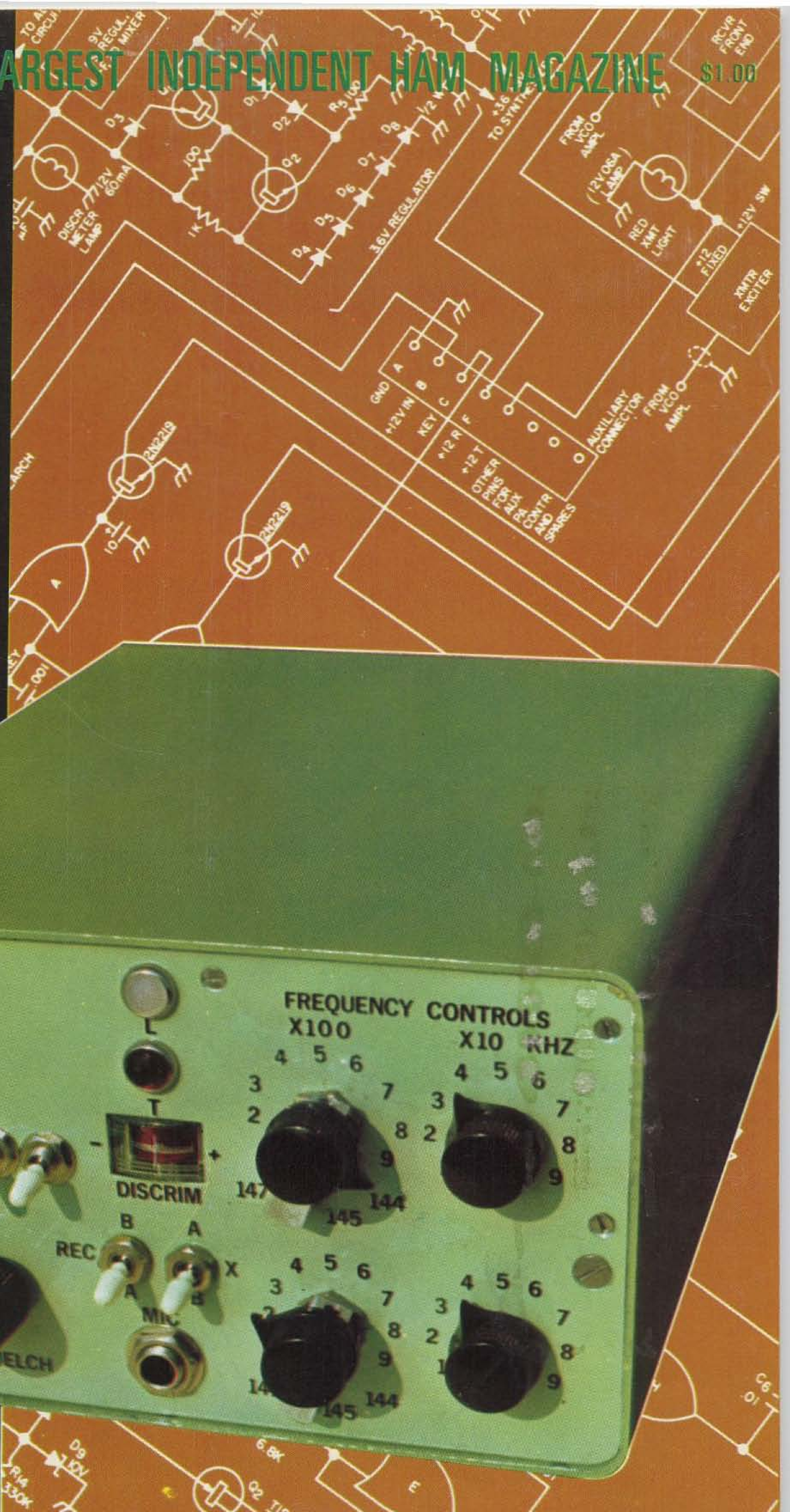
WORLD'S LARGEST INDEPENDENT HAM MAGAZINE $1.00

AMATEUR RADIO 73

No. 113



Frequency Synthesis with a single crystal!

73 MAGAZINE

#113, February 1970

Features

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STAFF

Publisher
Wayne Green WB2NSD/1

Managing Editor
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Production
Roger Block
Phil Price
Jane Tracey
Jeanne Caskie
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Whitney Tobias

Art
Bill Morello
Wayne Peeler K4MVW

Circulation
Dorothy Gibson

Comptroller
Joe LaVigne

Propagation
John Nelson

WTW Editor
Dave Mann K2AGZ

Books
Bruce Marshall

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NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

Crowded Bands

If you, too, have been involved with amateur radio for some thirty years, I think you'll have to agree with me that one of the big all-time complaints has been QRM. Even those with sixty years of hamming under their belts will tell you that from the first day of their operating, QRM was murder.

Since, in practical application, QRM can be largely avoided, I suspect that most of the true sufferers from the condition are masochists, unduly stubborn, or perhaps just not too swift. At one time in our history amateur radio was rather well known to the general public, though the image they had was one of young boys staying up all night in attics. I'm not sure that even that image is better than not having one at all, which is about the shape we're in these days.

Green's Law

If you insist on forcing amateur radio to fit your convenience, you may be a sufferer from QRM. The evening hours and weekends are the most convenient, so that obviously is when there are the most stations on the air . . . and the most QRM. These are prime times for developing a mental hernia trying to get a short ragchew on 20-40-80. Meanwhile, up on 2 and 6 meters, this heady peak of activity will, in many parts of the country, give you a choice of two stations to contact instead of one. Green's QRM Law No. 1 (an extension of the Finagle Principle) tells us that if there are just two contacts on a band, they will probably be just about on the same frequency and will be QRM'ing each other.

The RTTY gang can be heard typing up a storm with little interference, and, lonely of the lonely, the Extra Class CW ops can be heard during peak operating hours all huddled near one frequency down in their exclusive bands.

If you are too stubborn to head for the wide open spaces of 2 or 6 meters, don't dig typing out your contacts, and don't cotton to the untrammeled higher frequencies on 10 meters, then perhaps you could bend to the extent of changing your operating hours a bit? I may be ruining a perfectly good thing for myself by telling you about this, but the bands are almost empty in the early mornings. That's when you'll hear *me* operating.

Generally I'm in bed by 10 p.m., which means that along about 4 a.m. or so my eyes open up and I either lie there staring at the ceiling or else get up, get dressed, and head for the office, a twisty 10-mile drive through the New Hampshire hills. After fixing a quick breakfast I head for the rig and see what is doing. The signals are few, but the band is most certainly open and the contacts are generally free of QRM. In winter I can usually work just about anyone who happens to be on the air in Asia, the Pacific, South America, Antarctica, and even Europe.

Don't Follow the Pack

A little trick I learned the hard way nets me a lot more DX than the average operator. Now and then you will hear me in a pileup, but most of the time you'll hear me *starting* pileups, not continuing them.

After listening to the gangs of operators trying to get through to rare spots, you may get the erroneous idea that the op in the rare spot has it easy–any time he gets on he is loaded with fellows trying to contact him. It doesn't work that way. This fellow has a good deal of frustration because he is in an out-of-the-way spot.

The problem is that when Europe is coming through to the States, almost every beam is pointed at Europe. The fellow down on a small Caribbean island can call his fool head off and no one will hear him. I remember one particularly frustrating time. I had just received my license to operate as VR2FD in the Fiji Islands and I fired up on 20 sideband. The band was hopping . . . this was going to be fun. I heard Dorothy K2MGE in a roundtable with some other friends and I called in. Nothing. I tried breaking. Nothing. After a half hour of trying to break between every leg of the roundtable, I heard Dorothy say she thought she heard someone trying to break the QSO. My relief was short-lived. The next station came on and dismissed me with the remark that whoever was trying to break in was not cutting the mustard. They never did stand by for me. I tried up and down the band for another hour, calling CQ, answering CQs and trying to break in on friends. The VRs that were in the shack with me explained that it is always like that. Everyone has his beam pointed toward Europe and there is little chance of getting through.

Eventually I snagged a KH6 and a couple of the more alert W6s heard the contact. Suddenly there was a pileup and I was busy handing out contacts as fast as I could. You could almost hear the rumble of a thousand beams turning all over the U.S.

Now, when I get on the air from home, I seldom point my beam along with the crowd. If they are working Europe I swing my beam around and call a CQ toward Asia or the Pacific. If they are working the Pacific, then I call for the Indian Ocean or the Mid-East. These directional CQs work for me. Just yesterday I contacted VK6GK mobile (VK6 is the antipodes from up here), 9V1OH, and VU2GE. The VU was running 15W of SSB, by the way. More often than not, a directional CQ like that will bring in something rare, giving you a contact that you otherwise might have to spend hours working for, fighting the pileups.

. . . Wayne

Gentlemen:

With regard to your Christmas photo in the December issue:

We've looked at the picture–examined the scene,
Which is quite reminiscent of Mad magazine.

We've paid close attention and Lin Green looks nice,
And so does Dot Gibson–ditto Phil Price.

Walt Manek looks sad through a grin that's excessive.
Is that what you call a Manek depressive?

Horray for Diane who in mini looks racy
And hello there to Roger and Don and Jane Tracey.

Hi, to Joe, Jeanne and Wayne–the rest of the cast–
And now for the best which we've saved for the last.

Your gang sure appears like a fun-loving group
And we quite hate to throw an old fly in the soup

But all through the years, in hamming, in life,
In all of the good times, and all of the strife

Past all tribulations–past winnings and losings
Past days being sober, and days filled with boozings,

You can torture us, mangle us, freeze us or fry us–
There *can't* be a girl named Whitney Tobias!!

Jules E. Blitz
7934 Winterset Ave
Pikesville MD 21208

Dear Reader Jules: much thanks for your poem.
It has spiced up the air at our magazine's home.
As to your comments about Lin and Dot,
We agree with you fully–they said "Thanks a lot."
Phil Price thought it funny–he shed a small tear,
And our Manek depressive is no longer here.

As for Diane, well she accepts, with a wink,
And Roger and Jane say "Hi, Jules," I think.
Our Joe and our Jeanne send 73's,
And Wayne, our big chief, completely agrees.

Yes, we are a fine bunch, and we do have much fun,
But your fly in the soup is such a bad pun.
For in truth and in friendship (I'm not being pious),
There is truly a girl named Whitney Tobias.

. . .Diane Shaw

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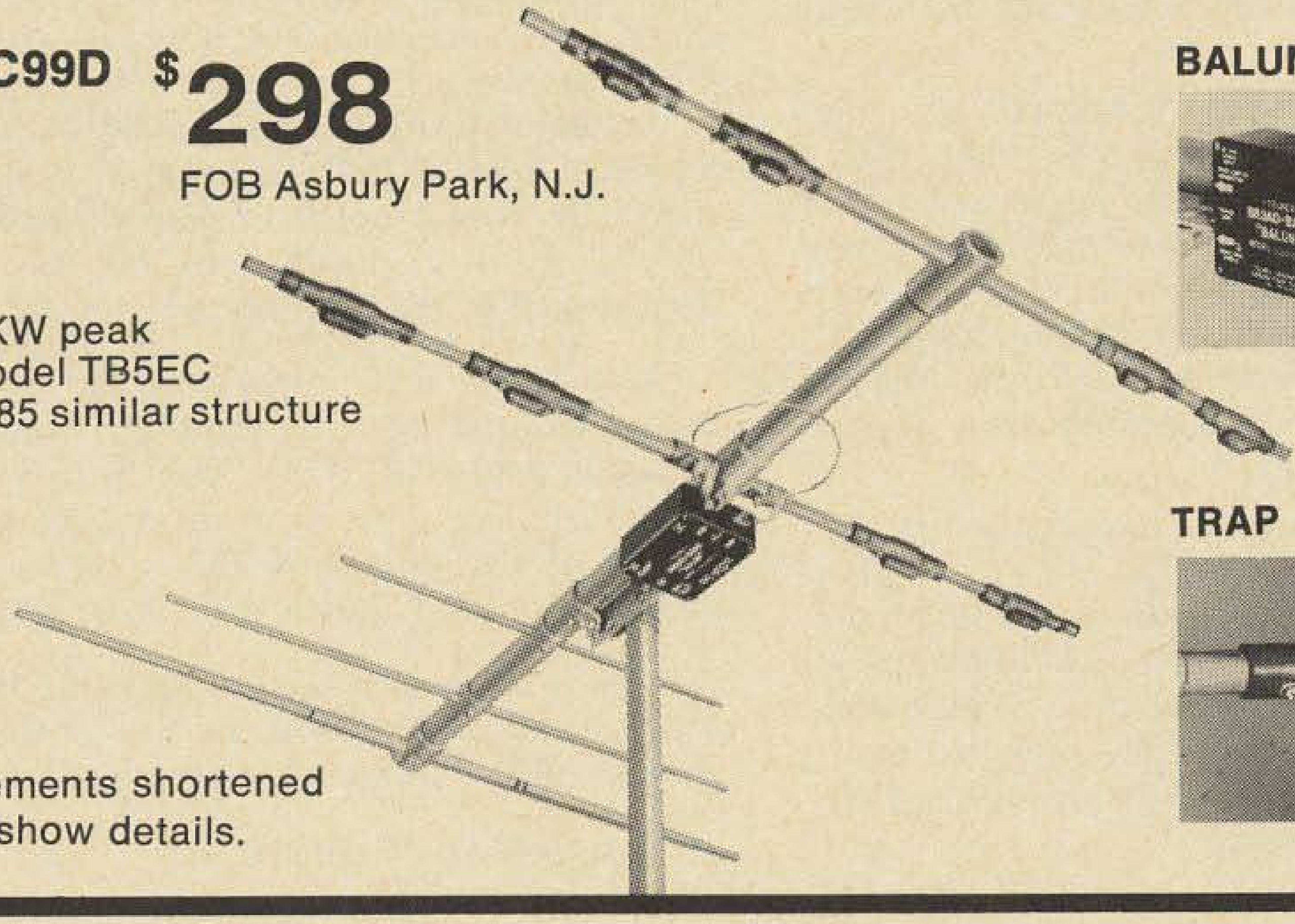

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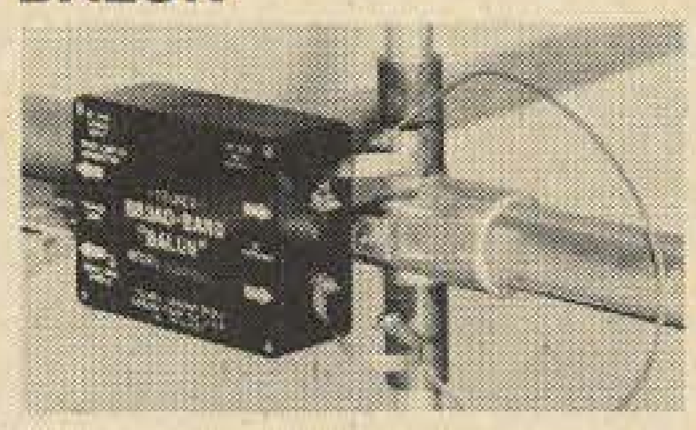
BALUN



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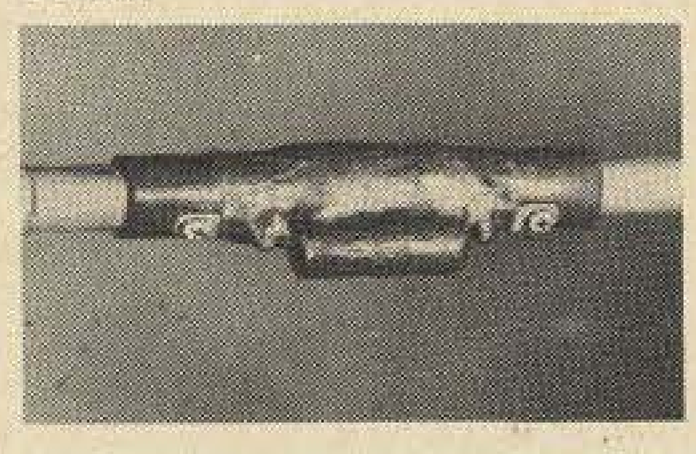

Some thoughts from Mike Ercolino, P.E. — W2BDS, Telrex Chief Engineer . . .

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Modulated Vibrator Hash

AN EDITORIAL
BY K6MVH
KEN SESSIONS, JR.

Why This Issue of 73 is Dedicated to WA8UTB

This is an obituary.

An entity that lived fast and hard and well has passed. This living thing was FM Magazine. For me it was a promise unfulfilled. For Mike Van Den Branden it was a dream turned nightmare. For a world of new people—the repeater men, the two-way hams, the FM pioneers—the death of FM Magazine was the loss of something that was uniquely their own.

Mike Van Den Branden WA8UTB was the originator of the magazine, back in February 1967. He put out a sheaf of duplicated papers and called it FM Bulletin. Everything seemed right. There was a general turning to FM on our VHF amateur bands that was to grow beyond everyone's belief. And the Bulletin was to become the widely approved and unanimously accepted voice of this new and expanding group.

Matching the contagious popularity of the mode, the publication expanded too . . . until it seemed the bulletin-turned-magazine would bust apart. It went from duplication to lithography. And within months it was a well dressed slick with four-color cover and professionally prepared interior that could stand abreast with the best of the well established old-time pros.

I was editor of this magazine, and shared the ownership with Mike until it nearly broke my back. When I gave up, he carried on, assuming responsibility for a financial burden that would make Rockefeller cough.

Oddly, Mike Van Den Branden was not in the publication business for the money. He was one of those rare, one-in-a-lifetime types who follow a dream because of the dream. Mike believed in FM as a communications mode. And he believed his magazine filled a definite need. This is not to say that Mike would not have been pleased to see his "baby" turn a profit; but he was not once discouraged by the fact that it never did.

And Mike was always willing to bear the financial brunt of new ways by which his baby could be improved. If you happen to be one of the very very few fortunates who have a complete library of FM, you know the metamorphoses that characterized the 3-year lifespan of FM Magazine.

This is the end of the obituary of FM Magazine. But it by no means marks the end of the Mike Van Den Brandens. So maybe a toast is in order:

Here's to the dreamers.

Buffalo Hams Influence Rulemaking in Canada

The members of the Buffalo Amateur Repeater Association are to be congratulated; for these individuals, who spent many long and arduous hours drafting a detailed and comprehensive petition to the FCC concerning the operation of repeaters in the VHF amateur bands, have achieved at least a degree of success. The efforts of Gil Boelke W2EUP, Francis Stengel WB2GUG, and a handful of others of the BARA organization have not gone unnoticed. Some time ago, Canada's regulatory agency, the Department of Communications, sought guidance in laying out a plan of rules for prospective Canadian repeater licensees. Using the Buffalo petition as a foundation from which a set of realistic regulations could evolve, the DOC recently published a tentative mandate that will

serve as "interim regulations" until such time as permanent rules for amateur repeaters are passed into law.

Of the mandate's seven points, at least four had been put forth in the famed Buffalo petition, and several of the others were unofficially advocated by BARA representatives in letters drafted after the petition was originally filed.

The points of significance to repeater owners are:

- Licensee will be responsible for TECHNICAL operation of the repeater, including ultimate control over any amateur's access (or the access of a restricted group).
- Licensee will maintain a TECHNICAL log showing malfunctions, servicing data, on-the-air tests, etc. (This precludes the necessity for running a continuous tape log of operation, presumably, and is the essence of the Buffalo petition.)
- Repeaters will identify at one-minute intervals by transmission of the repeater call sign at reduced amplitude.
- Links are to be in the frequency range above 220 MHz, but they are exempt from the aforementioned identification requirement.
- The licensee is required to put a three-minute automatic shutdown transmitter on each of his remotely controlled transmitters. And it must be rigged in such a way that only the licensee can turn the transmitters on again once they are shut down.

These rules are a step in the right direction, and they serve to show that the Canadian government is on its toes with respect to what's happening in the amateur world there. But there is one aspect of the rules that has frightful implications. I can only hope it is a mistake in wording, because it can serve no useful function of itself and can only result in making repeaters in Canada less utilitarian for the many users.

The rule I am referring to, of course, is the last one cited above. The mandate specifically states that when a repeater is timed out at the end of a three-minute period, it must be reenergized by the licensee only. In practice, virtually all repeaters—both in the U.S. and in Canada—are already equipped with such timers; when an incoming transmission exceeds a duration of three minutes, the repeater (and usually the links) shuts down. But reactivation is typically automatic; that is, when the longwinded individual drops his carrier, the repeater can be energized again by the next incoming signal.

Ostensibly, the Canadian ruling was put forth to assure technical control under all conditions. But the DOC should be made aware that such control could be assured in a variety of other ways, nearly any of which would result in a more useful, reliable system. For example, the licensee could transmit a control signal that would positively (rather than passively) shut down the transmitter when such shutdown is warranted. Or he—or anyone else using the repeater—could keep the system shut down by transmitting a continuous low-power carrier on the input frequency until positive control was effected.

There are a variety of means for achieving the same end. But the finality of automatic timeout suggested by the mandate does not seem to be in the best interest of the amateurs who will depend on the reliability and dependability of a repeater that will frequently be shut down by individuals who can't seem to turn themselves off after 2.999999 minutes of talking.

An interesting sidenote: QST published a short note about the Canadian doings in the December issue. Several ARRL directors were credited, but there was no mention of the effort expended by the Buffalo group. I consider this a bit odd, considering the fact that the ARRL has had a copy of the Buffalo petition since the time it was filed, back in 1967.

Repeater Petition to Get Docket Number

A repeater rulemaking petition was submitted to the FCC on December 3, 1969, and is currently undergoing processing so that a docket number can be assigned. The petition is too lengthy for reprinting here, but here is the essence of it:

1. An amateur repeater is officially recognized and defined.
2. Repeaters to be made legal on all frequencies where AØ is authorized.
3. Timed shutdown is required after long non-use periods.
4. Repeaters can be turned on from the frequency of operation provided that UHF control is capable of overriding such turn-on, when necessary.
5. Repeaters can be "unattended," since shutdown is automatic when repeater is not used. It can thus be assumed that the repeater is being monitored (from the frequency of actual use) when it is on. The petition seeks to dispense with "UHF control" monitoring in favor of the "on-when-used, off-when-not-used" approach, which is essentially "unattended" operation, but with a realistic and workable twist.
6. Repeaters should not be logged in the conventional sense. A log would consist of a few basic particulars and would be filled in only when the remote repeater is visited, serviced, or modified.
7. Repeaters should be identified at 3-minute intervals, and the ID can be nothing more than the repeater call letters, in Morse code or voice.

(continued on next page)

The SAROC Funfest

In case it's slipped your mind, time is running out for those of you who haven't made advance reservations for SAROC, the Stardust Amateur Radio Operators' Convention, to be held on February 4 - 8 at the Stardust Hotel in Las Vegas. The SAROC funfest has been getting bigger by the year, and indications to date are that this year will top all previous records.

For the nonteetotaling among you, SAROC will offer a number of advantages for you to mooch free booze; cocktail parties are being hosted by the magnanimous managements of Swan, Galaxy, and Ham Radio.

National FM Convention. Ham FM'ers should take particular note because SAROC serves as an operating base for the annual national FM convention. Tom Burford W7TDQ is the principal representative for the FM portion of the shindig; and if you drop him a card, he can give you the details on the FM programs slated for this year (which, incidentally, marks the third annual national FM convention to be held in conjunction with SAROC). Tom's address is 6328 Shawnee Ave., Las Vegas.

At this writing I have no idea as to what the agenda is, but I can guarantee that it will be interesting. Last year, a national repeater group was formed, and national repeater frequencies were adopted. There were a few disappointing problems associated with FM scheduling last year, but most of these were attributable to apathy on the part of the hotel management. Switching of SAROC from its previous base to the Stardust has solved these potential headaches, I hear.

If you have gripes about 73 or its policies, or if you have pet circuits you want to see printed, grab me at SAROC. I won't be hard to spot; just look for the guy who has the "special deal" on subscriptions.

Reservations. If you don't know how to get your reservations or how much money the affair will cost, send SASE to SAROC, Box 73, Boulder City, NV 89005. You'll get the details back fast.

... K6MVH ■

LETTERS

Audible 73s

Dear Mr. Green:

Someone mentioned to me the possibility that your magazine was being recorded on magnetic tape for the use of interested blind persons. If this is true, please let me know where I might apply in order to borrow these tapes.

Oliver K. Mixon W4DJF
Augusta-Richmond County Municipal Building
Augusta, Georgia

Recorded tapes of 73 are available from:
Science for the Blind
221 Rock Hill Road
Bala Cynwyd PA 19004

Hospitality Notes

Dear Friend,

I am very interested in your Ham Hospitality scheme and hereby offer my home for any visiting hams, especially Stateside DX.

My interests are ham radio, organ music, and politics (I am a City Counselor, Johannesburg). XYL is 45 years old. Her interests are cooking, garden, stamps and politics. We have two delightful dogs (our children are married and live elsewhere) and, apart from two full-time servants, we live alone.

This offer is made in all sincerity–no strings attached. Visitors and their children would be made very welcome. We love having guests and would be offended if any offer of payment is made. Reciprocity one day is all we expect. Are there any California hams who could house Corrie and self over December 1970? I would like to write to them.

Dan Mahony ZS6OS
PO Box 1729
Johannesburg, S. Africa

Help!

Editor:

I would like to purchase or scrounge, whichever is applicable, RCA publications:

RCA Silicon Power Circuits.

Application sheet SMA36.

Application sheet SMA40.

Also, any data re ICs used in FM i-f strips at 10.7 MHz and 455 kHz, narrowband (±5 kHz) quadrature detector, etc.

John C. Meyland VK3AMI
Wangaratta, Vic.
Australia 3677

Study Courses

Dear Wayne:

I hold an Advance ticket, Wayne–thanks to your very fine recent series devoted to helping amateurs climb the ladder. The exam–which I took and passed last week–was a cinch, only because I *understood* every question and could answer all with equal comprehension. Any amateur who feels he can pass the Advance exam by memorizing the ARRL license manual is fooling himself. It just won't work. Incidently, your November editorial correctly observed that the emphasis is now on SSB and transistors. It should be. Needless to say, I have accumulated and digested your Extra lessons, and this exam, too, I expect to be a breeze (thanks to your very fine handling of the material). My only problem is my code speed, which I hope to bring up to 25 wpm.

Charles J. Vlahos WB2ICV
Managing Editor
Plant Operating Management
205 East 42nd St.
New York NY 10017

TVI Case

To the editor:

The other day I spent some time at a friend's house, and as I was leaving I borrowed five or six copies of 73. When I reached home I sat down to glance through this magazine and ended up devouring one issue. It was sheer pleasure to sit down and read interesting material, page after page. As you can tell, I am sold on 73.

I believe now is the time to express an opinion and ask a question. First the opinion.

In your February 69 issue of 73, on page 36, is an article "$1,000,000 TVI Suit Filed." I read this through twice and wondered if 73 was the only amateur magazine interested enough to speak out. I found five issues of QST, for the months of February, March, April, May, and June 1969. I could not find one word about this "amateur world" law suit.

Now for the question. Would you please inform me of the outcome of this case, and does Grid W4GJO have the backing of the amateur population? I hope that this will not pose too much of a problem, but I am interested, as all hams should be.

I wonder why, after two years of QST, I never wrote a letter; but after one weekend of 73 magazine, here I am.

Daniel G. Willis, SSgt, USAF
CT2AS/WA2BDA
Box 183, 1605 CAMS
APO New York 09406

As a result of the exposure accorded the case in 73, the defendant has received assistance from a number of sources: From the ARRL, he received (without strings attached) a mimeographed list of suits involving tower cases; and from fellow amateurs, he has received a great many cash donations, which have been used to assist him in paying for the burdensome legal fees. Grid Gridley W4GJO, the defendant, tells us he is extremely grateful for the publicity in 73 and the support from within our fraternity. He reports that the suit has been dropped under a mutual agreement.

Self-Appraisal

Dear Mr. Green:

Having just gotten my October issue of 73 and having just read the letters column I want to make my opinion heard. We want to encourage new blood in the hobby. Introducing new people to the phone bands is most certainly not the way to do it.

We want to show them our better side. But the question is, what is our better side? I have yet to find the better side of ham radio (better side in my eyes). The phone bands are made up of hams that couldn't copy 3 words a minute of code, discourteous people, old people that scorn the "new breed" of appliance ops, and young people, who scorn the oldtimer–a lot of good ops and fine personalities. The CW bands are made up of dead segments where you can call for hours without a contact, segments so crowded that no one can copy anyone, and you have essentially the same crowd thinking much the same way as phone men with either the man thinking about getting one of those higher grade licenses and trying to get up his code speed, or you have the group that think the phone men are all lids that can't copy a word of code and are only slightly better than CB'ers.

The lure for many newcomers is the old farce of communicating with amateurs in foreign countries. In two years I have had calls from 18 countries. But I haven't *communicated* with them. I've communicated with three countries (one was an American working in a foreign embassy). I started in ham radio to find out what it is *really* like in Iron Curtain countries. Oh, you can talk to these countries. You usually have a long QSO of maybe 30 seconds if someone isn't continually tuning up on you. Some people are lucky enough to be able to communicate with foreign stations. They are usually the ones with 2 kW linears, big multielement beams on tall towers, with expensive gear.

And we really expect to compete with CB and SWLing? W4PZS is certainly correct in saying "they have divided the amateurs." They pushed incentive licensing through, even though there was much opposition (and much more apathy).

I am having much trouble saying exactly what I mean. Just the same, I think amateur radio is awfully lucky to get any newcomers that keep at it and get their General (or any of the others). After all, what does amateur radio really have to offer a newcomer? Many of the statements that might have once been true about amateur radio don't seem to even apply to amateur radio now.

Jim Pruitt WA7DUY/AFB7DUY
111 Hirschbeck Heights
Aberdeen WA 98520

New FM'er

Dear Wayne,

I have decided to become a ham and I am studying for a Technician license. I plan to go on 2 meters FM, but I am having trouble locating an FM unit. I hope they are not expensive! I am not in an ideal antenna location and might have trouble mounting a large array. I hope I can get good distance with a less expensive antenna. I have heard of hand-operated rotors from the old days and if I could find such a system, it would be practical since my shack would be in the attic.

I hope there is enough activity on VHF FM so that I can get some good QSOs. I started interest in FM when I heard so many 80 meter AM hams talk about such 2 meter nets.

My main interest would probably be ragchewing and possibly DX (especially when the aurora kicks up, as it sometimes visibly does up here). I have most of the technical part of the exam wrapped up and the code speed is coming, slow but sure.

Rae Shortt

Lots of FM gear available. Check the Double Bonus subject index in the back of this 73.

More Backlash

Dear Wayne:

Your recent thorough treatment of the incentive licensing problem, relating it to the miscalculations emanating from Newington, were excellent. Keep up the good work.

I detect a groundswell of considerable magnitude on this matter, with everybody giving up on ARRL as the source to look to. In this state hams are writing directly to the FCC to lodge their protests.

I suspect that Newington will change its mind eventually . . .as soon as ARRL revenue drops off and salaries must be cut.

Louis R. Huber, President
Northern Films
Box 98 Main Office Station
Seattle WA 98111

Still More Backlash

Dear Wayne:

It is not often I write letters, but after reading so many comments in your magazine and also in another magazine I thought I would also comment.

I did not think the ARRL's incentive license plan would be worth very much and it seems I was right. I don't know what the extra education necessary to get the Extra Class license is going to do for the greater number who get it. If they are going to follow a commercial radio future, it might be of value; otherwise, I think at least 99% go out and buy a shack full of equipment as soon as the license comes. The ARRL representatives at the Dayton Hamvention admitted the reason there was not too many homebrew projects in QST any more is there are no homebrewers any more.

Why should there be so many classes of licenses? I think after a Novice license any citizen with a capability of 5 or 6 wpm of CW and the knowledge necessary to operate properly should be able to get a license to operate anywhere on any band available to hams. When you go for a driver's license it would be the same to have the instructor tell you that with your limited mechanical knowledge, you could not drive a Cadillac; only a VW until you could upgrade your knowledge. The temporary permit to drive is the same as a Novice–and after you prove you can obey the driving laws, you get your license to drive on any highway in any auto you choose to buy. Why should not any ham, having obtained a regular "license," be able to go into a store and purchase any piece of "ham" gear, then take it home and put it on the air?

The sooner something is done to allow every citizen the rights he is entitled to in this country, the sooner we shall have peace.

Harold D. Mohr K8ZHZ
5670 Taylor Road
Gahanna OH 43230

Manitoba Centennial Award

Dear Sir,

A copy of the starting date, rules, etc. for our 1870-1970 Manitoba Centennial Award is enclosed. We would appreciate it very much if you would publish this:

The Amateur Radio League of Manitoba will present certificate awards to amateurs submitting proof of the requisite contacts with amateur radio stations in Manitoba. All contacts must be made after Dec. 31, 1969. Contestants must accumulate 100 points. W/K, XE, and VE stations receive two points per contact; all other stations receive five points per contact. (A contact consists of exchanging signal reports.) Contacts may be made on different modes on each band, but cross-mode contacts are not allowed.

Two different members of the Amateur Radio League of Manitoba will be designated "Bonus Hams" each month. Contacts with these stations will be worth double points.

Contestants should send a copy of their log and two IRCs to:

Mr. J. N. Knowles VE4JK
PO Box 365
Carman, Manitoba, Canada

Reciprocal Trade

Dear Mr. Wayne:

I am an Indian radio amateur with call VU2JEZ and a 3 yr subscriber to 73. I am a high school student and India's youngest radio amateur.

Well, it was a sort of impossible urge that made me write this letter to you, hoping that vou will understand and sympathize with my problem:

In India out of the 500-odd amateurs, all depend on war surplus and homebrew equipment. The maximum amount an Indian ham spends on a rig is $50 - $75.

I have built my transmitter myself, and I tried to get a BC 348 working (which I had bought on the junk market). But all efforts failed. Well, now I have saved about $100 after two years. I got my ticket 6 months ago, and I'm still not on the air. What I want to propose is this: You ask some other amateur to send me a ham receiver (used will do) and I shall send him Indian goods (antique carvings, paintings, embroidered shawls, etc.). I make this proposal because import restrictions do not allow cash payment.

Thus, he can send me this receiver as a gift and I can send what he wants as a gift!

Or, if he prefers, I can give the money in Indian currency to any of his relatives in India or the USIS in Bombay.

I know I have said what I have to say rather clumsily but, I sincerely hope that you understand my situation and will help me out by dropping a hint to some of your vast multitude of U.S. amateurs.

I shall certainly remember you all my life long for having helped me to get started in amateur radio.

Gopal Kamat (VU2JEZ
Municipal Soc,A/8, L. J. Road,
Mahim Bombay-16 INDIA

Two Cents' Worth

Dear Wayne,

A couple of comments and opinions on articles in the December issue:

1. Topographic maps now cost 50¢ each. Inflation has hit the U.S. Geological Survey too. The Bureau of Land Management has some attractive maps of many areas of the West; available free (the price is right) from BLM offices located in state capitals. These have almost as much detail as the topographic maps.
2. The Swan TV2's instruction book contains a drawing of proper connections for a switch to avoid cable changing from the TV2 and its exciter. It even gives the Swan part number. I got one of these, plus two cables with the Jones plug already attached from them and threw together the switch–without resorting to coaxial relays (no pain, no strain). Only problem was changing one wire on the plug for the low voltage dc for the PC board. The unit would FM on 2m SSB; however, a new zener diode and more suitable crystal (factory-installed at no charge) took care of it. I even power a little 2m preamp from this line.

Paul Schuett WA6CPP
14472 Davis Road
Lodi CA 95240

Boos and Hisses

Dear Wayne:

I take umbrage to W4NVK's article in the December 73. I have yet to align or service any piece of ham equipment that I could not get at least 50 dB suppression of the carrier. Second, there is no way, under any circumstance, that bias shift on finals can cause an increase of carrier content on the signal. For the edification of Mr. Dusina, the author, I service and repair amateur goodies in the Detroit area. My operating bench is loaded with about $4,000.00 worth of equipment. I paid for these items by repairing equipment for 11 meter operators with General class or higher licenses. Only last Sunday, a fellow brought his transmitter over because he could get only 40 dB of suppression and while I checked, he yakked about how many years he was operating and no sense doing this or that to his rig, etc. While he talked, I removed 22 more dB of carrier from his set and $35.00 from his wallet. Anyway, if Mr. Dusina will ship prepaid his bucket of bolts to me, I'll remove his residual carrier free of charge. Otherwise, let him properly center the audio in the bandpass (then a $2.00 mike won't sound so good) and put an rf probe on the antenna output jack–lo and behold, he will have 60 dB of suppression. Next, his remark that a 100W CW signal is 200W SSB is erroneous. *A transmitter cannot put out more power than it has been loaded for without doubling plate voltage.* If you don't believe that, load your transmitter fully on CW, and with a scope, note the height of the solid rf display. Switch to SSB and the peaks will not exceed the CW.

Paul Kirsch WA8ASQ
14158 Foch
Livonia MI 48154

(Continued on page 128)

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Part IV-The Terrible Jar At Leyden

The year was 1745, and scientific circles were all agog over that strange force called electricity. In England, several decades earlier, Francis Hawksbee had built an electric machine which produced unprecedented quantities of this mysterious power, and Stephen Gray had demonstrated that the power could actually flow from one substance to another. Two Frenchmen, Francois de Cisternay Dufay and Abbé Nollet had discovered two different kinds of electrical power, each capable of neutralizing the other.

Many theories had been offered as to the nature of electricity. The most popular was that it was some kind of an invisible fluid. (That's why we refer to it today as "juice.") All in all it certainly was an exciting time.

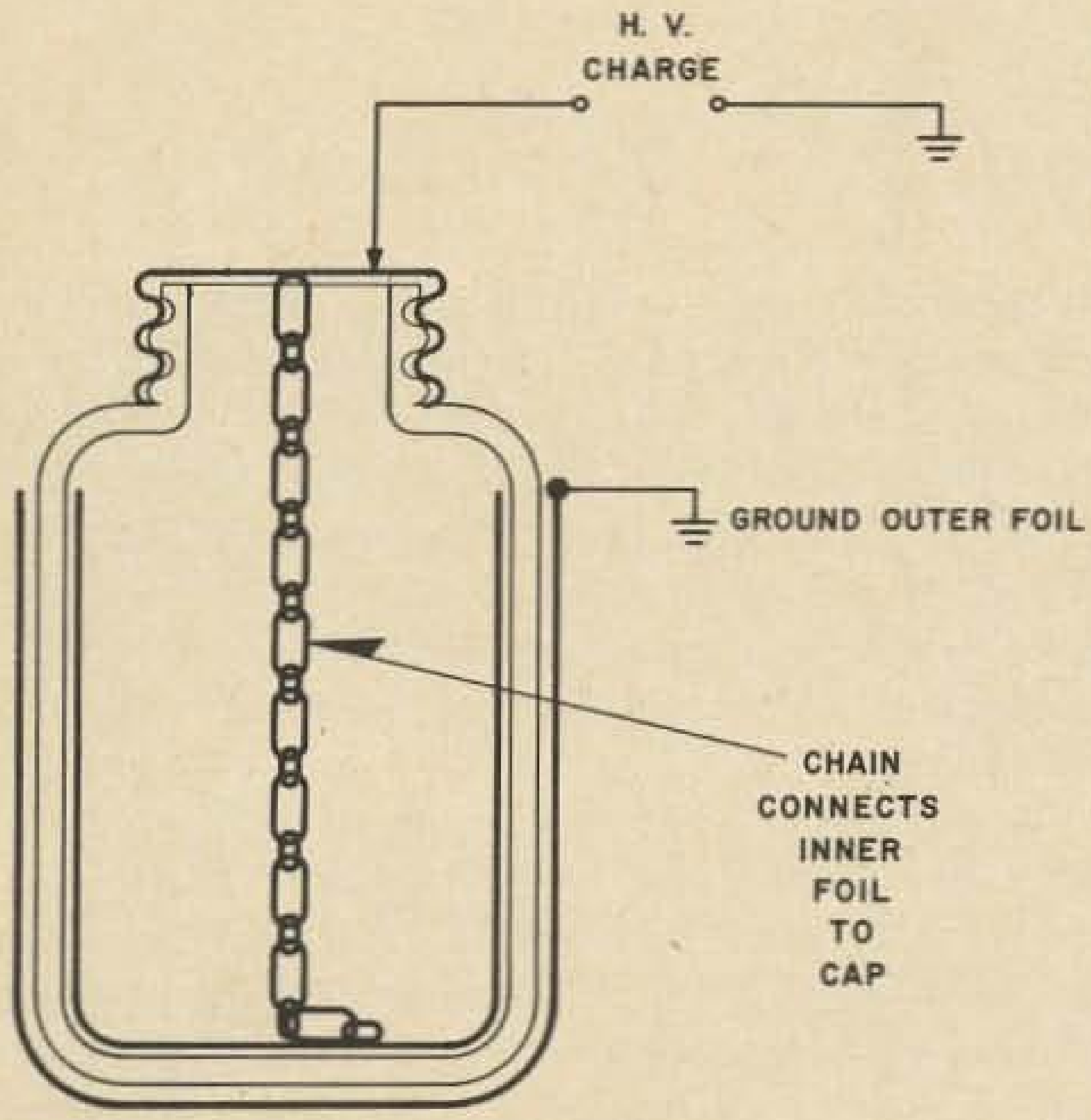
Leyden is a small town in Holland, about fifteen miles north of Rotterdam. It was there, during these exciting times, that a distinguished scientist, van Musschenbroek set out to find a way to collect this electric fluid. Could it possibly be collected in a bottle? With the aid of a pupil named Cuneus, van Musschenbroek connected his Hawksbee electric generator through an iron chain to a gun barrel. Another chain hung from the other end of the gun barrel. Van Musschenbroek had his student hold a jar so that the loose chain dangled into it. After the machine had run for a while, the jar was found to have an electric charge, but there was no fluid present. Van Musschenbroek then decided to put some water into the jar. He knew that electric fluid seemed to flow most easily through wet materials.

Soon they were set up and the machine was running again. Cuneus held the bottle at one end while the professor turned the generator. This time they carefully watched the level of the water, hoping to see evidence of more fluid. Time passed, and the liquid level in the jar was unchanged. The experimenters were discouraged. Van Musschenbroek stopped the machine, and Cuneus reached up to disconnect the chain.

Suddenly Cuneus dropped the jar and seemed almost to fly backward. The professor rushed over to his student. Cuneus was pale and scarcely breathing. He had received a shock such as no man had ever felt before. After his student recovered, Musschenbroek wrote of his "terrible" experiment to a colleague at the French Academy. He advised that no one else try it. Naturally, everyone else did.

At the same time as van Musschenbroek performed this nearly fatal experiment, the Bishop of Pomerania, E. G. von Kleist did essentially the same thing with similar results. He failed to publish his findings through acceptable channels, that is, by writing of them to a university or other seat of learning, so the credit went to Musschenbroek. The device was named the "Leyden Jar."

The scientists didn't realize it at the time, but they had actually made a capacitor. The water served as one conductor and the student's hand as the other. The glass was the dielectric. It was later to be improved by using foil conductors, but in the meantime the water was thought to be essential. The scientists believed that the cool water condensed the electric fluid, and the Leyden Jar was nicknamed a "condenser." That term is still used to this day.

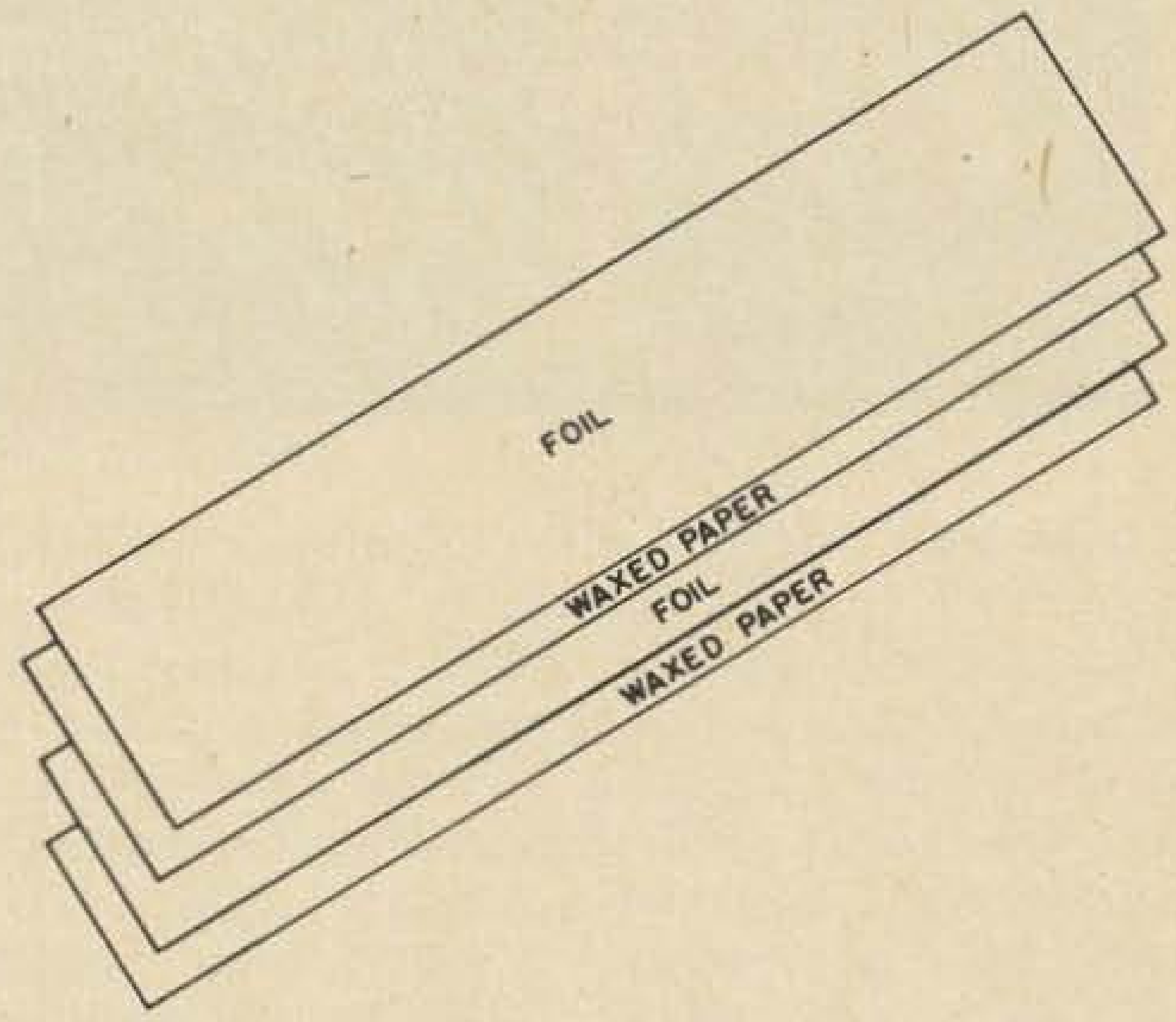


The home experimenter can make his own Leyden Jar quite easily. All that is needed is a peanut-butter jar, some aluminum foil, and a small length of chain. The inside and outside of the jar are lined with foil up to within ½-inch of the top. The chain is soldered to the center of the cover, and hangs down into the jar. It should be long enough that a couple of inches rests on the foil on the bottom.

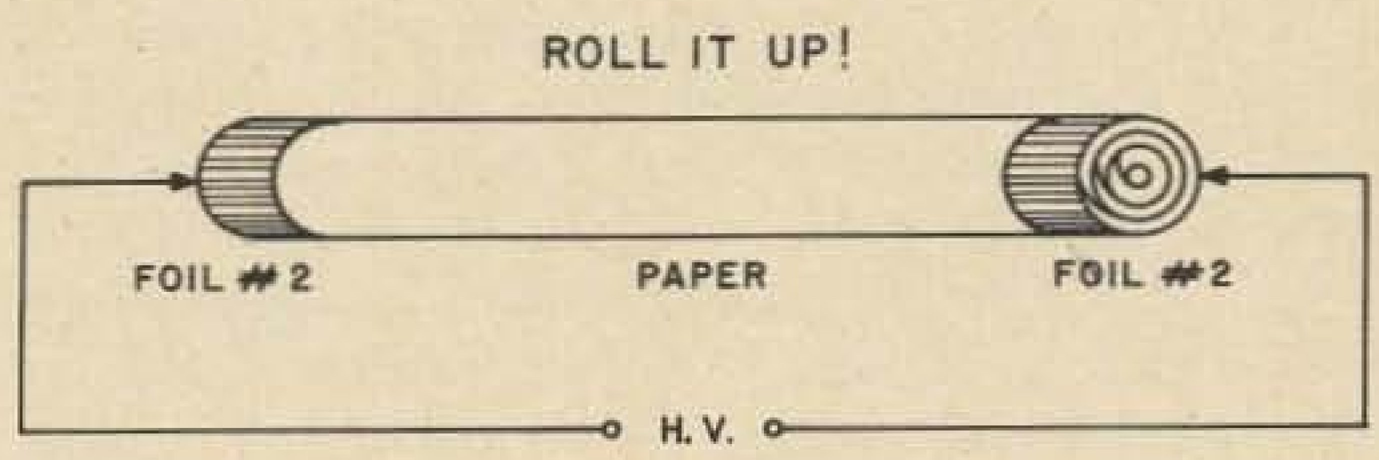
To charge your Leyden Jar, the outside foil should be grounded. You can use a battery, high voltage supply, or you can charge it up by static electricity. Simply rub a glass rod with a piece of silk and touch the rod to the cover of the jar. If you do this enough times, the jar will accumulate quite a charge.

Now, since some clod might be stupid enough to try it, *don't* connect it to a lightning rod. The early scientists who tried that seldom lived long enough to publish their results.

I once made a capacitor to demonstrate the principle to a group of Boy Scouts, using a roll of waxed paper and a roll or two of aluminum foil. Begin by unrolling four or five yards of waxed paper onto the floor. Place a strip of aluminum foil on top of this so that the foil overlaps the paper by a few



inches on one side, and the paper sticks out an inch or so on the other side. Lay a strip of waxed paper on top of this, exactly covering the first. You now should have a sandwich with the foil in the middle, one edge sticking out. Lay another strip of foil over this whole thing, but protruding on the other edge. The ends of the waxed paper should stick out far enough that the pieces of foil do not touch. Roll the whole mess up



as tight as you can. If you do it right, you'll have a fairly good capacitor. It should take a charge up to 100 volts or so. Mine broke down at 150.

. . . W2FEZ ■

Leaky Lines

AN EDITORIAL by DAVE MANN K2AGZ

1 DANIEL LANE, KINNELON NJ 07405

Ever since that time a few months ago, when I wrote, "the handle here is Ignatz. . .Idiot, Garbage, Nuts, Alimony, Termite, Zilch. . ." I have been swamped with unsolicited examples of this outrageous phonetic claptrap. It seems that everyone has a favorite set of phonetics which he wishes to bequeath to a breathlessly waiting world. . .you know the type of stuff. . ."Floyd; Funny Little Old Yellow Dog." And. . ."WA2IWS; We Are Two Indians With Scurvy," and all that sort of penny-dreadful nonsense. The more farfetched it is, the more unfunny it becomes.

Now, as a chap who makes his living by putting words together, I warrant that if I desired to be a party to these grotesqueries, I could doubtless be very successful at it. But I think the thing is starting to get out of hand. We ought, really, to start clamping down on it. Unless it is a brilliant work of sparkling genius, I regard it as just sounding brass and a tinkling cymbal; and besides, it's beginning to fray my nerves.

Can you envision the result if this preposterous tripe is allowed to continue flourishing? Webster's Third New International includes over 450,000 entries, each of which is fair grist for the phonetic fetishist's mill. The possibilities are menacingly infinite! And, bear in mind, please, that's only one side of the problem; our own English language. How about all the others? There's Afro-Asiatic, Altaic, Indo-European, Macro-Khoisan, Malayo Polynesian, Indic, Luorawetlan, Niger-Congo, Sino-Tibetan, Uralic, Azteco-Tanoan, Hokan-Siouan, Macro-Chibchan and Penutian. . . . .a series of main linguistic stocks, covering some 700 different tongues, not counting regional dialects. Add to this the languages totally unrelated to any others; Basque, Andamanese, Ligurian, Yenisei-Ostyak. . .each of the 96 Australian aboriginal tongues, and all 132 of the Papuan languages, and perhaps you'll get an inkling of the utter incongruity and hopelessness of it all.

A long time ago I decided that the use of funny phonetics is not so much a method by which to clarify spellings as it is a display of other things altogether; would-be cleverness. . .sarcasm. . .and most of all, ego! The wildest flights into this adventurism and exhibitionism arise out of a profoundly felt need to assert the ego. Scratch the surface of the guy who gives his call as Willie Broke Four Plate Glass Windows, and underneath you are likely to discover an insecure, uncertain, indecisive, vacillating jerk with a pronounced inferiority complex, who is attempting to bolster his inward weaknesses by earning a reputation for great wit and brilliance.

Now please, I beg you. . .no more phonetics in the mail. I just can't take any more. However, if you're interested in some real clever ones, I just happen to have a few dillies. Just five bucks apiece; two for eight ninety-five; first come, first served. But, please keep it under your hat. I wouldn't want anyone to get the mistaken idea that my ego needs bolstering. Not a bit of it!

* * *

There is a situation which has arisen, and I'd like to throw it out to see what you all think about it.

A friend of mine who was a member of ARRL for many years, but who dropped his membership just before acquiring his Extra Class ticket, was in contact with another chap in the same boat. Both these boys are members of the highly vaunted A-1 Operators Club, and both are well seasoned, having a combined total of over 65 years of hamming under their belts. They are not given to shoddy operating habits, nor have I ever found them to be anything but considerate and courteous. From any point of view they are decent people.

Because they are not members of the League, they seldom read QST, and they were unaware that W1AW had changed its operating frequencies. This, despite opinions to the contrary, is neither here nor there. Even the membership of the League is not wholly aware that the frequencies have been changed.

Well, anyway, these two guys were in contact one evening on about 38.20. In the midst of a transmission, and without the slightest advance warning, in came the Official Bulletin from Newington. It wiped out the QSO as effectively as if the band had gone dead.

Now, if W1AW is an amateur station, operating within the same restrictions as the rest of us, then why may they be excused when they commit a breach of courtesy toward other stations. We are all expected to observe the etiquette which the ARRL prescribes: to check the frequency before transmitting. Even if a net with a scheduled operating time discovers that its frequency is occupied, the SCM has the decency to request that the occupant QSY so that the net may operate on a clear channel. If the chap who is thus asked is a gentleman, and most of them are, he will most assuredly move. But, to come right on the frequency without even checking to see, seems to me to be the most arrogant and unwarranted type of rule-flouting in the book.

Since W1AW happens to be the League amateur station, I feel strongly that it should be operated in an exemplary fashion. There is no valid excuse for breaking this basic regulation. In fact, if some extenuating circumstance were to excuse an individual ham for doing this, W1AW should be operated so superlatively that the case would never have arisen. No station should break this rule. It is most distressing when the rule is circumvented by the Headquarters station.

When the bulletin was over, the operator signed the call and announced that the station was standing by for calls. My friend gave them a call and they came right back to him. He took issue with the operator, asking him why he had not checked the frequency before transmitting the text of the bulletin. The operator replied, "I can't comment about that. If you wish to complain, you may write to the League, and take it up with them."

Well, that's it. What do you feel about it? Do you think that W1AW, despite its undeniable help to amateurs, should have the right to ignore the good operating practices which we are all constantly enjoined to observe? I do not think so. But that's only my opinion. What's yours?

* * *

This isn't an original idea, of course. . . .I'm sure somebody must have proposed it. Why, if there's a thing called Operator of the Month, isn't it feasible to publish a list called Lid of the Month? Some of the characters on the ham bands really do deserve this sort of publicity, as you will undoubtedly agree. It's just too bad that the most iniquitous ones invariably operate anonymously, so that it's difficult to identify them.

One thing is certain. If you would like to discourage the intrusions of unwelcome carrier throwers, burpers, whistlers, razzers, and other intruders, never. . . .but never, never comment openly about them. That's exactly what they want in the first place. So don't give them the satisfaction of successfully provoking you into an altercation on the air. If you ignore them, chances are that they will move off your frequency and seek someone else who might just rise to the bait.

Apropos of my recent rhymed diatribe against TV commercials, I recall with delicious amusement an incident of about six years ago.

My father, who had a marvelous admixture of bored cynicism and a highly sophisticated sense of humor, loathed and abominated TV commercials. One of these in particular used to offend him very much. There was an animated character with a head formed of a seltzer tablet. He sang a childish little jingle which ended with an advertising slogan for the product. You simply could not avoid this thing . . .it was like the plague; repetitious and redundant.

Dad got hold of an old mezzo-tint of Socrates, drinking the cup of hemlock. In bold letters, and with a red marking pen, he inscribed it, and sent it to the advertising agency which handled the account. His inscription read, simply, "RELIEF IS JUST A SWALLOW AWAY."

* * *

I'd like to discuss an event which rankles in the breast of almost every amateur even now, several years afterward. I refer, of course, to the removal of 27 MHz from the amateur spectrum, and its reassignment and deterioration into the monstrosity and misbegotten mishmash it was inevitably to become.

Most of us have to take a position. We cannot blow hot and cold with the same breath. We cannot plant both feet firmly in mid-air. Yet, there are those who pretend to be the champions of both contending forces, both unalterably in opposition to each other. . . .both of whose interests lie clearly in diametrically opposite directions.

Can you imagine a man playing both sides of a chessboard? Can you conceive of one general acting as strategist for two warring armies? Can you picture one attorney representing both plaintiff and defendant in a lawsuit? And, if such a lawyer were to advise you to act in such and such a manner, would you be expected to follow his advocacy with implicit faith and confidence? I think not. You would be most imprudent, if you did.

A certain publishing company issues two magazines; one for hams; the other for CB'ers. Now this, in and of itself, is certainly no sin. It is perfectly possible to serve the interests of both, SO LONG AS THEY DO NOT ATTEMPT TO GAIN AN ADVANTAGE FOR ONE, AT THE EXPENSE OF THE OTHER. Through the years, however, in the pages of CQ Magazine, we have seen hints, outlines, draughts, suggestions, proposals, resolutions, and motions, all calling for the creation of additional frequencies for Citizens' Band. They have called for the implementation of a new class of amateur license which would open up the ham ranks to CB'ers, (as if the doors were closed to them now). There is a persistent subterfuge—a nice little fiction—that these people constitute a pool of potential amateur operators, the encouragement of whom all will ultimately supplement our growth, and make us strong and healthy. In other words. . . "Let's have this teentsy-weentsy slice of 10 meters, fellows. You're not using it anyway. Let's allow these nice, deserving folks to use it so that they can develop their skill and talent. They are really different than you think, way down deep inside. They are serious, earnest, purposeful and dedicated, and we owe them an opportunity to develop these splendid and sterling qualities so that they may take their rightful place beside us as full-fledged amateurs.

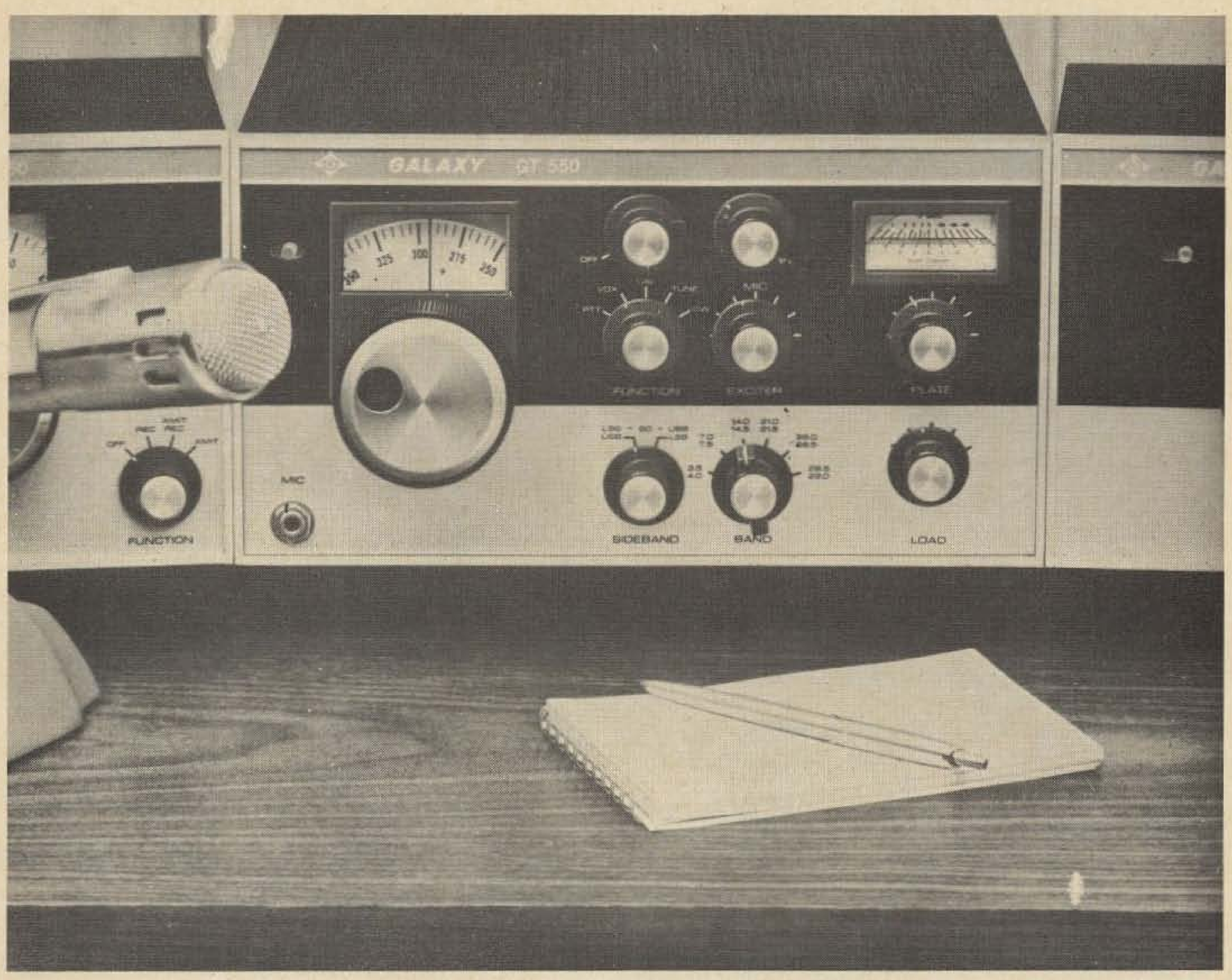
Now, really, I ask in all candor. . .is there a single ham who has the slightest inclination to take this stuff seriously? I certainly hope not! The only quarter in which it might meet with approval is among the CB manufacturers.

Picture this fantasy. The moment these fine, misunderstood fellows are given these additional frequencies, they will instantly begin to observe all the FCC regulations. By some strange and miraculous atavism, they will become first-class operators. The only thing, you see, that keeps them from doing this right this very minute, is because the poor dears are all squeezed and squished into those horrid, little 23 channels. That's why they call skip, use VFOs, run high power, use illegal antennas, don't give proper callsigns, interfere intentionally, persist in the use of profanity and obscenity, and break all the other rules. But never you mind; the moment they are granted this allocation, they will change. They will become fine, law-abiding members of the ham fraternity, and dedicate themselves to constructive purposes. They will be a credit to us all. Just do away with the nasty old code and theory requirements. . . please . . .pretty please . . .and you'll be surprised at how they'll change.

I'm not anxious to pillory CQ. I have some very good friends there—people for whom I have the utmost regard. But I can't help feeling that the front office allowed its "druthers" to be seen in public print, in spite of—not because of—these nice people. And I think that we hams ought to express our united opposition to all such plans, though they may sound ever so lofty and constructive. They can have but one result. . .the weakening of amateur radio. And there has never been a time in our history when we needed so badly to maintain all the strength we can muster.

* * *

A few weeks ago it was decided that I would lie "doggo" on the subject of the League for a while. Wayne felt, and I agreed with him, that there would be no point in continuing to take issue with certain aspects, since I had already expressed most of the reasons for my objections, and had given voice to many of the sentiments unexpressed by the common, garden-type variety of ham, which deserved to be articulated. I fully intended to concern myself with other matters which would be of interest to the readership. But I find that I cannot seem to get away from these issues, after all. The latest issue of QST includes a League proposal, which, if advanced to FCC as it is now proposed, can possibly be even more dangerous than any other ARRL-sponsored change within memory, including incentive licensing.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At this point, allow me to emphasize unequivocally that I have absolutely no prejudice against those who hold Technician grade licenses. If I do object to any of them, it is on the ground that *some* of them operate in violation of the spirit, if not the letter of the FCC regulations. Many of them, probably a majority, conduct themselves conscientiously, but it is simply impossible to ignore the infantile antics of the violators among them. This is not to say that there are no culprits among other classes of amateurs. But the reasons are not the same. In my judgment, one of the important reasons for the misbehavior of certain individuals among Techs, is that they obtained their licenses fraudulently to begin with. Many well-meaning operators, acting in the prescribed role of volunteer examiners, and probably in a spirit of overpermissiveness, have given an inordinate measure of assistance to applicants for the Tech ticket. In some cases the CW requirements were completely bypassed. In other cases the examiner rendered illegal aid on the written portions of the examinations. In this fashion a group of persons who were never really interested in conforming to the stated purpose of this particular grade of license, but who were merely desirous of pursuing the communications end of the hobby, were permitted to infiltrate the ranks of the Technicians. They became figuratively and literally marooned in that category, because there were but few avenues through which they might upgrade their skills in order to meet the standard requirements for the other grades. There have been Techs, of course, who buckled down to work, and developed their code speed. But, on the whole, they did not seem to care too much about becoming General class operators, being content, rather, with staying in their own special niche.

There is no point beating about the bush. You have heard, as I have, the expression "mail-order license" used over and over again. There is no doubt that a sizable segment of those who hold this ticket earned it as a result of less than fastidious observance of the rules by the volunteer examiners. And this practice, though it might appear to be negligible in actual numbers, has tended to lower standards for entire group.

Now ARRL has decided to propose that Techs be permitted phone and other privileges between 29.5 and 29.7 MHz. There is no mention of any qualifying examination for this additional privilege. And I believe that each and every ham who had to go and upgrade his ticket in order to continue to operate, not on newly granted frequencies, but on the same frequencies where he had previously been entitled to do so, should be raising his or her voice in protest. It may be perfectly true that this particular slice of the spectrum is not overused. It may be lying completely fallow. But this fact should not constitute justification for cheapening or vulgarizing it in this fashion.

I say, compel all Technicians who wish to avail themselves of this or any additional privilege to submit to a proper examination in the presence of an official FCC examiner. Those Techs who wish to get this additional slice of the spectrum should be, and undoubtedly will be, in my view, willing to buckle down, as did the rest of us in similar circumstances. This privilege, if offered at all, should not be a free gift, but an incentive. If the League truly believes that incentives will really upgrade the quality of amateur operations, then it *must not* allow this concept to be torpedoed with an inconsistent approach toward one segment of the ham population! If the League is thinking that it will gain membership as a result of a huge and enthusiastic influx of grateful Techs, responding to this magnanimous gesture on the part of Newington, let them contemplate the wholesale hegira from the ranks by thousands of members, already disenchanged with the way things have been going. For every grateful Tech who joins ARRL, I believe there will be a score of members of long standing who will simply quit in disgust.

I am very unhappy with this proposal. I would be much more unhappy if I thought that my fellow amateurs would allow this proposal to go through without a mighty outcry of dissent. If we do not yammer to our directors and to the League executives about this injustice, we will not have the right to complain about it afterward! Nor would we deserve that right.

Here is a golden opportunity for us to test the League's willingness to be responsive to the desires and needs of its members. Typically, of course, in its time-hallowed attitude of paternalism, the League will tell us that it knows what is best for us. Is there anyone left who actually believes this? Is there any soul who has observed the debacle of the unused sub-bands, and the horrendous congestion in the unrestricted portions, who can be gullible enough to buy this ancient and worn-out canard?

I would be very much surprised if this atrocious proposal should meet with the approval of the majority of the amateurs. Since it would result in an advantage to some, gained through preferential bias for this one license grade, it spells a disadvantage, in effect, for all the rest of us.

Let us all make certain that we express our feelings on the question. Let no amateur fail to communicate with ARRL and its leaders, so that we may avoid a perilous situation in future years. This proposal constitutes a dangerous precedent. It would enable some FCC, as yet unnamed, perhaps, to reassign portions of our bands to whomever it wishes, on the simple ground that it is right to exact standards of ability from some, while permitting others to ignore any standards whatsoever! It would also establish that frequencies which are not widely utilized may be preempted by groups which might make more use of them. On this basis it would be possible to witness a gradual attrition of the entire amateur spectrum, through their reassignment to anyone or any group with sufficient influence to convince or mislead the Commission.

Please, I entreat you with all earnestness and sincerity, do not let this proposal get to first base. This could be the most important decision you can make during your entire amateur life. Don't let it get through, especially by default. Write, wire, and call your director. Do it today!!!!

. . . Dave Mann K2AGZ■

Emergency Net Changes Name, Frequency

MEDINET—Medical Information Network—is the new name of the Public Health Service Emergency Radio Network, the Secretary of Health, Education, and Welfare announced today. The network was organized a year ago by the Division of Emergency Health Services, Health Services and Mental Health Administration, to provide communication during health emergencies when downed telephone lines have closed normal communication channels.

MEDINET is made up of employees of the Department of Health, Education, and Welfare (HEW) who live outside the Washington, D.C. metropolitan area and who are licensed amateur radio operators, or "hams." MEDINET's most vital function is to provide rapid communication among health officials at the local, state and federal levels during disasters. When normal communications channels are closed, MEDINET steps in to insure the fastest possible response to the health needs of disaster areas. Participation in MEDINET is voluntary. It is undertaken as a public service by the HEW employees involved. When an emergency occurs, MEDINET members are excused from their normal duties so that they can participate in the network. Network control for MEDINET is provided by the National Institutes of Health Radio Amateur Club station, K3YGG, at Bethesda, Maryland, a Washington, D.C. suburb.

The change of name, from PHS Emergency Radio Network to MEDINET, will permit routine on-the-air meetings of the network's members without any Federal connotation. To promote the use of a single frequency by all medically oriented networks—such as the Medical Amateur Radio Council, Ltd., an organization of physician hams—MEDINET's frequencies were recently changed to 7260 kHz and 14280 kHz (with 21360 kHz as an alternate).

Presently, MEDINET is meeting on the air every Monday at 12:00 noon and every Wednesday at 5:00 p.m. Eastern Time. MEDINET Control, K3YGG, operates at 20 meters on 14280 kHz and 40 meters on 7260 kHz simultaneously at these times.

A few of the MEDINET members do not have transmitters powerful enough to communicate directly with Washington, D.C. MEDINET, however, is set up so that it can relay messages from station to station across the continent. This technique was used with dramatic success in the recent Hurricane Camille disaster on the Gulf coast.

Announcement

12th Annual Dinner

The East Coast VHF Society's 12th annual dinner will be held Saturday, March 21, 1970, at the Neptune Inn, Route 4, Paramus, N.J., starting at 7 p.m. Ted Mathewson W4FJ will talk on "VHF—Past, Present, and Future." Awards will be given by Ed Tilton W1HDQ, including awards for highest single and multioperator station in the September VHF contest. The menu will be prime ribs of beef and tickets will be sold for $7.50. Group reservations are available in blocks of 5 to 10. Ticket deadline is Wednesday, March 11. For tickets and reservations write the East Coast VHF Society (WA2WEB), PO Box 1263, Paterson NJ 07509.

Amateur Radio

AMATEUR RADIO IN INDIA

Marie Welsh W6JEP
Reprinted from LERC Bulletin

G. V. Sulu (VU2GV) was kind enough to send a copy of the Radio & Electronics Society of India (RESI) Book Series 1 Amateur Radio Regulations in India, compiled by M. V. Kini (VU2SZ). This 1968 First Edition is very interesting and our readers may appreciate the following highlights which I've extracted from the book:

1. No 160 or 6 meter privileges.
2. 10 kHz only on 80 meters; 3890-3900 kHz.
3. 100 kHz only on 40 meters; 7.0-7.1 MHz.
4. 20, 15, and 10 meters are the same as our bands.
5. 2 meter band is 144-146 MHz.
6. 420-450 MHz also used by radio altimeters.
7. 1215-1300 MHz shared with fixed and mobile services.
8. 2300-2450 MHz primarily assigned to fixed, mobile, and radio location services. 2450 MHz shared with Industry, Medicine, and Scientific groups.
9. 3300-3500 MHz shared with fixed and mobile services.
10. 5650-5850 MHz shared with fixed and mobile services; 5800 MHz is for industry, medical, and scientific purposes.
11. 10.000-10.500 GHz and 21-22 GHz are used as ham bands.
12. The top license is called Grade I. This ticket is available to those who are 16 or older. The code test is at 12 wpm and the theory test is about the same as our Novice exam.
13. The other license is called Grade II. This ticket is available to those 14 or older. The code test is at 5 wpm and the theory test is 25% easier than the Grade I exam.
14. The maximum input power for SSB operation has been increased from 100 to 400W PEP.
15. Mobile operation is now authorized on the VHF bands.
16. There are about 500 licensed hams in India, and the majority of them are quite new to the hobby.
17. Ham literature is very scarce in India and ordinary electronic components are just about nonexistent.
18. Amateur licensing exams are conducted (by appointment only) at 5 monitoring stations of the Department of Communications and Civil Aviation with requests addressed to the Wireless Adviser, Wireless Planning and Coordination, Ministry of Transport and Communication.
19. The Grade I exam fee is 10 rupees and the Grade II fee is 5 rupees.
20. Grade I station applications cost 15 rupees and Grade II ones cost 10 rupees.
21. Grade I licenses will soon be renewable for 3 years at 42 rupees.
22. Grade II licenses are not renewable after 3 years; the holder must upgrade to Grade I or lose his license.
23. Ham licenses can be granted to nationals of other countries.
24. Station particulars must be detailed on the

News Page

station application. If not commercial or surplus equipment, a diagram of the transmitter must be attached. Receiver details must be attached. A sketch of the antenna (showing dimensions and mechanical supports) must be included.

25. The powers at the (1) power supply, (2) final amplifier input, and antenna input must be stated on the station application.
26. The desired transmitting and receiving frequencies must be stated on the station application.
27. The equipment frequency range capability must be stated on the station application.
28. Two passport-size photographs are required with the operator application.
29. The applicant's physical description and personal data are required on the operator's application.

FCC Notes

CB Traffic Reporting Authorized

CB rules (Section 95.83(a) (14) have been amended to permit licensees to transmit information on highway conditions to persons or emergency organizations furnishing such information to the motoring public by way of radio broadcast facilities (Docket 18625; RM-1388). The amendment will provide for road information furnished by a CB radio station to be compiled and edited by the broadcaster and then announced over a broadcast facility.

40 Meter Segment Opens for Ham Band Marine Operation

Amendment of the amateur service rules Section 97.95(b) (2) concerning maritime mobile operation permits United States amateurs, when outside the jurisdiction of a foreign government, to operate in the 7.0-7.1 MHz band in areas of Europe, Africa, and Northern Asia (Region 1) and Southern Asia and Oceania (Region 3), effective December 31, 1969. The 40 meter frequencies from 7 to 7.1 MHz have been allocated for exclusive use of the amateur radio service on a worldwide basis.

Fort Sill Fest

The annual Fort Sill hamfest will take place in Lawton, Oklahoma on February 22. For details, write Lawton—Fort Sill ARC, Box 892, Lawton OK 73501.

Storm Warning

In the March 1969 issue of Popular Science there was an interesting article explaining the Newton Weller system of using your TV set as a tornado warning device. The mechanics are simple:

- Tune your TV set to channel 13
- Turn the brightness control until the screen is dark
- Tune to channel 2

If the screen is white, then there is a tornado nearby. White streaks on the screen are an indication of lightning activity. A dark screen shows there are no electrical storms in the area. If there is a local station on channel 2, you may see its picture instead of a blank screen.

Newton Weller found that tornados have an oscillating electrical field around the eye. The frequency of this oscillating field is very close to 55 MHz (that is, channel 2). One darkens the screen while tuned to channel 13 to give a reference as far from 55 MHz as possible. The high signal level produced by the tornado or electrical storm is enough to turn the screen white on channel 2.

. . . WA6YZD, as lifted from the Sacramento Club paper

Blossomland Annual Auction

The 3rd Annual Blossomland Amateur Radio Auction will be held March 15, 1970 at the Youth Memorial Building, Berrien County Fairgrounds, one mile north-west of Berrien Springs, Michigan.

Last year over 300 amateurs turned out for Southwestern Michigan's fastest growing ham event, and went home with carloads of fine gear (or money). The 1970 auction promises to be bigger and better.

Acres of free parking will be available for the trailerloads of bargains that will no doubt show up. Don't pack a lunch. . .hot food will be available. Prefer to do your own selling? Rent one of the swap tables. If that fails, a skilled auctioneer will put your gear on the block.

One happy ham went away with a Heathkit Hotwater 100—the grand prize last year. A lot of others won smaller items. What will this year's door prizes be? Be there March 15 and find out.

Coming from out of town? Just get on US 31-33 to the Fairgrounds north of Berrien Springs. Running mobile on 75 or 2? Direction service and call-in on 3925 or 146.94 FM.

Check your shack now. . .and be at the auction between 10 a.m. and 1 p.m. (starting time) to convert that old gear into something easier to carry. . .money.

OLD TIMERS

The "Old Timers Dinner" for the Southeast U.S. sponsored by the Birmingham Amateur Radio Club will be held at 7:30 p.m., February 14, at the Holiday Inn East (Highway 78 East). Leland Smith, W4AGI/W5KL, will be the featured speaker.

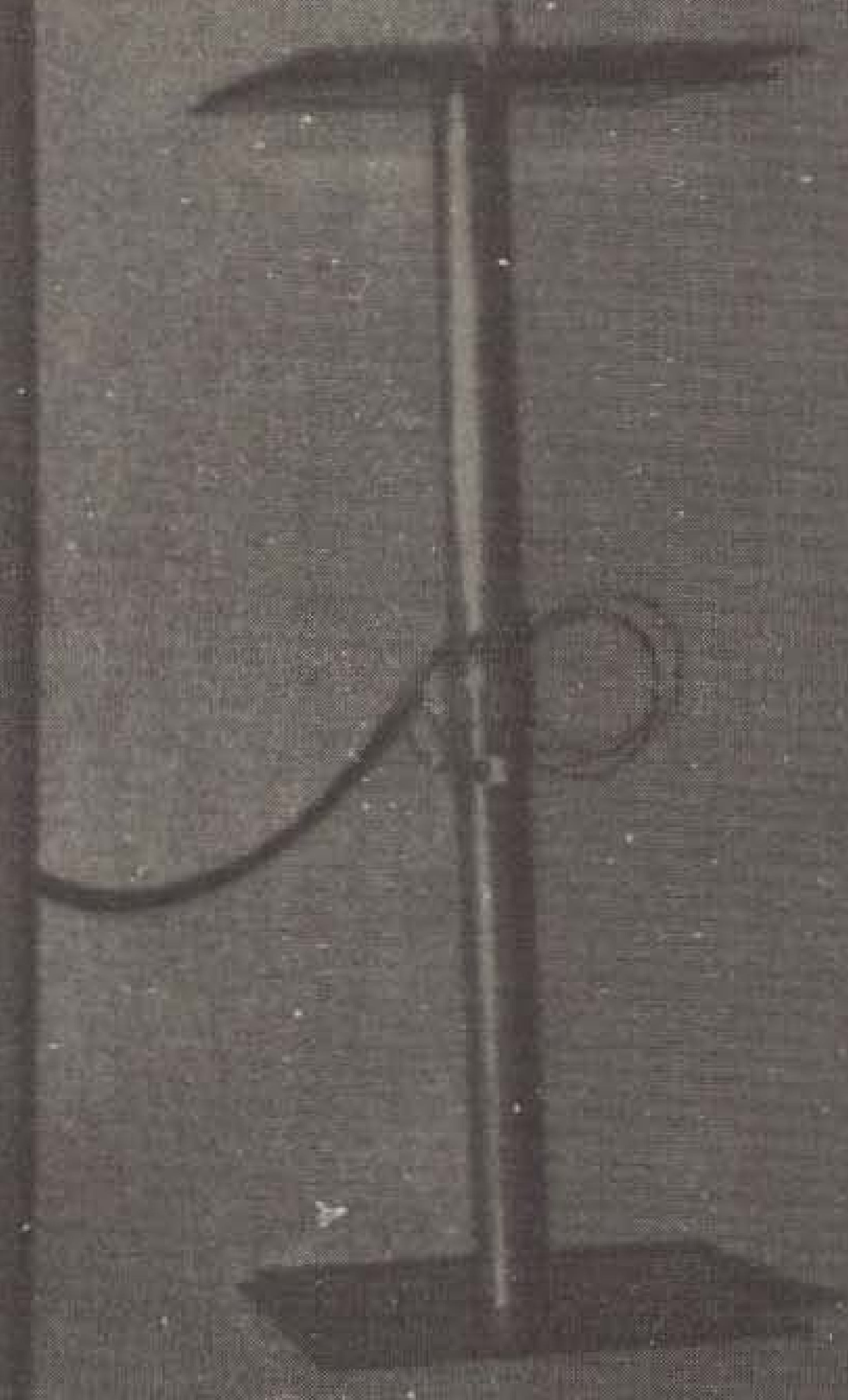
This appears to be an annual event, predicated on the tremendous crowd attending last year. A license issued before 1930 entitles a ham and his wife to a free dinner.

Antique equipment, magazines and "hams" will be on display.

For further information contact W4GET or W4AXL, Box 603, Birmingham AL.

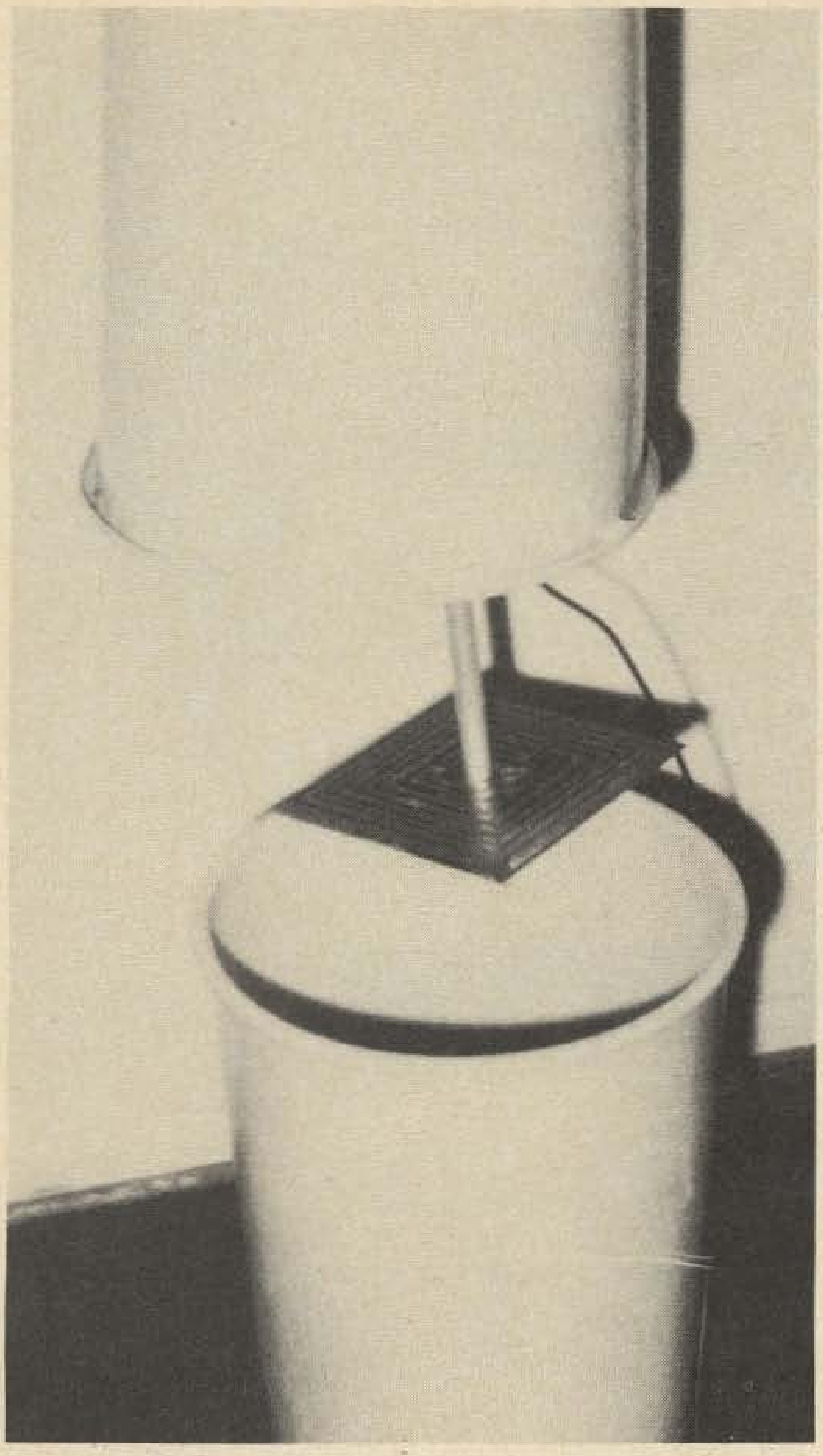
An Eighteen Inch Dipole On Fifteen Meters

Allan R. Brown K9LGH
210 E. Fairfax Wt., Apt. 520
Falls Church VA 22046



"You're pulling my leg," he said. I was working the east coast on 40 CW from W9 land. I had just mentioned that my antenna was a 4 ft dipole. Whether phone or CW, a 1 ft dipole on 10 meters, or an 8 ft dipole on 80 meters, expressions of curiosity and interest have poured in over the years. For instance, would you believe working three other amateurs in one QSO involving three states while transmitting and receiving 80 meter SSB on a 2 ft dipole in the basement? This occurred early one morning at my Park Ridge, Illinois, residence and included two contacts in Iowa and one in Minnesota.

It was after considerable experience with these antennas and in the spring of 1966 when the 18 in. dipole was designed and constructed. It was constructed of 3/4 in. diameter by 9 in. long aluminum tubing sections held together and spaced 1/2 in. at the center with a piece of polystyrene tubing. The end coils are pc boards (glass epoxy), and the center matching device is a 1-3/4 turn, 2 1/4 in. O.D. coil of 16 AWG enameled copper wire.



The circuit boards were hand painted with photoresist after first ruling the edges of the lines with a resist pen. Then the circuit boards were etched with ferric chloride. The ends of the straight dipole section were plugged, and the coils held in place with a single screw in each end. There is one left-hand and one right-hand coil, so that with the conducting sides of the coils turned toward each other, the currents in the coils oppose each other to reduce premature radiation.

The final touch is the tuning means, which consists of telescoping brass tubings (I obtained them from a local hobby shop). The inner tubing is 1/16 in. O.D. and the outer tubings are soldered to the ends of their respective coils.

This little antenna turned out to be my favorite, as it was inconspicuous and could be taken down and lost in a small piece of airplane luggage. Since it is matched to a 50 ohm coaxial cable (usually RG-58/U), all that is necessary is to connect it, tune it, and go on the air.

Good results were obtained from the outset with the antenna sitting on the nylon web of a lawn chair on the balcony. In the fall I hung it in two plastic wastebaskets, one inverted on top of the other; there it sat all winter long bringing in the contacts. The maximum power used was provided by four 1625 tubes in a homebrew grounded-grid linear. Estimated input is 300W PEP with additional feedthrough from the exciter. That power level is about the limit for the printed circuit coils.

These antennas have been a real fun thing, from the very first successful model—which was a 2 ft dipole on 40 meters. A prototype 4 ft antenna was made for 40 meters and a few were made and sold to test the market. There is presently no commercial product available, but a patent* has been granted on the antenna.

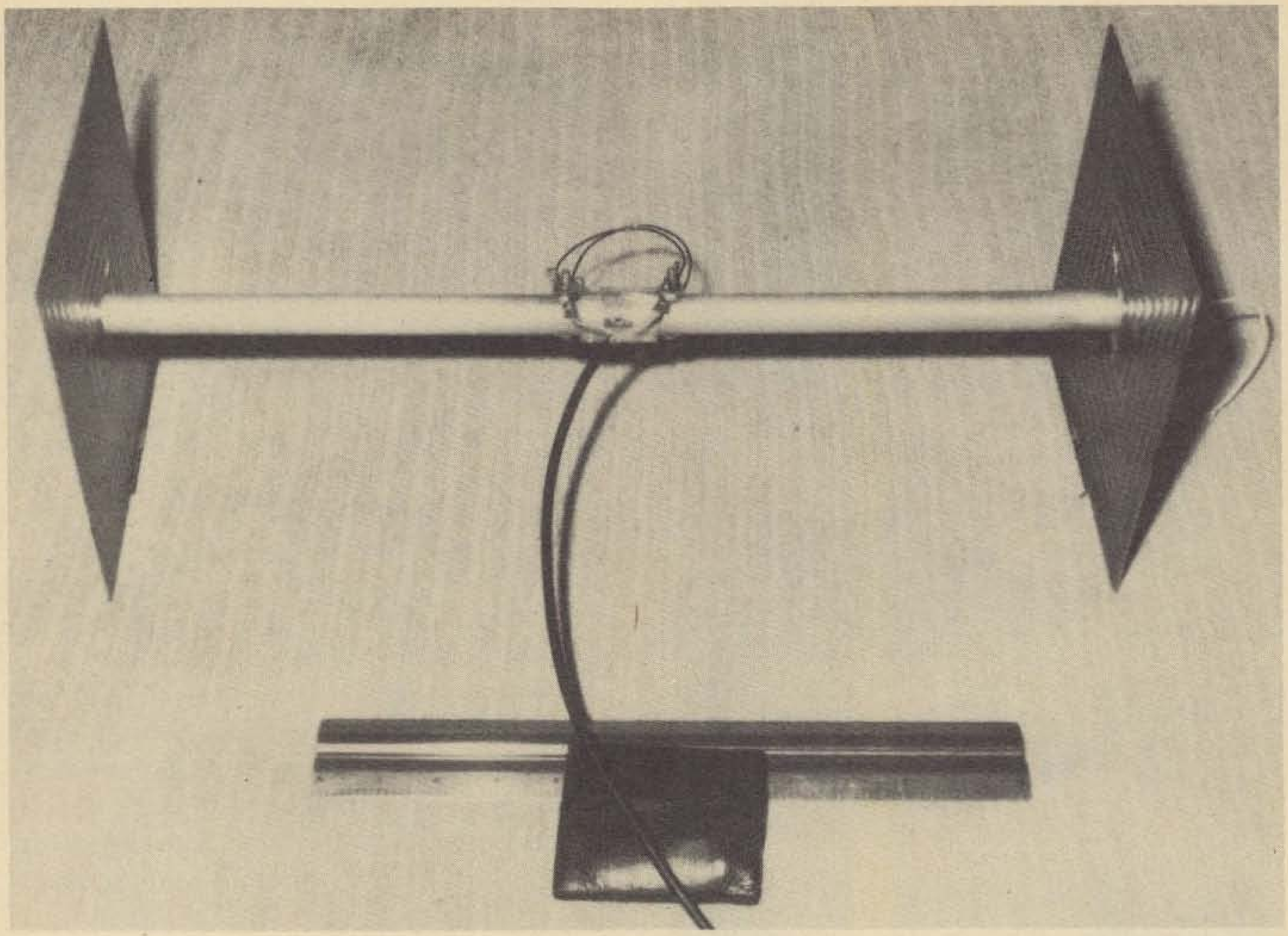
The antenna system comprises an end-loaded dipole with matching impedance in the center. The straight dipole has a high radiating efficiency, and there is undoubtedly a substantial contribution from the strong electrical dipole produced by the two end coils which are opposed magnetically. This accomplishes two things:

1. Radiation at right angles to the principal field of the straight dipole is reduced or nearly eliminated.

2. Radiation off the ends is also greatly reduced, thus avoiding or reducing losses which might otherwise occur through coupling with nearby lossy objects.

Although a highly efficient antenna should be possible in this configuration, the efforts have been concentrated on making small lightweight antennas, for economy, ease of handling, and with minimum space requirements. The actual efficiencies would be very difficult to calculate since the distribution of the current in the coils is a

*Patent No. 3,432,858 owned by the author. The author does not object to having amateurs build these antennas exclusively for their own experimental use.



The keycase and ruler are shown beside the 18 in. 15 meter dipole for size comparison. A string attached to a clamp under the screw on one end permits hanging the antenna from a convenient support. One word of caution: the coax must be kept several inches away from the coil edges to avoid a detuning effect.

complex phenomenon. However, with antennas, performance is the prime criterion—and this has proved very gratifying; the antennas have been tested and used by several of the author's friends with consistently good results.

One of the greatest advantages of the antenna is its small size and weight which permit it to be placed more favorably at times than such antennas as the ground-based vertical or a half-wave dipole. Taking advantage of its size and independence from the ground, it can be placed at an optimum height for the desired angle of radiation. Or it can be used either horizontally or vertically to achieve optimum propagation over short or long hauls. For example, the 4 ft 40 meter dipole worked very well vertically for the long hauls, but better horizontally for distances of 60 to 100 miles.

The advantage of raising the antenna to an optimum height, which for longer skips may be one-half to one wavelength above the ground, may be seen from the graphs contained in an article by W. H. Anderson VE3AAZ (Antenna Behavior Over Real Earth, QST, June 1965, pages 61-64). The 9 ft 40 meter antenna weighed 3 1/2 pounds and thus could be placed on a light support anywhere on the house or other structure where a little free space was available. Thus in a vertical position at some height above the ground, it might perform as well, or better, than a quarter-wave ground-based vertical. As seen from the above, there is no reason why the antenna cannot be mounted horizontally and rotated. This, of course, has been done, and although the tests made were not extensive, it was found that the short dipole (4 ft on 40 and 8 ft on 80 meters have been tried this way) behaved directionally about like a half-wave dipole.

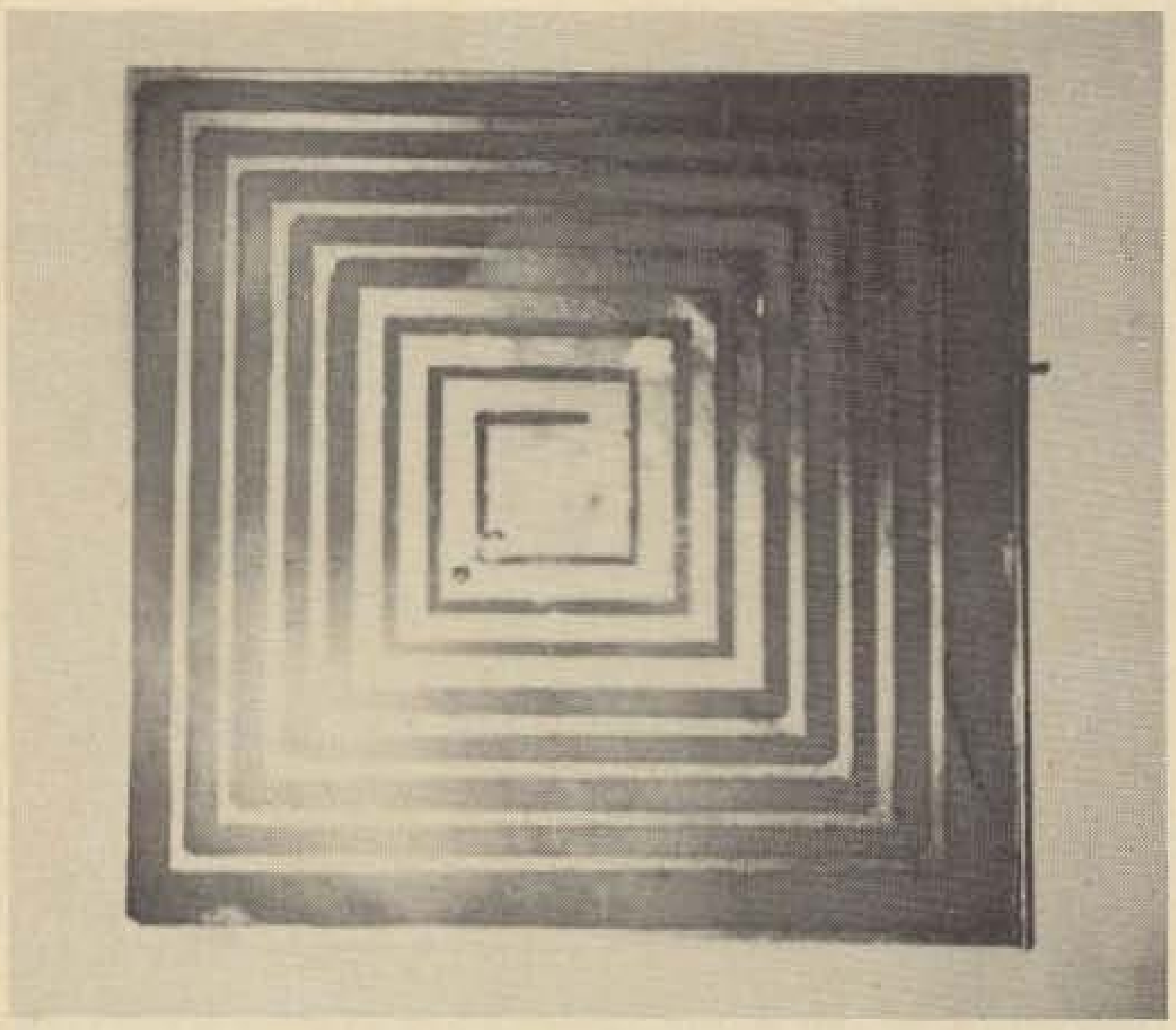
Very good results have been achieved with the 40 meter dipole in the vertical position at a height of 25 ft. Africa and Ireland were worked from the W9 location with this arrangement. However, one thing was learned with the 40 meter antenna on the top of a telescoping steel pole. The base of the pole was on the ground, and when the ground was wet and the pole extended to a quarter-wavelength, the pole started resonating and changed the radiating resistance of the short dipole and, consequently, the vswr which is normally kept low (1:1 at the center-tuned frequency in the vertical position when optimum adjustment is achieved).

The experience with the radiating support, of course, is indicative of what can happen with any portable antenna. It is subject to variations in characteristics when brought near other objects with nearly the same frequency of resonance. When the lower end of the telescoping steel pole was insulated from the ground, it was possible to extend it to any height (within its 40 ft capacity) without changing the tuning of the antenna. Of course, this was with the antenna in the vertical position. With the short dipole in the horizontal position, it could be expected to change its characteristics as its height was changed due to imaging in the ground.

The possibilities of experimenting with antenna height vs propagation effects on the 40 and 80 meter bands with small lightweight antennas of this type are excellent since they require only lightweight supports and may be easily mounted in either the horizontal or vertical positions down to a very small fraction of a wavelength from the ground. The 40 meter dipole worked very well 6 ft above the ground and could undoubtedly be used even lower. This was in the vertical position which, with a half-wave dipole, would put the current node 40 ft off the ground (instead of 8 ft). In the horizontal mode, both the 4 ft antennas on 40 meters and the 8 ft antenna on 80 meters have been mounted directly to a steel mast with right-angle clamps with good results. The clamps were placed close to the center of the straight dipole section and on the same side to which the coax shield was connected.

One of the first questions asked is whether multiband operation is possible with these short dipole antennas. First, the antennas may be tuned to the odd harmonics of the fundamental frequency of the antenna. Thus, the 4 ft dipole for 40 meters worked very well on 15 meters. One 2 ft dipole for 15 meters and 20 meters tuned to a low vswr on 6 meters.

The 2 ft dipole for 15 and 20 meters contained a trap in each coil to permit operation on the two bands. Fine adjustment in both bands was accomplished by adjusting taps on the inside turns of the end loading coils. The coils tune sharply, much like mobile antennas, as the radiating resistance is low and the overall Q of the antenna is high. It was found that with the 18 in. dipole for 15 meters, the entire phone band could be tuned with my SBE Model 34 transceiver. However, the 4 ft dipole required adjustment to cover the entire phone band on 40 meters, as when tuned 1:1 at the center of the phone band, the vswr at 7.2 and 7.3 MHz was about 3:1. An experimental remote tuning device with a reversible motor was built and operated on 40 meters. This device permitted tuning right "on the button" on both 40 and 15 meters.



The coil dimensions for 15 meters are 7-3/8 by 7-3/4 in., and the turns are purposely made wider in the center where the current is higher. The inner conductor (first turn) is 1/4 in. wide, and the next two graduations in conductor width are supposed to be 3/16 and 1/8 in. respectively. On the left side may be seen the tuning stub, which is a 1/16 in. O.D. brass tube which slides in a larger tubing. The larger diameter tubing is soldered to the end of the printed circuit coil.

Three 4 ft dipoles were wide-spaced 6 ft above the ground to form a beam. As they were fixed and could not be rotated, the direction of the beam was changed by running out and quickly interchanging the director and reflector or front and back dipoles. The beam seemed to have a good front-to-back ratio, but the gain was not checked. It appears that two or three such dipoles on a boom might be great for 40 or 80 meters. They could be used as a rotatable beam either with horizontal or vertical polarization. This could be changed remotely by a motor drive, which should lead to some interesting experiments in propagation effects.

Tuning these antennas requires some type of instrumentation to determine optimum operating conditions. The minimum should include at least a vswr meter. The antennas should be tuned so that near zero or very low reflected power is in evidence. If the center matching impedance is proper, the only tuning required is to adjust the two coils until the antenna is resonant at the operating frequency. Then the vswr should be near 1:1. Initially, if the matching impedance is a little off, it may not be possible to bring the reflected power down near zero, but a low point will be found indicating resonance has been achieved. Increasing or decreasing the matching impedance should then permit achieving a low vswr. Retuning the coils may be necessary if a large change is made in the center matching impedance.

A grid dip meter or other instrument such as the Omega-t Systems antenna noise bridge can come in handy to find out the resonant frequency of the antenna before tuning. The antennas are generally made with slightly longer coils than necessary to permit adjustment to various conditions. The 18 in. dipole for 15 meters has a jumper from the center conductor to the first turn to bring the antenna into tuning range. The jumper is a piece of bare copper wire soldered at the ends.

For the amateur who likes to experiment, or the amateur with limited space for antennas, these antennas have many interesting possibilities. For the amateur who has everything, one for portable use, or maybe for use just for the fun of shocking someone by saying, "I'm using a 4 ft dipole antenna on 40 meters," may be the order of the day. . . . K9LGH■

MODEL 508 VFO—SWAN 500C TRANSCEIVER—117XC POWER SUPPLY—MARK II LINEAR

For several years Swan Electronics has been specializing in value engineering of single sideband transceivers to give radio amateurs the best possible equipment at the lowest possible price. We're pleased to say that we have thousands of satisfied customers all over the world, many who have purchased their third or fourth Swan as we continue the evolutionary improvement of our product. (Trade-in value of a used Swan is well above average.) We would like to say that the station illustrated above is a typical Swan station, but that would be misleading. Actually, the average Swan owner finds the quarter kilowatt or half kilowatt transceiver very adequate for his operating needs. What the picture illustrates is some of the Swan accessories that will add more versatility and greater operating pleasure to your Swan station. For the DX operator, the model 508 external VFO provides separate control of transmit and receive frequencies, or for the MARS and Net operator, the 510X crystal oscillator provides up to 10 fixed channels. For breaking through those weekend QRM pile-ups there's no better cure, legally, than the Mark II Linear Amplifier with its 2000 watts of P.E.P.

TOP OF THE SWAN-LINE
THE FAMOUS 500C TRANSCEIVER

520 watts P.E.P. input on 10, 15, 20, 40 and 80 meters. Finest crystal lattice filter with 1.7 shape factor. ½ microvolt receiver sensitivity. Voice quality, performance and reliability are in the Swan tradition of being second to none. **$565**

MODEL 508
EXTERNAL VFO

Provides full coverage of 80, 40, 20, 15 and 10 meters in 8 ranges of 500KC each. Enables you to transmit and receive on separate frequencies. Plugs directly into either the 500C or 270. **$145**

CRYSTAL CONTROLLED
MARS OSCILLATOR

For Mars or Net operation. Model 510X. 10 channels. Plugs directly into 500C or 270. Less crystals. **$55**

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2000 watts, P.E.P. input, 10 through 80 meters. Uses two 3-500Z triodes. Complete with matching power supply. **$660**

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For 117 volts, 50-60 cycles, with speaker and phone jack. **$105**

12 VOLT DC POWER
SUPPLY FOR 500C TRANSCEIVER

Model 14-117, designed for mounting under hood. Includes cables, plugs and fuses. Can operate from 117 volt AC by detaching DC module and plugging in 117 volt line cord. **$130**

SWAN HORNET
BEAM ANTENNAS

Latest addition to the Swan-Line. High quality, high performance antennas for the amateur bands. Best known are the famous Hornet Tribanders, made in 2, 3 and 4 element models. The TB-1000 series is rated at 2000 watts, the slightly smaller TB-750 at 1500 watts.

TB-1000-4 4 element...$159
TB-1000-3 3 element... 129
TB-750-2 2 element.... 89
TB-750-3 3 element.... 109

SWAN
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OCEANSIDE, CALIFORNIA
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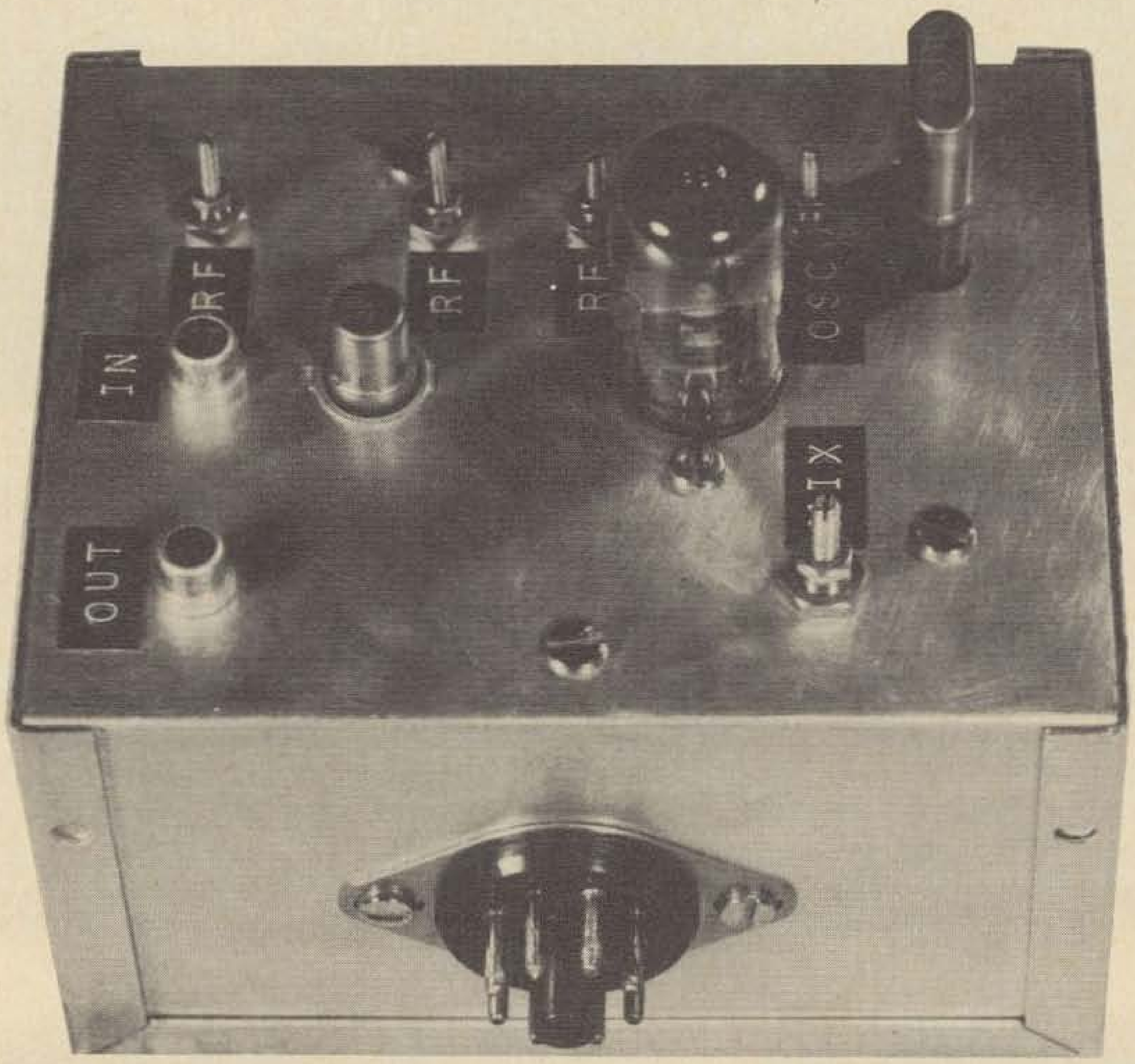
HIGH PERFORMANCE CONVERTER FOR 6



Alan Wilson WA9HES
308 East Wood Street
Hillsboro IL

Been looking around frantically for one of the good old converter circuits? Here's one that uses a Nuvistor for high gain and low noise on 6 meters.

The first addition to my 6 meter station was the converter described below. The unit is designed with the idea of obtaining high performance with a minimum of circuitry. I will attempt to describe the unit in such a way that it can be easily duplicated.

Circuit

A 6CW4 Nuvistor serves as the rf amplifier. Oscillator and mixer functions are provided by a single 6U8A. The 6CW4 must be neutralized, but the low noise figure obtained by the use of this tube makes the extra effort worthwhile. The pentode section of the 6U8A is utilized as the mixer. This arrangement provides adequate output for any reasonably sensitive receiver.

The oscillator uses the triode section of the 6U8A. A third overtone crystal determines the frequency. In my unit a 43.2 MHz crystal gives coverage from 50.2 to 50.5 MHz using the 40 meter band as an i-f. Other crystal frequencies could be used to cover other segments of the band, or if a general coverage receiver were employed, a 43.0 MHz crystal would cover the entire band with output between 7 and 11 MHz.

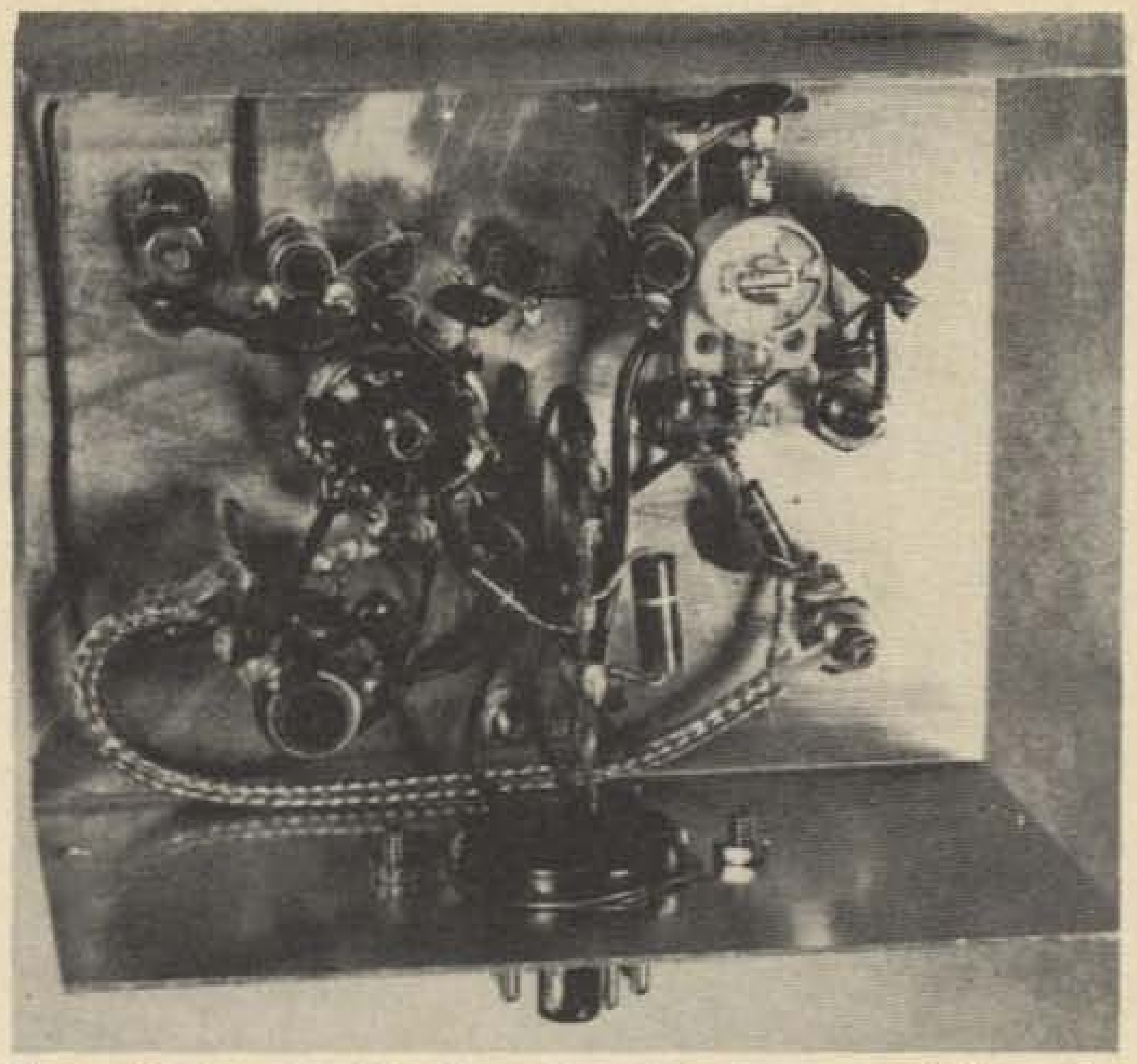
Construction

In order to obtain optimum results the converter should be built in accordance with good VHF practices. All components should be mounted rigidly, keeping the leads as short as possible. Prewound Miller coils are used throughout. Note that the mixer output coil is from the 21A000RBI series. A coil of the same inductance but from the smaller 20A000RBI series would not allow for winding the output link. I used silver mica capacitors for all tuned circuit and coupling purposes. Small tubular ceramics would serve as well. All bypassing is done with 1000 pF ceramic discs.

The only critical part of the converter is the neutralization circuit. The 1.5-7 pF neutralizing capacitor must be secured solidly. The body of the 6.8 kΩ resistor should be positioned as close to the lower end of L3 as possible. This is necessary because the resistor has a dual purpose. It functions not only as a series dropping resistor but also serves to keep the bottom of L3 above ground.

Tuneup Procedure

The first step after applying power is to adjust L7 for maximum rf output as indicated by a grid dip meter in the wavemeter position. Next, connect a short length of wire to J1 and set the grid dip meter to generate a 6 meter signal. Now connect the converter to the receiver with a short piece of coax and adjust L5 for maximum signal as indicated on the receiver's S-meter. Next, set the neutralizing capacitor at midrange and tune L2, L3, and L4 for maximum signal strength. Now disconnect the 6.8 kΩ resistor from the high voltage source and adjust the neutralizing trimmer for *minimum* signal as noted on the S-meter. Finally, reconnect the resistor and repeak all five coils. The converter is now set for near optimum performance.



The rf stage with the associated neutralizing circuitry is at the upper left. Output from the mixer is coupled to J2 via a length of RG-58/U.

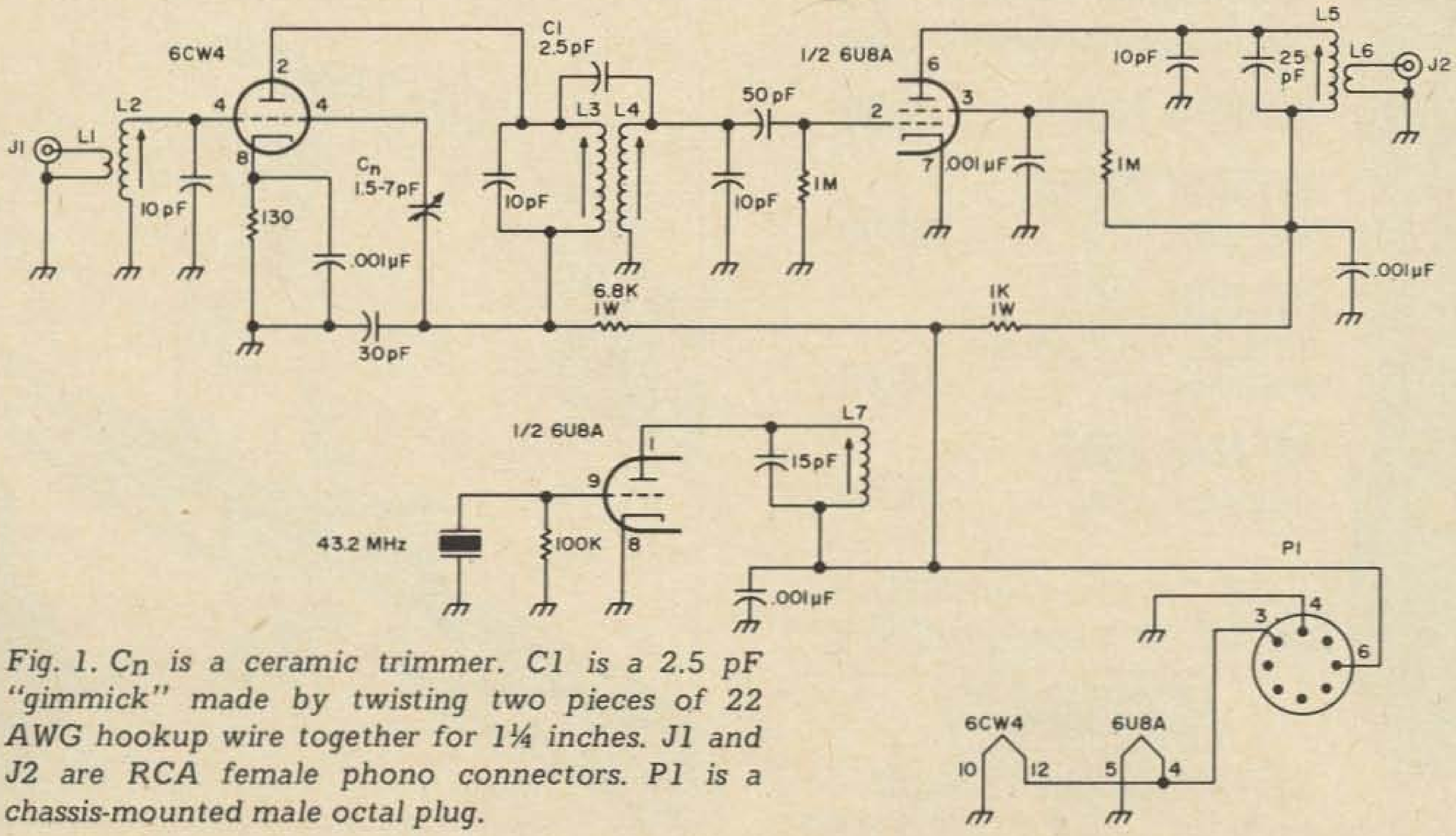


Fig. 1. Cn is a ceramic trimmer. C1 is a 2.5 pF "gimmick" made by twisting two pieces of 22 AWG hookup wire together for 1¼ inches. J1 and J2 are RCA female phono connectors. P1 is a chassis-mounted male octal plug.

Power Supply

The power source used should supply +150V and 6.3V with minimum current ratings of 50 mA and 750 mA, respectively. The high voltage should be regulated. In my application a single OD3 regulated supply serves both the 6 meter converter described here and a similar 2 meter converter. The high voltage is continuously on in both units at all times, and the filament voltage is applied to the converter in use.

Coil Data

L1	3½ turns No.22 insulated over L2
L2, L4	Miller 20A687RBI
L3, L7	Miller 20A827RBI
L5	Miller 21A155RBI
L6	5 turns No.22 insulated over L5

L3 and L4 spaced ¾ inch center to center

Results

After using the converter for several months, I am completely satisfied with its performance. At no time have I experienced problems with stability or the "birdies" commonly encountered in VHF converters. When the band is open the converter pulls in the weak ones, yet does not suffer from cross-modulation effects with the locals. If you build the converter as shown, I am sure that you will be thoroughly pleased. Be seeing you on 6.

. . . WA9HES■

More than 5 million two-way transmitters have skyrocketed the demand for service men and field, system, and R & D engineers. Topnotch licensed experts can earn $12,000 a year or more. You can be your own boss, build your own company. And you don't need a college education to break in.

HOW WOULD YOU LIKE to earn $5 to $7 an hour...$200 to $300 a week ...$10,000 to $15,000 a year? One of your best chances today, especially if you don't have a college education, is in the field of two-way radio.

Two-way radio is booming. Today there are more than *five million* two-way transmitters for police cars, fire trucks, taxis, planes, etc. and Citizen's Band uses—and the number is growing at the rate of 80,000 per month.

This wildfire boom presents a solid gold opportunity for trained two-way radio service experts. Most of them are earning between $5,000 and $10,000 a year *more* than the average radio-TV repair man.

Why You'll Earn Top Pay

The reason is that the U.S. doesn't permit anyone to service two-way radio systems unless he is *licensed* by the FCC (Federal Communications Commission). And there aren't enough licensed experts to go around.

This means that the available licensed expert can "write his own ticket" when it comes to earnings. Some work by the hour and usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses. Others charge each customer a monthly retainer fee, such as $20 a month for a base station and $7.50 for each mobile station. A survey showed that one man can easily maintain at least 15 base stations and 85 mobiles. This would add up to at least $12,000 a year.

How to Get Started

How do you break into the ranks of the big-money earners in two-way radio? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC License. Then get a job in a two-way radio service shop and "learn the ropes" of the business.

2. As soon as you've earned a reputation as an expert, there are several ways you can go. You can move out, and start signing up your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales, where one sales contract might net you $5,000. Or you may be invited to move *up* into a high-prestige salaried job with one of the same manufacturers.

The first step—mastering the fundamentals of Electronics in your spare time and getting your FCC License—can be easier than you think.

Cleveland Institute of Electronics has been successfully teaching Electronics by mail for over thirty years. Right at home, in your spare time, you learn Electronics step by step. Our AUTO-PROGRAMMER® lessons and coaching by expert instructors make everything clear and easy, even for men who thought they were "poor learners."

Your FCC License... or Your Money Back!

By the time you've finished your CIE course, you'll be able to pass the FCC License Exam with ease. Better than nine out of ten CIE graduates are able to pass the FCC Exam, even though two out of three non-CIE men fail. This startling record of achievement makes possible our famous FCC License Warranty: you'll pass the FCC Exam upon completion of your course or your tuition will be refunded in full.

Find out more. Mail the bound-in post-paid card for two FREE books, "How To Succeed In Electronics" and "How To Get A Commercial FCC License." If card has been detached, use coupon below.

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Please send me without cost or obligation:

1. Your 44-page book "How To Succeed In Electronics" describing the job opportunities in Electronics today, and how your courses can prepare me for them.
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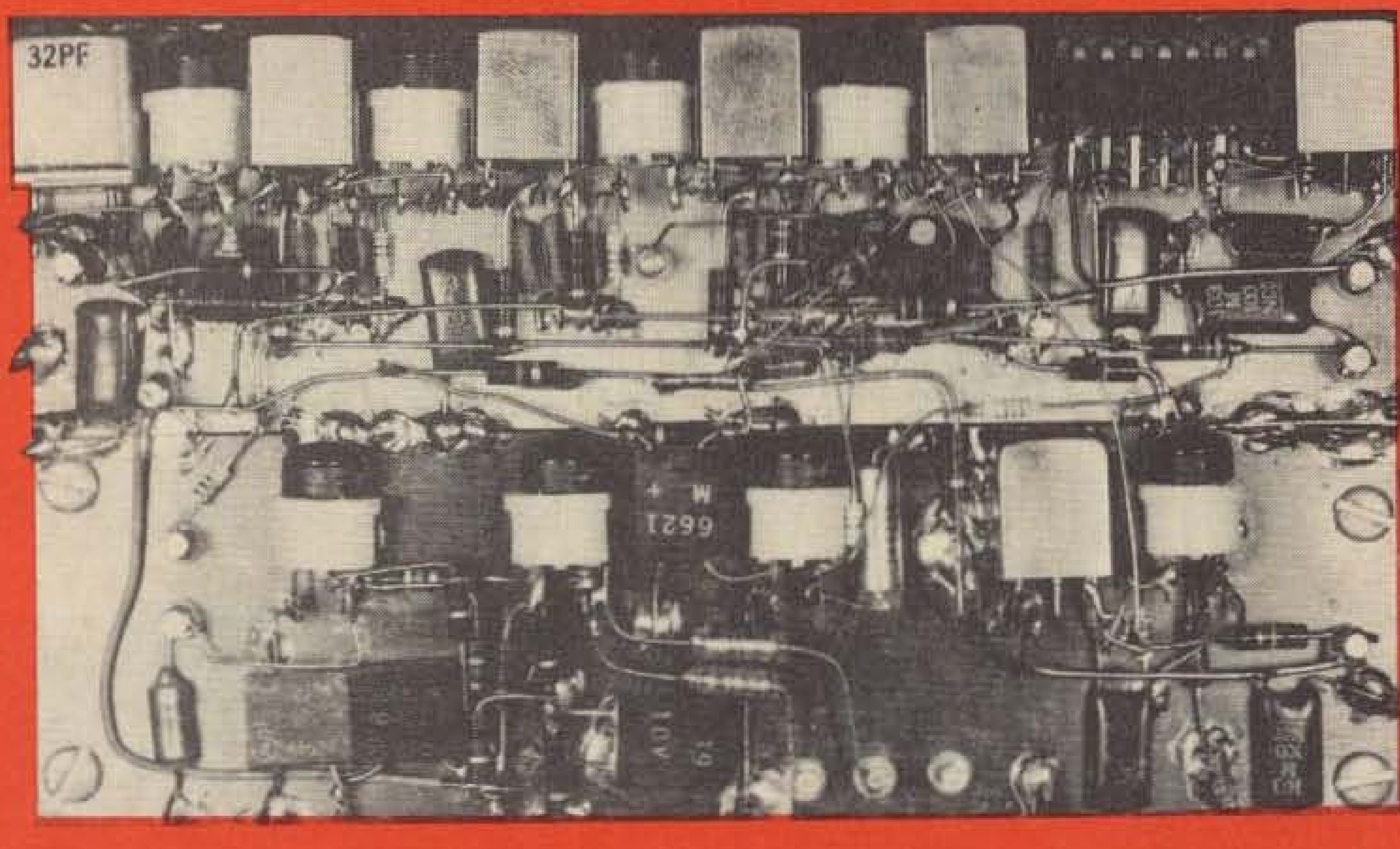
How to get into one of today's hottest money-making fields—*servicing 2-way radios!*

He's flying high. Before he got his CIE training and FCC License, Ed Dulaney's only professional skill was as a commercial pilot engaged in crop dusting. Today he has his own two-way radio company, with seven full-time employees. "I am much better off financially, and really enjoy my work," he says. "I found my electronics lessons thorough and easy to understand. The CIE course was the best investment I ever made."

Business is booming. August Gibbemeyer was in radio-TV repair work before studying with CIE. Now, he says, "we are in the marine and two-way radio business. Our trade has grown by leaps and bounds."

from BREADBOARD *to* Printed Circuit *the easy way*



. . . . . a sneaky system that gives you "professional" boards fast !

How many times has a particular circuit caught your attention and interest only to be passed by because you didn't have the exact components and you felt that you didn't want to put all the work into constructing it if there was a chance that you might not be able to get it to function? Perhaps the thought of changing various parts and having extra holes in the finished product deterred you. Many people, myself included, like to construct an item once and have it work properly with minimum changes. The more complex the circuit or meticulous the work, the less I like to make changes.

Since the average junkbox seldom yields all the specified components for any project, how are we to avoid unnecessary effort in construction projects? After many miles of solder joints a method has evolved which I believe is the most direct route from circuit to finished product, be it chassis or printed circuit board.

Breadboarding

The first step was to evolve a minimum-effort method of breadboarding a circuit, particularly eliminating drilling, mounting, and hardware wherever possible. An arrangement was sought whereby minimum material was used and this material could be used over, time and time again for other circuits. Another requirement was that the method be consistent with good VHF wiring techniques.

What followed was an extremely simple system consisting of two basic components, a piece of copper-clad printed circuit board, and a quantity of inexpensive miniature terminal strips. The board can be purchased at almost any electronic supply house or from any number of mail order firms for about $2 a square foot. The miniature terminal strips are also inexpensive.

At first a selection of multilug strips were purchased as well as the single-lug strips; however, after many projects if was found that the multilug strips were seldom used as most circuits were constructed with the single-lug strips. The miniature terminal strips are a lot easier to work with than their normal sized predecessors, and enable you to get a higher component density for a given area of copper-clad board.

The method is simple to use; merely decide where on the board a connection is to be made between two conductors and simply solder down the foot of the terminal strip in that spot (see **Fig. 1**).

Conductors to be grounded are soldered directly to the board. In this manner the entire circuit is constructed and changes require only the resoldering of a terminal lug. I usually keep my component leads as long as the circuit considerations will allow; after completion of the breadboard phase, I can unsolder everything. The components are then used in the actual finished product

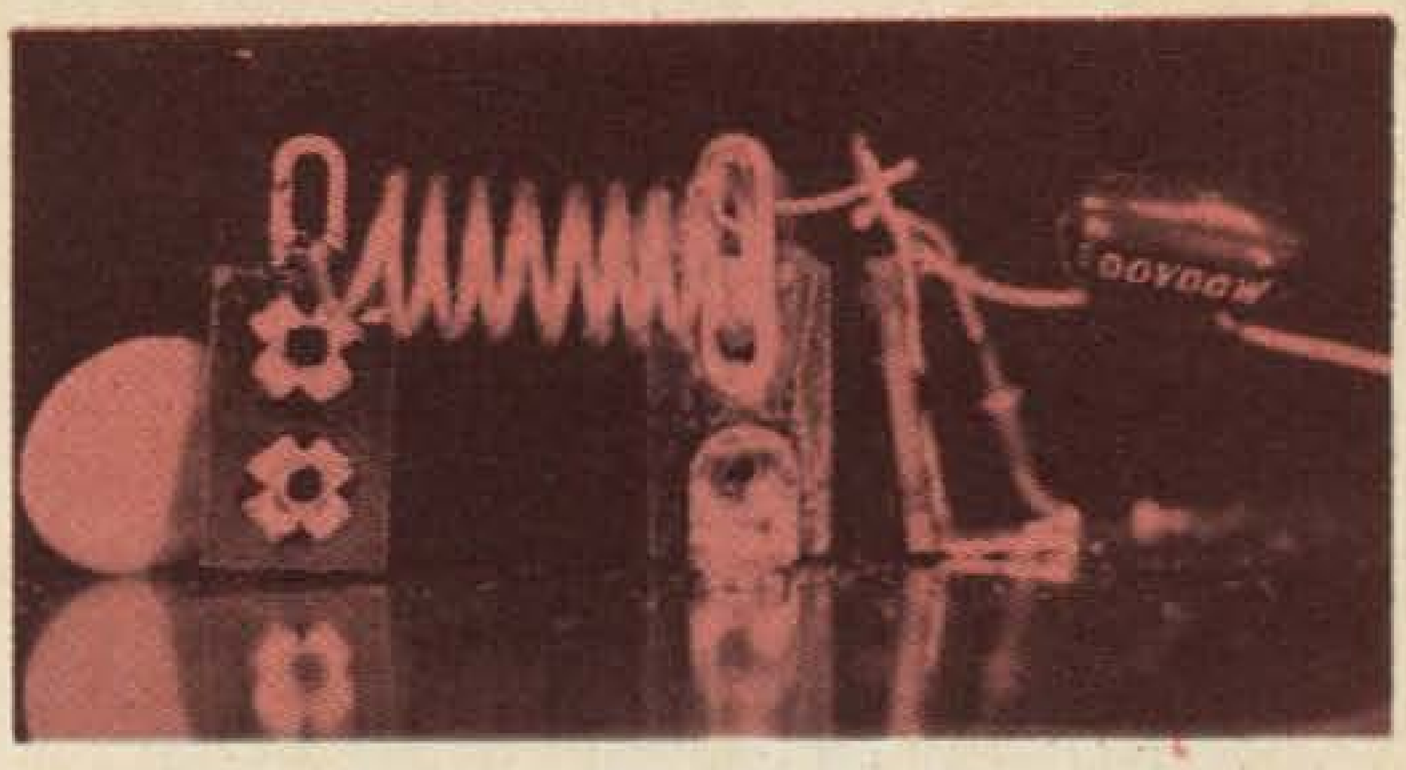


Fig. 1. Terminal strips simplify prototyping because of the ease with which they can be soldered to a copper-clad printed circuit board. (Photo by G. Gfrerer.)

and the terminal lugs can be used again. I am still using the same dozen lugs that I originally purchased five years ago!

PC Construction

Once an operable circuit is realized, you will no doubt wish to put it in some finished form. The most common packaging technique is the printed circuit mounting arrangement. This appears to be a lot of work to the average person, and most of the "simple" methods described in articles on the subject tend to leave doubt in readers' minds.

After trying many methods I found a way which satisfied these basic requirements:

- Only one chemical required
- Minimum artwork
- Minimum time between circuit and printed board
- Capability of small quantity production if desired
- Ability to directly utilize PC layouts already in magazine articles

The key to the entire system is a flexible clear plastic sheet which has adhesive on one side. This is sold as an inexpensive method for plastic laminating of documents. One large envelope contains two 8 x 12 in. pieces for 99¢.*

If you would like to build an item from a magazine article and the author has printed the artwork for his board, you're home free. Cut the artwork out, and stick one or two layers of laminating plastic on each side of it. Take a razor blade and cut out all of the conductor areas and remove them. You now

*Clean-Vu Plastic Film Protector, Sterling Plastics Co., Mountainside, NJ.

have a piece of plastic laminated paper with holes in it, which we will call a mask.

Cut a piece of copper-clad board to size and place the mask on the board. Use a couple of small alligator clips to keep the mask from moving position. Take a can of opaque spray lacquer (any color), and using minimum paint, spray the board and mask. The board and mask should be lying on a flat horizontal surface, and you should be spraying straight down.

Be sure to shake the paint thoroughly and hold it about 12 in. away from the board. Some practice may be necessary in spraying to keep the paint from running. The job may be done with a series of light sprayings with about 5 min. drying time between. Once you have finished spraying, lift the mask up vertically from the board to avoid smearing the paint.

After allowing the painted surface to dry 30 min. we can correct any feathered edges in the painted areas. These will sometimes occur to varying degrees because the mask will not usually lay perfectly flat on the board. This can be alleviated to some extent by using more layers of plastic on each side, but it then becomes more difficult to cut the mask. A sharpened ink eraser will easily rub away smears.

After the board is prepared to your satisfaction, immerse it in a plastic or glass tray of ferric chloride or iron perchloride. These solutions are now commonly sold in supply houses under the description of "etchant."

The etching time will vary with the strength of the etchant, its temperature, the thickness of the copper layer, the amount of agitation, etc.

Once the unpainted copper has been completely etched away, remove the board from the solution. But be especially careful to avoid getting any acid on you or your clothing! Carefully wash the board with lukewarm water and soap.

The lacquer may be removed by a variety of means. The easiest way is to brush on lacquer thinner, which removes it very quickly. Or it can be removed with steel wool or a kitchen scouring pad.

The remaining copper should be coated with solder to protect it from corrosion.

This also builds up the conductive cross section. Do this with 60/40 soldér and a soldering iron. After depositing the solder, wash off excessive resin from the board with lacquer thinner.

The only remaining steps are to drill holes in the board at the appropriate spots for the component leads, and the actual mounting and soldering of the components themselves. The mask may be stored and used to make future copies of the circuit board, if needed.

What we have done so far is perhaps the easiest method, that of using an already existing conductor layout. Only a few additional steps are needed to design an original layout. Plan the conductor pattern on a sheet of quadrille graph paper (8 x 8 squares to the inch), drawing in the symbols for the components, actual size. Transfer the conductor pattern below the drawing on the same page and use this as your mask, saving the original as a guide to drilling holes and installing actual components in the board.

High-Density Packaging

Sometimes we may wish to get a large number of components in a small volume, or our circuit has many conductor crossing points and does not lend itself well to printed circuitry. Classic "chassis" construction can be ruled out because by using such things as transistor sockets you have most of the components under the chassis, and the socketed components, transistors or whatever, protrude from the top. This dimension from the top of the chassis can be eliminated and a saving in space realized.

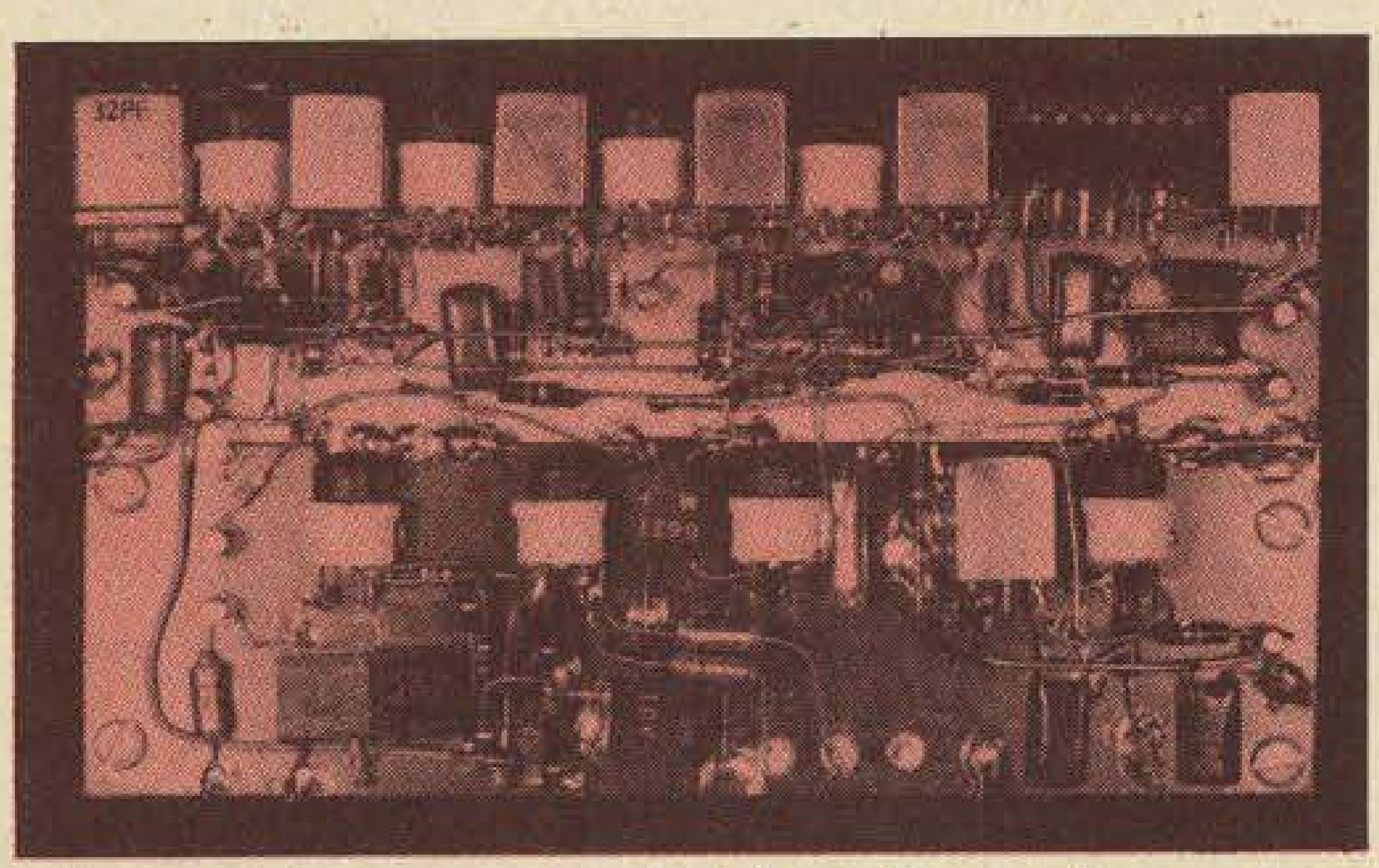


Fig. 2. With a copper-clad board as a base plate, very high-density packaging can be achieved by mounting bulky components, such as miniature relays, i-f cans, and crystals, on their sides. This receiver section packs 90 components within the volume of a 3 x 5 in. board! (Photo by G. Gfrerer.)

HAM HOSPITALITY

How about Johannesburg?

Dan Mahony ZS605 offers his home for visiting U.S. hams. His address is 88 Milton Road, Lombardy East; telephone 608-1454. Area: 1 acre. (9½ miles southwest of Johannesburg Centre. Children welcome!

Accommodations: Guest room with private bath. Ham shack makes nice spare bedroom for junior ops.

Reciprocity: 1 day, particularly in California area.

Limited Ham Hospitality

David G. Flinn, Starlane Farms, Ridge Road, Ludlowville, New York 14862.*

English speaking DX and U.S. hams welcome. Plenty of advance notice requested. We have two boys (ages 6 and 8) and 330 acres. Overnight accommodations are 10-15 miles away, but we could put up 1 or 2 people in an emergency. Interests are flying, model railroading, music, and art. Wife's tastes: weaving, crafts, music, art. Particularly interested in meeting Rotarian hams.

*Ed. Note. Dave Flinn is owner of Stellar Industries (ham equipment dealer and 73 advertiser).

My home will be open to visiting DX Hams.

William G. (Jerry) Allnoch WA4TST
507 Pinecone Street
Waycross, Georgia
(912-283-0285)

Hospitality offered: meals, snacks, and possibly overnight accommodations, if they don't mind sleeping on a couch in the livingroom.

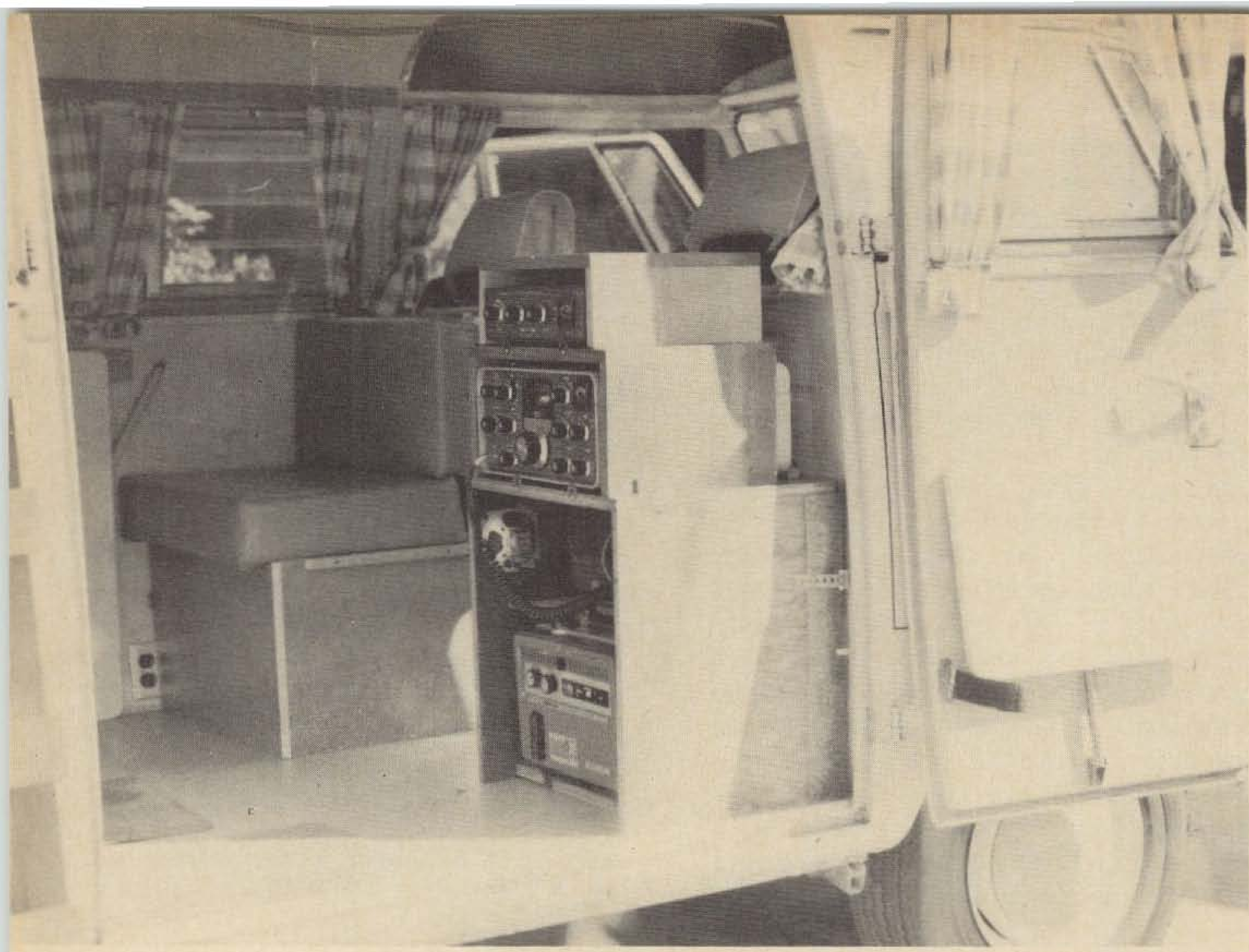
George Pataki YO2BO/2
34-24 76th Street
Jackson Heights, N. Y. 11372
(212-639-3195)

Visiting DX'ers: Tour CBS, visit radio clubs, meet other hams. I'll serve as your guide around town.

The technique is simple. Using a piece of copper-clad printed circuit board as a base plate, mount all sockets and major components such as i-f cans on their sides. An example of this is the i-f section of a receiver, such as that shown in the photo of **Fig. 2.** The transistor sockets are epoxied to the board and the i-f cans are soldered to it. The minor components are then soldered onto the terminals of the sockets and i-f cans as required. An inherent disadvantage to this type of system is that it is not as rugged and cannot take as much physical abuse as a printed circuit.

It is hoped that this discussion will give some ideas to experienced builders, and encourage the novice to delve deeper into this rewarding hobby.

. . . K1AOB/3■



THE CAMPER: Mobile and Portable

C. W. Wandrey WA9EHE
915 North President St.
Wheaton Il 60187

More than just a mobile, the camper can become a base station on wheels.

One of the things I was anticipating with joy when I took an early retirement was the additional time that I could spend operating my rig. Unfortunately, I also enjoy traveling, so, during two years of retirement, my wife and I spent only seven months of this time at home. Some of our traveling was done overseas, but that which we did in the States was primarily done in our VW camper. With the advent of the many deluxe overnight trailer and camper parks throughout the country, traveling in a VW camper allows one to do a maximum amount of traveling at a minimum of cost, a must when living on a retirement income! So now our problem was how to enjoy traveling and ham radio at the same time. One of the things that spurred us on to find a solution was the fact that our son, in Thousand Oaks, California (W6GST) is also a ham and enjoys following us on our trips via ham radio. Here's how we worked it out.

The ambient noise level in a VW camper is relatively high, particularly when driving at high speeds. Also, the available space below the instrument panel is rather limited. We decided that we would limit our mobile operating to Citizens' Band and operate the amateur bands on a portable basis. The first problem to be solved was the antenna mount. The standard ones available didn't seem to have the desirable mechanical strength to allow us to mount a variety of antennas (including a full-length telescoping vertical for 40 meters. With the use of stainless steel (ordinary plated steel or brass could be used) and some plastic rod, I concocted the mount shown in **Fig. 1**. We normally drive using the Citizens' Band for on-the-road communications (**Fig. 2**). It is surprising how many of the long-haul truck drivers have CB units in their truck cabs. They are usually most anxious to carry on a conversation, particularly when they are driving the lonely open stretches out west. In addition to providing a delightful pastime while driving, CB communication can be rewarding. Some gas station chains on our major interstate highways constantly monitor Channel 9, which makes them available in case one runs out of gas, has a flat tire or other mechanical trouble, or—most important—in case of emergency. The Heathkit CB transceiver was mounted as shown in the photo without any interference with the driving controls. It was simple to trim the antenna to its proper length with the help of a vswr meter and the ground plane area provided by the large area of the VW camper roof gives about a 5 mile range for reliable mobile operation with enough volume to overcome the ambient engine noise.

For operating portable in the ham bands, I selected appropriate Heliwhip antennas, wound and tuned at the factory for my selected favorite frequencies; however, they are fairly broadbanded and allow operating over a spectrum either side of the specified frequency. I'm sure a Hustler or some other multiband antenna will be just as satisfactory, and it is just a matter of personal preference. At home, I use the Heathkit SB-301, SB-401, SB-200 combination, and we chose the SB-100 and the Kompact Kilowatt HA-14 for use in the camper. The

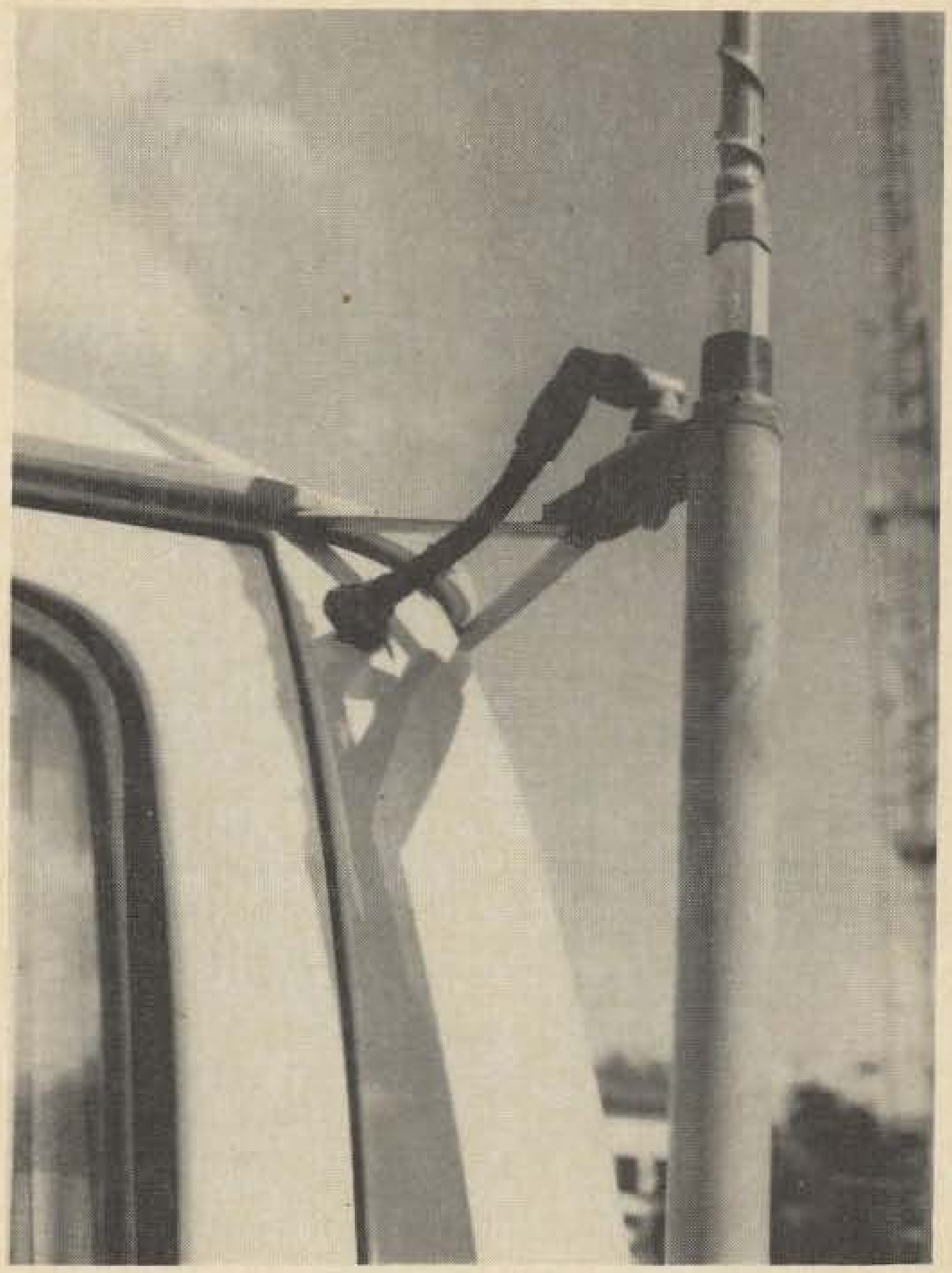
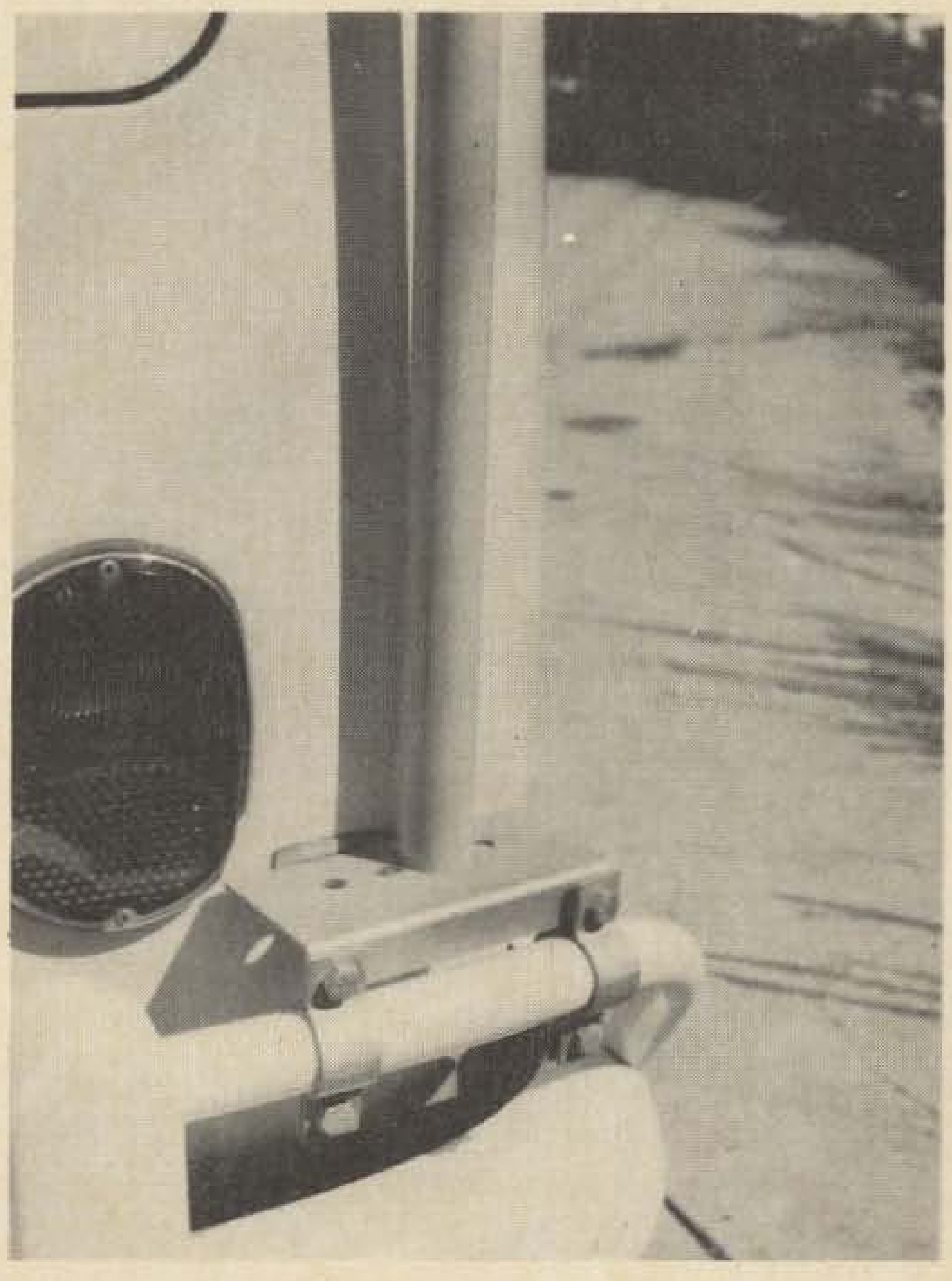


Fig. 1. Homebrew mount places antenna high above the street, yet is stable and electrically sound.



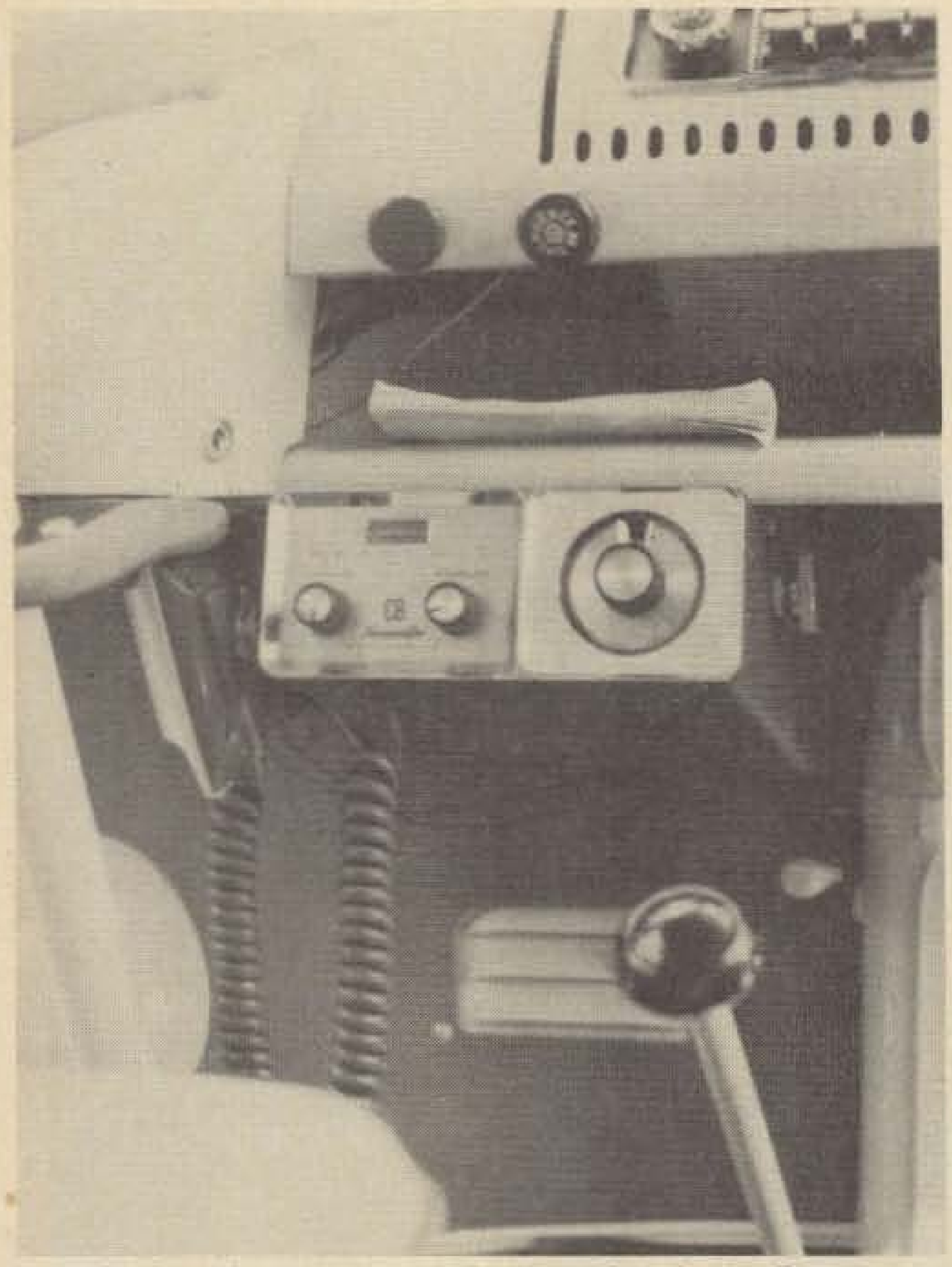


Fig. 2. On the open road, the Heathkit CB transceiver keeps us in touch with the world. It is comforting to know that one CB channel is monitored on a national scale by many of the gas station chains.

combination icebox and portable sink which is standard equipment in the camper was removed and replaced with a foam ice chest purchased for 88¢ and a plastic water jug costing less than one dollar. These are stowed in any convenient place in either the trailer and camper, and to us are actually more convenient and flexible than the original equipment. The space vacated by the icebox provided an excellent place to mount the radio equipment. To make the installation neat and stable we constructed a rack (Fig. 3) from some old plywood that many years ago had done duty as a Ping Pong table. As shown in the photo, adequate ventilation must be provided by drilling as many holes as possible without impairing the strength of the rack.

Wooden stops are positioned behind the two rear rubber feet of the Kompact Kilowatt, the transceiver, and the power supplies. This prevents them from sliding to the front (rear of the rack); large washers, with off-center holes drilled in them, screwed to the front of the rack, prevent movement in the opposite direction. The height of the shelves is such that if the equipment should bounce, it will still be held captive by the stops and screwed-on washers. The bottom of the rack holds a Honda 300W gasoline engine power supply. This unit is very quiet in operation and surprisingly light in weight, considering its output capability. This unit also delivers 12V dc for battery charging in case of emergency. I drilled a small hole to run the coax from the antenna inside the camper. The hole was then sealed with a plastic rubber sealer compound. This made a perfectly waterproof joint. Though most of the private trailer parks include free electricity, some of the state and national parks do not. When juice is available, of course we use it, and this allows us to use the full kilowatt. When the gasoline power supply is used, we operate barefoot. It is quite a sensation to be sitting on the side of the highway talking to someone several thousand miles away and get 20-over-9 reports.

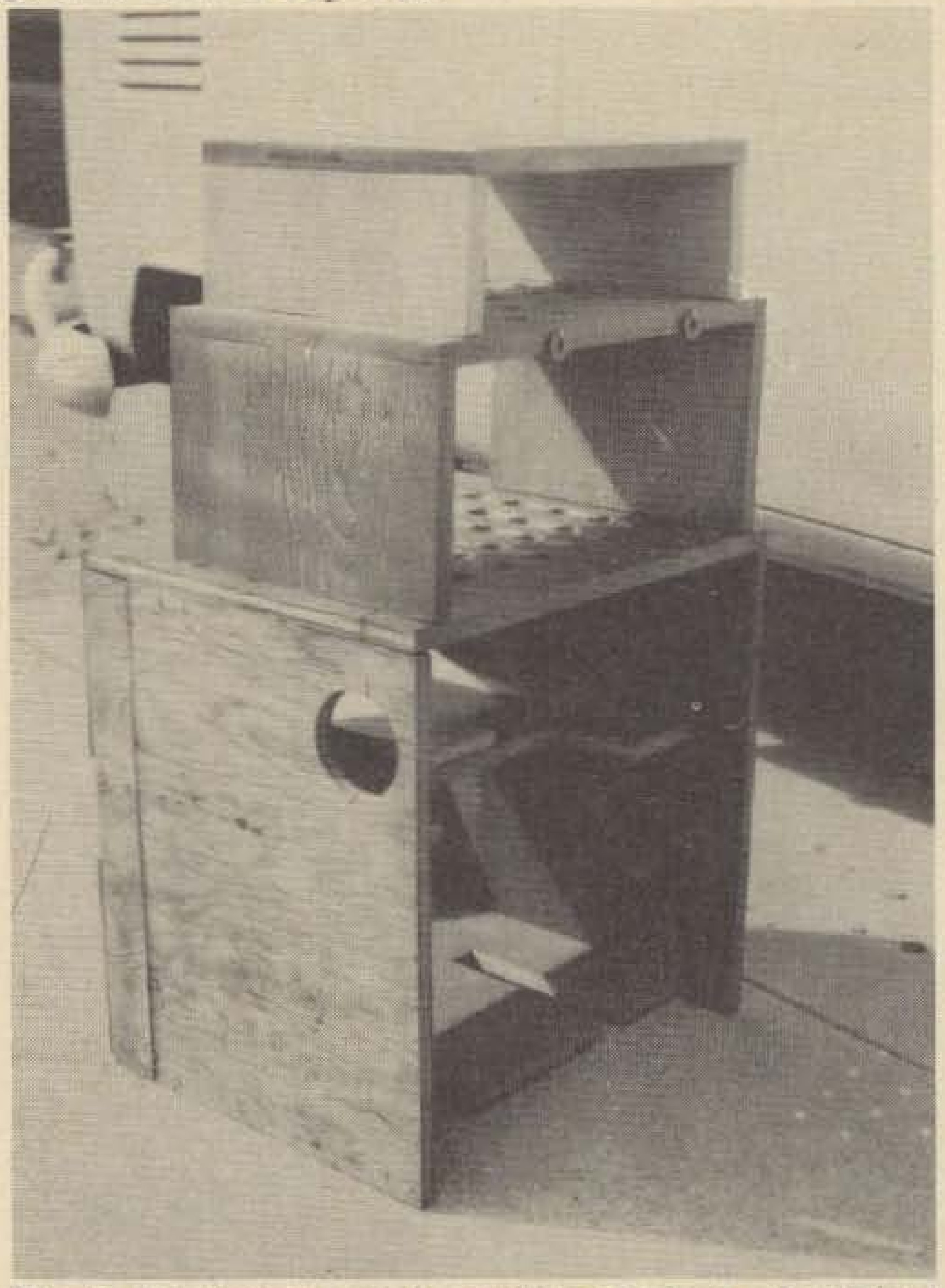


Fig. 3. Equipment rack replaces icebox of original camper. Lots of air holes help to dissipate the heat generated by the units.

I'm sure my wife would rather leave the cooking equipment home than the radio equipment—especially when we have a schedule with our son.

. . . WA9EHE ■

You Think You Have Troubles?

Take the case of Charlie Damico W3VXO. Charlie is one of our sightless hams. However, he has not allowed his handicap to get in his way. He is employed in electronics, repairs all his own gear, with few exceptions, can rig up an antenna without help, and seems to get along just fine.

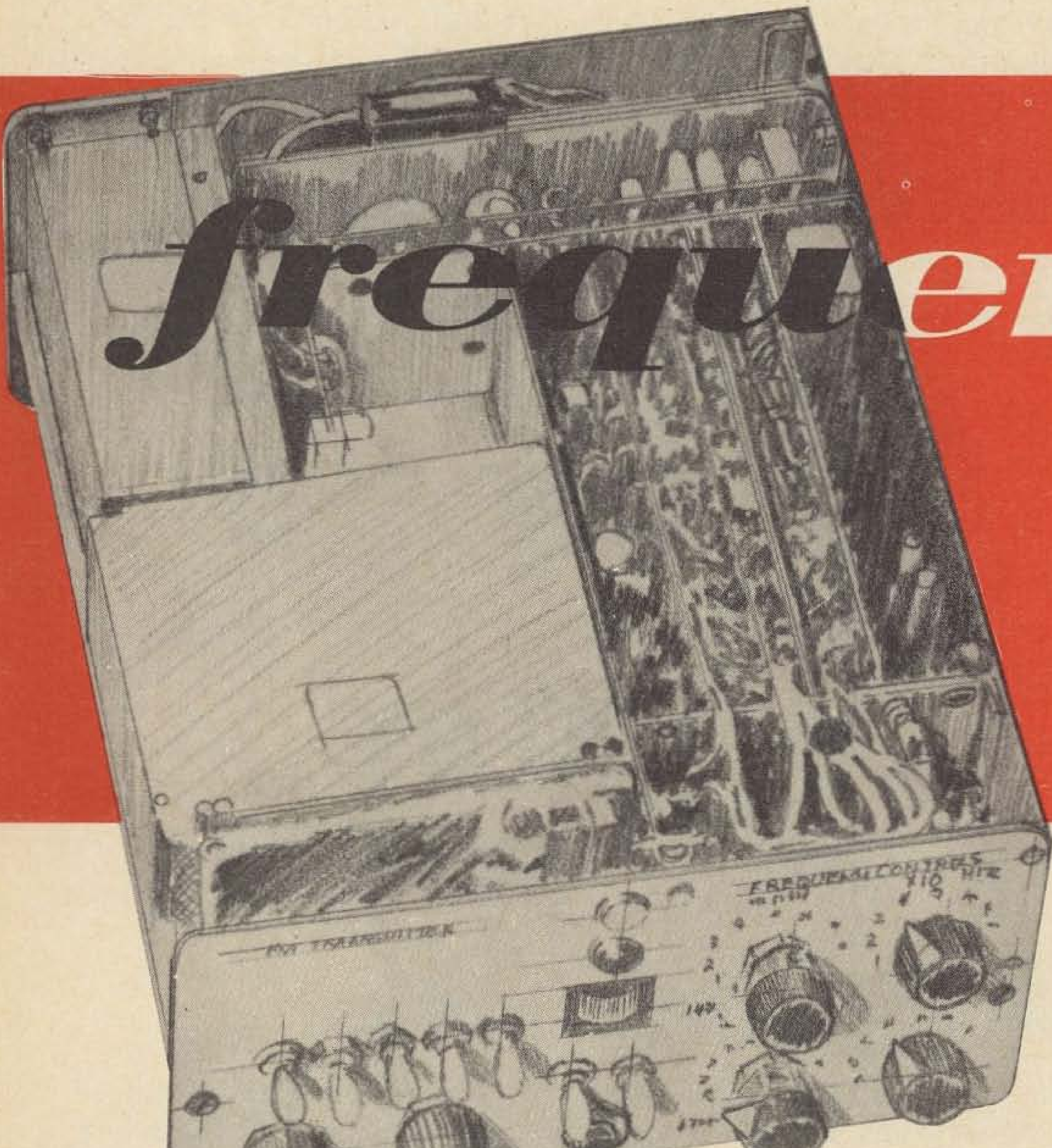
A few months ago, he began getting TVI complaints from one of his neighbors. This fellow (who lives in the City of Brotherly Love, incidentally) really got hot under the collar and began circulating a petition around the neighborhood.

The FCC stepped into the picture and investigated the complaints. After finding that Charlie was putting out a clean signal and was not creating interference on a good TV set, a committee questioned the 20 signers of the petition to find that 14 of them thought they were signing a petition for someone running for Mayor of Philadelphia. Of the remaining six, four had had no interference, but were friends of the original complainant; the remaining one was willing to drop the subject upon installation of a highpass filter. So, Charlie was left with one irate neighbor.

One would think this would be the end of the story. Unfortunately, this was not the case. One night, Charlie came on the air and said, "You know, something seems to be wrong here. I'm not getting the right readings on the output of this rig, and I can't figure out what might be wrong." We all noted that his signal was not up to its usual strength, but he was still readable. After checking his swr, he came to the conclusion that something was wrong in the antenna. He left the air. The following night he told us the story. *Someone had cut his coax feedline to his 75 meter dipole.*

Charlie had gone up to the roof and strung a Marconi antenna to get back on the air. ... **Kayla Hale W1EMV** ■

frequency



gets you 400 channels, frequency-standard accuracy with just one crystal!!

Gil Boelke shows how it's done...

synthesis

the modern way to control frequency

by Gilbert Boelke W2EUP

A complete and comprehensive article covering theory and techniques of indirect frequency synthesis, plus schematics and a description of a practical 400-channel synthesizer used in a two-meter FM transceiver with only one frequency-determining crystal.

I
THE PROCESS

Frequency synthesis is the term used to describe the process of synthesizing (or "putting together") many frequencies from a small number of starting frequencies. In theory, any number of channels may be so generated from only one master oscillator, using the electronic techniques of adding, subtracting, multiplying, and dividing frequencies. In practice, the larger the number of channels the more worthwhile it is to go the synthesizer route.

A *direct* synthesizer uses such conventional techniques directly, filtering the undesired output products at each step in the process. This technique has the disadvantage that many high quality filters are required to reduce the undesired (spurious) output frequencies to the desired extent.

An *indirect* synthesizer uses a voltage-controlled oscillator to generate the output signal, electronically "steers" it to the correct frequency and "locks" it there. Its main advantage is that the output needs no filtering; it comes from an on-frequency oscillator. All spurious products are kept within the confines of the synthesizer loop (with any luck) and do not appear in the output.

Figures 1 and 2 illustrate two ways a synthesizer can be used. In Fig. 1, the synthesizer covers the full range of transmitter and receiver frequencies for a General Electric TPL unit. An extra X8 multiplier must be added to the receiver so that both re-

* 505 Main Street West Seneca, New York 14224

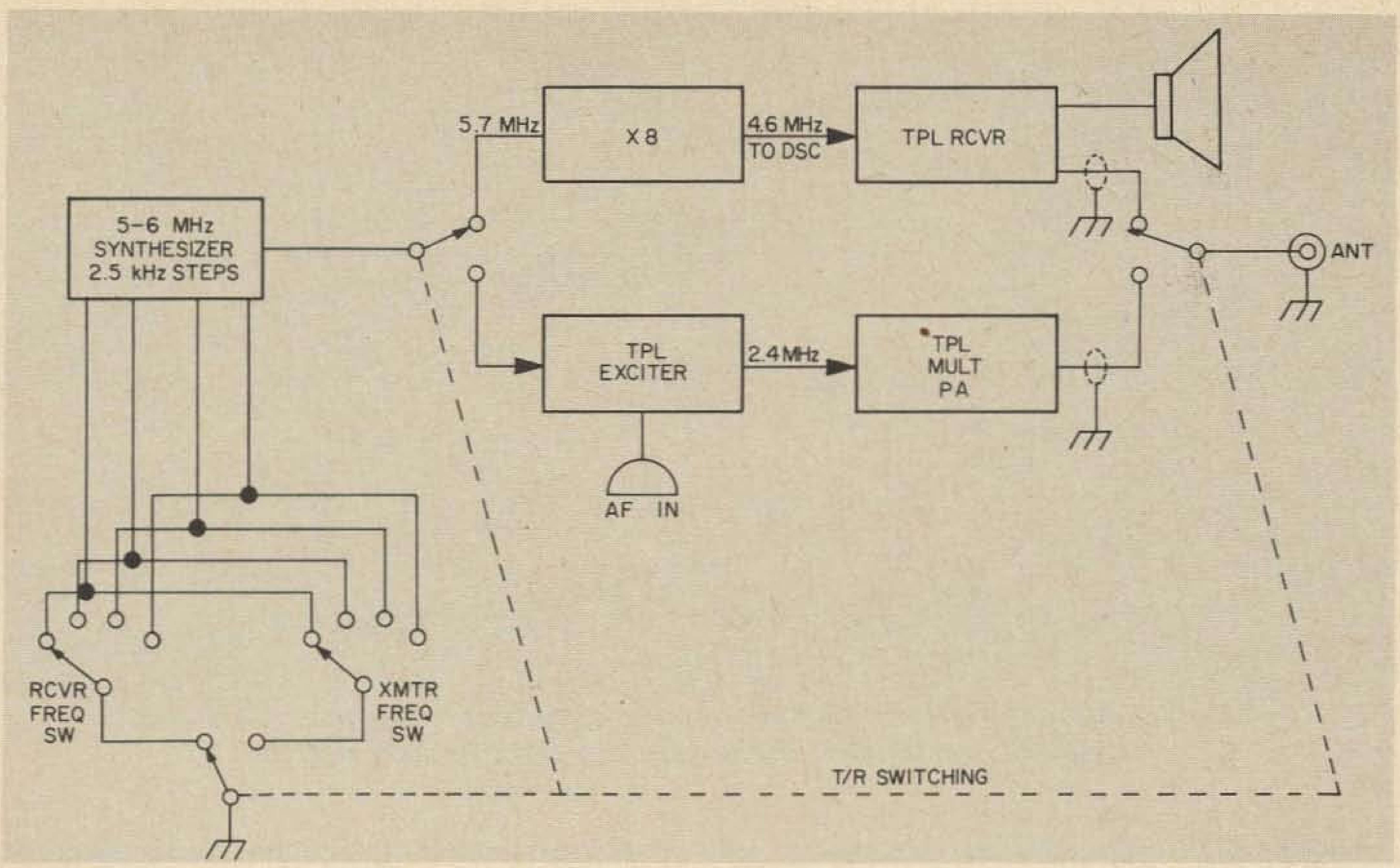


FIG. 1 How to use synthesizer for 60 kHz incremental switching in existing units

ceiver and transmitter multiply the synthesizer output by 24, to make channel spacing the same for both receiver and transmitter.

Although a synthesizer could be built as a crystal oscillator substitute for existing types of equipment, it can be more effectively exploited in a "start from scratch" design, as shown in Fig. 2. True FM can be produced by direct modulation of the synthesizer, eliminating the need for a phase modulator or frequency multiplication to build up the deviation level. Or, as a receiver local oscillator, a synthesizer can just as well be designed to deliver the oscillator injection frequency directly, eliminating the need for frequency multipliers.

Figures 3 and 4 show block diagrams representing the synthesizers used in Figs. 1 and 2. The synthesizer block diagram of Fig. 3 generates 2.5 kHz steps in the 6 MHz range. Used to drive existing transceivers, this arrangement produces 60 kHz steps in the two-meter band. If the range is extended to 5.7 MHz and the output multiplied by 24, the same synthesizer can be used for the receiver.

Addition of a mixer and a multiplier as in Fig. 4 makes it possible to generate 60 kHz steps directly in the two-meter band. A separate crystal oscillator is used to heterodyne the output signal down to a frequency suitable for division. By switching crystals — in this case to 141 MHz — the synthesizer output can be moved down 9 MHz to provide oscillator injection for a receiver having a 9 MHz i-f. These mixer injection frequencies could also be obtained by suitable means from the basic reference oscillator, rather than adding two more crystals.

How it Works

Consider the simplified synthesizer of Fig. 5. This example is for a 5 – 6 MHz output range in 10 kHz steps. A tunable VCO (voltage-controlled oscillator) is used to generate the output signal; in doing so, of course, it must tune electronically from 5 to 6 MHz by varying the dc input voltage. The stability of such an oscillator doesn't even begin to match that of a crystal oscillator, but it *does* have the flexibility of operating on any channel in the desired range. So the remainder of the circuitry is devoted to detecting the VCO frequency,

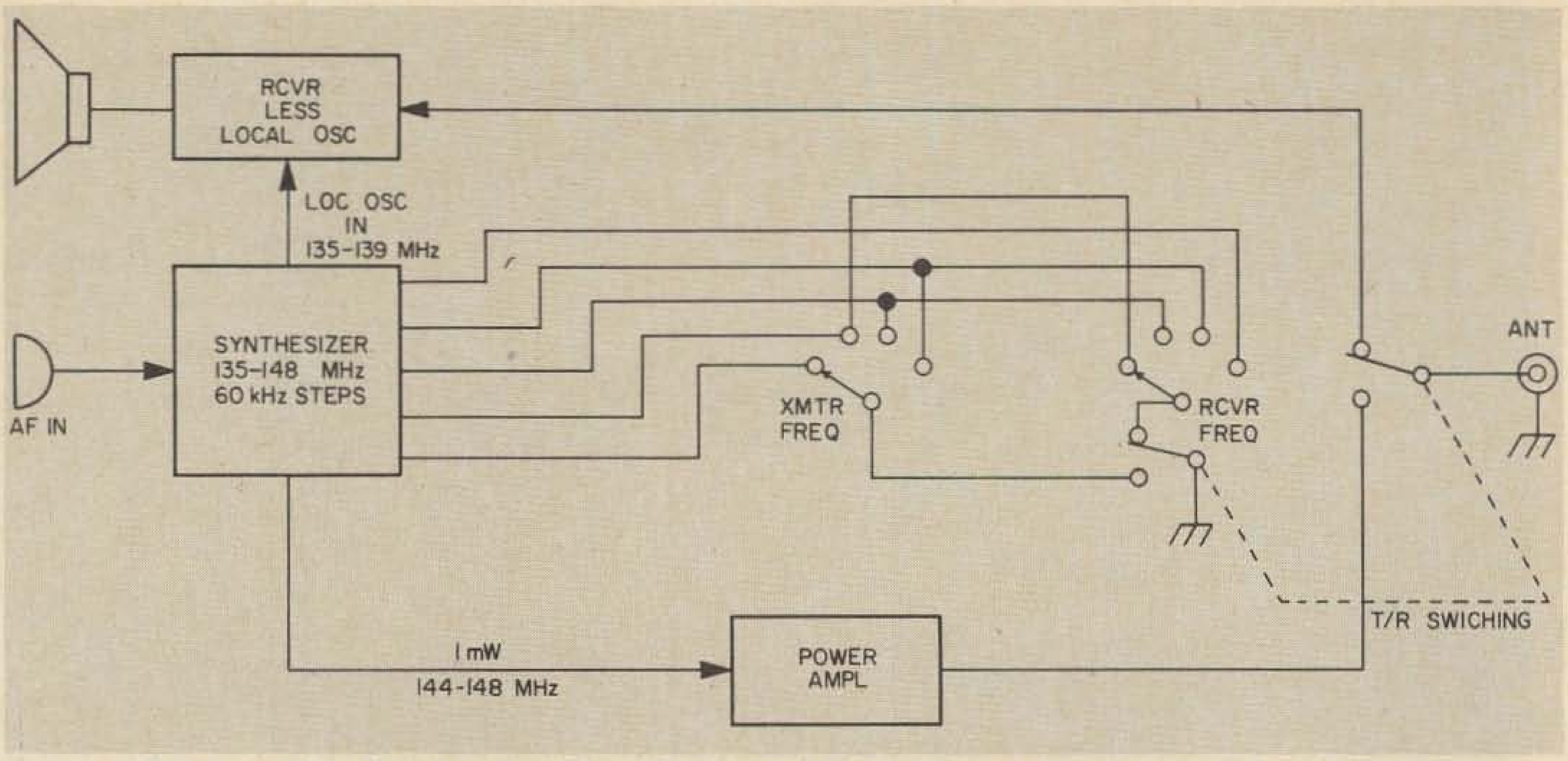


FIG. 2 Synthesis of local oscillator and transmitting frequencies eliminates frequency multipliers and greatly simplifies receiver design

relating it to the *desired* frequency, and adjusting the oscillator *electronically* to it.

Spacing of the output steps is determined by the reference frequency. In this case, a 10 kHz reference means that the circuit can lock to any harmonic of 10 kHz such as 5.000, 5.010, 5.020, 5.030 . . . etc. to 6.000 MHz. Direct multiplication could be used to get the same result, but it would be nearly impossible to eliminate undesired harmonics of the 1 kHz signal, even with the best of filters. So, instead of multiplying 10 kHz to, say, 5 MHz, start with the VCO at (or near) 5 MHz and divide it by 500 instead. This function is accomplished in the programed divider ($\div n$, or "divide-by-n"). Consisting of a chain of flip-flops, this circuit can be programed to divide by any ratio between 500 and 600. When it divides the 5 MHz output of the VCO by 500, the result is 10 kHz.

The phase detector circuit compares the $\div n$ output to the reference signal, delivering a dc output proportional to the phase difference between them. This dc level controls the VCO. When the VCO output drifts from exactly 5 MHz, the output of the $\div n$ will drift in exact proportion to it since it always is 1/500th of the output signal. The phase detector sees this as a phase change and shifts its dc output to the phase detector immediately to steer it back to 5.000 MHz exactly. Since it compares phase instead of frequency, the frequency at the $\div n$ output is never permitted to shift so much as one hertz either way, and the output of the VCO is held precisely to 5.00 MHz. *Frequency accuracy depends only upon the stability of the reference frequency oscillator.*

To change frequency to 5.760 MHz it is only necessary to change the *divide* ratio of the $\div n$ circuit by switching the programing inputs of the $\div n$. Since this is a larger divide ratio than 500, the $\div n$ output will at first be below 10 kHz. The phase detector senses this shift as a phase change in the very first cycle following the shift and immediately starts action to correct it. When the correction is complete, the $\div n$ output is again on 10 kHz, but the VCO is on 576 X 10 kHz, or 5.760 MHz.

The synthesizer of Fig. 3 is only a little more complicated than the basic unit of Fig. 5 . Since 2.5 kHz steps are desired, the reference frequency must be 2.5 kHz. Stable crystals of this frequency are not notably practical, so a 1 MHz master oscillator is used, divided down to 2.5 kHz by a series of flip-flops. A harmonic of the 1 MHz signal is conveniently adjusted to zero-beat with WWV, thus precisely aligning all channels to frequency. A higher divide ratio is necessary in the $\div n$ circuit due to the lower reference frequency, as shown.

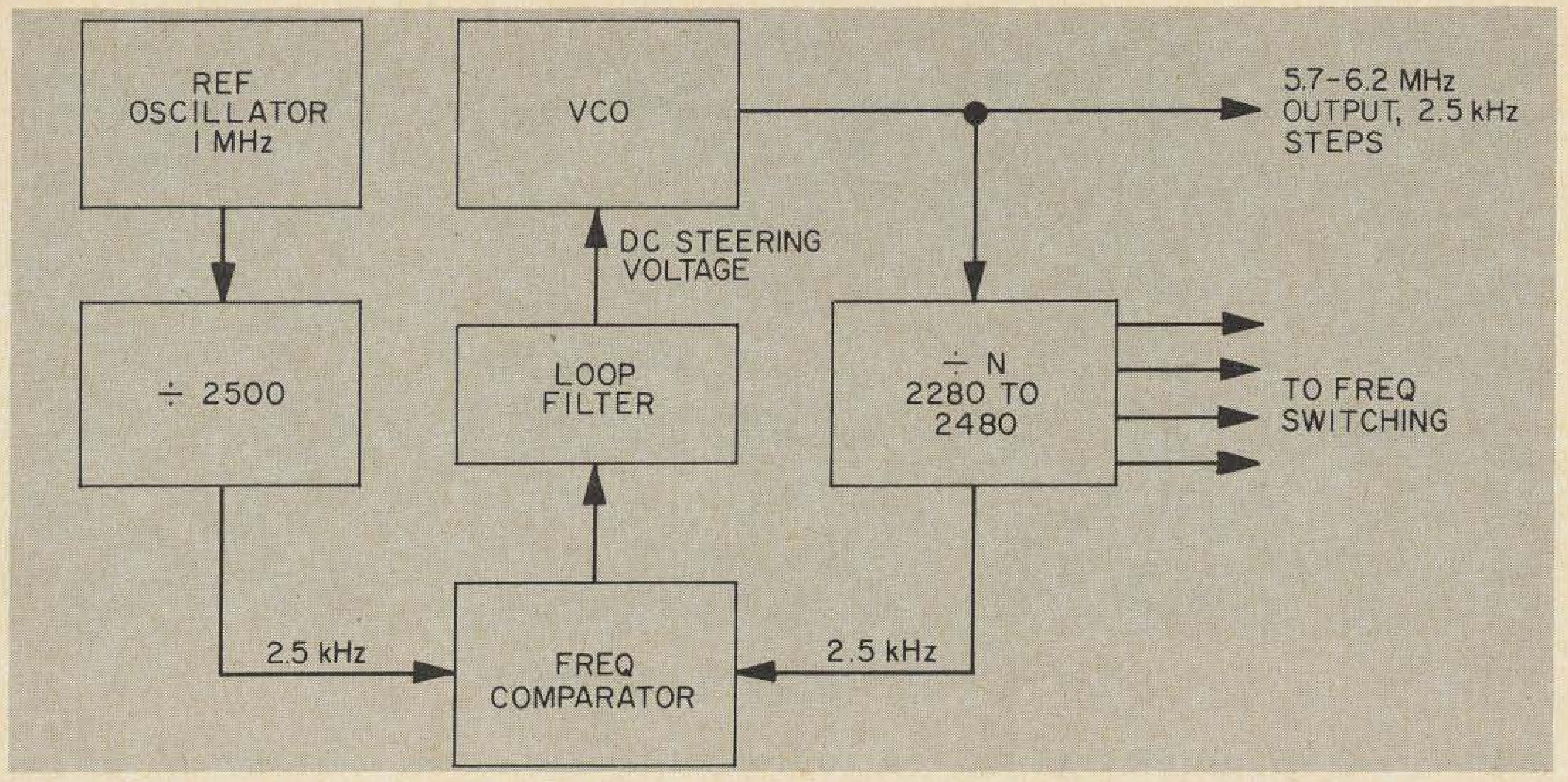


FIG. 3 Block diagram of synthesizer for use in existing transceivers (see also Fig. 1)

The loop filter, necessary in all cases, must remove all traces of the reference frequency at the output of the phase detector (in this case 2.5 kHz). A simple *RC* low-pass filter configuration is usually employed.

The next step in synthesizer development, shown in Fig 4, has a VCO operating in the 135 — 148 MHz range, heterodyned to the 2 — 6 MHz range. This mixing process is necessary because present-day low-cost flip-flops can only divide to about 8 — 10

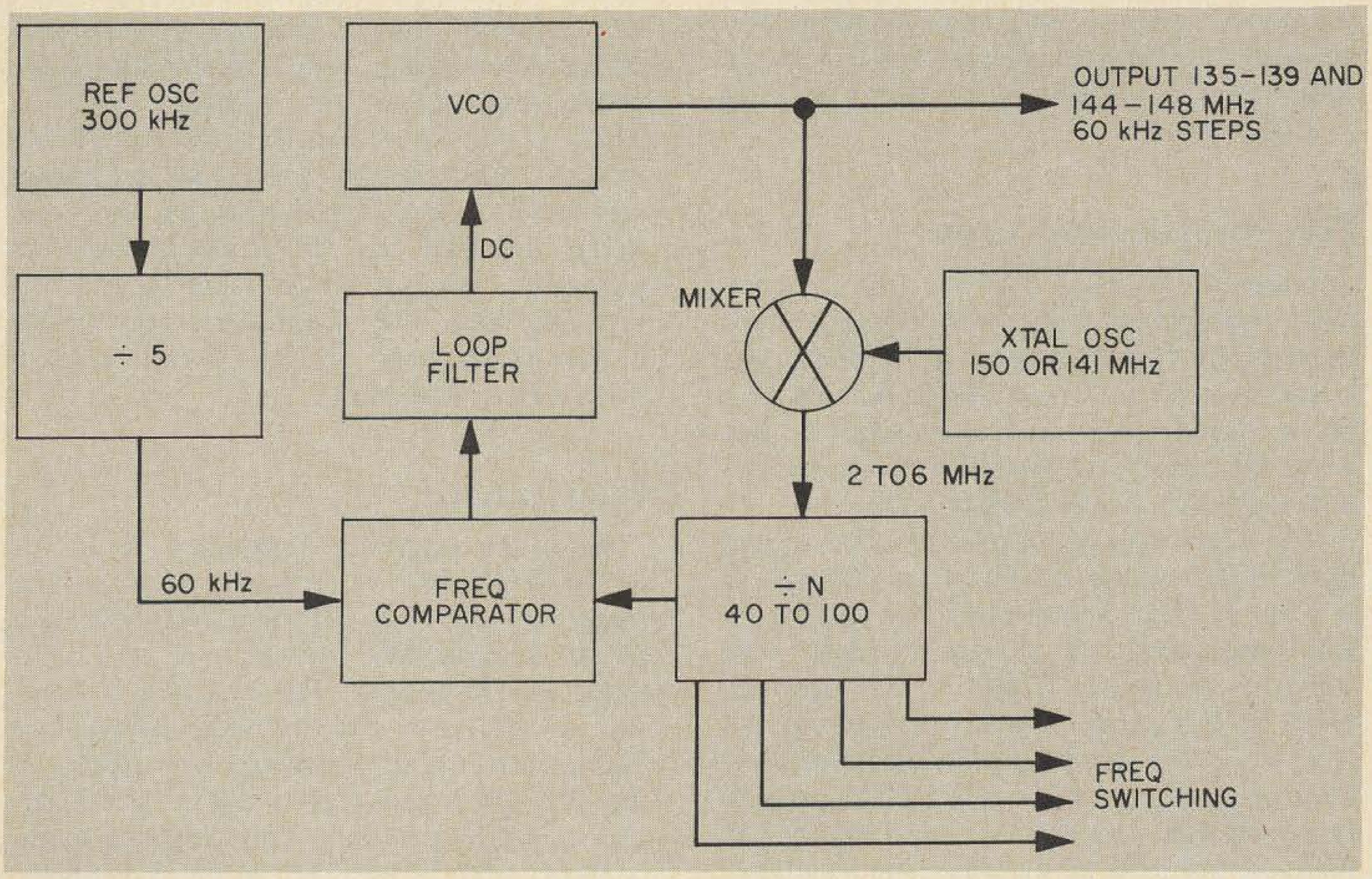


FIG. 4 Block diagram of synthesizer incorporating a mixer and multiplier for generating 60 kHz steps directly in two-meter band

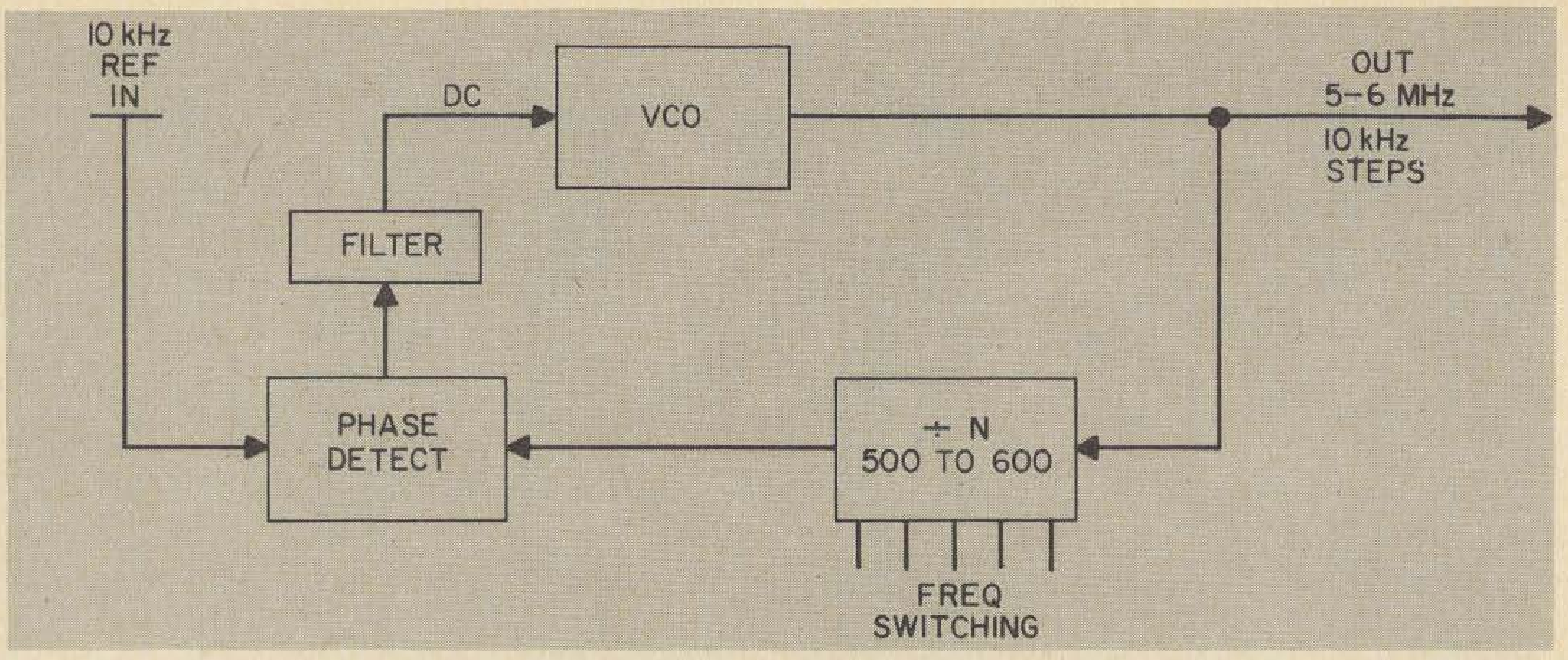


FIG. 5 Simplified synthesizer diagram

MHz in a programed divider circuit. A 60 kHz reference can be used to generate 60 kHz steps because the signal is not multiplied in the receiver and transmitter as in Fig. 3 , thus simplifying both dividers greatly. Frequency stability in Fig. 4 depends mainly upon the accuracy of the 150 and 141 MHz oscillators. Frequency adjustment is necessary in all three oscillators with this scheme. Judicious selection of the frequency spacing, reference oscillator frequency, receiver i-f, and the mixer injection frequencies can result in a design that uses a single crystal.

The Phase-Locked Loop

Indirect frequency synthesizers are basically feedback systems, where phase error is detected and fed back as a correction signal. Such a closed loop is called a phase-locked loop. As a consequence, certain rules must be followed to keep the system stable, as in any feedback system.

The phase-locked loop must have a loop filter at the output of the phase detector to prevent rf from leaking into the VCO control signal (which should be as clean a dc signal as possible). If any rf or ripple appears at this point, it will frequency-modulate the VCO. If the ripple is deliberately applied *as audio*, a desired FM signal can be produced. Undesired high frequency components such as the reference frequency will produce spurious sidebands. Thus, it is the function of the loop filter to remove these undesired products. A second function, however, is to determine the phase — gain characteristics of the loop, which determine its response time, stability, and "capture range."

Capture range is the term applied to the maximum frequency difference the loop will tolerate between the VCO output and the desired output frequency and still *lock up*. Capture range is directly proportional to loop bandwidth. The higher this bandwidth, the higher the adjacent spurious levels — the lower it is, the closer the VCO must be before it will lock up to the desired frequency. A low loop bandwidth also takes longer to lock up. So a compromise is necessary. Despite all of these design criteria, the loop filter is usually a very simple circuit when used in conjunction with a good phase detector.

Phase Detectors

Since the reference frequency of an indirect synthesizer is typically equal to the frequency spacing between channels, the phase detector also operates at this relatively low frequency. The best phase detector circuits are those which deliver the highest ratio of dc to inherent ac ripple. A flip-flop can be used as a digital phase detector, but its output is quite high in ripple content, and it requires a more sophisticated loop filter than other circuits. The

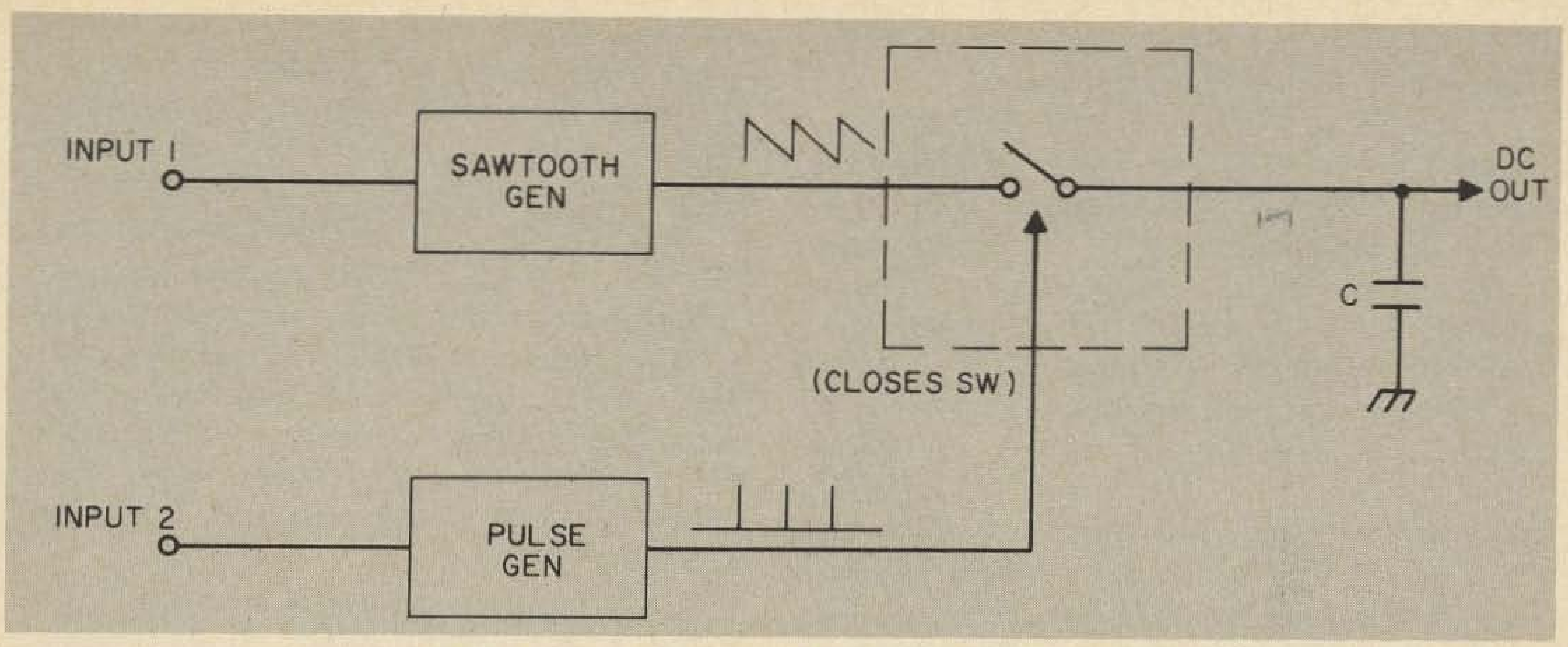


FIG. 6 Sample-and-hold phase detection

best phase detectors in current use work on a *sample and hold* principle. One of the two input signals is converted to a sawtooth, the other to a narrow pulse. The former is called the *ramp*, the latter a *sampling pulse*. As shown in Fig. 6, the sampling pulse operates a series switch for brief intervals so that the value of the ramp voltage at that instant is transferred to a "holding" capacitor. If at the next sampling time there was no change in relative phase between the two signals, the output will not change from the first sample. If there *is* a difference, the output capacitor voltage shifts abruptly up or down to the new value. It can be seen that as long as the two signals are in *phase lock* the output ripple is (ideally) zero. With practical implementation it isn't zero, but it can be made extremely low with careful design.

False Locks

When the phase-locked loop is initially turned on or the frequency is changed, the VCO may be out of the capture range of the loop. Under this condition the synthesizer output is that of the free-running VCO: unstable and at an unknown frequency. The VCO must therefore be tuned to the near vicinity of the desired frequency before the loop will lock up. With most phase detectors a number of *false lock* conditions can occur. A false lock is present when the $\div n$ and the reference frequencies are not equal, but the phase detector "thinks" they are and locks the VCO to the wrong place. A circuit which assures proper acquisitionof the desired frequency is called a "search." It acts as an AFC-type control of the VCO by detecting frequency differences between the $\div n$ output and the reference frequency, rather than phase differences. The search is normally turned off when the phase detector locks the loop. There are a number of ways in which a search can be implemented. Digital methods are compatible with the pulse-type signals available, and they offer simplicity of construction and freedom from adjustment. Best of all, they are nearly foolproof.

$\div n$ Circuits

Except for the advent of low-cost integrated circuits, this part of an indirect synthesizer would probably be impractical to build. It consists of a chain of flip-flops whose function is to divide the VCO signal down to the reference frequency. The number of flip-flops depends upon the maximum divide ratio. Since each flip-flop can divide by a maximum of 2, two can divide by 4, three by 8, etc.; and n flip-flops can divide by 2^n. If the maximum divide ratio is 100, as in Fig. 4 , it takes 7 flip-flops, which can divide up to $2^7 = 128$. Six would not be enough because they can divide by only $2^6 = 64$. In Fig. 3 , a divide ratio of 2240 is needed; $2^{11} = 2048$, too low; $2^{12} = 4096$. Therefore, 12 flip-flops are needed.

The next problem is to find some way to change the ratio of the $\div n$ by switching so that channels may be selected. Two common methods are used. To understand them, some of the properties of binary dividers must be known. First, the divider can be considered a counter since at each input pulse, or step, the flip-flops take on a unique combination of states. A useful analogy can be drawn to an automobile odometer (mileage indicator), which works in a similar way but counts in decades (powers of ten) instead of binary (powers of two). Including the *tenths* decade, a typical car odometer can count up to 999,999 tenths of miles, and the millionth step brings it back to all zeros. If a switch was provided to close only when all zeros are present, the switch would close once for every 1,000,000 input steps, thus dividing by one million.

One method of changing this ratio would be to reset the odometer to zero whenever it reached the desired count. For example, if a divide-by-567,000 count is desired, it could be accomplished by providing a resetting device which detects the 566,999 state, then resets all decades to zero on receipt of the 567,000th input. By programing the desired state when this occurs, the divide ratio can be any desired number.

Another way is to preset a number into the divider each time it recycles to zero. Achieving a $\div 567{,}000$ with this method requires that a 433,000 be inserted when the counter reaches a natural state of all zeros. The counter then counts from 433,000 to 1,000,000, where it is again preset. This count is 1,000,000 minus 433,000, or 567,000.

Presetting is the preferred method because it is usually easier to implement. Design of high-speed $\div n$ circuits is full of subtleties which make it deceptively easy to design on paper, but another matter to make workable.

Frequency Display

Up to about 12 channels, switching and display of the channel in use is a simple matter. For 30 or more channels it can become a problem, because even if a 30-position switch could be obtained, it would be considerably less convenient to

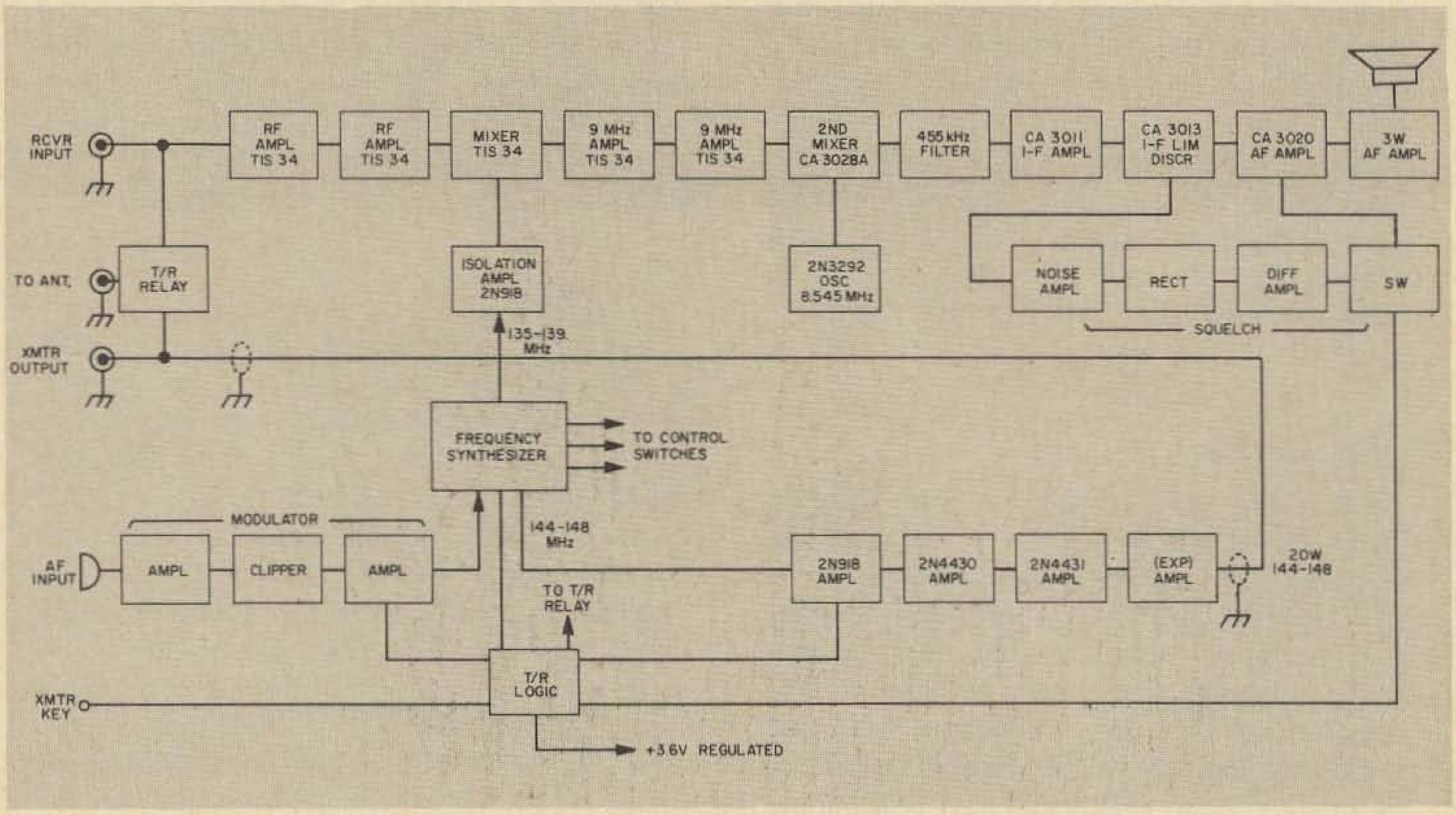
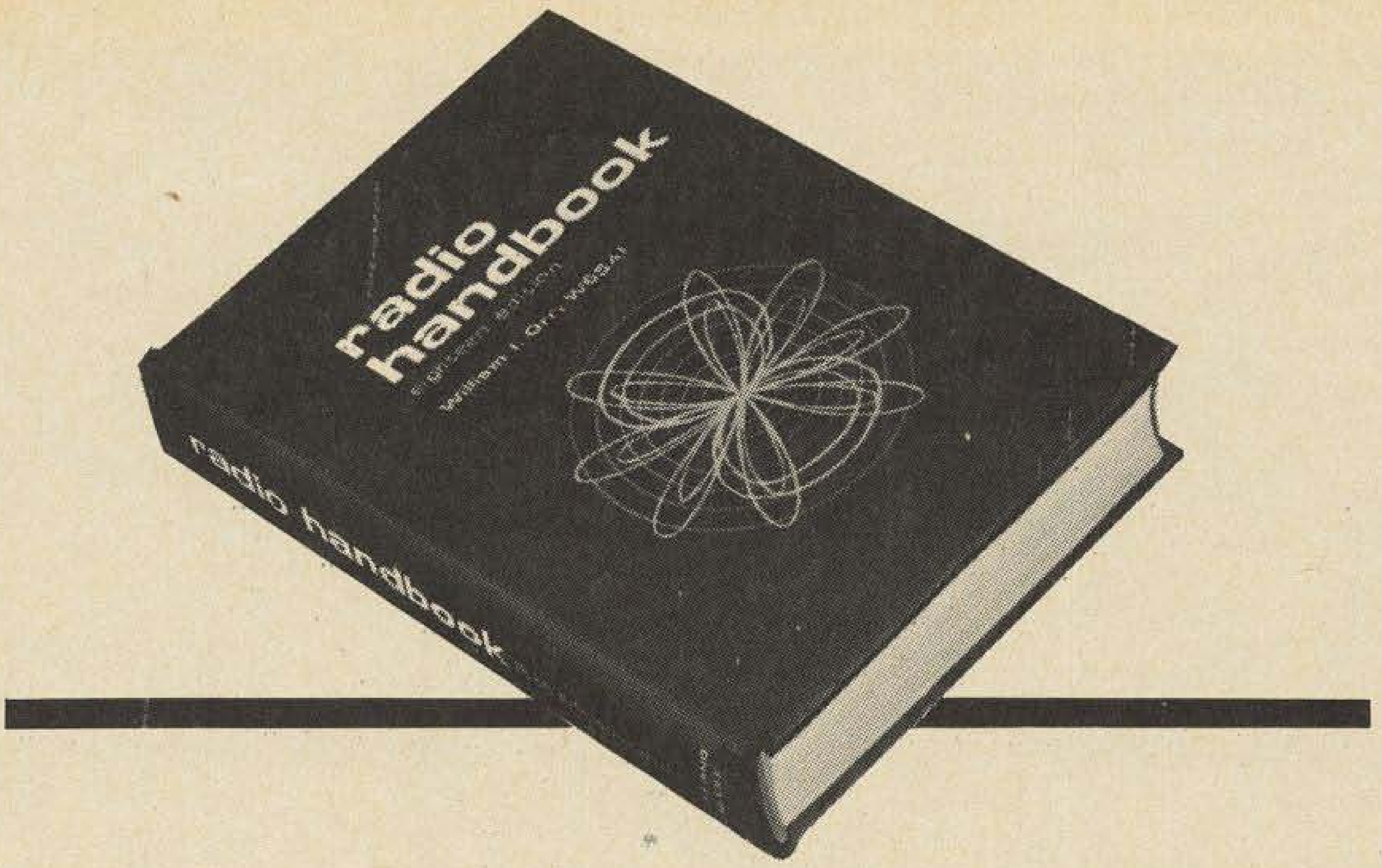


FIG. 7 Block diagram of an FM two-meter transceiver showing how frequency synthesis is incorporated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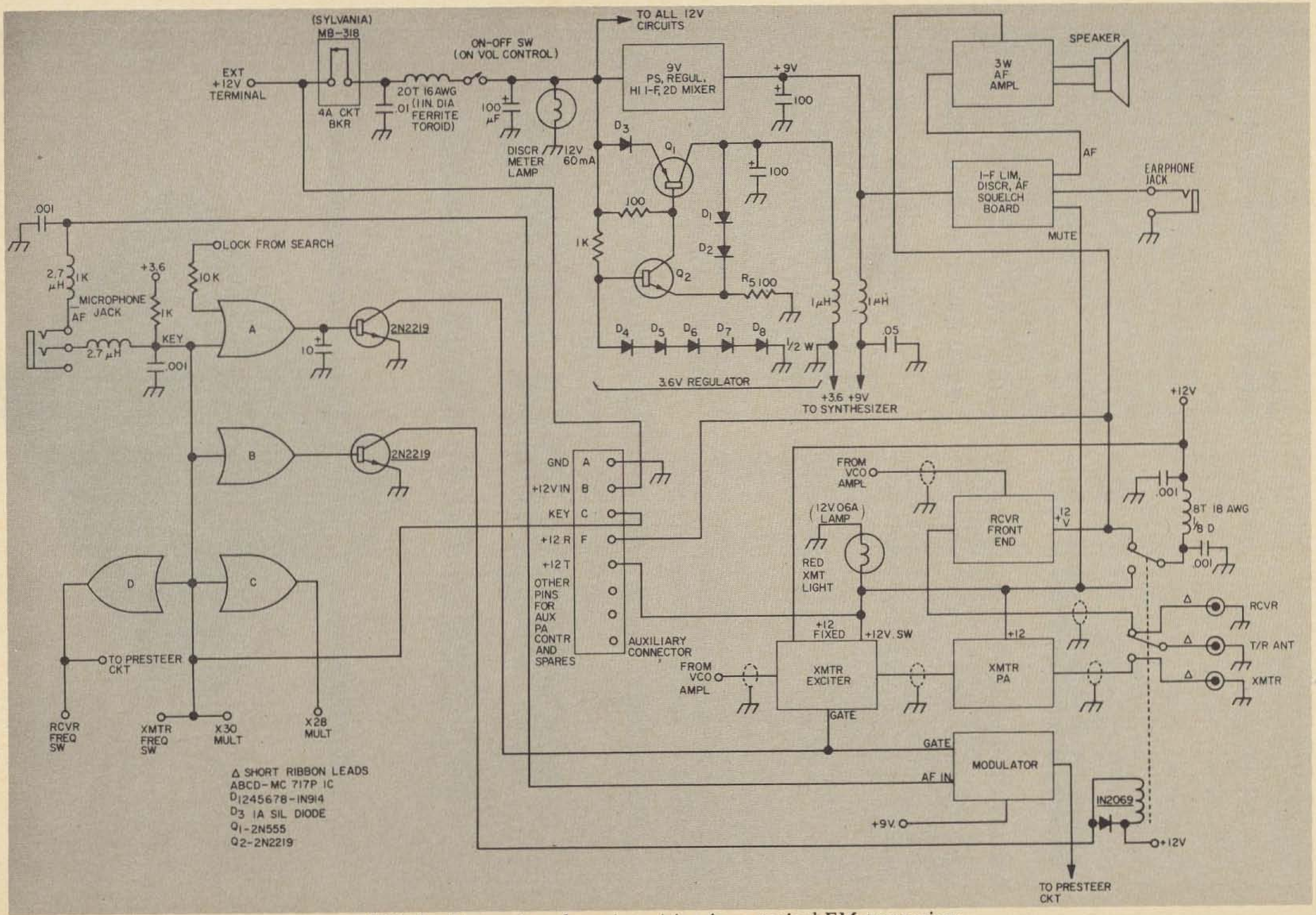


FIG. 8 Transmit and receive wiring for a typical FM transceiver

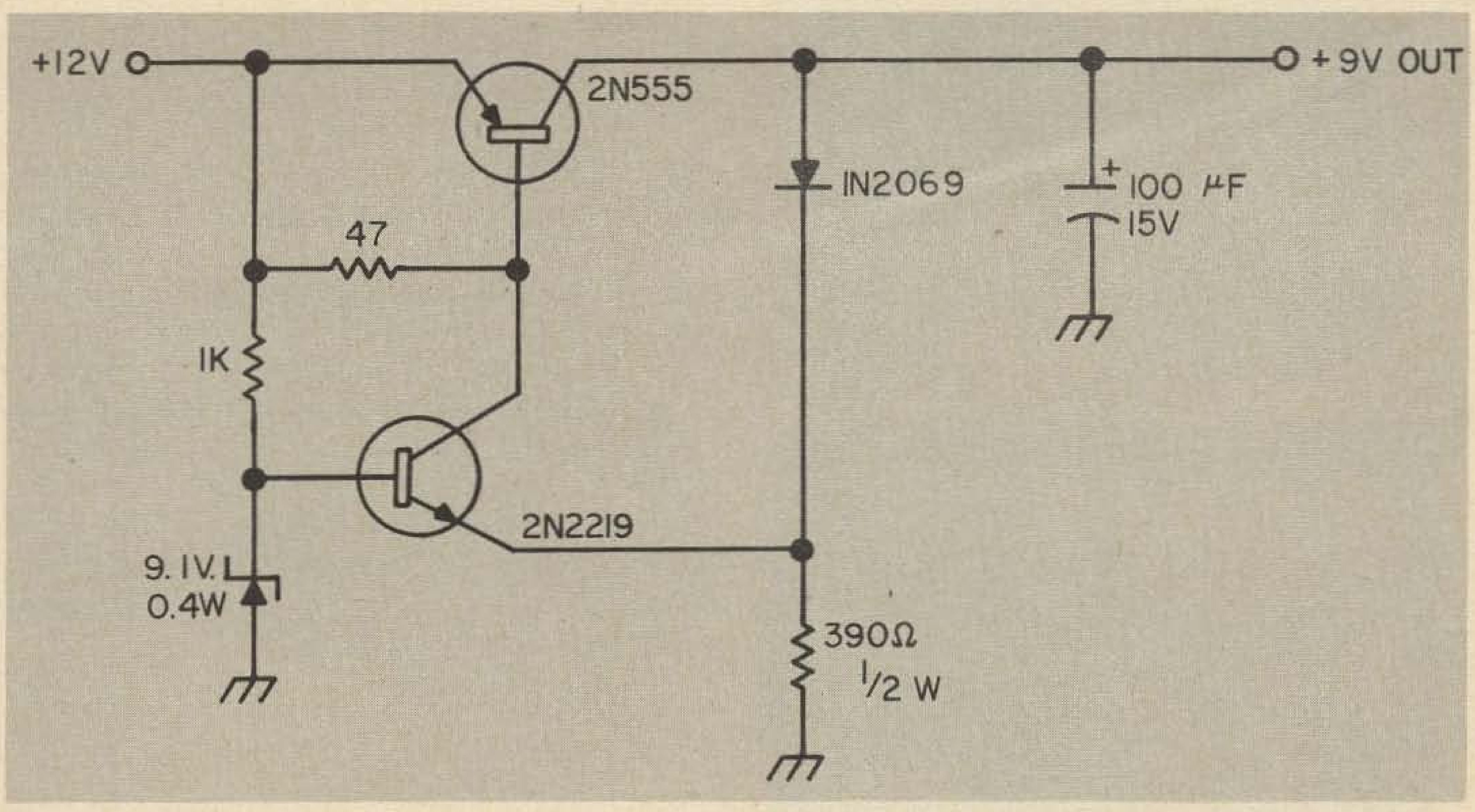


FIG. 9 +9V regulator

find the channel you want than with only 12 channels.

For this reason, switches are usually arranged in a power sequence, such as a *MHz, hundreds of kHz, and tens of kHz* arrangement, extended to as many places as desired. If the $\div n$ were left in its natural state, the switches would have to be set in a binary fashion, which could be awkward. However, the decade type of display is easily accomplished by designing the $\div n$ circuit to work in decades instead of straight binary. It takes 4 flip-flops to produce a $\div 10$ section; cascading three such decades results in a capability of up to 1000 channels. If the channel kilohertz spacing is 1, 10, 100, etc., the frequency display is in familiar decimal numbers. Other schemes can be worked out for different channel spacings, but the decimal method is the most convenient, since most of us think in terms of decimal numbers.

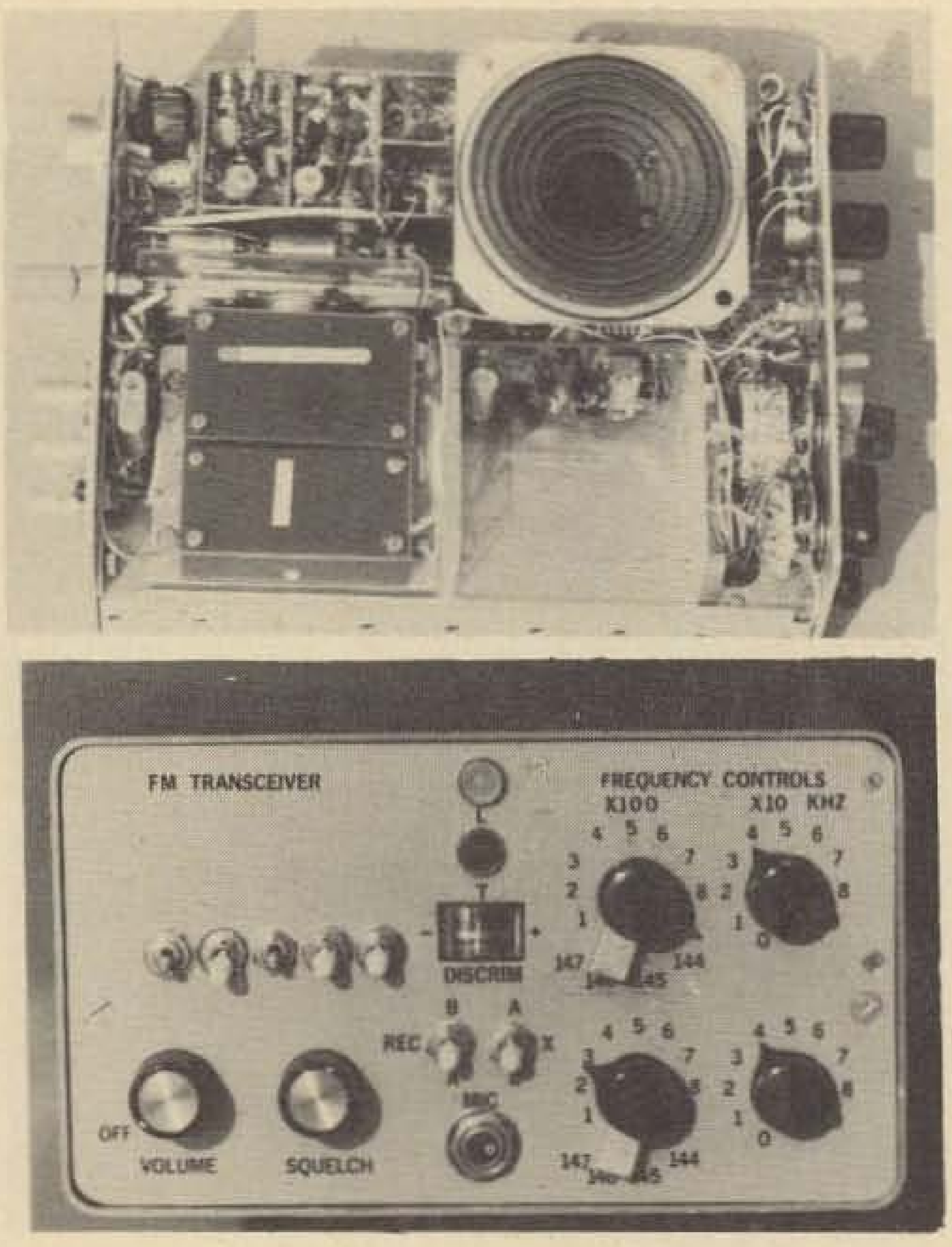
It should be kept in mind that the VCO output is the output of the synthesizer, and even though the loop keeps it exactly on frequency, it can't correct for audiofrequency variations (below the loop filter response). Even if it could, it would be necessary to slow it down for modulation purposes; otherwise the loop would attenuate the audio. Therefore, the VCO of a synthesizer is as sensitive to microphonics as a VFO is, and good VFO construction techniques should be used. VCO tuning range should just overlap each end of the desired output range, and its temperature drift should be kept low to maintain band coverage.

The following text describes the synthesizer used in a 10-kHz-step, 400-channel, 144 – 148 MHz transceiver utilizing a single 5 MHz crystal.

II

A PRACTICAL 10-kHz-STEP SYNTHESIZER FOR TWO METERS

Figure 7 shows the full transceiver block diagram. Output from the synthesizer is 1 mW in the frequency range of 144 – 148 MHz (transmitter), and 1 mW, 135 – 139 MHz, to the receiver first mixer. Modulation is applied directly to the synthesizer for the transmit function. The block labeled *T/R logic* is the circuit board that changes the synthesizer output range when the transmitter is keyed; it also serves to switch the receiver and transmitter and drive the antenna relay.



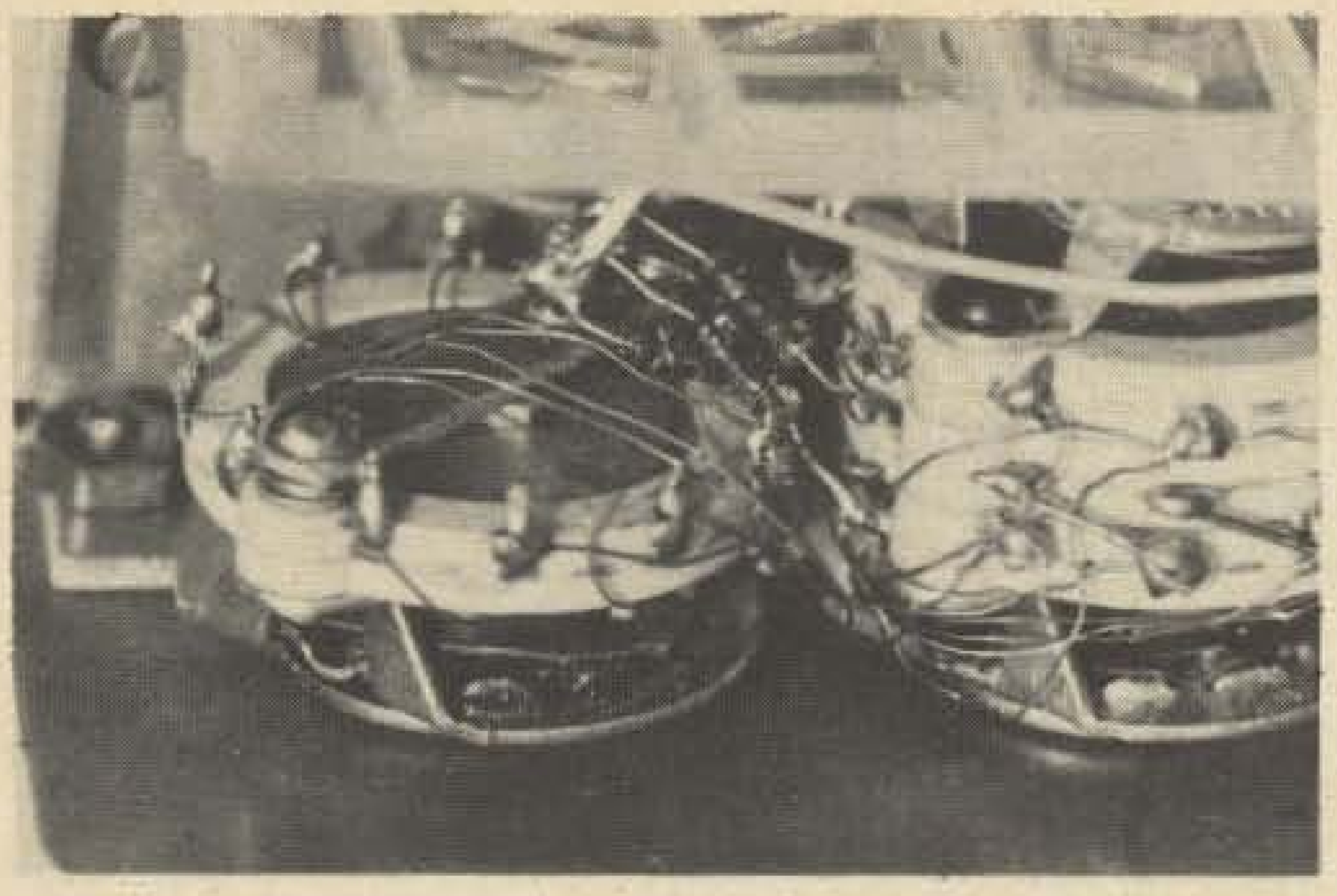
W2EUP'S homebrew two-meter FM transmitter/receiver looks unbelievably professional. The synthesizer controls are the four at the right of the panel. The top pair sets the receiver frequency, the bottom pair sets the transmitter. The basic frequencies of operation are selected by the integral four-position switches (under the X100 knobs). The frequencies of operation on the pictured unit are 146.34 MHz for the transmitter (national repeater input frequency), and 146.94 MHz for the receiver (national repeater output frequency).

Figure 8 shows the transceiver transmit — receive circuits and the system wiring. Two power supply regulators are used; one generates +9V at 250 mA and the other +3.6V at 1A. Nine volts is the B+ level used in the receiver circuits, the transmitter modulator, and the synthesizer. The schematic for the +9V regulator is shown in Fig. 9.

The +3.6V supply is used to provide power for the digital integrated circuits, which are rated for a temperature range of +15 — +55°C (guaranteed performance). Instead of a zener diode, a series string of silicon diodes is used as a voltage reference for this regulator. This technique produces a temperature-programed supply that delivers over 4V when cold and less than 3.5V when hot. The logic works reliably over a very wide range of temperatures when operated in this manner.

Figure 10 shows the synthesizer block diagram. The single 5 MHz crystal oscillator drives, through an amplifier, a ÷500 fixed divider to obtain the 10 kHz reference frequency, and a dual-frequency multiplier section. When in the receive mode, a multiplication factor of X28 is used, producing a 140 MHz signal. When transmitting, a X30 multiplier supplies a 150 MHz signal to the mixer. The multipliers are selected by the transmit — receive (T/R) logic. When receiving, the VCO output range is 135 — 139 MHz (9 MHz below the corresponding transmit frequency). When mixed with the 140 MHz signal, the mixer output ranges from 5 to 1 MHz ($140 - 135 = 5$; $140 - 139 = 1$) and the $\div n$ divide ratio is preset to divide by any number between 500 and 100, to deliver the 10 kHz output. Since 10 kHz is the reference frequency, the channel spacing is 10 kHz. In the transmit mode the mixer produces from 6 to 2 MHz ($150 - 144 = 6$; $150 - 148 = 2$), and the $\div n$ is preset to any ratio between 600 and 200.

The VCO and VCO amplifier are shown schematically in Fig. 11. The B+ to the VCO should be kept small to maintain maximum tuning range. As it turned out in the unit pictured, tuning range was no problem and had to be reduced by trimming the high end of the range with C6. The VCO is housed in a section of the oven assembly, which also contains the 5 MHz oscillator and an electronic temperature regulator. The VCO itself could have been mounted in a nonheated environment without stability problems because frequency drift with temperature turned out



Detail of frequency selection switches show how "MHz" section connections are skewed 1 MHz offset on receive mode. At right an extra detent (switch clicking and locking mechanism) is reversed and mounted behind. A 1/8-inch shaft is attached and brought to panel through drilled-out shaft of front detent. Rear deck is X100 (hundreds of kilohertz, front two are MHz selection decks. Solderable magnet wire was used for connections to keep the wiring manageable.

to be very low. However, in the author's transceiver, the oven insulation also acts as sound and vibration shielding (polyurethane foam), minimizing VCO microphonics.

Radiofrequency shielding is absolutely essential in the VCO. In the prototype unit, the VCO amplifier was mounted in a separate shielded box, but it was later combined with the VCO itself.

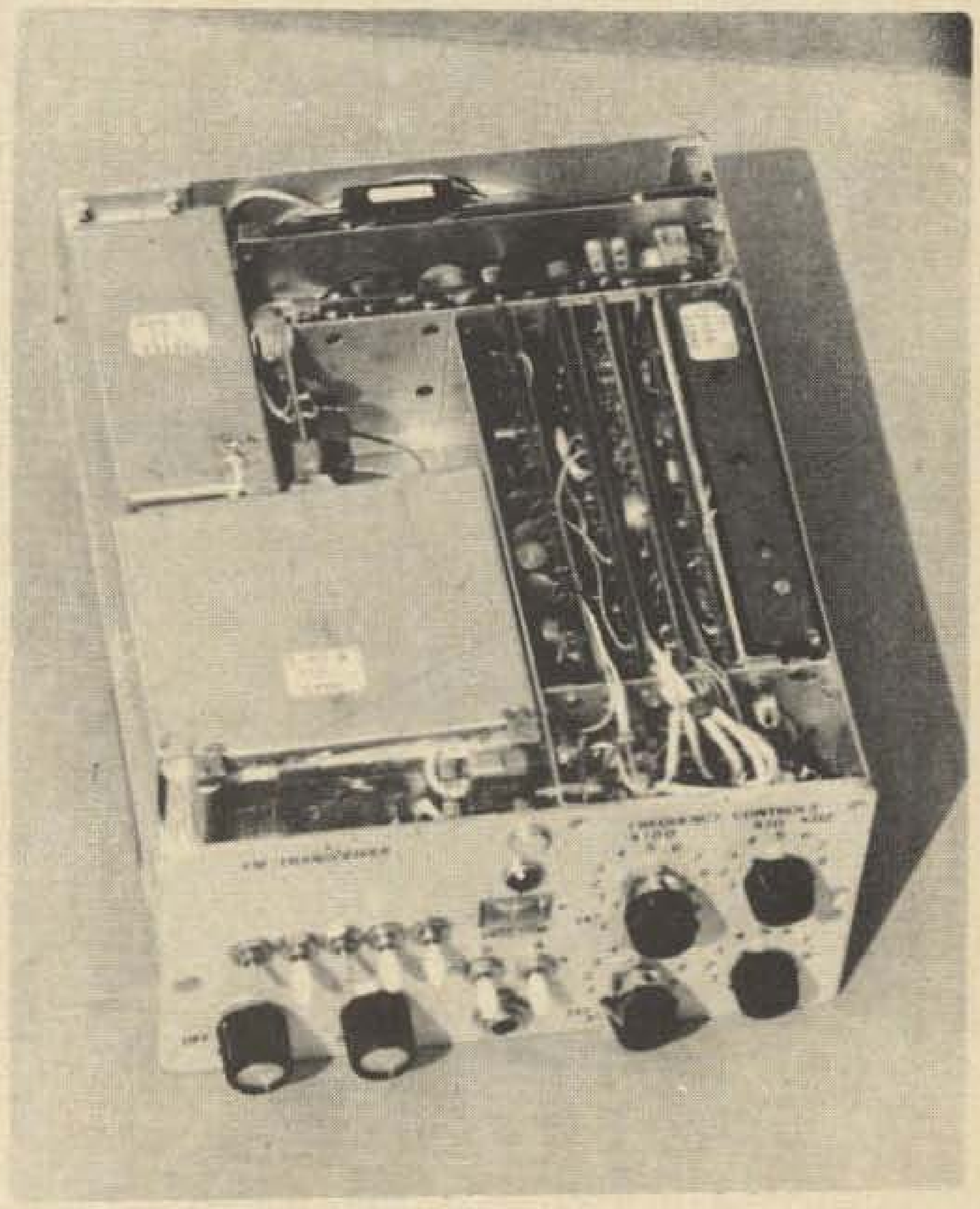
The *steer* input of the VCO comes from the frequency comparator (consisting of the phase detector and search) for electronic lock. An extra varactor (D4) is used to accomplish this by means of a voltage supplied from a presteer circuit (described later) and switched by the T/R circuits.

Three outputs are provided by the VCO amplifier: In addition to the receiver and transmitter outputs, there is a 0.1 mW signal fed to the synthesizer mixer for loop feedback, The resistor network provides some degree of isolation between the outputs. Again, shielding of the VCO amplifier is a must.

Figure 12 shows the frequency multiplier section, the synthesizer mixer and the amplifier used to square up the waveform to feed the $\div n$ circuit. The multipliers are conventional and their outputs are connected in series to feed the mixer. Only one multiplier operates at a time, selected by the T/R circuits. Grounding the X28 or X30 lines selects the desired one.

Mixer output is amplified by several resistance-coupled stages. Transistor Q8 squares the waveform and Q9 acts as an inverter to provide the two out-of-phase signals needed to drive the $\div n$ circuit.

The $\div n$ schematic is shown in Fig. 13. Note that the divider is sectioned into decades I and II and a $\div 8$ section. The terminals shown along the bottom are the



Top view of unit shows circuit board construction and "plug-in" accessibility concept of two-meter FM transmitter/receiver. The two rearmost cards are for receiver. Card next to i-f filter is i-f amplifier. The synthesizer section is shown at right. Left to right, the cards are: phase detect and divide-by-500; search; diode matrices; divide-by-n; mixer-multiplier. The heavy white leads from switches to matrix board are insulating sleeves; each sleeve contains 8 — 12 leads of 32 AWG magnet wire. Slots and holes in shields are similarly guarded with insulation to prevent the possibility of shorts by chafing.

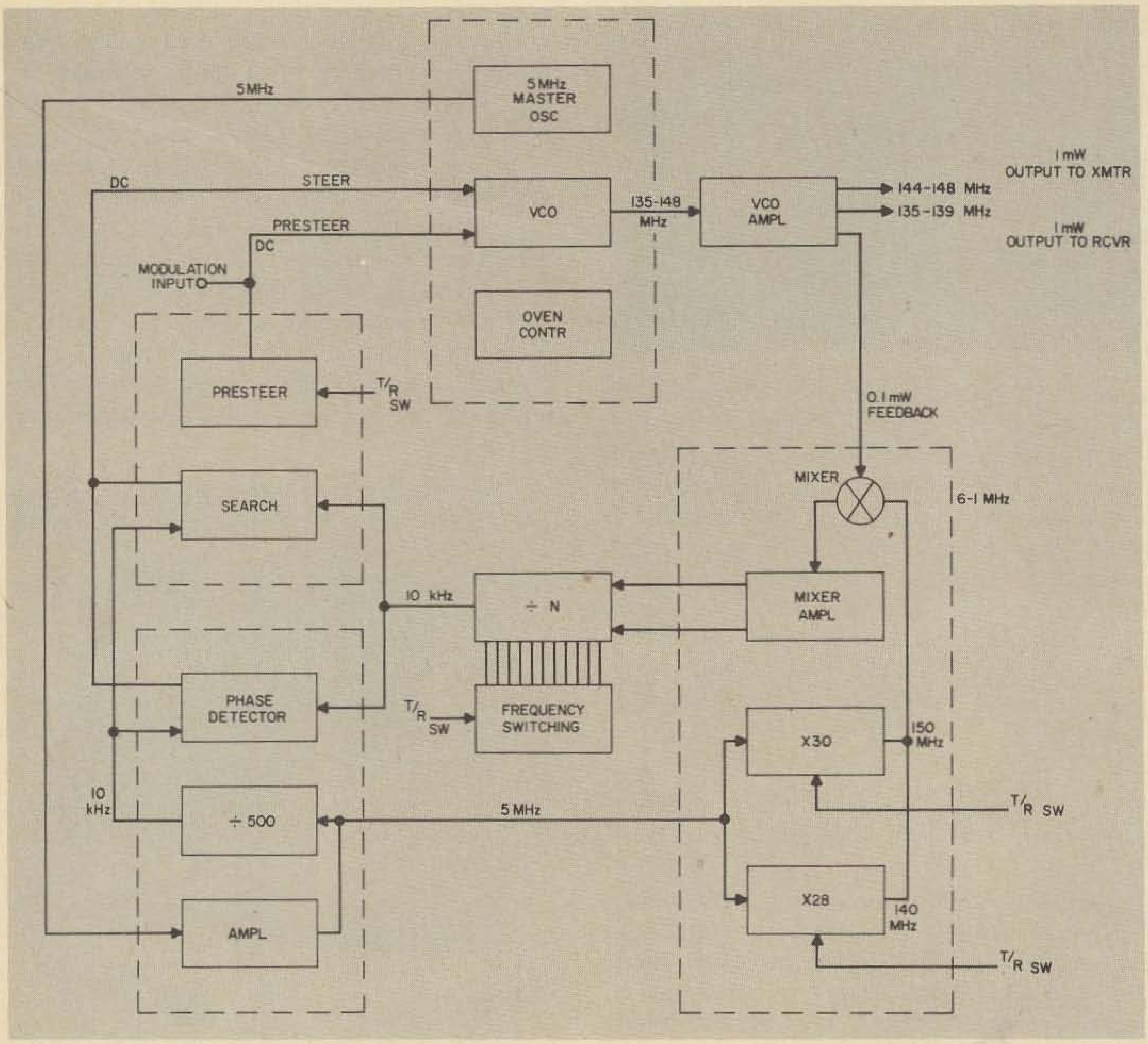


FIG. 10 Detail block diagram of frequency synthesizer

preset inputs. For maximum divide ratio (÷800) all of these terminals are biased to a positive 1 – 4 volts and thus no presets are inserted. Other divide ratios are chosen by selectively grounding (or opening) these terminals. For example, if A1 is grounded, it will divide by 799; if B1 is grounded, it divides by 798; C1 grounded yields ÷796, etc.

A table of presets is given in **Table I**, showing how the presets affect the divide ratio and the resulting frequencies of operation in this synthesizer. A zero indicates no preset; a "1" indicates a preset on terminals A1 through C3. Under the $\div n$ ratio heading is shown what happens to the normal ÷800 ratio as different combinations of presets are inserted. For example, a preset at A1 only (second line) shows a – 1; this means that the ratio is reduced by a 1 *from 800 to 799. If A_1 and A_2 were both preset,* the $\div n$ ratio is reduced by a 1 and a 10, or 11; therefore, n = 789. Preset lines A1 to D1 thus switch *tens of kilohertz*, lines A2 to D2 go to the *hundreds of kilohertz* switch, and lines A3, B3, and C3 go to the *megahertz* switch.

A 10 MHz shift is accomplished in this design by changing the injection frequency into the synthesizer mixer. Since the receiver oscillator injection requirement is in the 135 – 139 MHz range (to produce a 9 MHz i-f), a 10 MHz shift is necessary to get the output into this range. As previously described, this function is accomplished by the T/R logic selecting the appropriate fre-

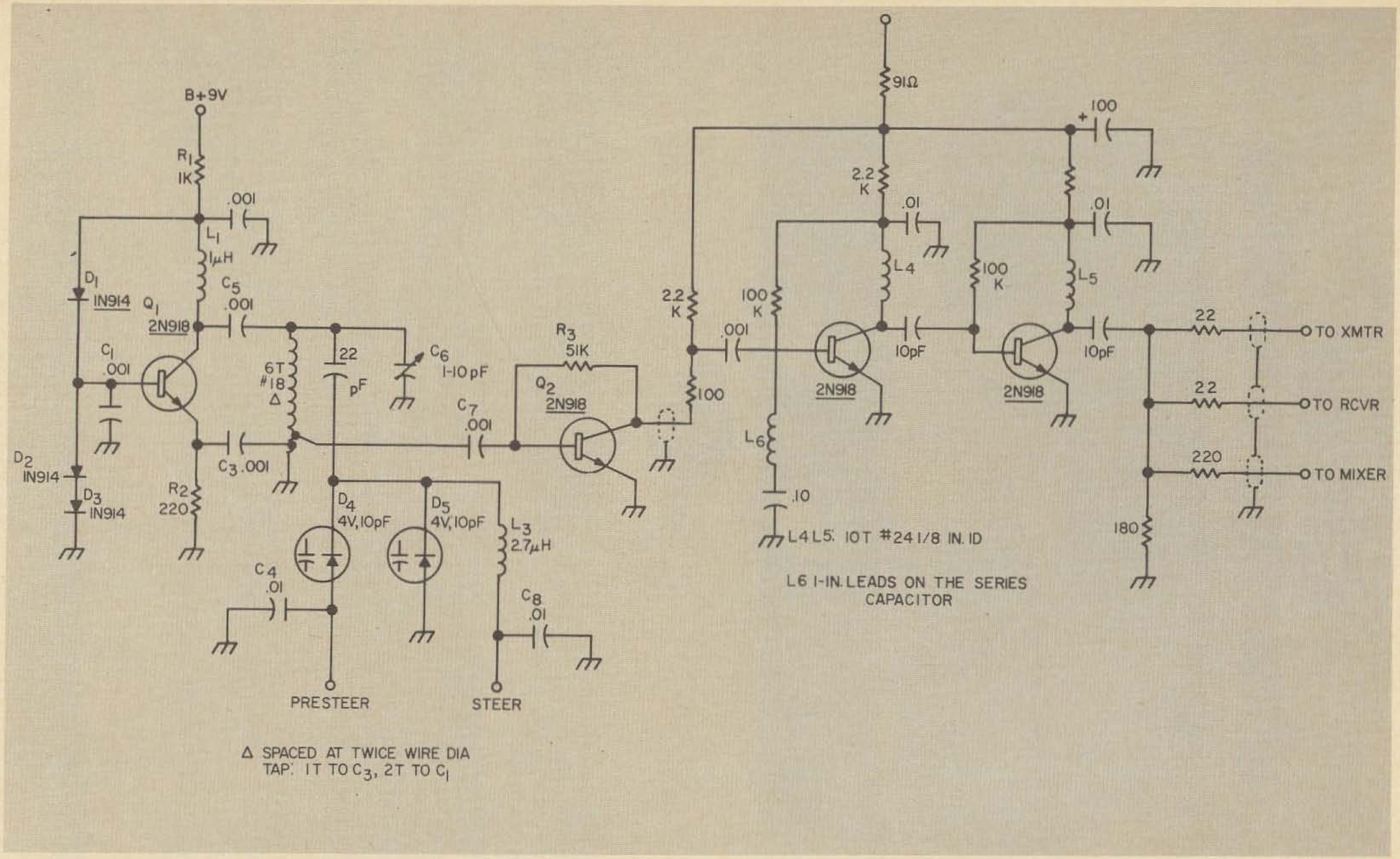


FIG. 11 Voltage-controlled oscillator and associated amplifier

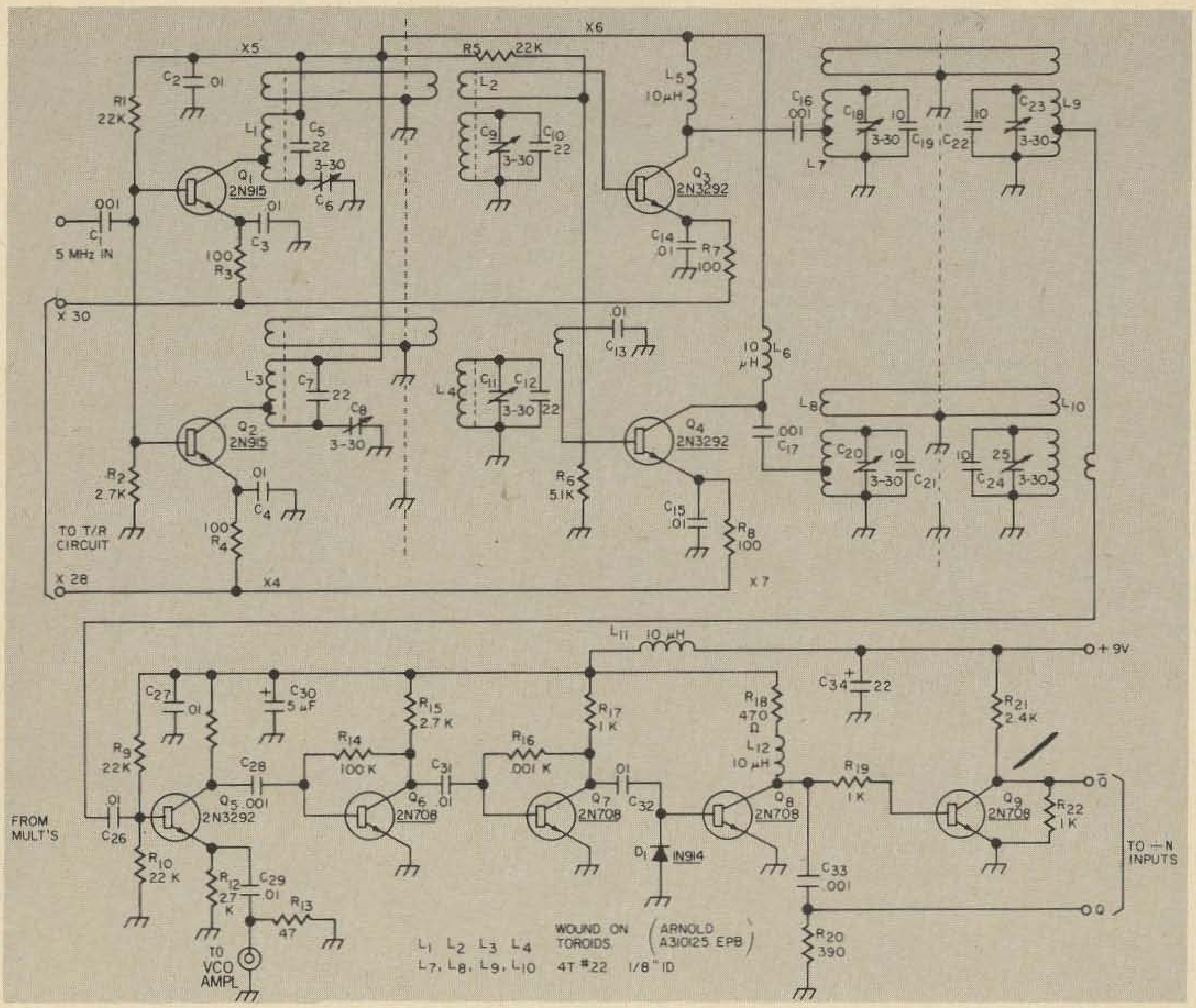


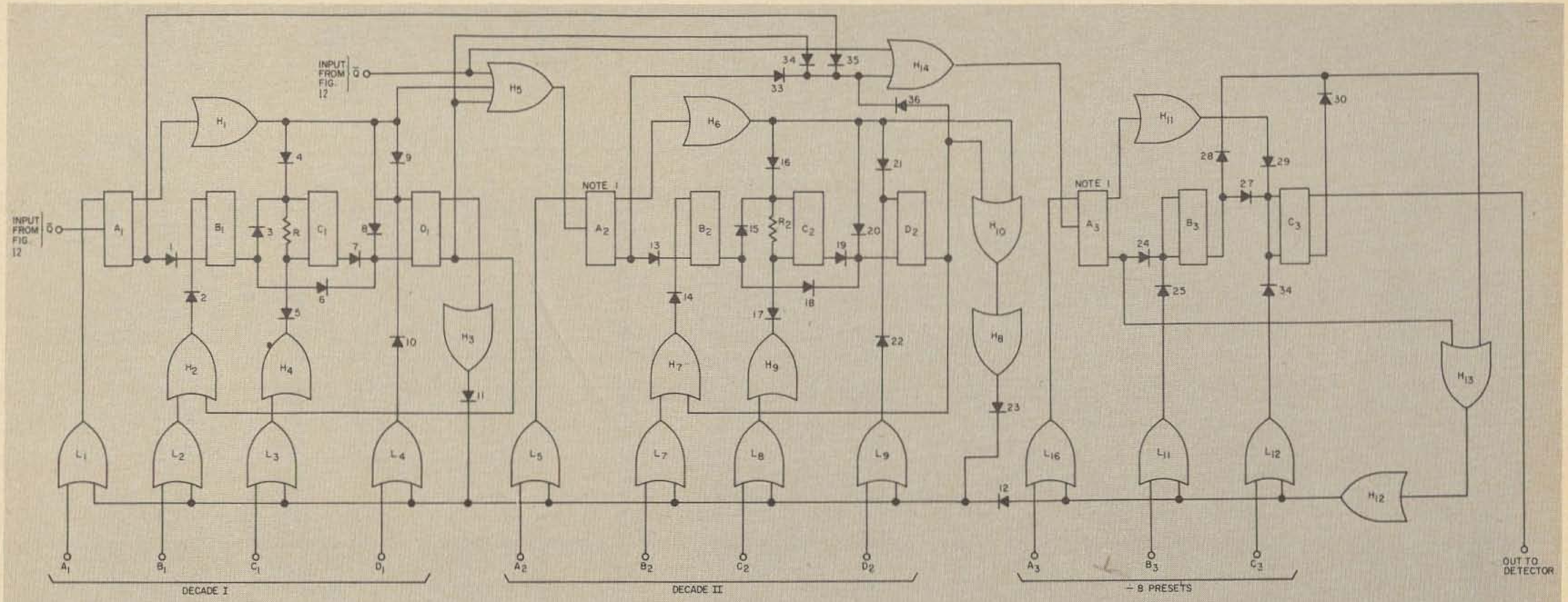
FIG. 12 Multiplier, mixer, squaring amplifier schematic diagram

quency multiplier. However, the MHz preset must also be shifted by 1 MHz to receive the same frequency as the transmitter is on, since only a 9 MHz offset is desired. Thus, as seen in the table, the *receive* presets are offset one place in the MHz column.

The $\div n$ circuit shown is capable of operation to 10 MHz for all presets and represents the results of a hard brainstorming session. It should be reproducible and will work as it is shown, as long as the wiring is correct. Unless you understand its theory of operation *completely* it is recommended that you simply copy it *carefully!* Have someone else check *every connection* since troubleshooting is difficult. Space doesn't allow a complete explanation of its operation.

Frequency switching circuitry is shown in Fig. 14. Two complete sets of switches allow independent selection of receive and transmit frequencies. The diode matrices shown permit the use of standard 10-position rotary switches. Input voltage for the preset lines is provided through the 10K resistors. When one of the lines is grounded, a combination of presets is grounded through the diodes.

The arm of S1 is grounded in the transmit mode, and the arm of S2 is grounded in the receive mode. If S1 is in the *A* position, the transmit frequency is controlled by switch set *A*; if it is in the *B* position it transmits on the frequency on set *B*. The same is true for S2 on receive.



NOTES:

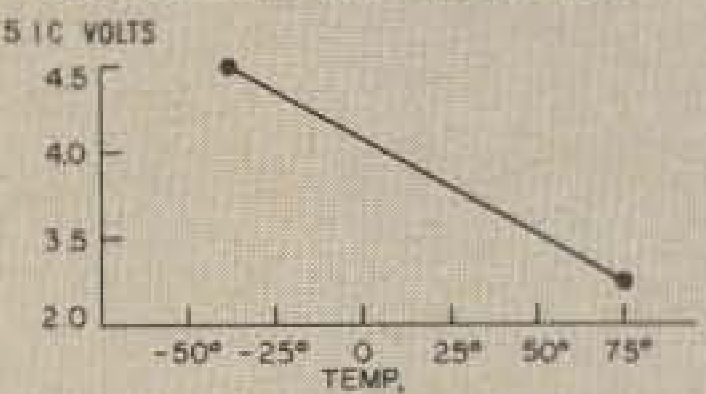
1 CLOCK INPUT OF A_1 B_1 C_1 & D_1 ARE PARALLELED
" " " A_2 B_2 C_2 & D_2 " "
" " " A_3 B_3 & C_3 " "

2 GATES ARE RTL "NOR" THOSE MARKED "L" ARE mW RTL AND "H" ARE MEDIUM POWER RTL

3 A_1 B_1 C_1 D_1 A_2 B_2 C_2 D_2 A_3 B_3 AND C_3 ARE J-K FLIP-FLOPS, MC790P OR MC890P
(+15–55°C) (0–70°C)
ALL "L" GATES MC717P OR MC817P GATES
H_5 H_{10} AND H_{13} ARE ONE MC792P OR MC892P
"H" GATES ARE MC724, OR MC82P

4 C AND $\bar{C}$ INPUTS ARE COMPLEMENTARY MAX. ALL DIODES ARE IN277 OR EQUIVALENT

5 IC VOLTS



6 NATURAL COUNT IS ÷ 800 WITHOUT PRESETS. BINARY NUMBERS ARE PRESET BY OPENING OR GROUNDING THE PRESET INPUTS OTHERWISE A MINIMUM OF 1 AND MAXIMUM OF +4V SHOULD BE APPLIED.

7 R_1 AND R_2 1K 1/8W

8 FLIP-FLOP CONNECTIONS:

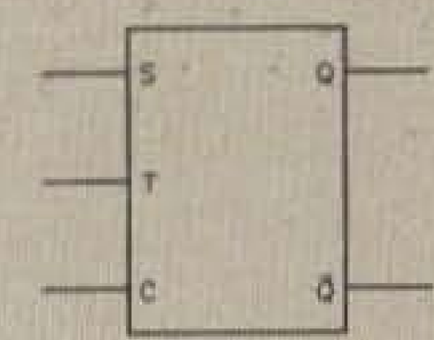
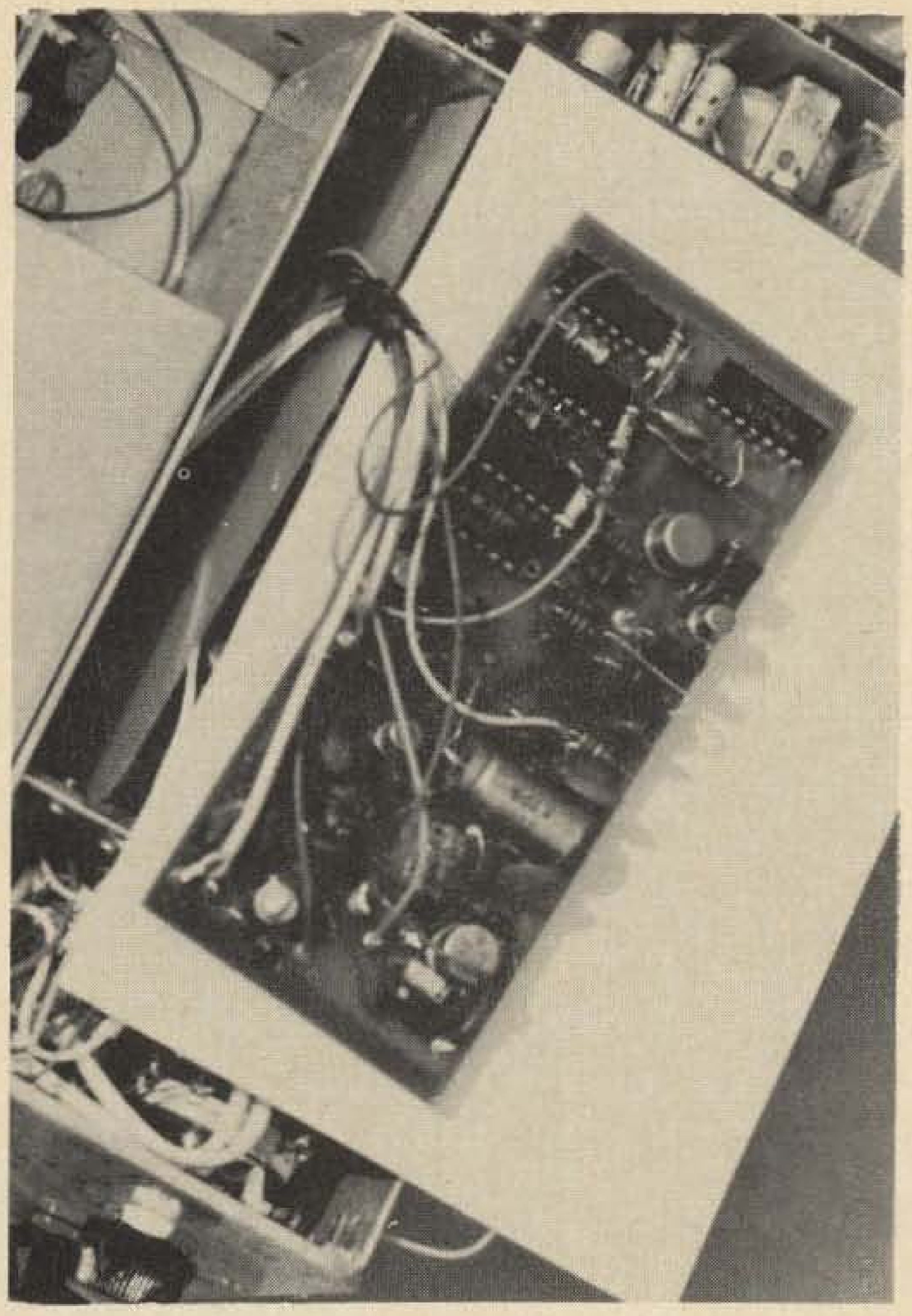


FIG. 13

÷*n* CIRCUIT



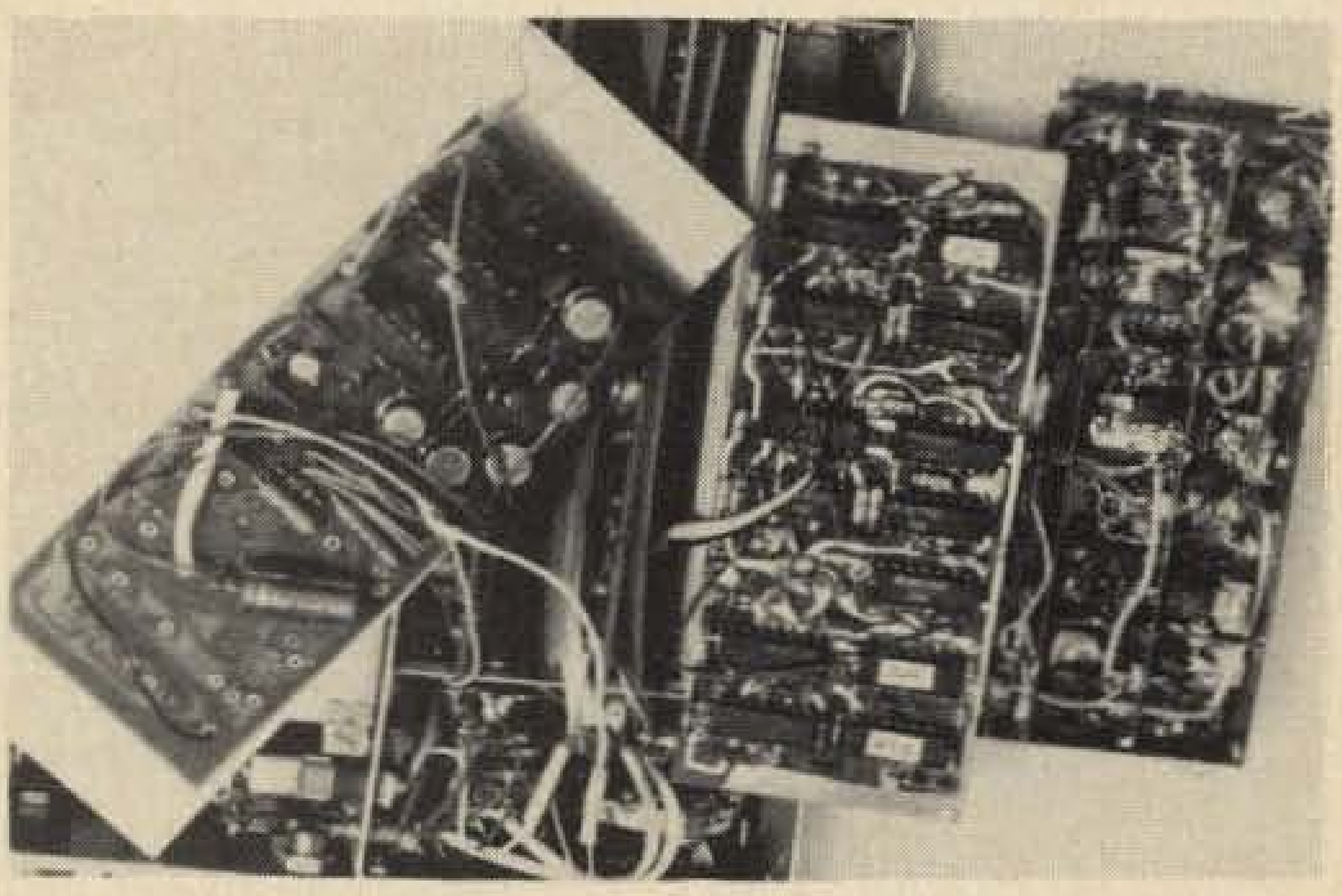
Closeup photo shows that it is practicable to get all the components of the phase detect and divide-by-500 circuit onto a single small card.

These switches provide great flexibility. With both switches in the *A* position, you transceive on frequency *A*. Similarly, with both in the *B* position you transceive on frequency *B*. Receive A and transmit *B*, receive *B* and transmit *A* are other combinations. It may sound complicated, but this system is very easy to use and a beginner can master it in seconds.

Once understanding of the method of controlling the synthesizer is complete, you can dream up all kinds of ways to control it. For example, it is simple to instantly select a preset channel, such as 146.94 (the national FM repeater output frequency) by throwing a toggle switch. This addition can be completely independent of other switch positions. And remote switching is easy because all control lines to the ÷*n* circuit handle only dc and simply are grounded in different combinations.

Figure 15a shows the master oscillator. It uses a field-effect transistor and has an automatic gain control arrangement for high stability. It is completely shielded and oven-controlled (**Fig. 15b.**).. Asterisked components are thermally mounted to the oven box; the thermistor senses the oven temperature, and the other asterisked components deliver heat to it. In the original unit, the temperature control pot is mounted outside of the oven.

Referring to **Fig. 15c**, the 5 MHz low-level signal from the master oscillator is amplified in Q1 and Q2. Output from Q2 goes to the multiplier section and to squaring amplifier Q3, which drives the ÷500 circuit. Two outputs are used from the last flip-flop (I) 180 degrees out of phase. One goes to the search circuit, the other to the phase detector, below. The 10 kHz square wave is converted to a *spike* by C6 — R9, as seen in waveforms *a* and *b* in **Table II**. Each positive spike turns Q5 on momentarily, charging C7 to +9V. Between spikes (waveform *c*), C7 discharges through R15, producing a sawtooth. (A linear sawtooth could be used instead of the nonlinear one used here, but the nonlinear waveform is actually beneficial in this system and is easier to generate.



Closeup photo shows the search board at left, the divide-by-n card and, at right, the mixer — multiplier assembly. The wall shield between those boards still in place are made from a conducting material deposited onto the fibrous board material; the close spacing increases the possibility of card-to-wall shorting, so a Mylar insulation sheet was attached over the surface of each of the shield walls.

Table I. Presets.

Frequency		$\div n$ Ratio Reduction	A_1	B_1	C_1	D_1	A_2	B_2	C_2	D_2	A_3	B_3	C_3
0		0	0	0	0	0							
10		-1	1	0	0	0							
20		-2	0	1	0	0							
20		-2	1	1	0	0							
30		-3	0	0	1	0							
40		-4	1	0	1	0							
50		-5	0	1	1	0							
60		-6	1	1	1	0							
70	Steps,	-7	0	0	0	1							
80	kHz	-9	1	0	0	1							
0		0					0	0	0	0			
100		-10					1	0	0	0			
200		-20					0	1	0	0			
300		-30					1	1	0	0			
400		-40					0	0	1	0			
500		-50					1	0	1	0			
600		-60					0	1	1	0			
700		-70					1	1	1	0			
800		-80					0	0	0	1			
900		-90					1	0	0	1			
142		0									0	0	0
143		-100									1	0	0
144	XMT,	-200									0	1	0
145	MHz	-300									1	1	0
146		-400									0	0	1
147		-500									1	0	1
142		-100									1	0	0
143		-200									0	1	0
144	RCV,	-300									1	1	0
145	MHz	-400									0	0	1
146		-500									1	0	1
147		-600									0	1	1

Sampling pulses are produced from the $\div n$ output in a blocking oscillator (Q3) and fed to the gate of Q6 (waveform *d*). This pulse turns Q6 on briefly, charging or discharging C9 to the value of voltage on C7 at that instant. Capacitor C9 can only charge or discharge through Q6, so it holds that value of voltage until the next sampling pulse. Different $\div n$ outputs and the resulting voltages across C9 are shown in Fig. 18, *d* through *i*. Transistor Q7 is a source follower which drives the following circuitry at a low-impedance level, while maintaining a near-infinite load on C 9. The loop filter consists of R13, C10, R14, R16, diodes D5 and D6, and the rf bypasses at the VCO. The diodes effectively short out R16 for sudden large shifts in phase-detector output to speed the lockup process. For small changes, as seen when the loop is in lock, they have no effect.

A bias voltage is developed from the high-amplitude blocking oscillator output with D3 and D4. This bias is used to hold Q6 off between sampling pulses and to bias the varactor presteer input on the VCO.

Figure 16 shows the search circuit. It operates from the same two frequency inputs that the phase detector uses, except that its purpose is to detect *frequency* in-

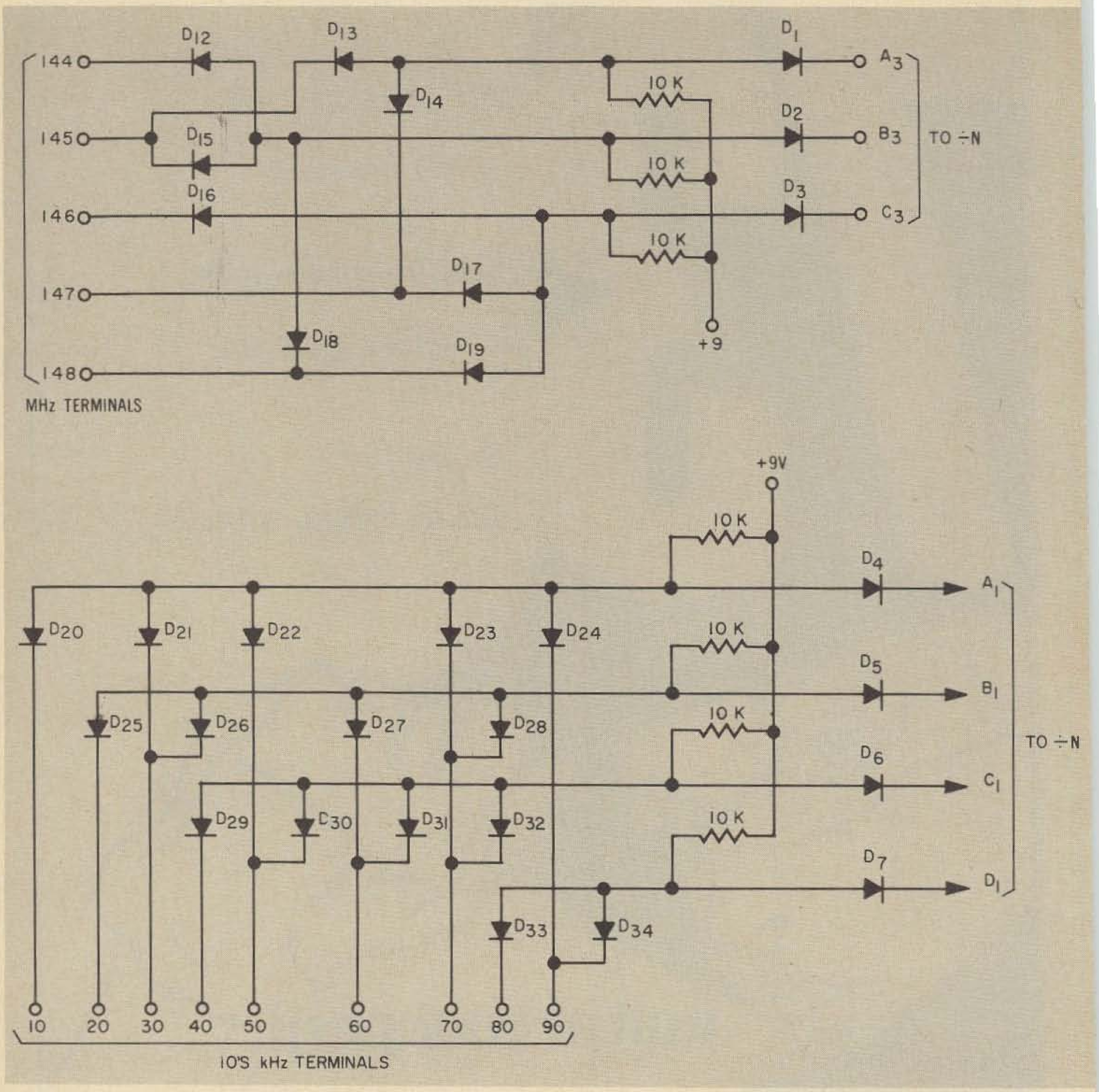
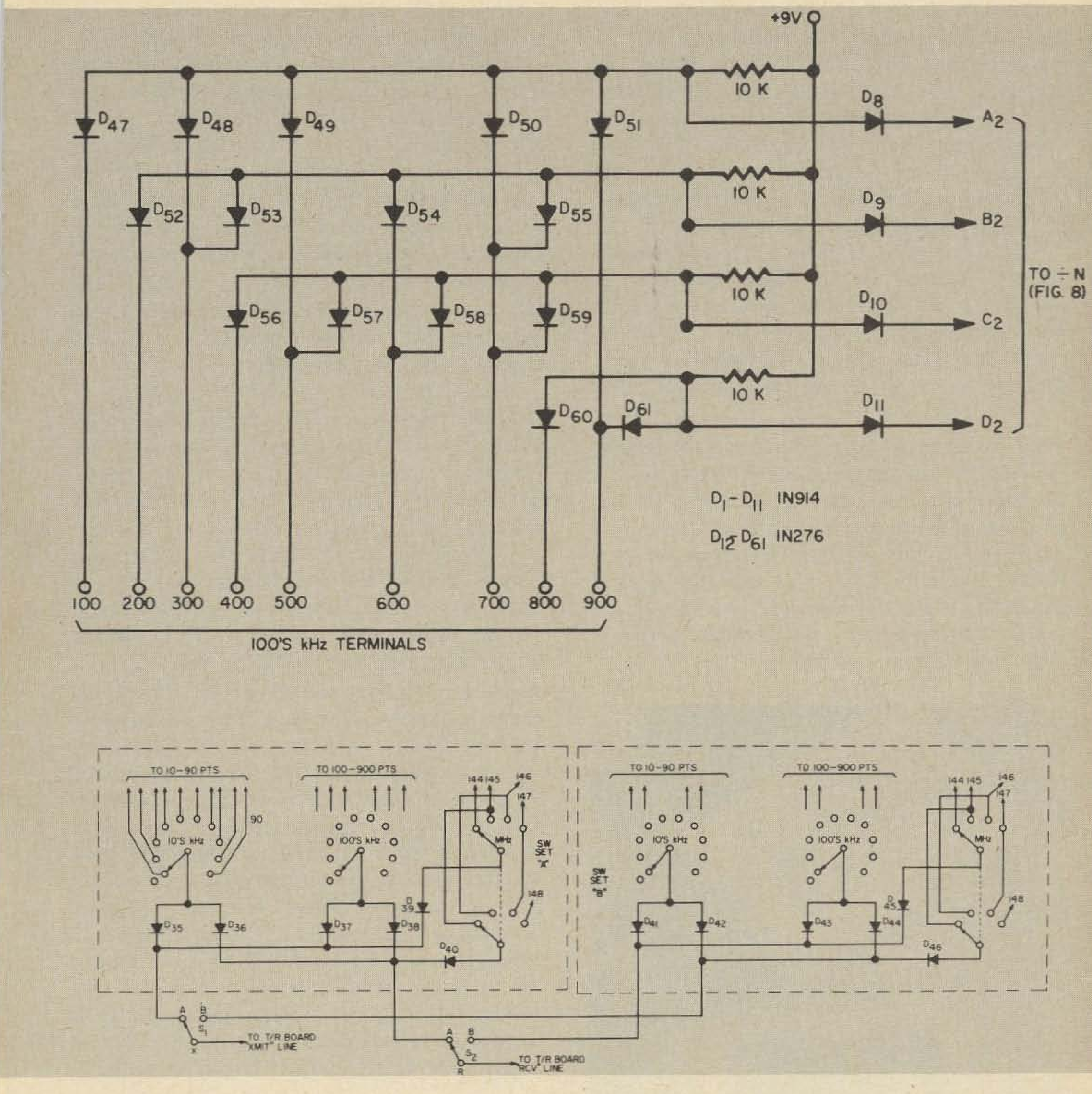


FIG. 14 *Frequency-switching with*

stead of *phase differences,* and to coarse-tune the VCO to the desired frequency, where the phase detector takes over. It accomplishes this by checking for pulse interlace; that is, to see that for every pulse received on one input there is *only one* pulse received at the other input. Obviously, if two pulses occur from one input during which time no pulse from the other input is received, the two pulse trains can't be of the same frequency.

Table III shows waveforms for the locked condition (*a, b, c*) where the comparator, consisting of gates BCGEHF, etc., does not produce any output pulses; and where the $\div n$ output is too high in fre-



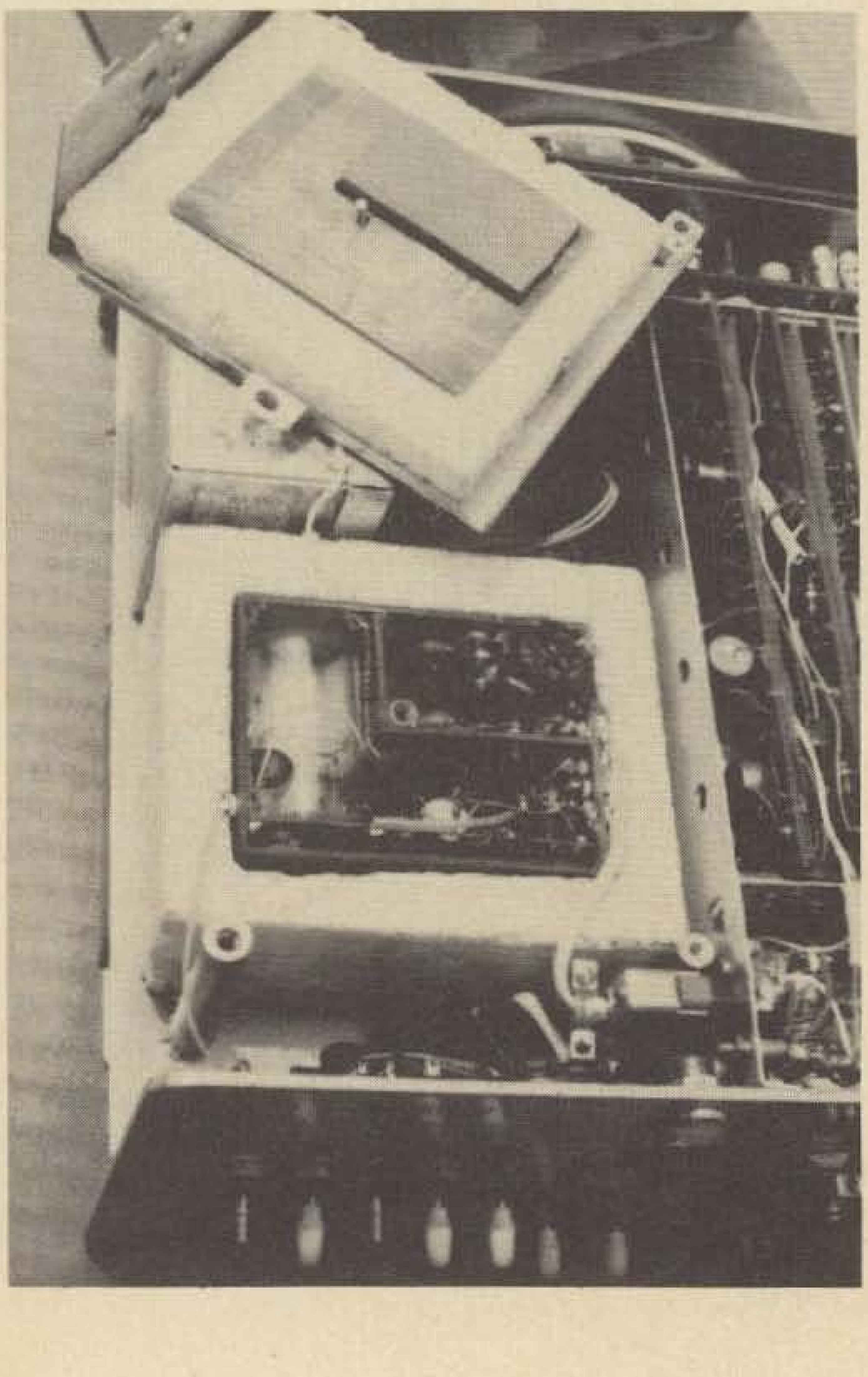
diode matrices for rotary-switch utilization

quency (*d, e, f*). When this case exists, gate H delivers pulses. When the ÷*n* output is too low in frequency, gate F puts out a series of pulses. When pulses come from H, Q6 and Q3 are pulsed on, producing a stepwise increase in voltage across C9. This voltage is summed with the voltage from the phase detector. As it rises, the VCO is tuned higher in frequency, which decreases the output frequency from the synthesizer mixer, decreasing the ÷*n* output frequency as desired. A correction in the opposite direction is accomplished by pulsing Q4 from gate F, decreasing the C9 charge in steps.

Gates I, J, and D do two things: they gate the transmitter off while the loop is searching (so you don't search while on the air) and they drive the out-of-lock indicator light (which tells you when something is wrong). The indicator normally flashes briefly between receive and transmit If anything goes wrong in the synthesizer the light is almost sure to indicate it.

Transistor Q8 is used as a presteering gate. Controlled by the T/R circuit, it is biased on in the receive mode, placing a positive voltage on the presteer input of the VCO. This voltage, adjusted by R16, reduces the voltage across varactor D4, increasing its capacitance and shifting the VCO tuning range down. When Q8 is off (in the transmit mode) the bias is allowed to swing to −10 volts, which reduces the capacitance of D4 to a minimum. Diode D9 regulates this bias level. Modulation is ac-coupled to the presteer input instead of the steer input so that it does not interfere with the operation of the loop. The 220 pF capacitor is an rf bypass. Modulation input impedance is 330K, and very little voltage swing is needed for 15 kHz deviation. Linearity for this level of deviation is excellent and hi-fi audio is possible.

The oven assembly should be thermally isolated to the greatest extent possible. In the unit pictured, the crystal oven circuit is isolated from the remainder of the circuitry by means of a thick styrofoam surround. Shown in the oven are: the crystal (at left), voltage-controlled oscillator (in corner compartment), and 5 MHz oscillator with oven control circuit.



Transistor Q2 is used to prevent a possible hangup condition of the loop, where the VCO gets tuned so low that the frequency supplied to the $\div n$ is beyond its counting capability. The $\div n$ would then start counting erratically, delivering too few pulses instead of too many, due to skipping pulses. The search circuit interprets this to mean that the $\div n$ output is too low instead of too high, so it steers the VCO in the wrong direction, perpetuating the situation. Luckily, the bias supply in the phase detector happens to depend upon a continuous supply of $\div n$ pulses, so that when this hangup condition occurs, it can be detected by a large drop in bias voltage. Transistor Q2 is normally biased off by this supply, but when the loop hangs up, bias collapses, so Q2 turns on and turns search transistor Q3 on in good *Rube Goldberg* fashion. Transistor Q3 charges C9 to maximum voltage, sweeping the VCO to the high end of its range, where normal lockup can take place. The entire process takes place in a few milliseconds. C3 causes a delay to make sure that Q3 turns on completely.

Shielding

Most of the circuits are susceptible to the high-level rf fields typically generated by an adjacent transmitter. The $\div n$ circuit is an efficient hash generator to nearby receivers at nearly any frequency. It is therefore important that most of the synthesizer circuits be shielded from the outside world as well as from each other. All leads should be filtered and bypassed with *RC* or *LC* circuits. Extra B+ bypasses in

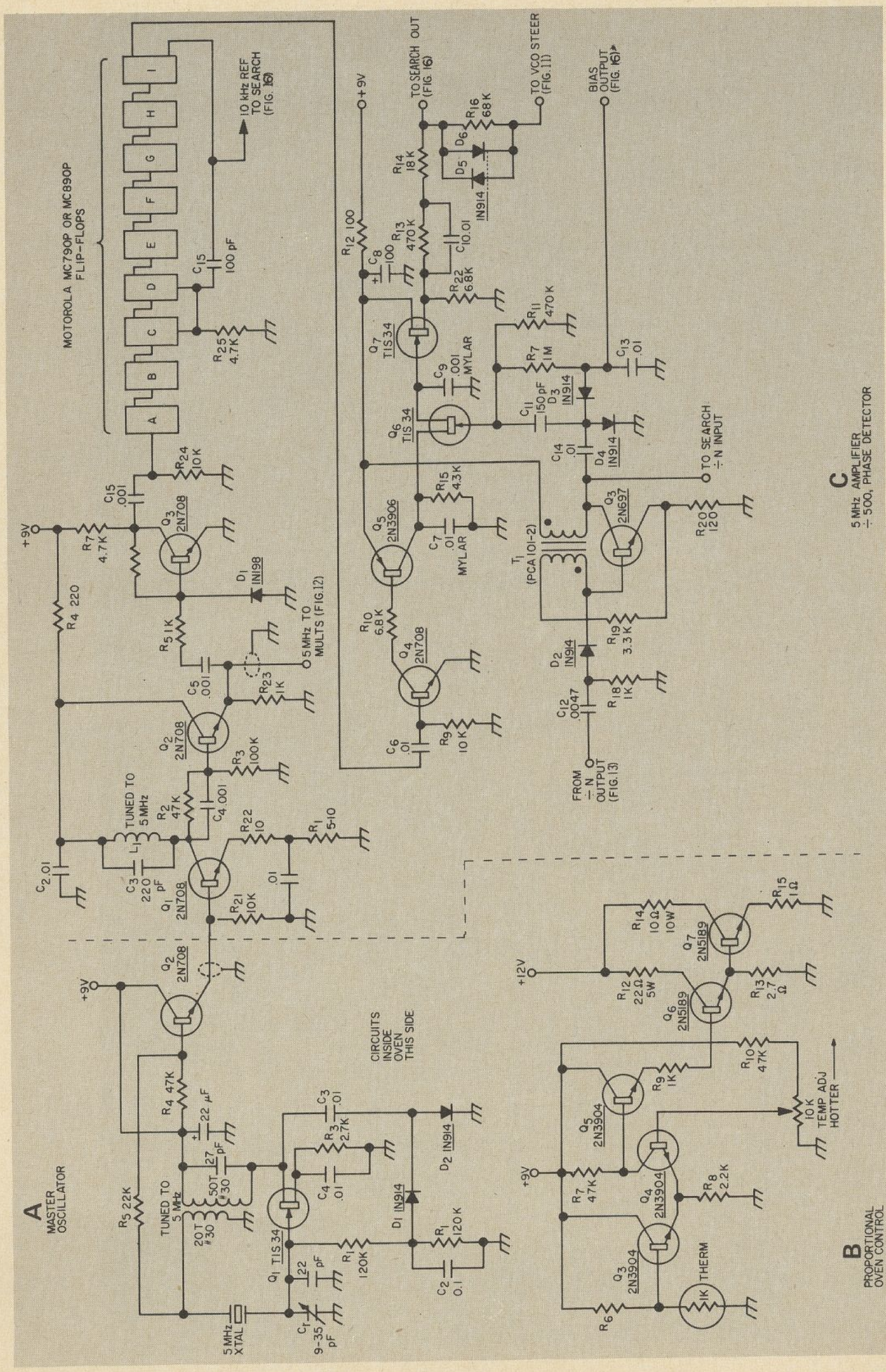


Fig. 15. Oscillator, 5 MHz amplifier, and oven control.

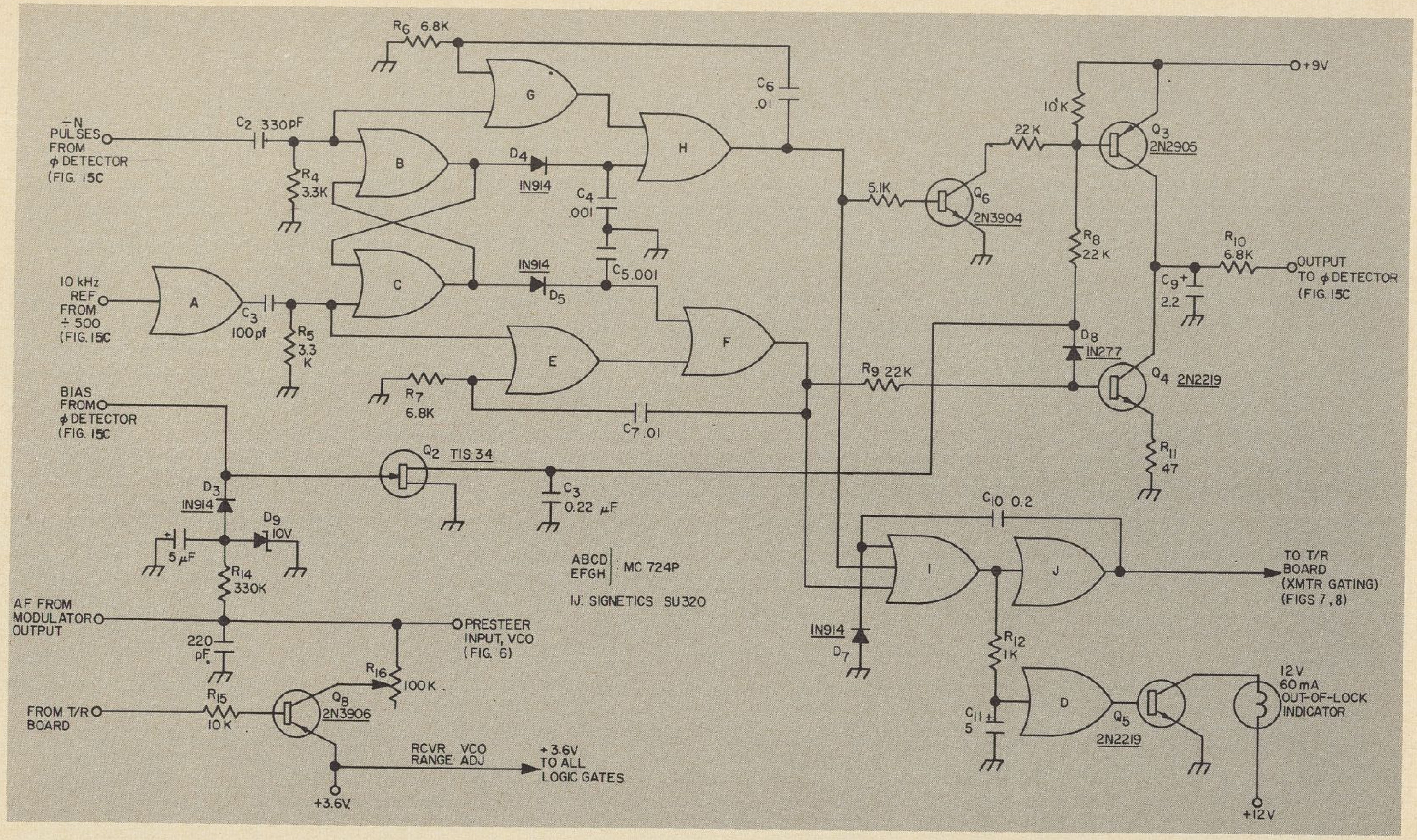


Fig. 16. Search, out-of-lock indicator, and presteer.

Table II. Phase detector waveforms.

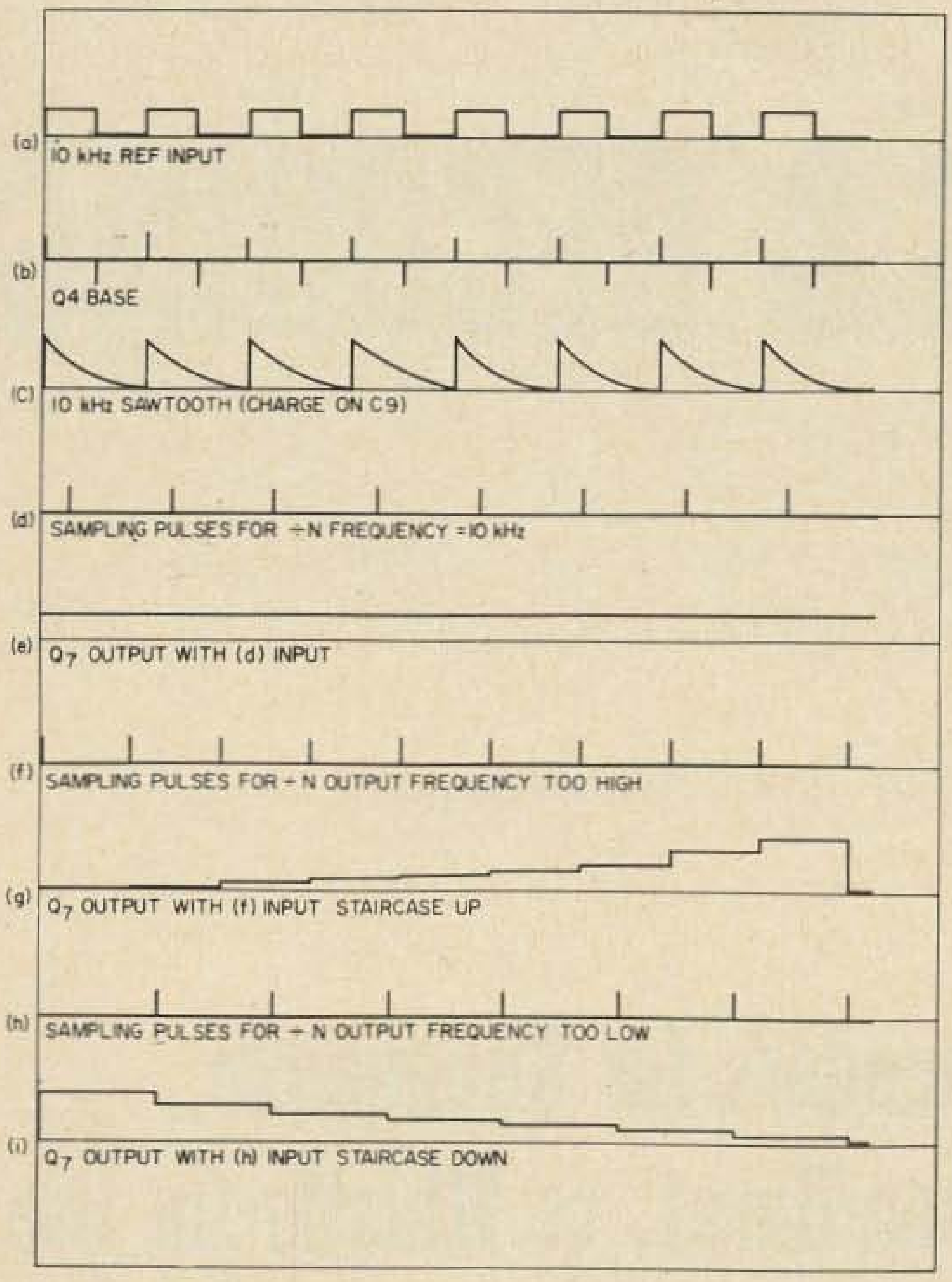
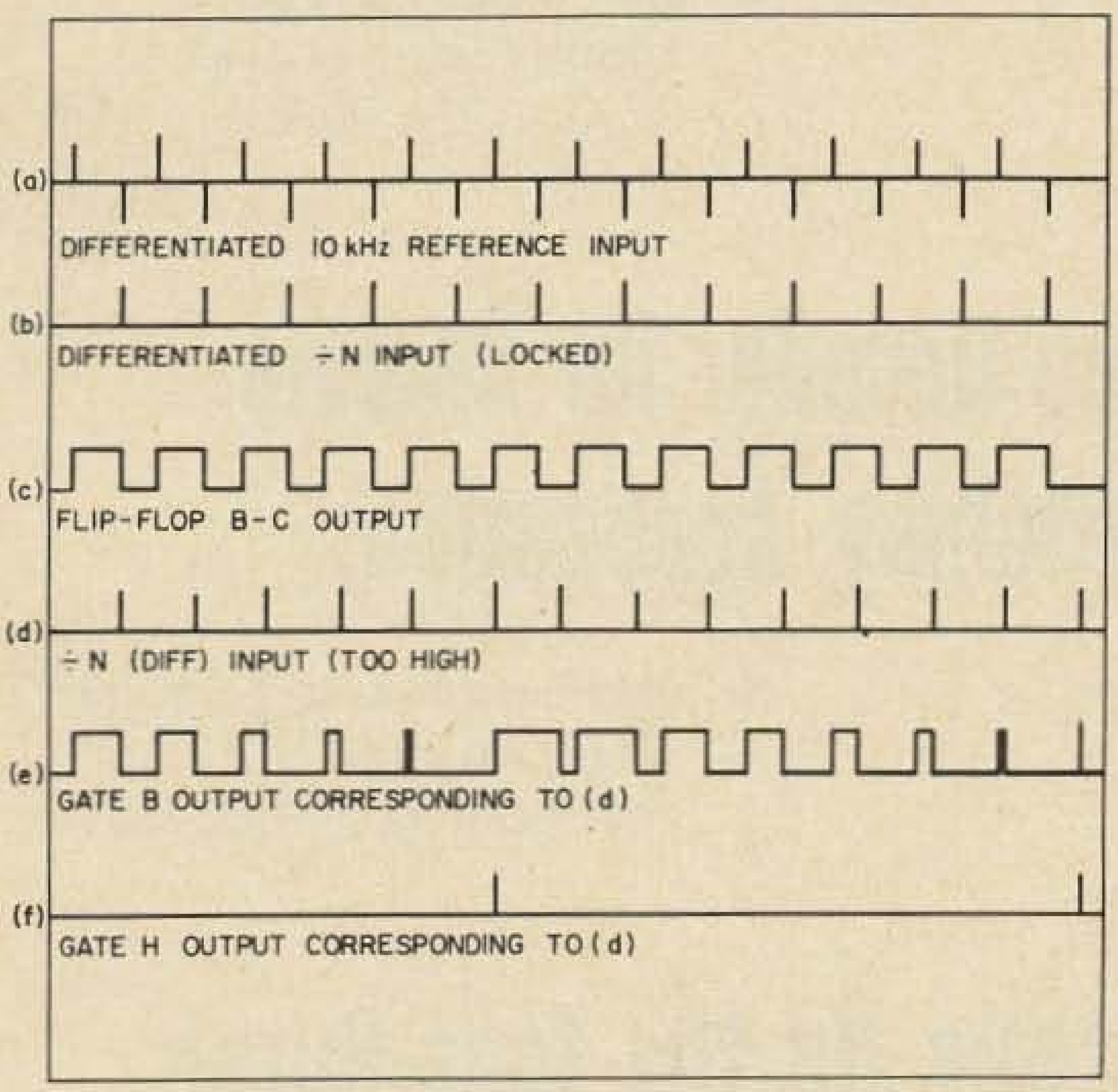


Table III. Search waveforms.



the system will be found helpful in various spots. The most insidious form of system trouble is when complex circuits interact in ways not anticipated; so make sure the circuits function as they should separately, and then combine them in sections. Test everything for proper function before making any attempt to close the loop. When the loop is out of lock, everything jumps at once, and it is truly enough to make a grown man cry. Usually, the only hope is to open the loop and check individual circuits. With experience you can read the signs and troubleshooting becomes just as easy as robbing Fort Knox.

Performance

With a good master oscillator you can get counterlike frequency accuracy on all channels. The author's unit is accurate to better than plus or minus 20 Hz at two meters with a 20 minute warmup. Even without a warmup period, it is considerably better than most crystal-controlled rigs after stabilization.

Unlimited channel flexibility is a recurring pleasure that intensifies with time. Anyone who tells you that you are off frequency has just *got* to be from out of town! Even if you have a doubt, it takes only one quick zero-beating check against WWV to *guarantee* superaccuracy on all channels!

The big worry most people have about synthesizing frequencies is the potential spurious outputs. The author's unit was cheked on an H-P spectrum analyzer from 10 MHz to 2,000 GHz and found to be clean to −70 dB from carrier, excepting harmonics. And even at that level there was only a 5 MHz sideband pair, originating from the master oscillator. Adjacent 10 kHz sidebands couldn't be measured directly, but calculations based on the ripple level measured in the VCO feedback loop indicate them to be over 65 dB down. This figure is consistent with on-the-air observations.

It *is* worth the trouble. You must use a synthesized rig to appreciate it!

GILBERT BOELKE

And They'll All Wear Green . . .

The Annual St. Patrick's Day Swapfest, organized by the Midland Amateur Radio Club, is slated for March 14 and 15. Write MARC, Box 967, Midland TX 79701 for details.

ENCODING & DECODING

. . . a series of three related articles

PART I: Encoders for Subaudible, Tone-Burst, or Whistle-On Use

by John Gallegos W6ZCL
14646 Flatbush Ave.
Norwalk CA 90650

PART II: Tone Decoder for Remote Switching Applications

by Ken Sessions, Jr. K6MVH
73 Grove Ext.
Peterborough NH 03458

PART III: Setting Up the Tone-Burst System

by Les Cobb W6TEE
4124 Pasadena Ave.
Sacramento CA 95821

in FM REPEATERS

COMPLETE IN THIS ISSUE

Editor's Introduction;

An interesting and unforeseen problem developed as a result of the tremendous growth in popularity of FM repeaters: When two or more repeaters operate with overlapping coverage on the same input or output frequency, mobile operators occasionally find themselves triggering more than one repeater. The mobile operator who does so may thus cause interference by his unintentional keying of the repeater in a neighboring community.

As a rule, shifting the frequencies of one of the repeaters is no solution, because both relay stations will want to be on the nationally accepted standard (146.34 MHz input, 146.94 MHz output). Such standardization is a boon to the mobileer who has a limited supply of crystals and must travel across the country or from one area to another once in a while.

But there are workable solutions. More and more, repeaters in highly congested areas are going to a "tone-burst entry" approach or a "whistle-on" system of keying. With a whistle-on system, the control circuits are all at the repeater site. The repeater is never operative unless specifically activated by one of the users. A broad whistle on the input frequency energizes a decoder at the repeater site, which in turn activates the automatic signal-relaying system. Typically, the repeater stays on, once activated, retransmitting the signals of all carriers on the input. When the traffic dies down a bit—that is, after a short period of no signals—the repeater shuts down again, and cannot be used unless someone deliberately calls for it by whistling on the input.

When multiple-repeater conditions are more severe, the tone-burst keying system is the more satisfactory solution. Here, a specific tone frequency—usually 1700 to 2000 Hz—must be present briefly at the outset of every transmission before a signal can be automatically relayed. In practice, all who intend to use the repeater will install simple audio oscillators into their transmitters, connecting them in such a way that the tone comes on briefly each time the transmitter is keyed. The tone, decoded at the receiver of the relay station, is used to activate the repeater— but only for the duration of a single carrier.

The first article in this series of three describes how whistle-on and tone-burst repeater systems are used and presents schematics of a simple oscillator suitable for use in whistle-on systems as well as a "micro-encoder" that can be adapted to either tone-burst entry or subaudible continuous-tone squelch systems. The second article in the series gives construction and theoretical details for a decoder ideal for use with either of the two single-tone oscillators of Part I. The third article, by Les Cobb, describes a network of tone-burst repeaters, and includes information on how to set up a tone-burst oscillator in a mobile transmitter and how to connect a decoder into a repeater system. Together, these three articles provide complete information for converting an existing repeater facility to tone access.

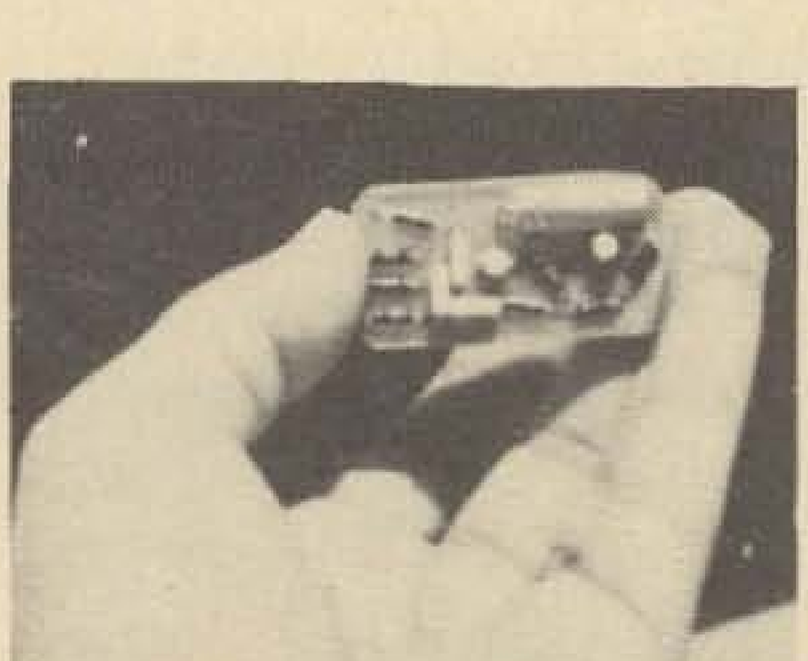
Part I: *by John Gallegos W6ZCL*

Encoders for Subaudible, Tone-Burst, or Whistle-On Use

The FCC sanctions the use of semicontrol techniques such as continuous-tone carrier squelch systems (very low frequency tones accompanying all carriers) and single-tone (tone-burst entry or whistle-on access) in applications where limited access to a remote station or a repeater is desirable. The W6FNO repeater in Southern California went one step further, and the result is a repeater that is fully compatible with two-way nonrepeater operation taking place on the input channel.

In many ways, the W6FNO repeater at Radio Ranch could serve as a model installation: The repeater stands ready for use 24 hours a day and is never shut down where it cannot be accessed by a station on the input frequency. On the other hand, the repeater will shut itself off if a three-minute period elapses with no signals on the input. Sounds a little contradictory, but it isn't—not really. The W6FNO repeater was an experiment to test the concept of subcontrol, i.e., limited control of the repeater from the actual frequency of operation.

The repeater is equipped with two timers. The first timer is a transmission-limiting device: when the input carrier exceeds three minutes duration, B+ is removed from the transmitter final; and it can only be reapplied after the input carrier drops out momentarily. The second timer removes the transmitter B+ also. But in this case, the timer is activated by the absence of an input signal. Since the shutdown is only B+ removal, the repeater is ready to be activated immediately upon application of the proper signal, which in this case is nothing more than a shrill whistle.



Barely more than a thumb's width, the W6ZCL phase-shift oscillator is small enough to be packaged within the case of almost any commercially available hand-held transceiver.

The W6FNO repeater is a "talkback" type, as opposed to a "prime" repeater. A talkback repeater uses a national FM channel as the input frequency and a nonactive channel as the output. A prime repeater uses a nonactive channel as the input and an active, popular frequency as the output. The popular 146.34-to-146.94 repeaters across the country are primes. If the frequencies were reversed, they would be talkbacks.

The active FM channel for direct nonrepeater operation in the W6FNO territory is 146.82 MHz, which also serves as the repeater input. The repeater output frequency is not used at all except by stations who want to hear what's going through the repeater. When two stations are conversing on the FM channel, the repeater is not even a part of the operation unless one of the operators wants it to be (as for instance when the copy gets rough).

When a user wants to monitor the active 146.82 channel, but he is too far away from the area of activity to hear the stations, he merely puts a carrier on the channel and whistles into the microphone. Instantly the repeater comes on, regardless of the time of day or night, and the user finds himself right in the middle of the action. The only

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f) Special overseas prices available to sterling customers. Remember this set works on 230 volts 50 cycles equally well.
g) Offer limited to first come first served. (Although we bought them all they will not last long.)

Price schedule:

NCX-500 with AC-500 (no spkr & no cabinet)	**$299.95**
NCX-500 with NCXA supply (spkr and cabinet included)	**$319.95**
NCX-500 with Linear Systems Universal Mobile power supply 400-12	**$359.95**
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XC-28 plug in solid state Xtal calibrator (available February 15th, 1970)	**$ 19.95**

If you are a beginner or even if you have a big rig and need a second one for a spare, the NCX-500 should be your cup of tea. Study the specs, read the magazine reviews but send in your order while our stocks last.

SPECIFICATIONS

Frequency Coverage: 14,000 - 14,500 kHz, 3,500 - 4,000 kHz, 21,000 - 21,500 kHz, 7,000 - - 7,300 kHz, 28,500 - 29,100 kHz.

(Two additional crystals available at $7.00 each to provide expanded coverage of entire ten meter band)

Power Input: 500 watts PEP on side band; 360 watts on CW; 125 watts on AM; Derated 20% for mobile operation. **Emission:** SSB upper on 10, 15, and 20 meters; Lower on 40 and 80. **Output Impedance:** 40-60 ohms minimum pi network. **Receiver offset tune:** By means of a varactor controlled oscillator you obtain plus or minum 3 kHz. **SSB Generation:** Crystal lattice filter 6-50 DB shape factor 2.2-1, gate 2.8 kHz on 6 DB; center frequency 5.202 MHz; uses stable solid state ring modulator. **Dial Calibration:** 5 kHz on all bands. **Tuning Ratio:** Excellent mechanical resolution with 45-1 rate. **Electrical Stability:** Nominally 1,500 cycles in first thirty minutes. Thereafter, plus or minus 400 cycles for room ambient. **Suppression:** Carrier minus 50 DB, rejected side band minus 40 dB, third order products minum 30 dB at full output. **Sensitivity:** .5 microvolts for 10 dB s/N in SSB mode. **Audio Output:** Better than 2 watts into 3.2 ohms. **Metering:** PA cathode current in transmit, S units on receive. **Special Features:** Includes side tone monitoring plus built in code practice oscillator for novices; incremental tuning; provision for crystal calibrator. **Dimensions:** 6-3/16" high by 13-3/8" wide by 11" deep. Weighs but 15 pounds. **Accessories Available:** AC-500 21 pounds; NCXA 25 pounds; 400-12 DC supply 13 pounds; AC supplies operate on either 117 or 234 VAC 50-60 cycles; suitable for export; Mobile bracket and instructions furnished at no extra charge. **Shipments:** Preferably via United Parcel Service, Railway Express or Parcel Post. Specify and include provisions for same otherwise charges will go COD.

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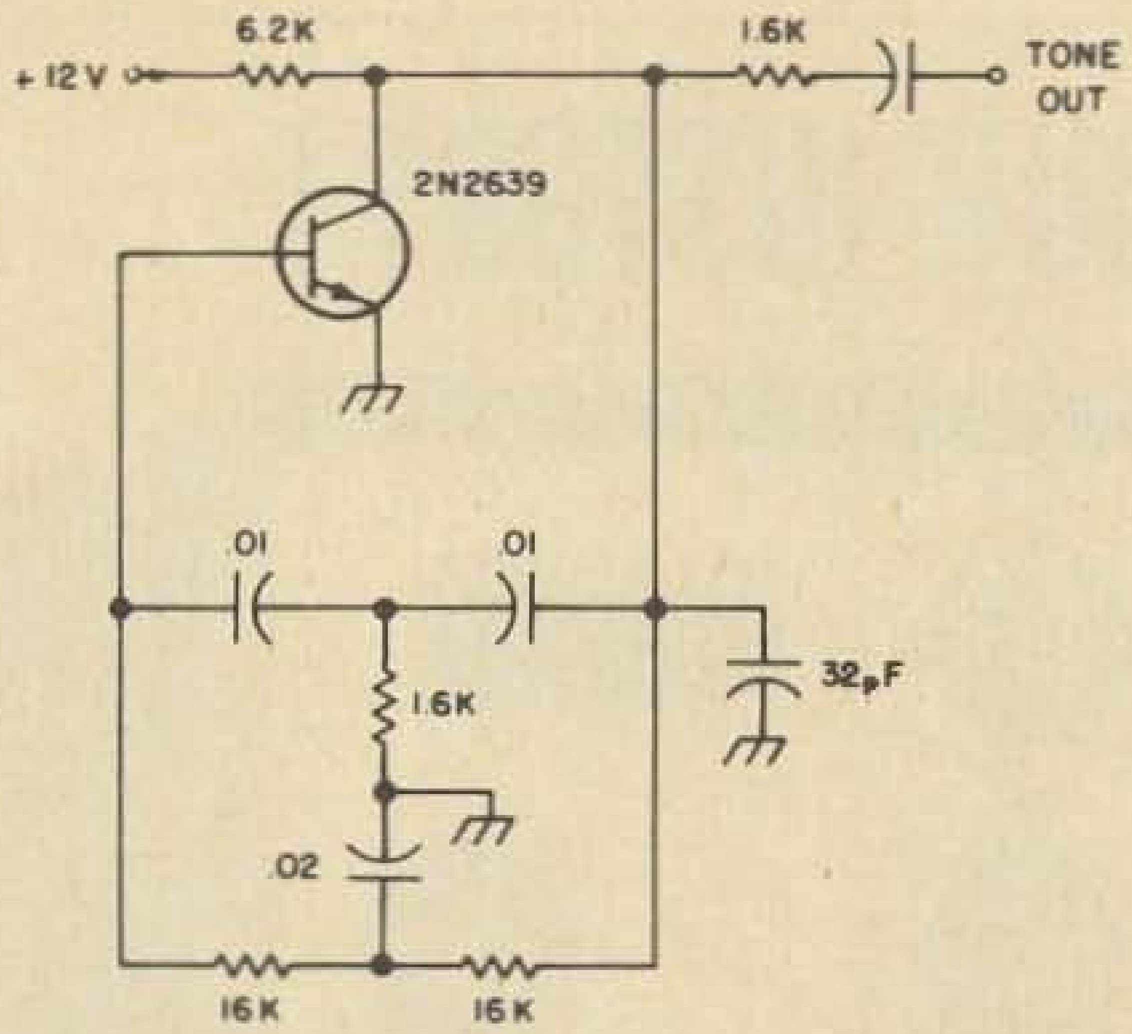


Fig. 1-1. Single-transistor tone oscillator for tone-burst or whistle-on use produces 1750 Hz at sufficient amplitude for most transmitters.

difference is that he hears the 146.82 action on some other channel.

The decoder at the repeater site that provides the turn-on function is nothing more than a simple frequency-to-dc converter such as the semiconductor decoder shown in the second article of this three-part series (included with this issue). This device is set to respond to as broad a range of frequencies as possible without being energized from ordinary conversations.

Even though the W6FNO decoder was set to respond to a wide frequency range, a few users found it difficult to key the repeater on by whistling. Perhaps their audio levels were not quite what they should have been to reproduce properly the required tone (1750 Hz), or perhaps they were simply not proficient whistlers. At any rate, I decided to install a simple automatic whistler in each of my transmitters.

The circuit is the epitome of simplicity: a single-transistor oscillator using a twin-T feedback network. As can be seen from the circuit of Fig. 1-1, a few minutes and a good junkbox are all that is required.

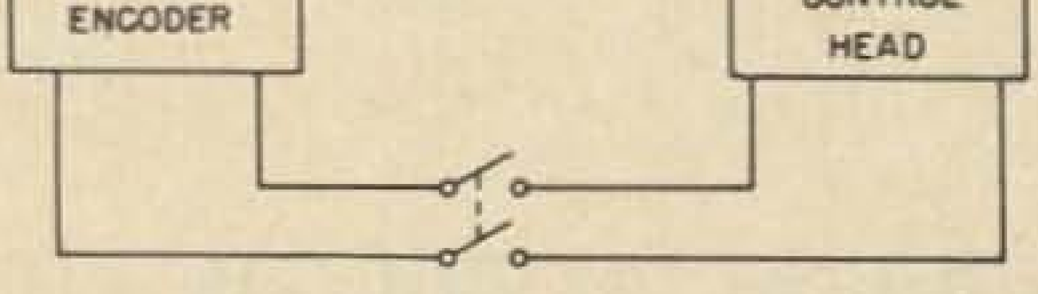


Fig. 1-2. A momentary-contact switch can be used as shown to interconnect the encoder audio into the mike line at the control head for whistle-on applications.

I didn't connect the whistler so that it would go on with each transmission. Not only would this have defeated the purpose of the repeater's automatic-off function, but it would have given my signal the unpleasant characteristic of a squeal at the outset of each transmission. Instead, I connected the device into the transmitter so that it is energized by pressing a momentary-contact switch on the control head. Figure 1-2 shows how the oscillator is interconnected into my Motorola mobile unit.

The oscillator circuit shown in Fig. 1-1 works for tone-burst entry applications, too, where the tone frequency tolerances are not particularly critical. But the interconnection would have to be a little different from that shown in Fig. 1-2. For tone-burst operation, remember, the audio note must appear for a short period every time the transmitter is keyed. A timing circuit for accomplishing this is shown in Part 3 of this series, Les Cobb's article entitled "Setting Up the Tone-Burst System."

Where the tone frequency is critically set, decoder instability is intolerable and whistling won't quite cut the mustard. For such applications, the encoder requirements become quite stringent. But it is possible to build a highly stable encoder unit with a minimum of parts. The circuit described below, for example, represents a very versatile transistorized encoder that can be built small enough to use with hand-held transceivers, yet stable enough for the most demanding applications normally associated with FM two-way communications. Because of its tiny size, I call the device a "microencoder."

A particularly attractive feature of the microencoder is the fact that it can be used for either continuous-tone squelch (commonly known in these parts as PL, for Private Line), or for tone-burst entry. As noted in the editor's introduction to this series, a continuous-tone squelch scheme utilizes a subaudible very low-frequency note, whereas the single-tone method depends on generation of a fairly high-frequency note. Most low-frequency encoders require vibrating reeds for stability; the one described here is a notable exception.

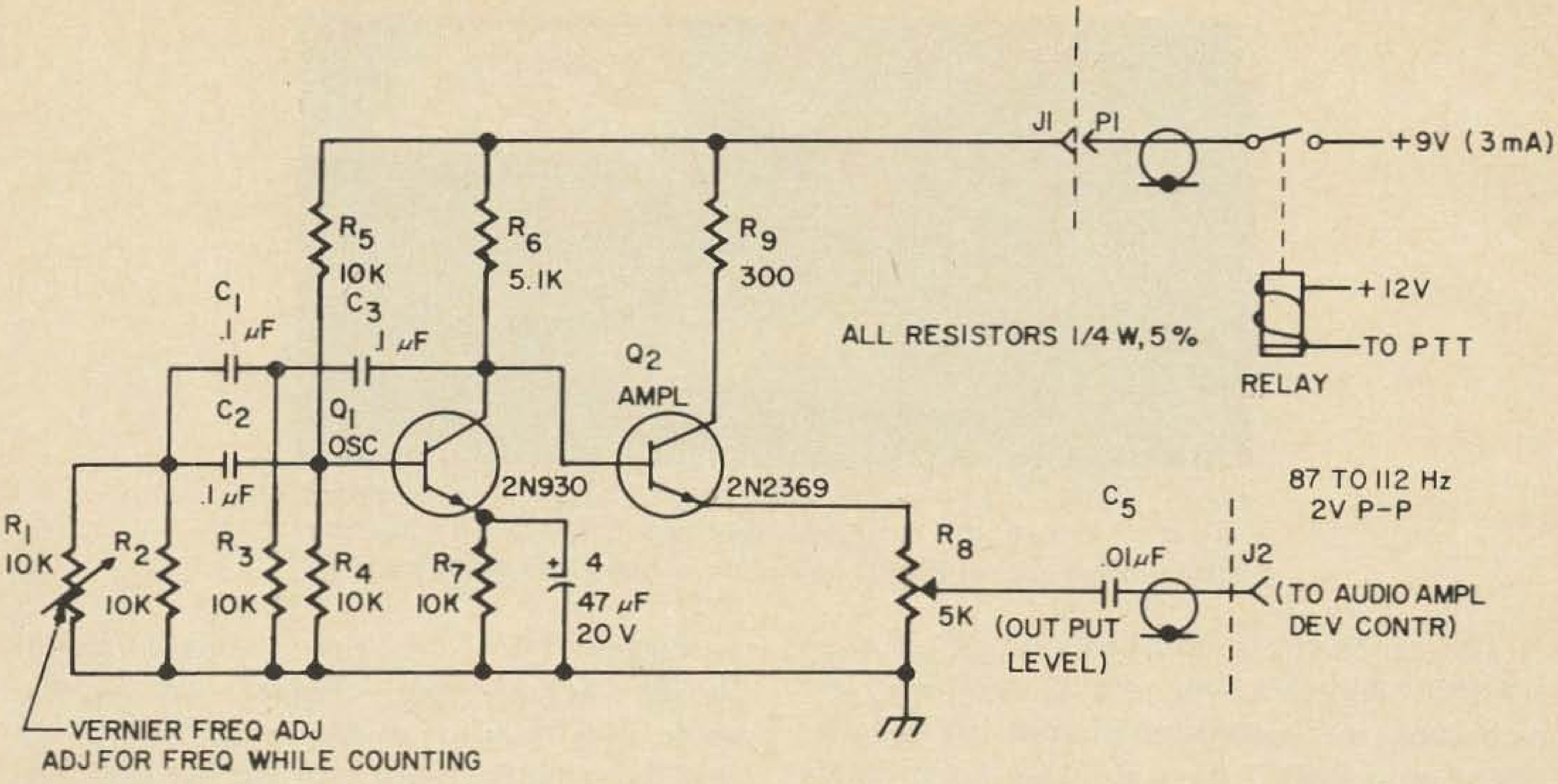


Fig. 1-3. Schematic diagram shows basic circuit as used in a continuous-tone-squelch repeater access system. Parts values shown are not applicable to single-tone encoder applications (see text).

Figure 1-3 is the schematic diagram for the unit, which is essentially a phase-shift oscillator coupled into an emitter follower. Since the power consumption of the oscillator circuit is so low, a standard 9V transistor-radio battery will provide an ideal power source. At full output, the oscillator draws no more than about 3 mA.

Table I. Parts Lists for CTS and Single-Tone Systems

Component	87—112 Hz range	1750 Hz
R1	10 pot (multiturn)	50K pot (multiturn)
R2, 3, 5	10K	47K
R4	10K	22K
R5	10K	47K
R6	5.1K	5.1K
R7	5K pot (multiturn)	4.7K 5K pot (multiturn)
R8	300Ω	300Ω
R9	0.1μF	0.001 μF
C1, 2, 3	47 μF, 20V tantalum	47 μF, 20V tantalum
C4		1 μF
C5	0.01 μF	tantalum
Q1	2N930	2N930
Q2	2N2369	2N2369

Table I shows two complete parts lists. The application of the encoder (continuous-tone squelch or tone-burst entry) will determine the parts selection for your particular use.

The very small size and the apparent simplicity of the microencoder might logically lead you to suspect its performance. But these factors notwithstanding, the device can produce a very healthy looking sine wave, as can be seen from the photo of **Fig. 1-4**. Laboratory temperature cycling tests on the three units that I built indicate that the tone output will remain stable and will not drift more than 0.5 Hz over the range of 25-60°C. My units were built using disc ceramic capacitors, incidentally, substitution of Mylar capacitors for C1, C2, and C3 will undoubtedly result in even better temperature stability.

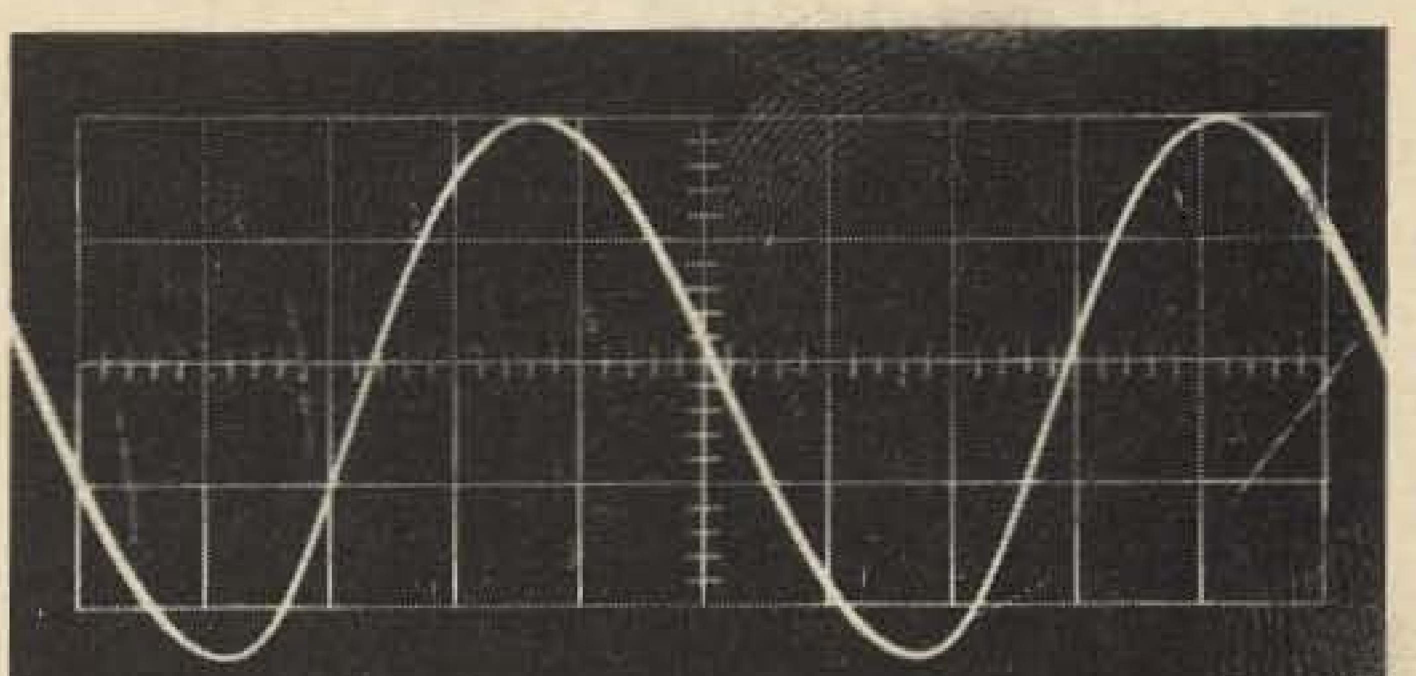


Fig. 1-4. Scope trace shows the sine wave obtained with the author's encoder unit. Increments shown are 2 msec per centimeter for the horizontal scan and 500 mV per centimeter for the vertical scale.

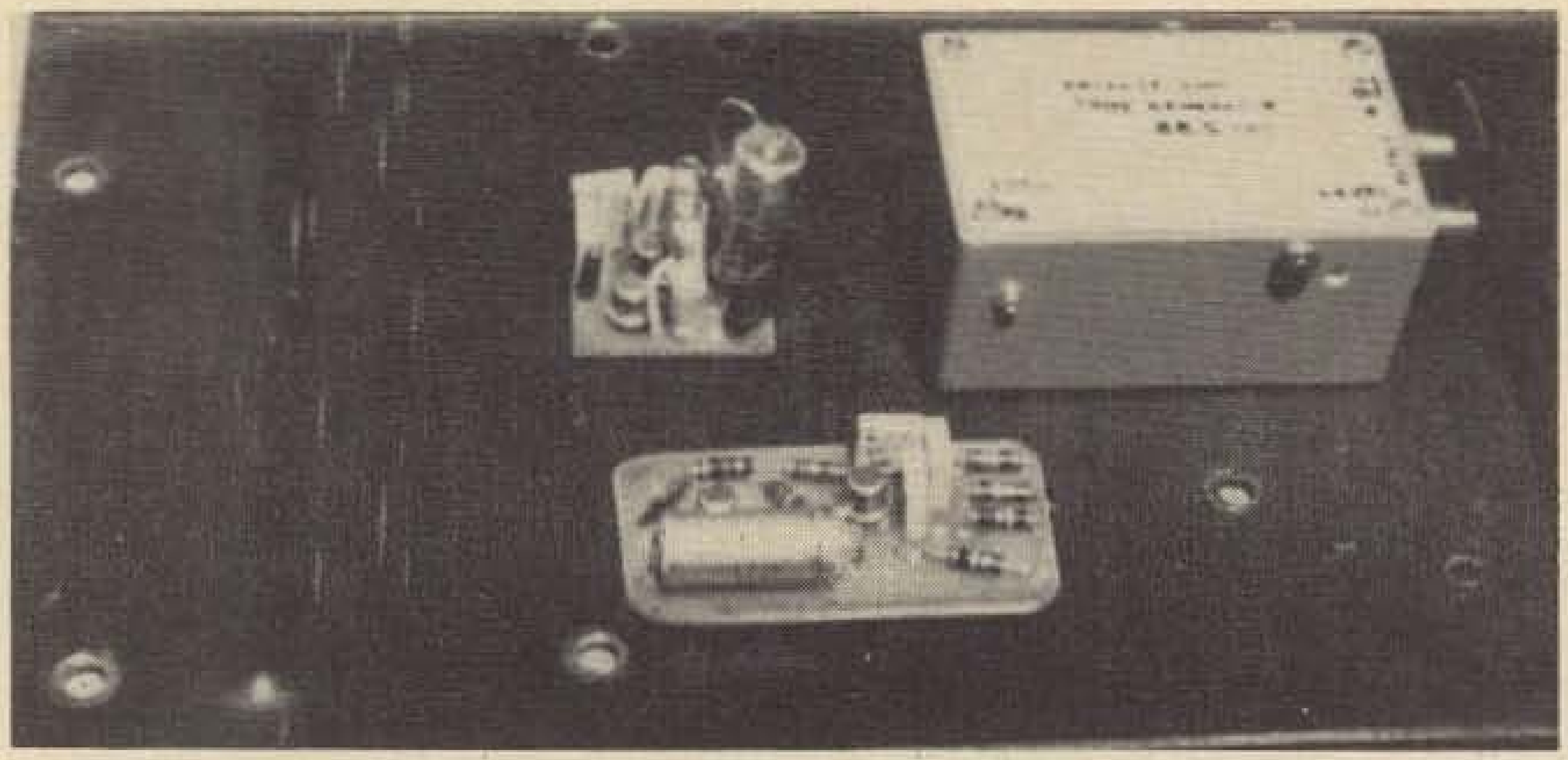


Photo shows three separate packaging schemes: printed-circuit layout; "cordwood" technique, and the "crystal-can" method, using a conventional Pomona Electronics miniature mounting box.

The schematic shows transistor Q1 to be a 2N930, but this type was chosen arbitrarily because it is something I happened to have "kicking around." Actually, any good NPN will suffice, as long as it is a type with a *beta* of 100 or so. The transistor used for the emitter follower is even less critical, and can be effectively duplicated with just about anything in the junkbox that has the same polarity.

As a continuous-tone-squelch encoder, the one mounted in my 41V has proved quite capable of keeping me communicating through the local toned repeater, which uses a GE KT-5 decoder to open the squelch with an input of 88.5 Hz. Another of the units, built from the other parts list, of course, very efficiently provides me with a 1750 Hz tone burst when I operate through the W6FNO repeater.

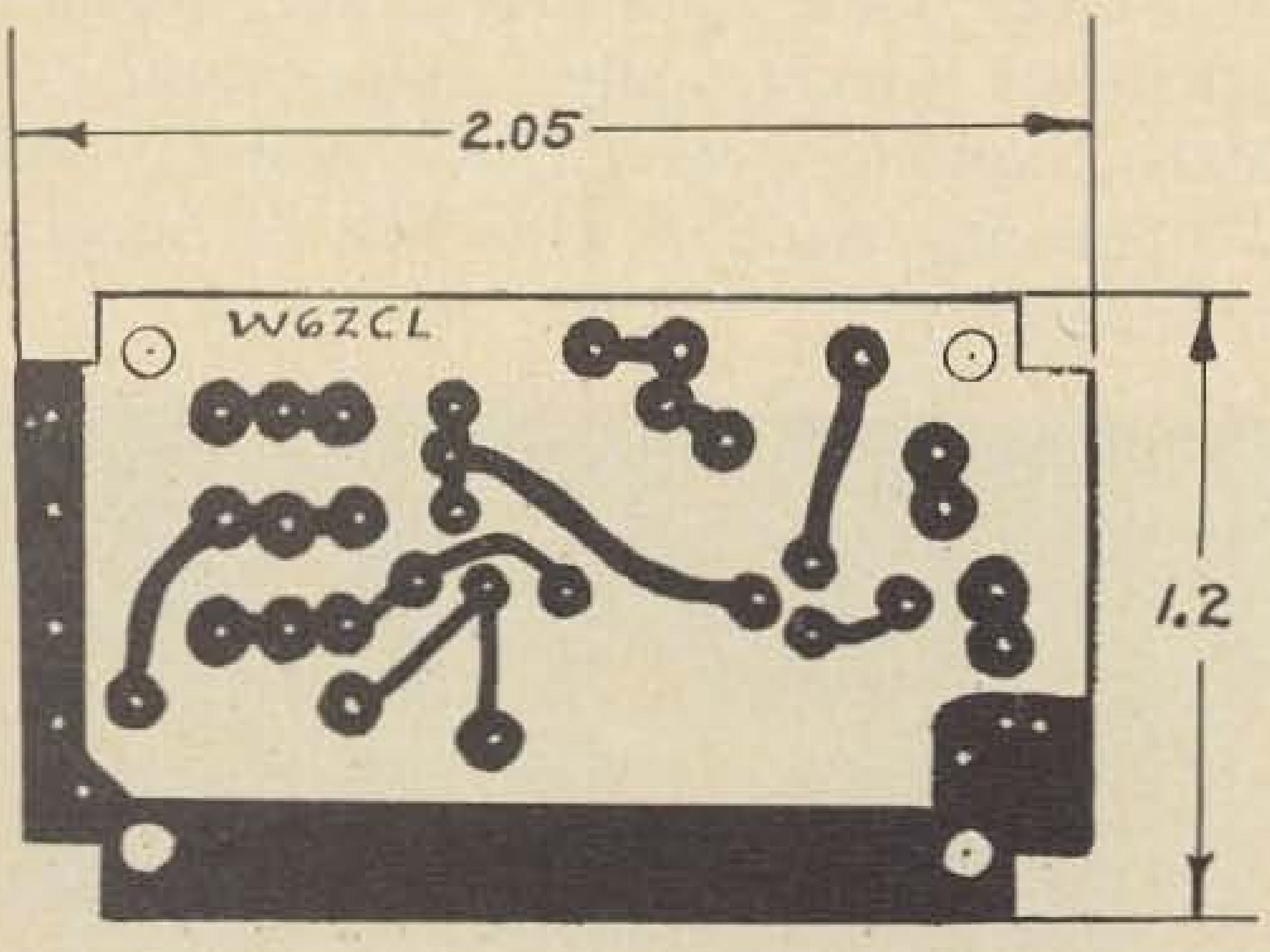


Fig. 1-5. Actual-size reproduction of printed-circuit layout. The copper side of the board is shown; components all mount from far side. (There is no copper on the component side.)

Figure 1-5 is a circuit board layout shown actual size. **Figure 1-5** is for those of you who intend to do the job up first class with printed-circuit wiring. The printed-circuit version looks sharper, of course, and it has the added advantage of ending up with a slimmer overall profile. The layout shown in **Fig. 1-6**, however, is perfectly satisfactory for "brass-board" models. This version requires nothing more than a few holes and some standoff terminals on a flat piece of almost anything.

The dimensions of the boards are suitable for mounting the completed unit inside a Pomona Electronics Model 2417 shielded box ($1.50 at practically any self-respecting electronic sales outlet). The low-frequency version that I am using is mounted on the inside rear chassis wall of my mobile 41V,

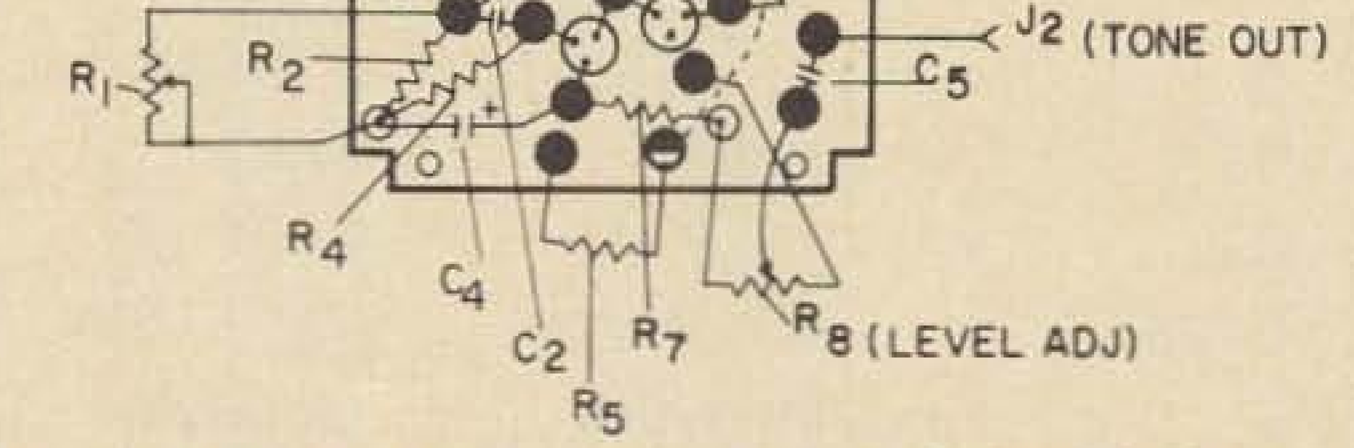


Fig. 1-6. Wired-board layout was designed for use with Sealectro push-in Teflon standoffs and ground terminals. Transistors can be held in place by TO-18 heatsinks. (Heatsinking is actually unnecessary. The cases of the transistors are hot and must be insulated from ground; the heatsinks perform this job by virtue of their anodized finish.)

immediately above the transmit crystals. I use miniature coax to apply the dc supply voltage (9V) and to carry the 88.5 Hz signal to the deviation control potentiometer through a 500 kΩ resistor, as shown in **Fig. 1-7**. If space is not available in the radio to mount the Pomona box, the printed-circuit board itself can be mounted in any available underchassis spot. The two variable resistors can be replaced without detriment by fixed resistors after the proper values have been

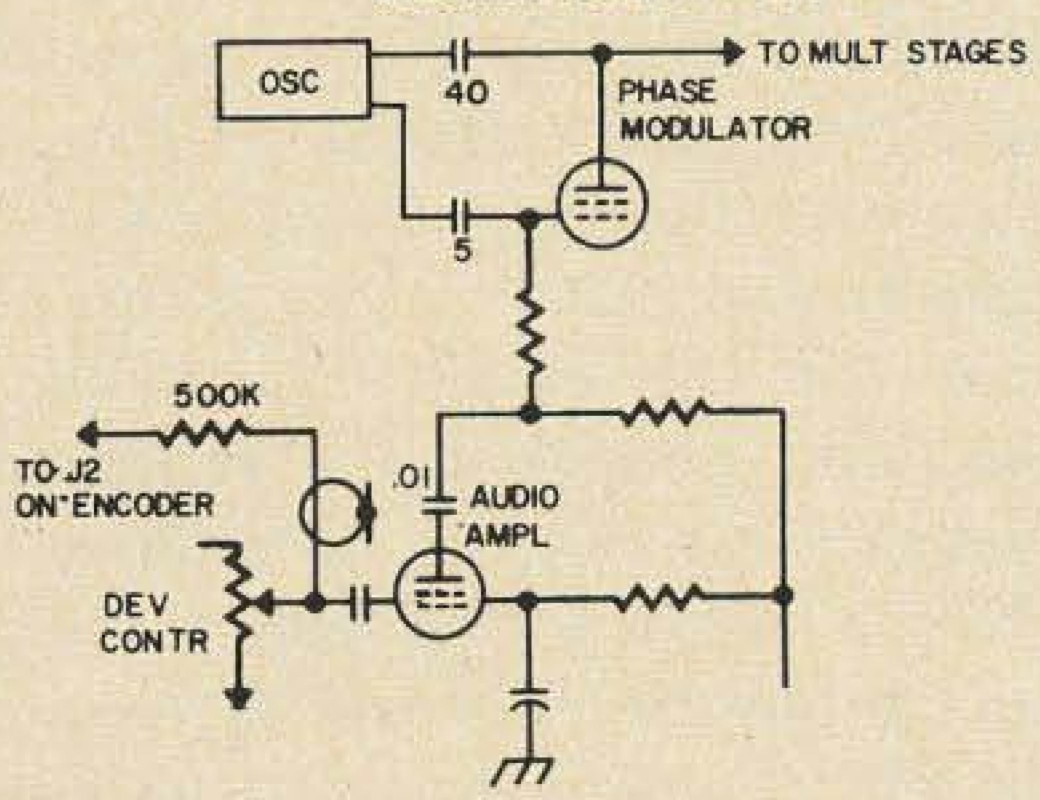


Fig. 1-7. Schematic showing manner in which the low-frequency version of the phase-shift oscillator can be tied into the transmitter.

determined for your particular frequency and output-voltage level. But potentiometers are handy if you have the space. If you *can* use them, I suggest the use of the miniature multiturn devices (Bourns *Trimpots*), because of the vernier tuning they afford.

The parts lists shown in **Table I** cover the continuous-tone-squelch range of 87–112 Hz and the single-tone frequency of 1750 Hz. For those whose requirements are not met by either of these sets of values, the frequency of the encoder may be calculated from the equation

$$f = \frac{1}{2\pi\sqrt{6RC}} \qquad \frac{0.085}{RC}$$

If the single-tone version is used rather than the continuous-tone-squelch version, the audio need not be coupled to the transmitter as shown in **Fig. 1-7**. At these higher frequencies, it is practicable and convenient to simply mount the encoder unit inside the control head and connect the audio output lead from the oscillator directly onto the mike line. If you choose to adopt this method, just connect a 200Ω resistor in series with the tone oscillator output lead before attaching it to the carbon mike pin on the control head connector.

If the local repeater is the whistle-on variety (rather than tone-burst entry), you might also find it convenient to run the audio lead through a single-pole switch mounted on the control head. In this way, you can switch the tone on whenever you want it, and keep it out of the circuit the rest of the time. (A whistle-on repeater stays on after the tone is applied for a few milliseconds, and does not drop off the air until several minutes after the repeater is not occupied.)

For tone-burst entry applications, the timer circuit described in Part III will prove very worthwhile. With the addition of this simple timer, the oscillator can be made to key on briefly with each initiation of the push-to-talk circuit. (Again, a tone-burst-entry system requires a short fixed-frequency tone to accompany each incoming signal to be repeated.)

. . . W6ZCL■

Part II: *by Ken Sessions, Jr. K6MVH*

Tone Decoder for Remote Switching Applications

The most critical element of a tone-access system is the decoder. When some problem exists in the encoder, or when the encoder frequency shifts a bit or when the encoding level goes up too high or down too low, the control operator can solve the problem with a few local adjustments. But when the decoder starts acting up, the impact can be a great deal more severe: In the first place, the decoder is installed at the repeater site, which is, more often than not, situated atop some remote mountain peak–miles (and sometimes hours) from physical accessibility. Second, while an encoder malfunction affects one individual's operation, a decoder problem affects the operation of every user of the repeater. Thus, care in building and sound conservatism in design are paramount considerations in deploying a tone control scheme.

I have had occasion to use many decoders during my days of remote control and repeater operation–some homebrew, some commercial. (Virtually every aspect of remote control involves the installation of a tone decoder somewhere along the way. And I can truthfully say that I have never come across a circuit that offered performance superiority over the one shown in **Fig. 2-1**.

I hasten to add that I can lay no claims as to design, for the circuit illustrated was conceived, built, debugged, and perfected by Bob Mueller (K6ASK), of Alhambra, California. Nor is this the first time the circuit has been published. I have incorporated copies of the circuit in past articles dealing with remote control of telephones, function selection in repeaters, and coded signaling for selective-call applications. It simply is a good sound circuit and can be applied wherever there exists a need to perform a switching function in one place by radio command from another place.

Decoder Requirements

The response curve of the decoder must be selective enough to preclude the possibility of off-frequency signals triggering the system, yet broad enough to allow decoding under a variety of input signal conditions.

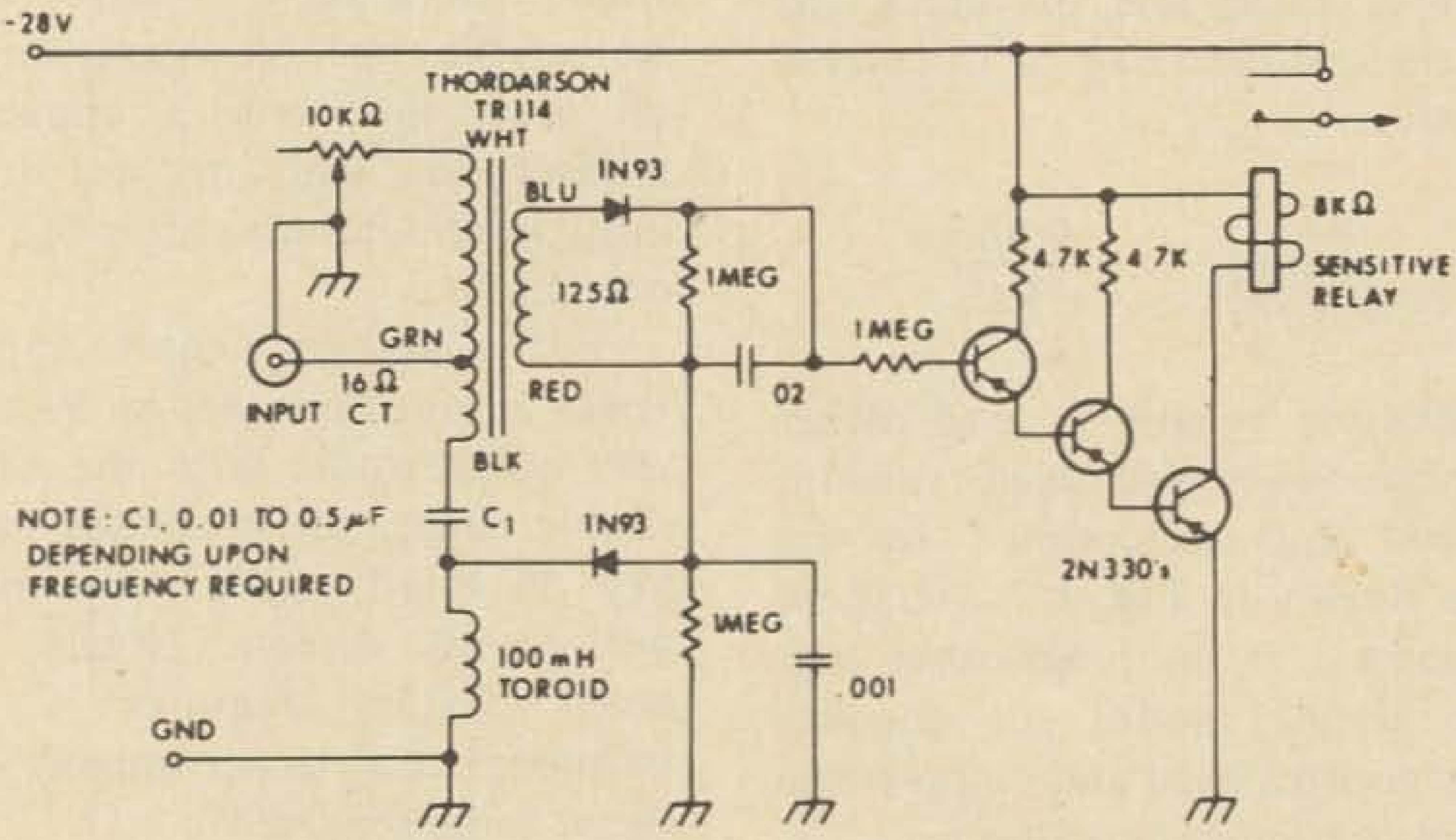


Fig. 2-1 Single-tone decoder.

Ideally, a control should be available so that the threshold sensitivity of the decoder could be adjusted.

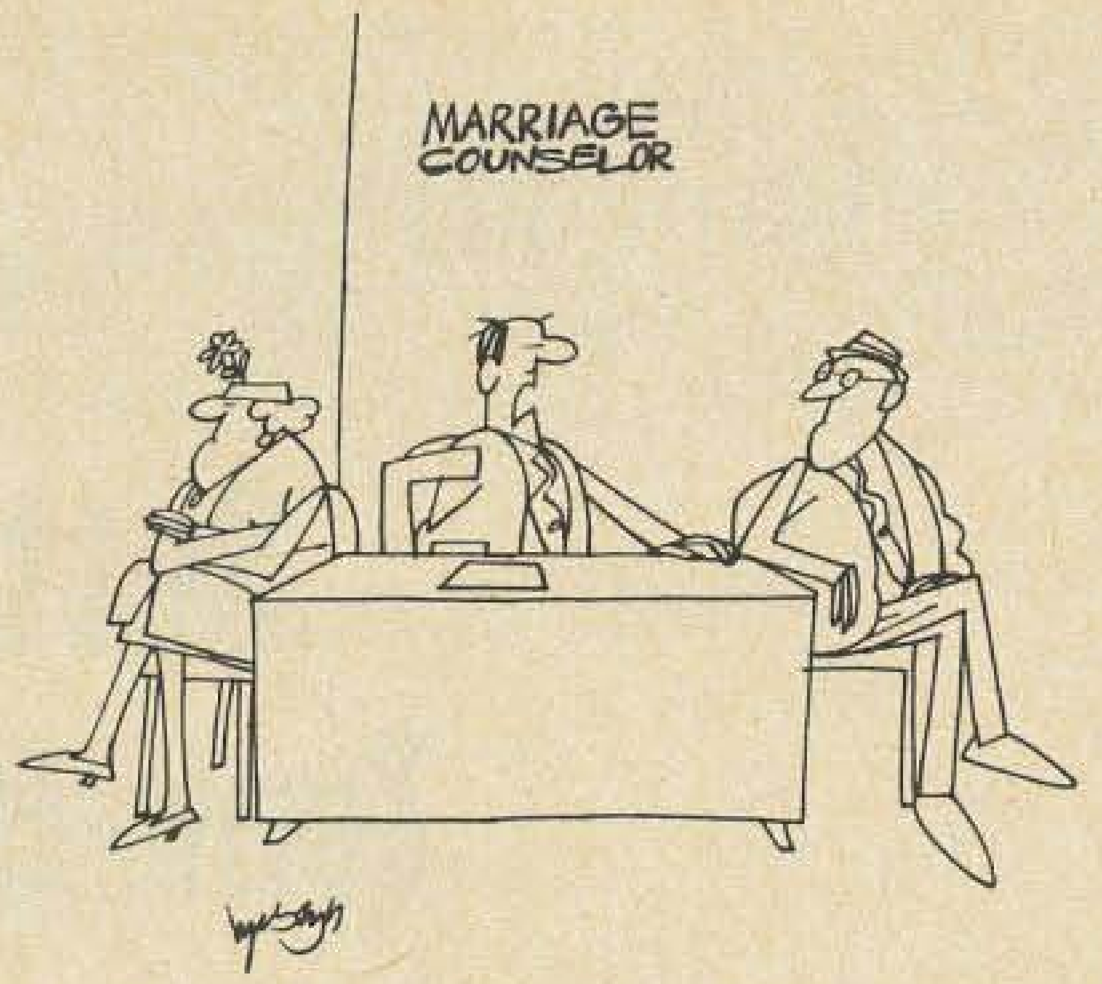
Adjustment of the input sensitivity accomplishes the effect of narrowing or broadening the spectral response of the device. At the least sensitive setting, the decoder has an input bandwidth of about 50 Hz. As the series resistance to the input of the transformer is decreased, the bandwidth widens. In the most sensitive position, the decoder will respond to a bandwidth that includes random noises and high-pitched voices. Thus, the decoder should fulfill the requirements of the whistle-on crowd as well as the more critical needs of the tone-burst fans.

The frequency of the decoder, using the values shown in the schematic, is 2300 Hz. This frequency can be shifted by the expedient of changing the value of capacitor C1. The 2300 Hz is fully appropriate for tone-burst applications, where voice tripping is to be avoided and whistle-on use discouraged. (The frequency is high enough to make whistling a difficult method of access.) It should be reemphasized, however, that whistle-on use of this decoder is possible—using the values shown—by simple adjustment of the sensitivity control of the input transformer.

Interconnection

The simplest part of getting a tone-access system to work is the interconnection of the decoder itself. All you have to do is provide the proper power to drive the transistors and relay, then connect the speaker audio from the repeater receiver to the low-impedance input of the decoder. After that, it is simply a matter of making a few adjustments with respect to level (at the decoder input and at the receiver output). When the controls have been properly set, an incoming tone of the correct frequency will cause the plate relay in the decoder to close. Use of the relay's contacts is a matter that is best left to the judgment of the repeater owners. If you're short of ideas, however, you might just read on. Part III tells how to go about setting up a complete tone-burst-entry repeater system. And the decoder described here will fill the bill nicely for that application.

. . . K6MVH■



". . . she wants to give you a divorce so you can marry your ham radio equipment."

Part III: *by Les Cobb W6TEE*

Setting Up the Tone-Burst System

Among the various techniques for selective control of remote devices, including repeaters, one of the simplest is tone-burst keying. This method consists of a short burst of a specific audio tone automatically sent at the start of a transmission. In a repeater application, a burst detector (see Part II of this three-article series) is used in conjunction with the carrier-operated relay to activate the repeater transmitter upon reception of the proper burst frequency, and to hold it on as long as the incoming carrier is present.

The simplicity and versatility of tone-burst keying should not be overlooked where a simple control or selection function, not related to primary control, is required. As an example, the number of 146.34-to-146.94 repeaters on the air or being built in Northern California and Nevada was such that it became obvious that overlapping input coverage was going to cause unintentional keying and interference to adjacent machines. To obviate this, a tone-burst frequency allocation plan was agreed upon. As shown in **Fig. 3-1**, the plan covers four repeaters and one remote base station with a burst-protected 146.94 receiver.

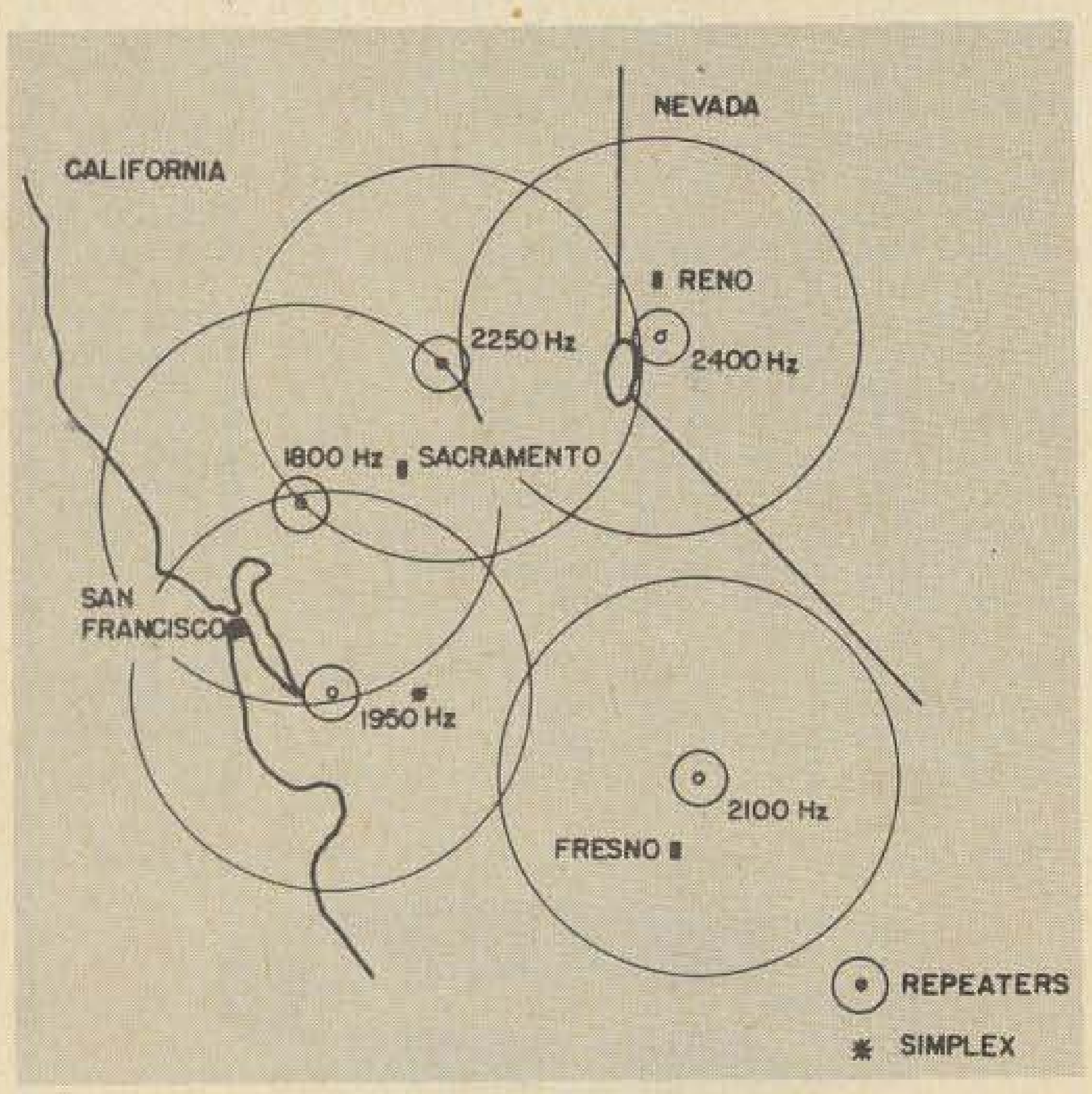


Fig. 3-1. Tone-burst entry plan—34/94 repeaters—No. Calif./Nevada.

While it is admitted that the tone-burst approach does not solve all of the problems associated with overlapping repeater coverage, it certainly tends to minimize them by permitting the users to call for only the particular repeater needed for a given two-way communication exchange.

If tone-burst entry is used on open repeaters on the nationally adopted frequency of 146.34, some semblance of standardization should be maintained to give travelers some hope of universal access capability. Partly because of the abundance of Motorola equipment, the frequencies long considered standard by Motorola are most common in amateur use. The following frequencies are stock outputs for the Motorola P-9301A encoder: 1800, 1950, 2100, 2250, and 2400 Hz.

In amateur service, there are many tone-burst systems operating in the 1700 to 1800 Hz range, but these lower frequencies might better be reserved for whistle-on use because of the ease with which they can be orally reproduced.

For those wishing to use commercial equipment, the Motorola P-9301A encoder and P-9303 decoder are available on the surplus market. More recently, the Motorola SP-1005-TAAE solid-state under-dash oscillator has become available. This unit has a selector switch and can generate all tones from 1800 to 2400 Hz, in 150 Hz increments.

But if you've a mind to build up the encoders and decoders, the circuits shown in the accompanying articles should do nicely. That leaves only the problem of interconnection.

When an encoder such as the one depicted in Part I is used, some means must be employed to limit the oscillator's output to no more than a half-second or so with each keying of the transmitter. To accomplish this, the timing circuit shown in **Fig. 3-2** was developed by K6GUC. In his approach, the 12V supply for the encoder must be keyed on and off with the transmitter.

At the repeater site, some wiring must be done at the decoder to keep the transmitter locked on for the duration of a carrier, even though the tone itself drops out. **Figure 3-3** illustrates how this might be easily achieved. The repeater control relay (K2) should be fairly husky; it can be driven directly by the decoder relay (K1). It is not wise to derive the K2 switching functions by wiring the contacts of K1 directly, because K1's contacts are likely to be of a delicate nature. K1 is a sensitive, current-operated relay and its contacts are best used for no greater requirement than to control a heavy-duty dc relay.

. . . W6TEE ■

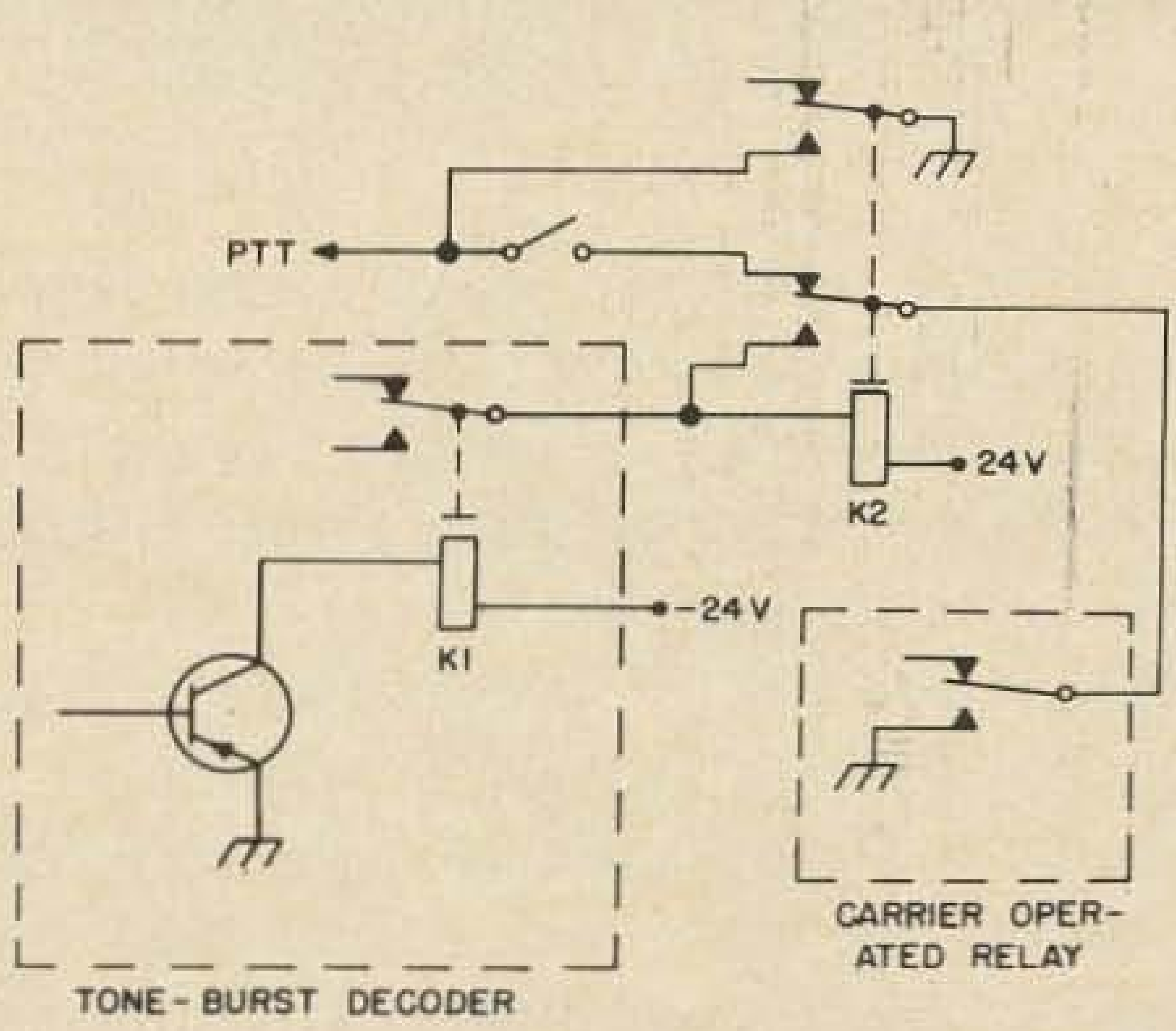


Fig. 3-3. Burst decoder and carrier-operated relay connections.

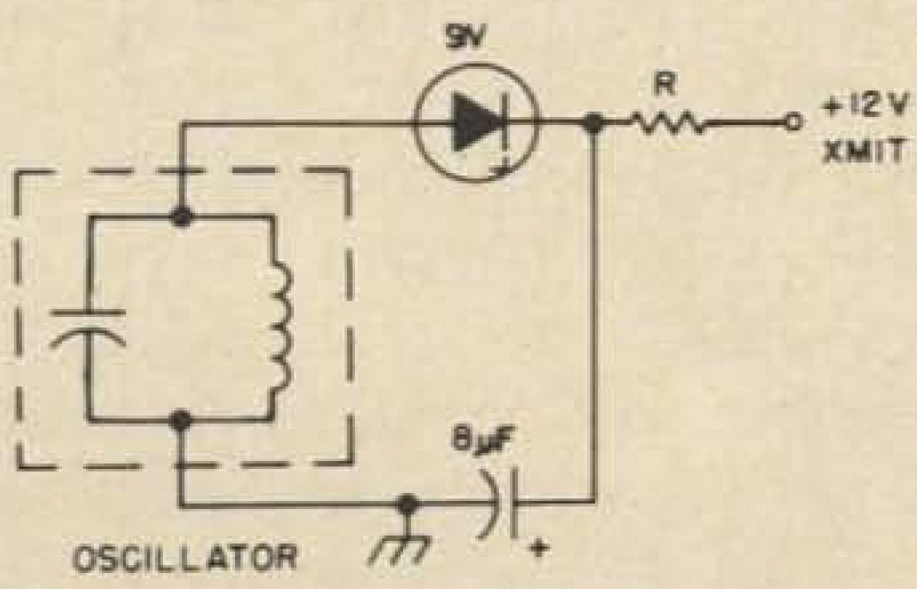
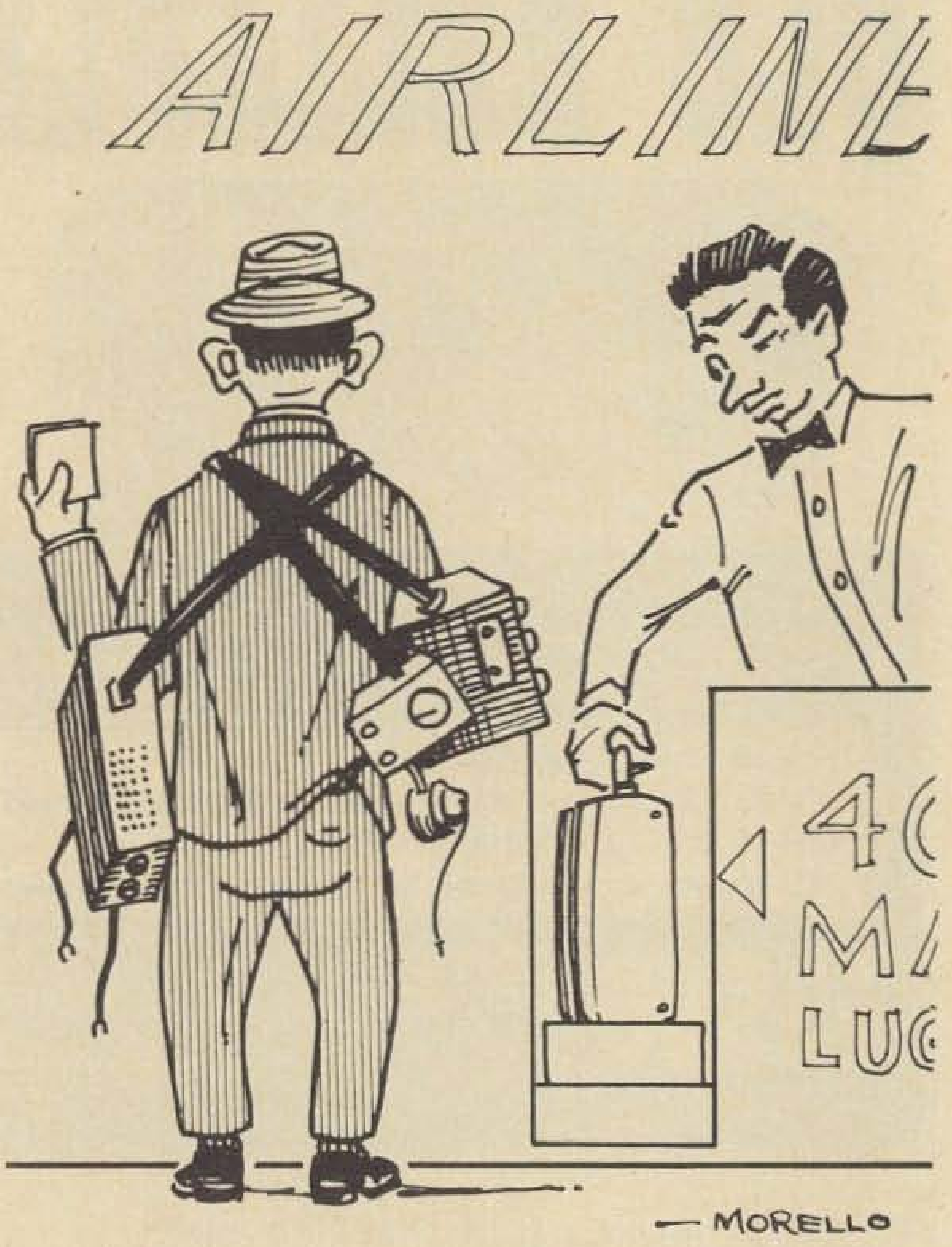


Fig. 3-2. K6GUC tone-burst timer.

HOW TO VISIT FOREIGN COUNTRIES



by Wayne Green W2NSD/1

A reader, about to make a trip abroad, asked for hints on how to get in touch with amateurs in foreign countries. As one who has done this sort of thing a lot, I think I have some helpful ideas.

First, by way of preparation, I devote several weeks to intensive activity on 20 meters. I look for contacts in the countries I am about to visit, and I find that these contacts almost invariably lead to interesting invitations to dinner and sightseeing. They also lead to my getting to meet many more of the local amateurs.

I follow up my contacts with a QSL card and a letter giving my itinerary in detail for my trip. If I am going to be met at the airport, I try to make sure that my DX contact knows just what flight I will be on, and I let him know immediately of any plan changes. I realize that he will be taking a lot of trouble on his end, rearranging his work schedule, his family plans, and setting up meetings with friends, so I try to be as considerate as I can. If I am not traveling a long distance, I phone ahead and let him know that I am on schedule.

It is well worth while to write ahead to the secretary of the national amateur radio club of the country you are going to visit. The club officer can arrange for you to meet a representative and this often leads to introductions to local amateurs, visits to club meetings, and even getting in touch with someone to stay with on occasion.

If you are interested in operating, the club can often help you to get an operating permit and may even have a club station available for you. If you use the call letters of the station, often no permit is required and all you have to do is just sit down and operate. I have done this from dozens of countries. Always offer to take care of the QSLing brought on by your operating.

Rare Countries

There are very few rare countries where there is not even one active amateur. If you are going to DXpedition to a completely inactive country, you will have to bring along your own equipment, obviously. This is expensive and difficult, as any reading of articles by DXpeditioners makes very clear. For my part I avoid countries of this rarity and try and stick to those that have at least one active amateur.

I have found that the amateurs in rare countries are all too happy to have me visit and sit down for a day or so at their rigs and rack up a few thousand contacts. The pressure for contacts and more contacts every time they get on the air gets to be depressing after a while, and they tend to limit their operating time or keep out of the American phone band. In just a couple of days I can take a lot of this pressure off.

English is the native language for very few DX operators, so I find that under QRM conditions I can make contacts many times as fast as can the local op. Knowing English, I can sort out call letters quickly from the mass of calling stations.

Even when I visit relatively common countries I find that I get pileups. When operating from 5Z4ERR in Nairobi I gave contacts to a lot of the lower power stations that normally miss out on DX. Further, I found that I was in great demand by mobile ops by the dozens. My system of working right down to the weakest signal in each call area made it possible to work even the flea-power stations.

When I visited FK8 I found that the country was in great demand because almost all of the local ops spoke only French. The FK8 ops appreciated my getting a few thousand W's off their backs by giving them a contact with their country. Ditto FO8 in Tahiti.

Your trips abroad will be infinitely more fun if you make arrangements to visit amateurs. They will wine and dine you, show you their city and country, just as you would them. They will offer to put you up and they will get in touch with friends in the cities along your path. You will have an opportunity to explain the U.S. to them in a way that no Hollywood movie has ever done. You will also have a chance to find out anything about their country that you want to know, just for the asking. And they will love you for being interested enough to ask.

. . . W2NSD ■

WHERE DO YOU FIT?

The FCC regulations give as the purpose of amateur radio:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications.

(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur radio service through rules which provide for advancing skills in bot the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international good will.

Where do you fit?

Warren MacDowell W2AOO
11080 Transit Road
East Amherst NY 14051

The DX-35 REVISITED

A trick or two for modernizing the old standby

Many of us, when we first started in amateur radio as a Novice, purchased the Heathkit DX-35. This transmitter was capable of 75W input and was running quite hard to achieve this power level. The oscillator and final were both keyed, so with certain crystals there was an inherent chirp.

We were contemplating the use of the DX-35 as a CW exciter for a kilowatt linear. Our main goal was to modify the circuitry of the DX-35 to improve the efficiency and eliminate the chirp.

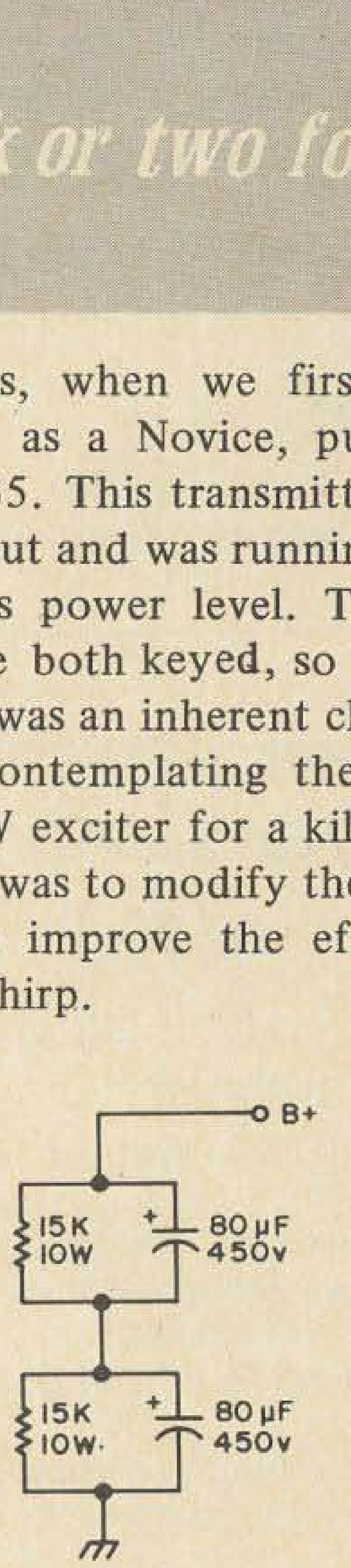


Fig. 1. Existing 20 µF capacitors can be replaced by 80 µF cans to up the filtering to 40 µF total.

The first modifications to be made were in the B+ filtering circuit. Normally, two 20 µF, 450V capacitors were being used in series to give a total of 10 µF, 900V of filtering. We replaced these paper capacitors with can type 80 µF, 450V capacitors to give a total of 40 µF for filtering (See **Fig. 1**). Appropriate holes were cut in the chassis so as to mount the can type capacitors. One of the capacitors will require an insulating mount to isolate it from the chassis due to the fact that these capacitors are in series. The original equalizing resistors (15 kΩ, 10W) were retained and placed in parallel with the new capacitors.

The 5U4 rectifier was replaced with a 1N1239 silicon rectifier unit. This solid state rectifier plugs directly in the socket of the 5U4. (An alternate method is to build up your own replacement in the base of a broken 5U4.) You conserve on power transformer drain through the use of this because the 5V filament source is no longer necessary. The solid state rectifier will also provide an increase in total plate voltage.

We had received reports of chirp using the DX-35 as a barefoot transmitter. Of course this would be undesirable when using the linear. A considerable voltage drop was observed on the oscillator plate when the transmitter was keyed. Also, both the final and oscillator are keyed. We removed the cathode grounding lead of the oscillator from the front panel keying jack and ran this to a single-pole toggle switch that was also mounted on the front panel. This switch was wired so as to ground the oscillator cathode and allow the oscillator to run at all times when the final was keyed. Less chirp was noticed but there was still a small amount present.

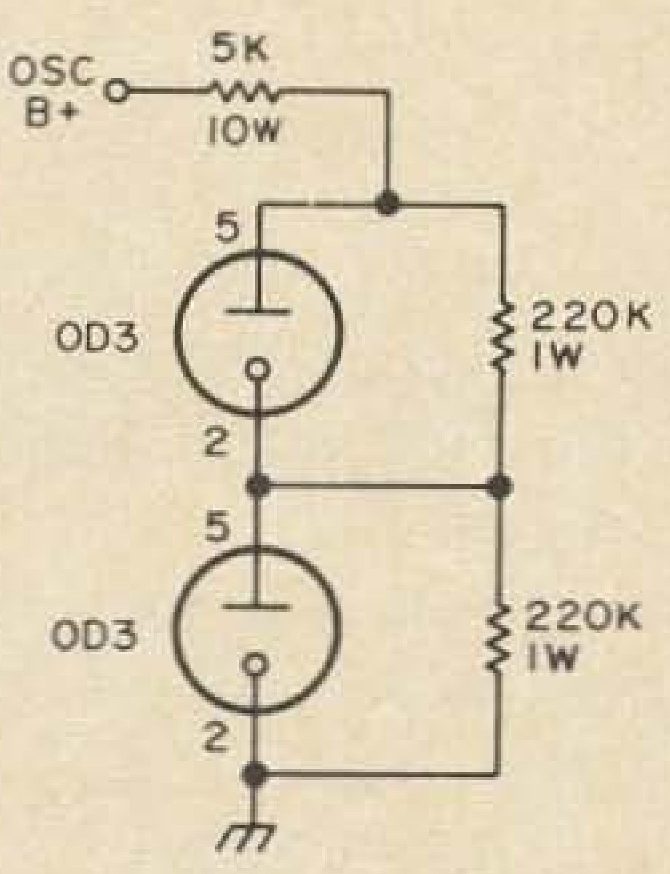


Fig. 2. The 220 kΩ resistors across the series regulators help to equalize the oscillator voltage distribution.

The next step was to get rid of the voltage variation on the oscillator that was present when keying. Two OD3 regulator diodes were placed in series to give a 300V regulation level. Resistors (220 kΩ, 1W) are paralleled across the OD3's to equalize the voltage and a 5 kΩ, 10W current-limiting resistor was placed in series with the OD3's (**Fig. 2**). This assembly was inserted between the oscillator B+ and chassis ground. The voltage on the 12BY7 oscillator now remains at 300V during the keying sequence, and the chirp is eliminated.

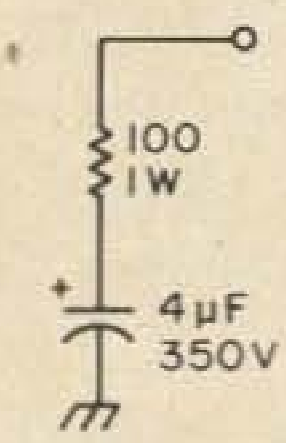
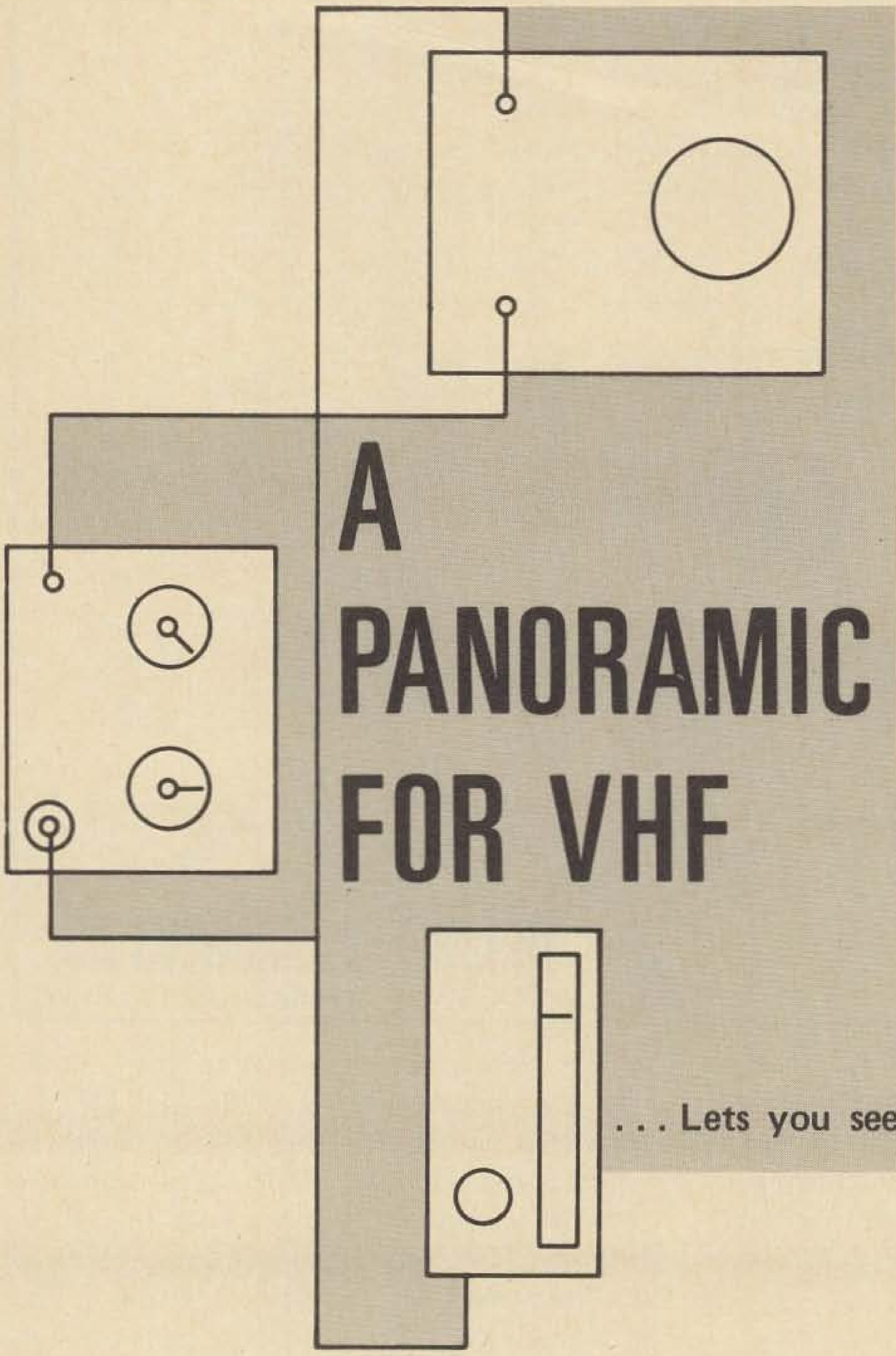


Fig. 3. Keying shaping circuit.

Though not really necessary, we added a keying shaping circuit consisting of a 100Ω, 1W resistor in series with a 4 µF, 350V capacitor. This circuit shown in **Fig. 3**, goes from the keying "hot" lead to ground.

. . . W2AOO■

Sergio Lovisolo I1SLO
Via Ravina 70,
Malnate, Varese, Italy



A PANORAMIC RECEIVER FOR VHF

. . . Lets you see the whole band at once

One of the more typical aspects of my father's (I1LOV) personality is that he wants something new in his ham shack every day, and this requires a lot of brainwork from me, to satisfy his never ending need for strange gadgets.

A few evenings ago, he was as usual having his complicated QSOs on 2 meters, tuning the band with three different receivers at the same time, when he said, "How nice if I could take a look at the complete band, and know every moment what goes on the air."

There was no possibility of mistakes! I lighted a cigarette, as usual, before I went to explore in the junkbox and began to work. A day later, there was the panoramic receiver, with his calibrated scale showing up every signal on the 2 meter band. And now the complete story.

The first approach was quite fast. I took a generator, injected a sweep signal in the socket of the crystal in the local oscillator of the converter (144-28 MHz), connected the oscilloscope to the last i-f in the receiver, and in a few minutes I had the band on the screen (**Fig. 1**). But the local oscillator wasn't working properly, and sensitivity wasn't very high.

If you are a lazy fellow, have a scope and a sweep generator, and a few extra converters for the various VHF bands, this is the job for you. For me, it was nice to see that everything worked as it should, but I was sure that there was a simpler approach, one requiring no modifications in the converters, and giving the possibility of hearing and seeing with only one antenna and one converter. So, it was clear I had to work on the tunable i-f receiver. But you cannot put your hands in the station receiver, especially if it is a 75A1 or 51S1, as it was in our case; so, there are two possibilities: you have some old i-f receiver around, or you build it. Fortunately, I found an old receiver I had made some years ago, a double conversion unit with no rf stage in it.

I disconnected the tuning capacitor from the local oscillator coil and connected a varicap diode in parallel. A wire from the sawtooth generator in the scope furnished the sweeping voltage. A few more modifications to the detector and first audio stage, and the output of the receiver went to the vertical plates of the oscilloscope. After a bit of tuning, the panoramic receiver was ready to monitor the 2 meter band.

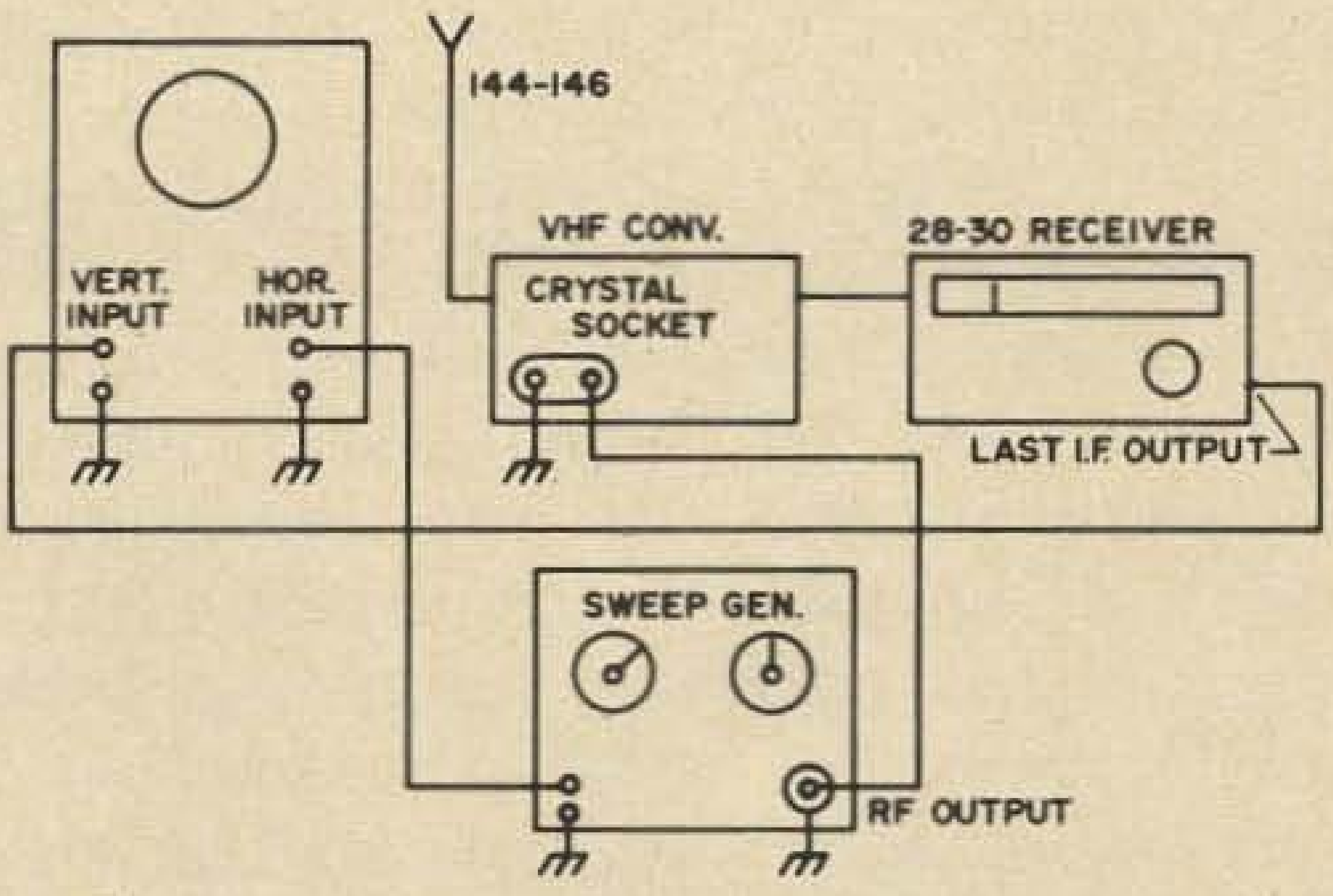
Principles of Operation

A few words to explain how it works for those who are not acquainted with oscilloscopes, sweep generators, and panadapters. In every oscilloscope the trace you see is the result of the rapid sweep of the luminous spot across the screen which is produced by a sawtooth voltage applied to the horizontal plates. Now if you apply an ac voltage to the vertical plates, the spot will be subjected to a double force, one compelling it side to side, and the other up and down. Let us assume that the frequency of the alternating voltage driving vertical plates is two times that of the horizontal ones. Then in the time it takes to go from left to right, the spot will be deviated up and down twice, and will show a two-period sample of the voltage under examination.

Now, if the vertical plates of the oscilloscope are connected to the detector of the receiver, a signal will appear on the screen every time the receiver is tuned to a station. Now, imagine tuning across the band very fast—exactly as fast as the spot on the screen runs on its way from left to right. If you tune a full megahertz while the spot makes a trip, you will see a pip on the scope every time a signal is tuned in. This is due to the fact that the signal generates an output voltage only during the short time in which its conversion frequency allows it to pass through the narrow bandpass of the receiver's second i-f. If you tune from 5 to 6 MHz, the left side of the screen will be 5.0 and the right side 6.0. Every signal will show up on the scope in a place on the screen in direct relation to its frequency. Now the problem is that you cannot manually tune your receiver up and down. This function is provided by a Variac, to which is applied the same voltage that sweeps the trace. This provides synchronization between the scope and the receiver local oscillator.

Circuit Description

The receiver circuit is quite conventional and requires only a little care in isolating the circuits working at different frequencies to prevent spurious responses that will appear as pips on the screen. The input signal is link-coupled to the grid coil of an EC88 triode mixer. (You can use a 6AM4, or



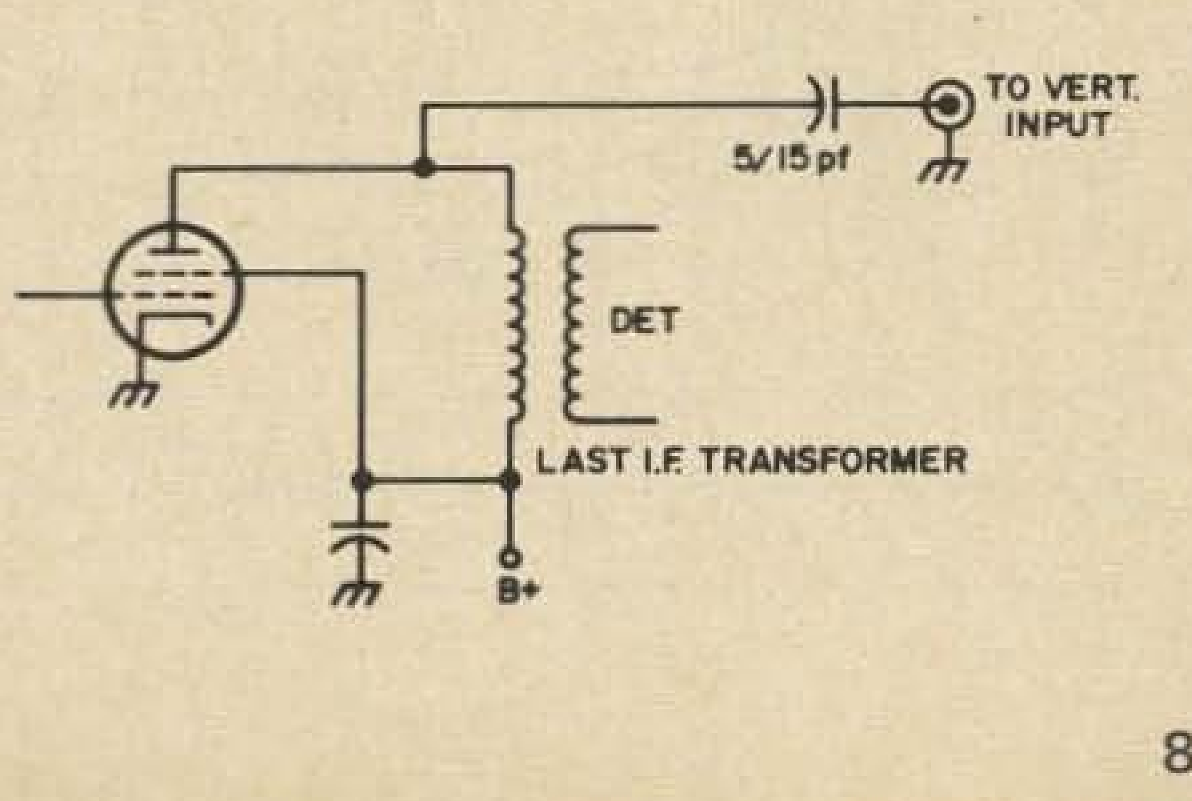
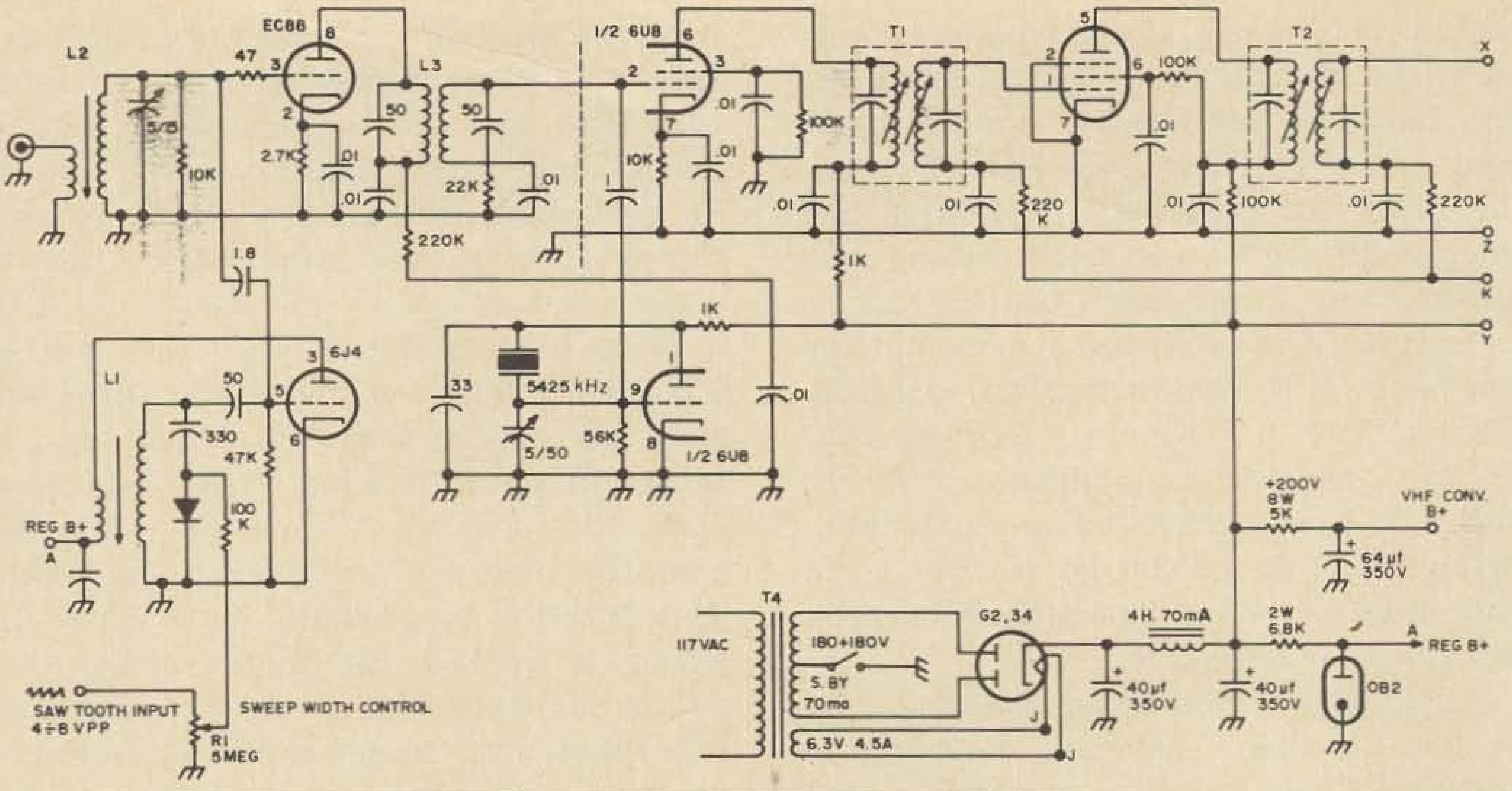


Fig. 1. Block diagram. Above, first assembly: sweep on VHF converter. Below, connect the sweep scope on vertical input to the last i-f transformer with a 5 to 15 pF capacitor.



L1—Primary. 8 turns 26 AWG close wound 3/8 in. slug-tuned coil. Secondary. 8 turns 26 AWG close wound. L2—Primary. 2 turns 26 AWG on cold side of grid coil, 1/2 in. slug-tuned coil. Secondary. 7 turns 26 AWG close wound.	L3—10.7 MHz i-f transformer. T1, T2, T3, — 455 kHz i-f transformers. All resistors 1/4W except otherwise noted. D1 capacitors are mica or ceramic disc.

Fig. 2. Schematic of the panoramic receiver.

something like that; any rf triode will work.) A BA 102 (5–15 pF range), driven by a sawtooth voltage coming from the scope's sweep generator, is connected across the grid coil of a 6J4 local oscillator, sweeping its frequency from 21.120 kHz to 23.120 kHz to provide a first i-f of 6.8 kHz. A 6U8 second mixer local oscillator converts this signal to 455 kHz with a quartz crystal resonating at 5.425 kHz. I was compelled to use such unusual i-f frequencies by the crystal I had on hand. You can try other combinations, but be sure you don't use a first local oscillator frequency starting at 24 MHz; otherwise, you will have a spurious response at 144 MHz that will probably be heard by your VHF converter. The same care in selecting the second oscillator's quartz crystal must be used in order not to have spurious responses in the 28-30 MHz range. Two 6BA6 stages at 455 kHz provide plenty of gain and are very stable, showing no tendency toward oscillation. One diode section of a 6AT6 tube is the detector, the other provides a little agc, while the triode section is the video preamplifier. You can omit it and use a crystal diode if your scope has a multitube vertical amplifier. B+ voltages are provided by a GZ34 full-wave rectifier. As you can see from the photo, screening is provided between rf and first i-f stages and 455 kHz i-f section.

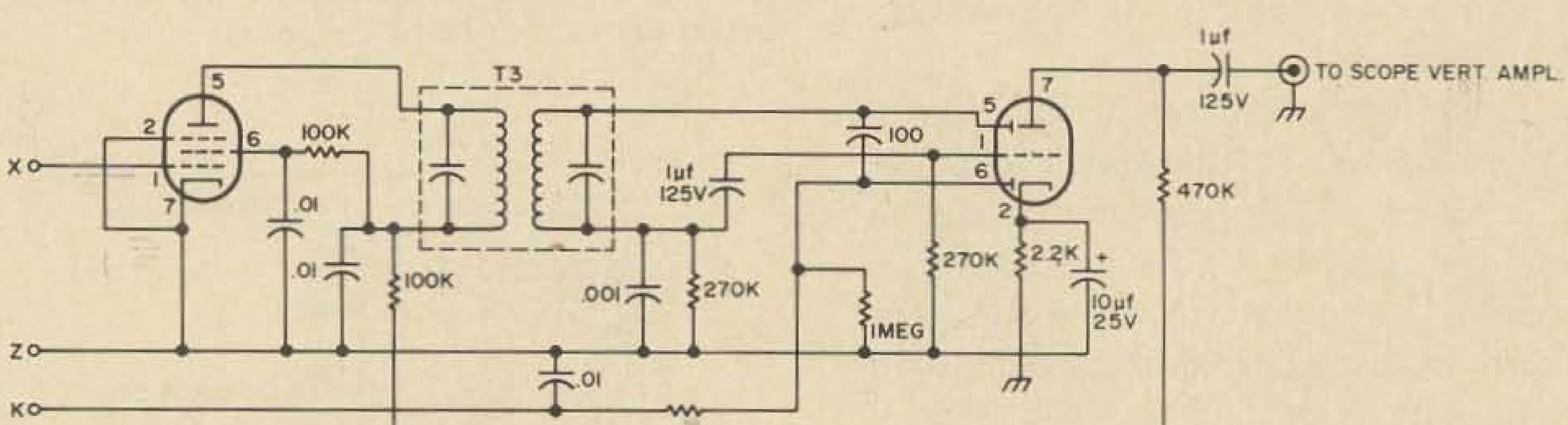
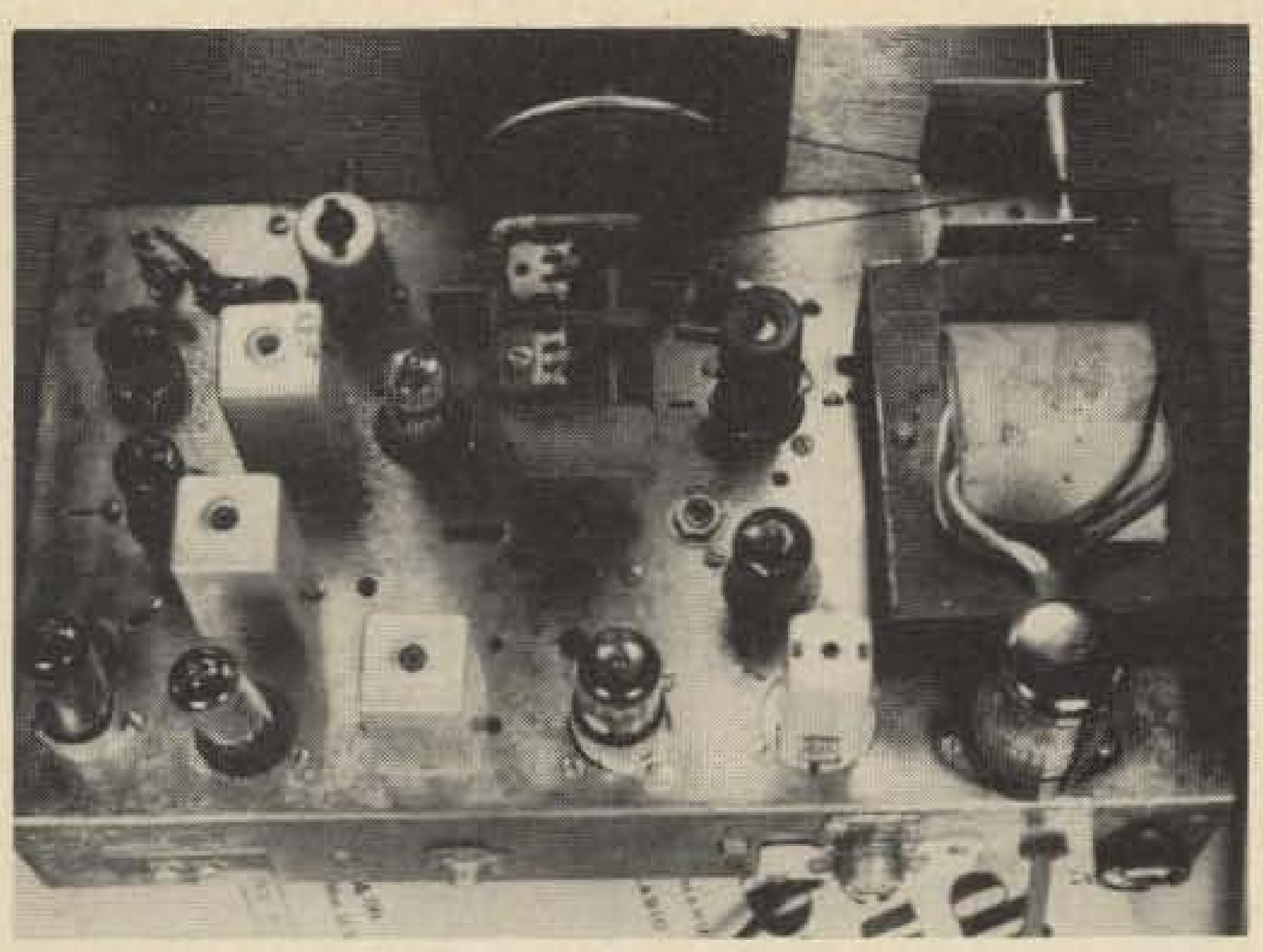


Fig. 3. Output section.

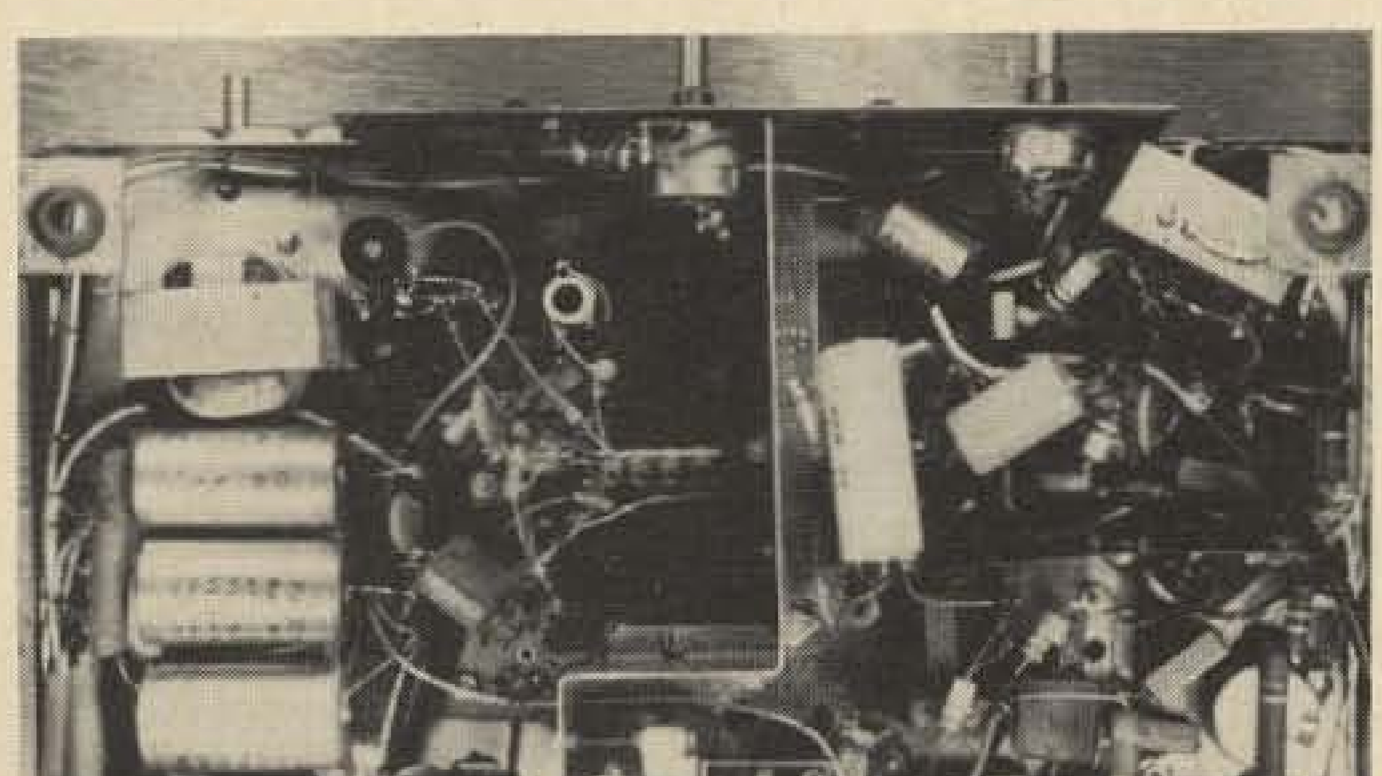


Top view of panoramic receiver.

Construction Details

You can get an idea of the disposition of the various parts by looking at the photos. (The tuning condenser and the screened tube near the last i-f transformer are no longer in use, due to the fact that the receiver was built as a normal audio unit.) As you can see, the power transformer is a very big one. You can simplify the supply without degrading the performance of the receiver. This will allow you to use a smaller chassis.

The positions of the various components are not too critical, and you have only to be careful that you make good ground connections and use good quality bypass capacitors. As shown in the picture, I used a lot of big old mica capacitors from surplus strips. In the rf and i-f stages, connections should be as straight and short as possible. Bypass every hot filament pin. Coil L3 is a 10.7 MHz i-f transformer, and you must modify it to tune around 7 MHz. Take the coil out of its can and parallel small-value capacitors to



Bottom view of unit.

the internal ones, if any, until you find resonance around 7 MHz (with the slugs half in) on a grid dip oscillator. After that, you can close the cans again. (Mine tuned with 50 pF.)

The crystal controlled local oscillator is very simple, with nearly nothing to tune, and starts without any difficulty. Coupling is provided by a 1 pF capacitor from pin 9 to pin 2. A few twisted turns of wire work equally well. The i-f amplifier, having a very high gain, requires a little care. Short wiring, bypass capacitors connected to the i-f transformers where the leads enter the cans, and eventual shielding connected across the tube sockets will keep everything quiet.

My receiver was built on a normal chassis (that of an old S-102 Hallicrafters 2 meter receiver), but the second time, I found that it is much easier to build converters and little receivers on printed circuit boards. They are easy to drill, offer a very good, easily soldered ground, and you can readily make a chassis of any dimensions you want, and begin to build while you wait for the box to be made.

Tuning Up

First, connect the vertical amplifier of your scope to the video output of the receiver. Then, with no B+ on the 6U8, 6J4, and EC88 tubes, connect a 455 kHz generator to the grid pin (2) of the pentode section of the 6U8 tube, and tune all the slugs in the 455 kHz i-f transformers (beginning from the last one) for maximum height of the trace. Keep the output from the generator as low as possible, consistent with a readable trace on the scope. Too much output will cause distortion, and no more trace height. Repeat two or three times. Next, connect B+ to the 6U8 tube. The local oscillator should start immediately. Connect the generator, tuned near the first i-f frequency (6.88 kHz in our case) to the grid pin of EC88 tube, and try to get an output (be careful not to tune on the image, which is about 900 kHz lower than the fundamental. Tune the slugs in L3 and trimmer capacitor from pin 9 of EC88 for maximum output. Now disconnect the 10 kΩ resistor in parallel with L1 and tune it at 29 MHz with a grid dip oscillator. Find the sawtooth generator tube in your scope. Normally, when the sync selector is in the internal position, the output from this tube is connected across the "horizontal gain" potentiometer. Be sure that there is no high voltage on this control. With a VTVM or a scope, verify that there is 5–10V of the sawtooth voltage between the hot side of the potentiometer and ground.

If everything is right, connect a shielded wire from the hot side to the "sawtooth input" in the receiver. Now, connect B3 to the EC88 and 6J4 tubes. With the generator connected at the antenna plug tuned at 29 MHz turn R1 (sweep width control) till you see a pip on the center of the screen. Rotate the sweep frequency of the scope till you get the narrowest pip. (Sweep frequency must be as low as possible, around 30–60

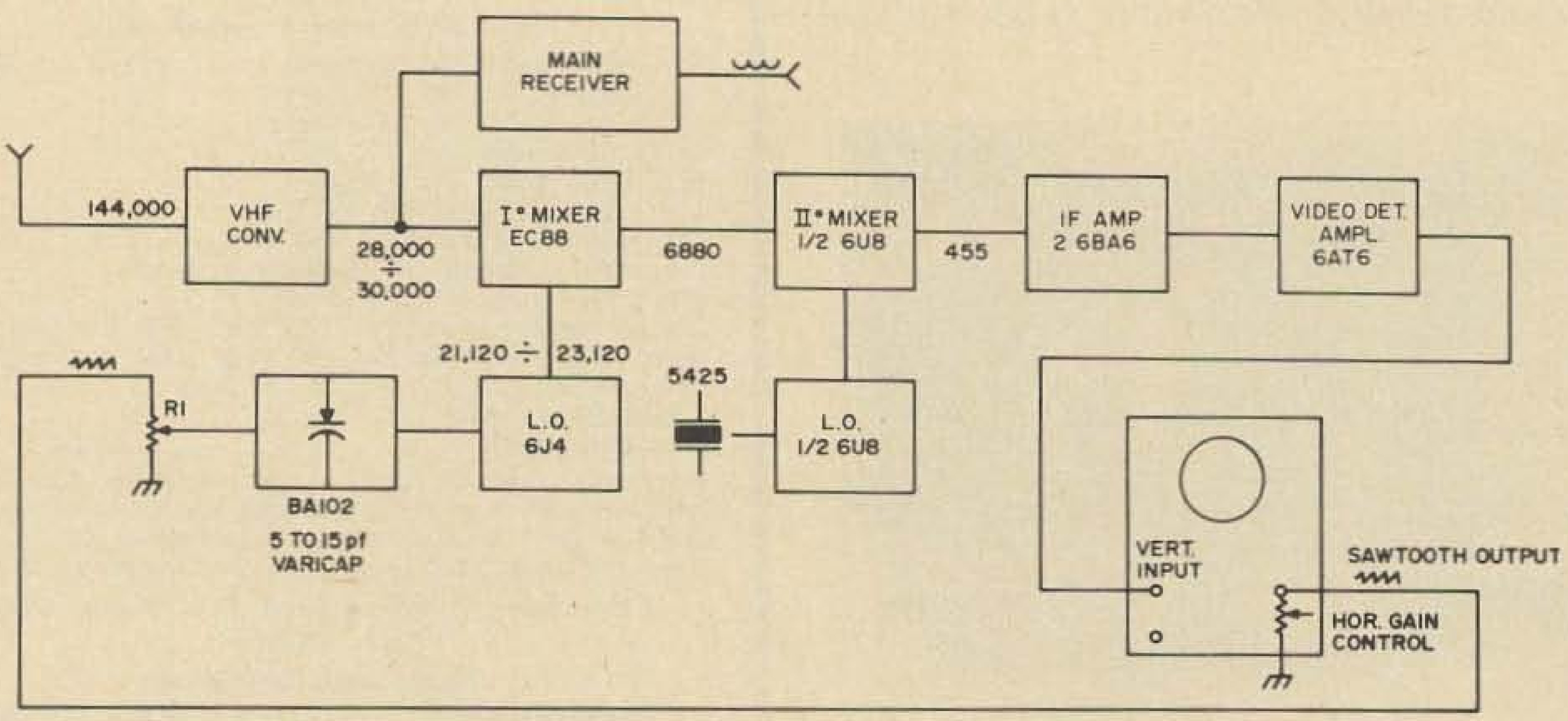
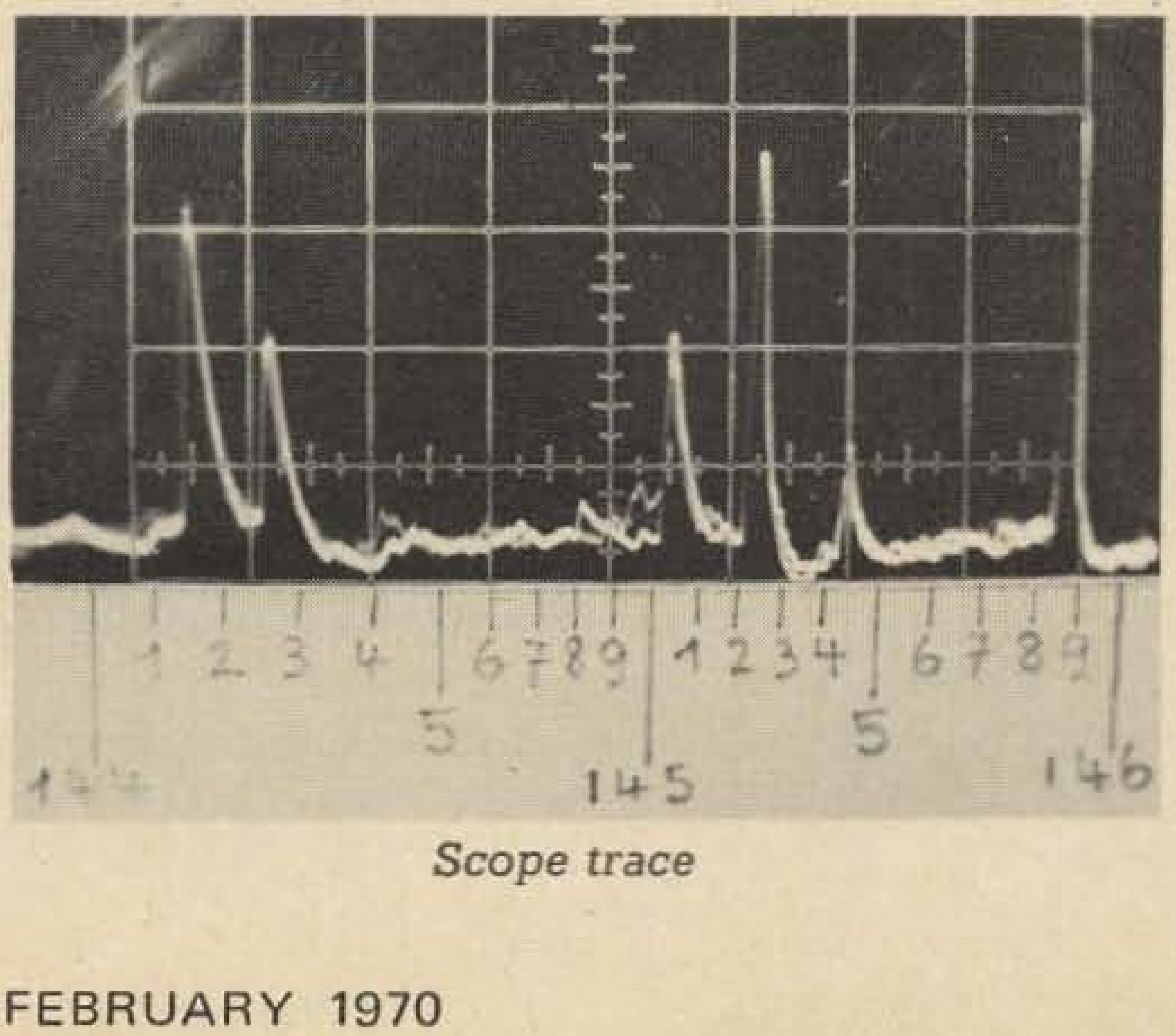


Fig. 4. Block diagram, final assembly

Hz.)Tune around with the generator and notice how many MHz you are seeing on the scope. If the sweep is too wide or too narrow, rotate R1 till you get the wanted width. Now, with the generator again at 29 MHz, recenter the pip on the scope, turning the slug in L1. Repeat the preceding steps several times, till you get the wanted bandpass.

If you are not interested in the center frequency being at the center of the screen, with slight adjustments, you can put 28 MHz at the left side and 30 MHz at the right side of the screen. (Naturally, if you want, you can select other frequencies, from about 26 to 32 MHz just tuning the slugs, with up to 4–5 MHz bandwidth.) Now, tune L2 for maximum response at the center of the trace, and select a swamping resistor that gives an equal response in every point of the trace. Usually, the 10 kΩ unit marked on the diagram will do, depending on coil Q and the desired bandpass width.



Scope trace

Now you can calibrate the screen with a frequency scale. As you can see from the photo, the scale is not linear, as in any capacity-tuned oscillator. Another source of nonlinearity can be an irregular sawtooth tension. Differences often found in inexpensive varicaps make it difficult to track oscillator and antenna coils. The first time, I tried to track L2 with another varicap fed with sweep voltage (you can see two little black controls near L1), but that resulted in sweep noise coming into the station receiver, and this approach had to be abandoned. This happens when the 2 meter converter used for the panadapter and the receiver is the same.

Now you can connect the output of your VHF converter to the panoramic receiver and *see* the band. If there is too much "grass," it is better to reduce it, detuning the last i-f transformer a little instead of reducing the vertical gain on the scope.

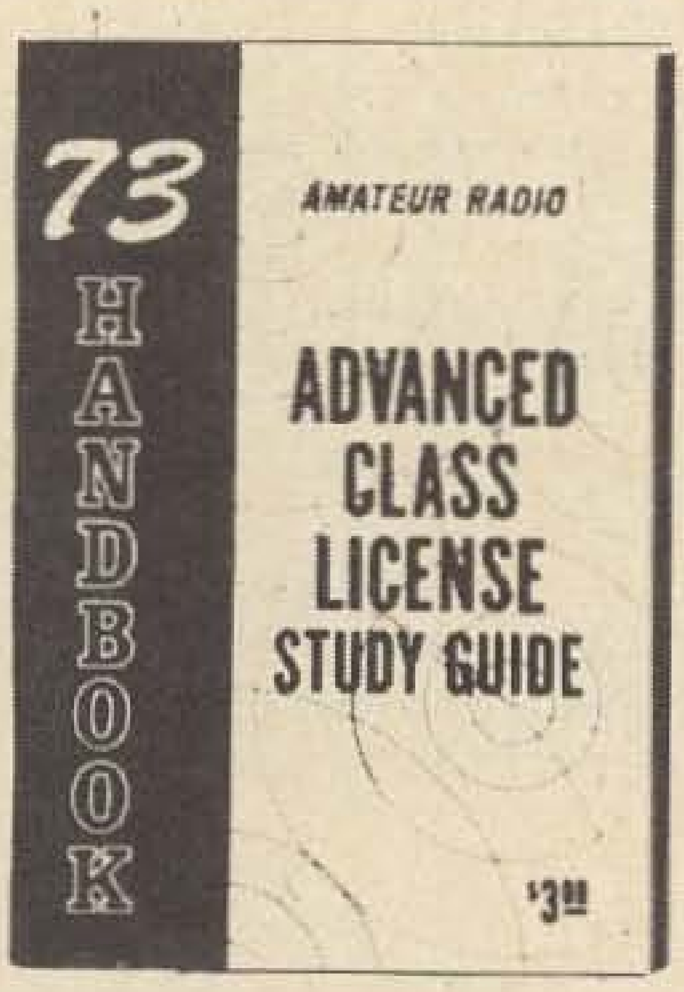
On-the-air Performance

It is possible to see many signals just above the noise level. (In the photo you can see six). The panoramic view proves useful on many occasions—to have an idea of activity on VHF, while working other frequencies, for roundups, for turning the antenna to the best compromise position in a multisided QSO, to tune VHF converters, for zero beating, etc.

The best part: I got a reprieve, of sorts. This toy has kept my father busy enough that he's lost the kick for something new every day.

. . . I1SLO ■

73 Books for Hams



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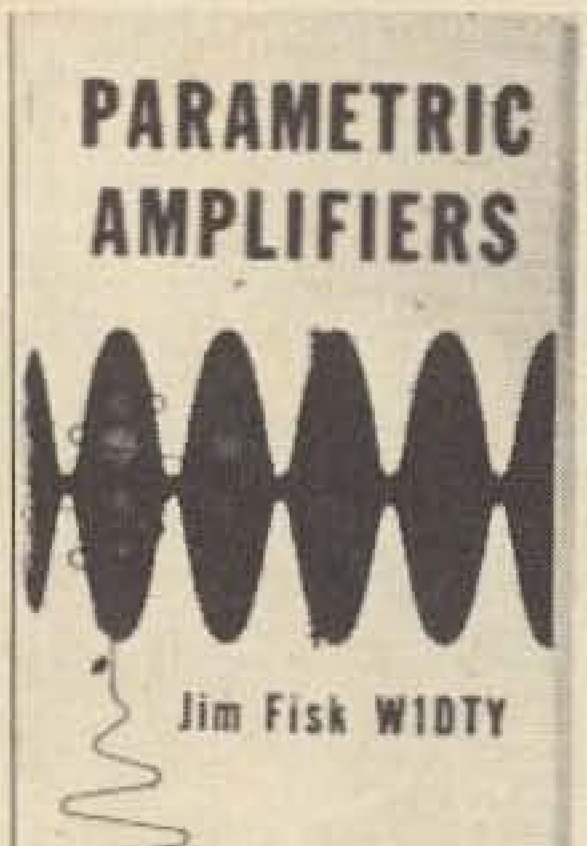

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The Amateur Television Anthology is a collection of the technical and construction articles from the **ATV Experimenter**, edited by WØKYQ. If you're interested in ATV, this is the book for you. It covers the gamut from the simple to the complex in amateur television equipment. **$3**

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Vol. I. This book is largely a collection from FM Bulletin, edited by K6MVH and WA8UTB. The material is taken from the editions of February 1967 through February 1968.

Vol. II. This book contains selected technical and construction articles taken from FM Magazine after March 1968. $3

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by K6MVH

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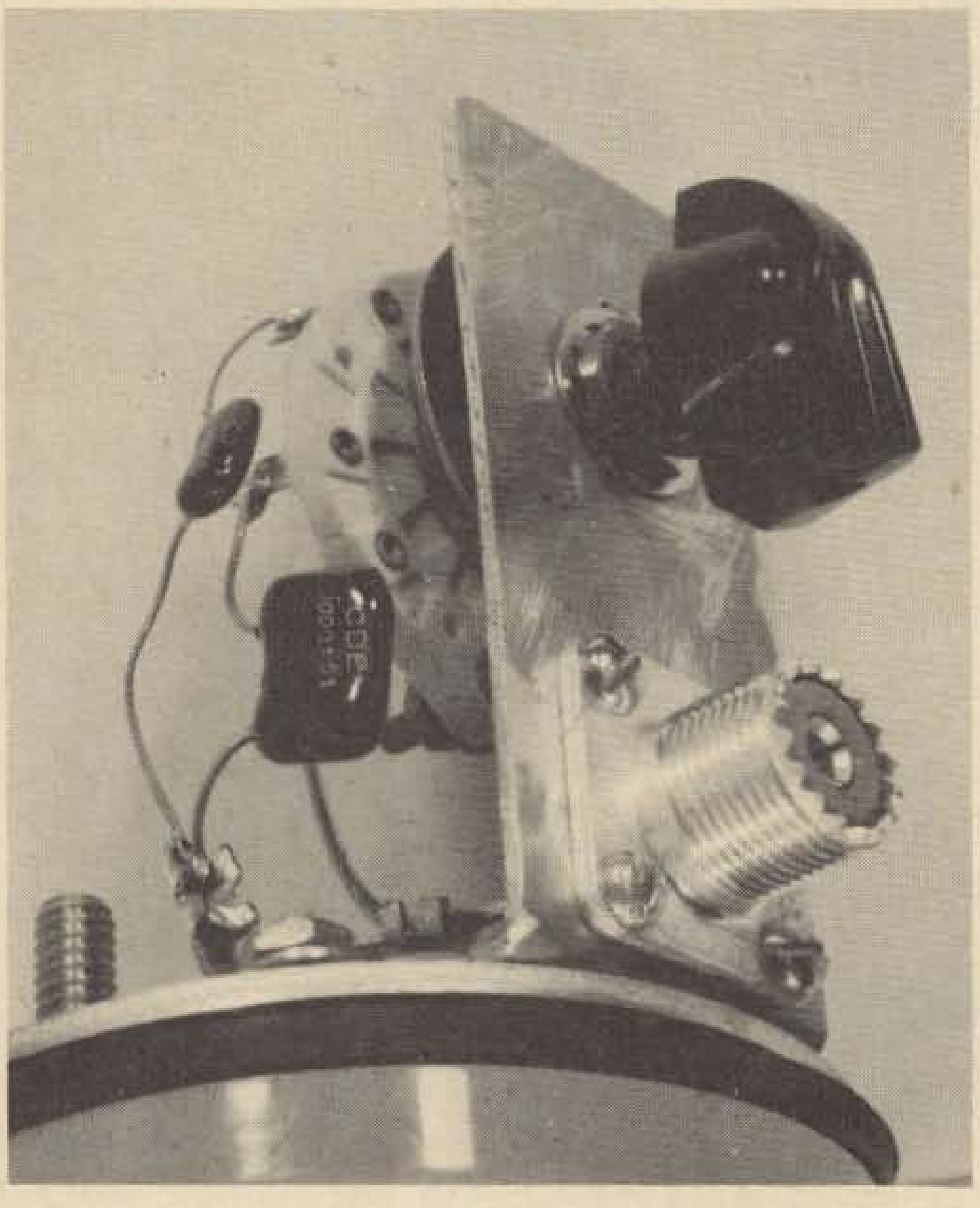
VARIABLE-IMPEDANCE MOBILE MOUNT

By far the most popular mobile antenna is the center load coil variety. These come in various sizes, shapes, and colors, depending upon the whim of the manufacturer. The New-Tronics model, for instance, comes in a quiet shade of gray, and depending upon power rating and frequency, varies between about ½" and 2" in diameter. Waters Manufacturing favors black for the color and has an assortment of shapes for the coils. Webster has recently come out with a new KW series. The coils are white in color. They are sometimes referred to as the "White Bubble."

Each of these has its advantages, and efficiency varies from band to band. So it is highly possible that one might use different coils and tips for different bands. In my particular case, the Webster KW-80 has proved very successful for 75 meter operation. However, on a long trip, multiband



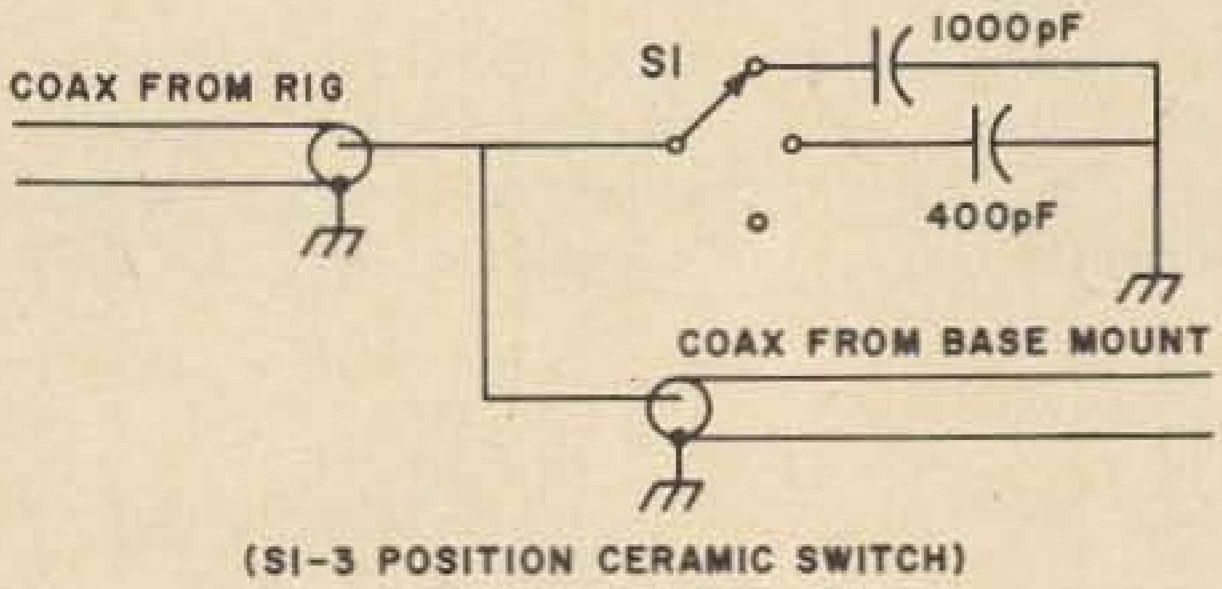


Fig. 1. Schematic diagram.

operation using the Waters 75 meter coil with the Band-Adder (see Dec., '67, *73 Magazine*) makes it possible to operate 10-15-20 and 75 without getting out to change coils.

Waters and New-Tronics claim a 52 ohm match and require no further matching device. Webster suggests the use of some type of impedance matching on 80 and 40 meters. Tests have shown that a 1,000 pf silver-dipped mica capacitor from the center conductor to ground provides a good impedance match on 80, and a 400 pf capacitor provides the proper match on 40. No matching is required on 10-15 or 20 meters. Now, let's face it – connecting and disconnecting capacitors at the base of the antenna every time you want to change bands becomes Excedrin Headache No. 74.

After knocking heads with Bill McCracken, K1GUU, we came up with this nice little switching arrangement. In this case, a deck mount is used. A ceramic switch and an Amphenol SO239 connector have been mounted on a bracket attached to the backing plate. The two capacitors have been connected from the switch to ground, leaving one position a direct connection with no capacitance added. In this way it is a simple matter to hop out of the car, change the coil and tip, and merely turn the switch to the position required for the given antenna. My thanks to Bill for the actual construction.

. . . W1EMV ■

lossy transmission lines

An amateur I contacted the other day said he was using a 10 meter dipole for 20 meters and was getting an swr of 1.2:1 —which is hard to believe. He said his "swr is low and the transmitter loads up" and therefore he was perfectly happy with this arrangement. However, on 40 and 80 meters, he could not use this 10 meter dipole since the swr was greater than 8:1.

The idea of a two-band dipole intrigued me, so I pressed for more details. He was using 200 ft of RG-58/U coax and a 1 kW amplifier. The weather was cold (New England winter), he was getting out, and therefore he was not about to change this arrangement.

His transmission line was acting as a "loss pad," an impedance matching scheme which is used extensively in audio work. A loss pad can take the form of a T, H, ladder, or even a simple series resistor. Its gain is always less than unity.

Consider the simple case of a 5 kΩ plate load to be matched to a 10Ω voice coil. A perfect match results if a 4.99 kΩ resistor were put in series with the 10Ω voice coil. But look what happens to the useful power output. Approximately 1/500 of the power appears across the voice coil and the rest is lost as joule heat in the resistor.

This also reminds me of two experiments which I developed for lecture demonstrations. In one experiment I load up a pair of oldfashioned bedsprings connected back-to-back in dipole fashion, gamma matched, to perfect swr. The transmitter loads up but there is little radiation.

The other experiment uses 225 ft of RG-8/U coaxial line of mongrel origin which shows good swr but blisters badly when 1 kW is pumped into it.

... Katashi Nose KH6IJ/1 ■

Getting Your Extra Class License

STAFF

Part XIII: Examining Filtering and RTTY

In the beginning, ham radio had only one kind of communication available—telegraphy, using a hand key. (We can't call it CW, because in those days continuous-wave transmissions didn't exist; spark gaps generated the rf.)

As the years passed, the spark gave way to CW, and telegraphy gave way to voice communications to some degree. Voice work was all done with AM originally, but as the art progressed FM and the many varieties of sideband joined the procession.

Today, ham radio has its choice of many kinds of communication techniques. Hand-key CW, automatic-key CW, AM voice, FM voice, SSB, and DSB are the most widely used, but facsimile, television, and digital telegraphy (more commonly known as RTTY) are also very much in the picture.

Since the Extra Class license is the highest grade issued in the Amateur Radio Service, the FCC rightfully insists that aspirants to this ticket be familiar with the entire range of techniques available to hams. As a result, the examination for the Extra Class license includes questions on the lesser-used techniques as well as on the more common practices.

In this section of our study course, we'll look at some of these more specialized questions. Specifically, we'll cover the subjects of RTTY and filtering. On the official study list, these subjects are the basis of the following questions:

5. What is meant by "frequency shift keying" and how is it accomplished?

13. Draw a block diagram of an RTTY system showing the primary function of each stage. What is the proper way of identifying an RTTY transmission? What is the most widely used frequency difference between the mark and space frequencies in a conventional RTTY transmitter?

41. How do filters attenuate harmonic emissions?

49. If a crystal lattice filter has bandwidths of 3 kc/s at the 60 dB points and 1.5 kc/s at the 6 dB points, calculate the shape factor. At what frequency is the best shape factor achieved in a crystal lattice filter?

64. How do phasing condensers help stabilize crystal filter circuits?

Following our usual practice, we'll supplant these highly specific questions with a set of more general questions for our discussion. This time, we will actually have two sets, one for each of our two subjects.

The starting point for RTTY is most general—"What is RTTY?" Filling out this subject is our second question, "How is RTTY transmitted and received?"

On the subject of filters, we must be almost as general and begin by asking, "How do filters operate?" We can then ask, "How is filter performance rated?" and finally become a bit more specific when we examine "How are rf bandpass filters constructed?"

Radioteletype

What Is RTTY? The first electrical communications technique was, of course, telegraphy. Samuel F. B. Morse is generally credited with the invention of telegraphy (although, like Marconi in the case of radio, Morse's major contribution was to gather a number of discoveries made by others into a working system and promote it to the world). The familiar hand key was, for several decades, the only means of originating any electrical communication.

As the years passed, a number of inventors attacked the problems imposed by the hand key and its requirement for an operator who knew the telegraphic code. Eventually, Joy Morton and Charles L Krum developed a machine which was able to bypass the operator requirements. It was, essentially, a cross between a typewriter and a telegraph system. In 1915, the Associated Press adopted the Morkrum machine.

Meanwhile, Edward Kleinschmidt independently came up with a machine to perform the same purpose. In 1925, the Morkrum and Kleinschmidt companies merged, and five years later AT&T bought the firm. The machine was named "Teletype" by blending the prefixes of "telegraph" and "typewriter," and the firm was named the Teletype Corporation. The word "Teletype" is, incidentally, still a registered trademark of the Teletype Corporation and cannot legally be used to refer to any other make of teleprinter equipment. Its common abbreviation, "TTY," is not a trademark and can be used as a general term.

TTY machines were designed with the requirements of land-line telegraphy in mind, but during World War II it became apparent that radio transmission could replace the land-lines with little change in techniques—and RTTY (radio TTY) was born.

Amateur RTTY got its start in 1946 when a number of hams on both coasts, in a parallel but apparently unconnected action, persuaded several companies to release obsolete machines to ham use instead of smashing them for junk.

Today, TTY equipment has many uses besides the original land-line telegraphic application, and as a result machines are not too difficult to locate. For instance, TTY equipment is widely used in the digital computer industry (where the machine is known as a "remote terminal") and as of the summer of 1969, at least a dozen firms were producing machines for this purpose which had never participated in the telegraph-communications use.

The principle upon which TTY operates is similar to that of normal CW transmission, with one major difference. Where CW makes use of five different kinds of signals—dits, dahs, and three lengths of spaces to indicate in-the-character space, word space, and sentence space—TTY uses only two. The two kinds of signals used by TTY are called "mark" and "space" and may be represented in several different ways. The advantage gained by using only two kinds of signals is that a machine can then interpret the signal with a minimum of "logic" or decision-making circuits; conventional CW with its one-unit dit, three-unit dah, and one-, three-, and five-unit spaces would require much more interpretation to decode. This is simple for humans, but most complicated for a machine to perform (although machines *have* been built to do so).

Because of the differences in the kinds of signals used, TTY equipment does not employ the International Morse Code. Instead, it uses one of several other codes which assign characters to combinations of the mark and space signals. Amateur and most commercial equipment uses the "International Five-Unit Code," but equipment designed for use with computers is more likely to employ the "American Standard Code for Interchange of Information" or a different code originally introduced by the Friden Company for its "Flexowriter" equipment.

Regardless of the code used, the signals sent and received by a TTY machine consist of groupings of "mark" and "space" signals. At the machine itself, "mark" is usually represented by the presence of current in the line, and "space" by the absence of current, so that they can be thought of as "on" and "off" conditions. This same representation *can* be used in the circuit from one machine to another, and the result is known as "make and break keying." Ordinary CW is sent by make and break keying, for instance. For the machines, however, the use of make and break keying makes it impossible to distinguish an extended "space" condition from a circuit failure and resulting total loss of signal–and so other representations are usually employed instead.

The most common technique used to represent "mark" and "space" conditions in RTTY is to use two radio frequencies rather than just one. One frequency represents "mark" and the other is "space." Now a loss of signal can be recognized by the absence of *both* the mark and the space signals, while an extended "space" condition is signaled by the presence of the space signal.

The two frequencies are usually very close together. The difference between the mark frequency and the space frequency is known as the "shift," and the normal shift is only 850 Hz. This tends to minimize fading because the two signals will fade together. Narrow-shift is also used, with a shift of as little as 150 Hz, to minimize fading effects still more. Any shift less than 900 Hz is legal for use.

It makes no difference which of the two frequencies is used for "mark" and which for "space," but common ham practice is to use the higher of the two frequencies for "mark." In case one station chooses to reverse this, all the other station need do is to reverse the polarity in his receiver–which may be done by merely tuning to the other side of zero beat. The situation is exactly the same as the choice between upper and lower sidebands in SSB operation.

In TTY work, again regardless of the actual code used (and for the rest of our discussion we will assume that the International Five-Unit Code is the one to be used, since it is the one required for ham RTTY by FCC regulations), each character begins with a "start" signal and ends with a "stop" signal. This makes the total character length with a five-unit code actually seven units.

The "start" signal is always a "space" and the "stop" is always a "mark." These two signals establish timing synchronization between the transmitting machine and the receiving machine, and thus make it possible for the intervening code signals to be decoded.

When no character is being transmitted, a steady "mark" signal is sent. The "space" condition produced by the start portion of a character then starts the machine's decoding mechanism. The decoding mechanism sorts out the next five signal conditions to determine what character is being sent, and stops. The "stop" portion of the character simply provides enought time for the decoder to come to rest before another character can be sent.

Normal speed for amateur RTTY equipment is 60 wpm. At this speed, each part of a single character (except for the "stop") lasts for 22 milliseconds. The stop is half again longer, or 31 msec, for a total character duration of 163 msec.

A TTY machine has the appearance of a typewriter; its major parts so far as the operator is concerned are the keyboard and the printer.

When a key on the keyboard is pressed, it sets up in some type of memory device the actual code to be transmitted. This memory device may be either mechanical or electronic. The machines in general use all employ mechanical memory; pressing a key pushes down a notched lever, which then latches in the "down" position. Each key has a different lever, and the notches on each lever correspond to the "space" portions of the character for that key. All these notched levers rest on top of and across another set of five levers, so that when a notched lever is latched down it pushes down any of the second group of levers which do not have notches above them, and leaves up any of the second group which are matched by notches.

This second group of levers operates a set of five contacts, one for each unit of the character code. A motor-driven distributor then wipes a selector brush across the five contacts in turn (the "start" bit of the character is built into the selector mechanism, as is the "stop" bit at the end). If the contact lever for any one unit is up, a "space" is sent when the selector brush wipes across that contact; if the contact lever is down, a "mark" is sent. When the selector brush leaves the last contact, the distributor motor stops and the keyboard is unlatched in preparation for the next character to be sent.

Figure 1 shows the international 5-unit code, without start and stop bits. The

CHAR. LTR	CHAR. FIG	1	2	f	3	4	5
A	—	x	x	o			
B	?	x		o		x	x
C	:		x	o	x	x	
D	$	x		o		x	
E	3	x		o			
F	!	x		o	x	x	
G	&		x	o		x	x
H	lbs			o	x		x
I	8		x	o	x		
J	'	x	x	o		x	
K	(	x	x	o	x	x	
L	)		x	o			x
M				o	x	x	x
N	,			o	x	x	
O	9			o		x	x
P	Ø		x	o	x		x
Q	1	x	x	o	x		x
R	4		x	o		x	
S	bel	x		o	x		
T	5			o			x
U	7	x	x	o	x		
V	;		x	o	x	x	x
W	2	x	x	o			x
X	/	x		o	x	x	x
Z	"	x		o			x
space				o	x		
car ret				x		x	
line fd			x	o			
fig		x	x	o		x	x
ltr		x	x	o	x	x	x

Fig. 1. International 5-Unit Teleprinter Code, required by FCC regulations for use in ham TTY. "x" entries represent "mark" pulses and blank entries represent "space" pulses. See Fig. 2 for timing of signal and start-stop frame which surrounds each character code.

column headed "code bits" shows the code as it would be represented on paper tape; bit 1 is the first one sent after the start bit, and bit 5 is the last sent. The "f" column with its all-"o" entries represents the sprocket feed hole of the punched paper tape, and is *not* a part of the code. An "x" in any entry represents a "mark" condition, and a blank represents a "space."

We have seen how the operator's pressure on any one key is translated into the code pattern to be transmitted to represent that character. The reverse operation, translation of a received code pattern into a character to be printed, is accomplished in much the same way by the printer. However, the printers of the various models of TTY machines are the areas in which the most drastic differences occur.

The explanation of printer action which follows is based on the action of the Teletype Model 12 machine, which is now obsolete. More recent machines operate in substantially different ways, but the model 12's operation serves to explain the basic idea without complicating the description with the complexities of single-magnet operation.

The received signal is applied to the printer as a make-and-break keyed current, with "mark" represented by the presence of current and "space" represented by its absence. In the absence of any received signal, "mark" condition exists and current is flowing through the printer line.

In the printer, this current flows through a latch relay and six selector magnets. So long as current flows through the latch relay, the printer is inactive.

When a character appears, its arrival is indicated by its "start" bit which is a "space" condition. This drops out the latch relay and permits the drive motor to turn the receiving distributor through one revolution.

As the receiving distributor rotates, it connects each of the six selector magnets, in turn, to the signal line at 22 msec intervals. Each selector magnet is either tripped or unaffected by the signal line; if the line condition is "mark" when the selector is connected to the line, the magnet is tripped, and if the line condition is "space" nothing happens.

The first five selector magnets control notched levers, which in the "tripped" position block movement of the key levers which do the actual printing. When all five of these notched levers have been tripped, only *one* key lever can match the notches in all of them. Every other key lever will fail to match a notch in at least one of the code levers.

The sixth selector magnet, which is tripped by the stop bit, permits the printer motor to drive the key-lever mechanism and print the one character which matches. After the printing, the entire mechanism is reset to its initial conditions and the receiving distributor stops, ready to start again which the next start bit arrives.

In later machines, only a single selector magnet is used and its mechanical action is routed to the appropriate points for each bit by a cam which sets up toggle action at the

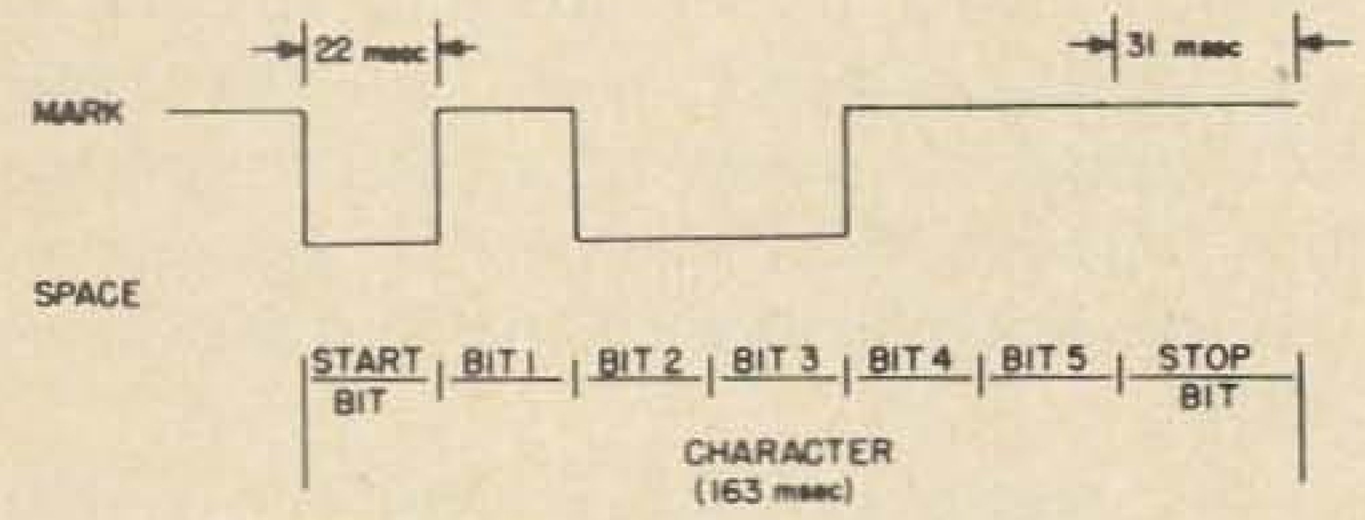


Fig. 2. This waveform shows the appearance of the character "B" as transmitted in the asynchronous serial RTTY code. While code contains only five units, character as sent includes seven. Every character has a "space" start unit, and a "mark" stop unit, in addition to the five units which carry character's meaning. All bits except stop bit are equal length, 22 msec at 60 wpm speed. Stop bit is longer, 31 msec at 60 wpm, to "pad out" to transmission rate and allow time for equipment to stop between characters.

proper time. Some machines do not use key levers; instead, they position a "type box" in front of a hammer so that the selected character will be printed when the hammer strikes.

Not all characters in a TTY machine cause printing. Some, such as "carriage return," "line feed," "letters," and "figures" cause mechanical action in the printer instead.

What we've looked at so far in this examination of RTTY principles is simply the keyboard and printer portions of the TTY machine itself, and applies equally to land-line or wireless operation.

In a land-line setup (called a "local loop" when one is set up in a ham shack, as for test purposes), the keyboard contacts are connected in series with the printer selector magnets and a power supply which frequently is 150V dc at 20 or 60 mA. Pressing a key causes generation of the code character, and the serial code character operates the selector magnets and causes the printer to print. If this all happens in the same machine the result is an electric typewriter; if the keyboard and printer are in different machines, the result is telegraphy without Morse code.

To convert the telegraphy setup to radio, all we need do is find some way to put the "mark" and "space" information on rf rather than on copper wires, and then recover it to drive the printer.

We could simply substitute the keyboard for the hand key in a CW installation, and we would have make-and-break keying. The first amateur work over long distances was done in this manner because no other form of teletype operation was permitted by the FCC. At the receiver, the audio was converted to dc current to drive the selector magnet and that was all it took.

However, make-and-break is no longer used in RTTY. Frequency shift keying (FSK) is almost universally used. The frequency shifted may be the carrier itself (FSK), or an audio frequency modulated upon the carrier (AFSK). FSK is used in the HF bands, but AFSK is used by VHF RTTY enthusiasts because of the difficulty in controlling small shifts at high frequency.

A typical RTTY station is shown in block diagram form in Fig. 3, and compared to an AM station. You can see that the major differences lie in the TTY machine itself, and the circuits connecting it to the transmitter and the receiver.

The transmitter and receiver themselves serve the same purposes as in any other radio communications system. The TTY machine's keyboard generates the proper code for the character to be sent, and the "TTY modulator" converts this code into the proper modulation for the transmitter (frequency shift or FM for FSK, and a shifting audio frequency plus audio modulator circuits for AFSK). The "converter" or "terminal unit"

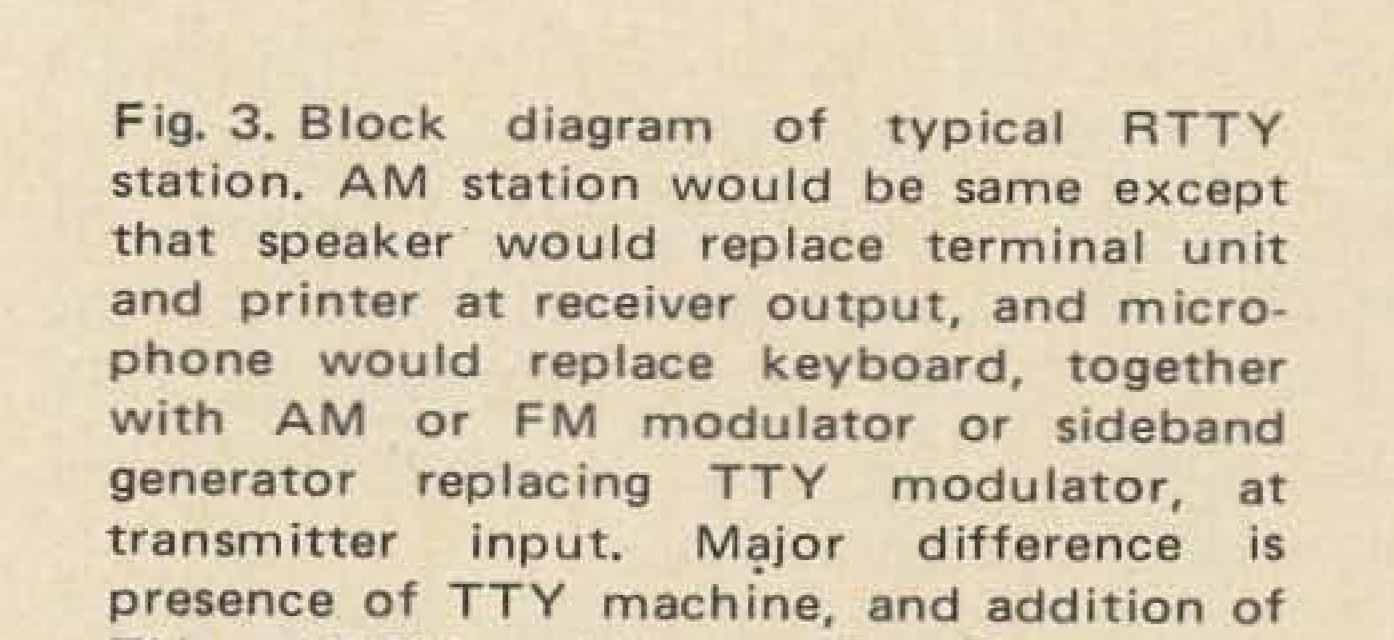


Fig. 3. Block diagram of typical RTTY station. AM station would be same except that speaker would replace terminal unit and printer at receiver output, and microphone would replace keyboard, together with AM or FM modulator or sideband generator replacing TTY modulator, at transmitter input. Major difference is presence of TTY machine, and addition of TU and TTY modulator to interface with it.

converts the receiver's output into a make-and-break-keyed current suitable for the TTY machine's printer, and the printer then converts this intermittent current flow into a character image on paper.

In the early days, amateur RTTY stations were required to identify themselves by ordinary CW at 10-minute intervals, as well as identifying in the TTY transmission. Rules have since been modified to permit all identification to be done in TTY. The general requirements for identification are the same as for all other amateur stations; both the transmitting station and the receiving station must be identified by call sign.

How is RTTY Transmitted and Received? We've already examined the means by which the operator's pressure on any one key of the keyboard is converted into an electrical code representing the chosen character, and the received electrical code is converted back into a printed representation of the character. But what goes between?

Of course, a radio transmitter and a receiver are used, but the TTY modulator and the converter or terminal unit are the items we're most interested in at this point.

There are almost as many different TTY modulator circuits and terminal unit designs as there are RTTY enthusiasts, but most of these different designs have many items in common.

The major differences, in fact, are brought about by the choice of FSK or AFSK for the modulating technique, and by the choice between FM discrimination and simulated make-and-break for the terminal unit.

If FSK is to be used, the TTY modulator must vary the frequency of the transmitter, and the terminal unit may either generate the driving signal to the printer directly from the receiver's i-f, or indirectly from audio tones produced by the bfo.

If AFSK is to be used, the TTY modulator must first provide a frequency-shifting audio tone and then modulate the transmitter with this tone. Except for the keyed audio oscillator, normal AM transmitter techniques are usually used. The terminal unit for FSK must be of the audio variety.

Since an audio terminal unit can be

employed for either AFSK or FSK operation, most of the popular designs have been based on this principle. For FSK-only use, however, the straight FM technique can provide the ability to dig much deeper into the crud and noise of a crowded band for solid copy of a weak signal.

Let's examine at least one of each of these types of equipment to see how it functions. Since RTTY in amateur radio began with AFSK, we'll examine an AFSK modulator and terminal unit first, followed by the FSK equipment.

One of the most popular RTTY terminal units ever described was that designed by Marvin Berstein, W2PAT, and originally published in QST. The W2PAT unit provided an introduction to RTTY for a majority of the pioneer RTTY enthusiasts–and more to our point, is an excellent example of a complete AFSK unit. It included both the oscillator to provide a keyed audio tone to a conventional AM transmitter, and the receiving converter to turn received tones into serial character codes to operate the printer.

The AFSK oscillator (Fig. 4) is almost completely conventional. The Hartley circuit provides a stable sine wave output with a minimum of components, but any other oscillator circuit could have been used (and most other circuits were, in one or another of the various designs which followed). The part which makes this circuit different from an ordinary oscillator is the diode switch and frequency-shift capacitor circuit, consisting of resistor R1, diodes D1 and D2, and capacitor C2.

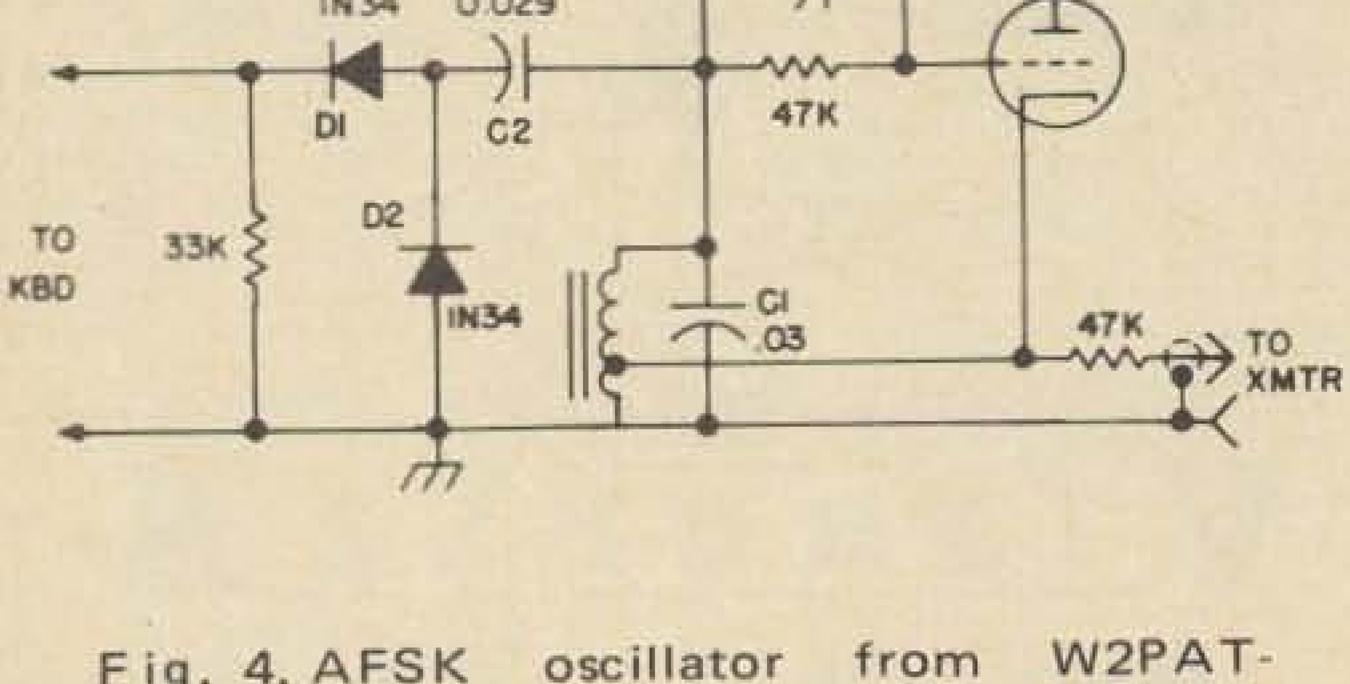


Fig. 4. AFSK oscillator from W2PAT-designed installation. Inductor is TV width coil. Output of this oscillator feeds conventional AM transmitter's mike jack. Capacitor C2's value is varied to adjust for proper shift.

AFSK operators normally indicate "mark" condition with a tone of 2125 Hz, and "space" with a tone of 2975 Hz. The oscillator is tuned, by adjustment of the coil inductance and the value of capacitor C1, to produce output at 2975 Hz when the keying circuit is open-circuited.

When the keying circuit is closed, R1 is shorted out. This permits diodes D1 and D2 to switch capacitor C2 into the circuit in parallel with C1, thus lowering the output frequency. The value of C2 is adjusted by trial and error until the output frequency is 2125 Hz.

Operation of this diode switch may appear a trifle mysterious at first, since no external power is supplied to turn the diodes either "on" or "off." What actually happens is that the diodes rob enough power from the oscillator tank circuit to develop their own switching voltages. D2 conducts for half of each cycle regardless of the keyboard contact position; during the half-cycle that D2 is "off,' D1 attempts to conduct. The current flow through D1, however, must flow through R1, and a voltage is developed at the "hot" end of R1 which tends to keep C2 isolated from ground.

When the keyboard contacts are closed, R1 is no longer in the circuit and the current flow is direct to ground on both halves of the audio cycle (through D2 on one half and D1 on the other). The diodes now act just like a closed switch, and cut C2 into the circuit.

Because of the diodes, the keyboard contacts handle only a small amount of dc rather than being required to switch ac or high-current dc. This minimizes rf interference to the receiver–in RTTY this is an important point, because the printing action on the machine normally results from the signals which have gone all the way through the system, rather than on any direct connection between keyboard and printer.

The receiving-converter portion of the W2PAT terminal unit (Fig. 5) is not so familiar-looking as the oscillator. It consists of a double-diode limiter followed by a two-stage amplifier which is operated in an over-driven condition to serve an additional limiting function. Output of the active

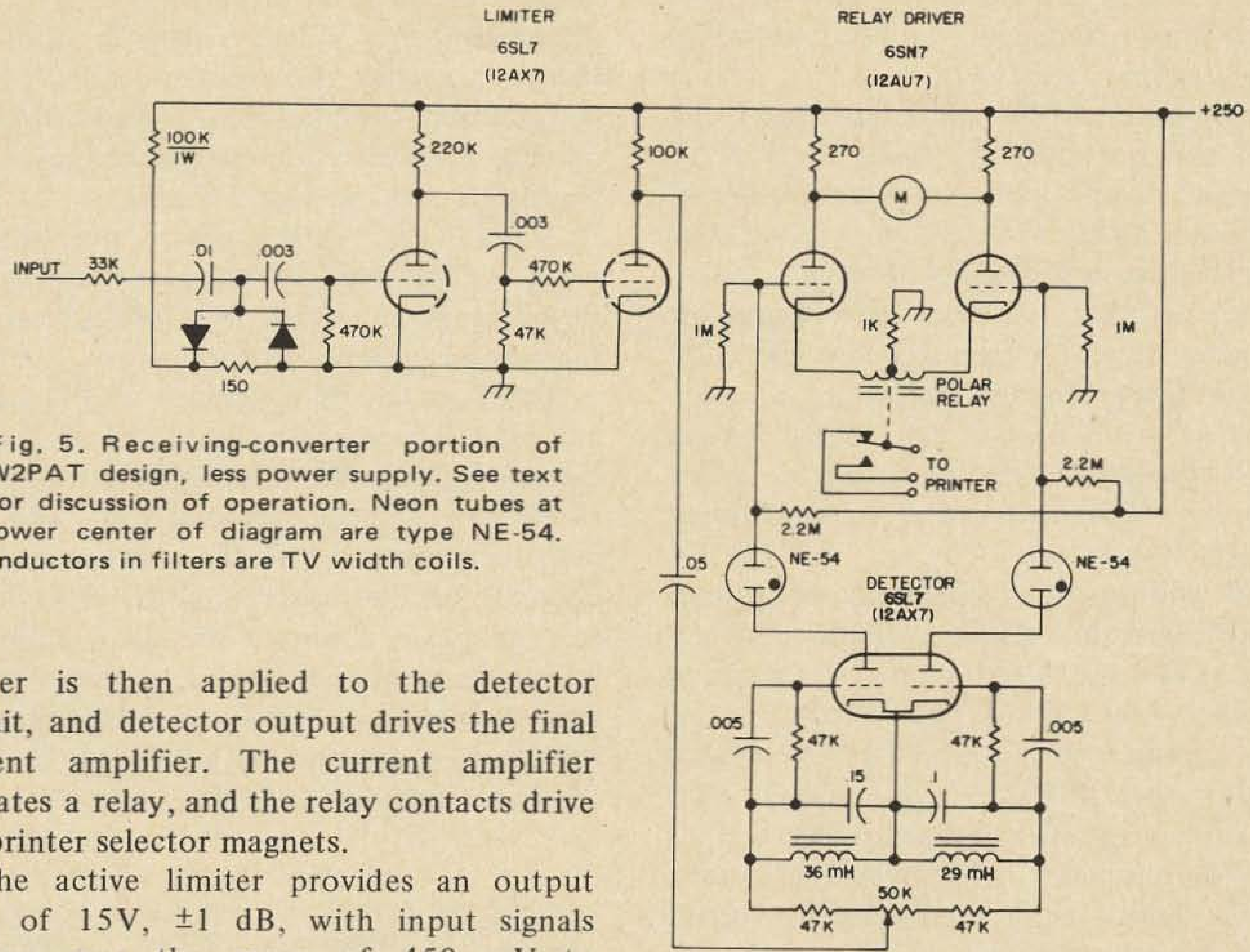


Fig. 5. Receiving-converter portion of W2PAT design, less power supply. See text for discussion of operation. Neon tubes at lower center of diagram are type NE-54. Inductors in filters are TV width coils.

limiter is then applied to the detector circuit, and detector output drives the final current amplifier. The current amplifier operates a relay, and the relay contacts drive the printer selector magnets.

The active limiter provides an output level of 15V, ±1 dB, with input signals varying over the range of 450 mV to more than 30V. This 15V signal is applied to the detector, which actually consists of two separate grid-leak detectors, each tuned to a separate audio frequency. One half of the circuit is tuned to the mark frequency and the other half to the space frequency. Since only one of these two frequencies is present at any one time, one side of the circuit is always drawing more current than is the other side, and this swing of the heavy current flow from one side to the other in the detector stage corresponds to the mark-or-space condition of the TTY signal.

The plates of the two detector circuits are coupled through neon bulbs to the grids of another dual-triode tube. The neon bulbs act as threshold devices. Until firing voltage for the neon is reached, grid voltage on the final tube remains zero. When current flow in one side of the detector drops due to lack of signal at the associated frequency, the plate voltage rises, and when the neon fires the grid of that side of the current amplifier tube goes positive. This makes that half of the final tube draw heavy current, thus pulling the polar relay to the corresponding position.

When the AFSK signal's frequency returns to that to which the detector is tuned, the detector stage current increases and plate voltage drops. When plate voltage falls below about 55V, the neon goes out and the grid of that side of the current amplifier returns to ground voltage. At the same time, plate voltage in the other half of the detector was rising and turning on the other side of the current amplifier, thus reversing current through the output relay and driving it to its other position.

The milliammeter connected between the plates of the current amplifier stage is a tuning indicator. When tuned to a TTY signal which has a mark-to-space ratio of 1:1 (as much time spent in mark condition as in space condition), the meter will indicate zero average current. This is because the meter movement is unable to follow the rapid fluctuations of current, and if the mark-to-space ratio is 1:1, the *average* current fluctuation will be zero.

Another way to provide such a test signal is simply to key an AFSK oscillator with a square wave or an electronic key set for all dits; the RYRYRY sequence is traditional but the keyed oscillator is more reliable since it does not depend upon the keyboard being in proper adjustment.

Many other AFSK units have been described and put into use since the W2PAT unit made its appearance; a large portion of those in use today use transistors rather than tubes. The basic principles of all are similar, however, in that the two audio tones are split into separate channels and the TTY code is recovered by detection of both channels. The limiter is also a usual feature since it provides the ability to operate with a minimum of critical receiver adjustment between stations.

FSK equipment is similar in many ways to AFSK gear, but differs in some important respects. The modulator consists of a circuit to switch capacitance across the tuning circuit of the regular transmitter vfo (crystal oscillators are difficult to get enough shift on). Such a circuit is shown in **Fig. 6**. Like the AFSK oscillator, a diode switch is used, but this diode switch is powered by voltage stolen from the transmitter B+ supply. The function of the switch is to connect the added capacitor C1 across the tuning capacitor when the keyboard contacts are open, and to remove it when the contacts are closed. This makes "mark" the lower frequency and "space" the higher one. Note that this is the exact reverse of AFSK practice.

The frequency shift is usually 850 Hz, but any shift less than 900 Hz can be used legally. The variable resistor controls the

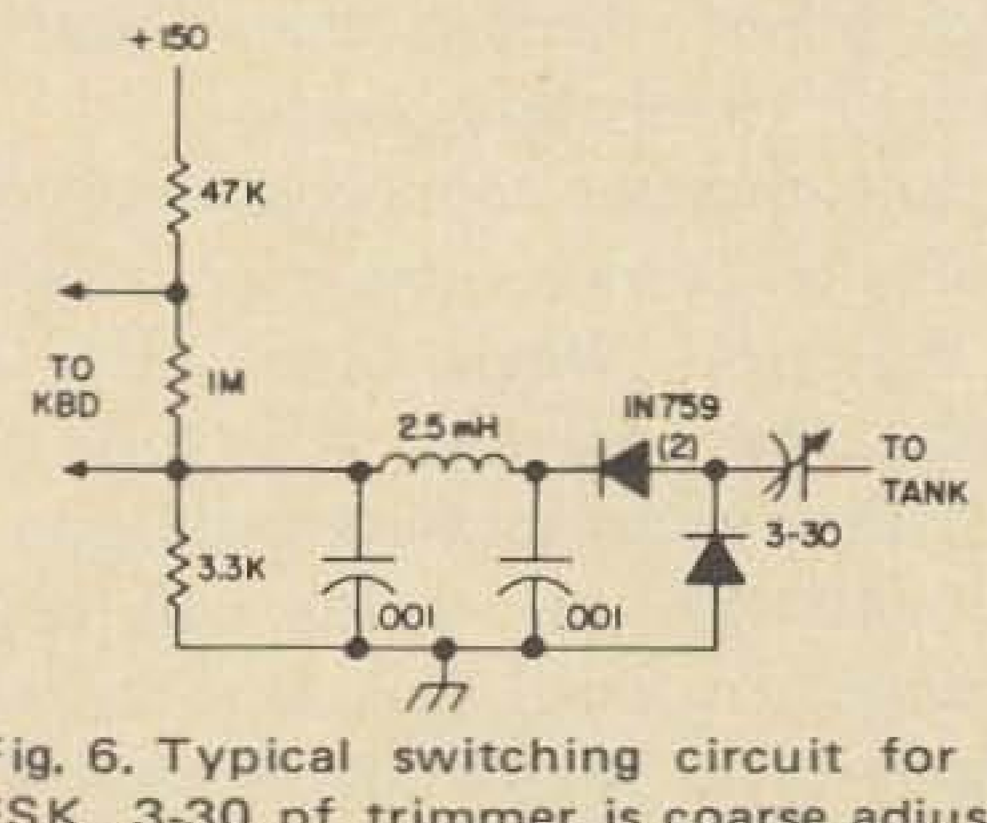


Fig. 6. Typical switching circuit for direct FSK. 3-30 pf trimmer is coarse adjustment on maximum amount of shift attainable; 1 meg pot is operating adjustment. All components to right of rf choke should be mounted as close as possible to vfo tank circuit, and be made mechanically solid to avoid frequency instability. Components to left of rf choke may be located anywhere. Keyboard contacts must be insulated from ground for use in this circuit.

amount of shift, by varying the effect of the added capacitor. When changing from one band to another, this resistor normally must be adjusted to take into account the frequency multiplication introduced by most transmitters at the higher bands.

Many RTTY enthusiasts receive FSK by using AFSK terminal units, converting the FSK signal to AFSK by turning on the receiver bfo and tuning carefully.

However, an FSK signal *is* an FM signal, and an FM detector operating at the receiver's intermediate frequency can in many cases give superior performance. The FM detector can be any of the conventional FM detector circuits—discriminator, ratio detector, or pulse counter. Its major point of difference from audio AM detectors is that it must respond to low-frequency signals, since the 22 msec duration of a TTY bit is about 23 Hz in sine-wave terms.

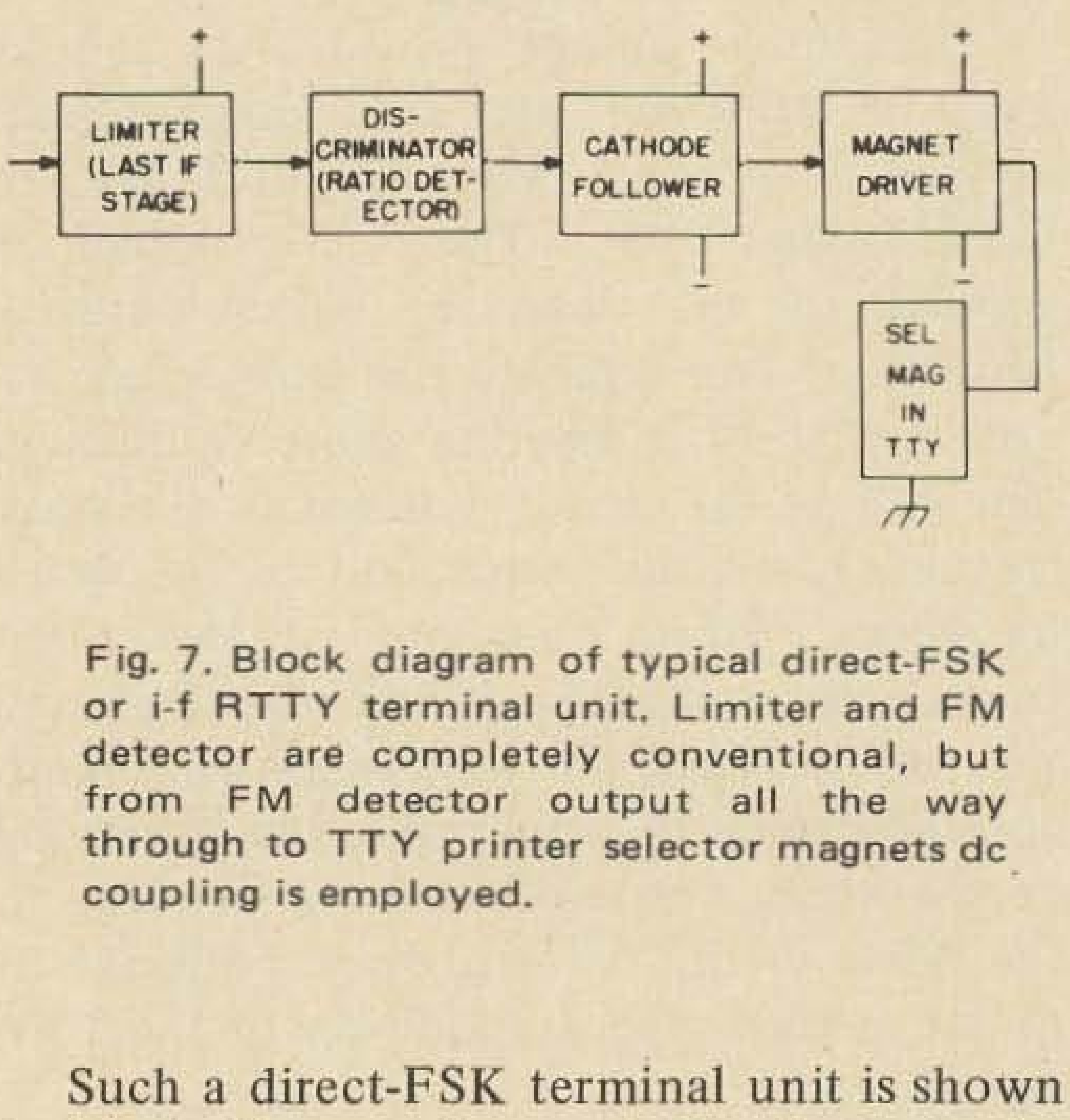


Fig. 7. Block diagram of typical direct-FSK or i-f RTTY terminal unit. Limiter and FM detector are completely conventional, but from FM detector output all the way through to TTY printer selector magnets dc coupling is employed.

Such a direct-FSK terminal unit is shown in block-diagram form in **Fig. 7**. Both the limiter and discriminator stages are completely conventional. The cathode follower between the discriminator and the driver stage permits direct coupling for good low-frequency response.

The driver stage is a switching circuit, so hooked up that a "mark" signal produces current flow through the output terminals and a "space" signal stops the flow of current. Both positive and negative power supplies are used so that the output terminals will be at approximately ground potential to minimize shock hazards.

Filtering Devices

How Do Filters Operate? The temptation is always present to answer a question phrased "How do . . . " with "Very well, thank you!" and let it go at that—but this would hardly be fair, since we asked the question ourselves in the first place. Besides, many filters operate only poorly, if at all, because until very recently filter design was essentially a cut-and-try proposition. Classical theory upon which the design was based called for physically impossible components in the filter, and substitution of realizable items led to inaccuracies in the design. This situation, fortunately, has now been cured, and we'll look at "how" a little later.

The purpose of a filter is to separate ac signals. In general, a filter must fall into one of four categories—"highpass," "lowpass," "bandpass," or "bandstop." A highpass filter passes all signals higher in frequency than its cutoff frequency and stops all lower-frequency signals. A lowpass filter does the reverse. A bandpass filter passes all signals between its lower and upper cutoff frequencies and blocks signals either higher or lower in frequency than its passband limits, and a bandstop filter blocks passage of frequencies within its band while permitting all others to pass.

These four categories of filters are based upon the action performed by the filter. Any filter, though, must operate at some specific frequency or frequencies. The frequencies involved may be subsonic, audio, intermediate, or radio frequencies. The design of any specific filter depends upon both the action to be performed, and the operating frequencies involved. Components employed in the filter, and the apparent principle of operation, may vary widely with the action and the frequency.

However, when we get right down to the basics we find that all filters operate on the same basic principles despite apparent differences. These apparent differences are best illustrated by some examples of various filters: The filter portion of a power supply is a lowpass filter operating in the subsonic frequency range, while the TVI filter on a transmitter output is usually a lowpass filter operating in the rf region. A TVI filter of the sort connected to affected TV receivers is a highpass filter operating in the rf range. The mechanical filter used in SSB work is a bandpass filter operating at the intermediate frequency, and so are the crystal lattice filters also used in SSB. For that matter, an i-f transformer is a bandpass filter, as is any resonant circuit. RTTY filters are also bandpass designs, but operate in the af region.

All filters are based on the frequency-dependent properties of reactances (even the mechanical filter makes use of the mechanical equivalent of electrical reactance). Capacitive reactance X_c decreases as signal frequency f rises, while inductive reactance X_i goes up with increasing frequency. By proper choice of the type and amount of reactance any desired filter action can be obtained (within reasonable limits, as we shall see a little later).

To illustrate the principle, let's examine a single stage, subsonic, lowpass filter typical of those used in many power-supply designs. The schematic appears in **Fig. 8**.

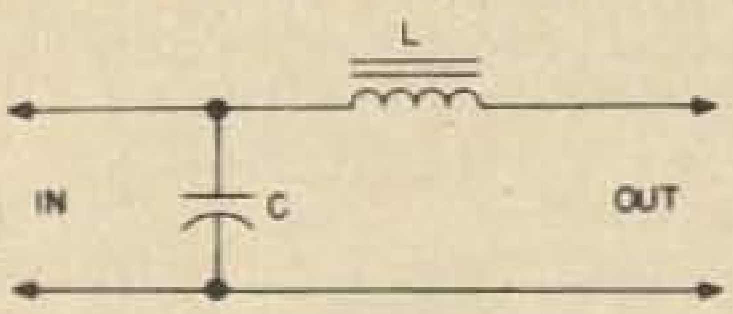


Fig. 8. Single section lowpass filter. Values of L and C determine cutoff frequency of filter section.

At frequencies far below the "cutoff" frequency of this stage, the inductor presents a very low value of X_i and the capacitor has a very high value of X_c. Both reactances are so extreme that they may be ignored, and the filter becomes in effect a straight piece of wire with no effect on the signal.

At frequencies far above cutoff, the situation reverses. The inductor's reactance is very great and the capacitor's reactance is very low. The filter becomes in effect a dead short, with no path from input to output, and the signal is blocked.

The "cutoff" frequency of this type of filter is defined as being that frequency at which X_i equals X_c. At this frequency, since reactance is equal in both directions, half the signal current flows to ground and the other half flows through the filter. The signal is neither passed without loss nor blocked completely.

At frequencies near cutoff, the situation is similar to that at the cutoff frequency. Signals slightly below cutoff frequency will be slightly attenuated, but the lower the frequency becomes the more of the signal goes through and the less of the signal is bypassed to ground. Signals slightly above cutoff are still partially passed, but as the frequency rises less and less of the signal makes it through the filter. There is no such thing as a perfect filter which passes everything below cutoff and blocks all above.

Filter performance can be improved, though, by adding more stages. If two of these stages are cascaded one after the other, then at cutoff frequency the first stage will block half the signal and permit half to pass. The second stage will block half of the half that passes through the first, and permit only 1/4 of the original signal to get through the composite filter.

Adding a third such stage will reduce the output signal level to 1/8 that at the input. A fourth stage will halve this, to 1/16 the original level. Five stages will cut the output to 1/32, and so forth.

When extra stages are added, though, the definition of "cutoff frequency" must be changed. Each stage's cutoff frequency is defined exactly as before, but the cutoff frequency of the filter as a composite unit becomes lower with each added stage, because for any filter the definition of "cutoff frequency" most generally used is that frequency at which the filter reduces output signal level to half the level present at the input.

Our two-stage filter in the example would have a composite cutoff frequency only 0.7071 times as great as the single-stage filter; the three-stage filters cutoff would be at a frequency half that of the single stage filter. These ratios apply only to the simple design shown in **Fig. 8**; more complex filter designs have different rates of cutoff-frequency change, and in general a filter is designed for specified performance rather than being built up of some arbitrary number of identical stages.

We have just examined the basic principles as applied to a simple lowpass filter. A highpass filter works the same, except that the inductor and capacitor are interchanged so that signals *above* cutoff are passed and those below cutoff are blocked rather than vice versa as in the lowpass circuit.

To get a bandpass filter, we could simply build a highpass filter with cutoff set at the lower band limit, and follow it by a lowpass filter with cutoff set at the upper band limit. For extremely wide passbands this is sometimes done. One example is the 300-3000 Hz band frequently used for voice communication; this is too wide a bandpass for simple bandpass filters to handle, and the economical way out of the problem is to first trim off one limit and then trim the other.

For narrow passbands, though, something more like a tuned circuit is generally used.

Not all filter stages are as simple as that shown in Fig. 8. Tuned circuits may be included instead of simple reactances, and the resonance frequencies may be far different from the intended cutoff frequency in order to modify filter performance. The variations possible in filter design on this basis gave rise to the "image-parameter" theory of filter design, which ruled the design of most filters for more than 30 years and even today is still widely used.

However, reactances which satisfy the demands of image-parameter theory are physically impossible, because the theory demands that the resistive portion of the circuit be zero at cutoff frequency, changing in the same manner as a capacitive reactance below cutoff, and changing in the same manner as an inductive reactance above cutoff, while actual resistances are independent of frequency.

Because many filter requirements are only approximate, this design method has been able to give circuits acceptable for most purposes. When more accurate designs were required, cut-and-try fitting of values was the normal course.

Any filter, though, is a network of components connected together, and any such electrical network must obey certain basic rules known to engineers as "Kirchoff's Laws." These state, in essence, that as much current must flow into any point as flows out and vice versa. We might say simply that the current must go somewhere—it can't just disappear!

These rules can be written as a series of algebraic equations, and to apply them to the analysis of any arbitrary network we must do just that. The laws state that all the current must be accounted for, and the equations do the accounting.

Since a filter is a network, the filter can be described by a suitable series of equations. The filter designer can then solve the equations to find the network parameters which will produce optimum performance in some desired respect. Performance will be poorer than optimum in some other respects when this is done, since all design represents compromises, but the "modern network theory" design technique for filters permits the designer to choose the performance he wants where the "image parameter" approach permitted only one or two parameters to be designed for.

We won't go any deeper than this into modern network theory, since it *is* a mathematical technique and one of our guiding principles in this course is to stay away from all mathematics which we can avoid. If you're interested, the fourth edition of "Reference Data for Radio Engineers" (and presumably the just-published fifth edition as well) contains 47 pages (pages 189 through 235) describing the technique.

We'll merely note that the modern-network-theory design approach permits a number of different filter response curves, and the resulting different filters are usually identified by names associated with the shapes of these curves. The two most widely known are the Chebishev (also spelled Tshebysheff, Chevishef, and Tshebishev) and the Butterworth filters. The Chebishev design provides the sharpest possible rate of cutoff at the cost of permitting ripple in the passband, while the Butterworth design maintains passband response flat at the cost of moderate phase shift and less steep cutoff rates.

It may seem a bit odd for us to declare that all filters are based upon reactance when crystal lattice filters composed of several quartz crystals are so widely used, but electrically the crystal is just a very-high-Q tuned circuit and contains both X_l and X_C. When used in a filter, the X_l and X_C provide the filtering action. We'll look at this in more detail in a subsequent section. First, let's see how filter performance is rated.

How Is Filter Performance Rated? Filter performance is rated according to several factors, and the factors involved vary to some degree with the type of filter in question. One factor present in the rating of every filter is its "attenuation"; this is a measure of the signal level at the output side of the filter compared to the level at the input side.

Every filter possesses some definite value of attenuation at every frequency. A lowpass filter has attenuation both below and above its cutoff frequency, as do highpass filters, bandpass, and bandstop varieties. Attenuation is usually expressed in dB.

If the output level at some specified frequency is the same as the input level, the attenuation at that frequency is Ø dB. If the output level is zero for any value of input level (a condition theoretically possible but not attainable in practice because of stray coupling around the filter), the attenuation at that frequency is infinite.

A plot of attenuation versus frequency gives the "response curve" of the filter. Fig. 9 shows typical response curves for the four categories of filters.

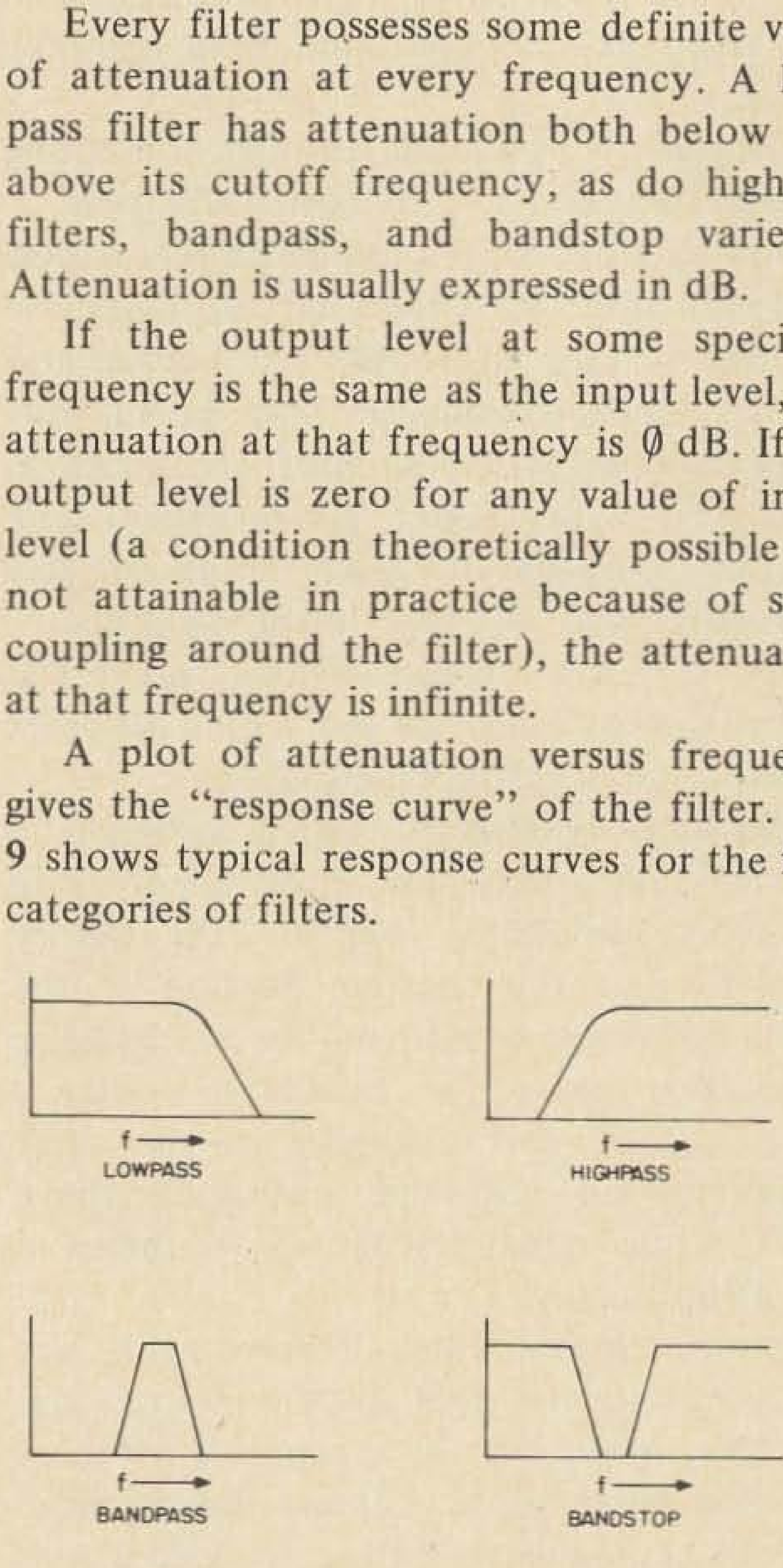


Fig. 9. Typical response curves of the four major categories of filters. These response curves are idealized; actual response curves have more rounded corners and never quite reach the zero-output point.

Another factor in common for all filters is "cutoff frequency," but now that we have established the meaning of "attenuation" we are in position to define cutoff frequency more accurately than we did earlier. The cutoff frequency for a given attenuation may be specified as the frequency at which the filter has that value of attenuation. Thus the 3 dB cutoff frequency for a lowpass filter will be lower than the 6 dB cutoff frequency. The definition we developed earlier—that frequency at which output level is half of input level—actually defines the 6 dB cutoff frequency of any filter.

A glance at Fig. 9 will show that both bandpass and bandstop filters have not one but two cutoff frequencies, since for any specified value of attenuation there is a frequency below the filter's center frequency which has that attenuation, and another frequency above center frequency. The two cutoff frequencies of band filters are designated as "upper" and "lower" cutoff frequencies.

Sometimes filters are compared according to their "slope" or "cutoff rate." This is a relative term referring to the rate at which attenuation changes with frequency. Engineers speak of slope or cutoff rate in units of "dB per octave"; this means the number of dB change in attenuation when the frequency is doubled. A single reactance has a slope of 6 dB per octave; that is, if frequency is doubled the reactance is either doubled or halved, and the resulting ratio is 6 dB (2:1 voltage or current, and 4:1 power ratio). Filters with two reactances usually have slopes of 12 dB per octave, with the slope increasing 6 dB per octave for each added reactance in the filter. This is not an airtight law, however; many filters have slopes which do not follow this rule, and almost no filter follows this rule at frequencies near the cutoff point or within the passband.

All filters have a "bandwidth," but the term has different meanings depending on whether the filter is (1) lowpass or highpass, or (2) bandpass or bandstop. For lowpass or highpass filters, the bandwidth for a specified attenuation is the actual frequency at which the filter has that attenuation. The "width" means the number of cycles from zero frequency to the frequency in question. Thus the bandwidth for 3 dB attenuation of a lowpass filter with a 3 dB cutoff frequency of 100 Hz is 100 Hz.

For symmetrical bandpass or bandstop filters, the bandwidth is the difference (in hertz) between the two cutoff points for the specified attenuation. A bandpass filter with an upper 3 dB cutoff frequency of 10 kHz and a lower 3 dB cutoff frequency of 8 kHz would have a 3 dB bandwidth of 10-8 or 2 kHz.

Bandwidth is always specified for a definite attenuation level, because it is defined in terms of cutoff frequencies, which are themselves defined only by attenuation level. Unless the attenuation level is specified, any use of "bandwidth" as a rating factor is meaningless.

For bandpass filters in particular, the bandwidth is one of the primary measurements—but it is by no means the only one. Consider two different bandpass filters, both having 6 dB bandwidths of 3000 Hz. The first, however, is a very simple filter with only a few reactances and consequently has a very slow rate of cutoff, while the other is a complex Chebishev design with steepest possible cutoff rate. The first filter may have a 60 dB bandwidth of 30 kHz and the 60 dB bandwidth of the second might be as narrow as 6 kHz. (Fig. 10).

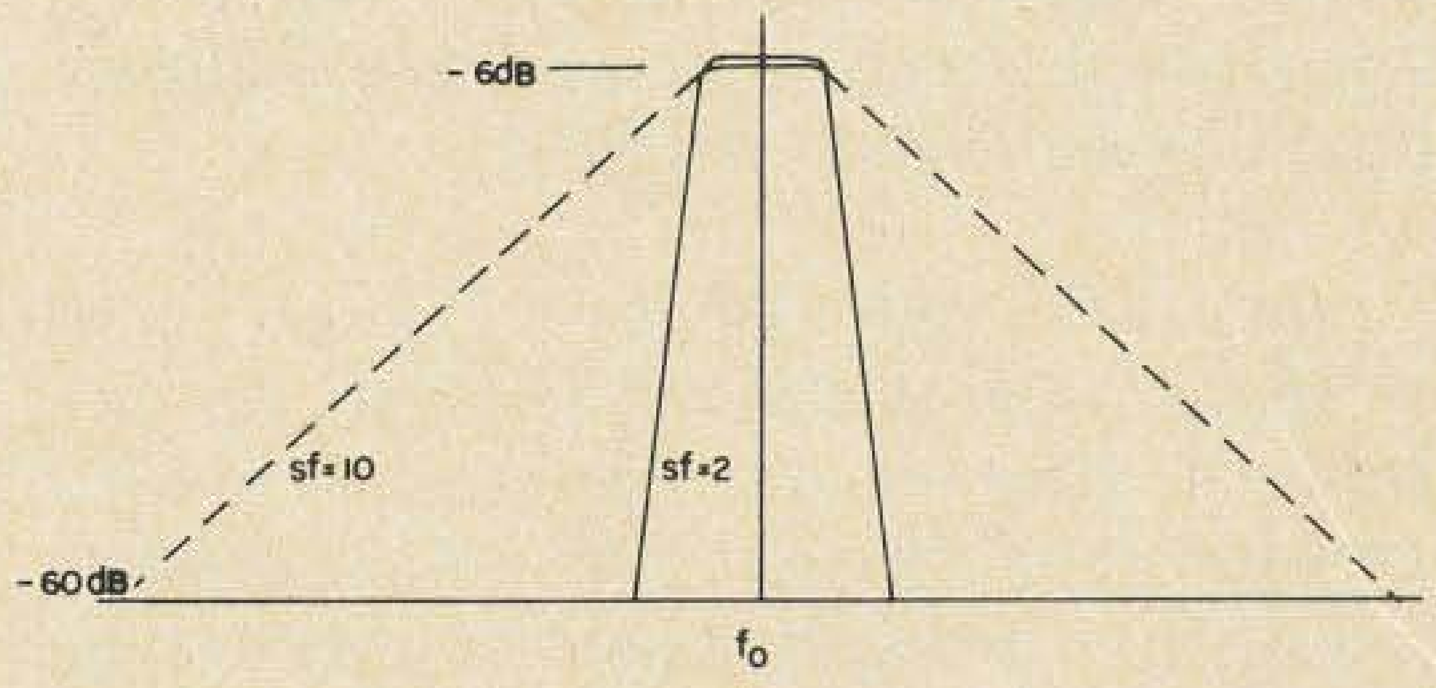


Fig. 10. Significance of "shape factor" is shown here. Both filters whose response curves are illustrated have 6 dB bandwidths of 3 kHz. That in solid lines has a 60 dB bandwidth of only 6 kHz, while that in dotted lines has 60 dB bandwidth of 30 kHz. Difference in effective passband is clearly evident.

Obviously, the second of these filters will do a far better job of trimming applied signals down to its passband.

The term "shape factor" is used to describe the property we have just compared; the "shape" referred to is that of the filter's response curve. A perfect bandpass filter would have absolutely vertical sides to its response curve, with zero attenuation between the two cutoff frequencies and infinite attenuation outside that range. Actual bandpass filters have response curves which vary from a barely perceptible hump up to a steep-sided curve very much like that of the perfect filter.

The "shape factor" of a bandpass filter is the ratio between its bandwidths at two different attenuation levels. In ham practice, the 6 dB and 60 dB bandwidths are the ones most often used. The shape factor ratio is always obtained by dividing the larger bandwidth by the smaller, so that it is always greater than 1. A perfect filter with vertical sides to the response curve would have the same bandwidth at all attenuation levels, and so would have a shape factor of 1. Practical filters always have greater bandwidth at high attenuation levels than they do at the lower-attenuation points, and so their shape factors are always greater than 1. If the 6 dB bandwidth of a filter is 1.5 kHz and the 60 dB bandwidth is 3.0 kHz, the 6-60 dB shape factor of that filter is 3.0/1.5 or 2; this represents excellent performance. Many bandpass filters in use today have shape factors as great as 10. The shape factor of a single tuned circuit when used as a bandpass filter may be as great as 100.

How Are RF Bandpass Filters Constructed? One of the requirements for any receiver intended to operate in today's crowded rf spectrum is that it have extreme selectivity. Ideally, it should be able to tune in either sideband of an AM signal while rejecting both the carrier and the other sideband. This is known as selectable sideband capability, and marks an extremely selective receiver.

Almost universally, such selectivity is achieved by use of bandpass filters operating in the rf or i-f range. Since normal i-f's are actually radio frequencies, we'll lump these filters together for our discussion.

RF bandpass filters capable of providing shape factors smaller than about 10 are most often one of two major types—mechanical filters and crystal filters. We won't go into details of the mechanical filters here, since they have little to do with electrical and electronic phenomena.

Crystal filters themselves divide into two major groups. One of them uses only a single crystal, to provide a very narrow response curve with relatively poor shape factor. This type, which was standard equipment on older communications receivers, provides excellent results on CW but is not so hot for reception of voice signals. The second group, which used two or more crystals, provides greater bandwidth than the first, with smaller shape factor. It is widely used in SSB operation, since the shape of its response curve matches the requirements for voice communication.

The single-crystal type of filter is normally known simply as a "crystal filter," while those using two or more crystals are generally called "crystal lattice filters." Technically, a lattice filter must use four crystals, or multiples of four, but an electrically equivalent circuit called a "half-lattice" requires only two crystals, and is possibly the most popular type of lattice filter in use now.

Let's examine both groups of filters separately, taking the older single-crystal filter first. The schematic of a typical single-crystal filter circuit appears in **Fig. 11**. The driving transformer splits the signal into a pair of signals, equal in strength but opposite in phase. One of these two signals is applied to the quartz crystal while the other is applied to a "phasing condenser" which is simply a variable capacitor. The two signals are then put back together at the input to an amplifier stage.

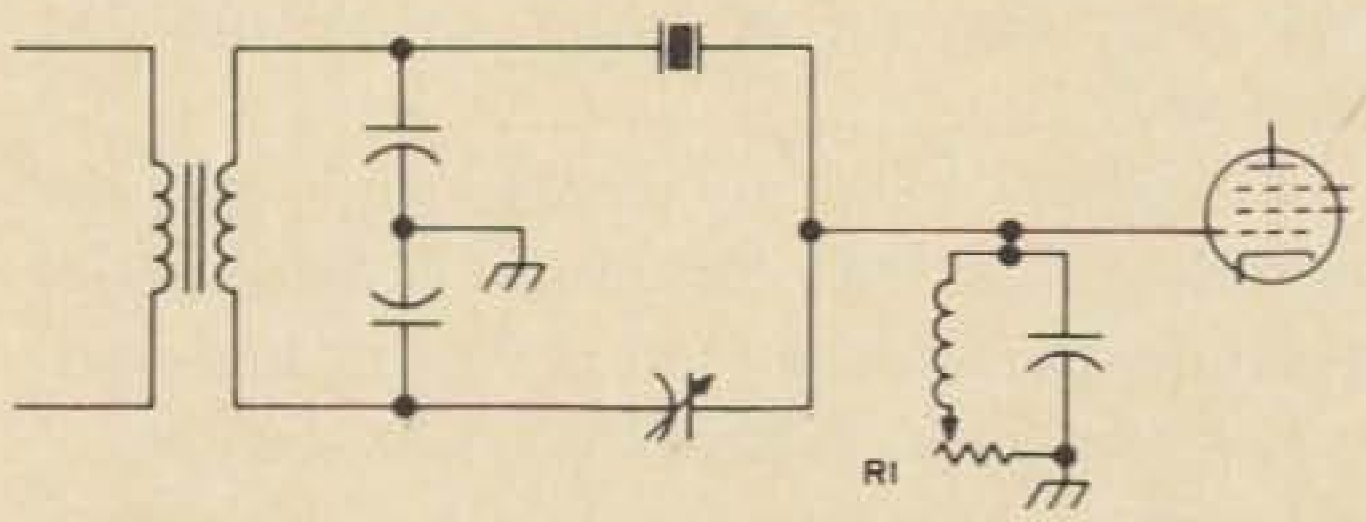


Fig. 11. Typical single-crystal i-f filter of type used for CW reception. Adjustment of capacitor tunes out parallel resonance of crystal to give symmetrical passband, or can move parallel resonance to either side of series resonance to insert a "rejection notch" anywhere within passband except at series-resonant frequency itself.

The quartz crystal is equivalent to a very high Q resonant circuit; it has both series and parallel resonances. At the frequency of series resonance, it is an extremely low resistance, while at the frequency of parallel resonance it is an extremely high resistance. In the absence of the phasing condenser, this circuit would permit signals at series resonance to pass through almost unchanged, while attenuating signals at other frequencies greatly and providing almost infinite attenuation at parallel resonance.

The phasing condenser, however, provides an alternate path for the signal around the crystal. When the phasing condenser is adjusted so that its capacitance exactly balances the parallel capacitance of the crystal and its holder, the parallel resonance of the crystal is eliminated and the filter's response curve becomes a single sharp peak. The rejection notch at parallel resonance is eliminated.

When the phasing condenser is adjusted for either more or less capacitance than that required to balance the crystal, the effect is to tune the parallel resonance of the crystal to some definite frequency. This introduces the rejection notch, and makes it possible to move the rejection notch relative to the passband peak, permitting a single interfering frequency to be "notched out" of the signal.

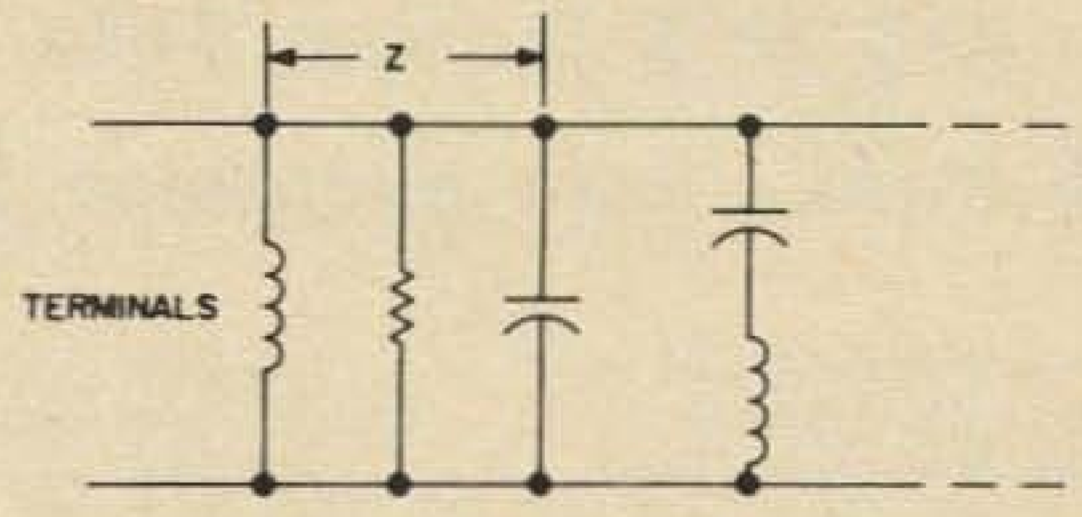


Fig. 13. Equivalent circuit of each impedance in full lattice filter. Parallel-resonant circuit at left represents parallel resonance composed of crystal and stray circuit capacitance, together with loading resistances. Series-resonant circuit at right (which may be extended indefinitely as indicated by dotted lines) represents series resonances of each crystal in each leg. Impedances "A" and "B" are parallel resonant at lower cutoff frequency. Series resonances introduce "infinite rejection" notches just outside passband to sharpen skirts of filter.

Adjustment of resistance R1 modifies the loading imposed on the filter, and varies the effective bandwidth. The 6 dB bandwidth of such a filter circuit can be varied from about 50 Hz when R1 is extremely large, out to greater than 6 kHz when R1 is very small.

The multiple-crystal filter designs are based on the lattice structure shown in **Fig. 12**. Each section of this lattice structure consists of one or more crystals, and provides the equivalent of the circuit shown in **Fig. 13**. Much of this circuitry can be eliminated by replacing the lattice with its equivalent shown in **Fig. 14**; the lattice arms themselves now require only single quartz crystals using their series resonances.

Characteristics of such a filter are determined primarily by the number of crystals used, and the degree to which they are matched. Those crystals marked A and those marked B must not tune to the same frequency. In fact, the spacing between the series resonant frequency of crystals A and that of crystals B is the major factor determining the filter's bandwidth.

Design of such a filter is done by modern network theory, usually using the Chebishev techniques, and is too complex for us to explore here. In general, the bandwidth determines the spacing between resonant

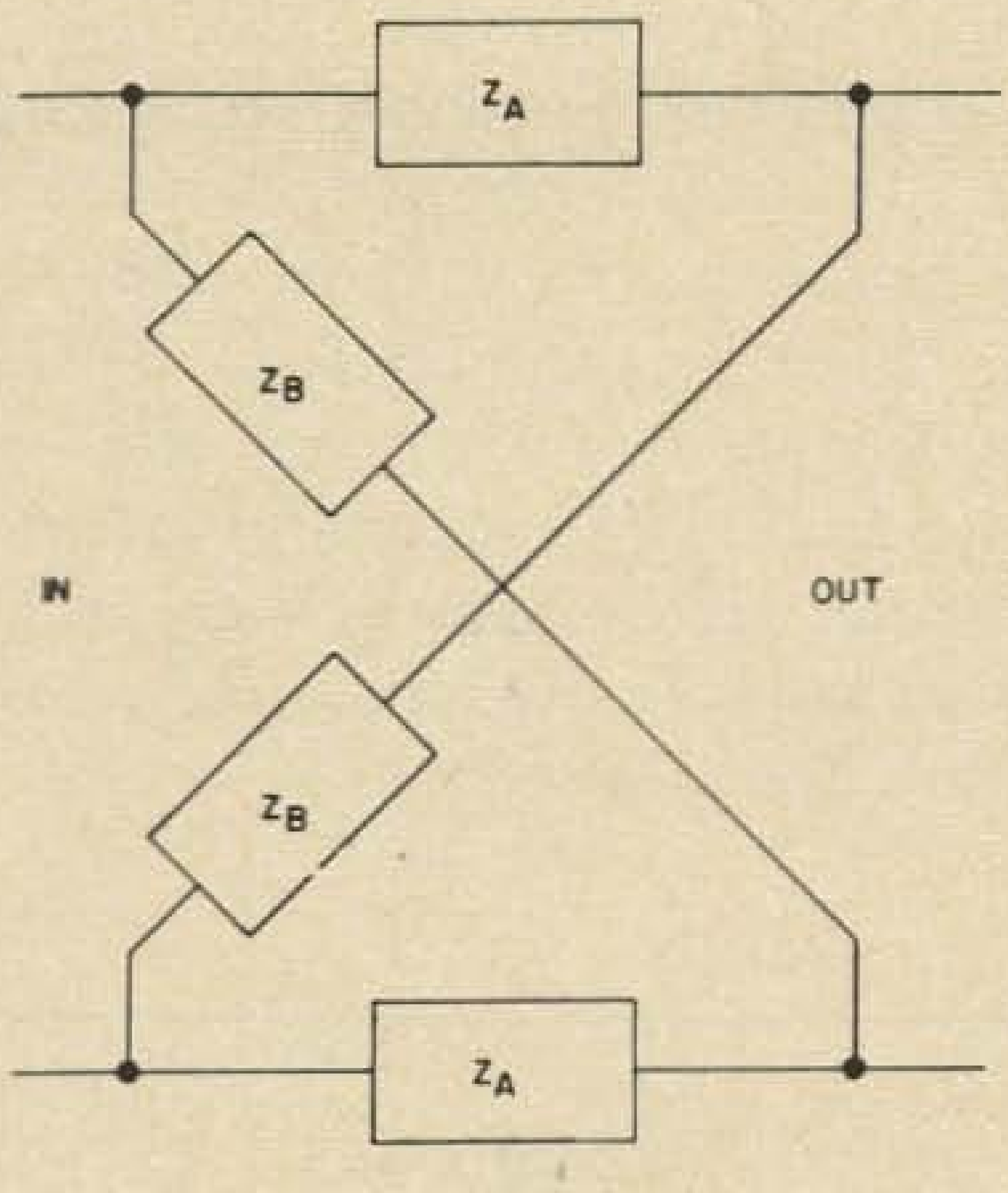


Fig. 12. Full-lattice filter arrangement in block diagram form. Each block represents an impedance having characteristics of the circuit shown in Fig. 13. When interconnected as shown here, passbands of "A" and "B" sections interact to provide a flat-topped passband with excellent shape factor.

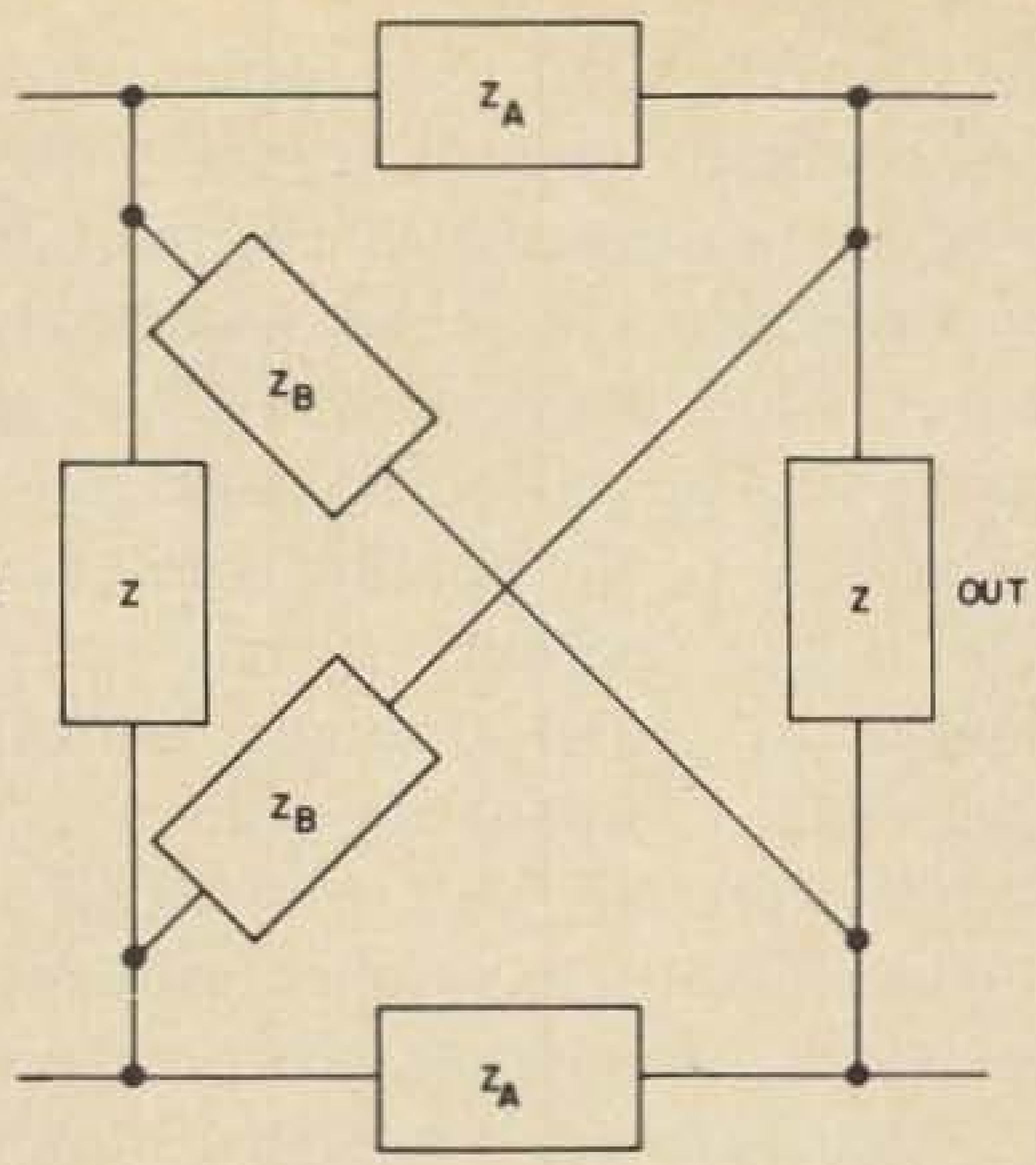


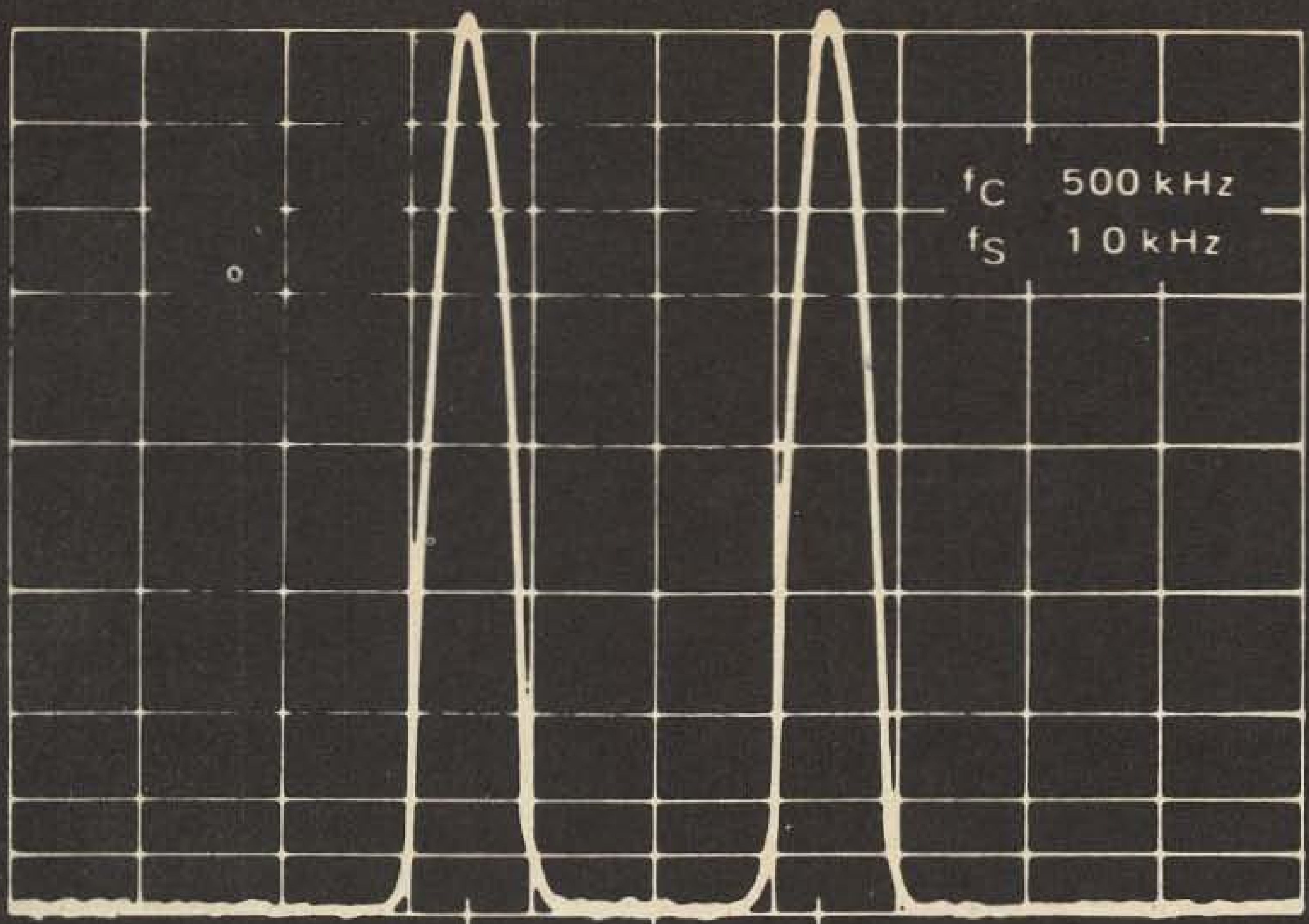
Fig. 14. Load resistances and stray circuit capacitance of full lattice filter can be moved to input and output terminals as indicated here. This circuit is electrically the same as that of Fig. 12. Each "A" and "B" block is still the circuit of Fig. 13, which may in practice consist of a single crystal for each block.

frequencies of the two groups of crystals. Within each group, characteristics of each crystal must match as closely as possible (many commercial crystal filters use a single crystal with multiple electrodes on it, each pair of such electrodes serving as a "different" crystal in the lattice, to assure identical characteristics). So long as the filter's center frequency is not greater than about 250 times its desired bandwidth, good shape factor can be attained easily. That is, for a "phone" bandwidth of 3 kHz, any center frequency up to 750 kHz could be employed. In fact, successful lattice filters with center frequencies as high as 10 MHz and bandwidths as small as 2 kHz have been built, but design is more critical.

. . . Staff ■

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.



Paul Franson WA4KRE
7430 E. Minnezona Ave.
Scottsdale AZ 85251

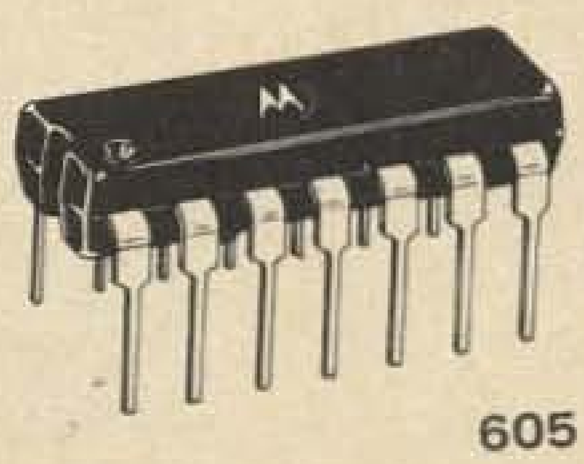
NEW LINEAR ICs FOR THE HAM

. . . . . THEY'RE NEW, HOT, AND CHEAP !

Hams have been using integrated circuits almost since they were first introduced commercially at reasonable prices. The earliest ham uses were keyers and frequency standards using digital ICs. ICs are so useful in these applications that it is difficult to imagine anyone building a keyer out of discrete semiconductors, or (perish the thought) vacuum tubes, anymore. ICs with their low-voltage operation and great circuit simplification make even complex projects relatively easy and inexpensive to build.

The resistor-transistor logic (RTL) family (the Motorola MC700P series and the Fairchild μL900 series) has been the most popular type of integrated circuits for experimenters. Both are packaged in inexpensive plastic cases, and though the Motorola devices have won out in most uses because they are lower in cost and furnish more functions per package, many of the Fairchild parts have also been used.

There has been relatively little use by hams of linear integrated circuits up to now, though a few of the audio power amplifiers that have been introduced by RCA, Motorola, and GE in the past few years have seen some use. This would be surprising at first glance because most ham applications are linear or analog ones, rather than digital. However, the digital circuits were much cheaper and more widely available, hence attracted more attention in the past. Recently, however, many different types of linear integrated circuits have become very attractive for ham use. They are now available at reasonable prices for many applications.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Many of the new linear integrated circuits that are of particular interest to hams have been designed for consumer use. This assures that they will have reasonable prices; expensive ICs can find little use in consumer equipment. Table I lists many of the linear integrated circuits that are now available. They include voltage regulators, audio amplifiers of various types, i-f amplifiers, a unique new circuit called the balanced modulator, and operational amplifiers. Any one of these ICs can replace many discrete devices, and in many cases can provide much higher performance than any practical combination of discrete devices could. They also are relatively inexpensive, ranging in price from $1.50 for an i-f amplifier to $7.15 for the balanced modulator/demodulator, a recently

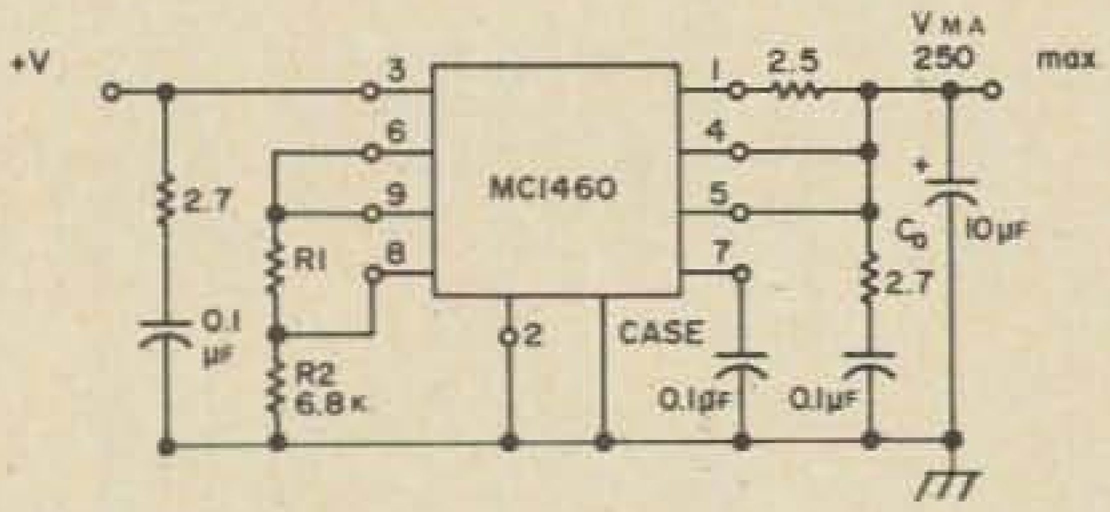


Fig. 1. High-performance IC regulator using the MC1460. The input voltage, V_{IN} must be at least 3V greater than the output. Maximum input for the MC1460 is 20V. The MC1460 is good for 35V input. An etched circuit board is recommended for construction. Use VHF techniques.

introduced part. All of the parts described are manufactured by Motorola, and are readily available from the many Motorola distributors, including Allied Radio and Newark.

Voltage Regulators

One of the most dramatic examples of the simplification that a linear integrated circuit can provide in a circuit is the voltage regulator.

The MC1460 series of voltage regulators can provide up to 600 mA of output current at over 30V with no external transistors or other semiconductors. Only a few small resistors and capacitors are required to produce a complete regulator with excellent characteristics.

Four members of the MC1460 family are of particular interest to hams. The MC1460 has a maximum input of 20V and the MC1461, a maximum input of 35V. The "G" versions (in a package very much like the TO-66 case used for silicon power transistors except that it has 9 pins instead of 2) can handle 600 mA when it's mounted on an adequate heatsink. Four similar regulators are available in the MC1560 series with a full temperature range which makes them more suitable for military use. They cost significantly more.

The MC1460 series has a typical low output impedance of only 0.025-0.035Ω at frequencies up to 100 kHz. Regulation for changes in input voltage is typically only 0.003% per volt, a remarkably low figure. The MC1460 can put out voltages as low as 2.5V and as high as 17V. The output voltage must always be at least 3V less than the input voltage for the regulator to work properly. Another interesting feature of the MC1460 series is its short-circuit protection. The regulator will not be damaged by a continuous short circuit.

A basic MC1460 circuit is shown in **Fig. 1**. It can put out a maximum of 250 mA. It uses only a few small 0.25W resistors and capacitors. In the circuit, resistor R1 is selected to give the desired output voltage. A potentiometer can be used for a variable output, but this circuit is really more suitable for a fixed rather than a variable voltage.

The regulator as shown will limit output current to 250 mA. If you try to draw more current than this, the regulator will automatically reduce the output voltage. This short-circuit current is determined by the 2.5Ω resistor connected to pin 1. This resistor can be changed to get other maximum output currents.

The MC1460G, which is in the TO-5 package, will require a heatsink for currents near its maximum, and the MC1460 will likewise require a heatsink for high current values. Probably the most practical type of heatsink for the R package is one with a hole large enough for all 9 pins to pass through without shorting. This is much more practical than trying to drill holes for each one of the nine pins. A socket is available for the MC1460R, but it is hard to find and relatively expensive.

One word of caution if you are used to building dc power supplies: The transistors used in the MC1460 are very high-quality VHF devices; hence, the circuit must be treated properly or it's likely to oscillate at very high frequencies. You'll notice in **Fig. 1** that a number of capacitors and resistors are included for high-frequency suppression to prevent the circuit from oscillating. You should use an etched circuit board for

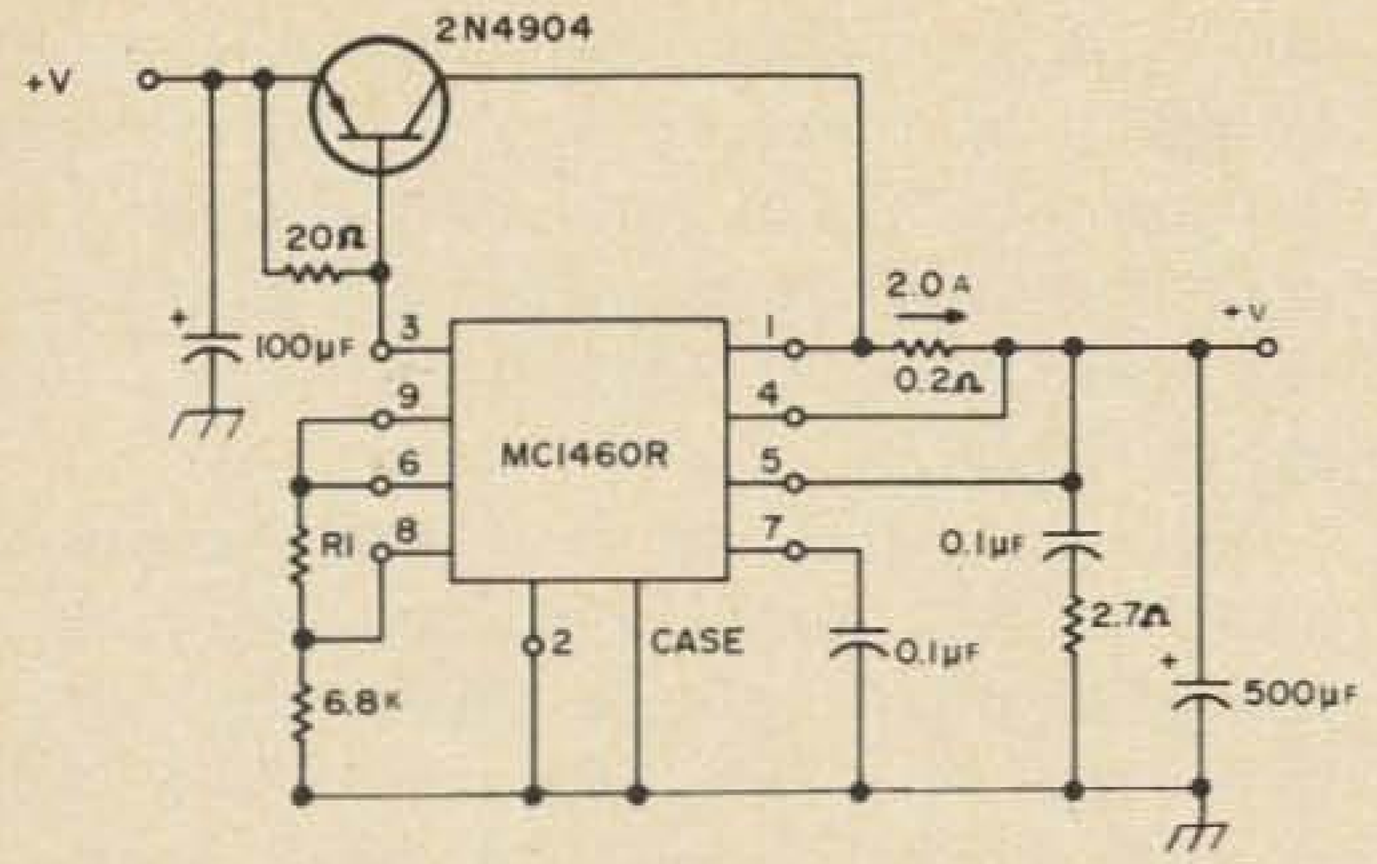


Fig. 2. IC voltage regulator with 2A capability using external series-pass power transistor.

constructing this regulator so that you can get very short leads and a good ground.* It is not practical to go into all the fine points of the circuit; however, the data sheet for the MC1460 series is comprehensive and provides complete information on using the device.

Two other circuits using members of the regulator family are shown in **Figs. 2 and 3. Figure** 2 is a 2A voltage regulator using an external PNP series-pass power transistor. A similar technique can be used to provide up to 10A for applications requiring this amount of current. More information is given in the data sheet.

Figure 3 is a laboratory power supply with an output adjustable from 0 to 25V. It will provide up to 400 mA. This circuit, unlike many power supplies, can go all the way down to zero volts. It is also interesting because of the extreme simplicity of the circuit. It would be interesting to compare **Fig. 3** with a typical regulated power supply using discrete devices. The discrete version would be far more complex and expensive, and yet would not provide the same performance.

The Motorola MC1469 is a regulator similar to the 1460, but even less expensive, and designed for less exacting uses. No circuits are included for this device because they were not available at the time this article was prepared. However, the data sheet on the devices will give considerable information.

Another voltage regulator of particular interest is the MC1466, which is designed for use with external transistors. It can be used to regulate voltages as high as 1000V or even higher. In this application, the regulator is floating, but it can be protected against shorts even though the external pass transistor used with it may not be able to stand this high voltage if the output is shorted. More practically, or perhaps of more interest, the 1466 can be used to provide very high current at lower voltages, or provide medium current with voltages in the 100 to

*A board is available for $1.50 from Project Supply Company, PO Box 555, Tempe AZ 85281.

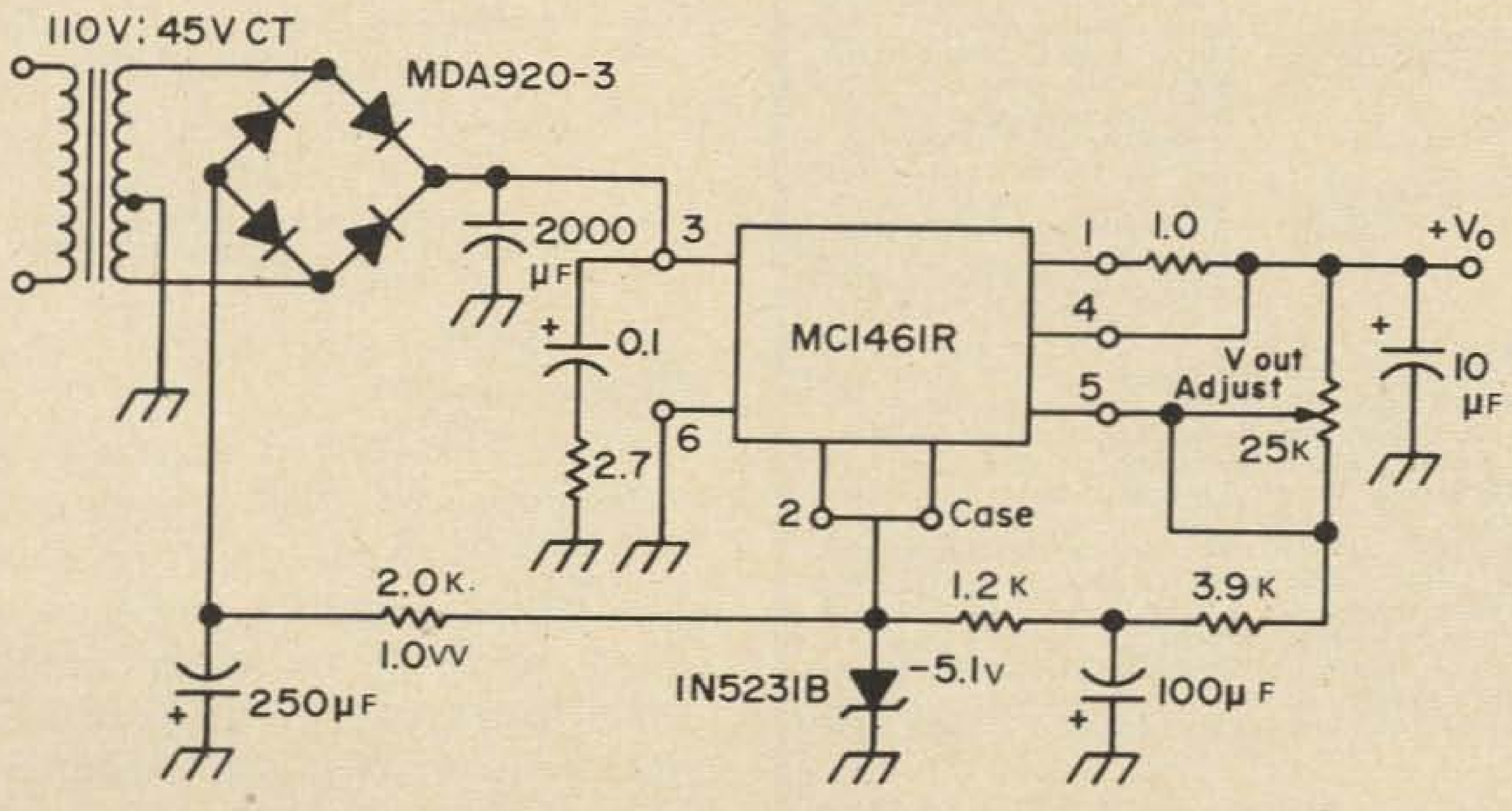


Fig. 3. 0-25V, 400 mA laboratory power supply.

200V range. This would be useful, for example, as a screen supply for a transmitting tube. Other voltage regulator ICs are available; most are made for use with external transistors for currents of more than about 10 mA.

All in all, the new IC voltage regulators make it very easy to design and build a power supply to provide almost any current or voltage with very little work, and assurance that the circuit will work properly without needing any adjustments. The day of the discrete semiconductor regulator seems to be rapidly approaching its end.

Audio Amplifiers

Many of the new inexpensive linear ICs are audio amplifiers. Some are designed for low-level use, others for moderately high power; that is, a watt or more. Starting at the low end of the price and complexity scale is the MFC4010, a wideband amplifier that can provide up to 60 dB of gain at 1 MHz, so it's suitable not only for audio, but also i-f applications.

The MFC4010 is one of the first of a new breed of consumer ICs. It has only four pins; the package is a small version of the dual in-line package that has become so popular. The four pins are positive voltage, ground, and the input and the output. That's all; no complex compensation is needed as has been required in the past for most ICs.

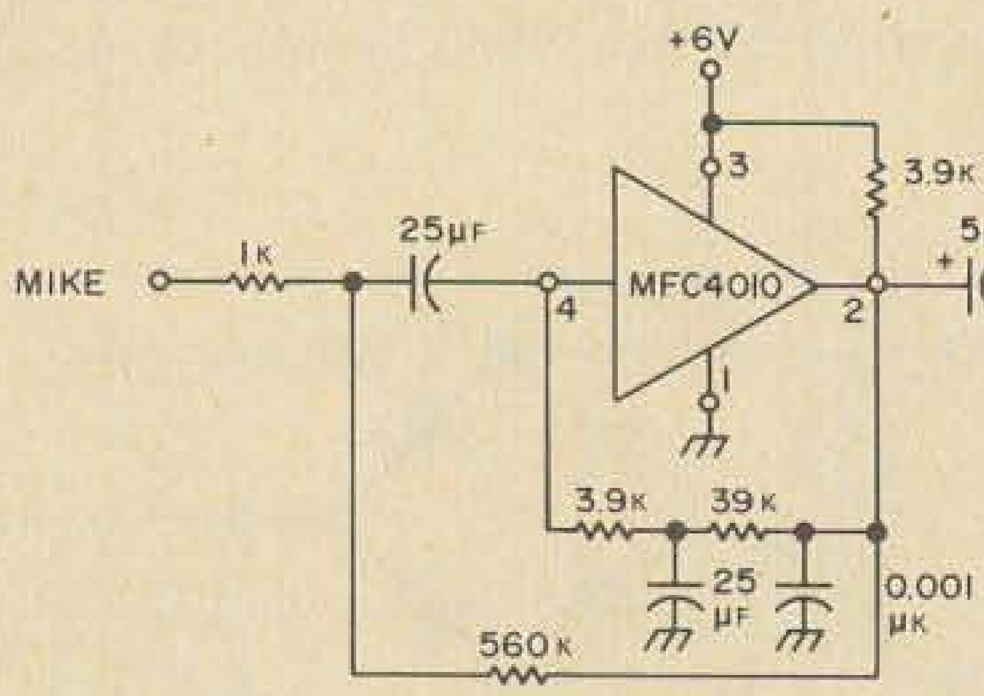


Fig. 4. High-gain audio amplifier using MFC4010 wideband amplifier.

The MFC4010 is especially useful as a microphone amplifier or as a general-purpose 455 kHz i-f amplifier. A typical circuit using this device is shown in Fig. 4. It operates from 6V; it's an audio amplifier for a microphone, and as you can see, very few external components are required to provide high gain. The MFC4010 itself contains three transistors and five resistors.

Another low-level audio amplifier is the MC1303P in the popular dual in-line 14-pin package. This dual audio amplifier was designed to be used as a preamplifier in stereo phonographs and similar equipment. It provides 60 dB of gain and is useful where high gain and two separate amplifiers are needed.

The MFC4000 is a 0.25W audio power amplifier with 15 mV sensitivity. It contains six transistors, three diodes, and five resistors. The MFC4000 uses the same small package as the MFC4010 and also has only four terminals: input, output, supply voltage, and ground. Its 250 mW of audio output may not seem like much, but it is quite satisfactory for many applications, such as pocket radios, and home equipment, where the noise level is not very high. When used with an efficient speaker, that quarter watt will drive you out of the room.

The MFC4000 draws very low standby current, typically only 3.5 mA at 9V. Perhaps the best feature of the MFC4000 is compactness. A whole audio output stage takes up very little space.

The MC1306P is also a 250 mW audio amplifier, but it includes a preamplifier, giving it a sensitivity of 3 mV for full output—considerably higher gain than the MC4000. It's packaged in a new eight-pin plastic package that looks like a shortened dual in-line package. Four transistors in the preamplifier section and ten transistors in the output section are contained in the small package. The two parts are independent and can be used in cascade with other circuitry, such as a volume control or filter between them. Like the MFC4000, the MC1306P is designed for 9V operation and has a similar low zero-signal current drain (4 mA). Typical harmonic distortion is only 1%.

A typical application of the MC1306P is shown in **Fig.** 5. This is a high-gain 250 mW audio amplifier for use in a portable receiver. Its total gain is 1000, or 30 dB. Only a few external components are required, but as with all these ICs, the component leads should be short to prevent high-frequency oscillation.

The next IC has been available for some time in an expensive hi-rel (military term for "high reliability") version. The recent introduction of a low-cost, relaxed-spec version makes it much more interesting. This device is the MC1454G. It is similar to the older MC1554G, but as mentioned, has relaxed specifications and a much lower price, $3.30 instead of $14.25.

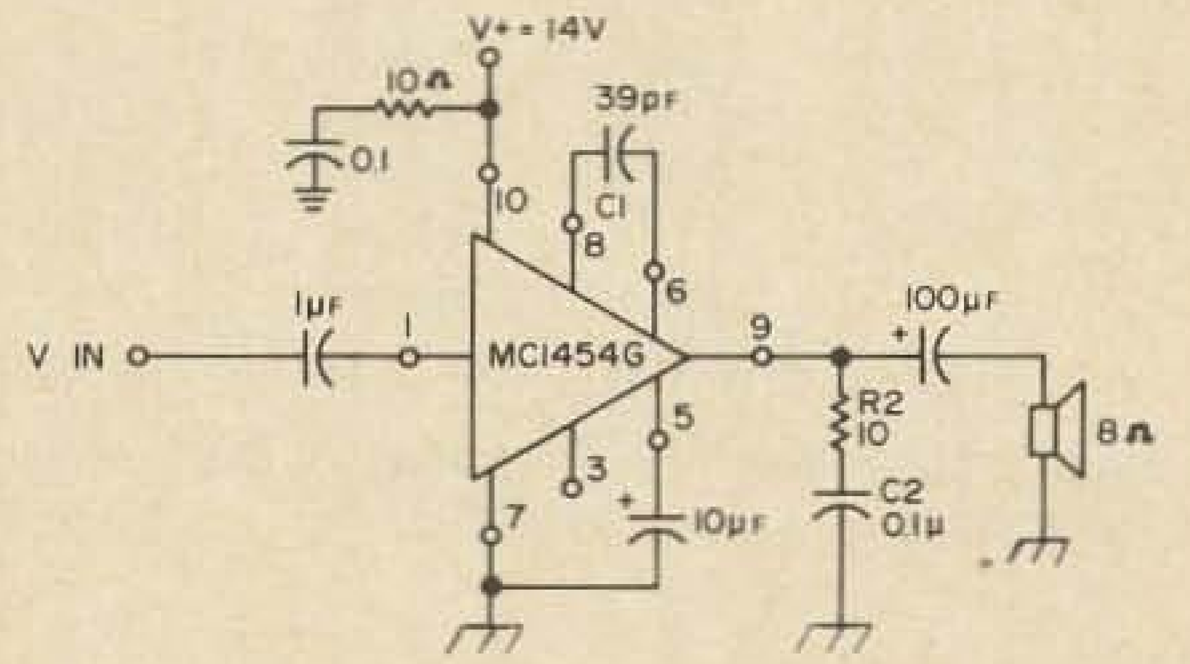


Fig. 6. Audio power amplifier has 1W gain of 10; input impedance of 10 kΩ. An external heatsink is required. The HEP593 can also be used in this circuit with similar results.

Figure 6 shows a 1W audio power amplifier. You'll notice that it uses no transformers, and operates directly from 12.5 to 14V. The gain of this circuit is 10, and the input impedance is 10 kΩ. An external heatsink must be used with this device for maximum power output.

The HEP 593, readily available at almost all electronic stores in the country, is similar to the MC1454G. Either of these devices makes an excellent output amplifier for use in mobile or home equipment. Its 1W of audio power is adequate for most ham uses,

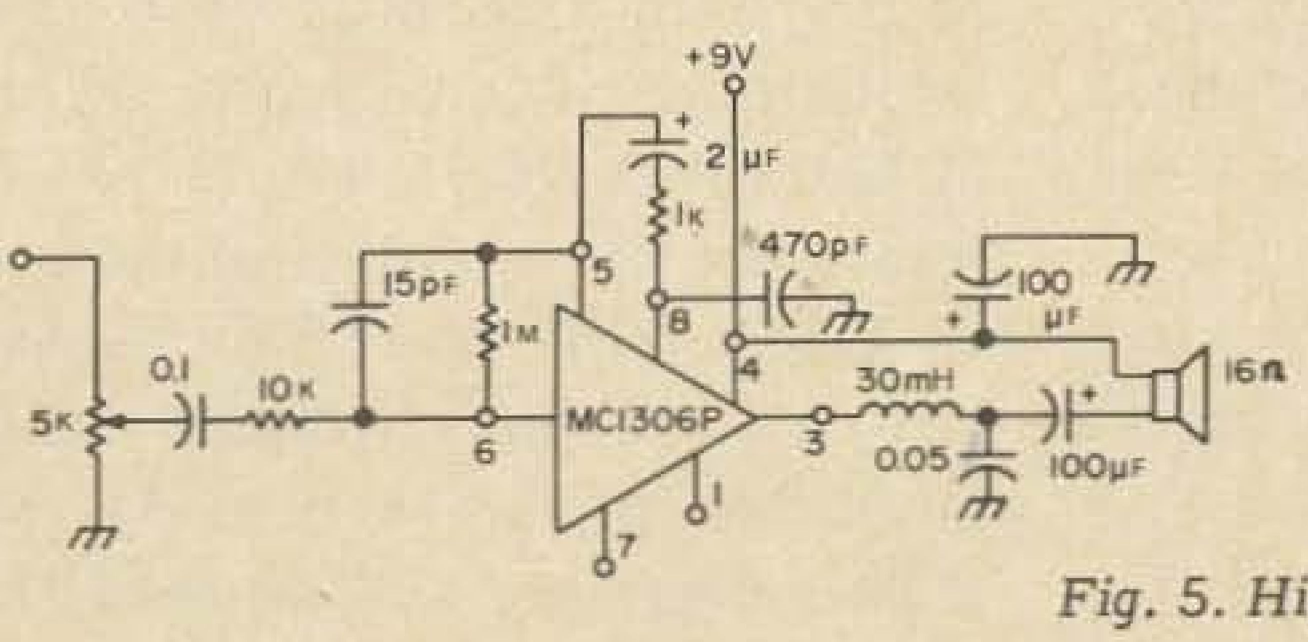
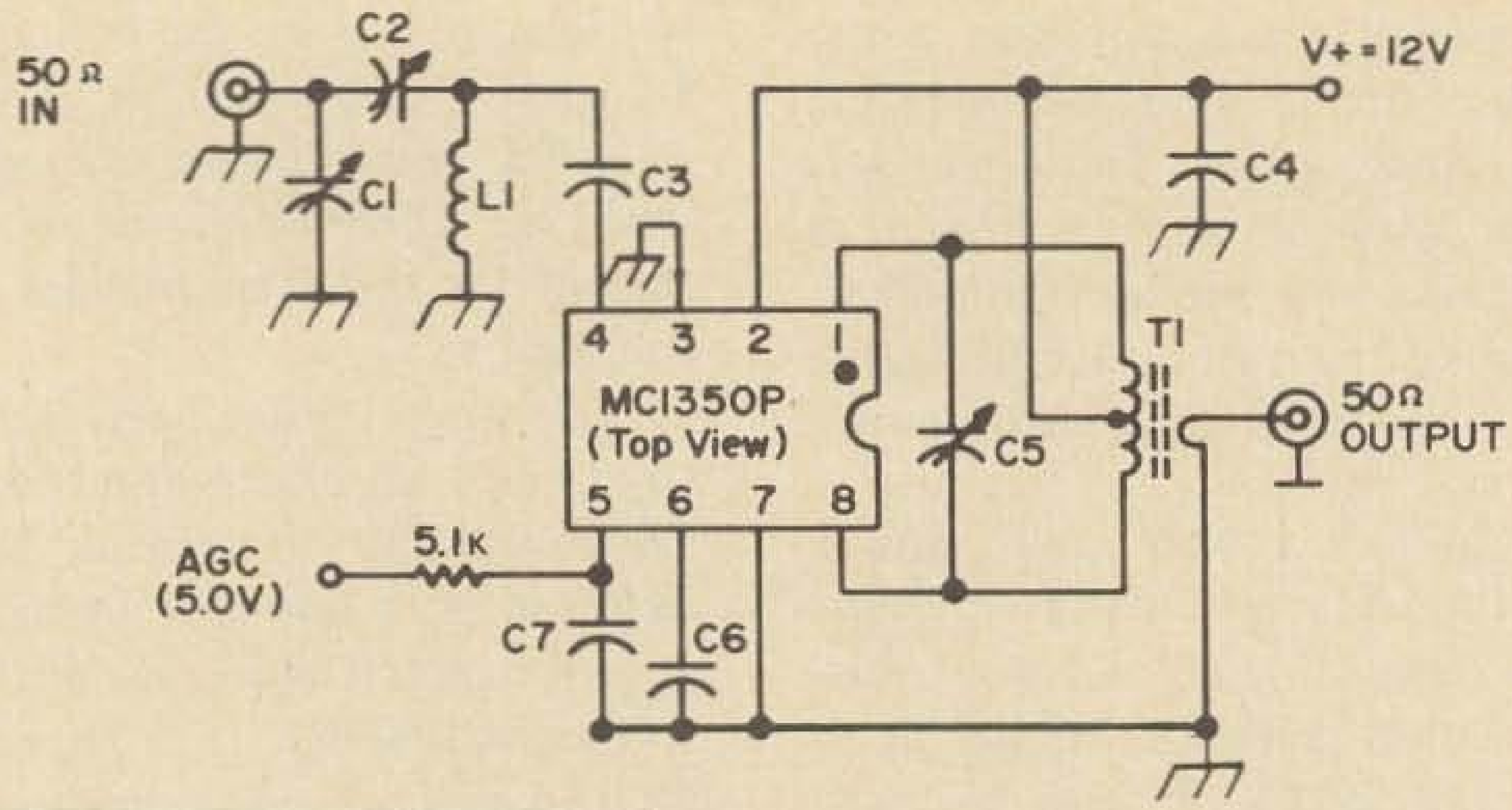


Fig. 5. High-gain (30 dB) 250 mW audio amplifier for use in portable receiver.



Component	Frequency 455 kHz	10.7 MHz	45 MHz
C1	–	80–450 pF	9.0–35 pF
C2	–	5.0–80* pF	2.0–8.0 pF
C3	0.05 μF	0.001 μF	0.001 μF
C4	0.05 μF	0.05 μF	0.001 μF
C5	0.001 μF	36 pF	1.0–5.0 pF
C6	0.05 μF	0.05 μF	0.001 μF
C7	0.05 μF	0.05 μF	0.001 μF
L1		4.6 μH*	0.8 μH
T1	Note 1	Note 2	Note 3

*Circuit positions of L1 and C2 are interchanged.

Note 1. Primary: 120 μH (center-tapped)
Q_u = 140 at 455 kHz
Primary: Secondary turns ratio ≈ 13

Note 2. Primary: 6.0 μH
Primary winding = 24 turns #36 AWG (close-wound on 1/4" dia. form)
Core = Arnold Type TH or equiv.
Secondary winding = 1-1/2 turns #36 AWG, 1/4" dia. (wound over center-tap)

Note 3. Primary winding = 18 turns #22 AWG (center-tapped)
Secondary winding = 1 turn #22 AWG (over-wound at center of primary)

Fig. 7. High-gain i-f amplifier with wide-range agc action. Circuit values are shown for 455 kHz, 10.7 MHz, and 45 MHz.

except modulating large AM transmitters, which hardly anyone does any more. Motorola Application Note AN-401, "The MC1554: A One-Watt Monolithic Integrated-Circuit Power Amplifier," gives more information on applications of this useful circuit. As mentioned, the MC1454 is a relaxed version of the MC1554, and the circuits described apply in almost cases.

I-F Amplifiers

A number of new i-f amplifiers have been introduced recently; many are of great interest to the ham. In addition, one that's been around for a few years takes on a new interest in view of its recent reduction in price from $4.25 to $1.50.

The MC1350P is perhaps of greatest interest. It features very high gain at frequencies up to 60 MHz and also includes provision for very wide-range agc. Power gain is typically 50 dB at 45 MHz, and agc range is 60 dB minimum. It has very low feedback capacitance, thus does not need neutralization in spite of its very high gain. The device is designed for operation on 12V from a single power supply, unlike many of the earlier ICs. The MC1350P was designed for use in television receivers; however, it's equally valuable for many other uses, such as i-f amplifiers at any frequency up to 60 MHz. Typical gain at 45 MHz is 50 dB; at 10.7 MHz, it's 58 dB, and at 455 kHz, 62 dB. Noise figure at 60 MHz is a respectable 9 dB, but you probably would want to use a low-noise preamp if you were using this i-f amplifier in a microwave receiver. For other applications, this noise figure is more than adequate. Typical circuits for the MC1350P are shown in **Fig. 7**. Component values are given for frequencies of 455 kHz, 10.7 MHz, and 45 MHz.

Very similar to the MC1350P is the MC1590G, a higher-performance version sealed in a metal can for use in military equipment. The MC1590G costs $5.60 in single quantity, so you can see that the MC1350P at $3.75 would be of much more interest in most ham applications.

Either the MC1350P or the MC1590G also makes an excellent video or audio amplifier for any application requiring very wide range agc, such as speech compression circuits.

A very simple receiver providing quite good performance could be made using a few of these integrated circuits. Discrete dual-gate MOSFETs are better in the front end: an MFE3007 is an excellent rf amplifier. An MFE3008 mixer with a separate oscillator could feed an MC1350P i-f amplifier, then a detector and MC1306P audio output amplifier.

An older, but very good, linear IC is the MC1550G rf/i-f amplifier. This is a much simpler circuit than the MC1350P, but it also offers very wide agc range, high power gain (typically 30 dB at 60 MHz), good noise figure, and extremely low feedback capacitance. The MC1550G used to cost $4.25; now it's down to only $1.50, which makes it very attractive for many applications.

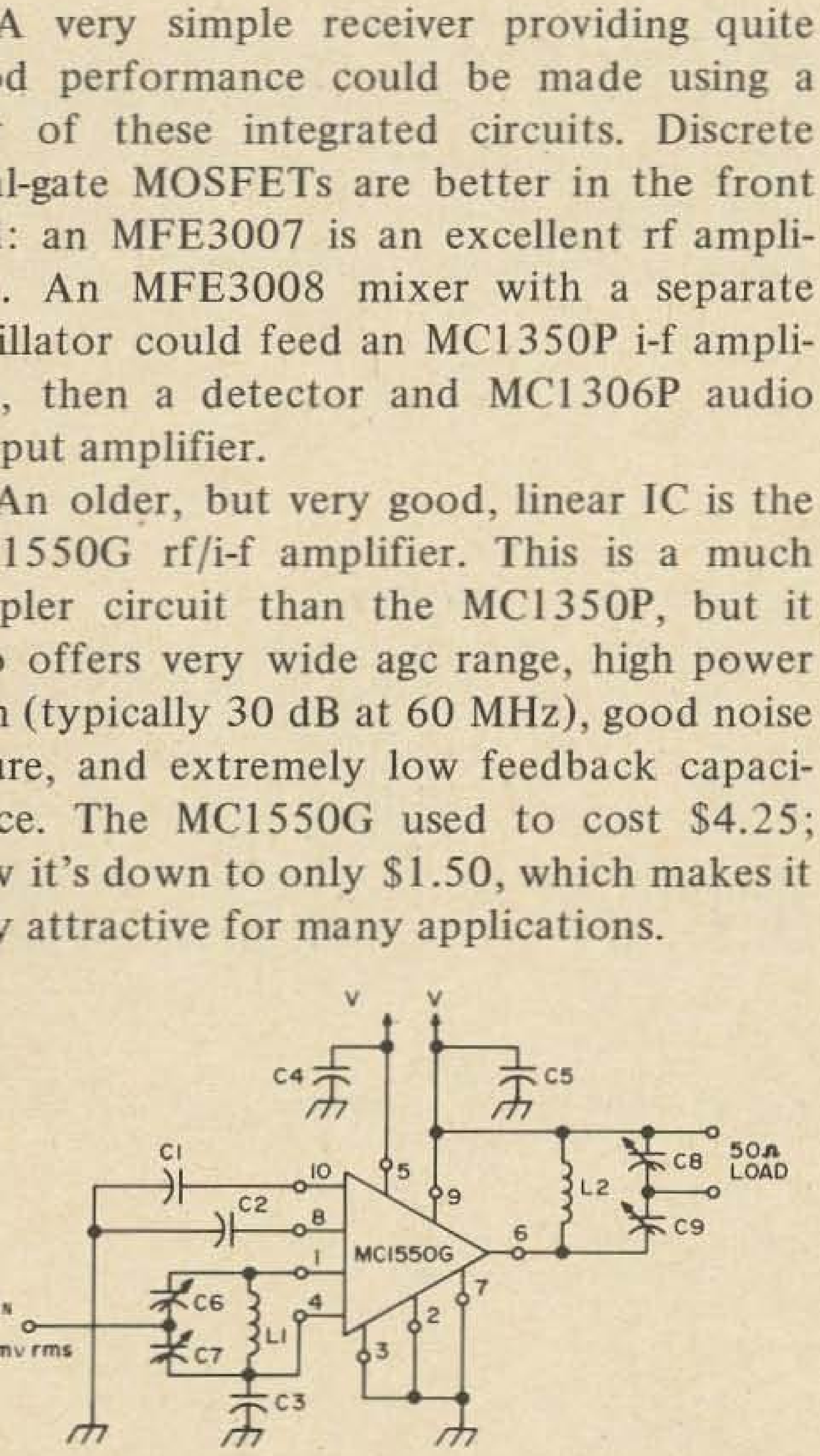


Fig. 8. MHz amplifier with 25 dB gain and good agc characteristics. The HEP 590 can also be used in this circuit with similar results.

Many circuits have been described using the MC1550G, increasing its appeal to the ham builder. A typical example is shown in Fig. 8. This is a 60 MHz amplifier with 25 dB gain; it can furnish excellent agc. Motorola Application Note AN-247 "An Integrated Circuit RF/IF Amplifier," provides more information on using the MC1550G.

The HEP590 is similar to the MC1550G. Both are packaged in the TO-5 metal can.

One of the most interesting of new linear integrated circuits is the MC1351P. This wideband FM amplifier provides i-f amplification, limiting, detection, and audio amplification. This circuit is almost a complete FM receiver, fitting in well with the recent amateur repeater trend. The MC1351P typically has 65 dB gain. It uses an interesting FM detector that requires only one external coil and capacitor in its resonant circuit.

The MC1351P was designed for use in the 4.5 MHz sound channel of television receivers (5.5 MHz for Europeans); however, it's very adaptable for use in FM receivers, either commercial FM broadcast receivers at 10.7 MHz, or in mobile communications receivers. A typical circuit using the MC1350P is shown in **Fig. 9**. This is a complete FM i-f system. It is most adaptable for use in the home, since it requires 140V dc for the audio power amplifier. However, a similar type of circuit can be used at 12V with a different audio amplifier. Motorola Application Note AN-468, "A Monolithic Circuit for Television Sound Systems," describes the use of the MC1351P in TV reception. The ham can easily convert this for FM reception in communications work.

Balanced Modulator

An interesting new linear IC is the MC1596G balanced modulator/demodulator. This circuit is a complete SSB product detector or a balanced modulator for generating DSB with no coils or external tuned circuits. It requires only a few resistors and

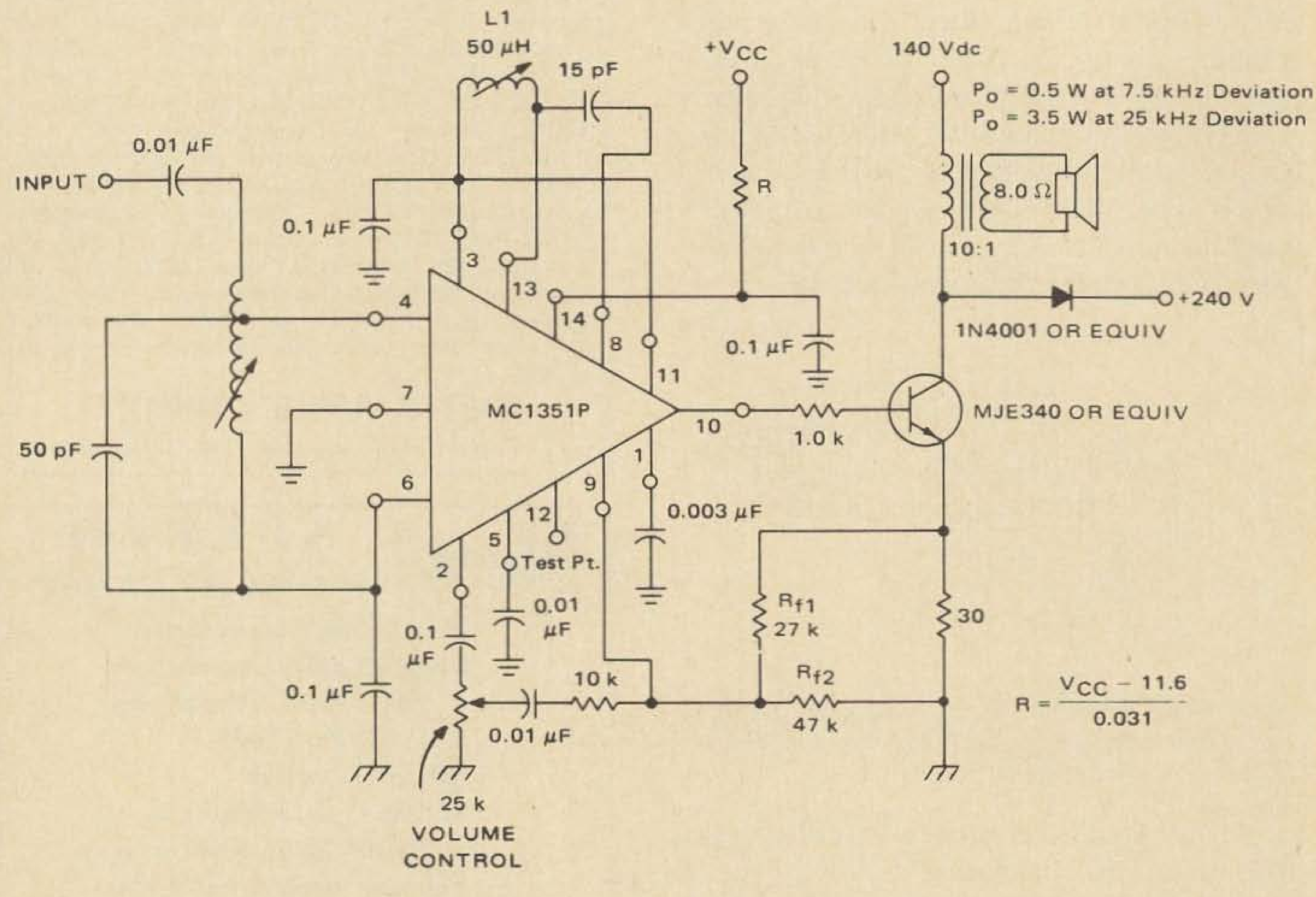
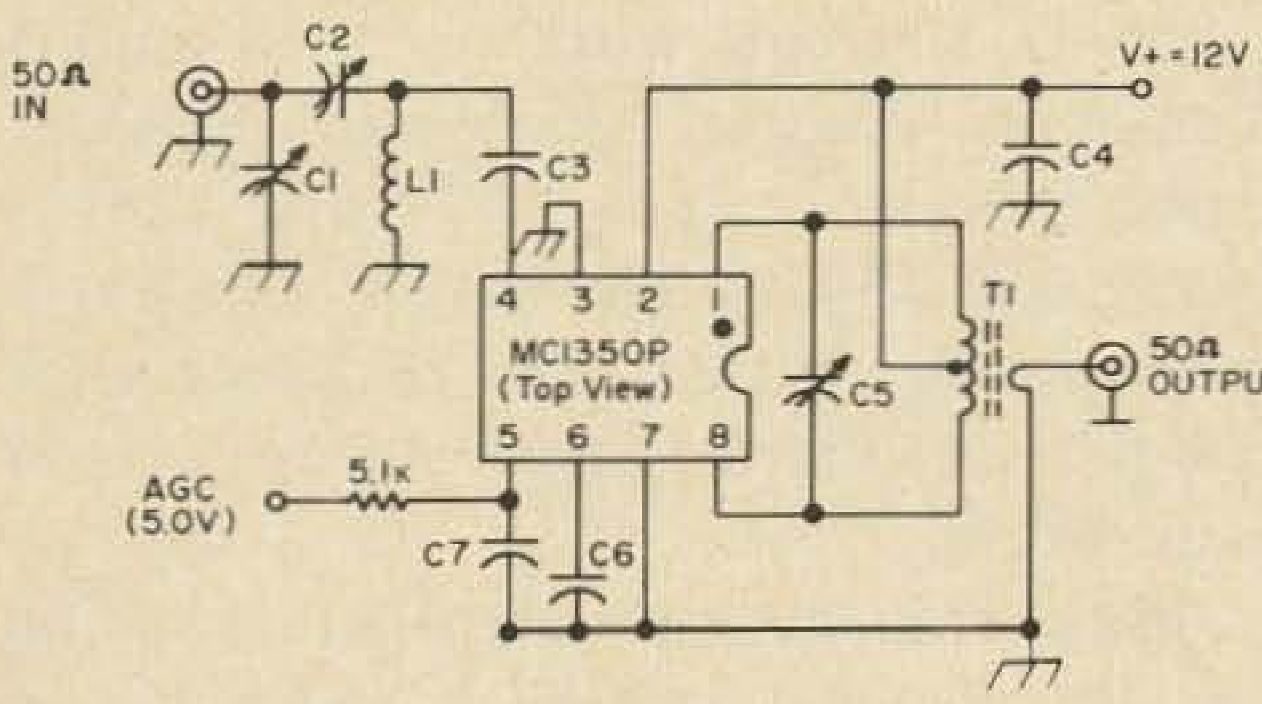


Fig. 9. Complete FM i-f system. Though this circuit was designed for use in TV receivers, it is also excellent for ham FM reception. For portable use, another type of output stage would be preferable.

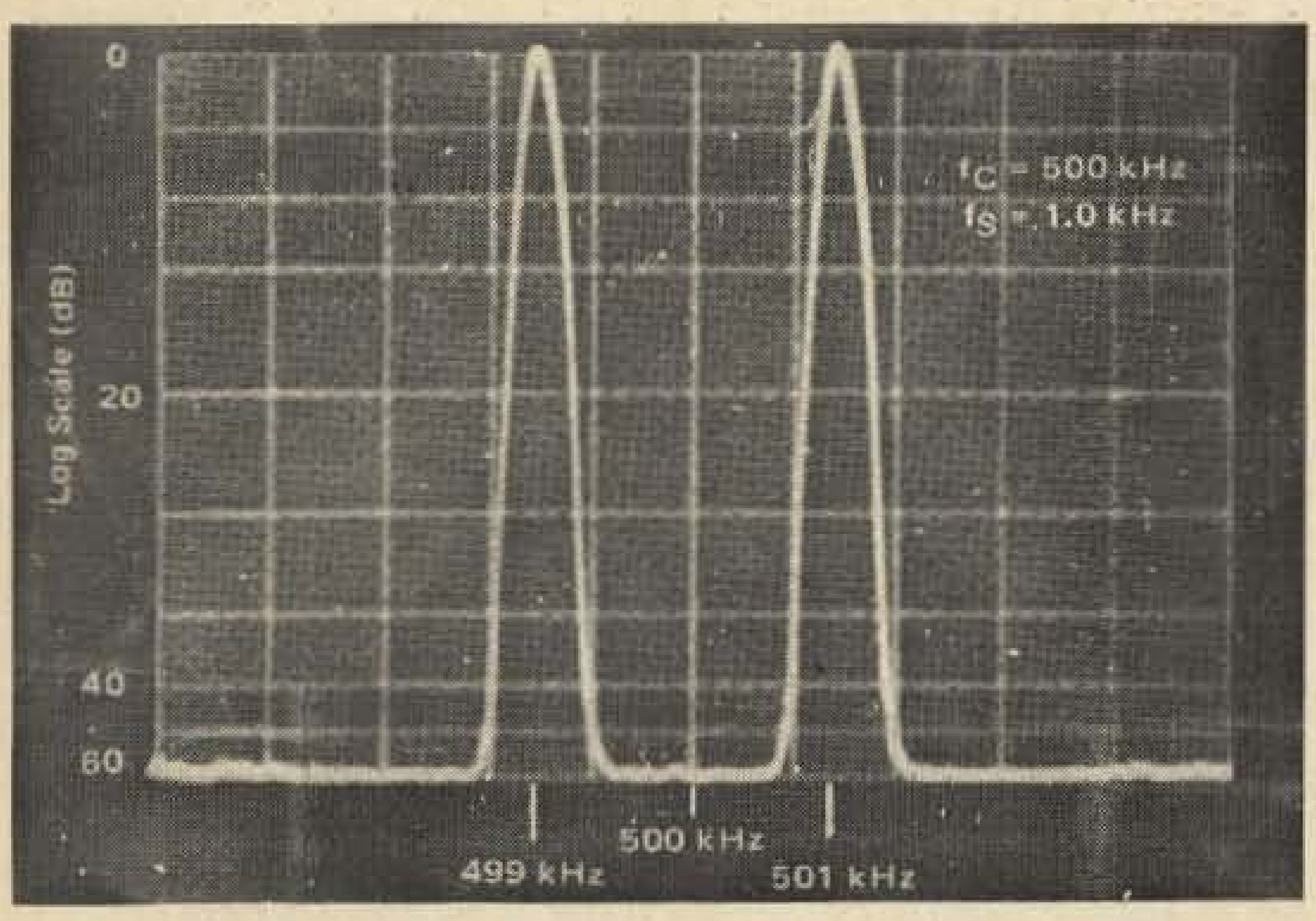
capacitors. **Figure 10A** is a typical balanced modulator circuit using the MC1596G. **Figure 10B** also shows the typical double-sideband-output spectrum that it produces. The 500 kHz carrier is completely eliminated, at least to the definition of the spectrum analyzer used, about 60 dB down. The MC1596G can easily provide 40 dB of carrier suppression at 9 MHz, perhaps the most popular frequency for generating SSB signals these days.



A

Fig. 10 (A). Balanced modulator using MC1596G and (B) double-sideband output spectrum. Carrier rejection is greater than 60 dB without using any coils.

B



At $1.75, the MC1596G is not inexpensive; however, its versatility and the simplification and high performance it brings to a circuit should make it very popular and we will likely see many applications of this type of device in the future.

Incidentally, to those of you who follow the engineering magazines, the MC1596G is a simplified cousin of the MC1595 multiplier that has been attracting a great deal of attention. The monolithic multiplier seems to be the new analog building block, similar to the op amp in its versatility, and can be

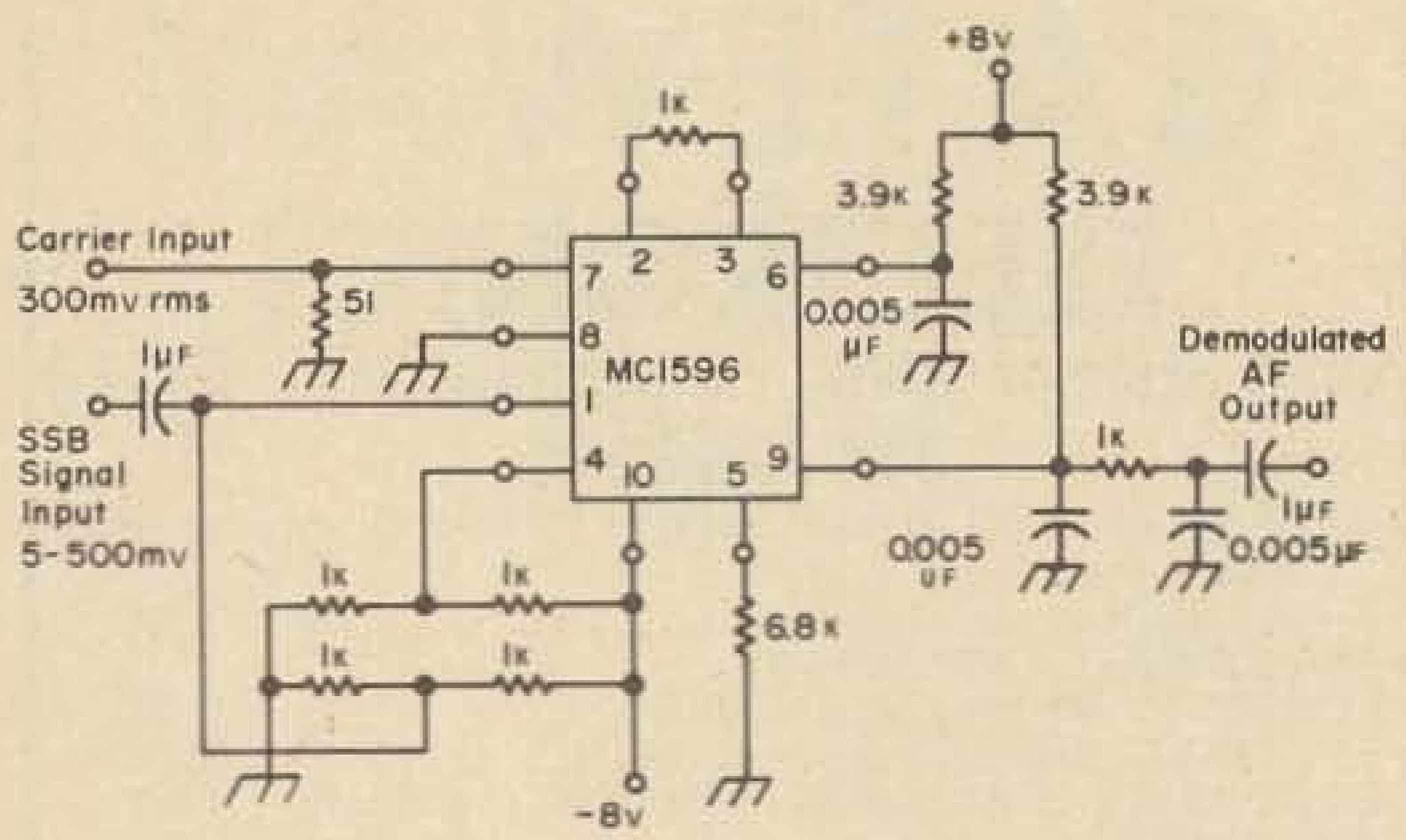


Fig. 11. Product detector using MC1596G balanced modulator/demodulator.

used in many different applications. The MC1596G is considerably simpler and less expensive; however, it still provides excellent performance in many applications.

Operational Amplifiers

Many circuits have been described using operational amplifiers, or op amps. Op amps have been around for many years, and cost as much as $200 at one time. Now you can buy a very high-quality, high-gain operational amplifier, the MC1439L, for only $2.70 in single quantities. This op amp is a relaxed version of the MC1539, which is widely used in military and commercial equipment. This circuit, though inexpensive, is extremely versatile, and can be used in almost any circuit requiring an op amp.

Conclusion

This article has provided a quick look at some of the new linear ICs of particular interest to hams. It has provided only very sketchy information, however. For more information on any device in which you are interested, you can write to the Technical Information Center, Motorola Semiconductor Products, Inc., PO Box 20924, Phoenix, AZ 85036. The data sheets on the devices provide a great deal of information, and where mentioned, application notes are also available.

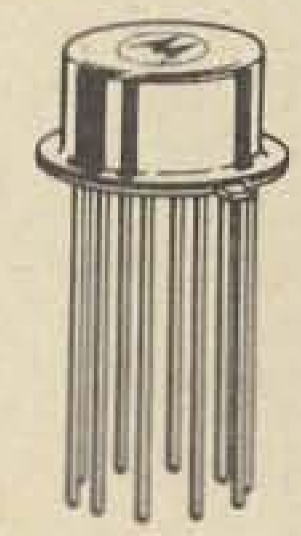
I hope this description of these circuits helps to convince you that linear ICs are now at the stage where hams can use them in their equipment. They are more economical circuits using discrete devices in many cases, and are much easier to work with.

. . . WA4KRE■

Table I. Linear ICs of Particular Interest to Hams

TYPE NUMBER	DESCRIPTION	CASE	PRICE (1-99)
Voltage Regulators			
MC1460G	20V, 250 mA	602A	$ 5.25
MC1460R	20V, 600 mA	614	6.75
MC1461G	**Voltage Regulators** 35V, 250 mA	602A	6.79
MC1461R	35V, 600 mA	614	8.25
MC1469R	35V, 600 mA	614	6.75
Audio Amplifiers			
MFC4010	Wideband amplifier, 60 dB gain, to 1 MHz	629	1.85
MC1303P	Dual audio preamplifier, 40 dB gain	605	5.25
MFC4000	250 mW audio power amplifier, 15 mV sensitivity	629	2.10
MC1306P	250 mW audio power amplifier, 3 mV sensitivity	626	2.90
MC1454G*	1W audio power amplifier	602B	3.30
IF Amplifiers			
MC1350P	Agc i-f amplifier (to 60 MHz), 58 dB gain at 10.7 MHz	626	3.75
MC1550G**	Agc i-f amplifier (to 100 MHz), 25 dB gain at 60 MHz	602B	1.50
MC1351P	I-f amplifier, FM detector, audio preamplifier 65 dB gain at 4.5 MHz	605	4.10
Balanced Modulator			
MC1596G	Balanced modulator/demodulator, 40 dB carrier suppression at 10 MHz	602A	7.15
Operational Amplifier			
MC1439L	High-gain, high-performance op amp	605C	2.70

*The HEP593 is similar
**The HEP590 is similar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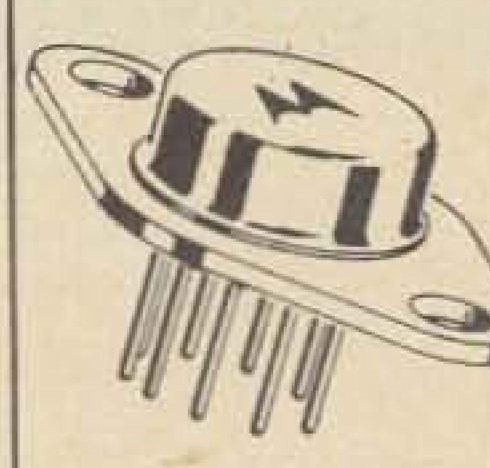
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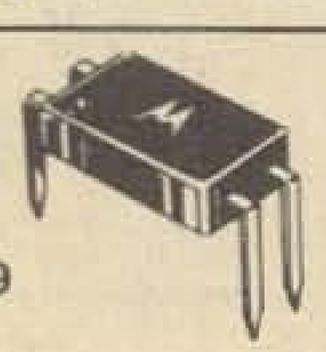
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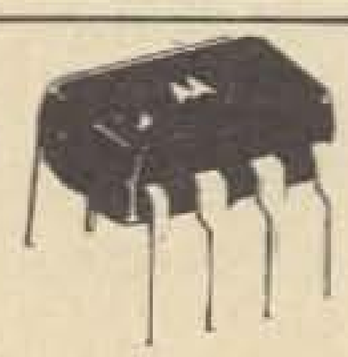
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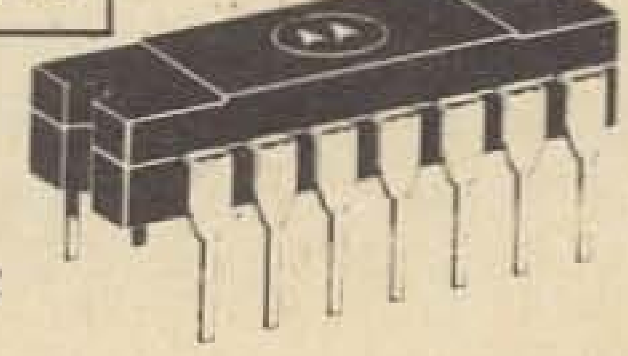
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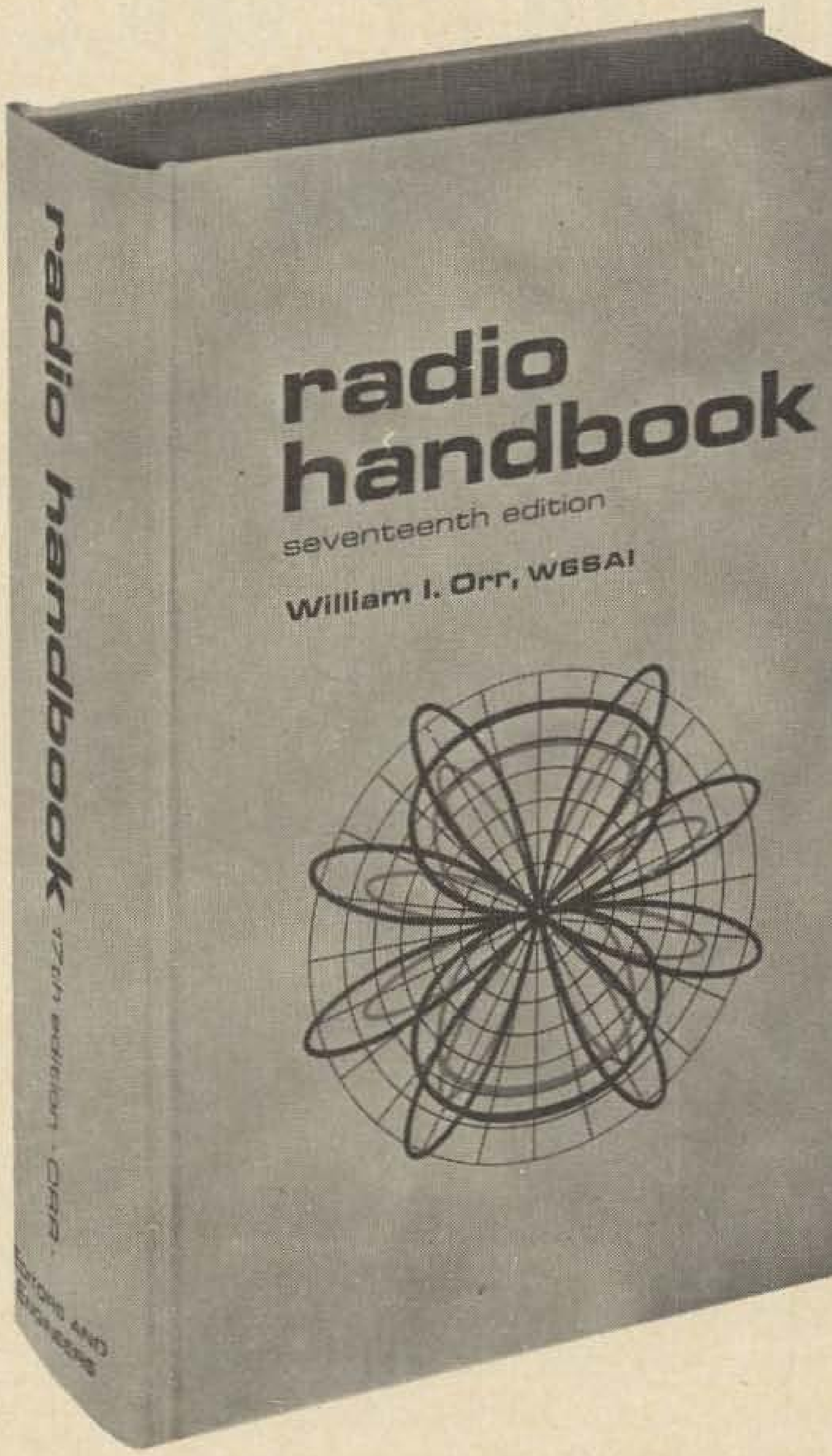

What makes the Radio Handbook so different from the others? This is the *only* handbook that has all original material rather than just being a bunch of reprints of magazine articles. The hundreds of construction projects were built specially for this handbook by some of the top amateur radio builders. This is a hardbound book, with some 850 pages of theory, construction projects and reference data covering every aspect of amateur radio.

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Send to: 73 MAGAZINE, Peterborough, NH 03458

Yes – $10 enclosed – send me the Radio Handbook!

Name____________________ Call____________

Address____________________________

City______________ State______ Zip__________

Neil Johnson W2OLU
74 Pine Tree Lane
Tappan NY

THE GLOP WILL GET YOU- IF YOU DON'T WATCH OUT

This is an old story but it's worth telling again. Twinlead can deteriorate in its performance at radio frequencies, especially when it's wet. This is old hat to most hams that have been around a while, but we tend to forget. This forgotten point was re-emphasized to me a few nights ago. I tried to fire up the rig on my favorite band, but the antenna just wouldn't take any power. All received signals sounded normal, so my suspicion was directed to the twinlead; about 75 feet of it feeds the antenna.

There had been a small rain shower, and the twinlead was covered with a thin layer of moisture, something resembling dew. Since it was late, I resolved to do something about it the first thing in the morning. Next day, the flat-top was lowered and the twinlead was scanned. Sure enough, there was a thin coating of dirt, dust and a dark sooty-looking compound. This was carefully removed with a soft piece of paper towel, which had been dampened with water. It is surprising how this stuff will pile up on your antenna insulators and transmission line. This is the same stuff that attaches itself to your car, only you are more aware of it since you must see through the windshield in order to drive. It's also piling up on your antenna system at the same time, the big difference being that you can't drive your antenna to the carwash every time it accumulates a fresh layer of dirt. But it's piling up nevertheless.

This is not something peculiar to the amateur fraternity. Couple of years ago, there was a big blackout in a Canadian province. It turned out that carbonaceous compounds had attached themselves to the high tension insulators–those big six foot insulators–and the next time it got damp, the circuits arced over. Everyone gave up on TV for that night, and went back to candles for light!

Once the black glop is wiped clear of your twinlead, it is fairly simple to wipe a little "magic compound" over the twinlead and your troubles will be gone for quite a while. The magic stuff in this case is the Dow Corning type 4 compound, a silicone base surface-coating compound, sometimes called "DC-4." This stuff will make your twinlead shrug off water like a duck's back. It is available at Allied Radio and at other well-stocked suppliers. The cost is $2.00 for a two ounce tube. At first blush, this may seem rather high. But you don't smear it on, you wipe it on with your fingers. And remember only a thin, thin layer is needed. Anything thicker than one molecule deep is unnecessary. I have a tube on hand that's been around for years. Sure it's an old story, but worth telling once more.

By the way, you can use the same compound for waterproofing the ignition wires and other components in your car which handle high voltage. The family car will be less prone to fail when you drive through a deep puddle, and the XYL will think you're an electronic genius.

. . . W2OLU ■

SHOP-BY-MAIL SPECIAL VALUES!

RF Field Strength Meter 1-400 mhz

Comes with 5-section antenna and earphone for modulation checking. Invaluable for tuning any transmitter. Magnetic base for mobile use.

Model FL-30 **ONLY $8.95**

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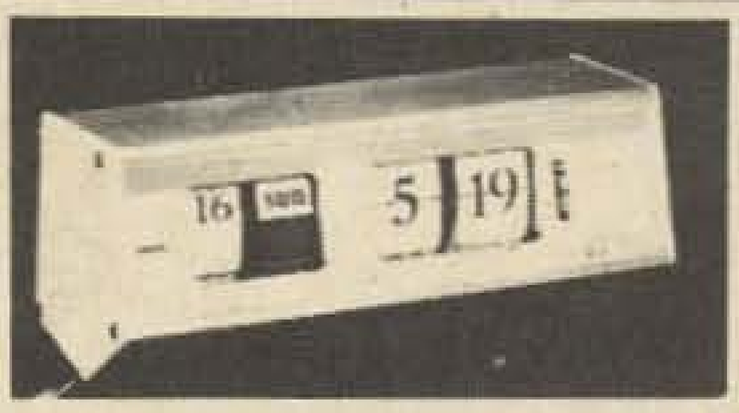

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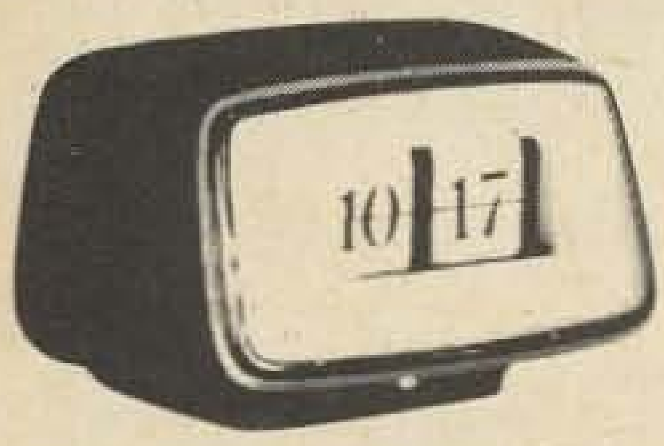

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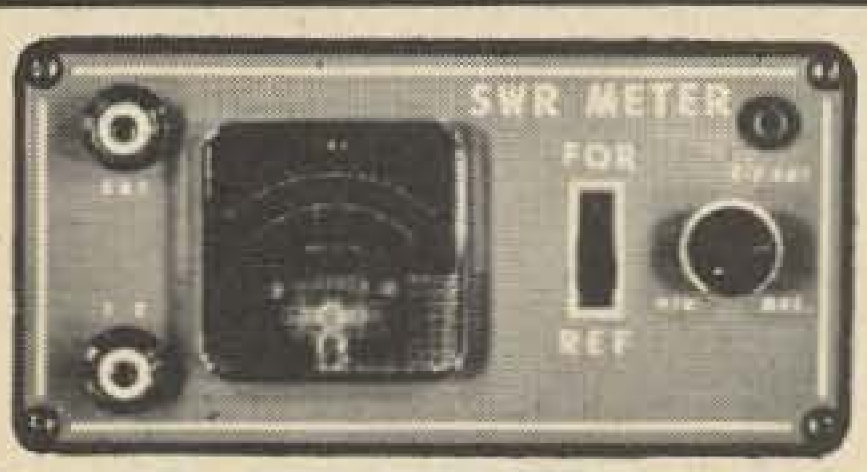

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Simple
Inexpensive
Effective
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AC Voltmeter	DC Voltmeter
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9V DC Supply	RF Field Strength
Self Powered	7½" x 3¾" x 3¼", 1¾lbs.

Thanks to transistors and printed circuits you can hold this complete lab in one hand. Not long ago this would have been a whole shelf full of test equipment. 455 khz generator for aligning if's, 400 hz generator for audio circuits. Plus a normal VOM and R&C substitution. Field Strength meter for tuning transmitters. Everything in one small box!

Model SE-400 Mini-Lab **ONLY $25.00**

This is by far the single most valuable piece of test equipment. Built in meter for measuring gain of each stage under test. Easy to find weak or defective stages. Output speaker built in or to VTVM or scope. No line cord since it is self powered. **ONLY**

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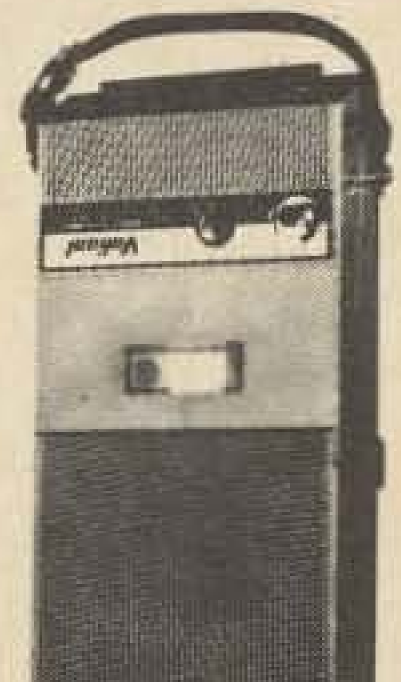

REDLINE presents the Valiant. This neat little cassette tape recorder has excellent fidelity and an easy push button system that means everyone in the family can use it and have fun. It has a battery level meter, recording level meter, a jack for feeding hi-fi or your receiver (or tv), and operates from a switch on the mike. Record those rare DX contacts as well as your regular friends off the air. The price is ridiculously low. SPECIAL, ONLY $33.00 postpaid.

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(continued from page 12)

Mismanagement, Incompetence, or Both?

Dear Mr. Green:

Your November editorial and Dave Mann's article regarding the ARRL were a pleasure to read. My experience as a ham has been limited as I have held a General license for less than six months. I have no basis to judge your statements regarding ARRL's lack of leadership and initiative in the technical areas surrounding amateur radio. However, as an attorney, I feel competent to comment on the other matters raised.

If what you have reported is true, I must conclude that the leadership of ARRL is grossly incompetent, dedicated to the demise of amateur radio, or mismanaged in order to suit the self-interest of a select few. A viable, dynamic company or organization, if it is seeking its greatest productive effort, cannot afford to hold $618,000.00 in cash securities. I would immediately question those in charge as to where the funds are kept, at what interest and on what basis does ARRL decide which banks will be favored with their deposits?

As you may know, any cash reserves over $100,000.00 are usually suspect by Internal Revenue as accumulated surplus. Good reason must be shown as to why the amount is carried instead of distributed to shareholders. A penalty in the form of 27½% can result if a reasonable basis fails to exist. Does a reasonable basis exist for ARRL to carry funds in excess of $100,000.00 without distributing the rest in benefits to its members? I think not. Why isn't this money being used in the many areas of amateur radio that are in dire need of increased activity? My experience in commercial affairs leads me to conclude that someone's self-interest is being held in higher regard than that of the majority. I believe that from reading your comments under ARRL National Convention Report, ARRL Articles of Association Waived, etc., that you have reached the same conclusion.

The success of your magazine is an indication that the masses of dedicated amateurs agree. They can see what is happening to their dollars and privileges. How could ARRL ever give its blessing to incentive licensing and still maintain the interests of the majority of amateurs?

I have compiled a list of some objectives which I believe would be in the best interests of the great majority of hams. Unfortunately, I also believe that ARRL would not lend support to them. They are:

1. Devising of a plan of incentive licensing which would return the frequencies lost, and further grant new frequencies for those who have advanced past General.
2. Establishment of effective representation in Washington. Greater privileges for the amateur can only come through the FCC and Congress; without their help we are powerless. How creative effort has never been utilized in this area previously is beyond belief. The possibilities are endless. It is not hard to foresee the day when amateurs could be compensated directly by the Government in return for the maintenance of an emergency communications network. Government surplus equipment could be offered directly to the amateur at reduced costs. These ideas may be "way out" to some, but think a moment about the great advantages now being extended to other special interest groups.
3. Improved public relations.
4. Recruiting drives.

I cannot imagine how an educated populace like the amateur radio community could remain silent for so long a period of ARRL inactivity. The ARRL leadership structure is, in my opinion, guilty of gross mismanagement.

Like yourself, Mr. Green, I believe that a change in ARRL thought and direction would mean greater growth for amateur radio.

I believe the time has come for an all-out drive to elect a complete slate of new directors who share our thoughts and opinions. Your magazine is one of the few vehicles available for such an objective. I strongly urge you to consider such a campaign. If I can be of any assistance, please do not hesitate to contact me.

Sheldon A. Harris WB9BCZ
Attorney at Law
Chicago IL 60603

What Price ARRL?

Dear 73,

I have been reading your magazine for a few years now and I have yet to become tired of its content. I was disgusted with the others within a year. They always have the same articles in them. I always look forward to 73 arriving at my shack.

I have been reading with interest your feature "Leaky Lines." One paragraph of it is worth a whole issue of QST. The boys at ARRL have been in amateur radio so long they have forgotten what it's like to be a relatively new ham like me of only seven years. In my opinion, it's the ARRL that is stagnating, not the general ham population. They beat down any idea for improvement which is the least bit contrary to their way of thinking.

I read the minutes to the May board meeting in QST after reading them in 73 and QST's version is funnier. How these people can waste so much time and money doing absolutely nothing is unbelievable. I feel sorry for those who join ARRL expecting betterment of amateur radio and then seeing it spent on those worthless board meetings. You tell me to support ARRL because it's the only national organization we have. By joining I would support this clown circus in Newington. No sir! I won't give them any more of my money.

They sit and argue about putting info on repeaters in the handbook, when there should be no argument at all. Then QST has the guts to ask for articles on the subject, which they don't pay for, and yet they have a PAID technical staff at ARRL. What are they doing? Dusting off the spark rigs in the museum?

Any outfit can print handbooks, logsheets, and DX maps. And W1AW ought to be in the center of the country, not sitting out on the east coast. They even had to start up a code practice station on the west coast because nobody could hear that one squeaking out east. As for FCC petitions, anyone can get one up so who needs ARRL?

Jerome Grokowsky WA9HCZ

Pulsars, Quasars, and the Like

Dear Sir,

As Mr. Hoisington's article was, to me anyway, a rather controversial one, and perhaps inaccurate here and there, readers may find additional comments interesting.

The subject matter is very tricky and I only wish I were capable of understanding more about these seemingly basic laws. I recall fighting my way through a quantum mechanics course only to find electric fields are quantized, too! That's where I stopped!

Your magazine is very enjoyable, and has stimulated me to the point where this is the first letter I've written in response to an article in any magazine.

Ed Schweitzer

Dear Sir:

The article by Bill Hoisington, K1CLL, in the September 1969 issue of your magazine reflects the work of a good inquisitive and active mind, and I certainly agree that satisfactory explanations of quasars and pulsars are in short supply.

I recall a book written by a Mr. Dolbear, entitled *Matter, Motion and Ether*. The book was written around 1900, and Dolbear was a physicist at a university in this country, perhaps at Duke, but probably at Tufts University. It has been five or more years since I've seen the book, and it is not now available to me, and I apologize for the scanty details on the book and its author.

However, I recall he investigated the ether problem from a similar point of view, that is, vortex waves, or rings. I was intrigued enough to build a number of vortex ring generators and spent many days fascinated by their behavior. For example, one ring may be made to pass through another if they are directed on the same path but head on in exactly opposing directions. I also recall that a slight angle between the paths was sufficient to upset this amusing effect. Note that this is rather contradictory to the behavior of electromagnetic radiation.

After reading elsewhere that soldiers during the Civil War were reportedly observed to fall as the result of cannon blasts far from the soldier (this refers to some soldiers whose position was not coincident with the trajectory of the projectile), I experimented with devices capable of producing much larger vortex rings than the coffee can devices could. I succeeded in extinguishing candle flames at 20 to 30 feet ranges with a ring about four or five inches in diameter. This was done in a college dormitory where drafts perpendicular to the propagation direction were uncontrollable. That the drafts interfered has more significance than making it difficult to aim my generator at a small, distant target.

Consider the experiments of Michelson and Morley in California around 1900. The ether mystery was one target of their classic and famous interferometer experiments. I refer to *Studies in Optics* by A. A. Michelson, where he describes the details of his work in relation to the controversial theories of the day. Any ethereal wind, perhaps as a result of the earth speeding along its orbit, should cause differences in propagation times along the legs of the interferometer. No differences were observed, a result strongly supporting the no-medium-necessary camp. Please recall how the cross drafts upset my vortex ring experiment, and note the conflicting but, I think, explained results.

The ether matter deserves questioning on other bases, but the proof is in Michelson's experiments. Basing theories on the postulation of an ether will lead to results as disastrous as the results for planetary motion based on an earth-centered system.

May I also comment on Mr. Hoisington's discussion of the unacceptable nature of the dual nature of light, i.e., waves and particles. In quantum mechanics, the wave-particle problem is attacked from a probabilistic point of view, and the results are in excellent agreement with observation. For example, radiation in quanta (photons) and Heisenberg's uncertainty principle are results predicted by quantum mechanics, and apparently not questioned by Mr. Hoisington.

At this point, where quantum mechanics and relativity are starting to merge on me, I stop. But the theory and confirming experiments from here on add more and more support to two points I've tried to illustrate.

1. There has never been evidence presented to support the existence of an ether.
2. A dual nature is evidenced in light when considered in terms of our concepts of particles and waves.

I hope I am not insulting by writing that I at first thought this to be an April QST type of article, and further hope that I have not been taken in on a spoof.

Edmund O. Schweitzer III WA3LPD/K9ZXE
3507 Lancer Drive
Hyattsville MD 20782

Ed. Note. Mr. Hoisington is quite earnest in his theories.

CW in Perspective

Sir:

For the last fifteen years of my life I have been directly involved in the field of electronics and radio; my duties have taken me from design to test, to maintenance sales and every other aspect of the field of electronics, not necessarily in the above order; a number of these years to the present time I have shared with amateur radio, and I must say, they have been most enjoyable.

My interest has been focused lately in the current controversy about the latest changes in regulations by the regulatory body of amateur radio, the FCC. I have followed with interest the opinions of different sectors of the "ham population" in the States, as well as reaction from outside the country, and when viewed individually, I think the arguments in favor are as strong as the arguments against them.

I, however, decided to look at them from a different point of view... The purpose of amateur radio in the United States as well as in most countries around the world, is one of "service to the community," "service to society," and self-improvement of the operator, in both technical and mental aspects.

The amateur frequencies in this country have been divided in several portions, where operations in one or other mode are permitted or restricted; mainly we can observe a lower part of a band of frequencies used for CW and another part being used for "phone" work, with some more divisions allowing certain privileges to certain classes of license. In order to qualify for them, prospective amateurs have to pass a test which will measure their ability and knowledge in the field of radio amateurism.

I have been very interested in the emphasis being placed on CW operation, higher and higher speeds are required in order to qualify for general, advanced or extra class; presumable we are assuming that this ability to operate the key at higher rates is a service to society or a way to improve the operator and prepare him for a better future... nothing could be further from the truth, and don't get me wrong: I have absolutely nothing against CW operation *per se*, like I have nothing against radio control or RTTY or any other form of expressing one's preferences in the field of radio, but I do feel that the unnecessary restrictions and regulations placed on the amateur community by these laws are repressing progress and producing an effect completely opposite to the one originally intended by the FCC. Let me make this clear, I am going to submit to you very convincing arguments that can be checked by anybody at any time, but I do not propose that we do away with CW operations; quite the contrary, all the amateurs that prefer this type of operation should continue to do so without any restrictions of any kind, but the emphasis placed on it should be channeled to some other fields of research more useful to society and the country.

For the past few months I have been researching industry, schools, and government agencies in the Western area of the USA, and sad as it may be, the consensus is unanimous, without exception: CW is a thing of the past, of another time, long gone. It seems that only the ham fraternity clings to it, it will not leg go—perhaps due to the FCC, perhaps due to the fact that we are stagnant, more probably a combination of both facts, the truth is that CW regulations are holding down progress in amateur radio, it occupies a great portion of our frequencies that could be used to research some more advanced means of communication and perhaps recover the leadership that we lost when Teletype and computers were given the job of transferring intelligence from one point to another.

A Los Angeles City School official told me that as far as he can remember, there was only one school in Los Angeles that ever had a course in telegraphy, and that course was discontinued a long time ago FOR LACK OF JOBS in the industry to place the graduates.

A head engineer for the telephone company told me that as far as he remembers, telegraphy is not being used nor had it been used for a long PERIOD OF YEARS.

Good old Western Union representatives told me that telegraphy was too slow and inefficient a way of communication to be used any more, he knows of no operation in the USA that uses CW, and he can remember none.

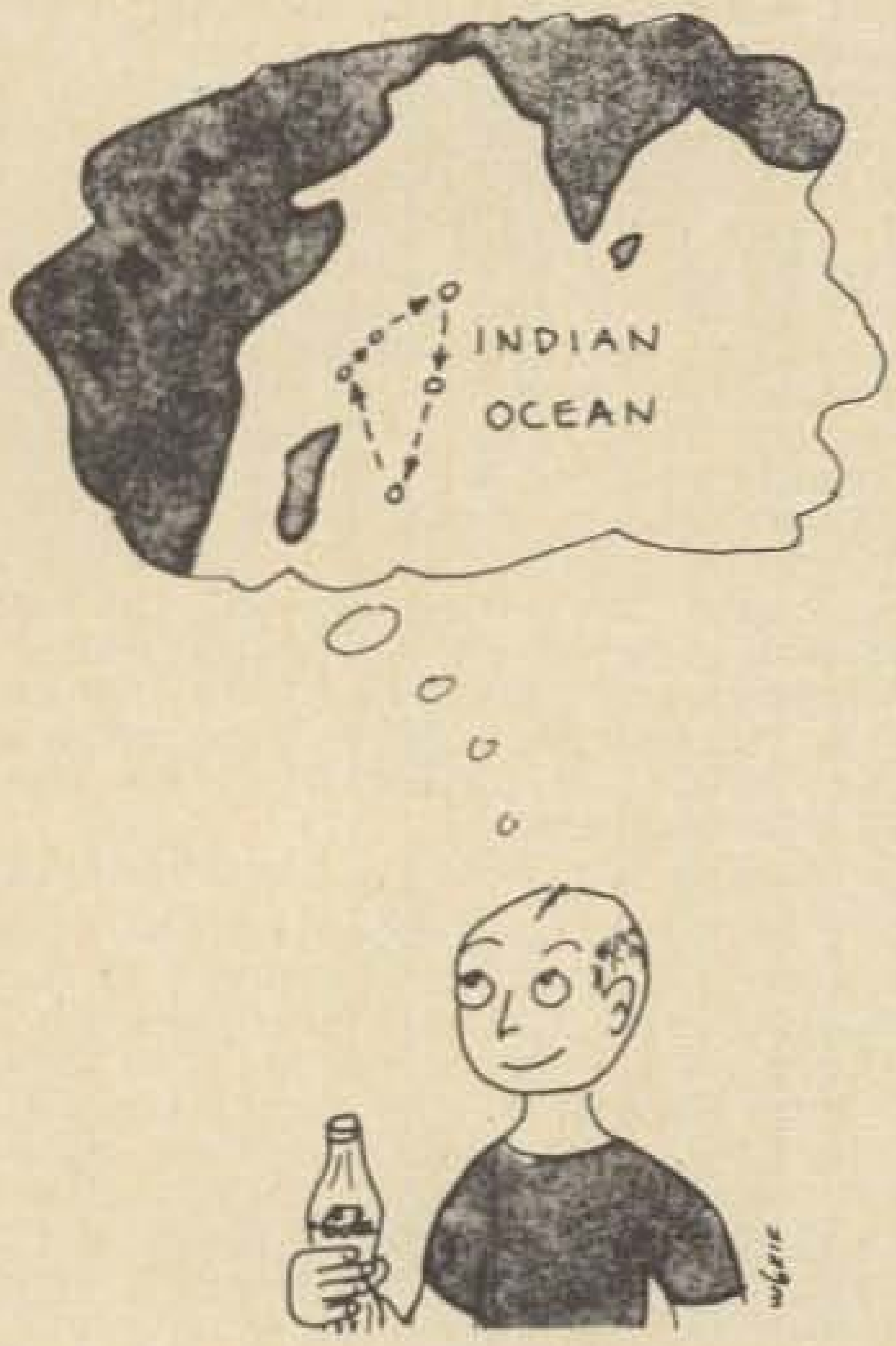
It seems to me that those are pretty conclusive statements, and a quick check around the country will show that conditions are the same. The question is: What are we being led to; are we preparing ourselves to serve the country in case of need; are we ready to be a service to society in case of emergency or are we preparing ourselves to provide a disservice to the community, with our antiquated practices; and perhaps eventually lose our frequencies to some other service that proves to have more foresight than we did. Are we getting ready to go to the planets and stars with our high speed: 25 words a minute; or should we be getting ready for a more sophisticated way to convey intelligence at *millions of bits per second* and more...

It is time that those who represent the amateur community, look at the future, at the present, and at our activities. Since the first wireless was turned on, we have progressed to the fantastic speed (new regulations) of 25 words per minute. It is time that we really make some progress, it is time that the FCC and the members of the regulatory bodies take a new look at amateur radio, the ARRL, the amateur publications; and all amateurs should express their opinions and views on the subject. The growth of amateur radio has come to a standstill, and it is our responsibility to do something for it, to give a new challenge to our group; it is the responsibility of its leaders to petition the FCC and Congress for the necessary laws and regulations to make our goal possible.

Edgar A. Romo HC2RP
7312 Mason Ave
Canoga Park CA 91306

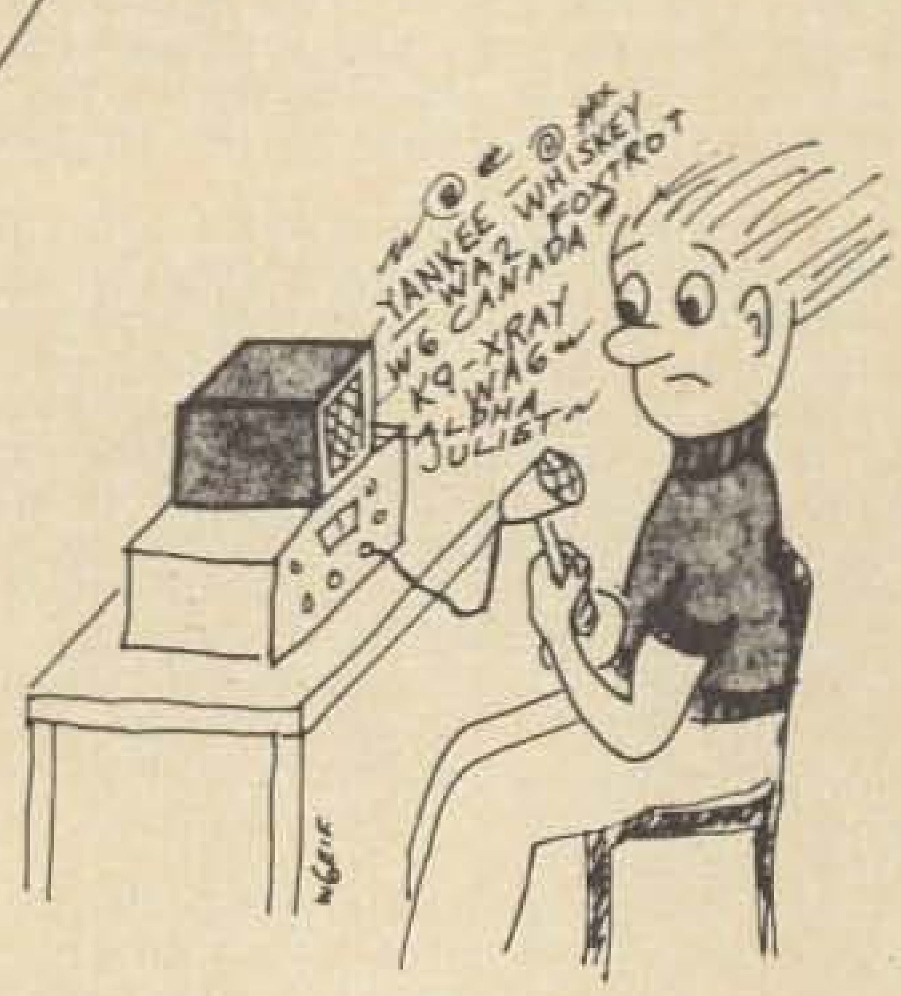
DX AS SEEN BY...

Tom Orr W6EIF
249 Juanita Way
Placentia CA 92670



Gus

The QSL Bureau

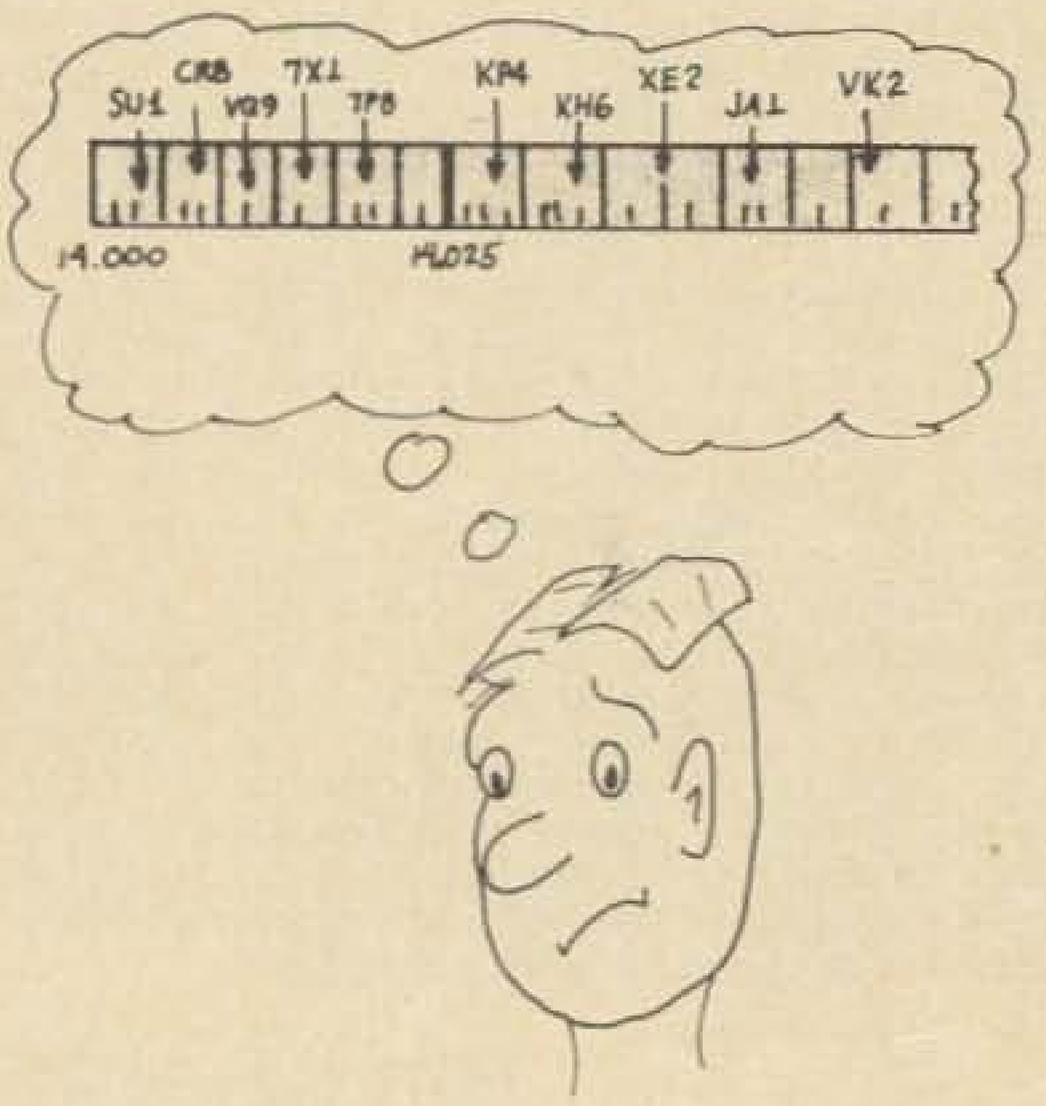


The Rare DX Station

The DX'er

The Tower Manufacturer

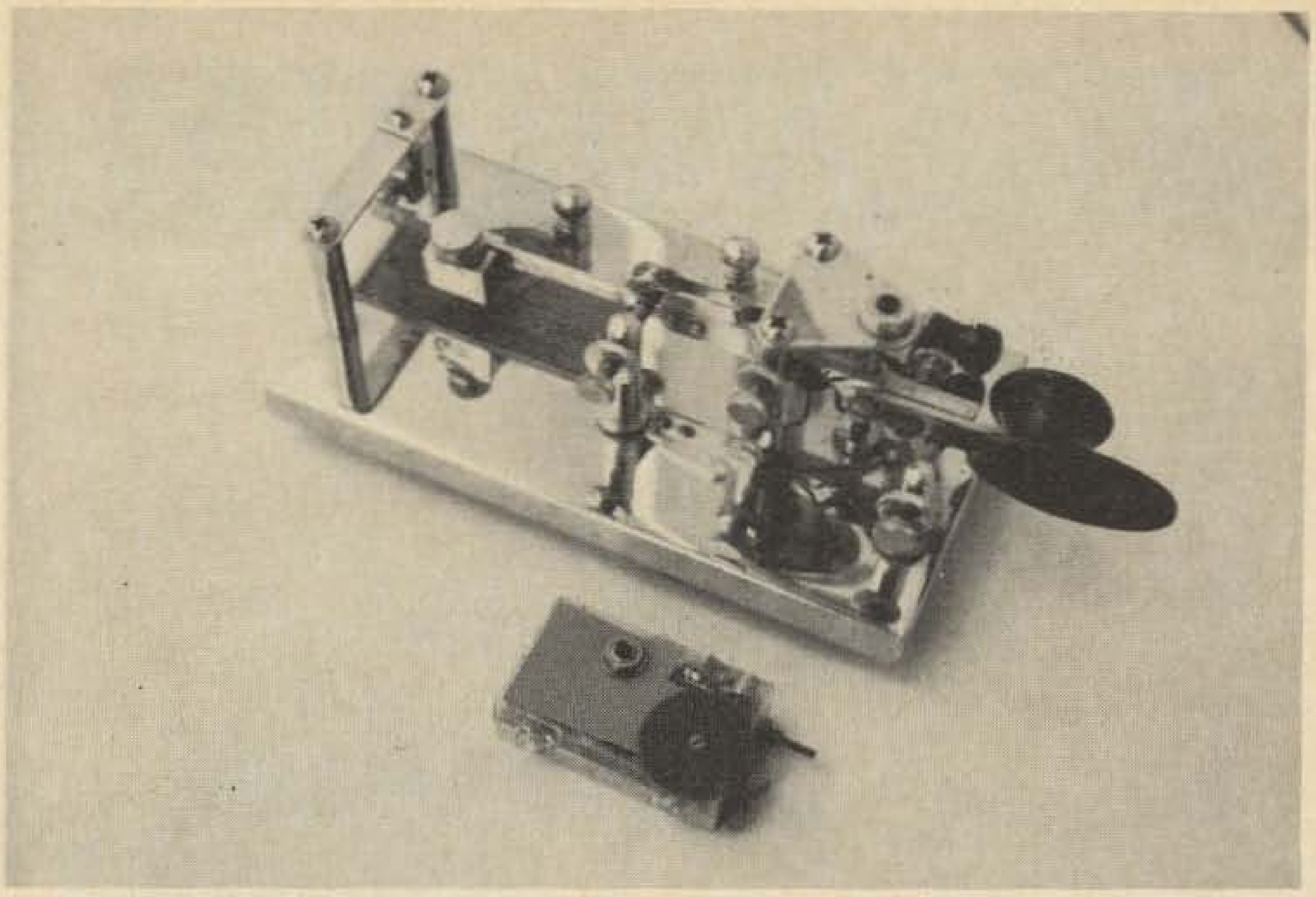
The Novice



The General

The DX Station's QSL Manager

Lee Zipin WA3GGH
1013 Melrose Avenue
Melrose Park PA 19126



Micro-Mitter compared to a Vibroplex Lightning Bug.

MICRO-MITTER ... TEENSY-WEENSY QRP ON 40

In the March, 1968 issue of 73, an article was published entitled, "Mini-Mitter; the Ultimate in Miniatures!" Mr. Pyle suggested the possibility of having built the smallest CW transmitter to date. Several months earlier, however, I constructed a complete CW transmitter which, with the power supply, fits into the case that the crystal came in (for convenience, the crystal remains outside, plugging into an internal socket).

The circuit is a typical crystal oscillator circuit, using a 2N2188 transistor. The unit was built to operate on 40 meters, but with proper adjustments in the LC section and crystal value, any low frequency can be obtained. The parts are strictly junkbox, and the smaller the better. I used a miniature tuning capacitor from a junked transistor radio, and wound the coil so the pair would resonate at 40 meters. The battery is a watch-type mercury cell, with its socket made from two pieces of sponge rubber and wire contacts. Any suitable glue can be used to hold everything together.

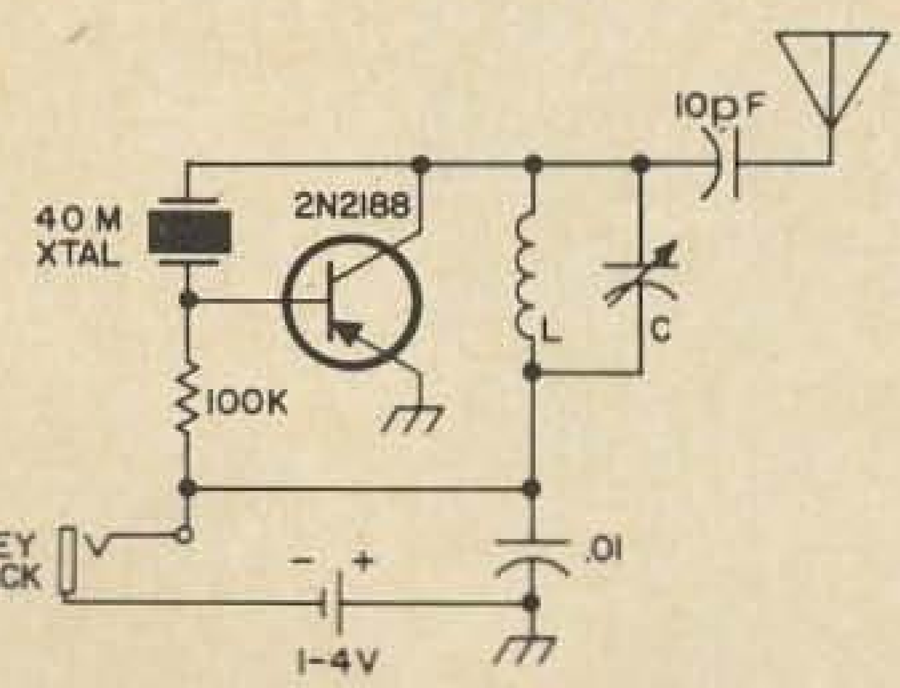


Fig. 1. Schematic of Micro-Mitter. L and C should resonate at the crystal frequency.

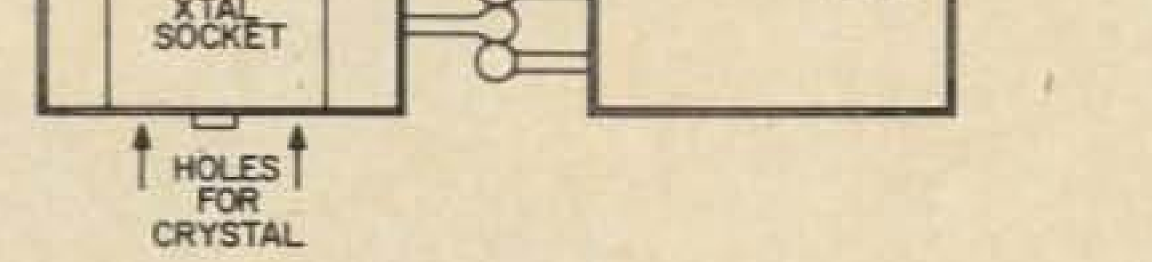
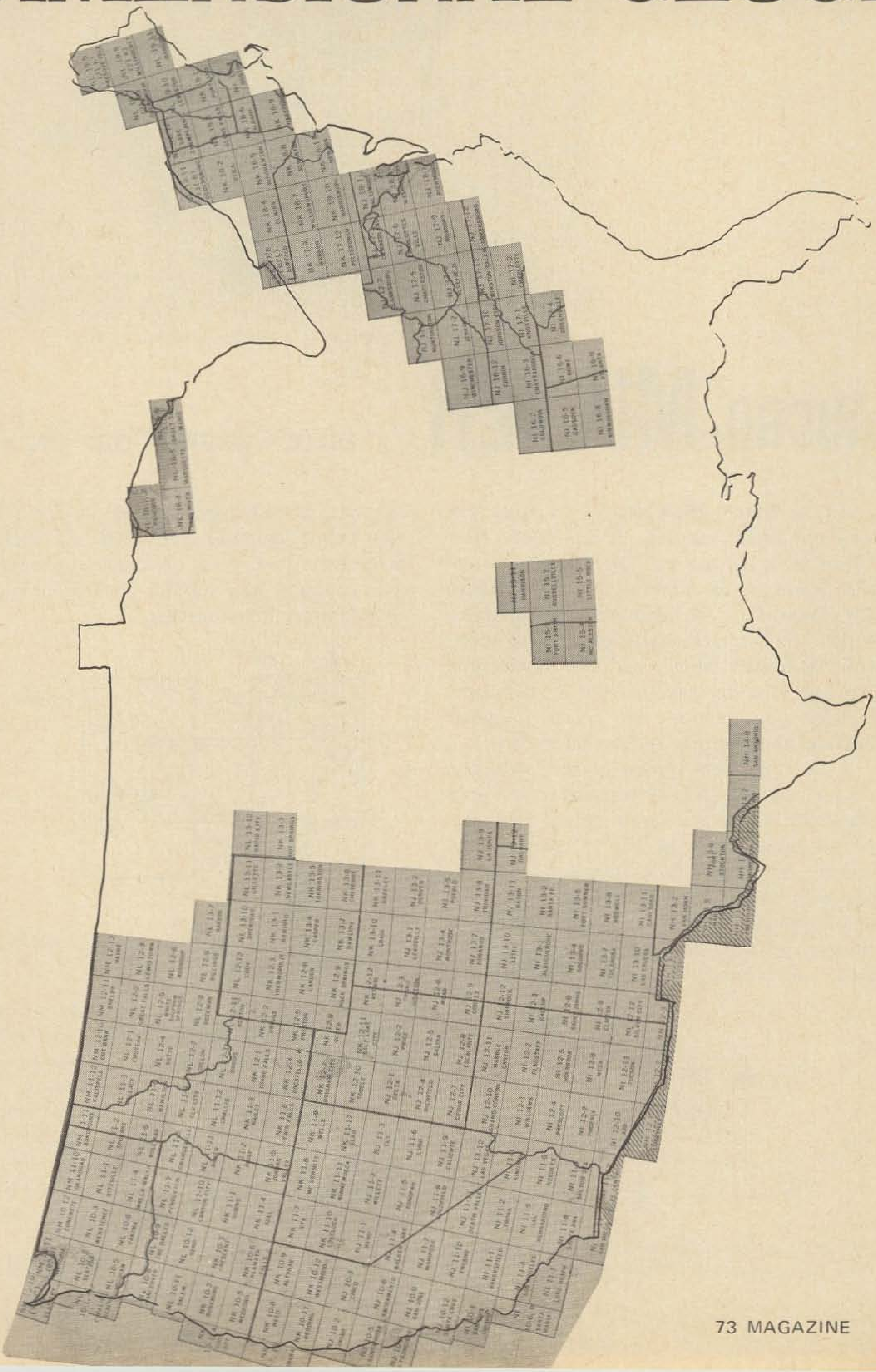


Fig. 2. Case layout. The case is opened on its back, and the battery is removed for clarity.

To operate the unit, attach antenna and ground wires to their respective clips. Push the key down and tune the variable capacitor for maximum signal (as indicated on your receiver—don't worry, it won't burn out the front end). I haven't measured input or output power on the rig, but I carried on a QSO with a station 50 miles away. Not bad for something you can lose in your shirt pocket!

... WA3GGH ■

DIMENSIONAL GEOGR



PROPAGATION CHART

J. H. Nelson

February 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
①	②	3	④	⑤	⑥	⑦
8	9	⑩	⑪	⑫	⑬	14
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㉒	㉓	㉔	㉕	㉖	27	28

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7B	14	21	21A	21
ARGENTINA	14	7A	7A	7	7	7	14A	21	21	21	21	21A
AUSTRALIA	21A	14	7B	7B	7B	7B	7B	14B	21	21	21	21A
CANAL ZONE	21	14	7	7	7	7	14	21A	21A	21A	21A	21
ENGLAND	7	7	7	7	7	7	14	21A	21A	21	7A	7
HAWAII	21	14	7B	7	7	7	7	7B	14	21A	21A	21A
INDIA	7	7	7B	7B	7B	7B	14	14	7B	7B	7B	7
JAPAN	21	14	7B	7B	7	7	7	7	7B	7B	7B	14
MEXICO	21	14	7	7	7	7	7	14A	21	21	21A	21
PHILIPPINES	14	14	7B	7B	7B	7B	7	7	7B	7B	7B	7B
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	7	7	7	7B	14	21A	21A	21A	21	21	21
U. S. S. R.	7	7	7	7	7	7B	14	21	14	7B	7B	7
WEST COAST	21	14	7	7	7	7	7	14	21	21	21A	21

CENTRAL UNITED STATES TO:

ALASKA	21	14	7	7	7	7	7	7	14	21	21	21A
ARGENTINA	21	14	7A	7	7	7	7A	14A	21	21	21	21A
AUSTRALIA	21A	14	14	7B	7B	7B	7B	7B	14A	21	21	21A
CANAL ZONE	21	14	14	7	7	7	7	14A	21A	21A	21A	21A
ENGLAND	7	7	7	7	7	7	7B	14	21	14	7B	7B
HAWAII	21	14	14	7	7	7	7	7	14	21A	21A	21A
INDIA	7	14	7B	7B	7B	7B	7B	7	7	7B	7B	7B
JAPAN	21	14	7B	7B	7	7	7	7	7	7B	7B	14
MEXICO	14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	7B	7B	7B	7B	7	7	7	7B	7B	14
PUERTO RICO	21	14	7	7	7	7	14	21	21A	21A	21A	21
SOUTH AFRICA	14	7A	7	7	7B	7B	14	21A	21A	21	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	7B	7B	7B

WESTERN UNITED STATES TO:

ALASKA	21	14	7	3	3	7	7	3	7	14	21	21
ARGENTINA	21	14	14	7B	7	7	7B	14	21	21	21	21A
AUSTRALIA	21A	21A	14	14	7B	7B	7F	7B	14	14	21	21A
CANAL ZONE	21	14	7	7	7	7	7	14	21A	21A	21A	21A
ENGLAND	7B	7	7	7	7	7	7B	7B	14	14	7A	7B
HAWAII	21A	21	14	7	7	7	7	7	14	21A	28	21A
INDIA	7B	14	7B	7B	7B	7B	7B	7	7	7	7B	7B
JAPAN	21	21	14	7B	7	7	7	7	7	7B	7B	14A
MEXICO	21	14	7	7	7	7	7	7A	14A	21	21A	21
PHILIPPINES	21	21	14	7B	7B	7B	7B	7	7	7	7B	14
PUERTO RICO	21	14	7A	7	7	7	7	14	21	21	21A	21A
SOUTH AFRICA	14	14B	7	7	7B	7B	7B	14	21	21A	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	7B	14	7B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21	21	21A	21

A = Next higher frequency may be useful also.

B = Difficult circuit this period.

A Simple

Almost any integrated circuit operational amplifier can be used to build this Q-multiplier. Its advantages are extreme circuit simplicity and a useful frequency range that extends from audio frequencies to almost all i-f frequencies. Both the peaking frequency and Q can be made variable.

Both vacuum tube and transistor Q-multiplier circuits find wide application in improving the selectivity of transceivers and receivers, particularly on CW when the Q-multiplier is used to peak the i-f response following a steep-skirted crystal or mechanical SSB filter. The Q-multiplier provides a very narrow bandpass but if used alone does not provide steep skirt selectivity. When used in conjunction with an SSB filter, however, the latter provides the necessary skirt selectivity (see **Fig. 1**).

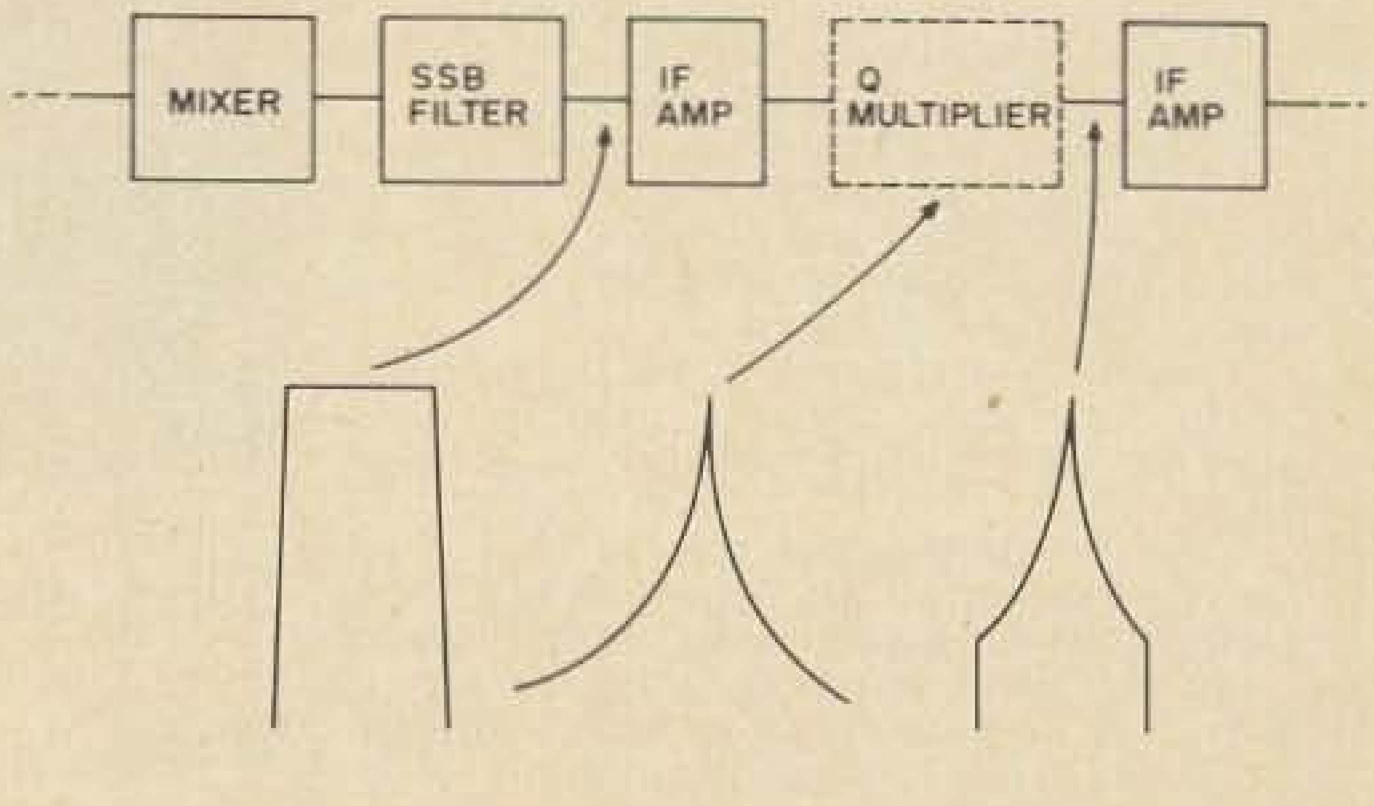


Fig. 1. Placement of Q-multiplier after SSB filter provides effective narrowband response for CW reception.

Integrated Circuit Q Multiplier

John J. Schultz W2EEY
1829 Cornelia Street
Brooklyn NY 11227

The Q-multiplier described in this article is meant to be inserted between any i-f stage in a transceiver or receiver following an SSB filter. It can be easily switched for broadband operation so it does not affect normal SSB operation. Since it is adjusted for unity gain, it does not upset any gain relationship in the i-f stages. As compared to vacuum tube and transistor-type Q-multipliers, the circuitry of the unit is extremely simple due to the use of an integrated circuit operational amplifier. The unit can be successfully used on frequencies far higher than those normally used with vacuum tube or transistor Q-multipliers up to 5 MHz or more, depending upon the integrated circuit used. The circuit can also be used at audio frequencies, if desired. One can also build an audio selectivity unit for outboard use when it is not desired to make internal modifications to a transceiver or receiver.

Circuit Description

The Q-multiplier is constructed around an integrated circuit operational amplifier. Many such amplifiers are available on the market at prices starting at a few dollars. The main requirements for choosing a suitable unit are that it have a differential input (inverting and noninverting inputs), and a single-ended output and a bandwidth sufficient for the frequency of operation. For example, Fairchild 709T amplifiers are available for about \$3 and are usable up to at least 500 kHz. I built a unit using a Fairchild 741 which is usable up to 1-2 MHz. Other amplifiers such as a Motorola MC1530 can be used up to 10 MHz.

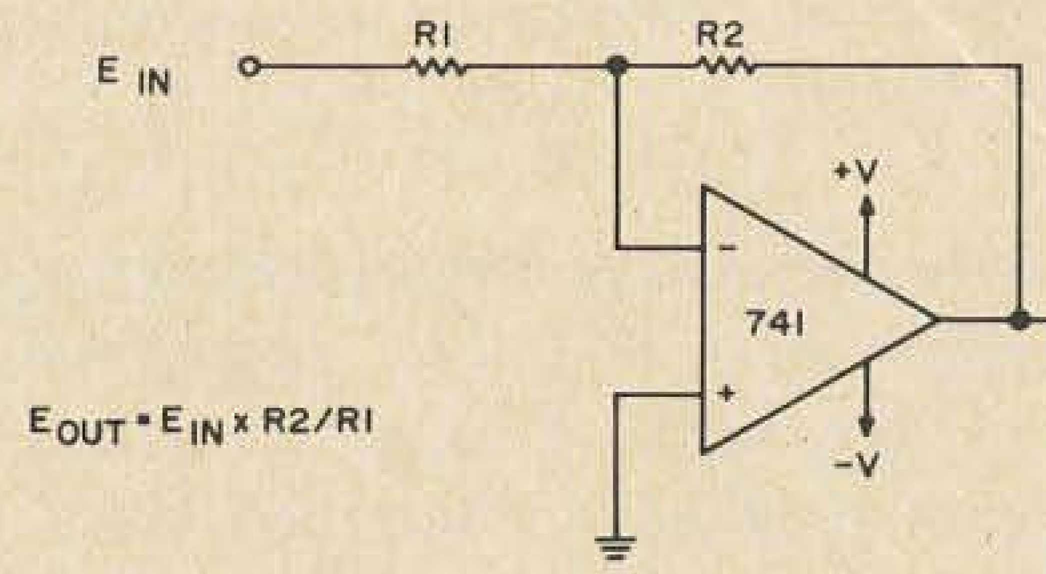


Fig. 2. Basic type of integrated circuit operational amplifier with a differential input and single-ended output that is needed for the Q-multiplier circuit.

Figure 2 shows the schematic of the type of operational amplifier which is used and the formula for the output voltage of an ideal amplifier. The Fairchild 741 amplifier which I used requires no external frequency compensation components. Other amplifiers may require a few external components for this purpose as specified on their data sheet. The frequency rolloff components should be chosen such that the amplifier gain starts to decrease just above the frequency where it is used as a Q-multiplier. There is no advantage to having the gain "rolloff" at any higher frequency and would just make the amplifier more susceptible to oscillation due to a stray feedback path via external components. As noted from the gain formula, the gain of the amplifier depends upon the ratio of R2 and R1. If R2 is made equal to R1, the gain is unity. The Q-multiplier effect is based upon replacing R2 with a parallel resonant circuit which will present a very high impedance at one frequency and, therefore, maximize the overall gain at that frequency. Positive feedback is also used to enhance the Q-multiplying effect of the circuit.

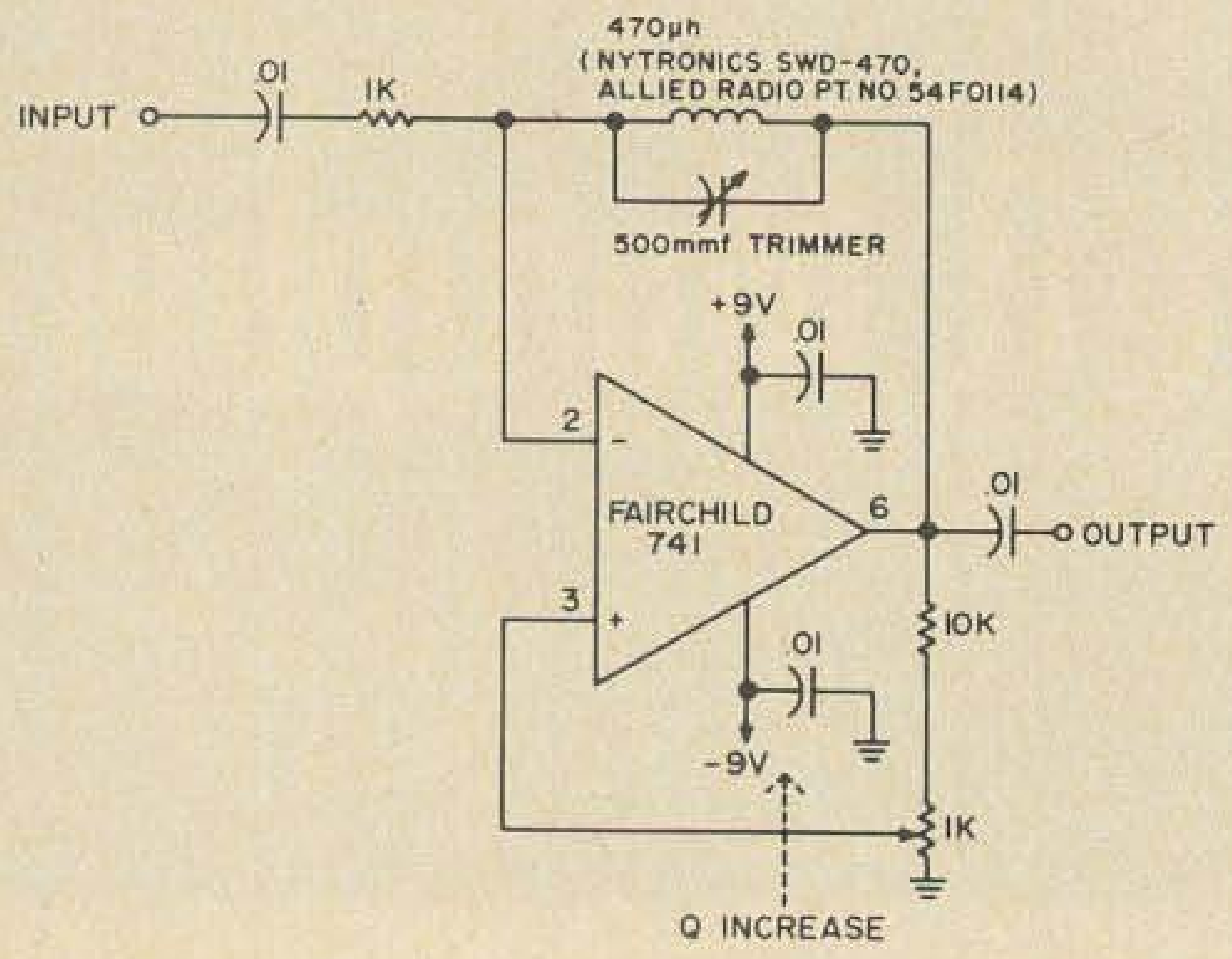


Fig. 3. Circuit of the Q-multiplier as constructed for a 455 kHz i-f

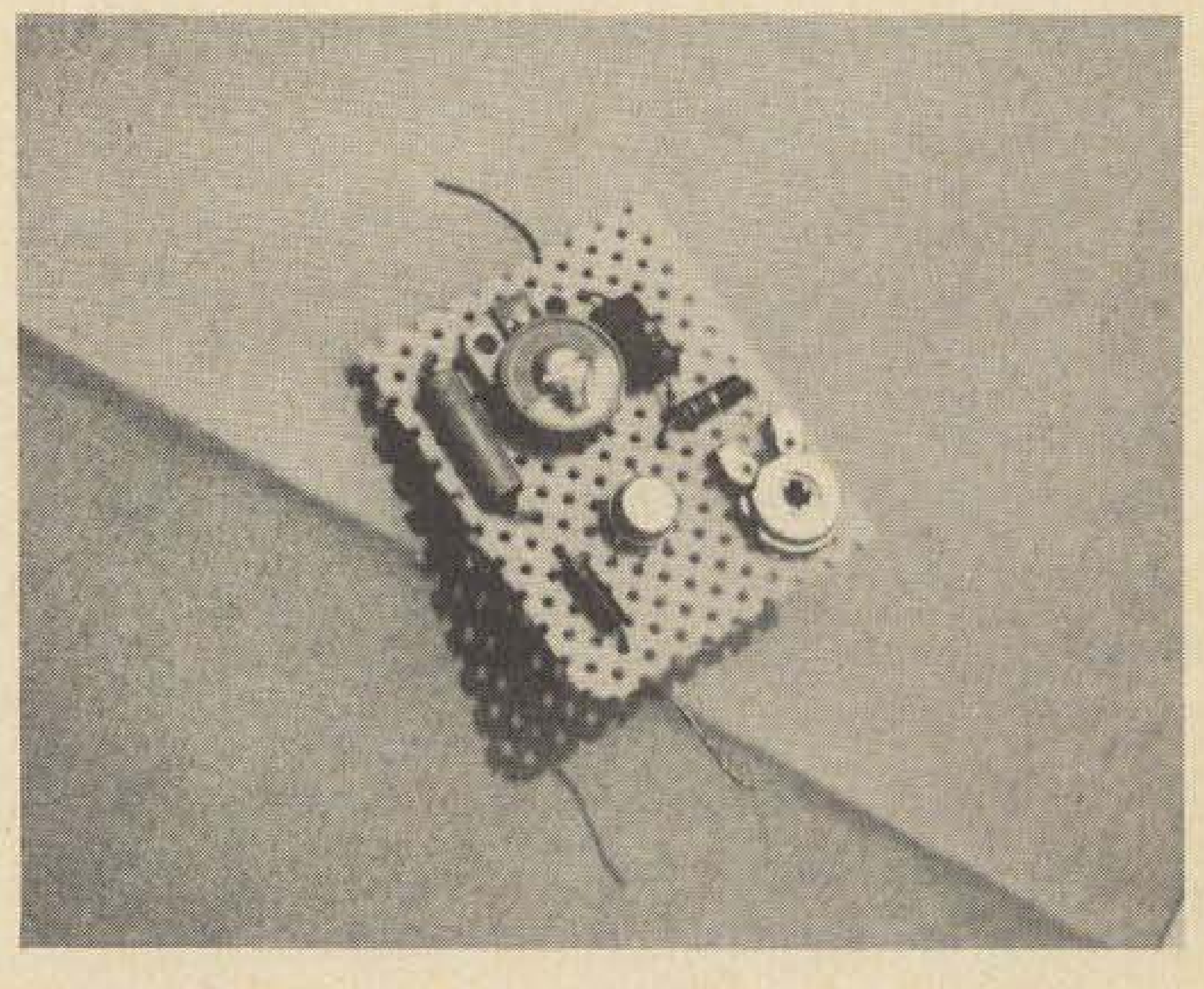
Figure 3 shows the schematic of a practical Q-multiplier circuit with the LC circuit resonant at 455 kHz for use in a 455 kHz i-f chain. Positive feedback is supplied via a 1 kΩ potentiometer. As with other Q-multiplier circuits, the Q can be increased by regulating the feedback until a point is reached when the unit will break into oscillation. The Q-multiplying effect is most effective when components are used for the resonant circuit which in themselves have a good Q. The inductor used for the 455 kHz Q-multiplier is a molded type which provides a Q of about 55 at 455 kHz by itself. The circuit can multiply this value by about 50 times or more. Another suitable inductor can be obtained by using only one or two sections from a regular 1 mH rf choke. The trimmer capacitor is used to set the frequency of the Q-multiplier in the middle of the i-f passband. It can, of course, be used as a variable tuning control for the peaking frequency of the unit. The input resistor, although shown with a nominal value of 1 kΩ, should be chosen so that the gain of the overall circuit is approximately unity.

Construction and Adjustment

There is nothing critical about the construction of a unit utilizing the circuit described as long as the various lead lengths are kept short. The photograph, for instance, shows how the various components can be directly wired together on a small piece of Vector board. The board itself can be directly mounted near the i-f chain in a transceiver, receiver, or together with the potentiometer used for feedback control if the latter is panel mounted.

If the Q-multiplier is not made tunable, the initial adjustment consists of peaking up the LC circuit. This can be done with the unit connected in an i-f strip and using any test signal centered in the i-f bandpass. The adjustment is best done with the feedback control set for minimum Q and with a barely audible CW test signal. The input resistor value should be then chosen for approximately unity gain. The adjustment is not difficult and need not be made exactly. The output level produced by a test signal without the Q-multiplier connected is noted. Then when the Q-multiplier is used, the input resistor is chosen so that the output level remains approximately the same. With most transistor i-f stages, the value of the resistor needed will be about 1-5Ω.

Bypassing of the Q-multiplier can be done in a number of ways in order to allow for normal SSB reception. If the Q-multiplier is made frequency tunable, it can simply be tuned outside the i-f bandpass. In order not to have the i-f gain decrease too far when doing this, the input resistor must be chosen for unity gain to take place when the Q-multiplier is just tuned outside the i-f bandpass. This will result in some increase in gain when the Q-multiplier is tuned to the center of the i-f bandpass but normally the



The Q-multiplier components can be directly wired together using Vector board mounting. In this case, a PC board potentiometer is used to set the operating Q rather than making it continuously variable.

result will not be objectionable. Another way to bypass the unit is to replace the LC circuit with a simple resistor equal in value to the input resistor (as in **Fig. 2**). The switching action can be accomplished by using a 1 kΩ potentiometer for the feedback control which also incorporates a SPDT switch. The switch must be wired such that the resistor replaces the tuned circuit when the wiper arm of the potentiometer is at ground potential.

Summary

The simple Q-multiplier circuit described can be used for a variety of purposes besides that of improving i-f selectivity. It is useful for improving the Q and selectivity of a variety of tuned circuits as they might be used in FSK converters, audio filters for distortion tests, etc. Stagger-tuned circuits used in series can be formulated to provide a variety of bandpass shapes, often replacing more expensive components where bandpass shape factor is not important.

The permission of Dick Gerdee of Optical Electronics to present this circuit, which he originally developed, is gratefully acknowledged. . . . W2EEY ■

QUICK STOP & REVERSING For Antenna Rotator

My antenna rotator is a homebrew type made with a 1/3 hp motor. An early problem I notices was that the rotor had a tendency to keep turning for a few degrees after the stop command. So I use a discharge of capacitors in the motor as an electric brake. I also applied this technique to a small lathe that I bought to build 432 MHz cavities. It works great. When used in the

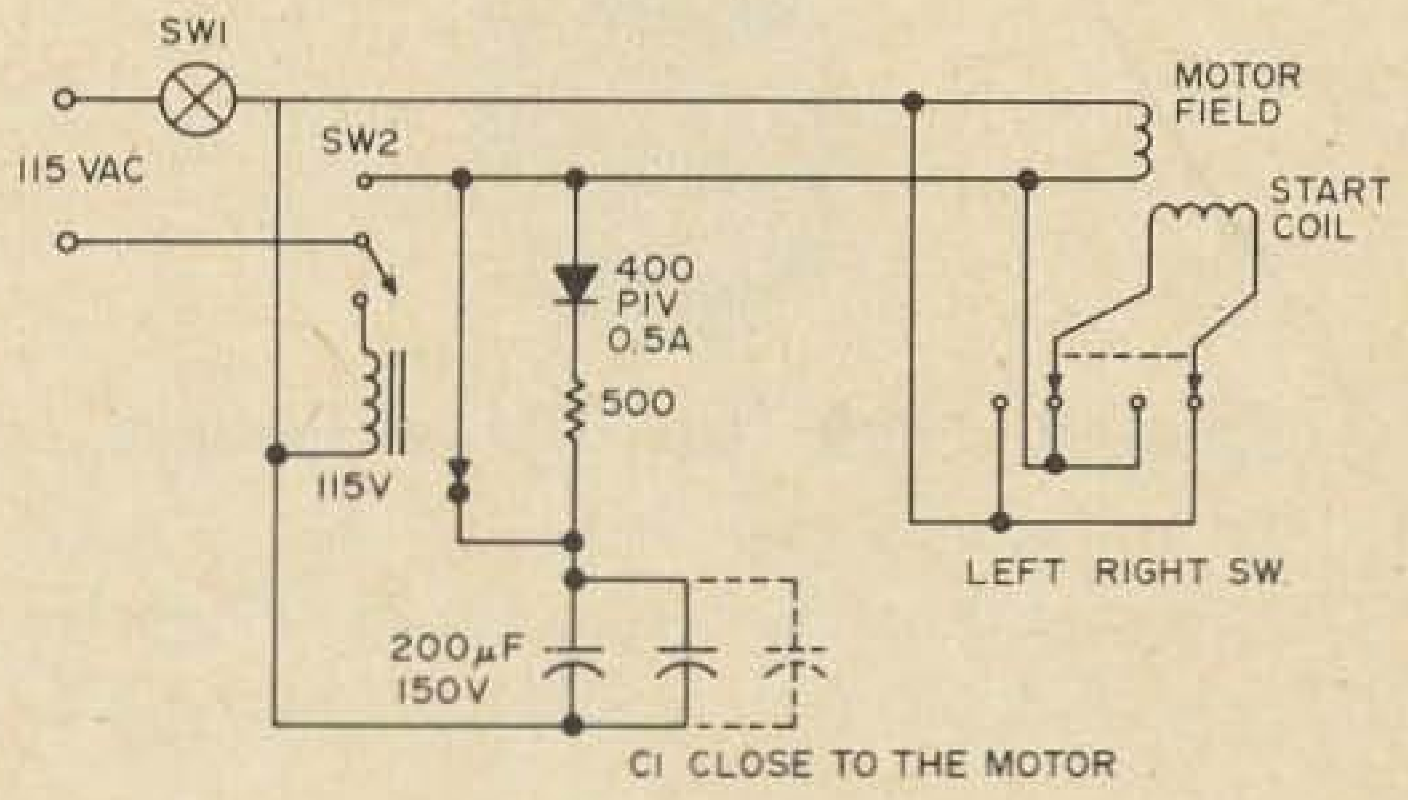


Fig. 1 Extra contact in the go switch

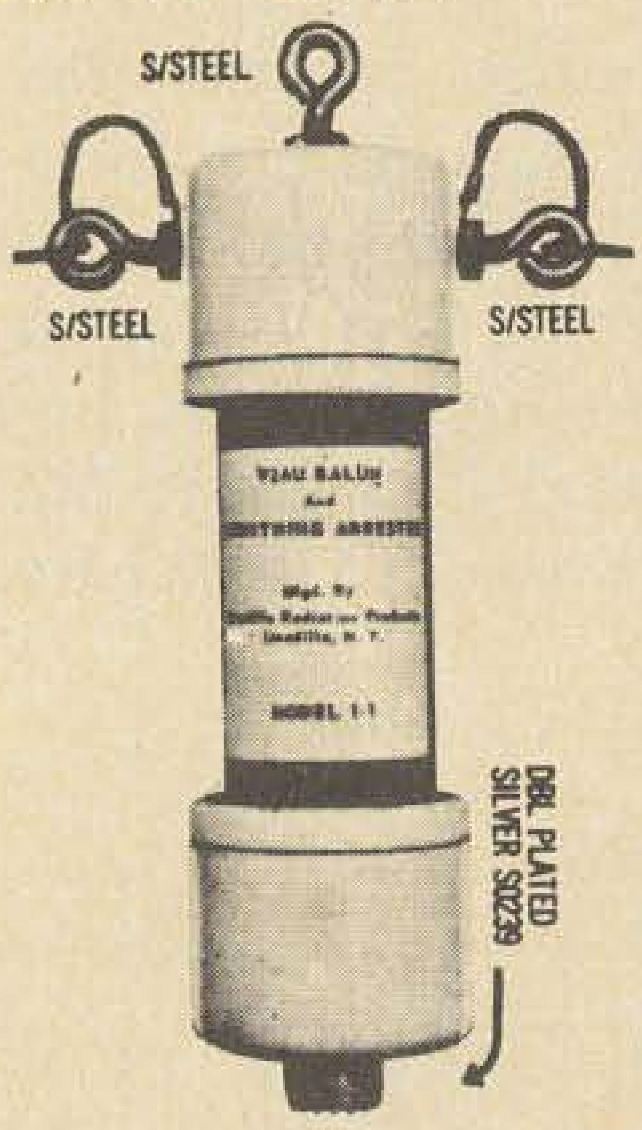
antenna rotator, the brake also provides an instant reversing capability. You need only an extra contact in the off-one switch to command a heavy duty relay near the rotator. When you are turning the antenna, the silicon rectifier charges a bank of capacitors, and when you stop, the condensers are discharged in the motor, bringing it to an instant halt. Put the capacitors in one by one until you get instant stop with your motor. (It is not good for dc motors.)

. . . **Jose Vicente PY2AUC**■

NEW PRODUCTS

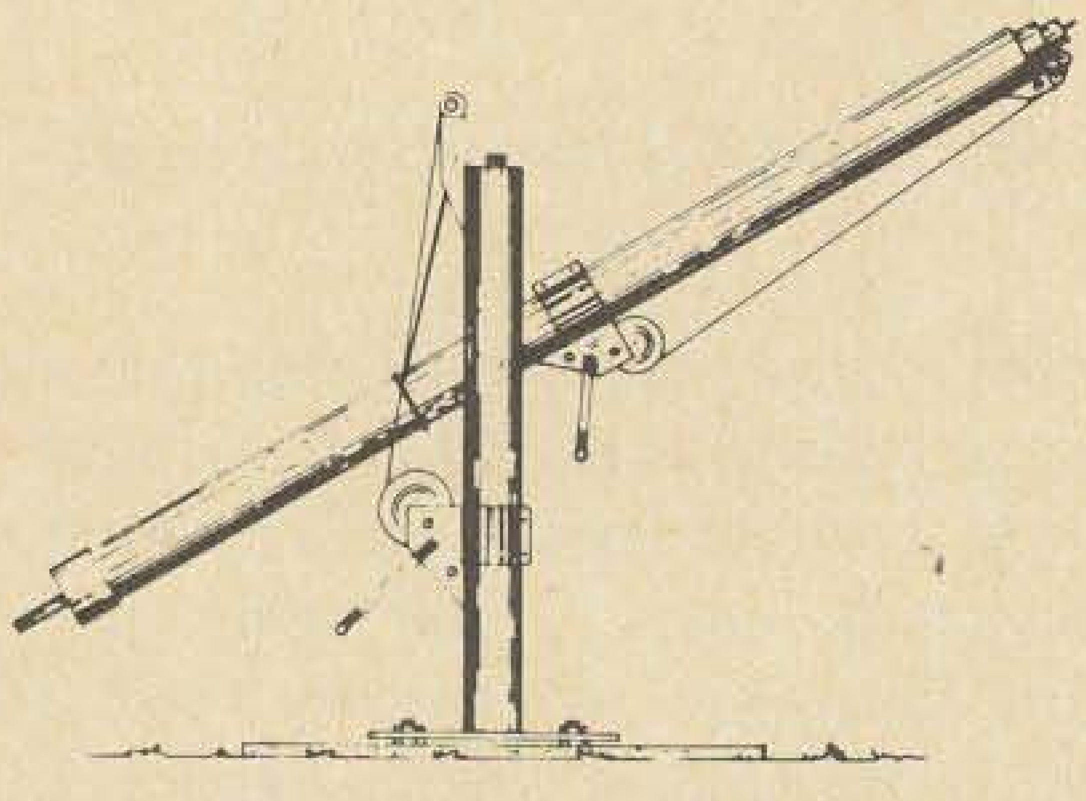
Hi-Power Balun Offers Lightning Protection

The *Big Signal* W2AU balun comes in either 1:1 or 4:1 conversion ratios, and boasts a full kilowatt (the California kind) capability, built-in lightning arrester, and a bandwidth of 3 to 40 MHz. Manufactured and distributed by *Unadill Radiation Products, Unadilla NY 13849.*



Crank-Up Mast has Tiltover Feature

Tristao is now marketing a crank-up mast. The two-section mast goes to 49 ft and the three-section version reaches a towering 66



EASY 2 STEP INSTALLATION

ft. The rotator rests right near the ground, simplifying service of this mechanism. The complete system (called Magna-Mast) can be installed entirely by one man. The tiltover mast enables work to be done on the antenna from the ground, a safety feature which should appeal to amateurs with weak hearts. Both models are hot-dipped galvanized steel. Drop a note to *Tristao, Box 115, Hanford CA 93230.*

Swan Develops Bandpass Antenna For VHF Bands

The Swan bandpass antenna, developed for use in home television reception, has recently been adapted for the 2 and 6 meter amateur bands. Swan's bandpass antenna has the combined properties of constant impedance match across the entire passband of response, with gain superior to that of an equivalent-sized yagi. The antenna features a very high front-to-back ratio as well as front-to-side in both the X and Z planes. Match is in the order of 1.1:1, and gain across the entire design bandpass remains virtually constant.

The Swan bandpass array uses four driven elements, and saturates the first director with virtually all of the power radiated from those active elements. Since the first director sees four driven elements at four different distances, it responds to the designed bandwidth, giving gain at four different frequencies, hence the bandpass response. Similarly, each dipole is matched to four separate frequencies, giving a constant impedance match across the design bandpass.

The advantages are:

- Controlled bandwidth response
- Controlled bandwidth impedance
- Rejection of undesired frequencies and noise above and below desired bandpass response
- Unidirectional response
- Improved signal-to-noise ratio
- Greater gain than the yagi array for the size

The bandpass antenna is a product of the *Swan Antenna Company, 646 N. Union St., Box 1122, Stockton CA 95201.*

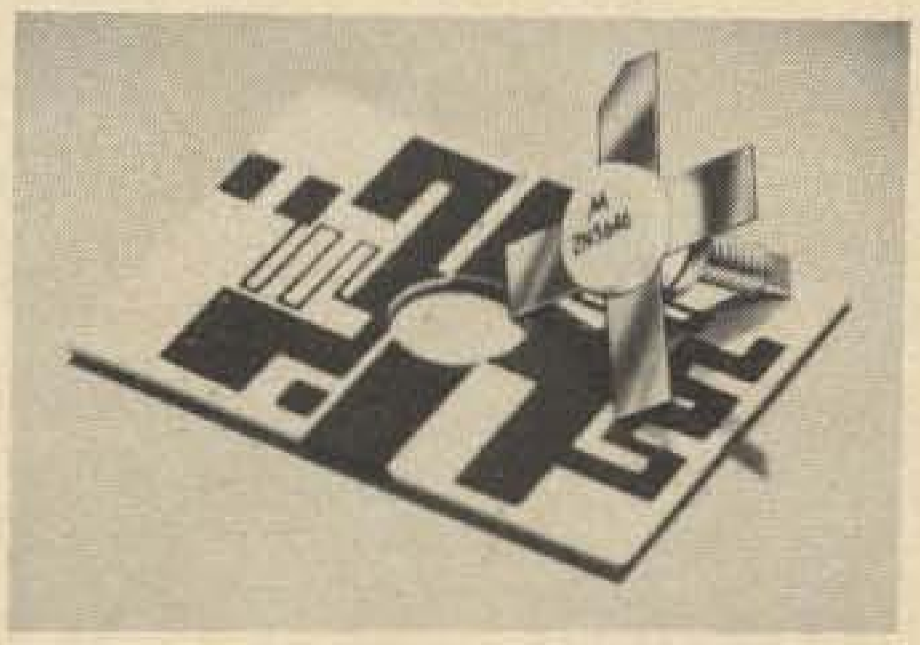
Portable Checker Tests FET Gain, Leakage

The Model FT155 is an FET tester designed for easy use by technicians. Field-effect transistors, like vacuum tubes, cannot be checked out on a conventional transistor tester. The FET is measured like a cold vacuum tube and requires charts that measure the gain in transconductance and leakage in different terms than a regular transistor. Use is not limited to the service trade but is expected to fill the need of the many industrial technicians and engineers who can now test transistors but cannot check the FET. *Sencore, Inc., Addison IL 60101.*

12V Power Transistors for 450 MHz FM

A chain of balanced-emitter rf power transistors is capable of providing 12W in the 450 MHz band with a 12V supply. The new transistors, 2N5644 through 2N5646, are intended for use as power amplifier stages of mobile transmitters in the UHF FM band. The 2N5646 family is supplied in the popular 3/8 in. ceramic stripline opposed-emitter package. Wide, low-inductance leads provide easy design and adjustment, especially in broadband circuitry.

An important feature of the new transistors is their balanced-emitter construction: Each unit is composed of many monolithic transistors in parallel, with a thin-film Nichrome resistor in series with each emitter. If current should increase in any one of these transistors, the rise in voltage across the emitter resistor will decrease base-to-emitter voltage, reducing the current flow. The equivalent parallel resistance of all the resistors is very low, hence does not cause significant degeneration. Because of the balanced-emitter construction, these transistors are very resistant to damage from mismatched loads or detuning. *Motorola Semiconductor Products Inc., Box 20924, Phoenix AZ 85036.*



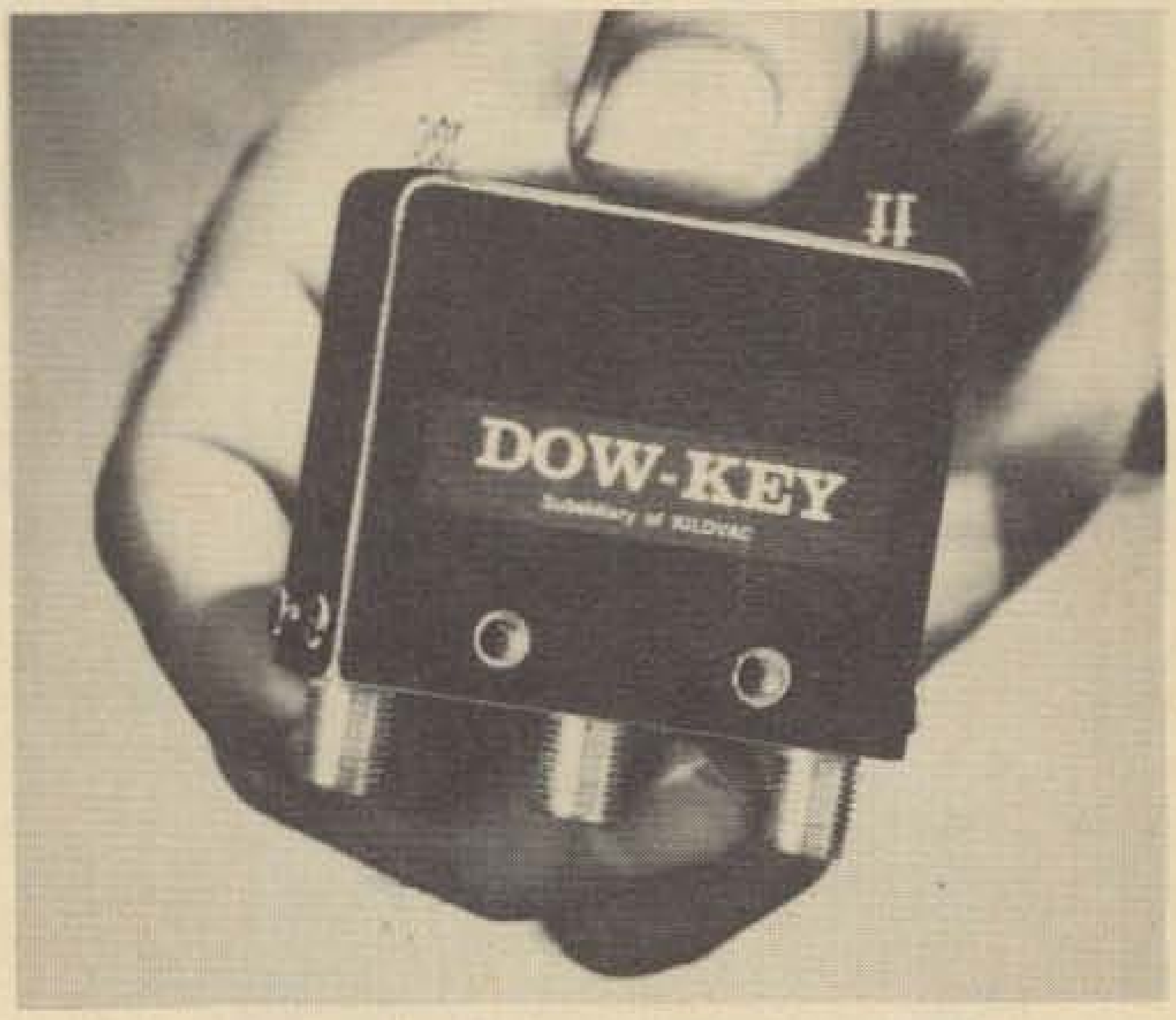
The Motorola 2N5646 rf power transistor has an output of 12W in the 450 MHz band with a 12V supply. Balanced emitter construction makes device resistant to detuning and mismatching.

Semiconductor Book in the Printing

The just-released Motorola Semiconductor Data Book (Fourth Edition) provides specifications on all EIA-registered semiconductor devices, and complete data sheets on all discrete semiconductors manufactured by Motorola (3626 types). The 2160-page hardbound and fully indexed book also includes useful selector guides, package and application information, and vital semiconductor statistics. *Motorola Semiconductor Products Inc., PO Box 20912, Phoenix AZ 85036.*

Magnetic Latching RF Relay

Development of a new single-pole, double-throw magnetic latching coaxial relay has been announced by Dow-Key. The relay, which measures approximately 2 x 2 x 3/4 in., will handle 50W CW or FM, 100W PEP at frequencies up to 1.2 GHz. The no-bounce latching feature of the new relay makes it especially suitable for satellite and other applications where power consumption is of critical importance. The maximum vswr is 1.3:1 at 12 GHz. Coil voltage is 26V (dc). *Dow-Key Co., Broomfield CO 80020.*



Scan Receiver has Lockout Feature

Among the first in a new series of 2 meter FM receivers that provide autoscanning, the Kris also contains switches that allow channels to be skipped over in the scanning process.

The autoscan receiver samples 7 channels, sequentially and continuously, and "locks on" whenever a signal appears on one of the 7 channels. The scan rate is 20 samples per second. Crystals are not included in the $149 price. *Kris, Inc., 1026B S. Washington Ave., Cedarburg WI 53012.*

5-Element Single-Band Beam Offers High Gain, Low SWR

The *"Classic 20"* is a 20 meter single-band beam featuring the Classic Feed System (Pat. No. 3419872). An improved electrical balance, "Balanced Capacitive Matching," combines with optimum spacing to provide maximum gain, increased bandwidth, and more efficient performance than other antennas of its class. The rugged construction typical of all Mosley beams is incorporated into the *Classic 20*: high-impact insulators and clamping blocks, aluminum tubing, and stainless steel hardware.

Specifications:

Power rated: 1 kW AM/CW; 2 kW PEP SSB
Forward gain: 9.8 dB (11.9 dB over isotropic source)
Front-to-back ratio: 20 dB
SWR: 1.5:1
Feedpoint impedance: 52Ω

The *Classic 20* is a product of *Mosley Electronics Inc., 4610 N. Lindbergh Blvd., Bridgeton MO 63042.*

Electronic Keyer has Multiple Functions

In addition to providing perfectly formed and spaced characters when used with a paddle or squeeze key, the EK-38 "Electronic Fist" provides semiautomatic keying with a straight key or a "bug" for use

on-the-air or as a code practice oscillator. Power supply, sidetone oscillator, and speaker are built into the small attractive cabinet. Sidetone pitch and volume controls are provided as well as momentary and locked TUNE switches. A jack is provided for an external manual standby key. *Curtis Electro Devices, Box 4090, Mountain View CA 94040.*

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SWAN 250 with AC supply and Shure 444 mike. All mint condition. $250 FOB. No trades. McCormack, 5008 N. Carlyn Spring Road, Arlington VA 22203.

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GREENE. . .center dipole insulator with. . .or without balun. . .see 73, November '69, page 107.

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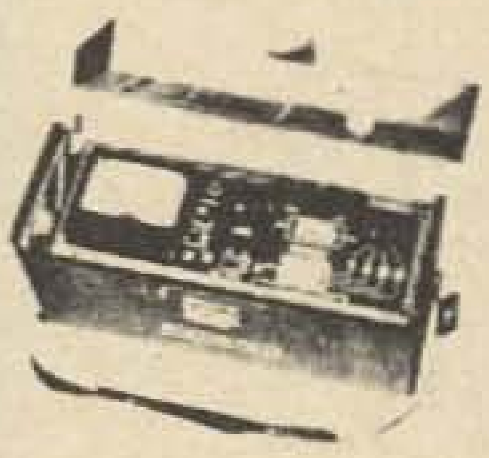

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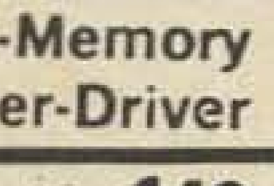

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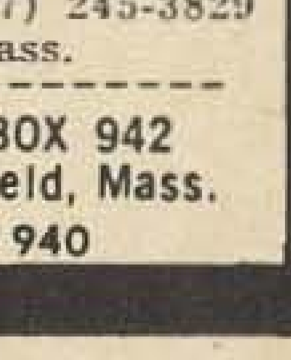

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