73 magazine
for radio amateurs

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#145 OCTOBER 1972

COVER: Mary Jane Trokel fondling a Standard 146 hand transceiver in front of the WB6ZDI repeater building on Mt. Wilson. Our thanks to Ron Mayworm WB6NOU, the photographer, and to Fred Deeg K6AEH the president of the Palisades Amateur Radio Club for arranging for the picture to be taken. Again the Palisades Amateur Radio Club does a great public service!

FEATURES

STAFF

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NEVER SAY DIE

. . . de W2NSD/1

EDITORIAL BY WAYNE GREEN

Robot Surprise!

The announcement in the September issue of 73 of the Robot plan to sell direct from the factory and thus make it possible to cut the price of their slow scan units to $295 each for the camera and monitor should keep them busier than a skin diver in a bunch of jellyfish keeping up with orders.

That new price tag should help a lot of fellows make the decision to go slow. And don't forget that you don't have to get that camera right off either. You can make do perfectly with a little cassette tape recorder with a tape made up from any neighboring camera.

Hams Don't Build?

The other day an article came in, written by an old timer, complaining that amateurs don't build any more. In the old days the amateurs used to build everything, now they all go out and buy their rigs and just operate them like appliances . . . etc.

This old timer meant well, but he sure was uninformed. I don't doubt that most of the fellows he talks with buy instead of building. The chaps in his club probably do the same. The fact is that not very many old timers do build.

But the newer amateurs are building gear like never before in the hobby.

Now, is Green telling it like it is or is he exaggerating? Who is right? The fact is that you can check for yourself and get the answer in a couple of minutes. Please just thumb through the last sixteen pages or so of this issue and see just how many pages of ads there are for parts. Now, grab the first old timer you see and get him to break out a 30's copy of QST and count the number of pages of parts advertising. There is no comparison whatever. I rest my case. If parts weren't selling and selling like crazy you know darned well that all those companies wouldn't be in there advertising them.

The old timer does not build. With but few exceptions the older amateurs are tube men in the day of the transistor. All they know how to build are tube sets and who would bother to build them today? With the exception of Bill Hoisington and Frank Jones, how many of the old experimenters have been able to convert to solid state?

Our technology has been escalating rapidly. Twelve years ago when we started 73 we had a few transistor circuits – mostly audio amplifiers and code oscillators. The nuvistor was the big news in 1960, if you remember. By 1965 tubes were in the minority and virtually all articles were on transistorized construction. Now transistors are about gone by and we are dealing with integrated circuits most of the time.

Counters which boggled the mind a few years ago now are on one little board. We have the GLB frequency synthesizer on a small circuit board – a complete unit on a tiny board that would have taken a couple relay racks of tubes just a few years ago. More and more ham shacks are now using the digital clocks – clocks that were restricted to laboratories and large computer installations not long ago.

Tubes – transistors – ICs – what's next? Something will come next, of course.

Looking at the latest all IC VHF receiver built by Bill Hoisington, I rejected the article on how hams don't build any more.

Invitation to Steal

Most amateurs are pretty good eggs. Some are rotten. Add to that mix a few "listeners" who can be either and you have a few people monitoring the bands who might be up to no good.

The fact is that there have been several incidents where things went all wrong after an amateur mentioned over the air that he was going to be away from home. The worst case reported was where the amateur mentioned over a repeater in New York that he would be away for the day on a business trip. He arrived home to find his home had been ransacked and his wife raped.

There is a good deal to be said about prudence. Remember that even FM receivers are sold to anyone and everyone. Those little VHF monitors which get the weather and police will also bring in your local repeater – and you – and they could bring unwelcome guests.

FAT NOVEMBER ISSUE

There are a few more ads in this issue of 73 than we expected, so it is a little more packed than we like. This is one of the problems with last minute ads – by the time they come in, unannounced, we have already laid out the articles and have them in negative form ready to print and it is too late to change them.

If the ads keep coming in for November the way they have started, this could be the biggest issue we've ever published. We'll see. We have some corking good articles being readied for this special issue – a whole lot of them. Imagine a magazine as fat or fatter than QST, but with articles instead of operating news, contest results, RACES, IARU, and all that!

And say, if you have any articles in mind which might be of interest for a special FM issue – a surplus issue – an antenna issue – a mobile issue – a CW issue – a VHF issue, then get to your typewriter and get started. We're hard at work right now on these special issues for 1973.

FM DEVELOPMENTS

Old timers are coming on the FM repeaters in droves all over the country. No wonder, of course, since the word has been spreading that here, for the first time in years, is a way to get on the air and have contacts without interference.

Mobile on the lower bands was fun – kind of – if you didn't mind always being the low man, getting stepped on by higher powered stations, losing contacts, and extremely fragmented conversations. About the only gripe on FM is that a few of the repeaters are so busy that rag chewing gets discouraged during the busier hours – but then there are always repeaters that are not being used and which will welcome all but the fustiest of old timers.

The Repeater Bulletin is doing very well, by the way. This is a little publication put out by 73 for the repeater users in the northeastern part of the country. The August issue ran to 48 pages (Radio Electronics size magazine), partly due to the amount of material submitted by the readers and partly due to Wayne Green writing at length. The cover picture of Judi Repeater turned everyone on so much they didn't notice she was talking into the back of her microphone. Shades of Playboy! The most startling announcement in the Bulletin had to do with limiting the circulation to amateurs of high moral turpitude. This far-reaching decision obviously would tend to limit the circulation in certain areas of Connecticut.

Not a little space was devoted to news of the Northeast Repeater

Association, which coverage elicited angry letters and even legal threats of suits and attachment from some of the principles. I really must be careful or I am liable to damage my hard-earned reputation for being non-controversial.

The FCC still is sitting on the promised repeater regulations, and a good thing it is. Virtually none of the problems that they were developed to cure have turned out to be worthy of rule changes, so the whole docket was an exercise in wasted time. Repeaters have not spread out and encroached on AM frequencies and legislation to prevent it is totally unneeded. The fact is that the service provided by repeaters has been so fantastic that there are only a few AMers left on two meters, most of them having long since gone FM, and the emerging problem is how to put the old AM parts of the band to use to keep Citizens Band manufacturers from getting the EIA to try and liberate 144 MHZ for the Ten-Roger masses.

Repeaters have not linked up in long strings either and rules to prevent it would be little short of disastrous at this time. Every time a rule like that comes along today it shoots down a hundred possible future developments that weren't even thought of at the time of the rule. Let's stop this mania for regulation and consider new rules only when things really get out of hand.

The Los Angeles FMers are getting together at last to work out their problems. Hooray! If more of them could pay a visit to New England they would get a good view of what FM and repeaters could be when managed well. New England has turned out to be a model for the whole country on how great FM can be developed. About 70 repeaters are serving over 5000 active FMers and serving them extraordinarily well. Some repeaters have as many as 400 users – others maybe only twenty or so.

Most of the standard thirteen FM channels are active from New York right on up through Boston. If you have a 13–73 crystal pair you can work WA2SUR in Manhattan, WA1KHC in Massachusetts and WA1KGP in Maine. On 04–64 you start out with K2LJC on Long Island, go to WA1KHA in CT, and WA1KGS in Boston. On 25–85 you have WA2PDJ on Long Island, WA1KGY in CT, and K1MNS in Derry NH. Ditto on 37–97, 34–94, 28–88, 22–82, 19–79, etc.

The 220 MHz band is being repeaterized rapidly in an effort to spike the EIA drive to steal the band from us. There are about ten active 220 MHz repeaters in New England and more popping up around the country every week. Clegg and Tempo are building gear as fast as they can. Wait'll you see the Tempo 220 rig in the November 73.

The 73 Tour

We wondered why it was taking so long to get an okay from the Russian tourist agency Intourist confirming the 73 tour accommodations. Finally word came through that there were no rooms available in Moscow. Okay, how about Leningrad or some other city? No, came back the immediate reply, all hotels are filled up. Translation: they don't want USSR amateurs to meet and talk with US amateurs. The group decided to make it Madrid instead of Moscow.

Although the group is still in flux, it now appears that there will be aroud 20–25 going on the trip. It should be a blast – and frankly, a lot of us will be much more comfortable not going to Russia. Few tourists coming out of there say much to encourage others to go. Who wants to be watched and spied on with suspicion while visiting a country – to know that befriending a local amateur might jeopardize his future – to know that other visitors have landed in jail for years through no fault of their own and in spite of everying the U.S. could do. Who needs it?

DISASTROUS DISASTERS

The floods this summer exposed the weakness of our emergency communications. In Pennsylvania all existing communication systems fell apart. Civil Defense was set up in cellars in preparation for bombs and they immediately flooded out. Police and other short haul systems were useless. CB operators tried to help, but lacked any organization or experience and more often than not were a waste of time.

The fact was that, as in most other serious emergencies, the responsibility fell on amateur radio – and amateur radio was ill prepared for the responsibility. They needed short, medium and long-haul communications – which amateur radio is ideal for. Most of all they needed someone in charge . . . this is where things fell apart. Orders were conflicting – great things happened – terrible things happened.

One of the most valuable communications systems set up for the emergency was a two meter FM repeater. Food, shelter, clothing, health and welfare messages, the works, were routed through this repeater. And would you believe that while tens of thousands of people were depending on this there was an amateur in a responsible position in Massachusetts trying his best to keep FM amateurs from driving to Pennsylvania to help?

The Clegg company helped a lot by providing a dozen FM transceivers. These were picked up and flown out by helicopter on the same day that the above mentioned Massachusetts amateur was talking people into not going to help because he heard from a friend that there really was no emergency.

. . .Wayne

AMSAT NEWS

OSCAR

Michael Frye WB8LBP
640 Deauville Dr.
Dayton OH 45429

I have been recently informed that A-O-C will again be delayed until November and possibly into early December. This is again due to NASA scheduling.

This column will be just a short rundown of recent happenings since all activities are progressing normally.

I strongly suggest that you at least monitor the AMSAT Nets as quite a lot of current information can be gathered there. If you have specific questions, check in and ask it, someone in the net will probably be able to help.

AMSAT members are working quickly to weld together a stable tracking network. And in my opinion they're doing a great job. Twelve definite command stations have been established around the world so that satellite monitoring will never be out of reach. NASA has graciously let AMSAT use their antennas at Goldstone California for tracking purposes. This will greatly increase reliability of communications.

If you want to work A-O-C the thing you should now be doing is setting up your antennas, and since this project will last through the winter, making sure they will withstand the extremes of your area. Transmitter and receiver operation should also be given a good check. Since A-O-C will accept any mode that appears in its passband maybe this should be looked into. Rumor has it that there is stiff competition going on between a number of groups to be the first to send Slow Scan TV through the satellite. Well I hope the best man wins.

. . .WB8LBP

NEW PRODUCTS

DX ENGINEERING CLIPPER

Quite a few schemes have been developed to increase the average power of the voice for sideband transmission, with the system used in the DX Engineering clipper being one of the more successful and popular.

The problem is that when you set the sideband transmitter to operate properly without splattering, the aver age power is quite low. Only the voice peaks fully modulate the transmitter. A clipper increases the average voice power, effectively increasing the transmitter output power. Indeed, when you check a station using such a clipper or compressor, you will usually see on the order of a full S-unit (6 dB) increase when the clipper is turned on.

Why doesn't everyone use one of these gadgets? Why aren't they built into all of the transmitters? They will be. The NCX-1000 has one built in, so does the Signal One. Unfortunately, the circuit is not at all simple and for reasons of economy it is left out of many rigs.

The DX Engineering clipper is designed to plug right into the transceiver. You unplug the first i-f tube from its socket, plug in the clipper, and replace the tube in the clipper. This adds the clipper to the circuit. The work is done at the sideband i-f intermediate frequency, with a 2.1 kHc mechanical filter built in to reduce the second and higher order harmonic which would otherwise cause miseries.

The clipper is transistorized, so it does not borrow enough power from the transceiver to upset anything. All in all, a clever device. The model presently available is designed specifically to work in the 32S1, 32S3 and KWM rigs. Cost $79.50 from *DX Engineering, 2455 Chico Ave., South El Monte CA 91733.*

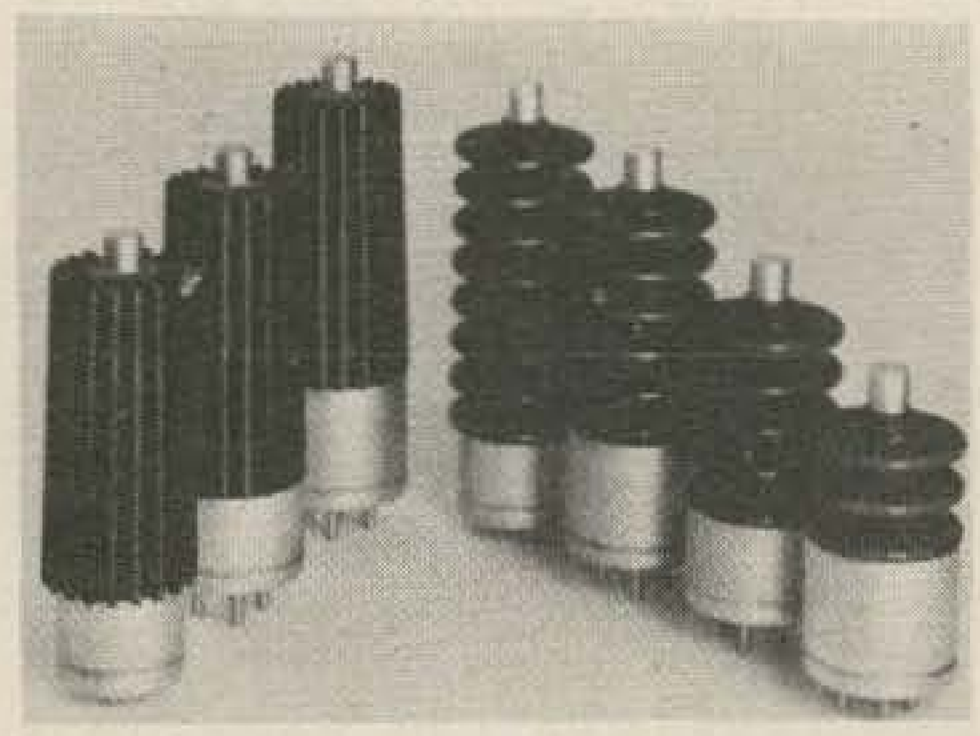
LINEAR IF AMPLIFIERS

A new 4-page product bulletin (IFA-203) describes the expanded line of linear i-f amplifiers available from RHG Electronics Laboratory, Inc., manufacturers of microwave components, receivers and transmitters.

The bulletin contains information on the new line of Hybrid IC i-f amplifiers. In addition to the new products, the bulletin lists new features, improved specifications and reduced prices on many models. Scope photos, performance charts, and outline configuration drawings are shown along with comprehensive and informational technical text.

Bulletin IRA-203 can be obtained from: *Sales Manager, RHG Electronics Laboratory, Inc., 94 Milbar Boulevard, Farmingdale NY 11735. Telephone: 516-694-3100.*

SEMTECH "TUBE-PAC"



"Tube-Pac" is Semtech's new line of silicon, high-voltage rectifiers intended as a direct plug-in replacement part for most popular mercury-vapor and vacuum glass tube-type rectifiers.

Designed to last the life of the equipment, Semtech's Stacks are smaller, corona free, dissipate heat more effectively and eliminate filament power. No special adapters are required to use Semtech's Stacks. For more information contact *Semtech Corporation, 652 Mitchell Road, Newbury Park CA.*

JUNIOR UHF CONNECTORS

When coaxial cable was invented, surely the thinkers of the day had in mind the ease with which rf energy could be coupled from one place to another. As originally planned, the rf coupled fine . . . but what about the coax itself? Was it *designed* to present the mechanical difficulties it does? Specifically, the problem is the copper braid. It sits there and dares you to try and unravel it. An awful job. The only practical solution is to do quick sloppy work and hide it all away inside some sort of connnector.

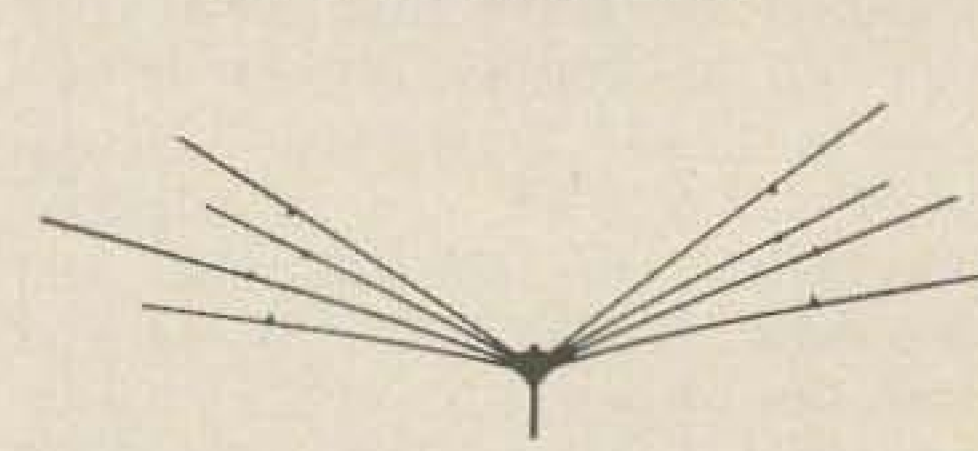
Coax connectors are an item all in themselves. They make coax a pleasure to use once they are installed, but you still have to connect the coax to the connector, etc. This means hasseling with the braid and hauling out the soldering iron. Compare your best effort to the drawings in the Handbook. Now you know why they use drawings instead of pictures!

Offering a partial solution to all this, L-COIL, an antenna manufacturer, has introduced a new line of solderless, no effort coax connectors. They are designed for RG58/59 coax and are compatible with the popular UHF series chassis connectors. To install one, all you do is trim the cable and screw everything together. The only tools needed are a pocket knife and a small pair of pliers. Since everything is held together by pressure, the tighter you screw it together – the stronger your connection will be.

Although most commercial equipment comes with UHF connectors, many hams like to use BNC connectors when they build a piece of gear. Part of the reason is that short interconnecting cables of RG58/U cable look sloppy and are clumsy to use when they have giant PL-259s hanging on each end. Also an amazing number of strange looking adapter cables must be made up to keep everything flexible. These new connectors are a chance to standardize. Use UHF connectors on all chassis, PL-259s on your large coax, and these little beasts on your small coax and interconnecting cables. They are small, light weight and look good.

L-COIL also markets two no-solder splices for RG58 or 59 coax. It's time to piece together all the odd lengths of scrap that's been collecting dust in the garage. According to the test graph supplied by L-COIL (actual test done at University of Michigan), you can end up with nearly virgin cable when using their splices. The graph shows variations of only about 2–3Ω impedance when 50Ω RG58 cable was connected with one of their splices. Their connectors' results were similar. For comparison, they tested two UHF connectors. These gave results of 33 and 37Ω. Send for the graph. *L-COIL Research, Brighton MI 48116.*

M² FOUR BANDER



Here is a four band short antenna designed specially for marine use – up on top of the mast. It is a horizontally polarized antenna, a fact which may be appreciated by vertical antenna users. The lower angle of radiation does generally give quite an advantage over most verticals.

The M² is light – only about 15 pounds! – is made of stainless steel to frustrate the sea breezes – and loads up nicely on 40m up through 10m. It is made up of four "cats whiskers" which stick out from the mast horizontally. Frankly we have no idea whatever why it works and the manufacturer is guarding the secret as "proprietary" information.

The specifications show that an SWR of almost 1:1 can be obtained with the M² on all four bands! Since the longest element is only about seven feet long, the antenna is a natural for shipboard use. For more info drop a line to *M² Electronics, 28627 Bridle Lane, Miraleste CA 90732.*

SPECTRONICS FREQUENCY COUNTER MODEL YC-305

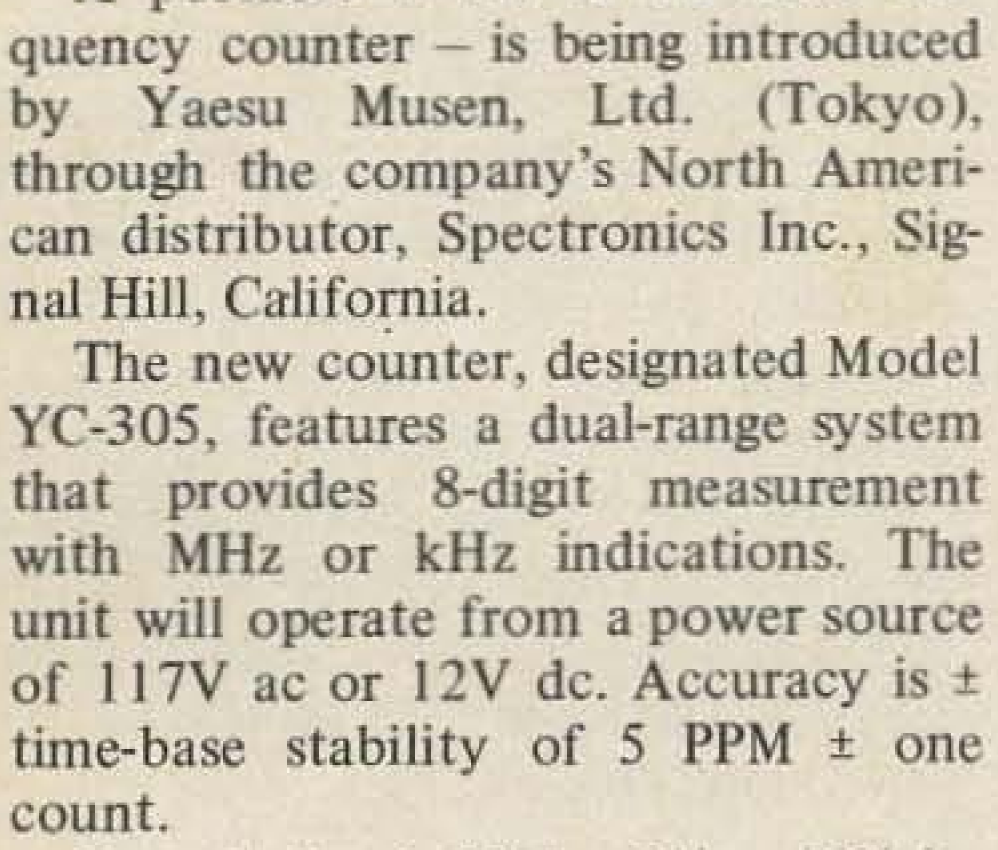
A portable 5 Hz to 30 MHz frequency counter – is being introduced by Yaesu Musen, Ltd. (Tokyo), through the company's North American distributor, Spectronics Inc., Signal Hill, California.

The new counter, designated Model YC-305, features a dual-range system that provides 8-digit measurement with MHz or kHz indications. The unit will operate from a power source of 117V ac or 12V dc. Accuracy is ± time-base stability of 5 PPM ± one count.

Overall size is 8¾ by 3¼ x 10½ in. Weight is 8 lbs. The unit is warranteed for one year and is priced at $249.95.

Further information on the Yaesu Model YC-305 is available from *Spectronics, Inc., 1491 East 28th Street, Signal Hill CA 90806. Phone: 213-426-2593.*

TWO FREQUENCY TONE SQUELCH



Alpha Electronic Services announces the smallest and most reliable two-frequency sub-audible tone encoder/decoder available for the FMer. The Alpha SS-80J dual tone, measuring 2-2/3" x 1" x 5/8" can now provide for many of the smaller mobile units and certain hand-held units two distinct tone frequencies for the purpose of controlling or selecting repeaters, base stations or mobile units.

Two frequency sub-audible tone operation makes possible the employment of multiple repeater systems, increasing the range capabilities of a communications system. The selective calling of two base stations, two groups of mobiles or special control functions are other capabilities of the two-frequency tone unit.

Contact *Alpha Electronic Services Inc., 8431 Monroe Avenue, Stanton CA 90680.*

STANDARD 146A

In fact the 146A is remarkably like the 146 hand transceiver. It has the same five channels, the same remarkably sensitive receiver, the same selectivity which keeps it from being clobbered when it is used near a transmitter – it still has that S-meter built in which doubles as a battery monitor – the jack to plug into your station antenna or mobile antenna so you can use the unit anywhere and take advantage of whatever antenna situation you have available – the remote microphone jack so you can wear the transceiver on your belt and use a hand mike – by the way, the regular Standard mike will plug into the 146A in case you have an 826 or other Standard model at home or in the car and want to use the same mike for both sets. There is a jack on the side so you can plug it into the car power while you are running mobile. The whole transceiver plugs into the Standard battery charger or you can easily pull out the battery and recharge it with any small power supply which will put out 50 mA.

The 146A comes with a telescoping antenna, but there is also available a short rubber whip (the rubber ducky) where you don't need as much signal and the shorter antenna is easier and safer to use.

The main difference between the 146 and 146A is that the new unit runs two watts output instead of only one – double the power out! Also there is room inside for an optional continuous tone unit for those of you who work through PL repeaters.

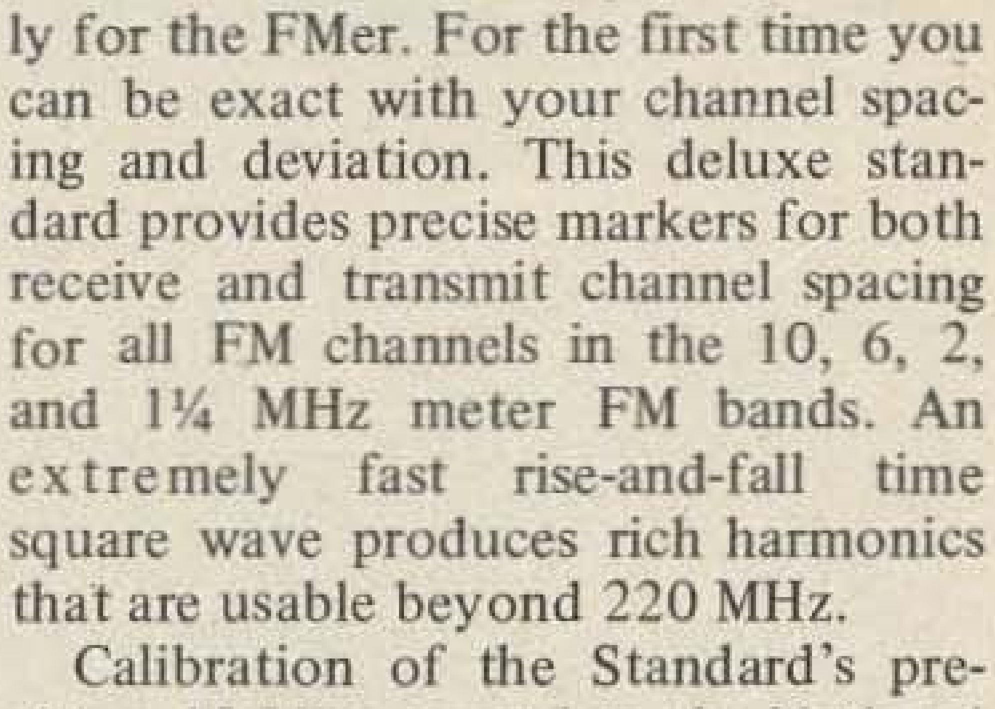
The features of the Standard 146 make it invaluable for many applications. It is by far the best selling hand unit in the country today according to all of the sales figures available. *Standard Communications Corp. P.O. Box 325, 639 North Marine Avenue, Wilmington CA 90744*

FM FREQUENCY STANDARD

This is a precision frequency standard that has been designed specifically for the FMer. For the first time you can be exact with your channel spacing and deviation. This deluxe standard provides precise markers for both receive and transmit channel spacing for all FM channels in the 10, 6, 2, and 1¼ MHz meter FM bands. An extremely fast rise-and-fall time square wave produces rich harmonics that are usable beyond 220 MHz.

Calibration of the Standard's precision 12 MHz crystal to the National Bureau of Standard's signal from WWV or WWVH is made possible by a simple adjustment provided through the front panel. Price is $44.50 from: *Data Engineering Inc., Box 1245, Springfield VA 22151.*

MODEL 48MV TOP BAND 160 METER ANTENNA TUNER



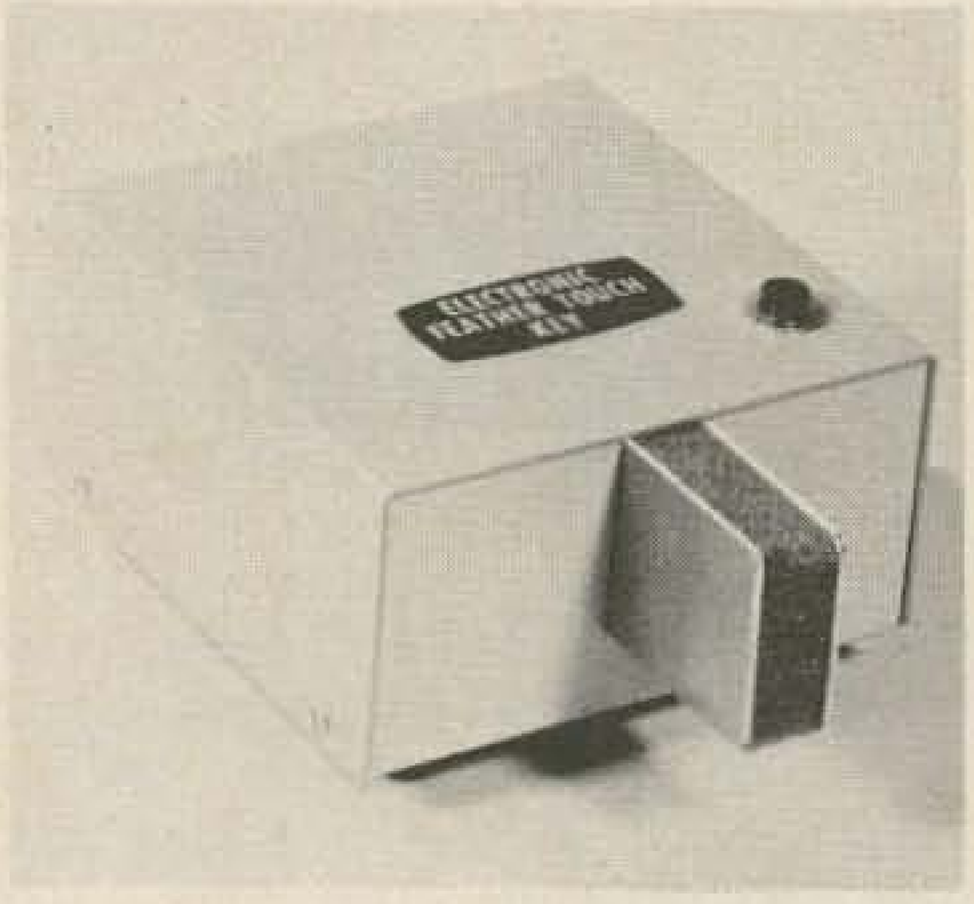
The FCC's recent initiative to raise power limits and expand frequency privileges on 160 meters has given rise to a tremendous increase of interest in the Top Band.

A variety of commercial rigs on the market today provide facilities to operate 160 meters, but antenna requirements for the Top Band have always seemed to hinder those hams living in residential areas.

Now, with the development of Top Band Systems Model 48MV 160 Meter Matchverter, any ham having enough room for a 40 or 80 meter inverted vee/dipole can share in the thrill of working DX on the Top Band.

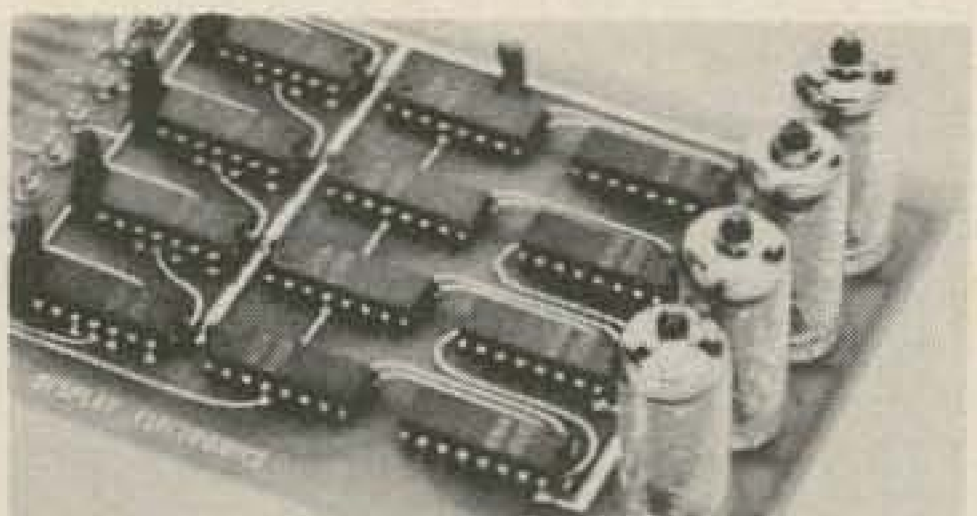
Top Band Systems offers immediate delivery for any quantity of 48MV Matchverters. Write for complete information on terms and delivery: *Top Band Systems, 5349 Abbeyfield Street, Long Beach CA 90815.*

ELECTRONIC FEATHER TOUCH KEY



The Electronic Feather Touch Key is completely solid state. It requires no paddle movement, no spring tension or contact clearance adjustments and has no keying contacts. Keying problems caused by contact corrosion and bounce as well as paddle tension and movement adjustments are no longer a concern. The key is the natural interface for the extremely low current, high speed integrated circuits used in solid state electronic keyers. It sells for $22.95 (with remote spot P.B. switch). *Data Engineering Inc., Box 1245, Springfield VA 22151.*

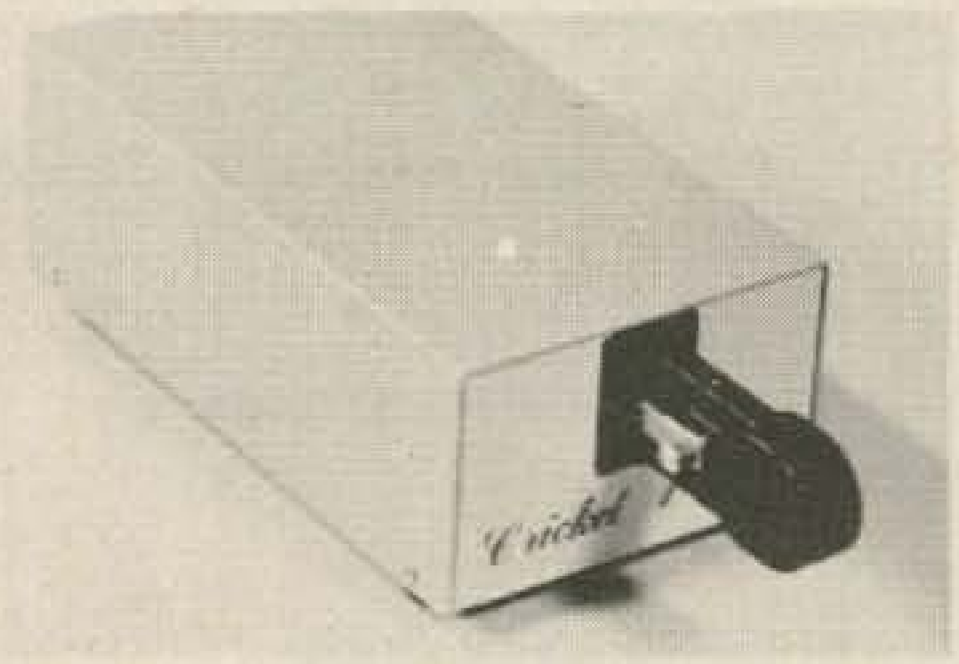
NEW COUNTER AND DISPLAY MODULES AVAILABLE



A new series of counter and display modules is available from Display Electronics. The CM Series modules include a decade counter, latch, decoder-driver, and readout for each digit. Standard modules are available with from 2 to 6 digits.

The price of a typical four digit module is $79.00 in single quantity. Delivery is from stock to 30 days. Custom designed modules are available on special order. Further information is available from: *Display Electronics, P.O. Box 1044, Littleton CO 80120.*

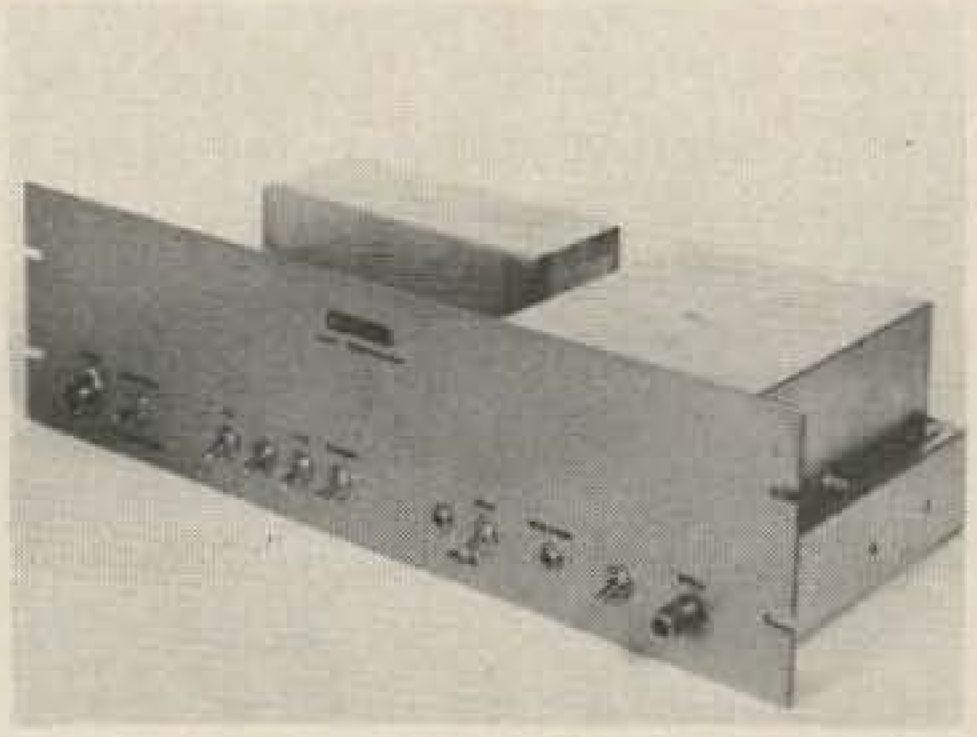
CRICKET 4 MORSE CODE KEYER



This popularly-priced keyer has more features for your dollar than any others in its price range.

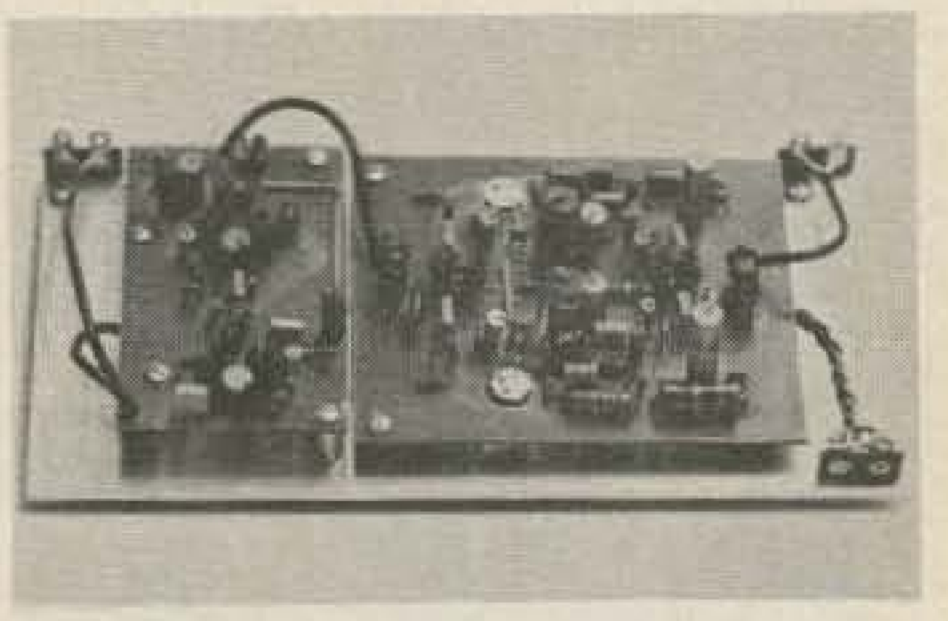
A small solid state keyer designed for the beginner as well as the most advanced operator. It provides the user with fatigue-free sending and it's clean, crisp CW allows for easy copying at all speeds. $49.95 from *Data Engineering Inc., Box 1245, Springfield VA 22151.*

SC-ARPT-1 SOLID STATE REPEATER



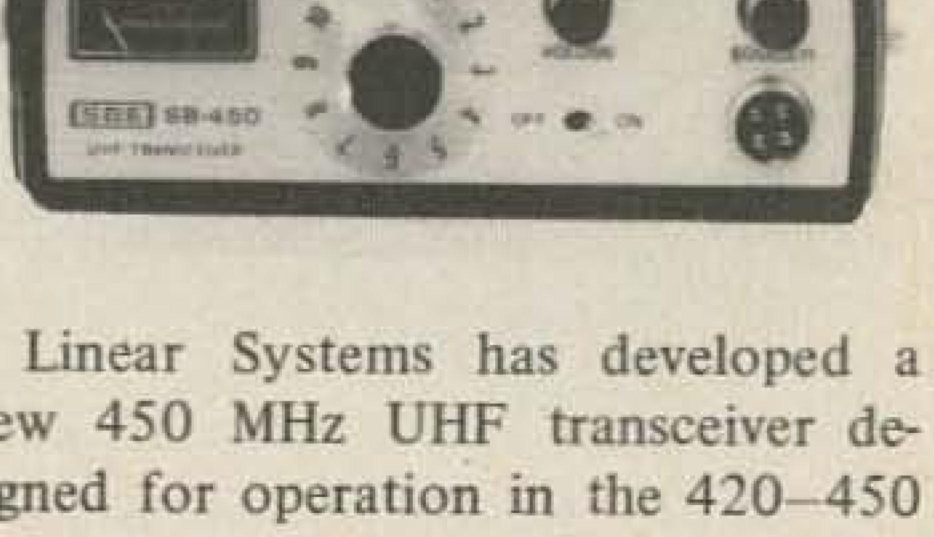
The Standard SR-ARPT-1 is the latest in totally solid state repeaters for the land, mobile and amateur radio communications industry. Constructed to the most critical specifications for years of mountain top. trouble-free service, this unit will provide that extra edge of range needec for even difficult locations. Ready fo. immediate standard 19 inch rack mounting, the Standard repeater will fit in immediately to your existing communications network. Simply add 12 volts and connect your input and output antennas to the two antenna connections, add the proper crystals, and you are on the air with the finest in repeater communications equipment! Meets FCC type acceptance requirements for land, mobile and amateur radio service. This unit will ideally fit into your communications network and budget. *Standard Communications Corp., P.O. Box 325, 639 North Marine Avenue, Wilmington CA 90744.*

BROADBAND POWER AMPLIFIER KIT



Kit MP-100 is an all solid state broadband power amplifier covering the range of 0.5–100 MHz. Rated at 2.5W CW, it accepts inputs of AM, SSB, Pulse, and other complex modulation. It delivers full power output when driven by any signal or sweep source of 0.15V over the entire frequency range without tuning adjustments. The unit will not oscillate for any condition of load or source impedance and will withstand a 15 dB overdrive including short and open circuit loads. Of printed circuit board construction, the kit can be assembled in approximately 3 hours. A data and specification sheet is available from *Larkton Scientific, P.O. Box 302, Munroeville PA 15146.*

SBE 450 MHz TRANSCEIVER



Linear Systems has developed a new 450 MHz UHF transceiver designed for operation in the 420–450 MHz band. The book sized transceiver is the first SBE entry into the rapidly growing 450 MHz amateur band. The

MARS

Back on 16 February 1972, Wayne Green graciously agreed to allow space for these articles on MARS, beginning with the May, 1972 issue. The writer immediately attempted to contact the Chiefs of Air Force and Navy-Marine Corps MARS but met with little success. Due to more than twenty years membership in Army MARS, getting Army information is no problem but to say that I have met with small success in prying information from the other two services would be to understate the case! To be utterly candid, I have been met with silence. In spite of repeated phone calls and letters to those offices, requesting that I be placed on the mailing list of area bulletins, newsletters, etc., not one word has been received. Therefore I shall continue to concentrate on the information immediately available.

One thing *was* learned – if you write Navy-Marine Corps MARS at the address shown in the May issue of *73* Magazine – Bailey's Crossroads, VA, your letter will be returned marked "MOVED, LEFT NO FORWARDING ADDRESS!" That address was taken from the current MARS brochure, distributed by the three services. This year, Navy MARS had the responsibility for mailing out Certificates of Merit after Armed Forces Day. Hallelujah! Navy-Marine Corps MARS is alive and well! The return address was right there on the manila envelope! It is: *Chief, Navy-Marine Corps MARS, 4401 Massachusetts Ave. N.W., Washington, D.C. 20390, Mail Stop 394.* Shortly thereafter a very nice letter was received from the Michigan Navy MARS Coordinator Clayton Dewey, giving the same address so it must be official!

One other correction, Army MARS member AA3FMH writes from Germany that it was A3NFX who won the First Army Commander's Trophy rather than A3NFS. The typographical error is regretted.

The deluge of letters from 73 readers concerning MARS membership is very gratifying. I have been slaving over a hot typewriter in all available spare time, answering mail and sending out MARS brochures. Why do I spend all this time and effort? Simply because it is a labor of love! When you become a MARS member, you quickly discover that it's not just another organization – it's a way of life!

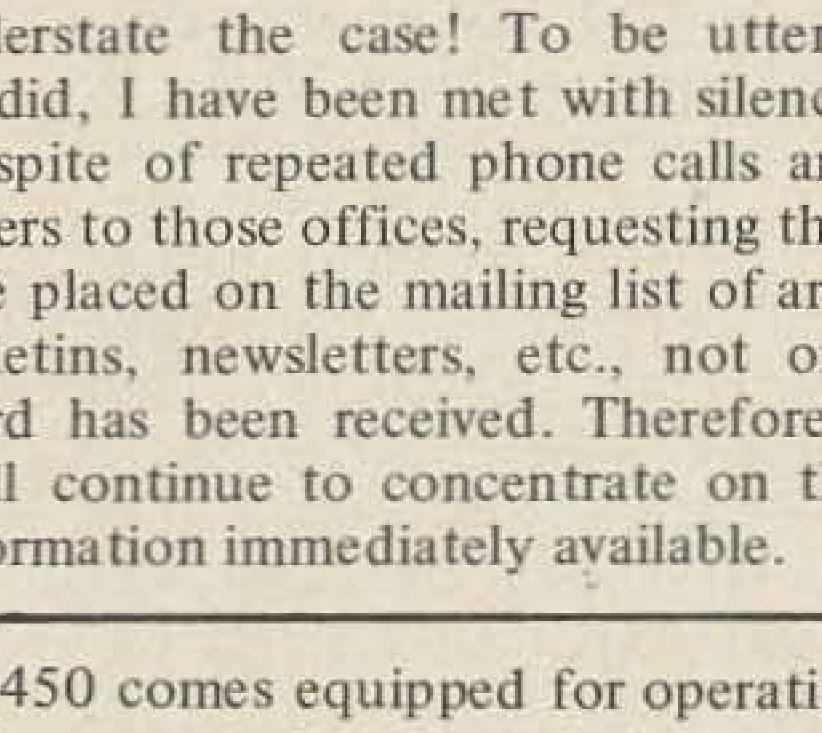
Here's a suggestion – if you are in the eastern portion of the nation, listen to one of the fine Pennsylvania Army MARS Nets on 4025 kHz from 6:00 to 7:00 AM EST each morning; tune in the Southern New England Training Net on 4020 kHz at 8:00 AM EST; if you are interested in radio teletype, listen Saturdays on 4035 kHz at 2:00 PM EST. If you live in the central portion of the nation, Third U.S. Army has an area-wide net Monday through Friday from 1:00 to 5:00 PM EST on 7358 kHz – always a very busy frequency. Other Third Army nets begin at 5:00 PM EST on 4001.5, 4020, 4025 and 4030 kHz, on a schedule too complex to explain in this space – suffice to say you can always find two Third Army Nets in operation between 5:00 and 11:00 PM EST. These frequencies are shared with the other Army areas, and when one net is finished, another Army area starts its own operation. The same frequencies are utilized in Sixth Army area – so you can always find some activity!

Better yet – make your plans to attend the Tennessee Army MARS meeting, to be held in conjunction with the Memphis Hamfest on September 17. I will see you there and gladly discuss any MARS matter. For a MARS brochure or other information contact me at:

Harry Simpson A4SCF
73 Magazine MARS Editor
Peterborough NH 03458

SB-450 comes equipped for operation with crystals for two of the twelve channels already installed. An attractive panel meter provides field strength information. For further information contact *Mr. David C. Thompson, Linear Systems, Inc., 220 Airport Boulevard, Watsonville CA 95076.*

SC-ATBE-1 TONE ENCODER



The SC-ATBE-1 tone burst encoder is a quality unit designed to compliment your Standard, or any other transceiver, for access to the various tone coded repeaters now in operation. It features the five most popular tones currently in use. These may be easily changed at any time for specialized applications. Superior stability employing quality mica capacitors. It comes complete with mounting hardware and connectors to make a neat, under the radio installation. For more information write: *Standard Communications Corp., Box 325, 639 North Marine Avenue, Wilmington CA 90744.*

HOT GEAR

Stolen early this year: 1) Home-built 2M rig built in a surplus .50 cal. ammo box. 1" diameter black meter with redrawn face in upper right corner; separate Xmit and Rcv oscillators, each with switchable channels. Built from components of RF-401 Series VHF Xcvrs. Has 13 internal nicad batteries. Box is brown except for aluminum plate on which oscillator switches are mounted. 2) Heath HW-100 Xcvr and AC power supply. Marks on top where a bracket was mounted. Also "WAØDAM Sooper Dooper Band Blaster" typed on Scotchtape above the S-meter. Information to Dave McFarland WA2JGP (ex-WAØDAM), 1074 Kenmore Avenue, Apt. 9, Buffalo NY 14216.

List from Past Issues:

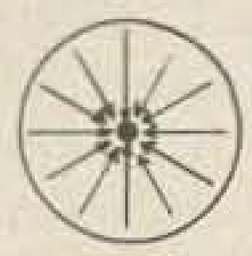
Mfr., Model, Ser. No.	Owner	Issue
Halli, SR46A, No.446100	WA1EMU	9/71
Reg., HR-2, No.04-03505	WA5BNM	11/71
Sonar, FM3601, No.1003	WB2ARM	11/71
Coll., 75A4, No.804	WØMGI	12/71
GE, Portable, No.1041218	K2AOQ	1/72
Coll., 75SE-B, No.15640	Col.St.U.	1/72
Coll, 21S3, No.12000	Col.St.U.	1/72
Coll., 516F1,No.1649	Col.St.U.	1/72
Simp. Mod-A, No.35457	W2PWG	1/72
SBE SB-33 No.103906	WA5JGU	2/72
Heath HW22A No.907-1835	W1BDX	2/72
Nat'l HR050 No.280019	WA5DQF	2/72
Halli., SR160 No.416000-108039	K9YVA	2/72
Drake TR3 No.3858	WA9EYL	2/72
Coll., KWM2A No 13815	ARRL HQ M. Godwin	2/72
Coll., 312B4 No.59920 Coll., 30L1 No. 40084 Coll. MPL No. 44507 Coll. MM1 (mob. mike) Misco minispkr.	Sgt. Hopkins Wilm. DE Police	2/72
Swan SW174 No. 416-5	WØAXT	2/72
Reg. HR2A No.04-05896	K4GBL	2/72
Heath SB102,No.132-128107	W.Singer Woodbridge VA 703,491-2257	3/72
Yaesu FT-101 No. 107036	WA2YSW	4/72
Standard 2m FM No. 102703	W6NPV	4/72
Drake ML2 No. 20189	WB2LLR	4/72
Standard SRC-806M No. 009210	K1TLP	5/72
Aerotone 6M 355LT, No. 685064	RR Police Grd.Ctrl.Trml. NYC	5/72
Standard SRC-806M, No. 102703	C. Mathias 3234 Coronado Ave Imperial Beach CA	5/72
Lafayette HA-410 No. 009210	WA2KDG	5/72
Coll., 62S1 No. 10728	MSU ARC E.Lansing MI	6/72
WRL Duo-Bndr 6010AT302	WA6FCY	6/72
HR-2A, 11 chan., 04-07152	WA1NVC	9/72
Swan Cygnet 270,No. 313022	K4ACJ	9/72
Collins Mic, Mod. MMs, No. 4294	K4ACJ	9/72

Microwaves

Amateur Microwave Question

WA600J: *"What is microstrip and stripline?*

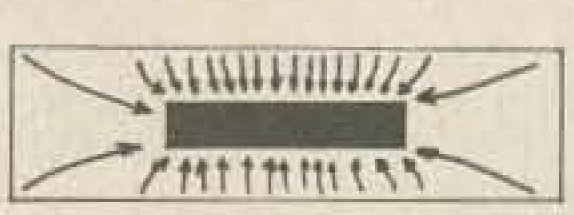
The answer to that question is reasonably simple. One day in the 1920's some enterprising amateurs took two different sizes of copper water pipe, cut some rubber supports, slid all three pieces together and, presto, the world's first coaxial transmission line. Later, manufacturers substituted woven braid for the outer copper pipe, polyethelyne for the rubber support, and solid center conductors for the inner copper pipe.



COAX

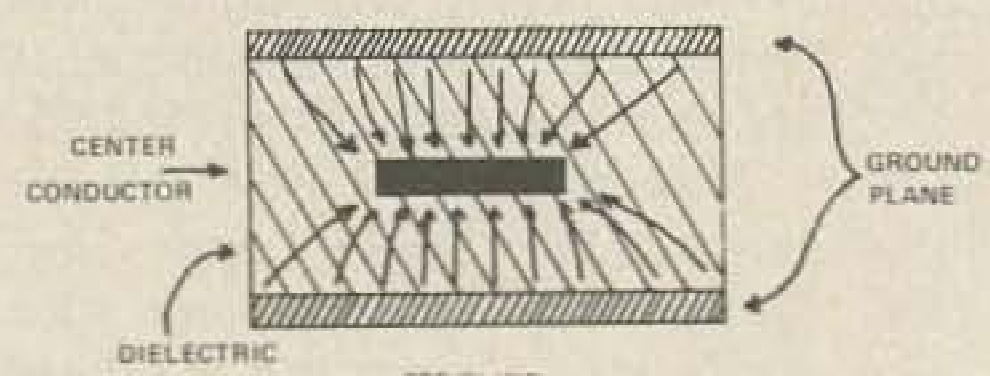
Then they sold millions of feet of this stuff by calling it "coax." We won't argue *why* electromagnetic waves propagate down this stuff, but we will note that the electric lines of force extend *from* the shield *to* the center conductor.

Later (in the '30s) some machinist with time on his hands made some big and small rectangular tubes and rectangular insulators, and, by fitting them together, made rectangular coax. By careful measurement, they found that almost all the electric force lines were crowded in the center, in the narrow gap between the center bar and the closest point on the outer tube (shield). This piece of information was duly noted and forgotten about, because all the engineers and scientists suddenly had their hands full with radar and WW II.



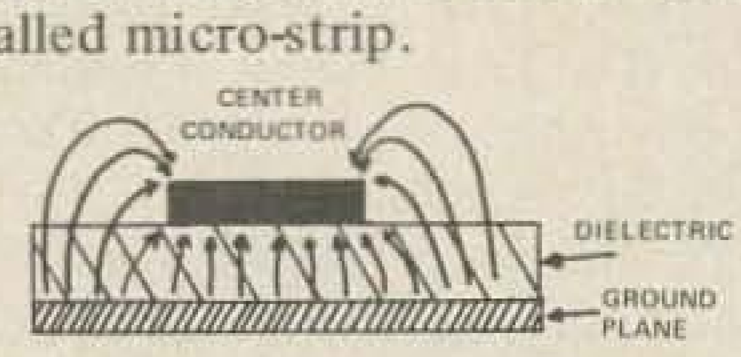
After this war, and the Korea thing, some mention was made of space travel. Now, scientists, engineers, and amateurs (e.g. "OSCAR") were all looking for a way to make microwave printed circuits. Someone remembered this rectangular thing and said this: suppose we make the rectangle thinner and longer, so that the ends have almost no effect on the electric lines. Then let's take away the end plates.

Let us then take two pices of double-clad p.c. board and etch our center conductor on one piece. Now, this "etched" side of the board makes our center conductor, the fiberglass or phenolic becomes the dielectric, and the copper "backing" becomes the outer conductor. This, they said, is a coaxial line in strip form, or strip-line. The impedance of the line could be varied by etching the line wide or narrow; the "sandwich" could be made small by choosing the dielectric as thin as desired. Several refinements have been made to this strip-line. Teflon® fiberglass was found to be one of the best dielectrics, and this board material is now commercially available. Impedance curves, filter design charts, and matching section curves were generated using this double-board approach to microwave circuit design.



STRIPLINE

Then along comes some crazy guy who wonders, what happens if you take away one of the ground planes? Will it still work? Fortunately for the world of science, yes, it will work, and it is called micro-strip.

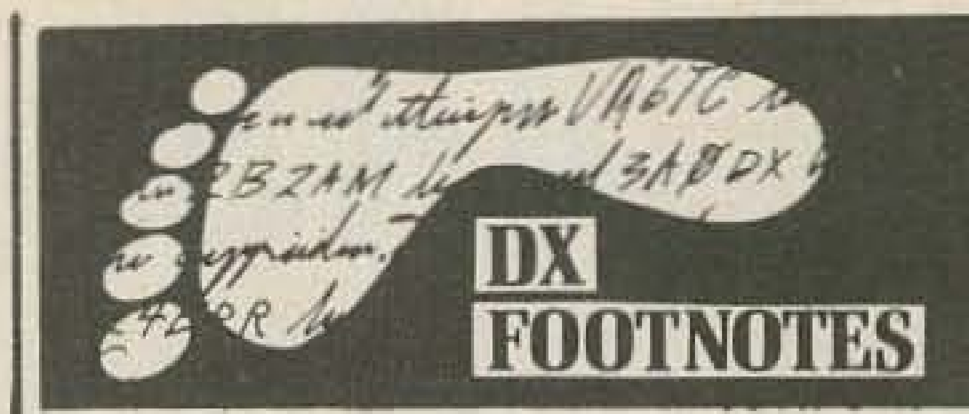


Once again, design curves were generated to make microwave circuits on this type of construction. Then, as different dielectrics were tried, it became apparent that over a 10:1 reduction in circuit size was possible for some of the high dielectric ($E \approx 200$) titanium dioxide type of dielectrics. For some critical space applications, solid sapphire ($E = 9.5$) has been used as the dielectric.

In short, if you take round coax and make it rectangular, you stil have a transmission line. If you take away the side ground planes you have stripline transmission line. If you take away the top cover of strip transmission line, you have microstrip transmission line.

If you have any questions or comments about microwaves, drop me a line.

Jim Weir WB6BHI
Box 23233
San Diego CA 92123



DX FOOTNOTES

Station YV-5-DZZ will grant a certificate to each amateur in each city and in each band for the first QSO contact with VY-5-DZZ or YV-5-DZY. YV-5-DZZ or VY-5-DZY can be worked every day on the following frequencies: 14,300 at 1100 to 1200 GMT, 21,252 at 1600 to 1700 GMT, and 14,150 at 2300 to 2400 GMT. Any amateur who desires this certificate should send a confirmed QSL and either \$1.00 or 5 IRC to Francisco Reyes Viada, P.O. Box 517, Barquisimete, Venezuela.

* * *

VQ9FOS Amateur Radio Station will be operating from Mahe during the period Oct. 2–5, 1972 inclusive, as part of the Island's festivities.

Contacts will be offered on 10, 15 & 20 continuously throughout the period, and other bands by arrangement.

A Festival of Seychelles QSL card will be sent to all contacts and your return QSL card should be sent to: Hon. Secretary, Di. Cardell, VQ9DC, Amateur Radio Exhibition, P.O. Box 321, Mahe, Seychelles.

* * *

In response to an inquiry by Senator Goldwater, Chairman Burch of the FCC indicates concurrence with the view that there is minimal AM operation now on the 80 through 15 meter bands and that it might be a good idea to phase out AM by an amendment of the rules. This has been forseen as a forthcoming development by many influential amateurs for quite some time and everybody should be prepared to make their position known to their Directors if and when the commission comes out with a proposed rulemaking. There are potent arguments both pro and con on the subject and it is a step which should be taken without full consideration of every phase of the matter.

Equipment at A5IKV.

A5ITY, Radha XYL of A5IKV and A5IKV at Thimphu.

The above photos show the people involved and the equipment used in the operation of A5IKV, the DXpedition to Bhutan by Venkat, VI2KV.

SSTV SCENE

Dave Ingram K4TWJ
Rte. 11, Box 499, Eastwood Vil. 50N
Birmingham AL 35210

The real enjoyment of Slow Scan is being actively involved in both operating and building gear. This way you can add the little "goodies" you in particular desire, and possibly in the process stumble upon ideas to further the state of the art. Remember, Slow Scan is one field in which advancement can still be made on an individual amateur basis.

In the same manner spark gap paved the way for CW, and AM for SSB, Slow Scan may be the forerunner to communication facilities of the future. Ever heard of Holography? A three dimensional picture accomplished without lens. The Hologram is reproduced, presently, in a box. The viewer can look above, below and around the image. In fact, you can see as many angles of the object as the viewing windows of the box allows. One can conceivably visualize a system, for example, of color Slow Scan Holography analysis, transmission, and synthesis, where a heart bank in, say Chicago, analyzes a donated human heart and transmits a form of Hologram to, maybe a hospital in London, where an open heart surgery operation is in progress. The synthesized heart is reconstructed in free space (in the future) right above the patient so the surgeons have a guide they can look above, around, and under. The doctor in Chicago can display any sector at will, thus guiding the operation perfectly.

This is well within the realm of possibility and there are rumors of a way around the necessary monochromatic, coherent light (Laser beam) have been uncovered. Light emitting swept diodes? Special phosphor crt? Gee, the latter 1970's and the 1980's are going to be exciting. If slow scan research and communication technology advancements are your bag, check into ideas like Holography. Some companies, for example, like Edmund Scientific Co., 300 Edscorp Bldg, Barrington NJ 08007, have a full line of books and gear that are a "gold mine" for experimenters.

The slow scan directories are out and going like mad. If you haven't latched onto a copy yet, contact Robot Research, or an authorized dealer. The directories are quite nice. Although they list well over 500 active slow scanners, this number has practically doubled since printing started on the book. Some growth, huh?

Photo from KH6HJF received by K3SLJ.

The flying spot scanner article by Taggart in July *73* is destined to be a classic. Already there are many of these units in service. The generator is also used in other gear; the Plumbicon camera, I1LCF flying spot scanner, and another article to be published. If you are looking for a really great snyc generator check this one out. It's a winner.

The boys' "down under" are quite busy on Slow Scan these days. Among the most active are: VK's 2BRA, 2GR, 3ARM, 3LM, 3ARD, 3AMC, 3TE, 4NP, 4XV, 5BX, 5MF, 6ES, 6CS, 7JV, 7TB, 8KK, and 8CW. ZL population consists of ZL1DW, 1AOY, 4MB and 4CU. A good many of these are not listed in the directory, so you might want to write in their calls. You can feel sure if you drag them out of a pile-up, they will be glad to swap pix. Most VK/ZL activity is on 14.230 and 28.680 MHz. Weekly net meets on Sundays, 0100 GMT. I understand a company in Melbourne has invented a new phosphor, designated P26, which can even be viewed in bright sunlight. They re-phosphor and re-gun CR tubes for a reasonable sum. I am still checking into this and will give you more information later.

If you would like to really dress up that home brew monitor, take a look at the bezels made by Millen. Designated 80073, for 3 inch tubes and 80075 for 5 inch tubes these two piece units really give a professional appearance to any monitor.

Al WØDRT (St. Louis) as seen by K3SLJ.

The most popular method of operating slow scan is to run audio and video consecutively, thus gaining the advantage of watching the pictures closely, then talking about them. But this is not the only method. Some of the fellows have run audio and video simultaneously – audio on one sideband and video on the other. Another less elaborate method is to run the audio 10 to 15 dB below the pictures (it sounds like a weak station in the background). There are any number of simple ways to mix two audio sources, from 3 resistors (like I use) to a ten dollar mike mixer, so I will not go in to circuit details here. All you

W6EYY identification as received by K3SLJ.

need is to have another slow scanner watch your pictures, while you lower your mike level. As soon as your audio drops out of "picture interference" you have all adjusted fine. Then the front end of the monitor will get the video, and you can still be heard talking "down under" the slow scan signal.

Jane, ten day old daughter of Bill Arrasmith W6TEZ as seen in PA by K3SLJ.

Slow Scan on FM? Fine, closed circuit! Through repeaters? Sure, I checked into this months ago. A SSTV signal is no more than an audio signal. Deviation is the same as voice. If the repeater is within deviation limits, so is the slow scan. If an excessive audio level of slow scan is introduced into a repeater, it merely goes into clipping. And two is fine for Slow Scan experimenting.

. . .K4TWJ

SOCIAL EVENTS and CONTESTS

The Hilton Inn at Tarrytown, New York, will be the site of the 1972 ARRL Hudson Division Convention on October 21 and 22. There will be exhibits, lectures and a banquet. Technical experts will be on hand to explain the latest gear. Registration is $3.00 and is required for forum attendance and special events. Banquet tickets are $10.00 in advance, or $12.00 at the door. There are free gifts to early registrants. To register or for more information contact Dave Popkin, WA2CCF, 303 Tenafly Road, Eaglewood NJ 07631.

The Pony Express award is available to all amateurs who make contact with five St. Joseph, Missouri operators. General and above can look for contact individually or on the CHC-FHC Service Net on 3943 kHz about 0200 GMT. At present there are only six Novice operators who are active. Novices wanting this award can look for WNØHNO WNØDPS, WNØDNE, WNØDNC, WHØHEF and WNØGGD on the following frequencies: 3710, 27120, 37130, 7158, 7166, 7168, 7170, 7176, 7180, 7186, 21110, 21120, 21132, 21150, 21170, 21177, 21180, 21200, 21220 and 21240.

The MOUNT AIRY VHF RADIO CLUB, Inc. presents the first annual Pack Rat Hamarama, Sunday October 1, 1972, at the Warwick Fire Co., Jamison Pa. The Warwick Fire Co. is located on Rt. 263 above Willow Grove and is easily accessible from Rts. 309, 202, 611, 132 and the Pa. Turnpike. Activities include a giant flea market, auction and an amateur TV demonstration by the leading local ATV'ers. Festivities begin at 10 AM. Food concession on premises. Registration is $1.00, flea market tables or tailgate sales, $2.00. Talk in on 146.94 and 52.525. For further information contact W3ZD at 520 Centennial Rd., Warminster, Pa. 18974.

The 10th Annual Greater Bay Area HAMFEST will be held at the Royal Coach Inn, just off the Bay Shore Freeway, on October 14th and 15th. For further information contact Veikke West, K6ORP, Box 751, San Mateo CA 94401.

The Quarter Century Wireless Association, Inc. will hold its 25th annual dinner meeting at 7:00 PM, Saturday, October 14, at the Twin Bridges Mariott, located on Route 1 I-95 in Washington, D.C. Senator Barry Goldwater will present the Fifty Year Awards. The guest speaker will be the Hon. Dean Burch, Chairman of the FCC. For further information contact A.J. Gironda, W2JE, Box 394, Mamaroneck NY 10543.

The Moosehorn Amateur Radio Club of the Kenai Peninsula is offering the All Alaska Counties Award. The rules are as follows: Applicant must work one station in each of the four judicial districts plus one member of the Moosehorn Amateur Radio Club. Each two-way contact must be confirmed by QSL card. QSL cards plus return postage are to be sent to Moosehorn Amateur Radio Club, Box 733, Soldotna, Alaska 99669. All contacts must be dated May, 1972, or later.

SCIENCE HALL OFFERS CLASSES IN HAM RADIO

The Hall of Science of the City of New York will conduct a series of twelve instructional and practice sessions for teens and adults in Amateur Radio beginning September 30 at the Hall, 111th Street and 48th Ave., Flushing Meadows Corona Park.

Course for the Novice, Technician, General and Advanced class FCC Amateur Radio licenses will be presented, with all courses scheduled from 10 AM to 12 noon and repeated from 1 PM to 3 PM on consecutive Saturdays.

There is a registration fee of $5.00 and a nominal charge for text books and code practice equipment for participants who require these materials. For further information and to obtain registration form, write or phone *Hall of Science, P.O. Box 1032, Flushing NY 11352 (212-699-9400.*

50 MHz BAND

Bill Turner WAØABI
5 Chestnut Court
St. Peters MO 63376

Andy, VE1ASJ, was much more successful on his second attempt at a DXpedition to Prince Edward Island. The rig held together this time allowing 119 contacts to be made. Best DX heard was WA6JRA, unfortunately no contact was made. Utah and Wyoming were the best DX worked. Jim, W7VDZ, made the grade while VE1ASJ was using 30 feet of wire attached to a dead tree, the regular antenna was a 6 element. Andy has a KW linear in the works which should be on the air shortly. Andy would like to make some contacts on CW in the 50 wpm bracket. Any takers may write him at P.O. Box 51, St. John, New Brunswick.

WA1EXN, Art, says, "I worked W7VDZ for state number 44 . . . also called by K7ICW (I gave him number 50 last year); nice to talk to Al again . . . have heard all the states I need this year but Montana and Hawaii."

Randy, WB4LHF, is on every Sunday evening (0100Z) looking for groundwave, scatter or whatever happens to show up on 50.110. At the same time and day you might look for the North Carolina sideband net on 50.120. Any other six meter nets around?

Earlier this summer I was in QSO with a station in the Northeast who repeatedly wondered aloud if he were being copied. Repeated assurances that his signal was running 20 over 9 didn't ease his mind, his plate current and SWR bridge told him his output was down rather drastically. A few days ago a local ham had occasion to measure the output of his exciter and linear with a borrowed Drake WV-4 wattmeter. To his surprise, the exciter (rated at 180 watts input) measured only 10 watts and the linear (with tubes totaling 750 watts plate dissipation) was putting out only 200 watts. His signal reports from both local and skip contacts had given no indication of this condition. Both the above situations point out the futility of cranking up the MIC gain or repeatedly retuning in order to get a few extra watts output. If you were, for example, running 100 watts output and being received at some distant point at "S9," then your output decreased to 6¼ watts, the net loss in signal strength would be only 2 "S" units. By the same token, if you were being received at "S2" with 100 watts output, an increase to 125 watts would not be discernible and an increase to 400 watts would be necessary to bring your signal up to "S3." From the above it should be clear that any attempt to wring the last watt out of your equipment can result only in splatter, QRM, and hard feelings – not more or better contacts. Higher power is fine, it helps when working groundwave and scatter, it even has a place during skip, just make sure your equipment is designed for the power level in use . . . or a little more.

. . .WAØABI

LETTERS

After working at a TV station for the summer, I have a suggestion for "ham publicity." I have found that even in Rochester (I would assume it is in the top 100 market), there are a number of PSA's (public service announcement), especially in syndicated shows (Star Trek, etc.), which local stations buy and show themselves. These PSA's are picked at random from a supply of PSA's. I presume the showing of PSA's is free as they have nothing better to put there. The PSA's cover a wide range (public libraries, CAP, Army, U.S. Depts., Catholic services, etc.) and I think that amateur radio would fit in well. The best subject would probably be emergency preparedness, but other subjects could easily be used. Near the end we could put an address to contact for further information (such as ARRL) or the phone of a local radio or TV station (there are usually a few amateurs on the staff).

The best lengths for such films would be 60 sec. and 30 sec., however an "oddball" length like 40 sec. might work too.

The project seems a natural for the ARRL, however I mention it to you for your comments and suggestions.

Daniel Kinsella WA2JHF
Rochester NY

Yes, I always have and always will.
Yes, I always have and always will.
Yes, I always have and always will.
(love you)

P.S. I resubscribed

A Resubscriber

As in the "Sorcerer's Apprentice," How Do I Shut It Off? . . . the letters I mean. As a result of my offer to supply transistors to the needy or remotely located – 2 Buck •Gen – August issue, I've sent out almost 250 pieces and have run out. Never believed that many people would be interested. Received another 11 letters today and am substituting the PNP counterpart which only requires battery reversal but I'm afraid my writing arm and envelope licking tongue will not last the 30 days promised – not to mention the transistor supply.

There is sure going to be a lot of QRP 2m FM flying through the air.

I worked 4 blocks into TV channel 13 sound 215.7 MHz with the circuit using a 1X1X1 loop and 1.5–15 pF, so I guess you could say there is 220 MHz activity in Kentucky – almost A⊦A1.

Walt Pinner WB4MYL

As a new Novice who also was frustrated over being able to copy only CW on my HW-16, I am now a bit happier. I performed the simple modification as shown in your August 1972 edition for HW-16's to decrease the selectivity, thus making it possible to copy AM/SSB/and foreign BC on 40m. I enjoy it as a change of listening, and it makes copying after a CQ a bit easier.

The only problem is it does result in a little extra "pop" when the key is released, due to picking up the collapsing CW signal. Solid state TR switching is the drawback there.

Keep up the MARS articles. I am a sergeant in the U.S.A.F.

Bill Armstrong WN8NKT/4
Sumter SC

The article on page 119 of the August issue entitled "FM Adapter" was of considerable interest since I am slope detecting FM signals in a communications receiver with a crystal controlled converter ahead of it. However, after reading the article and studying the schematic, I concluded that I wouldn't build the adapter on a bet. Following are the errors I have found so far in this article:

1. Page 119, first line of text – "F" left off of "Frequency."
2. Page 120, schematic:
   2.1 "J1 455 kHz INPUT" designation is confusing placed in front of the input connector ground side contact.
   2.2 Transformer T3, capacitor C10, and the "TUNE" position of switch S2 are not labeled.
   2.3 The V6b designation is adjacent to the lower section.
   2.4 The regulated 150 volt bus is tied to the 2.5 volt AGC delay voltage bus instead of the bottom of R25.
   2.5 The grid pin (1) and the plate pin (2) of V6b should be tied together as this section works as a diode.
3. Page 121, parts list – R24 is a 100,000 ohm resistor, not 1000,000 ohms.
4. Page 122, The sentence "It should be noted that the bandwidth at the receiver output jack is governed by shorting plug can be applied to the output jack when the FM adapter is not in use." is an extra collection of garbled words.
5. Page 123, – Reference 7. Handbook Preferred Circuits, NAVWEPS 16-1-519, (etc.) is NAVAER 16-1-519.

I am going to file the article until all the errata is in, and then will undoubtedly build the adapter. Am sort of disappointed in your proofreading.

Harold S. Eisley WA3SPD/W3NET
Saint Marys City MD

Picky,picky!

Received your proof (New Products, September) and have one correction. Frequency stability of the GLB Model 400B Channelizer is .0005%.

We will have a 5 kHz adapter modification for the Channelizer late this fall.

Bernie Sanders, Sales Manager
GLB Electronics
So. Cheektowaga NY

Enclosed please find my check for a subscription to *73*. After 14 years of interest in amateur radio I finally got my ticket. I was out of touch with the hobby from 1965 to 1972 and was amazed to find all of the changes that have taken place during that time. What I can't believe is the "leadership" provided by the ARRL during this period, despite their motto. To catch up on all the recent developments, I borrowed the back issues of *73* from the library of Dean Metzgar, WB4KAN/3, who also filled in the gaps with a pretty thorough history of what has been happening.

I think what the ARRL needs is a communications system which would *require* each of the section communications managers to report to headquarters two months before every directors' meeting, and also report whenever any major issue should be handled by the league. The SCM's should get opinions on all issues from the amateurs in his area. HQ would then be *required* to compile the 74 reports it receives and the information contained therein would be *required* to be presented at the board meeting.

The real problem in the ARRL is the fact that HQ decides what is good for amateur radio without consulting the amateurs. It all boils down to a "failure to communicate." Maybe they could use some of the league's money to institute a survey system whereby league members would be sent a questionnaire at least every 4 months. Something must be done.

Keep up the good work you've been doing by offering constructive criticism in your editorials, however direct and pointed it might be. You have created the finest amateur radio magazine around. Congratulations, OM.

I just heard from a local ARRL man that the ARRL is going to claim full credit for the development of 2m FM! What a farce!

Herb Brasington WA3TDI

Although it's rather far downstream by now, the article on revising the Morse Code in your November 71 issue has a lot going for it. The author has done a lot of thinking, and certainly from a time-and-motion standpoint is right on.

The chances of getting this done are, alas, very slim. It's the old story – it's easier to walk in the same old rut than to climb out and blaze a new trail. How long have proponents tried to get the U.S. to adopt the Metric System?

Many hams use a typewriter – I wonder how many ever heard about the existence of a superior keyboard, the Dvorak Simplified Keyboard? Its proponents have been trying to get this keyboard adopted by industry and government since 1944, with only sporadic success in getting anyone to listen to them. (I've used this keyboard since 1965, Wayne, and it's great.) It has the same logic and reason and time-and-motion efficiency as the Morse Code proposal. But . . . like all logical and reasonable proposals, this too must await the day when men begin to reason together.

On the basis of bandwidth, the International Code (which is really what the author is talking about, not "Morse") is not yet obsolete, and will be around for a long, long while. I have been a 55-wpm operator (ex-Navy) of International, and 35-wpm Morse (landline) op. Naturally, the code is nostalgic for me, but with great effort to separate the emotional from the rational, I'd be delighted to learn a revised signaling code if it would be as well designed as the new typewriter keyboard. I don't agree with the author's new system, but I applaud his reasoning.

W. Boyd
Geyersville CA 95441

Two meter FM does it again. Through the WA7KZC repeater located on Sherman Hill near Laramie, Wyoming, Chimney Park Scout Camp for the first time, enjoyed two way communication with the outside world.

WA7JYO, his XYL WA7SOH and junior op WA7SUL provided communication between the camp site and camp headquarters. WA7SQJ the junior op's grandmother, operated the town site to complete the family team and communication link.

Wilma E. Hirst, Ed.D. WA7SQJ
Gheyenne WY 82001

I've been reading the 73 License Study Guides – Congratulations on putting out such well written books. I let my license expire while I was away in college back in 1962, but I am again getting very interested in ham radio, especially SSTV.

I remember trying to learn radio from the manuals available back in the 1950's and wondering why anyone would want to write the English language in that fashion. Since that time, with exposure to IBM manuals and Air Force Tech data, I have learned that obscurity and circular definitions are the height of fashion among technical writers. So, thanks for the thought and time involved in putting out such lucid and enjoyable books.

Bert Mayo
Middletown CT

Well, the military can be a real drag, even in London, especially with rising costs and tourist traps within the United Kingdom. However, wherever an amateur goes, whether he is sent on his own volition or otherwise, life can be very interesting. Thank you amateur and thank you *73*. There are plenty of G5 call signs left I am told from the Ministry of Posts and Telecommunications at Waterloo and the price for a year's enjoyment is still the meager sum of three pounds. Even with the monetary crisis the way it is today, it works out to be $7.80. In addition, no renewal applications are necessary. After about two hours and seven phone calls through British red tape and an apparent language barrier between American English and English English, I've found that all they want is for the Anglo-American ham to send the money . . . renewal is taken from there as I understand it.

One might ask what reception is like on this island of islands. The answer I'm afraid has to be that you can work and indeed hear all the Italian stations you wish and perhaps more than you wish. Filters for this human QRM have yet to be developed. Perhaps in this case Johnson Island would have been a better assignment for a ham DXer.

Norman N. North WA1DBR/G5ATR
South Ruislip, England

The comment in the July issue of *73* on FCC harassment of hams, is I feel, grossly unfair to the vast majority of the FCC staff that I have come in contact with in about 37 years plus of amateur, mobile, marine and broadcasting experience.

Like the rest of us, there are some bad people working for the FCC, but there are also and have been many darned nice men that I have had contact with, and it has been my experience that if you are in the wrong, then they will issue the citation, but if it is a grey area, the vast majority are willing to accept the doubt, with just a caution, and suggestion to correct the questionable practice.

Also, as the laws are written by lawyers, different individuals can read different meanings into them, and as a result the individual FCC staffer may interpret them differently, although they do have a guideline for inspections, it still falls to the individual to make an on-the-spot decision if something is right or wrong. I do not envy them this.

There are generally about 20 to 30 DB citations and fines issued each week according to FCC public notices, with just a sprinkling of hams, at the most two or three, and most are for operating on wrong frequencies, or failure to properly identify themselves.

The one thing that has bothered me is the FCC phrase, "For repeated violation of . . . " Apparently once is just a violation, but twice is repeated, even as in amateur radio it takes place, let us say, within seconds, like two transmissions, while if it had continued as a single transmission it would have been only one violation . . . This is again the word against the action.

George W. Brooks W2GX
Newburgh NY

Here's one that might possibly be worth a hint or kink or oddity or something or other. Our small lab has a number of bench power supplies but we are constantly needing another 5 volt supply – and one that can stand a bit of abuse or carelessness, so we have placed several of National's 309K regulators on flat heat sinks with four small rubber feet that we find extremely useful. We punch out holes in the sinks, cut a hole in plastic tape slightly smaller than the stake-ins we use, place the tape on the sink covering the stamped hole, center the stake-in in the hole and fill with epoxy and let set. Then when we need five volts we just strap it across any of the available power supplies between nine and about 38 volts and have a 5 volt current limited power supply. We have a high current regulated supply of 12 volts that can get a bit nasty if you get a bit careless with shorts. I have a small screw driver that is being used now as a scriber to testify to that fact. They are easy to store and provide an instant 5 volt supply when needed. We also have the same units in several other voltages that we use the same way.

73 and congratulations on the continued excellence of *73*.

C.W. Pate
Bryte CA

I am an ARRL life member. This is addressed to all ARRL members, as well as to you to ask for your help in a matter that has been troubling me since last November. That month a guest editorial supporting the ARRL – actually a letter printed as an editorial – by James Russell, W8BU of Cleveland, appeared on page 77 of *QST*. Mr. Russell did a very unfortunate thing in that letter – he owed how we oughtn't only chastise ARRL for its shortcomings, but how we should also stand behind it as the best hope for a strong, viable amateur radio. This would've been fine except that Mr. Russell used the case of a young Cleveland welfare recipient to support his argument. Quoting from the Cleveland 'Press,' Mr. Russell let us know that the young girl con-

(Continued on page 122)

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FREQUENCY SYNTHESIZER for 2 METER FM

Part II

Last month we started describing our frequency synthesizer and gave the parts list. This month we will show all the diagrams and describe how it works, and next month we will have the printed circuit board layout, parts layout drawings, and construction and operation information.

Figures 2 thru 12 show the diagrams of the various parts of the synthesizer. To see how these parts fit together refer back to Fig. 1, the block diagram, in last month's article.

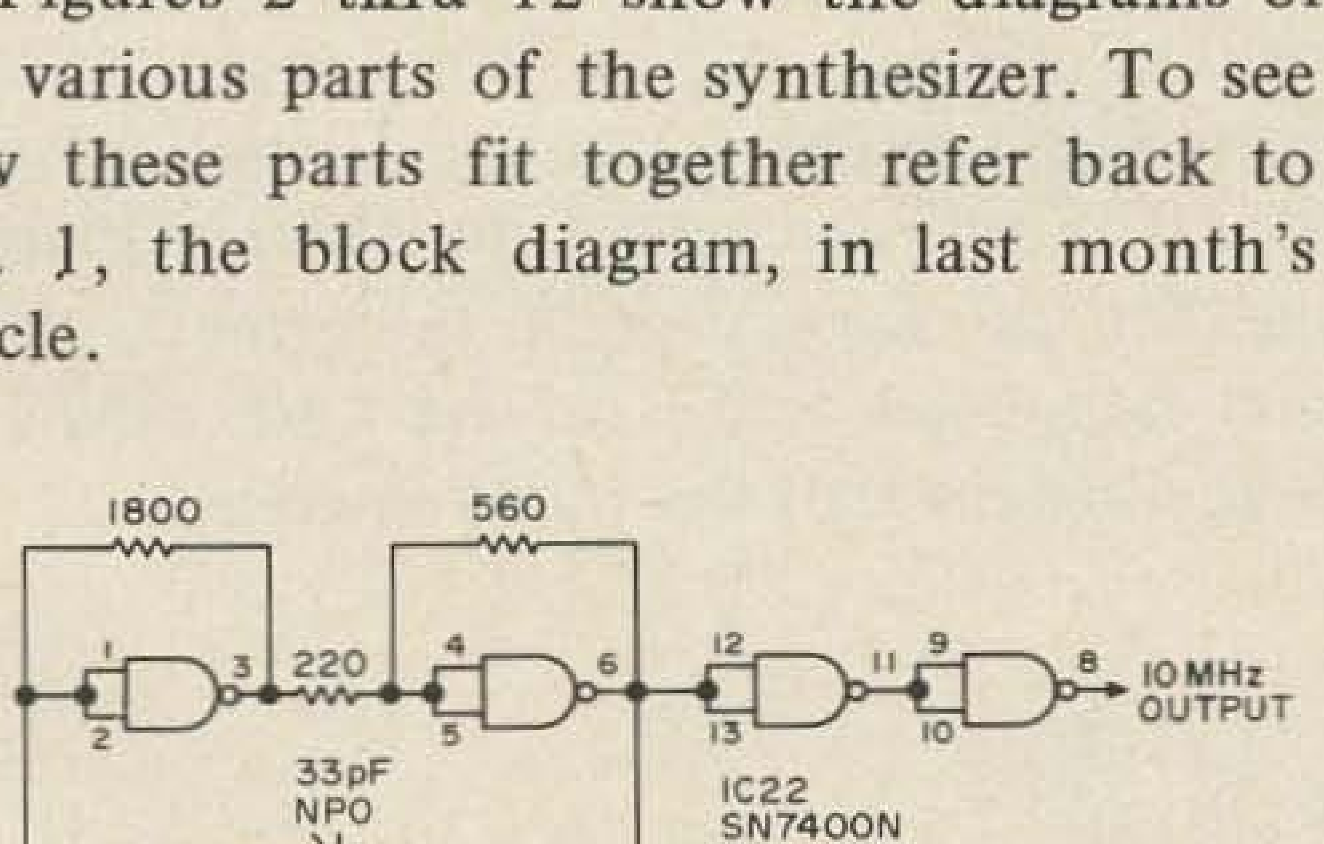


Fig. 2. 10 MHz crystal oscillator.

10 MHz Crystal Oscillator (Fig. 2)

The basic reference for the synthesizer is an AT-cut series resonant 10 MHz crystal in a simple circuit using the four gates from an SN7400N IC. This is a fairly simple circuit which is stable enough for the prupose. If you want the utmost stability, though, you may want to put the entire circuit into an oven. The crystal oscillator circuit is mounted at the very edge of the p.c. board, and so is easily removed later, if you want. But we haven't found this necessary so far.

Reference Frequency Divider (Fig. 3)

This frequency divider takes the 10 MHz signal from the crystal oscillator and divides it down into the reference frequency needed

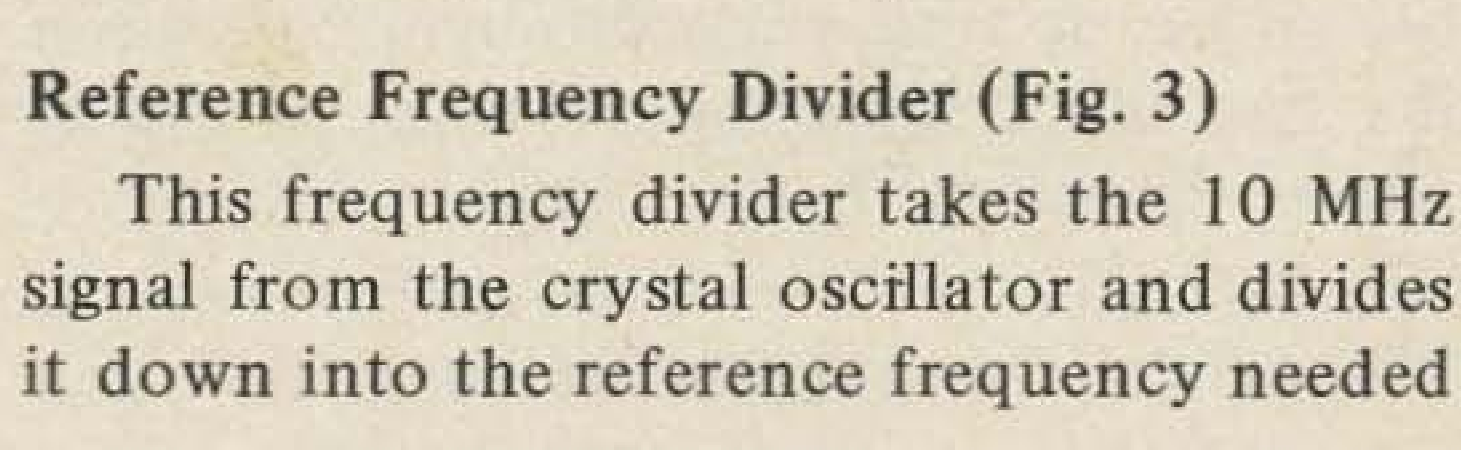


Fig. 3. Reference frequency divider. Notes: 1. All ICs shown have +5V to pin 5, and ground to pins 2, 3, 6, 7, and 10; 2. IC18 type and wiring depends on desired synthesizer output frequency as follows:

Synthesizer Output Freq.	IC18 Data Type	Divides by	Output Pin	Output Freq (Hz) from IC18	from IC17
6 MHz	SN7493N	8	11(D)	2500	208-1/3
8 MHz	SN7492N	6	8(D)	3333-1/3	277-7/9
12 MHz	SN7493N	4	8(C)	5000	416-2/3

by the phase comparator. In our version, which provides 6 MHz output, the reference frequency divider provides a reference frequency of 208-1/3 Hz. For a synthesizer output of 8 MHz, the reference would be 277-7/9 Hz, and for a 12 MHz output the reference would be 416-2/3 Hz. The division from 10 MHz down to these frequencies is done by five IC's. The note at the bottom of Fig. 3 tells the differences in hookup for the three different circuits.

Phase Comparator (Fig. 4)

The reference frequency and the output from the programmable divider both go into the phase comparator, where they are compared. If there is any difference in the two, a control voltage to the VCO changes the VCO frequency to bring it back to the right frequency.

We tried many circuits before coming up with the one in Fig. 4. There are several integrated circuits specially designed for phase-locked-loop applications, and we tried them all. Signetics makes a series of phase-locked-loop IC's which contain the phase detector, several amplifiers, and the VCO all in one, but we found the performance unsatisfactory. Likewise, Motorola makes a phase comparator IC which also did not work out well. An "exclusive-OR" circuit made out of an SN7400N gate package was also disappointing. In each case, the problem is that the output of the phase comparator has to be a pure dc voltage proportional to the phase or frequency difference between the two input signals, while each of the IC phase detectors has a large amount of feed-through of the input pulse signals. While the IC manufacturers claim that you can get rid of these pulses with heavy filtering, that does not quite result in a clean enough output. In our circuit we have managed to eliminate all traces of the input pulses on the output line.

The reference frequency input into the phase comparator is a square wave which is applied to an integrator circuit consisting of the 1K resistor and 1 μF capacitor. These two components shape the square wave into a somewhat distorted triangular wave with curved edges, which is then applied to the source of an MFE 3002 FET. This is an enhancement-type MOSFET which acts like a very fast switch.

At the same time, the output from the programmable divider is applied to the base of Q3. The signal coming in is a series of very narrow pulses (on the order of a tenth of a microsecond wide) whose repetition rate is equal to the reference frequency (when the synthesizer is operating normally). The .001 capacitor in the collector circuit of Q3 widens these pulses to about a microsecond wide, so that the output of Q4 are wider pulses. Between pulses, the output of Q4 is about zero volts, and each pulse goes up to about +12 volts.

These positive-going pulses are connected to the gate of Q1. Q1 forms what is called a "sample-and-hold" circuit. When its gate is held around zero volts (between the pulses from Q4) Q1 acts like an open switch. But during the 1 μS wide pulses, when the gate of Q1 is at +12 volts, Q1 acts like a closed switch. Hence, for a very short instant during each pulse, Q1 connects the 1 μF and the 0.1 μF capacitors together, charging the 0.1 μF capacitor to the exact voltage that happened to be on the 1 μF capacitor at the instant that the pulse occurred.

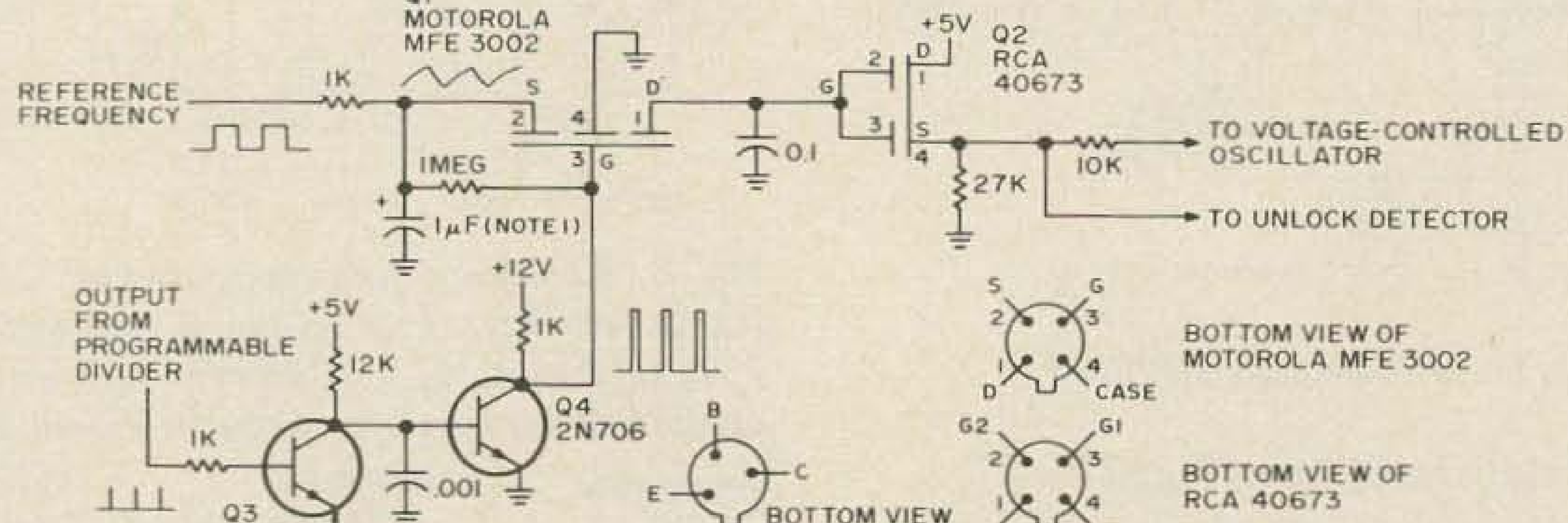


Fig. 4. Phase (and frequency) comparator. Notes: For 8 MHz, change to .75 µF, for 12 MHz change to 5 µF.

If the pulse frequency out of the programmable divider is exactly the same as the reference frequency, then the pulses always occur at the same time in relation to the triangular wave; in that case the voltage across the 0.1 μF capacitor will always be the same, since the FET switch will always sample the same part of the triangular wave. But if the two frequencies are not the same – so that the pulses occur either more often or less often – then the FET switch will sample different parts of the triangular wave, and the voltage across the 0.1 μF capacitor will change.

The output of the 0.1 μF capacitor is connected to a source-follower, using an RCA dual-gate-protected MOSFET, the 40673. The source-follower is very similar to a cathode follower, and provides a very high input resistance to the 0.1 μF capacitor. The purpose here is to monitor the voltage across the 0.1 μF capacitor without loading it down, so that the voltage across the capacitor stays constant even between successive input samplings – this is what is meant by "sample-and-hold." The output from the source-follower is then sent to the unlock detector and to the VCO.

As pointed out earlier, the output from the phase detector is a constant dc voltage when the synthesizer is operating normally. This dc voltage is in the range of about 1.9 to 4.4 volts, and is used to control the frequency of the VCO. Under normal operation, we say the loop is locked on the reference signal. But if the phase detector output is changing, that means that the two inputs into the phase detector were not the same frequency, and thus the VCO frequency is changing. Under these conditions we say that the loop is not locked, and the unlock detector senses this by seeing that the output of the detector is a changing voltage.

Voltage-Controlled-Oscillator (Fig. 5)

The VCO is another tricky part of the system and we must confess that we are not quite happy with this one yet. The heart of the VCO is a Motorola MC1648P ECL oscillator IC, which uses L1 and C1 to set its frequency. The output of the IC is amplified and conditioned by a 2N5771 transistor, and

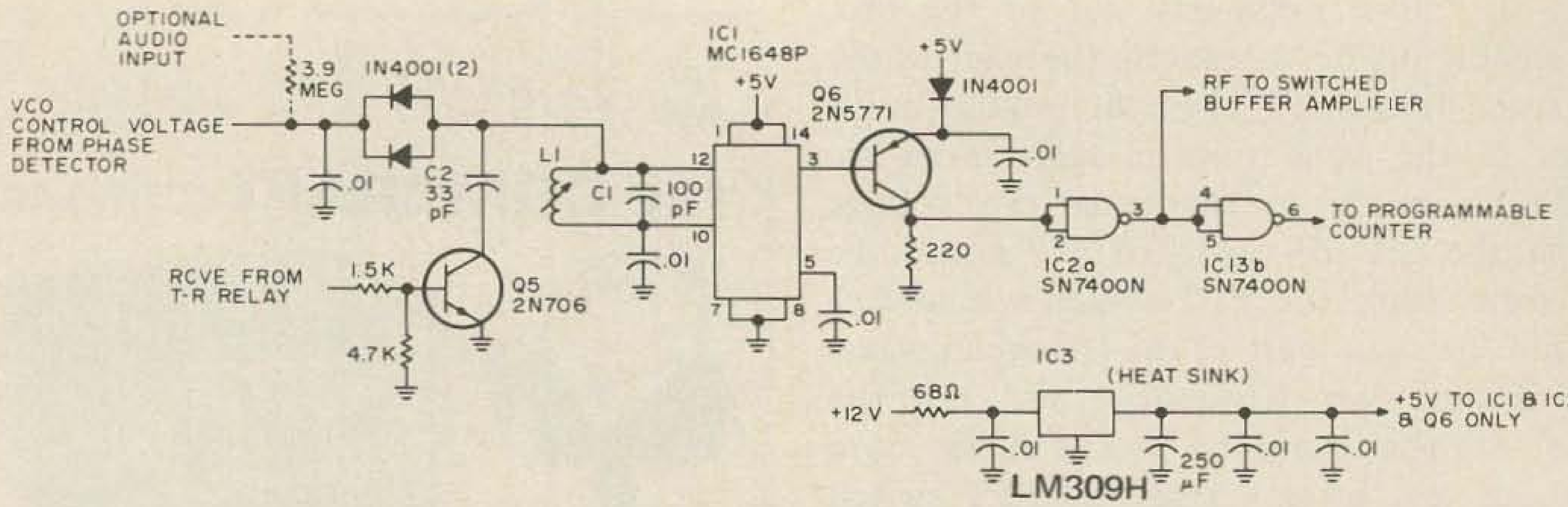


Fig. 5. Voltage-controlled oscillator. Notes: L1 is 26 turns of No. 32 enamel wire close wound on 7/32 in. dia. by 19/32 in. long ceramic core, with ferrite slug (6 MHz output). Coil is adjustable from 3 to 6 µH, and is normally set to about 4.8 µH (6 MHz output).

then further amplified and buffered by some gates before being sent to the rest of the system.

The values specified for L1, C1 and C2 in Fig. 5 are for 6 MHz operation only; we haven't built the 8 or 12 MHz versions yet, and so the choice of coil and capacitor for other operating frequencies will be up to you. We will discuss in a moment the way to decide these values.

The oscillator is tuned over its range by changing the shunt capacitance across the tuned circuit. Instead of using a varicap diode, we found two paralleled 1N4001 diodes just as good. The VCO control voltage (which is positive) is applied to the cathodes of these two diodes. The higher this positive voltage, the lower the diode capacitance, and the higher the operating frequency.

Because the oscillator has to operate at a lower frequency during receiving, we switch in another capacitor, C2, just during receive. This is done by applying +5 volts to the base of Q5, turning it on. When Q5 is off, C2 is essentially out of the circuit, except for about 5 pF circuit capacity.

Since the phase comparator output ranges from about 1.9 to 4.4 volts, we designed the VCO to cover the entire range with a control voltage from 2.2 to 4.1 volts, which leaves a 0.3 volt overlap at both ends, to make sure that enough control voltage is available from the phase detector to control the VCO over the whole range. On our 6 MHz synthesizer, the output frequency during transmit is in the range of 6041 to 6167 KHz, and during receive is in the range of 5595 to 5721 kHz. Hence our VCO is designed to satisfy the following data:

	Output Frequency from VCO (kHz)	
Input Control Voltage	**Transmit** (0V on base of Q5)	**Receive** (+5V on base of Q5)
+2.2V	6040 or less	5595 or less
+4.1V	6170 or more	5725 or more

If you build the synthesizer with 8 MHz output, then the transmit output frequency range is from 8055 to 8222 kHz, and the receive range (assuming 10.7 MHz i-f offset) is 7461 to 7628 kHz. Then you will have to change L1, C1, and C2 to get the following:

	Output Frequency from VCO (kHz)	
Input Control Voltage	**Transmit** (0V on base of Q5)	**Receive** (+5V on base of Q5)
+2.2V	8055 or less	7460 or less
+4.1V	8225 or more	7630 or more

Notice that in each case we add a little overlap, just to make sure that the final circuit is going to work properly. If you want 12 MHz output, then the output frequencies will be twice those in the 6 MHz case. Also, for 11.7 MHz receive offset, the receive frequencies will be a little lower than those shown above.

In order to keep the noise and hum out of the VCO, we found it necessary to put the VCO into a corner of the board, separated by a ground strip from all other components on the board, and had to install a separate +5V regulator. We used an LM309H regulator with a small clip-on heat sink. The LM309H is similar to the LM309K regulator, but is in a small TO-5 style can instead of the big TO-3 case. You can use the LM309K instead, if you wish, but it will not fit directly on the board. If you mount it on the chassis, make sure to insulate it from the chassis ground. Instead, bring a separate ground wire back to the VCO and ground it where the LM309H would have been grounded. You must avoid all ground loops to avoid problems.

It is possible to FM modulate the VCO to produce a very nice signal, by simply feeding about 1V of audio to the VCO control input through a 3.9 MΩ resistor. You can reduce the value of this resistor a bit, but if it is made too small then probably you will get hum from the audio input because of a ground loop. In our case, we have a Touch-Tone pad mounted on the case, and this is where we bring in the audio. If you want to voice modulate the VCO, make sure to put in a cut-off filter into the audio path to cut off below about 500 Hz. Any audio introduced at this point that is at a lower frequency than the reference signal at the phase comparator will appear as an error in the phase-locked-loop, and the loop will try to correct for it. You won't get much modulation, and it will just make the loop a little more unstable. We're planning to try to feed in PL tones at this point in the future, but suspect that it won't work out too well.

As mentioned earlier, we are not too happy with the VCO at this point, primarily because it has a little noise. The output has a bit of random residual FM, which shows up on the transmitted signal as a hiss. Since it is not too objectionable we decided to accept it in the interests of simplicity, but may get ambitious on this circuit in the distant future.

Unlock Dectector (Fig. 6)

A relatively straightforward circuit checks whether the loop is locked by monitoring the VCO control voltage. An emitter-follower, Q7, is connected to the control line, with its output driving Q8, an amplifier, whose output in turn goes to Q9 and Q10. Both Q9 and Q10 are normally biased just below turning on. If an ac signal is present, one or the other of these two transistors turns on. In normal operation, pins 13 and 12 of IC13d are at about +5V. If Q9 turns on, pin 13 is grounded; on the other hand, if Q10 turns on, then the input into IC13c

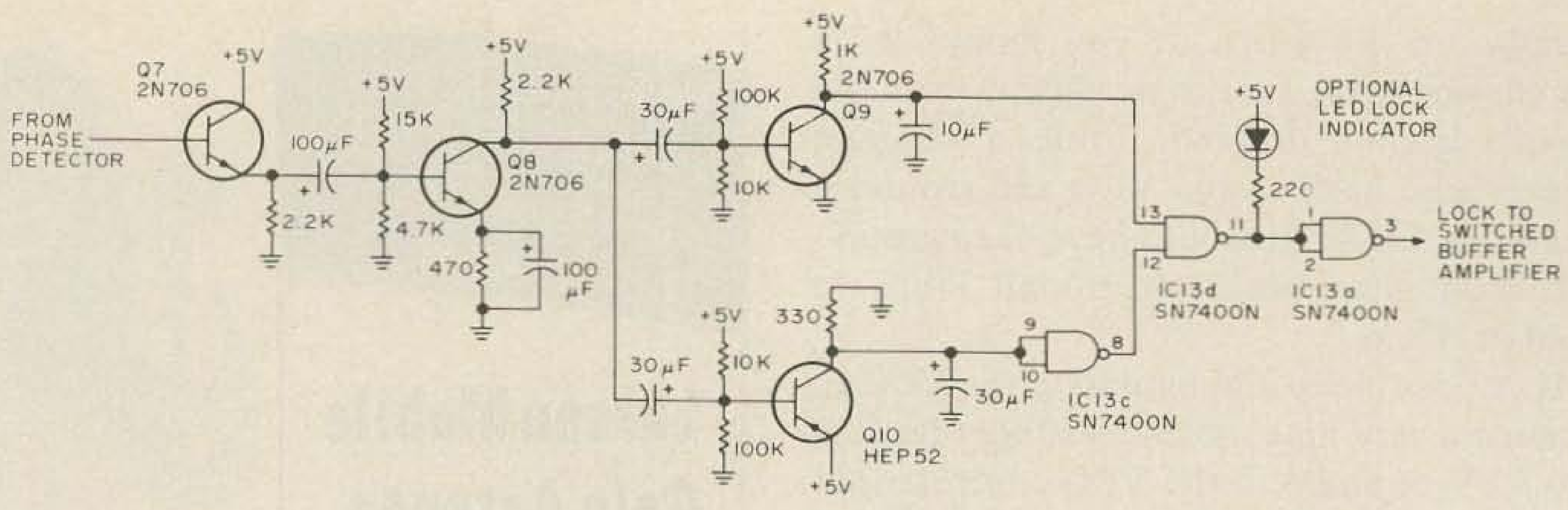


Fig. 6. Unlock detector.

goes to +5V, and the output of IC13c ground pin 12 of IC13d. Either of these two conditions brings pin 11 to +5, turning off the optional LED LOCK indicator, and bringing the LOCK signal, which goes to the switched buffer amp, to about 0V. This LOCK signal is about +5V (a binary 1) when the loop is in lock, and goes to ground (binary 0) when the loop is unlocked.

The optional LED diode makes a very handy way of checking whether the loop is locked or not. There is room for the diode right on the p.c. board, or it may be brought out to the front panel. When the diode lights we have a fairly nice way of making sure that everything is operating normally.

Switched Buffer Amplifier (Fig. 7)

The switched buffer-amp uses three two-input gates in IC2 to buffer the output. When the LOCK signal from the unlock detector is a logical 1 (+5V) the gates are on and the rf signal is sent to the multipliers. If the LOCK signal goes to zero, the gates are turned off and the output is disconnected.

Programmable Divider (Fig. 8)

Although this circuit looks the most complicated, it is actually very easy to understand. IC4 through IC7 are programmable decade up-down counters which, along with IC12, do the actual counting. As mentioned earlier, the value of N, the

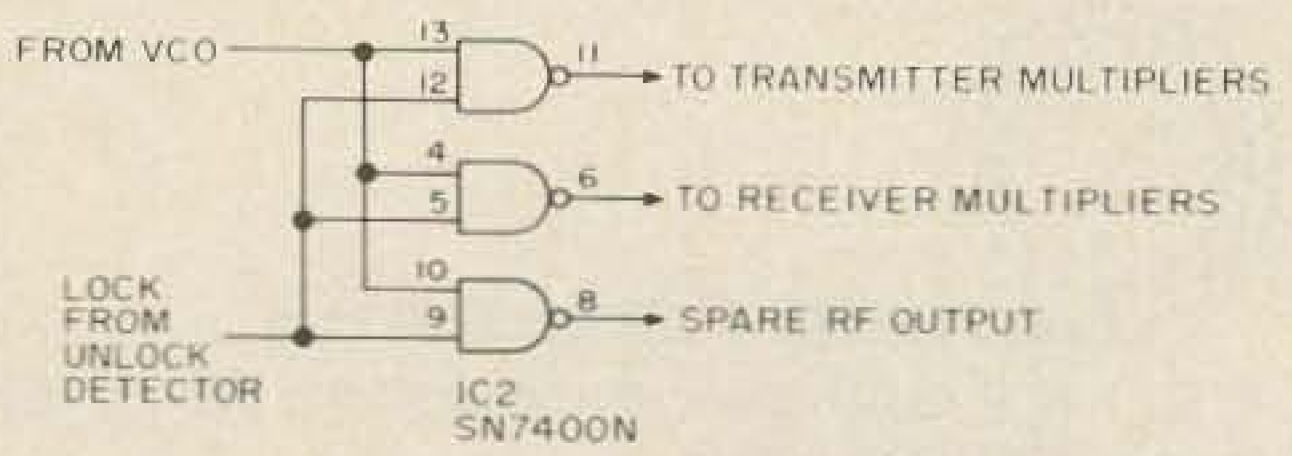


Fig. 7. Switched buffer amplifier.

number by which we divide, is a constant between 29,000 and 29,599 during transmitting, and is 2140 less during receiving. Temporarily forget about what happens during receiving, and look at the numbers 29,000 and 29,599. Since the digits 29 at the beginning are the same all the time, IC12 is permanently wired to count to 2, while IC7 is permanently wired to count to 9. The last three digits of N are entered into IC6, IC5, and IC4, in that order, by the 11 pairs of diodes connected to pins 15, 1, 10 and 9 of those IC's (pin 9 of IC6 is always grounded since that bit is always a 0). The actual connections to those diodes are shown later.

To see how the divider works, let's take an example. Suppose we want to transmit on a frequency of 146.940 which corresponds to a value of 29,388 for N. The digits 29 are permanently wired into IC7 and IC12, the 3 is set into IC6, and the digit 8 is set into both IC4 and IC5. In this way the counter is preset to the starting value of 29,388. As soon as this is done, each input pulse from the VCO circuitry subtracts one from the counter. After exactly 29,388 input pulses the counter gets down to a count of 00000, and we repeat the whole process all over again.

In actuality, there is a bit of fancy footwork required to do all this; to understand all of the fine detail, we have labelled some of the lines in Fig. 8 with letters A through F. After the counter starts counting down toward zero, a number of things happen. First, IC12 gets down to a count of 0; when this happens line C goes high (meaning positive, or about +5V). A short time later, when IC7, IC6, and IC5 all reach

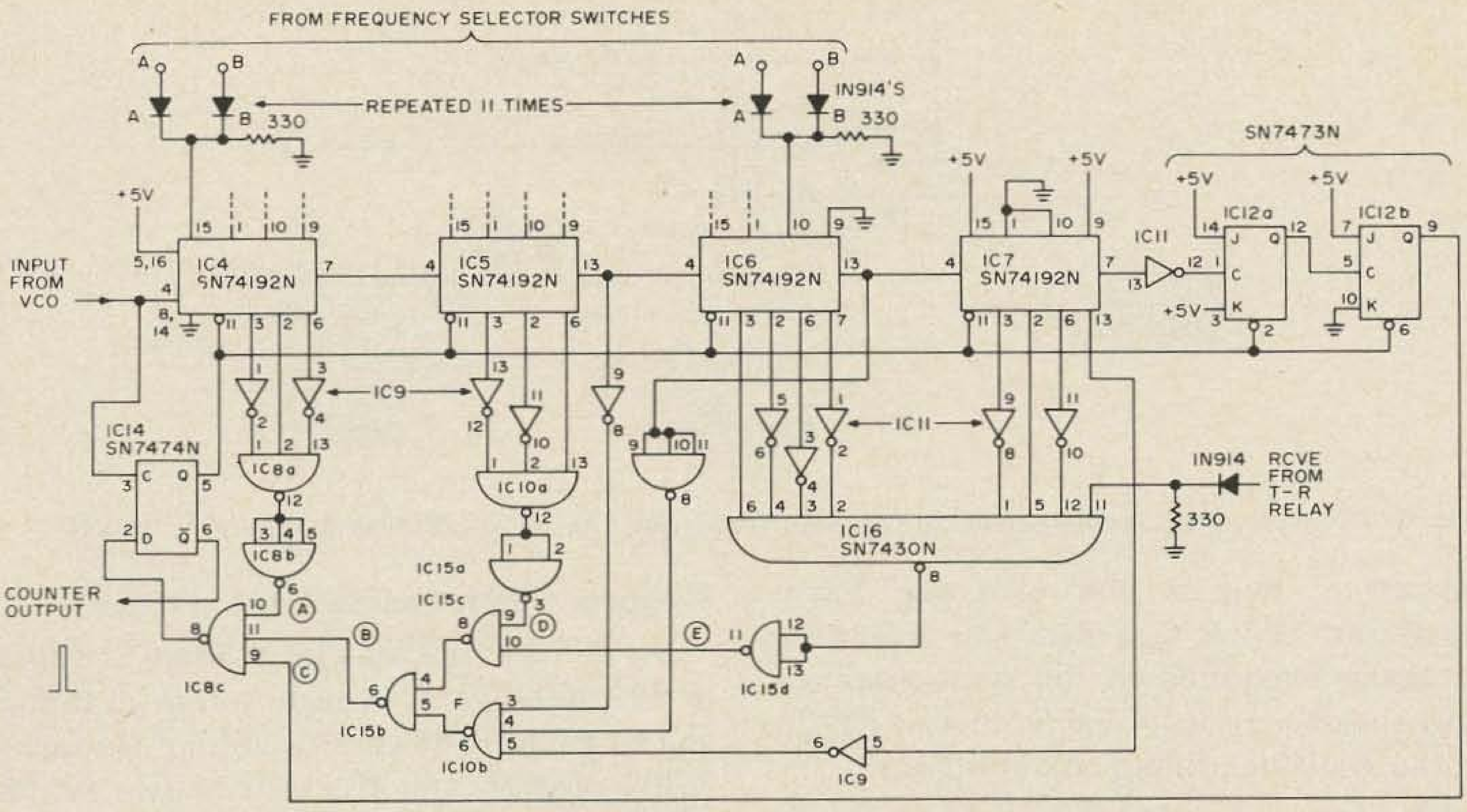


Fig. 8. Programmable divider (÷N).

the count of 0, line F goes low (near zero volts); therefore line B goes high. Then IC4 reaches a count of 2, line A goes high. Thus when the counter has gone from its original preset count down to a count of 00002, the output of IC8c goes low. This applies about zero volts to the D input of IC14, a so-called Type-D flip-flop, but the flip-flop does not react until the next input pulse. At this pulse the counter tries to count down to 00001. But at the same time IC14, which was set until now, resets and its Q output grounds the load lines, pins 11 of IC4 through IC7, and pins 2 and 6 of IC12. This forces all of the counter stages to preset back to the starting value of 29,388. But the counter can't start counting yet – it has to wait until the next input pulse (when the counter would otherwise have been at the count of 00000,) at which time IC14 sets again.

Hence IC14 goes through a complete set-reset-set cycle exactly once every 29,388 input cycles (or whatever N corresponds to the frequency selected), which gives us the frequency division by N. The output from pin 6 of IC14 is a short positive pulse occurring exactly once every N input pulses.

When the synthesizer is switched into receive mode, the T-R relay puts +5V on the RCVE line, which in turn makes pin 11 of IC16 go high. This brings IC11, IC15, and IC16 into the picture. As before, the counter starts to count down from its preset value towards zero, but this time it never reaches anywhere near it. As soon as IC7 and IC6 reach a count of 21, line E goes high. When IC5 reaches a count of 4 line D goes high, and so line B goes high. Lines A and C work the same as before, and so the entire reset process starts when the counter gets to a count of 02142, and resetting finishes at the count of 02140 (instead of 00000 as in transmit). Since this reduces the quantity N by exactly 2140, it drops the frequency (after it is multiplied up to the two meter range) by exactly 10.7 MHz.

If the first i-f frequency of your rig is different from 10.7 MHz, then it will be necessary to change this circuitry. For an 11.7 MHz i-f (such as in the Standard transceivers), for example, we need to start resetting the divider at a count of 02342 instead of 02142. In this case the change is very simple – just eliminate the inverter shown as IC11 pins 5 and 6. Probably the best way to do this on the board is to cut off pins 5 and 6 on IC11's socket to disconnect the inverter, and then put a jumper between pins 5 and 6 on the board.

Notice also that we subtract the count of 2140 from the quantity N, we don't add it. That means we can only accomodate oscillator injection on the low side of the received signal. This fits most imported

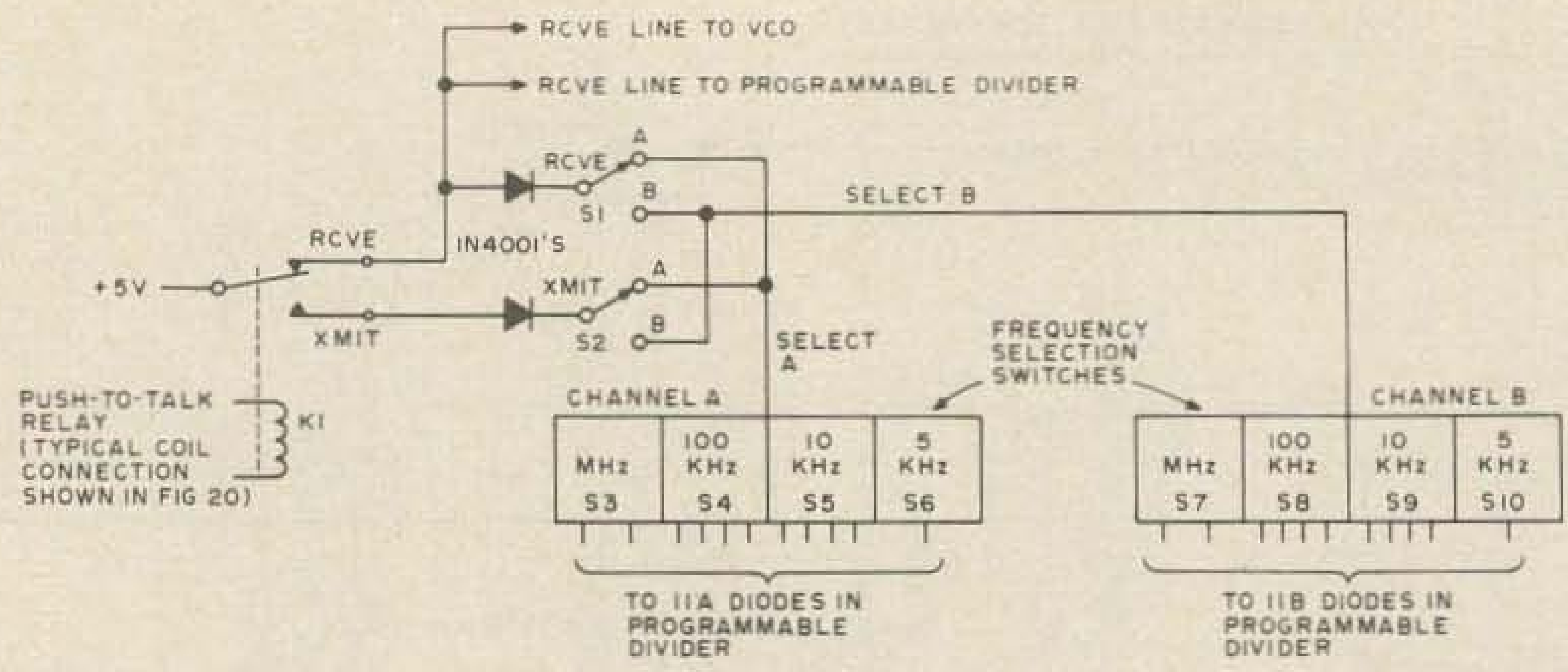


Fig. 9. T-R Relay and channel selection switches. Note: See Fig. 10 for detailed wiring of S3 to S10.

transceivers. But if you own the Yaesu transceiver, which uses high side injection, the changes required to the synthesizer are really major, and it probably doesn't pay to use the available printed circuit board.

T-R Relay and Channel Selection Switches

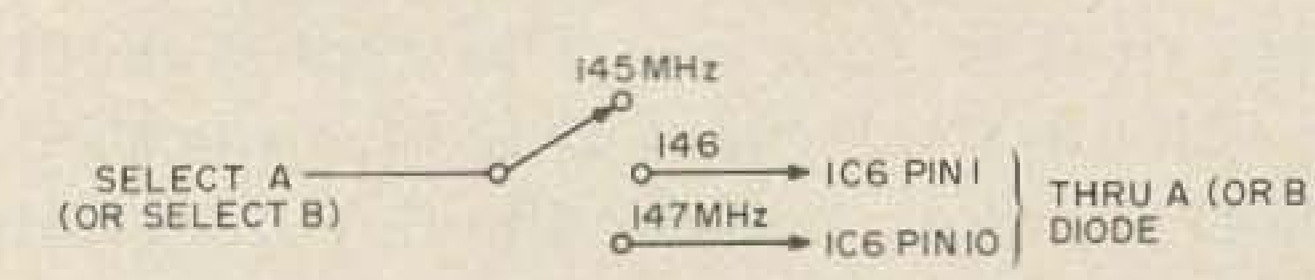
Undoubtedly we could have replaced the push-to-talk relay shown in Fig. 9 with a transistor, but the relay is more universally adaptable to most transceivers, and so we used it. When the relay is deenergized the synthesizer is in the receive mode, and +5V is supplied to the RCVE channel switch S1, to the VCO (to turn on the transistor which switches extra capacitance into the VCO tuned circuit) and to the programmable counter (to cause subtraction of 2140 from the factor N). When the synthesizer goes to transmit, +5V is only supplied to the XMIT channel switch, S2.

The RCVE and XMIT channel switches select either channel A or channel B for operation, and in turn send +5V to either the channel A frequency selector switches (S3 through S6) or the channel B frequency switches (S7 to S10). In this way we get independent frequency selection for transmit and receive, which you need for going through a repeater. For simplex operation you can also preset two different frequencies and simply flip back and forth. With only a little more effort, you could add a scanning circuit which would automatically go back and forth between frequency A and B; it would have to work slowly, though, since the synthesizer takes about 1/4 to 1/2 second to settle on a new frequency (it will take less time if the two receive frequencies are close together).

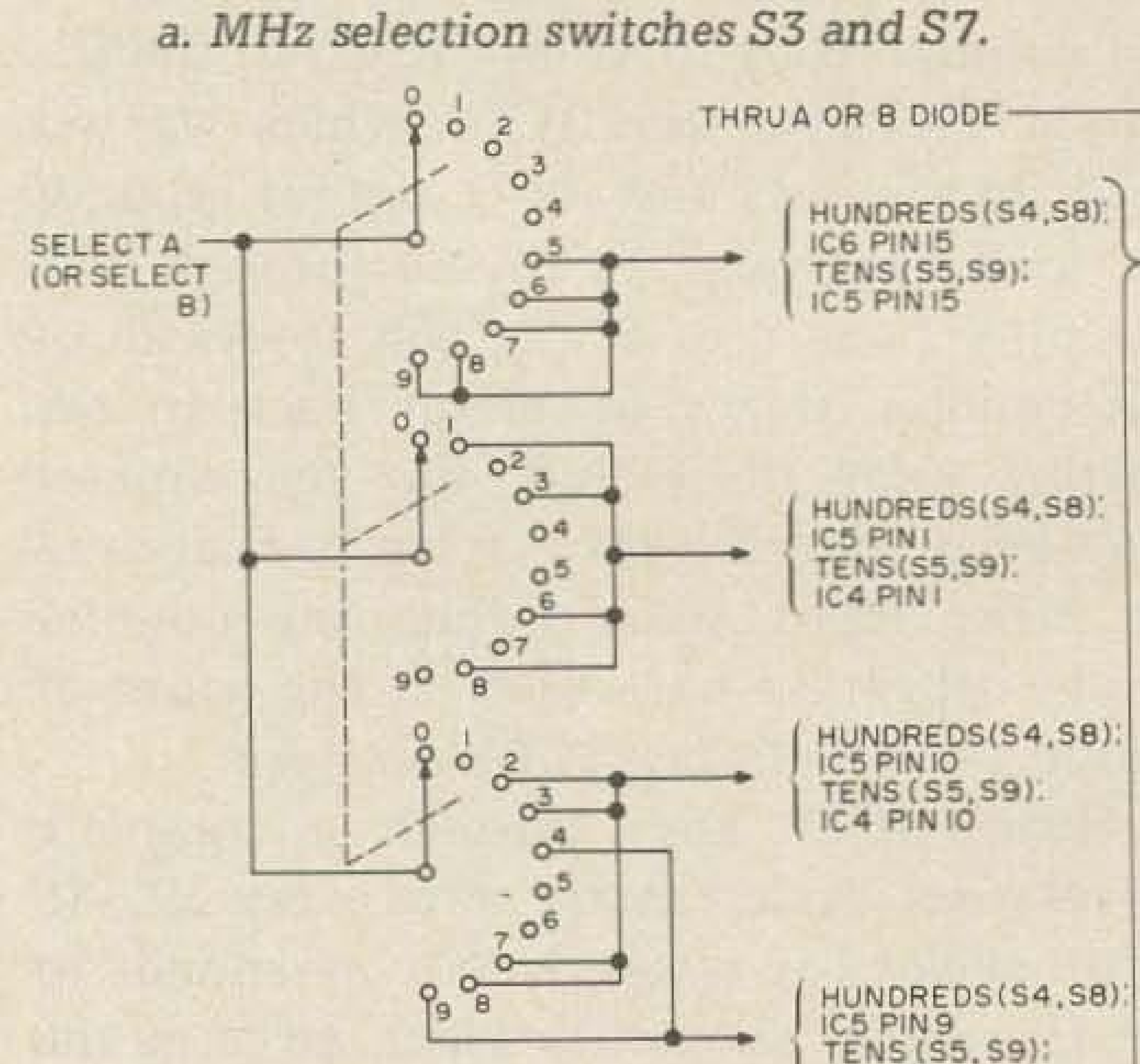
Frequency Selection Switches (Fig. 10)

As shown back in Fig. 8, there is a total of 11 preset inputs brought out from IC4, 5, and 6. Each input goes to ground through a 330Ω resistor, and also goes to two diodes. Of each pair of diodes, one goes to the channel A frequency selection switches, and the other goes to the channel B switches. The diodes are there to isolate the two sets of switches from each other.

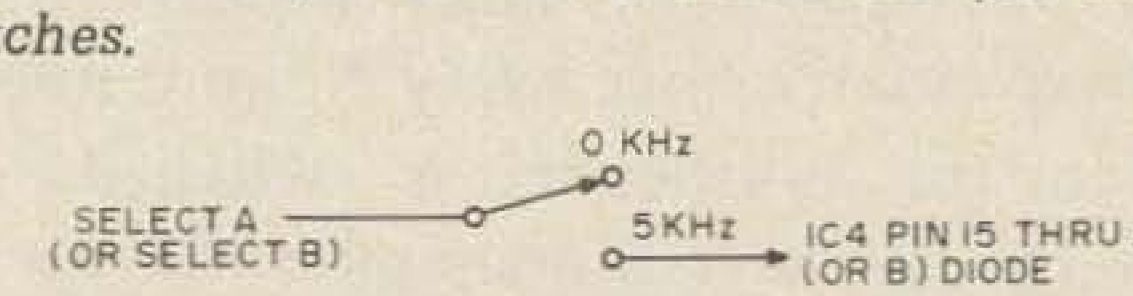
The actual wiring of these switches is shown in Fig. 10. The MHz switches (S3 and



a. MHz selection switches S3 and S7.



b. Hundreds (S4 and S8) and Tens (S5 and S9) switches.



c. 5 kHz selection switches S6 and S10.

Fig. 10. Wiring of frequency selection switches S3 through S10.

S7) are single-pole, three-position rotary switches; the hundreds of kHz switches (S4 and S8) and the tens of kHz switches (S5 and S9) are all three-pole ten-position rotary switches, and the 5 kHz switches (S6 and S10) are single-pole two-position rotary switches. The wiring to these switches is not BCD coding, by the way, and the thumbwheel BCD switches you see occasionally sold surplus can't be used here.

Power Supply (Fig. 11)

The synthesizer is designed to work from +12V, and the power supply consists mostly of regulators and filtering. A simple series regulator using a 2N3055 or similar NPN silicon power transistor is used as a preregulator to keep large changes in input voltage (as in mobile operation) from affecting the unit. The resulting voltage, which is a bit under +12V, is then sent to the VCO (which has its own regulator), the phase detector (where additional regulation is not needed), and to an LM309K IC regulator which provides the +5V at about 0.6 ampere, needed by most of the logic circuitry.

The LM309K in the main regulator should be mounted on a heat sink or on the chassis. The LM309H in the VCO circuitry mounts right on the board, and should have a small clip-on heat sink. The 2N3055 and the 12V zener should also be heat sinked or chassis mounted.

Frequency Multipliers (Fig. 12)

The frequency multipliers take the output of the synthesizer and multiply it up in frequency to whatever value is needed by your transceiver. Since various transceivers need different amounts of multiplication, we

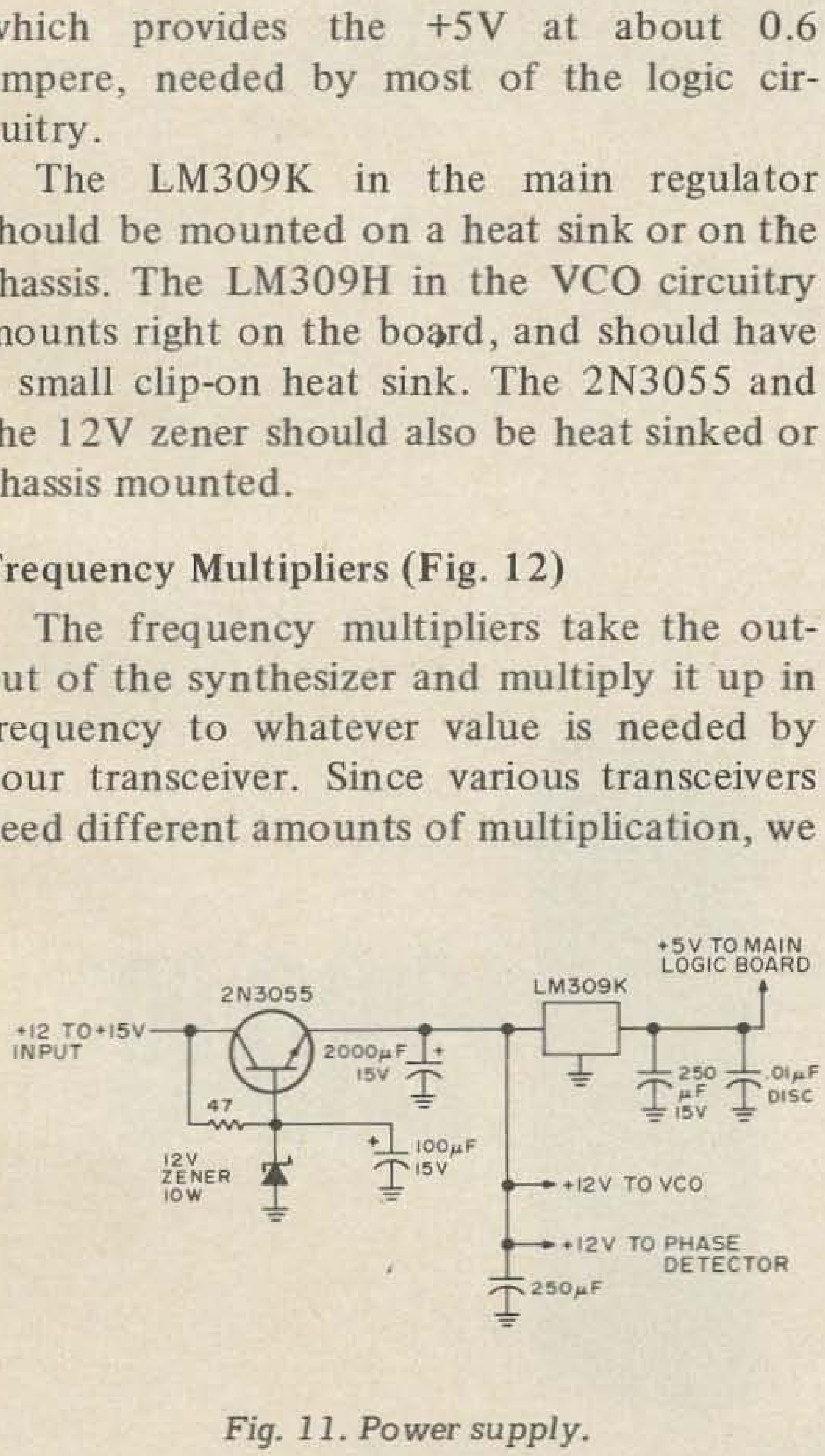


Fig. 11. Power supply.

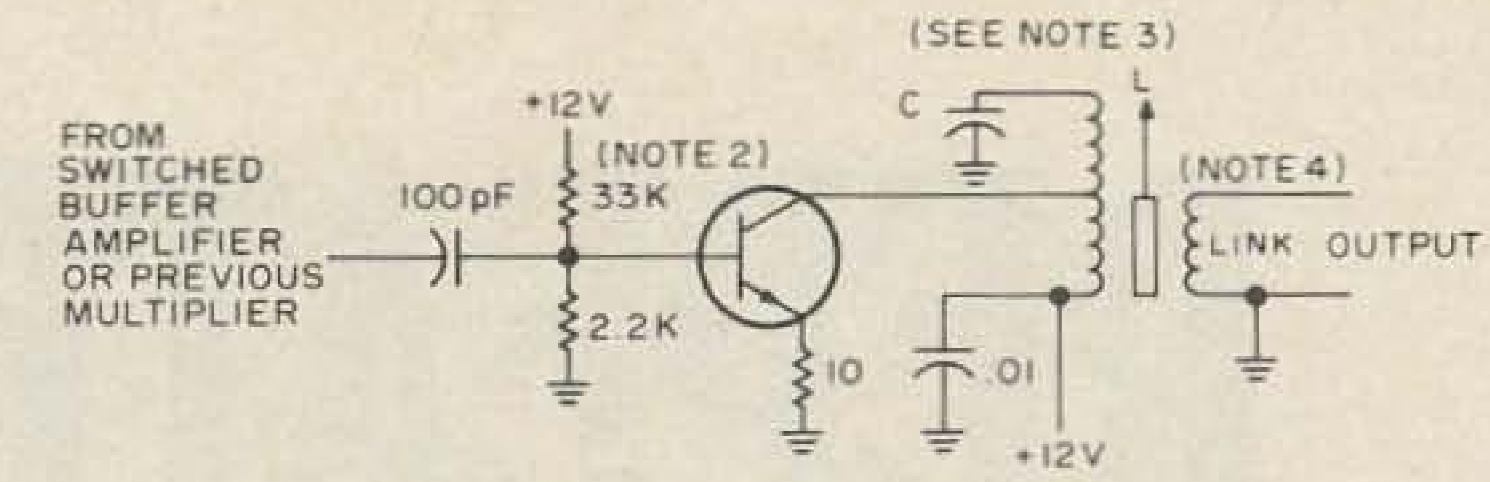


Fig. 12. Frequency multipliers. Notes: 1. Uses components and board of International Crystal PAX-1 rf power amplifier; 2. Add a 33K resistor into holes marked R on PAX-1 board; 3. Select L and C as shown in PAX-1 instructions for range covered. Adjust for max output with synthesizer set for 146.5 MHz; 4. Use 10-turn link with yellow coil and 5-turn link with red coil for coupling to next multiplier. Experiment with correct number of turns on final link to transceiver.

decided not to design our own, but to simply use a commercially available amplifier, the PAX-1 power amplifier from International Crystal.

As shown in Fig. 12, the circuit is quite simple. As it comes in the kit, the amplifier is designed for class C and needs quite a bit of drive. We added a 33K resistor to provide some base bias (it mounts in a set of holes already provided on the board) and found that it works very well as a frequency multiplier. Though it is only rated as being good up to 30 MHz, we found that it works at 45 MHz. In our unit we use four of these units, one to triple from 6 MHz to 18 MHz for our transmitter, and three to double from 5.6 MHz (during receiving) to 11.2 MHz, then to 22.4 MHz, and finally to about 45 MHz. The kit comes with three color-coded coils which cover the range through 45 MHz. But disregard the instructions provided with the kit as to the number of turns in the link, and use the number of turns specified in Fig. 12 between multipliers. The last link, used to couple from the multiplier to your transceiver, will have to be chosen experimentally. If you have an rf voltmeter or high frequency oscilloscope you are in luck, since then you can measure the voltage drive using a crystal, and tailor the link to provide the same voltage.

In the third part of the article, we will show you how the printed circuit board is laid out, where to place the parts, and how to hook the whole thing up.

. . .K2OAW

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A BIG NEW VOICE IN CHICAGO

A powerful new repeater is on the air in Chicago. It has been established by the Pioneer Amateur Radio Club, a group that has become known more by its QSL cards than by its publicity. Most of the club members are professionals in the communication field, and their club's story is an interesting one.

The telephone industry has a sort of old timer's club that has been named "The Telephone Pioneers of America." Membership is open to anyone who has worked in the telephone industry for 21 years or more. Local chapters are numerous and most metropolitan areas are likely to have several. While much of their time is devoted to public service work, they also encourage their members to develop hobbies that will hold their interests in their retirement years. As you might expect, the telephone business has a healthy share of radio hams, and so an amateur radio club made up of active and potential telephone pioneers is a "natural."

In Chicago, the Pioneer organization has made office space available to the radio club and the hams have made good use of . WA9PAC has been on the air for sever. l years with CW, sideband, 2m and 3/4m FM equipment. In January of this year, they started regular operation of a repeater under the call WB9AEJ. Talk-out is presently on 449.60 MHz while the talk-in frequency is 449.85 MHz. A change of the talk-out frequency will soon be made to 447.85 MHz. The transmitting antenna is over 500 feet above street level just west of Chicago's loop; and ERP of about 600 watts has been achieved.

The repeater is open to all users a d is carrier-controlled. Receiver selection ci. cuits prevent more than one receiver from getting

Len Bateman, K9ZNE, makes an adjustment on the automatic voice identifier. The entire cabinet is used as the repeater control terminal; it ties together the base transmitter, remote receivers, wire-line control circuits and the remote control points. The cabinet on the right contains a test transmitter that is used to key up the remote receivers for test purposes. The repeater is normally open to all users and is carrier operated.

Dan Bohi, W9HZJ, takes a quick look at the base transmitter. This rig is located under the roof of a building just off of the west side of Chicago's loop. It transmits on 449.60 MHz with an ERP of about 600 watts. The control terminal and the fixed receivers are in other buildings. This transmitter is part of the repeater that operates under the call sign WB9AEJ. Talk-in is on 449.85. The antenna is more than 500 feet above street level.

On Sunday, April 9, 1972, portable rigs were on the air from a hobby show in Northbrook, Illinois. George, W9NLT (right) is shown explaining all about ham radio (in 25 words or less) to two young visitors.

to the transmitter at one time. Another interesting feature is the soft feminine voice that identifies the transmitter. The transmitter is controlled by wire line from three authorized control locations. While only two receivers are currently in operation, the club is hoping to establish two more in suburban locations by late spring.

Ray Fusick, K9FBL, checks out a teleprinter with loving care. On RTTY at home, Ray will be active in work on and with an FSK rig that is being planned for the station.

Bob Klein W9KRZ, may be smiling at the idea that he is looking at a "portable" rig. This cabinet is to be taken to hobby shows and similar displays of spare time activity. It will communicate with other stations through the repeater, WB9AEJ.

Don Dehn, WB9CXE, has just completed a frequency check on the test transmitter and is shown adjusting the record level on the logging tape recorder.

One activity that appeals to club members is setting up a portable station at hobby shows, hamfests or other appropriate affairs. They have constructed two portable rigs that can be taken out to shows and set up on reasonable notice. Communication will be with other stations via the repeater. Several of the hams in the pictures also work the hobby shows from their home QTH. On March 19, visitors to shows at Glenwood and Oak Brook, Illinois were able to talk through the repeater. Several hundred people were present at each location and the ham exhibit was considered to be one of the main attractions.

Club President Don Dehn, WB9CXE recently announced the results of the seventh annual Pioneer QSO party. With a record high of 446 stations participating, WA9PAC took second place in the club station award category. It was operated by George Hickman, WA9QIA and his son George Jr., WA9QHZ. The Chicago group placed third in the chapter award category.

. . .W9NLT

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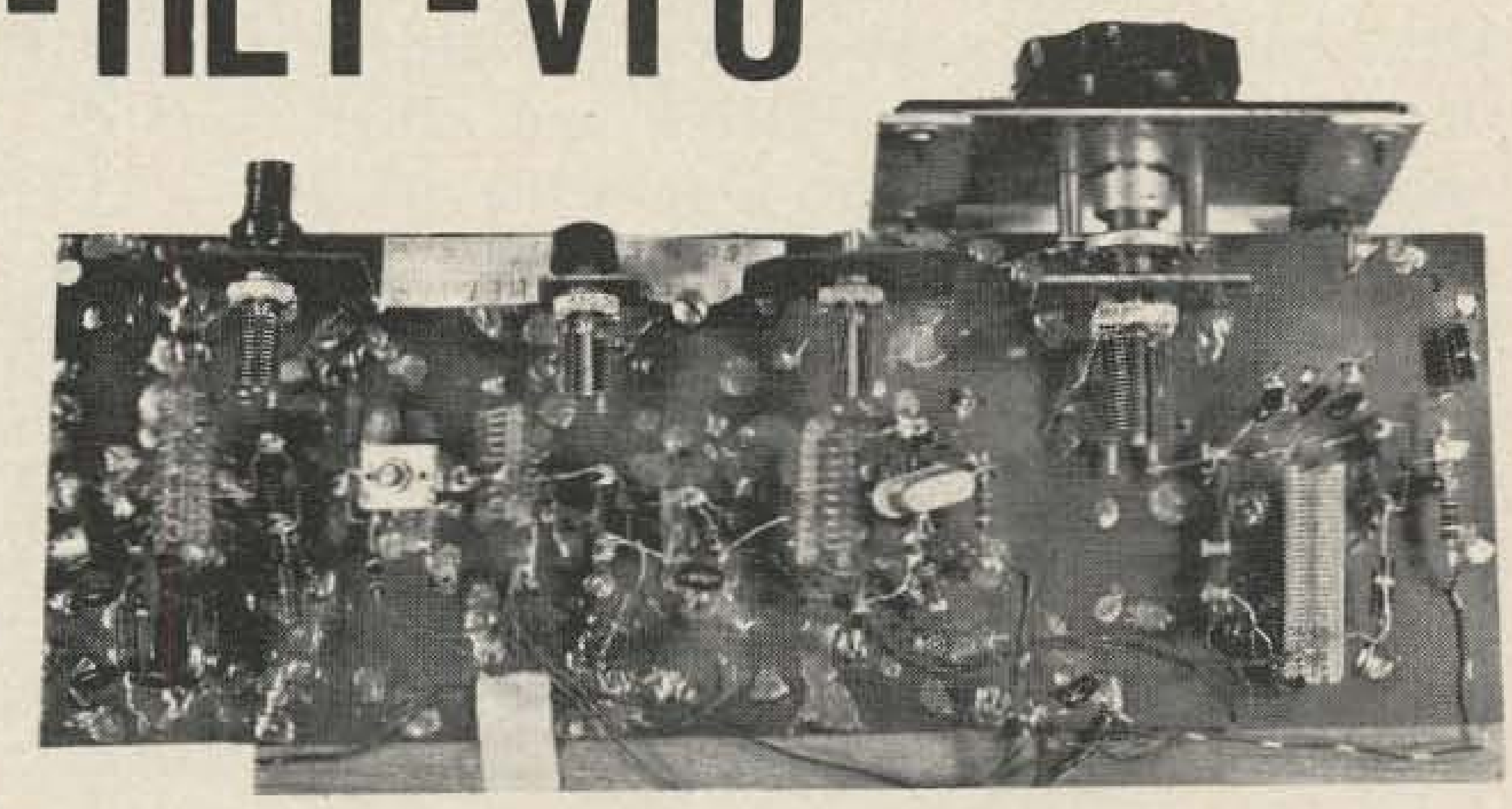
Peterborough NH 03458

SOLID STATE 6 METER CRYSTAL-HET-VFO



This describes the basic design, circuit, and theory of a solid state crystal-controlled, battery-operated, heterodyne vfo using low-cost transistors, which delivers a stable 120 mW output from 50 to 51 MHz.

The new Miller two-speed dial is used on the vfo which makes zero-beating a pleasure. A stable oscillator operating from 5 to 6 MHz beats with a 45 MHz crystal oscillator to produce 50 to 51 MHz energy in the mixer output. An rf amplifier brings up this output to 120 mW.

The main feature of this exciter is the *addition* of the stable 5 to 6 MHz vfo to the crystal oscillator, thus avoiding the usual *multiplication* of any shift or drift.

Emphasis is on the basic theory and circuit design. Features that can be added later include a low-pass filter for the low-frequency vfo, crystal switching for greater coverage, direct crystal control, and packaging.

Block Diagram and Overall Schematic

Figure 1 shows the block diagram with the rf output from the 5 to 6 MHz vfo and the crystal oscillator going to the mixer. This type of circuit has been used with success by the military services for many years. It is hard to imagine a better combination of low-cost transistors giving an equally stable variable frequency, easy-to-build, vfo. A tuned amplifier following the mixer serves to further reject unwanted frequencies and amplify the 6 meter energy. The basic theory involved is the use of a variable-frequency oscillator whose output is *not* multiplied but is *added* to a high-frequency crystal oscillator.

This system greatly reduces the demands ordinarily made on a vfo for stability and drift. a 5 MHz oscillator, if multiplied to 50 MHz, suffers from the equal multiplication of drift, FM, hum, or other unwanted modulation, and other

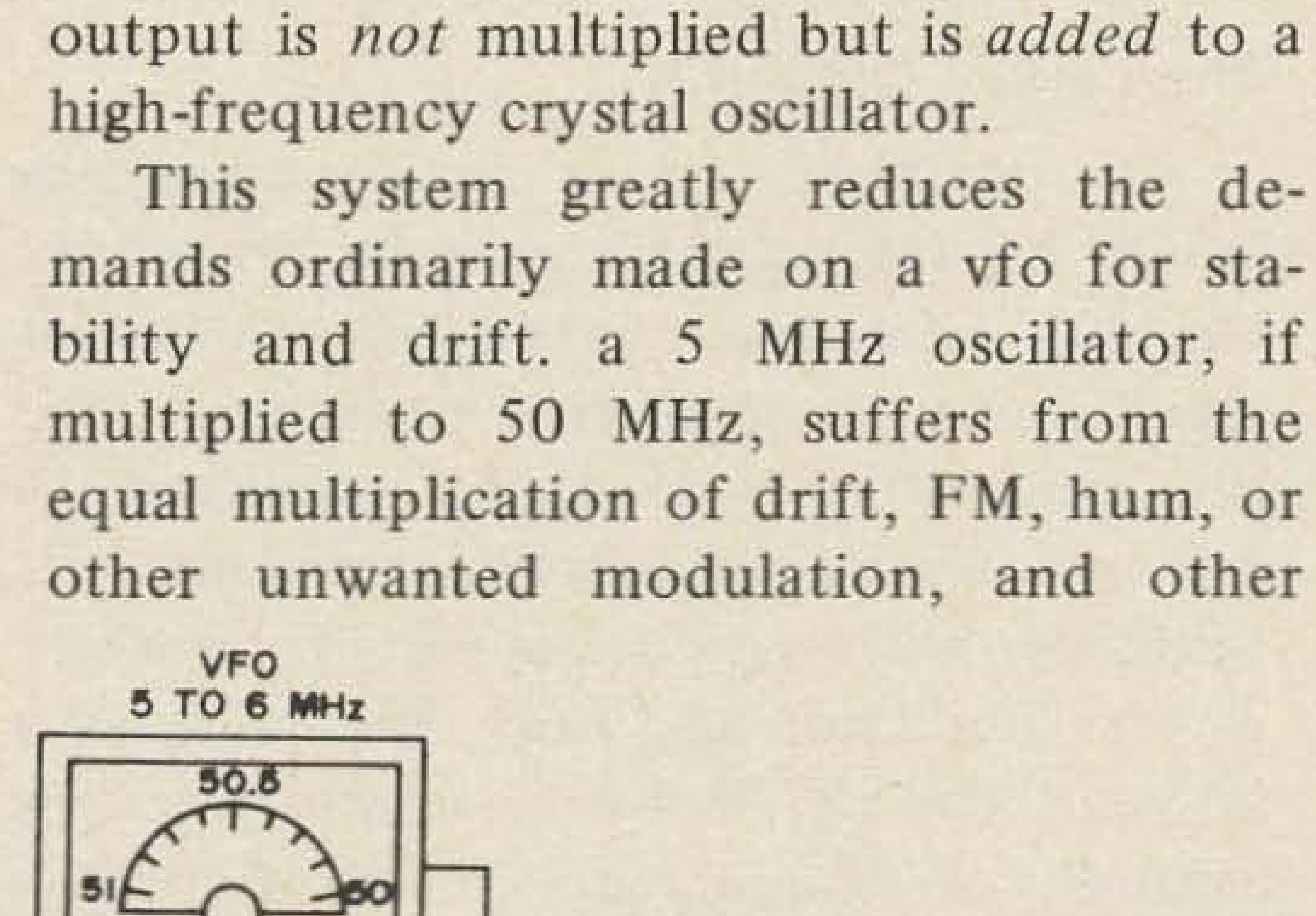


Fig. 1. 6 meter crystal-HET-vfo, block diagram.

undesired oscillator defects. A 5 MHz variable oscillator which is added to a crystal-controlled 45 MHz oscillator avoids this *multiplication* of instabilities.

When two oscillators with different frequencies are fed into a mixer, there are four frequencies always present in the collector circuit. These are F1, F2, F1 plus F2, and F1 minus F2. In the system being described here there will thus be present in the mixer collector 5 MHz, 40 MHz, 45 MHz, and 50 MHz. The mixer collector is of course tuned to 50 MHz, and subsequent amplifiers serve to reduce the other frequencies to an undetectable level at any reasonable distance from the antenna.

The emphasis is on selectivity, using a tuned amplifier to get the desired power output rather than pushing any one stage for maximum power, which is not generally coincident with maximum selectivity. Note the base and collector circuits, which are tapped down on their inductors. This matches their impedances to the proper point on the coils for sufficient power plus maximum selectivity.

In a spare-no-cost design, generally the criterion for military circuits, a balanced modulator is often used, but tests here show that a small number of tuned circuits following the mixer will prevent any detectable amount of undesired energy from reaching the antenna.

The Crystal Oscillator

The question of how much power output to try for here is important for several reasons. First, you would like to get as much power as possible in order to reduce the number of subsequent amplifiers. A famous (for its uniqueness) transmitter, I think pre-WW 2, used one Taylor tube as a crystal oscillator and only *one* more as a kilowatt CW rig! However, contrary to this example of exaggeration, most of today's crystal manufacturers say that a rock should be used only to control the generation of a *small* signal, and that power should be sought in following amplifiers.

Another item is the fact that VHF crystals will drift and/or jump if you try for too much power, as I well know from past experience. Any time that I used more than about 80V on tube oscillators, drift would set in, if not worse, such as jumps in power or frequency, and noise. Dc power of around 800 mW was involved, and if this is used as a criterion for solid state oscillators, we arrive at quite a few mils, using a 12V supply. A power region should be chosen which is not too far below the maximum for the crystal but which at the same time will assure its safety from drift. The way to find out is to try it, which I did, and the circuit shown works in fine style.

Referring again to the Old Days of tubes, a pilot light was often put in series with a crystal to check on the power and to act as a fuse. With today's VHF crystals this is not too feasible, unless some enterprising lads in the electric lamp business make some bulbs with a milliwatt or so of power. Also, as mentioned before, the crystal people are very disinclined to rate their crystals on power, so we're kind of on our own in this matter. The best place to regulate the power of both the crystal oscillator and the vfo, if you need to do so, is with the value of their emitter resistors.

The circuit is shown in Fig. 3. I checked once again both the regenerative and the degenerative feedback circuits and find that the degenerative circuit is more stable and produces more usable power output than the other. Note that if a capacitor is substituted for the crystal, *no* oscillation

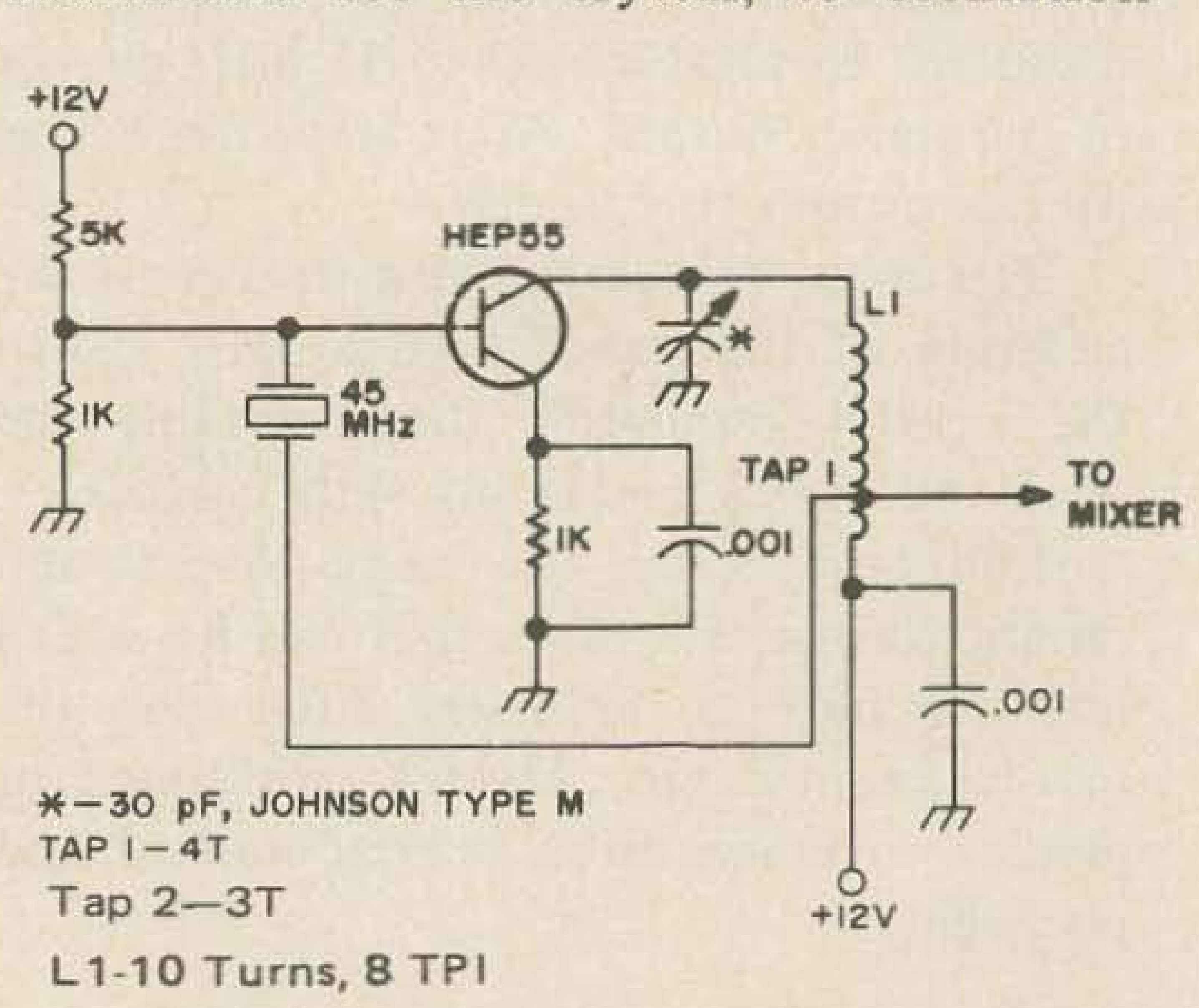


Fig. 3. Crystal oscillator, 45 MHz.

will occur. This is because the base is *in phase* with the collector and the emitter is

out of phase with the collector; this is the circuit which is degenerative (also known as negative feedback). As a result of this, until the frequency of the crystal is reached with L1 and C1, no oscillations will occur. The crystal then reverses the phase and the system oscillates. I have mentioned this circuit many times and will probably do so in the future, as it really is sure fire for VHF work.

The Vfo

Here again we shouldn't try for maximum power but instead should check carefully for the power that can be obtained with complete safety against drift. If the transistor heats to any large degree, you can be sure you *will* have drift. There is a well-known complete rig on the market right now which does just that! Fortunately in the rig being described here, I not only keep the vfo at a power which does not heat it up, but I also have a circuit which does not multiply any remnant of instability which might not be economical to remove completely.

Figure 4 shows the oscillator as finally worked out and it is a good one. Reliance is placed on heavy capacitor padding, a standard method for stability but which does call for good capacitors.

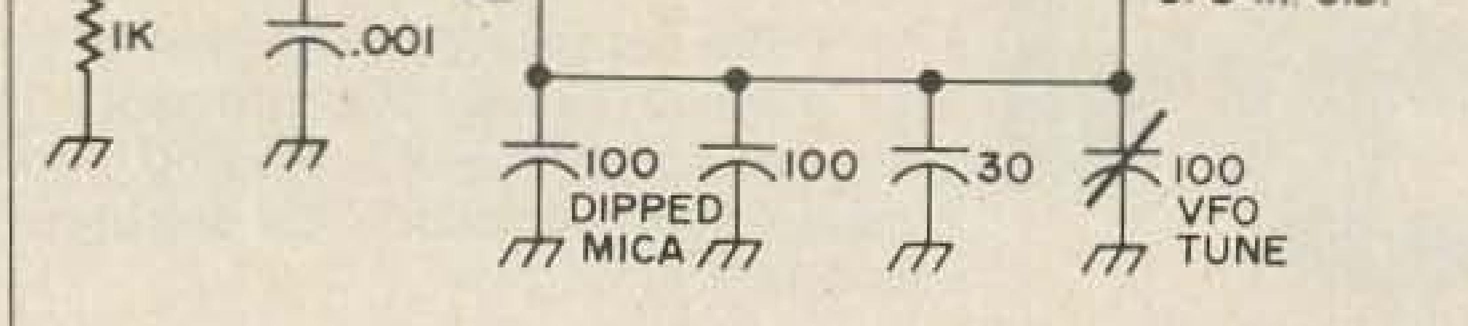


Fig. 4. 5 to 6 MHz vfo.

This unit is the heart of my future 6 meter transmitters, and probably will be for the two meter design as well, along with the Miller MD-4 dial, an automatic two-speed dial and very handy. Using the inductor, padding capacitors, and the 100 pF variable shown, the range tuned is from 50 to 51 MHz. That is, the actual vfo oscillator runs at 5 to 6 MHz, and the final output from the mixer is 50 to 51 MHz. This is cutting things a shade too close, so add a few turns to L1, cut the padding down a little, and set up something like 49.9 to 51.1 MHz. As mentioned, you can also switch crystals, or get 2 MHz on the dial by increasing L1 still further and dropping down on the padding again. We're just indicating the method here.

The oscillator is very neat and clean and uses the "universal" transistor, the Motorola HEP55. Positive feed is assured by the base connection being out of phase with the collector. It is ac grounded, and the opposite end of the coil from the collector is also grounded. The emitter is tapped up on the coil from the ground end, which puts it in phase with the collector, for the proper relation. The number of turns of this tap up from the ground end controls the amount of feedback. Output is through a tap on L1 which goes over to the mixer base input.

Numerous additions can be considered, such as "battle-ship" construction for real tough mobile environments on boats, planes, etc. An interesting thought is a switch that cuts out the vfo and the crystal oscillator on 45 MHz and switches over to another crystal socket on the front panel for a straight-through crystal oscillator at your choice of fixed frequencies in the band, for nets and round tables. Just thinking out loud – I mean on paper.

As is, this 5 to 6 MHz vfo worked immediately and has given no trouble of any kind since then.

Preliminary calibration of the dial is made easier for beginners who may not have a collection of 50, 50.1, 50.5 and 51 MHz crystals on hand, by the presence on the air of WWV on 5MHz and Montreal, Canada on 6 MHz. This latter is a B.C. station but seems to be audible over most of the East Coast, and probably quite a way to the West. Zero-beating these stations with the calibration dial at 50 and 51 MHz can be easily done with your receiver. Once again, be *very* sure you are on 5 and 6 MHz, because of the possible occurrence of image and harmonic detection in your receiver. Once you have the 5 and 6 MHz logged, you can transfer the dial markings to 50 and 51 MHz. Remember that absorption wavemeter when you do this operation.

The Mixer

Figure 5 shows the circuit. It is not much different from a receiving mixer. The

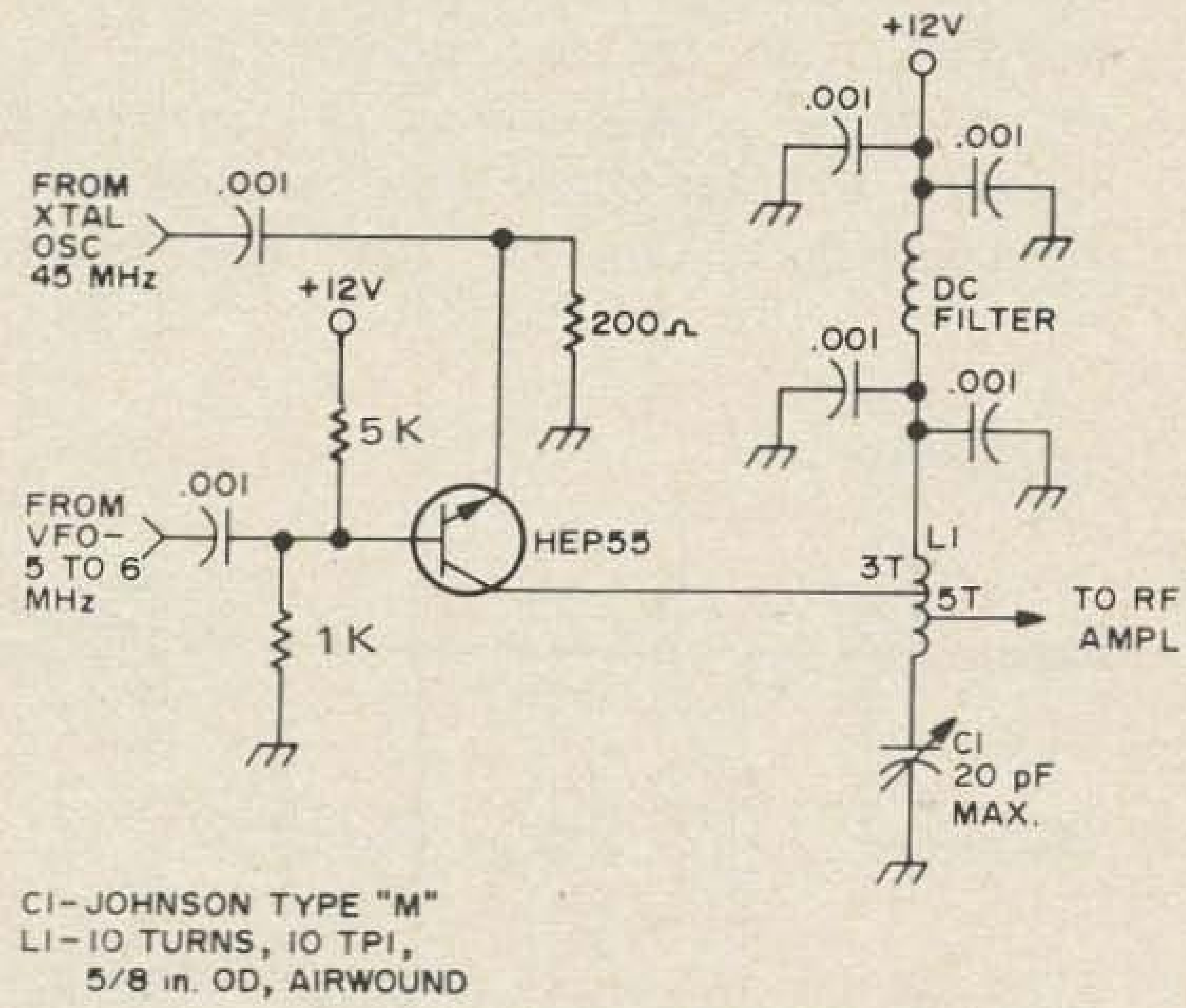


Fig. 5. Mixer, 6 meter-HET-vfo.

signal from the 5 to 6 MHz oscillator is brought in to the base, and the 45 MHz crystal oscillator is coupled to the emitter. Dc bias is furnished by the standard 5K and 1K resistors. The emitter has a 200Ω resistor to ground, which sets the operating point for best mixing.

The collector is tapped on to L1 only three turns up from ground, or cold end, which gives the best output for the 50 MHz beat note. Again, use that absorption wavemeter to check the mixer output. Figure 6

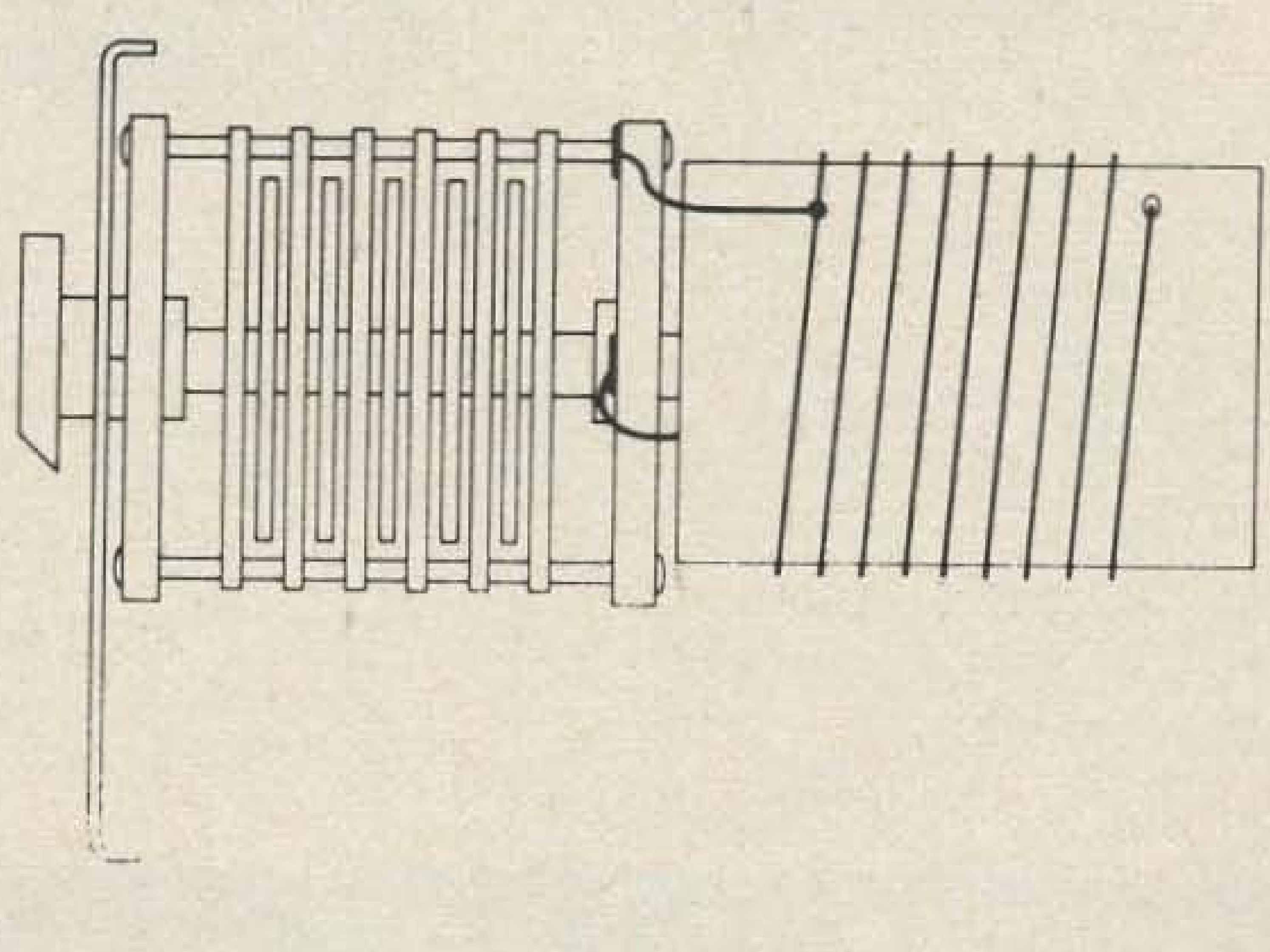
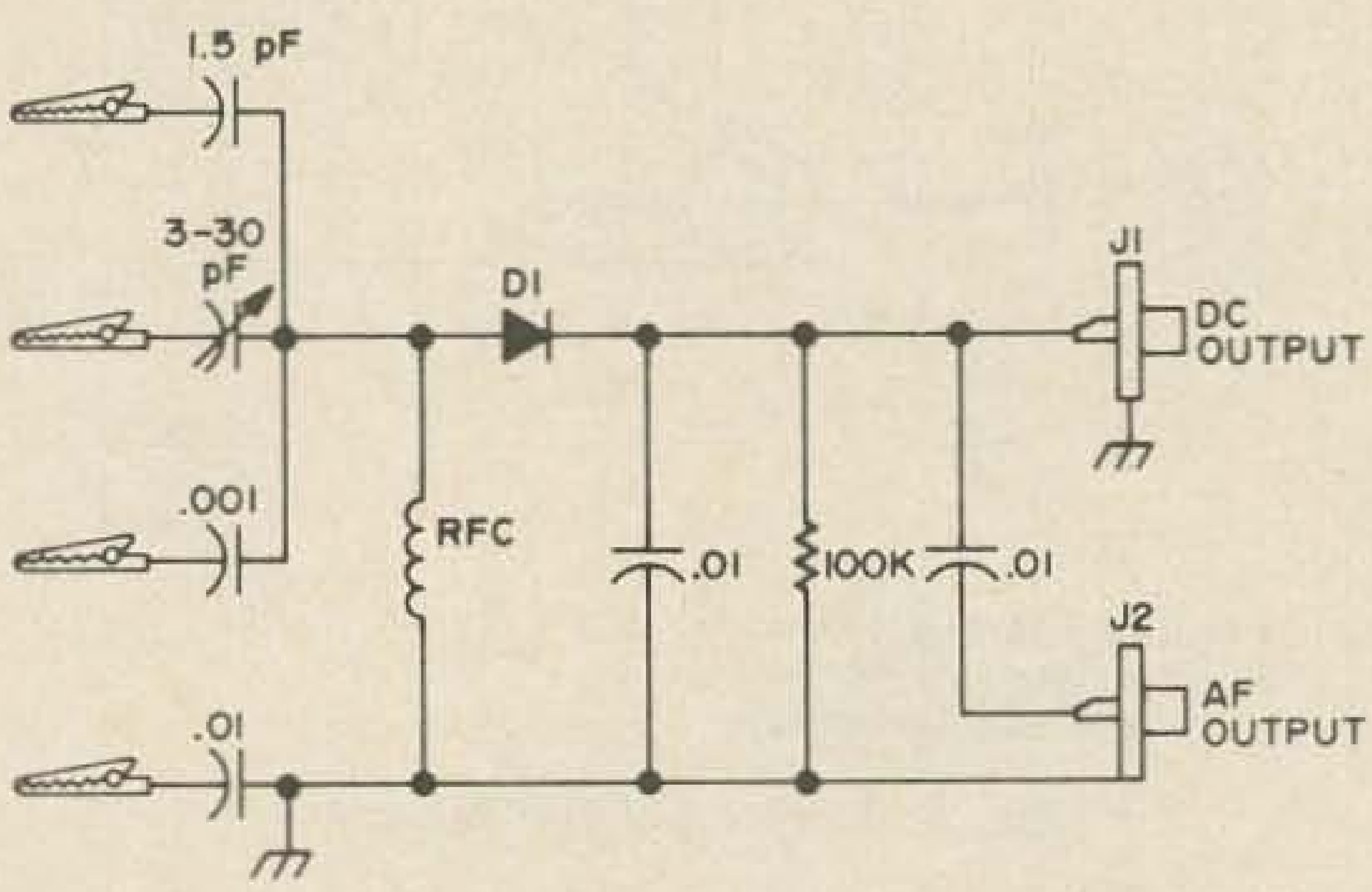


Fig. 6. Sketch, absorpotion wavemeter, James Millen type.

shows what such a device looks like, in the James Millen version, which is the best known. Remember those various outputs that are present in the mixer collectcr circuit as mentioned above. The 45 M'Iz energy in the collector can even have more power than the beat note on 50, so don't mistake it or try to use a receiver alone to identify these two outputs, unless it is of the TRF type, like my old favorite – the tuned diode receiver. You *can* use your receiver to listen to these various frequencies once you are *sure* the mixer output circuit is correctly lined up on 50 MHz.



I also listen on an *untuned* diode to note any spurious, squegging, discontinuous jumps in power or frequency, etc. This is a little diode "plank," made up as in Fig. 7. Note the variety of inputs to suit the various frequencies you may be monitoring. For UHF up into microwaves use the 1.5 pF. On VHF and UHF the 3 to 30 trimmer is good For lower frequencies the .001 capacitor delivers more rf to the diode for test purposes. The diode output also has more than one connection. With the alligator clips attached to your rf circuit under test you can thus measure gain with a microammeter plugged into the dc output jack, and listen to what is going on at the same time with a small af amplifier plugged into the audio jack. This can be really vital as you go up into the UHF region. RCA's excellent book, *Transistor and Diode Manual* has the following remarks on these subjects: "Various instabilities can occur in transistor frequency multiplier circuits, including low-frequency resonances, parametric oscillation, hysteresis, and high frequency resonance." Hysteresis refers to "discontinuous mode jumps in output power when the input power or frequency is increased or decreased." So don't be downhearted if you find troubles in your solid-state building projects. You're not alone!

There will be more of this cautionary material, so keep reading, and try to understand what I mean by "smooth tuning." You really need it with solid state devices.

When everything is working right, the mixer collector or circuit *does* tune easily without those discontinuous jumps. But watch out for that 45 MHz which is just a little up on the mixer capacitor knob from the 50 MHz point.

Expect in the neighborhood of 10 mW output from the mixer.

The RF Amplifier

Refer to Fig. 8 for the schematic. This one adjusts fairly easily once you get the base input capacitor adjusted to the right value. Start with a small amount and increase it a little at a time. The collector tap should then be adjusted to the proper place and C1 tuned to 50 MHz. The collector tap can be left at three turns from the cold end if you do not wish to check it yourself, as it is not too critical. The No. 48 rf output test bulb is critical as to match though, as you will see.

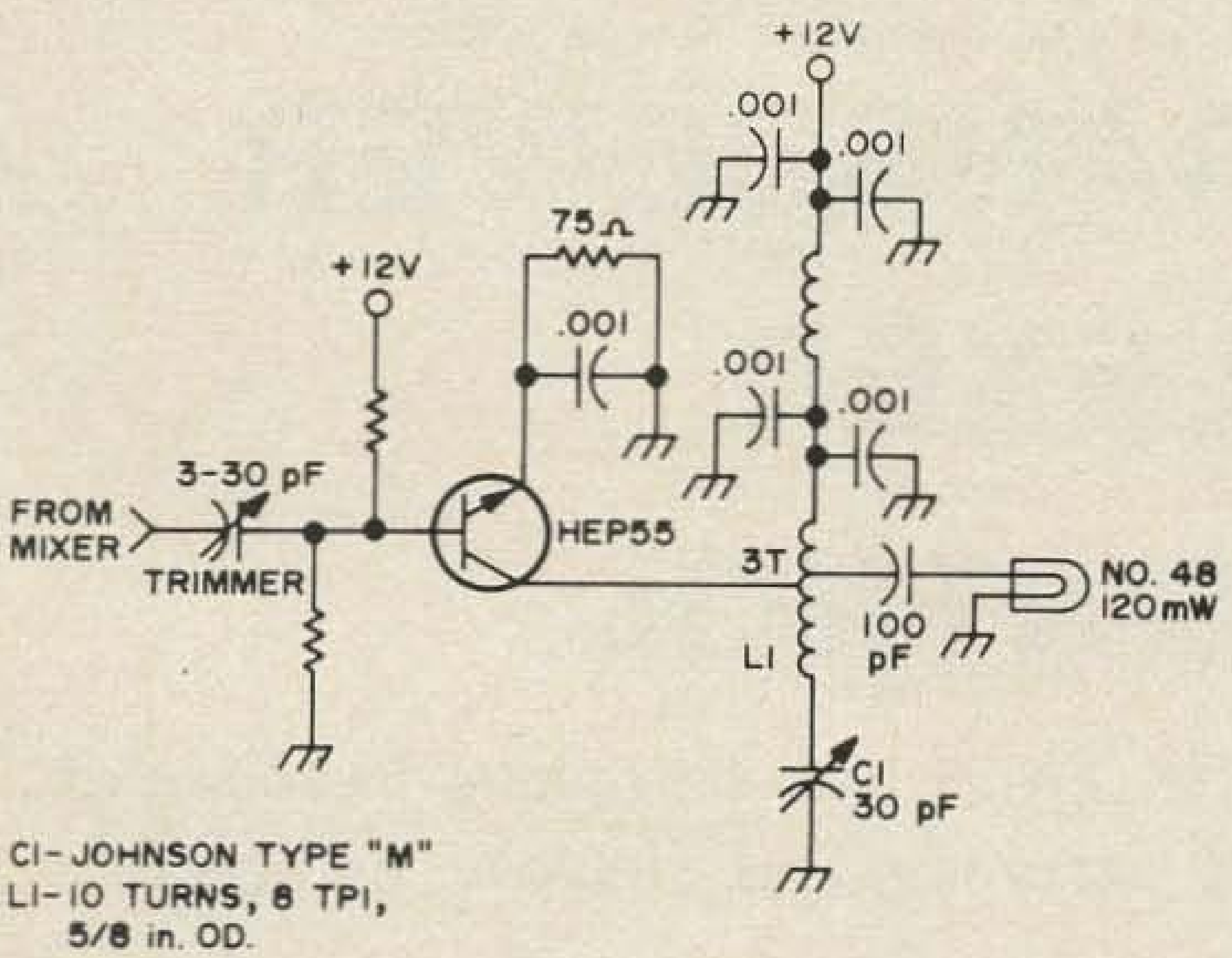


Fig. 8. Rf stage, 6 meter-HET-vfo.

Due to the normal internal feedback of transistors this stage can oscillate easily, so start with the input capacity at a small value, keep tuning both the mixer collector and the rf stage collector, and push the power up gradually with a temporary pot of 500 or 1000Ω in the emitter in series with the 75Ω shown. If everything is right you will find 50 MHz output when the collector circuit is coupled to a tuned diode detector. Keep increasing C1 until you come to the condition where self-oscillation occurs, then back off a little. The tap on the mixer coil can also be reduced from 5 turns above ground to a lower number at first. As it is now, in final adjustment, both circuits tune nicely without oscillation and are not critical.

This stage can be modulated in the usual manner, but I advise a Motorola HEP75 with a dissipation of *three* watts and a cut-off frequency of 800 MHz as a following stage. It puts out 600 mW on 432 MHz so you can expect at least a watt or so on 6.

Breadboard Layout

Figure 9 shows the layout exactly as built up here, and working fine. There is plenty of room for changing all the values as needed, testing transistors, and selecting another set of components for packaging in a minibox. The ground plane works as it should, with no ground-loop currents noticed so far. You can see the four separate stages on the breadboard and check out the individual operation of each stage by itself if you need to. Their packaging in a small box should not be difficult providing a little shielding is used correctly. Of course, nothing stops you from putting this one on the air as is.

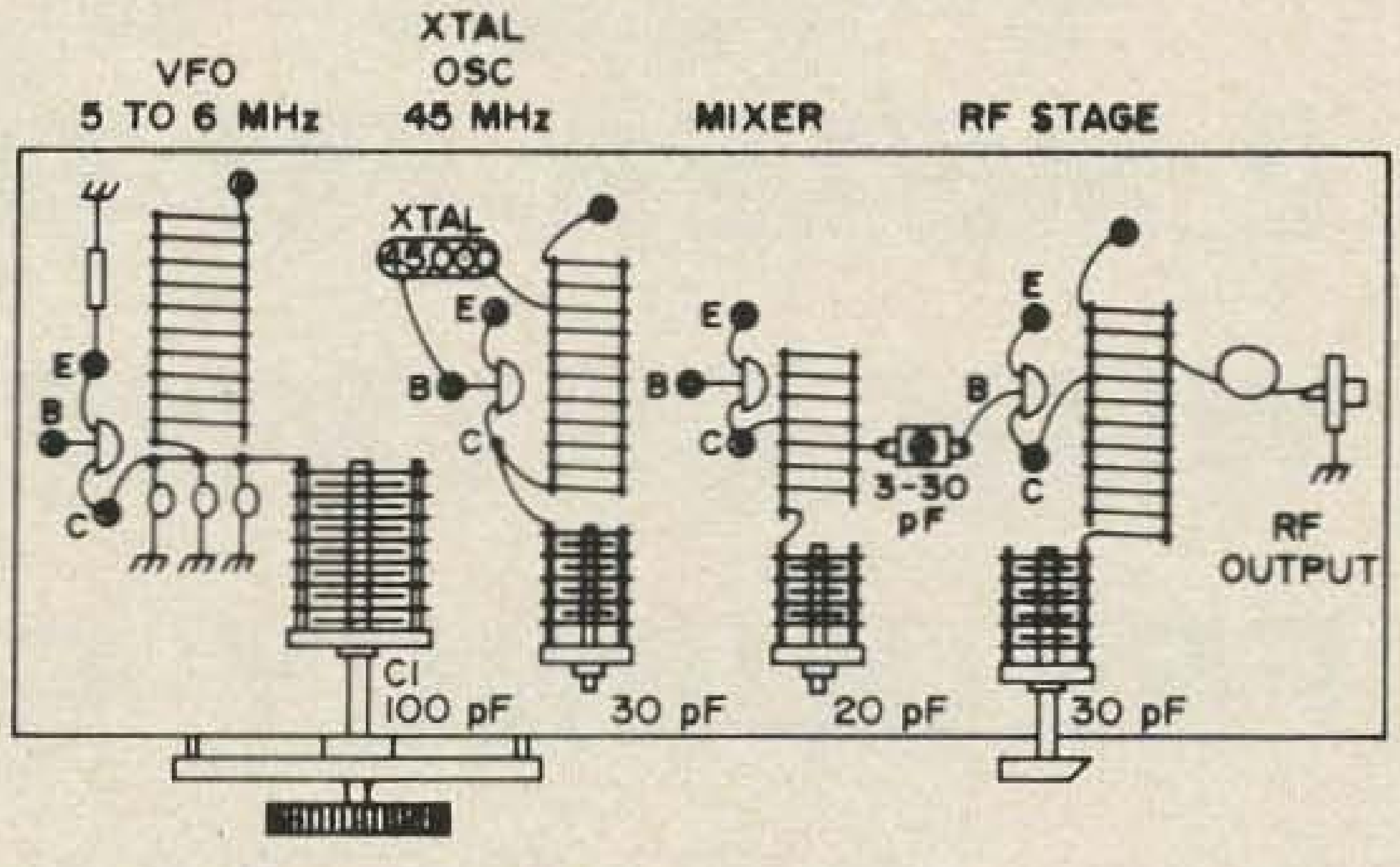


Fig. 9. Breadboard layout, 6 meter-HET-vfo.

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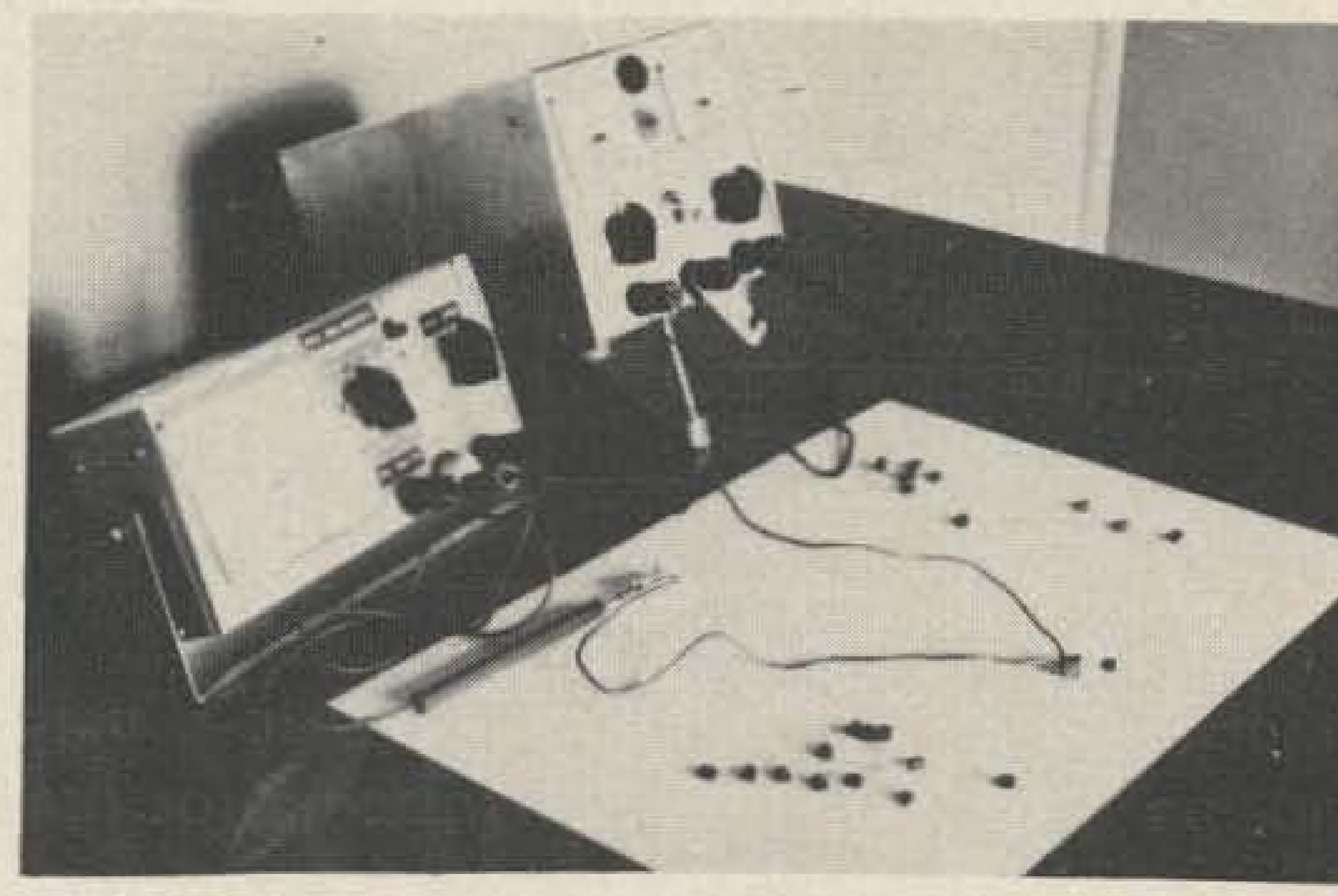
THE FET VOLTMETER AS A NANO-AMPERE METER

The Field-Effect Transistor voltmeter, an instrument which has an imput impedance of 22MΩ on all ranges with a full-scale deflection of 0.5V on the most sensitive range, is an extremely useful device and one that all hams should build. An added application of this instrument is as a nano-amp meter for measuring the gate-to-channel leakage of individual FET samples. This leakage current (called I_{GSS}) is quoted on the manufacturers' specification sheet as being 2 mA maximum for the 2N3819 and 20 mA maximum for the 2N3820 with 15V applied. This small current is just about impossible to measure using the usual selection of ham test equipment.

The I_{GSS} of a FET sample can be measured directly by using a 15V dc source and a K3LCU FET voltmeter. The circuit diagram shows the hook-up. The source and drain are connected and in effect the gate-channel junction is being tested as a reverse-biased diode.



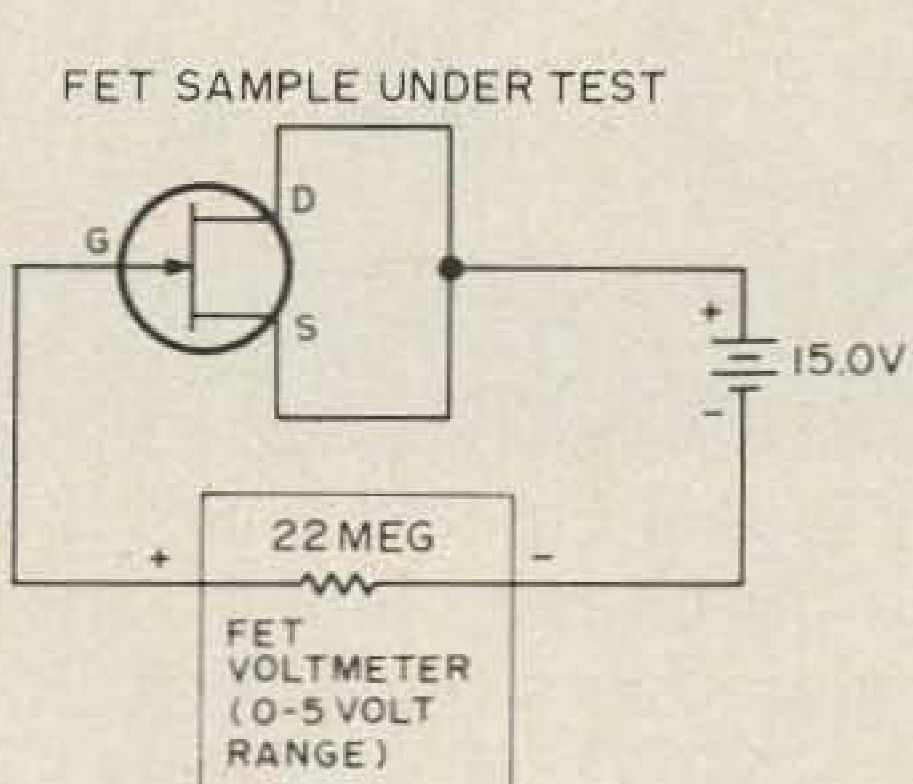


Diagram: The circuit of the I_{GSS} test. Note that the FET voltmeter is set to the 0.5V range and reads as 22.72 nano-amps full-scale. Polarities shown are correct for an N-channel device. If P-channel devices are to be tested then the supply connections and the meter connections must be reversed. This is most easily done by reversing the transistor socket connections.

The photograph shows my version of the K3LCU meter (see *73* July 1966 issue) – one of the handiest instruments I have ever built – and a home-built regulated low-voltage power supply. I have a transistor socket with suitable leads attached that I keep for this I_{GSS} measurement. The FETs are plugged into this socket and the I_{GSS} is shown on the FET voltmeter. I_{GSS} is temperature-sensitive so the reading depends upon the applied voltage and the junction temperature as well as the quality of the device junction. In practice, faulty FETs are very quickly sorted out.

The full-scale reading on the FET voltmeter is really the current corresponding to 0.5V applied across22MΩ.This works out at 22.72 nano-amps. For the 1.0V range on the FET voltmeter, the full-scale represents twice this current (45.44 mA).

This test will help to sift out the good ones from the surplus FETs now available.

. . .ZL2AMJ

Monroe McDonald K5DUS
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Dallas TX 75209

TIME/FREQUENCY MEASURING SYSTEM
PART I
system concepts

This is the first of a three-part series describing the component parts of a time/frequency measuring system for a well equipped amateur radio station and workshop. The goal is to obtain an accurate station clock and frequency counter which can be calibrated by the amateur in his own shop; the reasons for organizing the system as it is are given in the following paragraphs.

Two pieces of equipment are used: the GMT clock/time base, described in this month's article, and a 220 MHz frequency counter to be described in Parts II and III. Each of these items is useful by itself, but they are intended to work together as shown in the system block diagram, Fig. 1. This system will provide the amateur with a time and frequency measuring system which he can maintain accurately to better than one

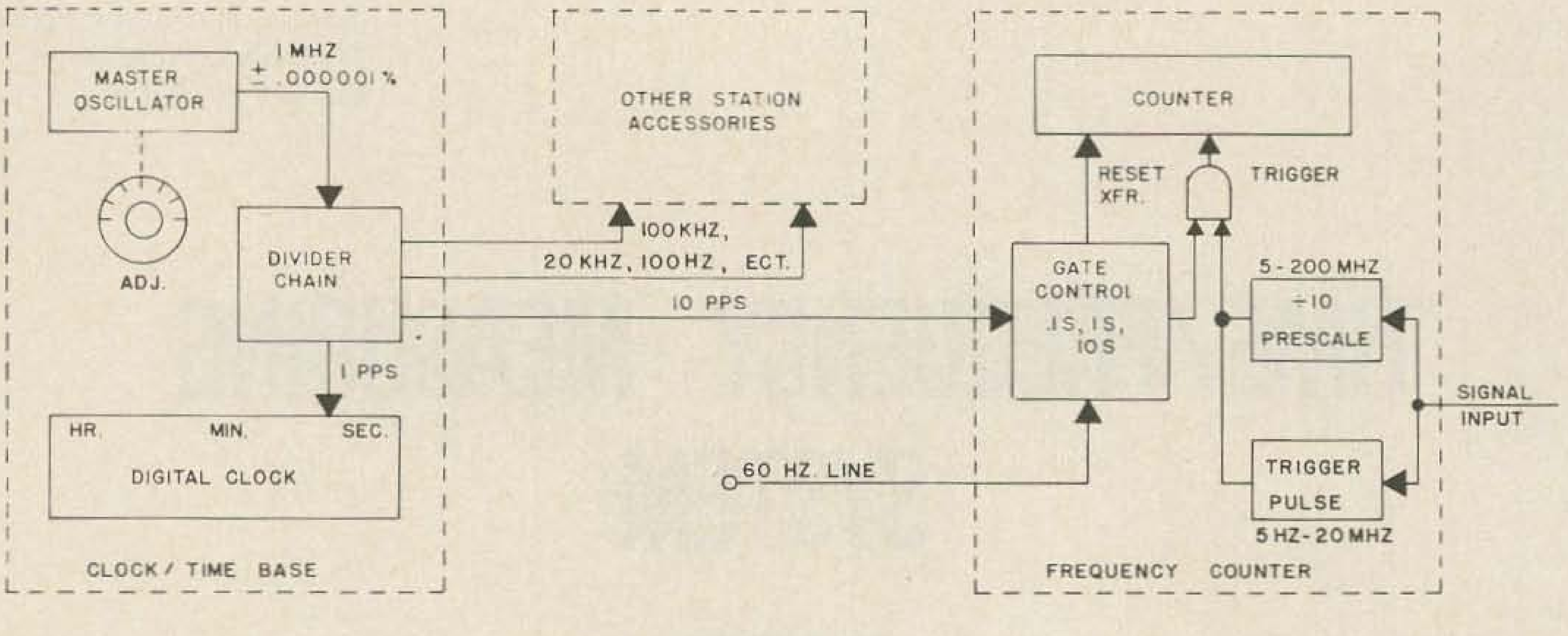


Fig. 1. System block diagram.

part in 10^6 (.0001%) with only a WWV receiver and a little patience.

There is no need to elaborate on the usefulness of a frequency counter, as it is fairly well recognized. This counter is different from most others in that it works to 220 MHz and has a different approach to the time base. The counter is intended to be used with the companion time base to get the specified accuracy, but has provision to use the power line for a reference with reduced accuracy (.01%) for use away from the home shop.

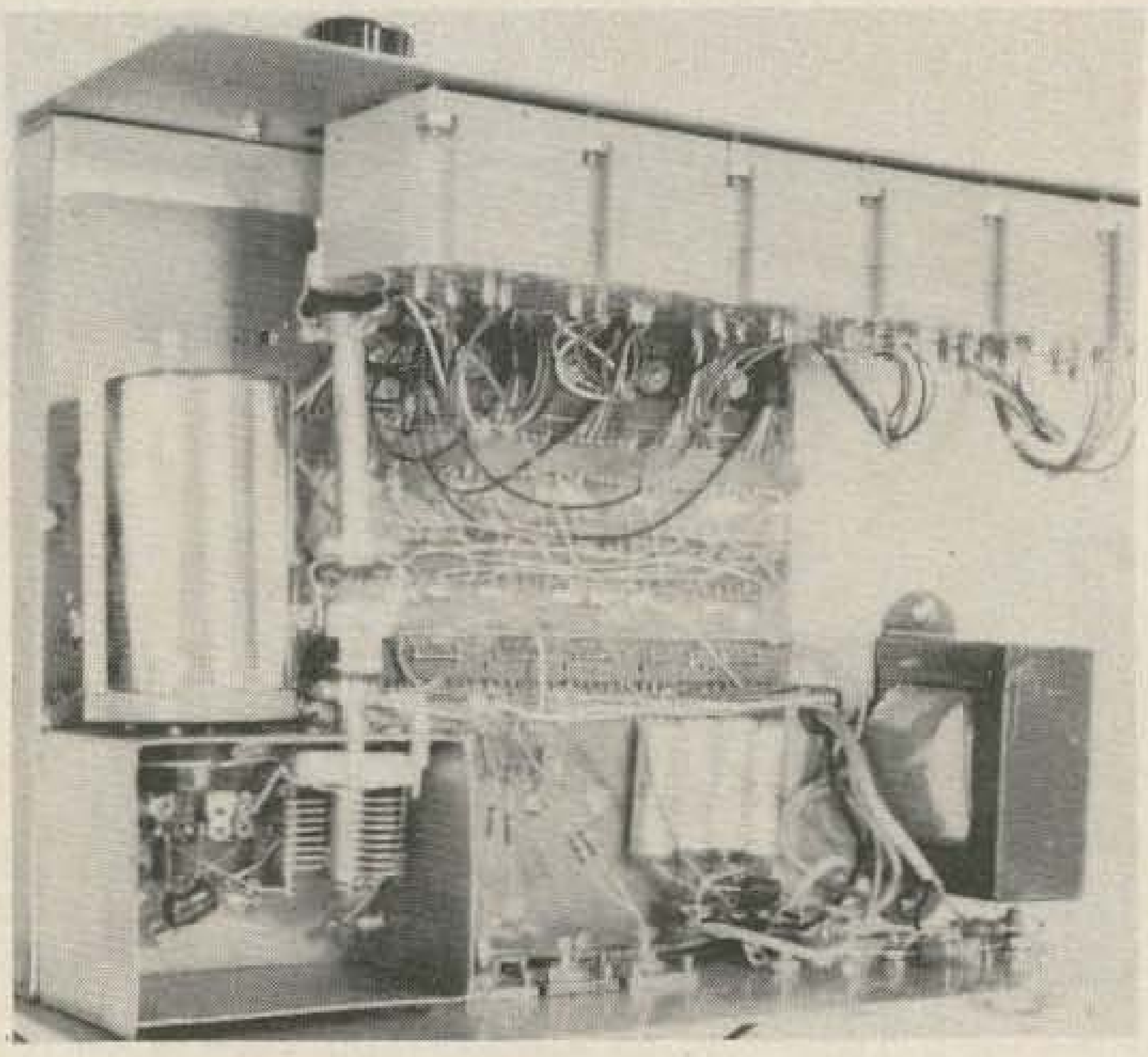
The 6½ digit counter features a Schmitt trigger, narrow pulse generator, and 10 second gate for accuracy at very low frequencies, a 1 second gate for low and medium frequencies, a 0.1 second gate (with kHz decimal point) for high frequencies, and a divide-by-ten prescaler for VHF. A decimal point is automatically set in the display to agree with the switch setting. A latching storage register is used to give a steady display as in all modern counters. Most circuitry is transistor-transistor logic (TTL) integrated circui (IC), with some discrete transistors in the trigger/pulse amplifier.

The clock is a 24-hour digital with hours, minutes, and seconds readouts, and also can be used to run remote slave readouts. All circuitry is IC, mostly TTL. The time base is a crystal oscillator with oven, followed by a divider chain to derive the specific trigger periods needed by the rest of the system. A battery power backup is used to prevent losing clock timing in case of ac power interruptions.

Besides the frequency counter, there are other uses for precision frequencies: VFO calibrators, phase-lock loop synthesizers, crystal substitutes, oscilloscope markers, etc. One station time base can run all of these.

Accurate Home Calibration

The clock is combined with the time base to provide a monitor on the accuracy of the time base, allowing the amateur to perform his own very accurate calibration. One part in 10^6 is 0.6 seconds per week, so weekly checks on the drift of the clock versus WWV provide a means for gradually getting the time base oscillator "right on." After several months of occasional adjustments I have achieved a drift rate of less than 0.1 second per month in my own unit, which is better than one part in 10^7 (.00001%).



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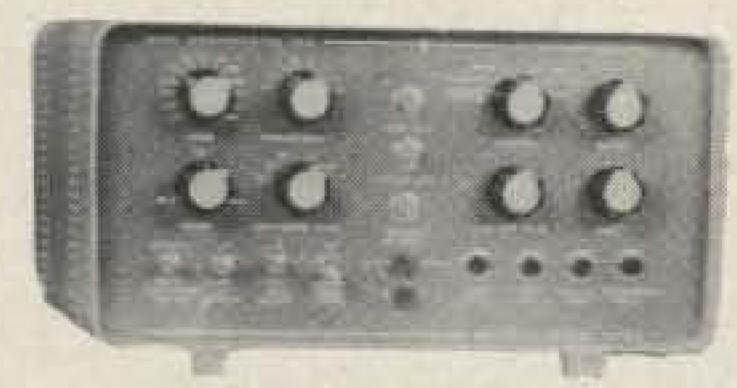

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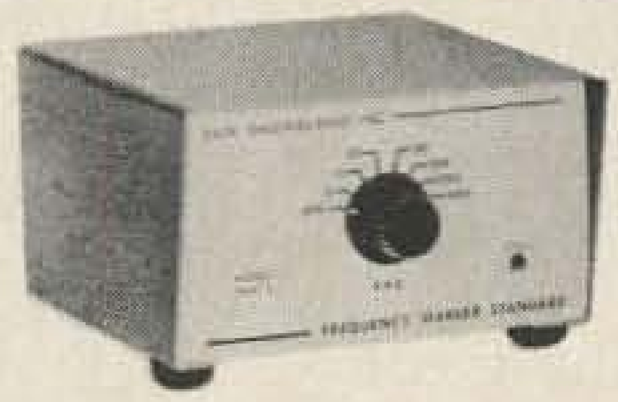

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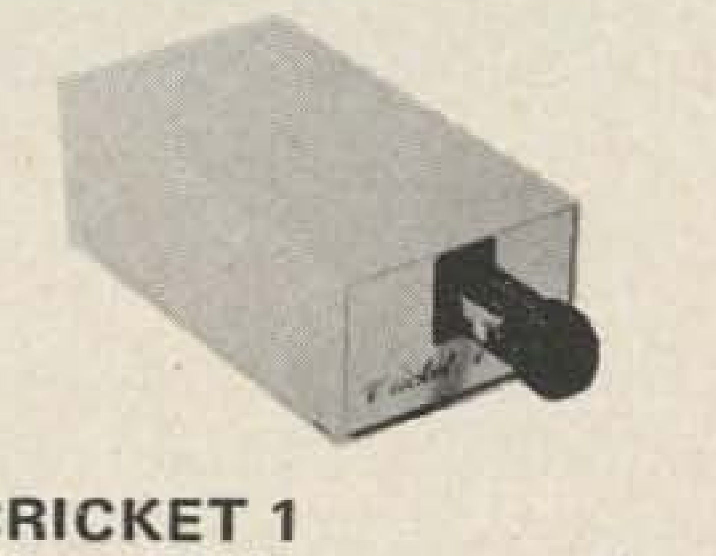

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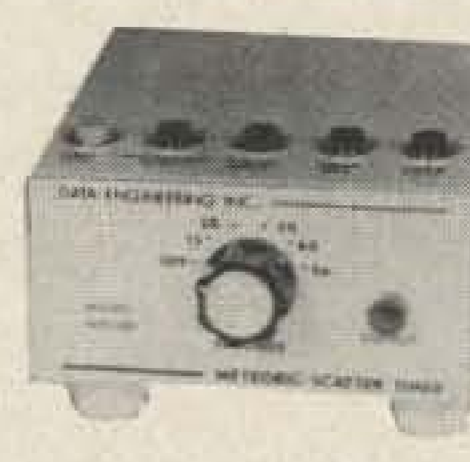

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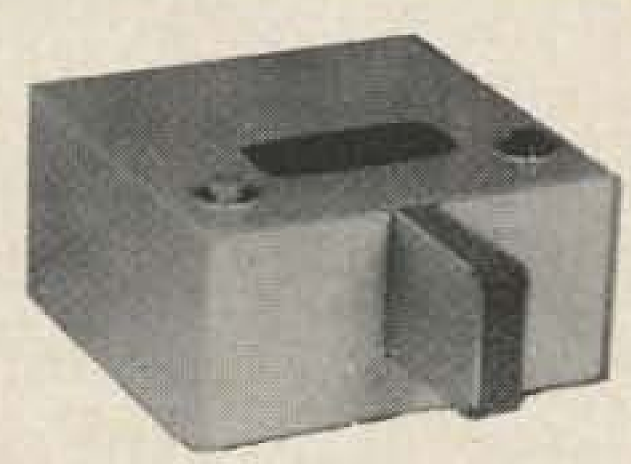

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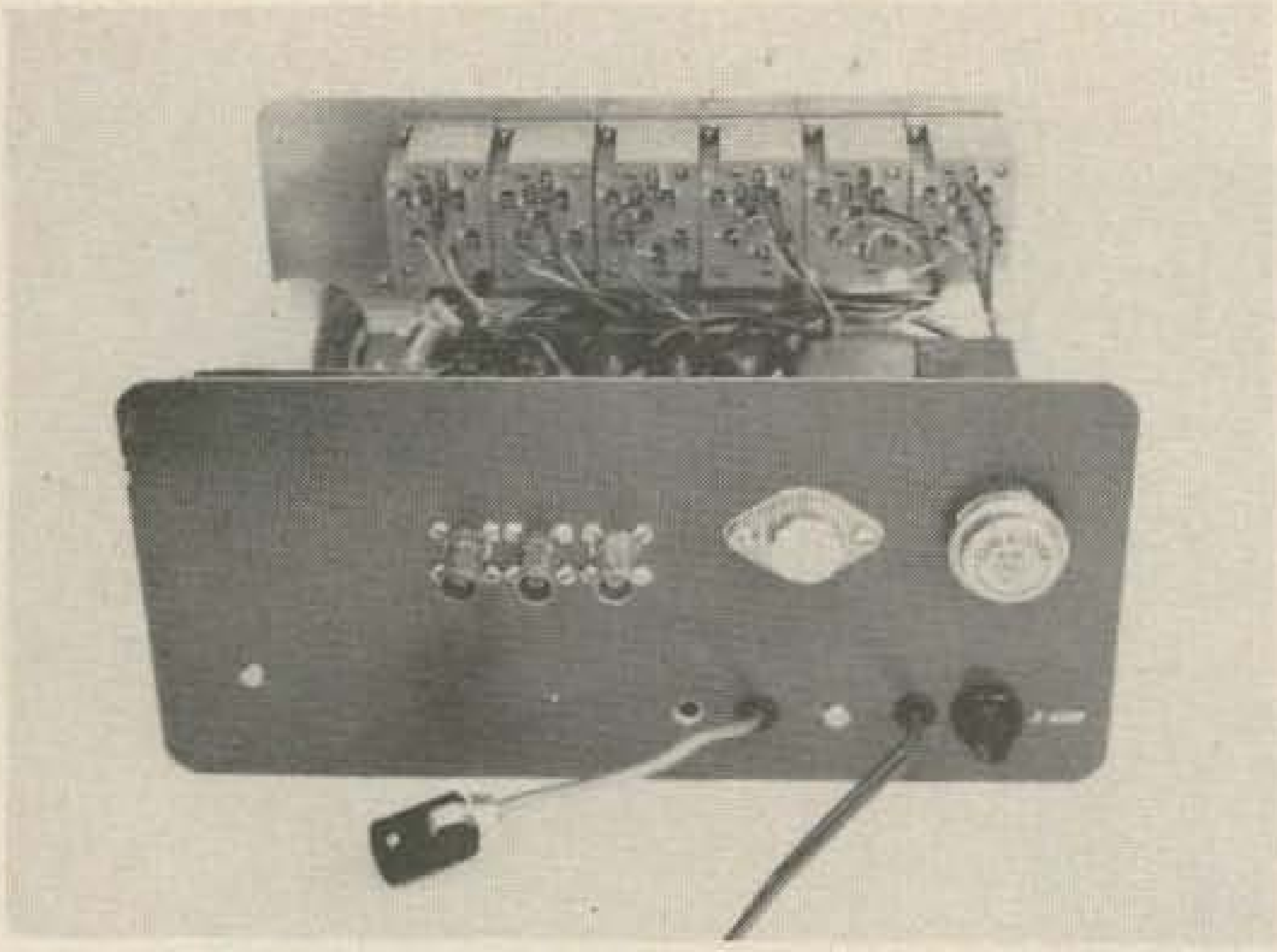

The time drift calibration method may seem a little tedious, requiring several weeks to months to achieve good calibration. There is actually very little to it, however. In my case, I spend about five minutes every Sunday morning listening to the one-second ticks on WWV and comparing them to the time changes on the clock. When the clock shows drift of more than 1/4 second from the previous week, I adjust the oscillator vernier control slightly in the direction to reduce the error, reset the clock to synchronize with the ticks, and wait another week. Many weeks go by with no adjustment required at all. If I miss a week, I just double the allowance for the next week.

It may occur to some (who haven't tried it) that one could calibrate an oscillator to any desired degree of accuracy by zeroing harmonics of the oscillator's output against the WWV carrier. This has been the classic method for many years of checking HF radio calibration with the 100 kHz crystal calibrator. This works fine as long as one is shooting for accuracy no better than one part in 10^4 (1.4 kHz on 20 meters for example). That is OK for 20m, but you will never net a 2 meter FM rig with measurements that crude! It may come as a surprise to some that the WWV carrier, as received in most locations, is not accurate to better than one part in 10^7 because of doppler shift in the skywave reflection from the ionosphere, which is constantly moving. The different techniques used to check zero-beat against the carrier degrade accuracy further; an audio beat for example is very poor, being no better than 10 Hz on a 10 MHz signal, or one part in 10^6, and usually worse. Some more exotic methods may introduce less error, but the ultimate limitation of the WWV signal itself still limits the accuracy to less than that needed to check a modern, state-of-the-art time base for a counter.

The 20 kHz VLF signal put out by WWVL is not subject to the doppler errors of the HF signals, and therefore is the frequency reference signal used by most laboratories requiring precise frequency calibrations. To use this signal, however, requires a VLF receiver and phase comparator, which is more equipment to build.

On Picking Frequency Tolerances

The reason for picking one part in 10^6 as being the minimum accuracy to shoot for in a counter design is that current VHF frequency tolerances (and VHF is where you *really* need a counter) require radios to be set to .0005%, or 5 parts in 10^6.

A device to measure this frequency must be significantly better than this, so one part in 10^6 is a worst case. As a related matter, the readout capability of the counter should be compatible with the accuracy of the instrument. In other words, a counter with an accuracy of one count out of one million (10^6) should have a six-digit readout. Any less than this, and the full capability of the counter is not being used. Any more, and the user is kidding himself by reading meaningless numbers. For instance, I could have built a nine-digit counter and thus be able to read 220 MHz to the nearest cycle, but this is better than one part in 10^8, and the last two digits would be unreliable. Something like "measuring with a micrometer and marking with chalk." This same rebuttal applies to those who argue that they don't like prescalers because they can't read the frequency to one cycle!

I chose to make the counter/time base and the counter in separate units, because I use the counter/time base as an accessory with my HF rig; that's where I want the clock and that's where the WWV receiver is, while the counter stays across the room at the work bench. The two units are connected by one coax cable. A builder could economize by putting both units in one cabinet to share a power supply, decoders, and readouts.

...K5DUS

ACTIVE FILTER DESIGN AND USE PART IV

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State College PA 16801

In the previous parts of this series on active filters we have converted LC passive filters to active RC transistor filters and integrated circuit designs to active RC transistor filters and integrated circuit designs with external frequency compensation. Although all common types of filters were covered, design emphasis was placed on filters in the low or audio range of frequencies where bulky inductors tend to become both inefficient and unwieldy. However, the same principles can be applied to higher frequency filters and in this last part we will design a number of active filters in the high frequency range in addition to some circuits that should prove useful to the amateur.

As the frequency of interest rises, active filters utilizing RC networks tend to become progressively less efficient. In an attempt to maintain a satisfactory component value ratio, and still maintain reasonable Q, the resistors of the twin-T configuration are reduced in value only as much as necessary to allow the corresponding capacitors to fall in the low picofarad range. Such sacrifices reduce the usefulness of the twin-T above ultrasonic frequencies to relatively wide bandpass amplifiers and other requirements where bandwidth/attenuation values are not too low. Figure 1 shows a circuit designed around the RCA CA3035 linear integrated circuit amplifier and a twin-T network. At a frequency of 455 kHz, the component values of the network have dropped to a point where Q becomes a problem. However, the circuit is still useful as a buffer amplifier to follow a local oscillator stage, or give low attenuation over a medium range such as might be desired in the first i-f of a scanning receiver. Capacitors C5 and C6 act only as dc blocking capacitors. Varying R4 will provide a slight change in center frequency and Q The response of the circuit is shown in Fig. 2. Increasing the value of R1 will increase Q, but at the expense of gain. The curves of Fig. 2 show the response with both 120 kΩ and 270 kΩ resistors at R1.

In Fig. 3, a variation of the twin-T notch allows the active filter to be tuned over a 10:1 range. Resistor R1 again affects Q and

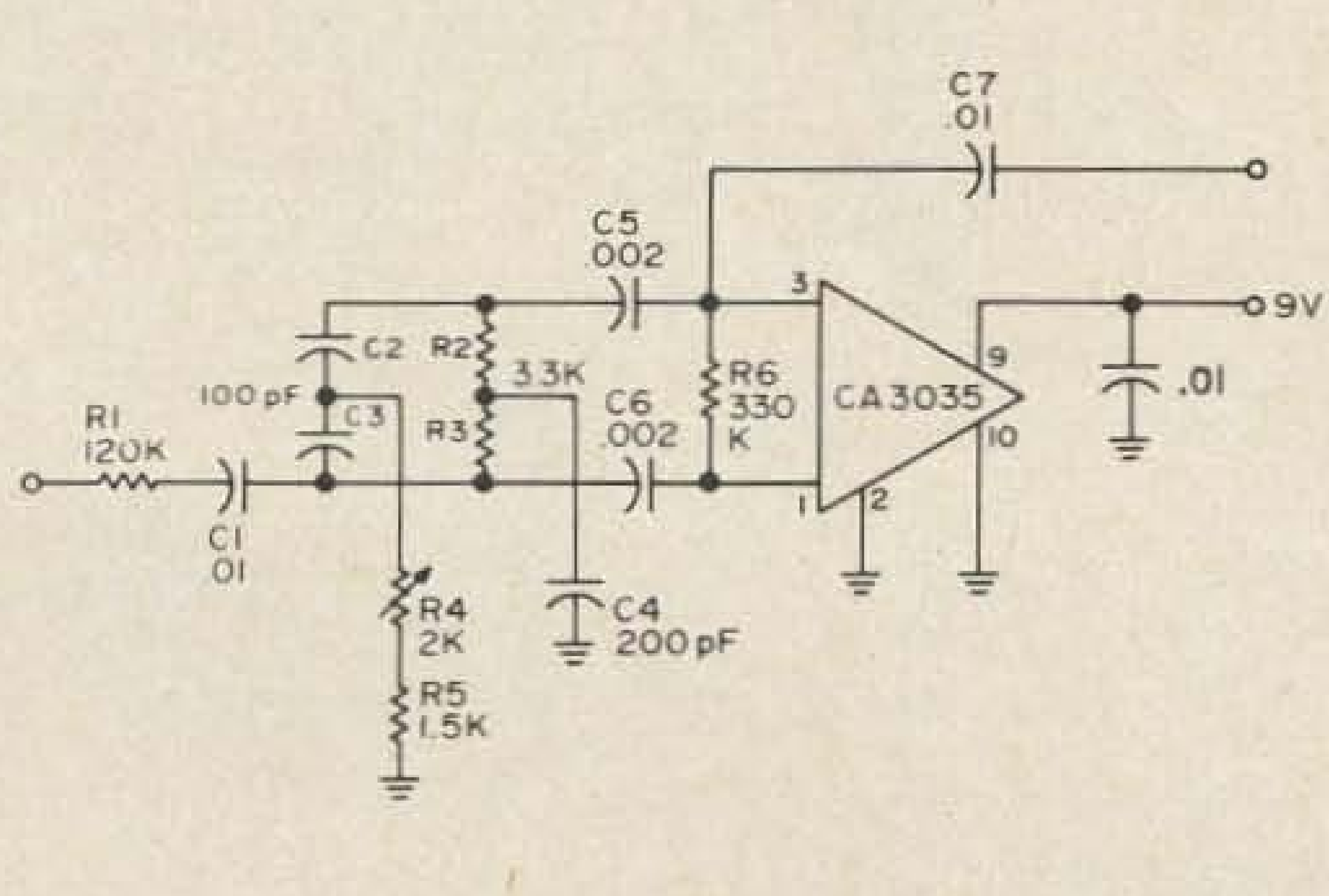

Fig. 1. 455 KHz bufferamp/filter.

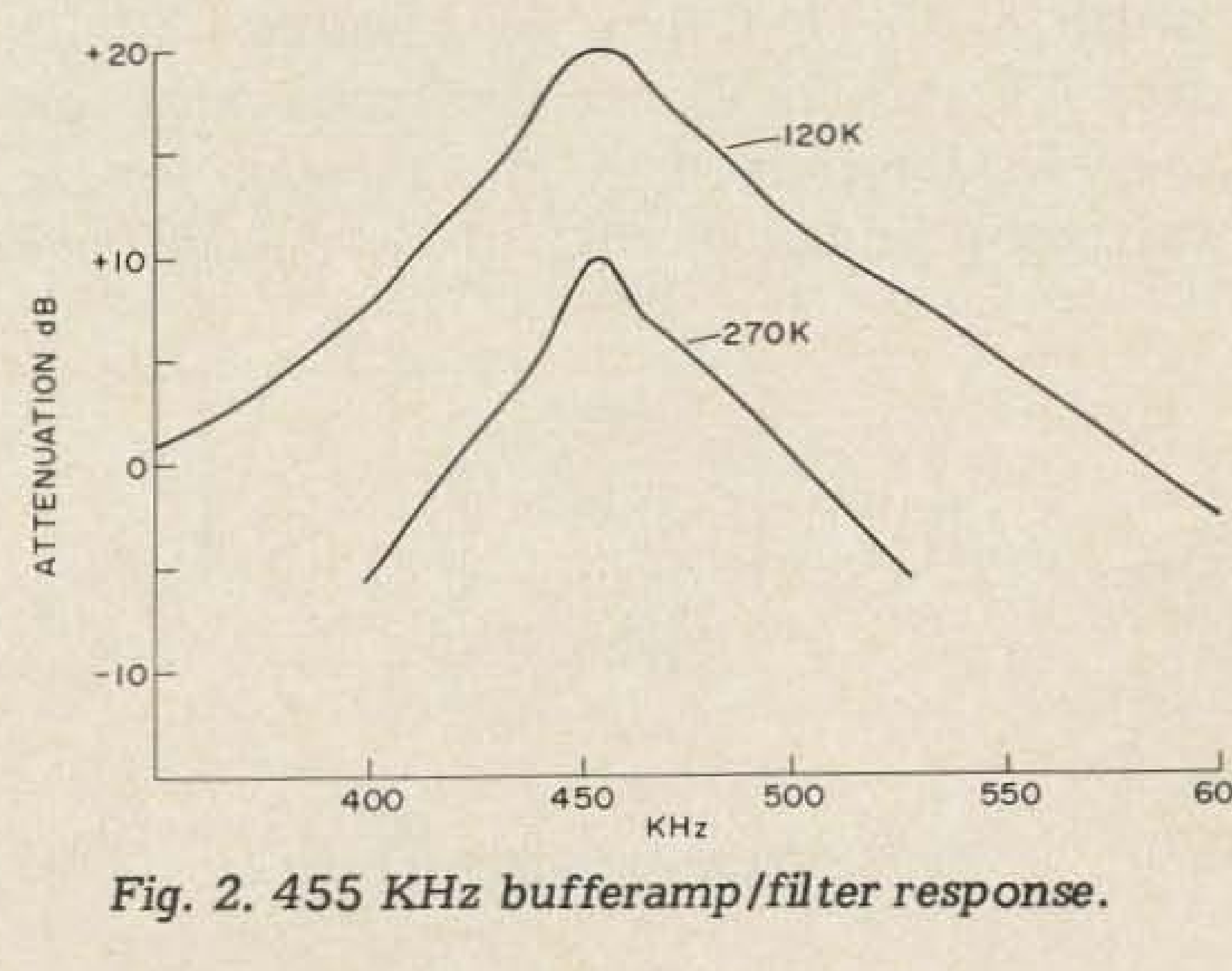

Fig. 2. 455 KHz bufferamp/filter response.

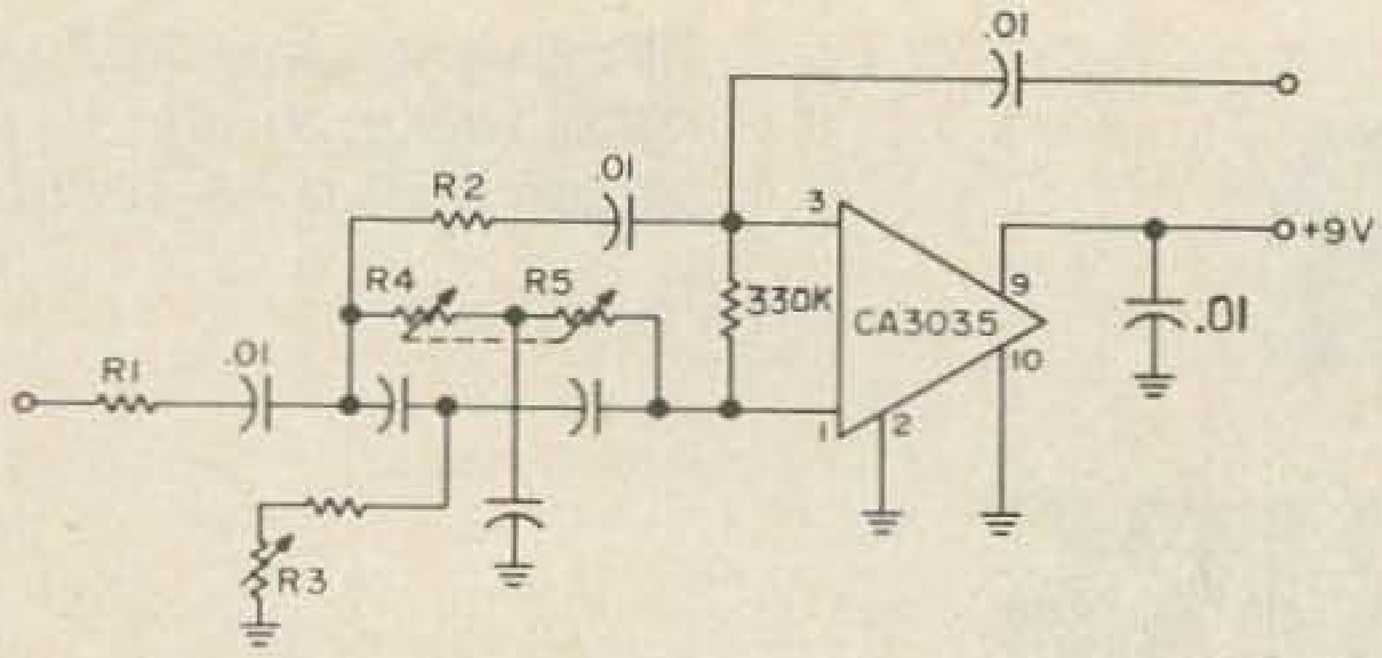

Fig. 3. Variable notch filter.

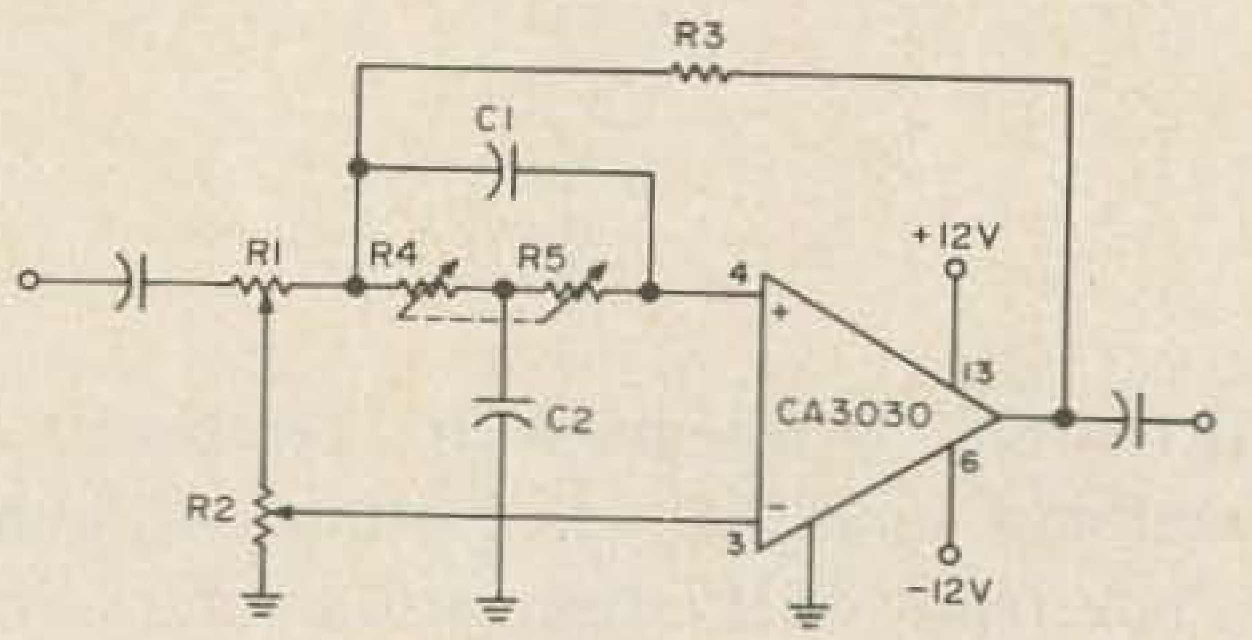

Fig. 4. Deep notch filter w/variable Q, frequency.

gain while R3 fine tunes Q. Ganged variable resistors R4 and R5 control the frequency of the notch while resistor R2 limits feedback.

Carrying the design of Fig. 3 further yields the configuration shown in Fig. 4. This deep notch filter may be varied in both Q and frequency. Using an operational amplifier as the active element allows differential operation of the amplifier to assure high attenuation of the notch frequency. The input signal is fed to the positive terminal, while a portion of the input signal combined with feedback from resistor R3 is fed to the negative input terminal. By adjusting R2 so that both inputs are equal, the output becomes zero, producing infinite attenuation at the notch frequency. This notch frequency can be varied over a 10:1 range by resistors R4 and R5. Varying resistor R1 alters the circuit Q allowing the width of the notch to be adjusted. Capacitors C1 and C2 are of the same value and may be determined by the formula for the capacitor bridge section of the twin-T net-

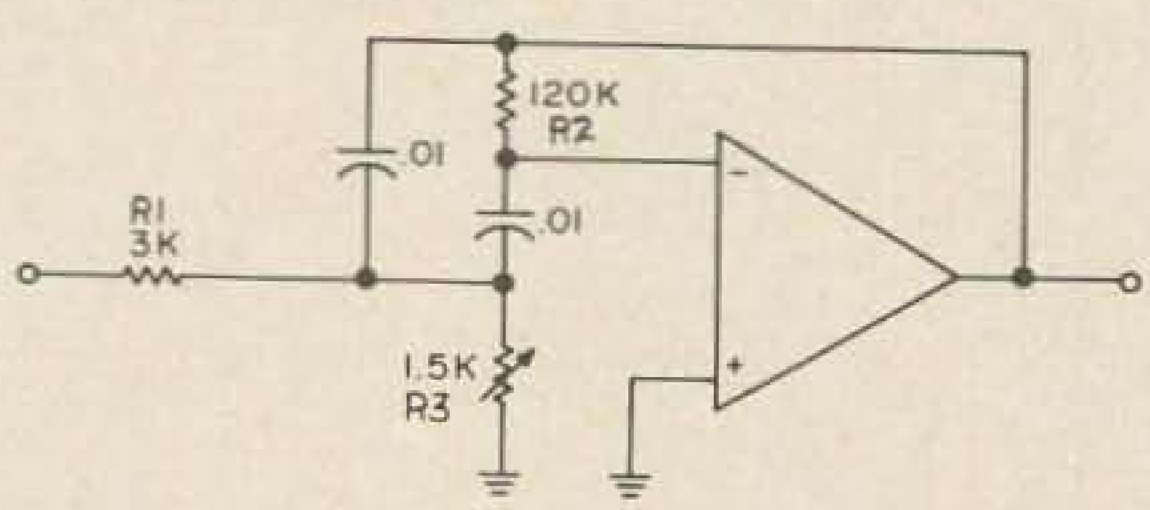

Fig. 5. Variable bandpass filter.

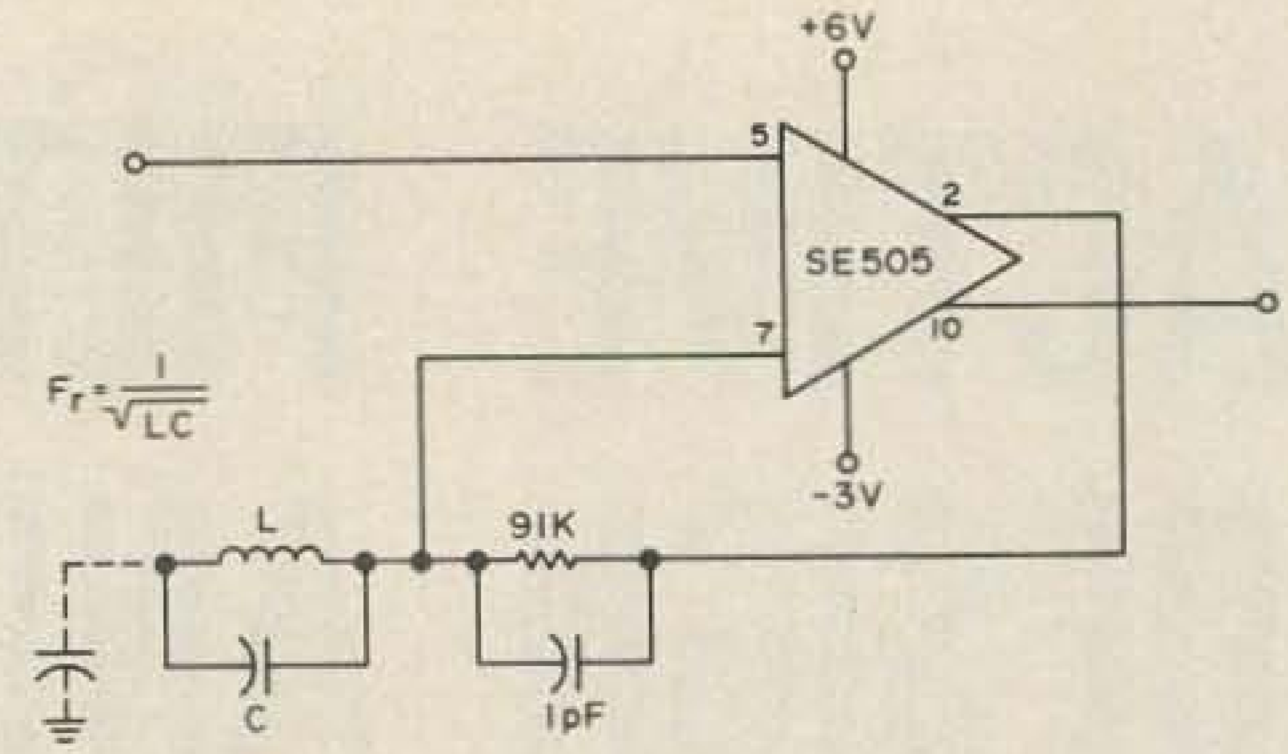

Fig. 6. Band reject amplifier.

work discussed in an earlier part of this series.

An active bandpass filter which can be varied in frequency, without affecting the bandwidth or gain, is shown in Fig. 5. The center frequency is controlled by resistor R3 while retaining a constant bandwidth of about 260 Hz. The component values shown will produce a bandpass response centering close to 2 kHz, with more than 26 dB gain. To design for a frequency of your choice, choose a convenient value for the capacitors, the desired gain and bandwidth, and plug these values into the following formulas:

$$R_1 = \frac{1}{2\pi BcGC}$$

$$R_2 = \frac{1}{\pi BwC}$$

$$R_3 = \sqrt{\frac{1}{2\pi C[(2f2/Bw) - BwG]}}$$

As with other active filters, this type may

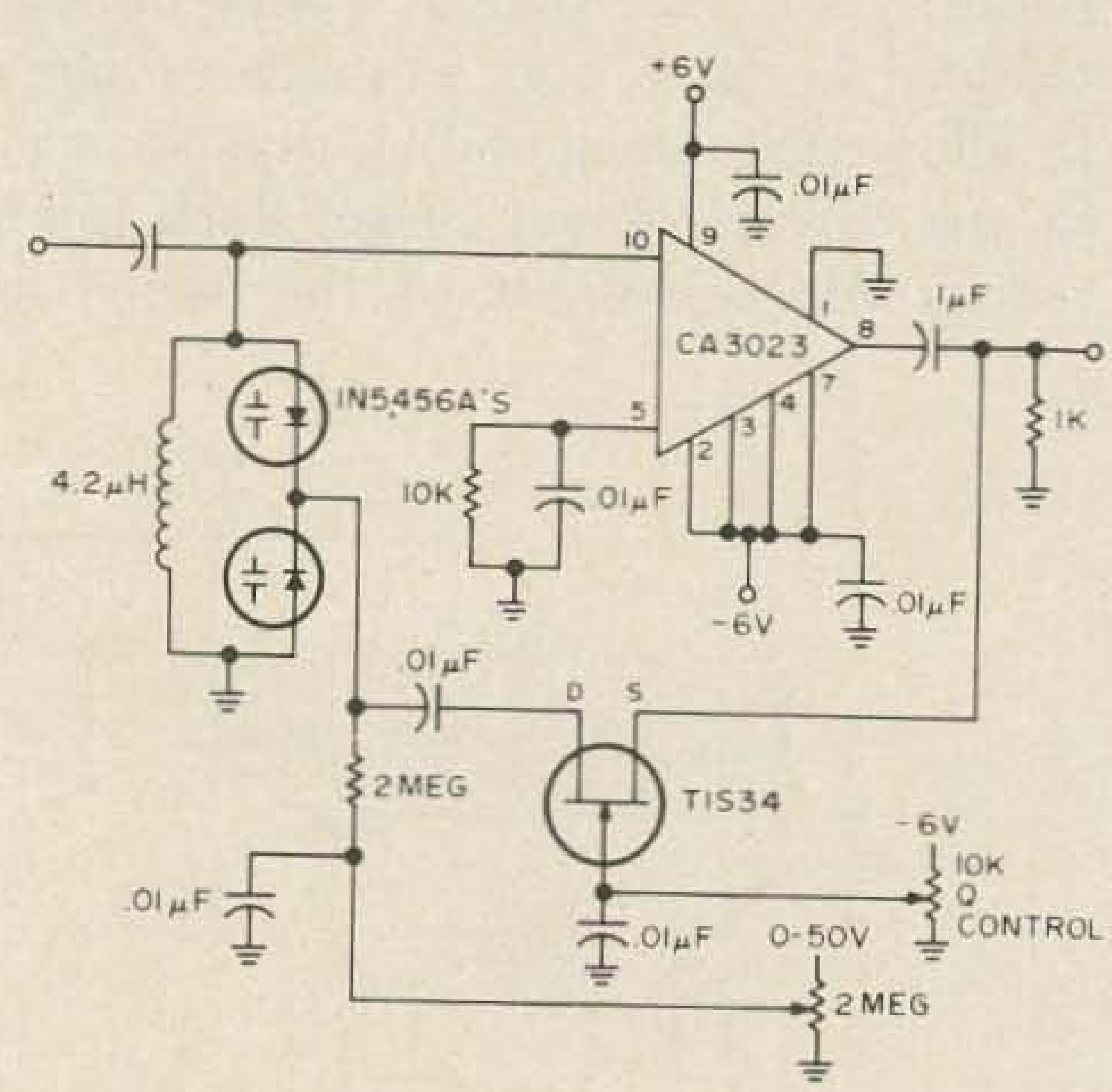

Fig. 7. Tunable i-f amplifier w/variable Q.

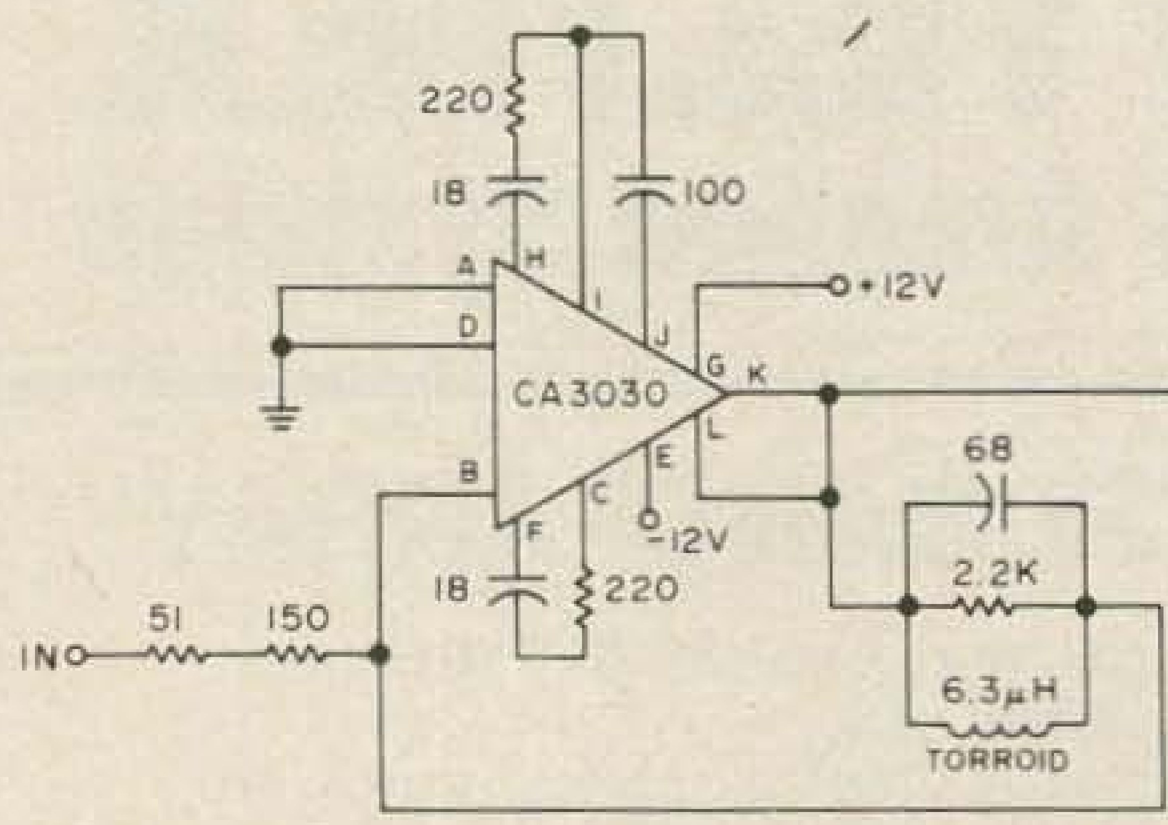

Fig. 8. 10 MHz bandpass amlifier.

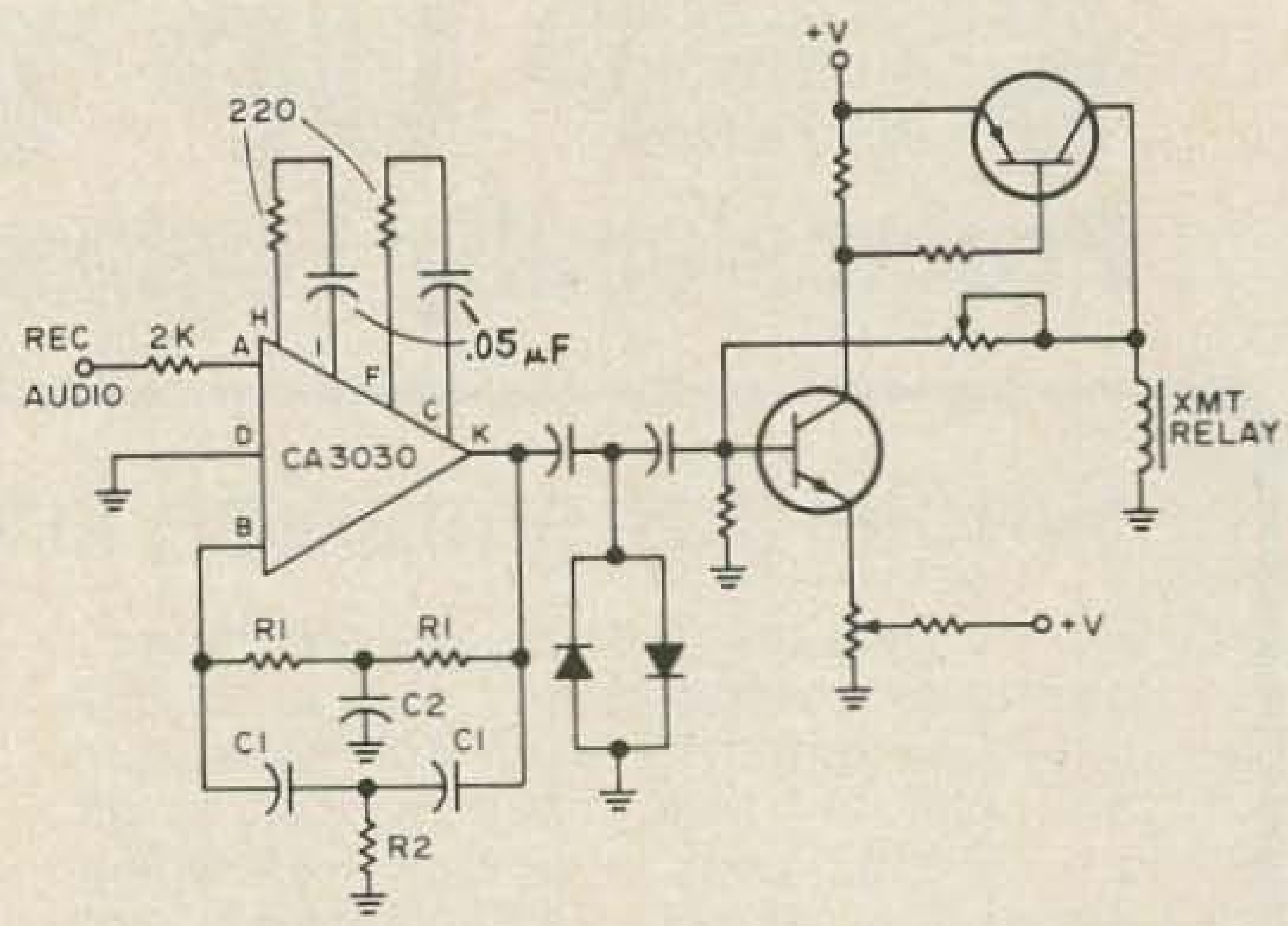

Fig. 10. Tone decoder filter.

also be cascaded and the individual filters tuned to different frequencies to provide a variable comb effect.

Active filters at radio frequencies require integrated circuits with the necessary frequency response and the return to inductors, although of a more convenient size. Figure 6 shows a band reject amplifier utilizing a Signetics differential amplifier. Good Q can be obtained, where wide response is not a requirement, by using torroid cores for winding the coils. By changing the position of C to that shown in the dashed line, the circuit becomes a bandpass amplifier. The Signetics integrated circuit has a bandwidth dependent upon power supply voltage, approximately 10 MHz for the voltages shown in Fig. 6, and may be pushed to 30 MHz with a maximum total voltage supply of 12 volts (+9 and -3 volts, etc.).

Every ham has, at one time or another, wished he could tune his receiver i-f off frequency slightly and/or increase i-f gain to get rid of interference. The novel circuit shown in Fig. 7 will do both, and when used with a high frequency integrated circuit, will provide a tunable rf amplifier. The values shown give a tunable response at about 10.7 MHz. The RCA CA3023 integrated circuit amplifier provides gain to 30 MHz. The field effect transistor acts as a variable resistance of the tuned circuit network and thus the input resistance of the amplifier. A change in the amount of feedback, or load resistance, will affect the Q of the tuned circuit. An increase in circuit Q of more than 2000 is possible while tuning control places the highest gain of the response at the desired frequency.

An RLC bandpass amplifier, utilizing the RCA CA3030 integrated circuit, is shown in Fig. 8. This amplifier will provide a gain of 20 dB at a center frequency of 10 MHz with a 3 dB response of about 1 MHz, as shown in Fig. 9. The effective Q of this circuit works out to be about 10.

Tone signaling and decoding circuitry can be greatly simplified by incorporating operational amplifiers as filter amplifiers. Use of the twin-T design is shown in Fig. 10. Values for the twin-T network are determined according to the following formulas:

$$R_1 = 2R2$$

$$C1 = \tfrac{1}{2}C_2$$

$$f_o = \frac{1}{2\pi R_1 C_1}$$

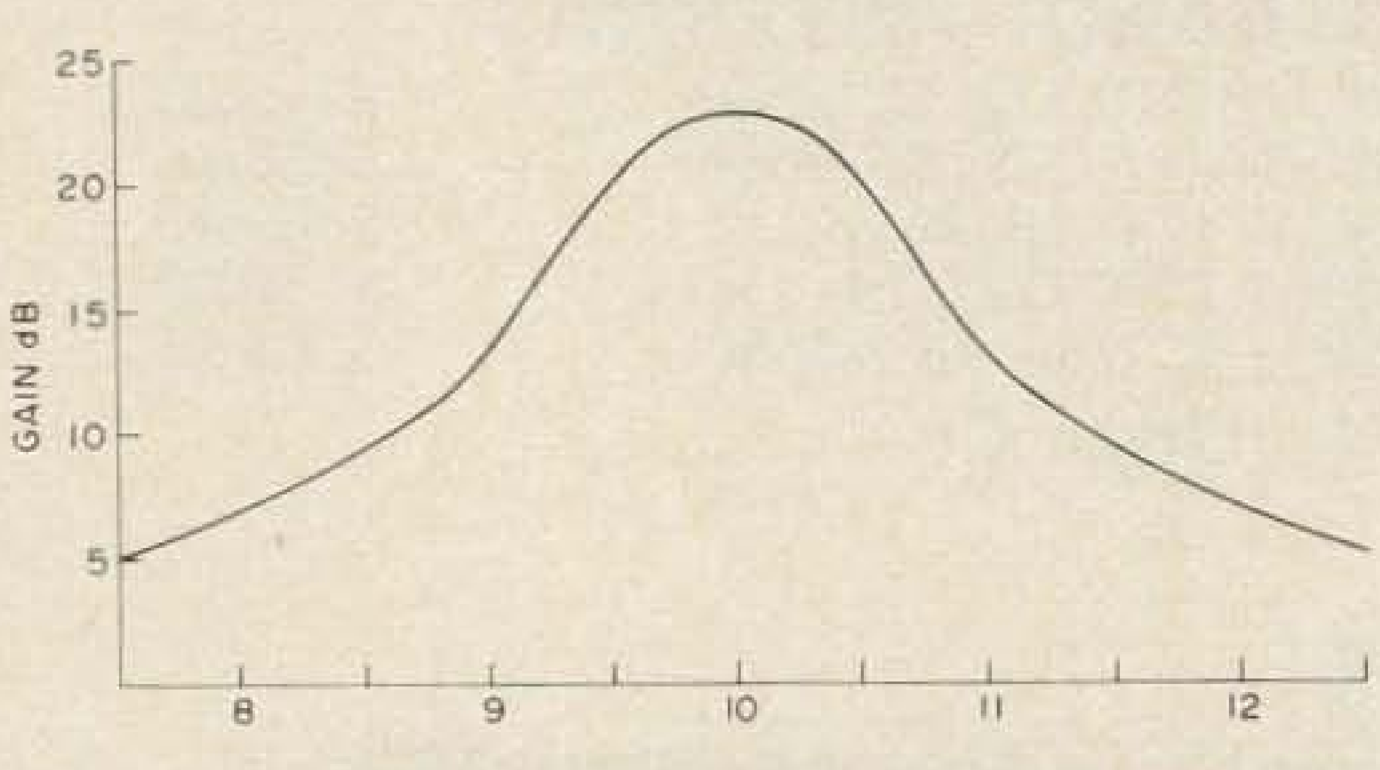

Fig. 9. 10 MHz bandpass response (w/o toroid).

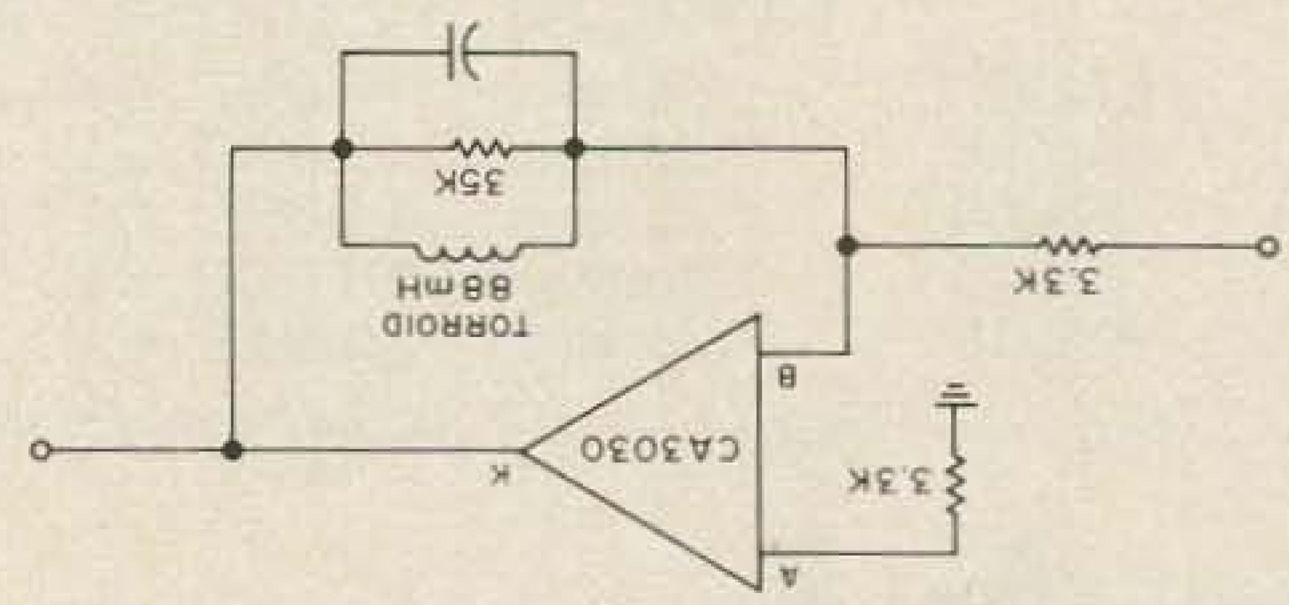

Fig. 11. LC circuit for tone decoder filter.

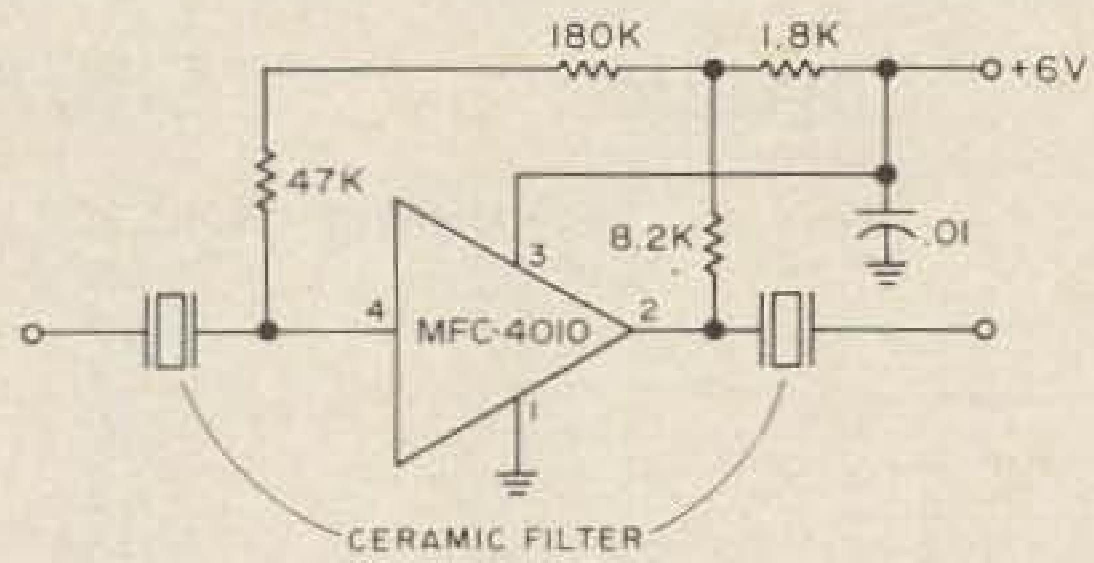

Fig. 12. 455 kHz i-f amplifier.

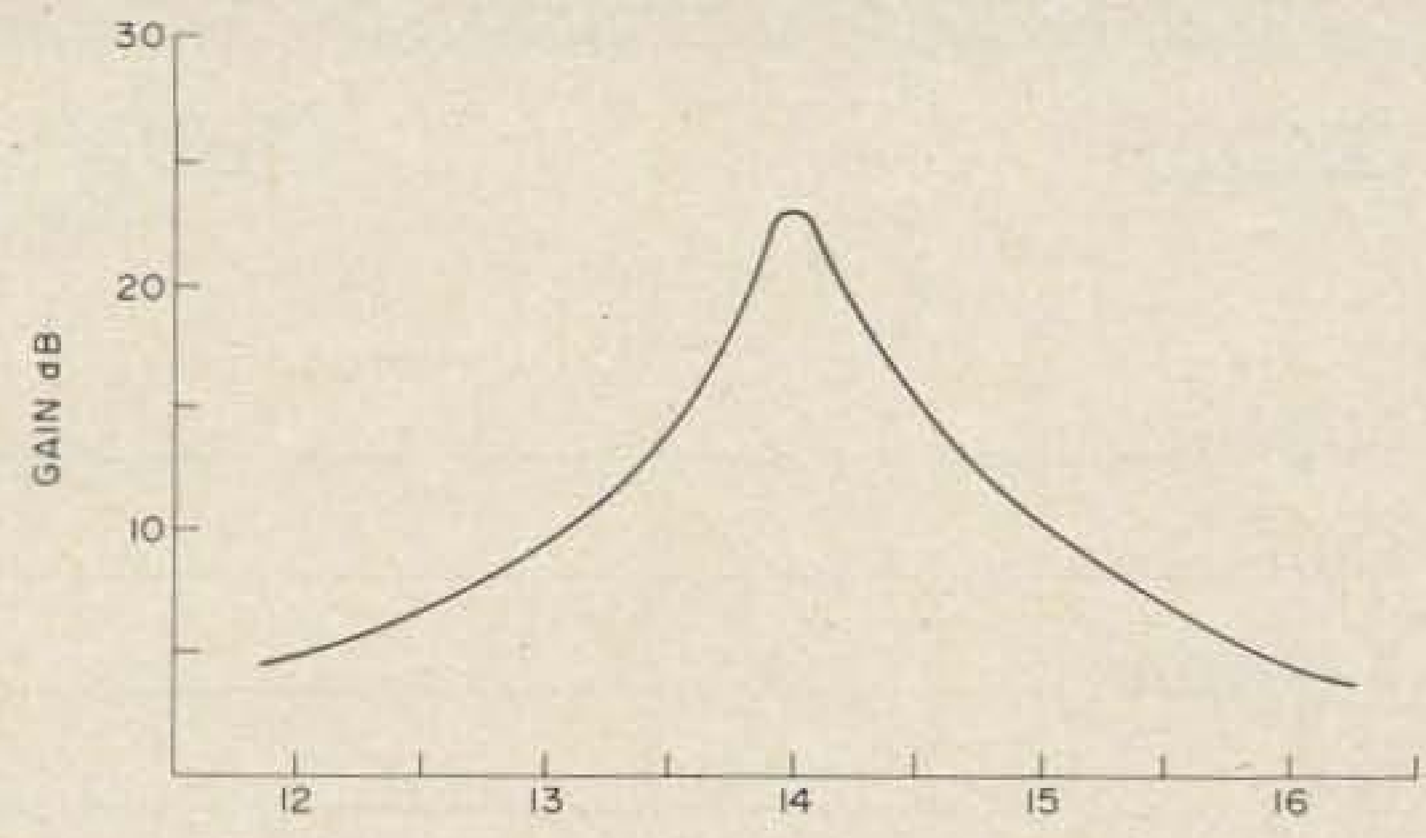

Fig. 14. Response curve of 14 MHz amplifier.

If you have a few 88 mH torroids in your parts box, the circuit of Fig. 11 can be used. This configuration shows the operational amplifier in an inverted mode, the only design which will produce a true single tuned response. Circuit Q here approaches 33 with a gain of more than 20 dB. In multiple frequency decoders, different tuned amplifiers may be paralleled with the necessary switching circuitry to provide coded entry into a repeater system.

Integrated circuits can also be used with ceramic or crystal elements as frequency components. The circuit of Fig. 12 gives 70 dB gain at a frequency of 455 kHz. Due to the fact that more gain is available from integrated circuits as compared to discrete components, impedances are easier to match without worrying about insertion loss or distorted responses.

Although single resonant circuits coupled with a linear or operational integrated circuit cannot be expected to provide narrow band responses at higher frequencies, they are useful as preamps or in other areas where a wider response curve can be used. Offering more than 20 dB gain, the circuit shown in Fig. 13 is designed for 20 meters where the 3 dB points of the response are less than 1 MHz wide. Figure 14 shows the response of the 14 MHz amplifier.

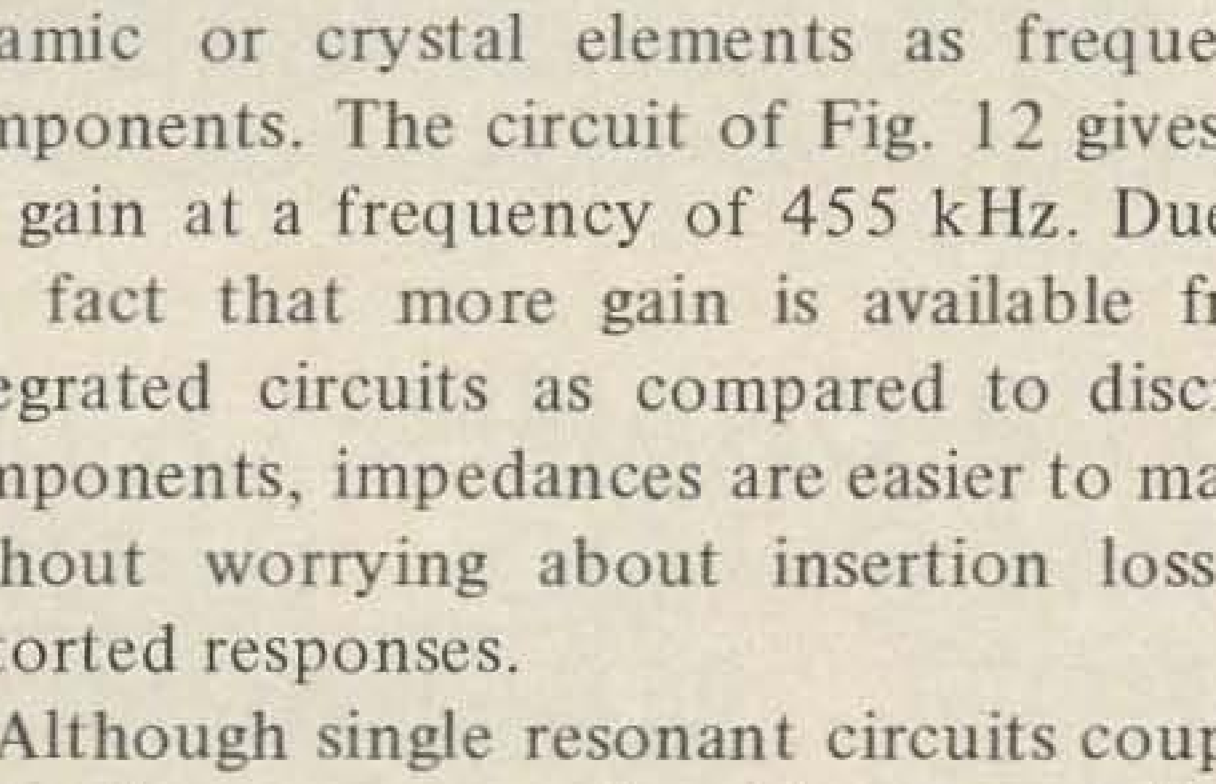

Fig. 13. 14 MHz amplifier.

By the time you read this article, there will have been new advances in integrated circuit fabrication and design. However, the basic design methods will remain the same. We will probably see integrated circuits with greater available gain without the probability of feedback and possibly circuitry incorporating inductors and capacitors which can be changed in value by application of external control voltage.

For those interested in pursuing the subject of active filters further, I recommend, in addition to the article references, the newly published book *Active Inductorless Filters*, edited by Sanjit K. Mitra. It can be obtained through the IEEE, 345 E 47th Street, New York, NY 10017, at $7.50 for members and $9.95 for non-members.

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Ken W. Sessions, Jr. K6MVH

TRANSMISSION-LIMIT TIMER for REPEATERS

The ARRL won't be issuing Ragchew certificates to your repeater users, but then you won't be replacing finals every other day either.

A repeater should think for itself! It makes sense if you really consider it. The thing sits by itself all day every day (and night, too), spewing out whatever anyone wants to put into it. The only brain it has is the one owned by the body who sits at the business end of a control link. How much of a relief it would be to the control operator if the repeater itself could do most of the active monitoring – reducing his duty to not much more than keeping an ear tuned for dirty words.

The kind of brain every repeater really needs is actually quite simple. Primarily, it must limit the length of the repeater transmitter's "on" time. When a relay gets stuck shut, the "brain" would sense the problem and cut off the transmitter. When the local clown decides to play music through your system, or send endless Teletype signals through it, he won't be able to do it for long because the "brain" will know, and it will shut the repeater down for the duration of the attack. When a mobile operator sets his mike down on the seat and sits on the push-to-talk switch (it happens all the time!), the brain will put up with it for a minute or so – but if the anomaly persists, the brain cuts off the output of the big machine. When a long-winded operator ties up the repeater with another of his drawn-out ragchewing dissertations, you don't have to worry about hurting his feelings by telling him about it. Let the brain cut him out – automatically; he'll soon learn to keep his transmissions short, giving others a chance to use that fantastic communications system up there on the hill .

The Circuit

The timer circuit shown in Fig. 1 is the brain; it's ideal for just about all your repeater's timed operations because it is highly reliable on the one hand, and it is adjustable over a very broad period range on

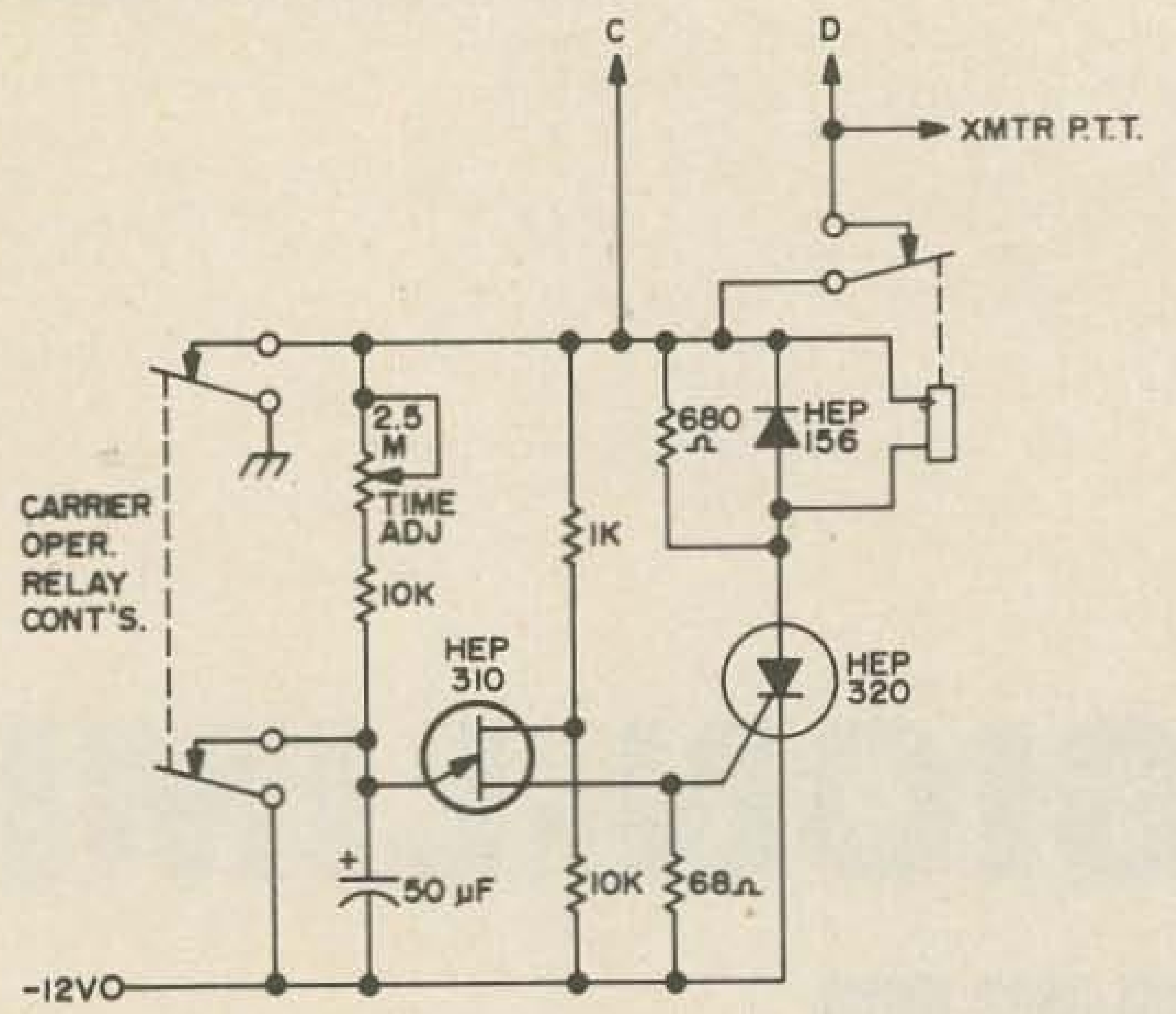

Fig. 1. This timer circuit is ideal for repeater applications because its period can be adjusted to any duration from 2 seconds to 4½ minutes. The top set of COR contracts starts the timed sequence and the lower set, on closing, resets the circuit. The relay is a Potter-Brumfield RS5D with a 6V coil having a resistance of 335Ω. Other relays can be used but the coil resistance must be no lower than that of the RS5D.

the other. It can be set for a period as short as 2 seconds, or as long as 4½ minutes. For a transmission-limit device, you'll probably want to set it for no more than 2 minutes at the most. It won't take the users long to cut their transmissions to less than that, you'll find.

The circuit shown employs a 6V dc relay with a coil resistance of 335Ω. Use of a relay with less resistance could cause excessive current, resulting in possible thermal destruction of semiconductors in the circuit. Just about any high-resistance relay will work in the circuit, though. The only precaution you should observe – other than that related to coil resistance – is to make sure that the relay contacts will be capable of handling the current load in the push-to-talk circuit. The contact rating of the RS5D is 2A; if your requirements exceed this value, the relay shown can be used to switch another relay with higher current-handling capability. Or, as an alternative, you can switch a circuit other than the push-to-talk line. The relay contacts, for example, can be used to remove B+ from the transmitter driver stages or the final amplifier. The idea, of course, is simply to get the transmitter off the air after the timed period.

When the relay is switched off, the coil's collapsing field will cause a very high voltage spike to be induced in the circuit – as most hams who have worked with semiconductors have learned in dismay. This spike can easily destroy many types of semiconductors; so avoid problems by placing the HEP 156 diode across the relay coil as shown. The diode provides a discharge path for voltage spikes, thus insuring against wipeout of your semiconductors. And be particularly careful not to get the diode installed backwards, too – or the circuit current will be shunted around the relay coil, creating another very real threat to semiconductor devices.

How It Works

When a signal appears at the receiver, the A set of contacts on the carrier-operated relay (Fig. 1) close and the B set opens, thus starting the timed operation. At the end of the period, if the COR contacts are still actuated by an incoming carrier, the P-B RS5D relay will put in, removing the push-to-talk signal from the repeater transmitter. As long as the carrier is on the channel after this point, the relay keeps the transmitter off the air. When the carrier finally drops out, though, the B set of contacts resets the timer and the A set removes the operational voltage. And the whole sequence is ready to begin anew.

Timer Defeat Circuit

If your repeater is subject to abuse from channel jokers, you might want to incorporate a separate reset system in your own UHF control link. This precludes the pos-

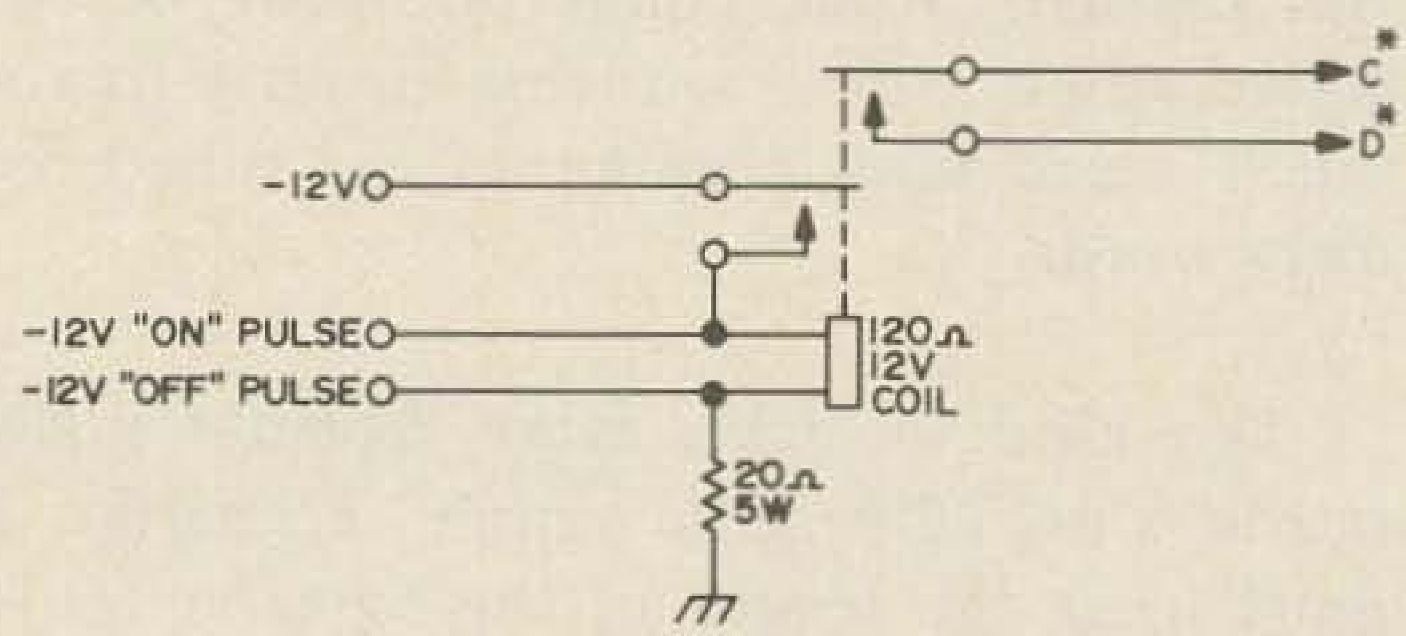

Fig. 2. Controlled timer "defeat" circuit. A momentary voltage pulse at the "on" point pulls in the relay and defeats the timer. A momentary pulse at "off" point returns the repeater to timed control.

sibility of some clown placing an endless carrier on the repeater input frequency just to keep your repeater shut down.

Figure 2 shows one satisfactory method for bypassing the timer from the control point. The control contacts should be installed across points C and D of Fig. 1, as shown.

The resistor in the defeat circuit will act as a voltage-dropping device, so you have to select a value that will not reduce the voltage on the relay below its critical pull-in point. Most low-cost 12V dc relays will put in with 10V, though, so you can probably use that figure as a logical starting point. If the coil resistance of the relay is about 120Ω (current drain of 100 mA), you should use a resistor of about 20Ω. This cuts the voltage to just under 11V, which should easily give rapid pull-in.

When the "on" pulse actuates the relay, the lower set of contacts (Fig. 2) applies a constant voltage to the coil to keep the relay latched in its energized state. But when a −12V "off" pulse is applied at the coil-resistor terminal, the potential across the relay coil is cut to zero, since both coil terminals are being fed with the same voltage. However, for the brief period of the "off" pulse, the resistor must dissipate the full power of the 12V signal; therefore, the resistor should be of sufficient wattage to handle that high-power surge.

If the values are as shown in Fig. 2, the resistor will be dissipating just over 7W during application of the "off" pulse. A 5W resistor should easily handle that, though, considering the fact that the signal is only applied for perhaps a fraction of a second (depending on your individual control scheme, of course).

Semiconductors

The unijunction transistor, diode, and thyristor (SCR) are all Motorola devices . . . (Why not? The timer circuit itself was provided by Motorola's design engineers!) These devices are available from *Circuit Specialists, Inc., Box 3047, Scottsdale, Arizona*. The other goodies should come from your junkbox or the local electronics supplier. . . .K6MVH

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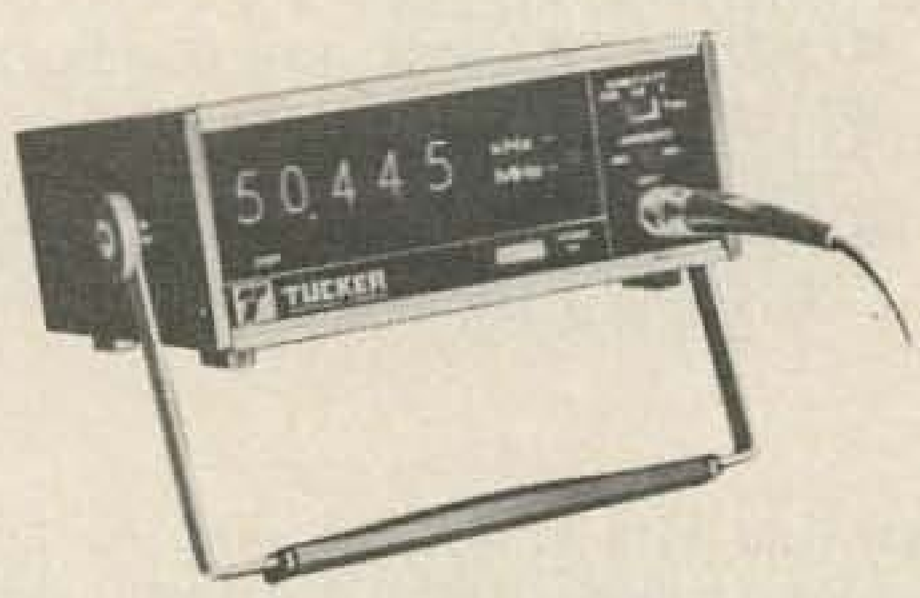

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EXTRA CLASS LICENSE STUDY GUIDE

Questions & Answers Part III

46. What is the vacuum tube counterpart of a (1) grounded base circuit; (2) grounded emitter circuit; (3) grounded collector circuit?

A. (1) the grounded-grid circuit; (2) the conventional grounded-cathode circuit; (3) the cathode follower.

47. What useful functions does a balanced modulator perform in a radio transmitter?

A. None, except in a SSB or DSB transmitter. The function of the balanced modulator is to simultaneously provide amplitude modulation and carrier suppression. In a DSB or SSB transmitter, it eliminates the carrier.

48. How does the directivity of an unterminated "V" antenna and parasitic beam antenna compare?

A. The unterminated "V" is bidirectional, with its major lobes extending in both directions along the line which bisects the angle of the "V." The parasitic beam is unidirectional, with its major lobe extending in the direction toward the director (away from the reflector). Both designs also have a number of minor lobes which are ignored in this discussion.

49. If a crystal lattice bandpass 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?

A. "Shape factor" is defined only for two specific levels of attenuation; in this problem, the only shape factor which may be calculated is the 6–60 dB shape factor, which is 2.0 (3 kc/s divided by 1.5 kc/s, or the wider passband divided by the narrower).

50. What would happen if the grid-bias supply of a Class C modulated amplifier was suddenly short-circuited?

A. The results would depend upon the design of the modulated amplifier. If it followed good design practice and obtained a major portion of its operating bias from a grid leak, the effects might be unnoticeable. If all bias were obtained from the bias supply (which would be poor design in the first place, tending to produce poor modulation) the amplifier's plate and screen (if any) currents would soar, probably damaging the equipment. In between these extremes, output and efficiency would probably drop, and modulation suffer.

Of course, any protective fusing on the bias supply would let go – and in the absence of fuses, portions of the bias supply itself would probably be destroyed or severely damaged.

51. How do trimmer and padder capacitors affect the low and high frequencies in receiver tuning?

A. Trimmer capacitors establish the minimum capacitance in a circuit, and padders establish the maximum capacitance values. Thus the trimmer capacitors determine the highest frequency to which a circuit may be tuned, and the padders determine the lowest frequency. In normal receiver practice, the coil inductance is adjusted to establish the lowest frequency, and the padder capacitors are then used to "track" the oscillator and rf circuits (which must tune to frequencies separated by the i-f, and should maintain constant frequency separation at all points in the tuning range – an impossible task). Trimmer and padder adjustments interact rather seriously with each other, and the proper procedure calls for adjustment of the low frequency portion of the range first, followed by adjustment at the higher frequencies, and touch-up of the lows. The process continues circularly in this fashion until operation is satisfactory at all points in the tuning range.

52. What is the phase relation between the input and output signals in the common-emitter, common-base, and common-collector transistor circuits?

A. In the common-emitter circuit, output signals are 180 degrees reversed in phase from input signals. In the other two configurations, output and input signals are in phase with each other.

53. How can a transmitter be tested for self oscillation? What precautions should be observed during testing?

A. The transmitter is tested for self oscillation by first operating each amplifier stage individually (in the absence of any driving signal) at normal operating levels, tuning all adjustments of each stage through their normal range, and determining that in the absence of input signals, no output signals are produced. The output stage should be tested first, followed by its driver, and so forth back to the stage immediately following the oscillator.

When each stage has been given a clean bill of health operated alone, they should be coupled to each other, again starting at the output end of the chain. Only when the entire amplifier chain can be operated at normal operating conditions without output in the absence of input can the transmitter be determined to be oscillation-free.

Output may be detected by means of an rf voltmeter connected to the antenna terminal, or by observing grid current in each stage (any grid current under these conditions usually indicates oscillation is occurring).

It may prove necessary to operate at reduced input voltages, and to supply bias voltage to keep power dissipation within limits. This is particularly true of grid-leak-biased stages; without input signal, they have no operating bias.

A transmitter undergoing such testing should never be connected to an antenna; a well-shielded dummy load is necessary.

54. How can unwanted VHF resonances in a transmitter amplifier be moved from TV channel frequencies?

A. VHF resonances within an HF transmitter are due to stray capacitance of circuit elements resonating with the self-inductance of connecting leads, both internal and external. The resonances can be shifted in frequency by changing either the capacitance of the inductance, or both. Capacitance can be increased by moving leads closer to the ground plane (chassis, in most cases), or decreased by moving leads farther from the ground plane. Inductance can be changed by changing the length of leads. Substitution of different types of components which are electrically equivalent at the normal operating frequency is a frequency cure; disc ceramic capacitors, for instance, usually have much less inductance than do equal-valued micas, and so move the parasitic resonances much higher in the spectrum.

Before attempting any of these cures, however, the specific part or parts contributing to the unwanted resonance must be identified, by careful probing with a grid-dip oscillator. When it is located, its nature usually gives good hints as to the means of moving the resonant frequency.

55. A 70 ohm transmission line is connected to a 35 ohm antenna. Calculate the standing wave ratio (SWR), the reflection coefficient, and the percent reflected power. If 10 amperes are flowing in the antenna terminals, what is the current in a transmission line node? How is the SWR related to the forward and reverse current flow?

A. When both the line impedance and load impedance are known, the VSWR is found most readily by dividing the lesser into the larger. In this case, it is 70/35, or 2.0.

With VSWR known, the reflection coefficient is calculated by the formula $k = (VSWR - 1/(VSWR + 1)$, which gives us $(2-1)(2+1)$ or 1/3.

Reflected power equals the square of the reflection coefficient, which would be 1/3 times 1/3 or 1/9, and this fraction, expressed as a percentage, is 11.111% (you can carry the string of "1's" out as far as you like).

Assuming that line losses are negligible (an assumption which is frequently false, in practice), the current at each node along the line will be equal to VSWR divided by current in the load (where the load impedance is higher than the line impedance, it would be reversed, to be VSWR *times* load current), so in this problem it would be 5 amperes.

Finally, VSWR is defined as the ratio of peak voltage to minimum voltage, or peak current to minimum current. This ratio is related to the forward and reverse current flow by the reflection coefficient. Most present "SWR Meters" actually measure forward and reverse voltage, with the conversion to VSWR accomplished by a meter face which is calibrated by means of the reflection coefficient formula; this formula is algebraically manipulated to yield VSWR $= (1+K)/(1-K)$.

56. What is a grid-bias modulated amplifier? Should the source of fixed bias have a high or low internal resistance? Explain.

A. A grid-bias modulated amplifier is one in which the mixing or modulating action occurs in the grid circuit, rather than in the plate or screen circuits. Modulation is accomplished by superimposing the audio modulating voltage on the fixed bias of the amplifier stage, thus causing the instantaneous grid voltage to vary in step with the modulating signal. Grid-bias modulation is not limited to audio frequencies; it is the preferred method for video modulation of TV transmitters, because the modulation can be accomplished at a relatively low impedance level which permits large bandwidth. The bias source should have low internal resistance, because the grid current varies in a non-linear manner over the modulation cycle, and the flow of grid current through the bias source's internal resistance adds a distorting component to the modulating signal. By keeping the bias source impedance low, this distortion is minimized but not eliminated.

57. Of what importance is the signal-plus-noise ratio of a receiver? At what radio frequencies is this ratio most important?

A. The signal-plus-noise/noise ratio, usually called signal-to-noise ratio and abbreviated S/N ratio, sets an absolute floor to a receiver's sensitivity. Any signal which is appreciably weaker than the noise level is buried in the noise, and no amount of amplification can retrieve it because the noise is amplified as much as is the signal. The S/N ratio of a receiver becomes of extreme importance only at those frequencies where external noise is lower than the receiver's internal noise. This occurs near the upper limit of the HF range, somewhere between 15 and 50 MHz (depending upon the location of the receiver with respect to such external noise sources as automobiles, neon signs, and power lines). S/N ratio is always important at VHF and above, but is frequently expressed in terms of "noise figure" or "effective temperature." "Low-noise" amplifier circuits are intended to improve the S/N ratio of receivers in which they are used.

58. What are Aurora-reflected VHF signals? If such a signal is heard, what does it sound like?

A. Aurora-reflected signals are VHF signals which travel from transmitter to receiver by way of reflection from the ionized curtains of the aurora borealis ("Northern lights"). This propagation technique is used at frequencies of 50, 144, and sometimes 220 MHz for extended-range operation. Because the aurora curtains are always in rather rapid motion, the signals are distorted by doppler shifts of frequency; the distortion is usually so severe that voice modulation cannot be copied, and CW becomes the only usable modulation technique.

The tone of an aurora signal has been likened to the whine of a variable-speed power saw burning through a tough pine knot. It is a distinctly uncomfortable signal to copy, but aurora addicts burn the midnight oil in search of VHF DX by this means.

59. What is meant by percentage of modulation? What determines if a carrier wave is under- or over-modulated?

A. Percentage of modulation is a measure of the relative strength of sidebands and carrier wave, applicable only to AM signals in which the carrier is not suppressed, and the measurement is made by comparing the peak envelope voltage to the minimum envelope voltage over a single cycle of the modulating signal. A 100% modulated signal has no amplitude variations and so is effectively unmodulated.

The factor determining under or over modulation of the carrier is the strength of the modulating signal in relation to that of the carrier. Another way of putting it is to say that it is determined by the relative amplitude of sidebands and carrier. "Selective fading" distortion can cause temporary overmodulation of a normal AM signal by attenuating the carrier without reducing sideband level, or undermodulation, by attenuating the sidebands and leaving the carrier strength untouched. For full modulation, the sidebands must be of such amplitude and phase relative to the carrier to produce an evelope in which the instantaneous voltage never falls below zero, and never rises above twice the unmodulated-carrier level.

60. How does a cathode-ray tube operate? What magnitude of voltage is normally used to bias the plates of a cathode-ray tube? What purpose does this magnitude of bias voltage serve?

A. A cathode-ray tube (CRT) consists of an electron gun, which includes a source of electrons in the form of a heated cathode together with electrodes which shape the electron emissions into a tight beam; deflection plates or coils which deflect the beam in both the horizontal and vertical directions; and a phosphorescent screen which glows with visible light wherever the electron beam strikes it. The focused beam is swept over the face of the screen by one set of deflection plates in a known pattern, and signals to be measured are applied to the other set of deflection plates. The resulting visible display on the screen provides the desired information about the signals under test.

The bias voltage on the plates of a CRT is normally several kilovolts more positive than is the cathode voltage. In addition, the deflection plates are biased from 10 to 100 volts with respect to the beam itself. The deflection plate bias is used to position the beam where desired on the screen, by attracting or repelling the electrons in the beam. The high voltage across the beam is necessary to provide sufficient energy in the beam in order to achieve satisfactory bright-

ness of the trace. Some TV sets use acceleration voltages as high as 50,000 (but at only microamperes of current).

61. What are some causes of the excessive production of harmonics in rf amplifiers? How can these causes be remedied?

A. Excessive production of harmonics in rf amplifiers usually results from one or more of three basic causes: the amplifier is overbiased, overdriven, or has insufficient selectivity to reject the harmonics which are a necessary part of Class C amplification.

To remedy the causes, modification of the design is often necessary. No more bias should be used on each stage than is necessary to achieve reasonable efficiency, and no more drive should be applied than is necessary to reach saturation during the signal cycle. Selectivity can be increased by increasing the loaded Q of both input and output tank circuits; this is most easily accomplished by reducing the inductance of the tuned circuit, and increasing capacitance to restore resonance. Reducing the inductance removes resistance more rapidly than it does inductance, thus raising circuit Q (especially since the actual load impedance remains constant).

If excessive harmonics persist after all these remedies have been applied, additional tuned circuits can be added between stages, or at the amplifier output terminals, to aid in their rejection.

Excessive harmonics normally are a problem only with Class C amplifiers; linear amplifiers must be free of distortion, which implies almost total lack of harmonics in their output.

62. What effect does a transmission line which is not properly terminated have on the plate tank circuit of a transmitter?

A. The effect of an improperly terminated transmission line on the plate tank circuit of a transmitter depends almost entirely on the length of the transmission line (both its absolute length, and its relative length in fractions of a wavelength).

If the line is extremely long and has moderate to high losses, the increase in line losses due to the high SWR which results from improper termination will effectively swamp out the reflected power, and at the transmitter end the line will appear to be properly terminated, even if the actual termination is an open or short circuit. In this case, the effect will be nil.

If, however, the line is relatively short, the effects then depend upon the exact type of termination as well as the length of the line. If the line is any exact multiple of 1/2 wavelength long (electrical length as distinguished from physical length), the load seen by the transmitter will be the same as that existing at the load end of the line. If this load is highly reactive, it will detune the plate tank circuit, possibly so far out of its range that the circuit cannot be tuned at all. If it is resistive (including open and short circuits) the effect will be to alter the amount of power which is extracted from the circuit; the transmitter may load easily, or may "refuse to load" if the impedance is too high.

If the line is any exact odd multiple of 1/4 wavelength long, the impedance at the terminating end will be inverted at the transmitter end. The effects are similar to those of 1/2 wave line lengths, but opens are converted to shorts, low impedance to high impedance, capacitance to inductance, and vice versa in all cases.

For any other line lengths, the impedance at the transmitter end is virtually always reactive, causing tuning difficulties. The major exceptions are those in which the reactance introduced by the line length exactly cancels the reactance present in the improper termination, thus presenting a resistive load to the transmitter. Even in this case, loading difficulties may result.

In general, then, improper termination of the transmission line manifests itself at the final tank circuit as difficulties in either tuning or loading or both. However, in any specific instance a line with mildly improper termination and highly serendipitious length (that means extremely lucky) may tune and load more easily than a properly terminated one. This is the reasoning behind "pruning" of transmission lines to simplify loading problems – which in practice is frequently the most practical solution to them.

63. How are reactance tubes used?

A. In these days of voltage-variable semiconductor capacitors, as little as possible. The reactance tube is an ordinary pentode in a special circuit which causes it to vary its output reactance as a function of its grid voltage, and before simpler components became widely available, such circuits were used to produce frequency modulation by varying the tuning of an oscillator tank circuit, or phase modulation by varying the tuning of an amplifier. Modern designers prefer the voltage-variable capacitor, which is used in the same way but takes a much simpler circuit.

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

A. Phasing capacitors perform two functions in crystal filter circuits. They stabilize the circuit by balancing out the capacitance of the crystal's electrodes, thus elminating any path for energy to pass around the crystal itself, and they permit tuning of a rejection notch across the filter's passband, by varying the loading upon the crystal and the phasing of the balancing energy slightly.

65. What means may be employed to measure low frequencies? High frequencies? VHF and UHF?

A. Provided a sufficiently well-equipped lab is available, almost any frequencies short of UHF may be measured by counting the individual cycles for a known period of time, using a gated counter. Such devices are, however, expensive. Most amateurs measure frequencies in the audio range by comparison with the known audio frequencies broadcast by WWV, and those in the rf range up to UHF by comparison to calibrated standards which are calibrated against WWV. The calibrated standards can be used to verify calibration of the station receiver, which can then be used to measure frequencies which fall between the harmonics of the standards.

At UHF, "lecher wires" are often used. These consist essentially of an open-circuited parallel-wire transmission line along which a sensing device can be moved. The VSWR of the line is high because of the open-circuit termination. The sensor is moved through two successive peak or null points and the distance between them accurately measured. This is 1/2 wavelength, which can then be converted to frequency.

. . .Staff

R. Guard K4EPI
750 Lily Flagg Road
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A 5/8 WAVELENGTH WEATHER BALLOON VERTICAL THAT WORKS!

The antenna described in the June, 1971 issue of *73 did* work, as verified by witnesses and dozens of FB signal reports. To determine *why* it worked, another weather balloon antenna was sent up on July 16. Viewing the antenna from the ground, the answer was in plain sight, for in the gentle breeze, the antenna was on a 20–25 degree slope most of the time. Guying lines were not used on the first antenna, but were suggested as a method of holding the balloon in wind. Hence, the antenna was not a true vertical, but a "sloping longwire" or Hertz. While obviously the transmitter's pi-network was affording a fair match to it, the SWR observed may have been a false reading.

False SWR readings were also noted by an O.T. when using tuners on the transmitter end with extremely long antennas of this type. His article, written twenty-five years ago, will prove to be most interesting reading.[1]

This time, shooting for 5/8 wavelength, which is optimum for the lowest angle radiation from a vertical, I measured off 83 ft of 22 gage enameled wire for operation on 40 meters. A size "E" (22 cu. ft) cylinder of helium, a helium regulator, and an 8 ft diameter weather balloon were acquired.[2]

Helium and regulators are available from your local welding supply house. You *buy* the contents of the helium cylinder; you

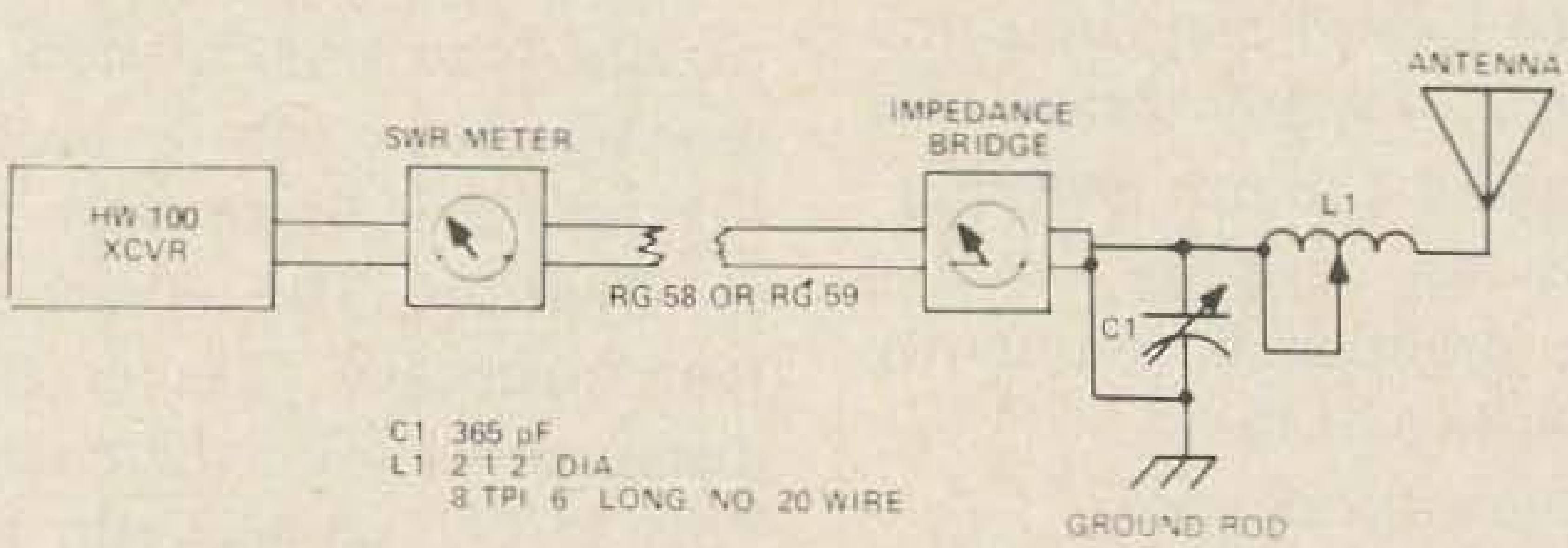

Fig. 1. The equipment setup used to match the 5/8 wavelength vertical. The impedance bridge is not necessary, but saves time by getting the coil tap "in the ball park" quickly. The matching network shown below gives an SWR of 1:1 on 40 meters.

rent the regulator, and put a deposit on it and the cylinder. The deposit is refundable when you return them.

The setup in Fig. 1 was then constructed. The impedance bridge is not necessary but saves time by getting your coil tap "in the ball park" quickly. The particular impedance bridge used here used a grid-dip oscillator for its operation, and thus operating the transmitter was not necessary. If using the impedance bridge in the ARRL handbook, tune up using just enough power to obtain a reading. Set the bridge to 50 ohms or 72 ohms, depending on whether you use RG-58 or RG-59 coax. Using just enough power for a reading on the impedance bridge, run the alligator clip up and down the coil to get a coarse dip on the meter. My coil tap was 4 turns from the antenna side. The 365 pF capacitor is then adjusted for lowest dip with the capacitor approximately half-open.

The impedance meter is then taken out of the circuit and the rig tuned up, again using just enough power to achieve an SWR reading. At this point the SWR read 3:1. This is because the impedance bridge can only read pure resistance accurately and the reactance of the matching network upsets it. A friend stationed in the yard adjusted the capacitor ever so slightly while I motioned through the window, and we had our 1:1 SWR!

We turned up on 40 CW and consecutively worked WB8GBK, WA5UGE, WB9FWJ and W5BYP, receiving 599 reports. Our last QSO was with W3EEK, who gave us a 589. Reason: a 3:1 SWR again.

We ran out back in the dark to find the weather balloon, still fully inflated, sitting on the ground. What brought it down? Dew! The kite string guy wires were soaked with it and quite heavy; for this reason, I recommend lightweight waterproof, floating, fly-fishing line.

With guy wires in place, the balloon vertical will perform satisfactorily on a relatively calm day. However, in stronger winds, the balloon will buffet downward, causing the antenna to become slack and even to touch the ground. For greater reliability, more lift is needed, and hence, more helium. As helium is quite expensive, the alternative then is hydrogen gas. Hydrogen cylinders and regulators are available, but as the cylinder is under great pressure, its use is quite dangerous. A safe alternative is the hydrogen generator kit offered by Fair Radio Sales, which uses lithium hydride in a steel cylinder, and is operated by immersion in water. The firm also sells a balloon inflating tube for use with the cylinder. As their price for the kit is cheaper than a size "E" cylinder of helium (22 cu. ft) and gives more gas volume (approximately 44 cu. ft), it should definitely be explored first, before purchasing helium.[3]

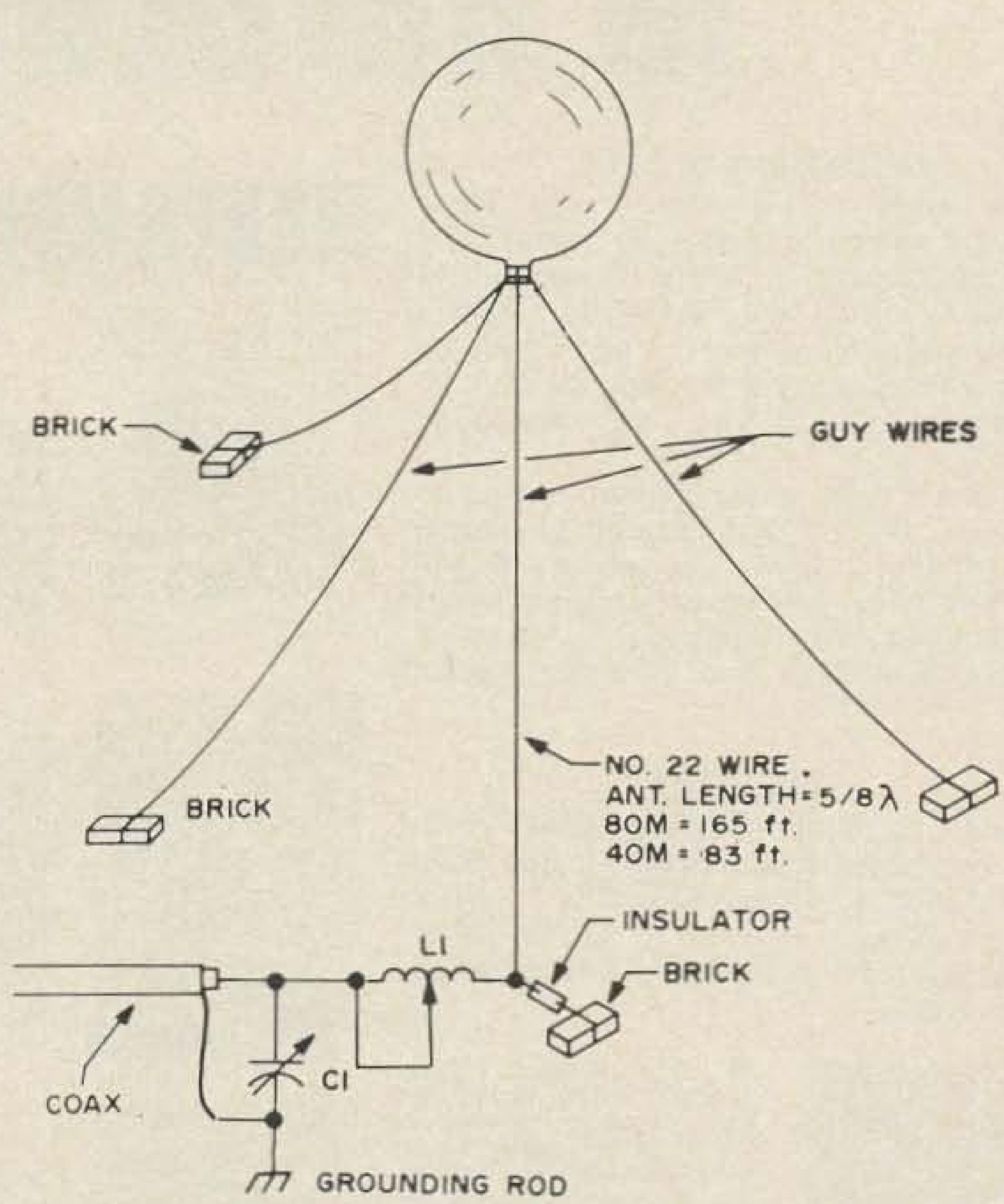

Fig. 2. The 5/8 wavelength weather balloon vertical with base matching network. No ground radials were used, although they could be added to improve performance. C1 – 365 pF receiving type variable; L1 – 2½" dia., 8 T.P.I., 6" long; 40M – 4 turns used.

Good luck and good flying! Comments will be appreciated; enclose a stamp.

. . .K4EPI

1. George Bonadio, "The Balloon Antenna Flies Again," *QST* March, 1947.
2. Eight foot balloon, stock No. 60568, available from Edmund Scientific Co., Barrington, N.J. 08007. $2.00 postpaid.
3. Fair Radio Sales Co., 1016 E. Eureka St., Lima, Ohio 45802. Catalog No. 71, page 31, Hydrogen Generator Kit, #M-315 $6.95. Balloon Inflating Tube, #M-315 $1.50. Shipping weight 8 lbs.

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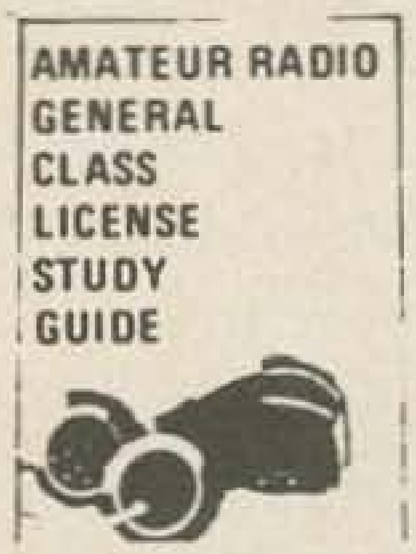

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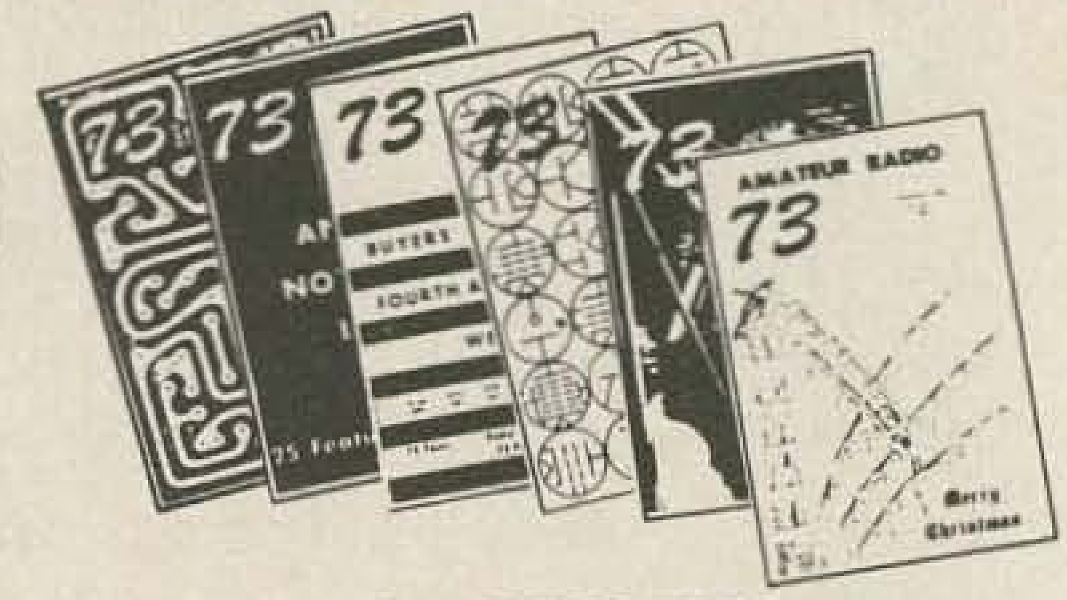

BACK ISSUES TOO?

Where can you buy a one year subscription to a magazine and get a set of twelve back issues as a bonus? That sounds like a pretty good deal doesn't it? Well, unless you have a complete set of back issues of 73 that is a fabulous deal. It is such a good deal that it has a string attached – the twelve back issues are a free bonus for a subscription, but there is one more problem that has to be faced. This is the postage involved. Twelve back issues are darned heavy and the postage cannot be dismissed lightly. If you want one of the three different back issue packages you will have to send along an extra $2 to cover the cost of postage and handling. It's still a great deal. The problem is that books can be mailed at the library book rate, while magazines have to go parcel post, which costs an arm and a leg.

Over 3000 great articles have appeared in our back issues and most of them are just as good today as the day they were printed. You will have the time of your life reading all those wonderful issues you missed. We have separated the back issues into three packages. issues from 1960 – 1964 (I), 1965 – 1967 (II), and 1968 – 1970 (III). These back issue bundles are put together by illiterate apple pickers borrowed from other ham magazine staffs and thus there is no possibility of our guaranteeing any particular issue in your bundles . . . you take pot luck.

A DX FRIEND?

Foreign subscriptions to 73 are a bit more expensive than local ones, naturally – however we will be happy to enter a gift subscription for a DX op at the same low U.S. rate as part of this book offer. Here is your chance to spread a lot of happiness around the world. One of the most appreciated gifts any DX ham can get is a subscription to 73. Indeed, we suspect that 73 is read in more countries around the world than any other ham magazine – in well over 200 countries at last count!

If you work DX you must have a couple good friends who will practically fall out of their tree over a subscription to 73. Try them.

Have you ever been shown a kindness by a DX op? Maybe you visited him? Remember his kindness with a 73 subscription.

WHY THIS OFFER?

The whole purpose of this offer is to bring 73 to the attention of more active amateurs – to get more subscriptions. Obviously we are paying dearly for the initial subscription – but we frankly intend to make it up next year when the renewal comes due. In the long run all of us will benefit from this.

It is obvious that it is not possible to send two books with a two year subscription. This offer is valid for one year subscriptions only.

FREE HANDBOOK

1200 PAGES!

Where else can you get an amateur radio handbook for free? That's right, you get about 1200 pages of articles in 73 every year and the magazine is designed so that each and every article is on separate pages – and 73 is the only magazine that does this – with no flipping to the back of the magazine for a parts list or anything. Every page of the magazine is numbered with the regular numbers plus special yearly handbook page numbers – all so you can, if you like, take apart your issues of 73 and put them together by subject into a giant handbook at the end of the year. No other magazine has anything like this available.

ACTIVE EDITORS

Only one ham magazine of the four has editors that are active and on the air – and have been for years. 73 has its own repeater going – the only ham magazine staff that has done this. 73 has its own mountain top laboratory for VHF – the only ham magazine with one. 73 is active on slow scan television – the only magazine to do this. 73 goes on DXpeditions – the only ham magazine to do this. 73 runs DX tours – the only ham mag to do this. And so it goes.

And what difference does all this make? Perhaps you've noticed that 73 is more involved with the hobby – 73 not only reports the most interesting news, sometimes it helps to make the news. It helps 73 to be more fun to read, to attract better authors for articles, to bring you more valuable information on the newest of ham products.

Which ham magazine was the first to report on the first commercially made two meter synthesizer? 73 of course. And which got the first new units made by Genave? And which got the first Clegg units? The first International Signal units? The first Drake FM units? The first Tempo units? And so on – being active and on the air helps make 73 more interesting and valuable, doesn't it?

73 NEWS PAGES

You'll enjoy the monthly news reports on what is going on in the hobby – new products – political happenings – news of DX – RTTY news – Slow Scan news – VHF news – FCC news, etc. 73 is the ONLY ham magazine to cover the news of amateur radio in this easy to read manner. Keep really up to date with the 73 newspages.

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73 MAGAZINE PETERBOROUGH NH 03458

If you prefer not to shred your copy of 73 there is no real reason why you should not put the subscription information on a separate piece of paper, on the margin of a hundred dollar bill, or whatever turns you on.

Regular subscriptions ordinarily start with the next published issue of 73 – the November issue, in this case. Gift subscriptions marked for Christmas will start with the Giant January issue since that is the one that should arrive right around Christmastime. If you want otherwise just indicate same on the order.

The regular subscription rate for 73 is $6 for one year $11 for two years, $15 for three years in North America and $1 extra per year for foreign subscriptions. This special book premium offer is valid world wide at $6 for one year until December 31, 1972.

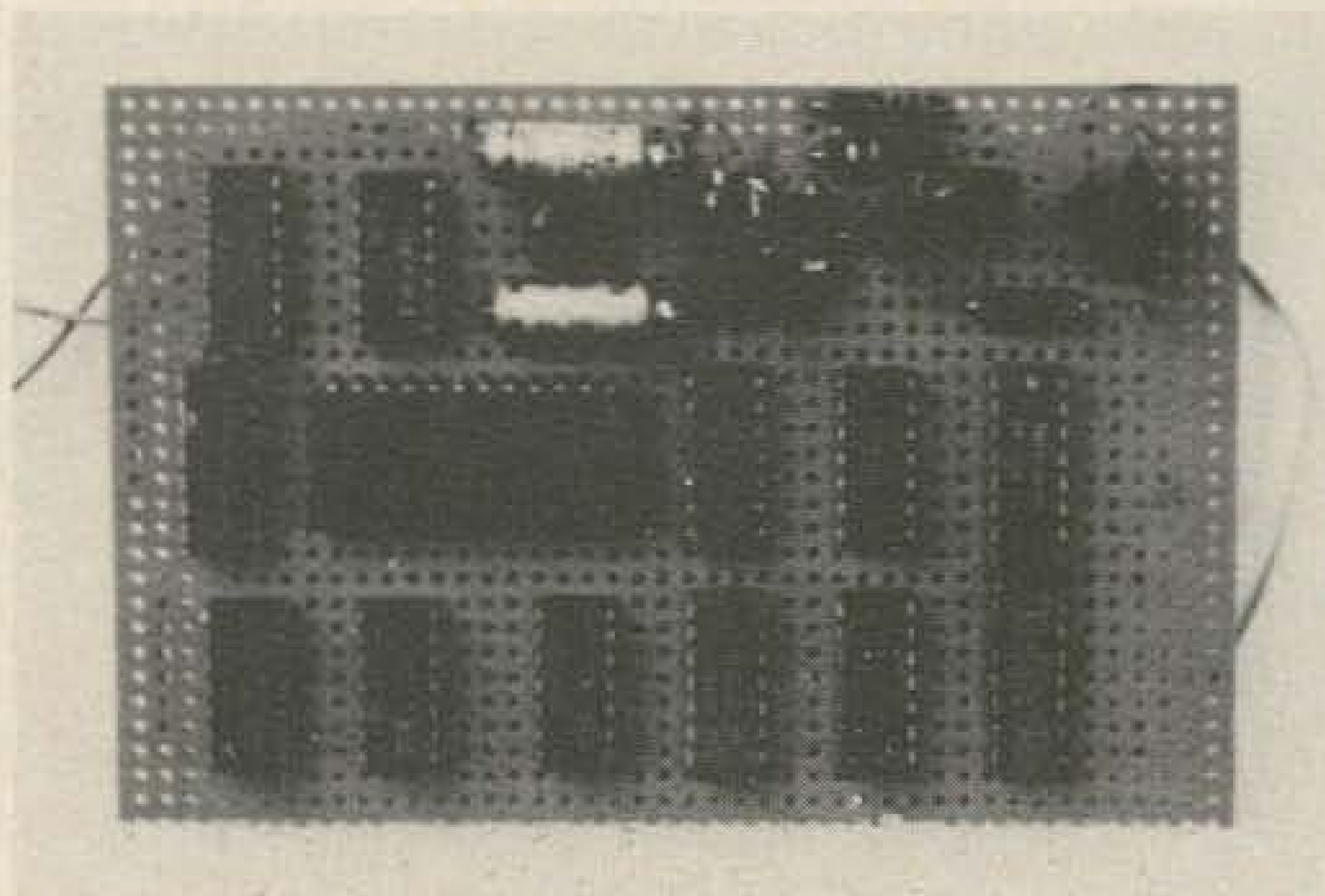
The recent serious rise in postal rates will be forcing 73 to increase the subscription rate soon – don't say you weren't warned.

Did you enjoy the article in August on the DXpedition to Navassa? This is one of the reasons that 73 is different – it is involved. The editors get out there and operate, go on DXpeditions, organize them even – organize ham tours – set up repeaters – work in the contests – work lots of DX – are actually on slow scan – on RTTY – it makes the magazine come alive. When the editors write about something you know that they have the background to bring you the inside scoop. If you are the type of person who fights progress – opposes change, you are going to find 73 getting your back up, for 73 is in there first with the new things.

Amateur Radio
is more fun
When you read 73

Clifford Klinert WB6BIH
520 Division Street
National City CA 92050

A Simple & Inexpensive ID



Automatic identifiers are the rule now for repeaters and remote base systems, but often the seemingly complicated or expensive electronic ID machines lead many repeater owners to use crude mechanical contrivances. This article describes an ID'er that takes advantage of MSI integrated circuits to reduce cost and wiring effort. This unit was built from design to completion in one day, and cost less than ten dollars in surplus IC's. Without power supply, it is about the size of a transistor radio.

Circuit

Figure 1 shows the basis for the concept behind the simple design of this unit. The entire character generation hardware is simply a counter with the desired outputs decoded to key an oscillator. A counter is a device that takes a series of input pulses to a single input terminal and produces a single output at one of several output terminals in sequence with each input pulse. Figure 1 shows two counters and two decoders. Since the output from the counters is in binary coded decimal, or binary, a decoder is used to convert the four digit binary number from the counter to a one digit decimal number. The 7493 counter will produce 16 different

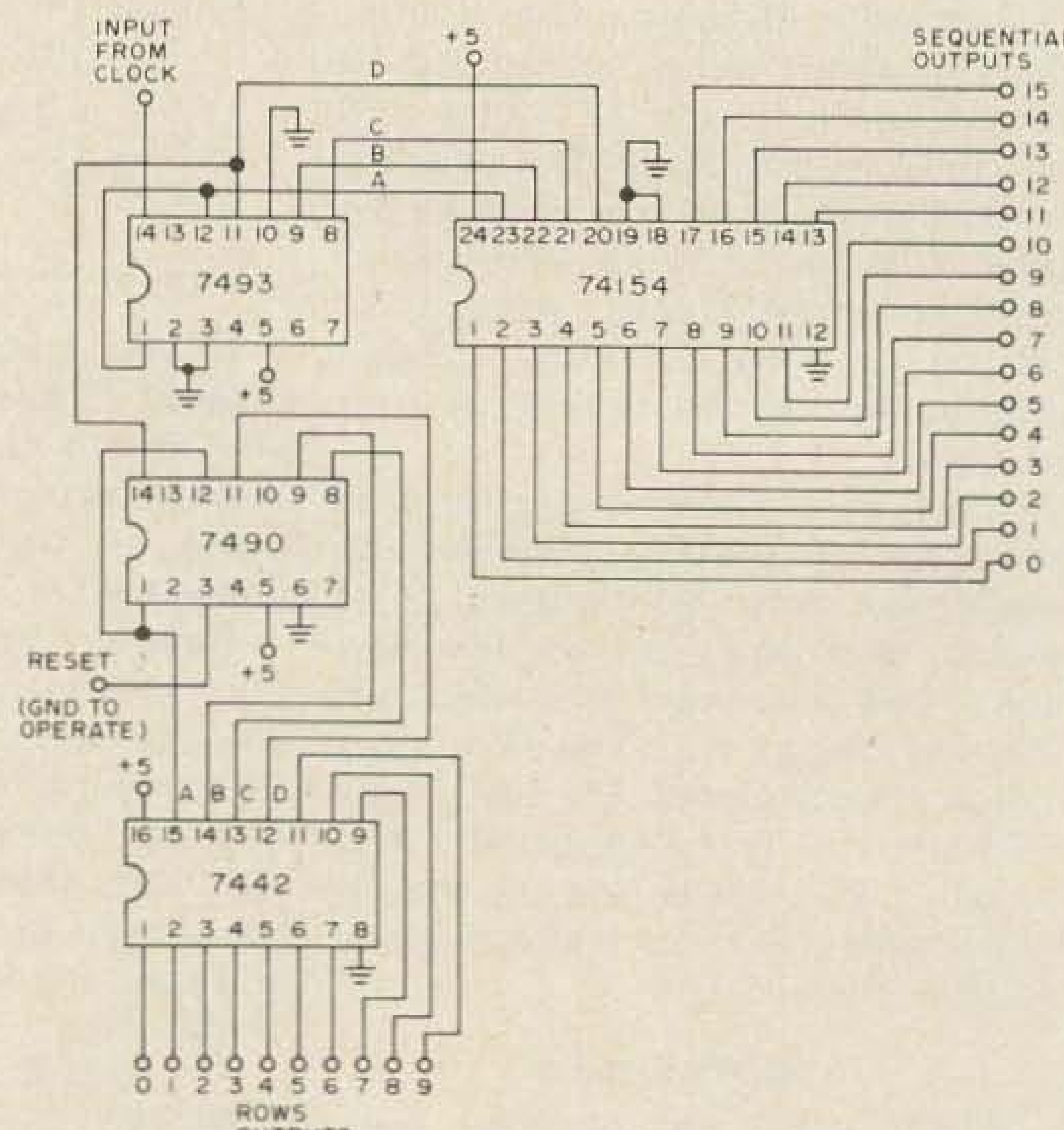


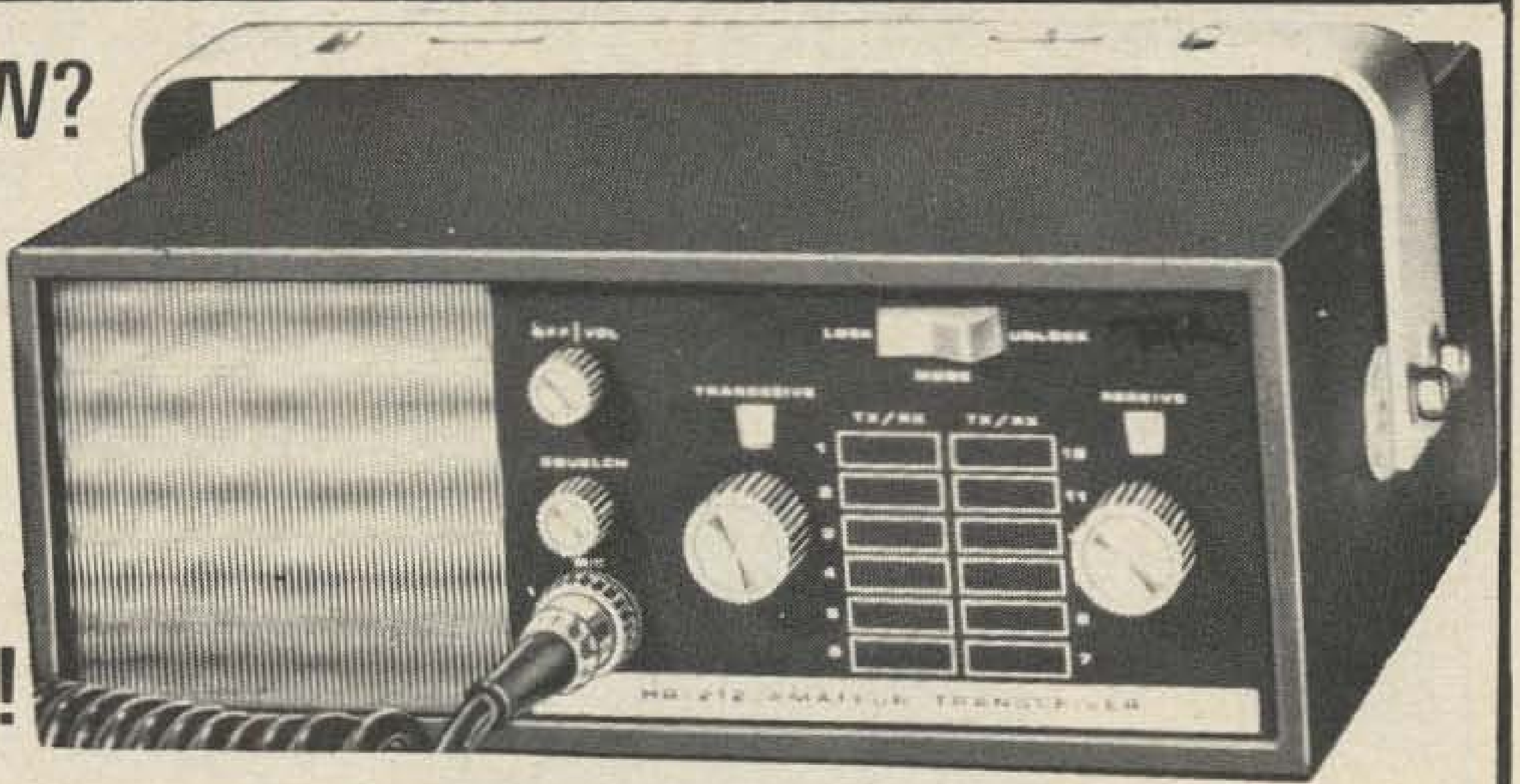
Fig. 1. Sequence generator.

JUGE

DID YOU KNOW?

Regency's HR-212

IS DIFFERENT!



At the flip of a switch you have a choice of 2 modes of operation:

1) 12-channel transceiver with transmit and receive frequencies controlled by one knob.
2) 12-channels with one knob controlling transmit channel and a second knob controlling the receive channel independently.

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output conditions for a series of input pulses, and the 7490 counter has ten. The drawing of Fig. 1, as with other drawings is an actual wiring diagram rather than a schematic. This will aid in construction and will simplify the description of what it does rather than how it does it. When the simple circuit of the counters and decoders is wired together and activated it can be seen that applying a pulse to the input of the 7493 will cause the output of the 74154 to change by one position. A bounceless pushbutton must be used for this demonstration. The high speed of the counter will show many outputs at one attempt to close or open mechanical contacts. Figure 7 shows a simple circuit that will change state on the first bounce and stay that way until the first bounce in the opposite direction. All but one of the 74154 output terminals will be high. When the pushbutton is pressed and released the low terminal will go high, and the next terminal in the sequence will go low. This is the basic concept of counting. The output of the 7490/7442 decade counting system will change every sixteen pushes of the button since it is connected to the output of the 7493 sixteen counter. This gives ten times sixteen, or 160 different possible states of the sequence generator.

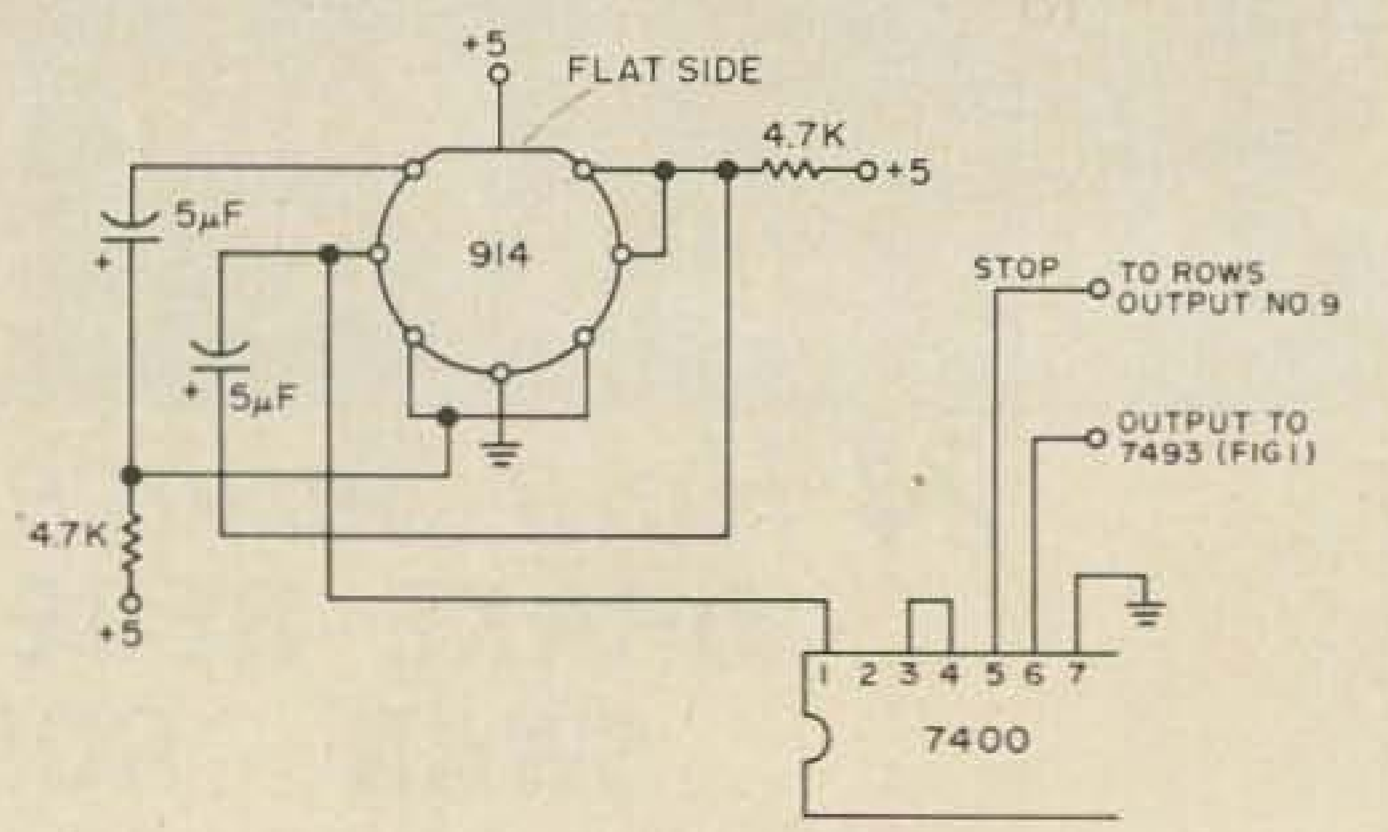
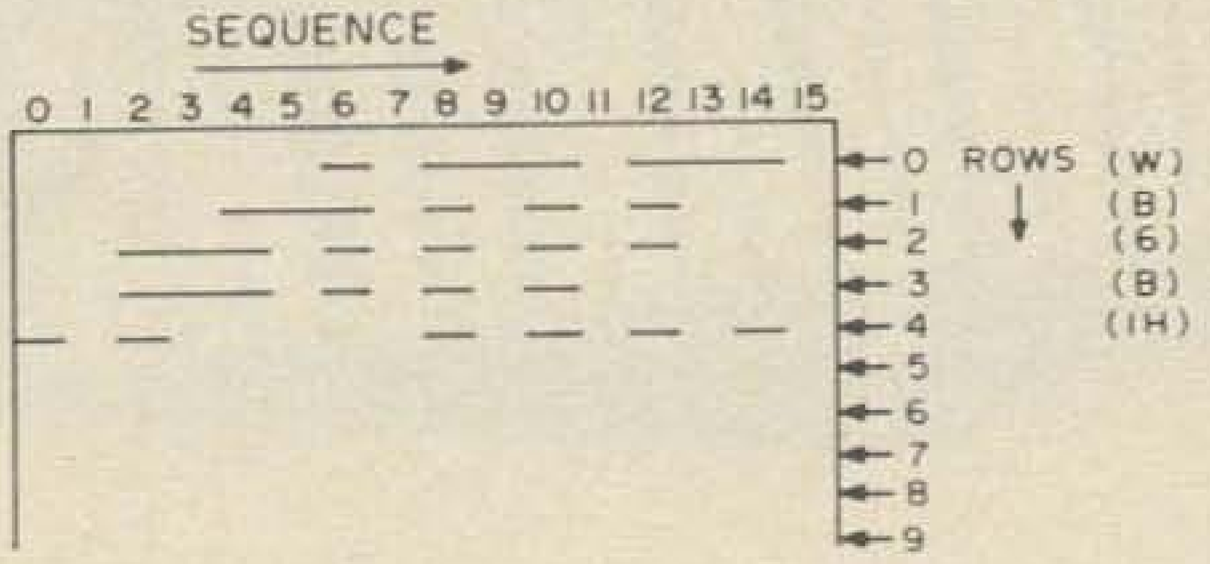


Fig. 2. Clock generator.

Figure 2 is an astable multivibrator that generates a square wave train of pulses to drive the counters. This is also a wiring diagram, but a bottom view. The multivibrator is made from an RTL dual gate μL914. RTL seems to work better in this application than TTL and a few 914's were available for this use. The 7400 is a quad two input gate used to "square up" the output of the 914, and to turn the output of the clock circuit

Table 1
Example for Encoding Character Sequence
WB6BIH



off when the 7442 has reached the next to the last position in its counting sequence. Releasing the reset line in Fig. 1 from ground will reset the 7490 to the first position in its count and start the clock pulses to the 7493. Regrounding the reset lead will allow the 7490 to count every sixteen clock pulses.

By now it is probably possible to anticipate how the ID will work. Table I illustrates how the counters generate the code characters. Each clock pulse represents a unit of time. A dit is one unit, a dah is three units, and the space between them is one unit. A space between letters is five units. The characters are generated horizontally by the output of the 74154, and when one sequence is completed the other counter switches to the next row. This could continue for 160 units, but the decade counter stops at the beginning of the last row, and when it is reset, it starts at the beginning of the first row, so there are only 144 units if the counter is stopped in this manner.

Figure 3 gives an example of how the code characters are selected from the counter output. Since the oscillator is to be keyed only for about half of the time, an eight input gate is about right for each row of sixteen time units. A 7430 is an eight input gate. If any input of the gate is grounded (goes low) the output will go high. This drawing gives the wiring diagram to show how the letters "W" and "B" are generated. In this case each 7430 generates one letter, but for a letter with a lot of dahs in it it may be necessary to use two 7430's for one row. In this case a 7404 inverter section could be used after each 7430, and then connected to the two inputs of a 7400 two input gate section. The outputs also

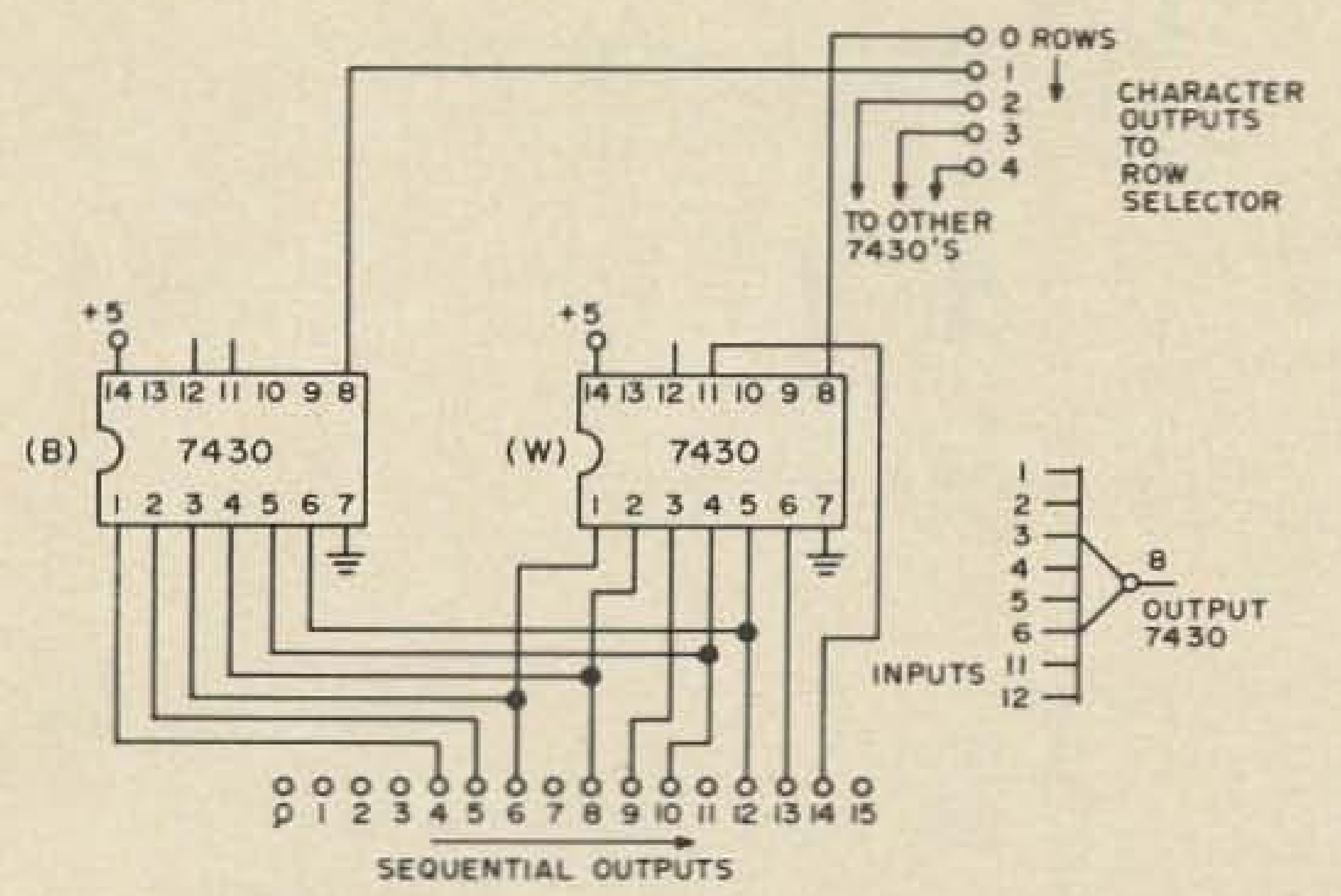


Fig. 3. Character selector wiring example for letters "W, B".

could be connected together simply with two diodes. In wiring up this character selector, a table such as Table I should be written and checked carefully. An error at this point can cause the rewiring of the entire character selector.

Figure 4 shows how the different rows of characters are selected. Both inputs of a 7400 gate must go high for the output to go low. The decade input from the 7442 goes low to select, so a 7404 inverter is used to make them go high. Since each 7430 output goes high, no inverter is needed. These two high going outputs are applied to a 7400 two input gate, one gate for each row. The outputs of the 7400 gates go low, so they are combined at the inputs of another 7430.

It can be seen from this that the number of 7430's, 7404's and 7400's will be determined by the length of message desired. Other information besides call signs may be

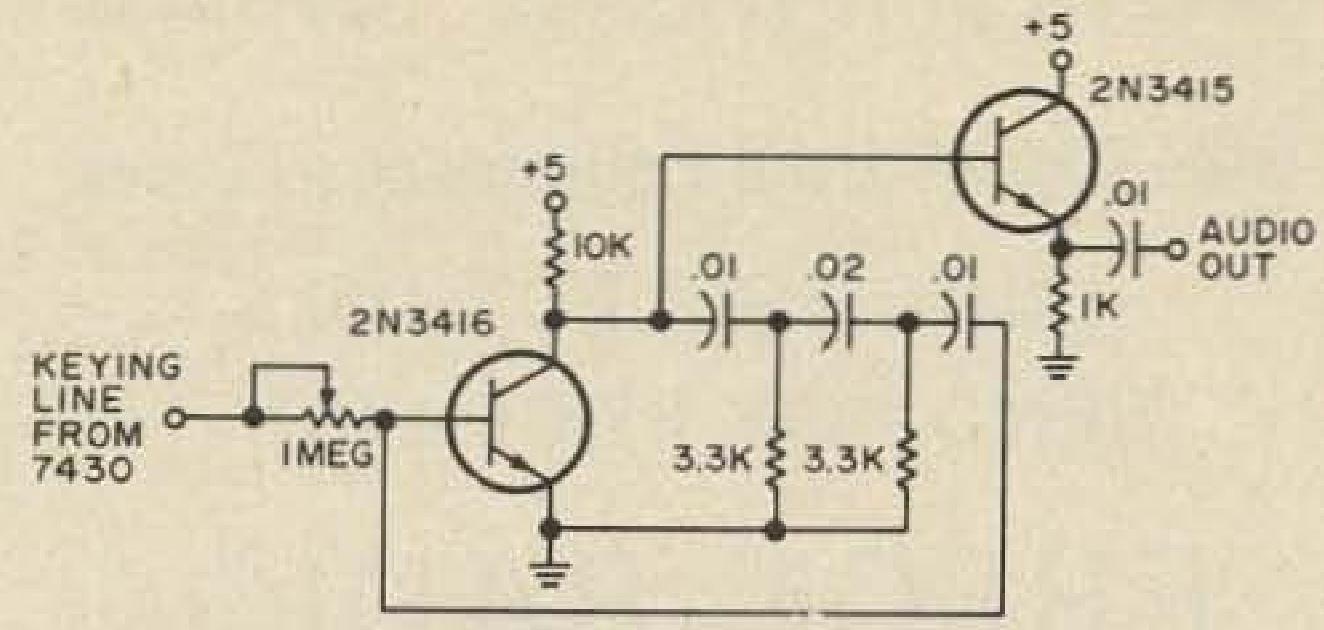


Fig. 5. Tone oscillator.

sent up to 144 units, or a 7493 and 74154 could be used in place of the 7490 and 7442 to increase the length of the message, at higher cost.

Figure 5 is a phase shift oscillator that was used with the ID'er. It is keyed by biasing the transistor on from the high output of the last 7430. The 1 meg pot is used to set bias on the transistor so that the collector voltage is about half of the B+ voltage. There will be beta variations between different transistors so the pot is needed to set bias exactly. It is difficult to get this oscillator to work reliably on five volts at higher audio frequencies because of the low voltage gain, so if higher B+ is available the frequency may be increased by making either the capacitors or resistors in the phase shift network smaller in value. The 2N3415 was added to minimize loading from the output that may prevent oscillation. RF from a nearby transmitter may prevent oscillation, so it may be necessary to shield the oscillator, and bypass and filter the leads to it.

Figure 6 shows a block diagram of the entire unit if there are any questions at this point.

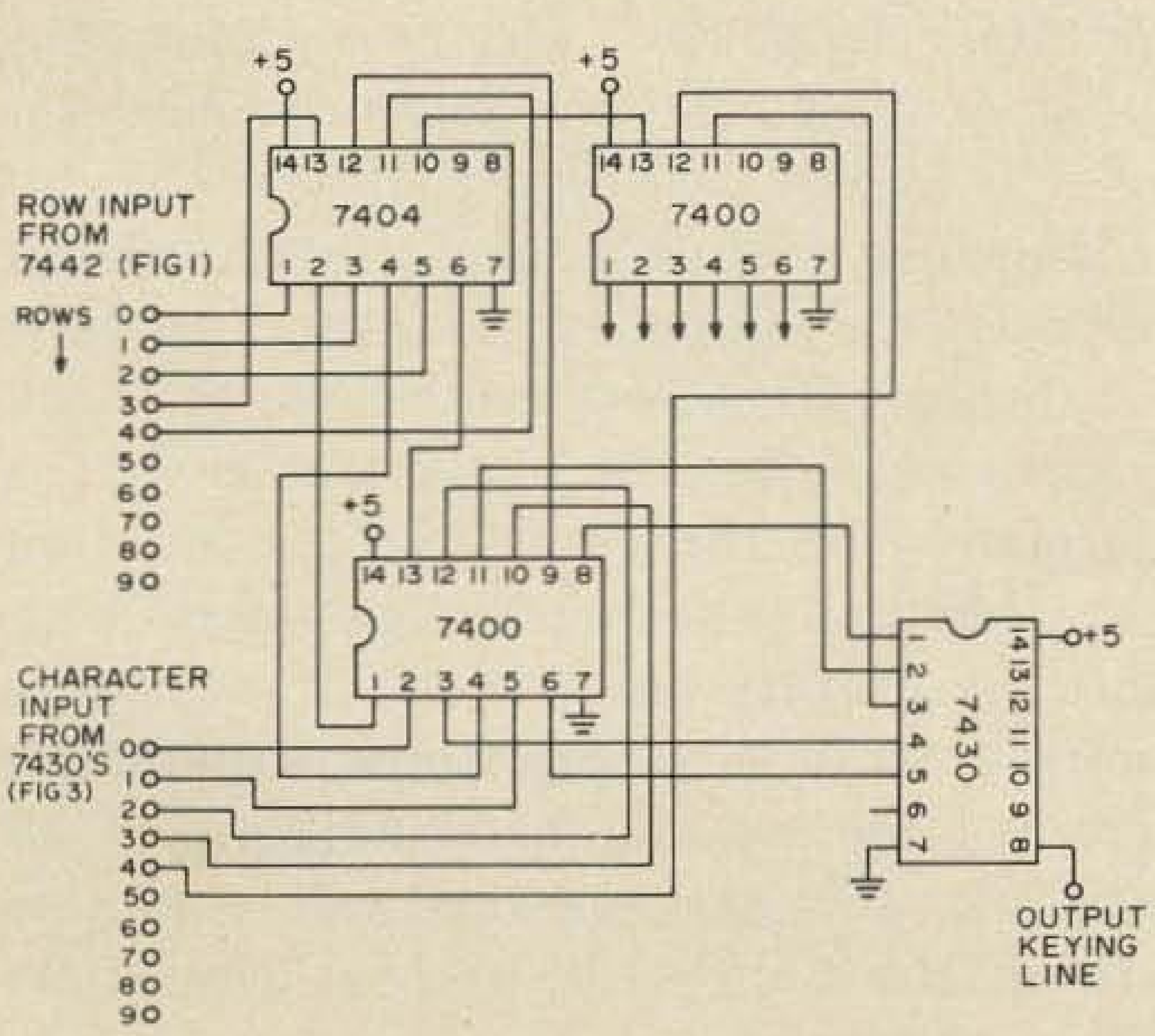


Fig. 4. Row selector.

Construction

The circuit can be built on a perforated

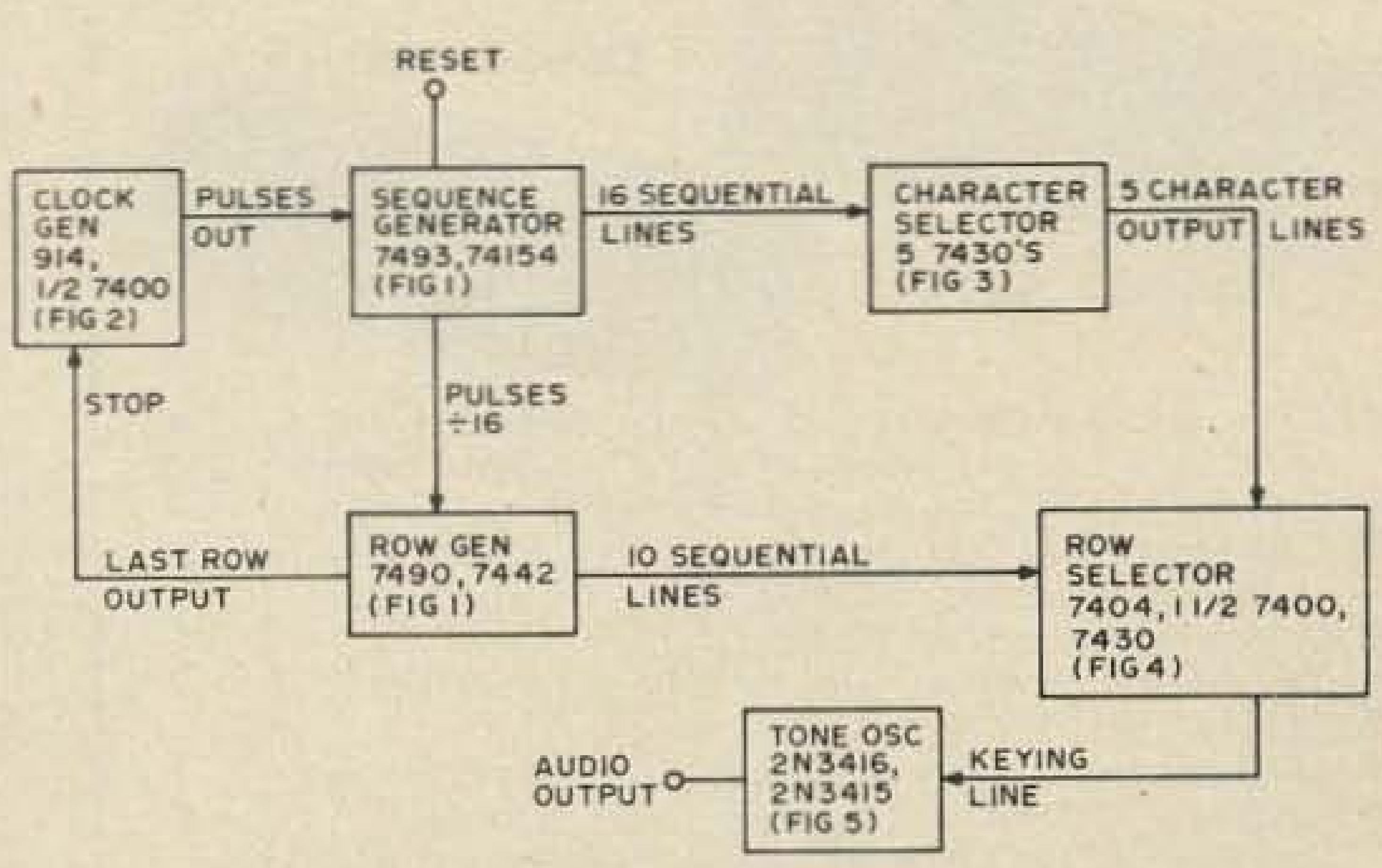


Fig. 6. Composite block diagram.

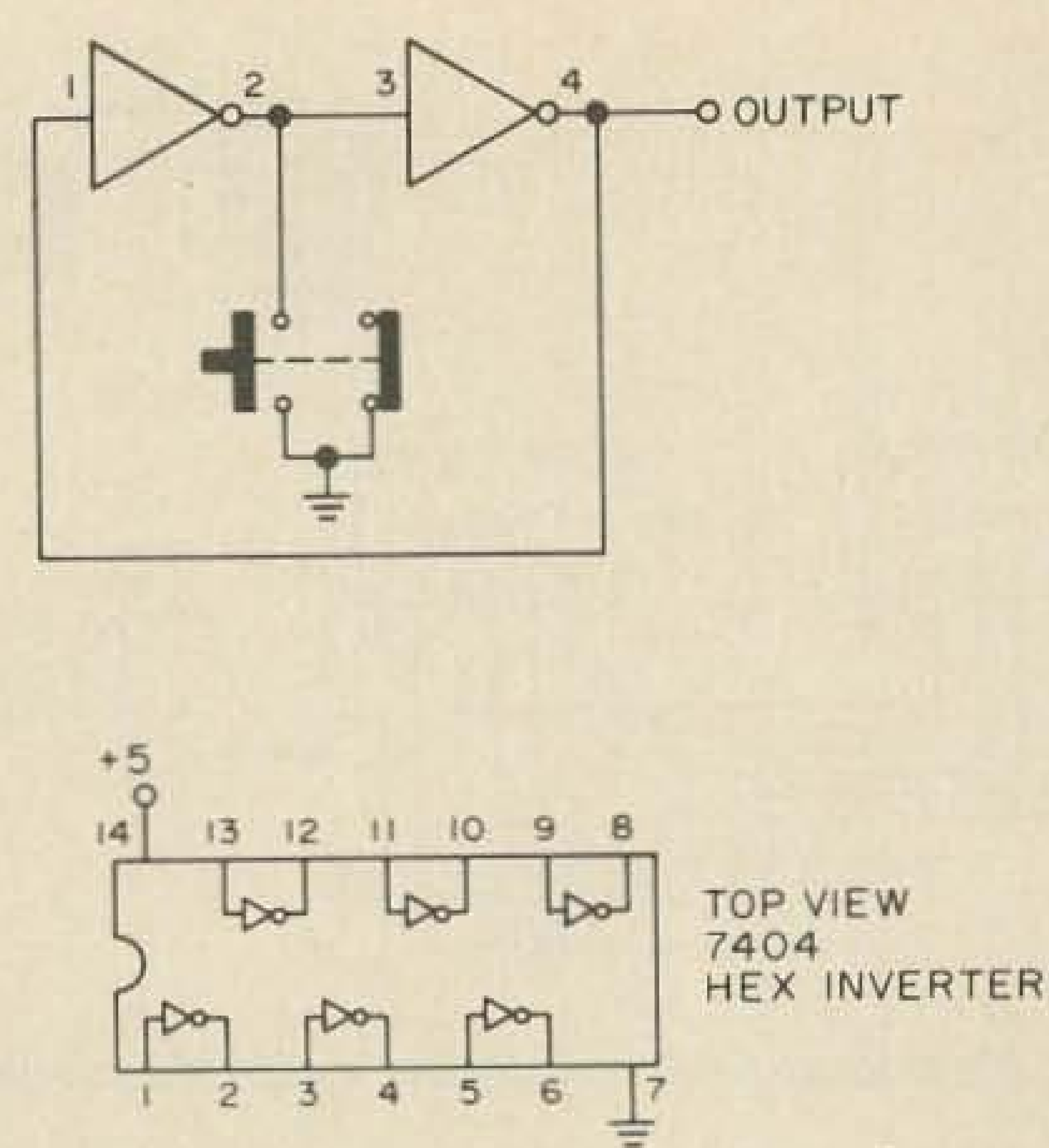


Fig. 7. Bounceless pushbutton.

board with holes that match the pins on the IC's. Small wire, solder soldering iron; and long patience are required. The wire ends can be inserted in the holes alongside the IC pin (in the same hole) and soldered. A desoldering tool of some type is helpful since molten solder often sticks in a blob between IC pins and is difficult to remove because of surface tension. The entire thing can be wired in one day, but it may seem like forever.

An LM 335 IC regulator makes an excellent component for a five volt, up to 900 mA power supply. A battery could be used for portable operation. Every HT needs an auto ID.

Results

This article described an automatic identifier that operates with digital precision and solid state reliability. The basic concept is simple to grasp, and the parts are inexpensive. The largest part of the story is told by the drawings, and data sheets obtained from the IC dealers will help the explanation. New or "surplus" IC advertisements at the back of this magazine offer low prices as well as information on the devices, so construction is not beyond someone inexperienced with logic. Since every repeater group must have someone with some electronic experience, there is little excuse for not having an all electronic ID. Perhaps this will eliminate some of the sloppy CW we hear every time 52.525 opens up!

. . .WB6BIH

Otis Wrench WØMQB
6436 Longmont Drive
Wichita KS 67219

ADJUSTABLE TIME DELAY RELAY CIRCUIT

Any ham who has shopped around for a time delay relay knows they are hard to come by, particularly the adjustable type. Not only are they large but they are also relatively expensive. I have recently seen the vacuum type sealed relays advertised on the surplus market, but have never tried them, even though they were offered at ridiculously low prices, because the delay time was always some figure that didn't tie in with what I had in mind, such as 5 seconds or 5 minutes.

Several years ago I tried the following delay relay circuit, and have used it since. It has given absolutely no trouble, and I still have the original 6AL5 tube in service. It was a used one that had been in a TV set for several years before I junked it out.

As you well know, it takes time for the heaters of indirectly heated cathodes to raise the emitting surface of the cathode to a temperature high enough to start conduction in the tube. Set manufacturers have spent considerable time and money to overcome this nuisance of delay time from the instant the set is turned on to the instant a picture or sound appears. Several "instant on" TV sets have appeared on the market in recent years.

However, it is this "nuisance" that can be put to good use in a time delay circuit. Normally, with rated filament voltage applied, it will take from 10 to 15 seconds for the heater of a vacuum tube to raise the cathode to emitting temperature. We can increase this delay time if we decrease the applied filament voltage. By putting a variable rheostat in one leg of the filament circuit, and a sensitive relay in either the cathode circuit or the plate circuit, we have an adjustable time delay relay. And sensitive relays are available in plentiful supply on the surplus market at give-away prices. My latest flyer from Polypaks lists a SPDT 6500Ω coil, 2 μA relay at 2 for a dollar. This is a fraction of their original cost and a small fraction of the cost of an adjustable time delay relay. A 7-pin miniature socket and a used 6AL5 tube and a 20–50Ω wire wound pot shouldn't be too expensive to obtain, if

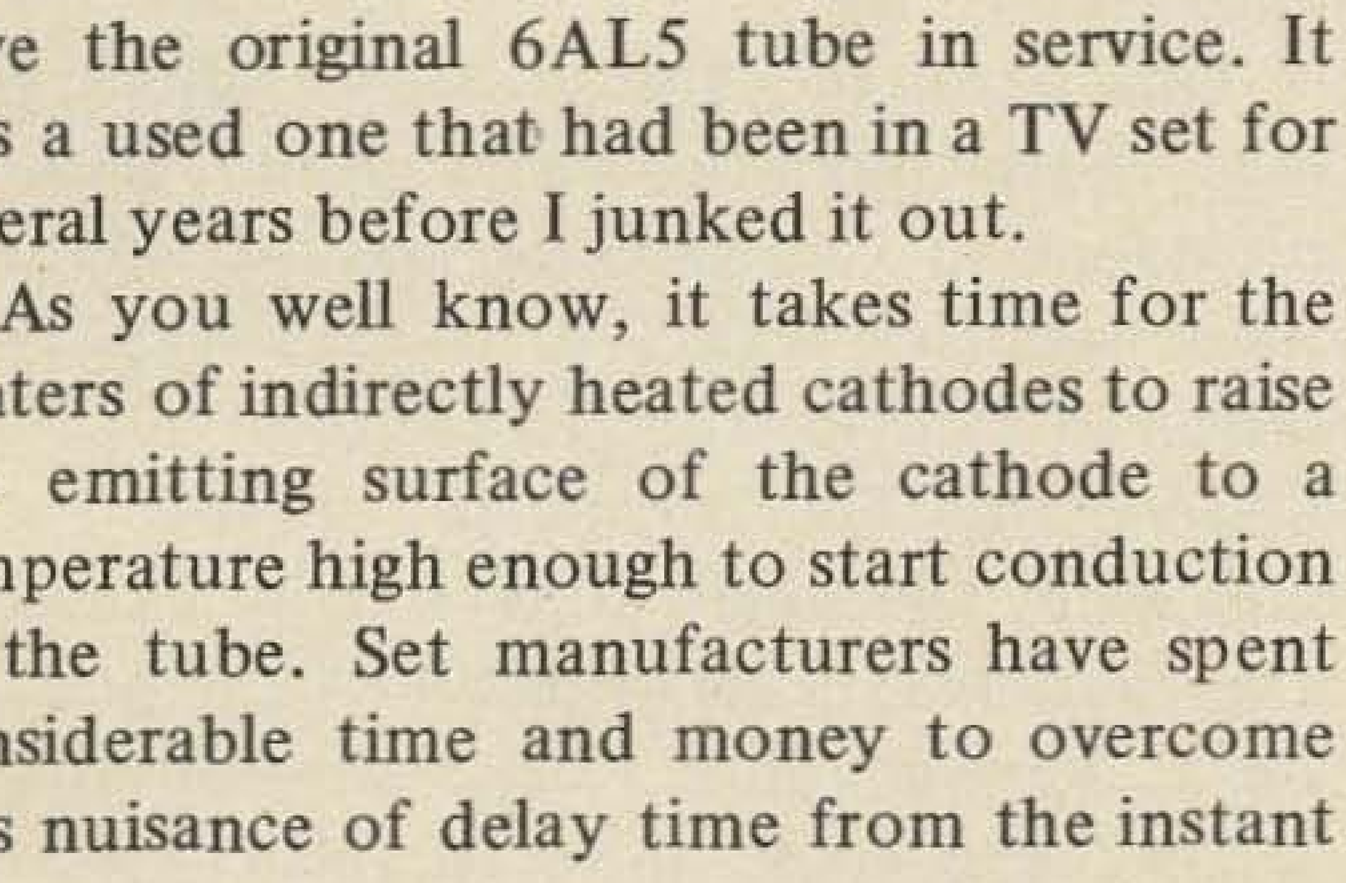
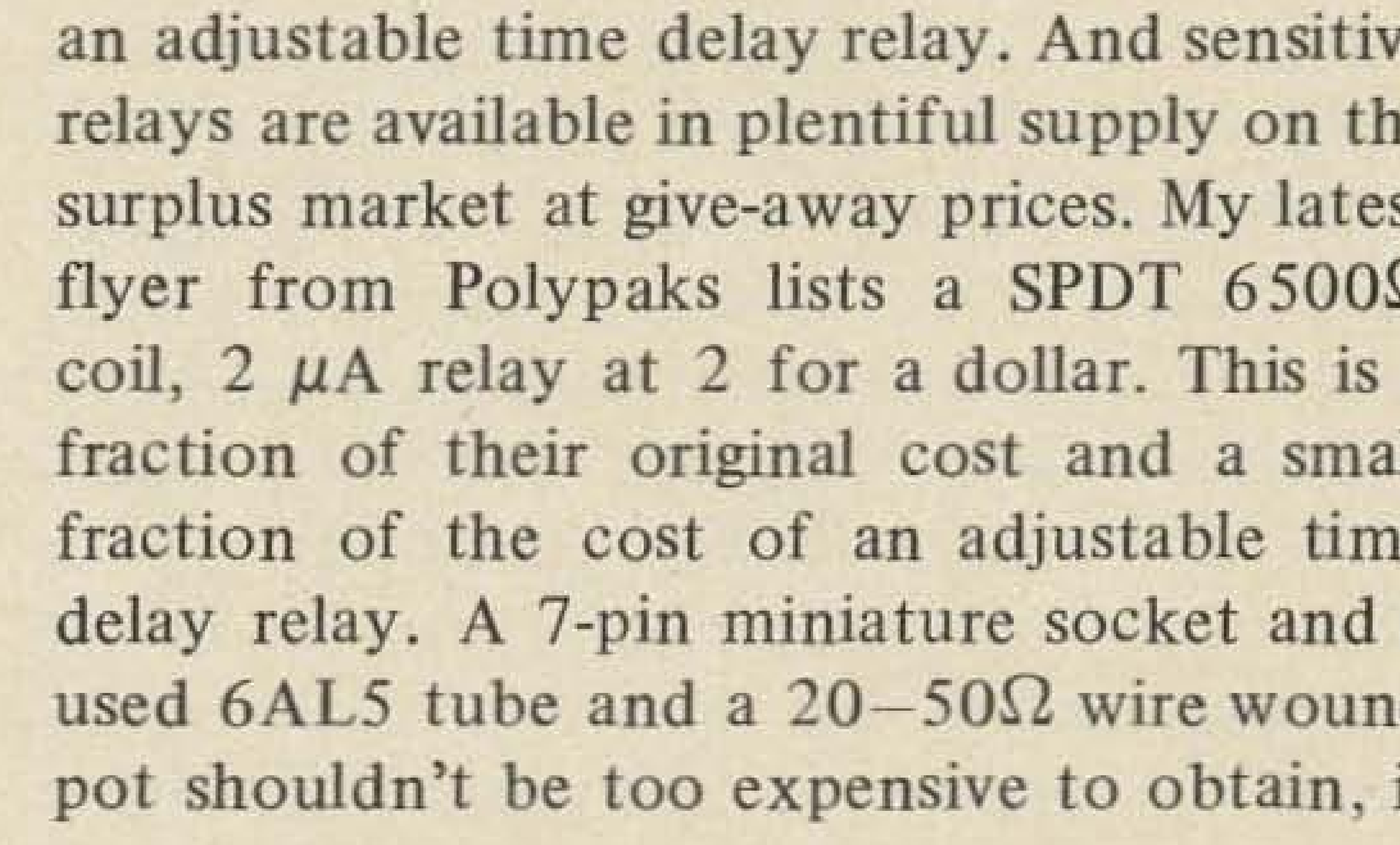


Fig. 1. The basic circuit for the time delay relay.



Neat external appearance of relay adjustment screw.

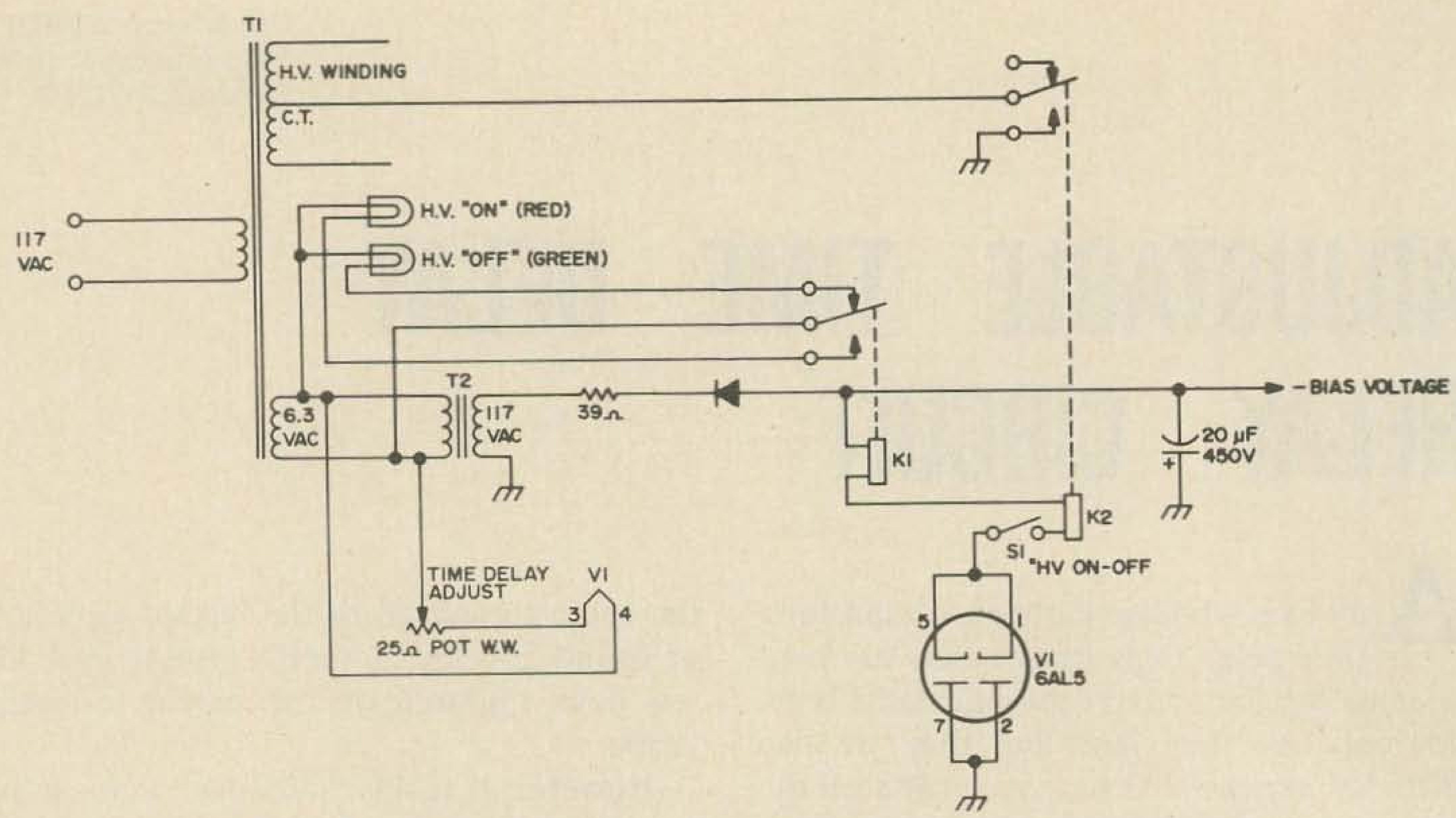
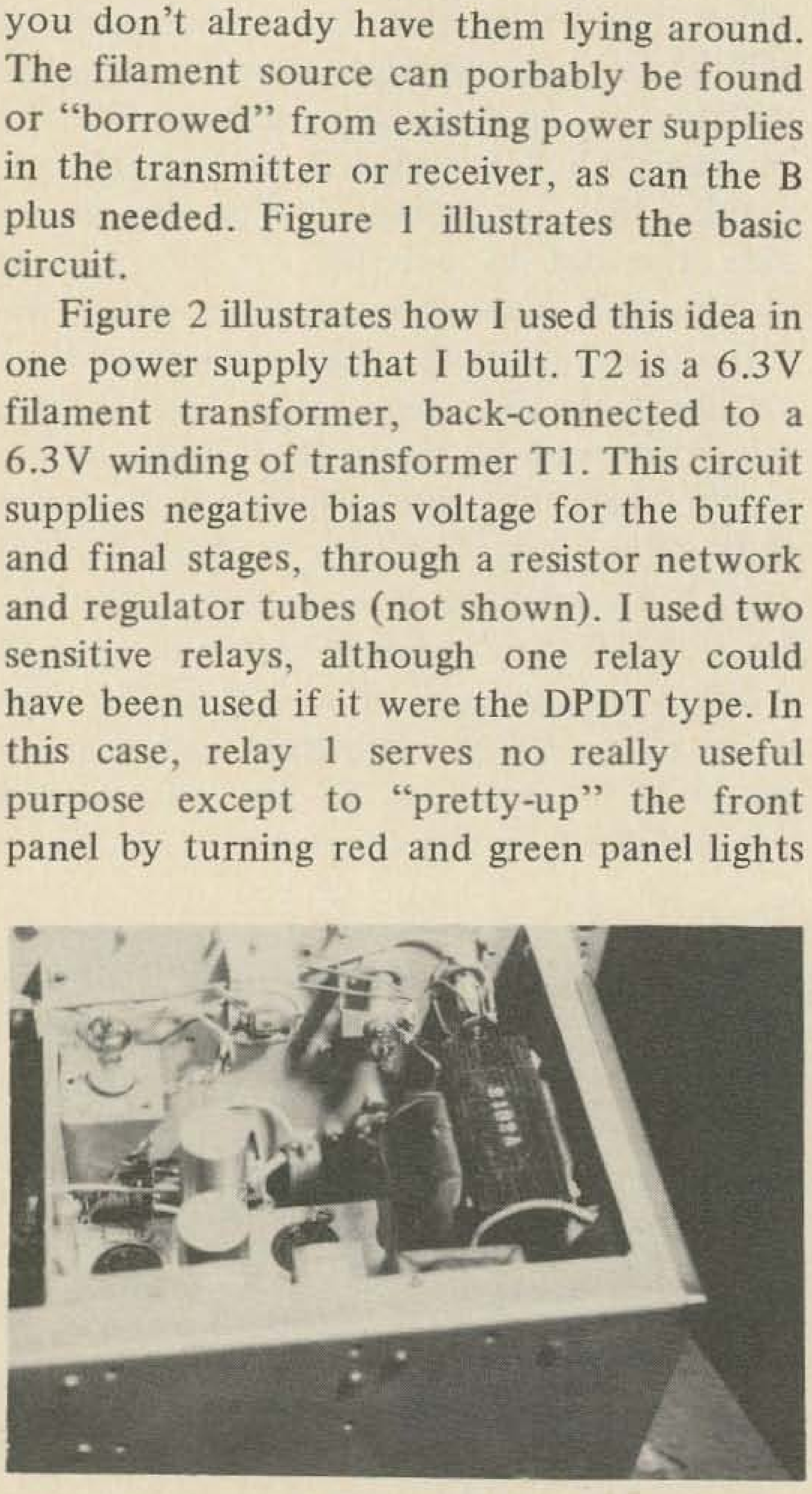


Fig. 2. The time delay relay as used in a power supply.

you don't already have them lying around. The filament source can porbably be found or "borrowed" from existing power supplies in the transmitter or receiver, as can the B plus needed. Figure 1 illustrates the basic circuit.

Figure 2 illustrates how I used this idea in one power supply that I built. T2 is a 6.3V filament transformer, back-connected to a 6.3V winding of transformer T1. This circuit supplies negative bias voltage for the buffer and final stages, through a resistor network and regulator tubes (not shown). I used two sensitive relays, although one relay could have been used if it were the DPDT type. In this case, relay 1 serves no really useful purpose except to "pretty-up" the front panel by turning red and green panel lights



The delay circuit takes up very little space.

on and off. SW 1 opens up the relay circuit so the high voltage can be turned off manually after the delay circuit closes. The 25Ω wire wound pot is listed as available at supply houses, and the value isn't critical. Twenty to 50Ω should do the trick as long as it has the capacity to handle 300 µA of current.

One word of caution. Don't check your stop watch by the delay time. With no resistance in the filament cincuit, the delay time will vary from 10 to 15 secons; there seems to be that much variation in individual 6AL5s. As the resistance of the pot is increased, the delay time will be increased. Two minutes seems to be about the practical limit. Beyond that, the operation is very erratic, and sometimes the relays will take several minutes to close. I have mine set for about 30 seconds and clocked it several times, and it stays fairly steady at 30 to 35 seconds delay time.

As the photographs show, this installation takes up very little space in the power supply. I originally had 866 Jr's in this power supply, but have since replaced them with silicon diodes. I left the delay circuit in because I liked the idea of letting the final and buffer tubes warm up a little before hitting them with full plate voltage. And I liked the red and green lights.

. . .WØMQB

WIN A FREE SBE-144

Here's your chance to win one of those great SBE-144 transceivers . . . FREE . . . nothing to buy . . . and join the gang on two meter FM. And it is a gang too, with almost one third of the active amateurs now on FM.

The SBE-144 is a terrific little rig – all solid state, of course – with twelve channels and a very large lighted channel switch (about the easiest to read in the business) – built in S-meter and power output indicator – 10 watts output (plenty to get into any repeater) – protective circuit for final in case of antenna being shorted – jack for external speaker (like the car radio speaker, for instance, though it does have a nice speaker built into the set if you don't want to bother) – jack for external push-to-talk – just about everything you could want in an FM set.

HOW TO WIN

Take the entry blank from page 75 (or even a copy of it) to your local distributor and get him to initial it. If you spend anything during the visit have him mark that in – and should you be the winner that will be refunded in its entirety. Then send the entry blank to 73 so it can be in the hat for the next drawing. Extra entry blanks are available at the distributors listed on pages 74–75. No purchase is necessary, of course.

WHEN IS THE DRAWING

A drawing for the Rig Of The Month will be held on the 15th of each month. All entry blanks received before that date will be eligible for the prize rig. Blanks received too late for the SBE-144 drawing will be held for the following month's drawing. The drawing for the SBE-144 will be held NOVEMBER 15th.

The winner will be notified immediately and arrangements will be made for the rig to be presented by the local dealer – and the refund of whatever money was spent with the dealer and marked on the blank will be made. Maybe this is the best time to think about a Signal One or something.

ENTRY BLANK
ON PAGE 75
AND AT PARTICIPATING
DEALERS

The first Rig Of The Month drawing was for a Gladding-25 transceiver (drawing: October 15th). The November drawing will be for the SBE-144 rig. Future rigs are being arranged for – with some being transceivers and some being interesting units such as the Data Engineering super memory 8000 keyer – and like that.

The purpose of the contest is to encourage you to visit your local ham dealer and get your entry blanks. The fact is that there is a rumor going around that several amateurs have been wasting their perfectly good money on rent and food when they could better be using it for longer range benefits such as making life long friendships via amateur radio – and that means you gotta have good equipment. Bum equipment can easily bring you bum friends, as several amateurs in the Connecticut area will readily testify. Get good gear.

A new piece of equipment is fun. It's fun to buy – fun to hook up – fun to use – fun to talk about. And, if you've thought it out carefully, the fun will continue for a long time. The fellows who bought the Regency rigs a couple years ago have had many times their money's worth of fun – and it is still going on.

If we can get a few dozen – or maybe even a few hundred amateurs to get into their dealer's store and see what is new, perhaps our contest will be well worth the effort and expense. There are a thousand repeaters or more out there waiting to be used – DX is popping out all over the world – and there are about 150,000 active amateurs looking for you to get on the air and talk with them.

FULL REFUND

Just in case the SBE-144 isn't enough to get you to enter the Rig Of The Month contest, we are also offering you the opportunity to buy as much ham gear as you like and possibly get a full 100% refund on every penny you spend.

When you get your local dealer to initial your entry blank you should have him mark down at the same time the amount that you have spent with him during your visit. If your entry wins you will get a check from 73 Magazine for the amount of your purchases.

We thought we'd give this a try and see if the idea was popular. The main thought was to not take any chances on stopping the sale of SBE-144's for a month all over the country while thousands of amateurs wait to see if they are the winner. This way, if they do buy an SBE-144 and the purchase is marked on the entry blank, they will have an extra rig – for the car – for the office – or whatever.

Of course if it turns out that no one really cares about the refund feature of the Rig Of The Month contest we can always save the money and use it for another prize or something.

By the way, in case you wonder about where the money comes from for the contest, just think about it for a moment – 77,000 readers are involved and at 1/2¢ per reader we have enough to buy nice rigs and thus provide fun for everyone.

ENTRY BLANK
ON PAGE 75
AND AT PARTICIPATING
DEALERS

73 RIG OF THE

FM HEADQUARTERS!

2 meter FM
TRANSCEIVER

SB-144

Been denying yourself all that great fun so many other amateurs are having with their rock-solid, through-the-repeater contacts?

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Confirm the price then make the deal. Lose no time in securing this book-size beauty under your dash with the tiltable mounting bracket supplied. Then, **power on! ENJOY!**

BE SURE TO
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GET YOUR
SB-144
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Amt of Purchase $______ Salesman __________ Date_______

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George W. Fyler W9JT
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PETITION TO THE FCC

This petition was originally submitted to the FCC on April 26, 1971. It was acknowledged only as "comments," not as a petition, and no further word has been received from the FCC to date.

Objections to FCC Proposal for Rulemaking Docket 19162.

1. Does nothing to stop U.S.A. CW interference to foreign amateur fone signals and resulting ill will.

2. Does practically nothing to improve the very poor occupancy of all amateur bands caused by overcrowding of fone sub-bands and excessive CW bandwidth.

3. Continues the inequities in privileges all in favor of CW vs SSB fone including; power and communication ranges, suballocation bandwidths, use of international frequencies, susceptibility to mutual interference, and discrimination under the FCC "Incentive Licensing."

4. Continues the coercion of an ex post facto regulation, "Incentive Licensing," under which General Class fone stations lost 50% of their already inadequate and crowded fone frequencies, with Advanced Class fone stations also losing frequencies. Docket 19162 would return only a token part of the revoked fone frequencies and does nothing to alleviate the overcrowding of U.S.A. fone sub-bands, where only the highest power fone stations are frequently able to operate, and as a result many amateurs have quit amateur radio in disgust.

5. In the 80 meter band, Extra and Advanced Class stations could use fone in only a small already crowded portion of the international communication frequencies. Most of Region 3, Russia and many other foreign countries still could not be contacted directly.

6. A piecemeal extension of only Extra and Advanced fone stations into a small portion of the international frequencies without clearing out the widespread and unnecessary CW interference from U.S.A. stations will only add more confusion and probably more ill will.

Points of Agreement with FCC Proposal Docket 19162

1. The direction is correct in allowing U.S.A. fone stations to operate in frequencies established for international amateur communications.

2. Reduction of the exclusive Extra Class CW segments from 25 KC to 10 KC is justified because of poor occupancy. But all U.S.A. CW including the Extra segment should be moved out of the inadequate and extremely crowded international frequencies 7.0 to 7.1 MC as explained later.

General Considerations for Amateur Band Suballocations

1. U.S.A. CW amateurs can operate throughout all bands, regardless of interference produced on amateur fone signals, foreign or domestic. U.S.A. fone stations are allowed only small fractions of the amateur bands under present FCC rules, and the fone sub-bands are greatly overcrowded while large portions of the U.S.A. amateur bands frequently have negligible occupancy.

2. In the face of already crowded fone segments and the accelerated growth of SSB fone communications throughout the amateur bands, FCC's "Incentive Licensing" regulation arbitrarily cut the crowded fone bands in half for the largest group of General Class stations. The Advanced Class stations also lost fone frequencies. Many amateurs gave up in disgust, others switched to CW with its undiminished privileges, and many were coerced into becoming technical and Morse code experts and passing the Extra Class exam, *in order to regain the fone frequencies which had been taken away under "Incentive Licensing."* But nothing of consequence had been taken away from General Class CW operators who can still contact all foreign countries directly in the international frequencies of all bands, even though they are less qualified technically and in code speed than Extra Class fone operators who cannot contact fone stations except with split frequencies on the 40 and 80 meter bands – and with U.S.A. CW interference on the weak foreign signals.

3. It is apparent that "Incentive Licensing" tends to: perpetuate the semi-obsolete CW mode and discriminate against fone, prevent almost all foreign fone contacts by General Class fone stations, overcrowds the fone bands so as to discourage fone operation except for highest power stations. Why were no sanctions placed on General Class CW operators if the purpose was to upgrade licenses? Why are FCC monitoring stations ignoring all CW interference to foreign and domestic fone signals? It seems obvious that the FCC Amateur Division has been and probably still is dominated by CW advocates.

4. Split frequency fone operation is required on the 40 and 80 meter bands because U.S.A. fone stations are not allowed by the FCC to transmit in the frequency ranges agreed upon for international communications. And foreign fone stations cannot operate in most cases in the U.S.A. fone frequencies because in the rest of the world the U.S.A. fone frequencies are allocated to high power broadcasting, commercial and jamming stations. Many of the high power signals are more audible to foreign amateurs than in the U.S.A. Thus it is almost impossible for a U.S.A. fone station to pick a frequency where it can be heard in a foreign country, and it is equally difficult for a foreign station to find a U.S.A. station in the strong commercial and broadcast interference of the present U.S.A. fone bands. Split frequency fone contacts are wasteful of frequency space and are especially bothered by unavoidable as well as deliberate interference at both ends.

5. SSB fone requires about 2000 cycles bandwidth and at least 100 times the 20 cycle bandwidth needed for typical CW signals. With proper receiver filters and assuming full power for each mode, the signal/noise is at least 20 dB better in CW vs SSB fone, equivalent to 100 times in

power. The International Regulations (694-2) state, "All stations shall radiate only as much power as is necessary to ensure a satisfactory service." The use of unnecessary power is also a factor in TVI. Since 1 KW is the maximum power allowed SSB fone it would seem proper to limit CW to the same communication range as SSB fone. Therefore, the maximum power for CW should be reduced to 10 watts. Furthermore, since there are fewer CW than fone signals on all amateur bands the CW sub-band should not exceed 1% of the total in each amateur band.

6. SSB fone signals are much more susceptible to CW interference in the 2000 cycle bandwidth than are CW signals requiring only 20 cycles bandwidth. With proper CW filters a CW operator is able to reject almost all interference such as other CW signals which would completely blot out an SSB fone signal. Rejection tuning controls have been tried in SSB fone receivers but experience shows that rejection of even a single strong CW signal is not possible without partial or complete loss of intelligibility of a weak fone signal. As many as 100 distinct CW signals could be selected within the 2000 cycle passband needed for SSB fone. It is imperative that SSB fone have the "right-of-way" over CW and the only practical way is to segregate U.S.A. CW stations into an equitable sub-band.

7. Because of crowded fone bands, SSB fone equipment has undergone intensive development, to optimize SSB communications and to reduce interference between fone signals. Many new SSB receivers, transmitters and especially transceivers are produced each year in ever increasing quantities and in several countries. On the other hand there has been little if any progress toward achieving the potentialities of CW communication, probably because of excessive power and bandwidth allowed CW, and the ability to reject most interference with simple audio filters under these favorable conditions. A receiver having optimum design for CW reception is not known to have been described in the literature, or to be available for sale to amateurs.

To stimulate the development and design of improved CW receivers and filters and to allow time for CW operators to update their equipment, compromise bandwidths and power are proposed for amateur CW stations on a temporary basis. Instead of 1% for a CW sub-band, a range of 8 to 15% is suggested in various bands for the reasons described, with a power limit of 100 watts. The CW power limit might be reconsidered in a future international meeting.

8. U.S.A. CW interference, usually between U.S.A. CW stations, is particularly bad in the 40 and 80 meter bands and effects fone contacts between foreign fone stations as well as between foreign and U.S.A. fone stations in crossband operation. Considering the small number of CW signals and the large unused frequencies in these bands there is absolutely no valid reason for CW stations to interfere with foreign fone signals. Again, the answer to CW interference is segregation into an equitable sub-band for all U.S.A. CW stations. Examples of CW interference on the 40 and 80 meter bands follow:

3.55–3.7 MC 9–12 GMT:
Japan, Australia, etc. fone.
3.7–3.8 MC 22–14 GMT:
Europe, Africa, Region 2 fone.
7.0–7.1 MC 22–14 GMT:
Regions 1, 3, most of 2 fone.
7.15–7.2 MC 22–14 GMT:
Region 2 fone.

W1AW (ARRL) teletype broadcasts regularly kill all foreign fone contacts on or near 7.095 MC. Daily CW nets on 3790 (W5's) regularly interfere with Canadian phone patch nets on the same frequency. A number of U.S.A. CW stations normally operate on top of strong Canadian fone stations in the 3.75 to 3.80 range and sometimes above 3.8 in the U.S.A. Extra Class fone sub-band. U.S.A. Novice CW stations also operate in the "Canadian" fone band in the range 3.725 to 3.750. As a direct result of the U.S.A. CW interference, Canadian fone stations have managed, however deliberately, to prevent U.S.A. fone stations above 3.8 MC from contacting weak foreign fone stations who attempt to operate just below 3.8 in the required split frequencies. The situation has persisted for several years with a small but well known group of VE3 fone stations, many with very strong signals which preclude reception of any weak foreign signals, even if no U.S.A. CW signals are present.

It makes no sense to add to the present mess of signals below 3.8 MC and below 7.1 MC by allowing Extra and Advanced U.S.A. fone stations to operate in the proposed (Docket 19162) small segments of the international frequencies without clearing out the compeltely unnecessary signals, the root cause for widespread ill will. A far better solution to the problem of international fone contacts for U.S.A. fone stations results from segregation of U.S.A. fone and CW signals into equitable sub-bands. General Class fone stations must be given the same rights to contact foreign fone stations in the international communication frequencies which General Class CW stations have enjoyed with foreign CW stations.

9 Amateur bands belong to all amateurs in all countries and efficient use of these bands requires maximum occupancy and maximum communications between all radio amateurs, eliminating unnecessary, irresponsible and deliberate sources of interference wherever possible, and establishing equitable sub-bands for non-compatible modes of transmission. The FCC and the U.S.A. must provide leadership in establishing sensible sub-allocations for U.S.A. radio amteurs.

Regarding the statements of certain Canadian groups, it is ridiculous that a VE3 fone station in Niagara Falls Ontario should be able to contact European fone stations directly in the international frequencies below 3.8 MC while a W2 in Niagara Falls, New York, cannot – even with an Extra Class ticket. There are just not enough frequencies available in the amateur bands so that the U.S.A. with over half of the world's amateurs should limit its fone bands to only Stateside contacts, while providing for exclusive use of all of the international frequencies by neighboring countries. This is clearly a violation of civil rights for the U.S.A. fone amateurs.

There is also no question of "domination" of the amateur bands by U.S.A. fone stations because propagation to the rest of the world at best occurs for only a few hours each day, if at all, for only a few days each month, and on most amateur bands for only a few years in each 11 year sun spot cycle. The unfortunate crowding of the U.S.A. fone bands with only strong signals able to compete might suggest "domination" of the entire band if the fone bands are expanded. Similar crowding of VE fone stations into a 10 KC fone band would justify a similar argument.

There are today Canadian, South American and other amateur stations having signals as strong as, if not stronger than most U.S.A. stations. Maximum power, so called, is no longer a perogative of U.S.A. amateurs, and enforcement of a power limit for transmitters is probably as lax in foreign countries as it is in the U.S.A.

There is no provision in the international agreements for exclusive use of amateur frequencies by one country at the expense of another. There are no national boundaries to divide the amateurs of one country from those in another country, except as determined by each country in its rules and regulations The answer to any possible crowding of Canadian fone stations should come from

Ottawa and not from the FCC. And the answer to crowding of U.S.A. fone stations is full usage of all amateur bands based on an equitable segregation of CW stations.

10. The proposed Suballocation Chart is simplified to CW and SSB fone modes of transmission. SSB fone includes any single sideband transmission. SSB fone includes any single sideband transmission, as of a slow scan TV picture. AM. (amplitude modulation), FM (frequency modulation) DSB (double sideband) and slow scan TV as an AM signal are all omitted because all tend to cause unnecessary interference and are wasteful of frequency space. A time limit of perhaps 2 years should be placed on these transmission modes with interim operation limited to the proposed Novice fone band.

There is little justification for exclusive Extra Class fone bands, or for becoming a Morse code expert in order to be able to contact certain foreign stations using fone, as on the 80 meter band. Since the Advanced and Extra Class exams are essentially equivalent except for the code test, the Extra and Advanced fone subbands are identical.

Similarly, Conditional licenses are assumed to be the same as General Class, although the reason for so many Conditional Licenses is not understood.

11. Lack of occupancy by the U.S.A. of the international amateur frequencies has invited takeover of these frequencies by unauthorized transmitters and eventual loss of these frequencies. Those in the FCC Amateur Division who oppose legitimate and obviously needed expansion of the U.S.A. fone bands should ponder these facts.

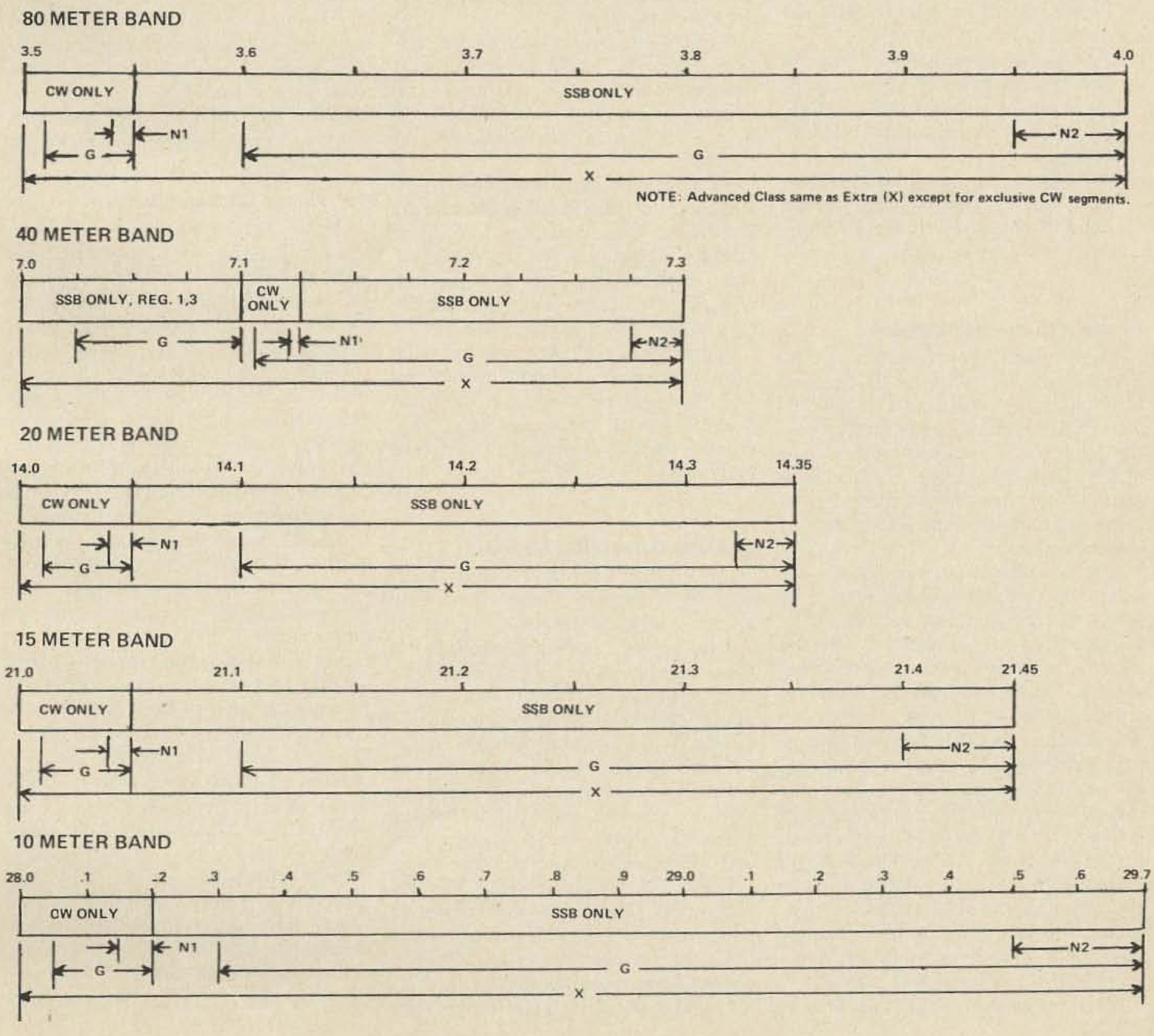
Specific Proposals for Amateur Band Suballocations

See chart

U.S.A. CW stations are segregated into an adequate 'CW only" sub-band at the low end of the international frequency range 3.5 to 3.7 MC. An exclusive 10 KC segment for Extra Class CW, identical with the FCC proposal in Docket 19162, is included plus a 10 KC non-exclusive CW segment for Novices. The 50 KC CW sub-band has ten times the indicated bandwidth for an equitable division of the 80 meter band with U.S.A. SSB fone, as a temporary expedient and for the reasons described previously.

SSB fone has the remaining bandwidth with an exclusive 50 KC seg-

PROPOSED SUBALLOCATIONS FOR USA RADIO AMATEURS



ment for Extra and Advanced Class fone, and a non-exclusive 50 KC segment for Novice (N_2) licenses which are described later.

The proposed CW and SSB fone subband provide:

1. Elimination of U.S.A. CW interference on foreign and U.S.A. SSB fone signals.
2. Elimination of U.S.A. SSB fone interference on CW signals in the CW sub-band.
3. Maximum occupancy of the entire U.S.A. band.
4. All classes of U.S.A. SSB fone stations can contact all foreign fone stations directly.
5. General Class fone has four times the present bandwidth, with equal rights to contact foreign fone stations.
6. More U.S.A. fone stations should be able to operate with modest power, and antenna investment.
7. Attraction for many fone stations forced to stop operating because of "Incentive Licensing."
8. Reasonable incentive for upgrading licenses.
9. Provision Novice (N_2) SSB fone experience.
10. Fosters worldwide fone contacts and development of better equipment and antennas for 80 meters.
11. Stimulates improvement of CW equipment.
12. Anticipates optimum communications and maximum usage of this band during several years of minimum sun-spot activity.

Amateur Licensing Proposals

The exams for amateur radio licenses include technical and regulation questions which can usually be learned after reasonable study, plus the ability to transmit and receive Morse Code. Learning the code is difficult for most and especially for those who are only interested in fone communication.

The international regulations require that amateurs shall be able to send and receive Morse code but they do not require amateurs to become experts in Morse code before being able to make foreign contacts by voice. Instead of primary emphasis on Morse code it is suggested that operating proficiency and experience should be required at each step above the initial Novice license. This suggestion is based on the gradual obsolescence of the CW mode, the worldwide trend toward SSB fone, the vagueness of the old international regulations on code speed, the lack of code tests in some countries, and the growth of "amateur" activity in the citizen's band.

It is suggested that the present Novice Class be known as Novice (N_1), but with greater freedom in operating on all bands, although in a narrower frequency segment. Furthermore, tunable oscillators are suggested so as to permit contacts on the same frequency and to prevent obsolescence of special Novice transmitters. Still another reason is to permit a logical progression to Novice (N_2) SSB fone operation.

The Novice (N_2) exam might require that 25 QSL confirmations must be verified before the exam is taken, and verification might be made by a qualified amateur who would also conduct the exam in a manner of a Novice (N_1) exam. After passing the N_2 exam a Novice (N_2) license (or endorsement of the N_1 license) would permit operation in both CW and SSB fone Novice segments. However, before the General Class exam could be taken the Novice operator would have to receive QSL confirmations for at least 25 or 50 2 way SSB fone contacts. In this way all Novice operators would have to demonstrate operating proficiency in both CW and SSB fone before a higher grade license could be obtained.

Similar requirements for confirmations might be added for higher class licenses, for instance perhaps 100 countries for an Advanced, and 250 before an Extra Class exam could be taken.

It should be mandatory for U.S.A. amateurs to answer all legitimate requests for QSL cards, or have their licenses suspended, or even cancelled, when many complaints are received. QSL replies are as important as foreign contacts in fostering good will.

Exchange of QSL cards may be rather expensive, or quite slow when QSL Bureaus are used, for confirmation of foreign contacts. The U.S.A. exports many things for free, why not QSL cards?

40 Meter Band (7.0–7.3 MC)

All of the fone and CW amateur stations in Regions 1 and 3 have only a very restricted frequency range of 7.0 to 7.1 MC, and some countries in these regions allow only a small portion of this range. Additionally, most South American amateurs in Region 2, which can operate throughout the 7.0 to 7.3 MC range, prefer to operate below 7.1 so they can contact foreign stations directly, and to avoid the extremely strong broadcast, jamming, and commercial interference above 7.1 MC and extending to 7.3 MC. But U.S.A. CW stations usually in contact with other U.S.A. CW stations cause the greatest interference in the over-crowded international band 7.0 to 7.1 MC, and particularly with foreign fone signals. The CW interference causes widespread ill will and is inexcusable, and unnecessary, because CW operation including Novice CW normally operates on split frequency, whereas SSB fone normally uses transceivers which must operate on the same frequency.

It is proposed to provide a "CW only" sub-band at 7.10 to 7.125 MC with 5 KC segments for exclusive Extra Class and for non-exclusive Novice (N_1) CW. The 25 KC CW sub-band is consistent with the limited total bandwidth, and with the restrictions placed on SSB fone operation below 7.1 MC. It is also easier for CW to cope with broadcast and other interference because of its narrow bandwidth requirement.

To minimize U.S.A. fone interference in the crowded 7.0 to 7.1 MC range, it is also proposed to limit direct U.S.A. fone contacts to Region 1 and 3 fone stations, and within segments allowed each license class.

A 25 KC Novice (N_2) fone band is shown at the top end but otherwise there is no split-up of the fone range above 7.125 MC because of the heavy interferences mentioned above, and therefore the limited usefulness of the fone range above 7.125 MC. General Class fone would have five times the present fone bandwidth including Regions 1 and 3 under this proposal.

10, 15, and 20 Meter Bands

These three bands already have some capability for direct fone contacts with foreign countries, although the General Class fone bands are usually very crowded and fone operation is limited to a fraction of the total available bandwidth. The occupancy during periods of good propogation is relatively poor, particularly on the 10 meter band. It is suggested that this band be reduced to the range 28.0 to 28.5 with the same sub-bands as proposed for the 80 meter band.

The 15 meter band is nearly as wide as the 80 meter band and has about the same sub-bands for all modes and license classes as proposed for the 80 meter band.

The 20 meter band is particularly useful for long distance contacts throughout most of the sun spot cycle and also popular for contacts between U.S.A. stations. The 50 KC CW sub-band is relatively wider than on other bands while the proposed Novice fone band is only 25 KC wide. Both variations recognize the relatively greater present occupancy of the 20 meter band. Nevertheless, General Class fone would have 3-1/3 times the present bandwidth and the ability to contact all foreign fone stations directly.

. . .W9JT

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POWER LEAD FILTERS FOR 432

There is a particularly nasty form of trouble which can afflict solid state transmitters, and multi-rf stage receivers too, much more than the old fashioned tube jobs, and considerable attention must be paid in order to avoid it. This is interstage coupling through the low-impedance power lead connections and wires which ordinarily with tubes would not allow sufficient rf voltage to be sent from stage to stage to cause much trouble.

Even with tubes, precautions against this type of trouble had to be taken at times, especially as one went higher and higher in frequency up into UHF. One of the bad features about it is that it can happen easily enough between a first stage and a last stage, transforming one millivolt into one volt and causing violent reaction.

Very complicated power lead filters have been devised for this deal, as for example 8 and 16 section filters for an 8 tube radar i-f strip.

Ceramic feedthrough bypass capacitors were designed for use where power leads went through partitions, which cut down the nuisance rf voltage to a certain extent, enough for the tube type sources, exciters, and finals, if sufficient care and shielding was used in the overall design. Some of these ceramic feedthroughs work at 432 and some do not, as you will see.

Now we are faced with devices (transistors) which exaggerate this kind of trouble due to very low rf impedances. Some transistor collector circuits operate with impedances of less than 10Ω, and for high power it may go under 1Ω. This means that a bypass that was good at 432 MHz with tubes, may let through rf voltage at low impedance, driven by those high current solid state devices to couple back from the final right past a "bypass" capacitor and into the exciter and knock it right out, subject to the phase involved. Or worse, throw the stages into self oscillation, because the input of these devices is also low and so operates on very small voltages of just the kind we're talking about. This is further aggravated if low cost devices are used in the first stages because then the low level operation is more subject to feedback.

Low cost in tubes was nothing. A 6CL6 for $1 had a Gm of over 10,000 and could deliver a watt or more as a 54 MHz crystal controlled oscillator. The same type would then double to 108 with several watts, and two $4.50 surplus 2C39's with Gm's of thirty to forty thousand brought you up to 432 with 5W.

Solid state devices are not quite up to that point as yet, unless money is no object and you order several dozen of the very latest at $200. Even with that kind of money, specs sometimes read like "two watts at 2GC" and then if you read the fine print or turn the page you'll find "gain of 4 dB."

Fortunately it's not quite that bad on 432 MHz, but say you've got a gain of 10 or 12 in each of two rf stages, the last one putting out one or two hundred milliwatts and you couple back just one percent along the battery leads to a tripler stage with an output of only one or two milliwatts. You see what can happen? And it does, too! Not only that, but if it just happens to be in phase, you get output even when you pull the crystal out, and that is about the worst thing that can happen to any transmitter.

So it will pay to examine this question in detail, because as amateurs we have an obligation as well as the need to develop our skills in the art, and this subject is a basic one for all types of transmission and reception by solid state devices.

With this in mind, I started in on the power lead filter deal with the goal being a small low-cost unit easy to make, with at least 40 dB of attenuation in voltage, if possible. It turned out that it was.

These tests and the final low cost filters are good for receivers also. A contemporary author in a magazine I happened to be reading recently mentioned, "You'll have an easier time with one rf stage than with two." No argument there at all. Just that these tests and filters should help reduce the effort needed to "tame" two rf receiver stages, as well as multi-stage transmitters.

How to Get "Cold" Connections

Most of our work on UHF calls for hot wires, that is, wires carrying plenty of rf, and losing the least amount possible through insulation losses, radiation, wire resistance, or by any other nuisance method. For power leads we want just the opposite, to carry dc and lose all the rf immediately. Or at least so much that you can neither detect it, nor find any nuisance effects, which amounts to the same thing. An oscillator and rf amplifier will do for the source and a tuned diode detector will do the job of measuring. After all, we're not doing a research job for a capacitor company, we're just interested in learning how to put a solid state transmitter on the air with a good stable signal without touchy feedback, connectors that jump rf-wise, and other transmitting plagues. The same holds for the multi-stage receiver also.

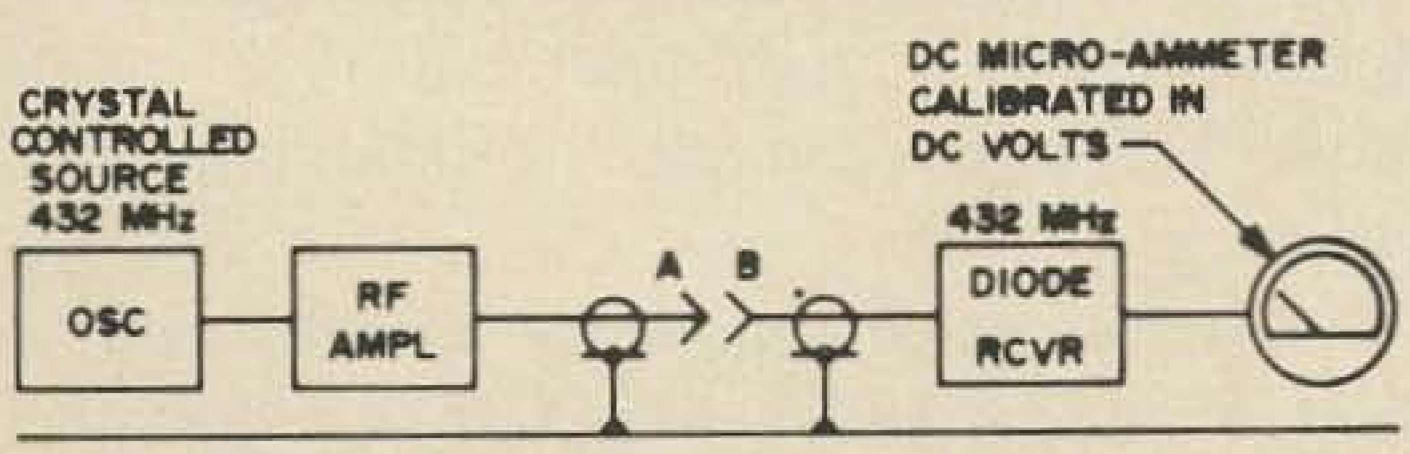

Fig. 1. Test setup, power lead filters.

Figure 1 shows a test setup that can tell us what's what in this matter. After all, if I do it and tell you about it, that gives you more time to build things and get them on the air.

At "A" we have a good 20 mW at 432 MHz coming onto the test plank. At "B" we have another cable going to the tuned diode detector, and with the units shown the meter reads 4V dc when "A" is connected to "B."

The trick is to connect "something" between A and B that will carry heavy current 12V dc with only a small drop or none at all. This may mean a thin wire choke, or a resistor for a low power first stage drawing only 10 or 20 mils and it may mean later on a heavy wire choke for 12V at ¼A for a 3W final.

Tests

Referring to Fig. 1, all results are given in dc volts at the output of the diode detector.

Coaxial cable A to B, 4V; piece of wire on the ground, 3.5; piece of wire with 1000 pF to ground at B, .3; 1000 pF at A, .29; 1000 pF at A and B, .04 (40 mW); 100Ω resistor between A and B, .042; with 1000 pF at A and B, plus 100Ω between A and B, 0V. This could be used with a low current stage like a receiver where even down to 6V is all right for low noise rf, but let's keep going. You certainly couldn't modulate a solid state final through a 100Ω resistor.

Choke coil between A and B, No. 40 wire, ¼ in. diameter, length ½ in., no capacitors, .2; with 1000 pF at A, .01V; with 100 at A and B, ½ mV. Beginning to look good.

Ten turns No. 34 wire, 20 mV, showing that the choke question is subject to variations in filter power, in this version.

Yellow surplus choke, 1/8 in. diameter, ¼ in. long, about 25 turns, 1 mV, good but not quite the ideal yet. Ten turns on the choke and 1000 dipped mica at A and B, 10 mV. Same, with small 3/16th Lafayette ceramics, 3 mV.

Homebrewed flat coax, as in Fig. 2, 10 mV; two 1000 pF at A and B, plus 20 turn choke, 1 mV. At this point I thought about a small module as in Fig. 2. The meter hit the pin. Bringing the two capacitors to *one*

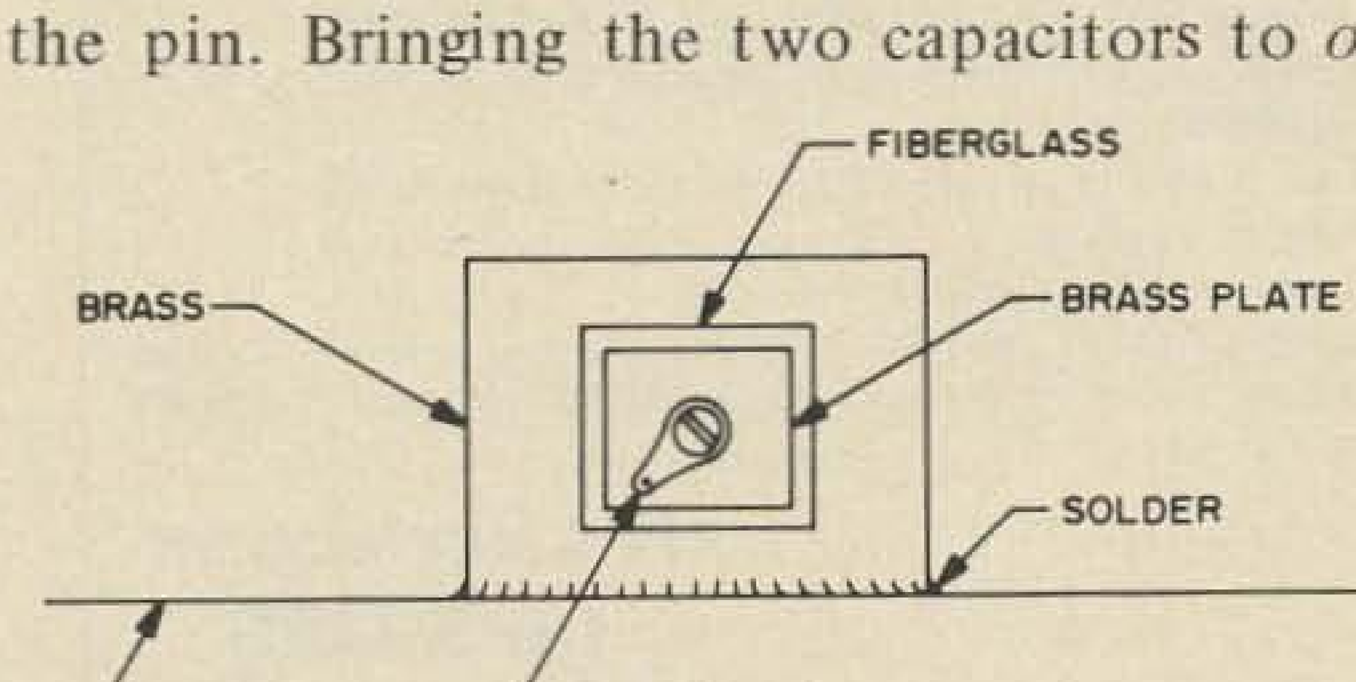

Fig. 2. Simulated, flat coaxial filter.

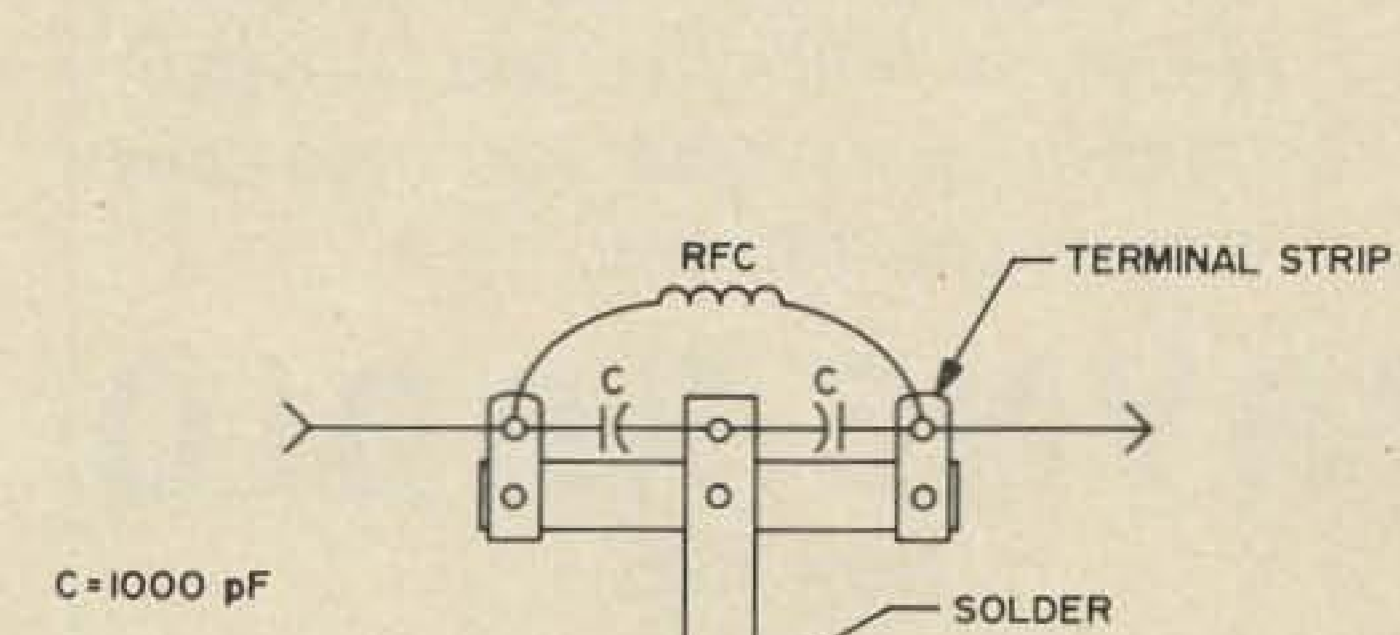

Fig. 3. Filter module.

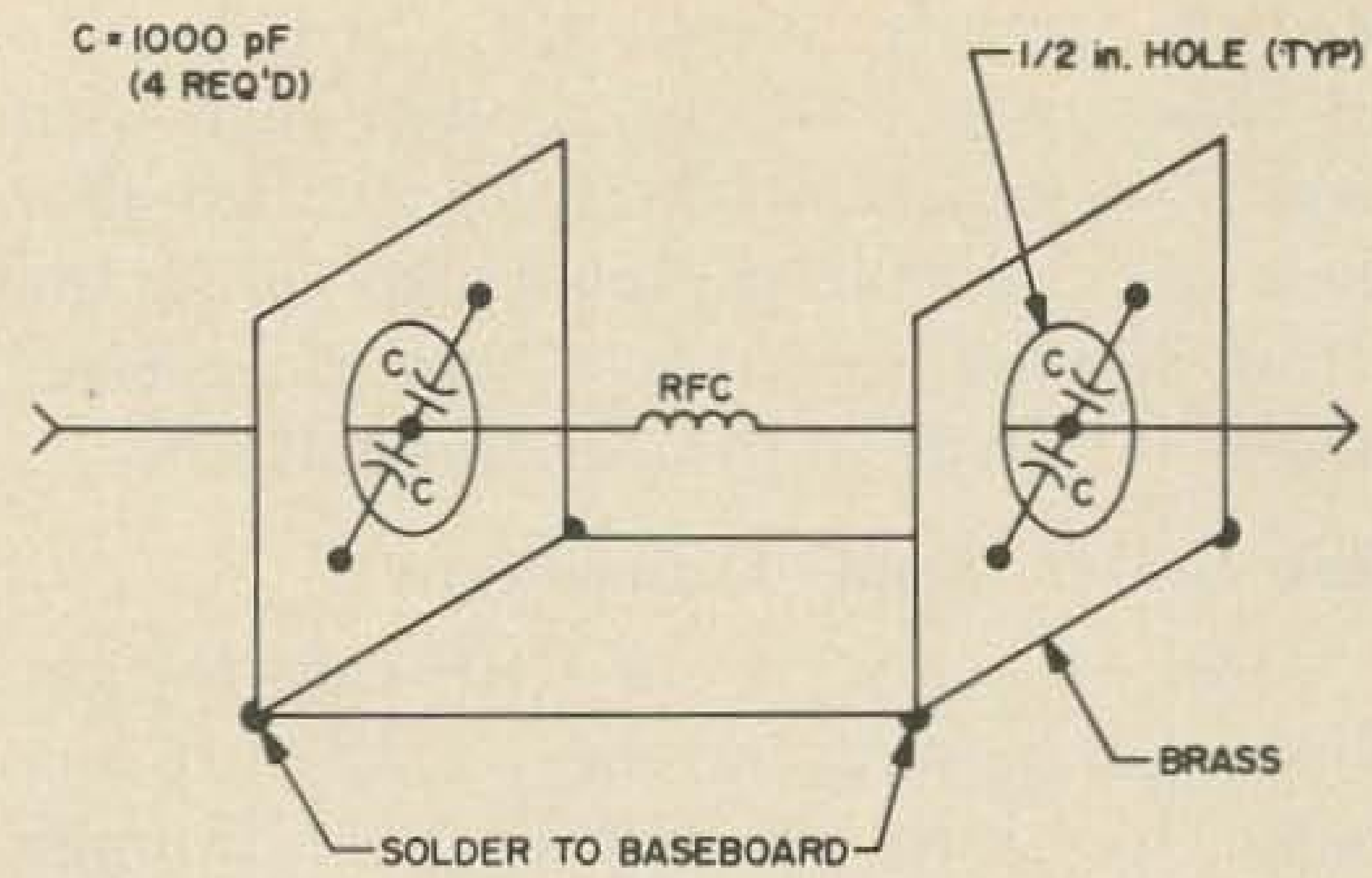

Fig. 4. Brass frame module.

connector, which had some inductance to ground, was absolutely no good.

I then cut out a small brass frame as in Fig. 4. Hurray! The first time to hit a real zero volts. It makes you haul out the ohmmeter and check for a short or an open! Same, but without choke, also zero.

I noticed that every time I checked with another 1000 pF on a little coffee stick from A or B to ground, in effect paralleling the one already there, the meter plunged to near zero. At 432 MHz this is the same thing you may have read about more than once in my writings. More than one capacitor at the same place. It parallels the inductance and drops it.

Now we're getting close to the ideal; in fact, to cut it short, Fig. 5 shows the ideal. No brass plate is needed, and you can use it either on the baseboard or with the choke resistor installed in a hole in a box wall, or what have you.

The two-section filter using 4 capacitors plus a choke in between, really does the job. You imagine the meter moves, maybe. There might be somewhere between 1/10th and 100th of a millivolt of rf leaking through, and some or all of this may be "jumping" through the air.

So now you can make up units in advance, as in Fig. 5, and be sure they'll work at 432 MHz.

30 pF Capacitors

Just for fun, another two-section filter was assembled, as in Fig. 5, but with the low value of 30 pF for each of the four capacitors. Of course at 432 MHz the rf impedance of 30 pF looks almost like a dead

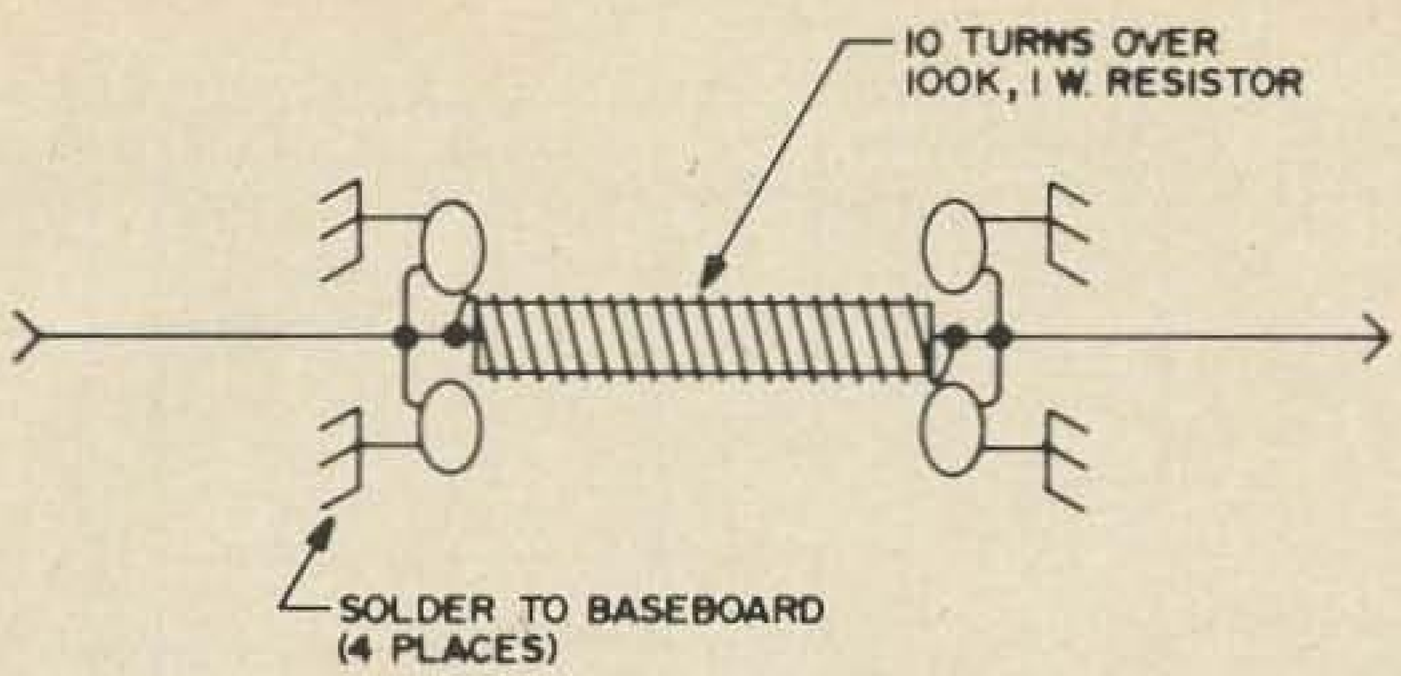

Fig. 5A. Ideal low-cost power lead filter, top view.

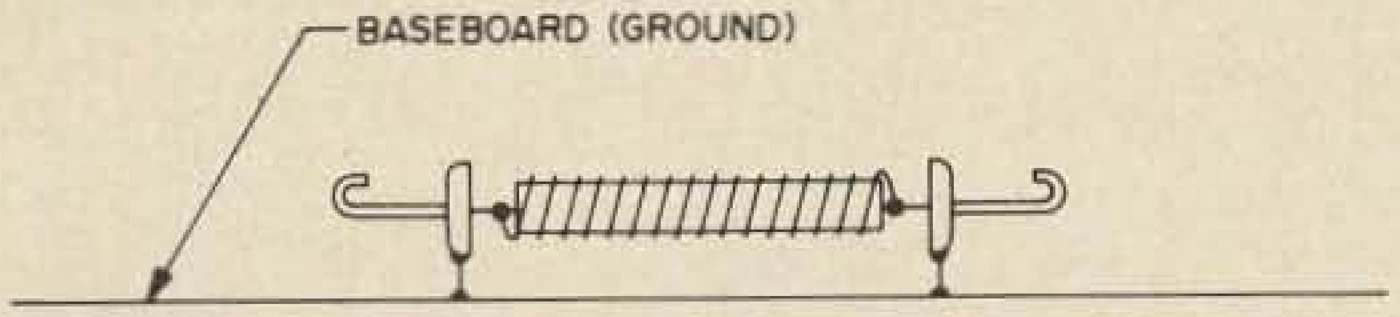

Fig. 5B. Side biew of power lead filter.

short, and it was. I could not tell the difference between the 150 pF filter and the 30 pF one. This makes it easy if you have large quantities of surplus dipped mica capacitors of odd values.

The reduction in rf voltage is something like 50 dB, dropping from 4V down to about one hundred thousandth of a volt. This is plenty for power lead filters. The cost in parts is that of four capacitors at around 10¢ each, and a resistor for a coil form.

"Boughten" Feed-through Capacitors

The first ones tried were disappointing. The type "FT," shown in Fig. 6 allowed 20 mV to leak through.

I did dig up a couple of good ones out of a 1946 surplus UHF Navy unit. I suspect that the price will be quite high on such units, if they can be found. These look like Fig. 7, and perhaps some reader from the sales department of Sprague or Centralab or

Fig. 6. Type "FT" feedthrough capacitor.

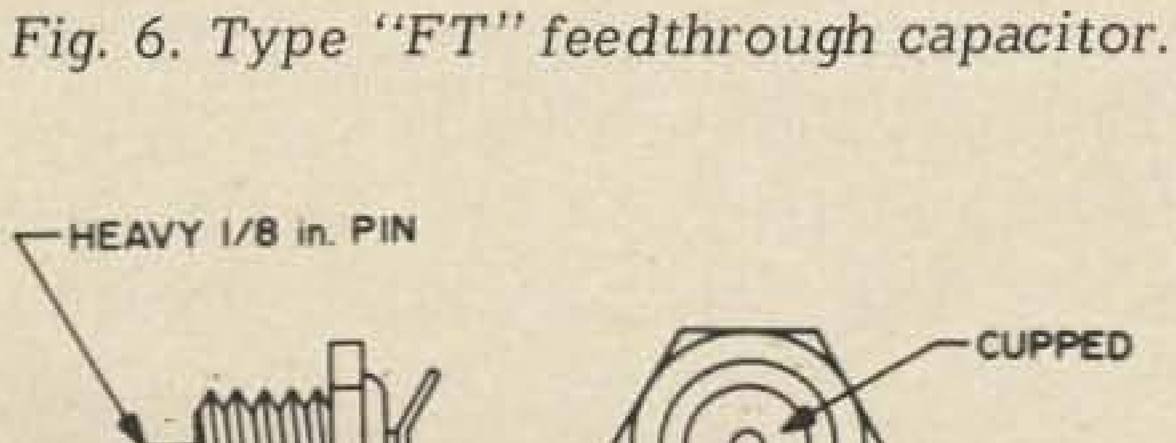

Fig. 7. Feedthrough capacitor.

Erie can tell me what they are, and for how much to amateurs interested in good UHF feedthrough bypasses. They do seem to work as well as the final form shown in Fig. 5, so if you can find them, pay the price, and have a wall to put them in, such as in an enclosed rf stage, you can use them.

Subminiature Filters

The test setup of Fig. 1 being in operation, a smaller version was tried, to be ready for the size reduction being looked forward to with all kinds of new and exciting very small components becoming available on the market.

As long as 30 pF capacitors worked well, anything over that would naturally be all right, so with a tenth watt resistor for the choke coil form, away we went.

While this is not as small as can be made today, when you get into chips and hybrids, prices go in an inverse ratio. Little 1/8 in. x 1/8 in. x 1/16 in. square Lafayette ceramics cost around 13¢ so we still can call this one low cost.

The assembly is just the same as in Fig. 5, with the total space occupied being ½ x 5/8 x ¼ in., and, as mentioned, it could be cut down even more if you tried.

It worked just the same as the larger one in Fig. 5. Need I say more?

Checking Out the Filter

Figure 8 shows the results of tests conducted on a crystal-controlled exciter and rf

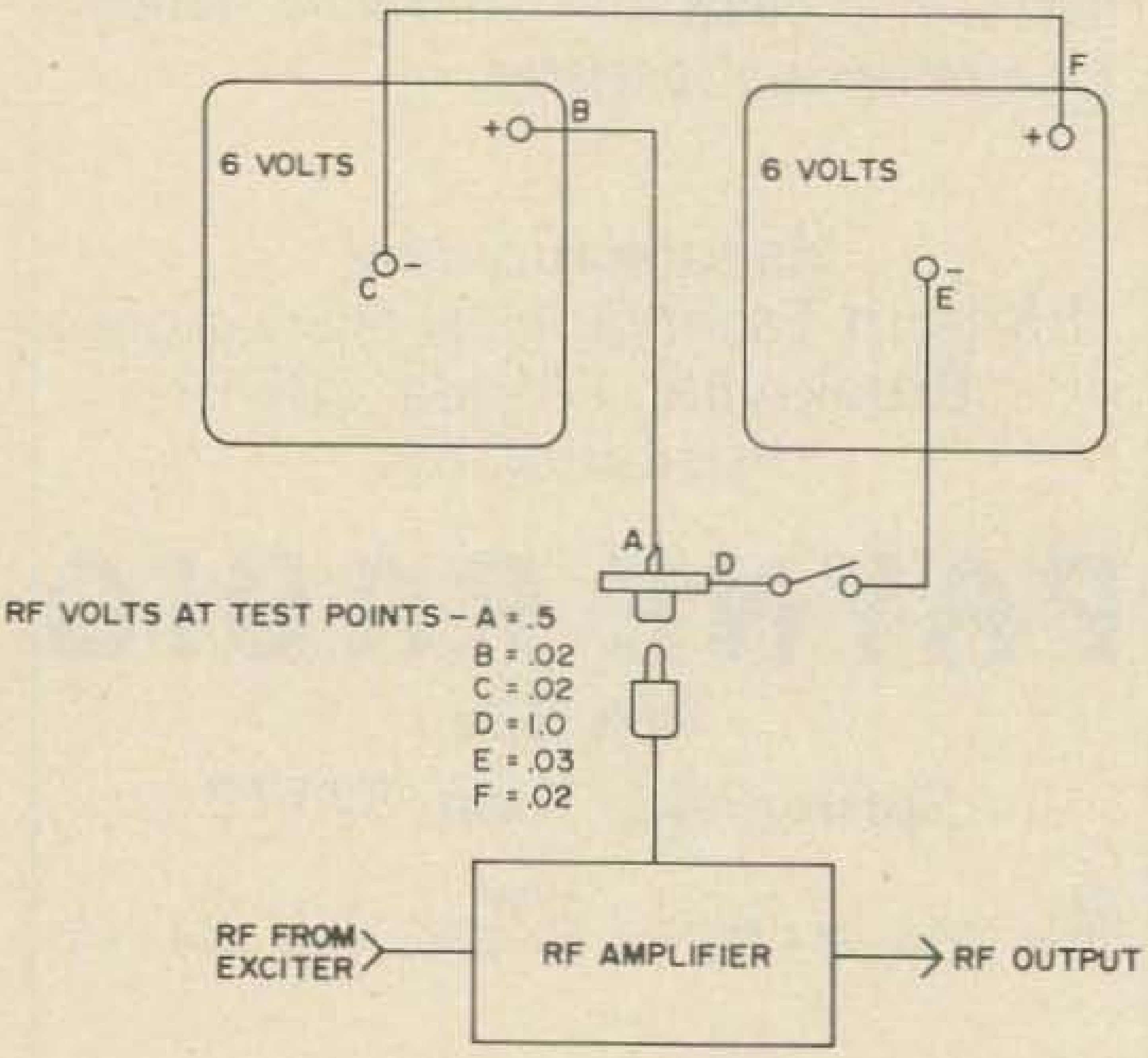

Fig. 8. Test results, rf on batteries and leads.

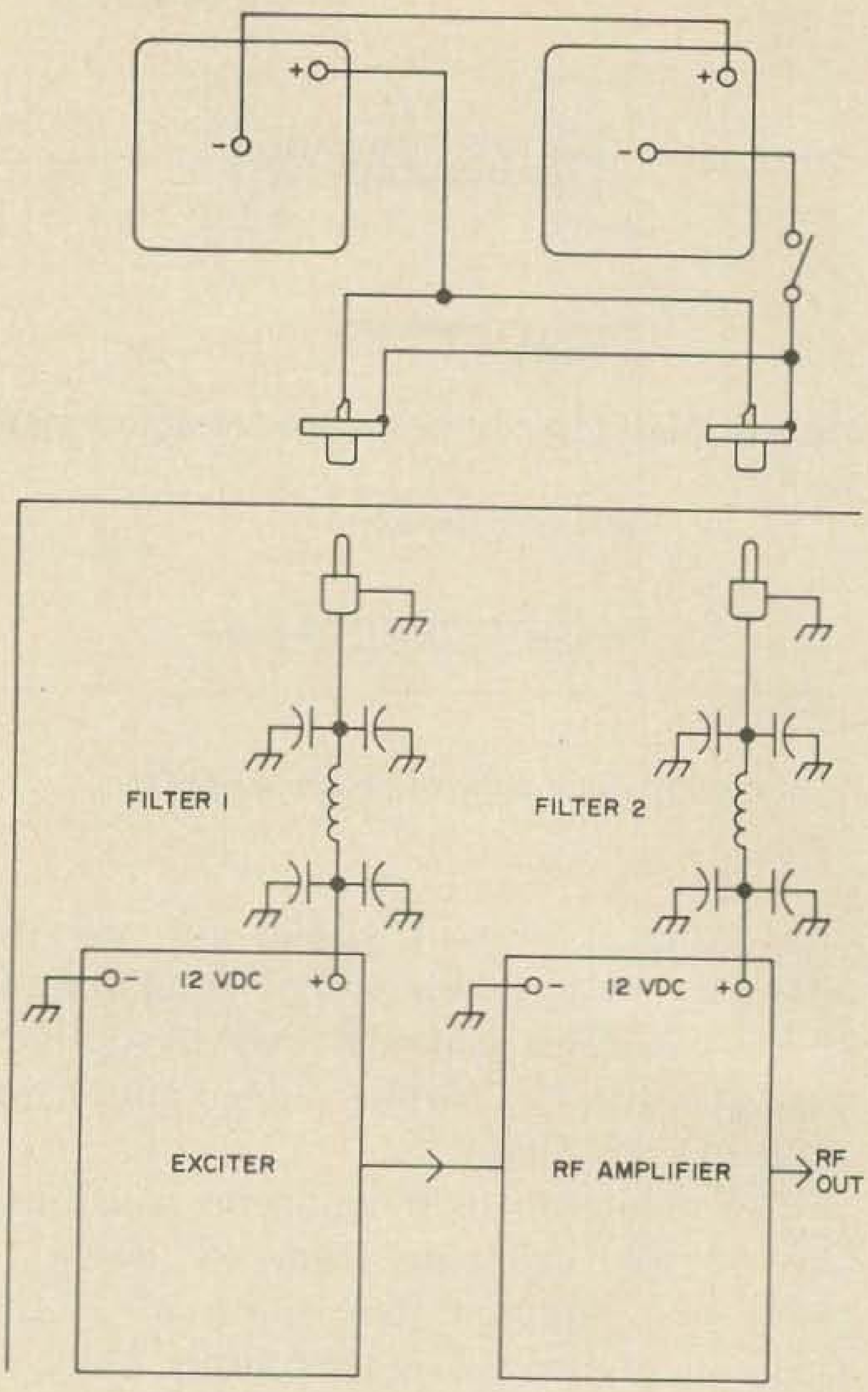

Fig. 9. Battery lead filters.

final destined for use in the 432'er solid state assembly. Note the one volt of rf at test point D *without* the filter. At the same point, also without the filter, about a tenth of a volt was found with only the exciter fired up. See Fig. 9. You can see what that kind of rf path will do for feedback from a quarter watt or a one-half watt final.

So a piece of copper-clad was put down under the two units as shown in Fig. 9 and the two filters installed. Perfect! No rf could be detected at all at any place on the batteries. Note that *two* filters are now present across any feedback path through the batteries and their leads.

There still exists possible voltage field and magnetic field feedback paths between the rf final and the exciter, but that's another story. The battery lead feedback path is not eliminated. And at least one thing shows up in favor for the solid state deives. There is only *one* wire in which to put a filter!

. . .K1CLL

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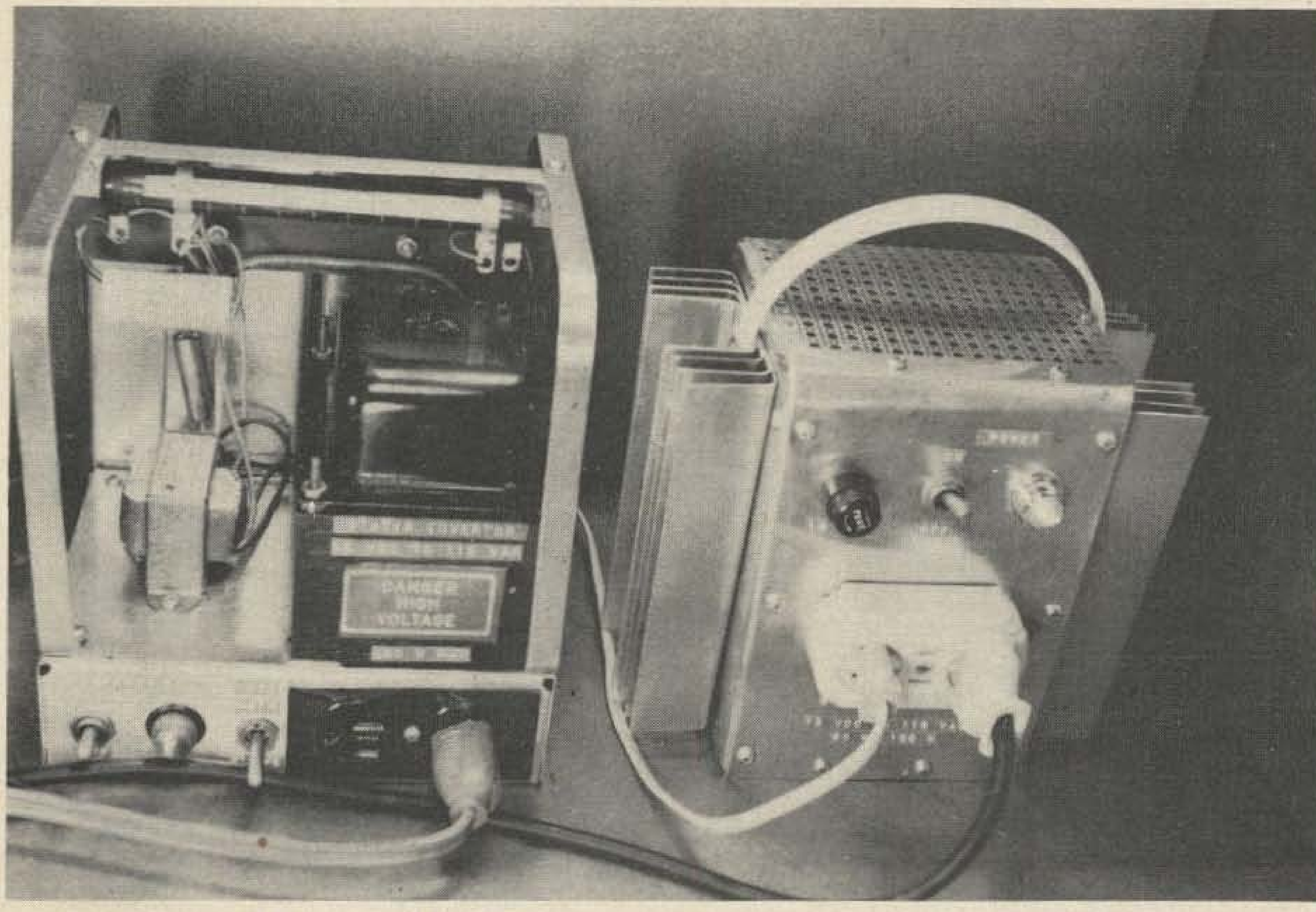
Baltimore MD 21236



Complete power system in operation. Unit B to the left – Unit A to the right.

PORTABLE HOUSE POWER

Adding a 12V dc to 110V ac 60 Hz static inverter to the equipment list of the amateur experimenter will increase the versatility of his station to a degree that makes any reasonable labor in this direction worth while. The two units, presented here, are intended to be used together and, with a 12V auto battery as primary power, have the necessary output capability to supply 110V ac 50–60 Hz to an entire 150W station, including the receiver. There are no communications equipment modifications required. Just plug the transmitter and receiver into their receptacles and turn on the inverter switches.

Unit A has an output of 90W and Unit B 200W. Both outputs are 50–60 Hz symmetrical square waves. It might be well to note at this point that the peak value of a 110V ac, rms, square wave is 110V, while the peak value of a 110V ac, rms, sine wave is 155V. This difference in peak values will not be noticed in resistive loads such as tube filaments, but will cause lower voltages in rectifier circuits that depend upon capacitor input filters and voltage doublers. The output frequency of Unit A is 50–60 Hz and is not affected by any type of load, resistive or transformer. When Unit B is in the slave mode, it is driven by a signal from the output of Unit A. The frequency will be the same as Unit A and will not be affected by loading. When operated in the master mode, it converts to an oscillator tuned to 60 Hz which

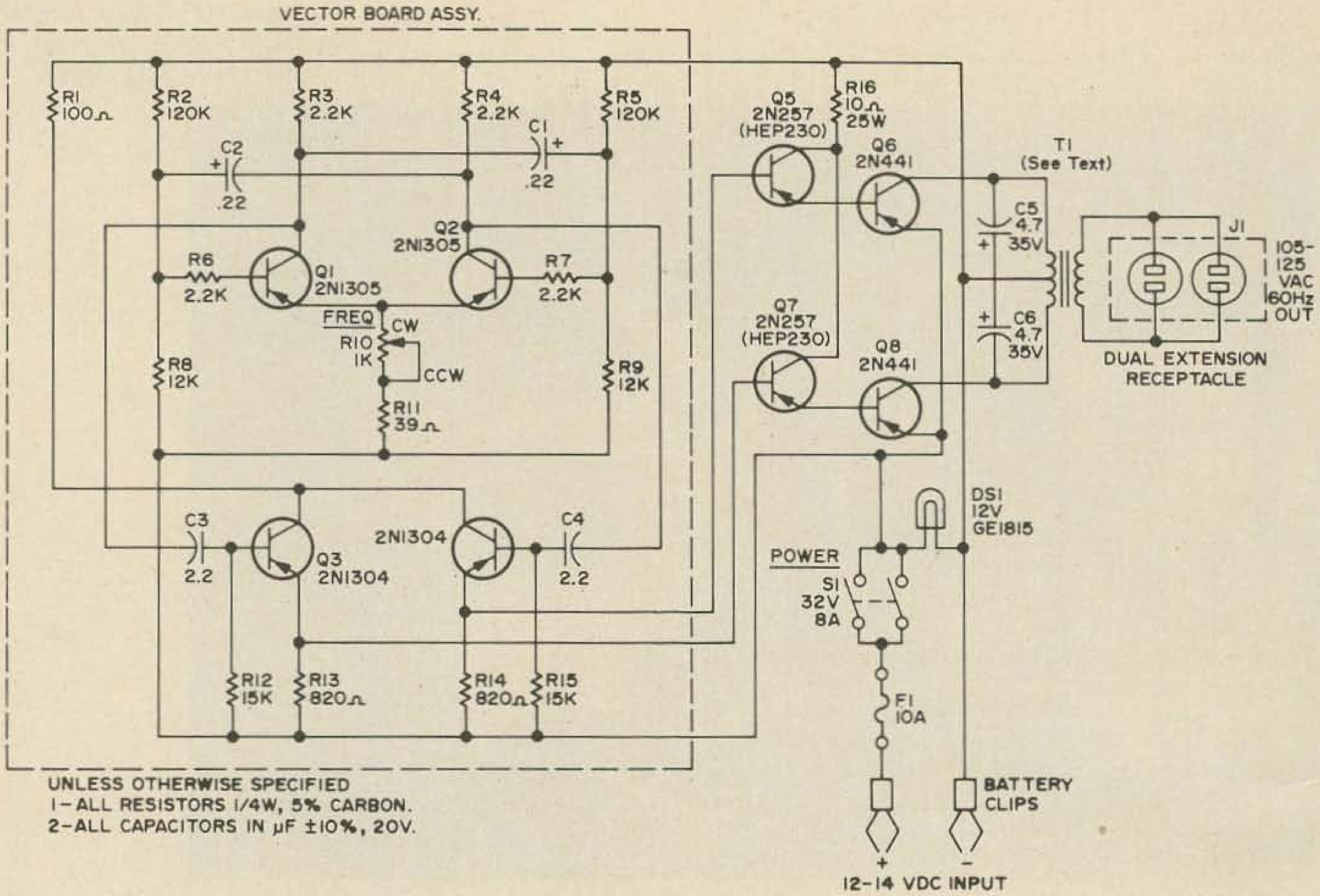


Fig. 1. Unit A inverter.

produces an output without external drive. It will maintain this frequency very well when providing power for resistive appliances, such as soldering irons and lamps, that require inputs within the range of 50 to 100W.

Both units make excellent projects for amateurs with an urge to use their oscilloscope and to gain experience with transistor power switches.

The fundamental problem in making our high power square wave is to switch the 12V dc from one side of a center-tapped transformer primary to the other at a predetermined rate. If the secondary has 10 times more turns than the primary, the output of this winding – neglecting losses – will be a 120V ac rms square wave. Using a transformer as a tuned circuit element of a 60 Hz transistor oscillator solves this switching problem very nicely, so long as its load is not of the type that will pull the frequency – for example – equipment containing input power transformers. To eliminate these load effects the circuit shown in Fig. 1 was developed. We shall call it Unit A. It consists of a 60 Hz free-running multivibrator, Q1 and Q2, whose outputs, phased 180° from each other, are fed through buffer amplifiers Q3 and Q4 to the switch drivers, Q5 and Q7. Q5 and Q7 are over-driven to square the waveforms and to supply the 0.5A input signals required by the power transistor switches, Q6 and Q8. This high current is necessary to keep Q6 and Q8 in saturated conducting condition so that very little voltage is dropped across the emitter to collector junction. This condition reduces internal heating (P=EI) to the minimum possible. Q6 and Q8 alternatingly snapping off and on changes the current flow through the transformer primary, which is coupled to the step-up secondary, and produces a 110V ac output.

While trying to power a receiver and a transmitter from the same inverter, I uncovered a formidable voltage regulation problem. To get around this trouble another inverter was constructed that would carry the heavy transmitter power, Unit B. This circuit, Fig. 2, was made for high current, and its switches consist of two parallel connected transistors, Q9 and Q10 in one, and Q11 and Q12 in the other leg of the transformer primary. When the mode switch S3 is in the slave position, these transistor pairs are driven by a centertapped 6.3V filament transformer, T2, which is excited by the square wave output of the frequency controlled inverter, Unit A. When the mode switch is in the master position, Unit B changes from an amplifier of a sort to an oscillator tuned to 60 Hz. Current limiting resistor R17 is switched to a voltage divider, furnishing forward bias to the power transistor switches, and at the same time, the output of the inverter is switched to the primary of T2 at the proper phase to sustain oscillations. The mode switch is a refinement that adds flexibility to the unit by allowing it to operate independently of any outside circuitry.

The construction of the inverters is not difficult. One of the reasons is that the physical appearance of either one can be anything that pleases the individual. Nothing is critical as far as pickup or lead length is concerned. However, we are using relatively high current, five to twenty Amperes, so any long wire runs to the power circuits should be heavy gauge. It is very easy to drop a couple of volts through the leads connecting the inverter to the auto battery if they are not much larger gauge than necessary to protect them from overheating. One volt drop at the input results in ten volts less at the output. It is recommended that jumper cables of the type that are made for starting one car from another's battery be used for the input leads.

Inverter Unit A was constructed around a chassis that just fits its transformer. The case is made of solid 1/32-in. thick aluminum with the back and top the perforated type. The front panel was doubled so as to provide a firm mounting for the power switch, S1, fuse, F1; indicator lamp, I1; and receptacle, J1. A piece of belt looped over the top makes a convenient carrying handle. The multivibrator and buffer circuits, because of the nature of their parts, are assembled on a Vectorboard. These circuits, containing Q1 through Q4, are

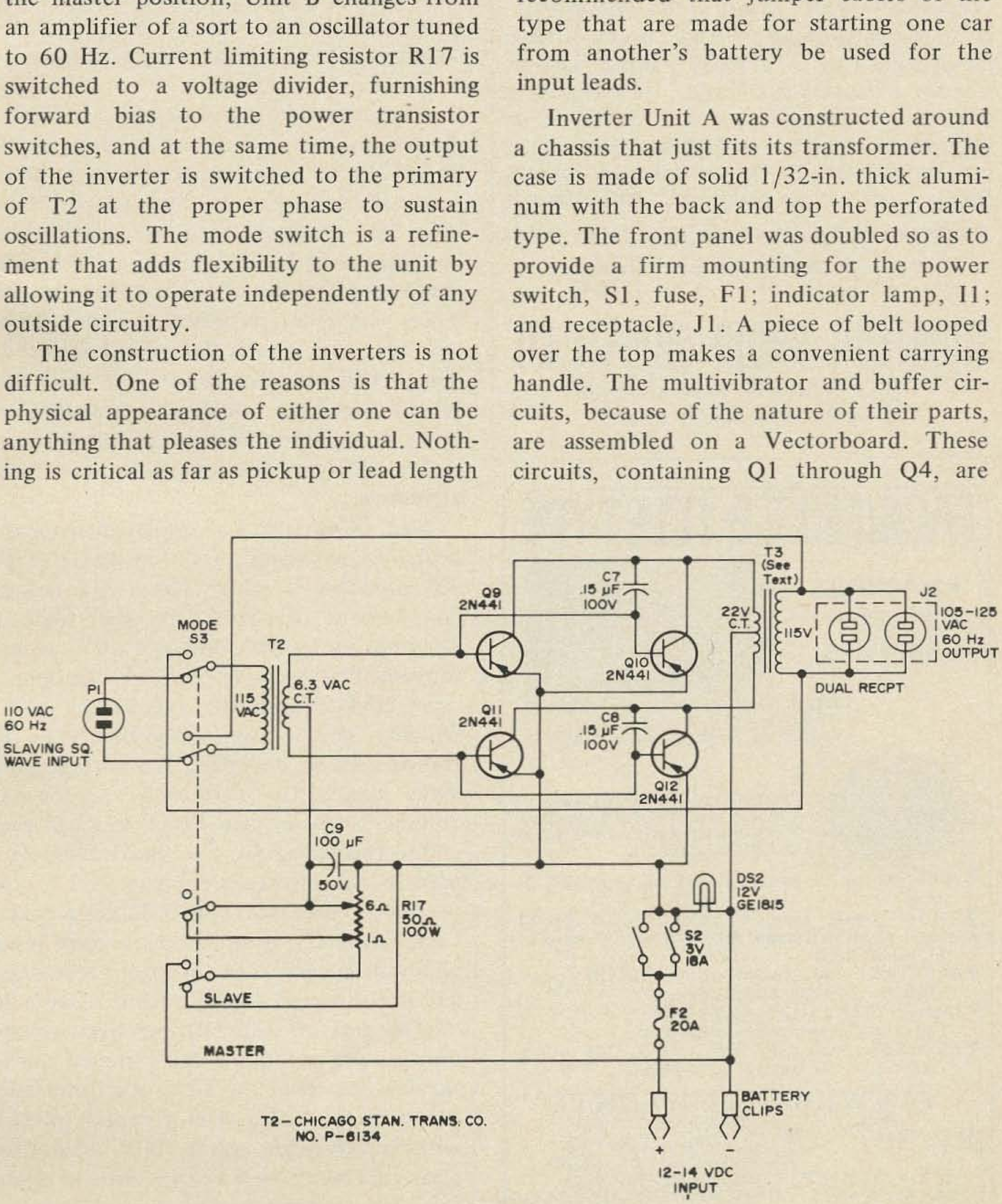


Fig. 2. Unit B inverter.

neatly arranged on a 4¾ in. by 2¾ in. piece; a size that provides room for flea-clip tie points around its edges. After this assembly is wired, it can be tested before it is mounted above T1, by the use of clips that hold it just inside of the back cover. The switch drivers, Q5 and Q7, generate no heat, but for the sake of a place to put them each one is mounted on the bottom of the heatsink containing its switching transistor, Q6 and Q8, respectively. These transistors are spaced at 2 in. and are centered as well as clearances will allow.

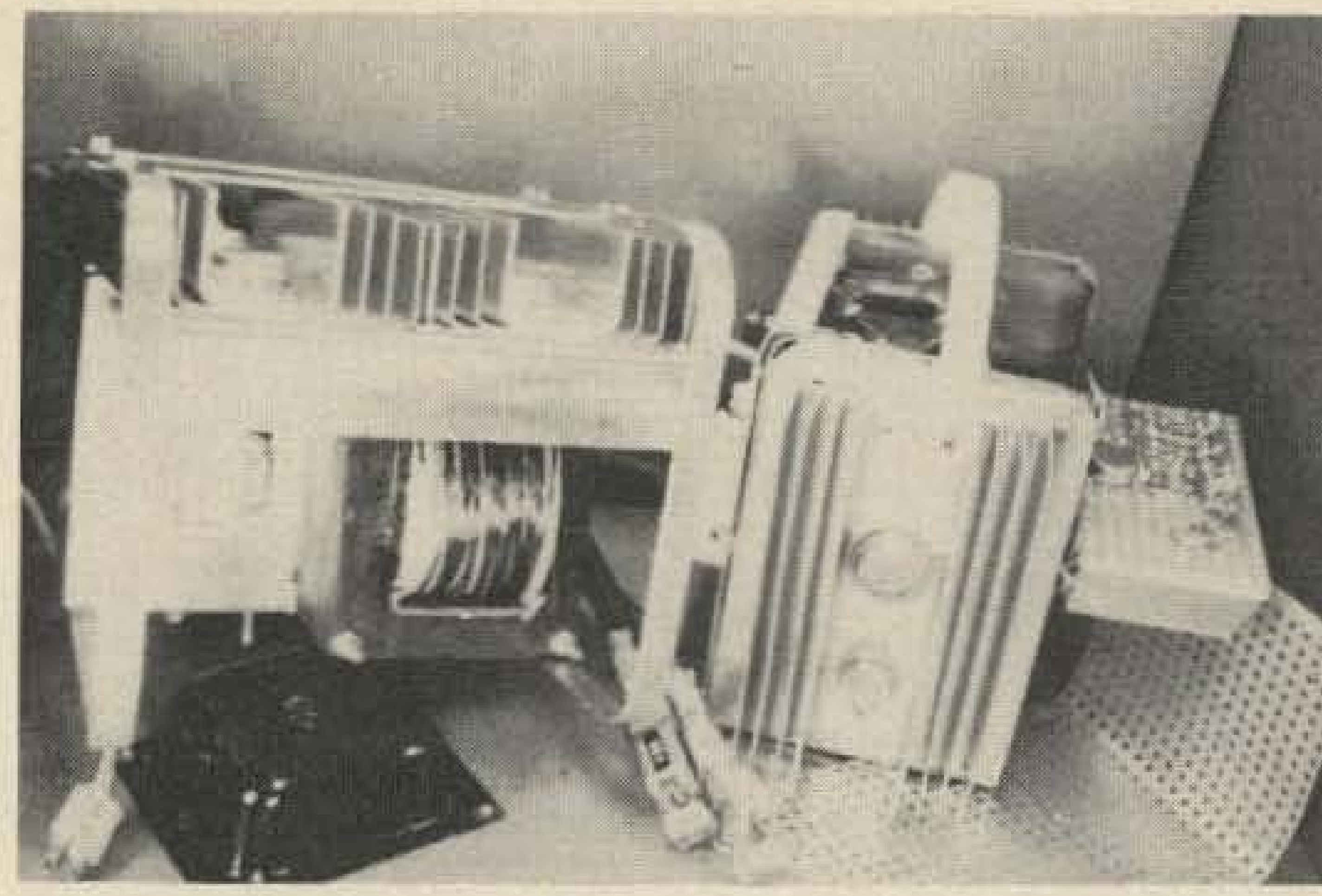
The heatsinks are assemblies of scrap aluminum, each consisting of three pieces of 1/32 in. and one piece of 1/16 in. thick material. All are 6 in. long and are bent into "U" channels with legs 1¼ in. high and widths of 3¼, 2 5/8, and 1 3/8 in. The narrowest is made of the thicker material. These channels are nested together, being sure that each one is flat against the other. The transistor mounting bolts hold the pieces together. Homemade heatsinks require a surprising amount of material and make commercially available ones very attractive.

The transistors are insulated from the heatsinks by using mounting kits. T1 is a TV transformer which has a low voltage complement of two 5V rectifier filament windings along with one of 12.6V, center-tapped. One end of each 5V winding is connected to opposite ends of the 12.6V winding. They are phased so that when the transformer is energized the voltage measured across the three series connected coils is 22.6V ac and 11.3V ac from each end to the centertap. This 22.6V winding is used as the inverter's primary and is connected to the switching transistor collectors. The 110V winding (the original input winding) is used as the inverter's secondary and is connected to the output receptacle.

The rest of the leftover high voltage outputs are separated and fastened out of the way to flea-clips along the outer edge of the Vectorboard. The potential of these wires is very high, about 700V ac, so keep clear of them when the inverter is operating. TV transformers of this type are not uncommon and save lots of work winding a useful primary. If a TV transformer of this type cannot be found, then one must be modified in the manner described in Unit B's construction procedure for T3.

Unit B has a different layout because a 7 x 5 x 2 in. chassis happened to be laying in front of me at the right moment. The heatsinks are identical to those of Unit A, with the transistors equally spaced from each other and the edges. These transistors are bolted directly to the heatsink surface without insulators. This allows better heat conduction and not too much added construction difficulty, keeping the heatsinks insulated from the rest of the chassis. The two heatsinks, one containing Q9 and Q10, the other Q11 and Q12, are bolted 1/8 in. from each other to a 1¾ x 7 in. piece of insulating board running across their top and to a second piece across their bottom. Large clearance holes are provided for the lower bolts through the rear side of the chassis, and the lower insulating board is drilled and bolted in this location. The heatsinks will then be held firmly vertical. R17 is fastened to the inner side of the top board along with a curved shield over it for protection. Roll bars made of 3/32 in. thick metal are run around the outside edge of the unit to keep the heatsinks from coming into contact with any conducting obstruction and to be used as carrying handles. These bars are also tied together with two ½ in. strips of insulating board across the back where the heatsinks might be bumped. The power switch, S2, is a DPST with both sections connected in parallel so it will carry the input current. This switch; the mode switch, S3; indicator lamp, I2; and receptacle, J2; are attached to the front of the chassis along with a liberal number of labels and high voltage signs. The input leads enter the back of the chassis, where the fuse is also placed, and T2 and T3 take their place on the top surface.

T3 is a modified TV transformer. The primary current requirement for Unit B is too high to permit the use of the existing windings. To modify it the end bells are removed, the filament windings unwrapped, and the high voltage leads cut



Unit B – top view (left) and Unit A – side view (right). The T3 winding seen is ½ of its new primary. The Vectorboard is tilted outward to show its inner side.

short and insulated, all without disassembling the core. There is very little chance that the filament winding will not be the first layer. When taking off the original windings, count the number of turns of the coil of a known voltage, so that when the new primary is wound, 23V of turns can be replaced. For example, if the 5V coil had eight turns, for 23V you would need 8/5 x 23 which equals 36.8 turns. Rounding this figure to the nearest half will not affect the end result. Number 14 gauge enamel wire is used, and it is divided into two pieces, each long enough for one 11.5V coil. The length of these pieces is determined by wrapping a short wire around the coil once and measuring it. Multiplying that length by the number of turns required will give the approximate length. Allow about three feet for safety. The sharp edges of the core are covered with masking tape, especially between the coil and the core, and the wire is slid under the core and around the coil the required number of turns. It will not take more than two layers, which are separated by brown paper. There will be ample room, because all kinds of high voltage insulation will have been removed along with the filament windings.

After the coils are completed, jam pieces of cardboard between the coils and the core to hold the wire in place. The four ends are marked so that you will know which two are going to make the centertap. Energizing the transformer from its normal primary is advised before the leads are cut to size. This way any errors that might have occurred may be detected and corrected by adding or removing wire. The ends of this primary connect to the power transistor collectors and the centertap to negative power lead. The 110V winding will become the secondary and connects to the receptacle.

Before applying power to either unit some precautions should be observed. Be sure that your auto electrical system is able to supply the required current. To give you something to work from, my 1964 Chevy shows no ill effects. Be constantly on the alert for overheating transistors. Any large temperature difference between the heatsink and the transistor should be regarded as overheat as the heatsink is supposed to lead all normal heat away from the power transistors. Excessive heat will ruin these transistors and is an indication that they are not being driven "on" hard enough. Voltage transients will also cause damage, so do not operate the inverters with an unloaded output.

Before you power Unit A, R10 should be set. If the frequency of the multivibrator was not set when the Vectorboard assembly was tested, turn R10 fully CCW and back 1/8 of a turn. Connect the input power leads directly to the battery terminals. Plug a 50W lamp into the output receptacle and place the power switch on. The lamp should glow brightly. Check the power transistors for overheat as quickly as possible. Check the output waveform with your oscilloscope. It should be symmetrical and square as a box and have the frequency of 50 to 60 Hz. Touch up R10 if necessary to change the frequency, but try to keep it as near CCW as possible. If heat is noticed or the wave is unsymmetrical change Q1 with Q2 or Q3 with Q4 to balance the drive. Plug a second lamp into the receptacle, a 40W one. If both lamps are glowing brightly and there is no excessive heating, Unit A is ready for use.

Before powering Unit B, adjust the taps on R17. The tap near the S3 end of the resistor should be located 1Ω from that end, and the top near the positive end should be positioned 6Ω from that end. Connect a 100W lamp to the output receptacle, connect the power leads directly across the battery terminals, set the mode switch to "master", and place the power switch on. The lamp should glow brightly. If it does not glow, the feedback from T2 is most likely out of phase and reversing its primary connections will correct the fault. The tap at the positive end of R17 can be readjusted so that the lamp will glow immediately after the power switch is placed on, but as close to that end as reliable operation will allow. Set the mode switch to "slave" and the lamp will go out. Plug the drive cable into Unit A's receptacle along with a lamp. When Unit A is operating, the lamp in Unit B will glow. Bring the lamp load up to 200W and check for transistor overheat. To reduce any excess heating, adjust the tap on R17 near the S3 end closer to that end. This will increase the signal to the power transistor bases. The output of Unit B should be a duplicate of Unit A, when in the slave mode. When in the master mode the output is still square and the frequency very close to 60 Hz.

Some possible changes to the components of the system that have been tried and might be of interest follow: First, the switch drivers of Unit A are powerful enough to drive two parallel connected 2N441 transistors. This will raise its output capability to almost that of Unit B, 180W, providing T1 has a large-gauge primary. Also, the drivers will handle four diamond power transistors parallel connected in each primary leg. What the output capability will be depends upon the quality of the transistors, but should not be less than the original 90W. Unit B does not require parallel connected switches or modified transformer if it will not be called upon to deliver more than 100W. I have not tried either unit at frequencies other than 60 Hz but do not see why changing the transformers and multivibrator will not allow both units to work well at 400 Hz. The ultimate application of the idea presented here will come when some homebrewer designs his transmitter's power supply so that it may be plugged into his 110V ac home outlet, or into his auto's 12V dc system without fuss of any sort.

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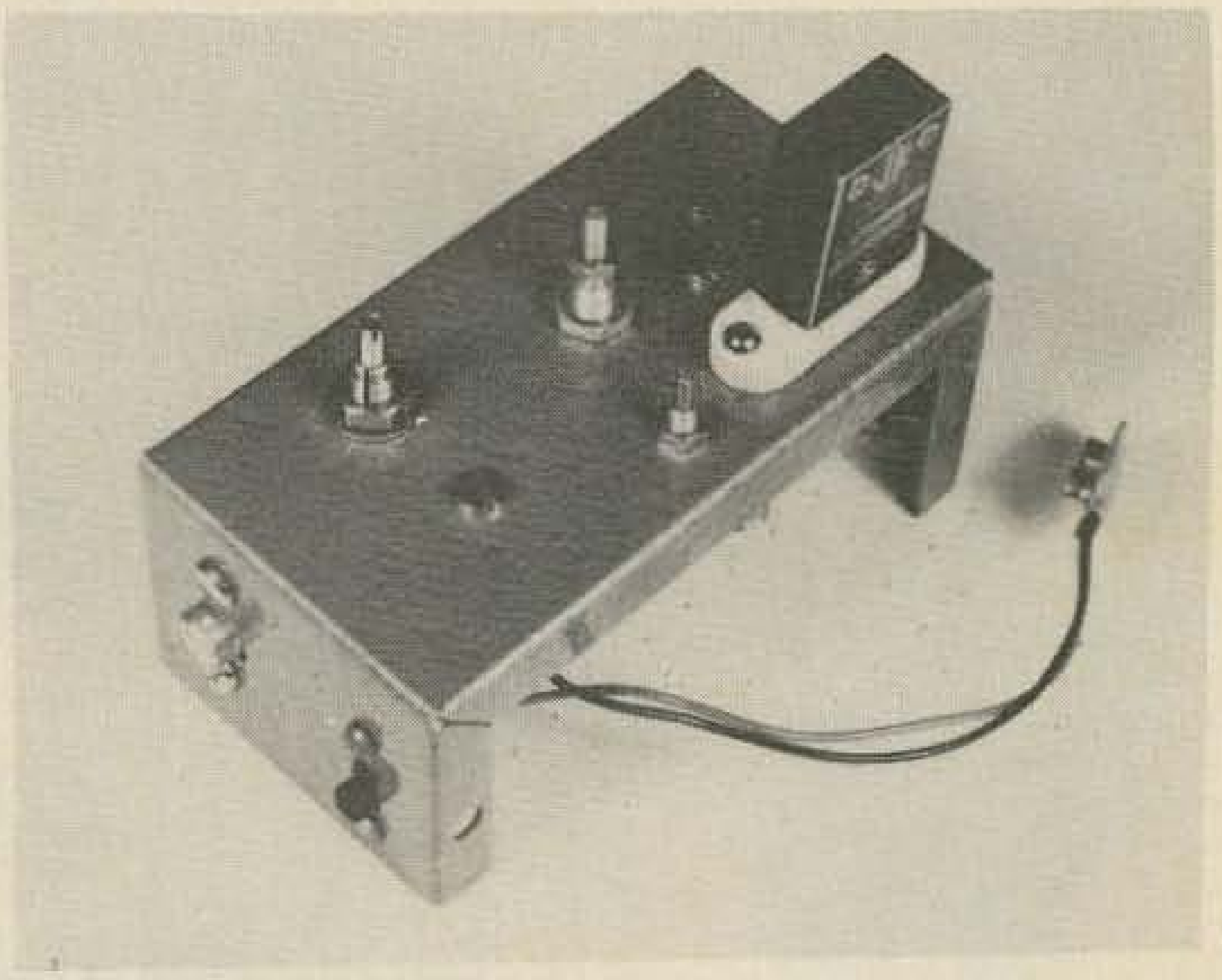


HOT CARRIER DIODE CONVERTER

For several years most of my hamming has been done with a three-band transceiver. Now, that's fine most of the time, but then there are times when I get to wondering what's going on on the other bands. So I began to look around for a good, simple, economical solution. It was during this search that I ran across the hot carrier diode.

One of the claims made by the manufacturer – "The hot carrier diode's performance . . . can be described as closely approximating the ideal diode" – started me to wondering just how well they would work in a 15m converter. So four of them were purchased, and the converter described here is the result.

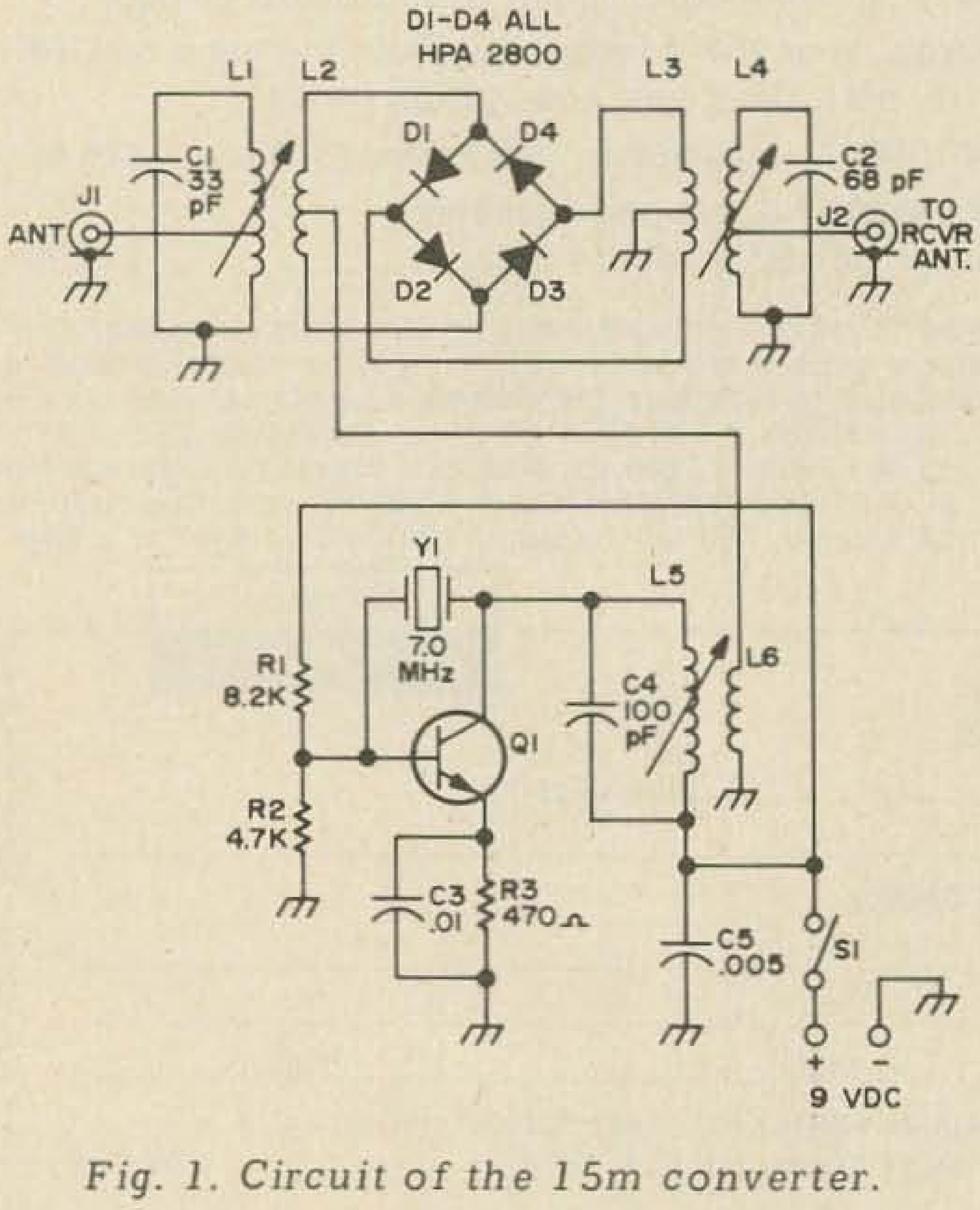


Fig. 1. Circuit of the 15m converter.

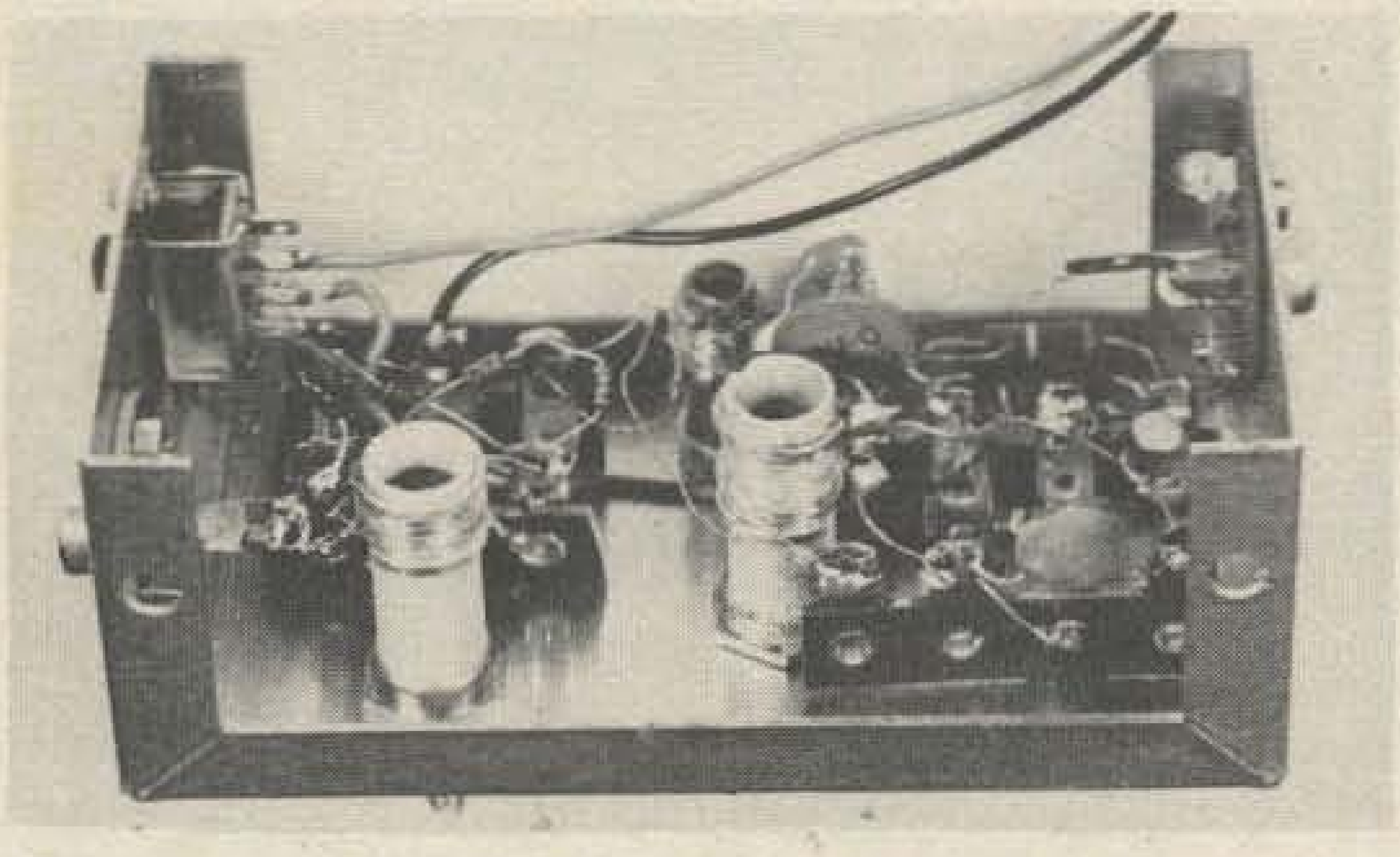
How do they work? The fantastic claims made for them are no exaggeration. They make excellent low-noise mixers and there is very little loss of signal. Consequently no rf amplifier is necessary. These diodes also possess a large dynamic square-law range which helps considerably with cross-modulation problems. When you add economy and simplicity to these advantages, what else could one want in a converter?

The particular diodes used in this converter, HPA 2800s, are made by Hewlett-Packard and are available from them for less than a dollar each. If you don't know where your nearest Hewlett-Packard distributor is, write directly to Hewlett-Packard, 620 Page Mill Road, Palo Alto, CA.

Circuit Description

The four diodes, D1–D4, are arranged in a balanced circuit. Both the input and the output are tuned, the input to 15m and the output to 20m. Because the input and output impedances of the detector arrangement are rather low, link coupling is used to couple to these tuned circuits.

The local oscillator is straightforward in every respect. It uses a 2N706 along with a 7 MHz crystal. I used an old FT243 type because I happened to have it. If you have a good active crystal in another type of holder, use it. Of course you will have to change the crystal socket to fit your crystal. The collector of the 2N706 is tuned to 7 MHz with a 3/8 in. diameter slug-tuned coil.



Construction of the Converter

The hot carrier diode converter is built into a small minibox (Bud CU-2101-A). Take a good look at the photograph and you can see the arrangement of the parts. The oscillator components are mounted at one end and the diodes and associated parts are at the other. All of the small parts are mounted on terminal strips. No socket is provided for the transistor. It and the diodes are soldered directly to the terminal strips. Use caution in soldering these devices in place: Too much heat will destroy them, and quickly. My method of doing this is to solder all other parts in place leaving these until last. Be sure you observe the polarity of the diodes.

Antenna coil L1 consists of 17 turns of 28-gage enameled wire close-wound on a ¼ in. slug-tuned form. It is tapped 5 turns from the bottom. L2 consists of 4 turns of 28-gage wire wound over the center of L1 and is centertapped. Both the output and oscillator coils are wound on 3/8 in. slug-tuned forms. Output coil L4 is 11 turns of 26-gage wire tapped 3 turns from the bottom. L3 is 3 turns centertapped wound over the center of L4. Oscillator coil L5 is 30 turns of 30-gage wire close-wound. L6 is 5 turns of 30-gage wound over L5.

I used RCA phono connectors for the antenna as well as output connections. If you prefer coax connectors you will have to use a larger box. The power switch is a miniature slider type. The converter is powered by a 9V miniature transistor battery.

Adjustment and Operation

Connect the converter output jack to the receiver (or transceiver) with a short shielded cable. Connect an antenna and the 9V battery. With the receiver on and tuned to 14 MHz, turn the converter power on and you should hear the second harmonic of the crystal oscillator in the converter. You might have to tune slightly to find it. If you don't, adjust the slug in the oscillator coil until you do. With the oscillator working, tuning higher on the receiver should bring in 15m signals. Peak L1 and L4 for maximum signal strength.

Using this little converter with a National NCX3 brought surprisingly good results. DX signals come in like locals. For the price and labor involved, it's a little jewel.

. . .W5LET■

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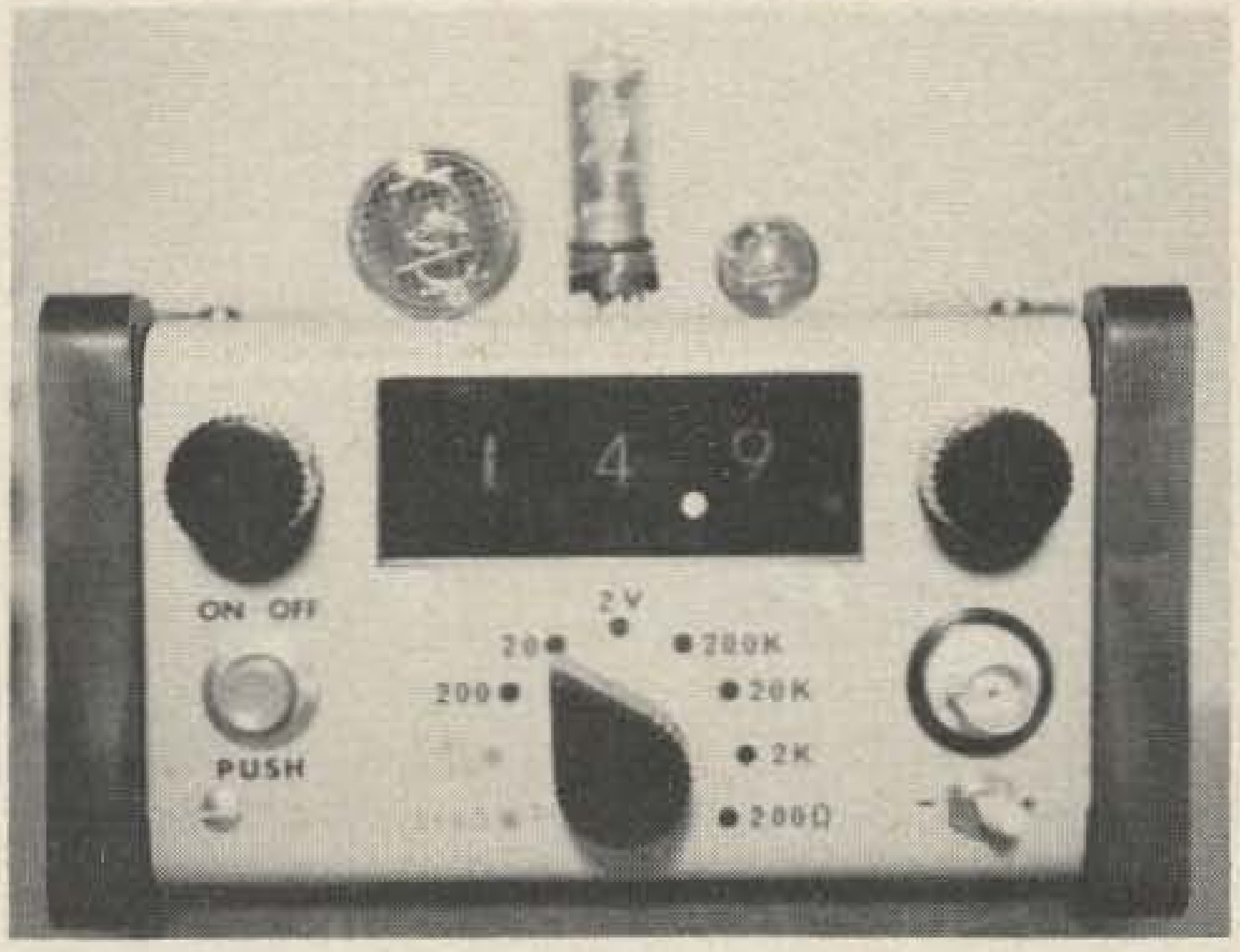
Wood Dale IL 60191

RTL DECADE AND DRIVER

There have been numerous articles using inexpensive RTL (resistor - transistor - logic) integrated circuits in frequency counters and in digital volt-ohmmeters. A good friend, Joe WA9CGZ, built the digital volt-ohmmeter from a magazine article[1], and, after making some changes in its circuitry (to improve its drift problem), brought it over for me to try. I was favorably impressed, but it left me cold in one respect. It had "idiot lights" for readouts, as do all the other frequency counters I've seen in the ham magazines. What do these flashing lights do? They get your eyeballs sore from jumping up and down and left and right while trying to follow the reading. I don't know about some people, but I was trained at a young and tender age that we read from left to right in a straight line. It's so much faster and easier.

To get back to Joe's voltmeter, I decided to build one, but with a different readout method. After looking over the many types (7 segment, projection, and others) I decided that the old gas-discharge numeric indicator was still a good performer, and so I chose it. As can be seen from the photograph, this type of tube comes in varieties of sizes and shapes. They are manufactured by National Electronics, Raytheon, Amperex and others. Lately these tubes have been appearing on the surplus market, but as it says in the back of *73*, Caveat Emptor! The NL-5750 is about the least expensive of indicator tubes on the market, and is stocked by Newark Electronics in Chicago as well as others.

There are disadvantages, of course. (You want to have your cake and eat it, too?) The first is cost. These tubes do cost more than ten pilot lamps; however, most of the tubes are rated for 200,000 hours of service. If ten long-life lamps were used, then the lamps would cost more than the tubes.



Front view of the DVOM using the decade divider and driver discussed in article. Several types of gas discharge indicator tubes are on top. The one on the right is the type used in the DVOM. The cabinet shown is by Justin.*

The second disadvantage is that at least 170V dc is needed for the gas discharge tube. In the case of the voltmeter mentioned above, this was not a problem since the voltage was already there. Since the tubes draw only 2 or 3 μA each, it isn't difficult to get one way or another.

Now to get a working circuit. In looking over some of the circuits used by others, I found that several different binary counting systems were used (there are many types – gray, bi-quinary, excess three, and more); however, these didn't have much appeal because of the difficulty in decoding. For those not familiar with binary counting, let's just point out that in the binary counting system we count with the base two instead of base ten as in our familiar decimal system.

*Justin Inc.
2633 North Lee Avenue
So. El Monte CA.

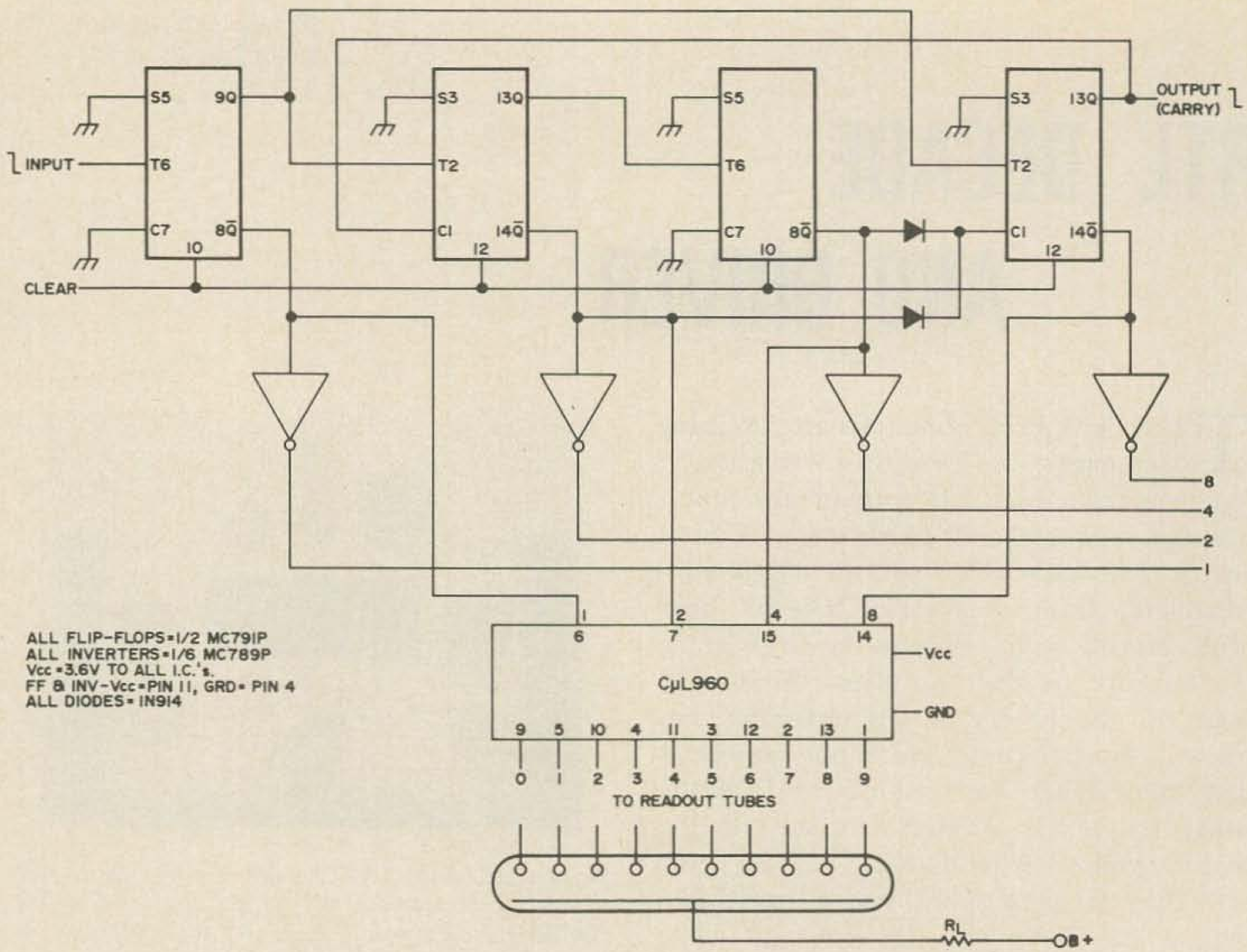


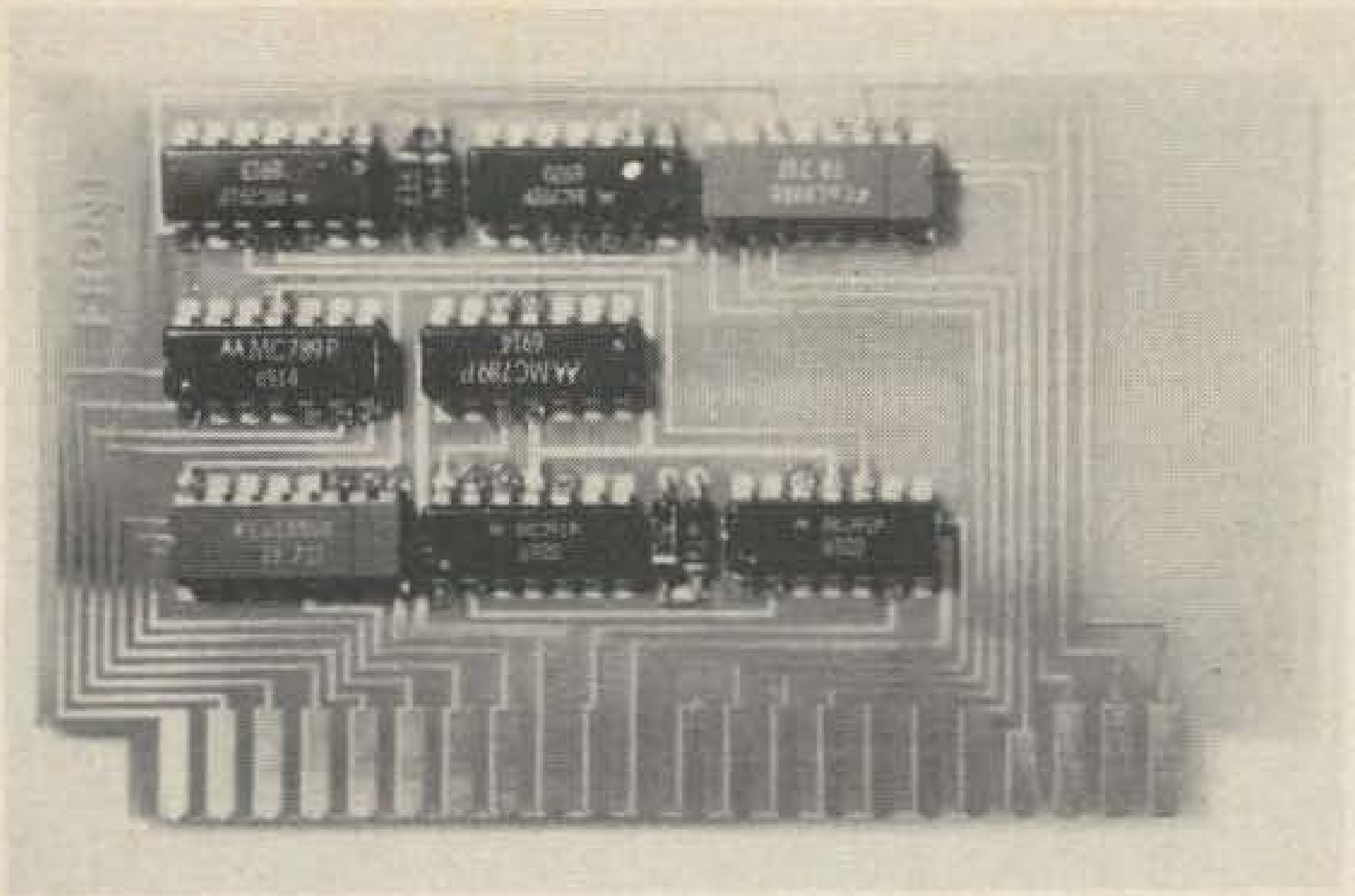
Fig. 1. Notes: All flip-flops ½ MC791P, all inverters 1/6 MC789P, Vcc is 3.6V to all IC's, F.F. & Inv. – Vcc Pin 11 – gnd pin 4, all diodes 1N914.

So we have to change the binary numbering system to the decimal system. This can be done with discrete components (diodes, resistors and transistors), but this costs as much as using a single integrated circuit. The single IC route was chosen for simplicity; the one used is made by Fairchild, and is completely compatible with RTL ICs. This choice limits our binary code selection since the μL 9960 requires an 8421 BCD (binary coded decimal) input. This is a common code used in the industry; I'll tell you why later. All that is needed now is a Mod 10 that has a 8421 BCD output.

Since four flip-flops can count to sixteen, we can permute them to count only as high as ten. As can be seen from the schematic, the outputs of the Mod 10 come off from the "NOT" side of the stages because the 9960 requires negative logic. A word about the flip-flops . . . MC791P's made by Motorola were used. These have the same pin connections as the widely used MC790's, but are capable of the greater output needed here. Do not use the MC790!

I felt that a BCD output could prove useful in the future to drive a digital printer so it is necessary to bring only the four leads from the Mod 10 out. This could be done directly off the counter, but is not desirable because the added capacitance of long leads could pick up stray rf and cause false counting. The best way is to buffer the output and this is easily accomplished with another IC, the MC789P hex inverter. By connecting the inputs of four of the inverters to the 8421 negative logic side of the Mod 10, we have a buffered output of 8421 positive logic. The remaining two inverters are not used. The positive logic output, which is more commonly used than negative logic, will drive 5 RTL or 3 DTL or TTL loads.

I built two identical circuits on a double-sided printed circuit board[2] that plugs into a double 22-pin connector. I used this method



Front view of the double-sided PC board used to hold two decade dividers and drivers.

to save space and provide greater ease of repair should it ever become necessary (the remainder of the voltmeter was built on two more boards of the same size). Hand-wiring of the circuit can be used, of course, but I recommend the plug-in method in either case.

By cascading as many of these stages as you desire, you can make a frequency counter with the addition of a time base and appropriate gating. Just look over the circuits of frequency counters that have appeared in magazines in the last couple of years. If it uses RTL, chances are you can substitute a circuit for the one used and have an easier time reading out the answer. If you feel that a buffered BCD output will never be necessary, then omit the inverter stage.

Happy counting.

. . .W9SEK

Glossary

Positive logic – Where the logical "1" is more positive than logical "0".
Negative logic – Where the logical "1" is more negative than logical "0".
Modulo (Mod) – A counter circuit. The number indicates how many pulses are counted, i.e. a Mod 10 counts 10 input pulses. The output occurs on the 10th pulse. A Mod 5 will count 5 pulses, etc.
Permuting – A means of providing a feedback path to stages into counter to force it into desired state.

References

[1] Lancaster, Don – Digital Volt-Ohmmeter, *Popular Electronics*, Dec. 1968, Page 29.

[2] The printed circuit boad shown is available for $5.50 each P.P. from: *R.M.V. Electronics, Box 283, Wood Dale IL 60191.*

PROPAGATION CHART

J. H. Nelson

Good (Open), Fair (□), Poor (O)

OCTOBER • 1972

S	M	T	W	T	F	S
1	2	$\boxed{3}$	$\boxed{4}$	5	6	7
8	9	$\boxed{10}$	$\boxed{11}$	12	13	14
15	$\boxed{16}$	17	$\boxed{18}$	19	20	21
22	23	$\boxed{24}$	25	$\boxed{26}$	27	28
29	$\boxed{30}$	$\boxed{31}$				

Possible aurora Oct. 1—5

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7A	7	7	3	3	3	7	7A	14	14	14
ARGENTINA	14	7A	7	7	7	7	14A	21	21A	21	21	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14B	14	14	21	21A
CANAL ZONE	14	7A	7	7	7	7	14	21	21	21A	21A	21
ENGLAND	7	7	7	3A	7	7	14	21	21	14A	14	7
HAWAII	14	14	7B	7	7	7	7	7B	14	21	21	21
INDIA	7	7	7B	7B	7B	7B	14	14	14	7B	7B	7
JAPAN	14	7B	7B	7B	7	7	7	7	7B	7B	7B	14
MEXICO	14	7	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	14	7B	7B	7B	7B	7B	7	14B	7	7	7B	14
PUERTO RICO	7A	7	7	7	7	7	14	14	14	14	14A	14
SOUTH AFRICA	7	7	7	7B	7B	14	21	21	21A	21A	21	14
U. S. S. R.	7	3A	3A	7	7	7B	14	14A	14	14	7B	7
WEST COAST	14	7A	7	7	7	7	7	14	21	21	21	21A

CENTRAL UNITED STATES TO:

ALASKA	14	14	7	7	3	3	3	7	7A	14	24	14A
ARGENTINA	21	7A	7	7	7	7	7A	21	21A	21	21	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14	14	14	21	21A
CANAL ZONE	21	14	7	7	7	7	7A	21	21	21	21A	21
ENGLAND	7	7	3A	3A	7	3B	7B	14	14	14	14	7B
HAWAII	21	14	14	7	7	7	7	7	14	21	21	21
INDIA	7	7B	7B	7B	7B	3B	3B	7A	14	7B	7B	7
JAPAN	14	14	7B	7B	7	7	7	7	7	7B	7B	14A
MEXICO	14	7	7	7	7	7	7	14	14	14	14A	14A
PHILIPPINES	14	14	7B	7B	7B	7B	7	7	7	7	7B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	7	7	7	7B	7B	14	21	21	21	21	14
U. S. S. R.	7	3A	3A	7	7	3B	7B	14	14	14	7B	7B

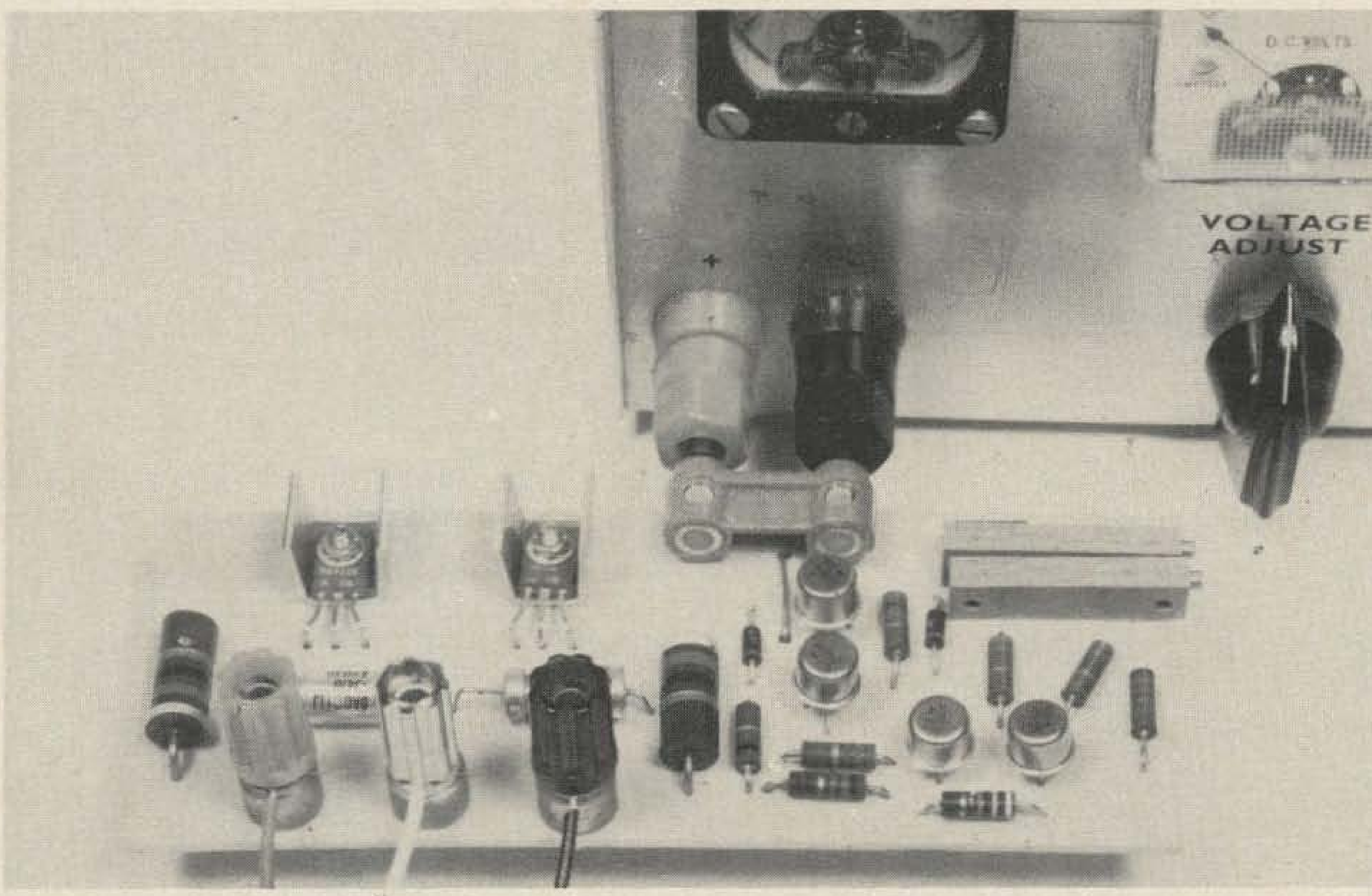
WESTERN UNITED STATES TO:

ALASKA	14	14	7	7	3	3	3	7	7	14	14	14
ARGENTINA	21	14	14	7	7	7	7B	14	21A	21	21	21
AUSTRALIA	21A	21A	14	14	7B	7B	7B	7	14	14	21	21A
CANAL ZONE	21	14	7	7	7	7	7	14	21	21	21A	21A
ENGLAND	7B	7	3A	3A	7	3B	3B	7B	14	14	14	7B
HAWAII	21A	21	14	7A	7	7	7	7	14	21	21	21
INDIA	7B	14	7B	7B	3B	3B	3B	7	7A	7A	7B	7B
JAPAN	21	14	14	7B	7	7	7	7	7	7B	14	14A
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	14	7B	7B	7B	7	7	7	7	7B	14
PUERTO RICO	14	7A	7	7	7	7	7	14	21	21	21	21
SOUTH AFRICA	14	7	7	7	7B	7B	7B	14	14	14A	21	14A
U. S. S. R.	7B	3A	3A	7	3B	3B	3B	7B	14	14	7B	7B
EAST COAST	14	7A	7	7	7	7	7	14	21	21	21	21A

A = Next higher frequency may be useful also.
B = Difficult circuit this period.

Hank Olson W6GXN
Box 339
Menlo Park CA 94025

A POWER-SUPPLY SPLITTER FOR LINEAR IC'S



In a previous article, two dual regulated power supplies were described for use with the new linear IC's, which require $\pm 6V$ or $\pm 15V$.[1] While the dual supply approach is not a bad one, the method herein described has several advantages. By plugging this "splitter" into any existing regulated power supply, a centertap is electronically created which will stay midway, voltage wise, between the plus and minus terminals. This centertap will stay at the midpoint even if current is drawn from it, and will stay at the midpoint even when one varies the supply voltage. This relaxes the requirement of extremely good supply regulation, as most linear amplifiers are more tolerant of supply voltage changes if the positive and negative voltages change equally.

The splitter is built on an etched circuit board, with a dual male banana-pin plug mounted on it for direct connection to one's regulated supply. Three binding posts are similarly mounted on the board and serve as the output terminals. The splitter is shown in use in the photo, operating with a regulated power supply I have previously described.[2]

The original circuit of a similar splitter appeared in one of the engineering magazines, and as such was not exposed to ham readership.[3] Also, the original circuit used semiconductors that are either too expensive or hard to obtain for hams. By use of economy transistors, the price of parts of the splitter herein described is a fraction of the price of the parts required to build the original. Two type-numbers are given for each semiconductor in the circuit of Fig. 1,

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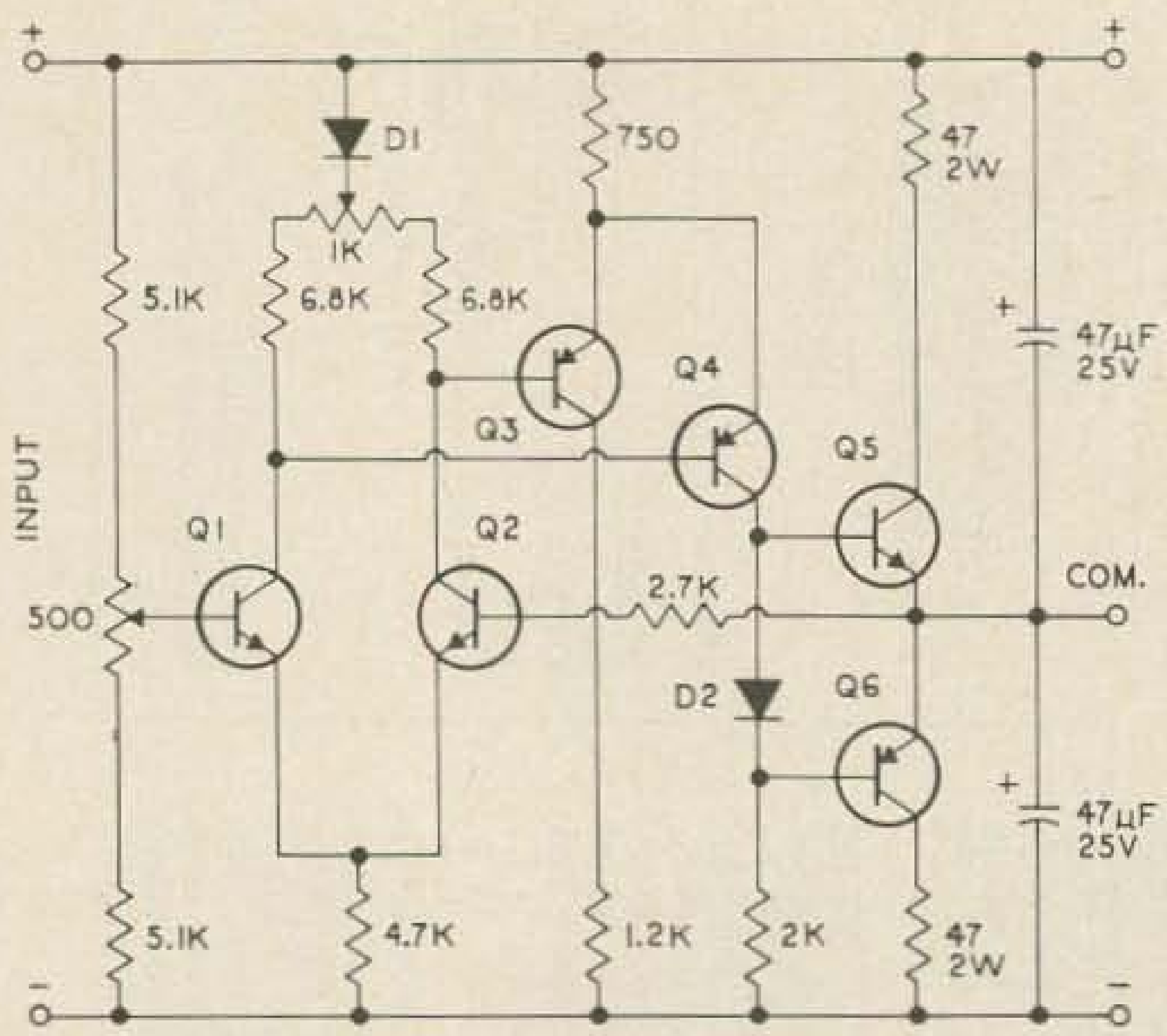

NOTES:

1. Q1, Q2 -- MOTOROLA HEP 243 OR FAIRCHILD 2N3641
2. Q3, Q4 -- MOTOROLA HEP 242 OR RCA 2N4037
3. Q5 ----- MOTOROLA HEP 245 OR MJE 520
4. Q6 ----- MOTOROLA HEP 246 OR MJE 370
5. D1, D2 -- MOTOROLA HEP 156 OR GE 1N4454

Fig. 1. Power supply circuit.

the Motorola HEP numbers being the more available types. The other type-numbers are perhaps more readily obtainable by those hams who work in the electronic industries and regularly deal with large industrial electronic supply houses.

The etched circuit board and the parts placement on it are shown in Figs. 2 and 3. Note that the MJE 370, MJE 520, HEP 245 and HEP 246 are in what Motorola calls a "Thermopad package." Heat dissipators may be easily and inexpensively made for these transistors out of small "U"-shaped pieces of aluminum or copper sheet, as shown. The circuit board was laid out to fit Beckman 78PR type trim-pots (cermet).

Once the parts have all been soldered to the board – an easy hour's effort – you're ready for testing. I think it best to try the splitter on a current-limiting type supply, such as that described in reference 2, with the current limiting set to about 50 mA.

The regulated supply feeding the splitter is set to 24V, so that the output of the splitter will be ±12V. The reason for calibration at this voltage is that it is in the middle of the useful operation range (10–40V input) and also it fits the 12V requirement for one of the *best* operational amplifiers that I have found – the General Electric PA223. The splitter will draw about 15 mA with no load; if it draws considerably more, check for soldering errors or faulty semiconductors. The 500Ω trimpot is adjusted until the plus and minus outputs are equal. The setting of the 1000Ω trimpot is more tedious; the setup is shown in Fig. 4. Offset of the centertap from a true "split" is indicated by the VTVM as the input voltage

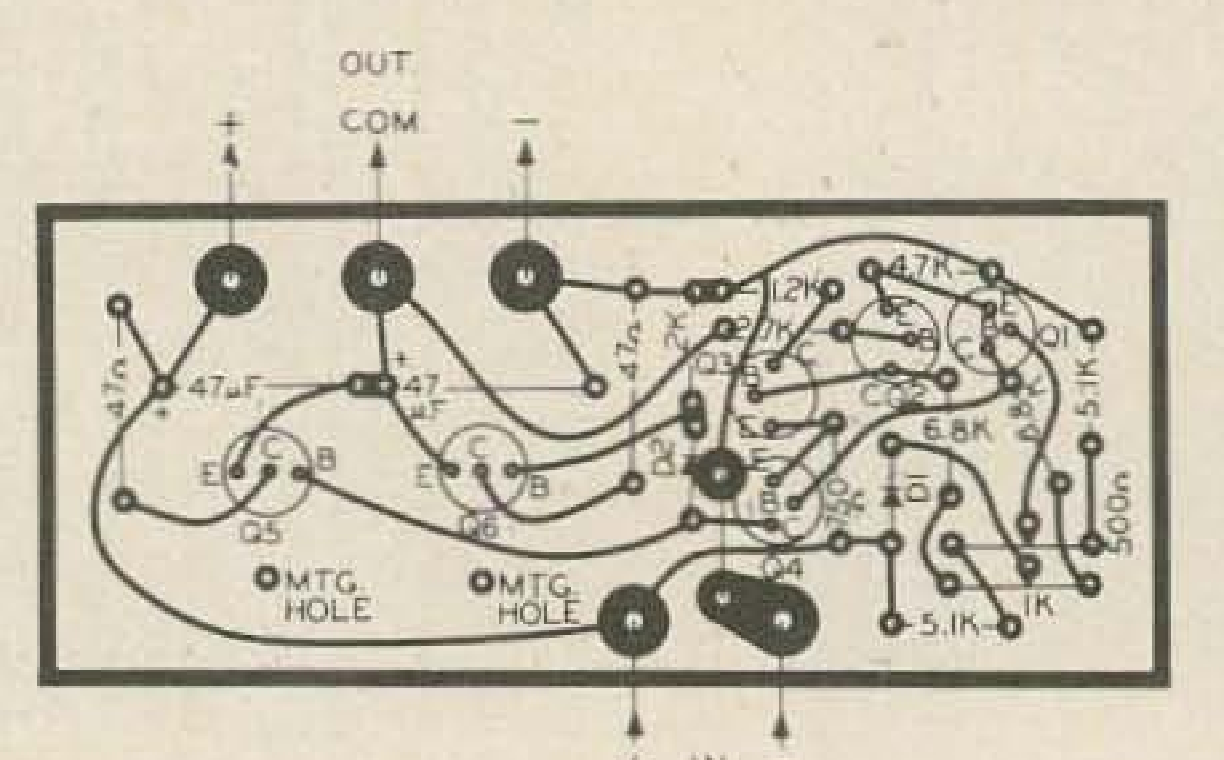

Fig. 3. Circuit board, parts placement.

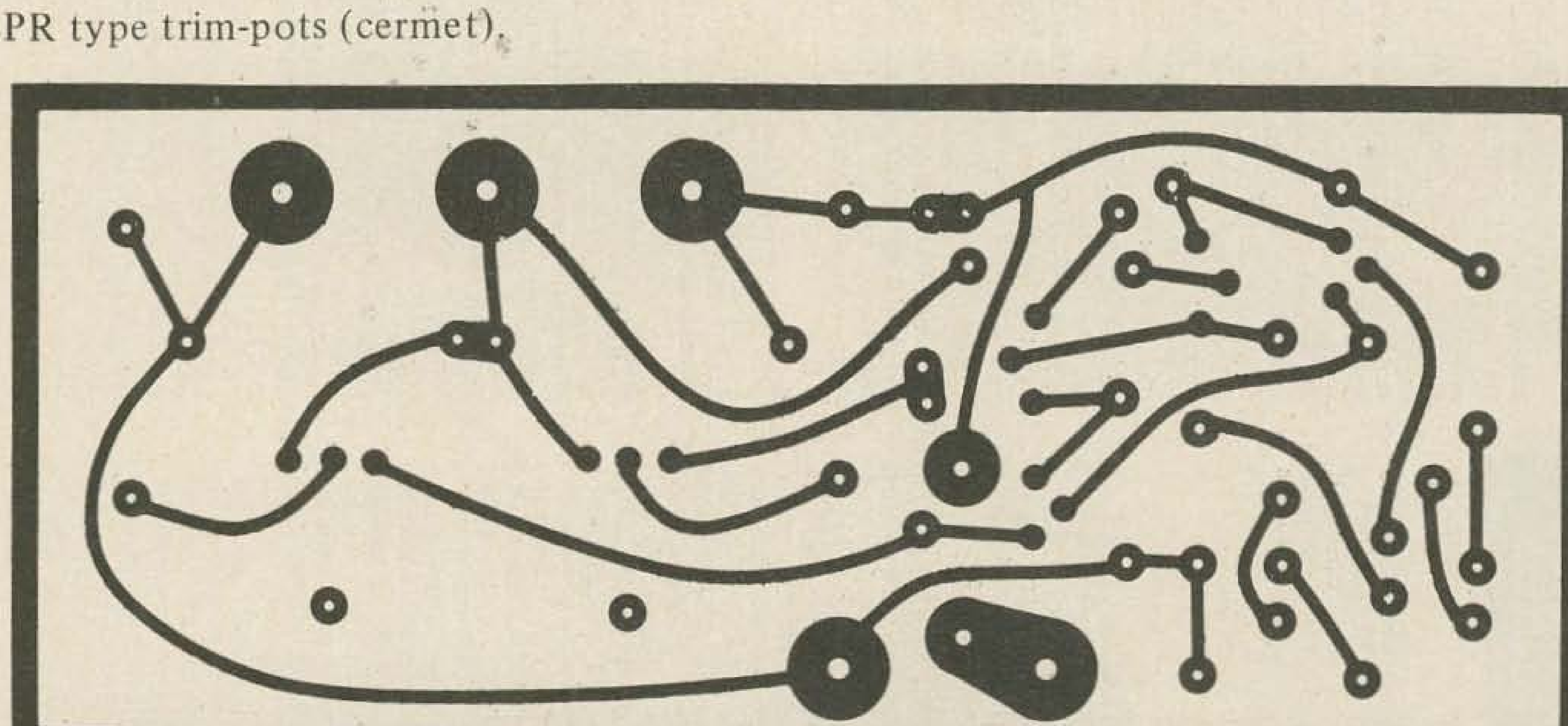

Fig. 2. Circuit board shown copper side up (80% reduction).

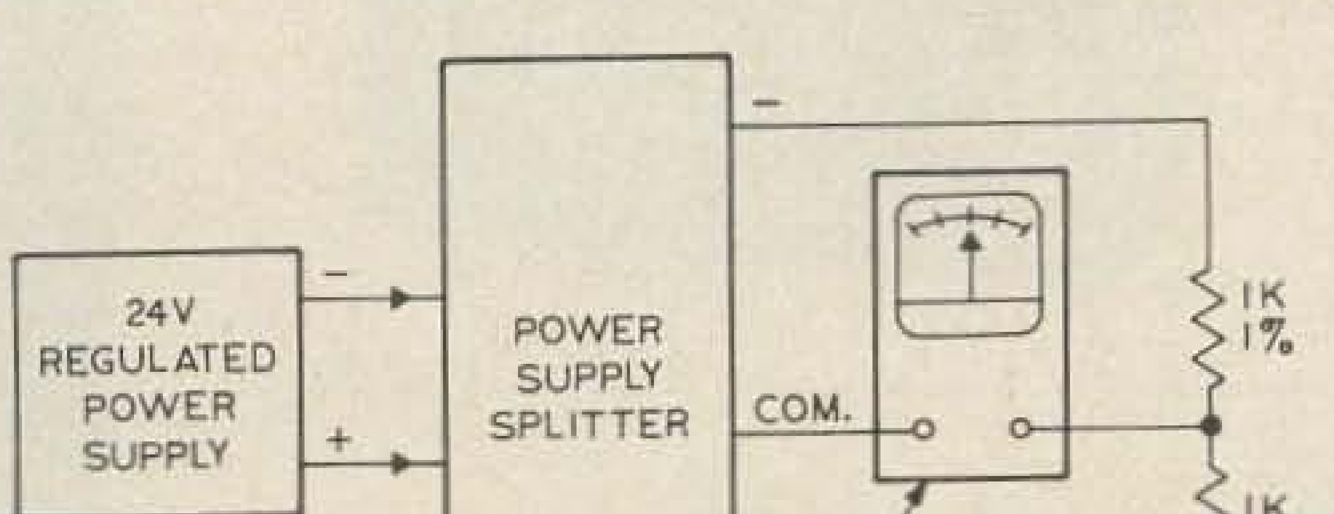

Fig. 4. Test setup for setting adjustment pots on splitter.

is varied from 10 to 40V. The offset is corrected by adjusting the 1K pot, and again sweeping the input voltage from 10 to 40V. This procedure is repeated until the best approximation to perfect splitting is obtained.

The splitter can deliver up to about 100 mA through the centertap, but this should rarely be necessary, since the main current drawn by operational amplifiers and other linear IC's is between the plus and minus terminals. The splitter has been used to power Fairchild μL709's and National LM201's on ±15V, General Electric PA223's on ±12V, and General Electric PA238's and RCA CA3029's on ±6V, all with success. As the world of linear IC's expands, this simple power supply splitter may easily become the handiest piece of bench equipment you own (next to the basic regulated power supply, of course).

I wish to thank Russ Wolfram W6ERX for his help in developing the circuit from its original form to the amateur version shown. Circuit boards and kit of parts are available from A.R.S. Enterprises, P.O. Box 555, Tempe AZ 85281.

. . .W6GXN

Bibliography

1. Olson, H. "IC-Regulated Power Supplies" *Ham Radio*, March '68, p.28.
2. Olson, H. "A Laboratory Power Supply" 73, Dec. '66, p. 38.
3. Sylvan, T. "Regulator Makes Two Power Supplies Out of One" *E.E.E.*, May '66, p. 117.

Parts List

1. Circuit board: A.R.S. Enterprises, P.O. Box 555, Tempe AZ 85281.
2. Input plug: Pomona MDP-ST sawed off as shown.
3. Output terminals: General Radio 938-C, 938-D, 938-G (one each) and three 938-F.

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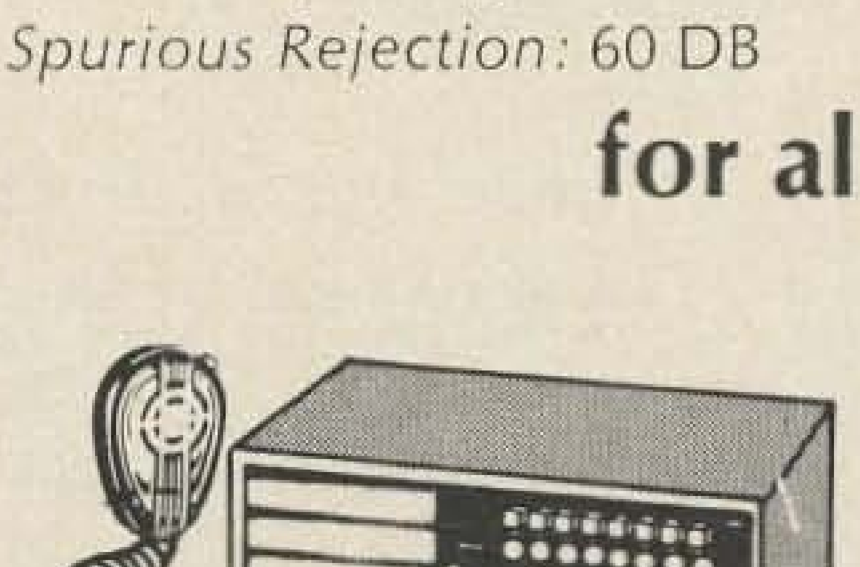

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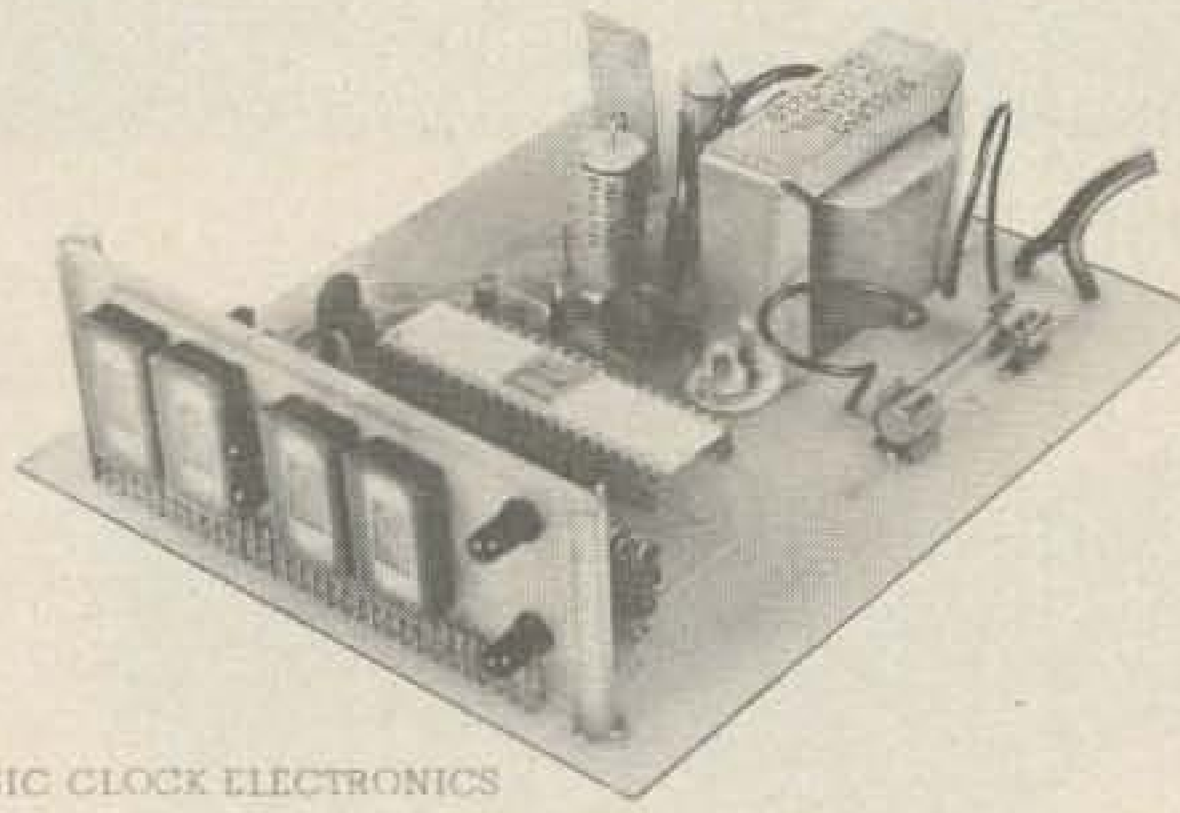

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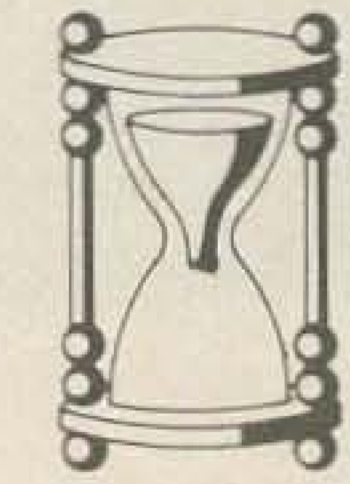

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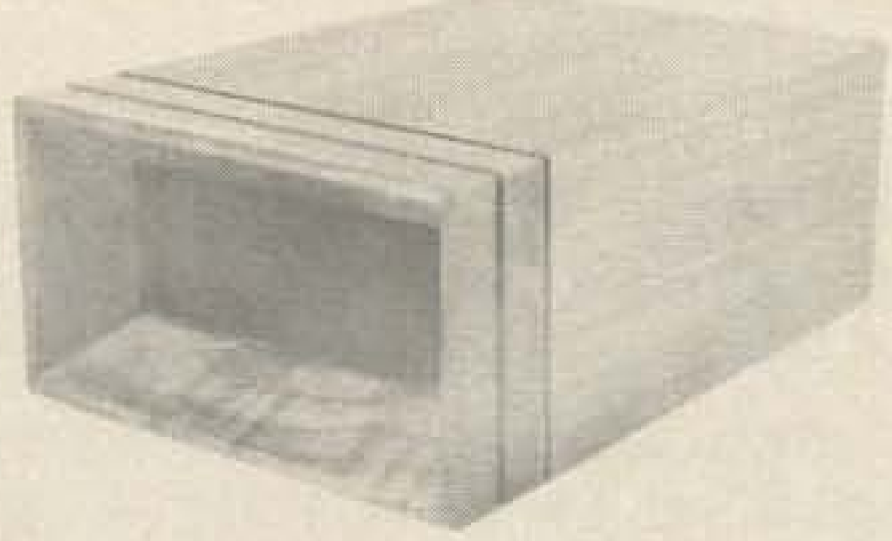

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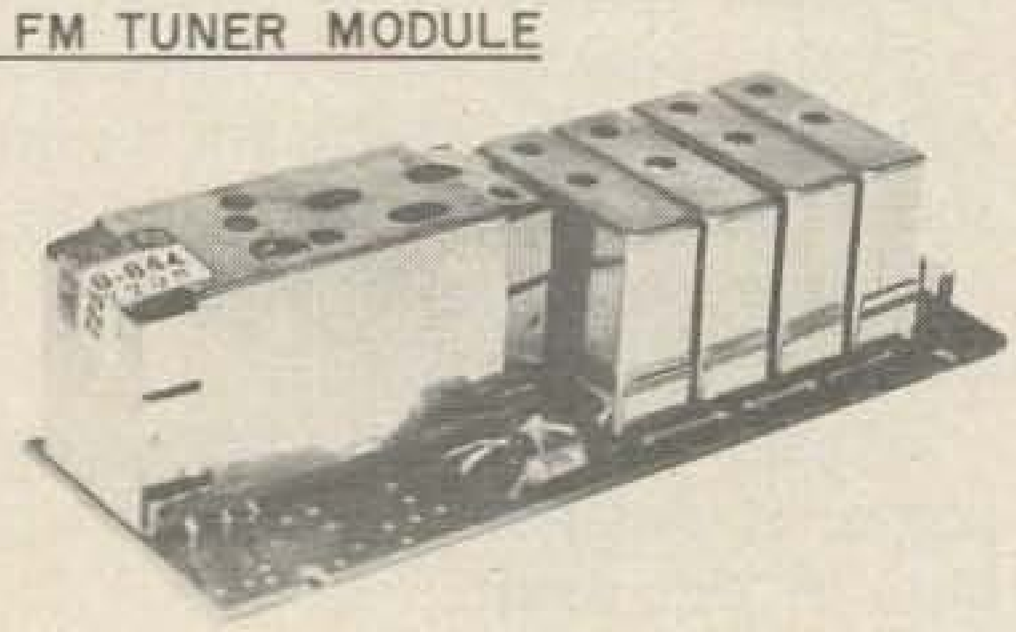

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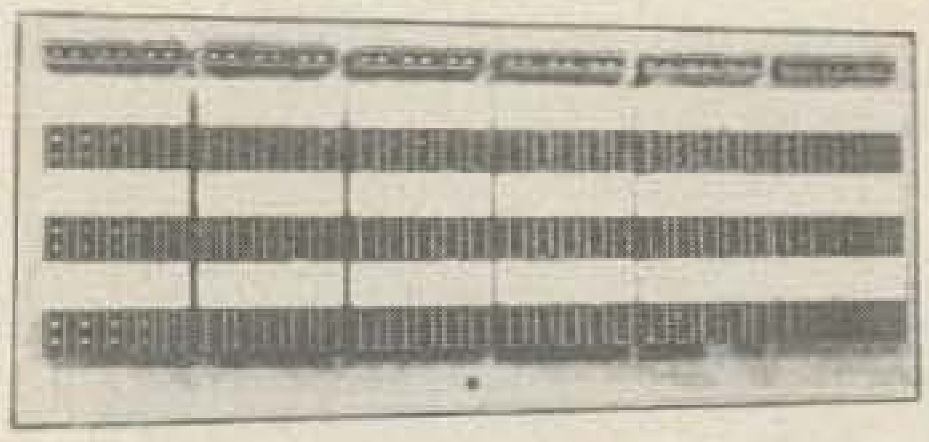

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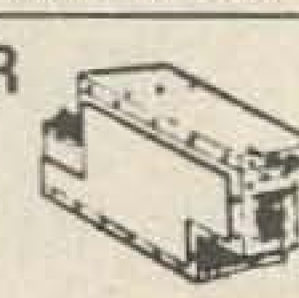

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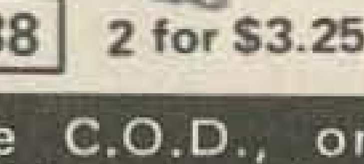

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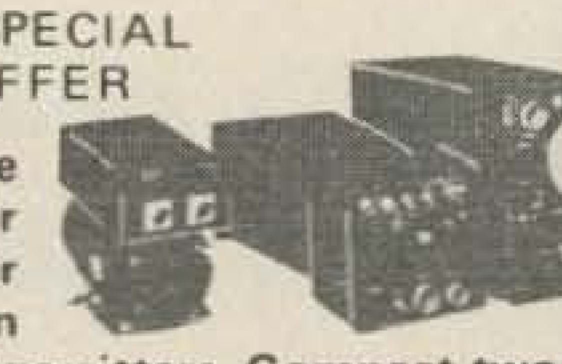

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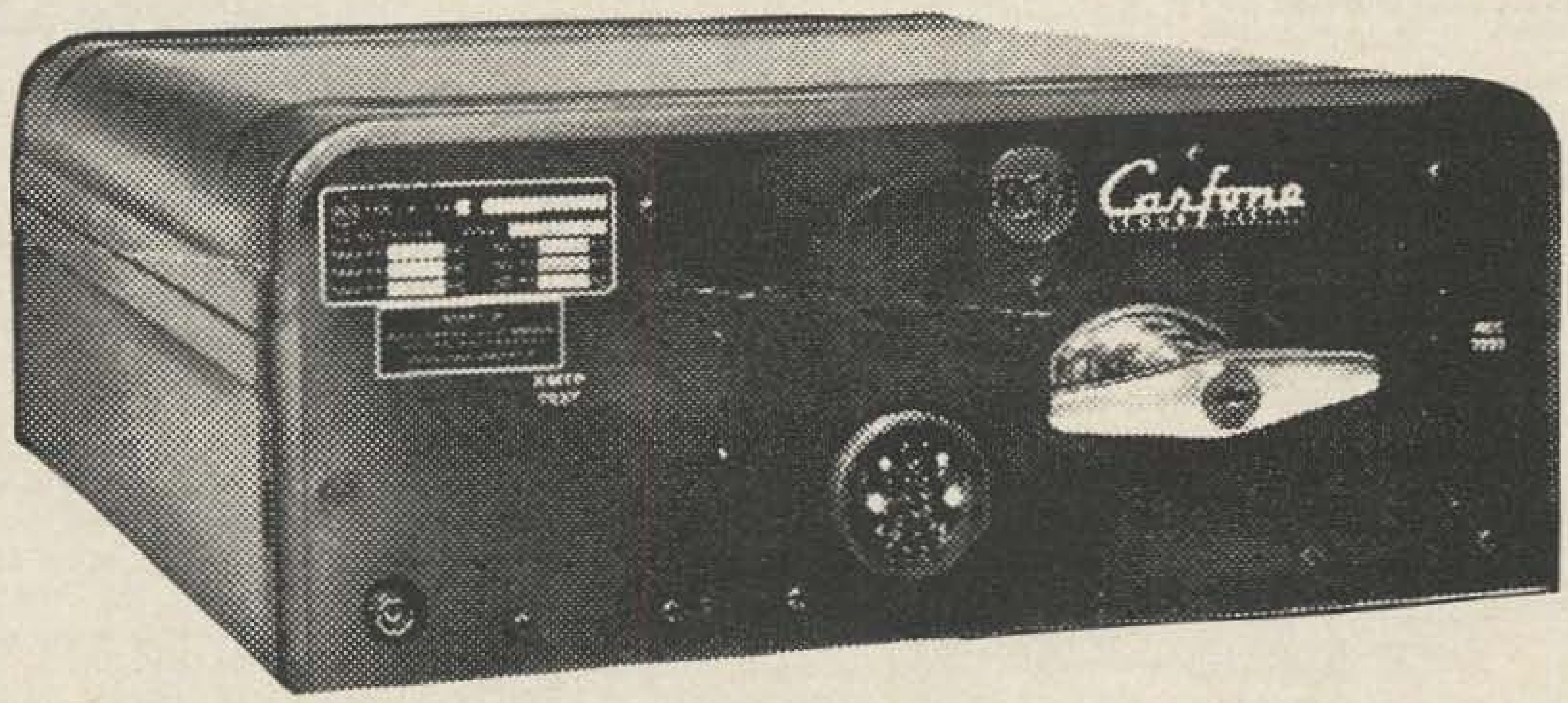

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LETTERS

(Continued from page 12)

cerned, who had six children to support, had been hauled into a Cleveland court for wearing an American flag on the seat of her pants, and with the suspension of her subsequent $1000 fine and thirty day jail sentence, had been properly humbled (humiliated) to the point of telling the judge, meekly, "... Yes, she thought it was a pretty good government, after all." Obviously this situation is emotionally, socially, and politically supercharged – it is much deeper than the level at which Mr. Russell chose to use it as a ploy for the introduction of his pro-League argument. Yet this is exactly what he did, i.e., use the words of a troubled welfare mother as a good example of how we ought not knock our "good government," or our good League. This is nothing but patent – and potentially dangerous – malarky. This kind of thing belongs nowhere in amateur radio – a realm of technical, not social, investigation – let alone the editorial pages of *QST*. Yet, there it was, in black and white. I wrote to ARRL in protest. My letter was not printed in *QST*, though W8BU had had a *second* letter of his printed as the first letter in the correspondence section of the *same November issue*! Check this out (page 88) if you do not believe me. Where does this man get off? Does he own the ARRL? I am an ARRL member, Extra Class, etc., just as W8BU is. How does he, or anyone, rate *two* letters in one issue, one of them printed as an editorial, no less, to my *zero* letters – especially when one of them is untenably political and potentially divisive in its implications? The ARRL would not answer me on this – John Huntoon told me in his answer to my letter that I had misinterpreted W8BU. I ask, what is there to misinterpret? It is all there in print, in *QST*. Moreover, *no* letters protesting W8BU's ill-considered stand were printed – while letters supporting him were, e.g., one by K8MMH/9, of Buffalo Grove IL, a personal friend of W8BU (by the way, try to find Buffalo Grove on the map). Yet I *know* protest exists – I protest this. WA9SZQ protests it. I brought this issue to the attention of the ARRL Hawaii SCM, KH6BZF, one night on twenty meters and he admitted, after I had stood by for him to read the editorial, that he felt like hanging his life membership plaque upside down on the wall of the shack. What I want is for all ARRL members who feel likewise – and I urge those of you who haven't read W8BU's editorial to do so – to write their Division Director, as well as Headquarters, demanding the retraction of this editorial. That's all I want, that, and that the amateur world know there are people who disagree with W8BU and ARRL on this and were not allowed to express that disagreement in the same forum that bred it – the pages of *QST*. That's why I ask your help in printing this – injecting politics of any kind into ARRL policy is bad, but apparently ARRL has an even worse policy of not allowing dissent against its major blunders to be voiced. Let's get that editorial retracted!

Sgt. Peter Erk WA9TCR/KP4
Camp Garcia, Vieques, P.R.

Please tell me what the number '26009' under the date and price on front covers for the last couple of months means?

Really enjoy the magazine.

Dick Altman
San Francisco CA

Roughly half of 73's copies are sold on the newsstands and this is being handled by a national distributor. Newsstands keep track of magazines by means of the little code number on the cover. Right near the number you will find the insignia of the distributor, Ace News.

I thought you would like to know that 6 xtals for my TR-22 from KW Industries and all were OK even without a tune-up. They also delivered within a week including 2-way mail.

Jim Kirkgasser WA2ELA

This letter is a little negative feedback, and an offer to help.

The article in the August issue, "The 1926'er: The Ideal Crystal Oscillator,' may describe a fine oscillator that performs as claimed, but the "How It Works" is pretty far off base. In fact, it's down-right wrong. Some unsuspecting reader may believe the statement on page 116 that says the crystal provides 180° of phase shift. It just ain't so!! Maybe Bill Hoisington can't be objective about his own analysis, but the theory of operation given implies a basic misunderstanding of crystals and oscillators; his 30 years notwithstanding.

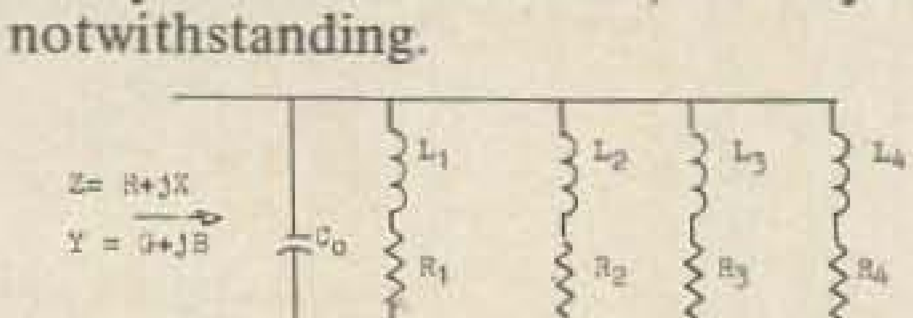

Fig. 1. Crystal unit equivalent circuit.

Control crystals have the generally accepted electrical equivalent circuit shown in Fig. 1. Ordinarily the first mesh is sufficient for analysis of the operation of the crystal unit. The extra branches account for the spurious mechanical responses that often affect the measured response. The impedance variation of a crystal unit near the principal mechanical resonance is shown in Fig. 2. There are two frequencies at which the reactance is zero, or where the crystal resonates. (This zero reactance point is the classical definition of resonance); the resistance is very low at one and very high at the other. The lower frequency, at which the resistance is very low, is referred to as the series resonant frequency, and the higher frequency, at which the high impedance is seen, is referred to as the anti-resonant or parallel resonant frequency. Crystals operating on a mechanical overtone have a low impedance and appear to operate in the series mode. The impedance of the crystal unit is near zero and resistive. (The holder capacity or load capacity, Co, has minor effect when shunted by the low impedance series-tuned circuit.)

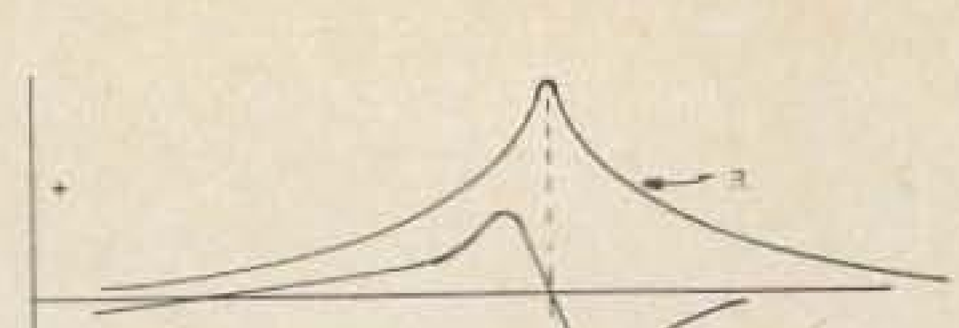

Fig. 2. Crystal unit impedance variation.

The fact that the oscillator circuit uses the crystal unit between collector and base does not mean the crystal provides 180° of phase shift. (In the Pierce oscillator, the crystal is between plate and grid, and I don't believe anyone claims 180° in that application.) So, if the crystal operates at series resonance with nearly zero reactance, how does it work? To explain the operation, I'll assume a qualitative understanding of the Clapp oscillator, and go from there. A typical Clapp oscillator is shown in Fig. 3; bias sources are not shown. At the lower frequencies, the capacitors Cbe, Cce, and Ccb may be physical capacitors augmenting the internal capacitance of the transistor. At higher frequencies the transistors internal capacity may be enough. In passing, note the similarity between the equivalent circuit of the crystal and L, Ct, and Ccb in the Clapp's resonant circuit.

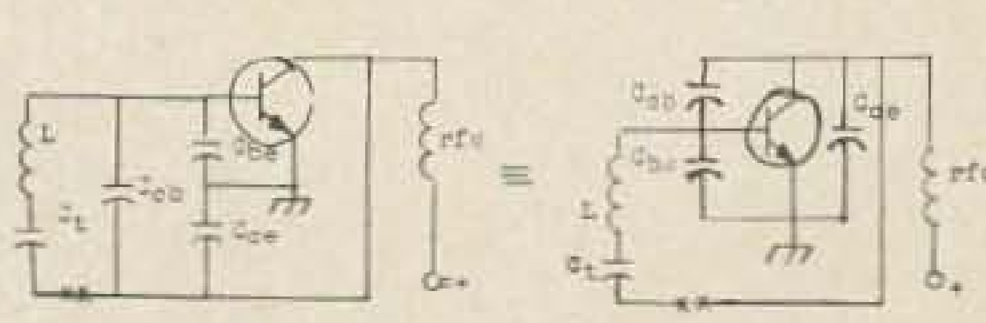

Fig. 3. Typical Clapp oscillator.

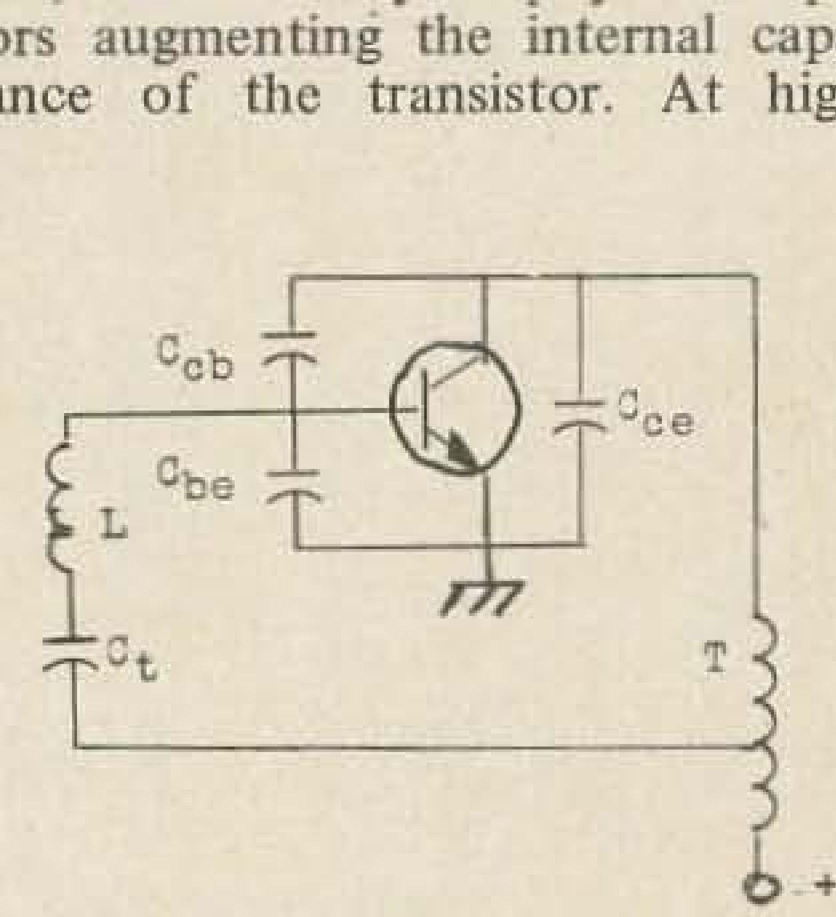

Fig. 4. Modified Clapp oscillator.

Generally, the oscillator designer can choose components compatible with the impedance levels required by the transistor. If such is not the case,

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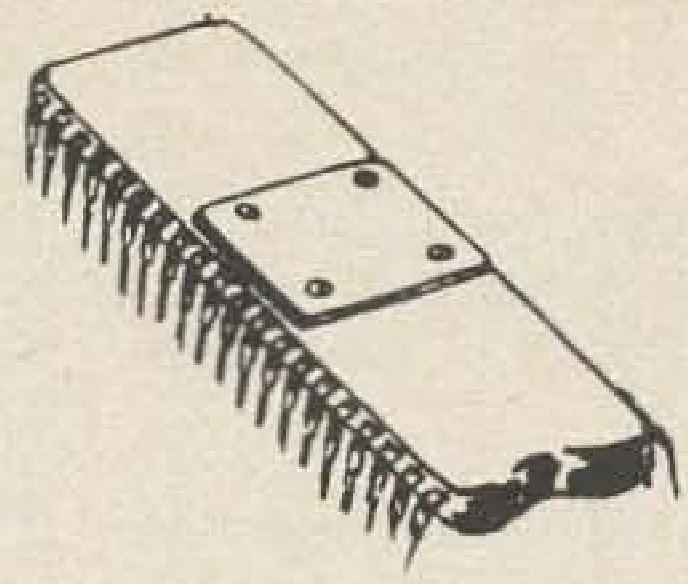

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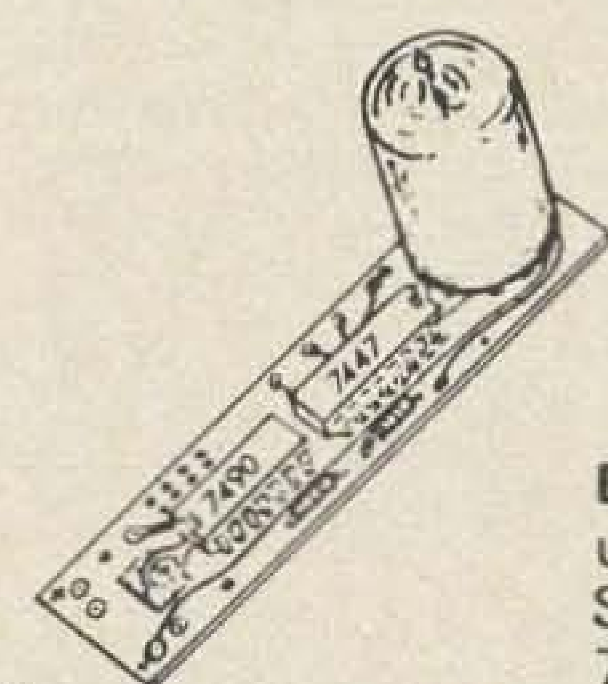

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LM302 voltage follower op-amp 1.25
709 operational amplifier 40
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LM309K 5V-1A power supply module 2.50

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unit includes board, SN7490, SN7475 quad latch, SN7447 7-segment driver and RCA "numitron" display tube W/decimal. 1" x 4.5" module will mount on 1" centers.

kit $10.95 – wired and tested $13

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7447 7 segment decoder driver $1.60
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8261 fast carry for above $2.00
8223 256 bit bipolar field programmable,
read-only memory $10.00
8570 9 bit S1, PO, shift register $2.50
LED Red Emitting Lamp . . . . $.60

All IC's are new and fully tested – leads are plated with gold or solder. Orders for $5 or more will be shipped prepaid. Add 35¢ handling and postage for smaller orders. California residents add sales tax. IC orders are shipped within two workdays of receipt of order – kits are shipped within ten days of receipt of order. Money back guarantee on all goods sold.

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LETTERS CONT.

the impedances can be transformed one way or another to a suitable level. For example, an auto-transformer can be inserted at "X-X" to provide the

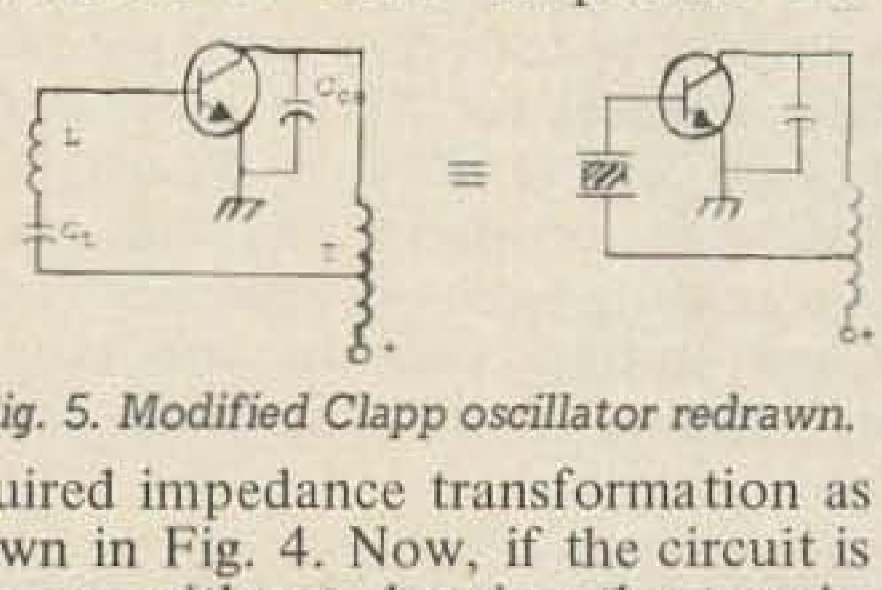

Fig. 5. Modified Clapp oscillator redrawn.

required impedance transformation as shown in Fig. 4. Now, if the circuit is redrawn without showing the transistor's internal capacities, and showing only the physical components, Fig. 5 results. If L and C_T are replaced by the series-tuned circuit of the crystal, lo and behold we have the "Ideal Crystal Oscillator" sans bias. Now the crystal can be seen to operate in conformance with the laws of physics, and there is no need to demand the impossible 180° phase shift.

If the operation of the Clapp or Colpitts are not understood, let me know and I'll write a tutorial article explaining them and relating them to the real world.

Parker R. Cope W2GOM
Amsterdam NY 12010

That's a lot of Clapp!!

Don't miss the blastoff!! Free gifts to early registrants. Info from Dave Popkin, WA2CCF, 303 Tenafly Road, Englewood, N.J. 07631.

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SSTV, RTTY, WWV, tone to logic decoder projects. Chassis, plans, hardware, eight 2¼" x 3" epoxy cards, $6. Hornung, 1630 Bowling Lane, San Jose CA 95118.

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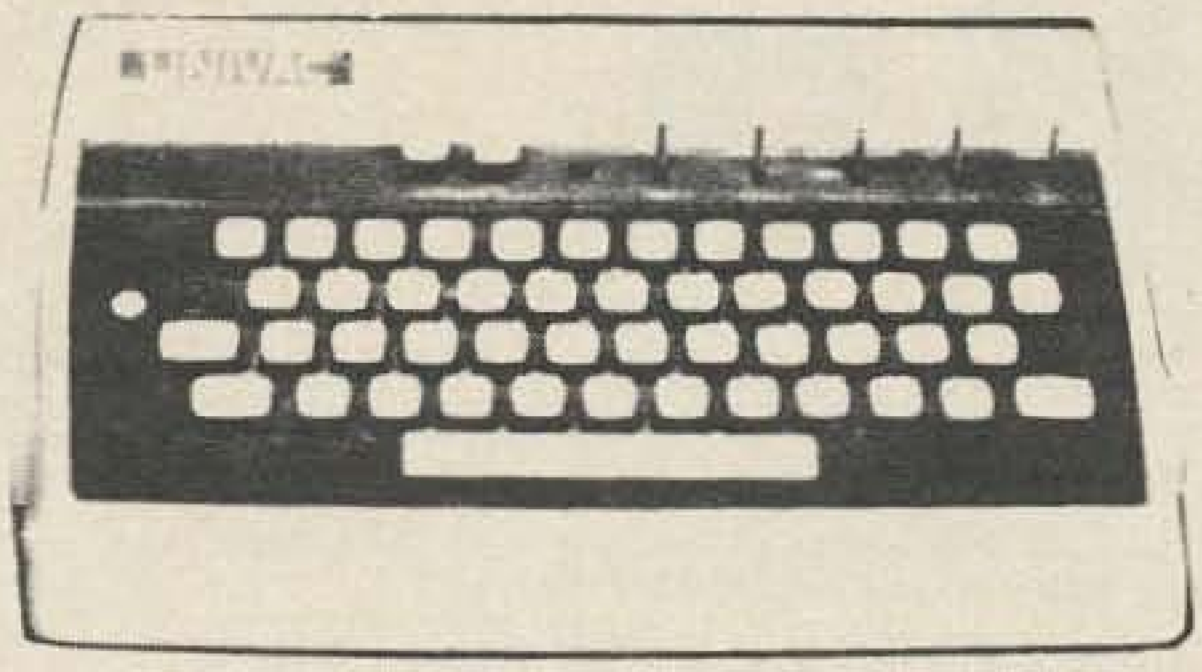

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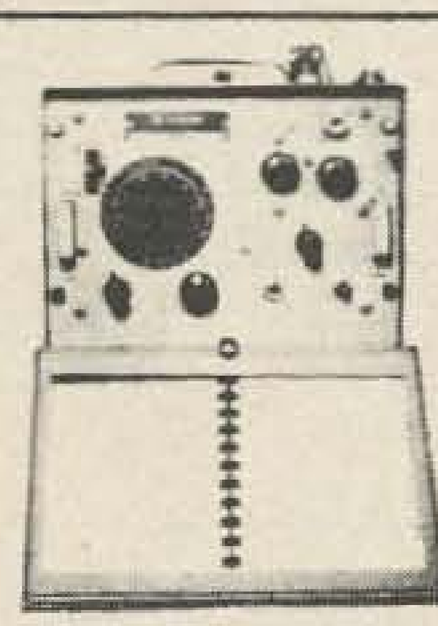

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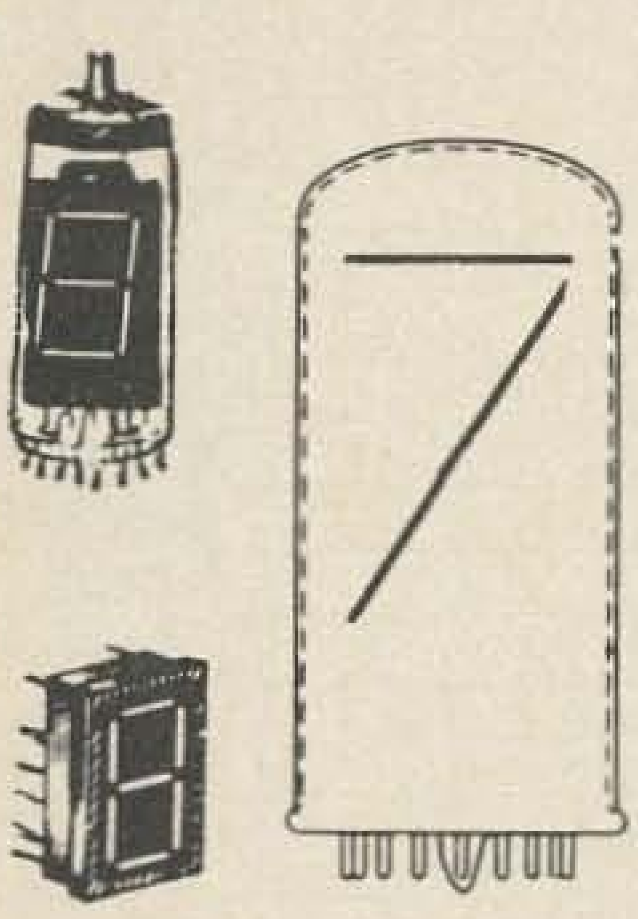

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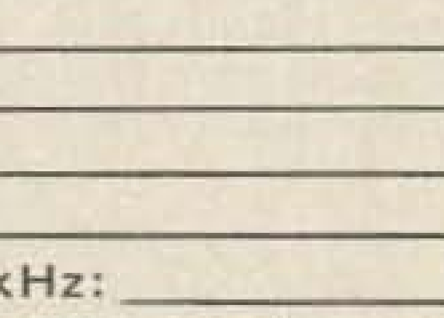

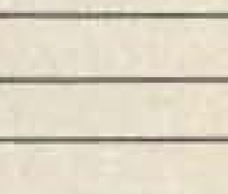

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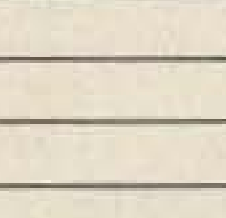

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Only Yaesu offers this type of remote, one-handed control of the scanning function.

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4

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