April 1978 $2.00

73 AMATEUR RADIO

PLUS 18 More Exciting Feature Articles (see page 5)

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Fifty years ago in 1928, Henry Radio first offered to help amateur radio operators solve their communications problems. Today Amateurs, not only in the United States but throughout the free world, still look to Henry Radio as their pre-eminent supplier of fine communications equipment.

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May we help you?

Ted Henry

Mary E. Silva W6VWL

Meredith Henry W6WNE

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Ted S. Henry W6YEY

Walt Henry W6ZN

Henry Radio

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#211 APR 1978

Don't Miss the Petition on page 30

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NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

WASTED REPEATER CHANNELS

Will hams be satisfied before they reach that totally ideal situation of one repeater for each two meter operator? One of the more fundamental flaws in this scenario is that repeater owners *never* use any other repeater than their own, even when traveling. Thus, every time someone puts on a new repeater, this takes another user away from all of the existing area repeaters ... and our ideal situation will not only have one person per repeater, but will also thus include no rag chewing or contacts ... just people occasionally kerchunking their repeaters to make sure they are still working.

In this case, we should be able to economize on channels to some extent. A repeater used only five minutes a day for testing could coexist with hundreds of others on the same channel, providing some means of tone activation of the receivers was used ... repeater owners don't want to be bothered listening to other repeaters on the channel being kerchunk ... hello test ... kerchunked.

In the interim, before we start trying to fill up the 144 MHz segment of the band with repeaters, let's try to use some common sense and more adequately use the 53 channels we already have set up. The fact is that most of the repeater channels are being occupied by seldom-used repeaters. The small groups using these channels will put up vigorous fights to retain their channels, even though they are rarely using them. They are providing little benefit for amateur radio in general and not much for themselves, outside of a bit of ego massage.

Though I prefer to come to you with proposed solutions to problems rather than with problems and no solutions, in this case I'm wide open for any ideas. I know the present system is terrible. Sure, we have repeater coordinating councils, but in most cases they are working on the basis of repeaters and channels, with not much consideration given to the actual use of a channel. Indeed, we don't have any concepts as yet developed about what does constitute a used channel and what doesn't. How much right does a group of three people have to exclusive use of a frequency pair for their repeater ... which is used perhaps once or twice a day for a few minutes?

Perhaps some system could be tried where coordinators would stack repeaters with smaller groups on the same channel, but with continuous tone separation. Yes, I know this is happening already in some areas, but the fact is that very few coordinators are doing this so far and expansion into the 144 MHz segment is a very poor substitute for cooperation.

Let's do all we can to keep repeater growth sane ... to discourage the frivolous setting up of repeaters ... and leave the 144-146 MHz part of the band for other developments, at least until it is really needed for repeaters ... which is still a long, long way off.

So, should the FCC again move to deregulate the lower part of the two meter band, I plead for a moratorium on repeater allocations there ... a bit of brainstorming on ways to better utilize the band we are already only partially using ... and some test projects to see if cooperation can be achieved between repeater groups sharing channels.

THE YELLOW PERIL

Some U.S. manufacturers of ham equipment are trying to get restrictions on the importing of ham gear from Japan. What is the problem? Is it that we are not able to keep up with Japan technically ... that they are able to out-engineer us? Is it that they are able to work more efficiently than we can?

Japanese firms have their own problems which work to bring up their costs. It is not inexpensive to ship equipment an extra 10,000 miles to be sold. Then there are the import duties which have to be paid. Add to that the costs of warehousing here so shipments to dealers are not overly delayed. Service must be set up ... a not inexpensive project so far from the factory ... complete with parts and technician training.

U.S. firms are much better able to meet sudden changes in the market. Look what happened to Japan when CB sets stopped selling. It took months to slow down the pipeline. Even after the production lines stopped making sets, there were millions of CB sets ready for shipment, on ships coming across the Pacific, and on piers on the U.S.

The most basic truth of international trade is that if we want to sell our equipment in Japan, we have to let them sell theirs here. If we don't, they won't have the money to buy ours. And if you don't think they are buying American ham gear in Japan, you just haven't talked to many Japanese hams.

I can be quite critical of Japan for the import restrictions on some goods, but then they are paying the price for this protectionism. When they let the balance of trade swing too much one way or the other, the relative value of the currencies changes to even it out. This increases the cost of Japanese equipment for us and decreases the cost of American equipment for them ... until things are back in balance again.

THE LONG-RANGE DISASTER

The recent snowstorms in the midwest and Boston area reconfirmed the value of amateur radio under emergency conditions. Hams were right in the middle of everything, from the beginning ... and they performed well.

In the Boston mess, there were hams among the 3000 cars stranded on perimeter Route 128. This helped officials know just what was going on at different locations along that route and to keep up communications with groups of stranded cars. You may have read about the pilot boat which was lost with five people aboard going out to try and rescue sailors from a stranded oil tanker. One of them was a ham and he kept those ashore in touch with what was going

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on via an HT-220 and a nearby repeater right up until the ship sank. It was shocking to hear him reporting on the wave that broke over the ship and tore away the bridge. Then they set anchor to try and pump out the water which had poured in. Next the anchor gave way and all was lost.

But what about CB radio? It was a mess. Everybody wanted to help and the result was chaos. Channel 9 sounded like channel 19. And just to help matters, the skip came rolling in with a vengeance and the S-meters sat at S9 all through the days, with southern and midwest CBers ratchet-jawing away, making DX contacts with their high-powered stations and wiping out all efforts at emergency communications.

Some groups of CBers tried mightily to get organized, but a call for vehicle A1 would result in twenty cars responding. Little could be done.

The Boston conditions were incredible. The snow, running to three and four feet in some areas, was plowed out of the roads, making ten- and twelve-foot-high cliffs on each side of the narrow one-lane canyons. Sidewalks were gone, so anyone walking around had to walk in the narrow streets. This made it almost impossible for cars to get through. After a solid week of being kept home by law, almost everyone was out walking around, just to get out of the house. All but emergency use of cars was forbidden, with stiff fines and towing away of your car if you messed around. All businesses were closed, so there was really nowhere much to go. The result was about a half million people out wandering around with no particular place to go and nothing much to do. Emergency cars had to creep around trying to get through the packs of people.

It was most fortunate that telephones were working well, for they were used for a large part of the emergency communications. Amateur radio centers and mobile units acted as backup for the phones and provided the needed control of mobile units. One can't even imagine what it would have been like without amateur radio.

WHICH BRINGS UP WARC

What will be the result in future emergencies if amateur radio is crippled or even killed at WARC, the International Telecommunications Union conference in Geneva next year? Remember that most of the countries which will be voting on frequency allocations next year do not have

Continued on page 35

LETTERS

ANTI-SEMANTICISM

W3ZVT's otherwise excellent article, "Ham Shack Anthropometrics," is somewhat marred by its title. It's unfortunate that the term "anthropometrics" has been so badly warped into almost erroneous common (mis)usage. "Anthropometrics" means, in its strictest sense, "measurements of the human body to determine differences in races, ethnic origin, individuals, etc. . ."

I would like to suggest an alternative, since I chose to make a minor criticism in the first place. "Ham Shack Ergonomics" tells it like it is. I hope this doesn't open up a semantic debate, but rather a new avenue of future *73* articles.

Don Ore WB9CMT
Flossmoor IL

Let's not have any anti-semanticism around here.—Wayne.

STERN KICK

Joe Vicere
Bristol VT

Dear Joe:

Here is one ham who hopes this "kick in the stern" you asked for will be enough to make you "get with it" ("Ham Help," January, 1978, p. 19).

You sound like a smart guy, and I have been in Vermont enough to know that northern Vermont is more than "pucker-brush!" Vermont has a goodly number of fine hams whom I have gotten to know in the sixteen months that I have been a ham.

In July, 1976, I got the silly idea that I, too, was tired of the things that tired you, and that I would like to become a ham. I was seventy-two years old, and that's just too old to start learning new tricks . . . much less such a complicated thing as code! But like a chump, I asked George Lange K5CAT, an Extra here in Muskogee, Oklahoma, if he thought I could ever become a ham, and if so, would he help me.

George said, "If you will do what I tell you to do, I can get you past the Novice code test in five weeks . . . and in ten weeks you can be a full-fledged Novice." I didn't believe him, and still don't, but . . .

George and I organized a ham class in our church recreation building and we met . . . ten of us . . . each Thursday evening for a couple of hours. In *five* weeks, George surprised us with a code test, and we all passed but *one* . . . and he was a high school boy with a chronic case of girlitis.

Late in August, we took our theory written test and all of us passed. One of the class took the Tech theory, and he, too, passed. One year later, at the age of 73, I took my General and got that thrill of all thrills when the FCC examiner looked up from my test papers and said, "You made it!" Out of the ten, six or seven of us are Generals . . . a couple are Techs and a couple took leave of the ham shack in favor of college.

Anyone can learn code if he is of a mind to . . . and any ham will help you. WA1NSY, a professor at the University of Vermont, lives not too far from you. WA1LXL lives in Marlboro and W1MRJ is a flight instructor and former FAA flight controller . . . any one of those three would give you a kick in the stern to get you on CW. And you'll never know how you will like it until you try it.

Loren Carlberg WB5WDG
Muskogee OK

P.S. I am not the only old buzzard who started late on his code. In my class was a guy who is now WB5WDD. He's almost as old as I am and he's a General now, too . . . but we both still prefer code to mike. You don't need a kick in the stern to start you . . . what you need is a kick in the stern because you haven't started yourself. It's there for you with plenty of help just for the asking. That's what hamming is all about.

CALCULATING POWER

The article in the February issue by K4TWJ was well written, but did show that he apparently does not understand how to calculate the power input of his station and unknowingly operates in excess of the 1 kW legal limit.

In part, rule 97.67a states that the power input shall not exceed 1 kW as measured feeding "the vacuum tube or tubes supplying power to the antenna."

In a grounded grid amplifier, the cathode circuit is driven (which is in series with the plate and output circuits). It can be shown that considerable driving power is coupled through the PA to the antenna. Therefore, the exciter output tube input must be included in the power input calculations because it is coupled to and supplies power to the antenna.

If it is assumed that the author's four 811As were operated with a 1 kW dc input and that the TR-4CW was operated at its full rated CW input, then the dc input power of the tubes supplying power to the antenna was 1260 Watts. These assumptions are consistent with the author's stated measured rf power output of 850 Watts.

Dick Wilder W3DI
Crownsville MD

Maybe he's using it on the HF band, where 1 kW is known as QRP.—Wayne.

AFTER 55 YEARS

Yesterday, the mailperson left a strange-looking envelope in my mail box. Inside was something I have been waiting for for over 55 years. Yes, over 55 years ago when I was 12, an old man of about 18 who was a ham tried to teach me the code at about 50 words a minute—or so it seemed. As I did not learn it in about 10 minutes, he told me I was dumb and would never get my license. Several times in the years gone by I have tried to, but it was no use. Several things got in the way, like a little depression with two daughters to raise, then a couple of wars, then a heart attack and forced retirement. I needed something to do with my time, so I started building radio control models. After the loss of several airplanes due to outlaw CB transmitters on 27 and 72, I was told to get on 53, but another hitch came up—I must have a ham license. So I sent away for a Heathkit Novice course and joined the Sun City ham club. After several months of practice with the Heathkit tapes, I got nowhere. I kid you not, at 68 it is hard to study. Anyway, someone mentioned your tapes, so after two months I am now WD6EZM. I have sent for your 13 and 20 tapes, as I am going to get my General. I also have subscribed to your magazine for three years. Also, one of my best investments for information is that I sent for a lot of your back issues. I enjoyed the Ancient Aviator very much, as I spent most of my working life as a mechanic and inspector on airplanes. I have worked in the Congo, Libya, England, and several other places, and am retired from Pacific Southwest Airlines.

Harold R. Gallant WD6EZM
Sun City CA

Don't get mad, Heath. We get ten times as many complaints about the ARRL tapes, but people always think we're picking on the ARRL, so we don't publish those gripes very often. The poor picked-on League.—Wayne.

SWLING

I would like to write a few words encouraging you to continue publishing occasional articles of interest to those of us who enjoy listening to the international shortwave broadcasts. The January "Looking West" column with Bill Pasternak's sidelight on Radio Nederland was especially welcome, as was the review of the Sony ICF-5900W general coverage receiver in the February issue.

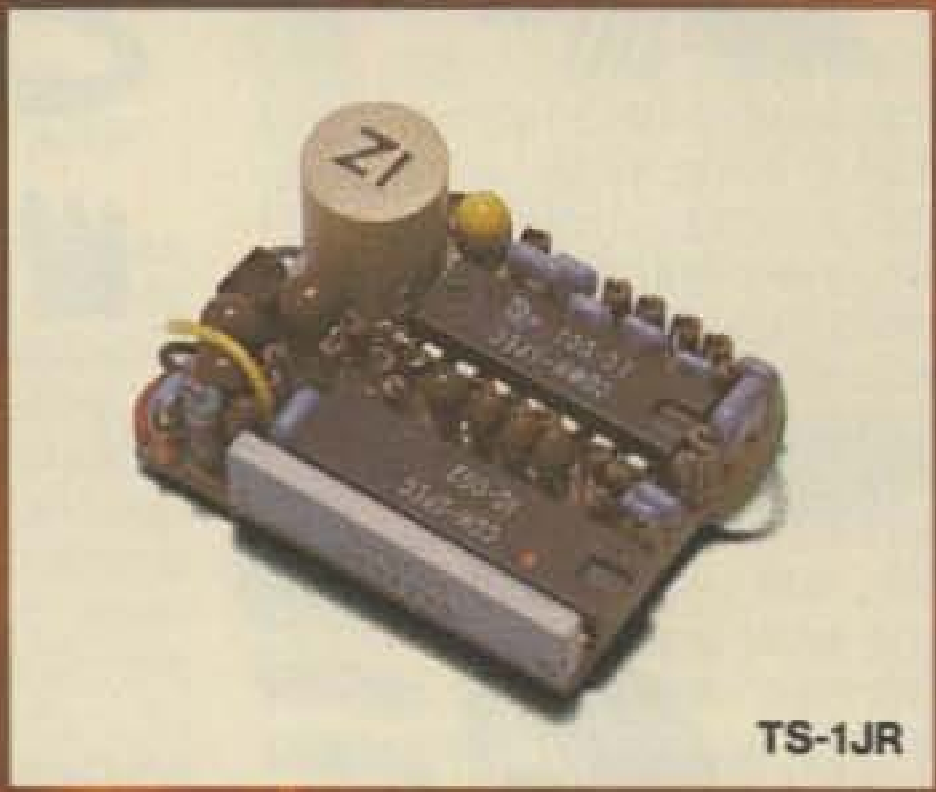
As a regular listener to shortwave broadcasts, I may be somewhat biased. However, I feel that those hams who have not recently listened to the shortwave bands are missing a lot of useful and entertaining information. For example, WARC '79 has received considerable air time over the past year on many of these stations. In addition, since many of the stations speak for the government of the country involved, it is quite easy to see the political situations that are likely to develop at WARC '79.

Finally, I would like to point out one item of common courtesy. Answer QSL requests from SWLs as you would from any other ham. I got started in ham radio by being involved as an SWL, with some help from the local amateur radio club. With a little help and encouragement, hams and SWLs can share in two interesting and educational hobbies.

Gregory W. Smith WD9GAY
Woodridge IL

You can order more QSLs from 73 for those SWL reports.—Wayne.


TS-1


TS-1JR

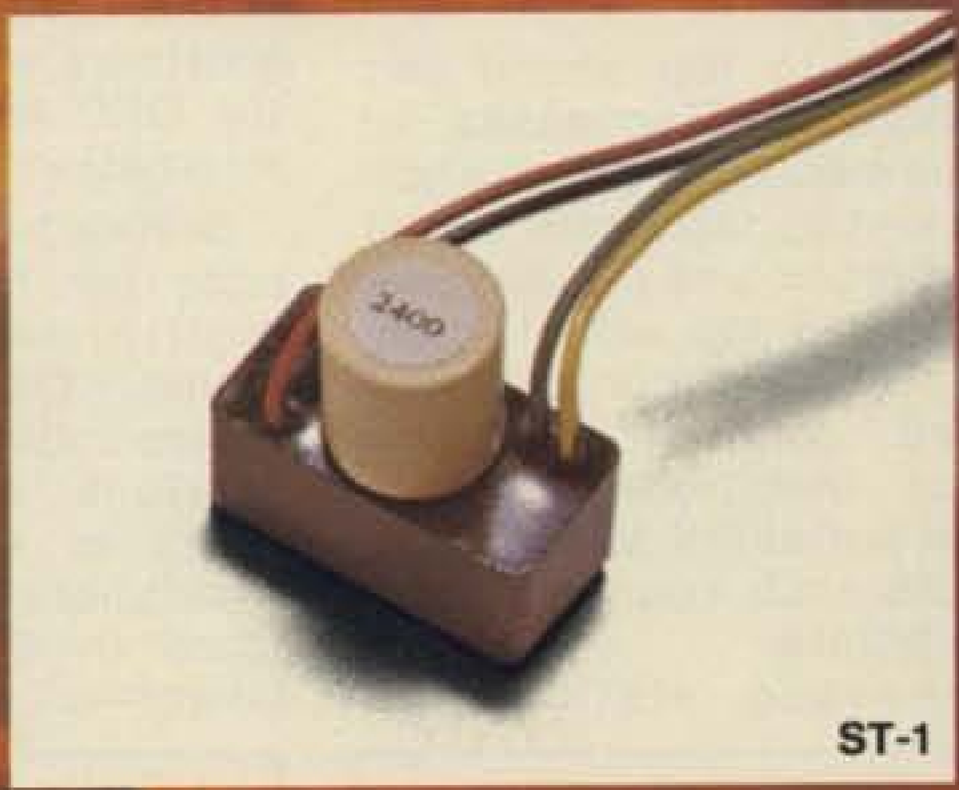

PE-2


SD-1

THE DAWNING

The age of tone control has come to Amateur Radio. What better way to utilize our ever diminishing resource of frequency spectrum? Sub-audible tone control allows several repeaters to share the same channel with minimal geographic separation. It allows protection from intermod and interference for repeaters, remote base stations, and autopatches. It even allows silent monitoring of our crowded simplex channels.

We make the most reliable and complete line of tone products available. All are totally immune to RF, use plug-in, field replaceable, frequency determining elements for low cost and the most accurate and stable frequency control possible. Our impeccable 1 day delivery is unmatched in the industry and you are protected by a full 1 year warranty when our products are returned to the factory for repair. Isn't it time for you to get into the New Age of tone control?



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ME-3 Sub-Audible Encoder • Microminiature in size, measures .45" x 1.1" x .6" • Instant start-up • **$29.95** complete with K-1 element.

TE-8 Eight-Tone Sub-Audible Encoder • Measures 2.6" x 2.0" x .7" • Frequency selection made by either a pull to ground or to supply • **$69.95** with 8 K-1 elements.

PE-2 Two-Tone Sequential Encoder for paging • Two call unit • Measures 1.25" x 2.0" x .65" • **$49.95** with 2 K-2 elements.

SD-1 Two-Tone Sequential Decoder • Frequency range is 268.5 - 2109.4 Hz • Measures 1.2" x 1.67" x .65" • Momentary output for horn relay, latched output for call light and receiver muting built-in • **$59.95** with 2 K-2 elements.

TE-12 Twelve-Tone Sub-Audible or Burst-Tone Encoder • Frequency range is 67.0 - 263.0 Hz sub-audible or 1650 - 4200 Hz burst-tone • Measures 4.25" x 2.5" x 1.5" • **$79.95** with 12 K-1 elements.

ST-1 Burst-Tone Encoder • Measures .95" x .5" x .5" plus K-1 measurements • Frequency range is 1650 - 4200 Hz • **$29.95** with K-1 element.

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Editor:
Robert Baker WB2GFE
15 Windsor Dr.
Atco NJ 08004

CONTESTS

TENNESSEE QSO PARTY
Contest Periods:
2100Z Saturday, April 1 to 0500Z Sunday, April 2
1400Z to 2200Z, Sunday, April 2

Bonus period April 2 from 0500Z to 0600Z for out-of-state stations only to work Tennessee mobile and portable stations only on 75 meters.

EXCHANGE:
Tenn stations send signal report and county. Out-of-state stations send signal report and state, province, or country. Work same station different bands or county if mobile or portable.

SCORING:
Separate CW and phone contests (one point each contact). Tennessee stations—QSO points times sum of (different states including Tennessee plus different provinces plus different Tenn counties).

Out-of-state stations score 1 point per QSO, 3 points per mobile/portable. Final score = QSO points times number of different Tenn counties.

Bonus points—200 extra points to mobiles and portables for each county operated outside home county (10 QSOs min.).

FREQUENCIES:
3550, 7050, 14050, 21050, 28050, 3980, 7280, 14280, 21380, 28580.

LOGS:
Date/time in GMT, station worked, band, mode, exchange, and score. Use separate log sheet for each band over 25 contacts; contestants with 100 contacts or more must submit cross-check sheet similar to ARRL operating aid No. 6. Logs must be legible to avoid disqualification.

AWARDS:
Plaques to top phone and CW scores in Tennessee, to winning mobile, to winning portable, and to top score out of state. Certificates to every station sending log with 15 contacts. Repeater contacts not allowed. Mobiles compete against mobiles, portables against portables. Minimum 10 contacts each county to earn bonus points.

Tennessee stations on phone call "CQ Tenn QSO Party," on CW "CQ Tenn" or "TEST"—variations to encourage contacts from noncontestants will result in disqualification.

Mailing deadline May 1, 1978. Send self-addressed stamped envelope to Dave Goggio W4OGG, 1419 Favell Dr., Memphis TN 38116.

ANNUAL APRIL QRP QSO PARTY
Starts: 2000 GMT Saturday, April 1
Ends: 0200 GMT Monday, April 3

The contest is open to all amateurs and is sponsored by the QRP Amateur Radio Club International, Inc.

Stations may be worked once per band for QSO and multiplier credits. Each member QSO counts 3 points, non-member QSOs, 2 points. Stations other than W/VE count as 4 points per QSO. Multipliers are as follows: More than 100 Watts input power—x1; 25 to 100 Watts—x1.5; 5 to 25 Watts—x2.0; 1 to 5 Watts—x3.0; less than 1 Watt power—x5.0.

Final score is QSO points times total number of states/provinces/countries *per band* times power multiplier.

EXCHANGE:
Members—RS(T), state/province/country, QRP number.
Non-Members—RS(T), state/province/country, power.

FREQUENCIES:
CW—3540, 7040, 14065, 21040, 28040.
SSB—3960, 7260, 14300, 21360, 28600.
Novice—3720, 7120, 21120, 28040.
All frequencies ±5 kHz.

ENTRIES:
Send full log data, including full name, address, and bands used. Indicate equipment, antennas, and power used. Include a #10 SASE for results. Logs must be received by May 30, 1978, to qualify. Send logs to: E. V. Sandy Blaize N5BE, 417 Ridgewood Drive, Metairie LA 70001.

Certificates will be awarded to the highest scoring station

CALENDAR

Apr 1-2	Tennessee QSO Party
Apr 1-3	QRP QSO Party
Apr 8-9	Open ARRL CD Party—CW
Apr 11-12	DX to W/VE YL CW Party
Apr 15-16	County Hunters SSB Contest
	ARRL CD Party—Phone
Apr 21-30	Holiday-In-Dixie Festival QSO Party
Apr 22-23	Zero District QSO Party
	Bermuda Contest
Apr 25-26	DX to W/VE YL Phone Party
Apr 29-30	PACC Contest
May 6-8	Georgia QSO Party
May 13-14	Massachusetts QSO Party
May 20-22	Kansas QSO Party
June 3-4	IARS/CHC/FHC/HTH QSO Party
June 10-11	ARRL VHF QSO Party
June 17-18	West Virginia QSO Party
June 24-25	ARRL Field Day
June 24-25	First REF Ten Day
July 1-2	7 Land QSO Party
July 4	ARRL Straight Key Night
July 8-9	IARU Radiosport Competition
July 15-16	VHF Space Net Contest
Aug 19-20	New Jersey QSO Party
Sept 9-10	ARRL VHF QSO Party
Sept 16-17	Scandinavian Activity Contest—CW
Sept 23-24	Delta QSO Party
	Scandinavian Activity Contest—Phone
Oct 14-15	ARRL CD Party—CW
Oct 21-22	ARRL CD Party—Phone
Nov 4-5	ARRL Sweepstakes—CW
Nov 18-19	ARRL Sweepstakes—Phone
	Second REF Ten Day
Dec 2-3	ARRL 160 Meter Contest
Dec 9-10	ARRL 10 Meter Contest

RESULTS

RESULTS OF THE 1977 INTERNATIONAL POLICE ASSOCIATION '77 CONTEST
November 12-13

First place IPA member was DJ8RK with 6498 points.
First place Non-IPA was DA2DC with 688 points.
First place SWL was HE9ILN with 1914 points.
Of the three US entries, WB4QJO finished top with 1440 points and 11th place overall.

Heinz DJ8RK, the first-place winner of the 1977 IPA Contest. He is active on CW and SSB, but prefers high-speed CW work.

RESULTS

RESULTS OF THE 1977 DELTA QSO PARTY

High score from within Delta division—K5GO with 73,219 points (1003 QSOs).
High score from outside Delta division—K9BG with 10,692 points (162 QSOs).
(This is the second year in a row for K9BG, formerly WB4OGW.)
High score club station—WB5NEX with 35,564 points.
High score mobile station—WA5KQN with 13,158 points.

Delta Division:		
ARK	K5GO	73,219
LA	WB5NEX	35,564
MISS	K5SVC	45,298
TENN	WB4FPH	25,500
First District:		
CONN	W1GNR	2,312
EMASS	W1AQE	1,848
VT	K1ORS	875
Second District:		
ENY	W2WSS	350
NLI	W2RPZ	2,183
NNJ	K2PF	960
SNJ	N2CM	300
WNY	N2RT	1,643
Third District:		
DEL	W3JZA	368
EPA	WA3GNW	672
MD	W3PYZ	924
WPA	W3HDH	665
Fourth District:		
GA	WB4RUA	736
SC	N4LM	540
VA	WD4IMB	1,479
Fifth District:		
NMEX	K5MAT	665
NTEX	W5GVP	580
STEX	K5TM	2,556
Sixth District:		
ORG	N6MU	950
SDGO	WA6ORJ	110
SBAR	K6XO	276
Seventh District:		
ARIZ	WA7WOC	294
MONT	W7JYW	3,840
NEV	W7HI	703
Eighth District:		
MICH	W8WT	1,056
OHIO	K8EKG	1,922
Ninth District:		
ILL	K9BG	10,692
IND	WB9ZEZ	266
WISC	K0CHE/9	594
Tenth District:		
IOWA	WB0VCP	888
MO	WB0SAA	946
NDAK	WA2DJM/0	36
Canada:		
ONT	VE3CDK	1,590
MAN	VE4EA	1,014
DX:		
BRAZIL	PY1DBE	64

RESULTS

RESULTS OF THE 1977 DELAWARE QSO PARTY
November 12 and 13, 1977

Out-of-State Scores
*Denotes state winner.
**Denotes high score for out-of-Delaware station.

State	*Station*	*Score*	
Ala.	W4RAL*	150	tie
	WB5SLC/4*	150	
Alaska	KL7IXZ*	5	
Ariz.	N7MM*	600	
Cal.	WB6JQP*	525	
Conn.	W1VH*	400	
Florida	WA4RRB*	200	tie
	K4TF*	200	
	K4YS*	200	
Idaho	W7GHT*	325	
Ill.	W9QWM*	325	
Iowa	WB0TLE*	625	
Ky.	W4KFB*	400	
Maine	WA1ZAX*	525	
Md.	W3AKD**	725	
Wash D.C.	K3KWJ*	200	
Mass.	W1ATO*	300	
Mich.	WD8CYR*	600	
Minn.	W0PEC*	200	
Mo.	WB0QZY*	100	
N.J.	WA2ZWH*	400	
N.Y.	N2JJ*	375	
N.C.	WA4LWO*	375	
Ohio	K8TH*	325	
Oregon	WB7BVG*	400	
Pa.	WB3BKV*	200	tie
	W3ZID*	200	
Tenn.	W4DGX*	105	
Texas	W5HNS*	650	
Vermont	K1IK*	150	
Va.	N4LE*	200	tie
	W4ZRJ*	200	
W. Va.	WD8EHZ*	150	
Wisc.	WB9PVI*	575	
Canada	*Station*	*Score*	
Ontario	VE3DAP*	450	
	VE3CDK	300	
Manitoba	VE4RF*	400	
Br. Col.	VE7DSA*	675	
Country	*Station*	*Score*	
Japan	JA2HLX*	90	
	JA2HGA	60	

Delaware Scores
*Denotes county winner.
**Denotes high score for Delaware.

New Castle Station	*Score*
WA3WPY*	6636
K3BBR	5775
W3TCI	5640
Kent Station	*Score*
K3SXA/3**	23199 multi-op
K3SXA/WA3QLS (ops)	
W3CTM*	288 single-op
Sussex Station	*Score*
K3JL/3*	14575
W3WLO	8802
WA3WIY	4620

in each state/province/country; other places depending on activity. One certificate for the station showing three "skip" contacts using the lowest power.

COUNTY HUNTERS SSB CONTEST
Contest Periods:
0001 GMT Saturday, April 15 to 0800 GMT Saturday, April 15
1200 GMT Saturday, April 15 to 0800 GMT Sunday, April 16
1200 GMT Sunday, April 16 to 2400 GMT Sunday, April 17

Please note two four-hour rest periods!

This is the 7th annual contest sponsored by the Mobile Amateur Radio Awards Club, Inc. Mobile stations may be worked each time they change counties or bands, but if worked again from the same county on a different band count for point credit only. Mobile stations contacted on a county line count as one contact but two multipliers. Portable stations will be considered *fixed* stations. Fixed stations may be worked by other fixed stations only once during the contest regardless of bands. Repeat contacts between fixed stations on other bands are not permitted! Fixed stations may be worked by mobile stations each time they

Continued on page 58

FCC Math

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In this and the final installment of our series, we'll be putting some finishing touches on the math edifice we've been constructing and in the process pick up some additional symbolism and techniques.

By now, you may have gained a bit of confidence if you did not have such in the past. And if you're still not too confident, at least you can see that by going back to elementary school arithmetic, back to beginnings, we can spin out all the stuff we need, without all that much difficulty. It's just a matter of going slowly, practicing, questioning, reviewing, playing around with numbers, and, above all, refusing to become uptight. (A can of beer or two can be a real help sometimes!)

One of the symbols we run into every so often in electronics is $\sqrt{\ }$, called the *radical sign. Radical* comes from the Latin for *root*, and $\sqrt{\ }$ means square root. It's just the reverse of squaring. 4^2 (four squared) is 4 x 4 or 16. Well, $\sqrt{16}$ means the number which multiplied by itself equals 16, namely 4. So we can write $\sqrt{16} = 4$. Similarly, $\sqrt{9} = 3$, $\sqrt{49} = 7$, $\sqrt{100} = 10$, $\sqrt{10{,}000} = 100$ and $\sqrt{1{,}000{,}000} = 1000$.

Last time, we saw that at resonance the reactance of the coil equals the reactance of the capacitor, from which we got: $2\pi fL = 1/(2\pi fC)$. We solved that equation for capacitance (got the C up by itself on one side with everything else on the other). But supposing we had been asked to solve for f, frequency. The problem is that there are *two* f's. How do we handle a situation like that? Following the rules we developed, we get $ff = 1/[2(2)\pi\pi LC]$, which at least gets the f's by themselves on one side (the two f's mean f times f or f^2, as usual). Using squares, we might write that: $f^2 = 1/[(2\pi)^2LC]$. The $(2\pi)^2$ means that both the 2 and the pi are squared (multiplied by themselves). We could then substitute whatever values L and C have into the right-hand side, and work that side out to a single number, so that we had f^2 = some number. But where do we go from there? Well, let's take an example. Suppose $f^2 = 100$. Then doesn't $f = 10$? Because f^2 would then be 10 x 10, which is 100. So f, then, equals simply the square root of whatever is on the right-hand side. Going back, $f = \sqrt{1/[(2\pi)^2LC]}$. Since there is only multiplication and division on that right-hand side (no addition or subtraction), we can apply the radical to each part. $\sqrt{1} = 1$. $\sqrt{(2\pi)^2}$ = simply 2π, and $\sqrt{LC}$ is just $\sqrt{LC}$. That gives us the relatively important formula for a resonant circuit: $f = 1/2\pi\sqrt{LC}$).

If there had been addition or subtraction of the right-hand side above, we could not have applied the radical sign to each part separately. Note, for example, that $\sqrt{25 + 9} \neq \sqrt{25} + \sqrt{9}$. $\sqrt{25 + 9}$ is less than 6 (because $\sqrt{36}$ is 6 and 25 + 9 is just 34), whereas $\sqrt{25}$ is a 5 and $\sqrt{9}$ is 3, and 5 + 3 = 8. Try things out with numbers if there's any question, and you'll seldom go wrong.

And if you're not certain that $\sqrt{1} = 1$, just recall that $1 \times 1 = 1$. Likewise, $2\pi \times 2\pi = (2\pi)^2$. (Notice that I have to use parentheses there, because if I didn't you might think that just the pi was squared, not the 2.)

Summarizing what we just saw, we can establish the rule that where things are squared we solve by finding square roots. Another example: $P = E^2/R$. Say we have to solve for E, voltage. Using the algebra we've developed, we'd get $E^2 = PR$. Then we apply the rule above to get $E = \sqrt{PR}$, voltage equals the square root of the product (what we get from multiplying) P and R, power times resistance.

But, of course, all this implies that we know how to find the square root of numbers of all sizes. Lots of calculators have square root buttons. And there's an algorithm (a neat little process) for finding square roots in a fairly straightforward fashion in most algebra books. We'll assume you don't have such a calculator and don't know the algorithm. Since FCC exams usually require no more than one- or two-digit accuracy, we'll look at the simplest technique, namely trial and error, for finding these roots.

Say you've worked the resonance formula to the point where you've found L times C to be 0.0000000000086 (8.6×10^{-12}). Look closely at that power of ten. Notice that it's a multiplication. We just saw that where there's just multiplication or division you can find the square root of each part separately. Now 8.6 is very close to 9, and $\sqrt{9}$ is 3. But what about that 10^{-12}? Well, $(10^{-6})^2$ means $10^{-6} \times 10^{-6}$, and from our rules for powers of ten we get $10^{-6 + -6}$, or 10^{-12}. Since this kind of thing happens every time, you can see where our rule about halving comes from. The square root of 8.6×10^{-12}, then, is about 3×10^{-6}, 0.000003.

But what do you do if the exponent of 10 is not an even number? What if we're trying to find the square root of 7.2×10^{11}, for example? In our next installment, we'll play around with things called logs (not the wooden variety). Logs is short for logarithms. And all logs are weird powers of ten, weird exponents of ten, more precisely, like 5.5 which is half of 11. but where we're at, we employ a little trick that we've already seen in another context, in changing *micros* to *nanos*, for example. We've seen that 0.07 microfarads is the same as 70 nanofarads. $0.07 \times 10^{-6} = 70 \times 10^{-9}$. No doubt you'e been puzzled by these things, and rightly so, since I've never clearly explained what's going on. So here goes!

Again, it's the old "multiply by *one* in some clever form" trick. Take that 0.07×10^{-6}. Multiply the left part by 1000, and divide the right by 1000. 0.07 x 1000 is 70. 10^{-6} divided by 1000 is 10^{-6} divided by 10^3. We subtract exponents to get 10^{-9}. Put them together and we have our 70 nanofarads. We multiplied the original number by 1000 and divided it by 1000. In other words, what we did to one part of the number we *un*did to the other part. Looked at another way, we multiplied by 1000/1000. The multiplication was the top 1000, and the division, the bottom.

Pull the same kind of trick on our 7.2×10^{11} and we get, for example, 72×10^{10} (can you figure out how I did that?*). Now we can easily get the square root. $\sqrt{72}$ is about 8.5 ($8^2 = 64$; $9^2 = 81$; 72 is about halfway in between). Divide the exponent, 10, by 2 to get 5. Put them together and we have our square root, 8.5×10^5 or 850,000.

We haven't seen much trial and error so far. It's getting that first part, the 8.5 in the example above, that's often a matter of trial and error. When you're not sure just what that first part should be, you *guess*, and then multiply your guess by itself (the simplest calculators are helpful). If it's not close enough to the square you started off with, you try another guess. 8.5^2, for example, is 72.3, plenty close to 72 for most purposes. But you might have tried 8.4 or 8.6 or something in an altogether different ball park, for that matter. Any of those multiplied by itself would have given squares further away from 72 than 8.5 gave. Just by trying out different guesses, you can get as close to an exact value as you need.

Now here's an exercise for you. Answers (with work) at the end, as usual.

Exercise 1:

(1) Solve for I: $P = I^2R$

(2) Using the formula you just derived, find I when P = 5 W and R = 200Ω

(3) Find these square roots using powers of ten: (a) 382 (b) 0.000018 (c) 520,000,000 (d) 0.0000000000047

We have several times referred to the fact that when there are additions or subtractions in a fraction one cannot perform certain operations and get correct answers. $R_t = R_1R_2/(R_1 + R_2)$, the formula for computing the equivalent resistance of two resistors in parallel, is a case in point (and there's a bunch of other formulas, reactance, inductance, etc., of the same form). Let's go to a number equation to help us out here: $2 = [3(6)]/(3 + 6)$. In other words, there's 2 Ohms' resistance across parallel 3- and 6-Ohm resistors. We're trying to discover what kinds of wiggling we can do with an equation like this and still come up with true equations. It's easy to find lots of things one can't do! For example, I can't bring the 3 or 6 up from the bottom of the right side to the top left separately. $2(3) \neq [3(6)]/6$, for example, nor does 2(6) equal [3(6)]/3. Play around with it, and you'll find lots of others that don't work.

Sooner or later, though, you'll probably stumble upon some that work. 2(3 + 6) = 3(6) is one such. Here the 2 multiplies both the 3 and 6 on the left side. In other words, 2(3 + 6) = 2(3) + 2(6) or 2(3 + 6) = 2(9), and either of those equals the 3(6) on the right. Play around with a few like this, and you'll see that where there are additions and subtractions you're okay as long as you move the things added or subtracted as *a unit* if they're on the bottom of a fraction. We brought the 3 and 6 up together, with the + sign between them.

So what? Now that we have that stuff up on the left, what do we do? Well, often enough we know what the total resistance we want is, and we're after the value of resistance to put in parallel

Continued on page 182

*Multiply the 7.2 by 10, divide the 10^{11} by 10 (which is 10^1).

RTTY Loop

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Last month we considered the requirements for systems to store information generated on RTTY. Seven criteria were presented and elaborated upon. This month we will investigate various methods in use and see how they stack up against these criteria. As a recap, the factors were:

1. Ease of entering data into storage;
2. Ease of inspecting stored data;
3. Ease of editing stored data;
4. Ease of removing data from storage;
5. Volatility of storage form;
6. Cost and availability of technique;
7. Interchangeability between users.

Now, let's see what's around.

The first method I shall call the "tear-sheet method." This involves tearing the page from your page printer, after receiving something worthwhile, and putting it in a folder for safe keeping. A related technique, the "strip-rip method," is used for ticker tape fanciers or voyeurs and shall not be discussed in detail here. Let's see how this method meets those criteria. It certainly is easy to enter data into storage, requires no additional effort, and stored data is readily inspectable. Unless the shack burns down or your wife goes on a cleaning rampage, the record is quite nonvolatile. The technique is free and available to just about anyone, and a Xerox® copy could certainly be made to interchange between users. But . . . unless you are a very good, fast, and accurate typist, there is no easy way of retransmitting the stored information. Also, while the record may be edited with pen or (blue) pencil, production of a new error-free record requires manual retyping of the whole. While the deficiencies in this technique make it impractical for on-line storage and retrieval, it does have some uses. This is the most convenient technique for storing information which will not be retransmitted. Typically, that would be material such as bulletins or third-party traffic received for delivery.

The most widely used methods of information storage in amateur RTTY involve paper tape that is 11/16 of an inch wide. They all share certain features, which will be discussed jointly. Transmission of data contained on paper tape requires a tape reader or transmitting-distributor. With a TD, data is sent without difficulty at machine speed. Paper tape is relatively nonvolatile, although the oiled tape generally in use does deteriorate after several years. Tape is fairly cheap and easily available, as is equipment to produce and read it. Of course, five-level Baudot tape is encoded in a standard format, and tape can be swapped without problems. There are different means of producing tapes, however, and that's where the rub lies.

A device which produces punched paper tape from a keyboard is called a "perforator." While possessing all those advantages enumerated for tape techniques in general, the "perforator method" has one serious drawback. Information cannot be recorded as it arrives, but only from manual input. This makes the perforator method suitable only for origination of material for later transmission. Although a copy of the material stored can be produced by running the tape through a TD in a local loop, changes entail retyping the entire tape manually, a tedious process.

With a "reperforator," arriving signals may directly control the tape punch, and storage is at machine speed. This "reperf method" thus comes closer to our ideal, with the exception of being able to read the stored data without an intervening step. The "typing-reperf method" takes care of that by adding a mechanism to type the text directly on the tape. Some machines type on the top of chadless tape, while others punch the holes clear out and print the letters near the sprocket holes. Corrections or changes may be entered by having the TD control the reperforator and stopping the tape to manually enter changes.

By the way, while we're on the topic of tape, there are really two types of tape to be found in Baudot systems. The 11/16-inch tape we have been describing is the Teletype Corporation's system, while the Kleinschmidt machines use tape that is 7/8 of an inch wide. While both of these tapes are Baudot-encoded, they are not interchangeable and must be used on their respective machines. This means, of course, that a Teletype TD is not compatible with a Kleinschmidt perforator and vice versa.

While, with the typing-reperf method, it may appear as though we have reached our ideal, there are still several problems. These tape readers and punches are large noisy mechanical beasties that collect dust and have to be cleaned, lubricated, and adjusted often or they go wacko. And, while they are reasonably available, there is often no local source for them and, heaven forbid, just about no way to home brew one. Also, although tape is quite sturdy, it does break and tear. A half hour of transmission requires 900 feet of tape, and there is frequently no place to unwind and wind it all! Further, what do you do if you run out and can't get any locally?

What we need is a dense, cheap, and readily-available recording material that behaves like paper tape. Enter the cassette! Recording the RTTY as AFSK and recovering the signal by conventional AFSK reception techniques is a viable alternative to paper tape. The primary disadvantage is that the playback will be at the same speed as it is recorded. That is, if typed in hunt-and-peck style at 20 wpm, it will come out that way. Its primary advantage is its density for storing great quantities of material (a C-30 versus 900 feet of paper) which may have originally been contained on punched paper tape, such as for archival storage.

Fig. 1 is an attempt to order these techniques to show that each has its own niche in the scheme of things. There are other techniques than those mentioned here, but, for the most part, they do not apply to the amateur applications. One notable exception is digital storage in read/write memories, but we will pick that up later in this series.

I appreciate the questions received from readers, and am trying to answer as many of general interest as possible in the pages of *73*. A self-addressed stamped envelope must accompany requests for a personal reply. Next month, we will look into different kinds of fun with a Teletype™ machine.

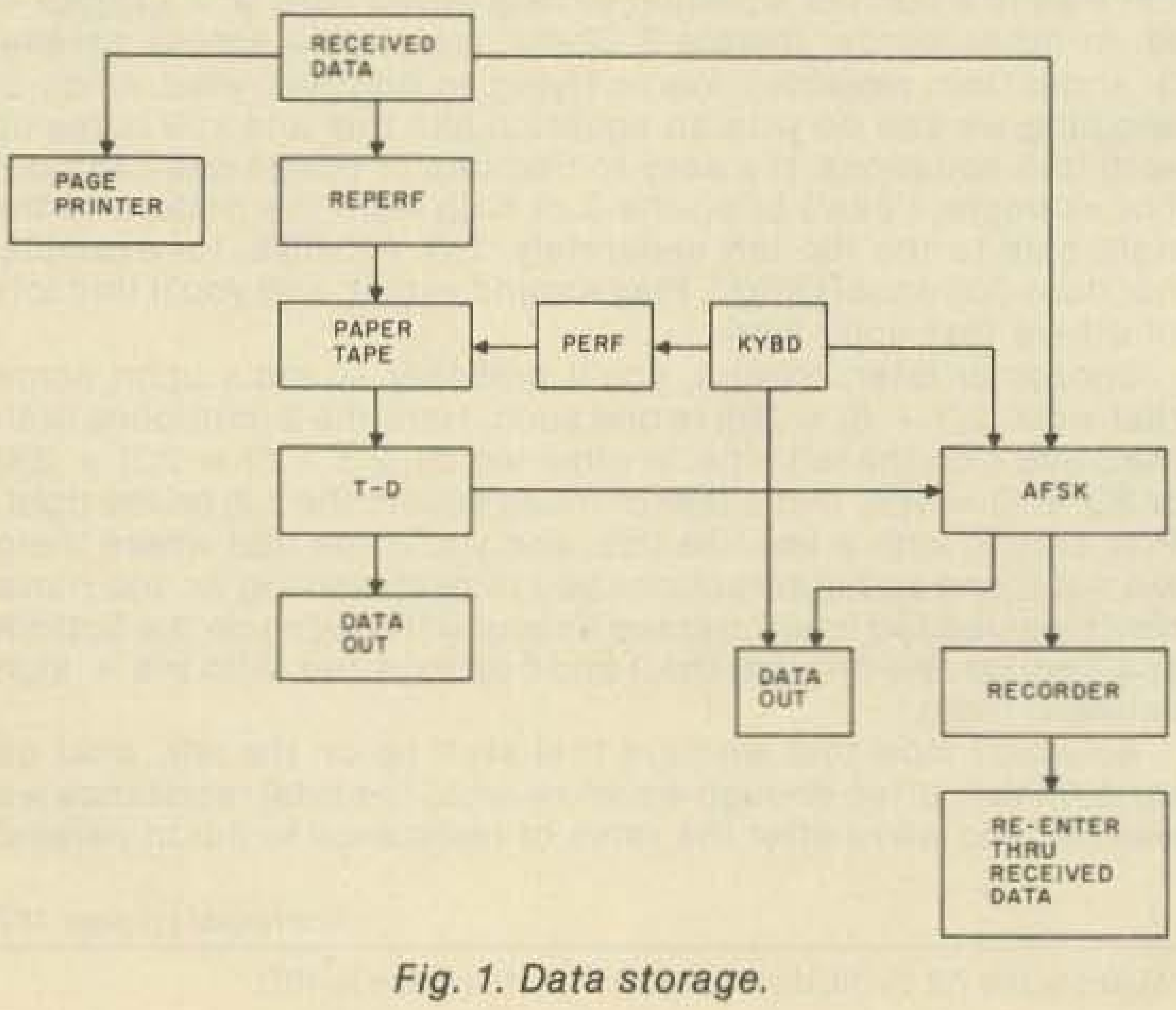
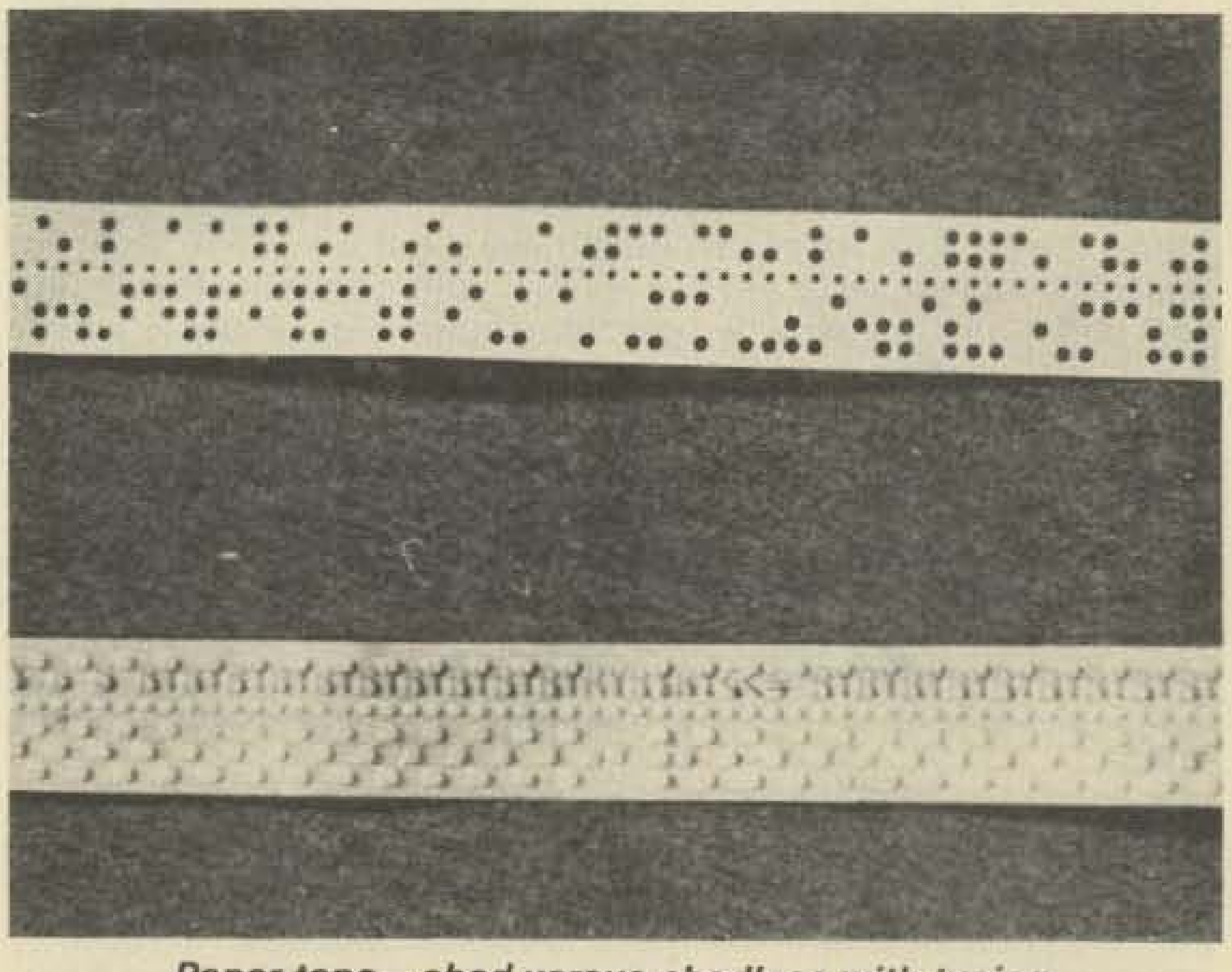


Fig. 1. Data storage.



Paper tape—chad versus chadless with typing.

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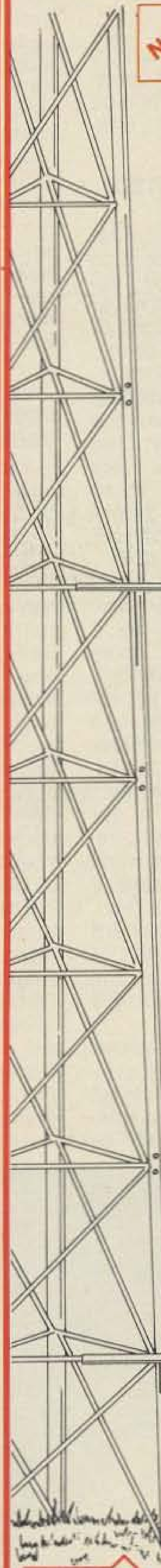

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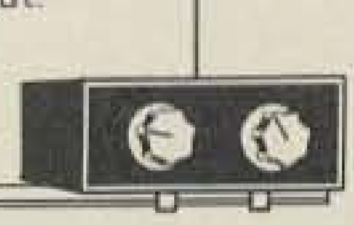

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Looking West

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SAROC was a waste; CES made the trip to Vegas worthwhile; and a bit more on international SWLing: all this and more (?) in this month's "Looking West."

DOWN THERE REVISITED DEPARTMENT

My postal delivery lady must hate me. While she is used to delivering all sorts of envelopes and packages, never before did it amount to a bit of an "envelope rush." It seems that my "LW" dealing with international shortwave listening struck a sweet note in the minds of many. Daily, the responses roll in; to date, every one of them has been positive. If that particular "LW" brought some real joy to many of you, then I'm very glad I wrote it.

In the months since that was written, I have updated the "LW" "SWL position" to a more modern receiver, from Radio Shack. It's called their Realistic Model DX-40 and, for an under-$50 radio, it sure runs rings around most of the older tube-type equipment of the fifties and early sixties. While I freely admit that this is far from the ultimate in SWL receivers and I would not mind owning either the Kenwood or Yaesu entries in the SWL field, for the price, the DX-40 is hard to beat. It, along with 100' of wire, has given me back the world—and it's sure a nice place to visit.

One of the nicest pieces of mail in this regard was a copy of *Happy Station Fan Club* DX magazine published in Adamstown, Pennsylvania, by an amateur named Larry McKinney WB3FJO. Subtitled, "Smiles Across the Miles," this very professional-looking publication features a basic course in amateur radio theory along with many other features dedicated to international SWLing in general and Radio Nederland in particular. Larry gets $6 a year for US membership and $10 for overseas. If you want more information on the Happy Station Fan Club, write Larry at 424 Grant Road, Adamstown PA 19501. If you get the feeling that his magazine impressed me, you are right. It did.

OVER THE MOUNTAINS AND ACROSS THE DESERT TO LAS VEGAS WE GO DEPARTMENT

Yep, it's that time of year again, so we hop into the Torino and head it northeast along California Highway 14. Our destination? You guessed that as well: Las Vegas, Nevada. This year, though, there was more than just SAROC. It seems that someone had thought that Las Vegas might be a fine place to hold the annual winter Consumer Electronics Show. Talk about spectacular. CES completely stole the thunder from SAROC. In fact, I find it a bit hard to write about SAROC this year since I spent far more time at CES.

The majority of my SAROC time was dedicated to such things as the FCC/Amateur Regional Media Conference, FCC Forum, and ARRL Forum. Very little else. This month, we will concentrate on the Media Conference, one which the FCC personnel haved termed a resounding success.

John B. Johnston K3BE, Chief of the Amateur and Citizens Division (now titled the Personal Communications Division) of the FCC seemed delighted at the number of people turning out for this first "regional version" of the FCC/Amateur Media Meetings. While I was too engrossed in the meeting proper to give you a head count, it's my opinion that the decision to take these meetings to the people rather than vice versa was the right one, and the FCC people are to be complimented on this approach.

John acted as host and moderator for this gathering, beginning things with an updated version of his FCC slide show that included one slide depicting the many stacks of mail received from people like you and me. John assured us that it all does get read, though most never receives a direct answer. To do so would be an impossible task, so the Commission tries to cover pertinent topics through periodic bulletins. Trying to answer each and every question on a one-for-one basis would make for an insurmountable paperwork load. We in the media were also asked to remind you all that at present, and until further notice, *the suspension of fees still is in effect*. Therefore, *do not send the FCC any monies with applications*. If you do, you will receive your license with the words: "If You Paid By Check, It Was Destroyed." This was the simplest way that the Commission could find to handle this problem. Simple and effective, but it does tend to make a license look a bit messy.

Here are some interesting statistics for you, as provided us by John. Question: Each month, how many (average) people pass amateur exams at FCC offices? Answer: Technician—232, General—150, Advanced—57, Extra—8. These are people who walk in "cold"! People with the knowledge to pass the test, but no prior license! Not too shabby, I must say. Remember, this does not count the hordes of new Novices being licensed each month and those upgrading. John also brought a bit of laughter to our assembled multitude when he informed us that better than 75% of those taking the 20 wpm code exam at the FCC offices pass it, and added: "This must prove that 20 wpm is by far the easiest."

To those of us involved in the world of VHF/UHF communications, the presentations of two of the speakers hold signifi-

SCRA Past Chairman Bob Thornburg WB6JPI, speaking at the SAROC FCC/Amateur Media Meeting.

Heath Kline of Priority One Electronics shows his wares at SAROC.

cance. Overall spectrum management was covered by Will Anderson AA6DD. Will explained spectrum management in terms of space (available frequencies) versus time (utilization factor), as such applies to both HF and VHF/UHF. He stressed the need of developing new techniques to provide more relay spectrum availability without an increase in relay spectrum per se, stressing technological advancement as the key to the problem. Through use of modulation folding techniques as applied to "commercial 2.5 kHz sliver band," Will feels that a massive increase in available relay pairs could be found. He feels that use of computerized PCM techniques could enhance this even further. Why? Why the need for all this advancement now? In one word, "Communicator." Should a Communicator Class license come to pass, and with it the possibility of millions of new amateurs needing a place to operate, and most wanting the advantage of relay communication, we will be hard put to handle this kind of problem *unless* we begin to plan our destiny now.

Later in the afternoon, Bob Thornburg WB6JPI spoke on repeater/remote deregulation. Bob, former SCRA Chairman and current member of that organization's 2 meter Technical Coordination Committee, stressed the need for "livable rules" that do not restrict technical advancement. He cited the present controversy over the Report and Order on Docket 21033 and the massive resistance from within the amateur community to its implementation as an example of this. There was just too much "good" and "bad" lumped together at one time in one document, with almost no time to evaluate and plan for its implementation. It was stressed that such deregulatory factors should have been handled as individual points and individual reports rather than as a "total lump," so that the "good" would not have to remain restricted because so many are against the small amount of "bad" contained therein. Bob specifically made mention of the hold on remote base deregulation as an adverse effect of the overall staying of 21033 by saying: "Kelsey and Schlessinger made a fine written presentation to the Commission on the case for remote bases. Perhaps the best such (presentation) ever made on the topic. Unfortunately, it got lumped in with repeater deregulation, which it has very little to do with." (The Kelsey and Schlessinger referred to are Mr. William Kelsey and Mr. Gordon Schlessinger of the Southern California Repeater Remote Base Association. Last year they filed a very technologically complete request for remote base deregulation which became part of 21033's initial Report and Order.)

Bob's presentation stressed that "we amateurs" have the resources to handle any and all problems which might confront the amateur service, be it HF or VHF, that what we need are "guidelines" to work from rather than rules covering specific points and/or operational procedures, and that such guidelines must be structured in a way that will foster technological growth and at the same time bring an awareness of the "self-policing" responsibility to all amateurs. Bob and the SCRA feel that within the amateur community lies all the necessary talent to handle current and future deregulation, and that the Commission need only ask for this talent to come forth. He suggested that, in the future, the Commission "field test" any form of regulation and/or deregulation by "farming it out" to a group of experts on a specific topic and then using the feedback it receives to make any final decision prior to total implementation.

On the matter of self-policing in relation to total deregulation, Bob commented that the one rule or law we need is some way of prosecuting the "bad guy" or "turkey" and getting his license pulled. "The amateurs can find the bad guys . . . it's done every week here on the repeaters in LA . . . the problem is what do we do with them once we find them . . . we need a law, a rule that will enable us to get them out of the amateur service . . . to stop them from jamming repeaters, WESTCARS, or what have you . . ." Jumping in with a comment, Ney Landry of the FCC's San Francisco Field Office stated that though he thought all this was a fine idea, "Who will write the legal definition of the term 'turkey'?" Needless to say, this brought more than a chuckle from the audience.

CES WAS A BLAST DEPARTMENT

Ever wish that you could visit one place and see every new electronic gadget that your heart might ever desire to own? Bet you have. I was lucky . . . this year the "dream" became reality thanks to the 1978 winter Consumer Electronics Show being held in Las Vegas simultaneously with SAROC. CES is to the consumer electronics industry what Dayton is to amateur radio. While no final tally is available, on closing day (and I was there at the close of the show) unofficial figures placed attendance at over the 50,000 mark. I heard estimates up as high as 65,000! CES themselves will eventually have an official figure, but whatever it turns out to be, the one word I have to describe CES Las Vegas is "crowded."

Just a small part of the CES at the Las Vegas Convention Center.

1978 looks to be the year of the home VCR (videocassette recorder), with home video entertainment (games, etc.) equipment running a distant second and CB/CB-related items still quite visible. Now, these are my views and do not necessarily represent the views of those showing their wares. However, I have never seen more interest exhibited in home videotape equipment than was apparent at CES Las Vegas. For those not aware, there is still a bit of a "fight" going on as to which one of two ½" tape cassette formats will become the eventual market standard. These two are the VHS and the Beta formats. Each seems to have certain advantages and disadvantages, with VHS claiming twice the record/play time offered in the Beta format (4 hours for VHS vs. 2 hours for Beta) and Beta claiming superior adjacent line noise rejection and slightly better resolution in exchange for the shorter record/play time. As far as I am concerned, both systems exhibit good quality reproduction, with the Beta being my personal preference. Both systems are helical scan and both appear to be based upon the time-proven ¾" U-Matic format introduced a few years back by Sony. (I still prefer the quality obtainable from ¾" over ½", but U-Matic tape cartridges cost twice that of either VHS or Beta cassettes. It's been the advent of high quality ½" tape and associated techniques that has brought video recording to a point where most of us can afford it.)

"Advanced" home video games were also in abundance, along with mainstays such as home and mobile stereo equipment, the latest in television sets, and some CB radios (though not to the extent I thought I would see). I suspect that it's a sign of our times. Last year, CB was in the public eye—you know, the big fascination. This year it's video games and videotape . . . next year???

There were a number of exhibitors showing their amateur equipment lines, including both Regency and Wilson. Wilson's booth continually drew a big crowd of those interested in their newly announced pint-sized two meter hand-held, and Regency was not wanting for visitors either. The Consumer Electronics Show was, in my opinion, the best such show I have ever attended. If it continues to run in Las Vegas at the same time as SAROC, SAROC will be very hard put to compete with it. CES is a show which offers something of interest to everyone, man, woman, or child. It's a show of dreams and dreams come true, one that is well thought out and well managed on a very highly professional level. I seriously doubt if SAROC or anything else can hope to compete with it. It's that good!

Before leaving CES, I have to remark about one particular booth that was, in my eyes, the "Show Stopper." Kudos go to Kraco, the CB and auto audio manufacturer, for coming up with the idea of having a bit of a show at their booth featuring trained exotic birds provided, I understand, by the San Diego Zoo. These "fine, feathered," and colorful friends seemed to gather crowds simply by uttering their normal "bird sounds." They were beautiful to behold and probably gave Kraco an edge over the competition. I know that I enjoyed watching them.

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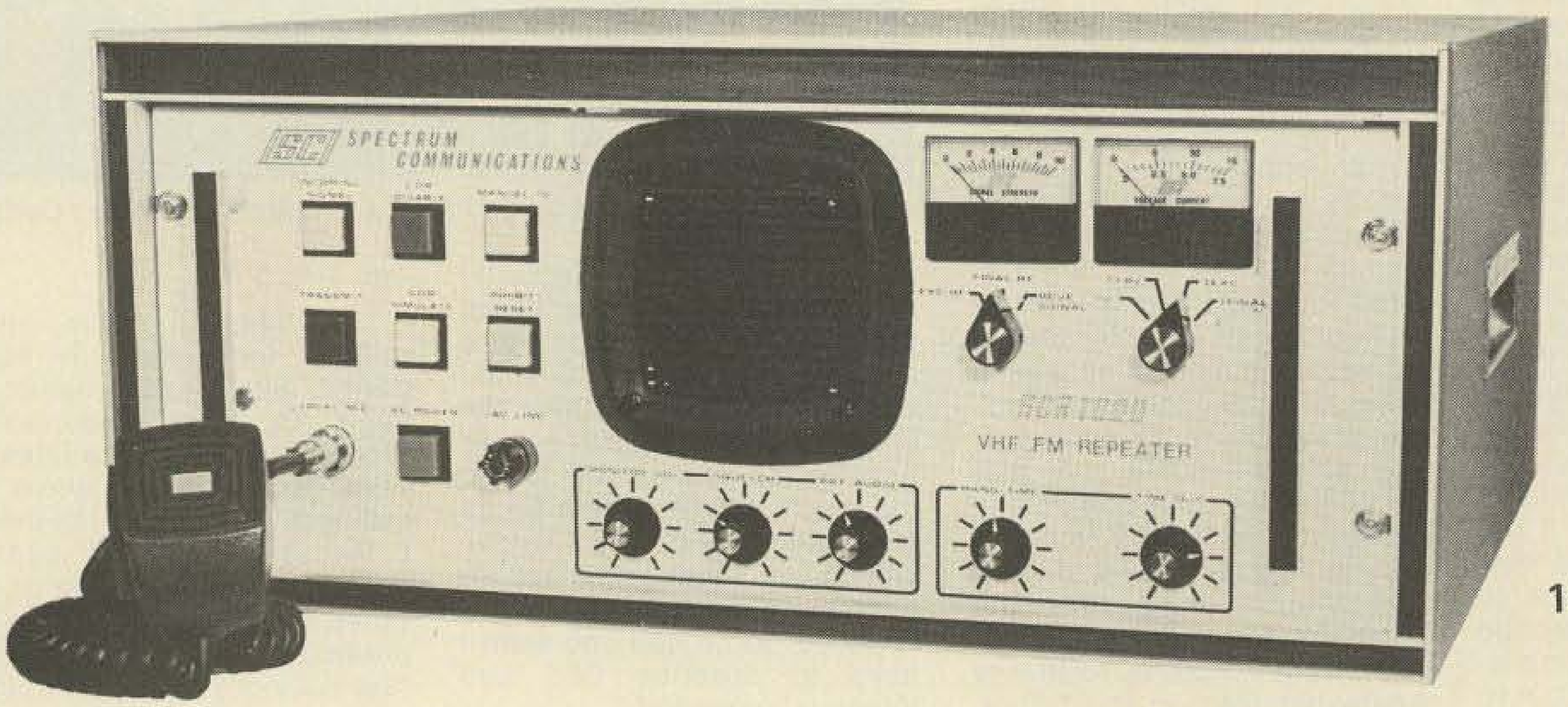

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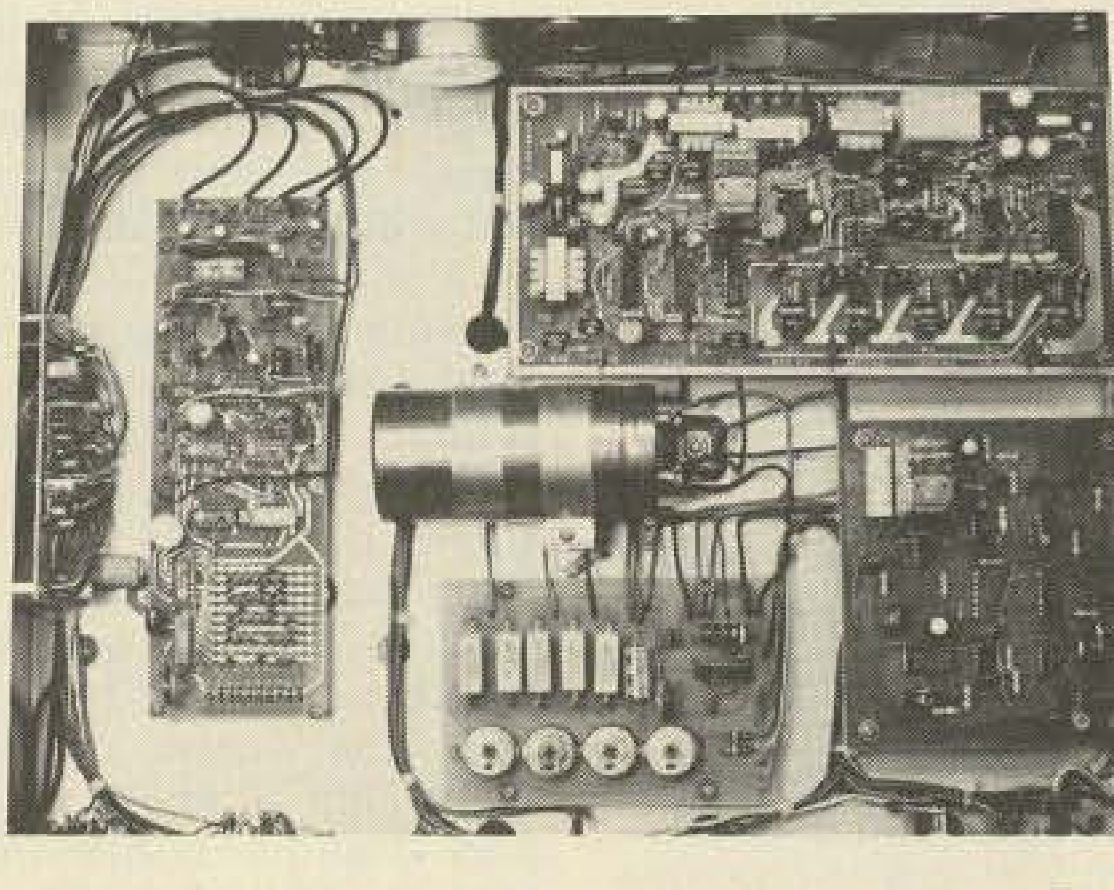

Under chassis view of SCR1000 with Autopatch installed.

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"... The quality of the audio is unbelievable — a true reproduction of the input. It really does sound like simplex. The receiver sensitivity of our Spectrum system is at least twice the Motorola system we had in service. We have 24 Watts out of our duplexer. We all have fallen in love with your machine ... Again, thank you for an excellent piece of equipment. We are ceratinly glad that we purchased a Spectrum 1000 Repeater."

Jim Wood W3WJK
Mars, PA 16046

"You have a product that more than meets the specifications you claim ... In the receiver you have a winner, the intermod is negligible ... We have many other repeaters both amateur and commercial in the area and as of yet no problem ... ***In closing, I would like to thank you for producing a product that does what is expected of it. In this world one seldom gets what he pays for; I feel our group has bought and received our moneys worth."***

Jim Todd WA5HTT
Dallas TX

"The receiver is excellent: typically, if a 25-watt mobile can hear the machine (running 100 watts out of the duplexer), he can get into it. That's pretty good, I must say. Although I'm on a 15-kHz "splinter" between two BIG repeaters, we don't have any adjacent-channel problems with the SCR1000's receiver ... although the "local" 19/79 group has headaches from their repeater's receiver whenever a mobile operating 146.205, (our freq.), in their area keys up. And their machine is totally "commercial"! Needless to say, the audio quality of the SCR1000 is pretty spectacular. Switching from input to output, even Melissa Manchester can't tell the difference — and neither can I."

S. Katz WB2WIK

- **The SCR1000** — simply the finest repeater available on the amateur market ... and often compared to "commercial" units selling for 3-4 times the price! This is a 30Wt. unit, with a very sensitive & selective receiver. Included is a built-in AC Supply, CW IDer, full metering and lighted status indicators/control push-buttons, crystals, local mic, etc. Also provided are jacks for emergency power, remote control, autopatch, etc.
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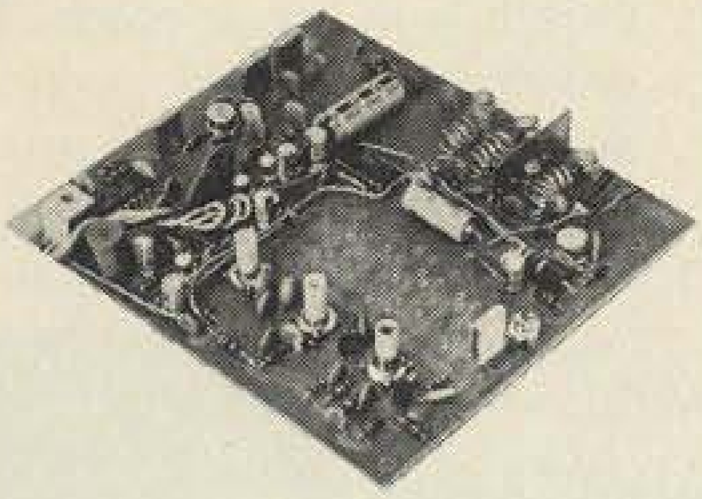


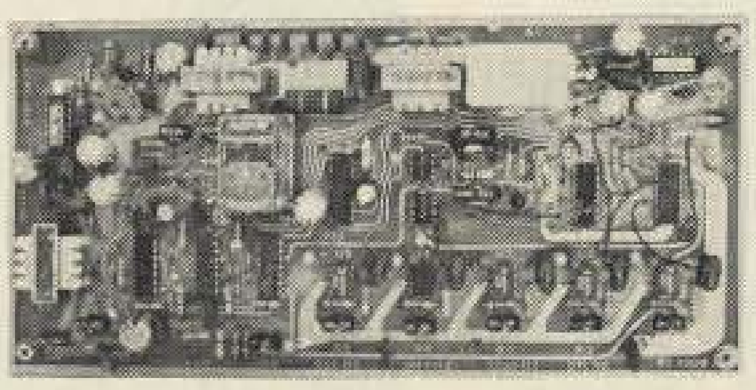
SCR100 Receiver Board
- Ext. wide dynamic range! Greatly reduces overload, 'desense', and IM.
- Sens. 0.3uV/20dB Qt.
- Sel. -6dB @ ± 6.5 KHz, -90dB @ ±30KHz, (-110dB w/opt. 8 Pole Fltr.)
- Exc. audio quality! Fast squelch! $115.00 w/xtal.

SCR100 Receiver Assembly
- SCR100 mounted in shielded housing
- Same as used on SCR1000
- Completely asmbld. w/F.T. caps, S0239 conn., AF GAIN POT, etc. $185.00

TRA-1 Timer Reset Annunciator Board
- Puts out a tone "beep" on rptr. xmtr. apx. 1 sec. after rcvd. signal drops — thus allowing time for breakers
- Resets rptr. time-out timer when tone is emitted
- Adjustable time delay and tone duration
- Typically used with CTC100 and ID100
- $20.95 (Add $18.00 for inst. & ck. out in SCR1000)

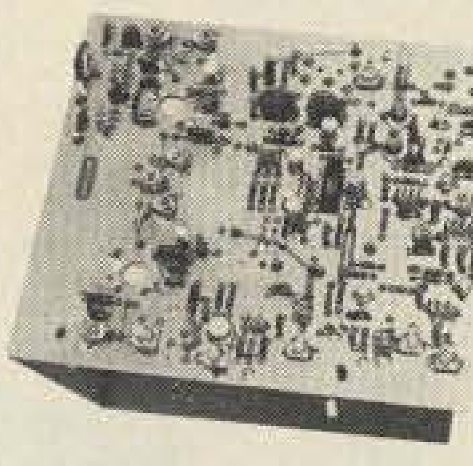
CTC100 COR/Timer/Control Board
- Complete COR circuitry
- Carrier 'Hang' & T.O. Timers
- Remote xmtr. control
- 100% Solid State CMOS logic
- Many other features $35.00

FL-6 Rcvr. Front-End Filter/Preamp
- Low-noise preamp combined with 6 section filter
- Provides tremendous rejection of "out-of-band" signals
- Extremely helpful at sites with many nearby transmitters
- Gain: apx. 12dB
- Selectivity: −20dB @ ±1.7 MHZ; −60dB @ ±4 MHZ (typ.)
- $69.95 (Add $10.00 for installation & ck.-out in SCR1000)



SCAP Autopatch Board
- Provides all basic autopatch functions
- See features on opposite page. $225.00

RPCM Board
- Used w/SCAP board to provide "Reverse Patch" and land-line control of rptr.
- Includes 1-1 "answering" circuitry. $95.00



SCT 110 Xmtr/Exciter Board
- 7 or 10 Wts. Output
- Infinite VSWR proof
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- New Design — specifically for continuous rptr. service
- Very low in "white noise"
- Spurious -70 dB
- With .0005% xtal. $135.00
- BA-10 30 Wt. Amp board & Heat Sink. 3 sec. LPF & rel. pwr. sensor. $51.95

SCT110 Transmitter Assembly
- SCT110 mounted in shielded housing
- Same as used on SCR1000
- Completely asmbld. w/F.T. caps, S0239 conn.
- 7 or 10 Wt. unit $199.95. Add $62.00 for 30 Wt. unit.

WP641 Duplexer
- Superior Band Pass/Band Reject design
- Provides great rejection of "out-of- band" signals
- Extremely easy to adjust
- −93dB typ. isolation. $495.00 (fully ckd. out w/SCR1000).

ID100 ID & Audio Mixer Board
- Adjustable ID tone, speed, level, timing cycle
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- COR input & xmtr. hold
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Ecstasy In Multimeterland

—build this autoranging marvel

Charles J. Green WA4AIH
114 No. Osceola Drive
Indian Harbour Beach FL 32937

The most frequently used and trusted piece of test gear is the VOM. New ICs have changed the appearance of the VOM by taking a giant step in providing numeric readouts in the place of the sometimes difficult-to-read meter movement. Even if the greater accuracy was not considered, the ability to match voltage currents and resistors was greatly improved. However, not until recently have the IC manufacturers been able to provide the function we have all been waiting for . . . autoranging!

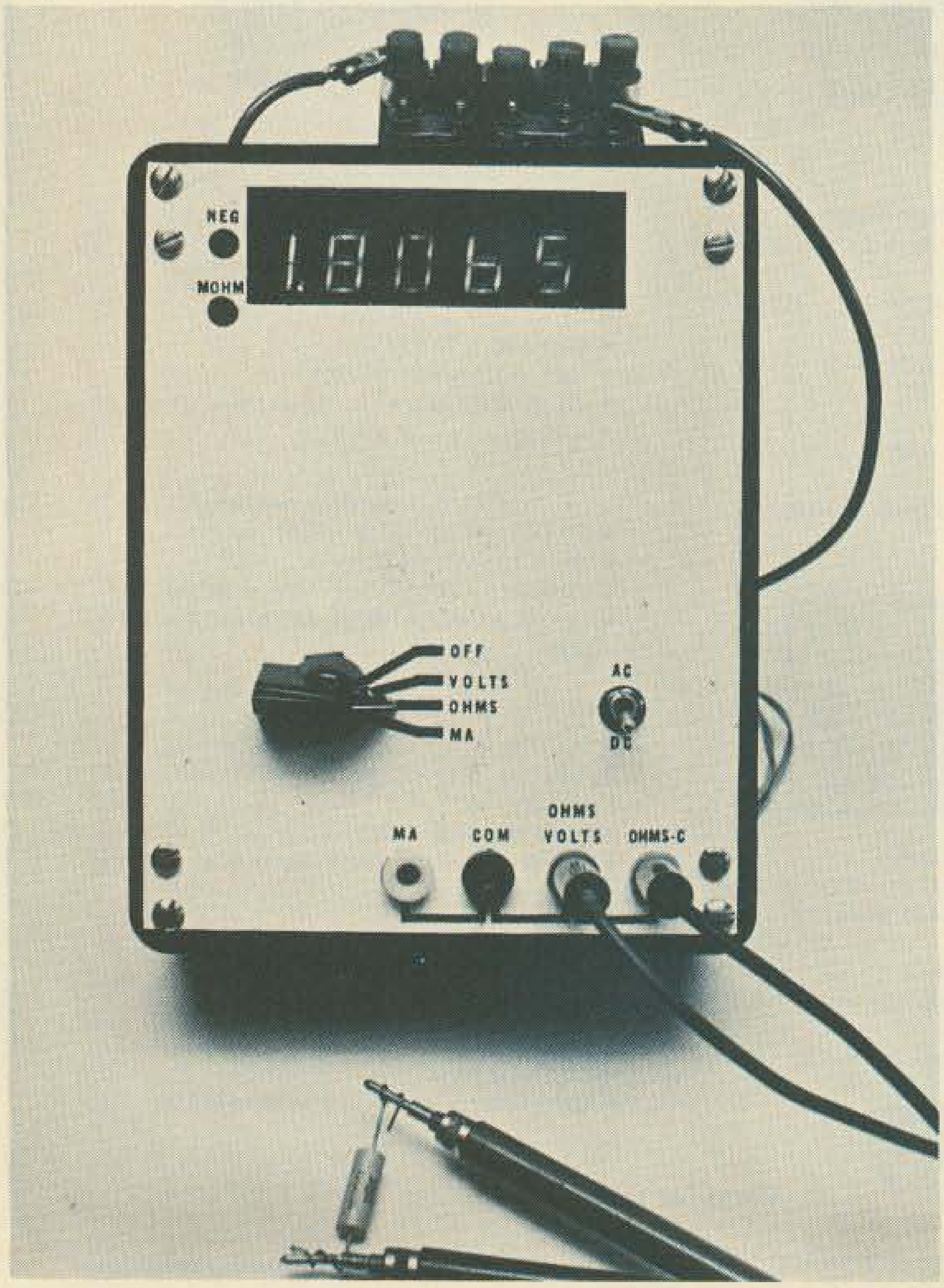
This article describes the operation, construction, and calibration of a complete 4-3/4-digit autoranging, autozero, autopolarity digital multimeter capable of measuring dc or ac volts (.1 millivolt to 2.9999k V), dc or ac current (1 uA to 2.9999 Amps), and Ohms (.1 Ohm to 29.999 megohms). The autoranging feature will automatically provide the proper decimal location to give the most significant digits possible. A single 5 V supply is all that is needed for operation of the meter.

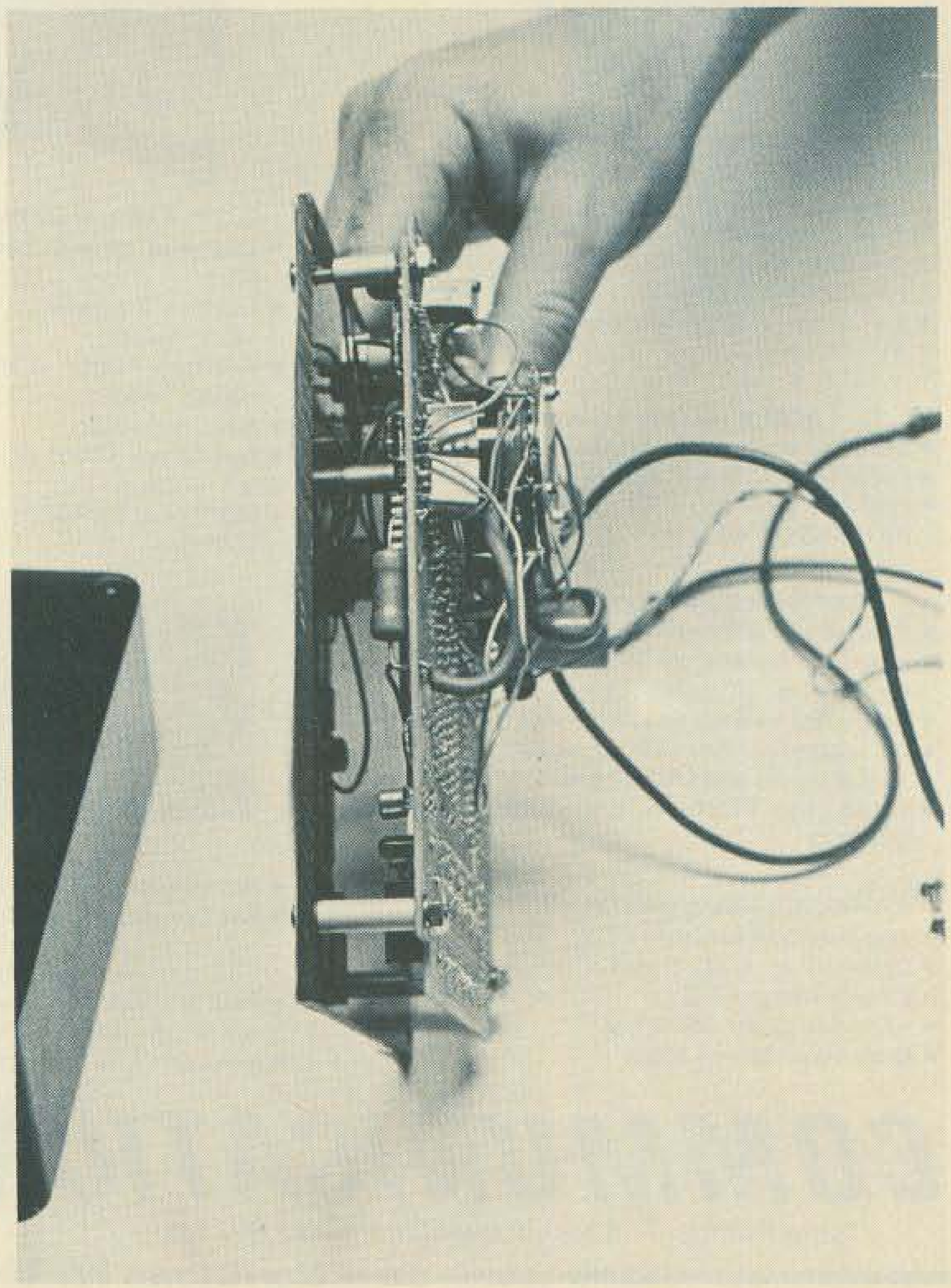
Circuit Description

The block diagram (Fig. 1) shows how simple the circuitry has become with the introduction of Intersil's 8052 analog signal conditioner and General Instrument's AY-3-3550 4-3/4-digit DMM integrated circuit.

A voltage of unknown amplitude is applied to the variable gain amplifier. Ideally, the output of the amplifier will be between +2 V and -2 V. The output will be converted to dc if the ac/dc switch is in the ac mode. This unknown voltage will be applied to the input of the 8052 (IC11) only when the

Photos by Arnold Cain WB4FDQ





AY-3-3550 (IC3) is ready to make a measurement. When ready, the sample switch will be enabled for 10,000 counts, the sample switch is turned off, the comparator output is sensed for polarity by IC3, and the polarity data is used to force the dual slope integrator to integrate in the opposite direction. IC3 will store the count required for the integrator to cross zero. This count will be directly related to the amplitude of the unknown voltage. If the integrator does not reach 0 V by 20,000 counts, the unknown voltage is too large. In this case, the variable gain amplifier is set to reduce the unknown voltage by a factor of 10 and start the sampling over again. If the count is less than 1800, then the variable gain amplifier has insufficient gain. In this case, the gain will be increased by 10, and the sampling will repeat. Note that, as the gain is changed, the decimal point is shifted.

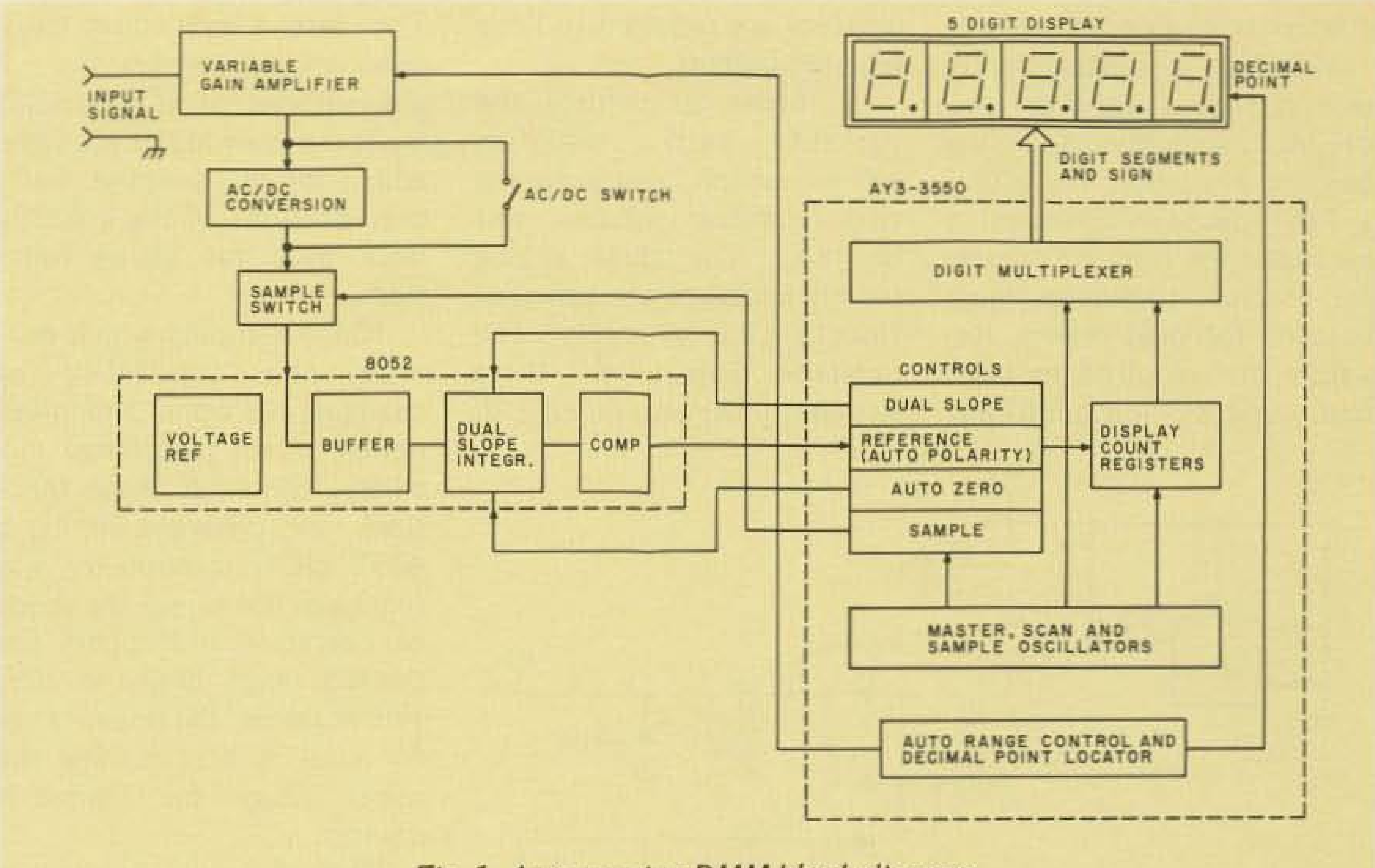
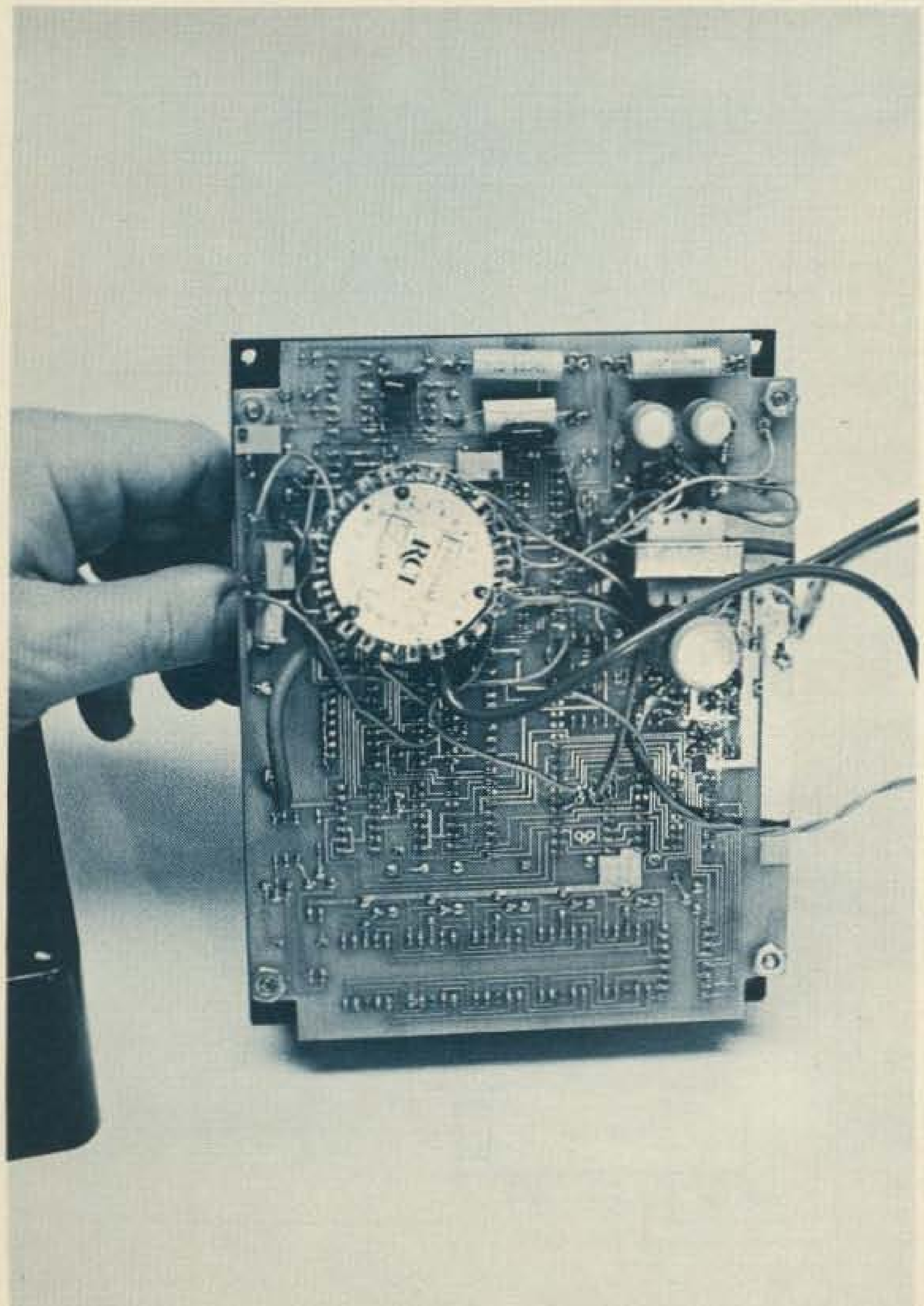


Fig. 1. Autoranging DMM block diagram.

Between voltage samples, the autozero circuit of IC3 will recalibrate specific capacitors so that the new measurement will start from zero.

The 5-digit display is controlled by the digit multiplexer internal to IC3. An LED to the immediate left of the display is on for negative measurements.

The circuitry is complicated by the requirement of an accurate positive and negative voltage reference for dual-slope integration. A "flying capacitor" technique is used to bias all input voltage to IC11 to +1 volt. This way, a ground level appears to be -1 volt, and only a



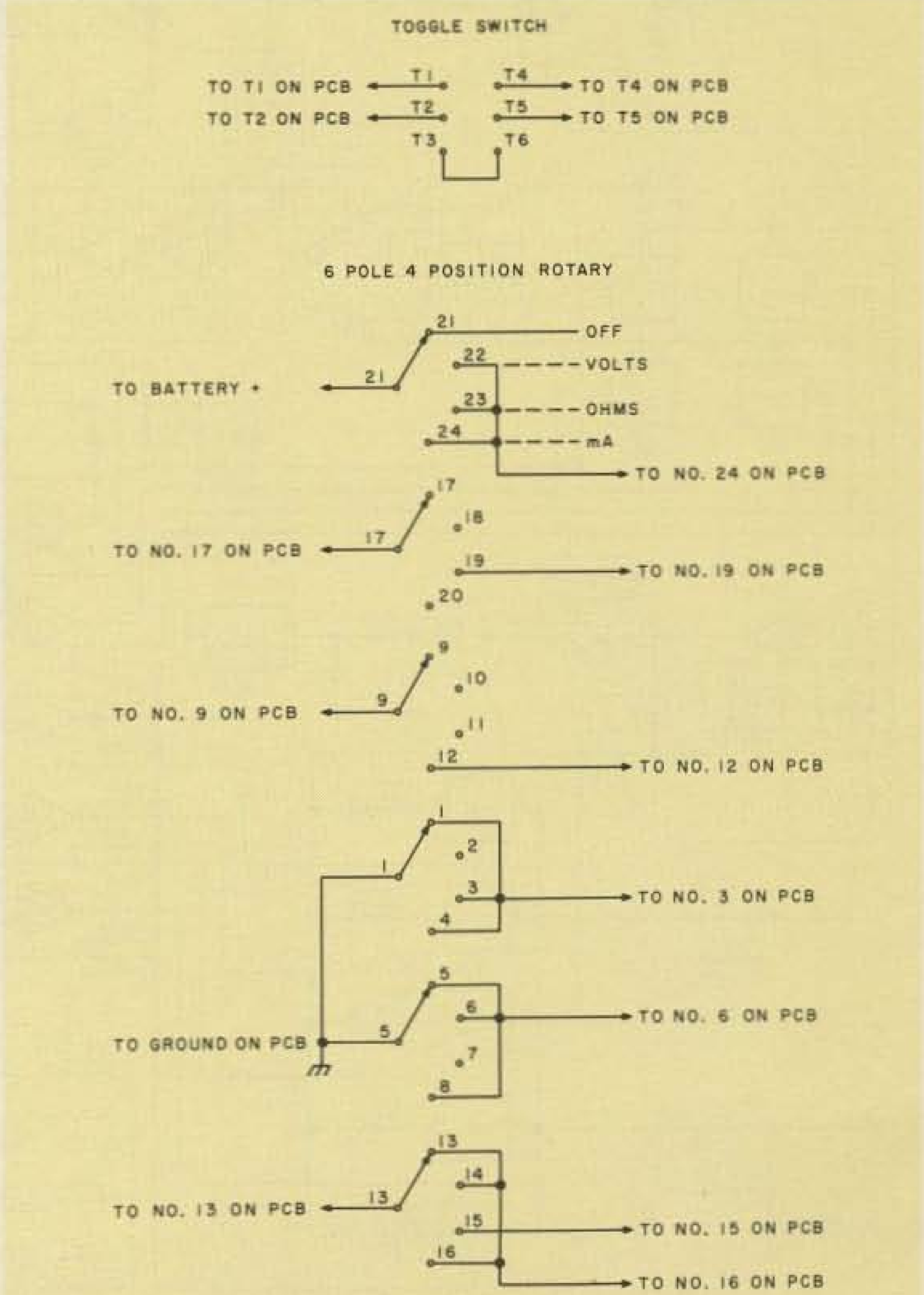


Fig. 2. Switch wiring diagram.

positive reference is required.

Another complication is that IC3 does not have the drive capability for the numeric readouts. Therefore, a 7447 decoder driver must be added for segment drivers, and discrete transistors must be used for digit drivers. Resistors are required to limit base currents, and additional resistors are required to limit segment current.

In order to control the variable gain amplifier, sample switch, and autozero circuit, analog switches must be used. The three analog switch packages are powered from a ±8.2 V supply. The control input to these switches must also be ±8.2 V. Therefore, a level converter is necessary to convert the +5 ground level of IC3 to ±8.2 V. The three LM339 ICs were added for this purpose. Leftover portions of the LM339s were used for gating functions.

IC3 has inputs which provide the capability of changing the upper and lower limits of the autorange circuitry. Since all three functions use different limits, a 4052 (IC4) multiplexer was required. IC4 senses the mode of operation and applies the desired range limits to IC3. For example, the upper range for volts is nnnn.n, and the upper range for Ohms is nn.nnn.

The ±8.2-volt supply was developed experimentally. A 555 (IC7) oscillator drives the primary of a transformer. Each side of the center-tapped secondary forms a half-wave rectifier circuit with one being positive and the other being negative. Each voltage is regulated at 8.2 volts to limit the maximum output voltage.

Since IC3 is a digital multimeter, not a digital voltmeter, use of existing circuitry to measure resistance and current is simplified. In addition to providing two inputs to IC3 for the function desired, slight modification to the variable gain amplifier is required. When reading Ohms, the unknown resistor becomes the feedback resistor for IC12, and the feedback resistors become the input resistors for IC12. Current measurement is made possible by measuring the voltage drops across a 1-Ohm resistor.

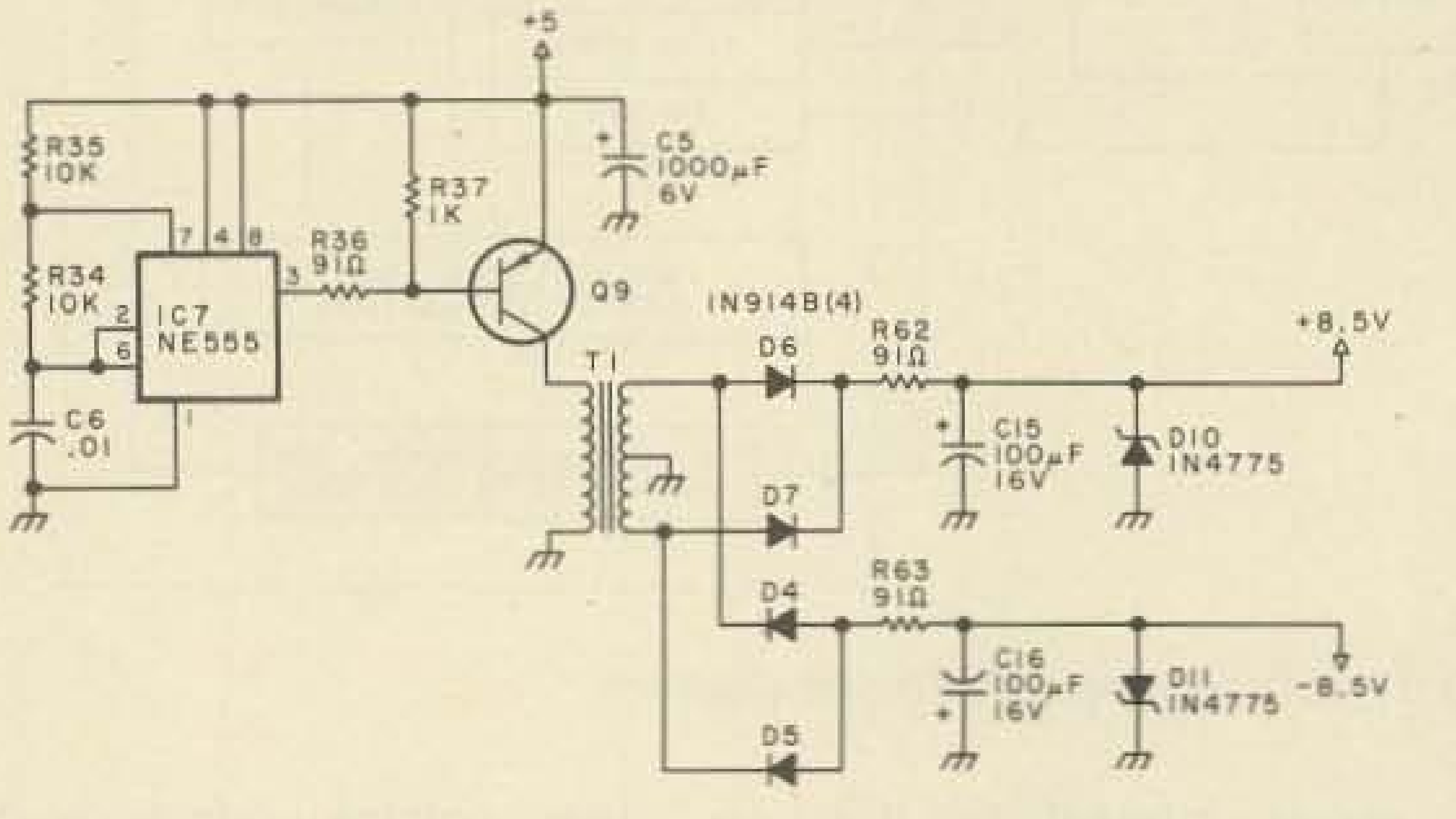


Fig. 3. ±8.2-volt supply.

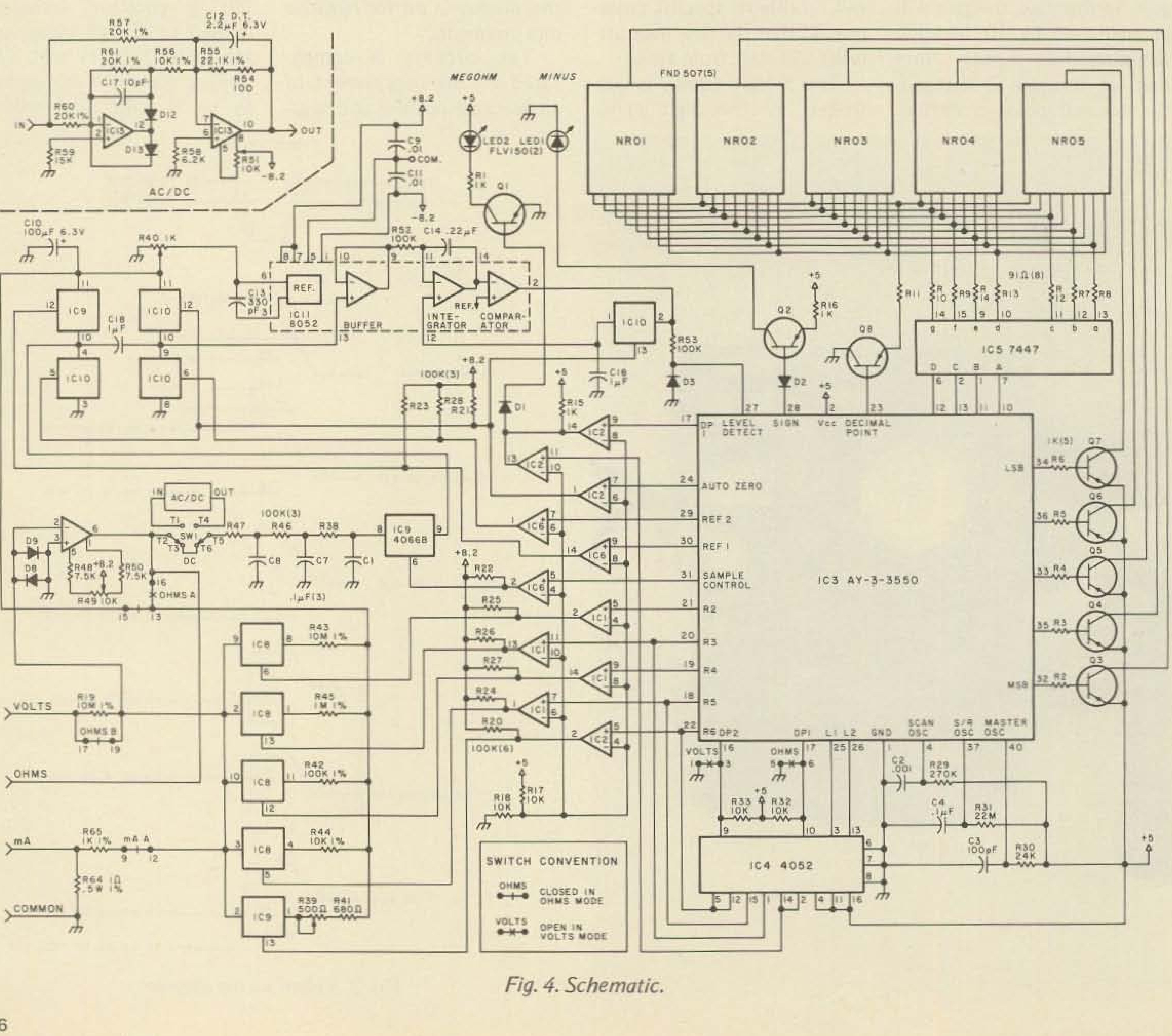


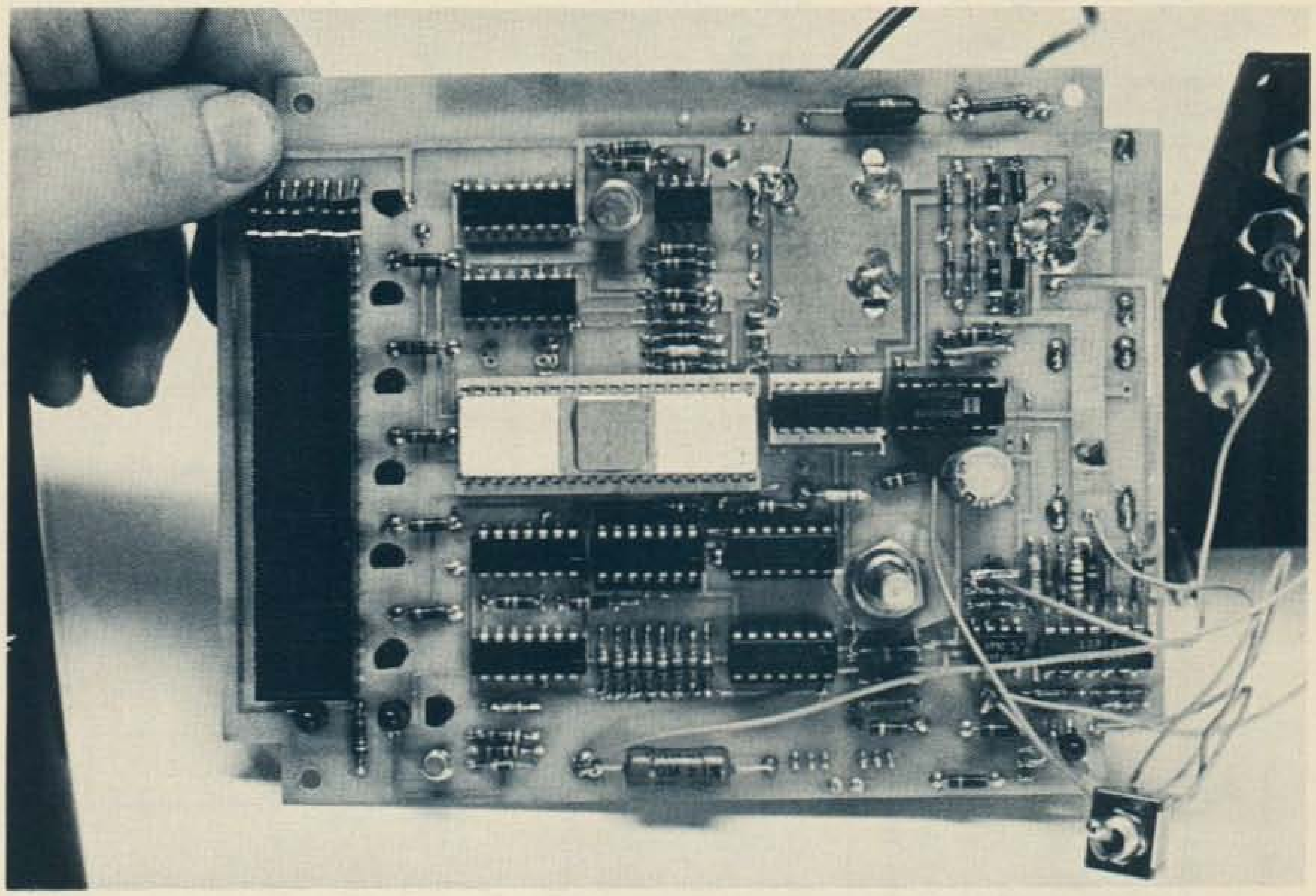
Fig. 4. Schematic.

Construction

The use of a double-sided plated-through printed circuit board simplified construction. The most important decision, prior to inserting parts as shown on the assembly drawing (Fig. 6), is to consider the mounting of the PC board. The photographs show the front panel 3/4" from the board. It was with this in mind that most capacitors were mounted on the bottom side. The transformer also presents a problem and is mounted on the bottom.

The four 18-turn pots can be mounted on the bottom. This will permit calibration without removing the front panel.

The rotary switch must be insulated from the board using nonconducting washers. Do not remove the nut on the switch; doing so can change the stop pin for the switch. Wiring from the switch to the PCB is simple, since the points on the board contain



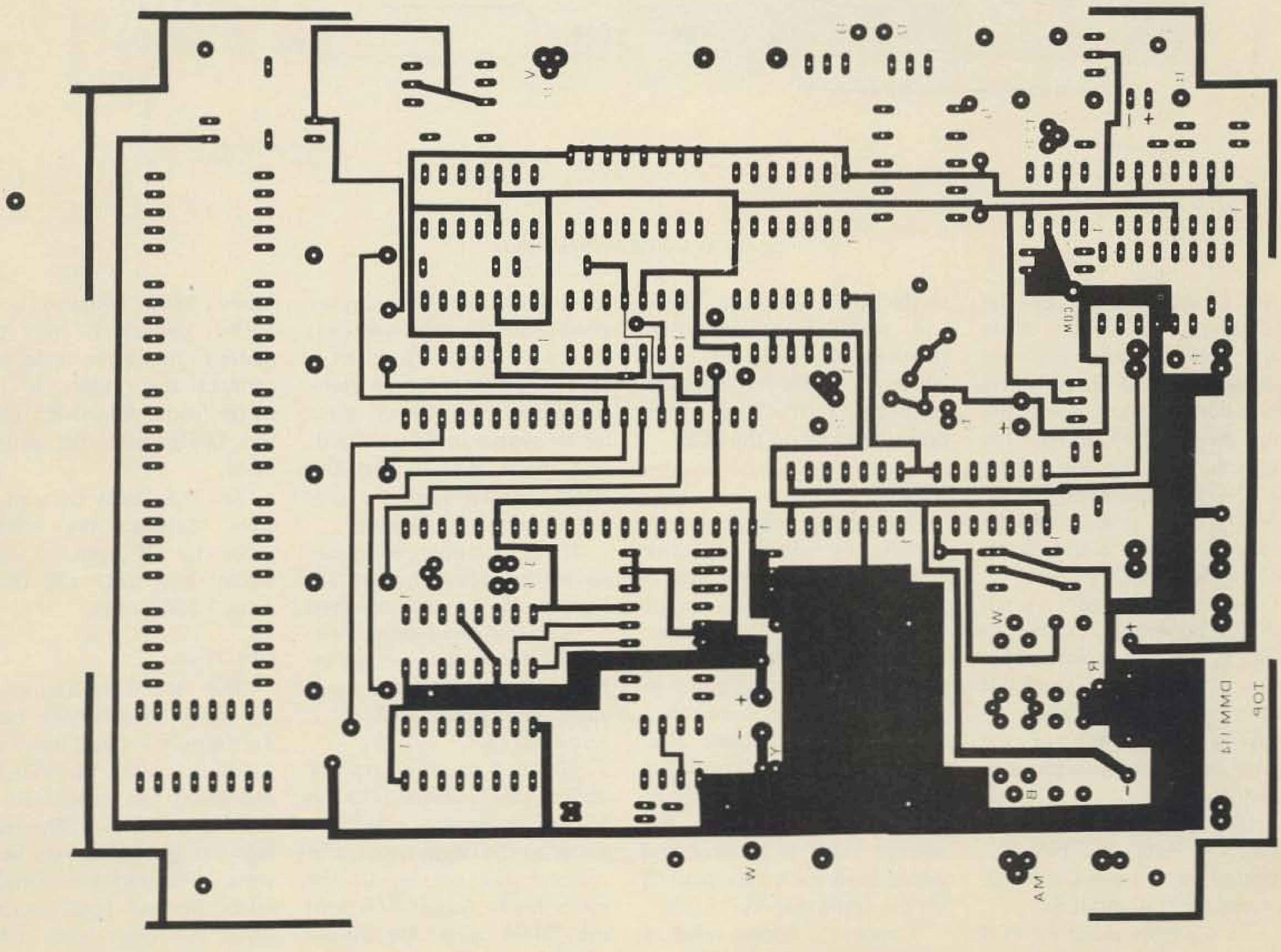


Fig. 5. PC board.

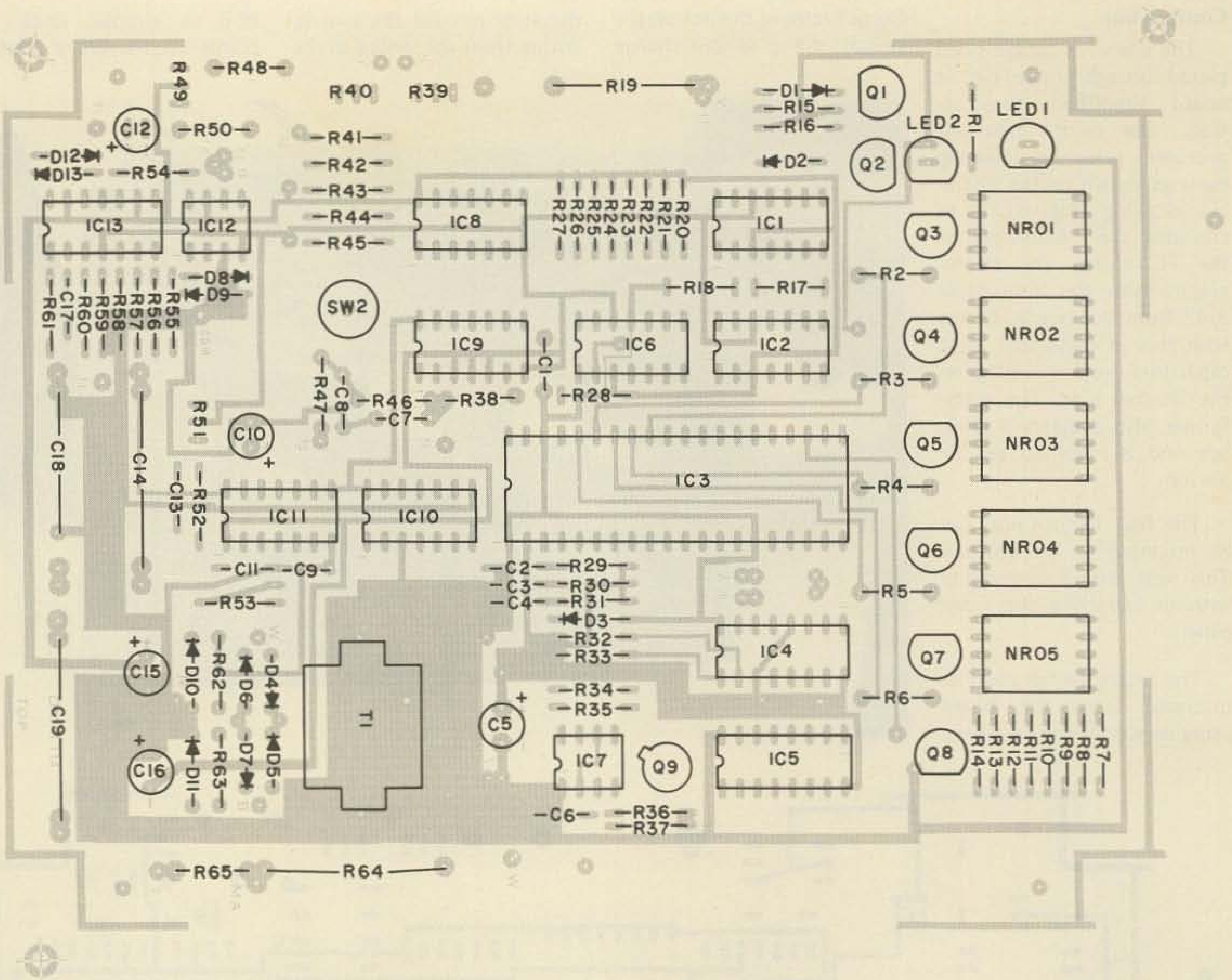


Fig. 6. Component layout.

the same number as the points on the switch. Note that the common lugs are slightly recessed. When wiring to a common lug, go to the number specified, and use the recessed lug (the one closest to the shaft). Switch lug-to-switch lug wiring should be done according to the switch wiring diagram (Fig. 2).

The ac/dc toggle switch should be wired as shown in Fig. 2. The PCB is marked for easy switch-to-PCB wiring. Be careful when installing this switch in the panel, as it is easy to put it in upside down.

Use caution when inserting the ICs. Note that pin 1 is located away from the NRO, except for IC4 and IC5.

T1 wiring is aided by PCB marking. The white, black, and yellow leads are closest to the NRO. Only the yellow and white leads are used (marked Y and W). The white, blue, and red leads are connected to the W, B, and R points marked on the PCB.

Calibration

The most critical adjustment is R40 — the 1.0000-volt reference. This is the one calibration point where it is desirable to borrow an extremely accurate voltmeter. An easy point to pick up this line is switch 2 lug 15. Simply adjust R40 until a 1.0000-volt reading is measured. With the DMM in the volts mode, short the voltage input to ground, and adjust R48 for a zero reading on the DMM display.

Connect a known-value ac voltage to the voltage input, and adjust R50 for a proper reading on the DMM display (make sure the ac/dc switch is in the ac position). Insert a 1k to 1.799k precision resistor across the Ohms input (ac/dc switch in dc position), and adjust R39 so that the DMM display gives the correct value for the resistor.

If an accurate voltmeter cannot be obtained, then calibration can be accomplished by the following procedure:

1. Short out the voltage input leads, set the meter to dc volts, and adjust R48 for a zero reading.
2. Obtain a precision resistor above 1800 Ohms (10k to 17.9k desirable), set the meter to the Ohms mode, and connect the resistor to the meter leads. Adjust R40 until the DMM gives the proper value.
3. Obtain a precision resistor below 1800 Ohms (1k to 1.79k desirable), set the meter to the Ohms mode, and connect the resistor to the meter leads. Adjust R3 until the DMM gives the proper value.
4. Set the DMM to read ac volts. Connect the voltage probe to SW2 pin 15, and adjust R50 until the DMM reads 1.0000 volts.

Operation

The actual operation of the DMM is relatively easy. To measure voltage, move the function switch to VOLTS, and insert the meter leads in COM and VOLTS. The reading you get will always be in volts. To measure current, select the mA function, and insert the meter leads in MA and COM. All measurements will be in mA. To measure

Ohms, select the Ohms function, and insert the meter leads in OHMS-C and OHMS. All measurements made without the MOHMS indicator on will be in kilohms. If the MOHMS indicator is on, the reading is in megohms. ■

Parts List

R1-R6, R15, R16, R35, R37	1k, ¼ W, 5%
R17, R18, R32-R34,	10k, ¼ W, 5%
R7-R14, R36, R62, R63	91 Ohm ¼ W, 5%
R19*	10 meg, 1%, 1 Watt, 3500 volt (TRW CGH-1 or equiv.)
R20-R28, R38, R46, 1R47, R52-R53,	100k, ¼ W, 5%
R29	270k, ¼ W, 5%
R30	24k, ¼ W, 5%
R31	22 meg, ¼ W, 5%
R39	500 Ohm pot
R40	1k pot
R41	680 Ohm, ¼ W, 5%
R42	100k, 1%, RN55C
R43	10 meg, 1%, RN55C
R44, R56	10 k, 1%, RN55C
R45	1 meg, 1%, RN55C
R48, R50	7.5k, ¼ W, 5%
R49, R51	10k pot
R54	100 Ohm, 1%, RN55C
R55	22.1k, 1%, RN55C
R57, R60, R61	20k, 1%, RN55C
R58	6.2k, ¼ W, 5%
R59	15k, ¼ W, 5%
R64	1 Ohm, 1%, 3 W
R65	1k, 1%, RN55C
C1, C7, C8, C4	.1 uF disc ceramic
C6, C9, C11	.01 uF disc ceramic
C2	.001 uF disc ceramic
C3	100 pF disc ceramic
C5	1000 uF, 6 volts
C10	100 uF, 6 volts
C12	2.2 uF, 6.3 volts solid tantalum
C13	330 pF disc ceramic
C14*	.22 uF polypropylene
C15, C16	100 uF, 16 V
C17	10 pF disc ceramic
C18, C19	1 uF mylar
IC1, 2, 6	LM339
IC3	AY-3-3550 General Instruments
IC4	CD4052
IC5	SN7447
IC7	NE555
IC8, 9, 10	CD4066B
IC11	ICL8052ACPD Intersil
IC12	LF355
IC13	747C
D1-D9, D12, D13	1N914B
D10, D11	1N756A, 8.2 V zener, 5%
LED 1 and 2	FLV150
NRO1-5	FND507
Q1	TIS 92
Q2-Q8	TIS 93
Q9	2N2905
T1*	Archer 273-1381 transformer
SW1	DPDT subminiature toggle switch
SW2	RCL 16-ECB-4J 6-pole 4-position rotary switch

Miscellaneous

Printed circuit board

Spacers, screws, banana jacks, pointer knob, case, front panel

*Substitutions not recommended.

The following items are available from: SOA Products, P.O. Box EG0256, Melbourne FL 32935:

1 double-sided plated-through hole PCB — $15.00

Kit #1: 1 PCB (see above), 1 General Instruments AY-3-3550, 1 Intersil ICL8052ACPD: total price — $44.95

Kit #2: complete kit of all components itemized above including case and front panel: total price — $99.95

All orders add $2.50 postage and handling. Florida residents add sales tax. Master Charge and BankAmericard accepted.

Please copy Please copy Please copy Please copy Please copy Please copy Please copy

FIGHT THE DICTATORSHIP!

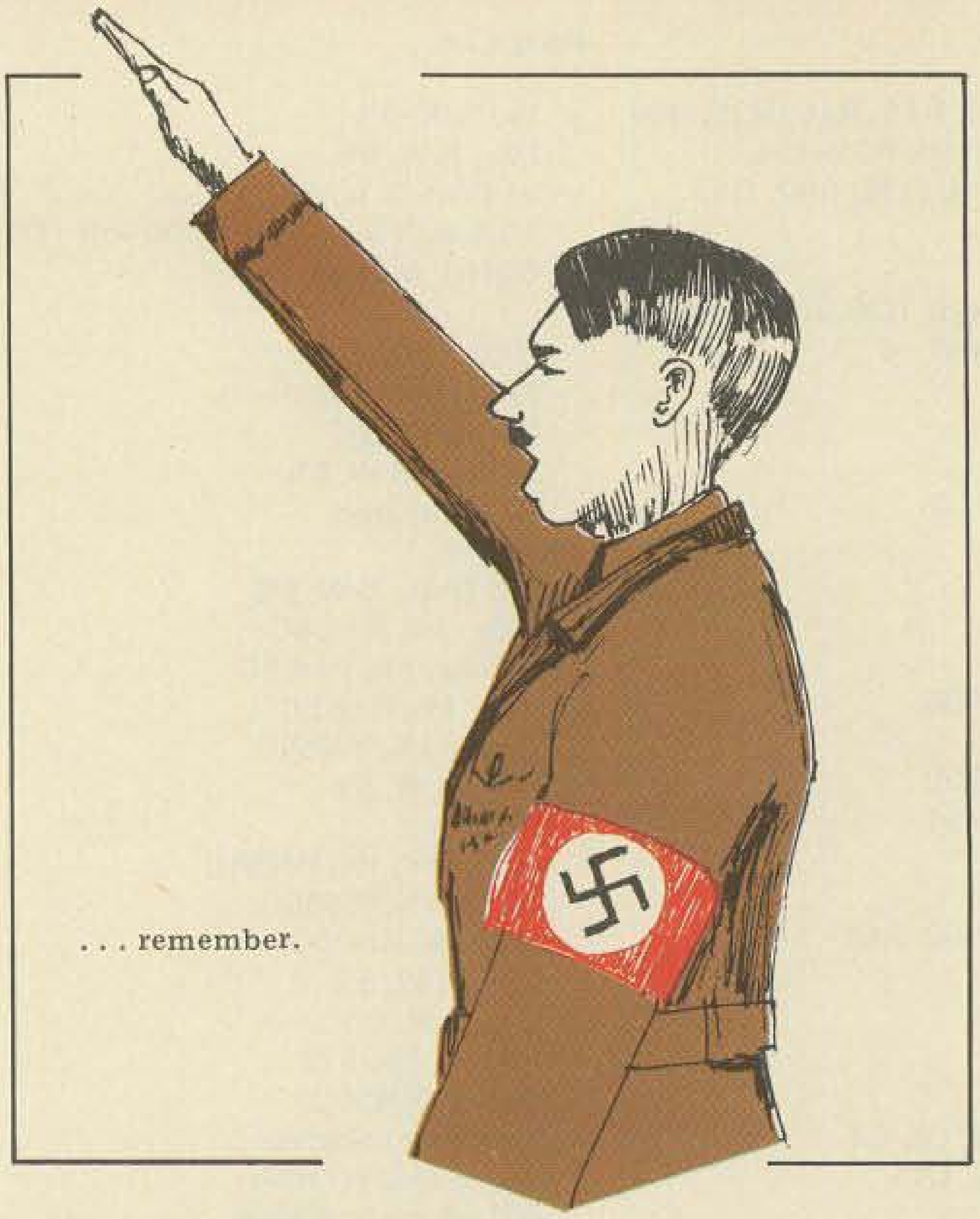
Rick Cooper, who operates out of a post office box in southern California, says he has over two million petitions backing him in his drive to take the ham bands and give them to the CBers. When he was asked about the structure of his group, which he claims has over 7,000 local officers around the country, he answered: "It's a dictatorship and I'm the dictator."

Cooper further claims that he has received over 100,000 paid ($25 each) subscribers to his Communications Attorney Service (not to be confused in any way with the Personal Communications Foundation) ... if so, he has plenty of money to back up his seemingly outrageous demands.

Amateurs have a choice right now ... ignore all this and take a chance that Cooper may not be able to use all that money and the millions of petitions to get Congress to go along with him ... or FIGHT BACK! If you are willing to live with a dictatorship, then no problem. If you want to do something about this ... you can ... right now.

Cooper has been getting his millions of petitions via a chain letter system ... and we can do the same. If you will make at least five copies of the petition below, get five other people to sign them, and send them to me, I'll see that they are used where they will do the most good.

When the FCC refused to listen to us back in 1973, we got thousands of ham petitions and presented them to the FCC at a hearing – and it changed the whole rules and regulations picture completely. We can do it again, but we need hundreds of thousands or even millions of petitions this time. We need petitions from amateurs, from friends, family, neighbors, co-workers ... everyone. We don't want to be run over roughshod by a dictator ... we must fight back ... fight back in the way Congress and the FCC understands – votes. Vote for amateur radio by sending in a petition right now ... and then get as many copies signed and sent in as possible. Flood me with them.



... remember.

Your *only* registered lobbyist for amateur radio is me ... Wayne Green. I am the only person officially authorized to represent you before Congress. With your petitions in hand, our voice will ring out loud and clear in Congress and with the FCC. This is your big chance to back up amateur radio ... if you want to see it like it is instead of the way dictator Cooper wants.

Chain Letter Petition in Support of Amateur Radio

Before doing anything else, make at least five photocopies of this petition and give or send these copies to friends, neighbors, radio club members, hams you have contacted, etc. They do not have to be radio amateurs, but just people who realize the importance to the community, to our country, and to the world of amateur radio. We don't want to lose our bands to CBers and a dictatorship.

The Petition

We, the undersigned, being American citizens, do hereby indicate our support of amateur radio and our opposition to any efforts to destroy this valuable service. Since radio amateurs have been directly responsible for developing and pioneering virtually every communications technique in use today, furnish an invaluable source of engineers and technicians for our government and industry, and furnish efficient communications during any emergencies, we cannot afford to let this important resource be wiped out.

Name________ Address________ City______ State____ Zip______

Name________ Address________ City______ State____ Zip______

Name________ Address________ City______ State____ Zip______

Name________ Address________ City______ State____ Zip______

Name________ Address________ City______ State____ Zip______

Support this political action to preserve amateur radio. Send your petition to:
Wayne Green
73 Magazine, Peterborough NH 03458

73/4/78

New Products

from page 11

QTH as well. Model TF-1000 is for fixed station use only, and it doubles as a six-digit clock.

Using the counters couldn't be simpler. The unit is merely inserted between the antenna and the rf output of the transmitter or transceiver. When an unmodulated carrier is transmitted, the counter displays the frequency of the signal.

It's important to realize that these counters, along with others which are not internally connected to the transmitter, will display an accurate reading only in the absence of modulation. When operating SSB, for example, the display changes constantly in response to voice fluctuations. On CW, of course, the frequency is displayed only when a "dit" or "dah" is being sent. Once this limitation is accepted, however, they become enjoyable operating accessories. It quickly becomes second nature to check the exact frequency by momentarily turning the transceiver function switch to TUNE after QSYing. The frequency range for either unit is 1.8-40 MHz.

In addition to its frequency counter function, the TF-1000 also includes a clock function, selectable for either 12- or 24-hour format. This brings us to a clever aspect of the operation of the TF-1000. In the absence of rf, the display is that of a normal six-digit clock. However, when rf is applied to the unit, internal circuitry automatically switches the display to show the transmitted frequency. At the end of transmission, the device returns to the clock mode. A front panel switch allows the operator to defeat the automatic operation of the unit, in which case it displays time only. Controls on the rear panel include push-button switches for setting the clock and selecting the 12- or 24-hour format. A slide switch selects the appropriate power range, either 25 or 250 Watts. The 60 Hz line voltage supplies the time base for the clock.

In contrast, the FC-12 has only a single control, an on-off switch. It is limited to 200 Watts input and displays all zeros when no rf is present.

An instruction manual is included with each unit. It contains operating instructions, schematics, a circuit description, and directions for calibrating the units against a frequency standard. *Pride Electronics, 6241 Yarrow Drive, Carlsbad CA 92008.*

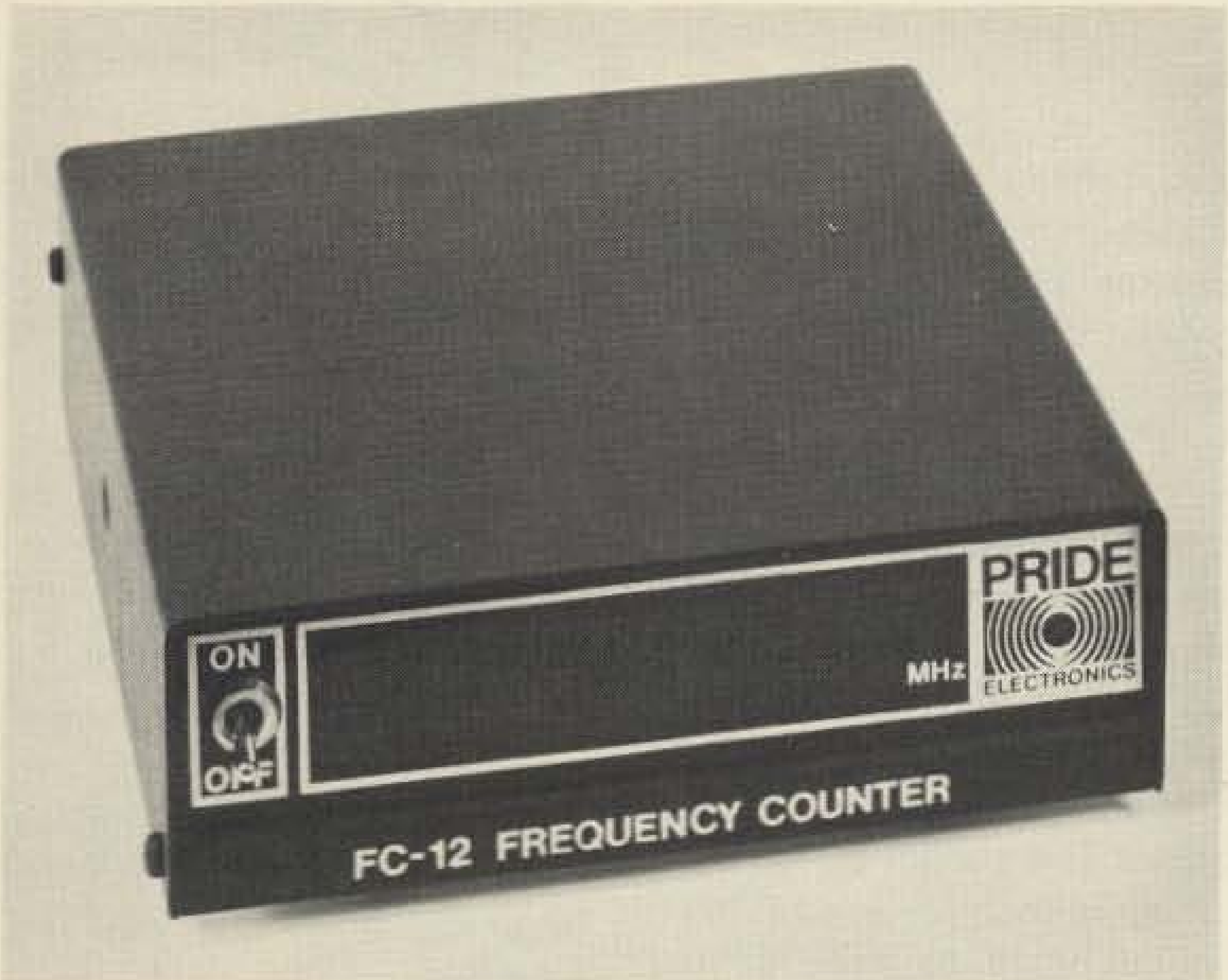
Jeff DeTray WB8BTH/1
Publications Editor

TEN METER CONVERSION OF STANDARD HORIZON CB TRANSCEIVERS

Standard Communications' Horizon 29 23-channel CB transceiver and Horizon 29A 40-channel unit are now available in ten meter amateur versions. One of the more popular developments in amateur radio recently has been the widespread conversion of CB transceivers to the ten meter band. Mobile and base station nets have been formed by various clubs on certain "channels" or frequencies within the ten meter band, with affiliated clubs in other states participating when propagation permits.

The Horizon 29, now identified as the 29-10, provides 23 channels starting at 28.965 MHz, and the Horizon 29A, now the 29A-10, offers 40 channels starting with that frequency and extending up to 29.405 MHz. No crystals are required, due to the transceivers' phase-locked-loop design. Both units have in-the-mike modulation control, a sophisticated noise blanker, a large easy-to-read

Continued on page 180



New FC-12 frequency counter from Pride Electronics.

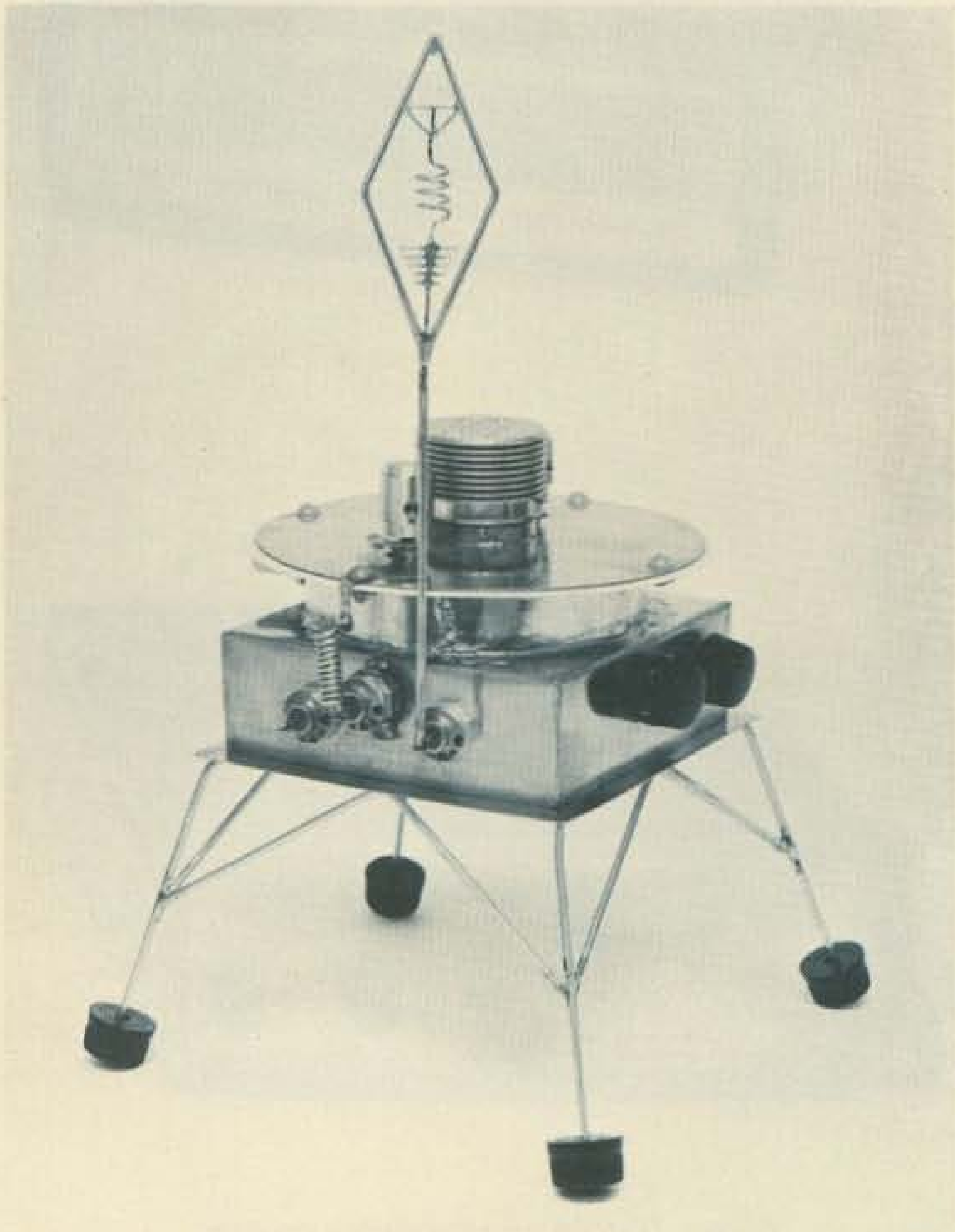
Pride's TF-1000 time/frequency counter.

Robert M. Richardson W4UCH/2
PO Box 1065
Chautauqua NY 14722

How To Succeed On 1296

— cat-food can 50-Watt amplifier

Amateur radio literature[1,2,3] abounds with many excellent articles describing tube-type 2C39/7289 1296 MHz triplers and/or amplifiers. Most of these require an inordinate amount of machine shop work not available to most amateurs. With the advent of readily-available moderate-cost varactor triplers[4] with power output after filtering in the 5-Watt range at 1296 MHz, it was believed there would be interest in a nominal 10 dB gain amplifier using a cavity that would enhance and increase ¼ meter DX activity during VHF contests.



Making the following amplifier requires only a circle cutter, sheet-metal shears, and a few socket punches. A small 18-inch Lafayette sheet-metal brake to bend up the .016" brass chassis would be a help, but it isn't necessary, as it may be bent up in an ordinary small vise.

Construction

The cavity bypass capacitor, part A (Fig. 2), top of cavity, part C (Fig. 3), and chassis, part E (Fig. 4), are cut from .016" sheet brass. The vertical cavity wall, part D (Fig. 3), is cut from a Purina 6-3/4 oz. cat-food (sardines) can or, alternatively, a Friskies Buffet Dixie Dinner 6½ oz. cat-food can (note: My cat recommends the former). Parts G, H, I, and J (Fig. 5) are press-fit tube contact rings made out of .010" brass sheet. They are assembled in the following sequence:

1. Wrap part G around the 2C39/7289 anode, and secure it with 2 pieces of #18 bare hookup wire twisted tightly with pliers. Make sure the ends of part G do not quite touch each other. Slip the tube with part G wired on just barely into part A so that the bottom of parts G and A are flush. Tack solder G to A about every quarter inch on the upper surface before smoothly flowing the solder around the full circumference. Use plenty of Nokorode soldering paste and an Ungar #4033 50-Watt soldering element to make the job easy. Remove the tube from part A. It should be a good tight press-fit, but, by slowly twisting as you pull, it should be readily removable.

2. Wrap part H around the tube's grid ring, and secure it with 2 or 3 wires, as above. Insert the tube into the chassis' center hole until part H is flush with the top of the chassis. Solder.

3. Wrap part I around the tube's bottom outer cathode ring and secure it with wire. Insert into part F all but 1/16" of part I, and solder.

4. Part J is made by wrapping around a 9/16" drill and squeezing with pliers until it makes a snug press into the inner filament ring in the tube base.

5. Center part A on top of part B on top of part C and drill the 4 outer holes each 9/64" diameter. Bolt the 3 parts together with conventional 1/4" 6-32 nuts and bolts. Solder the 4 nuts to the bottom of part C. Also drill the two 9/64" diameter holes for the 2 tuning capacitors, and disassemble. Run two ordinary ¼" 6-32 nuts and bolts through the holes in part C, and solder the nuts to the top of part C. Drill 3/8" diameter holes through part A's tuning capacitor holes, and then reassemble parts A, B, and C with four ¼" 6-32 nuts and bolts each.

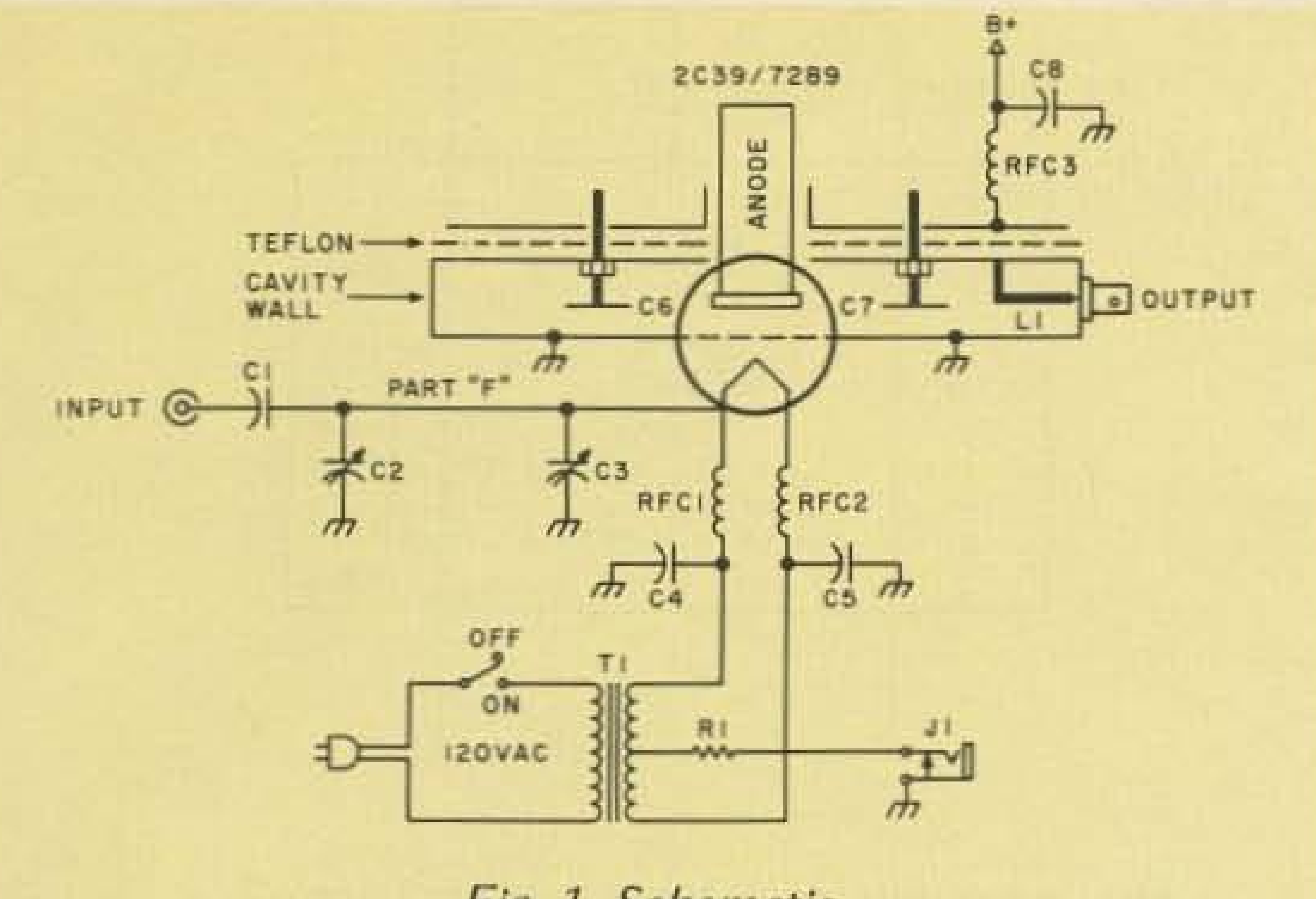


Fig. 1. Schematic.

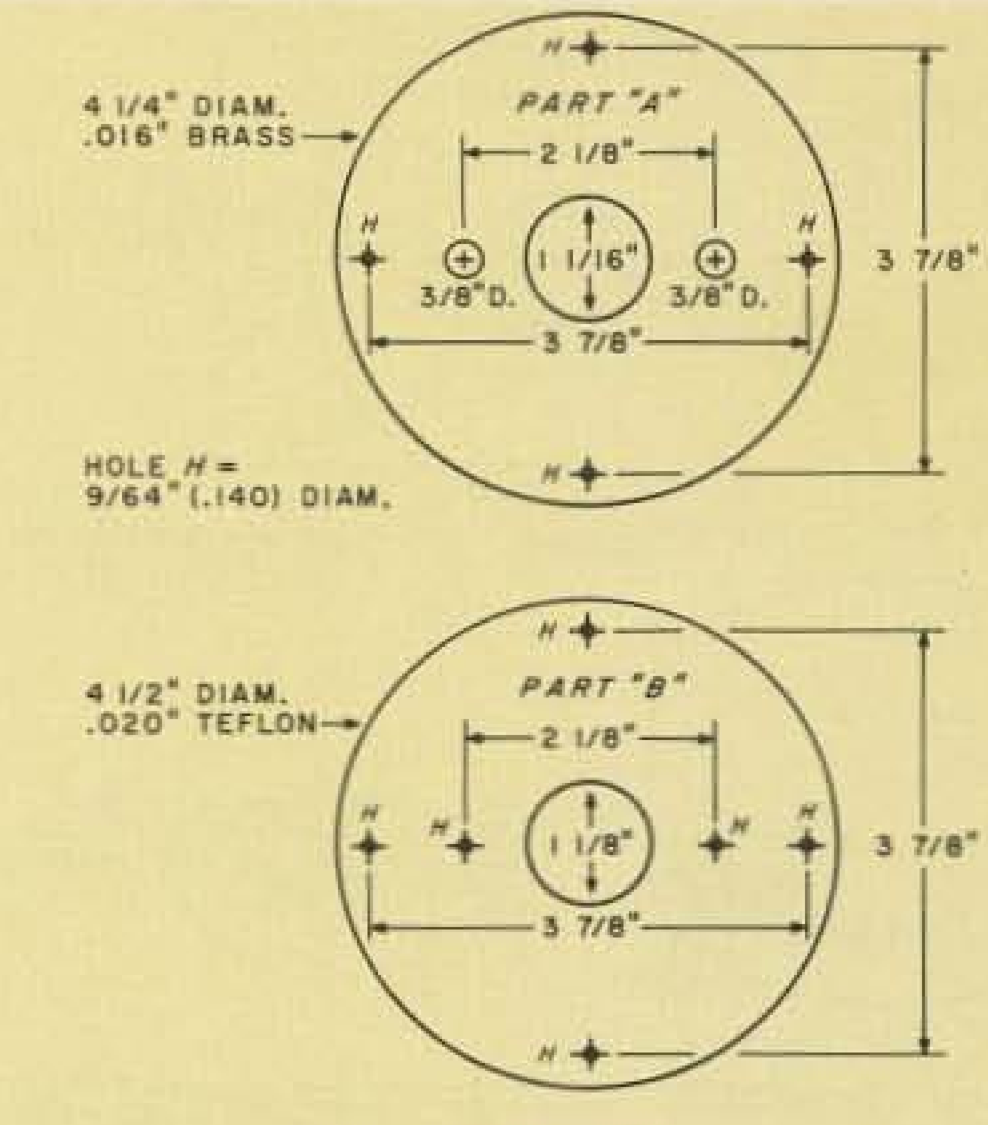


Fig. 2.

6. With scissors cut a 3/4"-wide section of the cat-food can of your cat's choice. File it smooth, or, better yet, sand it smooth on a belt sander. With parts A, B, and C still bolted together, turn them upside down on a flat surface and tack solder part D to the bottom of part C before flowing the solder smoothly around the entire circumference.

7. Install and solder the output link and BNC connector as shown. Thread in the two tuning capacitors in the bottom of part C.

8. Install the tube in part G and A so that the top of part G is flush with the bottom of the protruding anode ring (tube is in as far as it will go). Carefully insert the tube into the chassis and part H until the bottom of the cavity is flush with the top of the chassis. There should be no radial or axial side loads on the tube if you have followed these steps in sequence – just a comfortable press-fit. Now, maintaining a gentle downward pressure on the tube, tack solder the cavity to the chassis before smooth flowing solder around the entire circumference.

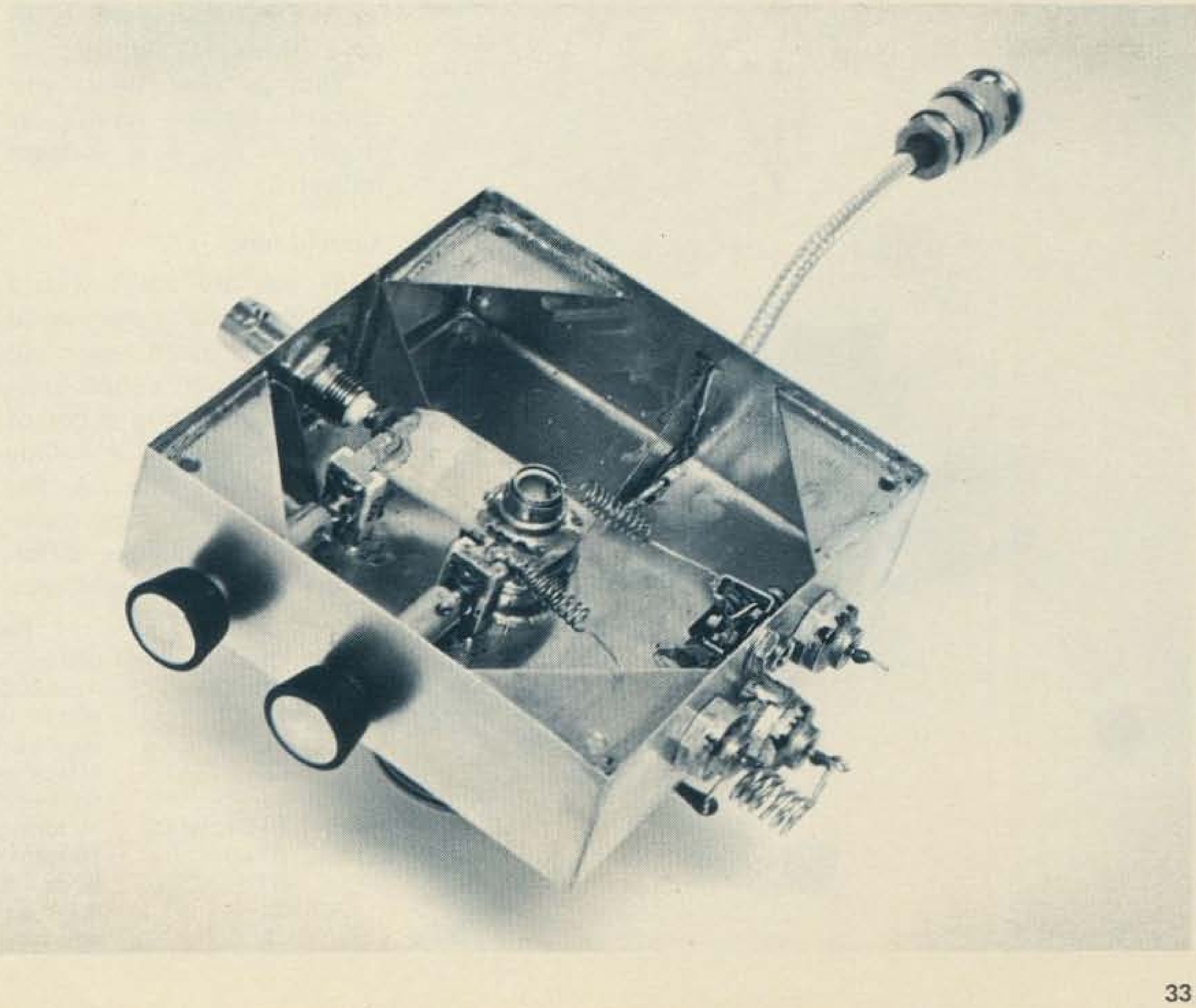
9. Install the input BNC connector. Press-fit Parts F and I onto the cathode ring as far as they will go. The input blocking capacitor is modified by filing each side of a 500 pF ceramic disc cap until half of the leads have been filed away. Carefully tin each side with a small (25 Watt or less) soldering iron. Solder in the 2 pi-net capacitors as shown. Solder the 500 pF modified disc cap to the end part F and to the inner conductor of the BNC connector. This is a fragile part and easily broken when removing and/or installing tubes. To further mechanically stabilize part F, take two burned-out 3/4"-long glass fuses and solder them to part F on the side opposite the two pi-net capacitors. They are structurally quite strong, good insulators, and they are free.

Operating

If you are like me, unable to resist buying those one buck each 2C39 tubes at hamfests, you are most probably, also like me, throwing your money away. Of the first twelve tubes acquired this way, one was good; the others gave only marginal gain or were worthless. Jaro Electronics[5] offers factory-new 2C39s or 7289s in quantities of 5 each that cannot be beat. I prefer the 7289 tubes with the more heat resistant ceramic seals.

It is best to tune up this amplifier at a reduced plate voltage of, say, 300 volts. Use W1HDQ's favorite microwave 50-Ohm load, consisting of 100 feet of RG-58 coax. If you are an optimist, by all means terminate the coax with 10 each 1000-Ohm, 1-Watt resistors in parallel. Be assured that you will not burn them out.

Using a Bird Thruline™ wattmeter with plate power off, and a 25-Watt full-scale 1.0-1.8 GHz slug, adjust the input pi-net capacitors for zero reflected power with approximately 5 Watts input. If



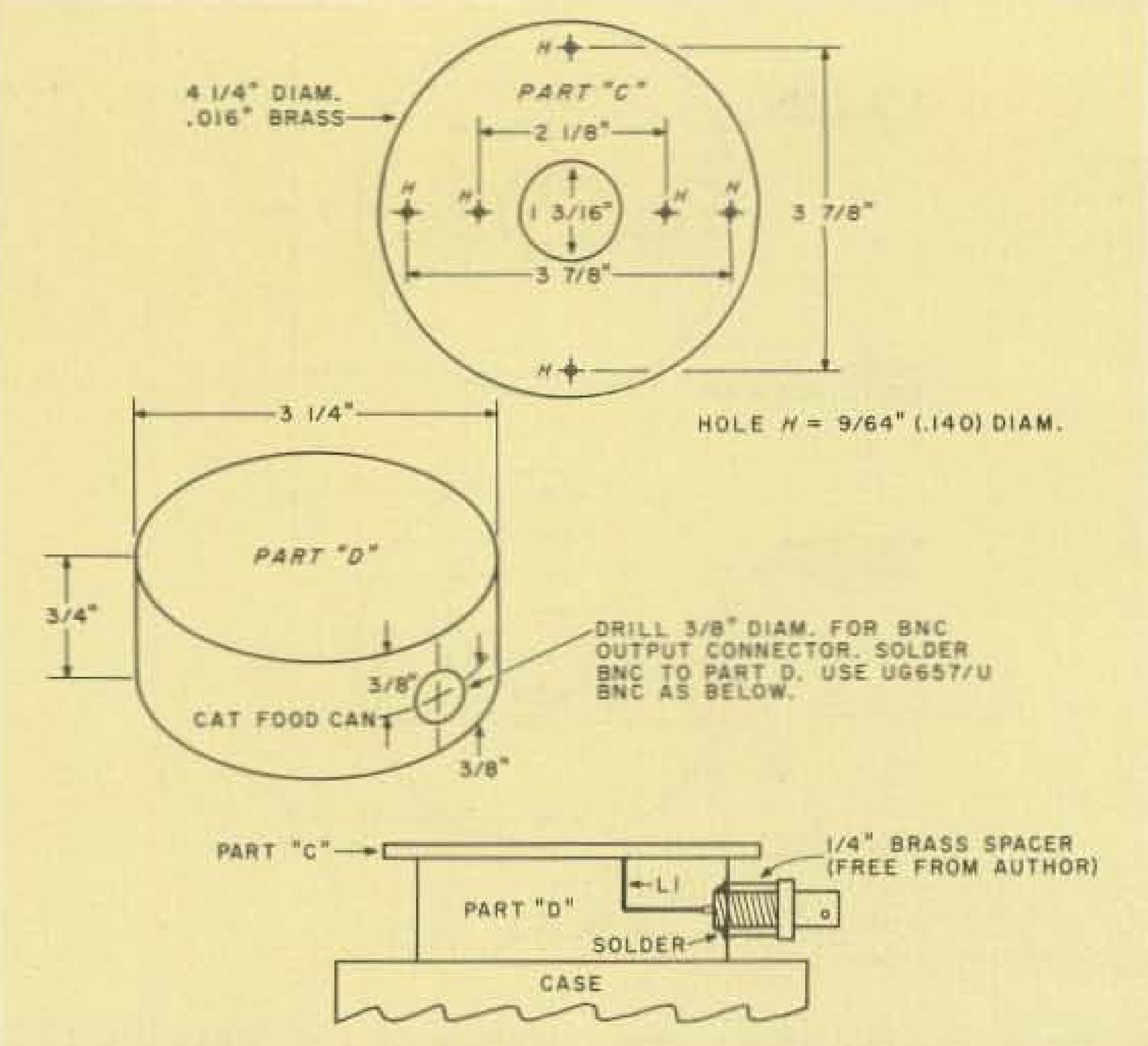


Fig. 3.

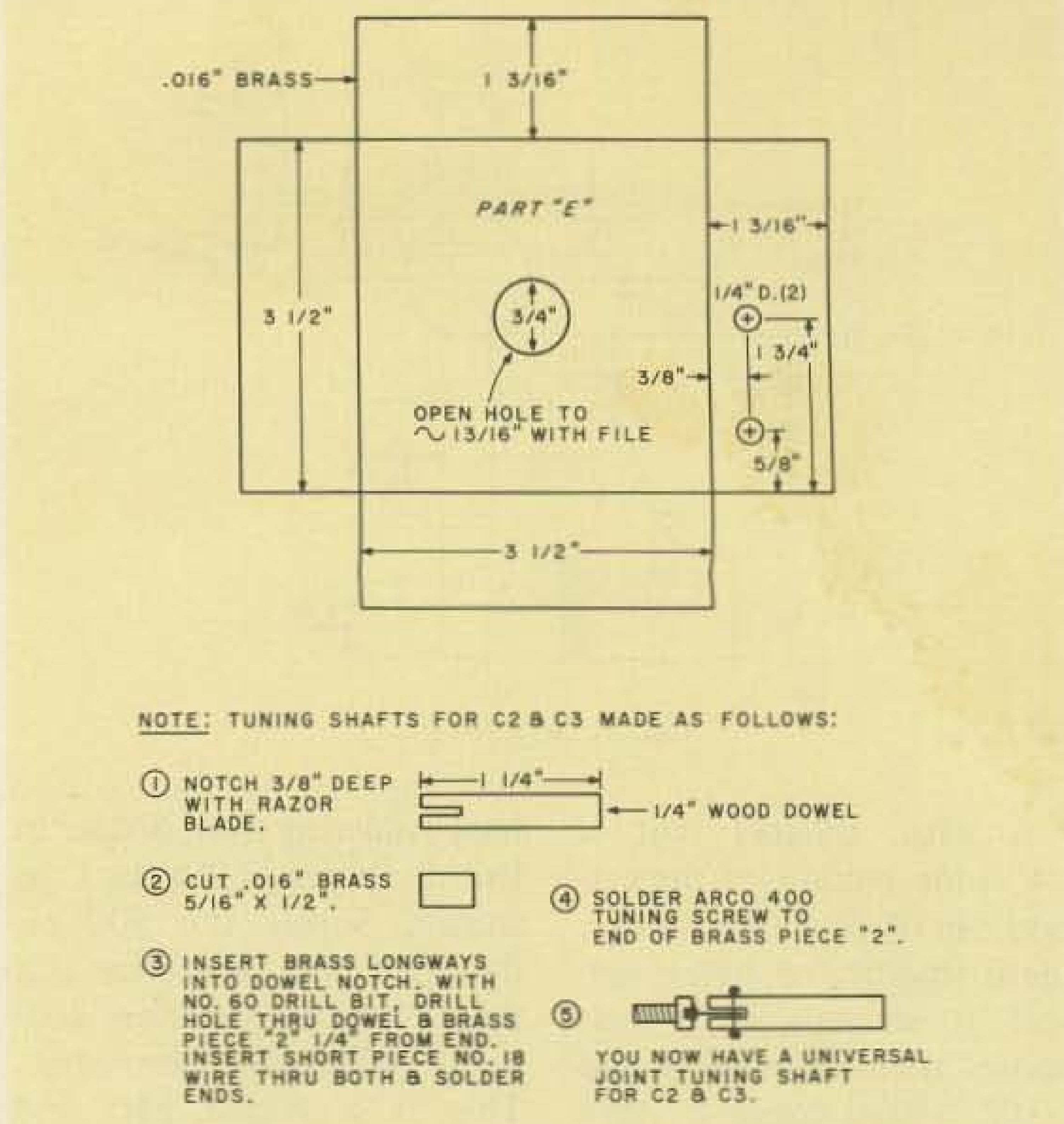
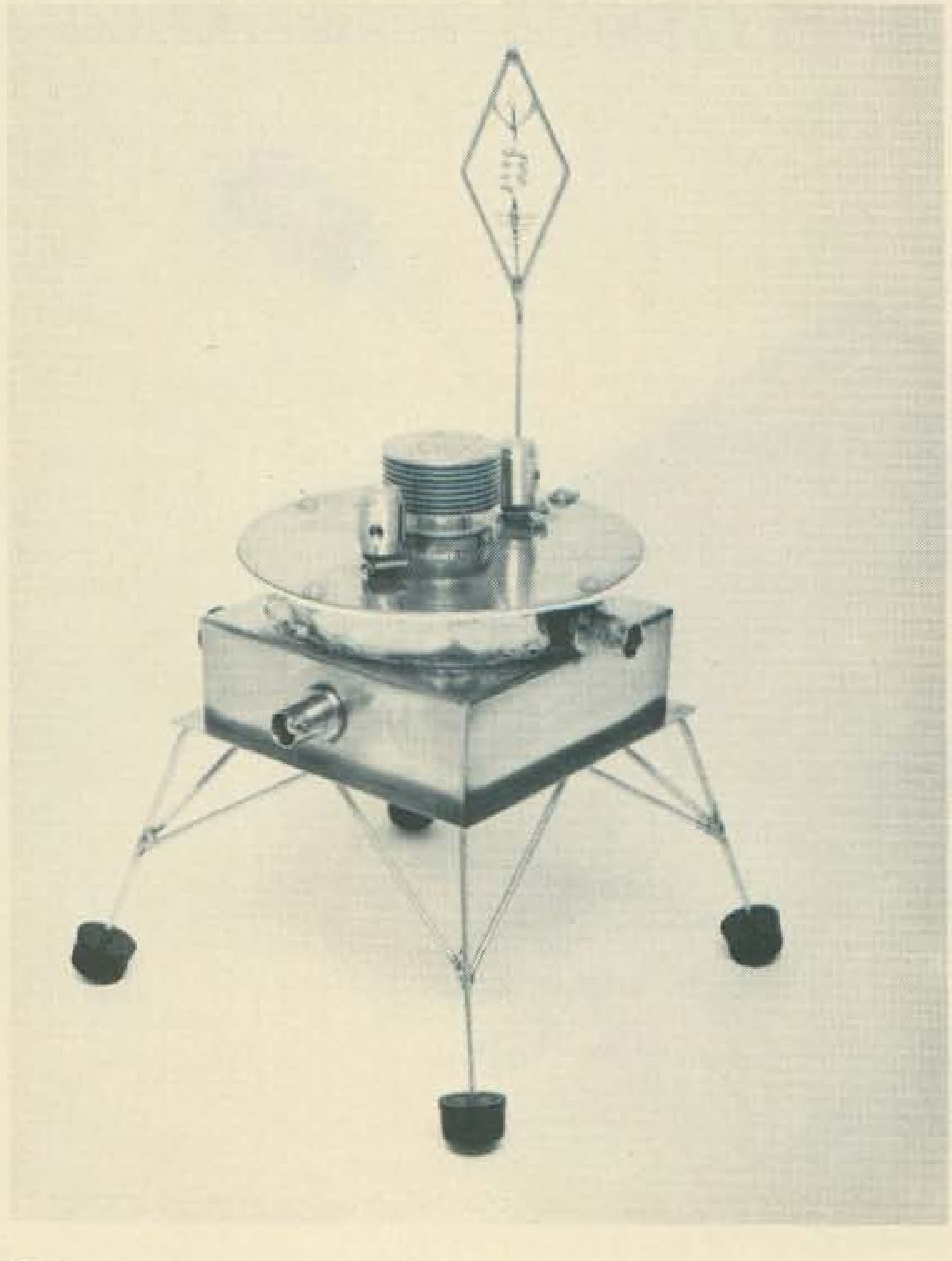


Fig. 4.

you are using a varactor tripler, you must have a good 1296 MHz filter between the tripler and amplifier input, otherwise your measurement will be totally meaningless as you will probably be measuring as much power at frequencies not on 1296 MHz as you are on 1296 MHz. With a milliammeter in series with the cathode resistors, you should obtain 30 to 50 mA of grid current with the plate supply off. Remove the milliammeter.

With the Bird Thruline™ wattmeter in the cavity's output line and your dummy load attached, you should indicate about 1-Watt output, still with no voltage on the plate, when the cavity is properly tuned. Normal position of the tuning capacitors is about 1/8" from full IN. Though the aluminum knobs make a pretty photo, it is best to remove them and use 2½" x ¼" diameter wood dowels drilled to screw on the 6-32 tuning capacitors for adjustment when the plate voltage is ON, or you will be in for a "shocking" surprise.

With a new tube, you should obtain results as shown in Fig. 6 at voltages indicated.



Conclusions

If you are adept with a soldering iron and sheet-metal shears, it is much easier and quicker to build a sheet-brass cavity than to hog it out of brass ingots with a milling machine and lathe. A tin-plated cat-food can cavity shows no measurable difference in output or efficiency when compared with the same tube in a similar silver-plated cavity. This is not to infer that a silver-plated cavity would be no better than one made out of kraft paper or Plexiglas™, just that the IR losses of cavity walls made out of cat-food cans is less than expected and not measurable with ordinary test equipment.

Should you wish to get on 1296 MHz and are either too lazy to roll your own or too affluent to wish to, try Spectrum International's filters, varactor triplers, receiving converters, and antennas. I have no association with this reputable firm in any form whatsoever, but I would like to see this band more populated to help preserve our precious amateur spectrum and to make available more VHF contest points, too.

Virtually every ham transmitter/amplifier article ends

Parts List

C1	500 pF (see text) or ceramic chip
C2, C3	Arco 400 (see Fig. 1)
C4, C5	500 pF feedthrough
C6, C7	see Figs. 1 and 5
C8	500 pF button bypass
L1	see Figs. 1 and 5
RFC1, RFC2	10 turns #26 1/8" diameter x 1" long
RFC3	10 turns #18 1/8" diameter x 1" long
R1	50 to 270 Ω, ½ Watt
T1	6.3 V c-t @ 1 Amp
J1	normally-closed mini jack

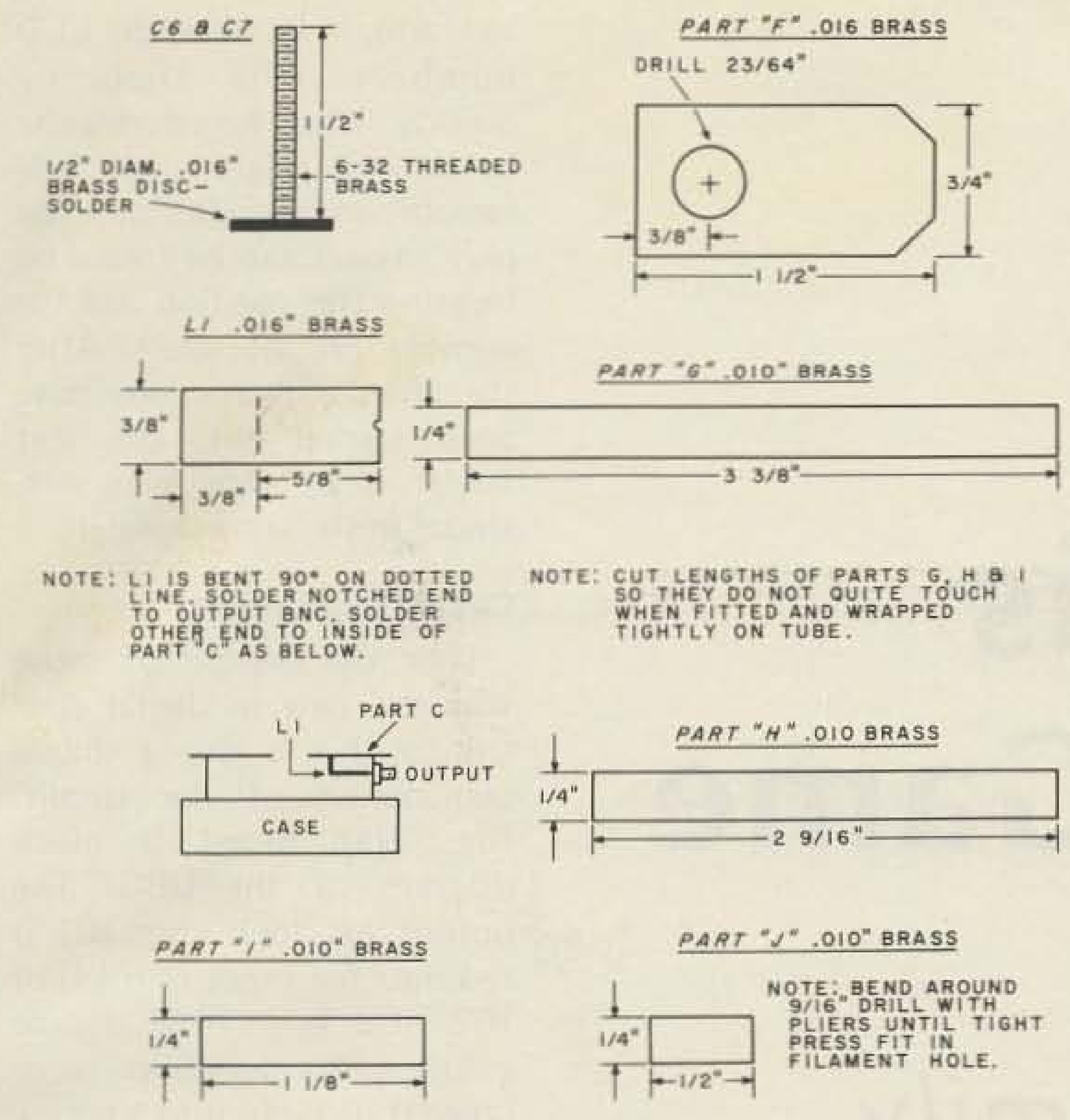


Fig. 5.

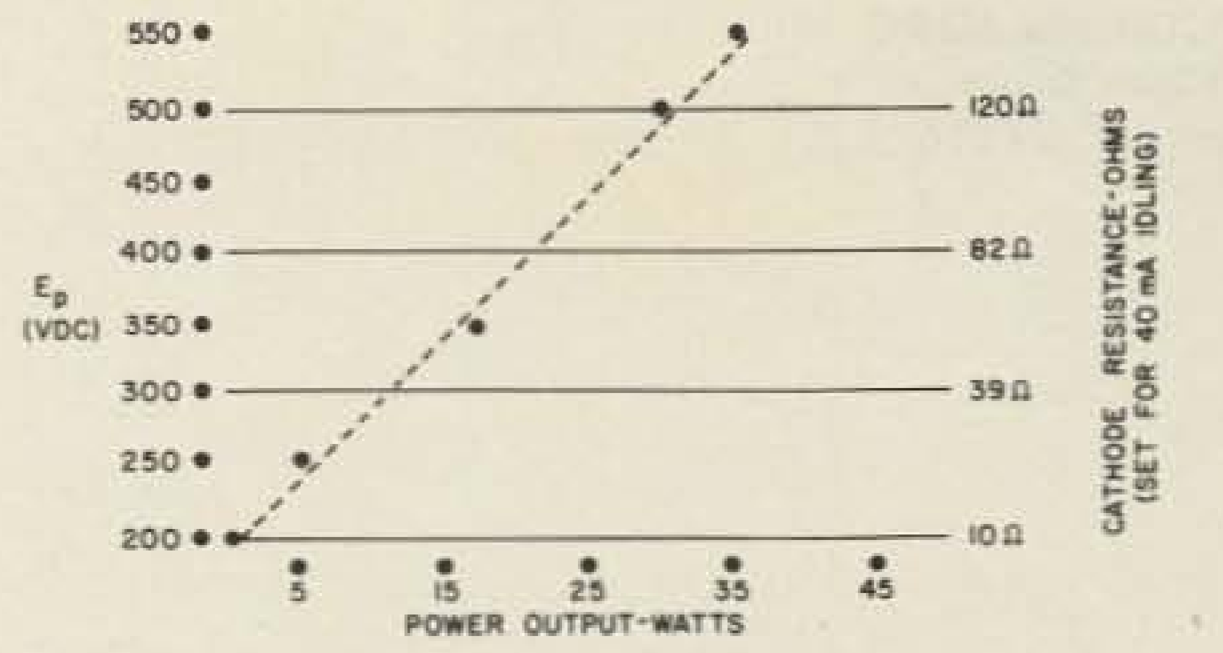


Fig. 6. Input held at 4 Watts.

with the author's[6] proud comment: "My first contact with the HBRII was with ZE2ABS in Rhodesia." He called me while I was tuning up with the much over-the-hill A, B, and C batteries connected and only a delta matched curtain rod in the basement for an antenna. I will not disappoint readers who have read this far.

While tuning up this amplifier the first time on the air, I was pleasantly surprised by K2UOP's voice saying, "I hear you, I hear you!" Actually, I should stop right now, but Boy Scout honesty will out. K2UOP is a portable 4 living just 10 miles away, and his "I hear you" voice was on the telephone. We have worked with each other the last 3 VHF contests on 1296 MHz, and, though I am trying, I still have not burned out his receiving converter's first stage. ■

References

1. Robertson, "Tripler For The 1215 Mc. Band," July, 1955, *QST*.
2. Laakman, "Cavity Amplifier For 1296 Mc.," Jan, 1968, *QST* and *ARRL Handbook*, 1968 - 1972.
3. *R.S.G.B. VHF-UHF Manual*, pp. 6.48-6.52, 1969 edition.
4. Microwave Modules Ltd. models MMV 1296 and MMV 1296H – distributed in the U.S. by Spectrum International, Inc., Box 1084, Concord MA 01742.
5. Jaro Electronics, P.O. Box 414, Orlando FL 32802, in quantities of 5 each: 2C39 – $10.00 each and 7289 – $12.00 each.
6. Richardson, "High-Power VHF Triode Amplifiers," *QST*, July, 1959; "K.W. Amplifier For 6 and 2 Meters," *QST*, June, 1963.

EDITORIAL BY WAYNE GREEN

from page 8

much in the way of amateur radio and certainly not enough to be of any serious help in emergencies. Few of these countries even have a rough idea of why amateur radio can be of any benefit to them . . . no one has ever taken the time to explain the advantages to their country of amateur radio.

Very few countries are going to voluntarily give up radio frequencies, which they feel they need, for something which is of no value to them—hams. They know that even if they get more radio channels than they need for their own immediate use, they will be able to rent these frequencies out to commercial interests . . . and the going rate is about $10 million per channel. The recent ITU maritime conference made this fact of life clear and inescapable.

Since amateur radio could be an enormous asset to any third world country, it is a shame that no coordinated effort whatever is being made to make these countries aware of what they are missing and how they could go about getting these benefits.

SALTING THE WOUND

As bad as the Boston situation was after the blizzard of '78, this would be nothing compared to what would be needed in communications should there be a nuclear war. Yes, I know this is an old harp and we aren't really worrying about that any more . . . war is not an alternative any longer . . . etc.

One of the reasons for our almost impenetrable complacency is the SALT agreement which essentially placed the populations of the major cities of the U.S. and U.S.S.R. in the role of hostages. Both sides agreed to cease efforts to protect the city populations as a deterrent to massive attack and massive counterattack.

As any of you who are involved with Civil Defense know all too well, the U.S. has not only lived up to this agreement, but has bent over backwards not to make any effort to protect city populations. We have no shelters, no food storage, no drills, etc.

Contrast this, if you will, with the Soviet Union, where virtually every factory has a built-in shelter, equipped to feed and protect the workers until the radiation from a nuclear bombing would be low enough to reap a new harvest. The Soviet cities are riddled and ringed with shelters, built deep enough to survive just about anything. They have air filters and extended-term living facilities to outwait fallout contamination.

The ugly fact is that we've been taken to the cleaners again by honoring an agreement with Russia. This is of no serious consequence as long as no international crisis arises where we feel we must rattle our nukes. As long as we are content to let Russia, with the help of satellite Cuba, take over one country in Africa after another, we have no worry. They grabbed Angola and have the top hand in a half dozen other African countries. Now they are well along with taking over Somalia, Ethiopia, Djibouti, and environs.

In personal relations, in business, and in politics, the weak and indecisive lose out . . . and how else could you characterize the U.S. in recent years?

Okay, what does all this mean to amateur radio? Unless Civil Defense is brought back to life and changes beyond imagining are made, any nuclear exchange would inconvenience about 80% of the U.S. population, with about 50% inconvenienced to the point of death. In a recent statement, the Chairman of our Joint Chiefs of Staff estimated that we would lose ten people for every Russian killed—thus we would lose about half our people in a nuclear exchange while Russia would lose about 4% of theirs . . . half what they lost during WW II.

With a situation like that, the only means of communications that would be usable would be amateur radio. Telephones would be out since they are controlled from the cities . . . and cities would be wiped out. There is no other radio communications service which covers local and long ranges . . . just amateur radio.

Continued on page 38

Ralph A. Giffone N2RG
963 E. 105th Street
Brooklyn NY 11236

Build This Digital Ball Game

—amaze your family

Note: The fielding chart in this article is adopted in part from "Strat-o-matic Baseball," manufactured by the Strat-o-matic Game Co., Inc., 82A South Bayles Ave., Port Washington NY 11050.

At one time, if you wanted to play baseball, you needed a bat and ball. Now, through the magic of digital electronics, all you need is one finger. A simple, but elegant, digital baseball game (DBG) can be built for little over $8, ICs and all.

The DBG has two parts. The first is a simulated playing field with an LED at every defensive position. The other is a single digital LED readout. Play is as follows. The batter "bats" the ball by pushing the batter's button. When he does, the 9 LEDs will go on and off in a random order. When he releases the button, only one LED will remain lit. This is the position to which the ball has been hit. The batter then goes to a *fielding chart*, where all the positions are listed, each having ten different instructions (0-9). The pitcher then pushes his button, and, as he does, the LED numbers will flash by quickly. When he releases the button, a single digit will remain on the display. The play's result can be found by locating the position and the number on the chart. After the chart's instructions have been carried out, the next batter is up, and play continues in the same manner.

Circuit Description

For the benefit of those who are new to digital electronics, I will give a simple explanation of the circuit. Fig. 2(a) shows a block diagram of the DBG. The output of clock chip IC1 is fed into the input (pin 14) of IC2. IC2 is a 7490 decade counter. Its function is to convert its input into a binary coded decimal (BCD), or, more simply, a binary number. For example, on the *first* clock pulse into IC2, IC2's output pins 11, 8, 9, and 12 will be 0001, the binary number 1. On the *second* clock pulse, IC2's output will be 0010, the binary number 2. And so on, until the tenth pulse, where the counter's output will reset to 0000. IC3 is a 7445 BCD-to-decimal decoder. Don't let the name scare you though; it's pretty simple. See Fig. 2(b). IC3 has 4 input pins, D, C, B, and A, and its input is the output of IC2. IC3 has 10 output pins, all of which are initially logic 1. IC3 "decodes" the 4-digit BCD.

Let's see what happens. Let's say that the four input pins, 12, 13, 14, and 15 (D, C, B, and A), are fed the BCD or binary number 0001. Then pin 2, which is output 1, will

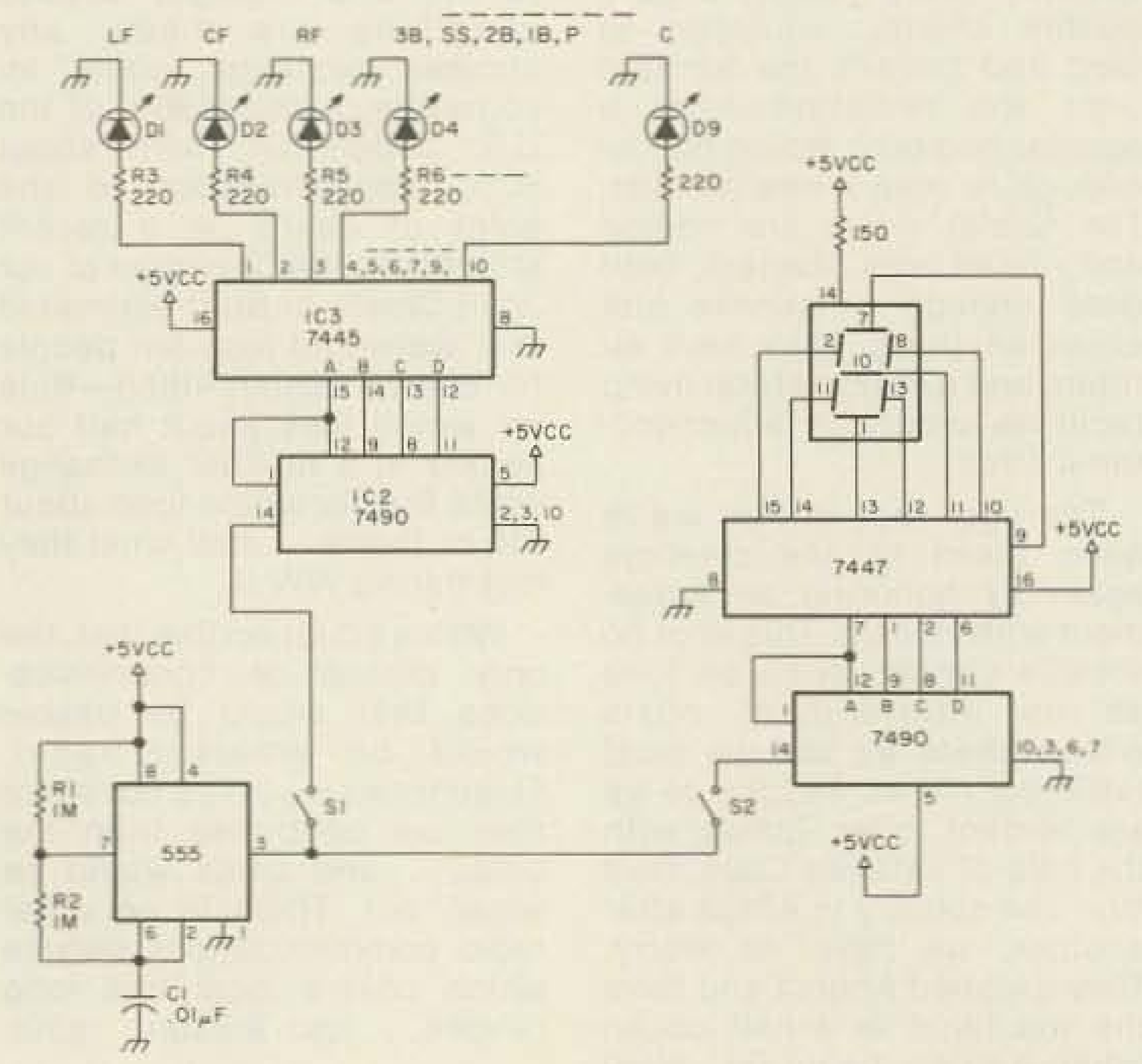


Fig. 1.

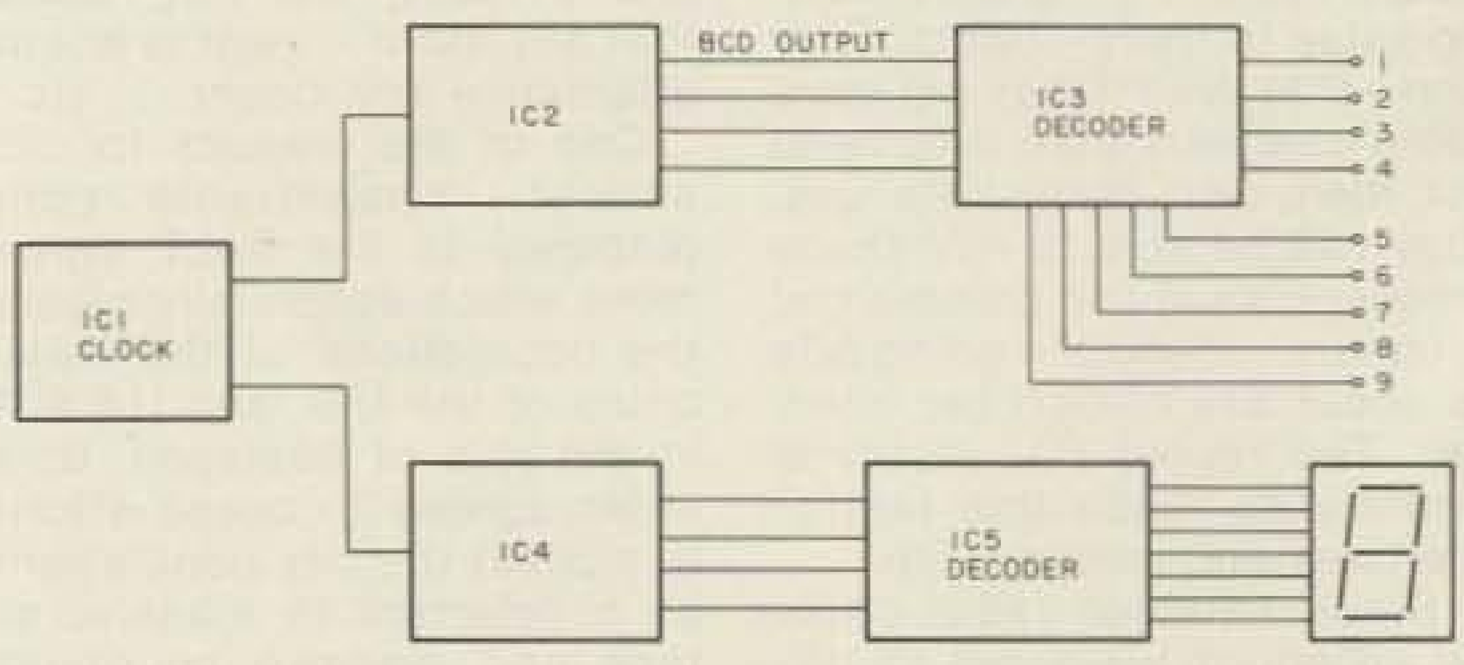


Fig. 2(a).

go low. (The rest are high, remember.) As IC3's input (IC2's output) changes to the next number, 0010, then pin 3, which is output 2, will go low (only). With a BCD input of 0011 (binary 3), the output 3 (pin 4) will go low.

Let's now look at the three ICs as one function complete. The output of IC1 is changed into a BCD by IC2. IC3 decodes this BCD into its respective output pin. Then, nine outputs of IC3 are used to drive nine LEDs. (Note that when S1 is closed, IC2's output is changing, and the LEDs will flash sequentially. When S1 is opened, though, IC2's output will remain constant, and only one LED will remain lit.)

The digit display operates in pretty much the same way. IC4 is a 7490 decade counter, too. IC4's output will be 0001 on the first clock pulse, 0010 on the second, etc. The difference is in IC5, the 7447 BCD-to-seven segment decoder. IC5 takes the BCD from IC4 and decodes it into seven outputs which will drive the seven segments of your LED readout. When the BCD 0100 (binary 4) is at its input, the LED readout will display the digit 4. With an input of 0010 (binary 2), the display will read 2. This is the same for all BCDs, 0000-1001 (0-9). (Note that, when S2 is closed, the digits will keep flashing by. When S2 is opened, though, only one digit will remain on the display.)

Building the DBG

Since there are relatively few connections to make, the DBG can be built on a perforated board. Although I didn't need the inside space, I housed the DBG in a 6¼" x 3¾" x 2" Bakelite box (Radio Shack 270-627). I used very small diameter LEDs, about 1/8". If you use larger ones, you may want to use a box with a larger surface to compensate. On the top surface of the box (metal side down), I painted a baseball field (Fig. 3). Any model paint will do; enamel is nice. I used a bright green and light brown for the grass and dirt, respectively. A bit of white is needed for the bases and baselines.

Drill holes for the LEDs at each defensive position, namely pitcher, catcher, first base, second base, third base, shortstop, left field, center field, and right field. Bring the LEDs up from *inside* the box. They may be glued in place.

Use Fig. 3 as a guideline for placing your push-button switches and LED digit display. Drill holes for each switch. Drill a hole beneath each pin on the LED display, and place display pins through them, so that you have access to the pins from inside the box. Wire as you would a perfboard, taking special care not to melt the Bakelite with the soldering iron.

Build the rest on perfboard. You may want to put ICs 1, 2, and 3 on one board and ICs 4 and 5 on another, for easier point-to-point wiring. To power your DBG, you will need a 5-volt source. The current drain is (on mine) 160 mils. A small 9-volt battery can be used; with the current drain, the battery voltage is brought to about five volts. It's better, though, to use a more consistent supply. Since the current draw is constant, you do not need voltage regulation. If you have an old filament transformer or what have you lying around, you can use a resistive voltage divider to get the proper current and voltage.

Complete the construction, and you'll be ready to play.

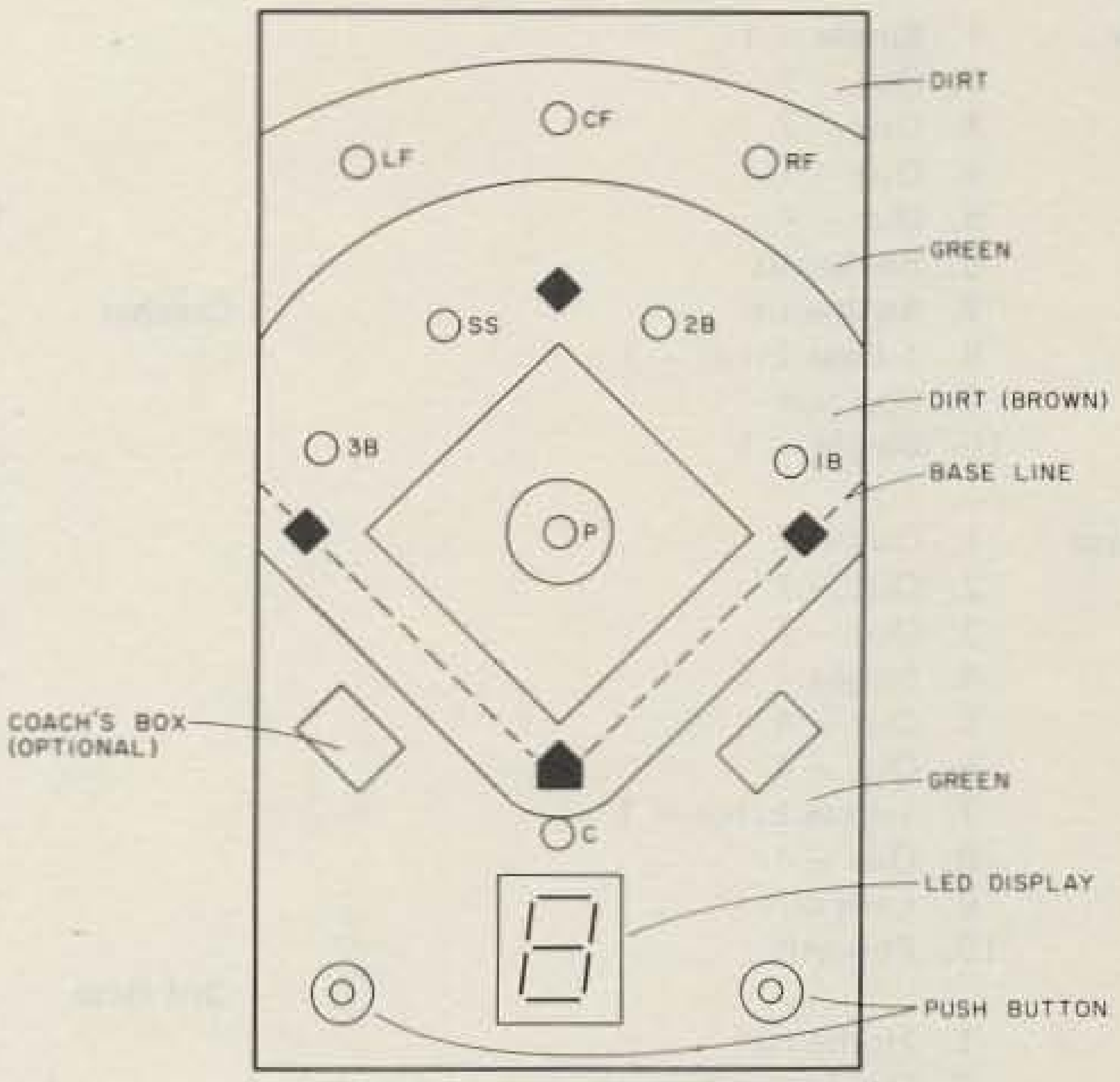


Fig. 3.

Digital Baseball

A brief description was given at the beginning of this article on how to operate the DBG. Table 1 simulates one inning of play, so that you fully understand how to play digital baseball. Please use the fielding chart, Table 2, to read out each given play.

Be sure to observe those little numbers after each play result (on the chart). These indicate the movement of the runners (runners hold, runners advance, etc.).

If the batting team wishes that a runner steal a base, he may call the steal *before* any play. He must then push the digit button twice to find the results of the steal attempt. For example: There's a man on first base, and he wishes to steal second base. The batter pushes the digit button, and it reads "7". We look on the chart and find that numbers 1-7 are safe, and 8-10 are out. He pushes the button again. This time the display reads "8". The runner is out going to second base. Play continues, unless that is the third out.

You should be aware that sometimes none of the LEDs

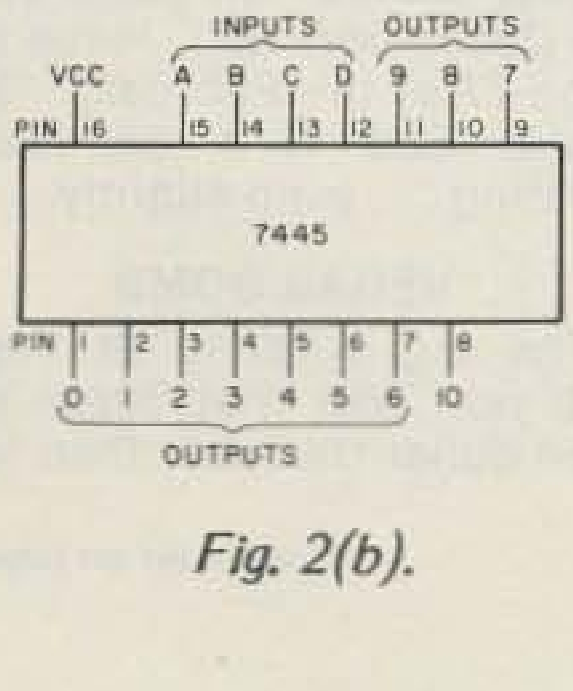


Fig. 2(b).

	Hit To:	Number	Results
1.	3B	8	Man on second base (2B).
2.	1B	1	Batter out, runner advances. Man on third base.
3.	CF	2	Sacrifice fly, batter out, man on 3B scores.
4.	SS	0	Man on first base.
5.	P	5	Runner is forced at 2B; 3 outs.
	*	*	*
1.	RF	0	Man on first base.
2.	C	4	Batter safe on error, men on 1B and 2B.
3.	3B	7	Double play; batter is out, player on first base is out running to second base. Player from 2B is now on 3B. (2 outs.)
4.	LF	6	Man on first base, runner on third base scores.
5.	LF	5	Man on second base, runner on first base advances *three* bases and scores.
6.	P	6	Strikeout; 3 outs.

Table 1.

Pitcher
1. Single – 1
2. Out – 7
3. Out – 7
4. Out – 1
5. Out – 4
6. Strikeout
7. Strikeout
8. 1-Base Error – 1
9. Pop out
10. Single – 1

2nd Base
1. Out – 7
2. Out – 7
3. Out – 7
4. Single – 1
5. Out – 4
6. Out – 4
7. 1-Base Error – 1
8. Out – 1
9. Line out
10. Pop out

RF
1. Home run
2. Double – 3
3. Fly out – 6
4. Fly out – 6
5. Fly out – 6
6. Fly out – 5
7. Fly out – 6
8. 2-Base Error – 2
9. Fly out – 5
10. Single – 1

Steals
1. 1 safe, 2-10 out
2. 1-2 safe, 3-10 out
3. 1-3 safe, 4-10 out
4. 1-4 safe, 5-10 out
5. 1-5 safe, 6-10 out
6. 1-6 safe, 7-10 out
7. 1-7 safe, 8-10 out
8. 1-8 safe, 9-10 out
9. 1-9 safe, 10 out
10. 1-10 out

Catcher
1. Strikeout
2. Strikeout
3. Pop out
4. Safe at first on dropped pop-up – 1
5. Foul out
6. Wild pitch followed by foul out – 1
7. Safe at first on erored dribbler – 1
8. Passed ball followed by foul out – 1
9. Foul out
10. Pop out

3rd Base
1. Line out
2. Foul out
3. Pop out
4. Out – 4
5. Out – 4
6. Out – 7
7. Out – 7
8. Double – 2
9. Single – 1
10. 1-Base Error – 1

CF
1. Double – 2
2. Fly out – 5
3. Triple – 3
4. Fly out – 6
5. Fly out – 6
6. 2-Base Error – 2
7. Fly out – 6
8. Fly out – 6
9. Fly out – 5
10. Single – 2

1st Base
1. Out – 1
2. Out – 7
3. 1-Base Error – 1
4. Single – 1
5. 2-Base Error – 2
6. Out – 1
7. Out – 1
8. Out – 2
9. Double – 2
10. Out – 4

SS
1. Pop out
2. Line out
3. 2-Base Error – 2
4. Double – 2
5. Out – 7
6. Out – 7
7. Out – 7
8. Out – 7
9. Out – 7
10. Single – 1

LF
1. Fly out – 6
2. Fly out – 5
3. Foul out
4. Home run
5. Double – 3
6. Single – 2
7. 2-Base Error – 2
8. Fly out – 5
9. Fly out – 6
10. Fly out – 6

Table 2. Fielding Chart.

on the field will be lit. (This is because the 7445 has 10 outputs, and we are only using 9 LEDs.) In this case, it is the batter's choice of any position he wishes. The pitcher then pushes his button, etc.

Well, that's it, folks – digital baseball. You know, when the idea first came to me, I built it as a joke, not thinking too much of it. But I can say that I was quite surprised to find that it really is a lot of fun to play, and it's challenging, too! So get out your peanuts, Cracker Jacks, and soldering iron – and play digital baseball! ■

Runners Guide

1. Runners advance one base.
2. Runners advance two bases.
3. Runners advance three bases.
4. If no runners are forced out, batter is out and runners hold. With one or more runners forced, batter is safe on first, runner on first is out going to second. All other runners advance one base.
5. Runners hold.
6. Runner on 3rd scores (if any); other runners hold. (Batter is out.)
7. Runner on first is out going to second (providing there is one – completion of double play). Other runners advance one base.

Parts List

IC1	NE555 timer
IC2, IC4	7490 decade counter
IC3	7445 BCD-to-decimal decoder/driver
IC5	7447 BCD-to-seven segment decoder
D1-D9	miniature LEDs
S1, S2	push-button miniature switches
LED display	Opcoa SLA 1 or equivalent anode.

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

from page 35

Now, with the ITU meeting coming next year, we might not even have amateur radio . . . what then? What would there be to even try and hold our country together?

Farfetched? I sure hope so. But I once ran an article which told the inside story of how Israel got started . . . and radio amateurs played a key part in that. Without amateur radio, Israel might not have made it. A country without communications is not a country.

We don't have to go back very far to be reminded of how sturdy amateur radio communications are when all else fails. When that earthquake hit Alaska, the *only* communications the Air Force had with its SAC base in Alaska was via amateur radio for about two or three days!

Of course, as long as we permit Russia to do whatever it wants, sending in arms and troops to take over one country after another, we have no real worry. But Russia has made no bones about wanting to control the mideast oil, so we'd better stop arguing about alternative energy sources and get ready to run cars on something other than gas.

We could look on the bright side. If a nuclear exchange wipes out half of our people, it will make parking a lot simpler . . . and land prices might go down.

For a rough estimate of the situation with Russia, I suggest you read the *Reader's Digest* articles on page 97 of the December, 1977, issue and page 77 of the February, 1978, issue. See if I am exaggerating . . . even slightly.

VEGAS BOMB

The big surprise at Vegas this year was that Saroc was even duller this year than last.

Continued on page 43

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New Life For Your Old Dipper

It was more than fifty years ago when I first became acquainted with the useful little instrument which was then called a "grid-dip meter." It was merely a vacuum tube oscillator with a milliammeter in its grid return circuit. When a load was put on the oscillator, the grid current decreased or "dipped." The primary use for the dipper is to find the resonant frequency of a tuned circuit. (For brevity, I will use the letter X in all that follows to denote the circuit whose natural frequency is to be determined.) The dipper oscillator has a dial calibrated in frequency and a set of plug-in coils to cover a wide range of frequencies. To use the dipper, its coil is placed close to the X circuit, then the dial is slowly turned until a sudden dip is seen in the meter reading. At that point, the resonant frequency of X is read off the dial.

Other Uses for a Dipper

The simple coil and condenser tuned circuit is not the only thing whose resonant frequency can be measured by a dipper. Any resonant system to which the dipper can be coupled may be used as the X circuit: for example, a resonant length of transmission line, or a dipole, or a cavity resonator. In fact, if the dipper coil is held close to a large chunk of barium titanate, dips will be found at various high frequencies. These are due to internal standing wave patterns whose wavelengths are hundreds of times shorter than they would be in air on account of the high dielectric constant of the titanate. Incidentally, it is interesting to note that the simple original dipper circuit is exactly what was used in the proximity fuse which played so important a part in World War II. In the fuse, the oscillator radiated very high frequency waves via a tiny antenna which had a certain normal radiation resistance. Reflection of these waves back to the antenna from a target such as an airplane or earth caused a slight variation of the effective radiation resistance as the distance to the target changed. This constituted a varying load on the oscillator and hence a varying grid current. A two stage audio frequency amplifier brought these variations up to sufficient intensity to fire the explosive in the shell.

Impedance Imported By Coupling

The ordinary dipper depends for its operation on the loading caused on its oscillator by the coupling of its coil to an X circuit resonant to the oscillator frequency. Fig. 1 shows how this works. The solid arrow represents the impedance of the dipper coil when the X circuit is way off tune. The dotted arrow shows its apparent impedance when X is tuned a trifle below the oscillator frequency. As the tuning of X is varied upward through the oscillator frequency, the head of the dotted arrow moves counterclockwise around a tiny circle whose diameter is ωLk^2Q, where ωL is the dipper coil reactance, Q is the figure of merit of the X circuit, and k is the coefficient of coupling between the dipper coil and the coil in X. At exact resonance, a pure resistance ωLk^2Q is added to the normal resistance of the dipper coil and this is what loads the oscillator. Substantially the same sort of thing occurs when the oscillator frequency is varied past the natural frequency of a fixed X circuit. It will be noticed that the extra resistance that can be imported into the dipper coil varies as the square of the coupling coefficient k. Now the coefficient of coupling between two coils separated by a distance that is large compared to the coil dimensions falls off as the inverse cube of that distance, and hence the square of the coupling falls off as the inverse sixth power of the separation. Thus, doubling the spacing between the dipper coil and X would reduce the imported resistance by a factor of 64. Actually, of course, the distance between coils is usually not large compared to their dimensions, but even so, it is evident that the sensitivity of a dipper must be increased far more than in proportion to the distance over which it is expected to work.

Backwards Operation

So far we have been discussing the normal operation of the dipper. But it can also be used in what I will call the backward manner, that is, to permit tuning an X circuit to a desired frequency. In this case, the dipper oscillator is set to the desired frequency and left alone. Then the tuning of X is varied until a meter dip occurs which shows that X is now tuned to the desired frequency. When used

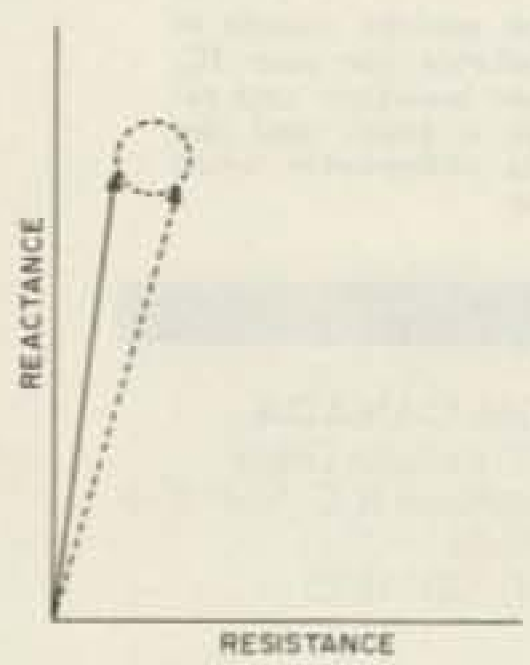

Fig. 1.

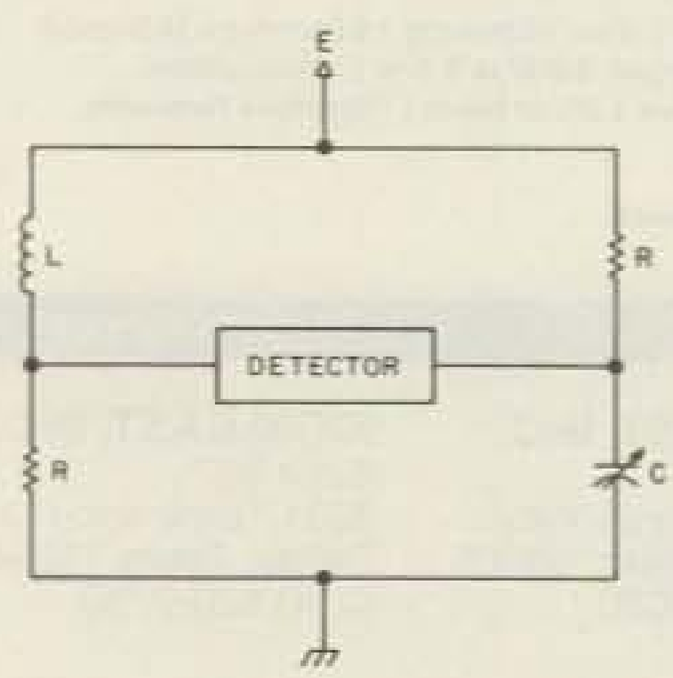

Fig. 2.

backwards, the only requirement for satisfactory operation is that the dipper be sensitive enough to give an easily noticeable dip. However, for getting a circuit tuned to a desired frequency, it is not necessary to make use of a dipper. A very simple and sensitive way to do the job is to set any oscillator to the desired frequency and listen to it with a CW receiver whose beat frequency oscillator is adjusted to produce a low frequency tone in the loudspeaker. Then place the X circuit somewhere near the oscillator, and, as X is tuned past the desired frequency, changes in the pitch of the tone will be noticed. Fig. 1 explains why this happens, for it shows that when X is tuned a little off resonance, the effective *reactance* of the oscillator coil is increased or decreased slightly. This makes the oscillator frequency change by a minute percentage. But this trifling percentage variation at radio frequency becomes a very noticeable percentage change in the pitch of the tone heard. The maximum change in effective oscillator coil reactance is given by the radius of the circle in Fig. 1, namely $\pm \frac{1}{2}\,\omega L k^2 Q$, and the fractional frequency change is $\frac{1}{4}k^2Q$.

What's Wrong with Ordinary Dippers?

As has been noted, any dipper works fine backwards, but in normal operation, every commercial dipper I have used has one annoying drawback – its meter reading does not stay constant as the frequency is varied. Fluctuations of the meter reading can sometimes mask a small dip caused by resonance with an X circuit, especially one of low Q. Also, the more sensitive dippers require readjustment of an extra control as the frequency is varied to keep the meter reading on scale.

For some years now, I have from time to time tried out various ideas for getting around the drawbacks to the ordinary dipper. The ideal dipper I have had in mind is one whose meter or other indicator would show no change at all as the frequency is varied until it hits resonance with an X circuit. It should also be sensitive enough to find the resonance of a pipe dipole or other low Q system to which close coupling is not attainable. And, hardest of all to achieve, it should be easy to build and simple to operate.

If I had ever hit upon a device that satisfied all these requirements, I would probably now be busy trying to market it. However, some of the schemes I have tried meet some of the requirements, and three of these will now be described in enough detail so that any fairly competent ham should have no trouble in making them work. The circuits and constants that will be shown are what have worked for me. The knowledgeable experimenter can no doubt improve on them.

A Bridge Type Dipper

A fairly obvious idea for meeting the first requirement for an ideal dipper is to use a bridge that stays in balance at all frequencies except that at which an X circuit coupled to one of the bridge arms upsets the balance and causes a voltage to appear between the output terminals of the bridge. Thus the detector meter reads zero at all frequencies except at the resonant frequency of X when it makes a pip instead of a dip. Such an arrangement might be called a pipper, but let's keep using the word dipper for anything that indicates resonance between an oscillator and a passive resonant system.

There are various ways to make a suitable bridge, but the one I prefer is the one shown in Fig. 2. It uses only one coil, and the only adjustment needed for balancing it is the variable condenser. Once balanced it has two rather surprising properties:

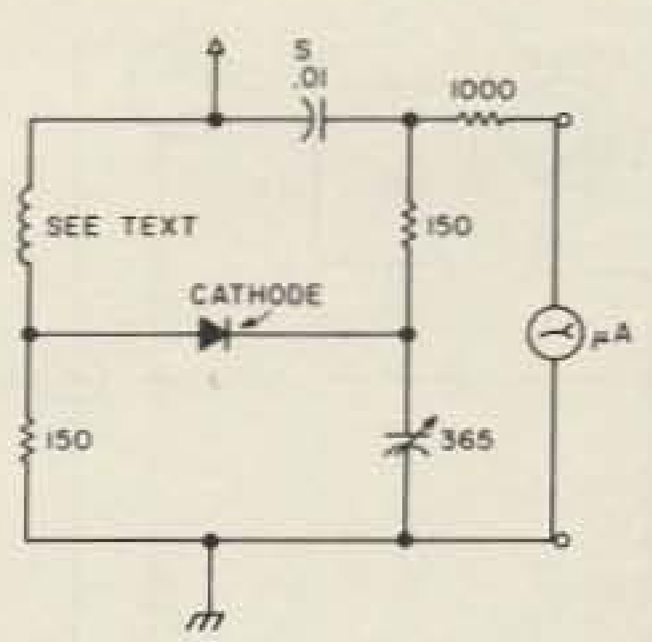

Fig. 3.

It stays in balance at all frequencies, and its input impedance is a pure resistance R at all frequencies. The condition for balance is $L/C = R^2$. Its most efficient operation is at the frequency F determined by L and C. The voltage on the detector caused by coupling to an X circuit is:

$$Ek^2Q\left\{(f/F)/[1 + (f/F)^2]\right\}$$

where f is the actual frequency, E is the voltage impressed on the bridge input, and k and Q have the same meanings as described earlier. When f = F, the output is maximum, but as f departs from F, the output falls off rather slowly so that the same coil can be used over a wide range of frequencies, even as much as a hundred to one.

Fig. 3 shows some constants I have used for operation from less than one MHz to over 30. The inductance L is nine turns on a 1½" diameter form, with about ½" winding length. The large blocking condenser S permits removing the meter from the bridge proper so that its capacity to ground does not affect balance. The whole affair can be built into a small box with the coil sticking out front, the meter and condenser knob on top, and a coax cable coming out the rear to connect with the oscillator that supplies the input voltage E. If the oscillator is capable of supplying several volts to the bridge (the only difficult part of the whole business), then Fig. 3 as it stands makes a very nice instrument. If, however, only a small voltage can be applied to the bridge, the sensitivity

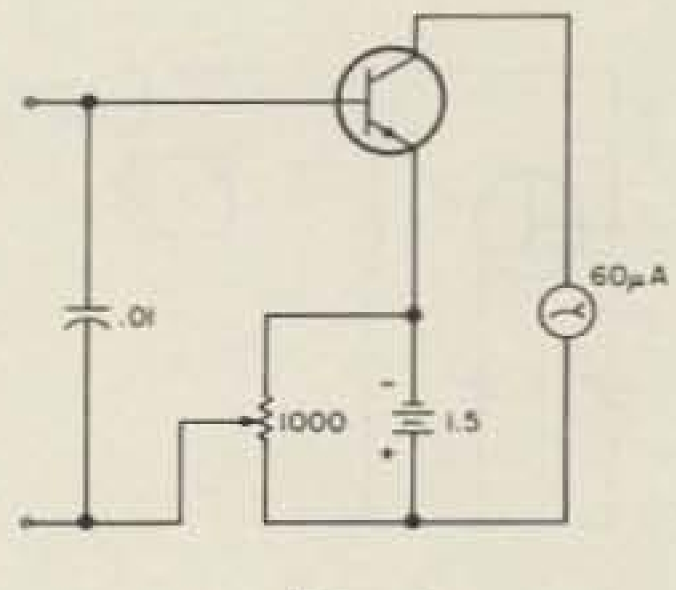

Fig. 4.

will be rather low because a certain threshold voltage must be applied to a diode before it starts detecting at all. One expedient for providing the necessary starting voltage is to unbalance the bridge a trifle, just enough to cause a few microamperes to flow in the meter. This, of course, is entirely contrary to the ideal of having no meter current at all until resonance with X occurs, but in practice it works out fairly well.

A More Sensitive Detector

Rather than unbalance the bridge, it is better to put a little dc bias on the diode as shown in Fig. 4, which may be substituted for the meter of Fig. 3. With polarities as indicated, adjustment of the potentiometer will permit setting the meter to a desired deflection, say half scale or more. This reading will stay put so long as the bridge stays in balance. The purpose of the condenser is to keep everything but dc from getting into the transistor. The addition of Fig. 4 makes it possible to obtain good pips where little or none would be seen with Fig. 3 alone.

The Link Dipper

What I am calling the link dipper differs from other dippers in that it does not depend for its action on the phenomenon described in connection with Fig. 1. The link principle is very simple: Two units are involved which will be called the transmitter and the receiver. These two units are so arranged that the receiver gets no signal directly from the transmitter. But when an X circuit is coupled to both units at once, then

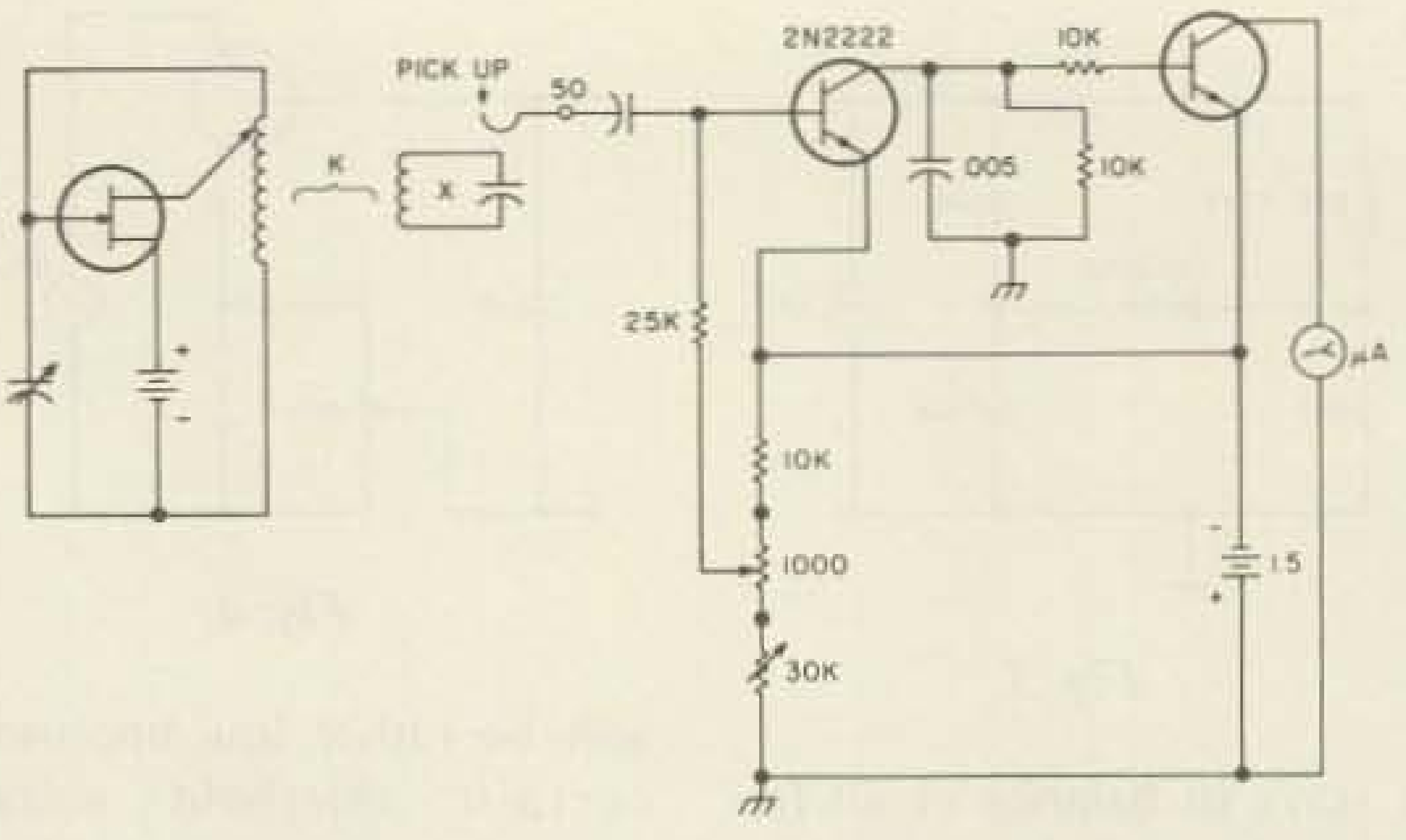

Fig. 5.

current is induced in X (when resonant) by its coupling to the transmitter, and this current in turn creates a voltage input to the receiver. In other words, X acts as a tuned link circuit between transmitter and receiver. Only when X is resonant does the receiver get anything, and that result is just what is wanted for ideal dipping.

The Hard Way To Do It

When the receiver tuning is unicontrolled with the transmitter frequency, and no direct coupling between the two units exists at any frequency, the link dipper is very sensitive and gives no indication except at the natural frequency of X. But it seems impracticably difficult to do all this. For one thing, accurately unicontrolling the tuning of two circuits is a fussy job. And a gang condenser is not satisfactory for unicontrol because its rotor element is common to the two circuits and causes a slight coupling between them. Arranging the circuits to have no mutual inductance is not hard, but electrostatic screening seems necessary to eliminate capacity coupling between circuits. And finally, matched pairs of coils must be provided for operating in different ranges. I found it most tantalizing that a dipper built along these lines worked so beautifully over a very narrow range of tuning, but to cover a wide range required frequent trimming to maintain maximum sensitivity and frequent readjustment of coil orientation to keep the direct coupling strictly zero between transmitter and receiver.

The Easy Way

It was only after trying to do it the hard way that I suddenly realized that resonance of the X circuit itself could be utilized to take the place of unicontrol tuning, and that the problem of eliminating direct coupling between transmitter and receiver could be solved by putting electrostatic screening around the transmitter so that it put out only a magnetic field, while the receiver was made to be sensitive only to an electric field. The receiver could then be energized by putting its input pickup wire into the electric field produced by current in X, and the receiver could be aperiodic so that there would be no coils to change.

Fig. 5 should explain the idea better than words can. Here the transmitter is the oscillator circuit shown at the left. It is perhaps as bad a design as could be chosen, but I have put it in deliberately to show how simple the transmitter can be. It contains only the three essentials for any oscillator: a tuned circuit, a source of power, and an amplifying device. But for satisfactory operation, you should select an N channel FET that draws only a small current, such as 3 or 4 milliamperes, from a battery of 4½ volts more or less, when the drain tap is put at the top of the coil so that oscillation does not occur. Then if the tap is moved

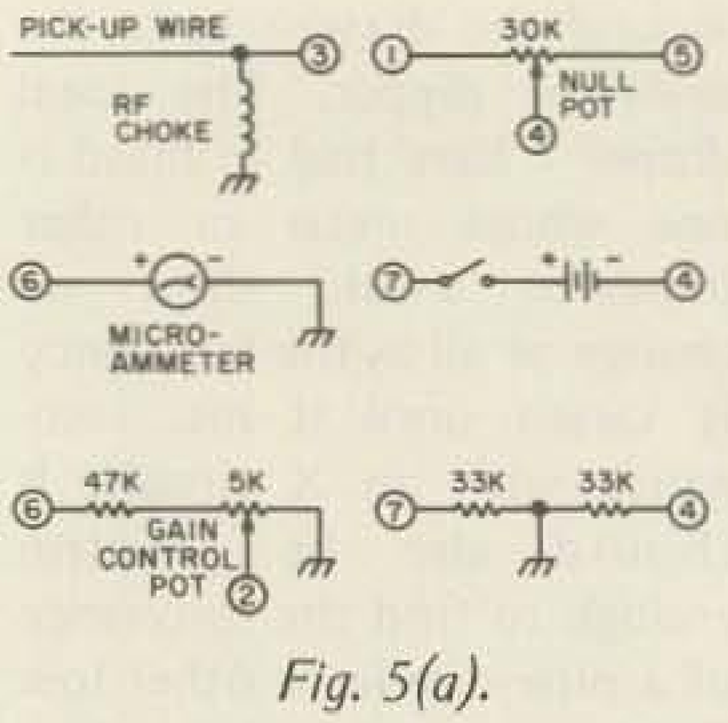

Fig. 5(a).

down only a trifle, oscillation begins and the battery current decreases somewhat provided you have not moved the tap down unnecessarily far.

The detector circuit shown at the right is designed so that the meter current goes down when the pickup wire is put into an rf electric field. This assures that the meter needle will not fly off scale. The only critical thing about this circuit is the adjustment of the bias on the base of the first transistor. This is too critical to be done with a single potentiometer, so two are shown, the lower one for coarse setting and the upper one for fine adjustment of the meter current to somewhere near full scale. The meter current is quite sensitive to changes in ambient temperature. This is of no use for present purposes, but maybe you would like to use the circuit as a thermometer. The meter reading is also affected by hand capacity if there is much 60 cycle voltage floating around in the shack. This can be cured by connecting an rf choke between the pickup wire and the emitters.

A Better Detector

The detector circuit shown in Fig. 5 was devised especially for use in the link dipper, and it worked quite well when great sensitivity was not needed. But it was later found that a far more sensitive detector can be made by using a 741 operational amplifier with low battery voltage so that its non-linearity results in detection. Instead of a conventional circuit diagram, it

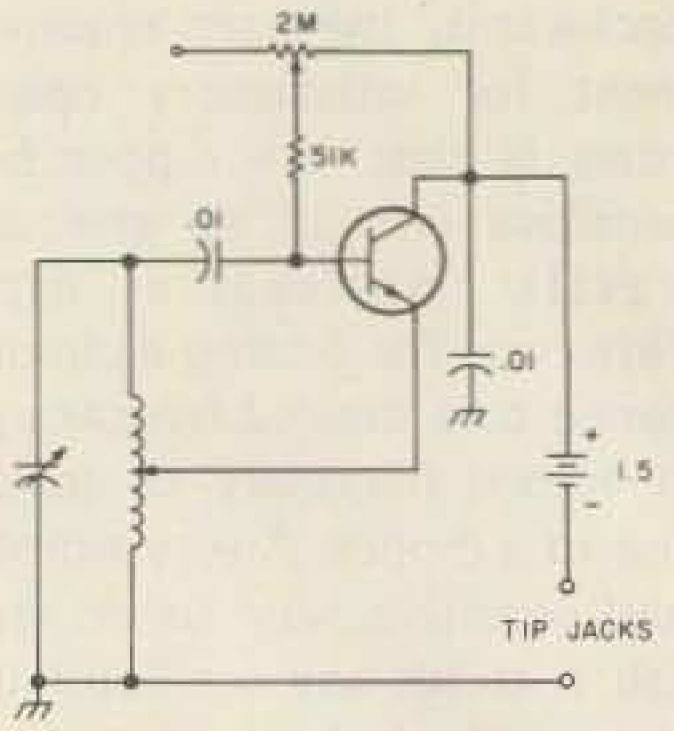

Fig. 6.

seems simpler just to show components that I have found satisfactory, together with the pin numbers of the 741 to which they are connected. See Fig. 5(a). The battery can be as low as 4½ volts, but a little 9-volt battery is more compact. The gain control pot adjusts the sensitivity from low up to more than is ever likely to be needed. The null pot is used to keep the meter reading on scale. Reversing the connections to the meter changes the indication of resonance from an up kick to a down kick; take your choice. All in all, the op amp seems to be just what the doctor ordered for link dipping.

To operate the dipper, place the oscillator coil near X so as to get some magnetic coupling, then lay the pickup wire as close to X as possible, preferably near a high voltage point. On varying the frequency, the meter should show no change except at resonance with X. In practice, it turns out that no electrostatic screen around the oscillator is needed unless the pickup is pretty close to the oscillator, and it need not be.

The Cheapie

I doubt that a simpler or cheaper dipper could be devised than the one shown in Fig. 6. Yet it "gets you there . . . " as the old Model T Ford slogan ran. When its coil can be put reasonably close to an X circuit of good Q, it is very satisfactory, but, to bring out its full sensitivity, skillful handling is needed. Its principle of operation is akin to that of the superregenerative receiver, cheap and nasty but a lot for the money. When a pair of headphones is plugged into the phone jacks, the battery circuit is completed and blocking oscillations will be heard. As the variable resistance is increased, the pitch of the tone lowers and ultimately stops. (If it won't stop with maximum resistance in, ground the left end of the pot.) The sensitivity of the device to an X circuit is greatest when the pitch is very low, and keeping it low as the frequency is varied is where the operating skill comes in. It is a two-handed job. A closely coupled X circuit will stop the blocking oscillation entirely, but a low Q or weakly coupled X will merely affect the tone somewhat. In case there is doubt whether a change in tone is really due to resonance with X, move the dipper coil toward and away from X, and if this does not affect the tone, you are not on the right frequency. The location of the coil tap for best operation over the full range of tuning will have to be found by experiment for it depends somewhat on the particular coil and transistor used. About a third of the way up the coil is suggested as a starting point. Plug-in coils are the easiest way to cover a wide range of frequencies, and, if the coil forms have four pins, you can easily make the dipper convertible to a CW oscillator by adding a tiny DPDT switch to change the base condenser and tap location to values suitable for non-blocking oscillation. In any case, the cheapie is a very handy little device to have around the shack, and it does not tie up an expensive microammeter.

Conclusions

Three radically different types of dippers have been described, each of which has some advantage over the conventional dipper. I do not feel that there is one best of the three. If someone were to hand me a transmitter tank circuit and ask me to find what frequency it was tuned to, I would undoubtedly reach for my cheapie as the easiest and quickest to get going. But for checking thousands of circuits in a factory, the bridge dipper would be the fastest and best. On the other hand, if the low Q resonances of a trap dipole are to be found, the link dipper is by all odds the best. In such a case, the oscillator coil is placed near the midpoint of the dipole and the detector pickup wire laid against the dipole tubing at a point far enough off center to pick up some electric field at the various resonances.

Appendix

In discussing the bridge of Fig. 2, perfect elements were assumed, and this assumption seems warranted for use of the bridge as described. However, to push the sensitivity of the bridge much further, especially at very high frequencies, as for example by rf amplification of its output, something must be done to compensate for the lack of perfection of its elements. For one thing, the impedance of a composition resistor drops, as I remember it, at high frequency, and also develops a capacity component, while a wire-wound resistor has some inductance. A plot of impedance versus frequency would have to be made in order to be able to develop means to give some degree of compensation. But something can be done rather easily about the inevitable resistance of a coil. In fact, something has already been done in Fig. 3 by the insertion of the condenser S. For if the coil resistance r is constant, it can be compensated at all frequencies by making S satisfy the equation $r/R = C/S$. This is called the Owen bridge.

Unfortunately, the resistance of a coil is not constant but tends to increase with frequency. However, there is a way to compensate for increasing resistance. This can be done by adding a small capacity q across the grounded resistor of the bridge. When this is done, the equation that must be satisfied in order to compensate exactly for the coil resistance is $r/R = C/S + \omega^2 Lq$. It can be seen that to satisfy this equation, r would have to behave like a constant plus a quantity that increases as the square of the frequency. An actual coil is not likely to behave just that way, but it should come closer to it than to being simply constant. A pretty close compensation should be achieved by first choosing S to give a good balance at low frequency without the aid of any q, then adding enough q to get a balance at the high frequency region.

The foregoing does not cover all the possible compensating arrangements. For instance, a high resistance across C can compensate for a constant coil resistance. To explore further possibilities of the bridge mathematically, just write the general equation for balance, which is that the product of the impedances of a pair of diagonally opposite arms must equal the product of the impedances of the other diagonally opposite arms. In the simple case of Fig. 2, this leads at once to the single equation $L/C = R^2$. But when you put complex impedances into the arms, the balance equation is one among complex quantities, so its real parts must be equal and its imaginary parts also equal. Thus, in general, there are two equations to satisfy, and the object of the game is to try to find structures for the arms that will make both these equations stay satisfied as nearly as possible at all frequencies without having to readjust anything. You are not likely to make a perfect score at this game, but at least I guarantee that it will keep you busy for several long winter evenings. ■

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

from page 38

With virtually no program, a handful of exhibits and a rising chorus of complaints from hams who had prepaid, confirmed reservations, only to find no rooms, the main saving factor was nearby CES, the Consumer Electronics Show, at the Las Vegas Convention Center.

One of the larger ham distributors expressed a common sentiment: "Never again."

Every other year or so I try to get to Saroc just to see what is happening. As the show has gone downhill, I've found fewer and fewer old friends showing up. I skipped it entirely in 1977 and would have again in 1978 except for its coincidence with the Consumer Electronics Show.

When you compare this dud with Atlanta, Dayton, and other well-run ham conventions, it is no wonder it has withered away. For instance, there was an FCC media forum . . . and considering the legislation afoot, any normal hamfest would have a packed house for this . . . yet the best Saroc could run up was about 50 people. I think ARMA (Amateur Radio Manufacturer's Association) did as well or better. You can't get people into meetings if they don't know there are meetings, and if those who do know can't find out where the meetings are and when.

It doesn't help matters that Saroc is run during the low, low, low Vegas season . . . right after Christmas . . . and at a time when there are virtually no name acts in town. Could *you* choose between Totie Fields and Liberace? Buddy Hackett was off skiing in Aspen, etc., so you couldn't even make up for the lack of Saroc action by seeing a good show.

At a better time of year, with

Continued on page 118

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Denville NJ 07834

How Do You Use ICs?

— *part IX*

Advertisements show a number of audio preamplifier ICs that look interesting and cheap. This series would not be complete without a word about a few of the more common types.

That word is maybe. There are few applications in ham use where you would be able to use high-gain voltage preamplification.

Only a few of the available circuits are adaptable to reliable breadboard operation or easy-to-use finished circuits. The available design information is too difficult to apply and does not appear to give reliable results for experimental use.

A few common characteristics were noted, with the three I tried, that limit their use in breadboarding. Those three are the LM382, the LM381, and the LM387.

The published circuits in the data books either did not work, worked poorly, or were too critical. Even when identical values were used, some of the circuits did not appear to function. Most of the circuits were for a voltage range other than the 12 volts this series is based upon, and were too critical to work at other voltages.

There are circuits which can be dropped right into place without fuss, but if you are going to develop your own, there are circuit characteristics to watch for as you work.

For simple tests, I used a crystal mike input, a pair of high impedance phones to hear the output, and an oscilloscope to watch the output for distortion. When measurements are given, they were made by feeding the output of an audio signal generator to the phones coupled to the mike. This made a better low-level signal than direct coupling of the generator would.

The following terms are used throughout the article:

Sensitivity — This was done with the mike and background noise. It refers to the circuit's ability to deal with a very low-level signal. A circuit might have a given gain but need a lot of drive to get the output, because the circuit loaded down the input source.

Gain — When given, this was the measured voltage gain from an input voltage versus an output voltage. The figures are approximate and do not necessarily represent the optimum possible, but just what those values produced. There will be variation between devices of the same type and variation caused by value changes or substitution.

Voltage range — Many of the manufacturer's circuits were highly voltage-sensitive. Any change in the source voltage would cut off the stage or cause other problems. The working circuits given here are of two types. The normal circuit will operate from about ten volts on up. The wide-range circuits will operate at lower voltages, approximately six volts on up.

Voltage output — Some circuits kept the output constant over the operating voltage range, and with some circuits it was possible to get higher output voltage with more drive.

All the devices were designed for a nine- to forty-volt source. Most are critical at the lower voltages. They can take a 300 mV input before overloading; however, circuit loading affects the actual magnitude of the signal at the input, and some circuits will accept a larger

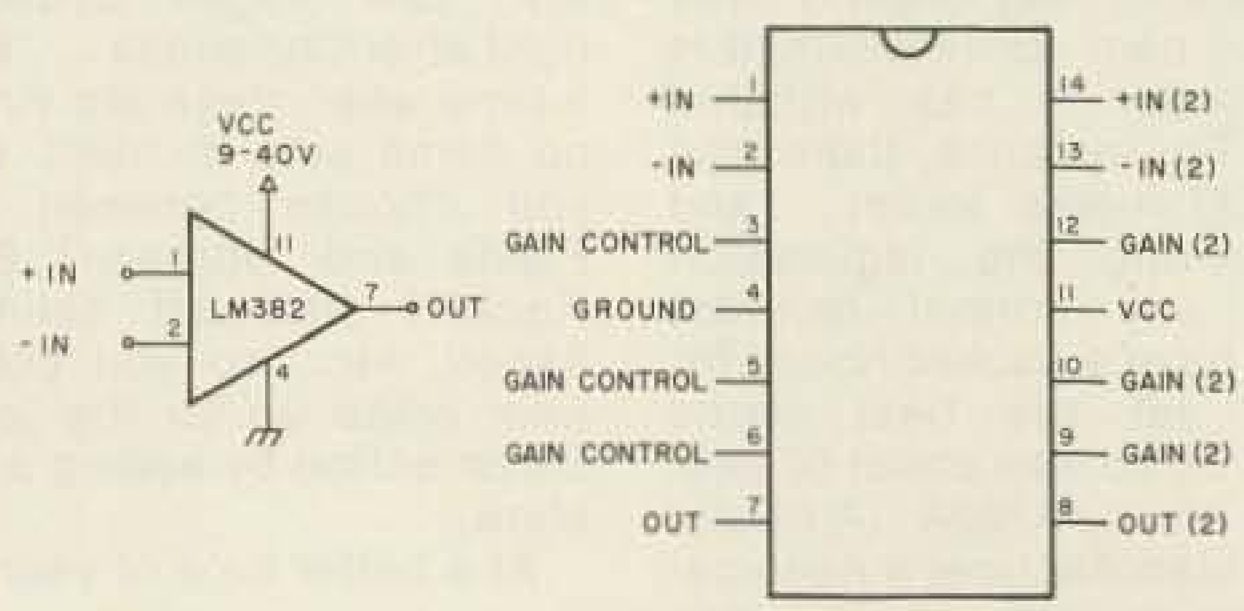


Fig. 1. LM382 dual preamplifier.

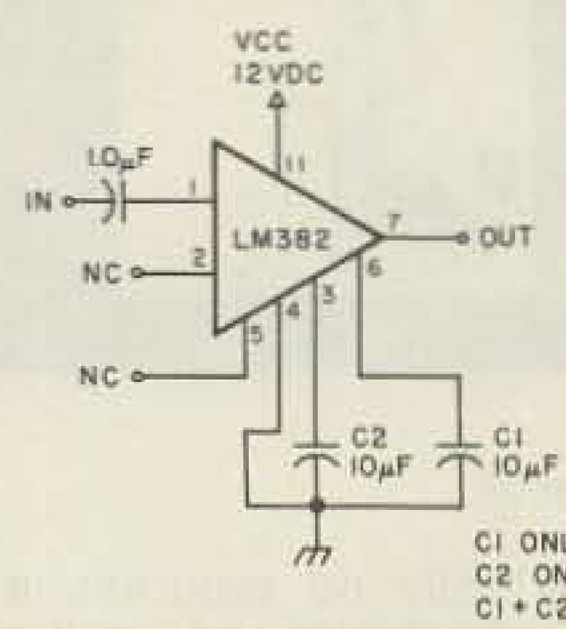


Fig. 2. LM382 flat-response amplifier. (For LM382 only — not recommended: high gain, high hum, very unstable, HF oscillation.)

actual voltage swing than others without distortion. Just how much more is a question. I blew out one IC with the output from an FM tuner. The voltage was too much. Monitor the actual input voltage when you work.

There are several specific types of trouble to watch for. In this case, a scope will be needed, as they may not be that noticeable to the ear.

Cutoff – Many of the given circuits simply were cut off. A strong signal would drive them into conduction, but the output was a square wave and useless for audio purposes.

Positive peak clipping – With some of the voltage-sensitive circuits, as the source voltage was dropped, the positive scope peak would clip. This was normally quite severe.

Negative peak clipping – This happened with some of the wide-voltage-range circuits. When overdriven, the extreme tip of the negative peak would cut off. This was slight, but it could be seen on the scope.

Overdrive – This was most noticeable on the high-gain, high-sensitivity circuits. Here both peaks would clip and, in its extreme form, you would almost get a square wave output.

The cure for the last three is obvious. Cut down on the input to the device. Whether you have the problem or not depends on the actual input and circuit you have.

Instability – This takes several forms. It is mainly an effect of high gain coupled with breadboard wiring. The basic form is oscillation.

This can be a square wave at almost any frequency. It commonly is an audio frequency, but some higher-than-audio-frequency oscillations were observed. Sometimes it comes as a few pulses at a time. You can really have fun watching the scope traces of some of these waveforms.

Hand effect – The higher the gain, the more it will act up if you touch parts of it. This does not mean that the circuit can't be used, but you will have to keep hands off while testing.

Hum – This is the enemy of high-gain circuits. They will pick up any hum in the area from other test gear or what have you.

Another effect is the equivalent of open grid hum. The leads to the input circuit will pick up hum, and even the matrix board will generate hum.

This is a problem with any high-gain stage. When you breadboard, you just compound the problem. These problems did not yield to bypassing or even more careful leads. For noncritical layout, they are here to stay.

The ICs tested were all dual (stereo) devices with differential inputs, which are ignored for audio use. The LM381 and LM387 are almost identical electronically. The LM382 is slightly more special purpose.

In the diagrams, only one section will be shown; the other you can get from the pin-out diagram. The values given will be of two types.

Some of the circuits are the manufacturer's recommended circuits and did not seem to work with the test setup. The other values were arrived at by cut and try.

The circuits recommended in this article were tested under varying conditions. They work over a reasonable voltage range, can tolerate value substitutions, and are stable for breadboard use. They may not represent the ultimate, but the circuits should work for you.

The LM382 (Fig. 1) is the most consumer-oriented of the ICs. It was made with inboard resistors to make it easy to get NAB and RIAA frequency response for tape and phono use, its main purpose in life.

For our purpose, it is virtually useless. The circuit in Fig. 2[1] is the basic flat response hookup. Make a note of capacitors C1 and C2. This IC has an unusual number of pins labeled gain.

Bypassing the appropriate pin sets the gain, which sounds nice, but it doesn't help. The test circuit, Fig. 3, used just one capacitor, C2. It's a high-gain, sensitive circuit, but it doesn't work. It had a very high hum level of almost 2 volts peak-to-peak. Using just C1 gave more gain plus more hum.

Using both capacitors was a liberal education in high hum and circuit instability. I got all sorts of square waves and oscillations.

I tried bypass capacitors here, there, and everywhere to no effect. I could not tame the circuit enough to make it usable.

On paper, the LM381 (Fig. 4)[1] is not as easy to hook up as the LM382. It takes more external parts. However, it is a far more practical IC for breadboard or experimental use and has a number of stable options.

The application notes[2] give a number of none-too-clear factors which go into the working formula, but it is not something you want to figure on a hot day.

Fig. 5[1] is the basic circuit, intended for a mixer. The values in (a) and (b) were those given by two different data books.[1,2]

The best of these values, (b), had a gain of about 22 dB, but it was so insensitive and had so little actual output voltage that it was useless. It appeared that the input resistance dragged down the high impedence input to almost nothing. It took a real punch to get a signal through.

It also had another problem. The circuits were designed for 24 volts and cut off at fifteen, useless for our purposes anyway.

Figs. 6(a), (b), and (c) give better working values for a practical circuit. Fig. 6(a) gave about 36 dB and better output, but it was still skimpy and still a load on the input.

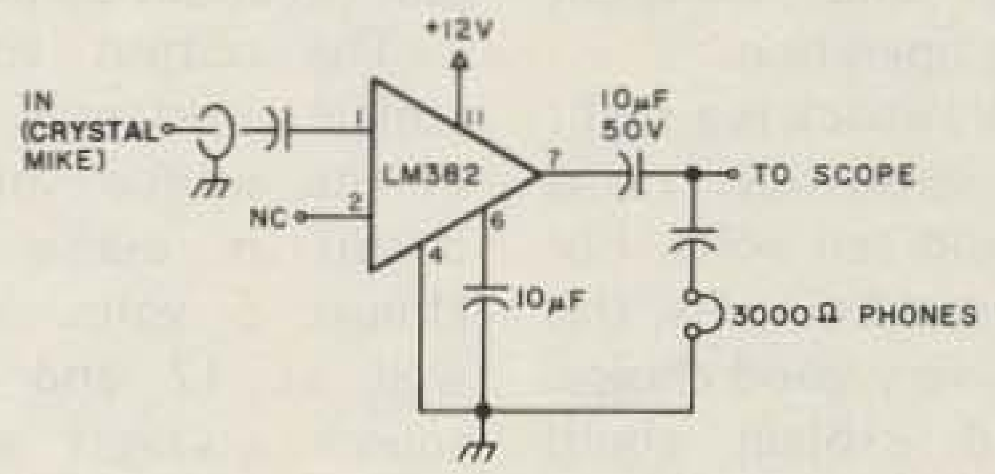


Fig. 3. LM382 test circuit.

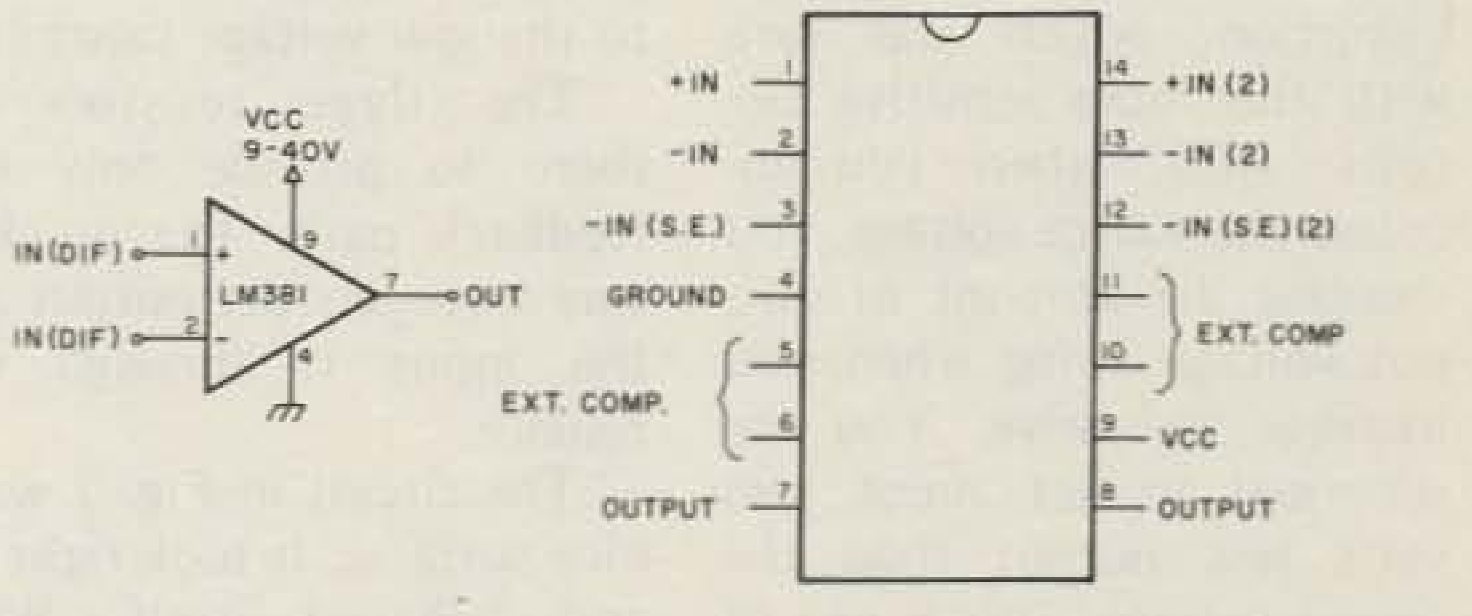
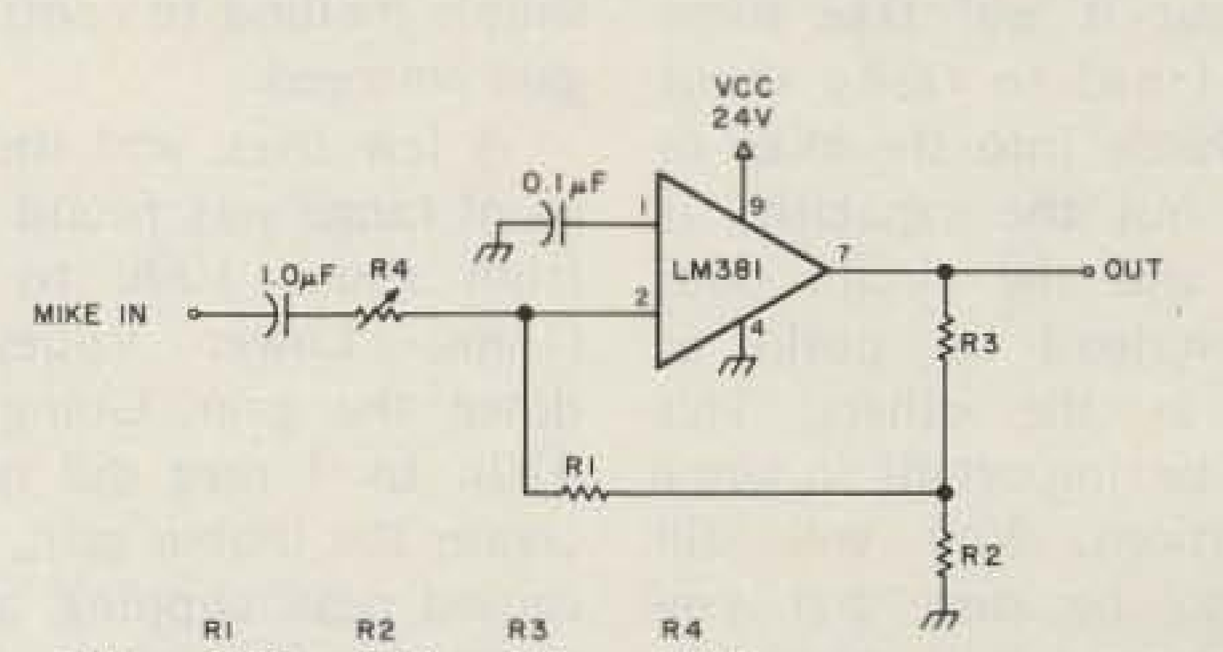


Fig. 4. LM381 dual preamplifier.



	R1	R2	R3	R4
A(1)	790Ω	2.4K	22K	500K
B(2)	8.2K	22K	220K	5M

Fig. 5. LM381 mixer (flat gain, poor operation).

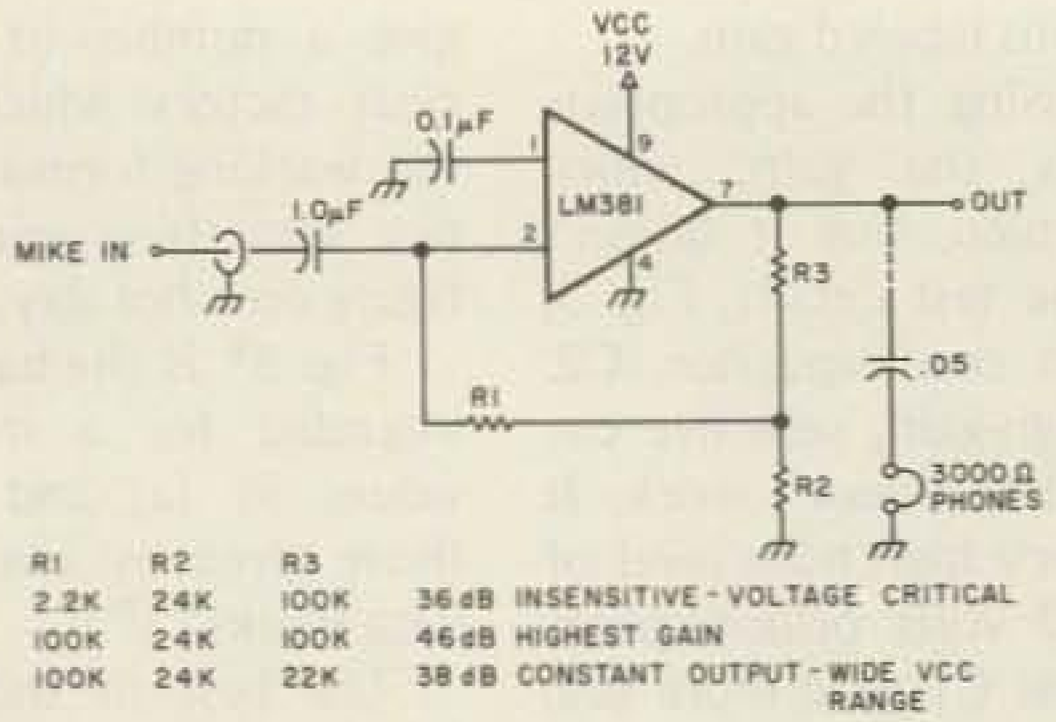


Fig. 6. Practical LM381 circuit values. [6(b) – top choice: sensitive, high gain, moderate hum, excellent overload tolerance, works down to 10 V source; for LM381, LM387. 6(c) – highly recommended: good gain, low hum, excellent overload tolerance, constant output voltage, low voltage operation; for LM381, LM387.]

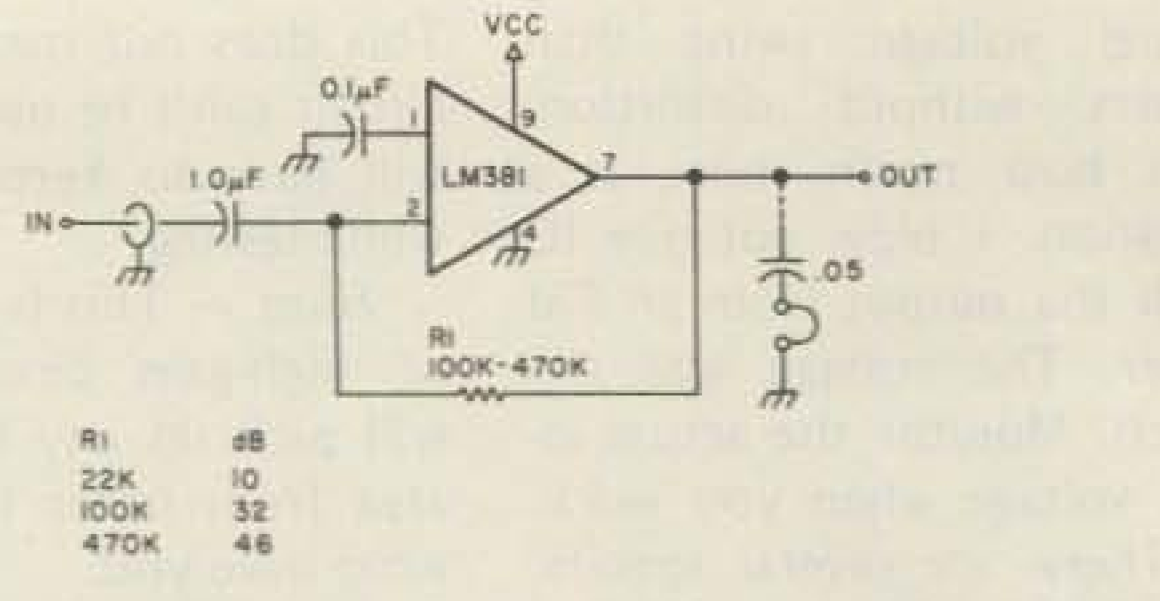


Fig. 7. Wide-voltage-range circuit. (Highly recommended: simplest, good gain, moderate hum, good overload tolerance, wide voltage range, easily adjustable gain; for LM381, LM387.)

However, it was usable, and the voltage range widened.

The best variation was 6(b). This is nothing like what the values should be, but it works. It gave about 46 dB. With the mike, I could get about 6 volts p-p.

In many respects, this is the top circuit choice. It has high gain, moderate hum, excellent overload characteristics, and excellent high-voltage operation.

Its one drawback is a slight low-voltage sensitivity. It cuts off at around ten volts. For fixed equipment circuits, this would be a very good choice.

I should explain about overload and high-voltage operation. This circuit can take a lot of drive without distortion, which was rare with the more sensitive circuits. Also, when you increase the source voltage, you increase the amount of output voltage swing when you increase the drive. You are supposed to get about two volts less output than the source voltage. This is one of the few circuits to actually do that, but it will take some drive. I had to really shout and whistle into the mike to do it, but the capability is there, and the circuit does not overload on peaks as easily as the others. This might be important in some applications. You will still have to be sure that you don't dump a really high voltage into the input and fry it, but this is the most rugged circuit of them all.

Varying R1 had an effect on the gain and the sensitivity – mostly the gain. Decreasing R1 also lowered the output voltage.

Lowering the value of R3 to 22k, as in 6(c), overcame the worst bad effect of 6(b). It widened the operating voltage range, but also cut down on the output voltage and gain (to about 38 dB).

The output voltage will remain constant with change in the source voltage. The circuit is usable down to almost 5 volts, and works well at 12 and at higher source voltages within the device ratings. It still has only moderate hum and excellent overload characteristics added to the low voltage capability.

The three resistors are there to provide only one feedback path. The quickest way between the output and the input is through one resistor.

The circuit in Fig. 7 was a nice surprise. It took right off and behaved itself. While fooling with various values, a simple method to control the gain emerged.

A few tries, and the optimum range was found to be from about 100k to 470k Ohms. Lower values cut down the gain. Going from 470k to 1 meg did not increase the usable gain, but it caused peak clipping, a characteristic of a circuit which is just about to cut off.

Without a feedback resistor, that stage will be cut off. A high input signal can drive it into conduction, and you almost get a square wave output.

The feedback resistor can be a single fixed value or a variable resistance. This should be a linear taper pot, not audio taper. It is acting as a voltage divider, not a volume control. You might also want some fixed value for minimum gain and bias even with the variable.

The circuit is quite sensitive and, at its highest gain, gives about 46 dB. It has a wide voltage range and cuts off at around five volts. The output voltage is constant over the source voltage range and is about 2-3 volts p-p.

Some other typical gain figures would be about 32 dB with 100k and 10 dB with 22k. It has low hum and good overload characterastics, although you may get some peak clipping at low source voltage levels from input overloading.

Fig. 8[2] shows a two-resistor circuit. Notice that the input goes to the inverting input which had been bypassed to ground in the other circuit.

The grounded feedback resistor is also bypassed to ground. This keeps the gain up there. I used 10 uF. For really low frequency audio, you might want a few hundred uF.

The values given in the application notes didn't do the job. By formula,[2] R1 should be a maximum of 1.2k, and, from that, R2 should be about 108k. With these values, the stage was cut off and had to be driven into conduction. This circuit quickly showed that it was going to be critical.

The circuit is very sensitive. It has a tendency to overload easily, and the square wave effect is not good for audio quality. The best circuit values worked from ten volts up. The range 10-15 would be best for our use anyway.

The values have to be chosen at the actual operating voltage to avoid cutoff. This may not be the circuit optimum, but it will be at that specific voltage. The source voltage will have to be kept close to the chosen value, or the stage will act up.

One bad problem with this circuit is the gain. With the high sensitivity and gain come increased hum pickup and oscillation.

The leads are critical and the open grid effect is noticeable. Feedback is a problem. This circuit is critical as to leads and proximity effect when your hand is there.

I was not able to measure the actual gain. The test leads threw the circuit into fits. Working with the background noise and comparing it with the other circuits, this one probably had the highest gain and sensitivity. The question is, how much do you get to use it before the circuit acts up? This is where you may have to cut and try.

R1 is needed to prevent oscillation. The best range seemed to be 2200-4400 Ohms. If there was less, the stage would cut off; more, it

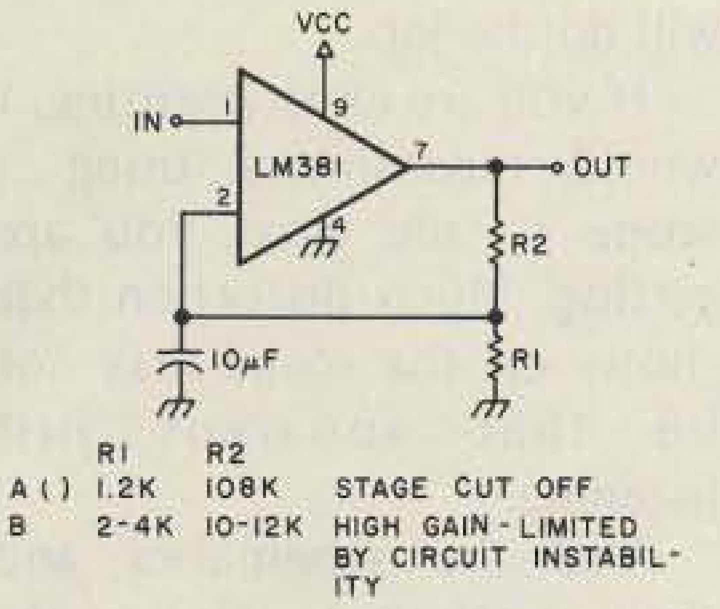


Fig. 8. Very-high-gain circuit. (High gain, high hum, voltage sensitive; for LM381. Not recommended for LM387: too unstable.)

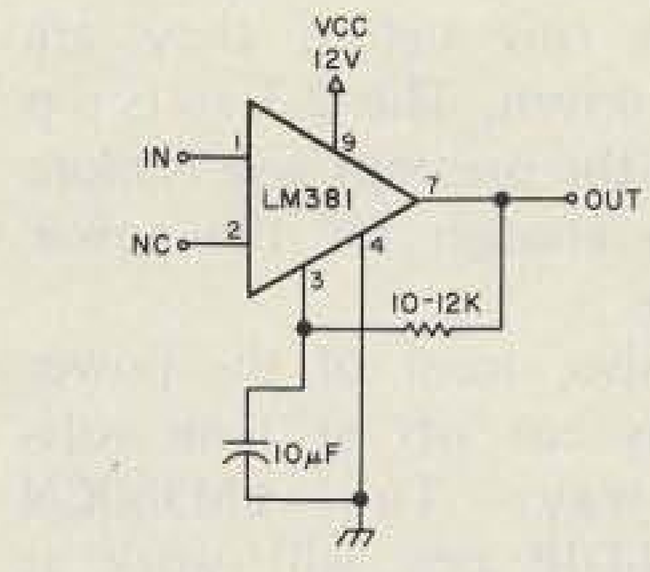


Fig. 9. High-gain circuit. (Recommended: highest stable gain, higher hum, may clip negative peaks with overload, wide voltage range; for LM381 only.)

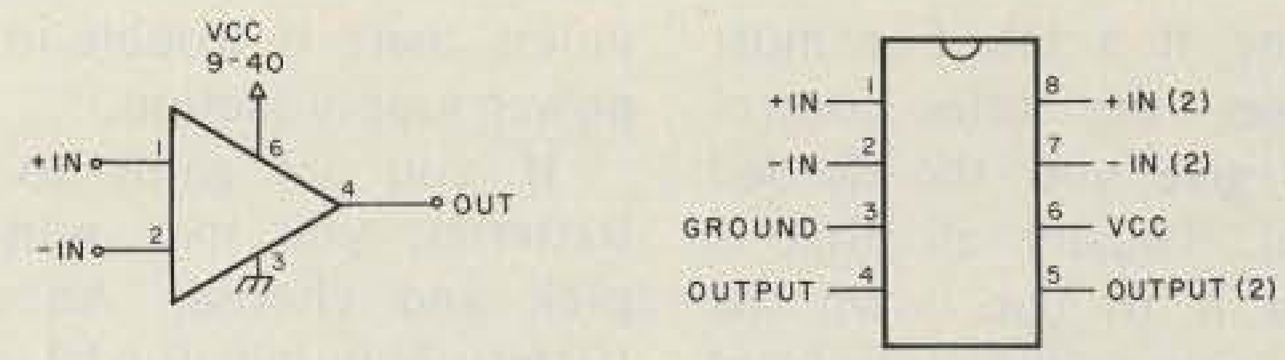


Fig. 10. LM387 dual preamp (8-pin mini-DIP).

would oscillate.

R2 is the main feedback resistor. The best value appears to be around 10-12k Ohms. If there's less, you decrease the gain; more, you oscillate. These values are not exact, only guidelines to try.

The headache is that the circuit could give you more gain, but the breadboard layout is giving you too many troubles to be able to use it.

The circuit is input-sensitive and easily overloaded by a higher input, clipping the peaks. However, when you increase the source voltage, you increase the allowable input, which will give you higher output voltage.

There is one interesting pin on the LM381 which has no equivalent on the other ICs — pin three, labeled -IN(S.E.). The S.E. probably refers to single-ended. None of the sources given made much mention of this pin.

On the schematic, it is shown as the common emitter resistor for the two input transistors. It is not bypassed. Bypassing it led to instability and oscillation with no noticeable good effect.

The unbypassed resistor is probably an advantage. It would tend to improve the stability of the stage much like an unbypassed cathode resistor.

There was a hint that it could be used as the feedback point. The feedback resistor goes to pin three, and pin two is grounded, bypassed, or ignored.

This is quite stable but not high gain. You might be able to use it, though. Now, if you add a bypass capacitor, about 10 uF as in Fig. 9, you will get all sorts of gain.

At 12 volts source, the top resistance will be about 50k Ohms. Less decreases the gain, and more becomes unstable.

This appears to be the highest stable gain configuration using breadboard techniques. Other circuits may be able to give higher gain, but not without critical leads and layout. However, at that high gain, there is noticeable hum. There is noticeable hand effect, too. When you get close to some of the leads, it will oscillate, but it seems to be effective as a circuit.

That much gain can be a problem all by itself. I had no trouble hearing every background noise in the room. If I tried to talk directly into the mike, it would overload. It will pick up a whisper and amplify it, but there is too much gain for any close use. This circuit is slightly voltage-sensitive. It will work over the wide voltage range until it cuts off at around five volts, but it loses its ability to tolerate high input as you lower the voltage. This means more chance of overload.

There is one other preamp which should be mentioned, although it is not as common as the others. This is the LM387 dual preamplifier shown in Fig. 10.[1]

This is a mini-DIP IC, only eight pins, for which you pay slightly more (costs $2 and is available from James Electronics).

Think of it as a simpler version of the LM381. Fewer pins make it that much easier to work with. The given circuits were identical to the LM381, only the pin numbers were changed. They worked just as poorly, too.

The practical circuits and values given for breadboard use with the LM381 can be used as is with the LM387. Just change the pin connections for the different package. Some typical circuits are shown in Fig. 11. Use the values in the other schematics.

There are two exceptions. There is no pin for the common emitter resistor like there was in the LM381. You will not be able to duplicate that very-high-gain, single-resistor circuit.

The circuit in Fig. 8 is not recommended for the LM387. For some reason, when the LM387 is used, the circuit becomes far too unstable for reliable breadboard work.

Most of the other circuits gave very similar results and are a more realistic choice of working gain, anyway.

Having to cut back on the input level to avoid distortion has been a characteristic of a number of the high-gain and wide-voltage-range circuits. While there are a number of options for varying the gain of the circuit, this is not the input to the circuit, just the gain. Adjusting the gain will have little or no effect on that type of distortion.

Some of the data book circuits showed a volume control in series with the signal. Typical values were 500k to 5 meg Ohms. I didn't test volume control circuits, as I was interested in the full gain capabilities and simple circuits. However, for most uses, you may need to have some control.

My feeling is that the series control will never fully cut off the signal. There may be some feedthrough. I would try a control as in Fig. 12. This is more like the usual control circuit and should cut the input off completely. The value range would be about the same. Keep it a high resistance to avoid loading down the input signal.

Even a single fixed value can be used across the input

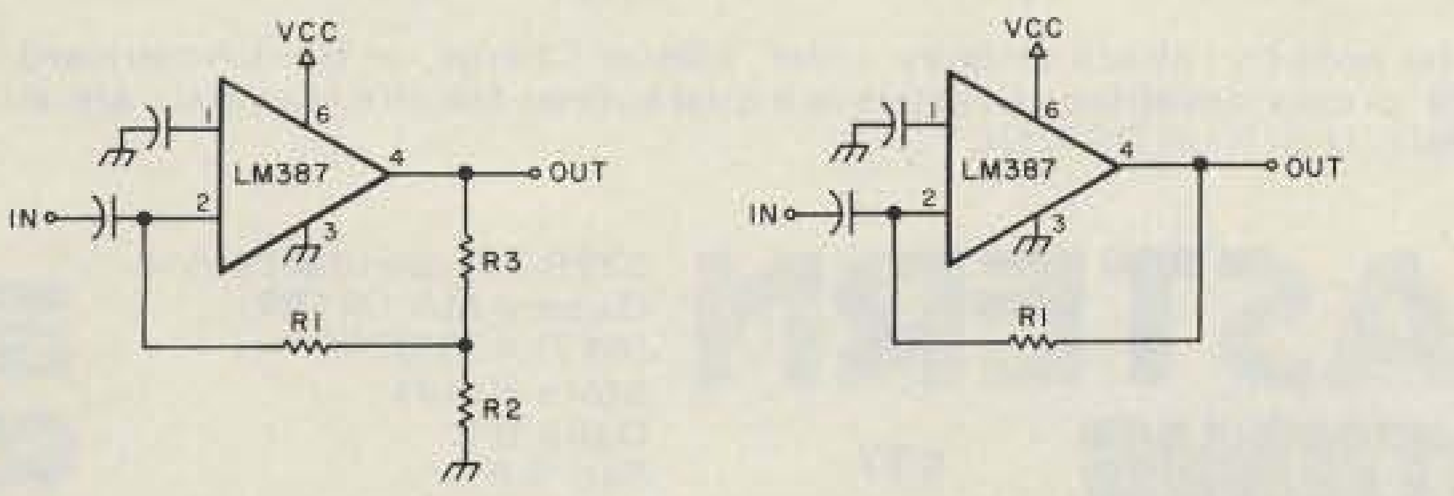


Fig. 11. Typical LM387 circuits (values same as LM381).

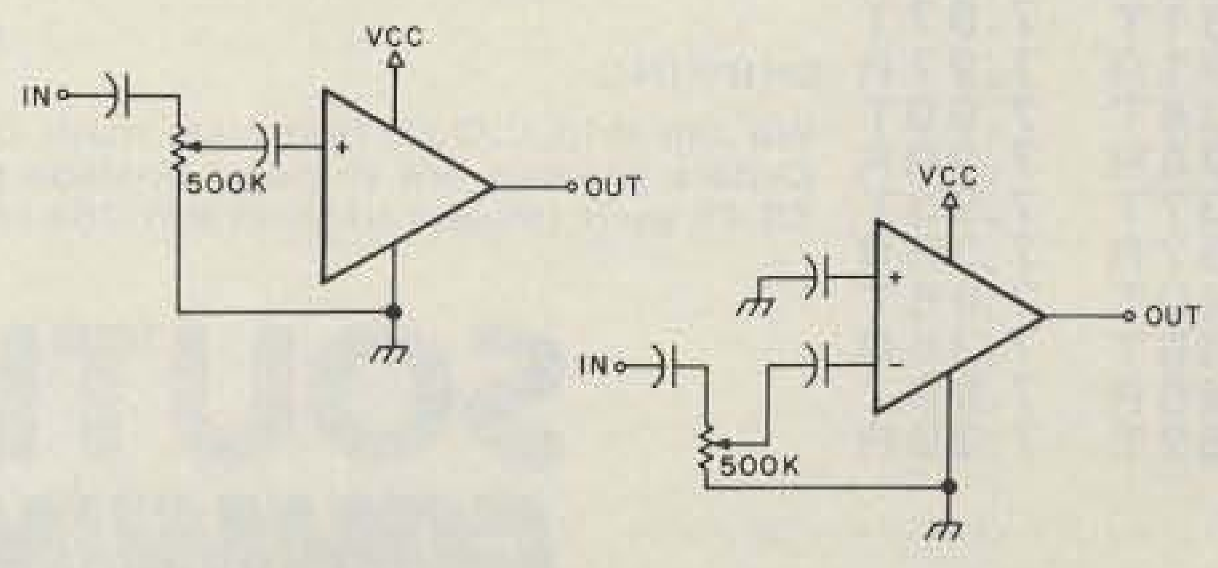


Fig. 12. Alternate volume control circuits.

to tame it a bit. For most purposes, the series control would give you the needed control. Usually all that is needed is to cut down the signal some to get away from the overload problem.

It is now time to put all this into some sort of perspective. For pragmatic use, there are several factors which might indicate one circuit over another.

First, let's get rid of that extra section. Unless you need two sections, you will be left with a high-gain stage floating around on its own. This might pick up something and send it off as an amplified signal which could get into other circuits. Just short the two differential inputs together. That should do it.

There is one basic choice to keep in mind. How are you going to power the circuit? If it is by ac, you will have no voltage stability problems that should make any real difference. You will have a constant or regulated voltage, unless there is trouble in the power supply section.

If you are going to use batteries, you may want to pick and choose,. An auto battery is nominally 12 volts, usually 13.5 or so, well within the design center.

Under normal conditions, its voltage will stay within a few volts of that. However, as you get near ten volts, you may start to have circuit problems.

The normal nine-volt transistor radio battery is the real stinker. It only stays at nine volts for a while, then it drops. When that transistor radio battery begins to drop, only the wide-voltage-range circuits will still function well below nine volts.

You will lose a little gain and output voltage with the wide-range circuits, but these figures should be viewed in the perspective of the next stage which would normally follow.

The LM380 power amplifiers only need about 0.5 volts rms before they are overdriven. The 2-3 volts p-p that the preamps give is more than enough for the power stage.

Also, most of the power amps cut off at nine volts anyway. The LM380CN mini-DIP one will work at nine volts but not much less.

As a general rule, use the least gain you can to do the job. There's less chance of hum or instability. The power amp is going to amplify whatever it gets.

The need for high-gain audio stages is not that common in ham gear. The output from most detectors would be enough to drive the power stage, and more preamplification would just cause distortion.

The most logical thing for a preamp would be as a mike amplifier to feed a power amplifier or as part of a transmitter circuit. However, there might be other applications where some extra gain is needed and one of these ICs will do the job.

If you are experimenting, I would recommend using a scope to see what you are getting. Much distortion that shows on the scope may not be that apparent just listening.

Use the schematics and their captions to pick a circuit which fits your requirements. Remember that there will be some variation between devices, and if you substitute values. You may not get the exact performance as shown.

What it adds up to is that there are a few reliable preamp circuits that you can use. The LM382 is a washout for experimental use, but the LM381 and LM387 appear to be reliable circuits when used within their breadboard limitations. ■

References

1. *Linear Integrated Circuits*, National, Feb., 1975, pp. 5-45 to 5-50 and 5-55 to 5-58.
2. *Linear Applications*, Volume I, National (Radio Shack), Feb., 1973, section AN-64.

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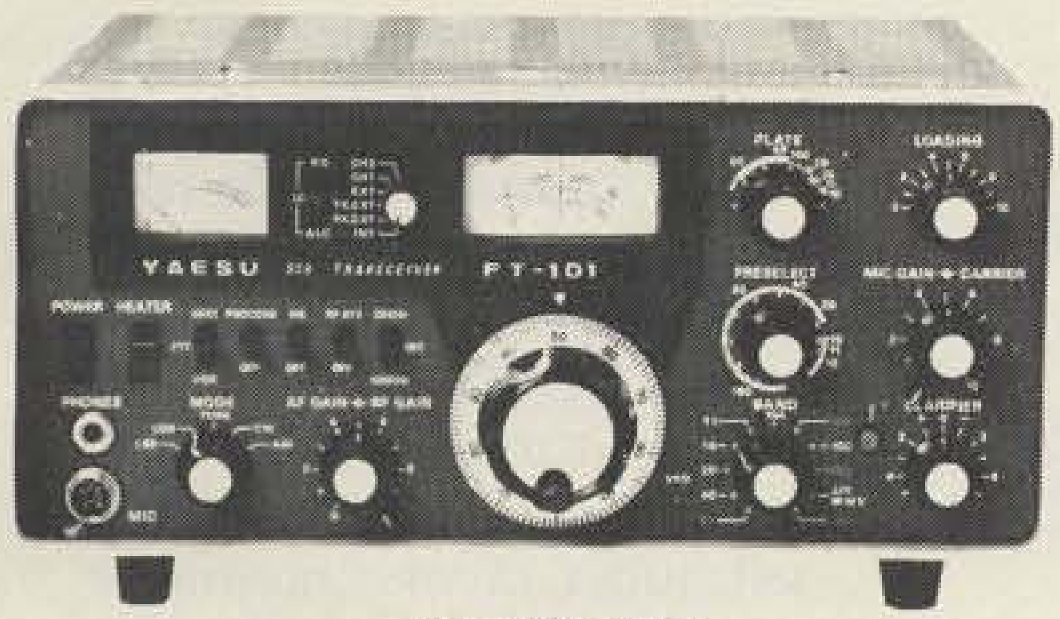

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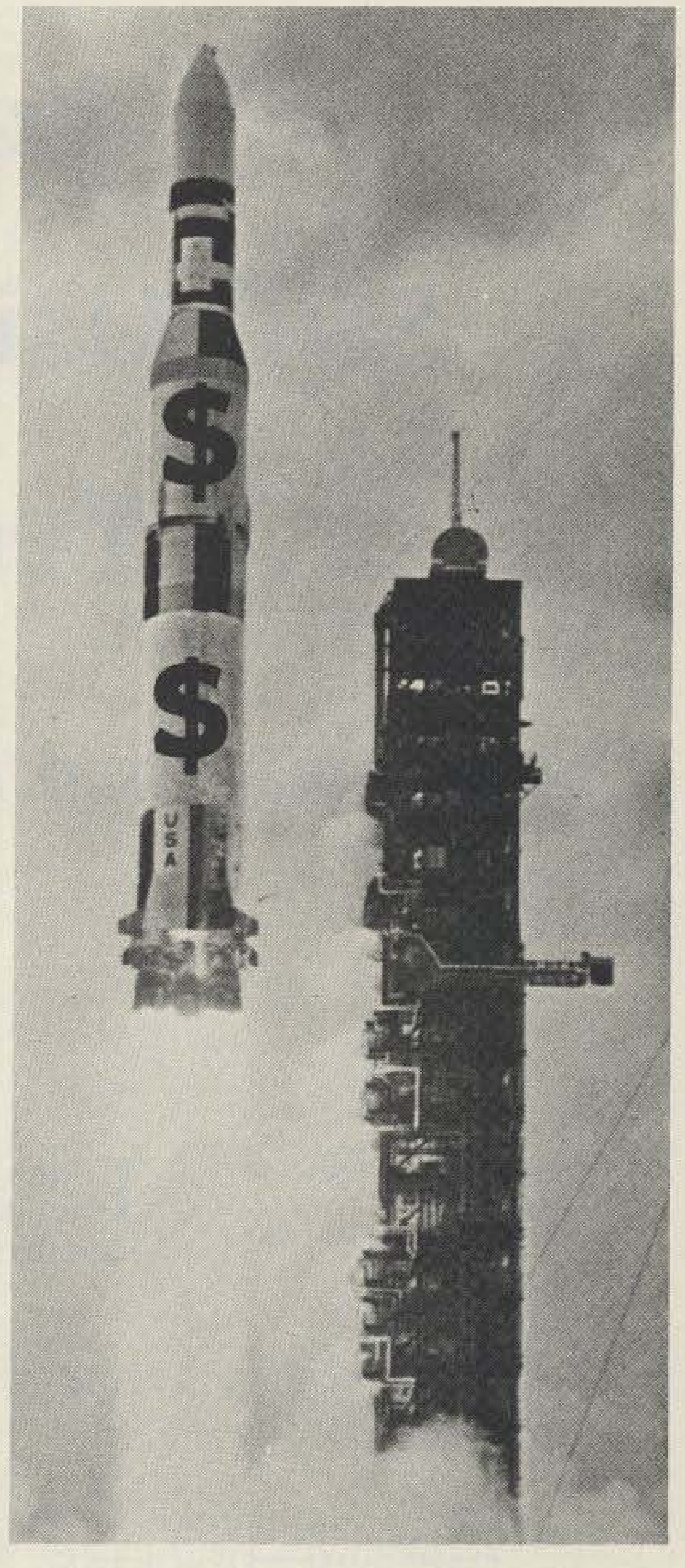

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In this day and age, tubes are obsolete, let's face it. Even the lowest power receiving tube requires at least a Watt just to light the heater — enough power to operate

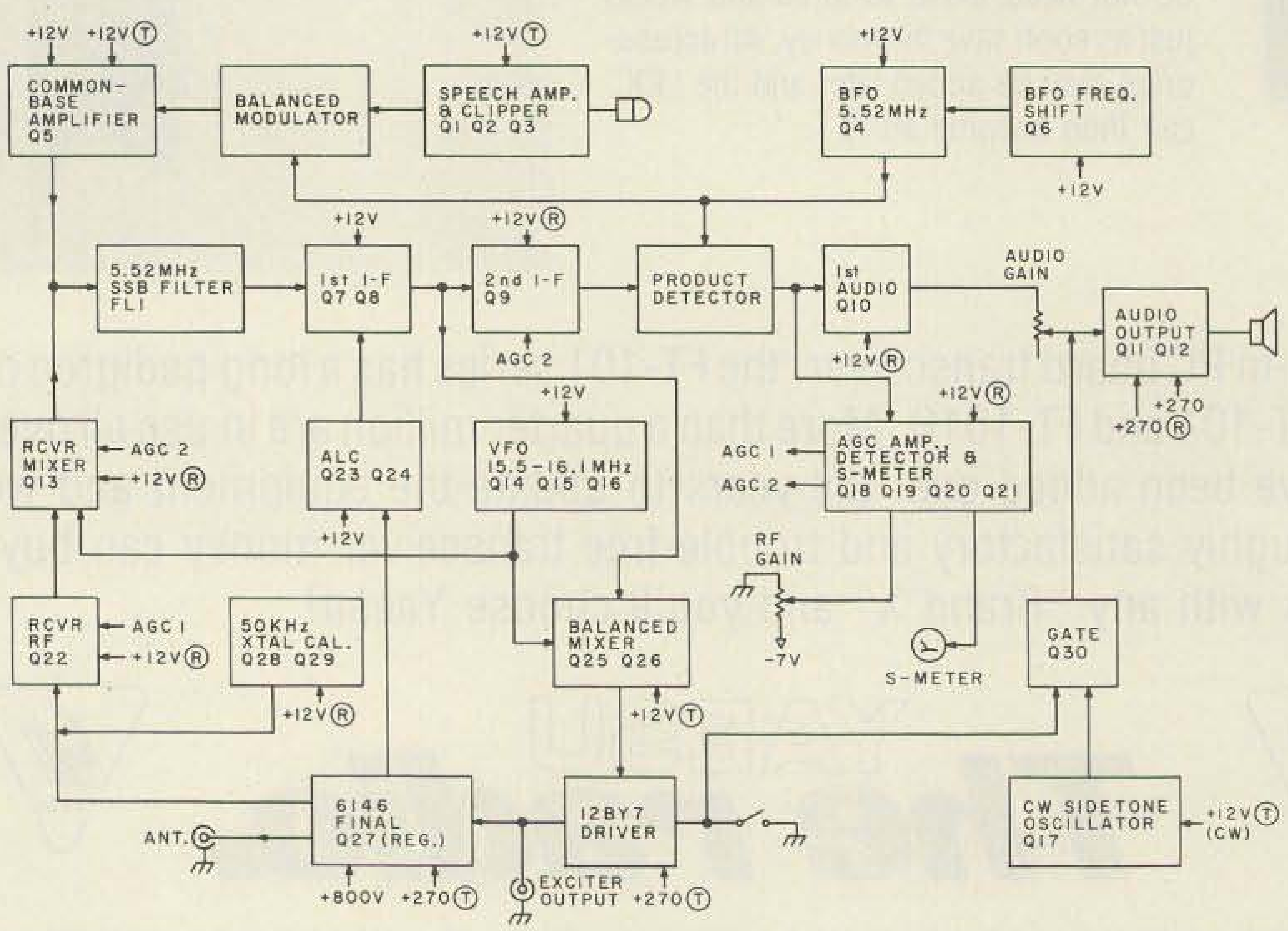


Fig. 1. Block diagram of the modified Swan. Supply voltages labeled "T" are present only on transmit. Voltages labeled "R" are present only on receive.

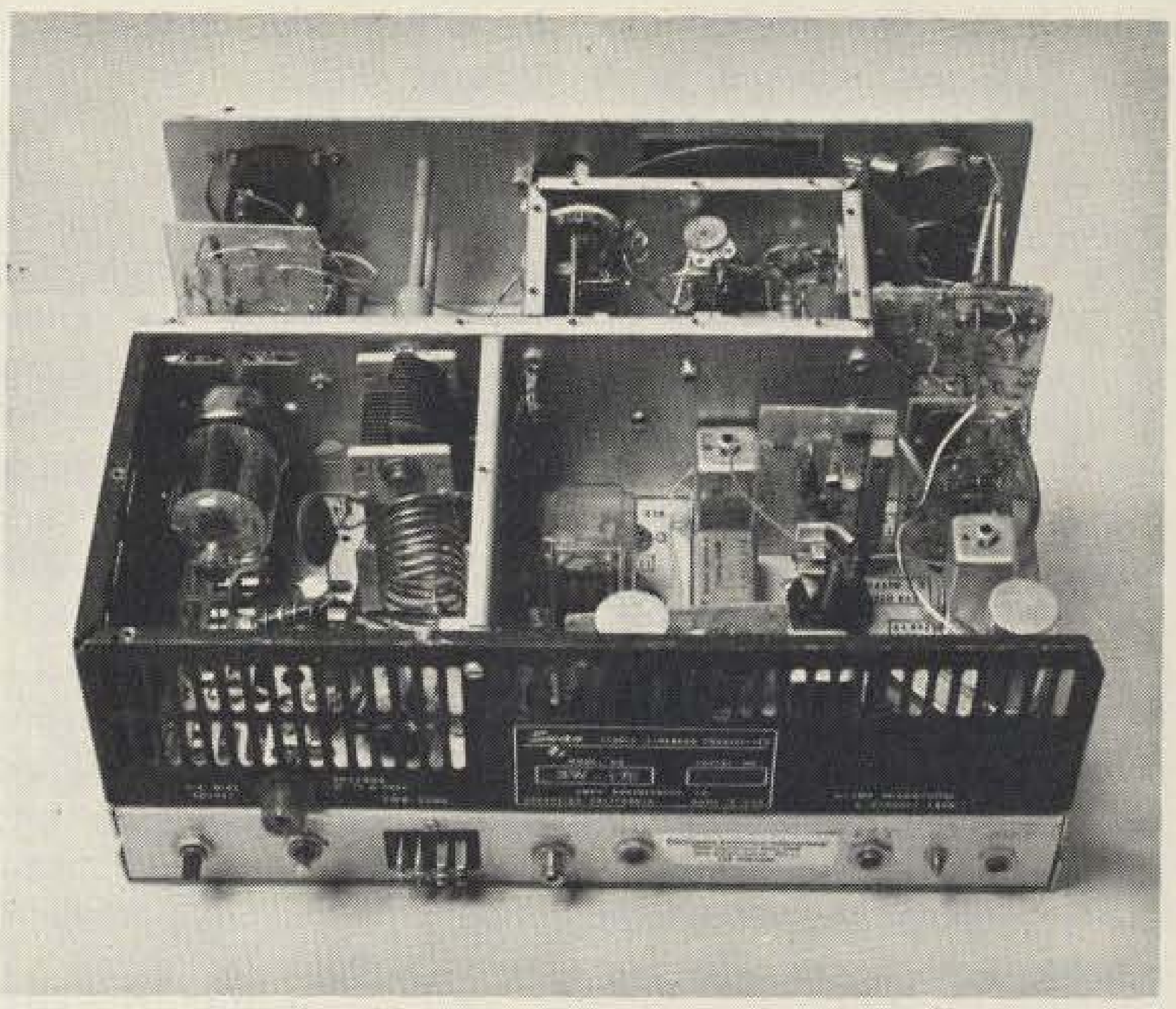
more than 100 low-level transistors. The power consumed by tubes is all wasted in the form of heat, and the resulting temperature rise creates a number of problems, such as frequency drift and component aging. In addition, tubes nowadays are expensive and have a finite life expectancy, whereas transistors are immortal (theoretically, if not abused) and can be had for as little as 3¢ each. With the advent of the triode JFET and dual-gate MOSFET, it is now easy to replace every small-signal vacuum tube in your transceiver with only relatively minor circuit changes.

The early Swan single-banders were among the first SSB transceivers on the market, and, of course, used vacuum tubes throughout, even for low-level audio stages. In this SW-175, I did not go 100% solid state, but left tubes in the transmitter driver and final stages. It would have been possible to transistorize these stages, as well. A transistor final would have the advantages of no tuning and potentially better linearity, but the disadvantage of requiring a well-matched low-swr load. In addition, rf power transistors are still not quite as cheap as equivalent-power tubes, and, as every experimenter has found out, transistors are very unforgiving about mistakes. A wrong connection or voltage spike can wipe out an expensive power transistor in a millisecond, whereas tubes can take minutes, or even hours, of abuse without failure.

Probably the easiest way to transistorize your rig is to proceed one stage at a time, as this allows you to be sure the stage you replace is working perfectly before you go on to the next one. Any single down time will be minimized, so you will not be kept off the air while you are gradually making the transition.

Of course, we must be somewhat cognizant of the

The front panel of the modified Swan retains much of its original appearance. The S-meter is mounted on an aluminum plate which covers the large hole left from removal of the original meter.



In this view, the final amplifier and vfo cover plates have been removed. The ALC circuit board can be seen between the 6146 and the S-meter. The vfo range switch, S1, is visible in the upper left corner of the vfo box. To the right of the vfo box is the agc circuit board.

different signal levels and different impedance levels of tubes versus transistors. To replace tubes with FETs will usually require only minor circuit modifications, whereas the impedance level of bipolars will demand more radical circuit redesign. But, even with bipolars, it is no big hassle. In this transceiver, both FETs and bipolars were used. 14 tubes were replaced with 31 transistors, but some of these transistors were used for new features not present in the original version.

In many cases, you can use the empty tube sockets as tie-points for your transistor circuits. I did this in the receiver rf and mixer stages, the bfo, the first i-f stage, and the audio stages. In other places, I made up small circuit boards of flat Alsinite. This is a translucent plastic-fiberglass material sold in sheet form at most building-supply stores. Alsinite will not melt at soldering iron temperatures, and it has the further advantage of being translucent, which makes it possible to see component locations from the reverse side of the board. Components are easily mounted by drilling small holes and poking the leads through.

The Swan 175, 140, and 120 models are almost identical single-conversion transceivers covering 75, 40, and 20 meters, respectively. I had little interest in 75 meters, but I did need a low-power SSB transceiver primarily for use with a 2 meter transverter. The original coverage of 3.8 to 4.0 MHz was too low in frequency for two meter transverting, so consideration was given to moving the transceiver frequency up to either 20, 15, or 10 meters. Of these three bands, I enjoyed operating on 15 and 10 much more than 20, but, on this part of the sunspot cycle, 10 is pretty dead. Also, it would have been hard to make the Swan vfo cover more than a small part of the 10 meter band. This left 15 meters as the best choice. The original tuning dial covered only 200 kHz, and, since I wanted full coverage of 15 meters, I added a range switch to the vfo so that 21.0 to 21.6 MHz could be covered in three 200 kHz segments. This gave more than full coverage of 15 meters and also made it possible to cover 144 to 145.2 MHz by switching between two crystals in the two meter transverter.

Block Diagram

A block diagram of the modified transceiver is shown in Fig. 1. I wanted many features not present in the original Swan, such as agc, S-meter, ALC, and CW capability, which called for a bit more complexity. Most of the blocks in Fig. 1, however, correspond to some stage in the original transceiver, and, since I replaced most stages one at a time, the physical layout is much the same.

The original 4-pole crystal filter on 5500 kHz has been replaced with an Atlas 8-pole filter on 5520 kHz. These filters are available from Atlas Radio for $36.40, including bfo crystals.[1] It was not absolutely necessary to replace the original filter, but the new filter gives markedly improved performance.

I replaced the 6DQ5 final with a 6146, mainly with a view toward eventual mobile operation. For mobile, the 6DQ5 presents a heater problem, since there is no 12-volt version, although there is a 12-volt equivalent of the 6146 – the 8032. The 6DQ5 is a much more powerful tube, however, and it will deliver 150 Watts CW – about 3 times as much as the 6146.

Included in Fig. 1 are the voltages supplied to each stage. Voltages suffixed with an (R) or (T) are only present in receive and transmit modes, respectively. Voltages without a suffix are present in both modes. Switching is accomplished with the original 3-pole double-throw 12-volt relay.

Vfo

For 15 meter operation, the vfo frequency must be moved up from 9.3 to 15.5 MHz. Since the modified vfo then operates on the low side of the signal rather than the high side, the transceiver will function on upper sideband with the original bfo crystal. The 3-position vfo range switch is mounted in the upper right-hand corner of the vfo shield box, and the shaft protrudes through the hole formerly occupied by the dial light.

The modified vfo circuit, shown in Fig. 2, uses many of the original components. All vfo componennts to the right of C1 in Fig. 2 are mounted on a small Alsinite circuit board which, in turn, is located in the space formerly occupied by the 12AU6 oscillator tube. The original vfo coil, L4, was reduced to 7 turns, which gave it an inductance of 1.4 μH and a measured Q of 253 at 16 MHz. The two small range-switch coils, L1 and L2, are air wound and are mounted by their leads on S1. These coils are adjusted by squeezing or spreading the turns. When properly adjusted, this range-switching method provides exactly 200 kHz coverage on each range, and dial calibration comes out right on the nose. Voltage stability of the vfo has proven to be excellent; a 20% supply-voltage change moves the vfo frequency only 65 Hz.

There is some interaction between the different vfo adjustments, but, generally speaking, the function of L3 is to set the oscillator to frequency, and the tuning range is controlled by the two trimmer capacitors, C2 and C3. A 5.5 MHz trap, L8 and C4, is used on the vfo output to prevent any i-f signal from the transmitter mixer leaking back into the crystal filter through Q13.

Receiver

Fig. 2 also shows the receiver front-end circuits. The received signal is taken directly off the final tank circuit through the 3.3 pF coupling capacitor, C12. The back-to-back diodes, D1 and D2, limit the amount of rf transmitter voltage at the receiver input to a few volts. The transmit signal is further attenuated by diodes D3 and D4, which are biased into conduction in the transmit mode by the OA2 regulator tube current.

A broadband 21 MHz bandpass filter, made up of L6 and L7, is used between the rf and mixer stages for good i-f and image rejection. Notice that the lower end of L7 is bypassed to ground through the trimmer capacitor, C5. This capacitor is adjusted to series resonance with L7 at the image frequency of 10.3 MHz and effectively shorts out the image signal. With this technique, receiver image rejection measures 105 dB. Perhaps that's more than will ever be needed, but signals in the 10 MHz region become extremely strong at times, and it's good to have ample rejection.

The output of the mixer goes to T1, the original first i-f transformer, and to the crystal filter through the capacitive divider, C6 and C7. Diode D5 acts as a switch to disconnect the mixer from T1 when in the transmit mode. The other winding on T1, which originally went to the 7360 balanced modulator, now forms the collector tuned circuit for Q5 and couples in the transmitter DSB signal from the balanced modulator.

Referring now to Fig. 3, the i-f signal proceeds through the crystal filter, FL1, the first i-f stage, consisting of the emitter-coupled pair, Q7 and Q8, and on to the 40673 second i-f stage. A dual-gate MOSFET was used for the second i-f because strong signal-handling capacity is important at this point. Output from the 40673 is coupled to the product detector through T3, which is the original T3 modified by winding a 6-turn link on the bypassed end of the coil form.

The product detector is an adaptation of one first described in 1965; this circuit is also now being used in the Drake R4B receiver.[2] Audio from the product detector drives the first audio stage, Q10, as well as the agc amplifier, Q18 and Q19. The original Swan did not have an audio gain control, but, since I consider separate audio and rf gain controls essential in any receiver with an S-meter, I added an extra gain control for this purpose and mounted it in the hole formerly occupied by the receive-transmit toggle switch. This switch seems pretty much redundant, since the microphone push-to-talk switch does the same job.

The audio output stage is

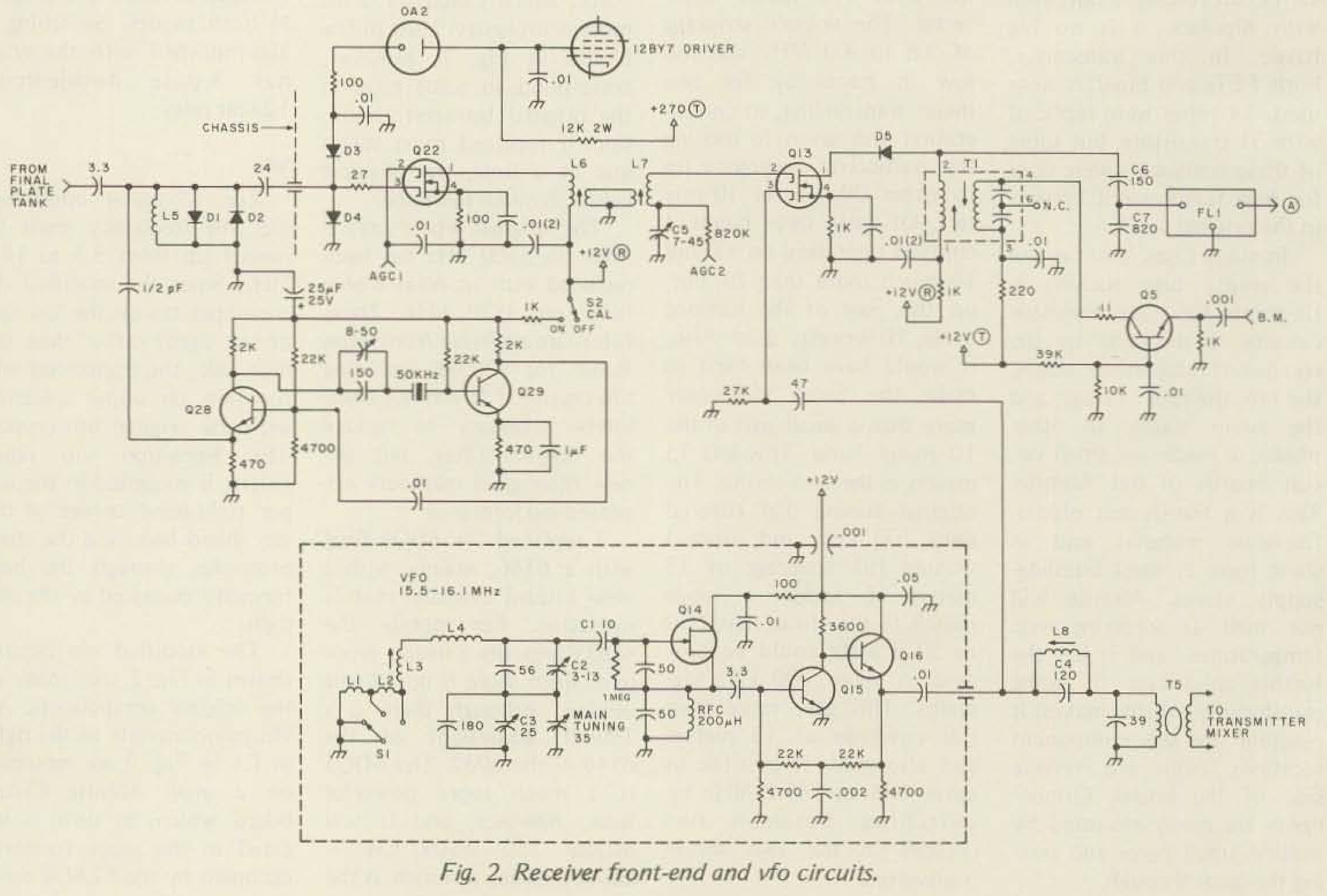


Fig. 2. Receiver front-end and vfo circuits.

unusual in that it is powered by +270 volts. This stage was originally a 6V6 and was the first tube to be replaced with transistors. Normally, transistor audio output would be class B and would be powered from the 12-volt supply. However, a class A output stage, although not quite as efficient, has the advantage of being a constant load on the power supply. It also minimizes the 12-volt power requirements. The maximum 12-volt drain for the entire transceiver is only 37 mA. The 2N3439s are rated at 350 volts collector-to-emitter breakdown, so two are used in series. This also helps reduce the collector dissipation, although it is still necessary to heat sink these two transistors. The original output transformer, T4, provides a good match to an 8-Ohm speaker.

Agc and S-Meter

I wanted a good fast-attack/slow-decay agc system, and the circuit shown in Fig. 3 has worked well. Transistors Q18 and Q19 form a conventional audio amplifier and drive the agc rectifier, D10 and D11, through transformer T7. Transformer coupling may not be absolutely necessary at this point, but it does facilitate full-wave rectification, which helps to minimize the rise time. The transformer, a UTC Ouncer, is surplus; originally it was a 400 Hz, 115 V to 115 V c-t device, but anything with approximately the right turns ratio and sufficient primary inductance can be used for T7. The agc decay time is determined by the time constant of C8 and C9 (2 μF total) discharging through R1 and R2. This fixed-time constant of two seconds is about right for me, but it could be made variable by switching different resistance values from the agc line to ground.

Transistors Q20 and Q21 are used to drive the S-meter. The original cathode current meter could not be used for an S-meter since it was 300 mA full scale; it was replaced with a Micronta (Radio Shack) 0-1 mA S-meter. The S-meter also doubles as the final amplifier cathode meter and circuit values are chosen so that its 0 to 10 scale corresponds to 0 to 100 Watts input.

Notice that full agc voltage is applied only to the rf stage, Q22; the mixer and second i-f stage receive half voltage (agc #2). Agc performance is plotted in Fig. 4. For signals stronger than 1.2 microvolts, a 100 dB range of input signal causes less than a 10 dB change in audio output.

Switch S6 serves as an mgc-agc switch. In the manual-gain position, the meter still reads the output of the agc detector, but, since agc is not functioning, the S-meter reading will be approximately proportional to signal strength, rather than a logarithmic response. This is a handy feature for precise peaking of antennas, VHF converters, receiver alignment, etc.

Speech Amplifier and Balanced Modulator

According to the *ARRL Handbook*, 12 dB of audio speech clipping will give a 3 dB improvement in SSB signal-to-noise ratio. That's a very cheap and simple way to double your talk power, although admittedly not as effective as speech processing.

Fig. 5 shows the speech amplifier and balanced modulator circuits. The speech amplifier, Q1 and Q2, is designed to accommodate either high-impedance dynamic or ceramic microphones. Low audio frequencies are attenuated by the small values of capacitors C10 and C11, and audio clipping is accomplished by the back-to-back

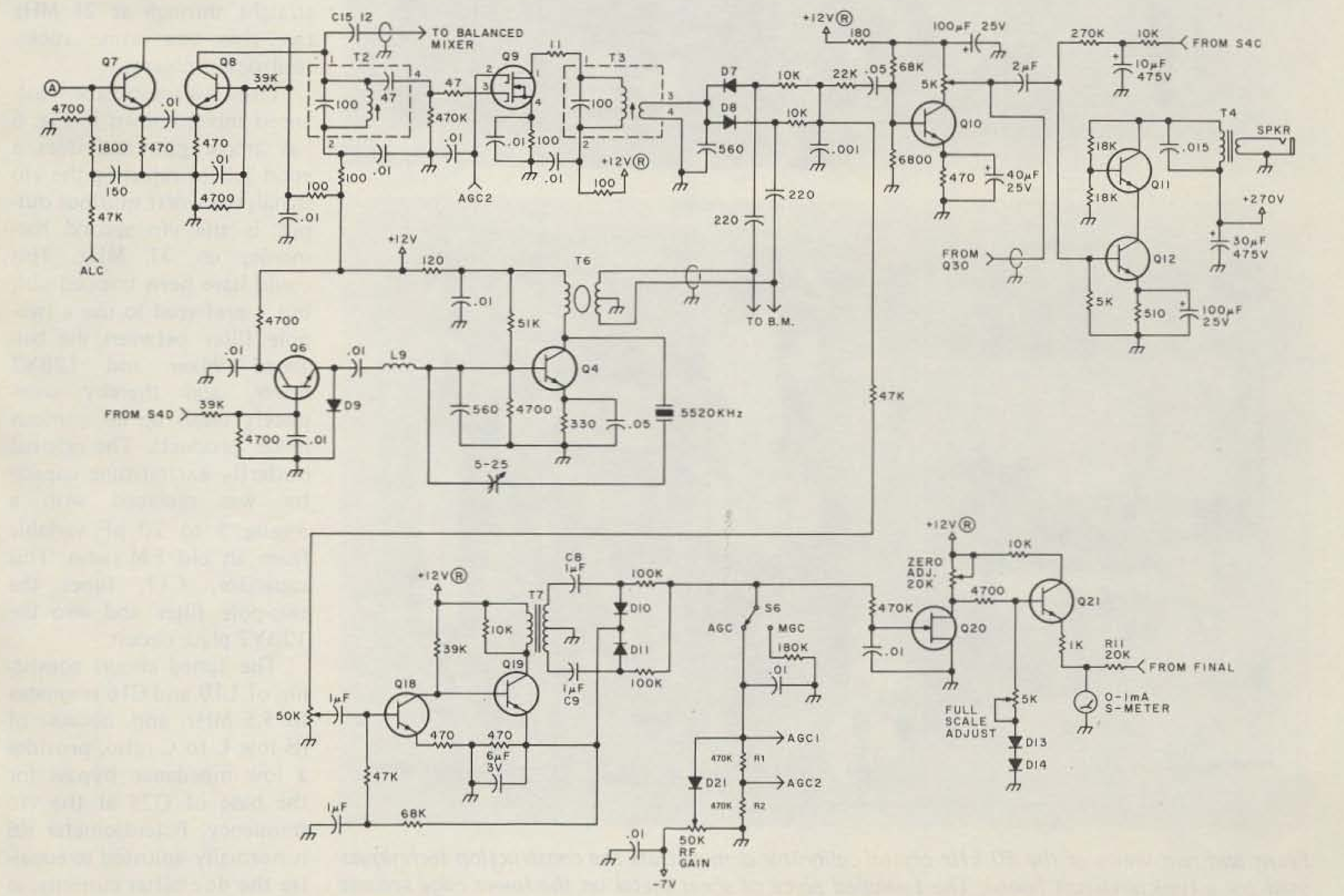


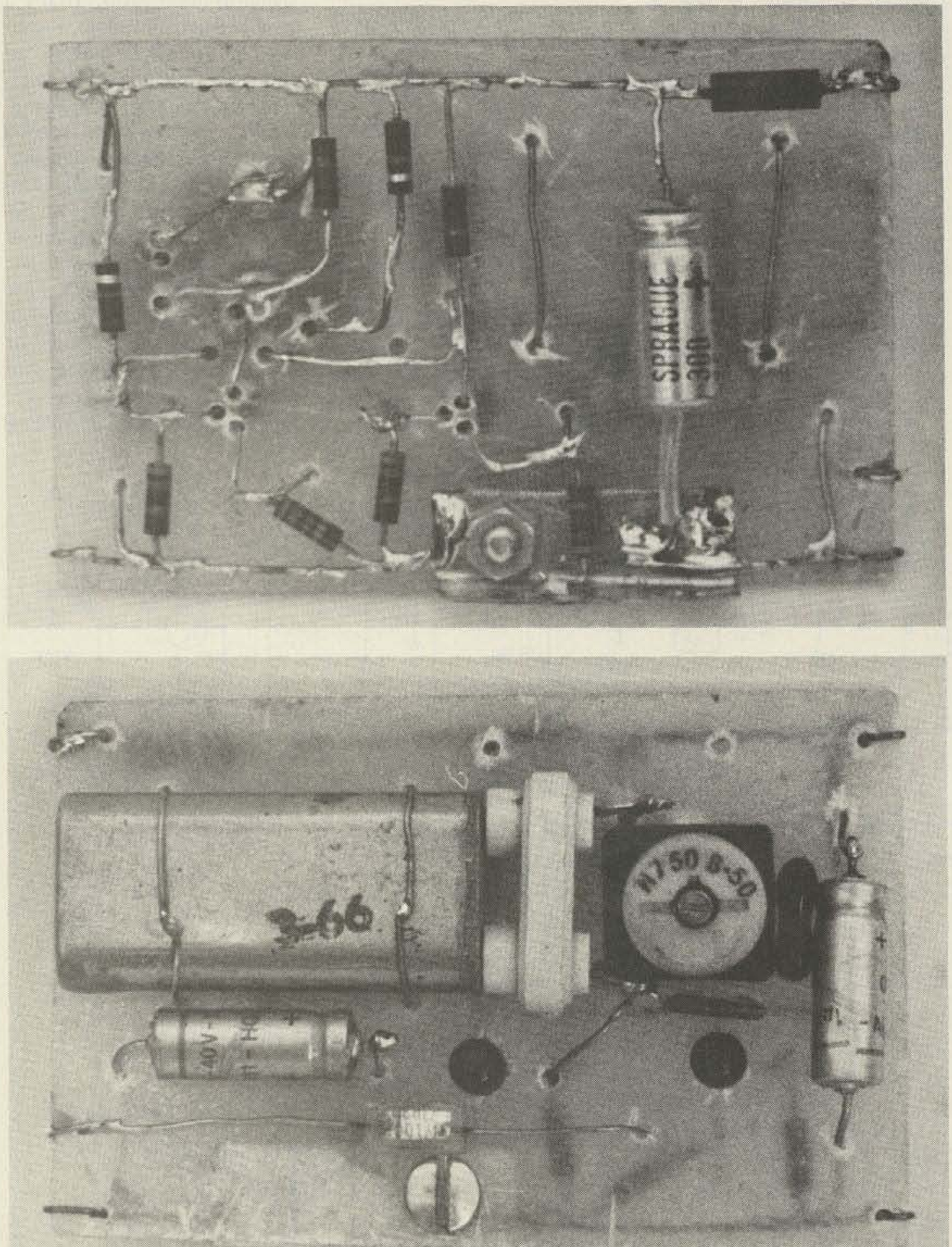
Fig. 3. Final stages of the receiver showing bfo, agc, and S-meter circuits.

diodes, D15 and D16. There is no gain control ahead of the clipper; clipping level is controlled by the distance between the operator and the microphone.

Several balanced modulator circuits were tried, but the simplest turned out to be the best. The bfo supplies push-pull drive to both the balanced modulator and the product detector from T6. The first version of this balanced modulator used 1N270 germanium diodes, but there was trouble with temperature drift of the carrier balance until they were replaced with silicon diodes. If you use the Atlas filter, you can replace the 1k pot, R3, with a pair of matched 500-Ohm resistors and still get more than enough carrier rejection with the front-panel carrier-balance control. This control, incidentally, could well be removed from the front panel, since it rarely needs adjustment.

The grounded-base stage, Q5, is needed more as an isolating switch than as an amplifier. In the receive mode, any bfo signal leaking through the balanced modulator would otherwise be amplified by the i-f stages and would unbalance the product detector. Switching is accomplished by removing the supply voltage from Q5 during receive.

The 5.5 MHz DSB signal is applied to the SSB filter through T1, the original first i-f transformer, connected as shown in Fig. 2 and Fig. 5. The DSB signal level can be adjusted by detuning Q5's collector tuned circuit in T1. The SSB signal from the filter is amplified by the first i-f stage, Q7 and Q8, and applied to the transmitter mixer through C15.



Front and rear views of the 50 kHz crystal calibrator demonstrate the construction techniques used for a typical circuit board. The L-shaped piece of sheet metal on the lower edge secures the board to the chassis and also serves as ground connection.

Balanced Mixer, Driver, and Final

For the transmitter up conversion, I wanted to use a balanced-type mixer in order to reject the 16 MHz vfo signal. I first tried a commercial ring-modulator type of double-balanced mixer, but I found that it required quite a bit of vfo drive (+7 dBm) and also suffered from too much conversion loss. The weak output required an additional amplifier stage to drive the 12BY7, and three stages straight through at 21 MHz can give you some sticky feedback problems.

The two-transistor balanced mixer shown in Fig. 6 has ample gain and does a good job of rejecting the vfo signal; the worst spurious output is the vfo second harmonic, on 31 MHz. This could have been trapped out, but I preferred to use a two-pole filter between the balanced mixer and 12BY7 driver, and thereby completely clean up all spurious mixer products. The original butterfly exciter-tune capacitor was replaced with a 3-gang 5 to 20 pF variable from an old FM radio. This capacitor, C17, tunes the two-pole filter and also the 12BY7 plate circuit.

The tuned circuit consisting of L10 and C16 resonates to 5.5 MHz, and, because of its low L to C ratio, provides a low-impedance bypass for the base of Q25 at the vfo frequency. Potentiometer R6 is normally adjusted to equalize the dc emitter currents, as measured with a VTVM across the matched resistors, R4 and R5. If you are a perfectionist, you can adjust it for minimum vfo feedthrough to the driver, but it will do nothing for the second harmonic on 31 MHz. I used a toroid for T5, but you could probably get by with an ordinary solenoid-type transformer, at this point.

The driver requires neutralization, which is accomplished through C18, and, because of the 12BY7's high transconductance, neutralization is a bit critical. Properly neutralized, it will be possible to tune C17 throughout its range without any sign of instability.

A link on L13 connects to a phono jack on the rear apron of the chassis to provide exciter output for VHF transverters. Driver output is about a quarter Watt, and the vfo signal at this point measured 62 dB below peak output. The vfo second harmonic on 31 MHz measured 55 dB down. When the rig is used with a transverter, the 6146 heater is switched off by a toggle switch (S5) which is also located on the rear apron.

Cathode bias was chosen for the final to eliminate the need for an additional supply voltage and also to simplify the ALC circuit. Cathode voltage is held to a fixed value by the transistor regulator, Q27. Base voltage on Q27 is adjusted with the original 5k bias-adjustment pot, R9, and is regulated by an NE-17 neon bulb, although a 60-volt 1-Watt zener diode would work just as well.

The 7.3-volt zener in series with the emitter of Q27 reduces the collector-to-emitter voltage and heat dissipation of this transistor. Collector dissipation is further reduced by R10, and this resistor also provides a sampling voltage for driving the cathode current/S-meter through R11. Because of the S-meter's low resistance of 100 Ohms, the cathode current circuit does not interfere with the S-meter function, nor vice versa.

Screen-grid neutralization is used on the 6146, as this is a bit simpler than the original bridge-type neutralization and works fine in a single-bander. The original plate-tuning and loading capacitors are used in the final amplifier plate circuit, but the parasitic suppressor, plate current rf choke, and tank coil have been changed. Notice that the high-voltage lead to the 6146 plate is double filtered inside the final amplifier compartment; this was necessary to prevent rf feedback to earlier stages.

ALC

Automatic level control is derived from the 6146 grid current. When the 6146 heater is switched off, grid current is simulated by diodes D19 and D20. In either case, a voice peak will cause grid current (or diode current) to flow into the base of Q23, which will cut off collector current and allow C20 to charge through R7 and D21. This results in a positive gate voltage on Q24, which will reduce its drain voltage and lower the forward bias on the first i-f amplifier, Q7, thus reducing i-f gain.

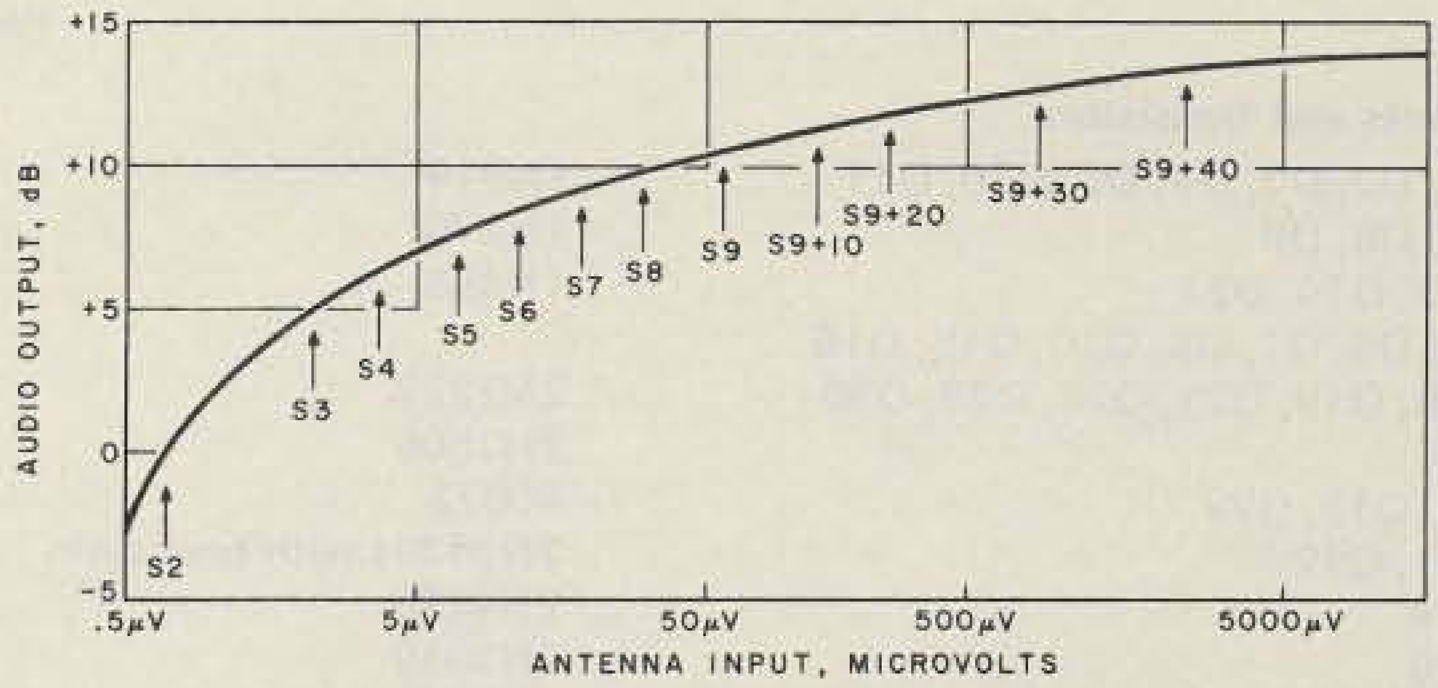


Fig. 4. Agc performance and S-meter response of the transistorized Swan.

The charge on C20 is retained after the voice peak, because D21 is then reverse biased, and C20 gradually discharges through R8 and allows the i-f gain to slowly build back up. The action is very similar to fast-attack/slow-decay agc. The LED in the source lead of Q24 is mounted on the front panel just below the S-meter; this LED will flash a warning if a voice peak causes any grid current to flow. The ALC range is about 15 dB. It could have been made greater, but, if the mike gain is adjusted so that a flash occurs on only occasional peaks, flat-topping will be adequately prevented.

Because of the very wide range of I_{dss} for JFETs of any given type, the zener voltages of the two zener diodes associated with Q24 will have to be individually selected. The values given in Fig. 6 worked with my particular FET and can be taken as starting points, but the I_{dss} for the 2N3819 varies over a ten-to-one range. This advice also applies to the drain resistor of Q1.

CW and Switching

I wanted full CW capability with sidetone monitoring, and Fig. 7 shows how this was accomplished. For CW operation, it's necessary to shift the bfo frequency up into the crystal-filter passband in order to get enough carrier through the filter for full drive. The frequency is shifted only in the transmit

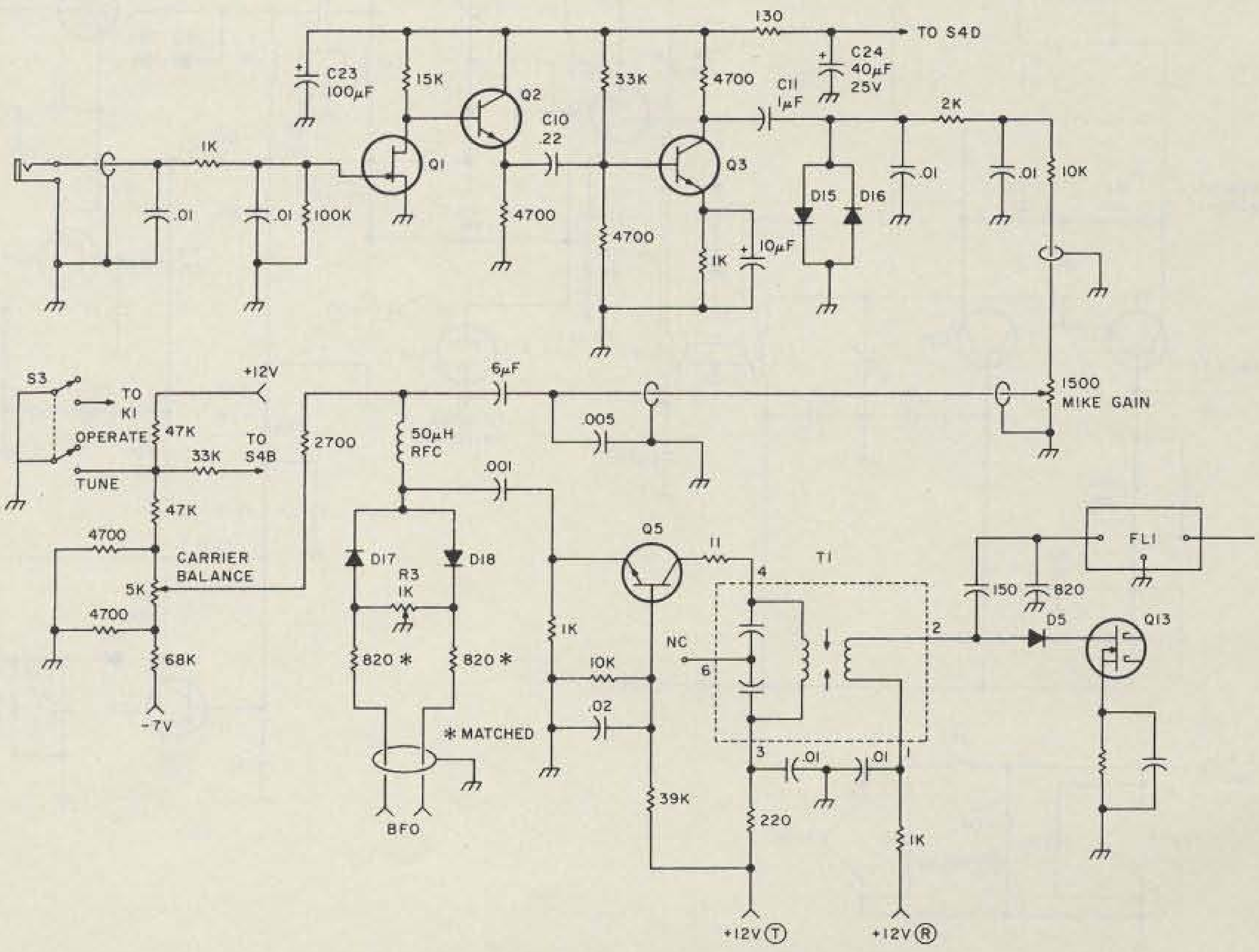


Fig. 5. Speech amplifier and balanced modulator.

Parts List

Diodes and transistors

D1, D2, D3, D4, D5, D10, D11	1N914
D7, D8, D9	1N270
D13, D14, D21	1N458
Q4, Q6, Q7, Q8, Q10, Q15, Q16	
Q18, Q19, Q21, Q28, Q29, Q30	2N2222
Q5	2N3565
Q9, Q13, Q22	40673
Q11, Q12,	2N3439s with heat sinks
Q14	2N4220
Q20	2N3819
D15, D16, D17, D18, D19, D20, D22	1N914
D21	1N458
D23	any rectifier diode
Q1	2N3370
Q2, Q3, Q6, Q23, Q30	2N2222
Q5, Q25, Q26	2N3565
Q17	2N306, or equivalent
Q27	ECG 129 with heat sink
Q24	2N3819
Q31	2N2102, or equivalent

Coil data

L1, L2	3½ turns #22 e. 1/8" i.d., 0.2" long, air wound
L3	0.32 uH, 5 turns #24 vinyl insulated, close wound on ¼" diameter slug-tuned form
L4	1.4 uH, 7 turns of 1" miniductor
L5, L14	5 uH, 40 turns #32 e. close wound on ¼" diameter form
L6	30 turns #36 s.c.e. close wound on ¼" diameter slug-tuned form, 1 turn link #24 vinyl insulated
L7	48 turns #36 s.c.e. close wound on ¼" diameter slug-tuned form, 1 turn link #24 vinyl insulated
L8	30 turns #30 e. close wound on ¼" diameter slug-tuned form
L9	2.6 H, 28 turns #30 e. close wound on ¼" diameter slug-tuned form
T6	Amidon T-50-2 toroidal core, 36-turn primary, 16-turn center-tapped secondary #32 e.
L10	16 turns #30 e. close wound on ¼" diameter slug-tuned form
L11-L12	14 turns #28 e. close wound on ¼" diameter slug-tuned form, 1 turn link #24 vinyl insulated
L13	10 turns #28 e. close wound on ¼" diameter slug-tuned form, 1 turn link #24 vinyl insulated
L14	40 turns #32 e. close wound on ¼" diameter slug-tuned form
L15	13 turns #30 e. close wound on ¼" diameter slug-tuned form
L16	70 turns #34 s.c.e. close wound on ¼" diameter form
L17	9 turns #12 bare, air wound, 1" i.d., 1¼" long
T5	Amidon T-37-10 toroidal core, 7-turn primary, 4-turn secondary
Z2	6 turns #30 e. on 120-Ohm half Watt resistor
Z3	3 turns #18 on 220-Ohm 2-Watt resistor

mode, by Q6, which is used as a switch. When S4D is turned to the CW position, the 12-volt supply is removed from the speech amplifier and applied to the base of Q6 through R13. Both Q6 and D9 are then biased into conduction, and this effectively bypasses the left end of L9 to ground. The result is an increase in bfo frequency of about 500 Hz, which puts it well within the filter passband. In the receive mode, there is no shift, so your CW signal will always be zero-beat with the station you are working, provided you tune for a 500 Hz beat note.

The same switch section, S4D, turns on the sidetone oscillator, Q17. Output from this twin-T audio oscillator is applied to the base of Q12 through capacitors C21 and C22. Cathode keying of the 12BY7 driver provides a positive key-up voltage for the base of Q30, which makes it conduct and thereby shunt the sidetone output to

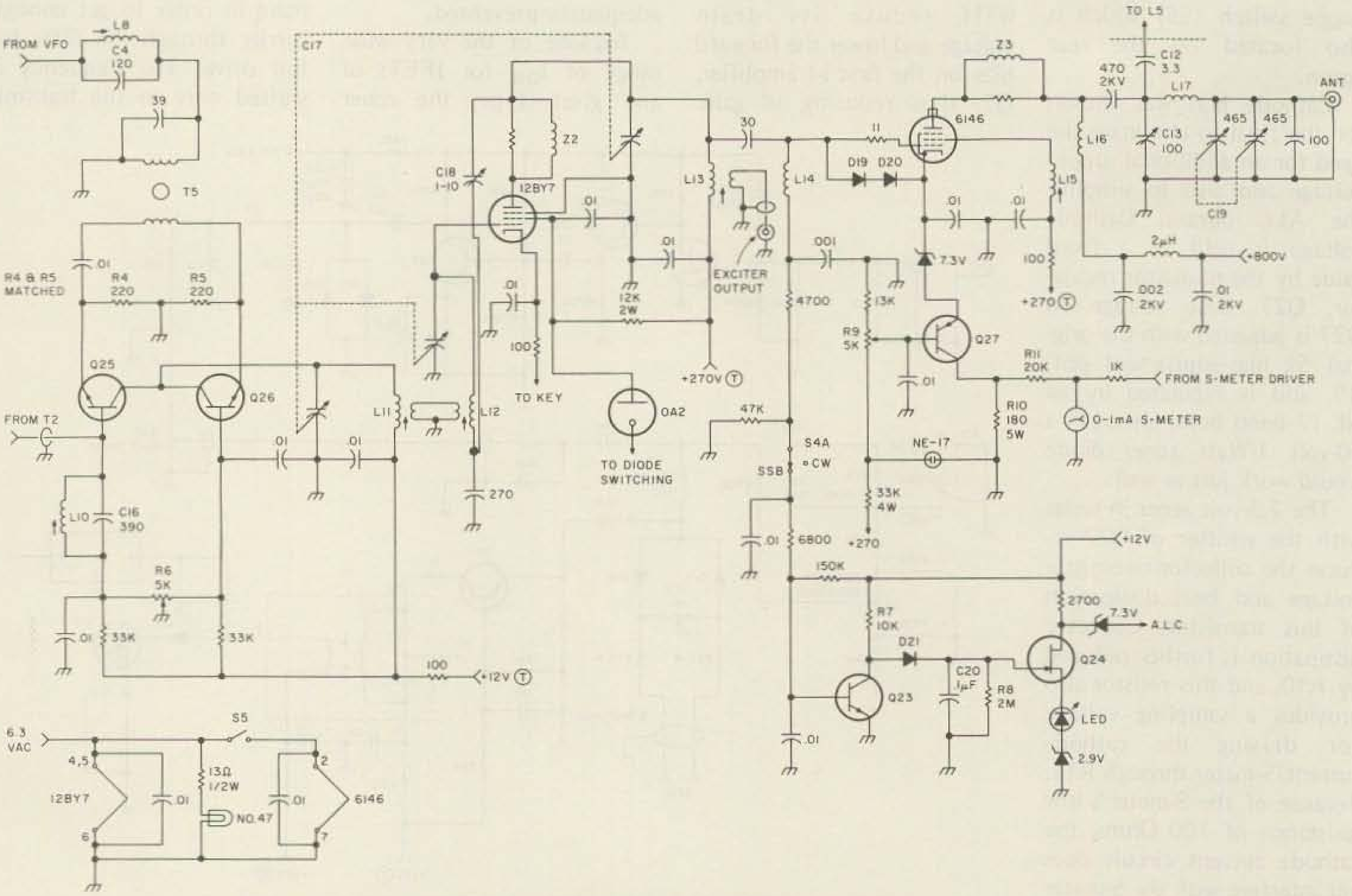


Fig. 6. Transmitting mixer, driver, and final.

ground. With the key down, Q30 is turned off, and the audio tone can reach the base of Q12.

The receiver audio gain control has little effect on sidetone volume unless it is turned all the way down. A separate volume control could have been added, but the level is about right for my ear, as is. Forward bias for the base of Q12 is provided in the CW transmit mode by S4C.

A third section of the SSB-CW switch, S4B, is used to short out the key jack in the SSB position and to severely unbalance the balanced modulator in the CW position. The fourth section of this switch, S4A, is shown in Fig. 6; this section switches out the ALC so the final can run class C for CW. The SSB-CW switch is mounted in the hole formerly occupied by the front-panel on-off toggle switch, which, I think, is more appropriately located on the external power supply.

Switch S3 is the original tune-operate switch; in the tune position, this switch actuates the changeover relay, K1, and unbalances the balanced modulator, as in the CW mode. With the original crystal filter, this switch worked fine for tune-up, but the Atlas filter has such steep skirts that very little carrier gets through, even with the balanced modulator completely unbalanced. This could be remedied by adding some additional diode switching to shift the bfo upwards, as in the CW mode, but I haven't bothered to do so.

Fig. 7 also shows the relay switching. Because there are large bypass and filter capacitors on both sides of the relay contacts, resistors are placed in series with the contacts to limit peak currents. When one capacitor is discharged directly into another, peak current is theoretically infinite. In practice, it is not infinite, of course, but it can be large enough to erode the relay contacts.

Transistor Q31 is used to

This under-chassis shot shows the 3-gang exciter-tune capacitor, C17. Above it can be seen the transmitter balanced mixer circuit board with Q25 and Q26. The trimpot on the right side of the board is R6.

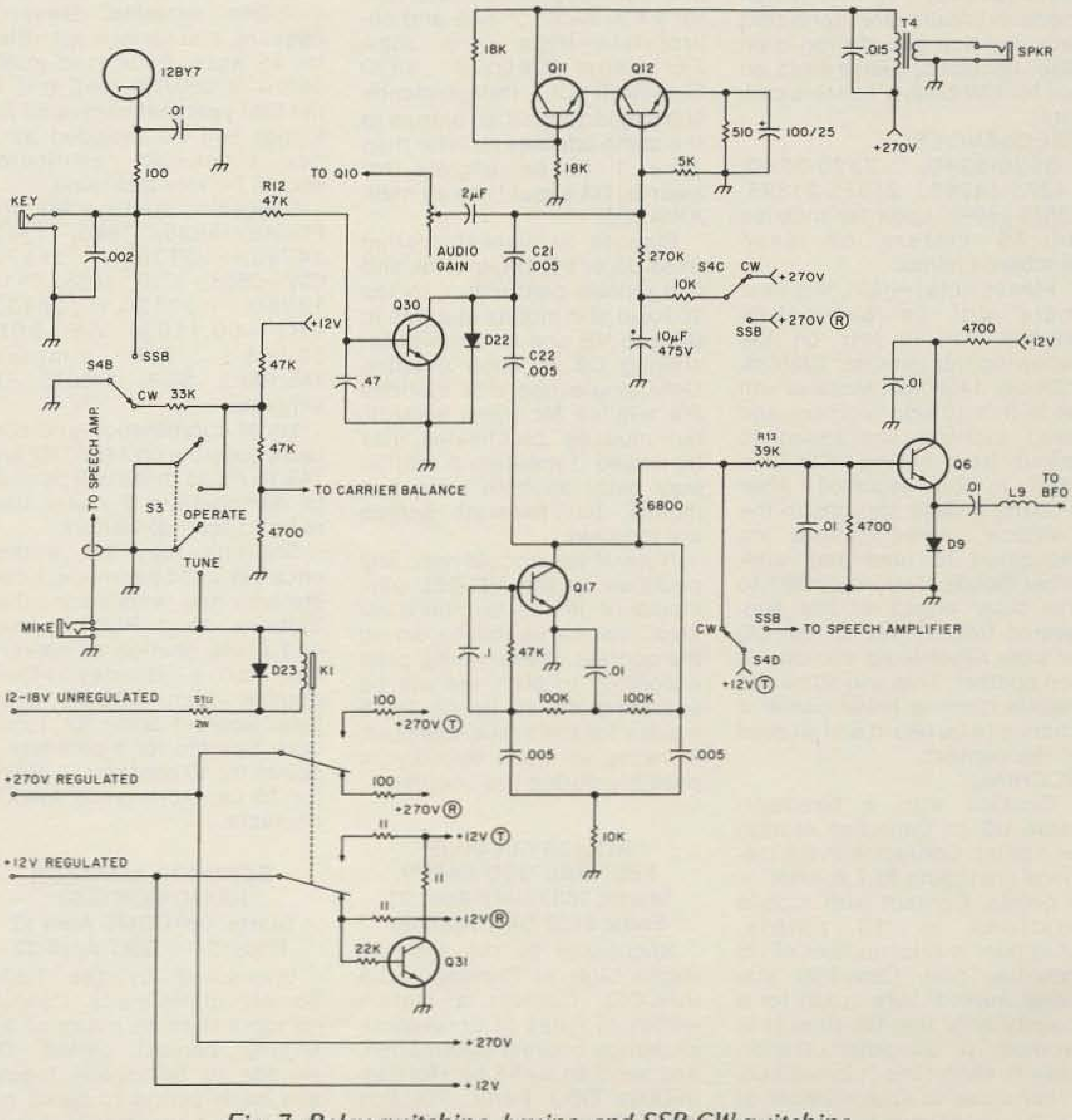


Fig. 7. Relay switching, keying, and SSB-CW switching.

quickly discharge capacitors C23 and C24 (Fig. 5) when the relay returns to the receive position. Otherwise, the speech amplifier remains activated for a brief period after changeover and causes a momentary "squeak" to occur.

Power Supply

One advantage of replacing tubes with transistors is that power supply wattage requirements are substantially reduced. Most of the power can go into the final amplifier, where it belongs, rather than into the plates and heaters of intermediate stages.

Since this final amplifier uses cathode bias, the plate and screen supply voltages should be about 50 volts higher than what they would be with grid bias. The final plate needs about 800 V at 100 mA peak, which can be handled by an old TV transformer and solid state bridge rectifier. Maximum drain on the 270-volt supply is 40 mA; in my case, this is regulated by a 6SJ7/6L6 combination.

The maximum current drain on the 12-volt supply is also only about 40 mA, and regulation can be handled by a small TO-5 transistor. A separate, unregulated 12- to 18-volt input for the changeover relay was provided in order to minimize the drain on the regulated 12-volt supply. This voltage can be taken off the 12-volt supply at a point between the rectifier and the regulator.

The other supply requirements are 6.3 V ac at 2 Amps for the heaters and dial light and -7 volts at 0.2 mA for the rf gain and carrier balance controls. The latter voltage can be easily obtained by rectifying and filtering the 6.3 V ac heater supply and regulating with a 7-volt zener diode. ■

References

1. Atlas Radio, Inc., 417 Via Del Monte, Oceanside CA 92054.
2. "The Tubeless Product Detector," *CQ*, March, 1965.

CONTESTS

from page 15

change counties or bands. Repeat contacts between mobile stations are permitted provided they are on a different band or in a different county.

EXCHANGE:

Signal report, county, and state (country for DX). Mixed mode contacts are permitted provided that one station is on SSB. (Mobiles, please keep an ear for CW county hunters calling!)

FREQUENCIES:

3920-3940, 7220-7240, 14275-14295, 21375-21395, 28575-28595. Look for mobiles on 15 meters on even numbered hours.

Please note: Again, this year there will be a "mobile window" of 10 kHz on the following frequencies: 3925-35, 7225-35, 14280-90. Mobiles will be in this 10 kHz segment and fixed stations are asked to refrain from calling "CQ Contest" in this segment. After working mobile stations in the "window," fixed stations are requested to tune and work other mobile stations or QSY to the outer edges of the suggested frequencies to call CQ or work other fixed stations in the contest. This will allow the mobile running lower power a chance to be heard and worked in the contest.

SCORING:

Contact with a fixed/portable US or Canadian station = 1 point. Contact with DX stations (including KL7 & KH6) = 5 points. Contact with mobile stations = 10 points. Multiplier is total number of US counties plus Canadian stations worked; take credit for a county only the 1st time it is worked. A Canadian station counts each time it is worked. Final score is total number of QSO points times total number of different counties and VE stations worked.

ENTRIES:

Logs should show date/time in GMT, station worked, report exchanged, county, state, band, claimed points (1, 5, or 10), and each new multiplier numbered. Official log sheets and summary sheets are free for a #10 SASE or SAE and appropriate IRCs from John Ferguson WØQWS, 3820 Stonewall Ct., Independence MO 64055. Submit all entries to the same address no later than June 1 to be eligible for awards; DX should use air mail.

AWARDS:

Plaques to highest scoring fixed US or VE, DX, mobile, and 2nd mobile certificates to top 10 fixed and mobile stations in US and VE and to the highest scoring DX in each country. Only single operator stations are eligible for these awards, but multi-op certificates may be issued if merited. A station may enter as both fixed and mobile, but separate scores are required.

Note: If you should need any counties on the MD-DEL peninsula or in the Southern NJ area, look for us mobile during the contest. If everything goes according to plan, we will be operating on all bands 80-15 meters for the entire weekend, covering as much territory as possible during the contest.

HOLIDAY-IN-DIXIE FESTIVAL QSO PARTY

Starts: 1800 GMT April 21
Ends: 2400 GMT April 30

Sponsored by the Amateur Radio Club of Shreveport LA (ARCOS). Contact a station within 75 miles of Shreveport, exchange contest information, and send an SASE to: Holiday-in-Dixie QSO Party, PO Box 1485, Shreveport LA 71164. For extra points, contact ARCOS members and get their Holiday-in-Dixie certificate number in addition to the contest information. To kick off the 10-day festival, ARCOS members will be on the air as a group from 1800 GMT April 22 until 2400 GMT April 23 continually, but contacts can be made anytime during the festival.

The Holiday-in-Dixie Festival was begun in 1948 to commemorate the signing of the Louisiana Purchase and now includes parades, Queen's Pageant, and various activities for all ages. Estimated attendance is 350,000, and this is the first year that ham radio activities will be included as a new event, so certificates should be very desirable.

Suggested frequencies are: Phone—3935, 3975, 7125, 14280, 21380, 28575; CW—3555, 3710, 7055, 7110, 14055, 21130, 28130; VHF—50.110 ± on SSB, 52.525 ± FM simplex, 145.100 ± SSB, 145015 FM simplex.

Local coordination and contacts possible on 146.07/67 and 146.16/76, as these will be used to demonstrate 2 meter ham radio to festival visitors.

Stations may be worked once per band per mode. Local stations may work each other. Stations send RS(T), power, and ARRL section or country. Ask for a Holiday-in-Dixie number from ARCOS members. Score 1 point for 1 contact, 2 points for 5 contacts, 3 points for 10 contacts, 4 points for 15 contacts or 10 ARCOS contacts.

BERMUDA AMATEUR RADIO CONTEST

Starts: 0001 GMT April 22
Ends: 2400 GMT April 23

Sponsored by the Radio Society of Bermuda. Operate no more than 36 hours of the 48-hour contest period. Off periods to be clearly logged and each period to be of not less than 3 consecutive hours. All stations shall be single operator only and must be operated from their own private residence or property. Each station may be worked only once per band regardless of mode. Use all bands 80 to 10 meters, but no crossband or crossmode contacts permitted.

EXCHANGES:

All stations exchange RS(T) and following: UK—county, US—state, VE—province, Bermuda—parish.

US and VE stations must exchange reports with UK and Bermuda stations only. UK stations must exchange reports with US, VE, and Bermuda only.

SCORING:

Each QSO = 5 points. Multiplier for all stations outside Bermuda is the total number of VP9s worked on each band. The same VP9 can be worked on all bands. For Bermuda stations, it is the total number of states, provinces, and counties worked on each band.

AWARDS:

Top scorer in each state, province, and county shall receive a certificate. Trophy to top scorer in VE, US, and UK. Round trip air transportation plus accommodation will be provided to overseas winners to enable them to receive their awards.

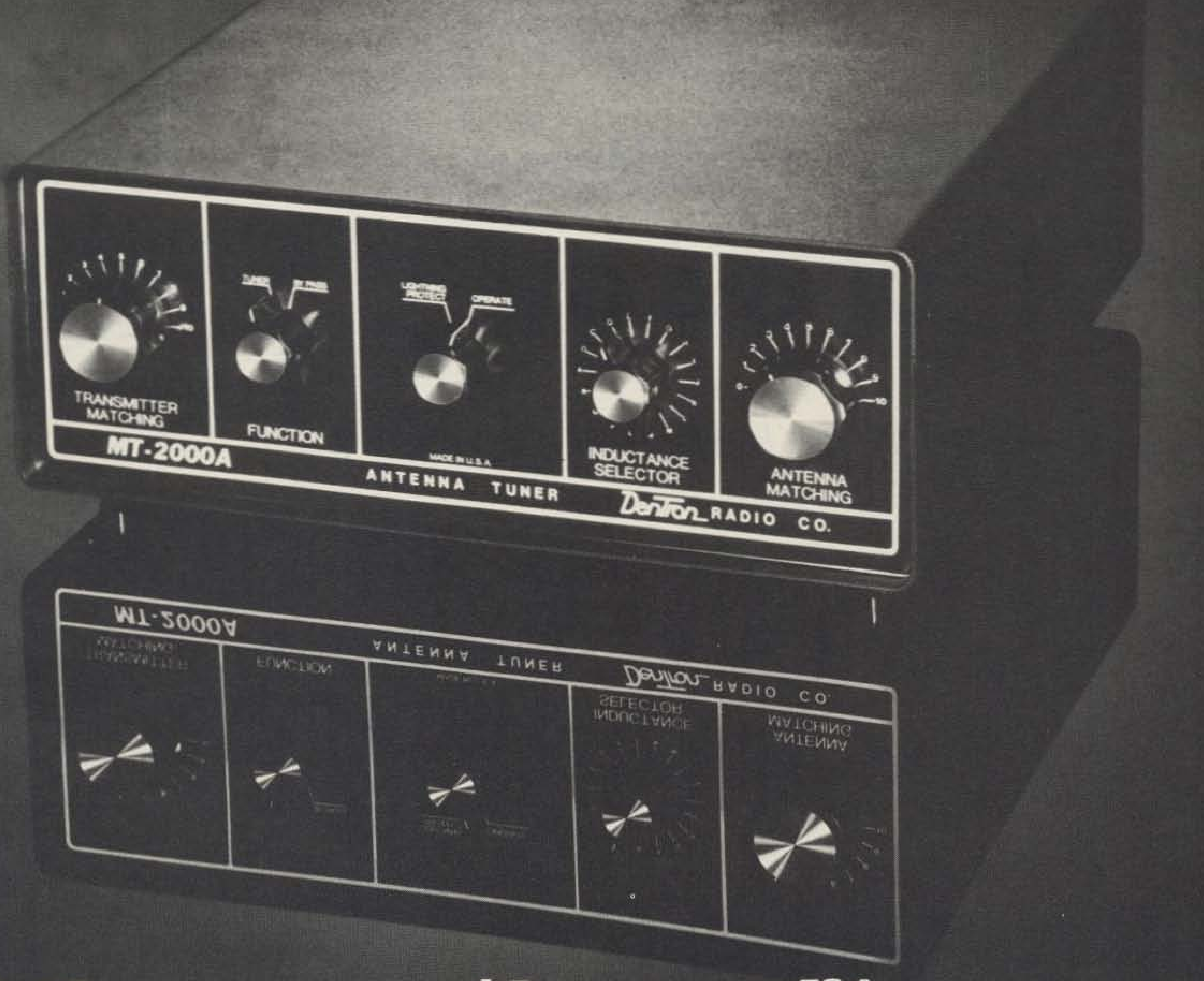
ENTRIES

All dates and times in GMT. All contestants to check for duplicates and to compute their own scores. Sign a statement that all rules and regulations have been observed. Each page must be clearly marked with call, name, and address, and must be received by the contest committee before June 30. Send entries to: PO Box 275, Hamilton 5, Bermuda.

Note: Please submit a log if you operate in the contest. This is the only indication of

Continued on page 133

If they copy the style, they can't match the quality.



If they copy the quality, they can't meet the price.

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When you consider the MT-2000A's unique features: 5¼"H x 14"D x 14"W, front panel coax bypass switching, front panel lightning protection antenna grounding switch, 3KW PEP, and the ability to match coax, random wire and balanced feedline, we're sure you'll decide to buy an American original and stay with DenTron.

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The Challenge Of 10.5 GHz

— use it or lose it to Smokey

The reader interest in this series of microwave-oriented projects has been tremendous. Stirling indicated in a letter to 73 that he has been flooded with requests for additional information relating to the original "Smokey Detector" article (73, Holiday, 1976). Please bear in mind that experimenting with UHF and microwave devices requires restraints not required at lower frequencies. There is considerable evidence that microwave radiation, even at very low levels, can have strange physical effects. Research in this area is continuing, so, for the present time, play it safe. Under NO circumstances look into the horn of an operating microwave transmitter. Heating of the inner eye may occur, causing sight impairment. Do not direct the beam at other persons. Allow common sense to prevail while experimenting with microwaves. The New Yorker Magazine *published an article ("The Roving Reporter — Microwaves," Dec. 13 and 20, 1976) concerning the research into the possible effects of microwave radiation. Read it. — Ed.*

Photo A. The tuning screws and modulator diode are shown in a different position from that described in the text. These components may be located in either position, but the detector diode must be fed as shown to allow access to the tuning screws.

The smokey detector[1] was presented to drivers for, among other things, the safety value it presented. It was intended to provide a radar warning and therefore slow the driver down to a safe speed.

There are many possible options for modifications of this device for the smokey constructor who uses his imagination. I have received a lot of letters asking how to incorporate them.

One very fine idea came from Wayne W2NSD. He suggested that the smokey detector have an oscillator which would operate on X-band incorporated into the design. This addition, with suitable circuitry, would make it a transceiver. It will also do many more things that can provide some amusing effects. This single addition was the subject of many requests for a how-to-do-it circuit.

The addition will make the unit into a transceiver and Doppler radar. In fact, the addition of the oscillator will make it exactly like the rf head of surveillance radars used in traffic control.

Other letters indicated an interest in a variable-frequency modulator oscillator giving a range of 300 to 2000 Hz. I even had one request for the addition of the Trekkie circuit, so the Starfleet of the UFPCC could be contacted.

Let's get on with the circuit additions by examining the electronics first. You will see that the primary circuit, consisting of the smokey de-

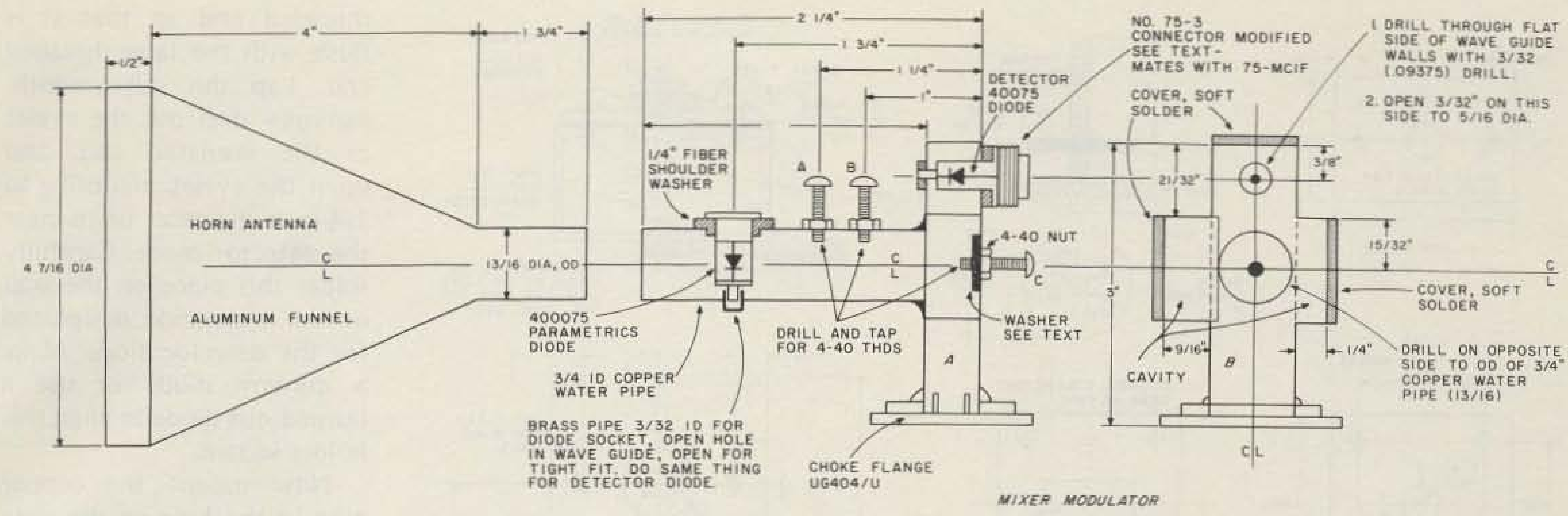

Fig. 1. The mixer modulator. Materials: 4-7/16" diameter funnel; ½" x 1" copper waveguide — RG-52/U.

tector preamplifier, is still incorporated. The amplifier is roughly the same circuit, except that it consists of integrated circuits, occupying a much smaller space.

Also, this unit is more easily adapted to serve as part of the transceiver modulator. The microphone incorporated is a standard CB mike which has a switch that is pushbutton operated to do the many functions required in a CB transceiver. This switch blends nicely into the transceiver, and, best of all, it's inexpensive.

Now examine the function switch, S3. You can see that it serves to shift the unit from duty as a transceiver to performance as a Doppler radar or smokey alarm. Note that, when in the alarm position, a variable oscillator at audio rates should meet the requirements of the variable-frequency modulator enthusiasts. Note also that the control switch for this circuit, a 3-position switch, allows it to modulate the diode with a "bee baw" frequency response, a wailing sound familiar to all of us, and, of course, most importantly, a variable-frequency oscillator at the audio rate of 300 to 3925 Hz.

This oscillator may be calibrated in its frequency range, but, for better reference, the dial can be directly marked in miles per hour by dividing the frequency output of the oscillator by the one mph Doppler frequency,[2] 31.4 Hz. The variable-frequency oscillator pot dial will then be calibrated from 9.5 to 125 mph.

In the Doppler radar function position, the Doppler sounds of vehicles moving toward or away from the antenna will be easily recognized as a beat that rises in frequency when a vehicle approaches and drops in frequency when the vehicle recedes.

Many other sounds, such as aircraft and large ships, can also be detected. A helicopter can be heard quite a while before it can be seen. This technique is used as an intruder alarm in many burglar warning systems.

In the Starfleet warning position, Trekkies[2] will, of course, be able to carry on their communications with one another simply by turning the switch to that position and pressing the mike button, which momentarily sends the ID signal.

In the transceive position, speech modulation is applied to the Gunn effect diode oscillator. The level of modulation is controlled by the audio amplifier volume control. The speaker is disabled so that no feedback will exist. Note also that an audio jack is incorporated so that the signals for any function can be directed into the car stereo or two meter audio system. When this option is used, the speaker switch, S4, must be turned off.

Note that a voltage regulator is shown for the Gunn oscillator. This is a three-terminal regulator and should not be left out in favor of some lesser regulator system. Failure of the diode will surely bring forth new expletives, since the diode costs approximately $25. A second protective circuit is made up of a low-voltage, high-current diode connected after the fuse. If primary voltage reversal occurs, this diode will blow the fuse before most of the semiconductors are ruined.

A tune-up aid, consisting

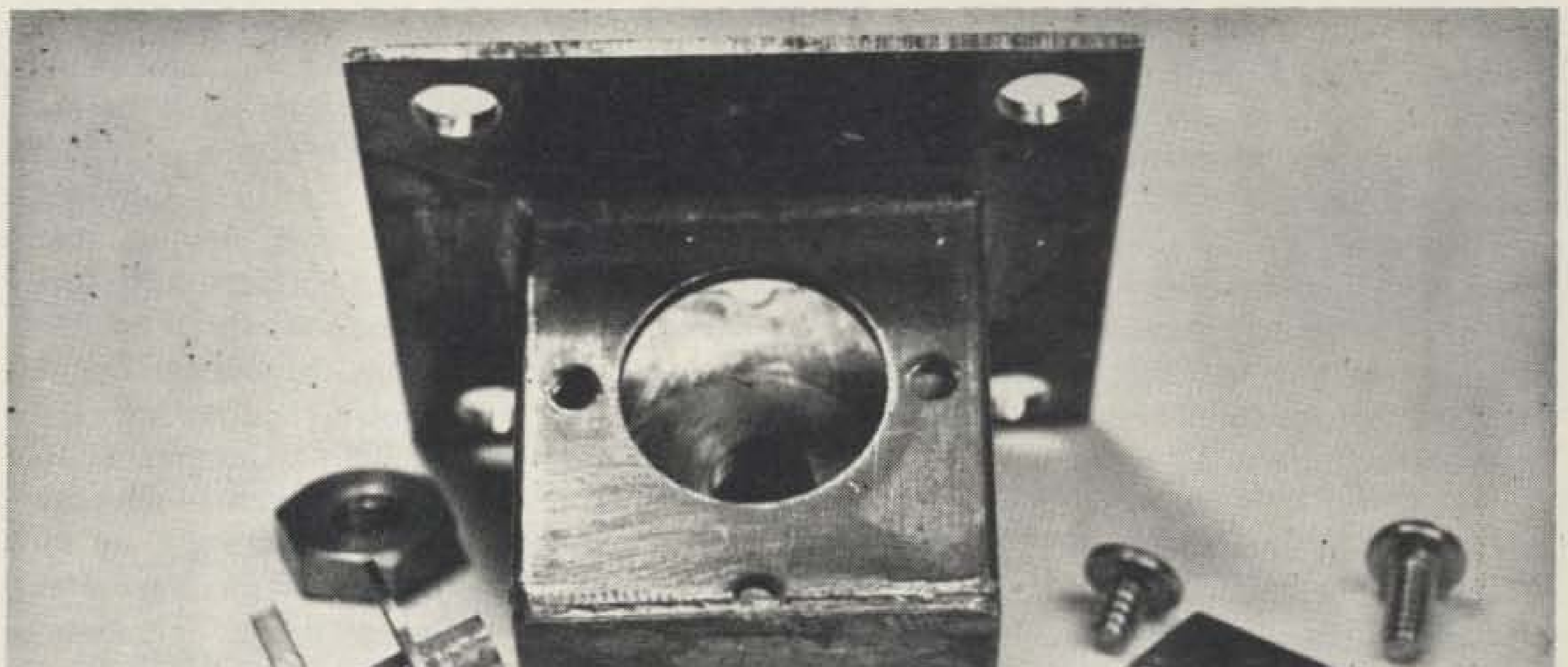

Photo B. Gunn effect oscillator assembly parts. Not shown is the cover iris to the waveguide flange.

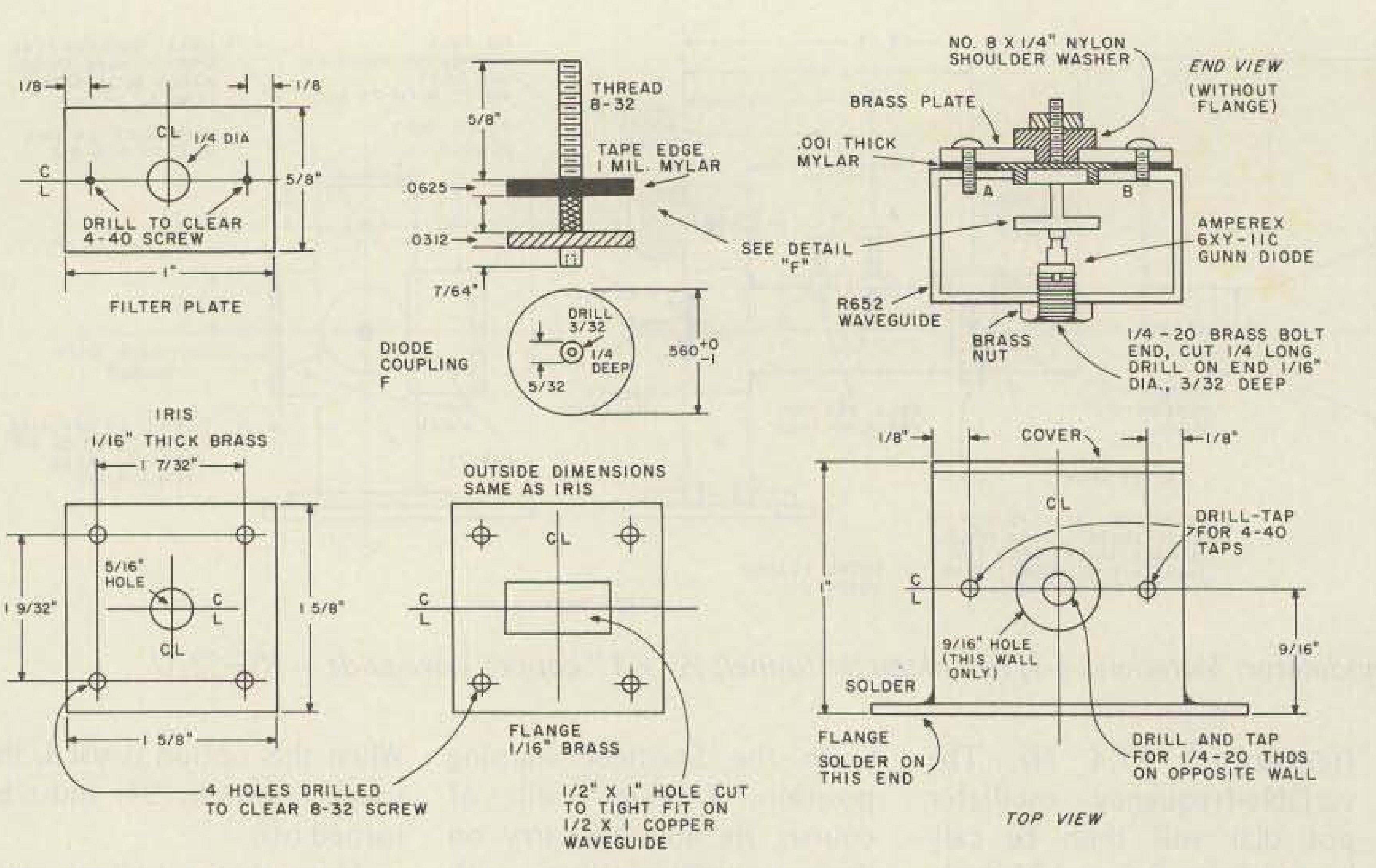

Fig. 2. Gunn diode oscillator for 10 GHz.

of a microwave diode connected across a meter, is used in the initial tune-up and can be temporarily constructed for this purpose. A VOM and a muffin fan are all that are needed to tune this rig up.

Construction of the electronics can be done on a small piece of perfboard. Since there are no real problems in the layout other than those common to audio circuits, I will discuss the microwave plumbing, which must be fabricated by the constructor. Hand tools are all that are needed, with one exception – the diode coupling unit, which must be turned on a lathe.

The horn for this unit is made from an aluminum funnel of the approximate dimensions shown in Fig. 1. The throat of the funnel must be broached out to take the taper out of it. Funnels of this size can be obtained from a farm supply dealer and are primarily used in dairies. I broached mine to shape with a 13/16-diameter rod stuffed down the funnel throat gently tapping the rod with a hammer. It's easier than you think, but care must be used or the metal will tear. When the broaching is completed, the throat of the funnel will slide over the outside diameter of the 3/4" i.d. copper water pipe section used as the diode modulator and circular waveguide to rectangular guide adapter shown in Fig. 1(a), the mixer modulator.

To construct the mixer modulator plumbing, start by cutting off a section of RG-52 waveguide so that each end is square and deburred. Lay out the holes as shown in Fig. 1(b). Drill the two sets of holes by first running a number 43 drill in each location shown, through both walls. These holes will serve as pilot holes for further drilling of larger holes and, therefore, should be drilled carefully so that the holes are directly in line with each other.

Open the holes, as shown in Fig. 1(b). Deburr each hole, and then open and tap for threads, as shown in Fig. 1(a). Solder in place small sections of 3/32" i.d. pipe to serve as sockets for the ends of the Parametrics 400075 Schottky diodes. This pipe is obtainable at model shops. Do the same thing for the detector diode. Locate a 3/8"-diameter, 1/16"-thick brass washer that will pass a 6-32 screw on the wall of the waveguide facing the copper pipe, as shown in Fig. 1(a). Solder the washer in place so that it is concentric with the screw. Complete drilling all holes as shown in Fig. 1(a) on the copper pipe. Complete tapping all holes on the pipe. Lay this piece aside for the moment.

Measure off the two openings shown for the waveguide cavities on the ½-inch wall of the waveguide section you just drilled. Carefully and squarely saw through the walls so that the saw cuts just break through the sidewall metal. Then file the edges between these cuts until the flats fall away. Level these cuts off so that the thickness of the sidewall is exposed. Next, cut two small pieces of waveguide, as shown, for the sidewall cavities. Cut these square, and deburr them. Clean all surfaces with "Brite Dip" or soldering acid. Now assemble the sidewall cavities, as shown, and hold them in place with a C-clamp. Be sure to place the ½ x 1-inch covers under the C-clamp, and soft-solder all parts in place. Next, place a flange (choke-type UG-404/U) on the waveguide end shown in Fig. 1(a). Be sure it is square with the vertical wall. Then solder it in place. Put a ½ x 1-inch cover plate on the opposite end, and solder it into place.

Modify an Amphenol #75-3 microphone connector by sawing off the small-threaded end so that it is flush with the large-threaded end. Lap this cut smooth, carefully drill out the eyelet in the insulated end, and open the eyelet mounting to 1/4-inch diameter or to clear the detector diode. Carefully solder this piece on the wall of the waveguide designated for the detector diode. Make a dummy diode or use a burned out diode to align this holder square.

Now mount the copper pipe in the hole on the wide wall of the guide as shown in Fig. 1(a). Place the screws and jam nuts as shown in the drawings. Clean all solder flux from the assembly with hot water, wash them with alcohol, and dry them thoroughly.

Check all of the assembly to see that all parts are securely soldered and square with the waveguide walls. Slide the horn throat over the outside of the copper pipe now mounted on the waveguide assembly. It should look something like Photo A. Not shown is a hose clamp which holds the horn in place securely.

If you wish to build your own Gunn diode oscillator, the details are shown for this construction. It is as simple as most of the previously described plumbing. A Gunn diode, Amperex-type CXY-11-C, obtainable from North American Phillips, which costs in the vicinity of $25, is used in this assembly and is relatively low in power, but is sufficient for the job. The assembled Gunn oscillator is also shown mounted on the plumbing. Photo B shows the components required. With the assembly construction drawing and the photo, you should have no trouble constructing this.

If you wish to buy the Gunn oscillator assembly, it is available from Microwave Associates or General Electric. The units used for this purpose are usually available for police or intruder alarms and vary in price depending upon power output. If a commer-

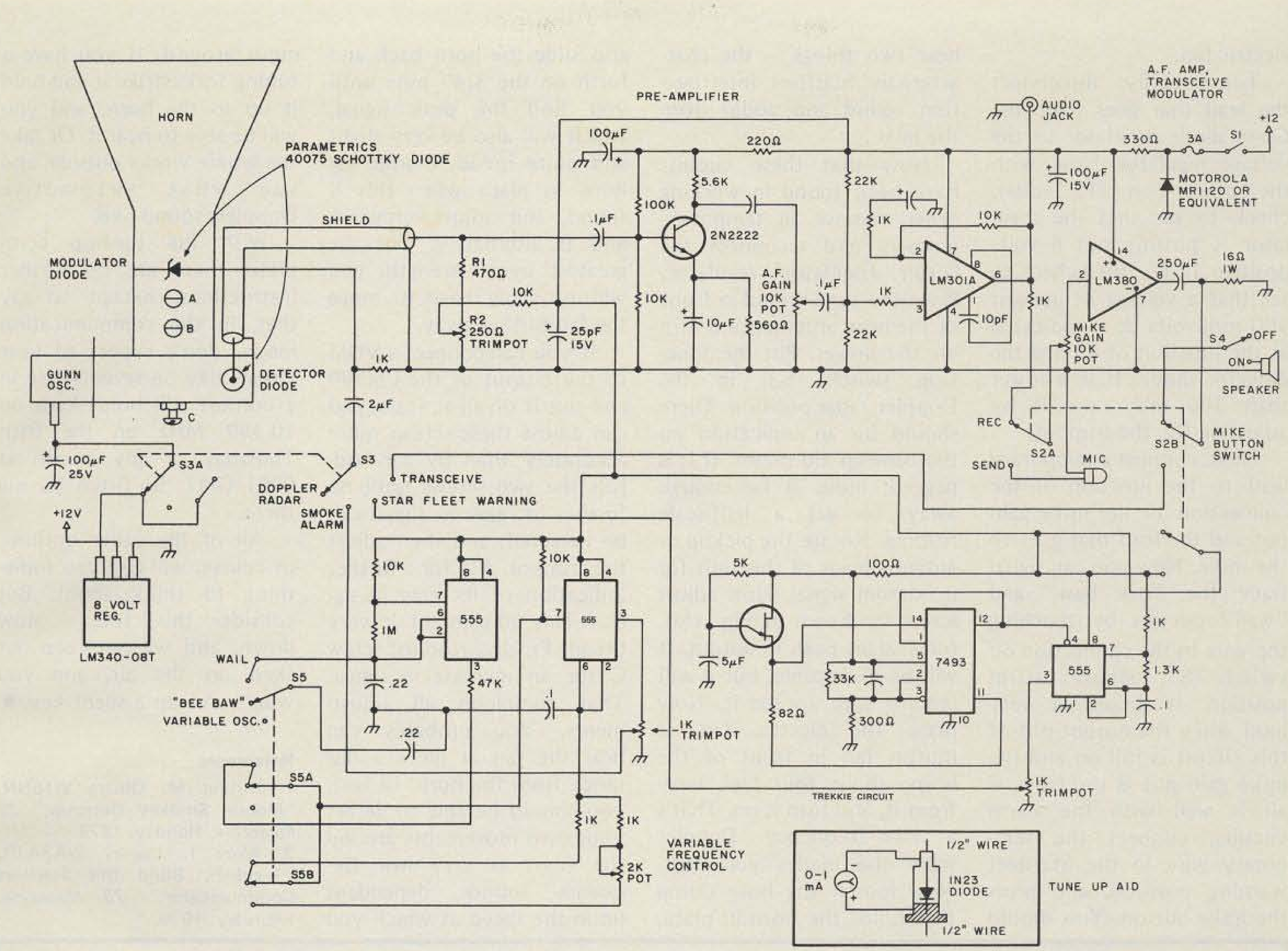

Fig. 3.

cial unit is chosen, the three-terminal regulator indicated may have to be changed to one which delivers a higher voltage. Usually a spec sheet accompanies the oscillator.

As a last resort, if a Gunn oscillator is beyond your means, a Klystron oscillator can be used. Suitable information on these tubes, as well as power supply information, is available in amateur handbooks.

The construction of a Gunn oscillator is accomplished as follows:

There are two views given for a Gunn oscillator that should occupy your attention. (See Fig. 2.) These show the top view, with a flange in place, and the end view, with the flange absent. The flange was purposely left off so that the assembly of components and mounting screws would be in view. The two screws marked A and B in this view serve an obvious double purpose. The B screw is a 4-40 x ¼-inch-long brass screw and should be set in place so that it is not protruding into the waveguide. If it does, file it until it just fills the hole and is flush with the inside of the guide. The A screw is 3/8-inch long and of the same material. It sets the frequency of the oscillator. Making it longer will lower the frequency, and, conversely, shortening it will raise it.

The insulating material for the diode coupling unit should be mylar, but other material can be substituted.

When installing the diode, mount it in the hole of the short 1-20 brass plug with the large flange of the diode on the plug. Screw the plug into place so that the other end of the diode engages the diode coupling firmly, but do not compress this $25-dollar jewel, or the diode will be destroyed by cracking. Just a firm clamp will do.

As shown in the top view, all holes should be drilled and tapped and the cover and flange attached with soft solder. For drilling and soldering, use the same techniques as described in the plumbing assembly.

The diode coupling should be turned on a lathe and should adhere to the dimensions as shown. If you are ambitious enough, you could make this unit with a screw and washers. The edge of the top section of this unit must be insulated with mylar tape. A 1-mil thickness is required. It can be obtained from a drafting supply house or perhaps from a friendly draftsman. Use another piece of the same tape over the top of the guide to insulate the top of the diode coupling from the filter plate which is gounded to the waveguide. This plate provides the other half of an rf capacitor in conjunction with the top of the diode coupling.

When all of the parts are assembled, including the diode, place the iris over the flange. Be sure the holes all align. They are drilled to fit the choke flange on the plumbing assembly and are not uniformly spaced, so there will be no possibility of crossguiding the two units.

Crossguiding will absolutely put you out of business and may even blow your diode. The microwave industry thought of this years ago, so that's why the commercial chokes and flanges are drilled this way – not because I thought of it.

So now let's get on with the tune-up procedure. I said in the beginning that all you were going to need was the tuning meter and diode shown in the drawings and an electric fan.

Temporarily disconnect the lead that goes from the Gunn diode oscillator to the voltage regulator. Now, with the power on (12 volts), check to see that the regulator is putting out 8 volts positive. If it is, then check to see that a voltage of at least 100 millivolts dc is indicated at the junction of R1 and the detector diode. If it is lower than 100 mV, raise it by adjusting R2, the trimpot.

Next, connect a temporary lead to the junction of the connection to the mike gain pot and the lead that goes to the mike. Now you can signal trace the "bee baw" and "wail" circuits by touching the wire to the connection on switch S3, smoke alarm position. It should be very loud when the output pot of this circuit is full on and the mike gain pot is up. Now, if all is well with the alarm circuits, connect the temporary wire to the Starfleet warning position, and press the mike button. You should hear two things – the characteristic Starfleet interrogation sound and audio from the mike.

Now that these circuits have been found in working order, remove all temporary jumpers and reconnect the Gunn oscillator regulator. Place the tune-up aid in front of the horn antenna, and turn on the power. Put the function switch, S3, in the Doppler radar position. There should be an indication on the tune-up aid meter. If it is pegged, move it far enough away to get a half-scale reading. Rotate the pickup or antenna leads of this unit for maximum signal. Now adjust screw C, shown in Fig. 1(a), for a slight peak in output. It will be discernible, but it will require care to see it. Now place the electric fan or muffin fan in front of the horn, about four feet away from it, and turn it on. That's a low-frequency Doppler from the blades you hear. Now loosen the hose clamp that holds the horn in place, and slide the horn back and forth on the 3/4" pipe until you find the peak signal, which will also be very slight and quite broad. Clamp the horn in place when this is found, and adjust screws A and B alternately. For the greatest signal strength, you will probably have to move the fan further away.

If you can connect a VOM to the output of the LM380 and put it on an ac scale, you can adjust these screws more accurately than by ear. Adjust the two screws until no further increase in signal can be detected, and then adjust the trimpot, R2, for a further indication of increase in signal. This adjustment is very broad. Finally, readjust screw C for an increase in signal. That completes all adjustments. You probably can hear the fan at quite a distance from the horn. In fact, you should be able to detect your own movements around the horn as very low frequency sounds, dependent upon the speed at which you move around. If you have a tuning fork, strike it and hold it up to the horn, and you will be able to hear it. Or take the whole works outside, and see what automotive Dopplers sound like.

With the tune-up complete, there are no further instructions, except to say that, in the communication mode, don't expect to hear signals like on seventy-five in a contest. I'll hold skeds on 10.499 MHz on the fifth Thursday of any month at 0001 GMT. So listen for me there.

All of the other options, of course, will give you something to think about. But consider this, too – slow down, and we can keep our sked on the air, and you won't end up a silent key. ■

References

1. Stirling M. Olberg W1SNN, "Mobile Smokey Detector," *73 Magazine*, Holiday, 1976.
2. Marc I. Leavey WA3AJR, "Trekkies, Build this Starfleet Communicator," *73 Magazine*, February, 1976.

Robert E. Bloom W6YUY
8622 Rubio Ave.
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In Search Of the Ultimate

—an incredible counter calibrator

Wouldn't it be exciting if it were possible to have all of the following in one simple small package?

1. The maximum readout accuracy a frequency counter or reference oscillator design will permit.
2. A calibration device so simple that it requires only a level set control, a momentary switch, and two BNC coax connectors on its panel.
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4. The cost of building under \$60.00, if everything is purchased off the parts house shelf (under \$25.00, if you know where to shop).
5. Fast calibration, once the counter or reference standard to be calibrated has reached stability.
6. Fun and excitement for both operator and spectators while in the process of calibration.
7. Accuracy as great as one part in 10^{-11} (if the counter could only have this kind of stability!).

The only other equipment required is a family color TV set.

A wild dream? Not at all. I have been using such a device for over a year now, and, in addition to the above features, it beats the long, drawn-out WWVB methods used by calibration (metrology) laboratories throughout the country. This long-awaited method is called the color bar calibration method. See my article in the April, 1976, issue of *73*, "How Accurate is Your Counter — Really?" Once you possess this device, calibrating your counter timebase reference oscillator or other reference standard becomes as exciting as using the instrument for its intended purpose.

The method to be described has been developed by Dick Davis of the National Bureau of Standards, and additional information relating to frequency measurement methods can be obtained by writing their Time and Frequency Services Section.

Let's start with a little of the history behind the development of the system. As you are aware, our government has been transmitting standard radio frequencies over both marine (Navy) and NBS stations. Just NBS alone has had over 10 stations on harmonically-related HF frequencies in Hawaii and Fort Collins, Colorado, namely WWV, WWVH.

The accuracy at the point of transmission has been a few parts in 10^{-9}. The accuracy at the point of reception could be as poor as one part in 10^{-7}, depending on season, time of day, and the effect of the Doppler shift. Most commercial users require a much higher accuracy level than these stations now afford and have been using the NBS VLF transmissions of WWVB and WWVL. The WWV stations transmit other information in addition to time and frequency, while the low-frequency stations radiate only frequency information.

The cost to maintain all of these transmitters, however, has reached astronomical proportions. About two years ago, NBS sent out a questionnaire to users asking what impact would be created by shutting down some of the transmissions and/or possibly closing some of the stations. The employees at NBS are not only dedicated to their work but are also quite efficient, so they do not just send out questionnaires and sit back awaiting answers which could result in shutting down some of these services. They developed, instead, a new method that is efficient, highly accurate, and available to anyone owning or having access to a color TV set.

NBS consulted with the heads of the four broadcast networks (NBC, CBS, ABC, and PBS), suggesting that they could provide a public service by precisely controlling the frequency of their TV color burst. This would require a modest one-time expenditure. The networks obliged by purchasing rubidium signal sources so modified that they included a synthesizer to generate a 3.579545454··· MHz signal to generate their color-burst subcarrier. The rubidium frequency oscillators have accuracy beyond one part in a hundred billion, but are offset from the exact frequency by about -3000 parts in 10^{11}. NBS would provide a daily computer readout of the frequency offset required by the networks as compared with the nation's primary standard.

The NBS standard is a siesium beam atomic oscillator which has a frequency accuracy of better than one part in 10^{13}. From April through June, 1976, the exact value for UTC time was within -0.6×10^{13} or less than one part in 10 trillion. The WWVL transmissions of this frequency also have an offset to compensate for the nonuniform variations in the rotation of the Earth on its axis.

With that out of the way, you should be moderately excited, at least. But first the question is, "How does this accuracy manifest itself in my color TV set?" All color television receivers lock onto the color subcarrier signal, and, if the color set is tuned to a network program, its internal 3.58 MHz oscillator generates a replica of the atomic oscillator signal back at the network studio. This 3.58 MHz

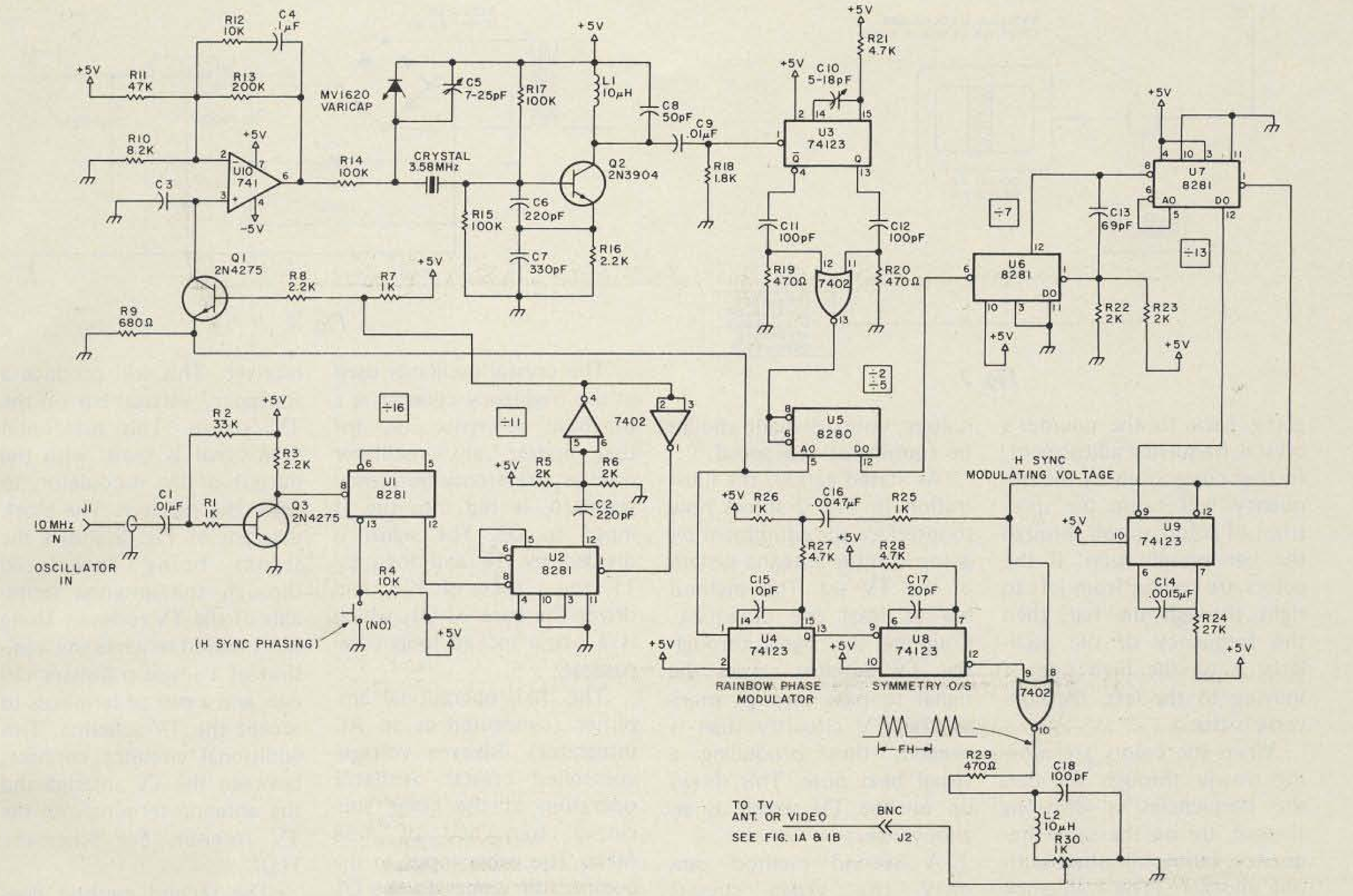

Fig. 1. Schematic diagram of the color bar calibrator. Note: Place .01 to .05 mF disc ceramics freely at B+ points and at 5 V dc at ICs. 8280 is equivalent to 74176. 8281 is equivalent to 74177. The 4-section 7402 is used for gating and inverting.

signal from the color receiver is not a substitute for the oscillator in the frequency counter. It is a calibrating signal that can be used to set the oscillator. In only 15 minutes, one can match the results of days of data gathered from the NBS radio stations WWVL or WWVB.

In order to interface the counter oscillator with the TV set, a small box will have to be built (see Figs. 1 and 3) containing 12 inexpensive ICs, a one-dollar color TV quartz crystal, 3 cheapie transistors, and a few other simple components. This small box is called a color bar generator. All of its components fit on a 4" x 7" PC board.

Essentially, this box takes the 3.579545454 MHz network signal and phase-compares it with the 1.0 MHz, 5.0 MHz, 10.0 MHz, etc., frequency standard or crystal timebase you have in your ham shack.

An article by WD8ASL in the Feb., 1977, issue of *73* describes a method for reading out the TV receiver's 3.5795454 locked-on crystal oscillator. This method will provide limited accuracy, depending upon the length of the counter's timebase. I suggest reading the article. It does not provide the ultimate accuracy but is an excellent method nevertheless. For those requiring long-term accuracy using phase comparison of the timebase, the color bar phase comparison will provide this accuracy.

The block diagram in Fig. 2 illustrates one of two ways the equipment is interfaced with the TV set. Basically, the color bar generator produces a wide vertical bar on the face of the picture tube simultaneous with receiving a network telecast.

With the crystal timebase oscillator of the counter coupled into the color bar generator, the bar generator's level control is adjusted for a comfortable bar presentation level. The bar will be moving horizontally across the face of the TV screen. If moving to the right, the counter oscillator frequency is high; to the left, it is low. Adjusting the counter crystal frequency in the proper direction will slow the horizontal movement of the bar until it stops moving. Pressing the momentary switch on the color bar generator positions the bar on the screen. Just keep pushing until the bar positions itself where you want it. Now,

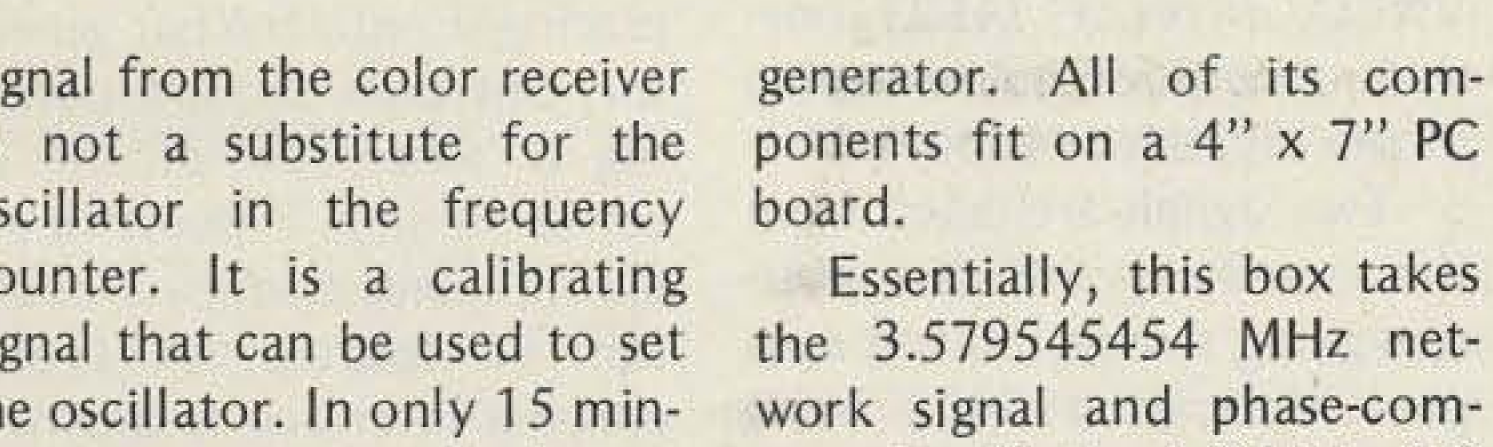

Fig. 1(a).

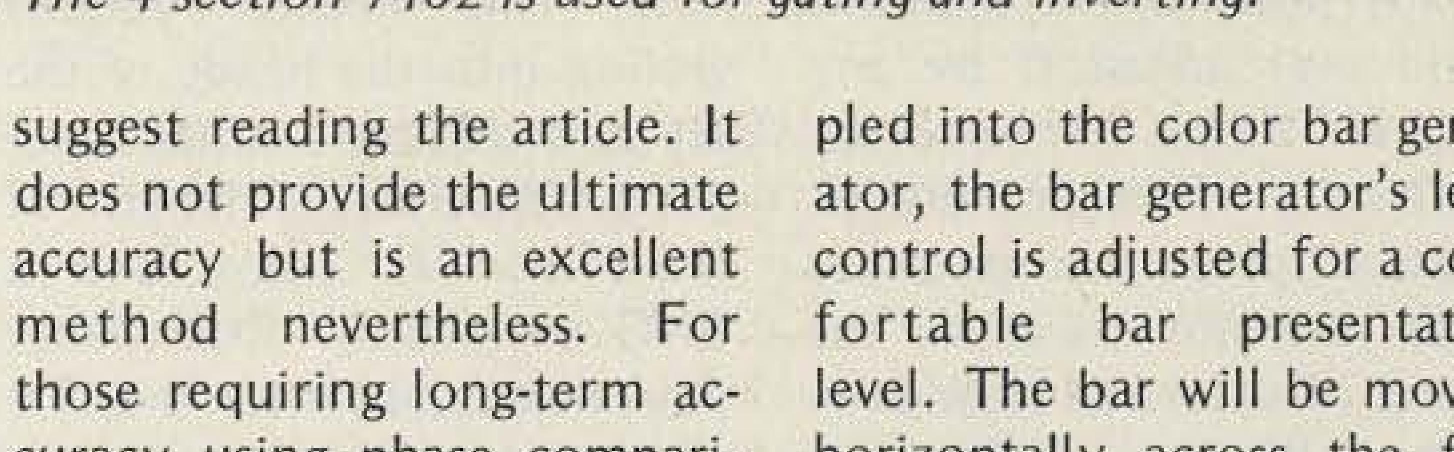

Fig. 1(b).

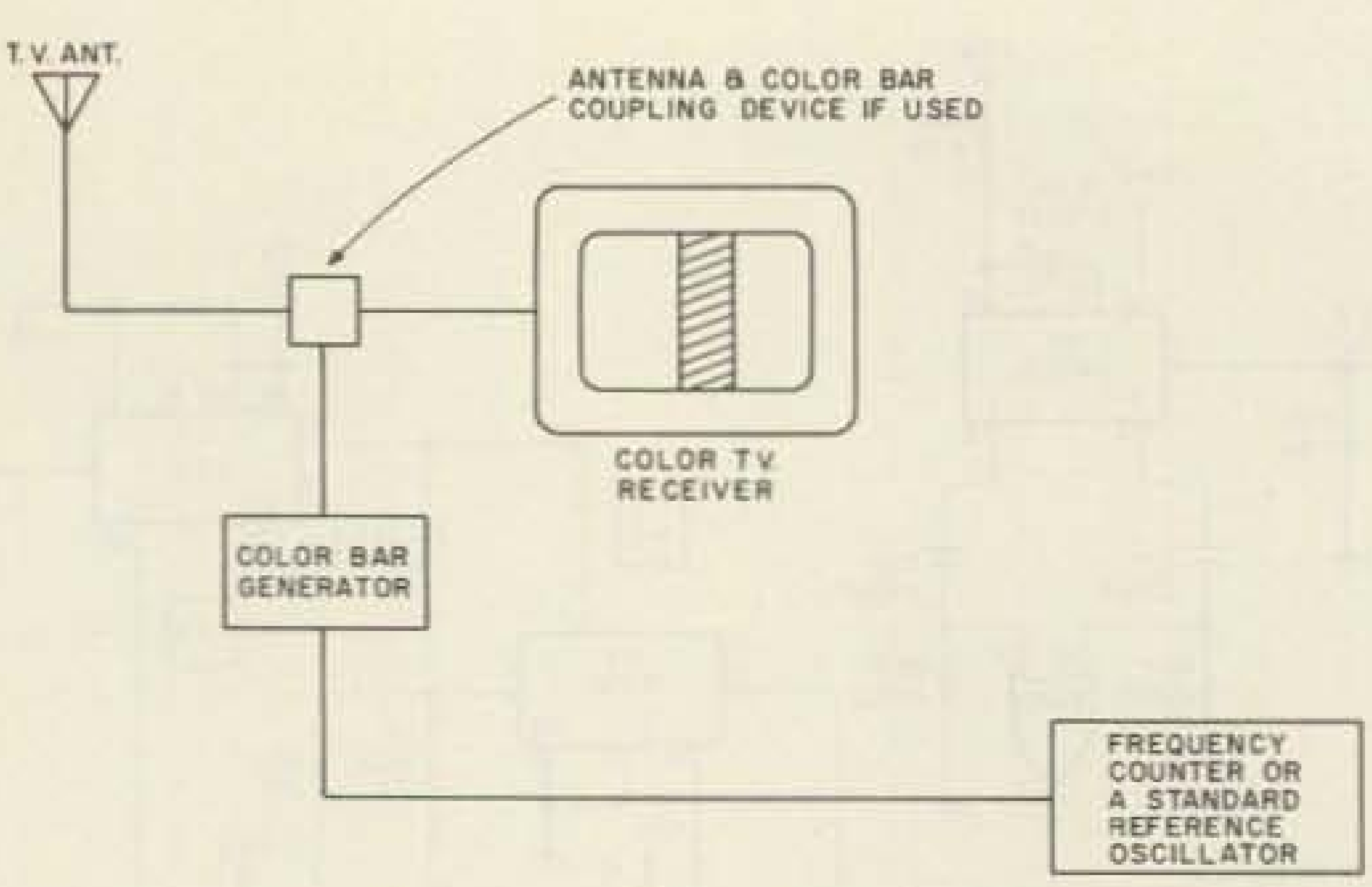

Fig. 2.

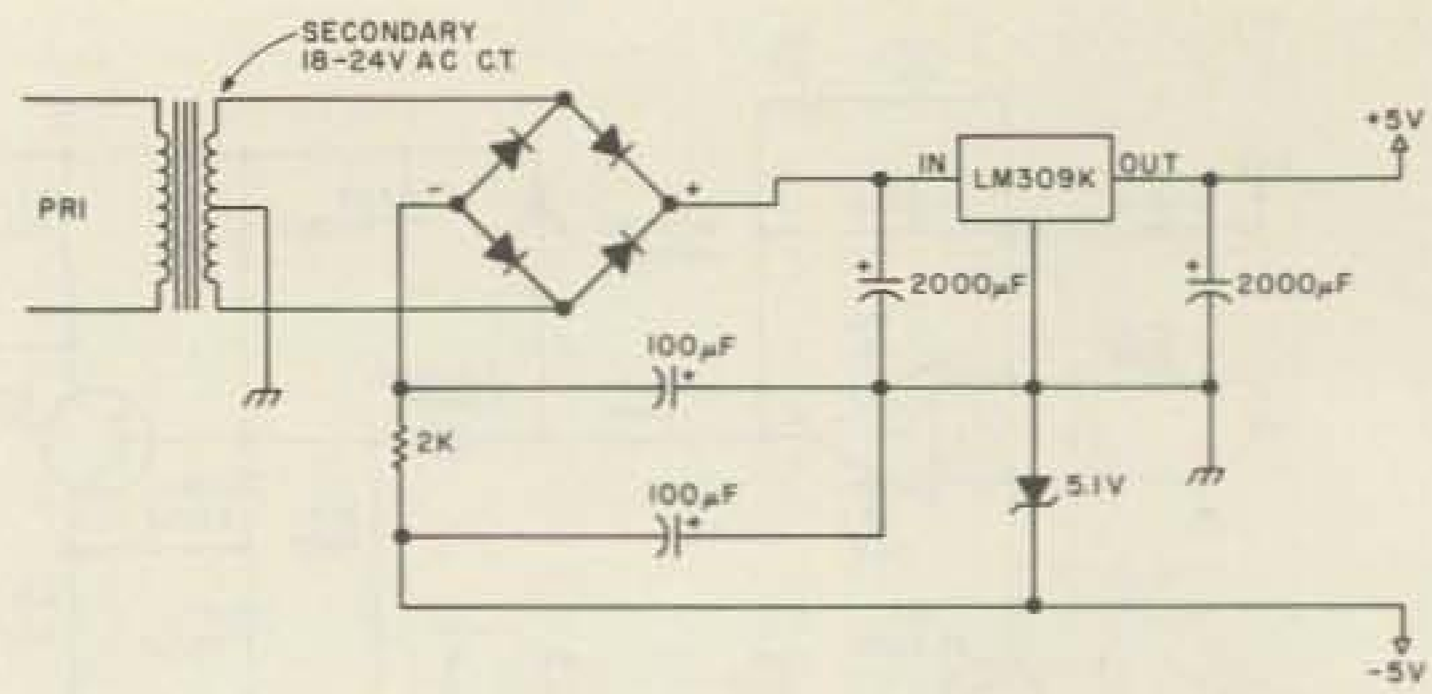

Fig. 3.

going back to the counter's crystal frequency adjustment, further corrections of the frequency will cause the spectrum of colors to roll through the bar presentation. If the colors are rolling from left to right through the bar, then the frequency of the oscillator is on the high side; if moving to the left, the converse is true.

When the colors are moving slowly through the bar, the frequencies or divisions thereof are on the same frequency, but not in phase with one another. (The frequency of the counter timebase is already much closer than one could ever adjust it by any aural beat frequency method.) Further adjustments in phase are necessary in an attempt to cause the rolling of colors to slow even further. When a single color can be retained for about 7 seconds, the timebase accuracy has parts measurable in 10^{-8}. If a single color can be retained for about 15 minutes, then you have attained a crystal timebase stability measured in parts in 10^{11}. One thing to remember is that, if the crystal oscillator and associated circuitry does not have this inherent stability, then it will never be attained no matter how long a warm-up period is given the counter. However, one thing is certain: This system will squeeze out every bit of accuracy of which the counter is capable. Now that you know what this device does, and if you have the appreciation of this advancement in the state of the art of frequency technology, your adrenalin should be running at top speed.

As stated earlier, the illustration in Fig. 2 shows how to interface the equipment by going into the antenna system of the TV set. This method has at least one drawback. Coupling the signal through the TV antenna causes the signal to pass through more of the TV circuitry than is needed, thus producing a visual beat note. This shows up on the TV screen as an annoyance.

A second method uses only the video circuits needed, eliminating this beat note. This method requires getting into the inside of the set and adding a small coupling capacitor, a length of RG-174 50Ω coax, and a BNC connector. Essentially, you must tap into the TV chrominance bandpass amplifier stage. I did this and know many hams who have. It in no way degrades the normal operation of the TV set. If you have the technical competence to expose the innards of your TV set, mother, father, or spouse willing, then it is recommended you do so. Otherwise, the antenna input method will suffice.

What makes the color bar generator work is best illustrated by the schematic in Fig. 1. Let's see just how this thing takes an odd frequency like 3.57954545 and makes it harmonically related to a 10 MHz crystal and/or any submultiple, that is, 10 MHz divided by N where N = 1, 2, 3, up to 100. This allows one to compare frequency sources of many frequencies.

The crystal oscillator used in the frequency counter as a timebase reference or, for that matter, any oscillator used as a reference frequency standard, is fed into the J1 input to Q3. The signal is divided by 16 and then by 11, for a total of 176, and drives the base of Q1, which is a phase locked loop comparator.

The 741 operational amplifier (connected as an RC integrator) drives a voltage-controlled crystal oscillator operating at the color subcarrier frequency of 3.58 MHz. The other input to the comparator comes to the Q1 emitter from the loop output circuit. The output from the VXCO drives a 74123 one-shot circuit for pulse-shaping of the oscillator output.

Two signals are taken from the one-shot, and the positive-going transitions are coupled through a 7402 NOR frequency doubler, the output of which is fed into the inputs of a 8280/74176. Part of this signal is divided by two and fed back to Q1 for phase lock.

The result of phase lock is that you have a crystal-controlled oscillator operating at the subcarrier frequency phase locked to a local standard. This permits you to inject a signal into a television receiver and compare it to a network color subcarrier. The second part of the injected signal to the 8280/74177 binary counters is further divided by 7 and 13, providing a total division of 455. The resultant frequency of 15,734,265 Hz is equal to the horizontal oscillator signal of the color TV receiver. This will produce a stationary vertical bar on the TV screen. This horizontal rate signal is used, with the output of the modulator, to drive the receiver. The block diagram of Fig. 2 shows the signal being interfaced through the antenna terminals of the TV receiver. Using this method requires the addition of a single transistor circuit and a pair of terminals to accept the TV antenna. This additional circuitry connects between the TV antenna and the antenna terminals on the TV receiver. See schematic 1(a).

The second method does not require removing the antenna from the receiver and placing it onto the bar generator, but does require obtaining a schematic of the receiver so that a point in the chrominance bandpass circuit can be located. A typical chroma interface is shown in schematic 1(b). Dick Davis of NBS was quite helpful in providing information on my 12" Sony.

Fig. 4 may be helpful in making up a printed circuit board. I do not have any boards available at this time. (If the demand is heavy enough, I may provide quality G-10 epoxy boards for a nominal amount.)

A 15 MHz oscilloscope will be helpful in determining that all of the ICs are operating and dividing properly. There is only one circuit in the unit that requires tuning, and that is the 3.58 MHz crystal stage; C10 requires adjusting to produce doubling of the frequency at pin 13 of the 7402 IC. Check pins 4 and 13 of U3 for equal ampli-

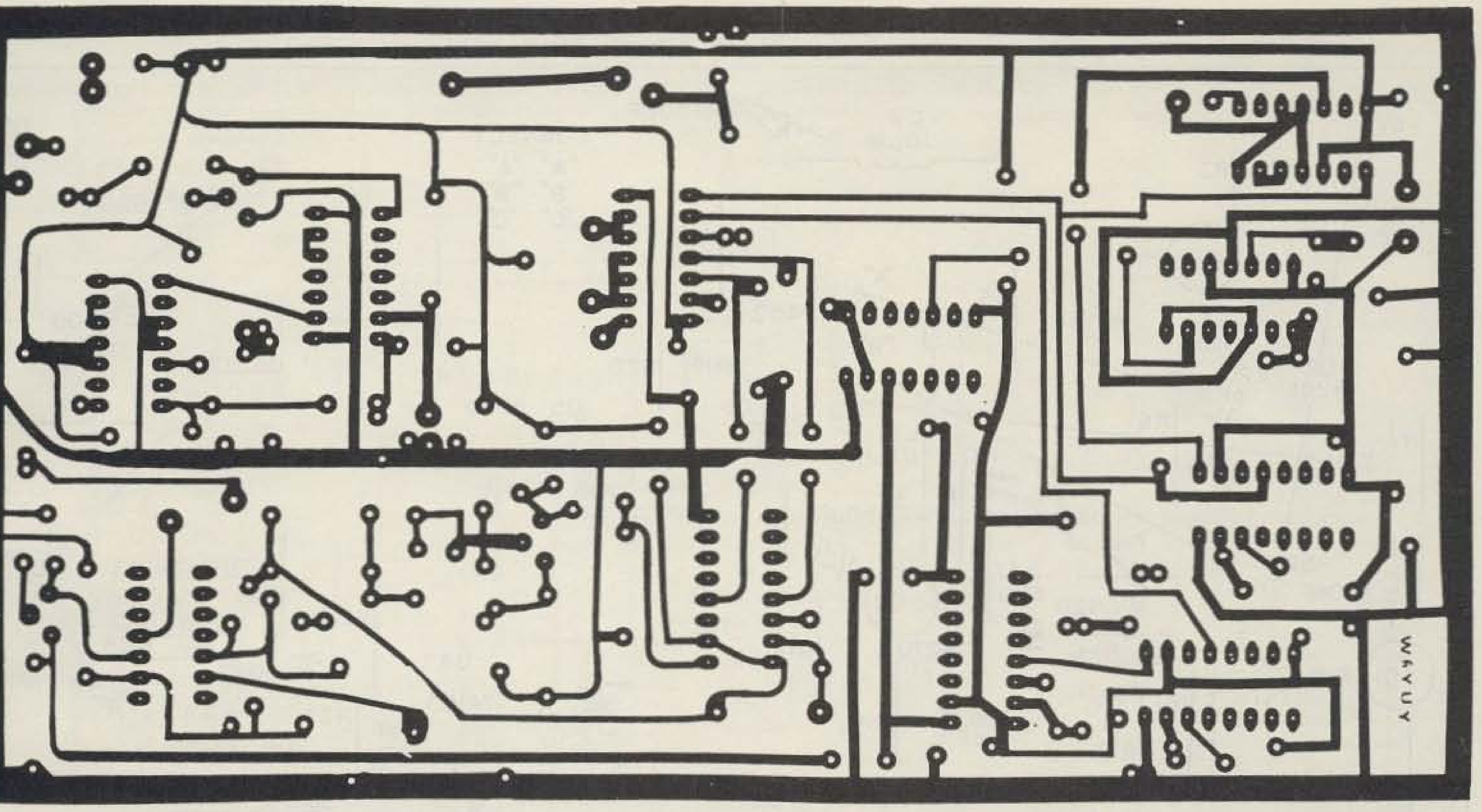

Fig. 4(a). PC board.

tude signal. Now connect the color bar generator to the TV set, tune in a color program, preferably a network program but not absolutely necessarily at this point, and adjust the level control R1 for an acceptable presentation of the vertical rainbow color bar on the screen. Adjust the 7-25 pF C1 crystal trimmer capacitor until the movement of the bar slows sufficiently. This will place the crystal frequency so that it is within range of the 741 op amp voltage swing and so that the varicap can lock the crystal on frequency when the local frequency standard approaches phase resonance.

A VTVM at pin 6 of the 741 op amp is another good test point. Variations of C1 will cause changes at pin 6. When everything is working properly, the device for calibrating the frequency standard is ready to be used.

Everything is now ready for that very exciting moment, except for an extended period of warm-up time for the local standard. This period depends upon how accurate a calibration one is looking for. Obviously, if you are seeking the ultimate, then it is recommended that the oscillator, once turned on, remain on indefinitely. For a starter, I would suggest a 24-hour warm-up be considered as minimum. Then start a program of measuring the frequency every 24 hours, preferably at the same time each day. The stability will be erratic for about a week. If a careful record is kept, you will note that this stability will improve over the next 90 days, when it will settle out with a predictable aging rate thereafter. So there is no misconception at this point, it should be understood that, if the standard oscillator is one of mediocre quality (has no oven, not a low drift crystal cut, etc.), then one cannot expect accuracy of better than perhaps parts in 10^{-7} or worse. In this case, the unit should be warmed up for a period of 5 to 24 hours, calibrated as best you can, and used as soon thereafter as possible. If the crystal has an oven, the expected accuracy will be better. The quality of the crystal and the oven are of major consideration.

There are other causes for error. First, you must be certain that there is a network program or that the local outlet stabilizes its color burst using a rubidium standard. Also, note that some network programs are taped and then transmitted over the local station at a later time. Furthermore, at times between programming, the control is returned to the local station for commercial broadcasts and identification. Finally, there are momentary jumps in phase as great as ±70 nanoseconds that are produced when switching from one video tape machine to another with different lengths of cable in the path. There is also the multipath distortion between the local station and the receiver.

There is, however, another point that you must be aware of when calibrating for parts in 10^{11} accuracy. That is that the network rubidium broadcasts are slightly offset from the NBS standard frequency, and these offsets vary a small amount between networks and east and west coasts. These offsets are around minus 3000 parts in 10^{11} (-3000×10^{-11}). The exact offset is measured by the NBS and published monthly in their *Time and Frequency* bulletin. This publication can be obtained free by writing the Time and Frequency Services Section, NBS, Boulder CO 80302.

How to Measure the Frequency Offset

Those who have an extremely stable frequency source with a potentially high capability of accuracy may be interested in compensating for this offset. Frequency offset can be measured by calculating the accumulated phase differences between two signals. In the above case, where the subcarrier has an offset of -3000×10^{-11}, take the time, T (period of the beat note), required to accumulate one cycle of phase difference (Δt) at 3.58 MHz. Use $\Delta t = 1/f = 1/(3.5795 \times 10^6) = 27936 \times 10^{-11}$ seconds.

Offset = $\Delta t/T$ = (How much it moves)/(How long it takes) = (1 period of 3.58)/(1 period of beat note). The known offset for the TV networks is normally -3000×10^{-11}, so solve for $T = \Delta t/\text{offset} = 27936 \times 10^{-11}/3000 \times 10^{-11} = 9.31$ seconds as the period of the beat note. This means that the network subcarrier oscil-

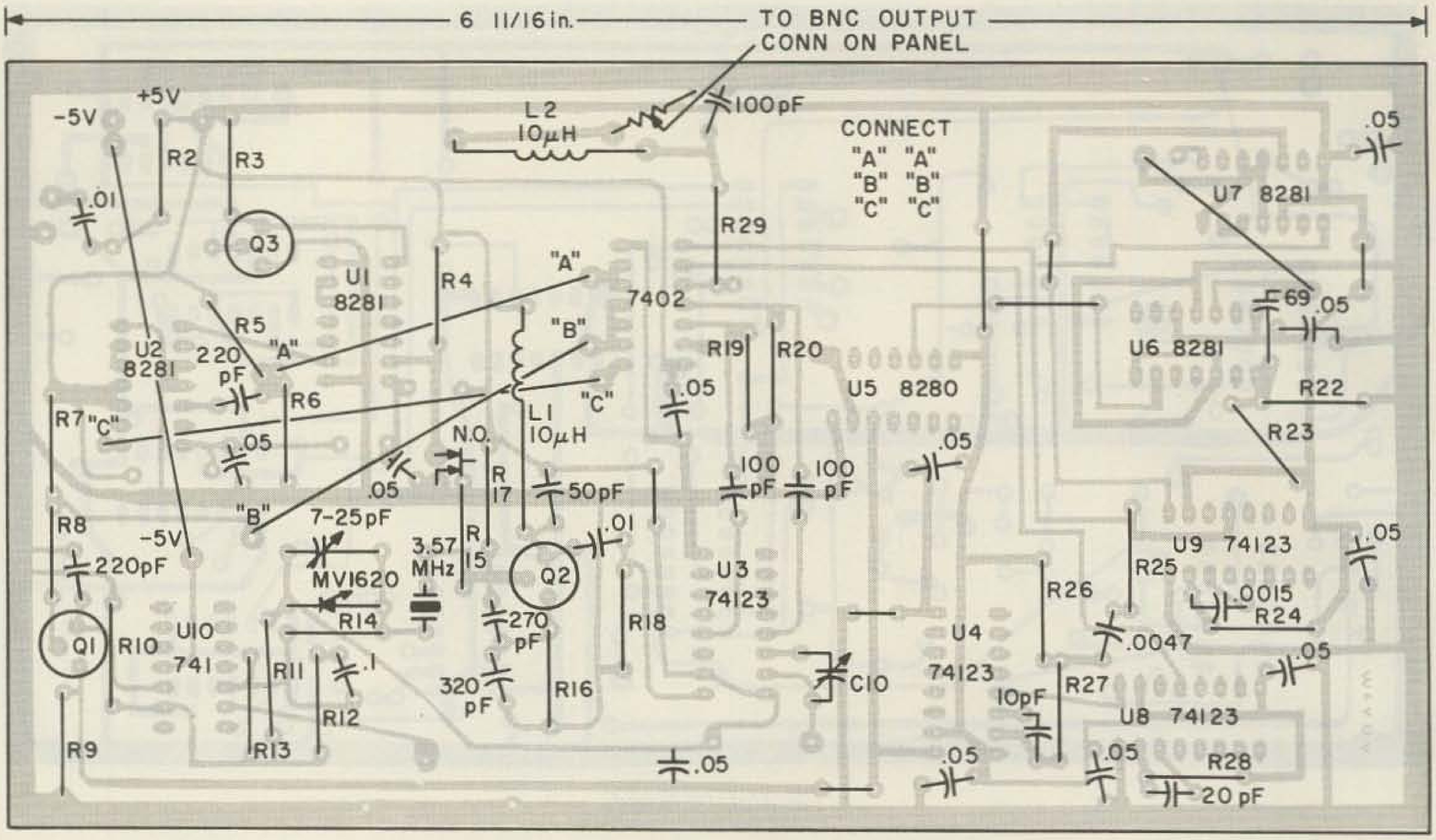

Fig. 4(b). Component layout (shown from foil side).

lator of 3.58 MHz would lose one cycle with respect to an NBS zero offset 3.58 MHz oscillator in 9.31 seconds.

Let's pull all the loose ends in now and review. You have two options for interfacing the oscillator you wish to calibrate and the network rubidium signal into your TV set – the antenna interface and the video interface. No matter how you get these signals into the receiver, they will be processed just as though they were a normal picture. The beat of the local crystal oscillator with the network signal forms a vertical "rainbow" bar. The color of the bar changes with respect to the network rubidium. Your job then becomes one of using a stopwatch to measure how long it takes this color change to occur. The stopwatch reading is equal to the period of the beat note.

To calibrate the crystal oscillator, tune in a network broadcast, and set the oscillator to be calibrated so that the rainbow appears to move across the bar from right to left in about 10 seconds. If the frequency of the oscillator is far off, the colors in the rainbow pattern will change rapidly and the entire bar will move in the direction of the color changes. The bar can be positioned to the middle of the screen by the push-button labeled "horizontal sync phasing." With the rainbow repeating colors in about 10 seconds, carefully adjust the crystal oscillator until the period is $T = 27936 \times 10^{-11}$/NBS published offset for the network being viewed. The result is a calibration with traceability to NBS.

Conclusion

For the previously discussed formula of $T = \Delta t/\text{offset} = 9.31$ seconds for the period of the beat note, it is recommended that one make the measurements over 10 beat-note periods. If they are taken over only one beat-note period, the effect of reaction time with the stopwatch will be reduced. For example, if, for a one-period measurement, an error of 0.3 seconds corresponds to a frequency error of 100 parts in 10^{11}, for ten periods, a measurement error of 0.03 seconds results in a frequency error of 10 parts in 10^{11}.

It has been observed that there is a general tendency among some amateurs who do not often come into contact with precision measurements to interchange such words as accuracy, tolerance, stability, resolution, and possibly a few others. It therefore seems appropriate to include a glossary of definitions.

Standards – Reference standards, as opposed to house standards, local standards, and working standards, are often called a transfer standard and are the standard used to convey frequency or time from the house standard to the working standard. The house standard may itself be considered a reference standard. The local standard is local in the sense that it is not a national standard, hence it may be a house standard or a reference standard or a working standard.

Time interval measurements – This means counting a frequency over an extended time period in order to average out short time anomalies. An example is measuring a one-second time readout counted over for a period of 10 seconds. At high frequencies, the error is small in either case. However, this method of measurement becomes important at low frequencies, for example, measurement of a 60 Hz line current frequency by the time interval or averaging method when fed directly into a counter using a one-second count rate or at a ten-second time interval rate. Counters have a plus or minus one count accuracy. Therefore, you can only read to a resolution of 1.0 Hz, whereas, if the period of measurements is 10 seconds, the accuracy improves to within 0.1 Hz.

Aging rate – This is the frequency drift rate of a well-designed quartz crystal, once the crystal and oscillator have reached stability. Commonly, a high quality A-T-cut crystal, well-protected against operating temperature variations, reaches a drift or aging rate of 5 parts in 10^{10} per day. This usually requires an initial operating time of 90 days.

Frequency offset — Fractional frequency offset is the amount by which a frequency lies above or below reference frequency. For example, if a frequency measures 1,000,001 MHz when compared against a reference of 1,000,000 MHz, then its fractional frequency offset is 1.0 Hz/MHz or one part in 10^6.

Phase anomaly — A sudden irregularity in the phase of a low-frequency or very high-frequency transmission.

Phase noise — A measure of the random phase instability of a signal.

Doppler effect (also called scatter) — Propagation delay time of a high-frequency radio transmission. This equates the great circle distance between the transmitter and receiving points, the number of Earth-to-ionosphere reflections during the transmission path, and the vertical height of the ionospheric reflection layers.

Frequency accuracy — The degree to which the measured or calculated value conforms to the accepted standard or rule.

Tolerance — The permissible deviation in the fineness, or between a pair of numbers of a measurement, owing to the difficulty of securing the exact conformity to the standard prescribed, for example, 100 kHz ± 0.1 Hz, or, as another example, the NBS in calibrating a 10 dB fixed attenuator. A reference standard which a manufacturer submitted for calibration against one of 10-times-greater accuracy (a magnitude better accuracy) may receive a certificate of certification stating that, at a given frequency on a given date under certain environmental conditions, the measured value was 10.05 dB ± 0.1 dB ± 1.0%. The tolerance of the measurement was within 0.1 dB with uncertainties of 1.0%.

Stability, short- and long-term — One of the most important characteristics of frequency and time standards. Long-term stability or long-term instability refers to the low changes in average frequency with time arising from changes in the resonator or other elements of an oscillator. Statements of long-term stability for quartz oscillators often term this characteristic aging rate and specify it as "parts per day" fractional frequency change over 24 hours.

Short-term stability or instability is an expression of the change in average frequency over a time sufficiently short (but exceeding some minimum time) that long-term effects are of small significance. A typical statement for an ultra-precise quartz oscillator would be, "Fractional frequency deviation is one part in 10^{11} for 0.1 second averaging time and is 5 parts in 10^{11} per day."

Precision, reproducibility, resettability — All imply the existence of an observation consisting of a series of readings taken in a prescribed manner. Precision is a quality of sharpness of definitions. It also incorporates the random error of a reading. Reproducibility is a sequence of comparisons (as an instrument against a standard) which will yield a mean and a standard deviation. The latter may be called the reproducibility of the instrument. Use of this term implies that the instrument was independently adjusted between measurements, so the resettability of the instrument is a factor.

Error — The difference between the true value and an observed or calculated one.

Uncertainty — That value remaining once the error has been corrected. ■

References

1. *New Frequency Calibration Service of the National Bureau of Standards* by Dick Davis.

2. *Frequency and Time Standards*, Hewlett-Packard Application Notes #52.

3. "How Accurate Is Your Counter — Really?", Bob Bloom W6YUY, April, 1976, *73 Magazine*.

Super Deluxing the TR-33

—build this synthesizer

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The Drake TR-33C is a real money-saver when it comes to buying crystals because one rock gives transmit and receive on a standard repeater pair plus simplex on that repeater output frequency. If you're like me, however, you still don't like to wait 3 weeks for a crystal to get on a new machine or be out in the cold when your favorite repeater changes frequency. This happens a lot in southern California, and, out here, having only 12 channels can be a real limitation, too.

Why not synthesize the TR-33? It's a great idea, since only one frequency needs to be generated. But the published synthesizer circuits seem to all use lots of TTL, which eats up precious battery power.

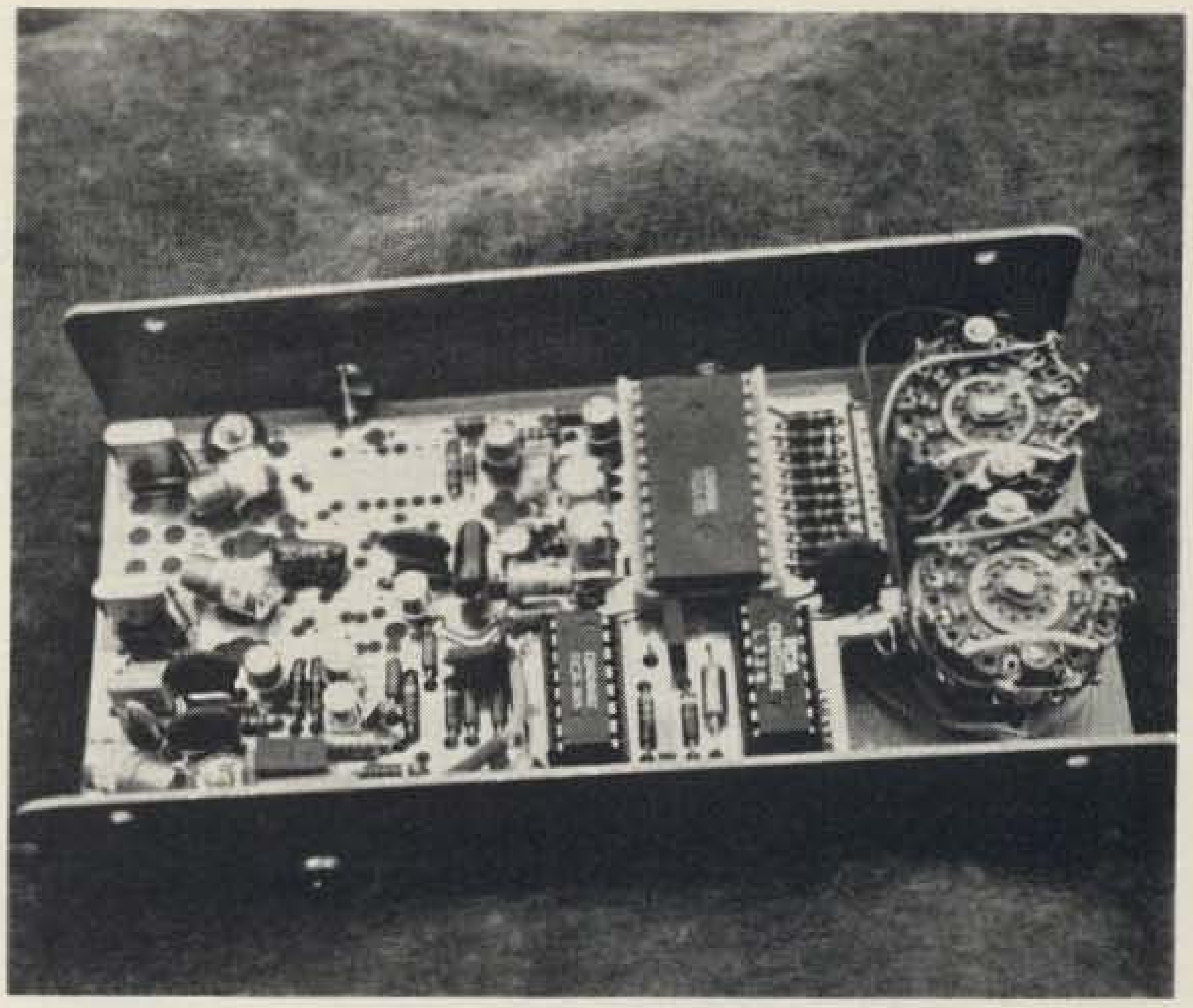
The answer is CMOS logic and a loop circuit originally designed for the HT-220 by Dale Heatherington WA4DSY.[1] The HT-220 requires that both transmit and receive frequencies be generated, and Dale's circuit achieves this with offset oscillators and T/R switching circuits that use three extra crystals and five extra transistors. The TR-33's built-in offsets eliminate the need for all those parts and result in a synthesizer circuit with two crystals, 3 ICs, 7 transistors, and miscellaneous small parts. Any 5 kHz-spaced channel between 146.000 and 147.995 can be selected. Tune-up is simple, since there is only one tuned circuit. If your junk box can provide the resistors, capacitors, and bipolar transistors, you can synthesize your TR-33 for about 40 dollars. And, since only one frequency is generated, the synthesizer can be hooked to the rig with just one coax line for both power and rf. Spurs on this line measured -53 dB or better. Battery drain is a measly 25 mA.

How It Works

The frequency to be generated is given by the formula $F_S = F_O - 10.7\ MHz/9$, and Fig. 1, the schematic, shows how this occurs. The reference frequency is 5 kHz divided by 9, or 555.555555 Hz, generated by dividing a 9.102222 MHz crystal oscillator output by 16384. The vco output at F_S is buffered by Q5 and Q7, and a sample is mixed with the 14.3666 MHz offset frequency at Q6. The difference is applied to U1, a programmable divider which is set by the frequency-select switches to divide by a number between 1200 and 1599. U1's output, at 555.555555 Hz, is compared to the reference frequency by the phase detector in U2, a CMOS PLL chip. The phase detector output is filtered and controls the frequency of the vco via varicap D2, closing the loop. Regulator transistor Q1 supplies 10 V to all circuitry from the TR-33's 12 V batteries or any external source powering the rig.

Construction

Dale built his synthesizer on a 2¼ x 4¼-inch board which fit inside his HT in place of the optional PL board for that rig. If you're a miniaturization nut with tiny fingers, I bet you could fit my circuit somewhere inside the TR-33C on a board about 2/3 the size of Dale's, although it wouldn't be easy. I may try it myself someday, but I don't like the idea of using a BCD-coded DIP switch to enter the frequency, which seems to be the only way to do it if it's built in. Besides, I was in a hurry to get it on the air, so I ordered a board from WA4DSY, slapped in just the required parts, stuffed it all in a 5½ x 3 x 1¼-inch aluminum box, and it worked right away.[2] I suggest you do the same, since the board is top quality, fully drilled with plated-through holes, and makes for a neat unit about



the size of your calculator with plenty of room for rotary or thumbwheel switches. Along with the board you also get tune-up information, including key waveform photos which are applicable to this use.

It's a good idea to use sockets on the ICs — the low-profile kind work well with the plated-through holes

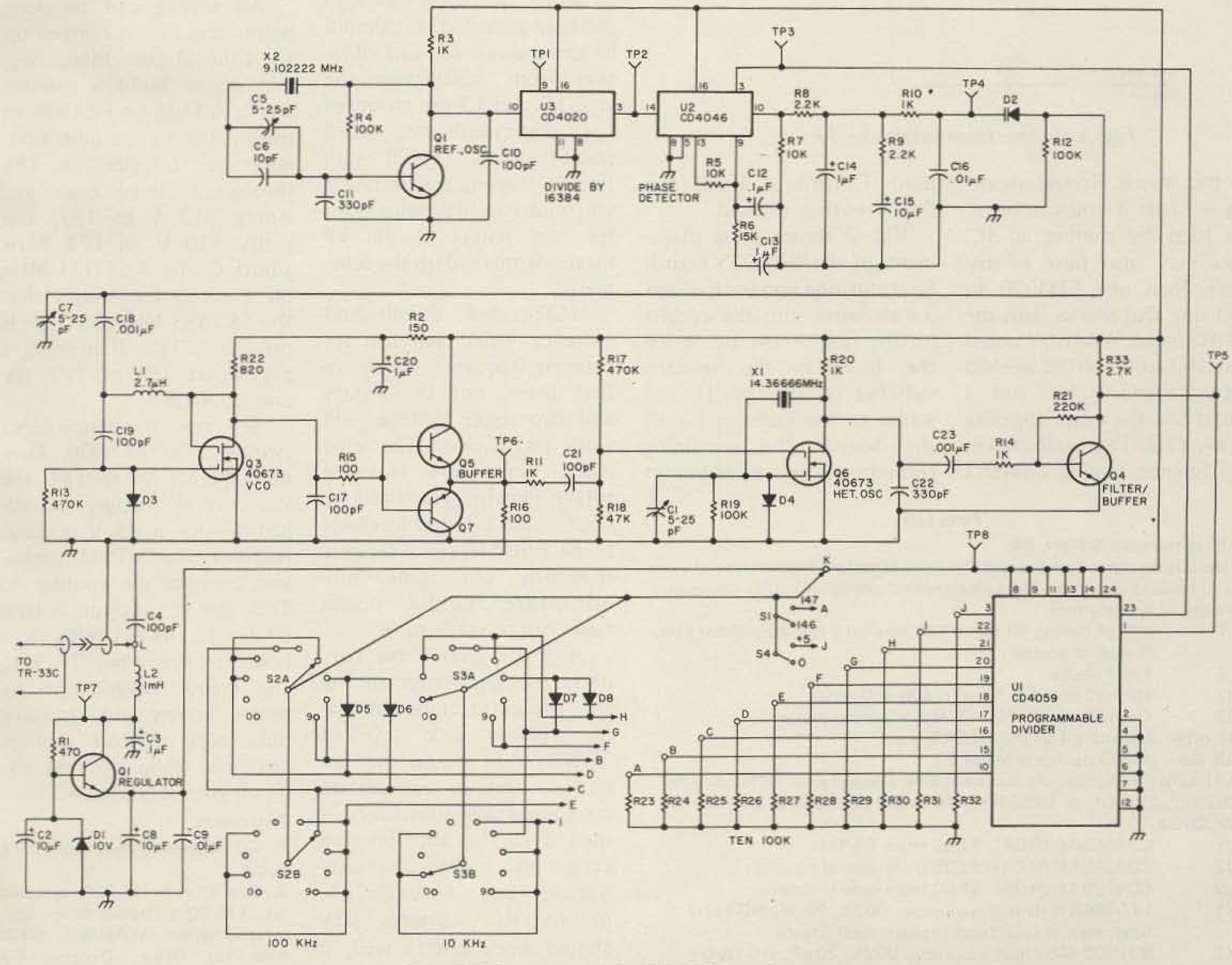


Fig. 1. Schematic of the TR-33C synthesizer.

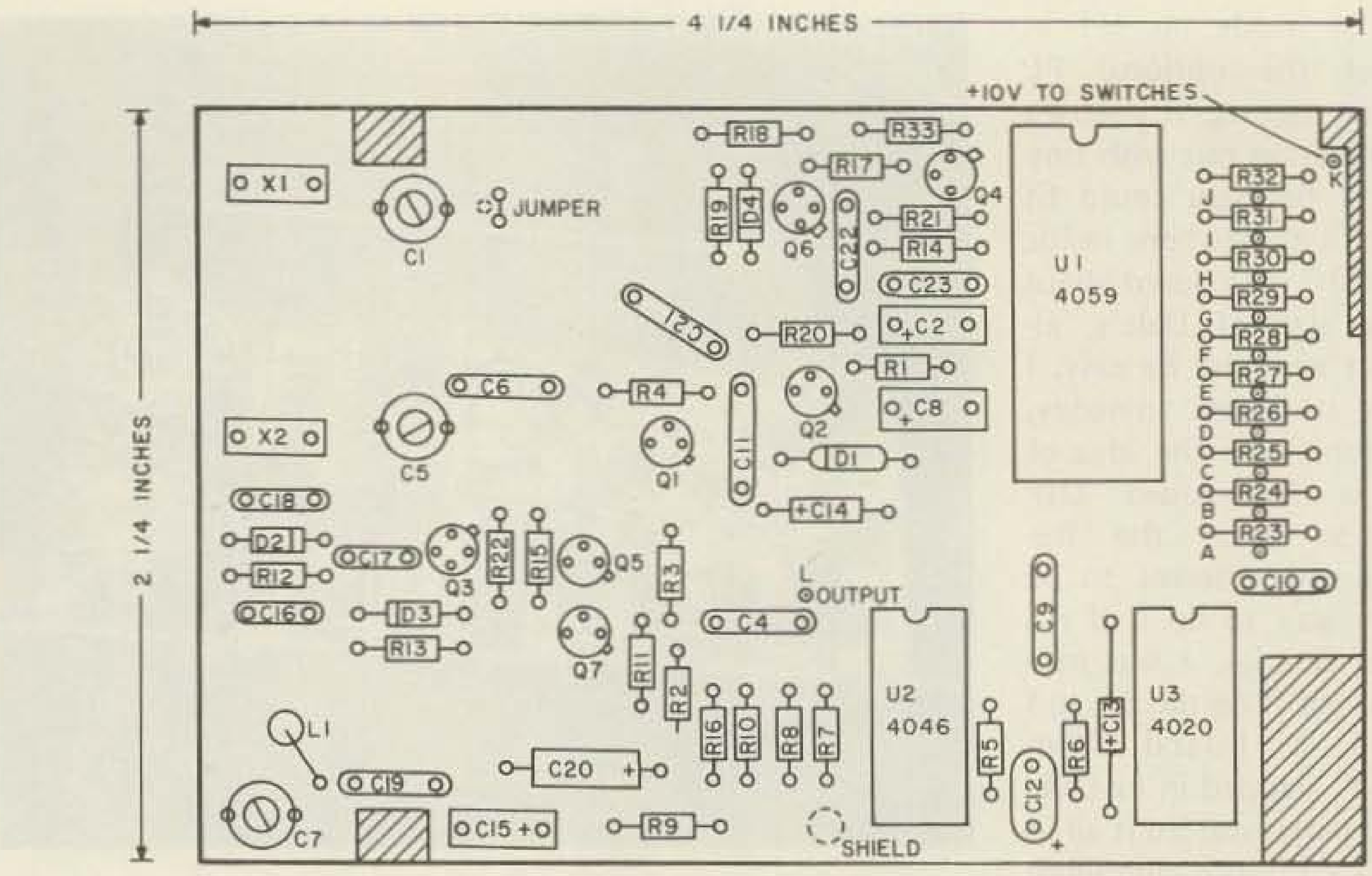


Fig. 2. The WA6JFP synthesizer as constructed on the WA4DSY board. L2 and C3 are not shown, as they mount underneath the board where it's convenient.

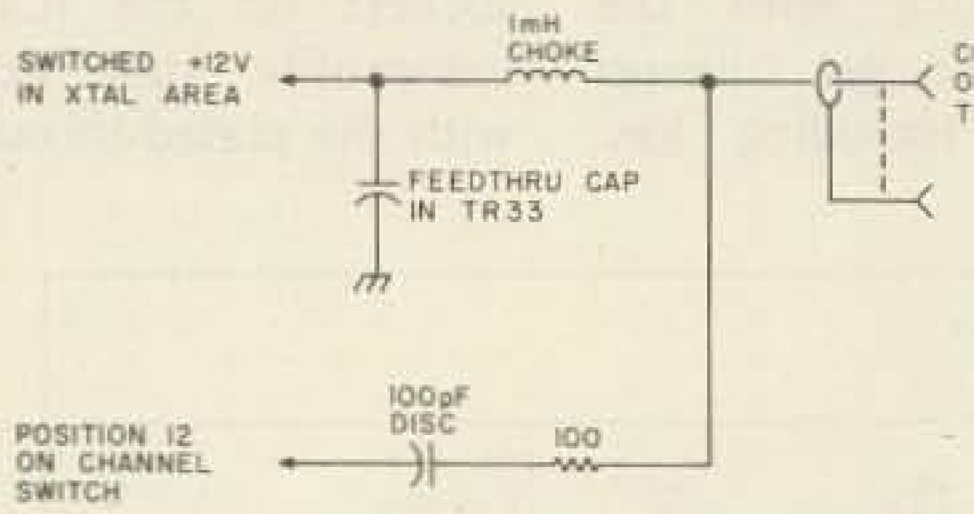


Fig. 3. Connections inside the TR-33C.

on this board. Troubleshooting is easier if you can break the loop by pulling an IC. You may also have to try more than one CD4020 to find one that works with the 9 MHz input. WA4DSY noted that Motorola's 4020 worked better than RCA's, but I found just the exact opposite in my case. The batch makes a difference, I guess. I haven't tried Fairchild's 4020, but Dale says they worked.

Fig. 2 shows parts placement on the WA4DSY board. First put one end each of ten 3-inch wires into the eyelets on the rear of the board for the leads to the selector switches (A through J) and solder to the etch on top of the board. The remaining components and wires mount from the top, are soldered in on the bottom, and can be installed in any order. L1 is mounted vertically through the hole provided and should be glued down to keep vibration from modulating the vco. L2 and C3 are mounted last, underneath the board point-to-point. You'll save time in aligning and testing if you solder in little wire loops for test points at the TP locations marked on the schematic.

BCD-coded thumbwheel switches would be ideal for entering frequency if you can find them, but two rotary and two toggle switches will work just as well. The schematic shows how two-pole rotary switches are wired in. C1, C5, and C7 were intended to be Erie 518-series ceramic trimmers, but some subminiature surplus piston types can be made to fit.

A single coax cable connects the synthesizer to the rig. The extra unused miniature phone jack (marked TONE IN) should be removed, and an appropriate coax receptacle substituted. I used a surplus subminiature screw-on microwave connector, but a single-hole mount RCA phono jack should work just as well, if the hole is drilled out slightly.

Fig. 3 shows the additional coax and components in the TR-33C. There should be plenty of room in the crystal compartment, even if there are already 11 rocks in the rig. The synthesizer is hooked to position 12 on the selector switch after the 12th crystal (if you had 12) is removed. A feedthrough capacitor in the crystal compartment will provide switched +12 volts. To use the unit, turn the selector switch to 12. The other crystal positions are available as before, and the unit can be unplugged when you're operating rock-bound. I'd recommend this not only to reduce battery drain somewhat, but also to avoid the funny birdies caused by rf from the synthesizer coupling to the crystal oscillator in the compartment.

Tune-up and Testing

All testing can be done before the unit is hooked up to your Drake. First, beg, borrow, or build a counter and a VTVM or FETVM to use in aligning the unit. Connect the counter to TP1 through a 20 pF capacitor. Apply +12 V to TP7, and verify +10 V on TP8. Now adjust C5 for 4.551111 MHz on the counter. Verify that the 555.555 MHz reference is present at TP2. If nothing is present at TP1 or TP2, try another 4020.

Set the frequency-select switches for 147.000. Connect the VTVM to TP4, the vco control voltage, and adjust C7 for a +5 V reading. Remove the VTVM probe, and connect the counter to TP6, the vco output. Adjust C1 for 15.144444 MHz. Now hook it up to your TR-33C, and enjoy snooping on repeater inputs and checking out those oddball simplex channels while carrying the rig on your shoulder. ■

Parts List

All resistors are ¼ Watt, 5%.
Electrolytic capacitors are subminiature tantalum types with radial or axial leads as shown on parts placement drawing. All other capacitors are small disc ceramics.

L1	2.7 uH choke, 40 turns #36 wire on a ½ Watt resistor body (1 meg or greater)
L2	1 mH choke
D1	1N5530 or other 10 volt, 400 mW zener
D2	1N5144 or other 22 pF at 4 V tuning diode

All other diodes are 1N4148, 1N914, etc.

Q3, Q6	40673 dual-gate MOSFET

All bipolar transistors are fast-switching silicon types. NPNs may be 2N2222, 2N4401, or MPS3704. PNPs may be 2N2907, 2N4403, or MPS3703.

U1	CD4059AE (RCA), $7.95 from Tri-Tek
U2	CD4046AE (RCA), $3.00 from several suppliers
U3	CD4020AE (RCA), $1.00 from several suppliers
X1	14.36666 MHz high-accuracy, .002%, 20 pF, HC-18/U fundamental type from International Crystal
X2	9.10222 MHz high-accuracy, .002%, 20 pF, HC-18/U fundamental type from International Crystal

References

1. *CQ Magazine*, February, 1977, p. 52.
2. Board and HT-220 write-up are $15.00 postpaid from Dale Heatherington WA4DSY, 3126 Flamingo Drive, Decatur GA 30033.

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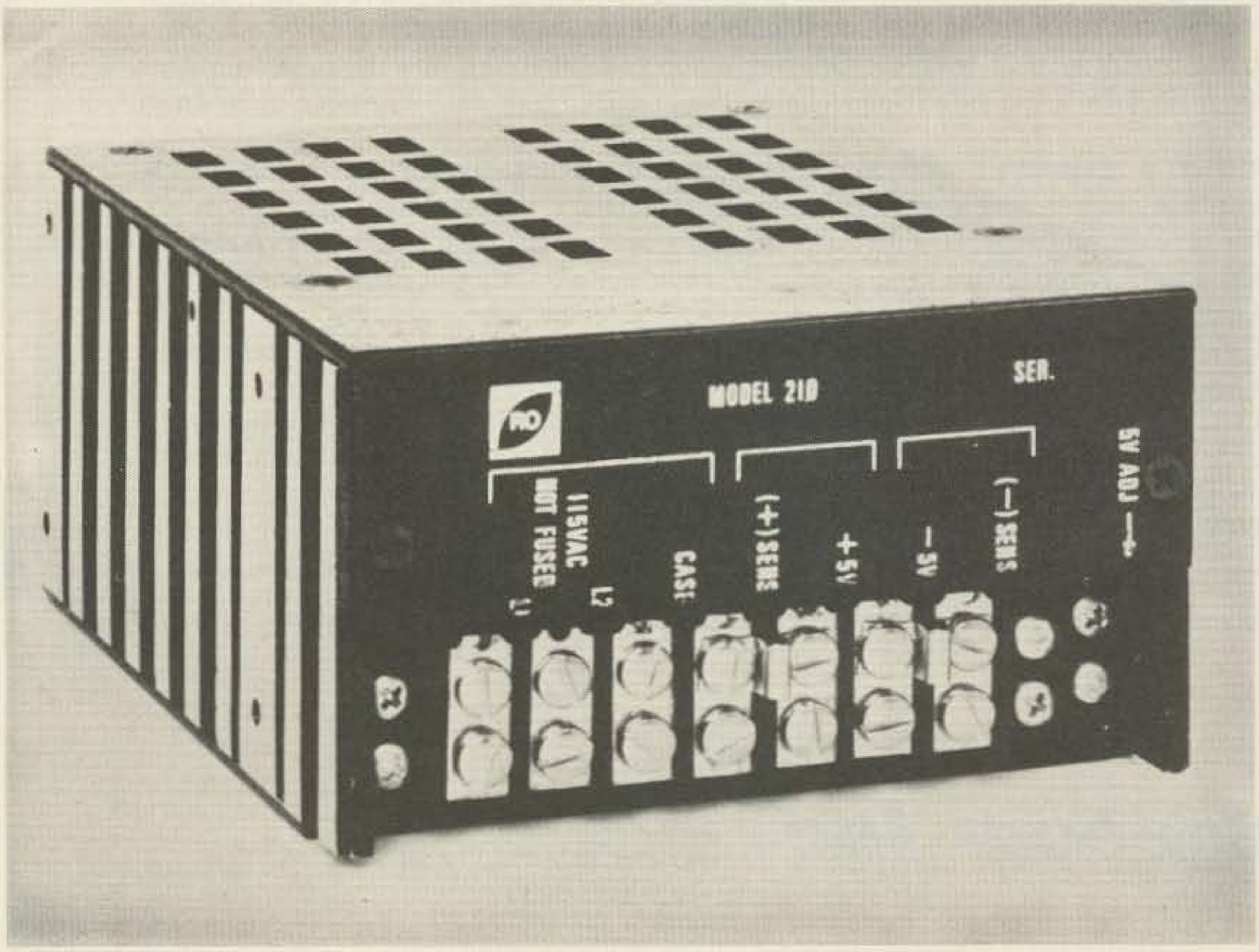
Feeding a Hungry Microcomputer

—power supplies

The microprocessor is a wondrous device, and, with its other associated ICs, it can do things of logical complexity that were unimagined by the tube-circuitry users of several decades ago. While most modern digital ICs are frugal in power consumption, compared to tubes in similar service, the sheer scale of a microcomputer often puts its power consumption up into the hundreds-of-Watts category. A look into almost any of the hobby computers will reveal a power transformer that would rival in size that found in an early tube-type TV set. This is not surprising, since, for any given set of transformer basic materials, the volume of a 60 Hz transformer is directly related to its power-handling capability.

Let us look at power supplies in general and also in particular as they are used in microcomputers. A power supply generally consists of roughly four blocks, as shown in Fig. 1. The transformer has the duty of reducing the line voltage (120 V ac, 60 Hz or 240 V ac, 50 Hz) to some lower voltage that is compatible with the solid state circuitry. It also could step voltage up to be more compatible with tube or other high-voltage components, but you'll be mostly concerned with low-voltage supplies in microcomputers. The power transformer usually steps the line voltage down to an ac voltage that is somewhat larger than the final dc output voltage that you'll wish to use in your circuitry. This excess allows for the various losses that take place in the transformer, rectifier, filter, and regulator.



To illustrate this point, let's examine the typical case of a 5-volt, 8-Amp supply for a TTL system. The portion of the supply before the regulator is shown in Fig. 2. Two series-connected (6.3 and 2.5 V) transformers provide full-wave rectified dc via a silicon bridge rectifier, and the filter is a 12,000 μF capacitor. There are losses in the transformer itself, the most obvious one being the secondary winding resistance. The rectifiers also have a forward voltage drop, which varies with current, as shown in Fig. 3.

Note that, in the bridge rectifier, since two series rectifiers are involved in charging the capacitor, the forward voltage drop is double that of a single rectifier. And, finally, the capacitor itself (because of its finite capacity) has an apparent drop of voltage across it as increasing current is drawn from it. This is not a loss per se, but rather is simply due to the fact that the capacitor can only store so much energy between rectified ac cycles. The net effect of all this is that the filter output voltage at point C versus the current of the supply shown in Fig. 2 is like that shown in Fig. 4. The output at point C can be as high as 12.6 volts at no load and as low as 8.6 volts at an 8-Amp load. The regulator attempts to "slice off" the variations at the dotted line in Fig. 4 and put out a constant +5 volts regardless of the loading (up to 8 Amps).

Most regulators require that their unregulated input be at least 2 or 3 volts above the output voltage. So, in order to have a nice constant 5-volt output capable of operating 8-Amps worth of TTL and other microcomputer IC chips, you must waste considerable power in the supply. The wasted power shows up as heat, and, therefore, you find large aluminum heat sinks and even fans in some microcomputers.

Power transformers are generally made up of E-shaped and I-shaped thin laminations of silicon steel interleaved and mutually insulated with a varnish. This standard configuration has been around, pretty much unchanged, since the earliest days of electronics. The windings, generally of insulated copper wire, are wound so as to pass through the "windows" formed by the E-I iron stack (core). There may be only a primary and a secondary, or there may be multiple secondary windings, and some windings may be tapped. Occasionally, transformers may have two primaries, too, so that they may be connected in parallel for 120 V ac or in series for 240 V ac. As an example of a common transformer having both primary and secondary taps for almost universal use in low-voltage power supplies, consider the Triad F92A, as shown in Fig. 5. Note that the secondary is center-tapped, and then one section of the secondary between the (yellow) center tap and the red lead is again center-tapped (blue). With these taps and those on the primary, you can achieve all the voltages shown. The Triad F92A is rated at 1 Amp secondary current. As you'll see, this may provide up to 2 Amps of dc in the full-wave rectifier connection. Triad has a series of transformers (F90X through F94X) that have the same voltages and taps as the F92A, but have smaller current ratings, down to 35 mA.

The variations of rectifier-filters further increase the flexibility with which we can adapt a given transformer to suit a desired output voltage and current. In Fig. 6 are presented seven different rectifier-filter combinations, all based on the same transformer and the same capacitance-voltage product. Note the seven rather different load curves for the seven different circuits. It also should be noted that all the rectifier-filter circuits except (a) and (g) produce full-wave rectification, having a ripple frequency of twice the line frequency (which is easier to filter out of the dc than a ripple frequency that is equal to the line frequency).

There are two variations on the bridge circuits that can be useful in logic designs using microprocessors, where multiple voltages and positive and negative voltages are often required. The circuit of Fig. 7(b) produces equal positive and negative voltages. It might be argued that the circuits 7(a) and 7(b) are one and the same, with a different point serving as common in the two cases. This, of course, is a valid way of looking at the circuits. Circuit 7(b) might also be looked upon as being two full-wave rectifier circuits, like that in Fig. 6(b), operating from the same

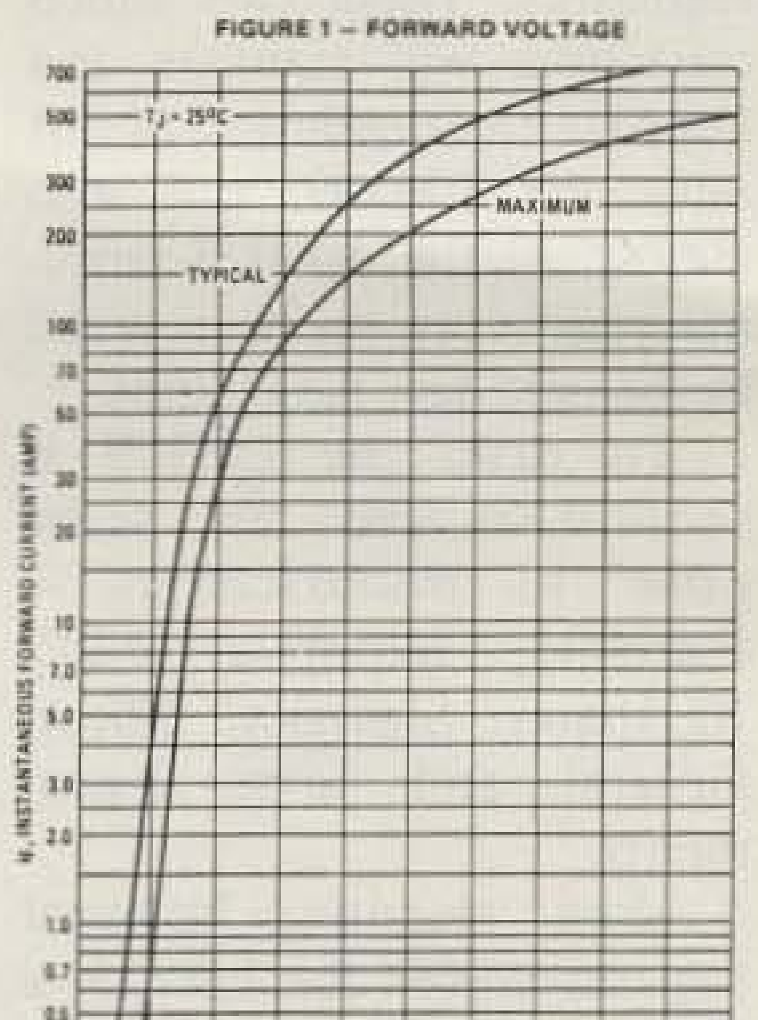


Fig. 3. Forward voltage drop (of one diode) of a Motorola MDA980 bridge rectifier.

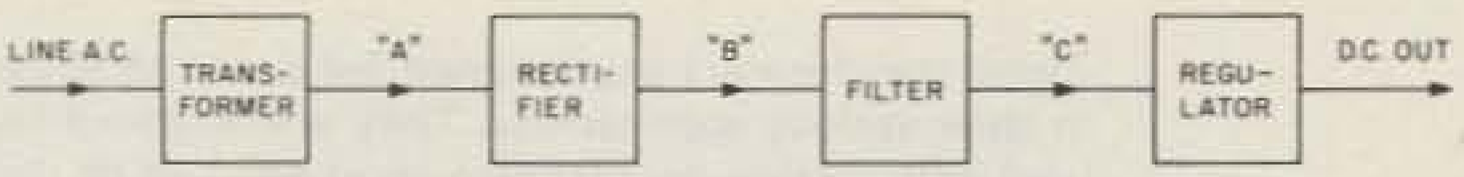


Fig. 1. Block diagram of a conventional regulated power supply.

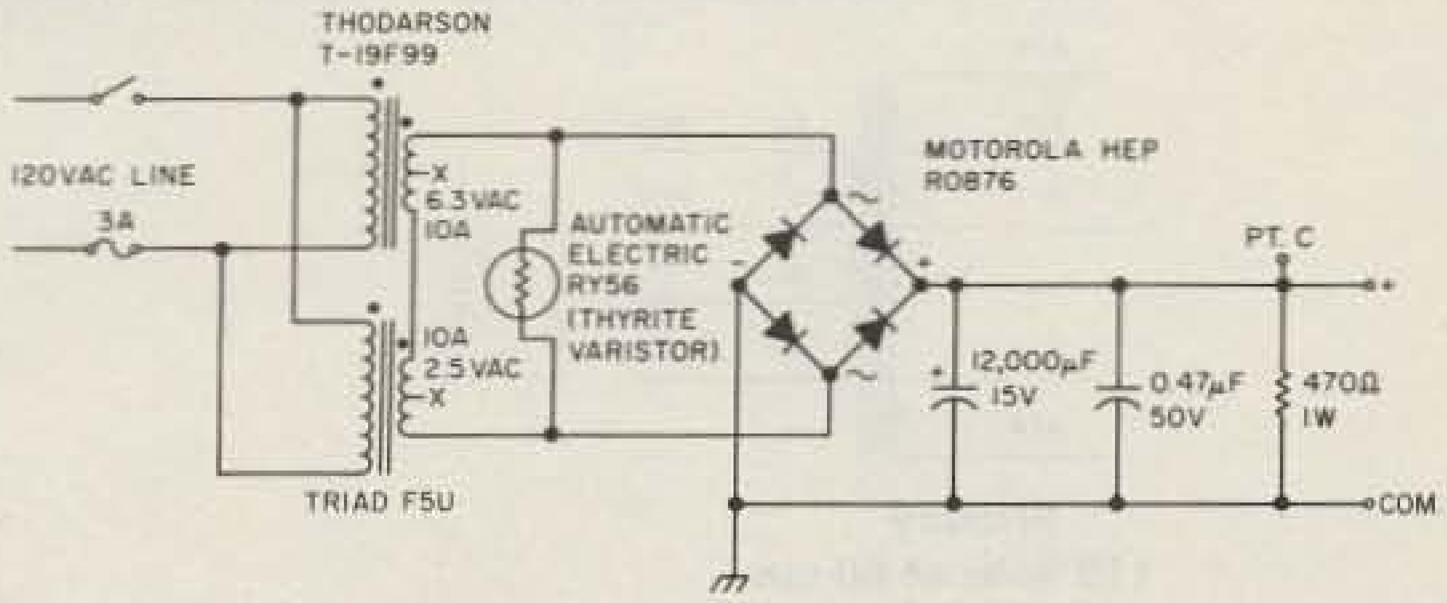


Fig. 2.

transformer.

Regulators have grown in sophistication from a simple resistor-zener combination, through the emitter-follower regulator, the simple one-transistor gain stage closed-loop regulator, the closed-loop regulator using differential amplifier or op amp, and the special-purpose IC regulator. These stages of regulator evolution (Fig. 8) have brought us to the modern 3-terminal and 4-terminal IC regulators, which need no external power transistors in conjunction with them. The modern 3-terminal or 4-terminal regulator can handle currents up to 5 Amps alone (on an adequate heat sink) and is the type of regulator almost universally used in hobby microcomputers.

The first really popular three-terminal regulator IC was the National LM309, a +5-volt fixed regulator in a TO-3 (large diamond) package. The LM309 is also available in the TO-5 "metal can" package, when smaller current capability is needed. The 5 V, 1 Amp rating of the LM309 made it instantly accepted for use in TTL systems. Since microcomputers often need as much as 20 Amps of the regulated +5 volts, the general practice was to "put an LM309 on every board" and use a sort of distributed regulation system. A block diagram of such a scheme is shown in Fig. 9. Note that unregulated dc is distributed on the bus of the microcomputer, and regulation for each board is accomplished by a regulator IC on that board. This method has a number of advantages over using one big brute of a regulator and then fanning out regulated +5 volts over the microcomputer bus. The first and most obvious advantage is that the heat dissipated in the regulators is spread out over the length of the bus, which helps prevent hot

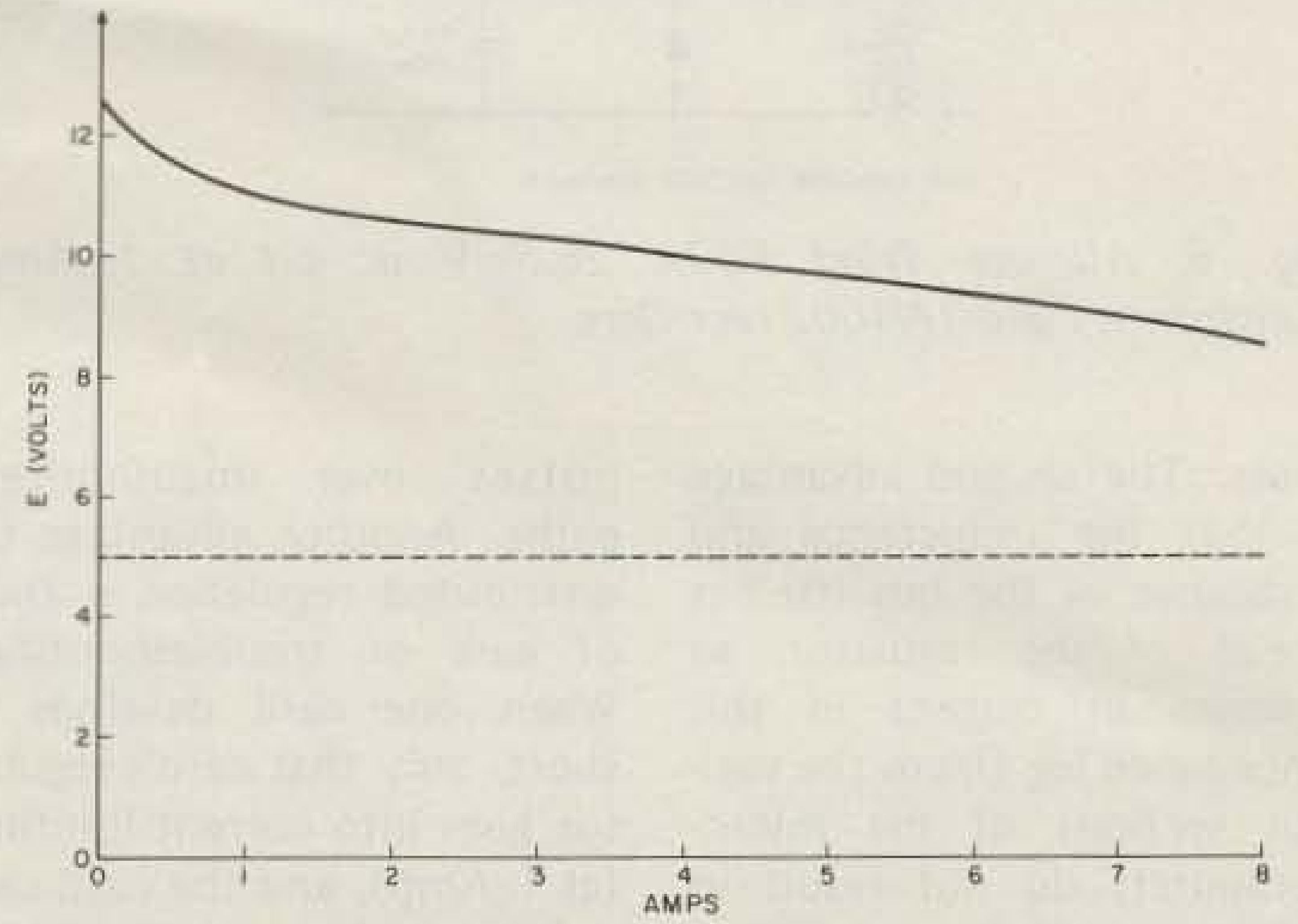
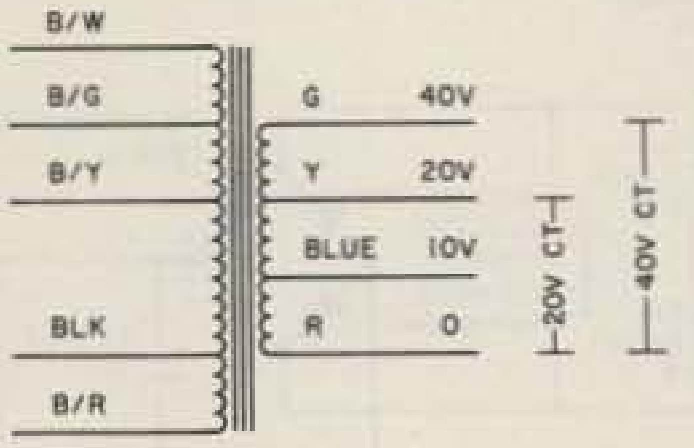


Fig. 4. Regulation curve of supply in Fig. 2.

These transformers are designed for use with silicon diode rectifiers, to supply the dc voltages for transistors in their various applications. They are intended for use with full-wave bridge or bridge rectifiers, but may be used with voltage-doubler circuits at one-half of the rated current.

Caution: Never apply the full line voltage (115 volts) between the Black/Red and Black leads of the primary. One of these leads is used as a primary common lead in all applications. The lowest output voltage is obtained when the available line voltage is applied to the Black/Red and Black/White primary leads.



Primary
115 volts ac 60 cps

Secondary ac voltages obtainable

40 V c-t, 38 V c-t, 34 V c-t, 32 V c-t, 30 V c-t,
28 V c-t, 20 V c-t, 19 V c-t, 17 V c-t, 16 V c-t,
15 V c-t, 14 V c-t
30 V 28.5 V 25.5 V 24 V 22.5 V 21 V
10 V 9.5 V 8.5 V 8 V 7.5 V 7 V

Secondary

Lead	Lead	Leads	Green Red	Leads	Green Blue	Leads	Yellow Red	Leads	Blue Red
Black/Yellow	Black	40 V c-t	Yellow	30 V		20 V c-t	Blue	10 V	
Black/Yellow	Black/Red	38 V c-t	Yellow	28.5 V		19 V c-t	Blue	9.5 V	
Black/Green	Black	34 V c-t	Yellow	25.5 V		17 V c-t	Blue	8.5 V	
Black/Green	Black/Red	32 V c-t	Yellow	24 V		16 V c-t	Blue	8 V	
Black/White	Black	30 V c-t	Yellow	22.5 V		15 V c-t	Blue	7.5 V	
Black/White	Black/Red	28 V c-t	Yellow	21 V		14 V c-t	Blue	7 V	

Fig. 5. Triad F92A transformer (1 Amp rated) showing how primary and secondary taps can increase flexibility.

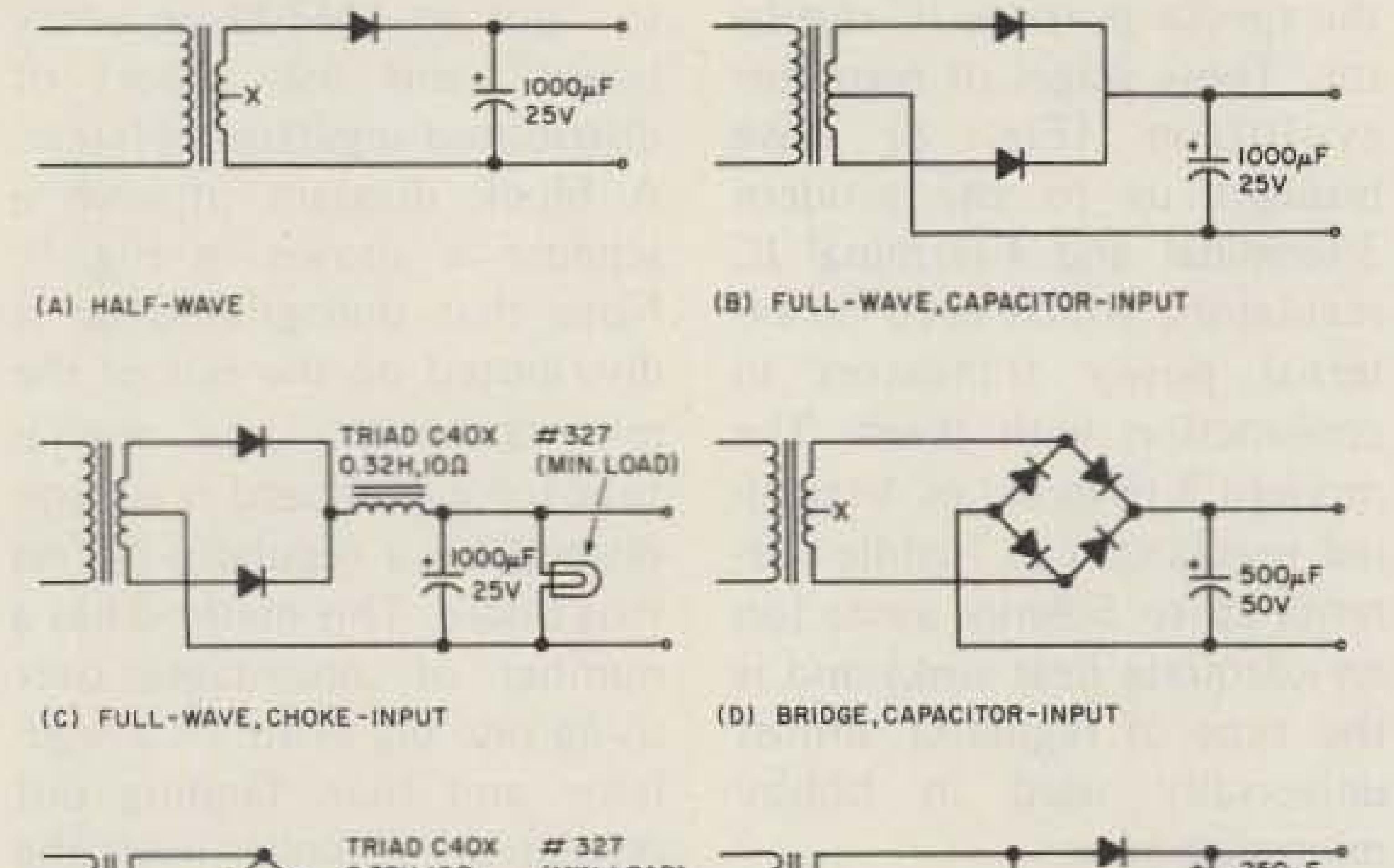


Fig. 6. All use Triad F40X 26.8 V ac c-t at 1 Amp transformers and 1N4002 rectifiers.

spots. The second advantage is that the inductance and resistance of the bus itself is ahead of the regulator, so changes in current in this impedance leg (from the various sections of the microcomputer) do not result in voltages that cause card-to-card communication of logic pulses over unauthorized paths. Another advantage of distributed regulation is that of ease of troubleshooting. When one card develops a short, only that card's regulator goes into current limiting (at 1 Amp), and the card can quickly be isolated, removed, and repaired.

Some notes and precautions should be added on the LM309 and its use. The LM309 is required to have at least 0.22 µF across its input and common pins. This requirement can be filled by the rectifier-filter capacitor if it is within about 2 inches of the input pin of the LM309. I also add the 0.22 µF capacitor across the output of the IC. The output capacitor doesn't affect stability, but it lowers the high-frequency output impedance of the regulators. These two added capacitors will stabilize and improve the regulation of not only the LM309, but also almost all the other 3-terminal regulators to be covered in the next few paragraphs.

To date, the LM309 is second-sourced by seven other IC manufacturers – Fairchild, Motorola, NPC, Raytheon, Signetics, Silicon General, and Texas Instruments.

More recently, National has introduced the LM323, a sort of super LM309. It, too, is a 5-volt regulator, but has 3-Amp output capability.

Since National introduced the LM309, a number of companies have expanded the fixed-voltage three-terminal regulator IC business considerably. Fairchild introduced the µA7800 series in both the TO-3 package and also in the economical TO-220 plastic power package. The µA7800 was available in a variety of output voltages from +5 volts to +24 volts. The last two digits of the µA7800 number indicate the output voltage; for instance, a µA7812 is a +12-volt regulator.

After the introduction of the LM309 and the µA7800 series by National and Fairchild, most of the other linear IC manufacturers in the U.S. got into the act. Now experimenters can buy one of the "7800" series from a variety of IC producers, and the mail-order houses have them at what appear to be shockingly low prices. Often the surplus or hobby-grade regulators will be out-of-spec units having voltage-output or current-limit specs not within the published requirements. I've even seen a few such bargains that apparently regulated, but had high-frequency oscillations in their output. You certainly can get a bargain in surplus 3-terminal regulator ICs, but it's wise to check your purchase care-

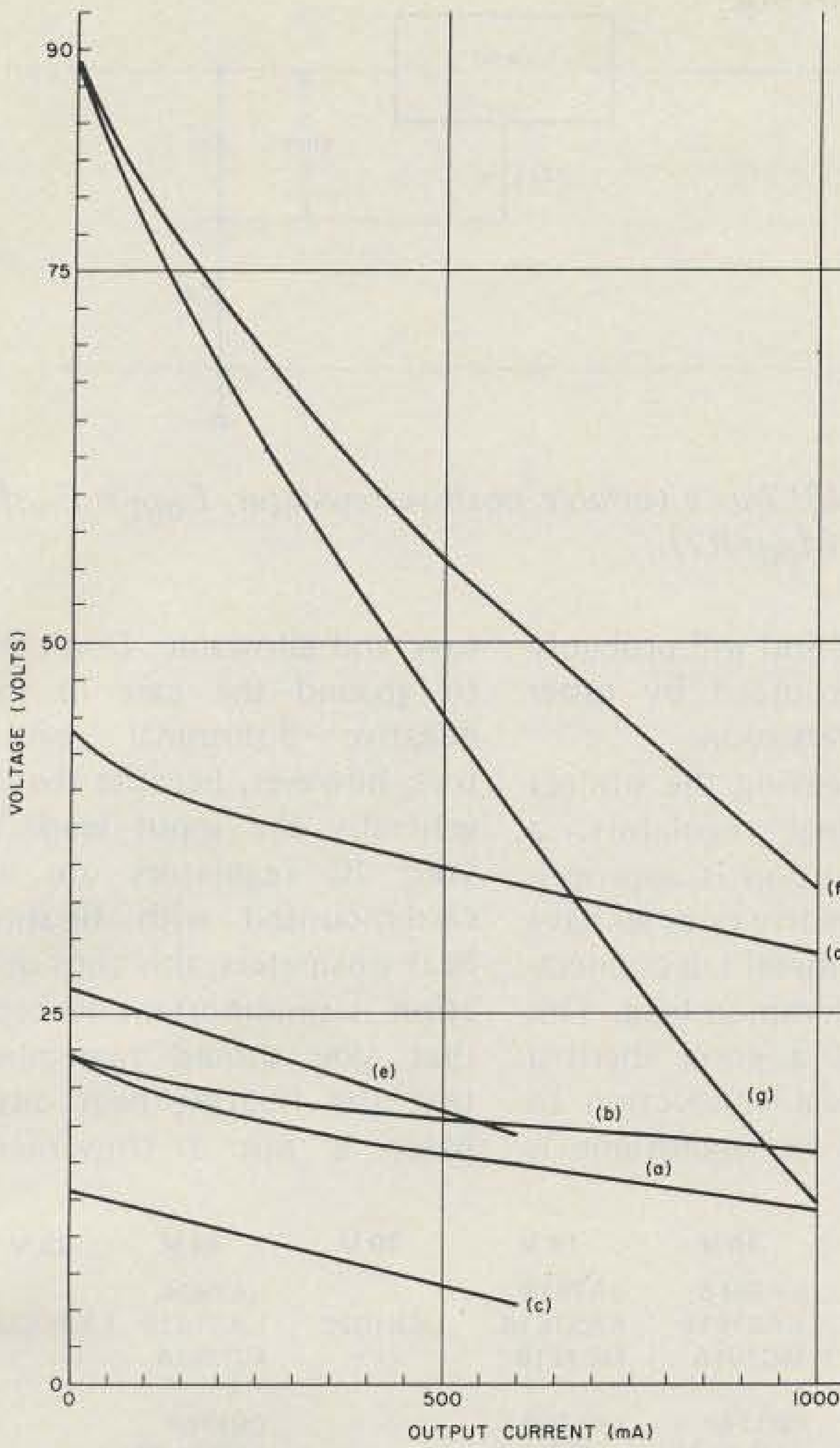


Fig. 7. Curves (c) and (e) are continued only to 600 mA because of choke rating.

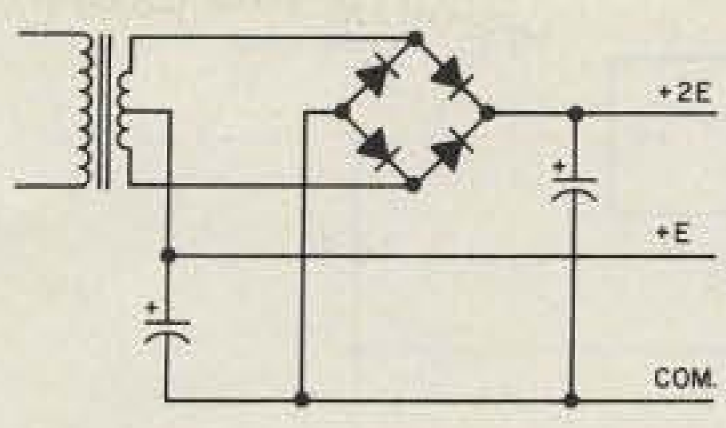


Fig. 7(a).

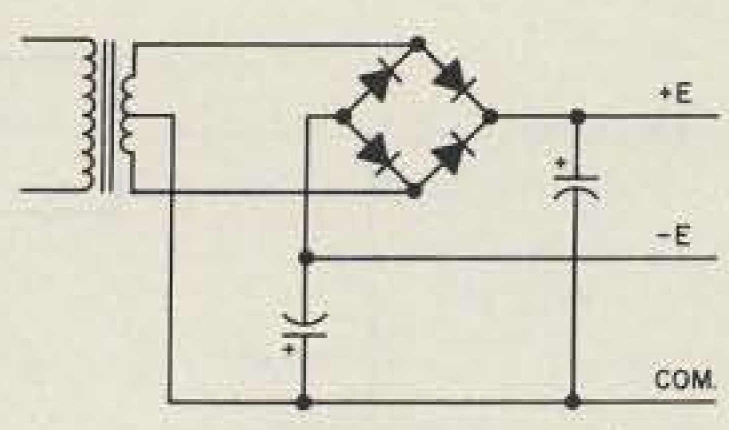


Fig. 7(b).

fully.

The 3-terminal regulator IC business has expanded in several directions since the μA7800 series introduction. Both larger and smaller current versions have been introduced, and a whole series of negative 3-terminal regulators has been made available. The most common negative version is the "7900" series, although the National LM320 series is also popular. National has the LM340 for its positive 3-terminal regulator and LM320 for its negative units. The two digits following the dash in the National part number identify the regulated output voltage.

So that you can order the proper 3-terminal regulator IC from among all the various types available, I have compiled some tables. In these tables, I have included only the commercial grades of regulators; military and high-reliability parts are not usually used by the hobby market because of their cost. In Table 1 are presented the 7800 and 3400 series of 3-terminal regulators, representing the base line or standard family. Table 2 gives the 78M00 medium-current families, having less current capability than those in Table 1. Then Table 3 goes still further down in current rating to the 78L00 group. Fairchild has recently introduced a family of higher current 3-terminal regulators, which is shown in Table 4. These ICs have greater current capability than the 7800 series.

A new and rather innovative addition to the 3-terminal positive-regulator IC series is the Signetics μA78HV00 series. These are essentially the same as the Signetics μA7800 series (Table 1), except that they will take voltages at the input up to 60 volts, as compared to the standard of 35 to 40 volts. This option protects the regulator IC against transients

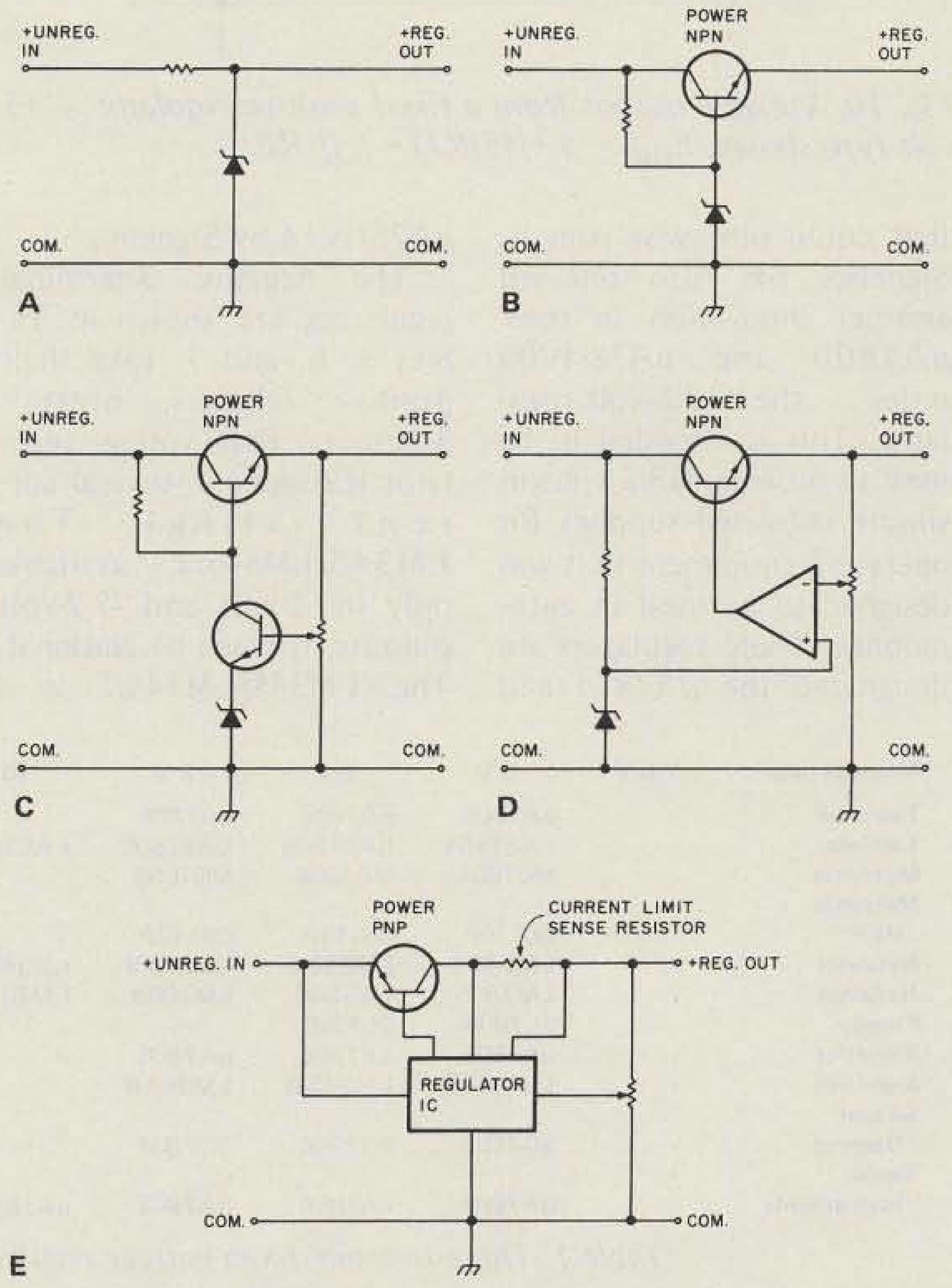


Fig. 8. (a) Resistor-zener regulator. (b) Emitter-follower regulator. (c) Regulator with one-transistor gain stage. (d) Regulator using differential amplifier or op amp. (e) Regulator using one of the first-generation IC regulators, such as the Fairchild μA723, National LM300, or Motorola MC1460.

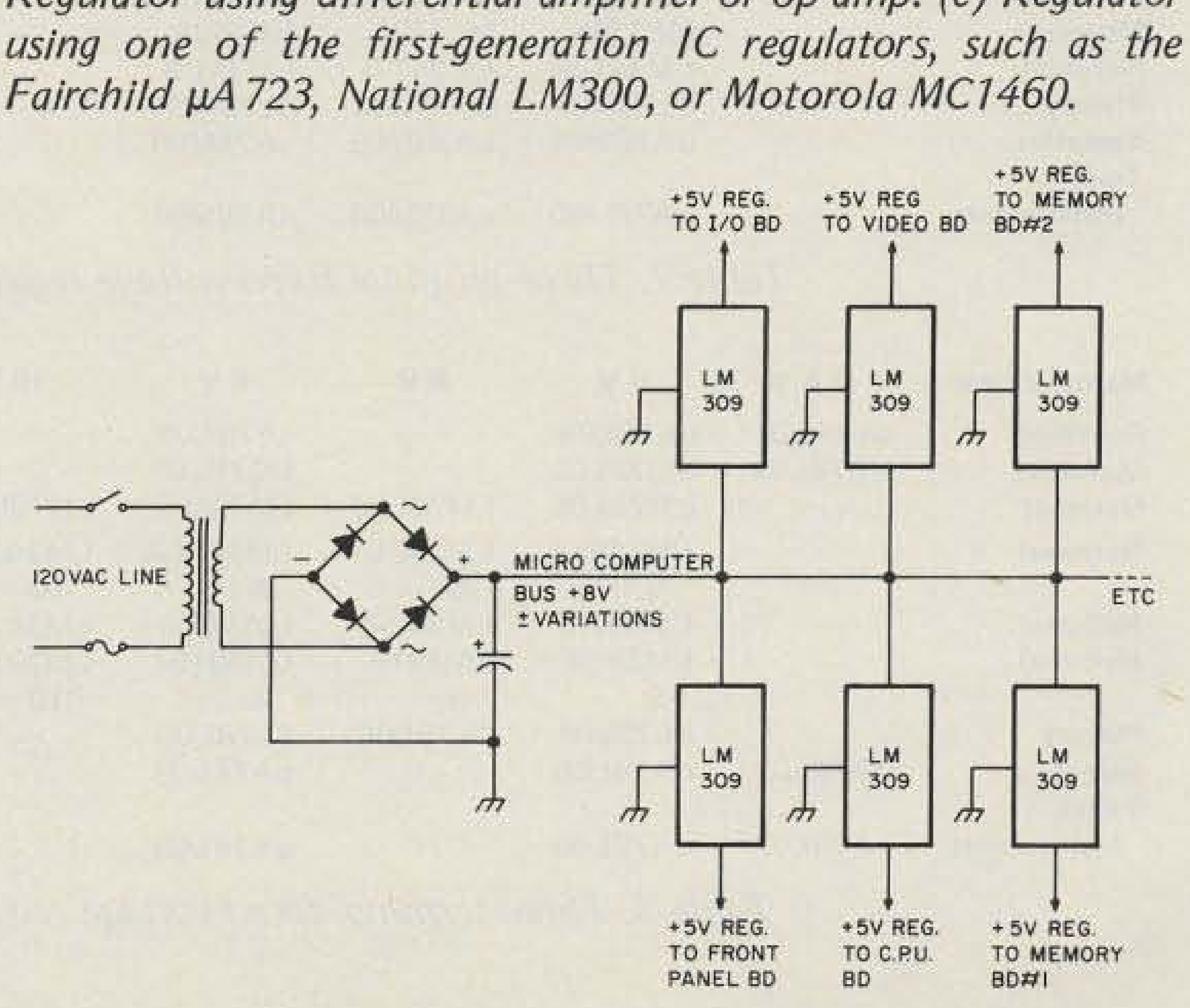


Fig. 9. A distributed regulator, where unregulated dc is connected to individual IC regulators on each card in the microcomputer via the bus.

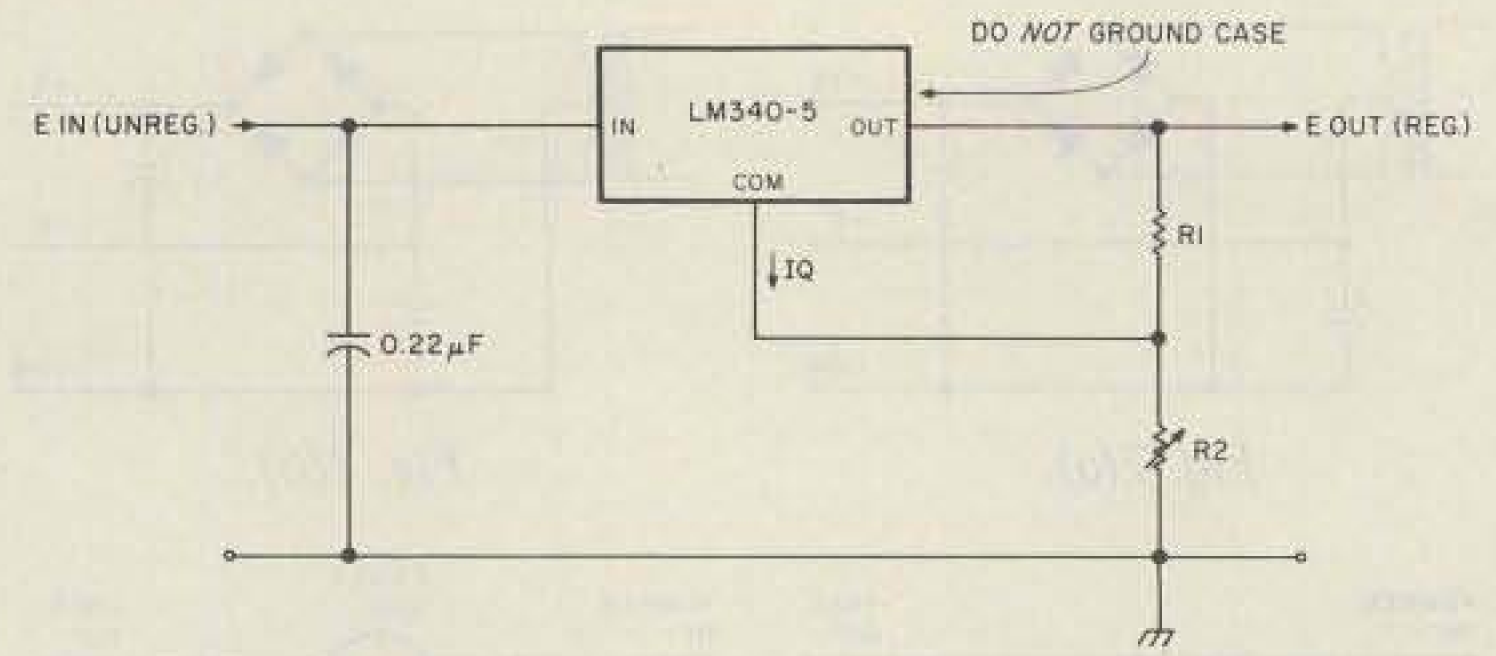


Fig. 10. Variable output from a fixed positive regulator — +5 volt type shown. $E_{out} = 5 + [(5/R1) + I_Q]\ R2$.

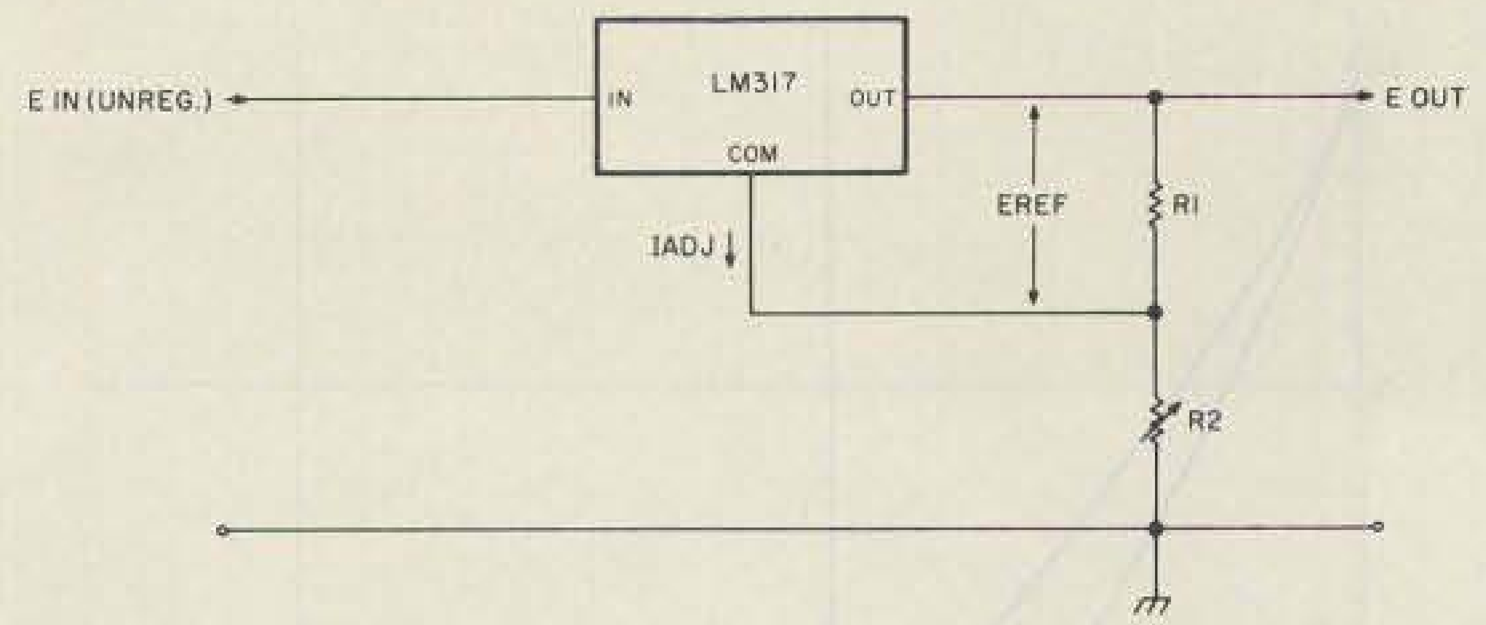


Fig. 11. LM317 as a variable positive regulator. $E_{out} = E_{ref}[1 + (R2/R1) + I_{adj}\ R2]$.

that could otherwise ruin it. Signetics has also released another innovation in their µA7800 and µA78HV00 series — the +13.8-volt regulator. This is intended to be used to provide +13.8 volts in simple regulated supplies for operating equipment that was designed to be used in automobiles. These regulators are designated the µA7814 and µA78HV14 by Signetics.

The negative 3-terminal regulators are shown in Tables 5, 6, and 7. Like their positive relatives, negative 3-terminal fixed-voltage regulator ICs come in several current ratings. The LM345/LM345.2, available only in -5-volt and -5.2-volt outputs, is made by National. The LM345/LM345.2 is a 3-Amp unit and will probably be second-sourced by other manufacturers soon.

Before leaving the subject of 3-terminal regulators, a word of caution is appropriate. The positive ones all have the case or metal tab connected to the common lead. This means that a good thermal and electrical connection to the chassis or mainframe is easy and allowable. Don't try to ground the case of the negative 3-terminal regulators, however, because that is generally the input lead. If your IC regulators are all card-mounted with floating heat dissipaters, this consideration is unimportant (except that you should remember that the floating heat dissipater is not a convenient

Manufacturer	2.6 V	5 V	6 V	8 V	10 V	12 V	15 V	18 V	20 V	24 V	28 V
Fairchild	- -	uA7805	uA7806	uA7808	- -	uA7812	uA7815	uA7818	- -	uA7824	- -
Lambda	- -	LAS1505	LAS1506	LAS1508	LAS1510	LAS1512	LAS1515	LAS1518	LAS1520	LAS1524	LAS1528
Motorola	- -	MC7805	MC7806	MC7808	- -	MC7812	MC7815	MC7818	- -	MC7824	- -
Motorola HEP	- -	C6110P	C6111P	C6112P	- -	C6113P	C6114P	C6115P	- -	C6116P	- -
National	- -	LM340-5	LM340-6	LM340-8	LM340-10	LM340-12	LM340-15	LM340-18	- -	LM340-24	- -
National	- -	LM7805	LM7806	LM7808	LM7810	LM7812	LM7815	LM7818	- -	LM7824	- -
Plessey	- -	SL7805	SL7806	- -	- -	SL7812	SL7815	SL7818	- -	SL7824	- -
Signetics	- -	uA7805	uA7806	uA7808	- -	uA7812	uA7815	uA7818	- -	uA7824	- -
Signetics	- -	LM340-5	LM340-6	LM340-8	- -	LM340-12	LM340-15	LM340-18	- -	LM340-24	- - -
Silicon General	- -	SG7805	SG7806	SG7808	- -	SG7812	SG7815	SG7818	- -	SG7824	- -
Texas Instruments	- -	uA7805	uA7806	uA7808	uA7810	uA7812	uA7815	uA7818	- -	uA7824	- -

Table 1. Three-terminal fixed-voltage regulators. Maximum current output = 1 to 1.5 Amps.

Manufacturer	2.6 V	5 V	6 V	8 V	10 V	12 V	15 V	18 V	20 V	24 V	28 V
Fairchild	- -	uA78M05	uA78M05	uA78M08	- -	uA78M12	uA78M15	uA78M18	uA78M20	uA78M24	- -
Motorola	- -	MC78M05	MC78M06	MC78M08	- -	MC78M12	MC78M15	MC78M18	MC78M20	MC78M24	- -
Motorola	- -	MC7705	MC7706	MC7708	- -	MC7712	MC7715	MC7718	MC7720	MC7724	- -
National	- -	LM341-5	LM341-6	LM341-8	- -	LM341-12	LM341-15	LM341-18	- -	LM341-24	- -
Plessey	- -	SL78M05	SL78M06	SL78M08	- -	SL78M12	SL78M15	- -	SL78M20	- -	- -
Signetics	- -	uA78M05	uA78M06	uA78M08	- -	uA78M12	uA78M15	- -	uA78M20	uA78M24	–
Texas Instruments	- -	uA78M05	uA78M06	uA78M08	- -	uA78M12	uA78M15	- -	uA78M20	uA78M24	- -

Table 2. Three-terminal fixed-voltage regulators. Maximum current = 0.5 to 0.75 Amps.

Manufacturer	2.6 V	5 V	6 V	8 V	10 V	12 V	15 V	18 V	20 V	24 V	28 V
Fairchild	uA78L26	uA78L05	- -	uA78L08	- -	uA78L12	uA78L15	uA78L18	- -	uA78L24	- -
Motorola	MC78L02	MC78L05	- -	MC78L08	- -	MC78L12	MC78L15	MC78L18	- -	MC78L24	- -
National	- -	LM78L05	LM78L06	LM78L08	LM78L10	LM78L12	LM78L15	LM78L18	- -	LM78L24	- -
National	- -	LM340LA -5	LM340LA -6	LM340LA -8	LM340LA -10	LM340LA -12	LM340LA -15	LM340LA -18	- -	LM340LA -24	- -
National	- -	LM342-5	LM342-6	LM342-8	LM342-10	LM342-12	LM342-15	LM342-18	- -	LM342-24	- -
National	- -	LM3910 -5	LM3910 -6	LM3910 -8	LM3910 -10	LM3910 -12	LM3910 -15	LM3910 -18	- -	LM3910 -24	- -
Plessey	- -	SL78L05	SL78L06	SL78L08	- -	SL78L12	SL78L15	SL78L18	SL78L20	SL78L20	- -
Signetics	uA78L02	uA78L05	- -	uA78L08	- -	uA78L12	uA78L15	- -	- -	- -	- -
Texas Instruments	uA78L02	uA78L05	- -	uA78L08	- -	uA78L12	uA78L15	- -	- -	- -	- -

Table 3. Three-terminal fixed-voltage regulators. Maximum current = 100 to 200 mA.

Manufacturer	2.6 V	5 V	6V	8 V	10 V	12 V	15 V	18 V	20 V	24 V	28 V
Fairchild	- -	uA78H05	- -	- -	- -	uA78H12	uA78H15	- -	- -	- -	- - -

Table 4. Three-terminal fixed-voltage regulators. Imax = 5 Amps.

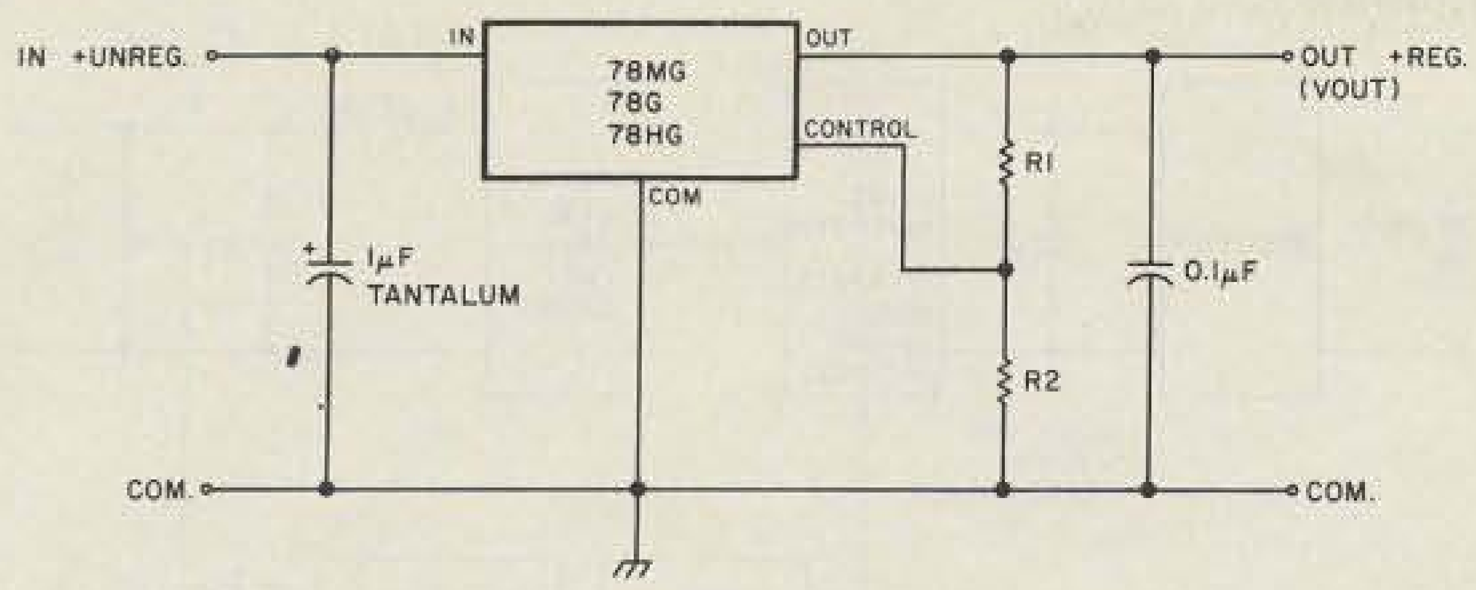


Fig. 12(a). $V_{out} = 5[(R1 + R2)/R2]$.

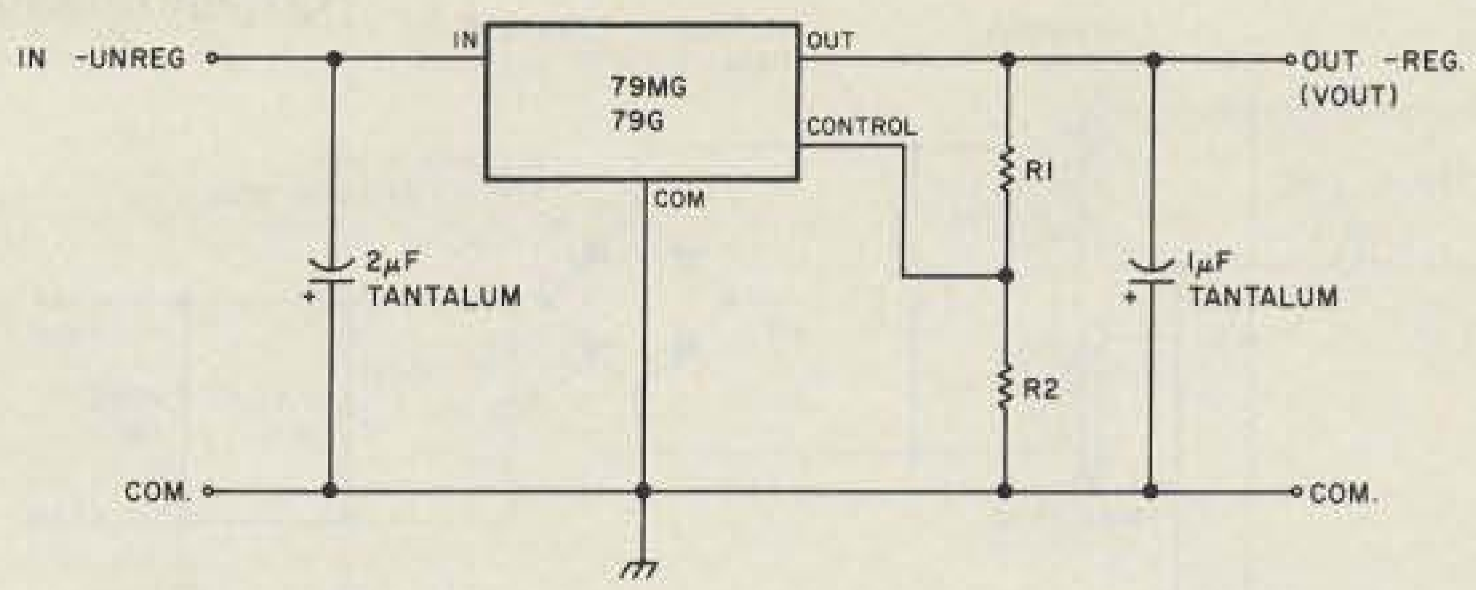


Fig. 12(b). $V_{out} = -2.23[(R1 + R2)/R2]$.

place to clip on the ground lead of an oscilloscope when troubleshooting).

The four-terminal regulators are power ICs of a later design than the fixed output 3-terminal regulators. There are no families of these ICs, since one size fits all. Of course, almost any of the positive 3-terminal fixed-voltage IC regulators can be adapted to variable output, as shown in Fig. 10. However, National Semiconductor makes one especially designed for such use – the LM317. The LM317 is available in TO-3, TO-5, TO-202, and TO-220 packages; the last two are the plastic power packages. The current rating is in excess of 1.5 Amps. In Fig. 11, the LM317 is shown in use with the two external resistors used to make it variable. The LM317 is second-sourced by Motorola and Texas Instruments.

Fairchild has chosen the 4-terminal approach in variable-output voltage power IC regulators. In positive four-terminal regulators, there are the 78MG, 78G, and 78HG types. These are, respectively, 500 mA, 1 Amp, and 5 Amps current rating. The negative four-terminal regulators are the 78MG and 79G in 500 mA and 1 Amp current ratings. In Fig. 12(a) are shown the 78MG, 78G, and 78HG, and in Fig. 12(b) are shown the 79MG and 79G in regulator circuits.

Lambda has also introduced positive and negative four-terminal IC regulators. These regulators, the LAS-15-U and LAS-18-U, respectively, are rated at 1.5 Amps. Another positive Lambda four-terminal regulator rated at 3 Amps is the LAS-14-U.

It is a matter of fact that many of today's computer freaks are members of the younger generation, who have to do a great deal of making-do to stretch their computer budgets. One of the things you can do to effect economy in the microcomputer is to build your own power supply. Rather than buying a large special transformer to do the job, it is possible to use combinations of old filament transformers to accomplish the same end. Since tubes (especially the older transmitting types) have 2.5, 5, 6.3, 7.5, and even 10 V filaments, there is a large variety of such transformers available from most ham auctions and flea markets. Rectifiers capable of 18 Amps (silicon) are very cheap because of their use in automotive alternators. So you ought to be able to construct a supply for a fairly good-size microcomputer for not too much money. As an example of such a supply, my own version of an Altair-type supply is presented in Fig. 13. This supply is by no means copied from the Altair, but produces similar output voltages and currents, since my own micro uses the Altair bus system and is similar to the Altair in several other respects.

Because even relatively modest microcomputers use copious quantities of power and, in the process, waste about as much power as they use (in heat), much attention has recently been given to making more efficient power supplies. One way to do this is to rectify and filter the 120-volt ac line and then use a switching regulator. By switching at a frequency of about 20 kHz, a small ferrite transformer may be used (for

Manufacturer	-2 V	-5 V	-5.2 V	-6 V	-8 V	-12 V	-15 V	-18 V	-24 V
Fairchild	uA7902	uA7905	--	uA7906	uA7908	uA7912	uA7915	uA7918	uA7924
Lambda	LAS1802	LAS1805	LAS18052	LAS1806	LAS1808	LAS1812	LAS1815	LAS1818	LAS1824
Motorola	MC7902	MC7905	MC7905.2	MC7906	MC7908	MC7912	MC7915	MC7918	MC7924
Motorola (HEP)	C6117P	C6118P	C6119P	C6120P	C6121P	C6122P	C6123P	C6124P	C6125P
National	--	LM7905	LM7905.2	LM7906	LM7908	LM7912	LM7915	LM7918	LM7924
National	--	LM320-5	LM320-5.2	LM320-6	LM320-8	LM320-12	LM320-15	LM320-18	LM320-24
Silicon General	--	SG320-5	SG320-5.2	--	--	SG320-12	SG320-15	--	--
Texas Instruments	--	uA7905	--	uA7906	uA7908	uA7912	uA7915	uA7918	uA7924

Table 5. Three-terminal fixed-voltage regulators. Maximum current = 1 to 1.5 Amps (negative).

Manufacturer	-3 V	-5 V	-5.2 V	-6 V	-8 V	-12 V	-15 V	-18 V	-24 V
Fairchild	--	uA79M05	--	uA79M06	uA79M08	uA79M12	uA79M15	--	uA79M24
National	--	LM320M05	LM320M05.2	LM320M06	LM320M08	LM320M12	LM320M15	LM320M18	LM320M24
Silicon General	--	SG320-05T	SG320-05.2T	--	--	SG320-12T	SG320-15T	--	--
Texas Instruments	--	uA79M05	--	uA79M06	uA79M08	uA79M12	uA79M15	--	uA79M24

Table 6. Negative three-terminal fixed-voltage regulators. Maximum current = 200 to 500 mA.

Manufacturer	-2.6 V	-5 V	-5.2 V	-6 V	-8 V	-12 V	-15 V	-18 V	-24 V
Motorola	MC79L03	MC79L05	--	--	--	MC79L12	MC79L15	MC79L18	MC79L24

Table 7. Negative three-terminal fixed-voltage regulators. Maximum current = 100 mA.

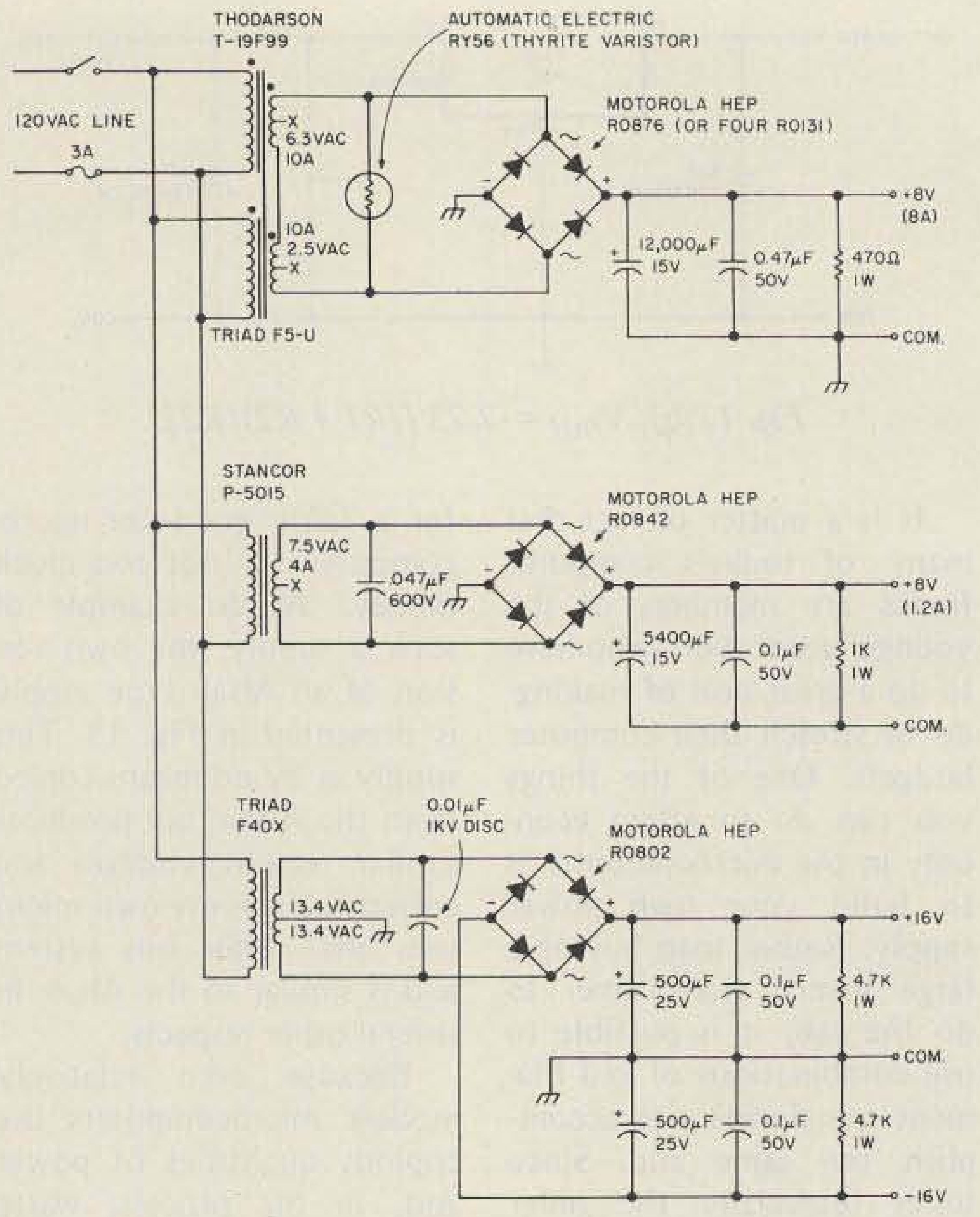


Fig. 13. Power supply built from available transformers for powering a microcomputer similar to the MITS Altair.

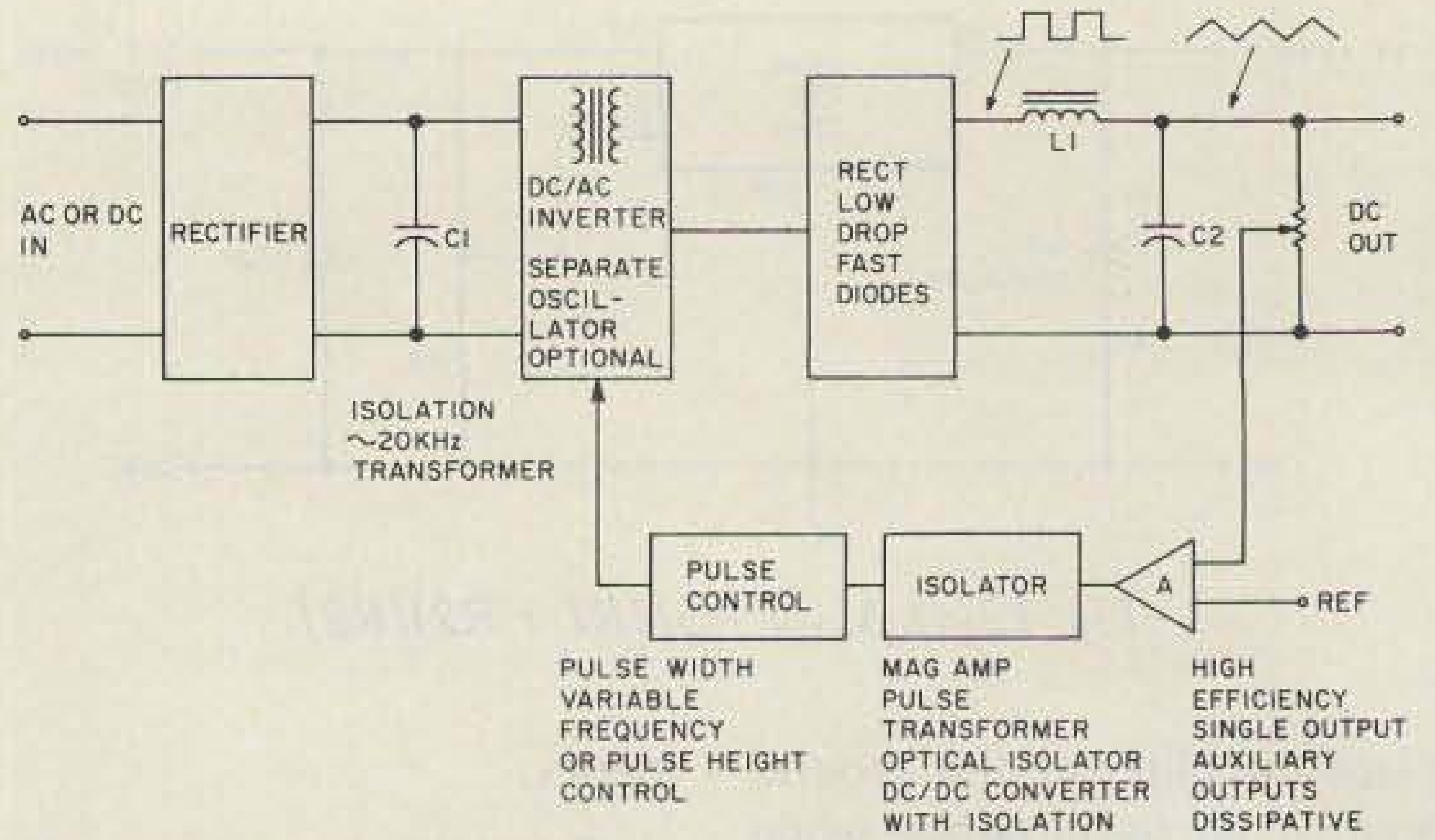


Fig. 14. A commercially-available switching-regulated supply (RO Associates).

line isolation), and the magnetostriction noise is not annoying, because it's higher than human ears can hear. Not only does such a regulator reduce the transformer size by using a 20 kHz switching rate, but its main feature is that the regulation is accomplished in a nearly lossless fashion. This is done by pulse-width modulation and then integration of the pulses. Consider that the regulator puts out a 20 kHz square wave (before integration) when providing a normal load. An increase in loading of the supply would then increase the width of the positive pulse, and a decrease in loading would cause a decrease in the pulse width, because the feedback circuitry forces these conditions. Since we use transistors in either "off" or "on" (saturated) conditions, there is essentially no dissipation, as in the case of a series-pass transistor in a conventional regulator.

Why are not all regulators built with switching-mode regulators? They are not because switching regulators are complex and use semiconductors that are nearer the state of the art than do ordinary regulators. The switching transistors must be high-voltage switching types, 20 kHz rectifiers must be fast-recovery types, special transformers and chokes must be used, transient protective devices must be used throughout the circuitry, and extreme care must be used to make sure no 20 kHz (or its harmonics) leaks out of the supply into other sensitive circuitry. There are a number of power supply producers who have solved the problems associated with switching-regulated supplies, and sell such compact efficient supplies with rather good results in terms of reliability.

Recently, a number of IC manufacturers have produced ICs especially made for use in the control section of switching regulators. These ICs do alleviate some of the complexity, as illustrated in references 1 and 2. The main bugaboos (those in the power-handling components) remain, but the attractive features of switching-regulated supplies are so strong that a continuing engineering assault will probably ultimately make them simple enough so that home construction becomes feasible. This simplification will most likely come from the IC technologists, as it has in the past.

As an example of a commercially-available switching-regulated supply, the RO model 210 is shown in Fig. 14. This supply packs 55 Watts into 45 cubic inches and is capable of 3.5 to 5.5 volts output at up to 10 Amps. The cost is $245.00 in single units, which puts it above conventional regulated supplies. However, if you are trying to squeeze ever more memory and other cards into your micro, and there's no more room or current available, the RO unit might be a welcome solution. RO makes similar switching-regulated supplies from 5 Amps up to 50 Amps (covering the +5-volt range), and it also supplies other voltages and multiple voltages.* There are certainly a number of other manufacturers of switching-regulated supplies, but I've picked one for an example that I know (from actual product use) to be worthy of mention.

*RO Associates, 3705 Haven Ave., Menlo Park CA 94025, (415)-322-5321.

As ever newer microprocessors are introduced, you can expect power supply requirements to change. Intersil and RCA, for example, have introduced CMOS µP families, with the capability of operating a complete microcomputer (at least for instructional purposes) on a few D cells. Also, Motorola has introduced a µP that is very fast and uses ECL. This sort of innovation will change the future power requirements of even the hobby microcomputer field. However, for the present, hobby microcomputers will (for economic reasons) probably muddle along using the power requirements we're used to — ±12 volts and lots of Amps at +5 volts.

For reference materials on the general subject of power supplies, I would suggest references 3, 4, 5, and 6. ■

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3. Unitrode, "The Importance of Rectifier Characteristics in Switching Power Supply Design," Publication U-73, Unitrode Corporation.
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The Exterminator

— for buggy KIMs

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Locating programming errors is never easy, and it can become immensely difficult as the size and complexity of the program increase. This debugging aid provides three facilities to assist in finding those programming errors.

The first facility allows the programmer to define locations in his program where he wishes the program to suspend execution so that he may examine data and registers to insure that the code is executing as designed. These locations, where program execution is suspended, are called breakpoints. During execution, when the program reaches a breakpoint location, control is passed to the KIM monitor, and the programmer has access to all the standard KIM functions. Execution may be resumed at the point of interruption by reestablishing the program counter and pressing the GO key.

The second facility allows the programmer to continually monitor a specific main storage location and have the program suspend execution when the contents of that location meet given criteria (e.g., stop when the contents equal zero, go negative, equal some specific value, are not equal to zero, etc.). This facility can be used to catch loop counters that exceed legal bounds or to trap a piece of code in one subroutine that is erroneously modifying an instruction or data in another subroutine.

The third facility allows the programmer to single step through his code as if he were using the KIM standard single-step function.

Hardware Operation

1024 bytes of KIM application RAM reside at addresses 0-3FF (hex). In addition, there are 103 bytes of application RAM at addresses 1780-17E6. The KIM monitor resides at addresses 1800-1FFF (see Fig. 1). The standard KIM single-step function causes control to be passed to the KIM monitor every time an instruction is

Single-step output*	Decode circuit output*	Desired output*
Low	Low	High
Low	High	Low
High	Low	High
High	Low	High

*Fig. 3. Voltage level for debug circuit. *Low voltage = true.*

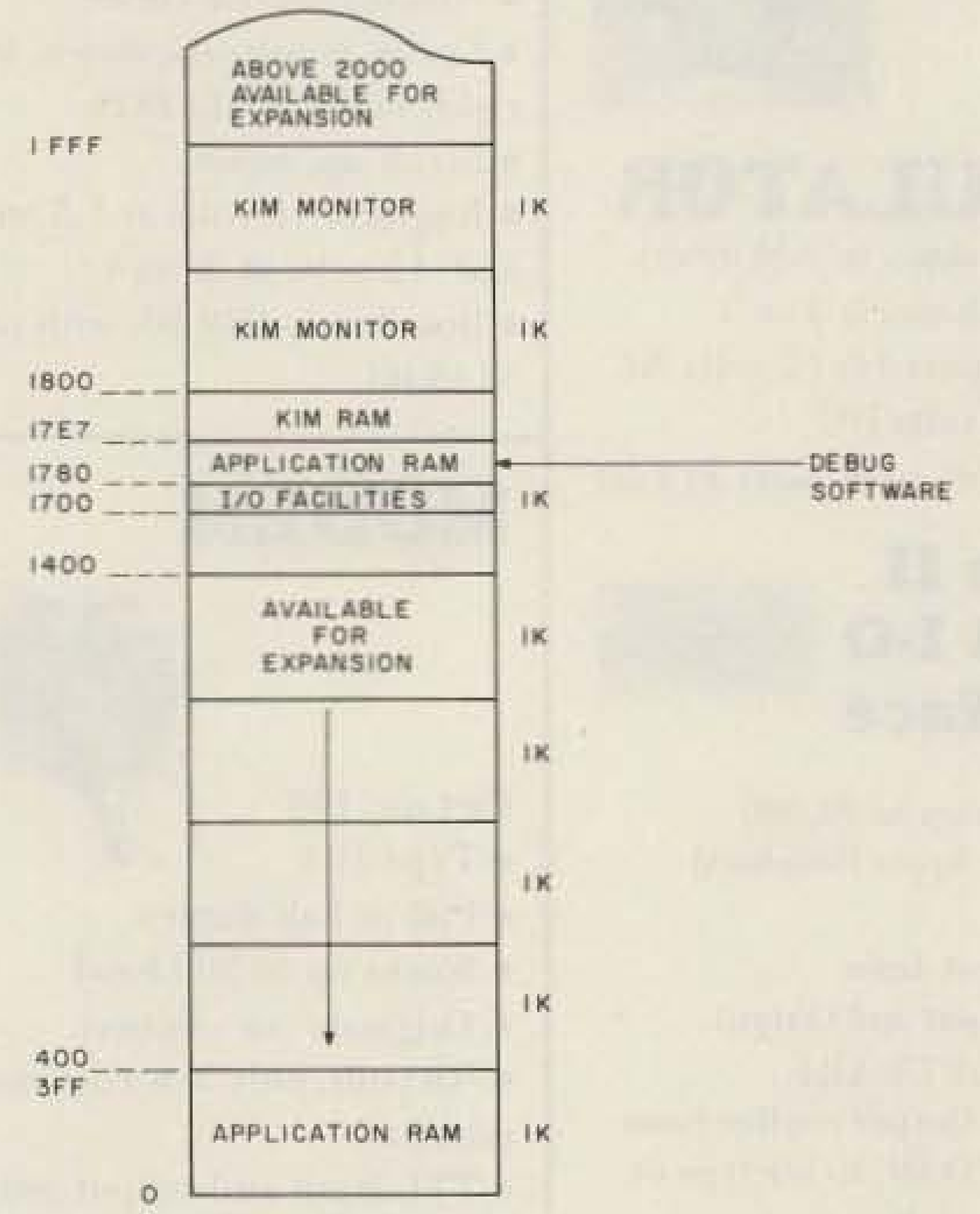

Fig. 1. KIM memory map.

Single-step output (true = fetching an instruction outside KIM monitor)	Decode circuit output (true = fetching an instruction from 1780-17E6)	Desired output (true = single step)
True	True	False
True	False	True
False	True	False
False	True	False

Fig. 2. Truth table for debug circuit.

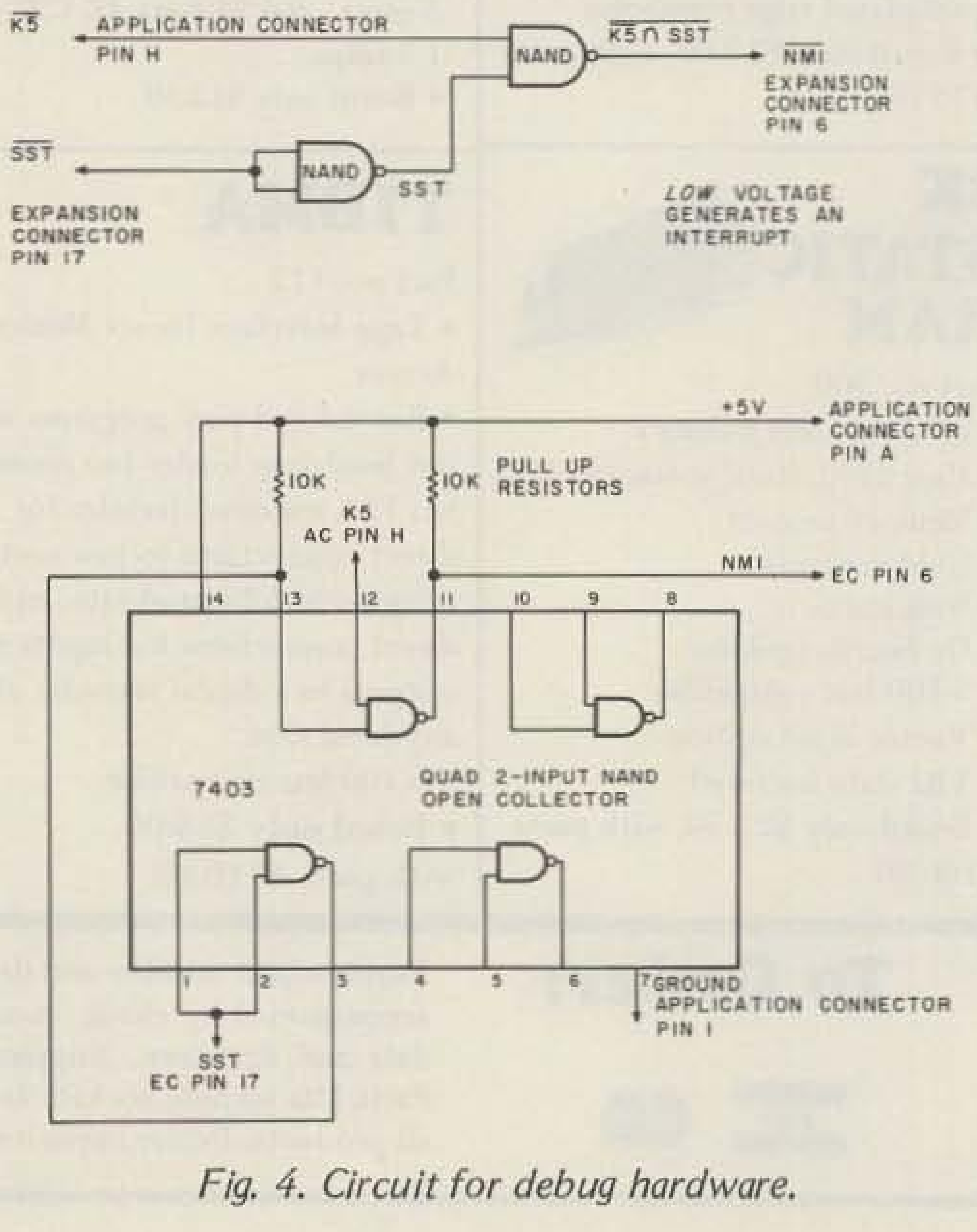

Fig. 4. Circuit for debug hardware.

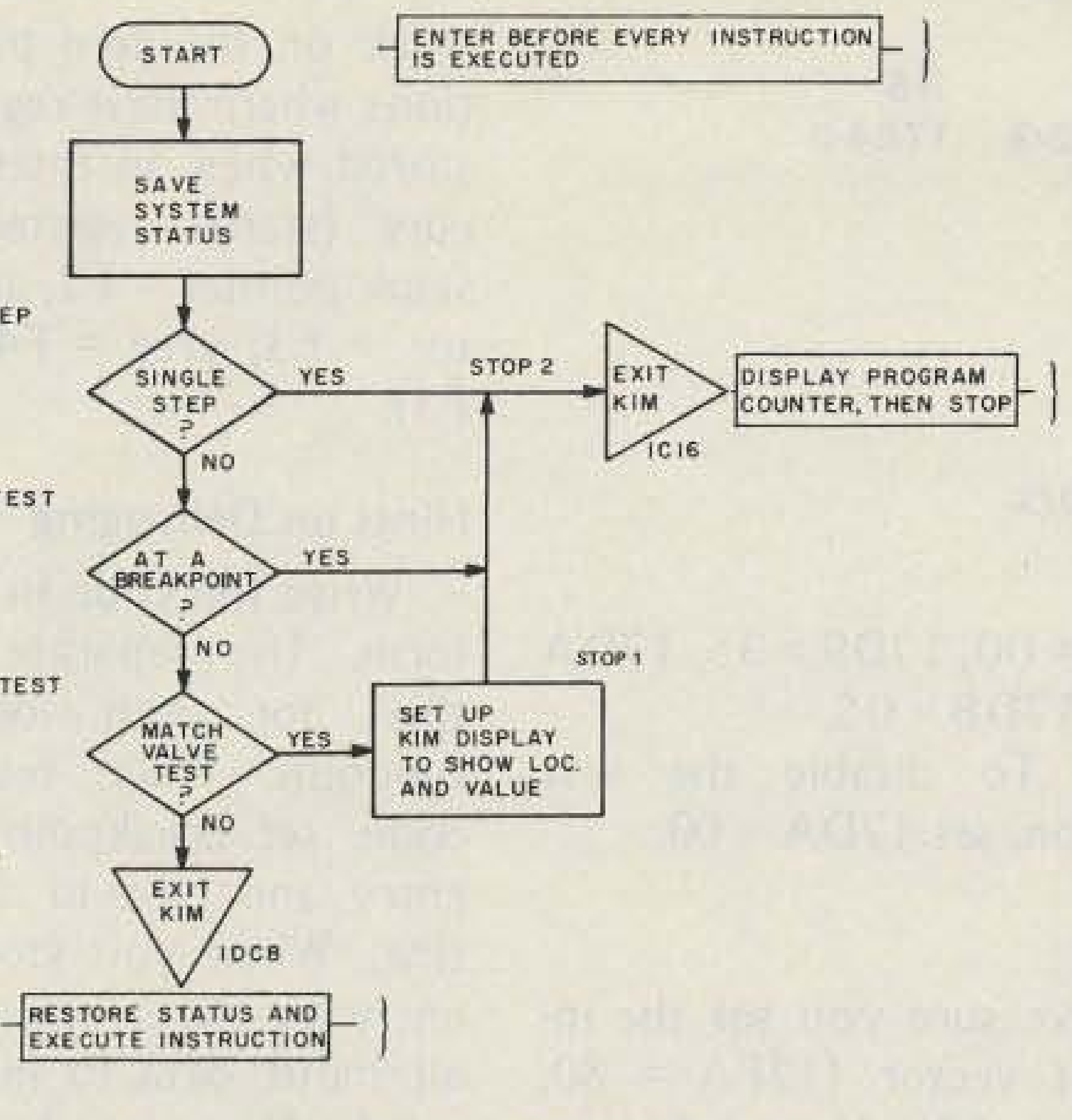

Fig. 5. Debug program flowchart.

fetched outside the range 1800-1FFF (the monitor). This allows the programmer to single step through his code, and it allows the monitor to execute at normal speed. The debug hardware modifies the single-step function so that any code at 1780-17E6 is also executed at normal speed, as if it were an extension of the monitor. In these 103 bytes, place the debug software. To accomplish this modified single-step function, combine the normal single-step output (SST OUT, pin 17 on the expansion connector) with the decode circuitry that indicates the instruction is being fetched from 1780-17E6 (K5, pin H on the application connector), and suppress the interrupt. The truth table for the circuit is shown in Fig. 2, and the associated voltage level table is shown in Fig. 3. Note, it is not clear from the KIM documentation that the normal single-step output voltage is LOW to generate an interrupt and that the output of K5 is LOW when an instruction is being fetched from 1780-17E6. The circuit is shown in Fig. 4. It uses two gates of a 7403 quad 2-input NAND gate IC. The two resistors are 10k Ohm, 1/4 Watt pull-up resistors, needed because the 7403 is an open-collector device.

Software Operation

The debug software (Program A) receives control before each instruction is executed. It first saves the status of the system, registers, program counter, and status register. It then checks to see whether the user is in single-step mode. If he is, the debug software exits to the KIM monitor. Note that the KIM single-step switch is not used. If it was, then the system would single step through the debug software, which we do not want.

Next, a check is made to see whether a user-specified breakpoint has been reached. If so, the software exits to KIM and displays the breakpoint address. If the program is not at a breakpoint, a check is made to see whether the user has specified a value test. To do this, the user would have provided an address, the type of compare to be performed, and a test value to be compared against. The software performs the test, and, if a match is found, the software exits to KIM, displaying the address specified and its contents. If a match is not found, the program exits to KIM at a different point to restore the system's status and to allow the instruction to be executed. See the flowchart in Fig. 5.

```
LOC  CONTENTS          LABEL    OP     OPERAND   COMMENTS
                       ;
                       ;        EQUATES
                       ;
                       ;
                       ACC      =$F3
                       PREG     =$F1
                       PCL      =$EF
                       PCH      =$F0
                       POINTL   =$FA
                       POINTH   =$FB
                       YREG     =$F4
                       XREG     =$F5
                       SPUSER   =$F2
                       ZERO     =$0000
                       KIM1     =$1DC8
                       KIM2     =$1C16
                       ;
                       ;        SAVE THE SYSTEMS STATUS
                       ;
1780 85F3              START    STA    ACC       SAVE ACCUMULATOR
1782 68                         PLA              PULL THE STATUS REGISTER
1783 85F1                       STA    PREG      SAVE STATUS REGISTER
1785 68                         PLA              PULL PGM COUNTER LO
1786 85EF                       STA    PCL       SAVE PGM COUNTER LO
1788 85FA                       STA    POINTL    SET UP KIM DISPLAY
178A 68                         PLA              PULL PGM COUNTER HI
178B 85F0                       STA    PCH       SAVE PGM COUNTER HI
178D 85FB                       STA    POINTH    SET UP KIM DISPLAY
178F 84F4                       STY    YREG      SAVE Y INDEX REG.
1791 86F5                       STX    XREG      SAVE X INDEX REG
1793 BA                         TSX              SAVE THE USERS STACK
1794 86F2                       STX    SPUSER
                       ;
                       ;
                       ;        CHECK FOR SINGLE STEP MODE
                       ;
                       ;
1796 ADE617            SSTEP    LDA    SSTEPSW   LOAD SINGLE STEP SWITCH
1799 D039                       BNE    STOP2     IF ITS NOT ZERO, STOP
                       ;
                       ;
                       ;        THIS ROUTINE  TESTS WHETHER A BREAKPOINT
                       ;        HAS BEEN REACHED.
                       ;
                       ;
179B A200              ATTEST   LDX    #$00      X INDEXES INTO BP LIST
179D BDDC17            CHECK    LDA    ATADR,X   GET HI PART OF ADDRESS
19A0 C5F0                       CMP    PCH       DOES HI PART MATCH PCH
19A2 D007                       BNE    NEXT      IF NOT...GET NEXT BP
17A4 BDDD17                     LDA    ATADR+1,X    LO PART OF ADDRESS
17A7 C5EF                       CMP    PCL       DOES IT MATCH PCL
17A9 F029                       BEQ    STOP2     YES...STOP
17AB E8                NEXT     INX              SET UP FOR NEXT TEST
17AC E8                         INX
17AD E00A                       CPX    #$0A      DONE TESTING?
17AF D0EC                       BNE    CHECK     NO...GO DO ANOTHER
                       ;
                       ;
                       ;        TEST WHETHER THE USER HAS SET UP
                       ;        A VALUE TEST.  IF SO, TEST THE CONTENTS OF
                       ;        ADDRESS AGAINST THE VALUE SPECIFIED AND
                       ;        IF THEY MATCH, THEN STOP.
                       ;
                       ;
17B1 AED817            VALTEST  LDX    VALADR    GET HI PART OF ADR.
17B4 8ECA17                     STX    COMP+2    STORE IN COMPARE INSTR.
17B7 ACD917                     LDY    VALADR+1  GET LO PART OF ADR.
17BA 8CC917                     STY    COMP+1    STORE IN COMPARE INSTR.
17BD ADDA17                     LDA    CODE      GET TYPE OF COMPARE
17C0 F00B                       BEQ    END       SKIP IF CODE=0
17C2 8DCB17                     STA    BR        ELSE STORE OP CODE
17C5 ADDB17                     LDA    VAL       GET VALUE TO BE TESTED
17C8 CD0000            COMP     CMP    ZERO         COMPARE
17CB F003              BR       BEQ    STOP1        BRANCH IF MATCH
17CD 4CC81D            END      JMP    KIM1      NO MATCH, GO TO KIM
17D0 86FB              STOP1    STX    POINTH    SET UP KIM DISPLAY
17D2 84FA                       STY    POINTL    SET UP KIM DISPLAY
17D4 4C161C            STOP2    JMP    KIM2      GO TO KIM
17D7 EA                         NOP
                       ;
                       ;
                       ;        CONSTANTS
                       ;
                       ;
17D8 0000              VALADR   .WORD  $0000
17DA 00                CODE     .BYTE  $00
17DB 00                VAL      .BYTE  $00
17DC FFFF              ATADR    .WORD  $FFFF     THESE ARE THE
17DE FFFF                       .WORD  $FFFF     FIVE BREAKPOINT
17E0 FFFF                       .WORD  $FFFF     LOCATIONS
17E2 FFFF                       .WORD  $FFFF
17E4 FFFF                       .WORD  $FFFF
17E6 00                SSTEPSW  .BYTE  $00       SINGLE STEP SWITCH
```

Program A. Debug software.

Instructions

Load the program into locations 1780-17E6. Set the interrupt vector (17FA=80 and 17FB=17). Connect the output of the circuit (Fig. 4) to NMI (pin 6 on the expansion connector).

A. To single step.

1. Set the single-step switch location 17E6 to any nonzero value. Start the execution of your program. Each time you press GO, you will execute one instruction.

2. At any time, you can disable the single-step function by setting 17E6 back to zero.

B. To set a breakpoint (up to five breakpoints may be active at once).

1. Set any of the breakpoint locations to the desired stopping address. Breakpoint locations are: 17DC-17DD, 17DE-17DF, 17E0-17E1, 17E2-17E3, and 17E4-17E5. For example, to stop at location 0245, set 17DC = 02 and 17DD = 45, and to also stop at location 0350, set 17DE =

Test address 17D8-9	Code 17DA	Value 17DB	Breakpoints #1 17DC-D	#2 17DE-F	#3 17E0-1	#4 17E2-3	#5 17E4-5
0147	F0	00	0245	0350			
0250	D0	A9					
0235	F0	FF					
0177	90	C0					
0035	B0	05					

Fig. 6. Sample form for keeping track of break points.

03 and 17DF = 50.

2. To remove a breakpoint, reset the breakpoint location to FFFF.

C. To perform a value test.

1. Set locations 17D8-17D9 to the desired memory address (17D8 = high part of the address and 17D9 = low part of the address).

2. Set 17DA for the type of compare desired (17DA = F0 for an equal compare, 17DA = D0 for a not equal compare, 17DA = B0 to test for the memory location being equal to or less than the value specified, and 17DA = 90 to test for the memory location being greater than the value specified). Set 17DA = 00 if you do not want to perform any test.

3. Set 17DB to the value to be compared against.

Example: To stop if location 0147 = 00, set: 17D8 = 01, 17D9 = 47, 17DA = F0, 17DB = 00.

Example: To stop if location 0250 is not equal to A9, set: 17D8 = 12, 17D9 = 50, 17DA = D0, 17DB = A9.

Example: To stop if location 0325 goes negative (equals -1), set: 17D8 = 03, 17D9 = 25, 17DA = F0, 17DB = FF.

Example: To stop if location 0177 becomes greater than C0, set: 17D8 = 01, 17D9 = 77, 17DA = 90, 17DB = C0.

Example: To stop if 0035 is less than or equal to 05, set: 17D8 = 00, 17D9 = 35, 17DA = B0, 17DB = 05.

Note: To disable the test function, set 17DA = 00.

Notes

Make sure you set the interrupt vector (17FA = 80, 17FB = 17). If you have a BREAK instruction in your code (opcode = 00), it will not exit to KIM as usual. To make it work properly, set a breakpoint at the location of the BREAK instruction. The STOP key will not exit to KIM either. If you lose control of your program, hit RESET. If you want to perform a value test on any of the registers (accumulator, index, status), set the value test to work on the zero page locations where these registers are stored when an interrupt occurs (status register = F1, stack pointer = F2, accumulator = F3, yreg = F4, xreg = F5).

Hints on Debugging

Write the code in modular form. Use separate subroutines for each identifiable function. When testing the code, set breakpoints at the entry and exit to a subroutine. When you stop at the entry to the subroutine, test all input data to insure it is valid. Now set breakpoints and value tests within the subroutine to test loop counters, variables, etc. When you stop at the exit from the subroutine, test the output data created by the subroutine. Repeat for other subroutines. It is very helpful to keep track of where you are by writing down active breakpoints and value tests. Use a form such as the one in Fig. 6. ■

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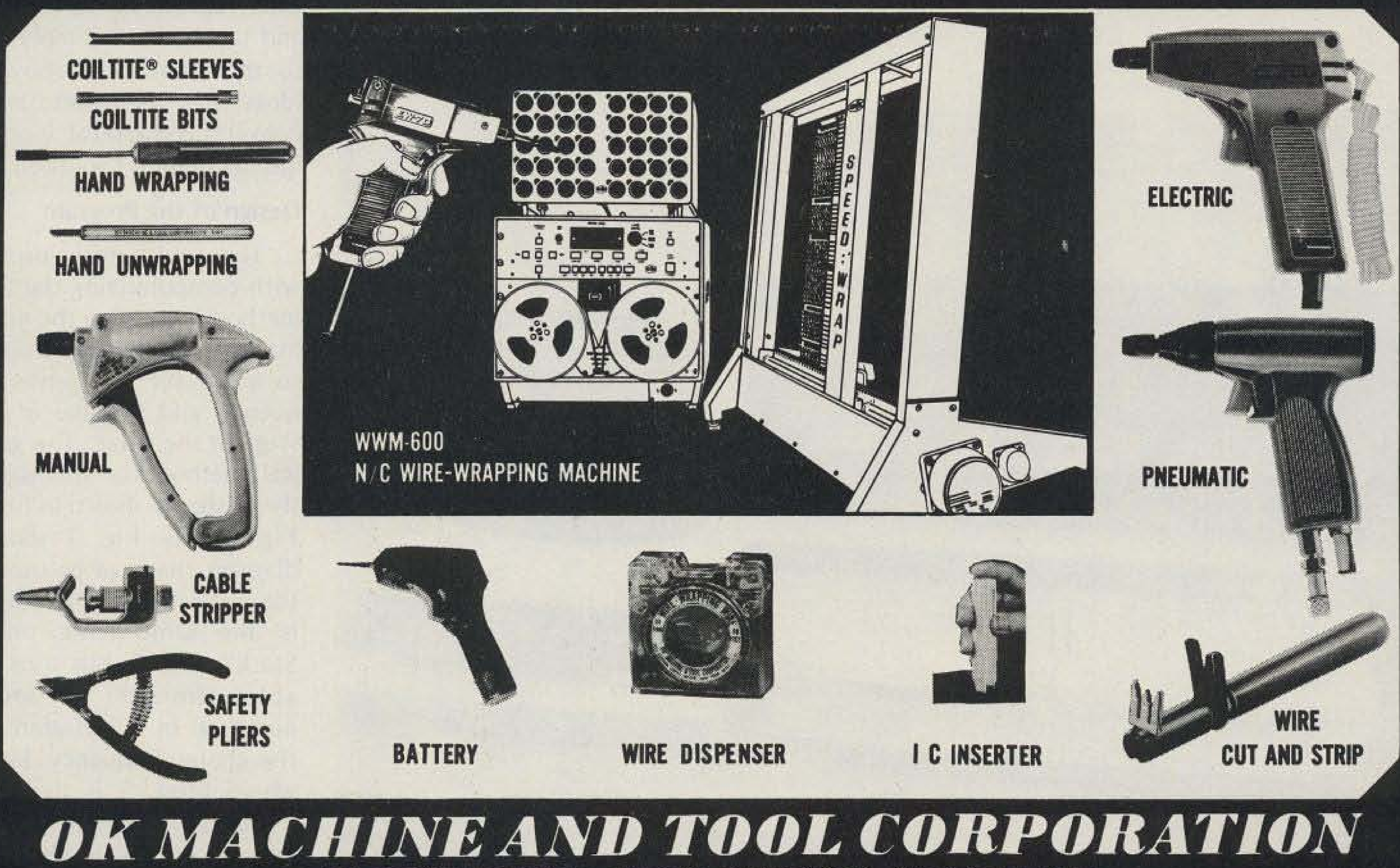

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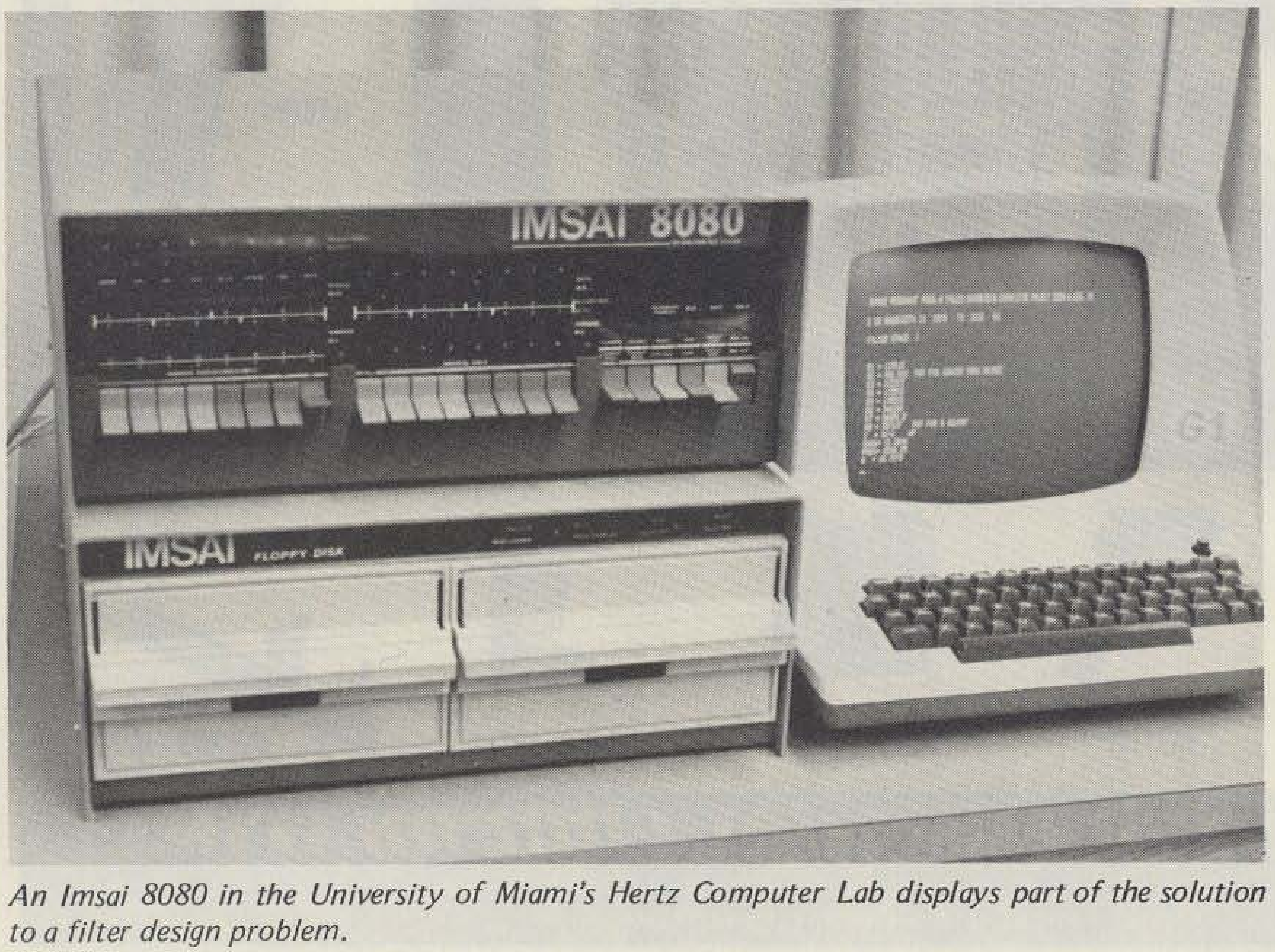
At Last! A Use For Your Computer!

—RTTY filter design program in BASIC



An Imsai 8080 in the University of Miami's Hertz Computer Lab displays part of the solution to a filter design problem.

The September, 1977, issue of *73 Magazine,* which was devoted to amateur RTTY, has quite a lot of good information in it. One of the articles that appealed to me the most was "Design an Active RTTY Filter" by Peter Stark K2OAW. The method presented in this article for designing active bandpass filters is well illustrated and makes the whole design process relatively easy.

It occurred to me while reading the article that this type of scheme is a perfect candidate for computerization. It should make a good example of a computer making life a little easier for the radio amateur attempting to home brew RTTY gear. This function of removing drudgery is the capacity in which I feel that computers will make their major impact on amateur radio, much as they have already done in the business world.

Since what I will do here is develop the computer program for the Stark method of filter design, you should read that article thoroughly before going any further. Rather than reproduce his diagrams and tables, I will simply refer to them and only show the ideas that were necessary to convert his graphical approach into a computer solution.

Design of the Program

The only real problem with computerizing the Stark method is deriving the mathematical equations necessary to solve for the center frequency and Q value of each stage in the filter. The graphical method for this part of the design is shown in Stark's Fig. 6. My Fig. 1 shows a diagram that can be used for the derivation. This diagram is the same basic one as Stark's Fig. 6, but uses variables instead of specific numbers. In this diagram, F is the center frequency for the whole filter, S is the center frequency for one of the stages, and B is the bandwidth of the whole filter.

Using Fig. 1, trigonometry

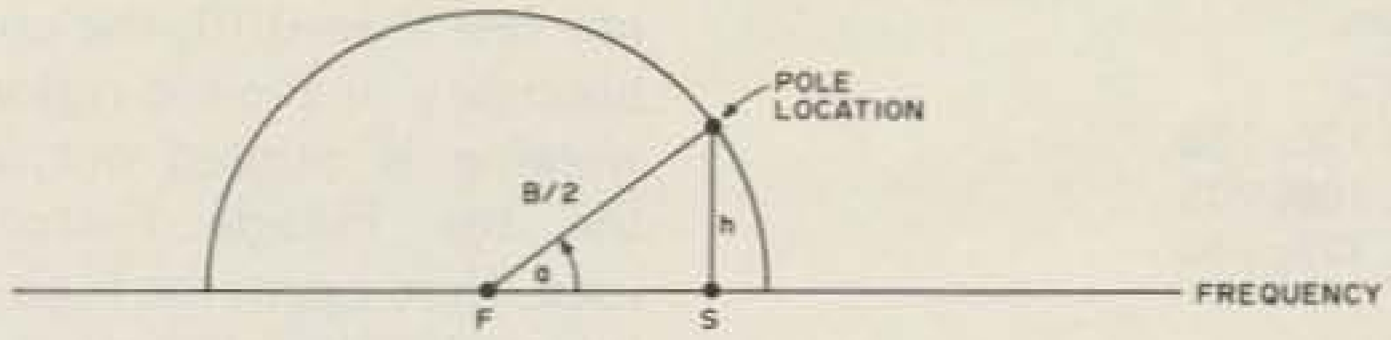


Fig. 1. Diagram for pole location derivation.

tells us that:

$$S = F + \frac{B}{2}\cos a. \quad (1)$$

where a gives the angle in degrees from the horizontal axis counterclockwise to the location of a particular pole. The values of the variable a are given in Stark's Fig. 7, except that his numbers must be converted to counterclockwise angles from the horizontal so that the formula works properly. This is easily done. For example, the pole location angles for the 4-pole filter would be 45° and 135°, for the 6-pole filter 30°, 90°, and 150°, etc.

In the example used by Stark, a 6-pole filter is being designed for a center frequency (F) of 2200 Hertz with a bandwidth (B) of 260 Hertz. Thus the center frequencies for the three filter stages are:

$$S_1 = 2200 + \frac{260}{2}\cos(150° + 3°) = 2084.17.$$

$$S_2 = 2200 + \frac{260}{2}\cos(90° + 3°) = 2193.20.$$

$$S_3 = 2200 + \frac{260}{2}\cos(30° + 3°) = 2309.03.$$

The 3° addition to each of the pole location angles is the Finagle Factor given by Stark in Table 2. As can be seen, the results of these calculations agree closely with Stark's graphical results. The graphical results are, of course, only approximations of the true values given by the equations.

The Q values for each stage can be derived using the fact that the pole locations are all on a semicircle above the horizontal axis. The equation of this semicircle is:

$$h = \sqrt{\left(\frac{B}{2}\right)^2 - (S - F)^2},$$

where h is the height of the semicircle in Hertz above the horizontal axis at a frequency of S Hertz. The variables B and F are defined as before. Stark gives the Q value for each stage as center frequency for the stage divided by twice the semicircle height above the horizontal axis. Thus,

$$Q = \frac{S}{2\sqrt{\left(\frac{B}{2}\right)^2 - (S - F)^2}} \quad (2)$$

where S must be calculated from equation 1. For the Stark example, the Q values of the three stages are:

$$Q_1 = \frac{2084.17}{2\sqrt{\left(\frac{260}{2}\right)^2 - (2084.17 - 2200)^2}} = 17.66.$$

$$Q_2 = \frac{2193.20}{2\sqrt{\left(\frac{260}{2}\right)^2 - (2193.20 - 2200)^2}} = 8.45.$$

$$Q_3 = \frac{2309.03}{2\sqrt{\left(\frac{260}{2}\right)^2 - (2309.03 - 2200)^2}} = 16.31.$$

Again, the calculated values, which are exact, agree closely with the values obtained by means of the graphical method.

Given the center frequencies and Q values for each stage of the filter, all that is left to do is to use the appropriate set of equations from the second and third columns on page 39 of the Stark article to determine the required resistances. The first set is used for Q values less than 10; the second set is for Q values between 10 and 50.

Only two additional pieces of information are necessary — the value of the capacitor for each stage of the filter and the gain of the stage. Stark recommends setting the capacitor value to either 0.1 or 0.01 uF, so that potential problem is easily solved. The gain, however, is somewhat more of a problem. Here Stark recommends a small gain, say a gain of two, for the single op amp filter. For the two op amp filter, the suggestion is for a gain between two and five times the square root of the stage Q. I have picked a gain of three times the square root of Q for use in the program. This value conforms to the numerical examples given in Stark's article.

```
1 REM BUTTERWORTH ACTIVE FILTER DESIGN PROGRAM
2 REM
5 DIM C(11),N(4,5)
10 P1=3.141592654
15 FOR I=1 TO 4
20     FOR J=1 TO I+1
25     READ N(I,J)
30     NEXT J
35 NEXT I
40 FOR I=1 TO 11
45 READ C(I)
50 NEXT I
55 PRINT "ENTER RESONANT FREQ,# POLES,BANDWIDTH,CAPACITOR VALUE";
60 INPUT F,P,B,C1
61 IF INT(P/2) <> P/2 THEN 55
62 IF P/2 < 2  OR P/2 > 5 THEN 55
65 C1=C1*1.0E-6
70 F1=B/(3*F)
75 FOR I=1 TO 11
80 IF F1 < C(I) THEN 100
85 NEXT I
90 PRINT "WILL USE HIGHEST FINAGLE REGION"
95 I=11
100 F2=I-1
105 PRINT
110 PRINT "3 DB BANDWIDTH IS ";F-B/2;" TO ";F+B/2;" HZ"
115 PRINT
120 FOR I=1 TO P/2
122 PRINT "FILTER STAGE ";I
125 S=B/2*COS(P1*(N(P/2-1,I)+F2)/180)+F
130 Q=S/(2*SQR(B**2/4-(S-F)**2))
135 PRINT
137 PRINT
140 IF Q < 10 THEN 160
145 IF Q <= 50 THEN 200
150 PRINT "PROGRAM CANNOT HANDLE Q > 50"
155 GO TO 290
160 REM 2-POLE FILTER FOR Q < 10
162 G=2
165 X=Q/(2*P1*S*C1)
170 PRINT "R1 = ";X/G
175 PRINT "R2 = ";2*X/(2*Q**2-G);" POT FOR CENTER FREQ ADJUST"
180 PRINT "R3 = ";2*X
185 PRINT "R4 = ";2*X
190 PRINT "C  = ";C1*1.0E6;" UF"
192 PRINT "GAIN=";G
193 PRINT "FREQ=";S
194 PRINT "Q   =";Q
195 PRINT
196 PRINT
198 GO TO 258
200 REM 2-POLE FILTER FOR 10 <= Q <= 50
202 G=3*SQR(Q)
205 R1=Q/(2*P1*S*C1)
210 PRINT "R1 = ";R1
215 PRINT "R2 = ";2*R1/(Q**2-1-2*SQR(Q)/G+1/(G*SQR(Q)));
216 PRINT " POT FOR CENTER FREQ ADJUST"
220 PRINT "R3 = ";R1
225 PRINT "R4 = ";R1
230 PRINT "R5 = ";R1
235 R6=G*R1/SQR(Q)
240 PRINT "R6 = ";R6
245 PRINT "R7 = ";R1*R6/(R1+R6)
250 PRINT "R8 =";2*P1*G*SQR(Q)/(2*Q-1);" POT FOR Q ADJUST"
255 GO TO 190
258 PRINT "HIT CR TO CONTINUE";
259 INPUT A$
260 NEXT I
261 PRINT "ANOTHER DESIGN (Y OR N)";
262 INPUT A$
263 IF A$ = "Y" THEN 55
265 DATA 135,45
270 DATA 150,90,30
275 DATA 157.5,135,45,22.5
280 DATA 165,150,90,30,15
285 DATA 0.01,0.025,0.04,0.06,0.08,0.1,0.11,0.13,0.15,0.17,0.19
290 END
```

Fig. 2. Imsai 8080 BASIC program listing.

Program Description

The program, written in Imsai BASIC, is shown in Fig. 2. It is logically divided into three sections. The first section extends from line 1 through line 115. In this section, all variables needed to perform design calculations are defined. Lines 15-35 define the doubly subscripted array N using the pole location data from lines 265-280. Each data line gives the location (in degrees) of each pole for one of the filter types. The four types are 4-pole, 6-pole, 8-pole, and 10-pole. Thus, if P is the number of poles desired, row (P/2) -1 of the array N gives the P/2 pole locations necessary for the filter. For example, for a P = 6-pole filter, the P/2 = 3 pole locations from data statement 270 are located in the (P/2)-1 = 2nd row of the array N. While this scheme may seem complex, it makes the calculation part of the program much simpler than it otherwise would be.

Lines 40-50 define an array C with the data from line 285. These numbers are the upper bounds of the Finagle Factor regions, as de-

Scalar	Stands for	References
A$	Alphabetic information.	259, 262, 263
B	Bandpass of whole filter.	60, 70, 110, 125, 130
C1	Capacitor value — .1 or .01 uF.	60, 65, 165, 190, 205
F	Center frequency of filter.	60, 70, 110, 125, 130
F1	Index to Finagle Factor.	70, 80
F2	Finagle Factor.	100, 125
G	Gain of filter stage.	162, 170, 175, 192, 202, 215, 235, 250
I	Index for loop control.	15, 20, 25, 35, 40, 45, 50, 75, 80, 85, 95, 100, 120, 122, 125, 260
J	Index in nested loops.	20, 25, 30
P	Number of poles in filter.	60, 61, 62, 120, 125
P1	Pi = 3.141592654.	10, 125, 165, 205
Q	Q value of filter stage.	130, 135, 140, 145, 165, 175, 194, 202, 205, 215, 235, 250
R1	Resistor value.	205, 210, 215, 220, 225, 230, 235, 245, 250
R6	Resistor value.	235, 240, 245
S	Center frequency of filter stage.	125, 130, 135, 165, 193, 205
X	Temporary storage.	165, 170, 175, 180, 185
Array		
C(.)	List of upper boundaries of Finagle Factor regions.	5, 45, 80
N (.,.)	List of pole positions for each type of filter.	5, 25, 125

Fig. 3. List of variables, definitions, and references.

fined in Table 2 of the Stark article.

Lines 55-65 define, by means of a prompt sequence, the center frequency (F) for the filter, the number of poles (P) desired in the design, the desired bandwidth (B), and the value of the capacitor (C1) in microfarads. Line 65 converts C1 into farads.

After checking to make sure the number of poles desired is valid (line 61 rejects P if it is not an even number; line 62 rejects P if it is not 4, 6, 8, or 10) and converting C1 to farads, the program calculates the Finagle Factor in lines 70-100. The logic is to look at the upper ends of the eleven Finagle regions and determine the lowest upper end that the quantity F_1 = B/3F is less than. If this quantity is less than the "Ith" upper boundary, then the Finagle Factor is I - 1 degrees. For example, if F_1 is less than the third upper boundary (0.04), then the Finagle Factor is 2°. If F_1 is not less than 0.19, the upper boundary of the top region, a warning is printed out, and the top Finagle Factor is used. Here again, the logic is a bit tricky, but this pays off later when it is time to do calculations.

The first part of the program ends with the printout of the 3 dB bandwidth in Hertz in line 110. This printout is helpful in spotting errors in the data as entered.

The second part of the program performs the design calculations and includes lines 120-260. This part of the program is one large loop which is repeated for each pole location in the filter. Thus the loop index in line 120 goes from 1 to P/2.

Line 125 calculates the center frequency (S) for each stage in the filter, as explained above. If the design is for a P pole filter, then the appropriate pole location angle is N(P/2-1,I) for the "Ith" stage of the filter. Since the pole location angle must be modified by the Finagle Factor (F_2), the modified location is N (P/2-1,I) + F_2. Finally, since, in BASIC, trigonometric functions must

```
ENTER RESONANT FREQ.# POLES.BANDWIDTH.CAPACITOR VALUE ? 2200, 6, 260, 0.01

3 DB BANDWIDTH IS  2070   TO  2330   HZ

FILTER STAGE  1

R1 =  130123
R2 =  900.5  POT FOR CENTER FREQ ADJUST
R3 =  130123
R4 =  130123
R5 =  130123
R6 =  390368
R7 =  97591.9
R8 =  402162   POT FOR Q ADJUST
C  =  1E-2   UF
GAIN= 12.3869
FREQ= 2085.22
Q  = 17.0484

FILTER STAGE  2

R1 =  30625.6
R2 =  870.162   POT FOR CENTER FREQ ADJUST
R3 =  122502
R4 =  122502
C  =  1E-2   UF
GAIN= 2
FREQ= 2195.46
Q  = 8.4493

FILTER STAGE  3

R1 =  115515
R2 =  826.543  POT FOR CENTER FREQ ADJUST
R3 =  115515
R4 =  115515
R5 =  115515
R6 =  346546
R7 =  86636.5
R8 =  357197   POT FOR Q ADJUST
C  =  1E-2   UF
GAIN= 12.2846
FREQ= 2310.25
Q  = 16.7679

ANOTHER DESIGN (Y OR N)? Y
ENTER RESONANT FREQ.# POLES.BANDWIDTH.CAPACITOR VALUE ? 2550, 6, 1100, 0.01

3 DB BANDWIDTH IS  2000   TO  3100   HZ

FILTER STAGE  1

R1 =  18890.1
R2 =  1682.72   POT FOR CENTER FREQ ADJUST
R3 =  75560.4
R4 =  75560.4
C  =  1E-2   UF
GAIN= 2
FREQ= 2040.07
Q  = 4.84272

FILTER STAGE  2

R1 =  7306.21
R2 =  3514.99   POT FOR CENTER FREQ ADJUST
R3 =  29224.8
R4 =  29224.8
C  =  1E-2   UF
GAIN= 2
FREQ= 2473.46
Q  = 2.27094

FILTER STAGE  3

R1 =  11750.5
R2 =  1276.75   POT FOR CENTER FREQ ADJUST
R3 =  47002.1
R4 =  47002.1
C  =  1E-2   UF
GAIN= 2
FREQ= 2983.41
Q  = 4.40534

ANOTHER DESIGN (Y OR N)? N
```

Fig. 4. Sample run session using the two examples given in the Stark article.

have their argument expressed in radians rather than in degrees, this quantity must be multiplied by $\pi/180$. Line 125 is the resulting calculation.

The Q value for this stage of the filter is the center frequency (S), as just calculated, divided by twice the height of the circle above S. Line 130 performs this calculation.

Following these two calculations, the remainder of this part of the program is straightforward. Depending on whether the Q value as just calculated is less than 10 or between 10 and 50, the program jumps to the calculation and printing of the resistor values for a one or two op amp filter stage. The equations used are the ones given in the Stark article in columns two and three on page 39.

The only decision left at this point is the value of the gain (G) for each stage. As mentioned above, Stark uses a gain of two for single op amp filter stages and that convention was upheld in this program in line 162. A gain of two to five times the square root of the stage Q is suggested for two op amp stages. Line 202 sets the gain to three times the square root of Q for these stages. This can be modified as desired.

The third part of the program consists of data lines 265-285. Since these numbers have already been discussed above, no further commentary is necessary here.

Fig. 3 defines all the variables used in the program and gives the line number(s) in which the variables are used. This information should be of help to anyone who wishes to delve more deeply into the mechanics of the calculations.

A Sample Run Session

I have used the two examples worked out by Stark to illustrate the running of the filter design program. The inputs to these two runs are shown in Table 1. Fig. 4 presents the run session in detail.

What will be immediately obvious from the results presented is that the exact resistor values required for the design will not be available. Thus you must select the standard resistor value closest to the exact value given by the program. To compensate for this deviation from the required resistances, the values of R_2 in the single op amp filter and R_2 and R_8 in the two op amp stages are doubled, and the nearest standard pot is selected for these resistors. These pots allow the center frequencies and Q values of each stage to be set precisely. All resistor values are expressed in Ohms, and the use of pots is noted on the output.

A nifty and not too difficult modification to the program would be to have the computer select and print the nearest standard value resistors rather than the exact design values. I would have built this feature into the original program except for the difficulty of locating a comprehensive list of standard resistor and pot values. I will be glad to make this change for anyone who will send me such a list, an SASE, and $1 to cover duplication costs.

	Run 1	Run 2
F	2200 Hz	2550 Hz
B	260 Hz	1100 Hz
P	6	6
C1	0.01 µF	0.01 µF

Table 1.

Summary

Active filters have a number of advantages over their LC counterparts. While the original Stark article provides a workable scheme for designing active bandpass filters, the graphical solution suffers from the lack of precision inherent in all graphical solutions. Since it is so easy to computerize the design process, we may as well give the computer one more task to perform for us. Maybe computers actually can be useful to the radio amateur! ■

Now Anyone Can Afford A Keyboard

—surplus keyboard, KIM, and software

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One of the best methods of inputting alphanumeric data to a computer system is with a typewriter-style keyboard. It has proven itself an effective man-machine interface and can be found on a multitude of systems from the smallest micro to the largest IBM.

A low-cost 63-key non-encoded keyboard is available from many computer distributors for under \$20. It is essentially a 63 single-pole-single-throw (SPST) N.O. switch matrix that is lettered and arranged as a keyboard. This article describes a method to interface this type of keyboard to an I/O port using two TTL ICs. A software listing that uses this keyboard to control a 16 x 64 video board is also given. A block diagram of the system is shown in Fig. 1.

This interface uses software instead of hardware to

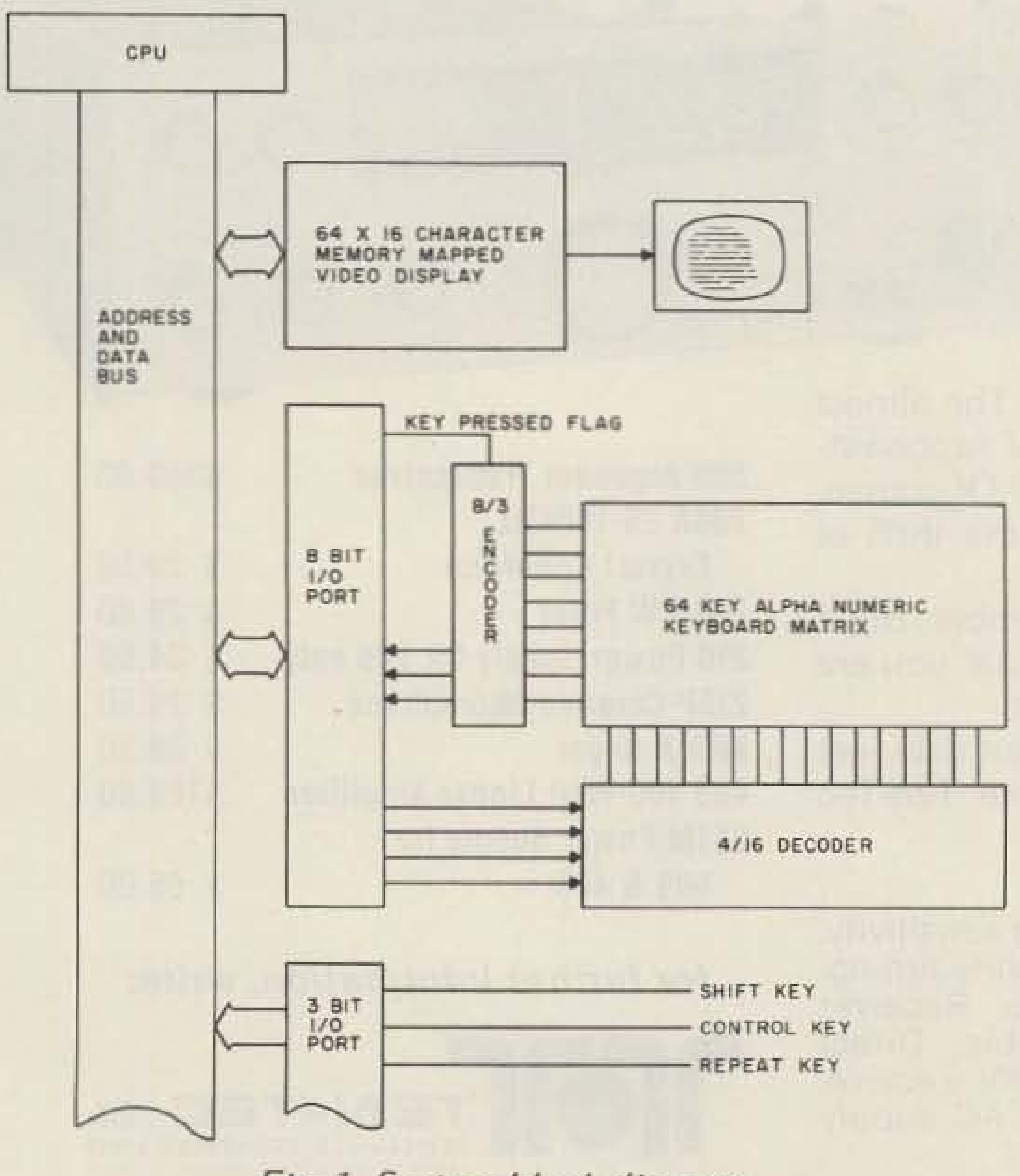


Fig. 1. System block diagram.

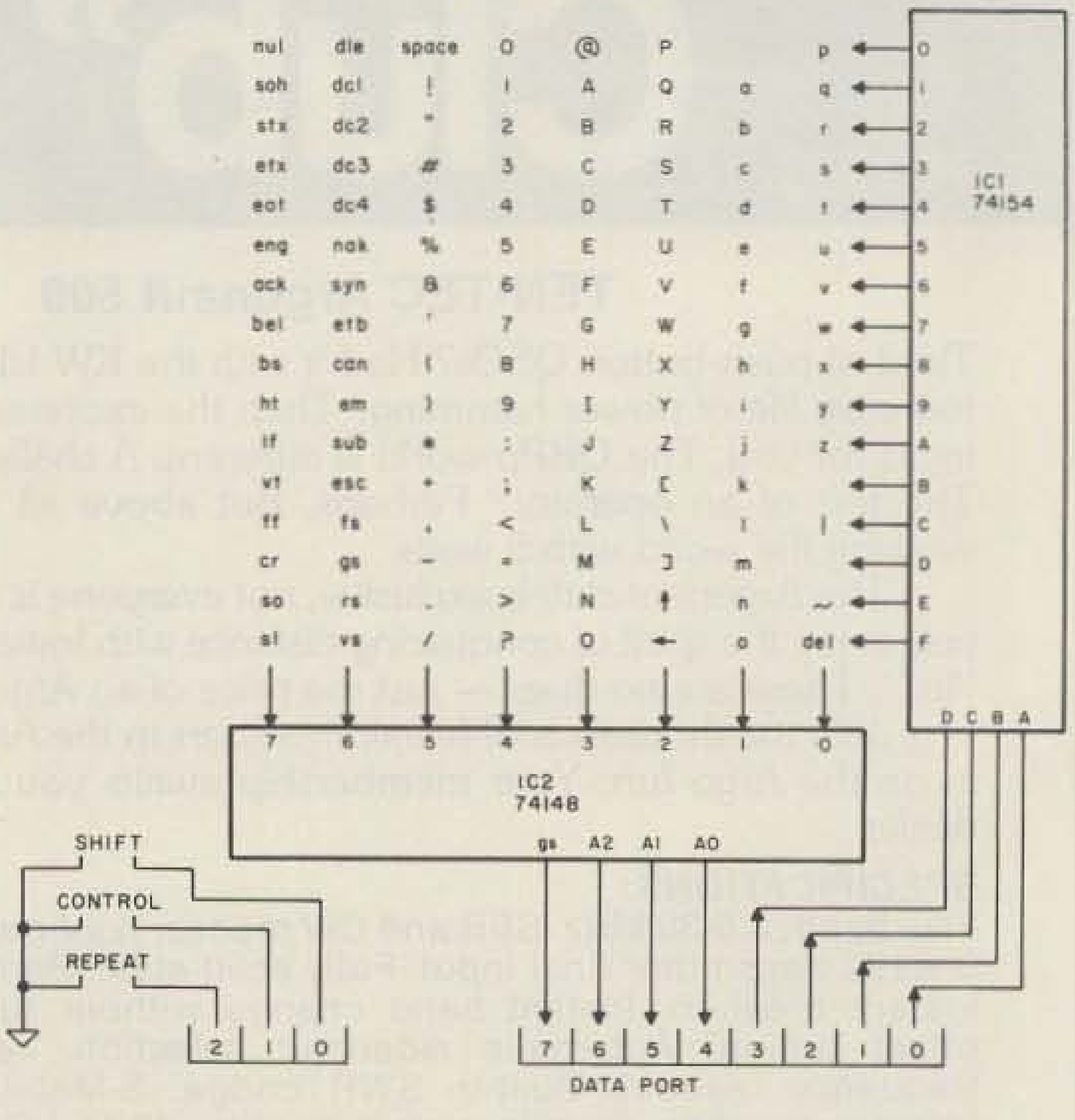


Fig. 2. Keyswitch matrix diagram showing all 128 functions and alphanumeric characters available.

perform many of the keyboard functions. It requires a great deal more CPU time than an interrupt-driven system, but it can be built using less hardware. Since software costs time, and hardware costs money, it is more economical to use software.

How Does It Work?

To understand how the interface works, imagine a keyboard with 128 keys that represent the entire ASCII character set. This keyboard could be wired as a 16 x 8 matrix, as shown in Fig. 2. (Fig. 3 illustrates my configuration and interface to my KIM.) Data is passed through an 8-bit bidirectional peripheral port. The four low-order bits are set as outputs and connect to a four/sixteen decoder (IC1). By writing a number from 0_H-F_H into the data port, the CPU can cause any one of the sixteen output lines of IC1 to drop to 0. If a key that is connected to the selected line is pressed, then the 0 from IC1 will be connected to one of the eight inputs of IC2. IC2 will then output a 3-bit binary number from 000-111 to indicate exactly which one of the eight input lines is low. At the same time, pin gs outputs a low whenever any one of the input pins is low. By connecting this pin to the data port bit 7, the CPU can test it to see if a key is pressed. If it is, then the four output bits combined with the three input bits give a 7-bit number that indicates which one of the 128 switches is pressed.

To test the entire keyboard, the CPU must continuously increment the lower four bits and test bit 7 for a low. When a low is

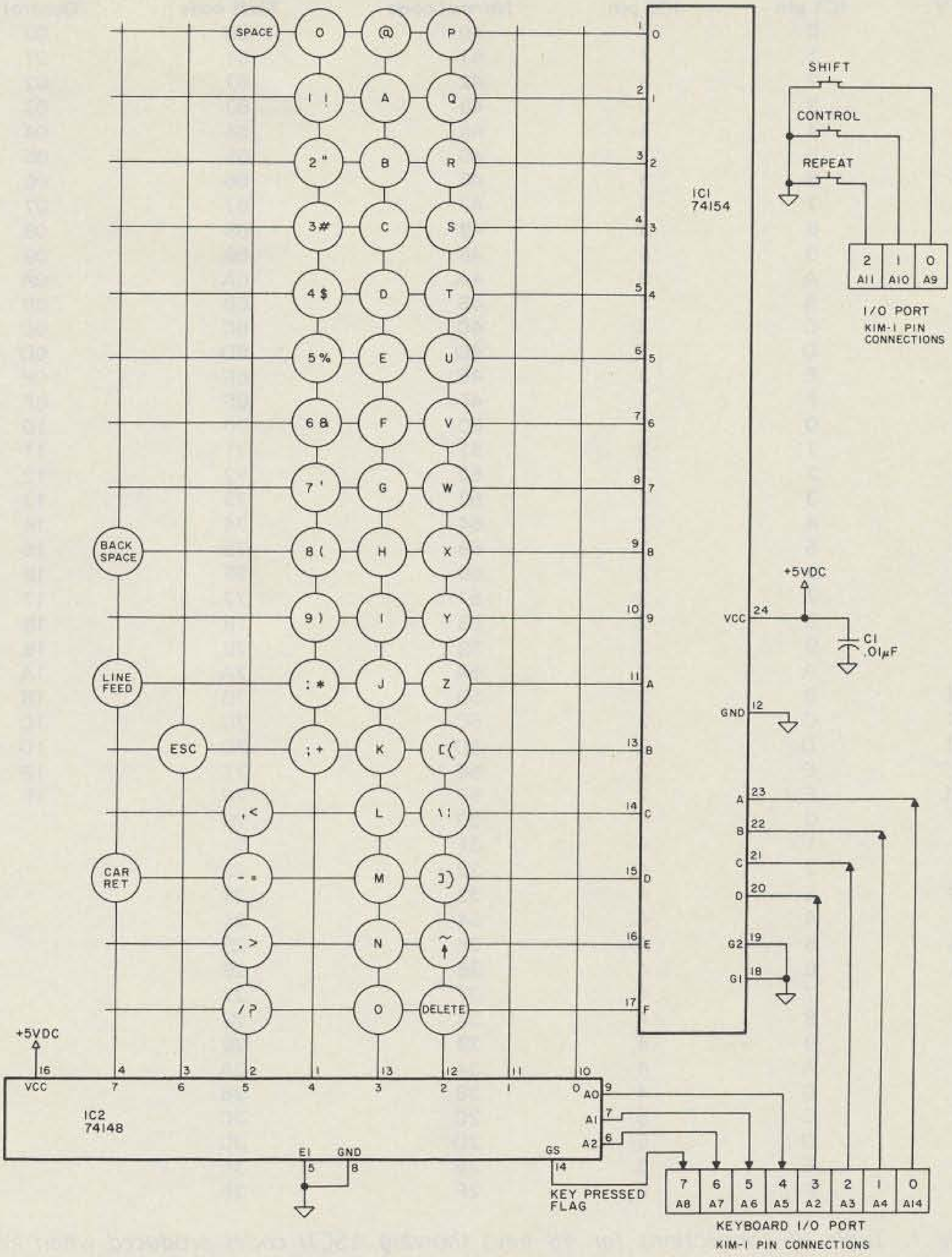


Fig. 3. Configuration for 48 characters (with KIM-1 interface information).

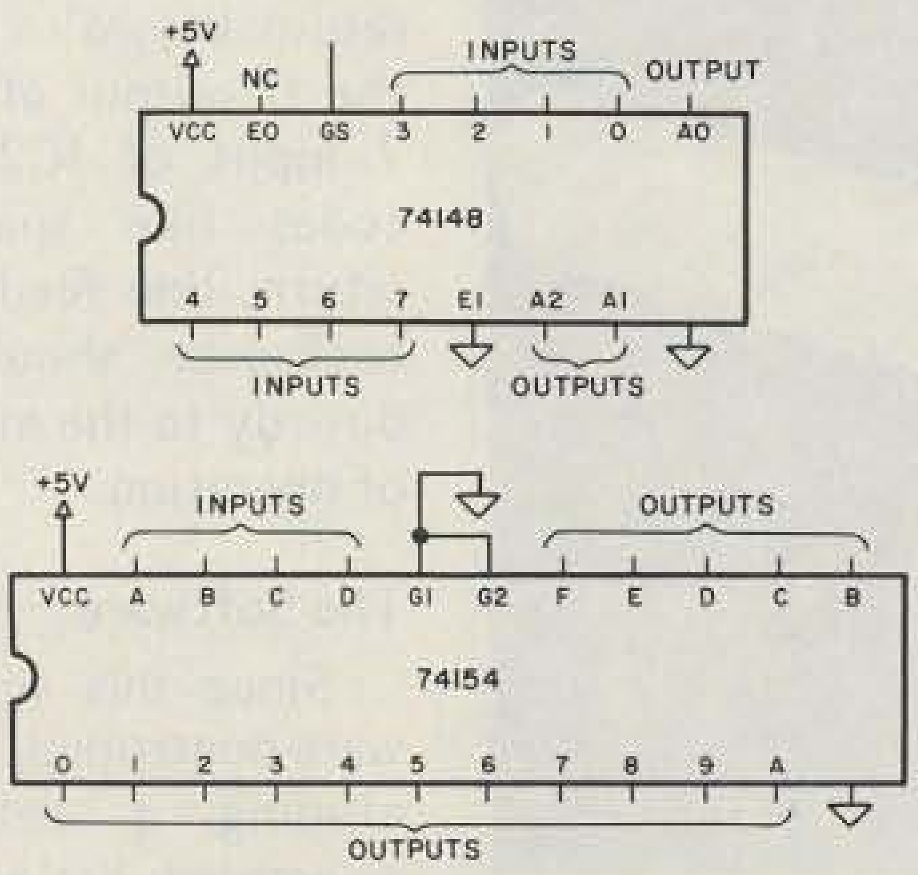
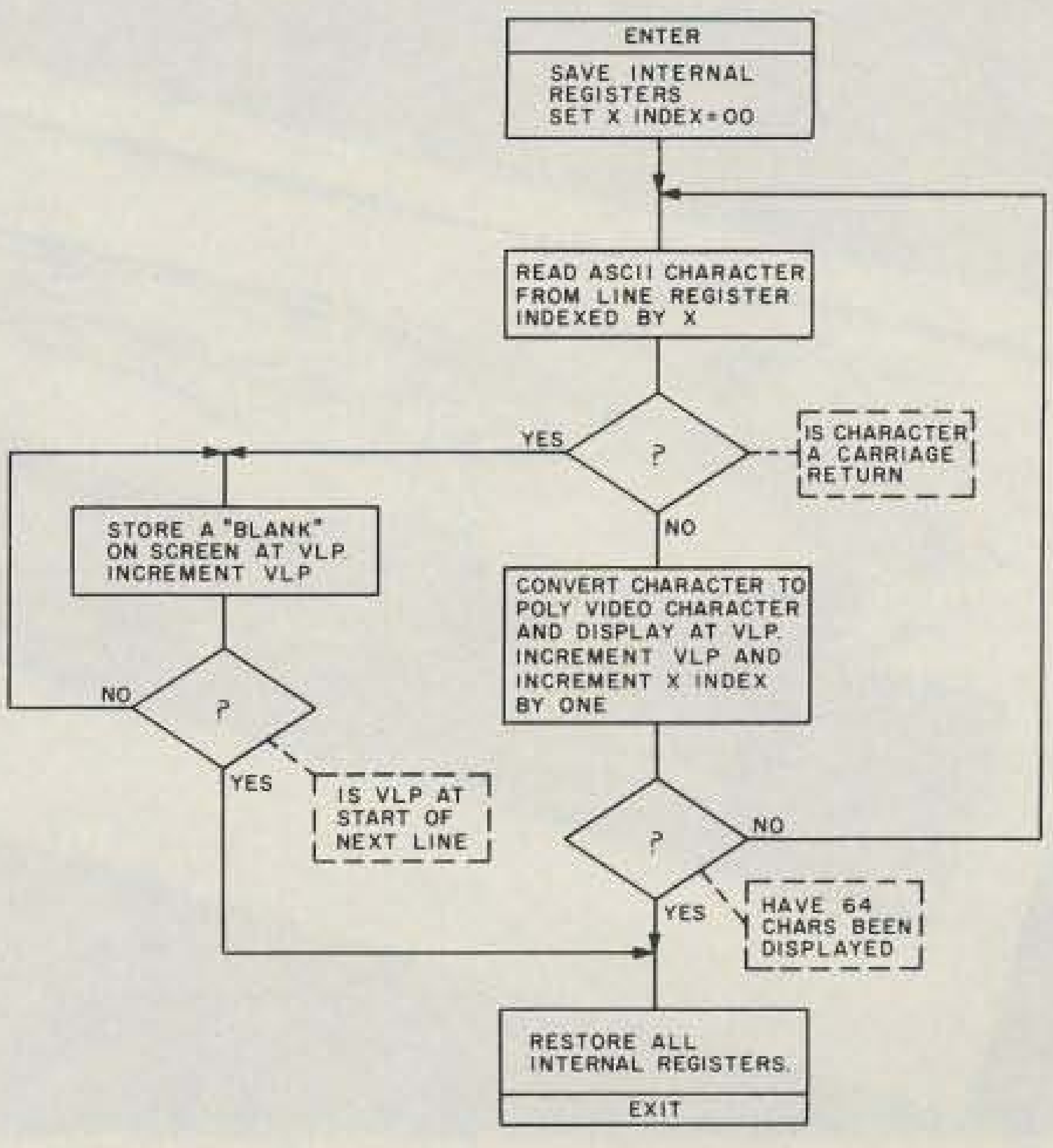


Fig. 4. Pinout diagram of ICs used.



Flowchart A. The software "Big Picture."

KEY	IC1 pin	IC2 pin	Normal code	Shift code	Control code
@	0	3	40	60	00
A	1	3	41	61	01
B	2	3	42	62	02
C	3	3	43	63	03
D	4	3	44	64	04
E	5	3	45	65	05
F	6	3	46	66	06
G	7	3	47	67	07
H	8	3	48	68	08
I	9	3	49	69	09
J	A	3	4A	6A	0A
K	B	3	4B	6B	0B
L	C	3	4C	6C	0C
M	D	3	4D	6D	0D
N	E	3	4E	6E	0E
O	F	3	4F	6F	0F
P	0	2	50	70	10
Q	1	2	51	71	11
R	2	2	52	72	12
S	3	2	53	73	13
T	4	2	54	74	14
U	5	2	55	75	15
V	6	2	56	76	16
W	7	2	57	77	17
X	8	2	58	78	18
Y	9	2	59	79	19
Z	A	2	5A	7A	1A
[{	B	2	5B	7B	1B
\ ¦	C	2	5C	7C	1C
] }	D	2	5D	7D	1D
↑ ~	E	2	5E	7E	1E
DEL	F	2	5F	7F	1F
0	0	4	30	20	
1 !	1	4	31	21	
2 "	2	4	32	22	
3 #	3	4	33	23	
4 $	4	4	34	24	
5 %	5	4	35	25	
6 &	6	4	36	26	
7 '	7	4	37	27	
8 (	8	4	38	28	
9)	9	4	39	29	
: *	A	4	3A	2A	
; +	B	4	3B	2B	
, <	C	5	2C	3C	
- =	D	5	2D	3D	
. >	E	5	2E	3E	
/ ?	F	5	2F	3F	

Table 1. Table of connections for 48 keys showing ASCII codes produced when keys are pressed.

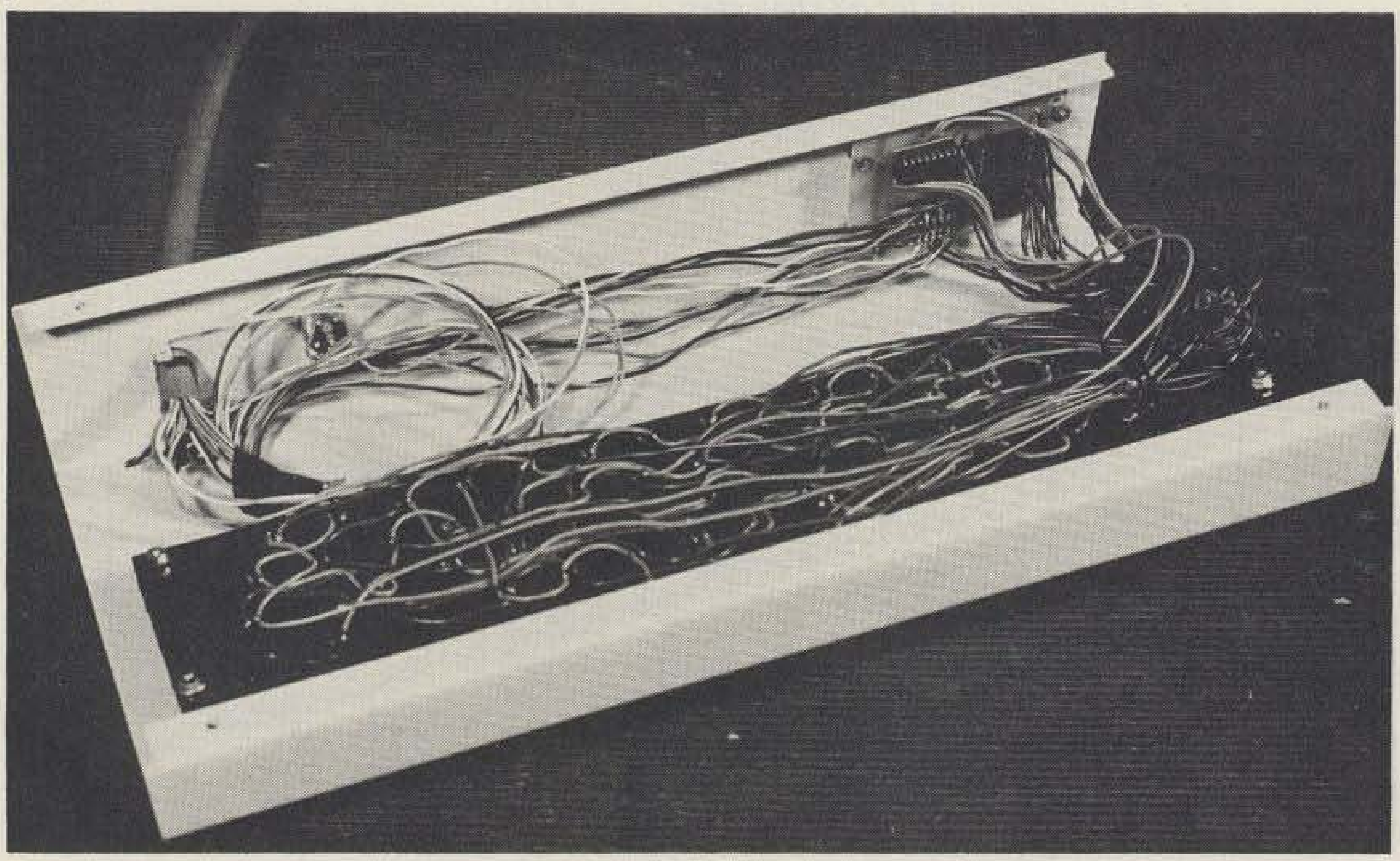


Photo B. The hard part — wiring the keyboard.

found, the 7-bit ASCII code can be directly loaded from the port.

Since 128-key terminals are relatively scarce and hard to use, most of us use a 64-key terminal with shift and control keys. Figs. 2 and 3 show how these two keys can be connected to another I/O port so that the CPU can test them. Table 1 lists 48 common keys of a 64-key terminal and shows where they can be connected in the matrix. The ASCII code shown in the normal column is produced when that key is pressed. The software used with this interface will also test the shift and control keys. If they are pressed, it will mathematically shift the code and produce the codes shown in the shift and control columns. This way, the 48 keys, when used in conjunction with the shift and control keys, will produce all 128 ASCII combinations.

This system by itself can be awkward to use. Even though a carriage return (ASCII 0D) can be produced by pressing M and Control, most of us would prefer to use a separate key. Any of the codes produced by shift and control keys can be wired to a separate key just by placing the key in the matrix. Fig. 2 shows the lines needed to connect any of the keys to IC1 and IC2. You must be aware that IC2 actually inverts the output bits, so, when line 0 is pulled low, it outputs a 111. To correct for this, the lines are wired in reverse. To connect a carriage return key, wire the switch to the D output of IC1 and the 7 input of IC2. Often-used codes like space, carriage return, line feed, delete, and backspace should be wired directly to the matrix for ease of operation.

The Software

Since this system is software-controlled, I am including a detailed hand-assembled listing of the input/output for my KIM-1

Line register — A 64-byte area of RAM in page 0 used to hold one line of ASCII characters. Both the input and output subroutines use the same line register.

Memory mapped video display — A video display board that looks like a section of read/write RAM to the CPU. A 16 x 64 video display uses 1024 bytes of memory space. Each address corresponds to a unique location on the screen. Writing an ASCII character to a video address will cause that character to appear on the screen.

Video line pointer — Two consecutive bytes in page 0 RAM that contain the 16-bit address of the screen location currently being filled.

Cursor — A white block that appears on the screen to show where the next typed character is to be placed. The cursor is turned on by saving the character at the cursor location in memory and then storing an FF on the screen. It is turned off by retrieving the old character from memory and writing it back on the screen in its old location.

Table 2. Definitions.

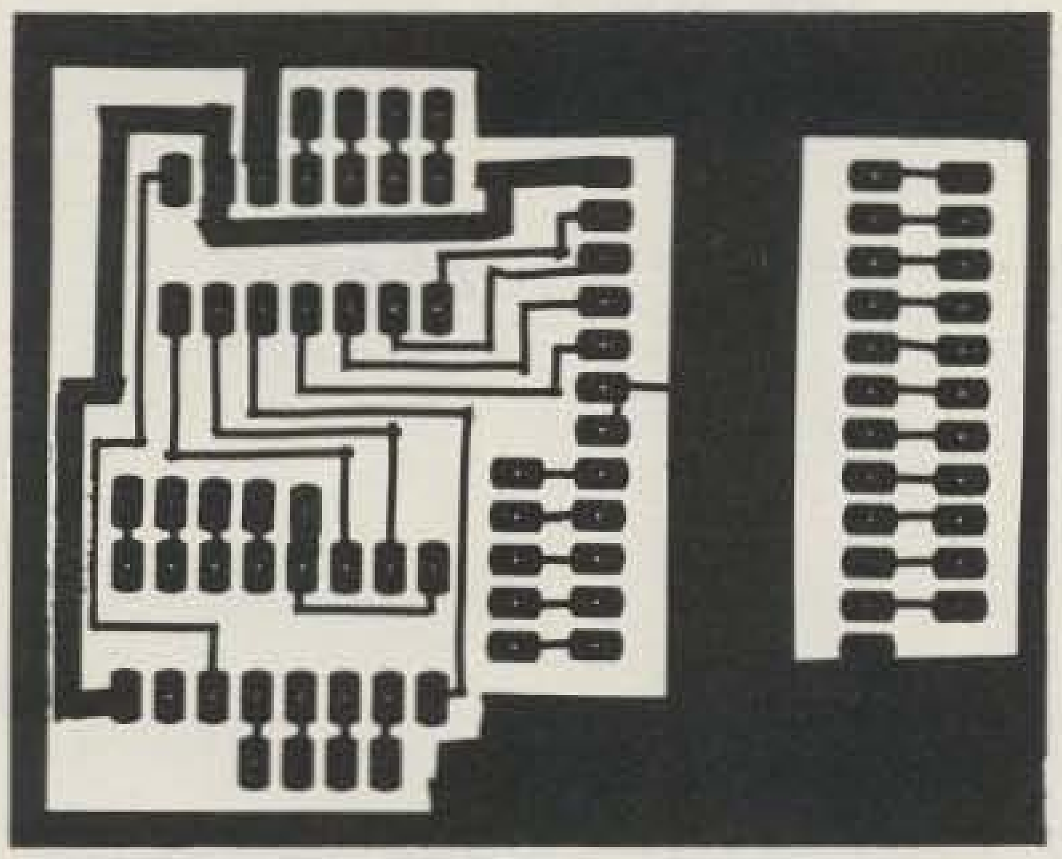


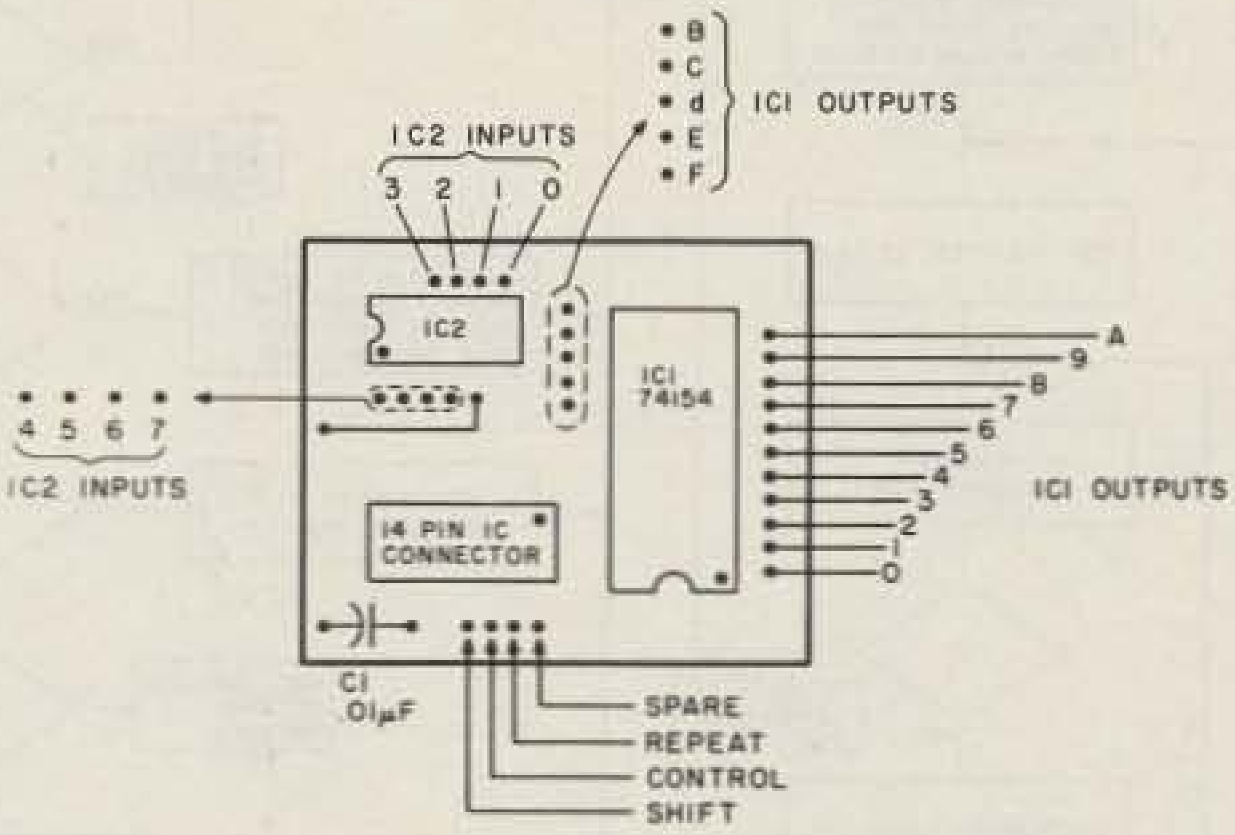
Fig. 5. PC board artwork.

0200	20	00	20	LOOP	JSR	LINEIN
0203	4C	00	02		JMP	LOOP

Table 3.

0200	20	00	20	LOOP	JSR	LINEIN
0203	20	8D	20		JSR	LINEOT
0206	4C	00	02		JMP	LOOP

Table 4.



Connections to 14 pin connector from KIM-1.

1 PA0	KA-14
2 PA1	KA- 4
3 PA2	KA- 3
4 PA3	KA- 2
5 PA4	KA- 5
6 PA5	KA- 6
7 PA6	KA- 7
8 PA7	KA- 8
9 + 5 V dc	KA- A
10 Ground	KA- 1
11 PB0	KA- 9
12 PB1	KA-10
13 PB2	KA-11
14 PB3	KA-12

KA = KIM applications connector

Fig. 6. PC board component layout and KIM-1 application connector interface.

(Program A). This also controls a video display board. It is written for an MOS 6502 and is currently running on my system. General and specific flowcharts are provided for those who would like to incorporate this technique into another system.

The software contains two main subroutines:

LINEIN: Scans the keyboard and accepts up to 64 characters which are to be displayed on the screen. The ASCII codes are stored in page 0, starting at 0000 for use by the calling routine.

LINEOT: Displays the ASCII characters starting at 0000. It will display 64 characters unless a CAR RET (0D) is found.

The video line used for both programs depends on the address in the video line pointer (00ED, 00EE). This should be set to the starting address of the video memory. The subroutines will update it.

Using the input subroutine is simple. When the cursor appears, it means that the subroutine has been called and is requesting data. You may type in up to 64 characters. If you press the repeat key by itself, the cursor will

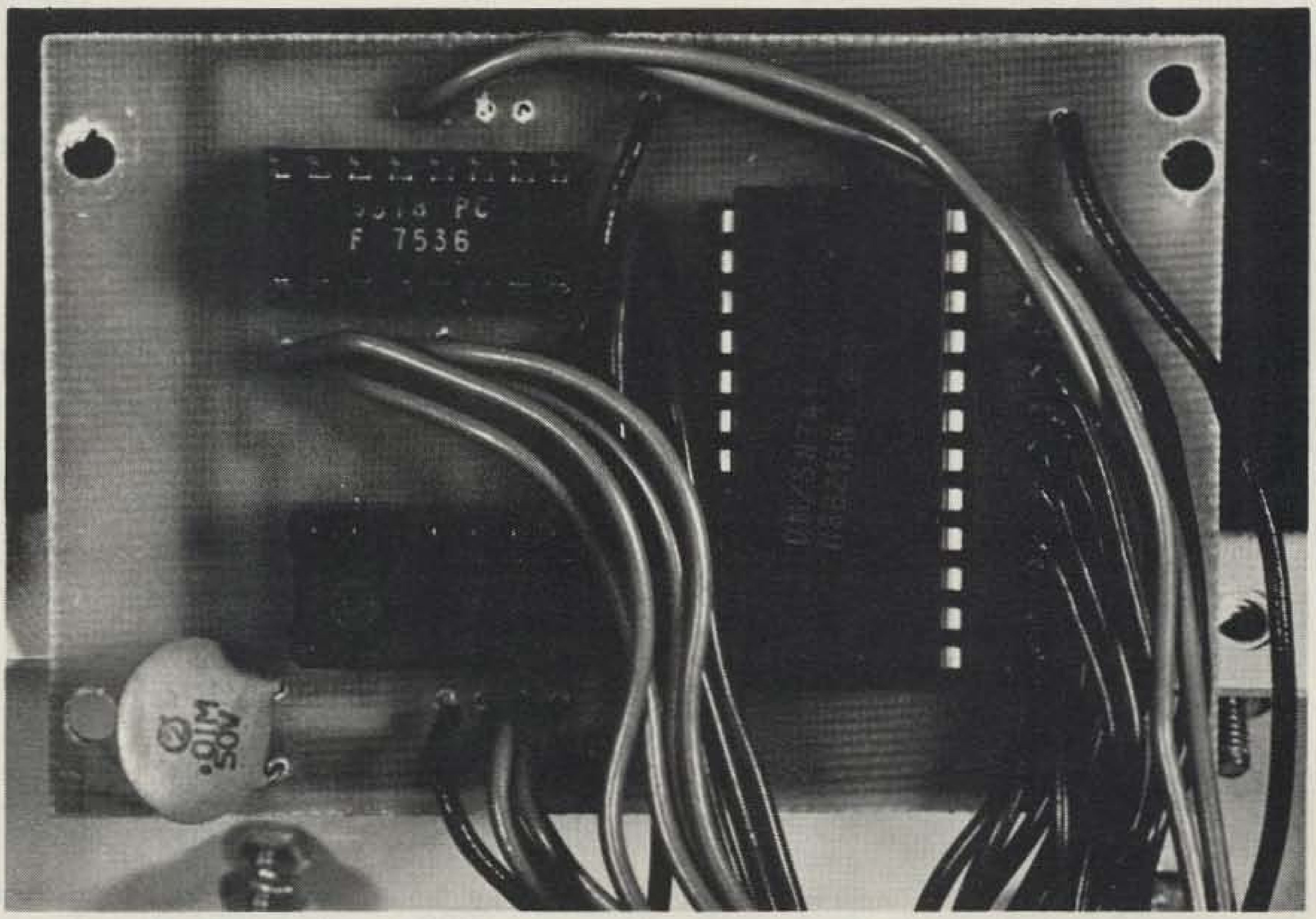
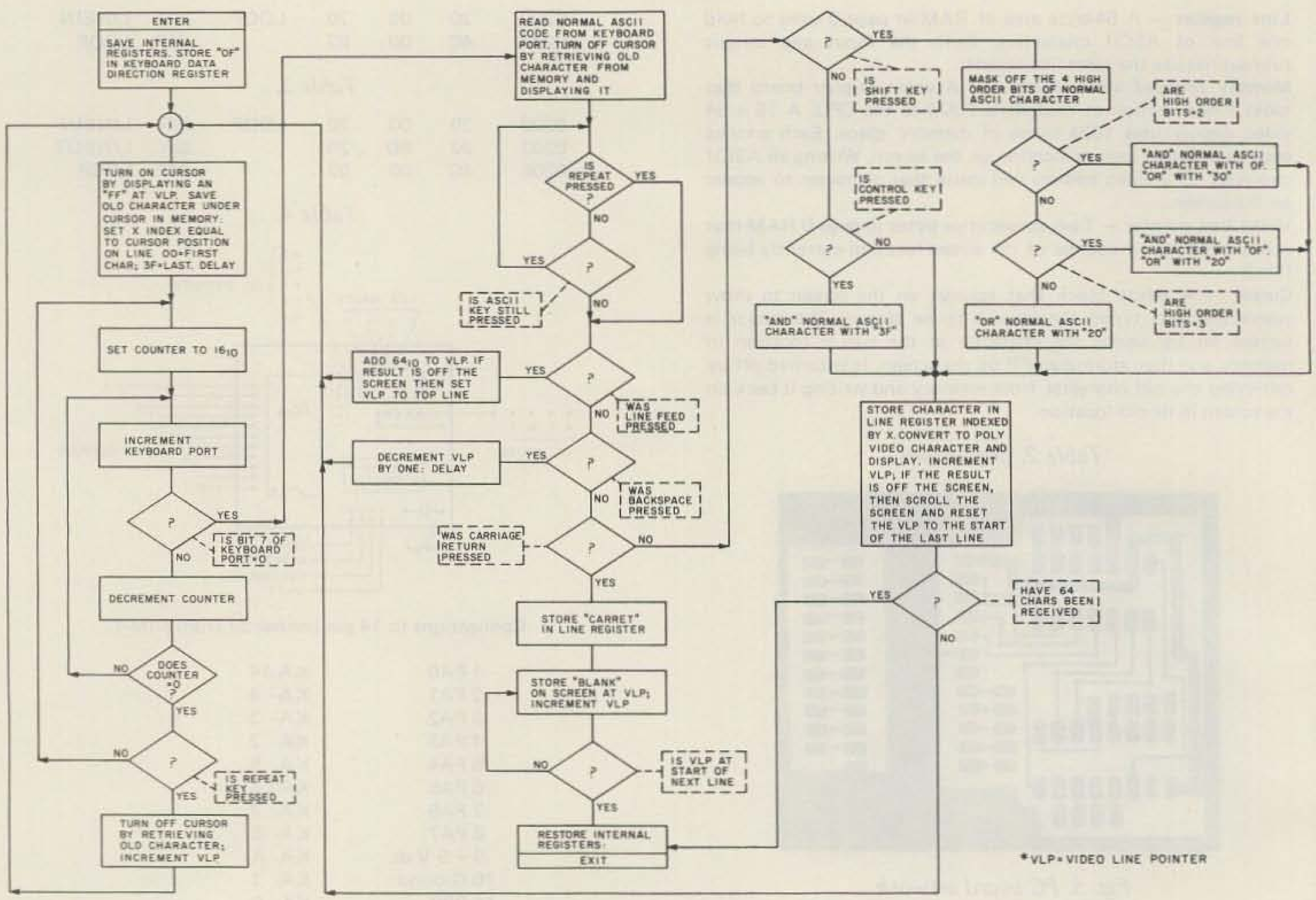


Photo C. Component side of PC board.



Flowchart B. Detailed flowchart for keyboard "encoding" and display of characters.

move to the right without changing any of the video. Pressing any other key along with the repeat key will continuously input the selected key onto the screen. Backspace will move the cursor to the left but will not change any of the video. Line feed will cause the cursor to move down one line. If a line feed occurs on the bottom line, the cursor will jump to the top of the page. Car Ret will cause the rest of the line from the cursor to the right edge of the screen to be blanked out. The cursor will be reset to the start of the next line, and control is returned to the calling program.

If the cursor was on the bottom line, then the display is scrolled up one line. The input subroutine will set the video line pointer to the next available line and leave the cursor off.

To use the output subroutine, the ASCII characters that you wish to display will be in page 0, starting at 0000. If there are fewer than 64 characters, a termination of 0D should be used. Then jump into subroutine LINEOT. The characters will be displayed on the line selec-

Program A. Source listings for KIM-1 or other 6502-based processor.

```
0000                 LR                               Line register 64 bytes
0080                 TEMP                             RAM scratch pad 4 bytes
0084                 CURSOR                           Storage for character in cursor position
00ED                 VIDLINlo                         Video line   [2
00EE                 VIDLINhi                         pointer      [Bytes
1700                 PORTS                            Data I/O ports
2000  48             LINEIN   PHA                     Save A, X,Y
2001  8A                      TXA
2002  48                      PHA
2003  98                      TYA
2004  48                      PHA
2005  A0  00                  LDY#00                  Set up index registers
2007  A9  0F                  LDA#0F                  Set up data direction registers
2009  8D  01  17              STA PORTS+1
200C  B1  ED         START    LDA(VIDLIN),Y           Turn on the cursor by saving the char
200E  85  84                  STA CURSOR              in the cursor's position and storing
2010  A9  FF                  LDA#FF                  an FF on the screen
2012  91  ED                  STA(VIDLIN),Y
2014  20  F0  20              JSR DELAY
2017  20  C2  20              JSR SETX                Set X index to the cursor position 00-3F
201A  20  AC  20     SCAN     JSR GETASC              Test for a pressed key
201D  A5  80                  LDA TEMP
201F  10  11                  BPL PROC                Branch if key was pressed
2021  AD  02  17              LDA PORTS+2             Test for a repeat key
2024  29  04                  AND#04
2026  D0  F2                  BNE SCAN                Branch if repeat was not pressed
2028  A5  84                  LDA CURSOR              Turn the cursor off by retrieving the
202A  91  ED                  STA(VIDLIN),Y           previously stored char
202C  20  C8  20              JSR NEXCHA              Increment the video line pointer
202F  38                      SEC
2030  B0  DA                  BCS START               Relative jump
2032  A5  84         PROC     LDA CURSOR              Turn cursor off
```

Continued.

```
2034  91  ED             STA(VIDLIN),Y
2036  AD  02  17  PROC1   LDA PORTS+2     Test for repeat key
2039  29  04              AND#04
203B  F0  05              BEQ CONT        Branch if repeat key is pressed
203D  AD  00  17          LDA PORTS       If repeat key is not pressed, then loop
2040  10  F4              BPL PROC1       until the ASCII key is released
2042  A5  80      CONT    LDA TEMP        Fetch the ASCII char normal code
2044  C9  08              CMP#08          Test for backspace
2046  D0  08              BNE CON1
2048  C6  ED              DEC VIDLINlo    Backspace routine, decrements video pointer
204A  20  F0  20          JSR DELAY
204D  38                  SEC
204E  B0  BC              BCS START
2050  95  00      CON1    STA LR,X        Store the char in line register
2052  C9  0D              CMP#0D          Test for CAR RET
2054  F0  2A              BEQ CART        Branch on a CAR RET
2056  C9  0A              CMP#0A          Test for a line feed
2058  D0  06              BNE CON2        Branch if not a line feed
205A  20  DE  20          JSR NEXLIN
205D  38                  SEC
205E  B0  AC              BCS START
2060  09  80      CON2    ORA#80          Convert to Poly ASCII char
2062  91  ED              STA(VIDLIN),Y   Display the character
2064  AD  02  17          LDA PORTS+2     Test for SHIFT or CONTROL keys
2067  29  03              AND#03
2069  C9  03              CMP#03
206B  F0  03              BEQ OUT         Branch if no SHIFT or CONTROL
206D  20  28  21          JSR SHIFT
2070  20  C8  20  OUT     JSR NEXCHA      Point video pointer to next position
2073  20  C2  20          JSR SETX        Set X to char position 00-3F
2076  E0  00              CPX#00          Test for 64 chars
2078  D0  92              BNE START       Branch if less than 64 chars received
207A  68          EXIT    PLA             Restore ACCUMULATOR and INDEX REGs
207B  A8                  TAY
207C  68                  PLA
207D  AA                  TAX
207E  68                  PLA
207F  60                  RTS             Return to calling routine
2080  A9  3F      CART    LDA#3F          Load a blank (Polygraphics char)
2082  91  ED              STA(VIDLIN),Y   Display a blank
2084  20  C8  20          JSR NEXCHA
2087  25  ED              AND VIDLINlo    Mask the lo order byte of the video
2089  D0  F5              BNE CART        pointer with 3F. If it is the end of
208B  F0  ED              BEQ EXIT        line, then the result will be 00
208D  48          LINEOT  PHA             Save A,X,Y
208E  8A                  TXA
208F  48                  PHA
2090  98                  TYA
2091  48                  PHA
2092  A0  00              LDY#00
2094  A2  00              LDX#00
2096  B5  00      LOOP    LDA LR,X        Fetch ASCII from line register
2098  C9  0D              CMP#0D          Test for CAR RET
209A  F0  E4              BEQ CART
209C  09  80              ORA#80          Convert to Poly ASCII char
209E  91  ED              STA(VIDLIN),Y   Display the character
20A0  20  C8  20          JSR NEXCHA
20A3  20  C2  80          JSR SETX        Set X to char position 00-3F
20A6  E0  00              CPX#00          Test for end of line (64 chars)
20A8  D0  EC              BNE LOOP        Branch if less than 64 chars
20AA  F0  CE              BEQ EXIT
20AC  8A          GETASC  TXA             Save X — This routine scans the keyboard
20AD  48                  PHA             16 times and returns ASCII key pressed
20AE  A2  10              LDX#10          in TEMP if no key then TEMP = FF
20B0  EE  00  17  SRCH    INC PORTS
20B3  AD  00  17          LDA PORTS       Fetch ASCII code
20B6  10  05              BPL KP          Branch if key is pressed
20B8  CA                  DEX             Decrement counter
20B9  D0  F5              BNE SRCH        Branch if less than 16 loops completed
20BB  A9  FF              LDA#FF          No key was pressed
20BD  85  80      KP      STA TEMP        Save ASCII or FF
20BF  68                  PLA             Restore X
20C0  AA                  TAX
20C1  60                  RTS
20C2  A9  3F      SETX    LDA#3F          This routine sets the X index to the
20C4  25  ED              AND VIDLINlo    character position (value of 00-3F)
20C6  AA                  TAX
20C7  60                  RTS
20C8  48          NEXCHA P PHA            This routine advances the video line
```

Continued.

ted in the video line pointer, and all video from the end of your string to the right edge of the screen will be blanked out. The video line pointer will be incremented to the next available line.

This software is designed to work with a Polymorphics video board and requires that all ASCII codes have their high order bit set to one. The software will do this. All machine functions (ASCII 00-1F) are displayed in the Greek alphabet. Entering any alphabetic character causes the upper case to be displayed. Shifting it will cause the lower case to be displayed. The following memory allocations are used:

0000-003F	64-byte storage for ASCII characters being input or output.
00ED,00EE	Video line pointer (set to 00, 7C).
0080-0084	Scratch pad RAM used by the subroutines.
1700	Address of data port that keyboard is connected to.
1701	Data direction register for keyboard port.
1702	Address of data port that shift, control, and repeat keys use.
1703	Data direction register.
7C00-7FFF	Memory used by video board.

Construction

The circuit is constructed on a single-sided printed circuit board (5 cm x 6 cm). The keyboard was wired using point-to-point soldering. Wiring all the keys into their proper place on the matrix will be the most tedious part of the project. Take your time, and do it right the first time. All connections between the KIM-1 and the keyboard are made

```
20C9  E6 ED              INC VIDLINlo     pointer to the next position. If the
20CB  D0 0F              BNE END          result points to address 8000, the
20CD  E6 EE              INC VIDLINhi     screen is scrolled and the pointer
20CF  10 0B              BPL END          is set to 7FC0, which is the beginning
20D1  20 01 21           JSR SCROLL       of the last line.
20D4  A9 C0              LDA#C0
20D6  85 ED              STA VIDLINlo
20D8  A9 7F              LDA #7F
20DA  85 EE              STA VIDLINhi
20DC  68        END      PLA
20DD  60                 RTS
20DE  18        NEXLIN   CLC              This routine adds 64 to the video line
20DF  A5 ED              LDA VIDLINlo     pointer lo byte. If a carry is
20E1  69 40              ADC#40           generated, then the hi order byte is
20E3  85 ED              STA VIDLINlo     incremented. If the result is greater
20E5  A9 00              LDA#00           than 8000, then the hi order byte is
20E7  65 EE              ADC VIDLINhi     set to 7C, which places the cursor
20E9  10 02              BPL OUT1         on the top line.
20EB  A9 7C              LDA#7C
20ED  85 EE     OUT1     STA VIDLINhi
20EF  60                 RTS
20F0  48        DELAY    PHA              This routine provides a delay for
20F1  8A                 TXA              debouncing and slowing down the
20F2  48                 PHA              repeat function to human speeds.
20F3  98                 TYA              Total delay may be varied by changing
20F4  A0 40              LDY#40           the value in 20F5.
20F6  CA        DEL      DEX
20F7  D0 FD              BNE DEL
20F9  88                 DEY
20FA  D0 FA              BNE DEL
20FC  A8                 TAY
20FD  68                 PLA
20FE  AA                 TAX
20FF  68                 PLA
2100  60                 RTS
2101  84 80     SCROLL   STY TEMP
2103  A9 40              LDA#40
2105  85 82              STA TEMP+2       This routine scrolls the display by
2107  A9 7C              LDA#7C           setting up two pointers in RAM scratch
2109  85 81              STA TEMP+1       pad. They are spaced apart by 64 chars,
210B  85 83              STA TEMP+3       which is one line. A character is loaded
210D  B1 82     CONI1    LDA(TEMP+2),Y    from the high pointer value and stored
210F  91 80              STA(TEMP),Y      in the low pointer value and both are
2111  E6 80              INC TEMP         incremented. When the high pointer
2113  D0 02              BNE CONI2        is set to 8000, then the last line
2115  E6 81              INC TEMP+1       is blanked out, and the video line
2117  E6 82     CONI2    INC TEMP+2       pointer is set to 7FC0 (bottom line)
2119  D0 F2              BNE CONI1
211B  E6 83              INC TEMP+3
211D  10 EE              BPL CONI1
211F  A9 3F              LDA#3F           Load a Polygraphics blank
2121  91 80     CONI3    STA(TEMP),Y
2123  E6 80              INC TEMP
2125  D0 FA              BNE CONI3
2127  60                 RTS
2128  C9 01     SHIFT    CMP#01           This routine will SHIFT the ASCII char
212A  D0 06              BNE SHF          in TEMP and display it if the shift or
212C  A5 80              LDA TEMP         CONTROL KEY is pressed
212E  29 3F              AND#3F           Mask off lower 5 bits to convert to
2130  10 10              BPL OUT2         a control character
2132  A5 80     SHF      LDA TEMP         This section will shift a ASCII according
2134  29 70              AND#70           to the following:
2136  C9 20              CMP#20              2X====3X
2138  F0 0F              BEQ LO              3X====2X
213A  C9 30              CMP#30              4X====6X
213C  F0 13              BEQ HI              5X====7X
213E  A5 80              LDA TEMP         Section shifts a 4X,5X to a 6X,7X
2140  09 20              ORA#20
2142  95 00     OUT2     STA LR,X         The converted character is stored in
2144  09 80              ORA#80           the line register and displayed on
2146  91 ED              STA(VIDLIN),Y    the screen
2148  60                 RTS
2149  A5 80     LO       LDA TEMP         Section to shift a 2X to a 3X
214B  29 0F              AND#0F
214D  09 30              ORA#30
214F  D0 F1              BNE OUT2
2151  A5 80     HI       LDA TEMP         Section to shift a 3X to a 2X
2153  29 0F              AND#0F
2155  09 20              ORA#20
2157  D0 E9              BNE OUT2
```

through a single 14-pin DIP connector. Refer to Photos 2 and 3 along with Figs. 4, 5, and 6 for construction details.

System Checkout

The keyboard interface and video display software is designed to work with a KIM-1 with 512 bytes of memory at address 2000, and a Polymorphics video display device at address 7C00.

After loading the software into memory, set the video line pointer to the top left corner of the screen by storing 00, 7C at addresses 00ED and 00EE. Also, be sure that the decimal mode of the 6502 is cleared by storing 00 at address 00F1.

The input program can be tested by having it operate as a TV typewriter. Load and run the program shown in Table 3.

A cursor will appear in the upper left corner. Press the carriage return key along with the repeat key until the screen is blanked out and the cursor is on the bottom line. Press line feed to restore it to the top of the screen.

Typing on the keyboard will cause the cursor to move to the right and display what is typed. Try all keys along with the shift and control keys to see what symbols are produced by each key.

After typing a line, stop the program and examine the memory starting at address 0000. It should contain the ASCII codes for the line you just typed.

To test the LINEOT subroutine, you can modify the calling program at 0200 as shown in Table 4. Now every line that you type in will be echoed and appear twice on the screen.

The program responds best to short, quick strokes on the keyboard. If your typing is slow, you can avoid debouncing errors by changing the value at address 20F5. Raising it will slow down the program and provide more time to debounce the keystrokes. ■

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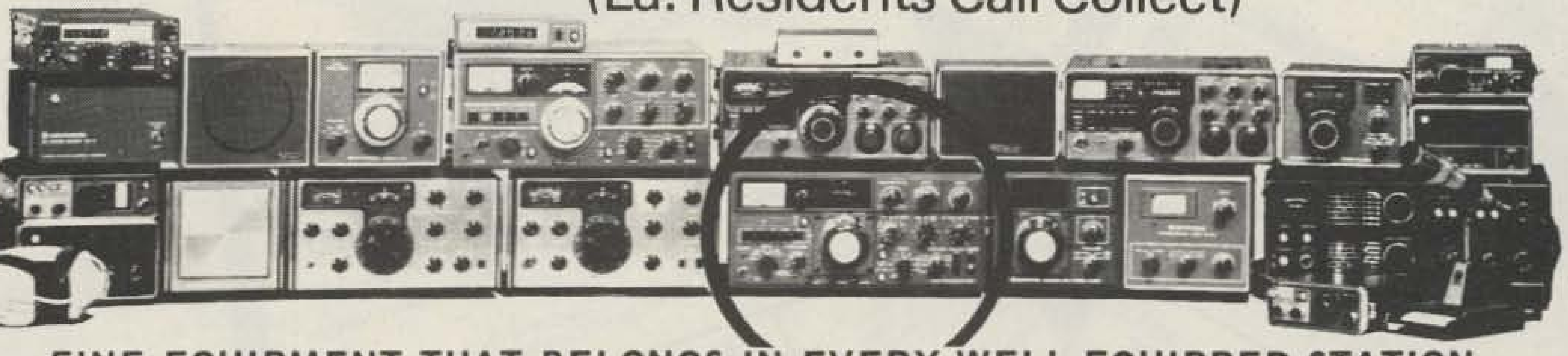

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18 pin	.75	.68	.62
20 pin	.84	.77	.71
22 pin	1.00	.97	.95
24 pin	1.00	.94	.75
28 pin	1.09	.98	.84
36 pin	1.59	1.45	1.30
40 pin	1.49	1.39	1.29

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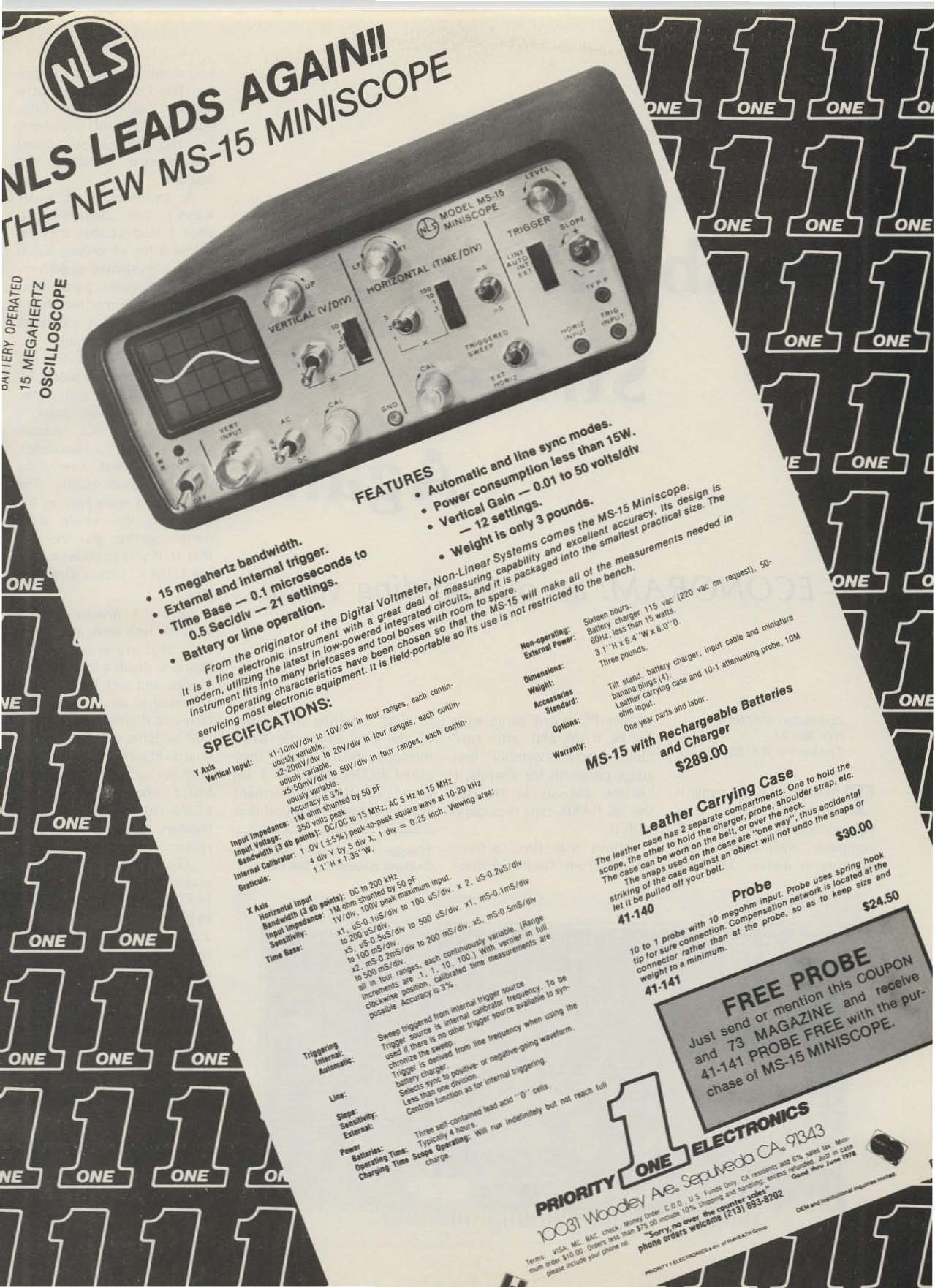
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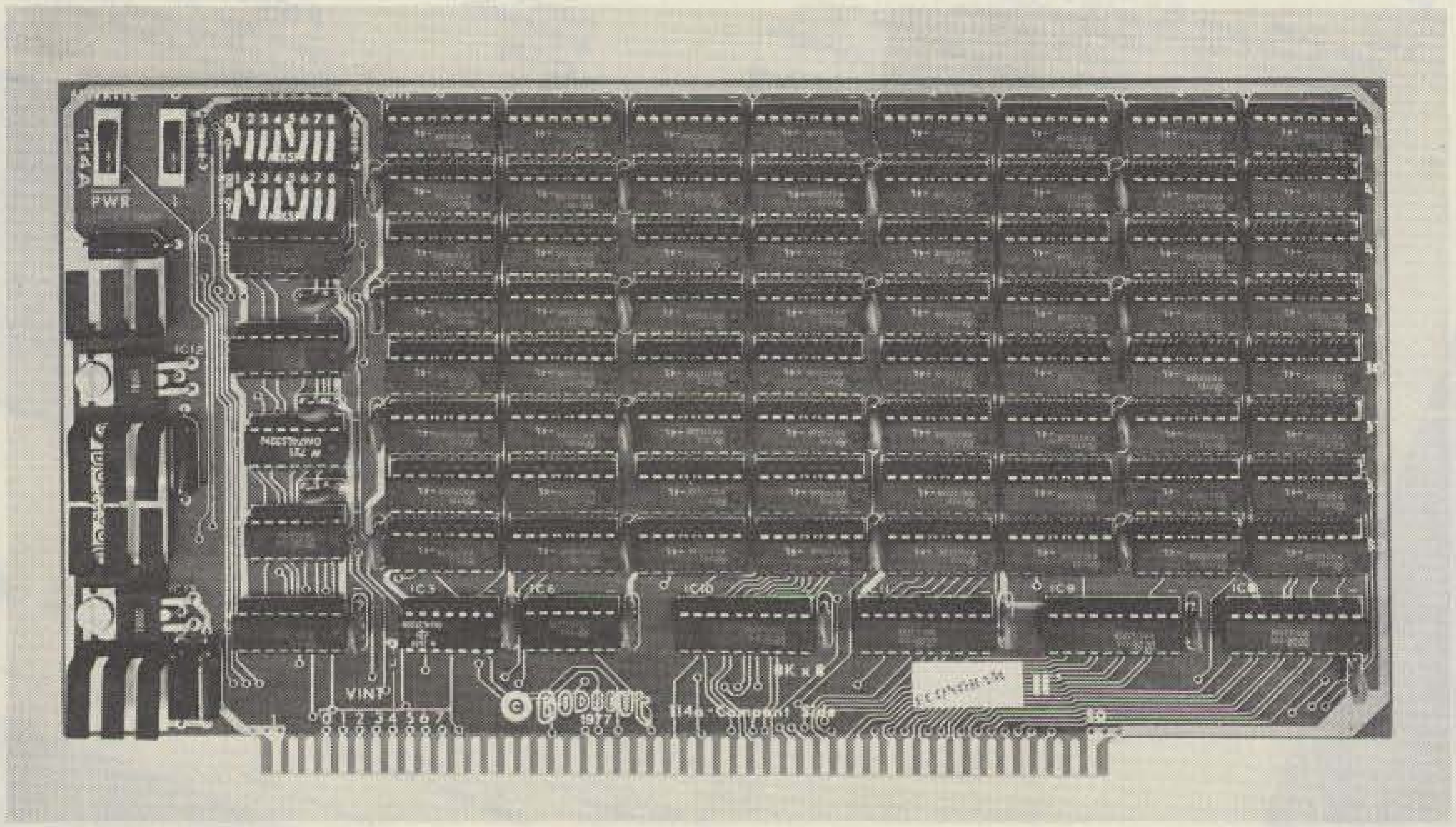
The name of the game is memory after your microprocessor is built. A computer with little or no memory is useless. My SOL system PC board came with 1K of RAM, and, after running simple assembly language programs for a while, I became anxious to try out the 5K BASIC tape that came with it.

About that time, a flyer arrived from Godbout Electronics* extolling the virtues of the new 8K static RAM memory board that they called ECONORAM II. I am leery of bargain-basement prices because I've found that you usually get what you pay for. But I've had many satisfactory dealings with Godbout, so I sent off my check for $163.84 (an odd price) and started watching my mailbox.

*Godbout Electronics, Box 2355, Oakland Airport CA 94614.



A two-week back order wasn't too disappointing, since I suspect that they received a lot of orders, but is 31 days (postmark to delivery date) reasonable parcel post service for a trip of less than a thousand miles? I will stick with UPS from now on!

What did I get for my money? A double-sided PC board with through-plated holes and a solder mask, a mountain of ICs, miscellaneous other components, and a data sheet. Everything was very good quality. The instructions were easy to follow, and the whole thing went together painlessly — that is, if you consider soldering 1200 IC socket pins painless.

Before I discuss how it worked, let's look at the features that are provided. The board is divided into two 4K blocks, and each block can be allocated to any address location you desire, using the two DIP switches mounted on the board. Placing all of the DIP switches off will disable the board when you want two boards to occupy the same memory location for some reason.

The memory normally operates with zero wait states (450 ns RAMs), but a slide switch is furnished for you Z-80 fans which will force one wait state for each memory operation. Another slide switch sets the board for use with or without a front panel.

There is also on-board protect circuitry and a vectored interrupt that will signal if an attempt is made to write into protected memory. These last two features require special hardware and software in your computer, but they are not needed for normal operation. Tristate outputs are provided.

After construction, I plugged the board in and powered up. The board carries two 1-Amp, 5-volt regulators which appear to be adequate. Their heat sinks get very warm to the touch, but not uncomfortably so.

I tried my Memory Monitor II (a program that I wrote which will load a block of memory for testing purposes), and it immediately became apparent that something was wrong. I could only load alternate memory locations. For instance: 0000 would write and read, but 0001 would not. 0002 was okay, but not 0003, and so on – very strange.

After much fruitless testing, I took advantage of Godbout's offer of repair service and sent the board back. I received it back in two weeks with a note that they had found an open trace and two 2102 pins bent under instead of inserted in the socket. There was no charge for the repairs, but none of that solved the problem. In a phone conversation, the person I spoke to at Godbout said they were willing to look at the board again, although they were sure that it was OK.

It was still loading every other memory location, and I was now ready to blame it on my computer. A call to Processor Technology elicited the hint that the protect line on the 8K board was actually floating, since SOL does not use that feature. It would be better if the protect line were tied low (unprotected). With a short wire soldered from pin 12 to pin 10 of IC11, my problem was solved.

Another Godbout product which should be of interest to expansion-minded hobbyists is their ten-slot mother board. This board has active terminations on all S-100 control and data lines, and, while I'm not too familiar with this concept as yet, this seems to be popping up in other designs also.

Godbout advertises this item as a "ten-slot mother board," but it actually has provisions for eleven sockets, ten of which are provided. The eleventh slot is intended as a connection point for jumpers to the main board, or another socket can be purchased if you plan to use this board as a stand-alone microcomputer mounting, either in a cabinet or rack mounted.

I use my mother board with a SOL PC which has only one S-100 socket, so I was happy to get more plug-in space. Rather than give up the eleventh slot to a bunch of jumpers, I bought a wire-wrap socket, and, after soldering it in place, I wire-wrapped a fifty-pair cable to it. The other end of the cable I soldered to the traces on an extender board which I plug into the SOL. This gives me a total of twelve sockets. As an added convenience, I can plug any board that is giving me trouble into the extender board socket, and it stands up in the clear for testing various points on it.

The mother board is of very heavy construction, and there are fourteen mounting holes, which makes for a rigid finished product. The power traces are very wide, and this will help with current flow when it becomes heavily populated. Construction was very straightforward but tedious, as was the case with the 8K board, with more than twelve hundred connections to solder. Documentation was adequate, and a simple adjustment of the active termination circuit is all that is required after construction is finished.

The ten-slot mother board costs $90, and an eighteen-slot board is available for $124.

I now have 8K of reliable memory and a row of sockets to plug it and a few other goodies into. But, when I get ready to buy another memory board, I'll order the assembled version of ECONORAM II for $188.50, which is still a bargain. Above all, watch that protect line! ■

The Klingons Are Coming!

—new depth charge game

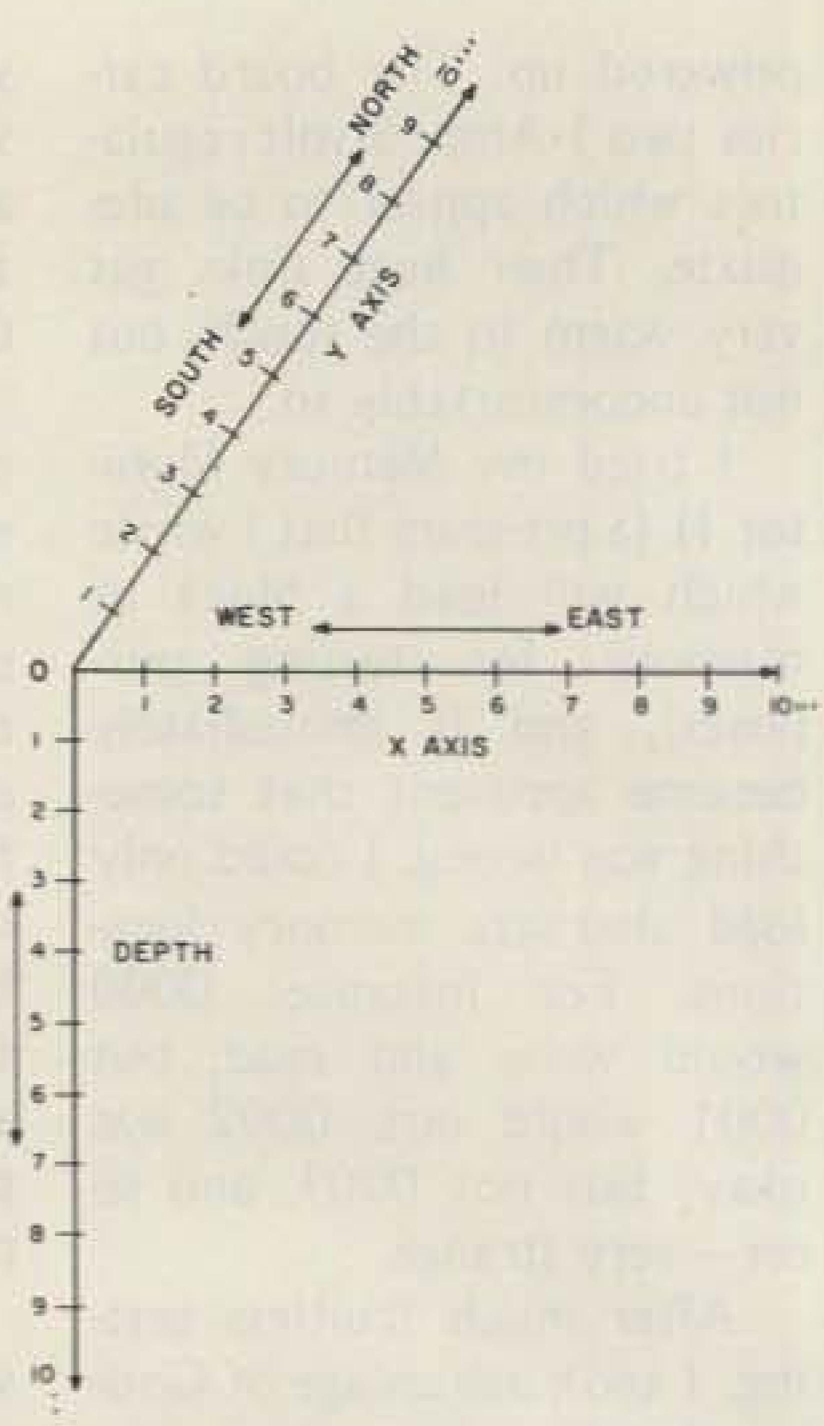
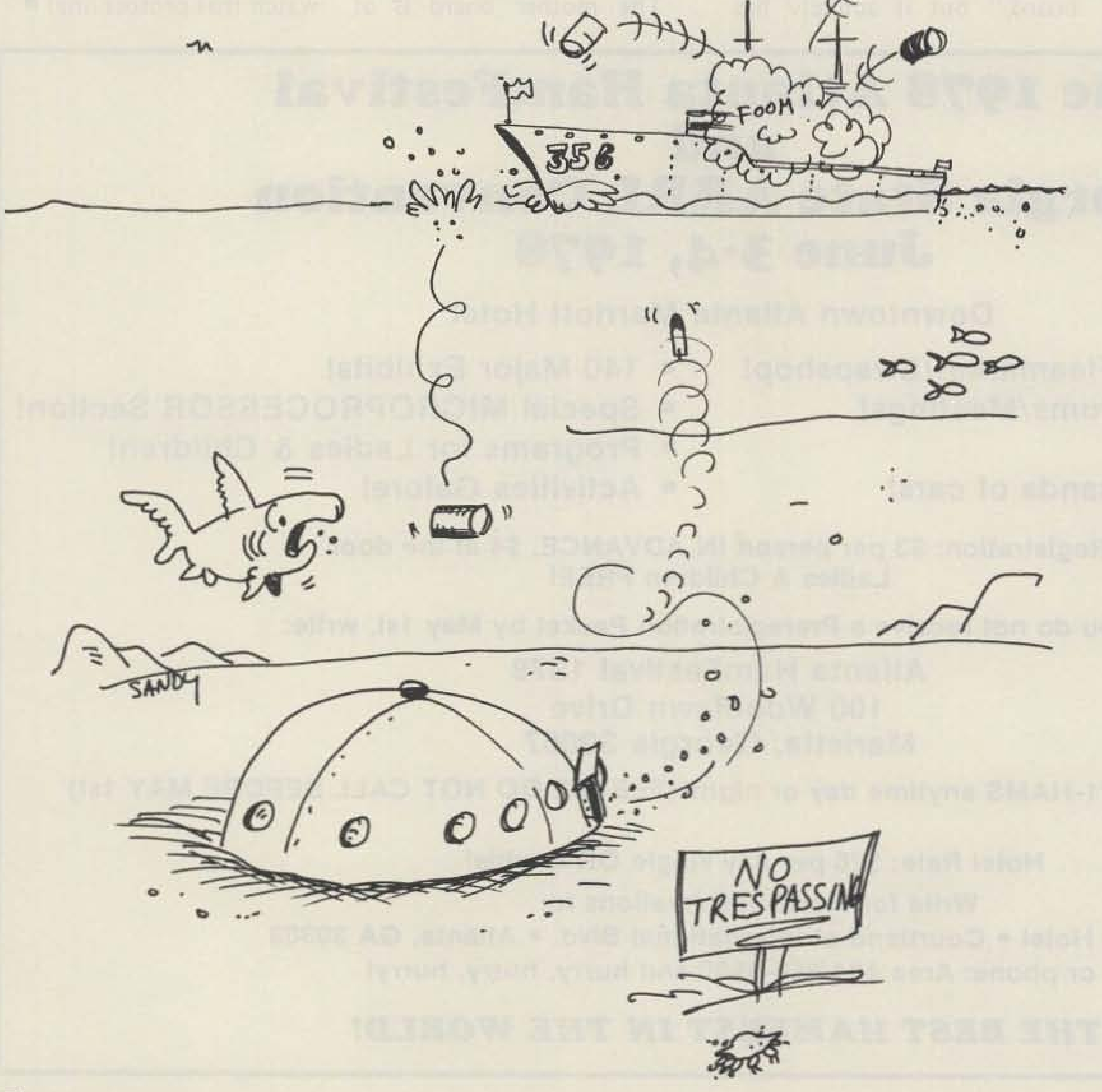


Fig. 1. Coordinate system.

Mark Herro WB9LSS
311 Woodlane Lane
Oconomowoc WI 53066



The idea for this article came, at least in part, from Pete Stark's "Submarine" game (*Kilobaud*# 2, February, 1977) and a similar game that appeared in our school's time-sharing library some time ago. However, this program has several additional features that can make it very challenging.

Background

"Depth Charge" is written in BASIC for a Compucolor 8001 which has 8K of user memory. The program itself doesn't take up nearly that much. It uses probably half, so it should run on any machine with 4K of "play room."

Use of the Compucolor was generously donated by General Precision Electronics, Inc., in Watertown, Wisconsin, as, at the time, I didn't have access to our school's time-sharing terminal (no, I didn't get kicked out — school was out for the year).

The Game

Picture a coordinate sys-

```
THIS IS THE DEPTH CHARGE GAME
YOU ARE THE CAPTAIN OF A DESTROYER LOOKING FOR
THE EVIL KLINGON UNDERWATER TORPEDO BASE.

YOUR JOB IS TO DESTROY THE BASE  USING YOUR DEPTH
CHARGES BEFORE THE KLINGONS ZERO IN AND TORPEDO
YOU AND TAKE OVER THE SEAS

YOU MAY SPECIFY THE MAXIMUM SEARCH AREA BY GIVING
THREE NUMBERS--ONE FOR THE Y AXIS (NORTH/SOUTH),
THE X AXIS (EAST/WEST), AND DEPTH.
THE LARGER THE AREA THE MORE SHOTS YOU GET
BEFORE THE KLINGONS ZERO IN AND TORPEDO YOU

TO MAKE A SHOT, ENTER THE THREE NUMBERS (Y, X, DEPTH)
WHERE YOU THINK THE BASE IS.  THE SHIP'S SONAR
WILL REPORT BACK WHERE THE SHOT WAS IN RELATION TO
THE BASE.  GOOD LUCK!!!

MAXIMUM SEARCH AREA (Y, X, DEPTH)? 10,10,10

DETONATION COORDINATES? 5,5,5

SPLASH!
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    *----THUMP

NORTH
EAST
TOO HIGH

DETONATION COORDINATES? 3,3,7

SPLASH!
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    *----THUMP

NORTH
WEST
TOO HIGH

DETONATION COORDINATES? 1,4,10

SPLASH!
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    I
    *----THUMP

SOUTH
TOO LOW

DETONATION COORDINATES? 2,4,9

BLAM!!------------STATION DESTROYED!!!  THE WORLD
IS SAFE!

TRY AGAIN? (1=YES)? 2

READY
```

Fig. 2. Sample run.

tem as in Fig. 1. Now, make believe that it is a section of the ocean. You may make this section as large or as small as you like, but the coordinate origin (0,0,0 as y, x, Depth) will always be in the southeast corner (on the surface) of the ocean.

Somewhere within the boundaries of this section of ocean lies the evil Klingon (Why not? We blame them for just about everything else.) torpedo base. The base does not move, but it does pose a threat to world peace (sound familiar?) by torpedoing the passing "unfriendly" (to them) shipping. However, in typical Klingon style, it takes them awhile to "zero in" before they can fire. The amount of time it takes to zero in is directly proportional to the size of the section of ocean you have selected. In other words, the larger the area, the more time you have to get them before they get you.

You are the captain of a depth charge carrying destroyer. Your mission is to rid the seas of the evil Klingon torpedo base by destroying it with the ship's depth charges. This is accomplished by entering the detonation coordinates of a depth charge and using ship sonar reports to find the location of the base.

The request "detonation coordinates?" ("SPLASH . . . THUMP") is a request to enter the three numbers where you think the base is. Type a y (north/south) coordinate, an x (east/west) coordinate, and a depth (zero is the surface) coordinate, in that order, separated by commas.

You will then get a sonar report telling where your shot was in relation to the target. For example, if sonar reported the depth charge was "SOUTH," "EAST," and "TOO HIGH," the next shot would have to be more north (larger y coordinate), further west (smaller x coordinate), and deeper (larger depth coordinate). I use y, x, depth instead of x, y, depth because people are used to saying "southeast" – right?

Anyway, so the game goes until either the evil Klingon base is destroyed by a depth

```
10 PRINT"THIS IS THE DEPTH CHARGE GAME"
20 REM BY MARK HERRO FOR A COMPUCOLOR 8001
30 PRINT"YOU ARE THE CAPTAIN OF A DESTROYER LOOKING FOR"
40 PRINT"THE EVIL KLINGON UNDERWATER TORPEDO BASE."
50 PRINT
60 PRINT"YOUR JOB IS TO DESTROY THE BASE USING YOUR DEPTH"
70 PRINTCHARGES BEFORE THE KLINGONS ZERO IN AND TORPEDO"
80 PRINT"YOU AND TAKE OVER THE SEAS."
90 PRINT
100 PRINT"YOU MAY SPECIFY THE MAXIMUM SEARCH AREA BY GIVING"
110 PRINT"THREE NUMBERS--ONE FOR THE Y AXIS (NORTH/SOUTH),
115 PRINT"THE X AXIS (EAST/WEST), AND DEPTH.
120 PRINT"THE LARGER THE AREA THE MORE SHOTS YOU GET"
130 PRINT"BEFORE THE KLINGONS ZERO IN AND TORPEDO YOU"
140 PRINT
150 PRINT"TO MAKE A SHOT, ENTER THE THREE NUMBERS (Y, X, DEPTH)"
160 PRINT"WHERE YOU THINK THE BASE IS.  THE SHIP'S SONAR"
170 PRINT"WILL REPORT BACK WHERE THE SHOT WAS IN RELATION TO"
180 PRINT"THE BASE.  GOOD LUCK!!!"
185 PRINT
190 REM SET UP CONDITIONS
200 INPUT"MAXIMUM SEARCH AREA (Y, X, DEPTH)"; A,B,C
210 LET Y=INT(A*RND(1))
220 LET X=INT(B*RND(1))
230 LET Z=INT(C*RND(1))
235 REM SHOT LIMIT
240 LET S=INT((A+B+C)/5)
250 FOR L=1 TO S
260 REM START SHOOTING
270 IF L=S-1 THEN PRINT"BETTER HURRY...THEY'RE ZEROING IN FAST!"
280 PRINT
290 INPUT"DETONATION COORDINATES"; D,E,F
300 PRINT
310 PRINT"SPLASH!"
320 FOR H=1 TO 15
330 PRINT"   I"
340 NEXT H
350 PRINT"   *----THUMP"
355 REM "DEL" CAN BE SUBSTITUTED FOR THE "*" IN SOME SYSTEMS
360 PRINT
365 REM SONAR REPORT
370 IF D<>Y THEN GOTO 420
380 IF E<>X THEN GOTO 440
390 IF F<>Z THEN GOTO 460
400 PRINT"BLAM!!------------STATION DESTROYED!!!  THE WORLD"
405 PRINT"IS SAFE!"
410 GOTO 530
420 IF D<Y THEN PRINT"SOUTH"
430 IF D>Y THEN PRINT"NORTH"
440 IF E<X THEN PRINT"WEST"
450 IF E>X THEN PRINT"EAST"
460 IF F<Z THEN PRINT"TOO HIGH"
470 IF F>Z THEN PRINT"TOO LOW"
480 NEXT L
490 PRINT
495 PRINT"WHOOSH-------------------------KERBOOM!!!!"
500 PRINT
510 PRINT"YOU'VE BEEN HIT!!!!  ABANDON SHIP!!!!!"
520 PRINT"ITS ALL OVER BUT THE SHOUTING"
525 PRINT
530 INPUT"TRY AGAIN? (1=YES)"; T
540 IF T=1 THEN GOTO 200
550 END
```

Fig. 3. Program listing.

charge ("BLAM"), or the Klingons finally "zero in" and torpedo you ("WHOOSH ... KERBOOM!"). Fig. 2 shows a sample run to illustrate how this can work.

The Program

Fig. 3 is the program listing. Except for the random number generation at 210 through 230, you should have little difficulty in adapting the program to your system. For the random generation statements, the idea is to generate a random integer between zero and your maximum area value. If you have some trouble getting it going, try this:

245 PRINT Y,X,Z

That will print your random values to troubleshoot other parts of the program (or cheat at the game, if that's what you want). Most of the program is pretty much self-explanatory. I'll be more than happy to answer any questions, as long as you enclose a self-addressed stamped envelope for my answer.

Good luck. Have fun. ■

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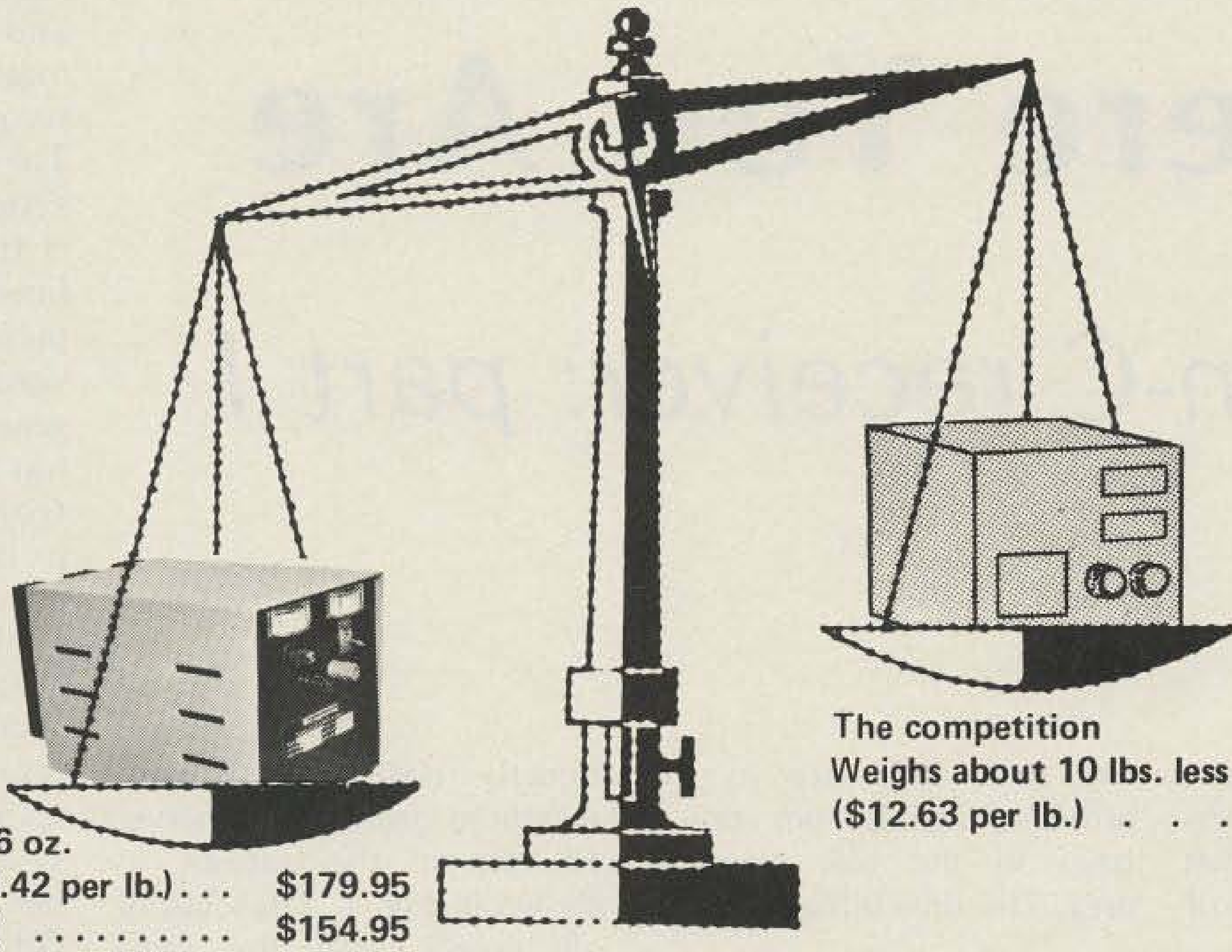

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If You Want To Know Where You Are

—loran-C receiver: part I

Loran-C is a pulsed low-frequency (LF) hyperbolic navigation system which is based on measurement of the time difference in the arrival of signals from station pairs in the user coverage area. The time differences are directly related to a distance measured from the observer to each of the stations, as shown in Fig. 1. The locus of all points with the same microsecond time difference is a hyperbola or a line of position (LOP). The intersection of two or more LOPs provides a fix and defines the position of the observer relative to the two station pairs used in the measurements, in this case M-X and M-Y.

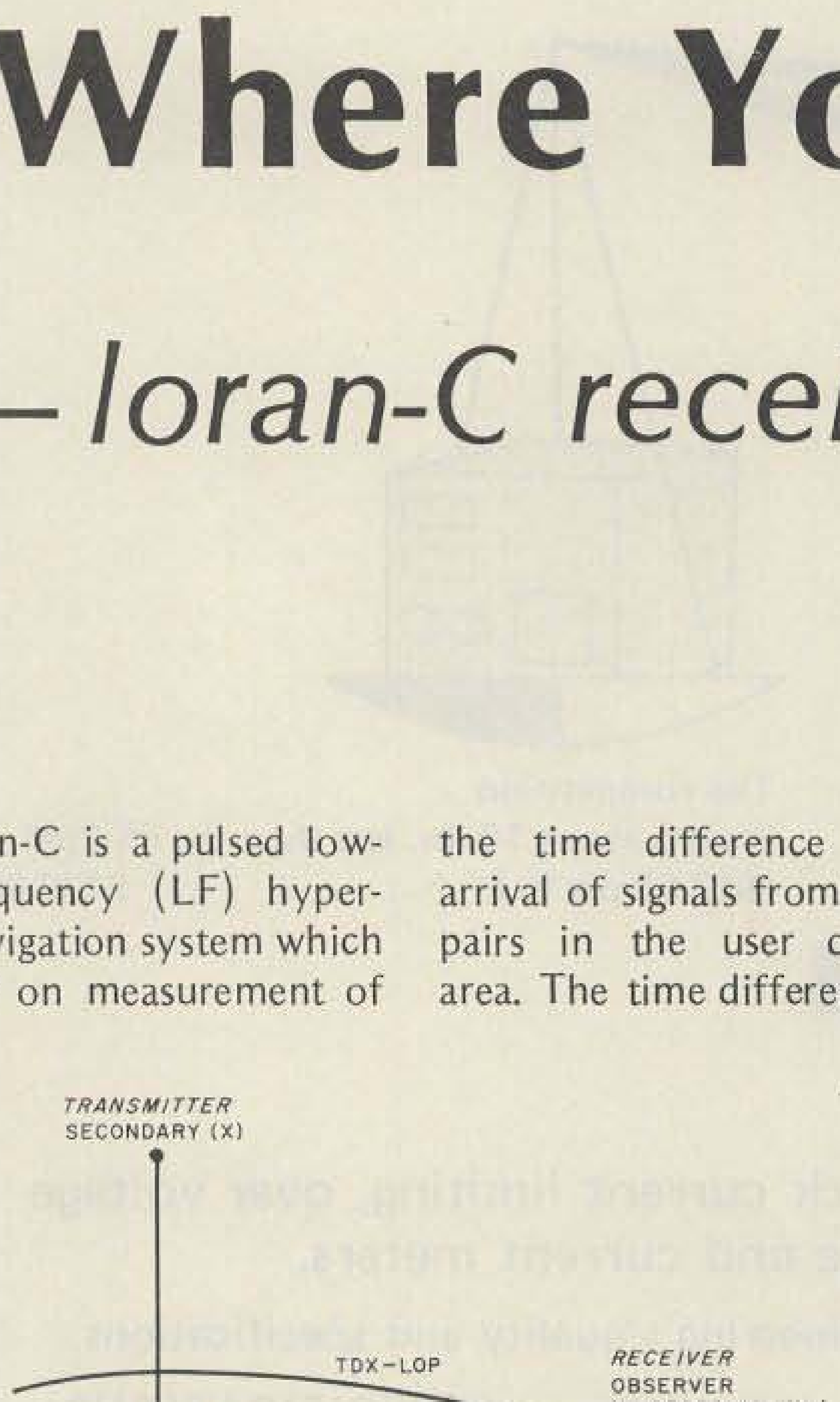

Fig 1. Hyperbolic fix geometry. TDX = the locus of all positions where the observed time difference between the times of arrival of the M and X signal is constant. (Illustration from CG-462 Loran-C Users Handbook, *August, 1974, U.S. Coast Guard, Washington DC.*

The precision depends on the receiver's ability to measure time intervals accurately and the observer's ability to correct for propagation errors. Charts and rate tables are published by the U.S. Department of Defense (DOD) Mapping Agency (see Table 1). Propagation of LF signals is quite stable for the ground wave out to 600 miles or so (1000 km). Reduced accuracy signals can also be received out to 1200 miles (2000 km).

The Mini-L receiver is a basic rf front end or converter for the loran-C pulse format. It can provide about 1-microsecond timing precision on the ground wave signal. This corresponds to about 500 feet at 500 miles or so. Commercial receivers using a 100-nanosecond (10 MHz) clock can provide greater precision, but they are usually much more complex than the Mini-L.

The idea here is to provide the experimenter with a 100 kHz rf front end which can actually be used for elementary navigation experiments and for time-frequency measurements at the 1-microsecond timing precision level. The Mini-L is not a navigation system, but rather is only an rf front end which generates interrupt requests or timing pulses locked to the loran-C signals. It is up to the user to generate his own software or hardware timing methods from the Mini-L output pulses. Some ideas and possible ways of using the Mini-L are presented in this article for those who are skilled in the receiver interface fabrication art.

Some commercial receiver systems may involve 50 ICs per LOP in digital hardware. Other very complex loran-C systems have, in the past, involved multiple processors where a separate microprocessor is used to keep track of each station pair, and still another uP is used for a synchronization or search-mode channel. This is beyond the capability of most amateurs, so some simpler alternatives are suggested. One of the things that most radio amateurs can do is use loran-C as a time-frequency standard reference source.

Radio amateurs may recall, and probably some mariners still use, the APN-4 or R-65, APN-9 loran-A receivers of World War II vintage, operating in the 160 meter band above the AM BC band. Loran-A has restricted radio amateur use of the 160 meter band since the late

1940s. The loran-C system is intended to eventually replace loran-A, although the phaseout will be quite slow. Loran-C is designed for improved precision, reducing the effects of sky waves, and provides greater coverage with fewer stations than loran-A. A problem in the past with loran-C has been the cost to achieve these goals for the average receiver user. The advent of microprocessors and modern IC circuit techniques provides means for possibly reducing this cost-complexity problem so that loran-C receivers might become available at much less cost. The Mini-L is a start in that direction.

Loran-C is a hot prospect at the moment for a general-purpose locating system in the CONUS (continental U.S.A.), as well as the coastal confluence regions of North America, the North Atlantic, Europe, the North Pacific, and elsewhere. There were some 22 chains operating or planned on a worldwide basis as of 1976, including two chains in the U.S.S.R. Fig. 2 illustrates the east and west coast U.S.A. chain coverage. High precision has been demonstrated in locating ground reference points for public service vehicles by the DOD, the state of New York, and others, where an rf front end in the vehicle telemeters the raw loran-C pulse rate data back to a central processor over an HF or VHF communications link.

Loran-C coverage for the U.S.A. will increase, with some new chains becoming operational in the period from July, 1978, to February, 1980. Table 2 is a list of the new chain configurations. These stations should provide at least one transmitter for all observers in the continental U.S.A. when loran-C is used as a time-frequency reference source.

Mariners and airborne users claim repeatability of 50 feet in locating reference buoys or touchdown points when using a 10 MHz (100 nanosecond) local clock reference in the receiver processor. The DOD has recommended loran-C and the military loran-D as standards for future airborne, marine, and ground-based locating systems. The U.S. Army Signal Corps has demonstrated remarkable precision in backpacking sets with 16K words of processor memory in locating the same ground reference point at almost any time of the day or night with loran-C-D. Airborne users are studying loran-C to augment wide-area navigation methods (R-NAV) where the GDOP (geometric dilution of precision) errors are usually less than for present VOR-DME methods.

The U.S. Naval Observatory keeps track of the timing precision of all the loran-C chains. They can be accurate to within 0.1 microseconds per day, or about 1×10^{-12}. This is a super-accurate clock. The signals may be used to determine the offset of local clocks with a relatively simple calibration method. In a matter of a few minutes, it is possible to determine the offset of your 1 MHz crystal oscillator to within 1×10^{-7} with respect to loran-C, and, in a 24-hour period, you should be able to determine the offset a few orders of magnitude better, if you happen to have a proportional oven-controlled clock that is stable enough to be worth this precision measurement effort.

For navigation, a high-precision clock on board the receiver processor is not required. Generally, the local reference should be within 1×10^{-5}, or 10 cycles, at 1 MHz for 1-microsecond timing precision (about 500 feet) or within 1×10^{-6} for a 10 MHz clock with 100-nanosecond measurement precision. The repetition rate of the chains is always less the 100,000 microseconds, thus a receiver is always capable of updating itself every 0.1 seconds or less.

Radio amateurs and microcomputer buffs who are skilled in the receiver interface electronics art can easily provide themselves with a loran-C front end for less than $100 worth of parts. The front end provides signals to a BCD or binary word generator for each loran-C pulse under a combination of hardware and software control, depending on the needs of the user. A loran-C processor and CPU with memory can provide the amateur with a mobile, marine, or airborne navigation set, as well as be used as a bench monitor for a house time-frequency standard reference. A simplified processor might require 4K or less memory. Commercial receivers presently sell in the $2k to $20k class, with a $5k model

Publication number	Loran-C rate tables	Price
221(1001)	East coast U.S.A. (Pair 9930-W)	$2.25
221(1002)	East coast U.S.A. (Pair 9930-Y)	2.25
221(1013)	East coast U.S.A. (Pair 9930-X)	2.25
221(1014)	Eastern U.S.A. (Pair 9930-Z)	2.25
221(2018)	West coast U.S.A. (Pair 9940-X)	2.25
221(2019)	West coast U.S.A. (Pair 9940-Y)	2.25
Chart number	**Loran tables and diagrams**	**Price**
5130	Loran-C coverage diagram, scale 1:45,000,000	$3.00
5148	Loran interpolator diagram	1.50

Table 1. Loran-C charts and tables are available from: Defense Mapping Agency, Hydrographic Center Depot, 5801 Tabor Avenue, Philadelphia PA 19120, phone: (215)-697-4262; or Defense Mapping Agency, Hydrographic Center Depot, Clearfield UT 84016, phone: (801)-773-3254. Order east or west coast publications, as needed. In addition, write for catalog and prices of the 7800-7900 series loran-C plotting charts and GLC-C-series global loran-C charts.

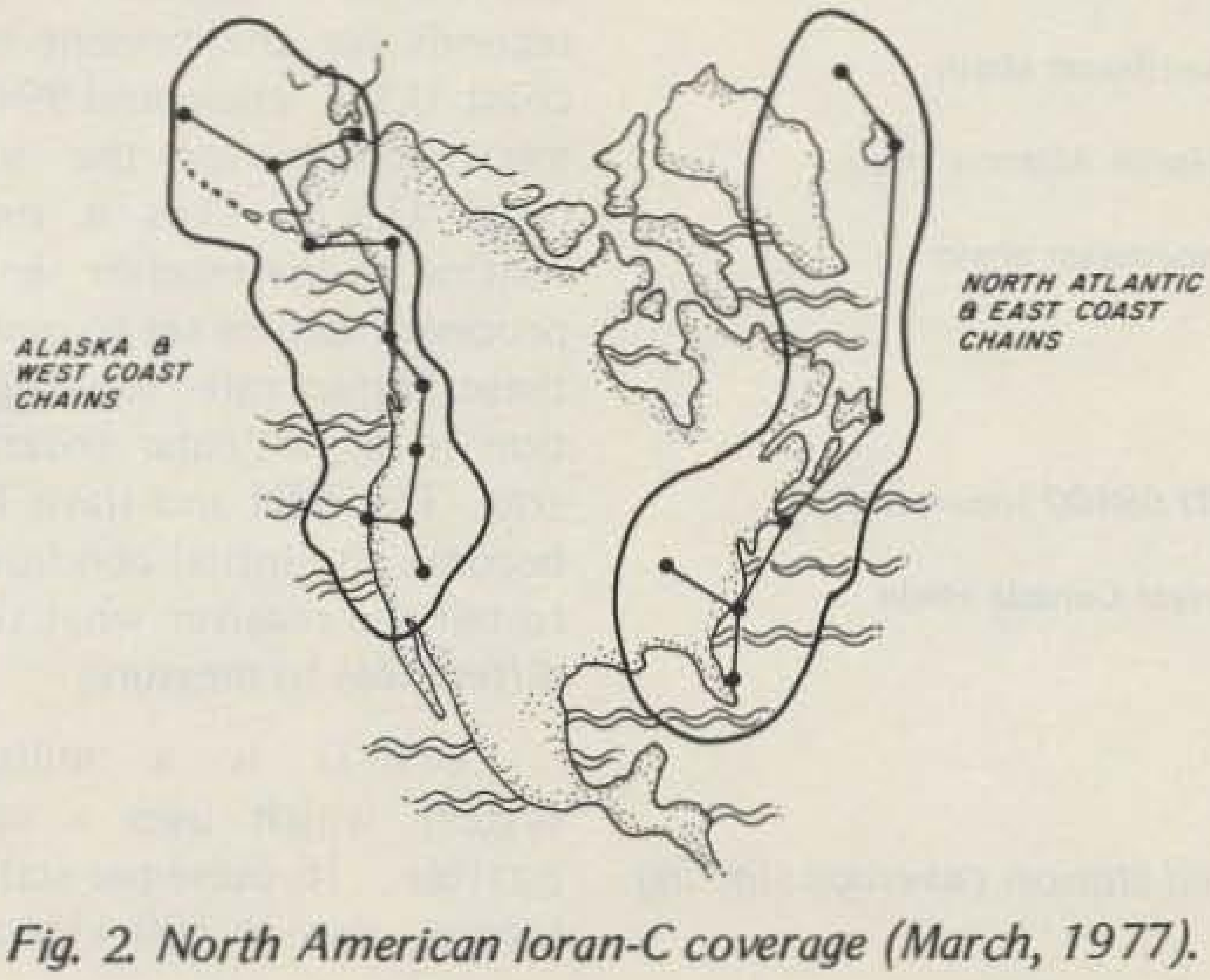

Fig. 2. North American loran-C coverage (March, 1977).

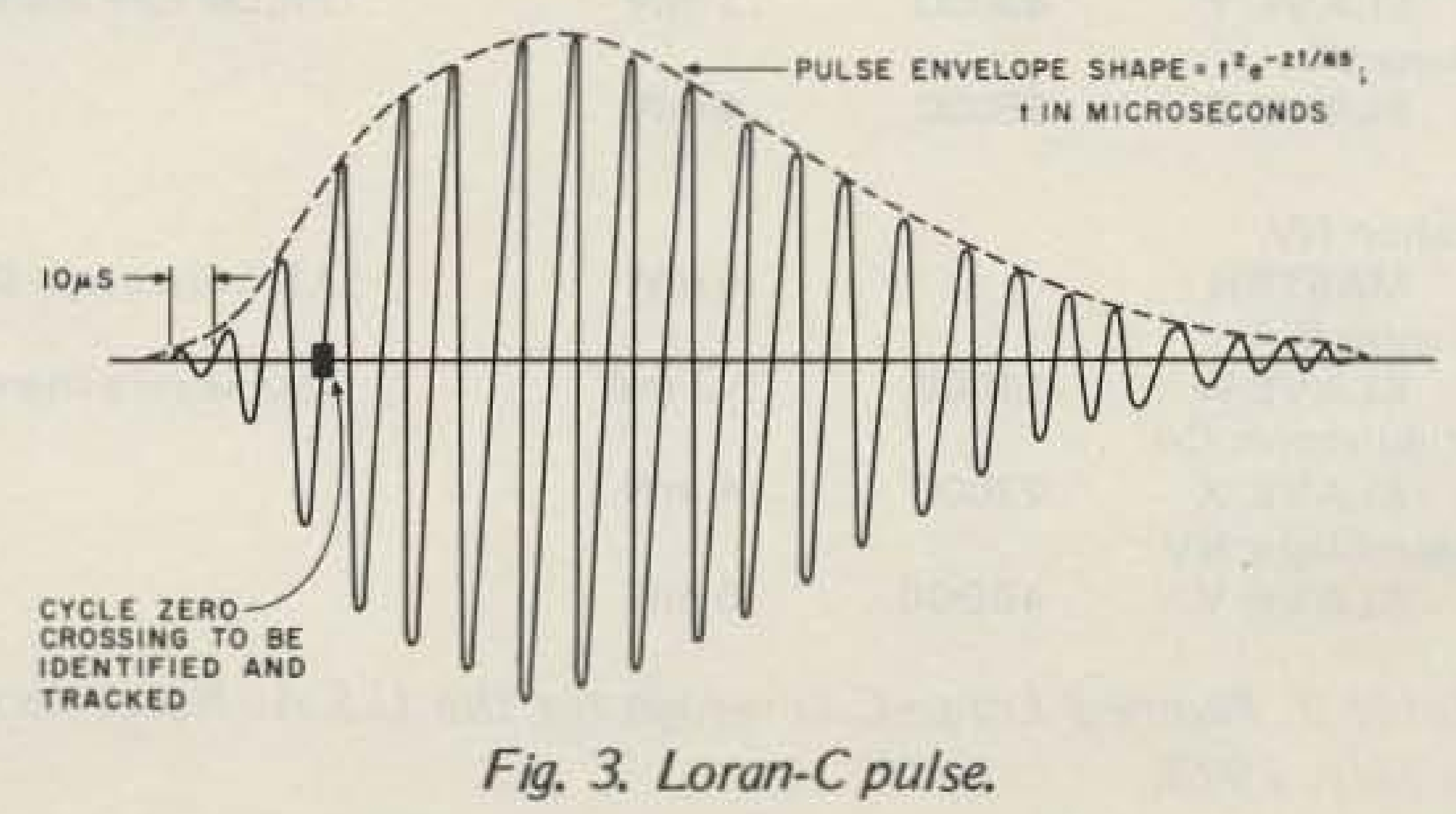

Fig. 3. Loran-C pulse.

using a microprocessor and readout systems for determining two lines of position in a microsecond time-difference mode, which can be directly read from charts or tables published by the DOD and the U.S. Coast Guard (USCG). Loran-C users should obtain a copy of the USCG CG-462 *Loran-C Users Handbook* (1974 edition or later) from a local USCG district office. Another very useful source of information is the Wild Goose Association (WGA), c/o Lloyd D. Higginbotham, 4 Townsend Rd., Acton MA 01720. The WGA publishes a yearly *Radio Navigation Journal* devoted to loran. The 1976 issue is full of information on basic receiver operational problems. Membership in the WGA is $10/year. As a member, you receive periodic newsletters and copies of their annual reports. WGA also sponsors an annual convention for loran buffs and anybody else who is interested.

Principles of Operation

The basic principle of operation of loran-C involves slave stations, which transmit groups of 8 pulses separated by exactly 1 ms intervals, and a master station, with a 9-pulse group inserting an additional 1 ms gap before the ninth pulse for easy identification. High radiated power in the 200 kW to 1 megawatt range is transmitted from each station such that most users will have a positive S/N in their receiver for a 20 kHz bandwidth on the ground wave at ranges up to 1000 km (600 miles). Usable signals for most receivers are also obtained out to about 1660 km (1000 miles), with somewhat reduced accuracy due to sky wave contamination of the ground wave signal.

The shape of each transmitted pulse is very carefully controlled at the transmitter so that the user can identify the third zero crossing of the 50% envelope amplitude point when using a hard-limiting type of receiver input circuit. It does not matter if a receiver chooses the second or fourth zero crossing here, but what is important is that the receiver must measure the same relative zero crossing for all signals used in the actual time-difference measurement. By determining one of these early zero crossings before 65 microseconds, as in Fig. 3, it is possible to largely eliminate sky wave contamination of the pulse envelope, which starts to rise after the first 30 microseconds in most of the user coverage area. The stations transmit groups of pulses, as illustrated in Fig. 4, with a known coding time delay (TD) which enables a receiver to predict when to start looking for the time differences in comparing a particular slave with the master. The pulses are also phase-coded so that further sophistication is possible in identifying stations and eliminating interference. The phase code repeats every other GRI and can be averaged out in a simplified measuring system. The GRI is a constant 99300 microseconds for the present east coast U.S.A. chain and 99400 microseconds for the west coast U.S.A. Thus a timer routine in the receiver sensor processor can be set to one of these known rates for navigation in a particular coverage area. The GRI and slave TDs become the initial conditions to tell the receiver what time differences to measure.

Loran-D is a military system which uses a compatible 16-pulse-per-station format, also at 100 kHz and

Station	TD	Power	Remarks
Seneca NY MASTER	--	1 mW	Northeast U.S. chain: ***GRI 99600***, July, 1978
Caribou ME SLAVE W	11000	.35 mW	
Nantucket MA SLAVE X	25000	.3 mW	Double rate shared with east coast chain
Carolina Beach NC SLAVE Y	39000	.7 mW	Double rate shared with east coast chain
Dana IN SLAVE Z	?	.4 mW	(present east coast chain – operational February, 1980)
Dana IN MASTER	--	.4 mW	Great Lakes chain: ***GRI 99300***, February, 1980
Malone FL SLAVE W	11000	1 mW	Double rate shared with southeast chain
Seneca NY SLAVE X	28000	1 mW	Double rate shared with northeast chain
Int. Falls MN SLAVE Y	44000	?	
Malone FL MASTER	--	1 mW	Southeast U.S. chain: ***GRI 79800***, August, 1978
Grangeville LA SLAVE W	11000	1 mW	
Raymondville TX SLAVE X	23000	.4 mW	
Jupiter FL SLAVE Y	41000	.3 mW	Double rate shared with east coast chain
Carolina Beach NC SLAVE Z	59000	.7 mW	(present east coast – operational July, 1979)
Carolina Beach NC MASTER	--	.7 mW	***GRI 99300*** until July, 1979 U.S. east coast chain – discontinued July, 1979
Jupiter FL SLAVE W	11000	.3 mW	Double rate shared with southeast chain
Cape Race NFLD SLAVE X	28000	1.8 mW	Double rate shared with North Atlantic chain
Nantucket MA SLAVE Y	49000	.3 mW	Double rate shared with northeast chain
Dana IN SLAVE Z	65000	.4 mW	
Fallon NV MASTER	--	.4 mW	U.S. west coast chain: ***GRI 99400*** (operational)
George WA SLAVE W	11000	1.2 mW	Double rate shared with west Canada chain
Middletown CA SLAVE X	27000	.4 mW	
Searchlight NV SLAVE Y	40000	.5 mW	

Table 2. Planned Loran-C coverage for the U.S.A. Note: reconfigured station coverage starting in July, 1978.

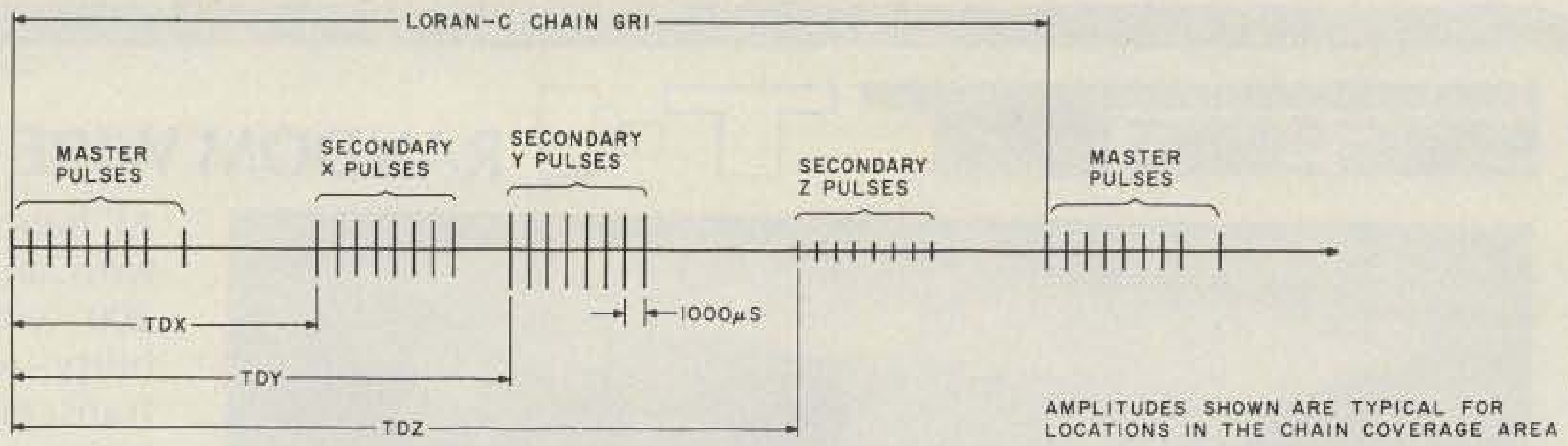

Fig. 4. Example of received loran-C signal.

usually at less power. These will often be observed in loran-C receivers, but the sensor processor can be arranged to ignore this type of cross-chain interference which is not at the same GRI as the desired loran-C signal. The spacing between pulses of the loran-D signals is 0.5 ms, or half of the normal 1 ms spacing for loran-C. Mini loran-C chains are also sometimes used for local area navigation, and private chains for operation in certain offshore areas are possible by special arrangements with the USCG. These usually operate with a low power level of only 100 Watts per station, have a very limited coverage, and generally do not interfere with the operation of the major chains. GRI rates can be chosen so that a receiver, when used in a particular area, does not have much of a problem locking up on the desired repetition rate. When an observer first starts to look at raw loran-C signals on a simple oscilloscope display, dozens of signals may be observed, particularly at night, when sky waves predominate for the more distant signals.

The most controversial aspect of loran-C receiver operation is the proper identification of the third cycle. Sky wave contamination of the received pulse envelope can often result in confused identification of the proper starting point for determining the desired time differences. Receivers sometimes use what is known in the trade as a derivative adder or a delay-and-adder circuit. This provides an envelope cycle deriver (ECD). One form of the circuit consists of combining the envelope signal with a delayed version from the same envelope detector in an adder, which generates a peak amplitude at the desired third cycle. This depends on having an envelope detector and front-end bandwidth of approximately 20 kHz, so that the rise time of the recovered envelope is preserved at the input to the derivative adder.

The second part of this article will present the complete circuit details of the Mini-L loran-C receiver front end. This will include an antenna preamplifier, the basic rf envelope processor board, a suggested GRI rate generator for frequency standard calibration, and some KIM software for time-interval experiments.

Fig. 5 shows a family of experimental loran-C receivers.

The bibliography lists additional reference material for those readers who wish to dig deeper into the loran-C art. ■

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Fig. 5. Some experimental Mini-L loran-C receivers.

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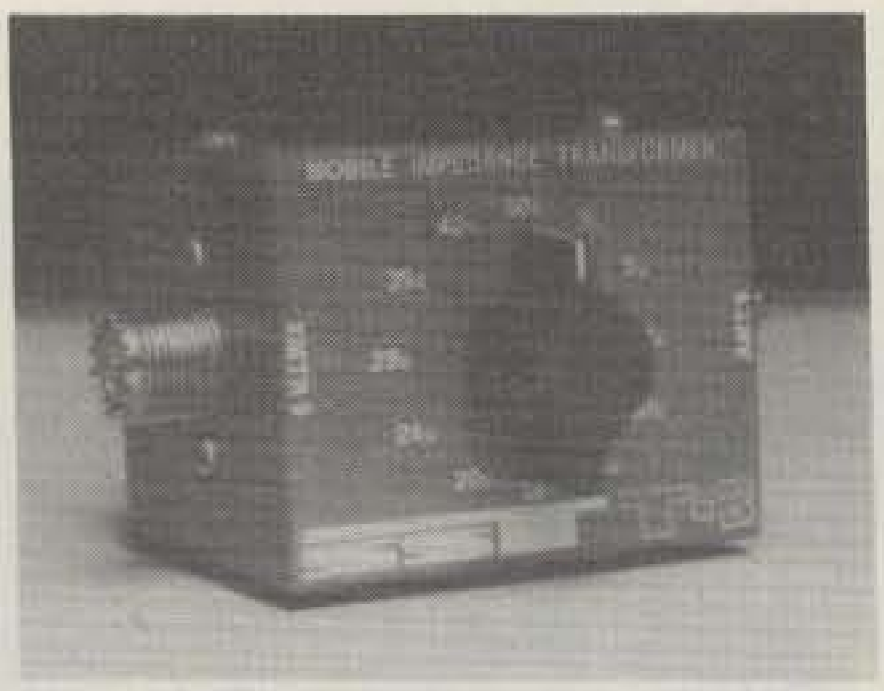

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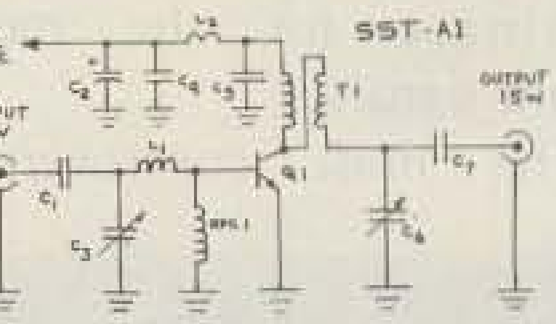

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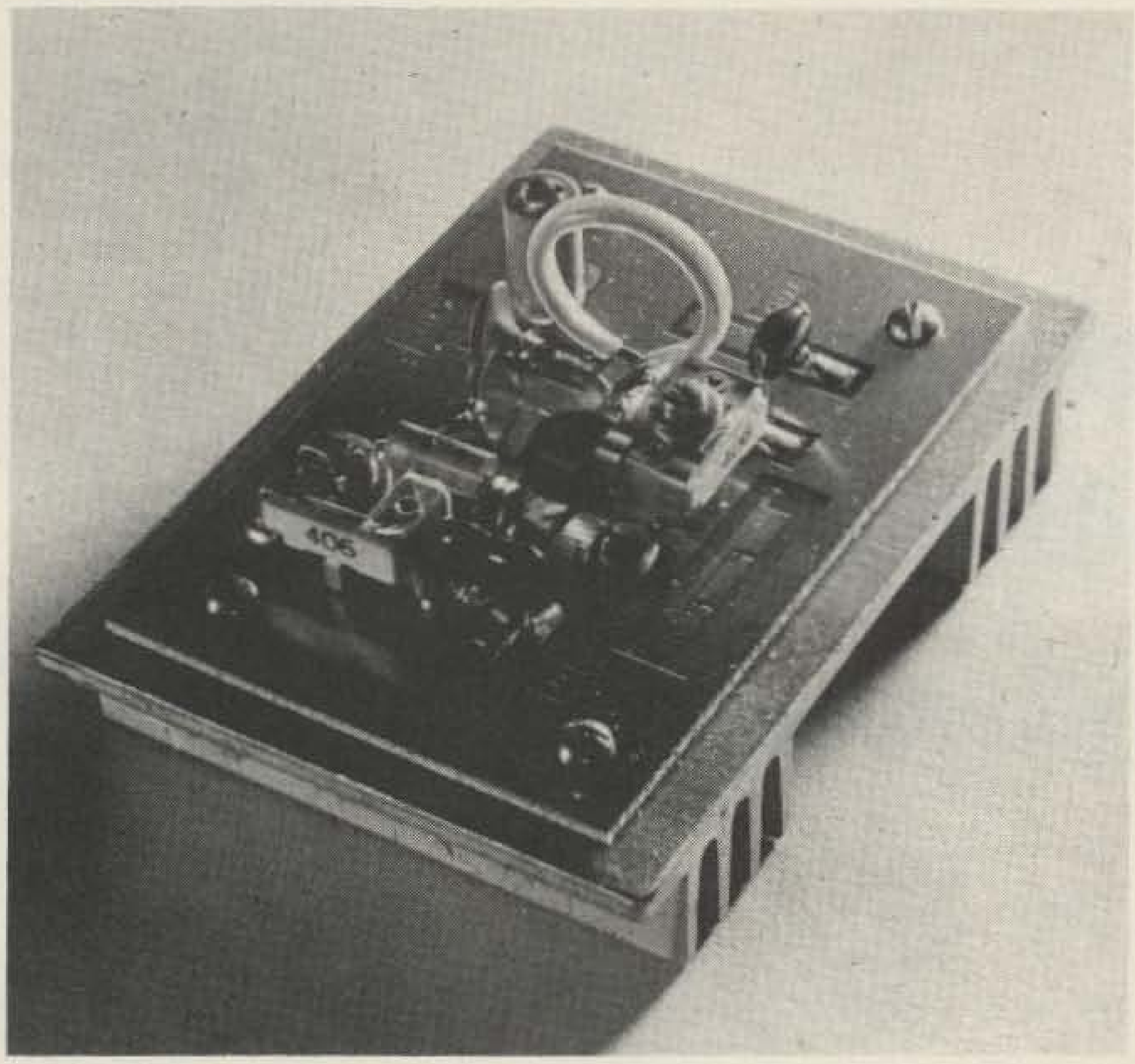

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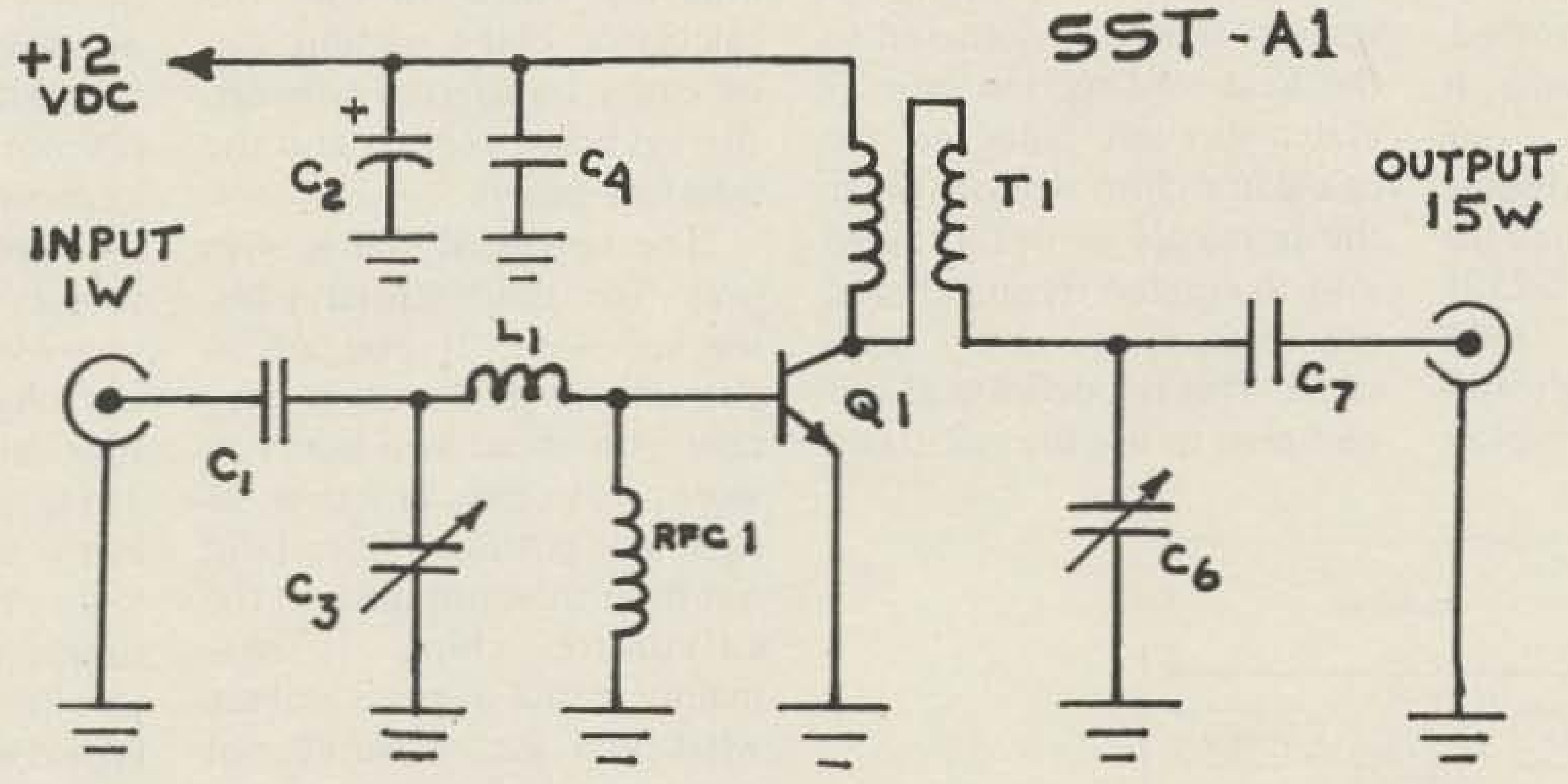

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S10

Errol D. Reid
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St. Augustine
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The Experimenter's Dream Calculator

— $5 scientific surplus special

A short time ago, I got myself an S. D. Sales surplus scientific calculator for $4.95. The calculator comes completely assembled, less case and key tops. It consists of two boards — one is the keyboard and display section, the other carries the calculator chips (MPS2525 and MPS2526 from MOS Technology) — the high-voltage generator, display blanking, and low-voltage detection circuits. The two sections are connected mechanically by pressing 27 vertical terminals soldered to the keyboard section into 27 plated-through holes on the calculator chips section. Since the terminals are not soldered into the plated-through holes, the sections are easily separated. This is a definite plus if you plan to use the calculator in a microprocessor-based system. You simply arrange identical terminals on your interface board so that the calculator chips section can be easily transferred between the keyboard section and the interface board.

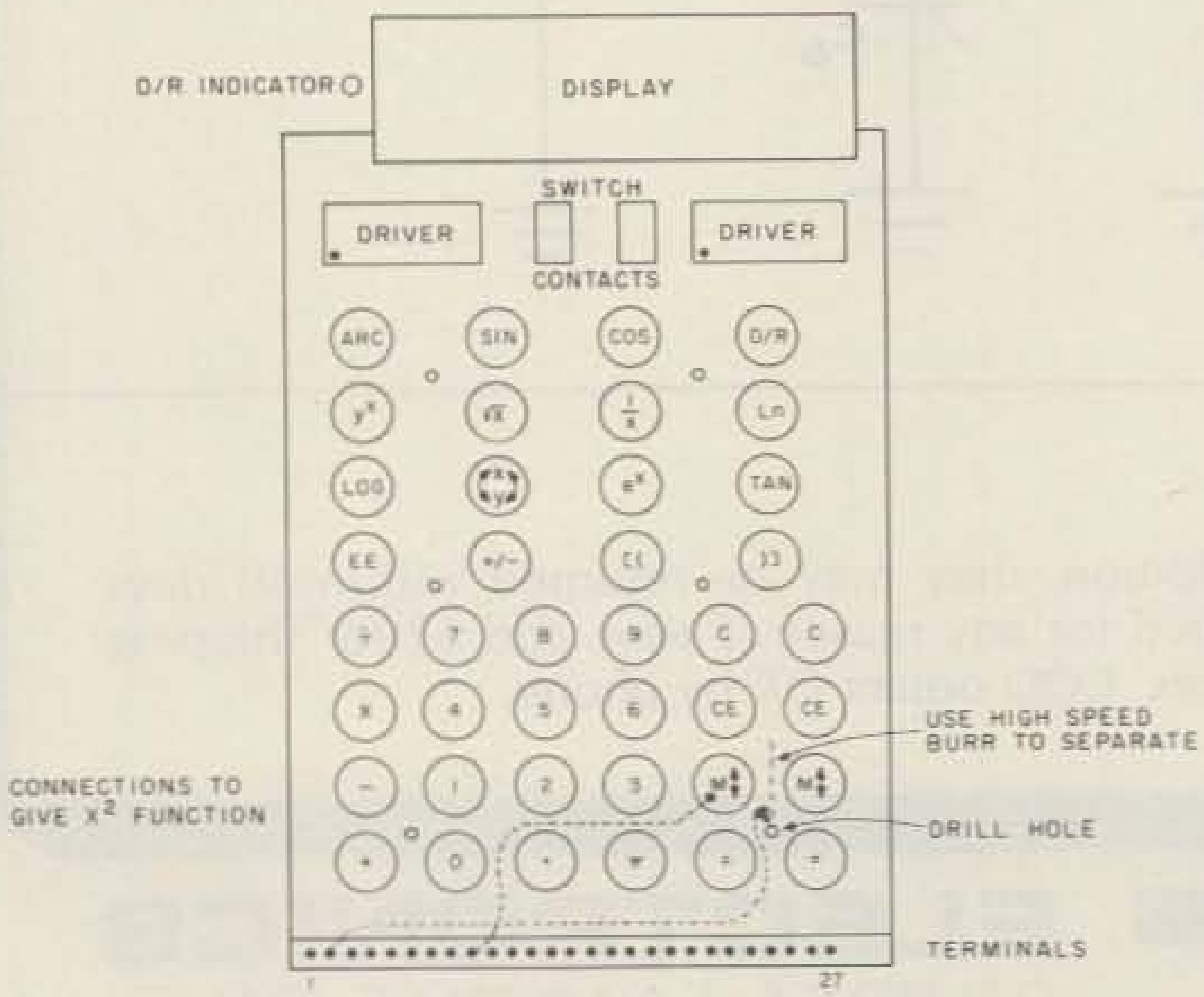

Fig. 1. Top view of the calculator showing the key functions.

The keyboard comes with only the unidentified pads, no key tops. If you are as determined as I was, it may take you about two hours to work out the function of each key position. Since I did not have access to data on the calculator chips, it was mainly a case of press and see what you get. I would not recommend the same to my best enemy, so I have prepared Fig. 1 for you. There is no shift key, so each key has one function only (except possibly the M‡ and D/R keys). I expect that those persons who would take time out to buy a scientific calculator are aware of the use of the various functions in Fig. 1. However, let's examine a few which will enhance the use of the calculator. Sin^{-1}, Cos^{-1}, Tan^{-1} (Cosec, Sec, Cot) can be found by evaluating Sin, Cos, Tan, then using the 1/x key.

The D/R key determines whether the trigonometric argument being used is interpreted in degrees or radians. When the calculator is first powered up, it comes up in the normal degree mode, and the D/R indicator is extinguished. Pressing the D/R key puts the calculator in the radian mode with the D/R indicator lit. Pressing the key a second time returns the calculator to the degree mode.

The M‡ key has two functions. It stores intermediate results, and it recalls the stored quantity to the display register. It will only function in the store mode after the = key is pressed. Recall of stored data occurs by subsequent pressing of this key. Neither of the clear keys will clear this memory register. Clearing is achieved by storing a O, using the key sequence C, O, =, M‡.

One very desirable function which is missing is X^2. But don't start crying yet; I'll show you a way to beat this disadvantage. Luckily, the X^2 function is available, although it's not used in the original keyboard design. Since you are going to add another function to the calculator, you will need to find another key. Again luckily, there are four redundant keys present. These are indicated in Fig. 1 as the extra C, CE, M‡, and = keys. The two keys of each similar pair are connected in parallel, so all you need to do is disconnect the required key and connect it wherever you wish. Of the four keys available, I used the inner M‡ key.

Here is how you go about the modification. Carefully lift the adhesive-backed plastic cover retaining the discs over the key positions. Lift it only so far as to give you working access to the chosen key position. Remove all the key discs in the immediate area of the M‡ key (inner). Using a high-speed burr, remove the copper area connecting the two M‡ pads on the top of the keyboard. Drill a small hole in the position marked in Fig. 1. Remove the adhesive-backed plastic sheet protecting the printed wiring on the underside of the keyboard. Using a strip of #32 insulated wire, connect the outer copper pad of the inner M‡ key, using the hole drilled to access this pad from the underside of the board, to the underside base of the Y^1 terminal pin (see Fig. 2). This takes care of one side of the key. Again using the high-speed burr, separate the center conductor of the inner M‡ key from the rest of the circuitry to which it is connected, at about 3 mm from the center of the key position. Using a similar piece of wire as before, connect the center terminal of the inner M‡ key to the underside base of the D5 terminal pin (see Fig. 2). Your modification is now complete. Replace the adhesive-backed sheet on the underside of the keyboard.

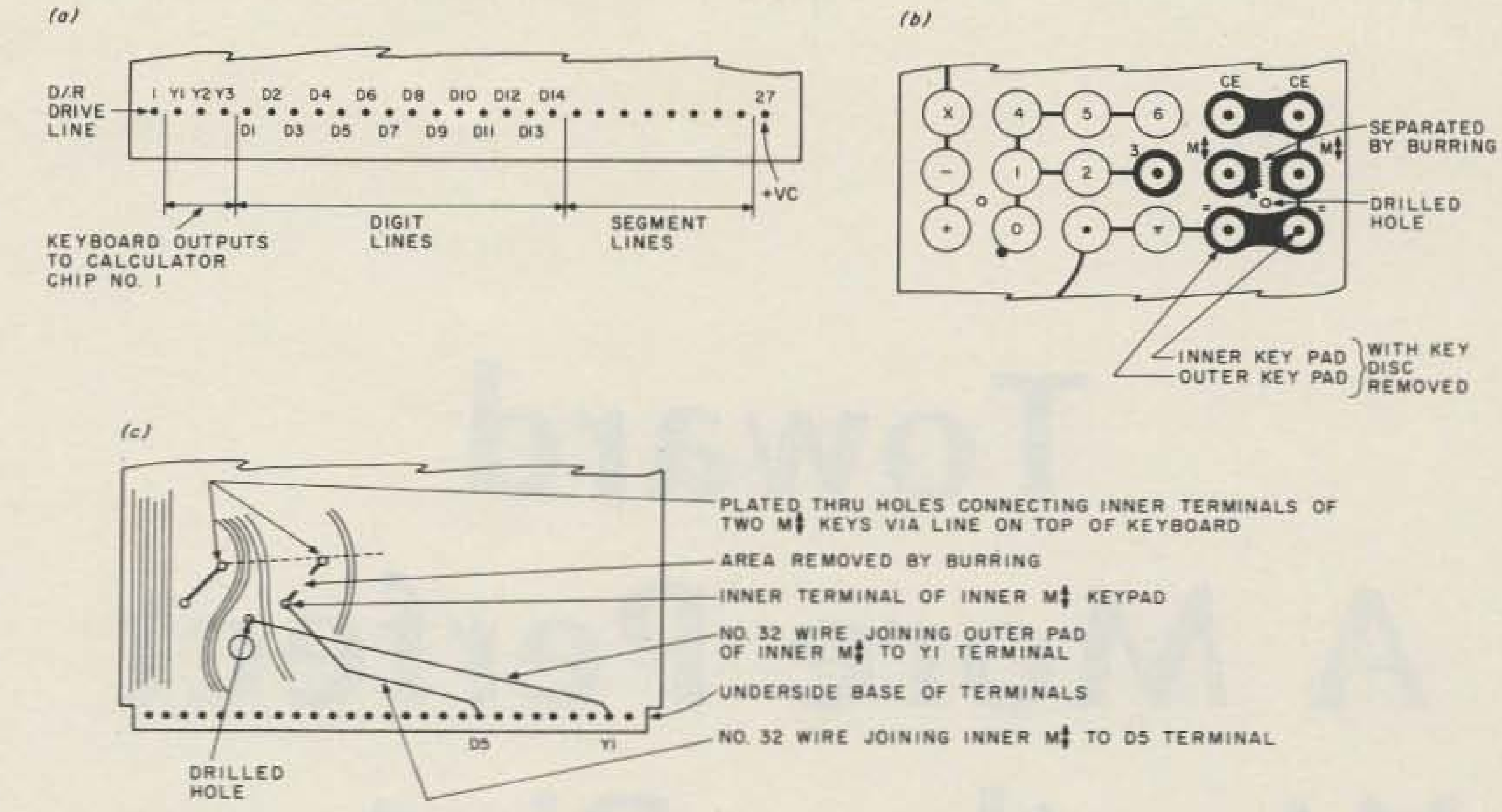

Fig. 2. (a) Expanded view of the terminal strip showing digit and segment output lines. (b) A section of the top of the keyboard showing where the key discs have been removed, where the hole is drilled, and where the outer pads of the M‡ keys have been separated by burring. (c) Bottom view of the keyboard showing the modifications.

Carefully remove all metal particles from the areas you burred on the top of the keyboard. Replace the discs carefully and press down the disc-retaining plastic sheet over the area from which it was removed. Relabel the inner M‡ key X^2. Try a few calculations to ensure all is okay.

The only fault (if it can be called such) that I could find in this unit is that, when the Y^X key is used to evaluate exponents, the answer is not always an integer when it should be. Thus, evaluating 4^2 gives 15.9999999 instead of 16; similarly 4^5 = 1023.99999 and not 1024. However, this does not even begin to be a serious limitation. ■

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Toward A More Perfect Weather Picture

—pattern generator

About a year and a half ago, I updated my APT station to use the new GOES WEFAX broadcasts on 1.691 GHz. I built a display capable of reproducing the high-quality data that is relayed over the WEFAX transponder. This article describes a test-pattern generator I designed to align or test satellite facsimile machines. The machine generates twelve shades of grey from black to white and is compatible with the 240-line/minute format. A good machine will faithfully reproduce twelve or more shades of grey. The photograph, Fig. 4, was made by my machine. In the original photograph, all twelve shades can be distinguished.

The electronics of the test-pattern generator are broken up into Figs. 1, 2, and 3. Fig. 1 shows the 2.4 MHz clock and dividers along with the 3 kHz low pass filter. Fig. 2 contains more frequency dividers plus the staircase generator. In Fig. 3, the power supplies for the generator are shown. Beginning with Fig. 1, the theory of operation is discussed below.

The purpose of the electronics in Fig. 1 is to generate the appropriate timing or clock pulses needed to run the staircase generator in Fig. 2. To begin with, a low-cost model OT-2 oscillator was purchased from International Crystal Mfg. Co. A 2.4 MHz crystal was purchased to use in the oscillator. Many amateur satellite ground stations already use this oscillator to generate horizontal sync in their APT pictures.

The output of this oscillator, OSC-1, is converted to TTL levels by CR1 and CR2. The 2.4 MHz square wave is buffered by U6A and B and

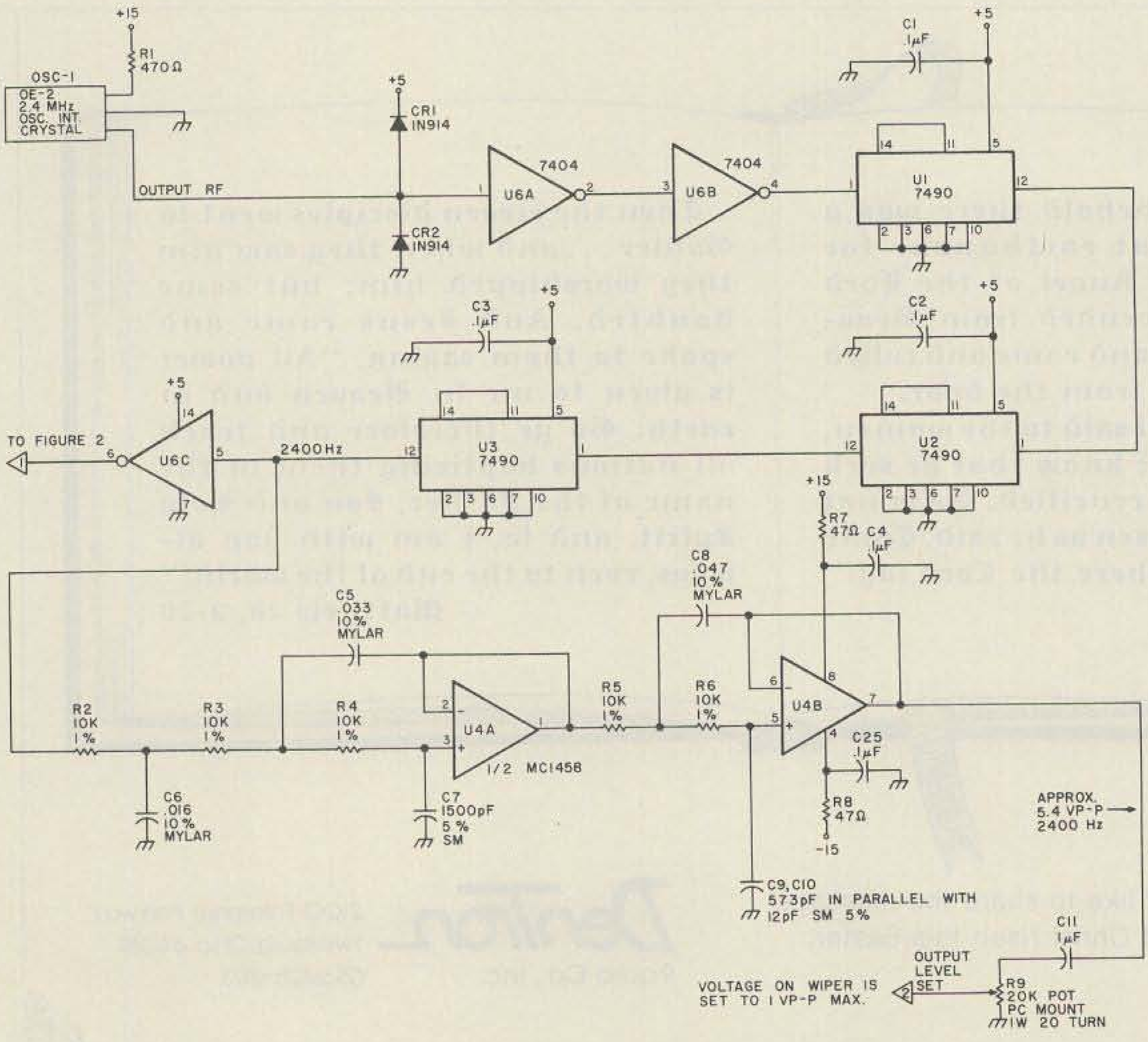

Fig. 1. Reference oscillator, 3 kHz low pass filter, and frequency dividers.

applied to the first frequency divider, U1. ICs U1, U2, and U3 are configured to divide by ten. The output at U3, pin 12, is a 2400 Hz square wave. This is the APT and WEFAX subcarrier frequency. The 2400 Hz square wave is routed two places. First of all, it is buffered by U6C and drives further dividers on Fig. 2. Also, the 2400 Hz square wave is filtered by a 3 kHz low pass filter, U4A and B, on Fig. 1. The low pass filter removes the higher order harmonics in the 2400 Hz square wave and yields a clean 2400 Hz sine wave at U4, pin 7. Capacitor C11 provides dc isolation, while pot R9 is used to set the 2400 Hz drive level to the staircase generator in Fig. 2.

The 2400 Hz square wave from U6C in Fig. 1 drives the remainder of the divider chain in Fig. 2. ICs U7 and U8 divide the 2400 Hz square wave down to 48 Hz. The 48 Hz TTL square wave is at U8, pin 8, and is used to drive U9, a four-bit binary counter. The four-bit binary counter has a special reset provided by U10A and B at count twelve. This gives a count of 0 to 11, or twelve states. The A, B, C, and D outputs on U9 count in binary from 0 to 11 in a 250 ms time frame. As these four outputs progress in their

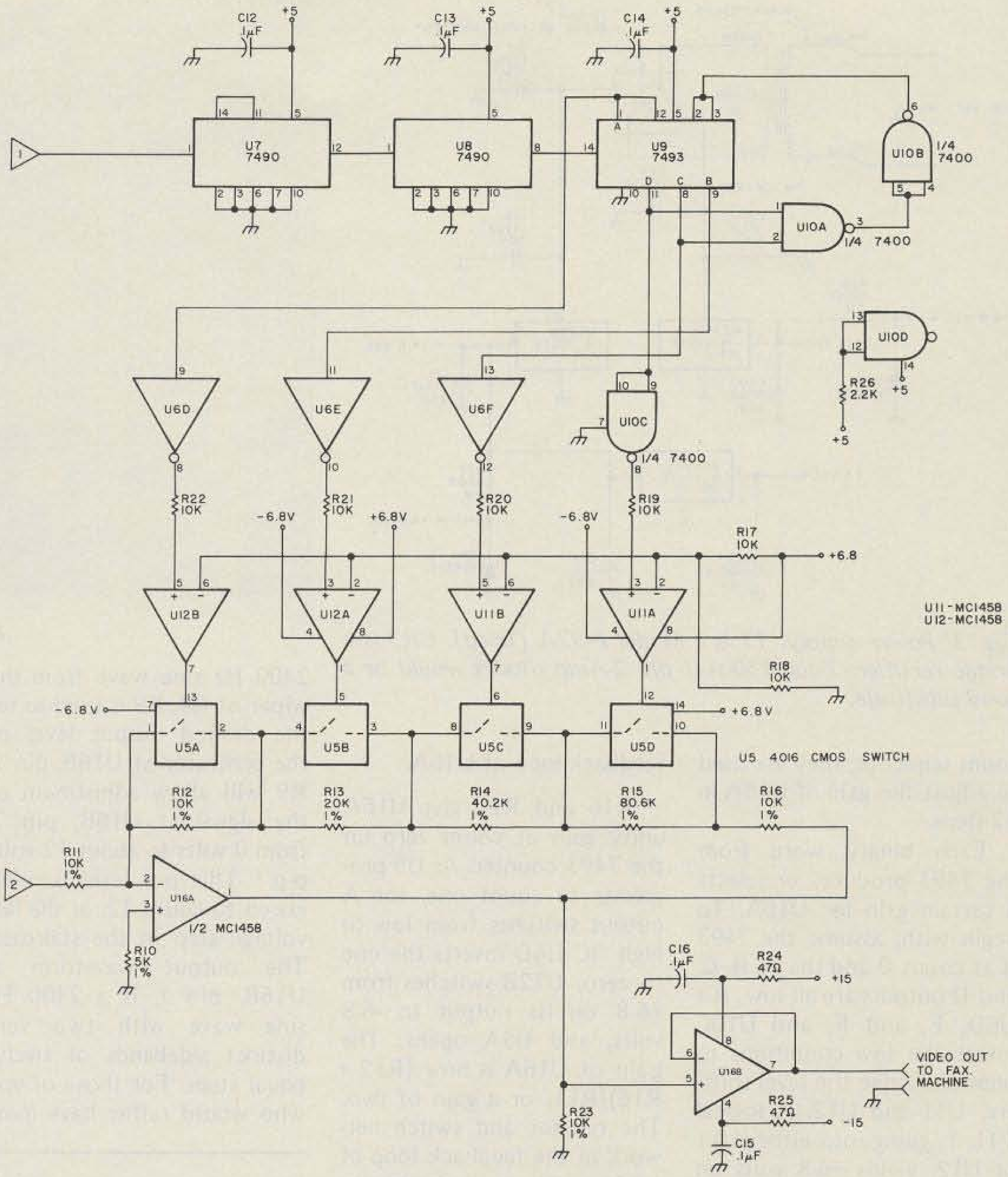

Fig. 2. Staircase generator.

Parts List

CR1, 2	1N914	R11, 12	10k RN55 1%
CR3	VS-644 bridge	R13	20k RN55 1%
CR4, 5	1N4736 6.8 V zener	R14	40.2k RN55 1%
C1-4	.1 uF 50 V	R15	80.6k RN55 1%
C5	.033 uF mylar 10%	R16	10k RN55 1%
C6	.016 uF mylar 10%	R17-22	10k ¼ W 10%
C7	1500 pF silver mica 5%	R23	10k RN55 1%
C8	.047 mylar 10%	R24, 25	47 Ω ¼ W 10%
C9	573 pF silver mica 10%	R26	2.2k ¼ W 10%
C10	12 pF silver mica 10%	R27, 28	820 Ω ½ W 10%
C11	1uF 50 V	T1	Triad Model F-92A (38 V ac c-t winding is used)
C12-16	.1 uF 50 V	U1-3	7490 decade counter
C17	1100 uF 50 V electrolytic	U4	MC1458
C18	.47 uF 50 V	U5	4016 CMOS quad switch
C19, 20	100 uF 25 V electrolytic	U6	7404 hex inverter
C21	.47 uF 50 V	U7, 8	7490 decade counter
C22	1100 uF 50 V electrolytic	U9	7493 4-bit binary counter
C23	.47 uF 25 V	U10	7400 quad NAND gate
C24	100 uF 15 V electrolytic	U11, 12	MC1458
C25	.1 uF	U13	MC7915 -15 V dc regulator
R1	470 Ω ½ W 10%	U14	MC7815 +15 V dc regulator
R2-6	10k RN55 1%	U15	MC7805 +5 V dc regulator
R7, 8	47 Ω ¼ W 10%	U16	MC1458
R9	20k 1 W 20-turn PC pot	S1	115 V ac 5 Amp DPDT toggle switch
R10	5k RN55 1%	OSC-1	OT-2 International Crystal Mfg. Co. oscillator
			One 2.4 MHz crystal required.

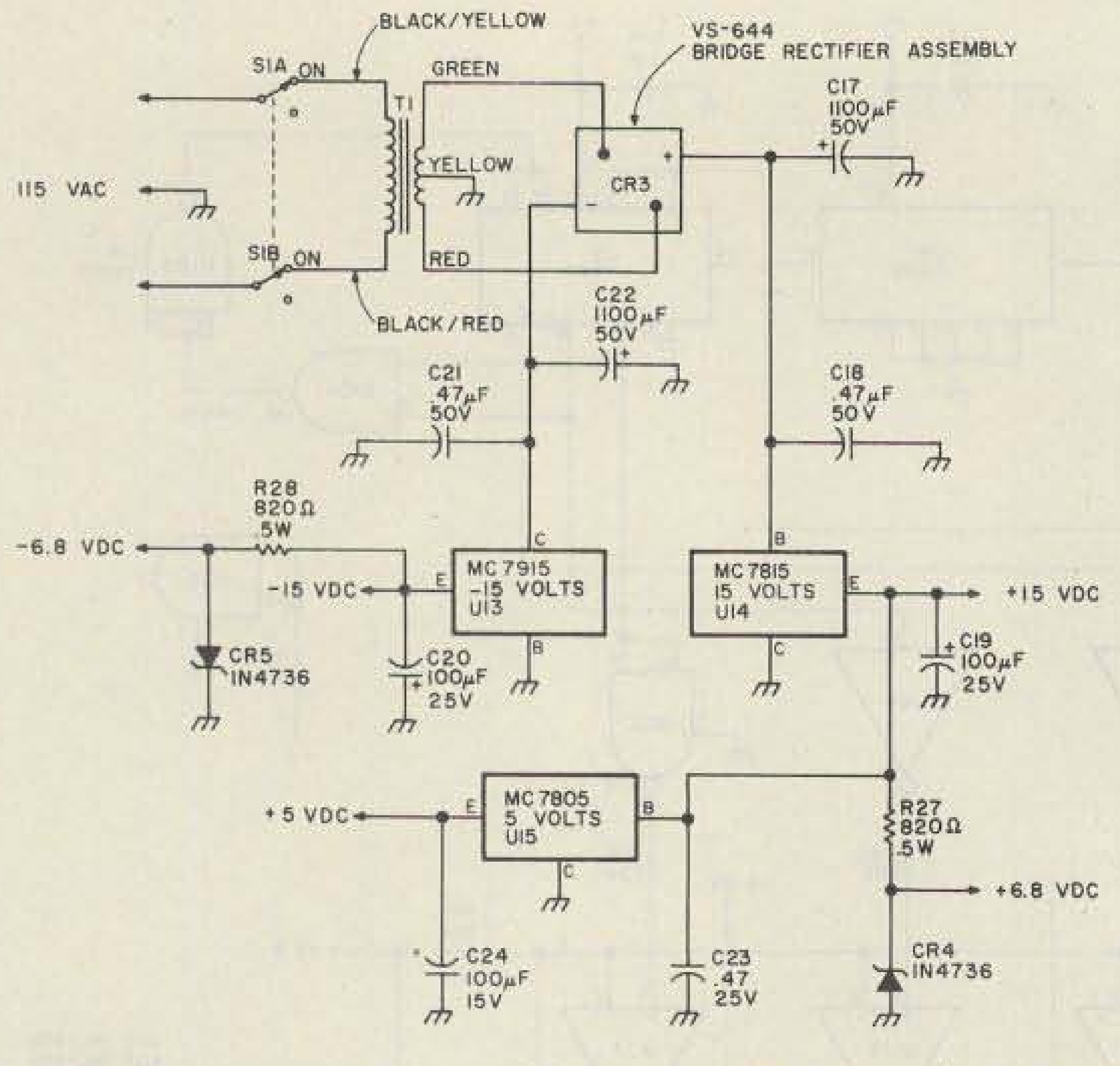

Fig. 3. Power supply. T1 is a Model F-92A (Triad). CR3 is a bridge rectifier. Four 150-volt piv 2-Amp diodes would be a good substitute.

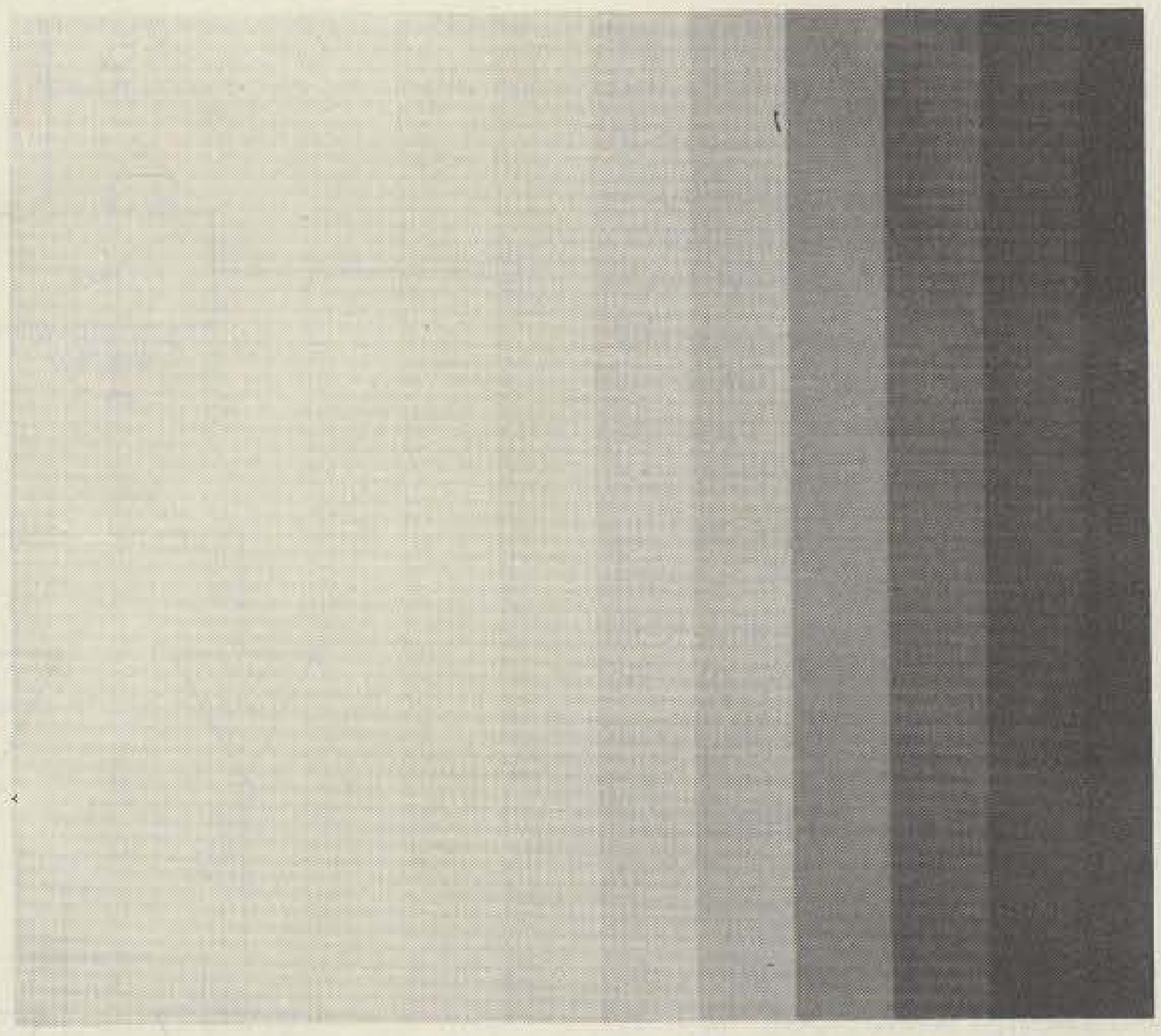

Fig. 4.

count sequence, they are used to adjust the gain of U16A in 12 steps.

Each binary word from the 7493 produces or selects a certain gain for U16A. To begin with, assume the 7493 is at count 0 and the A, B, C, and D outputs are all low. ICs U6D, E, and F, and U10C invert the low conditions to ones and drive the level shifters, U11 and U12. A logical TTL 1, going into either U11 or U12, yields +6.8 volts on the output. A logical TTL 0 gives a -6.8 volts at U11's or U12's output. Since U11 and 12 have all 1s going in, we get +6.8 V on all outputs, and each section of the 4016 CMOS switch, U5, closes. This leaves only R16 in the feedback loop of U16A.

R16 and R11 give U16A unity gain at count zero on the 7493 counter. As U9 progresses to count one, the A output switches from low to high. IC U6D inverts the one to zero, U12B switches from +6.8 on its output to -6.8 volts, and U5A opens. The gain of U16A is now (R12 + R16)/R11, or a gain of two. The resistor and switch network in the feedback loop of U16A will produce twelve changes of gain in 250 ms. At maximum count of U9, the gain of U16A is (R14 + R15 + R16)/R11, or 13. A gain of 13 from one, unity, yields twelve steps.

The input of U16A is the 2400 Hz sine wave from the wiper of R9. R9 is used to set the desired output level of the generator at U16B, pin 7. R9 will allow adjustment of the signal at U16B, pin 7, from 0 volts to about 12 volts p-p.* This p-p level is referenced to count 12, or the last voltage step in the staircase. The output waveform at U16B, pin 7, is a 2400 Hz sine wave with two very distinct sidebands of twelve equal steps. For those of you who would rather have more than 12 steps, the input frequency to U9 could be changed to 64 Hz. The reset circuit, U10A and B, could be removed and U9, pins 2 and 3, grounded. The 7493 has its normal 16 states, and U16A would go through 16 gain changes.

Finally, Fig. 3 contains the power supplies needed. The circuits are very easy to understand, and I feel that the schematics are more or less self-explanatory. Good luck with building your grey-scale generator. The circuits seem quite reliable and produce a nice test picture when fiddling with black and white lamp currents on a facsimile machine. At least now you can see if your machine is really adjusted properly by having the correct type of signal generator. ■

*The staircase generator should be given no more than 1 V p-p input from R9. Too much input will result in U16B going into saturation. The 1 V p-p value for the signal on R9's wiper should be an absolute maximum input. Most machines will only require a few volts p-p output from U16B in order to operate.

EDITORIAL BY WAYNE GREEN

from page 43

some intelligent management, we could have a nice hamfest at Vegas . . . Saroc isn't it.

ASPEN

The Third Annual Ham Industry Conference and Workshop met in Aspen for a week of work with occasional invigorating jaunts to the nearby slopes to get the cobwebs out. The consensus of opinion was that this was an absolutely invaluable series of workshops . . . on advertising, promotion, sales, marketing, financing, etc. The 1979 Fourth Annual Ham Industry Conference and Workshop is scheduled for Aspen, snow permitting, January 7-13. Most of the workshopees were clustered in the Continental, but others were spread out into nearby hotels such as the Aspen Inn, etc.

There has been no other opportunity for manufacturers, dealers, and the media to get together for relaxed and extended talks. This Conference provides a welcome opportunity for a badly needed exchange of ideas.

MORE PEOPLE NEEDED

As the list of *73* staff grows ever longer, one wonders where it is going to stop. There is no sign of even slowing down as yet. The fact is that we have quite a few interesting job openings for hams who are looking for a career in publishing.

We need more help as the magazine gets larger—help with testing and writing up new ham gear, help with setting up microcomputer systems and testing them out, help in checking out computer programs for microcomputers, help in advertising sales, in subscriptions, renewals, in marketing, editing, drafting, data processing,

Continued on page 135

William E. Browning WB5IRY
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Tulsa OK 74115

Is TTL Already Obsolete?

— *CMOS vs. TTL*

Is it time for a change? For several years now, the TTL logic family has been the standard for the digital hobbyist and home experimenter. It has given us the $50 frequency counter, the 50 wpm CW keyboard, and the frequency scanner for our 2 meter receivers. It has affected every amateur who has tried to keep up with the state of the art.

But, for the past couple of years, a new logic family has started to move into the picture. It is beginning to look like we had better get to know it now, as it just may put TTL in the back seat before much longer. What is this new logic family? Well, for those who haven't already guessed, I am referring to complementary metal oxide semiconductors, commonly known as CMOS.

Why would we want to use CMOS instead of TTL? To answer that question, I'll make some comparisons between the two families.

First: Average power dissipation for most TTL will run about 10 mW per gate. With low power TTL available, that will be down to about 1 mW per gate under static conditions. That's not bad, until we look at CMOS, which has an average power dissipation of .00001 mW (10 nW) under the same test conditions.

Second: Power supply voltage for TTL operating voltage is a minimum of +4.5 volts to a maximum of +5.5 volts, with an absolute maximum of +7 volts. This compares to CMOS operating voltage of minimum +3 volts to maximum 15 volts, with an absolute maximum of 16 volts.

Third: Noise immunity for TTL is typical at 1 volt. For CMOS, it is typical at 45% of the full logic swing.

There are other comparisons which could be made between the two families. In most, CMOS will win out; in some, TTL still has some advantage.

For those not familiar with CMOS, we can take a look and see how this family works and how it behaves in a system.

Let's start with the CMOS inverter gate which is shown in Fig. 1. It is made up of two MOS enhancement mode transistors, the upper a P-channel type and the bottom an N-channel type. The two transistors are connected in series across the power supply. Note that the gates of the transistors are connected together so that the input signal is applied to both.

If the input is high (V_{dd}), the P-channel is turned off (acts as a high impedance or open circuit) and the N-channel is turned on (acts as a low impedance or short circuit). An equivalent circuit of the inverter with the input high is shown in Fig. 2. You will notice that, in this condition, the output is effectively connected to ground (low output) and there is no path for current through the transistors (no current, no power dissipated).

If the input is low (ground), the P-channel is turned on and the N-channel is turned off. An equivalent circuit of the inverter with the input low is shown in Fig.

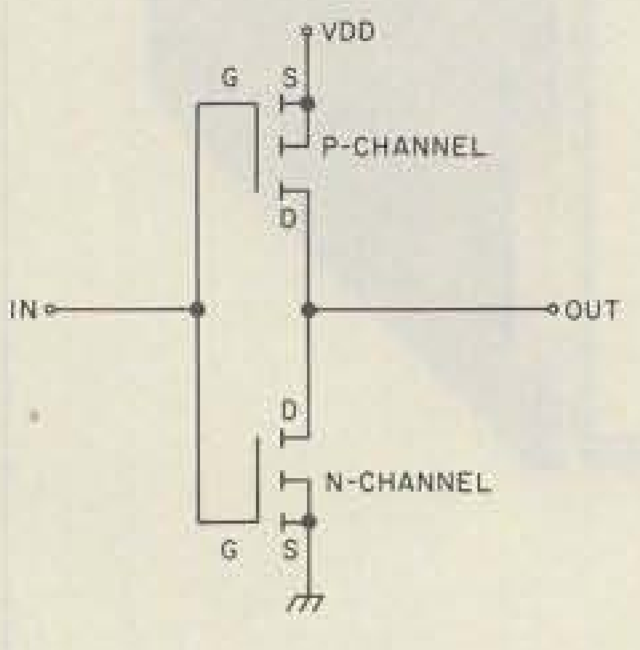


Fig. 1.

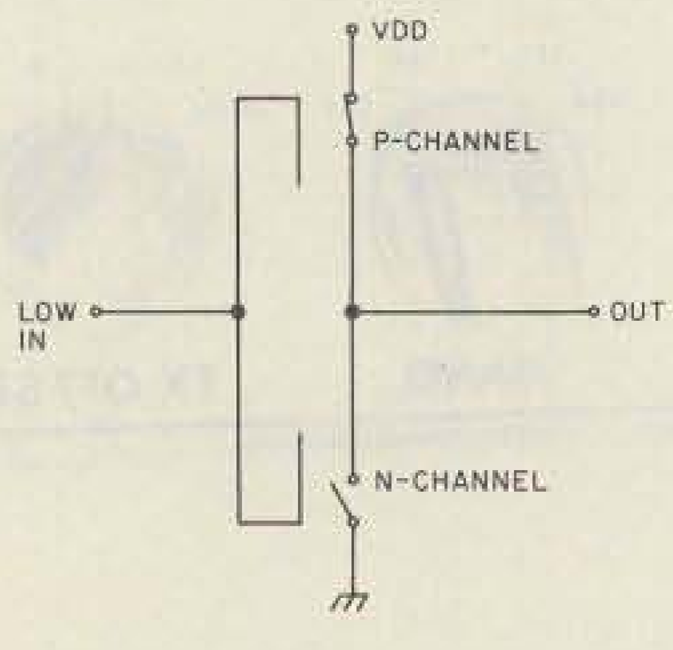


Fig. 2.

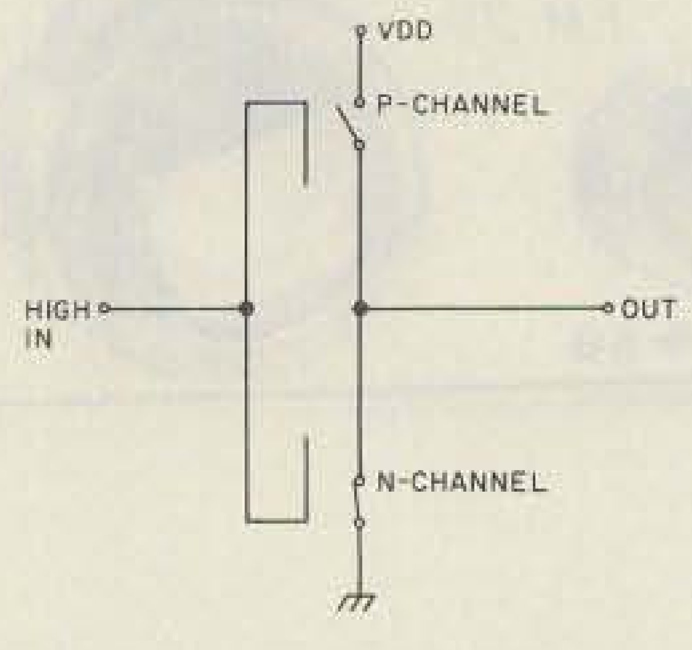


Fig. 3.

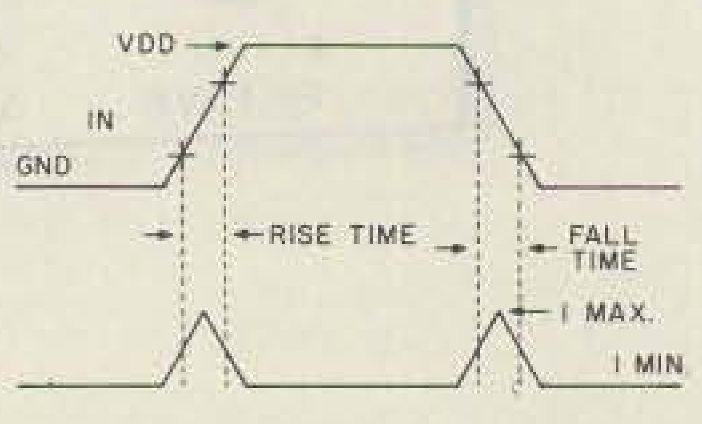


Fig. 4.

3. In this condition, the output is effectively connected to V_{dd} (high output), and there is no path for current through the transistors (no current, no power dissipated).

In the inverter, as with any CMOS device, there is a path for current from power supply to ground during switching. The longer the rise time and the fall time of the input pulse, the more power is dissipated, as shown in Fig. 4.

Another circuit that you will find in CMOS is the "bilateral switch." When the switch is turned on, the input is connected to the output and operates essentially like a closed switch. When the switch is turned off, the input is disconnected from the output and, like an open switch, offers a high impedance to input and output. Also, as in a switch, the input and output are interchangeable. Fig. 5 shows the bilateral switch. Note the inverter section which allows both switching transistors to be turned on or off at the same time by the same control voltage.

The use of the bilateral switch on CMOS integrated circuits allows us to have three output conditions – high (V_{dd}), low (ground), and high impedance (open circuit). If you have done any work on a system using common bus lines, you will see the importance of this circuit.

Now take a look at how CMOS behaves in an operating system. First, the CMOS input is a very high impedance, about 10^{12} Ohms, if you need a value to work with. This causes any floating inputs to drift back and forth between a high and a low, which can create some intriguing system problems. So one important rule to observe when using CMOS is that no unused input should be left open. They should be tied to V_{dd}, ground, or another used input, whichever is appropriate for your system.

For example, if you had a NOR gate and wished to use it as an inverter, you could tie the unused input to ground. Then the other input would control the output. If you had tied the unused input to V_{dd}, one input would always be low, and the output could not change conditions but would always be low. The third possibility of tying the two inputs together would also work. Fig. 6 shows the truth table of the NOR gate and the results after tying.

Fig. 7 shows a 4-input NAND gate tied to produce a 2-input NAND. You will notice that this time you need to tie the input to V_{dd} for proper operation. Tying to ground would not allow the output to change state. Once again, the third possibility of tying the two inputs together would also work.

A second CMOS system consideration is the power supply. Since CMOS can operate over a large range of power supply voltage, minimal filtering is necessary. The voltage does affect the operating speed of CMOS, so the minimum voltage is determined by the frequency of operation. The power dissipation is also a function of voltage. Power dissipation increases approximately as the square of the supply voltage. To minimize power consumption, the system should run at the minimum speed to do the job with the lowest possible power supply voltage. Because of the low current requirements of CMOS, especially at low frequency and low voltage, the family is well suited for battery operation.

As you start working with CMOS, you may find that you want to interface to other logic types. In any interface there are three considerations to take into account: Is the supply voltage compatible, can the CMOS output satisfy the current and voltage requirements of the other family's input, and can the other family's output meet the required voltage swing for the CMOS input?

Let's look at an interface of CMOS to PMOS: Most PMOS integrated circuits are specified with a power supply voltage of 17 to 24 volts. A possible way to interface is shown in Fig. 8. A zener diode is used to set the bias of the CMOS and, if the values are selected properly, it will allow the PMOS to drive the CMOS directly. CMOS can drive PMOS directly. Be sure that not more than 15 volts is across the CMOS. If you have PMOS which can operate on 15 volts

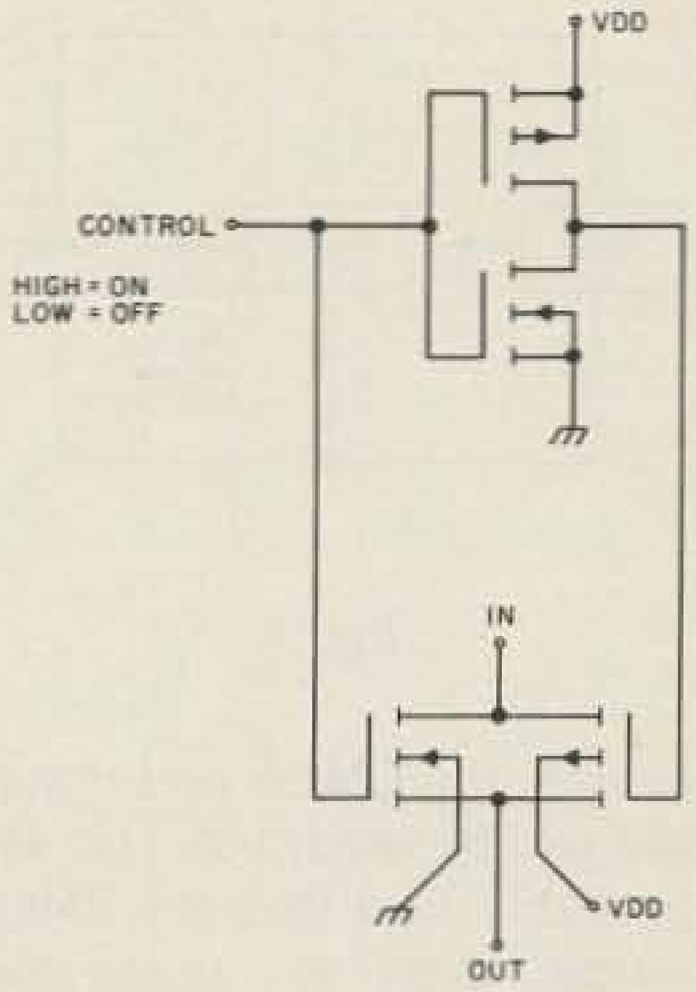
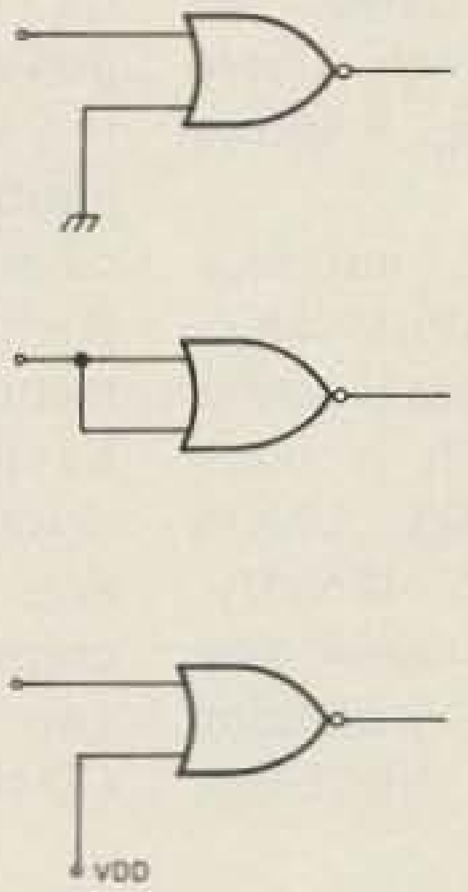


Fig. 5.

INPUT S		OUT
0	0	1
0	1	0
1	0	0
1	1	0



IN	OUT
0	1
1	0

IN	OUT
0	1
1	0

IN	OUT
0	0
1	0

Fig. 6.

1	2	3	4	OUT
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
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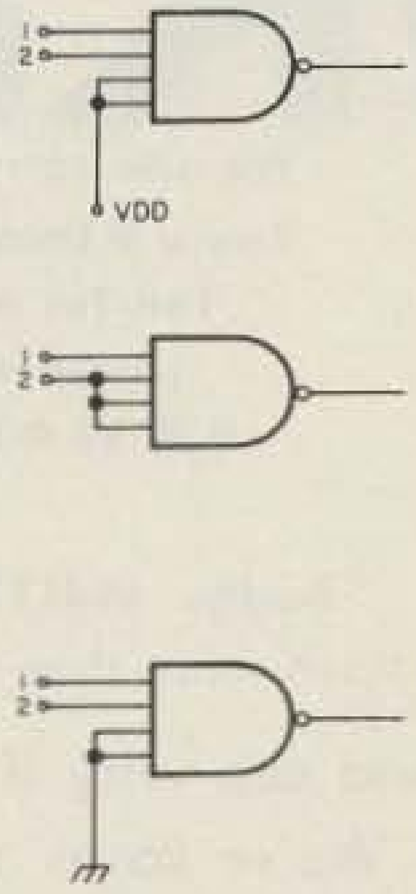
1	1	1	0	1
1	1	1	1	0



1	2	OUT
0	0	1
0	1	1
1	0	1
1	1	0

1	2	OUT
0	0	1
0	1	1
1	0	1
1	1	0

1	2	OUT
0	0	1
0	1	1
1	0	1
1	1	1

Fig. 7.

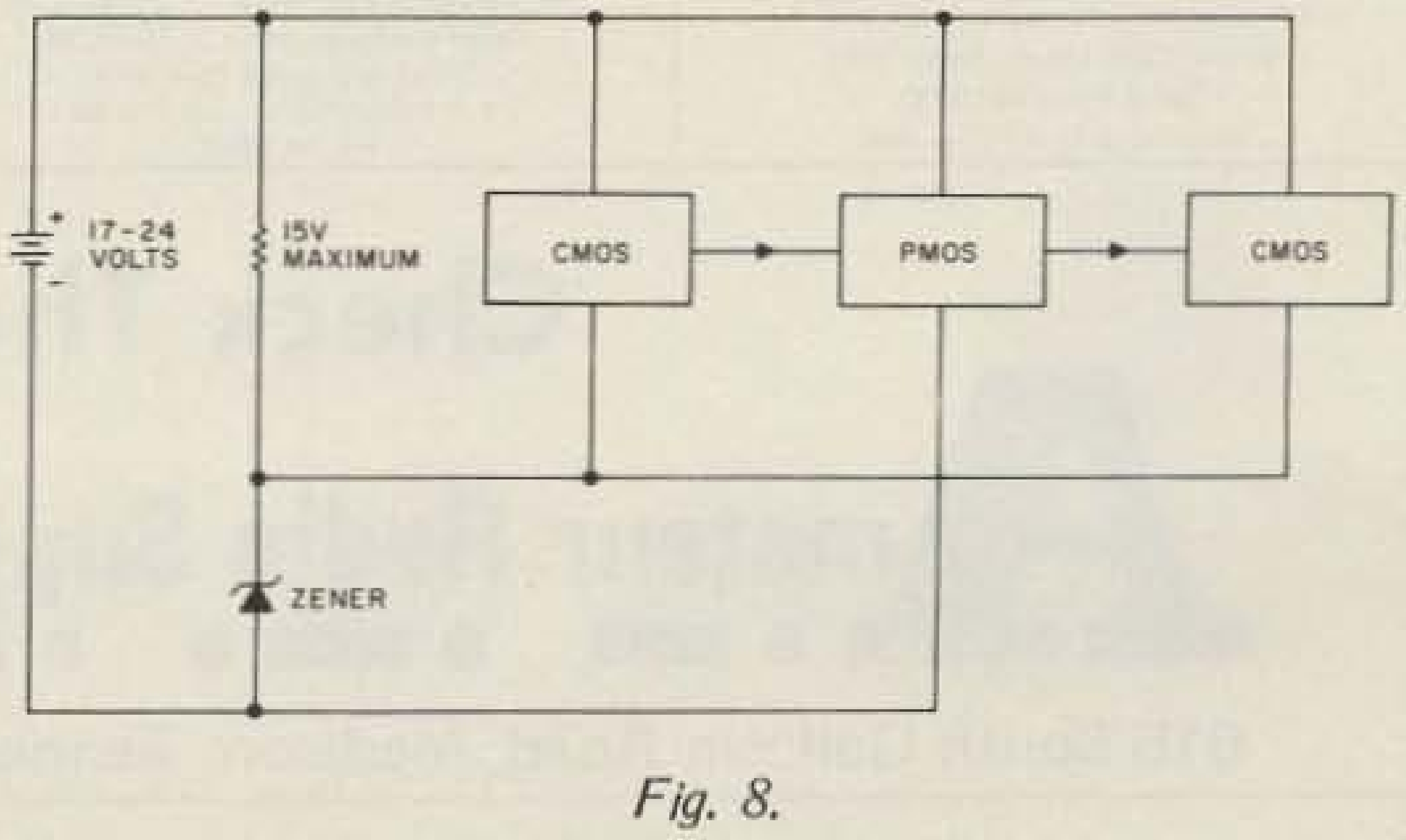


Fig. 8.

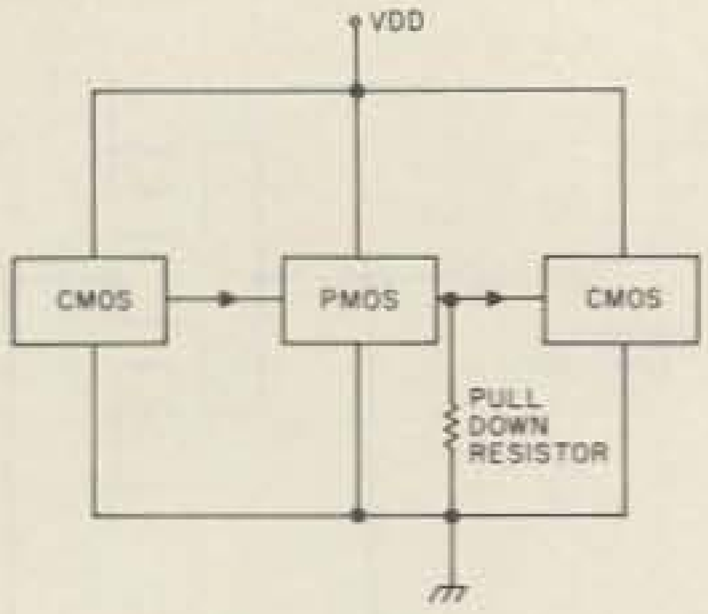


Fig. 9.

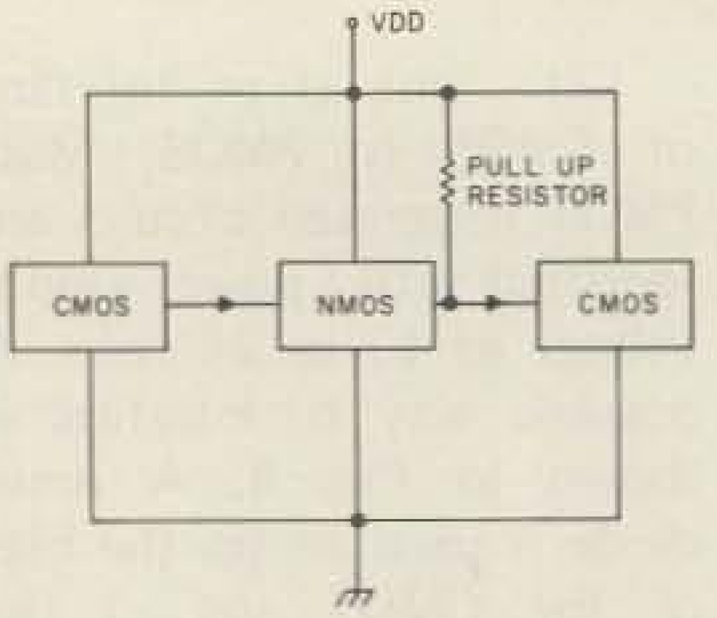


Fig. 10.

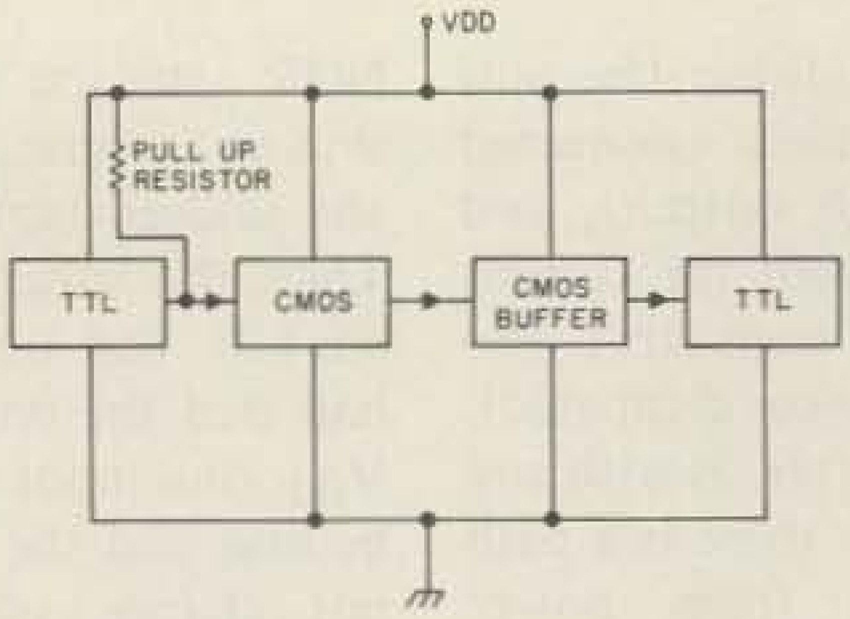


Fig. 11.

or less, the CMOS power supply can be used, but you will probably find that the PMOS output does not swing low enough to drive the CMOS input. This can be corrected with a pull-down resistor at the output of the PMOS. As before, CMOS can drive PMOS directly. Fig. 9 shows this interface.

Or you can interface CMOS to NMOS. Most NMOS power supply voltages are 5 to 12 volts, which is compatible with CMOS. CMOS will drive NMOS directly. However, NMOS may or may not drive CMOS, depending on the particular chip being used and on the supply voltage. A simple solution to this is the addition of a pull-up resistor on the output of the NMOS. Fig. 10 shows this interface.

If you want to interface CMOS to TTL, the normal power supply voltage for TTL is 5 volts, which will be compatible with CMOS. In most cases TTL will drive CMOS directly, but it is recommended that a pull-up resistor be used. Most CMOS will not drive standard TTL. There are, however, some CMOS chips that will drive up to two TTL loads, such as the CD4050A buffer. An interface for TTL and CMOS using the buffer is shown in Fig. 11. The MM74C02 2-input CMOS NOR gate by National can be used to drive a normal TTL load in lieu of a special buffer, if the designer is willing to sacrifice some noise immunity to do so.

The CMOS family provides all the basic gates, flip-flops, memories, and large scale integration logic required to perform all digital system functions. In addition, many CMOS integrated circuits may be adapted to both analog and linear applications. It does all this and, at the same time, operates over a wide supply voltage range while dissipating very low power. CMOS has a typical noise immunity of 45% of V_{dd} and a high fan-out of up to 50 or more. CMOS is becoming widely available, and at a cost only slightly above that of TTL.

At the start of this article, I asked if it was time for a change. What do you think? ■

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1. *CMOS Integrated Circuits Data Book*, Motorola, Inc., 1973.
2. *CMOS Integrated Circuits*, National Semiconductor Corporation, 1975.
3. *COS/MOS Digital Integrated Circuits*, RCA, 1974.

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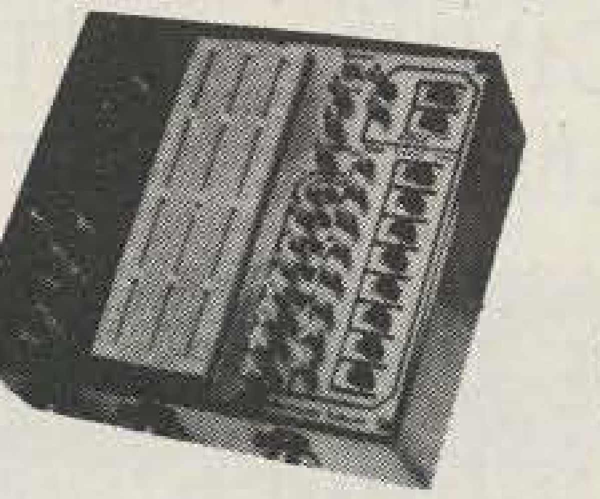

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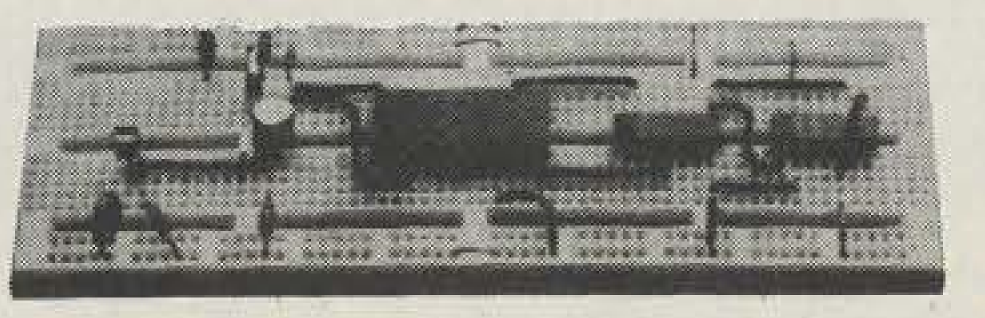

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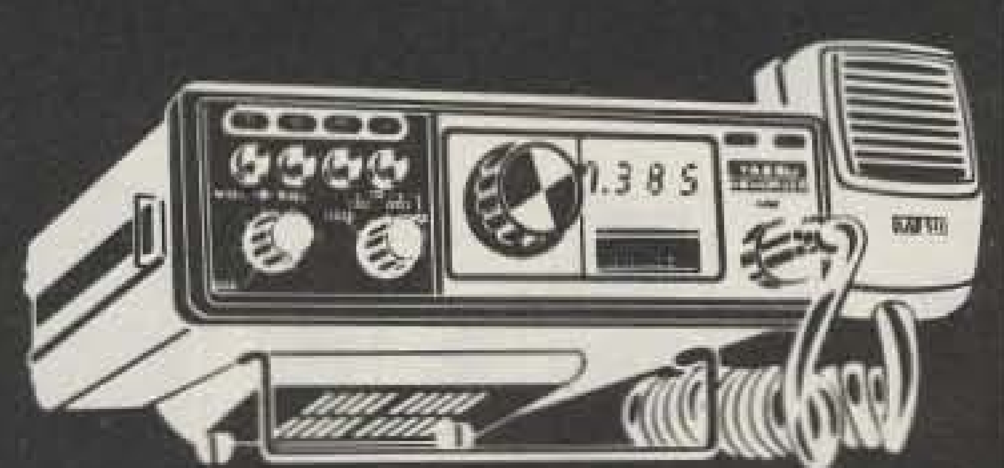

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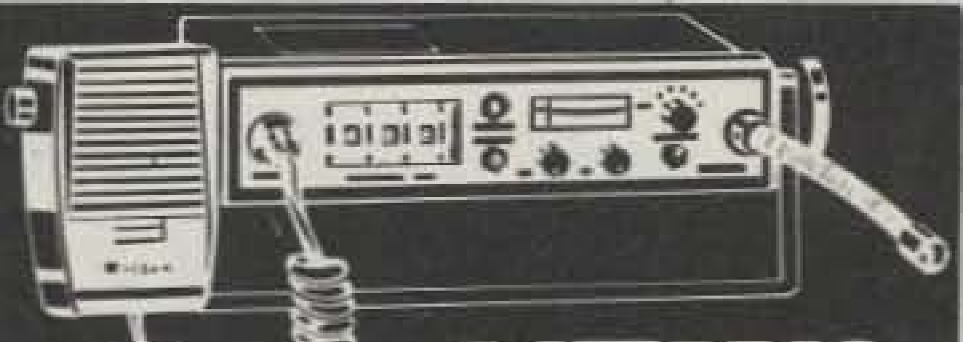

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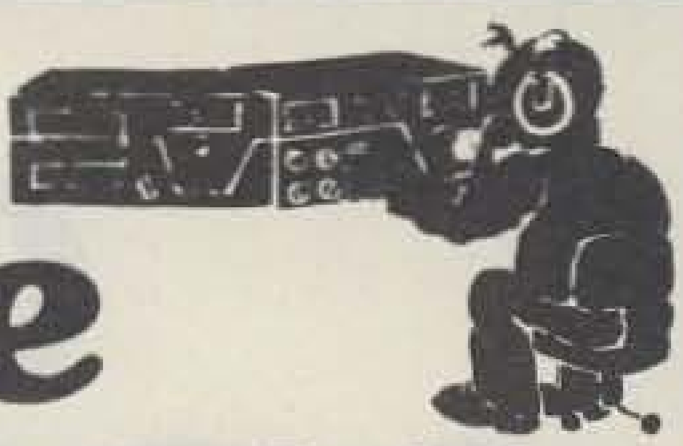

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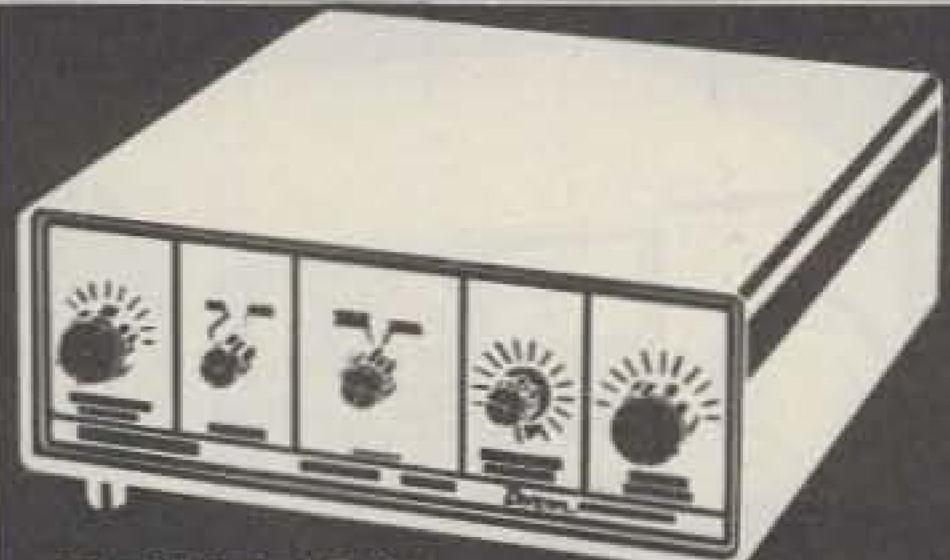

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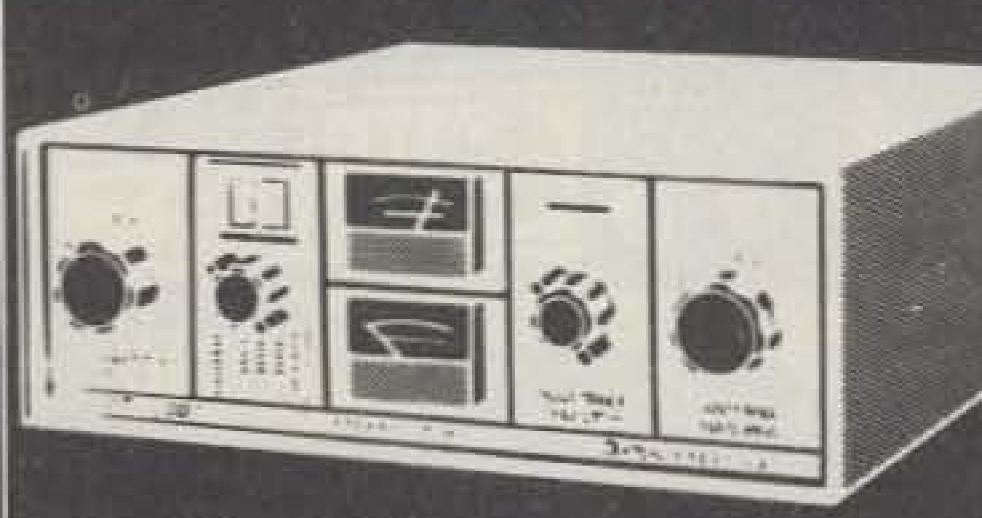

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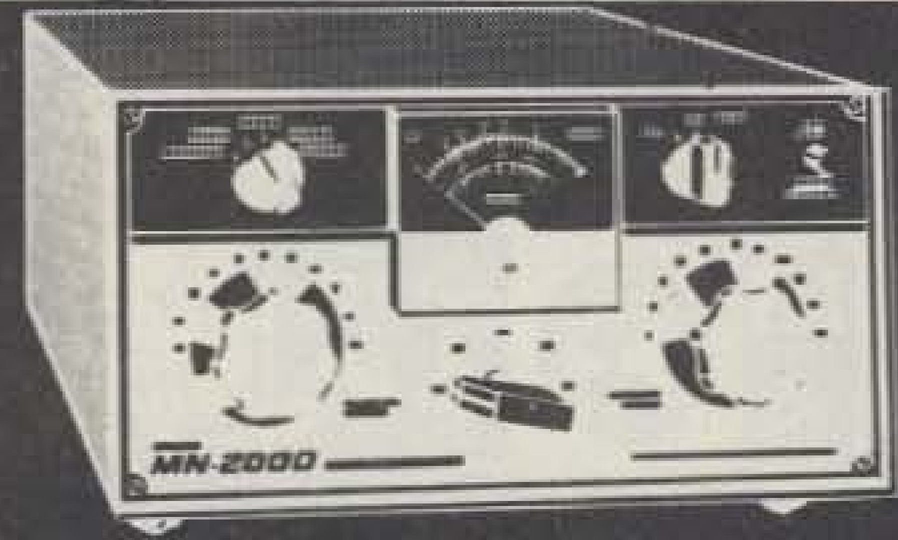

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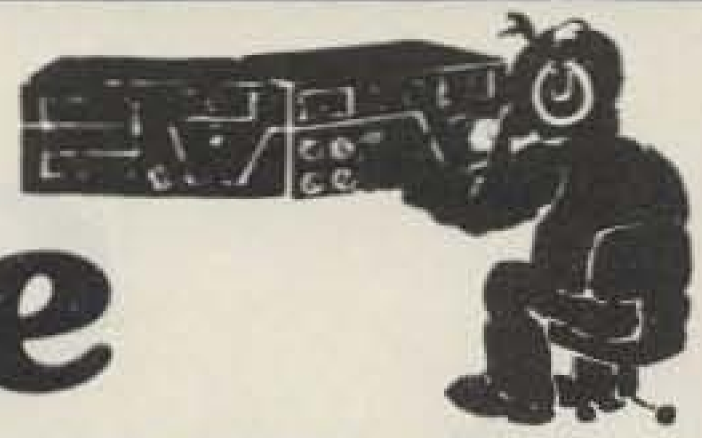

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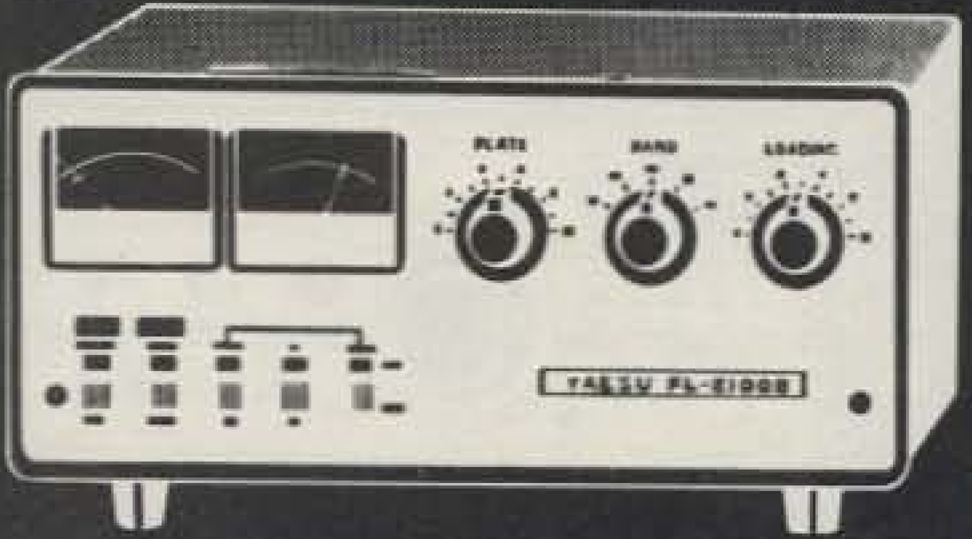

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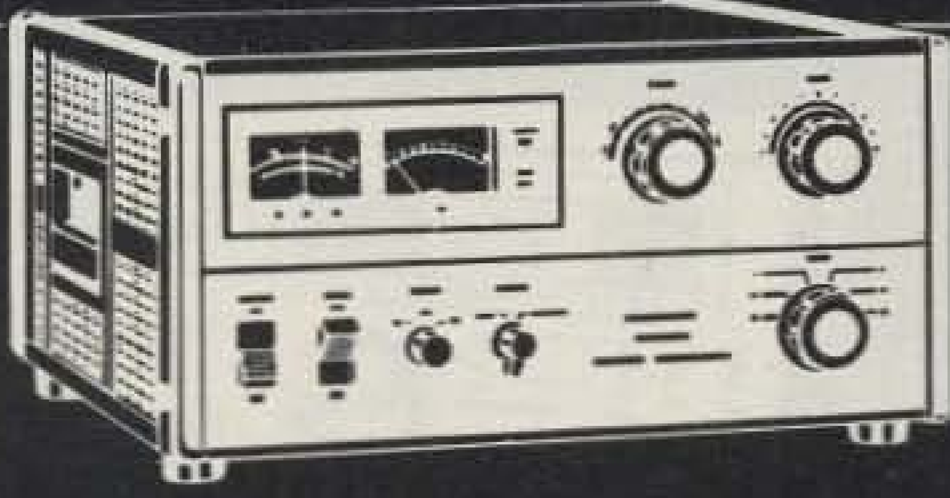

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869.00 list price. Call for quote.

DRAKE TR-4CW transceiver

TR-4CW covers 80 thru 10 meters • Modes: SSB, AM, CW • 300 watts PEP input on SSB, 260 watts on AM & CW • Transceive or separate PTO • Wide range receiving AGC • Solid-state VFO • CW semi-break-in • VOX or PTT • Shifted-carrier CW • Constant calibration mode to mode.

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KENWOOD TS-520S SSB transceiver

TS-520S features: • 160 thru 10 meter coverage • Optional DG-5 frequency display (on top of unit) • New speech processor with audio compression amplifier • Built-in AC power supply (DC-DC converter, optional) • RF attenuator • Provision for separate receive antenna & phone-patch.

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YAESU FT-901 DM HF transceiver

Check these: • Reject tuning • Variable IF band width tuning • Audio peak frequency tuning • Digital LED frequency display w/memory for TX & RX, no external VFO required for split frequency operation • Built-in Curtis keyer • Rugged GE 6146B final tubes • 160 thru 10 meter coverage & much more!

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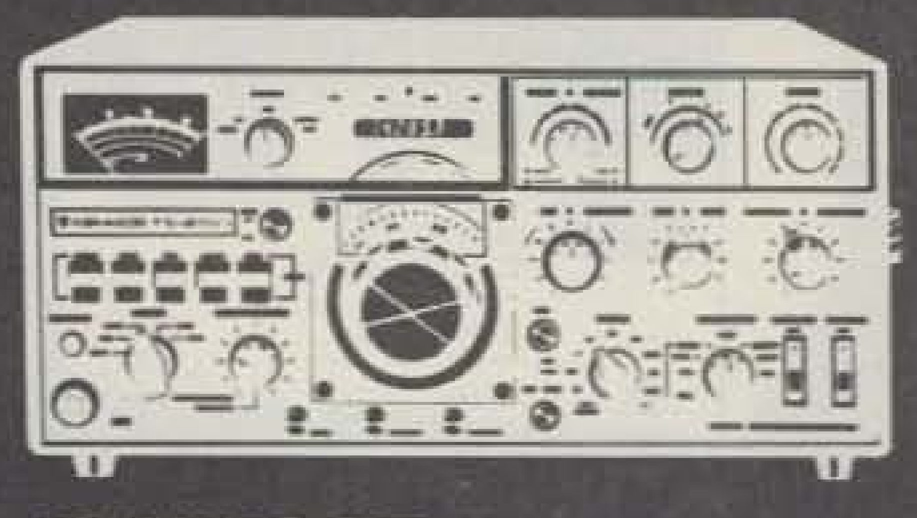
YAESU FT-101E transceiver

FT-101E is completely solid-state • Coverage: 160 thru 10 meters • Built-in AC/DC power supplies • Built-in RF speech processor • 260 watts PEP on SSB, 180 watts on CW, 80 watts on AM • Solid-state VFO • VOX • Auto break-in CW sidetone • WWV/JJY reception • Heater switch.

799.00 list price. Call for quote.



KENWOOD TS-820S transceiver

TS-820S features: • Factory installed LED digital readout • 160 thru 10 meters coverage • 200 watts PEP • Integral IF shift • Noise blanker • VOX & PLL circuitry • DRS dial • IF out, RTTY, XVTR capabilities • Phone patch IN & OUT terminals • RF speech processor

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Tom Cullen K1WXK
53 Sherman Ave.
Meriden CT 06450

Improve Your HW-2021

— more flexibility, etc.

I've wanted a handie-talkie for a long time, but I did some shopping around, finally decided that I couldn't afford one, and dropped the idea. Christmas was just about here, so I pooled all of my funds for the purpose of giving gifts. The YL asked what I wanted for Christmas and I very jokingly said, "How about a 2 meter walkie-talkie?" and let it lay. To my surprise on the fateful morn, there was a HW-2021 under the tree! After looking over the assembly manual and pasting in all of the changes that Heath had supplied, I went about putting it together. Six days and long nights later it was finished. On went the power switch; I checked for smoke – none. Oh, boy! Maybe it will work – it did.

I used it for about a week and it worked flawlessly; the 2021 is a real fine piece of equipment. All of a sudden, I couldn't bring up the local repeater with the mobile antenna or with the rubber duckie. A quick check with a wattmeter showed no rf output. The HW-2021 uses an RCA 2N5913 rf output transistor, which is supposed to resist burnout from a shorted or open antenna load. Don't believe it! Checking the external antenna jack, which is a mini 1/8" type, I found that the jack was open, so no antenna and one fried rf output transistor.

First on the list of things to do was locate a 2N5913. Called the local Heath store: none in stock, must be ordered; called local parts supplier: same answer – must be ordered. A visit to the local Radio Shack for some parts for one of my many projects turned up something very interesting. They have a transistor that is supposed to be good for a VHF driver and final and has one Watt for a power rating. The Radio Shack number is RS2038 and it costs $1.99. I bought one; for $1.99, it was worth a try. The case of the RS2038 is the same as the 2N5913, a TO-39, so no mods for the heat sink. I put it in and got indication of rf output. The driver and final stages of the HW-2021 must be retuned for best output; in mine, I found that I got the best out of it with the slug in the final coil completely removed. I think that this is due to the different characteristics between the two transistors. The original output gave me 1¼ Watts to a Heath wattmeter, and the RS2038 had an output of 1½ Watts. A check with the rubber duckie and the local repeater came right back on the air again.

The next thing to do was eliminate that 1/8" jack that caused so much grief. I always liked the BNC type of connector for rf jacks, so I decided to see if one would fit where the rubber duckie screwed in. I found that the single hole mount BNC connector (female) would fit into the hole nicely, but wasn't long enough to have the mounting nut tightened on the rear of the cabinet. A little bit of epoxy cement on the connector soon solved that problem. The flange that sits on the chassis when the connector is mounted perfectly covers the hole where the original screw-in type connector was and looks like original equipment. I soldered a small piece of braid from a piece of RG-174/U coax to the threads of the connector and passed it through the hole where the original connector was for grounding the shield of the rf output coax. Please remember to do this before you epoxy the connector to the case; I didn't and had one heck of a time trying to feed the braid through the hole. It is a tight fit, but can be done.

Now you are going to say, "What am I going to do with a rubber duckie that doesn't have a BNC fitting on it?" I said the same thing. If you are good with hand tools, you can make it fit on a BNC plug. One of the local hams here did it, but I purchased one with the BNC plug on it; I'm a chicken at heart.

The most use that my HW-2021 gets is in the mobile, and I wanted a way to run it off the car battery system instead of using the nicads. I didn't want to put another hole in the case, so I used the hole where the external antenna jack was! I got a good quality 1/8" jack made by Switchcraft and put it in the same hole. I didn't want the same thing to happen to the external power jack that happened to the antenna, so I used an open circuit type jack. Then it dawned on me: When the power from the car system was plugged in, the nicads would be across the full charge of the car and would overcharge them, causing their certain death. I put a 50 piv 1 Amp diode in series with the nicad power lead to allow voltage to pass from the nicads, but to prevent the car 12 volts from going across the batteries.

These mods have made a good handie-talkie a little more pleasant to operate. I hope that you have as much fun with yours as I have with mine. ■

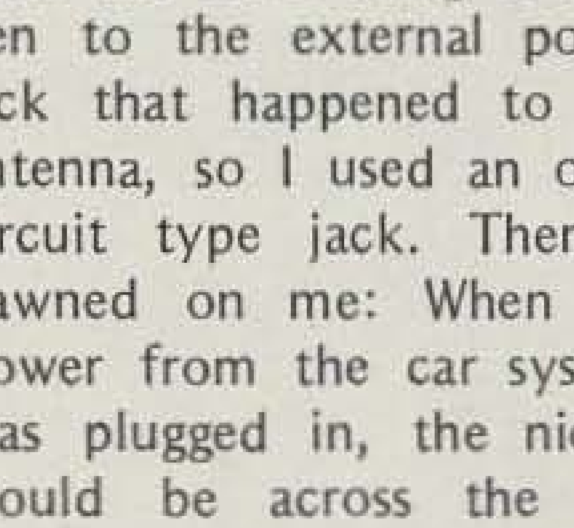

Fig. 1.

Pictured with optional HD-1984 Micoder II™

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AM-366

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Simple CW Interference "Filter"

—diode code regeneration

It goes without saying that most CW operators can send much better code if they have some means available to hear what they are sending out. If you use a separate transmitter and receiver, it is possible to turn down the rf or i-f gain controls while transmitting and listen to your own signal as it is actually radiated. Of course, there are a number of disadvantages to this method of CW monitoring, such as the need to constantly "ride gain," blasting in the phones when going from receive to transmit, and, worst of all, if the other station in QSO is not right on frequency, it is necessary to retune each time you stand by, with the resultant risk of losing contact when retuning. This last disadvantage is particularly disconcerting if the contact lost is WAS state number 50 or a rare VU2 or JT1.

Most of the fancier transmitters and transceivers available on the current market have built-in sidetone monitors, which work on a strictly audio-frequency basis and do not depend on the radiated rf signal at all. This is definitely the most reliable method of monitoring your keying (unless you insist on actually monitoring the radiated rf signal). Most lower-priced CW-only rigs and many of the popular home brew Novice designs do not include provisions for built-in sidetone monitoring.

A very simple and inexpensive method of monitoring your signal recognizes the fact that, most of the time, one of the first pieces of ham gear a prospective newcomer acquires is the code-practice oscillator, usually no more than a keyed audio oscillator driving a low-power audio amp into either phones or a small speaker. Unfortunately, this is also frequently the first piece of gear relegated to a dusty shelf, once the ticket is obtained. This article proposes a low-cost way to adapt practically any code-practice oscillator to monitor CW as transmitted, independent of either the receiver or transmitter gain or tuning.

The device shown in Fig. 1 connects to the transmitter or transceiver's coax output line at any convenient point, using a coax T-fitting. It is self-powered by rectification of a very small amount of the transmitter's output power (less than one Watt), driving a sensitive dc relay which follows keying automatically without any other direct connection to the key or elsewhere in the rig. Its output is connected to the key jack on the code oscillator, just as though it were a straight key itself. For code practice, the key can be connected to the jack provided in the unit so as to make its disconnection from the oscillator unnecessary.

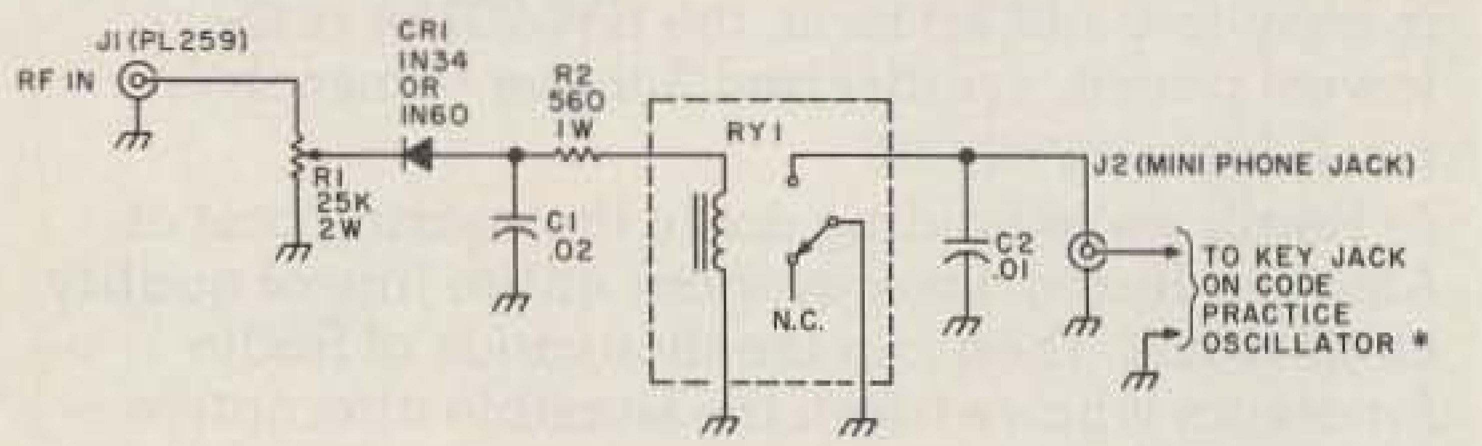


*Fig. 1. Complete circuit. *A basic minimodule code-practice oscillator, model CPO-4, is available from Poly Paks, Inc., Box 942, S. Lynnfield MA 01940, for $1.49, requiring a small PM speaker and 1.5 V battery for operation.*

Construction is very simple, and no special techniques are required. The monitor-adapter fits nicely into a 3-1/4" x 2-1/8" x 1-1/8" Bakelite box (Radio Shack #270-030, with aluminum cover), or, if radiation and TVI are factors, it can be built into an aluminum minibox, such as the Radio Shack #270-235 or equivalent, which is about the same size. A standard PL-259 coax plug is mounted to one end by drilling a hole just large enough for a UG-175/U or UG-176/U reducer to go through the hole, the end flange on the reducer holding the connector to the box (a dab of epoxy will keep it from slipping). A miniature phone jack and the 25k Ohm potentiometer are mounted to the aluminum front panel.

The heart of the monitor-adapter is the 6-volt sensitive miniature SPDT dc relay, available from Radio Shack as #275-004. (Although the relay is supplied as an SPDT type, one contact is left unconnected for our purposes.) If the relay is substituted for, be sure to obtain one which has similar characteristics, particularly one which will operate over a range of 6-9 V dc and requires no more than about 12 mA for operation. (Large, heavy relays are unsuitable, as this is definitely a QRP device — the germanium diode just won't rectify the quarter Amp or so that some relays need for operation.) Incidentally, although a 1N34 or 1N60 diode is specified, almost any large-signal diode that will handle at least 25-50 volts at around

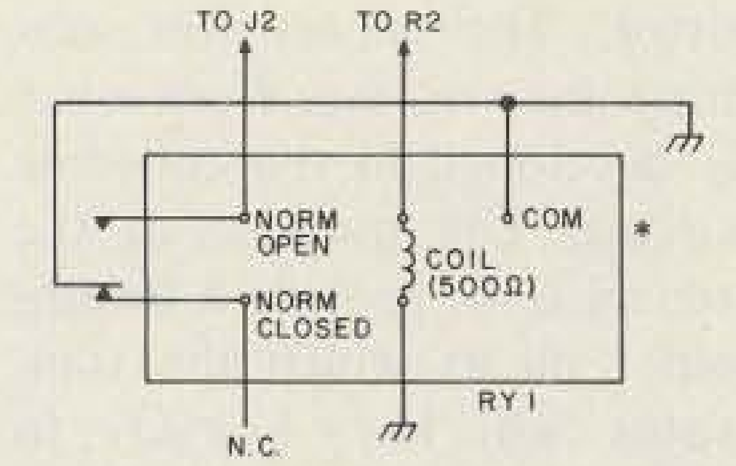
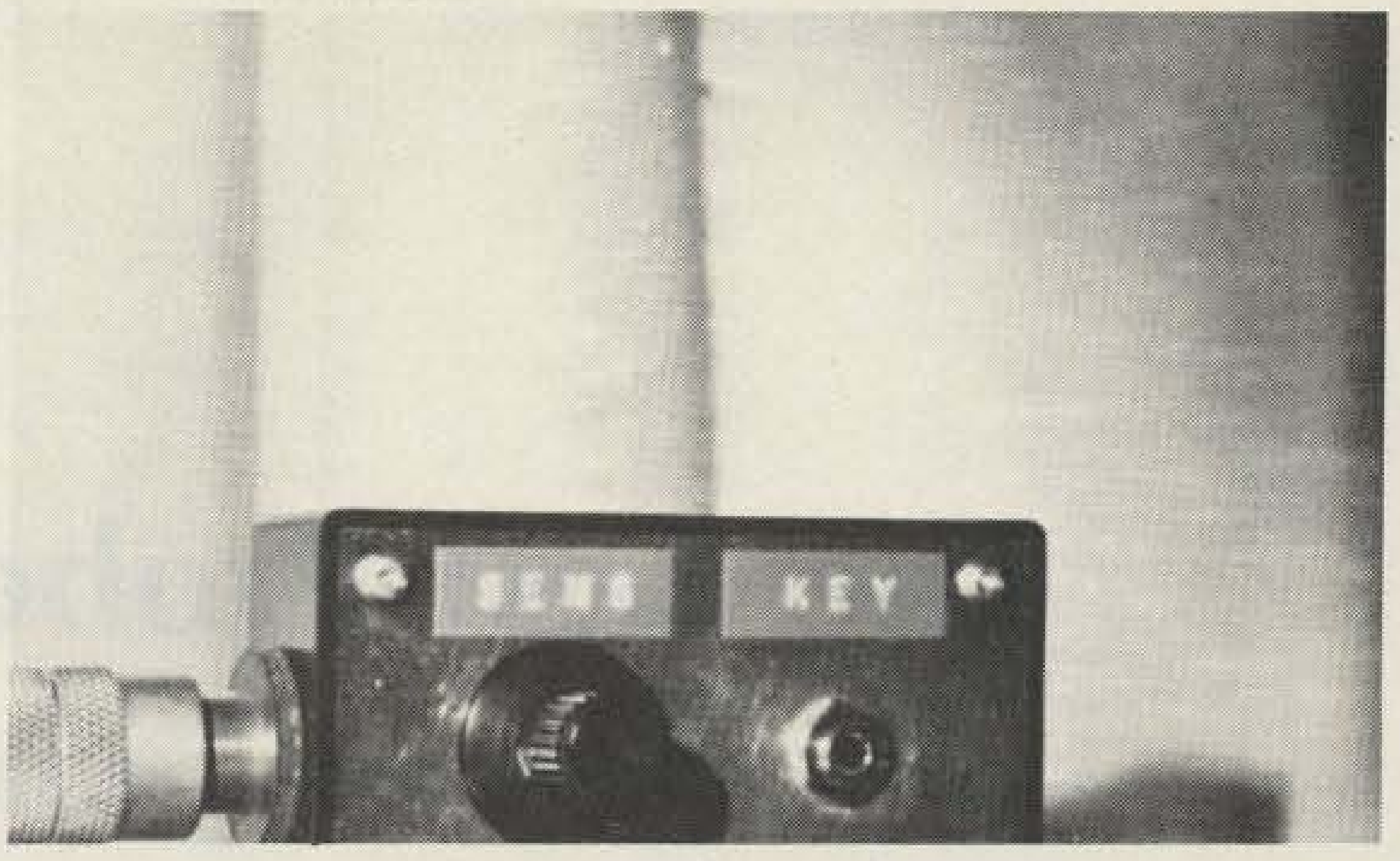


*Fig. 2. Blowup of relay connections. *Relay as it appears looking from the bottom (see diagram on back of "blister pack" package). Relay specifications (Radio Shack #275-004): voltage — 6 V dc (operating range — 6-9 V dc); resistance — 500 Ω; current — 12 mA; contact rating — 1 Amp at 125 V ac.*

12 mils or better should work well; I used an unnumbered surplus diode that was supposed to take over 100 volts at 100 mA. (Stock up, in case the diode you select won't handle the power. If you're running fairly high power, try paralleling a couple of diodes.)

About the only precaution to observe in construction is making sure that the relay is seated firmly. This is best done by epoxying its plastic case to the inside of the aluminum front panel. In tuning up, before connecting one side of the relay coil, check the voltage at the output side of R2. With full transmitter power applied, it shouldn't exceed 10 or 12 volts (start things off with R1 fully counterclockwise, advancing the control until the voltmeter reads 10-12 volts). The relay coil can then be connected to R2, and you're in business. Readjust R1 and recheck the voltage across the coil with full transmitter power applied. It should read 6-9 volts. Failure to observe these precautions could cost you a pot, diode, and relay!

The little unit is fairly frequency insensitive, but R1's setting may be tweaked if necessary when changing bands or output power levels. As designed, the unit should handle power levels up to 150 Watts or thereabouts.



If a linear amplifier is used, connect the monitor-adapter between the exciter and the linear, not between the amplifier and antenna or antenna coupler. (For higher power levels, try link coupling to the final output stage rather than using the resistance coupling I used. And don't substitute a higher rated wire-wound resistor for R1 — this may cause impedance matching problems for your rig.)

The unit can, as mentioned, be used as a code-practice oscillator without disconnecting it from the line by simply plugging a key into the phone jack on the front panel. Of course, it shouldn't be used for CW monitoring when practicing code!

I have used the unit with a Heath HD-16 code-practice oscillator with good results, following keying up to 25 wpm and more. It can be used with other code oscillators in which the key simply acts as a circuit closure. Total construction cost is about $7.50, even if all new components are used. ■

CONTESTS

from page 58

amateur interest the Bermuda Dept. of Tourism has. US stations may obtain a copy of the rules, logs, and check sheets from: Bernie Swandic K3DH, 7417 Mill Run Drive, Derwood MD 20855. Please include a large envelope with 13¢ postage.

ZERO DISTRICT QSO PARTY
Starts: 2000 GMT
Saturday, April 22
Ends: 0200 GMT
Monday, April 24

Organized by the Mississippi Valley Radio Club, this contest covers a lot of territory and should create a lot of activity. Stations outside of Zero district will work Zero district stations only, but Zeros may work both in and out of district stations. The same station may be worked once on each band and each mode.

EXCHANGE:

QSO number, RS(T), and QTH. QTH is county and ARRL section for Zeros, ARRL section only for all others.

SCORING:

For Zeros—total QSOs multiplied by (ARRL sections + Zero counties + DX counties) worked. Others—total QSOs multiplied by (Zero counties + Zero sections).

FREQUENCIES:

3560, 7060, 14060, 21060, 28060, 3900, 7270, 14300, 21370, 28570, 3725, 7125, 21125, 28125.

ENTRIES & AWARDS:

Beautiful four-color certificates will be presented to the General class section high scorer and to the Novice/Tech class section high scorer. Mailing deadline for entries is May 31, to: WB0UUA, Mississippi Valley RC, 3518 W. Columbia, Davenport, Iowa 52804. Include an SASE for results.

SHERLOCK HOLMES AWARD

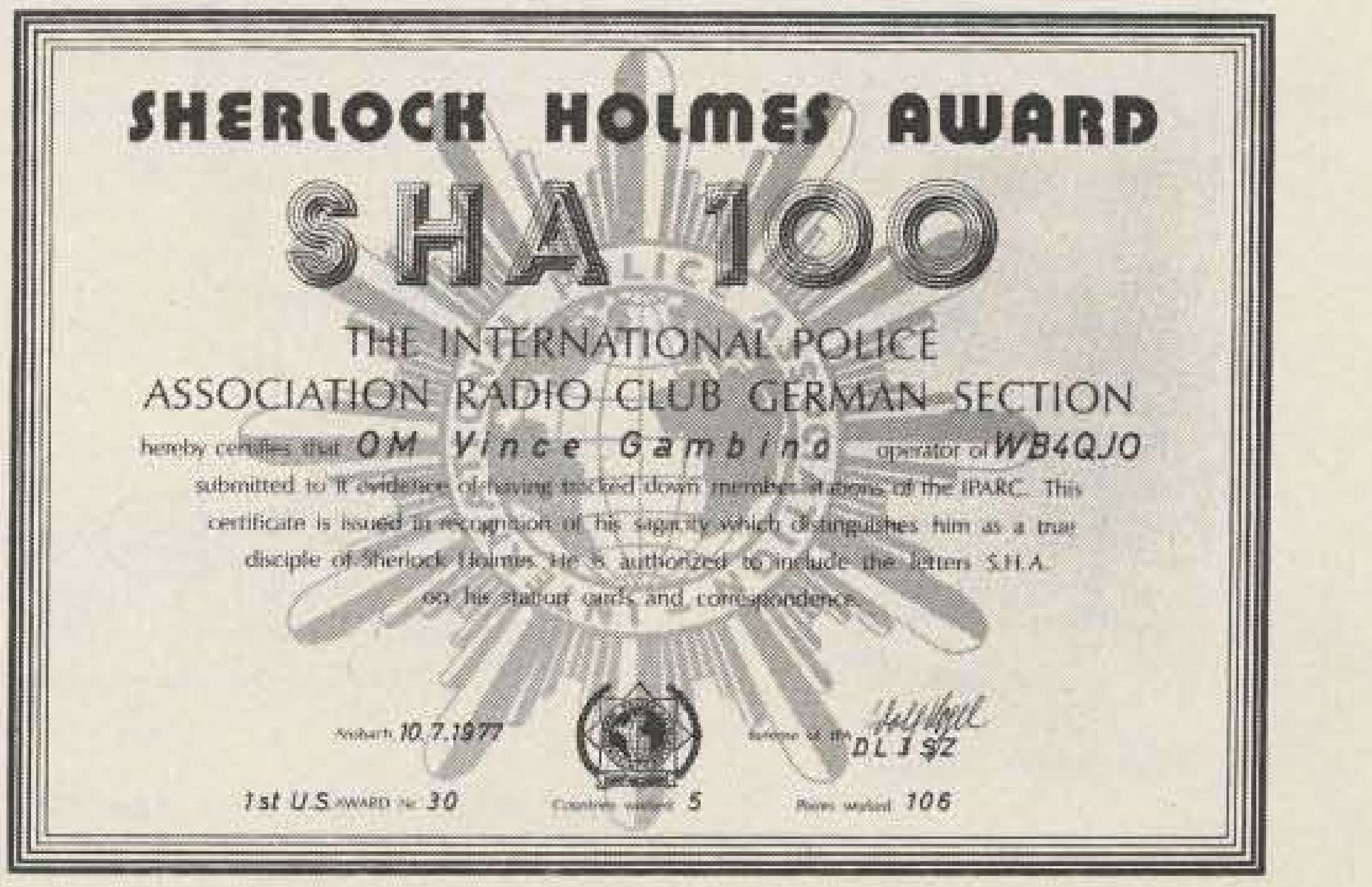
The Sherlock Holmes Award (SHA) is sponsored by the German Section of the International Police Association. It is designed to enhance the spirit of friendship among radio amateurs according to the motto of the IPA Radio Club: Servo per Amikeco (meaning Service through Friendship).

Amateur and SWL stations can apply for the SHA. Award hunters must work IPA RC member stations. A member station can be worked once on each amateur band. Application forms and a list of IPA RC stations are available from either DL3SZ or WB4QJO. DX stations send one IRC; other stations send an SASE.

The award is issued only for contacts made after 1 March 1976. There are three (3) SHA classes: a. SHA 50 (basic award); b. SHA 100; c. SHA 200. Participants must hold the SHA 50 before being eligible for the SHA 100. Only holders of SHA 100 are eligible for SHA 200. The fee schedule is listed below. Stamp endorsements are available for SHA 300, 400, and 500.

Schedule of points: The basic award requires a minimum of fifty (50) points. Contacts count as follows: IPA RC members in hunter's country—2 points; IPA RC member in DXCC country, hunter's own continent—5 points; IPA RC member in DXCC country, all other continents—10 points. IPA RC *club* stations count double on each amateur band.

Send completed verified application with 8 IRCs (resp. U.S.$ or DM 5) to cover cost of handling and printing, to: Adolf Vogel DL3SZ, Ritter-von-Eyb-Strs. 2, D-8800 Ansbach, Germany.



C. Warren Andreasen WA6JMM/N6WA
P.O. Box 8306
Van Nuys CA 91409

The Best Probe Yet?

—this audible probe is safer to use

The other day I had to debug some CMOS logic, and as I reached for my oscilloscope, it dawned on me that I had forgotten to bring it home. I reached for my trusty DVM (digital voltmeter) and started checking levels. To those of you who have never tried this method of logic debugging, don't. First you have to find the correct pin to put the probe on, and then when you look up to see what the meter says, the probe slips and you start all over again. I thought, "Gee, wouldn't it be nice if I didn't have to look to see what the meter said?" I thought about the normal logic probe with its indicator in the tip, and thought how nice that is; however, you still have to take your eyes off your work to look. This may sound like a small thing, but I find it irritating.

My next thought was, "Why not make a piece of test gear that gives the output in audio?" The unit does not have to fit totally in the hand since it's for bench work, and if I don't have to have the entire unit in my hand, creation of the sound (loudspeaker) won't be a problem.

To get to the point, I designed and built a logic probe that works with CMOS, produces a high tone for a logic high, a low tone for a logic low, and no sound for an open or floating string. In addition to this, the unit will detect narrow pulses and stretch them so the user is able to hear them.

The audio probe will detect high to low, or low to high pulses, and will do anything any good probe will do, except its output is in sound. It works great!

Circuit Description

Transistors Q1 and Q2 form the input stage. Under no signal or floating input condition, both transistors are biased on by the base resistors. In the ON state, the collector of Q1 is near ground and the collector of Q2 is near plus volts. I say near because of the 3 volt zeners in the emitter of each transistor. The zeners will subtract their voltage from what is developed in the collector circuit. The purpose of the zeners is to provide a threshold level at which the transistor will key. For Q1 to turn on, the base must be greater then 3.5 volts, and for Q2 to turn off, its base must be higher than supply voltage minus 3.5 volts. This choice of zener value is not critical. The choice I made is based on the fact that I run all of my CMOS circuits from 12 volts, and with this value of zener, my probe rejects any signal not below 3.5 or above 9 volts. A functioning circuit will easily exceed these values, and if it won't, the circuit is bad. From this point on, I can think logic. I will call the collector of Q1 "A", and the collector of Q2 "B". If the probe tip is floating, A is low and B is high. If the tip is low, A is high and B is also high. If the tip is high, A is low and B is also low.

Three unique states — one for each condition. Now all that is necessary is to decode the states. Only the 1 and 0 states are decoded, since if the state is not a 1 and 0, it must be the open state and nothing happens during this state. If a high condition occurs, the 1 decoder triggers the pulse stretcher. This pulse stretcher is a bit different in that it uses an OR gate. If pin 1 goes high, pin 3 also goes high, feeding back through C1 holding pin 2, and itself high for the time determined by the time constant of C1 and R5. When C1/R5 time out, the output of pin 3 will drop low again *if* there is not a high still on pin one. The gate acts like a straight piece of wire except that it will stretch a short pulse. Any time the output of pin 3 is high, it will enable the high pitch oscillator, causing a high tone to be generated.

The 0 decode, pulse stretcher, and oscillator work exactly the same as the circuit just described, except, of course, the tone generated is a low pitch. The two tones

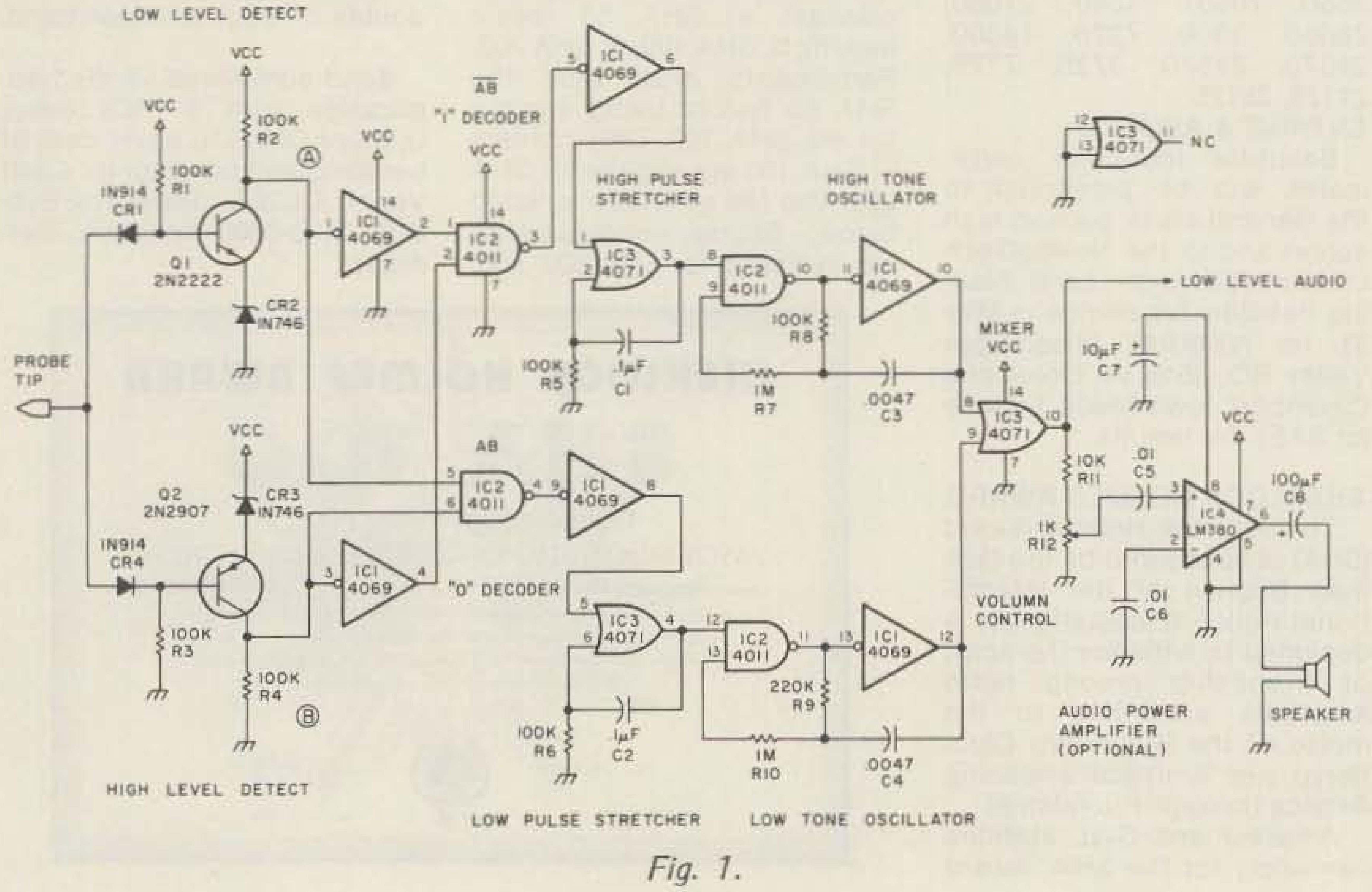


Fig. 1.

generated are mixed in the final section of IC3, with the inputs on pins 8 and 9, and the mixed audio on pin 10. The output at pin 10 is good for an earphone (used with a volume control) or a small speaker. Since I went this far and want to use this unit even if the environment is noisy, I went ahead and added a small audio amplifier which will blast me out of the room if necessary. As mentioned, the unit will produce a high tone for a high and a low tone for a low. With a bit of practice, as with other types of probes, you can get a pretty good idea of what is going on by the sound. If it sounds like both tones are on, you have a square wave signal; if you have a high tone with a low tone "ticking," you have a high with a low pulse, and so on. Now, if I should adjust the low tone to 2125 Hz and the high tone to 2975 Hz, and stick the probe into my Teletype™ machine, hummm . . . ■

Parts List

IC1	CD4069	Hex Inverter (RCA)
IC2	CD4011	Quad 2-input NAND (RCA)
IC3	CD4071	Quad 2-input OR (RCA)
IC4	LM380N	Audio Power Amplifier (National)
Q1	2N2222	NPN Transistor
Q2	2N2907	PNP Transistor
CR1,4	1N914	Signal Diode
CR2,3	1N746	3 Volt Zener Diode
R1-6,8	100k	1/4 Watt Resistor
R7,10	1 Meg	1/4 Watt Resistor
R9	220k	1/4 Watt Resistor
R11	10k	1/4 Watt Resistor
R12	1k	Variable Resistor (Pot)
C1,2	.1 uF	Capacitor
C3,4	.0047 uF	Capacitor
C5,6	.01 uF	Capacitor
C7	10 uF	Capacitor
C8	100 uF	Capacitor

NEVER SAY DIE

. . . de W2NSD/1

EDITORIAL BY WAYNE GREEN

from page 118

secretarial, and managing.

This is a wonderful environment for people who don't smoke . . . who are anxious to build a good career . . . to learn . . . and who don't need much supervision. There is no room for people who are just looking for a job. Non-achievers drag everyone down. We expect people to be proud of what they accomplish and to constantly strive to improve themselves. We give you enough rope here to climb any mountain . . . or to hang yourself. The choice is entirely up to you and what kind of a person you really are. This is a workaholic's paradise.

During the next year we're anxious to increase the circulation of *73* . . . perhaps double it. This is going to take a lot of work. We also want to double the number of ads and are aiming at someday running a 500 page magazine every month . . . one that will take two months to read. More work. The circulation will come—*73* is the biggest and best of the ham magazines—it's mostly a question of getting the word around. 429 articles published in 1977 against 164 in *QST*. Ads in *73* almost always outpull ads in the other magazines by a wide margin; still some firms are doggedly throwing away hundreds of thousands of dollars in sales by not advertising in *73* . . . a move which increases the cost of ham equipment, obviously.

If you'd like to be part of the dedicated group which puts out *73*, send a resumé, references, and a letter telling me about yourself, your interests, and what you've accomplished so far in life. We're open for anyone . . . with no strong prejudices on color, religion, age, sex, etc. The only exception is smoking . . . if you smoke or are addicted to other drugs, don't write.

A DX COLUMN IN 73?

A few years ago, I got the idea of writing to all of the governments of the world and getting information on how visiting amateurs could get licensed. About three score quickly sent in the information, and suddenly I had a pile of papers about eight inches high to pore over and write up in brief form.

After a while, it became evident that it was going to take more than good intentions to get this pile into publishable form. Luckily at this time . . . or perhaps unluckily . . . a good friend volunteered to take on the responsibility. The days dragged by and nothing arrived . . . then weeks . . . months . . . and now it has been years. I suspect that I had better not depend on him further . . . I'm beginning to lose faith.

I'd like to see a monthly DX column in *73* which would tell us how to get licenses in other countries . . . which would bring us pictures and the stories of some of the more exciting DXpeditions . . . which might even help organize some DXpeditions. The person to write this should have a good deal of time . . . a respectable DX score (at least 300 countries confirmed . . . it took me about two years to get 300 confirmed) . . . the ability to write . . . and the determination to get a job done despite obstacles. It will take a lot of correspondence with foreign governments. It will also take a lot of listening and asking around on the DX bands, ferreting out the stories.

Anyone interested?

BIRMING-HAM-FEST
MAY 13-14

It looks as if Birmingham is going to have one of the biggest hamfests they've ever had this year . . . well worth the trip, I'd say. There'll be something for everyone, with Dave Ingram K4TWJ hosting the SSTV forum, Steve Gilbert WD4EKN the 10m channelized band session (converted CB units), Hop Hayes K4TQR the repeater forum, plus forums on microprocessors, computer programming, MARS, solid state design, ARRL, emergency net systems, etc. There will be a 30-second forum where I will cover in depth the merits of the League and a one hour Q&A session afterwards, followed by the usual ritual tar and feathering.

In an effort to keep the hamfest banquet a small affair, word has been leaked that I am the banquet speaker . . . possibly Rick Cooper was unavailable. Will the chicken be better than the speaker?

Many of the top ham manufacturers will be exhibiting . . . Atlas, Data Signal, Dentron, Drake, Icom, Radio Shack, Palomar, Long's, Opto-electronics, ZZZ, and others. There will also be a goodly number of microcomputer exhibits. This will be a good time to come and see these pesky contraptions.

The prizes are not to be discounted either . . . like one of the new Dentron transceivers (DTR-1), a Drake TR-4CW and TR-33C, an Icom IC-215, a Wilson HT, a Regency HR-312 and HR-2B, etc. Micro fans have a chance at an SWT 6800 computer. No, forget that last one, for I fully intend to put as many tickets in for that as I can and walk away with it. Know you that I am known as Lucky Green when it comes to hamfest prizes, so despair. I've been wanting a Southwest Tech 6800 ever since they were announced . . . it's just that I've been too poor (or Scotch) to buy one.

MAUNDER MINIMUM CONFIRMED

A recent Sunday *Times* article (thanks to W2OLU for sending the clipping) on ice cores in the Antarctic mentioned that these cores reflect the level of sunspots with the nitrogen compounds in the snow. By bringing up cores of ice, scientists have been able to confirm that there were no sunspots between 1645 and 1715, the Maunder Minimum, as it has been called.

This confirms that our sun is a variable star and that the Earth went through a little ice age during the sunspot lapse.

So far the cores have been examined only back a few hundred years. On the strength of this confirmation of the Maunder Minimum, scientists will now start examining cores which are already in storage, brought in from Antarctica and Greenland, extending solar history back over 100,000 years. It will be interesting to see what correlation there is between the sunspot activity of the past and climate changes such as ice ages.

Without sunspots, DX must have been terrible in the 1600s.

STANDARD EXPANDS

Standard Radio, at one time one of the largest ham manufacturers, got off into CB for a while and now is coming back into hamming with a major effort. Marv Driscoff is moving from VHF Engineering to work with Standard, aiding Glenn

Continued on page 138

L. A. Erwin, Jr. WA4FDE
210 Earl Dr.
Lyman SC 29365

How Sunspots Work

— basics for the Novice

For the newcomer to radio communications, as well as for many old-timers, the subject of sunspots can be very confusing. With the new cycle expected to begin increasing, there is increasing interest in the subject of how they will affect propagation. The purpose of this article is to give a brief understandable explanation of what sunspots are and how they affect radio wave propagation.

Though great advances have been made in recent years in understanding the many modes of propagation of radio waves, variables affecting communication over long distances are very complex.

The sun, ultimate source of life and energy on Earth, dominates all radio communication beyond the local range. Conditions vary with such obviously sun-related earthly cycles as time of day and season of the year. There are also short- and long-term solar cycles which influence propagation. The state of the sun at a given moment is critical to long-distance communications.

Solar Phenomena

Sunspots play a major role in radio wave propagation, so it is necessary to have a general understanding of the spots themselves. The *McGraw-Hill Encyclopedia of Science and Technology* presents the following description of sunspots:

> "A sunspot begins as a small dark area known as a pore, 2000-3000 kilometers in diameter. The pore develops into a full-fledged spot in a few days, and the maximum development is reached within the next week or two. Decay, which consists simply of shrinkage of the spot area along with its magnetic field, is much slower. The life span varies from a few days for small spots to about 100 days for large groups."[1]

Sunspots have two parts: umbra, the darker central area, and penumbra, the lighter surrounding area. They appear dark because of the brilliant surrounding area of the sun. Their temperature is 4500 degrees Kelvin, which is cooler than the rest of the sun. They appear in groups with a leader and a follower and are quite large in size. Some groups have been observed whose length equaled the distance from the Earth to the moon.[2]

At times, they appear singly, but the most common appearance is in groups which are dominated by two large spots in a bipolar center.

The magnetic fields of the sunspots are probably responsible for the cooler temperature and darker appearance. (They are about eighteen percent darker than the surrounding area of the sun.) The magnetic field is also responsible for the radiation associated with the spots.[3] The magnetic fields may also appear with opposite magnetic polarity. When this occurs, large flares are produced, and an extremely large amount of energy is released due to the interaction and annihilation of the fields.[4] This usually takes place during the week when a sunspot goes through maximum development. The flare has the appearance of a violent ejection of material from the surface of the sun.

Sunspots occur in cycles of approximately eleven years. They begin in high latitudes in the northern and southern hemispheres. They increase in size and number, reaching a maximum in about four years. The decay process is about twice as long, with the cycle ending in about eight years and located in low latitudes.[5]

Even before their correlation with radio propagation was well known, the periodic rise and fall of sunspot numbers had been studied for many years. Though these cycles average roughly eleven years in length, they have been as short as nine and as long as thirteen years.

Current observations are recorded by use of the Zurich Sunspot Number. A useful modern indication of overall solar activity is the solar flux index, which is sometimes called the "A" index. Solar flux readings are made several times a day by the National Bureau of Standards. A solar flux reading of sixty relates to a sunspot number close to zero.

The cycles do not go smoothly from low to high or high to low in intensity; they fluctuate during the cycle. In October, 1974, which was only a few months from the bottom of cycle twenty, there were a few days when the index reached 145, which is higher than the peak of some cycles. A few months later, the index had dropped to below seventy.

The high and low indexes for the cycles vary greatly. Cycle nineteen peaked in 1958 with a sunspot number of 200. In 1969, cycle twenty peaked with a number of 120, which was near average intensity. One of the lowest on record was cycle fourteen, which peaked at sixty in 1907. We are currently beginning cycle twenty-one.

Sunspot cycles should not be thought of as having sine-wave shape. There can be isolated highs during the normal low years. A remarkable example was a run of several days in October, 1974, only a few months from the approximate bottom of cycle twenty, when the solar flux reached 145, a level well above the highs of several cycles on record. Only five months later, several days of solar flux below seventy were recorded.[6]

Solar Radiation

Insofar as it affects most radio propagation, solar radiation is of two principal kinds: ultraviolet light and charged particles. The first travels at about 186,000 miles per second, as does all electromagnetic radiation. The effects on wave propagation take place almost immediately from ultraviolet radiation. The charged particles travel much more slowly and may take up to forty hours to have an effect on propagation.[7]

The sun produces a constant stream of radio waves. During periods of large sunspots, an excessive amount of emission occurs. This large amount of emission corresponds to the high electron concentration in the ionosphere. When sunspots become highly active, the flares which are produced cause a large quantity of charged particles to be emitted. These also have an effect on the ionosphere.

Variations in the level of solar radiation can be gradual, as with the passage of some sunspot groups and long-lived activity centers across the solar dish, or sudden, as with solar flares. An important clue for anticipating variations in solar radiation levels and radio propagation changes resulting from them is the rotational period of the sun, approximately twenty-seven days. Sudden events may be short lived, but active areas capable of influencing radio propagation may recur at four-week intervals for four or five solar rotations. Evidence of the twenty-seven day cycle is most marked during years of low solar activity.[8]

Ionosphere

The effects sunspots have on radio wave propagation become clearer if the characteristics of the ionosphere are understood.

Long-distance communication (and much over shorter distances), on frequencies below thirty megahertz, is the result of bending of the wave in the ionosphere, a region between about sixty and 200 miles above the Earth's surface where free ions and electrons exist in sufficient quantity to affect the direction of wave travel. Without the ionosphere, long-distance communication would be impossible.

Ionization of the upper atmosphere is attributed to ultraviolet radiation from the sun. The result is not a single region, but several layers of varying densities at various heights surrounding the Earth. Each layer has a central region of relatively dense ionization that tapers off both above and below.

The lowest useful region of the ionosphere is called the "E" layer. Its average height of maximum ionization is about seventy miles. The atmosphere here is still dense enough so that ions and electrons set free by solar radiation do not have to travel far before they meet and recombine to form neutral particles, so the layer can maintain its ability to bend radio waves only when continuously in sunlight. Ionization is thus greatest around noon, and it practically disappears after sundown.

In the daylight hours there is a still lower area called the "D" region, where ionization is proportional to the height of the sun. Wave energy in lower frequencies, four megahertz and below, is almost completely absorbed by this layer. Only the highest angle radiation passes through it and is reflected back to Earth by the "E" layer. Communications on these frequencies in daylight is thus limited to short distances.

The region of ionization mainly responsible for long-distance communications is called the "F" layer. At its altitude, about 175 miles at night, the air is so thin that recombination takes place very slowly. Ionization decreases slowly after sundown, reaching a minimum just before sunrise. The obvious effect of this change is the early disappearance of long-distance signals on the highest frequencies that were usable that day, followed by loss of communication on progressively lower frequencies during the night. In the daytime, the "F" layer splits into two parts, "F1" and "F2", having heights of about 140 and 200 miles, respectively. They merge again at sunset.[9]

When a radio wave passes through the ionosphere, the electron field of the wave exerts a force on the electrons of the ionosphere. The moving electrons cause conditions in the ionosphere that alter the path of the wave. The wave is bent away from the regions of high electron density, thus bending the wave back toward the Earth.[10]

The effect the ionosphere has on radio wave propagation is described in *Electronic and Radio Engineering* : ". . . each vibrating electron acts as a small radio antenna that abstracts energy from the passing radio wave, and then reradiates this energy."[11]

The bending of the wave is highly dependent on the ionized particles and electrons in the various layers of the ionosphere. The sunspots have a direct effect on the level of electrons. The greater the intensity of ionization in a layer, the more the wave path is bent. The bending also depends on wavelength; the lower the wave, the more its path is modified for a given degree of ionization. Thus, for a given level of solar radiation, ionosphere communications are available for a longer period of time on the low-frequency bands than near the upper limit of the high-frequency spectrum.[12]

Relationship Between Sunspots and Ionosphere

There is a direct relationship between the eleven-year sunspot cycle and propagation, because there is a direct relationship between the cycle and ionization. The intensity and character of solar radiation is subject to many short-term and long-term variables.[13]

The steady flux of solar ultraviolet and x-radiation maintains the ionosphere by ionizing a small fraction of the molecules of the Earth's atmosphere above the 100-kilometer level.[14] The level of ionization increases as sunspot activity increases, and thus accounts for increases in radio wave propagation.

Tilton gives research data[15] that shows the relationship between solar flux index and propagation. With several months of data, he shows how the increase in solar flux is followed several days later by an increase in propagation. On June 2-4, 1975, the solar flux had been at sixty-six. It began to rise on the next day and reached sixty-nine on the ninth. On the eighth, a major change was observed in a group of sunspots being observed, and, on June 11, the "A" index peaked as a result of the observed condition in the preceding days.

The frequency of radio wave that will be reflected is dependent on the density of the ionized layers — the greater the density, the higher the frequency. Maximum sunspot activity causes the density to become greater than normal.[15]

The maximum usable frequency varies according to the time of day, season of the year, and the eleven-year sunspot cycle. For example, the maximum usable frequency during a year of low sunspot activity may be seven or eight megahertz, while in a year of high sunspot activity it may be forty megahertz or higher.[16] This variation is caused by the changes in the electron density in the ionosphere layers during these times. The condition of the ionosphere can be predicted based on the position of the sunspot cycle.[17]

The eighty meter band is useful for only about 200 miles during the daylight hours, with long distances possible at night, especially during low solar activity periods.

The forty meter band is similar to the eighty meter band with somewhat greater distances. The propagation path follows the line of darkness around the world, making long distances possible during the winter months.

The twenty meter band is best for long-distance propagation. During peak solar cycle years, the band is useful almost continuously. During low solar activity periods, it is good during daylight hours.

The fifteen meter band is greatly affected by the level of solar activity. Almost around-the-clock use is available during high activity periods for long-distance propagation. During intermediate activity, the band is useful mainly during daylight hours for long distance.

During peak solar cycle years, the ten meter band is useful for long distance during daylight hours. The useful time is shorter during intermediate years. When solar activity is at at a minimum, usefulness tends to be infrequent.

Variation in sunspot activity also occurs in the twenty-seven-day cycle, which is the time required for one rotation of the sun on its axis. The maximum usable frequency varies during this cycle from fourteen to twenty-eight megahertz.[18]

Some of the short-term effects on the ionosphere are solar flares and magnetic storms. Solar flares have a definite effect on the ionosphere, causing a sudden ionospheric disturbance. A new layer of ionization appears at a height of only sixty kilometers. Radio waves cannot pass through this layer and be reflected by the higher ionosphere layers. This causes long-distance radio communications to be degraded or blocked out completely for several hours. Solar flares show a high correlation between their occurrence and the eleven-year sunspot cycle.[19]

Magnetic storms can produce a type of absorption of the wave which will also disrupt propagation.[20] The storms occur most frequently during the sunspot cycle peak. They vary in intensity and duration, lasting from one to several days. They also recur at twenty-seven-day intervals since they are associated with a particular sunspot or group of sunspots.

Lower frequencies are affected by a decrease in daytime absorption and an increase in the signal strength. The higher frequencies, however, become useless, as if the refracting layers had disappeared.[21]

Summary

The condition of the Earth's ionosphere and the propagation quality for a given time are directly related to conditions in the sun.

Sunspots, one of several activities taking place on the sun, are primarily responsible for changes in radio wave propagation. This source of increased radiation causes an increase in the density of the ionosphere.

This increase in the density of the ionosphere causes an increase in the maximum usable frequency and the distance of wave propagation.

Man's interest in the sun is older than recorded history. Sunspots were seen and discussed thousands of years ago, and they have been studied since Galileo observed them with the first telescope ever made. Records of sunspot observations translatable into modern terms go back nearly 300 years.

Sunspots and their associated activity play a major role in the propagation of radio waves on the Earth.■

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EDITORIAL BY WAYNE GREEN

from page 135

Malme. Both are long-time industry men and dedicated hams . . . it should work out well for Standard if they are given their heads.

JANUARY WINNER

Our $100 check for the best article in the Janury issue goes out to W. Edmund Hood W2FEZ for "Think You Understand SSB?", a better than 2-to-1 winner over its nearest competitor, "Test Those ICs!" by Howard F. Batie W7BBX/4.

CANADA PROPOSAL

The DOC is proposing cutting out the amateur 420-430 MHz band and adding one from 902-928 MHz. That's not exactly a good swap, but it's better than nothing . . . except that ham use would be secondary to the fixed service, which would mean that hams could use the band as long as they didn't interfere with the primary service.

CB LOSING IN AUSTRALIA?

The Australian government has done the unthinkable . . . moved CB from 27 MHz up to 476.675 to 477.400 MHz . . . still 40 channels. The government has given CBers until June 30, 1982, to get off 27 MHz. We won't find out whether they'll be able to make that stick for another four years.

see page 214

Get into "220" Mobile the Easy Way with Midland

Midland has a pair of proven performers, crystal controlled or P.L.L. synthesized . . . both designed to be easy on the pocketbook

To start with, here's Midland's Model 13-509. It's a compact, rugged mobile with capacity for 12 crystal-controlled channels. The "509" transmits with 10-watt or 1-watt output. Its receiver has a dual gate MOS FET front end with hi-Q resonator and ceramic filters. There are SWR and polarity protection circuits, internal DC filtering and electronic switching. With its jack for optional tone burst and discriminator meter, the "509" has even been the basis for many repeaters.

Midland's choice alternative in "220" is P.L.L. synthesized Model 13-513. Here's advanced design with modular construction and digital frequency readout. It's programmed for 500 frequencies between 220 and 225 MHz, with a 5 KHz shift up giving 500 more . . . and 4 offsets are available for repeater use. The receiver has a multiple FET front end with monolithic crystal and ceramic filters. The transmitter switches for 20-watt, 10-watt or 2-watt output. With automatic SWR and polarity protection, internal DC filtering, electronic switching and a jack for tone burst and discriminator meter, the "513" is a very desirable "220" mobile . . . or base.

Pair either of Midland's "220" mobiles with Midland's trunk/roof mount or magnet mount antennas (Models 18-950 and 18-951) for top-notch performance on the band.

MIDLAND INTERNATIONAL

For more about Midland "220" Mobile, write: Midland Amateur, P.O. Box 1903, Kansas City, Missouri 64141

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PART 97—AMATEUR RADIO SERVICE

Sections 97.40, 97.43, 97.88, and 97.126 of the Commission's Rules Waived

AGENCY: Federal Communications Commission.

ACTION: Temporary rule waiver.

SUMMARY: This Order temporarily waives those FCC regulations which require that an Amateur operator receive FCC approval prior to beginning operation of a repeater, auxiliary link, control or remotely controlled station. The FCC is taking this action to grant relief to those persons who wish to place a new repeater station in operation. At the present time, the FCC is not processing applications for new repeater stations, pending completion of a review of its earlier decision (Docket 21033) to discontinue the licensing requirements for these stations.

DATES: This waiver is effective immediately and terminates as soon as the Commission releases a Memorandum Opinion and Order in Docket 21033.

FOR FURTHER INFORMATION CONTACT:
Joseph M. Johnson, Personal Radio Division, Federal Communications Commission, Washington, D.C. 20554, 202-632-7250.

In the matter of waiver of §§ 97.40, 97.43, 97.88, and 97.126 of the Commission's Rules. Order re waiver.

Adopted: February 9, 1978.

Released: February 14, 1978.

1. The chief, Safety and Special Radio Services Bureau, acting under delegated authority, has under consideration a waiver of §§ 97.40, 97.43, 97.88, and 97.126 of the Amateur Radio Service Rules. This waiver would suspend the present requirement that licensed amateur radio operators wishing to operate repeater, auxiliary link, control or remotely controlled stations must obtain Commission permission before commencing such operations.

2. In a combined Notice of Inquiry and Notice of Proposed Rule Making in Docket 21033 released on January 6, 1977, the commission proposed, among other things, to amend Rule §§ 97.40, 97.43, 97.88, and 97.126 to delete the present licensing requirement for repeater, auxiliary link, control, and remotely controlled stations. A Report and Order in docket 21033 released on September 27, 1977 amended these rule sections essentially as proposed. The amended rules were to take effect November 4, 1977; however, in response to petitions for Reconsideration and Stay from the American Radio Relay League, the Commission stayed the effective date of the Report and Order. In its stay, the Commission also ordered the continuation of its freeze on the acceptance of new repeater station applications filed after September 21, 1977.

3. As a result of the actions described above, no applications are now being granted for new repeater stations. We have been receiving many requests urging us to take some action to permit the operation of new repeater stations, and it is clear that some sort of administrative relief is warranted in this situation. We do not believe that a waiver of the Commission's Rules will, in this instance, prejudice consideration of the League's Petition for Reconsideration. If the Commission's review of its action results in approval of the league's request for continuation of separate licenses for repeater stations, then new repeaters will again be licensed. If the Commission affirms its Report and Order, then new repeater stations may be activated under the authority of an amateur's primary station license. In either event, amateurs could continue to build and put into operation new repeater stations. For this reason, a waiver of the pertinent rule sections on a temporary basis until such time as the Commission formally acts on the League Petition for Reconsideration appears warranted. when utilizing a primary station as a repeater or auxiliary link station, the station must be identified by the transmission of its call sign, followed, on telegraphy, by the letters RPT or AUX, as appropriate; and on telephony by the words repeater or auxiliary, as appropriate. All other rules applying to repeater, auxiliary link, control, and remotely controlled stations, other than those waived by this Order, are to be strictly observed by primary station licensees operating under the terms of this waiver.

4. Accordingly, the Commission, by the Chief, Safety and Special Radio Services Bureau, under authority delegated pursuant to Section 0.331 of the Commission's Rules, *orders*, That Sections 97.40, 97.43, 97.88, and 97.126 are waived to permit licensed amateur radio operators to operate their primary stations as repeater, auxiliary link, control, and remotely controlled stations without prior Commission approval. This waiver is effective immediately and terminates upon the release by the Commission of a Memorandum Opinion and Order in Docket 21033.

FEDERAL COMMUNICATIONS COMMISSION,
CHARLES A. HIGGINBOTHAM,
Chief, Safety and Special Radio Services Bureau.

[Docket No. 21135; FCC 78-76]

PART 97—AMATEUR RADIO SERVICE

Simplification of Licensing and Call Sign Assignment Systems in Amateur Radio Service

AGENCY: Federal Communications Commission.

ACTION: Final rules.

SUMMARY: The FCC is adopting new rules in the Amateur Radio Service eliminating secondary stations and special event stations. We are also amending the rules to assign all amateur station call signs on a systematic basis. We are taking this action to bring our amateur regulatory programs into closer alignment with the resources we have available. We expect our action will enable us to provide amateur radio licensees with better, more efficient service in other areas.

EFFECTIVE DATE: March 24, 1978.

ADDRESS: Federal Communications Commission, Washington, D.C. 20554.

FOR FURTHER INFORMATION CONTACT:
Gregory M. Jones, Personal Radio Division, 202-634-6619.

SUPPLEMENTARY INFORMATION: In the matter of the simplification of the licensing and call sign assignment systems for stations in the Amateur Radio Service (See 42 FR 15438); First report and order.

Adopted: February 8, 1978.

Released: February 23, 1978.

WHAT IS THE BACKGROUND OF THIS PROCEEDING?

1. In a Notice of Proposed Rulemaking in Docket 21135, released March 11, 1977, FCC 77-156, 42 FR 15438 (1977), the Commission acted on its own initiative and proposed several major revisions of its Amateur Radio Service regulations, 47 C.F.R. §§ 97.1, et seq. Comments on our proposals were due no later than June 2, 1977. Reply comments were due no later than June 30, 1977. The American Radio Relay League, Inc. (ARRL) petitioned for an additional thirty days in which to submit comments and reply comments. On May 19, 1977 the Chief, Safety and Special Radio Services Bureau, acting under delegated authority, denied the ARRL's petition, stating that the 83 day comment period the Commission provided was adequate, and that rapid resolution of the issues raised in the Notice of Proposed Rulemaking in Docket 21135 was essential. We have carefully considered our proposals and the comments submitted in response to our proposals. We are now prepared to take action in this proceeding.

WHAT WERE OUR SPECIFIC PROPOSALS?

2. In our Notice of Proposed Rulemaking in Docket 21135 we made several proposals which, if adopted as proposed, would have a significant impact on both the licensing of amateur stations and the assignment or call signs to amateur stations. Briefly summarized, our proposals in Docket 21135 were to simplify the licensing structure in the Amateur Service by discontinuing the issuance of all types of amateur station licenses, except space stations and so-called "primary" station licenses. Specifically, we proposed to eliminate—

Repeater stations, auxiliary link stations, and control stations.[1]
Military recreation stations.
Club stations.
Secondary stations.
Special event stations.
Radio Amateur Civil Emergency Service (RACES) stations.

We imposed an immediate "closed season" on the filing of applications for special event stations and new secondary stations. We also proposed to simplify greatly the regulations concerning the assignment of station call signs in the Amateur Service by replacing the current complex provisions with a concise rule stating that call signs will, in almost all instances, be assigned by the Commission on a systematic basis.[2]

WHY DID WE MAKE THESE PROPOSALS?

3. In adopting our proposals in Docket 21135 we acted in response to the greatly increased interest in personal radio communications in the United States. We stated that the number of Citizens Band Radio Service and Amateur Radio Serv- ice applications we were receiving were both at all time highs.[3] We also stated the record number of applications we were receiving had caused an extraordinary and sustained increase in the workload of the Commission's Personal Radio Division, and that, assuming no additional resources were to be forthcoming, we believed it necessary to take immediate steps to improve the efficiency of our license processing system, in order to prevent an unacceptable backlog of pending applications. We concluded that the increased demand for personal radio communications, taken with our limited resources, required that we assign priorities to our current licensing activities. Those activities found to be high priority—the issuance of operator and primary station licenses—were proposed to be continued. Lower priority activities—the issuance of special call signs and all non-primary station licenses—were proposed to be eliminated. In proposing the discontinuance of special call signs and non-primary stations, we noted that we were forced to allocate a large percentage of our resources to the maintenance of these programs, despite the fact that only a very small segment of the Amateur Service benefits from or takes advantage of them. We found the overall public interest would be best served by discontinuance of special call signs and non-primary stations, an action which would permit us to allocate our resources in a more effective manner than they are now allocated. Finally, we stated that although our proposals appeared radical, we believed actual operations in the Amateur Service would be affected little, if at all, by their adoption.

[1] Repeater stations, auxiliary link stations, control stations and "WR" call signs are also under consideration in Docket 21033. We will deal with these matters in a Memorandum Opinion and Order in Docket 21033 and a Second Report and Order in this proceeding, to be considered simultaneously, in the near future.

[2] Amateur Extra Class licensees would be permitted to obtain certain non-specific call signs with desirable formats.

[3] Since release of our Notice of Proposed Rulemaking in this proceeding, the population of the Amateur Service has increased from 293,000 to 326,000 licensed operators.

WHO COMMENTED ON OUR PROPOSALS?

4. We received approximately 400 comments and reply comments in response to our Notice of Proposed Rulemaking in this proceeding. Many of the comments received were submitted by amateur radio organizations, so the number of individual opinions reflected by the comments is considerably greater than the number of comments might by itself indicate. The remaining comments were submitted by individual amateur licensees and various governmental civil defense agencies.

WHAT DID THOSE COMMENTING ON OUR PROPOSALS SAY?

5. The large number of comments we received in response to our Notice of Proposed Rulemaking in Docket 21135 makes it impossible to discuss each comment individually. Each comment has been read and carefully evaluated by members of the Commission's staff, however. On the whole, the comments we received were highly critical of almost all of our proposals in this proceeding. Although there was limited support for a few of our proposals, the overwhelming majority of our respondents urged us to take no action whatsoever. In capsule form, the comments we received were along these lines—

a. We were urged not to eliminate the availability of club station licenses. Elimination of club station licenses would allegedly destroy a long-standing amateur radio tradition. See, Comments, JPL Amateur Radio Club. Many respondents, such as the Mobile Amateur Radio Club, stated that club stations are important contributors to the recent growth in interest in amateur radio, that club stations require a separate, distinct identity, and that club stations often play significant parts in emergency communications. The ARRL[4] and the M.I.T.-UHF Repeater Association claimed that at many schools and universities equipment and space for amateur stations are made available only to qualified student groups, not individuals, and that if club station licenses are eliminated, financial support of club stations at educational institutions is likely to be withdrawn. In sum, the comments attempted to argue that separate club station licenses are an indispensable part of today's Amateur Radio Service.

b. Most respondents commenting on the matter argued that separate licenses for repeater stations should be retained. To eliminate separate repeater station licenses would, it was alleged, encourage the construction and operation of "frivolous" repeater stations. Others stated that operation of a repeater station is a serious, and often expensive matter, and that effective spectrum management planning and coordination require that an amateur be placed on notice, by means of a separate repeater station license application, that "something more than the grant of a simple application is required." Comments, ARRL at 19. On the other hand, our proposed deletion of separate licenses for auxiliary link and control stations and creation of another form of amateur operation known as "auxiliary operation" met with general approval.[5]

c. The majority of those submitting comments opposed our proposal to eliminate secondary station licenses. Respondents such as the ARRL stated that "secondary station licenses are almost as old as amateur radio itself." Comments, ARRL at 23. Respondents such as the Pentagon Amateur Radio Club and Mr. Thomas J. Kirby cited the attachment of amateur licensees to long-held secondary station licenses as justification for the continued licensing of such stations. Others submitting comments argued that secondary stations are necessary to permit the maintenance of separate amateur stations by those with two or more homes in different parts of the country to enable the accurate pinpointing

[4] The ARRL filed its comments in this proceeding late but accompanied its comments with a Motion to Accept Late Filed Comments. We are granting the ARRL's Motion.

[5] Relatively few of those commenting in this proceeding addressed the licensing of repeater, auxiliary link and control stations, inasmuch as that was a primary subject of our proposals in Docket 21033. See n. 1, supra at 2.

of interference sources, and to permit the prompt receipt of correspondence from the FCC. The ARRL also argued that the number of secondary station license applications received by the FCC is so small that drastic action of the sort proposed by the FCC cannot be justified.

A few of those submitting comments agreed with us that separate licensing of secondary stations is unnecessary in today's Amateur Radio Service. See, e.g., Comments, Mr. James K. Maynard and Comments, Mr. Herman R. Schmitt. Others, such as the Intercity Amateur Radio Club of Richland, Ohio, noted that much of the previous need for separate secondary stations was eliminated by the FCC's Report and Order in Docket 20686, 61 FCC 2d 337 (1976), which greatly liberalized our rules governing the operation of amateur stations at portable and mobile locations. Finally, a number of respondents concurred with us in our belief that maintenance of separate systems for the issuance of secondary and primary station licenses cannot be justified in view of the relatively small numbers involved. See, Comments, Egyptian Radio Club.

d. Most comments did not address the question of whether military recreation stations should continue to be licensed, but of those that did, most opposed the proposal. The Secretary of Defense stated that the 425 licensed military recreation stations "make a significant contribution to the overall welfare, morale, and esprit of military personnel * * *." Comments, Secretary of Defense at 2. Such stations handle a substantial amount of third party traffic for military personnel and their families, and the continued success of the third party traffic program depends, in large measure, on a separately licensed, readily identifiable military recreation station. Id. The ARRL asked that the FCC recognize the unique problems of operating amateur equipment on a military base, as well as the contributions to the nation of those serving in the armed forces of the United States, and not eliminate military recreation stations. Comments, ARRL at 31-32.

e. Comments on our proposed elimination of special event stations were mixed, but for the most part urged the FCC to continue to license such stations. Although a few respondents, such as Mr. Carl J. Kennedy, agreed that processing of special event station license applications is probably an unjustifiable waste of the FCC's resources, most submitting comments said special event stations serve a valuable purpose and should be retained. Mr. William E. Moyes, for example, said special event stations provide significant exposure of the Amateur Service to the public, while the Mid-Continent Chapter of the Quarter Century Wireless Association noted that special event stations often generate much favorable publicity for amateur radio. Other respondents stated that a special event station call sign (e.g., NN3SI) is helpful in demonstrating amateur radio to the public, and that special event stations have contributed to the growth of amateur radio in recent years.[4]

f. Our proposal to discontinue the licensing of stations in the Radio Amateur Civil Emergency Service (RACES) was the subject of highly critical comment by many state and local civil defense agencies. The Sheriff of the County of Los Angeles stated that, if adopted, our proposal to eliminate RACES stations would erode RACES operations. It was alleged that requiring each amateur operator participating in RACES to use his own station call sign would cause a great deal of confusion, which could conceivably result in dangerous delays in the transmission of emergency communications. The Emergency Services and Disaster Agency of the State of Illinois also stated the existing practice of licensing RACES stations and assigning them distinctive call signs is satisfactory and should be continued. The city of Carson, Calif. claimed that our proposal, if adopted, would render \$1.5 million worth of radio equipment in Los Angeles county unusable, while the ARRL said discontinuance of the licensing of RACES stations would be a "disaster". Comments, ARRL at 40.

g. Our proposed simplification of the amateur radio call sign assignment system met a mixed reaction. Many respondents, such as Mr. R. P. Whitton, supported the proposal only with great reluctance, while others, such as the Dayton Amateur Radio Association, supported the proposal only as long as the rules were amended to insure that holders of "preferred" call signs be permitted to retain those call signs when moving from one call sign area to another call sign area. Other comments opposed our proposal categorically. The ARRL was particularly concerned with elimination of our "1×2" specific call sign program for Amateur Extra Class licensees. (A "1×2" call sign is a call sign consisting of one letter, one number, and two letters.) Permitting Amateur Extra Class licensees to choose their own call signs has, it was argued, been a powerful incentive for amateur operators to "upgrade" their operator licenses. Still other comments observed that station call signs are of extreme importance to amateur operators, and that the FCC should hesitate to take any action that would seriously affect the existing call sign assignment system.

What Rules Are We Adopting and Why?

6. With this Report and Order we are discontinuing the issuance of secondary and special event station licenses, and deleting from the rules all but one of those provisions which presently allow licensees to select specific call signs and/or call sign formats. In a separate Further Notice of Proposed Rule Making in this proceeding we are proposing to continue issuance of club, military recreation, and RACES station licenses, but with certain rule changes which should ease our workload.

7. The ARRL, among others, alleged in its comments that adoption of all our proposals would have only a very small effect on our operation. Comments, ARRL at 47. This argument is based on the erroneous assumption that elimination of all nonprimary station licenses and special call sign programs would result in a reduction in our workload in direct proportion to the number of non-primary station license applications we receive. Thus, the ARRL estimates that, assuming all our proposals are adopted, the processing workload would be reduced by only 5.43 percent.

8. Although it is true that the number of non-primary station and special call sign applications we receive each month is relatively few, their impact on the overall processing system is far out of proportion to their volume. Such applications take much longer to process than simple operator/primary station license applications. Their elimination will have a much greater effect on the efficiency of our processing system than the ARRL alleges. To resume processing secondary and special event station license applications, as well as special call sign requests, would require several additional positions.

9. We believe our action in adopting three of the proposals in this proceeding, however unpleasant it may be to some, is manifestly in the public interest. We recognize our responsibility to encourage the growth of the Amateur Service and believe our action in Docket 21135 will not significantly affect the development of a strong Amateur Service. We also believe, however, that we have an overriding obligation not only to amateur licensees, but also to the public-at-large, to use the public's tax dollars in the most efficient manner. Our action in this proceeding is intended to further that end. We emphasize that the amendments we are adopting will not adversely affect anyone. Operations in the Amateur Service will be conducted as they have in the past. No amateur equipment will become obsolete. In short, the administrative burden of these programs far outweighs whatever benefit they may have for the Amateur Service, and we are compelled to discontinue them.

10. In eliminating most non-primary stations and most special call sign programs, we make the following specific observations:

a. *Secondary stations.* It is true that secondary stations have been in existence for a long time. It is also true that some amateur radio licensees have held secondary station licenses for many years and have grown "attached" to their secondary station call signs. We continue to believe, however, that there is no need to continue to issue separate authorizations for secondary stations. Maintenance of a system to issue secondary station licenses is an unnecessary drain on our limited resources, particularly in view of the fact that a licensee can do no more nor less with a secondary station license than he can with his primary station license. Amateur operation will not be affected by the elimination of secondary station licenses. A licensee wishing to install a station at a location other than his primary station location may do so by simply operating his primary station portable or mobile. Interference from stations in portable operation may be detected the way it usually is today, through radio frequency direction-finding techniques. An amateur operating his station portable or mobile for an extended period should take steps to ensure that any FCC correspondence mailed to him arrives safely. There is, in sum, no compelling need to continue to license secondary stations in the Amateur Service. Existing secondary stations may continue to be operated until their license expiration dates. We will not renew or modify secondary station licenses, but we will permit holders of existing secondary station licenses to modify their primary station licenses to obtain the call signs of their secondary stations. In so doing, we are making a very limited exception to Section 97.51 of the Rules, which, after the effective date of the rules adopted in the Report and Order, prohibits the Commission from granting any request for a specific call sign.

b. *Special event stations.* In eliminating the future availability of special event stations, we agree with those submitting comments that amateur stations operated at certain public events, such as county fairs, have provided the Amateur Service with a great deal of favorable publicity over the years. We hope that amateur organizations will continue to engage in such activities in order to expose a larger segment of the public to amaeur radio and amateur radio operation. It is clear to us, however, that the operation of amateur stations at public events will not be affected in the least by the absence of a separate license authorizing such operation. Operation at a special event may be conducted just as easily under the authority of an ordinary amateur station license. The argument that distinctive special event station call signs contribute to the success of special event stations is invalid, because the average member of the public observing the operation of an amateur station could not possibly distinguish a special event station call sign from a typical amateur station call sign or understand the significance of a special event station call sign.

c. *Call sign simplification.* At its base, much of this proceeding is about call signs. As far as many of those submitting comments were concerned, the thrust of many of our proposals in this proceeding was directed not so much at the simplification of the station licensing system but at the simplification of the call sign assignment system. We believe, however, that the public interest is best served by elimination of most special call signs for amateur stations. We are therefore adopting as proposed our proposal to amend Section 97.51 of the Rules simply to state that all amateur call signs will be assigned by the Commission on a systematic basis. We believe the system by which we will be assigning call signs to be the fairest system possible. In virtually all instances, our system will involve the sequential alphabetical issuance of available call signs, beginning with the suffix AAA and proceeding letter by letter through AAB, AAC to ZZZ. For 1×2 and 2×2 call signs, of course, we will proceed from AA through ZZ. For 2×1 call signs we will assign the suffixes from A through Z. Section 97.51, as amended, does not specify the call sign assignment system we will be using. However, we will publicly announce the details of our system and any changes to that system, as they occur. We will require that an application for modification of station license be filed whenever the station location of a licensee is changed. However, under the new call sign rules we are adopting, a licensee moving from one call sign region to another will not necessarily receive a call sign of the same format when he modifies his license to reflect the move. In order to minimize the hardship on those licensees wishing to retain a call sign of a particular format (e.g., a "1×2" call sign) when moving to new call sign areas, we are changing our policy to permit a licensee to retain his original call sign, if he chooses, when the station location changes, even if the change of location is from one call sign region to another call sign region.

Further, to provide a licensee with additional incentive to "upgrade" the class of his operator license, we hope in the near future to be announcing a program to enable Advanced Class licensees, and perhaps General Class and Technician Class licensees, as well, to obtain upon request non-specific "1×3" station call signs. (A "1×3" call sign is a call sign consisting of one letter, one number and three letters.) As a service to amateurs, we will assign all new licenses outside the continental United States in the Pacific area call signs with the distinctive prefix "KH", followed by a digit denoting the island or group of islands where the station is located. All new stations outside the continental United States in the Atlantic area will be assigned call signs with the distinctive prefix "KP", followed by a digit denoting the island or group of islands where the station is located.

11. Accordingly, we order amendment of Parts 1 and 97 of our rules as set forth below effective March 24, 1978. Authority for this action is contained in Sections 4(i), 5(e), and 303 of the Communications Act of 1934, as amended. We also order acceptance of the ARRL's Petition for Acceptance of Late Filed Comments. We do not believe any useful purpose would be served by oral argument in this proceeding, and we are denying the ARRL's Request for Oral Argument. We order dismissal of any pending applications for secondary stations. We also order a continuation of this proceeding.

(Secs. 4, 5, 303, 48 Stat., as amended, 1066, 1068, 1082; 47 U.S.C. 154, 155, 303.)

Federal Communications Commission
William J. Tricarico,
Secretary.

The Federal Communications Commission amends Parts 1 and 97 of Chapter 1 of Title 47 of the Code of Federal Regulations, as follows:

1. Section 1.952(b) is amended to read, as follows:

§ 1.952 How file numbers are assigned.

* * * * *

(b) File number symbols and service or class of station designators:

Amateur and Disaster Services

Y—Amateur
D—Disaster
R—RACES

* * * * *

2. Section 97.3(c) is amended and in § 97.3(i) the definitions of secondary station and special event station are deleted, as follows:

§ 97.3 Definitions.

* * * * *

(c) *Amateur radio operator* means a person holding a valid license to operate an amateur radio station issued by the Federal Communications Commission.

* * * * *

(i) *Additional station.* Any amateur radio station licensed to an amateur radio operator normally for a specific land location other than the primary station, which may be one of the following:

Control station. Station licensed to conduct remote control of another

[4] NN3SI is operated at the Nation of Nations exhibit at the Smithsonian Institution.

amateur radio station.

Auxiliary link station. Station, other than a repeater station, at a specific land location licensed only for the purpose of automatically relaying radio signals from that location to another specific land location.

Repeater station. Station licensed to retransmit automatically the radio signals of other amateur radio stations.

* * * * *

3. Section 97.40 (b), (c), and (d) are amended to read, as follows:

§ 97.40 Station license required.

* * * * *

(b) Every amateur radio operator shall have one, but only one, primary amateur radio station license.

(c) An amateur radio operator may be issued one repeater station license, one control station license, and one auxiliary link station license for a land location where another station license has been issued to the applicant.

(d) Any transmitter to be operated as part of a control link shall be licensed as a control station or as an auxiliary link station and may be combined with a primary or club station license at the same location.

* * * * *

4. In § 97.41, paragraphs (d) and (f) are deleted, paragraph (g) is redesignated paragraph (e), paragraph (e) is redesignated paragraph (d), and paragraphs (a), (b) and (d) are amended, as follows:

§ 97.41 Application for station license.

(a) Each application for a club or military recreation station license in the Amateur Radio Service shall be made on FCC Form 610-B. Each application for any other amateur radio station license shall be made on FCC Form 6100.

(b) Each application shall state whether the proposed station is a primary or additional station. If the latter, the application shall also state whether the proposed station is a control, auxiliary link or repeater station.

* * * * *

(d) One application and all papers incorporated therein and made a part thereof shall be submitted for each amateur station license. If the application is only for a station license, it shall be filed directly with the Commission's Gettysburg, Pa. office. If the application also contains an application for any class of amateur operator license, it shall be filed in accordance with the provisions of § 97.11.

* * * * *

5. Section 97.51 is amended to read, as follows:

§ 97.51 Assignment of call signs.

(a) The Commission shall assign the call sign of an amateur radio station on a systematic basis.

(b) The Commission shall not grant any request for a specific call sign.

(c) From time to time the Commission will issue public announcements detailing the policies and procedures governing the systematic assignment of call signs and any changes in those policies and procedures.

§ 97.53 [Deleted]

6. Section 97.53 is deleted.

7. In § 97.95, the headnote and paragraphs (a)(1) and (a)(2) are amended, as follows:

§ 97.95 Operation away from the authorized fixed station location.

(a) * * *

(1) When there is no change in the authorized fixed station location, an amateur radio station, other than a military recreation station or auxiliary link station, may be operated under its station license anywhere in the United States, its territories or possessions, as a portable or mobile operation, subject to § 97.61.

(2) When the authorized fixed station location is changed, the licensee shall submit an application for modification of the station license in accordance with § 97.47.

Ham Help

I am interested in direction-finding, both for emergency situations, such as ELTs and motorists stranded in fog or snow, and for locating troublesome signals. I have a URD-2 receiver, but cannot find its matching antenna, AS-410/URD-2. This looks like four dipoles arranged around a coaxial center antenna, but the center housing has a motor-driven direction-sending device in it. Does anyone know where I could get one?

Joel S. Look W1KCR
Box 25
Claremont NH 03743

I am interested in forming a full gospel Bible study group and sharing with other Spirit-baptized Christians.

Dale Richman W4NHM
Apt. 8
122 South Boulevard Way
Sevierville TN 37862

I have had a Rogers Majestic transmitter and receiver strip with power supplies donated to me, and I am trying to get it operating as a repeater for the local club. The receiver has the serial number 180 and model number CWE-9267. At present, I have no manuals or schematics for this unit. Any help in obtaining these would be greatly appreciated.

Rick Gibson VE3ASH
PO Box 1423
Kincardine, Ontario
Canada N0G 2G0

Can anyone loan (for copy and return) an instruction book or schematic for an AUL Instruments model TVOM3 solid state multimeter? The manufacturer admits making it, but doesn't know how.

John Cavett W2AUZ
8570 Herbert Ave.
Pennsauken NJ 08109

A little "Ham Help" is needed. I'm attempting to tap into a TS-520 i-f section with the Heath SB-610 signal analyzer. Obviously, analysis of the transmit signal is no problem, but connecting the proper i-f tap into the tuned vertical scope input is a problem I haven't been able to solve. Various values of coupling capacitors have been tried, tapping into all areas of the 520's i-f section to produce a usable signal on the scope during receive. Darned if I know what to try next. Any help would be most appreciated.

Ron Starr KØOXB/5
12309 Split Rail Parkway
Austin TX 78750

SWL with 15 years experience would like to be QSL manager for a ham in South America or the Pacific islands, particularly one of limited financial resources. Will pay costs of preparing QSL cards.

Donald E. Erickson
6059 Essex Street
Riverside CA 92504

Help! I am in desperate need of an LM1595 or MC1595 14-pin DIP IC. It is part of a speech processor for SSB on page 394 of the *Radio Amateur's Handbook.* If anybody has them or knows where to get them, I need two and will gladly pay any reasonable price for them.

Regis Briney, Jr. WB3KHR
1142 Goettman St.
Pittsburgh PA 15212

I need manuals or any info for the following: Shallcross model #638-2 Kelvin-Wheatstone Bridge; Ballantine model #305-A peak voltmeter; Philco "Mobiliner" model #5005 (sweep generator?). Any help would be greatly appreciated!

Clyde N. Smith
11 Brown St.
Reynoldsville PA 15851

I need a schematic for a Boehme frequency shift converter, type 5-C, serial number 1739-B, manufactured by Boehme, Inc., New York, N.Y., in the late '50s. I will gladly pay for copies or manuals if available. An address where I can send for information would also help.

Stan Glumac WB3CKV
Box 519
Grindstone PA 15442

I am starting a Protestant missionary traffic net. I call the net the M.A.R.T.I.N. B.I.R.D. net (Missionary Amateur Radio Traffic International Net—Best In Radio Domain). States will be numbered by numerical sequence by date of admission to the union. I would prefer NCS stations not in the larger cities, or stations who are operated by hams who can devote time to the net as it expands. Anyone interested should please write to me giving communication capabilities (equipment, time, etc.).

Harold Donaldson WB6SKV
8850 Phoenix Ave.
Fair Oaks CA 95628

Oscar Orbits

The listed data tells you the time and place OSCAR crosses the equator in an ascending orbit for the first time each day. To calculate successive orbits, make a list of the first orbit number and the next twelve orbits for that day. List the time of the first orbit. Each successive orbit is 115 minutes later (two hours less five minutes). The chart gives the longitude of the first crossing. Add 29° for each succeeding orbit. When OSCAR is ascending on the other side of the world, it will descend over you. To find the equatorial descending longitude, subtract 166 degrees from the ascending longitude. To find the time it passes the North Pole, add 29 minutes to the time it passes the equator. You should be able to hear OSCAR when it is within 45 degrees of you. The easiest way to do this is to take a globe and draw a circle with a radius of 2480 miles (4000 kilometers) from the home QTH. If it passes right overhead, you should be able to hear it for about 24 minutes total. OSCAR will pass an imaginary line drawn from San Francisco to Norfolk about 12 minutes after passing the equator. Add about a minute for each 200 miles that you live north of this line. If OSCAR passes 15 degrees from you, add another minute; at 30 degrees, three minutes; at 45 degrees, ten minutes. Mode A: 145.85-.95 MHz uplink, 29.4-29.5 MHz downlink, beacon at 29.502 MHz. Mode B: 432.125-.175 MHz uplink, 145.975-.925 MHz downlink, beacon at 145.972 MHz.

Oscar 7 Orbital Information

Orbit	Date (Apr)	Time (GMT)	Longitude of Eq. Crossing °W
15439 Bbn	1	0136:41	80.9
15451 Bbn	2	0036:01	65.8
15464 Abn	3	0130:19	79.4
15476 Bbn	4	0029:39	64.2
15489 Bbn	5	0123:56	77.8
15501 Abn	6	0023:17	62.7
15514 Bbn	7	0117:34	76.2
15526 Bbn	8	0016:55	61.1
15539 Abn	9	0111:12	74.7
15551 Bbn	10	0010:32	59.5
15564 Bbn	11	0104:50	73.1
15576 Abn	12	0004:10	58.0
15589 Bbn	13	0058:27	71.5
15602 Bbn	14	0152:45	85.1
15614 Abn	15	0052:05	70.0
15627 Bbn	16	0146:22	83.6
15639 Bbn	17	0045:43	68.4
15652 Abn	18	0140:00	82.0
15664 Bbn	19	0039:21	66.8
15677 Bbn	20	0133:38	80.4
15689 Abn	21	0032:59	65.3
15702 Bbn	22	0127:16	78.9
15714 Bbn	23	0026:36	63.7
15727 Abn	24	0120:54	77.3
15739 Bbn	25	0020:14	62.2
15752 Bbn	26	0114:31	76.7
15764 Abn	27	0013:52	60.6
15777 Bbn	28	0108:09	74.2
15789 Bbn	29	0007:30	59.0
15802 Abn	30	0101:47	72.6

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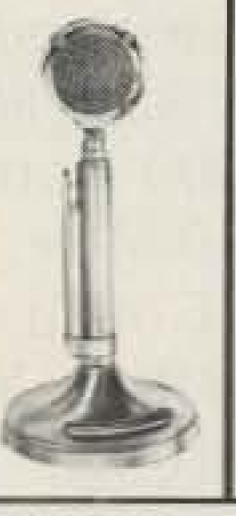

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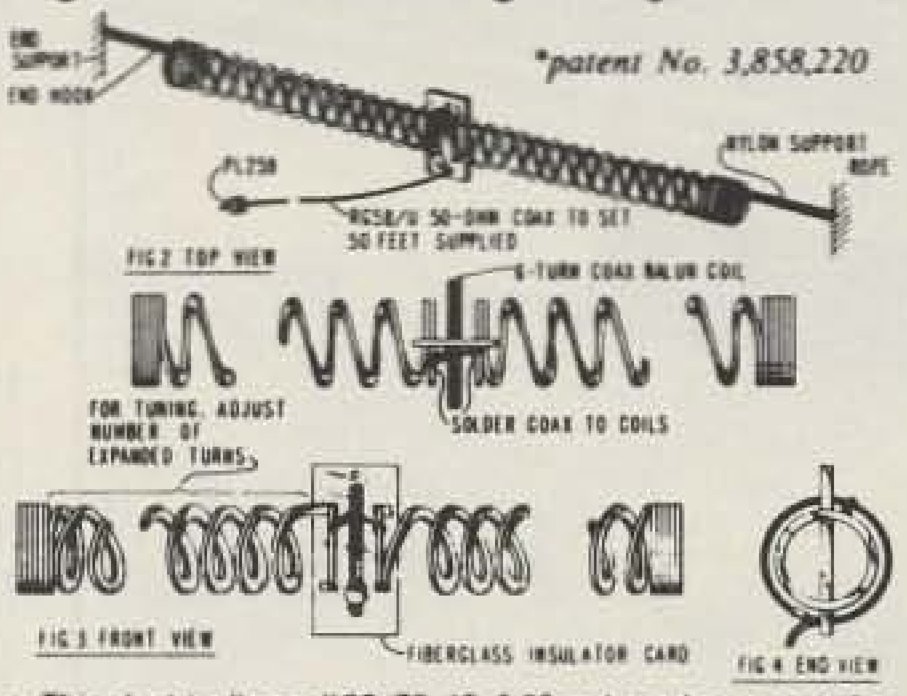

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MMB-4	620B, 221, 301	23
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YC500S	500 MHZ 1 PPM	399
YC500E	500 MHZ 0.02 PPM	537
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YD844	Hi-Z Base Mike	29
YD844L	Lo-Z Base Mike	29
YD846	Hi-Z Mike 101EX/401B	16
YM86	Lo-Z Hand Mike	16
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Reliability is built in for years of continued use. Each circuit board is "baked-in" for over 100 hours prior to installation in the transceiver assembly. After system testing, each transceiver is again "baked" prior to final system testing — your guarantee of on-the-air performance.

Discover the ease and accuracy of electronic tuning. Calibrate all bands with WWV at the turn of a switch. Lowest frequency drift, with no VFO to calibrate. Only 2.8" high x 9.5" wide x 12.3" deep. Ideal for mobile use or, with accessories, provides complete fixed station operation. Net Price $995.00.

Accessories: AC Power supply $135.00; Speaker in cabinet $29.95; Station operating console with phone patch, 24 hr. digital clock, speaker, 10 min. timer $295.00; Desk microphone $38.00; Mobile mount $12.00; Mobile mic $15.00; 400 Hz narrow band CW filter $50.00.

CIR TRANSCEIVERS

2 Meters VHF Disguise
ASPS-748 (most cars); ASPS-798 (Ford, Mercury) ASPR-788 (Chrysler, Dodge, Plymouth) $45.00 each

Featuring a 5/8 wavelength taper ground stainless steel whip, this antenna provides exceptional performance with the exact appearance of a conventional broadcast receiving antenna. The DURA-CON™ plated whip reduces power losses to deliver more signal. When used with ASPR619 coupler, this antenna will allow simultaneous use of both two-way and broadcast radios. Stub tuning provides 2.5 MHz bandwidth for multiple channel use. Swivel base may be mounted on surface with up to 35° slant. Specify frequency when ordering.

AST/SERVO SYSTEMS, INC.

Gain:	2.5 dB	VSWR:	Less than 1.5:1
Maximum Power:	100 watts	Bandwidth:	2.5 MHz
Frequency Range:	144-174 MHz (specify frequency)	Nominal Impedance:	50 ohms

HM-180

HM-187

HM-225

HM-179 Low Profile Mount – $25.00
HM-180 Trunk Mount – $27.00
HM-187 Magnet Mount – $32.00
3 dB Gain* HIGH PERFORMANCE VEHICULAR ANTENNA SERIES

All new low profile antennas feature a 5/8 wavelength high conductive whip. Spring and whip may be removed leaving only 1-3/16" high base for minimal car wash clearance.

Coils are low loss, shock-resistant, directly fed ungrounded configuration and encased in plastic base. New high conductive whips are made of 17-7 PH stainless steel . . . coated with copper and nickel for high conductivity and greater heat dissipation. Mounts are Teflon-insulated, aluminum and plated steel.

ELECTRICAL SPECIFICATIONS

Antenna power rating:	100 watts
Frequency range:	144-148 MHz
VSWR:	1.5:1 or less
Nominal input impedance:	50 ohms
Transformer:	16 AWG copper wire, low loss coil, waterproof cover
*Gain:	3 dB over 1/4 λ whip

HM-223 Trunk Mount – $26.00

3 dB Gain 5/8 λ Mobile Antenna on easy to install "Quick-Grip" trunk mount. Whip is easily removeable for storage or car washes. 17' RG-58/U and connector.

ELECTRICAL SPECIFICATIONS		MECHANICAL SPECIFICATIONS	
Gain:	3 dB	Radiator:	.125 dia. 17-7 PH stainless steel plated with copper and nickel
Bandwidth:	5 MHz	Length:	Whip 37"
Power rating:	100 watts		
Impedance:	50 ohms		

HM-224 Trunk Mount – $36.00

The most powerful mobile antenna available for 1-1/4 meter mobile activity. 4 dB gain is achieved by stacking a 5/8 λ and 1/4 λ radiator. "Quick-Grip" trunk mount means easy no hole mounting. Whip is quickly removed for car washes or storage. 17' RG-58/U and connector.

ELECTRICAL SPECIFICATIONS		MECHANICAL SPECIFICATONS	
Gain:	4 dB	Radiator:	17-7 PH stainless steel plated with copper and nickel
Bandwidth:	5 MHz	Length:	Whip 40"
Power rating:	100 watts		
Impedance:	50 ohms		

HM-225 Unity Gain (Marine Mobile Service) – $42.00

Unity Gain 3' fiberglass antenna for marine use. No ground plane required. Can be mounted at masthead on sailboats or on any vertical surface on power boats. Comes with 2' RG-58C/U cable.

ELECTRICAL SPECIFICATIONS		MECHANICAL SPECIFICATIONS	
Gain:	Unity 1/2 λ dipole reference		
Power:	25 watts	Length:	Approx. 3'
Frequency range:	220-224 MHz	Radiator material:	Copper encapsulated in fiber glass
Impedance:	50 ohms	Mount:	Anodized aluminum bracket

Why Waste Watts?
SWR-1A $29.95

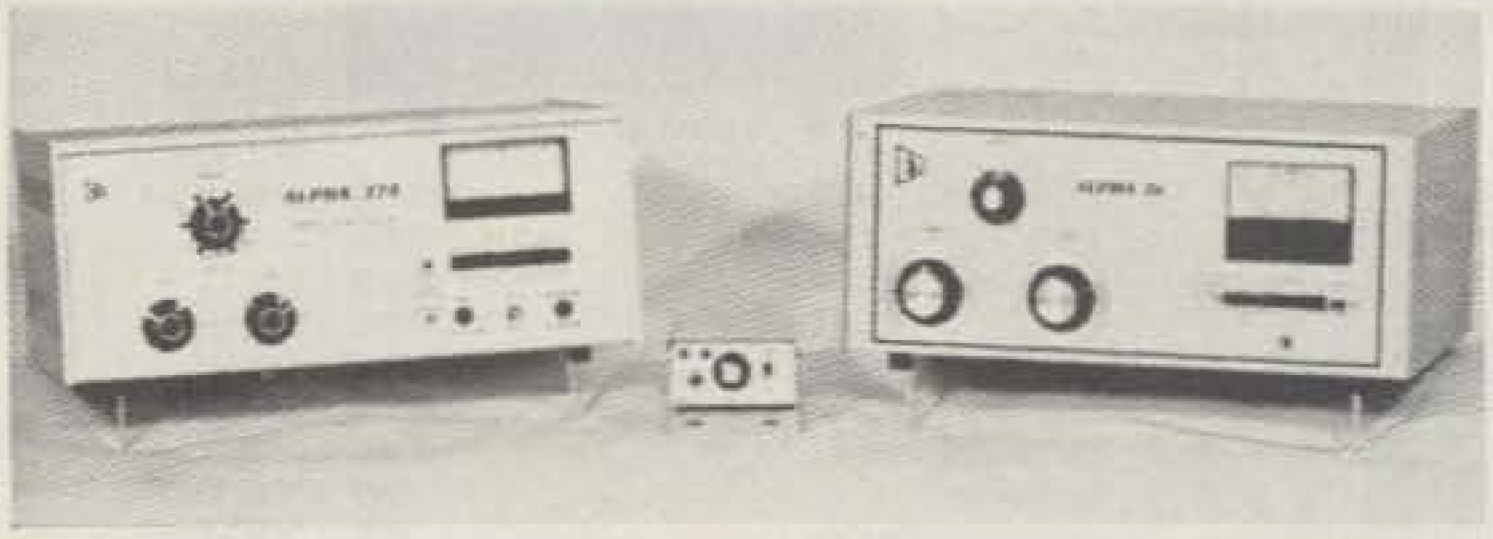
SWAN ELECTRONICS

SWR-1 guards against power loss

If you're not pumping out all the power you're paying for, our little SWR-1 combination power meter and SWR bridge will tell you so. You read forward and reflected power simultaneously, up to 1000 watts RF and 1:1 to infinity VSWR at 3.5 to 150 MHz.

Got it all tuned up? Keep it that way with SWR-1. You can leave it right in your antenna circuit.

GET ON TOP WITH ALPHA



A GREAT OPERATING YEAR IS STARTING RIGHT NOW. SUNSPOTS ARE UP – CONDITIONS SHOULD BE THE BEST IN YEARS. THOUSANDS OF ENTHUSIASTIC NEW AMATEURS ARE ON THE BANDS. HAMMING WILL BE TERRIFIC – BUT COMPETITION WILL BE ROUGH!

WHEN QRM RAGES AND THE PILE-UPS DEEPEN, WOULDN'T YOU LIKE TO HAVE. . .

- ALL THE ROCK-CRUSHING POWER YOUR LICENSE ALLOWS – on *all* modes – with no need to 'baby' your linear, no duty cycle or time limit at all?
- INSTANT BANDCHANGE 'NO-TUNE-UP' all the way from 10 through 80 meters, with the exclusive **ALPHA 374?**
- COVERAGE ALL THE WAY DOWN TO 160 METERS with the smooth-tuning, extra-rugged **ALPHA 76** powerhouse?
- CRISP, PENETRATING "TALK POWER" – as much as 10 dB extra to 'punch through' when the going gets really tough, with the **ALPHA/VOMAX** split band speech processor? It's as effective as the best rf processor, lower in distortion, and very easy to use with *any* rig!
- THE PROTECTION OF A FACTORY WARRANTY THAT RUNS A FULL 18 MONTHS – *six times as long* as competitive units? **(ETO tries to build every ALPHA to last forever . . . and we're making progress: not one single case of ALPHA 76, 77D, or 374 power transformer failure has ever been reported!)**
- THE PURE PLEASURE OF OWNING **ALPHA**?

Alpha 76 - $1195.; Alpha 77D - $3195.; Alpha 374 - $1595.

EHRHORN TECHNOLOGICAL OPERATIONS, INC.

HMR172 5 Element Yagi – $29.00

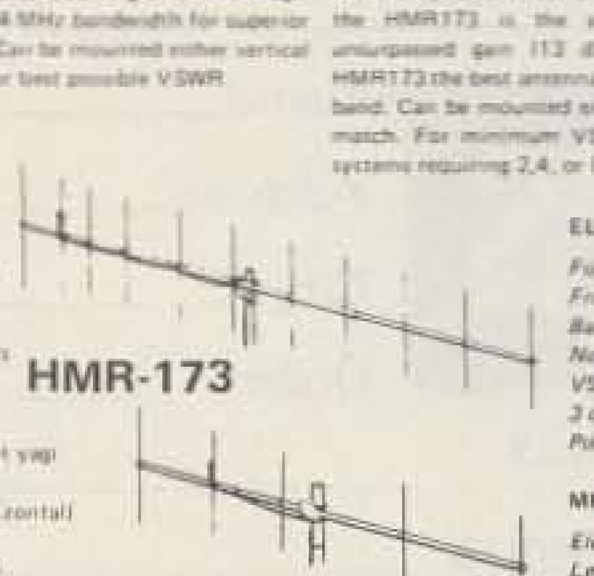
Whether you use a low-powered QRP "lunch-box" rig or the full legal limit, the HMR172 offers 10 dB gain and 4 MHz bandwidth for superior performance under any band conditions. Can be mounted either vertical or horizontal. Adjustable gamma match for best possible VSWR.

ELECTRICAL SPECIFICATIONS

Forward gain:	10 dB
Front-to-back ratio:	15 dB
Bandwidth:	4 MHz
Nominal input impedance:	50 ohms
VSWR:	1.5:1
3 dB beamwidth:	58°
Power capability:	500 watts

MECHANICAL SPECIFICATIONS

Element configuration:	5 element yagi
Length:	6'
Turning radius:	3.5' (horizontal)
Weight:	3 lbs.
Rated wind velocity:	100 mph
Windload area:	.53 sq. ft.



HMR-173

HMR-172

HMR173 11 Element Yagi – $49.00

Whether your interest lies in Moon Bounce, Tropo, or meteor scatter, the HMR173 is the solution to long-haul communications. The unsurpassed gain (13 dB) and 36° (3 dB) beamwidth makes the HMR173 the best antenna for the VHF world. Covers the entire 2 meter band. Can be mounted either vertical or horizontal. Adjustable gamma match. For minimum VSWR. – Information available on "high-gain" systems requiring 2,4, or 8 HMR173 yagi antennas.

ELECTRICAL SPECIFICATIONS

Forward gain:	13 dB
Front-to-back ratio:	16 dB
Bandwidth:	4 MHz
Nominal input impedance:	50 ohms
VSWR:	1.5:1
3 dB beamwidth:	36°
Power capability:	800 watts

MECHANICAL SPECIFICATIONS

Element configuration:	11 element yagi
Length:	17'
Turning radius:	9.3' (horizontal)
Weight:	6.5 lbs.
Rated wind velocity:	100 mph
Windload area:	1.25 sq. ft.

HM-20 Marine Mobile Service – $35.00

Unity gain 5' fiber glass antenna for marine use. No ground plane required. Can be mounted at masthead on sailboats or on any vertical surface on power boats. Comes with 2' of RG-58C/U cable.

ELECTRICAL SPECIFICATIONS

Gain:	Unity (reference 1/2 λ dipole)
Power:	25 watts
Frequency range:	146-148 MHz
Nominal impedance:	50 ohms

MECHANICAL SPECIFICATIONS

Length:	Approximately 5'
Radiator material:	Copper encapsulated in fiberglass
Mount:	Anodized aluminum bracket

ASPR619 Coupler – $16.00

Coupler for simultaneous 2 meter and AM/FM broadcast radio usage.

TEE/AX

Coax Toggle Switch
$39.95
Coax Relay Version
$55.95

Model SW-5000

- All Brass Construction
- Teflon Insulated
- Captivated Internal Contacts
- Available in UHF, BNC, N, F, all series

- 52 ohms
- SPDT, DPDT
- Power 1 KW

DELUXE 742 TRI-BAND MOBILE ANTENNA
- Automatically adjusts to proper resonance for 20, 40 and 75 meters.
- Power rated at 500 Watts P.E.P.
- Includes base section, automaticoil and whip top section. 742 Antenna

Price: $109.95

EXCLUSIVE DELUXE 5-BAND MOBILE 45 ANTENNA
- All band manual switching antenna for 10, 15, 20, 40 and 75 meters.
- Power rated at 1000 Watts P.E.P.
- Includes base section with mobilecoil and six foot whip top section. 45 Antenna

Price: $119.95

SWAN METERS HELP YOU GET IT ALL TOGETHER

These wattmeters tell you what's going on.

With one of these in-line wattmeters you'll know if you're getting it all together all the time. Need high accuracy? High power handling? Peak power readings? For whatever purpose we've got the wattmeter for you. Use your Swan credit card. Applications at your dealer or write to us.

WM2000 In-Line Wattmeter With Muscle. Scales to 2000 watts. New flat response directional coupler for maximum accuracy. $87.95

WM3000 Peak-reading Wattmeter. Reads RMS power, then with the flick of a switch, true peak power of your single-sideband signal. That's what counts on SSB. $87.95

WM1500 High-Accuracy In-Line Wattmeter. 10% full scale accuracy on 5, 50, 500 and 1500 watt scales, 2 to 30 MHz. Forward and reflected power. Use it for trouble-shooting, too. $74.95

SWAN ELECTRONICS®
A subsidiary of Cubic Corporation

JMR MOBIL-EAR™

Two-way-radio headset with superior fidelity Electret-Capacitor boom microphone and palm-held talk switch.

$69.95

MODEL 1015-A

FOR BROADCAST-QUALITY TRANSMISSION AND RECEPTION FOR BOTH MOBILE UNITS AND BASE STATIONS.

- Boom-mounted electret-capacitor microphone delivers studio-quality, undistorted voice reproduction. Variable gain control lets you adjust for optimum modulation.
- Cushioned earcup lets you monitor in privacy -- no speaker blare to disturb others. Blocks out environmental noises, too. Made of unbreakable ABS plastic.
- Headband self-adjusts for comfortable wear over long hours. Spring-flex hinge lets you slip headset on and off with just one hand. Reversible for right or left ear.
- Headset can be hung on standard microphone clip.
- Compact palm-held talk switch lets you keep *both* hands on the wheel for safer driving. Made of unbreakable ABS plastic.
- Built-in FET transistor amplifier adapts microphone output to any transceiver impedance.
- Compatible with most two-way radios including 40-channel CB units.
- Built-in Velcro pad for easy mounting of the talk switch.
- Made in U.S.A.

SPECIFICATIONS

Earphone impedance and type:	8 ohms, dynamic
Microphone type:	Electret capacitor
Microphone frequency response:	200–6000 Hz
Amplifier type:	FET transistor, variable gain
Amplifier battery power:	7-volt Mallory TR-175
Switching:	Relay or electronic

IDEAL FOR EVERY TWO-WAY RADIO COMMUNICATIONS NEED . . .

CB operators • Amateur radio operators • Police and fire vehicles • Ambulances and emergency vehicles • Taxis and truckers • Marine pleasure and work boats • Construction and demolition crews • Industrial communications • Security patrols • Airport tower and ground crews • Remote broadcast and TV-camera crews • Foresters and fire-watch units •

SHURE

JNIDIRECTIONAL MICROPHONE MODEL 522

$56.85

'his is a dynamic microphone with a nidirectional pickup pattern that supresses unwanted background noise — the ype of noise generated by other dispatchers orking nearby, ventilating equipment, or ffice machines in the same area. It also uppresses feedback in public address paging oplications. Long-life finger-tip control bar ocking and non-locking action) actuates microphone circuit and normally open external relay circuit. Adjustable height from 248 mm (9¾ inches) to 318 mm (12½ inches) overall. Sturdy, high impact ARMO-DUR® base and case. High or low-impedance selector switch. 2.1 m (7 ft.) four-conductor (two-conductor shielded) cable.

SPECIFICATIONS

FREQUENCY RESPONSE: 60 to 11,000 Hz.

IMPEDANCE AND OUTPUT LEVEL: Dual. 150 ohms +–-57 dB*; .10 millivolts/microbar. High ++–-57 dB**; 1.42 millivolts/microbar.

*0 dB = 1 milliwatt per 10 microbars
**0 dB = 1 volt per microbar

+For connection to microphone inputs rated at 19 to 300 ohms
++For connections to high-impedance microphone inputs

TUFTS RADIO CATALOG TUFTS RADIO

SWAN 1200X LINEAR AMPLIFIER. TALK LOUD FOR A SONG.

Everybody likes power and nowhere can you get more of it for $449.95 than with our Cygmet 1200 X linear amplifier.

With 100 watts of driving power you're on the air with a solid 1200 watts PEP input and most people won't be able to tell you from somebody operating full bore.

Linearity on the 1200X is excellent, efficiency is outstanding, 117/230 A.C. power supply is built in, and features like provision for external ALC give you the flexibility you need to get the most out of your rig.

Mark II for power and glory, too. But if you've got your heart set on block-buster power we've we also got the right linear amp for you.

It's the Mark II, the proven unit everybody thinks of when you talk about workhorse linear amplifiers.

The Mark II dominates the bands with all the power that's allowed—2000 watts PEP—and a clean, linear signal that's music to your ears.

The Mark II features a separate, matching power supply, big, quiet blowers for both the RF deck and the power supply, all bands from 10 to 80 meters and all you need to enjoy it is 100 watts driving power.

Get a Swan 1200X or Mark II linear amplifier today and stop letting people shout you down. Use your Swan credit card. Applications at your dealer or write to us.

Cygnet 1200X 1200-watt linear amplifier complete with built in 110/220V power supply $349.95

Mark II 2000-watt linear amplifier complete with separate 117/230 VAC power supply and two 3-500Z tubes $899.95

NEW TRANSCEIVERS

750 CW — $679.95

If you're ready for 700 loud-talking watts, you're ready for the new 750CW.

- 700 watts P.E.P. input on SSB
- 400 watts DC input on CW
- CW audio filter selectable 80 or 100 Hz.
- CW sidetone monitor with adjustable pitch and volume control
- 80 through 10 meters, USB, LSB, CW
- Selectable 25 or 100 KHz crystal calibrator
- Standard 5.5 Mhz, 2.7 Hz bandwidth crystal filter or optional accessory 16 pole filter available with 140 Db ultimate rejection.

Accessories
- VX-2 Vox
- MK-II Linear amplifier
- DD-76 Digital Dial

The 750CW is a CW man's dream come true. What's more there's a long list of accessories you can add later for increased performance.

350A — $599.95

- 300 watts P.E.P. input SSB
- 200 watts DC input on CW
- 80 through 10 meters, USB, LSB, CW
- 5.5 Mhz, 2.7 KHz bandwidth crystal filter
- Oscillators are solid state and IC regulated for stability
- CW sidetone monitor with adjustable pitch and volume
- CW audio filter 80 and 100 Hz selectable
- Built in 117 VAC power supply and speaker. (220 VAC power supply available on special request)

Accessories
- VX-2 Vox
- 14A DC Converter
- 1200X linear amplifier
- Crystal Calibrator (350A only)

350D — $699.95

- Same basic features as 350A except added feature of:
- 6 Digit LED frequency display with readout to 100 Hz

Both the 350A and the 350D are compatible with the same line of Swan accessories that has built a reputation for reliability and performance that's second to none. Including linear amplifiers to boost your power to the legal limit.

So they're perfect for novices or anyone else because you can build capability as you need it.

OUR NEW M-34 EXPANDABLE MOBILE ANTENNAS

The M-34 mobile antenna gives you 10, 15, and 20 meters and great performance in a tough, rugged design for only $52.75.

Then whenever you want it you can buy the optional 160, 80 or 40 meter coil and top section for $20.00 to $25.00 depending on the band and make a full-capability four-bander out of it. One that never needs coil changes or adjustments after initial tuning.

What's more, at no extra cost you get features like 500 watts PEP, low standing wave ratio at resonance, independent resonance adjustments on each of the four bands, exceptional bandwidth and a neat, clean, low-wind-resistance profile that also goes great with mobile homes, motor homes and apartments.

That's the kind of innovative, problem-solving thinking that goes into Swan mobile antennas. Not just the M-34 but these, too:

742 Automatic. Swan automates mobile antennas with the 742 tri-band antenna. Work 20, 40 or 75 meters with your 742 without need for coil change or other adjustments after initial tuning. A high Q mobile antenna designed for maximum efficiency capable of 500 watts PEP $109.95

Mobile 45. This switch-adjustable 5-band antenna features a Swan HI-Q coil and positive-stop, 9-position switch with GOLD-PLATED contacts. Select 10, 15, 20, 40 plus five positions for 75 meters and go to work knowing this rugged antenna is doing its job $119.95

SWAN. ELECTRONICS
A subsidiary of Cubic Corporation

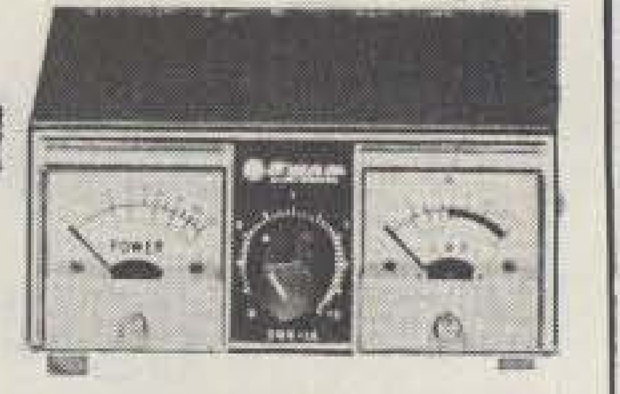
AMERICAN RADIO RELAY LEAGUE PUBLICATIONS

- THE RADIO AMATEUR'S HANDBOOK 1978 Edition ($8.50 Retail)
- THE RADIO AMATEUR'S HANDBOOK 1978 Edition Cloth Bound ($13.50 Retail)
- ARRL ANTENNA BOOK ($5.00 Retail)
- UNDERSTANDING AMATEUR RADIO ($5.00 Retail)
- THE RADIO AMATEUR'S V.H.F. MANUAL ($4.00 Retail)
- FM AND REPEATERS ($4.00 Retail)
- ARRL ELECTRONICS DATA BOOK ($4.00 Retail)
- SINGLE SIDEBAND ($4.00 Retail)
- ARRL HAM RADIO OPERATING GUIDE ($4.00 Retail)
- SPECIALIZED COMMUNICATIONS TECHNIQUES FOR THE RADIO AMATEUR ($4.00 Retail)
- A COURSE IN RADIO FUNDAMENTALS ($4.00 Retail)
- RADIO AMATEUR'S LICENSE MANUAL ($3.00 Retail)
- GETTING TO KNOW OSCAR ($3.00 Retail)
- HINTS AND KINKS ($2.00 Retail)
- LEARNING TO WORK WITH INTEGRATED CIRCUITS ($2.00 Retail)
- SOLID STATE DESIGN ($7.00 Retail)
- TUNE IN THE WORLD WITH HAM RADIO ($7.00 Retail)
  Packages to be sold as a unit consisting of: Workbook, Tape Cassette, Call Area Map
- ARRL CODE KIT ($8.00 Retail)
- ARRL MAP ($3.00 Retail)
- QST BINDER ($5.00 Retail) for 6½ x 9½ QST
- LOG BOOK ($1.50 Retail)
- MINILOG ($.75 Retail)
- L/C/F CALCULATOR, Type A ($3.00 Retail)
- Pads of MESSAGE BLANKS ($.50 Retail)

THE SWAN METER SHOWCASE.

Sniffs out radiated power wherever it is. This little unit is so compact it could measure relative radiated power in your pocket. Telescoping antenna and a frequency range of 1.5 MHz all the way to 200 MHz. **FS-1 Field Strength Meter** $13.95

Easy-on-the-pocket pocket SWR. Mighty mite SWR meter with high accuracy, SWR-3 gives you 1:1 to 3:1 SWR at 50 ohms on frequencies from 1.7 to 55 MHz. Precision PC board directional coupler makes it a solid value at a rock-bottom price. **SWR-3 Pocket SWR Meter** $14.95



SWR bridge bridges the price barrier. This little jewel gives you relative forward power and SWR on two 100 microampere meters at a remarkably low price. Indicates 1:1 to infinity VSWR of up to 1000-watt signals on frequencies from 3.5 to 150 MHz. With low insertion loss, it's great for mobile operations, too. **SWR-1A Power Meter and SWR Bridge** $29.95

At last. A precision wattmeter for the 6 and 2-meter man. We design the WM-6200 for the upper-band man who needs to know with ± 7% accuracy. Reads power of 50 to 150 MHz signals on two scales to 200 watts plus SWR on expanded range scale from 1:1 to 3:1 with ± 3% accuracy. **WM-6200 In-Line Wattmeter** $63.95

Put your power up in lights. The new WMD-6200 does everything our WM-6200 does and ends guesswork, interpolation errors and eyestrain besides with a 4-digit readout. 50 to 150 MHz, power to 200 watts with an accuracy of ± 10%. SWR from 1:1 to 19.99:1 with ± 3% accuracy. **WMD-6200 Digital SWR Power Meter** .... $262.00 (requires AC source)

The new WM-200A does it all. As an in-line wattmeter it gives you power to 200 watts on two scales plus SWR from 1:1 to 3:1 for signals from 50 to 150 MHz. And as a peak reader it reads true peak envelope power of your voice modulated signal. Flat response forward or reflected power on scales to 200 watts in switch-selected RMS or peak. **WM-200A Peak Reading Wattmeter** $87.95

Nifty little meter just for VHF mobile. This brand new, easy-to-install swivel-mount unit is the perfect illuminated wattmeter for 2-meter mobile. Compact and capable, it gives you two scales, 0-20 watts and 0-200 watts at 10% accuracy. SWR from 1:1 to 3:1. Frequencies from 50 to 150 MHz. **WMM-200 SWR Power Meter** $45.95

DenTron MLA-2500 $799.50

DenTron Radio has packed all the features a linear amplifier should have into their new MLA-2500. Any Ham who works it can tell you the MLA-2500 really was built to make amateur radio more fun.

- ALC circuit to prevent overloading
- 160 thru 10 meters
- 1000 watts DC input on CW, RTTY or SSTV Continuous Duty
- Variable forced air cooling system
- Self-contained continuous duty power supply
- Two EIMAC 8875 external anode ceramic/metal triodes operating in grounded grid
- Covers MARS frequencies without modifications
- 50 ohm input and output impedance
- Built-in RF wattmeter
- 117V or 234V AC 50-60 hz
- Third order distortion down at least 30 db
- Frequency range: 1.8MHz (1.8-2.5) 3.5MHz (3.4-4.6) 7MHz (6.0-9.0) 14MHz (11.0-16.0) 21MHz (16.0-22.0) 28MHz (28.0-30.0)
- 40 watts drive for 1 KW DC input
- Rack mounting kit available (19" rack)
- Size: 5½" H x 14" W x 14" D Wt. 47 lbs.

BOMAR Crystal Company

Novice Crystals (Specify Band Only)

TWO METERS

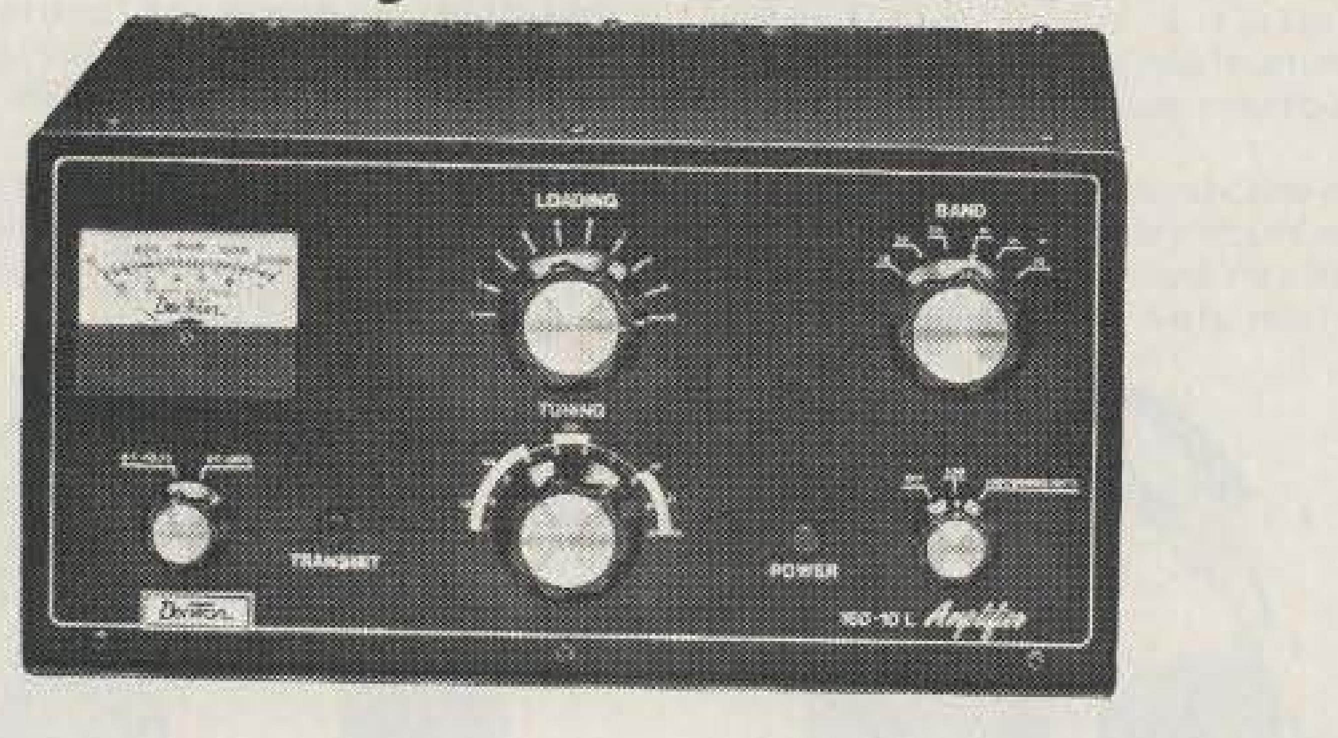
CRYSTALS IN STOCK

Motorola HT 220 Crystals In Stock!

Standard • Icom • Heathkit • Ken • Clegg • Regency • Wilson • VHF Eng • Drake • And Others! $4.50 @ Lifetime Guarantee

Make/Model	Xmit Freq.	Rec. Freq.

SUPER AMP
from DenTron



If the amplifier you're thinking of buying doesn't deliver at least 1000 to 1200 watts output, to the antenna, you're buying the wrong amplifier.

Our New Super Amp is sweeping the country because hams have realized that the DenTron Amplifier will deliver to the antenna, (output power), what other manufacturers rate as input power.

The Super Amp runs a full 2000 watts P.E.P. input on SSB, and 1000 watts DC on CW, RTTY or SSTV 160-10 meters, the maximum legal power.

The Super Amp is compact, low profile, has a solid one-piece cabinet assuring maximum TVI sheilding.

The heart of our amplifier, the power supply, is a continuous duty, self-contained supply built for contest performance.

We mounted the 4-572B's, industrial workhorse tubes, in a cooling chamber featuring the on-demand variable cooling system.

The hams at DenTron pride themselves on quality work, and we fight to keep prices down. That's why the dynamic DenTron Linear Amplifier beats them all

$574.50

The 80-10 Skymatcher

Here's an antenna tuner for 80 through 10 meters, handles 500 w P.E.P. and matches your 52 ohm transceiver to a random wire antenna.

- Continuous tuning 3.2 - 30 mc
- "L" network
- Ceramic 12 position rotary switch
- SO—239 receptional to transmitter
- Random wire tuner
- 3000 volt capacitor spacing
- Tapped inductor
- Ceramic antenna feed thru
- 7" W. 5" H. 8" D., Weight: 5 lbs.

$59.50

Read forward and reflected watts at the same time

Tired of constant switching and guesswork?

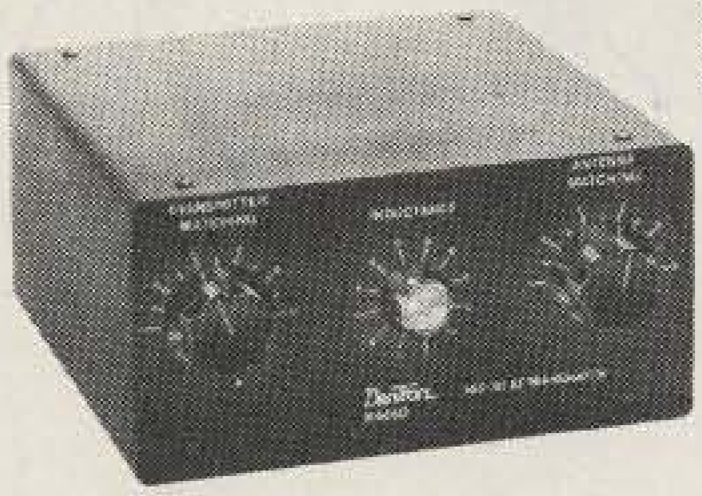
Every serious ham knows he must read both forward and reverse wattage simultaneously for that perfect match. So upgrade with the DenTron W-2 Dual in line Wattmeter.

$99.50

Match everything from 160 to 10 with the new 160-10 MAT

NEW: The Monitor Tuner was designed because of overwhelming demand. Hams told us they wanted a 3 kilowatt tuner with a built-in wattmeter, a front panel antenna selector for coax, balanced line and random wire. So we engineered the 160-10m Monitor Tuner. It's a lifetime investment at $299.50.

$299.50



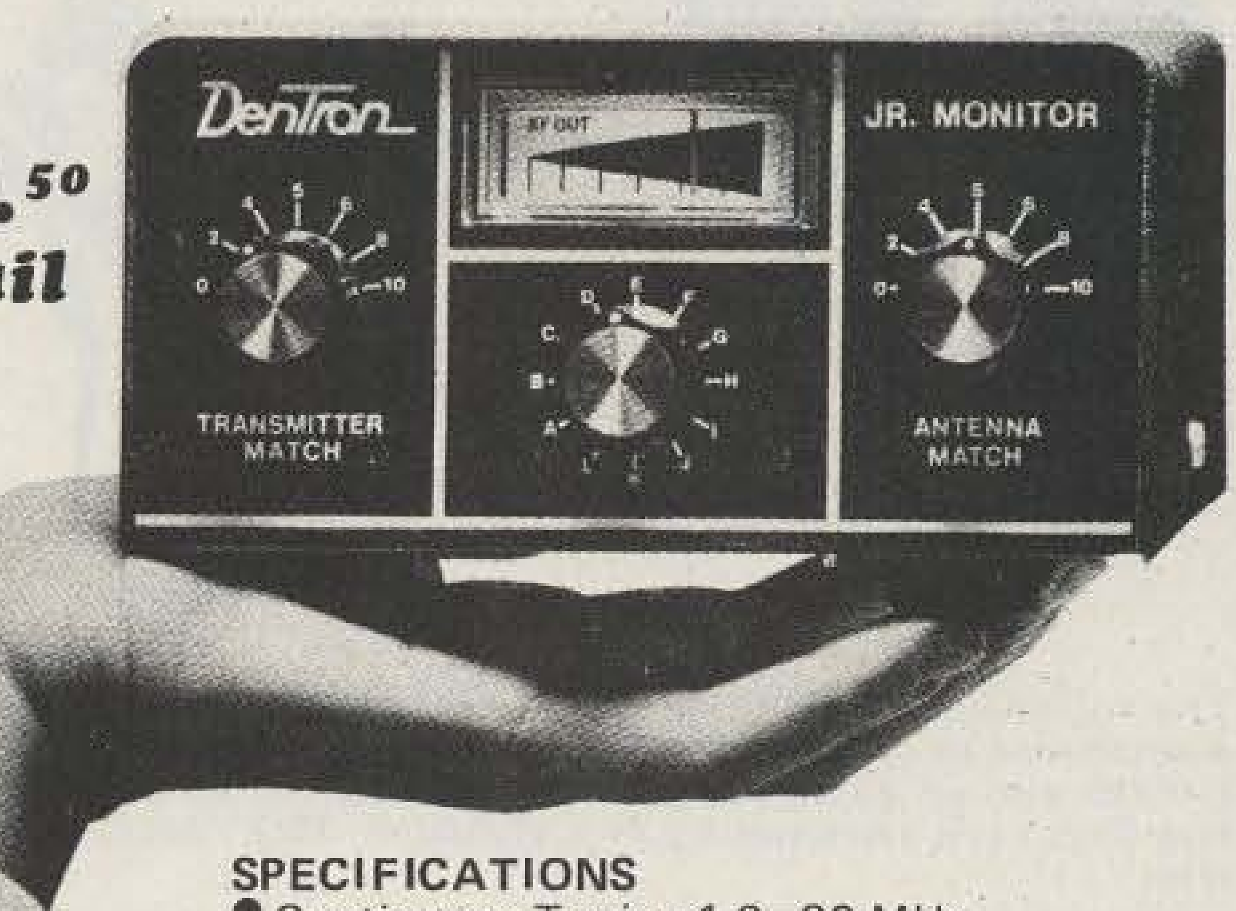
Meet the SuperTuner

The DenTron Super Tuner tunes everything from 160-10 meters. Whether you have balanced line, coax cable, random or long wire, the Super Tuner will match the antenna impedance to your transmitter. All DenTron tuners give you maximum power transfer from your transmitter to your antenna, and isn't that where it really counts?

1 KW MODEL **$129.50** 3 KW MODEL **$229.50**

Introducing Dentron's NEW
Jr. Monitor Antenna Tuner

$79.50 Retail



SPECIFICATIONS
- Continuous Tuning 1.8—30 MHz
- Forward reading relative output power meter
- 300 watt power capability
- Built-in encapsulated balun
- Mobile mounting bracket
- Ceramic Rotary Switch 12-position
- Capacitor spacing 1000 volts
- Tapped toroid inductor
- Antenna inputs:
  - a. Coax unbalanced SO239
  - b. Random wire
  - c. Balanced feed line 75—660 Ohm
- 5¼" w. x 2¾" h. x 6" d.
- All metal black wrinkle finish cabinet
- Weight: 2½ pounds

DenTron

DRAKE TVI FILTERS High Pass Filters for TV Sets provide more than 40 dB attenuation at 52 MHz and lower. Protect the TV set from amateur transmitters 6-160 meters.

Drake TV-300-HP
Model No. 1603
For 300 ohm twin lead
Price: $10.60

Drake TV-75-HP
Model No. 1610
For 75 ohm TV coaxial cable; TV type connectors installed
Price: $13.25

DRAKE TV-3300-LP
1000 watts max. below 30 MHz. Attenuation better than 80 dB above 41 MHz. Helps TV i-f interference, as well as TV front-end problems. Price: $26.60 Model No. 1608

LOW PASS FILTERS FOR TRANSMITTERS have four pi sections for sharp cut off below channel 2, and to attenuate transmitter harmonics falling in any TV channel and fm band. 52 ohm. SO-239 connectors built in.

DRAKE TV-5200-LP
200 watts to 52 MHz. Ideal for six meters. For operation below six meters, use TV-3300-LP or TV-42-LP. Model No. 1609 Price: $26.60

DRAKE TV-42-LP Model No. 1605
is a four section filter designed with 43.2 MHz cut-off and extremely high attenuation in all TV channels for transmitters operating at 30 MHz and lower. Rated 100 watts input. Price: $14.60

TELEX® PROFESSIONAL HEADPHONES & HEADSETS

BOOM MIC HEADSETS

For the ultimate in communications convenience and efficiency select a boom mic headset. Long-time favorites of professional communications, boom mic headsets allow more personal mobility while always keeping the mic properly positioned for fast, precise voice transmission. Boom microphones are completely adjustable to allow perfect positioning. And, boom mic headsets leave both hands free to perform other tasks.

All models are supplied with "close-talking" microphones to limit ambient noise pick-up and provide superior intelligibility. Each model has a convenient, inline push-to-talk switch, which can be wired for either push-to-talk relay control or mic circuit interrupt for voice operated transmitters. The switch may be used as a momentary push-button or it can be locked in the down position. All models have tough, flexible, 8 foot cords which are stripped and tinned, unterminated. Communication grey with black trim.


MODEL CM-1320


MODEL C-1320


MODEL C-1210


MODEL C-610

MODEL C-610 Economical, dual receiver magnetic headphone. Delivers clear reception. Lightweight and comfortable yet ruggedly constructed for daily use. Earcushions seal out distracting noise and are removable for cleaning. Price: $9.95

MODEL SWL-610 Similar to Model C-610 but with 2000 ohm impedance. Ideal for shortwave receivers requiring high impedance headphones. Price: $11.65

MODEL C-1210 Medium priced, dual receiver dynamic headphone. Precise sound reproduction. Deluxe foam-filled earcushions are extremely comfortable for those long sessions. The removable cushions reduce ambient noise penetration and concentrate signal strength. Great for noisy environments or for digging out weak signals. Price: $28.30

MODEL C-1320 Our finest communications headphone. Audiometric-type dual dynamic receivers assure the ultimate in reception and performance stability. Extremely sensitive receivers provide high output levels even from weak signals. Luxurious foam filled circumaural earcushions are removable for cleaning. Price: $37.90


MODEL CM-1210


MODEL CM-610


MODEL CM-1320S

DUAL MUFF HEADPHONES

The following headphones offer outstanding sound quality and superb comfort for long term wearing. All the models have circumaural earcushions to seal out distracting ambient noise and concentrate the signal at your ear. Foam filled vinyl earcushions on Models C-1210 and C-1320 add an extra margin of comfort. Adjustable headbands and self-aligning earcups assure proper fit. All models are equipped with a five foot cord terminating in a standard .250" diameter phone plug and have 3.2 to 20 Ohm impedance. Communication grey with black trim.

MODEL CM-610 Lightweight, dual receiver magnetic headphone (similar to Model C-610). Ceramic boom microphone with -51 dB output. Can be used with any mobile or base station with high Z mic input and 3.2 to 20 ohm audio output. Price: $42.80.

MODEL CM-1320 Deluxe dual receiver dynamic headphone with audiometric-type headphone elements (similar to Model C-1320). Ceramic boom microphone with -51 dB output. For use with any mobile or base station requiring high impedance mic input and 3.2 to 20 ohm audio output. Price: $68.30.

MODEL CM-1210 Rugged, reliable, dual receiver dynamic headphone (similar to Model C-1210). Ceramic boom microphone with -51 dB output. For use with any mobile or base station with high Z input and 3.2 to 20 ohm audio output. Price: $56.90.

MODEL CM-1320S Deluxe single receiver dynamic headphone with audiometric-type headphone element (similar to Model C-1320). Ceramic boom microphone with -51 dB output. For use with any mobile or base station requiring high impedance mic input and 3.2 to 20 ohm audio output. Price: $54.50.

MODEL	C-610	SWL-610	C-1210	C-1320	CM-610	CM-1210	CM-1320	CM-1320S
Headphone Sensitivity Ref. .0002 Dynes/cm² @1mW input, 1kHz	103dB SPL ±5dB	103dB SPL ±5dB	103dB SPL ±3dB	105dB SPL ±5dB	103dB SPL ±5dB	103dB SPL ±3dB	105dB SPL ±5dB	105dB SPL ±5dB
Headphone Frequency Response (useable)	40-15,000 Hz	40-15,000 Hz	20-20,000 Hz	20-20,000 Hz	40-15,000 Hz	20-20,000 Hz	20-20,000 Hz	20-20,000 Hz
Headphone Impedance	3.2-20 ohms	2000 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms
Microphone Frequency Response	—	—	—	—	50-8000 Hz	50-8000 Hz	50-8000 Hz	50-8000 Hz
Microphone Impedance	—	—	—	—	High	High	High	High
Microphone Sensitivity Below 1 volt/microbar at 1kHz	—	—	—	—	−51dB ±5dB	−51dB ±5dB	−51dB ±5dB	−51dB ±5dB
Cord	5'	5'	5'	5'	8' (2.4m)	8'	8'	8'
Plug	.250" dia.	.250" dia.	.250" dia.	.250" dia.	unterminated	unterminated	unterminated	unterminated
Gross Weight	8 oz. (227g)	8 oz.	12 oz. (341g)	15 oz. (426g)	12 oz.	15 oz.	18 oz. (511g)	12 oz. (341g)
Catalog Number	61630-063	61630-062	61210-031	61320-012	61630-064	61200-058	61320-013	61320-015

KENWOOD

TS-520S **$649.00**

SSB TRANSCEIVER. Proven in the shacks of thousands of discriminating hams, field day sites, DX and contest stations and mobile installations. Superb engineering and styling.

SP-520 **$28.00**

Optional external speaker for better readability.

TV-502 **$249.00**

TRANSVERTER. Puts you on 2M the easy way. 144-145.7 MHz or optional 145-146 MHz.

VFO-820 **$145.00**

Designed exclusively for use with TS-820. RIT circuit and control switch. Fully compatible with optional digital display.

VFO-520 **(Not Shown)** **$116.00**

Solid State Remote VFO. RIT circuit with LED indicator.

TR-2200A • PORTABLE 2M FM TRANSCEIVER

12 Ch. capacity. Removable telescoping antenna. External 12 VDC or internal NI-CAD batteries. 146-148 MHz. 6 CH. supplied. Switchable 2W or 400mW output. $229.00.

The NEW KENWOOD TS-820S transceiver

TS-820S now has factory installed digital readout • 160 thru 10 meter coverage • 200 watts PEP • Integral IF shift • Noise blanker • VOX & PLL circuitry • DRS dial • IF out, RTTY, XVTR capabilities • Phone patch IN and OUT terminals • RF speech processor. $1048.00.

The NEW KENWOOD TS-700S 2m transceiver

TS-700S has these new built-ins: • Digital readout, receiver preamp, VOX, semi-break-in and CW sidetone! Plus: • Solid-state construction • AC or DC capability • 4 band (144 to 148 MHz) coverage • 11 fixed channels • 600 kHz repeater offset. $679.00.

KENWOOD PRICE LIST

Model	Description	List Price
HF EQUIPMENT 820 PACESETTER SERIES		
TS-820S	TS-820 Deluxe Transceiver with Digital Display (DG-1) installed. 160-10 meters, IF shift	1,098.00
TS-820	Deluxe HF Transceiver 160-10 meters, RF speech processor, IF shift, RF negative feedback	919.00
DG-1	Digital Frequency Display for TS-820	179.00
VFO-820	Deluxe Remote VFO for 820 Series. Includes its own RIT circuit; frequency reads out on transceiver's digital display	149.00
SP-820	Deluxe External Speaker. Includes audio filters for added versatility on receive; 2 audio inputs	49.00
CW-820	500 Hz CW Filter for TS-820	49.00
520 SERIES		
TS-520S	160-10 HF Transceiver. Digital Display (option) speech processor, RF attenuator, super noise blanker	739.00
DG-5	Digital Display for TS-520S. Doubles as a frequency counter, too! Adaptable to TS-520 and 599 series	189.00
VFO-520S	Remote VFO for TS-520S. Built in RIT circuit provides super operating flexibility	135.00
SP-520	Matching External Speaker for TS-520S. 8 Ohms. Frequency response 100-5000 Hz	30.00
CW-520	500 Hz CW Filter for TS-520	49.00
599D Series		
R-599D	160-10 Solod State Amateur Receiver. 2 and 6 meters (optional). SSB, CW, AM, FM Transceives/splits with T-599D	549.00
T-599D	80-10 Meter Amateur Transmitter. Solid State (except driver andfinals). Semi break-in, sidetone, built in power supply	549.00
S-599	External Speaker for 599 Series. 8 Ohms. Frequency response: 100-5000 Hz	25.00
CC-29A	2 Meter Converter for R-599D	35.00
CC-69A	6 Meter Converter for R-599D	35.00
FM-599A	FM Filter for R-599D	45.00
HF MISCELLANEOUS		
R-300	All Band Communications Receiver. 170 kHz to 30 MHz – 6 bands, AC/DC/Batteries; built in speaker	249.00
AT-200	Antenna Tuner. Includes an tenna coupler, SWR meter, power meter, antenna switch, 200W	149.00
TL-922	Deluxe 160-10 Linear Amplifier. 2 KW PEP 2 x 3-500Z tubes, rugged built in power supply	TBA
DK-520	Digital Adaptor Kit (TS-520)	
DS-1A	DC-DC Converter for TS-820/TS-520S Series	65.00
VHF/UHF EQUIPMENT		
TS-600	6 Meter All Mode Transceiver. SSB, CW, FM, AM, 10 watts. Built in AC/DC power supplies	699.00
TS-700S	2 Meter All Mode Transceiver. SSB, CW, FM, AM, semi break-in, CW sidetone. Digital readout, receiver pre-amp	729.00
VFO-700S	External VFO for TS-700S. Frequency displays on TS-700S. Special "frequency check" feature	129.00
SP-70	8 Ohms External Speaker Matches TS-600 and TS-700S. Excellent frequency response	30.00
TR-2200A	2 Meter Portable Transceiver. FM, 12 channels (6 supplied); NI-CAD batteries, charger are included	229.00
TR-7400A	2 Meter Synthesized Transceiver. 25 Watts, 800 channels, 4 MHz, continuous tone-coded squelch (option)	399.00
TR-7500	2 Meter FM Transceiver; digital readout, one knob channel selector system, 10 watts output	299.00
TR-8300	70 CM FM Transceiver. 23 channels (3 supplied). 10 watts, broadband design	299.00
TV-502S	2 Meter Transverter, 8 watts; SSB and CW easily hooks up to 520/820 Series	TBA
TV-506	6 Meter Transverter, 10 watts; SSB and CW, easily hooks up to 520/820 Series	249.00
OTHER ACCESSORIES		
HS-4	KENWOOD Headphone set (8 Ohms)	16.00
MB-1A	Mobile bracket for TR-2200 A	13.00
MC-50	Dynamic Microphone for all KENWOOD stations (Hi/Lo Z)	39.50
PS-5	AC Power Supply; 12 VDC @ 3.5 Amps, matches TR-8300; built-in digital clock with timer	79.00
PS-6	AC Power Supply; 12 VDC @ 3.5 Amps; matches TR-7500; 8 Ohm speaker included	79.00
PS-8	AC Power Supply; 12 VDC @ 8 Amps; matches TR-7400A; well regulated; current limiting	129.00
VOX-3	VOX Unit for TS-700A and TS-600	25.00

Cushcraft engineers have incorporated more than 30 years of design experience into the best 3 band HF beam available today. **ATB-34** has superb performance with three active elements on each band, the convenience of easy assembly and modest dimensions. Value through heavy duty all aluminum construction and a price complete with 1-1 balun.

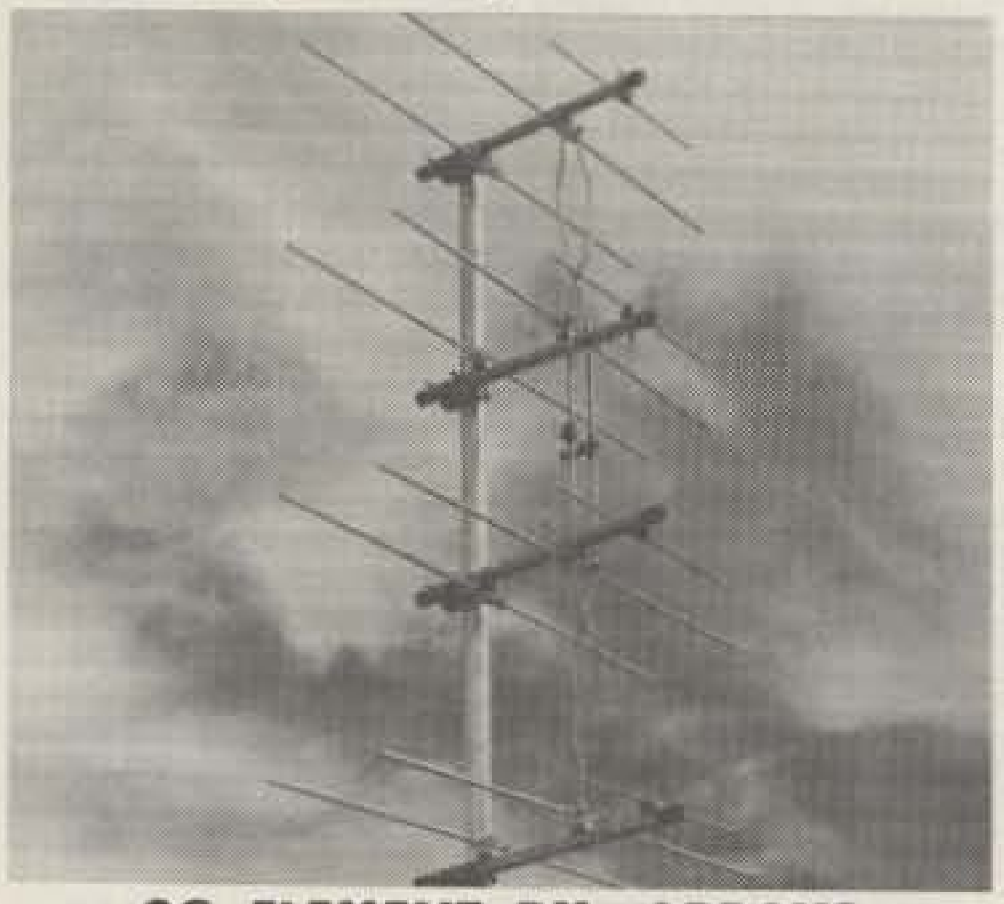
SPECIFICATIONS

FORWARD GAIN -	EXCELLENT	LONGEST ELEMENT -	32'8"
F/B RATIO -	30 dB	TURNING RADIUS -	18'9"
VSWR -	1.5-1	WIND SFC -	5.4 Sq.Ft.
POWER HANDLING -	2000 WATTS PEP	WEIGHT -	42 Lbs.
BOOM LENGTH/DIA. -	18' x 2 1/8"	WIND SURVIVAL -	90 MPH.

UPS SHIPPABLE **$239.95 COMPLETE**

ENJOY A NEW WORLD OF DX COMMUNICATIONS WITH ATB-34

VHF - UHF DX-ARRAYS
144, 220, 430 mhz



20 ELEMENT DX - ARRAYS

20 ELEMENT SPECIFICATIONS

Forward Gain ------ 14.2 db
F/B Ratio ----------- 20 db
Fwd. Lobe at 1/2 Pwr. Point
horizontal ---------- 48°
vertical ------------ 26°
Impedance --------- 52 ohms
VSWR at Frequency ---- 1 - 1
Bandwidth W/VSWR
Less than 2 - 1 ---- 4 mhz
Power Handling -- 2 KW PEP

	144 Mhz	220 Mhz	432 Mhz
Height	118"	78"	42"
Width x Depth	75" x 30"	53" x 20"	29" x 11"
Turning Radius	48"	32"	18"
Maximum Mast Dia.	1 1/2"	1 1/2"	1 1/2"
Net Weight Lbs.	8	7	6

Vertical support mast not supplied

2 METER DX-120	1 1/4 METER DX-220	3/4 METER DX-420
Am. Net $42.95	$37.95	$32.95

40 ELEMENT DX - ARRAYS

40 ELEMENT SPECIFICATIONS

Forward Gain -------- 17 db
F/B Ratio ----------- 20 db
Fwd. Lobe at 1/2 Pwr. Point
horizontal ---------- 32°
vertical ------------ 26°
Impedance --------- 52 ohms
VSWR at Frequency ---- 1 - 1
Bandwidth W/VSWR
Less than 2 - 1 ---- 4 mhz
Power Handling -- 2 KW PEP

	144 Mhz	220 Mhz	432 Mhz
Height	118"	78"	42"
Width x Depth	192" x 30"	132" x 20"	72" x 11"
Turning Radius	101"	65"	38"
Maximum Mast Dia.	2 1/2"	2 1/2"	2 1/2"
Net Weight Lbs.	32	22	12
Wind Rating	90 mph	90 mph	90 mph
Stack Kit No.	DXK-140	DXK-240	DXK-440
Amateur Net	$59.95	$54.95	$39.95

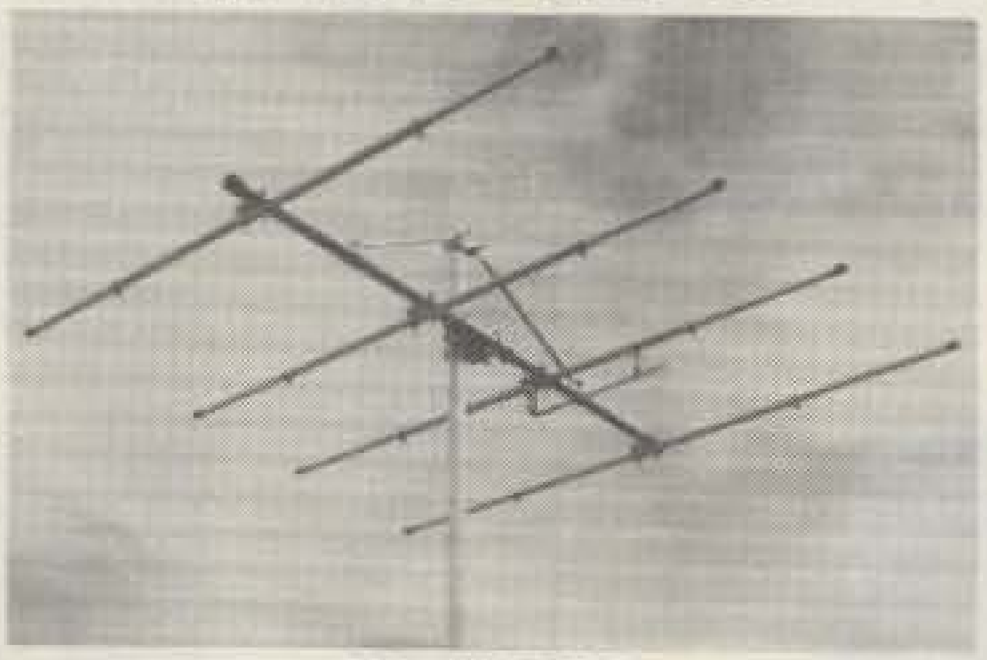
80 ELEMENT DX - ARRAYS

80 ELEMENT SPECIFICATIONS

Forward Gain -------- 20 db
F/B Ratio ----------- 20 db
Fwd. Lobe at 1/2 Pwr. Point
horizontal ---------- 32°
vertical ------------ 12°
Impedance --------- 52 ohms
VSWR at Frequency ---- 1 - 1
Bandwidth W/VSWR
Less than 2 - 1 --- 4 mhz
Power Handling -- 2 KW PEP

	144 Mhz	220 Mhz	432 Mhz
Height	275"	182"	97"
Width x Depth	192" x 30"	132" x 20"	72" x 11"
Turning Radius	101"	65"	38"
Maximum Mast Dia.	2 1/2"	2 1/2"	2 1/2"
Wind Rating	90 mph	90 mph	90 mph
Net Weight Lbs.	64	43	24
Stack Kit No.	DXK-180	DXK-280	DXK-480
Amateur Net	$109.95	$89.95	$79.95

HF MONOBEAMS
10 15 20 METERS



10 METERS

3 ELEMENT BEAM: You can have an outstanding signal using this compact three element beam. It is easily mounted on a lightweight rotator and takes only a limited amount of space.
MODEL NO. A28-3 $69.95

4 ELEMENT BEAM: A real DX'ers beam for the active ham who wants a top signal on 10 meters. Mount on a good ham rotator. MODEL NO. A28-4 $79.95

SPECIFICATIONS	A28-3	A28-4
BOOM	1 1/2" x 10'	1 5/8" x 18'
LONGEST ELEMENT	17' 6"	18'
ELEMENT DIAMETER	7/8" - 1/2"	7/8" - 3/4"
TURNING RADIUS	10'	14' 3"
FORWARD GAIN	8 db	10 db
FRONT TO BACK	22 db	25 db
SWR @ FREQUENCY	1 to 1	1 to 1
WEIGHT	11 lbs.	21 lbs.

15 METERS

3 ELEMENT BEAM: A high quality beam which can be mounted on a mast with other antennas. A heavy duty TV rotator will handle it.
MODEL NO. A21-3 $89.95

4 ELEMENT BEAM: For the 15 meter enthusiast this beam will give real DX performance. When mounted on a good ham rotator it will withstand the most adverse weather conditions.
MODEL NO. A21-4 $119.95

SPECIFICATIONS	A21-3	A21-4
BOOM	1 5/8" x 12'	1 3/4" x 21' 6"
LONGEST ELEMENT	22' 10"	22' 10"
ELEMENT DIAMETER	7/8" - 3/4"	7/8" - 3/4"
TURNING RADIUS	13' - 3"	15' - 8"
FORWARD GAIN	8 db	10 db
FRONT TO BACK	22 db	25 db
SWR @ FREQUENCY	1 to 1	1 to 1
WEIGHT	16 lbs.	32 lbs.

20 METERS

2 ELEMENT BEAM: Full size beam performance for the active 20 meter ham with limited space and budget.
MODEL NO. A14-2 $109.95

3 ELEMENT BEAM: A real DX-er's beam with full .15 wavelength element spacing. The heavy duty construction gives years of trouble free service. MODEL NO. A14-3 $139.95

SPECIFICATIONS	A14-2	A14-3
BOOM	1 5/8" x 10'	1 5/8" x 20' 6"
LONGEST ELEMENT	35' 10"	35' 10"
ELEMENT DIAMETER	1 1/8" - 3/4"	1 1/8" - 3/4"
TURNING RADIUS	18'	21'
FORWARD GAIN	5 db	8 db
F/B RATIO	13 db	22 db
SWR @ FREQUENCY	1 to 1	1 to 1
WEIGHT	20 lbs.	35 lbs.

HF VERTICALS 10 through 80 METERS

cushcraft

- EFFICIENT TOP RING
- FIBERGLASS TRAP FORMS
- ENAMELED WIRE COILS
- SOLID ALUMINUM CAPACITORS
- NO TUNING REQUIRED
- FULL COMPRESSION CLAMPS
- OMNIDIRECTIONAL COVERAGE
- REINFORCED BASE
- MAST OR GROUND MOUNTING
- PRE-MARKED SECTIONS
- EASY ASSEMBLY
- SUPERIOR QUALITY

3 BAND
20-15-10 METERS
MODEL ATV-3 $49.95

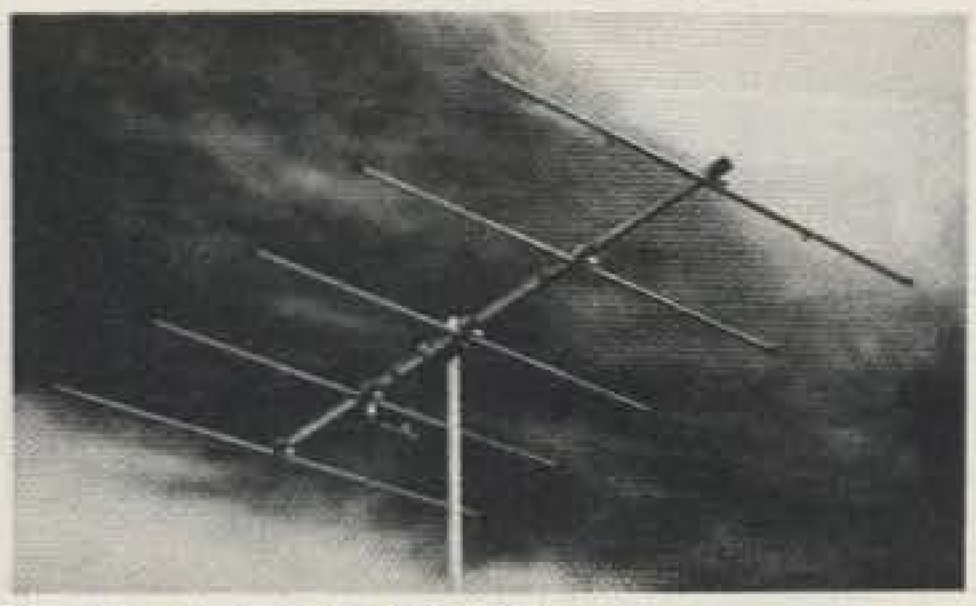
4 BAND
40-20-15-10 METERS
MODEL ATV-4 $89.95

5 BAND
80-40-20-15-10 METERS
MODEL ATV-5 $109.95

ALL MODELS UPS SHIPPABLE

cushcraft
THE ANTENNA COMPANY

6 METER BEAMS



3-5-6-10 ELEMENTS

Proven performance from rugged, full size, 6 meter beams. Element spacings and lengths have been carefully engineered to give best pattern, high forward gain, good front to back ratio and broad frequency response.

Booms are .058 wall and elements are 3/4" - 5/8" .049 wall seamless chrome finish aluminum tubing. The 3 and 5 element beams have 1 3/8" - 1 1/4" booms. The 6 and 10 element beams have 1 5/8" - 1 1/2" booms. All brackets are heavy gauge formed aluminum. Bright finish cad plated ubolts are adjustable for up to 1 5/8" mast on 3 and 5 element and 2" on 6 and 10 element beams. All models may be mounted for horizontal or vertical polarization.

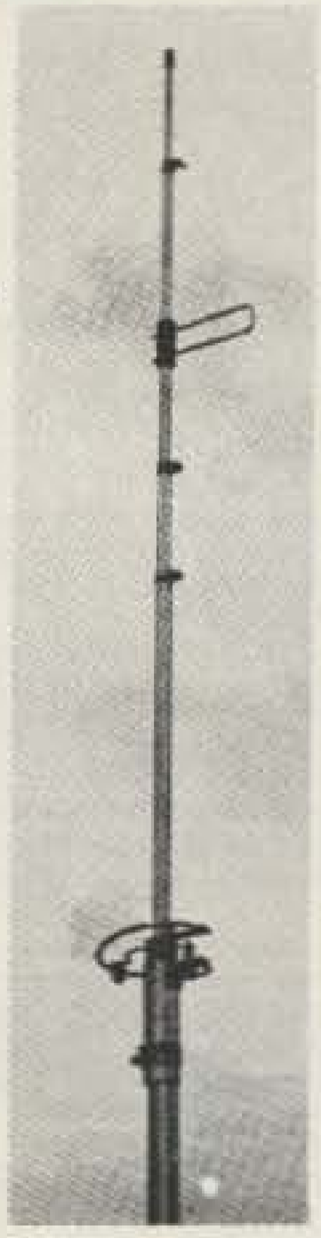
New features include adjustable length elements, kilowatt Reddi Match and built-in coax fitting for direct 52 ohm feed. These beams are factory marked and supplied with instructions for quick assembly.

Description	3 element	5 element	6 element	10 element
Model No.	A50-3	A50-5	A50-6	A50-10
Boom Lngth	6'	12'	20'	24'
Longest El.	117"	117"	117"	117"
Turn Radius	6'	7' 6"	11'	13'
Fwd. Gain	7.5 dB	9.5 dB	11.5 dB	13 dB
F/B Ratio	20 dB	24 dB	26 dB	28 dB
Weight	7 lbs.	11 lbs.	18 lbs.	25 lbs.

COAXIAL DUAL STACKING KITS

Double your effective radiated power by stacking 6 meter beams. Cush Craft coaxial stacking kits provide a simple and efficient method for realizing 3 db additional gain while maintaining the superior characteristics of our single beams. The stacking kits are complete with RG-59/U cable and preassembled fittings for direct 52 ohm feed.

MODEL NO.	FOR STACKING	AMATEUR NET
A535-SK	A50-3 or A50-5	$15.95
A561-SK	A50-6 or A50-10	$17.95



new
RINGO RANGER for FM

4.5 dB* – 6 dB**
Omnidirectional GAIN BASE STATION ANTENNAS FOR MAXIMUM PERFORMANCE AND VALUE

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

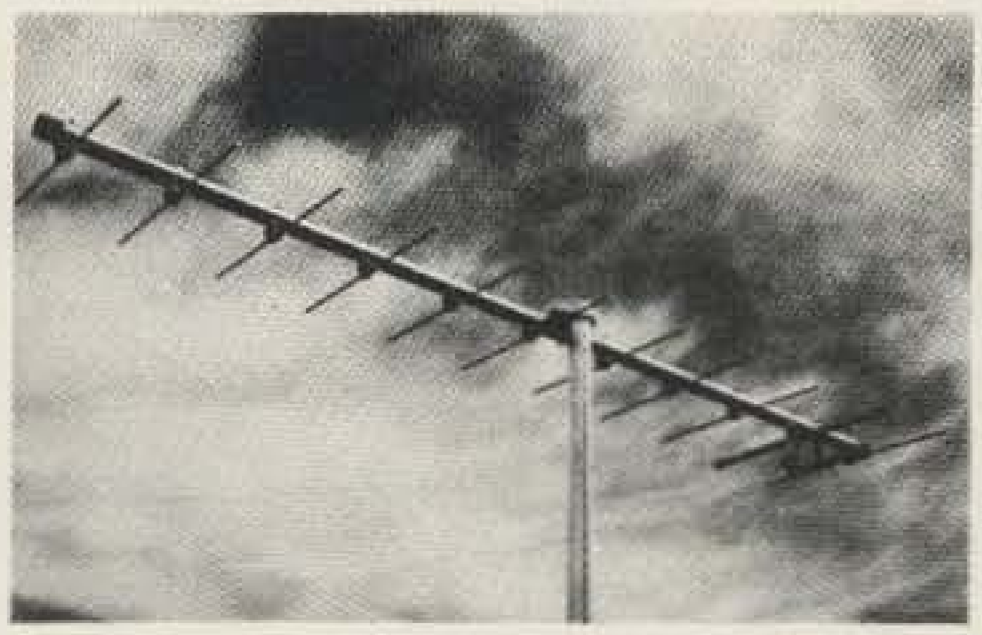
E-4-6-11 ELEMENT YAGIS The standard of comparison in VHF-UHF communications, now cut for FM and vertical polarization. The four and six element models can be tower side mounted. All are rated at 1000 watts with direct 52 ohm feed and PL-259 connectors.

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°	48°	60°	48°
Wind area sq. ft.	1.21	.43	.39	.30	.50
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

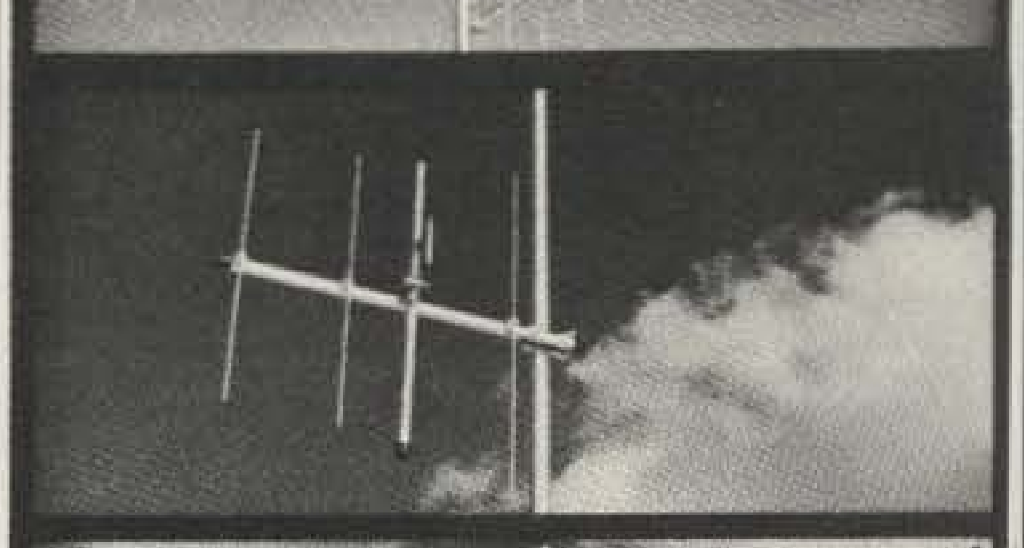
The standard of comparison in amateur VHF/UHF communications Cush Craft yagis combine all out performance and reliability with optimum size for ease of assembly and mounting at your site.

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	$ 32.95	A144-7	21.95
A50-5	49.95	A144-11	32.95
A50-6	69.95	A430-11	24.95
A50-10	99.95		

AMATEUR FM ANTENNAS

A147-4	$ 19.95	AFM-44D	54.95
A147-11	29.95	AR-2	21.95
A147-20T	54.95	AR-6	32.95
A147-22	84.95	AR-25	29.95
A220-7	21.95	AR-220	21.95
A220-11	27.95	AR-450	21.95
A449-6	21.95	ARX-2	32.95
A449-11	27.95	ARX-2K	13.95
AFM-4D	59.95	ARX-220	32.95
AFM-24D	57.95	ARX-450	32.95

	144 MHz.		220 MHz.		432 MHz.	
Description:	Model:	Price:	Model:	Price:	Model:	Price:
20 Element DX-Array	DX-120	42.95	DX-220	37.95	DX-420	32.95
Frame & Harness (40 E.)	DXK-140	59.95	DXK-240	54.95	DXK-440	39.95
Frame & Harness (80 El.)	DXK-180	109.95	DXK-280	89.95	DXK-480	79.95
1-1 52-ohm balun	DX-18N	12.95	DX-28N	12.95	DX-48N	12.95
Vert. Pol. Bracket (20 El.)	DX-VPB	9.95	DX-VPB	9.95	DX-VPB	9.95

TUFTS RADIO CATALOG TUFTS TUFTS RAD

—C — LINE AMATEUR EQUIPMENT **DRAKE**® —COMMUNICATIONS RECEIVERS—

Drake R-4C

Solid State Linear permeability-tuned VFO with 1 kHz dial divisions. Gear driven dual circular dials. High mechanical, electrical and temperature stability.

Covers ham bands with crystals furnished. Covers all of 80, 40, 20 and 15 meters, and 28.5-29.0 MHz of 10 meters.

Covers 160 meters with accessory crystal. In addition to the ham bands, tunes any fifteen 500 kHz ranges between 1.5 and 30 MHz, 5.0 to 6.0 MHz not recommended. Can be used for MARS, WWV, CB, Marine and Shortwave broadcasts.

Price: $699.00

Drake T-4XC

Solid State Linear permeability-tuned VFO with 1 kHz dial divisions. Gear driven dual circular dials. High mechanical, electrical and temperature stability.

Covers ham bands with crystals furnished. Covers all of 80, 40, 20 and 15 meters, and 28.5-29.0 MHz of 10 meters.

Covers 160 meters with accessory crystal. Four 500 kHz ranges in addition to the ham bands plus one fixed-frequency range can be switch-selected from the front panel.

Price: $699.00

Drake SPR-4 $699.00

Drake DSR-2 — $3200.00

DRAKE PRICE LIST

Model Number	Model	Description	
Communications Receivers and Accessories			
1242	DSR-2	VLF-HF Digital Synthesized Communications Laboratory Receiver SSB, AM, CW, RTTY, ISB	$3200.00
1211	R4C	Amateur HF Receiver, 160-10 meters	699.00
1217	4-NB	Noise Blanker for R4C	74.00
7011	FL-250	Accessory I.F. Filter	52.00
7013	FL-500	Accessory I.F. Filter	52.00
7015	FL-1500	Accessory I.F. Filter	52.00
7017	FL-4000	Accessory I.F. Filter	52.00
7019	FL-6000	Accessory I.F. Filter	52.00
1221	SPR-4	Solid State Programmable Receiver	699.00
1227	5-NB	Noise Blanker for SPR-4	80.00
1229	DC-PC	12VDC power cord (fits cigarette lighter)	5.00
6006	Dial	Plain crystal selector dial for SPR-4	3.00
1223	SCC-4	100 kHz Calibrator	22.00
7001	Kit	Aeronautical Overseas—7 crystals	36.40
7002	Kit	Amateur Band—6 crystals	31.20
7003	Kit	Citizen Band—1 crystal & freq. chart	5.25
7004	Kit	Marine Band—11 crystals	57.20
7005	Kit	MARS—5 crystals	26.00
7006	Kit	Teletype Commercial-UPI/AP/Stock Market/Weather, etc. 4 crystals	20.80
7007	Kit	Time & Frequency Standard—WWV 5 crystals	26.00
7008	Kit	Tropical Broadcast—3 crystals	15.60
Transmitters			
1411	T4XC	Amateur HF Transmitter 160-10 meters	699.00
Transceivers and Accessories			
8333	TR33C	2-meter FM transceiver, 12 channel portable	229.95
1333	MMK-33	Mobile/Dash/Desk Mount for TR33C	12.95
1312	TR4Cw	80-10 meter Amateur Radio SSB/CW Transceiver, RIT AND CW Filter included.	799.00
1317	34PNB	Plug-in Noise Blanker for TR-4 and TR4C above Serial No. 31320 and TR4Cw. For factory installation add $10.00	100.00
1313	MMK-3	Mobile Mounting Kit for TR4 and TR6	10.95
1319	RV4C	Remote VFO for TR4C and TR4Cw	170.00
1330	UMK-3	Remote Trunk Kit for UV-3 System	69.95
1340	UV-3	144	595.00
1343*	UV-3	144-220	695.00
1344*	UV-3	144-440	695.00
1346*	UV-3	144-220-440	795.00
1359*	UV-3E	144-430, European model	695.00

*Prices above include factory installed modules for bands as listed.

Model Number	Model	Description	
Power Supplies			
1501	AC-4	110/220V power supply for all R.L. Drake transmitters and transceivers	150.00
1504	PS-3	AC Supply (120/240 V.A.C.) for any UV-3 model	89.95
1505	DC-4	12 VDC power supply for all Drake transmitters, transceivers & receivers	160.00
Major Accessories & Miscellaneous			
1520	FS-4	Frequency Snythesizer	300.00
1523	Interface Kit	For SPR-4/FS-4	10.00
1524	Split Freq.	Adaptor FS-4/4-Line	10.00
1519	L4B	Linear Amplifier with Power Supply & Tubes	995.00
1508	MN4C	Antenna Matching Network, 160-10 meters, 250 watts.	165.00
1509	MN2000	Antenna Matching Network, 2000 watts	250.00
1510	B-1000	4:1 Balun Designed for use with MN4C	24.95
1511	MS-4	Matching Speaker for R4B, R4C, SPR-4, SW4A, TR4 and TR6	33.00
1513	W-4	HF RF Wattmeter 1.8 to 54 mHz 200/2000 watts	79.00
1515	WV-4	VHF RF Wattmeter 20 to 200 mHz 100/1000 watts	89.00
1525	1525EM	Encoder microphone w/plug for TR33C/UV-3	49.95
7079	7079	Vinyl Case for TR33C	9.95
3501	RP-500	Protects receivers operating in range 10 kHz to 30 mHz from RF voltages of up to 500 V RMS from 50 ohm antenna	90.00
1518	RCS-4	Remote Control Antenna Switch	120.00
Crystals*			
....	....	Crystals for 2C/R4B/R4C/SW4A/T4XB/T4XC/SPR4/ML2/TR4C/TR4CW	5.25
		Crystals for fixed frequency operation of tunable units/2NT	7.85
		Crystals for TR22	7.85
		Crystals for TR72/TR33C	6.30
Books			
.....	.....	TR4C/T4XC/R4C/2C/TR4CW	5.00
		All other Instruction Manuals	3.50
		DSR-2 Manual	20.00
7040		World Radio & TV Handbook	10.95
Receivers			
8201	SSR-1	Solid state general coverage synthesized shortwave receiver .5 to 30.0 mHz, continuous tuning.	350.00
8202	DC-PC	SSR-1 DCPC power cord	5.00
High Pass Filters			
1603	TV300HP	High Pass Filter for 300 ohm twin lead	10.60
1610	TV75HP	High Pass Filter for 75 ohm TV coax, type F connectors	13.25
Low Pass Filters for Transmitters			
1605	TV42LP	For transmitting below 30 mHz, 100 watt continuous/50 ohms/SO-239 connectors	14.60
1608	TV3300LP	1000 watts continuous to 30 mHz with sharp cutoff above 30 mHz/50 ohms/SO-239 connectors	26.60
1609	TV5200LP	100 watts continuous on 6 meter amateur band	26.60

- Remote
- Motor Controlled

RCS-4

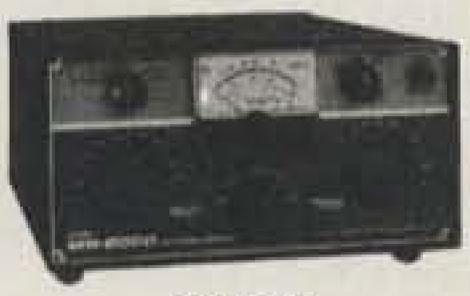
COAX ANTENNA SWITCH

- Control unit works on 110/220 VAC, 50/60 Hz, and supplies necessary DC to motor.
- Excellent for single coax feed to multiband quads or arrays of monobanders. The five positions allow a single coax feed to three beams and two dipoles, or other similar combinations.
- Control cable (not supplied) same as for HAM-M rotator.
- Selects antennas remotely, grounds all unused antennas. GND position grounds all antennas when leaving station. "Rain-Hat" construction shields motor and switches.
- Motor: 24 VAC, 2 amp. Lubrication good to −40°F.
- Switch RF Capability: Maximum legal limit. Price: $120.00

MATCHING NETWORKS

MN-4
200 watts

Price: $120.00



MN-2000
2000 watts PEP

Price: $250.00

General: • **Integral Wattmeter** reads forward power in watts and VSWR directly; can be calibrated to read reflected power • **Matches 50 ohm transmitter output** to coax antenna feedline with VSWR of at least 5:1 • Covers ham bands 80 thru 10 meters • **Switches in or out** with front panel switch • **Size:** 5½"H, 10¾"W, 8"D (14.0 x 27.3 x 20.3 cm), MN-2000, 14⅜"D (36.5 cm).
• **Continuous Duty Output:** MN-4, 200 watts; MN-2000, 1000 watts (2000 watts PEP) • **MN-2000 only:** Up to 3 antenna connectors selected by front panel switch.

RF WATTMETERS

W-4 **1.8-54 MHz** Price: $79.00
WV-4 **20-200 MHz** Price: $89.00

Reads forward and reflected power directly in watts (VSWR from nomogram). Two scales in each direction. **Size:** 5½"H, 3¾"W, 4"D (14.0 x 9.5 x 10.2 cm).

Model	Full Scale	Calibration Accuracy
W-4	200 watts	(5% of reading + 2 watts)
	2000 watts	±(5% of reading + 20 watts)
WV-4	100 watts	±(5% of reading + 1 watt)
	1000 watts	±(5% of reading + 10 watts)

DRAKE

SSR-1 COMMUNICATIONS RECEIVER

- Synthesized • General Coverage
- Low Cost • All Solid State • Built-in AC Power Supply • Selectable Sidebands
- Excellent Performance

PRELIMINARY SPECIFICATIONS: • **Coverage:** 500 kHz to 30 MHz • **Frequency** can be read accurately to better than 5 kHz • **Sensitivity** typically .5 microvolts for 10 dB S+N/N SSB and better than 2 microvolts for 10 dB S+N/N AM • **Selectable sidebands** • **Built-in power supply:** 117/234 VAC ± 20% • **If the AC power source fails** the unit switches automatically to an internal battery pack which uses eight D-cells (not supplied) • **For reduced current drain** on DC operation the dials do not light up unless a red pushbutton on the front panel is depressed.
The performance, versatility, size and low cost of the SSR-1 make it ideal for use as a stand-by amateur or novice-amateur receiver, short wave receiver, CB monitor receiver, or general purpose laboratory receiver.

Price: $350.00

TR-4CW SIDEBAND TRANSCEIVER

GENERAL: • **All amateur bands** 10 thru 80 meters in seven 600 kHz ranges • **Solid State VFO** with 1 kHz dial divisions • **Modes** SSB Upper and Lower, CW and AM • **Built-in Sidetone** and automatic T/R switching on CW • **30 tubes and semi-conductors** • **Dimensions:** 5½"H, 10¾"W, 14⅜" D (14.0 x 27.3 x 36.5 cm), **Wt.:** 16 lbs. (7.3 kg).
TRANSMIT: • **VOX or PTT** on SSB or AM • **Input Power:** SSB, 300 watts P.E.P.; AM, 260 watts P.E.P. controlled carrier compatible with SSB linears; CW, 260 watts • **Adjustable pi-network.**
RECEIVE: • **Sensitivity** better than ½ μV for 10 dB S/N • **I.F. Selectivity** 2.1 kHz @ 6 dB, 3.6 kHz @ 60 dB. • **AGC** full on receive modes, variable with RF gain control, fast attack and slow release with noise pulse suppression • **Diode Detector** for AM reception.

Price: $799.00

34-PNB Plug-in Noise Blanker 100.00
FF-1 Crystal Control Unit 46.95
MMK-3 Mobile Mount 7.00
RV-4C Remote VFO $150.00

POWER SUPPLIES
AC-4 Power Supply $120.00
DC-4 Power Supply 135.00

2 METER FM PORTABLE TRANSCEIVER Model TR-33C

Amateur Net $229.95

- SCPC* Frequency Control
- 12 Channels with Selectable Xmtr Offsets.
- All FET Front-end and Crystal Filter for Superb Receiver Intermod Rejection.
- Expanded Antenna Choice.
- Low Receiver Battery Drain.
- Traditional R. L. Drake Service Backup.
- Single Crystal Per Channel.

LINEAR AMPLIFIER Model L-4B

L-4B Linear Amplifier $995.00
• 2000 Watts PEP-SSB • Class B Grounded-Grid — two 3-500Z Tubes • Broad Band Tuned-Input • RF Negative Feedback • Transmitting AGC • Directional Wattmeter • Two Tautband Suspension Meters • L-4B 13-15/16" W, 7-7/8" H, 14-5/16" D. Wt.: 32 lbs. • Power Supply 6-3/4" W, 7-7/8" H, 11" D, Wt.: 43 lbs.

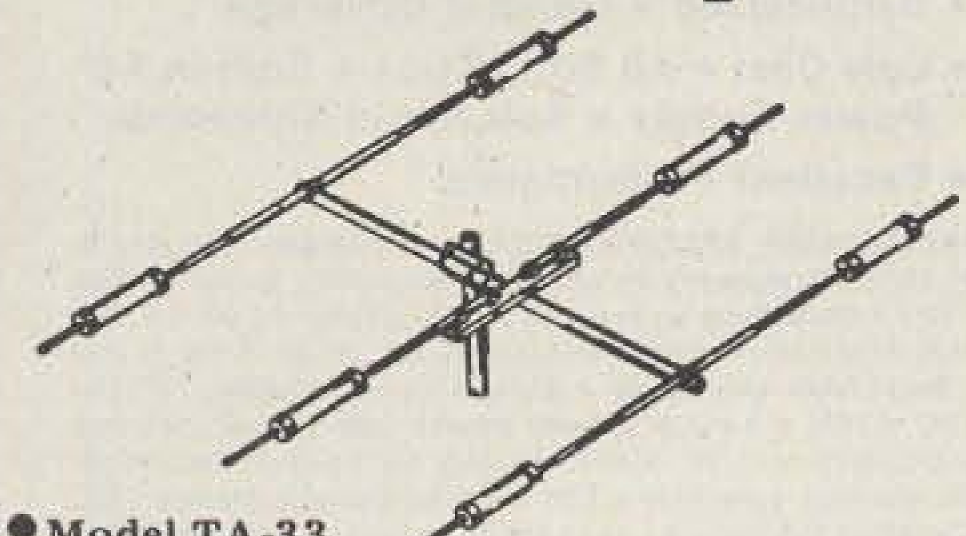
POWER SUPPLIES
AC 4 Power Supply $120.00
DC 4 Power Supply 135.00

Touch-n-go with DRAKE 1525EM Push Button Encoding Mike

Drake 1525EM, microphone with tone encoder and connector for TR-33C, TR-22, TR-22C, ML-2 . . . . $49.95

- Microphone and auto-patch encoder in single convenient package with coil cord and connector. Fully wired and ready for use.
- High accuracy IC tone generator, no frequency adjustments.
- High reliability Digitran® keyboard.
- Power for tone encoder obtained from transceiver through microphone cable. No battery required. Low current drain.
- Low output impedance allows use with almost all transceivers.
- Four pin microphone plug: directly connects to Drake TR-33C without any modification in transceiver. Compatible with all previous Drake and other 2 meter units with minor modifications.
- Tone level adjustable.
- Hang-up hook supplied.

Mosley



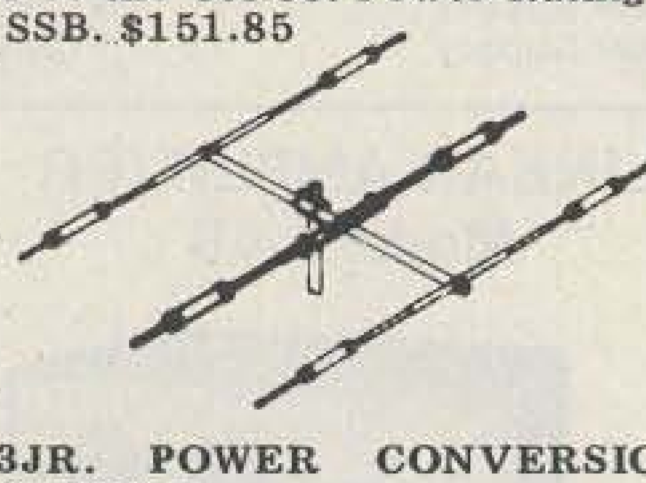
- Model TA-33
- 3 Elements
- 10.1 db Forward Gain (over isotropic source)
- 20 db Front-to-Back Ratio

The Mosley TA-33, 3-element beam provides outstanding 10, 15 and 20 meter performance. Exceptionally broadband — gives excellent results over full Ham bandwidth. Incorporating Mosley Famous Trap-Master traps. Power Rating — 2KW P.E.P. SSB. The TA-33 may also be used on 40 meters with TA-40KR conversion. Complete with hardware. $206.50

MULTI-BAND BEAMS
TRAP MASTER 33 . . . 10, 15 & 20 Meters

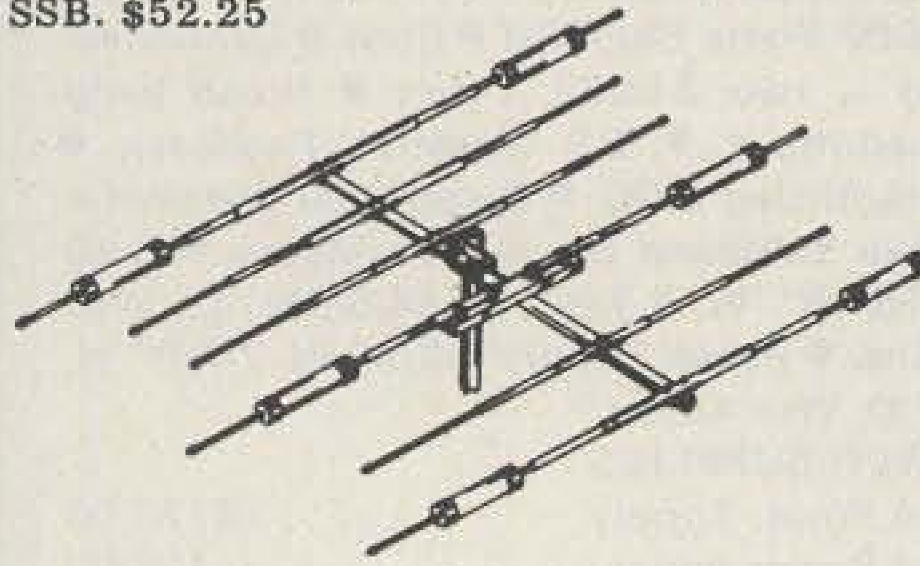
- Model TA-33Jr.
- 3 Elements
- 10.1 db Forward Gain (over isotropic source)
- 20 db Front-to-Back Ratio

The TA-33Jr . . . incorporates Mosley Trap-Master Junior traps. This is the low power brother of the TA-33. Power Rating — 1 KW P.E.P. SSB. $151.85



TA-33JR. POWER CONVERSION KIT MODEL MPK-3

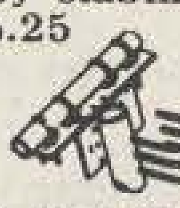
Owners of the Mosley Trap-Master TA-33Jr. may obtain higher power without buying an entirely new antenna. The addition of the MPK-3 (power conversion kit) converts the TA-33Jr. into essentially a new antenna with 750 watts AM/CW and 2000 watts P.E.P. SSB. $52.25



TRAP MASTER 36 . . . 10, 15 & 20 Meters

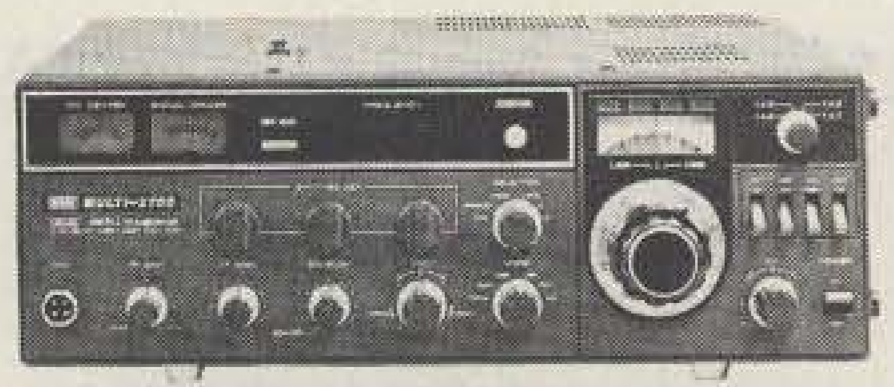
- Model TA-36
- 6 Elements
- Forward Gain (over isotropic source) - 10.1 db on 15 & 20 meters, 11.1 db on 10 meters.

Front-to-Back Ratio on all bands. 20 db.
This wide-spaced, six element configuration employs 4 operating elements on 10 meters, 3 operating elements on 15 meters, and 3 operating elements on 20 meters. Automatic bandswitching is accomplished through Mosley exclusively designed high impedance parallel resonant "Trap Circuit." The TA-36 is designed for 1000 watts AM/CW or 2000 watts P.E.P. SSB. Traps are weather and dirt proof, offering frequency stability under all weather conditions. $335.25



MOSLEY AK-60 MAST PLATE ADAPTER

Mast Plate Adapter for adapting your Mosley 1½" mounted beam to fit 2" OD mast. Complete with angle and hardware. $11.15



A brilliant new 2 meter transceiver with every in-demand operating feature and convenience

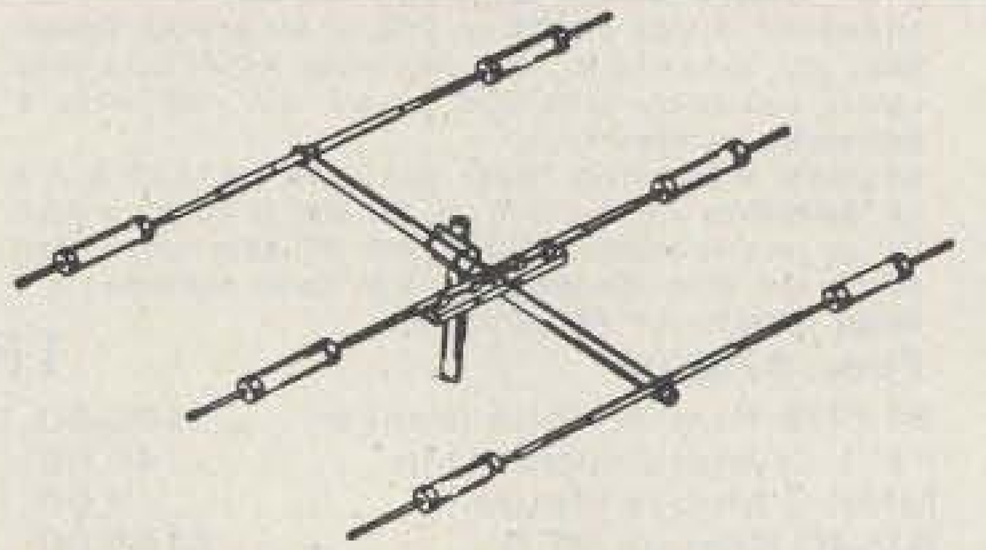
KLM MULTI 2700 — $756.00

★ Synthesizer and VFO.
★ All modes: NBFM, WBFM, AM, SSB w/USB/LSB and CW.
- Frequency synthesizer (PLL) 3 Knob, 600 channels, 10 kHz steps.
- VXO, plus or minus 7 kHz.

★ LED readout on synthesizer.
- Standard 600 kHz splits plus . . .
- Two "oddball" splits.

★ OSCAR transceive 2 to 10 meter operation.
- OSCAR receiver built-in.
- Connectors on rear for separate 2 meter and 10 meter antennas.
- Built-in VFO (continuous coverage, 144-148 MHz in 1.3 MHz segments. 1 kHz readout).
- 8 pole SSB filter plus two FM filters.
- 100 kHz crystal calibrator.
- Voice operated relay (VOX) or p-t-t.

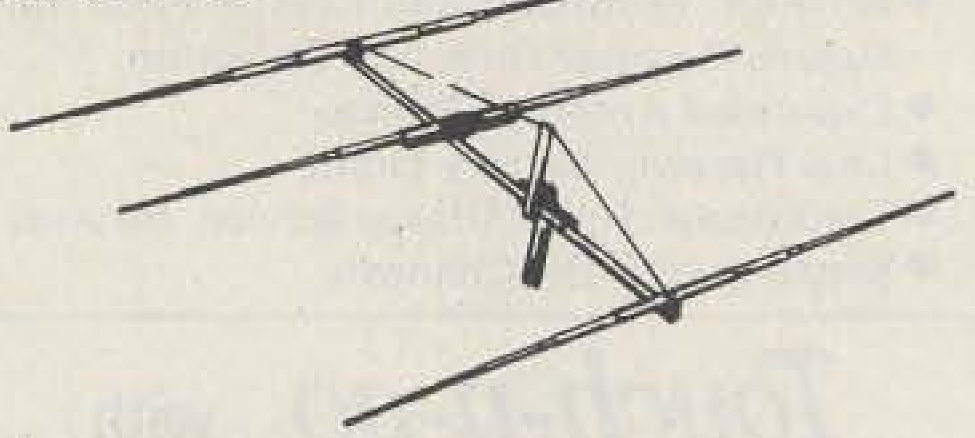
★ Audio speech compression.
- Noise blanker.
- RIT, plus or minus 5 kHz.
- Power out/"S" meter.
- FM center deviation meter.
- 10W minimum output power. NO TUNING!
- Hi-Lo power provision.
- Built-in AC/DC power supply.
- Double conversion receiver. 16.9 MHz and 455 kHz I-Fs.
- Receiver sensitivity:
  FM: 0.5μV for 28 dB S/N.
  SSB/CW: 0.25μV for 14 dB S/N.
  AM: 2μV for 10 dB S/N.
- Size: Inches: 5H, 14.88W, 12D. MM: 128H, 378W, 305D.
- Weight: 28 lbs. (13 KG).



CLASSIC-33 . . . 10, 15 & 20 Meters
Model CL-33

- 3 Elements
- 10.1 db Forward Gain (over isotropic source) on all bands.
- 20 db Front-to-Back Ratio on 15 & 20 meters, 15 db on 10 meters.

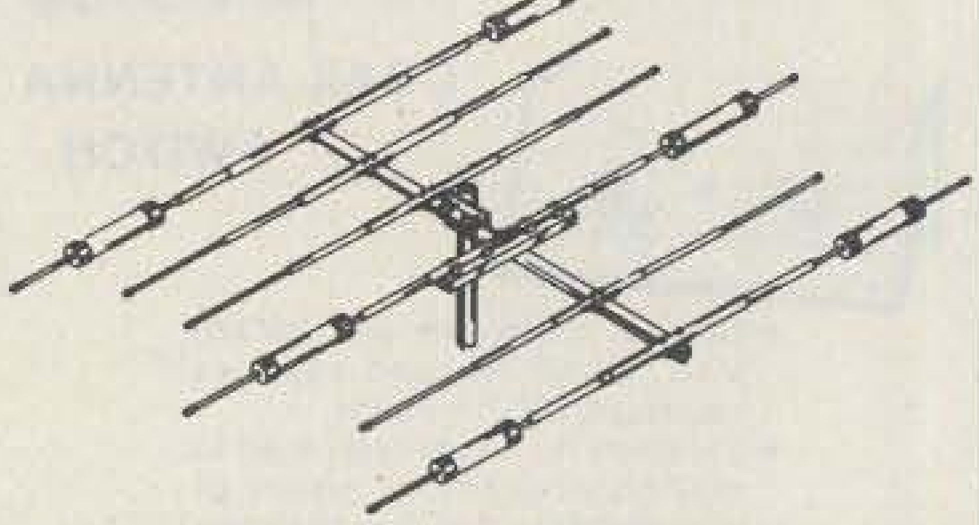
BRIDGING THE GAP . . . The Classic 33, combines the best of two Mosley systems. Incorporating Mosley Classic Feed System for a "Balanced Capacitive Matching" system with a feed point impedance of 52 ohms at resonance, and the Famous Mosley Trap-Master Traps for "weather-proof" traps with resonant frequency stability. This extra sturdy multi-band beam, Model CL-33, for operation on 10, 15 & 20 meters features improved boom to element clamping, stainless steel hardware, balanced radiation and a longer boom for even wider element spacing. Power Rating — 2 KW P.E.P. SSB. Recommended mast size — 2" OD. Wind Load — 120 lbs. at 80 MPH. Approx. shipping weight — 45 lbs. $232.50



CLASSIC-203 . . . 20 Meters
Model CL-203
3 Elements

- 10.1 db Forward Gain (over isotropic source)
- 20 db Front-to-Back Ratio

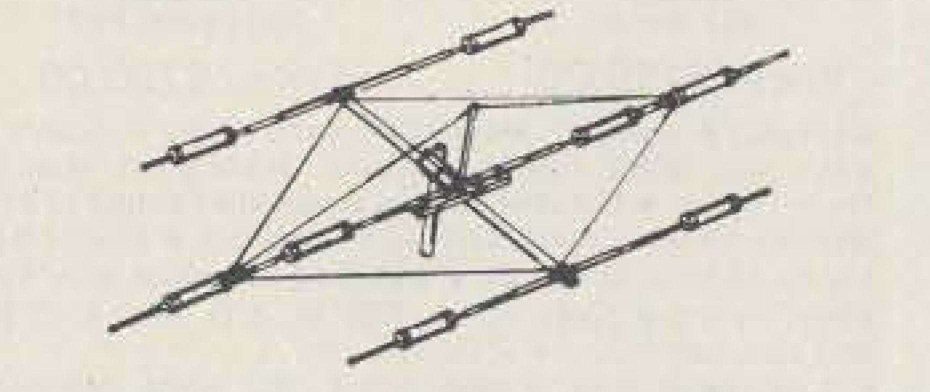
Incorporating the Mosley patented Classic Feed System, this full size 20 meter single-band beam has 1½" to 3/8" dia. "swaged" elements wide spaced on a 2" dia. 24' boom. Maximum element length-37' 8½". The high standards in quality construction established by Mosley in over a quarter-century of manufacturing is reflected in this mono-band . . . Model CL-203. Boom-to-mast clamping assures stability with a time-tested arrangement of mast plate, cast aluminum clamping blocks and stainless steel U-bolts. The exclusive "Balanced Capacitive Matching" System has a nominal feed point impedance of 52 Ohms at 2 KW P.E.P. SSB. Recommended mast size-2" O.D. Approx. shipping wt: 42 lbs. via truck. $227.65



CLASSIC-36 . . . 10, 15 & 20 Meters
Model CL-36

- 6 Elements
- 10.1 db Forward Gain (over isotropic source) on 15 & 20 meters, 11.1 db on 10 meters.
- 20 db Front-to-Back Ratio on all bands.

The Classic 36, like the smaller Classic 33, incorporates both the Mosley World-Famous Trap-Master Traps and the Mosley Classic Feed-System. Designed to operate on 10, 15 & 20 meters, this multi-band beam Model CL-36, employs the high standards of quality construction found in all Mosley products. The boom-to-mast clamping assures stability with a time-tested arrangement of mast plate, cast aluminum clamping blocks and stainless steel U-bolts. The exclusive "Balanced Capacitive Matching" system has a feed point impedance of 52 ohms at resonance. Wind Load — 210.1 lbs. at 80 MPH. Power Rating — 2 KW P.E.P. SSB. Recommended mast size — 2" OD. Approx. shipping weight — 71 lbs. via truck. $310.65

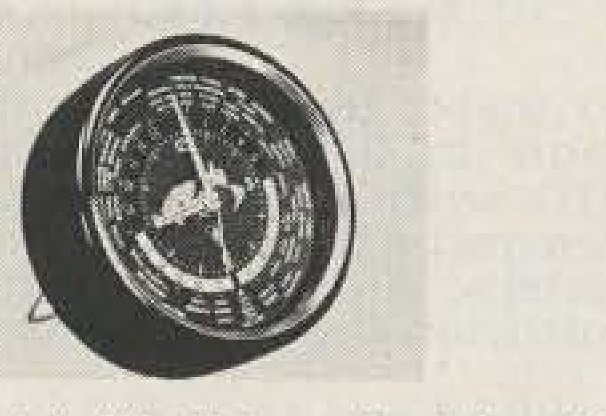


40 METER CONVERSION KIT MODEL TA-40KR

Work 40 meters in addition to 10, 15 & 20 meters by using a TA-40KR conversion kit on the radiator element of the TA-33 and TA-36. (Beams with broad band capacitive matching may not be converted!) Convert the TA-33Jr. with the MPK-3 (power conversion kit) before adding the TA-40KR kit. $92.25

SIGNAL-MASTER ANTENNA
Beam Antenna . . . Model S-402 for 40 meters

For a top signal needed to push through forty meter QRM, the Mosley Signal Master S-402 will do the trick! This 100% rust-proof 2-element beauty constructed of rugged heavy-wall aluminum is designed and engineered to provide the performance you need for both DX hunting and relaxing in a QRM free rag-chewing session. Beam is fed through link coupling, resulting in an excellent match over the entire bandwidth. $267.50



A new precision clock which tells time anywhere in the world at a glance, has been announced by **Yaesu Electronics Corporation.** The time in any principal city or time zone can be simultaneously coordinated with local time on a 24 hour basis. After the initial setting, as the clock runs, a Time Zone Hour Disc advances automatically, showing correct time all over the world without further adjustment. The clock is especially designed to withstand shock and may be hung on a wall or placed on its desk mount. The clock will run an entire year on a single 1.5 volt flashlight battery and the mechanism starts as soon as the battery is inserted. It measures six inches in diameter by two and one half inches deep. An excellent item for the business office, ham radio operator, short wave listener, boat owner, and others who want an accurate dependable clock.

Price: $30.00 Amateur net.

RADIO AMATEUR callbook

There's nothing like it !

Foreign Radio Amateur Callbook DX Listings $14.95

United States Callbook All W & K Listings $14.95

FULLY AIR TESTED — THOUSANDS ALREADY IN USE

#16 40% Copper Weld wire annealed to it handles like soft Copper wire — Rated for better than full legal power AM/CW or SSB-Coaxial or Balanced 50 to 75 ohm feedline — VSWR under 1.5 to 1 at most heights — Stainless Steel hardware — Drop Proof Insulators — Terrific Performance — No coils or traps to break down or change under weather conditions — Completely Assembled ready to put up — Guaranteed 1 year — ONE DESIGN DOES IT ALL.

MOR-GAIN

MODEL	BANDS (Meters)	PRICE	WEIGHT (Oz/Kg)	LENGTH (Ft/Mtrs)
40-20 HD	40/20	$49.50	26/.73	36/10.9
40-10 HD	40/20/15/10	59.50	36/1.01	36/10.9
80-40 HD	80/40 + 15	57.50	41/1.15	69/21.0
75-40 HD	75/40	55.00	40/1.12	66/20.1
75-40 HD (SP)	75/40	57.50	40/1.12	66/20.1
75-20 HD	75/40/20	66.50	44/1.23	66/20.1
75-20 HD (SP)	75/40/20	66.50	44/1.23	66/20.1
75-10 HD	75/40/20/15/10	74.50	48/1.34	66/20.1
75-10 HD (SP)	75/40/20/15/10	74.50	48/1.34	66/20.1
80-10 HD	80/40/20/15/10	76.50	50/1.40	69/21.0

NO TRAPS – NO COILS – NO STUBS – NO CAPACITORS

MOR-GAIN HD DIPOLES . . . ● One half the length of conventional half-wave dipoles. ● Multi-band, Multi-frequency. ● Maximum efficiency — no traps, loading coils, or stubs. ● Fully assembled and pre-tuned — no measuring, no cutting. ● All weather rated — 1 KW AM, 2.5 KW CW or PEP SSB. ● Proven performance — more than 15,000 have been delivered. ● Permit use of the full capabilities of today's 5-band xcvrs. ● One feedline for operation on all bands. ● Lowest cost/benefit antenna on the market today. ● Fast QSY — no feedline switching. ● Highest performance for the Novice as well as the Extra-Class Op.

EXCLUSIVE 66 FOOT, 75 THRU 10 METER DIPOLES

NOTES

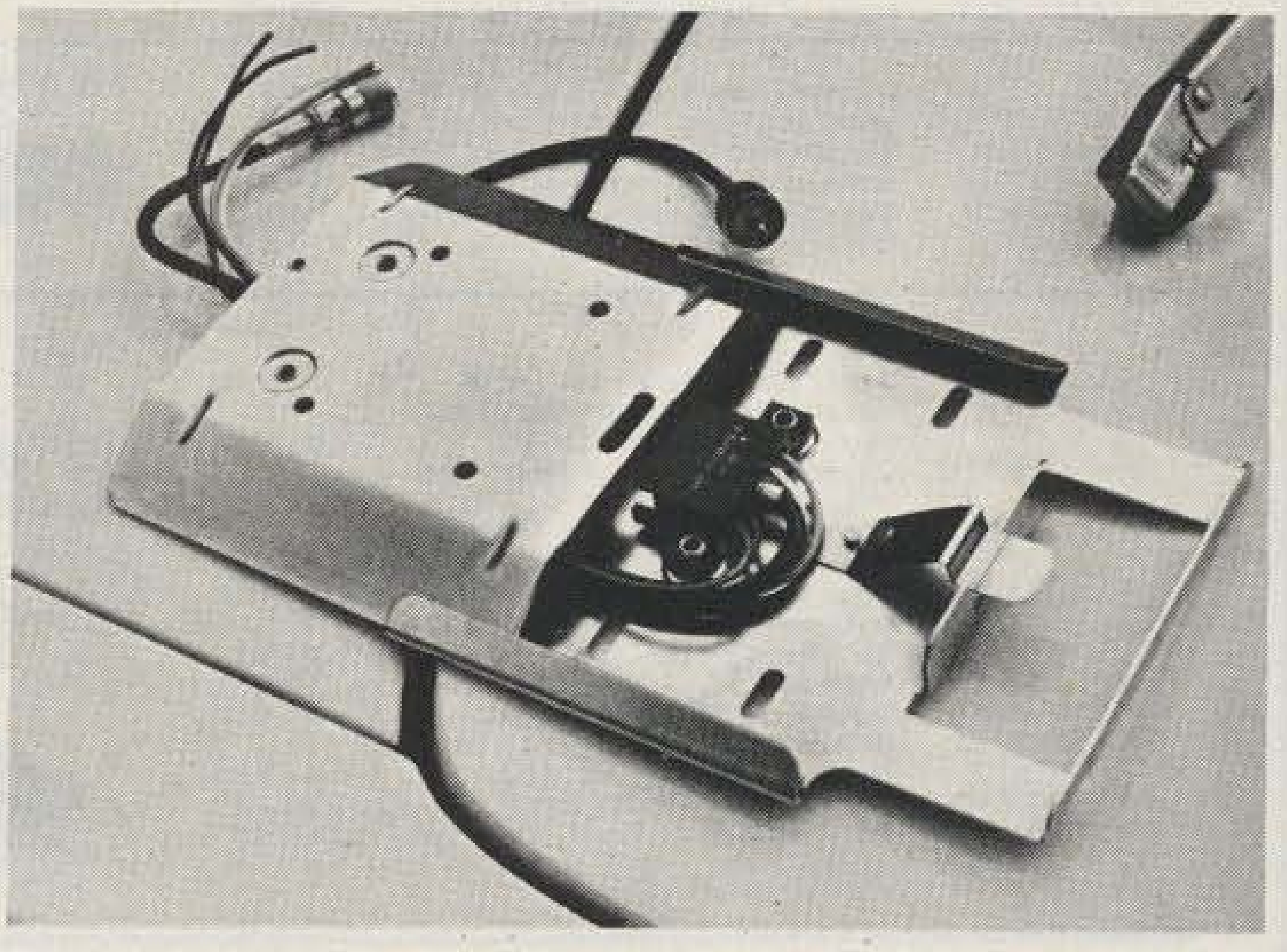
■ All models above are furnished with crimp/solder lugs.

■ All models can be furnished with a SO-239 female coaxial connector at additional cost. The SO-239 mates with the standard PL-259 male coaxial cable connector. To order this factory installed option, add the letter 'A' after the model number. Example: 40-20 HD/A.

■ 75 meter models are factory tuned to resonate at 3950 kHz. (SP) models are factory tuned to resonate at 3800 kHz. 80 meter models are factory tuned to resonate at 3650 kHz. See VSWR curves for other resonance data.

STOP A THIEF!

SAVE YOUR RADIO!



DESIGNED FOR COMMERCIAL USE UP TO 1000 MHZ.

The **TUFTS SAVE-YOUR-RADIO** bracket can save you a bundle . . . and a lot of hassle. Why worry about rig ripoff? The **TUFTS SYR** bracket mounts quickly and easily in your car and makes it possible to snap your rig out of its bracket when you park and put it out of sight.

The connector system has a special coaxial cable connector which will provide you with a lossless connection right up to 1000 MHz! No loss! In addition to the quick coax connector there are also four power and accessory connections which are made automatically when the rig is slid into its bracket . . . just what you need for feeding power and loudspeaker connections to the set.

This is a rugged bracket and connector system . . . it'll take a beating. There is a hole on each side of the 16 gauge steel plate for a padlock in case you want to leave the rig for short periods in its bracket. They'll have to rip out the dash to get it . . . and it won't be the first time for that.

With two of these brackets you can bring the mobile rig into the house and use it in seconds. On trips you can take an AC supply for the rig and use it in your hotel room. Price: $29.95

NYE VIKING CODE PRACTICE SET

NyeViking

No. 114-404-002

Get the RIGHT START!

With a NYE VIKING Code Practice Set you get a sure, smooth, Speed-X model 310-001 transmitting key, a linear circuit oscillator and amplifier, with a built-in 2" speaker, all mounted on a heavy duty aluminum base with non-skid feet. Operates on standard 9V transistor type battery (not included). Units can be connected in parallel so that two or more operators can practice sending and receiving to each other. List price, $18.50.

No. 114-320-003 – $9.90
No. 114-322-003 – Brass – $10.30

No. 114-320-001 – $8.30
No. 114-322-001 – Brass – $8.65

No. 114-310-003 – $8.25
No. 114-312-003 – Brass – $8.65

No. SSK-1 $23.95
No. SSK-1CP-Chrome – $29.95

NYE VIKING SQUEEZE KEY

Extra-long, finger-fitting molded paddles with adjustable spring tension, adjustable contact spacing. Knife-edge bearings and extra large, gold plated silver contacts! Nickel plated brass hardware and heavy, die cast base with non-skid feet. Base and dust cover black crackle finished. SSK-1 — $23.45.

SSK-1CP has heavily chrome-plated base and dust cover. List price, $29.95.

NYE VIKING SPEED-X KEYS

NYE VIKING Standard Speed-X keys feature smooth, adjustable bearings, heavy-duty silver contacts, and are mounted on a heavy oval die cast base with black wrinkle finish. Available with standard, or Navy knob, with, or without switch, and with nickel or brass plated key arm and hardware.

Pamper yourself with a Gold-Plated NYE VIKING KEY!

Model No. 114-31C-004GP has all the smooth action features of NYE Speed-X keys in a special "presentation" model. All hardware is heavily gold plated and it is mounted on onyx-like jet black plastic sub-base. List price is $50.00.

CODE PRACTICE SET You get a sure, smooth, Speed-X model 310-001 transmitting key, linear circuit oscillator and amplifier, with a built-in 2" speaker, all mounted on a heavy duty aluminum base with non-skid feet. Operates on standard 9V transistor type battery (not included). List price, $18.50.

PHONE PATCH Model No. 250-46-1 measures 6-1/2" wide, 2-1/4" high and 2-7/8" deep. List price, $36.50. Model 250-46-3, designed for use with transceivers having a built-in speaker, has its own built-in 2" x 6" 2 watt speaker. Measures 6-1/2" wide, 2-1/4" high and 2-7/8" deep. List price, $44.50.

TUFTS RADIO CATALOG

Tufts Radio Electronics • 209 Mystic Avenue • Medford MA 02155 • (617) 395-8280

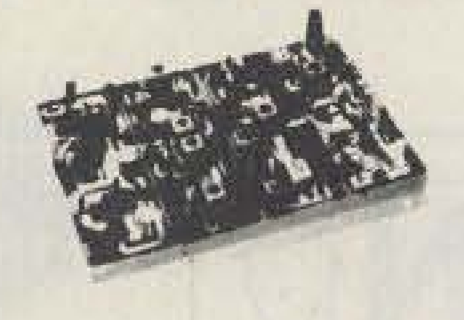
WORK ALL REPEATERS WITH OUR NEW SYNTHESIZER II

The Synthesizer II is a two meter frequency synthesizer. Frequency is adjustable in 5 kHz steps from 140.00 MHz to 149.995 MHz with its digital readout thumb wheel switching. Transmit offsets are digitally programmed on a diode matrix, and can range from 10 kHz to 10 MHz. No additional components are necessary!

Kit . . . . $169.95 Wired and tested$239.95

Also available for 220 MHz!

RECEIVERS

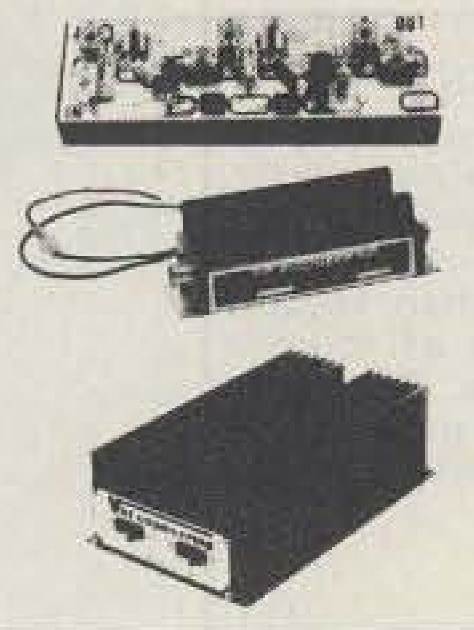


RX28C.	28-35 MHz FM receiver with 2 pole 10.7 MHz crystal filter . . .	$ 64.95
RX28C W/T . .	same as above–wired & tested. .	117.95
RX50C Kit . .	30-60 MHz rcvr w/2 pole 10.7 MHz crystal filter	64.95
RX50C W/T . .	same as above–wired & tested .	117.95
RX144C Kit . .	140-170 MHz rcvr w/2 pole 10.7 MHz crystal filter	74.95
RX114C W/T .	same as above–wired & tested .	119.95
RX220C Kit . .	210-240 MHz rcvr w/2 pole 10.7 MHz crystal filter	74.95
RX220C W/T .	same as above–wired & tested .	117.95
RX432C Kit . .	432 MHz rcvr w/2 pole 10.7 MHz crystal filter	84.95
RX432C W/T .	same as above–wired & tested .	129.95
RXCF	accessory filter for above receiver kits gives 70 dB adjacent channel rejection	8.95
RF28 Kit . . .	10 mtr RF front end 10.7 MHz out	13.50
RF50 Kit . . .	6 mtr RF front end 10.7 MHz out	13.50
RF144D Kit . .	2 mtr RF front end 10.7 MHz out	18.50
RF220D Kit . .	220 MHz RF front end 10.7 MHz out	18.50
RF432 Kit . . .	432 MHz RF front end 10.7 MHz out	29.50
IF 10.7F Kit . .	10.7 MHz IF module includes 2 pole crystal filter	29.50
FM455 Kit . . .	455 KHz IF stage plus FM detector	18.50
AS2 Kit	audio and squelch board	16.00

TRANSMITTERS

TX50	transmitter exciter, 1 watt, 6 mtr.	44.95
TX50 W/T . . .	same as above–wired & tested . .	64.95
TX144B Kit . .	transmitter exciter–1 watt–2 mtrs	34.95
TX144B W/T .	same as above–wired & tested. . .	59.95
TX220B Kit . .	transmitter exciter–1watt–220 MHz	34.95
TX220B W/T .	same as above–wired & tested . .	59.95
TX432B Kit . .	transmitter exciter 432 MHz . . .	49.95
TX432B W/T .	same as above–wired & tested . .	79.95
TX150 Kit . . .	300 milliwatt, 2 mtr transmitter .	24.95
TX150 W/T . .	same as above–wired & tested . .	39.95

POWER AMPLIFIERS

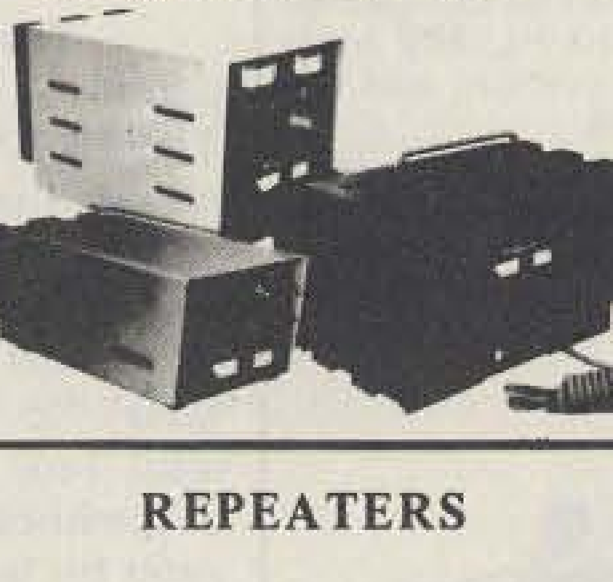


PA2501H Kit .	2 mtr power amp–kit 1w in–25w out with solid state switching, case, connectors	64.95
PA4010H Kit .	2 mtr power amp–10w in–40w out–relay switching	64.95
PA50/25 Kit. .	6 mtr power amp, 1w in, 25w out, less case, connectors & switching	54.95
PA144/15 Kit .	2 mtr power amp–1w in–15w out–less case, connectors and switching	44.95
PA144/25 Kit .	same as PA144/15 kit but 25w .	54.95
PA220/15 Kit .	similar to PA144/15 for 220 MHz	44.95
PA432/10 Kit .	power amp–similar to PA144/15 except 10w and 432 MHz	54.95
PA140/10 W/T	10w in–140w out–2 mtr amp .	219.95
PA140/30 W/T	30w in–140w out–2 mtr amp .	189.95

Blue Line . . . RF power amp, wired & tested, emission–CW-FM-SSB/AM

Model	BAND	Power Input	Power Output	
BLC 10/70	144 MHz	10W	70W	149.95
BLC 2/70	144 MHz	2W	70W	169.95
BLC 10/150	144 MHz	10W	150W	259.95
BLC 30/150	144 MHz	30W	150W	239.95
BLD 2/60	220 MHz	2W	60W	164.95
BLD 10/60	220 MHz	10W	60W	159.95
BLD 10/120	220 MHz	10W	120W	259.95
BLE 10/40	420 MHz	10W	40W	179.95
BLE 2/40	420 MHz	2W	40W	179.95
BLE 30/80	420 MHz	30W	80W	259.95
BLE 10/80	420 MHz	10W	80W	289.95

POWER SUPPLIES

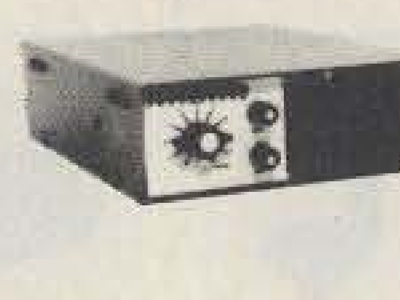


PS15C Kit . . .	15 amp–12 volt regulated power supply w/case, w/fold-back current limiting and overvoltage protection. . .	94.95
PS15C W/T. . .	same as above–wired & tested. . .	124.95
PS25M Kit. . .	25 amp–12 volt regulated power supply w/case, w/fold-back current limiting and ovp, with meter	154.95
PS 25M W/T. .	same as above–wired & tested. . .	179.95
O.V.P.	adds over voltage protection to your power supplies, 15 VDC max. . .	12.95
PS3A Kit . . .	12 volt–power supply regulator card with fold-back current limiting . .	10.95
PS3012 W/T .	new commercial duty 30 amp 12 VDC regulated power supply w/case, w/fold-back current limiting and overvoltage protection	249.95

REPEATERS

RPT50 Kit. . .	repeater–6 meter.	499.95
RPT50	repeater–6 meter, wired & tested	799.95
RPT144 Kit . .	repeater–2 mtr–15w–complete (less crystals)	499.95
RPT220 Kit . .	repeater–220 MHz–15w–complete (less crystals)	499.95
RPT432 Kit . .	repeater–10 watt–432 MHz (less crystals)	579.95
RPT144 W/T .	repeater–15 watt–2 mtr.	799.95
RPT220 W/T .	repeater–15 watt–220 MHz. . . .	799.95
RPT432 W/T .	repeater–10 watt–432 MHz. . . .	849.95
DPLA50	6 mtr close spaced duplexer	575.95
DPLA144 . . .	2 mtr, 600 KHz spaced duplexer, wired and tuned to frequency . . .	379.95
DPLA220 . . .	220 MHz duplexer, wired and tuned to frequency	379.95
DPLA432 . . .	rack mount duplexer	319.95
DSC-U	double shielded duplexer cables with PL259 connectors (pr.) . . .	25.00
DSC-N	same as above with type N connectors (pr.)	25.00

TRANSCEIVERS



TRX50 Kit . .	Complete 6 mtr FM transceiver kit, 20w out, 10 channel scan with case (less mike and crystals).	244.95
TRX144 Kit .	same as above, but 2 mtr & 15w out	234.95
TRX220 Kit .	same as above except for 220 MHz	234.95
TRX432 Kit .	same as above except 10 watt and 432MHz	254.95
TRC-1	transceiver case only	29.95
TRC-2	transceiver case and accessories . .	49.95

SYNTHESIZERS

SYN II Kit. . .	2 mtr synthesizer, transmit offsets programmable from 100 KHz–10MHz, (Mars offsets with optional adapters).	169.95
SYN II W/T . .	same as above–wired & tested. . .	239.95
SYN 220 Kit .	same as SYN II Kit except 220-225 MHz	169.95
SYN 220 W/T .	same as above–wired & tested . .	239.95

Vhf engineering

OTHER PRODUCTS BY VHF ENGINEERING

CD1 Kit	10 channel receive xtal deck w/diode switching.	$ 7.95
CD2 Kit	10 channel xmit deck w/switch and trimmers	15.50
CD3 Kit	UHF version of CD1 deck, needed for 432 multi-channel operation.	13.50
COR2 Kit . . .	carrier operated relay.	22.75
SC3 Kit	10 channel auto-scan adapter for RX with priority	19.95
Crystals	we stock most repeater and simplex pairs from 146.0-147.0 (each). .	5.00
CWID Kit . . .	159 bit, field programmable, code identifier with built-in squelch tail and ID timers	39.95
CWID	wired and tested, not programmed	54.95
CWID	wired and tested, programmed .	59.95
MIC I	2,000 ohm dynamic mike with P.T.T. and coil cord	12.95
TS1 W/T. . . .	tone squelch decoder.	59.95
TS1 W/T. . . .	installed in repeater, including interface accessories	89.95
TD3 Kit	2 tone decoder	35.95
TD3 W/T . . .	same as above–wired & tested .	59.95
HL144 W/T . .	4 pole helical resonator, wired & tested, swept tuned to 144 MHz ban . .	29.95
HL220 W/T . .	same as above tuned to 220 MHz ban	29.95
HL432 W/T . .	same as above tuned to 432 MHz ban	29.95

This NEW MFJ Versa Tuner II . . .

has SWR and dual range wattmeter, antenna switch, efficient airwound inductor, built-in balun. Up to 300 watts RF output. Matches everything from 160 thru 10 meters: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balance lines, coax lines. $79.95.

Antenna matching capacitor. 208 pf. 1000 volt spacing.

Sets power range, 300 and 30 watts. Pull for SWR.

Meter reads SWR and RF watts in 2 ranges.

Efficient airwound inductor gives more watts out and less losses.

Transmitter matching capacitor. 208 pf. 1000 volt spacing.

Only MFJ gives you this MFJ-941 Versa Tuner II with all these features at this price:

A SWR and dual range wattmeter (300 and 30 watts full scale) lets you measure RF power output for simplified tuning.

An antenna switch lets you select 2 coax fed antennas, random wire or balance line, and tuner bypass.

A new efficient airwound inductor (12 positions) gives you less losses than a tapped toroid for more watts out.

A 1:4 balun for balance lines. 1000 volt capacitor spacing. Mounting brackets for mobile installations (not shown).

With the NEW MFJ Versa Tuner II you can run your full transceiver power output — up to 300 watts RF power output — and match your transmitter to **any** feedline from 160 thru 10 Meters whether you have coax cable, balance line, or random wire.

You can tune out the SWR on your dipole, inverted vee, random wire, vertical, mobile whip, beam, quad, or whatever you have.

You can even operate all bands with just one existing antenna. No need to put up separate antennas for each band.

Increase the usable bandwidth of your mobile whip by tuning out the SWR **from inside your car.** Works great with all solid state rigs (like the Atlas) and with all tube type rigs.

It travels well, too. Its ultra compact size 5x2x6 inches fits easily in a small corner of your suitcase.

This beautiful little tuner is housed in a deluxe eggshell white Ten-Tec enclosure with walnut grain sides.

SO-239 coax connectors are provided for transmitter input and coax fed antennas. Quality five way binding posts are used for the balance line inputs (2), random wire input (1), and ground (1).

ANTENNA SWITCH lets you select 2 coax fed antennas, random wire or balance line, and tuner bypass.

$59 95

BRAND NEW

MFJ-901 VERSA TUNER

New efficient air wound coil for more watts out.

Only MFJ uses an efficient air wound inductor (12 positions) in this class of tuners to give you more watts out and less losses than a tapped toroid. Matches everything from 160 thru 10 Meters: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balance lines, coax lines. Up to 200 watts RF output. 1:4 balun for balance lines. Tune out the SWR of your mobile whip **from inside your car.** Works with all rigs. Ultra compact 5x2x6 inches. SO-239 connectors. 5 way binding posts. Ten Tec enclosure.

$49 95

BRAND NEW

MFJ-900 ECONO TUNER

Same as MFJ-901 Versa Tuner, but does not have built-in balun for balance lines. Tunes coax lines and random lines.

$39 95

MFJ-16010 RANDOM WIRE TUNER

Operate 160 thru 10 Meters. Up to 200 watts RF output. Matches high and low impedances. 12 position inductor. SO-239 connectors. 2x3x4 inches. Matches 25 to 200 ohms at 1.8 MHz.

$49 95

BRAND NEW

MFJ-202 RF NOISE BRIDGE

This MFJ RF Noise Bridge lets you adjust your antenna quickly for maximum performance. Measure resonant frequency, radiation resistance and reactance. Exclusive range extender and expanded capacitance range (± 150 pf) gives you much extended measuring range.

Tells resonant frequency and whether to shorten or lengthen your antenna for minimum SWR. Adjust your single or multiband dipole, inverted vee, beam, vertical, mobile whip or random system for maximum performance. 1 to 100 MHz. SO-239 connectors. 2x3x4 inches. 9 volt battery.

THE HAM-KEY

NOW 5 MODELS

**NEW
MODEL HK-5
ELECTRONIC KEYER
$69.95**

- Iambic circuit for squeeze keying.
- Self completing dots & dashes.
- Dot memory.
- Battery operated with provisions for external power
- Built-in side-tone monitor.
- Speed, Volume, tone & weight controls.
- Grid-block or direct keying.
- Use with external paddle such as HK-1.

Model HK-1 $29.95

- Dual lever squeeze paddle.
- Use with HK-5 or any electronic keyer.
- Heavy base with non-slip rubber feet.
- Paddles reversible for wide or close finger spacing.

Model HK-2 $19.95

- Same as HK-1, less base for those who wish to incorporate in their own Keyer.

Model HK-3 $16.95

- Deluxe straight key.
- Heavy base, no need to attach to desk.
- Velvet smooth action.

Model HK-4 $44.95

- Combination on HK-1 & HK-3 on same base.

**400% MORE RF POWER
PLUGS BETWEEN YOUR MICROPHONE AND TRANSMITTER**

$49 95

LSP-520BX. 30 db dynamic range IC log amp and 3 active filters give clean audio. RF protected. 9 V battery. 3 conductor, ¼" phone jacks for input and output. 2-3/16 x 3-1/4 x 4 inches.

$59 95

LSP-520BX II. Same as LSP-520BX but in a beautiful 2-1/8 x 3-5/8 x 5-9/16 inch Ten-Tec enclosure with uncommitted 4 pin Mic. jack, output cable, rotary function switch.

$17 95

NEW

CPO-555 Code Oscillator

**For the Newcomer to learn the Morse code.
For the Old Timer to polish his fist.
For the Code Instructor to teach his classes.**

• Send crisp clear code with plenty of volume for classroom use • Self contained speaker, volume, tone controls, aluminum cabinet • 9 V battery • Top quality U.S. construction • Uses 555 IC timer • 2-3/16 x 3-1/4 x 4 inches

$29 95

CWF-2BX Super CW Filter

By far the leader. Over 5000 in use. Razor sharp selectivity. 80 Hz bandwidth, extremely steep skirts. No ringing. Plugs between receiver and phones or connect between audio stage for speaker operation.

• Selectable BW: 80, 110, 180 Hz • 60 dB down one octave from center freq. of 750 Hz for 80 Hz BW • Reduces noise 15 dB • 9 V battery • 2-3/16 x 3-1/4 x 4 in.

$54 95

CMOS-8043 Electronic Keyer

State of the art design uses CURTIS-8043 Keyer-on-a-chip.

• Built-in Key • Dot memory • Iambic operation with external squeeze key • 8 to 50 WPM • Sidetone and speaker • Speed, volume, tone, weight controls • Ultra reliable solid state keying +300 volts max. • 4 position switch for TUNE, OFF, ON, SIDETONE OFF • Uses 4 penlight cells • 2-3/16 x 3-1/4 x 4 inches

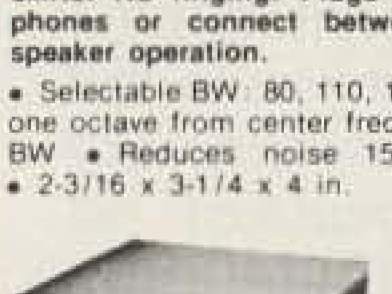
$29 95

MFJ-40T QRP Transmitter

Work the world with 5 watts on 40 Meter CW.

• No tuning • Matches 50 ohm load • Clean output with low harmonic content • Power amplifier transistor protected against burnout • Switch selects 3 crystals or VFO input • 12 VDC • 2-3/16 x 3-1/4 x 4 inches

MFJ-40V, Companion VFO $27.95
MFJ-12DC, IC Regulated Power Supply, 1 amp, 12 VDC $27.95

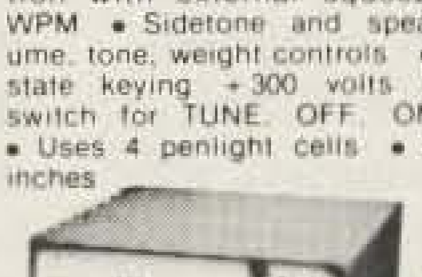


$29 95

SBF-2BX SSB Filter

Dramatically improves readability.

• Optimizes your audio to reduce sideband splatter, remove low and high pitched QRM, hiss, static crashes, background noise, 60 and 120 Hz hum • Reduces fatigue during contest, DX, and ragchewing • Plugs between phones and receiver or connect between audio stage for speaker operation • Selectable bandwidth IC active audio filter • Uses 9 volt battery • 2-3/16 x 3-1/4 x 4 inches

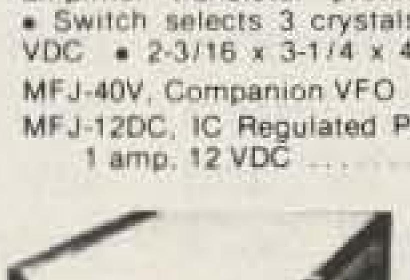


$27 95

MFJ-200BX Frequency Standard

Provides strong, precise markers every 100, 50, or 25 KHz well into VHF region.

• Exclusive circuitry suppresses all unwanted markers • Markers are **gated** for positive identification. CMOS IC's with transistor output • No direct connection necessary • Uses 9 volt battery • Adjustable trimmer for zero beating to WWV • Switch selects 100, 50, 25 KHz or OFF • 2-3/16 x 3-1/4 x 4 inches



$49 95

MFJ-1030BX Receiver Preselector

Clearly copy weak unreadable signals (increases signal 3 to 5 "S" units).

• More than 20 dB low noise gain • Separate input and output tuning controls give maximum gain and RF selectivity to significantly reject out-of-band signals and reduce image responses • Dual gate MOS FET for low noise, strong signal handling abilities • Completely stable • Optimized for 10 thru 30 MHz • 9 V battery • 2-1/8 x 3-5/8 x 5-9/16 inches

TUFTS RADIO CATALOG TUFTS RADIO

Gary McClellan
PO Box 2085
La Habra CA 90631

Schottky: A New IC Generation

—runs significantly cooler

Progress marches on, and that holds true for IC technology. If you like to work with TTL logic, there's a new type of IC you should be aware of — low-power Schottky. This logic is fairly new and is just starting to be advertised widely, so you will be seeing it in more construction projects as more authors discover its value.

So what is low-power Schottky? It is basically like TTL ICs, but with an important difference — the input lines of each IC are clamped with Schottky diodes instead of regular TTL-style diodes. Fig. 1 shows a typical gate input with diodes. The diodes are there to suppress ringing and overvoltages on the input lines. However, standard TTL-type diodes have relatively high shunt capacitance, shunting some of the signal away from the input. This limits the performance of standard ICs to about 20 to 50 MHz or so. Now add Schottky diodes, which have dramatically reduced capacitance and which switch faster with less signal kept from the gate input. As a result, the circuit becomes faster. Typical low-power Schottky runs more than twice as fast as standard TTL. And there is more. The circuit elements on the chip can be made larger (resistors), which means less power is consumed. In fact, most low-power Schottky runs at about 1/5 the power consumption of regular TTL. So you see, there is a lot to gain, both speedwise and powerwise, with low-power Schottky.

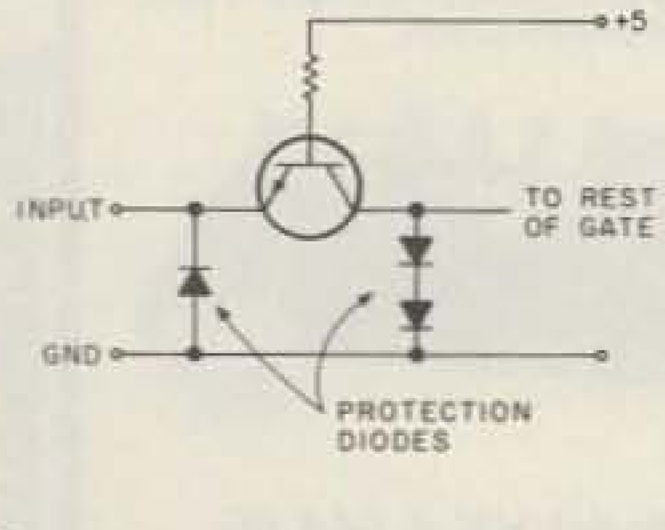


Fig. 1. Input circuit of gate or most other TTL ICs, for that matter.

Low-power Schottky can also offer some big advantages circuitwise. The first advantage is that low-power Schottky can be plugged in readily in place of standard TTL ICs. And better yet, circuit changes are seldom required. You can identify the most popular 7400 series by the addition of the letters "LS" between the "74" and the last two numbers. So a low-power Schottky (from here on "LS") part would look like this: 74LS00, which replaces 7400, or 74LS90, which replaces 7490. Another advantage is the increased speed, of course. A typical 7490 TTL decade counter IC will work to about 20 to 25 MHz. A 74LS90 will run from about 32 to 40 MHz and do it at 1/5 the power drain to boot.

The reduced power drain has great implications. Less drain means less strain on the power supply, be it battery or ac type. That means the batteries last longer, or there will be longer life for the power supply voltage regulator, which will run cooler. The filter capacitors will live longer because there will be less ripple on them and thus less self-heating. Are you sure you still want to keep using obsolete TTL?

But, to be fair, 74LSs do have some disadvantages. There are only two that will really concern you. The first one is that not all 74-series TTL have directly compatible 74LS cousins. This problem depends upon the circuit you are using. Prime candidates are the one-shots 74121 through 74123. There may be a little tweaking of the RC networks required to get the necessary pulse width. As for any others, the simplest way to locate and correct a problem is to substitute a standard TTL part for the one in question. I did this with a counter, where a single 74LS part had to drive the reset line of many TTL counters. It didn't work. But substituting a standard TTL part solved the problem, so I left it in. The other problem is that they are more noise sensitive than regular TTL. But with properly designed logic boards with good grounds and properly laid out power buses with bypasses, you shouldn't have any problems. 90% of the time you can just plug in a 74LS and have it work perfectly, so remember that!

Now that I have shown you the advantages and disadvantages of 74LSs, let's get to the heart of the matter and look at some real life applications. I'll also show you the results.

Counters can readily benefit from 74LSs. I have been involved with the design and manufacture of several units for years, and 74LSs have helped my designs tremendously. The first counter was the model 302, and it was designed in the fall of 1975, using CMOS and 3 TTL chips. This is one of the very first pocket-size frequency counters, and it measured frequency to a little over 20 MHz. Battery drain was around 125 mA — a little stiff from the power supply of 4 "AA"-size nicad batteries. Recently, I switched to 74LSs and gained plenty. The frequency range easily went to 30 MHz, and the power drain fell to under 100 mA in the worst case! None of the other parts were changed. Looking back on this change now, I realize that the LED display in this counter was the biggest current drain and not the TTL, as before. It's a nice improvement.

Another counter was improved with 74LSs. This one was my bench Heath 1B1103 unit, the one that goes to 180 MHz and has a low-frequency multiplier. I replaced all 7490s, about 16 of them, with 74LS90s. Then the 7475s went, all 8 of them. Then I replaced the 74151s, the 7400, the 7473s, the 7413, and so on. In fact, most of the ICs were changed. Only the ECL stuff, an op amp, and the 7441 nixie drivers stayed. It worked fairly well, but replacing IC211 with the old 7473 was necessary to cure a problem with the latching of the display. It then worked as well as before, the power consumption dropped to 30 Watts from 45 Watts, and the case ran a little cooler. The timebase stability improved slightly, and the power supply was dissipating less heat. The filter capacitors are still being run within their voltage ratings. In all, it was a successful conversion. It cost $29.00 in prime quality parts from Active Electronic Sales of Framingham MA to do the job.

Another gadget that gained from 74LSs was the Radio Shack ASCII keyboard I recently built for a data terminal. It "features" 18 old-fashioned TTL ICs. The current drain was 500 mA average. Then I switched to 74LSs. I was able to change every part but the 74154, which wasn't available, and the two 7410s – 74LS10s gave me trouble here. The result was an ASCII encoded keyboard that worked well and drew only 150 mA average. And that includes a 9 LED display that shows what ASCII code is sent when a key is pressed. Total cost was $12.00.

I would like to make a few comments concerning these applications before closing. 74LSs can be more expensive; the 7490s run 44 cents and the 74LS90s run 85 cents to $1.25 each, as this is written. However, Motorola is getting into 74LSs something big, and that should help to cut prices. Another thing is that there are a lot of quality parts on the surplus market – too early for junk, I guess, and that is amazing. I bought some 74LSs from a west coast parts house that is well known for super service and for selling not so super stuff (less known). I received some of the finest parts I have ever received from this house! So you are benefitting now and in the future. ■

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Salinas CA 93901

Use Noise To Tune Your Station

—build this simple noise generator

For several years, there have been quite a few noise bridges available. The noise generators are all based on the use of noisy diodes (usually a 1N753, 6.8-volt zener, back biased) which go through two or three stages of transistor amplification and then into the various configurations of bridges. They all do a creditable job, but they use a great number of components and draw too much current. I have trouble with every one I build, because it is not possible to build two generators that would put out the same broad band of noise.

A noise bridge is a must for mobile operation, where the mobile antennas have a high Q and should be operated at very close to resonance. Using a bridge, you can QSY quickly and readjust the top section of the antenna for exact resonance. Plus or minus 10 kHz is about the tolerable excursion.

During the war in 1942, I was doing some research at the radiation laboratory at MIT, Cambridge MA. We needed a "white noise" source for jamming enemy radar. Recently, recalling that tube-version white noise generator, I built and tested a transistor version. The results were far superior to any of the systems I tried with the noise diode. Some diodes were so noisy that little amplification was needed; others made so little noise that even three stages of amplification were not enough, to say nothing of the undesirable added current consumption.

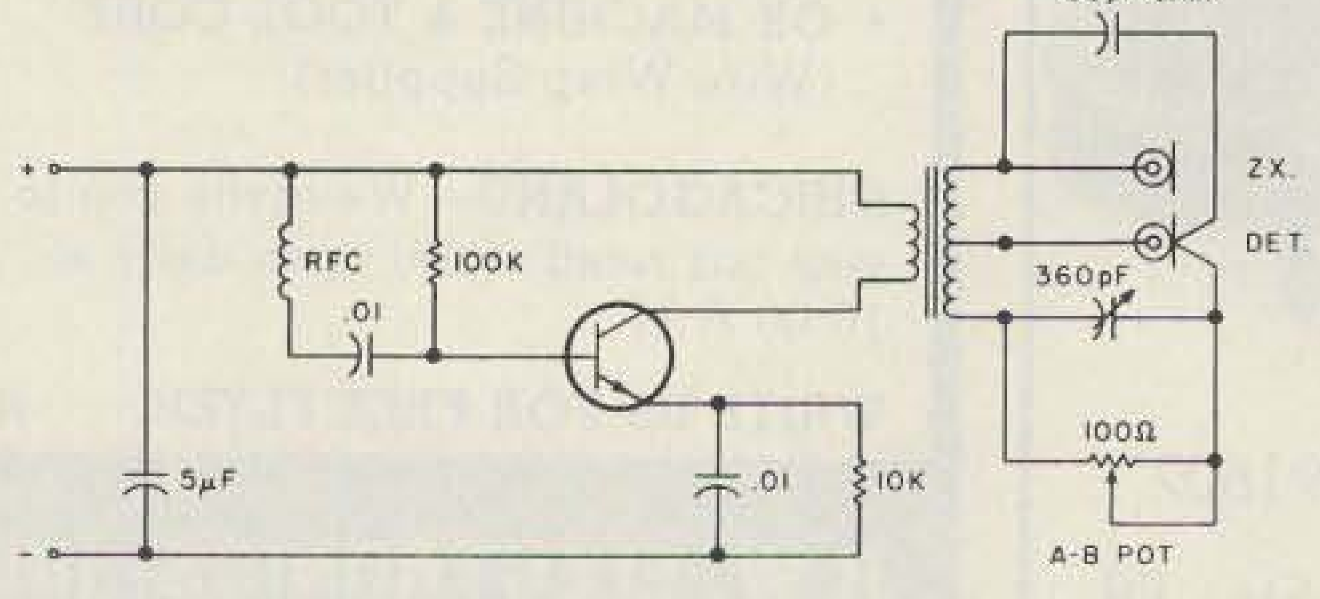


Fig. 1. Diagram layout for the noise generator. Note the special layout wiring arrangement for the output circuit. Both capacitor leads are the same length, and they terminate at one solder lug on the DET coax fitting. Keep the potentiometer leads as short as possible.

How does this new circuit generate such a wide band of frequencies? This oscillator may be described as a self-quenching device which is capable of generating square wave pulses with nearly ideal square wave. We know that a pure sine wave does not contain any harmonics. A sine wave with some distortion generates some harmonics. A "perfect" square wave generator will produce its fundamental frequency plus all the higher frequencies to infinity. With the materials used to produce this "perfect" square wave, we find that the usable bandwidth is actually far short of infinity. Lacking sophisticated measuring equipment, my tests indicate that the usable noise frequency is from somewhere around 500 kHz to far beyond 30 MHz, the amplitude remaining quite constant over the entire bandwidth.

Oscillation starts at 1½ to 2 volts and continues at a nearly constant level on all the HFs up to 20 volts. At 3 volts, the current drawn is about 200 microamps. At 20 volts, the current drawn is about 6 milliamps. This is ideal, whether you want to use the bridge with two AA cells, a 9-volt transistor radio battery, or 13 volts from your car battery.

Several types of NPN transistors, high gain and in metal can or plastic, were tried. Most of them worked; however, I found that 2N2222 transistors are the most easily obtained. They are cheap, and I recommend them.

There are three components that must be given special notice. They are the RFC, the number of turns on the toroid and the manner in which they are wound, and the disc ceramic capacitors. The .01 disc capacitors must be the 1,000-volt variety. Several dozen units have been built and sold with no problem, with these precautions taken.

The RFC consists of 24 to 26 turns of enamel #26 to #30 wire wound on a form about 4 to 6 mm (3/16 to 1/4 inch) in diameter and about 17 mm long (11/16"). The form to hold the wire may be any reasonably good insulator, such as a plastic knitting needle or a piece of #8 house wire with the wire removed from the plastic insulation and a wooden match stick inserted in place of the wire to make it rigid. A 1/2-Watt ohmite-type of resistor, more than 100,000 Ohms, also worked fine.

The toroid coil is wound on a T-50-2 (red mix) core. The core is rated for use between 500 kHz and 30 MHz.

For the primary winding on the core, which will connect to the transistor collector and to the positive voltage, wind 24 turns as follows: Hold the toroid in

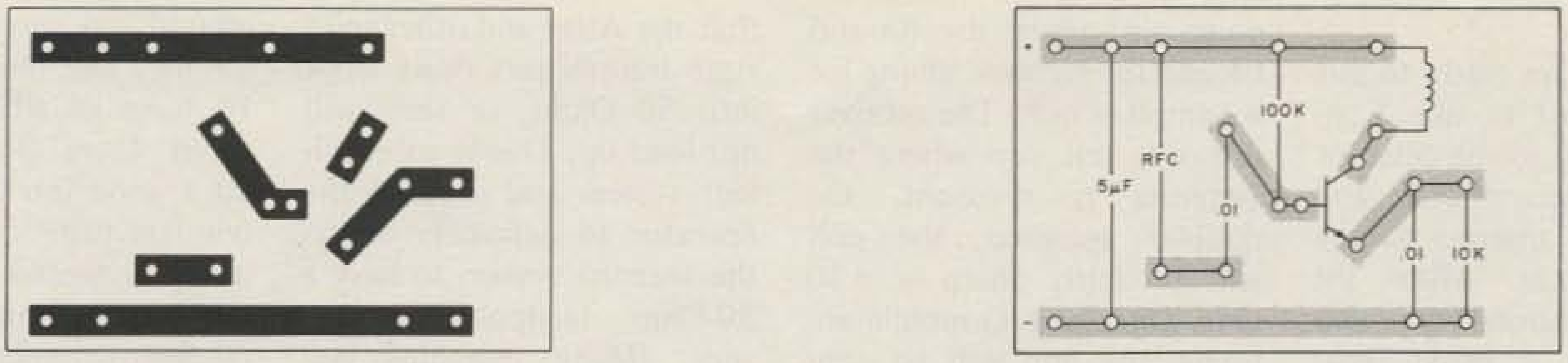


Fig. 2. PC board — actual size.

your fingers, in a horizontal plane, and make the first turn with the starting end of the wire sticking up out of the core about 5 cm (2 inches). Now make the first turn so that the long end of the wire will come out of the toroid on the right side of the starting wire. The next turn will come out of the toroid on the left side of the starting wire. The completed primary winding will have a bundle of 24 turns, or 12 turns on each side of the starting wire. By doing this, we have a coil with minimum stray capacitance coupling between primary and secondary.

The secondary, or output winding, will be 12 turns of bifilar, wound and connected to give a total of 24 turns. Cut two pieces of the same enamel wire about 40 cm (16") long. Put two ends together in a vise, and twist them about 1 twist per cm (2½ twists per inch). Wind twelve turns on the toroid, leaving about 5 cm (2") of wire out of the toroid on both ends. Use a pocketknife to carefully remove all the enamel far enough back toward the toroid so that you can cut off the excess length not needed for making the connections to the coax connectors, bearing in mind that the two outside ends of the winding should be exactly the same length.

Select a wire from each end of the winding and test with an ohmmeter to find two wires that do not show continuity. Connect those two wires together. Now you should test to make sure that you do have continuity on the remaining two wires. This gives you the two bifilar windings in series, with a center-tap, or 24 total turns. Adjust these windings on the toroid core so that the primary and secondary windings have equal spacing between the two coils on both sides.

The toroid core with its windings should be mounted on a small plastic or wood pillar about 2 mm (5/8") long and cemented on the PC board. The white silicone cement available at nearly any store is ideal for this purpose.

Refer to the PC board layout. Follow the pattern quite closely and all the parts will fit nicely into place. The values of all the components are indicated in Fig. 1. The diagram showing the Rx pot, the 360 pF variable capacitor, the 180 pF fixed capacitor, and two coax connectors should be studied and used as a guide for making it a balanced system. That is, the lead lengths of the fixed 180 pF capacitor should be the same length as the lead of the 360 pF variable where they connect to a solder lug at the detector (DET) output coax fitting. The lead to the 100-Ohm ohmite pot should be as short as possible. The PC board is shown actual size, and it may be used as a template to make small punch marks on the copper foil. All of my boards were laid out using G-C Electronics' .080" printed circuit drafting tape available at nearly all electronic stores.

With all the components in place and soldered, you are ready to test the unit. Run an antenna wire or coax from your receiver to the output of the noise generator. Even though you do not use a piece of coax at this time, a single wire from the receiver antenna input connected to either one of the output wires will permit a strong signal to be heard if the system oscillates. Apply 5 to 10 volts to the noise generator with the proper polarity, and there should be ample noise. Check for oscillation at 1½ volts or 2 volts, then increase the voltage to as high as 20 volts. No noticeable change in noise level should take place if the system is working properly.

As shown in the diagram, one of the outside bifilar wires will go to the nearest outside lug on the 100-Ohm pot. Also, the stator of the variable capacitor will go to this same point. The center lug on the pot and the rotor tab from the variable capacitor go to ground, which should be the lead connected to a solder lug under one of the four bolts holding the detector coax connector. Next, connect the center-tap wires from the toroid winding to the detector coax fitting center lead. The remaining single wire from the toroid winding will connect to the Zx coax fitting center lead. At the same connector, solder one end of the 180 pF silver-mica capacitor to the center conductor and the other end of the capacitor to ground at the same detector coax fitting. Short leads from the toroid should be equal in length to maintain a good balance.

The potentiometer (variable resistance) will be labeled Rx. The variable capacitor will be labeled Cx, with a center position which will be used for measuring circuits with neither inductive nor capacitive reactance. The coax fitting that has the center tap of the toroid winding will be labeled detector. (In this case, it will be your receiver.) The third wire will go to the other coax fitting and will be labeled Zx, which means the "unknown impedance," such as an antenna system, coil-capacitor combination, etc.

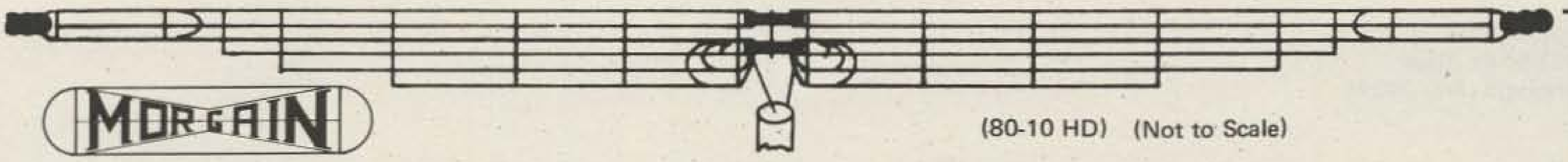
Calibrate the Rx potentiometer by using an ohmmeter which has reasonably good ohmic calibration. Calibration points should be made at 10, 20, 30, 40, 50, 75, and 100 Ohms. The radius for your calibration marks should coincide with the dial pointer that you use.

Now you may check the use of the variable capacitor. First, suppose you insert a 50-Ohm noninductive resistor with short leads into the Zx outlet. Carefully null both dials for the deepest null. Remove the resistor and solder on two leads about 20 cm (8") long. Connect these leads to the Zx outlet. You will now have to adjust the variable capacitor to regain a deep null, tuning out the inductive reactance. Then repeat the same process with a 50 to 100 pF capacitor connected in parallel with the resistor. Note that the variable capacitor must now be adjusted to the opposite side of center to obtain a null and tune out the capacitive reactance. You may calibrate the capacitor dial, if you wish, but I just eyeball the dial pointer and approximate the value of reactance as being somewhere between 0 (at the center of the dial adjustment) and 180 pF capacitive or inductive.

Now you are ready to put the instrument to use. Connect a receiver to the detector via a short piece of coax and connect the antenna to the Rx connector. With the instrument turned on, you should hear a husky roar from the receiver. With the Cx dial set at the half scale position and the Zx dial set at about 50 Ohms, tune the receiver until you hear a partial null of the noise. When you get a minimum noise dip, adjust the Rx and Cx and the receiver tuning for a complete null. The receiver dial will tell you where the antenna is resonant. On doublet antennas, the null will be fairly sharp — ± 10 kHz. On a high-Q mobile antenna, the null will be very sharp — ± 2 kHz.

For mobile antennas with an impedance of 30 to 75 Ohms, on which a short transmission line is used, I would not worry about impedance matching. The exception is that the Atlas and other solid state transmitters must work into 50 Ohms, or they will not load up. This is an excellent system and requires the operator to definitely design the antenna system to have a 50-Ohm feedpoint impedance. (Many matching systems not properly adjusted cause more loss than there would be without them.)

Below 30 Ohms, I would definitely use a matching system. A fixed capacitor at the base of the antenna to ground was never satisfactory for me. The more usual 7 to 10 turns of #10 or #8 wire about 4 cm (1½") diameter do a good job on 75, and a few less turns do a good job on 40. I would like to point out that a mobile antenna feedpoint impedance is dependent upon the location of the "center" loading coil. The longer the top section is (and fewer the turns in the loading coil), the higher the feedpoint impedance will be, within reason. ■



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75-40 HD (SP)	75/40	57.50	40/1.12	66/20.1
75-20 HD	75/40/20	66.50	44/1.23	66/20.1
75-20 HD (SP)	75/40/20	66.50	44/1.23	66/20.1
75-10 HD	75/40/20/15/10	74.50	48/1.34	66/20.1
75-10 HD (SP)	75/40/20/15/10	74.50	48/1.34	66/20.1
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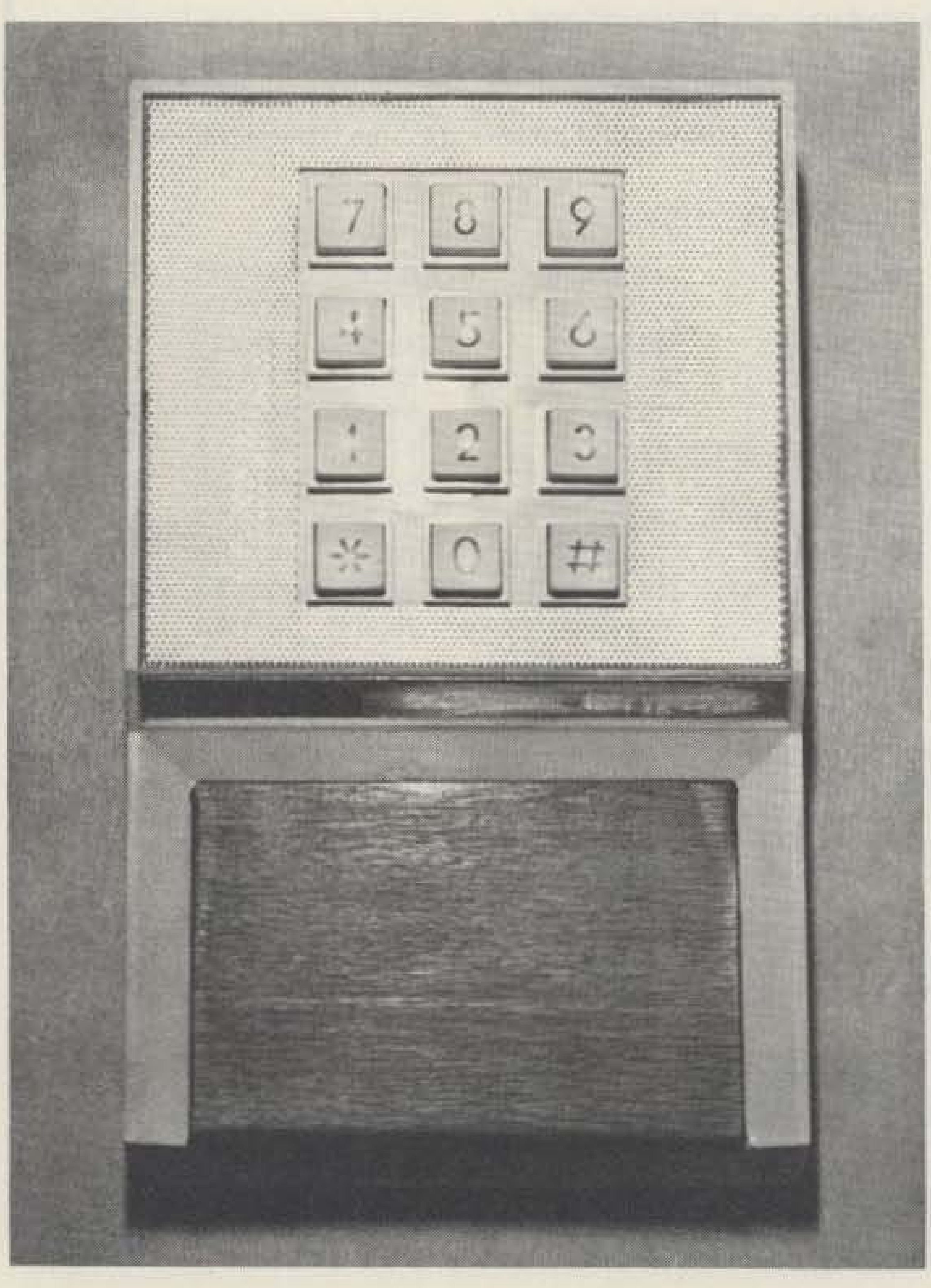
How To Thwart Ma's Dial System

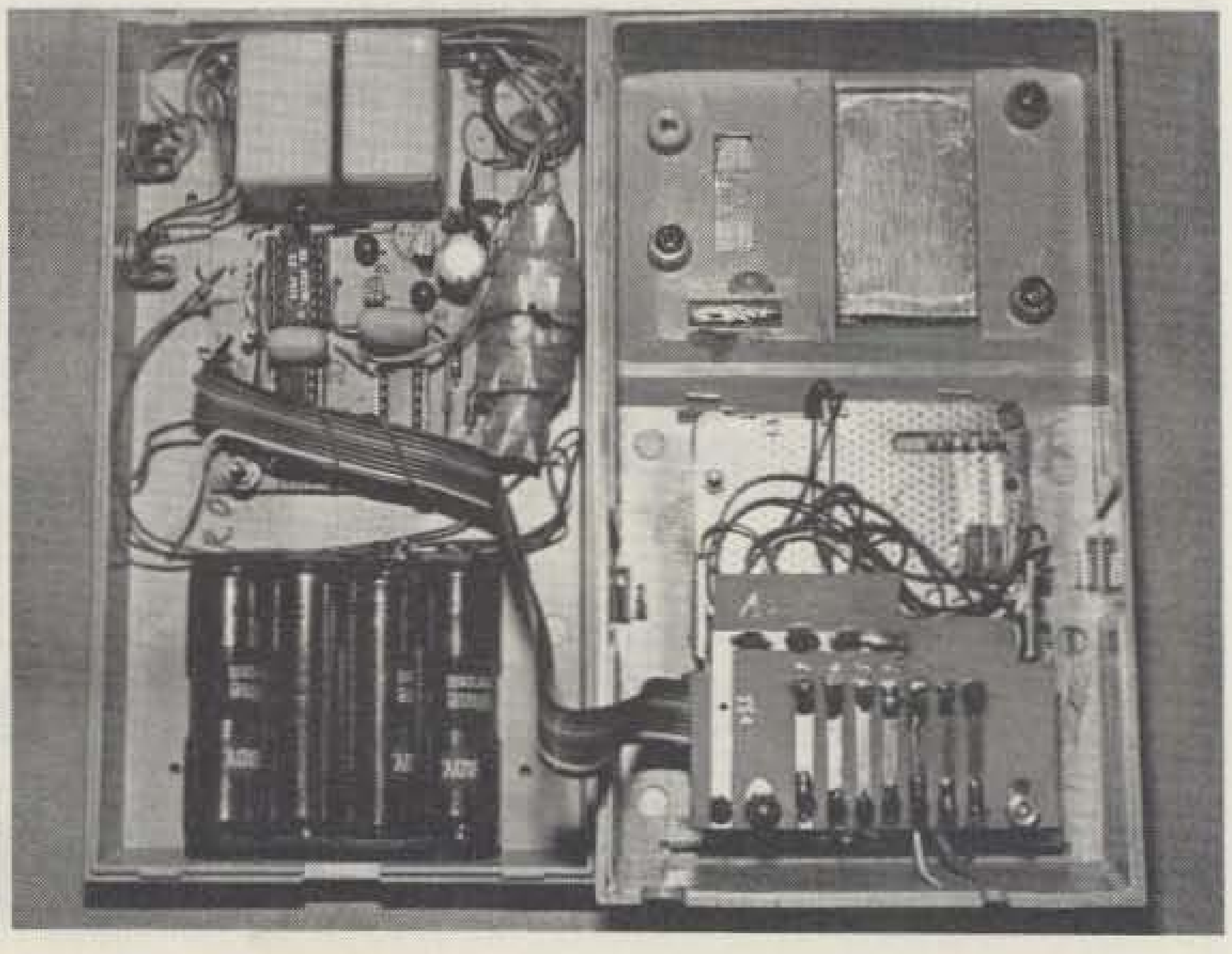
— TouchtoneTM-to-dial converter

Photos by Ronald Turner



There are still many towns and cities that do not have touchtoneTM telephone facilities, and it looks as though this will be the case for quite some time to come. But you who live in these areas now can enjoy the ease and convenience of making calls by pushing buttons. You can also have the fun of building your push-button phone converter.

The circuit described here uses two Motorola ICs and one common gate IC. Twelve push-button switches are connected to an MC14419, which accepts a 2 of 7 grounded input and gives a binary coded output corresponding to the button pushed. The second IC, an MC14408 or MC14409, accepts the BCD input and outputs two signals. The OPL output gives a burst of pulses equal to the number desired. The DRO output goes high at the beginning of the pulse



burst and goes low after the last pulse in that digit if the 14409 is used. In the 14408, DRO will go high at the same time but will remain high until the last pulse of the last digit of the number called. Two other inputs used in this circuit are CRQ and RED. When CRQ is taken low (Vss), internal counters are reset, and the IC is made ready for the next call.

A very nice feature of this chip is the memory. Each number called – up to 16 digits long – is entered into memory and remains there until power is removed or another call is made. This number can be recalled simply by resetting with CRQ and then taking RED low. Of course, only the last number called will be in memory, but maybe some computer nut reading this will find a way to connect some RAM or ROM to the BCD input and store many numbers. If someone does, I hope he will drop me a line and tell me how.

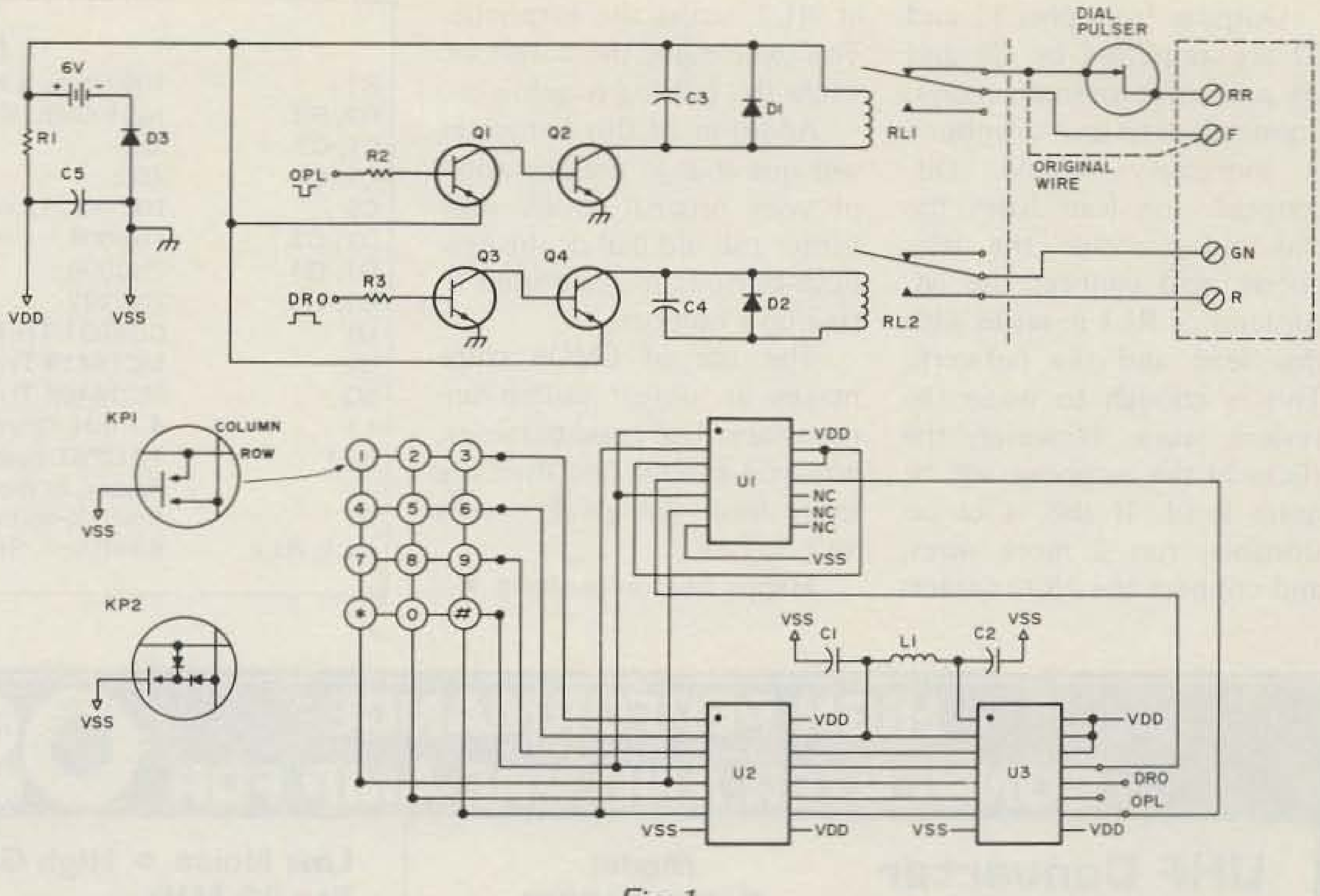
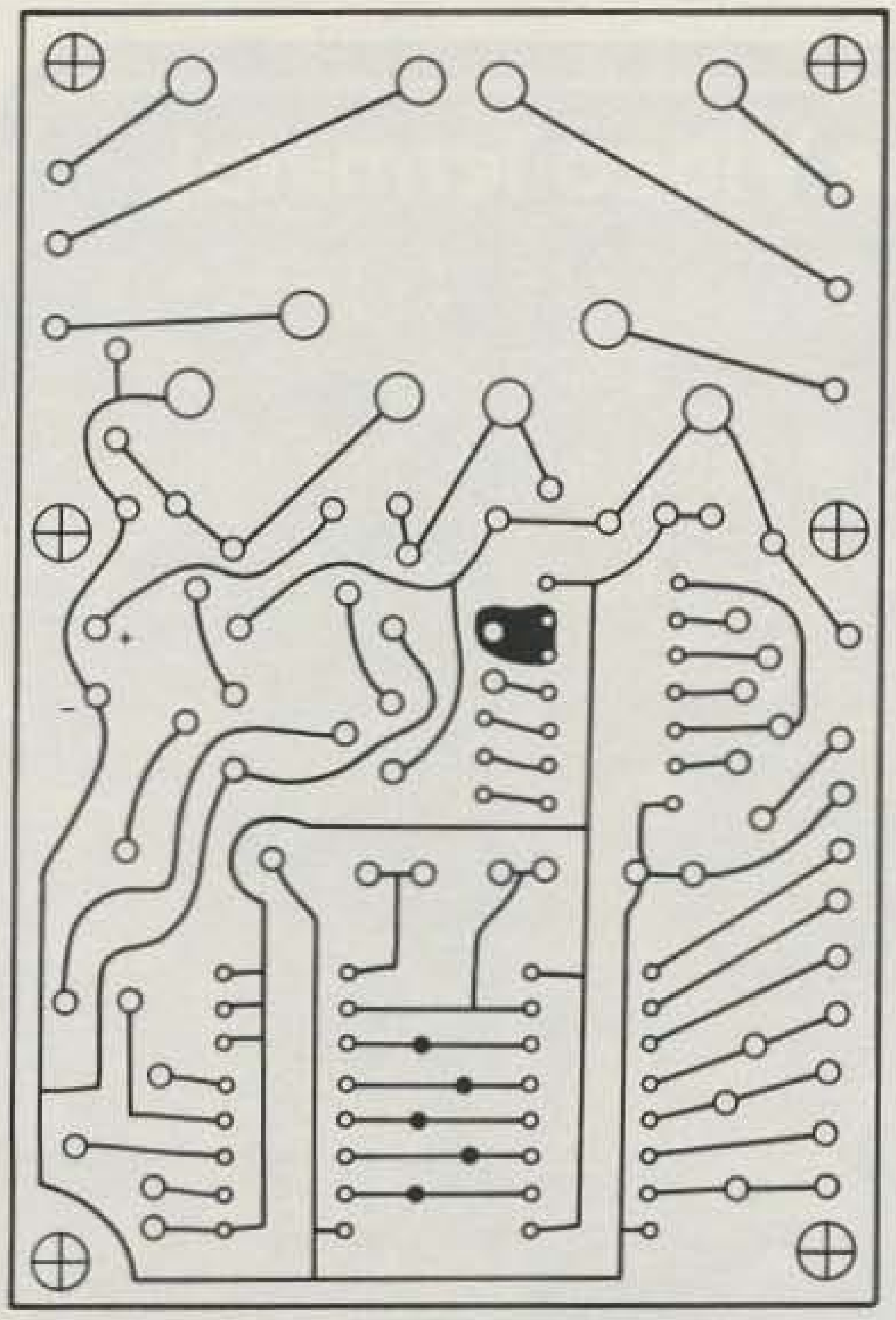


Fig. 1.

The data sheet that comes with the MC14409 has a very complete schematic of a modified Western Electric K-500 telephone, so I will not describe that here. The push-button telephone converter is for the person who may not want to modify his phone to that extent or perhaps not want to use a phone at all. How about replacing the push-buttons with a handful of relays and connecting the output directly to the phone lines for use in a repeater station without tone facilities? In any case, Ma Bell would probably like to have something to say about it, but that's between you and Ma Bell.

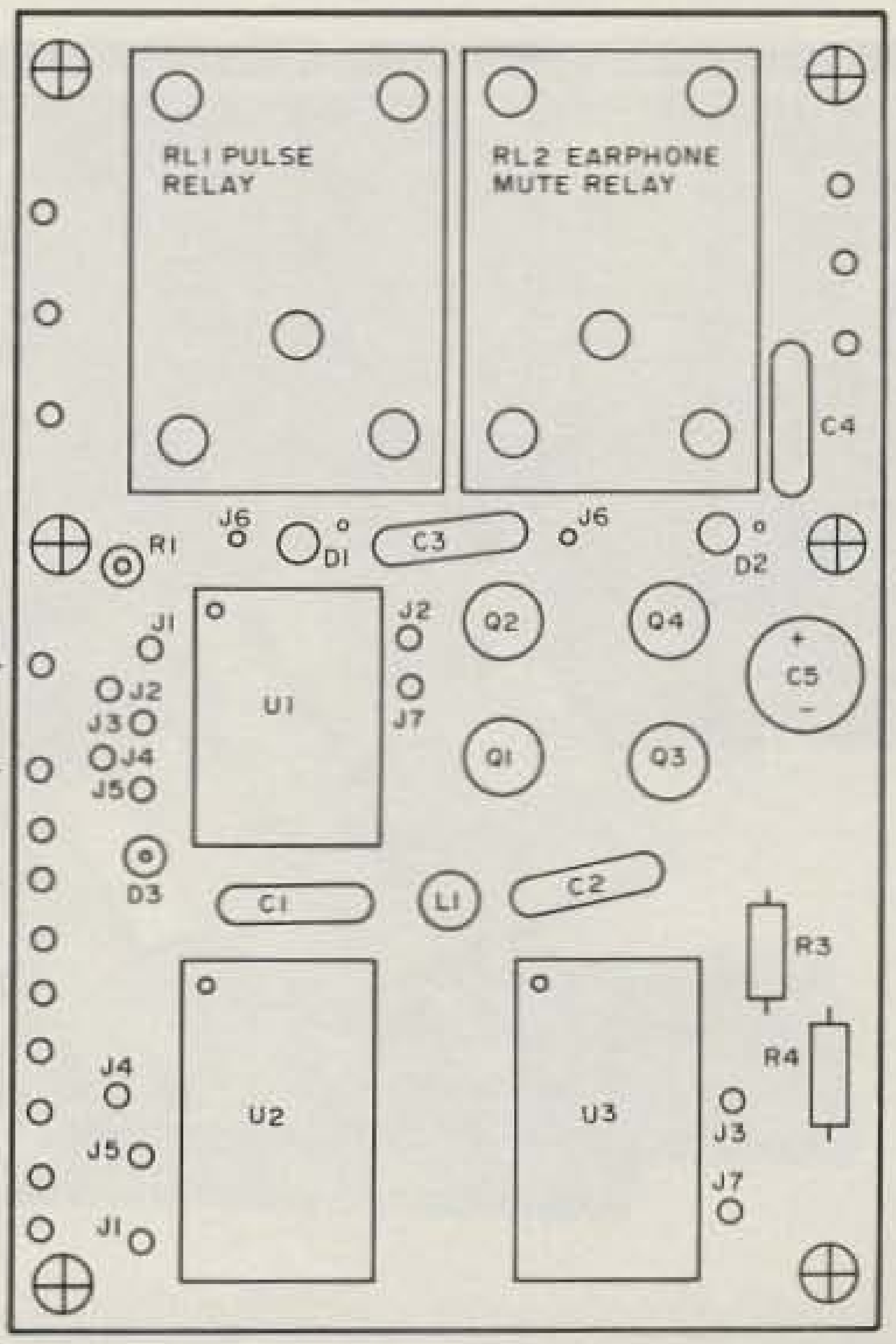
Incidentally, beware of the push-button connection shown on the MC14409 sheet. It's wrong. Use the one on the MC14419 sheet or the one described here. If you prefer a push-button pad with the buttons laid out in the standard adding-machine format, as I do, most pads can be disassembled and the buttons rearranged. One exception is the Chomerics pad. The one I like best is made by Automatic Electric and can be purchased from Meshna in Lynn MA for about $7. The button action is very nice, and it can be rearranged easily.

The purpose of the CD4001 is to activate the CRQ input when * is depressed and the redial feature when # is depressed. This leaves one NOR gate for future use, if desired.



FOIL SIDE

Fig. 2. PC board – foil side.



COMPONENT SIDE

Fig. 3. PC board – component side.

Outputs from pins 11 and 12 are amplified by Q1 and Q4 and drive the two relays. Connection to any telephone is extremely simple. Disconnect one lead from the dial pulser inside the telephone, and connect the NC contacts of RL1 in series with this lead and the network. This is enough to make the system work. However, the clicks in the earphone will be quite loud. If this is objectionable, run 2 more wires, and connect the NO contacts of RL2 across the earphone. This will mute the earphone while the pulsing is going on.

Addition of this converter will not change the operation of your original rotary dial. Either the old dial or the new push-buttons may be used to ring up a number.

The use of CMOS chips makes an on/off switch unnecessary. Use good batteries, and you should find their life quite long. AA alkaline cells will do fine.

Happy button-pushing. ■

Parts List

R1	100 Ohm, ¼ Watt
R2, R3	100k Ohm, ¼ Watt
C1, C2	.04
C3, C4	.022
C5	100 mF, 12 volt
D1, D3	1N4004
Q1, Q4	2N3906
Q2, Q3	2N2222
U1	CD4001 Tri-Tek, Glendale AZ
U2	MC14419 Tri-Tek, Glendale AZ
U3	MC14409 Tri-Tek, Glendale AZ
L1	4.7 mH, Cramer Electric, Newton MA
KP1	12 DPST push-buttons or 12 SPST push-buttons with diodes, as shown
B1	four 1½-volt cells in series
RL1, RL2	6-volt coil, SPDT contacts, Tri-Tek

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GT-500A Xcvr	329
AC-400 Supply	79
FM-210 2M FM	95

Gonset

Com II 2M	$ 75
Com II 6M	69
Com IV 2M	129
GC-105 2M	115
G-28 Xcvr	149
G-50 Xcvr	149

Hallicrafters

S-108 Receiver	$ 99
SX-101 Receiver	159
HT-32 Transmitter	179
HT-32B Transmitter	269
SX-99 Receiver	79
SX-115 Receiver	349
HT-37 Transmitter	159
HT-40 Transmitter	49
SX-99 Receiver	99
SX-117 Receiver	189
SR-150 Xcvr	259
SR-160 Xcvr	159
SX-146 Receiver	175
HT-44 Transmitter	159
SX-111 Receiver	149
SX-122 Receiver	249
S-36 UHF Receiver	125

Hammarlund

HQ-110 A VHF Receiver	$189
HQ-110C Receiver	119
HQ-110AC Receiver	149
HQ-145X Receiver	169
HQ-170C Receiver	159
HQ-180 Receiver	379
HQ-215 Receiver	259
SP-600 Receiver	179
HX-50 Transmitter	169

Heathkit

SB-300 Receiver	$199
SB-301 Receiver	229
HR-10-B Receiver	69
SB-303 Receiver	269
SB-220 Linear Amp	449
SB-102 Trivcvr	379
DX-60B Transmitter	69
HW-32 Transmitter	85
HW-100 Transceiver	249
SB-100 Transceiver	299
SB-401 Transmitter	249
SB-101 Transceiver	349
SB-650 Digital Freq. Display	149
HW-30 Twoer	29
Also Sixer	29
H-10 Monitor	69
VHF-1 Seneca	79
HW-12 Transmitter	75
HP-23 AC Supply	49
HP-23B AC Supply	59
HW-202 2M FM Xcvr	159
SB-620 Spectrum Analyz	120
SB-102 Xcvr	369
SB-610 Scope	95
HA-20 6m Linear	125
SB-634 Ccnsole	175
SB-604 Spkr	29.50
SB-644 VFO	129.50
SB-230 Linear	359
SB-104 Transceiver	625

ICOM

IC-21 2M FM Xcvr	$299
IC-230 Demo	369
IC-22A 2M FM Xcvr	185
IC-30A 432 MCFM	269

Johnson

1-KW Matchbox/SWR	$195
Courier Linear	139
Ranger I Transmitter	85
Ranger II Transmitter	139
Valiant I Transmitter	129
Invader 2000 Xmitt	495

Kenwood

T-599 Transmitter	$289
R-599 Receiver	289
TS-520 Tranc	429
QR-666	259
QR-666 Receiver	239
TV 502 Transvertor	179

Knight

T-60 Transmitter	$ 39
r-100 Receiver	59
TR-108 Trancur 2M	79

Lafayette

HA-800 Receiver	$ 89
HP-350 Receiver	149
HE-45 Transceiver	49

Midland

509 H.T.	$149

Millen

92200 Transmatch	$149
90651-A Grid Dipper	95

National

NC-270 Receiver	$119
NC-300 Receiver	129
NCX-5 Transceiver	279
NCX-5MKII Transcvr	299
NC-303 Receiver	199
AC-500 AC Supply	69
NCX-500 Transceiver	199
NCX-3 Transceiver	169
NC-190 Receiver	149
NC-105 Receiver	69

Regency

HR-2B 2M FM	$169
HR-220 FM 220 MC	185
AR-2 2M Amplifier	85
HR-25 2M FM	225
HR-6 Meter FM	189

SBE

SB-34 Transceiver	$249
SB-33 Transceiver	189
SB-144 2M FM	175
SBZ-LP Linear	179

Standard

SRC-146 HT	$149
826 M Trnscvr	195
SRC-144	395
SRC-851T	250

Swan

700-CX Xcvr	$459
260 Cygnet	289
279 Cygnet	329
500 Xcvr	299
500 CX Xcvr	389
117-XC AC Supply	95
14X DC Module	39
MK II Linear	475
KK VI 6 Meter	550
250 C 6M Xcvr	349
FM 2X2M Xcvr	169
FM-1210A 2M	249
350 Transceiver	269
350C Xcvr	299
600R Receiver	339
600T Transmitter	399
410 VFO	79

Tempo

Tempo one Xcvr	$299
AC One Supply	79
FMH 2M H.T.	149
CL-220 Tincur 220 MC	179
FMH 2M w/Talkie	149

Ten Tec

PM-3 Trnsur	$ 49
Argonaut Xcvr	199
KR-40 Keyer	79
RX-10 Receiver	49
S-30 Signalizer	29
Triton II	479

Yaesu

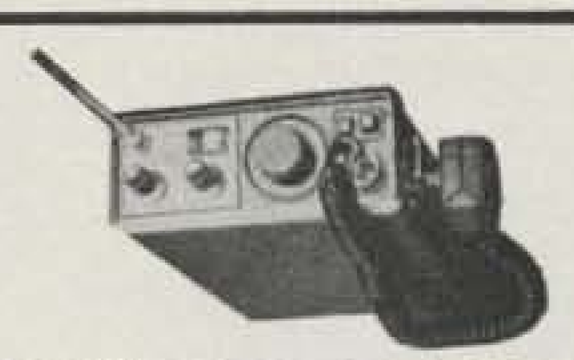
FT-401 Xcvr	$499
FRDX 400SD Rec	325
FT 2 Auto 2M FM	249
FT-101B Xcvr	549
FL-2100B Linear	295
FV-101 VFO	79
101E Xcvr Demo	695

Test Equipment Bargains

Boonton "Q" Meter	$295
Tektronix 5140	249
Tektronix 545A	950
5 3/54A Plug-in wide band preamp	75
Hickok 695 Generator	69
Bendix BC221 Freq Meter	39
Polarad Spectrum Analyzers A84T	1695
Hewlett Packard 400C	75
Precision E-400 Signal Generator	125
Electro Impulse Spectrum Analyzer	395
Dyna/Sciences Model 330 Digital Multimeter	195
Hewlett Packard 4905A Ultra Sonic Detector	550
Hewlett Packard 120A Scope	250
TS-323/UR Frequency Meter	175
Hewlett Packard 4910B Open Fault Locator	650
Bird Mod 43	80
General Radio 650A	150
Measurements Mod 80	195
Nems Clark 1400	495
Ballantine 300H	175
PACO Scope Mod-S-50	75
Singer FM-10C	3495
Simpson 260 V.O.M.	49.50

ICOM IC22S

Regular $299, save $50; buy an ICOM IC22S for $299 (no trades) and take a $50 credit for another purchase.



KENWOOD TR-2200A

Regular $229, save $30; buy a Kenwood TR2200A for $229 (no trades) and take a $30 credit for another purchase.

MIDLAND 13-510

Regular $399, save $50; buy a Midland 13-510 for $399 (no trades) and take a $50 credit for another purchase.

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TS820 $ 919.00
TS80S $1098.00

YAESU

FT101E – 799.00
FT101EE – 759.00
FT101EX – 699.00

DRAKE

TR4CW – $799.00

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The Double Whammy Mobile Clarifier

—tune out the wife and kids

John Skubick K8JS
1040 Meadowbrook
Warren OH 44484

It isn't easy to listen to a mobile rig with a car full of two or more children or nonham adults, especially when the mobile rig's tinny, raspy built-in speaker directs the audio under the dash or into the deep-pile carpeting. A separate speaker under the dash or in a console/floor mount is no good either, even though it may be aimed up toward your head.

This listening problem is caused by the fact that the above-mentioned speaker systems in your car are about the same distance from your ears as the voices from the other occupants. Turning up the rig's volume only causes the other passengers (especially adults) to subconsciously raise their voices to compensate for the rig's loudness. The passengers and passenger compartment are acting like an agc mixing chamber to your ears!

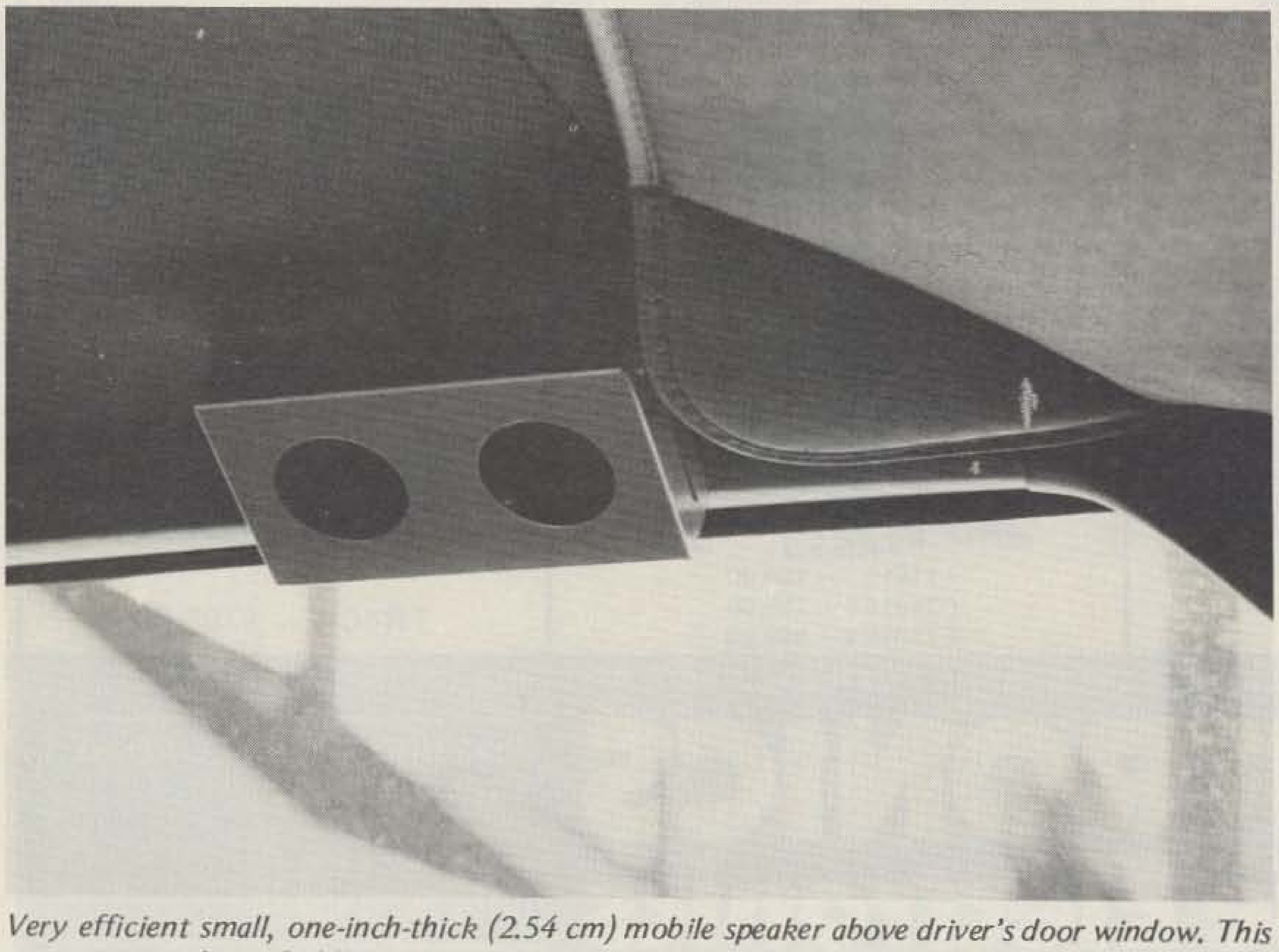
There are many solutions to this problem. I chose to devise a civilized course of action by greatly reducing the distance between the mobile rig's acoustical output and my ears. This installation had to be small, neat, and cheap. A speaker mounted on the ceiling seemed like the way to go. Since I couldn't find a small, thin commercial speaker, I built one.

Most of the parts came from Radio Shack. The enclosure is an aluminum chassis measuring 4½ x 2½ x 1 in. (11.43 x 6.35 x 2.54 cm). The exact size isn't very critical. The idea is to keep it small and thin.

The two speakers had to have one side of their rims filed flat so that they could fit inside the specified enclosure. The speakers were wired in parallel and contact cemented at their rims inside the chassis enclosure. The speaker output ports consist of two 1½-inch (3.68 cm) holes punched into the enclosure box, to get maximum sound output. I felt that this was much quicker and neater than trying to drill a bunch of cute little off-center holes and ending up with a junky appearance.

Don't worry about the 4-Ohm speaker impedance. You will find that a solid state amplifier with an 8-Ohm output will work often the same or louder into a 4-Ohm system. Many solid state mobile rigs have 4-Ohm audio output, anyway.

The backplate is simply a sheet of aluminum cut to cover the rear opening. Do not leave this off. Otherwise, it may have the typical tinny sound many metal-boxed so-called "communications speakers" seem to have. Instead of attaching the backplate with screws, I strongly suggest contact cement. This will insure against resonance buzzing, and the speaker can still be easily removed with a little prying.



Very efficient small, one-inch-thick (2.54 cm) mobile speaker above driver's door window. This one is mounted in a Cadillac.

Mounting

Here are two suggested ways to mount your speaker. If your car has a plastic-type ceiling, try using a little dab of contact cement on the back of the speaker near each of the four corners. It won't hurt the ceiling material, and it can be easily removed should you decide to relocate the speaker.

Another method is to use double-sided foam tape. I found that this won't stick (for over 10 minutes) on plastic-type ceilings, but it will adhere to the inside door-edge molding (if your car has one). In this case, part of the speaker is on the molding and part on the ceiling material — sort of at a 45 degree angle, aimed right at your ear. This is the method I ended up with. Incidentally, adhesive foam tape won't hurt the mounting surfaces, is easily removed, and is found in most discount variety stores. The photo shows the foam tape method.

My audio cable is thin speaker wire with miniature phone plugs at both ends — one for the rig and one for the speaker. This cable is routed under the dash, along the "crack" between the dash and body, and up the side between the windshield and corner post. It is entirely hidden, except for a couple inches at the speaker. With the visor up, even that is hidden (see photo).

Speaker Phasing

A very important point to remember is that both speaker cones must move in the same direction at the same time. This is easily accomplished by wiring up the speakers and attaching and detaching a fresh 1½-volt battery across the speaker leads to observe the directional movement of both cones. If both speaker cones are moving in and out in the same direction when the battery is connected and disconnected, then all is well. If not, then simply reverse the leads to only one of the speakers, and try again.

The reason for having two speakers is a matter of getting increased efficiency plus a better response in such a small enclosure.

Results

This speaker turned out to have suprisingly good voice quality, and it is very efficient! For example, it certainly improves the low audio output from an Icom 230. With other rigs that have several Watts of audio, such as the Koyokuto FM-144, the volume control is just cracked open a little.

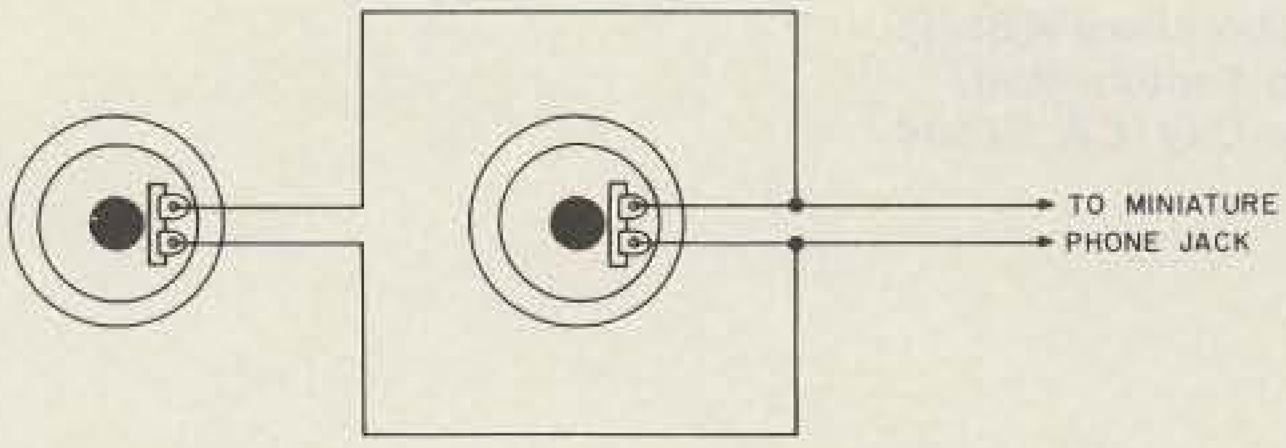


Fig. 1. Rear view drawing of two 2½-inch miniature speakers wired in parallel. See text for proper phasing. The enclosure has two 1½-inch-diameter holes, one for each speaker. Mount the speakers as close to each other as possible.

Also, it seems that the passengers aren't bothered by it and tend to talk lower. Meanwhile, to you, it is giving plenty of QRM-free volume. I believe this type of speaker system is very usable for hams who are family men or schools bus drivers!

When I describe my mobile speaker system and its intended purpose, many have asked me, "Why not use headphones instead?" Well, I tried them, and they are no good while driving. They tend to isolate the driver from his total driving awareness and could be creating a potentially dangerous situation. Apparently many states think so, too, such as New York, because they prohibit wearing headphones while operating a motor vehicle.

After using this inexpensive little speaker positioned near my head in the car, I have come to the conclusion that it is definitely superior to what I and others have been using in the past while driving and QSOing in a fully occupied family auto.

Inquiries accompanied by an SASE will be gladly answered. ■

Bob Thornburg WB6JPI
13135 Ventura Blvd.
Studio City CA 91604

Danger! Microwave Radiation!

—*just how much is dangerous?*

Whenever I talk to a group of amateurs about using microwaves for linking or other forms of communication, I am always asked, "Aren't microwaves dangerous? Won't they sterilize or otherwise damage my body?" The answer to these questions must be, "Yes, but . . . " Like a lot of things in a high-technology society, there is some danger, but the major problem is due to ignorance. The 120 V ac line into your radio can easily kill you, but that doesn't stop you from talking because you understand (or at least respect) the potential (pun intended) for the ac line to do you in. The same is true of the kilowatt(s) of rf energy in your HF transmitter and even (under rare conditions) the 12 volts in your car. These things you understand and have experience in handling, and, although they are dangerous, they don't stop or even slow you down much.

Microwave energy is nothing more than ordinary rf that has its frequency too high. There is nothing otherwise different about it. The higher frequency allows it to be concentrated (visualize it as being "focused"), and here is where it gets into trouble. We will get back to this, but first let's look at how animal parts and people cook.

The danger to people is the same property that cooks meat in the microwave oven. People parts cook, too. Of particular susceptibility are the eyes. The abnormal heating (cooking) of the eye causes a reaction in the cornea (lens) to protect itself by growing a protective layer over the lens (not unlike a blister on a burn, except it's permanent). This growth, or cataract, causes blindness. Other parts of the body are also susceptible to damage due to heating, including possible generic changes to your offspring from immediate exposure to your reproductive parts, but the required heating is several orders of magnitude greater than that required to make cataracts. Note that the damage is just overheating — no death rays, no magic, nothing but abnormal heating of living tissue. Other parts can cook, too. The moisture in the stuff that makes up people creates a lossy medium to all rf, including microwaves. You can be a dummy load at most all frequencies where your dimensions are greater than a significant fraction of a wavelength. Also, you usually can't feel yourself cooking, as the stuff with the moisture doesn't have the proper nerve endings to sense what is happening. You don't feel a thing all the way from rare to well done. Now that we know what happens and have an idea as to how it happens, let's look back to the microwaves and see how much of them it takes to cook.

The measurement of cooking capability is Watts per square centimeter. This parameter is known as power density and is the value to respect. Frequency alone is not the factor. It doesn't really matter how high the frequency is; what counts is the power density. This is the cooker. Now let's play with some equations.

Power density of a radiated signal can be calculated by: $P_D = P_T G_T / 4\pi R^2$, where P_D is the power density, P_T is the radiated power, G_T is the antenna gain, and R is the distance from the antenna to where the power density is to be determined.

Note that power density goes up with power available, goes up with increased antenna gain, and goes up the closer to the radiating source you are (less distance). Note that frequency isn't even allowed to enter this basic equation. So why condemn microwaves for their frequency? You'll see . . . Also note that, at zero distance (R = 0), the power density is infinite. Nature doesn't like infinites, so there is another phenomenon that controls power density at very close distances from an antenna (anything that radiates is an antenna, even a leaky oven door). When looking at the rf fields very close to an antenna, you can only "see" part of the antenna and can't get the full effect of the power density defined by the equation above. The region where you are too close for the above equation to apply is the "near field region" and extends to a point defined by $R_{NF} = \pi D^2 / 8\lambda$, where R_{NF} if the distance of the near field range, λ is the wavelength, and D is the major dimension of the antenna.

Within this region, the fields are getting organized and figuring out what it is they are supposed to be doing. The power density is flailing about but is about equal to or less than the value at R_{NF}. So, the maximum power density is that found at R_{NF}. Combine these two equations to find this value:

$$P_{Dmax} = 16 P_T G_T \lambda^2 / \pi^2 D^4$$

Now we have frequency in the act (or its relative wavelength: $\lambda = C/f$, where C is the velocity of light). But, as frequency goes up, wavelength goes down and the power density also goes down. This is backwards from what we have been led to believe: The higher the frequency, the *lower the power density*? Well, you can't believe equations anyway. Let's look at some examples: Consider a 100 Watt transmitter at 2 meters operating into a 10 dB gain antenna (D

= 3 meters, as in a superstation master). P_{Dmax} = 20 Watts/meter^2, or in the more common dimensions, P_{Dmax} = 2.0 milliwatts/cm^2.

Now let's just move the problem to 450 MHz (λ = .67m, D = 1 meter): P_{Dmax} = 18.2 mW/cm^2.

Aha! Frequency went up and so did the power density; maybe equations don't lie. Note that our examples have been in the VHF/UHF band. The equations also work there, but our concern is with microwaves. But first let's discuss what level of power density is important. Where do we have a problem? Just like with voltage: 5-10 volts can't give you much of a shock, but 250 volts can really wake you up. At what level is power density a problem?

Well, here is where the experts don't all agree. Some say 10 mW/cm^2 is safe for a few hours exposure (to the most vulnerable eye); others say 50 mW/cm^2 for a short term; still others say continuous exposure of 1 mW/cm^2 will not cause damage. Certainly a microwave oven at 150 mW/cm^2 can do damage rather quickly. Well, to us this is a hobby. We don't have to make a living risking our body parts or defending our country from the deck of an aircraft carrier being sprayed by a dozen multimegawatt radars, so let's use the lowest number, 1 milliwatt/cm^2.

Now that we have established our worry level at 1 milliwatt/cm^2, we can also note from our example above that the 100 Watts at 450 MHz surely exceeds this level, and we aren't even in the "deadly" microwaves yet. Really, what I am saying is that danger exists at UHF and even VHF frequencies as well. Don't radiate 100 Watts of UHF less than 5 feet (R_{NF}) from your body. On to the microwave problem.

Let's do some more examples. How about a 10 Watt source at 1200 MHz radiating from a 4-foot diameter dish (gain = 21 dB)? The maximum power density is 1.5 mW/cw^2 — well in the "don't look now" range. How about these new Gunn sources making 20 milliwatts at 10,000 MHz with a 17 dB gain horn (D = 3.5 inches)? Power density is also 1.5 mW/cm^2. is nothing safe? How about our Gunn source just radiating out of its waveguide (G = 7 dB; D = 1 inch)? Well, look out (pun intended), the power density is 8.8 mW/cm^2. Well, removing the antenna made it worse; let's put a 19-inch dish (32 dB gain) on the source and find that the maximum power density dropped to .021 mW/cm^2 even though the effective radiated power increased from 100 milliwatts to 32 Watts. Ah, the mysteries of microwaves.

Also be fully aware that we have been calculating the maximum power density available anywhere around the antenna. If you move 6 inches away from the antenna in the 10 GHz, 20 mW, 17 dB gain example, the power density drops from a maximum of 1.5 mW/cm^2 to 0.342 mW/cm^2, and, in general, a little way away from all the above examples, the radiation is safe. But, it can be dangerous; have respect.

This note has hopefully shed some light and generated some insight into the danger of microwave radiation. The nature of the danger and the mechanism causing it has been exposed, and, hopefully, any fear about using microwaves you might have had is or can be converted to simple respect. Danger exists; you can be hurt messing around with these weird frequencies, but don't let that stop you. By the way, it is recommended that you don't sign your microwave QSOs with "here's looking up your old waveguide . . ." ■

Corrections

In reference to my article, "Track OSCAR In Real Time," which appeared in the November issue of *73 Magazine*, several readers have written or called for help in getting it up and running. Their problems have fallen into three categories: new owners of HP-67 calculators, not yet familiar with the instruction set of the calculator; failure to load the constants before attempting to run the program; and confusion caused by my use of the computer programming symbol "*" to indicate multiplication instead of "X", which I should have used in an HP-67 program.

I will record the program on cards for any reader who sends me two blank HP-67 cards (one for the program and one for the data constants) accompanied by an SASE and his station latitude and longitude.

Thomas Prewitt W9IJ
2212 S. Webster
Kokomo IN 46901

Another correction for my "FCC Math" series, this one brought to my attention by Francesco Turella I3SWU. My apologies for letting this one slip through. In the February issue, on page 14, in the right-hand column, 2/3 of the way down: 2 x 3 x 6 x 1 = 36, not the 24 I somehow came up with. And that's, of course, 3.6 x 10^1 instead of 2.4 x 10^1. Dividing 3.6 into 10 gives about 3. So we get 300 kilohms instead of 400 kilohms at 60 Hz. Sorry about that!

John F. Leahy WB6CKN
Gonzales CA

This is in reference to my article, "Visual OSCAR Finder," in the November, 1977, issue. You may want to publish the following modification:

1. Change the 1k ½ W resistor in the power supply to a 12Ω ½ W.
2. Change the 3200 uF capacitor in the first 555 timer to a 33 uF tantalum.
3. Change R1 to a 1 meg pot.
4. Change the 10k above R1 to 1 meg.
5. Change the 68k below R1 to 1 meg.

These changes make the timing more stable. I have gotten a lot of mail response on this article, showing a high rate of interest. PC boards are still available.

Michael J. DiJulio WB2BWJ
Maplewood NJ

Social Events

CHARLOTTE NC
APR 1-2

The Mecklenburg Amateur Radio Society, W4BFB, will hold its 1978 Metrolina Hamfest on April 1-2, 1978, in Charlotte's new Civic Center. Plenty of parking will be available. The Roanoke Division of the ARRL will hold its annual convention in conjunction with this hamfest.

PITTSBURGH PA
APR 2

The University of Pittsburgh Amateur Radio Association's (W3YI) second annual hamfest will be held on Sunday, April 2, 1978. Festivities will be from 10 am to 5 pm in the Student Union Building across from the Cathedral of Learning. (Note: Meter parking is free on Sundays!) Check-ins on .69/.09 and .52/.52. For detailed information (and a map), send an SASE to the University of Pittsburgh Amateur Radio Association W3YI, Box 304 Schenley Hall, Pittsburgh PA 15260, or call Mark Bell WA3VJL at (412)-931-6700 or Harry Bloomberg WA3TBL at (412)-624-7768.

TOWSON MD
APR 2

The Greater Baltimore Hamboree will be held on Sunday, April 2, at 8 am at Calvert Hall College, Goucher Blvd. and LaSalle Road, Towson MD 21204 (1 mile south of exit 28, Beltway-Interstate 695). There will be food service, prizes, and a giant flea market. Admission charge is $2.50. 250 tables inside the gym and cafeteria. Over 2000 attended last year. For information and table reservation, contact Bro. Gerald Malseed W3WVC at the school or call (301)-825-4266.

COLUMBUS GA
APR 8-9

The Columbus Amateur Radio Club will hold its annual hamfest on April 8-9, 1978, at the Columbus Municipal Auditorium at the fairgrounds. Spacious, air-conditioned exhibit area, prizes, flea market, Saturday night banquet, FCC exams, and a luncheon will be featured. For further information, please contact Eddie Kosobucki K4JNL, 5525 Perry Ave., Columbus GA 31904.

ST. CLAIR SHORES MI
APR 9

The South Eastern Michigan Amateur Radio Association's annual hamfest will be held April 9, 1978. The hours will be 8 am until 3 pm, and the location is South Lake High School, 21900 E. Nine Mile Road at Mack Ave., St. Clair Shores, Michigan. This location is in the Detroit metropolitan area. For additional information, please contact, by mail or by phone, Philip R. Walker WD8BYE, 26541 Ridgemont, Roseville MI 48066, (313)-778-1297.

NEWINGTON CT
APR 9

The Pioneer Valley Repeater Association (PVRA) flea market and auction will be held on Sunday, April 9, 1978, from 10:00 am to 5:00 pm at Newington CT. Setup time starts at 9:00 am. This is an event for everyone. There will be planned family activities, food available, and free parking. The flea market and auction will run simultaneously in separate rooms. The auction will be held at regular posted intervals, with all items to be sold at each time slot on display before each auction. The ARRL Club and Training Department will have a Novice information booth to answer questions and provide League information. A guided tour of the League's new headquarters building will start at 2:00 pm. Those planning to take this tour should drop Arnie K1NFE a note indicating how many will be in their party. Talk-in will be on 19/79, 04/64 and 52 simplex. Admission will be $1.00, tables $5.00, and auction commission 10%. For additional information and guaranteed flea market space, contact: Arnie DePascal K1NFE, 20 Iowa Pl., Bristol CT 06010.

MADISON WI
APR 9

The Madison Area Repeater Association's 6th annual swapfest will be held, rain or shine, on Sunday, April 9, 1978, at the Dane County Expo Center Youth Building, Madison WI. Electronic equipment and components for hams, computer hobbyists, and experimenters. Delicious food, free movies, arts and crafts—bring the whole family for delicious food and entertainment. Tickets are $1.50 in advance, $2.00 at the door. Tables are $2.00 in advance, $3.00 at the door. Excellent overnight camping accommodations. Make check or money order payable to MARA, Box 3403, Madison WI 53704. Reservations must be in by April 1, 1978.

WELLESLEY MA
APR 15

The Wellesley Amateur Radio Society will be conducting its annual auction on Saturday, April 15, 1978, beginning at 11:00 am, at the Wellesley High School cafeteria on Rice Street, Wellesley, Massachusetts. Talk-in will be on 96/36, 04/64 and 52. Doors open at 10:00 am. Contact Kevin P. Kelly WA1YHV, 7 Lawnwood Place, Charlestown MA 02129.

ROCHESTER MN
APR 15

The Rochester Repeater Society will hold its hamfest on April 15, 1978, at St. John's Grade School, 420 West Center Street, Rochester, Minnesota. Doors open at 9:00 am. Door prize donations $1.00; admission $1.00; children under 12 free; $2.50 for tables. Plenty of parking available. Talk-in on 146.22/82 WRØAFT and 52. Take I-90 to Rt. 52 or Rt. 63 and go north. For advance ticket sales and information, contact Joe Fishburn KØTS, 2514 4th Avenue, N.W., Rochester MN 55901, (507)-288-2676, or Gary Sharp WD8AMA, 1610 34th St., N.W., Rochester MN (507)-282-5119.

MOBILE AL
APR 15-16

The Mobile Amateur Radio Club will hold its annual hamfest and computerfest at the University of South Alabama in Mobile AL on Saturday and Sunday, April 15 and 16, 1978. Swap and shop indoors both days from 9 am 'til 5 pm. Activities for the ladies and children. Campsites are available. Over 2000 are expected for the biggest fest on the Gulf Coast. For more information, contact: Ed Coker WA4VPI, 7650 Ashley Court, Mobile AL 36619.

POMONA NJ
APR 16

The Shore Points Amateur Radio Club will hold its first annual hamfest on Sunday, April 16, 1978, at Stockton State College, Pomona NJ. It will be from 9 am to 4 pm, rain or shine (sellers come at 7 am). There will be more than 200 indoor table spaces ($4 each) and 400 tailgating spaces ($2 each), an

New Products

from page 31

"S"-meter, and ten Watts of audio which may be used with an external horn for hailing purposes.

Hams who are CBers and own Horizon units may have them converted to ten meters at Standard's remanufacturing centers. The suggested distributor price for converting the 29 to 29-10 is $20.00, the 29 to 29A-10, $40.00, and the 29A to 29A-10, $25.00. New transceivers may be purchased at $106.95 (23 channels) or $119.95 (40 channels). Both converted and new units have a 90-day factory warranty. A data sheet is available to all amateurs. *Standard Communications Corp., PO Box 92151, Los Angeles CA 90009.*

THE HALTED SPECIALTIES VHF AMPLIFIER

Some of the most recent additions to the growing line of VHF signal boosters are the Klitzing amplifiers distributed by Halted Specialties Company. While the name "Halted" may be new to many hams, I can assure you that their gear is of top quality. One of the Klitzing amplifier's main advantages is its linear class operation. This allows the unit to be used for FM, SSB, CW, or SSTV without modifications or switches. Limiting yourself to class C amplifiers can reduce future expansion interest—like SSB or OSCAR.

I recently began using one of these 50-Watt amplifiers with my OSCAR setup and 2 meter handie-talkie, and the unit worked beautifully. The HT truly gained "seven league boots" when used mobile with the amplifier. Operation through distant repeaters became "duck soup" when the amplifier was switched on, and my fringe area transmissions became full quieting to receiving stations. The advantage of increased power is definitely worthwhile—particularly while traveling or vacationing! I also appreciated the capability of remote-locating the amplifier and carrying the HT when leaving the car. This arrangement doesn't leave any gear showing under the dash to entice thieves.

My main purpose in securing this 2 meter amplifier was for boosting my OSCAR uplink signal. Naturally, this required a linear amplifier which could also take the strain of SSTV operations. The Halted Specialties unit worked beautifully. My OSCAR setup includes an Icom IC-202 transceiver, and its 3 Watts output is a perfect match for the 3- to 50-Watt amplifier.

A brief technical evaluation of the amplifier produced the following results. The rf sensor used for T/R switching keyed perfectly, with input levels ranging from 0.5 Watts to 5 Watts. Likewise, the overdrive of 5 Watts (FM mode) didn't appear to adversely affect amplifier operation.

The amplifier includes external keying contacts which can be used for 400 milliwatt or lower driving signals. T/R switching dropout time is continously adjustable with an internally-mounted potentiometer. Although I have no intention of trying these features, it's reassuring to know that the amplifier also includes reverse voltage polarity and infinite swr protection.

All aspects considered, the Halted Specialties amplifiers are an outstanding dollars-per-Watt investment. In my opinion, the amplifier's construction and performance is excellent.

The complete line of Klitzing amplifiers (6 meters through 70 cm, 50 Watts through 160 Watts) is distributed by *Halted Specialties Company, 729 E. Evelyn, Sunnyvale CA 94086.* My particular amplifier is a 2M3W50A, which sells for $129.

Dave Ingram K4TWJ
Birmingham AL

The Klitzing amplifier line.

THE YAESU FT-227R TRANSCEIVER

Do advertisements present a creditable account of radio transceivers' capability? That's a question always present in the mind of a potential purchaser. It was lingering in my mind while I was awaiting the delivery of a new Yaesu FT-227R, but some doubt began to fade as soon as I began to unwrap the long-awaited unit.

Yaesu does an excellent job of packaging its equipment. The basic transceiver and a full complement of accessories are neatly nestled in the box, each protected by a heavy plastic covering. Yaesu knows the value of first impressions!

Before the plastic was removed from the transceiver, the instruction manual was extracted from its pouch and given a thorough perusal. It's well-prepared, written by someone familiar with the English language, and provides full instructions for setting up, operating, and maintaining the transceiver. Photographs are shown to illustrate the location of various sections and parts of the set's interior. Other photographs display the front and rear view of the unit and provide identification of each control or indicator. Thumbing through the manual brings one to the parts list, which is really complete, and to the master schematic wiring diagram. This latter item is impressive and pleasing. It spreads out when unfolded, providing enough detail to follow circuits with relative ease. Note the use of that word "relative." The FT-227R is far from a simple piece of electronic gear, and its schematic reflects its complexity.

The real unveiling of a transmitter or receiver comes when it's hooked to an antenna and a power supply. The FT-227R performed just as the literature said it would! Oh, there was one small exception, one of utterly no moment. When first turned on, instead of displaying 147.00 on the digital indicator, it showed 145.050. But with that small exception, everything worked as I had been led to expect.

Any frequency from the low end to the high end of the two meter band can be dialed in just by turning one knob. That knob has detents so that one can dial by feel as well as by sight, a feature sure to be appreciated by sightless users and by car drivers who'd like to keep an attentive eye on the road.

Once you've dialed in an oft-used frequency, a touch of a button marked M (for memory) sets that frequency up for future use. Now you can go to any other frequency and retain the ability to go back to that favorite one just by a touch of another button marked MR (for memory recall). You can erase the memory and replace it with another one with equal ease. There's just one small glitch: If the primary power to the transceiver is interrupted, the memory is lost. Just turning off the set's on-off switch does not clear the memory, so if the set is installed in your car, all is fine. In your shack, however, where you'd normally be switching the ac power to a 13.6 V power supply, be prepared to reset the memory (as well as any other frequency) each time the primary power is applied. As the set draws only 0.5 A in the receive mode, you may select to let the power supply run constantly.

And that brings us to another handy feature. In addition to the squelch normally included on all VHF FM transceivers, this one has a visual indicator of an incoming signal. With this feature, you can have the af gain turned off and still note channel activity by a glance at the BUSY visual indicator. Another plus factor is that all the visual indicators are bright enough to be seen readily in strong ambient light.

Operation of the transceiver has brought only satisfying reports. Uniformly, the quality reports have been good. Used on a ¼-wave indoor antenna, it accesses all repeaters in the metropolitan Oklahoma City area. And, in area, Oklahoma City is one of the largest cities in the United States, dwarfing those ten times its population! On simplex, it performs very well even on its low-power position (one Watt output), covering distances of several miles. (This with an inside ¼-wave antenna within a house shielded by aluminum siding!)

All repeater offsets can be coped with. The standard +600 and −600 can be taken care of with just a twist of a knob. Nonstandard offsets require the use of the memory to nail down one frequency while another is dialed. "Split" frequencies, those involving a five-kilohertz spacing, are reached easily by pushing a button marked 5 UP... very simple, very logical.

The internal speaker is bottom-facing. For use in the shack, a stand, which attaches to the case, holds it up for forward-facing sound. For mobile installation, the husky attaching mount is adjustable over a wide range, adequate to adapt the transceiver to almost any location.

Like any other real-world equipment, the FT-227R has a few negative aspects. For one, it's big, a bit too big to fit into some of the smaller cars now becoming popular. From the rear of the coax connector to the front of the microphone plug is a trifle over 13 inches. From the head of one mounting bolt across to the head of the other mounting bolt is 8.5 inches. From the bottom of the case to the top of the mounting bracket is 3.5 inches... and that figure doesn't allow room for sound from the downfacing speaker. Some persons might find it inconvenient to twirl a dial across many 10-kHz detents to jump from one repeater to another when they're sampling half a dozen channels. The microphone impedance falls into the category of "classified" information," which will outrage those who'd like to make use of a combination microphone-Touchtone™ pad. The microphone jack is on the far right-hand side, which means the cord will have to be stretched across the transceiver for use by the driver of a vehicle.

Ah, but it takes an inquiring soul or a confirmed nitpicker to root out faults in such a pleasing package! The average user will be delighted with his FT-227R. It has just about every feature he would desire, at a price that doesn't shake him to the very base of his billfold.

Carl C. Drumeller W5JJ
Warr Acres OK

PRIDE PM-1500 WATTMETER

Knowing your forward power and reflected power can be awfully useful, particularly when trying out a new antenna or making any number of changes an amateur is likely to make from time to time in his setup. Thus, having a compact and accurate wattmeter such as the Pride PM-1500 can be a real convenience.

The PM-1500 has five scales: 0 to 5, 0 to 25, 0 to 150, 0 to 500 and 0 to 1500 Watts. So, whether you are a QRPer or like to run the full legal limit, the meter will do the job for you.

Packaged in an attractive black crackle-finished box with gold panel, the PM-1500 has just two controls, a toggle switch for rev/fwd power and a five-position switch to select the appropriate power range to be measured. *Pride Electronics, 6241 Yarrow Drive, Carlsbad CA 92008.*

Morgan W. Godwin W4WFL
Assistant Publisher

HEATH LOW-COST 3-BAND SCANNING MONITOR

The Heath Company offers a solid-state automatic scanning monitor said to be ideal for fire or police stations, emergency vehicles, and home listening. Covering three bands (30-50, 146-174, and 450-500 MHz), the GR-1132 monitors public service transmissions including police, fire, weather, and emergency operations, and in addition operates in the 2 meter amateur band and on marine FM frequencies.

Receiver sensitivity is 0.5 uV or less, and the GR-1132's operational features include: priority channel (checks selected priority channel every 4 seconds), automatic or manual scan selection, built-in speaker, volume, and squelch controls, and lighted channel scanning indicators. The unit incorporates individual telescoping antennas for each band of operation and, for convenience, may be operated from an internal ac power supply or external 12 V dc source.

For further information on the GR-1132, write *Heath Company, Dept. 350-560, Benton Harbor MI 49022.*

The new Amphenol 83-58FCJ coax cable jack.

NEW SOLDERLESS AMPHENOL IN-LINE COAX CABLE JACK

A new Amphenol® in-line UHF coax cable jack that can be installed in seconds without special tools or solder—also eliminating all need for PL-259-to-PL-259 adapters previously required—has been developed as a follow-up to last year's introduction of the widely-accepted Amphenol no-solder 83-58FCP fast-assembly PL-259 connector for RG-58/U. The new companion in-line splice jack also uses the innovative "FCP" termination approach. The result is extremely fast cable termination—less than 20 seconds.

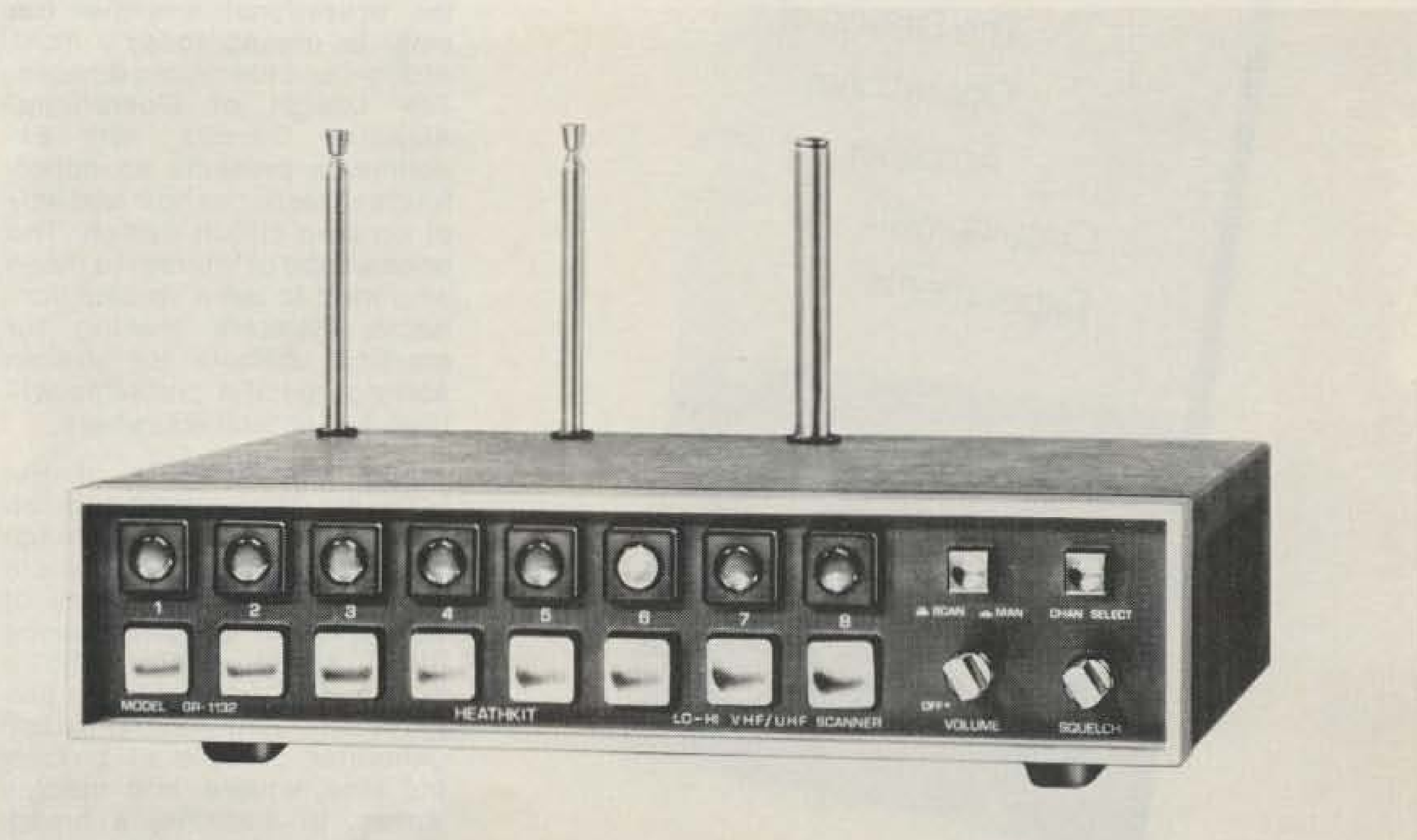
Whenever an in-line antenna or hookup coax cable splice is needed, the user has only to strip the cable, insert the center conductor into the back of the connector, and slide the ferrule into place. Once accomplished, termination is complete. The result is a handy, in-line SO-239 receptacle that will accept any PL-259 plug—directly.

All need for a second PL-259 connector plus PL-259-to-PL-259 adapter has been eliminated—at great savings in terms of space, cable weight, and, most important, purchase price for all these individual components.

Called Amphenol UHF Cable Jack 83-58FCJ, the new device easily handles all power levels up to maximum ratings of the RG-58/U coax cable itself. And, unlike conventional solder connection techniques, the 83-58FCJ can be easily disassembled and reused.

Amphenol 83-58FCJ connector adapters have a frequency range of 0-300 MHz, and a voltage rating of 500 V peak. Thermal limits are -67° to +300° F. They also have standard 5/8-24 threads for simple, screw-on mating with conventional UHF plugs.

The manufacturer's suggested retail price for the solderless Amphenol 83-58FCJ jack is $1.64. Availability is through a nationwide network of general line electronic parts distributors.



The Heathkit GR-1132 scanning monitor.

FCC Math

from page 17

with another to get that total resistance. In other words, we're after R_1 or R_2, want to get R_1 or R_2 by itself with everything else on the other side. What we have now (applying our number work to the formula) is $R_tR_1 + R_tR_2 = R_1R_2$. How do we go from there?

Say we want to get R_1 by itself. Referring to the number equation, $2(3) + 2(6) = 3(6)$, you'll notice that the 3 is in the R_1 position. Again, we have the problem that there are two 3's, and, to complicate things further, both of those 3's are being multiplied by some other number. But there are all sorts of tricks devised over the ages, all very logical, that enable us to get past just about any roadblock we encounter. One, that we've already seen, is doing the same thing to two numbers which are equal. If we start off with equals and then do the same thing to both or all, we are bound to still have equals. In our case, $2(3) + 2(6)$ equals $3(6)$. Let's subtract $2(3)$ from both sides. If I do that, I get rid of the $2(3)$ on the left, and here's what I have: $2(6) = 3(6) - 2(3)$. Now, at least I have both 3's on the right-hand side.

Note first that $3(6) - 2(3)$ is the same as $3(6) - 3(2)$. $2(3)$ equals $3(2)$, in other words. It doesn't make any difference what order, which comes first, when multiplying two numbers. Next, note that $3(6) - 3(2)$ is the same as $3(6 - 2)$, much the same as $2(6 + 3)$ equaled $2(6) + 2(3)$, only in reverse. Putting all that together, we now have: $2(6) = 3(6 - 2)$. We're getting there, little by little, but we *are* getting there. Now bring that $(6 - 2)$ as a unit down from top right to bottom left and we have it: $2(6)/(6 - 2) = 3$. We have the 3 by itself on one side. Now, remembering that 2 is R_t, 3 is R_1 and 6 is R_2, we have $R_tR_2/(R_2 - R_t) = R_1$. By playing around with numbers (never actually adding, multiplying, or subtracting, etc., but just moving them around), we came up with a formula for R_1.

Admittedly, what we did was pretty complicated. It's algebra, of course, a fairly complicated subject. But the incredible thing is that just by playing around with numbers we can develop and/or discover all the rules, algorithms, etc., of an algebra course, or of the algebra needed in electronics for FCC exams.

Now another little exercise. Again, work and answers at the end.

Exercise 2:

(1) Take that same formula, $R_t = R_1R_2/(R_1 + R_2)$, and solve for R_2, again employing the number equality, $2 = 3(6)/(3 + 6)$. Here, you want to get the 6 by itself on one side.

(2) Swr $= (V_f + V_r)/(V_f - V_r)$ is a formula in which swr is standing wave ratio, V_f = forward voltage, and V_r is reflected voltage. Solve for V_r! What is V_r when the swr is 2 and V_f is 75 V?

WORK AND ANSWERS TO EXERCISES

Exercise 1:

(1) $P = I^2R$, $P/R = I^2$, $\sqrt{P/R} = I$.

(2) $I = \sqrt{P/R} = \sqrt{5/200}$. 5/200 is $(50 \times 10^{-1})/(2 \times 10^2)$, or 25×10^{-3}, which is 2.5×10^{-2}, or 250×10^{-4}. $\sqrt{250 \times 10^{-4}}$ is about 16×10^{-2}, or 0.016.

(3) (a) 382 is 3.82×10^2. 3.82 is close to 4 simply, so $\sqrt{3.82 \times 10^2}$ is about 2×10^1 or 20.

(b) 0.000018 is 1.8×10^{-5} or 18×10^{-6}. 18 is close to 16, so $\sqrt{18 \times 10^{-6}}$ is about 4×10^{-3} or 0.004.

(c) 520,000,000 is 5.2×10^8. 5.2 is close enough to 4 that $\sqrt{5.2 \times 10^8}$ is about 2×10^4 or 20,000.

(d) 0.0000000000047 is 4.7×10^{-12}. Again, 4.7 is close to 4 simply, so $\sqrt{4.7 \times 10^{-12}}$ is about 2×10^{-6} or 0.000002.

Exercise 2:

(1) $2 = 3(6)/(3 + 6)$, then $2(3 + 6) = 3(6)$. Next, $2(3) + 2(6) = 3(6)$. Subtract $2(6)$ from both sides, giving: $2(3) = 3(6) - 2(6)$ or $6(3 - 2)$. Then bring the $(3 - 2)$ down to the left and we have: $2(3)/(3 - 2) = 6$. Now, putting R's in their proper places, we have: $R_tR_1/(R_1 - R_t)$, which is the same formula as for R_1.

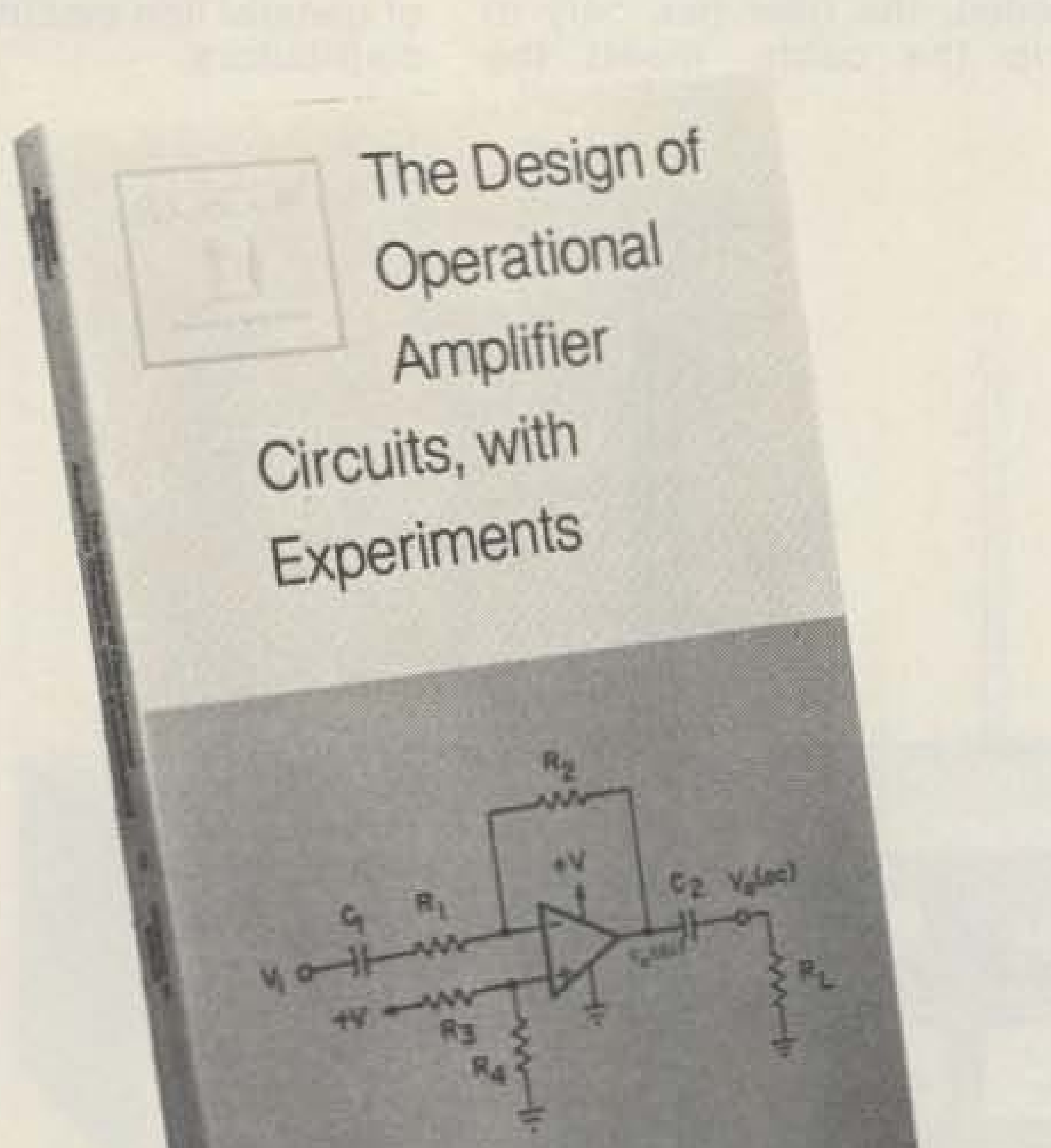
(2) Swr $= (V_f + V_r)/(V_f - V_r)$. First step: $\text{swr}(V_f - V_r) = V_f + V_r$. Then: $\text{swr}(V_f) - \text{swr}(V_r) = V_f + V_r$. This time *add* $\text{swr}(V_r)$ to both sides and subtract V_f from both sides. That gives: $\text{swr}(V_f) - V_f = V_r + \text{swr}(V_r)$. This is now somewhat tricky. We must now keep in mind that V_f and V_r have a hidden 1 multiplying them. That's because when we do our little reverse stunt, we need that 1—otherwise, we lose part of our equation. With the 1's written in, our equation now looks like this: $\text{swr}(V_f) - 1V_f = 1V_r + \text{swr}(V_r)$. And now when we pull that reverse stunt that we did with numbers before, we get: $V_f(\text{swr} - 1) = V_r(1 + \text{swr})$. If you didn't have that 1, you'd just multiply the swr alone and wouldn't get what you started off with. The final step is to bring the 1 + swr or swr + 1 (you get the same value either way) from top right to bottom left, to get: $V_f(\text{swr} - 1)/(\text{swr} + 1) = V_r$.

That's a complicated process we just went through. Try it with a number equation, and you'll find it's more understandable. I purposely did it directly with letters just to show that you *can* do that kind of thing. Of course, when you get good at algebra (some people *are* that way, you know), a lot of these steps are done in your head.

Plugging in the values given, we now have: $[75(2 - 1)]/(2 + 1) = V_r$. That's 75/3 or 25 volts that V_r equals. $(2 - 1)$ of course equals 1, and 75×1 is simply 75.

Again, let me emphasize the importance of playing around with numbers. Processes that seem awfully difficult because of the abstraction of letters become quite easy with small numbers.

Review



THE DESIGN OF OPERATIONAL AMPLIFIER CIRCUITS, WITH EXPERIMENTS
(Howard M. Berlin, E & L Instruments, Inc., 1977, $8.50)

Versatile and inexpensive, the operational amplifier (op amp) is among today's most widely-used electronic devices. *The Design of Operational Amplifier Circuits, with Experiments* presents an opportunity to learn the how and why of op amp circuit design. The book will be of interest to those who want to learn op amp concepts. Readers looking for practical circuits for use in solving specific problems will have better luck elsewhere.

The key elements of the book are the experiments offered at the conclusion of each of the ten chapters. In all, there are 37 experiments. Many of them require an oscilloscope (dual trace preferred), a multimeter (digital-type preferred), and a function generator capable of producing sine, square, and triangle waves. In addition, a breadboard and a dual voltage power supply are necessary, along with an assortment of capacitors, resistors, potentiometers, and other miscellaneous components. Most of the experiments use the 741 op amp.

The book is logically organized, beginning with a chapter on the general characteristics of op amps, a discussion of op amp data sheets, and rules for all subsequent experiments. Chapters 2 through 7 deal with various types of op amp circuits using the 741, including linear amplifiers, function generators, and active filters. Chapter 8 suggests schemes for operating op amps with a single supply voltage. The Norton or current-differencing op amp is discussed in Chapter 9, while Chapter 10 is devoted to instrumentation amplifiers.

This is not a book for casual reading. It is suited to the experimenter or hobbyist with the time and desire to gain a detailed knowledge of basic op amp concepts. As the author suggests, it would be useful in the laboratory section of a college course on linear integrated circuits.

Jeff DeTray WB8BTH/1
Publications Editor

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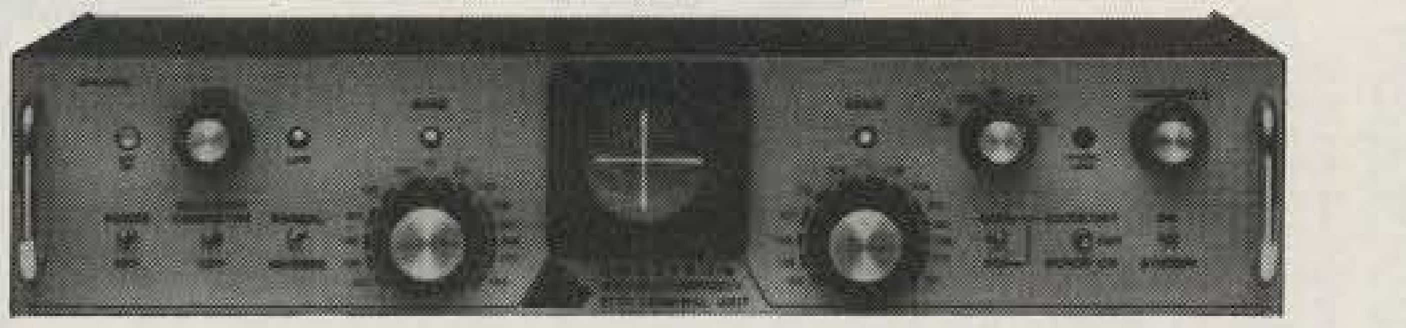

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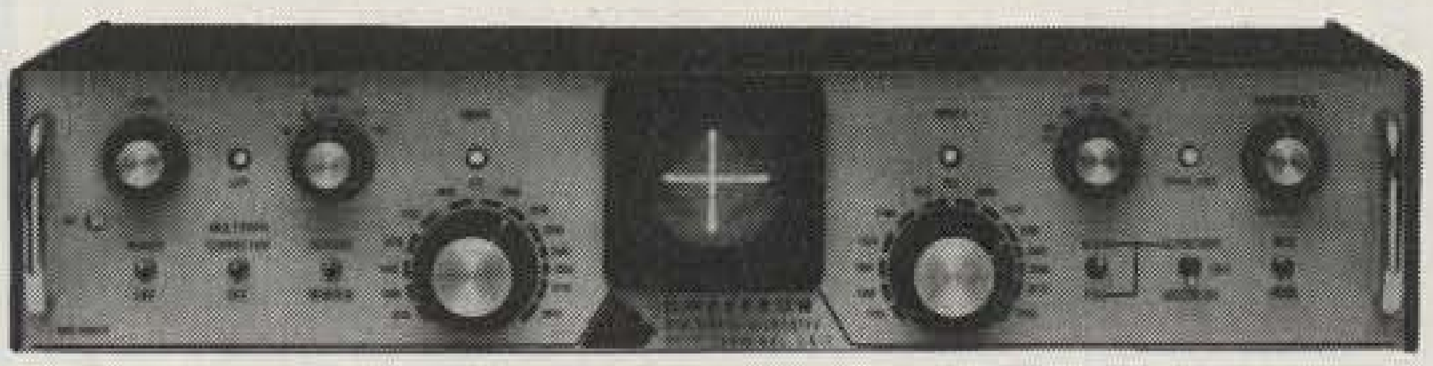

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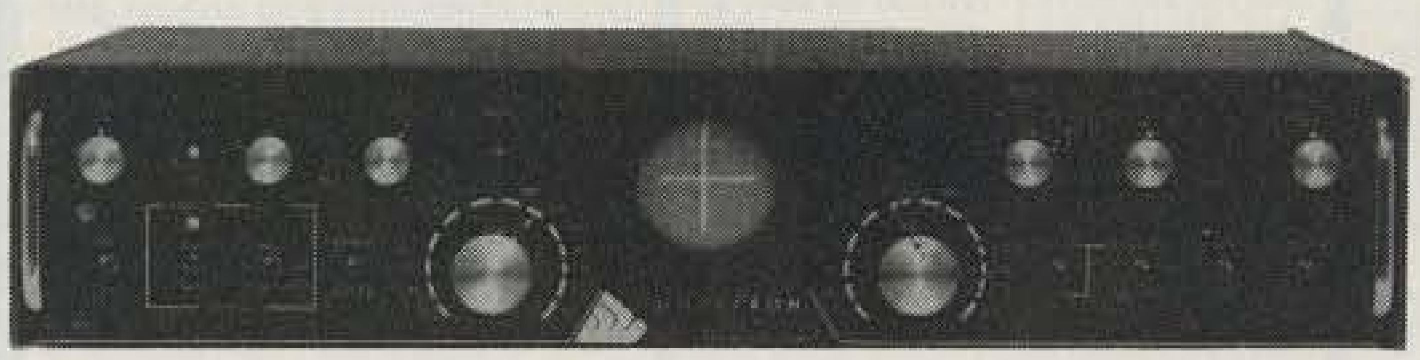

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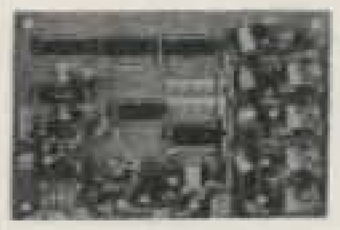

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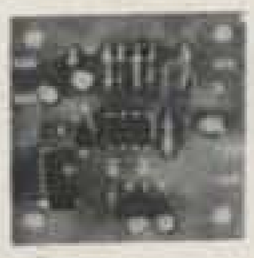

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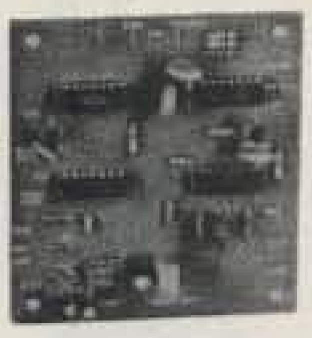

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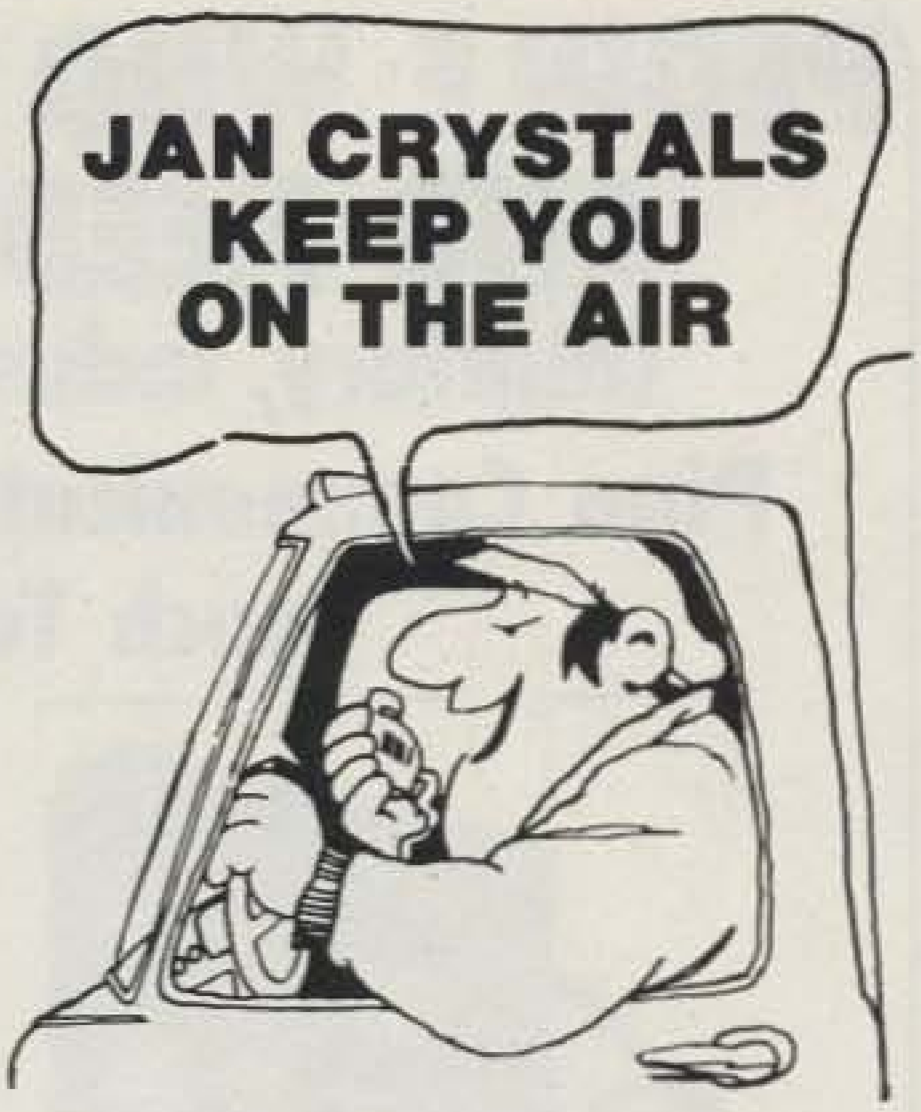

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- KLM • CUSHCRAFT • LARSEN
- REGENCY • HUSTLER • CDE
- ANT. SPEC. • DENTRON

. . . and many more.

- full factory authorized service
- immediate delivery
- competitive prices

master charge VISA

- large inventory

universal amateur radio inc

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COLUMBUS, OHIO
(Reynoldsburg) 43068

(614)-866-HAMS

INTERNATIONAL ELECTRONICS UNLIMITED

IC-LED INVENTORY CLEARANCE SALE

TTL

7400	.09	7489	1.75
7404	.14	7493	.28
7406	.19	7490	.35
7407	.19	7495	.35
7416	.22	7496	.35
7430	.12	74121	.21
7432	.15	74123	.23
7437	.15	74141	.65
7438	.15	74145	.55
7440	.12	74151	.35
7445	.45	74153	.49
7446	.40	74154	.75
7450	.12	74157	.52
7454	.08	74161	.52
7460	.08	74165	.85
7475	.32	9601	.29
7480	.25	9602	.35
7486	.23		

CMOS

4002	.19
4006	.95
4007	.19
4009	.39
4011	.16
4014	.79
4019	.25
4021	.87
4022	.89
4023	.18
4051	.89

320	1.19
2206	3.90
2207	1.49
2567	1.49
4136	.69
4202	.69
4212	.69
4739	.69

LEDs

MAN 1	.27" Red CA LHD	.99
MAN 2	.30" Red 5x7 LHD	3.95
MAN 5	.27" Green CA LHD	.99
MAN 7	.27" Yellow CA LHD	.49
MAN 54	.30" Green CC RHD	1.19
MAN 66	.60" Red CA LHD	1.19
MAN 72	.30" Red CA LHD	.59
MAN 82	.30" Red CA LHD	.99
MAN 3610	.30" Orange CA RHD	.69
MAN 3640	.30" Orange CC RHD	.69
MAN 4610	.40" Orange CC RHD	.59
MAN 6660	.56" Orange CA RHD	.59
DL 10A	.27" Red CA LHD	.99
DL 702	.30" Red CC LHD	.79
DL 707	.30" Red CA RHD	.79
DL 747	.60" Red CA LHD	1.19
FND 359	.375" Red CC RHD	.59
FND 500	.50" Red CC RHD	.69
FND 507/510	.50" Red CA RHD	.69
NSN 74R	.30" Red CC RHD	.69
MAN 6610	2 Dig .56" Orng CA RHD	.69
MAN 6630	1-1/2 Dig .56" Orng CA RHD	.59
MAN 6640	2 Dig .56" Orng CC RHD	.69
MAN 6650	1-1/2 Dig .56" Orng CC RHD	.59
MAN 6710	2 Dig .56" Red CA RHD	.69
MAN 6730	1-1/2 Dig .56" Red CA RHD	.59
MAN 6740	2 Dig .56" Red CA RHD	.69
MAN 6750	1-1/2 Dig .56" Red CC RHD	.59
DL 338	3 Dig .17" Red CC	.29
DL 338	2 Dig .17" Red CC	.49
NSN 33	3 Dig .17" Red CC	.39
HP 5082	4 Dig .11" Mag. RHD	.39
HP 5082	5 Dig .11" Mag. RHD	.49
SP425-09	9 Dig Gas Discharge	.69
Calc Disp	9 MAN 3s on board Red	.79
TI 434	9 Dig Red	.49

SIGNAL DIODES 400mw 100/$1.00

LINEAR

301M	.25	555M	.39
307M	.19	556N	.79
309H	.98	560M	1.95
311H	.59	565N	.99
311N	.59	567M	.99
324N	1.09	723N	.45
340T-5		733H	.49
(7805)	.59	739N	.69
340T-15		741M	.16
(7815)	.59	1414N	.99
370N	.79	1458M	.49
376M	.39	CA3046N	.89
380N	.99	75453	.19
380-8M	.59	75491N	.49
540H	1.59	75492N	.69

CT5002	Calc. Chip	.35
CT5005	Calc. Chip	.75
MM5725	Calc. Chip	.29
MM5736	Calc. Chip	.65
MM5738	Calc. Chip	.95
MM5739	Calc. Chip	.95

MM5314	Clock Chip	2.95
MM5316	Clock Chip	.95
MM5370	Clock Chip	3.95
MM5375AA	Clock Chip	2.95
CT7001	Clock Chip	4.95

8038 Funct. Generator 3.75

Jumbo Red LEDs	12/$1.00	140/$10.00
Jumbo Green LEDs	8/$1.00	100/$10.00
Jumbo Yellow LEDs	8/$1.00	100/$10.00
Jumbo Clear LEDs	12/$1.00	140/$10.00

MV108 TO-18 clear 15/$1.00

KEYBOARD
20 Keys - 2 slide switches
3" x 3-3/4" $1.00/3

2513(caps)	Char. Gen.	2.95
2513(L.C.)	Char. Gen.	2.95
MM1101	256 bit RAM	.65
MM1103	1K RAM	.75
1702A	EROM	4.75
MM5261	1K RAM	.55
MM5262	1K RAM	.95
F93410	256 bit RAM	.95
2708	8K EROM	$8.95

2510	Dual 50 bit Shift Reg.	.95
2511	Dual 100 bit Shift Reg.	.95
2518	Hex 32 bit Shift Reg.	1.25
2522	Dual 132 bit Shift Reg.	.95
MM5016	500/512 bit Shift Reg.	.95
SL-5-4025	Quad 25 bit Shift Reg.	.59

IC SOCKETS TT

Low Profile Solder Tail

8 pin	$.16	24 pin	$.36
14 pin	.19	28 pin	.44
16 pin	.21	40 pin	.61
18 pin	.28		

Wire Wrap

8 pin	.45
14 pin	.49
16 pin	.55

METAL FILM RESISTORS

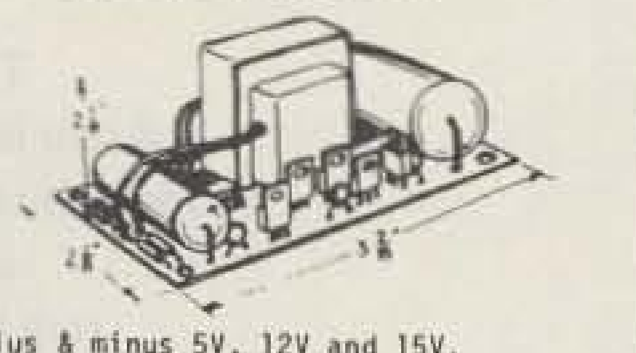
+ 1%, 1/4w, + 50 PPM/ºC
Standard Decade Values 10.5 - 464K

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.20	$.15	
100-999	.20	.10	$9.00/100
1000-			8.00/100

CERAMIC DISC CAPACITORS - 50V

1pf 22pf 56pf 120pf 270pf 820pf .022uf
5pf 27pf 68pf 150pf 390pf .001uf .030uf
7pf 33pf 82pf 180pf 470pf .0047uf .050uf
10pf 47pf 100pf 220pf 600pf .01uf
0-10 per value..$.10ea 10-up per value $.05ea
10-up per value $.05ea

REGULATED POWER SUPPLY



Plus & minus 5V, 12V and 15V.
Uses 3 LM340T and 3 LM320T regulators, 115V/29V CT transformer plus PC board capacitors & diodes. All parts, schematic, instructions
PS-29.........$11.95 + $1.00 Shppng.

PLASTIC CASES

VERO - dark and light gray nominal O.D.

2514F	2"x4"x1"	$4.34
2516G	2"x4"x1.6"	4.90
2518H	2.6"x 4.7"x1.6"	5.48
2520J	3.2"x6"x2"	6.24
2522K	4.3"x7.4"x2.4"	8.28
2755G	2.6"x4.7"x2.6"	6.74
2760D	4.3"x7.4"x2.4" (w/ handle/stand)	10.78
2525F	2.8"x5.4"x2.4" (ventilated)	5.40
HAMMOND - blue		
1591C	2.6"x4.8"x1.6"	2.65

Carbon Film Fesistors + 5% 1/4w, 1/2w

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.10	$.05	
100-999	.10	.04	$3.00/100
1000-			2.50/100

BEZELS - with red filters

140-2 cut-out 1.125" x 2.375"
max .062" panel thickness $1.75
140-4 cut-out 1.160" x 4.375"
max .125" panel thickness $2.75

CAPACITOR KIT - ceramic disc

50V, 24 values, 10 capacitors each

1pf	33pf	82pf	220pf	820pf	.022uf
5pf	47pf	100pf	270pf	.001uf	.030uf
10pf	56pf	150pf	470pf	.0047uf	.050uf
22pf	68pf	180pf	600pf	.01uf	.1uf

capacitors only...$11.95
Packeged in 15 drawer, 60 compartment cabinet....$19.95 plus $2.00 shipping

DIODES

Silicon SW diode assorted 400 mw	$.05ea
1N4148 (1N914) Silicon diode 400 mw	.10
1N3064 Silicon SW diode 400 mw	.10
1N4006 Silicon rect. diode 600V 400mw	.10
Zener diode 400 mw - 2.4V, 3.6V, 5.1V, 6.5V, 6.8V, 10V, 12V, 14.5, 15V, 120V	.15
Germanium diode 400 mw	.08

CLOCK KIT - CK 6-3

6 digit clock kit with MM5314 clock chip, 6 .3" CA displays, 2 PC boards. Contains all components except transformer. Includes 3 switches. $12.95
with 12V/300 ma transformer $15.95

ELECTRONIC BUZZER

Miniature, Solid State
6V 15ma (4-9V oper.) $1.69 ea.
12V 15ma (8-20V oper.) $1.69 ea.

TANTALUM CAPACITORS - solid dipped

.1u/35V	$.20	6.8/6	$.25	15/50	$.40
.22/35	.20	6.8/16	.25	22/16	.40
.33/35	.20	6.8/50	.30	33/10	.50
1/35	.20	10/16	.30	47/6	.50
2.2/20	.25	10/25	.35	47/25	.55
2.2/35	.25	10/50	.35	56/6	.65
3.3/35	.25	15/10	.35	150/15	1.25
4.7/16	.25	15/20	.35		

ELEKTOR MAGAZINE PROJECTS

3 1/2 DIGIT DVM - parts pack
LD110/111 chip set - 2V, 20V, 200V ranges auto zero, auto polarity, .3" LEDs. All components, PC voards, power supply for 115V use. Case not included.
$44.90 +$2.00 shipping
Inst. case (VERO 2760D) bezel & filter, cord & banana jacks.
$11.90 +$.75 shipping
Instructions only (refundable with DVM purchase) $3.50

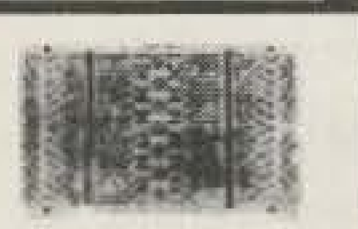
SCOPE CALIBRATOR - parts pack
Checks gain & band width of the Y ampl & attenuators and freq. calibration of timebase. Build into any scope. All parts, PC board & instructions..$3.80

SIGNAL INJECTOR - parts pack
Compact portable signal generator that produces 1 Khz square wave keyed at approx .2 hz. PC board, instructions, plastic case and all components except 5.6V battery and probes... $9.10

MUSIC CLEANER - parts pack
a treble and bass filter that eliminates snap, crackle 7 pop without eliminating half the music. May be connected virtually anywhere in an audio system. PC board (for stereo system) all components and instruction..... $16.50

VOLUME UNIT METER - parts pack
VU meter uses a column of LEDs to indicate signal level. Designed as a 2 channel meter Uses separate rectifier and display boards. +15V supply required. All components, PC boards and instructions........$32.50

UNIVERSAL BREADBOARD



Silver placed copper circuits fits any IC and related components. 2 triple rows of 27 holes for DIP. 3-3/16"x5-1/16" $1.00

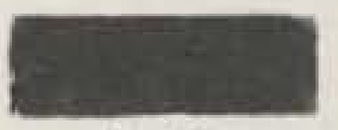
BUGBOOKS

I & II- Logic, memory text & experiments $17.00 /set
Instructors Manual (for I & 2) $ 3.00 ea.
IIA- Introduction, use of UART $ 5.00 ea.
V & VI- Experiments in Digital 8080A programming & interfacing $ 9.50 ea. 19.00 /set
555 - Timer applications, experiments $ 6.95 ea.
CMOS - Designers primer and handbook $ 6.00 ea.
SK10 - E & L Solderless Breadboard $16.50 ea.

TANTALUM CAPACITOR KIT

solid dipped, 12 values, 5 each
.1uf/35V 2.2/35 10/25 33/10
.33/35 4.7/16 15/20 47/25
1/35 6.8/16 22/16 56/6
capacitors only......$14.95
supplied in styrene utility box.... ....$19.95

I C BREADBOARD

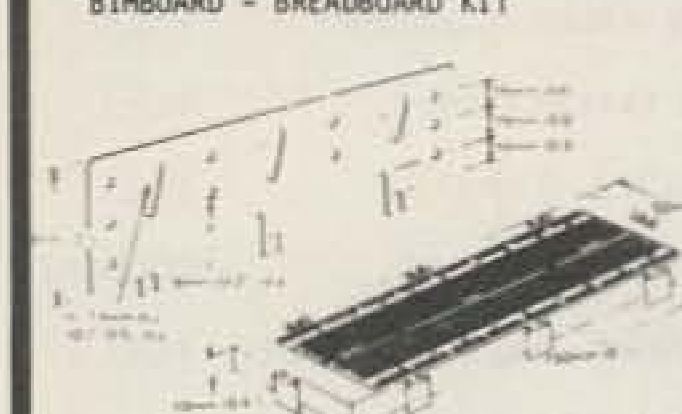


Silver plated copper circuits holds 5 - 16 pin DIP IC's and interconnection holes. $1.00

TRANSISTORS

2N1132	PNP Gen Purp. Ampl TO-5	$ .69
2N2218A	NPN Low Power Trans TO-5	.69
2N2222A	NPN Low Power Trans TO-18	.29
2N2223	NPN Low Power Trans. TO-5	.69
2N2369	NPN Low Power Trans TO-5	.29
2N2904	PNP Low Power Trans TO-5	.49
2N2905A	PNP Low Power Trans TO-5	.76
2N3227	NPN Low Power Trans TO-18	.69
2N3904	PNP Low Power Trans TO-92	.17
2N3906	NPN Low Power Trans TO-92	.17
SCA 13572	NPN Pwr Trans - 200V TO-5	1.75

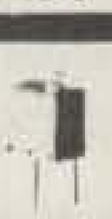
BIMBOARD - BREADBOARD KIT



Solderless breadboard section has 94 breadboard strips of 5 sockets each. 2 bus strips of 40 sockets each. Component bracket for switches lamps etc., accepts leads .01" to .035" diameter. $11.95 ea.

Zener Diode Handbook - Motorola $ 3.00 ea.
Switching Transistor Handbook - Motorola $ 2.50 ea.
CMOS Data Book - Solid State Scientific $ 3.00 ea.
Micro Computor Application Hdbk.- IASIS- 8080 microcomputor debugging, architecture and instruction set. $ 6.95 ea.

TRIMPOT - 25 turn
Bourns - Cermet 3299W
PC Mount, vert. adj.
2K, 10K, 20K $1.75 ea



ELECTRONIC DOOR CHIME KIT

WITH TI TMS 1000 MICROPROCESSOR CHIP PROGRAMMED TO PLAY 24 DIFFERENT TUNES

$39.50 SHIPPING $1.00

VECTOR BOARD - Phenolic
169P44-062 (.1"spacing .42" dia.)
4-1/4" x 4-1/2" x .0625"...$1.15 ea.

COMPLETE SATISFACTION GUARANTEED. SHIPMENT TO US AND CANADA PREPAID UNLESS INDICATED OTHERWISE. OTHER COUNTRIES ADD 10% - EXCESS REFUNDED. ORDERS SHIPPED IN 3 WORKING DAYS FROM RECEIPT. MINIMUM ORDER $10.00 CALIFORNIA RESIDENTS ADD SALES TAX. MINIMUM COD OR CHARGE ORDER $15.00

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VILLAGE SQUARE, P.O. BOX 449 E. CARMEL VALLEY, CA 93924 USA
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lowest prices

MA1003 MOBILE CLOCK MODULE (National)
$18.95 complete

Attaches directly to 9-12V Battery. Automatic Nighttime Dimming. Fluorescent Display gives Color Choice (Red, Blue, Green or Yellow) when used w/corresponding Color Filter. Includes — Module, Switches, & Filter

ALUMINUM CASE WITH FILTER.
(switches included with clock kit). In Silver, Black and Gold. Filter colors — red, blue, green, or yellow. $5.75

Complete Clock Kit $9.95
4 DIGIT 12/24 HOUR
Includes: PC Board, 5316 Clock Chip, all components and Power Supply.
Displays hours and minutes ... Switch to minutes and seconds ... AM-PM Indicator ... Elapsed Timer ... Fluorescent Display
Options: If alarm function desired add $2.50 (includes speaker and all components)
Plexiglas Case Kit (red or blue) $2.00

Transformer **$1.49**
6.3 volts at 1.2 amps

Capacitors
500 MFD at 50V .... **4/$1.00**
500 MFD at 15V .... **6/$1.00**

Clock Chips
MM5314 or MM5316 .... **$3.50**

Voltage Regulators.
Positive — To 220 Pkg **$1.00**
7805, 7806, 7812, 7815, 7824
Negative — To 220 Pkg **$1.25**
7905, 7912, 7915
To — 3 Pkg. — LM309K **$1.25**

Dry Reed Switch Capsules .... **25/$1.98**
Glass Sealed. 5 amp 115 VAC

1C Sockets **$1.00**
8, 14, 16, 18 Pin .... **5/$1.00**

Bridges
1.5 amp, 200v .... **3/$1.00**
3 amp, 200v .... **3/$1.25**

Bridges

VOLT	2 AMP	4 AMP	6 AMP	25 AMP
50	$ .60	$ .70	$ .80	$1.30
100	.70	.80	.90	1.40
200	.80	.90	1.00	1.60
400	1.00	1.10	1.20	
600	1.25	1.35	1.40	

WESTINGHOUSE TUBE SPECIAL BOXED AND BRANDED

1V2	1.50	6EJ7/EF184	2.20	6KZ8	2.40
2AV2	2.00	6EW6	2.20	6L6GC	3.60
3A3C	3.10	6FQ7/6CG7	1.85	6LB6	4.75
3AT2B	3.00	6GF7A	3.20	6LQ6/6JE6C	4.85
3CU3A	3.75	6GH8A	2.00	6Z10/6J10	4.30
3DB3/3CY3	3.30	6GJ7/ECF801	2.25	8FQ7/8C67	2.00
3HM5/3HA5	2.50	6GM6	2.50	12AT7/ECC81	2.00
5GH8A	2.75	6GU7	2.50	12AU7/ECC82	2.00
6AQ5A	2.00	6HB7	2.40	12AX7/ECC83	2.00
6AU6A	2.00	6HM5/6HA5	2.30	12BY7A/V/Q	2.20
6BK4C/EL4A	4.50	6HZ6	2.00	12HG7/6N7A	3.30
6BL8/ECF80	1.75	6JC6A	2.65	17JZ8	2.50
6CG3/W3/Q3	2.50	6JS6C	4.50	23Z9	3.00
6CJ3/6CH3	2.50	6JU8A	2.60	33GY7A	3.75
6DW4B	2.50	6KD6	4.90	36MC6	5.00
6EA8	2.50	6KE8	3.60	38HE7	3.85
		6KT8	3.25		

60 Hz. Crystal Time Base Kit ... $4.95
Use with Digital Clocks for 12 VDC or Portable Operation.
Kit includes: PC Board, 5369 Divider Chip, 3.5795 MHZ XTAL and all other parts plus complete instructions.

70 Volt Line Transformer $2.90
Power Rating — 10 watts, Model TR-1
Primary Volts: 70.7 — Primary Taps: 0.63, 1.25, 2.5, 5, and 10 W. Secondary Impedance: 4 & 8 ohms. Primary and Secondary Terminations: 8" color coded leads. 1⅝"H, 11/16D, 2"W, Base 2⅜"W

6" Pioneer Pincushion Speakers
3.2 ohms, 7½ watts .... **$3.95 pair**

Heavy Duty Alligator Clip Test Lead Set **$2.49**
Set of 10 color coded leads with insulated alligator clip on each end.

Switches
DPDT Slide Switch **10/1.00**
DPDT Momentary Slide Switch . **10/1.00**
DPDT Slide Switch, long handle **10/1.00**
DP4T Slide Switch (5 sets of terminals) **10/1.00**

High Power Transistors ...... **2/$1.00**
2N3055 NPN (ITT TO 3 Case)

1000 MFD 35 Volt Electrolytic Capacitor Axial Leads .. **4/$1.00**

AC/DC Wall Plug Adaptor-Charger **$1.00**
120 volt input/6VDC 130 MA output.

Sound Actuated Switch .... **$.85**

6 Ft. Line Cords .... **6 for $1.00**

DL741 Jumbo Displays **$1.35**
7 Segment-Common Anode

Diffused LED's, Jumbo Red LEDs 0.2", and Factory Prime **.7/$1.00, 100/$11.00**

7 SEG LED Displays $.59 ea., 10/$5.00
33" Type 707/MAN-1 14 Pin Dip, Common Annode or Cathode.

Jumbo Red LED's .... 10/$1.00, 100/$9.00

25 PK. LED's Asstd Sizes & Colors **$2.50**

Variable Trimmer Cap .... **5/$1.00**
3-18Pf 50v

6 D Cell Battery Holder .... **3/$1.00**

16 Pin Dip Strip Socket ...... **10/$1.00**
by AMP

50k Trim Pot .... **10/$1.00**
PC Mount thumb wheel

Power Resistors .... **8/$1.00**
620 Ohms 5% 5w

8 Ft. Stereo Extension Cord .. **2/$1.99**
RCA type plug at both ends

AC Adaptor: **$1.50**
Input: 120 VAC 60Hz 3.7w
Output: 9VDC 100 MA

Potentiometer Assortment . 12/$1.00
Includes 1K to 100K. Tab mounts, printed circuit, duals, push-pulls, nylon and metal shafts (long and short)

IN 4148 Switching Diodes .... 50/$1.00
Factory prime, taped and reeled

Mini-Audio Transformers .... 10/$1.99
Asst. of outputs 1" square

15 Trimmers & Sensitivity Controls .... **5/$1.00**
2.5 meg central cermet trimmers and miniature wire wound rheostats.

LM 555 Timers .... **3/$.99**

Vinyl Electrical Tape .... **2/$1.00**
8 mil x ¾" x 66'

Screws .... **$1.99 lb.**
1 pound, assorted sizes

C106 SCR to 202 Package .... **$.99**
300 V. 4 amp

Terms and Conditions

$7.00 Min. C.O.D. Order, Phone Orders accepted.
$15.00 Minimum Bank Americard/ MasterCharge order.
Add $1.50 Postage and handling on all orders.
Outside Continental U.S., U.S. Funds only. — Add postage -
N.J. Residents — 5% Sales Tax.
Money Back Guarantee on all orders.

April 1978

April 1978

NEW! ALDA 103 HF TRANSCEIVER

Please write for Special Package Prices

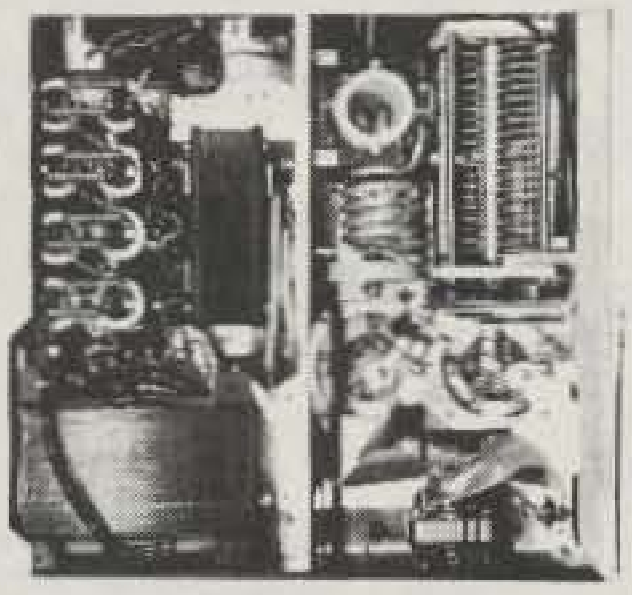
- Superb Commercial Grade Quality and Construction Second to none!
- Superior Audio Quality!
- Totally Solid State
- **250 Watts**
- Modular Plug-in Circuit Board Assembly
- Dual Speed VFO Dial-Vernier
- Semi-Break In CW with Sidetone

SIGMA XR3000D LINEAR AMPLIFIER

INTRODUCTORY PRICE

$789

2 Day Air Shipment Anywhere in U.S.
Airport to Airport $35
Alaska and Hawaii Slightly Higher



SPECIFICATIONS:

- Full band coverage 160-10 meters including MARS.
- 2000 watts P.E.P. SSB input. 1000 watts input continuous duty, CW, RTTY & SSTV.
- Two Eimac 3-500Z conservatively rated finals.
- All major HV and other circuit components mounted on single G-10 glass plug in board. Have a service problem? (Very unlikely) Just unplug board and send to us.
- Heavy duty commercial grade quality and construction second to no other unit at any price!
- Weight: 90 lbs. Size: 9½" (h) x 16" (w) x 15¾" (d)

NEW! SIGMA MODEL AF250L DEVIATION/MODULATION METER

Introductory Price

$169

FEATURES: Extremely stable local oscillator for easy measurement of HF, VHF, and UHF bands employing negative feedback, to insure extremely high stability ● Easy to read, accurate linear scale ● Direct off the air signal measurement capability. **OPTIONAL 12v DC Power Kit - $12.** ***FULLY CERTIFIABLE FOR COMMERCIAL USE.***

SPECIFICATIONS: Frequency: 1.8MHZ-520MHZ/3 range select (A,B,C,EXT), A range: 26.5 MHZ-40MHZ, B range: 48MHZ-60MHZ, C range: 140MHZ-156MHZ (generous overranges), EXT. range: 1.8 MHZ-520MHZ (Need Signal Generator) ● Input level: (1) Through type input level: IW-200W (RF Input Terminal), (2) Direct input level: More than 80db/50ohm impedance ● Amplitude modulation: 0-100% ● Frequency diviation: 0-20KHZ ● Accuracy: +/-3% of full scale ● Intermediate frequency: 10.7MHZ ● RF Attenuator: 0-60db variable ● Audio Signal oscillator: (1) Audio Frequency—1,000HZ (1 KHZ), (2) Output level—More than 1V RMS (variable) ● Power Source: AC117 ● Dimensions: H-5½" (140mm), W-10¼" (260mm), D-7¼" (184mm) ● Wt.: 7lbs.

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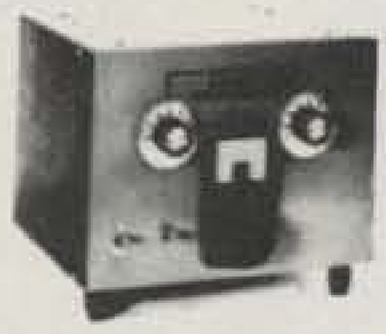
- In/Out Switch
- Commercial Grade Construction
- 160-10 Meters
- 3KW



Introductory Price
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40 foot Self-Supporting Crank-up Mast

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factory assembled not a kit

600 MHZ FREQUENCY COUNTER WITH CRYSTAL OVEN TIMEBASE

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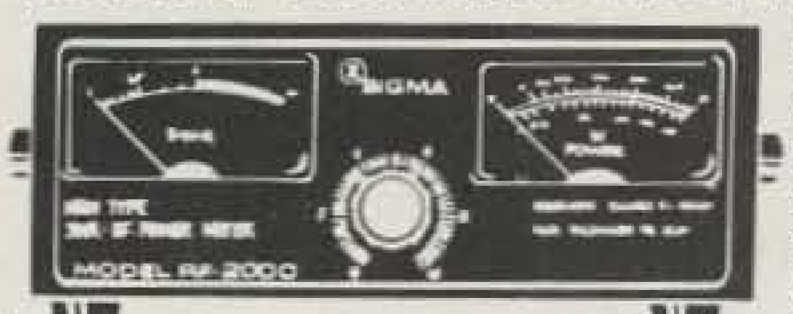
- Accurate—.5PPM ● Selectable Resolution

SIGMA RF-2000 SWR & POWER METER

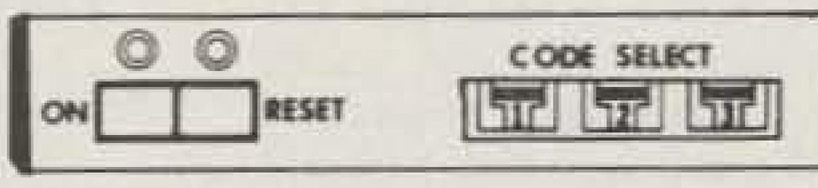


Cal PWR Scales 200W-2000W Freq Range 3.5-150 MHz. Please do not confuse the RF2000 with similar appearing lower priced units. RF2000 is an individually calibrated professional quality instrument. Unequaled at many times the price. Size 7" (w) x 2 1/3" (d).

$29
Introductory Price

SHIPPING ANYWHERE U.S. - $1

GO PRIVATE! on 2 meters with the FMTD-1*



Touch tone pad (encoder) actuated. Quiets your receiver until other station sends private 3 digit code, selected from front panel. 999 Channels. Receiver can be muted or opened manually or remotely with a touch tone pad. Bright led's indicate muting and reset. State of the art digital circuitry. Works with the KDK FM2015R or any 2-meter rig. 5 pin din plug supplied. Size 5½"D x 6½"W x 1"H. Wt. 12 oz.

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FM2015R Accessories — **KDK**

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FMMC-1*	Microphone with Built-in Touch Tone Pad......... $49.95
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MARS-CAP	and Multiple Offset Kit* - Any Frequency, Any Split, No Crystals $5
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SPECIAL SALE FM144 Accessories

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NEW!! ADD
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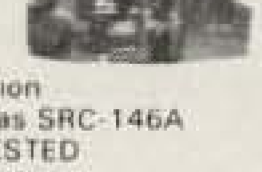
TO SRC-146A



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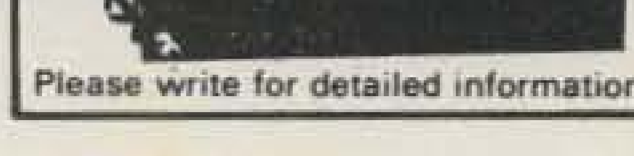

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E12

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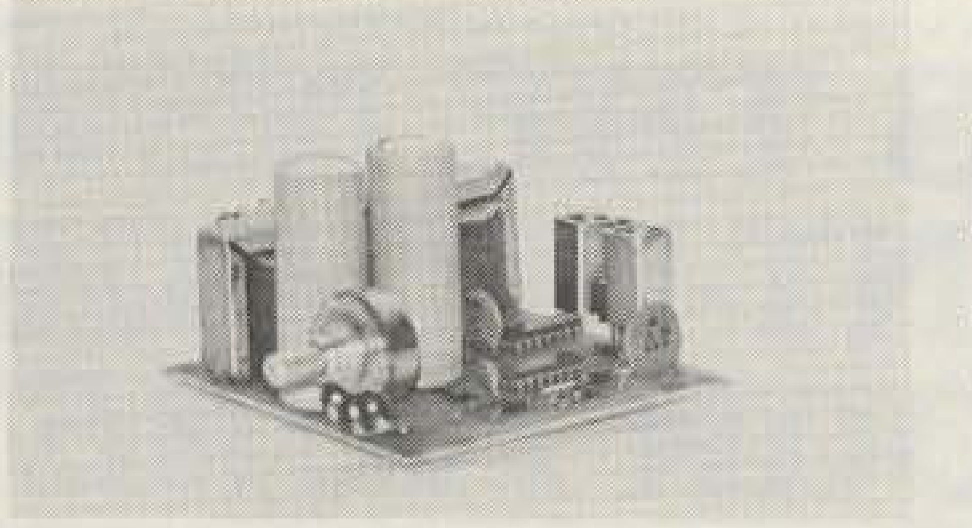

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A24

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$79.95 kit

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You've requested it, and now it's here! The CT-50 frequency counter kit has more features than counters selling for twice the price. Measuring frequency is now as easy as pushing a button, the CT-50 will automatically place the decimal point in all modes, giving you quick, reliable readings. Want to use the CT-50 mobile? No problem, it runs equally as well on 12 V dc as it does on 110 V ac. Want super accuracy? The CT-50 uses the popular TV color burst freq. of 3.579545 MHz for time base. Tap off a color TV with our adapter and get ultra accuracy — .001 ppm! The CT-50 offers professional quality at the unheard of price of $79.95. Order yours today!

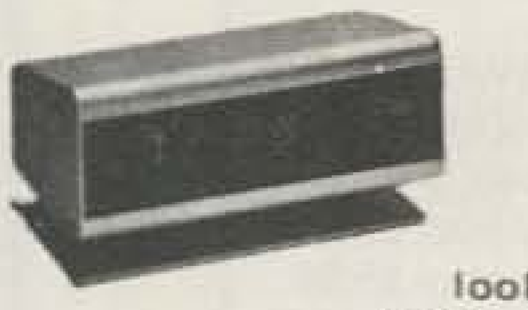
CT-50, 60 MHz counter kit $79.95
CT-50 WT, 60 MHz counter, wired and tested 159.95
CT-600, 600 MHz prescaler option for CT-50, add 29.95

SPECIFICATIONS

Sensitivity: less than 25 mv.
Frequency range: 5 Hz to 60 MHz, typically 65 MHz
Gatetime: 1 second, 1/10 second, with automatic decimal point positioning on both direct and prescale
Display: 8 digit red LED .4" height
Accuracy: 10 ppm, .001 ppm with TV time base!
Input: BNC, 1 megohm direct, 50 Ohm with prescale option
Power: 110 V ac 5 Watts or 12 V dc @ 1 Amp
Size: Approx. 6" x 4" x 2", high quality aluminum case

Color burst adapter for .001 ppm accuracy

CB-1, kit $14.95



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6 digit 12/24 hour

Want a clock that looks good enough for your living room? Forget the competitor's kludges and try one of ours! Features: jumbo .4" digits, Polaroid lens filter, extruded aluminum case available in 5 colors, quality PC boards and super instructions. All parts are included, no extras to buy. Fully guaranteed. One to two hour assembly time. Colors: silver, gold, black, bronze, blue (specify).

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Assembled and tested clocks available, add $10.00

VIDEO TERMINAL KIT $149.95

A compact 5 x 10 inch PC card that requires only an ASCII keyboard and a TV set to become a complete interactive terminal for connection to your microprocessor asynchronous interface. Its many features are single 5-volt supply, crystal controlled sync and baud rates (up to 9600 baud), 2 pages of 32 characters by 16 lines, read to and from memory, computer and keyboard-operated cursor and page control, parity error display and control, power-on initialization, full 64-character ASCII display, block-type see-thru cursor. Keyboard/computer control backspaces, forward spaces, line feeds, rev. line feeds, home, returns cursor. Also clears page, clears to end of line, selects page 1 or 2, reads from or to memory. The card requires 5 volts at approx. 900 ma and outputs standard 75 ohm composite video.

TH3216 Kit $149.95
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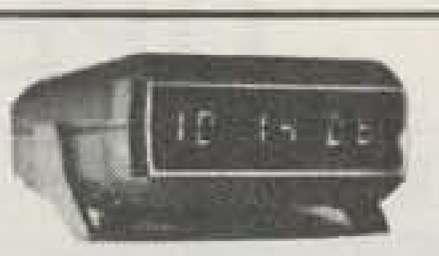
VD-1, Video to RF Modulator Kit 6.95

CAR CLOCK KIT $27.95



12/24-Hour 12-Volt AC or DC
- High Accuracy (1 minute/month)
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- Display blanks with ignition
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Complete Kit, DC-11 $27.95

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Automatically adjusts display brightness according to ambient light level. For DC-11 Car Clock.

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DC-4 Features:
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- 12 or 24 format

Does not include board or transformer

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600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity. Specify ÷10 or ÷100

Wired, tested, PS-1B $59.95
Kit, PS-1B $44.95

30 watt 2 meter Power Amp

The famous RE class C power amp now available mail order! Four Watts in for 30 Watts out, 2 in for 15 out, 1 in for 8 out, incredible value, complete with all parts, instructions and details on T-R relay. Case not included.

Complete Kit, PA-1 .... $22.95

CALENDAR ALARM CLOCK

Has every feature one could ever ask for. Kit includes everything except case, build it into wall, station or even car!

FEATURES:
- 6 Digits, .5" High LED
- 12/24 Hour Format
- Calendar shows mo./day
- Snooze button
- True 24 Hour Alarm
- 7001 chip does all!!
- Battery back up with built-in on chip time base

Complete Kit, less case, DC-9 .... $34.95

		LINEAR		REGULATOR		TRANSISTORS	
5314 Clock	$2.95	555	$ .50	78MG	$1.49	MRF-238 30W VHF	$11.95
74S00	.35	556	.75	309k	.89	NPN 2N3904 type	10/$1.00
74S112	.75	566	1.49	309H	.99	PNP 2N3906 type	10/$1.00
7447	.79	567	1.49	340K-12	.99	NPN Power Tab 40W	3/$1.00
7473	.35	1458	.50	7805	.89	PNP Power Tab 40W	3/$1.00
7475	.50	LED DRIVER		7812	.89	FET MPF-102 type	3/$2.00
7490A	.55	75491	.50	7815	.89	UJT 2N2646 type	3/$2.00
74143	3.50	75492	.50	7818	.89	2N3055 NPN Power	.75

SPECIAL

DIODES: 1KV,2.5A .... 5/$1.00   100V,1A .... 10/$1.00   1N914A type .... 50/$2.00

LED DISPLAYS

FND 359 ...... .75
FND 510 ...... 1.25
DL 707 ...... 1.25
HP 7730 ...... 1.25

Red Polaroid Filter . . . 4.25" X 1.125" . . .59

741 OP-AMP SPECIAL

Factory prime mini dip with both Xerox and 741 part numbers

10 for $2.00

SOCKETS

14 PIN	5/$1.00
16 PIN	5/$1.00
24 PIN	2/$1.00
40 PIN	3/$2.00

FERRITE BEADS

with info and specs
15/$1.00
6 hole Balun Beads
5/$1.00

MINI-KITS

TONE DECODER KIT

A complete tone decoder on a single PC Board. Features: 400-5000 Hz adjustable frequency range, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK demod, signaling, and many other uses. Use 7 for 12 button touchtone decoding. Runs on 5 to 12 volts.

Complete Kit, TD-1 .... $4.95

SUPER SLEUTH AMPLIFIER

A super-sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as a general purpose test amplifier. Full 2 watts of output, runs on 6 to 12 volts, uses any type of mike. Requires 8-45 ohm speaker.

Complete Kit, BN-9 .... $4.95

FM WIRELESS MIKE KIT

Transmit up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9 V. Type FM-2 has added super sensitive mike preamp.

FM-1 ...... $2.95   FM-2 ...... $4.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music or voice. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300 watts. Great for parties, band music, nite clubs and more.

Complete Kit, ML-1 .... $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 Jumbo LEDs. Use for name badges, buttons, or warning type panel lights. Runs on 3 to 9 volts.

Complete Kit $2.95

POWER SUPPLY KIT

Complete triple regulated power supply provides variable ±15 volts at 200 mA and +5 volts at 1 Amp. 50 mV load regulation good filtering and small size. Kit less transformers. Requires 6-8 V at 1 Amp and 18 to 30 VCT.

Complete Kit, PS-3LT $6.95

SIREN KIT

Produces upward and downward wail characteristic of police siren. 5 watts audio output, runs on 3-9 volts, uses 8-45 ohm speaker.

Complete Kit, SM-3 .... $2.95

DECADE COUNTER PARTS

Includes: 7490A, 7475, 7447, LED readout, current limit resistors, and instructions on an easy to build low cost frequency counter.

Kit of parts, DCU-1 .... $3.50

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R8

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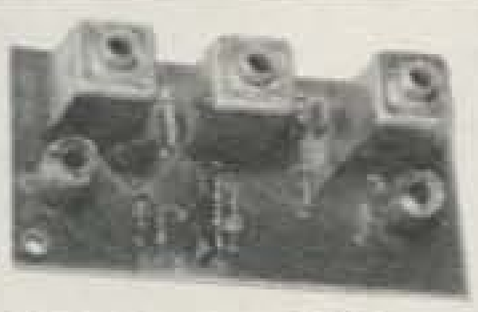
OSCAR?
Here are some helpful suggestions -

FAMOUS HAMTRONICS PREAMPS
let you hear the weak ones!

Great for OSCAR, SSB, FM, ATV. Over 10,000 in use throughout the world on all types of receivers.

P9 Kit ***$12.95***
P14 Wired ***$24.95***



Deluxe vhf model for applications where space permits.

•1-1/2 x 3" •Covers any 4 MHz band •12 Vdc •Ideal for OSCAR •Diode protection •20dB gain

MODEL	RANGE
P9-LO	26-88 MHz
P9-HI	88-172 MHz
P9-220	172-230 MHz
P14 Wired	Give exact band

P8 Kit ***$10.95***
P16 Wired ***$21.95***

Miniature VHF model for tight spaces - size only 1/2 x 2-3/8 inches.

•Covers any 4 MHz band
•20 dB gain •12 Vdc

MODEL	RANGE
P8-LO	20-83 MHz
P8-HI	83-190 MHz
P8-220	220-230 MHz
P16 Wired	Give exact band

P15 Kit **$18.95**
P35 Wired $34.95

• Covers any 6 MHz band in UHF range of 380-520 MHz
•20 dB gain •Low noise

FM/CW TRANSMITTER KITS

BUILD UP YOUR OWN GEAR FOR OSCAR CW OPERATION, FM REPEATERS, CONTROL LINKS
•Professional Sounding Audio •Free of Spurs
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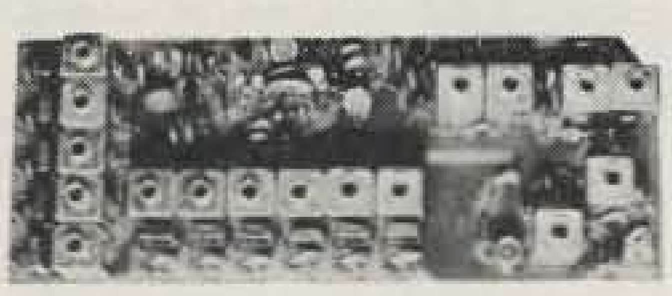
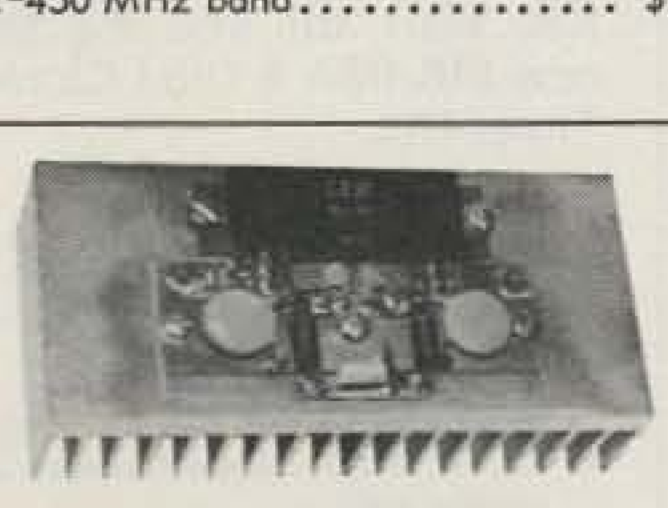


T40 11 Channel 200 MW Exciter Kit for 2M or 6M band........................... $39.95

T20 Tripler/Driver Kit. Use with T40 for operation on 432-450 MHz band............... $19.95

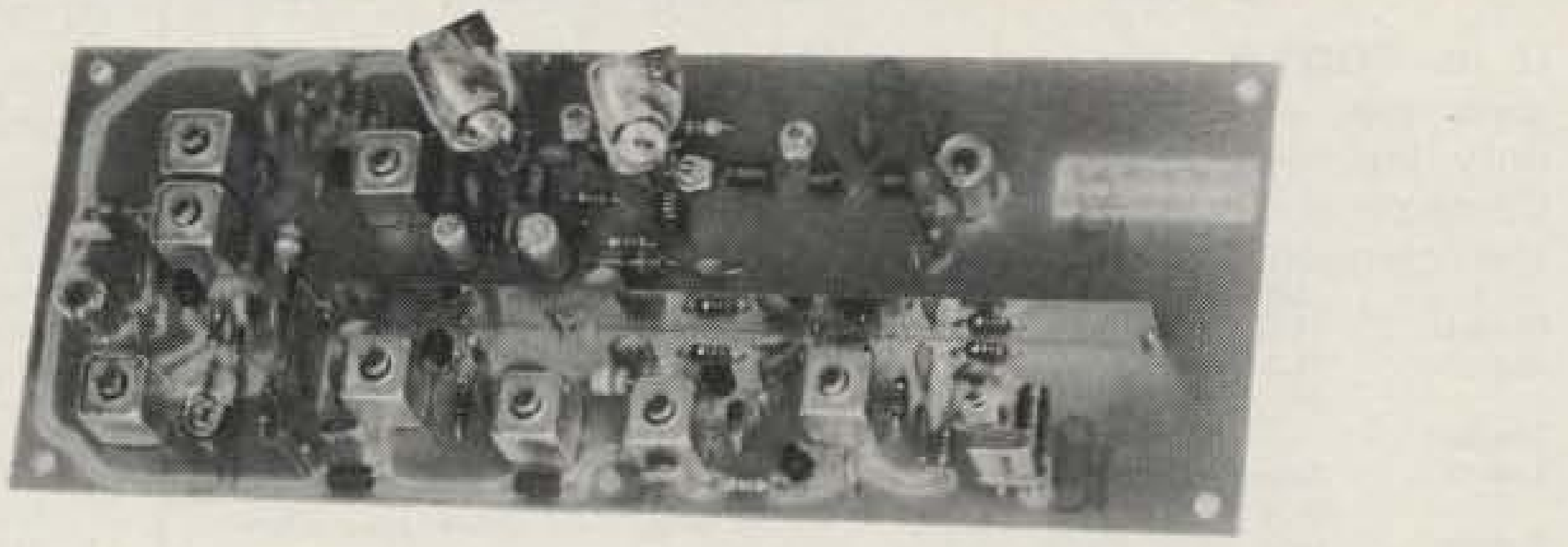


T80 RF POWER AMPLIFIER MODULES FOR ABOVE
•No tuning •VSWR Protected •Wired and Tested
•Rated for Continuous Duty - Great for Repeaters

T80-150: 140-175 MHz, 20-25W output $79.95
T80-450: 430-470 MHz, 13-15W output $79.95

AT LAST! A 2 METER SSB TRANSVERTER
At a price you can afford

Use inexpensive recycled 10 or 11 meter ssb exciter on 2 meters.



FEATURES:
- Linear Converter for SSB, CW, FM, etc.
- A fraction of the price of other units
- 2W p.e.p. output with 5 MW of drive
- Use low power tap on exciter or attenuator pad
- Easy to align with built-in test points

VX2-( ) TRANSVERTER KIT $59.95
A25 Optional Cabinet for Xverter&PA $20

Frequency Schemes Available:

VX2-4 28-30 = 144-146
VX2-5 28-29 = 145-146
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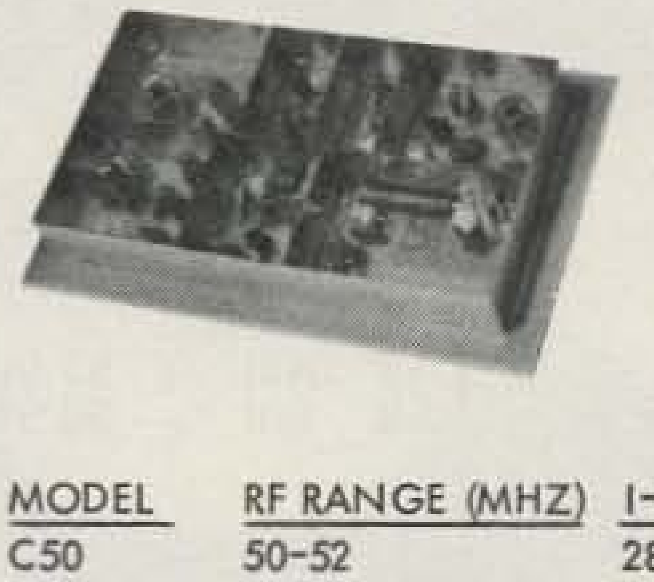
Other frequency ranges available on special order

2M LINEAR POWER AMPLIFIERS:

LPA 2-15 Kit	15 W p.e.p.	$69.95
LPA 2-70 Kit	70 W p.e.p.	$139.95

New VHF&UHF Converter Kits

let you receive OSCAR signals and other exciting SSB, CW, & FM activity on your present HF receiver.



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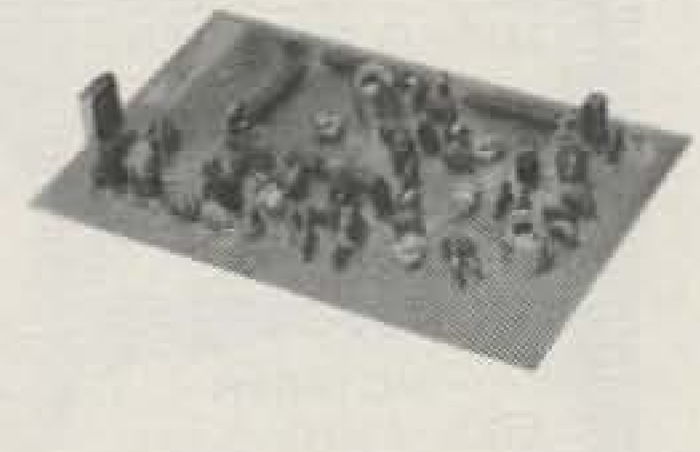
-ONLY $34.95
including crystal



MODEL	RF RANGE (MHZ)	I-F RANGE
C50	50-52	28-30
C144	144-146	28-30
C145	145-147 (OSCAR)	28-30
C146	146-148	28-30
C110	Aircraft	28-30
C220	220 band	28-30
Special	Other i-f & rf ranges available	

MODEL	RF RANGE (MHZ)	I-F RANGE
C432-2	432-434	28-30
C432-5	435-437(OSCAR)	28-30
C432-7	427.25	61.25
C432-9	439.25	61.25
Special	Other i-f & rf ranges available	

A9 Extruded Alum Case/Connectors $12.95

VHF/UHF FM RCVR KITS

★ NEW GENERATION RECEIVERS
★ MORE SENSITIVE ★MORE SELECTIVE (70 or 100 dB)
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R70 6-channel VHF Receiver Kit for 2M, 6M, 10M, 220 MHz, or com'l bands............ $69.95
Optional xtal filter for 100 dB adj chan 10.00

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PS-14 12V, 15A Power Supply Kit

If its **POWER** you need, than look no further. The PS-14 gives you a highly regulated power supply with features only the commercial units offer at a fraction of the cost. Compare our specs with any other unit on the market and then compare our price!

SPECS:

Output:	11.5–14.5 adjustable
Current:	15A continuous; 20A int.
Current Limit:	Adjustable Foldback type
Ripple:	Less than 1% @ 15A
Regulation:	Better than 200 milli-volts from no load to full load
Thermal:	Adjustable thermal shut down protects series pass.

YOU GET:

* Heavy duty 12 lb. transformer
* 2 large finned heatsinks
* Regulator PC board with all parts.
* Huge 34,000 mfd computer grade filter cap.
* 40 amps of series pass translators
* Wire, transistor mounting kits, line cord.

$39.95
Less Case & Meters

METERS: Quality 3½" meters for PS-14. 0–15VDC. 0–25 ACD matched set. Individually packaged.
NOT SURPLUS!

12.50/set

THE LAST CHANCE!

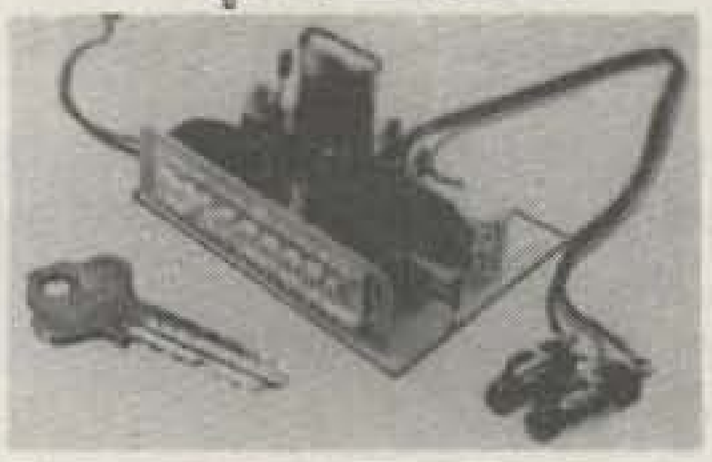
THAT'S RIGHT! THE LAST CHANCE TO BUY OUR SUPER POPULAR MK-05 MINI MOBILE SIX DIGIT CLOCK KIT at this super low price. The response has been great but supplies are starting to run low. So order NOW!

Features:

* Quartz crystal timebase
* Toroid & zener noise & over-voltage protection.
* Magnified .15", 6 digit LED readout
* Complete with presettable 24 hr. alarm.
* 9–14 VDC @ 40 to 50 ma.
* Readouts can be suppressed
* EASY, QUICK ASSEMBLY!
* All components required included (you supply the speaker).
* Top quality drilled & plated PC Boards
* Clock board: 2.6" x 2"
* Readout board: 2 3/8"x.75"

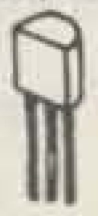
Small enough to mount in the instrument panel.

$12.95



OVERVOLTAGE PROTECTION KIT: $6.95
Provides cheap insurance for your expensive equipment. Trip voltage is adjustable from 3 to 30 volts. Overvoltage instantly fires a 25A SCR and shorts the output to protect equipment. Should be used on units that arefused. Directly compatible with the PS-12 and PS-14. All electronics supplied. Drilled & plated PC board. (Order OVP-1).

2N6028
Programmable unijuction super for oscillators, timers, time delay etc. 50c



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Limited Qty!
LM567 Tone Decoders while they last!
99c

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PNP Transistors
40Watt 3A
TO-220 case
2/$1.00

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220mfd @25V Axial Cap **7/$1.00**

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741 Amps 8 pin mini dip **5/$1.00**
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Heatshrink Tubing
A very good asst. of 3/32", 1/8", 3/16" 1/4" & 7/16" 6" lengths 12 pcs.
75c

MICRO TRIMMER CAPS
Tiny 4-40 pfd trimmer used originally in watches!
3/$1.00

MJ900; MJ1000
Complimentary Darlington. PNP. NPN power transistor. 8 amps. pair for **$3.**

Multicolored 26 Conductor Ribbon Cable
No. 28 wire with a woven binder. Super Flexible!
10' roll – $2.95
50' roll – $9.95

MC1469R
500ma postive regulator. 3 to 30 volts. with complete specs and applications.
$1.25 - **house no.**

MC1351P FM IF
AMP. 14 pin IC. Complete FM sound subsytem, similar tc LM2111. house no.
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WESTON MICRO
PC mount trim pots. Single turn
1K. **3/$1.00**

Above item *FREE!* **with $15.00 purchase or more!**

No. 30 Wirewrap Wire. Kynar jacket. 4 colors. 100 ft. of each color. **$4.00** **(400')**

CA3011 Wideband IC **50c**

2N3569 NPN
epoxy TO-5 case.
VCEO=60: Hfe=300
800MW power
6/$1.00

BULLET LUCKY NUMBER FOR FEB. IS: 158501. (Number worth $100.; numbers are in catalogs.)

FANTASTIC NEW SOUND SYNTHESIZER IC $3.95 each
Make any sound under the sun with this 28 pin marvel! Single IC contains: Noise generator, super low frequency OSC, VCO, one shot, mixer envelope control and amp. works from a single 5 to 9 VDC source. With 8 page manual.

MK-06 Clock/Calendar Auto Home Clock Kit

We designed this to be a SUPER CLOCK with ALL the features you want. Quality double sided PC boards make assembly easy. Mobile (12VDC) or home (12VAC)

* Large ½" LED Readout
* AM/PM Indication
* 28/30/31 day calendar displays automatically or manually
* Display can be dimmed or blanked
* Flashing Colon counts the seconds
* Intergal Timebase is adjustable
* Presettable Alarm with Snooze Feature.
* Noise and voltage protection circuits
* Single front mounted rotary switch selects all functions

21.50

Mini Grandfather Clock Kit – $39.95
Just in case you have spent the last six months in Siberia, we will tell you one more time that **Bullet** has the **ONLY Completely Electronic Grandfather Clock Kit** in the world that has all the below listed features. The biggest problem we have is to try and describe how unique and fascinating this clock really is! **The Swinging LED Pendulum and Matching Tick-tock sound** are available only on our clock. In addition the electronic chime notes each hour (ie: 3 times for 3 o'clock). Housed in the optional **Solid Hardwood Case**, the unit makes a beautiful addition to any room as well as a great gift.

* ½" 4 digit LED readout
* Adjustable tone & duration on chime
* Simulated swinging pendulum uses LEDS
* All CMOS construction
* All electronics, switches and transformer included
* Quality plated PC boards (2) 6.5" x 4.5"

BEAUTIFUL HARDWOOD CASE FOR MG-01: Case is cut, grooved and finished for clock. Includes ruby front filter. Quick, easy assembly requires only 4 screws (inc.)
$19.95

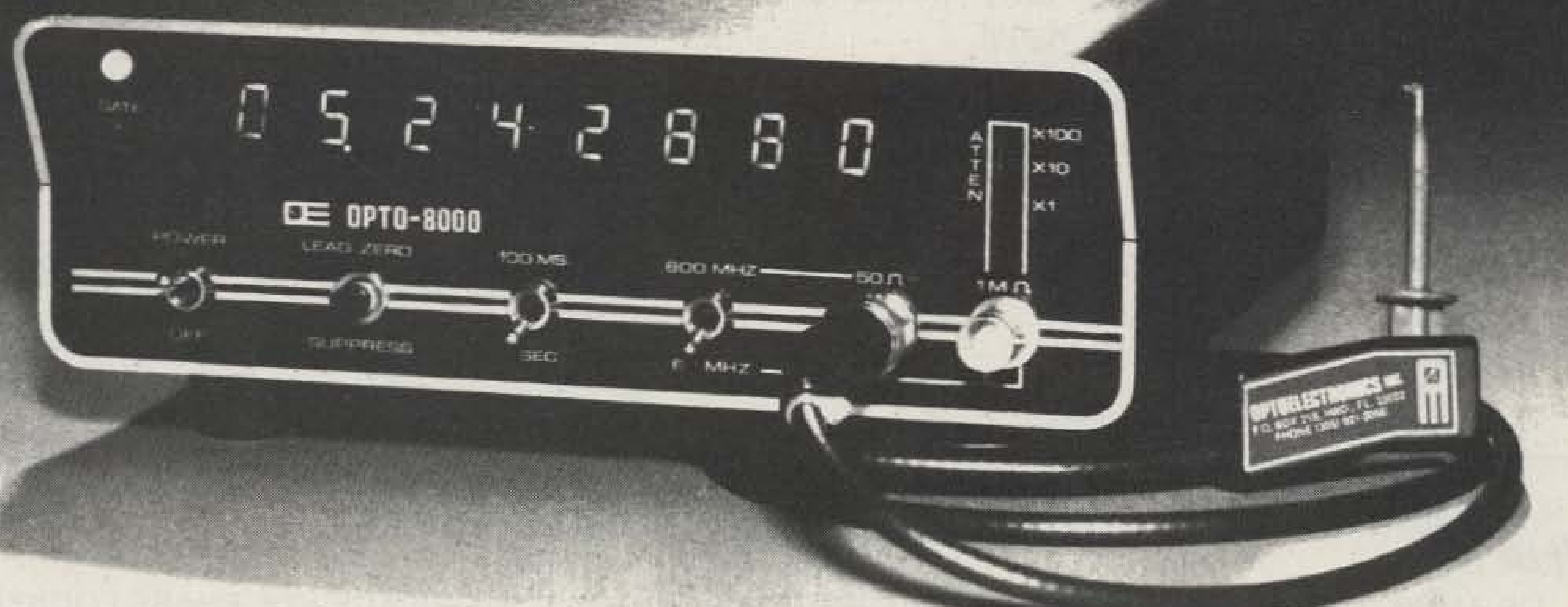
You've read the reviews on our MK-03 clock/Timer Kit. Wait till you see the new MK-03A 6 Digit Clock/ Timer Kit:

* Separate 24 hour clock and 24 hour elapsed timer functions.
* Presettable alarms on both clock and timer
* Smaller more compact kit is 2¼" wide x 3 5/8" long x 1½"
* Super revised manual makes assembly easy
* Many options available by adding switches.
* Sold less case & switches.

$28.95 (Will fit standard 3 1/8" instrument case)

600 MHZ. FREQUENCY COUNTER
±0.1 PPM TCXO

OPTO-8000.1



This new instrument has taken a giant step in front of the multitude of counters now available. The Opto-8000.1 boasts a combination of features and specifications not found in units costing several times its price. Accuracy of ±0.1 PPM or better — *Guaranteed* — with a factory-adjusted, sealed TCXO (Temperature Compensated Xtal Oscillator). **Even kits require no adjustment for guaranteed accuracy!** Built-in, selectable-step attenuator, rugged and attractive, black anodized aluminum case (.090" thick aluminum) with tilt bail. 50 Ohm and 1 Megohm inputs, both with amplifier circuits for super sensitivity and both diode/overload protected. Front panel includes "Lead Zero Blanking Control" and a gate period indicator LED. AC and DC power cords with plugs included.

SPECIFICATIONS:
Time Base—TCXO ±0.1 PPM GUARANTEED!
Frequency Range—10 Hz to 600 MHz
Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
Decimal Point—Automatic
All IC's socketed (kits and factory-wired)
Display—8 digit LED
Gate Times—1 second and 1/10 second
Selectable Input Attenuation—X1, X10, X100
Input Connectors Type —BNC
Approximate Size—3"h x 7½"w x 6½"d
Approximate Weight—2½ pounds
Cabinet—black anodized aluminum (.090" thickness)
Input Power—9-15 VDC, 115 VAC 50/60 Hz or internal batteries

OPTO-8000.1 Factory Wired	**$299.95**
OPTO-8000.1K Kit	**$249.95**

ACCESSORIES:
Battery-Pack Option—Internal Ni-Cad Batteries and charging unit **$19.95**
Probes: P-100—DC Probe, may also be used with scope **$13.95**
P-101—LO-Pass Probe, very useful at audio frequencies **$16.95**
P-102—High Impedence Probe, ideal general purpose usage **$16.95**

VHF RF Pick-Up Antenna-Rubber Duck w/BNC #Duck-4H **$12.50**
Right Angle BNC adapter #RA-BNC **$ 2.95**

FC-50 — Opto-8000 Conversion Kits:
Owners of FC-50 counters with #PSL-650 Prescaler can use this kit to convert their units to the Opto-8000 style case, including most of the features.

FC-50 — Opto-8000	**Kit $59.95**
*FC-50 — Opto-8000F	**Factory Update $99.95**
FC-50 — Opto-8000.1 (w/TCXO)	**Kit $109.95**
*FC-50 — Opto-8000.1F	**Factory Update $149.95**

*Units returned for factory update must be completely assembled and operational

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16K E-PROM CARD

Uses 2708's!

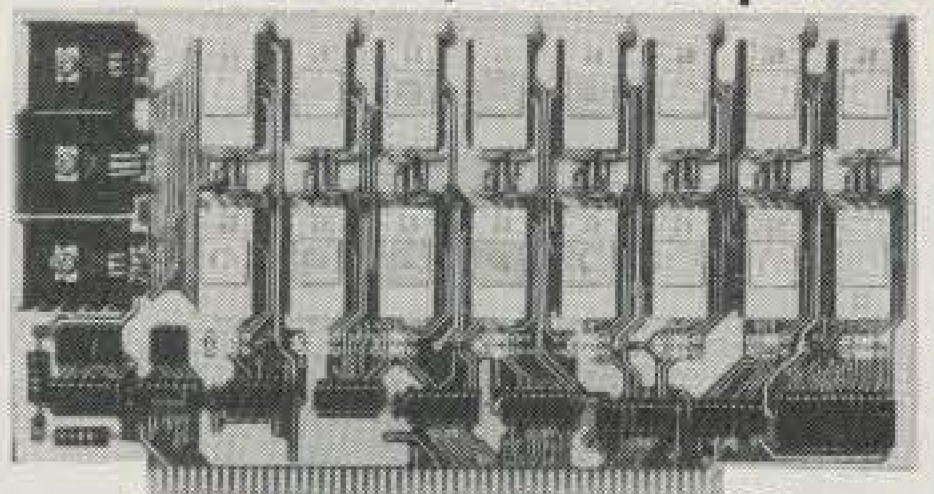
IMAGINE HAVING 16K OF SOFTWARE ON LINE AT ALL TIME!

S-100 (Imsai/Altair) Buss Compatible!

KIT FEATURES:

1. Double sided PC board with solder mask and silk screen and gold plated contact fingers.
2. Selectable wait states.
3. All address lines & data lines buffered!
4. All sockets included.
5. On card regulators.

KIT INCLUDES ALL PARTS AND SOCKETS (except 2708's). Add $25. for assembled and tested.



DEALER INQUIRIES INVITED!

$69.95 kit

SPECIAL OFFER:

Our 2708's (450NS) are $12.95 when purchased with above kit.

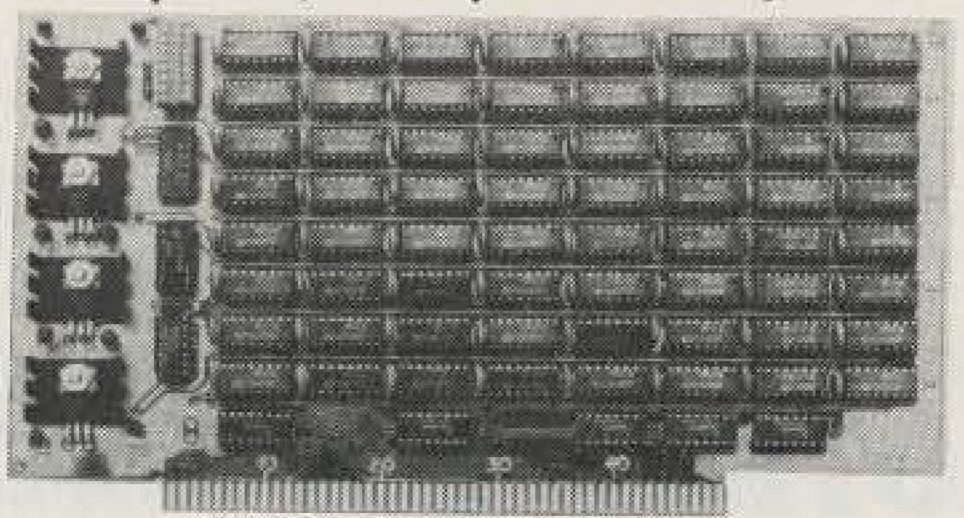
Fully Static!

8K LOW POWER RAM KIT-$149.00

S-100 (Imsai/Altair) Buss Compatible!

KIT FEATURES:

1. Doubled sided PC Board with solder mask and silk screen layout. Gold plated contact fingers.
2. All sockets included.
3. Fully buffered on all address and data lines.
4. Phantom is jumper selectable to pin 67.
5. FOUR 7805 regulators are provided on card.



USES 21L02 RAM'S!

Fully Assembled & Burned In $179.00
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FULL WAVE BRIDGE
4 AMP. 200 PIV.
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MOTOROLA 7805R VOLTAGE REGULATOR
Same as standard 7805 except 750 MA output. TO–220. 5VDC output.
44c each or 10 for $3.95

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Now full speed! Prime new units from a major U.S. Mfg. 450 N.S. Access time. 1K x 8. Equiv. to 4-1702 A's in one package.
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By Mostek, The major Z-80 second source. The most detailed explanation ever on the working of the Z-80 CPU CHIPS. At least one full page on each of the 158 Z-80 instructions. A MUST reference manual for any user of the Z-80. 300 pages. Just off the press! **A D.R.C. exclusive! $12.95**

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Stud Mount. 1N1187.
35 AMPS. 300 PIV.
Military Quality! $1.19 ea. or 4/$3.50

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1N4721. Axial Lead. 200 PIV.
HEAVY DUTY!
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4K STATIC RAM'S
2114. The new industry standard. Arranged as 1K x4. Equivalent to 4-21 L02's in 1 package! 18 pin DIP. 2 chips give 1Kx8.
2/$24. 8/$85.

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SLA-1. Common Anode. .33 inch character size. The original high efficiency LED display. 75c ea.
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262.144KHZ. This frequency is 2 to the 18th power. Easily divided down to any power of 2, and even to 1HZ. New by CTS-Knight. A $5. value!
$1.25 each

GE Ni-Cad Battery Pack
3 Cell pack, gives 4 volts at 900MAH. Brand new, factory fresh. Each cell is 2/3 "C" size. **$4.50 /pack. Buy 3 packs (12 volts) for $10.95. Limited stock!**

741C OP AMPS
Mini Dip. Prime new units. Has computer Mfg's house number.
12/$2. 100/$15.

Disc Capacitors
.1 MFD 16V. P.C. leads. Most popular value. By Sprague.
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HEAVY DUTY!
Full Wave Bridge
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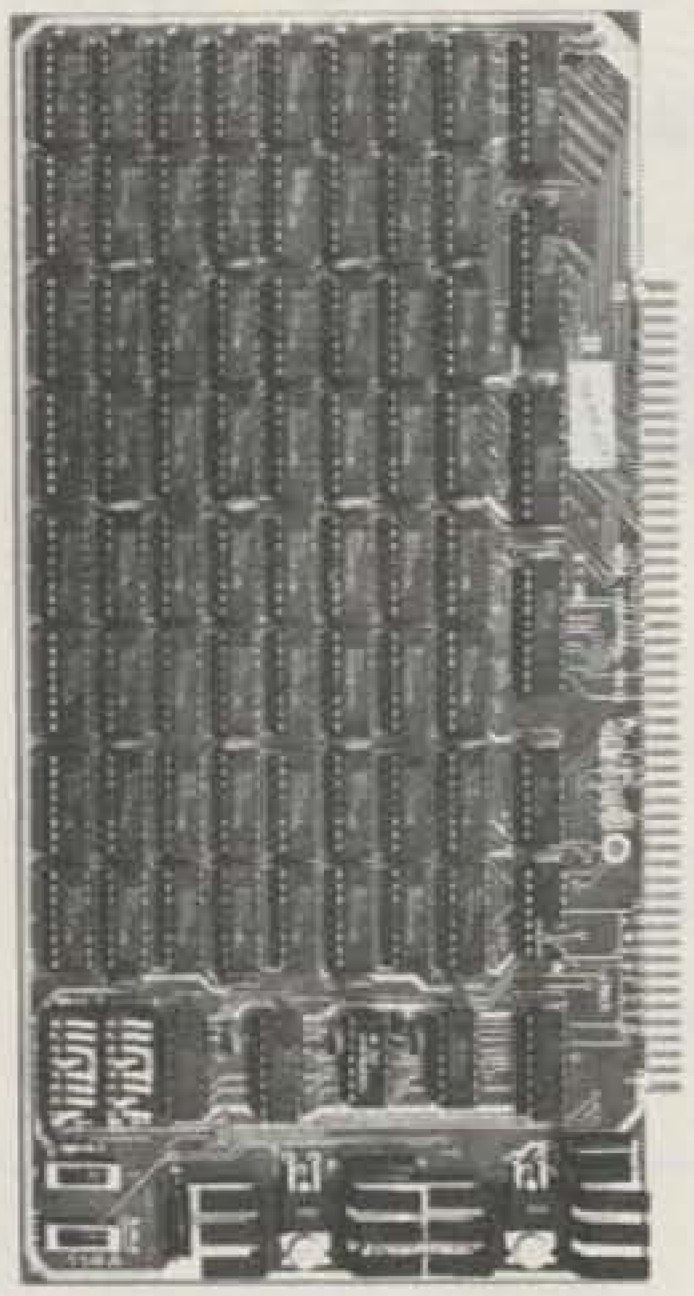

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MAN 6640	Common Cathode-orange-D.D.	.560	.79	5082-7304	Overrange character (±1)	.600	15.00
MAN 6650	Common Cathode-orange ±1	.560	.79	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50
MAN 6660	Common Anode-orange	.560	.79				

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA3023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3091	3.50
CA3053	1.50	CA3102	2.95
CA3059	3.25	CA3123	2.15
CA3060	3.25	CA3130	1.39
CA3080	.85	CA3140	1.25
CA3081	2.00	CA3401	.49
		CA3600	1.75

EXAR

XR-2206KB Kit $19.95 — **XR-2206KA Kit $14.95**

WAVEFORM GENERATORS

XR-205	$8.40
XR-2206CP	5.50
XR-2207CP	3.85

STEREO DECODERS

XR-1310CP	$3.20
XR-1310EP	3.20
XR-1800P	3.20
XR-2567	2.99

MISCELLANEOUS

XR-2211CP	$6.70
XR-4136	2.00
XR-1468	3.85
XR-1488	5.80
XR-1489	4.80
XR-2208	5.20

TIMERS

XR-555CP	$ .49
XR-320P	1.55
XR-556CP	1.85
XR-2556CP	3.20
XR-2240CP	4.80

PHASE LOCKED LOOPS

XR-210	5.20
XR-215	6.60
XR-567CP	1.95
XR-567CT	1.70

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	.16	.15	24 pin	$.38	.37	.36
14 pin	.20	.19	.18	28 pin	.45	.44	.43
16 pin	.22	.21	.20	36 pin	.60	.59	.58
18 pin	.29	.28	.27	40 pin	.63	.62	.61
22 pin	.37	.36	.35				

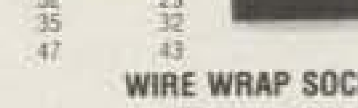
SOLDERTAIL STANDARD (TIN)

14 pin	$.27	.25	.24	28 pin	$.99	.90	.81
16 pin	.30	.27	.25	36 pin	1.39	1.26	1.15
18 pin	.35	.32	.30	40 pin	1.59	1.45	1.30
24 pin	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3



8 pin	$.40	.38	.35	22 pin	.95	.85	.75
10 pin	.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	1/4 WATT 5% — 50 PCS.
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	1/4 WATT 5% — 50 PCS.
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	1/4 WATT 5% — 50 PCS.
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	1/4 WATT 5% — 50 PCS.
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	1/4 WATT 5% — 50 PCS.
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	1/4 WATT 5% — 50 PCS.
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	1/4 WATT 5% — 50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
Dealer Information Available

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J1

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

$11.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.45 ea.**
- Cuts wire to desired length
- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

REPLACEMENT DISPENSER SPOOLS FOR WD 30
Specify blue, yellow, white or red **$1.98/spool**

Prime Stock Inventory Clearance — STEWART WARNER — Special Offer

P/N	10(min.)	100	1000	P/N	10(min.)	100	1000
SW7401	$1.20/lot	$9.00/lot	$80.00/lot	SW7482	$4.90/lot	44.00/lot	430.00/lot
SW7407	2.20	19.00	180.00	SW7483	3.50	31.00	300.00
SW7416	2.20	19.00	180.00	SW7486	2.20	19.00	180.00
SW7417	2.20	19.00	180.00	SW7491	3.50	31.00	300.00
SW7420	1.30	11.00	100.00	SW7494	3.50	31.00	300.00
SW7423	2.20	19.00	180.00	SW7495	3.50	31.00	300.00
SW7425	1.70	14.00	130.00	SW7496	3.50	31.00	300.00
SW7427	1.50	12.00	110.00	SW74100	6.90	66.00	650.00
SW7430	1.50	12.00	110.00	SW74104	2.20	19.00	180.00
SW7432	1.50	12.00	110.00	SW74105	2.20	19.00	180.00
SW7437	1.50	12.00	110.00	SW74107	2.20	19.00	180.00
SW7438	1.50	12.00	110.00	SW74121	2.20	19.00	180.00
SW7440	1.20	9.00	80.00	SW74123	2.50	22.00	200.00
SW7443	3.50	31.00	300.00	SW74145	5.50	51.00	500.00
SW7444	3.50	31.00	300.00	SW74150	6.90	66.00	650.00
SW7445	3.50	31.00	300.00	SW74151	3.50	31.00	300.00
SW7446	4.00	36.00	350.00	SW74153	4.00	36.00	350.00
SW7450	1.20	9.00	80.00	SW74156	4.00	36.00	350.00
SW7453	1.20	9.00	80.00	SW74180	4.50	41.00	400.00
SW7454	1.20	9.00	80.00	SW74181	9.90	96.00	950.00
SW7460	1.20	9.00	80.00	SW74182	4.50	41.00	400.00
SW7472	2.20	19.00	180.00	SW9601	2.50	22.00	200.00
SW7475	3.50	31.00	300.00	SW9602	4.90	44.00	430.00
SW7480	2.90	25.00	250.00				

Pre-tubed • No mixing or combining prices

TV GAME CHIP SET — $7.95

Includes AY-3-8500-1 Chip and 2.010 mhz crystal
(2.010 crystal — $.99 ea/AY-3-8500-1 Chip — $7.50 ea.)

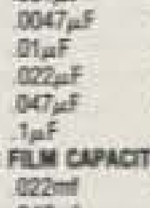
ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
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
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
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
1N485A	180	10m	6/1.00	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	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

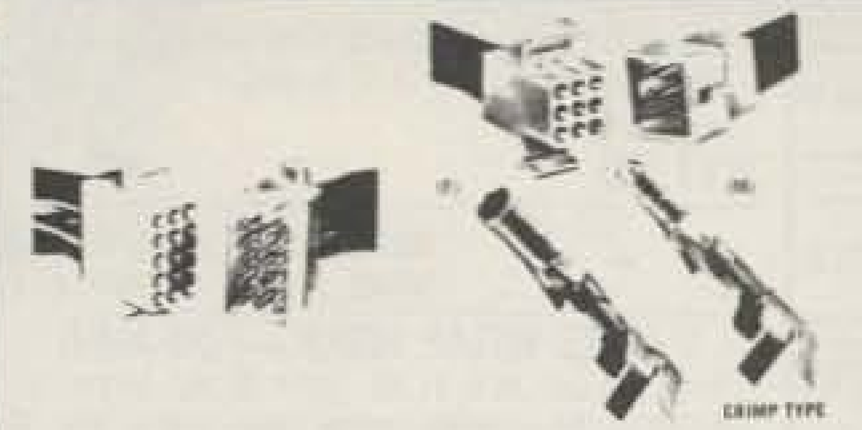



MPS A05	.30			PN4250	4/$1.00
MPS A06	5/$1.00			2N4400	4/$1.00
2N918	4/$1.00			2N4401	4/$1.00
2N2219A	3/$1.00	2N3638	5/$1.00	2N4402	4/$1.00
2N2221	4/$1.00	2N3702	5/$1.00	2N4403	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4409	5/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N5086	4/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00	2N5087	4/$1.00
2N2484	4/$1.00	2N3707	5/$1.00	2N5088	4/$1.00
2N2906A	4/$1.00	2N3711	5/$1.00	2N5089	4/$1.00
2N2907A	5/$1.00	2N3724	$.65	2N5129	5/$1.00
2N2925	5/$1.00	2N3725	$1.00	2N5138	5/$1.00
2N3035	2/$1.00	2N3772	$2.25	2N5139	5/$1.00
2N3055	$.89	2N3903	5/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N3904	4/$1.00	2N5210	5/$1.00
MJE3055	$1.00	2N3905	4/$1.00	2N5432	$2.00
2N3392	5/$1.00	2N3906	4/$1.00	2N5449	3/$1.00
2N3398	5/$1.00	2N4013	3/$1.00	2N5951	5/$1.00
PN3567	3/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
PN3568	4/$1.00	2N4123	6/$1.00	40409	$1.75
PN3569	4/$1.00	PN4249	4/$1.00	40410	$1.75

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.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
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.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
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.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
2200/16V	.70	.62	.55	470/25V	.31	.28	.26



NYLON CONNECTORS

Mfg by Molex

Complete Connectors Per Pkg.	Type No.	Class	Description	Price Ea. Pkg.
5	1625-1PRT	Min.(.062')	1 Circuit	$1.75
3	1625-2PRT	"	2 Circuit	1.90
3	1625-3PRT	"	3 Circuit	2.10
2	1625-4PRT	"	4 Circuit	2.10
2	1625-5PRT	"	5 Circuit	2.20
2	1625-6PRT	"	6 Circuit	2.35
1	1649-8PRT	"	8 Circuit	1.55
1	1625-9PRT	"	9 Circuit	1.75
1	1625-12PRT	"	12 Circuit	1.90
1	1625-15PRT	"	15 Circuit	2.30
1	1625-24PRT	"	24 Circuit	3.25
1	1772-36PRT	"	36 Circuit	4.55
5	1619PRT	Std.(.093")	1 Circuit	1.75
3	1545PRT	"	2 Circuit	1.90
3	1396PRT	"	3 Circuit	2.10
2	1490PRT	"	4 Circuit	2.10
2	1653PRT	"	5 Circuit	2.20
2	1261PRT	"	6 Circuit	2.35
1	1292PRT	"	9 Circuit	1.80
1	1360PRT	"	12 Circuit	1.90
1	1375PRT	"	15 Circuit	2.45

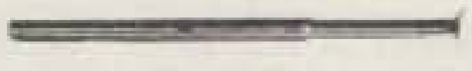
Prototype hand tools combine efficiency with economy. Ideal for prototype or limited production runs.

HT-1919 for .093" pin dia. terminals ... $8.95 each

HT-1921 for .062" pin dia. terminals ... $8.95 each

Econo-Extractor removes terminal from nylon connector housing with smoothness and ease.

HT-2054 for extracting .093" pin dia. terminals ... $2.25 each
HT-2023 for extracting .062" pin dia. terminals ... $2.25 each



Deluxe ejector tools, spring-loaded for simple, efficient removal of terminal from nylon connector housing extracts either male or female terminals of same pin diameter.

HT-2038 for extracting .093" pin dia. terminals ... $6.70 each
HT-1010-282 Replacement tip for HT-2038 ... $2.50 each
HT-2285 for extracting .062" pin dia. terminals ... $6.70 each
HT-1672-3 replacement tip for HT-2285 ... $2.50 each

INTEGRATED CIRCUITS

555 Timer 8 pin mini-DIP	.49
741 Compensated OP-Amp 8 pin DIP	.37
LM 1889N RF Video Modulator	7.45
CA3130 Bipolar/Mos-FET Op Amp	1.19
CA3140 MOS-FET Op Amp, Bi-polar out	.99
LM3909 Lo Voltage Led Pulser	1.50
LM3911 Temp Control CHIP	1.50
Signetics 2504TA 1024 bit S.R. memory (1404A)	$1.75
MCM 6571P Character Generator	11.95
MCM6571AP Character Generator	11.95
MCM6575P Character generator	$14.88
50240 Top octave generator	$14.95
LM399H Temp Stabilized Zener	5.95
AF100-1CJ Active Filter, State Variable	7.50
LM2907N Tachometer F/V Converter	2.65
LM1812N Ultra-sonic Transceiver	9.15
LM1815 Adaptive Sense Amp for Tachometer	5.73
TL170 TO-92 Hall effect switch w/spec sheets	1.25
MC14409P Telephone Rotary Pulser	10.98
MC14419P Touch Pad Converter for 14409	4.25
MC14411P Baud Rate Generator	11.98
MC14412VP CMOS Modem Chip	16.95
MM57109N Number Cruncher Micro	18.95
74C915 7 Segment to BCD Converter	2.99
74C922 16 Key Keyboard Encoder	6.35
74C923 20 key Keyboard Encoder	6.45
74C925 4 Decade Counter w/latches	12.00
74C926 4 Decade Counter w/carry	12.00
74C935-1 3½ Digit DVM CMOS Chip	16.98
9601 Retriggerable One shot	.50
MC4015P Hi Speed quad "D" low power TTL	$1.00

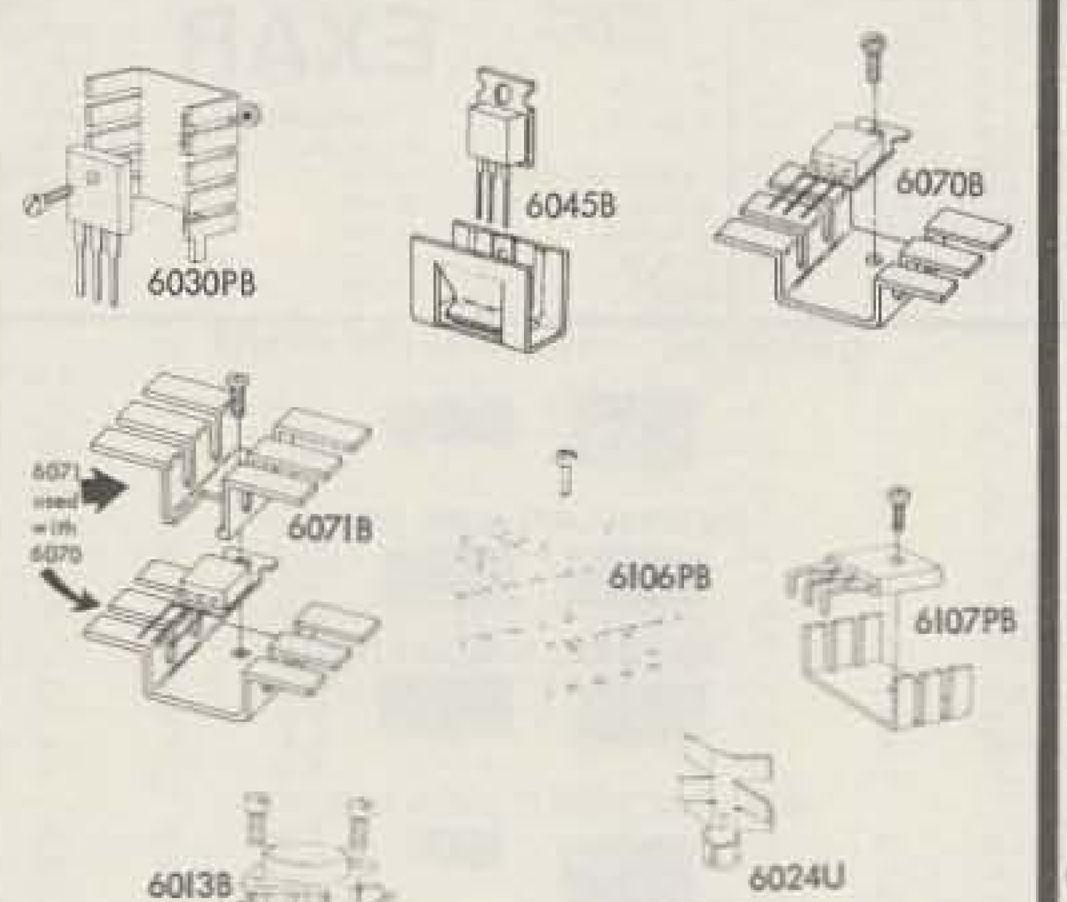
ADJUSTABLE NEGATIVE REGULATOR

LM337 is the compliment to the popular LM317 positive adjustable regulator. Capable of 1.5Amp from - 1.2V to - 37V.

LM337K.....(TO-3 Metal).................. $5.99
LM337T.....(TO-220 Plastic)............... $4.65
Specs and applications........................60¢

Neither snow, nor rain, nor heat,...etc,...etc, stops TRI-TEK from delivering quality parts. GIVE US A TRY!!!!!!

HEAT SINKS



Economical 1 piece heat sinks for plastic power parts in TO-220 and Motorola cases 77, 90, 199, and TO-126. All are black anodized aluminum. "B" series is anodized after forming. "PB" series is anodized prior to forming.

THM 6030PB	Vertical	25¢, 5/$1.00, 10/$1.90
THM 6045B	Slip Over	30¢, 4/$1.00, 10/$2.00
THM 6070B	Extra Disipation Horiz.	35¢, 3/$1.00, 10/$3.00
THM 6071B	Top Hat for 6070	35¢, 3/$1.00, 10/$3.00
THM 6106PB	Flat With Fingers	30¢, 4/$1.00, 10/$2.00
THM 6107PB	Smaller Size Flat	25¢, 5/$1.00, 10/$1.90
THM 6013B	TO-3 Diamond	69¢, 4/$2.50, 10/$5.00
THM 6024-U	Unfinished TO-92	10/$1.00, 100/$5.00

OPTO COUPLED TRIAC

MOC-3010 provides 115 vac full wave switching and isolation. Used alone can switch up 7.5 watts from low power inputs such as TTL logic. Drive larger triacs and control the world.

MOC-3010P............................... $2.65
Specs/Apps.................................. .40c

HEX DARLINGTON ARRAY

MC1413P is a 16 pin DIP package with (6) 50V 500mA Darlington pairs.

MC1413P.................................$1.59
Specs/Apps.................................30¢

S-100 BUS CONNECTORS (IMSAI TYPE)
Gold, Solder tail for Mother boards $4.50,4/$17.00
Tin-Nickel, (NASGLO) Solder tail $3.75,4/$14.00
Gold, wire-wrap................ $4.50,4/$17.00
Tin-Nickel, (NASGLO) wire-wrap $3.75,4/$14.00

I.C. SOCKETS

Lo Profile Tin Solder Tail Dip Sockets

8 pin	10/$1.50	100/$14.00	1000/$120.00
14 pin	10/$1.70	100/$16.00	1000/$140.00
16 pin	10/$1.90	100/$18.00	1000/$160.00

VOLTAGE REGULATORS

7805-06-08-12-15-24 TO220	95¢	5/$4.50
7905-06-08-12-15-24 TO 220	95¢	5/$4.50
78LO5A-12-15 4% 100 mA TO-92 Plastic		50¢
78HO5KC 5V 5A TO-3		9.15
78H12KC 12V 5A TO-3		9.15
78H15KC 15V 5A TO-3		9.15
Lm317K 1.5A *Adjustable* TO-3		4.99
Lm317T 1.5A *Adjustable* TO-220		3.99
Lm317MP .5A *Adjustable* TO-202		13.95
TL430C Adjustable Zener-*Think About It*		1.50
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RCA CA 3085 100 mA *Adjustable*		.60

Minature Reed relays

D.P.D.T. 12V DC 1000 Ohm coil. Only 3/8" x½"x7/8" molded case. 5/8" long flexible wire leads. Inventory reduction at large manufacturer brings you this super buy

RRY-2212G.................................$1.95

SPST N.O. 5VDC 140 Ohm coil. Measures a tiny 1" long 3/8" diameter. Has flexible solid wire leads.

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IN4004 400 V 1 amp		10/$1.00
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D2131 200 V, 25A Stud		85¢
D2135 400 V, 25A Stud		1.00
D2138 600 V, 25A Stud		1.55
D3289R 200 V, 160A Stud Anode		5.85
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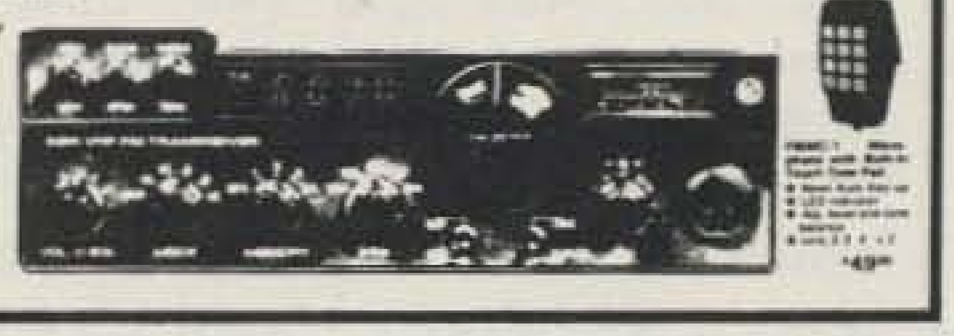

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3 amp. 400 volt 1.10
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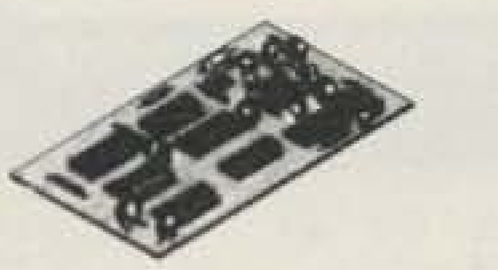
ACCUKEYER KIT



Board Measures 2-5/8" x 4-3/8"

ACCUKEYER KIT Similar to the famous ARRL Handbook version, Kit includes PC board, IC sockets, ICs, speaker switch and all parts and instructions.
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2N4427	1.0W	175 MHz	TO39	1.35
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2N5591	25W	175 MHz	MT72	10.25
2N5913	1.75W	175 MHz	TO39	1.70
2N6080	4.0W	175 MHz	MT72	5.40
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2N6083	30W	175 MHz	MT72	12.30
2N6084	40W	175 MHz	MT72	16.30
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2N6096	30W	175 MHz	X106 PNP	10.35
2N6097	40W	175 MHz	X106 PNP	20.00
GE28	12W	50 MHz	X51	2.15
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Each Clock separately controlled
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Easy assembly for clock and cabinet

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Same kit as above in unassembled Black Plastic cabinet with Red Filter.

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32K FOR $475 EXPANDORAM KIT 24K FOR $367.00

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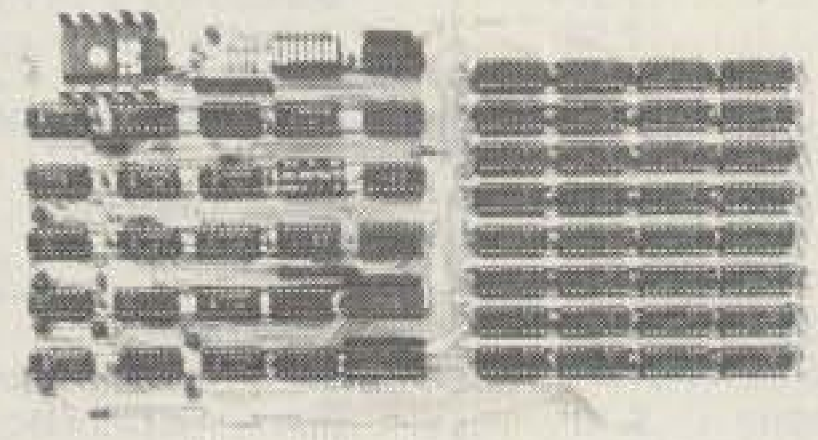
8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection. Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted. Allow 6 to 8 weeks for delivery.



INTERFACE CAPABILITY
Control, data and address inputs utilizes low power Schottky devices.

POWER REQUIREMENTS
+ 8VDC 400MA DC
+ 18VDC 400MA DC
—18VDC 30MA DC

on board regulation is provided. On board (invisible) refresh is provided with no wait states or cycle stealing required.

MEMORY ACCESS TIME IS 375ns.
Memory Cycle Time is 500ns.

Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

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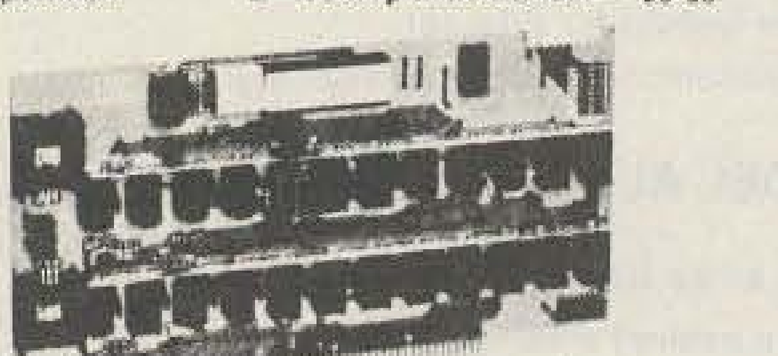

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16K or 32K EPROM **$49.95 w/out EPROM**
Allows you to use either 2708's for 16K of Eprom or 2716's for 32K of Eprom.

KIT FEATURES:

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2. Quality plated through P.C. Board, including solder mask and silk screen.
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5. All sockets provided w/board.

WE CAN SUPPLY 450ns 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

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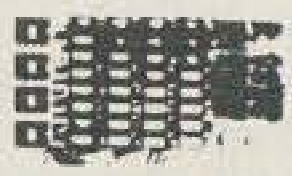
Fully Buffered — on board regulated — reduced power consumption utilizing low power 21L02 — 1 500ns RAMS — Sockets provided for all IC's. Quality plated through PC board. *Add $10. for 250ns RAM operation.



The Whole Works - $79.95

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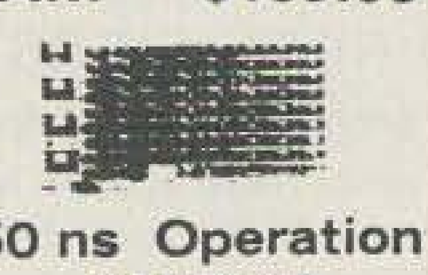
Fully assembled and tested. Not a kit. Imsai — Altair — S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask. 8 pos. dip switches for address select.



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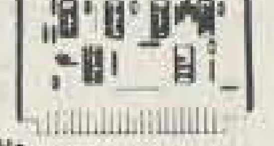
FD 1771B-1 CHIP ALONE $39.95

Low Cost Cassette Interface Kit



Features: Play and record K.C. Standard 2400/1200 Hz tapes, 300 Baud, TTL I/O Compatible, Phase Lock Loop, Both 22 Pin Connector and 8 Pin Molex Connector. Comes partially assembled. Oscillator and phase lock loop pre-tuned to K.C. Standard. Selector switch sends cassette data or auxiliary input data to microprocessor. LED indicates logic 1 level.

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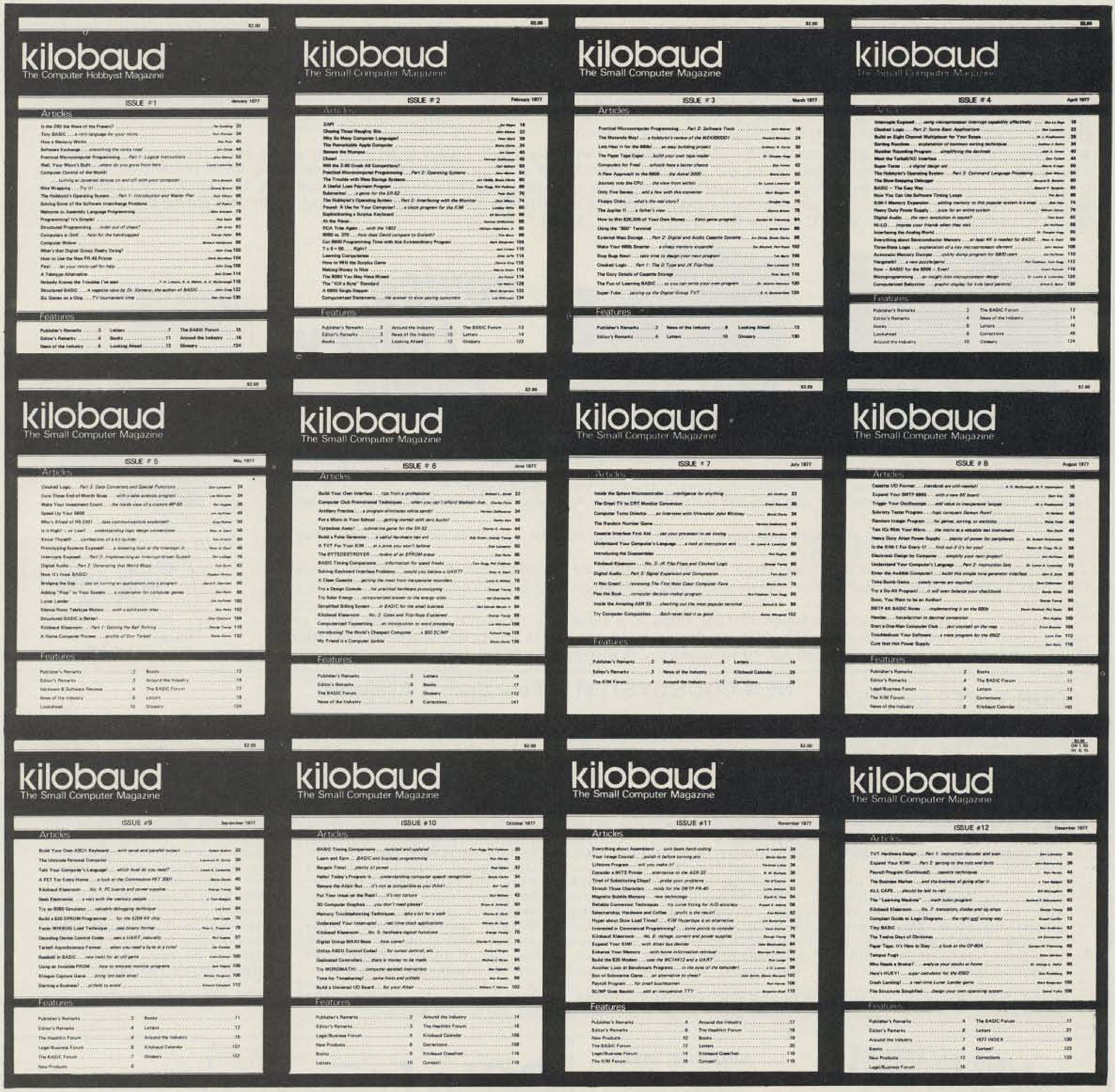

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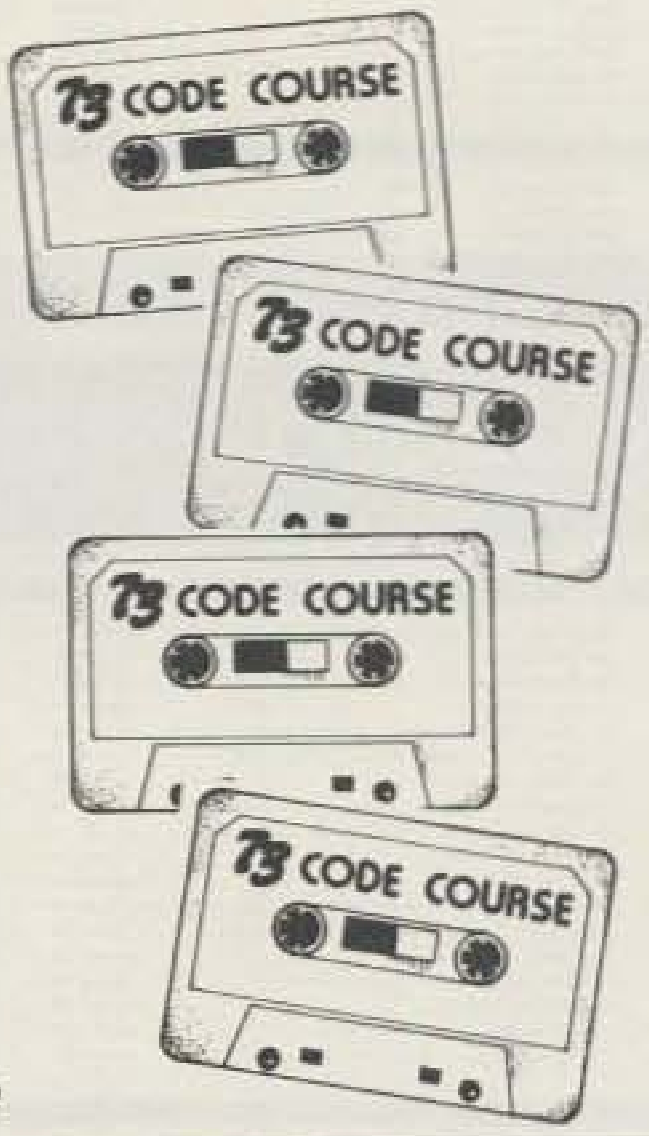

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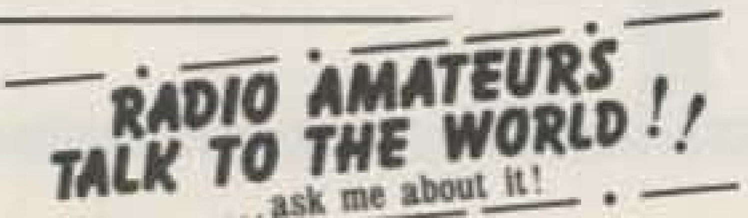

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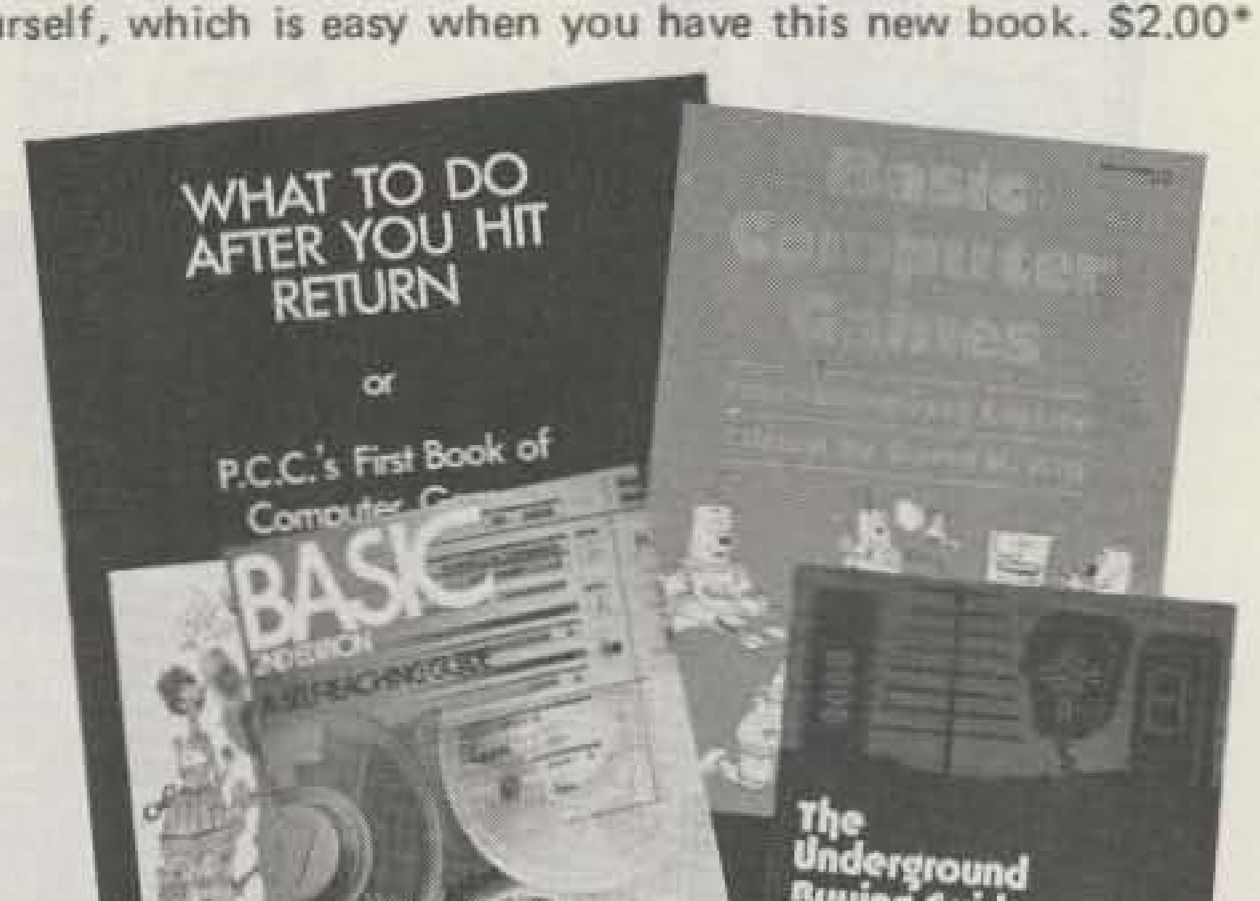

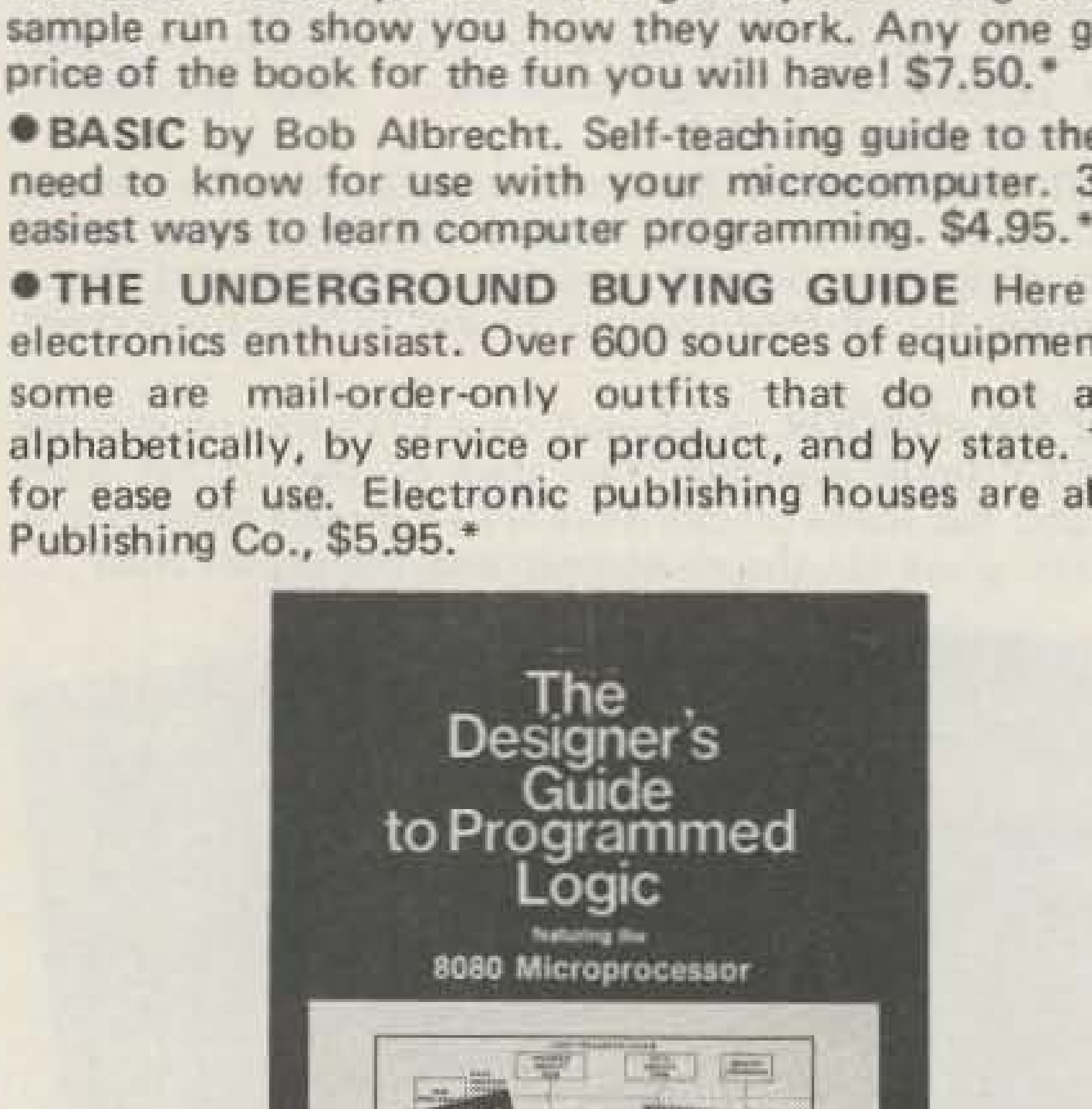

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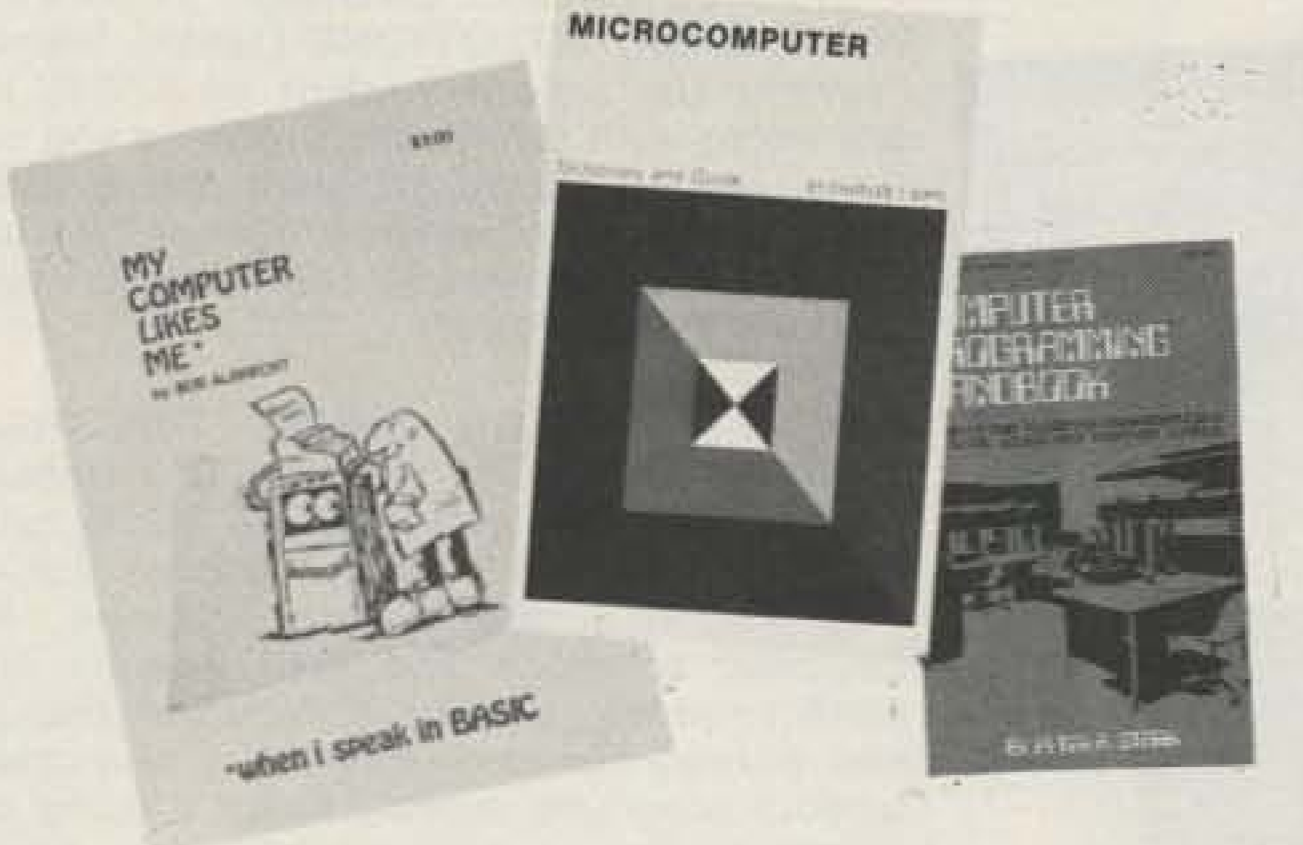

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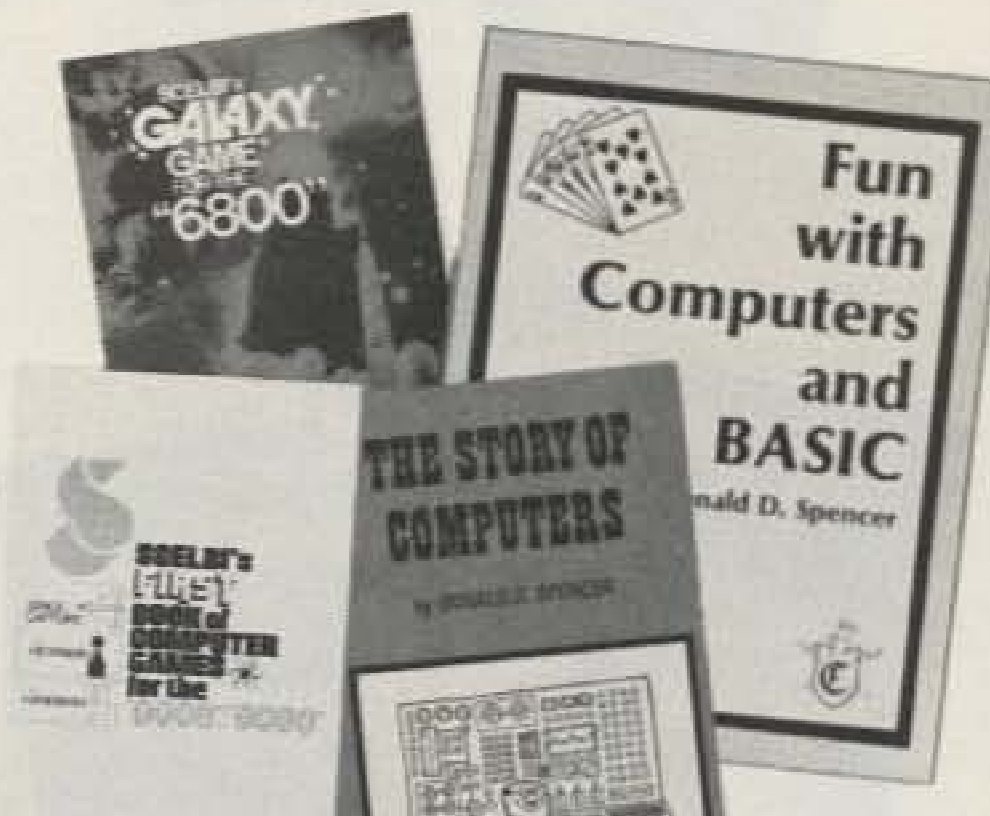

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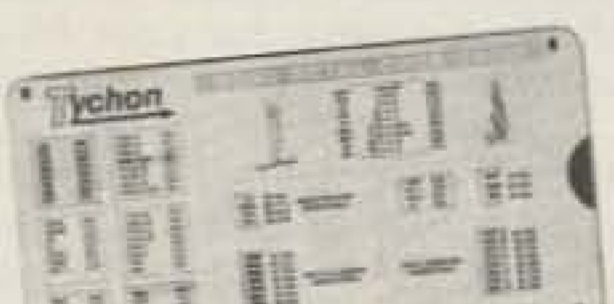

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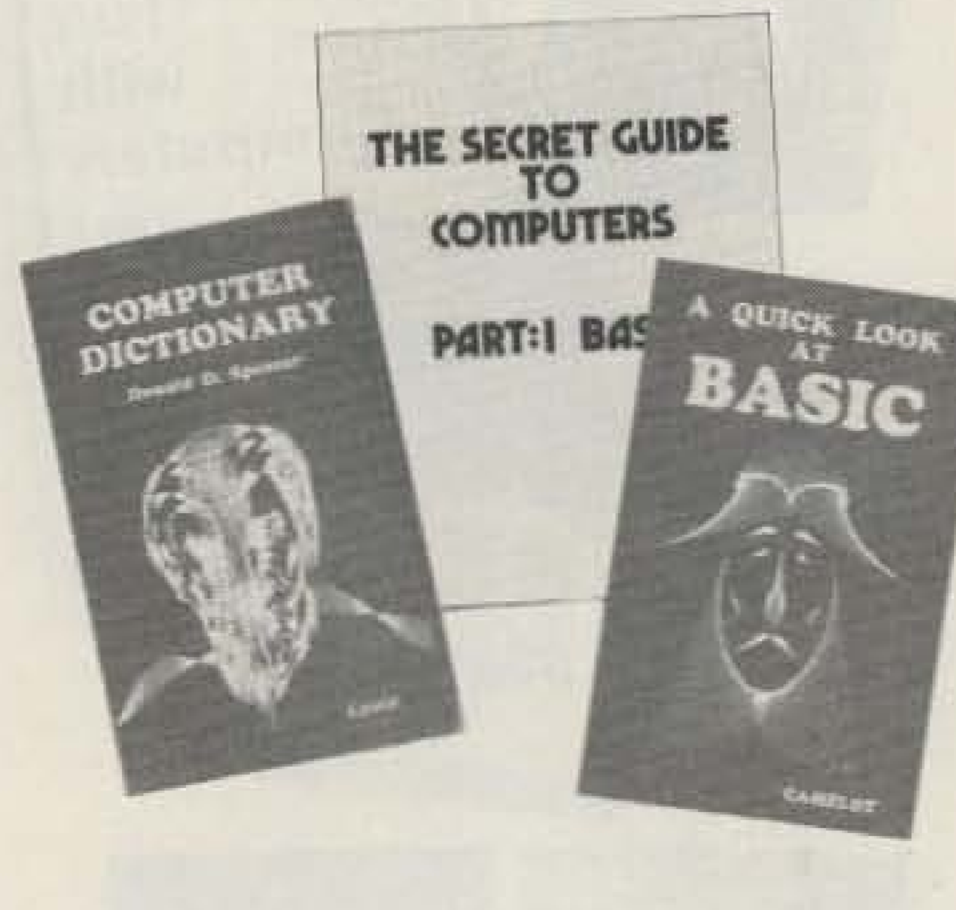

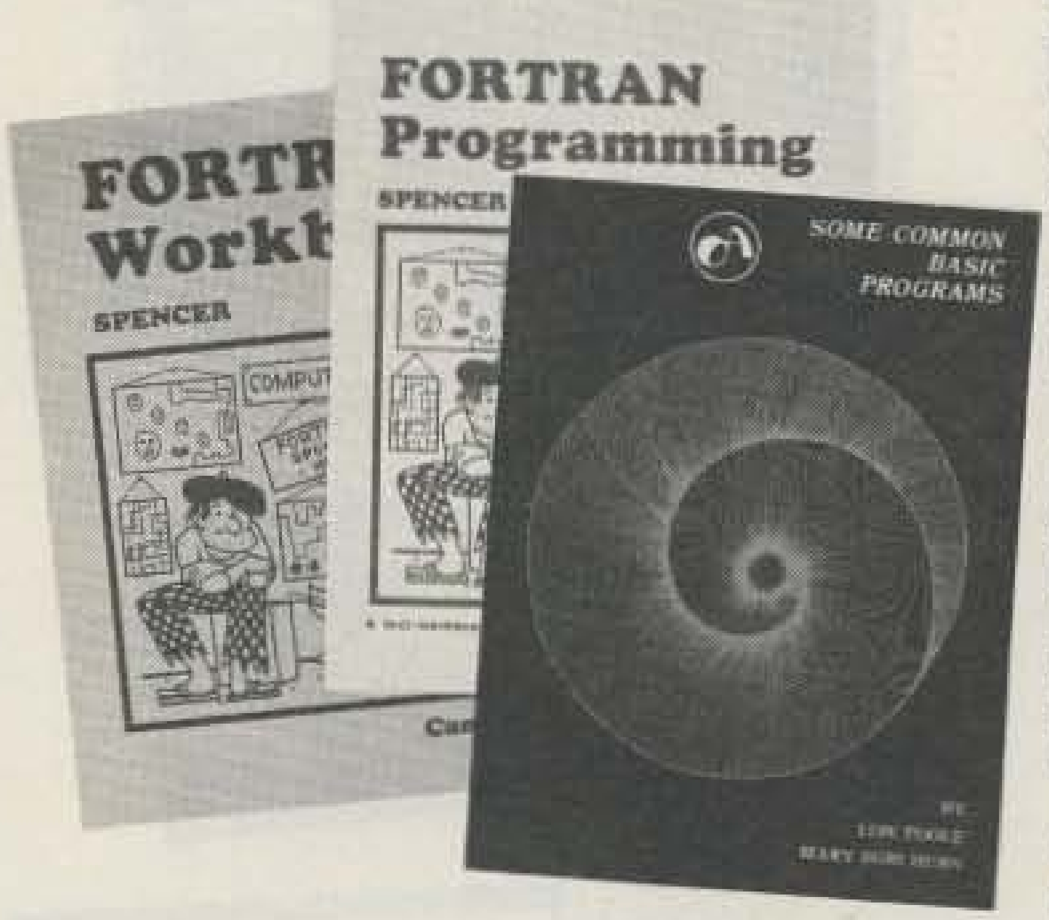

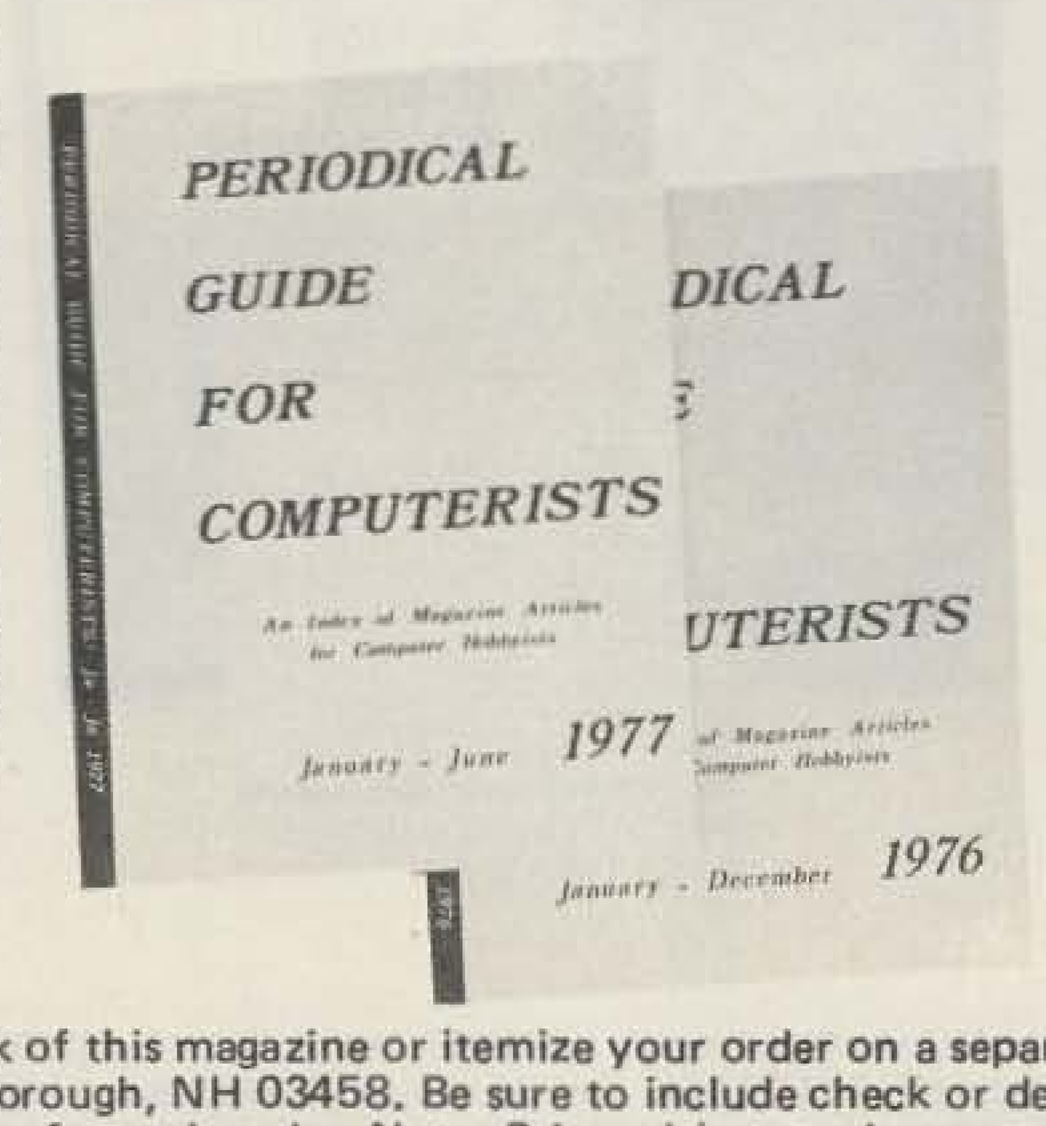

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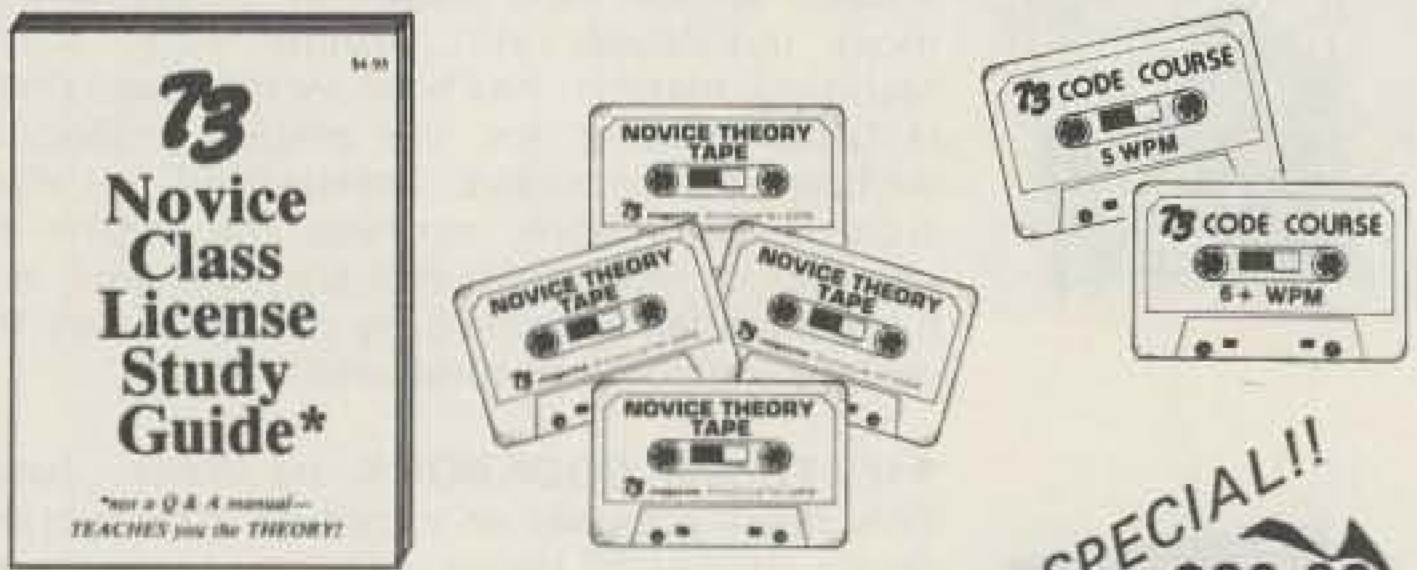

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☐ DEC 69
☐ JAN 70
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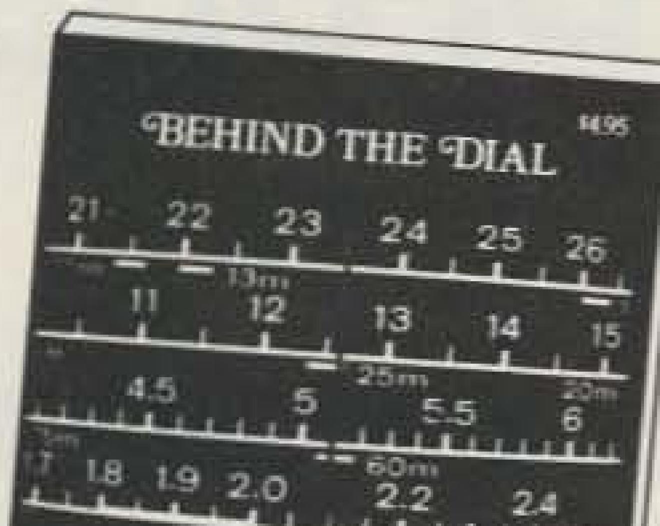

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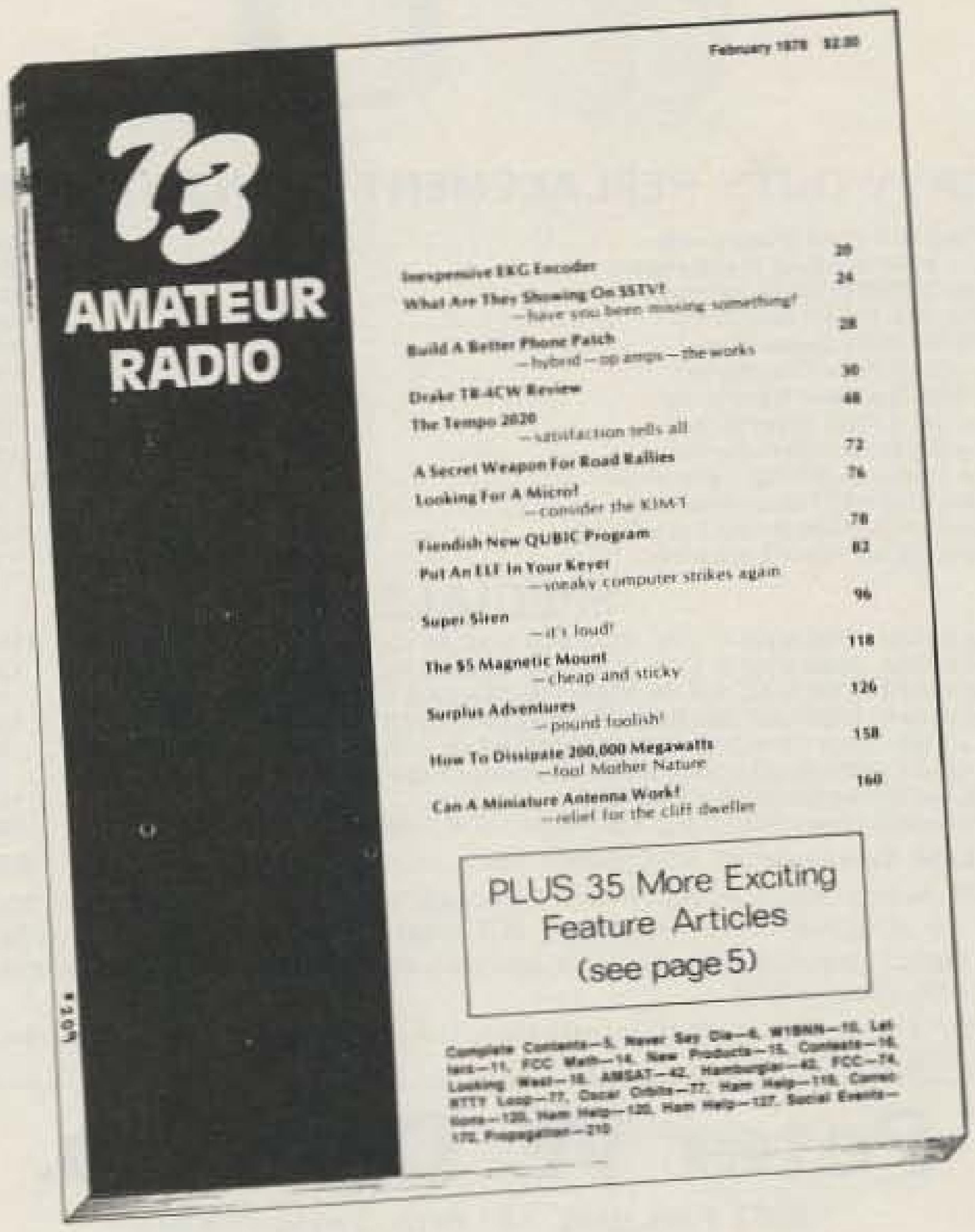

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GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	7	7A	14	14
ARGENTINA	14	14	7A	7	7	7	14	14	21	21	21	14A
AUSTRALIA	14	14	7B	7B	7B	7	7	7	7	7B	14	14
CANAL ZONE	14	14	7A	7	7	7	14	14	14	14A	14A	14
ENGLAND	7	7	7	7	7	7	7A	14	14	14	14	14
HAWAII	14	14	7B	7	7	7	7	7B	14	14	14	14
INDIA	7	7	7B	7B	7B	7B	14B	14	14	14	7	7
JAPAN	14	14B	7B	7B	7	7	7	7	7	7	7	14
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14B	7B	7B	7B	7B	7	7	7	7B	14B	14
PUERTO RICO	14	7	7	7	7	7	7A	14	14	14	14	14
SOUTH AFRICA	14	7	7	7	7B	14	14	14	21	21	14	14
U. S. S. R.	7	7	7	7	7	7	14B	14	14	14	7A	7
WEST COAST	14	14	7	7	7	7	7	14	14	14	14	14

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	7	7	7	7	7	7	7A	14	14
ARGENTINA	14A	14	14	7	7	7	7A	14	14	14A	21	21
AUSTRALIA	14A	14	14	7B	7B	7	7	7	7	7B	14	14A
CANAL ZONE	14A	14	7A	7	7	7	14	14	14	21	21	21
ENGLAND	7	7	7	7	7	7	7	14B	14	14	14	14
HAWAII	14	14	14	7	7	7	7	7	14	14	14	14A
INDIA	14	14B	7B	7B	7B	7B	7B	7B	7	7	7	7A
JAPAN	14	14	14B	7B	7	7	7	7	7	7	14	14
MEXICO	14	7A	7	7	7	7	7	7	14	14	14	14
PHILIPPINES	14	14	14B	7B	7B	7B	7B	7	7	7B	14B	14
PUERTO RICO	14	14	7	7	7	7	7A	14	14	14	14	14A
SOUTH AFRICA	14	7B	7	7	7B	7B	14	14	14	14	14	14
U. S. S. R.	7	7	7	7	7	7	7	7A	14	14	7A	7

WESTERN UNITED STATES TO:

ALASKA	14	14	14	7	7	7	7	7	7	7	14	14
ARGENTINA	14A	14	14	7	7	7	7	14	14	14A	21	21
AUSTRALIA	21	21A	21	14	14	7A	7	7	7	7	14	21
CANAL ZONE	14	14	7A	7	7	7	7	14	14	14	21	21
ENGLAND	7	7	7	7	7	7	7	7	7B	14	14	14
HAWAII	21	21	14	14	7A	7	7	7	14	14	14	21
INDIA	14	14	14	7B	7B	7B	7B	7B	7	7	7	7A
JAPAN	14	14	14	7	7	7	7	7	7	7	14	14
MEXICO	14	14	7A	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	7B	7B	7B	7	7	7	7A	14B	14
PUERTO RICO	14	14	7	7	7	7	7	14	14	14	14	14A
SOUTH AFRICA	14	7B	7	7	7B	7B	7B	14B	14	14	14	14
U. S. S. R.	7	7	7	7	7	7	7	7	14	14	7	7
EAST COAST	14	14	7	7	7	7	7	14	14	14	14	14

A = Next higher frequency may also be useful
B = Difficult circuit this period
F = Fair
G = Good
P = Poor

april

sun	mon	tue	wed	thu	fri	sat
						1 G
2 F	3 G	4 G	5 P	6 P	7 G	8 G
9 F	10 P	11 P	12 F	13 G	14 G	15 G
16 G	17 G	18 G	19 G	20 G	21 G	22 G
23/30 F/F	24 F	25 F	26 G	27 G	28 G	29 F

73 magazine

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A24	A51	A15	C63	D15	E19	G12	H16	I9	J9	L9	N10	P1	R1	S39	S43	V1	X1
A41	A21	B23	C58	D27	E21	G6	H8	I10	J10	L12	N11	P29	R19	S33	T13	V16	Y1
A2	A26	B29	C6	D20	E12	G4	H5	I4	J8	M35	N2	P2	R8	S37	T18	V5	Z1
A47	A14	B8	D6	D23	F5	G9	H3	I19	K13	M36	O5	P26	R21	S8	T1	W15	

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1976 \$__________; 1977 \$__________;
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What equipment have you (make, model)

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