enclosed. Entries must be postmarked no later than September 1st. Send all requests for logs and all entries to: ARRL, 225 Main Street, Newington CT 06111.

ORDER OF STATE ENTRY INTO UNION:

1 – CT – 5, ME – 23, MA – 6, NH – 9, RI – 13, VT – 14; 2 – NJ – 3, NY – 11; 3 – DE – 1, MD – 7, PA – 2; 4 – AL – 22, FL – 27, GA – 4, KY – 15, NC – 12, SC – 8, TN – 16, VA – 10; 5 – AR – 25, LA – 18, MS – 20, NM – 47, OK – 46, TX – 28; 6 – CA – 31, HI – 50; 7 – AK – 49, AZ – 48, ID – 43, MT – 41, NV – 36, OR – 33, UT – 45, WA – 42; 8 – MI – 26, OH – 17, WV – 35; 9 – IL – 21, IN – 19, WI – 30; 0 – CO – 38, IA – 29, KS – 34, MN – 32, MO – 24, NE – 37, ND – 39, SD – 40, WY – 44.

10-10 NET SUMMER QSO PARTY

Starts: 0000 GMT Saturday, August 7

Ends: 2400 GMT Sunday, August 8

All contacts must be made on 10 meters, any mode. Participation by non-members is welcomed but they are not eligible for awards. To become a member and receive a number, send a list of 10 members worked (DX work 5) and $3.00 to the manager in your district (DX to W6LRY).

EXCHANGE:

Name, QTH, and 10-10 number and chapter.

SCORING:

Members score 1 point for each contact and add 1 point if with another member (maximum of 2 points per QSO).

AWARDS:

First and second place certificates to each US district, Hawaii and Alaska, each VE province, S. Amer., Central America and Caribbean, Europe, Africa and South Atlantic, Asia and N. Pacific, Australia, New Zealand and S. Pacific.

ENTRIES:

Logs must include date/time, station, name, QTH, and 10-10 number. Members only should send logs to: Grace Dunlap K5MRU, Box 13, Rand CO 80473, postmarked no later than Sept 30th. Results will be listed in the Winter Bulletin (from 10-10).

EUROPEAN DX CONTESTS

CW – PHONE – RTTY

CW

Starts: 0000 GMT August 14

Ends: 2400 GMT August 15

Phone

Starts: 0000 GMT Sept 11

Ends: 2400 GMT Sept 12

RTTY

Starts: 0000 GMT Nov 13

Ends: 2400 GMT Nov 14

Only 36 hours of operation out of the possible 48 are permitted for single operator stations. The 12 hours of non-operation may be taken in one to three periods anytime during the contest. All bands, 80 to 10 meters, may be used on the specified mode. Classifications include: single operator-all band, and multi-operator-single transmitter. Each station may be worked once per band. A contest QSO can only be established between a non-European and a European station. In the RTTY section only, contacts with one's own continent are permitted and will count 1 point per QSO. Multipliers will be counted as described below.

EXCHANGE:

RS(T) and progressive QSO number starting with 001.

SCORING:

Each QSO counts 1 point. Each confirmed QTC (given or received) counts 1 point (see below) but only 10 QTCs to the same station on all bands together are allowed. The multiplier for non-EUR stations is the number of EUROPEAN countries worked on each band. Europeans will use the ARRL country list. In addition each call area in the following countries will be considered a multiplier: JA, PY, VE, VO, VK, W/K, ZL, ZS, UA9 and UAØ. Each multiplier may be multiplied by the following factor depending on the band: on 80 meters, multiplier times 4; on 40 meters, multiplier times 3; on 20, 15, 10 meters, multiplier times 2. The final score is the total QSO points plus QTC points multiplied by the sum total of multipliers from all bands.

QTC TRAFFIC:

Additional point credit can be included by utilizing QTC traffic. A QTC is a report of a confirmed QSO that has taken place earlier in the contest and later sent back to a EUR station. It can only be sent from a non-EUR station to a EUR station, the general idea being that after a number of EUR stations have been worked, a list of these stations can be reported back during a QSO with another station. An additional 1 point credit can be claimed for each station reported. Each QTC must contain the time, call and QSO number of the station being reported and can be reported only once (but not back to the originating station). You may work the same station several times, with a maximum of 10 QTCs to that station, but the original contact is the only QSO with QSO point value.

AWARDS:

Certificates to the highest scorer in each classification in each country, reasonable scores provided. Continental leaders will be honored. Certificates will also be given to stations with at least half the score of the continental leader. Additional certificates and plaques will also be awarded. The minimum requirements for the awarding of certificates and trophies are 100 QSOs or 10,000 points.

ENTRIES:

It is suggested that the log sheets of the DARC or equivalent be used. Send a large size SASE for logs and summary sheets. Use a separate log for each band. Violation of the rules of this contest, unsportsmanlike conduct, or taking credit for excessive duplicate contacts will be deemed sufficient cause to disqualify. The decisions of the Contest Committee are final. Mailing deadlines for entries are: CW – September 15; Phone – October 15; RTTY – December 1. Mail entries to: WAEDC – Committee, D-895 Kaufbeuren, Postbox 262, Germany. North American residents may send entries to: H. E. Weiss WA3KWD, 762 Church Street, Millersburg PA 17061.

EUROPEAN COUNTRY LIST:

C31 – CT1 – CT2 – DL – DM – EA – EA6 – EI – F – FC – G – GC Guer – GC – Jer – GD – GI – GM – GM Shetland – GW – HA – HB9 – HBØ – HV – I – IS – IT – JW Bear – JW – JX – LA – LX – LZ – M1 – OE – OH – OHØ – OJØ – OK – ON – OY – OZ – PA – SM – SP – SV – SC Crete – SV Rhodes – SV Athos – TA1 – TF – UA1346 – UA2 – UB5 – UC2 – UN1 – UO5 – UP2 – UQ2 – UR2 – UA Franz Josef Land – YO – ZA – ZB2 – 3A – 4U1 – 9H1.

SARTG WORLDWIDE RTTY CONTEST

Contest Periods:

0000 to 0800 GMT Saturday, August 21

1600 to 2400 GMT Saturday, August 21

0800 to 1600 GMT Sunday, August 22

The 6th WW RTTY Contest is again sponsored by the Scandinavian Amateur Radio Teletype Group. Use all bands, 80 to 10 meters.

RESULTS

Results of the 10-10 International Net of Southern California, Inc. Annual Winter QSO Party

The two top scorers in each district were:

K1KYC	221/522	VK4AMO	20/57
WA1STR	215/507	ZL1ARO	17/48
K9EGA/2	292/723	10X Chapter scores were:	
K2ARO	198/532	S. N.E. Nutmeg	6399/14758
WA3VQF	214/531	GATT (Cincinnati)	3390/7640
WA3INW	196/485	LIARS (NY-NJ)	2561/6318
K3IGA/4	124/322	Michigan Robins	1797/3603
WA4EBN	110/299	San Francisco Bay	1751/3316
WA5JDU	152/372	Gateway (St. Louis)	1276/3013
WB5FII	133/315	Sky Blue Waters	981/2066
WA6UZA	90/192	Delaware Valley	806/1941
WA6MOF	96/180	Chief Seattle	826/1622
K7PXI	83/207	So. California	534/1040
WA7YCQ	54/198	Thunderbird (Ariz.)	352/824
WB8FAG	189/464	Minute Man (Mass.)	351/774
W8DMY	148/356	Land o'Lincoln	212/547
WB9IUR	131/340	Houston Chapter	224/518
W9LUK	122/327	Milwaukee	164/413
WBØCEI	118/294	Colorado	176/366
WBØRCQ	103/241	Cypress (Florida)	149/357
KH6EXK	10/29	Bartlett Pair (Ill.)	131/340
KH6IJS	4/10	Md. - D.C.	164/338
VE2XL	9/12	Sun Coast (Fla.)	71/169
VE7DEN	57/135	All American City	58/138
TI2WX	110/314	Rio Grande	55/148
LU7FAG	138/386	Devil's Triangle	55/123
JH3GCN	26/51	Gr. Smoky Mt.	35/103
JA3XOG	21/46	New South (Ga.)	43/98
		Red River Valley (La.)	35/95

CLASSES:
Single operator up to 100 Watts input; single operator over 100 Watts input; multi-operator single transmitter (any power); SWLs.
EXCHANGE:
RS(T) and QSO number.
SCORING:
QSO points as follows: own country = 5 points; other country in same continent = 10 points; other continent = 15 points. In USA, Canada, and Australia, each call district will be considered as a separate country. The same station may be worked once on each band but only RTTY QSOs count. Final score is total QSO points times the number of different ARRL countries and W, VE, and VK call districts on each band. SWLs use the same rules for scoring based on stations and messages copied.

AWARDS:
Awards will be issued to the top stations in each class, country, W, VE, and VK call district.

ENTRIES:
Mailing deadline is Sept 18, 1976. Logs must contain: band, date and time in GMT, callsigns, exchanges sent and received, points, and multipliers. Use a separate sheet for each band and enclose a summary sheet showing the scoring, classification, your call, name and address. Comments will be very much appreciated. Send your log to: SARTG Contest and Award Manager, C. J. Jensen OZ2CJ, Meisnersgade 5, 8900 Randers, Denmark.

RESULTS

Results of 8th Giant RTTY Flash Contest
The top 10 scorers of the 51 entries:

Call	*Score*
I1BYS	13,379.542
K4GMH	8,528.384
W3EKT	8,933.145
DLØTD	5,128.512
WA2JVB	3,879.288
G3VXO	3,663.900
I6NO	2,898.135
WAØYDJ/4	2,502.162
SMØOS	2,086.080
K7BV	1,986.944

The 1975 RTTY Championship was won by I1BYS with 120 points, while W3EKT finished second.

NEW JERSEY QSO PARTY

Contest Periods:
2000 GMT Saturday, August 21 to 0700 GMT Sunday, August 22
1300 GMT Sunday, August 22 to 0200 GMT Monday, August 23

The 17th annual NJ QSO Party is again sponsored by the Englewood ARA. Phone and CW are considered the same contest. Each station may be contacted once on each band, and phone and CW are considered separate bands. Duplicate QSOs may not be made using bicentennial calls! NJ stations may work other NJ stations. General call is: "CQ New Jersey" on phone or "CQ NJ" on CW. NJ stations are requested to identify themselves by signing "DE NJ" on CW or "New Jersey calling" on phone. Stations planning active participation in NJ are requested to advise the EARA by August 7th, so that full coverage from all counties may be planned. Portable and mobile operation is encouraged.
FREQUENCIES:
1810, 3535, 3905, 7035, 7135, 7235, 14035, 14280, 21100, 21355, 28600, 50-50.5, 144-146. Suggest phone activity on even hours; 15 mtrs on odd hours (1500 to 2100 GMT); 160 meters at 0500 GMT.
EXCHANGE:
QSO number, RS(T), and QTH — ARRL section or country. NJ stations will send county for their QTH.
SCORING:
Non-NJ stations multiply total number of QSOs times number of NJ counties worked (21 max.). NJ stations: W and VE QSOs count 1 point; DX stations count 3 points. Multiply total number of QSO points times number of ARRL sections (including NNJ and SNJ — 75 max.). KP4, KH6, KL7, KZ5, etc., count as both 3 point DX contacts and as section multipliers.
AWARDS:
Certificates will be awarded to the first place station in each NJ county, ARRL section, and country. In addition, second place certificates will be awarded when 4 or more logs are received. Novice and Technician certificates will also be awarded.
ENTRIES:
Logs must show GMT date and time, band, and mode, and be received not later than September 18, 1976. The first QSO for each claimed multiplier should be indicated and numbered, and a checklist of contacts and multipliers should be included. Multi-operator stations should be noted and calls of participating operators listed. Logs and comments should be sent to: Englewood Amateur Radio Assoc., Inc., 303 Tenafly Road, Englewood NJ 07631. A #10 size SASE should be included for results.

ARIZONA QSO PARTY

Starts: 1700 GMT Saturday, August 28
Ends: 1700 GMT Sunday, August 29

The full 24 hour contest period may be worked. All stations are eligible to enter. Out-of-state stations work AZ stations; AZ stations work all stations. Stations may be worked on both phone and CW once per band on 80 to 10 meters. All stations are encouraged to use bicentennial callsigns.
EXCHANGE:
RS(T) and QTH; AZ county for AZ stations; state or country for non-AZ stations.
SCORING:
All stations score 1 point per SSB QSO, 2 points per CW QSO, and 4 points per Novice QSO. There are 2 scoring categories for AZ stations: single and multi-op. AZ stations operating outside their home county receive a bonus of 50 SSB QSO points. AZ stations multiply QSO points (plus any bonus) by the number of states/VE provinces/DX countries worked. Non-AZ stations multiply total QSO points by the total number of AZ counties worked on each band (14 max.).
FREQUENCIES:
Phone — 3935, 7235, 14285, 21360, 28575; CW — 3560, 7060, 14060, 21060, 28060; Novice — 3725, 7125, 21125, 28125.
AWARDS:
Certificates will be awarded to the top 3 AZ stations and to the top station in each state/VE province/DX country. A minimum of 5 QSOs is required to be eligible for an award. Include a description of all equipment used and the usual signed contest declaration. Include a legal size SASE for a copy of the results and any award. All logs must be postmarked on or before Sept. 30, 1976. Send all entries to: Motorola Amateur Radio Club, 8201 E. McDowell Rd., Scottsdale AZ 85252.

ALL ASIAN DX CONTEST

CW
Starts: 1000 GMT August 28
Ends: 1600 GMT August 30

All amateur bands under 30 MHz may be used with power, mode and frequencies as permitted by station license. No crossband contacts are allowed. Entry classifications are: single operator-single band (each band), single operator-multiband, and multi-operator multiband. Single operator entries cannot have more than one signal on the air at a time, while multi-operator stations cannot have more than one signal on each band at a time. General call is "CQ AA" for non-Asians and "CQ TEST" for Asians. Non-Asian stations contact only Asian stations.
EXCHANGE:
For OM stations: RS(T) and 2 digits indicating operator's age. For YL stations: RS(T) and ØØ.
SCORING FOR NON-ASIAN STATIONS:
Count 1 point per Asian contact. Multiplier is number of different Asian prefixes worked on each band. Contacts with KA stations are not eligible, since they are considered military stations and not amateur stations. Final score is sum of QSO points times the sum of the multipliers on each band.
AWARDS:
Various awards will be awarded the highest scorers in each category in each country and US call area, depending on the number of entries.
ENTRIES:
Submit a copy of your logs and a summary sheet no later than November 30, 1976, to: JARL, P.O. Box 377, Tokyo Central, Japan. Logs must show date and time in GMT, station worked, report sent and received, multipliers and points. Use a separate log for each band and include your callsign. Summary sheet should show name of contest, entry classification, callsign, operator class, country, address and name, site of station if mobile or portable, station details, comments, and signed declaration. Also, include a table showing number of QSOs, points and multipliers per band. At the bottom of the table show totals along with final score. Violation of the contest rules, false statement in report, or taking credit for excessive duplicate contacts may be cause for disqualification. Results will be announced about April, 1977. Include one IRC and an SASE with your logs to receive a copy of the results.
COUNTRIES LIST OF ASIA: A4, A51, A6, A7, A9, AP, BV, BY, CR9, EP, HL/HM, HS, HZ/7Z, JA/JE/JF/JG/JH/JI/JJ/JR, JD1 (Ogasawara Is.), JT, JY, OD5, S21, TA, UA/UK/UV/UW9-Ø, UD6/UK6C,D,K, UF6/UK6F,O,Q,V, UG6/UK6G, UH8/UK8H, UI8/UK8A-G,I,L,O,T-Z, UJ8/UK8J,R, UL7/UK7, UM8/UK8M,N, VS6, VS9M/8Q6, VU, VU (Andaman and Nicobar Is.), VU (Laccadive Is.), XU, XV, XW8, XZ, YA, YI, YK, ZC4/5B4, 1S (Spratly Is.), 4S7, 4W, 4X/4Z, 7O (S. Temen), 7O (Kamaran Is.), 8Z4, 9K2, 9M2 (W. Malaysia), 9N1, 9V1 (Singapore), (AbuAil).

TU-BORO FAST SCAN ATV CONTEST

On October 3, 1976, the Tu-Boro Radio Club will sponsor a fast scan ATV contest on 439.25 MHz. Any station working three or more Tu-Boro members will receive a certificate suitable for framing. Stations currently active on ATV who are Tu-Boro members are WB2TCC, W2LXC, WA2WAK, WB2KEK, W2JNU, and WA2NXB. All correspondence should go to: Tu-Boro Radio Club, 149-14 14th Avenue, Whitestone NY 11357. The time of the contest is from 9:00 am to 11:00 pm.

Continued on page 21

Open and shut case...

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solid state rf power amplifiers

talk farther...
sound better...
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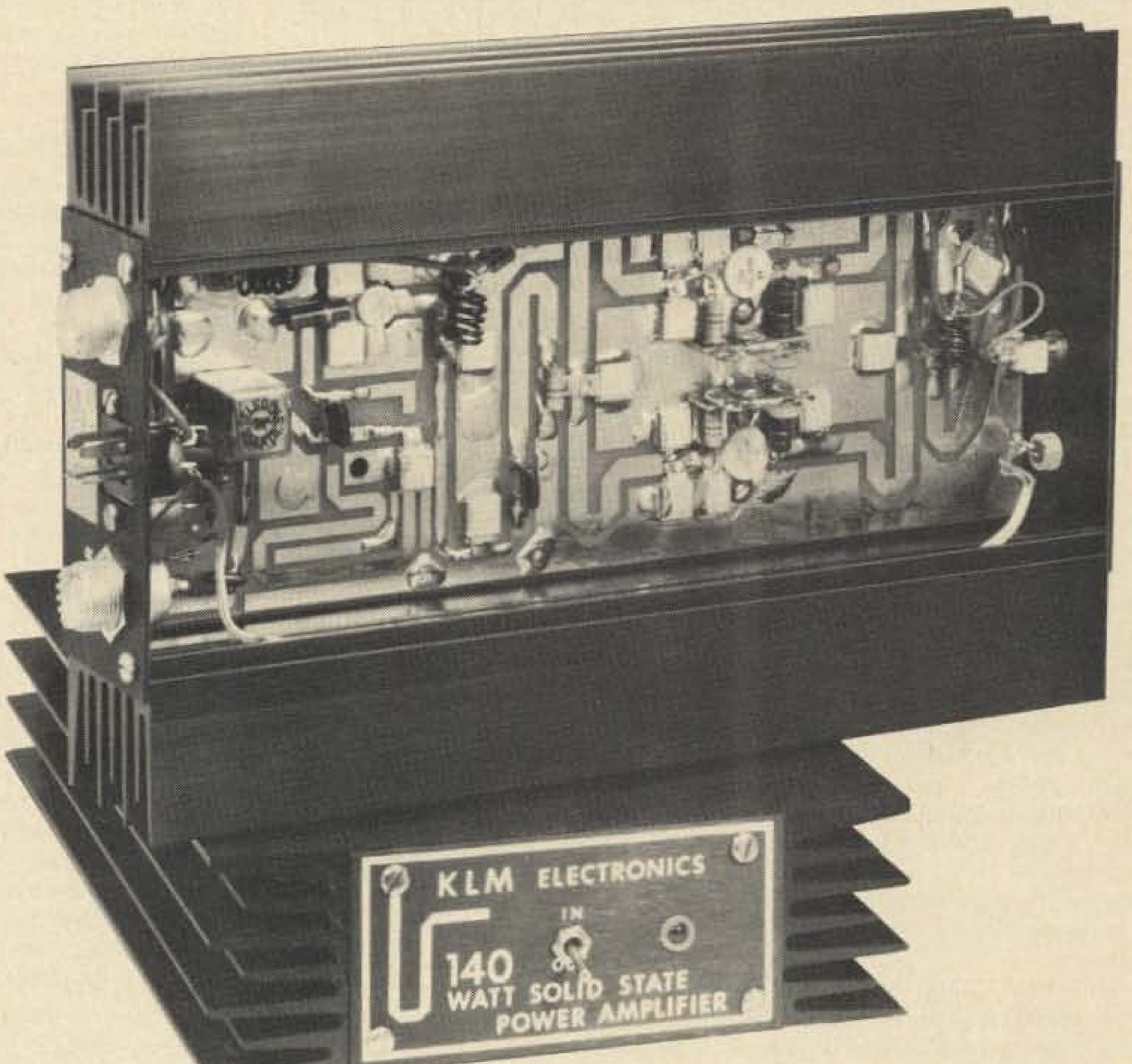

FREQ. (MHz)	MODEL NUMBER	PWR INP. (watts)	NOM. PWR OUTPUT (watts)	NOM. CUR. (amps.)†	SIZE	PRICE
144-148	PA2-12B	1-4	12	2	A*	44.95
"	PA2-70B	1-4	70	10	C*	149.95
"	PA2-70BL◇	1-4	70	10	C*	159.95
"	PA2-140B◇	1-4	140	20	D*	219.95
"	PA10-40B	5-15	40	5	B*	79.95
"	PA10-40BL◇	5-15	40	5	B*	89.50
"	PA10-70B	5-15	70	8	C*	129.95
"	PA10-70BL◇	5-15	70	8	C*	139.95
"	PA10-80BL◇	5-15	80	10	C*	149.95
"	PA10-140B	5-15	140	18	D*	189.95
"	PA10-140BL◇	5-15	140	18	D*	199.95
"	PA10-160BL◇	5-15	160	22	D*	209.95
"	PA30-140B	15-45	140	15	D*	169.95
"	PA30-140BL◇	15-45	140	15	D*	179.95
219-226	PA2-70BC	1-4	70	10	C*	169.95
"	PA10-60BC	5-15	60	8	C*	149.95
"	PA30-120BC	15-45	120	15	D*	189.95
400-470	PA2-40C	1-4	40	7	C*	149.95
"	PA10-35C	5-15	35	6	B*	119.95
"	PA10-35CL◇	5-15	35	6	B*	139.95
"	PA10-70C	5-15	70	13	D*	225.95
"	PA10-70CL◇	5-15	70	18	D*	245.95

SIZES: Inches: ***A.** 2.25×5×2. ***B.** 6.5×5×2. ***C.** 6.5×7.5×2. ***D.** 6.5×10×2.
MM: 57×127×50.8 165×127×50.8 165×190×50.8 165×254×50.8
◇LINEAR AMPLIFIER †At 13.8VDC.

Choose an amplifier from this big line that exactly meets the requirements of your particular transceiver. Boost power a mere 4 or 5 times... or 20 times... or more! Select a Class C amplifier for FM/CW or one of the versatile "linears" that operate on SSB **plus** FM and CW.

These fine amplifiers are All-American, lock, stock and barrel! The all-important RF power transistors are highest quality, "brand" types for utmost reliability and years of service. They are emitter balanced and protected against high VSWR, short and open circuits. For your added assurance, every amplifier carries a 90 day warranty on all parts and labor.

KLM engineering advances include microstrip circuitry for **no-tuning**, broad band operation, 144-148MHz (plus MARS) for VHF amplifiers, 400-470MHz for UHF models. Circuitry is rugged, stable, ideal for tough mobile use. Drive requirements (column 3 on the accompanying chart) are easily met by most transceivers.

Simple to install. Just co-ax connect between antenna and transceiver and to 13.8VDC power source. No internal connections or alterations. The internal RF sensing or remote amplifier keying circuitry provides the automatic or manual T/R function. Put the amplifier on automatic standby or out of the circuit with the panel switch.

At your dealer. Write for descriptive brochure.

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NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

from page 4

The fact is that it will permit you to get on the air . . . with low power . . . in a crowded band . . . using code only . . . usually with poor equipment which even an expert would quickly throw aside. No wonder such a small percentage of Novices stick it out.

Like it or not, darned few people get into amateur radio with the idea of making CW contacts. They want to talk on phone and they deeply resent CW as an abomination jammed down their throats. I suspect we would have ten times as many CW ops . . . and happy ones . . . if CW were optional, not required by law.

So what do I suggest? Well, when us doddering oldsters got into hamming, we started right out with 13-per and our first ticket permitted phone operation. We made it all okay and the percentage of increase of hams was better than it is today with the Novice starter system. I propose that a few clubs stop trying to con people into that Novice business and get them immediately into a General Class license. It'll take a little bit longer, but I think we'll have a lot more hams as a result.

How much longer will it take? I'd sure appreciate it if a few clubs would run some tests with their classes. I suspect that it won't take a lot longer to learn the code at 13 words per minute than 5. That seems impossible? Well, please remember that most people have been learning the code the worst possible way for many years . . . starting off slowly and then relearning it again and again one speed after another . . . each time having to train their brain to recognize the different sound patterns. The *73* code cassettes start right out with each character at 13 words per minute, right from the first introductory tape. From there it is not much more difficult to go immediately to the 13 per tape than it is to the 6 words per minute tape . . . each has all characters sent at 13 wpm.

Several fellows came up to me at Dayton and said that they had tried going directly to 13 per and had found little problem with it. They said that they had found it startling at first to only recognize a few characters, but that the rest of them quickly clicked into place, and before they knew it they were copying at 13 per. The *73* tape is so merciless that they could copy straight text at 15 per with solid copy . . . and the FCC 13 wpm test sounded slow to them.

How about it fellows . . . let's try some General classes for beginners and see what happens . . . if it works we might just dump that Novice ticket entirely. I think we'll get a lot more enthusiastic hams out of it.

BETTER OPERATING

An article was submitted recently which made fun of the ham operator who makes long and repetitive transmissions. Talk about shooting fish in a rain barrel!

Since I don't think that making fun of the mentally retarded is fair game, I returned the article . . . but not without wishing that someone would come up with some good ideas on how to improve the quality of the average ham contact. As a major offender in this matter, I think I can speak with authority.

When I'm trying to drive and talk over the radio at the same time, both suffer . . . a lot. I don't think I'm unusual in this, judging from what I hear coming through over the repeaters. My friends credit me with being a wit . . . my detractors give me at least half that much credit . . . so when my wits (what there are of them) are further split by the demands of trying to control my car careening down the road, watch for fuzz, keep one ear on the CB for Smokey reports, and not totally ignore my passenger, I end up with a hemi-demi-semi-wit on the repeater. I am not alone.

Let's do what we can, in spite of the odds outlined above, to encourage better operating. In particular, there are four things that we can try and watch for in our own transmissions: excessive repetition, trite phrases, ham language, and an obvious lack of anything whatsoever to say.

Excessive repetition encompasses such boring things as repeating anything twice when you know your signal is solid copy. You know how you hate it when someone keeps telling you he is going to sign off. Take a big clue from the CBers on this one . . . when they say they are gone, they are really gone. Some ham contacts go through a dozen or more final transmissions.

There are a few ops who are unable to call a spade a spade . . . they have to call it a digging implement. They don't go to the doctor, but to the sawbones. They modulate the mattress, see you down the log (what log?), and in general speak a very weird language, little of which is clever or original. Many of us get into the habit of using ham terms a lot more than is necessary, forgetting that there may be a bunch of non-hams listening to us who perhaps don't know our codes. It is not much more difficult to say we are going to change channels than to say we are going to QSY. Or that we are going to shut down instead of QRT . . . etc. You get the picture.

A little listening to the CB channels may convince you of the sterling qualities of the English language. You have to learn a whole new vocabulary to talk CB . . . kind of like learning Swahili (and not much more difficult). The CB Swahili is just an exaggeration of the bad habits we've gotten into on amateur radio.

Just a thought.

CLUB PROGRAM

One of the most important factors in holding a ham club together is an interesting program. Experienced club officers know that one of the surest ways to kill off a club is to permit business meetings to take up too much of the meeting time . . . members get all wrapped up in the hassle over whether to paint the clubhouse or not, but somehow they forget to come to meetings after that. Club members want to be entertained, and if you don't provide the entertainment, television will.

A talk by a manufacturer on his ham product is one of the best drawing cards for club programs. Unfortunately, these chaps are spread out all over the country, and there are seldom more than one or two available in any one area, so clubs quickly run out of ham-oriented speakers.

In order to make talks by ham manufacturers available to clubs and thus perk up the club programs, I am going to get them to put their talks on tape and I will send you a cassette tape of their talks. Once I get this thing going, I hope to have one or two half hour tapes available every month . . . and at no cost to you. The manufacturer is trying to sell you his products, so we'll let him foot the bill.

It is terribly difficult to get much information about new products. The ads don't tell very much . . . and neither do most of the product reviews. The one person who really knows the product is the manufacturer, and he is obviously the one we want to hear talk about his product. I will caution him that self-serving puffery will be transparent, and that if he really wants to get our confidence he'd better level with us. Since we can logically expect more than a little bias I suspect that a clever manufacturer will bend over backwards to make sure his talk has credibility.

If your club would like to get these tapes, all you have to do is get your secretary to send a card or letter letting me know how often you meet (like monthly), approximately how many attend meetings (in case there are flyers to go with the talks), the name of the club, and the address to which to send the cassettes and flyers (if any). You might let me know if you would prefer one half hour talk or two. Send that to *73* Club Programs, Peterborough NH 03458.

A CB AD IN 73? WHAT NEXT?

There are a lot of good reasons why every one of us should be active on CB these days, and darned few good reasons for avoiding CB. Yes, I know all about the bad language, the terrible things that have happened on CB . . . but I also know that much of that is past history. Another thing I know is that our own hands are not clean . . . we've had a bunch of the foulest language you can imagine jamming some of our service nets and locking up some of our repeaters. No, we can't come on as Mister Clean. You should see the mail I've gotten regarding the Eddy Palmer situation down in Tennessee!

We amateurs can do a lot of public service via our two meter repeaters and service nets, but by hooking into the biggest net of them all – CB – we have even more ears. I, for one, like to know where Smokey is lurking, but even without that benefit I wouldn't be without CB these days. Once you get off the truckers' (19) channel you can get into interesting and intelligent (at times) conversations with people who talk English. And if there are any road problems ahead, you will know about them in plenty of time to take evasive maneuvers. I managed to find a back way into a shopping center just before Christmas when the main roads leading into it were backed up for miles. I've avoided a lot of traffic snarls and accident scenes by keeping my CB set on channel 19. I've reported local accidents to the police via CB which otherwise I would have had to call in via long distance through repeaters.

But perhaps most important of all, I have a lot of fun telling CBers about amateur radio. I start talking with them as I drive along and soon they want me to stop and show them an HT with a touchtone pad on it or my two meter FM radio. They get all dazed at the ranges we consider normal on two meters, and when I tune in some DX for them on 20m they are almost stupified. Few of the really active CBers refuse to take the bait. They want to know about hamming; most of them have heard about it and they really want to know. Tell them. Get them into your club classes. You can't hook 'em if you aren't on there.

There are a lot of good CB rigs on the market and there are some real dogs. We're busy testing out as many as we can get here at *73* so we can let you know which seem to be okay. The other day, when I was visiting the FCC in Washington, they had just completed some tests of CB rigs in their labs and they were astounded at how dirty some of them were . . . putting out crud over a wide range of frequencies. I think you'll see some action from the FCC on this before long.

The CB gang almost got a bunch of extra channels. It was all set to go through. As I understand it, someone up at E. F. Johnson had his thinking cap on and wondered what would happen if two mobile rigs were on at the same time in close proximity and 455 kHz apart . . . wouldn't this raise hell with the broadcast i-f channels of AM radios and CB sets? A few tests showed that this was indeed true, and the okaying of the band expansion was halted at the last minute, probably staving off a disaster of enormous proportions. We think we have intermod problems on two meters!

If any readers have good factual data on which CB rigs are the best, we're interested . . . write an article. We don't want to turn even a part of *73* into a CB magazine, but since hams are looked upon as communications experts, we do have a responsibility to let you know what is what. I don't want you to be in the position I was in the other day when a chap wandered into the *73* offices and wanted to know where he could find out what CB rig was good. I thought it over for a while and had to admit that I had no answer for him. The CB magazines are no help. Neither are any books I've seen. Hmmm. Let's get that info out where it can do some good.

NEW MAGAZINE SIZE BOOMERANGS

Let's take a short trip back through memory lane . . . just a year ago when *QST* announced the new size magazine which would save thousands of dollars in publishing costs. My answer was baloney — a larger magazine takes more paper and that means more cost. I wrote this at the time and got a lot of flack from brainwashed ARRL members who believed *QST*.

So here we are a year later and the proof is there for anyone who *can* see to see. *QST* has met the increased costs in two ways. One, they've shrunk considerably in the number of pages . . . it was 34% thicker last year. Secondly, they've gone from about 30% ads to 50% advertising! Last year they had 85% more pages devoted to other than advertising . . . 130 pages last year to about 70 this year!

When costs go up, a magazine has to either raise advertising rates or else run a higher percentage of advertising. *QST* has done *both*. The costs of publishing *73* have gone up with the increase in size, just as I said they would . . . from about $36,000 per month last year to $56,000 a month this year. We've increased our ad rates and kept the percentage of advertising unchanged from last year.

I predicted that the costs of publishing the ham magazines would go up and that it would be the readers who would pay . . . through higher prices for ham gear which would result from the higher ad rates. Just you watch the prices of ham gear this summer and fall and then tell me that I was wrong. I hate being wrong.

MAKE A BUNDLE

How would you like to make $50 to $300 a month for a couple days of work? With the increased interest in amateur radio and *73 Magazine* resulting from the CB explosion, there is a big need for *73* to be distributed on the newsstands. If you would like to become a *73* regional newsstand distributor you might be able to make a nice extra bit of money.

Distribution in the newsstand field is set up with regional wholesalers, each of which services a hundred or so newsstands. These chaps handle so many magazines that most of them don't want to be bothered with a new one . . . particularly one of such esoteric interest as *73*. They prefer to deal exclusively with national distributors so they get their magazines in large bunches and have just one set of forms to fill out for a large number of magazines.

After trying two different national distributors and finding ourselves fairly well convinced that this was a bad way to do business, we have cancelled our national distribution sales contracts and are working via local wholesalers exclusively.

If you would like to be considered as a local wholesaler, please drop our Marketing Manager Sherry Smythe a note and tell her what area you want to cover, how many newsstands you would service, and about how many copies you would like to start with. You only have to pay for sold copies, so you can't lose.

How do the economics work? You buy copies for 75¢ each and sell them to the newsstands for $1.00. They sell them for $1.50, making a 50% profit. You make 25¢ for each copy sold. Thus you make $25 for each hundred copies sold in your area. You have to go around once a month and deliver the new issues, pick up the unsold issues, and collect for those sold. It's fun and it's profitable. And who knows, once you have the route set up and your contacts, you might want to try handling a few more magazines . . . at least until your spare time is used up. The deliveries can be made evenings and Saturdays . . . records can be kept evenings. And who couldn't use a few hundred extra dollars a month?

Write Sherry Smythe, *73 Magazine*, Peterborough NH 03458.

WRITE AND GET RICH!

For years I've been bumbling along, vaguely aware of a problem, but not coming up with a solution. Now I think I've got a splendid plan which will help everyone involved.

The other day I was talking with a manufacturer. He was griping because I ran a picture of a competing product as an illustration in an article. What made the situation really bad for him was that we were running his ads and not those of the competitor. He was aggrieved . . . and I would have been too were I in his shoes.

My suggestion was that instead of hassling me about it, he should make sure that I had plenty of photos of his products on hand. I reminded him that I had visited his plant and asked that he send pictures for just this use, but had not yet gotten anything. I further pointed out that since his product was a most interesting one, he could do a lot worse than have a writer prepare an article or even a series of articles about the products he was making. These articles should discuss the design philosophy, the uses, the benefits to the user . . . and in general tell everything possible about the product.

The manufacturer liked the idea, but said he had no one on his staff who could write these articles . . . and didn't even know anyone who could do the job . . . who would I suggest? I pulled a name out of the hat and he is going to contact the writer. Hopefully the result will be a very interesting series of articles . . . absolutely pure gold sales literature in reprints . . . and a writer who has made a big bundle writing on contract for the firm.

Though I have more than enough to do without getting into the manufacturer-writer marriage business, I will be glad to help writers contact firms who need material prepared. And vice versa.

There is no question that such articles are wanted . . . every time I do get one, the reader response is most gratifying. The big problem is getting the articles written.

If you are a *73* writer you might take a good look at any relatively new piece of equipment you've been using and get in touch with the manufacturer to see if he might be interested in underwriting an article on the unit for submission to *73*. I don't guarantee publication, naturally, but you know that I am hot for such material and if it is at all usable you won't be able to keep me from grabbing it.

One word of warning to both writers and manufacturers . . . no one truly believes that any equipment is perfect, so be sure to emphasize the good points and mention the drawbacks . . . it will make for a lot more reader credibility and, in the end, result in a lot more sales.

There is a great temptation to try and shush problems . . . like the early Clegg miseries with LEDs burning out. They burnt out one right after the other, and after a few days you couldn't tell what frequency was being read out. Sure, they solved the problem . . . but they missed a lot of PR and attention by not making a big deal out of the problem and the solution.

I think that a good writer could make a lot of money writing for the manufacturers. A big firm should be able to pay $500 to $1000 for a good article, and a writer can easily turn out a dozen of those a year in his spare time. Even at today's inflated costs that is a nice bit of change.

The field is not restricted to ham gear either . . . I know that I'm interested in material on equipment of interest to the ham, the experimenter, the computer hobbyist, and even the CBer. We've got some CB plans ahead and want to get ready for that, whether it be a series of books or a magazine.

FCC'S 5 WPM!

I've mentioned this before, but a lot of amateurs have missed it . . . and a letter from a reader in Kentucky brought it to mind . . . when you go to the FCC to take a 5 wpm test you'd better be able to copy each character at 13 wpm with the spacing between characters at 5 wpm. This is the way you are taught on the *73* code tapes, by the way, so if you find yourself called down to the candy factory for a retest, get hot with the #6 cassette.

THAT FEBRUARY COVER

Here's a picture of a Star Trek communicator as built by Ron Dodge WBØIHR of St. Paul MN and on demo by Jane Skeil. Ron and Jane were using it to beam down to the Dayton Hamvention (photo by W2NSD/8).

New Products

YAESU FT–221
2M TRANSCEIVER
Fred Goldstein WA1WDS

What's more fun than a barrel of crystals, more powerful than a smoking HT, more useful than a box of 6146s, and has a handle? If you're interested in getting on two meters in style, the Yaesu FT-221 will fill the bill handily.

The FT-221 has complete band coverage, VFO or crystal-controlled, on FM, SSB, CW and even AM. Output on SSB is 20 W PEP; on FM and CW it's 10-14 W. It's easy to operate, since all circuits are either internally compensated by the band switch or broadbanded. Full output is thus achieved across the whole band, which is tuned as eight 500 kHz segments.

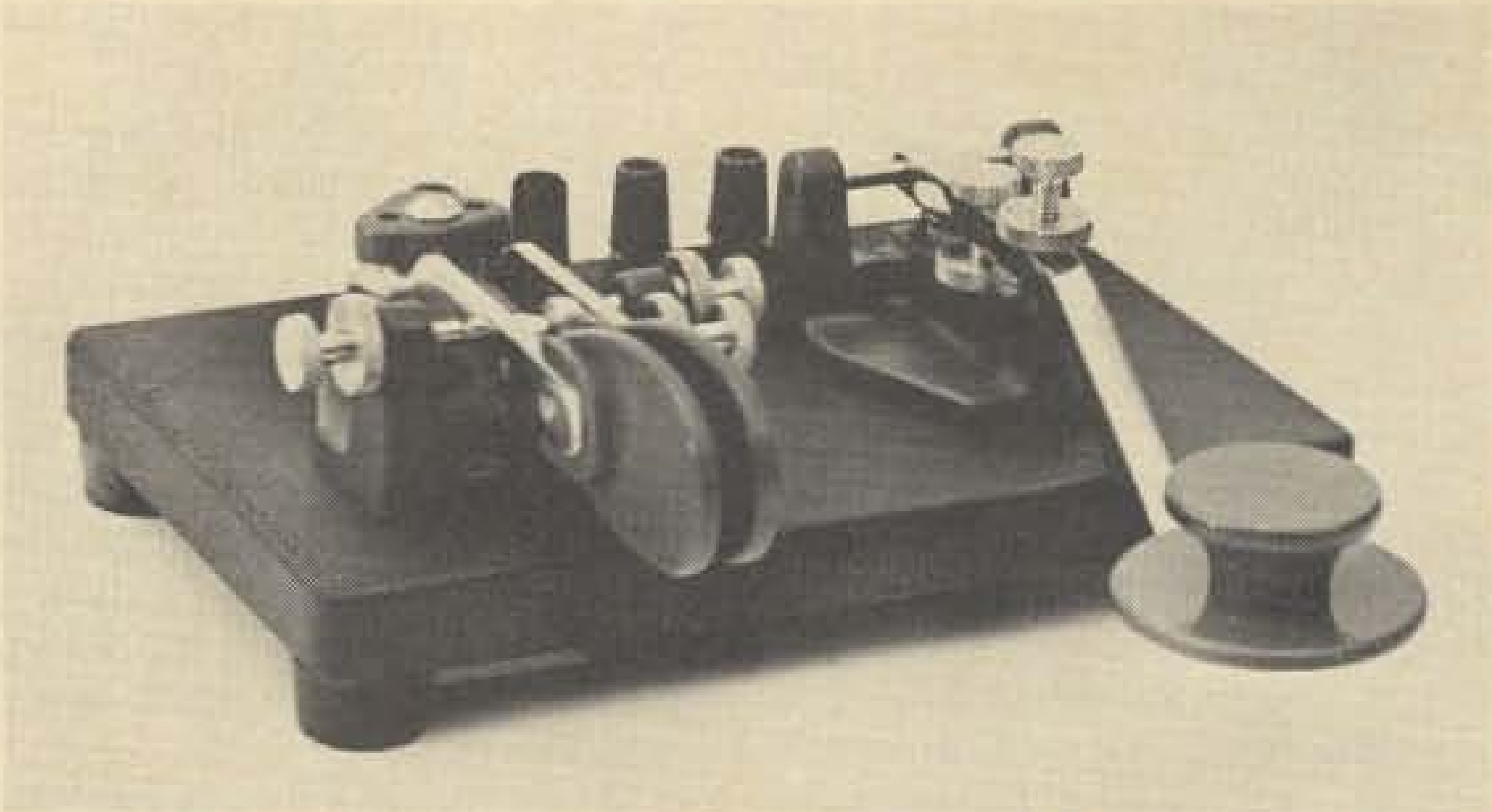
Until you try it, you might think eight band segments is too many. But virtually all SSB is within 25 kHz or so of 144.110 and 145.025, except for the OSCAR segment. Repeaters are tuned only from 146.5 to 147.5, so you can switch from 146.79 to 147.30 without having to tune the dial more than 10 kHz. 600 kHz offset is automatically provided on those two segments. A reverse switch inverts the operation, for California plan split-splits or just working inverted on a repeater pair. That's the best tool for catching Touchtone Tommies if you have a beam.

Among the other handy features are the front panel mike gain control and the built-in tone burst. Construction is modular, using computer cards that come out for repair or maintenance. The internal adjustments are right on top of the cards, for easy access. And the dial drive is a smooth dual-speed unit.

The circuitry shows that good engineering went into the rig. The receiver uses an FET preamp and mixer, feeding a 10.7 MHz crystal filter. For SSB, a noise blanking gate (very effective if you operate SSB mobile) precedes a sharp lattice filter and the i-f strip. The FM i-f is separate, using a second conversion to 455 kHz and a Murata F filter. Selectivity is excellent. The s-meter is fixed to the SSB i-f, so a carrier reading indicates that you're tuned into the repeater. The meter can also be switched into a center-tune position. On transmit, it indicates relative output.

Local injection is provided via a phase locked loop that mixes the crystal band segment oscillator with the VFO or channel crystal (8 MHz). The VFO is not multiplied, so there is very little drift. The PLL keeps the spurs and images down better than a bandpass mixer.

The result of all this circuitry is top performance. The receiver hears only what it's supposed to hear, and hears it well. The transmitter sounds fine. Most 2 meter radios are prone to intermod, so I took the FT-221 to the top of Pack Monadnock – a heavy duty rf zone. While the Brand X radio in the car was deluged by garbage all over the band, the Yaesu was clean as a whistle. I had a nice chat on SSB with a station in New Jersey, which gave me an S9 report. Not bad for twenty Watts and a five element hilltopper beam. Unfortunately, there's not much SSB activity yet up here in the sticks, so it helps to make skeds. But that should change soon as more people discover that SSB is at least as good on VHF as it is on the "dc bands" – especially with radios as good as the FT-221.



STRAIGHT KEY OR DUAL LEVER PADDLE?

The choice is yours with Ham Radio Center's Model HK4. Here's a double threat with both weight enough to stay put and velvet smooth action. All plastic parts are of high impact styrene, and the red plastic and black crackle finish really catch the eye. The color-coded binding posts make the unit idiot-proof. It's a joy to operate, with provision on the paddle for wide or close finger spacing. At $44.95, delivered, it's indeed that rarity in today's market – a bargain. *Ham Radio Center, Box 28271, St. Louis, MO 63132.*

STANDARD HORIZON 29
(see page 65)
Wayne Green W2NSD/1

Normally I wouldn't rush into *73 Magazine* with a big write-up on a new CB rig . . . but these are not normal times.

It should come as no great surprise to *73* readers that I've been active on CB for a couple of years now . . . even to the extent of getting a license, so you *know* I must be quite active! During all this time I've been using a very well-known brand of CB rig . . . one with an excellent reputation.

One of the bigger favors done to me recently was the theft of this fine rig. I came back from the computer convention in Albuquerque to find my car at the Boston airport sitting unlocked and my CB rig missing. Thank heavens I'd removed the IC-230 before parking! My stereo tape deck was still there . . . just the CB gone. Zounds! That'll teach me not to have an alarm on my car. I don't need it up in New Hampshire, but down in Boston is something else.

The old rig was a beaut . . . but the noise generated by my car . . . Datsun 280Z . . . was beyond belief and limited my reception to about a mile under good conditions. I found that when I wanted to hear much further than that, I had to speed up the car, turn off the engine, cut off the squelch, and turn up the volume control. Then, when the car slowed down enough to cause a traffic backup, I had to stop trying to hear and turn back the volume, turn up the squelch, and settle for local signals again. You wouldn't believe what a royal pain it was to try and find out about traffic conditions under those restrictions.

Then along came the Standard Horizon 29 rig . . . magically it fit right into the bracket still left hanging under the dash. Between the automatic noise limiter and the noise blanker, my threshing machine car noise was so gentled that I could hear the weak ones out for miles! It brought new life to old Snidely Whiplash, I'll tell you.

And you know how crumby some of the CB rigs sound? Well, I've listened on the other end to my Horizon 29 and it sounds as clear and crisp as you could ask . . . beautiful. It has a gain control built right into the microphone.

The public address part of the unit puts out 10 Watts, enough to be heard by motorists in front of you if you have any well-chosen comments to make . . . perhaps to warn them of a dangling exhaust system, burnt out lights, flat tires . . . or perhaps a helpful comment on their driving skills. It also allows you to monitor your CB when you are out of the car.

The Horizon 29 has one other feature you don't usually find on the smaller CB rigs . . . a clarifier tuning control. This will permit you to tune in any slightly off channel signals and bring them in clearly. It won't help off color channels. This only moves the received frequency, not the transmitter.

While many CB units still use crystals for frequency generation, the Horizon 29 is digitally synthesized, using a phased lock loop (now don't you wish you'd read the articles on PLL?).

About the only serious problem with CB these days is the tendency to get hung up on it and the fun of talking briefly with passing motorists. The other night I was perking along the Connecticut Turnpike, keeping one ear on CB for traffic warnings and having a very pleasant contact over a local 2m repeater when someone came on the channel and was extremely abusive . . . fortunately he didn't identify himself. I retreated to CB and struck up a conversation with someone somewhere ahead of me who was into car rallies. I didn't get back on 2m for an hour . . . and well out of range of WA1ABR.

CB isn't hamming, for the most part . . . it's different . . . and I wouldn't be without either service. I do manage to get in a lot of PR for hamming with CBers . . . because they are interested. Millions of people are just discovering two-way radio and the possibilities for fun it holds . . . the more we can encourage them, the better.

One more thing. While the Horizon 29 allows me to hear a lot further than before, I still have a lot of garbage generated by the 280Z. I'd sure appreciate hearing from anyone who has been able to clean up one of these mobile noise generators.

NEW MACHINE LANGUAGE MANUAL

Scelbi Computer Consulting, Inc., Milford CT, has just published and released a detailed new manual, *Machine Language Programming for the "8008" and Similar Microcomputers.*

According to the authors, this text is an easy-to-read, 170-page basic manual needed to develop today's machine language programs. The illustrated manual covers such areas as a detailed presentation of "8008" codes, flow charts, mapping, a floating-point package, and basic programs, including loops, counters and masks.

Further, there are sections on multiple-precision arithmetic, debugging, organizing tables, editing and assembling, mathematical operations, I/O, real-time programming, maximizing memories plus more. It has been said that the floating-point arithmetic package is worth the price of the manual alone.

Copies of *Machine Language Programming for the "8008" and Similar Microcomputers* are available by sending $19.95 ppd (foreign orders, add $6.00), or using Master Charge, to Scelbi Computer Consulting, Inc., 1322 Rear Boston Post Road, Milford CT 06460.

ALPHANUMERIC TRANSFER SHEET

There is no longer any pen and ink work needed to produce sharp component identifications. Now you can just rub off the designations you need from Trumbull's alphanumeric transfer sheet.

There is no need to hunt from sheet to sheet to match up an alpha designation with a numeric designation. All commonly used components are printed arranged in a/n series (R1, R2, R3 . . . R51, C1, C2, C3 . . . C30, etc.).

Multiple series of each of the above designations are available in each set. Lesser used designations such as CR, J, K, L, P, S, T, TB, TP are in each set but must be used with the multiple numeric series (which are also in the set).

To use, just place your drawing over a hard surface and position the designation. Transfer the designation by rubbing the sheet with a round stylus, such as the cap found on some ballpoint pens. After transfer, cover the pattern with the burnishing sheet and rub again to smooth the pattern down and activate the adhesive.

Two sheets, each containing a complete set of designations, are available for only *$1.25*. Order AN1X from Trumbull, 833 Balra Drive, El Cerrito CA 94530.

ELECTRONIC KEYER

Palomar Engineers has introduced a new IC keyer that takes less space on your operating table than the old semi-automatic mechanical key.

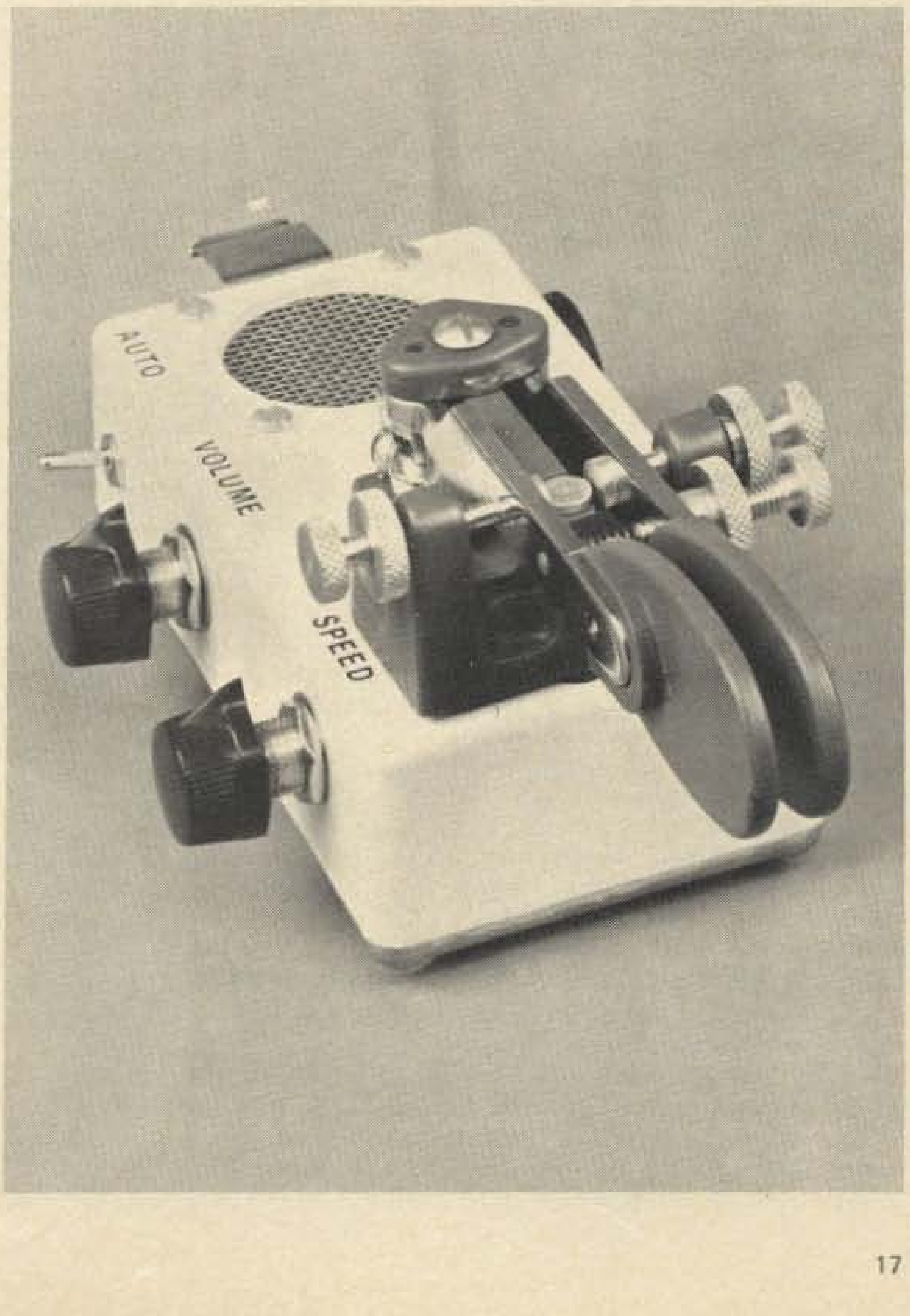
The new keyer sends semi-automatic, full automatic, self-completing, dot memory, iambic, and as a straight key. It has a built-in sidetone oscillator and speaker, volume and speed controls, automatic/semi-automatic switch, weight adjustment and battery holder. Any desired speed from 5 to 50 wpm can be selected while you send. The keyer is easy to learn and easy to use.

The IC keyer will key any transmitter, whether grid-block, cathode-keyed or plate-keyed, up to 500 volts and up to one ampere keyed current. Keying contacts are silver, and withstand heavy surge currents and voltage spikes.

The built-in paddle is fully adjustable for spacing and tension. A die cast metal case provides full rf shielding.

The clip-in 9 V transistor battery will power the keyer for about 75 hours of normal operating, making the keyer ideal for portable operation. At the home station, a lantern battery will last for about two years.

The keyer sells for $87.50 postpaid in the U.S. and Canada. California residents should add sales tax. To order, or for free brochure, write to Palomar Engineers, P.O. Box 455, Escondido CA 92025.



Looking *West*

Bill Pasternak WA6ITF
14725 Titus St. #4
Panorama City CA 91402

"Looking West" is heading east once again for our yearly visit to the homeland and, oh yes, to the Dayton Hamvention. While back there, we hope to have a chance to meet with some of those responsible for the new New York area "Tri-State Repeater Council" and thereby bring you some information as to how they got going and what their plans are for the future. In the meantime, the following release sent to us by Steve Mendelson WA2DHF will probably be of interest to you.

"On December 6, 1975, a formation meeting was held at Rye, New York with ARRL Hudson Division Director Stan Zack K2SJO as the host. Owners/operators from over 100 repeaters were present and agreed on the need for a repeater council to coordinate growth and negotiate disputes in the metropolitan New York, Southern Connecticut and Northern New Jersey area. The name chosen was the Tri-State Repeater Council. An interim board was chosen with Dave Minott WA2EXP President, Derwin Stevens WA2DHA Vice President, Steve Mendelson WA2DHF Secretary, and Sid Lieberman WA2FXB Treasurer. Directors were then chosen by caucus method with the group breaking up into telephone area code divisions.

"An executive meeting followed in the middle of March and a constitution was drawn up to be presented to the membership at the March 20, 1976 regular membership meeting. At that meeting, the board and officers were made permanent, and a 450 MHz band plan was presented. The band plan would have repeaters operating on 100 kHz channels and 50 kHz channels going high in/low out, while allowing repeaters operating on the 25 kHz channels to go either high or low in. As most of the repeaters in the area are low in now, it would allow them to slide down to a 25 kHz channel and cause almost no inconvenience to users now on these systems. This will also allow repeaters in the area to agree with the ARRL 450 MHz band plan, and take that plan one step further with the 25 kHz option. As you know, it is impossible to run a 450 MHz system in the New York City area without a vast amount of desense due to the commercial repeaters coming out low, and the amount of white noise generated by the dense rf population of the city.

"The Council approved the plan and constitution and went on to set up committees to operate within the Council and, as with all organizations, set up a minimal dues structure. The Council welcomes all area owners/operators, and has already served as a means of solving the problems that are generated by operating in a high rf environment. The Council also serves as an informal setting for owners to get together and enhance each other's technical abilities.

"Those interested in applying for membership should write to: TSARC, PO Box 402, Amityville, New York 11701 for information. Or, if in the tri-state area, contact one of the officers of the Council. Our structure also makes provision for membership of those waiting for their repeater license. To those who would want to put up a repeater in the tri-state area, they are requested to contact Duke Harrison K2QPF who has agreed to continue his fantastic job of frequency coordination for the Council."

Speaking for myself, and as one who was deeply involved in that area's "repeater scene" but a few short years ago, I truly welcome the establishment of this new organization. If only it had existed in my time. I have known both Dave and Steve for a long time and sincerely feel that they are the type of technologically competent people to provide leadership — and I wish them and TSARC all the best in coming years. I also wish to thank them for choosing "Looking West" to make their first major national announcement about the formation of TSARC. I consider this an honor.

Now, back home. I had promised to begin covering the WR6ABB/WR6AFR problem and had set the guidelines last month as to how it will be handled due to my involvement with one of the two organizations as a control station for WR6ABB and member of the PARC Executive Board. (See June "LW" for a more detailed explanation.) In short order I received a request for a bit more time from one of the parties and from the SCRA since negotiations are in progress to solve this dilemma. Hence, without all the "answers in hand," I do not feel it would be fair to cover this topic right now, so you might say that I am "copping out" at the moment in deference to all parties involved. Hang tight and in the near future you will have the story in the most objective and credible way it can be presented.

Have you heard the "Dick Van Dyke for Amateur Radio" PSAs on your favorite radio station yet? Thanks to the hard work of Byron Paul WA6RNG, who made the arrangements, and the fine editing work done by Lenore and Bob Jensen, W6NAZ and W6VGQ respectively, these spots tell the public about many of the interesting aspects of amateur radio and the simple way that one can become part of the amateur radio community. If you either work at or own a radio station and can air these PSAs, then a note to Mr. Don Waters, ARRL Public Relations Director at Newington, should bring your station a copy. In the meantime, a hearty thank you to all involved in the project, especially Mr. Dick Van Dyke for making it a reality.

A massive education effort of any sort is only possible if you have the people to train. In the case of amateur radio, one of the best places to find possible candidates is within the ranks of citizens radio operators. To tackle this possibility, an excellent new film is now being produced by Dave Bell W6BVN of "Ham's Wide World" fame. The new film, unlike Dave's previous efforts, is specifically designed to be presented to audiences of citizens radio operators who are interested in taking that "next step" and need the proper incentive. Hosted and narrated by Roy Neal K6DUE of NBC News, the film compares both forms of radio interest as well as explaining the many diverse aspects of amateur radio itself. From Novice operation to DX to repeaters — all important aspects of our hobby are covered, and thanks to Dave's genius as a film maker, covered in a way most enjoyable as well as educational. As to when this film will be ready, I am not sure at this time; however, again a note to Don Waters in Newington can possibly bring more info. I had a chance to meet Don a few weeks ago at an amateur radio PR seminar here in LA, and I am most impressed with the gentleman. He is a true professional doing his best to publicize amateur radio for us. Really enjoyed meeting him. Oops — the title of Dave's film? "Getting Started in Amateur Radio."

While on this topic of PR and the like . . . you have probably noted on the "tube" the myriad of commercials to sell CB equipment. This note is directed to those manufacturers so involved in that advertising. Many of you are involved in the manufacture and distribution of amateur equipment as well as CB gear. With CB expansion, temporarily at least, at a standstill, and the "big city" log jam what it is, and with many of today's CBers looking for "something better," it might be prudent to consider advertising your amateur line in the same way and perhaps become directly involved in the training of amateur radio operators. If the Commission refuses any further CB expansion, then in many areas the CB market will be saturated within a few years. When that happens, new markets will be necessary and it is a smart businessman that looks to the future. A very lucrative market can easily be developed if you have the interest. At least it's worth a thought.

Finally this month, we wind up coverage of the Guatemalan disaster relief effort by amateurs here in the southland and nationwide. I suspect that Bella Russ TG9HS expressed the feelings of her people best in the following message sent via amateur radio to the people of the USA: "This is TG9HS and my message goes to the people of the United States of America. It has been one week since the world stopped; have you heard about it? Every second, every minute that goes by we wonder if we will make it to the next hour. What happened?

"One of the worst earthquakes in world history hit our nation. So far we have counted 20,000 people dead, 50,000 people wounded and 1,000,000 poor people homeless. When and if we ever finish counting, God knows how many will be dead. It all depends.

"We are praying to God to please stop shaking our area. We have a tremor on the average of one every five minutes. Still we are not giving up. We are not defeated. Our people are working hard to help each other. We know it will not be easy, but we will rebuild our country if it takes the last breath of all Guatemalans.

"America, you have felt our despair but you also sense our spirit. Today the people of the United States are showing the true colors of the name compassion. Your help, food, medicines, doctors, nurses and hospitals are arriving in Guatemala and you can ask your newsmen who have seen it. It is being used as fast as it arrives and is being used where it is most needed. And on behalf of my people and government, our sincere gratitude to all of you and especially to your wonderful amateur radio operators who have been in constant communication in our emergency."

It has now been several months since that message was sent from the people of Guatemala to the people of the United States. Still the rebuilding goes on, and one has only to listen to low band QSOs between TG stations and others to realize that amateur radio is still involved in this effort. Though the media gave us little in the way of public recognition, still we, the amateurs of the United States, were there when all else failed, and there to begin the massive aid effort. No, the White House never issued any official proclamation commending our effort, and no one has done a "TV Special" about amateur radio's role in helping the people of Guatemala. I guess we are just not big or important enough for anything like that.

One thing I do know, however. If any disaster ever befalls any nation, and if at any time the need arises to provide communication where all other methods fail, amateurs like you and me will be there, and we will do it again and again. When all is said and done, that's what amateur radio and its people are truly all about. Walk tall, guys and gals; being a "ham" is something to be proud of!

My special thanks to Doug McDowell K4SWJ/6 and Shelly Chelsey WB6KED of the Palisades Amateur Radio Club and Bill Orenstein KH6IAF/6 of CARS for making the tape available from which Bella's message was transcribed.

Continued on page 22

"They don't make 'em like they used to..."

(lucky for you, if your next HF transceiver is a TRITON)

The new ultra-modern fully solid-state TRITON makes operating easier and a lot more fun, without the limitations of vacuum tubes.

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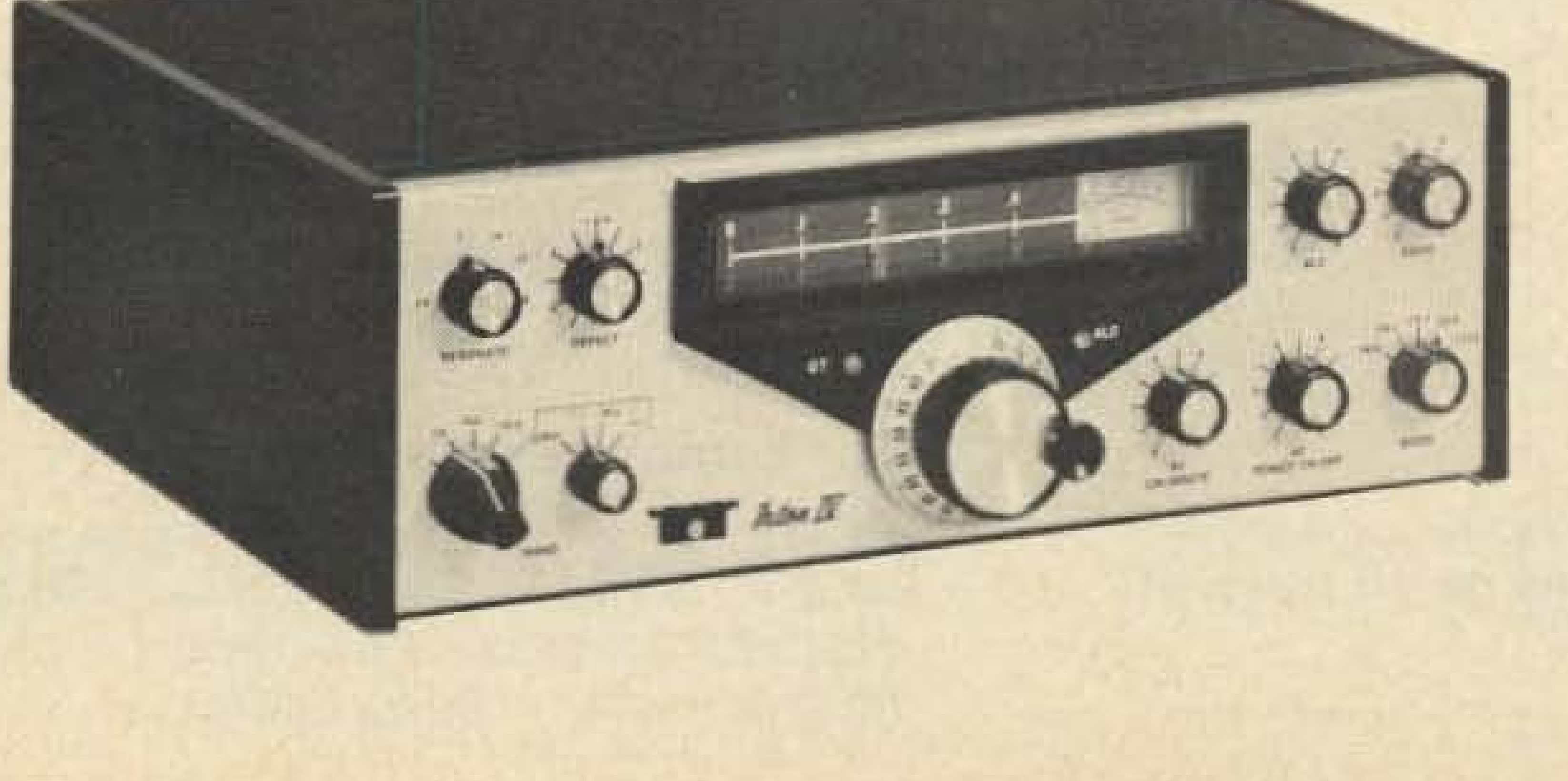

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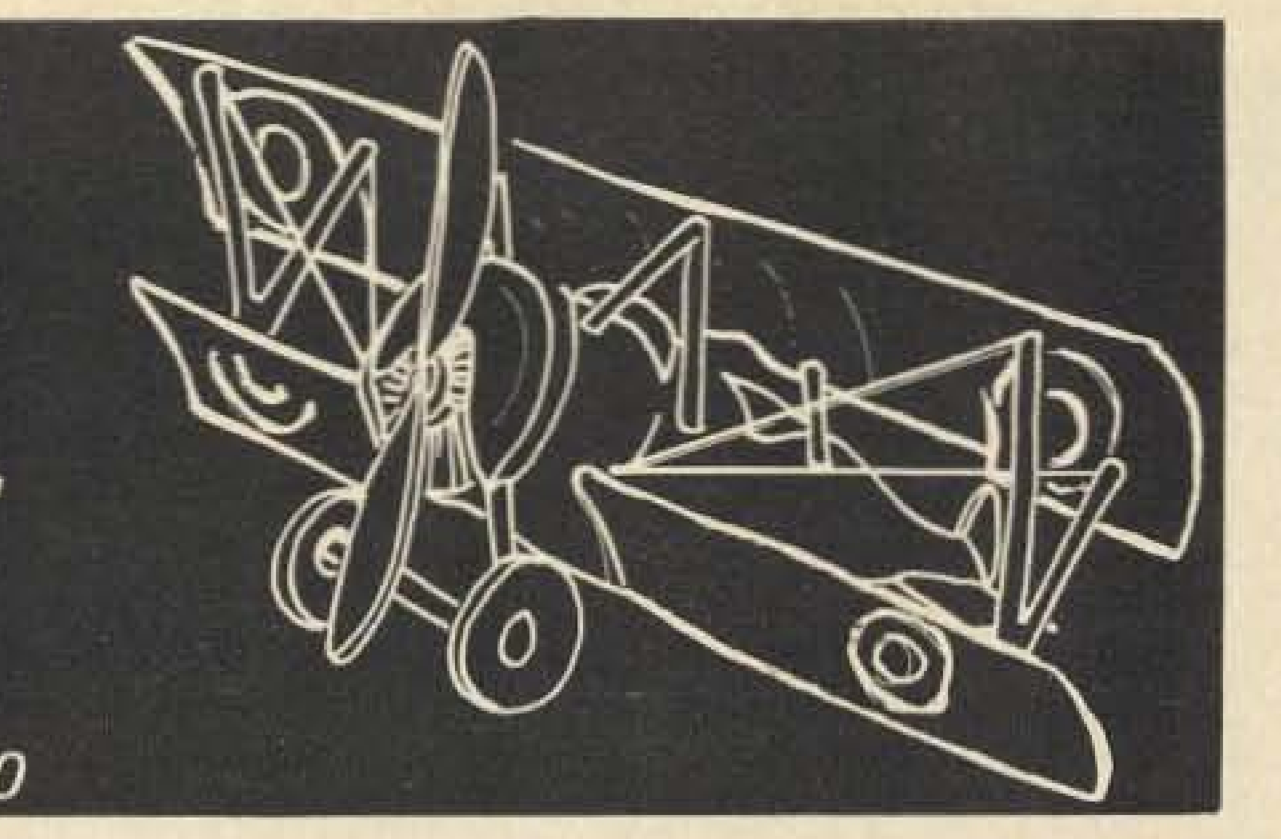
Autobiography of an Ancient Aviator



W. Sanger Green
1379 E. 15 Street
Brooklyn NY 11230

It was a bright, sunny morning in May, 1929. I arrived at Central Airport (Camden, N.J.) at eight o'clock, checked progress of the construction of the two new hangars, and went to my temporary office in the old hangar lean-to. I was looking over the morning mail when Bob Hewitt, manager of the Ludington Philadelphia Flying Service, phoned and asked if I could take a charter trip to Cincinnati that morning. I asked what the nature of the trip was, and he said they wanted to transport a man's body, his widow and two brothers. He proposed to use their Fairchild 71, so I said I'd check the weather and call him back. The Weather Bureau's forecast for the route was good, so I called Bob and told him to send the 71 over to Central from Philadelphia and I'd take the trip. He said he would have the party there by 9:30 and that the Philadelphia undertaker would make arrangements to have us met at Lunken Airport, Cincinnati, at about four that afternoon.

The party arrived at Central on schedule, but when I got a look at the basket the body was in I knew we weren't going to get it in the plane door. So I had them drive the hearse over to the far side of the field where there were no onlookers and I taxied the plane over. We had to take the body out of the basket, tie it in a seat, cover it, load the passengers and take off from there.

The flight was uneventful, weather C.A.V.U., and, after a brief refueling stop at Bettis Field, McKeesport, Pa., we arrived at Lunken Airport at 3:50 that afternoon.

Unloading at Cincinnati was not quite as discreet as our loading at Camden. I turned the ship so that the unloading door was away from spectators and the field personnel managed to keep photographers from taking pictures of the proceedings. Nevertheless, one of the Cincinnati papers carried a story about the "Flying Hearse."

That evening I had a sort of 1922 Cadet Class reunion with John Paul Riddle, "Jiggs" Huffman, and "Dubissary" Harris. They were then pilots on the Embry-Riddle Airline that operated a contract airmail route between Cincinnati and Chicago. In the morning I had a good tail wind, so I was back at Central in time for lunch.

The Jacobs Engine Co. was located at Central Airport, and from time to time I did some test flying for them. One test I'll always remember was when they had mounted a small engine of their own design in an Aeronca Scout single seater. Tom Carrol was their test pilot, but he weighed over 200 lbs. and couldn't get the ship off the ground. At that time I weighed around 140, so Al Jacobs asked me to try it. Early the next morning, when the air was its heaviest, I tried to take the ship off – but it would only get a few feet off the ground. So I taxied it back to the factory and shed all but my shorts. This time we got off and up to a ceiling of about 40 feet, so I made a very wide trip around the field and came in for a full power landing. I guess Al figured that his little engine was only good for lawn mowers. I never heard anything more about it.

My office in the new administration and station building at Central Airport had a large picture window facing the field. One morning I was working at my desk when I happened to notice a small Cessna coming in for a landing. Just as he came over the fence at the far side of the field I thought I saw a large object drop from his plane. He landed OK and taxied in to the line, killed his engine, and sauntered over to the hangar – giving no indication that anything had been amiss. I was so sure I had seen something drop that I went out and inspected the plane. Nothing was wrong there, so I picked up the pilot and drove to the far side of the field. It didn't take long to find a young man lying there unconscious. He seemed to be breathing all right and his pulse was OK, so I called an ambulance and had him moved to a local hospital. After a complete check, the hospital advised that he had no injuries that they could discover and that probably his "wind was knocked out" when he hit the ground.

How could an accident like this happen? Well, the pilot's story was that he had landed in a pasture about four miles away and, after visiting some friends nearby, was ready to take off for the short hop back to Central. Since the field was quite short, he had asked a couple of men to hold down his horizontal stabilizer (one on each side) until he had "revved" his engine up, and to turn loose when he waved his hand out of the left window. It seems that he opened his throttle wide and waved out of the window OK. The man on the left stabilizer saw it and jumped away, but the man on the right didn't see it and before he knew it the plane was gathering speed and the air pressure had him glued to the stabilizer. When the pilot came in to land he reduced his air speed enough to take most of the pressure off the man clinging to his stabilizer and allow him to fall to the ground. Not a broken bone. Not a bruise or abrasion. A miracle.

On a Saturday in May, 1931, I had a rather unique flying experience. They were having an air meet at the Philadelphia airport that afternoon, and one of the attractions was a "Sportsman's Pilot Race." It was open to anyone with an airplane. They had sixteen entries and, since there was such a difference between the planes involved, they decided to give each one a handicap. To do this they wanted to have each ship timed flying over the same one mile course at full throttle and piloted by a neutral qualified pilot. So they asked me if I would take on the job.

The procedure was for me to take each ship off from the Philadelphia Airport, make a wide circle at low altitude, fly low at full throttle over the timing course, come back around the field, and land. When I took off with one ship, the next to be tested was to have its engine started so that I'd lose no time in transferring from one ship to the next.

At this point I might say that the Philadelphia Airport in those days was little more than a flying field. It was small, had no runways, and the approaches left a lot to be desired. Anyway, we got the tests started promptly at 8:00 am, and from then until 12:30 I flew sixteen different airplanes over the course to qualify for their handicaps. The types varied from an Aeronca to a Taperwing Waco. Each had its own characteristics, but fortunately they all behaved well for me that day. It was an experience. The race went off on time that afternoon.

Next month, more happenings.

CONTESTS

from page 12

MT. RUSHMORE BICENTENNIAL STATION

The Black Hills A.R.C. will be operating a bicentennial special events station (NSØDAK) at Mt. Rushmore National Memorial, in the Black Hills of South Dakota, on July 3rd, 4th, and 5th. We hope to operate SSB and CW on General and Advanced portions of 80 through 10m and 2m FM. Special QSL cards will be available. Please QSL with SASE to KØCXL at 715 San Marco, Rapid City, SD 57701. Their authorization is good through September 6, so watch for them on other weekends and holidays.

SPECIAL "VIKING" LANDING COMMEMORATIVE

The Jet Propulsion Laboratory Amateur Radio Club (JPL-ARC) will be conducting one of its active participation programs for this year by making contacts with other amateurs all over the United States and many foreign countries in conjunction with the bicentennial project of landing on Mars.

The JPL-ARC will be active "on the air" with a special commemorative program during the Mars encounter by the Viking I and Viking II spacecraft.

Each of these spacecraft is comprised of two parts. One section is used to orbit Mars, while the second section is designed to land on the surface of Mars. Many scientific experiments will then be made, primarily to determine if there is or was any biological life on the planet.

The JPL-ARC will be using the special call of N6V (N = NASA, 6 = 1976, V = Viking), operating from Pasadena, Calif., and will operate on the following approximate frequencies: CW – 3530, 7030, 14030, 21030, 28030 kHz; SSB – 3810, 3930, 7230, 14225, 14325, 21360, 28630 kHz; Novice CW – 3730, 7130, 21130, 28130 kHz.

The exact time and dates of operation have not at present been determined because they are dependent upon the Viking spacecraft schedules. The closest approximation is: Viking I arrival at Mars, June 19, N6V on the air June 18 to 23; Viking I landing on Mars, July 4, N6V on the air July 3 to 18; Viking II arrival at Mars, Aug. 7, N6V on the air Aug. 6 to 12; Viking II landing on Mars, Sept. 4, N6V on the air Aug. 31 to Sept. 15. Viking status reports may be secured by calling (213) 354-4213.

Looking West

from page 18

SOUTHERN CALIFORNIA AMATEURS HONORED

On March 4, 1976, the Honorable Herschel Rosenthal, Assemblyman from California's 45th Assembly District, presented the following resolution to the Amateur Radio Community of Southern California:

RESOLUTION
Relative To Commending The Radio Amateurs Of Southern California

WHEREAS, The Amateur Radio Operators of California have provided important public services for more than 50 years to the people of the state, and are deserving of special recognition for their outstanding record of dedicated community service; and

WHEREAS, The Amateur Radio Operators of California and their American Radio Relay League provide vital emergency communications in times of natural disasters, such as fire, flood, and earthquake, and, in particular, the recent Guatemalan tragedy; and

WHEREAS, Inducing a constant strengthening of international friendship through their contacts with every country in the world, the Amateur Radio Operators, through their inventive and resourceful experimenting, led to the development of broadcast radio and its continued improvement; and

WHEREAS, They provide exemplary services in providing "phone patches," linking overseas servicemen with their stateside families; and

WHEREAS, The sophisticated Oscar satellites circling the globe make interpersonal contact by radio waves possible in remote areas, providing information for all occasions, including knowledge of space to school children, and emergency assistance to motorists, police, and stranded persons; and

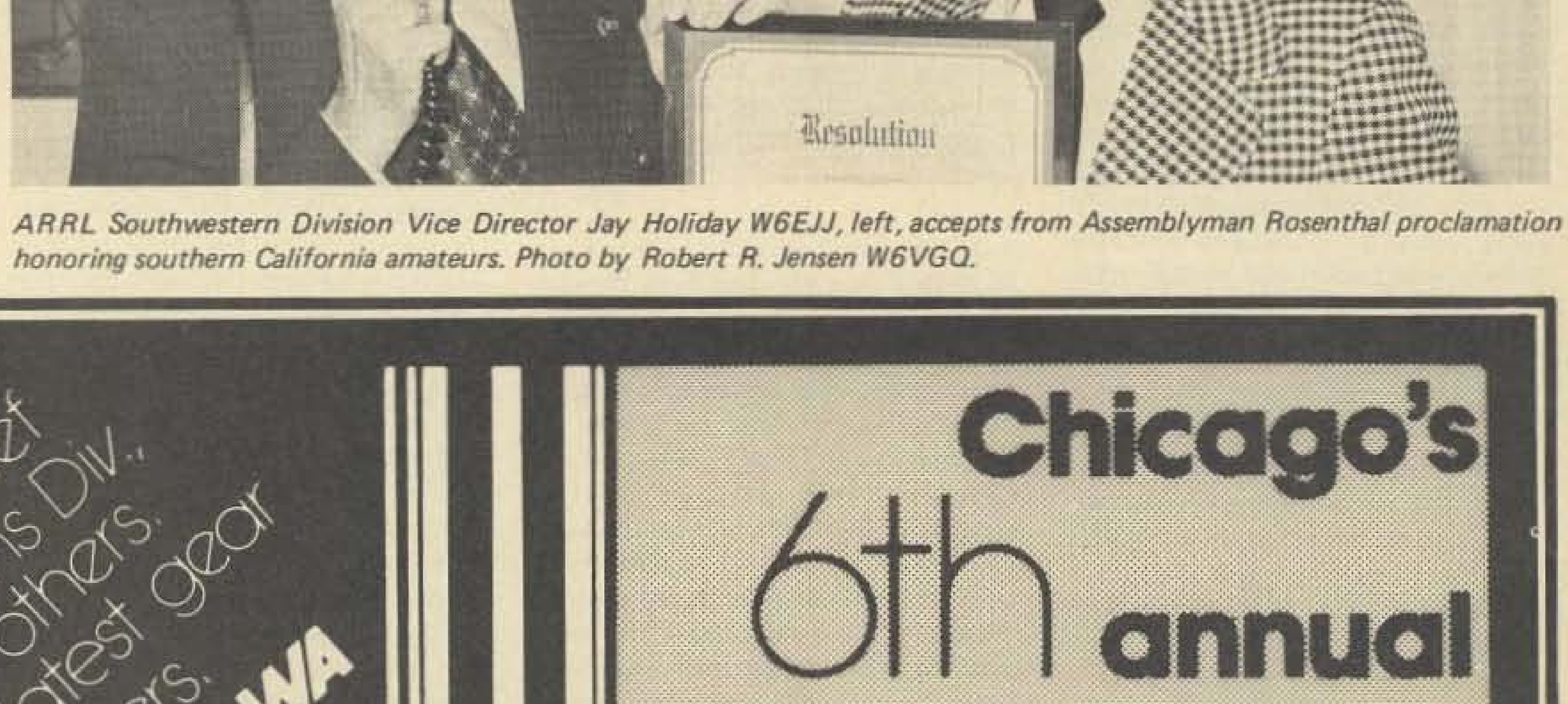
WHEREAS, The study, training, and practice of the amateur radio operators has provided the state and country with a huge reservoir of technical skills for the armed forces; and the activity provides a useful pastime to many of the shut-ins and isolated individuals of the state; now, therefore, be it

RESOLVED BY ASSEMBLYMAN HERSCHEL ROSENTHAL, That the Amateur Radio Operators of Southern California be commended for their outstanding record of dedicated and highly effective service to their community, state, and nation; and be it further

RESOLVED, That a suitably prepared copy of this resolution be transmitted to the Radio Amateurs of Southern California.

Members Resolution No. 395
Dated: March 4, 1976
Signed: Honorable Herschel Rosenthal 45th Assembly District

On hand to accept this award on behalf of the entire area amateur radio community was Jay Holiday W6EJJ, ARRL Southwestern Division Vice Director, along with many of the amateurs who had participated in this area's mass communication aid effort for Guatemala (including Doug McDowell K4SWJ of the Palisades Amateur Radio Club, organizer of this aid effort).



ARRL Southwestern Division Vice Director Jay Holiday W6EJJ, left, accepts from Assemblyman Rosenthal proclamation honoring southern California amateurs. Photo by Robert R. Jensen W6VGQ.

Alexander MacLean WA2SUT, NNN0ZVB
18 Indian Spring Trail
Denville NJ 07834

How Do You Use ICs?

--fundamentals

Most of the articles dealing with integrated circuits (ICs) either explain the theory of internal electronic operation or show some complex use for the device to someone who is already familiar with ICs.

It is not necessary to have an understanding of how they work to begin using and enjoy working with ICs. What is needed is the nuts and bolts practical information on how to get started usually overlooked by the more advanced technical article.

The IC can be basically thought of as a miniaturized printed circuit (PC) board. It is a complete electronic circuit within its package, built to perform some specific function.

This is both the problem and the key to easily working with them. Instead of working with components and building a circuit with them, you are working with the complete circuit as a plug-in unit adapted to your purpose.

The cheapest and most obtainable IC surplus available is the digital type. This was designed for computer use. Amateurs use it two basic ways: as it was designed when they can use that particular IC function, and by externally manipulating it to perform some unrelated function that it was never designed for.

Many counters use digital ICs to count the same way a computer would. Other equipment takes the computer circuit and makes it work as an amplifier, product detector, oscillator, and so forth .

This article will try to answer some of the more obvious questions about how to start working with digital ICs and get usable results. The first question is:

How Do I Tell What These Devices Are?

An IC is named for the particular computer function it performs in a digital computer. Most of the time the name will not be of any value to the amateur, except to identify the device to be used. He will be using it in a different way for a different purpose than it was intended.

It also has a code number, as tubes and transistors do. There are a limited number of specific computer functions, but a variety of ways they may be packaged.

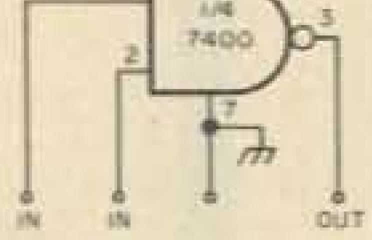


Fig. 1.

An IC package may contain only one actual circuit, or it may have a number of them inside. This is for computer building convenience. It may seem confusing at first that so many code numbers seem to be the same circuit, but they may be different combinations within the package.

An IC also belongs to a "logic family." This heading is usually given over the list of code numbers in the ads. This refers to the electronic means by which the circuit does its work.

The circuit function can be performed a number of ways electronically. While this is important for computer use, it is less so for amateur use. When you become more experienced, the need to become more selective about which logic family you use may arise – but not when you are starting out.

Where Do I Get More Specific Information?

Check the ads and send for the catalogs of surplus IC dealers. This will give you at least one number/name cross reference that you might need.

When you order, for a slight additional charge you can get the data sheets for the devices you order. If you plan to do a lot of work with ICs, there are several data books available on the common IC families (for about three dollars each).

Careful reading of IC articles will also give you quite a bit of information. One article may not give it all, but comparing several will yield something you can use.

With So Much To Choose From, What Do I Start With?

The important thing is to begin. Keep it simple. Some particular devices are standing out as most commonly used.

The family to start with is the TTL (transistor transistor logic) family, also referred to as T^2L. These are cheap, rugged and available.

Within this family there are two devices which are well known and easy to work with. They are the 7400 quadruple dual input NAND gate and the 7490 decade counter. Forget the names and look for the numbers. You may just see "7400 gate" and "7490 counter" in the ad.

What Can I Do With Them?

The 7400 is the heart of many IC oscillator circuits, and is often adapted to perform other common circuit functions. This is one area where the device is adapted to perform tasks it was not designed for.

The 7490 likes to divide

by two, five and ten. It is the heart of many dividing and counting circuits. This is a case of the device being used as it was designed.

One obvious use would be to combine the two and make a multiple output frequency standard such as 100 kHz, 10 kHz, 5 kHz or a custom output for a particular use.

By learning with the simple circuit you get the practical basics of the more complex dividing chains used in counters or other exotic gear.

These are basic circuits. The 7400 has also been adapted to perform many of the functions of a complete SSB generator, acting as oscillator, mixer, buffer and so forth. This makes it a good device with which to learn the basics of external circuit manipulation.

What Else Will I Need To Get Started?

Besides a few ICs to play with, you will also need a few basic items to start off with. These should be thought of as capital investments. You will use them over and over again as you work.

You will need a power supply. For digital ICs you need 5 V dc, preferably regulated. This is no problem and will be dealt with later.

You will need one of the IC breadboard matrices. For experimental circuits, there is no more practical way of working with them. Printed circuit board techniques are clumsy and don't lend themselves to quick changes. Individual sockets and components are much too fussy to work with conveniently.

You will also need a supply of small parts to use with the ICs. There are fewer used with an IC circuit than with tubes or transistors, and with careful buying they are much cheaper.

What Is It Going To Cost To Get Started?

The initial investment will be in the neighborhood of thirty-five to forty dollars, most of which is for non-expendable items used over and over again.

This compares favorably with what you would spend on a comparable breadboard setup for tubes or transistors if you started from scratch.

After the initial investment, the cost per circuit will be lower than with tubes. Careful planning of purchases and buying ahead at quantity prices can bring the cost way down.

The biggest expense will be the IC breadboard matrix. The Proto Board 100 at \$19.95 (plus postage) or the AP Superstrip at \$17.00 (plus postage) is probably the best investment.

Plenty of ready-built supplies, kits, and individual parts to build supplies are available surplus for between five and ten dollars.

As for the rest, five to ten dollars will buy a good supply of 7400s and 7490s, and a fistful of the small parts you will need to build a lot of the basic circuits.

The initial high cost will also be offset by the fact that, with the use of the breadboard matrix, you will be able to use the small parts over and over again without cutting the leads.

After the initial investment, the cost per additional experimental circuit will be much less than with tubes.

What Kind Of Power Supply Will I Need?

Digital ICs want 5 volts dc, preferably regulated. This is not hard to arrive at. It is much easier than with tube supplies.

While a complex piece of IC equipment might draw several Amps, for an experimental supply anything from 200 mA to an Amp will be satisfactory. Even a battery will run several ICs.

Linear ICs work from a wider range of voltages, usually in the 9-18 volt class, and there are some types of ICs (like differential amplifiers) which take two voltages – one plus, one minus – in that range. This sounds harder to do than it is, but start with the digital IC and the single supply.

What About Voltage Regulation?

Here is where you really get a break with ICs. A well regulated dc tube supply is quite an undertaking. With ICs, it's a breeze.

If you have a transistor-type bench supply in the 9-12 volt range, just add an IC regulator such as the LM309H (\$.75 to \$1.50, depending on the source) and your supply problem is solved.

These come in a variety of packages which look like familiar transistor types. They have three leads: one input, one output, and one ground. Can't get much simpler than that. They will handle about one Amp each.

What About Additional Filtering?

It is best to regulate the voltage right at the IC unit, which makes the IC regulators ideal. If the power supply is at a distance from the unit, it is best to bypass the input with .1 uF or more.

It is also advisable to bypass each IC package with .01 to .1 uF, to prevent interaction between ICs. This may not be needed experimentally and not all finished circuits will need or have it.

When you are ordering parts, include a few regulators and some disc capacitors. They are quite cheap.

Where Does The Power Go?

Many partial schematics are ambiguous about some of the IC connections. As with tube circuits that don't show the filament circuit, assuming that you know where it goes, the IC circuits use a form of shorthand.

Most ICs have a pin connection for the source voltage (Vcc) and a ground return for the other leg of the voltage. Many times this is just not shown.

With a multisection IC, there is still just the one Vcc input which feeds all the sections.

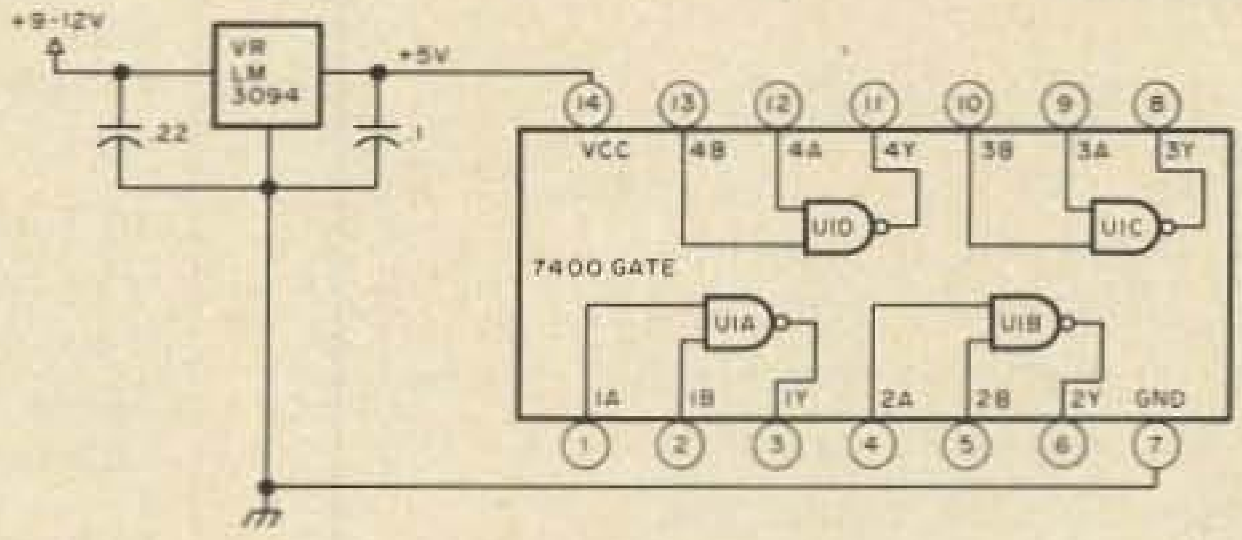


Fig. 2.

How Do I Read The Schematic?

Reading IC schematics is easy once you know how. Two systems are used. The first is to use the actual computer circuit function schematic symbol. This is often used when a multisection IC is broken up to perform several functions.

The important thing to remember is that the computer symbol is only used for convenience and usually has no computer meaning in the circuit.

The numbers on the pins refer to the pin numbers of the complete IC package. An example is shown in Fig. 1, which is one section of the 7400 with the pin numbers shown. The other three sections would be drawn the same way, with the correct pin numbers for each.

Often the entire IC is shown as a rectangle with the pin numbers on it, making it look like a large rectangular tube socket. The important thing here is that, unlike tube sockets, the IC pins are counted from the top of the case. Pin one is usually located by a mark.

Since most ICs are used with printed circuit boards, most of the other parts are top mounted; thus, the pins are shown from the top of the device.

Fig. 2 shows the complete 7400 IC package with the four sections drawn inside and the pins numbered. Also shown are the Vcc pin, common pin, and the associated bypass and voltage regulator, for basic recognition of the complete unit.

Can I Use My Junk Box Parts With ICs?

For outboard things like power supplies, switches, chassis, and chassis mounted parts, you probably can. For the parts directly connected to the IC, it is unlikely. They will be too big to fit conveniently and the leads may be too thick to use with the IC matrix without damage.

Considering the low cost of miniature surplus IC components and the convenience of using them, this is no problem. Use what you can of what you have. The little parts are cheap.

Where Do I Find Circuits?

Basic individual circuits are now common in most of the magazines. The larger articles may have what you need as part of another device which you might not want all of.

Can I Adapt Circuits From Other Pieces Of Equipment?

Very often you can. Unlike tubes, ICs are designed to be building blocks. The ICs in a family are designed to interface with each other.

Often it is possible to isolate the IC and its external circuit components that you want, and use it in another project without serious modifications.

How Are IC Circuits Coupled?

The two most common methods of coupling are direct coupling, where one output pin of an IC goes directly to the input pin of the next IC, and capacitor coupling. This makes it very simple most of the time.

What About Unused Leads Or Sections?

There is no hard and fast rule. Many ICs have such high gain that a floating input pin or section can cause instability problems. There are several ways of dealing with this.

One of the safest general methods is to return all unused input leads to the Vcc pin through a 1000 Ohm resistor. It is not necessary to use separate resistors for each lead. All leads from the IC can be returned through the same resistor.

Look at similar IC schematics. Sometimes the lead will be left floating or will be grounded. With grounding, some ICs will draw too much current. A milliammeter in the Vcc line will show you what the current is doing.

Transistors Are Easily Damaged; What About ICs?

ICs are quite rugged. Manv problems are simplified because they are matched to be interconnected. The most critical voltage is the Vcc voltage. There is a very small range above and below this in which ICs will work properly without damage. Using the small IC regulators will take care of this.

The next thing to watch is that they aren't overdriven. If you are using ICs with each other, this is unlikely, but if you are using an external drive voltage it may cause damage – the same as overdriving a transistor.

Don't let that scare you. It is not too common. They are quite rugged compared to transistors and they are very cheap. At 20¢ or less for a 7400, you can blow out quite a few learning and never feel it.

What About Using Other ICs?

The 7400 and the 7490 were chosen here because they are commonly used and information is readily available. There are plenty of others which can be used.

The basic oscillator circuit uses two gate sections. There are other computer gates which will also work. If you happen to have a stray IC gate type which is not a 7400, try it in the same type of circuit. It may work and it won't hurt to try.

Check through the IC articles and keep a file of the types of ICs used. The next most commonly used will show up that way.

What About Linear Devices?

Once you have gotten past the IC hurdle and have worked a bit with the digital type, you can begin to expand. As the prices come down, it becomes attractive to try the linear devices.

The regulator ICs you will be using are linear devices. The others which you might be interested in are the types that perform some radio or other desirable amateur function without the need for external fudging. They are

IC SHOPPING LIST

Power Supply

5 volt regulated or 9-12 volt transistor type
9 volt transistor radio type battery

Matrix

Protoboard 100 (@ $19.50 + postage)
AP Superstrip (@ $17.00 + postage)
Protoboard 6 (@ $15.95 + postage)

IC Types

TTL digital 7400 series
7400 gate, 7490 counter
Linear LM309H, K or equiv. 5 volt regulator

Capacitors

Supply of disc type 25-50 V
0.1 uF, 0.01 uF

Resistors

1/4 Watt carbon. Most used values for ICs listed: 150, 220, 330, 470, 560, 680, 1k, 1.8k, 2.2k (Available in sets quite cheaply with more values in set)

Hookup Wire

#22 or smaller solid

(Add other items needed for specific projects desired, in order to make up minimum order requirements, or get price break on quantity ordered.)

internally designed to perform that specific task.

One of the simplest and most available, directly applicable to many uses, would be the audio type IC. These range from dual stereo preamps to complete preamp/power amp ICs that are well within the range of what is used in communications work.

Working up from that, there are the ICs designed for commercial use which are complete i-f strips or complete subsections of communications type receivers. Some are specialized for FM or TV.

As these find their way into common amateur use, they may well put the design of simple but effective equipment back in the range of something which can be done with limited means.

Many of them will work with the IC matrix and a standard transistor-type supply. (5 volts is rather lean for the linear devices.) There are some that will not fit into the standard IC matrix, being designed for direct PC board use.

The thing to look for is the standard DIP (Dual Inline Package) configuration. Most of the ads will tell you if it is an unusual construction. Many of the audio power types have heat sink tabs. You can still use them, but not as easily as using the matrix.

What Am I Waiting For?

I don't know. What have you got to lose? Even if you blow out a few ICs while learning, they can be replaced for less than a buck. The initial investment is one of the cheapest available in amateur radio, when viewed in terms of the fun you will eventually have.

Set aside a little something each week and soon you'll have enough for the power supply, breadboard matrix, and a handful of ICs and parts. After that it should be downhill all the way. ■

Tracking the Hamburglar

KIDNAPPED: Drake TR-22 with crystals for 34-94, 94-94, 16-76, 04-64, 64-64, 88 receive. Texas D/L no. 4472525 on chassis. Jack VanNatta WB5DYE, Tulsa OK. Phone (918) 627-3738.

ABDUCTED: Regency HR2A s/n 04-10422. Crystalled for 94/94, 34/94, 16/76, 52/52. Has bracket attached and cigarette lighter plug on power cord. Stolen from Don Billings WØGOH, 2838 N. Prospect St., Colorado Springs CO 80907, phone 303-636-1661.

FILCHED: Motorola two freq., control head, Motorola T-power mike, Moto. speaker, 16 button TT pad with light, mounted in Bud Box. Stolen from Jim Best WAØRZI, 1923 Alpine Drive, Colorado Springs CO 80907, phone 303-471-1486.

HIJACKED: Regency HR2B, s/n unknown. Crystalled for 34/94, 34/34, 16/76, 19/79, 22/82, 28/88, 88/88, 145.80/80, 58/58, 25/85. Stolen from Glenda Butler WBØOCH, 1509 E. 12th St., Pueblo CO 81001, phone 303-544-7777.

STOLEN: Atlas 210X xcvr s/n TH3214 with Lafayette mobile mike modified with 3 conductor ¼" diam. plug. Does not have dc power cord or ac supply. Also Lafayette HA-146 2 mtr xcvr s/n 1111 with mike, power cord and the following xtals: 52-52, 16-76, 76-76, 19-79, 22-82, 34-94, 94-94, and 147-69-09. If any info call collect (213) 374-8528. Les Goddard WB6URL, 2121 Clark Lane, Redondo Beach CA 90278.

PLUNDERED: EBC 144Jr., s/n 50108, synthesized rig. Stolen from Dick Sucher WAØZLY, 27 Leaming Road, Colorado Springs CO 80906, phone 303-471-1696.

LOOTED: Kenwood TS520 s/n 140579, engraved WA7WDC, and an Icom 230 s/n 2405651 also engraved WA7WDC. In addition about $7,000 worth of tools and test equipment. If anyone has any information to the recovery of the this equipment please notify the Phoenix City Police. G. M. Chinn WA7WDC, 906 E. Broadway, Phoenix AZ 85040.

ROBBED: Genave GTX 200, s/n 22-03, ss number inside 031-28-9354. Crystalled for 157.63-03, 147.06, 156.37-97, 34-94, 94-94 and MARS frequency. BNC on back for duplex operation. Extra relay inside for sw. mike and motor control head; early vintage set. Stolen from Gus McKinney WBØOFR, 807 Holmes Drive, Colorado Springs CO 80909, phone 303-473-1397.

HIJACKED: Regency HR-2, s/n 04-02604 with nicad battery pack attached, s/n 7157; with microphone. Rig had modifications for Topeka preamp and extra 6 channel crystal deck. Stolen from my car parked at Ramada Inn, 1900 Fort Myer Drive, Arlington, Virginia, night of March 31, 1976. If you have any information on this equipment, please contact: A. D. Abercrombie W2GJS, 1002 Merrymount N., Turnersville NJ 08012, (609) 227-1383.

STOLEN: FM-27B 2 meter, stolen from car. Has 410-30-6102 engraved on back and side. Contact Allen Eskind W4ZLW, 6104 Hickory Valley Rd., Nashville TN 37205.

LIFTED: Drake TR22 s/n 640995 was stolen from my car located in the parking lot at 2121 East 63rd Street, Kansas City MO between 8 am and 11 am CST on Thursday, April 8, 1976. The radio was marked on the chassis with my Social Security number and amateur radio call. Anyone with information concerning this radio is asked to contact the Kansas City MO Police Department (816) 842-6525 or KØIDJ.

TAKEN: Drake Model ML-2, 12 channel all xtaled, serial no. 11239. Touch Tone pad attached to top. Call K2YKE attached to side and marked several places inside. Stolen from my car in Buffalo, New York April 9th. Ken Haas, 243 Crosby Blvd., Buffalo, New York 14226. Phone 716-834-4083.

RIPPED OFF: Heath HW 202, series 00316 transceiver. Modified: BNC antenna connector, scanner with LEDs over top (extra) barswitch. Three switches to left not connected. Right switch turns scanner on/off. Wires were cut at back panel. Contact Dick Ellis W5YCK, 104 West Avenue A, Alpine TX 79830, phone 915-837-3728.

PILFERED: Regency HR2, s/n unknown. Crystalled for 34/94, 17/67, 25/85, 88/88, has owner's name inside. Stolen from Dwane Barber WAØWWO, RFD 3 Box 353, Greeley CO 80631.

MISAPPROPRIATED: Icom IC22A, s/n 3401802. Crystalled for 94/94, 34/94, 22/82, 28/88, 52/52, 16/76, 37/97, 87/27, 19/79. Call is engraved on back, accessory plug wired for TT, PTT, and 455 kHz output. Stolen from Bill Croghan WBØKSW, 1030 W. Colorado, Colorado Springs CO 80905, phone 303-471-7504.

TAKEN: Regency HR-2A, s/n 04-07989 taken from car in Harrisburg PA. K3NVO 495-38-8556 engraved on chassis. Has scanner board mounted over receive crystals and four red LEDs mounted vertically on left front panel for channels one through four. Call or contact Ronald Kaullen K3NVO, 6326 Blue Flag Ave., Harrisburg PA 17112.

Oscar Orbits

Oscar 6 Orbital Information					Oscar 7 Orbital Information			
Orbit	Date (Aug)	Time (GMT)	Longitude of Eq. Crossing °W	Mode	Orbit	Date (Aug)	Time (GMT)	Longitude of Eq. Crossing °W
17348	1	0114:40	75.0	B	7822	1	0119:34	69.7
17360	2	0014:36	60.0	A	7834	2	0018:54	54.5
17373	3	0109:32	73.8	B	7847	3	0113:11	68.1
17385	4	0009:28	58.8	AX	7859	4	0012:32	52.9
17398	5	0104:24	72.5	B	7872	5	0106:49	66.5
17410	6	0004:20	57.5	A	7884	6	0006:09	51.3
17423	7	0059:15	71.3	B	7897	7	0100:26	64.9
17436	8	0154:11	85.0	A	7910	8	0154:43	78.5
17448	9	0054:07	70.0	B	7922	9	0054:03	63.3
17461	10	0149:03	83.7	A	7935	10	0148:20	76.9
17473	11	0048:59	68.7	BX	7947	11	0047:40	61.7
17486	12	0143:54	82.5	A	7960	12	0141:57	75.3
17498	13	0043:50	67.5	B	7972	13	0041:18	60.1
17511	14	0138:46	81.2	A	7985	14	0135:34	73.7
17523	15	0038:42	66.2	B	7997	15	0034:55	58.5
17536	16	0133:38	80.0	A	8010	16	0129:12	72.1
17548	17	0033:34	65.0	B	8022	17	0028:32	56.9
17561	18	0128:29	78.7	AX	8035	18	0122:49	70.5
17573	19	0028:25	63.7	B	8047	19	0022:09	55.3
17586	20	0123:21	77.5	A	8060	20	0116:26	68.9
17598	21	0023:17	62.5	B	8072	21	0015:47	53.7
17611	22	0118:13	76.2	A	8085	22	0110:03	67.3
17623	23	0018:09	61.2	B	8097	23	0009:24	52.1
17636	24	0113:04	75.0	A	8110	24	0103:41	65.7
17648	25	0013:00	60.0	BX	8122	25	0003:01	50.6
17661	26	0107:56	73.7	A	8135	26	0057:18	64.1
17673	27	0007:52	58.7	B	8148	27	0151:35	77.7
17686	28	0102:48	72.4	A	8160	28	0050:55	62.5
17698	29	0002:44	57.4	B	8173	29	0145:12	76.1
17711	30	0057:40	71.2	A	8185	30	0044:33	60.9
17724	31	0152:35	84.9	B	8198	31	0138:49	74.5

Once upon a time ham radio was nice and easy. You just went out into your own half acre backyard, put up a pair of ninety foot telephone poles, and hung an eighty meter Zepp antenna in the sky. To work the old 160 meter band you fed the same sky wire as an "inverted L" against ground. On the higher frequency bands you played tuning games on the open wire, six hundred Ohm transmission line leading to that flat top until the rig loaded. Such olden, golden times are now only fond memories in the minds of old-timers.

Today the radio amateur has a serious problem finding enough outdoor space in which to erect *any* kind of antenna, let alone an optimum one. There is, however, at least one way out of this restricted space dilemma, a way taken by military forces a few years back: Use an electrically small antenna! Conventional forms of such antennas, whose physical dimensions are small in comparison to the operating wavelength, are rather famous for converting more rf input power into heat than into good signals on the air. Antennas, unlike any other component making up a radio communications system, have stubbornly resisted efforts at miniaturization. Over the last sixty years, however, a quiet but fierce technical battle has been waged in many places in the world in an attempt to reduce the physical size of the transmitting antenna while keeping efficiency within reason. This battle is far from won. Nevertheless, some limited progress has been made to date, as well as certain surprising gains made in terms of antenna function flexibility. As one of the weary but still enthusiastic veterans of this technical warfare, I felt that some of the newer radiating gadgets which have come forth from the melee should be of interest and value to the radio amateur in his present hour of need. In that spirit, the aim here will be not to merely describe what some of these electromagnetic devices look like, but to include enough technical detail about them so the ham can design and experiment with these radiators himself.

Most of the antennas discussed are forms of radiating rf transmission lines of small electrical size. Most of them have originated from military interest in reducing the vertical height and size of conventional antennas. They are still so new, however, that they exist in very small numbers as yet and only render service in military applications. As past research has disclosed that the loading coil-only approach is the least efficient way of reactance loading short antennas, all of these newer, more exotic antennas are brought to resonance using exceedingly low loss capacitance; they make up for their high Q, narrow bandpass nature by being capable of very rapid frequency tuning. Some, like the LPT, are even capable of widebanded performance at good efficiency – in spite of

Surprising Miniature Low Band Antenna

-- the DDRR low noise antenna (part I)

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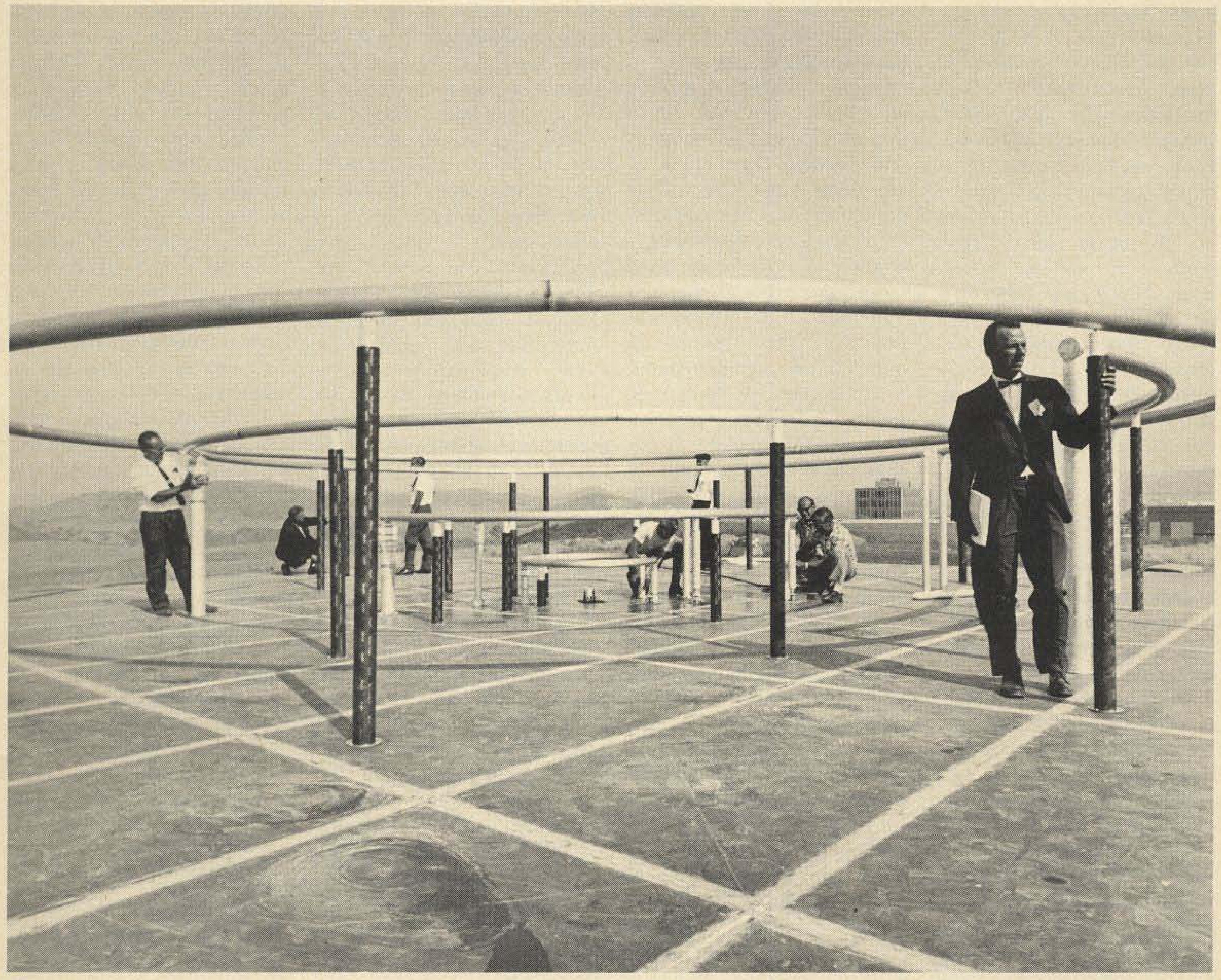

Fig. 1. Close-up view of military-type Directly Driven Ring Radiator (DDRR) antenna set up for long range communications tests in the 2.0 to 30 MHz frequency spectrum. Dark vertical posts supporting the ring elements are fiberglass tubing topped with "beehive" insulators. The hands of the engineer at the left rest on the 50 kV variable vacuum tuning condenser. The height of the ring in the foreground is six feet; the innermost 17.2 to 30 MHz ring element is 1.5 feet in height (Northrop Corporation photograph).

small height. All of them offer the ham with a small size QTH certain advantages over conventional antennas; some even afford a real advancement in overall ham band communications practice. Therefore, we will discuss the new antennas from the ham's point of view.

The Directly Driven Ring Radiator (DDRR)

The DDRR antenna[1] shown in Fig. 1 might well be called the *Little Wonder All-bander.* It tunes continuously from 2.0 to 30 MHz, and will accept *simultaneous* input from up to four 10,000 Watt auto-tune transmitters (Texas kW men and DX contest types take note!). The close-up view in Fig. 1 shows the DDRR set up for long range HF communications tests prior to being installed on the naval ship *USS Wheeling.* Fig. 2 is an aerial view of the same DDRR aboard the *Wheeling* during early sea trials. Although the rugged antenna operated well even when taking "green water" during storms at sea, it was later covered with a pillbox type fiberglass radome. Its location is on the roof of a helicopter hangar aft, the metal roof and surrounding sea serving as a highly conducting ground plane.

The maximum diameter of the *Wheeling* DDRR is thirty-five feet, with its outermost ring element at a height of only six feet above the ground plane. Although such dimensions may not immediately convey the idea of "small size," the antenna is seen to be "small" in terms of the four hundred ninety-two foot wavelength at 2.0 MHz. The *Wheeling* served in the Apollo space exploration program as an HF worldwide network control center, and is now off on similar scientific missions. There are a total of five concentric ring radiator elements. The outer one tunes 2.0 to 3.3 MHz, and the inner four rings tune the bands 3.3 to 5.7 MHz, 5.7 to 10 MHz, 10.0 to 17.2 MHz and 17.2 to 30 MHz, respectively. The ends of each of the ring elements are "grounded" to the metal image plane through metal

[1] U.S. patents (J. M. Boyer): #3, 151, 329; #3, 247, 515; #RE26 196; all assigned to The Northrop Corporation, Hawthorne, California.

posts. Half way around the circumference of each ring conductor, connection is made to ground through individual 50 kV rated, variable vacuum condensers. Each variable condenser is remotely controlled from the ship's radio room by means of two-phase servo drive motors of variable speed. Each DDRR ring element is directly fed with individual fifty Ohm coaxial transmission lines, no auxiliary impedance matching networks being required to obtain low vswr. Originally, provision was made to install reflectometers at the input terminals of each ring element to permit fully automatic servo tuning and frequency tracking with associated transmitters. To my knowledge, however, these units were never installed.

In the radio room there is a visual display readout console which gives constant information for (a) the identity of the transmitter currently in use with a given ring element, (b) the frequency to which each DDRR element is tuned, and (c) the vswr in each of the feedlines. In spite of all this automation, however, an experienced operator in total darkness can hand "slew" the tuning of the DDRR until a background noise peak is heard in a receiver tuned to the desired frequency. When the noise peak is observed, the input vswr in the feedline to the antenna is less than 2:1 and the antenna is ready to accept full transmitter power. Off this tuned frequency, the receiver connected to the DDRR sounds "dead," its S-meter resting on the zero peg.

In a DDRR, all antenna elements are at dc ground potential through extremely low impedance, high current capacity shunts. As a consequence, associated electronic equipment is quite well protected against damaging effects from voltage transients induced by lightning strikes on the ship's structure. Such dc shunts also serve as "static drains" during weather conditions when impact with charged snow or rain particles can build up very high magnitude voltage potentials on conventional antennas. Under such weather conditions, noise level during reception on the DDRR is a minimum of twenty decibels less than that attained on non-drained antenna systems.

Up to here we have been discussing a military antenna. Fortunately, however, I am able to give an account of how such a multiband DDRR operates on the ham bands. During preliminary land-based tests of the antenna in southern California, it was only natural that licensed amateurs serving as engineers and technicians on the project literally itched to know how the thing would work on ham frequencies. A notice of portable operation under the call W6UYH was sent off to Uncle, and one evening the gang adjourned to the large communications van nearby. To get a feel for band conditions using a standard radiator, a one hundred ten foot tall vertical quarter wave tower antenna was used to put out the first call on 160 meters. This antenna, of variable height, was available as a reference $\lambda/4$ monopole during military tests, and could be raised or lowered to ground within three minutes.

A number of contacts were quickly made with relatively local stations; naturally, excellent reports were secured using the big vertical skyhook. The QRN level was substantial and considerable Loran "buckshot" was noticed. The vertical was then dropped, and a touch of a control button sent the motor-tuned DDRR down into the high end of 160 meters (we had made sure it would "inch" a bit below 2.0 MHz, hi!). Almost immediately we heard a number of stations calling us from the Hawaiian Islands. The KH6s said they had been calling repeatedly since our first CQ. We had not heard their relatively weak signals, however, due to the fact that they were buried down under the QRN; now they stood out loud and clear against a much lower background noise level. We also observed that Loran buckshot was way down in magnitude and QRM from very near-channel strong locals was almost absent. To the island stations, there was very little, if any, difference detected in FS between the DDRR and $\lambda/4$ monopole in subsequent comparison transmission under conditions of slow fading.

As engineers, the hams present were a little surprised. We had all been somewhat concerned about the narrow frequency bandwidth of the electrically small height DDRR when operating efficiently with hard fought-for, low Ohmic environmental loss resistance R_Ω. Yet here, with this narrow frequency width antenna acting as a sharply tuned "bandpass" filter *ahead* of the first receiver stages, it was preventing loss of sensitivity due to random white noise loading, greatly reducing QRM and delivering a considerably superior signal-to-noise ratio advantage over the big antenna in a real world, *two way* HF radio communications mode. As one old-timer in the shack sagely observed: "You got to hear 'em, boys, before you can work 'em!" Shifting to 75 meters, it was the same story. Reception, using the relatively wide-banded tower $\lambda/4$ vertical, was a noise pain to the ear; on the DDRR we worked VKs, ZLs and Js, slicing them out from under the noise and QRM as if using a hot knife on butter.

Again, due to the unavailability of test stations on military assigned frequencies at intermediate distance range from our land-based test site, we were able to first observe on the ham bands another deliberately provided performance feature of the *two post* model DDRR antenna: the ability to work stations during daylight hours at distances greater than that of the ground wave fade out zone produced when using quarter wave vertical antennas. In the two post design DDRR, provision had been made to generate an auxiliary, very *high angle* radiation pattern lobe in addition to the DDRR's normal, vertically polarized, very low angle "doughnut" omni-pattern. In the lower frequency HF range of 1.0 to about 8.0 MHz, the ionosphere will strongly reflect signals incident upon it at high angles above the horizon. Such an effect is called the ionosphere "sounder mode" of communications and is of military interest because it can give contact range extension during daylight hours. We enjoyed daytime QSOs with stations ranging from 100 to 500 miles distant on 160, 75, and 40 meters – stations which could not be worked using the reference $\lambda/4$ monopole. Subsequent use of the DDRR on the *USS Wheeling* verified the same daytime range extension performance at sea on the lower HF channels outside the ham bands.

How the DDRR Works

Because many of the performance functions and much of the theory of the DDRR antenna apply equally well to the operation of other modern transmission line antennas to be discussed in Part II of this article, it is perhaps justifiable to give here some details about how a DDRR antenna works. While we are at it, we might as well give readers all the dope necessary to tailor one themselves for use in the ham bands. We're talking about an

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optimum design, though, so that you end up with a compact size, efficient *antenna*, instead of a "heating element" for rf. Don't worry — no higher math will be used.

A DDRR can be designed for use in just one ham band, or as a model covering all amateur frequency assignments in the HF region. Once the design of a single band element is understood, there will be no problems in adding other band coverage elements. We will assume that the prospective user lives in a typical cramped-space, urban QTH where the installation of a really effective artificial ground plane system is completely out of the question for many practical reasons; to make the design even more attractive, a total vertical height of only six feet will be used in the example here, together with a selection of just one outside diameter conductor size to be employed in all conductors of the DDRR. The design relations given, however, are in such form that other conductor diameters, antenna heights, and frequency bands may be substituted as desired. Later, details will be given for adding the other elements to the one band design example to convert it into an all-bander.

Fig. 3(a) shows a dual post DDRR like the *Wheeling* model, erected over a continuous surface, highly conducting ground plane. We will temporarily retain such a super ground plane for our discussion purposes here; later, we will *discard it* completely in the practical home QTH model. Also, we will end up with a one post DDRR, as the two post model does not afford the minimum size design we wish for ham use. In the drawing the rf currents are shown flowing in both the overhead conductors and as image currents in the ground plane at a single instant of time in the rf cycle. It is noticed that the directions of the currents in the ground plane are *not radial* like those produced by a simple vertical monopole antenna. In Fig. 3(b) just one half circumferential section of the two post DDRR antenna is shown in "straightened out" fashion. Because the part of the DDRR element of Fig. 3(b) includes a vertical post conductor, a horizontal conductor elevated above and parallel to the ground plane, a tuning condenser (C), as well as input feed terminals, it will function as a DDRR antenna element itself in our finished design.

Immediately, it would appear that all a DDRR really boils down to is a "one wire," unbalanced rf transmission line parallel to ground at a height h, and "shorted" to ground at one end by a vertical post. This ought to be easy! Now, we will agree with you that the horizontal conductor of total length S° parallel to ground does indeed form nothing more than a "one wire" rf transmission line "stub." But we are going to insist that you unlimber your imagination and go along with us in considering the vertical "shorting" post at one end of such line as *another* separate and different rf *transmission line* also. Any good amateur antenna handbook gives the formula for finding the characteristic impedance of the "one wire" line above ground in terms of its mean height (h) and conductor diameter (d). It is, merely,

$$K_C = 138 \log_{10} \frac{4(h)}{d} \text{ Ohms} \tag{1-1.0}$$

Armed with equation (1-1.0), let us begin by selecting the 75 meter band for use in our example. We will start the design at the upper frequency limit band edge of 4.0 MHz. At 4.0 MHz, wavelength λ in air is 984/4.0 MHz, or 246.00 feet. We said we would use only a vertical antenna height of six feet. We will not be precise here and take into account the conductor diameter in determining the electrical length (h°) of the vertical post element at 4.0 MHz. Instead, we will arbitrarily select 4.0 inch O.D., thin wall, aluminum alloy tubing (type 6061T6 or other weldable alloy) for both the post and horizontal conductor. Taking the post height (h) as 6.0 feet, its diameter of 4.0 inches as 0.33 feet, and its radius as 0.17 feet, we find the following "electrical dimensions" at 4.0 MHz:

$$h^{\circ} = 6'/246.0' \times 360^{\circ} = 8.78 \text{ degrees}$$
$$d^{\circ} = 0.33'/246' \times 360^{\circ} = 0.48 \text{ degrees}$$
$$a^{\circ} = 0.17'/246' \times 360^{\circ} = 0.24 \text{ degrees}$$

Knowing these dimensions allows us to use (1-1.0) to get the characteristic impedance (K_C) of the "one wire" over ground horizontal transmission line section as,

$$K_C = 138 \log_{10} \frac{4(8.78^{\circ})}{0.48^{\circ}} = 138(1.86) = 256.70 \text{ Ohms}$$

Turning now to the vertical post itself, it appears that we face a problem in determining its characteristic impedance as an rf transmission line. For example, we know that another way to define the characteristic impedance of ordinary rf transmission lines is in terms of the ratio of the distributed series inductance (L) of the conductor to its distributed shunt capacity (C) between the conductors. Such a relation is written as $Z_O = \sqrt{L/C}$ Ohms. We know we would get K_C equals 256.70 Ohms for the horizontal line section by this alternate formula if we could just measure the distributed series inductance (L) along our 4.0 O.D. conductor and its distributed shunt capacity (C) to ground per *unit length.* Such characteristic impedance is constant along the entire length (S°) of the horizontal DDRR transmission line, because its conductor diameter (d°) and height (h°) is constant per unit length and thus gives constant L to C per unit length. Just looking at the vertical post we see this cannot be the case for a cylindrical conductor mounted vertical to a flat ground plane. Anyone can see that if we sawed out a given width slice from the vertical post conductor at a height of, say, ¼ inch above ground, and measured the shunt capacity of this insulated section to ground there, and then repeated the same procedure at a height of 36 inches above ground, and then at 72 inches above ground, shunt capacity would be maximum at ¼ inch above ground, less at 36 inches, and least at a height of 72 inches. Because shunt C varies with length h°, the ratio of L/C cannot possibly be constant; therefore, the "characteristic impedance" of the vertical post — when considered as an rf transmission line — would have to be a variable function of height h°. At the same time you have a suspicion that the vertical post in the DDRR is something more than just a "shorting post." A grounded, vertical monopole antenna, maybe?? You may wonder what we are up to here.

Well, you are perfectly right. Not only does the characteristic impedance of the vertical post rf transmission line change with height, but it is also a grounded, vertical monopole antenna. How do you find the "characteristic impedance" of a monopole antenna? Well, thanks to a brilliant antenna man, Dr. S. A. Schelkunoff of the Bell Telephone Laboratories,[2] we can do just that:

$$K_m = 60 \left[2.3026 \log_{10} \frac{2(h)}{a} - 1.0 \right] \text{ Ohms} \tag{1-2.0}$$

The above equation gives the *average* characteristic

---

[2] S. A. Schelkunoff, "Antennas of Arbitrary Size and Shape," Proc. I.R.E., *29*, 493-521 (September, 1941).

Fig. 2. The DDRR antenna is shown here installed aboard the U.S. Navy communications ship U.S.S. Wheeling. *The antenna is seen mounted aft on the roof of the helicopter hangar. Operating efficiently even though exposed to the weather, the antenna was later covered with a pillbox fiberglass radome housing (official U.S. Navy photograph).*

impedance[3] of a cylindrical vertical conductor monopole antenna over ground having a conductor radius "a" and length h. It is an average value because of the variable nature of the post monopole antenna's characteristic impedance with length h. Schelkunoff's equation (1-2.0) looks so simple in form and very similar to (1-1.0), yet it is loaded with electromagnetic dynamite! We will discuss just how in Part II. Here we can honestly say that, aside from Ohm's Law, this simple little formula may become one of the most useful expressions known to the ham fraternity for getting quick and easy *practical* answers to real antenna problems of all kinds. Oh yes, if you multiply the answer you get from (1-2.0) by two, it gives the average characteristic impedance (K_a) of a balanced *doublet antenna* in *free space* of total length (2 h) formed from two identical "monopoles" of length h and cylindrical conductor radii "a".

[3]The symbols K_c and K_m are used to denote the characteristic impedance of the horizontal and vertical monopole antenna transmission lines, respectively, instead of Z_o, in order to avoid getting these values confused with the Z_o of the standard transmission line we will use to feed the DDRR antenna.

Tuning the DDRR

Armed with the simple formula (1-1.0) and the seemingly simple equation (1-2.0), we are fully equipped now to move on to design our DDRR for resonance and tuning over the width of the entire 75 meter band (or a bit more). Turning to Fig. 3(c), the DDRR antenna is now illustrated as being an antenna system composed of *two* distinct rf transmission lines, one connected to the other. Please do not let the drawing fool you. The first transmission line section, of electrical length h° and characteristic impedance K_m, shown "lying over on its side" still represents the vertical post of the DDRR antenna. It is just easier to indicate the post in this way when it is represented as an rf transmission line. In our "model" drawing of the DDRR antenna system of "open wire" lines, we have two terminals to represent the ground plane end of the post; terminal 1G is ground at a point where the base end terminal (1A) of the post connects to it. At a distance of h° away from the post base, the *top end* of the monopole transmission line has a second terminal (2A). However, "ground" is now labeled 2G, and represents a *circle* drawn *on the ground*

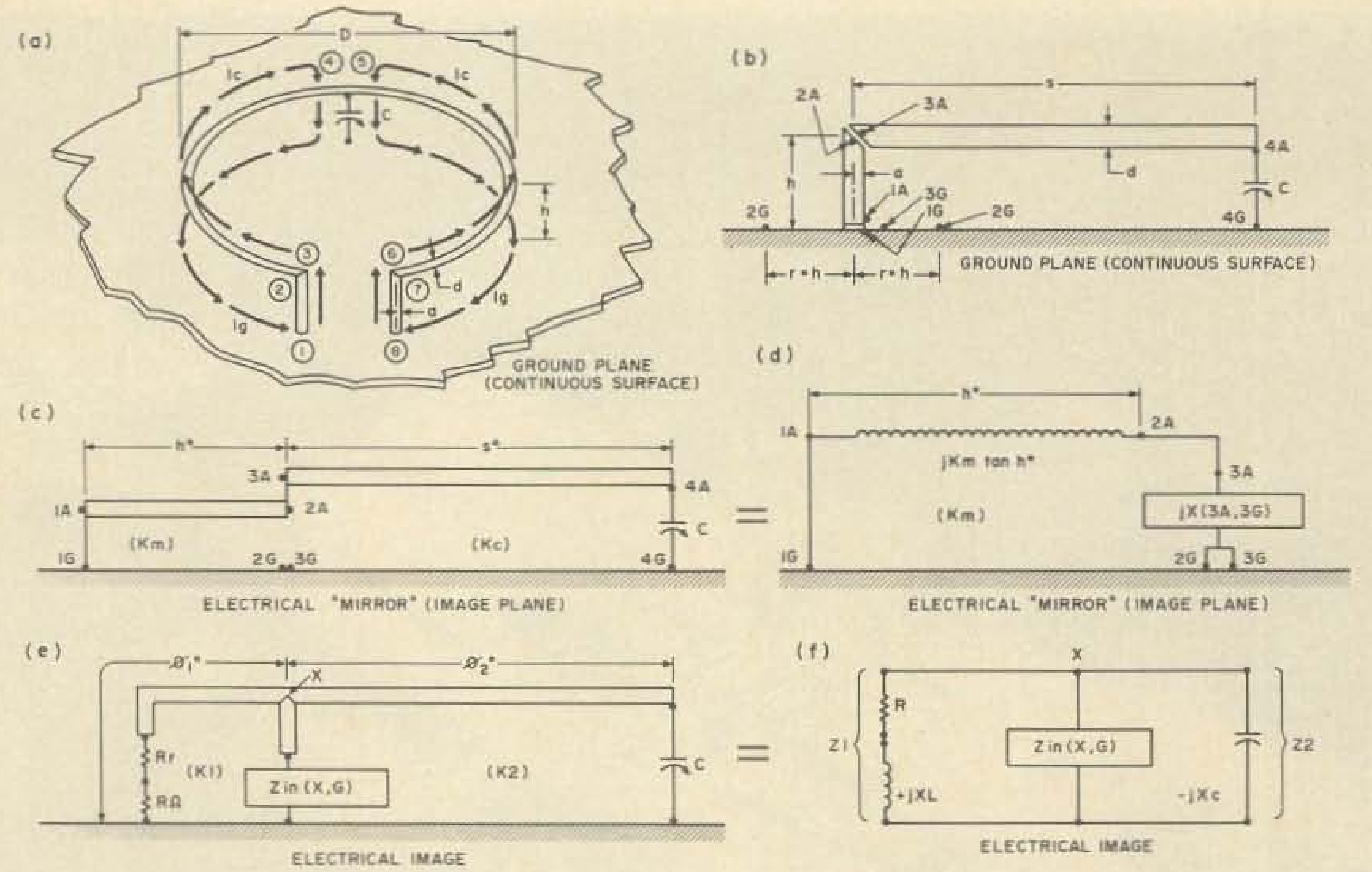


Fig. 3. (a) Wheeling-*type two post DDRR over metal sheet ground plane, showing current flow in elements and ground. (b) Half circumferential section of two post DDRR in linear alignment. (c) Design schematic of vertical post monopole transmission line "terminated" into horizontal transmission line section. (d) Equivalent circuit of monopole transmission line antenna loaded by top reactance. (e) Diagram for matching feed transmission line to the DDRR antenna. (f) Equivalent circuit of input impedance at feedpoint X.*

plane surface with a radius h°, the center of this circle being the post base (a little weird, perhaps, but we need imagination in dealing with antennas!). Then the end of the horizontal line conductor, at the point where it conductively joins the top of the vertical post terminal (2A), is labeled 3A. At a *point* on the ground plane directly below terminal 3A, a ground terminal (3G) is shown. At horizontal distance S° away on the transmission line, of characteristic impedance K_c and at a constant height (h°), the other end of this second transmission line conductor is labeled 4A. Again, directly below terminal 4A, a point on the ground plane forms the terminal 4G. The tuning condenser (C) is connected across terminals 4A and 4G of the horizontal rf transmission line.

Using equation (1-2.0), we can now find the average K_m of the particular vertical post of length h° = 8.78° and conductor radius "a°" = 0.24° we have chosen:

$$K_m = 60\left[2.3026\ \frac{2(8.78°)}{0.24°} - 1.0\right] = 60\ (3.29) = 197.57\ \text{Ohms}$$

Now let us imagine that in some way rf energy at 4.0 MHz is fed to our system of two rf transmission lines. As the two lines are *not* terminated into resistive "loads" equal to K_m and K_c respectively, these two rf lines are badly mismatched in impedance; they will act like what we call transmission line "stubs," and establish large amplitude standing waves along their respective lengths. For the moment, let's assume condenser C is either absent or set to an impossible minimum capacity of zero farads. For that condition, a reactive "load" $jX_{in}(3A,3G)$ produced by the horizontal line section of length S° will be "seen" across the "output" terminals 2A,2G of the vertical post transmission line. Because capacity C is absent, and we are temporarily ignoring things such as antenna radiation resistance R_r, we can describe the value of $jX_{in}(3A,3G)$ Ohms which will be "seen" by the vertical post line as a "load" across its output (top end) terminals. See Fig. 3(d). It is

$$jX(3A,3G) = -jK_c \text{ cotan } S°\ \text{Ohms} \qquad (1\text{-}3.0)$$

Because we are temporarily saying that our antenna possesses no resistance or "real" impedance terms, $jX(3A,3G)$ will be a pure reactance. Because the vertical post is now acting like an rf transmission line of length h°, the "load" $jX(3A,3G)$ across its output terminals 2A,2G will become *changed* in value as it "moves" or is transformed down the length h° of the post line to its own "input terminals" 1A,1G. This change or transformation property of rf transmission lines is compactly represented by the well-known terminated transmission line equation:

$$jX_{in}(\,) = K\ \frac{(jX(\,))\cos\emptyset° + jK\sin\emptyset°}{K\cos\emptyset° + (jX(\,))\,j\sin\emptyset°} \qquad (1\text{-}4.0)$$

Equation (1-4.0) is written in a form suitable only for lines terminated in a pure reactance load jX(). The symbol K denotes the characteristic impedance of the transmission line and Ø°, its length. So here is our DDRR design "law" number 1.0:

"For the vertical post monopole antenna of electrically small length h° to become resonant at a given frequency of operation f_o, the load reactance $jX(3A,3G)$ Ohms placed across its top and ground must be precisely of the correct value so as to change in reactance to the value $jX_{in}(1A,1G) = j0$ Ohms at the *base of the monopole* where it joins the ground plane."

It turns out that if, and only if, you require $jX_{in}()$ from equation (1-4.0) to equal j zero Ohms, you *needn't solve it completely.* All you have to do is to plug in a load impedance jX() which, when multiplied by the cosine of the line electrical length Ø°, makes the algebraic sum in the numerator equal to zero. For that condition, $jX_{in}()$ has to go to zero Ohms. Nature is kind to us here. It turns out that if

$$(jK_c \text{ cotan } S°) = -(jK_m \tan h°) \qquad (1\text{-}5.0)$$

the algebraic sum of (jX()) cos h° plus jK_m sin h° will add up to zero Ohms, making $jX_{in}()$ go to zero Ohms and the post monopole resonant at f_o. Remember, however, that $-jK_c$ cotan S° only equals $jX(3A,3G)$ when tuning capacity C is equal to zero farads. For this case of C equals zero farads, already knowing K_c, K_m and h°, we get:

$$-jK_c \text{ cotan } S° = -(j197.57 \tan 8.78°) = -j30.51\ \text{Ohms} \qquad (\text{ref } 1\text{-}5.0)$$

Then, knowing K_c, we rearrange (1-5.0) to find how long in electrical degrees S° has to be in the horizontal line to make (1-5.0) true (with all the little j operators and signs canceling out):

$$\cot S^\circ = \frac{K_m \tan h^\circ}{K_c}$$

(1-6.1)

For our particular DDRR, we find that the electrical length of the horizontal transmission line (with no tuning capacitor) must be:

$$\cot S^\circ = \frac{30.51}{256.70} = 0.1188$$

or,

$$\cot^{-1} 0.1188 = 83.22^\circ = S^\circ$$

Plugging our obtained value of S° back into (1-3.0), we can prove that $jX_{(3A,3G)} = -j\ 256.70 \cot 83.22^\circ = -j\ 30.52$ Ohms.

The answer is not precisely equal to $-(jK_m \tan 8.78^\circ)$ because we have not been using enough decimal places to make equality exact. Still, we are now resonant at 4.0 MHz if we place a load reactance of -j30.52 Ohms across the top and ground "circle" terminal 2G of the monopole. But wait a minute! You can't buy a tuning condenser which has a zero farads minimum capacity when tuned with its plates wide open! OK – we just look at the label on the box it came in and find the minimum capacity of our condenser. Say it is C_{min} equals 8.0 picofarads. Here is the question we must ask ourselves: How much "electrical length" at 4.0 MHz does a 8×10^{-12} farad condenser, connected across the end terminals 4A,4G of a line of $K_c = 256.70$ Ohms, add to that already existing in the line? Now, at 4.0 MHz, an 8.0 $\times 10^{-2}$ condenser offers a reactance $-jX_c = -j\ (\frac{1}{2\pi}\ 4.0 \times 10^6 \times 8.0 \times 10^{-12}) = -j$ 4,973.60 Ohms. Say we call the length *added by the condenser* ΔS°. Then,

$$\cot \Delta S^\circ = \frac{X_c}{K_c} = \frac{4{,}973.60}{256.70} = 19.331$$

$$\cot^{-1} 19.331 = 2.96^\circ = \Delta S^\circ$$

(1-6.0)

To correct the length of the horizontal transmission line to compensate for the effect of the "line stretcher" action of C when tuned wide open at the high frequency end of the band, we merely remove 2.96 degrees from the conductor so that our horizontal transmission line *itself* becomes

$$83.22^\circ - 2.96^\circ = 80.26 \text{ degrees}$$

The electrical length of the line itself, and the additional electrical line length added by the minimum capacity of C, now sum up to the necessary 83.22 degrees. In addition, to also take into account other small capacity from the leads to the condenser, another four inches or so (about 0.5°) should be removed to make *sure* we reach 4.0 MHz with C wide open. Right here we will continue to use, however, an actual horizontal transmission line length of 80.26 degrees in completing the DDRR design.

Our "paper" DDRR antenna element now is resonant at the 75 meter high frequency limit of 4.0 MHz. Once in a while we like to spin the rig down to 3.5 MHz (well, 3.499 MHz maybe) and do a little brass pounding and DX hunting. When the frequency of the DDRR is changed from 4.0 to 3.5 MHz, this represents a proportionality factor of 3.5 MHz/4.0 MHz equals 0.875. All the DDRR electrical length parameters will change by such proportionality. For example, the vertical post height will change to $h^\circ(3.5\ \text{MHz}) = 8.78^\circ \times 0.875 = 7.68^\circ$. The actual line length S° will become $S^\circ(3.5\ \text{MHz}) = 80.26^\circ \times 0.875 = 70.23^\circ$. We immediately suspect, without having to solve equations (1-3.0) and (1-5.0), that $-jK_c \cot 70.23^\circ$ no longer will be equal to $-(jK_m \tan 7.68^\circ)$. We just *know* that now the DDRR antenna is far out of resonance at 3.5 MHz. However, having seen how the tuning condenser C can act like a "line stretcher," we know how to solve our problem. We first ask, "What load reactance $jX_{(3A,3G)}$ do we now need across the end terminals 2A,2G of the monopole transmission line at 3.5 MHz?" Equation (1-5.0) answers:

$$jX_{(3A,3G)} = -jK_c \cot S^\circ = -(j\ 197.57 \tan 7.68^\circ) = -j\ 26.64 \text{ Ohms}$$

Second question: "How long would S° have to be at 3.5 MHz to give $jX_{(3A,3G)} = -j$ 26.64 Ohms *if capacity C was absent*?" Equation (1-5.1) answers:

$$\cot S^\circ_{(3.5\ \text{MHz})} = \frac{26.64}{256.7} = 0.104;\ S^\circ_{(3.5\ \text{MHz})} = 84.075^\circ$$

We require a total electrical line length S° of 84.075 degrees, but we already have an existing transmission line length of 70.23 degrees at 3.5 MHz. Therefore, we are $84.075^\circ - 70.23^\circ = 13.845$ degrees *too short*. Final question: "If we meshed in the variable plates of condenser C to make its capacity larger in value, how much capacitive reactance $-jX_c$ would we need to 'stretch' our 70.23 degree horizontal transmission line out to a total of 84.075 effective electrical degrees?" Now, if we look at equation (1-6.0) we see it can be rewritten to solve for X_c when ΔS° and K_c are given. We know K_c, and ΔS° is just our needed extra length of 13.845 degrees. Therefore,

$$X_c = (\cot \Delta S^\circ)\ K_c = (\cot 13.845^\circ)\ 256.70 \text{ Ohms}$$
$$X_c = (4.058)\ 256.70 = 1{,}041.56 \text{ Ohms}$$

To obtain 1,041.56 Ohms of capacitive reactance at 3.5 MHz, we will need a condenser capacity of $\frac{1}{2\pi}\ 3.5 \times 10^6 \times 1{,}041.56 = 43.66 \times 10^{-12}$ farads. Of course, the nearest standard tuning capacitor size to 43.66 picofarads is fifty picofarads. The remaining capacity in the variable tuning condenser would permit us to tune down a *bit below* 3.5 MHz, either to listen around or transmit if we had some legal reason (MARS?) to do so. As the DDRR antenna is electrically small, there will be quite a respectable voltage drop across the tuning condenser C. Use 10 kV per 1.0 kW of *peak* input power to the antenna to obtain a decent safety factor to prevent condenser flash-over on modulation peaks. Readers will see that if we kept adding capacity C, the 75 meter band DDRR could be pushed on down to the 160 meter band and even into the standard BC frequency assignments. Please don't try to do this! A *bit* below 3.5 MHz is fine. When you add more tuning capacity to the DDRR to stretch tuning too far, a number of undesirable things begin to happen to lower efficiency. We have an optimum design up to here. Don't ruin it, please. If you need 160 meter coverage, design a separate 160 meter band element according to the relations given here for 75 meters. In Part II we will tell how to combine the elements into a single allband DDRR which can hop from one band to the next like a jackrabbit.

Matching the DDRR

In Fig. 3(e) the DDRR transmission line section is shown, still in "straightened out" form. Although we do not yet know the values of radiation resistance R_r and the environmental ohmic loss resistance R_Ω, these two "resistors" are shown schematically connected in series between the base terminal 1A of the vertical post and ground 1G. In antenna theory, radiation resistance R_r is always referred, by convention, to a current maximum point in an antenna. Although "referred" to this point, however, the total resistance $R_t = R_r + R_\Omega$ may be "transformed" to any other point X on the antenna, just as our top load reactance $jX_{(3A,3G)}$ was transformed to the base terminals 1A,1G of the monopole. That, however, was a "movement" along the line length in the *opposite* direction. We also recall that when tuning capacitor C made $jX_{(3A,3G)}$ correct in value, it transformed along the length h° of the vertical post transmission line and became zero reactance at its base. The radiation resistance magnitude of an electrically small antenna is not large. By design, we also go all out to keep the ohmic loss resistance R_Ω small in value.

Now, if we tried to conventionally feed the DDRR in series with the vertical post base, we would face the very severe problem of making an impedance match between this very small value of *resonant* input impedance $Z_{in}(1A,1G) = R_r + R_\Omega + j0$ Ohms there and the characteristic impedance Z_o of our standard feedline. To achieve such match would require an *auxiliary* impedance matching transformer which would *also* have to be *tuned in track* with C when we changed frequency. To avoid this needless difficulty and technical messiness, we use the DDRR antenna itself as an impedance step-up transformer, so that we can connect the standard feed transmission line directly to the DDRR antenna at some conductor point X to obtain a low vswr match. It was said a while back that the DDRR is just a system of open wire, transmission line "stubs." There is a really wonderful thing about a resonant transmission line stub: At resonance, no matter at which point along its conductors you measure impedance, it always is found to be a *pure resistance*. If one end of a "one wire" line stub is "shorted," and you measure between the conductor point X and ground, you get an input impedance,

$$Z_{in}(X,G) = \frac{Z_1 \times Z_2}{Z_1 + Z_2} \qquad (1\text{-}7.0)$$

This input impedance is schematically shown in Fig. 3(f), where in equation (1-7.0)

$$Z_1 = K_1 \frac{(R_t + j0)\cos\theta_1^\circ + jK_1 \sin\theta_1^\circ}{K_1 \cos\theta_1^\circ + j(R_t + j0)\sin\theta_1^\circ}$$

$$Z_2 = K_2 \frac{(0 + jX_c)\cos\theta_2^\circ + jK_2 \sin\theta_2^\circ}{K_2 \cos\theta_2^\circ + j(X_c)\sin\theta_2^\circ}$$

K_1 is the characteristic impedance of the transmission line section to the *left* of point X of electrical length ϕ_1 degrees; and K_2 is the characteristic impedance of the transmission line section to the *right* of point X of electrical length ϕ_2 degrees; and $R_t = R_r + R_\Omega$; and X_c is the reactance of tuning condenser C at frequency f_o.

The great thing is that in practical design of a DDRR you don't have to bother to solve equation (1-7.0), nor do you have to have a nice but expensive Z bridge in order to make a low vswr impedance match to the DDRR in finding point X. This is because, when you design your DDRR antenna element section as given here and adjust condenser C to produce resonance at the operating frequency f_o, all shunt reactance at point X and ground goes to zero, leaving only a resistive value of input impedance. What you do instead is this: (a) carefully grid dip your new DDRR (loose coupling to the post base) to an f_o close to the *middle* of the ham band; (b) put the rig on low power or "tune" so that it feeds a signal at f_o into the coax leading out to the DDRR; (c) connect a vswr meter in series with the end of the coax close to the DDRR where you can read the instrument; (d) connect the shield braid of the coax on the other side of the vswr meter to a *temporary* ground point; and (e) starting at a point X a little way up the *vertical post*, tap the inner conductor of the coax to successively higher points X until vswr falls to 1.0:1 at f_o.

A few words of fraternal advice, however:

(1) Make your grid dip reading to f_o while adjusting C to get resonance *without the coax feed connected to the DDRR;* otherwise, you will get a false reading.

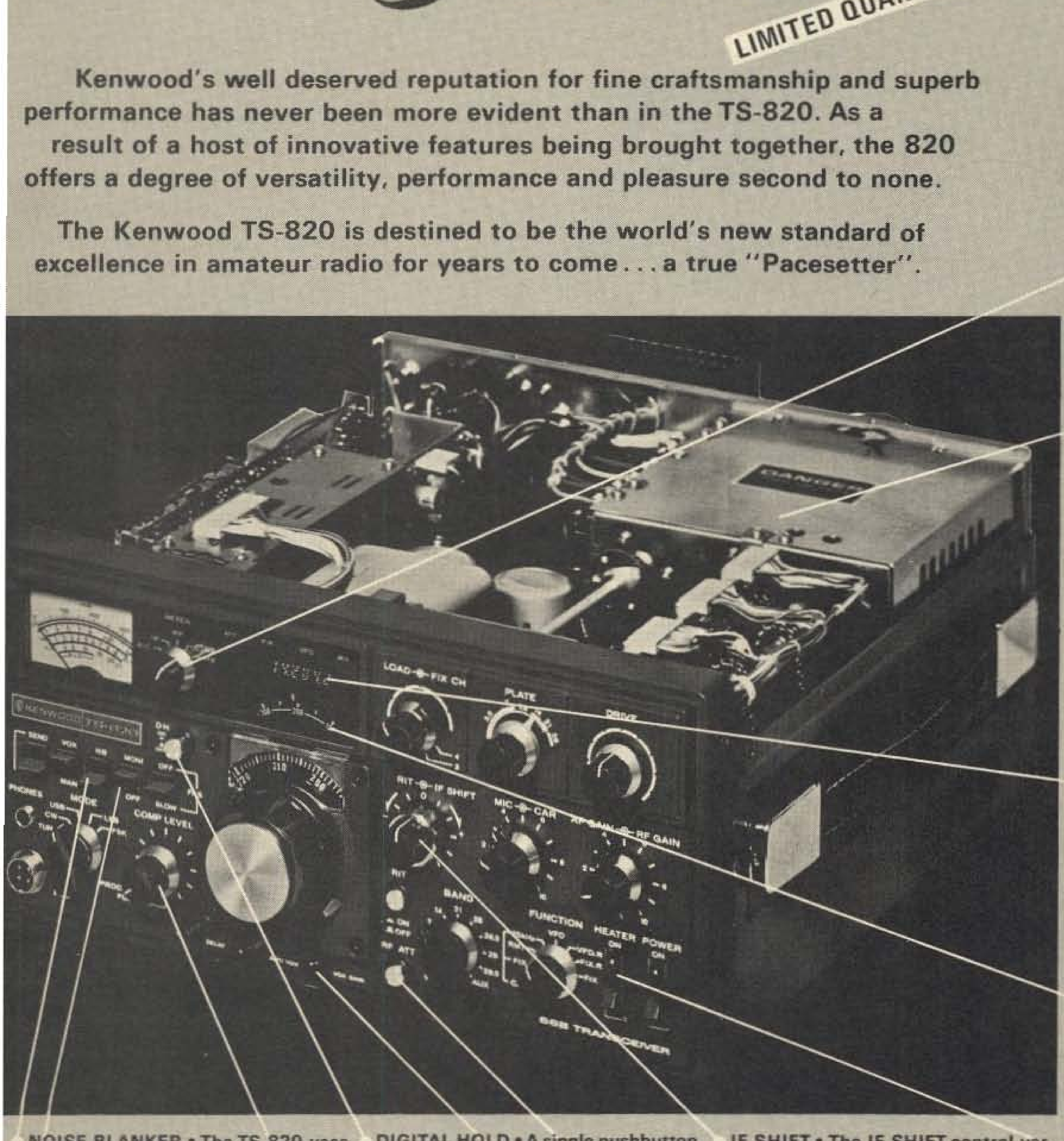
(2) When you then connect the coax in shunt across point X and ground you will disturb the DDRR's near-zone field and the resonance will shift frequency. That doesn't matter: With the rig *still on* f_o, "tweak" the tuning condenser CCW or CW until you find the point of *minimum* vswr at that point X on the antenna. If the *minimum* vswr found by careful adjustment of C is higher than 1.0:1, shift to a higher point X on the antenna and repeat the "tweaking" process. When you find the *midband* frequency point X where adjustment of C gives a minimum vswr of 1.0:1, you will find that this *same fixed point* X will yield a vswr of less than 2:1 when the DDRR is tuned anywhere in the band (or a bit more). The final point X, found for 1.0:1 vswr in the middle of the band, *may* end up either on the vertical feed post *or* out on the conductor of the horizontal transmission line section; its exact location is determined by h° and K_m. The larger h° is and the lower K_m is, the *lower on the antenna* the 1.0:1 vswr point X will be found. Lastly, you will be bothered by the fact that the DDRR tuning is very touchy and that the presence of your body near the antenna affects tuning. This happens in all electrically small antennas of *high* efficiency. When you actually match your finished DDRR it will be in a different shape and have a remotely driven tuning condenser, and there will be no ordinary kind of metal sheet or radial wire ground plane beneath it. You will be able to mount it on the wooden garage roof or rest it on coke bottles over the bare ground. After giving last touches to the ham band DDRR, we will go on to describe some other electrically small, transmission line antennas which we hope you will find both interesting and useful. Because of your briefing on the DDRR, understanding these other antennas will be mere child's play. ■

KENWOOD'S TS-820
the Pacesetter

LIMITED QUANTITIES AVAILABLE IN JULY

Kenwood's well deserved reputation for fine craftsmanship and superb performance has never been more evident than in the TS-820. As a result of a host of innovative features being brought together, the 820 offers a degree of versatility, performance and pleasure second to none.

The Kenwood TS-820 is destined to be the world's new standard of excellence in amateur radio for years to come . . . a true "Pacesetter".



NOISE BLANKER • The TS-820 uses an efficient noise blanker circuit, another Kenwood exclusive. A special crystal filter assures unsurpassed efficiency in eliminating unwanted pulse noises.

RF MONITOR • Built-in monitor circuit allows you to hear your own voice by sampling the RF signal. Especially useful for adjusting the RF Processor.

HIGH STABILITY VFO • The VFO, heart of any SSB transceiver, is an exclusive Kenwood design using FET technology.

DIGITAL HOLD • A single pushbutton switch offers the operator unprecedented versatility. The digital hold circuit will lock the counter and display at any frequency, but will allow the VFO to tune normally. Ever wanted to return to a certain spot on the band and forgotten the frequency? That won't happen again with the new digital hold feature on the Kenwood TS-820.

SPEECH PROCESSOR • An HF circuit provides quick time constant compression using a true RF compressor as opposed to an IF clipper. Amount of compression is adjustable to the desired level by a convenient front panel control.

IF SHIFT • The IF SHIFT control varies the IF passband without changing the receive frequency. Enables the operator to eliminate unwanted signals by moving them out of the passband of the receiver. This feature alone makes the TS-820 the pacesetter that it is.

RF ATTENUATOR • Easy, one touch activation of the attenuator supplies 20 dB of padding on receive.

VOX • A voice-activated microphone circuit is built into the TS-820 with VOX GAIN, ANTIVOX, and VOX DELAY controls placed on the front panel for convenient adjustment any time.

Features

PLL • The TS-820 employs the latest phase lock loop circuitry. The single conversion receiver section performance offers superb protection against unwanted cross-modulation. And now, PLL allows the frequency to remain the same when switching sidebands (USB, LSB, CW) and eliminates having to recalibrate each time.

FULL METERING • During receive, an easy to read meter functions as an S-meter. The same meter displays ALC level, plate current, RF output, and plate voltage during transmit. Includes COMP setting for adjusting the compression level of the built-in speech processor.

FINAL AMPLIFIER • The TS-820 is completely solid state except for the driver (12BY7A) and the final tubes. Rather than substitute TV sweep tubes as final amplifier tubes in a state of the art amateur transceiver, Kenwood has employed two husky S-2001A (equivalent to 6146B) tubes. These rugged, time-proven tubes are known for their long life and superb linearity. The input power of the TS-820 is conservatively rated at 160 W DC, 200 W PEP. Tubes run cool with the aid of a noiseless fan (standard) mounted on the rear panel. The above tube and power combination minimizes the possibilities of TVI and helps to maintain the Kenwood reputation for excellent audio quality.

DIGITAL READOUT DG-1 • (optional) A digital counter display can be employed as an integral part of the VFO readout system. Counter mixes the carrier, VFO, and first heterodyne frequencies to give *exact* frequency. Figures the frequency down to 10 Hz and digital display reads out to 100 Hz. Both receive and transmit frequencies are displayed in easy to read, Kenwood Blue digits.

DRS DIAL • Includes the same satin-smooth planetary drive found on other fine Kenwood models plus special, high-precision gears to add a new "monoscale" feature for easier frequency readout. LSB, USB, and CW operating frequencies can be accurately read from the same pointer.

HEATER SWITCH • The filaments of the three vacuum tubes may be turned off during periods of "receive only".

CW AUDIO CHARACTERISTICS • During CW reception, a special filter is used to alter the audio frequency response to provide a more comfortable, easy to copy tone.

Other features include:
- Built-in 25 kHz calibrator*
- Built-in speaker*
- CW Sidetone and semi-break in*
- Rear panel terminals for linear amplifier, IF OUT, RTTY, and XVTR.
- Handy phone patch IN and OUT terminals*

*Also available, the VFO-820 . . . the perfect companion to the TS-820.

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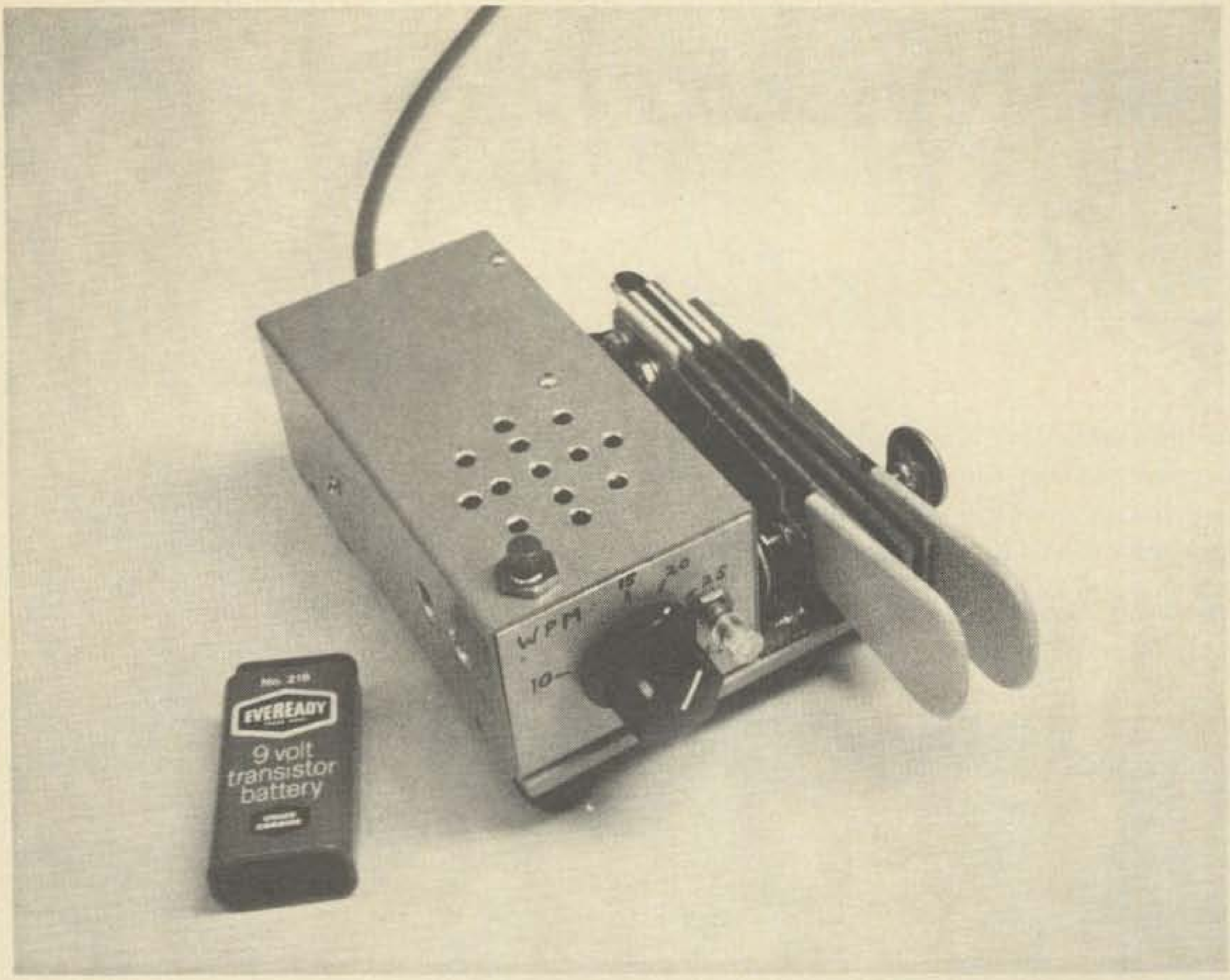

Fig. 1. MINI-MOS electronic keyer with dual paddle key. The transistor battery in the foreground not only shows the size of the keyer, but can also power the keyer for over one year of daily operation.

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MINI-MOS -- The Best Keyer Yet?

--nothing Mickey Mouse about this one

Some time ago, when my code speed had gradually crept up to 16 wpm, I felt ready to trade my straight key for something more advanced. A "COSMOS IC electronic keyer," described in an article by WB2DFA[1] seemed to be a good choice. The keyer was built and seemed to perform fine. In due time, however, some limitations were found, which unfortunately proved to be inherent to the design approach chosen by WB2DFA:

- The keyer did not have a dot memory. This makes it necessary to move the keyer paddle exactly in the right rhythm; otherwise one can easily lose dots, especially in letters like K, C and Y.
- The keyer used a continuously running clock. When the dot or dash contact is closed, the keyer has to wait for the next clock pulse before the code element is sent. This is especially noticeable at low code speeds.
- The keyer drew very little current and was, therefore, operated from a 9 volt transistor battery. Theoretically the battery should give over 200 hours of operation. If one forgets to turn off the keyer, however, it does not last very long.

At a local hamfest I had a chance to compare several commercially manufactured keyers, including some that had dot and dash memory and iambic keying. After this experience I was no longer satisfied with my old keyer and decided to design a better one. My keyer was to incorporate the features available in the best commercial keyers, but would also fully utilize the advantages of complementary MOS technology.

The result of this design project was the MINI-MOS keyer shown in Fig. 1, which has now been in use for over one year. This keyer has the following features:

- Dot and dash memory and gated clock.
- Iambic operation when used with a double ("squeeze") paddle.
- Extremely low standby current, which makes it unnecessary to provide an on-off switch.
- Low "key down" current, which makes it possible to operate the keyer from a normal 9 volt transistor battery for at least one year.
- Low component count (7 ICs and few discrete components).
- Built-in sidetone oscillator with speaker and keying circuit for grid-block keyed transmitter.

The completed keyer is very compact and can be packaged in a minibox measuring only 2 by 2 by 4 inches, including batteries and sidetone speaker. Together with a small dual paddle, the keyer was mounted on a base only 4 by 4 inches in size.

Circuit Description

The keyer utilizes the "complementary metal oxide silicon" or CMOS technology. Digital integrated circuits based on this technology were first introduced by RCA as the CD4000 series, which is now also available from several other manufacturers. While normally the acronym CMOS is used for the technology, RCA favors the term COS/MOS. Another family of CMOS ICs is the 74C series, which is pin compatible with the well-known 7400/5400 TTL series. Until not too long ago, CMOS ICs were a rarity on the surplus market and, if available, were much more expensive than comparable TTL ICs. But today CMOS ICs are available from many mail order suppliers. While prices have come down substantially, they still can differ a lot between dealers and it pays to compare advertisements. Because the CD4000 series seems to be available more readily than the 74C series, it was used in the design of the MINI-MOS keyer.

The operation of the keyer circuit will be described using the "positive logic" convention. This simply means that when the voltage at a certain point in the circuit is "high" (close to the positive supply voltage VDD), it will be assigned a logical "1." Conversely, the logical "0" corresponds to a "low" voltage (close to the negative supply voltage VSS).

Fig. 2 shows the circuit diagram of the keyer and lists the parts used. The dot and dash contacts of the keyer paddles are connected to two RS (reset-set) flip flops which serve as memories for the entered code elements. These flip flops are made up from four NAND gates contained in IC U1. One of the flip flops is redrawn in Fig. 3, which also shows the so-called "truth table" of the circuit. This table simply indicates the voltages at the outputs Q and $\bar{Q}$ of the circuit for the four possible combinations of input voltages. While these flip flops store the entered dot or dash, the code element currently being sent is stored in one of the two flip flops U3A and U3B. These flip flops are of the D (data) type and can be set and reset in two different ways. A logical 1 at the S or R input of the flip flop will set or reset it asynchronously — that is, at the instant the voltage goes from low to high. The flip flop can also be set by a logical 1 and reset by a logical 0 applied to the D input. This, however, occurs synchronously with a clock signal applied to the C (clock) input and at the instant this signal makes a transition from high to low.

When the keyer is in standby (that means if no code element is currently being sent), dot flip flop U3A as well as dash flip flop U3B are in the reset position and both their $\bar{Q}$s will be high. In this case the output of AND gate U4A is also high. This output is connected to one input of the AND gates U2B and U2D. This has the effect that the output of the dot memory is connected to the S input of dot flip flop U3A, while the output of the dash memory is connected to the S input of dash memory U3B. One input of NOR gate U7A also receives a high signal which stops the clock.

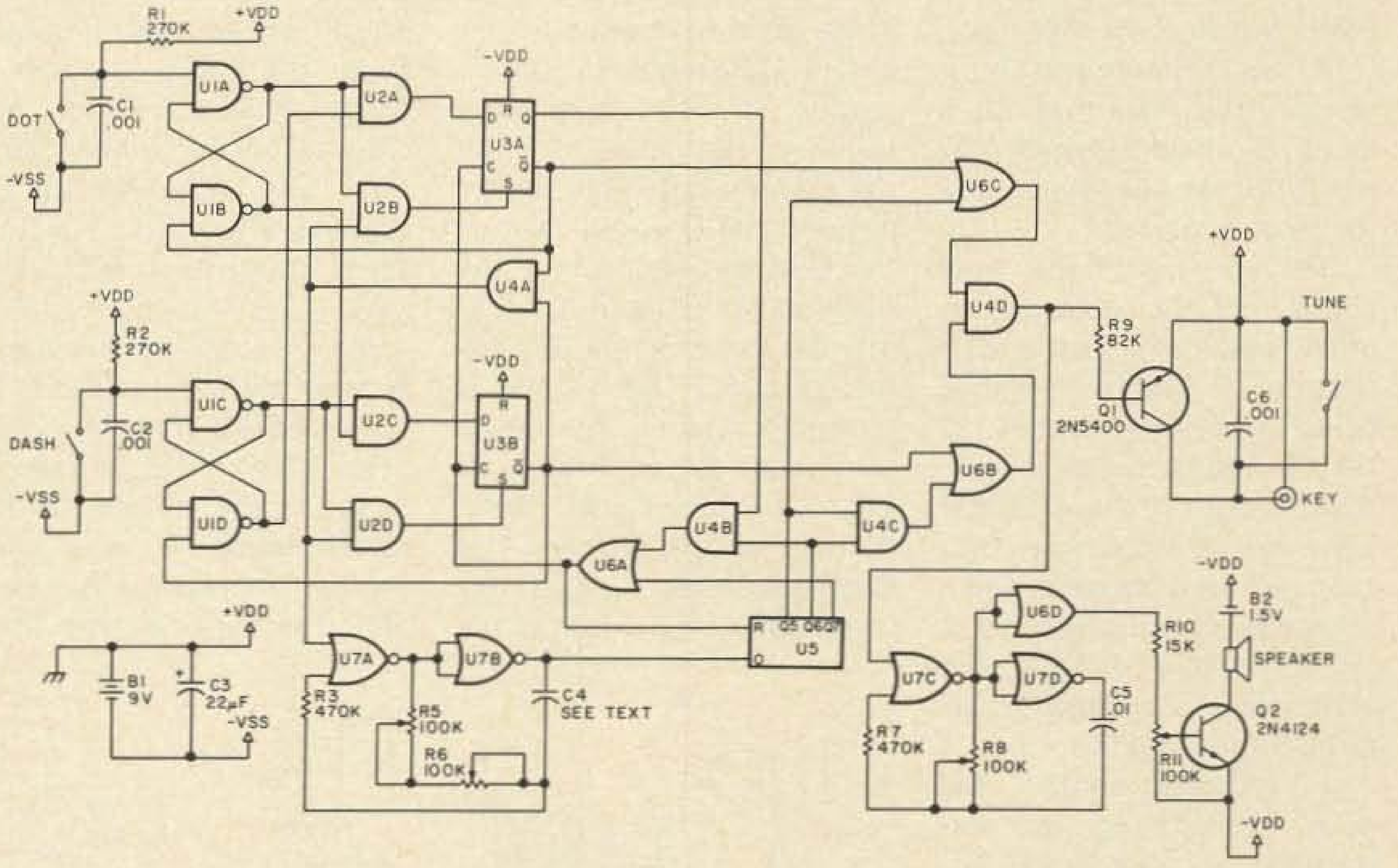
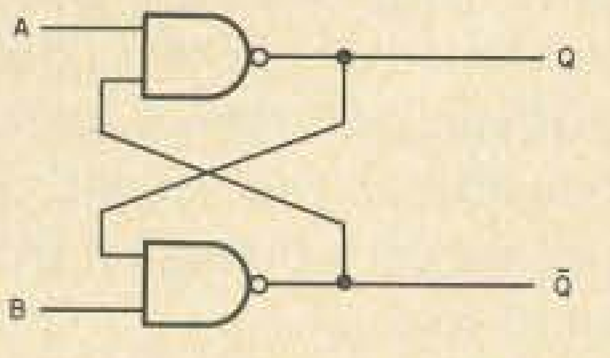


Fig. 2. Circuit diagram of the MINI-MOS keyer. Parts list: U1 — 4011 quadruple 2-input NAND; U2, U4 — 4081 quadruple 2-input AND; U3 — 4013 dual D-type flip flop; U5 — 4024 7-stage binary counter; U6 — 4071 quadruple 2-input OR; U7 — 4001 quadruple 2-input NOR; Q1 — 2N5400 or other small signal PNP transistor with a voltage rating sufficient for the keying voltage of the transmitter; Q2 — 2N4142 or most any other small signal NPN silicon transistor; R5, R11 — miniature potentiometers, 100k Ohm linear taper; R6, R8 — trimpots, one turn, 100k Ohm; C4 — see text; C3 — 22 microfarad, 15 volts; B1 — standard 9 volt transistor battery; B2 — AA cell, regular or alkaline type; SP — miniature speaker, 2 inch diameter (Radio Shack or other).

Fig. 3. Reset-set (RS) type flip flop made up from NAND gates. The "truth table" shows the relation between signals at the inputs and outputs of the circuit.



	A	B	Q	$\bar{Q}$
SET	0	1	1	0
RESET	1	0	0	1
STORE	1	1	X	$\bar{X}$
AMBIGUOUS	0	0	1	1

Now, when either the dot or the dash contact is closed, causing a logical 0 at the set input of the dot or dash memory, the Q output of this memory flip flop will go high. This in turn causes the corresponding D flip flop to be set instantaneously via its S input. When the D flip flop is set, its $\bar{Q}$ output goes low. This causes the appropriate memory flip flop to be reset at the instant the dot or dash contact is opened again. The logical 0 at the $\bar{Q}$ output of the D flip flop, via AND gate U4A, also disconnects both memory flip flops from the S input of their associated D flip flop. At the same time the clock is started.

The D flip flops now operate in the synchronous mode and can change their state only when a negative going transition occurs at their C inputs. Let us assume that the dot flip flop U3A has been set in this way, and examine what happens when a negative transition occurs at the C inputs of U3A and U3B. There are actually four different possibilities:

1. The dot contact has been opened and the dot memory has been reset. The dash memory has not been set. This results in a low signal at the D input of U3A. When the clock signal goes low, this flip flop will therefore be reset and the circuit returns to the standby status.

2. The dot contact is still closed and the dot memory, therefore, has not been reset. This causes a high signal at the D input of U3A. This flip flop thus does not change its state when the clock signal goes low, which results in another dot being sent.

3. The dot contact has been opened and the dot memory has been reset, but the dash contact has been closed, setting the dash memory. This results in a low signal at the D input of U3A and a high signal at the D input of U3B. When the clock signal goes low, U3B will be set, while simultaneously U3A is reset. Thus a dash will be sent following the dot.

4. Both the dot and the dash contact are closed and both memory flip flops are therefore in the set position. This would place a logical 1 at the D inputs of both U3A and U3B, were it not for the iambic gates U2A and U2C. These gates have one of their inputs connected to the $\bar{Q}$ output of the "opposite" memory flip flop. Because the dash memory is in the set position, its $\bar{Q}$ output is low. Via U2A this results in a low signal at the D input of U3A. The dot memory is also in the set position, but U3A is trying to reset it. As can be seen from the truth table in Fig. 3, this causes both outputs of the memory flip flop to go high. Via U2C this results in a high signal at the D input of U3B. When the clock signal goes low, this causes U3A to be reset and U3B to be set. If the dot and dash contacts continue to be closed, the process will be reversed the next time the clock signal goes low. The keyer, therefore, will send dots and dashes alternately in the so-called iambic mode until one or both key contacts are opened. (The word iambic, incidentally, comes from the iamb or iambus, a Greek verse in which long and short syllables alternate.)

U3A remains in the set position while a dot is being sent, as well as for the space that follows. The clock pulse to reset U3A, therefore, has to occur two dot elements after the flip flop has been set. The clock pulse for resetting the dash flip flop U3B has to come 4 dot elements after it has been set. In order to obtain the spaces after the dot and dash, pulses after 1 and after 3 dot elements are also required. These pulses are obtained from the clock through a pulse divider. The clock consists of the NAND gates U7A and U7B, which are connected as a free running, gated multivibrator[2,3]. This circuit is amazingly stable, and a variation of the supply voltage between 6 and 10 volts causes a frequency shift of only about 1%. The square wave at the output of the multivibrator is not completely symmetrical, however, and the first period after being gated on may have a slightly different length than the following periods. In order to avoid timing errors, the clock signal was not used directly, but was divided in a frequency divider. The IC U5 very conveniently contains not fewer than seven flip flops which are connected as a seven stage binary counter. The output of the fifth stage, Q5, goes high after 2^4 or 16 input pulses, and goes low again after 2^5 or 32 input pulses. This output is used to represent one dot element. Similarly, the output of the sixth binary stage, Q6, represents two dot elements, and the output of the seventh stage, Q7, four dot elements. A signal representing three dot elements is obtained by connecting Q5 and Q6 to the inputs of AND gate U4C. A reset pulse after 2 dot elements must occur only if a dot is being sent, that is, if U3A is in the set position. Output Q of U3A is therefore used to gate output Q6 via AND gate U4B. If U3A is not in the set position, the reset pulse comes from output Q7 and occurs after 4 dot elements. OR gate U6A is used to combine the two reset pulses. The output of this gate not only provides the clock pulse for the two D flip flops, but also resets the binary counting stages of U5. As a matter of fact, when Q6 or Q7 goes high and applies a high signal to the R input of U5, resetting the binary stages causes the output to immediately go low again. The clock pulse, therefore, is only about one microsecond long.

Most modern transmitters and transceivers use grid block keying and their keying input carries a negative voltage of somewhere between 50 and 150 volts with respect to ground. On "key down," the key has to sink a current of a few milliamperes. This voltage can easily be keyed with a PNP

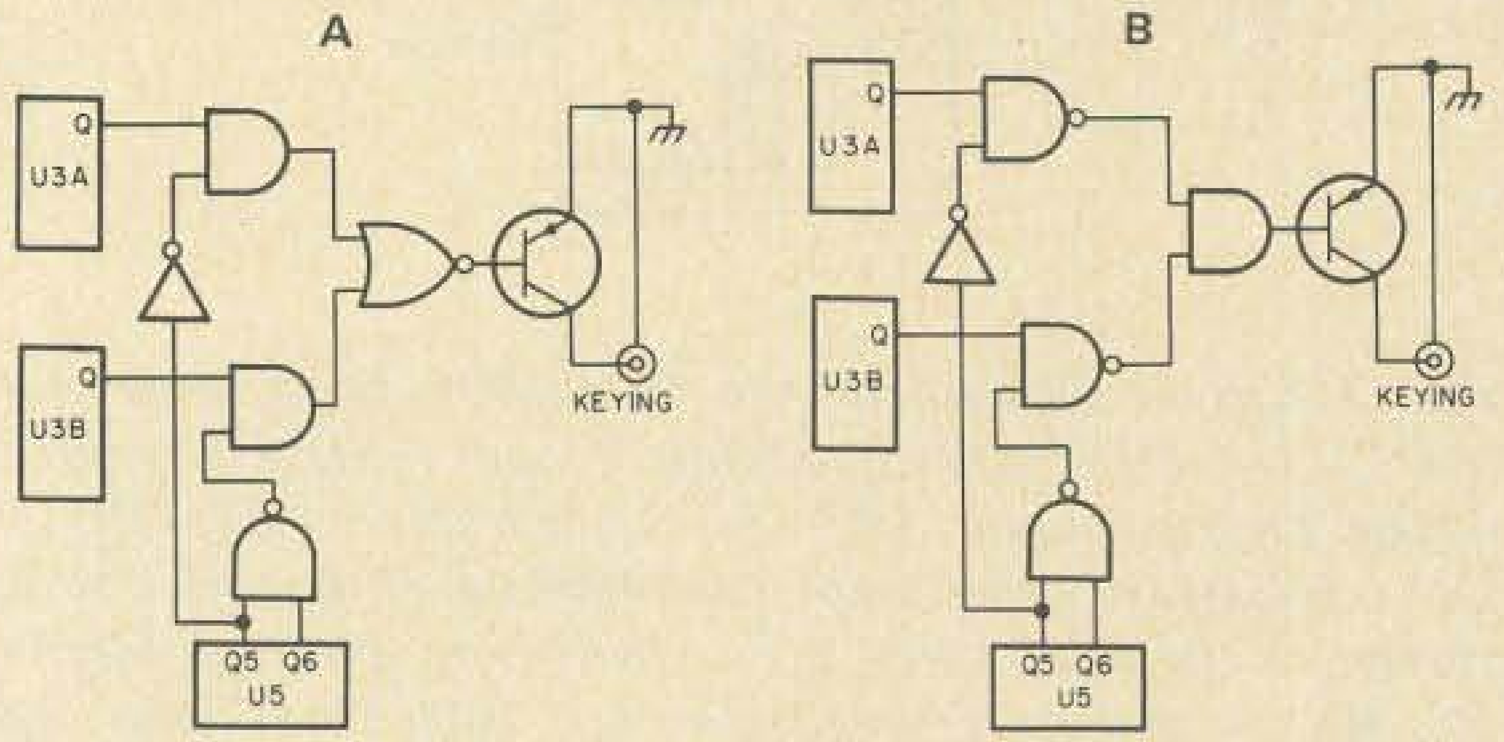


Fig. 4. a. First design of the keying section. b. DeMorgan's theorem (see text) applied to the NOR gate.

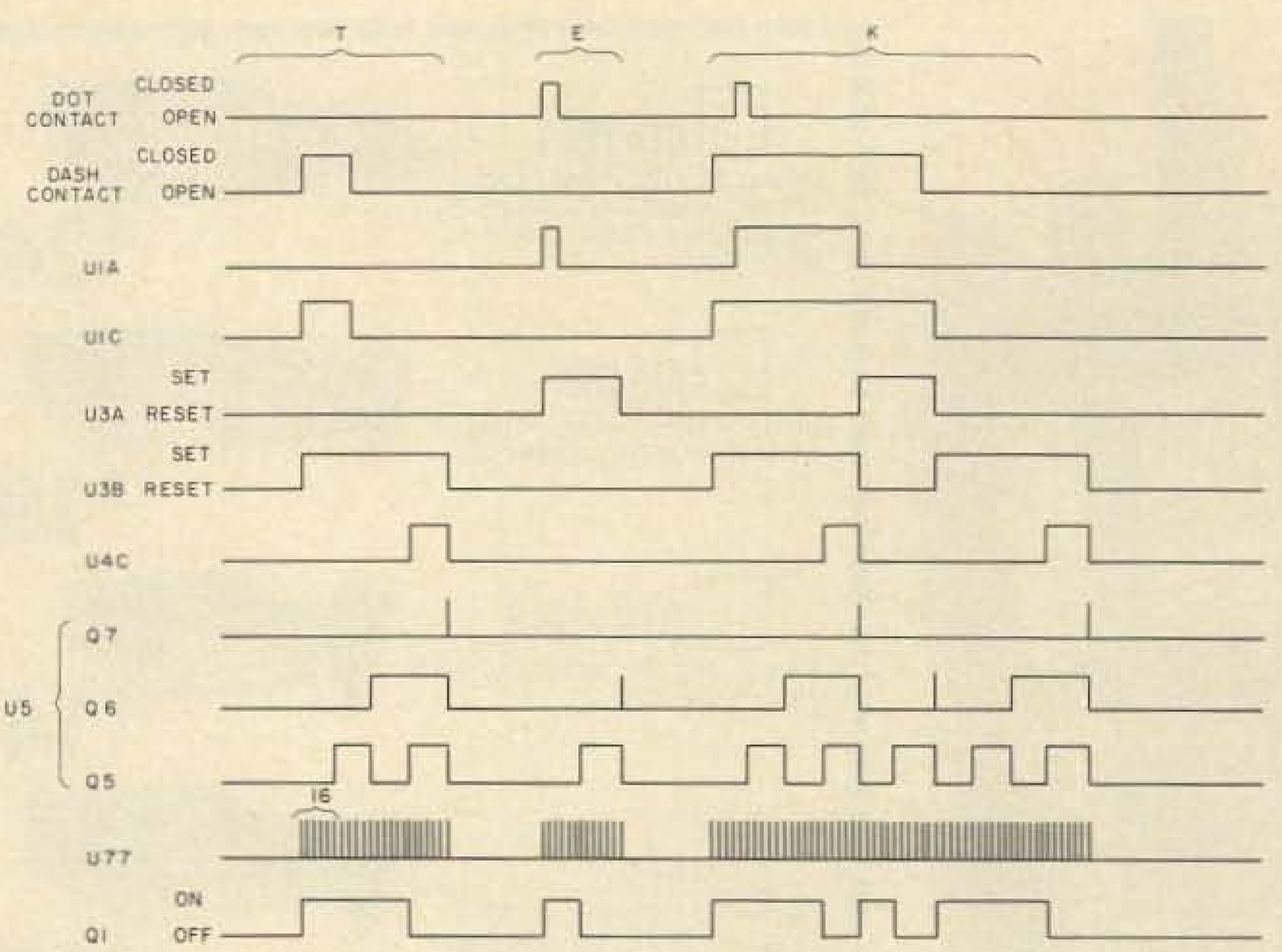


Fig. 5. Pulse diagram showing the signals at different points of the circuit when the letters "-T-E-K-" are being sent.

transistor of sufficiently high voltage rating. The emitter of this transistor has to be connected to the +VDD voltage of the CMOS circuit. The transistor is turned on by a logical 0 at its base.

The initial design of the keying section is shown in Fig. 4a. The two AND gates together with the inverter and NAND gate are used to turn

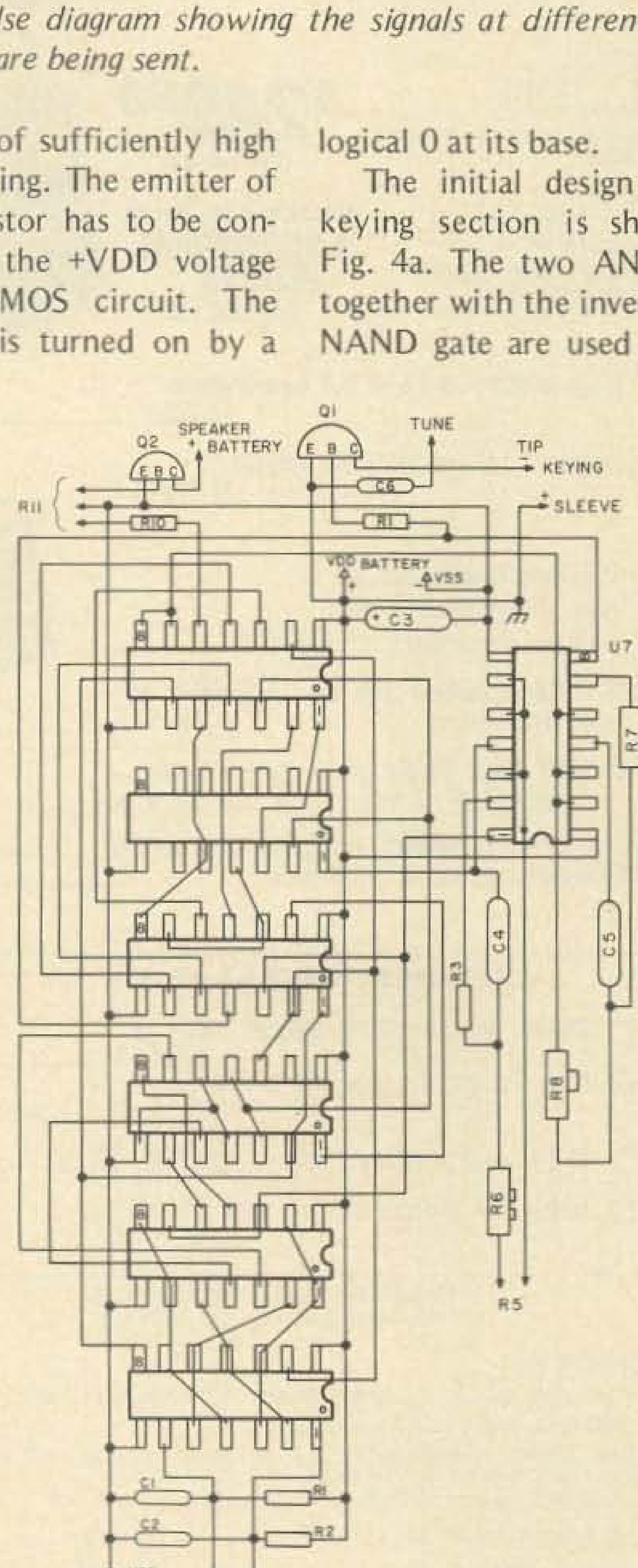


Fig. 6. Wiring diagram of the MINI-MOS keyer. View is at the pins *of the integrated circuits.*

the keying signal off during the last dot element of a keying cycle, thus providing the space after the dot or dash. The circuit in this form, however, does not utilize efficiently the gates that are left over from the timing section of the keyer. The circuit of Fig. 4a was therefore modified using a rule known as the DeMorgan theorem (named after a 19th century British mathematician). This rule simply states that a gate can be replaced by its opposite type (AND with OR or OR with AND) if inputs and output of the gate are inverted. If this rule is applied to the NOR gate of Fig. 4a, the circuit of Fig. 4b is obtained. If the rule is applied a second time, this time to the two NAND gates of Fig. 4b, the final circuit shown in Fig. 2 results, which utilizes the available gates much more efficiently than the initial design.

The sidetone oscillator was built from the remaining two NOR gates (U7C and U7D), using the same circuit as for the clock. One OR gate, U6D, which was left over, was put to good use as a buffer to make the frequency of the sidetone oscillator independent of the sidetone volume. U6D has to be connected to the output of U7C, which is low during standby to keep current from flowing during the standby mode. The sidetone signal is applied to the base of transistor Q2, which is driven in class C mode. When volume control R11 is completely counterclockwise, Q2 remains cut off and no separate on-off switch for the sidetone is necessary. The power for the speaker is supplied by a separate battery (one AA cell). This was found to be simpler than providing an output transformer for the speaker.

The keying transistor, Q1, is rated for a maximum collector-emitter voltage of -120 volts. Its current sinking capability is determined by the resistance of R9. With the value given in Fig. 2, the keyer can sink currents of up to 4 milliamperes even when the battery voltage has dropped to 6 volts.

For use with a cathode- or emitter-keyed transmitter, Q1 can be used to drive an NPN transistor with a voltage and current rating sufficient to key the transmitter. In this case R9 has to be chosen so that the NPN transistor saturates safely on "key down." The MINI-MOS keyer also will have to be grounded at the -VSS rather than the +VDD side of the battery. This modification, however, is likely to increase the current drain on the battery.

In order to show how the different parts of the MINI-MOS keyer circuit work together, a timing diagram is given in Fig. 5. This diagram shows the voltages at various points of the circuit when the letters "-T-E-K-" are being sent. For the letter K, which has been shown as being sent in the iambic mode, the function of the dot and dash memories can easily be seen.

Construction of the Keyer

It is much easier to build the MINI-MOS keyer than to understand the functioning of its circuit. The circuit was assembled on a small piece of perforated circuit board. The wiring was done with #24 bus wire, using spaghetti tubing (preferably teflon) as insulation at the points of wire crossing. All that is necessary for this technique is a small soldering iron, tweezers, a steady hand, and – if one is over 40 – a good watchmaker loupe. Long wire runs, like the supply buses, were "woven" through the holes of the circuit board to stabilize the wire in order to prevent shorts. From previous experience, however, it was found advisable to work from a wiring diagram in order to prevent errors. This wiring diagram is shown in Fig. 6. (It would be a service to mankind if some fellow ham experienced in the fine art of PCB layout would convert Fig. 6 into a printed circuit board.) A view of the completed circuit board, mounted in the minibox together with the other components, is shown in Fig. 7.

It might be worth mentioning that the circuit was first assembled on one of the plug-in boards available for the breadboarding of IC circuits. In transferring the breadboard to the final circuit board, an unusual problem was encountered: The circuit did not work, because the pinout diagram for the CD4013 in the RCA databook (1975 edition) contained an error (Fig. 6, however, shows the correct connection).

The keyer has only three external controls: adjustments for code speed (R5) and sidetone volume (R11), and the tuning button, which was mounted on top of the minibox. Trimpots, accessible through holes, allow setting of the sidetone frequency (R8) and the maximum code speed (R6). The minimum code speed is determined by C4. When a .05 microfarad capacitor is used, the slowest code speed is about 5 wpm, while a .025 microfarad capacitor results in a minimum speed of about 10 wpm. These capacitors should be of the mylar type in order to avoid frequency changes with changing temperatures. Because of the stability of the clock circuit, it is actually possible to calibrate R5 directly in wpm, which should be of interest if the keyer is used to send code practice lessons. The standard code speed, as it is used for the FCC code test, is based on words exactly 50 dot elements long (the reference word is "Paris"). Because 16 pulses at the output of the master clock (U7B) correspond to one dot element, the code speed can be calibrated by measuring the clock frequency. If available, a counter can be used for this purpose; otherwise, the frequency can be beat against an audio oscillator. A code speed of "X" wpm corresponds to a clock frequency of X times 13.3 Hz. Thus a code speed of, for instance 20 wpm, is sent when the clock is set to a frequency of 266 Hz.

The standby current drawn by the circuit is less than 1 microampere. In the standby mode the life of the battery, therefore, is actually determined by its shelf life. On "key down" (actually, when both paddles are pressed), the circuit draws between 850 and 1000 microamperes, depending on the setting of the sidetone volume. For this current value the tables of the battery manufacturers show an estimated life of about 450 hours until the battery has been discharged to 5 volts. The battery should therefore be good for well over one year of daily operation. So, once a year let the MINI-MOS keyer have a new set of batteries, whether it needs it or not. The sidetone amplifier, however, at maximum volume draws up to 10 milliamperes of current. With a standard (carbon-zinc) AA cell, this results in a battery life of only about 200 operating hours. If the sidetone is used at high volume settings, use of an alkaline type AA cell is therefore recommended to assure a full year of operation on one set of batteries.

The MINI-MOS keyer can be operated with any single or double (squeeze) paddle key, although the iambic feature can, of course, be utilized only with the latter type. ■

References

[1] James W. Pollock WB2DFA, "COSMOS IC Electronic Keyer," *Ham Radio*, June 1974, page 6.

[2] J. A. Dean and J. P. Rupley, "Astable and Monostable Oscillators using RCA COS/MOS Digital Integrated Circuits," *RCA Application Note ICAN-6267.* (This application note is reprinted in the RCA COS/MOS data book, 1974 and 1975 editions.)

[3] *RCA COS/MOS Integrated Circuits Manual,* Technical series CMS 271, page 89.

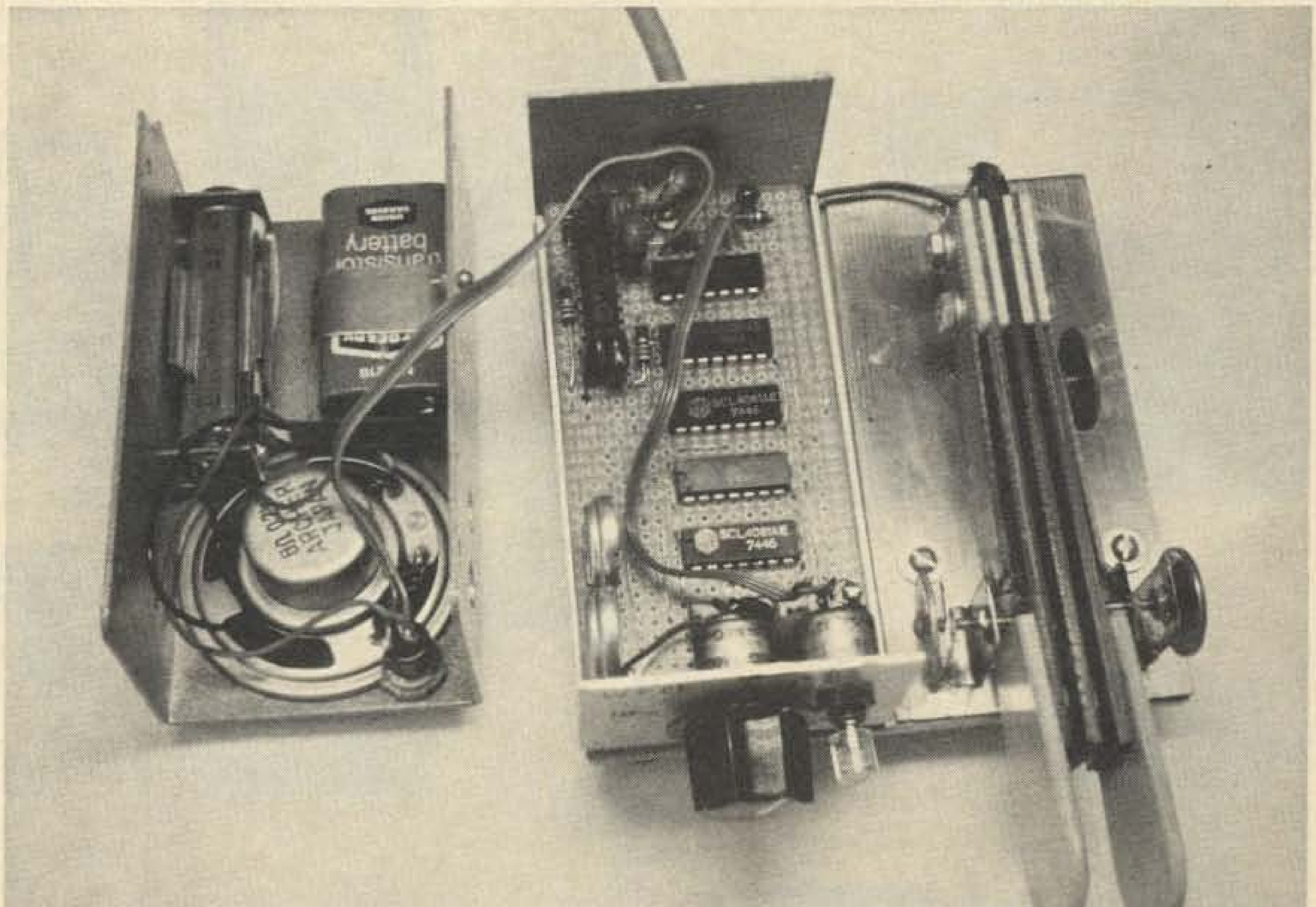


Fig. 7. View of the completed keyer with the top of the minibox removed. The sidetone speaker, the batteries and the tuning push-button are mounted in the top and connected to the circuit board by a 4 lead ribbon cable.

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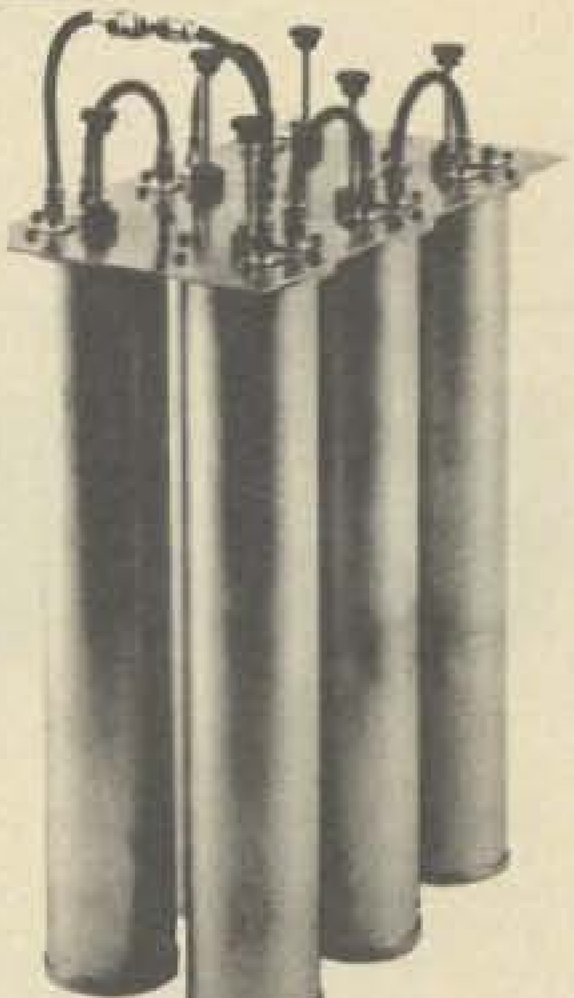

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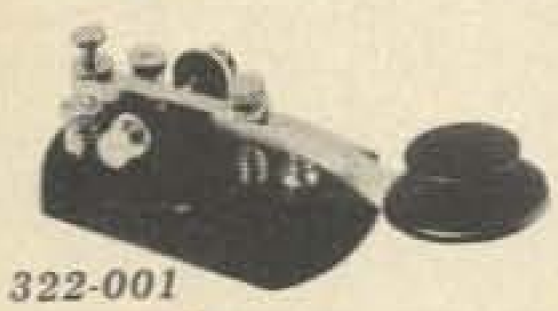

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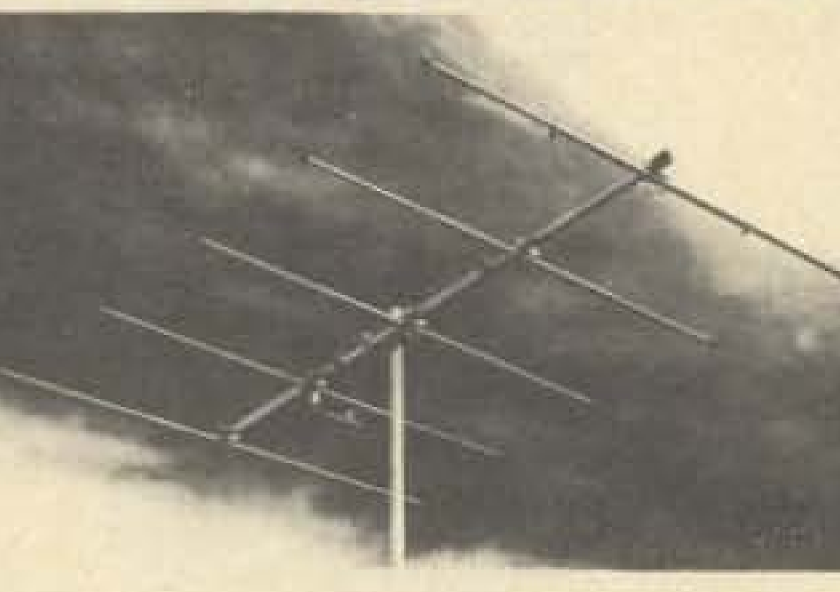

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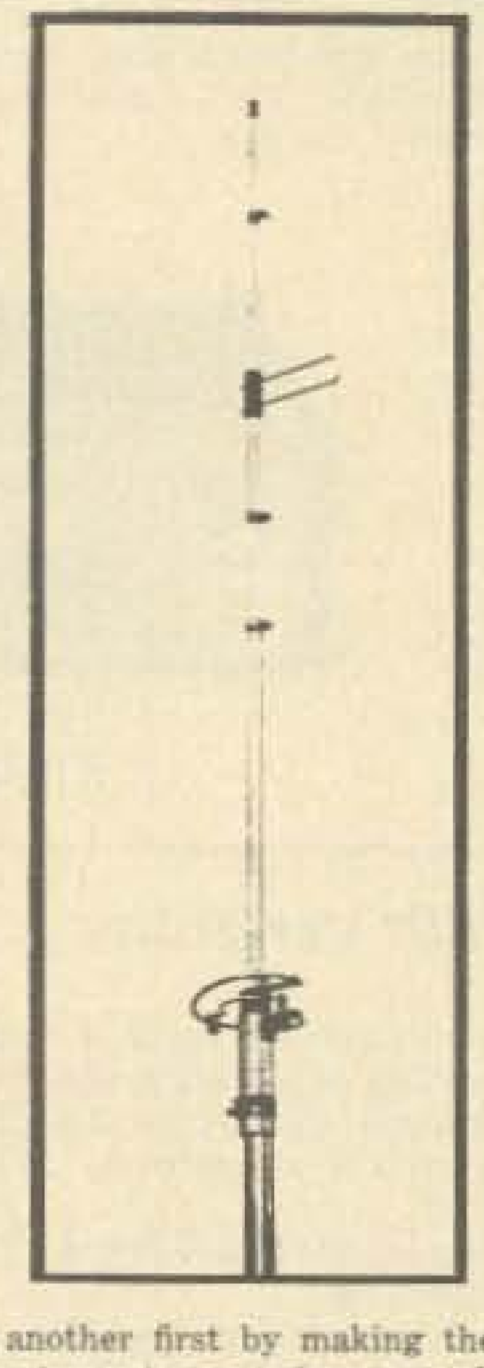

4.5 dB* – 6 dB**

Omnidirectional

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Cush Craft has created another first by making the world's most popular 2 meter antenna twice as good. The new Ringo Ranger is developed from the basic AR-2 with three half waves in phase and a one eighth wave matching stub. Ringo Ranger gives an extremely low angle of radiation for better signal coverage. It is tunable over a broad frequency range and perfectly matched to 52 ohm coax.

ARX-2, 137-160 MHz, 4 lbs., 112"
ARX-220, 220-225 MHz, 3 lbs., 75"
ARX-450, 435-450 MHz, 3 lbs., 39"

* Reference ½ wave dipole.
** Reference ¼ wave whip used as gain standard by many manufacturers.

Work full quieting into more repeaters and extend the radius of your direct contacts with the new Ringo Ranger.

You can up date your present AR-2 Ringo with the simple addition of this extende. kit. The kit includes the phasing network and necessary element extensions. The only modifications required are easy to make saw slits in the top section of your antenna.

ARX-2K CONVERSION KIT

2 METER ANTENNAS FM

A-FM RINGO 3.75 dB Gain (reference ¼ wave whip). Half wave length antennas with direct dc ground, 52 ohm feed takes PL-259, low angle of radiation with 1-1 SWR. Factory preassembled and ready to install, 6 meter partly preassembled, all but 450 MHz take 1¼" mast. There are more Ringos in use than all other FM antennas combined.

Model Number	AR-2	AR-25	AR-6	AR-220	AR-450
Frequency MHz	135-175	135-175	50-54	220-225	440-460
Power—Hdlg. Watts	100	500	100	100	250
Wind area sq. ft.	.21'	.21'	.37'	.20'	.10'

B-4 POLE Up to 9 dB Gain over a ½ wave dipole. Overall antenna length 147 MHz — 23' 220 MHz — 15', 435 MHz — 8', pattern 360° — 6 dB gain, 180° — 9 dB gain, 52 ohm feed takes PL 259 connector. Package includes 4 complete dipole assemblies on mounting booms, harness and all hardware. Vertical support mast not supplied.

AFM-4D 144 - 150 MHz, 1000 watts, wind area 2.58 sq. ft.
AFM-24D 220 - 225 MHz, 1000 watts, wind area 1.85 sq. ft.
AFM-44D 435 - 450 MHz, 1000 watts, wind area 1.13 sq. ft.

D-POWER PACK The big signal (22 element array) for 2 meter FM, uses two A147-11 yagis with a horizontal mounting boom, coaxial harness and all hardware. Forward gain 16 dB, F/B ratio 24 dB, ½ power beamwidth 42°, dimensions 144" x 80" x 40", turn radius 60", weight 15 lbs., 52 ohm feed takes PL-259 fitting.

A147-22 146 - 148 MHz, 1000 Watts, wind area 2.42 sq. ft.

D-YAGI STACKING KITS VPK includes horizontal mounting boom, harness, hardware and instructions for two vertically polarized yagis gives 3 dB gain over the single antenna.

A14-VPK.	complete 4 element stacking kit
A14-SK.	4 element coax harness only
A147-VPK.	complete 11 element stacking kit
A147-SK.	11 element coax harness only
A449-SK.	6 + 11 element coax harness only

E-4-6-11 ELEMENT YAGIS The standard of comparison in VHF-UHF communications, now cut for FM and vertical polarization. The four and six element models can be tower side mounted. All are rated at 1000 watts with direct 52 ohm feed and PL-259 connectors.

Model Number	A147-11	A-147-4	A449-11	A449-6	A220-11
Boom/Longest ele.	144"/40"	44"/40"	60"/13"	35"/26"	102"/26"
Wght./Turn radius	6 lbs., 72"	3 lbs., 44"	4 lbs., 60"	3 lbs., 18"	5 lbs., 51"
Gain/F/B ratio dB	13.2/28	9/20	13.2/28	11/25	13.2/28
½ Power beam	48°	66°	45°	60°	48°
Wind area sq. ft.	1.21	.43	.39	.30	.30
Frequency MHz	146-148	146-148	440-450	440-450	220-225

F-FM TWIST 12.4 dB Gain: Ten elements horizontal polarization for low end coverage and ten elements vertical polarization for FM coverage. Forward gain 12.4 dB, F/B ratio 22 dB, boom length 130", weight 10 lbs., longest element 40", 52 ohm Reddi Match driven elements take PL-259 connectors, uses two separate Feed lines.

A147-20T 145 - 147 MHz, 1000 watts, wind area 1.42 sq. ft.

HIGH PERFORMANCE VHF YAGIS

3/4, 1-1/4, 2 METER BEAMS

The standard of comparison in amateur VHF/UHF communications Cush Craft yagis combine all out performance and reliability with optimum size for ease of assembly and mounting at your site.

Lightweight yet rugged, the antennas have 3/16" O.D. solid aluminum elements with 5/16" center sections mounted on heavy duty formed brackets. Booms are 1" and 7/8" O.D. aluminum tubing. Mast mounts of 1/8" formed aluminum have adjustable u-bolts for up to 1-1/2" O.D. masts. They can be mounted for horizontal or vertical polarization. Complete instructions include data on 2 meter FM repeater operation.

New features include a kilowatt Reddi Match for direct 52 ohm coaxial feed with a standard PL-259 fitting. All elements are spaced at .2 wavelength and **tapered** for improved bandwidth.

Model No.	A144-7	A144-11	A220-11	A430-11
Description	2m	2m	1¼m	¾m
Elements	7	11	11	11
Boom Lngth	98"	144"	102"	57"
Weight	4	6	4	3
Fwd. Gain	11 dB	13 dB	13 dB	13 dB
F/B Ratio	26 dB	28 dB	28 dB	28 dB
Fwd. Lobe @ ½ pwr. pt.	46	42	42	42
SWR @ Freq.	1 to 1	1 to 1	1 to 1	1 to 1

cushcraft CORPORATION

VHF/UHF BEAMS

A50-3	$ 27.50	A144-7	19.95
A50-5	39.50	A144-11	24.95
A50-6	59.50	A430-11	19.95
A50-10	89.50		

AMATEUR FM ANTENNAS

A147-4	$ 15.95	AFM-44D	47.50
A147-11	24.95	AR-2	18.50
A147-20T	47.50	AR-6	24.50
A147-22	69.50	AR-25	21.50
A220-7	18.95	AR-220	18.50
A220-11	22.95	AR-450	18.50
A449-6	15.95	ARX-2	28.50
A449-11	21.95	ARX-2K	11.95
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AFM-24D	49.50	ARX-450	28.50

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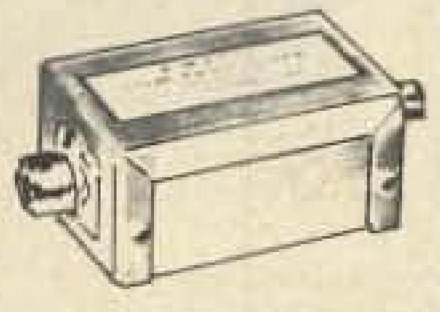

The Ameco low pass filter suppresses the radiation of all spurious signals above 40 Mc. It is designed for Coaxial cable (52 to 72 ohms). Other features include: Negligible Insertion Loss, 35 db. and more attenuation of harmonic and spurious frequencies above 50 MC., will handle up to 200 watts of RF power.

Model LN-2 $6.95

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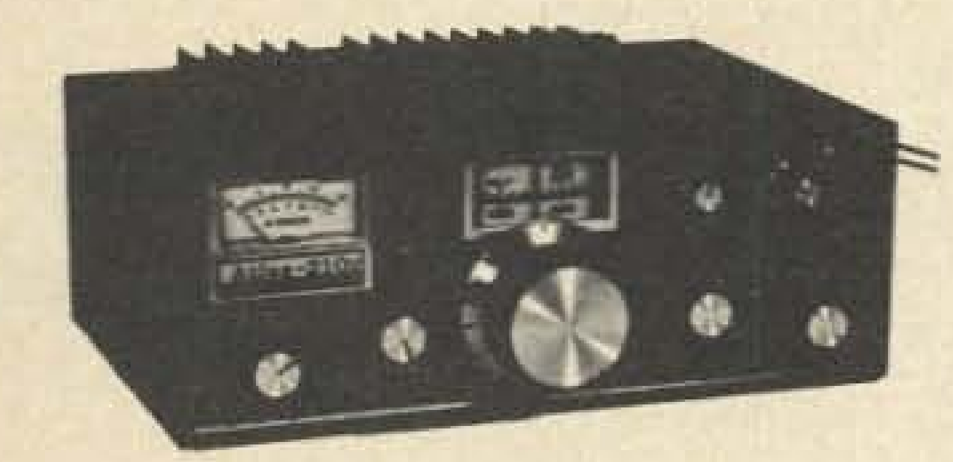
CB-330	Generator Filter, 3-30 MHz, Hi-amp.	4.90
G-23	Marine Generator Filter, Tunable	7.64
HF-3060	Generator Filter, Hi-amp., 30-60 MHz	4.90
T-52	Tunable Alt. Filter, 52A, 22-60 MHz	12.59
T-70	Tunable Alt. Filter, 70A, 22-60 MHz	13.14
TH-70	Tunable Alt. Filter, 70A, 100-200 MHz	13.14
TM-49	Tunable Marine Alternator Filter, 49A	13.14
TM-68	Tunable Marine Alternator Filter, 68A	13.69
VF-225	Voltage Regulator Filter	4.90



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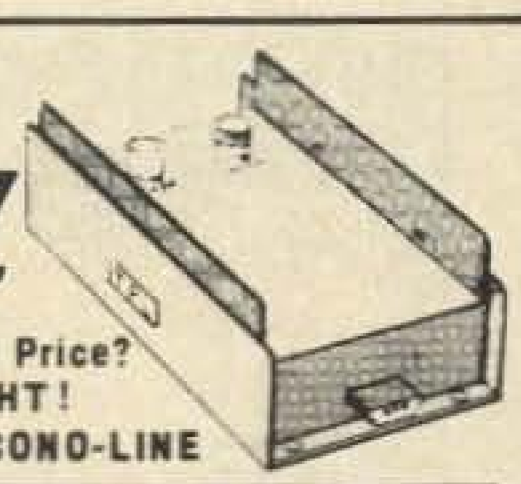

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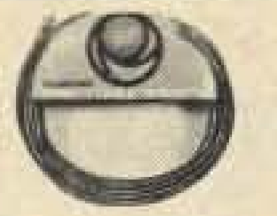

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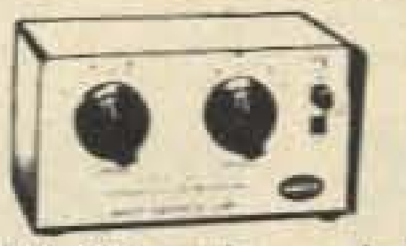

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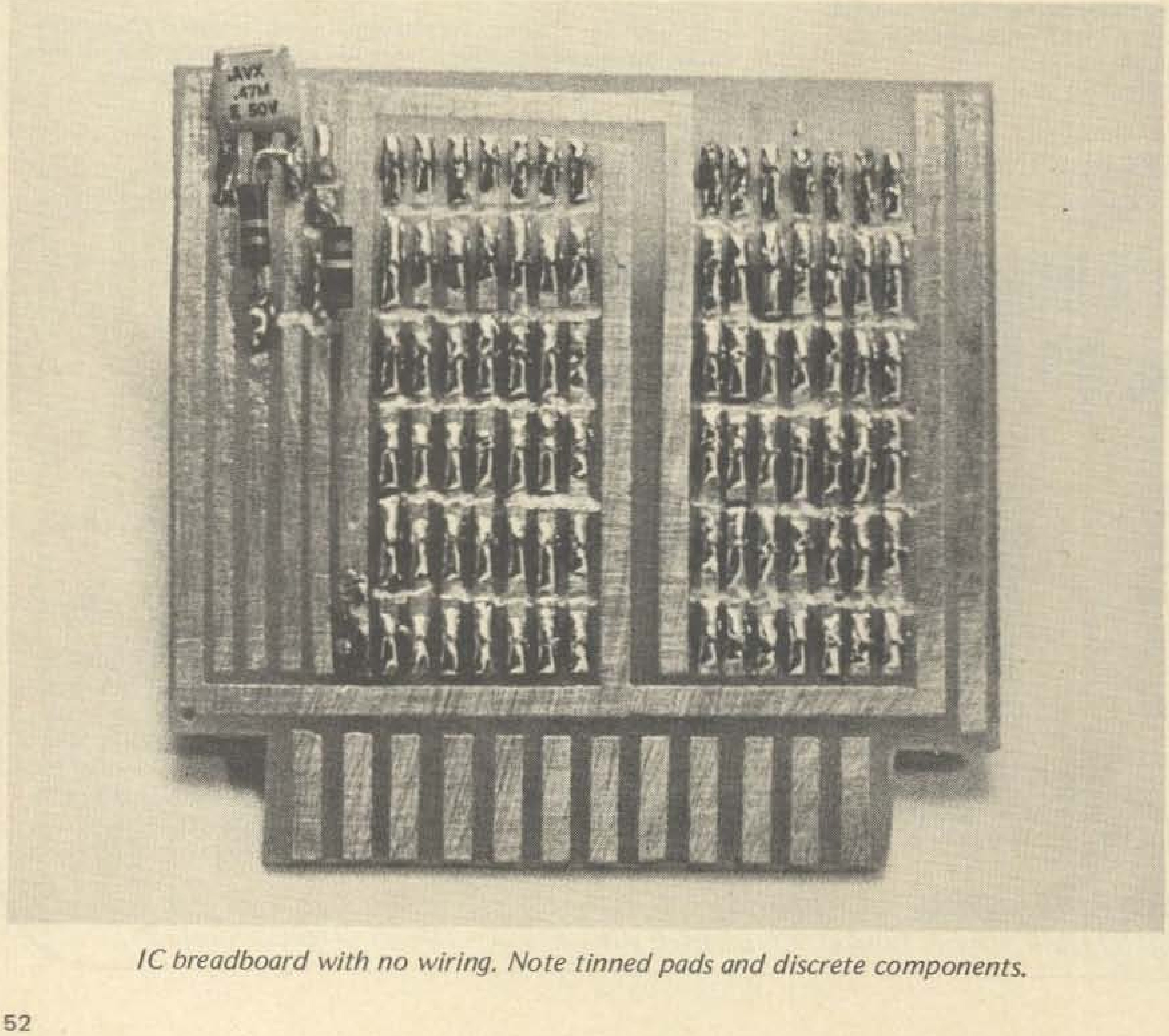
The Skinflint's Delight Breadboard

-- cheap imitation of a commercial IC DIP board

You say you've got that logic system all designed and are ready to give it a try? But you don't have anything to build it on and trying to build it without a circuit board would drive you crazy? And you hate to waste your time designing a circuit board for a circuit that may not even work? For a price, you could buy a bunch of those pre-etched breadboarding cards. Or you could give up the whole thing. Thankfully, there is another alternative.



IC breadboard with no wiring. Note tinned pads and discrete components.

Here is a system I've used with a fair amount of success. It's inexpensive, easy to fabricate, gives a high component density, allows for easy changes, and can perform quite well as a finished product. To be honest, there are disadvantages. Firstly, your eyesight had better be good, since things get pretty crowded (but don't all IC projects?). Also, because of the crowding, a *small* soldering iron (such as an Ungar Princess[R]) is recommended. Since this is a breadboard, the neatness of the resulting circuit is somewhat less than optimum. If you think the plusses outweigh the negatives, please read on.

What we are going to manufacture is a cheap imitation of a commercial IC breadboard. The board is designed to hold six 14 pin DIP ICs in two columns of three packages. Between each

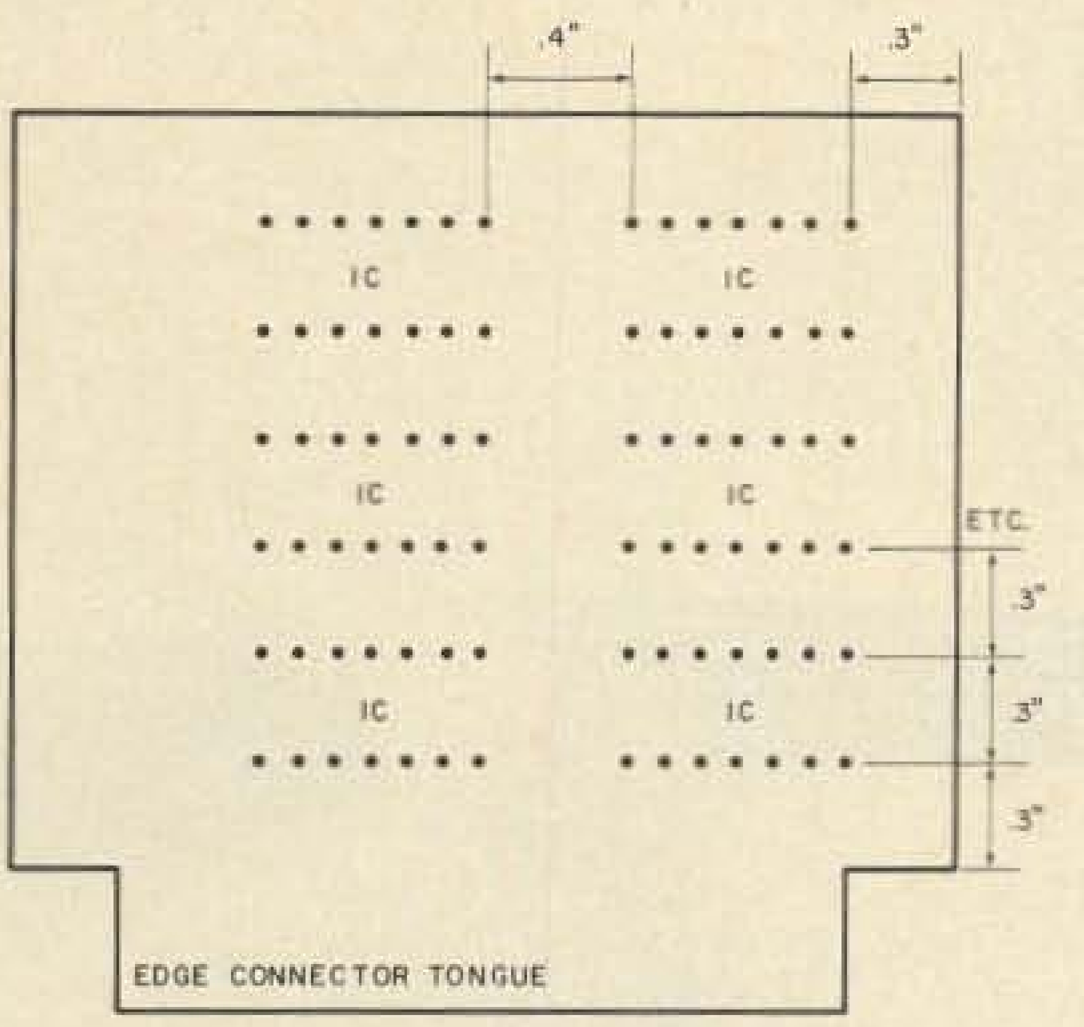


Fig. 1.

column and around the edges of the board are ground and supply voltage buses. A few extra conductor strips may be etched on the board, if desired, for mounting discrete components. Also, one edge of the board can be etched to mate with an edge connector. Getting all of those individual pads etched neatly sounds like quite a job. Luckily, there is a shortcut – called artwork tape. This is a narrow black tape, similar to masking tape, used primarily in drafting. The adhesive used on this tape is fairly impervious to etchant, so the tape can be used as etch resist by direct application to the copperclad board. And since this tape is available in a dozen widths from .015" (that's narrow!) to .25", the required conductor width is easy to obtain.*

How To

Before we start manufacturing the board, the necessary tools and materials should be collected. These are:

Artwork tape, .062" wide (for IC pads)
Artwork tape, .125" wide (for buses and edge connector pads)
Small X-acto knife
Copperclad glass-epoxy board
Etchant (I prefer ferric chloride – it etches fast but it's messy)
Dremel Moto-tool with small burr (optional but very handy)
Small center punch (try not to use an awl – they tend to punch holes clear through the circuit board)
0.1" grid paper
Masking tape
Pencil (with eraser)
Number 65 drill bit (somewhere around that size)
1 pair thin cotton gloves (so you don't get your prints all over the board)

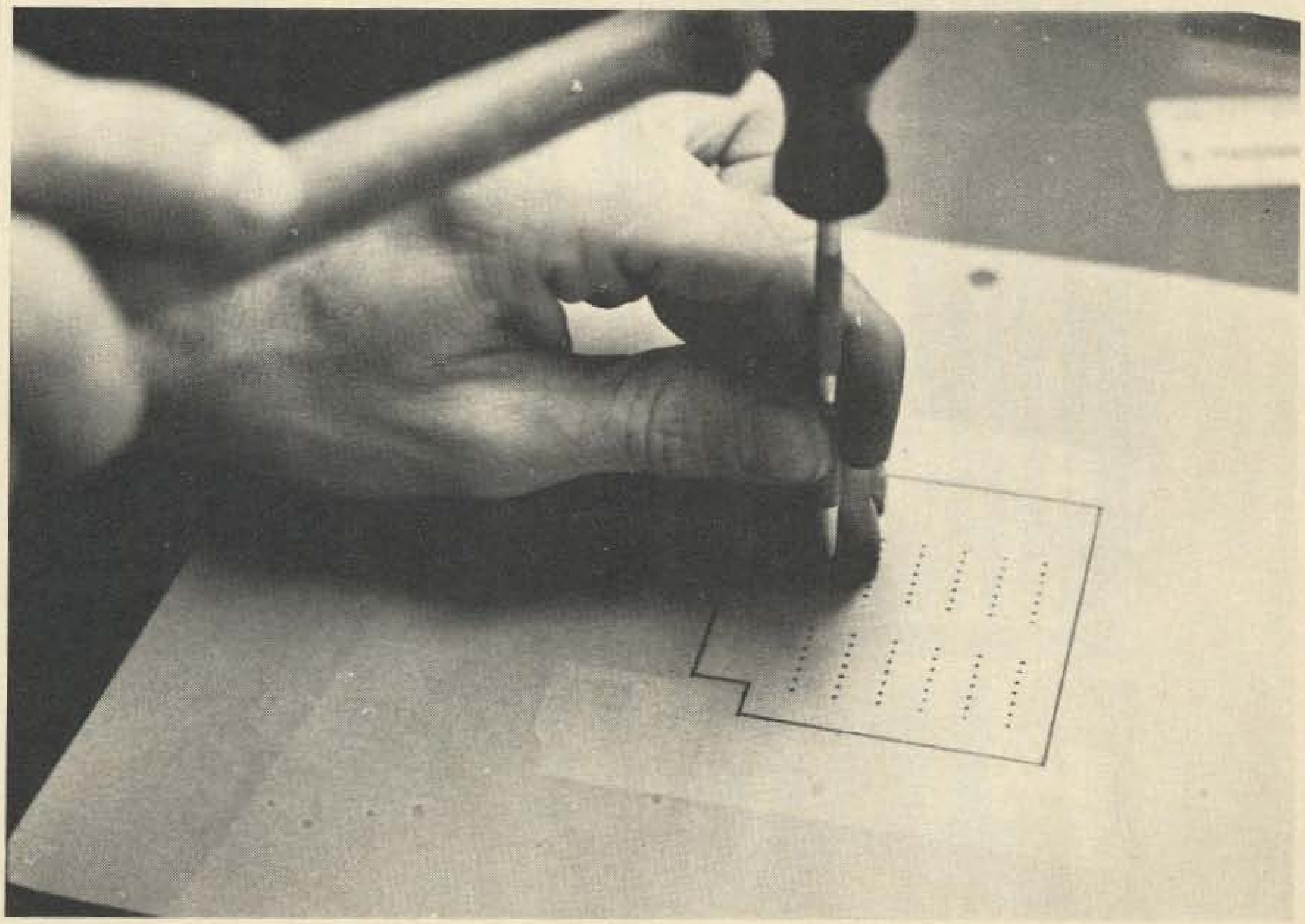
Now we can start. The process begins by laying out the IC pin locations on the .1" grid paper. (See Fig. 1.) Line up the packages parallel to each other with like pins in a line. The pins are separated by .3" and the same spacing between ICs is about right. Between each column of ICs there should be space for two .125" conductors. Allow .4" for this. The edge of the layout should be about .3" from the nearest IC pin location. In the layout shown, extra space has been left on the left side for mounting discrete components. The tongue on the bottom is of proper depth and width to fit an edge connector (measure yours), and starts .3" from the nearest IC pin location.

After the layout is completed, cut a piece of circuit board to the proper size. Tape the paper layout in the correct position over the copper side of the board. With the center punch, punch all IC pin locations hard enough to mark the copper and provide a start for a drill bit (but not hard enough to raise the copper around the punch mark). After punching all pin locations, remove the paper layout.

To prepare the board for application of the resist tape and eventual etching, scrub the copper with steel wool until it's shiny, and then wash it with warm, soapy water. As usual in any PC board article, you are now advised not to touch the copper with any part of your uncovered body (lest lightning strike). Since application of the artwork tape requires much handling of the board, thin gloves are recommended.

Now get out the .062" tape and a knife. We are going to lay a stripe of tape perpendicular to the IC orientation, covering all punch marks in that line. Start the tape about .2" above the first punch mark and end it the same distance below the last. It is easier to apply the tape longer than necessary and then trim it to the desired length. Press the tape firmly to the board with your covered finger or some sort of small roller. Repeat this taping process for all IC pin columns (7 times for one column of 14 pin ICs).

If you have or can borrow a Dremel Moto-tool, you can skip this paragraph. It is necessary to cut a gap in the

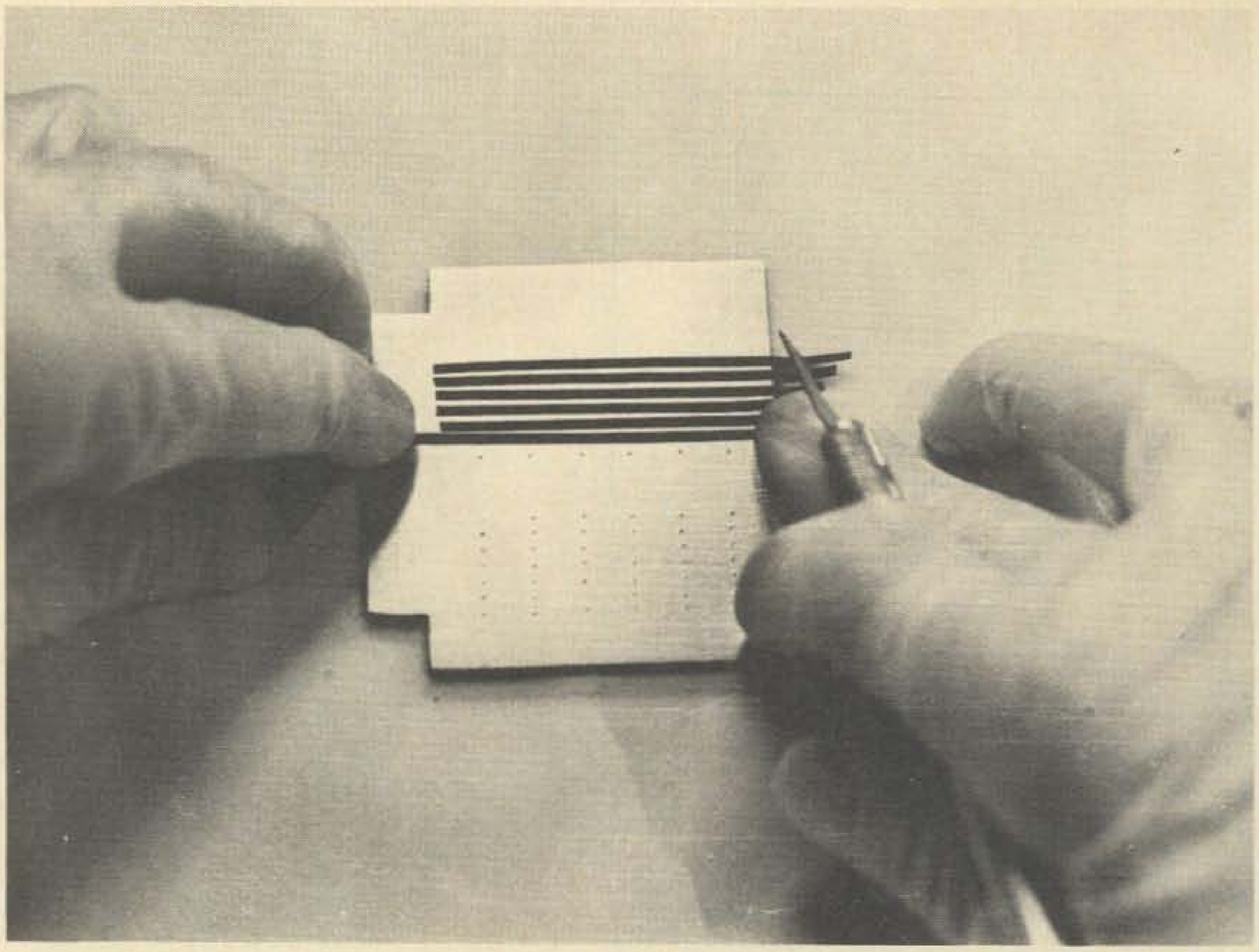


Center punching the .1" grid paper.

*Artwork tape is available from any engineering supply store.

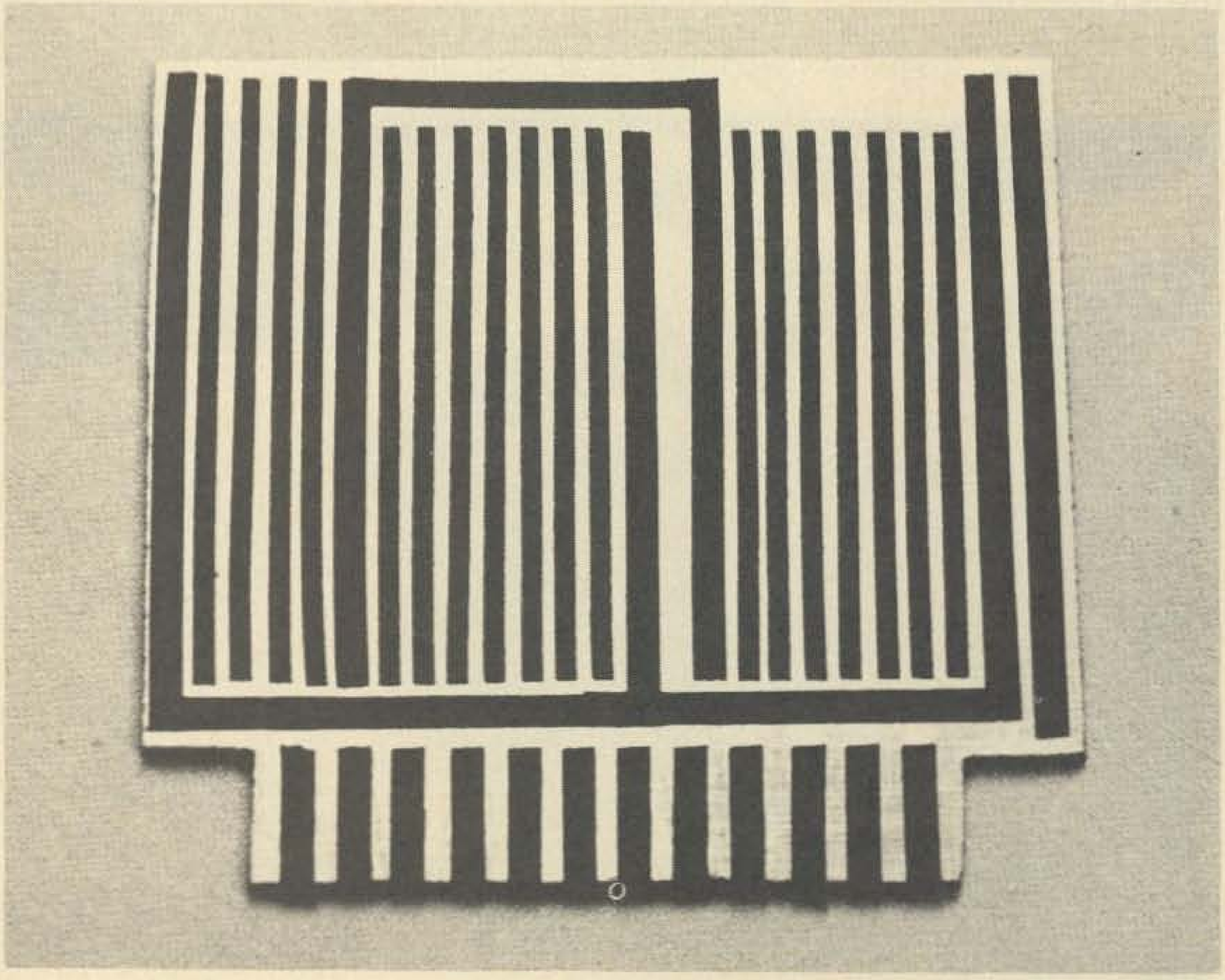
tape between each row of pin locations. Using the paper layout to mark guide points on the board, run your knife blade along a straightedge placed between rows of center punch marks. Remove a small section of the tape from between each pin location. This is necessary to allow the etchant to separate the pads. If a high speed burr is available, it can be used to cut the pads apart after etching (a much quicker process).

Next, the .125" tape is used to lay out power supply conductors. Run a continuous line of tape along the left side and top of the board and another along the bottom and right side of the board. These separate buses then branch off between the IC columns. Make sure that the pieces of tape overlap tightly where a conductor branches, and that there is sufficient gap between buses. Any area left over may be taped to provide independent conductors for mounting discrete components.



Applying tape to the board. Note rows of center punch marks.

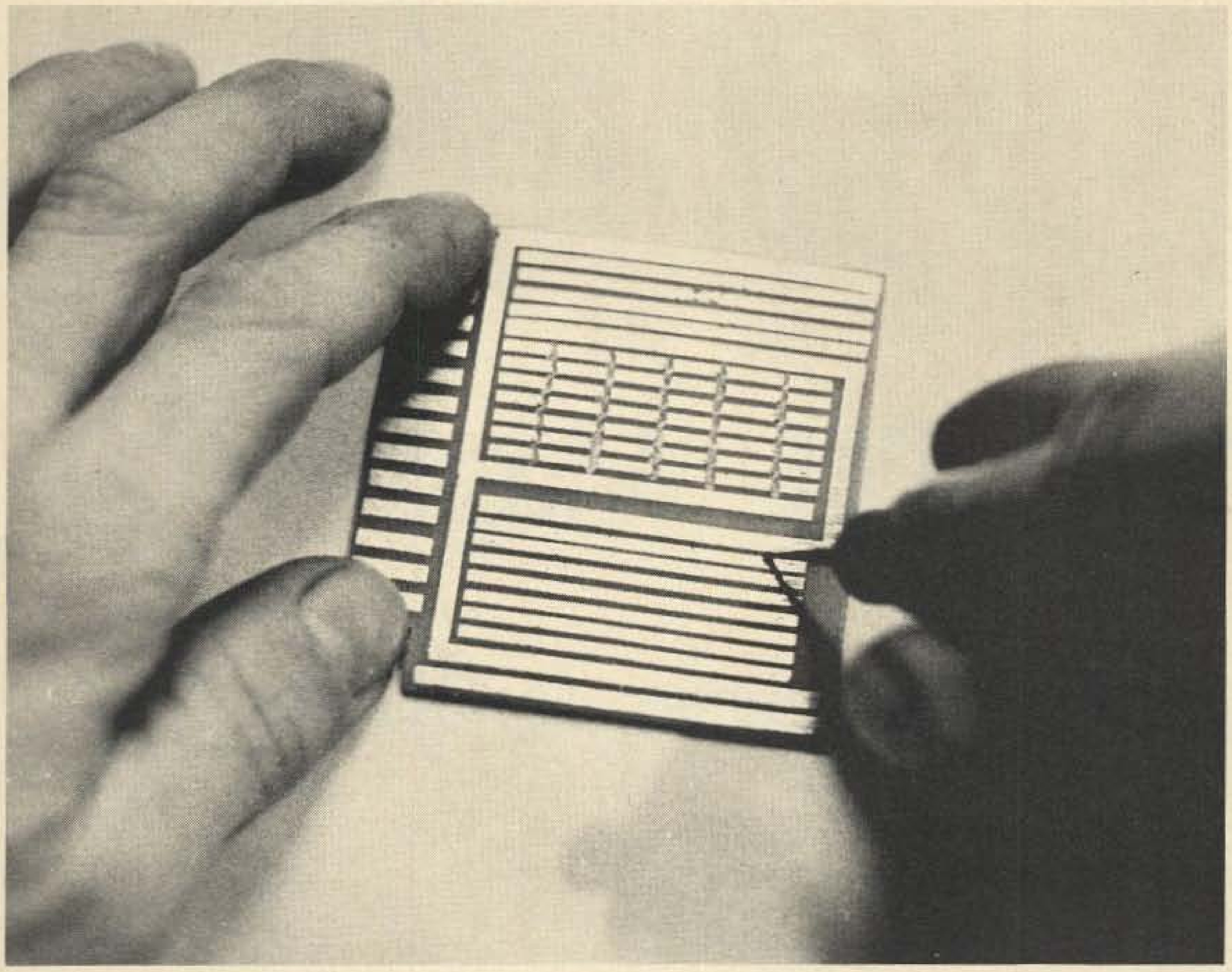
To provide edge connector fingers, tape must be applied to the tongue of the board to exactly match the connector pin spacing. The easiest way to do this is to insert the tongue into the edge connector several times (taking care to remove the connector between insertions). The exact locations of the connector pins will appear as light scratches on the copper. It is only necessary to cover these scratches with tape, and alignment is assured.



Completely taped board.

Now is the time to etch the board. Enough has been said about this process in other articles to avoid the subject entirely. But I can't help myself. An easy way to agitate the board is to drill small holes in diagonally opposite corners and tie a piece of string to each corner. The board can then be dropped into the etchant, copper down, and moved back and forth and up and down during the etching process. This technique will greatly speed up the process, and enables you to handle the board without getting that damned etchant all over your hands.

After etching, the pads are cut apart with a high speed burr (Dremel). Don't cut too deeply or accidentally cut a



Using the burr to cut the pads apart.

supply bus. The use of the burr takes a little practice, but once you get used to it it's a pretty quick process.

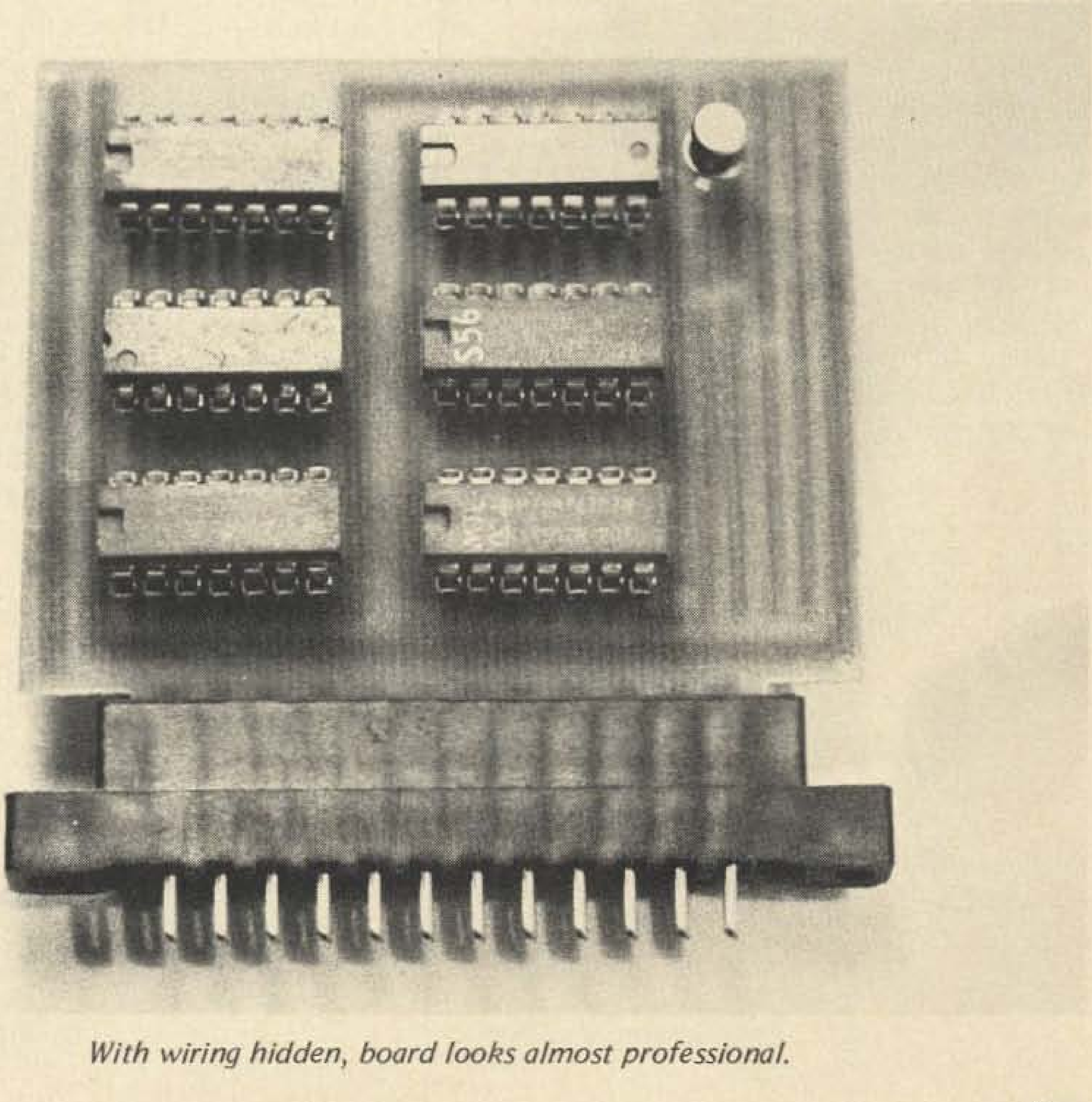
Now comes the most tedious part of the process. Drill all IC pin locations with a No. 65 drill. Insert Molex pins or ICs and solder, tinning the entire pad. Now we've completed what we set out to do.

Wiring

Now that you have a board to mount your ICs on, the only other necessity is a means of connecting them together. For short connections (e.g., Vcc and ground), I use No. 22 tinned solid wire, butt-soldered to the pads. For longer connections, insulation is a necessity. I use No. 24 stranded hookup wire cannibalized from multiline telephone cords. If you need to buy new wire, teflon would be ideal. Since the solder pads are already tinned, it is only necessary to tin the end of a wire and then hold it in place on a pad while applying heat. No additional solder is needed or wanted. Too much solder will only encourage shorts between pads. Wiring can be done neatly, using right angle turns and running the wire only between ICs or running directly point to point. Although the latter method looks pretty bad, it has the advantage of decreased noise pickup from wire to wire, since very few wires run parallel. Besides, it uses less wire.

The extra conductors etched on the board can be used for discrete components. Where a pad for a component is needed, just drill a hole for the component lead and isolate that conductor area by cutting across it with the burr.

The fact that all connectors are hand-wired when using this technique makes changes easy to make. The production cost of this board is much less than that of commercial ones. You can get more components (especially ICs) on this board than on a board with printed wiring, since little room is needed for conductors. And if you can stand the sight of the mess of wiring, the board will make a pretty good finished product. ■



With wiring hidden, board looks almost professional.

Calvin Sondgeroth W9ZTK
800 Fifth Avenue
Mendota IL 61342

More PLL Magic

--like low frequencies for RTTY

This article described a phase locked loop circuit that can be built with a single IC chip. Integrated PLLs are available, but building the loop out of discrete components and IC amplifiers allows for experimentation not possible with the integrated version. In addition, a general discussion of the LM3900 linear amplifier is presented.

This IC contains four identical amplifiers in a 14 pin DIP package. It satisfied the need for an economical op amp device which can operate on a single supply voltage. Those who have struggled with multiple batteries, power supply splitters, etc., will immediately appreciate the advantage of the single power supply feature. And best of all this can be anything from 4 to 36 volts.

A skeleton diagram of the internal amplifier circuit is shown in Fig. 1. Note how this resembles a normal common emitter amplifier rather than the differential stages found in other op amps. With the current mirror circuit at the non-inverting input, single supply operation is possible.

Instead of amplifying voltage differences between the inverting and non-inverting input terminals, this amplifier responds to current differences. The diode between the non-inverting input and ground is actually a transistor with collector and base connected together and the emitter on ground. With IC fabrication techniques, this "diode" transistor and Q1 have almost identical characteristics and track closely over wide temperature ranges. With this situation, it can be shown that the current into the non-inverting input and the collector current of Q1 are equal. Any current I1 flowing into the non-inverting input is "mirrored" about ground and is extracted from the base current for Q2 flowing into the inverting input. If I1 and I2 are equal, the net current into the base

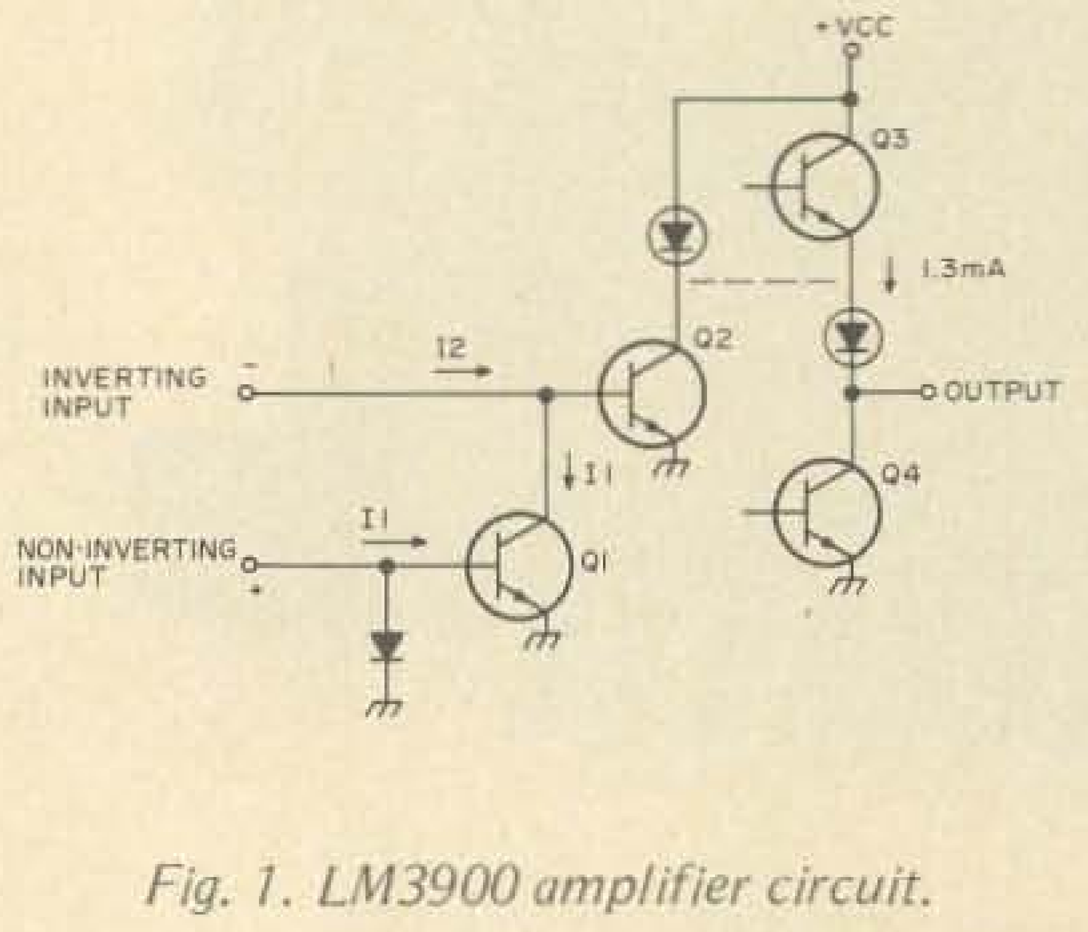


Fig. 1. LM3900 amplifier circuit.

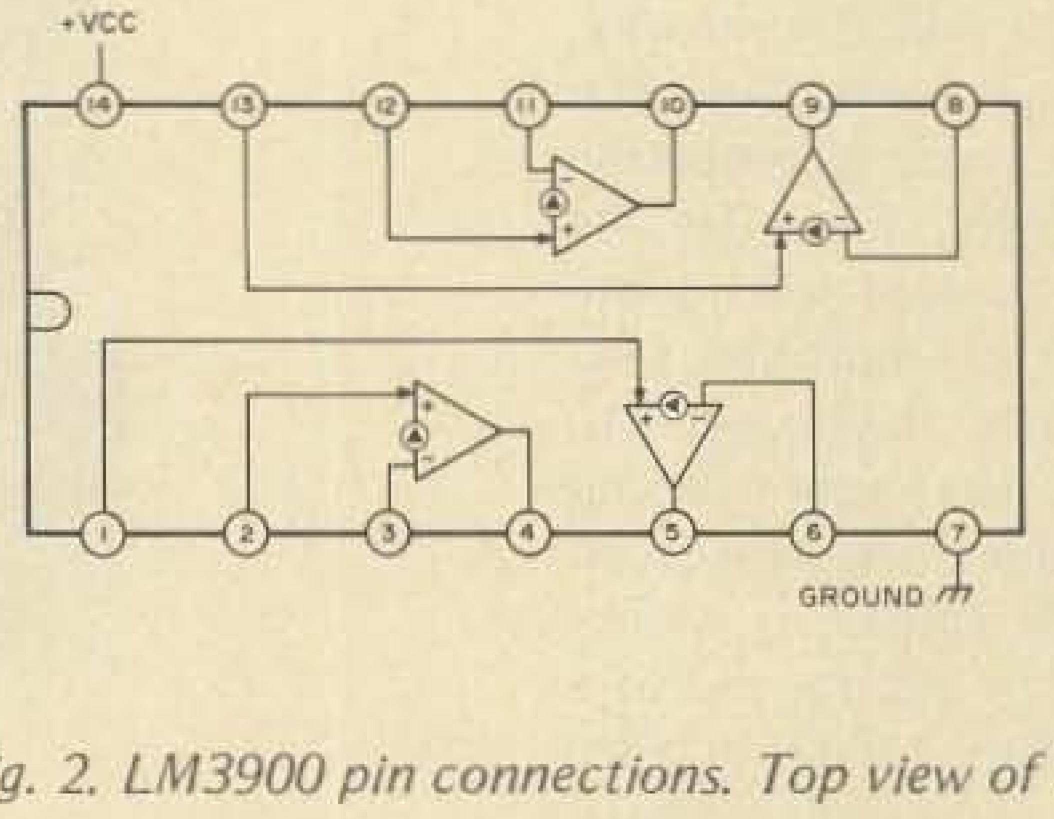


Fig. 2. LM3900 pin connections. Top view of IC.

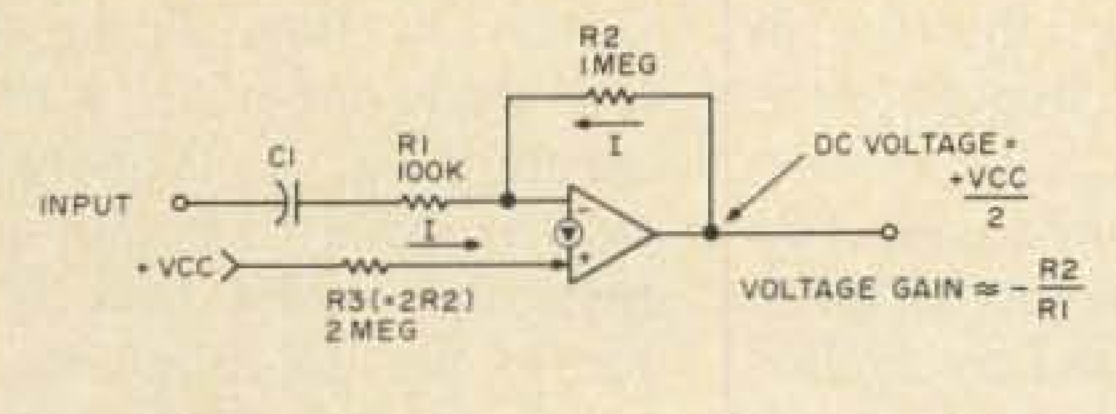


Fig. 3(a). Inverting amplifier.

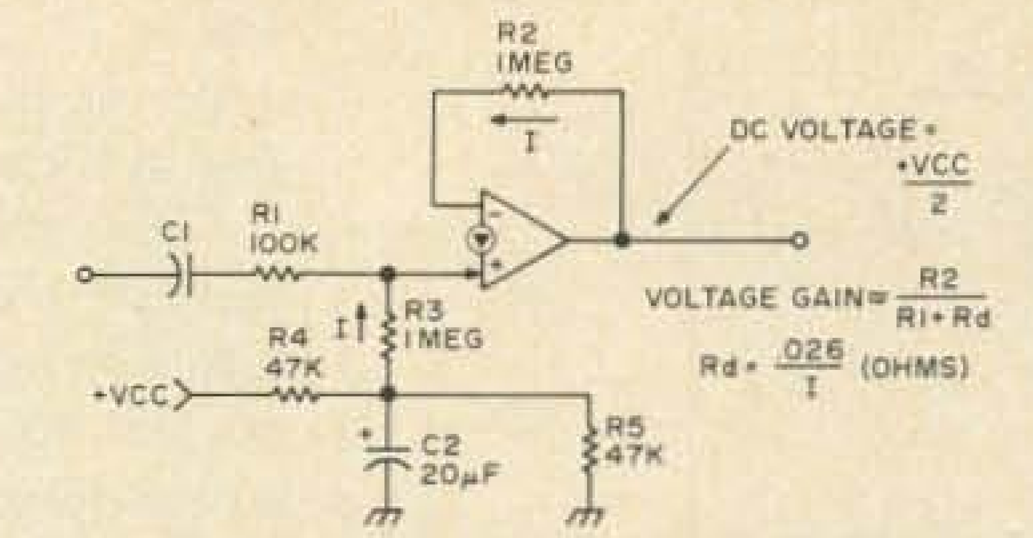


Fig. 3(b). Non-inverting amplifier.

of Q2 is balanced out and current differences between the two terminals are amplified.

As shown, the collector loads for the internal amplifying transistors are current sources. They present high impedance loads for these stages and achieve very high voltage gain. The output stage current is set at about 1.3 mA by its current source. Thus a package of four of these amplifiers draws 5-7 mA idling current. With the internal biasing circuit this current drain is relatively independent of supply voltage.

To provide for amplification with reference to voltages, the input terminals are connected to the signal and bias networks through rather high value resistors, which convert voltage changes into current changes the amplifier can work with. The entire configuration can be thought of as a transistor common emitter amplifier with a very, very high beta and provided with a non-inverting input. As can be seen in the various circuit diagrams, the LM3900 amplifier symbol is drawn with a current source between the input terminals and a current arrow at the non-inverting input. This helps distinguish it from conventional op amp types and also indicates its current differencing type operation. It is sometimes called a Norton amplifier to help make the difference identifiable.

Fig. 2 shows the pin connections for the four amplifiers in a 14 pin IC package. The amplifiers share common biasing circuitry but are otherwise independent for signal paths.

Typical Bias Circuits

An inverting amplifier circuit using the LM3900 is shown in Fig. 3(a). The resistor at the non-inverting input is tied up to the positive supply voltage. Since its value is twice that of the feedback resistor R2 and the currents at the inputs attempt to equalize themselves, the dc potential at the amplifier output biases off at approximately half the dc supply voltage. That is, the same current flows from the output through R2 to the inverting input as from the positive supply voltage into the non-inverting input via its bias resistor. Since R3 is twice the value of R2, the output dc level is half the supply voltage.

Ac signal inputs through the coupling capacitor make the output follow the input with a voltage gain of R2/R1. Note that the output is inverted with respect to the input.

The input bias current required by the IC is extremely small as compared to a regular transistor amplifier. Values as low as 30-50 mA may be used, thus the relatively large value resistors. The normal bias current for the non-inverting input should be limited to something like the 10-100 uA range for optimum operation. Larger values tend to overdrive the current mirror, changing its gain from unity as required to properly mirror the current at the inverting input.

Fig. 3(b) shows a non-inverting amplifier circuit. Note the biasing arrangement here. Again the dc level at the output is set at half the supply voltage. In this case, R2 and R3 are equal, but the bias potential for R3 is at half the supply voltage as determined by the voltage divider R4 and R5. Since the currents (dc) at the input terminals tend to equalize, the output voltage biases off at Vcc/2.

The expression for the voltage gain of the non-inverting amplifier takes into account the impedance of the diode at the non-inverting input. With values in the megohm range for R2 and R3 the effect of Rd is negligible.

For all practical purposes, both amplifiers shown in Fig. 3 have a voltage gain of ten (20 dB). The dc level at the output being halfway between the supply voltage and ground allows for maximum output swing before limiting. The LM3900 has an open loop gain of 70 dB out to 1 kHz and drops off linearly at 20 dB per decade with unity gain occurring at approximately 2.5 MHz. Thus it does not have the extremely high gain of the 741 type of op amp at dc and very low frequencies, but at 1 kHz and above it is about the same. The 3900 is internally compensated for this frequency rolloff characteristic.

With the biasing schemes shown, the LM3900 can be used for any application requiring an op amp. By applying two input voltages through high value resistors, one to the inverting and the other to the non-inverting input, the device functions as a comparator for the inputs. A square wave oscillator is shown in Fig. 4. In this circuit, when the op amp output is at the high level, current flows into the non-inverting input via both 2 meg resistors. When the capacitor charges up to a high enough potential, current flow into the inverting input from this source causes the op amp output to switch over to the low state. With the output low, the effective limiting resistance at the non-inverting input is now 2 megs, cutting its current source in half. As the capacitor discharges and reaches lower voltage level where the current into the inverting input is low enough, the output again switches high and the cycle repeats. By juggling the bias resistor values, different duty cycles can be obtained to produce varying pulse width outputs.

Low Frequency Phase Locked Loop Circuits

The entire loop can be built using one 3900 IC chip, a few resistors and capacitors and one switching transistor.

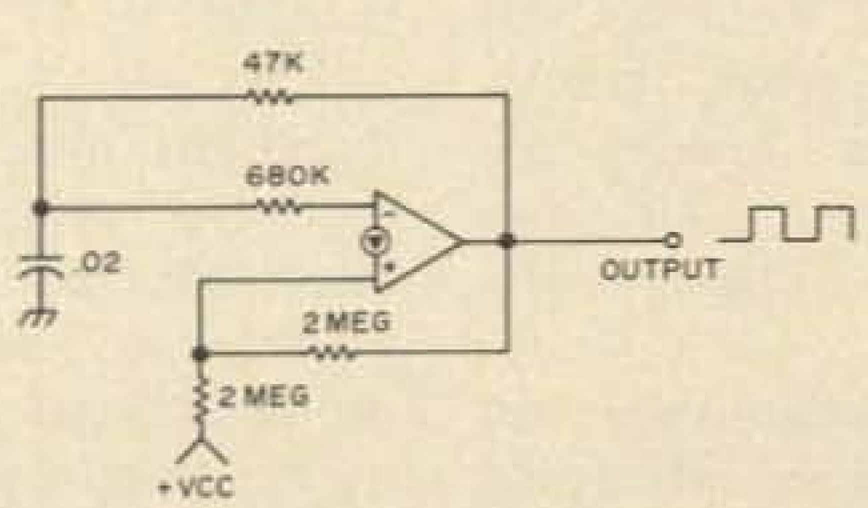


Fig. 4. Square wave oscillator.

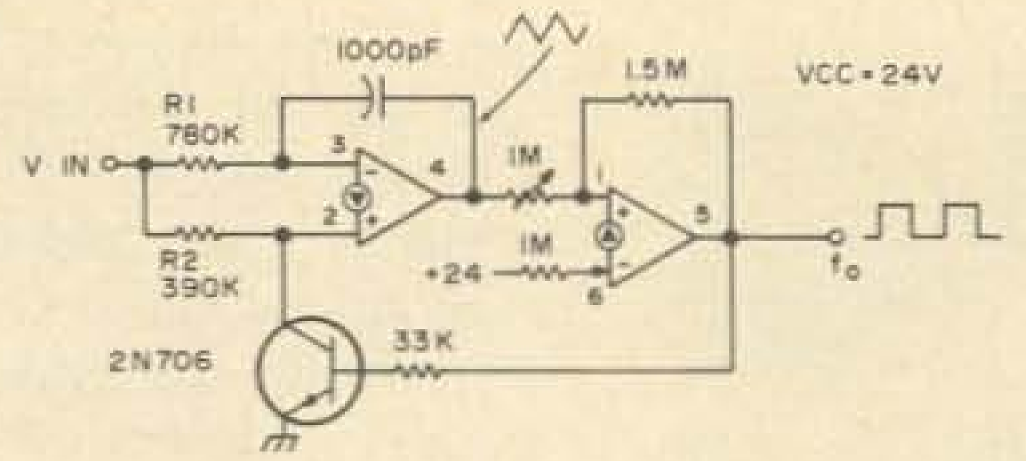


Fig. 5. Voltage controlled oscillator. Note that this circuit has very linear response between 2 and 12 volts.

The main portion of the circuit is involved with the voltage controlled oscillator. A diagram for a vco using two sections of the 3900 is shown in Fig. 5.

The first amplifier in the vco functions as an integrator, and the second is connected as a Schmitt trigger with wide hysteresis to monitor the output level of the first stage. When the Schmitt output is high, the transistor is turned on and diverts current away from the non-inverting input to ground. During this time, the current through R1 into the inverting input causes the integrator output to ramp down toward ground. However, when the lower trip point of the Schmitt circuit is reached, the transistor is turned off, and current into the non-inverting input causes the integrator output to turn around and ramp back up toward the positive supply. Note that the current into the plus input is twice that into the minus input. (R2 is half the value of R1.) With current into both inputs from the source, the effect of current into the plus input overcomes that at the minus since it is twice as large. When the Schmitt circuit flips back over to the other state (high output), the transistor again diverts current from the plus input, and current through R1 takes over making the integrator output again ramp down. And so the process repeats.

The vco circuit alone can be useful and an interesting one to breadboard. With a frequency counter on the output, it becomes a rudimentary form of digital voltmeter since it can be adjusted with the 1 meg pot so that 4 volts input produces 400 Hz at the output, 5 volts gives 500 Hz, etc. The linearity between three and ten volts input is within one half a percent. Not bad for a simple circuit. This curve was run with a supply of 24 volts. Higher values of Vcc are desirable to get good range and linearity. In many applications linearity is only required over a fairly narrow range and this vco will easily do that.

Fig. 6 shows the diagram for the complete phase locked loop. All four amplifiers in the LM3900 are used. U2, U3 and U4 make up the three basic sections: vco, phase detector and low pass filter. U1 is used as an amplifier for the input signal. This stage provides a square wave output swinging over almost the entire supply voltage range. The output symmetry is set by the 10k potentiometer at the input. It limits to square wave output for any input of over a couple hundred millivolts rms. The input impedance is strapped down to about 600 Ohms to make it compatible with typical audio generator and communications receiver outputs.

The vco is the circuit discussed previously. Note that the capacitor in the integrator section is made variable to set the free running frequency. With the high impedance of the LM3900 and the large external resistors, rather small values of capacitance are in order, even for frequencies as low as 1 kHz.

The vco square wave (U4 output) and the limited input signal (U1 output) are applied to U2 which is used as the phase detector portion of the loop. Note that the resistor at the inverting input of this stage is approximately twice the value at the non-inverting input. Thus the signal from the vco tends to take over and control the output of U2. When the input frequency becomes close enough to the oscillator free running frequency, the loop will lock onto the incoming signal and remain in lock for frequency variations within the lock range. The capture and lock ranges are set primarily by the values of RC in the single low pass filter section. Experimentation is in order here as well as in other parts of the circuit.

Once the loop is locked to the incoming signal, the vco frequency and the input frequency are identical except for a slight difference in phase. It is this phase difference which keeps the loop in lock by applying a dc output from the low pass filter to control the vco frequency. Fig. 6 shows the situation for a phase difference of 90 degrees between the outputs of U1 and U4. With these inputs, the output of U2 can only go to the low state during the time the input signal is high and the vco is low. Otherwise the vco signal takes over and drives the output back high due to the 2X difference in input resistors. The average dc level at the output of U2 shown in Fig. 6 is about 3/4 Vcc.

The RC low pass filter smoothes out the U2 output to drive the vco input. If the input frequency changes, the resulting phase change will cause the phase detector output to drive the vco such that it follows the input signal. As the resulting phase differences approach zero degrees and 180 degrees, the vco drops out of lock with the input. During lock the phase detector output will be somewhere between 1/2 Vcc and Vcc. A little study of the phase diagram in Fig. 6 should help clarify this. The important point in understanding loop operation seems to be grasping the fact that it locks onto an incoming signal by virtue of a phase difference between input and vco such that the phase detector dc output is right to make the vco frequency equal to the incoming frequency.

By applying the input signal to the vertical channel of an oscilloscope and U4's output to the horizontal channel, locking can be observed as the input

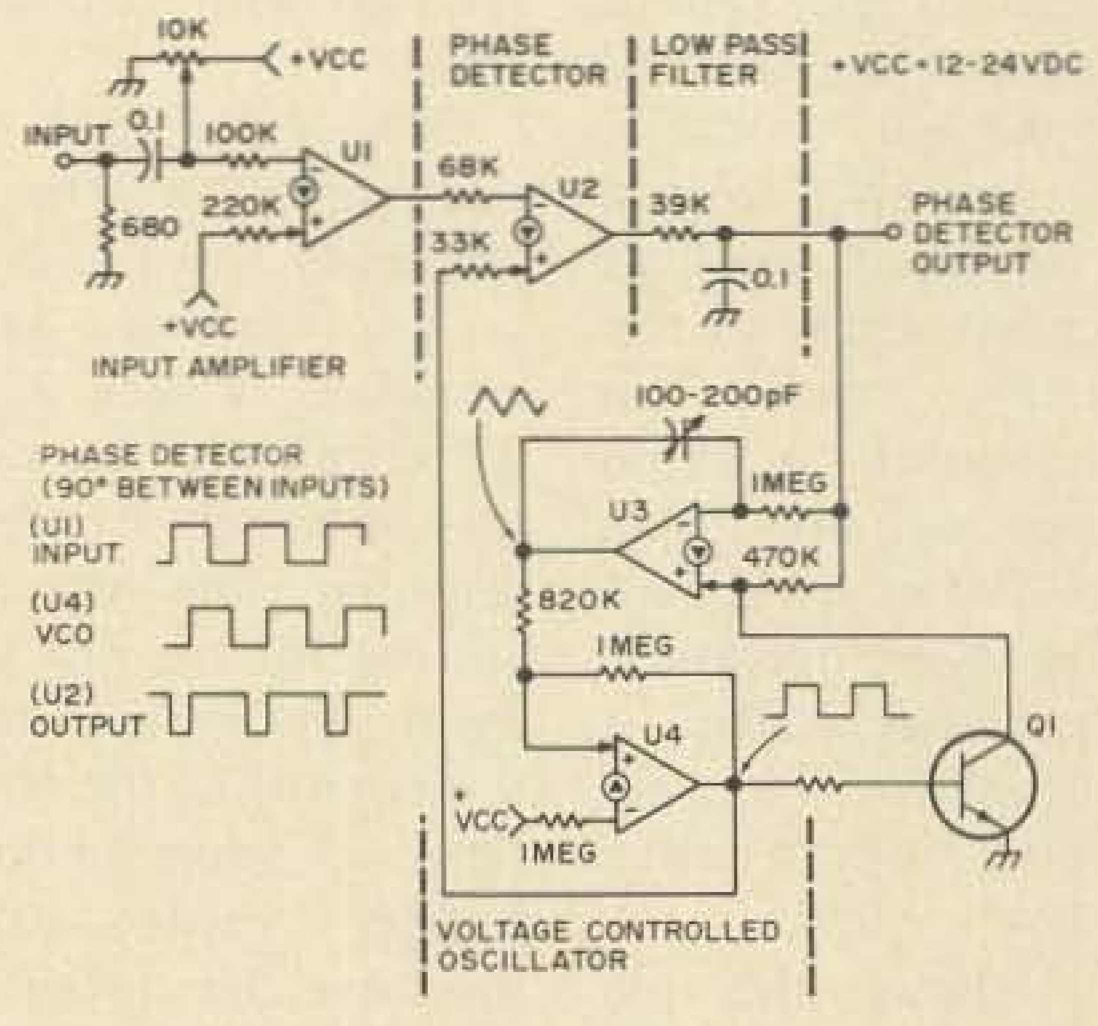


Fig. 6. Phase locked loop using the LM3900.

frequency is swung into the capture range of the loop. Then, as the frequency is varied within the lock range, the Lissajous pattern indicates the phase difference while still maintaining lock. This scope presentation is worth a thousand words while breadboarding the circuit. During lock, the scope display is steady as a rock.

Depending upon the values used in the low pass filter, the lock and capture range can be varied somewhat for specific applications. The values for the circuit in Fig. 6 are suitable for a center frequency of 2200 Hz which is adjustable by the variable capacitor in the vco. Initially, out of lock the loop captures over a range of about 1900 Hz to 2450 Hz. Once in lock, it will maintain lock over a wider range, approximately 1550 Hz to 2900 Hz.

RTTY enthusiasts will note that this frequency range includes the normal tones used in that mode. The dc output variations at the low pass filter are rather small with a 170 Hz shift in frequency, but adequate to drive an IC comparator stage. This makes a single terminal unit with the addition of some sort of keying circuit for the TTY selector magnets. Additional filtering of the low pass filter output is required before driving the comparator to eliminate false triggering of the slicer stage. Other than actually driving a printer with this circuit, no further work was done on a terminal unit for RTTY.

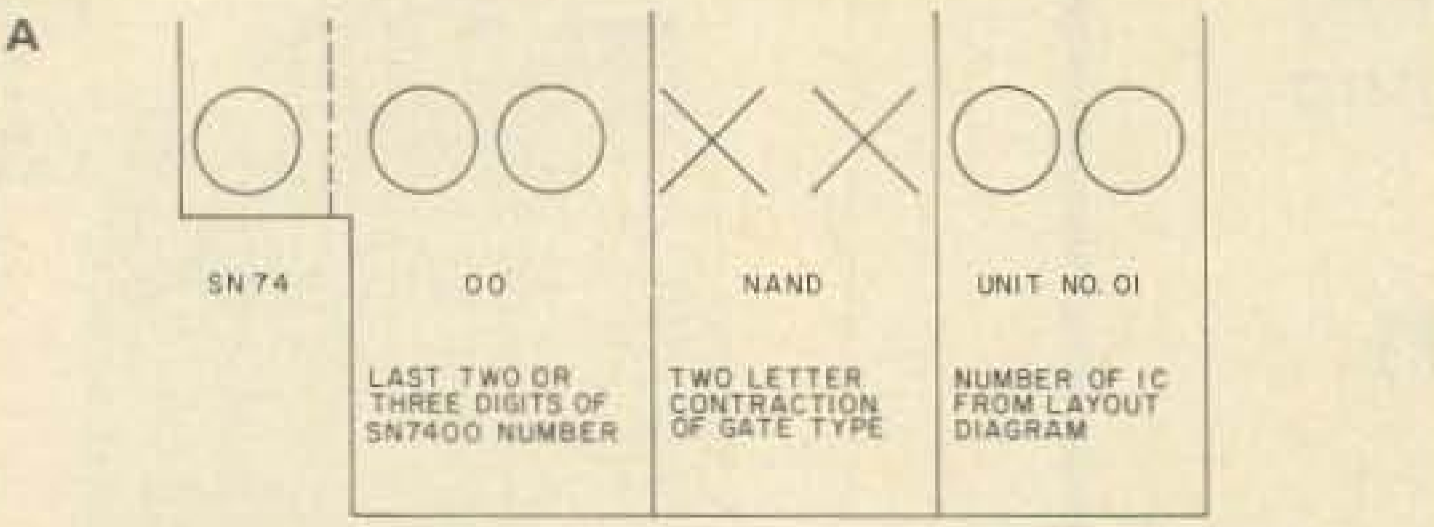
Hopefully, this article will be of interest to those interested in experimenting. The LM3900 itself is so useful in all sorts of applications that after playing with the phase locked loop circuit, the IC can be put to good use in any number of ways. Most of the ads feature this chip for about a half dollar, so getting a few to try is certainly worth the small investment. ■

Roger C. Galbraith WA3TCO
RD #2 Box 93-2
Guys Mills PA 16327

The Logic Grabber

--selected interval logic tracer (S.I.L.T.)

A



B

SN7400 Number	Gate Type	Code (assume 1st unit in diagram)
SN7400	NAND gate	00ND01
SN7402	NOR gate	02NR01
SN7404	Hex Inverter	04HX01
SN7408	AND gate	08AN01
SN7410	NAND gate	10ND01
SN7420	NAND gate	20ND01
SN7430	NAND gate	30ND01
SN7442	BCD to decimal decoder	42BD01
SN7473	JK flip flop	73FF01
SN7475	Bistable latch	75LH01
SN7489	RAM	89RM01
SN7490	Decade counter	90DC01
SN7493	Binary counter	93BC01
SN74107	JK flip flop	107FF01
SN74150	Multiplexer	150MX01
SN74195	Shift register	195SR01
SN74200	RAM	200RM01

Table 1. (a) Coding method. Code is typed or printed on masking tape and applied to bottom of ICs. This saves much referencing to the layout diagram and helps avoid wiring to the wrong IC. (b) Suggested list of codes.

The logic probes which are described in amateur radio magazines today are what I call static logic probes. That is, they require that the logic levels they are checking not change at all during the measurement period, or at least not so fast that the eye cannot follow. This is fine for simple low speed circuitry, but won't work well for complex or high speed circuits.

I would describe the S.I.L.T. unit, however, as a dynamic logic probe, as it allows one to make logic level measurements on the most complex and high speed digital logic circuitry one would expect to find in any ham shack. It will do this even while the circuitry is in normal operation. Time periods no longer than 20 or 30 nanoseconds may be "frozen" out of any longer period of time and examined

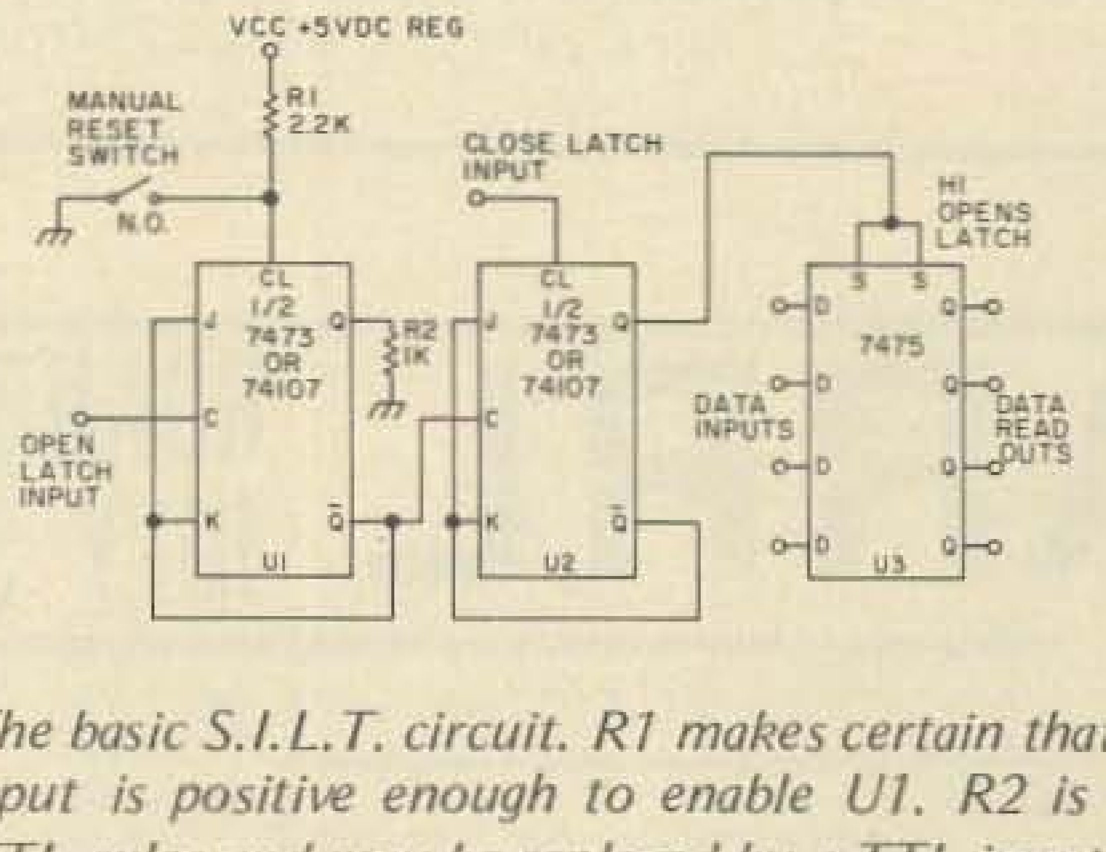


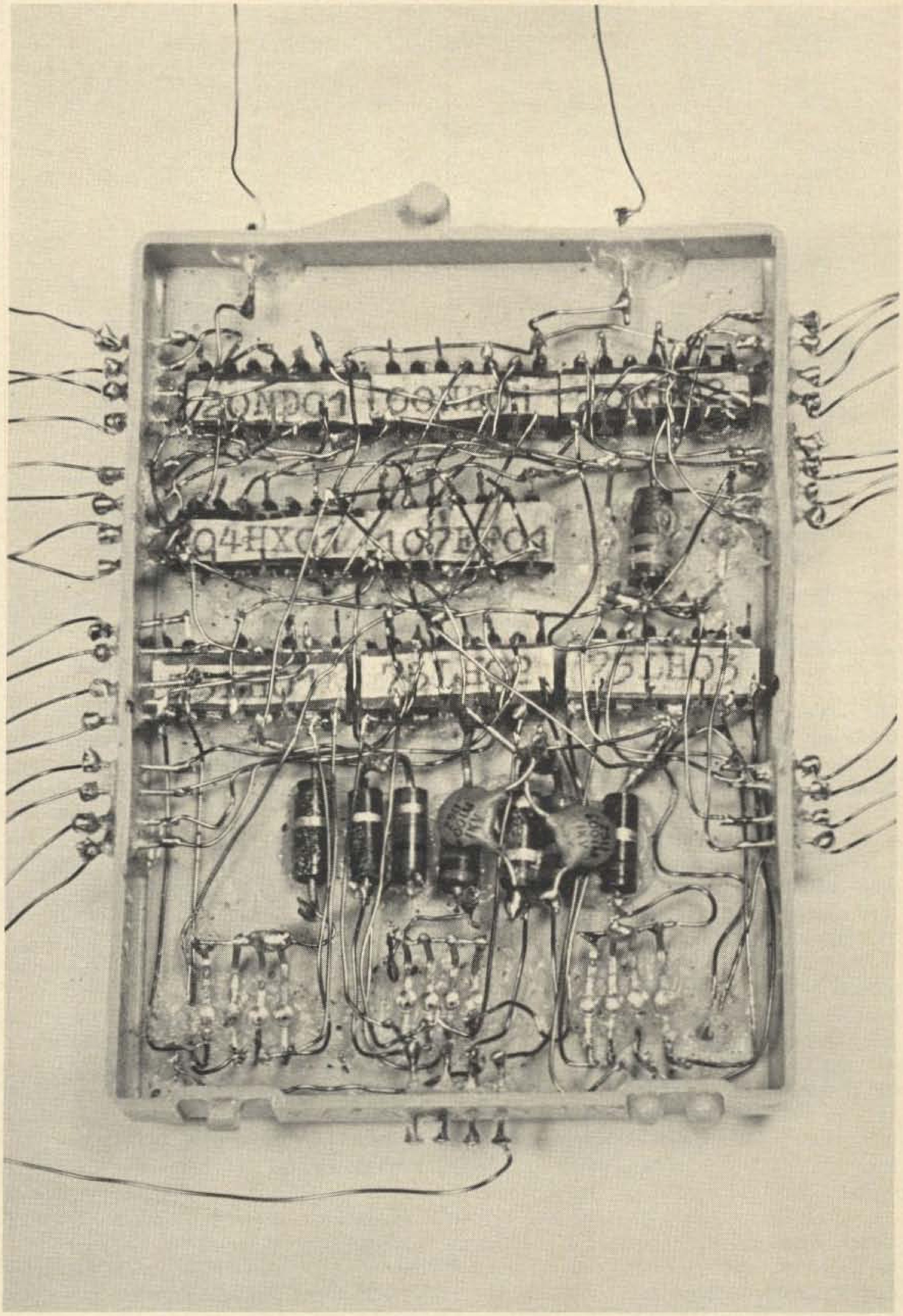
Fig. 1. The basic S.I.L.T. circuit. R1 makes certain that the U1 "CL" input is positive enough to enable U1. R2 is used to satisfy TTL rules and may be replaced by a TTL input or LED readout load.

at your leisure for proper pulse coincidence, absence of proper pulse at a specified time, presence of a wrong pulse, etc. This enables the home brewer to determine if his digital logic project is working properly, or to trace any troubles that may crop up in a particular digital logic project.

In this article I will attempt only to describe the heart of the S.I.L.T. unit. The variations that any particular user may want to include with this unit are unlimited, and determined by the type of use to which he intends to put it. You might compare it to a basic meter movement or a cathode ray tube, and the thousands of different uses they may be put to.

In the cases of very complex and/or high speed digital circuits, the S.I.L.T. can take the place of the much more expensive triggered sweep scopes in most amateur applications. The S.I.L.T. cannot, however, display waveforms. It can only tell you if a particular logic state (high or low) is present at any given instant of time — a very useful bit of knowledge, if you think about it.

Fig. 1 shows the basic S.I.L.T. unit. It uses two very common ICs. One is the 7475 quad bistable latch, and the other is the 7473 or the 74107 dual JK flip flop. The only difference between the 7473 JK flip flop and the 74107 JK flip flop is the pin basing diagram. In the 7473, Vcc is pin 4 and ground is pin 11. In the 74107, Vcc is pin 14 and ground is pin 7. Since the other pin connections are also different, I would suggest that when ordering these from your supplier you ask for a data sheet for the units you are getting. As far as electrical and logical operation go, the 7473 and 74107 are identical. For some unknown reason the difference between their prices varies from one supplier to the next.



Circuit Theory

Before I discuss the operation of this circuit, let me review the operation of the two ICs. The outputs of the JK flip flops will toggle (or shift) logic states at each negative going (high to low) transition of the logic level (at the "C" or "clock" input) *only* if two other logic situations are satisfied. First, the "CL" or "Clear" input logic level must be high. Second, the "J" and "K" inputs must also be at a high logic level.

If the "CL" input is a logic level low, the flip flop will clear and the outputs will be forced to a reset state. That is, the Q output will be forced to a low logic state and the $\bar{Q}$ output will be forced to a high logic state. Logic level transitions at the "C" input will have no effect on the outputs while "CL" is low.

If the "CL" input is high and both the "J" and the

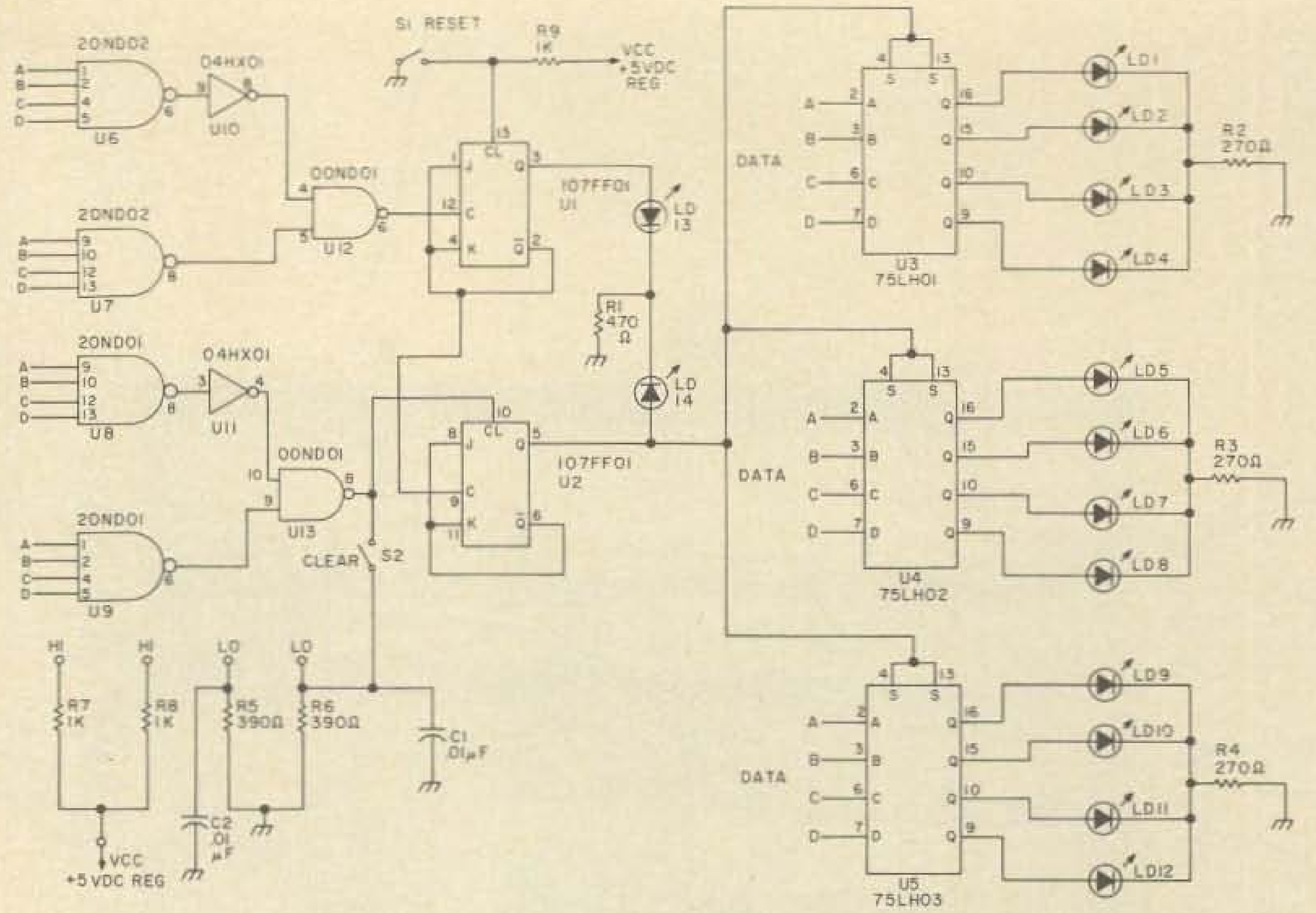


Fig. 2. The D.S.I.L.T. circuit. C1 and C2 are used to provide a direct ground for logic pulses. VCC and GND connections to ICs are not shown, but should be bypassed with at least .001 uF caps. Resistors are ½ or ¼ Watt.

"K" inputs are low, logic transitions at the "C" input will also have no effect on the output. However, unlike a "CL" logic low condition, the outputs will not be forced to a certain logic state, but will hold whichever logic state they had before the "J" and "K" inputs went low.

The "S" or "Strobe" inputs of the 7475 quad bistable latch work in a manner reminiscent of the "J" and "K" inputs of the JK flip flop. Some call this input "C", or "Clock." When the "S" inputs are at a high logic level, the "Q" outputs will reflect exactly the logic levels of their respective "D" inputs. When the "S" inputs go to a low logic level, the data present at the Q outputs is frozen and, even though the "D" inputs' logic levels may change, the data at the "Q" outputs will remain until the "S" inputs go to a high logic level again. It is worth noting that this IC also has the complementary $\overline{Q}$ outputs.

With all of this in mind, I will now go into the operation of the basic S.I.L.T. unit. If the "CL" input of U1 in Fig. 1 is grounded or at logic level low, the outputs will be a low at Q and a high at $\overline{Q}$. If the "CL" input is then ungrounded, it will be pulled up to a high level through resistor R1. Now, since $\overline{Q}$ is still high and it is connected to the "J" and "K" inputs, the flip flop is enabled. A low to high transition on the "C" input will have no effect, but a high to low transition on "C" will toggle the flip flop. The Q output will become high and the $\overline{Q}$ output will become low. Since the "J" and "K" inputs are tied to the $\overline{Q}$ output, they will also be low, and, as I said earlier, this disables the flip flop but does not reset the outputs. Any further activity at the "C" input is ignored by the flip flop. U1 is effectively latched up until a low is applied to the "CL" input.

The U1 $\overline{Q}$ output is also tied to the "C" input of U2. For the moment, let's assume that a high logic level is present at U2's "CL" input, and that U2 has been reset. That is, U2's outputs are Q = low and $\overline{Q}$ = high. Now U1 is tripped as described in the last paragraph and its $\overline{Q}$ logic level drops from high to low. Since this output is also tied to U2's "C" input, the high to low transition trips (or toggles) U2. Also, since U2's $\overline{Q}$ is tied to its "J" and "K" inputs, U2 also latches up just as U1 did. Again, U2 won't reset until its "CL" input goes low.

Since the switch used to ground U1's "CL" input is a manual normally open pushbutton, U1 won't be reset until you want it to be. U2's "CL" input is a test lead, just as U1's "C" input is. Now if I connect U2's "CL" input to a timer, I can cause U2 to reset at any time I choose after U1's "C" input has been tripped. More on this timer later.

Once U2 has been tripped and its $\overline{Q}$ output has gone low, its Q output will go high. Since this is tied to the "S" inputs of the 7475 quad latch, the Q outputs of this latch will follow any data present on the "D" inputs. At that instant of time I selected after U1's "C" input was tripped, a logic level low pulse hits U2's "CL" input and U2 is reset, U2's Q output goes low, and U3's Q outputs freeze on whatever data was present at that instant.

In my own S.I.L.T. units I use LEDs for reading out the data frozen at the outputs. Other readouts might be a VOM, VTVM, BCD to decimal decoder with numeral readout, etc. This will depend on your application. Once you have recorded the data from the outputs, you can hit the reset button and another reading can be taken, or you may want to move your "D" inputs and/or U1 "C" and/or U2 "CL" inputs to other points in the circuit.

Those who have built digital frequency counters will recognize this circuit, since it is the same as the hold latches in a counter. One difference is my method of using flip flops, and the idea of using this circuit as a test instrument.

Yes, the S.I.L.T. unit is very simple, but its uses are almost limitless. Fig. 2 is one example of how I first used the S.I.L.T. principle. This unit is a "Dependent" or D.S.I.L.T. I call it "dependent" because the basic S.I.L.T. unit depends on timing pulses from within the digital unit under test to reset the U2 flip flop.

The operation of U1, U2, and U3 is the same as in Fig. 1. U4 and U5 are also 7475s and are added to the Q output of U2 so that three times as much data can be displayed for each test. LEDs LD-1 through LD-14 are common red mini-LEDs. LD-1 through LD-12 are readouts for the quad latches, and LD-13 and LD-14 are used to keep track of the switching conditions of U1 and U2.

If U1 is reset and Q is low, LD-13 will be off. When U1 is tripped, Q goes high and LD-13 lights to let you know U1 has been tripped. When U2 is tripped, Q goes high and LD-14 lights. When U2 is reset, Q goes low and LD-14 goes out. R1-R4 are current limiting resistors for the LEDs. Switch S1 is the reset switch. Switch S2 is used to reset U2 in case a low pulse does not arrive at U2's "CL" input.

U6 through U9 are 7420 four input NAND gates. The inputs to these gates may be connected in various ways to the circuit under test so that a selected number of *coincident* pulses will trigger the appropriate response from U1 or U2. Unused inputs may be tied to the appropriate resistor-driven high or low terminals.

U10 and U11 are 7404 hex inverters which invert the outputs of U6 and U8. Their outputs, along with the outputs of U7 and U9, are fed to the inputs of ICs U12 or U13, which are 7400 dual input NAND gates.

My purpose in building the D.S.I.L.T. was to aid in troubleshooting a digital VFO that I have in design. You may not need as many as three latches, or you may require more than three. Also, the inputs may vary to suit your needs. Many methods of construction may be used. I offer my method only to give you some ideas.

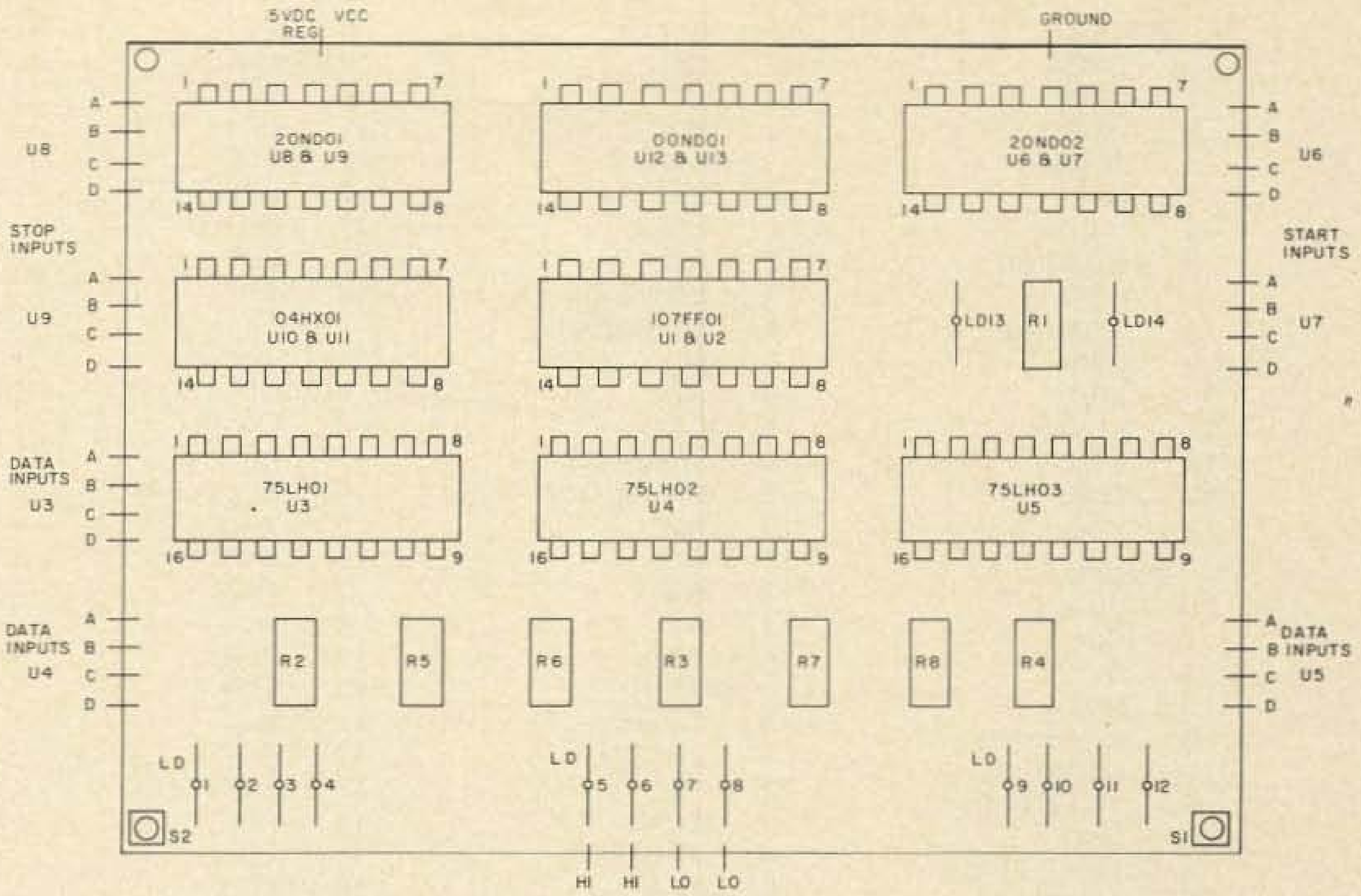


Fig. 3. D.S.I.L.T. layout is very handy for wiring and later troubleshooting. All parts except wiring and capacitors are shown. Caps should be disc types and lie flat across IC pins.

Construction

The first step in the construction process is to choose a wiring method. Printed circuit board is by far the best choice. I didn't choose it because I hadn't had much success with those tenth of an inch IC pin spacings, and also because usually, as soon as I finish etching a PC board, I decide to make a circuit change. Uses for the D.S.I.L.T. are so variable and changing that it may never be put on PC board at this station.

Another choice is perfboard, with molex IC socket pins. I've used this method, but it seems that when more than two ICs are used, a short almost always develops somewhere.

IC sockets are an excellent choice if you don't mind having more invested in sockets than in ICs.

The method I finally chose was a variation of the methods described in a *Ham Radio* article.[1] First, I decided on a layout (see Fig. 3). Then I chose a plastic box of proper size. Next, silicone rubber sealer was applied to the top of an IC and the IC was placed upside down in the bottom of the box so that its legs were pointing upward. Be cautious that you position pin 1 of each IC in the same direction each time, or you'll have trouble identifying the pins. All other parts, LEDs, resistors, and ICs were mounted using this method. If a part needs to be replaced, it is easy to pry it up and "glue" in another.

If you tip a couple of ICs upside down on a tabletop, you will soon discover that if you don't already know the IC number, you've got a problem. Not so. Type the number on a small strip of masking tape. Cut and trim the tape to size and apply it to the bottom of the IC. Better yet, use the coding system shown in Table 1.

The wire I used is #26 Beldsol enamel. It has an insulation that melts off when a high temperature soldering iron is applied to it. Don't worry if you should accidentally touch the wire with the soldering iron. The insulation doesn't come off that easily. Neatness in wiring, in this case, is an invitation to disaster. Direct point-to-point wiring is preferred. *Do not* bundle your wires, as these bundles are fair to excellent transformers for digital pulses. Use extra heavy wiring or copper strapping for the B+ and ground wiring, not so much because of high current requirements, but to cut down the impedance to high frequency square waves.

Using this system with seven or eight ICs, I soon found that wiring errors are next to impossible to avoid. So I developed an idea similar to that used in kit construction. First, I developed the code shown in Table 1. Then, using the pin numbers shown in Fig. 2, I made up the charts shown in Table 2. Following this table I made no wiring errors and the unit worked fine the first time.

I used common pins cut off to about three eighths of an inch lengths to run the wiring through the side of the plastic box. Common pins that are attracted to a magnet seem to take solder best. Again, silicone rubber sealer holds these firmly in place. You have several choices for the other end of your test leads. A large or small alligator clip will allow you to make simultaneous contact with no fewer than two IC pins. This is not exactly what I had in mind. One good choice is the GRABBER Model #3925 mini test clip.[2] This, in my opinion, is the best choice, but for units with as many data and trigger input leads as my D.S.I.L.T., these clips could make up a large percentage of the cost.

The choice I made was to use about two feet of #26 Beldsol wire for each lead and to solder the test lead directly into the circuit under test. This sounds like a nightmare, but it really is very easy — especially on the solder side

20ND01

Pin	To Pin
1	U8/A
2	U8/B
3	BLANK
4	U8/C
5	U8/D
6	9/00ND01
7	GND
8	3/04HX01
9	U9/A
10	U9/B
11	BLANK
12	U9/C
13	U9/D
14	VCC

00ND01

Pin	To Pin
1	NC
2	NC
3	NC
4	8/04HX01
5	8/20ND02
6	12/107FF01
7	GND
8	10/107FF01
9	6/20ND01
10	4/04HX01
11	NC
12	NC
13	NC
14	VCC

20ND02

Pin	To Pin
1	U6/A
2	U6/B
3	BLANK
4	U6/C
5	U6/D
6	9/04HX01
7	GND
8	5/00ND01
9	U7/A
10	U7/B
11	BLANK
12	U7/C
13	U7/D
14	VCC

04HX01

Pin	To Pin
1	NC
2	NC
3	8/20ND01
4	10/00ND01
5	NC
6	NC
7	GND
8	4/00ND01
9	6/20ND02
10	NC
11	NC
12	NC
13	NC
14	VCC

107FF01

Pin	To Pin
1	2/107FF01
2	*3
3	LD13
4	2/107FF01
5	*7
6	*2
7	GND
8	6/107FF01
9	2/107FF01
10	8/00ND01
11	6/107FF01
12	6/00ND01
13	SW1
14	VCC

75LH01

Pin	To Pin
1	NC
2	U3/A
3	U3/B
4	5/107FF01
5	VCC
6	U3/C
7	U3/D
8	NC
9	LD4
10	LD3
11	NC
12	GND
13	5/107FF01
14	NC
15	LD2
16	LD1

75LH02

Pin	To Pin
1	NC
2	U4/A
3	U4/B
4	5/107FF01
5	VCC
6	U4/C
7	U4/D
8	NC
9	LD8
10	LD7
11	NC
12	GND
13	5/107FF01
14	NC
15	LD6
16	LD5

75LH03

Pin	To Pin
1	NC
2	U5/A
3	U5/B
4	5/107FF01
5	VCC
6	U5/C
7	U5/D
8	NC
9	LD12
10	LD11
11	NC
12	GND
13	5/107FF01
14	NC
15	LD10
16	LD9

*Table 2. D.S.I.L.T. wiring tables from all ICs to their connections. This takes care of all major wiring except for some resistor and switch hookups. The numbers preceded by an * indicate the "fanout" required from an output with more than one connection. Thus, pin 2 of the 107FF01 goes to 3 inputs. Pin 5 of the 107FF01 goes to 7 inputs, which is close to maximum (about 10 TTL loads in most cases). NC means no connection. BLANK means that the IC has no internal connection on that pin.*

of a PC board. A Wald portable soldering iron is a great help, but is not necessary.

The power for the D.S.I.L.T. is robbed from the unit under test. Bypassing is the word to worship here. I bypass every IC with a .001 capacitor.

Switches S1 and S2 are unique. Manufactured switches are (a) expensive, (b) massive, and (c) unnecessary. I built my own SPST switches. First, two pieces of tin or copper are cut to one quarter inch squares. Then, using a center punch, a dimple is made in the center of each piece. A one sixteenth inch hole is drilled through the bottom of the plastic case in one corner. The two wires, one from ground and the other from U1's "CL" pin, are passed through this hole. Either wire is soldered to the dimpled side of one of each of the two squares of metal. Next, one wire is pulled back through the hole until the metal lies flat against the hole (with the bump in the metal facing away from the bottom surface). The metal is held in place by, you guessed it, silicone rubber sealer. Be careful not to get any sealer on the exposed surface of the metal.

Now, before the sealer hardens, the other wire is pulled back through the hole until the other square of metal can be positioned about one sixteenth of an inch above the other and be held there by just the stiffness of the wire supporting it. The bumps on the two squares should be facing each other and almost touching. Apply silicone rubber sealer around the metal pieces, being very careful not to force sealer between the two pieces. The finished blob of sealer should look similar to the little sample the sealer company puts on its cartons to demonstrate its qualities.

This entire procedure should be repeated on another corner of the box, using a wire from U2's "CL" pin and a wire from a resistor-driven logic low terminal. Also, blobs of sealer should be put on the remaining two corners of the case. Once this sealer sets up, these serve as excellent nonskid feet for the D.S.I.L.T. When a corner of the box with the switch in it is depressed, the two pieces of metal are forced together. Releasing the case allows the elastic qualities of the sealer to pull the metal pieces apart.

This simple switch saves much space and money. It also leaves several of my ham friends scratching their heads and wondering where the switch is. Most of these ideas come from trying to do something with as little as possible. They may seem weird, but the fact that they work is all that matters.

I would say that if you understand the logic of the D.S.I.L.T., you can probably use it properly on any logic circuit you *understand.* You may even be able to use it to figure out some logic schemes that you are not sure of.

If you are just starting to study logic circuits, however, I suggest you use the simpler static logic probes before building an S.I.L.T. type unit. Although the D.S.I.L.T. is a very simple circuit, its use does require complex logic. ■

References

[1] "Six Meter Frequency Synthesizer," W1KNI, *Ham Radio,* March, 1974, pp. 27-28.

[2] Pomona Electronics, 1500 E. Ninth St., Pomona CA 91766.

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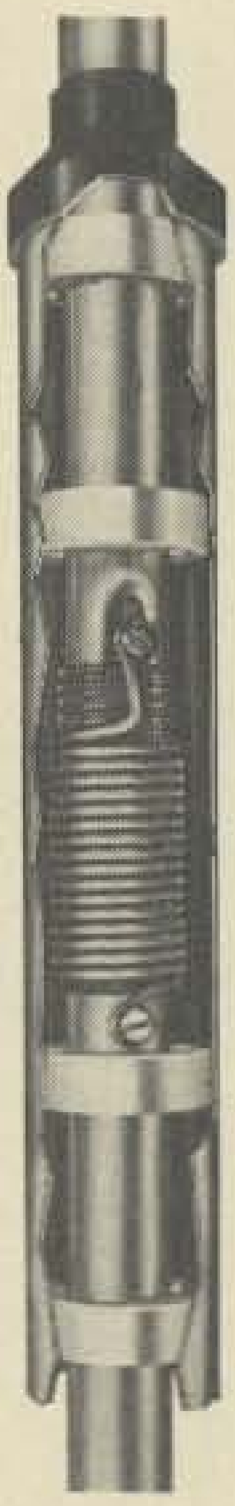

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Global Calculations for the DXer

--using a hand calculator

Have you ever wondered how far away that DX location was? Maybe you've even been curious enough to try measuring the distance from a map — and have found that it can't be done very well. Most maps are either too small to measure on accurately, or have inaccurate distances (this is the case for the common Mercator projection), or both. But if you have a pocket calculator and know your latitude and longitude, you can crank out an accurate distance to any place in the world, within a tolerance of a few miles, in a very short time. You don't need pencil and paper, and your calculator need not be a \$700 programmable beauty, either. Mine cost \$59, and like many under-a-hundred dollar units, it does the job nicely.

What is essential is that the calculator handle trig functions — sines and cosines — and their inverses. A memory register is also useful, although not essential. This means the calculator needed is one step up from the simple four function types that are the cheapest. However, there are many units that list for \$100 or under (and sell for much less) that will fill the bill. Included among these are the APF Mark 20 (which I used to work the examples below), the Rockwell 63R and 61R, the Sears ESR, Unitrex 80SR, Novus Math, Casio FX-10, Heath IC-2000 (a kit), and even the Sinclair Scientific (which I've never seen, but understand is listed for only \$50). If current calculator discounting practices are any guide, you ought to be able to get this one in trade for a pair of 807s and an old modulation transformer!

Of course, the calculation can also be done, and very efficiently, with a machine like an HP-35 or HP-45. The primary difference is that these machines use Reverse Polish Notation (RPN) which involves a slightly different keying sequence. The mathematics is, of course, exactly the same as given below.

The basic task is to solve for one side of a spherical triangle, given the other two sides and the angle between them. What may be a bit confusing, if you look this up in a reference on navigation such as Bowditch's *Practical Navigator*, is that the *lengths* of the sides of the triangle are stated in degrees in the formula — degrees as seen from the center of the earth. Here's the standard formula:

$$\cos c = (\cos a)(\cos b) + (\sin a)(\sin b)(\cos C)$$

where the quantities are as shown in Fig. 1. Point A is your QTH, point B is the distant location and point C is the north pole.

Solving this can take a lot of key punching, even with a machine to look up sines and cosines for you. And the answer comes out in degrees on the earth's surface, which requires a further conversion. The final blow is that, although a, b and C are angles in degrees, none of them is directly a latitude or longitude. You'll appreciate why in the past this type of figuring went on mainly on ships where position changes slowly. Aircraft navigation generally ignores lats and lons except if an inertial or VLF navigator is aboard, and those gadgets contain a lot of computer.

For our ham purposes, however, the formula can be

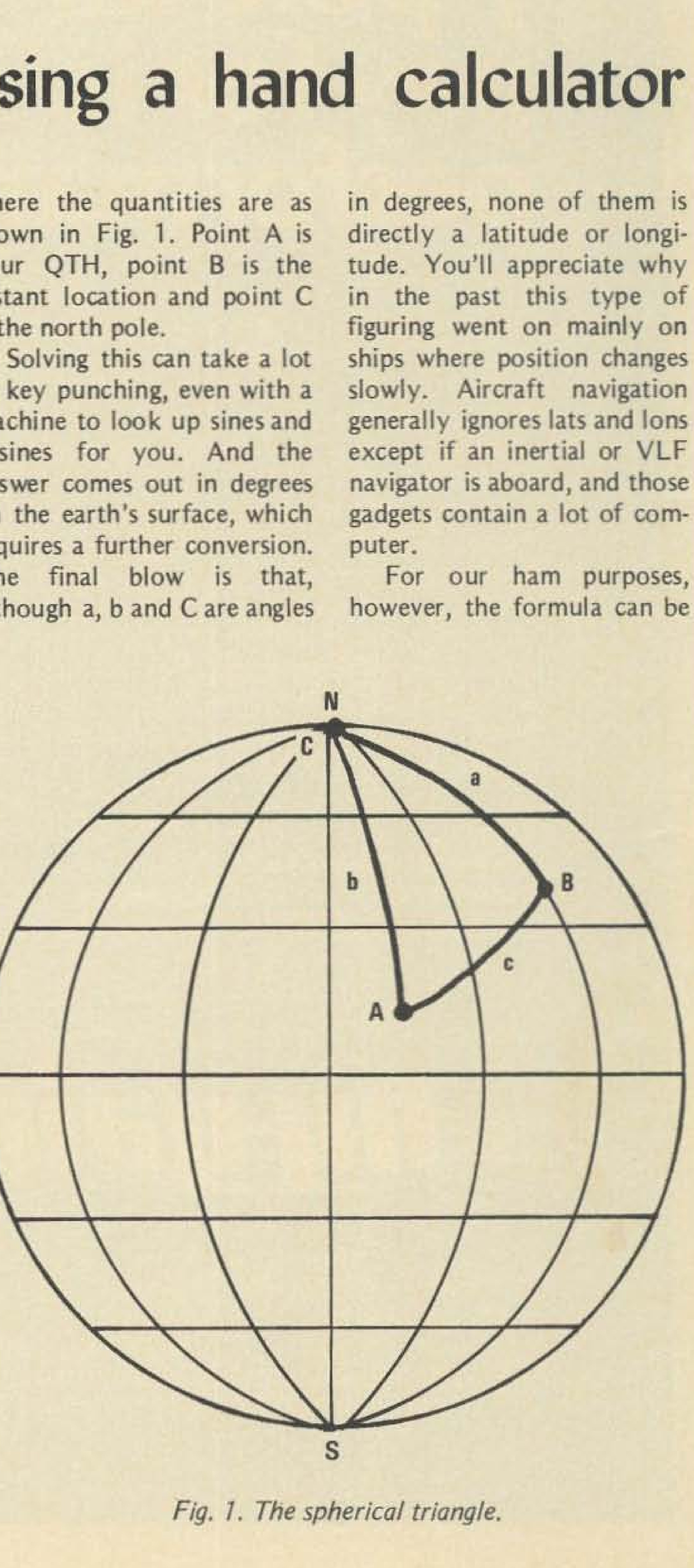

Fig. 1. The spherical triangle.

KEY STROKES	DISPLAY SHOWS	WHICH IS
(1) [1] [5] [0] [-] [7] [3] [=]	77	the angle C
(2) [F] [COS x]	0.224951	cosine 77°
(3) [M+] or [x→M]	0.224951	cosine 77° stored
(4) [6] [1] [F] [COS x]	0.48481	cos 61°
(5) [×] [MR] [=]	0.1090584	cos 61° x cos 77°
(6) [×] [.] [7] [6] [5] [2] [=]	0.0834515	(.7652) (cos 61°) (cos 77°)
(7) [x→M]	0.0834515	all above stored
(8) (Clear calculator, but not the memory.)		
(9) [6] [1] [F] [sin x]	0.874619	sin 61°
(10) [×] [.] [6] [5] [4] [3] [=]	0.5722638	.6543 sin 61°
(11) [+] [MR] [=]	0.6557152	(all)
(12) [F] [cos⁻¹ x]	49.02608	c in degrees
(13) [×] [6] [9] [.] [1] [5] [=]	3390.1534	d

Table 1.

simplified considerably. The first thing to do is to prefigure two constants from your home latitude: K_1 = cos b and K_2 = sin b. If you're in the northern hemisphere, side b of the triangle is 90° minus your latitude. Huntington, Long Island, New York, where I live, is at 40° 52' north latitude, so for me

$$K_1 = \cos b = \cos (90 - 40^\circ 52') = \sin 40^\circ 52' = .6543$$

and

$$K_2 = \sin b = \sin (90^\circ - 40^\circ 52') = \cos 40^\circ 52' = .7562$$

I plug these two numbers into the formula. They never change, so why recompute them every time? Now we have

$$\cos c = (K_1)(\sin LAT_D) + (K_2)(\cos LAT_D)(\cos C)$$

Notice that in rewriting the formula I've changed cosines to sines and vice versa so that latitudes can be used directly.

That angle C is the *difference* between your longitude and LON_D, the longitude of your destination. Simple enough; just subtract the larger longitude from the smaller in most cases. What can trip you up is if you're on one side of Greenwich and the distant point is on the other. In that case you add. Three examples should make this clear:

(1) Huntington, N.Y. (73° 19' W) to Honolulu, Hawaii (157° 55' W).

C = 157° 55' - 73° 1.9'

C = 84° 36'

Always subtract the larger from the smaller. What you want is a positive number of degrees.

(2) Huntington, N.Y. (73° 19' W) to Moscow, U.S.S.R. (37° 40' *E*)

C = 73° 19' + 37° 40'

C = 110° 59'

If this addition comes out to be more than 180 degrees, you've got the long path. Subtract the result from 360 and call *that* C.

(3) Huntington, N.Y. (73° 19' W) to Tokyo, Japan (139° 28' E).

C = 73° 19' + 139° 28' = 212° 47' (too big)

C = 360 - 212° 47'

C = 147° 13'

I've rearranged the standard formula for easier use and to come out with an answer in statute miles. The final version is:

$$d = (69.15) \cdot \left\{\cos^{-1} [(K_1)(\sin LAT_D)+(K_2) \cdot (\cos LAT_D) \cos (LON_D \pm LON_H)]\right\}$$

That's still a pretty formidable formula, but it can be worked through without memory stacks or parentheses keys, and without ever needing a pencil and paper (assuming you have a memory in your calculator). The secret is to have this formula, with your two constants already in it, posted in front of you. START INSIDE THE PARENTHESES AND WORK BACKWARDS. Here's how I work an actual example with my calculator, which, like many, has an "F" button to shift the keys from numbers to functions — like sin x, $\sin^{-1}$ x, etc. The two end points are my QTH (LON_H = 73°) and Anchorage, Alaska (LAT_D = 61° N, LON_D = 150° W). I've rounded off Anchorage's coordinates to even degrees. Do this. It saves keypunching, and the maximum error you'll ever get is 35 miles. Big deal.

The calculation we're going to do is:

$$d = (69.15) \cdot \left\{\cos^{-1} [(.6543)(\sin 61)+(.7562) \cdot (\cos 61) \cos (150-73)]\right\}$$

(Clear the calculator completely, and follow the steps shown in Table 1.)

So the distance from Huntington, N.Y. to Anchorage, Alaska is about 3390 miles. Using the minutes and seconds of coordinates as close as I can find them gives 3329 miles. I don't find the difference very significant.

Here's the formula for Huntington, N.Y. to Paris, France, which is on the other side of the Greenwich meridian at LAT_D = 48.52°N, LON_D = 2.2°*E*:

$$d = (69.15) \cdot \left\{\cos^{-1} [(.6543)(\sin 48.52)+(.7562) \cdot (\cos 48.52) \cos (73.32 + 2.2)]\right\}$$

$$d = 3596 \text{ miles}$$

The above works for any two points in the northern hemisphere, and can go quite fast.

With your personal version of the formula in front of you, you can run through the calculation (with no goofs) in under two minutes. If, during a phone QSO, someone will give you his latitude and longitude, you can do the whole thing while he's telling you about his super whizbang beam antenna, and get back to him with what we might call the QTD — the distance spanned by the QSO.

What about the southern hemisphere? After all, there are a lot of countries south of the equator. No problem, really: We just need a slight change in the formula. It becomes:

$$QTD = (69.15) \cdot \left\{\cos^{-1} [(-K_1)(\sin LAT_D)+(K_2) \cdot (\cos LAT_D) \cos (LON_H \pm LON_D)]\right\}$$

The only difference between this formula and the previous one is that minus sign before "K_1 (sin LAT_D)." It can easily be handled if your calculator has a "change sign" key. Just hit it at the end of line 10 in the step-by-step example. Using this for Huntington to Rio de Janeiro, Brazil (LAT = 22.54 *S*, LON = 43.15 W), I get a distance of 4794 miles.

There you have it — a fairly simple method to tell you your distance from any place in the world. If you really get hooked on this game as I have, you might consider owning *The International Atlas* by Rand McNally. It lists 160,000 places in the world alphabetically with their latitudes and longitudes. I'm looking forward to the day when I can work the ultimate in DX. For me that's Augusta, in Western Australia, lat. 34.19 S lon. 115.10 E, distance from my QTH — 11,794 miles. Of course, if I could somehow arrange to work somebody in South Huntington, N.Y. *long path* . . . ■

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Instant Counter Calibration

--using your TV set

If this is the first issue of *73* that you've read in the last five years, then perhaps you haven't noticed that we are *over* the threshold of the age of "gnat's eyebrow" frequency measurement! It's rather fortunate that the development of affordable frequency counters paralleled the recent rapid growth of two meter FM, because the serious FMer should have (or have access to) a reasonably accurate frequency counter for netting the crystals in his (her) rig. The luxury of being "talked-in" on the larger systems has passed. For the moment, let's suppose that you have your own frequency counter; how does one go about accurately calibrating (or at least verifying the calibration of) the little gem? Faced with this same problem recently, I began to look around for something *on hand* that would provide a solution (in the time honored "ham tradition"), and came to rest on the TV set, the one-eyed monster. Now, before you leave in disgust, stick with me a little longer and see what a handy little frequency reference a TV set can be when tuned to a network station.

All four TV networks, NBC, CBS, ABC, and PBS, presently use rubidium frequency standards to generate their color burst, horizontal sync pulses, and vertical sync pulses. Some local stations also use rubidium standards locked to the network with which they are affiliated, but unless you are sure, you can't count on it (pun?). These rubidium standards are traceable to NBS (National Bureau of Standards) of WWV fame, inasmuch as the networks are monitored by NBS and offsets are published periodically.

At this point, it should be explained exactly what a rubidium frequency standard is, since it sounds so good. Rubidium 87 is a metallic element whose atomic resonance is 6834.6826 MHz. This natural atomic resonance of rubidium 87 is very stable and not easily upset by external factors (particularly when properly shielded and operating in a temperature-controlled cavity). The rubidium unit influences control on a crystal oscillator, which then adopts the same order of stability as the rubidium reference. The crystal oscillator feeds a frequency synthesizer that contains outputs of 5.0 MHz and 3.579554 MHz (color burst frequency). The long-term (one year) stability of commercially available rubidium standards is $\pm 5 \times 10^{-11}$, and the short-term (one second) stability is $\pm 1 \times 10^{-11}$; these figures improve even more when correlated to NBS offsets.

The TV station uses the 3,579,545.4 Hz color burst signal as a reference for its sync generators, which then derive the familiar horizontal and vertical sync signals used to lock the sweep oscillators in the home TV receiver. The gears are undoubtedly clicking at this point and you're beginning to eye the mahogany knothole with some quick glances.

Here's how you can take advantage of those highly accurate signals that are beaming around us, all of eighteen plus hours a day. The easiest way I've found is to pick up the horizontal sync signal, which is in abundance inside the cabinet of a TV receiver due to its use for the derivation of the high voltage that's needed to run the picture tube. This high voltage spike can be found anywhere around the flyback transformer or the picture tube yoke (which is a safer area to work in). If the set has a wooden or plastic cabinet and your counter is sensitive enough, you may find enough signal to lock on even outside of the cabinet (try the picture tube screen for openers). Note that there is no need to connect either lead from the counter directly to the TV receiver. In fact, unless the TV set is equipped with a power transformer, it would be disastrous to do so (especially if the counter is grounded, which it should be)! Some of the newer portable TV sets have no power line isolation transformers and use bridge rectifier circuits for ac to dc conversion, with the result that even reversing the ac line cord won't place the dc common at ground potential (it's always hot). This situation makes it impossible to hook up externally grounded test equipment to these sets unless an external isolation transformer is used. The preceding was mentioned only to protect the innocent. During a network color broadcast, the horizontal scanning frequency will be 15,734.265 Hz, which I have read on my Heath IB-1103 by simply placing a *well insulated* lead from the counter over the deflection yoke on the neck of the picture tube. You'll notice, if your counter will read below 1 Hz, that the ".265" will vary between counter sampling periods (because you're not phase locked to the signal, but this is really splitting hairs). It should hit ".265" occasionally. On most counters, if you're within a couple of cycles of 15,734 Hz, you're in good shape. Incidentally, you can use a black and white TV instead of a color set, because its horizontal oscillator is locked to the color standards (H and V sync pulses) as well. Just be sure you are tuned to a network color program. Most network color mobile units now have rubidium standards on board, with the possible exception of the small news "mini-cam" units, so that even in-the-field sporting events will provide accurate sync signals. One more thing: Don't be in a hurry. Give yourself enough time to average the reading over a 10 or 15 minute period. This will give the clocking oscillator in the counter time to stabilize after adjustment, and also will permit you to observe the medium term stability of your counter. Whether or not you actually watch the program on the TV screen is strictly up to you.

There are some inherent errors in the system just described (such as distortion in the microwave relays used for cross-country TV signals, transmission and multi-path distortions within the local "ether," and distortions that take place within the TV receiver itself), but these are *phase* and not *frequency* distortions. So as long as you're not trying to read to three places below one cycle (Hertz), don't fret about 'em (the purists should be happy now).

There you have it: no digging into the circuitry, handy at most times of the day and night, available throughout the country, and very accurate. What more could be asked for? Just one thing — better give the TV set back to the wife and kiddies! ■

Super Simple 450 MHz Rig

--go ATV with a $42.50 module

Bruce J. Brown WB4YTU/WA9GVK
4801 Kenmore Ave #1022
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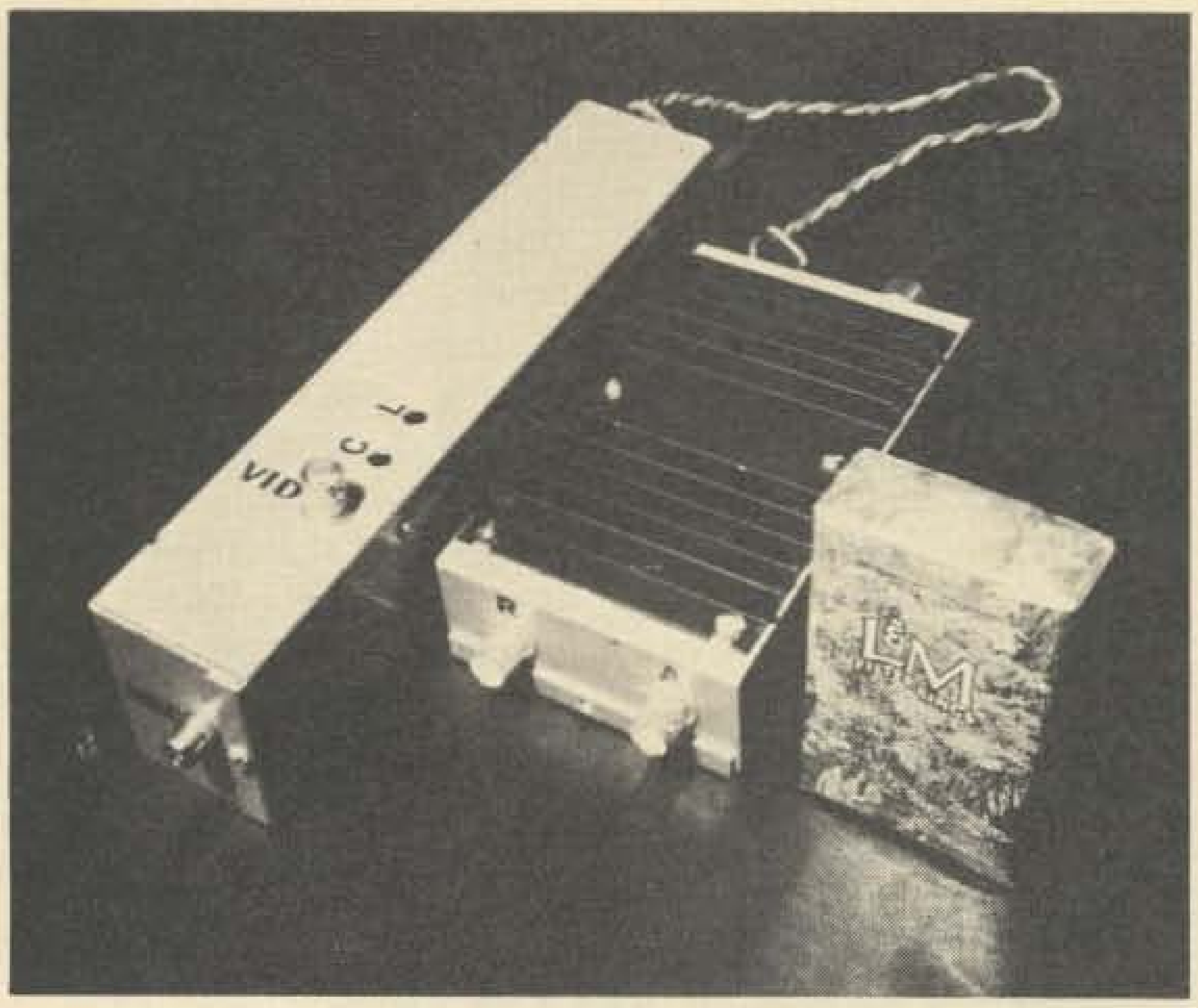


Fig. 1. Low cost 10 Watt ATV transmitter (exciter left, amplifier right).

Here's a compact 10 Watt fast scan amateur television (ATV) transmitter with audio on the video carrier and T/R switching that can be built for about $120 (Fig. 1). The rig incorporates the video exciter described in the June 1976 issue of *73* to drive a quasi-linear 10 Watt 3/4 meter amplifier. No amplifier tune-up is required since it utilizes the Motorola MHW-710 sealed power module. (For theory of operation of this module in the ATV mode, refer to Nov/Dec 1975, page 37 of *73*.)

Operating at 13.8 V dc, the transmitter draws about 2.7 Amps from an external regulated power source. Linearity and frequency response performance is shown in Fig. 2.

As noted above, the construction details for the exciter have already been given; therefore only the amplifier circuit will be described here. Several different mounting arrangements are possible, so you may wish to deviate from the following procedure. Of course, both the amplifier and exciter can be collocated in the same enclosure; however, experimentalists may prefer the two-box modular approach to effect rapid exciter or amplifier interchange with future designs.

A B

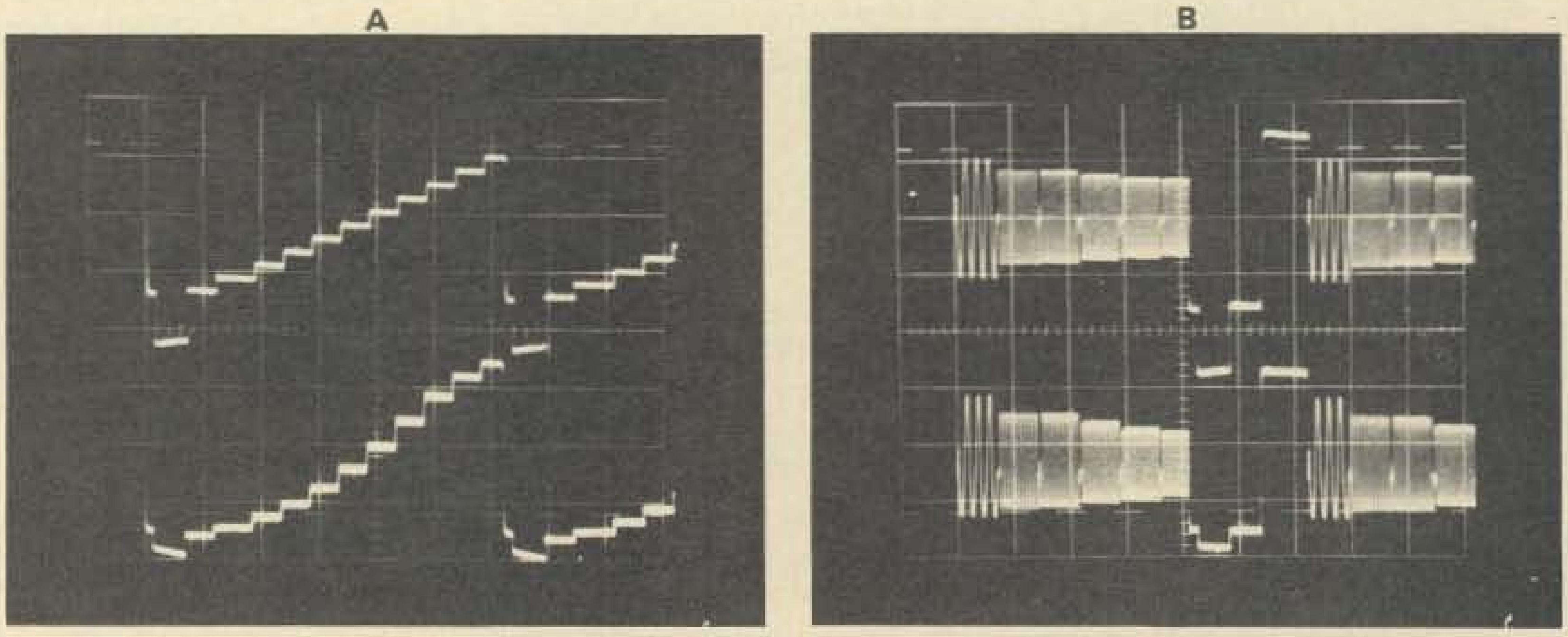


Fig. 2. Performance curves, 10 Watt ATV transmitter. All vertical scales uncalibrated. Power: 13.8 V dc @ 2.7 A. (a) Linearity: top scale — video in; bottom scale — detected rf output; 10 usec/div horizontal; 10 Watts out (average). (b) Frequency response: top scale — video in; bottom scale — detected rf output; 10 usec/div horizontal; burst order (in MHz) — 0.5, 1.5, 2.0, 3.0, 3.58, 4.2.

Amplifier Construction Procedure

Refer to Parts List and Fig. 3.

1. Drill holes in chassis and heat sink per Figs. 4 and 5. Make sure that holes in heat sink line up with holes in chassis.

2. Referring to Fig. 6, mount all components to PC board. (Foil layout for board is shown in Fig. 7.)

3. Using two #4-40 screws, lockwashers and nuts, bolt PC board to two "L" brackets as shown in Figs. 8 and 9.

4. Spread heat sink compound over back of heat sink and Motorola MHW-710 module. Place module on inside of chassis and heat sink on outside. Place PC board mounting brackets on module. Position brackets, module and heat sink so that all holes line up. Bolt all together with two #6-32 screws, lockwashers and nuts.

5. Using four #8 screws, lockwashers and nuts, bolt the corners of the heat sink to the chassis.

6. Solder all seven pins of the module to the PC board (pin numbers shown in Fig. 7).

7. Mount 3 BNC connectors, feedthrough capacitor and ground lugs to chassis. As shown in Fig. 9, also secure a #8 terminal lug to one of the screws holding the heat sink to the chassis. This is the relay ground lug.

8. Run twisted #20 wires from the feedthrough capacitor and ground lug (next to feedthrough) to + and GND on the PC board respectively. Solder a 500 uF electrolytic capacitor across the feedthrough and ground lug.

9. Completely cover the transparent plastic sides and end of the relay with copper foil. Also run a .2" strip of foil across the bottom of the relay (where the contacts are). The relay socket is not used. Solder all copper foil pieces together to insure a good shield.

10. Position the relay as shown in Fig. 9. Terminals A and B will be up. Solder the #8 terminal to the copper foil at the end of the relay opposite from the contacts. This will partially secure the relay in place while also grounding the relay's shield.

11. Solder wire from the ground terminal to terminal #4 of the relay. Solder a wire from the feedthrough capacitor (+ V dc) to terminal #1 of the relay.

12. Prepare four RG-188 cables as shown in Fig. 10.

13. Connect the 3" cable from the "IN" BNC to "IN" on the PC board (module pin 7). Solder the cable shield directly to the grounded portion on the BNC connector. The other shield is inserted in the hole provided on the PC board and soldered to the foil. All shield lengths must be as short as possible.

14. Solder the ½" long center conductors and shields of the two 4" long cables to BNCs "A" and "R." Also solder the ½" long center conductor and shield of the 6¼" cable to "OUT" on the PC board (module pin 1). Again keep shield lengths as short as possible.

15. Solder the 1¼" long center conductor of the cable from the PC board to terminal A of the relay.

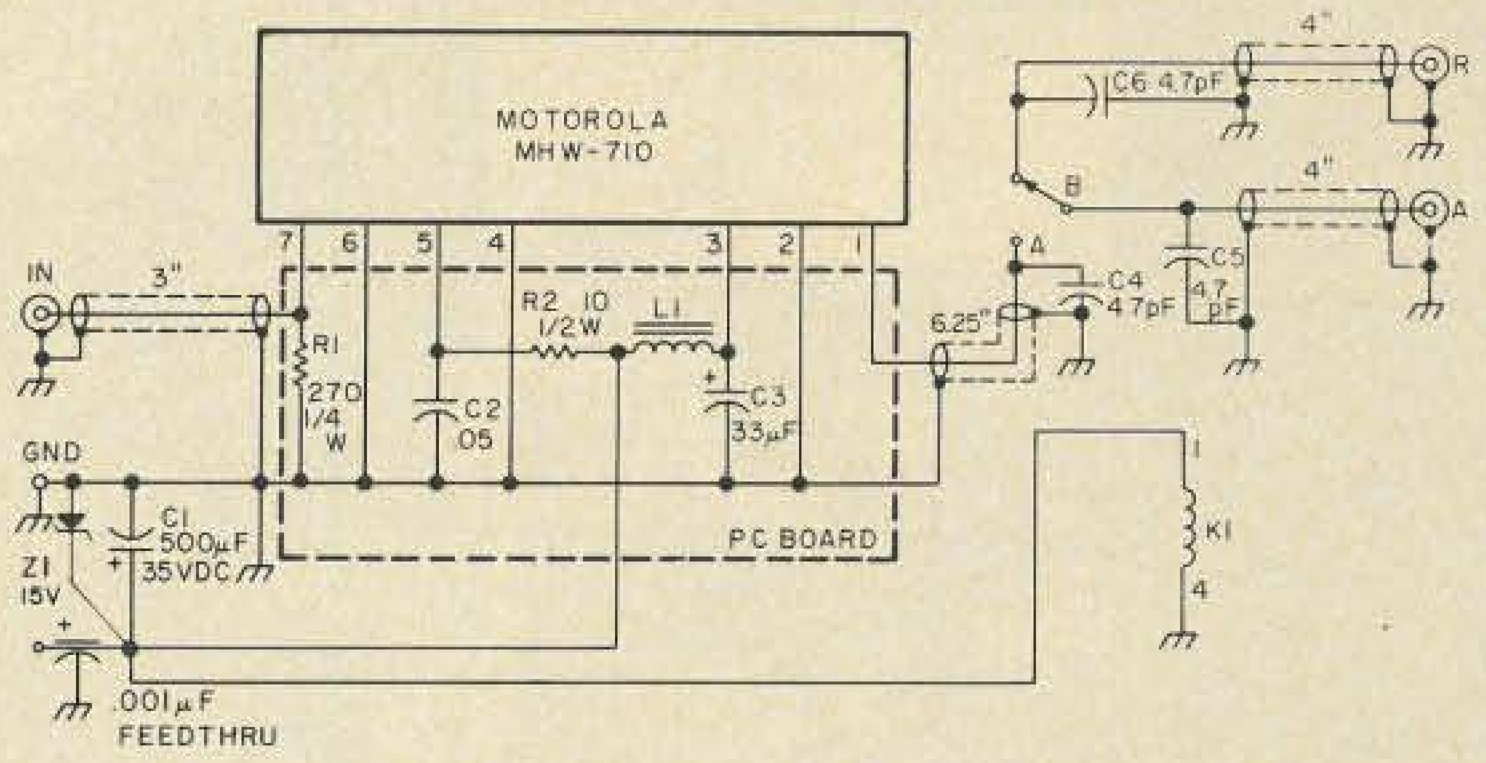


Fig. 3. 10 Watt amplifier schematic. K1 is Archer (Radio Shack) #275-206 relay. L1 is Ferroxcube. VK200-20/4B.

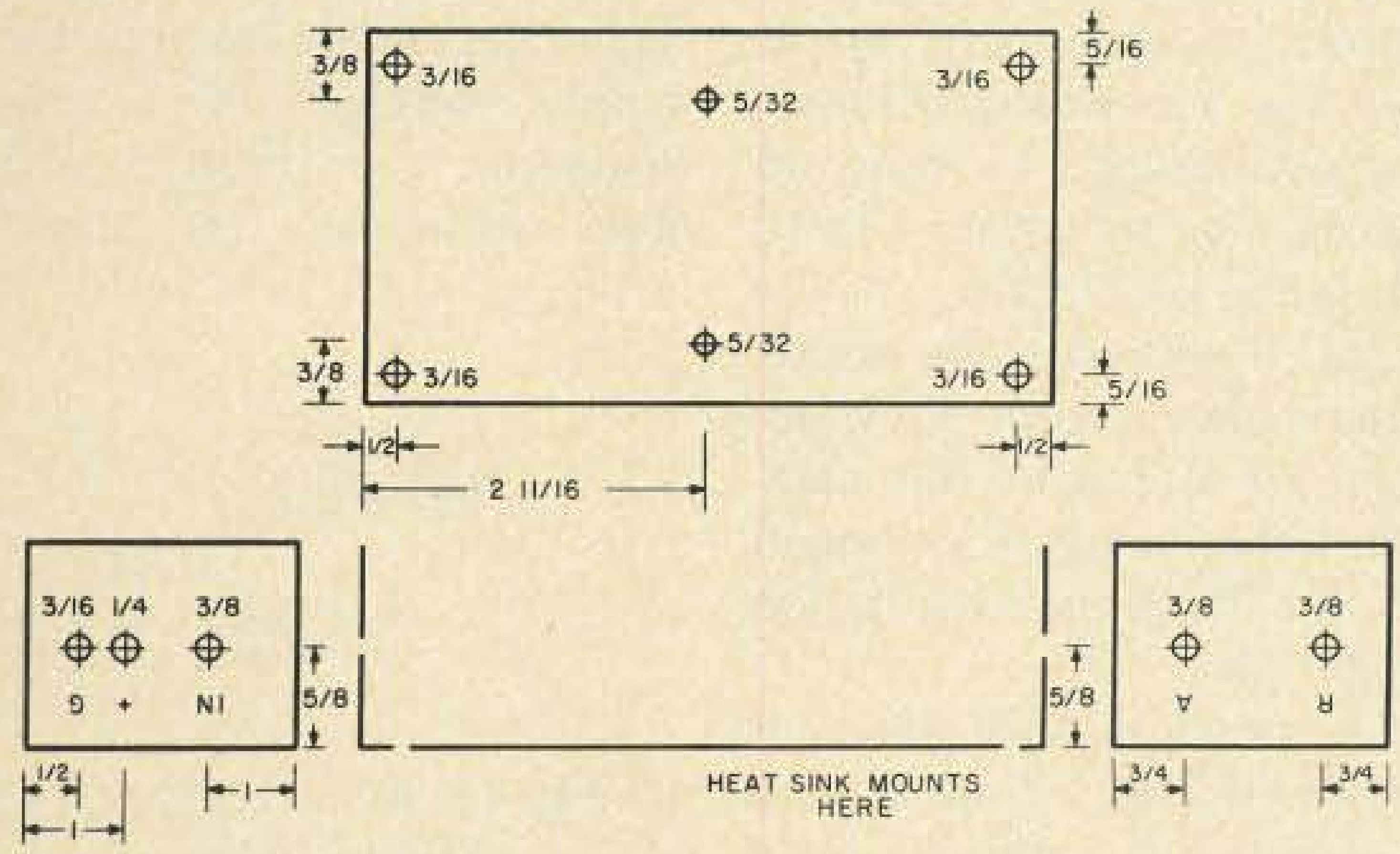


Fig. 4. ATV 10 Watt amplifier chassis drill guide. Notes: All dimensions are in inches. All measurements are from outside edge of chassis. Chassis is LMB #139. Guide is not drawn to scale.

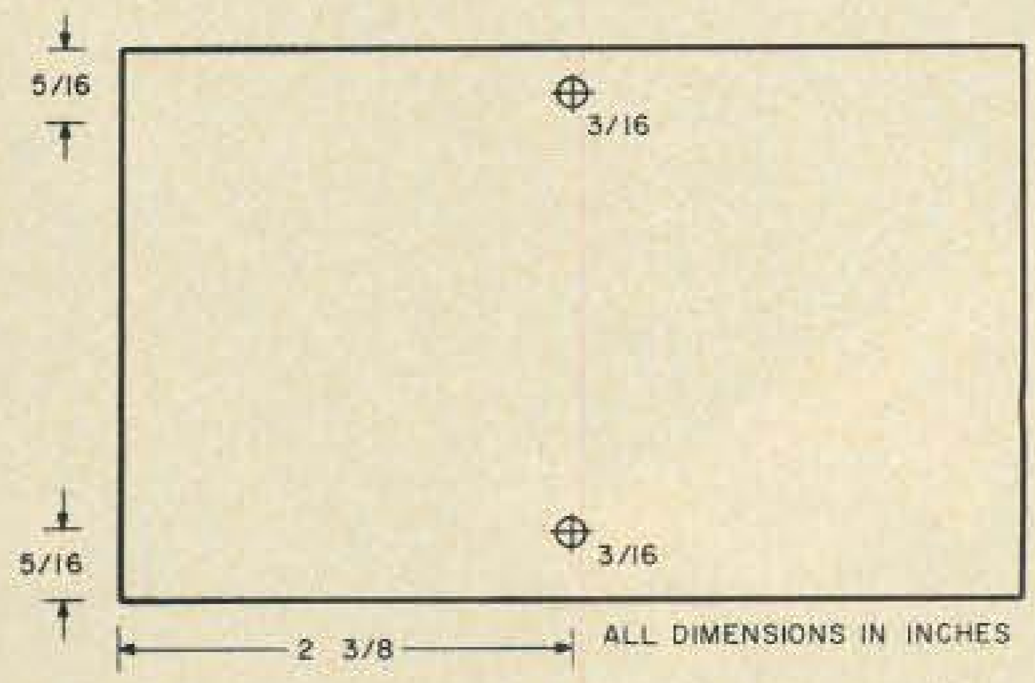


Fig. 5. Heat sink drill guide. Heat sink is International Rectifier HE330-C or Wakefield 623-K.

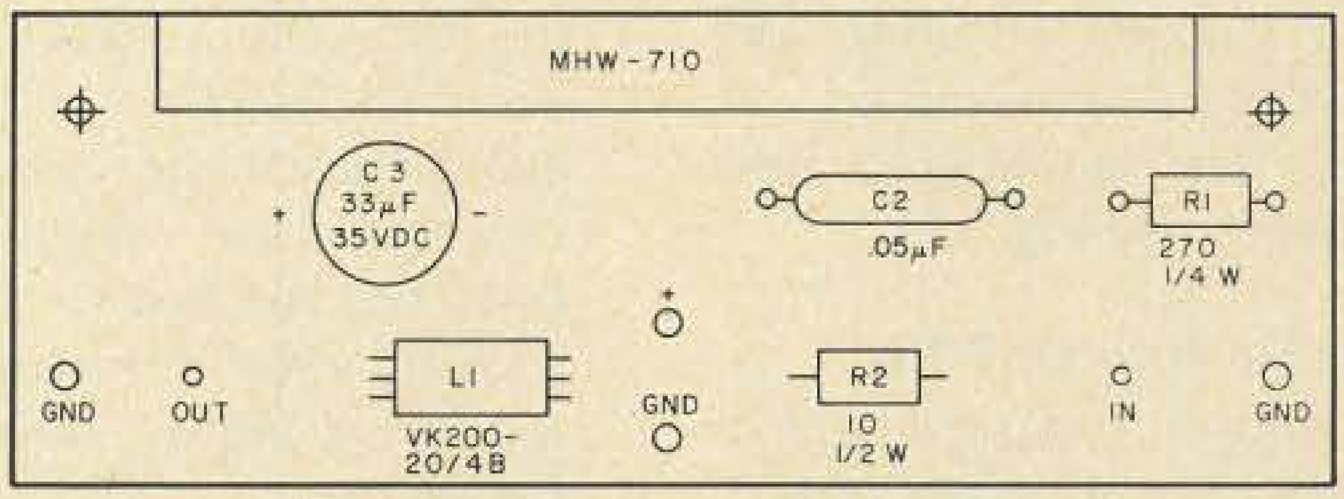


Fig. 6. 10 Watt ATV amplifier PC board, component side.

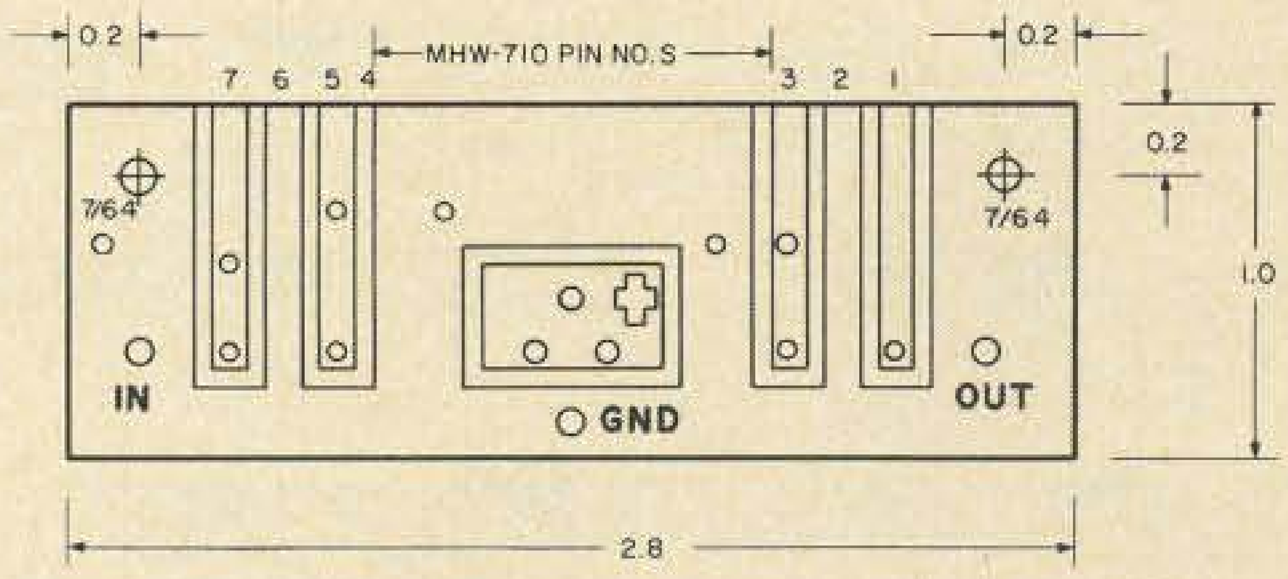


Fig. 7. 10 Watt ATV amplifier PC board, foil side. All dimensions in inches. Board is glass.

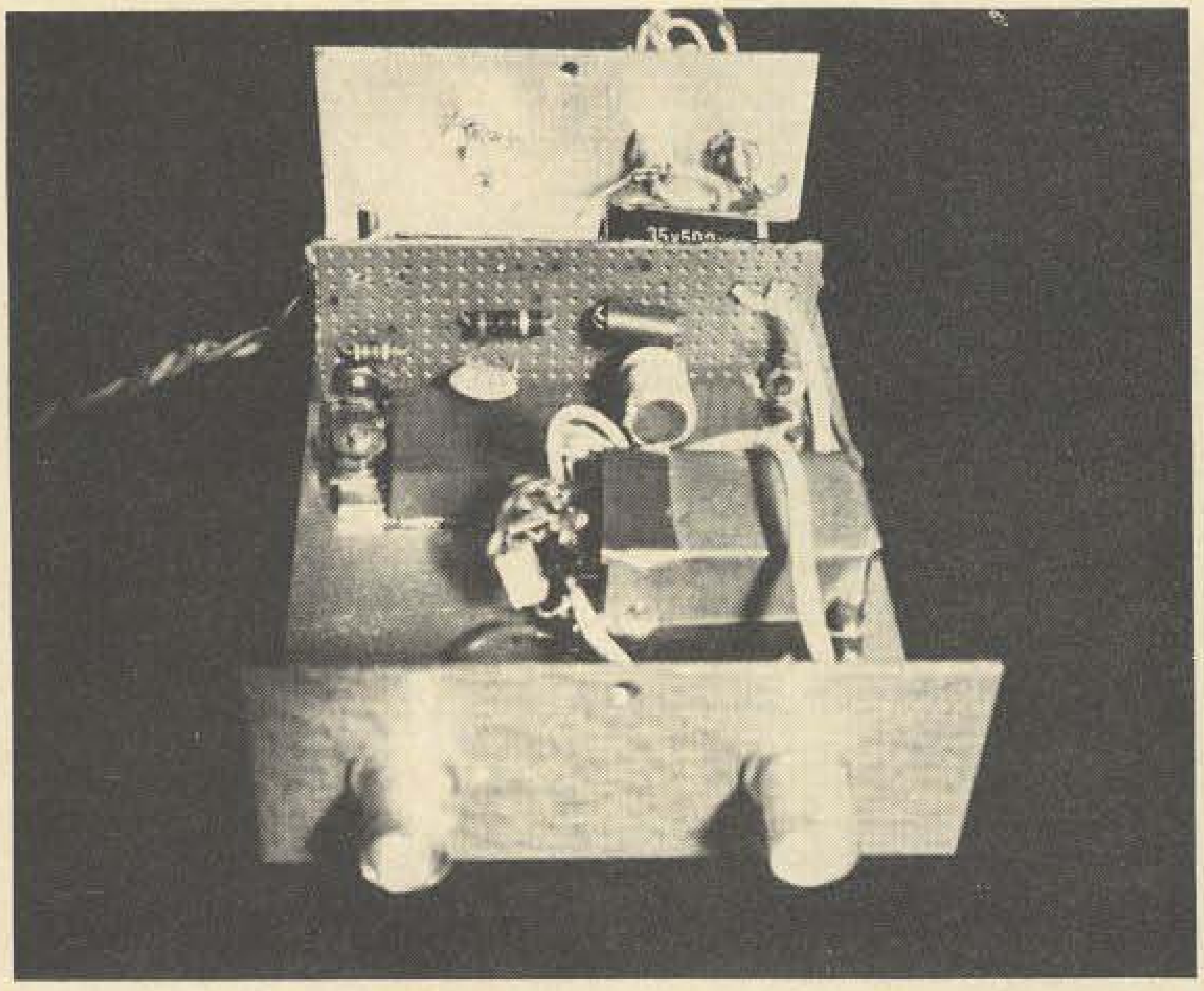


Fig. 8. PC board, prototype shown.

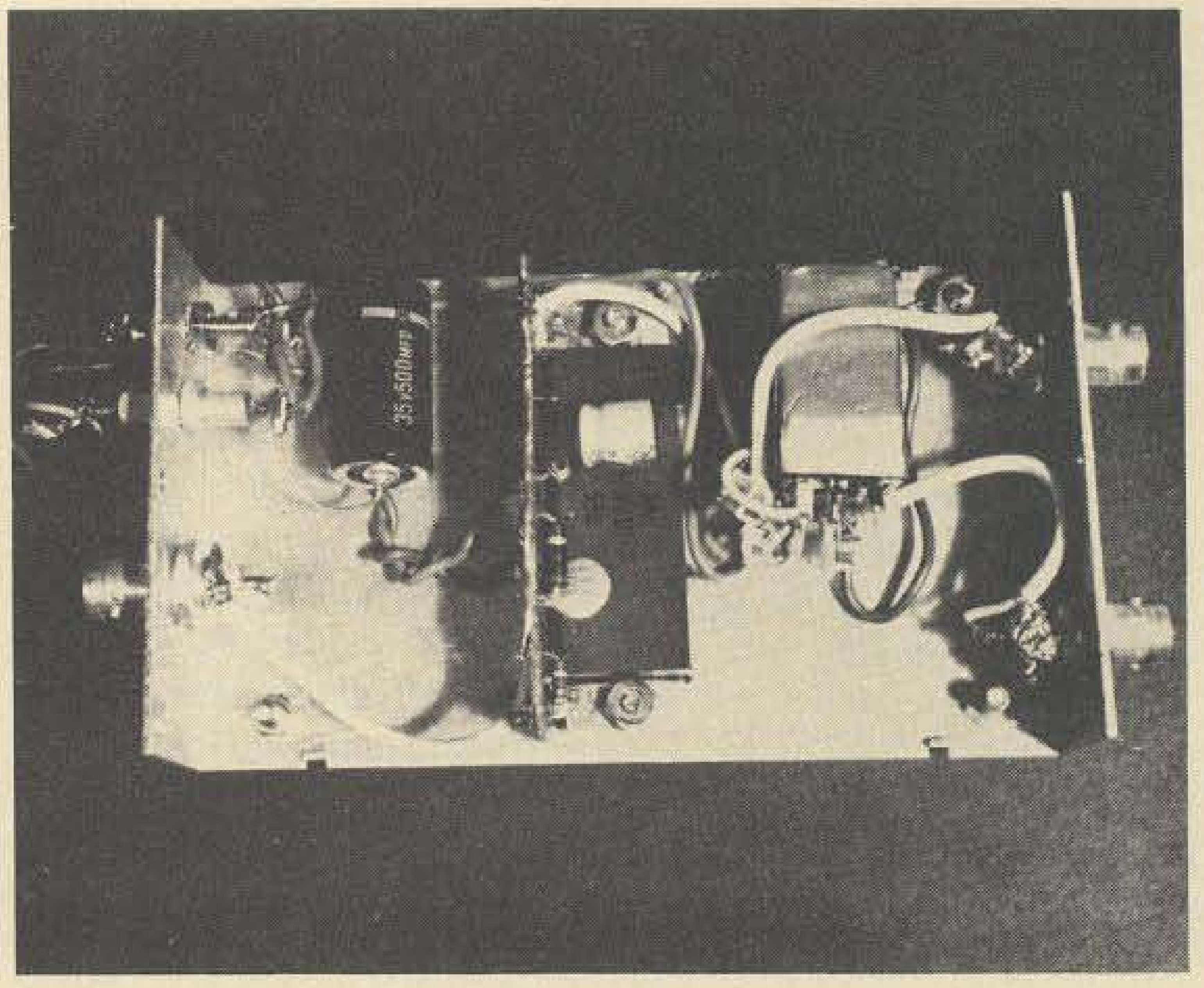


Fig. 9. Internal (bottom) view.

Solder the shield to the relay's copper foil near the terminal thus creating a small loop. Solder a 4.7 pF capacitor between the grounded shield and the terminal (see Fig. 11). Solder the cable from BNC "A" to relay terminal B in like manner. In the same way, solder the cable from BNC "R" to the relay terminal immediately below terminal A. Again all shield lengths should be as short as possible. Also keep loops as close as possible to their respective capacitors.

16. Screw on bottom cover of chassis and label using stick-on lettering (see Fig. 4 and 5 for lettering).

17. The amplifier is now complete (see Fig. 12).

Tune-Up With QRP Rig

Connect a short length of RG-58 coax from the "OUT" connector on the QRP transmitter to the "IN" connector of the amplifier. Also connect a through-line wattmeter and dummy load or antenna to the amplifier's output (BNC "A"). Apply 13.8 V dc from a regulated 4 Amp continuous supply to both the amplifier and exciter.

Basically follow the tune-up procedure given in the QRP rig article. Of course, now you will be aiming for a good picture at about 10 Watts instead of ¾ Watts. The following suggestions may be of help:

a) Remove the core from L6 on the exciter. Set the "L" (level) control fully counterclockwise. These actions will knock down the drive level which should make tune-up easier.

b) Start with "C" (contrast) control fully clockwise.

c) Adjust output modulation and power levels using the 4 variable capacitors in the exciter's output circuitry.

Don't rely too heavily on the picture you see on your local TV monitor since the 10 Watt transmitter will probably overload it. Try to have an on-the-air station, remotely located, assist you. If you use a coupler, detector and oscilloscope to tune up the rig, you may note a 15 to 20 MHz oscillation on the signal. It will generally not be observable on your TV monitor. To attenuate this parasitic signal, adjust L1 through L5 for minimum oscillation amplitude.

A complete ATV station is shown in Fig. 13. Be sure to use hardline and a good antenna for best performance. As explained in the QRP article, a separate receiver is required to derive audio from a signal using the audio-on-the-carrier format.

Important Design Notes

Amplifier power output is highly dependent upon power supply voltage. A 1 volt difference can result in a 3 Watt difference in output

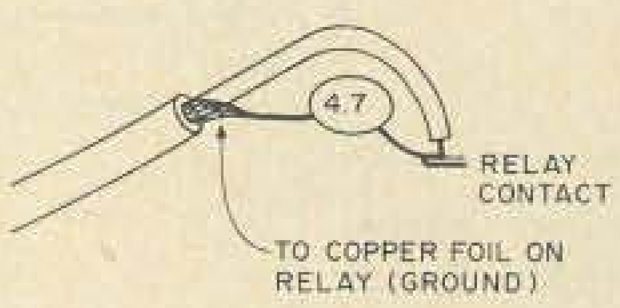


Fig. 11. Relay contact connection.

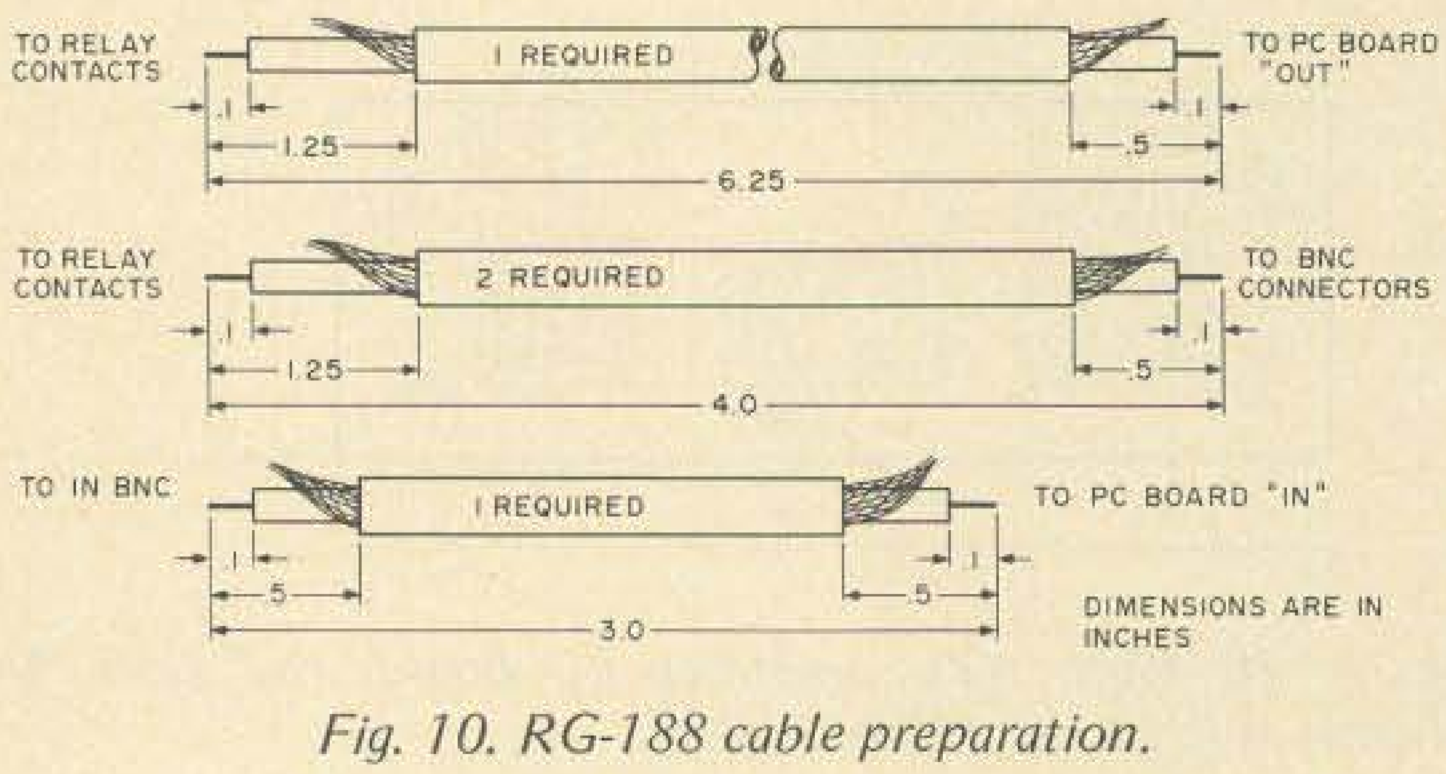


Fig. 10. RG-188 cable preparation.

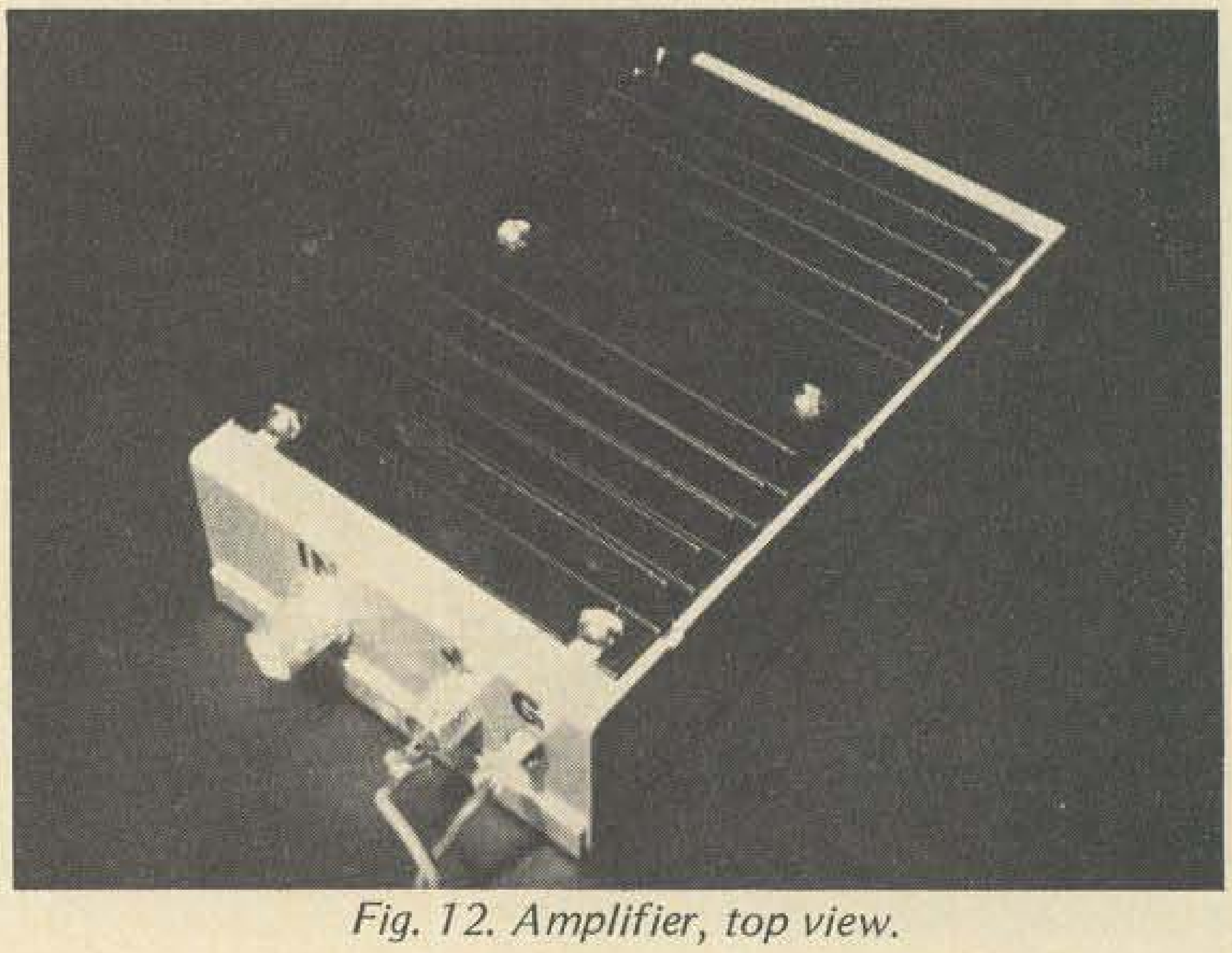


Fig. 12. Amplifier, top view.

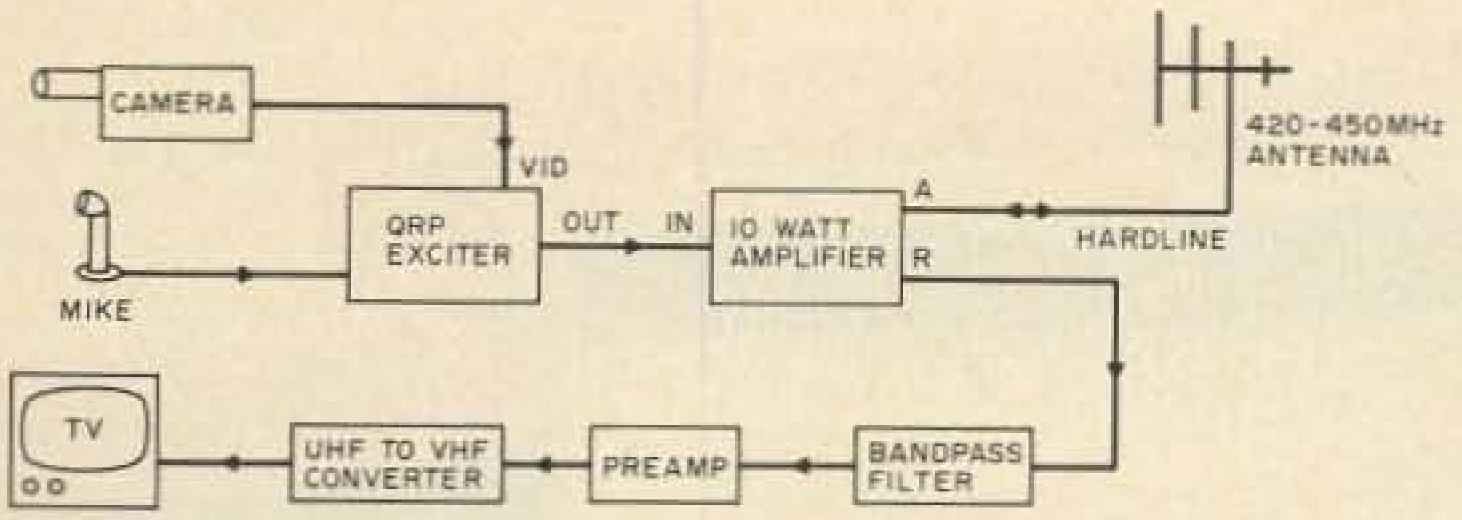


Fig. 13. Typical operational configuration.

power. To achieve a good video signal at 10 Watts average power, 13.8 V dc must be used. Current drain will be slightly less than 3 Amps. If the amplifier is driven hard into a class C mode (no video), it will be possible to initially obtain about 15 Watts. You will note that as the amplifier warms up, the power output will drop. This is natural operation for the Motorola module. Also don't be alarmed if the heat sink and case get very warm. This, too, occurs in normal operation. If you should use the amplifier without video, try not to overdrive it. Use the minimum drive power necessary to achieve full output power (about 300 mW). You will generate fewer spurs while also reducing possible damage to the input of the 710 module. WARNING: When exciting the amplifier, always make sure that BNC "A" is loaded. I smoke-tested the amplifier with about ¾ Watts drive and no load and found that the amplifier self-destructed in 2 minutes (an expensive experiment at $42.50 a module!). The MHW-710 is rugged and can handle short periods of misuse but don't overdo it.

When procuring the 710, you will note that two models are available: the 710-1 for 400-440 MHz and the 710-2 for 440-480 MHz. I have used both types and found that they perform equally well in the 435-450 MHz portion of the ham band.

If you can't get at least 15 Watts from your amplifier at a cold start using 13.8 V dc, you may be experiencing high losses in the relay circuitry. To verify this, connect a cable directly from the wattmeter to "OUT" on the PC board. Normally the relay will exhibit a 1 Watt loss in the 15 Watt range. Relay efficiency is highly dependent upon the length of cable between the relay and PC board "OUT." If you do have a loss problem, experiment using different cable lengths.

The rig is placed in transmit by applying voltage to both the exciter and amplifier power terminals. This arrangement is rather unconventional for normal PTT use, but has been implemented here for simplicity. You may wish to use the spare set of relay contacts and mount additional feedthrough capacitors to achieve a standard switching scheme.

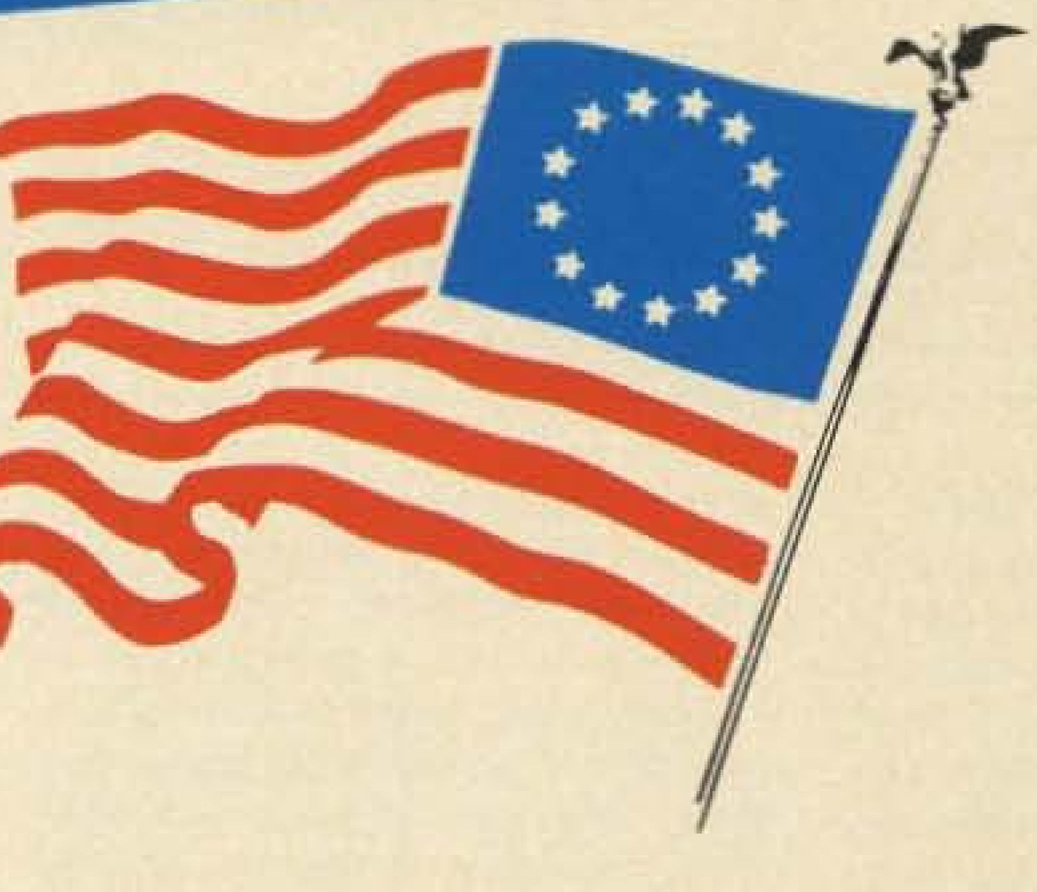
ATV 10 Watt Amplifier Parts List

Part #	Description	Qty	Unit Cost	Total Cost	Source of Supply
1	5½"x3"x1½" Chassis; LMB #139	1		$2.00	Electronic Supply Store
2	UG-1094 BNC Bulkhead Connector	3	$ .85	2.55	Electronic Supply Store
3	.001 uF feedthrough cap; Erie #327-005-X5UO-102M	1		1.62	Electronic Supply Store
4	3/8"x3/4" "L" bracket; Calectro #J4-641 (2 brackets in package)	2		.49	Electronic Supply Store
5	Heat sink, 3"x4.75"x0.46" International Rectifier HE330-C or Wakefield 623-K	1		2.72	Electronic Supply Store
6	Heat sink compound; Archer 276-1372	1		.89	Radio Shack
7	½" #8 screws, nuts and lockwashers (to mount heat sink to chassis; also for gnd lug)	5			Hardware Store
8	½" #6 screws, nuts and lockwashers (to mount MHW-710 with "L" brackets to chassis)	2			Hardware Store
9	#8 hole terminal lug; Waldom #KT-198	3			Hardware Store
10	#8 nut (to secure ground lug soldered to relay)	1			Hardware Store
11	¼" #4 screws, nuts and lockwashers (to attach PC board to "L" bracket)	2			Hardware Store
12	RG-188 cable	18"		3.00	Cable & PC Brd both from Stu Mitchell
13	Amplifier PC board; cut, etched and drilled	1		Ppd	WAØDYJ, 14761 Dodson, Woodbridge VA 22193
14	MHW-710-1 or -2 Power Amplifier Module, Motorola. The 710-1 covers 400-440 MHz; the 710-2 covers 440-480 MHz. Either device will give equivalent performance in the 435-450 portion of the band.	1		42.50	Call local Motorola sales office for source
15	#20 stranded wire, insulated	20"			Electronic Supply Store
16	Stick-on lettering kit				Stationery Store
17	DPDT relay, 12 V dc; Archer #275-206	1		3.99	Radio Shack
18	Copper foil, Circuit-stick #9252	1		1.49	Electronic Supply Store
L1	2½ turn ferrite choke; Ferroxcube VK200-20/4B		.51	1.02	Eastern Components 1407 Bethlehem Pk. Flourtown PA 19031 $10 min. order
C1	500 uF, 35 V dc, Axial #272-1018	1		.89	Radio Shack
C2	.05 disc, #272-134	1		.39	Radio Shack
C3	33 uF, 35 V dc, PC Type, Lead aluminum	1		.30	Lafayette; Elec. Supply
C4-6	4.7 pF (or 5 pF), #272-120	3	.29	.87	Radio Shack
R1	270 Ohms, ¼ Watt, 10%	1		.10	Electronic Supply Store
R2	10 Ohms, ½ Watt, 10%	1		.12	Electronic Supply Store
Z1	15 V zener, 1N4744	1		.40	Electronic Supply Store

A 13.8 V dc power supply with a rating of 4 Amps continuous is required.

Acknowledgements

I am grateful to Charles Spitz W4API for providing many of the components used in the development of the rig. Terry Fox WB4JFI provided many valuable suggestions and also supplied the test equipment used to optimize the design. Stu Mitchell WAØDYJ/4 fabricated the PC board. ■



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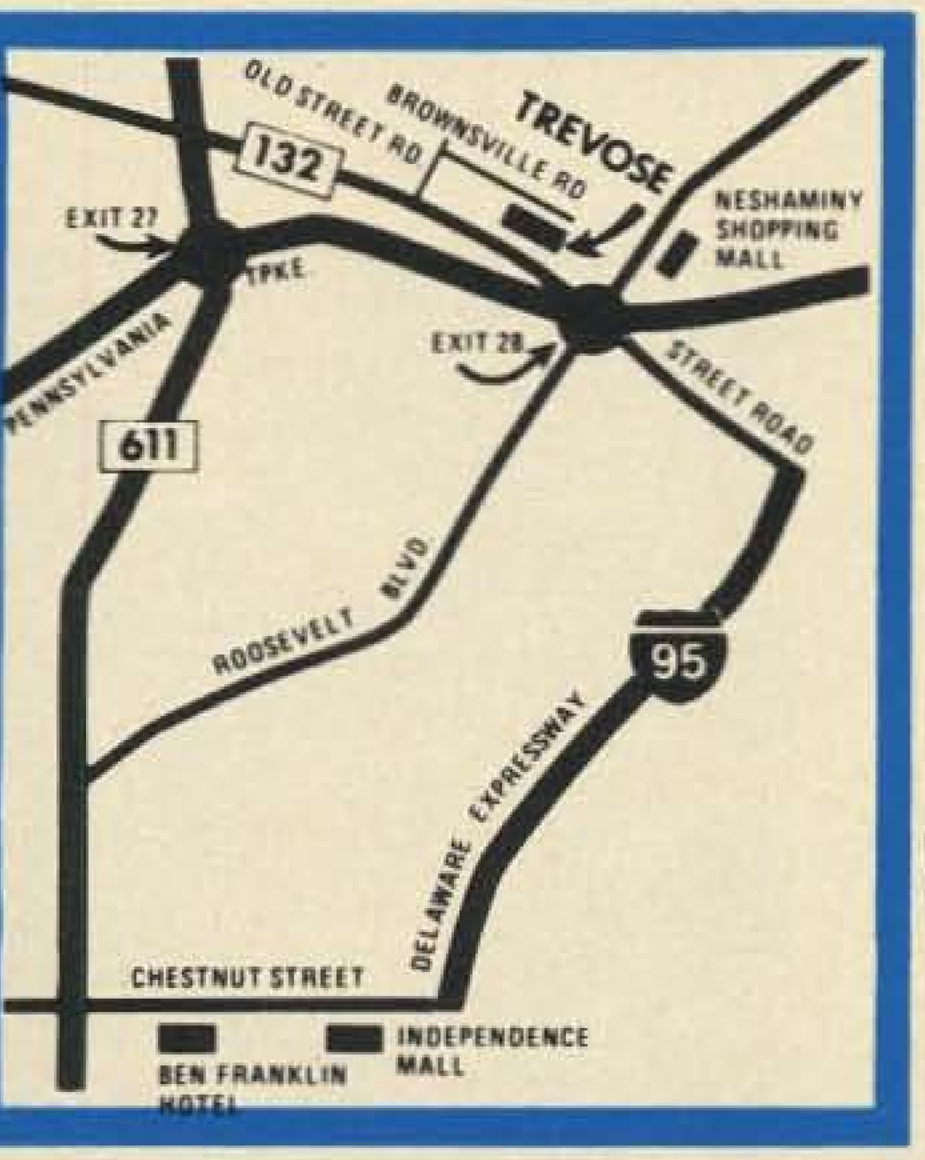

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by Wayne Green W2NSD/1

I/O EDITORIAL

PHOOEY ON COMPUTERS

Every now and then I get a letter complaining about the I/O section of *73.* They are in the middle of bundles of compliments, but that doesn't mean that I ignore them, for I know the heavy emphasis on something new like this is bound to get a few backs up. I haven't yet forgotten the ruckus when I decided that FM was a comer and should be pushed . . . and that was seven years ago!

Phooey #1. A letter from an old old-timer says that if he wants to read about I/O stuff he would read a magazine in the field. That's baloney because there *is* no magazine as yet providing fundamental material for newcomers to the computer field. Having started one magazine and preparing a second in the computer hobby field I think I can speak with some authority on that. The new magazine will *not* be on the fundamental level of the articles in I/O, by the way.

Phooey #2. Amateur radio is only a hobby, so I don't have to keep up with new developments if I don't want to. Yes and no. Amateur radio exists because it provides services . . . some during emergencies . . . some by virtue of pioneering and inventive efforts. If you are not doing anything of public benefit then you are a freeloader and are riding the coattails of others who are pulling the freight. The least you can do is shut up and not screw things up for those who are making all this fun possible for you.

IBM's advertising department came up with the concept of different generations of their computers. It was a tremendous put-down for other manufacturers when IBM was always one generation ahead of the others. The concept is a valid one . . . in amateur radio we've had the spark generation, the tube generation, the transistor and the IC . . . and now we're faced with what is for us a fifth generation of design . . . the super-IC. An IC usually has a bunch of transistors built into it . . . sometimes dozens. But the technology has moved ahead now where they are cramming thousands of transistors on ICs . . . LSI, Large Scale Integration, they call it . . . and this is one or two orders of magnitude improvement over those puny little ICs of last year. In three or four years they are looking for super LSIs with millions of components on them, and that might qualify as another generation.

Not only can amateurs keep up with this technological pace, they can pioneer with these new components. The new computer chips weren't designed for use as computers at all . . . they were designed for being built into cars to control their many functions, into cash registers, and other such machinery. It took hardly any time at all for a hobbyist to come along and find out that these chips make perfectly good computers . . . and the race was on. Many are being used for processes such as RTTY and slow scan TV, others are being set up and programmed just like the $1 million computer systems. The LSI is there and what is done with it depends upon us.

MONEY . . . PRESTIGE . . . FAME . . . ETC.

All these things can be yours . . . in modest amounts, of course. All you have to do is trade on your expertise in computers, if any, and help us get articles on the latest microcomputer systems and hardware to our readers. About the only prerequisite is some experience with computers as a hobby . . . preferably with a strong ham slant. It is also helpful, but not absolutely necessary, if you can write.

With more and more hobby computer systems coming out, all of us want to know as much as we can about them. How easy or difficult are they to build or get working? What problems do we run into and how are they solved? What accessories or I/O devices will work with them and how do you hook them up? How helpful was the instruction book? How much did the whole thing cost? How helpful was the manufacturer with problems? What could you do with it once you got it together and working? Have you made any changes or improvements to the equipment? Where have you gotten programs for it? Things like that.

I'd love to publish detailed articles on every microprocessor system being used by hobbyists . . . plus the accessory boards such as the Processor Technology and Godbout boards . . . and, unlike at least one of the other magazines, we do not require a Ph.D. level of writing, nor will we accept it.

If you run into any device or circuit that looks like a good deal for the hobbyist, please give serious thought to writing it up so the rest of us can learn from you. Getting information around in this new field is one of the toughest problems. Let's try to prevent too many of us from inventing the same damned wheel . . . okay?

COMPUTERS ARE HERE

The first of what we hope will be a long string of books for the computer hobbyist is now on the presses and is due out shortly. This book covers the basics of computers . . . the circuits involved . . . such as gates, flip flops, TTL logic . . . counting in binary . . . TVT units . . . Baudot/ASCII conversion systems . . . things like that. It is a good starter book for the ham without a lot of background.

We're anxious to put out a lot more books for newcomers to the computer hobby, so if you think you have the making of a good book in you, you could do worse than write to me giving an outline of the material you want to cover, a sample chapter or two, and info on how you will illustrate it. Books should be well illustrated . . . drawings, photographs . . . and we can help with this to some extent.

If you are into programming perhaps you have been at it enough with your own computer to put together a book on BASIC for the hobbyist, or FORTRAN . . . etc. You should give the user an idea of where to get the assembler for his machine . . . and then how to use the language. I suspect that we will eventually have all sorts of languages available for our hobby systems . . . plus instructions on how to use them. I'd love to have all the major languages available on cassette tapes and sell them via computer stores, but that will depend on super-programmers taking the time to develop them and letting me sell the cassettes for them on a royalty basis.

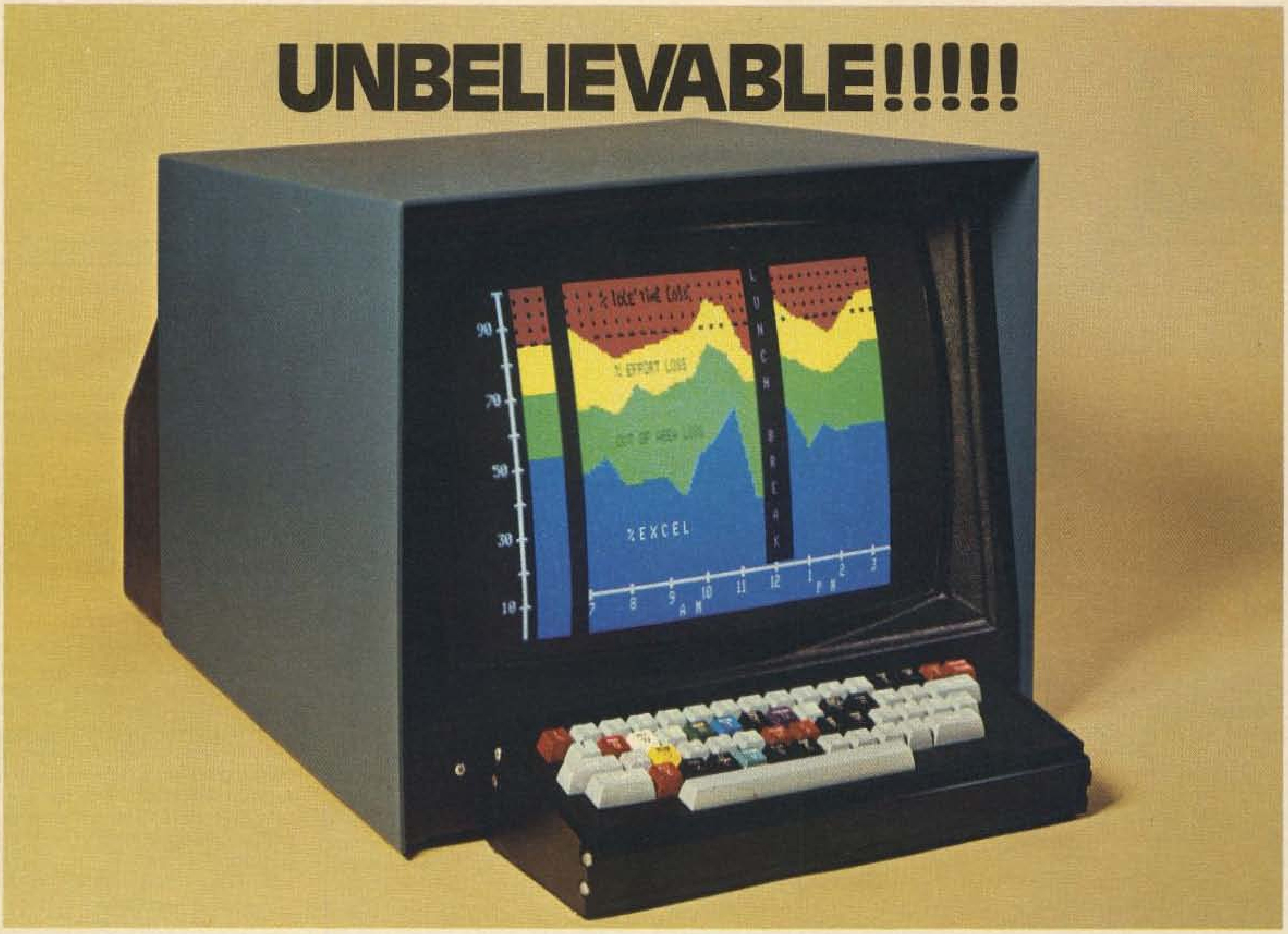
Let's get a lot of books out to help computer hobbyists learn how to use and develop their systems!

TRENTON COMPUTERFEST

In addition to exhibits by many of the manufacturers in the microprocessor field, there was a very brisk flea market going at Trenton on May 2nd. To give you an idea of some of the fantastic bargains, the brand new Burroughs mag tape unit with its own keyboard and documentation went for $75 . . . eat your hearts out over that one!

As at the Albuquerque computer convention, the main system up and running and doing anything much more than playing games was an amateur radio application . . . this time an Oscar computer which had more information available about Oscar 7 than most of us would ever want to know. Once you put in your latitude and longitude coordinates and got its clock set on time, it could tell you exactly what time you could access the satellite . . . it would aim your antennas and follow Oscar across the sky . . . and even adjust your frequency to take care of the Doppler shift!

The next big computer convention is scheduled for Atlantic City, August 28-29th. It looks like fun.



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by John Craig

I/O REPORT

Writing for the I/O section of *73* is a great way to become *rich and famous.* (Probably a lot more of the latter than the former, too!) In all seriousness, it can be profitable . . . we pay quite well for accepted articles. If you're like most computer hobbyists, you're always looking for those extra dollars to buy this or that peripheral. (And, of course, it always looks good on a resumé to have been published professionally.) But . . . and this is certainly important . . . you needn't be a professional writer to sit down at the old typewriter and pound out an article for our I/O section. Here are some guidelines to help you along . . .

WHAT TO WRITE ABOUT

Naturally, since we are a ham radio magazine, we're constantly on the lookout for interesting articles dealing with amateur radio applications. But something we should all keep in mind is that the thousands of hams interested in and using computers are going to be using their home systems for things other than ham radio. Therefore, we're going to be looking for articles covering the broad spectrum of hobby computer construction, programming, and applications.

One of the most interesting things for most of us is to read about some piece of equipment that someone has designed and built. While most of us will not be actually building the unit, we'll follow the construction in our minds and enjoy reading about it. With well over 100,000 readers, just about anything described will be built by at least a hundred or so people. It pays to be extremely careful in checking your article for just one mistake . . . or the mail comes pouring in.

If you happen to be doing experimental work in an advanced field that would be of interest to us, you might write about that. We make a particular effort to keep *73* ahead of the other magazines in publishing new discoveries and advancements. Remember that you're writing for the average ham and/or computer hobbyist . . . not engineers.

THE PLAN OF ATTACK

Generating an outline of your proposed article is perhaps one of the most important steps you can take (as well as, of course, sticking to it and not getting sidetracked). Remember the old rule: "Tell them what you're going to tell them; tell them; then tell them what you've told them." A construction article might be arranged as follows: Introduction, Theory, Construction, and Alignment and Adjustment, concluding with a wrap-up of results.

The title and opening paragraph are extremely important! If you don't convince the reader in the beginning that he *should* read on, the chances are he won't. Illustrations and photos shouldn't be overlooked, either. An article without either one can certainly appear to be dry . . . even if it isn't.

When writing, remember that *73* is an informal hobby magazine, and that you're writing for some friends. Don't be a stuffed shirt . . . keep away from "the author," and use the first person ("I"). "I fastened the nut" is better than "the nut was fastened." Write naturally in short, simple sentences, starting a new paragraph with each new thought. Avoid unnecessary abbreviations. Use subheadings for each new section to provide signposts for the readers. Dictionaries are too inexpensive these days for there to be any excuse for misspelling; look it up. (You'll never catch *us* doing it . . . we're quite infalable.) Minimize math. It is rarely necessary in *73* articles and scares readers. While most readers can use simple high school algebra and trig, they don't want to. They prefer practical circuits or practical approaches to a subject. Even engineers prefer predesigned circuits, if only as a starting point for their own work. Use math only where it is vital. Avoid footnotes, if possible, and just put your references in the text (it's easier to read that way). And don't forget to give credit when you borrow an idea from someone else. This is important both ethically and legally.

DIAGRAMS

Put all drawings on separate sheets of paper . . . never in the text. We have excellent draftsmen who redraw all diagrams and schematics, so be sure that your sketches are complete, neat, and readable. Put parts values on the schematic rather than in a separate parts list. Use terms "IC1," "R1," and "C2," etc., only if you are referring to them in the text. If a block diagram will be helpful in getting the "big picture," then by all means include one. Label all drawings as Figure 1, Figure 2, and so on. Write a caption for each and include this with the article text so our printers will be able to set the type. Put your name and/or call on every sheet of paper you submit.

All logic diagrams should reflect signal flow from left to right . . . and, if possible, not have signals enter or exit the diagram *except* from the left or right sides, respectively. Logic symbols must be of the *distinctive shape* variety (in other words . . . *do not* use the box symbols of ANSI Y32.14). Also, the logic symbols (gates in particular) should reflect the logic function being performed . . . a schematic with all NAND or all NOR gates usually doesn't.

PROGRAMS, LISTINGS, ETC.

All programs should be well-commented. There should be a column for the address (symbolic, octal, hex, or statement number), a column for the instruction or statement, and a column for the comments (or liberal use of "REMark" statements in a BASIC program). Memory dumps should be used only if a program is extremely long (in such cases you might do well to make arrangements to sell the program for the cost of duplication, or whatever). Flowcharts are fine, too.

Articles on programming should center around the languages of the more popular home computer systems. In other words, an article dealing with programming a particular problem in IBM 360 or DEC PDP/11 Assembly Language would not be appropriate. Machine language, Assembly language, and BASIC articles will be the most sought by our readers. If a program written in another language (such as FORTRAN) can be easily converted over to BASIC . . . or if it contains some interesting techniques or concepts . . . *73* might be interested.

ABBREVIATIONS

Don't make any rash assumptions regarding abbreviations . . . if you have any doubt, be sure to spell them out the first time they're used. We use the NBS-accepted abbreviations: Hz, kHz, MHz, uF, pF, mH, uH, H, W, mW, uW, V, mV, kV, A, mA, uA, dB. Do not use periods or pluralize the abbreviations. Separate them from the number: 10 MHz, not 10MHz.

PHOTOGRAPHS

Good photographs use up a lot of space and make an article much more interesting. If you can't locate an amateur photographer, you should use a professional. The amateur will probably do the job in exchange for a credit line in your article. The professional will, of course, charge you a fee, but the article will probably bring you at least that much more. Photos 4" x 5" are OK, but 8" x 10" are preferred. Instamatics and Polaroids just don't cut it. You'll want an overall photo of the equipment, plus views of any area that will be helpful to the reader who wants to duplicate your effort. Again, captions are separate and can be put at the end of the article text. (Number the back of each photo to correspond with each caption.) Do not use figure numbers for photos.

THE MANUSCRIPT

Use regular typing paper (not the erasable type) and double space your article, leaving wide margins. Number the pages and put your name and call (if any) on each page. Do not type titles, subtitles, or text in all capitals. Underlining a word indicates that it is to be in italics. Keep a carbon copy . . . just in case. Each page of typed copy will be equal to about one sixth of a page in *73*.

Send your article, First Class, to:

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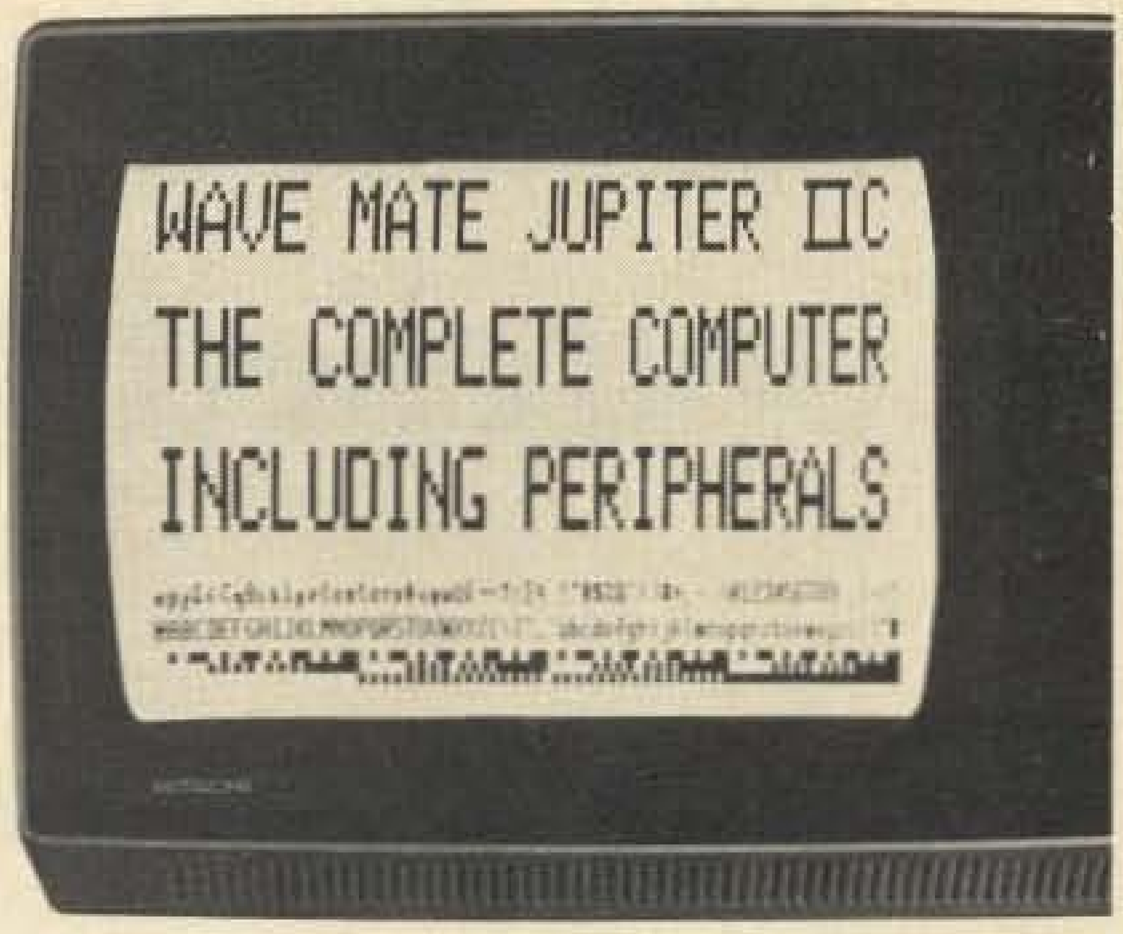

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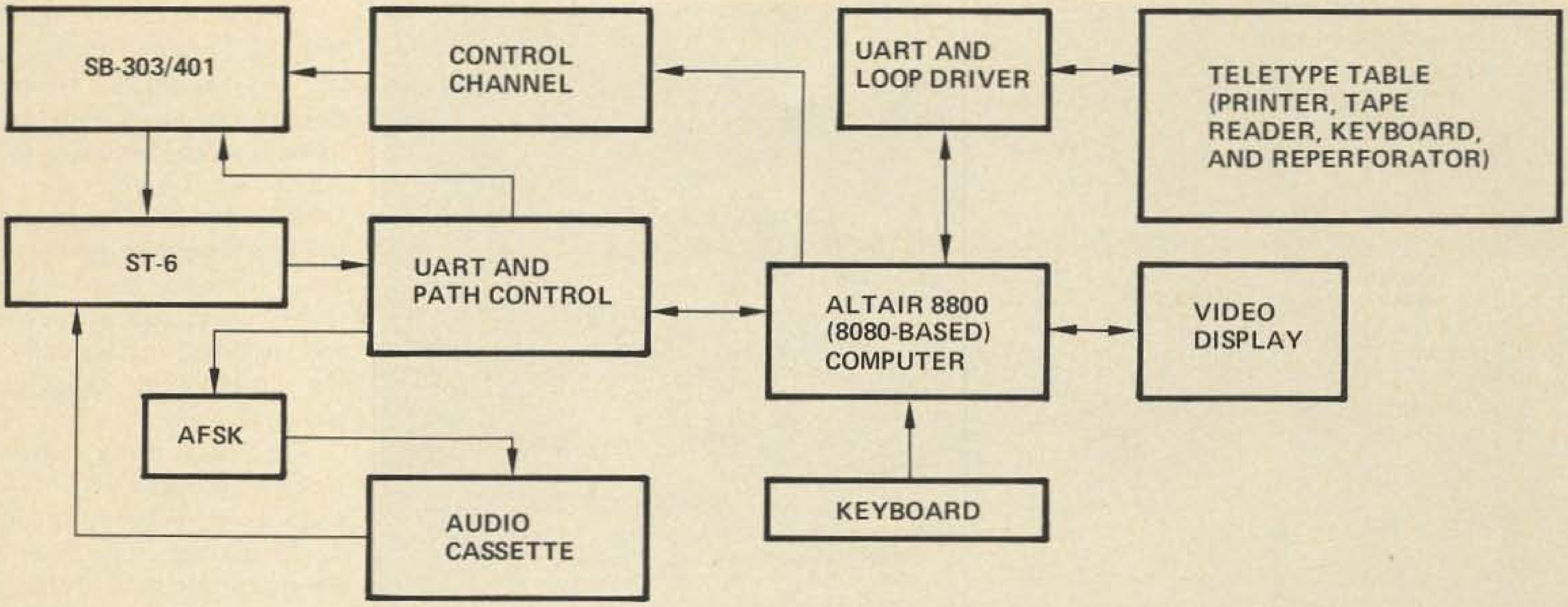


The microprocessor has established itself as one of the most useful and versatile products on the electronic market to date. It is not too surprising that many amateurs are experimenting with and using microprocessors in conjunction with their radio hobby. The applications for microprocessors within amateur radio are as varied as the individual imagination, the best part being that a microprocessor-based implementation of a complex function is relatively simple compared to its discrete component counterpart and is much more flexible. This article will attempt to give the reader an overview of what I've done with an Altair 8800 microprocessor-based system and a radioteletype station. Later articles will be more specific about software and will include construction articles for those wishing to use some of these ideas.

Don's station was the Grand Prize winner at the recent Altair Computer Convention in Albuquerque, New Mexico. His system consists of a Heath SB-301 and SB-401, Altair 8800 with 8K of memory, ST-6, ASCII keyboard, home brew video terminal, and Model 19 (for hard copy). It was the "only totally integrated system" among all the demonstrations set up there. — Ed.

Some Definitions of Terminology

A few definitions are in order before I get too far. These are my own definitions and are not necessarily rigorous.

1. *Microprocessor:* An integrated circuit (sometimes several integrated circuits) which will perform a number of varied operations according to a list of instructions stored in memory; a computer on an integrated circuit. I will use the words microprocessor, processor, and computer almost interchangeably through the rest of this article.

2. *Instruction set:* A list of logical, mathematical or manipulatory operations that a processor will perform on data stored in memory or within the internal register structure of the processor.

3. *Hardware:* The actual collection of electronic components, wire and other assorted stuff that makes up the computer system.

4. *Program:* A sequence of instructions (selected from the instruction set) and data which directs the operation of the processor to accomplish a given task. A program is stored in memory while it is in use.

5. *Bit:* The smallest unit of memory. A bit may be either on or off, logical one or logical zero.

6. *Byte:* Eight bits. The byte has come to be a standard measure of memory. Hang around a couple computer freaks and you will hear one of them ask how much memory so and so has. If the answer is over 8 thousand bytes you should be suitably impressed. If, on the other hand, the answer is some small number like 256 then you should say something like "What can he do with that?" If the number of bytes is given in so many K, for instance 32K, that is the same as saying 32 thousand except that it is easier. By the way, whenever someone is talking about memory, a thousand (or a K) usually means 1024. It's easier to say 16 thousand, or 16K, than 16,384.

7. *Word:* A unit of memory consisting of a somewhat arbitrary number of bits, the number being defined by the particular processor used. It is the number of bits that the processor operates on at any one time (don't quote me on that since there are always exceptions). The most common word size for a microprocessor is 8 bits, or one byte.

8. *Memory:* The medium which stores programs and data such that the processor has access to any word at any time.

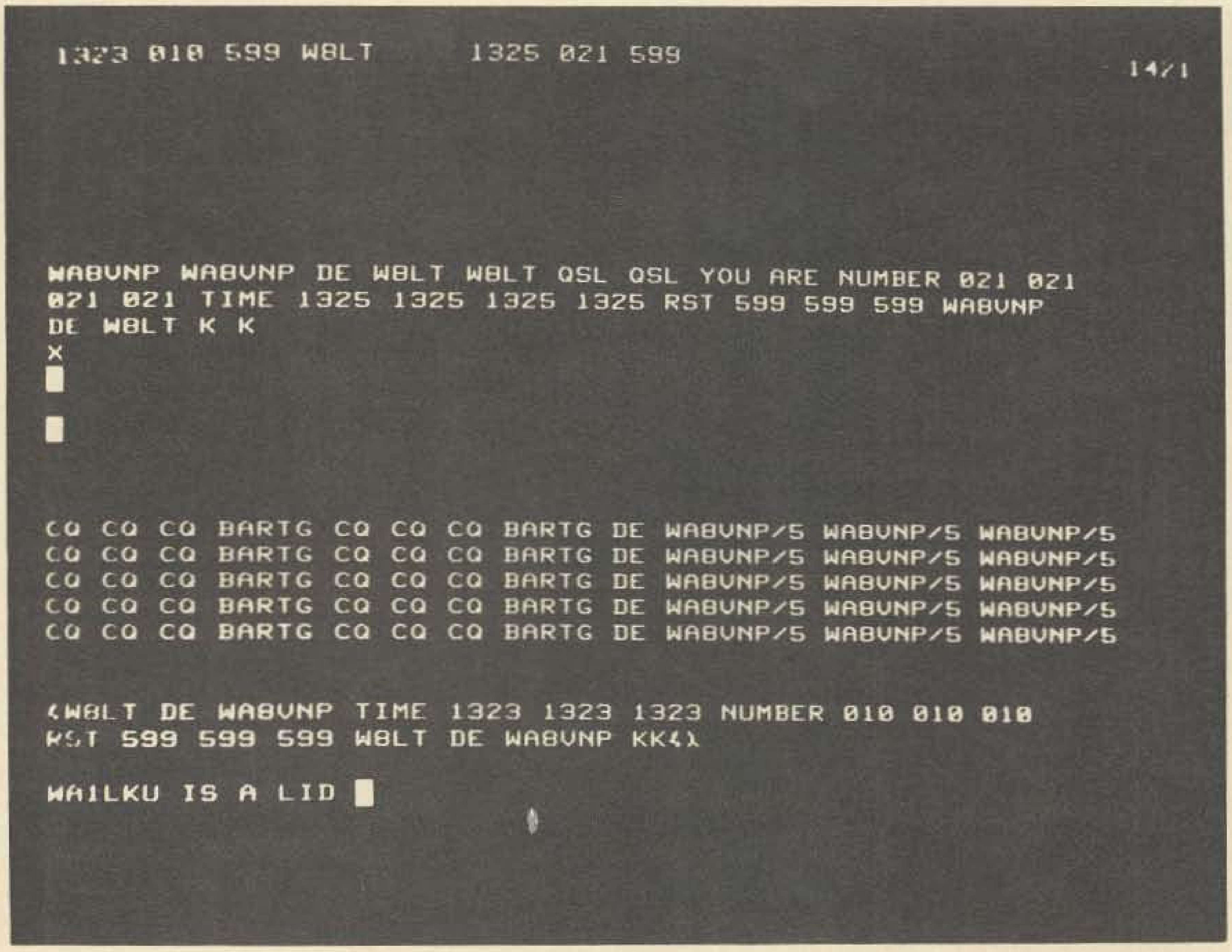
9. *Mass storage:* A medium which is used for long term or large volume storage of information. Examples are magnetic tape, paper tape and magnetic disc. I distinguish mass storage from normal memory on the basis that information stored on a mass storage device must be transferred to normal memory before it can be used by the processor.

10. *Software:* Programs. Programs are called software because they can be modified without too much trouble as compared to modifying a piece of hardware.

11. *Firmware:* The exception to the last definition. Sometimes programs are stored in a special type of memory that cannot be modified by the processor (except in very special cases or if the processor begins to burn). These programs are called firmware because it is not as much trouble to modify a firmware program as it is to modify hardware, but it requires more profanity to fix an error in a firmware program than is normally associated with changing software. See the next three definitions.

12. *ROM:* Read only memory. A type of memory that is programmed during manufacture. The contents of a ROM cannot be changed except by destruction.

13. *PROM:* Programmable read only memory. A read only memory that can be



Close-up of the video display showing, from top to bottom: current log line, receiver area, keyboard entry line (blank except for cursor), and the transmit buffer.

programmed in the field by the user (meaning you). It is more useful to the amateur market than ROM since programming charges for small quantities of ROM (less than several thousand) are prohibitive.

14. *EPROM:* Erasable, programmable read only memory. Same as PROM except that it may be erased by high intensity ultraviolet light and re-programmed. There is also a new type of ROM being introduced which is electrically alterable (which screws up my definition of firmware, but I doubt if anyone who knows about it bothered to read the definitions). I think it is called EAROM for electrically alterable read only memory. The main thing about ROM, PROM, EPROM (and EAROM, I think) is that it doesn't forget what it knows when the power goes off.

15. *RAM:* Random access memory. This type of memory can be read by the processor and modified by the processor. It also tends to forget what it knows if the power goes off unless it is magnetic core memory. Most microcomputers use solid state RAM since core memory is expensive and comparatively hard to use and uses much more power. Still, you will hear people talk about how much core they have even when they mean solid state RAM. Don't bother to correct them – it's a waste of time. I have been corrected many times and still have a tendency to call my memory core.

16. *FIFO:* First-in-first-out buffer. A type of memory buffer which stores information (usually characters) in such a way that the characters are expelled from the memory (when requested) in the same order in which they were originally entered. Many radioteletype stations use such devices to simulate the paper tape punch/paper tape reader combination which can be used to allow an operator to type information ahead of the transmitter.

17. *UART:* Universal asynchronous transmitter/receiver. A circuit which converts serial data to parallel data and vice versa.

The Inspiration

When I first got into radioteletype I never imagined that I would ever need or want anything beyond my RTTY converter (ST-6) and my Model 19 teletype machine. After operating my station for a couple years, I had talked to guys who had video displays, selective call-up, time/date prestidigitizers, UARTs and FIFOs, and all manner of other equipment better than mine. Hardly anyone knew what a Model 19 was except that it made a lot of noise. Pretty soon my ears confirmed the suspicion that a Model 19 is not as quiet as it could be. Then one day some guy told me what UART stood for and how to use one. I decided to build a super station.

I made a list of all the features I wanted to include in my ultimate teletype station. The major items were to be a video display, a solid state keyboard, use of UARTs and FIFOs, selective call-up, time/date generation and a message board. Minor items were added, deleted and modified almost daily at the outset of the design project.

The first major sign of trouble appeared when I was considering methods to edit a 72-80 character line down to 64 characters so it would fit on my display. The most obvious idea is to break the line on a space if it occurs near the end of the line. For this purpose one has to consider the line feed character to be equivalent to a space. I was talking to some station up in Nova Scotia and telling him about this when I noticed that he, like many amateurs including myself from time to time, had the habit of ending a sentence, sending 10-20 periods (or dashes), and then beginning a new sentence. This could result in split words or lines beginning with umpteen punctuation marks if I simply looked for spaces to break my lines on the display. It began to look like I would have to settle for some funny looking print occasionally. I was willing to accept that, so I plunged ahead. But, by the time I was actually near the point of building anything, the designs had gotten to be so complex and inflexible that I wanted to wander onto I-71 pulling my Model 19 right behind. Then I heard rumblings about the eventual legalization of ASCII for use on the amateur bands and all but gave up on the project.

One day, in the depths of despair, I read an article on recent microprocessor breakthroughs which had brought prices down to affordable levels. It didn't take too long to realize that by simply interfacing the various com-

ponents of my station to a computer, I would be able to simulate all of the desired features by writing appropriate software. In addition, I would be able to write programs that would do all sorts of other things I had never even considered building because of their complexity (e.g., almost automatic contest operation). Time/date and selective call-up would be trivial. A FIFO could be simulated by software with the addition of elaborate editing capabilities (I don't type so well). The legalization of ASCII would cause no problems since I could copy any code (including Morse) by doing the appropriate code conversion. I could even have the system whistle "Dixie." Such a deal.

The Realization

The block diagram shows the configuration that I finally decided to use. It is not as optimum as it could be, since it would be desirable to have a completely separate interface for the cassette recorder. However, it is reasonable to use the RTTY demodulator and AFSK generator for storing data on an audio cassette since it involves no additional construction other than a switch or two. I needed to get something going to fill the time it would take to get a dedicated cassette interface going. Besides, using normal AFSK for cassette recording will probably turn out to be one of the best ways for amateurs to exchange software.

The keyboard is a solid state keyboard (many types are available from the various surplus houses) which generates a seven bit code (ASCII). The interface for the keyboard is a simple parallel input port and will be described in one of the later articles.

The Heath SB-301 and SB-401 are monitored and keyed through the ST-6 demodulator and a UART. A control channel allows the processor to select the shift, reverse the shift, select the speed of the UART, turn the transmitter on and off, and send make break or narrow shift CW. It is pretty simple, consisting of the UART and some latches to provide the necessary control.

The video display is a home brew display and is the most useful item in the system next to the processor itself. It will display 29 lines of 64 characters per line in both upper and lower case, plus a few Greek symbols. The memory of the display is large enough to hold 32 lines of information but I have displayed only 29 lines to avoid uncomfortably close line spacing. The processor treats the display as normal memory rather than as an output device, and can read from or write to the display memory at a very fast rate, the actual rate depending on the program controlling the read or write functions. An upper limit for the transfer rate is about 2 million characters per second, the typical rate being closer to 100,000 characters per second. The high read/write speeds mean that there is no need to build extra hardware for scrolling the display – one simply writes a short program that reads each character of the display and re-writes it on the next line up. Scrolling the entire display then takes about 50 milliseconds of processor time. Another advantage of this technique is that the display can be partitioned into several sectors and each sector can be scrolled independently of the other sectors.

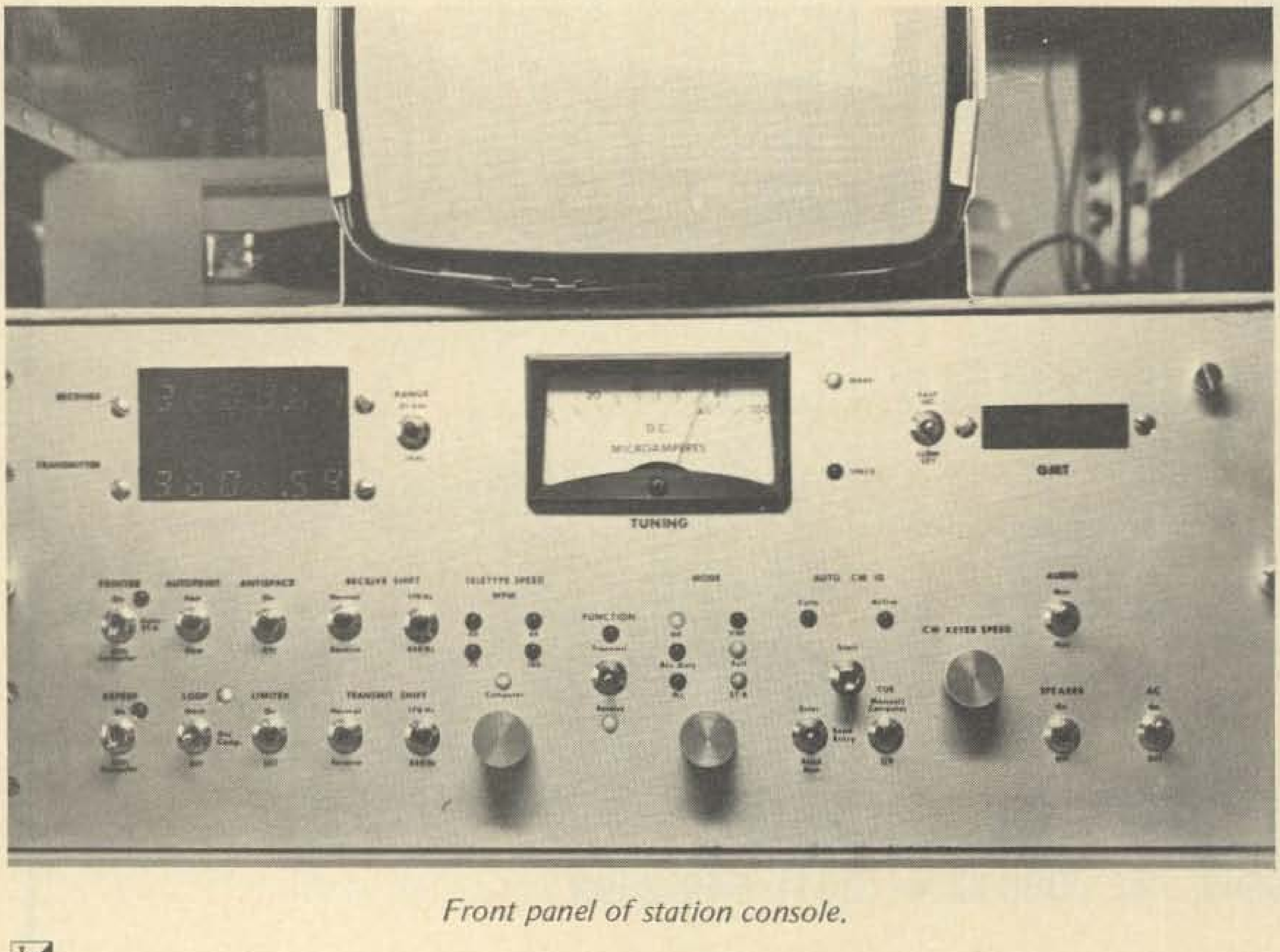
Another feature of the display is that each character can be controlled on an individual basis to produce a black character in a box of white. I use the video inversion feature for displaying cursors, which means that I can have as many cursors roaming around as I desire.

The teletype equipment (my old Model 19) is interfaced through a UART and simple loop driver and sensor. I use the teletype for producing hard copy of my programs, my logs, and for printing teletype art. It also serves as an excellent backup system for making and reading paper tapes in case the cassette recorder decides to give up the ghost.

The Sting

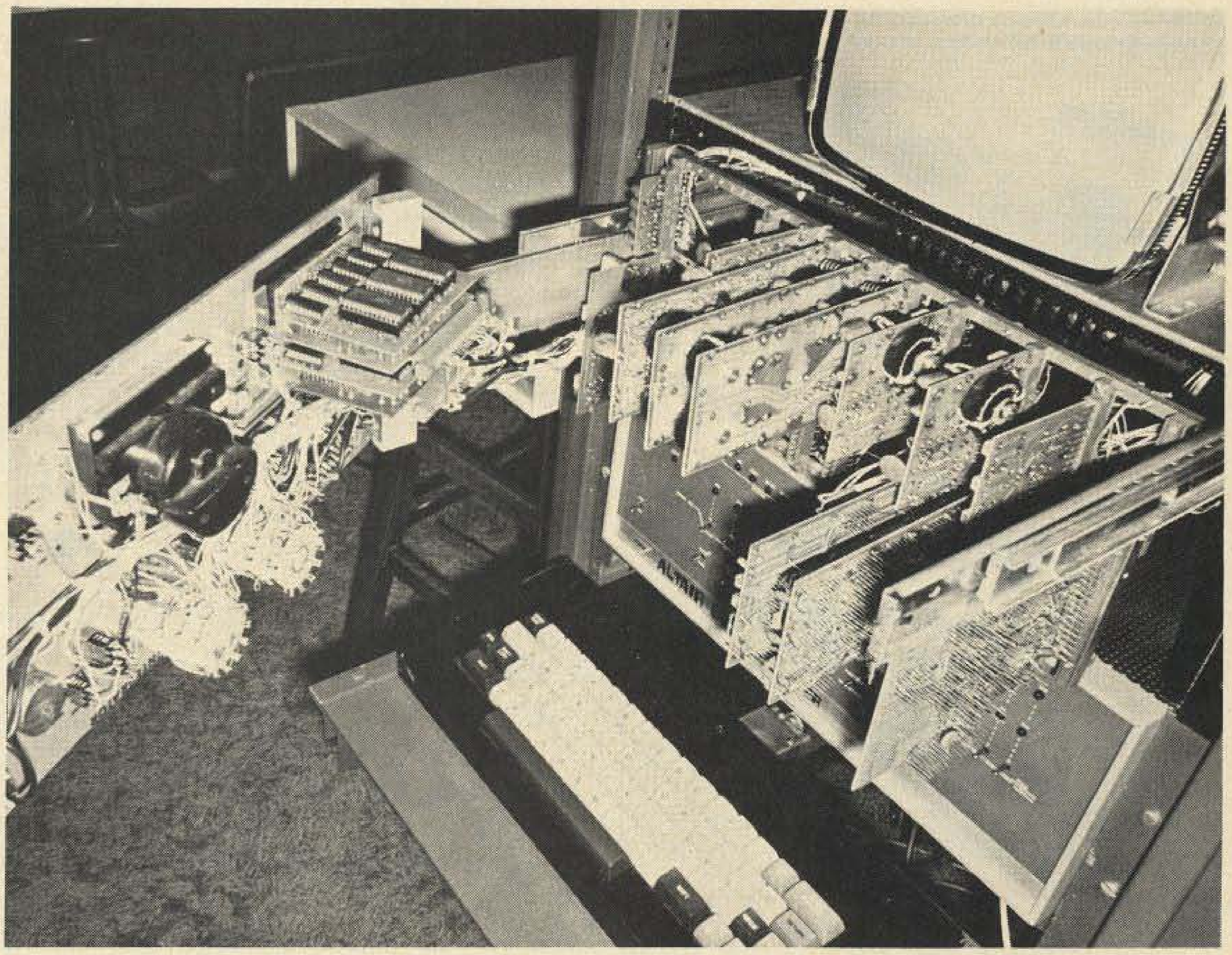
The first practical use I made of the system was as an operating aid in the BARTG RTTY contest during the last weekend of March. I had just finished putting the system together and had gotten a resident assembler running (a resident assembler is an extremely valuable programming tool – watch for articles on programming) when I was invited to bring my system to Albuquerque as a display entry in the Systems Demonstration Contest of the World Altair Computer Convention. It happened that the convention was the same weekend as the BARTG contest. In four long evenings I wrote a contest program that would enable me to operate the contest from the convention while I was devoting most of my attention to telling people about the system.

The processor "listened" to the receiver through the ST-6 and UART. When I was tuned to a valid RTTY signal, the information was edited



Front panel of station console.

and displayed in one area of the video display. If I saw a station that I wished to work, I typed in the call of that station. The computer would instantly tell me if I had already worked the station or not. At the same time it would enter the call of the station, the current time, and the contact number on a line of the display that I had reserved for developing log entries. The only other piece of information that I needed to type was the signal report I wished to send to the station. By using special two letter commands, I could have the computer call the station (or answer him if he was calling me), send the entire exchange, tell him that I QSL or ask him to repeat the exchange, or tell him that this was a duplicate contact. Other two letter commands allowed me to request the computer to send CQ and call QRZ. All of the text that the computer generated (which was complete with callsigns and carriage control) was displayed in another area of the screen. Upon completion of a contact the computer would turn on the printer and print a hard copy of all information required in the contest log. If a contact was started and not completed, then no log entry was made. The only information saved in memory after a valid contact was the callsign and a tag byte to indicate which bands the station had worked so the computer could do duplicate checking, as mentioned above. The computer also handled generation of the CW identification, when necessary.



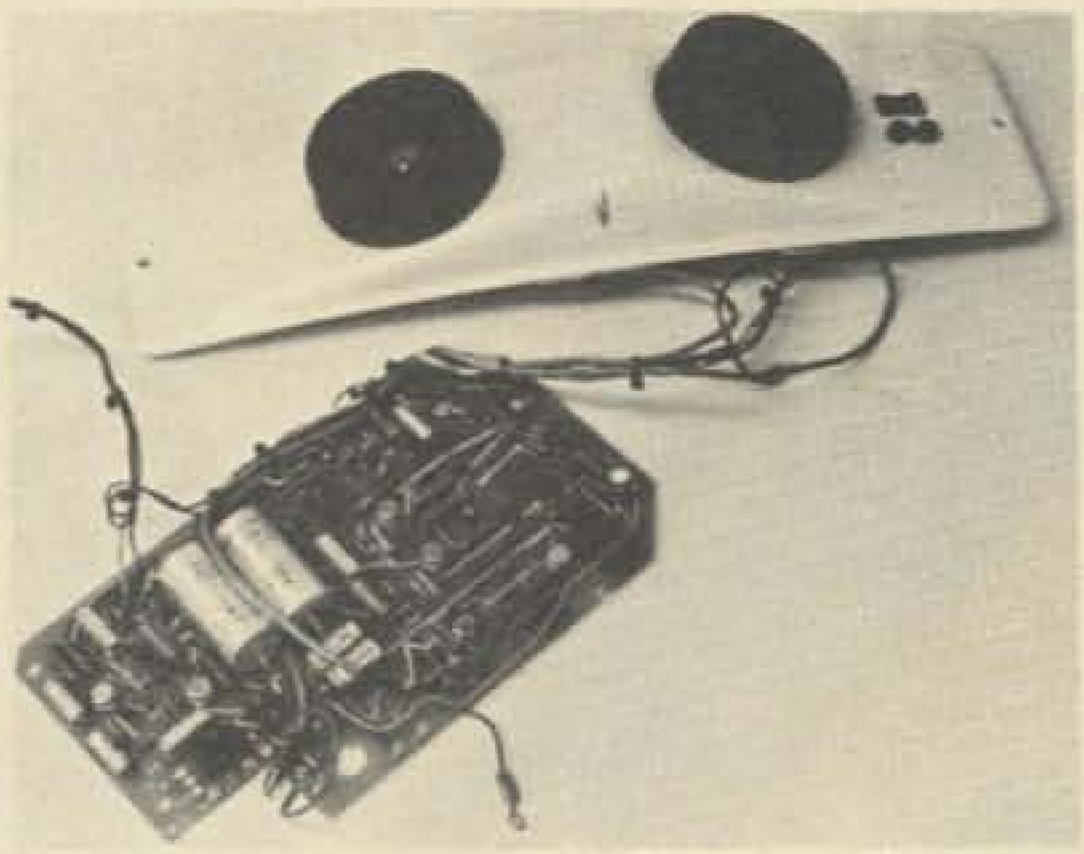
Interior of station console showing the ST-6 boards, frequency meters, electronic keyer, and interface boards.

The result was that I walked away with the first place prize in the system display contest, a floppy disc drive. Needless to say, I have altered my plans concerning construction of a separate cassette interface and will be devoting my time to writing software to utilize the disc drive as my mass storage device.

The Implications

So far I have only scratched the surface of the many possibilities for use of a microprocessor in the RTTY area alone. Other obvious uses for microprocessors within amateur radio include repeater control, CW reception and transmission, antenna control (for OSCAR or moonbounce especially), and who knows what else. A less obvious but equally or more useful application is digital filtering. Slow scan to fast scan conversion would also be another interesting possibility.

If you or your club has been doing work with microprocessor applications within amateur radio (or in any way related to amateur radio), I'd be interested in hearing about them. There are many ideas and techniques for using microprocessors rolling around out there, and I would like to help get them into print. Better still, write an article about your stuff so others will know what you are doing. ■



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The Which Chip Dilemma!

--4, 8, 12, or 16 bits: pros and cons

I have had my computer operational for nearly four years now, but there are not many people who know what kind of computer I have – I don't tell them. It is not that it is such a bad system; in fact, I have a floppy disc operating system with a TV display (including color graphics) and ASR33 Teletype for hard copy, and an almost-running audio cassette interface. I have programs that play tic-tac-toe and Life, and that allow me to paint pictures on the TV set with a joystick or to make music through the cassette player amplifier. I keep the local computer club mailing list on disc, and have programs to sort the file and print labels. I have two different text editors and several assemblers. But when I tell someone that I have a 4004 system, they look at me and think or say, "But that is a four bit processor. It is only half a computer."

Now, I will concede that four bits is only half of eight bits, and most of the microprocessors around are eight bit machines. But I dare say that my system is twice the computer that most of the eight bit systems I have seen are. My point is that to judge a computer solely on its word size is like judging a person solely on his national origin. I call it bigotry. This may be more evident in the following example: The IBM 704 of the 1950s had a 36 bit word; the IBM System 370 of our time has a 32 bit word. Yet the 370 is by no means 11% less of a computer than the 704. The real measure of a computer is what it can do and how well it can do it. True, the word size is significant, but less so than CPU architecture, the instruction set, the kinds of addressing modes, how the CPU interfaces to the outside world, and what else goes into the system. In this article we will consider some of these criteria, and compare some of the popular micros in this light.

Since the subject has already been broached, let us consider word size first. There are four standard word sizes in the available microprocessors: 4, 8, 12, and 16 bits; the bit-slice bipolar components are beyond the scope of this article. Each size has its advantages and disadvantages. First it should be noted that the optimum word size for a small computer instruc-

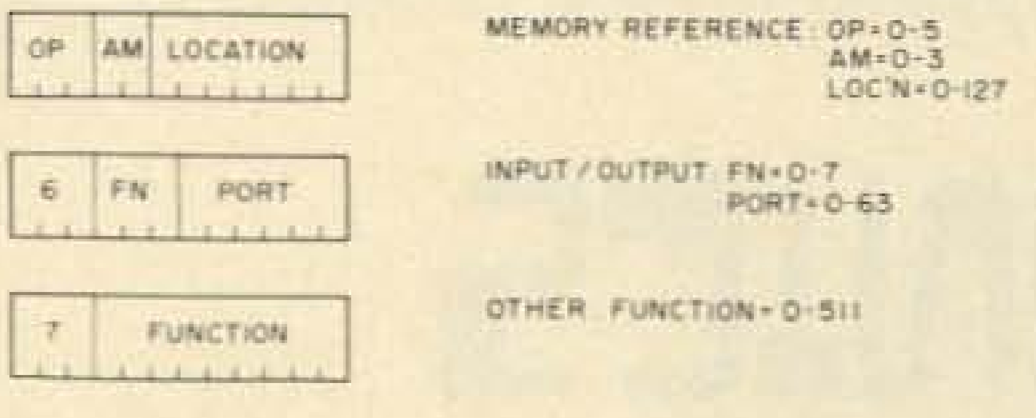

Fig. 1. 12 bit instruction word (PDP-8).

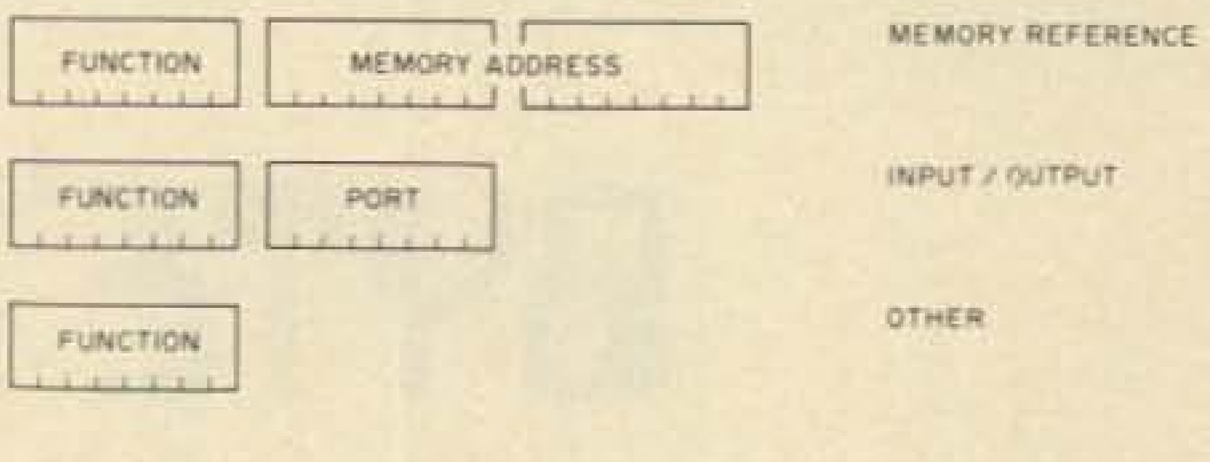

Fig. 2. 8 bit instruction word (8080).

tion is around 12 bits. This permits a few instructions direct access to a small amount of memory, and gives a generous number of bits to the instructions which do not reference memory directly. These are effectively allocated in the PDP-8 minicomputer (and the Intersil 6100, which is the microprocessor version of the PDP-8), as shown in Fig. 1. Three bits are the operation code (that part of the machine language instruction which tells the processor what to do with the data) in memory reference instructions, or serve to distinguish the non-memory reference instructions; two bits define the Addressing Mode, discussed later; the seven remaining bits select one of 128 words in memory. There are six memory reference instructions. Of the two remaining three bit codes, one defines the input/output (I/O) instructions, for which nine bits determine eight different operations on any of 64 different I/O devices (or "ports" as they are sometimes called). There remain yet 512 different possible op codes for the instructions which refer neither to memory nor I/O, though not all of these are meaningful in the PDP-8 instruction set.

The 16 bit computers allow more different instruction op codes for the memory reference instructions and/or a greater instruction address space (the number of memory locations a single instruction can reach) because of the larger word size, but there are wasted bits in the non-memory reference instructions (with only 12 bits the PDP-8 does not use all of the available combinations). The eight bitters, on the other hand, efficiently use the op codes for the non-memory instructions, but there are not enough bits to address a reasonable amount of memory in a single word

Fig. 3. Immediate addressing (8008).

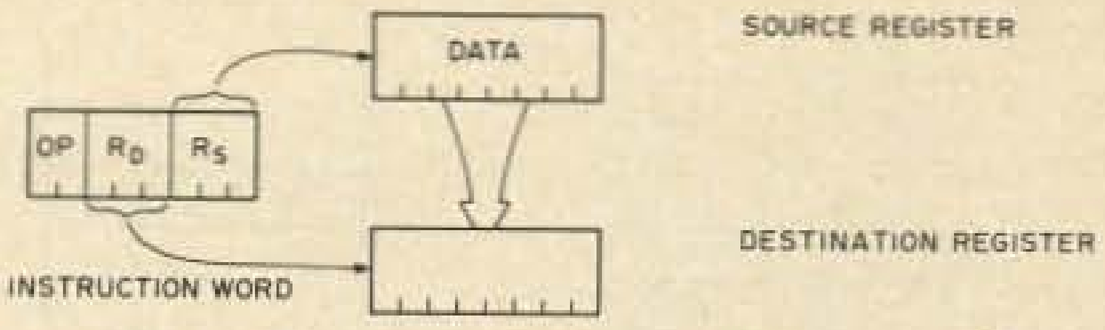

Fig. 4. Register addressing (8080).

instruction – two or more words are required for this purpose, as shown in Fig. 2. The four bit computers cannot contain their instructions in a single word of four bits; most of them use eight bit memory for instructions and four bit memory only for data.

Twelve bits is not a convenient size for data. Only numbers less than 4096 may be stored in a 12 bit word, so useful numbers often require two words in memory (good for numbers to 16,777,215). Two alphanumeric characters may be stored in one word if they are limited to capital letters, numbers, and a few standard symbols, but if you wish to process the full ASCII character set with lower case and control characters or if (heaven forbid!) you wish to process EBCDIC, then only one character can be fit into a word and the other four or five bits are wasted.

When most of the data to be processed are text characters, an eight bit processor is much more convenient, since each data word holds one character with minimal waste. But the problem with numbers is worse with eight bits than with twelve – the maximum number size is only 255, and two eight bit words still are limited to numbers less than 65,536 (although that is adequate for many needs).

A 16 bit CPU, as we have mentioned, gives more flexibility in the memory reference instructions and also permits a single word in memory to hold numbers to 65,535 or two text characters.

While it would appear at this point that there is no use for a four bit processor, it actually turns out that when most of the data are decimal numbers or one and two bit status and control signals, a four-bitter is more efficient in processing them. This is because when small pieces of data are buried in larger words, more computer time is required to isolate the data for processing. Thus, four bit processors are ideal for calculators (most calculators these days are actually four bit microprocessors, programmed for the calculator functions) and for logic replacement systems such as process control. The decimal arithmetic capability turns out to be so important in microprocessors that most 8 bit CPUs and even one 16-bitter (National's PACE) have special instructions for this purpose, but the user is stuck with an even number of digits, and decimal multiplication and division is difficult in anything larger than four bits. Consider the advantage of doing all your arithmetic in decimal (people think in decimal, not binary!) so that number conversion routines are not needed. Since more than one memory location is required for any number greater than one digit anyway, you have "infinite precision" (as large a number as you care to handle) at no extra cost.

Another important way to distinguish microprocessors is by the number and quality of CPU registers. In general, more registers result in more compact programs which execute faster. This is because the data for an instruction is already in the CPU, and does not need to be fetched from main memory. The instructions need only a few bits to identify a register, but a whole address is often required for memory data. On the other hand, a few general purpose registers may be more useful than many scratchpad registers which can only be used for loading and storing data. The F8 has 64 scratchpad registers, but only 12 of them are directly accessible to the program, and the others may only be accessed through an indirect address register. This is not as useful as, say, only 32 bytes of scratchpad which can be directly accessed by an instruction (as in the RCA COSMAC CPU), which in turn is less useful than four general purpose accumulators which can be used for calculation and/or index registers (PACE has four accumu-

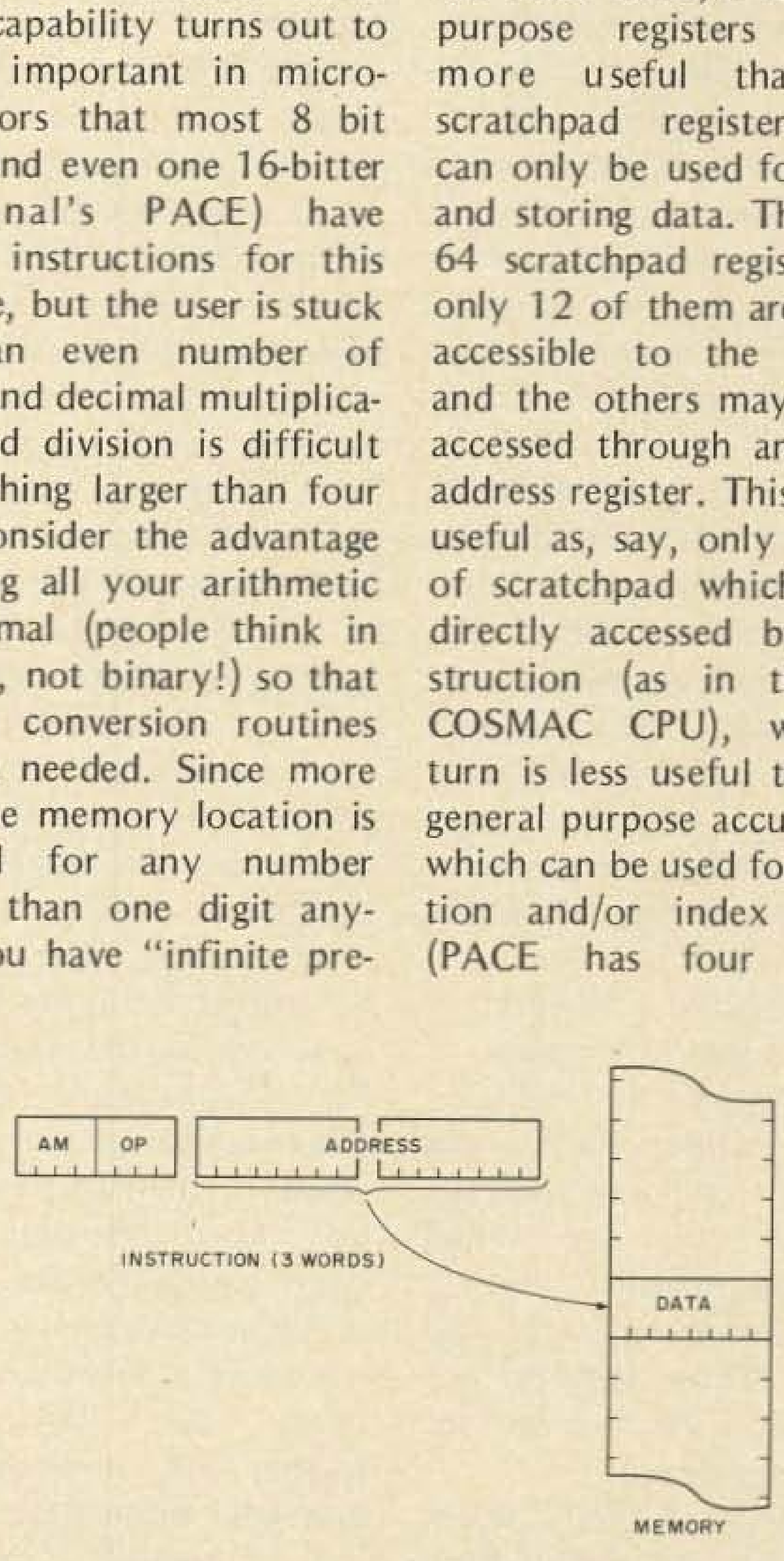

Fig. 5. Absolute addressing (6800).

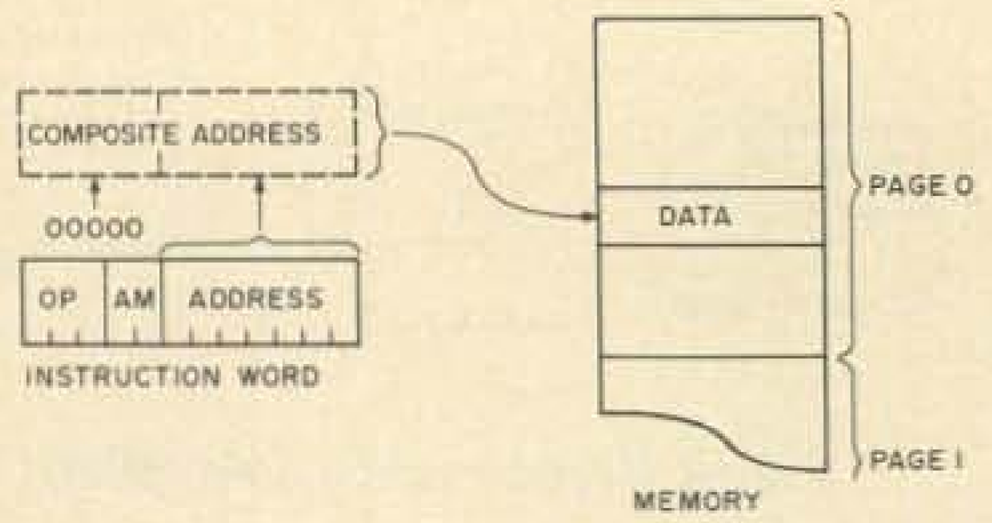

Fig. 6. Base page addressing (PDP-8).

lators, but only two of them may be used for indexing). In a microprocessor the registers may be used for any or all of the following functions:

Accumulators. Arithmetic or logical operations may be done on data in an accumulator, and the result returned to the same register in a single instruction. All of the micros have at least one accumulator. Some have more than one.

Data Memory Pointer. Most of the micros have at least one register which can be used to address memory for data. If the word size is less than the memory address size (as in the eight-bitters), two or more registers may be combined to form an address pointer, or the data pointer may be a double length register. If there is no data pointer (as in the PDP-8), then the CPU *must* have an indirect addressing mode into main memory to handle computed addresses. Often, if the CPU has an indexed addressing mode, the index register(s) will serve the data pointer function. Index registers are a more powerful form of memory address pointer.

Scratchpad. Registers which cannot be used as accumulators or memory address pointers are only good for temporary storage of data, and are called scratchpad registers. Not all CPUs have scratchpad registers. Those that do not must use main memory for temporary storage.

Other. Most CPUs collect the various status flip flops into a "status register." It is not useful for anything else and should not be considered in the same light as the other registers. Many of the micros have a memory address pointer which is used as a "stack pointer" (see *Addressing Modes,* below). It is not wise to use the stack pointer for any other purpose (because of interrupt handling requirements), so this register also has restrictions on its utility. A few processors have other restricted registers, usually used in transferring data between registers.

The different *Addressing Modes* available to the CPU are also an important criterion of rank. A CPU with few registers but many different addressing modes may be more powerful than one with many registers but only a few different addressing modes. The addressing mode of a particular instruction defines how the location of the data is to be determined. Like the number of registers, the more different addressing modes a CPU commands, the more powerful its instruction set is said to be. The following are the most common:

Immediate. The data for the instruction is immediately attached to the instruction. For smaller-word machines this data is usually in the next word in memory, making a two word instruction. For larger words the data is often in the instruction word, but it is limited to less than a whole word. Fig. 3 illustrates the format of immediate addressing. Immediate addressing is usually a very convenient way to load constants into CPU registers, so it is available in most processors.

Register. The data for the instruction is in one of the CPU registers. This is usually the fastest addressing mode, and requires the fewest bits, as illustrated in Fig. 4.

Absolute. The data is in memory, and its address is a part of the instruction, as shown in Fig. 5. The size of this address part determines how much of the system memory is "directly addressable." If the address part of the instruction is less than the address space (the total amount of memory the CPU is able to address at any time), then the address is said to be "abbreviated" and is usually further classified by the way the CPU derives that part of the address which is not specified in the instruction. Many CPUs command both an absolute addressing mode and several varieties of abbreviated addressing modes.

Base Page. In small-word machines it is common to divide the address space into blocks which one word or the address part of one instruction can uniquely address. For 8 bit CPUs this block is 256 bytes, so the total memory is divided into "pages" of 256 bytes each. Eight bits of address can uniquely define one of 256 locations in memory, so many addressing modes are related to the memory in each one of these pages. Which page is accessed is determined by the addressing mode. In particular, one of these pages has a page number (the most significant part of the address of any memory location is the page number) of zero. Page 0 is often specially accessible to instructions in what is called "base page addressing," which requires only one byte of address to access the first 256 bytes of memory. Fig. 6 illustrates base page addressing in PACE. Note that some people use the term "direct" to refer to base page addressing.

Page Relative. Another common abbreviated addressing mode uses the CPU program counter (the instruction address) for the page number, and the instruction specifies the location within the page, as shown in Fig. 7. Most micros with this addressing mode use it only for conditional branches, since the program counter usually is in a page of program memory which may not be appropriate for data. If the location to be reached is in the next page, this addressing mode cannot be used, so CPUs with this addressing mode tend to waste either program memory (by starting new routines on page boundaries) or programmer time (trying to fit them all into the fewest number of pages).

(PC) Relative. In this addressing mode, the abbreviated address is added (as a signed number) to the program counter to give the

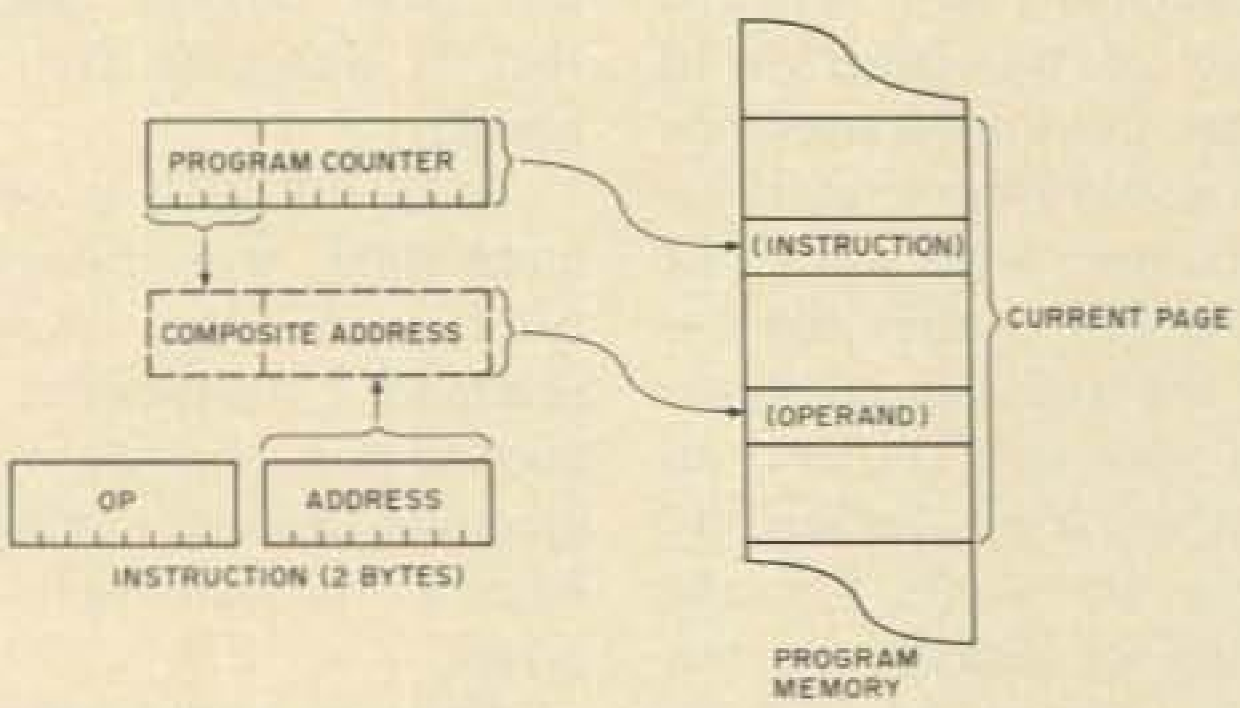

Fig. 7. Page relative addressing (4004).

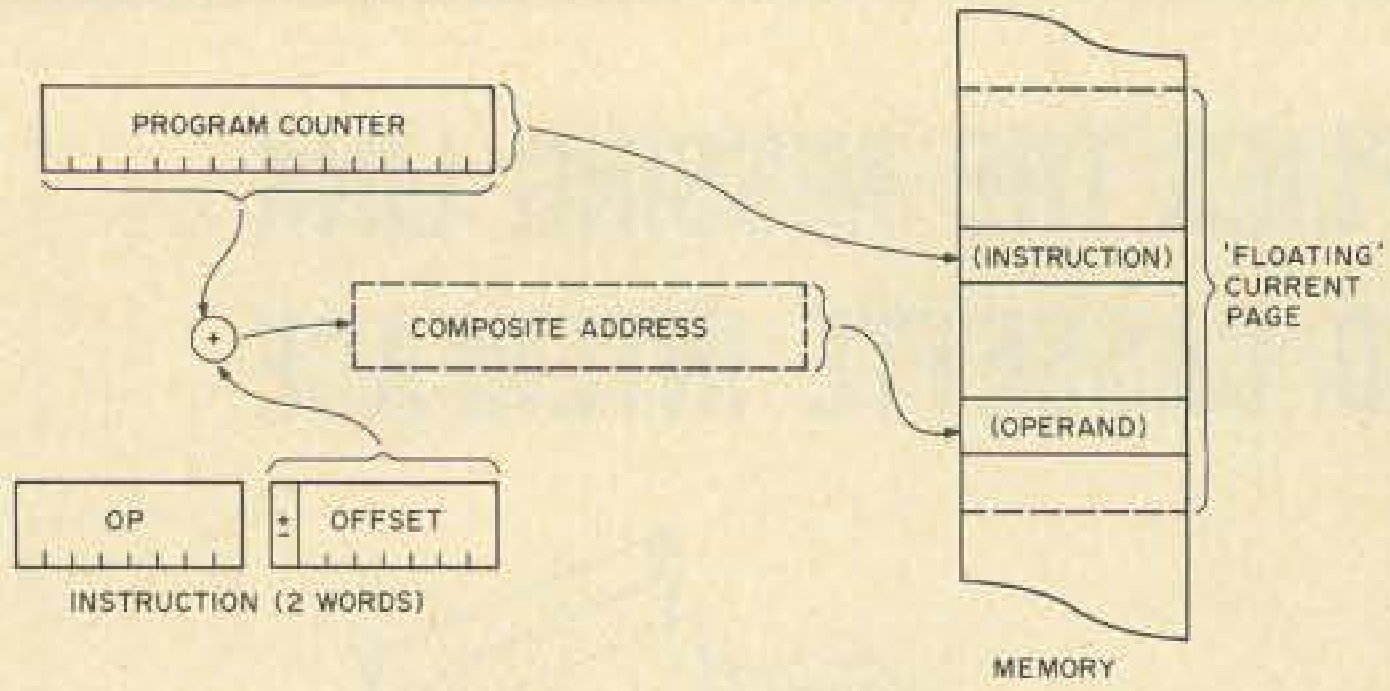

Fig. 8. Relative addressing (F8).

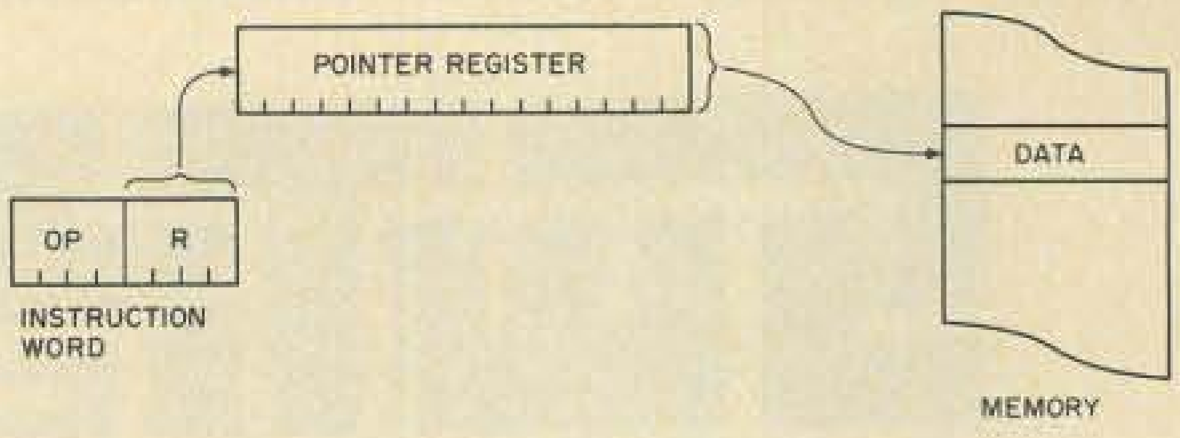

Fig. 9. Register indirect addressing (COSMAC).

operand address (again used only for branches). Thus the page accessible to any instruction seems to "float" around the current value of the program counter, as shown in Fig. 8. This is much more convenient than page relative addressing, since now the programmer need only be concerned with how far the destination is, not with page boundaries. But the cost is generally slower execution (that addition takes CPU time!).

Register Indirect. In this addressing mode the address of the data is in one of the CPU data pointer registers, and not in the instruction at all. As shown in Fig. 9, only one instruction word is required to access any word in memory, but the address must be set up ahead of time. This addressing mode is very useful for processing sequential data, especially if the address register can be optionally incremented (or decremented) simultaneously. Most micros have either register indirect or indexed (see below) addressing, but only a few have auto increment. One form of register indirect addressing with auto-increment and auto-decrement which is included in many CPUs is called "stack" addressing. Usually this is used to save return addresses in subroutine calls and for temporary storage of data. Sequential words of data are stored in (or retrieved from) sequential memory locations by one word instructions. This is slightly less useful than true auto-increment and auto-decrement register indirect addressing, since the programmer does not have the choice of incrementing or decrementing with stack addressing.

Indexed. When abbreviated addressing is combined with register indirect, the result is the indexed addressing mode. The address part in the instruction is added (algebraically if signed, but not all are) to the value in the index register to form the complete address of the data, as shown in Fig. 10. In some processors the address part is not abbreviated, but the index register may be; they cannot both be less than the full address size and still be useful. The indexed addressing mode is very useful for table handling, but more execution time and longer instructions are required for it than for register indirect.

Indirect. Many processors permit the address of the data to be stored in memory, and the instruction contains an abbreviated address pointing to that location. Processors with neither a data pointer nor a full address index register must have indirect addressing to get at tables, data buffers, and other data requiring a variable address. Indirect addressing is almost as convenient as register indirect, but has an additional advantage in that several memory locations may be set up with different addresses which may be accessed at random from different parts of the program. The indirect addressing mode may usually be combined with other addressing modes. Of particular interest is its combination with indexed addressing. Here the index register may be added either to the address part in the instruction to provide variability in the selection of which indirect address to use (called "pre-indexing"), or to the indirect address fetched from memory to provide variability in the data address relative to a given indirect address pointer in memory (called "post-indexing"). Post-indexed indirect addressing is illustrated in Fig. 11. Indirect addressing does not come free: An extra bit in the instruction word must be dedicated to signal it, and extra memory cycles are required to fetch the address.

Aside from what the programmer sees in the CPU, the processors may also be judged on their interface to the outside world. Some micros have several varieties of input and output instructions; others have none. Almost any microprocessor can have I/O devices connected to it that look like memory locations, but those without I/O instructions *must* do it this way. For I/O-intensive applications this may be a nuisance. It also prevents using all of the memory space for memory (if you need that much). On the other hand, I/O instructions use up valuable instruction operation codes, and if the I/O is part of the memory space all of the arithmetic and logical instructions may be used directly on the I/O data (if you feel so inclined; I have yet to see this happen in real programs).

An important distinction sometimes not considered fully is the interrupt capability of the CPU. How many different kinds of interrupt does the CPU support? The 8080 has a single interrupt signal into the CPU, but up to 8 interrupts are easily prioritized in the 8214 Priority Interrupt Encoder, which can provide "vectored interrupt" capability (the interrupting device gives the CPU a memory address indentifying the service routine for that interrupt at the time the interrupt is accepted by the CPU). The M6800 CPU has two interrupt input signals, so that vectored interrupts from two interrupt causes are easy, but for more than that it is much more difficult. Also, the user of the 6800 should be aware that one of those interrupts cannot be disabled and is incompatible with one of the more useful of the CPU instructions. PACE has six vectored interrupts. Unless interrupt service time is critical, vectored interrupts are not essential. In fact, interrupts themselves are not always essential, and some CPUs allow none. I have seen several major programs for CPUs which can support interrupts, but they are not used.

Then there is Direct Memory Access (DMA) for moving data into and out of memory. Only one of the micros (COSMAC) has the DMA logic built into the CPU. A few have DMA controllers in the chip set which supports the CPU. Most of them can be stopped by the peripheral for DMA opera-

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	MFG	TECH	POWER	CLK	ADD TIME	WORD SIZE	ADDR SPACE	REG'S	ADDRESS MODES	PAGE SIZE	X	STACK	INT	CPU I/O	I/O PORTS	I/O CHIPS	BCD	ADDR LATCH	PRICE
1600	G.I.	NMOS	+5, +12,-3	2D	2.4	10P, 16D	65K	6G	A,B±,D,I, R,S		16	M 65K		1/0		P,S	0	16	
2650	Signetics	NMOS	+5	1S	4.8	8	32K	A,6G	@,±,I,JA, P,R,X±,@X	8K	8	CPU 8	(64)	1/1	257	0	+	2	$72
4004	Intel N.S.	PMOS	+5,-10	2D	10.8	8P,4D	4KP, 512D	A,16S	BP,D,I,JA, R	256	–	CPU 3	0	1/0	16/32	P	+	4+4+4	$19
4040	Intel	PMOS	+5,-10	2D		8P,4D	8KP, 512D	A,24S	BP,D,I,JA, R	256	–	CPU 7	1	1/1	32/48	P	+	4+4+4	$20
6100 (=PDP/8)	Intersil	CMOS	+4 – +11	XS	2.5	12	4K	A,S	@,P,Z	128	–	0	1	0	64	P,S	0	12	$150
6502	MOS Technology	NMOS	+5	XD	2	8	65K	A,2X	@,A,B±,I,S, X,Z,@X,X@	256	8	M 256	2	0	0	P	±	–	$25
6800	Motorola AMI	NMOS	+5	2D	2	8	65K	2A,X	A,B±,I,R,S, X,Z	256	16	M 65K	2	0	0	P,S	+	–	$34
8008	Intel	PMOS	+5,-5	2D	12.5	8	16K	A,X,4S	D,I,JA,R	–	16	CPU 7	(8)	0	8/24	0	0	8+6	$19
8080	Intel TI AMD	NMOS	+5,+12,-5	2D	2	8	65K	A,3X	A,D,I,R,S	–	16	M 65K	(8)	0	256	P,S	+	–	$30
COSMAC	RCA	CMOS	+5 – +12	1S	5.6	8	65K	A,16X	BP,D+,I	256	16	0	1	4/0	8/8	0	0	8	$40
F8	Fairchild MOSTEK	NMOS	+5,+12	XD	2	8	65K	A,(2X), 64S	B±,D±,I, JA,R	256	16	CPU 1	M	16	256	P	+	(8+8)	$39
Micro Controller	SMS	BI-POLAR	+5	1	.3	16P,8D	4KP, 256D	A,2X, 6S	BP,D,I, JA,R	256	8	0	0	0	256	P	0	–	
PACE	National	PMOS	+5,-12	2D	8.5	16	65K	2A,2G	@,±,I,R, S,X,Z	256	16	CPU 10	6	3/4	0	P	+	16	$125
PPS-4	Rockwell	PMOS	-17	2D	4	8P,4D	4KP, 4KD	A,X,S	@,D-,I, JA,JP,R	64	12	CPU 2	0	8/4	16	P,S	+	–	
PPS-8	Rockwell	PMOS	-17	2D	4	8	16KP 16KD	A,2X,2S	@,D±,I, JA,JP,R,S	128	16	M 32	3	0	16	P,S	+	–	
SC/MP	N.S.	PMOS	+5,-7	XS	14	8	65K	A,3X,S	±,D±,I,R,X	256	16	–	1	3/4	0	0	+	4	

LEGEND

MFG — *Manufacturer*

TECH — *Chip technology*

POWER — *Power supply requirements (voltages)*

CLK — *Clock requirements: Number of clock inputs,*
- *X On-chip clock may be driven from crystal*
- *S Static – clock may be stopped or run slowly*
- *D Dynamic – clock has minimum frequency*

ADD TIME — *Minimum execution time for ADD instruction (some instructions may be faster)*

WORD SIZE — *Number of bits; P = Instruction word; D = Data word*

ADDR SPACE — *Maximum size of addressable memory*
- *P Program memory (if separate)*
- *D Data memory*

REG'S — *Number and kind of CPU registers (one if no digit):*
- *A Accumulator*
- *S Scratchpad, not usable as accumulator or data pointer*
- *X Index, register or data pointer (may consist of multiple separately addressable registers)*
- *G General register, usable as A or X*

ADDRESS MODES
- *@ Indirect (through memory)*
- *± Relative*
- *A Absolute*
- *B (with ± or P) Conditional branches only*
- *D Register Indirect*
- *D± Register Indirect with Auto-Increment, -Decrement*
- *I Immediate*
- *J (with A or P) Jumps only*
- *P Page Relative*
- *R Register*
- *S Stack (i.e., PUSH & POP instructions)*
- *X Indexed*
- *@X Post-Indexed Indirect*
- *Z Base Page*

PAGE SIZE — *Number of words in branch page*

X — *Number of bits in Index or Data Pointer register*

STACK — *Location and number of words; if in CPU, = number of nested subroutine calls*

INT — *Number of Vectored Interrupts (parentheses if external encoder required)*

CPU I/O — *Number of input and output lines on CPU; single number if bidirectional; otherwise Input/Output*

I/O PORTS — *Number of I/O ports addressable by CPU; single number if undifferentiated; otherwise Input/Output*

I/O CHIPS — *Peripheral Support Chips available with CPU:*
- *P Parallel I/O*
- *S Serial I/O*

BCD — *Decimal arithmetic instructions:*
- *+ Add*
- *- Subtract*

ADD LATCH — *Number of address bits which must be latched off the CPU; numbers separated by + indicate multiple time slices*

PRICE — *Quantity one price for CPU only; does not include any required support chips. These are published prices at time of writing, rounded to nearest dollar; lowest published price was used; chips meeting speed spec may cost more.*

Blank entries represent information unavailable.

Table 1. Microprocessor comparison.

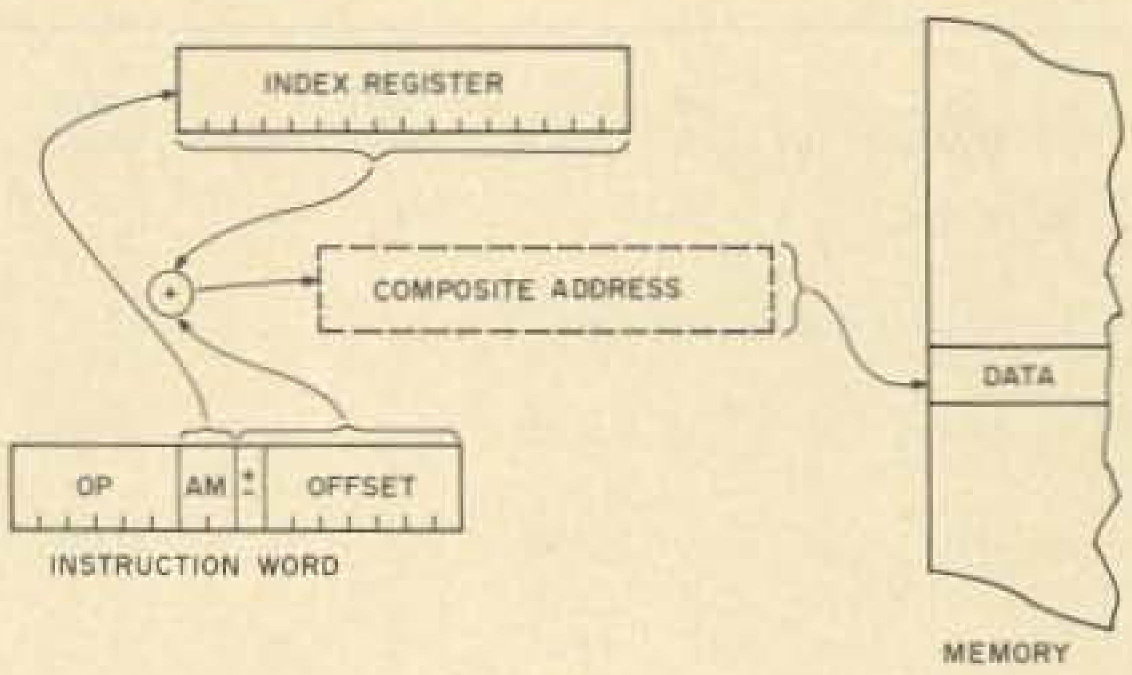

Fig. 10. Indexed addressing (PACE).

tions, and some actually get off the buses when stopped, to make it easier for the DMA logic to work.

Connecting the I/O devices is another problem. The 4004 chip set (my system) has input gates or output latches on every memory device in the family. There are also special I/O devices (4207, 4209, 4211) that connect right on the bus with no extra logic. Motorola came out with some real nifty I/O circuits (6820, 6850) with the 6800, but a certain amount of address decoding is required for all but the most trivial systems. Intel has recently come out with similar circuits, but, as with the 6800 family, plenty of interconnect logic is required. With the 8008 you are on your own. The F8 has lots of I/O right on the CPU and the memory interfaces. Other micros have a few I/O lines on the CPU and require that extra logic for anything over that.

Perhaps one of the more important criteria of distinction to the hobbyist is the interconnection requirements for the processor. How many power supplies are required? Some micros run on +5 volts only; others require +12 and/ or a negative supply. If the system uses a 4K RAM memory which needs +12 and -5 volt supplies, a processor with the same requirements is no problem. Some of the processors run on -9 or -12 volts. This could be a nuisance if nothing else in the system needs those supplies. Many of the microprocessors are "dynamic," which means that they require high voltage nonstop clock drivers; even "5 volt, TTL compatible" CPUs may require clocks that swing from 0.2 volts to 4.7 volts, which TTL outputs are not specified to deliver. "Static" CPUs are generally simpler to control because there is only one clock signal to drive, and it can be stopped at any time.

Some of the micros are more easily connected into systems than others, because of the related circuits available from the manufacturers. Is a clock driver available for those odd two phase high voltage clocks? How much extra logic is required to connect standard memory components? What is the fewest number of extra parts that must be added to get a working (special purpose) computer? What happens if I connect a Motorola PIA (M6820 – a good I/O chip) to an 8080 system? Most of these questions are beyond the scope of this article, but they drastically affect how good the resulting computer is.

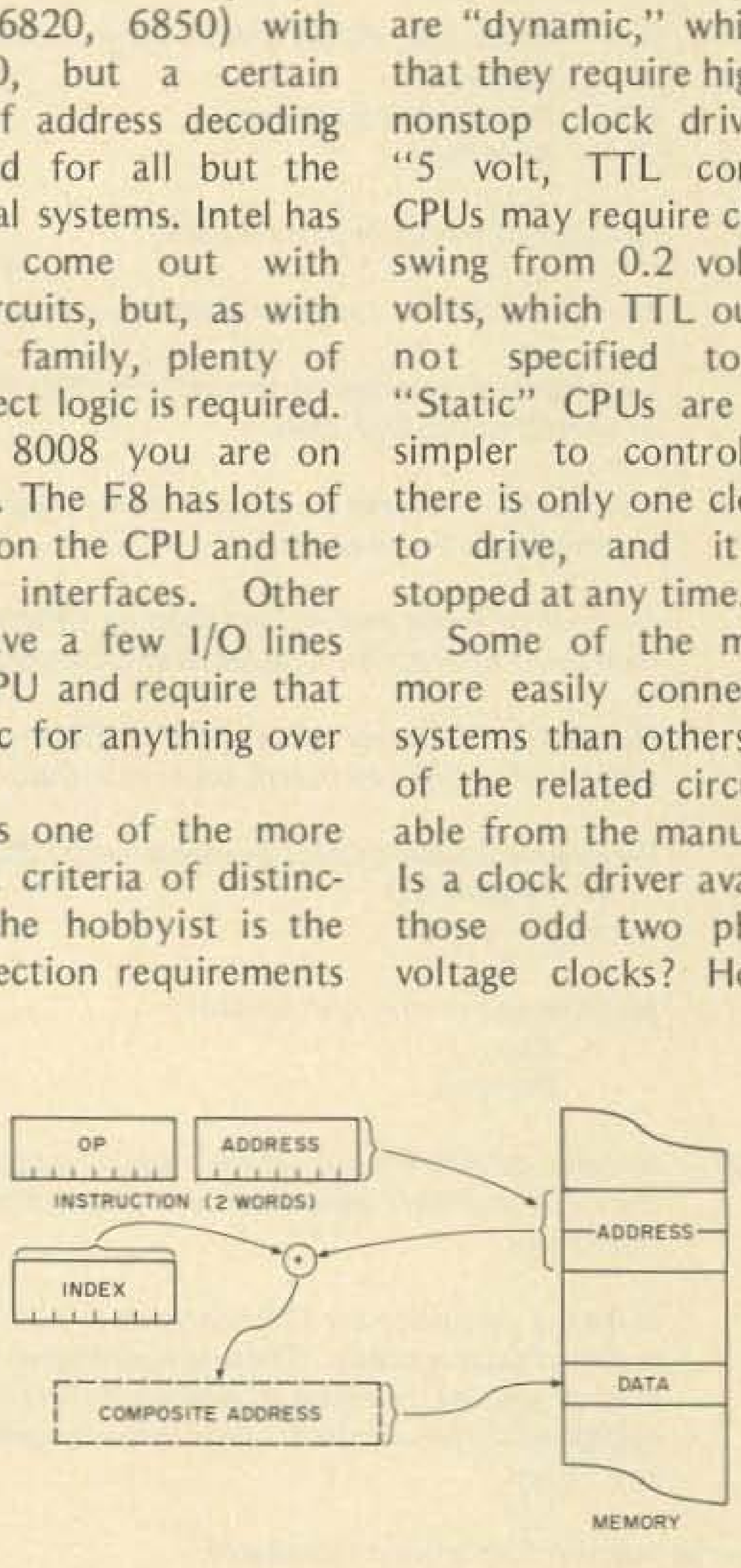

Fig. 11. Post-index indirect addressing (6502).

Table 1 is an analysis of some of the available microprocessors, according to the criteria we have discussed.

As I said earlier, the power of a system is measured largely by the kinds of peripherals available to it. An extremely important peripheral is one providing "off-line storage" in machine-readable form, so that programs can be saved and reloaded without a lot of manual effort. A paper tape reader and punch will do this adequately, but it is slow. Audio cassettes are somewhat faster, more compact, and considerably cheaper. Floppy disc drives are the most versatile for program and data storage, but there does not exist at this time anything for the amateur for less than $2000. This is unnecessary: I bought everything new and spent about $800, but I had to design my own controller.

A second essential peripheral is the human interface. While lights and switches look esoteric, they are not suitable for most programs. The so-called "TV Typewriter" is probably the best human interface you can get for your money. A Teletype with paper tape reader and punch is the cheapest single peripheral to give both machine-readable data storage and the human interface (with hard copy, yet).

Last here, but most important, is the *software*. The computer is worthless without a program. Writing that program and getting it into the computer and getting it to run correctly is not easy. It is harder for some microprocessors than for others. It is harder in some systems than it is in others with the same CPU. Different programmers will find different processors or systems to be easier or harder. But you can be sure all of the good systems (i.e., the ones that are easy to use) represent a lot of programming effort in operating systems, text editors, assemblers, high level language (such as BASIC) processors, and utility programs.

The next time someone tells you that this micro is better than that one, ask why, and for what. I did not mention that I have two operational computers now. One of them has an 8 bit CPU with a powerful instruction set, but I don't use it, because my 4004 system is "better." Better because the peripherals and the software support are better. I also have over a half dozen CPU chips for other processors, but I am unlikely to do more than make toys out of them, because the two systems I have are better. Better because they already have all the connections to memory and power – an operational computer is better than one that is not.

A final note. This manuscript was prepared on my "Half a Computer" using some of my software to edit the text, pull proofs and correct typographical errors. To add or delete a sentence did not require retyping the whole page; the computer did that. If the publisher had wanted, I could have delivered a paper tape to run automatic typesetting equipment. Maybe next year when I can afford a "whole computer" (that's more peripherals, not a different CPU), I will be able to deliver camera-ready copy. Computer power is what the computer can do. ■

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Meaningful Conversations with your Computer

-- what those mysterious "languages" are all about

A glance at the advertisements in *73* or almost any other technical rag will reveal a growing number of computer kits, memory boards, and peripheral devices being offered to the home experimenter. The "home" computer field is growing almost as fast as the two meter boom of several years ago. One of the problems always associated with a new field is the tremendous lack of *practical* knowledge possessed by the casual experimenter. The computer freak now has a wide choice of micro kits, input/output devices, and services to choose from, but the big problem remains: How does one COMMUNICATE with his computer? Ah, yes, you have just completed your Super-X microprocessor kit, and plan to use it to store OSCAR orbital data. A simple application? Yes, but there X sits with rows of switches and LEDs, and not calculating a thing. Something is missing – a method of "talking" to, or "programming" the machine, thus enabling it to perform a meaningful task.

The Language Processor

The missing link is the Language Processor, or LP. An LP is a program that allows a computer user to form the unique set of "machine instructions," which are the binary numbers that direct every machine function. The LP is to a computer what the keyboard is to your pocket calculator – it is a man-machine interface that bridges the gap between human requests and machine action. Without a keyboard, your pocket wonder is useless unless you like to collect big IC chips. Without an LP, a computer programmer is forced to form and insert into memory every binary code that forms a program, requiring a knowledge of the internal construction and machine codes unique to every computer.

Programming Your Black Box

A computer performs its task by executing a series of "machine instructions" that reside in the memory of the processor. The ultimate goal of any programmer is to relate the problem to be solved in terms of the machine instructions that the computer understands. This goal may be reached in two ways: by inserting each instruction into memory by "hand," using the front panel switches, after a tedious process of forming the correct codes, or by using an LP to form the codes for you. This LP may be an *assembler, compiler,* or *interpreter.* This article examines, in simple terms, the function of each type of LP, the associated trade-offs, and the benefits of each. Before starting, however, let's take a quick look at how programming works without the LP, bearing in mind that the final goal of any LP is to produce the binary machine code that only the machine understands.

Machine Language

Every computer, be it an IBM 370 or Motorola M6800 micro, has a unique set of "instructions," consisting of binary codes that direct every internal function of the running computer. Most machines are capable of executing certain basic operations, such as moving data to and from memory, addition, subtraction, and shifting (a process of moving "bits" to different locations within the computer). However, the problem is that each machine uses a different code for similar processes, requiring the programmer to know the details of each machine he wishes to use. One "machine language" program for solving the Ohm's Law ($I = E/R$) relationship is shown in Table 1.

The result of the operation expressed in Table 1 is the answer "I" stored in memory location 10, and the remainder of the division in location 12.

Several problems associated with machine language programming are apparent:

1. The code is unintelligible to anyone not specifically familiar with computer "X."
2. A change to the code to fix a "bug" (a common creature around computers) often requires rewriting much of the existing code, especially when more instructions are added.
3. Following the logic of the original program-

	Machine Code	Comment
Start	4830 0000	Fetch "E" from memory
	0722	Clear temporary
	4840 0002	Fetch "R" from memory
	0D24	Perform division
	4030 000A	Save answer "I"
End	4020 000C	Save remainder

Table 1. Typical machine code to solve $I = E/R$. This example assumes that data "E" and "R" were preloaded into the memory.

	Assembly Language	Comment
Start	LH R3,LOC0	Fetch "E"
	XHR R2,R2	Clear Register 2 (temporary)
	LH R4,LOC2	Fetch "R"
	DHR R2,R4	Divide
	STH R3,LOC10	Save "I" in Location 10
End	STH R2,LOC12	And save remainder

Table 2. An assembly language representation of a program to solve $I = E/R$.

	M6800 Assembly Code	Comment
Start	LDA A,LOC0	Fetch "E"
	LDA B,LOC1	and "R"
	JSR DIVD	Go to Divide routine
	STA A,LOC2	Save answer "I"
	STA B,LOC3	and remainder
End	SWI	Done
Divd	******	A software program to
	******	divide, as the M6800 has
	******	no specific divide instruction;
	RTS	Return to calling routine

Table 3. Routine to solve $I = E/R$ on a Motorola M6800 micro.

mer and documentation of the program is difficult, especially when the programmer takes another job.

All computer programming in the early '50s was done in direct machine language – prompting the development of the first type of LP, the *assembler.*

The Assembler – Symbolic Programming Made Possible

The first member of the LP family is the assembler, a computer program that allows machine instructions and operations to be represented symbolically, i.e., in a more human form than rows of numbers. The programmer is still required to know the specific machine instruction set of his computer, but the assembler allows him to refer to instructions by name (or *mnemonic*) instead of number. The end result of an assembly process is a machine language program similar to that in Table 1. The assembler only serves to make the generation of those codes a less tedious process. A sample assembly language program to solve our Table 1 problem is shown in Table 2.

The same program coded for the Motorola M6800 microprocessor is given in Table 3, illustrating the point of how a programmer must know the unique instructions of each machine he wishes to use when programming in assembly or machine language.

Several shortcomings of machine language programming are resolved by using an assembler. For example, changing or correcting the program requires only a "source" change, usually done by changing the punched card in error. The complete program is then reassembled, causing the output of correct machine code. The assembly process removes the requirement that the programmer know in advance how his change affects the code in instructions around the correction. Documentation of the program is easier also, as the symbolic representation of the machine code is understood by anyone familiar with the machine. Software development cycles are speeded up, as correction and modification of programs does not require extensive code changes.

Most microcomputer manufacturers provide an assembler with their micro kits. However, most assemblers require a large amount of memory to function, recalling that the assembler itself is a program coded in the machine code particular to a given microcomputer.

The Compiler – Or, Programming in English

The assembler LP greatly increased the capability of man to talk to his computer, but the basic restriction of having to know internal details and procedures still remained. An ultimate LP was required, one that allowed programmers to function in an English language environment. The first such LP was a language known as *FORTRAN,* a program dedicated to "*FOR*mula *TRAN*slation." FORTRAN is an LP that lets programmers represent problems as they occur on paper or textbooks, in English. This type of LP is often referred to as a "high level language": the higher the level, the more English-like the representation of instructions. Most high level LPs allow the program to contain notation and conventions that would normally be used to describe the problem, thus allowing the programmer to concentrate on the solution of the problem, not the internal workings of a computer. Using our old Ohm's Law example, Table 4 shows what the FORTRAN program looks like.

The power of the high level LP is provided by a very complex and large program. From Table 4 it can be seen that the single statement expressing the formula really requires several machine instructions (Table 1). A single complex FORTRAN statement may produce 50 or 60 machine instructions. (Remember, that's all the processor knows!) The real beauty of a *compiler,* the high level LP, is that the same source program may be run on any machine capable of supporting the compiler. The compiler for each machine knows that the incoming program is in a standard format (as defined by standards committees), so it must produce the unique machine code to solve the problem. It can be seen that each FORTRAN compiler will only run on the machine it supports, but the

```
C          Comment – Divide E by R giving I
C
C
           I=E/R
           STOP
           END
C          That's it – of course other instructions are
C          needed to input the raw data.
```

Table 4. A typical FORTRAN program.

```
1 REM Read E and R, then calculate and print I
2 INPUT E,R
3 LET I=E/R
4 PRINT "ANSWER IS = ",I
5 STOP
```

Table 5. A BASIC program that accepts input from a terminal, calculates the answer, and prints out the result, all in three statements. (Line 1 is a comment; line 5 needs no explanation.)

standard source program (written by a programmer) will be accepted by any compiler. This concept, known as "computer independence," is the foundation of the programming profession. A programmer used to coding IBM 370 FORTRAN can be writing programs on an INTERDATA minicomputer the day he changes jobs, as the LP takes care of the nitty-gritty details of producing the different machine code.

FORTRAN is not the only high level LP. A few seconds spent scanning any computer trade publication will reveal names such as *COBOL* (*CO*mmon *B*usiness *O*riented *L*anguage), *APL* (*A P*rogramming *L*anguage) or *JOVIAL* (believe it or not — *J*ule's *O*wn *V*ersion of the *I*nternational *A*lgorithmic *L*anguage). Each of these LPs has a source input format suited to a particular application. COBOL, for example, is well suited to business applications, such as payrolls, but finds little use in the scientific community.

The Interpreter — A Micro's Best Friend

Compilers are available for all large computers and most minis, but due to their complexity and cost have not filtered into the micro world yet. It often takes several man-years to develop a compiler and write it in assembly language, so it will be awhile before you can load up FORTRAN on your brand X micro and track OSCAR, even though the capability is there to do it in assembly language. Take heart, however — all is not lost. There is an alternative to the compiler available to microcomputer programmers — the *interpreter*. This LP offers most of the advantages of the compiler with one difference — no machine language is produced from the source program. Instead, the interpreter processes the incoming source statements "on the fly," and produces the answer or results by executing a series of built-in routines triggered by the "commands" produced by the programmer. The most popular interpreter is *BASIC* (*B*eginner's *A*ll purpose *S*ymbolic *I*nstruction *C*ode). Take a last look at our example, this time done in BASIC (Table 5).

Hopefully, the above explanations have taken some of the mystery out of the word "programming." A careful look at the microprocessor kit advertisements will reveal what LPs are available for your application. An assembler is required for all but the most simple applications, and BASIC is available for some of the machines — a big plus if you can afford the necessary memory to contain the interpreter. Even machine language programming can be fun on a micro, and there is probably no better way to learn the ins and outs of computer architecture. The programming tricks learned can always be applied to your next effort, even one using a high level LP. So have fun, and GOOD PROGRAMMING! ■

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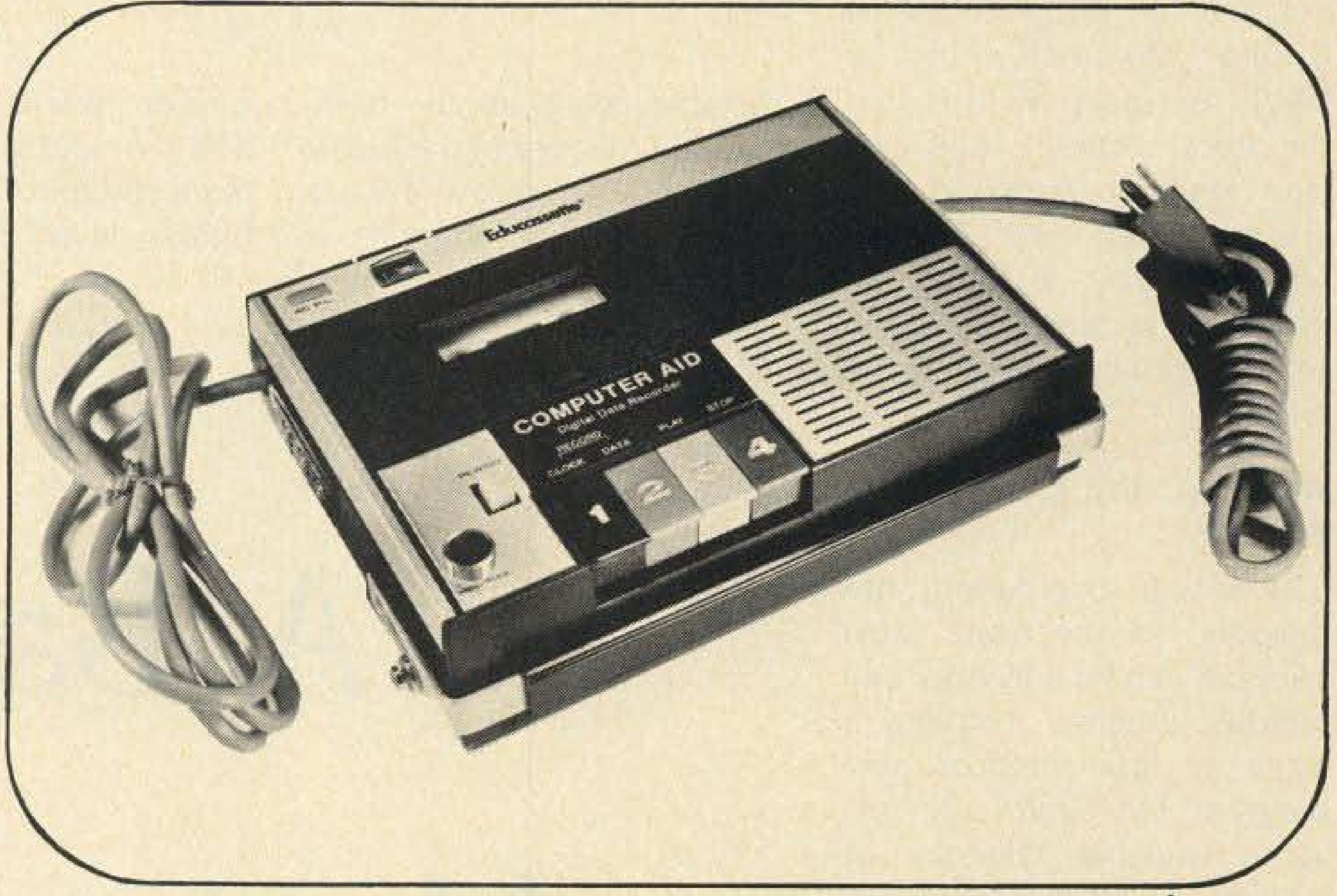

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A Baudot Monitor/Editor System

--program listing for the 8080

In an earlier *73* article, we described interfacing a Baudot teletype with a hobby computer. Once this hardware interconnection is made, the next step is to develop a software operating system that takes advantage of the keyboard/printer link to the computer. In this article we describe a program called Baudot Monitor/Editor, or BM/E for short. With it you can store, examine, and execute machine language programs using the Baudot teletype. This is quite an important step on the road to full utilization of your computer.

Why a BM/E Operating System?

Entering a program into memory via the front panel switches can be a lengthy and tedious process. Loading a three or four hundred byte program by hand will just about end the pleasure of owning a hobby computer. The limited usefulness of the front panel as a functional I/O device can be traced to the restriction of lights and switches to two states, i.e., "on" and "off." Thus entry must be in binary notation, which is perhaps the least efficient system for human use. The more satisfactory octal or hexadecimal systems cannot be used, since they require eight and sixteen states respectively. Adding a Baudot teletype can be viewed as a way of expanding the number of I/O states available to the user from two to sixty-four (upper and lower case characters). BM/E is in a sense a translator from the internal binary form to external octal format on the teletype. In addition, having the set of letters and symbols available opens up the possibility of developing a higher level language whose instructions can be entered in English words and phrases. The computer can thus be made to function on a more human level. BM/E is just a start on the path to such a higher level language, but it is an important step for someone who wants to learn about computers from the ground up.

Letter Command	Name	Description
D	Dump	Outputs contents of consecutive memory locations in octal
L	Load	Permits storing octal instructions in consecutive locations
E	Edit	Single locations can be examined and, at the user's option, changed
M	Message	Places the computer in a mode that echos the keyboard on the printer
X	Execute	Starts program execution at a specified address

Table 1.

Understanding Octal Number Representation

Before detailing the operation of BM/E, a short explanation of octal numbers should be made. As already noted, computers use binary format to represent instructions and addresses. Long strings of 1s and 0s, though handled readily by a computer, are difficult for humans to work with or remember. For instance, to specify an instruction at a certain memory location, one would have to write:

Address
0101011011001110
Instruction
11001101

Now suppose you were writing a 500 or 1000 byte program using this binary notation – I wonder which would run out first: your patience or the paper supply?!

Enter "octal notation" to save the day! By expanding the number of symbols from two to eight, the complexity of the binary representation can be reduced considerably. The example above can be written:

Address
126 316
Instruction
315

The improvement from the human standpoint is obvious.

The rewriting of a binary number in octal is accomplished in the following way:

1. Separate the binary number into three digit groups beginning at the rightmost digit.
2. Use the chart below to give each group its octal value.

Binary	Octal
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

3. If the leftmost group has less than three digits, just consider that it is prefixed as required with zeros.

Example:
01010110
(Binary)
1 2 6
or
126
(Octal)

Instructions and data for an eight bit computer such as the Altair 8800 can be represented as a three digit octal number ranging from 000 to 377. A sixteen bit address is most easily represented by two octal numbers obtained by first splitting the sixteen bits into two eight bit groups.

Example:
0101011011001110
(Binary)
01010110 11001110
(Split Binary)
1 2 6 3 1 6
126 316
(Split Octal)

Split octal address representation is useful because it fits the format of multibyte instructions used by microprocessors like the 8080 and 8008. The left octal number is referred to as the page, while the right octal number is the location of the given page. The example address would be stated as "location 316 on page 126 of memory." Thus, in a 65,535 word memory; there are 377 octal pages with 377 octal bytes per page. In further discussion of BM/E, split octal addressing will be used exclusively.

Sometimes it is necessary to convert an octal number to its equivalent. Suppose the three octal digits are given by XYZ. The decimal value can be calculated using the expression:

Decimal Value =
$X \cdot 64 + Y \cdot 8 + Z$
Example:
325 octal =
$3 \cdot 64 + 2 \cdot 8 + 5 =$
149 Decimal

To convert to decimal a 16 bit address written in split octal, first convert the page and location separately as given above. Then use this expression to complete the calculation:

Example:
025242 Split Octal
025 Octal =
$0 \cdot 64 + 2 \cdot 8 + 5 =$
21 Decimal
242 Octal =
$2 \cdot 64 + 4 \cdot 8 + 2 =$
94 Decimal
025242 Split Octal =
$21 \cdot 256 + 94 =$
5474 Decimal

D (Dump octal): This mode provides a listing of consecutive memory locations beginning at an address specified when the mode is first called. Listing continues for a specified number of eight byte lines. After entering this mode from the Monitor, the computer prints a colon prompt to indicate it needs the starting address. The user enters the six digit split octal starting address. The computer responds with a SPACE and awaits user entry in octal of the number of eight byte lines desired.
Example:
!D:010000 002 CR&LF
010000 110 123 204 315 112 010 365 325 CR&LF
010010 325 306 214 176 361 321 125 115 CR&LF !
After dumping two lines as required, the system returns to the Monitor and awaits another command. Notice that only the address of the first byte of each line is printed. This produces a quicker and denser listing. The addresses of the remaining bytes can be easily obtained by counting in octal from the known first byte address.

L (Load octal): In this mode the user can store octal data into consecutive memory locations. After entering this mode, a colon is printed to indicate that the computer needs a starting address for the load. When the address is entered, the computer echos the starting address and waits for the user to enter the first data byte. After the entry, the computer will issue a SPACE and wait for entry of the next data byte. A new line and the current address are output after eight bytes are entered. Return to the Monitor at any time is accomplished by typing a BLANK.
Example:
!L:004000
004000 101 102 103 115 126 135 315 246 CR&F
004010 226 (Blank Key)
!

E (Edit): The E mode is used to examine and, if desired, change specific locations in memory. After entering this mode from the Monitor, the computer prompts with a colon. The user then types the address to be examined. The computer outputs a SPACE plus the contents of the specified location. At this point the computer waits for the user to type either a CARRIAGE RETURN if no change is desired, or a minus sign if a change is wanted. In the latter case, the new data byte is entered following the minus. The new octal value is stored at the specified location, then re-examined and printed again as a check to be sure it has been changed. The system remains in the E mode until a BLANK is typed.
Example:
!E:010000 123-321-321
:010000 321 (Carriage Return)
:(Blank)
!

M (Message): This is simply an echo routine so that the keyboard/printer can be used as a typewriter. In this mode, a CARRIAGE RETURN produces an automatic LINE FEED. Return to the Monitor is accomplished by typing the BLANK key.
Example:
!M THIS IS A TEST. (Blank)
!

X (eXecute): This mode permits execution of programs already stored in memory. After entering the X mode, the computer will type a colon and await entry of the starting address of the program to be executed. To actually begin execution, a CARRIAGE RETURN must be typed. Any other character will cause a return to the Monitor.
Example:
!X:012000 (Carriage Return)
Program execution continues at 012000

Table 2.

BM/E uses octal notation to store and examine data in memory. Instructions and data are written as 3 digit octal numbers. Addresses are written in split octal with no separating mark between page and location. Although octal might appear strange at first, its resemblance to decimal will encourage your quick adjustment to it.

Basic Structure of BM/E

BM/E has two levels of operation: the Monitor (highest level) and the Editor (lowest level). Upon entering BM/E, an exclamation mark is printed to indicate the

000000	061	377	001	303	021	000	076	010
000010	315	215	001	076	002	315	215	001
000020	311	315	006	000	076	015	315	320
000030	001	076	037	315	215	001	315	304
000040	001	376	022	312	300	000	376	011
000050	312	341	000	376	035	312	015	001
000060	376	001	312	036	001	376	034	312
000070	110	001	000	000	000	000	000	000
000100	000	076	031	315	215	001	303	021
000110	000	305	345	315	304	001	041	146
000120	000	006	012	276	312	141	000	043
000130	005	302	123	000	076	377	341	301
000140	311	005	170	341	301	311	030	006
000150	007	025	020	012	001	023	027	026
000160	365	346	007	057	074	306	157	345
000170	157	046	000	176	341	315	215	001
000200	361	311	305	016	003	227	027	027
000210	027	107	315	111	000	376	010	332
000220	232	000	076	031	315	215	001	303
000230	212	000	200	015	302	206	000	301
000240	311	247	305	006	003	027	027	027
000250	315	160	000	005	302	245	000	301
000260	311	076	016	315	320	001	315	125
000270	001	076	004	315	215	001	311	000
000300	315	261	000	315	006	000	315	136
000310	001	076	004	315	215	001	315	215
000320	001	315	202	000	167	043	175	346
000330	007	312	303	000	076	004	303	316
000340	000	315	261	000	315	202	000	107
000350	315	006	000	315	136	001	076	004
000360	315	215	001	315	215	001	176	315
000370	241	000	043	175	346	007	312	006
001000	001	076	004	303	363	000	005	302
001010	350	000	303	000	000	315	261	000
001020	315	304	001	376	010	302	000	000
001030	315	013	000	351	000	000	315	261
001040	000	176	315	241	000	315	304	001
001050	376	003	312	063	001	315	006	000
001060	303	036	001	315	202	000	167	076
001070	003	315	215	001	176	315	241	000
001100	303	055	001	000	000	315	215	001
001110	315	304	001	376	010	302	110	001
001120	076	002	303	105	001	315	202	000
001130	147	315	202	000	157	311	174	315
001140	241	000	175	315	241	000	311	305
001150	325	001	000	005	333	376	037	332
001160	154	001	026	030	315	271	001	333
001170	376	037	171	037	117	026	020	315
001200	271	001	005	302	167	001	171	017
001210	017	017	321	301	311	305	325	365
001220	006	005	007	117	227	323	376	026
001230	020	315	271	001	171	017	117	346
001240	001	323	376	026	020	315	271	001
001250	005	302	234	001	076	001	323	376
001260	026	020	315	271	001	361	321	301
001270	311	076	214	075	302	273	001	025
001300	302	271	001	311	315	147	001	315
001310	215	001	376	000	312	000	000	311
001320	365	076	033	315	215	001	303	337
001330	001	365	076	037	315	215	001	361
001340	315	215	001	311	056	042	000	000
001350	000	000	157	146	040	164	150	145
001360	040	042	000	000	000	000	000	000
001370	000	000	000	000	000	000	000	000

Table 3.

Routine	Function	Calling Address
CRLF	Outputs a Carriage Return followed by a Line Feed	000006
BDBIN	Inputs a Baudot number from the keyboard and converts it to binary in register A	000111
BINBD	Outputs binary value in A on the printer; the binary value must be 7 or less	000160
OCTIN	Inputs 3 octal digits from keyboard into A	000202
OCTOUT	Outputs the value of A as 3 octal digits	000241
ADRSIN	Inputs 6 octal digits from keyboard into registers H and L	001125
ADRSOUT	Outputs the value of H and L in split octal	001136
INPUT	Inputs the Baudot value from the keyboard into A	001147
OUTPUT	Outputs a Baudot value on the printer	001215

Table 4.

monitor level is in effect. From the Monitor, entry is made to one of the Editor levels by typing a one letter command. The Editor mode includes the commands shown in Table 1.

Some of the Editor modes have a specific job to perform and afterwards return automatically to the Monitor level. Other Editor modes are terminated by the user when he strikes the BLANK key on the teletype. To change modes, it is necessary to first return to the Monitor and then select the new Editor mode. A more complete description of each mode is shown in Table 2, including example output. Underlined portions of the output were entered by the user, while the remainder was produced by the computer. To simplify operation, the computer controls the printer case (LTRS and FGS).

Bringing Up BM/E for the First Time

Loading the 500 or so bytes of BM/E for the first time will require exercising the front panel switches and your patience. The switches will survive, but, as for your patience, that depends on how interested you are in BM/E. Loading it once by hand is enough, but without some form of nonvolatile mass storage you may be forced to load it each time the system is down. There are two directions to go here: cassette tape or punched paper tape. For the long term, the cassette is probably the best choice. It is much denser and faster. One problem so far has been the lack of agreement on just what type of cassette system to use. Various efforts have been instituted to bring about standardization, but as of this writing there are still obstacles to general acceptance of any one system. The so-called "Kansas City Standard" system appears well on the way, but it is not yet in general use. In our own system we have used a Suding cassette interface for nearly a year without a single bad load. We were attracted to the system because it was FSK and used the wide frequency shift standard of amateur radio (2125 Hz-2975 Hz). Information on a Suding interface can be obtained from The Digital Group, P.O. Box 6528, Denver CO 80206.

Baudot teletype users also have the option of bringing paper tape on-line as a mass storage medium. An article in an earlier issue of *73* described the use we have made of Baudot paper tape equipment. Although not as dense or fast as cassette tape, it is convenient to use, especially for short programs.

In addition, if you have your Baudot teletype on-line already, no additional interfacing is required to use paper tape equipment. It should also be pointed out that paper tape is already standardized, so interchange problems are minimized. Regardless of the system you use, a nonvolatile storage medium is a necessity in a hobbyist system.

Table 3 is an octal listing of BM/E in the Dump format of BM/E. The program is intended for an 8080-based system. As given, it utilizes the software I/O described in the previous article. If you are using a serial I/O board, your required I/O routines should be loaded at 001147 input and 001205 output. Neither routine should exceed 38 bytes.

When the program is loaded, simply examine 000000 and hit RUN. An exclamation point typed on the printer indicates BM/E is operative. You can load programs anywhere above 002000. You should exercise the various Editor modes to be sure all is well.

Table 4 gives the address of various routines in BM/E that can be called by your external programs. For instance, suppose you want to output the A register in octal format. Simply place a CALL to 000241 at the appropriate place in your program.

The authors will supply a source listing of BM/E along with a Suding cassette, "Kansas City Standard" cassette, or punched paper tape (5 level binary format) for $7.50 postpaid. In your order please specify which type cassette or paper tape. Orders should be addressed to: BM/E Tape, Rt. 4, Box 52A, Tyler TX 75701.

With hard copy on your Baudot teletype and BM/E as an operating system, you should be able to greatly expand your software capabilities. ■

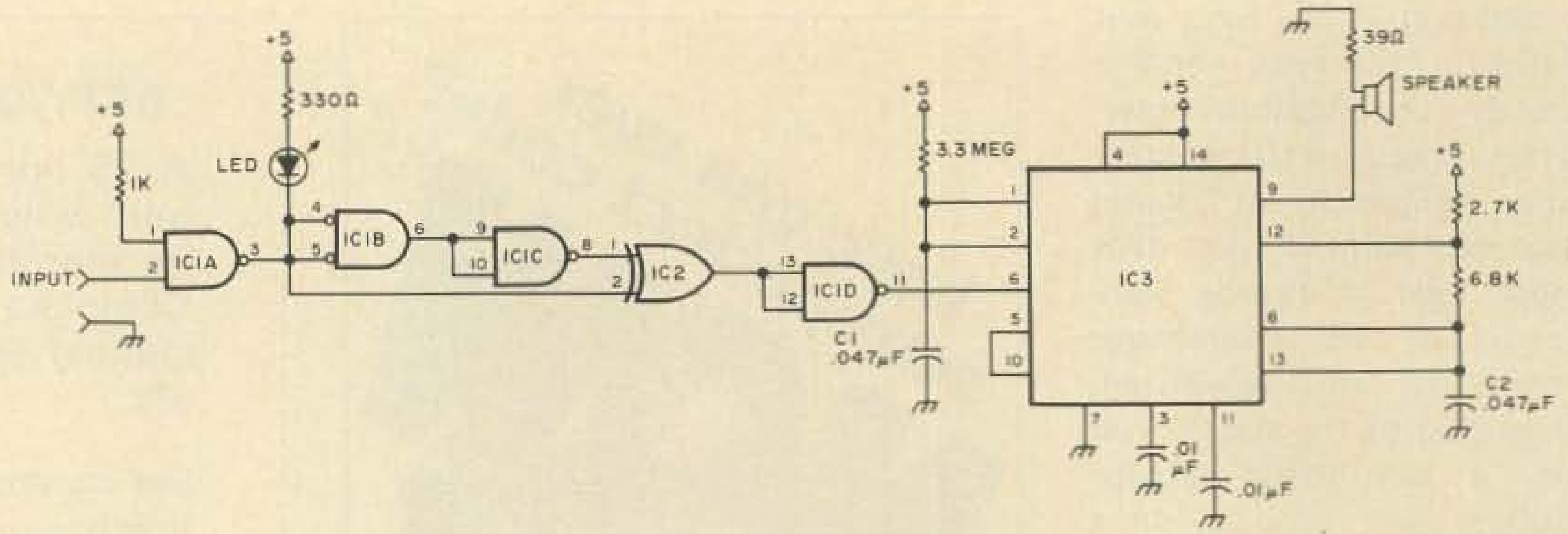

Fig. 1. IC1: SN74132N. IC2: SN7486N. IC3: NE556. All resistors are ¼ Watt, except for the one which is ½ Watt, 39 Ohms. Power supply current is approximately 70 mA.

Ted Lincoln WA6HWJ
410 Bell Ave.
Santa Ana CA 92707

A Logic Probe You Can Hear

--good not only for the blind

The most serious shortcoming of conventional logic probes is the need to watch for signs of a change. It's not always convenient to be watching the probe during a test.

This unit gives an LED indication of the static state of the line under test. When the LED is lit, the line is logic state "1." Any logic transition which lasts at least 50 nanoseconds is detected, and an audio beep is generated. Both a "1" to "0" and a "0" to "1" transition are detected.

Construction

My unit is built on a perforated epoxy board. Discrete components are mounted on a 16-pin header which plugs into an IC socket. Sockets are mounted by installing printed circuit board eyelets under pins 7 and 14. Each eyelet is peened in its hole by using opposing automatic center punches. The sockets are mounted, and pins 7 and 14 are soldered to the eyelets. The rest is a simple wirewrap job.

It is possible to run the device from batteries, although the current is a bit high (about 70 mA). Rather than use batteries or steal power from the circuit under test, I decided to include a small power supply. Everything is mounted in a small phenolic box of the type carried by Radio Shack.

Operation

There is no special procedure. Simply connect the input to the line to be monitored, and a ground between this device and the one under test. Once connected, an audible beep will be heard whenever the line pulses or changes state. The LED indicates the line's static state.

Theory

The input is squared by (Schmitt) IC1A, which is also the LED driver. IC1B and IC1C provide a delay before applying the signal to the exclusive OR gate, IC2. When the input changes state, the two signals applied to the exclusive OR gate will be different for a period equal to the delay through IC1B and IC1C. The gate will pulse low for this time. After inversion by IC1D, the positive pulse is applied to the first half of the NE556 (IC3). This half is wired as a one shot with a duration of approximately one half second. The output of this one shot is applied to the second half of IC3, which is wired as an audio oscillator. When the one shot is active, it turns on the oscillator, which in turn drives the speaker. Changing C1 will adjust the duration of the beep; C2 determines the output tone.

Troubleshooting

During initial wiring, leave out the jumper between pin 5 of IC3 and pin 10 of IC3. Check the power supply to be sure it is +5 V. Plug in IC3. The oscillator should be heard running. This is a good time to vary C2 if you would prefer a different tone. After the tone is working properly, connect the jumper between pin 5 and pin 10 of IC3. Plug in IC1 – but not IC2. Touch pin 12 of IC1 momentarily to ground. The oscillator should beep for approximately one half second. C1 can be adjusted to vary the beep duration.

The LED should be lit. Touching pin 2 of IC1 to ground should make the LED go out. Insert IC2 and test the complete unit. Short the input (pin 2) of IC1 to ground. The LED should go out and the oscillator should beep. Remove the short and another beep will occur.

If you want to test its ability to capture a pulse, I suggest wiring a one shot (such as an SN74121) as a switch deglitcher. This device will capture the pulse every time the switch is pushed. ■

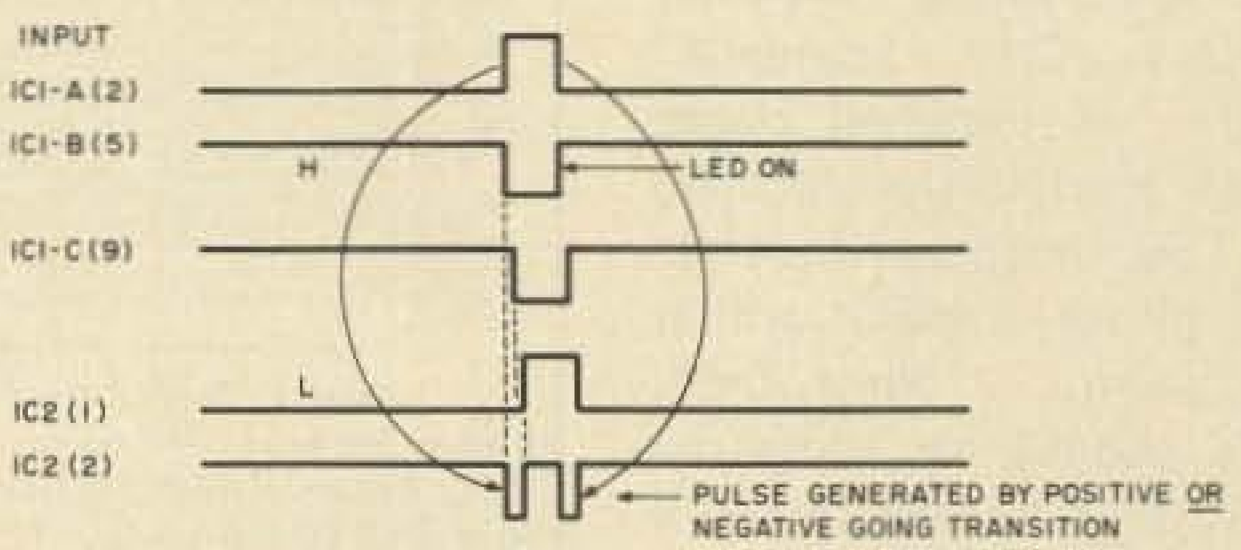

Fig. 2. Timing diagram.

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How Computer Arithmetic Works

-- do-it-yourself experiments

The easiest and most inexpensive way to get started in computers is to begin with inexpensive, easy to use, fundamental building blocks. These fundamental blocks can be used initially for educational purposes to promote understanding and confidence, and later combined to form a fundamental computer.

The arithmetic logical unit (ALU) is a fundamental part of a typical computer system. The ALU is inexpensive, is easy to use, and may be operated independently or in conjunction with other devices. This article uses the ALU as a stand alone device in order to demonstrate computer operations such as addition, subtraction, and complement. All necessary details and related information are given so that the experimenter can learn fundamental computer arithmetic.

The dollar outlay required to procure the parts and equipment needed to perform the experiments given in this article should be less than $12, not counting a breadboard or PC board.

The Parts and Equipment Required

The parts and equipment needed to perform the experiments in this article are as follows:

1 – 5 V power supply
1 – 74181 integrated circuit
1 – breadboard, perforated board, or homemade PC board
1 – voltmeter or 4 LEDs

A 5 V power supply may be purchased in kit form from James Electronics for $9.95, or a wired and test supply may be purchas from Micro Digital Corp., f $24.50. A 5 V power supp may be built in breadboa fashion, for about $6.00, using the circuit described Fig. 1.

The 74181 ALU is av able from many sources, su as Poly Paks, James El tronics, International El tronics Unlimited, and othe for less than $4.00. See ads in this issue for curr prices. An illustration of pin connections and c

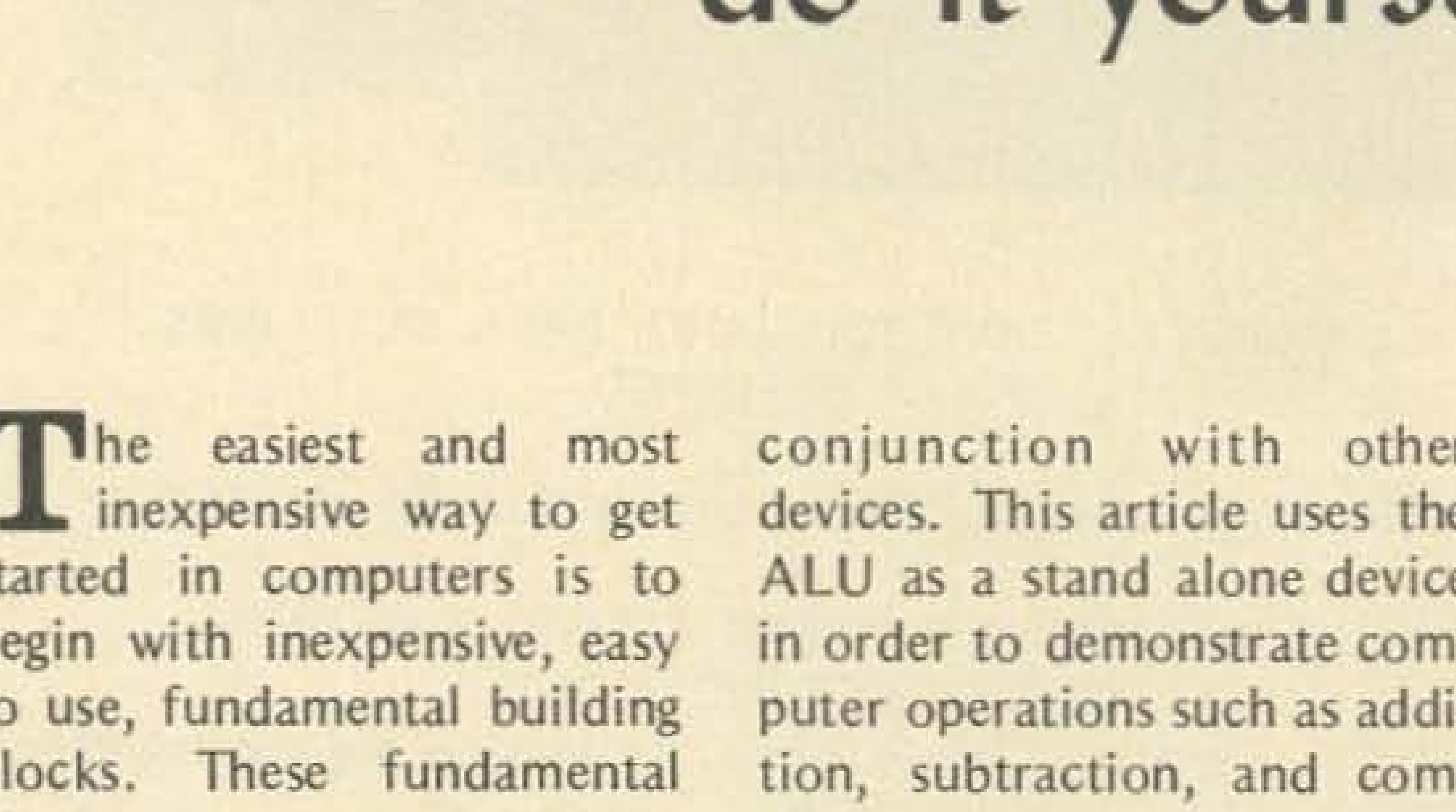


Fig. 1. Simple power supply. T1: 12 V, 1 A (Poly Paks 92CU2474, $2.95). Diode bridge: 2 A, 50 V epoxy (Poly Paks 92CU1346, $.69). C1: 3500 uF (minimum), 25 V dc (S. D. Sales, $.79). C2: 100 mF, 15 V dc (James Electronics, $.24). LM309K: 5 V regulator (Poly Paks, $1.50). Total power supply parts cost: $6.17.

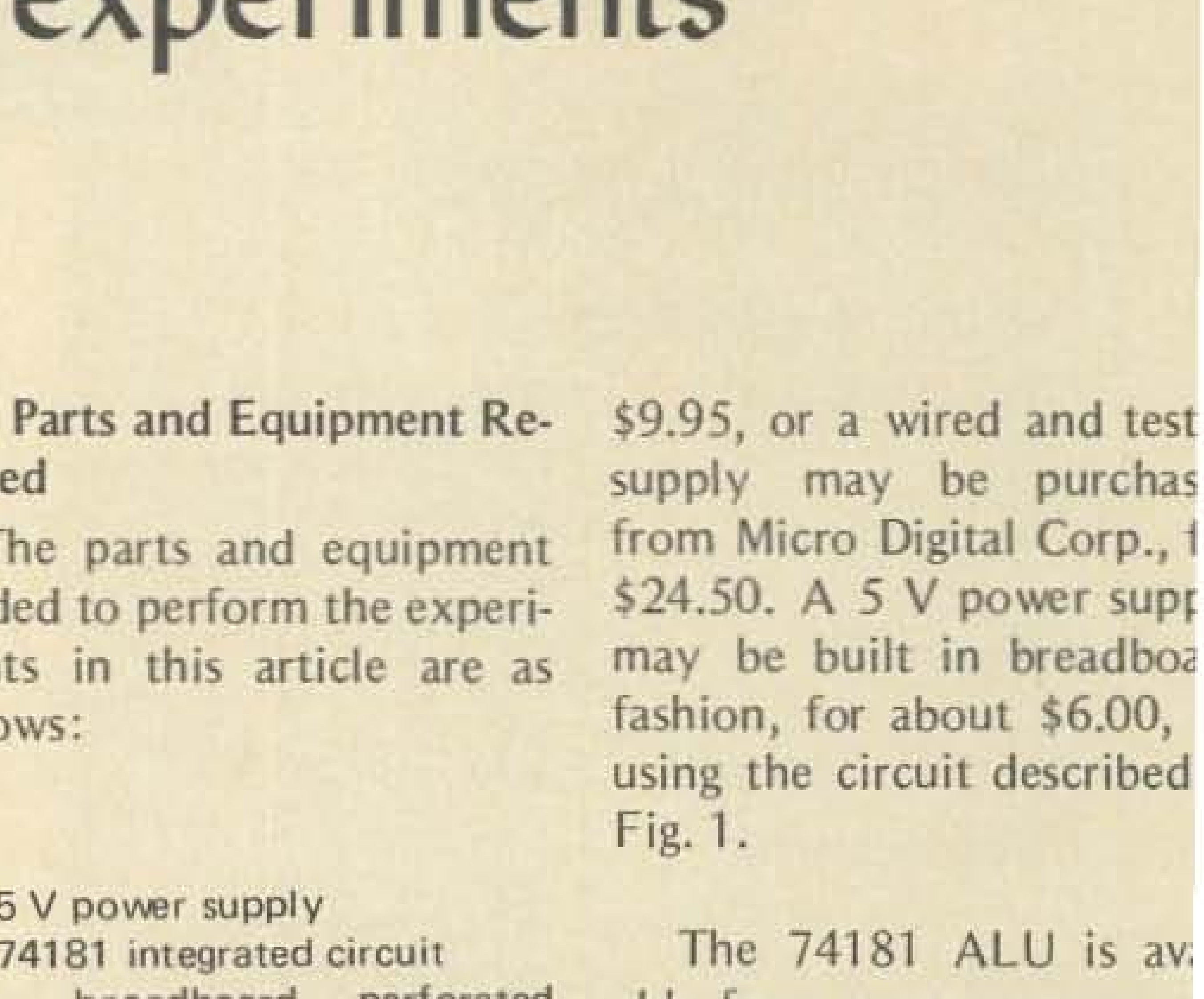


*Fig. 2. 74181 pin connections, top view (*The TTL Data B for Design Engineers, *Texas Instruments, Inc., 1973, p. 3*

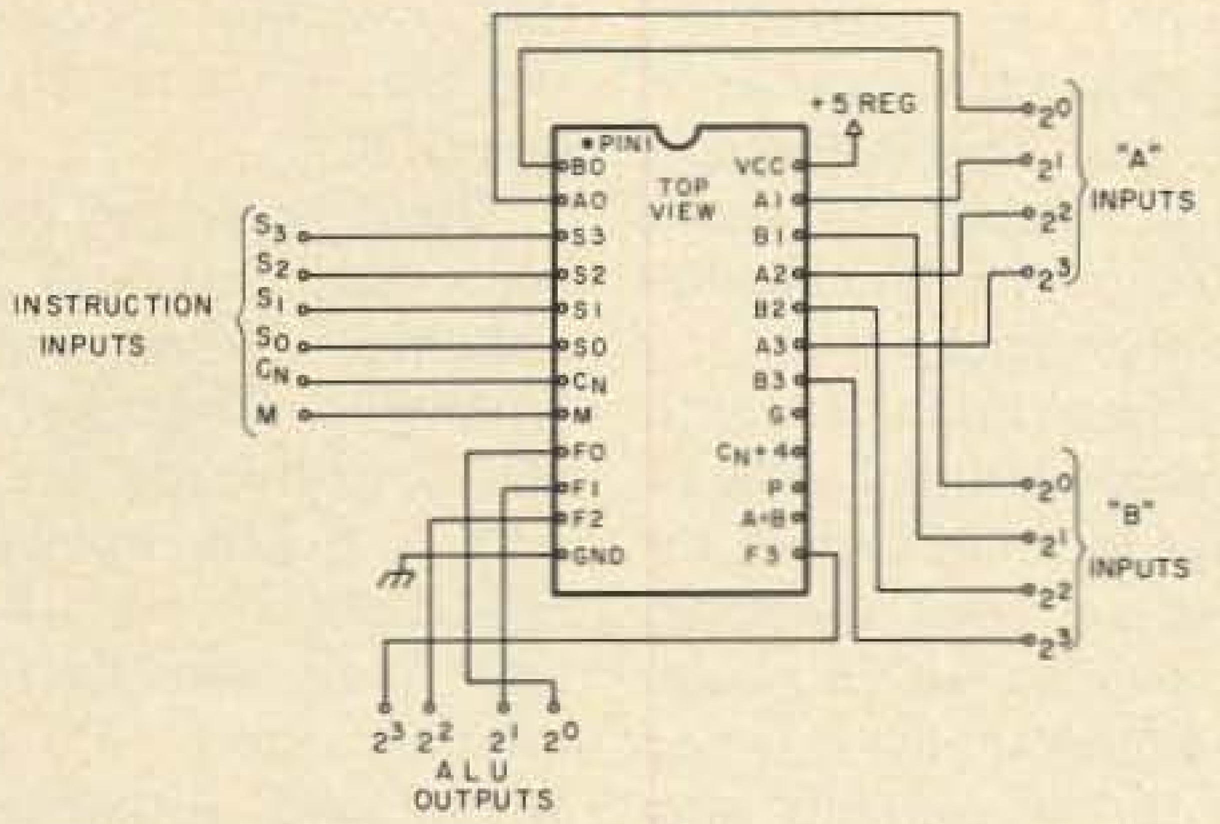


Fig. 3. Basic experimental setup. Bring instruction inputs out to left as shown. Bring function outputs either out to bottom or out to left, in order shown. Connect +5 V regulated power supply to pins as shown. Bring inputs out to right as shown.

layout is shown in Fig. 2.

The user may etch his own PC board or may use perforated board if he wishes; however, a universal breadboard such as a Continental Specialties QT-59S ($12.50) or AP Products 923261 Terminal Strip ($12.50) will make things a lot easier. With the universal breadboard, no soldering is required, as all connections are made with #22 AWG solid hookup wire. The breadboard is recommended to facilitate circuit changes and additions to the experiments.

Some type of indicator is needed to display the outputs of the ALU. A 20,000 Ohms/volt voltmeter (which will read 0-5 volts), a dc oscilloscope, or a series of light emitting diodes may be used. The circuit in Fig. 4 shows 4 LEDs connected to the ALU to indicate HIGH (1 bit) and LOW (0 bit). The LEDs used are type MV-55, available from Poly Paks (5 for $1.00, part number 92CU1790).

The Experimental Setup

The basic experimental setup is shown in Figs. 4 and 5. The instruction lines are brought out to the left, the data inputs are brought out to the right, and the outputs are brought out to the bottom, or lower left. The input, output, and instruction connections may be made to terminal strips, vacant connections on the breadboard, or to other suitable terminations. Pin 24 is connected to plus 5 V from the power supply, and pin 12 is connected to the power supply ground.

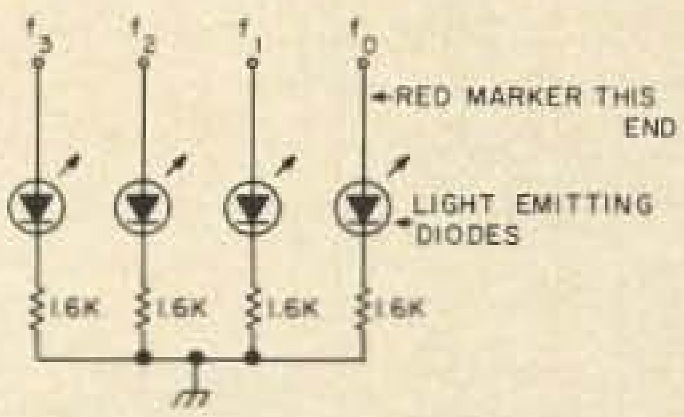


Fig. 4. LED readouts. LEDs are Poly Paks 92CU1790 low current LED MV-55.

The outputs from the 74181 will either be HIGH (H) or LOW (L) voltage levels. A HIGH will be 2.4 volts minimum, but not greater than 5 V. A LOW will be .4 V or less. A 20,000 Ω/V voltmeter may be used to read the output levels, or LEDs may be connected as shown in Fig. 4. If the LEDs are used, a lighted LED will be a HIGH and a non-lighted LED will be a LOW. In these experiments, a "0 bit" is represented by a LOW while a "1 bit" is represented by a HIGH.

Ground Rules and General Notes

1. The 74181 will operate over a range of 4.75 V to 5.25 V. Operating with voltages outside this range may produce results which are not defined. Operating with a voltage greater than 7 V (the absolute maximum rating) may damage the chip.

2. Don't short the outputs to ground. If more than one output in a HIGH state is shorted at one time, the chip may be damaged.

3. A previous article, "Two Finger Arithmetic,"[1] should be read thoroughly and kept handy as a reference when performing the experiments described.

EXPERIMENTS

Data Transfers

Connect the ALU as shown in Fig. 6. Note that 6 connections form the "instruction word" and are used to select the function of the ALU chip. As connected, this "instruction" will permit data to pass directly from the "A input" to the "output" without changing. The data appearing at the A input is a 0110 and is transferred directly to the output, without change, as a 0110.

The data transfer is a useful instruction within a computer, as it permits data to be transferred from one memory location to another memory location without being changed. Thus, data may be duplicated or placed in a more convenient memory location.

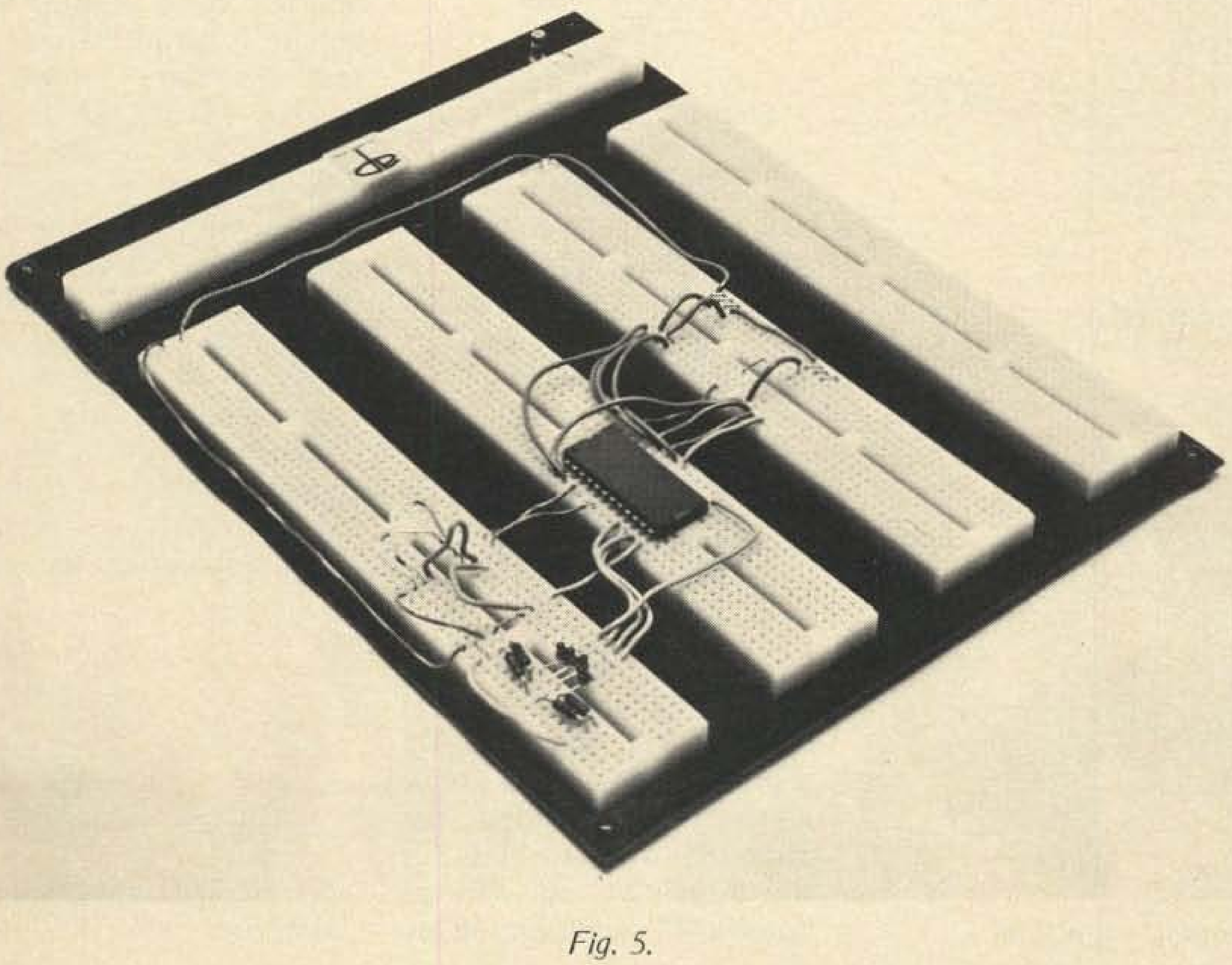


Fig. 5.

Clear or Set to Zero

Fig. 7 shows the instruc-

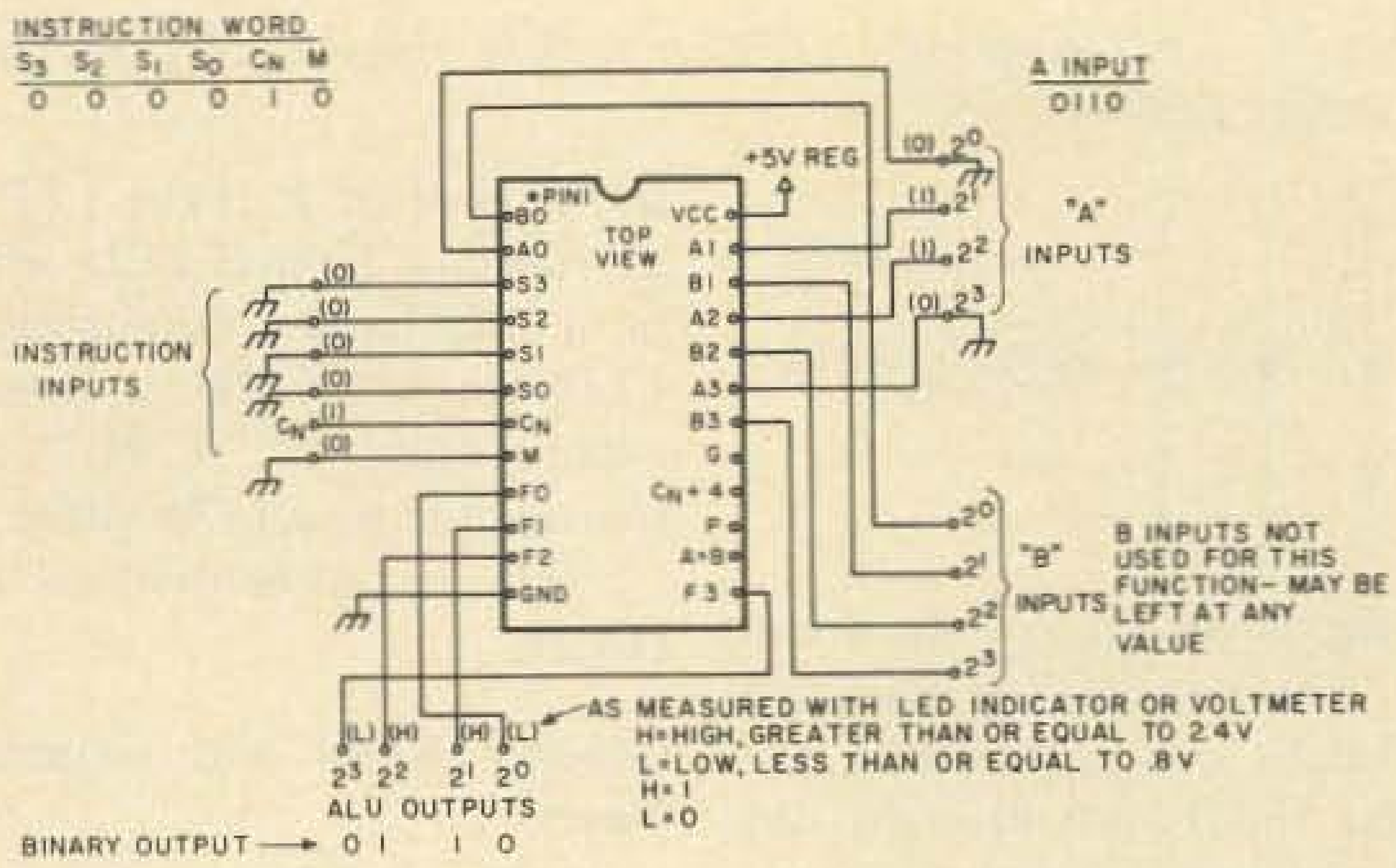


Fig. 6. Data transfer. Output = input from A.

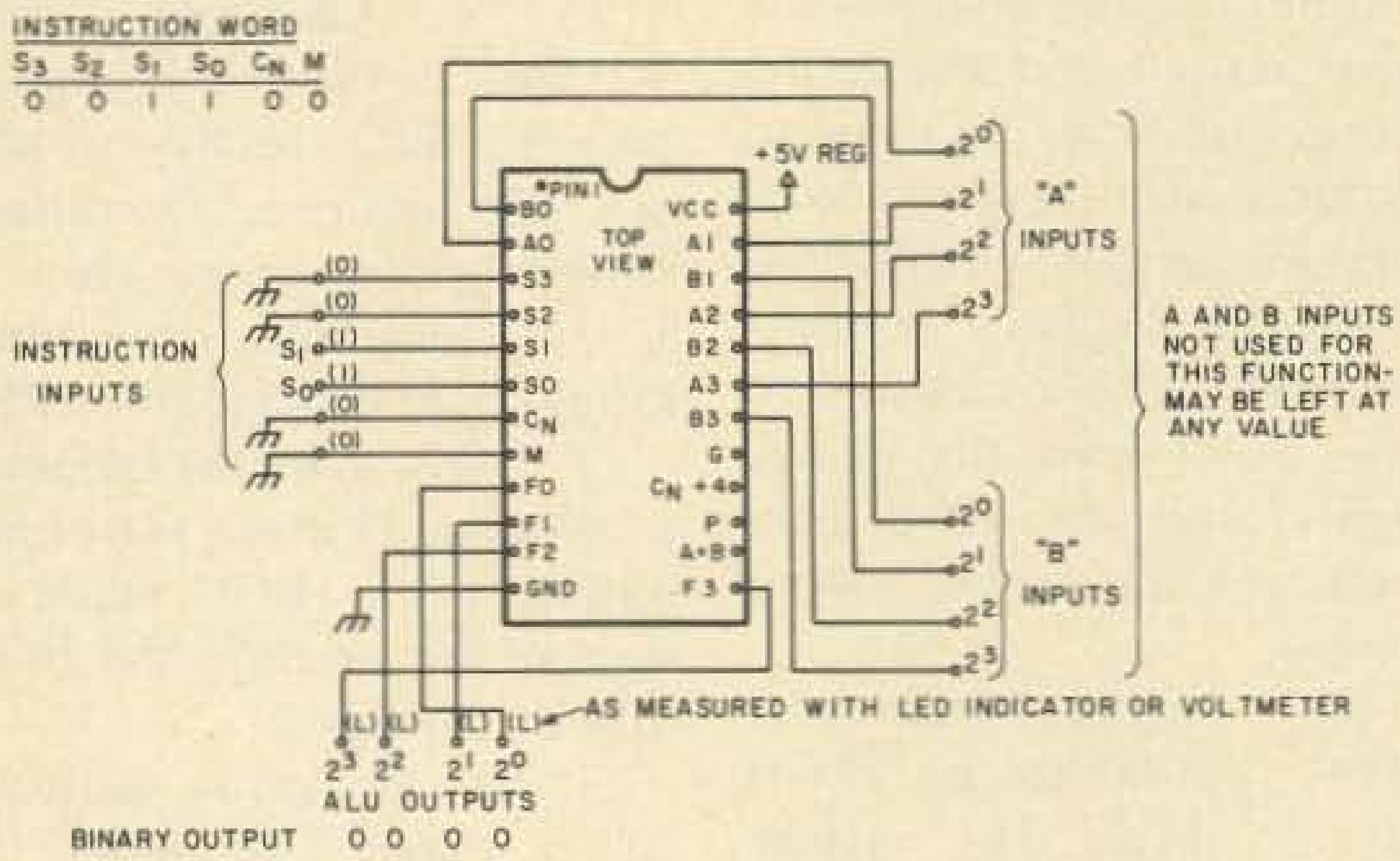


Fig. 7. Clear or set output to zero.

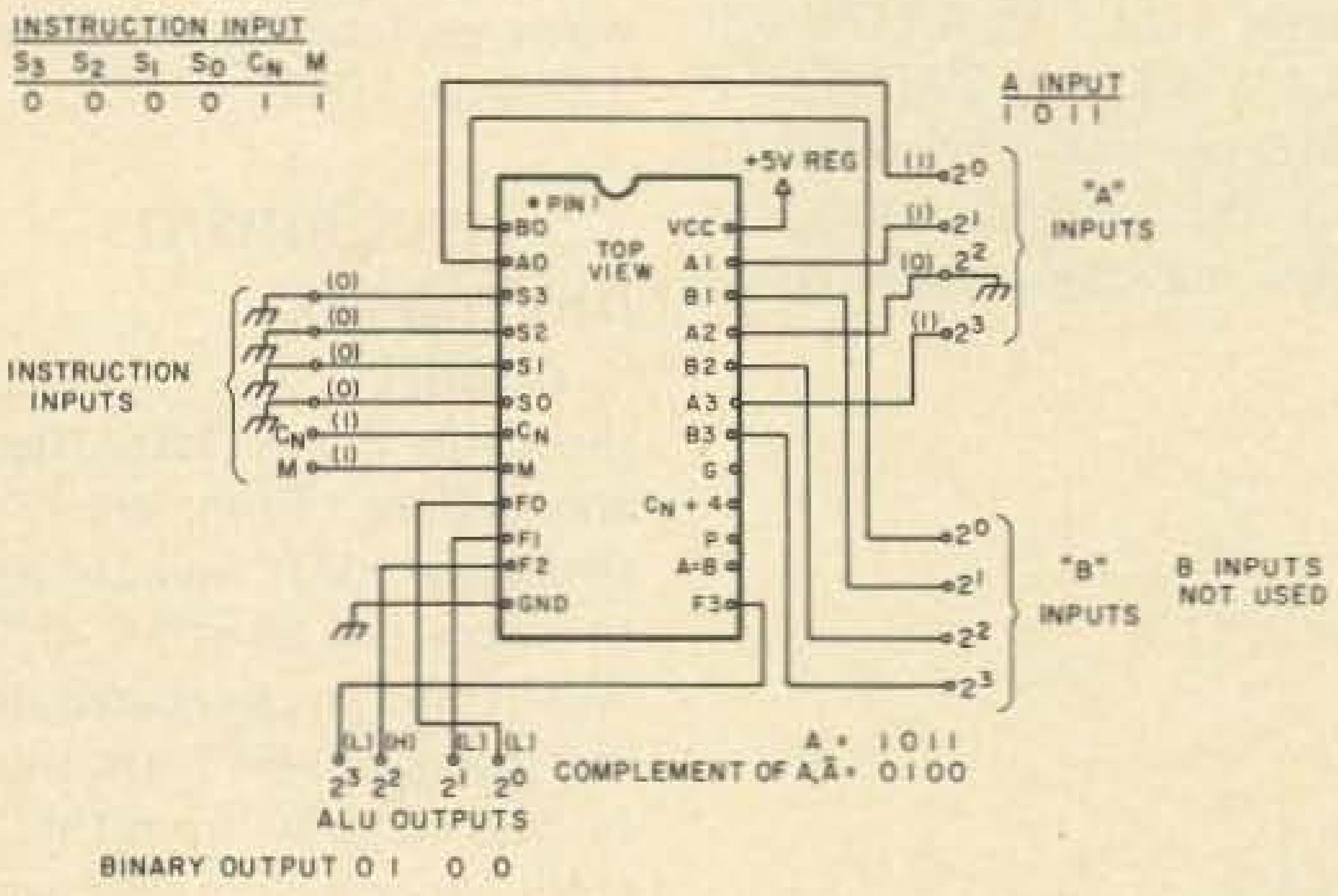


Fig. 8. Ones complement of A.

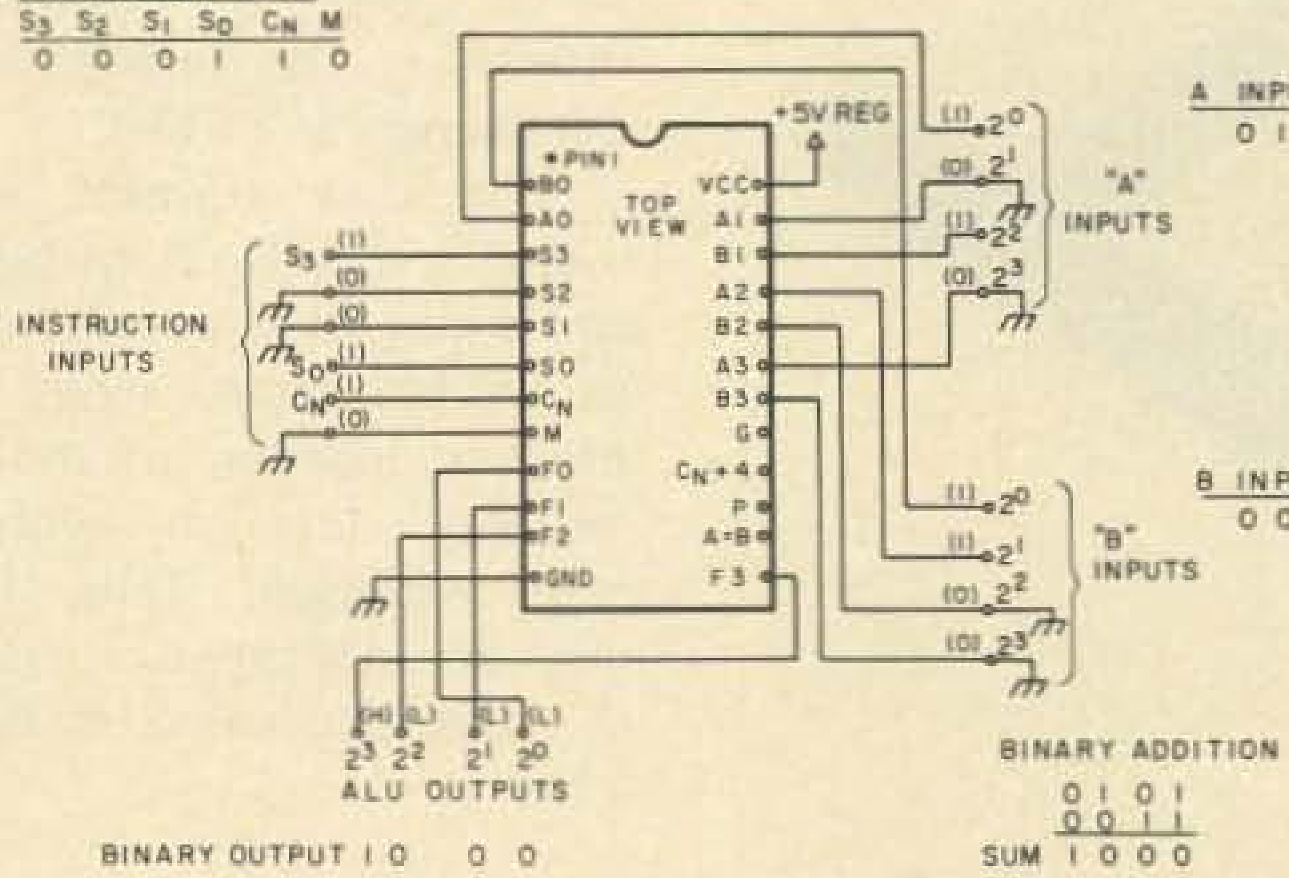


Fig. 9. Binary addition. Output = A plus B.

tion word (or instruction inputs) required for a clear or set to zero. This instruction sets the output to zero, regardless of the data appearing at either input.

This instruction is useful for setting the initial value of a storage location to zero for counting or other purposes. When counting within a computer, a programmer may add "one" to the contents of a memory location every time a given event occurs. To insure a correct count, the contents are set to zero or "initialized to zero" before the count starts.

Complement

The complement of a number can be obtained by using the instruction word as shown in Fig. 8. The data input is 1011 and the output is 0100, which is the complement of the input.

Addition

Addition is performed by using the experimental setup as shown in Fig. 9. The output will be the sum of the data on the A and B inputs. Thus, as shown,

$$\begin{array}{rl} 0101 & (5_{10}) \\ +\,0011 & (3_{10}) \\ \hline 1000 & (8_{10}) \end{array}$$

Similarly,

$$\begin{array}{rl} 0011 & (3_{10}) \\ +\,1010 & (10_{10}) \\ \hline 1101. & (13_{10}) \end{array}$$

But now add A and B as follows:

$$\begin{array}{rl} A = 0111 & (7_{10}) \\ B = 1011 & (11_{10}) \\ \hline 1\ 0010 & (18_{10}) \end{array}$$

carry bit

The ALU has only 4 data outputs; thus, the results will appear as 0010. This simple arithmetic operation has exceeded the capability of the ALU. We call this an "overflow" condition and say that "overflow" has occurred and that a "carry" has been generated.

Overflow is the phenomenon that separates binary arithmetic from computer arithmetic. When performing binary arithmetic on paper with a pencil, number size limitations are of little concern (you can always add another sheet of paper). When doing arithmetic with computer elements, number size is a serious concern since there is a hardware limit to the size of the "arithmetic word." In these experiments, the "arithmetic word" size is 4 bits. If we connected two ALUs together, we would have an 8 bit "arithmetic word." With an 8 bit arithmetic word, overflow would not occur and a carry bit would not be generated until a sum exceeding 8 bits was generated.

If overflow were to occur without the user being aware of its occurrence, erroneous results could occur. For this reason, it is important to have the capability to detect the occurrence of overflow. Overflow can be detected on the 74181 chip by monitoring the output of pin 16, the inverted carry output. This output is normally used to feed a "carry" input on another 74181, but it may also be used to detect the occurrence of a carry bit (overflow). This output is inverted, so it would normally read HIGH with no carry and LOW if a carry occurred. An LED may be connected to the carry output as shown in Fig. 10, so that the LED will light if a carry or overflow is present.

By connecting the addi-

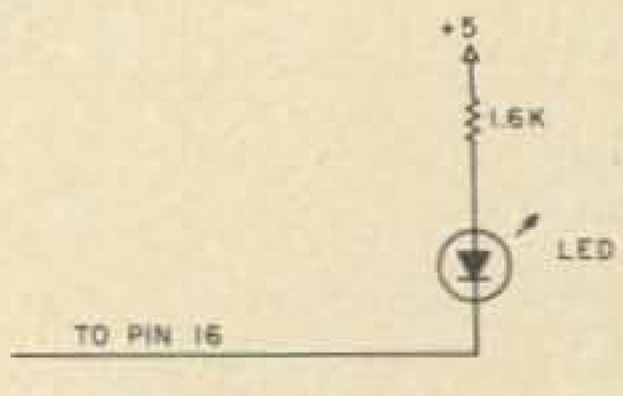
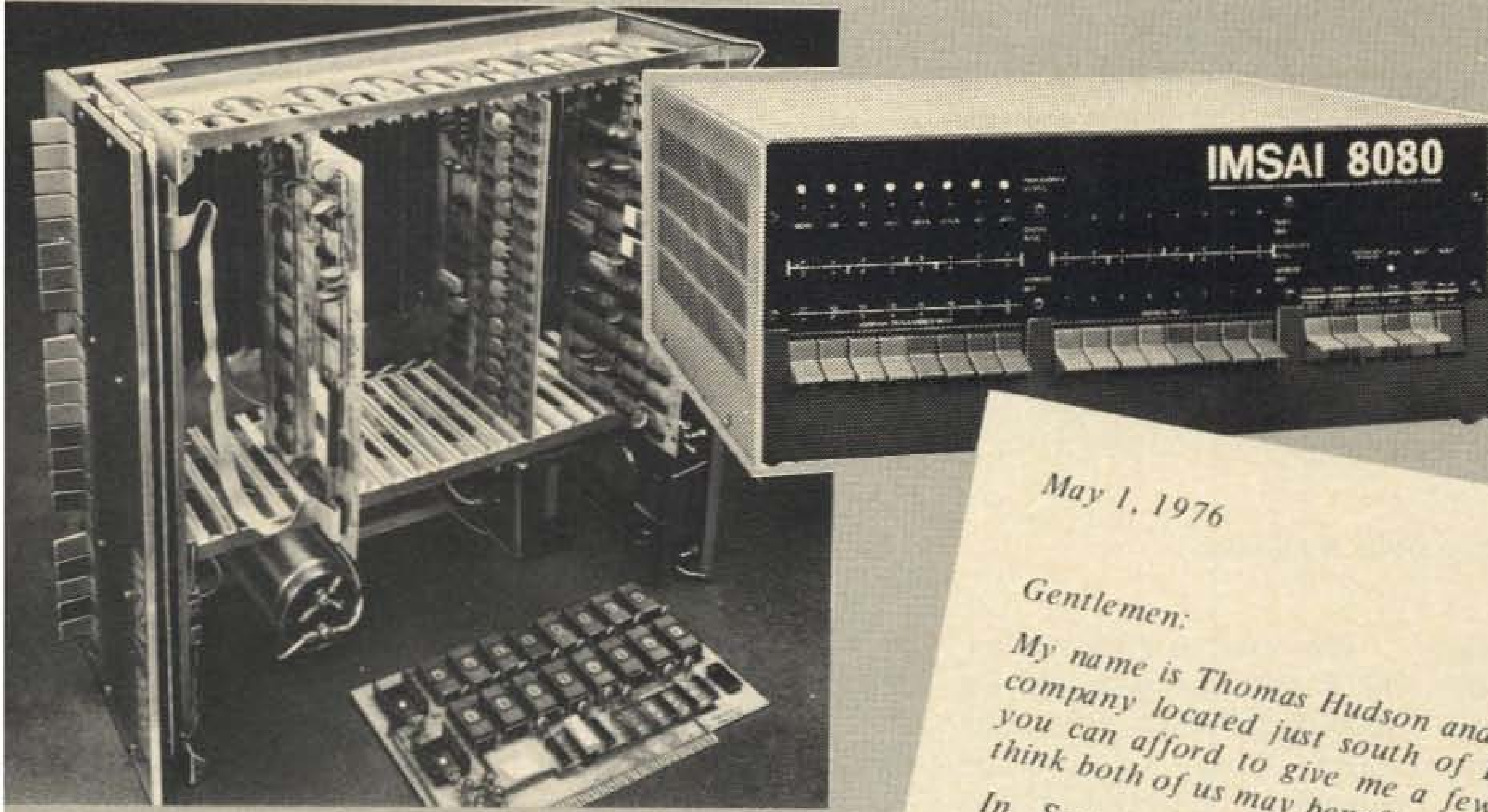


Fig. 10. LED connected to carry out.



IMSAI 8080 Kit, $540.00
IMSAI 8080 Assembled, $829.00
IMSAI 4K Low Power Memory Board, $125.00

May 1, 1976

Gentlemen:

My name is Thomas Hudson and I am President of a small company located just south of Los Angeles, California. If you can afford to give me a few minutes of your time, I think both of us may benefit.

In September of 1975 I decided to attempt to sell microprocessor-based computing systems to the commercial market. I visited every microprocessor-based kit manufacturer in the United States, and questioned numerous people in the industry. For many reasons, all of which hold true today, I decided on the Intel 8080 family of microprocessors as the best hardware choice. In November of 1975 we decided on a product offered by a company in San Leandro, California, IMS ASSOCIATES INC. Before Christmas we had 3 IMSAI 8080 kits on the way, and they have operated flawlessly ever since we turned on the power. We still use these original kits as development tools and for some really neat games. The IMSAI 8080 microprocessor kit is of the highest quality available. Company management is excellent, the engineers are first-class, deliveries are almost on time (within days, not months), and the ability to run DEC derived BASIC and FOCAL is a powerful not to be overlooked advantage. Once over the usual arguments for and against various chips, assuming you decide (wisely) on the 8080, the obvious best choice is IMSAI. I feel from experience that you cannot buy a better microprocessor-based kit.

OTHER PRODUCTS OF EXCEPTIONAL MERIT

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6 PORTS of parallel which can be any combination of in and out (software control)
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2 PORTS serial interface, or 20 mil current loop and one RS 232 or both PORTS either type.
Board select 110 to 9600 baud.
Kit price $219.95/each
DECWRITER LA 36 II 30 CPS printer brand new in box from factory, air shipped to your door $1776.00

MMI Model 40P

5 x 7 dot matrix impact type

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Double size print under software control — 1.25 lines per second.
Assembled price $599.00/each
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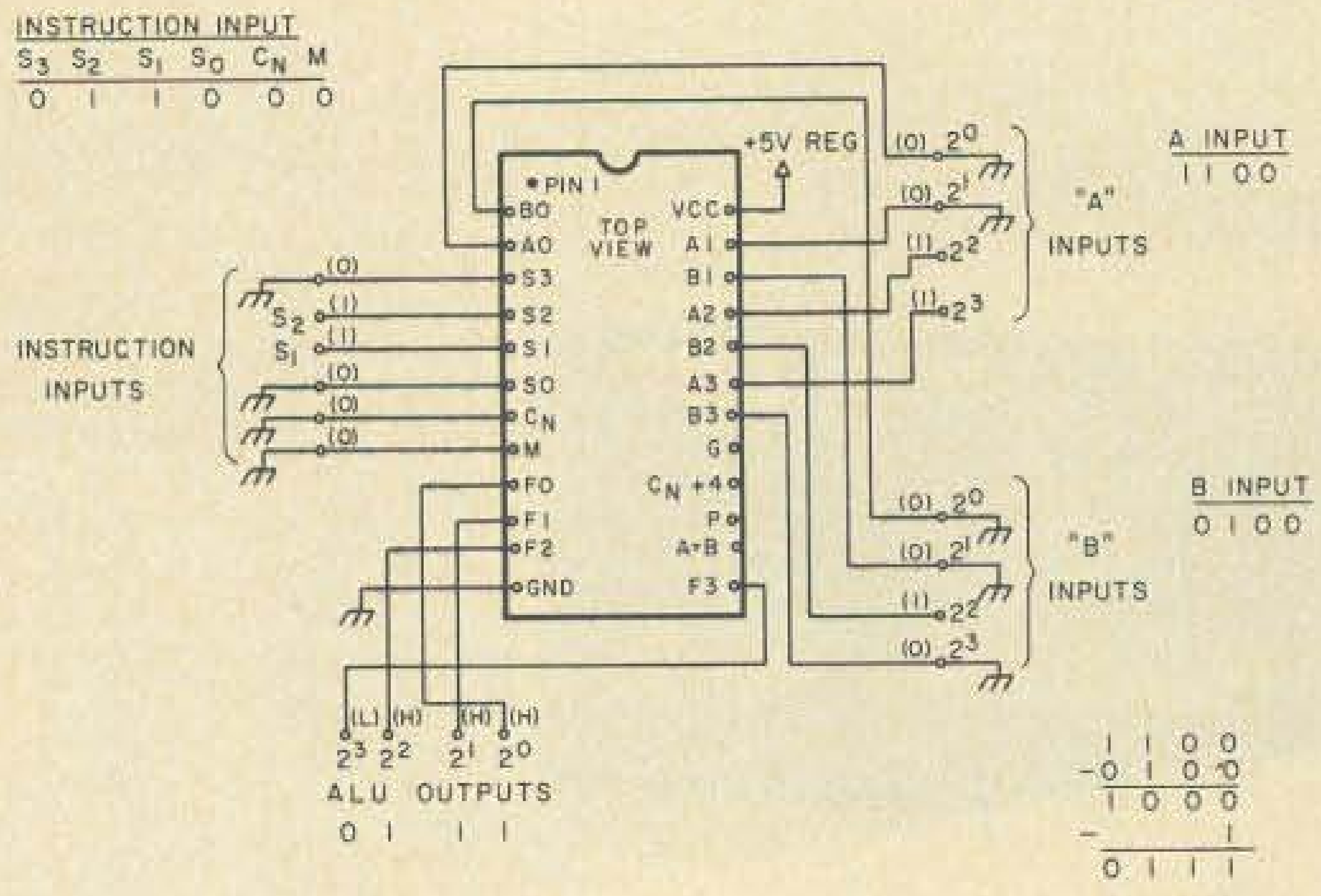

Fig. 11. Subtraction: A minus B.

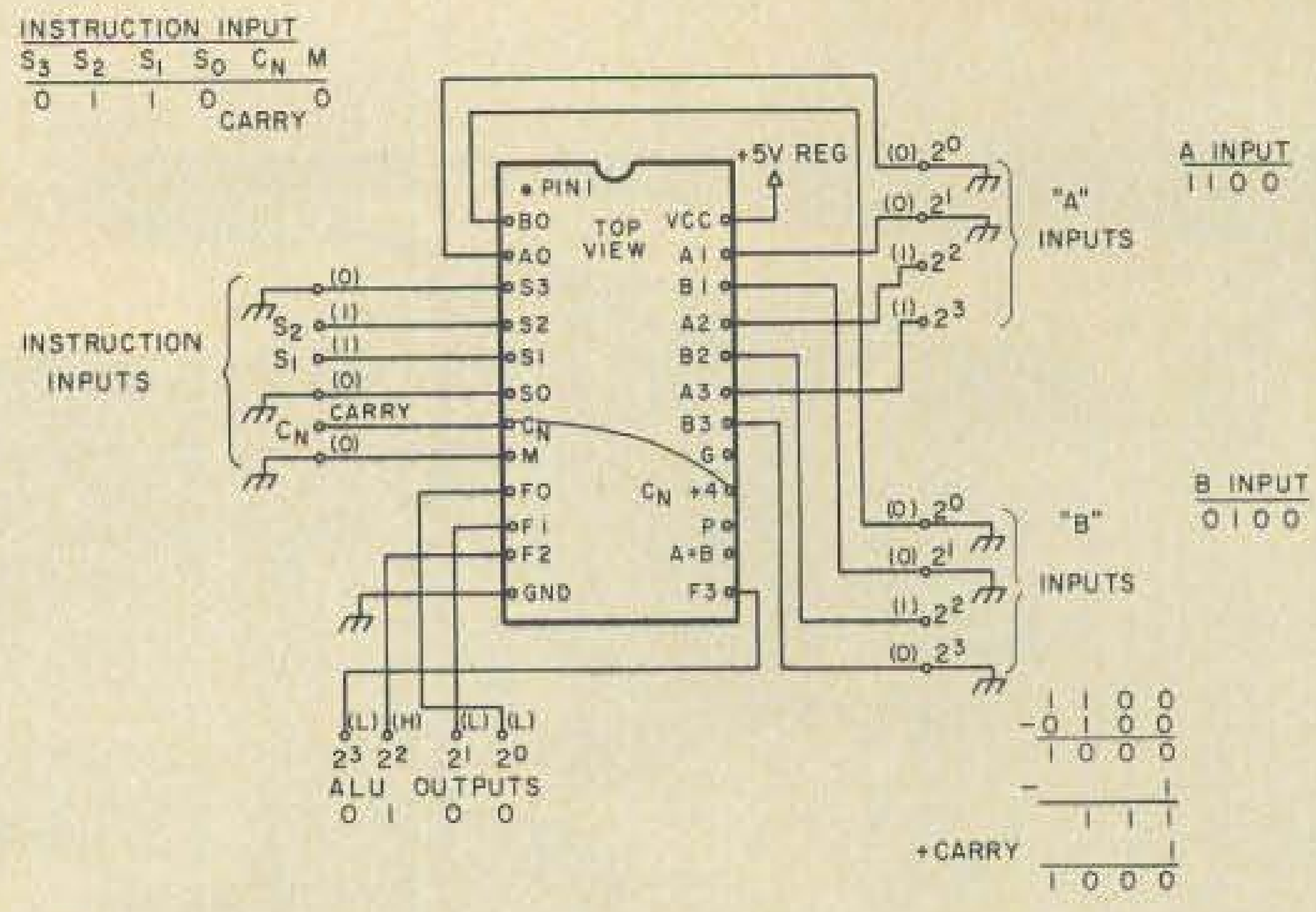

Fig. 12. Subtraction: A minus B, plus carry.

tional LED as shown in Fig. 10, we have gained an additional bit for arithmetic. We have a 4 bit arithmetic word, but we are able to display a five bit result.

For example:

```
  1 1 1 1   (A input)
+ 1 1 1 1   (B input)
1 1 1 1 0
↑
(the fifth bit, the LED for
carry, will be lit)
```

Subtraction

Subtraction using twos complement arithmetic is done by using the instruction shown in Fig. 11. This experiment shows an example of A-B. The 74181 performs the following functions in order to effect a subtraction:

1. The twos complement of the B input is obtained by complementing the value and adding 1. The addition of the "1" is a result of making the *inverted* carry in (C_N) a LOW.

2. The twos complement of the B input is added to the A input. For example, let us subtract 4_{10} from 12_{10}. The answer, of course, should be 8_{10}.

```
A = 12₁₀ = 1100 ──────────────► 1100
B =  4₁₀ = 0100 ── 2s comp. ──► +1100
                               1 1000 = 8₁₀
```

The result as displayed on the 4 output bits would be 1000 8_{10}. A=12, B=4, and A-B=8. Carry would occur and the carry LED would be lit, but in this case discarded, because it has no significance.

Do the following problem: 3 - 4 = ? Let A = 3, B = 4. What are the results?

```
                     internal operation
A = 3 = 0011 ──────────────► 0011
B = 4 = 0100 ── 2s comp. ──► +1100
                             1111 = negative 1
```

The result is negative 1 (or minus 1), which is the correct answer for 3 - 4.

It may appear that there is no way of knowing whether a result is negative or positive; however, this is not the case.

Consider the number 1 in binary. On paper, we may write the number one as 1, as 01, or even 0000001 if we wish. To get a negative one, we take the twos complement, which in the case of 0000001 is 1111111. This representation of a negative number is not completely correct, since the "1" really has an infinite number of zeros in front of it. To be correct, 0000001 is really "(infinite number of zeros) 0000001," and the complement is "(infinite number of ones) 1111111."

It can be shown that, in a negative number, the leftmost bit at infinity is a 1 bit. Of course in the real world we can't go on writing down an infinite number of 1 bits to get to the leftmost bit, but we can define the leftmost bit in our arithmetic word as the "sign bit." Using this definition, the leftmost bit of our four bit arithmetic word is now the sign bit, and in our example the number 1111 becomes a negative number.

Note that, by adopting the leftmost bit in our four bit arithmetic word, our arithmetic is now restricted to 3 bits. The largest positive number that we can generate is 0111=7_{10}. The largest negative number that we can generate is 1000=8_{10}.

Multiply by 2

The instruction shown in Fig. 13 is designated an "A plus A" instruction, and has the effect of multiplying A by 2. This instruction may also be called a "shift left by 1 bit" instruction, since it shifts the number A to the left by one bit.

This instruction is useful for generating the squares of numbers and may be used as a part of a program to perform multiplication.

Conclusion

ALUs, such as the 74181 described in this article, are practical building blocks for the computer designer and do exist as important parts of computers available on the market today. These ALUs may stand alone as independent units, or they may be combined with other functions to form a device such as a microprocessor. Thus, the concepts described are applicable to large scale computers, independent ALUs and microprocessors. ■

Reference

[1] G. R. Allen, "Two Finger Arithmetic," *73 Magazine*, June, 1976, p. 84.

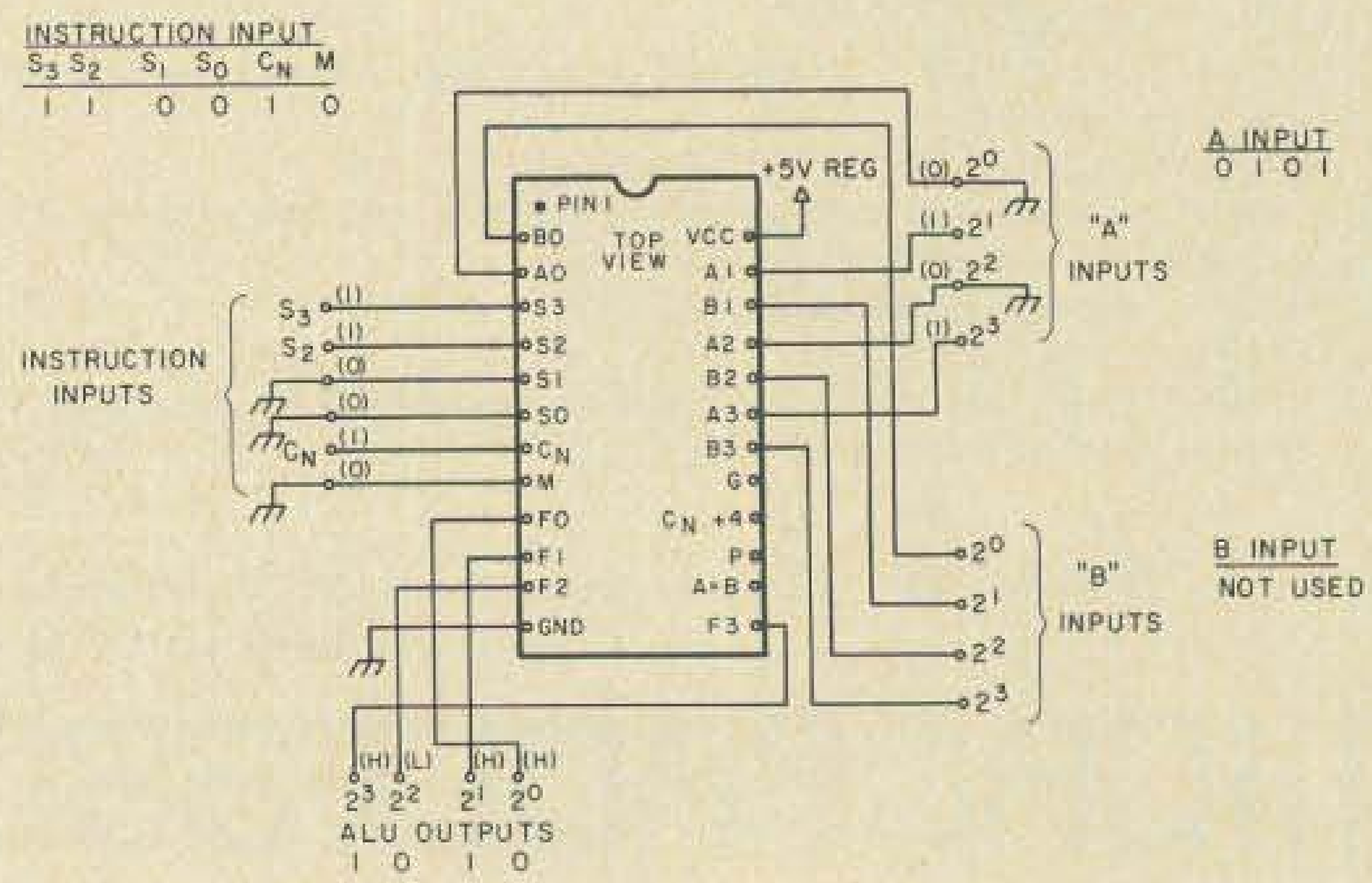

Fig. 13. Multiply by 2: A plus A (shift one bit left).

Satellite Orbit Predicting

--using a pocket calculator

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Reading MA 01867

How would you like to be able to press one button and get complete satellite orbit information without referring to various tables and graphs? Now that the new programmable pocket calculators are here, it is entirely feasible to do just that after a simple program entry which will give you all the information on your favorite satellite for the next month or so.

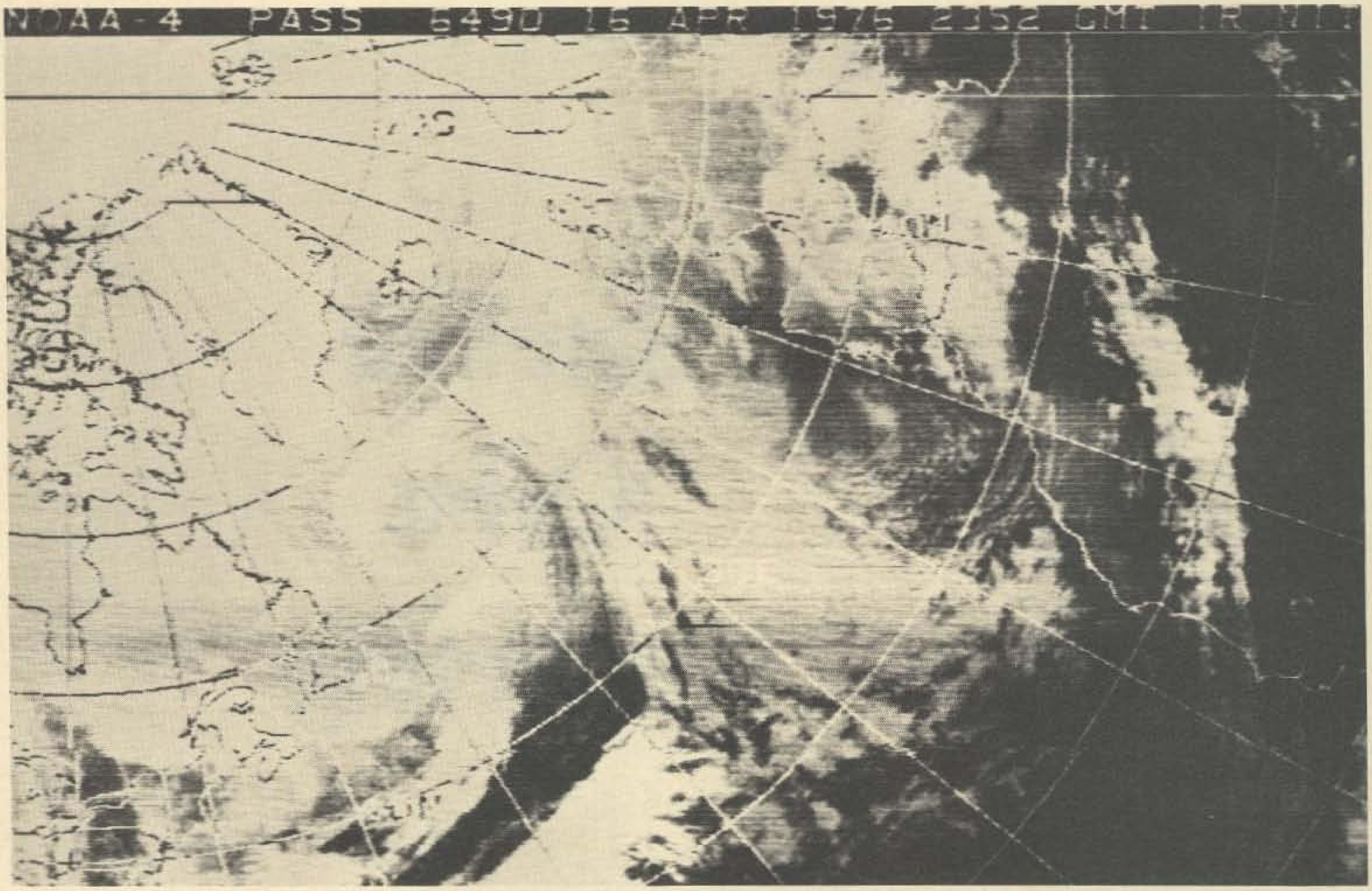
For the past several months I have been following the passes of the NOAA 3 and 4 satellites and recording the pictures coming from these modern day weather-predicting devices. Pictures have been obtained by FAX reproduction as well as oscilloscope display as described in a number of articles published in this magazine.[1]

A computer program has been written for the HP 25 pocket calculator, which is the new programmable calculator made by Hewlett Packard. The calculator is currently selling for around $180, and is an absolutely amazing little device which is fully programmable up to 49 steps. Programming is done in the same way a normal calculation is performed so that it is not necessary to study BASIC or FORTRAN 4 programming in order to program the device. Since there are "GO TO" and conditional steps available on the calculator, it is possible to have conditional branching in the program much the same as available in modern day computers.

In the program shown here it is possible to just punch in the date of the month, such as the number "3" for the third of April, and then by pressing the program "run" button, get the pass number, the equatorial crossing time for that date, and the degrees west that the satellite crosses the equator. What I generally do is assign a number to the first pass of the month, and then by consulting the *73* satellite table or ARRL nightly broadcasts for NOAA 4, get the first pass of the month info for making up[2] the program. It is necessary to know the time of a given pass of the satellite over your area and the degrees west longitude of this particular pass (which we will call pass #1 for reference). Once this info is found and entered into the program, it is only necessary to enter the date of the month and pass number in order to find out the time and equatorial crossing longitude. For example, in the program shown here, if we are interested in finding out the first pass of the day information for April 2, we just press the number two button and hit the run/start. We then see displayed the first orbit number (1), the day (2), and the time in hours (local 7.82). By then pressing the number one (orbit number just found) and the run/start button again, we see displayed the degrees longitude (242.9° W) equatorial crossing for that orbit.

After entering the program into the HP 25, also enter the satellite constants in the program memory shown as the "registers" 0-7. It then becomes obvious that the constants for any of the Oscar or NOAA satellites may be entered to give the desired orbit information.

A word about the register constants here: the first constant, R0, is the number of passes per day, in this case for NOAA 4. R1 is not used except in the program memory and can be ignored. R2 has the value 115, which is the time in minutes that the satellite takes to orbit the earth (in this case NOAA 4). R3 is 1440, the total number of minutes in one day. R4 is the day of the month to which is added the time, in days, of the first orbit. For example, the first orbit decided on is on the second of April, so we would add the number 2 to the time of the first orbit in days (not hours), which turns out to be .3256944 (7.82 hrs or 7:49 am); hence we come up with the number 2.3256944 days for the constant R4.



R5 is the degrees west longitude of the first orbit obtained as described above, and in this case is the number 242.9. R6 is the change in longitude for each pass of the particular satellite chosen and in this case for NOAA 4 is 28.75°. A more accurate number will give a more accurate predict orbit. R7 is 360 which turns out to be the familiar number of degrees in a circle!

As far as changes in the program from month to month, it is possible to be within one quarter of a degree or so after about one month's time, so I change the program about once per month to update the information.

Referring to line "02" in the program body: This particular entry is the only one that has to be changed in the program body if the date of the first orbit is changed when getting new orbit info. In this particular case, the number "2" refers to the day of the month for the first orbit programmed, which is the same number two discussed above in reference to constant R4.

The program here is particularly useful for tabulating a full month's orbits for a particular satellite. Since the passes for each day occur about the same time, it is only necessary to know about the first pass of each day, and the other passes can be found through simple calculation or by substituting the pass number in the second half of the program.

A similar program may also be developed for other programmable calculators such as the TI unit or more sophisticated computers. ■

References

[1] Taggart, *73 Magazine,* Aug. 1975; Sept. 1975; Oct. 1975; Sept. 1974.

[2] NOAA APT Coordinator, Calculating Satellite Crossing Times and Longitudes.

HP-25 Program Form

Title SATELLITE (NOAA 4) Page ___ of ___

Switch to PRGM mode, press [f] [PRGM], then key in the program.

DISPLAY LINE	DISPLAY CODE	KEY ENTRY	X	Y	Z	T	COMMENTS
00							
01	31	↑					
02	02	2					
03	73	·					
04	41	-					
05	2400	RCL 0					
06	61	x					
07	2301	STO 1					
08	2401	RCL 1					
09	01	1					
10	51	+					
11	1401	f int					
12	1474	f pause					
13	2401	RCL 1					
14	1401	f int					
15	2402	RCL 2					
16	61	x					
17	2403	RCL 3					
18	71	÷					
19	2404	RCL 4					
20	51	+					
21	2301	STO 1					
22	2401	RCL 1					
23	1401	f int					
24	1474	f pause					
25	2401	RCL 1					
26	1501	gfrac					
27	02	2					
28	04	4					
29	61	x					
30	74	R/S					
31	31	↑					
32	01	1					
33	41	-					
34	2406	RCL 6					
35	61	x					
36	2405	RCL 5					
37	51	+					
38	2301	STO 1					
39	2401	RCL 1					
40	2407	RCL 7					
41	71	÷					
42	1401	f int					
43	2407	RCL 7					
44	61	x					
45	2401	RCL 1					
46	41	-					
47	32	CHS					
48							
49							

REGISTERS
R_0 12.5217391 #passes/day
R_1
R_2 115 orbit time
R_3 1440 Min/day
R_4 2.32569444
R_5 242.9 First pass Long' west
R_6 28.75
R_7 360

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Del Mar CA 92014

The Death of Negative (IBM) Logic

--some fundamentals of logic design

During the past ten to fifteen years, conventions in logic design symbols have solidified to the point where one professional designer can finally communicate with a second with a minimum amount of confusion. This was a very painful growth period, but it's finally over. As an amateur logic designer, you have a choice of defining your own symbols and terms or going with the tide and using the industry standards. I strongly suggest you inflate your water wings and push out with the standards. The conventions are not very involved, and using them just takes a little practice. There are holes in some definitions, but by and large the system works.

I would like to make the newcomer's entry as simple as possible by going over the following terms and symbols:

- •Truth Tables
- •Positive/Negative Logic
- •Standard Symbols
- •Equivalent Symbols

I would also like to show how to name a function and why the choice of names is so important. The second section of this article, about positive and negative logic, should be of interest even to the experienced logic designer.

Truth Tables

The simplest version of this handy tool allows you to get a picture of what you want your logic design to do. The table consists of an input side and an output side. The input side contains a column for each of the input lines that you have to deal with; the output contains the results expected for every possible combination of inputs. For example: You need to light a lamp whenever one of your home sensors shows an open door or window or when you push a self-test button. You only want an entrance to light the lamp if the system has been enabled by a local switch.

Your inputs are:

- •Door #1 (D1)
- •Windown # (W1)
- •Self Test Switch (ST)
- •Enable Switch (ES)

Your output would be:

- •The Lamp

The truth table will contain five columns constructed as follows:

ES	ST	W1	D1	Lamp
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

The ones and zeros in the input field are simply the

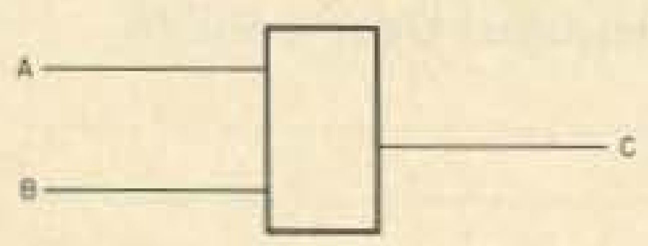
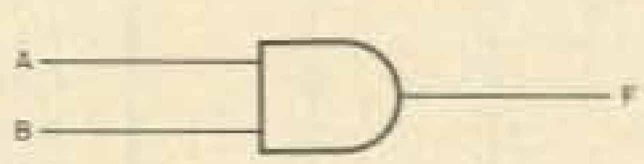


Fig. 1.

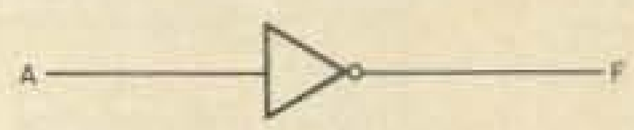


A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

Fig. 2. AND.

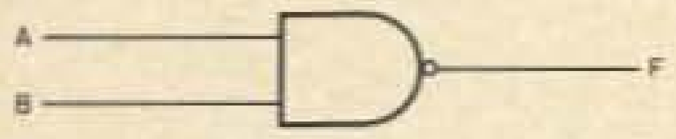
A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 3. OR.



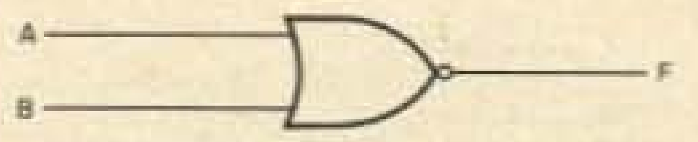
A	F
0	1
1	0

Fig. 4. Inverter.



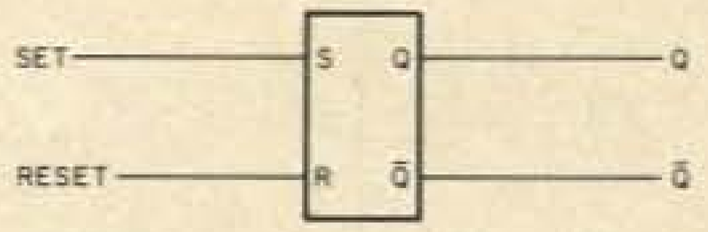
A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 5. NAND.



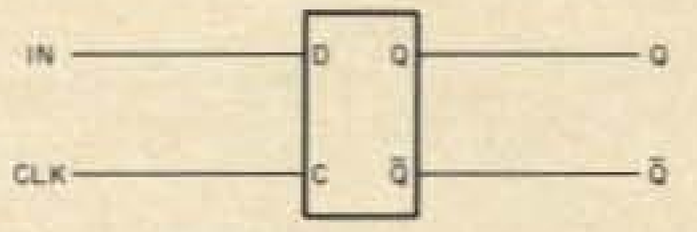
A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 6. NOR.



SR	Q
00	No change from last state
01	0
10	1
11	0 Undefined

Fig. 7. R/S.



D	C	Q
0	0	No change
0	1	0
1	0	No change
1	1	1

Fig. 8. D type.

binary progression of four bits. The binary progression makes sure that no combination is left out of the table. The output column is generated by analyzing your requirements for each possible combination of inputs. Tables larger than this can be used. I have a different version for my home grown computer that has 60 outputs with better than 100 inputs, but as you can see, they become large very quickly.

Positive and Negative Logic

Suppose that two logic designers, one on Earth and the other on Mars, are asked to analyze a logic module and to produce a truth table. Each designer is given a voltmeter and an operating module. Both modules are exactly the same and both operate exactly the same.

The first thing the two designers are asked to do is to construct a *voltage* truth table. The modules both look like Fig. 1.

The two *voltage* truth tables are:

Earth

A	B	C
0 V	0 V	0 V
0 V	+5 V	+5 V
+5 V	0 V	+5 V
+5 V	+5 V	+5 V

Mars

A	B	C
0 V	0 V	0 V
0 V	+5 V	±5 V
±5 V	0 V	+5 V
+5 V	+5 V	+5 V

Both tables are exactly the same, and both show that when a +5 V signal is applied to either A or B, the output on C will be +5 V. This appears to be an OR function, right? Not necessarily.

Both designers are then asked to produce a *logic* truth table from the *voltage* truth table shown above. The Earth designer has been taught that the higher voltage is represented by a TRUE shown as a "1" in his logic table. The lower voltage is shown by a FALSE or a "0" in the table.

The Martian designer has been taught just the opposite; that is, a high is a FALSE or "0", and a low is a TRUE or "1".

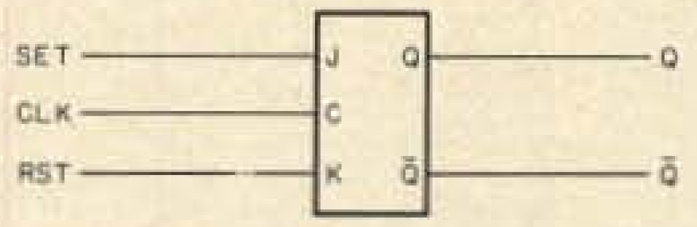
The substitution of 1s for +5 V and 0s for 0 V by the Earthling, and 0s for +5 V and 1s for 0 V by the Martian, produces the following different logic truth tables:

Earth

A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

Mars

A	B	C
1	1	1
1	0	0
0	1	0
0	0	0



K	J	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	Toggle

Fig. 9. JK.

The Earthman thinks he has an OR, the Martian thinks he has an AND, but both have the same logic module.

The Earthman is working in what we call POSITIVE logic, the Martian in NEGATIVE logic. If the two were to continue their analysis of all module types available, they would find that AND = OR and NAND = NOR, depending on your point of view.

Negative logic was used widely right here on Earth in many places (IBM for one), but luckily the practice is going away. There may be good reasons to use it in certain cases, but I would think that they would have to be very good reasons to put up with the confusion it causes. So much for the world of negative logic; from now on everything will be referenced positively. The higher of the two logic levels will be a 1 or TRUE, the lower 0 or FALSE.

Standard Symbols

The standard symbols for the most common logic elements are shown in Figs. 2-4. From these the elements in Figs. 5 and 6 were generated.

As you can see, the difference between a NAND and an AND is simply that the output is inverted (as signified by the small circle on the output).

Flip flops are a bit more difficult to describe. This family consists of Set/Reset (R/S), D type. and JK (Figs. 7-9). Most flip flops have several more inputs than those shown; for an exact definition of the operation of each, you should get a Texas Instruments Manual.

Equivalent Gate Symbols

Since it is possible to use a NAND to perform an OR function and a NOR to perform an AND function, logic designers came up with specialized symbols to show when gates were used in this manner. For example, if you have to OR three lines whose active state is low, you would use a three input NAND. The logic could be drawn using a standard NAND symbol, as shown in Fig. 10, but Fig. 11 would more clearly show the ORing function. Exactly the same logic gate is used in either case, but it is now apparent that an ORing is taking place by the shape of the symbol.

The gate symbols shown in Figs. 12-15 are all equivalent. The important thing about these symbols is the use of

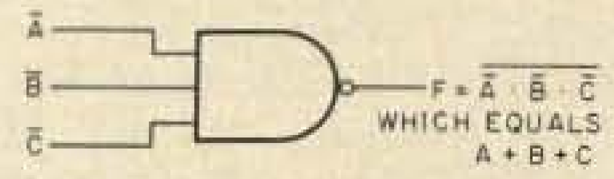


Fig. 10.

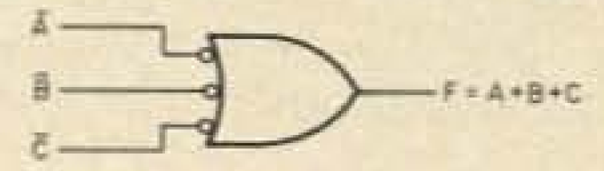


Fig. 11.

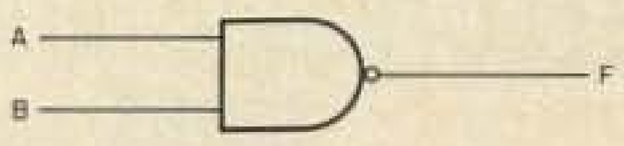


Fig. 12. ANDing function using a NAND.

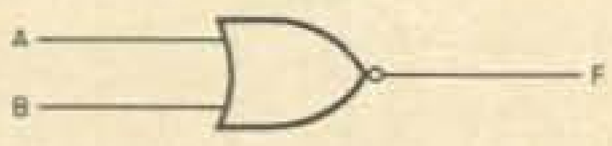


Fig. 13. ORing function using a NOR.

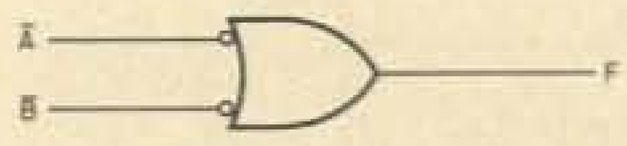


Fig. 14. ORing function using a NAND.

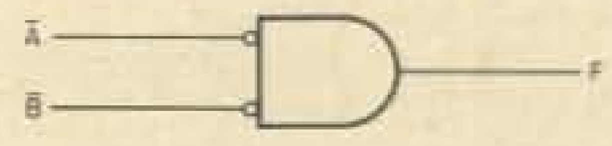


Fig. 15. ANDing function using a NOR.

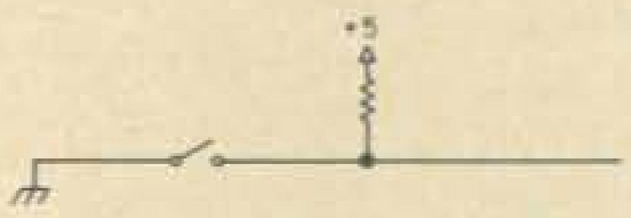


Fig. 16.

the inverter symbol on the input. After you have completed a logic design using these four symbols, if you have anything other than negated inputs connected to negated outputs, you have an error. Either your incoming term is misnamed, or it needs to be inverted. It is quite possible to do all your logic design without resorting to the equivalent symbols, but the result will be less readable.

Term Names

When picking names for the terms in your design, be sure to choose the active function. For example, the circuit shown in Fig. 16 is widely used to generate binary logic levels from a switch. If closing the switch pulls the line to a logic zero and clears the system, it should be named $\overline{\text{CLEAR}}$ (spoken, "CLEAR NOT"), rather than "DON'T CLEAR." Always think of the action to be performed, name it, and *then* add the negation if necessary. Don't attempt to find a name for the true condition first. ■

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... And on the Other Side

--binary and octalization of decimals

In a previous effort, I described a simple method of taking a whole number written in base 10 (your ordinary everyday numbering system) and producing its equivalent in binary (or base 2).[1] You could also turn it into its octal equivalent (base 8), if that's what you desired. The beauty of the method was that the entire math depended upon your ability to divide by the number 2 or the number 8.

The logical question is, "What do we do if there is a fractional part to the number?" Putting it another way, "What do we do with numbers to the right of the decimal point?"

Taking a peek in the rearview mirror, the temptation is to ask, "Why bother?" If the rearview mirror shows an interest in computers, the answer is, "Let's bother!" Systems that you and I might hope to afford generally eat binary and octal, so the least we can do is appreciate the "food" shoved down their expensive electrical gizzards.

We know that in the decimal system each digit to the right of the decimal point has a value. The progression is tenths, hundredths, thousandths, and so on. Thus 0.125 is really the sum of one tenth, two hundredths and five thousandths.

With muted thanks to Miss Venables, who taught me all these good things, let's climb out of the sandbox and examine the same idea in the binary system. The values to the right of the decimal point have values of one half, one fourth, one eighth, one sixteenth, and so on. Octal is a bit rougher, as base 8 progresses rapidly. The values are one eighth, one sixty-fourth, one five hundred twelfth, etc.

With these basics in mind, we can skip down the primrose path of conversion from decimal to either octal or binary by extending our grasp on basic math to the extent that we can skillfully multiply by two or by eight as the case may be.

Suppose we consider the delightful decimal 0.53 and wish to convert it to binary. We are really asking the following successive questions: "How many one halves does this number contain? How many quarters? How many eighths? How many sixteenths?" And so it goes, until we get to the final binary equivalent. To convert it to octal we would ask the same questions, but would substitute the octal place values. Rather than go through this, though, we merely start multiplying by two or by eight and look for the signposts that give us the proper numbers to put down in our conversion. For the binary conversion our numbers will be limited to zero and one, while for octal the numbers will range from zero to seven.

The Method

We will assume that we want to take the decimal base ten value 0.53 and convert it to the equivalent binary notation. Please make a firm note that there is a zero to the left of the decimal point. When you start flirting with computerese or definitive math, zero is a powerful animal that can really hang you up when ignored or misused. The method is simplicity itself:

- Multiply 0.53 by 2 ... 1.06.
- Any figure to the left of the decimal point, including zero, becomes our first binary digit in the desired answer ... 0.1.
- We now multiply the decimal portion of the first multiplication again by two (0.06x2) ... 0.12. Thus the next digit in the binary answer is a zero ... 0.10.
- We merely continue this process until we are satisfied that our conversion is relatively complete. In the case of 0.53 (base 10) to binary, carrying this process to seven places would give us an answer in binary of 0.1000011. It is definitely interesting to take the time to see what the absolute value of the binary answer is in order to see how successful the conversion has been. The binary answer is the arithmetic sum of the values of each binary place, i.e., the sum of one half (0.500), plus no fourths, plus no eighths, plus no sixteenths, plus no thirty-seconds, plus one sixty-fourth, plus one one hundred twenty-eighth.

Those numerical specifications look like this:

0.500 (one half)
0.015 (one sixty-fourth)
0.007 (one one hundred twenty-eighth)

0.522

Note that in the conversion process there is a slight discrepancy in the third decimal place. If we had taken the conversion of 0.53 base 10 to an additional binary place we would have gotten even closer, which illustrates that eight places is not overkill when converting a decimal base 10 form to binary.

The octal conversion process is identical in methodology but we now use the number 8 as our multiplier. Ergo:

$0.53 \times 8 = 4.24 \ldots 0.4$
$0.24 \times 8 = 1.92 \ldots 0.41$
$0.92 \times 8 = 7.36 \ldots 0.417$
$0.36 \times 8 = 2.88 \ldots 0.4172$

Thus the octal conversion held to four steps (for simplicity) is 0.4172.

On a one time basis to understand the point, it is worthwhile to wade through the place values of this conversion to see how close the octal conversion comes to the original decimal (0.53) that we started out with.

0.4172 in base 8 is really the sum of:

$4 \times 1/8$	or	0.5000
$1 \times 1/64$	or	0.0150
$7 \times 1/512$	or	0.0133
$2 \times 1/4096$	or	0.0004
		0.5287

Note that the difference between the binary expansion and the octal expansion is, as mentioned, due to the fact that binary uses only ones or zeros, while octal uses all numbers from zero to seven. Thus, when you examine the binary result to see how close your conversion is, the process is simpler than the octal case where each place value has to be multiplied by the number in the octal answer. It is also interesting to note that the octal conversion in this case was a more accurate conversion in four steps than the binary conversion was in a larger number of steps. If we had taken the binary conversion one more step (for a total of 8), our binary conversion would have gone from 0.522 to 0.525, which is still not quite as good as the octal conversion of 0.5287.

Without quibbling over the merits of binary versus octal final accuracy, you just might now be nourishing the faint suspicion that "the computer" may have some trouble in "exactly" representing some numbers fed into its inner workings. This is an accurate conclusion on your part. Putting it another way, the math through the computer may well not be "on the money" — just damned close. ■

---

[1] "What's That in Binary?", *73*, March, 1976, pp. 92-93.

Place Values to the Right of Decimal Point

	1	2	3	4	5
Base 10	0.1	0.01	0.001	0.0001	0.00001
Base 2 (Binary)	0.5 (½)	0.25 (¼)	0.125 (1/8)	0.0625 (1/16)	0.0312 (1/32)
Base 8 (Octal)	0.125 (1/8)	0.0156 (1/64)	0.0019 (1/512)	0.0002 (1/4096)	0.00003 (1/32,768)

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Build the Safari RTTY Terminal

--an active filter modem from Africa

After various experiments with coils and capacitors, it was decided to try active filters for decoding. The main problems in decoding RTTY are the high amount of noise on the signal, the QSB, and a very often found frequency instability of the received RTTY signals. To bring all this under one hat together with the demand of low cost, a lot of compromises had to be made.

Fig. 1 shows the block diagram of the RTTY encoder-decoder.

To become independent of QSB, a limiter had to be placed at the input. A low pass and a high pass filter reduce the noise above and below the wanted frequencies (2125 Hz and 2295 Hz). After these stages common to all frequencies, the filter stage follows. The filtering is done in a somewhat unusual way. The signal (a square wave) is fed through a notch filter designed to eliminate the basic frequency of the square wave.

Having passed this, the square wave looks like the one in Fig. 2.

This signal, together with the square wave as it looked before the notch filter, then enters an op amplifier used as a differential amplifier.

If the input signals to this op amplifier are equal (applies for all frequencies except the notch frequency), there is no output. For the notch frequency there is a sine wave output. This sine wave is rectified and detected in an op amplifier, wired as a Schmitt trigger. In order to observe a received signal, add a pair of LEDs including transistor drivers. The Schmitt trigger is followed by the pre-driver and driver stages for the teleprinter magnet.

The encoder basically consists of an unijunction oscillator. This of course does not generate a square wave and is therefore followed by a "flip flop" which generates a square wave of exactly 50% mark space ratio. Since a flip flop divides by two, the unijunction oscillator has to run at twice the frequency.

To change the frequencies (mark space) a transistor 2N2904 is used to change the value of the charge resistor for the unijunction oscillator. The BC108 in front of the 2N2904 is to change the switching for "upside down" transmission, in the SSB mode. The square wave coming out of the flip flop is fed into the decoder input. A sine wave signal to modulate any SSB or AM transmitter is obtained after the combining amplifier.

The frequency of the notch filter is determined by resistor R and capacitor C and is worked out according to the formula below (see Fig. 3):

$$f = \frac{1}{2\pi RC}$$

f in Hertz
R in Ohms
C in farads

The circuit of the complete encoder-decoder is shown in Fig. 4.

Construction

A print of the PC board is shown in Fig. 5 with wire links shown. The first step is to place the wire link between pins 4 of IC4 and IC5, as this is covered by the IC holders. Assembly from

Reprinted from *Radio ZS*, Volume 29, Number 3, pp. 10-13.

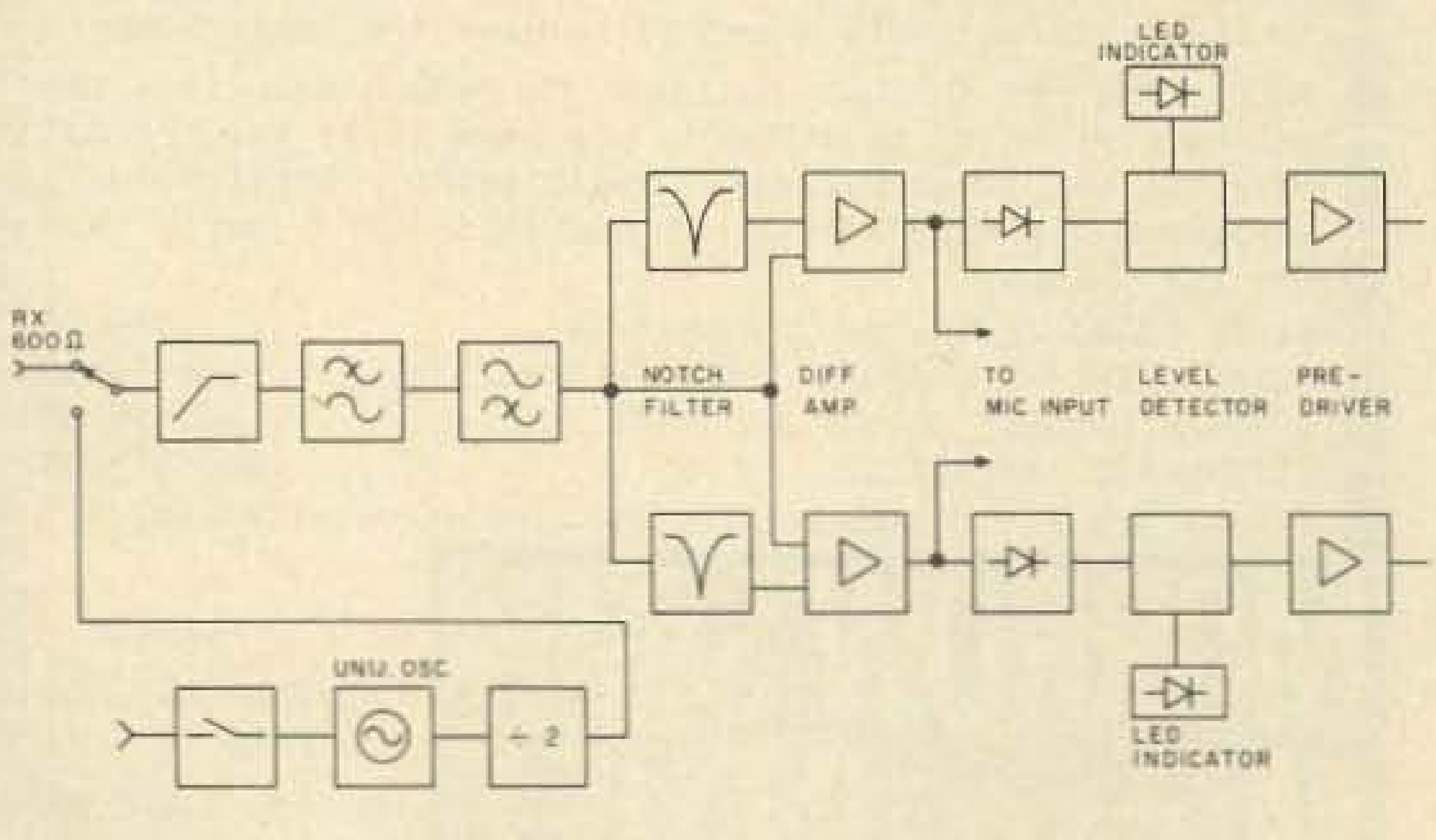

Fig. 1. Block diagram of 170 Hz shift RTTY modem.

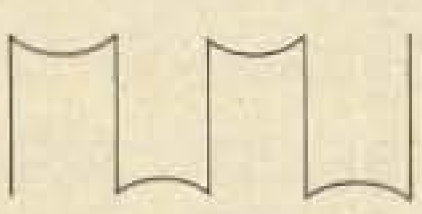

Fig. 2. Square wave after having passed through the notch filter.

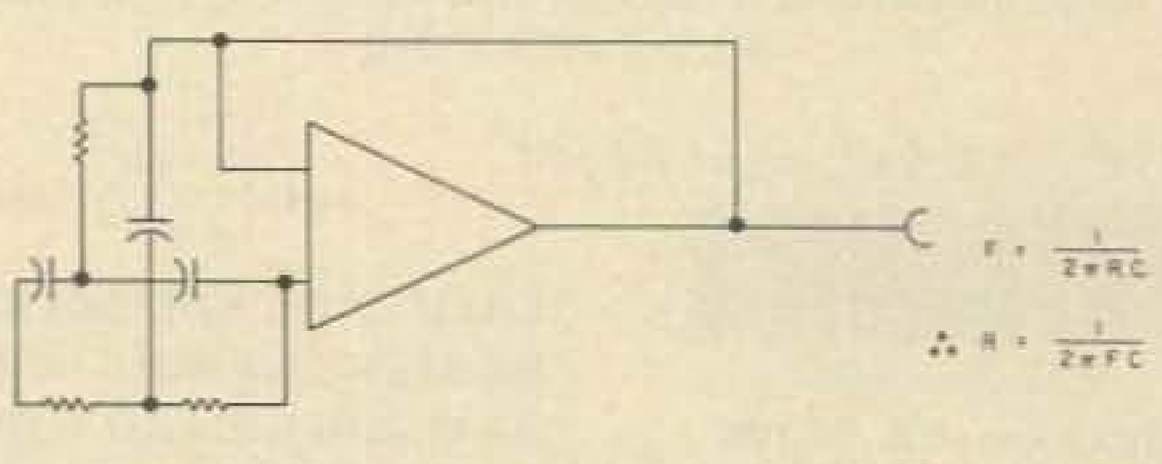

Fig. 3. Basic notch filter.

VERADA 214 SPECIAL

1971 SURPLUS VIATRON 2111 VERSION III

Back in 1971, Viatron Co. shipped three hundred 2111s to Texas where, for some reason, they sat around until Oct. 1975 when this lot was sold and split up amongst several dealers. While sitting in the warehouse, the keys on the keyboard grew hair, and this is why we call them Fungus Specials. The TVs look good, as do the main microprocessor and tape section. The power supplies are good, but are mostly dusty and/or scratched due to their having been stored without boxes. The rest of the system was well packed. With the demand for new 2111 systems keeping us busy, we don't have time to clean up and check out the surplus systems. So, we are selling the complete system, with all manuals available, for only $425, AS-IS. Due to the four years of storage, the units need cleaning. We also supply a checkout procedure, two Viatapes and a troubleshooting guide. We also have a computer hotline to help you analyze any problems by phone. Then, after you find the fault (if any), we will sell you any replacement parts at modest prices, and you will have saved more than $200 over the cost of our new 2111 units.

1971 Version III – $425.00

VIATRON SYSTEM 21 DATA

M1	V2111 OPERATOR'S MANUAL – 68 Pages	$ 5.00
M2	V21 TRAINING OUTLINE – 72 Pages	5.00
M3	V21 ENGINEERING DRAWINGS – 239 Pages	25.00
M4	REEL TO REEL, 7 TRACK & 9 TRACK OP. MANUAL – 8 Pages	1.00
M5	COMMUNICATION ADAPTER MANUAL – 10 Pages	1.25
M6	ROBOT MANUAL – 16 Pages	2.50
M7	VIATRON DISPLAY MAINTENANCE MANUAL – 8 Pages	1.50
M8	V21 CHECK OUT PROCEDURE AND FAULT SHEET	.25
M9	CARD PUNCH/READER ADAPTER MANUAL (029B) – 12 Pages	1.00
	COMPLETE SET OF M1 THROUGH M9	ONLY – 35.00
SM1	SYSTEM 2101 SERVICE MANUAL – 78 Pages	8.00

1976 NEW VIATRON 2111 VERSION IV

Verada 214 purchased the Viatron Computer Company's entire inventory in July 1975 and has been manufacturing new Viatron 2111 terminals ever since. We will soon run out of the wired mainframes and will have to stop selling completed systems. We do intend to continue our parts and service department until at least July 1980. Even though we will not be able to make more complete 2111s (we can't wire the mainframes and make the cabinetry for $699) our parts inventory is extensive, and we can supply any part you need to maintain your system. We will also continue to manufacture the Viatape cassettes, which are certified and have the special Viatron timing track. The 1976 Version IV Viatron 2111 comes with a set of tapes, complete set of manuals and is fully guaranteed.

1976 Version IV – $699.00

See Feb., 1976 issue of 73 Magazine, page 51, for a complete description of the Viatron 2111 or write or call for more information and price listings on parts and accessories.

VIATRON USERS ORGANIZATION

Verada 214 is seriously considering the organization of a Viatron Users Society for the purpose of providing an information exchange between owners of Viatron machines. This would be accomplished by a series of newsletters, worked up from information sent to us by members of the society (or other sources when available).

We would appreciate getting some reader response on the subject.

VERADA 2 1 4

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38 french st. p.o. box 438
lowell, mass. 01852 617-458-3077

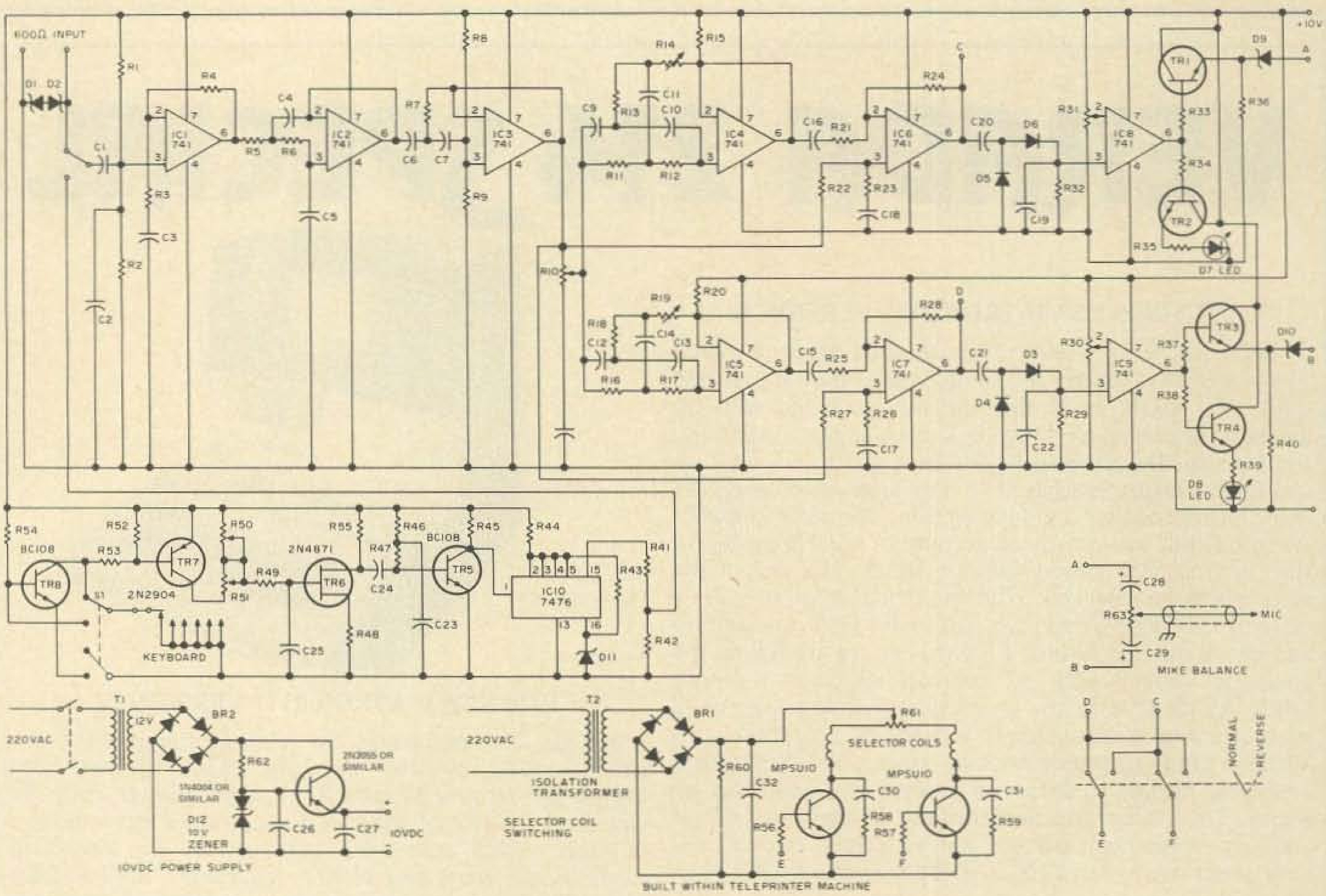


Fig. 4. Encoder-decoder circuit diagram, teleprinter switching, 10 volt supply, and other controls on the terminal unit.

then on is straightforward. After all the components have been installed, check the board but do not plug in the ICs. Connect the unit to +10 V and check that the voltage on pin 16 of IC10 is +5 V. If not, change R44 to achieve this value.

Encoder

With an oscilloscope connected to the collector of TR5, check that the unijunction is triggering. Then insert the IC 7476 into IC10 socket and check for a square wave at the encoder output socket. Connect a counter to this same position and adjust the two 5k trimpots so that, with the two leads which go to the keyer circuit shorted, the output is at 2295 Hz and with them disconnected, the output is at 2125 Hz.

Decoder

Insert IC1, and with audio signal generator connected to the input terminal, check with the oscilloscope on pin 6 that the output is a square wave and remains at the same level for all input voltages. Insert IC2 and IC3; check with an oscilloscope connected to the center of the potentiometer connected to pin 6 of IC3. Tune the audio generator across the band and see that the output increases from below 2125 Hz to above 2295 Hz. Insert IC4, IC5, IC6 and IC7. Connect the scope to pin C of IC6 and see that the output increases sharply at 2125 Hz. This resonant point is governed by the two 8.2k resistors connected to pin 3 of IC4; it may be necessary to pad these resistors to bring the peak exactly onto 2125 Hz, remembering that the lower the resistors, the higher the frequency.

Now do the same at IC7, at point D, but for a frequency of 2295 Hz. Remove the audio generator. Insert

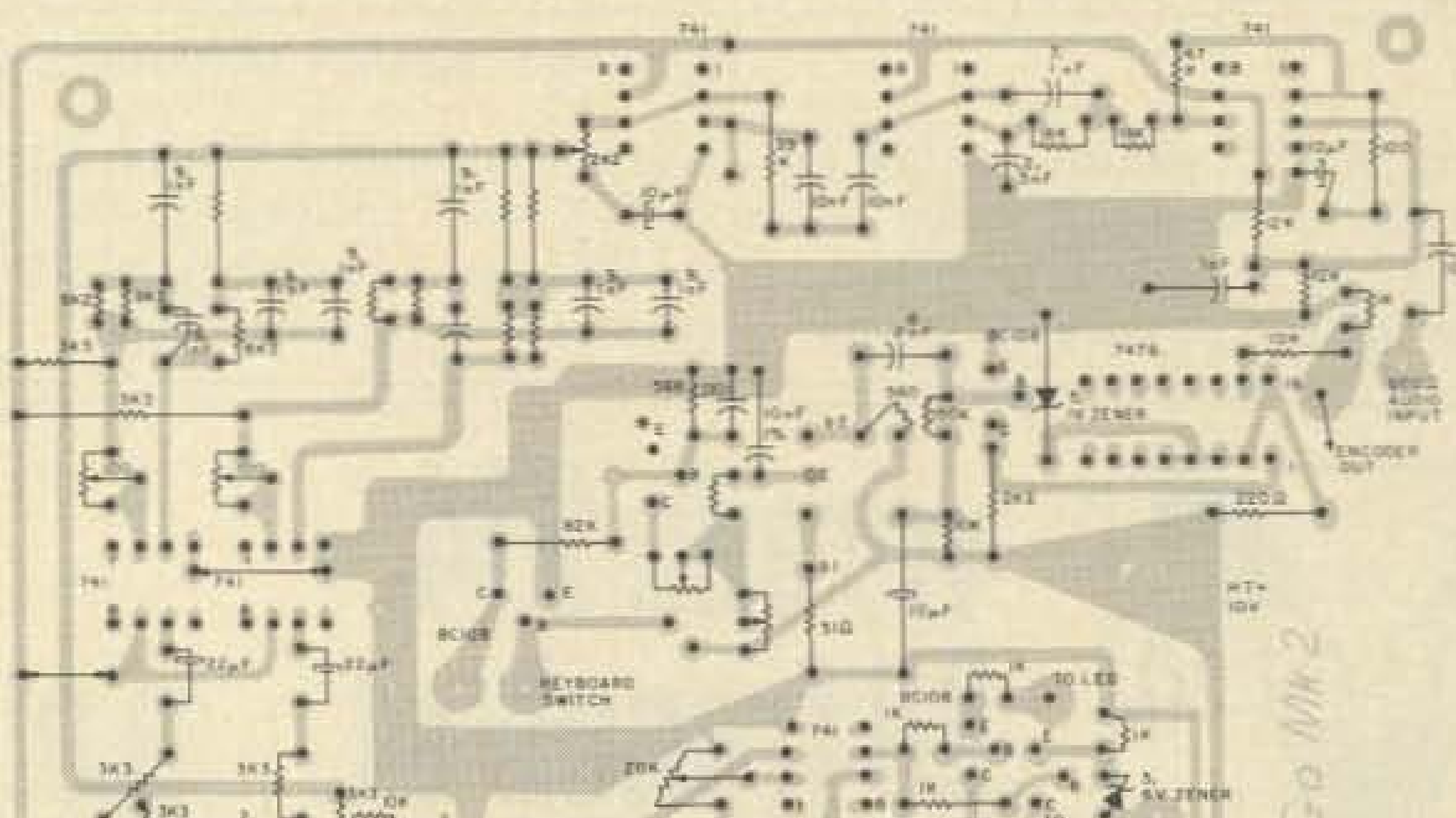


*Fig. 5. Encoder-decoder PC board and component layout. *Jumper emitter of TR7 to positive rail.*

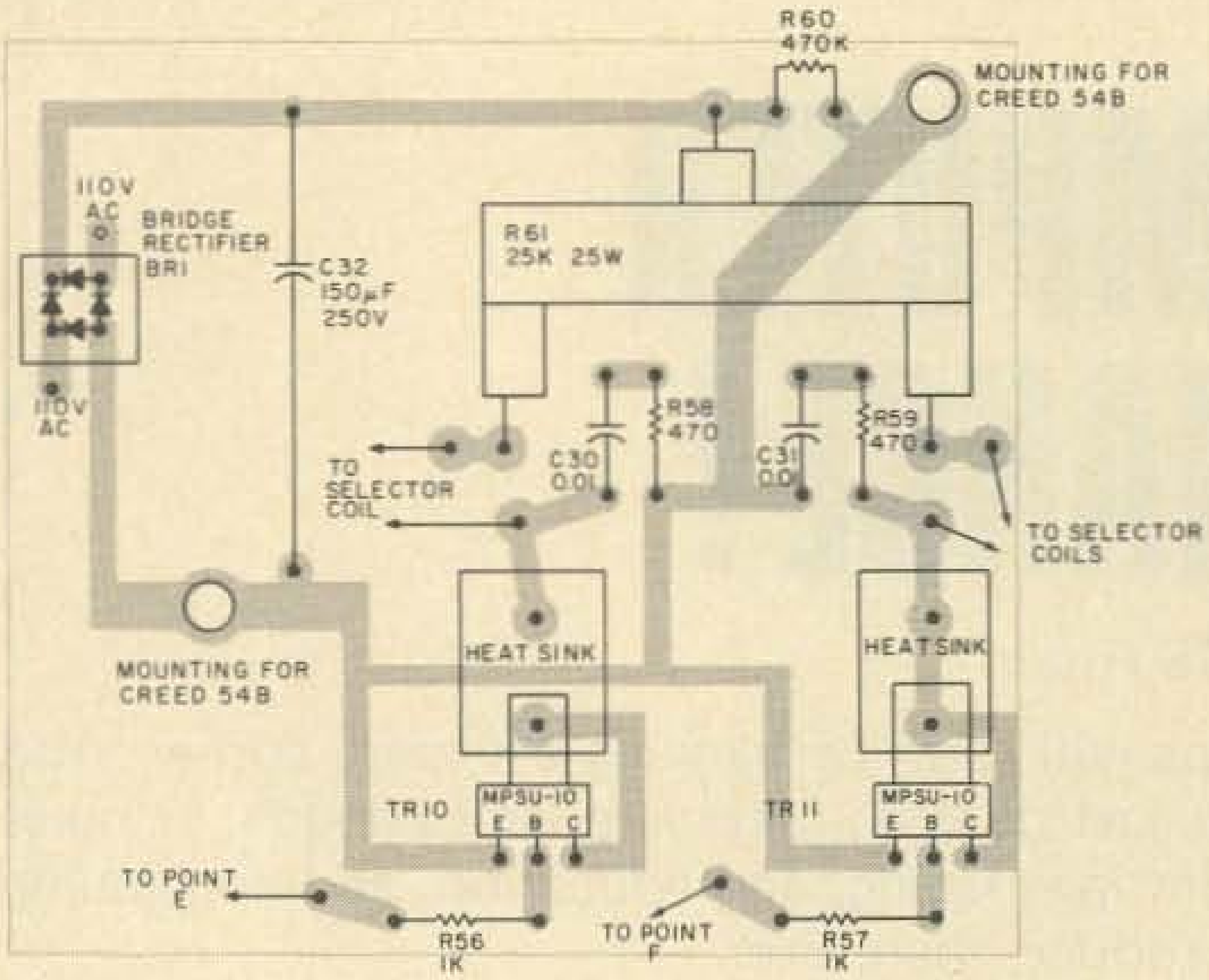


Fig. 6. Teleprinter switching PC board and component layout.

IC8, adjust the 20k potentiometer R31 connected to pin 2 of IC8 until the LED lights up, then back off the potentiometer slightly. Reconnect the audio generator and check that the LED lights up to 2125 Hz ± 45 Hz.

Repeat the above for IC9 and a frequency of 2295 Hz. If the bandwidth at the resonant frequency is too broad, adjust the R14 and R19, on IC4 and IC5, to narrow the bandwidth. These are normally set at about 5 Ohms. Be careful that the setting does not result in ringing in the notch filter.

Place a voltmeter between each output and earth and check that the voltages rise to +3.8 volts whenever the audio generator is on the correct frequency.

Now connect the output of the encoder, when it is switched to 2125 Hz, to the input of the decoder. Connect the oscilloscope to point C and adjust R12 so that the output is a sine wave. Switch the encoder to 2295 Hz and likewise check the output at point D. Now connect the oscilloscope to the mike input lead, and with the balance potentiometer, adjust both outputs to be the same while switching the encoder between 2125 and 2295 Hz.

The parts layout for the encoder-decoder is shown in Fig. 5 and the parts layout for the teleprinter switching is shown in Fig. 6.

The teleprinter layout shown in Fig. 7 was designed to fit into a Creed 54B teleprinter, but may fit into your teleprinter. The reason a separate board was used was to keep the 150 volt dc line well away from the main modem unit. It is advisable to use an isolation transformer if the unit is operated on 110 volts ac. ■

Parts List

R1-R2	12k
R3	100 Ohms
R4	47k Ohm
R5-R6	18k
R7	3.9k
R8-R9	24k
R10	2.2k
R11-R12	8.2k 1%
R13	4.1k (two 8.2k, 1% in parallel)
R14	100 Ohm skeleton preset potentiometer
R15	3.3k
R16-R17	7.6k 1% (8.2k + 68k 1% in parallel)
R18	3.8k 1% (3.9k + 150k 1% in parallel)
R19	100 Ohm skeleton preset potentiometer
R20-R22	3.3k
R23-R24	10k
R25	3.3k
R26	10k
R27	3.3k
R28	10k
R29	33k
R30-R31	20k skeleton preset potentiometer
R32	33k
R33-R40	1k
R41	10k
R42	1k
R43	100 Ohms
R44	220 Ohms
R45	2.2k
R46	10k
R47	150k
R48	51 Ohms
R49	15k
R50-R51	5k miniature 22 turn trimpot Spectrol 51-3-11
R52	56k
R53	82k
R54	33k
R55	560 Ohms
R56-R57	1k
R58-R59	470 Ohm
R60	470k 1 Watt 10%
R61	25k 25 Watt ohmite adjustable
R62	470 Ohm
R63	2.2k preset potentiometer

T1	Small 220 V/110 V – 12 volt transformer
T2	220 V/110 V – 110 volt isolator transformer
C1	10 nF
C2	1 nF
C3	10 mF 25 volt electrolytic
C4	7.1 nF
C5-C6	2.5 nF
C7	10 nF
C8	10 mF 25 V electrolytic
C9-C10	9.1 nF 1% polycarbonate
C11	18.2 nF 1% (two 9.1 nF in parallel)
C12-C13	9.1 nF 1% polycarbonate
C14	18.2 nF 1% polycarbonate
C15-C22	2.2 mF 25 V electrolytic
C23	10 mF 25 V electrolytic
C24	8.2 nF
C25	100 nF 1% polycarbonate
C26	250 mF 64 volt electrolytic
C27	2000 mF 25 volt electrolytic
C28-C29	10 mF 12 volt electrolytic
C30-C31	0.01 mF 150 V dc
C32	150 mF 250 V electrolytic
D1-D2	3.3 volt zener diodes
D3-D6	BAX13 or any small signal silicon diode
D7-D8	LED, red, small for mounting on front panel
D9-D10	3.8 volt zener diodes
D11	5.1 volt zener
D12	11 volt zener
IC1-IC9	MC1741C (Pi suffix)
IC10	7476 flip flop
TR1-TR5, TR8	BC108 or equivalent NPN silicon
TR6	2N4871 unijunction
TR7	2N2904 PNP silicon
TR9	2N3055 or equivalent
TR10-TR11	Motorola MPSU-10 or equivalent
BR1-BR2	Small 2 Amp rectifier bridge

All resistors 1/8 Watt,
5% except where shown.

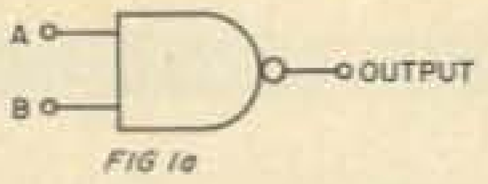


FIG 1a

INPUTS		OUTPUT
A	B	
0	0	1
0	1	1
1	0	1
1	1	0

FIG 1b

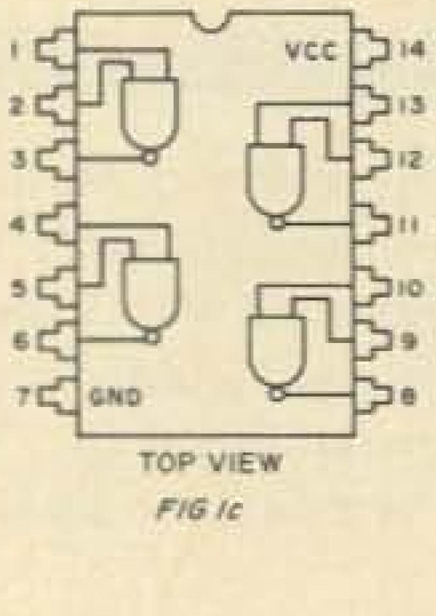


FIG 1c

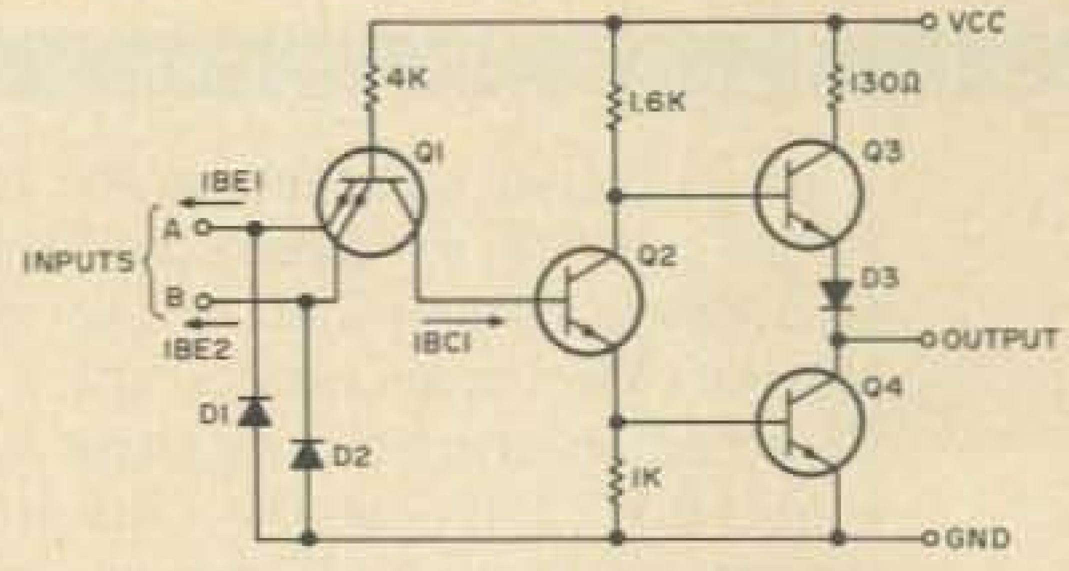


Fig. 1. The two-input NAND gate. 1(a) is the schematic, (b) shows the truth table. The pin layout of the SN7400 is in 1(c).

Fig. 2. The circuitry for one of the gates in the 7400 quad two-input NAND gate.

Never Underestimate the NAND

--introducing the 7400 quad NAND gate

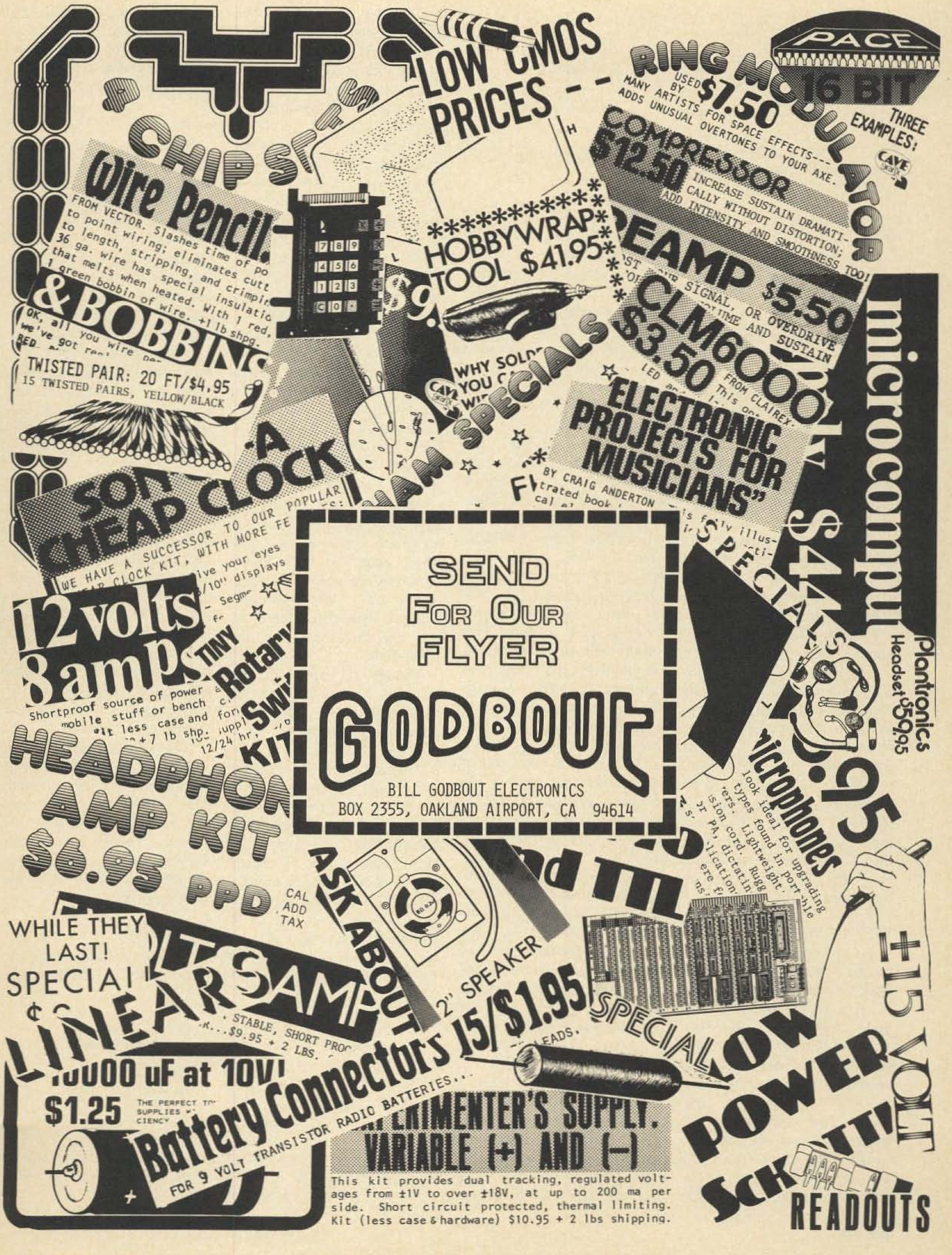
Robert Henson WBØJHS
1016 Polk Blvd.
Des Moines IA 50311

Even a ham who considers himself somewhat knowledgeable on digital logic can be confused when he glances at a new logic circuit for the first time. Though the logic elements involved in any particular circuit are seemingly simple to understand, their interconnection with other elements and devices often tends to make the circuit as a whole confusing to the point of incomprehensibility, especially to the inexperienced. Circuit analysis is also further complicated when logic devices are utilized to perform functions other than that for which they were primarily intended. Unfortunately, these sources of confusion often appear formidable enough to discourage some of the less experienced hobbyists from experimenting with digital logic circuits.

This article will attempt to dispel some of the mystery about the many uses of one of the most basic logic elements, the two-input NAND gate. In addition to explaining its primary function, it will be shown how it may be connected to perform the functions of an inverter, a set-reset flip flop, a switch debouncer, a pulse shaper, a square wave oscillator and even a crystal oscillator. In spite of the rather ominous forewarning that this article is about a *digital logic* element in an *integrated circuit* package, it will be shown that these applications are extremely simple, making this the ideal device for learning the basics about logic circuits.

Basics

For two important reasons, the NAND gates described in this article will all be of the TTL (transistor-transistor logic) family. First of all, TTL is by far the most commonly used logic in current ham projects. Second, it is the least expensive and the most readily available from surplus dealers. The current price of



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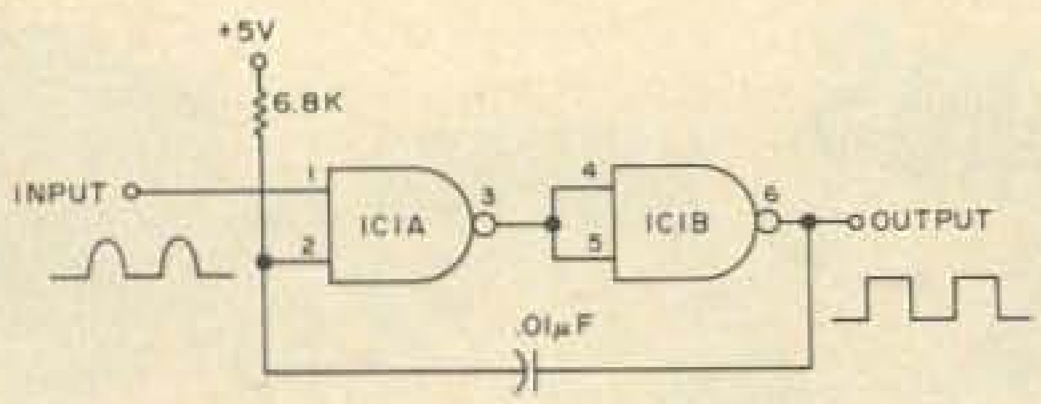

Fig. 3. An input conditioning circuit utilizing two sections of the quad two-input NAND gate.

the 7400 quad two-input NAND gate is a whopping sixteen cents.

Fig. 1(a) shows the common schematic representation of the two-input NAND gate. Fig. 1(b) is the truth table that shows the output of the NAND gate for all possible combinations of inputs. The truth table is the key to understanding the NAND gate, and will be referred to repeatedly in subsequent discussions and applications of this device.

For TTL logic, each "0" in the truth table represents a voltage of 0.8 volts or less. Each "1" represents a voltage of greater than 2.0 volts but less than the NAND gate supply voltage of 5.0 volts.

Fig. 1(c) shows the pin diagram for the SN7400 quad two-input NAND gate. As the word quad implies, there are four two-input gates contained in one dual in-line packaged IC. As was previously mentioned, a regulated five volt power supply is necessary to power the IC. Positive is connected to pin 14. Negative is connected to pin 7.

Internal Circuitry

At this point let's digress for just a moment and take a peek into the innards of the IC. If transistor circuitry isn't your bag, simply skip this section of the article. The following discussion of the internal circuitry is not essential in applying the device, but is presented for those who desire further insight into how the gate actually works. For those who are indifferent about this aspect of the IC, the NAND gate can be treated as a "black box" device.

Fig. 2 shows the transistor circuitry that actually comprises each section of the SN7400 two-input NAND gate. The inputs are actually the two emitter leads of Q1, a double emitter transistor. The output is connected to the collector of Q4.

First, let's consider the case where both inputs are tied to a "1", or a voltage of between 2.0 and 5.0 volts. This will correspond to the bottom line of the truth table listed in Fig. 1(b). The base-collector junction of Q1 will be forward biased for this particular set of inputs, allowing I_{BC1} to flow. This current will be of sufficient magnitude to saturate transistor Q2. The resulting collector current of Q2 will produce a voltage drop across the 1.6k Ohm collector resistor of sufficient magnitude to cause the collector voltage of Q2 to decrease to the point where transistor Q3 is cut off, or effectively open circuited. The rise in potential at the base of transistor Q4 caused by Q2's increased emitter current across the 1k Ohm emitter resistor will be sufficient to saturate Q4, causing its collector voltage to drop to near ground potential, or a logic "0". This is exactly as stated by the truth table of Fig. 1(b).

Now suppose that input A is tied to ground or to a voltage source of 0.8 volts or less. This would correspond to the second line of the truth table of Fig. 1(b). Now a current I_{BE1} will flow from the emitter of Q1 to the grounded input A. In this case, I_{BC1} will be zero, causing Q2 to be cut off or effectively open circuited. No current will flow in either the emitter or collector circuit of Q2. Therefore, Q4 will not be biased on as in the previous case, and will in effect be cut off, causing its collector-emitter junction to appear to be open circuited. On the other hand, the collector of Q2 will be approximately at the potential of V_{CC}. This will cause transistor Q3 to saturate, presenting a logic "1" voltage at the output terminal that is equal to the supply voltage, V_{CC}, minus the voltage drop across the base-emitter junction of Q3 and the diode, D3. This output voltage is typically about 3.3 volts.

Note that the conditions described in the preceding paragraph apply to the cases where either or both input terminals are connected to a logic "0" as previously defined. This corresponds to the top three lines of the truth table.

Diodes D1 and D2 are included to help protect the gate should the inputs be accidentally connected to a negative voltage.

One important TTL design rule should be evident at this point. An open circuited input of a TTL gate corresponds to a logic "1" input rather than a "0" input. Or in other words, to input a logic "0" you must tie the input to ground or to a voltage of less than 0.8 volts so that transistor Q1's base-emitter junction will conduct. To input a logic "1" you may either tie the input to a voltage of greater than 2.0 volts or simply leave that input open circuited.

Gating

Now that we've taken a look at what's inside the NAND gate, let's discuss some of its many uses. First of all, as its name implies, the NAND gate's primary function is that of gating. In a logic circuit, the NAND gate will provide a unique output response of logic "0" if, and only if, both inputs are simultaneously at a logic "1". A perusal of any of the recent issues of *73 Magazine* will uncover digital logic circuits using the NAND gate in this fashion.

Inverter

An inverter is a logic element that provides a "1" output for a "0" input and a "0" output for a "1" input. The two-input NAND gate can be easily converted to perform the functions of an inverter by simply tying the two inputs together. Now, only the top and bottom lines of the truth table apply. The output will always be the inverse of the input.

Like the gating function, the use of the NAND gate as an inverter is very common. The easiest way to gain further insight into the reasons for its use in this fashion is to study current digital logic projects in the ham magazines.

Pulse Shaper

A fast switching waveform is necessary to reliably trigger

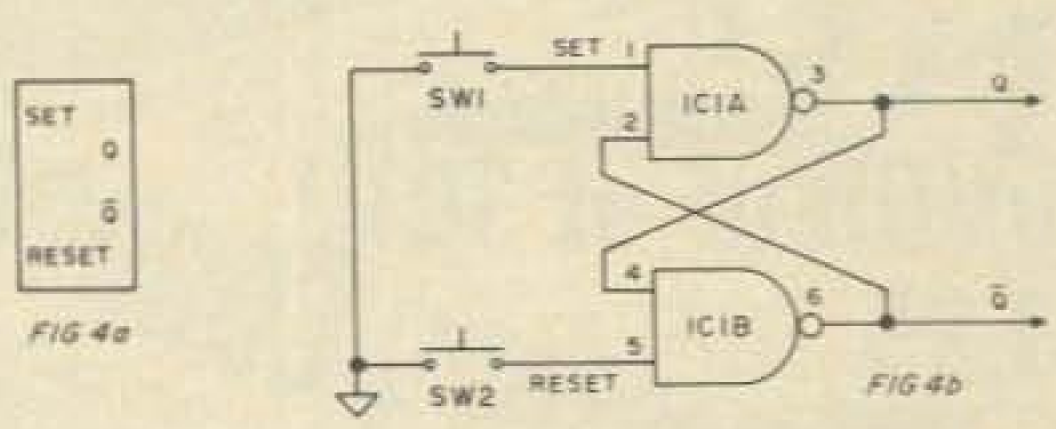

Fig. 4. In (a) is the common schematic for the set-reset flip flop; (b) shows how two sections of the SN7400 can be connected to form a set-reset flip flop.

Fig. 5. Switch "bounce."

TTL flip flops and counters. Slower switching waveforms such as low frequency sine waves will often result in erratic operation. The circuit of Fig. 3 shows how two sections of a 7400 NAND gate can be connected to form a waveform conditioning circuit, providing a TTL compatible square wave output from a slower switching waveform presented at the input.

As was discussed in the section on internal circuitry, the NAND gates are saturated logic elements. In other words, the output is either "on" (at a voltage of approximately 3.3 volts) or "off" (at a voltage of approximately 0.4 volts). The circuitry tends to avoid any in-between output states.

This characteristic is utilized in the circuit of Fig. 3. As the waveform at the input slowly changes from a "0" to a "1" logic level, and vice versa, the abrupt switching characteristic of the NAND gates transforms this input waveform to a square wave output at terminal 6. The inclusion of the .01 uF capacitor from pin 6 of section IC1B to pin 2 of section IC1A provides a transient feedback that further enhances the switching speed of the trailing edge of each pulse.

The circuit of Fig. 3 is often found in digital circuits that contain transistor or unijunction transistor oscillators that do not have TTL compatible outputs. The circuit is also often used to condition 60 Hz half-wave rectified sine waves for use in digital clock circuits.

Set-Reset Flip Flop

A set-reset flip flop is a logic element with two outputs commonly labelled Q and $\overline{Q}$. $\overline{Q}$ is said to be the inverse of Q, since $\overline{Q}$ is always a "1" when Q is a "0", and always a "0" when Q is a "1". A logic "0" applied to the set input of the set-reset flip flop will cause the Q output to go to a logic "1" and the $\overline{Q}$ output to go to a logic "0". The flip flop will then remain in this state when the "0" at the set input is removed. In this respect, the flip flop may be thought of as a memory device. A "0" applied to the reset input will cause $\overline{Q}$ to switch back to a logic "1", and Q to switch back to a logic "0".

Fig. 4 shows the common logic symbol for a set-reset flip flop, and how NAND gates can be connected to form this device. In this diagram, both SW1 and SW2 are normally open switches or contacts. If SW1 is momentarily closed, grounding pin 1 of IC1A, pin 3 will switch to a logic "1" as dictated by the truth table of Fig. 1(b). This logic "1" is then present at pin 4 of IC1B. Since pin 5 of IC1B is open circuited and therefore also at a logic "1" level, the output of IC1B switches to a logic "0". Now, when SW1 returns to its normally open position, pin 1 of IC1A returns to a logic "1" voltage. However, pin 2, being connected to pin 6 of IC1B, remains at a logic "0". Therefore the output of IC1A remains at a logic "1" state and the output of IC1B remains at a logic "0" state. This is the "set" condition of the flip flop.

Now, if SW2 is momentarily closed, a "0" is applied to pin 5 of IC1B, changing its output to a logic "1". Both inputs of IC1A are then at a logic "1" causing its output to switch to a logic "0". As before, both IC1A and IC1B retain these output states when SW2 returns to its normally open position. This is the "reset" condition of the flip flop.

Even though there are TTL ICs specifically designed as flip flops, it is not at all uncommon to see the 7400 quad NAND gate being used to implement the set-reset flip flop function. In many cases one half of the 7400 IC will be used as a flip flop while the other two NAND gates will be used as gates, inverters, pulse shapers, etc.

Switch Debouncer

We have already taken a look at one of the peculiarities of interfacing TTL logic with the outside world, namely the requirement of waveform conditioning. Another interfacing difficulty is depicted in Fig. 5. Mechanical inputs such as switch and relay contacts are relatively "noisy." As shown in the illustration, when a mechanical switch or relay contact closes, the contact actually bounces many times before coming to rest in the closed position. These bounces are very fast, being only fractions of a microsecond in duration, and therefore do not affect electromechanical or slower speed electronic circuits. However, to the high speed TTL logic, these contact bounces are a bona fide string of individual input pulses and can cause erratic or unreliable circuit operation. For instance, suppose that a counter circuit comprised of TTL logic elements was constructed to count the number of times the switch contact in Fig. 5 was closed. As can be seen from the waveform produced by this noisy switch contact, the counter would actually count the several contact closures that result as the contact bounces or "chatters" before coming to rest in the closed position. Obviously some sort of interface is necessary to prevent this type of misoperation.

The circuit of Fig. 6 shows how two NAND gates can be connected to form a bounceless switch or interfacing circuit. SW1 can be any SPDT switch or relay contact. As can easily be seen by comparison to Fig. 4, the bounceless switch is no more than a set-reset flip flop. Due to the memory action of the flip flop the circuit will always switch on the initial contact closure and will therefore be immune to the subsequent contact bounces. As can be seen from the illustration, the NAND gates will provide one clean pulse for each contact closure cycle even though contact bounce actually occurs at both the normally open and normally closed switching positions.

Square Wave Oscillators

The NAND gate can also be connected as a square wave generator as shown in Fig. 7. The particular component values of R_t and C_t shown in this diagram will allow oscillation in the 1 kHz range. To explain the operation of this astable multivibrator circuit, let's first assume that we are starting at the instant that pin 6 of IC1B has switched to a logic "0". Since pin 3 of IC1A is at a logic "1" at this same instant, C_t will begin charging through resistor R_t. When the capacitor has charged to a voltage sufficient

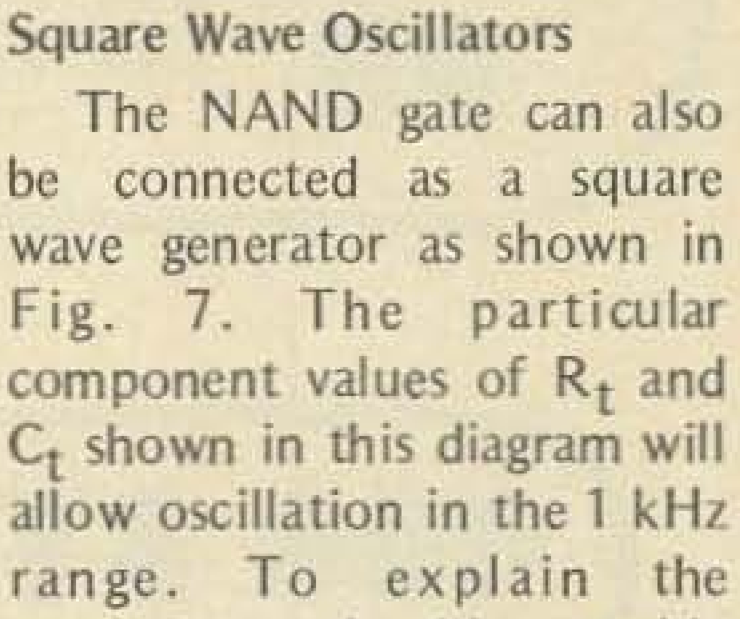

Fig. 6. Two sections of the SN7400 connected to form a bounceless switch.

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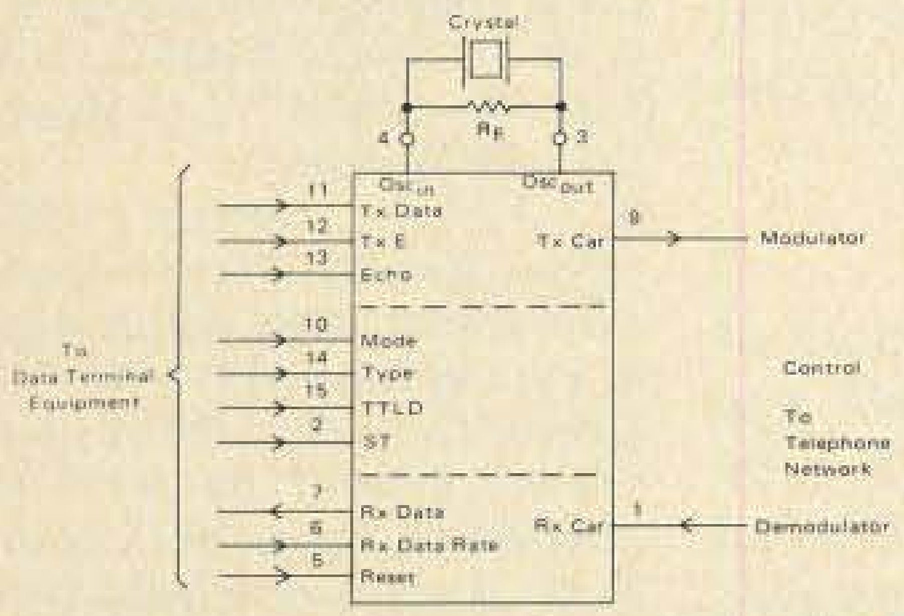

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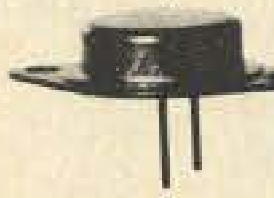

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to provide a logic "1" at pins 1 and 2 of IC1A, the two NAND gates abruptly switch logic output states. Then the logic "1" at pin 6 of IC1B and the "0" at pin 3 of IC1A cause C_t to begin discharging through R_t. When C_t has discharged to a "0" logic level, the gates abruptly change states again. Thus the oscillations continue at a rate dependent on the RC time constant of R_t and C_t.

Provisions for keying the oscillator can be made by disconnecting pin 1 from pin 2 of IC1A. Now, grounding or application of a "0" at pin 1 of IC1A will prevent oscillation, since according to the truth table the output of oscillators the frequency ranges may be varied by the selection of the RC components. The higher the RC product, the lower the frequency range that will result.

Oscillators of the type shown in Figs. 7 and 8 are often found in circuits that require a TTL compatible clock. Though these oscillator circuits are reliable, some frequency drift can be expected in normal operation.

Crystal Oscillator

Finally, as shown in Fig. 9, the NAND gate can be used to make a crystal oscillator for applications that require a

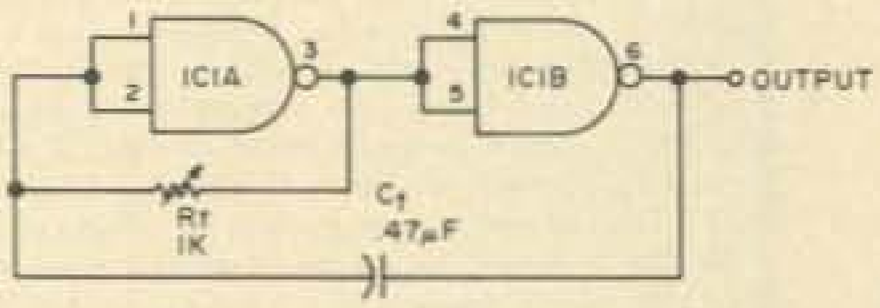

Fig. 7. Two sections of the SN7400 connected to form a square wave oscillator. See text for description of circuit operation.

IC1A must always remain at a "1" as long as one input is at a "0". A logic "1" or an open circuit at pin 1 would allow the oscillator to run.

Two other connections of NAND gates to form square wave oscillators are shown in Fig. 8. Like the oscillator just described, these oscillators also rely on the charge-discharge cycle of capacitors to provide oscillation. In all these more stable clock pulse than that yielded by the previously described square wave oscillators. As can be seen by comparison with Fig. 8(b), the crystal oscillator is basically the same as the square wave oscillator except for the replacement of one capacitor with a quartz crystal. The upper frequency range of the NAND gate as used in this application is typically 15 MHz though

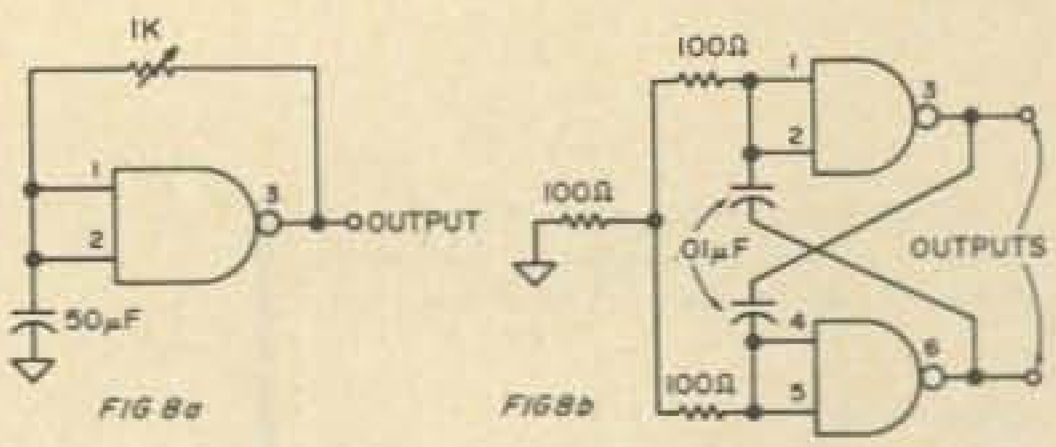

Fig. 8. Two more square wave generators. The oscillator of Fig. 8(a) will oscillate at approximately 45 Hz. The oscillator of (b) will have a frequency of about 50 kHz. See text for description of how frequency may be varied.

some gates will oscillate at somewhat higher frequencies. The addition of a trimming capacitor in the circuit of Fig. 9(b) will allow for netting the oscillator frequency if this is deemed necessary in certain applications.

Conclusion

The list of applications of the 7400 quad NAND gate presented in this article is by no means complete. Like all other devices, its possible applications are limited only by the ingenuity of the circuit designer. The basic simplicity of the device itself, its low price tag, and its versatility make it the ideal device from which the digital logic neophyte can gain valuable insight into digital logic circuitry. ■

References

1. Signetics Digital 54/7400 Data Book, copyright 1972, page 9.
2. W. F. Stortz K3QKO, "Can a Keyer Be Logical?", *73 Magazine*, Dec., 1974, page 53.
3. A. A. Kelley K4EEU, "Slow-Scan TV Test Generator," *Ham Radio*, July, 1973, page 6.
4. Stirling Olberg W1SNN, "Logic Oscillator for Multi-channel Crystal Control on VHF FM," *Ham Radio*, June, 1973, page 46.
5. C. A. Ellsworth W6OXP, and W. G. Malloch W8KCQ, "RTTY Message Generator," *Ham Radio*, Feb., 1974, page 30.
6. Don Lancaster, "IC Logic Demonstrator," *Radio-Electronics*, May, 1972, page 51.
7. H. Edward Roberts and David Bunnell, "Basic Digital Logic Course," *Popular Electronics*, Dec., 1974, page 38.

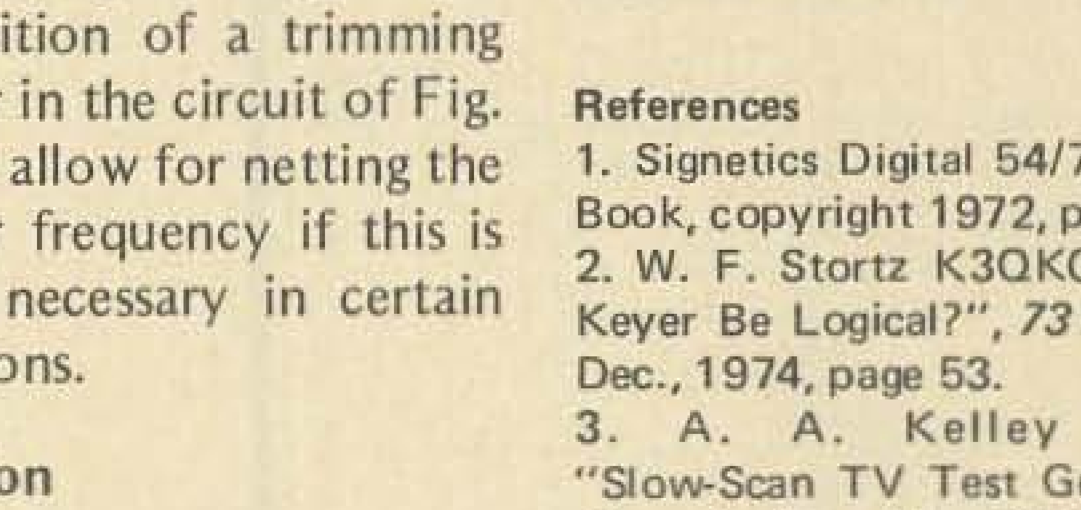

Fig. 9. Two examples of how the SN7400 can be connected to form a crystal oscillator.

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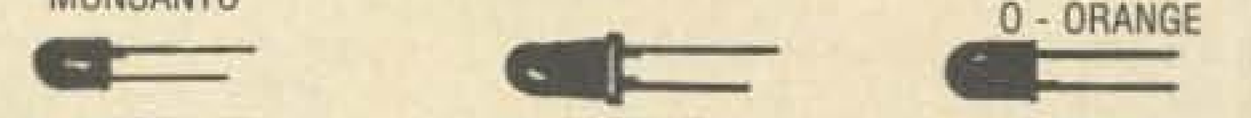

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74LS10	.39	74LS86	.65	74LS181	3.69
74LS13	.79	74LS90	1.25	74LS190	2.85
74LS14	2.19	74LS92	1.25	74LS191	2.85
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1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N965B	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
IN485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	IN1186	200 PIV	35 AMP	1.80
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	.05	.04	.03	.0047µF	.05	.04	.035
	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

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.0022	.12	.10	.07	.047mf	.21	.17	.13
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.01mf	.12	.10	.07	.22mf	.33	.27	.22

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.15 35V	.28	.23	.17	2.2 25V	.31	.27	.22
.22 35V	.28	.23	.17	3.3 25V	.31	.27	.22
.33 35V	.28	.23	.17	4.7 25V	.32	.28	.23
.47 35V	.28	.23	.17	6.8 25V	.36	.31	.25
.68 35V	.28	.23	.17	10 25V	.40	.35	.29
1.0 35V	.28	.23	.17	15 25V	.63	.50	.40

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1.0 50V	.16	.14	.11	.47 50V	.16	.14	.11
3.3 50V	.15	.13	.10	1.0 16V	.15	.13	.10
4.7 25V	.16	.14	.12	1.0 25V	.16	.14	.11
10 25V	.15	.13	.10	1.0 50V	.16	.14	.11
10 50V	.16	.14	.12	4.7 16V	.15	.13	.10
22 25V	.17	.15	.12	4.7 25V	.15	.13	.10
22 50V	.24	.20	.18	4.7 50V	.16	.14	.11
47 25V	.19	.17	.15	10 16V	.14	.12	.09
47 50V	.25	.21	.19	10 25V	.15	.13	.10
100 25V	.24	.20	.18	10 50V	.16	.14	.12
100 50V	.35	.30	.28	47 50V	.24	.21	.19
220 25V	.32	.28	.25	100 16V	.19	.15	.14
220 50V	.45	.41	.38	100 25V	.24	.20	.18
470 25V	.33	.29	.27	100 50V	.35	.30	.28
1000 16V	.55	.50	.45	220 16V	.23	.17	.16
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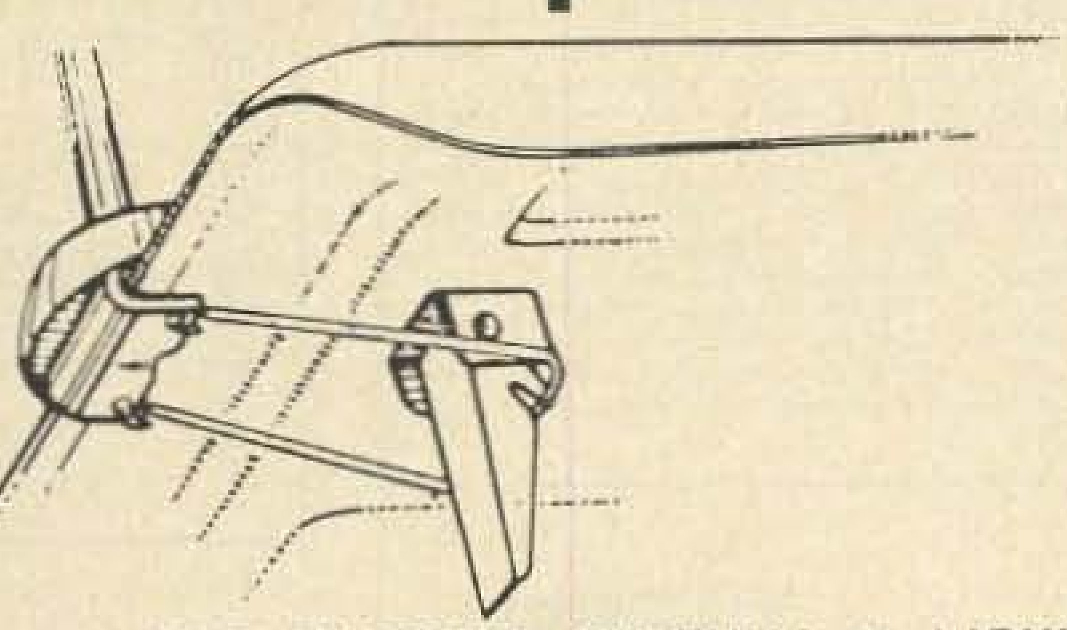

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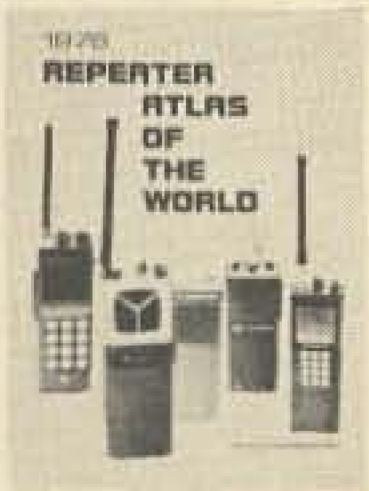

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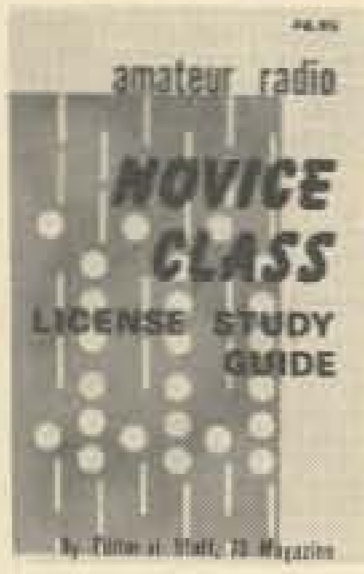

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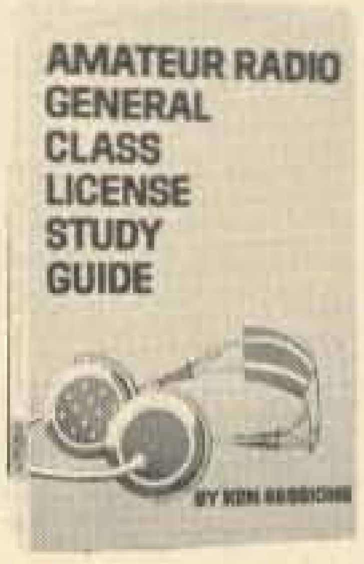

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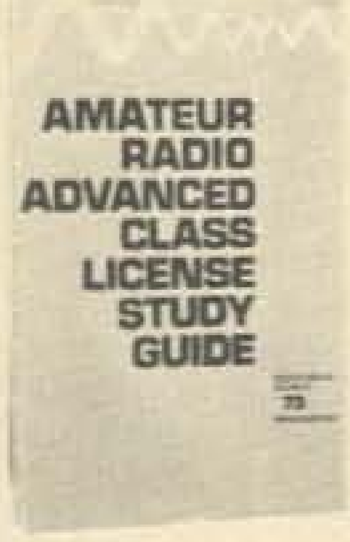

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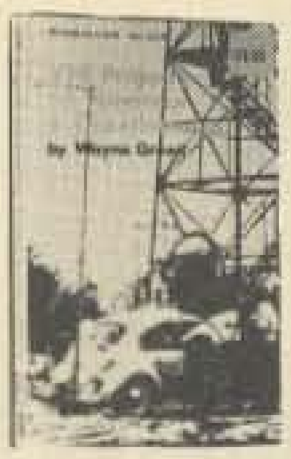

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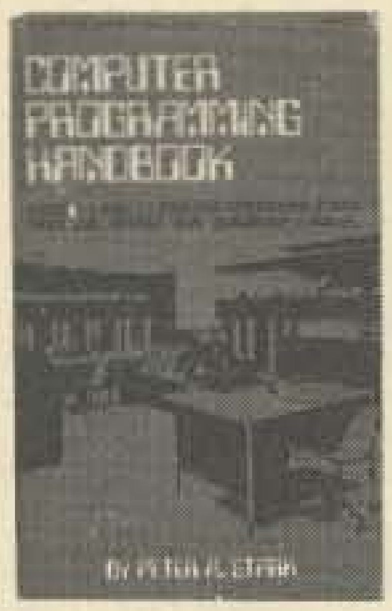

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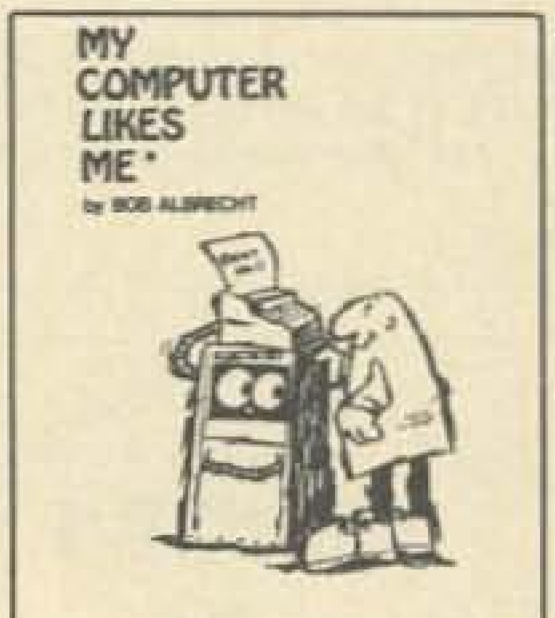

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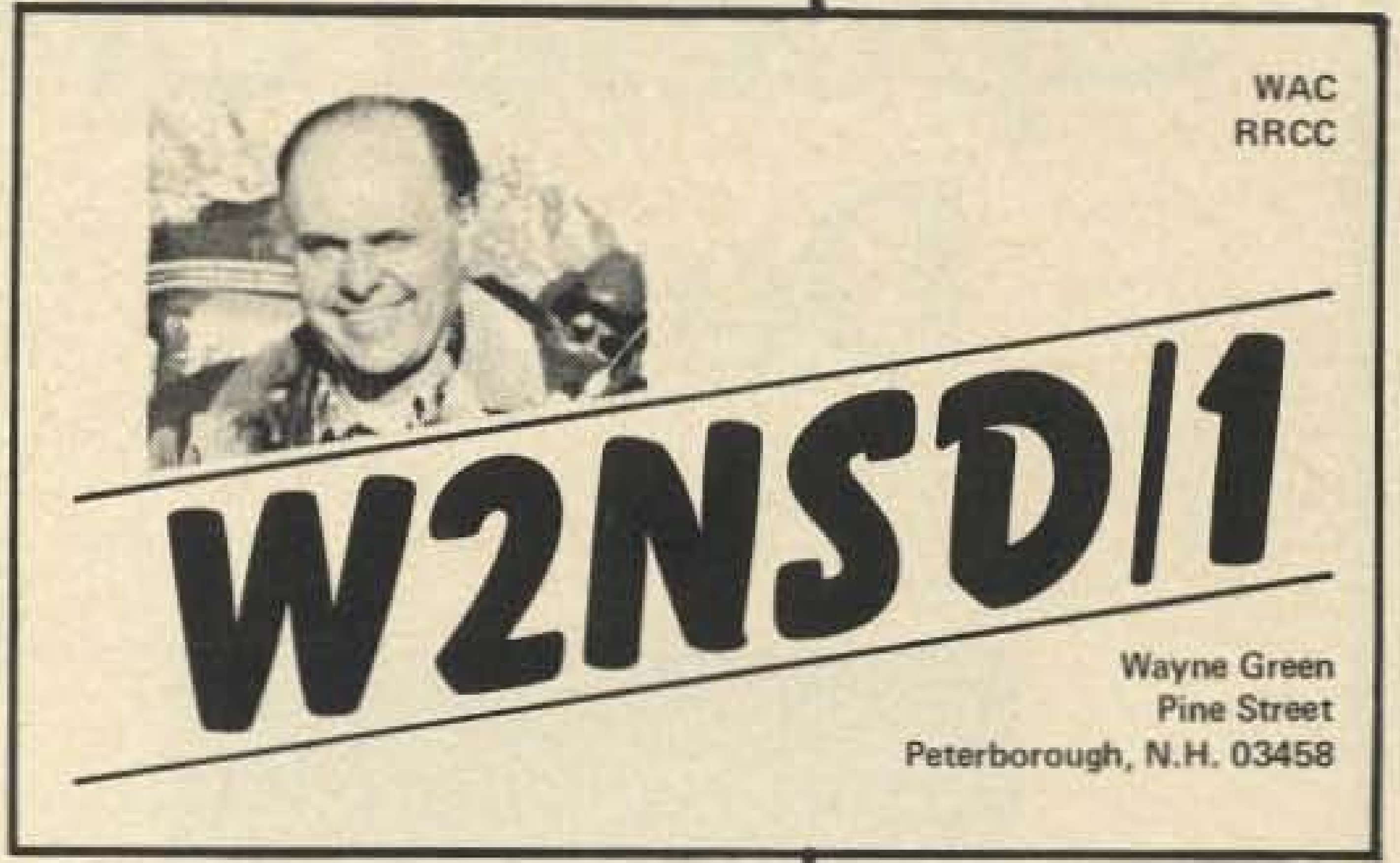

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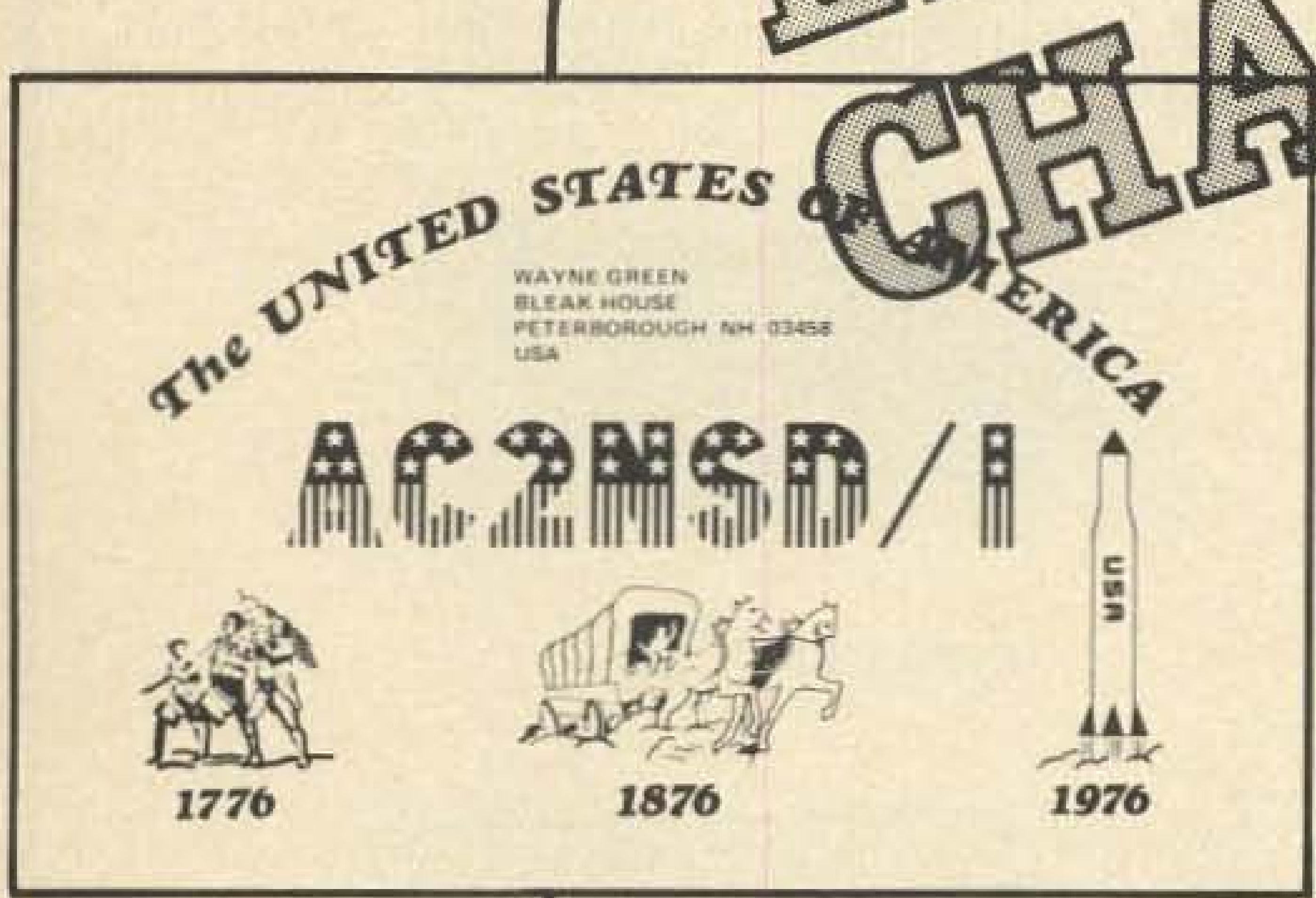

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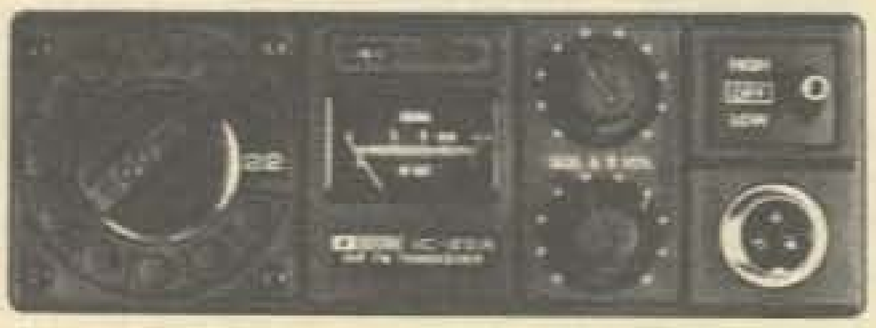

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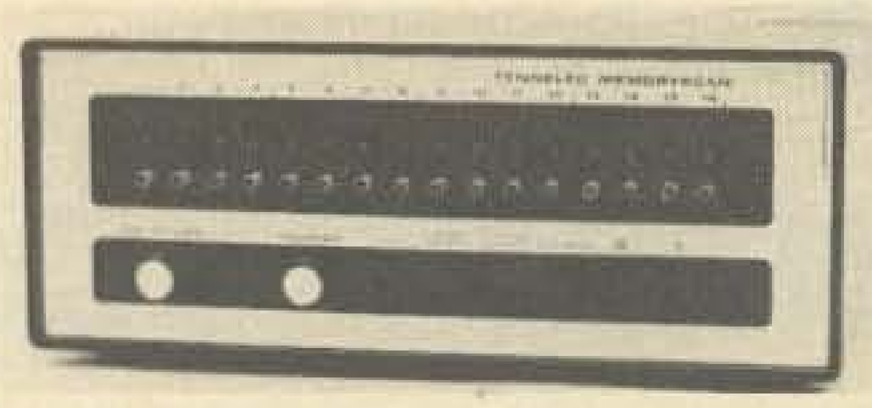

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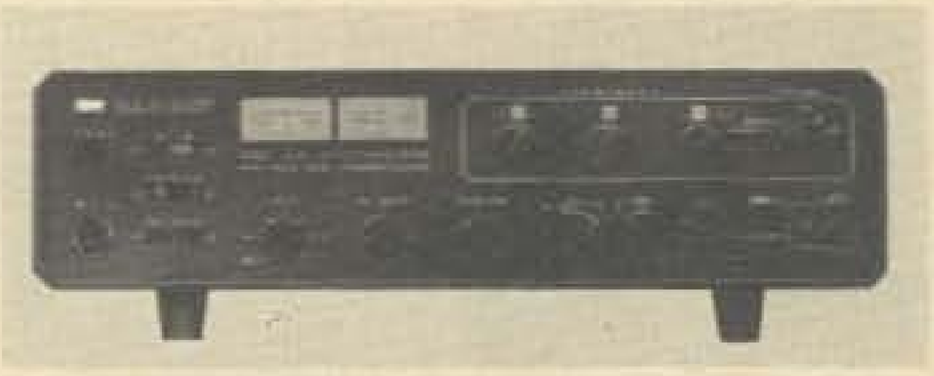

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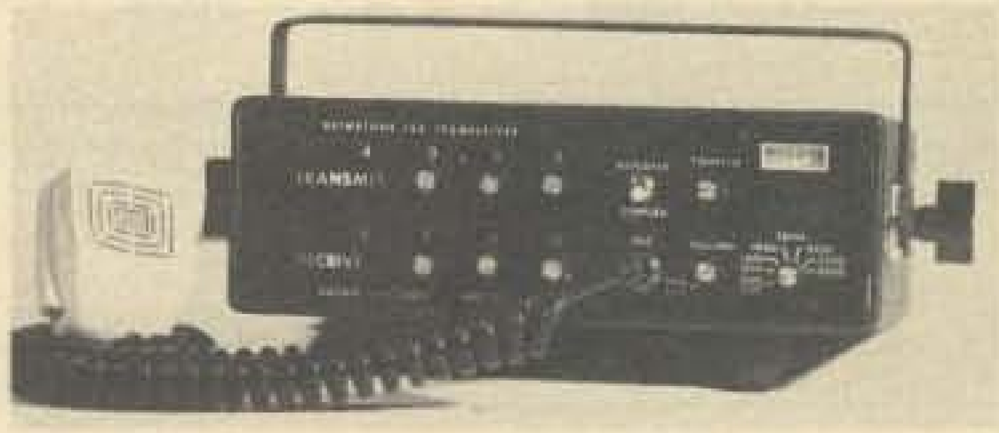

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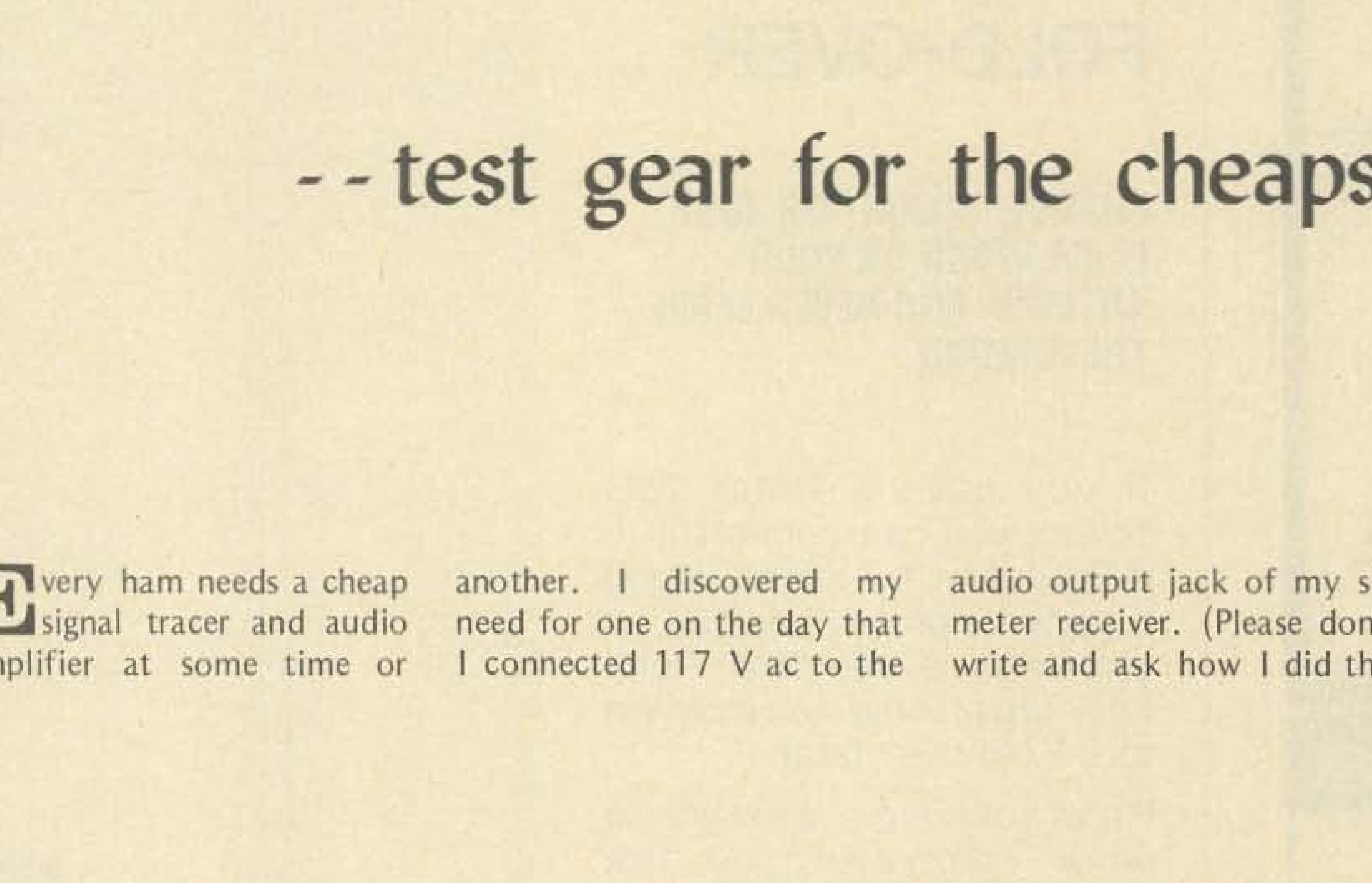
EL Cheapo Signal Tracer

--test gear for the cheapskate

Every ham needs a cheap signal tracer and audio amplifier at some time or another. I discovered my need for one on the day that I connected 117 V ac to the audio output jack of my six meter receiver. (Please don't write and ask how I did this – there are painful memories involved.) When the smoke cleared, the two audio output transistors and their transformer were in such a mess that they were eligible for foreign aid (it's a Japanese receiver). I wanted to get back on the air fast, so I rummaged through the junk box until I found a cheap transistor radio. With this, a resistor, and a capacitor, and ten minutes of work, we were back in business. Best of all, the transistor radio is still usable instantly if I ever fix the six meter receiver.

The modification to the pocket radio involves four steps. First, find the earphone jack and the earpiece and



This photo shows the dropping resistor connected to the positive battery terminal, and the lead from the volume control to the external jack.

Photos by Mike Likavec WA8NNX

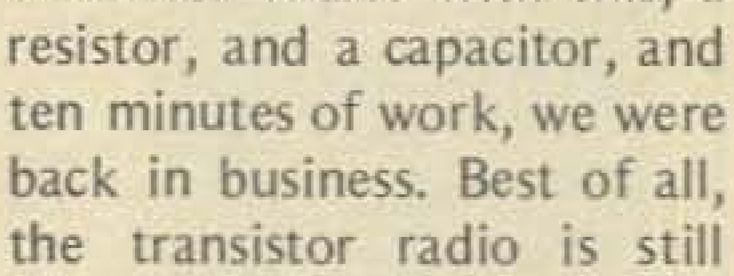


Fig. 1. The original circuit.

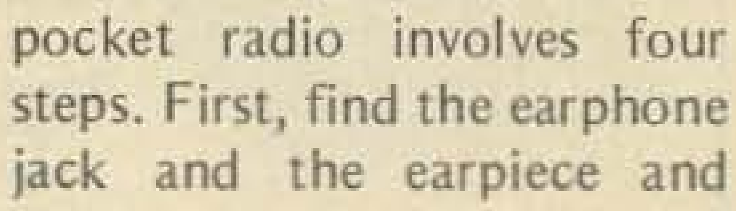
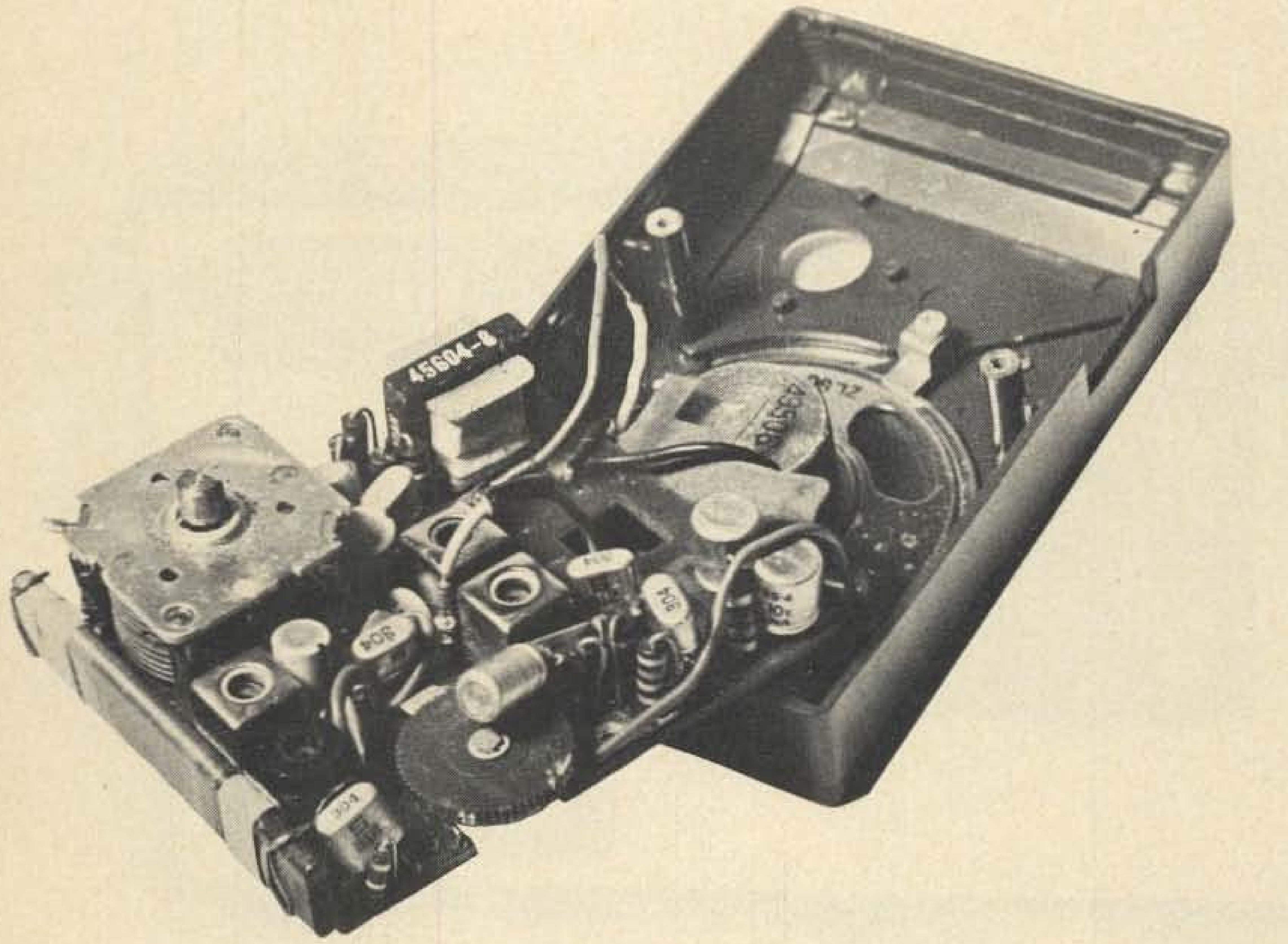


Fig. 2. The modified circuit.



This photo shows the diode detector (nestled snugly between two i-f cans) and its lead (going to the jack).

cord that plug into it. Inside, the jack will have three wires connected to it: a ground, a lead to the speaker, and another one trailing off to the innards of the radio somewhere. This last wire actually goes to the secondary winding of the audio output transformer (see Fig. 1).

Leave the ground wire undisturbed. Unsolder the wire to the speaker and the one to the innards, both at the jack, and note which went where. Solder the ends of these two together and tape them. Now the radio is permanently connected to its built-in speaker.

The second step involves finding the point where the diode detector connects to the volume control. This can be found by tracing back from the center pin of the volume control along the foil until you find the glass diode. Unsolder the end of this diode which goes to the volume control, but leave the other end connected. Solder a piece of insulated hookup wire to the free end of the diode. The other end of this wire is soldered to the pin on the earphone jack that was formerly connected to the speaker. Solder another piece of insulated wire to the point on the circuit board where the free end of the diode used to be. The other end of this wire is connected to the remaining pin on the earphone jack that used to be connected to the innards. Now, without a plug in the earphone jack, the pocket radio will play normally, since the diode detector is connected to the volume control once again, although now through the contacts of the earphone jack (see Fig. 2).

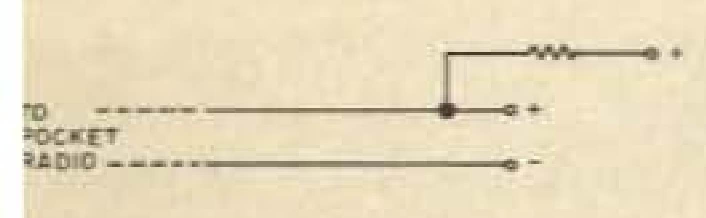


Fig. 3. Battery terminals with added dropping resistor.

For the third step, cut the earpiece off the end of its cord. Strip the ends of the wires, and with an ohmmeter or continuity checker, find out which of the wires goes to the inner pin of the jack, and mark it. The other lead is the ground connection, which can be connected to an alligator clip. Solder one lead of a 1 uF capacitor to the "hot" lead. This capacitor will keep stray dc voltages out of your pocket radio, thus preventing premature trauma. The free end of the capacitor is the probe tip, and is to be connected to the equipment under test, wherever you suspect audio should be. With the earphone plug inserted in the jack, and the probe connected to the circuit under test, you should now hear the desired signal, rather than Olivia Newton-John. The lead with the capacitor can be built into the plastic end of a discarded ballpoint pen, to make a neater probe tip. The voltage rating of this capacitor must be higher than any voltage you have in the equipment under test. For tube type receivers, 600 volts is usually adequate, while a 50 volt capacitor is adequate for transistor receivers and hi-fi gear.

If you're going to run the pocket radio from its own battery, this step may be omitted. If you would like to run the pocket radio from the voltage in the gear under test, this formula can be used to find the right value of dropping resistor:

$$\text{Resistance} = \frac{(\text{Available Voltage}) - (\text{Voltage Needed})}{\text{Receiver Current}}$$

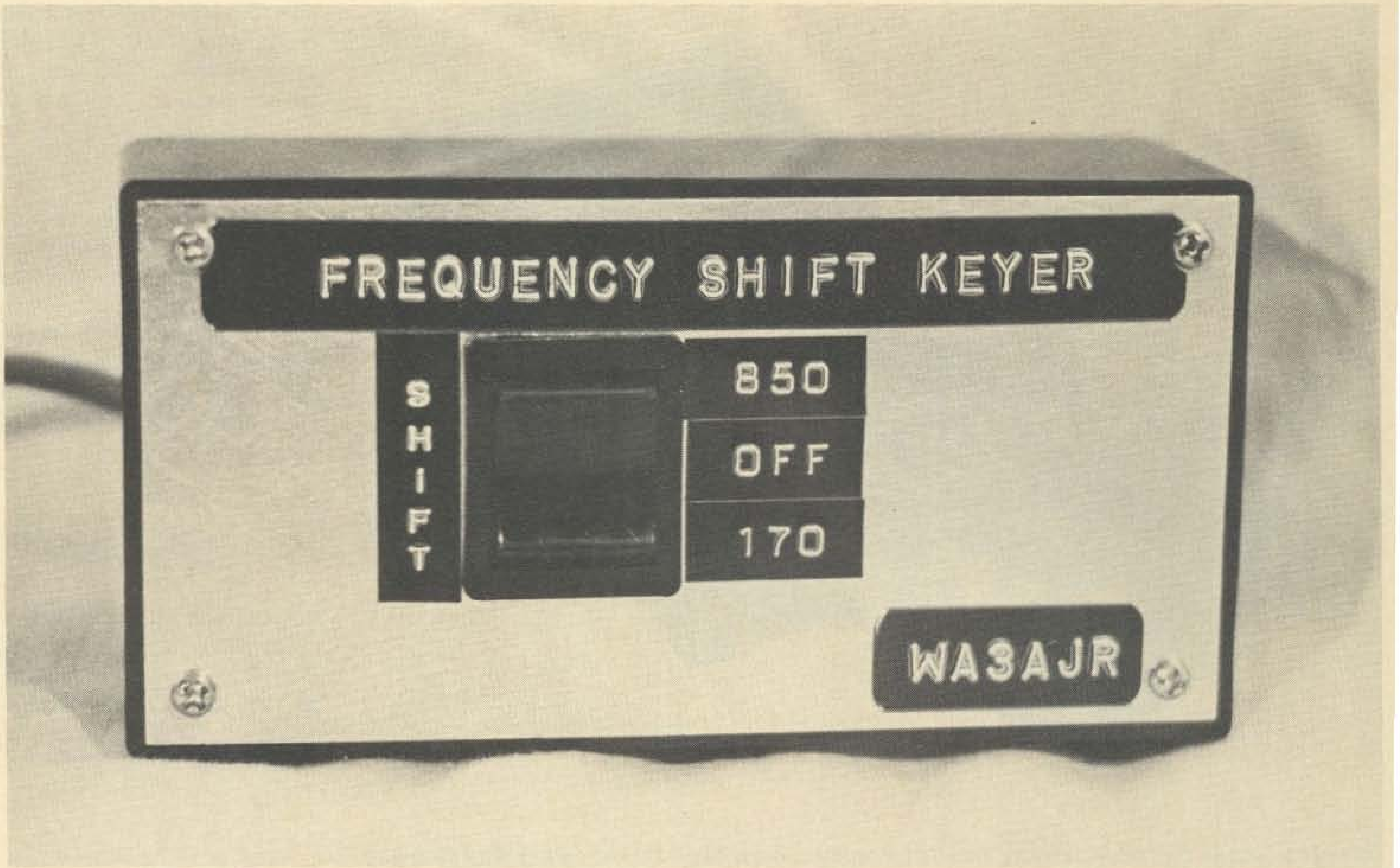
For example, if your pocket radio needs 9 V to operate, and 12 V is available, and the pocket radio draws an average of about .010 A, then by plugging the numbers in:

$$\frac{12\text{-}9}{.01} = \frac{3}{.01} =$$

300Ω resistance needed

The wattage needed for the resistor can be figured by the formula $I^2R = P$; that is, the current multiplied by itself, times the resistance, gives the needed power rating in Watts. In the example above, it would be (.01) x (.01) x 300 = .03 Watts. A ¼ Watt resistor would give a more than adequate safety margin. If you're planning to use a 150 V supply to run the pocket radio, a 14.1 kΩ at 1.4 Watts is the calculated value, and 15 kΩ at 5 Watts is adequate and a practical common value. This resistor is connected between the positive terminal of the battery holder and the supply voltage point, as shown in Fig. 3 and the photo.

Once completed, the pocket radio can be used normally, and, by just plugging in the earphone plug/test probe, it becomes a signal tracer or audio amplifier. Total cost is less than fifty cents as promised, and you've still got your radio. ■



Marc I. Leavey, M.D. WA3AJR
10-J Tentmill Lane
Pikesville MD 21208

FSK with the SB-401

- - simple way to get on RTTY

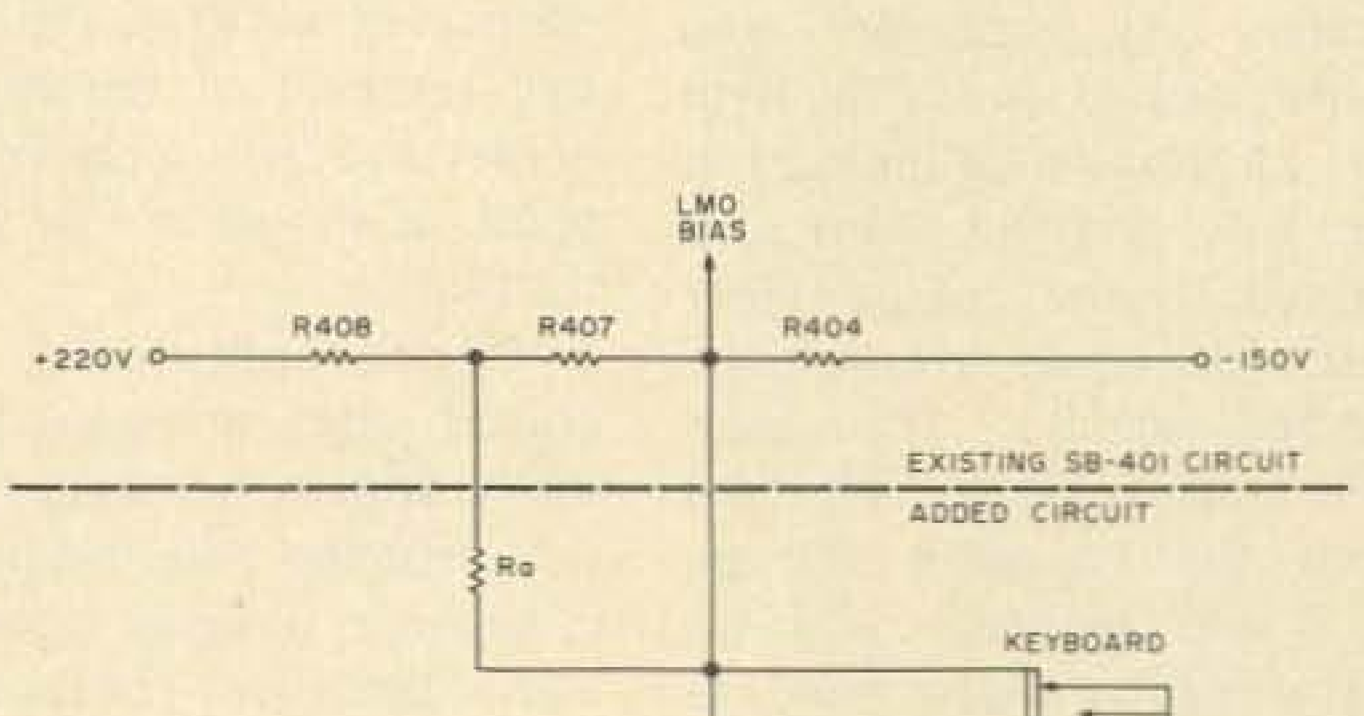
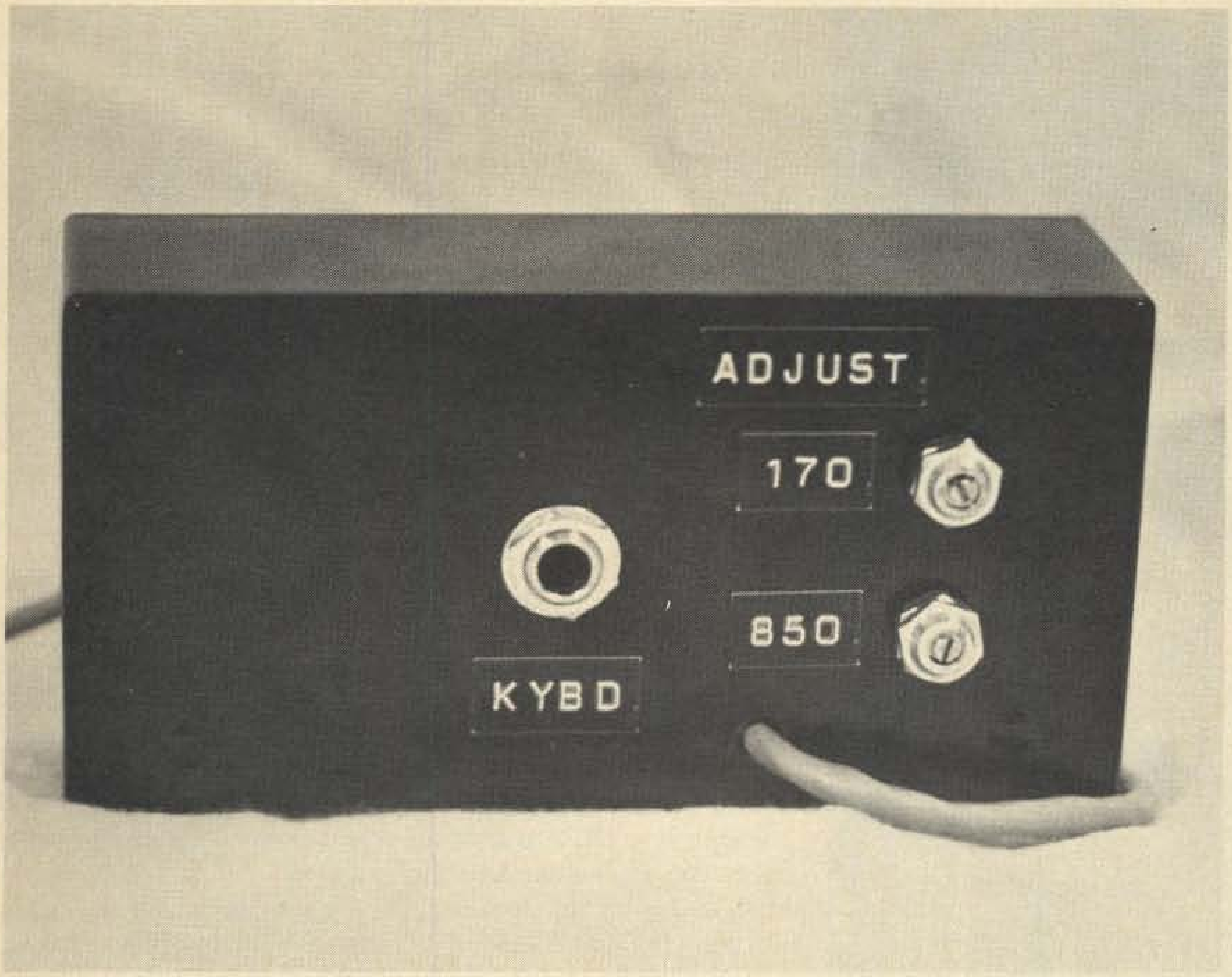


Fig. 1. Skeleton FSK network.

In the good old days (and when I say good old days I don't mean George M. Cohan days), the average ham had a CW or CW-AM (remember that?) transmitter and a separate VFO. For those enterprising enough to try radioteletype (RTTY), a simple diode keyer applied to the cathode of the oscillator tube (another oldie-but-goodie) would produce a frequency shifted signal. Those wanting to do some background reading, or who may still have a separate VFO and wish to try the old way, should refer to an excellent discussion of a "shift-pot" circuit in *QST*, May, 1965. Irv Hoff, a RTTY pioneer,



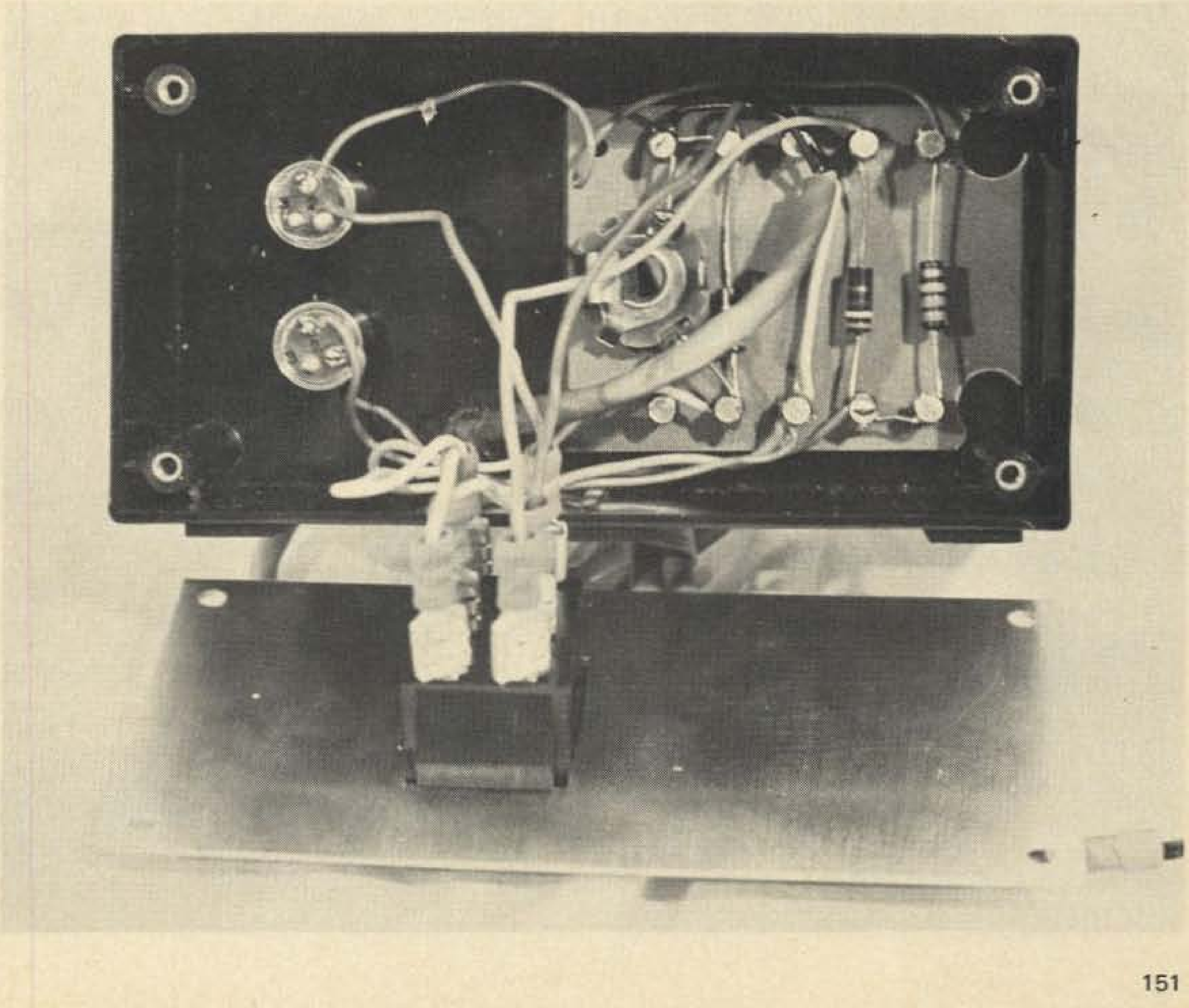
had a series that year which is required reading for anyone contemplating RTTY. If you are going to use the old, but venerable, shift-pot circuit, then you are excused from reading the rest of this article, and may drool at the ads elsewhere in this magazine. If not, stay with me.

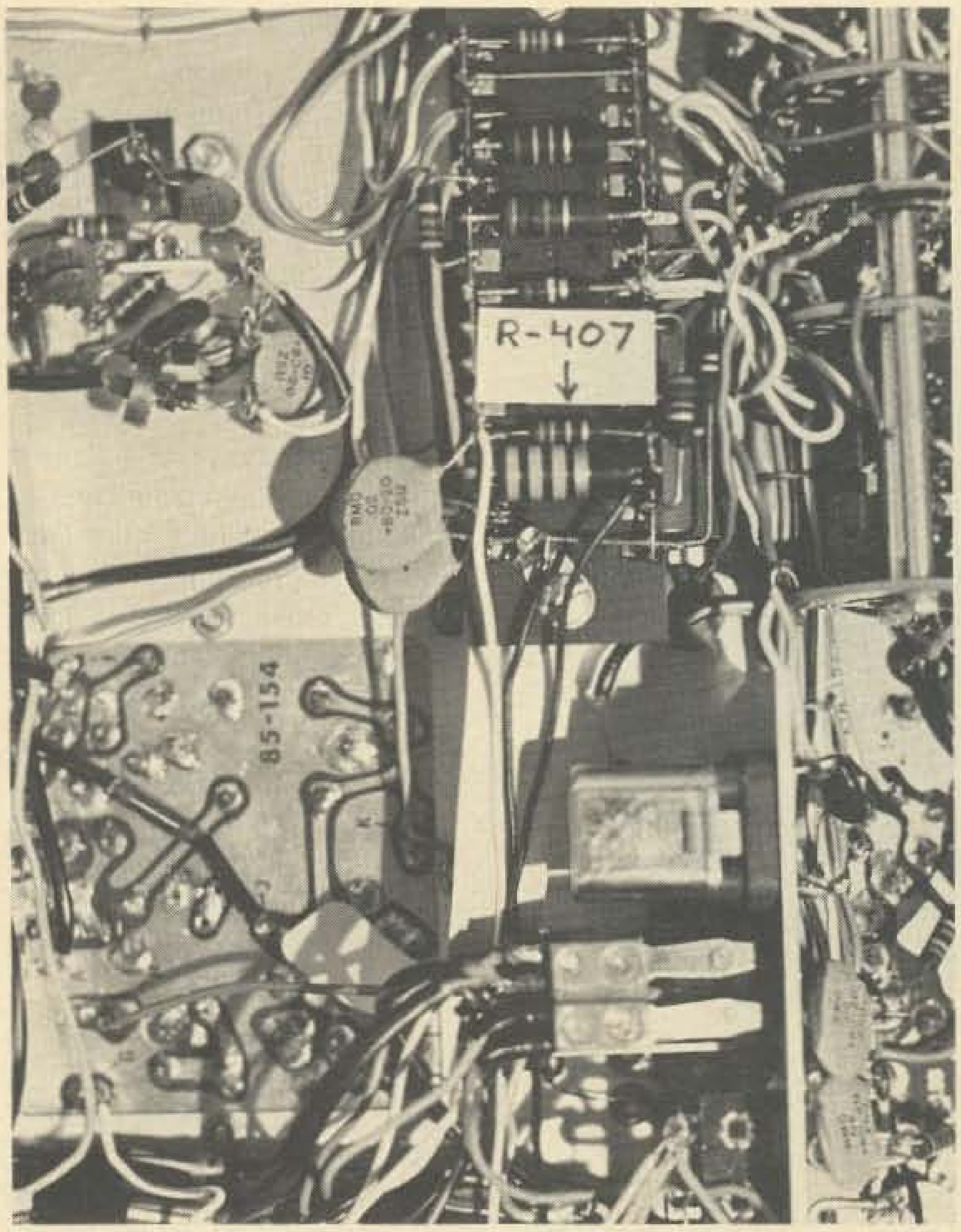
Not too many years ago, a new beasty, SSB (or SSSC, as it was first named) hit the airwaves. In order to put one of *those* on RTTY, you had two alternatives: Either use the rig as an expensive CW transmitter and use a shift-pot circuit, or inject audio tones and shift them, thus producing FSK at the output. Again, Hoff's landmark *QST* series goes into much detail on this. The AFSK input approach is certainly simple, but unless the transmitter is perfectly "clean" with regard to unwanted sideband and carrier, and the audio tones are perfect sine waves, all sorts of spurious signals can result. The end effect is to make us use the SSB rig as a CW transmitter, and fall back on the shift-pot.

Enter a new era. With the SB-400/401, Heathkit introduced the ham to the Linear Master Oscillator. Unlike the VFO, the LMO is said to be linear over the entire band, making frequency readout and calibration a cinch. Only one hang-up: The LMO is *sealed.* How can you transmit FSK? Until now, the only way has been the audio input (AFSK) method. This article details a method for frequency shift keying these transmitters that is easier than using the old shift-pot.

In order to maintain the same frequency on upper and lower sidebands, and still get the audio filtered through a mechanical filter to generate said sideband, it becomes obvious that some means of shifting the LMO frequency must be inherent in the system. The "BIAS" input does just that. By shifting the bias, the frequency of the LMO is shifted several kHz. Now, all we have to do is shift the bias in step with the desired FSK signal, and reduce the magnitude of the shift to 850 Hz, 170 Hz, or whatever is desired.

The circuit, shown in Fig. 1, does just that. Bias voltage for the LMO is derived from the junction of R404 and R407. A ground is established through Ra and Rb, with Rb shorted on "mark" – producing a high frequency. In order to make the circuit practical, a means of selecting





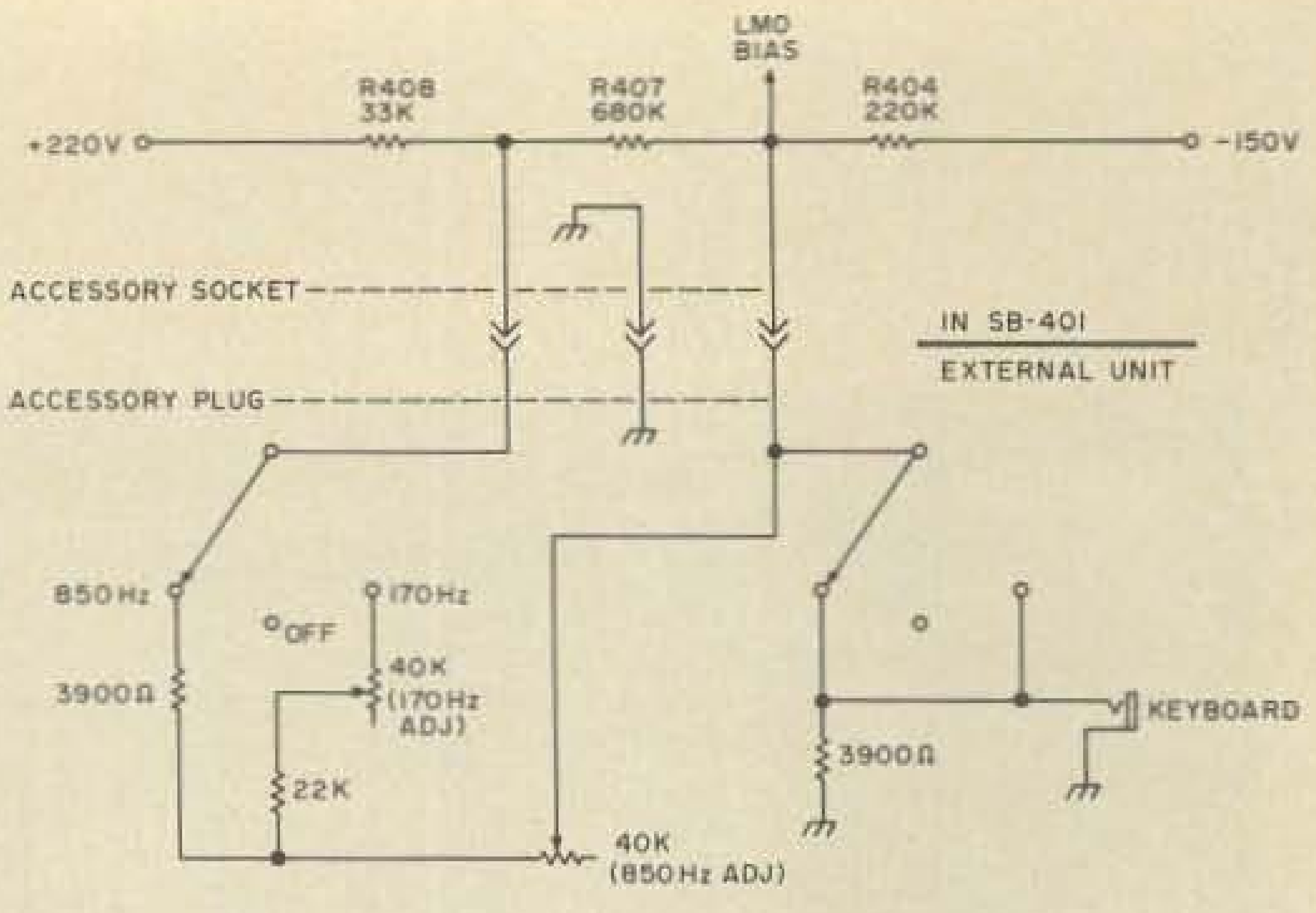
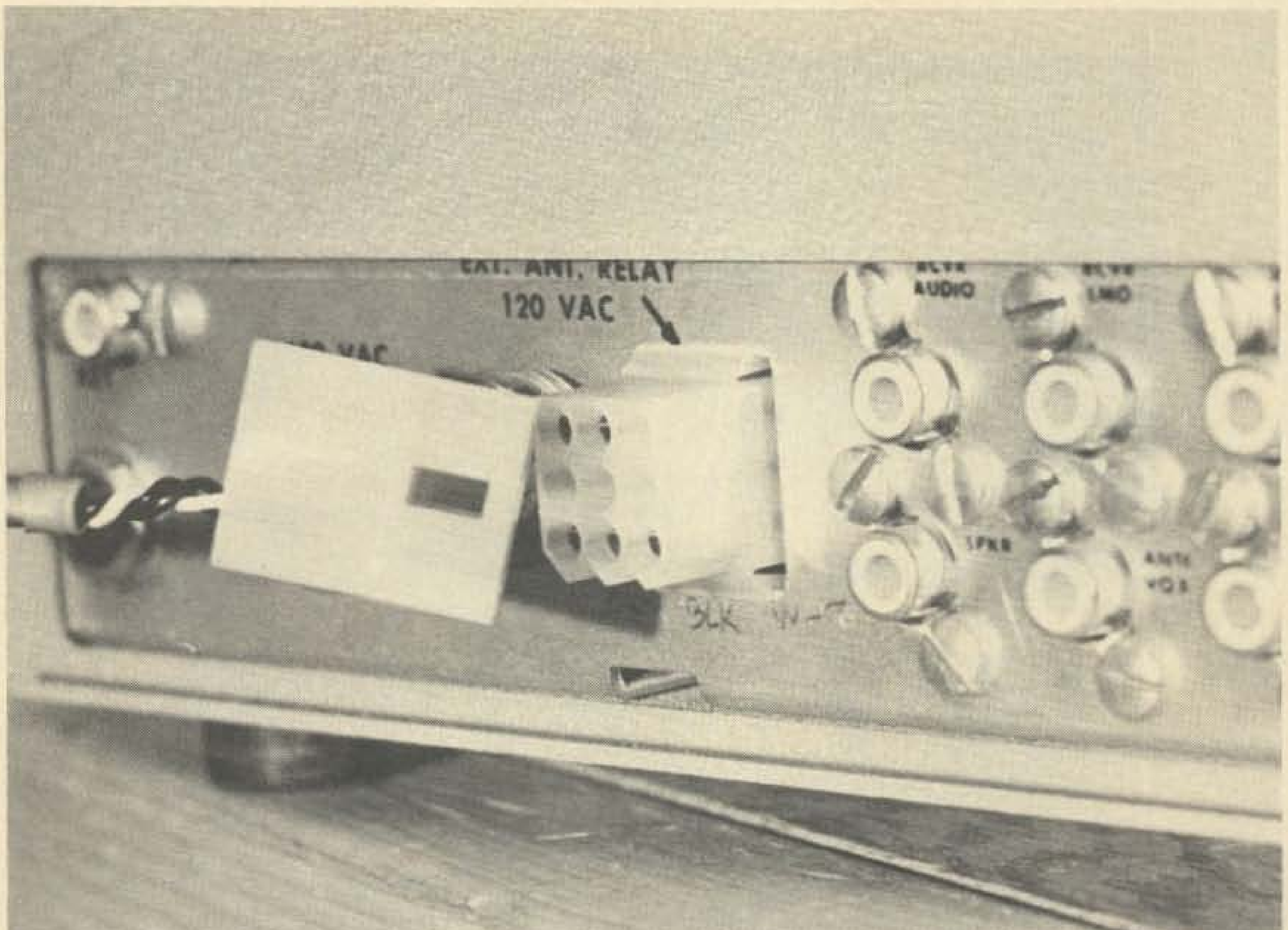


Fig. 2. Frequency shift keyer.

shifts, and disabling the circuit for SSB operation, is necessary. These additions result in the final circuit, Fig. 2. Keying for the FSKer must be done "dry," with clean contacts. This makes direct keyboard or loop keying impractical. A polar relay, or better yet a magnetic reed relay, may be used. For a discussion of the magnetic reed relay in keying, see my article, "AFSK Revisited," in the January, 1974 issue of *73 Magazine*. In it I go into the how and why of reed-relay keying.

Connection to the SB-401 is made on the underside, at Terminal Board No. 2. R407 is available there, and leads may be run from each side, and ground, to the accessory socket in the back. If you have lost the connectors for the socket, they are available from Heath, or in many parts stores (Waldom/Molex .093" Mating Pin Terminals, No. 1381-80). The unit may then be plugged in or unplugged as desired.



Calibration and operation are as with any FSK network. With the keyboard contacts in "MARK" condition, zero the transmitter to the desired frequency. Open the keyboard contacts and adjust the appropriate potentiometer for either 850 Hz or 170 Hz shift. The transmitter should be loaded to only 100 Watts or so, rather than the full 175 Watts, as long continuous transmissions are not conducive to final tube health. Cutting back from 175 Watts to 100 Watts is less than a 3 dB change, anyway. A straight key plugged into the key jack will serve as both a transmit/receive switch and a means to identify the station on CW.

Although the slant of this article has been directed toward the use of FSK for RTTY, any variable modality may be introduced to produce a corresponding frequency shift. Rather than use audio tones, an enterprising SSTV enthusiast might find herein a way to produce that peculiar signal in a novel way.

At any rate, I hope this method can find wide application, and get more of you out there on the green keys. ■

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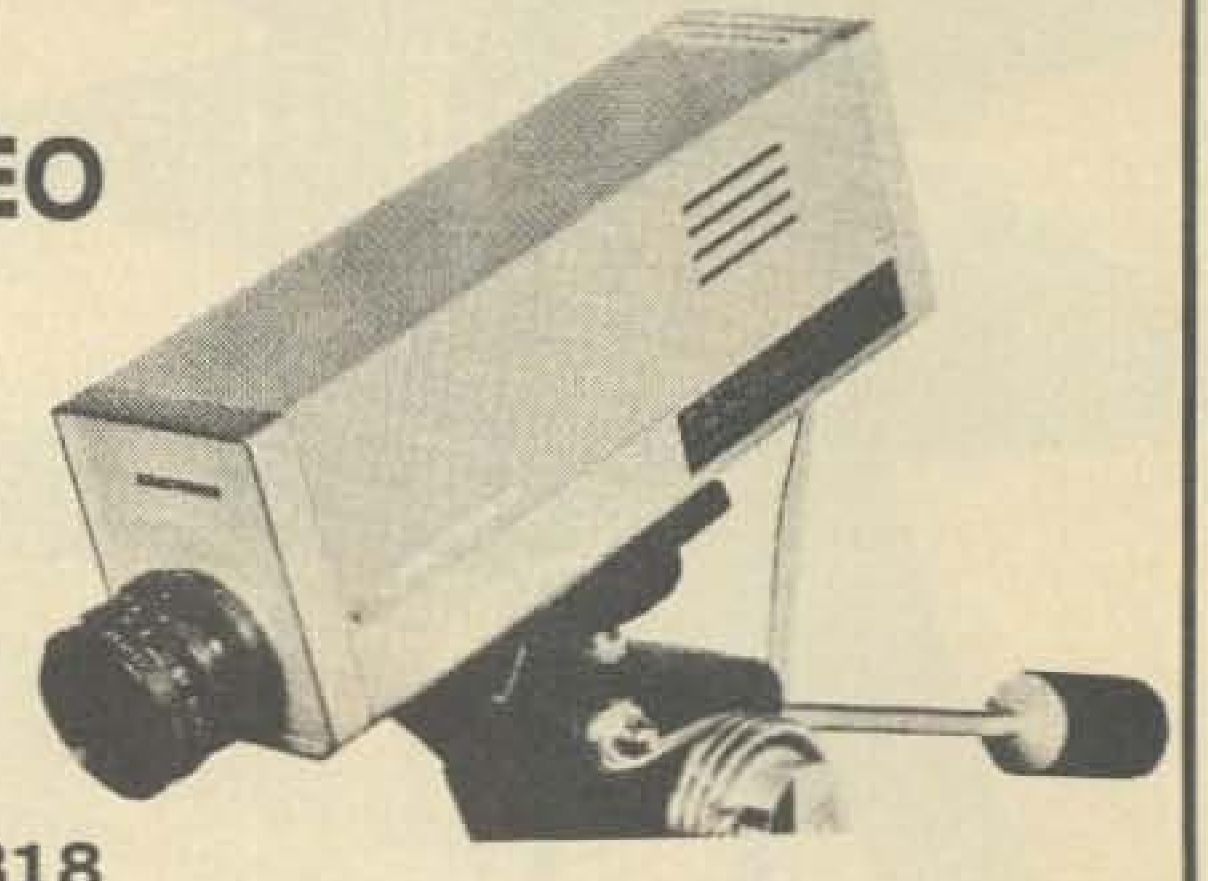

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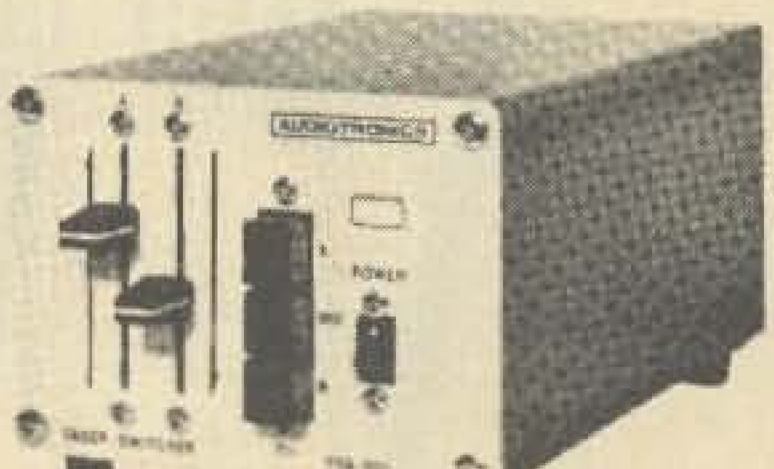

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#18,361 – All transistorized, small, light-weight camera features a stable & high quality picture. Auto. gain control, "Cat Eye" adjusts the sensitivity of the camera corresponding to the object-brightness. The camera contains a power supply, deflection circuits & sync circuit. It can be operated without any delicate initial adjustments. Simply focus by means of the "FOCUS" control. Because of its simplicity no technical knowledge is required to operate this system. Specifications: Tube – 1″ 7038; Scanning: H. Freq. 15.75 KC; V. Freq. 60 c/s; Freq. Resp. 4.5 MC. Output Signal: Video Output only; Output Z; 75 ohms; Output: 1.4V (p.p); Resolution: Horiz: 450 lines; Vert. 300 lines. Illum: Std. 500 Lux. Mini 100 Lux; ALC. 1:600 (100-60,000) Lux; Ambient Temp: 32°F – 104°F; Power Source: AC 117/220V; 50/60 C/s; Power Consumption: 15VA; Mechanical: Dimensions: 6.6″W x 9.5″D x 3.2″H Wt. 5.6 lbs. Only $149.95 – lens not included.

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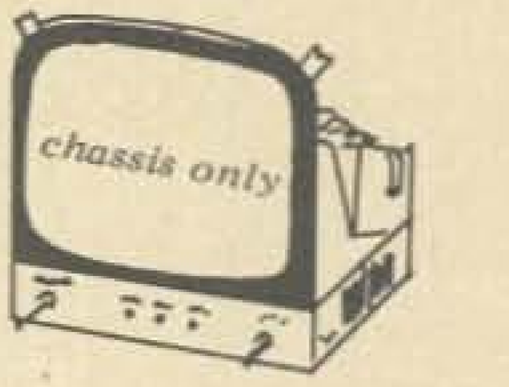

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#5759 – Conrac model KNB 9 Monochrome 9″ video monitor chassis. Designed for cont. operation & is fully compatible with EIA & industrial 525 line TV standards. Compl. solid state. Chassis measures 8 5/16W 8 3/16H 9 11/16D & Weighs only 9.5 lbs. Input power 35W, 120/240V, 60 Hz. Min. Video Signal Input requirement 0.30V. Video Response -3dB at 8 MHz. DC Restoration, resolution 600 lines; linearity within 3%. May be easily rewired for external sync operation. Brand new in orig. cartons w/sch. $149.95

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Social Events

DUNSEITH ND
JULY 10-11

The 13th Annual International Hamfest will be held July 10 and 11, 1976 at the International Peace Garden between Dunseith, North Dakota and Boissevain, Manitoba. This year it will be held in the Canadian Pavilion. Excellent camping, contests, prizes, party, dance and meetings. For information write WBØGFZ or VE4OD.

SANTA MARIA CA
JULY 11

The Satellite Amateur Radio Club is sponsoring the Santa Maria Amateur Radio Picnic And Swapfest to be held on Sunday, July 11th, 1976, beginning at 12 noon at the Newlove-Union Oil Picnic Grounds on Orcutt Hill. Watch for the signs marking the turnoff, 1 mi. south of Clark Ave. on US 101. Talk-in will be on 146.52 and 7280 kHz.

The highlight of the event is the Santa Maria style barbecue, to be served at 2:30 pm. All the meat, salad, beans, bread and salsa that you can eat. Soft drinks will be available, but bring your own beer.

The main door prize is a Tempo One 80-100 meter transceiver. Other prizes, too. Swap tables available at $3.00 each.

The meal alone is well worth the drive from L.A. or the central valley. Tickets are only $5.00 for adults/$2.50 under 12, and can be obtained by sending a check made out to Santa Maria Swapfest, Route 1, Box 55A, Santa Maria CA 93454.

Please obtain tickets in advance so that enough meat can be ordered.

SOMERSET KY
JULY 11

The Lake Cumberland Amateur Radio Association's hamfest will be held Sunday, July 11, 1976 at 10 am at the Somerset Outdoorsmen's Club, Somerset KY 42501. Lunch will be available.

CHARLESTON SC
JULY 11

The Charles Towne Hamfest will be held at the Gaillard Municipal Auditorium on Sunday, July 11, 1976, in Charleston SC. Registration is $2, which includes a door prize ticket. Activities include an indoor flea market, displays, home brew contest, CW copying contest, historic tours, and a special program on the Marconi Wells Fleet Wireless Station. Saturday activities include QCWA, MARS, S.C. SSB Net Banquet, and a hidden xmtr hunt. Talk-in on 34/94 and 3915. For further information write — Charles Towne Hamfest, Box 4555, Charleston SC 29405 or check into the S.C. SSB net on 3915 at 7 pm local time.

CORUNNA MI
JULY 17

The Shiawassee Amateur Radio Association (SARA) of Owosso, Michigan is hosting the Michigan Buzzards Roost and Emergency Nets picnic and sponsoring the 2nd annual SARA Swap and Shop at McCurdy Park, Corunna, Michigan. Early Bird get-together Saturday evening, July 17, Swap and Shop, picnic on Sunday, 8 am to 5 pm, July 18. Free admission, tables for Swap and Shop $2.00, tickets available for drawings, overnight trailer and camping space available. Talk-in on 3930 kHz, 146.52 MHz with repeaters on 147.63/.03 and 449.30/442.10 MHz. For further information, write SARA, 1302 W. Main St., Owosso, Michigan 48867.

FLOURTOWN PA
JULY 18

Picnic. Friends of WR3ABE bring family and food, noon, Sunday, July 18, 1976 at Fort Washington Park, Flourtown PA.

TERRE HAUTE IN
JULY 18

Turkey Run Hamfest has MOVED! New location is the Vigo County Fairgrounds on Highway 41 just South of Terre Haute. There will be prizes galore, lots of flea market space under a roof, XYL Bingo, and plenty of overnight camping will be available. Presale tickets are available 4 for $5 or $1.75 ea. At the gate 3 for $5 or $2 ea. For further information or tickets write to Wabash Valley Amateur Radio Assn., P.O. Box 81, Terre Haute IN 47808.

PORTAGE IN
JULY 18

The Lake County Amateur Radio Club's 2nd annual hamfest is July 18 at the Isaac Walton League in Portage, Indiana. Take I-94 to Ind. 249 exit, then north on Ind. 249 ½ mile. Tickets $1.50 advance, $2.00 at gate. Write: Herbert S. Brier W9EGQ, 409 S. 14th St., Chesterton, Indiana 46304.

SLATER MO
JULY 24-25

The Antique Aircraft and Amateur Radio Show will be held Saturday and Sunday, July 24 and 25, 1976 at the Slater Memorial Airport. Registration $1 in advance: $1.50 at the door. Buffalo burger feed Saturday night and Sunday noon. Talk-in 3963 kHz, 146.94 and 146.28/.88. For additional information and advance tickets write Dale Beilsmith WØKNF, 807 North Broadway, Slater MO 65349, (816) 529-2173.

CROSSVILLE TN
JULY 24-25

The Oak Ridge Amateur Radio Club, Inc., Annual Crossville Hamfest will be held in Crossville TN on July 24-25, 1976 at the Cumberland County Fairgrounds. Technical forums will be at the Holiday Inn on July 24 and the banquet will be at Holiday Hills Country Club on Saturday night with a Breeder Reactor Program planned. Sunday, July 25, features a picnic, flea market, raffle of many valuable prizes, and "eyeballing your friends" at the fairgrounds.

CANTON OH
JULY 25

The Tusco Amateur Radio Club and the Canton Amateur Radio Clubs are holding their Second Hall of Fame Hamfest on July 25, 1976. It will be held at the Stark County Fairgrounds, Canton, Ohio. This weekend, by the way, is the weekend of the National Pro Football Hall of Fame Football Game and Parade.

PITTSBURG KS
JULY 25

The annual Pittsburg Repeater Organization hamfest and watermelon feed will be held on Sunday, July 25, 1976 at the Lincoln Park shelters in Pittsburg, Kansas. Location is at 10th Street and Bypass 69 intersection. There will be a covered-dish picnic, transmitter hunts, swap meet, and lots of prizes including many for the YLs and harmonics. Talk-in will be WRØADZ 34/94 and 52/52.

FLAGSTAFF AZ
JULY 30-AUG 1

The Ft. Tuthill Hamfest will be held July 30-31 and August 1 at Flagstaff, Arizona at Coconino County Fairgrounds across I-17 from airport. R-V and tent camping. Three days in the tall cool pines. Swapmeet, tech sessions, contests, prizes, pot luck, and exhibits. Talk-in 146.22/82, 146.34/94, 146.52 and 3992 kHz.

WEST MILFORD NJ
JULY 31-AUG 1

The 550 Amateur Radio Club and Oakland Repeater Association will hold its annual hamfest/picnic at the Westbrook Park Kampgrounds, West Milford, New Jersey on July 31 and August 1, 1976. All amateurs, their families and guests are invited. Talk-in via club repeater WR2AHD 147.49 MHz/146.49 MHz and 223.34 MHz/224.94 MHz. For additional information contact Mark Kirshner WA2HLE, 73 Page Drive, Oakland, New Jersey 07436, phone (201)-337-0316.

WASHINGTON MO
AUG 1

The Zero-Beaters ARC will hold their annual hamfest on Sunday, August 1, at Washington, Missouri City Park. Free parking, auction, and bingo for the XYLs. No admission fee or fee for parking in the traders row. Many prizes including station accessories, books and a handmade quilt. For info or tickets contact Al Lanwermeyer WNØQBS, or Zero-Beaters ARC, WAØFYA, Box 24, Dutzow, Mo. 63342.

LEVELLAND TX
AUG 1

The 11th Annual Northwest Texas Emergency Net swapfest and picnic will be held in the City Park in Levelland, Texas on Sunday, August 1, 1976. Bring your own picnic basket. Free registration begins at 0900. Lunch at 1230. Swapping all day. Tables are provided. This event is for the entire family and is jointly sponsored by the Hockley County Amateur Radio Club and the Northwest Texas Emergency Net. Mobile talk-in frequency is on two meters only on 146.28-88 Mc., the Levelland Repeater: WR5AFX.

ANGOLA IN
AUG 1

Attention Midwest Amateurs! August 1, 1976 at the Steuben County Fairgrounds near Angola, Indiana will be the annual Fort Wayne Repeater Association FM picnic. Flea market, fun and prizes. Tickets are $1.50, children under 12 free. Talk-in frequencies will be 146.16-.76, .28-.88, .52 and .94. For further information contact Jerry Prumm WB9FOC, PO Box 6022, Fort Wayne, Indiana 46806.

MT LEBANON PA
AUG 1

Western Pennsylvania — the 39th Annual Hamfest of the South Hills Brass Pounders and Modulators will be held on August 1st, from noon until dusk, at St. Clair Beach, Upper St. Clair Township, 5 miles south of Mt. Lebanon on Route 19. Swap and shop, picnic space and swimming for the family. Mobile talk-in 29.0 and 146.52. Information and pre-registration at $1.50 per ticket ($2 at door) from Fred Schreiber K3FIW, 181 County Line Road, Bridgeville PA 15017. Vendors must register.

MACK'S INN ID
AUG 6-8

The Wyoming - Idaho - Montana - Utah Ham Club would like to announce that the 44th Annual WIMU Hamfest will be held August 6-8 at Mack's Inn, Idaho just 20 miles west of Yellowstone National Park. There will be a full line of activities including our famous breakfast under the pines. Camping on the grounds is available plus motels, cabins and restaurants. Pre-registration is $6 per person, $1 for children under twelve. For registration or more info contact: WIMU, c/o Larry Jacobs WA7ZBO, 5655 So., 4060 West, Salt Lake City, Utah 84118.

OKLAHOMA CITY OK
AUG 7-8

The Oklahoma Ham Holiday and State ARRL Convention will be held Saturday and Sunday, August 7 and 8 in Oklahoma City, Oklahoma. The meeting will feature the largest flea market in the Southwest, special programs, technical seminars, equipment displays, and unique activities for the ladies. For information and advance registration write Oklahoma Ham Holiday, Post Office Box 20567, Oklahoma City, Oklahoma 73120.

SAUK RAPIDS MN
AUG 8

The St. Cloud Radio Club Annual Hamfest will be held on Sunday, August 8, 1976, from 10 am till closing, at the Sauk Rapids Municipal Park. Free parking and overnight parking, hot dogs and pop available. Swapfest and ham gear sale. Talk-in on 34/94 and 3925. Hope to see you all there. For further info, contact Bill Zins WAØOTO, St. Cloud Radio Club, PO Box 752, St. Cloud MN 56301.

FT. WASHINGTON STATE PARK PA
AUG 8

The Mt. Airy VHF Radio Club (the Packrats) are holding their annual family picnic in the Flourtown Area of the Fort Washington State Park on Sunday, August 8, 1976 (rain date 15 August). Talk-in via W3CCX/3 on 52.525, 146.52, and 222.98/224.58 MHz.

CONCORDIA KS
AUG 8

Hamfest — Cloud County Community College, Concordia, Kansas, August 8, 1976. Swimming, tennis, and radio-controlled model airplanes for the kids. Events for the XYLs. Prizes, meetings: 2 meter, ARRL, MARS, satellite. WØFNS Award, ham auction. Lew McCoy will speak at August 7 banquet.

PETOSKEY MI
AUG 14

Straits Area Radio Club Swap and Shop will be held August 14 from 8 am to 4 pm at Emmet County Fairgrounds on US 31, ½ mile west of southern junction of US 31 and US 131, in Petoskey, Michigan. All amateurs, CBers, SWLs, $1 admission, 50¢ per table, door prizes, lunch counter, free parking. Talk-in on 3.920 MHz, channel 1, 146.52 MHz.

EAST RUTHERFORD NJ
AUG 14

The Knight Raiders VHF Club's auction and flea market will be held on Saturday, August 14th, at St. Joseph's Church of East Rutherford, Hoboken Road, East Rutherford. Free admission, free parking, refreshments available. Talk-in will be on 146.52. Doors will open 10 am. Flea market tables: $6 for a full table, $3.50 for half a table. Reserve your tables in advance by writing to The Knight Raiders VHF Club, K2DEL, PO Box 1054, Passaic NJ 07055.

NEW CASTLE DE
AUG 15

Delmarva's new annual hamfest will be held August 15, 1976 at Wilmington College, New Castle, Delaware — U.S. Route 13 just north of Delaware Route 141 in New Castle, New Castle County. Tail-gating $2.50 per space. Rummage and display tables $5 per table. Food and camping available. Ladies' Bingo. Admission $1.75 advance — $2.50 at gate. Children are free. Make all checks payable to Delmarva Hamfest Inc. Mail all requests for reservations and information to John Low K3YHR, 11 Scottfield Drive, Newark DE 19713.

HUNTSVILLE AL
AUG 15

The North Alabama Hamfest will be held on Sunday, August 15 at The Mall in Huntsville, Alabama. A hamfest supper will be held on Saturday night. Events include prize drawing, flea market, ARRL forum, MARS meetings, displays, and XYL programs. Talk-in on 146.94 and 3965. For more information contact N.A.H.A., PO Box 423, Huntsville AL 35804.

SPRINGFIELD MO
AUG 22

The Southwest Missouri Amateur Radio Club will hold its annual hamfest, swap meet and family picnic on August 22, 1976, at Lake Springfield Park. This picnic attracts over two hundred radio amateurs and their families from southwest Missouri, northwest Arkansas, southeast Kansas, and northeast Oklahoma each year. For more information write: James A. Crooke, Secretary, Southwest Missouri Amateur Radio Club, 1601 South Kimbrough Avenue, Springfield MO 65807.

AURORA IL
AUG 22

The Fox River Radio League W9CEQ Hamfest will be held August 22, 1976 at beautiful Phillips Park, east edge of Aurora, U.S. Hwy. Rt. #30. All day family fun, picnic, zoo, lake and flowers. Same old price — $1.00 advanced with SASE to FRRL, PO Box 443 Aurora IL 60507. Talk-in on 146.94.

ATLANTIC CITY NJ
AUG 28-29

The Personal Computing '76 Consumer Trade Fair will be held August 28-29, 1976 in Atlantic City, New Jersey. Seminars and technical talks, major exhibits, demonstrations, door prizes, and free literature all about software and hardware development, microcomputers, memories, comparisons, interfacing, implementation, AMSAT, computerized music, video terminals, construction, printers, games, and tapes. Admission $5 advanced, $7.50 at door (includes exhibits and seminars). Exhibition booths — call (609) 927-6950.

LA PORTE IN
AUG 29

The combined La Porte County Amateur Radio Clubs will hold their Fall Hamfest on Sunday, August 29th, 1976 at the La Porte County Fairgrounds in La Porte, beginning at 7 am Chicago time. Overnight camping available. Indoors in case of rain. No table or set-up charge. Paved midway, good food and drink. $2 donation at the gate. For more information write: PO Box 30, La Porte IN 46350. Talk-in on 01-61 and 94 simplex.

SO DARTMOUTH MA
AUG 29

The Southeastern Amateur Radio Club is having a Flea Market and Picnic on August 29, 1976 at the Stackhouse Fairgrounds in So. Dartmouth MA. Space will be $2 and table an additional $2. Homemade food, magic show for the children, and many raffles. For a flier write: Arthur Sylvia, 317 Nemasket St., New Bedford MA 02740.

MENA AR
SEPT 4-5

The Queen Wilhelmina Hamfest 1976 is Saturday and Sunday, September 4 and 5, at Queen Wilhelmina State Park, Rich Mountain, Mena, Arkansas. Excellent accommodations and food at the newly restored historic Queen Wilhelmina Castle. Door prizes hourly, grand prize, new equipment displays, flea market, camping area with utilities and rest rooms, amusements for harmonics. Talk-in 146.52. For more information write WB5CXX, P.O. Box 5191, Texarkana TX or phone (214) 838-0625.

DANVILLE IL
SEPT 5

The Danville Hamfest will be held at Douglas Park, Danville, Illinois September 5. Downstate Illinois' largest. Great prizes. Advance tickets $1.75 ea., 3/$5 with an SASE to Jim Wilson, 308 First, Ridgefarm IL 61870. Talk-in 22/82 and 3910.

MELBOURNE FL
SEPT 11-12

The 11th annual Melbourne, Florida hamfest will be held Saturday and Sunday, September 11-12, 1976, from 9 am to 5 pm each day in the air-conditioned Melbourne Civic Auditorium located on Hibiscus Boulevard. Donation is $2.50 per adult. Full program includes forums, meetings, auction, swap tables, commercial exhibits, awards, prizes, etc. Talk-in on 25/85 and 52/52. Sponsored by Platinum Coast Amateur Radio Society. For more info write PO Box 1004, Melbourne FL 32901.

FINDLAY OH
SEPT 12

The 34th Annual Findlay Hamfest will be held on Sept. 12 at Riverside Park, Findlay, Ohio. Talk-in 146.52. For advanced tickets and/or info write: Clark Foltz W8UN, 122 W. Hobart St., Findlay, Ohio 45840 (SASE please for under 5 tickets).

CHICAGO IL
SEPT 18-19

Radio Expo '76 will be held Saturday, Sept. 18 and Sunday, Sept. 19th at the Lake County Illinois fairgrounds, Routes 45 and 120 north of Chicago. Featured this year are an exhibit hall with dozens of displays by amateur manufacturers and distributors, forums with the FCC's John Johnston, *73*'s Wayne Green, ARRL, OSCAR and more. There's a giant flea market with both indoor and outdoor space, plus plenty of room for campers and trailers on the grounds. No waiting in line — the flea market opens Friday night for set-up. No extra charge, either. Talk-in on WR9ABY, 146.16/76, Chicago. Accommodations reserved at the Holiday Inn in Mundeline, Ill., a few minutes south of the fairgrounds. Mention Radio Expo. Advance tickets, $1.50 from Box 1014, Arlington Heights, Ill. 60006.

NEW KENSINGTON PA
SEPT 19

The Skyview Radio Society's Swap & Shop will be held on Sept. 19, 1976 at the Skyview Radio Club, New Kensington PA. Registration $1. Talk-in 52-52 and 04-64.

MOUNT CLEMENS MI
SEPT 19

The Fourth Annual L'Anse Creuse ARC Swap & Shop will be held on September 19, 1976 at the L'Anse Creuse High School in Mount Clemens, Michigan. Doors will be open from 0900 to 1500 EDST. First prize $200 cash. Talk-in on 146.52 and 146.94. Admission $1.50 at door, $1 in advance. For tickets enclose $1 and SASE and send to Robert Harder WB8ILI, 51769 Base, New Baltimore MI 48047.

NOTICE

We have received reports that W6JTT's "Simple VHF Monitor" (July, 1976, page 160) may interfere with certain kinds of aircraft instrumentation. While we continue to investigate this possibility, we suggest that readers refrain from constructing this converter.

CARF

Canadian Amateur Radio Foundation, Inc.

LATEST THIRD PARTY COUNTRIES

The DOC has announced a new list of countries that have agreed to permit third party amateur radio traffic with Canada for the period 3 July 76 to 15 August 76, when the Olympic Games will be held.

They are:

Bahamas
Belize
Bolivia
Cameroon
Chile
Colombia
Congo
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
Ethiopia
Fiji
Ghana
Guatemala
Guyana
Honduras
Hong Kong
Israel
Ivory Coast
Republic of Korea
Mexico
Nicaragua
Niger
Peru
Philippines
Trinidad and Tobago
United States
Uruguay
Venezuela
Zambia

FCC

In the Matter of
Deregulation of Part 97 of the Commission's Rules regarding emissions authorized in the Amateur Radio Service.
Docket No. 20777
RM-1429, RM-2163,
RM-2170, RM-2330,
RM-2429, RM-2507,
RM-2545, RM-2550

NOTICE OF PROPOSED RULE MAKING
Adopted: April 14, 1976

By the Commission:

1. Notice of Proposed Rule Making in the above entitled matter is hereby given.

2. The Commission has before it the above listed petitions (also listed in more detail in Appendix I) for rule making. Principally, petitioners seek amendment of the Rules for the Amateur Radio Service regarding authorized emissions. Of these petitions, RM-1429, RM-2163 and RM-2170 relate to the use of facsimile. RM-2330 relates to the use of wideband frequency modulation in the 50-54 MHz Amateur band. RM-2429 and RM-2550 would expand the types of codes and speeds permitted by Amateur radioteleprinter (RTTY) stations. RM-2507 and RM-2545 would amend the frequencies available for use by Amateur television (ATV) repeater stations in the 420-450 MHz band.

3. In RM-1429, RM2163 and RM-2170,

petitioners all propose to increase the frequencies available to stations using type A4 or F4 (facsimile) emission. In RM-2170, petitioner asserts that "... (technology has) reached a point where the economical transmission of pictures is possible in a bandwidth no greater than a standard single sideband signal ... Tests have indicated that it is even possible to transmit and receive high quality pictures in a bandwidth as narrow as 1900 Hz ... " In RM-2330, petitioner claims "...the region from 51.0 to 52.5 MHz is largely unused in current practice." Several reasons are cited as justification for this claim, including the present rule which limits the bandwidth of an F3 emission to the same maximum bandwidth of an A3 emission. This, it is claimed, has also had an adverse effect on the growth and development of repeater stations in the 52 to 54 MHz band. In RM-2429, petitioner asserts that "ASCII, American Standard Code for Information Interchange, has become the most popular mode of mechanical and digital encoding for both computer and communication teleprinter applications due to greater character and function versatility." The rules presently authorize only the use of the International Telegraphic Alphabet No. 2 five-unit (start-stop) teleprinter code for amateur teleprinter stations at standard speeds of 60, 67, 75, or 100 words per minute. In RM-2550, the American Radio Relay League, Inc., proposes to delete all references to teleprinter operating speeds and to permit the use of any of the standard codes in military or commercial usage. In RM-2507 and RM-2545, petitioners propose to permit operation of amateur television repeaters on frequencies in the 420-450 MHz band which are not presently available for repeater stations.

4. Rather than further complicate the present rules with additional provisions to accommodate the petitioners' requests, we are herein proposing to delete all references to specific emission types in Part 97 of the Rules. We propose, instead, to replace the present provisions with limitations on the permissible bandwidth which an amateur signal may occupy in the various amateur frequency bands. Within the authorized bandwidth limitations, any emission type would be permitted.

5. We propose that maximum permissible bandwidth increments be established as follows: less than 0.35 kHz, less than 3.5 kHz, less than 35 kHz, or 35 kHz or more. Each Amateur sub-band would have an appropriate maximum permissible occupied bandwidth. For instance, Morse code and teleprinter emissions would generally fall within the 0.35 kHz bandwidth sub-bands. Telephony, facsimile and slow scan television emissions using conventional single sideband techniques could operate in the 3.5 kHz bandwidth sub-bands. Double sideband amplitude modulation, narrowband frequency modulation and independent sideband emissions would be excluded from these sub-bands. However, these emissions using conventional amplitude modulation or frequency modulation techniques could operate in the 35 kHz bandwidth sub-bands. In addition, any other emissions that satisfy the bandwidth limitations would be permitted on all appropriate amateur frequencies. We also propose to establish a finite limit on the maximum permissible output power of all emissions outside the authorized occupied bandwidth, including spurious modulation products, harmonics, parasitic oscillations, etc. Because of a significant increase in activity in the 420-450 MHz band, we propose to limit the maximum authorized bandwidth in this band to 35 kHz. Since adoption of this proposal would eliminate the use of fast scan television, we invite comments as to what useful purpose is served, other than experimentation, by transmission of television signals in the Amateur Service.

6. The Commission is aware that some amateurs desire to use modes of emission which are not specifically provided for in the rules. We hope, through this proceeding, to produce amended rules which will encourage amateurs to develop and implement techniques for more efficient utilization of the radio spectrum, and to increase service to the public through the establishment of improved communications systems. Many new and unusual emission types will eventually appear on amateur frequencies as a result of these amendments. It should therefore be noted that the provisions of Section 97.117, which prohibit the use of codes or ciphers for the purpose of obscuring the meaning of the communications, will remain in effect. However, the employment of signals encoded solely for the purpose of facilitating communications would be permitted under the revised rules. In order to facilitate identification of stations using these emissions, we are proposing a minor change to clarify the present rule for station identification which would continue the requirement for use of either the international Morse code or unencoded telephony.

7. The specific rules changes proposed herein are set forth in the attached Appendix II. Authority for these proposed amendments is contained in Sections 4(i) and 303 of the Communications Act of 1934, as amended.

8. Pursuant to applicable procedures set forth in §1.415 of the Commission's Rules, interested persons may file comments on or before June 23, 1976, and reply comments on or before July 23, 1976. In accordance with the provisions of §1.419(b) of the Commission's Rules, an original and eleven copies of all statements, briefs, and comments filed shall be furnished the Commission. All relevant and timely comments and reply comments will be considered by

the Commission before final action is taken. The Commission may also take into account other relevant information before it, in addition to specific comments invited by this Notice. Responses will be available for examination by interested parties during regular business hours in the Commission's public reference room at its headquarters in Washington, D.C. (1919 M Street, N.W.).

FEDERAL COMMUNICATIONS COMMISSION
Vincent J. Mullins
Secretary

APPENDIX I

Petition Number	Petitioner
RM-1429	James L. Turrin
RM-2163	Jerome C. Grekowsky
RM-2170	Howard M. Krawetz
RM-2330	Gordon Schlesinger
RM-2429	Raymond E. Heimberger
RM-2507	Bruce J. Brown
RM-2545	Biagio Presti for Aptron Laboratories
RM-2550	Robert M. Booth, Jr., for The American Radio Relay League, Inc.

APPENDIX II

Part 97 of Chapter I of Title 47 of the Code of Federal Regulations is amended as follows:

1. In §97.7, sub-paragraph (d)(2) is amended to read as follows:

§97.7 *Privileges of operator licenses.*

* * * * *

(d)(2) Radio telegraphy using the international Morse code is authorized in the frequency bands 3700-3750 kHz, 7100-7150 kHz (7050-7075 kHz when the terrestrial location of the station is not within Region 2), 21,100-21,200 kHz, and 28,100-28,200 kHz.

* * * * *

2. In §97.61, the headnote, paragraphs (a) and (c) and sub-paragraphs (b)(11) and (b)(13) are amended to read as follows:

§97.61 *Authorized frequencies and bandwidth.*

(a) Following are the frequency bands and associated bandwidth available to amateur radio stations, other than repeater stations, subject to the limitations stated in paragraph (b) of this section, §§97.65, 97.109, and 97.110.

Freq. band	Max. auth. bdwdth (kHz)	Limitations (see par. b)
kHz		
1800-2000	3.5	1,2
3500-3775	0.35	----
3775-4000	3.5	4
4383.8	3.5	13
7000-7150	0.35	3,4
7075-7100	3.5	11
7150-7300	3.5	3,4
14000-14200	0.35	----
14200-14350	3.5	----
MHz		
21.000-21.250	0.35	----
21.250-21.450	3.5	----
28.000-28.500	0.35	----
28.500-29.700	35.0	----
50.000-50.100	0.35	----
50.100-54.000	35.0	----
144.0-144.1	0.35	----
144.0-148.0	35.0	----
220-225	35.0	5,6
420-450	35.0	5,7
GHz		
1.215-1.300	----	5
2.300-2.450	----	5,8
3.300-3.500	----	5,12
5.650-5.925	----	5,9
10.000-10.500	----	5
24.000-24.250	----	5,10
48.000-50.000	----	----
71.000-76.000	----	----
165.00-170.00	----	----
240.00-250.00	----	----
Above 300.00	----	----

(b)(11) The use of an authorized bandwidth in excess of 0.35 kHz in this band is limited to amateur radio stations located outside Region 2.

* * * * *

(b)(13) The frequency 4383.8 kHz, telephony using single sideband amplitude modulation with reduced or suppressed carrier, maximum power of 150 Watts, may be used by any station authorized under this part to communicate with any other station authorized in the State of Alaska for emergency communications. No airborne operations will be permitted on this frequency. Additionally, all stations operating on this frequency must be located in or within 50 nautical miles of the State of Alaska.

(c) The following transmitting frequency bands and the associated bandwidths authorized in paragraph (a) of this section are available for repeater stations, including both input (receiving) and output (transmitting):

FREQUENCY BAND (MHz)
29.5-20.7
52.0-54.0
146.0-148.0
222.0-225.0
442.0-450.0
any amateur frequency above 1.215 GHz.

3. In §97.65 the headnote, (a) and (b) are amended, and (c), (d), (e) and (f) are deleted

to read as follows:
§97.65 *Bandwidth of emissions.*

(a) Occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

(b) The authorized bandwidth is the maximum occupied bandwidth authorized to be used by a station.

§97.69 [deleted]

4. §97.69 is deleted.

5. In §97.73, the headnote and text is amended to read as follows:
§97.73 *Purity of emissions.*

The mean power of emissions on any frequency removed from the upper or lower limit of the authorized bandwidth, by more than 250 percent of the authorized bandwidth, shall be attenuated at least 40 decibels below the peak output power of the transmitter.

6. In §97.87, paragraph (h) is amended to read as follows:
§97.87 *Station identification.*

* * * * *

(h) The identification required by paragraphs (a), (b), (c), (d) of this section shall be given on each frequency being utilized for transmission and shall be transmitted either by telegraphy using the international Morse code, or by unencoded telephony, using the English language. If an automatic device is used for identification by telegraphy, the code speed shall not exceed 20 words per minute. The use of a national or internationally recognized standard phonetic alphabet as an aid for correct telephone identification is encouraged.

7. §97.93 is amended to read as follows:
§97.93 *Modulation of carrier.*

Except for brief tests or adjustments, and authorized remote control or experimental purposes, an Amateur station shall not transmit an unmodulated carrier on frequencies below 51.0 MHz.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554
FCC 76-348
40050

In the Matter of

Amendment of Part 97 to make special callsigns available to stations licensed to Amateur Extra Class operators.
Docket 20092

FIRST REPORT AND ORDER
Adopted: April 14, 1976

By the Commission:

1. A Notice of Proposed Rule Making in the above captioned matter was released on July 2, 1974, and published in the Federal Register on July 8, 1974 (39FR24922). In that Notice, the Commission proposed to amend Part 97 of the Rules and Regulations to permit an Amateur Extra Class licensee to request specific unassigned callsigns for his primary and/or additional stations. It was also proposed to discontinue the availability of "in memoriam" callsigns, i.e., callsigns requested by Amateur club stations for the purpose of honoring a deceased member.

2. In this First Report and Order, we will address only the issues of 1X2 (i.e., so called two letter) callsigns and "in memoriam" callsigns. We will defer consideration of 1X3 and 2X3 callsigns to a later Report and Order. The recent tremendous influx of Citizens Radio Service applications at our Gettysburg, Pa., licensing facility precludes the implementation of any changes in the Amateur callsign structure which would require significant addtional manpower or changes in the computer software systems. Because the number of available 1X2 callsigns is small, we believe the changes adopted herein will not impose an undue processing burden, and the manpower released from the processing of "in memoriam" callsigns can be used in this effort.

3. Approximately 150 comments were received by the Commission in this matter, and all were carefully considered. The overwhelming majority of the comments supported our proposal regarding choice of specific callsigns by Amateur Extra Class licensees. The comments were divided approximately equally between those who wished to retain a specific time period before becoming eligible for a 1X2 callsign, and those who desired to completely delete the waiting period. One of the most frequently raised objections was that the proposal would permit Amateur Extra Class operators who had been licensed only a short time to obtain 1X2 callsigns. (1X2 callsigns are presently issued to Amateur Extra Class operators who submit evidence that they held an amateur license at least 25 years prior to the date of application.) In the words of the American Radio Relay League (ARRL), "Two letter (1X2) callsigns traditionally have identified the holder as an 'old timer,' one who has devoted many years of dedicated public service as an amateur. To make two letter calls available to any Amateur Extra Class licensee irrespective of years of service would have the practical effect of downgrading the stature of present two letter callsign holders."

4. Those supporting our proposal without qualification cited the incentive a 1X2 callsign would provide. Comments suggested that the special significance of a 1X2 callsign would encourage many amateurs to upgrade their license class and thereby increase their overall technical and operational pro-

ficiency. Other comments indicated that longevity is not always an indication of a proficient operator with much public service, and therefore is not a valid criterion to use for the assignment of a 1X2 callsign.

5. We believe that the arguments for retaining a large measure of tenure associated with 1X2 callsigns have limited merit. Traditionally, 1X2 callsigns have been available only to those persons who have been long-term amateurs. Such callsigns, because they are in very short supply, must necessarily be rationed in some manner, and it has seemed the fairest procedure to allot them consistent with some measure of longevity. However, we also believe that once the "old timers" have had an adequate opportunity to obtain 1X2 callsigns, whatever such callsigns remain should be made available progressively to more recent licensees.

6. Accordingly, we have determined to phase out the tenure requirement in the following manner: All present Amateur Extra Class holders of 1X2 callsigns will be given an exclusive 3 month period to request a different specific 1X2 callsign. During this period, we will also accept applications for specific 1X2 callsigns from Amateur Extra Class licensees who were first licensed at least 25 years ago and who do not now hold 1X2 callsigns. At the end of this period, we will then also begin accepting applications for specific 1X2 callsigns from Amateur Extra Class licensees who first obtained that class of license prior to November 22, 1967 (the effective date of Docket 15928). Such applications will be accepted for a period of 3 months, at which time we will then also begin accepting applications from Amateur Extra Class licensees who first obtained that class of license prior to July 2, 1974 (the release date of Docket 20092). Such applications will be accepted for a period of 3 months, at which time we will then also begin accepting applications from Amateur Extra Class licensees who first obtained that class of license prior to July 1, 1976 (the effective date of Docket 20092). Such applications will be accepted for a period of 3 months, at which time we will then also begin accepting applications from any Amateur Extra Class licensee.

7. Many comments expressing agreement with our proposal also expressed concern over the administrative problems which could arise in implementing a working system. Inevitably, a single callsign will be requested by more than one applicant, and there are essentially two ways to handle such situations: 1) on the basis of which of the amateurs has been licensed the longest (or the earliest); or 2) on the basis of which request was received first for processing. Considering the manpower available for handling application processing, we have no alternative but to adopt the latter approach. To do otherwise would tremendously delay the processing of all amateur applications, Amateur Extra Class and others. Moreover, because we will permit an applicant to request several callsigns in order of preference, there should be few instances where an applicant cannot get a callsign of his choice, although it may not have been his first choice. All applications for specific 1X2 callsigns should be filed on a Form 610, with an attachment listing the callsigns desired, in order of preference, and should be sent to the FCC offices in Gettysburg, Pennsylvania. The filing fee is $28 if no renewal is desired, and $29 if renewal is desired.

8. We are adopting an effective date well beyond the release date of this Report and Order, and we will not accept prematurely filed applications. This will insure that the news of this rule making will reach most amateurs so that they will have sufficient time to gather the necessary information and application forms required. We recommend that requests for verification of past records and license dates not be directed to the Commission. Amateurs may seek licensing information in Commission files at our Washington, D.C., offices, or they may request such information via our duplication contractor. Requests for such information made to the Commission will be honored. However, because of staff limitations and other priorities, such requests are not likely to receive immediate attention and could be delayed, thereby causing a loss of position in the filing sequence. Additionally, to insure that applicants requesting 1X2 callsigns fully comply with the requirements for licensing background documentation, we would like to clarify exactly what must be submitted. An applicant may submit either an original license, a photocopy of an original license, or a photocopy of a recognized listing or source, such as the Radio Amateur's *Callbook*. When such a source is used, the applicant should include a photocopy of the title page of the source which indicates its title, and dates of coverage. We cannot accept affidavits or sworn statements from applicants, since they cannot be verified.

9. As proposed, we are deleting the availability of "in memoriam" callsigns. Less than a dozen comments directly addressed our proposal to delete the availability of such callsigns, indicating a general lack of interest among the many commentors. Arguments stated that since there were a relatively small number of requests, the additional manpower and 1X2 letter callsigns which would be gained from the deletion would be minimal. While we realize the "in memoriam" station may indeed be a tribute to a deceased amateur, we have found instances of abuses of such callsigns. In our Notice of Proposed Rule Making, we cited the difficulty in many instances of determining whether or not the evidence of the deceased's membership in the applicant club is valid. While most comments agreed that the burden of proof should lie with the applicant, no comment indicated a valid and

conclusive method of verifying the submitted evidence. Additionally, it is seldom, if ever, that a non-1X2 callsign is requested, although many more 1X3 and 2X3 callsigns have been issued to the Amateur population as a whole. It appears that, in some instances, the objective of the club to honor a deceased member is secondary to obtaining his prestigous 1X2 callsign for club use. We will therefore issue no such callsigns henceforth, but will continue to renew those now outstanding.

10. In view of the foregoing considerations, we find that the amendments to Part 97, set forth in the attached Appendix, are in the public interest, convenience, and necessity. The authority for such amendments is contained in Sections 4(i) and 302 and 303 of the Communications Act of 1934, as amended.

11. Accordingly, IT IS ORDERED, that effective July 1, 1976, Part 97 of the Commission's Rules and Regulations IS AMENDED as set forth in the attached Appendix.

FEDERAL COMMUNICATIONS COMMISSION
Vincent J. Mullins
Secretary

APPENDIX

Part 97 of Chapter I of Title 47 of the Code of Federal Regulations is amended as follows:

1. Rule Section 97.51(a) is amended to read as follows:

§97.51 Assignment of callsigns.

(a) * * *

(1) A specific unassigned callsign may be reassigned to a previous holder thereof.

(2) A specific unassigned callsign may be temporarily assigned to a special event station.

(3) One unassigned 1X2 callsign (a callsign having one letter, then the numeral, followed by two letters), may be assigned to the station of a previous holder of a 1X2 callsign.

(4) One specific unassigned 1X2 callsign may be assigned to the station of an Amateur Extra Class licensee who previously held or presently holds a 1X2 callsign.

(5) One specific unassigned 1X2 callsign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he held any amateur radio operator or station license, issued by any agency of the U.S. Government or by any foreign government, 25 or more years prior to the receipt date of an application for such assignment.

(6) Effective October 1, 1976, one specific unassigned 1X2 callsign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he first held that class of license prior to November 22, 1967.

(7) Effective January 1, 1977, one specific unassigned 1X2 callsign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he first held that class of license prior to July 2, 1974.

(8) Effective April 1, 1977, one specific unassigned 1X2 callsign may be assigned to the station of an Amateur Extra Class licensee who submits evidence that he first held that class of license prior to July 1, 1976.

(9) Effective July 1, 1977, one specific unassigned 1X2 callsign may be assigned to the station of any Amateur Extra Class licensee.

(10) The provisions of paragraphs (3) through (9) of this Section shall also apply to the issuance of 2X2 callsigns in Alaska, Hawaii, and U.S. possessions.

(b) * * *

2. Rule Section 97.53 is amended to read as follows:

§97.53 Policies and procedures applicable to assignment of callsigns.

(a) * * *

(1) 1X2 callsigns — callsigns with a single letter prefix and two letter suffix, e.g., W6AB, and 2X2 callsigns in Alaska, Hawaii, and U.S. possessions.

(2) 1X3 callsigns — callsigns with a single letter prefix and a three letter suffix, e.g., W6ABC.

(b) An eligible licensee will be permitted to hold only one 1X2 callsign. However, a licensee who, by reason of former rule provisions, presently holds more than one such callsign, may continue to hold those same callsigns in the same callsign areas.

(c) In those instances where an applicant is not eligible for a specific callsign, a 1X2 callsign beginning with the letter "W" will, subject to availability, normally be assigned to an eligible licensee.

* * * * *

(g) Subject to availability, a primary station will be issued the same type of callsign as the one relinquished upon modification of license to show a station location in a different callsign area.

(h) Except as provided in Section 97.51(a), licensees will not be assigned specific callsigns or counterpart callsigns (callsigns with identical suffix letters).

(i) Those Amateur Extra Class licensees eligible under the provisions of Section 97.51(a) for a specific unassigned 1X2 callsign may specify in their applications more than one callsign in order of preference. In those instances where none of the listed callsigns are available, the application will be returned without action unless the licensee has stated that he will accept, as a last choice, any unassigned 1X2 callsign.

(j) Callsigns which have been unassigned for more than one year are normally available for reassignment.

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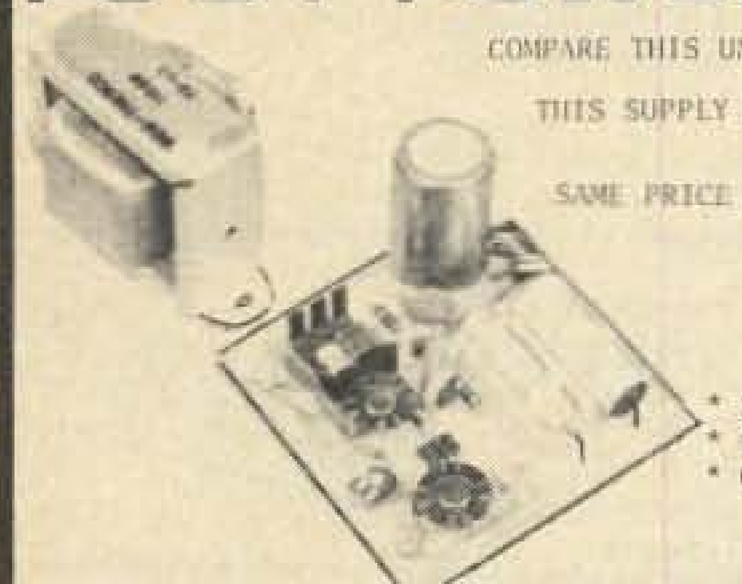

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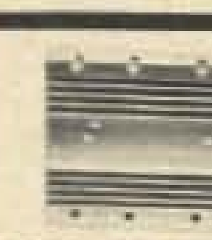

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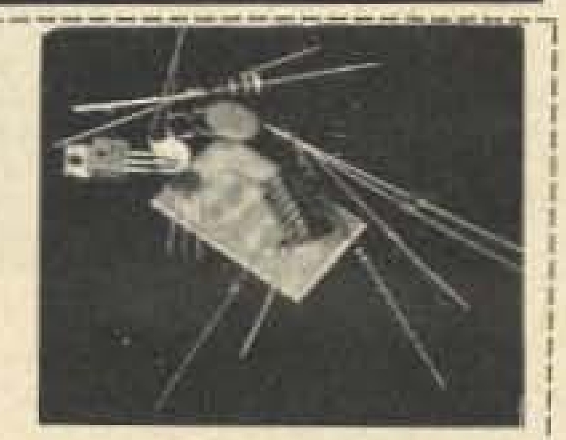

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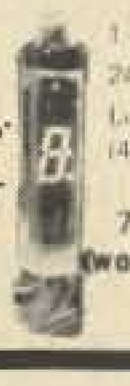

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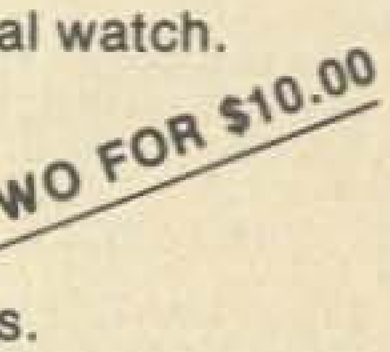

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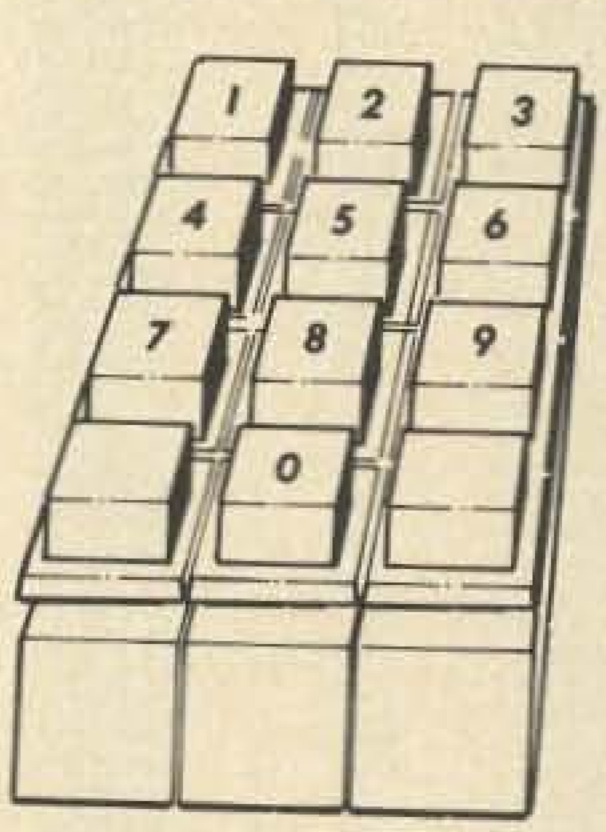

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LM709CH	.29	Operational Amplifier
LM710CH	.95	Differential Comparator
LM711CH	.50	Dual Channel Differential Comparator with strobes
LM720CN-14	1.50	Dual Differential Comparator
LM723CH	.52	Voltage Regulator
LM723CN-14	.52	Voltage Regulator
LM733CN-14	1.40	Differential Video Amp
LM739CN-14	1.25	Dual Stereo Pre-amp
LM741CH	.29	Operational Amplifier
LM741CN-14	.29	Operational Amplifier
LM741CN-8 (Mini Dip)	.28	Operational Amplifier
LM747CN-14	.75	Dual Operational Amplifier
LM747CH	.65	Dual Operational Amplifier
LM748CN-14	.45	Operational Amplifier
LM748CN-8 (Mini Dip)	.29	Operational Amplifier
LM748CH	.45	Operational Amplifier
LM1436CH	1.95	High voltage op amp
LM1458H	.65	Dual Operational Amplifier
LM1458N-8 (Mini Dip)	.79	Dual Operational Amplifier
LM1458N-14	.89	Dual Operational Amplifier
LM1488D	1.98	Quad Line Driver
LM1489D	1.98	Quad Line Receiver VT plus equals 1 volt
LM1489AD	2.45	Quad Line Receiver VT plus equals 1.75V
LM3045D	1.25	Transistor Array
LM3046N-14	.85	Transistor Array
LM3086	.63	Transistor Array
LM3089	2.39	FM IF System
LM3900N	.60	Quad op Amplifier
LM4136N	2.25	Quad op Amplifier
LM7800 Series TO-3	2.25	Positive Voltage Regulators 5, 6, 8, 12, 15, 18, 24 volts
LM7800 Series TO-5	1.95	Positive Voltage Regulators 5, 6, 8, 12, 15, 18, 24 volts
LM7800 Series (Plastic) TO-220	1.75	Positive Voltage Regulators 5, 6, 8, 12, 15, 18, 24 volts
LM78M00 Series TO-220	1.47	Positive Voltage Regulators ½ Amp 5, 6, 8, 12, 15, 20, 24 volts
LM78L00 AWC Series TO-92	.45	Positive Voltage Regulators 70 MA 2, 5, 6, 12, 15, 26, 62, 82 Volts
LM7900 Series TO-3	2.50	Negative Voltage Regulators, 1 amp 5, 6, 8, 12, 15, 18, 24 Volts
LM7900 Series TO-220	1.87	Negative Voltage Regulators, 1 amp 5, 6, 8, 12, 15, 18, 24 Volts
LM79M00 Series TO-5	1.80	Negative Voltage Regulators, ½ amp 5, 6, 8, 12, 15, 20, 24 Volts
LM79M00 Series TO-220	1.60	Negative Voltage Regulators, ½ amp 5, 6, 8, 12, 15, 20, 24 Volts
78MGT2C	1.35	Dual In Line Adjustable 4 Terminal Positive Voltage Regulator
79MGT2C	1.35	Dual In Line Adjustable 4 Terminal Negative Voltage Regulator
78GU1 TO-220	1.50	1 Amp Adjustable Positive Voltage Regulator
79GU1 TO-220	1.75	1 Amp Adjustable Negative Voltage Regulator
78GKC TO-3	1.95	1 Amp Adjustable Positive Voltage Regulator
79GKC TO-3	2.25	1 Amp Adjustable Negative Voltage Regulator

TTL LOW POWER SCHOTTKY PLASTIC DUAL-IN-LINE I.C.

SN74LS00N	.29	SN74LS83AN	1.49	SN74LS175N	1.45
SN74LS01N	.29	SN74LS85N	1.75	SN74LS181N	3.50
SN74LS02N	.29	SN74LS86N	.59	SN74LS190N	2.50
SN74LS03N	.29	SN74LS90N	1.15	SN74LS191N	2.50
SN74LS04N	.35	SN74LS91N	1.25	SN74LS192N	2.50
SN74LS05N	.35	SN74LS92N	1.15	SN74LS193N	2.50
SN74LS08N	.29	SN74LS93BN	1.15	SN74LS194AN	1.45
SN74LS09N	.29	SN74LS95AN	1.60	SN74LS195AN	1.45
SN74LS10N	.29	SN74LS96N	1.75	SN74LS196N	1.45
SN74LS11N	.29	SN74LS107N	.59	SN74LS197N	1.45
SN74LS12N	.29	SN74LS109N	.59	SN74LS221N	1.35
SN74LS13N	.75	SN74LS112N	.59	SN74LS247N	1.30
SN74LS14N	1.48	SN74LS113N	.59	SN74LS248N	1.30
SN74LS15N	.29	SN74LS114N	.59	SN74LS249N	1.30
SN74LS20N	.29	SN74LS122N	.90	SN74LS251N	1.60
SN74LS21N	.29	SN74LS123N	1.10	SN74LS253N	1.60
SN74LS22N	.29	SN74LS124N	3.00	SN74LS257N	1.70
SN74LS26N	.40	SN74LS125N	.75	SN74LS258N	1.50
SN74LS27N	.35	SN74LS126N	.75	SN74LS261N	2.95
SN74LS28N	.35	SN74LS132N	1.25	SN74LS266N	.59
SN74LS30N	.29	SN74LS136N	.59	SN74LS279N	.80
SN74LS32N	.40	SN74LS138N	1.68	SN74LS283N	1.40
SN74LS33N	.40	SN74LS139N	1.68	SN74LS290N	1.35
SN74LS37N	.40	SN74LS145N	1.35	SN74LS293N	1.35
SN74LS38N	.40	SN74LS151N	1.30	SN74LS295AN	1.75
SN74LS40N	.35	SN74LS153N	1.30	SN74LS298N	1.75
SN74LS42N	1.20	SN74LS155N	1.45	SN74LS324N	2.25
SN74LS47A	1.20	SN74LS156N	1.45	SN74LS352N	1.45
SU74LS48N	1.20	SN74LS157N	1.35	SN74LS353N	1.70
SN74LS49N	1.20	SN74LS158N	1.25	SN74LS365N	.75
SN74LS51N	.29	SN74LS160N	2.25	SN74LS366N	.75
SN74LS54N	.29	SN74LS161N	2.25	SN74LS367N	.75
SN74LS55N	.29	SN74LS162N	2.25	SN74LS368N	.75
SN74LS63N	1.75	SN74LS163N	2.25	SN74LS375N	.80
SN74LS73N	.49	SN74LS164N	1.98	SN74LS386N	.59
SN74LS74N	.55	SN74LS168N	2.75	SN74LS395N	1.95
SN74LS75N	.75	SN74LS169N	2.75	SN74LS670N	3.95
SN74LS76N	.49	SN74LS170N	2.95		
SN74LS78N	.49	SN74LS174N	1.45		

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by
J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	7A	7	7	7	7	7	7	7	7	7	7	7A
ARGENTINA	14	7A	7	7	7	7	7A	14	14	14	14A	14
AUSTRALIA	14	7A	7B	7B	7	7	7	7	7	7	14	14
CANAL ZONE	14	7	7	7	7	7	7	14	14	14	14	14
ENGLAND	7	7	7	7	7	7	7A	14	14	14	14	7A
HAWAII	14	14	7B	7	7	7	7	7B	7A	14	14	14
INDIA	7	7	7	7	7B	7B	7	7	7A	14	7A	7
JAPAN	14	7A	7	7	7	7	7	7	7	7	7	14
MEXICO	14	7	7	7	7	7	7	7A	14	14	14	14
PHILIPPINES	14	7A	7B	7B	7B	7B	7B	7	7	7	7B	14
PUERTO RICO	7A	7	7	7	3A	3A	7	7	7	14	14	14
SOUTH AFRICA	7	7	3A	7	7B	7A	14	14	14	14	14	7
U. S. S. R.	7	7	7	7	7	7	7A	14	14	14	14	7
WEST COAST	14	7A	7	7	7	7	7	7A	14	14	14	14

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	7A	7A	7	7	7	7	7	7	7	7	7	7
ARGENTINA	14	14	7	7	7	7	7	14	14	14	14	14
AUSTRALIA	14	14	7B	7B	7	7	7	7	7	7	14	14
CANAL ZONE	14	7A	7	7	7	7	7	14	14	14	14	14
ENGLAND	7	7	7	7	7	7	7	7	14	14	14	14B
HAWAII	14	14	7A	7	7	7	7	7	7A	14	14	14
INDIA	7	7	7	7	7B	7B	7B	7	7A	7A	7	7
JAPAN	14	14	7	7	7	7	7	7	7	7	7	14
MEXICO	14	7	7	7	3A	3A	3A	7	7	7	14	14
PHILIPPINES	14	14	7B	7B	7B	7B	7	7	7	7	7B	14
PUERTO RICO	14	7A	7	7	7	7	7	7A	14	14	14	14
SOUTH AFRICA	7	7	3A	7	7B	7B	14	14	14	14	14	7
U. S. S. R.	7	7	7	7	7	7	7	7	7A	14	14	7

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	7A	7A	7	7	7	7	7	7	7	7	7	7
ARGENTINA	14	14	7	7	7	7	7	7A	14	14	14	14
AUSTRALIA	14	14A	14	7A	7	7	7	7	7	7	14	14
CANAL ZONE	14	14	7	7	7	7	7	7	14	14	14	14
ENGLAND	7	7	7	7	7	7	7	7	7	7A	14	14B
HAWAII	14	14A	14	14	7	7	7	7	7A	14	14	14
INDIA	7A	14	14	7	7B	7B	7	7	7A	7A	7	7
JAPAN	14	14	14	7	7	7	7	7	7	7	7A	14
MEXICO	14	14	7	7	7	7	7	7	14	14	14	14
PHILIPPINES	14	14	14	7B	7B	7B	7	7	7	7	7B	14
PUERTO RICO	14	7A	7	7	7	7	7	7A	14	14	14	14
SOUTH AFRICA	7	7	3A	7	7B	7B	7B	7B	14	14	14	7
U. S. S. R.	7	7	7	7	7	7	7	7	14	14	7	7
EAST COAST	14	7A	7	7	7	7	7	7A	14	14	14	14

A = Next higher frequency also may be useful
B = Difficult circuit this period
N = Normal
U = Unsettled
D = Disturbed

1976			AUGUST			1976
SUN	MON	TUE	WED	THU	FRI	SAT
1 U	2 U	3 U	4 N	5 N	6 N	7 N
8 U	9 D	10 D	11 U	12 U	13 D	14 U
15 N	16 N	17 N	18 N	19 D	20 D	21 U.
22 U	23 N	24 N	25 D	26 D	27 N	28 N
29 N	30 U	31 U				

FRG-7 COMMUNICATIONS RECEIVER

SYNTHESIZED
ALL SOLID STATE
HI-PERFORMANCE GENERAL COVERAGE RECEIVER

The Model FRG-7 is a precision-built communications receiver with continuous coverage (500 kHz to 29.99 MHz) featuring:

- Drift Canceling Circuit
- RF Attenuator
- Noise Suppression Circuit
- 5 kHz Direct Dial Readout
- Ceramic I F Filters
- AC-DC or Internal Battery
- Hi Sensitivity
- Excellent Stability
- USB/LSB/AM/CW
- Triple Conversion

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