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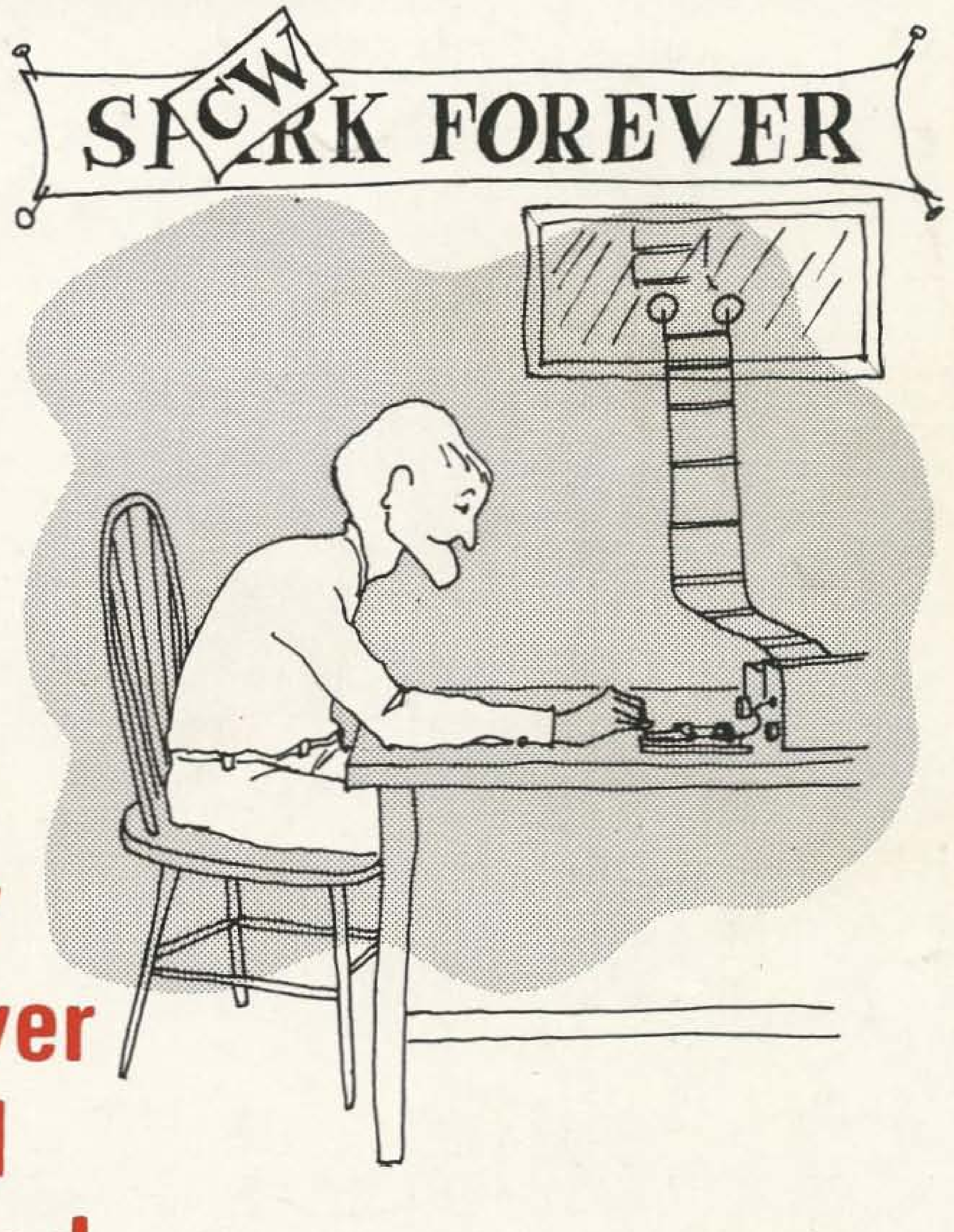
73 magazine
for radio amateurs



CW

- *CW Transmitter
- *Tuning Your Key
- *Cheapo IC Receiver
- *Perfect CW Signal
- *Raising Code Speed
- *SWR meter & CW monitor
- *Keyboard Morse Generator

QRP

- *DX With ½W
- *Improving Ten Tec
- *1000 miles/watt

73 magazine
for radio amateurs

#137 FEBRUARY 1972

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FEATURES

73 Magazine is published monthly by 73 Inc., Peterborough, New Hampshire 03458. Subscription rates are $6 for one year in North America and U.S. Zip Code areas overseas. $7 per year elsewhere. Two years $11 in U.S. and $12 overseas. Three years $15, and $16 overseas. Second class postage paid at Peterborough, N.H. and at additional mailing offices. Printed at Menasha, Wisconsin 54952 U.S.A. Entire contents copyright 1972 by 73 Inc., Peterborough NH 03458. Phone: 603-924-3873. FM oriented amateurs in the East should think seriously in terms of the First FM Symposium in Worcester on February 12th. See the newspages. All readers are requested to make sure that they do not stint on asking for information via the coupon on page 128. Money is a curse, get rid of it as fast as you can and pass that dread curse along to our advertisers. If you are really desperate send the money to 73 and invest in lasting happiness such as the 73 books, a nice subscription, etc. Who says money can't buy happiness?

Amateur Radio

FEBRUARY MCMLXXII Monthly Ha

MILESTONE WIN IN TOWER CASE

A classic victory for tower-owning has occurred in California recently. Some neighbors of such a man filed a lawsuit and got an injunction against the ham. The defending lawyer, also a ham, managed to win the case in favor of his client; in other words, the ham won. Rather than sit back and congratulate himself, the lawyer examined the injunction against his client.

In California, and possibly other states, such an injunction must be backed by a bond. The lawyer filed a claim against the bond for court fees, attorney's fees, and reasonable reparations (damages). The bonding company, it was found, had filed the bond to the wrong person and after much litigation, somehow managed to clear themselves and shifted the liability to the home owners who had filed the lawsuit and got the injunction.

The lawyer feels sure he will be able to collect fees and perhaps some reparations. The whole point is that a countersuit has been filed against the neighbors and the ham is in the driver's seat. Congratulations to the ham and his lawyer who did not give in under pressure and who have created a precedent in amateur radio.

IN OKINAWA...

BLIND HAM HONORED FOR PHONE PATCH SERVICES

Betty Blalock KR6BB, Awards and QSL Manager for the Okinawa ARC, presents the Okinawa DX Award for Ken Hinderleiter K7HQF, for service to the residents of the island. From left to right are Gordon Hale KR6RH, President of the Club, Ken, Mrs. Hinderleiter, and Betty Blalock KR6BB.

Ken Hinderleiter K7HQF, a blind ham from Phoenix AZ, has provided phone patches to the U.S. from Okinawa for over eleven years. Handling, on the average over 1,000 calls per month, Ken has performed a much appreciated service for American military personnel and their dependents. In appreciation of his service, the Assistant Secretary of Defense/Public Affairs invited Ken and his wife to Okinawa to attend the semi-monthly meeting of the Okinawa ARC to meet many of the people he has spoken to over the years. He was presented with an honorary membership to the OARC and he received the call letters KR6HT. At the meeting, Ken also was presented the Okinawa DX Award for the services he has unselfishly given, often placing calls in the small hours of the Arizona morning.

HELP STAMP OUT MENTAL HEALTH

SUBSCRIBE TO 73 NOW!

75th Anniversary of the Birth of Radio Communications

From May 14–21, 1972 the Barry College of Further Education Radio Society will be commemorating the 75th anniversary of the Bristol Channel Tests undertaken by Marconi and Kemp in May 1897. They will be establishing stations at Flatolm Island (GB3BCT) and Lavernock Point (GB3MKT).

The 1897 tests were significant in that radio signals were transmitted for the first time across water, radio signals were transmitted for the first time between two countries, and these were the last tests carried out by Marconi as an amateur. The 7th anniversary of such an event should not pass without special recognition.

The Society invites clubs located in areas which have an historical link with Marconi's early experiments to join in establishing special commemorative stations sometime between May 1972 and May 1973. The Society will award a special 75th Anniversary Certificate to radio amateurs who contact these stations. In the U.S. the Old Old Timers Club will handle the Marconi-Kemp celebration exclusively. Their Vice President, William B. Gould K2NP, has been designated as the individual in charge of the project.

To emphasize the international aspect of amateur radio, overseas amateurs holidaying in Britain are invited to visit the historic site at Lavernock Point, and operate across the stretch of water made famous by Marconi. A special commemorative certificate will be issued to all amateurs operating this historic link. Any reader interested in visiting the site should write in the first instance to K2NP, and Bill will be able to supply him with the necessary information for obtaining a reciprocal license. A special first-day cover stamp will be issued from Flatholm Island. Information on the stamp may be obtained (with I.R.C.) from GW3VBP.

73 Strikes Again!

Latest addition to the 73 fleet is the surprised *Onondaga*, a Canadian Armed Forces submarine. Where will 73 strike next? Send in a picture when you find out.

International Net

MARCO SAVES LIVES

Jerome Hurwitz W3EZT, was in his Silver Spring shack on November 12 when he heard a distress call from Venezuela. The South American was in dire need of a special medicine for a two-month-old boy in Caracas. Jerome, an engineer by profession, served as a relay between the State and Defense Departments, Panama, and Caracas. Within 24 hours, the medicine was safely on its way to Venezuela from New York.

Although this is not the usual substance of ham radio, emergencies such as this do occur and it is only because of the operating skill of dedicated hams that tragedy is avoided. There is a special net that meets on the air just for the purpose of exchanging information of a medical nature. This is the Medical Amateur Radio Council, MARCO for short. This is an international effort to share medical knowledge and to lend assistance where possible. MARCO frequencies are: 7264 kHz daily at 0200Z; same frequency on Monday, Wednesday and Friday at 0320Z; 7060, Monday and Friday, 0230Z; 14060, Saturday and Sunday, 1800Z; 14280, daily, 0300Z; 14280, Sunday for DX SSB, 1900 and 2000Z.

NEWS BRIEFS FROM AROUND THE WORLD

CANADA *(Tnx to Canadian A. R. Federation)*

The Gifford Marsh Memorial Trophy has been presented to Noel Eaton for his selection as Ontario Amateur of the Year. The trophy is presented annually by the Radio Society of Ontario to the Ontario amateur who has given the greatest service to amateur radio on the local, provincial, national, or international level.

The official banned countries list for Canada is: Cambodia (Khmer Republic), Cyprus (except on national and international field days), Gabon, Iraq, Libya, Pakistan, Turkey, Vietnam, and Yemen.

Repeaters in Canada will be under official scrutiny by the DOC, but the exact date for policy notices and even what the proposals will be is not yet final. Any repeater licensee who wishes to keep informed about operation and who wishes to play a role in the formulating of regulations should contact A. M. Vardenbelt VE3FXC, 699 Trojan Ave., Ottawa 7, Ontario. He is the chairman of the CARF auto-repeater committee which is primarily involved in advising on changes necessary in regulations governing the licensing and operation of the machines.

Will there be Novices in Canada? This is a question that many a Canadian may ask himself before the CARF submits its proposal for a restricted class of license to the DOC. This license would allow activity in the VHF/UHF part of the spectrum, and the intent is to increase amateur activity there. What with more general radio service users looking for additonal frequency space, the amateur bands are good places to question if there is no activity there (U.S. hams, remember 11 meters?). Hopefully, the status of amateur will spur the newcomer to obtain full status. Several clubs have commented that they would conduct code classes on the air to help these hams up-grade. Another item that is related to licensing is the proposed lowering of the age requirement from fifteen to twelve years of age. To express your feelings on either or both of these matters, contact your provincial society before a proposal is submitted to the DOC. The proposal that will be offered will be based on the results of questionnaires that the Federation has requested of the provincial groups.

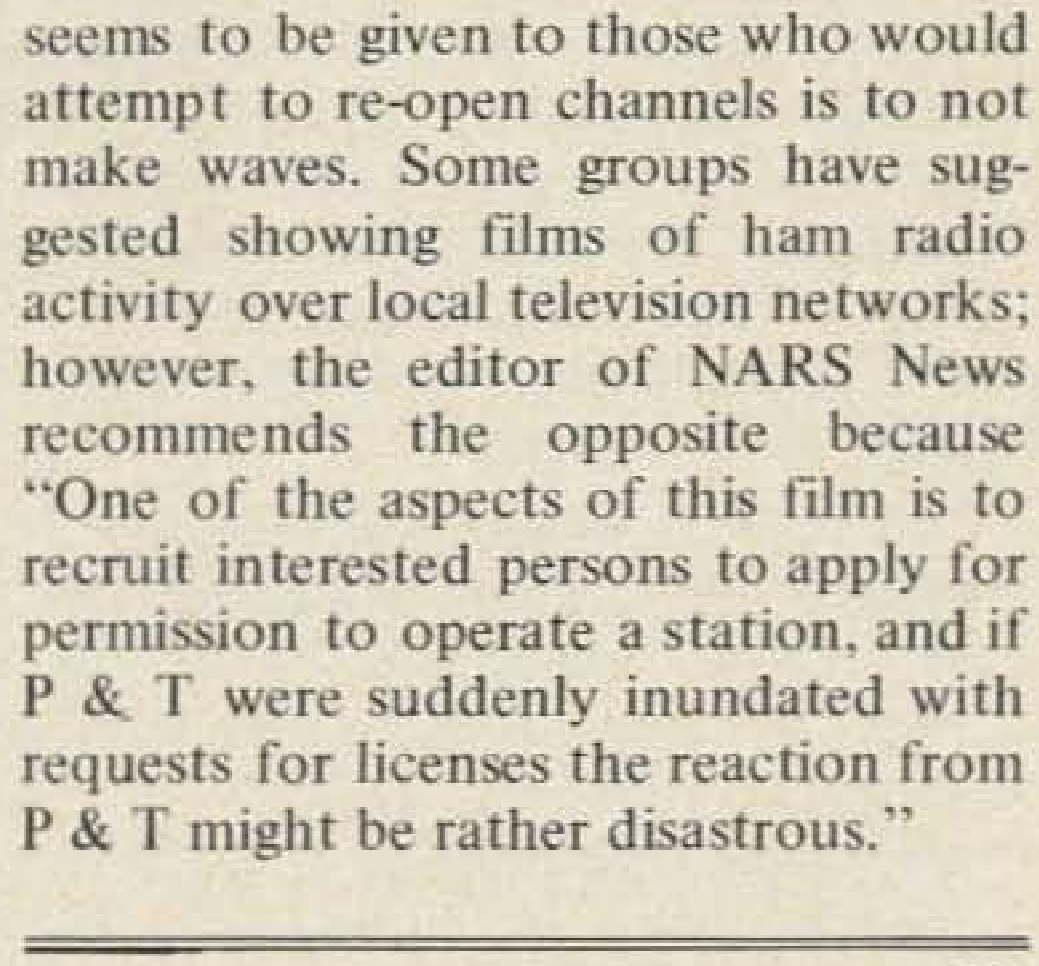
JAPAN *(MARCO News)*

The Hokkaido branch of the JARL has set up JA8IOC in Sapporo in conjunction with the Eleventh Winter Olympics. The objective is to inform listeners about the Olympics and to promote good will with other countries. Until February 13 they will operate CW and SSB on all bands 160 through 10 and six and two FM.

In early 1971, there were 139,400 hams, and almost one-third are in the Kanto area which includes Tokyo.

NIGERIA *(Courtesy NARS)*

There have been few new licenses granted to Nigerians due to the continuing political unrest that began in 1967. Negotiations have been attempted with the Post and Telegraph agency, the governing body of amateur radio in Nigeria, but very little has come of it. Advice that seems to be given to those who would attempt to re-open channels is to not make waves. Some groups have suggested showing films of ham radio activity over local television networks; however, the editor of NARS News recommends the opposite because "One of the aspects of this film is to recruit interested persons to apply for permission to operate a station, and if P & T were suddenly inundated with requests for licenses the reaction from P & T might be rather disastrous."



Moving? Please let us know.

WITH THE FCC

The Federal Communications Commission has passed an amendment to its rules to allow hams to increase speeds on teletype equipment to 60, 67, 75, and 100 words per minute. Previously, amateurs were limited to sixty words per minute, this limit mainly imposed by the type of equipment available. Now, however, more surplus TT gear is being released from commercial service and the ability to increase speed which has previously been denied is being allowed. Arguments in favor of the proposal included increased message handling capability and more efficient use of air time.

The FCC has recognized comments that this move is an advantage, as it promotes experimentation and will permit the development of new skills and techniques, in keeping with the basis and purpose of the Amateur Radio Service. Commission experience indicates that amateur operators have consistently demonstrated their versatility in adapting to new operating situations and conditions. The ARRL was one of the proponents of the measure, commenting that not restricting amateurs to specific speeds and codes would enhance experimentation and contribute to the development of new and improved techniques, experiment and practices.

No limitations to bandwidths were set as other parts of the Rules give indications of good engineering and amateur practices. According to the FCC release with this information, "This is in keeping with the intent of amateur rules to provide technical requirements which permit as much latitude as is practicable consistent with the prevention of undue interference between amateur stations and the prevention of interference to other radio services."

The FCC is there, so be careful to obey the rules. Richard Dixon WA8CKY, was cited for failure to have a licensed ham sign off his station, failure to identify at least once every ten minutes, and failure to file a notice of intended portable operation. Since Richard did not reply to letters to Show Cause why his license should not be revoked, his license was suspended for the duration of its term.

In other recent action, the FCC has revoked the Novice class license of Peter Kuehn WN6IER, Walnut CA. This is the result of improper use of his Citizens Band station, using excessive power, and off-frequency operation. His license is suspended for the remainder of its term, unless Kuehn wishes to appeal the suspension order.

An awareness of the rules is helpful. When someone receives a letter to Show Cause, it is not a suspension notice. It is the person's opportunity to tell what happened in his own words. No response is regarded as an admission of guilt and appropriate action is taken. A suspension order is then issued. If the accused wishes to challenege the order, he may make application for a hearing at which time the suspension notice is held in abeyance until the conclusion of the proceedings.

HOT GEAR

SBE SB-33 S/N 103906. Thieves broke wing glass and rolled down window to avoid setting off alarm on door. Charles Greene WA5JGU, 3028 NW 33rd St., Oklahoma City OK 73112.

Heath HW22A Transceiver S/N 907-18375. Richard Roberts W1BDX, P.O. Box 4, Rochester NH 03867.

National HR050 S/N 2800019. William Vance, WA5DQF, 410 Lakeside, Channelview TX 77530.

Hallicrafters SR160 S/N 416000-108039. Mike O'Grady K9YVA, 4611 N. Kenton Ave., Chicago IL 60630.

Drake TR3 S/N 3858. Virginia Voyles WA9EYL, East Main St., Petersburg IN 47567.

Collins KWM2A S/N 13815. Morgan Godwin ARRL HQ.

Collins 312B4 S/N 59920; Col 30L1 S/N 40084; Col MP1 S/N 44507; Col MM1 (mob. mike), Misco minispkr. Det. Sgt. W. Hopkins, Wilmington Delaware Police.

Swan SW175 S/N 426-5. Roger Sawyer WØAXT, 186 Lakeview Dr., Mason City IA 50401.

Reg. HR2A S/N 04-05896. John Crosby K4GBL, 4041 Compton Circle, Powder Springs GA 30073.

List from Past Issues:

Mfr., Model, Ser. No.	Owner	Issue
Halli., SR46A, #446100	WA1EMU	9/71
Reg., HR-2, #04-03505	WA5BNM	11/71
Sonar, FM3601, #1003	WB2ARM	11/71
Coll., 75A4, #804	WØMGI	12/71
GE, Portable, #1041218	K2AOQ	1/72
Coll., 75SE-B, #15640	Col.St.U.	1/72
Coll., 21S3, #12000	Col.St.U.	1/72
Coll., 516F2, #1649	Col.St.U.	1/72
Simp. Mod-A, #35457	W2PWG	1/72

DX FOOTNOTES

According to the *DXers Magazine*, we find the following items of interest: AC5TY can be found nightly on the SEA net at 1200Z and goes down to 14305 kHz with 4S7AB. QSL goes to T. Yonten, Thimphu, Bhutan via Calcutta, India. You can list the Republic of Nauru under its prefix of C21, C20 and C29. Portuguese Timor can be found on fifteen and the call is CR8AG. Adriano only recently arrived there but will have his quad up soon. If you work the Pacific Net, look for TJ1AW (QSL via K4MPE). For non-DXers, this is the Cameroons. And for lower frequency DXers, Christmas Island, VK9XX will soon be on 40 and 80 meters. Higher frequency DXers can find him around 14,285 at about 0930Z. In either event, QSL via Stu, W2GHK.

Is UA7KAE/7 really in the South Shetland Islands? That's what his QSLs say.

Fred, VP8KV, Falkland Islands might be found on 14230 SSB around 1015Z and he can be reached at Box 144, Port Stanley, Falkland Islands. The W6's have been working VR1AB, British Phoenix Island between 0500–0600Z around 14285. If you need Brunei and have not yet worked VS5CB, you will be upset to learn that he will soon be QRT. You will be pleased to learn that VS5PW will be on the air soon with a kw. ZK1CD, a real gentleman, will QSY to help others earn the 5BDXCC. He is on the island of Raroronga in the Cook Island group. Another one to watch for is 3B8CZ, Mauritius. Den can be found around 21300 and also on ten meters. QSL via RSGB. P.O. Box 467, Port Louis, will reach him direct. Togo, 5V7GE(?) skeds K4SKI daily on 14250 at 2100Z, give or take a little.

Only active XU is XU1AA, and he operates only from 0000–1500Z. The FCC is permitting American hams to work ONLY this XU station. QSL to XU1AA, University of Phnom Penh, Box 484, Cambodia.

Some other QSL info: VQ9R, Carl, Box 193, Port Victoria, Mahe, Seychelles.

VK Ham Tours Italy & U.S.

Ian Williams, VK3MO, has made many DX contacts from his Melbourne QTH, and so begins a happy tale.

Ian left Australia about the first of 1971 and soon arrived in Italy. There he purchased a bicycle and toured the continent, stopping off wherever possible to visit the many stations he had contacted before. Of course he did not meet hams everywhere and frequently camped out in fields or construction sites. Twelve thousand miles later the bicycle broke down completely. Ian then decided to visit the U.S. Traveling here was a little easier as he obtained a special bus ticket that allowed him to travel anywhere at any time within a certain time limit *(This ticket is available only to foreign visitors –Ed.)*

In the U.S. Ian had eyeball QSOs with the Americans and operated their stations when possible. In fact, Ian had developed a following of interested and well-wishing hams on both sides of the ocean and kept them all informed as to his welfare. By now he is back in Australia, working more DX stations and perhaps getting ready to ship out again.

Year round DX may soon be a possibility, even during sun spot cycle low points. The National Oceanic and Atmospheric Administration has been conducting research on heating the F-layer of the ionosphere, and possible results might be ways of altering this layer to produce long range radio communication. These experiments extend the ability of man to alter his environment from a distance with no harmful after-effects. So far, the heating effect has been controlled with results lasting seconds, minutes, and sometimes hours.

Results of these studies will prove useful for space as well as intraterrestial communication.

Eric 5N2ABG, reminds us that there is a small independent territory between Norway and Sweden called Morokulien. It is an international refugee area and the prefixes LG and SK9 have been specially issued. LG5GL and SK9WL are active from the territory, and QSLs may be sent to P.O. Box No. 1, N2242/S 67 044, Morokulien, Scandinavia.

Egypt, SU1IM, has been heard around 14057 at about 1500Z, and this is on an almost daily program. Also on 20 CW is VR5FX, Tonga. Usually showing between 0500 and 1730Z, he can be found around 14040, up or down about 5 kHz (QSL via ZL2AFZ). And still another 20 meter man is Keith VKØKA, MacQuarrie. Keith is found regularly on SSB, probably around 1700Z with a good sig to the west coast. QSLs for VKØKA are handled by the VK3 Bureau.

And if you need Africa, listen in to the West Africa Net daily at 21300 kHz.

REPEATER UPDATE

LISTENING
94 76 88 73 70 64 82. . .

Interesting note: Varitronics transmit crystals can be used in the Regency HR2. With this change, the 73 Varitronics crystal becomes Regency 76, the 91 Varitronics becomes 94 Regency . . .

AL	WB4QFR	Phenix City W1.8	28–88
CA	WA6ALV	San Bernardino Mtns. T1.8	34–85
FL	WB4KNQ	Merritt Island formerly 34–76	28–88
MA	W1CSF	Pelham	13–53
ME	WA1KGZ	Streaked Mtn. (Buckfield) (Delete W1QXR, W1EFF)	34–94
MI	WB8CSC	Ann Arbor	37–97
	WB8CQS	Detroit PL 100 Hz	34–76
	K8VLN	Detroit PL 100 Hz	46–64
MN	KØRTU	Elk River T1.8	34–94
NM	WA5QLZ	Albuquerque	28–88
NY	K2LDT	Boston	31–91, 34–94
	K2LEQ	Voorheesville	07–97
	WA2UYO	Cherry Creek31–81	, 34–146.147
OH	K8HRS	Ashtabula formerly K8EUR	34–76
TN	K4RSV	Lenoir City	46–706
WI	WA9ZEF	Appleton T1.8	34–76
CANADA			
	VE3BER	Pt. Colbourne	449.40–146.70 07–70

MARS repeaters are being built now and the standard frequencies for them are 148.01 in, 143.99 out. Two such machines are in Ridgefield CT and Beverly MA, and there are plans to have a series of similar repeaters on a Maine to Virginia network.

NEW PRODUCTS

WA6JOX has returned a Consumer Test report about the Vanguard Model 201 rf preamp. His evaluation says this is the "most accurate advertising spec ever seen. Very good product." And as for servicing problems, "None, easy to use." Dick recommends this two meter preamp very highly.

FREQUENCY MODULATOR FOR THE GONSET COMMUNICATOR

The Communicator has been the most popular two meter transmitter-receiver of all time. But it is an AM rig and two meters is now almost exclusively FM. Palomar Engineers' new Frequency Modulator puts the Communicator on FM without any modification or rewiring. The microphone plugs into the Frequency Modulator. One of the cables coming out of the Modulator plugs into the Communicator's microphone jack and carries the push-to-talk line. A second cable has the crystal plug which plugs into any one of the Communicator crystal sockets and the crystal plugs into it. A variable capacitance diode in the crystal plug frequency modulates the crystal and the frequency multipliers in the Communicator increase the deviation to about 8.5 kHz at the output frequency.

(continued on page 8)

The Japan DX Association (P.O. Box 7, Aobadai, Yokohama, Kanagawa, 227, Japan) is negotiating operation from such tantalizing locations as Burma, Bhutan and Iraq. The effort is being aimed at the Japanese Embassies in these locations. Different companies are being contacted as to equipment and travel considerations, too. And there are other possibilities of bringing on some of the rarer DX. Hopefully this will come about, giving many a DXer some new ones to chase after.

In an effort to promote meaningful communications among hams, the Electronic Representatives Association Ham Club has sponsored a contest among their own members and hams in Venezuela. "Eyeball to Eyeball," the project theme, expressed the desire of many hams to meet face to face with the voice on the other end.

Mr. Dave Hollis, the Club chairman, said "Venezuelan and U.S. amateurs who have contributed the most to promote this theme will be presented with a special prize for their accomplishments. Awards are being donated by prominent electronic equipment manufacturers."

The receipt of a QSL card from the American ham permits the Venezuelan operator to attend as a guest the banquet at Interface 2, the ER's 13th annual marketing conference, held at the Macuto-Sheraton Hotel in Venezuela. In order to continue face to face contact after the conference, the ERA Ham Club has received permission from the Venezuelan government to operate ham stations from Caracas.

DX station ON4QX (Bob) since 1936. He is an A2 op. DX 320/300, 294 CW, WPX 848, and a regular reader of 73. He has 250 awards and DX licenses 3A2CZ, ex-IL1QX, LX3QX, 9A1QX, PAØQX. Bob is an ex-radio officer of the British Navy.

EDITORIAL BY WAYNE GREEN

Columnists Wanted

For some ten years now we have avoided running much in the way of monthly columns in 73 . . . but now, with the concept of the newspages, perhaps the time is ripening. What I have in mind is a far cry from the four and five pages of rambling gossip that columns in some other magazines have been running. I'd like to see a short report on activities and news each month as a one-column feature in our newspages. If news is short, the column should be short.

Have we any volunteers to handle monthly reports for our newspages? I'm interested in people who are already expert on their subject, who already have most of their sources of information developed. I would entertain the idea of columns on RTTY, ATV, SSTV, DX, 160m, 6m, FM, 220 MHz, 432 MHz, moonbounce, certificates, contests, ARRL, ICs, Novices, YLs, traffic nets, or what else do you suggest?

I have in mind a column that would run maybe two double-spaced typewritten pages a month . . . plus perhaps one picture. Short and sweet.

Payment? Fame! Also little extras such as your own personalized QSL cards, letterhead paper, a Life subscription to 73, copies of new books as we publish them, and a small cash payment to cover your postage and expenses like that. Fame, mostly.

If you would like to manage a column sit down now and write up a sample of what you have in mind and send it in. Remember that once you start you are responsible to a lot of people to meet that monthly deadline . . . the 10th of the month.

Repeater Pictures Wanted

The 1972 edition of the Repeater Atlas is about to go on the press and we would like to include as many pictures of repeater sites as we can. Have you a good interesting picture of your repeater?

220 News

React has announced that it now supports the EIA proposal for setting up the citizens radio service in the amateur 220–225 MHz band. The full EIA proposal was printed in tiny type in the March 1971 issue of 73, page 124ff. React has petitioned the FCC to act quickly on the EIA proposal. How many of you who have read the EAI proposal prefer it to the "hobby class license" proposal which would still permit amateurs to use the entire 220 band?

Massive CB Antenna Announced

One of the EIA manufacturers has announced a "massive CB mobile antenna" which is guaranteed not to burn out in CB installations.

Photographs Needed

We would like to do some picture stories on the various aspects of amateur radio and would like to have some good illustrations.

We would like to have some good up-to-date illustrations to accompany a series of articles on the various aspects of amateur radio. How about it, you photographers out there, can you come up with some nice 8 x 10 glossy black and white photos showing the following?

1. A workbench with test equipment and tools with a partially built piece of ham gear on the bench.

2. A picture of a shack, complete with operator, obviously a DX op from the QSL's on the walls, neat and using equipment which is advertised in 73.

3. A slow-can television setup, perhaps with a good looking chick watching.

4. A ham-TV station, perhaps some enlarged test patterns on the wall. Could there be a chick here too? A girl makes things look ever so much more fun.

5. How about an RTTY shack photo?

6. There must be a gorgeous looking Novice out there somewhere . . . well, perhaps not, maybe then a Novice shack with a lot of QSL cards?

7. Yes, we need a 2m FM operator, probably in a car with rig showing plainly, and no QSL cards at all.

8. Let's not forget the VHF nut and his barrage of antennas . . . please, a nice VHF antenna picture.

9. Then there is the super DX VHF nut who works via moonbounce . . . dish pictures needed.

10. Club activities should not be forgotten . . . perhaps your club might pose for a big picture! With any luck I'll be able to get this into several magazines and perhaps a booklet or two. You'll all be famous.

11. If anyone can come up with a good picture of a mass of mobiles, whips showing, that could be a winner, too.

12. An interesting hamfest or convention shot showing a lot of hams having fun could be a winner.

13. Have you any good shots of contest operating such as Field Day or one of the VHF contests?

14. What did I forget? You think of it and send in the picture.

Good pictures which are acceptable for publication will bring $15 for the first in a category and $5 for each after that. Good pictures of girls doing something hammy are always needed. Licensed girls pay even more. Beautiful licensed girls pay a premium. Gorgeous sexy girls who are hams could bring you even more than a premium. And, say, don't forget to include a model release when you have people in your pictures.

Audio Amateurs

Those of you who are interested in building hi-fi gear will want to check out a new publication, *The Audio Amateur, 307 Dickenson, Swathmore PA 19061.* Like me, it's thin, but fun.

Mobile Installation

Not many years ago an FM installation in the car was a great big deal. The transmitter and receiver went into the trunk of the car, the antenna took an hour or so to install, the control head had to be mounted up by the driver, and all those wires!

The other day someone temporarily defuncted my Rover 2000TC and I had to change to an Alfa Romeo for a few days. It took about five minutes to remove the two FM units (with amplifiers) from the Rover and about an hour (at the most) to set it all up in the Alfa. Not bad for two complete FM units, one running 100 watts output!

I decided to use the Volvo for a trip to New York so the equipment was changed again, taking perhaps a half hour this time. The Standard 826 and the Regency Transcan went on the glove comparment shelf, the two amplifiers under the seat. We ran heavy wires to the battery with clips and didn't even have to put in new wires, the same harness being satisfactory in all three cars.

The big difference is in the small size of the units and the magnetic antennas which just clamp themselves to the car wherever you put them down.

(continued on page 7)

Building Club Interest

Clubs will die off, given the chance by inept officers. The big problem is how to get them to expand. This isn't really all that difficult if you think of it from the viewpoint of the prospective member rather than as a club officer. The key to getting new members is to offer them fun and entertainment which will make them want to come to meetings and participate in club activities.

Before I give you hints on how to attract members, may I take a moment to give you some good hints on how to kill off your club fast?

1. Rather than have the basic business decisions for the club made by a small executive committee, bring all matters up for discussion and agreement by the whole club. This will greatly entertain everyone by getting them into arguments and fights for hours at a time, frequently occupying the entire meeting period.

2. Exhort members who have shown little interest in coming to meetings or participating in club activities to shape up and stop leaving all the hard work to the little clique which has taken over the running of the club. Make them feel good and guilty about their laziness.

This list could go on indefinitely, but you get the idea.

Okay, now down to business . . . getting members. You are going to keep business out of those meetings as much as is humanly possible, right? You're going to have a nice coffee and doughnuts after each meeting, right? You're going to arrange to have interesting speakers and let everyone know they are coming, right? You're going to have a club bulletin full of reasons why the club is fun, right? You're going to wrack the brains of the elite clique who has taken over the club to think up more and more reasons why hams will have fun at meetings, right? You're going to have things going on that will interest Novices, right? You're going to make sure that the better known and more interesting amateurs in your area attend the meetings and that everyone knows they will be there, right?

Perhaps the idea comes through. You have to sell prospective members on the fun they will have at a meeting. You may find a short interesting film will help . . . a manufacturer of ham gear is often fascinating . . . an RTTY member will often just about break his neck to put on a demo and try to sell everyone his passion . . . ditto slow-scan television . . . and even regular television . . . and watch out for the repeater fiends, they are the most virulent of all and if you give them much time on the program they will have the club setting up a repeater in no time at all . . . and perhaps a repeater is a better club project these days than a club station? . . . and what club hasn't at least one member who has been traveling and can't come up with slides of Tonga or some damned place to make everyone else eat their heart out . . . you should have at least one inveterate builder who can take at least part of a meeting to show his latest TTL logical QSL-answering automatic transponder and keyer . . . and all this can be whipped to a frenzy of anticipation in that club bulletin.

You don't have a club channel on some band? Maybe on the club repeater? Well? And don't fight it if the SSTV fanatic wants to zip some of his pictures through the repeater now and then just to zing some of the other members into setting up a scanner. Or perhaps the TT nut should have a little time to send some of his diddle-de-diddle over the repeater to another typer. If you get members too excited over these things you may find a second TT repeater being set up for 10–70 and maybe even an SSTV repeater? Not likely.

That club bulletin . . . that is your workhorse . . . use it to let all prospective members know how much fun everyone is having at the meetings . . . use it to make them want to be at the next meeting . . . this is your advertisement to get more members so don't worry about the postage to inactives, if they don't see your ad they'll never come. Can you get each "active" member of the club to accept the responsibility to call one "associate" member (prospective member) and urge him to come to the next meeting? . . . everyone has been asking about the "associate" . . . they all want him to come . . . etc. Of course this all falls flat if the fellow finally comes out of his shell for a meeting and is royally ignored. The chap you see standing over there in the corner is attending his last club meeting.

Collinear Antenna Dimensions

Back in July we ran an article by K6MVH on a two meter collinear antenna. This article created quite a lot of interest in this easily constructed high gain vertical antenna which is so ideal for FM operation.

The antenna article was pretty good with one little exception . . . the dimensions of the antenna never made it to the printed page. That was an editor's "oops." It was particularly an oops for an editor who was printing his own article and who prided himself on being infallible.

A correction of the oops eventually made it through the mills and, for those who could find it, appeared obscurely somewhere in the pages of fine print. The correction left something to be desired too. Apparently the antenna in question was originally written up in the FM Bulletin by VE3BXA and a bit got lost along the way.

Referring to the 73 Coax Handbook, we find the following dimensions for antennas and coax which are pertinent. A half wave is double the quarter wave dimensions.

Dimensions: Let 146.5 MHz=(a), 222.5 MHz=(b), and 440 MHz=(c). Then the dimensions for a quarter wave antenna would be (a) 20.15 in., (b) 13.25 in. and (c) 6.71 in. A quarter wave of RG-8/U polystyrene coax would be (a) 13.3 in., (b) 8.75 in. and (c) 4.43 in. A quarter wave RG-8/U foam coax would be (a) 16.1 in., (b) 10.6 in. and (c) 5.37 in. Half waves are twice quarter waves.

The Coax Handbook also gives the dimensions for full, half and quarter wave sections for all amateur bands from 80m through 1296 MHz for antennas and coax with Polystyrene, Teflon, Amphenol Polyfoam and Beldem Foam.

The diagram in the article can be deciphered by substituting the numbers under "antenna" in the above chart for (a) and the other RG-8/U numbers for the (b)s. (c) = 2(b).

Some of the PURPOSES of the Institute of Amateur Radio

1. PR for amateur radio to improve the public image of the hobby.
2. PR for amateur radio with members of Congress.
3. Encourage newcomers to get their amateur radio licenses.
4. Encourage amateurs to upgrade their licenses.
5. Provide study guides to assist amateurs in upgrading their licenses.
6. Encourage clubs to be started and to grow.
7. Encourage amateurs to build and experiment.
8. Encourage amateurs to try new facets of their hobby.
9. Work with any willing organizations toward a stronger hobby.
10. Encourage planning for the future expansion of amateur radio.
11. Encourage international planning for ITU conferences.
12. Encourage satellite amateur radio communications.
13. Encourage amateurs to take an active interest in regulation changes.

YOU *CAN* HELP! Will you?

The newspages of 73 will carry Institute news to all active and interested amateurs. If you have information on any of the following it will be

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SOCIAL EVENTS

GATHERINGS

Fun for all is guaranteed at the Navy-Marine Corps MARS Picnic, Swapmeet, Auction and Hamfest. Everyone is invited to this gala festival of exhibits, displays, and fun. Hourly prize drawings, ladies' prizes, and auction (2 P.M.) are only some of the features of this get-together. April 16 is the date, 10 A.M. is the time, and it's at Adobe de Polomares, Pomona CA.

The Ninth Annual International Hamfest will be held at the International Peace Garden between Dunseith, ND, and Boissevain, Manitoba. The dates are July 8 and 9. Hams from California, Washington, Minnesota, North Dakota, Saskatchewan, and Manitoba have attended in the past for the gathering. How many more places will be represented there this year? Contact Mel McKnight WAØSJF for more details.

In Mansfield, Ohio, the Intercity Radio Club will hold its annual Ham Auction at the U.S. Naval Reserve Training Center on Friday Feb. 4 at 6 P.M. Address of the Center is 170 Ashland Road in Mansfield. Donation of one dollar at the door.

On February 20, the Toledo Mobile Radio Association will hold its 17th annual auction at the Lucas County Recreation Center, Maumee, Ohio. There will be exhibits by manufacturers and door prizes to add to the festivities.

The Playground ARC, Fort Walton Beach, Florida, will host the second annual Florida Boondocks Swapfest on March 19 from 8:00 a.m.–5:00 p.m. at the Community Center on Highway 98. Talk-in stations will be on 94 direct, 34–76, and 3957 kHz. Tickets available from PARC, P.O. Box 873, Fort Walton Beach FL 32548.

Watch for Special Events Station WY3MCA between January 23–30. This is the Severna Park YMCA ARC commemorating National Y Week. Phone and CW operation is planned on all bands, and a Novice station will be on the air also. Each contact will receive a special QSL.

The Texas VHF-FM Society will hold its winter meeting in Corpus Christi on February 26–27. Saturday's program begins with registration and in the afternoon progress reports from the different repeater groups of the state will be given. The evening offers a technical session that continues until all questions are answered. Sunday will be a variety of business meetings and speakers about aspects

MICHIGAN

Blossomland Amateur Radio Association presents its annual ham auction, Sunday, March 12, at the Shadowland Ballroom, St. Joseph, Michigan. Doors open 7:00 A.M. Admission $2. Auctioning free. Display tables available with one-half acre under roof. For additional information write: BARA, P.O. Box 175, St. Joseph MI 49085.

CONTEST

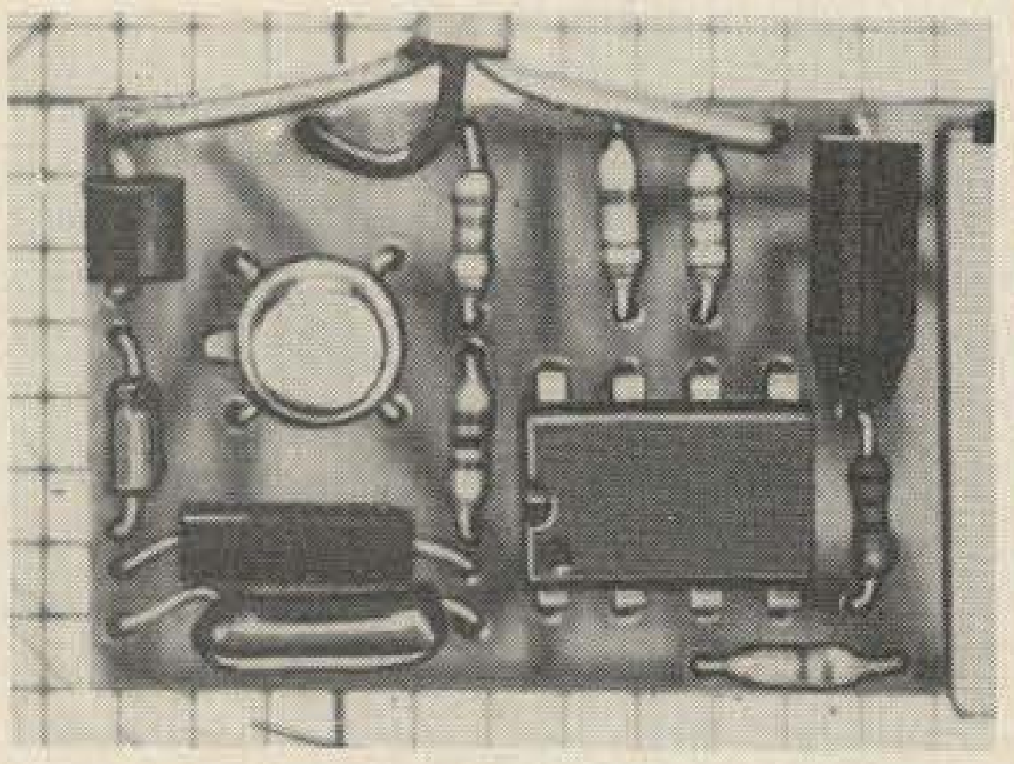
The Itchycoo Park VHF ARS announces the second annual World-Wide VHF Activity from 1900Z March 11 until 0300Z March 13. The purpose of the Activity is to promote VHF and to provide a testing ground for new systems during an otherwise low-activity period. To make a contact, exchange call and state. Foreign stations exchange province or country and call. Any amateur band above 40 MHz is acceptable. To score, multiply contacts times states, provinces, and countries worked. A station may be worked once per band. Recognition certificates will be awarded every ham station that meets either of two requirements: fifty contacts below two meters, or twenty-five on two and ten on any higher band or bands. Special endorsements will be given for the top scorer in each call area or country.

Logs should show date, time, freq, state, and call. All modes are acceptable. Logs must be postmarked by April 15, and send them to WA3NUL, Itchycoo Park VHF ARS, Box 1062, Hagerstown MD 21740.

NEW PRODUCTS *(cont. from p. 5)*

The Frequency Modulator works with any of the Communicators. Built-in tone burst is available for use with repeaters. A carrier frequency adjustment allows the frequency to be set exactly. Other modulation, such as FSK, can be applied to the frequency modulator. The unit is priced at $34.50. Built-in tone burst is $10. Communicator model and tone burst frequency must be specified with order. For more information write to *Palomar Engineers, Box 455, Escondido CA 92025.*

TONE BURST ENCODER



Tone burst activated repeaters no longer pose an entry problem to walkie-talkie owners who have the Ross and White model TE-P tone burst encoder. This is a single tone encoder that is field adjustable from 1700 to 2500 Hz. Since most hand-held units are ultra-compact, R & W will handle the installation for a fee, setting the freq to your request. Drop a line to *Ross and White at 50 W. Dundee Rd., Wheeling IL 60090* and tell them what you have so they can quote you a price for the unit and installation.

NOVICE

As Wayne wrote in the December issue, it is kind of rough as a Novice to explain ham radio with a demonstration. Frequently it is a matter of impressing your parents' friends with those electronic gadgets in the basement. Those bleeps and boops are not too intelligible to the average member of the bridge club. Their impression of ham radio depends on you and how you show off what you can do. Here's the way I used to do it, and it has proven to be successful for others.

Tell the listener what has been done, what is being done, and a hint of things yet to be in amateur radio. A little history of amateur radio, with the early wireless experimenters is a good point at which to begin. Only one or two names are necessary, and no mention of spark gap. The fewer technical terms you use, the fewer you will have to explain. Also, you don't look as though you are showing off. Explain a bit about some developments in electronics in which hams have been in the vanguard, such as transistors, computers, television, satellite and moon-bounce. You can touch on the public service aspect of the hobby but do not make it sound as though you personally handle life-or-death traffic every day. In almost ten years of operating, the most urgent message I handled was a mother wanting her son to call home immediately. If you are asked what traffic you have handled, explain what type, if any, or what type you are prepared to handle. Remember that

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there are Novice and slow speed nets that you can participate in.

All of this should take about three to five minutes. After you have begun, you can turn on the rig and slowly and absent-mindedly tune around the forty or twenty meter bands, two of the more active frequencies. Next you can explain a little about the licensing requirements and that you are at the beginning step and will soon have a higher class ticket that will permit you to operate without restrictions such as you have now. Now mention a few of them. Show your guests a crystal, how you keep a log, and tune in a few stations for about ten to fifteen seconds each, but move slowly enough so that if one of your guests hears something interesting, you don't lose it. If your visitors are ladies, tune to the high end of twenty to get some of the YLs that often are there. You can explain that there are a lot of women involved in radio and that they are among the more proficient operators. Let them hear Morse code also and listen to a station that is going at about your speed and translate a bit of it. Remember they don't know the code and will hold you in regard as a skilled op even if the station you copy is going at about four words per minute. Compare your speed with a fast CW man and explain that you are not that proficient yet. They will asssume you have false modesty and are really that good anyhow. You have now taken up about eight or ten minutes, which is about all they wanted in the first place. Answer any questions that come up, including the request to call someone.

Do not give the excuse that your antenna is down or that no one is on. Tune up your transmitter (into a dummy load, of course) and explain that you are tuning up. "What's tuning up?" someone will ask. Tell them that it is like getting the air and fuel mixtures right when tuning up a car, or getting everything set so that the final tube will like the electrical qualities of the antenna. Finally, the moment everyone has been waiting for . . . a real live broadcast from a radio ham. Tell them you will call CQ or answer one if you hear a loud one. Tell them also what CQ means. Inform the awe-struck voyeurs that you probably will not make contact due to the odds against it happening just when you would like most to demonstrate (Murphy's Law). This way they are only a little disappointed if you are right, and really ecstatic if you get someone. Look calm if you do get someone.

While the other guy is giving you a call, explain what you will say, but keep it short, like perhaps RST, QTH, and that you are showing off. Do pretty much the same if you can operate phone, and on your next transmission give the mike to someone who wants to talk. NEVER force anyone to say anything over the radio if they don't want to. Translate what the other ham says as he is saying it (it's better to copy in your head than on paper). Answer any questions the ham might have in your next message and tell him that you have to go back to your guests. Of course, you have told your guests that you'll say this and often they'll say, "Oh, no. Don't stop on our account. You go ahead and talk with him and we'll go back to playing bridge." If this is the response, you need not sign, but can carry on as usual.

If you didn't get a reply, they'll still excuse themselves so that you can be disappointed and embarrased in solitude; but you expected no reply anyhow. So you can call CQ again on your own time. If your guests stay on, talk some more with them and answer questions. The shack will speak for your prowess as a radio experimenter so there really was no need to prove it other than to show off a bit and to inform and impress the visitors. Your QSLs on the wall, the DXDC certificate, the map with the colored-in states all attest to your ability. A neat shack is more sophisticated than the rustic rat's nest, and it shows a professionalism that the latter lacks.

Your station is a reflection of you, the operator, and how you keep it organized reflects on you. Your presentation of what ham radio does is the impression you leave with your guests and friends. If your license prohibits you from making a remarkable demonstration, make it a good one instead.

. . .K1NUN

de W2NSD *(continued from page 7)*
of value to all amateurs if submitted for publication.

a) Events where amateur radio has helped save a life or helped someone in trouble.
b) Legal or other possible threats to amateur radio.
c) Events where amateur radio has made the national news.
d) Legislation pending of interest to radio amateurs.
e) Sources of speakers, films, etc., for radio clubs.
f) Hamfests picnics, conventions, dinners, exhibitions, etc.
g) Lists of stolen ham gear to help dealers locate missing equipment.
h) Stories of amateur radio demonstrations to government officials.
i) DXpedition stories and pictures which would be of general interest.
j) Certificates being made available.
k) Contests of general interest.
l) News of unusual feats in amateur specialties such as SSTV, RTTY, ATV, etc.
m) Satellite news in as much detail as possible.
n) User reports on new equipment, good and bad.

Rather than set up an expensive system of issuing membership certificates and pleading for money, and members, 73 is funding the operations of the Institute of Amateur Radio 100%. This includes all functions of the Institute such as the issuance of certificates which make operating a lot more fun for the newcomer to our bands, the sending of selected copies of the Amateur Radio Newspages to all members of Congress to help promote amateur radio where it really counts, in Washington, encouraging the publication of the most extensive and complete license study courses written specially for each grade of license exam, the publication of material to help clubs to be formed and grow, the publication of state-of-the-art construction articles to help amateurs have the fun and education of building their own equipment, the supporting of DXpeditions, the supporting of amateurs in legal difficulties which could have an effect on all amateurs, providing speakers and support for important amateur hamfests and conventions, and a myriad of other projects.

With YOUR help amateur radio will be bigger and stronger . . . and MORE FUN for everyone! Please go that little bit extra and help.

Inexpensive FM Crystals

The Ed Juge ads tell us that Ed is carrying crystals for the popular FM channels in the 6 MHz and 12 MHz ranges for transmit, which should work with the Regency, Simpson, Drake, Telecomm, Tempo, Gladding and Sonar. The receiver 45 MHz crystals should work in all the popular ham rigs except the Gladding, Standard, and IC20/21 units. The remarkable part is his price of $3.95 each! This is cheaper than even I can buy them from the crystal manufacturers, and I've bought over $500 worth so far to help me test out the many units which I've reported on in 73.

. . .W2NSD/1

GOOD GRIEF, WE MADE A BOOBOO (ERRATUM)

On p. 43 of the December issue, there is an error in the diagram of the power supplies for the Morse Memory. The middle bridge rectifier of the three should have the diodes all reversed, and the NPN transistor should be a PNP. This will give the –9V dc indicated.

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LETTERS

I insist that you print ev

About a month ago I decided to get on 40 SSB and try to carry on a *conversation* with somebody. I was really determined. After trying every approach possible (almost), I determined that it was not as easy as I had expected. Band condx were good – perfect for a good conversation. After a couple hours, I gave up.

I think that, as you said, there is no simple solution. I think that the problem is even deeper than you suppose. QST has had numerous editorials and articles on this very problem for years. I would be willing to wager it will get worse before it gets better.

New York City can be the loneliest place in the world with all its people. I think if that changes, our problem on the ham bands might change; but probably not before then.

Well, the idealists that we are, we can't give up. Keep trying to crack away at our shells!

Re getting rid of phone patches – as you can get from my prior statements, I don't feel that simple solutions will do any good at all. I think that stateside phone patches are a good way to "impress relatives." Often, I run a phone patch for just the sake of showing a non-ham friend how the radio works. In that way, these are meaningful contacts. Nets are okay if they serve a purpose (such as WCAR). Nets, formed just to talk, sometimes produce more meaningful conversation than single QSOs.

Gregory Ginn WB6ZNM
Hemosa Beach CA

Sorry about the late renewal but if I get one of those books I think it was a good idea to wait. You are not the only people with money problems. Maybe you should have a student rate.

Your magazine is pretty good except sometimes you should have articles explaining things that some of us don't know too much about. Like the propagation chart in the back.

Another thing is some people think that 2m FM is getting a lot like CB. I tend to think along those same lines, since you never see construction projects (except for antennas) for it. There also seems to be a lack of interesting things happening in it. In HF just working distant places seems to be enough, or ragchewing with another state, but on 2m it seems to be just a telephone service. OK for people who want it but I like doing something spectacular with my license like building something or talking with some distant person with a rig I had something to do with. Plugging it into the wall and working someone just doesn't thrill me. If you could do something about that I would be very interested and I am sure others would too. There are also higher bands like 220 and 432 that shouldn't be left out.

Ken Dragoon
Portland OR.

In regard to the article in your December issue on a "Morse Memory;" I think I can suggest an improved method of programming the device; if the user has a keyer that functions by counting down from a clock, he could add the output with the clock base to provide the desired input code. This would facilitate rapid reprogramming of the memory and greatly extend its usefulness.

John McHarry WA9FCH
Wappingers Falls NY

Could not resist writing a short note after seeing you listed as NH LocSec in the July/August Mensa Bulletin. I've been a member of Mensa (and, while it existed, of MM) for several years. Often wondered how many hams were members of Mensa, but didn't even know one more before. Can you shed any light on the subject?

I've not been too active in local groups – move around too much (am now a Major in the Army), and often end up where local groups aren't. Have written for 73 (May 69), as well as the competition. Must confess that, after some bad experience with CQ (Sept. 68) I have decided I much prefer your editorial policy. Unfortunately, a year in Viet Nam, and my current efforts to get an MS in Computer Science, have interrupted my writing for a while. The ideas are piling up, though, and next year may be a different story.

Possibly a short explanation and query in 73 might unearth a few more HaMs (or produce a few more).

Dale E. Coy W5LHG
Rolla MO

Amateurs interested in joining Mensa, an international club of people in the top 2% IQ, should write to Mensa, 1701 W 3rd St., Brooklyn NY 11223 for details. There are quite a few hams in Mensa, by the way. I dunno why.

I recently visited India on a business trip and had the good fortune of being able to meet some of the ham fraternity in Madras, India.

Back row, left to right: Rao, Venkata, Gokula; Front: Chauman VU2MZ, Bernie W9HTF, Savoor VU2RS and George VU2GF.

The Madras Amateur Radio Society held a special breakfast meeting for me where I got to meet and talk with them. They appear to be in favor of most of your stated ideas concerning amateur radio and feel that 73 is the most useful ham magazine for their purposes. They are a fine group of hams and SWL's. The 20m band is open to the U.S. from 1030 to 1230 GMT, and they are on 14.1–14.2 MHz and welcome DX break-ins. If the band is opened to U.S. hams below 14.2 they will move lower in frequency. Most operation is AM and CW but Savoor, VU2RS has just acquired a Yaesu and is on SSB. Chauhan VU2MV recently obtained a model 19 Teletype unit surplused by the Indian Army and hopes to be on RTTY soon.

By the way, they can obtain a reciprocal license for U.S. hams in 2 days.

Bernard Ostrofsky W9HTF
Gary IN

Articles on TTL logic, like the one by Darrell Thorpe in the December issue, are needed.

Please print some more of these. You might start with one on how to make an input circuit for a counter that uses TTL.

Present prices on these IC's must make them about the hottest item around.

Eugene H. Beebe W6SSB
Long Beach CA

DEPT. OF AMPLIFICATION

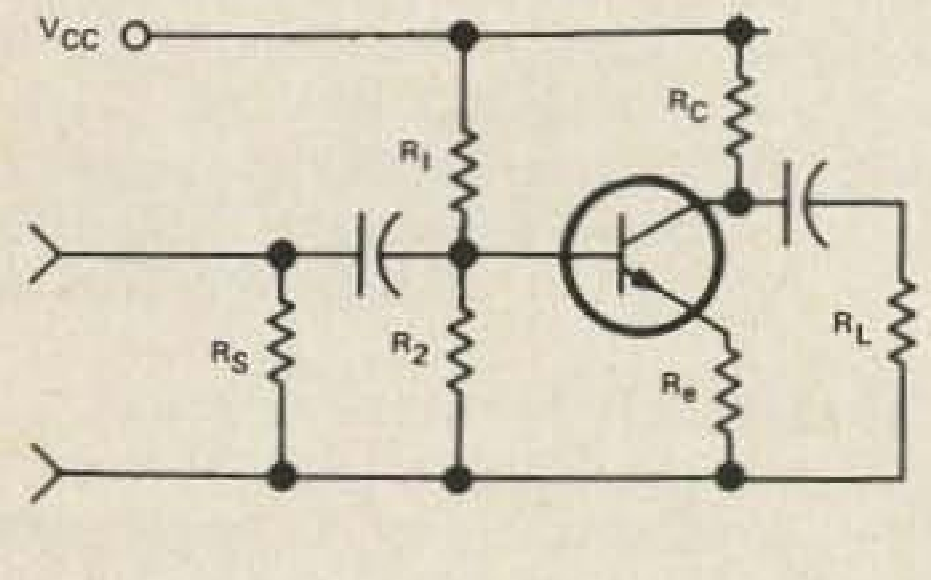
Carl C. Drumeller recommends in his article "Biasing the Transistor Audio Amplifier" in the November '71 issue of 73 that the "cookbook" method of amplifier design be dropped in favor of what is essentially an intelligent cut and try design procedure. In this letter I will expand some of the author's comments on common emitter, CE, amplifiers and suggest a design procedure that is a little more scientific than "cut and try."

The author correctly states that "Active devices, whether vacuum tubes or transistors, vary in characteristics from one sample to another," but for transistors used in low level audio amplifiers usually the only important parameter that varies widely is beta, or the forward current transfer ratio. Alpha, or the common base current gain can usually be assumed to be 1.0, and the forward biased base to emitter voltage for a silicon transistor is generally about 0.7 volts. The key to good design is to design circuits that have low sensitivity to beta, then virtually any transistor of the correct polarity and adequate voltage ratings will work.

Thermal runaway should not be a problem in low level CE amplifiers. For thermal runaway to occur in a circuit, an increase in collector current must result in an increase in power dissipated within the transistor. If the transistor in the CE amplifier is biased such that V_{ce} is less than ½ V_{cc} the reverse is true and thermal runaway can't occur.

I disagree with the philosophy of tailoring the bias network to an individual transistor for three reasons. First, even though replacement may be seldom, it is quite a bother to redesign each time. Second, the breadboard circuit usually winds up in a box of some kind where things may get a bit warmer than out on the bench. That carefully tweaked circuit may be a bit off as the temperature goes up. And finally, the gain that results from a cut and try procedure will vary widely. In a feedback circuit this could be disastrous, turning an amplifier into an oscillator. Knowing what gain you will wind up with is usually better than extracting that last dB of gain. After all, transistors are cheap now. If you need the gain, add an extra stage.

A reasonably easy design procedure that gives good results will be described by example. Part designations refer to the sketch below.



Problem: design an amplifier that will put out 10V peak to peak into a 10 kΩ load. A gain of 5 and an input impedance of 75Ω are required.

Procedure: first pick the supply voltage. Since the output signal is 10V, the supply voltage must be greater than this. Arbitrarily pick 15V.

Second step. In order to adequately drive the load, R_c must be smaller than R_L. Think of the output circuit as a voltage divider made up of R_c and R_L. (Normally the drop across the coupling capacitor will be small) The voltage being divided is V_{cc}. A collector resistor, R_c, of about 1/8th the size of the load resistance will do nicely here. Choose 1.2 KΩ for this example. Needed in the next step is the total collector load, 1.2 KΩ in parallel with 10 KΩ or 1.07 KΩ.

Third, calculate R_e. With a large unbypassed R_e stage gain is very nearly R_{cl}/R_e where R_{cl} is the total resistance the collector sees. This follows from 1, the collector and emitter currents are nearly equal, and 2, the emitter voltage swing nearly equals the base voltage swing. Therefore in the example for a gain of 5 R_e should be 1.07 KΩ/5=214Ω. Use a 220Ω resistor.

Fourth, for maximum output voltage swing, the quiescent (no signal) collector voltage should be about $\frac{1}{2}(V_{cc}-V_e)$ where V_e is the maximum emitter to ground voltage. There is usually no need to calculate the optimum, as a good guess is close enough. In this example pick the quiescent collector voltage to be 8V leaving 7V across R_c. Quiescent collector current is, therefore, 7V/1.2 KΩ = 5.83 mA.

Fifth step. Since the emitter current is about the same as the collector current, the emitter voltage will be about 5.83 mA X 220Ω=1.28V. Adding to this figure the usual 0.7V base to emitter voltage we find that the base must be biased 1.98V above ground.

Sixth step. The input resistance at the base is about beta times R_e for this configuration. In the example a beta of 50 is reasonable, so the input resistance of the circuit will be about 50 X 220Ω or 11 KΩ, but varying widely from transistor to transistor. To swamp out this variation, let the parallel resistance of the bias circuit be 1/10th of this or about 1.1 KΩ. Equations for R_1 and R_2 to simultaneously put out a desired voltage and have a desired parallel resistance are: $R_1=(R \times V_{cc})/V$ $R_2=(R \times V_{cc})/(V_{cc}-V)$

Plugging in R=1.1 KΩ, V_{cc}=15V, and V=1.98V yields R_1=8.11 KΩ and R_2=1.27 KΩ. Choose 8.2 KΩ for R_1 and 1.2 KΩ for R_2. To obtain the desired 75Ω input resistance, putting an 82Ω resistor across the input will suffice.

The size of the coupling capacitors will be determined by the desired low frequency response. Note that the calculation for the input capacitor has been made easier by substantially removing changes in the input resistance caused by variations in transistors. Calculating frequency response is an article by itself, but each coupling capacitor causes a roll-off at $F=1/2\pi RC$ Hertz where C is the capacitance in farads and R is the resistance in ohms that the capacitor sees. For example, the output capacitor above sees 10 KΩ plus 1.2 KΩ=11.2 KΩ.

Understanding the above method may appear to be difficult when compared to the cut and try method, but the rewards are greater. With a little practice you should be able to design an amplifier to specifications in less than 10 minutes.

David L. Button
Medway, MA.

REPEATER CONTEST?

A contest through repeaters? How many repeater operators would go along with it?

Repeaters are set up and maintained for extended local coverage of members using mobiles, portables and low power fixed stations. After a contest or two the big guns of contesting would be on with KWs, 64 element arrays and all the other goodies.

Probably very few repeater groups would be satisfied to sit on their hands and pay the light bill for these people to chat among themselves. After a contest or two there would probably be very few machines on the air during contests.

FM operation has grown because it is informal, friendly and you don't need acres of antennas and kilobucks in equipment to operate satisfactorily.

If we must have a contest let's make it once every five years from 00:00 to 00:15 local time with the top thousand scorers in the last contest ineligible to compete in the next.

Don Norman K8LLZ
Elyria OH

You have to be out of your tree to suggest a repeater contest!

Max W5ODF
Little Rock AR

I read your little suggestion (in the current 73) about having a repeater contest. My vote is NO! I knowthat controversy builds circulation,*(1)* and I'm all for your magazine, but please lay off this one. I know that the ARRL is all for lots of stupid contests, but I really thought more of you.*(2)* My thinking? Repeaters are for communications, not competition.*(3)* In areas having numerous repeaters with 50 to 100 watts output, the repeater owners and operators would become egotistic enough to wish to up their power (as a "public service") and help that distant signal many miles away to hear much better. While this goes on in contests, the man who has an emergency on his hands get covered in the general foul-up. Without having contests, when skip appears, the distant station works a few through several repeaters and stands by while others work distant stations. Courtesy is the rule, not something exceptional. Let me say here and now, I have never heard any contest on any band where courtesy was present except in nearly microscopic amounts, well hidden in the din. I have quit contests, but I'll listen if you have found some polite ones.*(4)*.

Don Chase WØDKU
Wichita KS

1. To the contrary, controversy cuts down on circulation. You have fallen for a big lie that one or two of the other magazines have perpetuated as an explanation for 73 telling it like *it is. Every time 73 is controversial the circulation takes a dive and ads fade away for awhile. It takes a lot of social conscience to print anything controversial when the reaction is going to be a loss of money. 2. Sorry to disappoint you, but I have always enjoyed contests. I agree that many of them are terrible and I have controversially written just this opinion on many occasions. The reason that 73 has NEVER run a contest is that I have yet to think up a contest that I would be proud to run. This does not mean to me that such a thing is impossible, only that it is difficult. Perhaps you are right and it is impossible to run a good contest. 3. Repeaters are for fun, in any way that is legal. If communications is fun, then let's use them for communications. If "communications" means I shouldn't rag chew, then we need a new definition of communications. If it means no contests then you need to look up the word. 4. I'll go along with that. What do you suggest?*

Wayne

A contest is supposed to be a test of operating skill. From your SCR-522 days in Brooklyn and even from operating the powerhouse on 73 Mountain, I am sure you remember a really good operator had to be able to hear signals, find clear spots to call CQ, hear the guy he was trying to work through several other signals, remember which way to point his beam for the rare sections, tune across the stations already worked, and so forth. How can he do these things with strictly crystal controlled operation with omnidirectional antennas? Plus which, on FM you usually hear only the loudest when there are many signals close to the same frequency.

Practically all FM channels and repeaters have been set up to provide a ready means of communication of relatively unimportant first party traffic plus their incidental usefulness for minor emergencies. A general emergency, or substantial message handling, as on the lower frequencies, would create havoc such as used to occur on the "6 meter" MARS channels when E skip would unexpectedly combine 2 or more nets. Widespread contest operation will result in the same thing with not even the repeater frequencies being safe since all the contest station need do is transmit on the repeater output frequency and listen (if he's honest) on the repeater input frequency to get around the rule against repeated signals. Imagine what it will be like when all the guys like me who prefer to leave the FM guys in their own world, are forced by competition to "go FM" to have any chance of ever again winning a contest. If I do, it will be with high power, a big rotatable beam, and crystals for every imaginable frequency.

Finally by your own definition, contesting or FMing or whatever is supposed to be fun. I do not consider it fun to brow-beat a VHF sweepstakes contact exchange out of some guy who just wants to know how to get on Interstate 95, South, nor do I think he gets much pleasure out of it. Those who want to work contest have tunable gear for CW, SSB, etc. in the first place, let them use it.

Terry Banks K3LNZ
Washington DC

Well, Terry, I agree with most of what you say. It has been my experience, though, that FM'ers do seem to enjoy giving a fast contest contact to those mountain-top stations that set up to work them. In point of fact W1DC sets up on top of Pack Monadnock for the ARRL VHF contests and, last year, made nearly as many contacts on 2m using FM as all other modes combined. I heard few gripes. Obviously it could all get badly out of hand.

Wayne

GOOF DEPT.

As an avid reader of 73, I enjoy your magazine immensely and look forward to every copy. I find it very informative in just about every mode of ham radio. However from time to time I do notice errors in some articles, and in most cases, corrections to those errors in later editions.

I would like to point out 1½ errors in your Dec. '71 edition.

Error Number ½ appears on page 19, paragraph 2, where it explains the function of a nand gate. It is stated that "when all inputs are Logic 0, the output is Logic 1." This is a half correct statement. It should read that when *any one* or all of the inputs are Logic 0, the output is Logic 1. I will therefore only credit you with ½ an error. Hi!

The other error appears in the article entitled, "Morse Memory," on page 37. In reference to Fig. 6 on page 44, it shows that the outputs (pins 10 through 13) of A11 and A12 are connected to the inputs (pins 1 through 6 and 11 and 12) of A7.

However, in Fig. 2, page 41, A7 identifies a memory device, and the gate that A11 and A12 are fed into is unidentified. This caused some confusion when trying to follow the circuit when relating to Fig. 6.

Perhaps a correction will clear this up for readers that are confused, or am I the only one? Both articles, however, even with the 1½ errors total, still rate an A+. Would like to see an article on the Hal Devices Teletype CRT Readout Device or whatever they call it. How about it?

Al Bratz WA8YNH
Dayton OH

We made those errors just to test you, Al. Can any of our readers tell us more about the HAL machine?

BOUQUETS

I ordered the 30 back issues of 73 for $6 I found advertised in the June issue of 73. I've been QRT for three years and I used them to ease me back into ham radio. They were DYNAMITE! 73 is much better than ** and I won't even mention that funny "street" magazine.

John Phillipp WB2HYI
Brooklyn NY

On page 2 of the November issue, it is asked if any readers have run across the number 73 anywhere interesting.

I am a radio operator in the Canadian Armed Forces serving in the Submarine Service. Halifax is the home-port of the three submarines serving on the Canadian East Coast. One of them, the "Onondaga," bears the number "73" on its hull. I am sending a picture of it taken when the submarine was on the synchrolift.

The other two submarines are the "Okanagan" (74) and the "Ojibwa" (72). Since I volunteered for submarine service I served on all three of them. The Okanagan is the only one with an amateur station license at the present. The call is VEØNS and is being operated by Bob Forbes VE1AAU and Jim Guilford VE1ANO. I am now serving on the Ojibwa and she might be getting a station license in the near future, so I'm looking forward to operating VEØ .

When the submarine goes deep during a QSO, I have to QRT and close down. There isn't much I can do down there except to sit back and read a few back issues of 73. So, if you stand by, I will QRX when the submarine goes back up to the surface.

Do you believe in love at first sight? I didn't until I looked at the front cover of the November issue. I got a few centerfolds of Playboy hanging on the radio shack walls but I think I will replace them with the January, March, April and November front covers of 73. Keep making the same type of covers and I might become a life subscriber to your excellent magazine.

Donald J. Courcy VE1AKM
Halifax NS Canada

Much thanks for the new format. No more swinging mag to read. Now try a little larger print on the newspages even if you sacrifice some of the "Slum Gullion."

Lee J. Delworth WB6RDW
Anaheim CA.

Do not exactly know if you want a letter from a simple SWL or not – but I do so much enjoy the letters in your magazine that I want to say a word or so.

Now, my good friend WB6DGJ – (darn Good Jim) Myers has urged me and done his best to get me to get a license – learn the code and so forth, that I am ashamed of myself for not doing that. Jim is too good a friend to tell me that I'm just too lazy, but it's a fact.

Let's go way back to 1920 – that is when I first got interested in electronics, or wireless as it was in those days. I was born with a strong desire to become an electrician, and of course the urge, augmented by a magazine

:alled the 'Electrical Experimenter' ıelped to push me along. In those lays, a WD11 was quite the thing, also he UN199. My friends were anxious o have a wireless set to listen to KDKA in Pittsburg, and the other tations who came along, slowly, SO, I ›uilt sets for them, and today, a riend of mine in Grandview, Washing-on has put one of my old sets in a nuseum there – haven't seen it yet, ›ut I'm sure it is authentic, with the ›ld horn speaker and the breadboard :hassis with a hunk of Bakelite for a ›anel!!

Today – Pity is: I have an SB31 0 hat I built myself (bless Heathkit!). It gives me much pleasure – the hams ›ut in the Pacific in the Micronesian ıet make me drool each night after I get home from managing the biggest heatre in Northern California. The hortwave stations from all over the vorld come booming in, and I try to ell myself that I am happy, yet knowing that if I ONLY had the guts o sit still long enuf to learn the code, 'd be one of them.

Your magazine is the best of the ›unch – which of course you know. Old 'Never Say Die' is a good editor! I ›nly wish I could contribute an article vorth reading.

Art Warner
P.O. Box 2511
McKinleyville CA 95521

Will someone PLEASE help Art to get his ticket!

Congratulations on the publication ›f the 135th issue of 73 Magazine! Along with Ralph Nader and Wally Hickel, we have you providing reading naterial for hams with an IQ above 100. Fortunate for us . . .

Your editorial covers "meaningful" :ontacts quite well; that is a major ›roblem and perhaps one reason why o many of us have long periods of nactivity, or, limit our contacts to a ew friends around the country/world ›rimarily.

As to phone patches, I think that is ›ne area where the hobby fulfills the ›ublic interest area of licensing ama-eurs or other radio services. Es-›ecially, the patches for overseas mili-ary personnel.

There certainly does seem to be a 'Vast Wasteland" out there . . . Best vishes to you and yours for a happy ıoliday season and a successful 1972.

Harlan D. Marcus W5MDT
Dallas TX

Have had tremendous response rom advertisers I requested info rom. Your consolidated request form or advertisers is a real winner!

John Andrews WB5ETV
APO, NY

I'm currently in the Marine Corps, ınfortunately being hospitalized in he U.S. Naval Hospital Camp Le-Jeune NC. I just got back from the Far East and am a little behind in my eading. However I just completed your Oct. '71 issue and must say that your article written by John Campbell W2ZGY "How to be an Amateur," is one of the most inspiring and moti-vating articles yet. Bravo – it was well written. I enjoy 73 Magazine much more than its competitors which I also subscribe to. Each is good, but your variety of topics and contemporary technical articles have made your mag-azine worth more than the price on the front cover. I even look forward to the front cover for its art. The entire October issue is marvelous, the articles by Jim Ashe W1EZT, Bob Cooper W5KNT, H.P. Fischer VE3GSP, W. W. Davey W7CJB and others in the October issue and hun-dreds of amateurs like them in each of your issues has greatly added to the success of your (OUR) magazine. I'm finding myself addicted to 73 and I greatly enjoy the high! Congratula-tions on a job well done.

Thomas E. Mills WB4UBA
Jacksonville NC

Caveat Emptor?

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21st ANNUAL DAYTON HAMVENTION will be held on April 22, 1972 at Wampler's Dayton Hara Arena. Technical sessions, Exhibits, Hidden transmitter hunt, Flea market and special program for the XYL. For information write Dayton Hamvention, Dept. 7, Box 44, Dayton, OH 45401.

ELEPHANT hide Leather. Keycase $2; Billfold $7; Pocket Notecase $10. All three – only $15. Beautiful gifts. Money back if not satisfied. Write ZE7JV, P.O. Box 23, Cranborne, Rhodesia.

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2M FM, 50W, Motorola 53 GJV, two with accessories, tuned on 146 mHz, one with no xtals $100. Other with 34–94, 85–85, 94–94, 82–70, $150. W6DZO, 1021 West Cedar Ave., Redlands, CA 92373.

NU SIGMA ALPHA International Radio Fraternity. Look to Advertisers Index for space ad.

SALE OR TRADE Tektronix 531A; Gertsch FM-3 Freqmeter Panadapter IP-173A/U. Interested in SSB Transceiver. Tilleman, K5IDD 351 Furr, San Antonio, TX 78201.

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ALMOST FREE. Taped code lessons. Beginners to 5 wpm. Refundable deposit on tapes, $1.00 for postage. Tomlinson College Radio Club, 3637 West Grandview, Tacoma, Wash. 98466.

TOLEDO MOBILE RADIO ASSOCIATION's 17th annual hamfest and auction will be held Feb. 20, 1972 at the Lucas County Recreation Center, Maumee, Ohio. $1.00 registration, open table sales. For map and info write TMRA W8HHF, Box 273, Toledo OH 43601.

STANDARD 816M like new condition with original box and manual, TX crystals 146.82-22-25-34-94-76. RX crystals 146.22-88-82-76-94. Cost new 6 months ago $370.00, first $240.00 takes it. Bill Thorpe WA1NLR, P.O. Box 306, Southboro, Mass. 01772.

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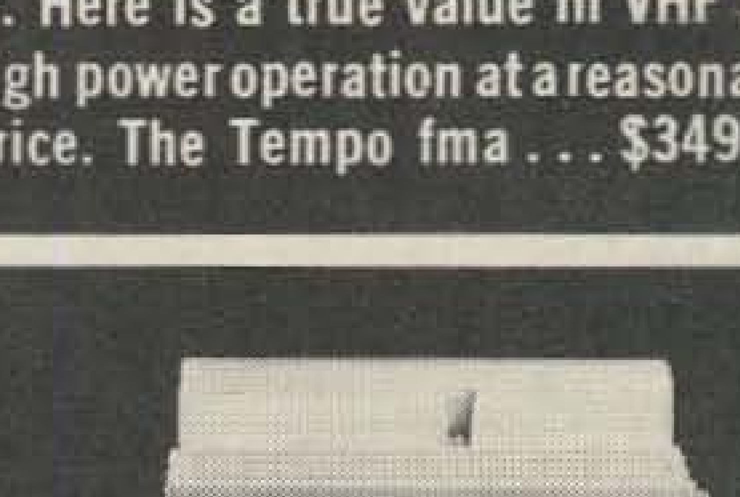

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TUNING Mr. MORSE'S KEY

Since every license holder has at some time done a stint of key walloping, it might be assumed that we are all completely familiar with the beast. In fact, a recent study of some of the most comprehensive books dedicated to our hobby revealed almost nothing concerning the care and feeding of the key.

However, an evening spent listening on the CW bands will prove that the 'glass arm' is still with us, indicating that the selection, adjustment and operation of the familiar key may have well become neglected among all the other technological advances. If you are a regular habitant of the CW bands, or perhaps a member of a high speed traffic net – read no further. But if you are a Novice, or an oldtimer getting reestablished on the key, some of the following may be helpful

The humble telegrapher's key has gone through an evolution emerging in many forms some of which have already become obsolete. Today the three basic types found in ham shacks are the straight or "manual" key; the "bug" or semiautomatic key; and the electronic key.

Straight Keys

The popular American key is most generally used by hams for manual operation, and permits the greatest ease of operation. The pump-handle key, beloved by European and some oldtime Navy operators has all but disappeared. The former is characterized by wrist operation, while the latter, mounted at table edge, was arm operated. So if you have one of these relics from some surplus buy, keep it as a conversation piece or donate it to the Smithsonian.

If you are in the market for buying a straight key, invest wisely and buy the best available. Many of the inexpensive varieties, available for a buck or two, may be fine for Boy Scouts to earn their badge, but will not guarantee lasting satisfaction.

The essential requirements of a good key are first quality material and construction, including friction-free pivot bearings, low resistance corrosion proof contacts, smoothly adjustable return springs, and well designed balance. There are a number of manufacturers that have been producing such keys for generations, and their products are well worth the cost (upwards of $10).

If you have on hand a good key, it is worth a little time to make sure it is correctly adjusted. Even if the key is brand new, contact spacing and spring tension will have to be set to suit your fist. Disassemble the whole thing, being careful to note how the bits and pieces have to be reassembled, and give everything a good cleaning. Use metal polish to brighten up the base and arm. If yours has a black crackle paint base, an old toothbrush and a little detergent in warm water will get rid of the dusty appearance. Examine the pivot points on the arm to make sure they are smooth and undamaged and that previous overtightening hasn't deformed the points or the cups in the bearing screws. See Fig. 1. A jeweler glass or one of those hand microscopes for inspecting phono pickup styli is handy for this examination. Check the contacts, and if they appear dark and oxidized, a few *light* strokes with a burnishing tool (Walsco type W529 or equivalent) will put them in shape. Do *not* use a file, even of the spark plug cleaning variety.

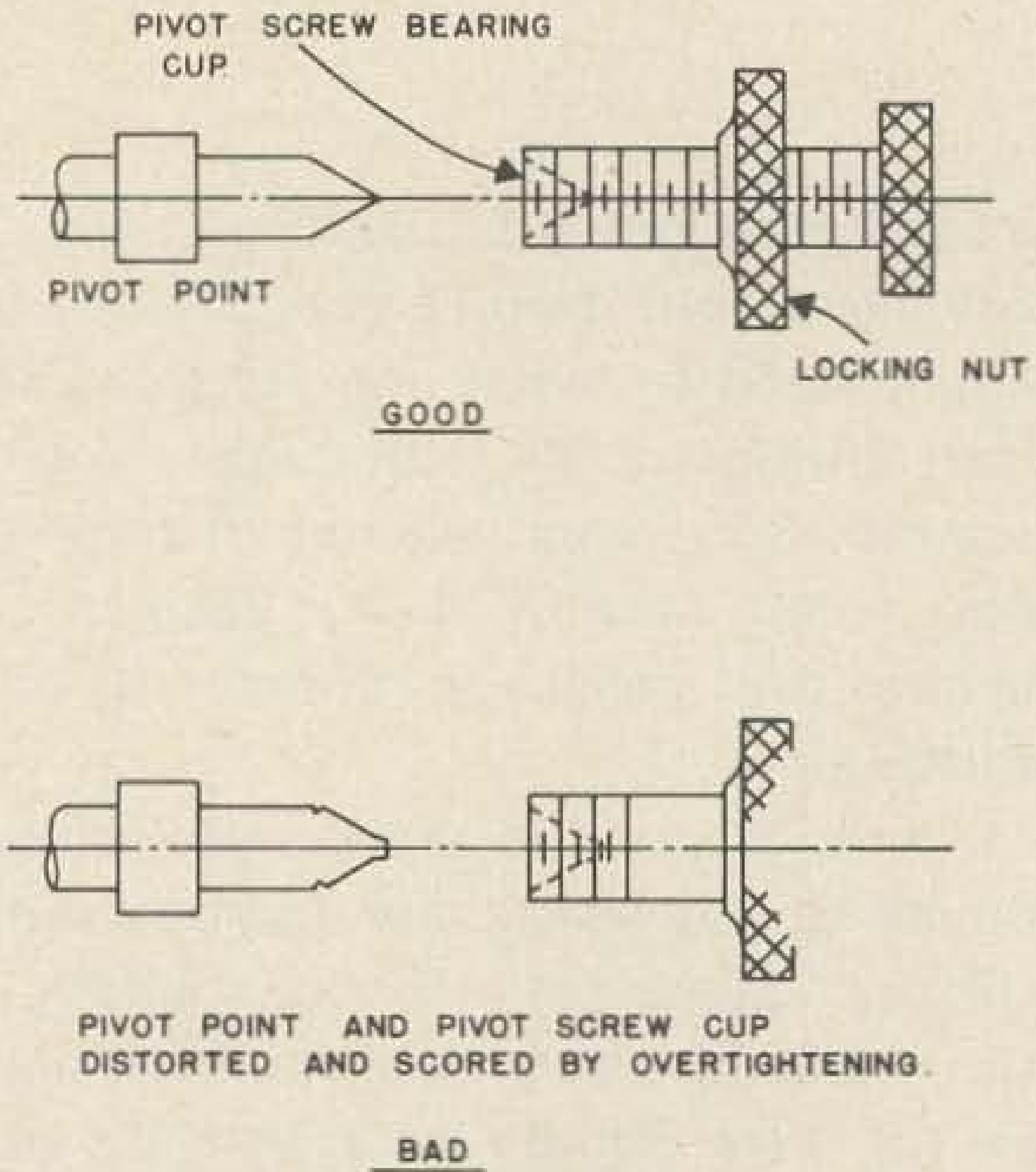
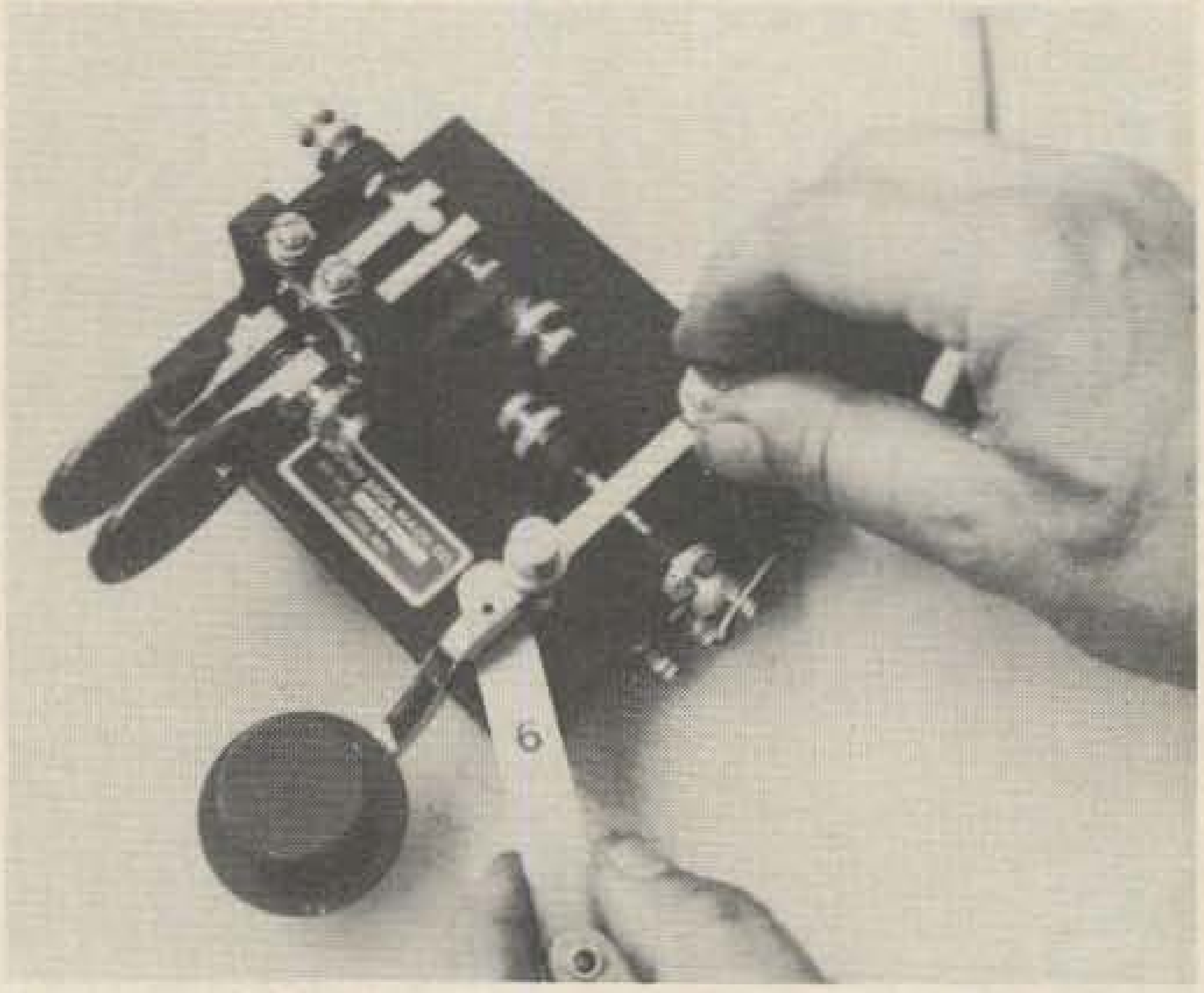


Fig. 1. Key adjustment.

Reassemble the arm, pivot screws and spring loosely, adjusting each of the pivot screws until the contacts are centered. *Very gently* turn both pivot screws clockwise, until you feel the pivot points just bottom in the cups. Do not tighten further or the points may be damaged. Tighten the locking nut on one pivot screw, while holding the screw stationary. Back off the other pivot screw about 1/10th of a turn and similarly tighten its locking nut.

Now adjust the rear stop screw for proper contact spacing. What is proper is largely dependent upon your fist and speed of operation. Slower speed, larger spacing, and vice versa. About 0.005 in. has been found appropriate for moderate to higher speeds, but if you are a slow sender you may find as much as 1/16 in. desirable. Using a feeler gage to measure the contact spacing best suited to you is a good idea. You can then always quickly reset the spacing after some future disassembly. Just remember that too wide spacing will limit speed, while too close spacing may affect the intervals between characters.


Adjusting manual key contact spacing with feeler gauge.

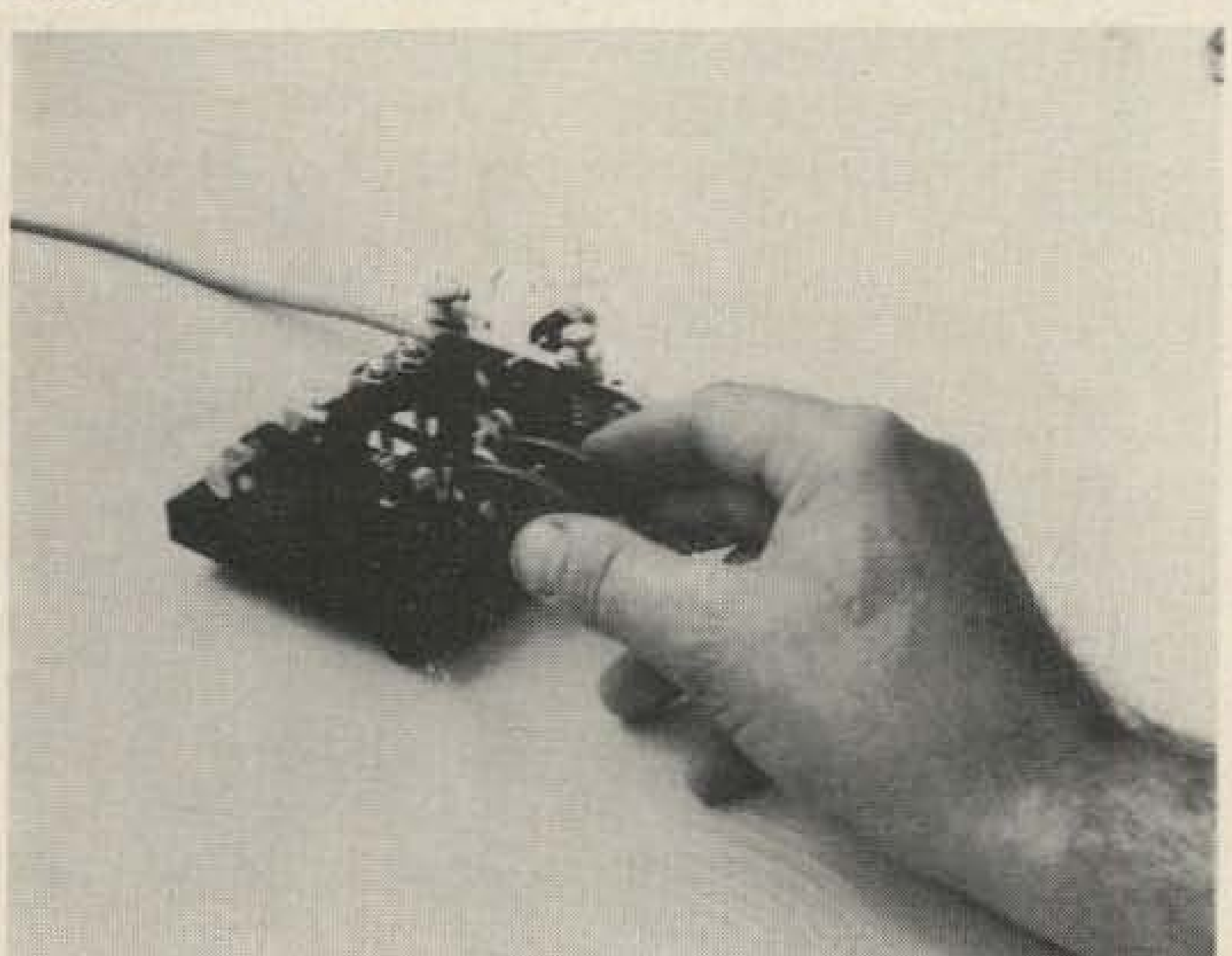
Finally adjust the spring tension to your liking. A good method is to send a series of dits at a comfortable speed, while slowly advancing the tension screw clockwise. You will find a point where the spring tension counterbalances wrist movement, and the arm returns easily without requiring excessive depressing action. At this point the string of dits should be almost effortless. As with contact spacing, so with spring tension, and some final compromise between both may be necessary after a little operating experience. Too strong a spring tension will result in rapid overtiring of the wrist and forearm muscles, while too light tension will require lifting the wrist, and eventual stumbling over characters.

No dissertation would be complete without a few words on proper operation. First, the key must be mounted on a heavy base that won't slide around, if not actually screwed to the operating table. If yours is mounted on a base with rubber feet and it still tends to "walk" across the table, try rubbing a little beeswax on the rubber feet.

The key should be positioned on the table so that the entire forarm can lie comfortably on the operating surface. If your table is too narrow, try sitting sideways to the table to properly position the arm, which under no circumstances should have the elbow or part of the forearm hanging over the table edge.

Semiautomatic Keys

The venerable "bug" key has long been the favorite of the higher speed operator, particularly for use in excess of 18–20 wpm. It hardly seems necessary to mention that no one who cannot send 20 wpm on a straight key should attempt operating with a bug. However, there are some who apparently feel that such an endeavor will help to increase the speed they cannot accomplish on the straight key. Nothing is further from the truth. Most bugs have mechanical dit speed adjustments which are difficult to set below the equivalent of 15 wpm. The characteristic result of sending 10–12 wpm, is complete unbalance in the dit-to-dah ratio, which can be pretty unintelligible to the fellow at the receiving end.



Correct grasp for manual key.

The bug employs a vibrating spring attached to the horizontally moving arm, to produce a series of dits when the paddle is depressed to the right by the operator's thumb. Dahs are made manually be depressing the paddle to the right with the second and third finger, as with the straight key.

All the factors previously stated about selection, inspection and maintenance of a straight key apply equally to the bug. A good quality bug costs from $19 to $30 (more if you like to dress up your shack with a little gold plating).

If you are reactivating your old bug, or have obtained a second hand one, submit it to the same kind of disassembly, inspection and cleaning recommended for the straight key. Be extra careful to take note of how the pieces come apart, particularly with regard to insulating bushings, washers and springs, which can take on the aspect of a Chinese puzzle come reassembly time. Keep small parts in a plastic tray.

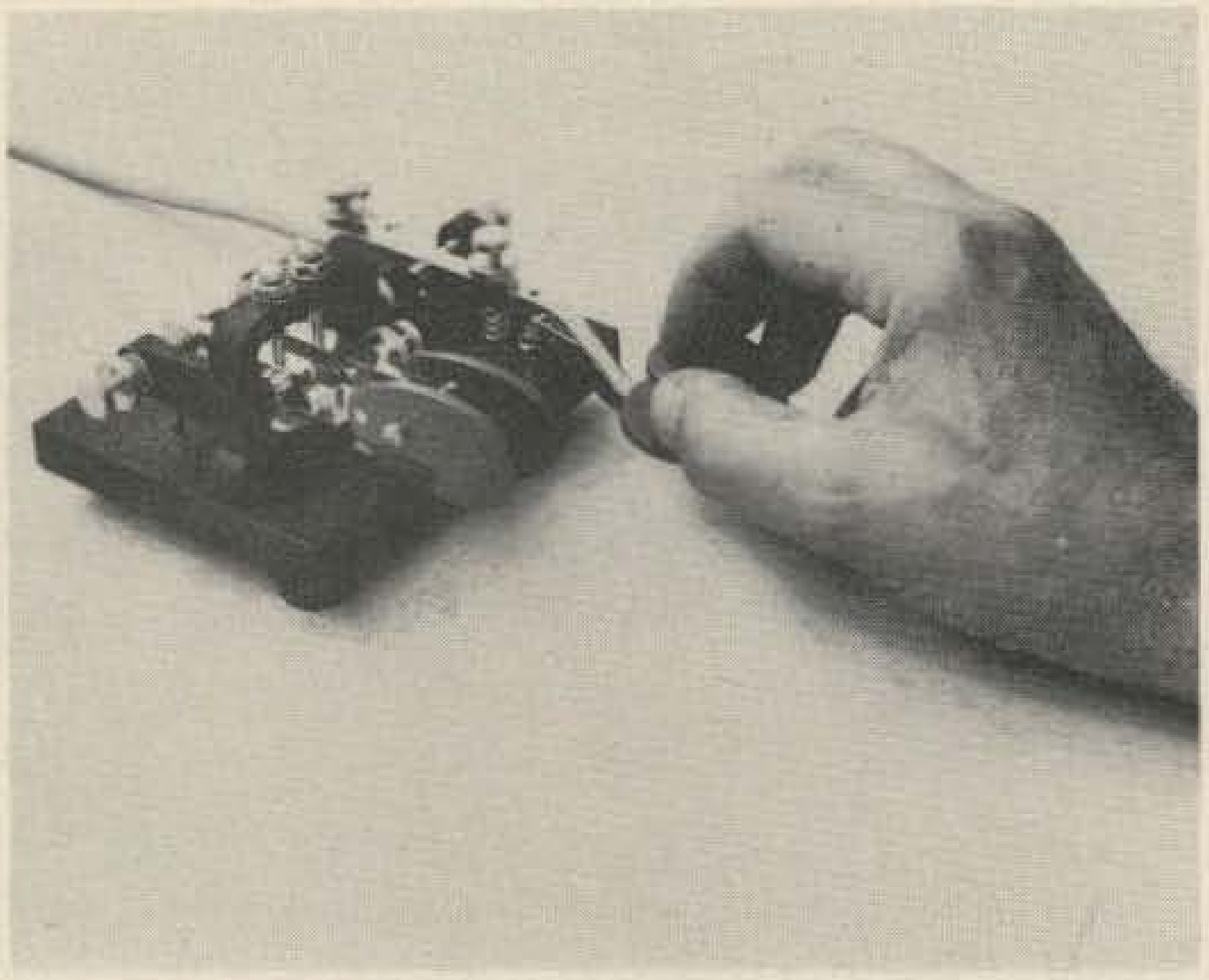
The tricky part is adjusting the paddle movement and contact spacing. Start first with the dit action, and adjust the left stop screw for the amount of dit-paddle depression you feel suitable. Just what is suitable is again individual, but bear in mind that too much will affect speed, while too little will give trouble with correct spacing. Some correction is likely to be required later.

Now adjust the right stop screw for an equal amount of travel of the dah paddle. Once you have the right-left paddle movement adjusted, tighten the lock nuts.

To adjust the dit contact spacing, first hook up a code practice oscillator or ohmmeter to the key terminals. With the dit paddle fully depressed, wait for the armspring to stop vibrating and become completely motionless. Then slowly adjust the dit contact screw until it just makes electrical connection with the spring contact, as evidenced by the oscillator or ohmmeter. Carefully tighten the locking nut without changing the screw setting.

Now try out a string of dots with the oscillator, having set the spring weights for slowest speed. The dits should sound about equal to their intervening spaces. If the dits sound clipped with overlong spaces, advance the stationary contact screw about 1/8th of a turn, and repeat this until the dit-space ratio is right. If your shack sports a scope, it can be a great help in observing the correct ratio by setting the horizontal scan rate to a slow sweep. Likewise, if the dits are overlong, and sound blurry, retract the contact screw 1/8th turn at a time until proper ratio is achieved.

Since the dah stop is usually also the dah contact on most bugs, initial adjustment has now been completed. And small



Correct grasp for electronic or bug key paddles.

adjustments of paddle travel and contact spacing, with intervening periods of operation are better than making wild changes that cause you to lose track of where you started from. Also, if you change the dit-paddle travel, it will also be necessary to reset the dit contact spacing..

Adjusting the left and right paddle return springs can be a bit tricky in models that have two such springs, but basically the same rules apply as for the straight key. Just enough tension to return the paddle snappily without requiring excess effort to depress the paddles.

After setting the bug to your liking, adjust the speed weight(s) for a dit speed equivalent to your comfortable operation. Then try sending a series of PARIS and ISH5. Just remember that a dah is equal to two dits with one intervening space (or three dits with no spaces), and only your manual skill can apply the correct ratio dahs to the mechanically produced dits.

Electronic Keys

Nothing has done more for effortless high-speed operation than the advent of the electronic key. While the same rules apply to perfecting straight key operation, advancement to the electronic key may be easier than to the mechanical bug. This is because many models can be set for as slow as 10 wpm and are less dependent upon operating skill for correct character ratio.

Early models took considerable skill, since completion of each dit and dah was dependent upon the operator holding the contact closed for the proper period, and early release would clip the character. Contemporary keyers all have self-completing features that insure that a full dit or dah is completed once the contact is closed.

Since the electronic key comprises two basic parts, the mechanical paddle and the associated electronic circuitry, the two will be considered separately. In many instances the two are packaged separately, and connected by an intervening cable, but in some recent commercial models the paddle movement is built-in to the electronic unit, such as in the Heathkit Model HD-10.

The mechanical paddle used with an electronic keyer closely resembles the bug, but lacks the dit-producing spring movement, and has instead a second pair of stationary but adjustable contacts to activate the electronic circuitry. This type of key itself breaks down into two basic types, depending upon the type of circuitry it is intended for use with. The simplest type has a single moving arm, like the bug, mounted on a pair of pivots. A more complex version has two independently pivoted arms, with individual paddles mounted close together, each being capable of simultaneous movement. The latter type of key is used with electronic keyers that automatically generate dits when the left paddle contact is closed and dahs when the right paddle contact is closed. The twin arm key can also be used with this type of circuitry, but is really intended for use with more elaborate electronic keyers that produce alternating dits and dahs when both pairs of contacts are closed by squeezing the paddles between thumb and fingers. This is known popularly as squeeze-keying, and reduces wrist movements required for sending given characters.

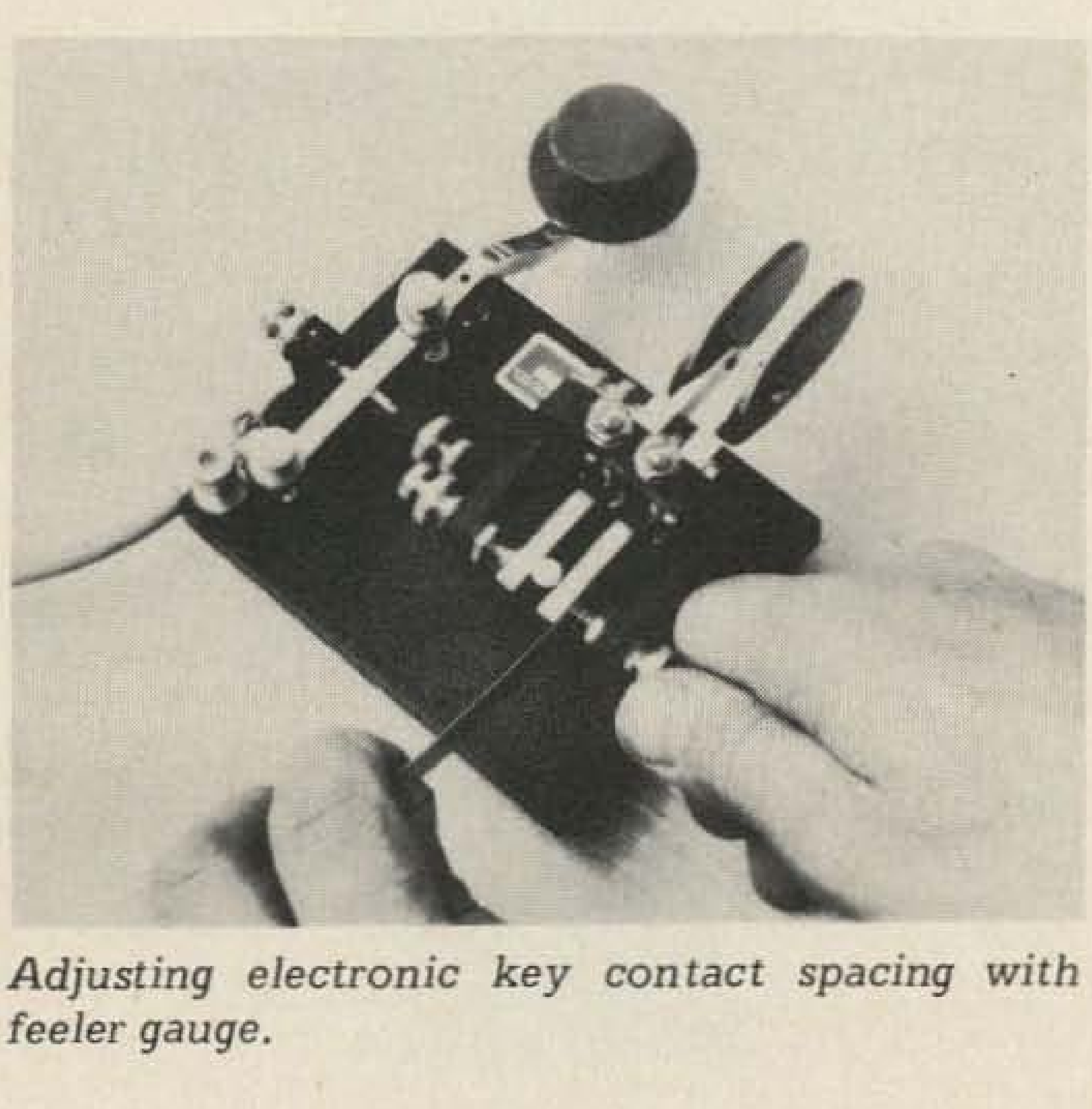
As for example: the letter C requires four independent wrist movements, one dah, one dit, one dah and one dit. With squeeze keying the right paddle is depressed for the first dah, and then held while the left paddle is depressed, so that both paddles are squeezed, producing the dit-dah-dit portion of the letter. Thus only two paddle movements are required for the letter C, instead of four with the simpler electronic key. Note also that this requires independent finger movement, rather than straight wrist action.

Apart from the independent arms of the squeeze-type key, mechanical assemblies are otherwise the same, and previous recommendations for inspection, cleaning and adjustment of pivots apply. However, one further adjustment is worth noting – that of equal contact spacing and paddle travel in both directions.

There are a number of electronic type paddle-keys available on the market, costing from $15 to $20, independent of the electronic keyer.

Now to consider the electronic keyer itself – the circuitry part which produces those flawless dits and dahs. Here the problem is somewhat more complex with the different features offered.

Early keyers provided individual controls for speed, ratio, and weighting adjustments. This may seem nice, but getting ratio and weighting just right can be tricky. Moreover, some circuits require resetting ratio and weighting whenever a major change in speed is made – obviously a disadvantage. Logic circuitry used in late units permits inclusion of a single control for speed, with ratio and weighting always being perfect whatever speed is selected. Ony excellent version of this type which you can build yourself is the Micro-TO Keyer by K3CUW (QST, August 1967 and ARRL Handbook 1968).



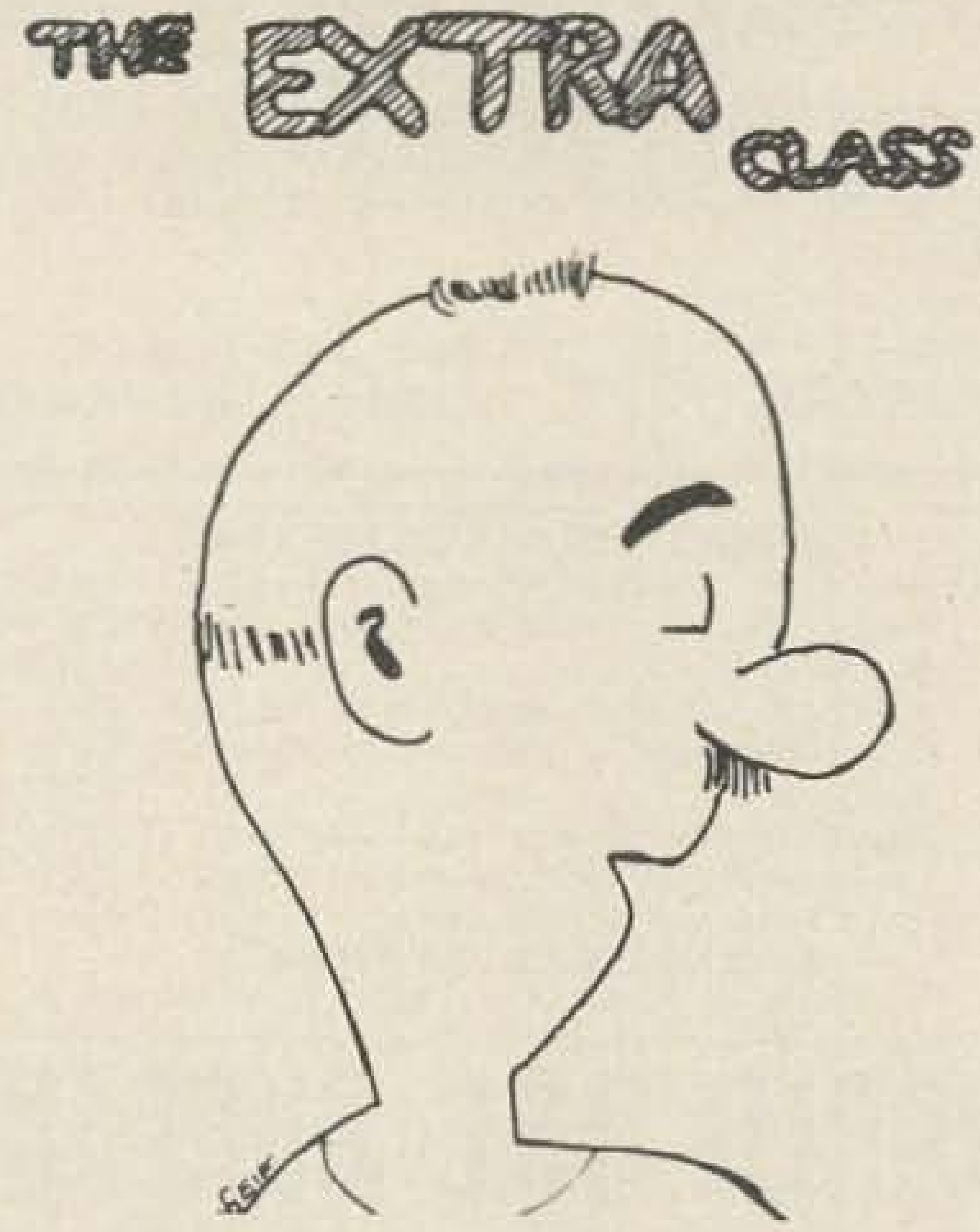
Adjusting electronic key contact spacing with feeler gauge.

Other features include optional full automatic, or semi-automatic (auto-dits, manual dahs as in the bug); built-in sidetone oscillators and speakers; and built-in paddle mechanisms. Many keyers utilize a high speed relay as the output to key the transmitter. Reed relays are commonly used to accommodate speed requirements, but their contact ratings are limited and may not be suitable for directly keying some transmitters (such as cathode keying a high power stage). Other units use a power transistor to perform the keying function, and these avoid contact sticking, and have absolutely no time delay. On the other hand correct polarity has to be observed, as does the maximum current handling capability of the transistor used. All manufacturers specify such constraints in their instructions so take care when buying to select one compatible with your transmitter. Selection of any commercial unit will depend upon the features most desired by the individual after a careful perusal of the manufacturer's specifications.

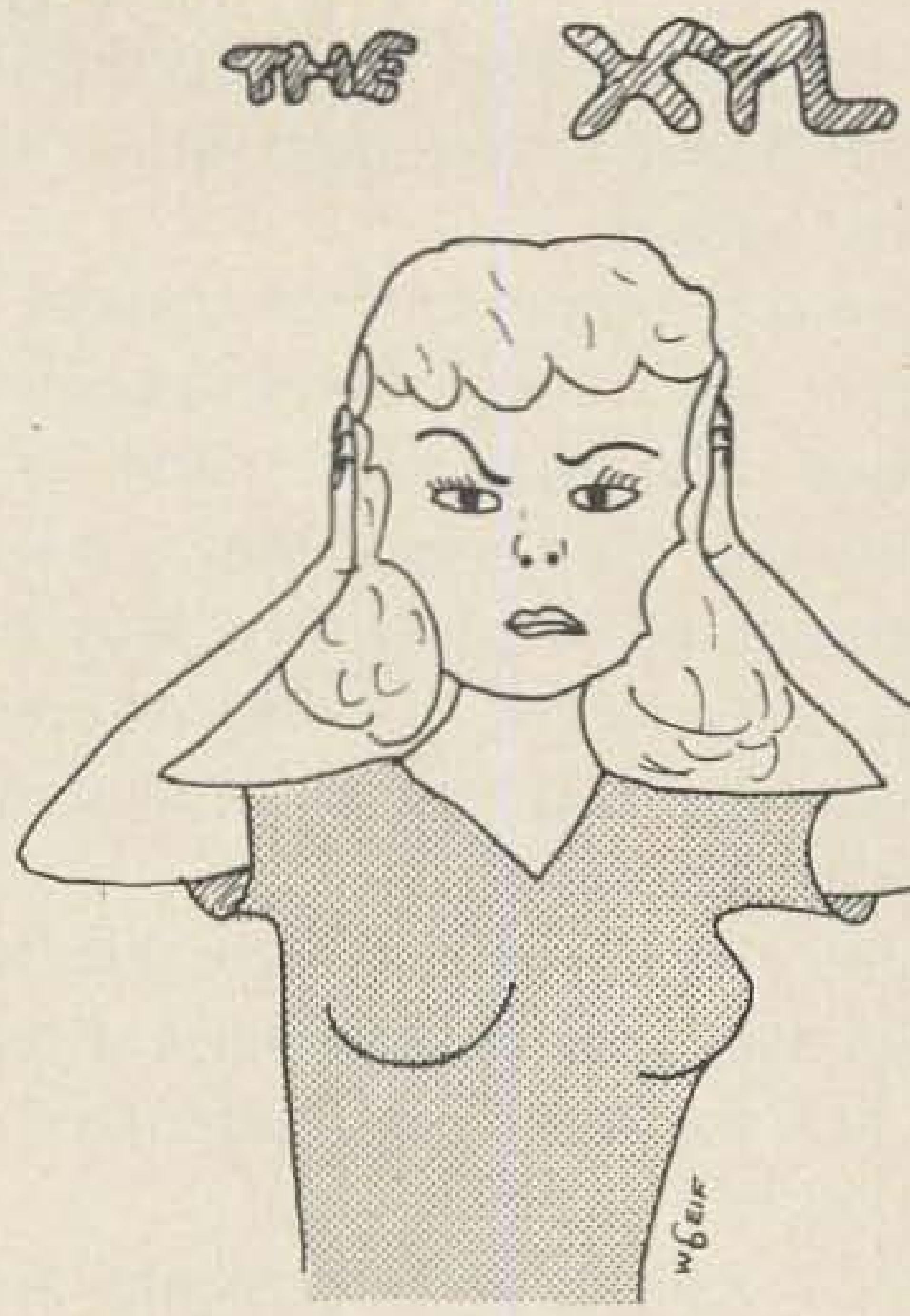
So whether for you it's manual, semiautomatic, or fully electronic – happy keying!

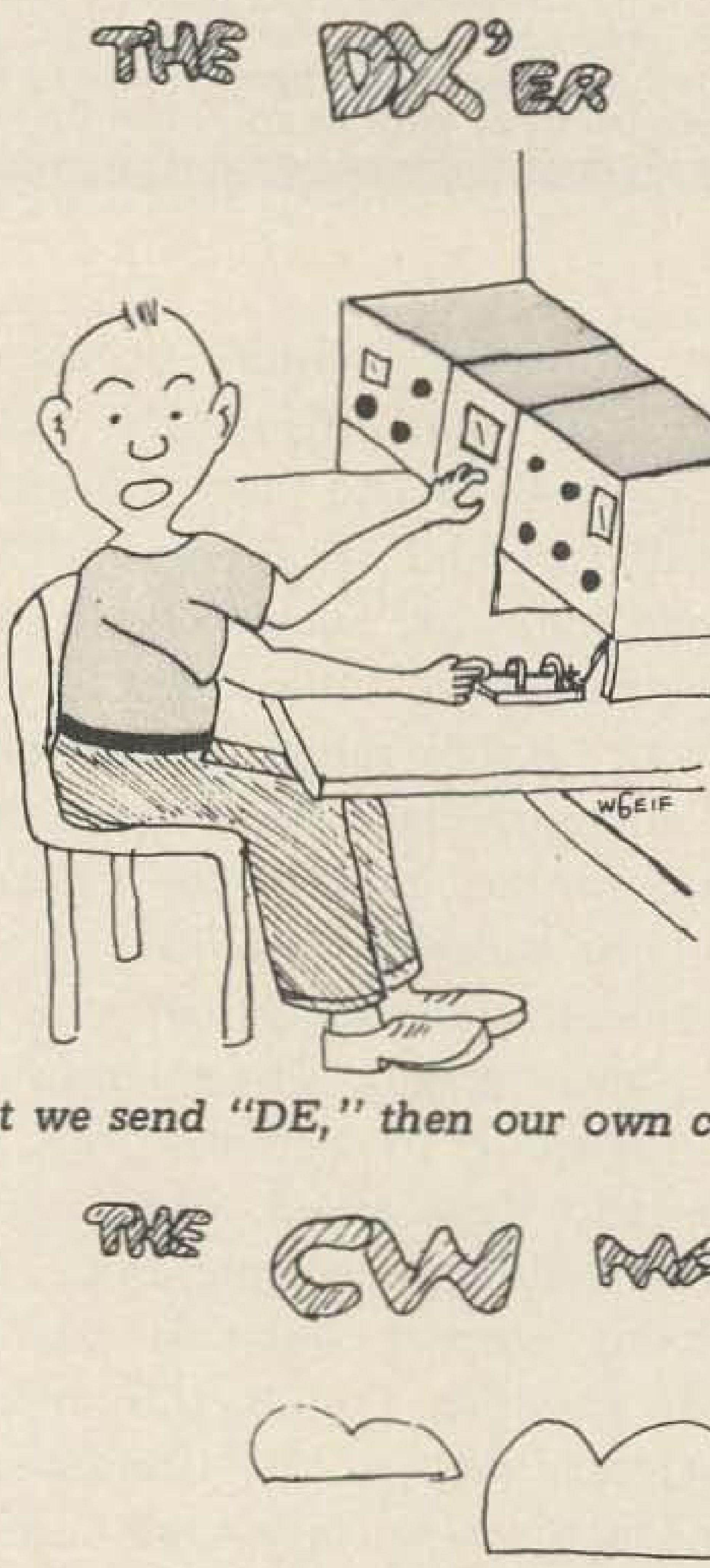
. . .W6AJZ■

CW as seen by . . .

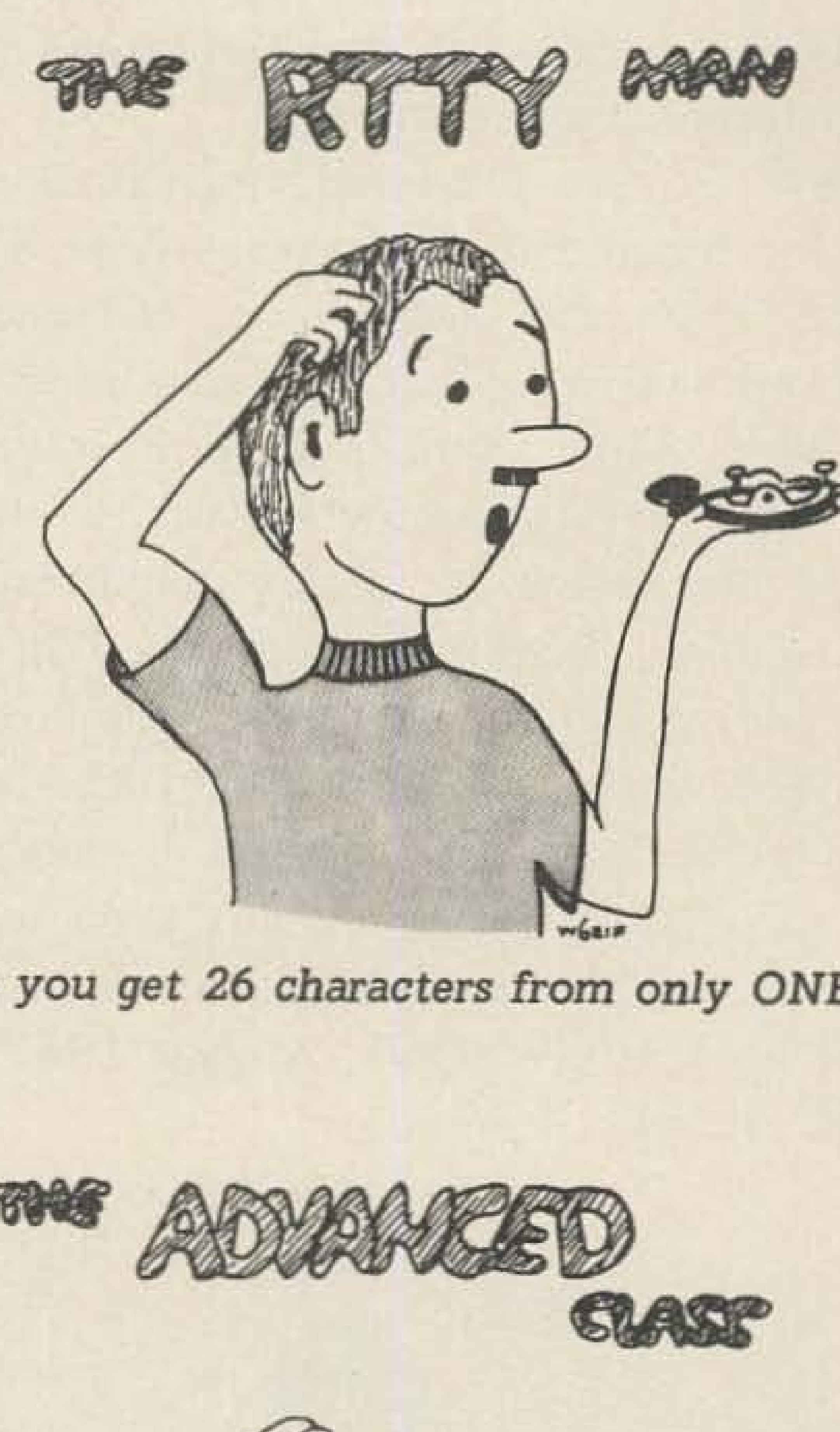


"Nothing to it!"



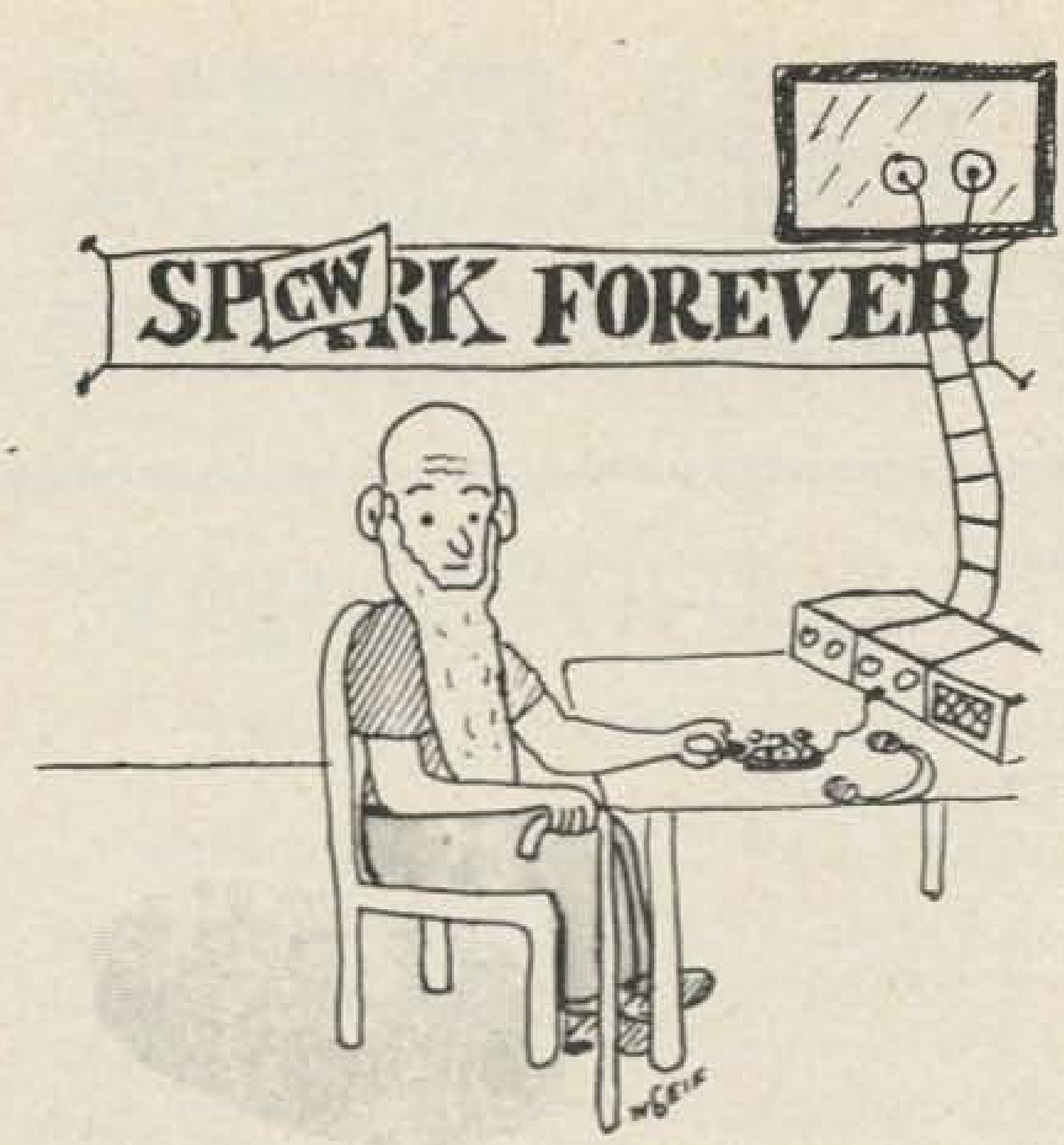


First we send "DE," then our own calls.



"How do you get 26 characters from only ONE key?"

"The ONLY way to fly!"



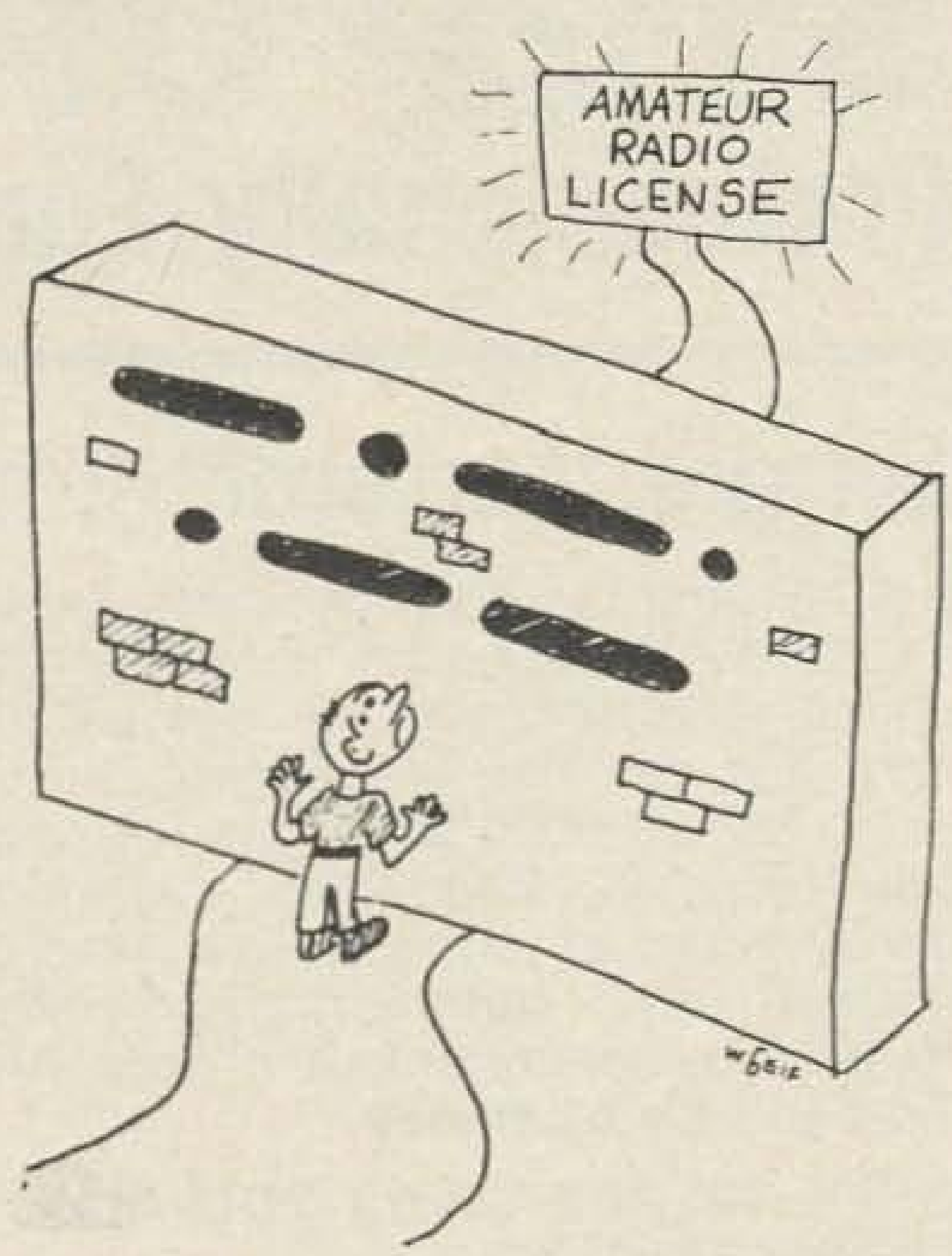
Wayne Green's view of a typical CW operator.

THE NOVICE

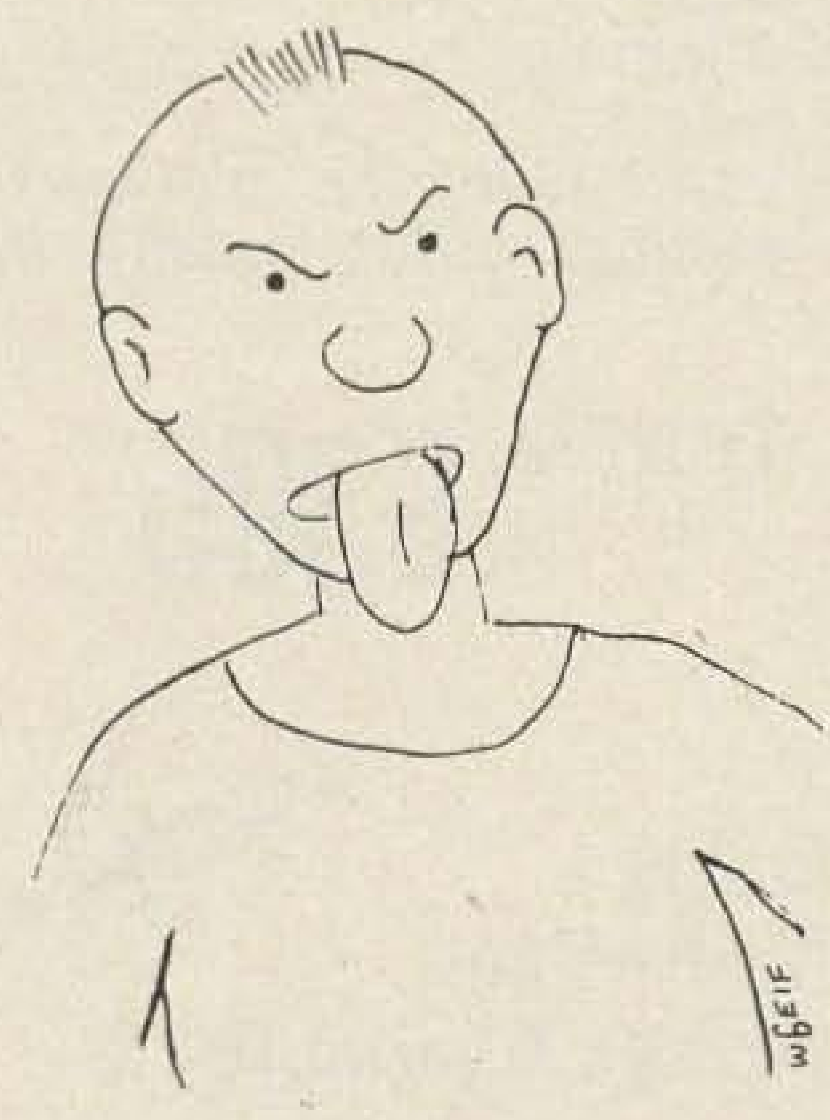
"What else is there?"

THE SWL

THE WOULD-BE HAM



THE TECHNICIAN



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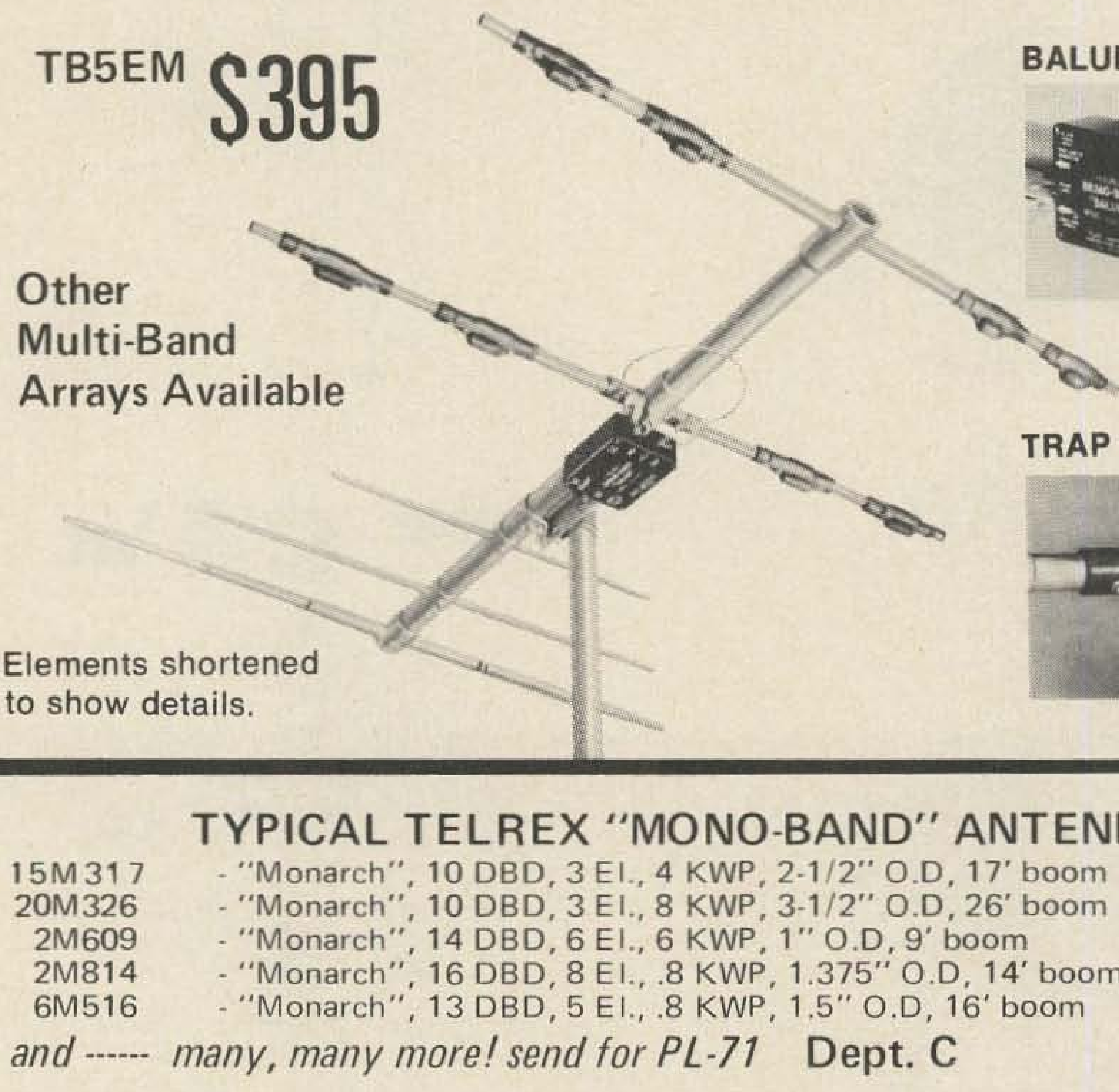

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Elements shortened to show details.

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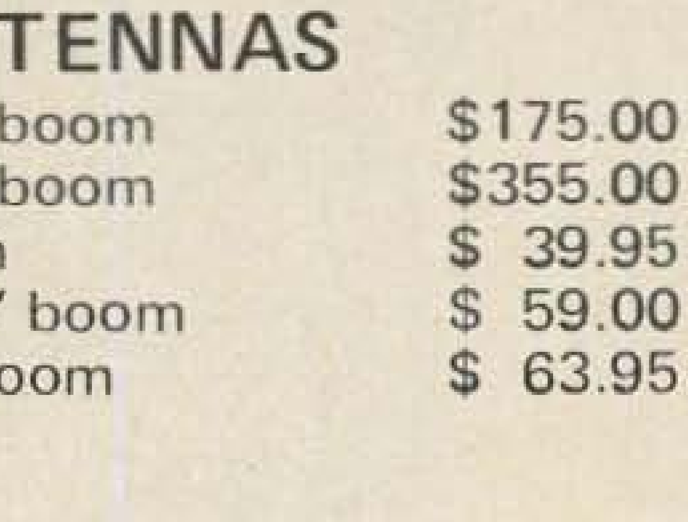
TRAP



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Sam Kelly W6JTT
12811 Owen Street
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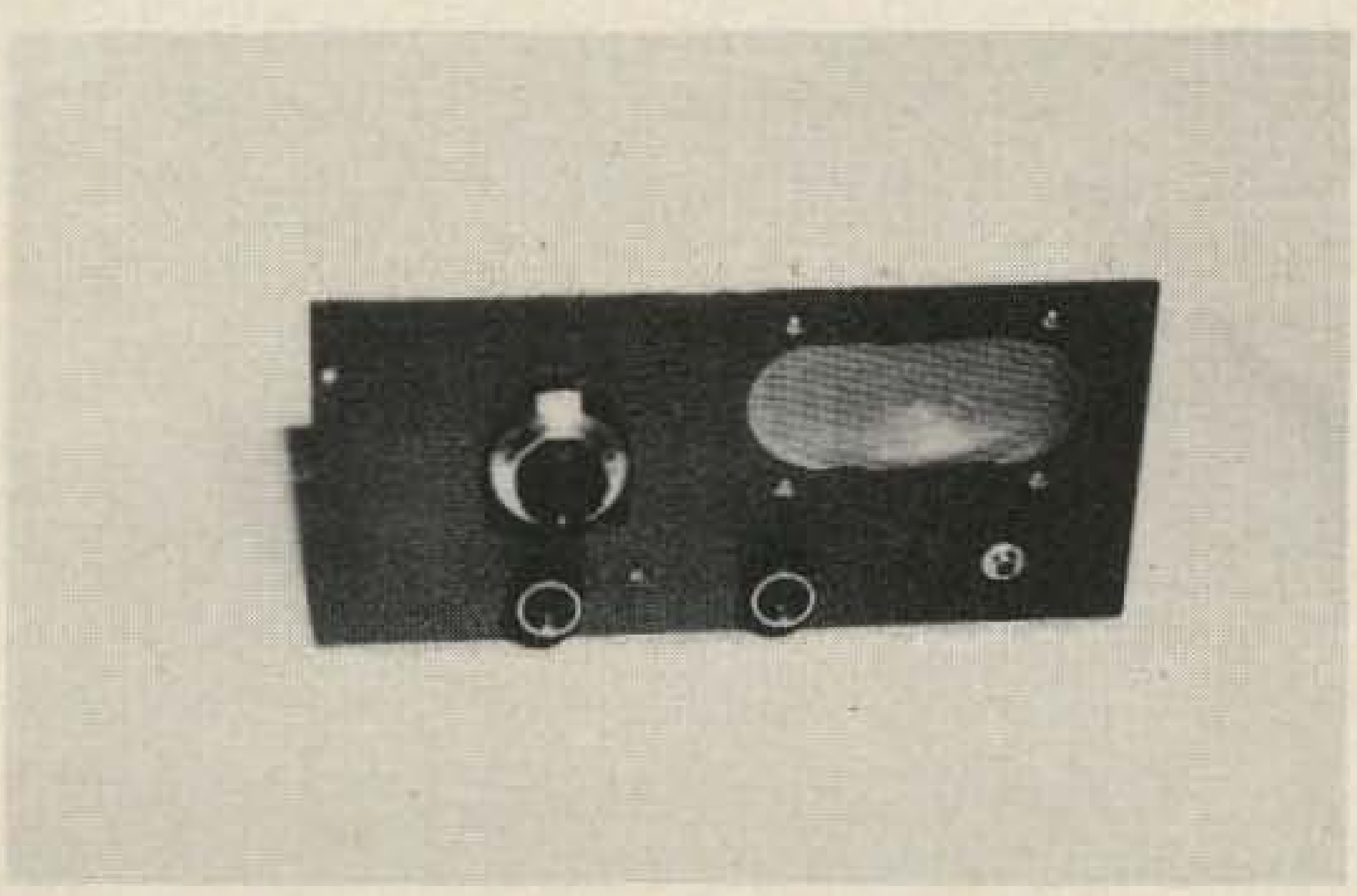
A Solid State High Frequency Regenerative Receiver

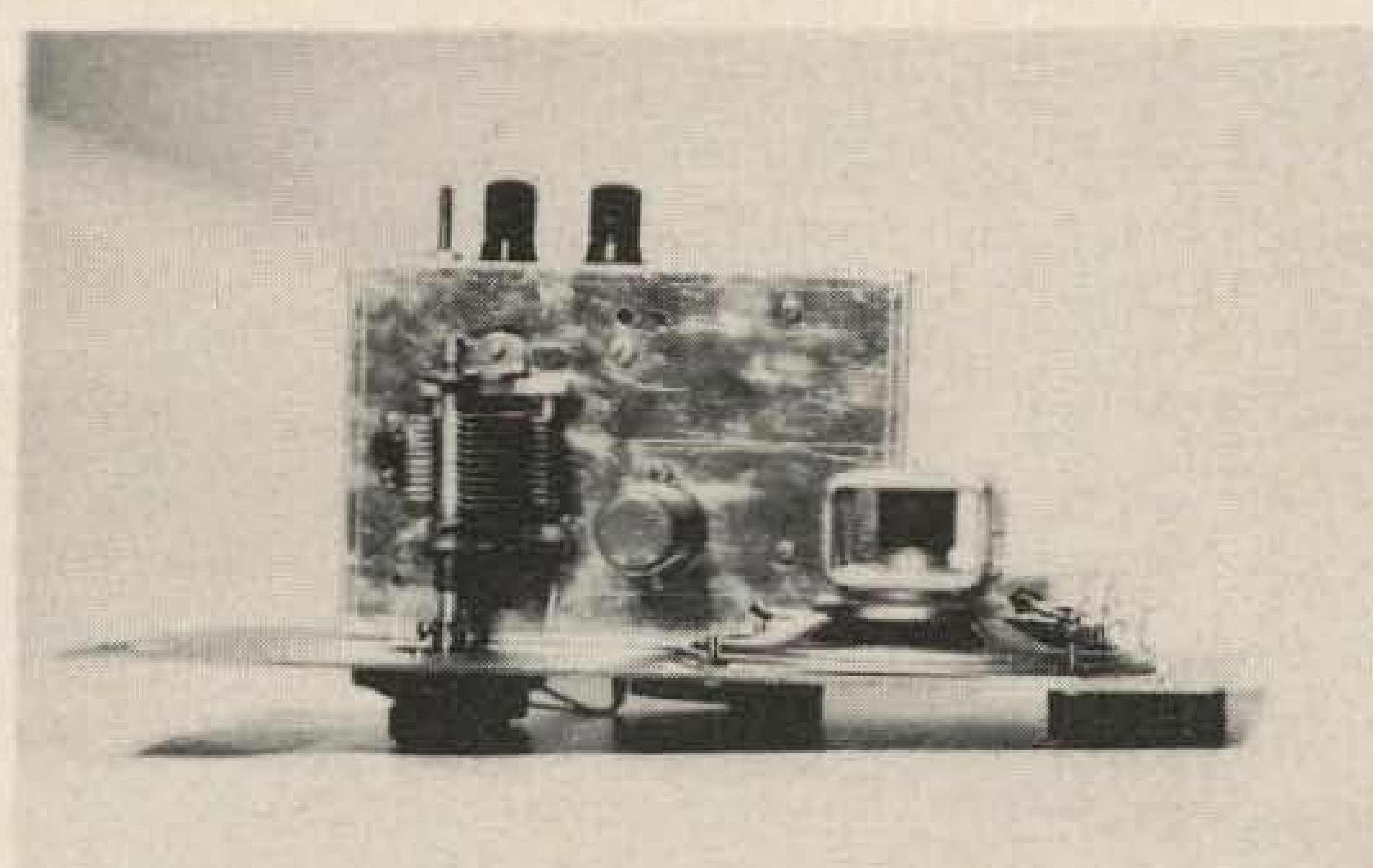
Like most hams, the first receiver I built was a one tube regenerative detector. Recently, while thinking back over old times, I decided to try my hand at building a solid state regenerative receiver just to see what kind of performance I could get. While the circuit shown has a few more components than my first receiver with its type 30 tube, it performs much better.

The receiver tunes from 14 to 35 MHz, a range that covers three ham bands, short wave stations and public service frequencies. The detector uses the readily available Motorola HEP 55 NPN VHF rf transistor. The audio amplifier stages are a single RCA 3020 linear integrated circuit. This is an entertainment grade IC and is quite a bargain.

The receiver was built on a 4 x 6 x 2 in.



The solid state high frequency regenerative receiver. A 3 x 5 in. speaker was used. The dial assembly is a Japanese import having a 10:1 ratio.



Top view of the receiver. Note the location of the transistor socket next to the tuning capacitor.

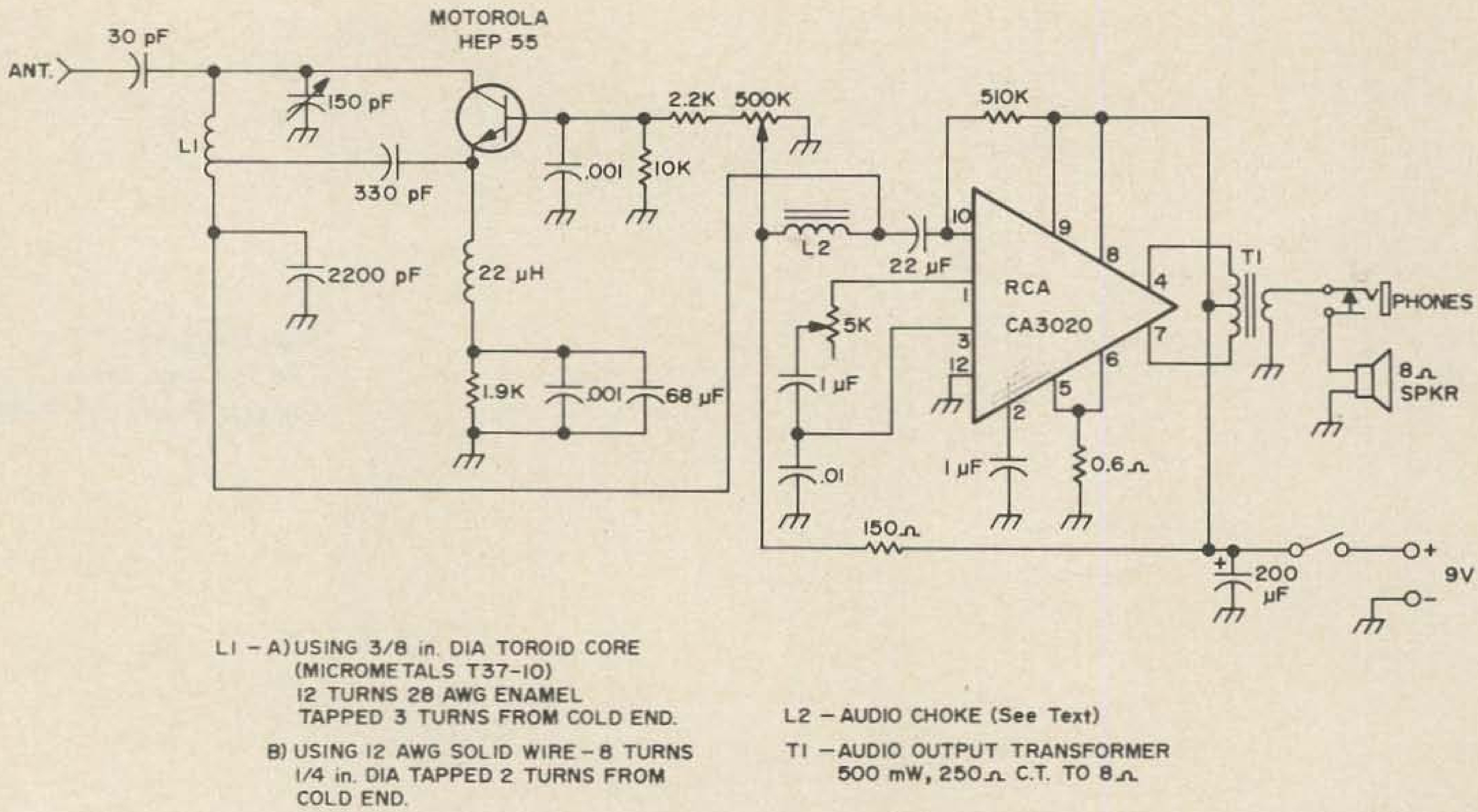


Fig. 1. Schematic of the regenerative receiver. L-1 A) using 3/8 in. toroid core (Micrometals T37-10) 12 turns #28 enamel tapped 3 turns from cold end; B) using #12 solid wire 8 turns ¼ in. diameter tapped 2 turns from cold end; L-2 audio choke (see text); T-1 audio output transformer 500 mW 250Ω CT to 8Ω

aluminum chassis. The audio circuitry, with the exception of the audio choke, was mounted on a 2 x 3 in. piece of vectorboard. The vectorboard was mounted to the chassis on threaded stand-offs. The input audio choke L2, is just the primary of a small 100K to 95K audio transformer. The secondary is not used. Practically any small audio transformer having an impedance in one winding of from 10 to 100K can be used. An alternate approach is to use transformer coupling with a small 20K to 50K interstage transformer.

All of the rf components except the tuning capacitor, are mounted below chassis. A transistor socket was used to permit experimentation with a variety of transistors. Actually a socket is a good idea unless you have had some experience in soldering to semiconductor leads.

You will notice that winding information is given for two different types of coils. The best bet is to use the small toroid cores which are carried by most major parts houses for about 10¢ each. If your local parts house doesn't carry them, use the alternate method. There isn't much difference in performance.

After wiring the circuit, carefully recheck your work. Remember, transistors, unlike tubes, are not forgiving about wiring errors. Now you are ready to hook up the antenna and apply power. Your best bet is to buy a battery holder that holds six D cells. While the idling current of the receiver is only 23 mA, peak currents are in the order to 50–60 mA. The cheap 9V transistor radio batteries aren't designed for this kind of use. Their internal resistance is quite high, and you will probably experience motor boating after short periods of use. The premium grade 9V batteries perform well, but their cost is high.

Connect the antenna. A 40 to 50 ft wire works well. Turn on the power and advance the regeneration control until a clean hiss is heard. Tune in a signal and alternately adjust the tuning and regeneration controls for best reception. A little practice will give you the knack of it.

Performance of this little receiver has been quite good. I have received signals from all over the world, not to mention the fun of listening to the local sheriff's department. Regenerative receivers aren't to be scoffed at for communications, either. I recently worked a station in Colorado (about 1200 miles) who was running five watts and receiving me on a regenerative receiver!

. . .W6JTT

Wm. G. Welsh W6DDB
3814 Empire Avenue
Burbank CA 91504

HEADSETS and HAM RADIO

There are several advantages to be gained by using a good pair of earphones in an amateur radio station. I hope this article will convince a few more hams to plug in their headsets and to cut out their loudspeakers.

Most hams operate from their homes and their stations are often set up close to where others are conducting activities completely unrelated to hamming. Using a good headset isolates us from most of the noises which might otherwise distract us from attentive listening. It is much more important, however, to realize that even the rarest DX is just so much objeetionable noise to those not interested in amateur radio.

You effectively double the power of the received signal when you switch from loudspeaker listening to using a pair of earphones. When copying weak code or voice signals, use of a headset can make the difference between whether or not you can enjoy a solid contact – or even complete the contact at all!

It is important to use earphones with good earmuffs. Earmuffs keep distracting external noises out and trap the desired acoustic energy where it will be applied to the hearing system. Old earmuffs get worn and they become rigid. The rigidity is mainly due to the effects of the earmuffs repeatedly becoming soaked in perspiration. When earmuffs deteriorate, they cause a loss in the high-frequency response characteristic of the earphones. Also, some of the desired signal leaks out and undesired noise leaks in past worn and rigid earmuffs. It is important to have thick earmuffs which are very flexible. Earphone efficiency is reduced if the headband does not exert enough pressure to hold the earmuffs firmly in place over both ears. Do not use a headset which exerts too much pressure, because it will be uncomfortable. Some headsets are actually painful when they are worn more than an hour.

The more powerful earphones provide improved performance, but they are larger and heavier. The increased size is usually not objectionable but heavy headsets are uncomfortable when they are worn for a long time.

We will not all agree that the same headset provides optimum sensitivity, earmuff pressure, noise protection, weight, and comfort. If you can do so, borrow several different types of headsets from your friends and run your own comparison tests to determine which set suits you best. There are several excellent military and commercial headsets available.

As delivered, both earphones are connected in phase in a headset. When listening to an extremely weak signal buried in noise, readability can be improved about 30% by just reversing the leads attached to either earphone in your headset. The human hearing system automatically cancels noise which is presented out of phase to both ears. The preferred (out of phase) connections can be determined by noting which connection arrangement provides the best reception of an extremely weak signal on a very noisy band. I simply installed a double-pole, double-throw rocker switch at my right earphone to permit me to change the phase of signals applied to one ear immediately; this allowed others to hear the results of the phase shift also.It is almost impossible to note any difference when listening to a strong signal or when listening to a signal on a quiet band.

If you are working a very noisy band, you can effectively mask out most of the noise by wearing a fitted pair of earplugs under your earphones. The signals will seem to filter through the earplugs remarkably well, while most of the noise will seem to disappear. If you use earplugs or transducer-type earphones, it is wise to have them fitted to your ears. An incorrect fit causes discomfort and inefficiency. The transducer-type (air column) earphones are not a good choice in any situation where several people use the same headset.

If you delay the input to one of your two earphones about 500 microseconds behind the input to your other earphone, you will realize about a 5% increase in the intelligibility of a weak signal on a noisy band.

A pair of earphones is preferable to a single earphone in a headset. Human hearing tends to cancel out noise which is presented equally to both ears. When using a dual-earphones headset, we can detect signals which are 2–3 dB lower than the signals we can hear using a single-earphone headset. Most people do not have equally good hearing in both ears. At one kHz the better ear is normally about 2 dB more sensitive and it is usually about 6 dB better at 10 kHz. Once we reach about age 25, our hearing starts to deteriorate. Our high-frequency hearing capability decreases much faster than our ability to hear low frequencies. Men usually suffer about twice as much hearing loss as women during their lifespan.

If you can apply noise out of phase to both earphones while you just apply the desired signal to one earphone, the signal will completely dominate your hearing and the noise will seem to disappear. When performing this experiment in a laboratory, the signal actually seemed to be coming from inside the head, whereas the noise sounded external and was easily ignored.

If noise is applied out of phase to both earphones – while signal is applied in phase to both earphones– signal detection capability is greatly increased. Again, this is more of a laboratory experiment than a real life arrangement.

High audio levels cause human hearing to suffer a loss called temporary threshold shift (TTS). TTS amounts to a built-in gain control which reduces the hearing level when one is subjected to loud sounds. TTS lasts from a few seconds to several hours, depending on the intensity and duration of the sound which originally caused this temporary hard of hearing condition to exist. Get in the habit of turning the gain down to the lowest point at which you can comfortably copy the signals you want. As a general rule, you will find that noise and interference are minimized by running your audio gain almost wide open and turning your radio frequency gain down to the point where you are just barely able to copy the signals you want. If you are working code, don't make the mistake of adjusting your beat frequency oscillator control to the point where you produce a pleasant low musical tone. If you're trying to listen to a signal buried in noise and other signals, it is much easier to pick out a higher pitch which is slightly objectionable.

Use a headset with an input impedance that matches the output impedance presented at the headphones jack of your receiver. Mismatched impedances cause power loss and distortion of the audio output signal. Many receivers are subject to damage of the audio output stage if they are operated without an output load such as a loudspeaker or headset. It is wise to leave a loudspeaker or a matching load resistor across the loudspeaker terminals to protect your receiver from damage which could occur when the headset plug is disconnected, or if the headset opens up.

Do not use high-fidelity earphones in your station. Headsets with wide-frequency-range characteristics just reproduce added interference which reduces communication capability. You should use communication–

type earphones with their limited-frequency -response characteristics. Effective communications can be conducted using an audio range of 400 to 400 Hz, or less. Generally the available headsets have a wider frequency response than is desired, but several come close to filling our needs.

In summary, headsets offer many advantages over loudspeakers. Nevertheless, hams frequently struggle through unsatisfactory contacts due to their use of loudspeakers. More important than the loss of communication capability is the simple fact that the use of loudspeakers makes amateur radio station operation disagreeable to other members of the ham's household. If you don't have a good headset, I am sure your family would be glad to buy one for you – providing you'll promise not to use that damned loudspeaker!

. . .W6DDB

The following references provide excellent additional details and contain many references to other sources of information on this subject:

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THE PERFECT CW SIGNAL

Rereading a bunch of old 73's recently, I came across an article by W3RMI on page 30 of the August, 1967 issue, "Visual Monitoring of Remote Carriers", subtitled: "What does your CW signal look like?" That set my mental gears rolling. What could a fellow do, I wondered, to get the best possible keying characteristics for his CW rig?

After thinking it over for a while, the problem resolved itself down to one question: What circuit could start and stop a sine wave (your carrier) without introducing any discontinuities (distortion) in the resulting keyed signal?

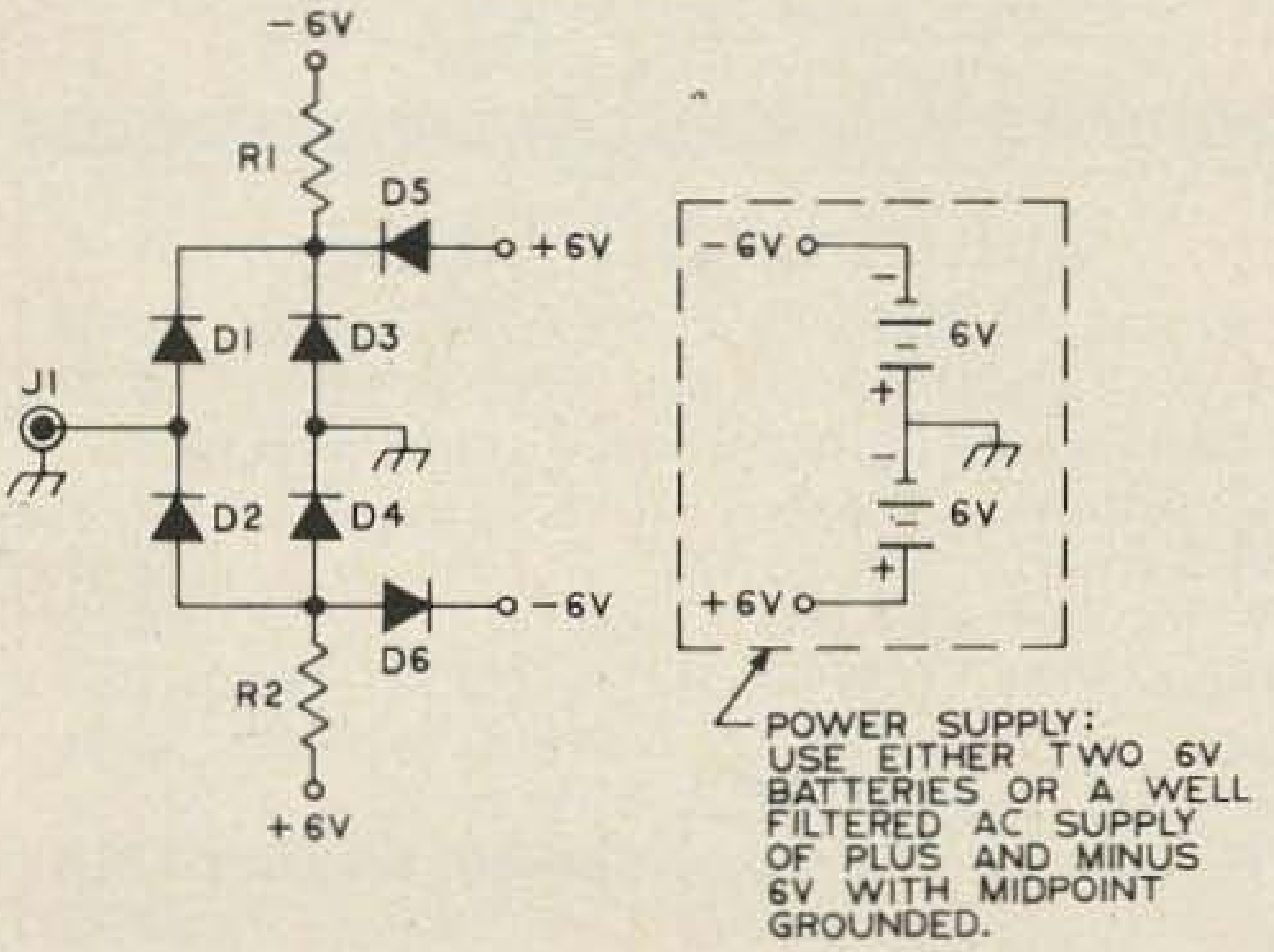

Fig. 1. A simple diode switch circuit using 6 diodes.

Suddenly the answer came – simple; the diode switch! Before I get deluged with a chorus of "Whatinhell's a diode switch?", let me explain. A diode switch is a half-dozen diodes (such as the IN4151) wired as shown in Fig. 1.

Easy, eh? Here's what happens: J1 carries the switched output. One side is already grounded and the action of the diodes causes the center terminal (the line going to the midpoint of D1 and D2) to be either open or grounded. For the open state, we apply the plus and minus 6V to D5 and D6 only. This causes diodes D1 through D4 to block both polarities of the applied voltage, causing the center terminal of J1 to stay at a very high impedance in reference to ground. In the closed state, we remove the voltages from D5 and D6 and apply them to R1 and R2. Immediately D1 through D4 conduct and effectively ground the center lead of J1 through D1 through D4 to the ground lead at the midpoint of D3 and D4. All we need now are some transistors to drive the diode switch, and a key to drive the driver transistors.

An emitter follower whose input can receive the signal from your vfo and whose output can be switched by the diode switch adds the final touch. The complete circuit is shown in Fig. 2.

Note that the circuit is set up so that the diode switch (D1 through D4) is conducting

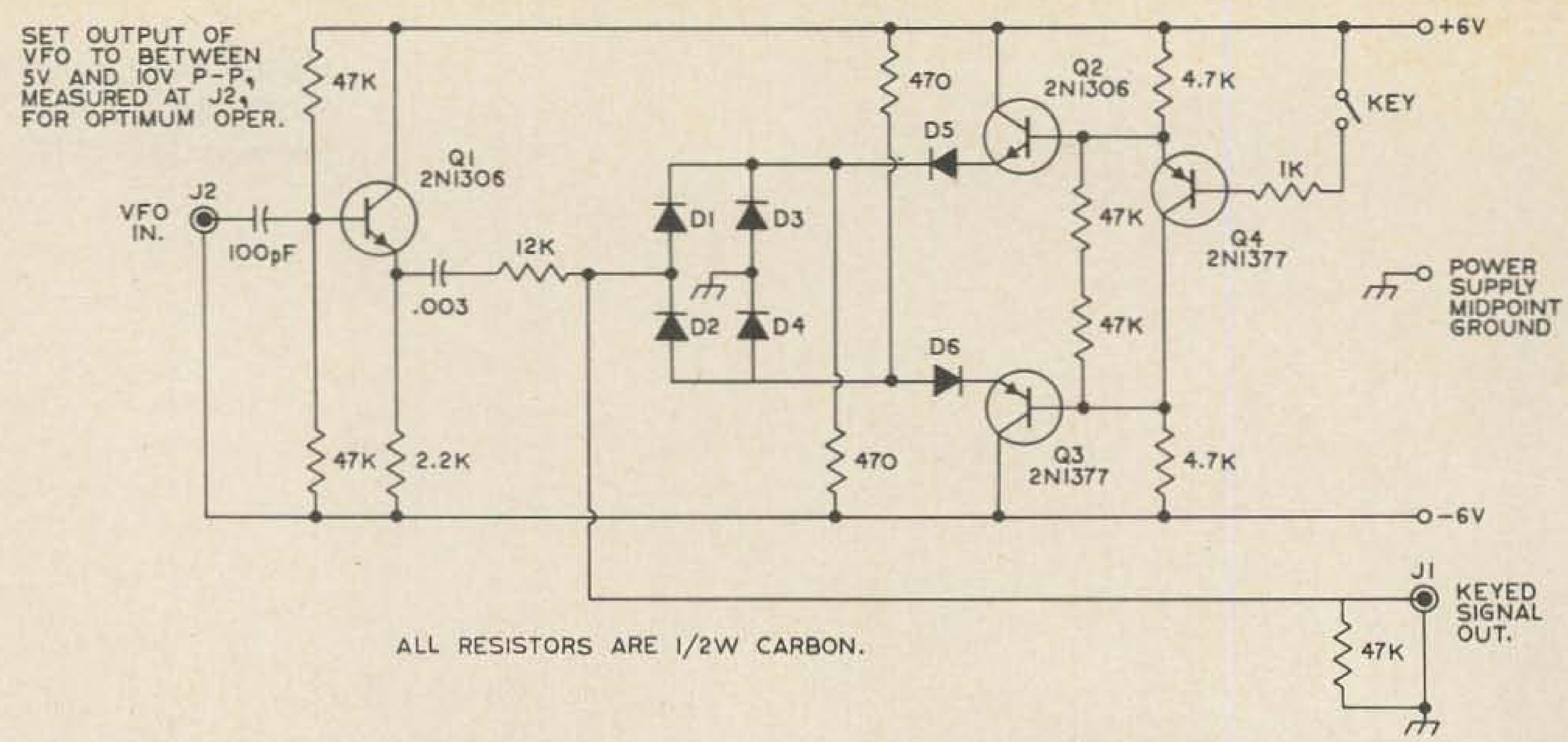

Fig. 2. The complete circuit. Note that it is set up so the diode switch (D1 through D4) is conducting with the key up.

with the key up, thus turning the carrier (at J1) off. When the key is closed, the diode switch opens up, allowing the signal from the vfo (through Q1, the emitter follower isolating amplifier) to appear at J1. Since there are only 6V across the key, there is no shock hazard and the whole circuit can be wired up on a simple pegboard.

As to how fast you can key this circuit, don't bother sitting up nights building up your code speed to test its limit. This little gem will just sit back and yawn at a speed of many thousands of words a minute because the specified diodes have a recovery "speed" of 2 nanoseconds!

All you need now are power amplifiers with good linearity, and a well-regulated power supply to transmit the "perfect" CW signal.

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Modulation Form:	Variable Reactance Phase Modulation
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Spurious Response:	less than −60 dB
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Receiver	
Receiving System:	Double Super Heterodyne
Intermediate Frequency:	1st. 10.7 MHz 2nd. 455 KHz
1st Osc. Frequency Stability:	0.002%
Band Width:	28 KHz at 6 dB down (Thru Mechanical Filter)
Selectivity:	60 KHz at 50 dB down (Thru Mechanical Filter)
Sensitivity:	−6 dB (0.5uV)
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TIPS for Raising Your Code Speed to 20 WPM

Many holders of the General or Advanced class license disavow any interest in raising their code speed to the magic rate of 20 wpm, and probably most Extra class amateurs felt the same way at some time in the past. When your code is just barely at the 13 wpm level, a speed of 20 wpm seems an impossibly difficult goal. The purpose here is to give you some practical tips on increasing your code proficiency.

Receiving and sending Morse code is purely a skill, requiring only minimal cognitive abilities. It belongs to the same class of acquired skills as learning to type, to ride a bicycle, or to ice skate. The principal ingredient needed to arrive at a certain level of performance is practice. However, the type and frequency of practice is quite important. Knowing approximately how much time will be required to increase your speed to 20 wpm can be helpful psychologically. Most of us expect faster improvement than can be reasonably expected. A realistic appreciation of the amount of practice that will be needed will help prevent the natural feeling of frustration that arises when you feel you aren't making fast enough progress. Individuals vary considerably in their learning rate for skills such as copying Morse code, but 120 to 140 hours of the right kind of practice should raise your speed from 13 wpm to 20 wpm. That amount of time may seem like a lot, but spread out over a period of time it becomes easier to contemplate. For example, if you can regularly put in 30 minutes of concentrated practice per day, five days a week for fifty weeks, your total time spent will be 125 hours. With that amount of the right kind of practice, you should be close to your goal of 20 wpm.

What is the Right Kind of Practice?

The first thought that comes to mind when you start thinking about increasing your code speed is to start having CW contacts. Working CW will certainly help your code speed, but it isn't the fastest way to make progress for at least two reasons. First, in a QSO we generally want nearly solid copy, and as a consequence we all tend to work stations that match our own speed quite closely or even those who might be a little slower than we are. And you never increase your receiving speed unless you are pushed and made to copy material at a speed somewhat higher than your top speed for solid copy. Another reason that on-the-air QSOs tend to be inefficient as code speed improvement exercises is that their content tends to be highly repetitious. Hams unfortunately tend to say about the same things in QSO after QSO, and as a result, you can predict too easily what is coming next.

A somewhat better procedure is to spend time copying amateur or commercial stations sending at a suitable higher speed than is comfortable for you. Finding such stations is not easy, and about the time you do find an appropriate signal it will often sign off. As a result, a lot of time can be wasted tuning around looking for suitable material to copy. A better idea is to listen to one of the stations sending out code practice material on a regular schedule. The ARRL headquarters station W1AW has an extensive program of such transmissions. The detailed schedule can be found in *QST*. A number of other amateur stations across the country also feature code practice sessions at speeds in the 5 to 35 wpm range. Unfortunately, rarely more than 10 minutes is spent at any one speed. You will usually find at most two speed ranges that are really suited to your learning needs, but nonetheless these transmissions are a good source of practice material.

The Tape Recorder as a Code Instruction Device

Perhaps the best solution for obtaining suitable practice code transmissions is to prepare your own code tapes using a tape recorder. A helpful procedure is to record at half the linear tape speed, half the code speed, and half the audio frequency that you want on playback. You can use either a hand key or some form of automatic key together with an audio oscillator set at 400–500 Hz.

Can you decipher this message within 60 seconds? "Nialp hsilgne txet with all tpecxe the elttil sdrow delleps scrawkcab sekam doog ecitcarp lairetam."

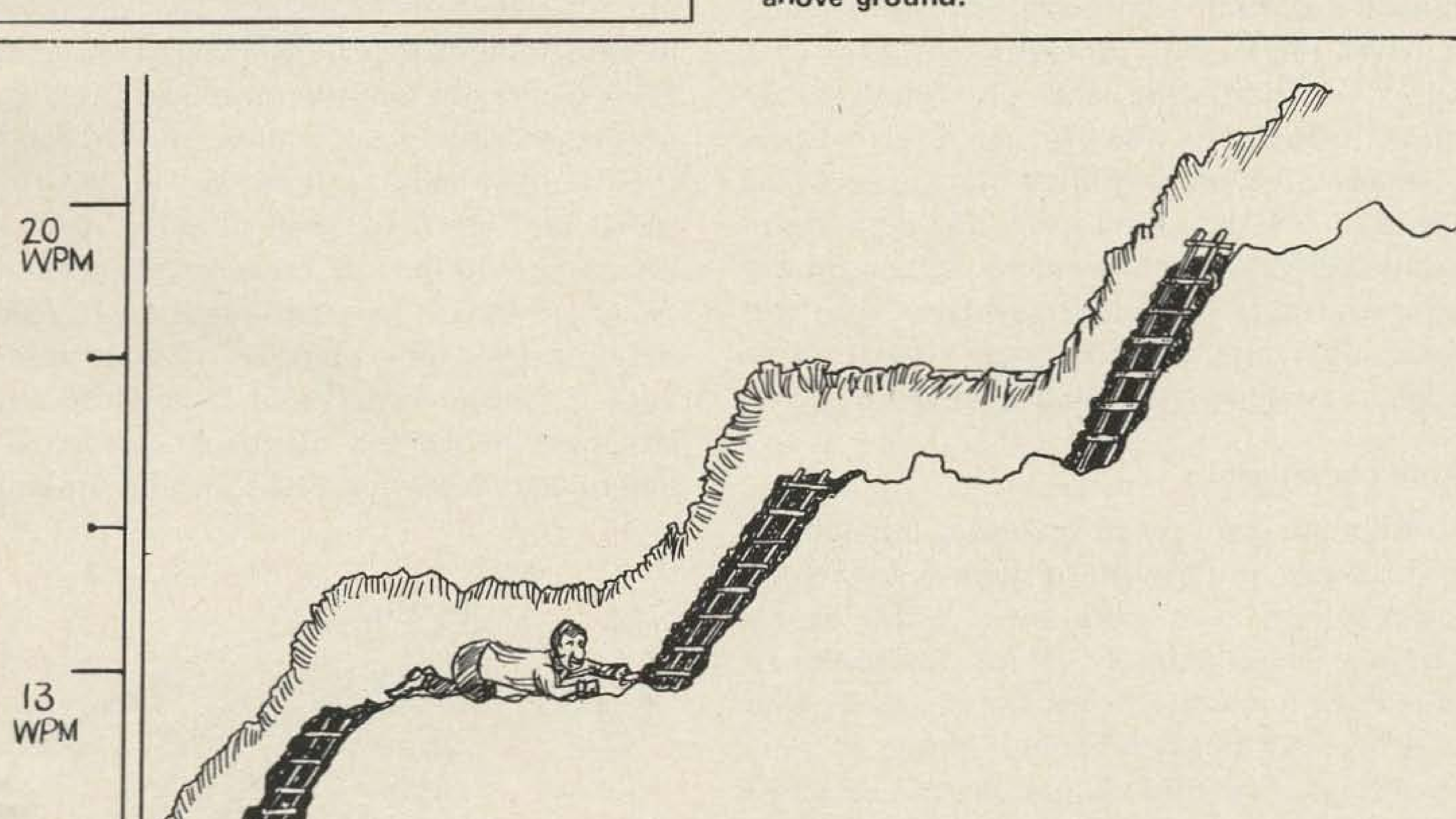
Sending at half speed will enable you to record really good-sounding, accurate code characters. Plan on a playback speed 5 wpm or so above your top receiving speed. Feeling pushed during your practice sessions is quite important. To prevent memorization of the material on the tape and thus soon vitiating any practice value it would have, record plain English text with all except the little words spelled backwards. Be sure to use material containing some numbers and punctuation marks. Spelling the short, common words such as *the, an, but, for, it, on,* etc., in their normal manner is helpful because as your speed increases you will begin to recognize the short, frequent words as single-unit sounds. This type of material is better for practice than code groups because the various letters occur with the same frequency as in plain English, and you will obtain valuable experience with the important high-frequency, short-length words.

When your copy begins to get too nearly solid, prepare a new tape at a higher speed. Always keep yourself on the stretch. Before tackling that FCC Extra class examination, you should be working with a tape in the 27 to 30 wpm range, and you should be able to take almost solid copy at 22-23 wpm. You will need a margin of two or three wpm to compensate for the natural nervousness and tenseness you will feel in the FCC examination room.

How Long and Often to Practice

With a code tape available, you will be free to practice at a time to suit your own

"...thus you can see that the grounded-cathode Hartley circuit uses parallel plate feed through an rf choke since the plate is at a high rf potential above ground."



Your progress will come by fits and starts – or a fundamental law of acquiring skills seems to be that progress toward a goal is never linear, but occurs by means of a series of frustrating plateaus followed by breakthroughs to new, higher levels of performance.

personal convenience and as often and for as long as you wish. However, don't make any one practice session too long. Once you begin to tire, prolonging the practice period will bring diminishing returns. Probably 30 minutes is long enough for any one session. If you are really eager, one 30 minute lesson in the morning and another in the evening would not be too much per day, but most of us will find one practice period a day is about all we can or want to have.

With one 30-minute session a day, you should plan on at least a year to raise your speed from 13 wpm to a comfortable 21 to 22 wpm. If you have to miss occasional daily sessions, you ought to think in terms of 18 months. Realistic estimates of the time that will be required will reduce the frustration so often felt by aspiring Extra class candidates who have grosssly underestimated the amount of effort needed to increase their code speed merely 7 wpm.

Plateaus and Breakthroughs

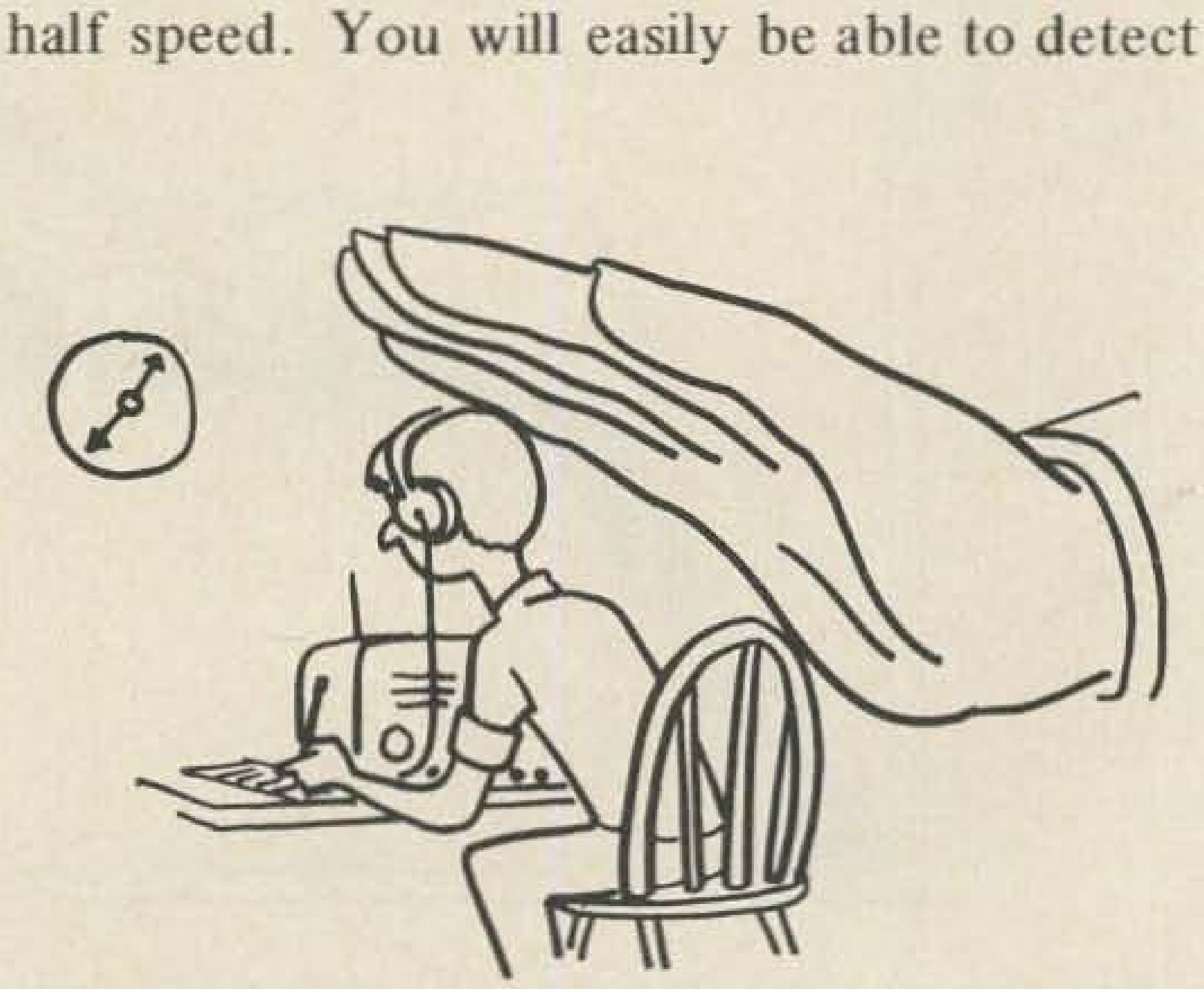
A fundamental law of acquiring motor skills seems to be that progress toward a goal is never linear, but proceeds by means of a series of frustrating plateaus followed by breakthroughs to new, higher levels of performance. When you hit a plateau at 14 or 16 or 17 wpm, don't give up. Sometimes your skill may even seem to regress, but if you continue to practice regularly, you will suddenly realize one day that you can now copy at a higher speed than ever before.

Copying Behind

As your code speed increases, it becomes increasingly important to copy behind by a letter or two, or even by a whole word. Copying behind simply means that the operator does not write down the character that is being sent, but lags behind by one or more characters. Copying behind has the effect of smoothing out the rate at which code characters must be transcribed, and does away with the panicky feeling resulting from trying to write down each character before the next one is heard. As code speed increases, a certain amount of copying behind becomes almost mandatory if one is to keep from feeling too frantic, but fortunately the ability to copy behind will tend to develop more or less naturally. However, the rate at which your code speed will increase can be accelerated if you make a deliberate effort to try to copy behind. Force yourself to carry a letter or two in your head before writing them down. At first this procedure will seem difficult and unnatural, but you will soon get the hang of it.

Sending

From all that has been said so far, you might conclude that the FCC examination covers only the ability to receive Morse code, but of course you must demonstrate your ability to send at 20 wpm as well. The type of key you want to use is up to you. Since the FCC furnishes only a standard, manual key, you must bring along your own if you want to use a special type key, such as a bug or an electronic keyer. Learning to use some type of automatic key is not necessary in order to pass the code text at 20 wpm. Most individuals find a speed of 20 wpm relatively easy to reach with a standard key, but for speeds much higher, the majority of us find some type of automatic key mandatory. Generally, considerably less practice is needed to raise your sending speed than for the corresponding increase in receiving speed. In your sending practice, the emphasis should be on quality and accuracy. One easy way to monitor quality is to record periodically a few minutes of your sending with a tape recorder, and then listen critically both at normal playback speed and at half speed. You will easily be able to detect



You must feel pushed during your practice sessions for best results.

If keeping cool and calm during the exam is half the battle, guess which guy will pass?

any abnormally formed characters, and can take steps to correct them.

The FCC Examination

That fearful yet wonderful day has arrived – you are going to present yourself at the FCC district office for the examination. As a candidate for the Extra class license, you have one marked advantage over the General or Advanced class aspirant – you have been through it before. However, if you are an oldtimer, you may fear that your last visit to an FCC office was so long ago that everything is different now. I can assure you on the basis of personal experience that nothing has changed, at least not in the last twenty years. The five-minute code transmission is sent automatically be means of a punched paper tape machine, and you will be provided with a pair of black, lightweight earphones for listening. The code message to be copied is preceded by a long string of *v's*. Although the text material proper is in plain English, it contains a generous number of punctuation marks, numbers, and even an occasional Q-signal. One minute of error-free copy, i.e. 100 consecutive correct characters in the 20 wpm range, is all that is required. If you pass the receiving test, the engineer will give you a chance to demonstrate your sending ability. No precise timing of sending speed is made, but if you send markedly too slowly, you will be asked to increase your speed. Nearly all who pass the receiving test also pass the sending test. Once past the code hurdle, you are given a chance at the written part of the test, but if you should fail the code test, the engineer will politely tell you to try again in thirty days, and all that has been lost is an hour of your time, and, alas, nine dollars.

Best of luck to you. I'll be seeing you on the Extra class bands.

...W7OXD

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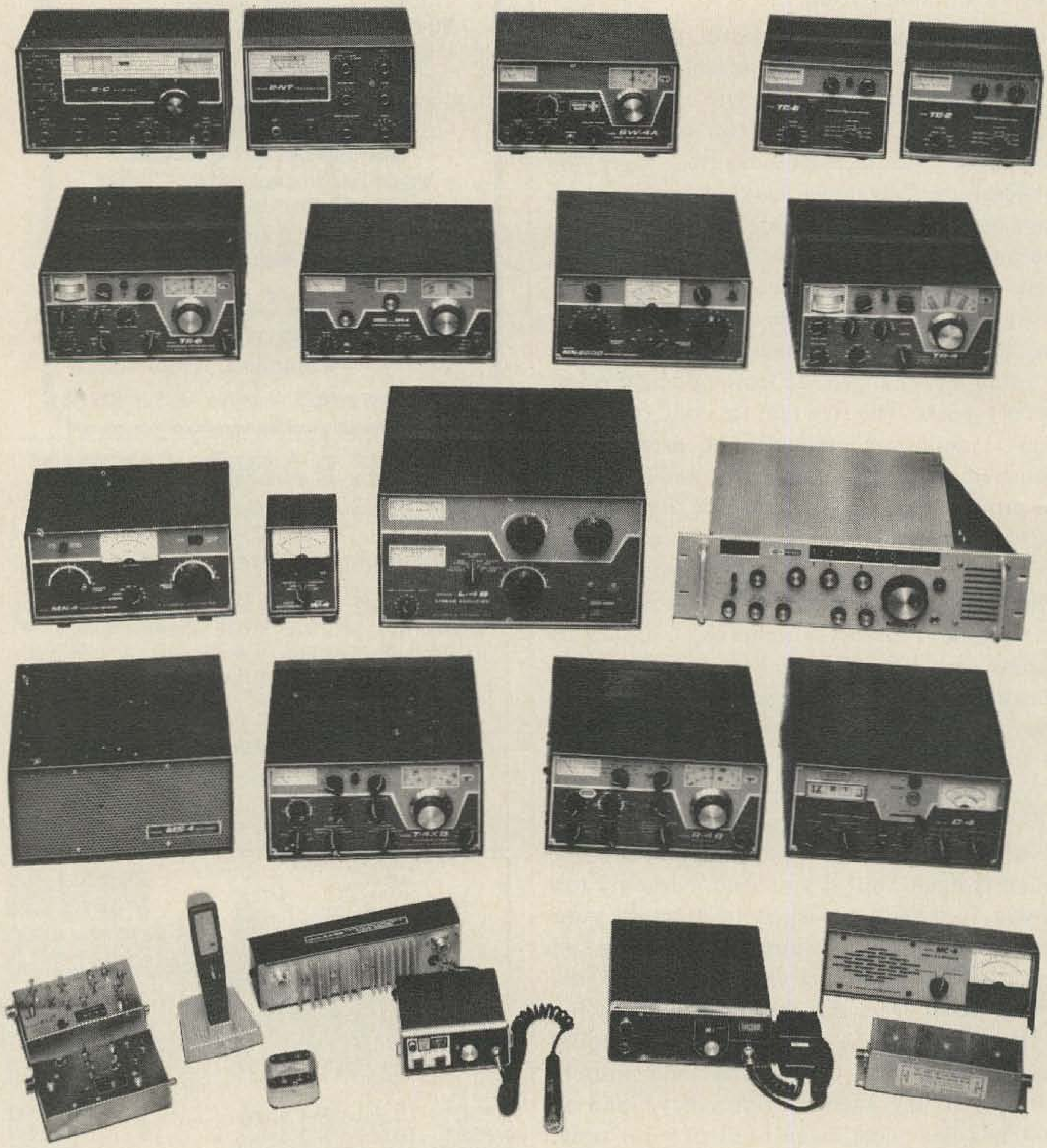

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WHY NOT TRY QRP?

In this day of kilowatts there is relatively little low-power operation. But running QRP can be a lot of fun, even if you don't get a lot of QSO's.

When running high power all one has to do is hit the key or blow into the mike and he gets a QSO. He can talk to just about anyone he wants. But after awhile one comes to realize there is not much fun to this. One can achieve the same effect by dialing the telephone at random, and save a lot of electricity while doing it.

When one starts running QRP, hamming takes on a new challenge. No longer does one say "QRZ-599-73-QRZ" endlessly. It is *work* to get a QSO, and much more of a thrill to get it with QRP. I really got a kick out of working FP8AP on 40 CW during the afternoon with 10W, while I thought nothing at all of working ZD8OFE with 180W of SSB on 20.

Before trying real QRP, such a 1W or less, it would be a good idea to start out with *relatively* low power. Try something like 10–15W, but not much more. This power is low enough to provide some of the fun of QRP, but not so low that contacts come really hard. It is a good idea to start out with rather high powered QRP, to get used to it gradually. If one were to start out running something like ½W, he would of course have a rather large contacts-to-calls ratio and would quickly become discouraged. But by starting out rather high, and getting used to low power operation, the small number of QSO's with real QRP won't bother a person as much.

I would not recommend much over 15W to start out with. While many will disagree, I consider something like 20–30W in almost the same class as 75–100W. With 20W it is possible to get quite a lot of QSO's. I have worked 45 States on 40 CW with 25W, and many, many QSO's, and lots of others have done the same.

It is hard enough getting QSO's with a watt or so under the best of conditions, and especially when the operator has no experience running that much. I would suggest for a start you confine your experiments to less crowded bands, like 80 meters. If you want to try 40 or higher – to get better distances – try and keep away from the more crowded parts of the bands.

Here are a few things to know before trying QRP:

1) Vfo operation is infinitely better than using crystals.

This is obvious in normal high-power operation, and much more so with QRP. What can you do if there is a kilowatt sitting on each of your crystal frequencies? And what good will a crystal for 7130 kHz do if all the activity is under 7100? You must put your signal where people will hear it right away. In these days of vfo's almost no one tunes after a CW. Even if they do tune around, they will probably hear someone else calling CQ and call them, leaving you out in the cold.

2) Wait until conditions are good.

If you hear a 559 signal tell someone he is running a kilowatt to a 100 ft high dipole, you can be pretty sure your 100 mW will be unreadable there. If someone is S 8-9 you can be reasonably sure he will hear you. But don't bother with S 6-7 signals unless you know they are also running QRP.

3) Call others, don't call CQ.

Anyone will tell you that a low power station has a better chance if he calls others. And when calling others, make sure no one else is. If you hear three 599+++ signals calling him you can be sure you will be drowned out. If you only hear weak ones calling, give it a try; you may be lucky and be the one he comes back to. Also, remember that if someone hears a 539 signal calling CQ he will assume that conditions are bad, and not bother calling.

Some will disagree on the point about calling while others are. For some, competing with QRO stations is half the fun of QRP, while others, like me, just like to get a maximum of QSO's with a minimum of trouble.

4) Don't settle for lousy antennas.

If your 100W rig does not get out well you can be certain that your 1W won't get out at all. You are already operating under a 20 dB or more handicap when running QRP, so don't make things worse by using an antenna that has loss rather than gain.

Of course, don't spend a fortune on copper and towers before trying QRP – give your existing antennas a try – you may be surprised. Read on to the examples of what has been done with QRP and look at what I did. I did it all with 10–15 ft high dipoles and a 20m vertical. (I do, however, have several logbooks full of unanswered calls, and many premature gray hairs from it.)

VE1ASJ has worked many stations on 80m CW, using 100 mW, and has worked as far West as VE5 and W6. His antenna is a three-element wire beam!!!

Some of you may have heard of the QRP Club, International. Members are limited to 100W and it has 3,000 members in 57 countries. Many of them experiment with low power. Later on are some of their accomplishments with QRPP. (QRPP is becoming the generally accepted term used for QRP Power, designating an input of 5W or less.)

The QRP Club issues several awards. One of them really has the low power operator in mind. It is the "1000 Miles per Watt" award, also called the "KM/W." It is issued for *either* transmitting *or receiving* signals from a low power station such that the great circle distance between stations divided by the power of the low power station equals or exceeds 1000 miles per watt. It is issued for work on different bands and modes. Over 150 of them have been issued. Perhaps thanks to the influence of this award, the generally accepted measure of QRP DX is "miles per watt."

This award is not really hard to win. Several people have even won it more than once. Here are some of those who have several hanging on their walls, and the bands and modes they used:

W9UZS – 40, 20, 10 CW
WA5NOM – 80, 40, 20 CW
VK3XB – 40 fone and CW, 20 fone and CW
W6TYP – 40 and 20 CW, 80, 10 2 fone*
WA8MCQ – 80, 40, 20, 15, 10 CW, plus one for receiving on 40 CW

*Current official record holder

When trying for this award, remember that the distance in miles one must work is equal to one thousand times the watts input, or one mile per milliwatt input; eg., 2 watts need 2000 miles; 5 watts needs 5000 miles, and 250 milliwatts needs 250 miles.

The QRP Club also has another award. It is the "QRPP-WAS" Award, for working states in steps of 10, 20, 30, 40, 45, and 50. (The reason for the 45 state class is that the last five states really come hard, especially when running QRPP, so people won't get discouraged as they approach 50.) For this award, the maximum power that may be used is 5W, and there is an endorsement for using under 1W.

Here are a few of the things being done with QRPP:

WA8MCQ: I have worked 47 states with 800 mW and under. Anyone in KH6, Oregon or New Mexico want to sked me? I have the KM/W six times, and have qualified many others for it by running low power. Have over 300 contacts with under 1W, and often run the 80 mW rig in contests, and make at least 20 contacts, and made 73 once. I usually establish contact with the small rig, but a few times I use the big rig first, and ask people to listen for my QRPP, in order to get a few of the harder states.

WA5BMN: Used to keep regular skeds with W6TYP, running under ½W both ways.

WB2YPA: Running 3 mW he worked WA6ZHP, a QSO good for 800,000 miles per watt. This fantastic feat is close to the official record, which is held by W6TYP.

WA8RQQ: Worked several VK's with 10W and less, plus much more DX, including 11 countries with under 5W. Of course he has the KM/W. He even worked an HK3 on 40 CW at *noon* with 1W, and got a report of *599*!!

W8AVB: Has a 200 mW vfo rig for 80 meters, with which he worked at least 30 states, including some 6's and 7's,

W7IGV: Had been keeping regular skeds with W6EAC on 40 CW, both using 1 to 2 watts. One day W7IGV showed up on sked "maritime mobile" from a rowboat on Lake Coeur d'Alene in Idaho! W6EAC could hear him but could not copy. The effort was not wasted, however, as WA7BIY, running 5W, W7OE and WA7FYW, all in Washington, broke in, and solid copy all around. W7IGV's antenna was 10 ft of loaded whip. (From Sept. 1968 issue of *Random Radiation* official organ of the Pacific Amateur Radio Guild, published by W7OE.)

WA9MFZ: Running 2W he worked a station in Colorado who was running 800W, and got a report of only 2 S-units lower – pretty good for a 26 dB power difference!

W6TYP: Art has worked at least 24 states with under ½W, plus 4 countries including ZL. He is the current official record holder for miles per watt. He worked WA6JPR on 40 CW to set the record. He was running 354 *microwatts*, and the other guy was 354 miles away, a QSO good for one million miles per watt.

W2UUV: According to a letter in the October 1964 issue of *QST*, on page 104, he is the unofficcial record holder for miles per watt. He worked W2BNA, 205 miles away, while running 67 *microwatts*, a contact good for over *three million miles per watt!!* This guy has got to be one of the top QRPPers around, as far as miles per watts go. He logged 15 successful attempts out of 15 to make over 105,000 miles per watt, working with W2BNA, a 205 mile path with a milliwatt and less. He says that W2BNA is tops, and often runs up scores of over 600,000 miles per watt. He also says that K1HNJ made 769,000 miles per watt, at 100 miles and 130 microwatts. He says he has 31 states plus KZ5 and DJ, all on 80 meter with 180 mW. Sometimes he runs his final off a solar-battery which he puts in the window, and others get quite a kick out of it. He also sponsored a "QRPP QSO Party" a couple of years ago, in which the maximum input allowed was 300 mW.

The foregoing should inspire some of you QRO people to give QRP a try. It's lots of fun, and beats running a KW anytime. (Note; I meant it's more fun than running a KW, *not* that it will do better than a KW!)

Anyone interested in joining the QRP Club can obtain information and application blank by sending a self-addressed stamped envelope to K3YNN, the Corresponding Secretary of the Club. Lifetime dues for the club are only $2.

Whenever you are on the air, give a listen for some of those real weak signals you hear, and you may make some. QRPPer very happy.

. . .WA8MCQ


W4BP

This is what the well-equipped ham of the thirties called his shack. Even by today's standards, he can do a lot.

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VHF DUMMY LOAD WATTMETER

The active vhf amateur often has need of some type of dummy load for transmitter checkouts. The units found in amateur applications range from the Bird "Termaline" units costing around $350, downward through the Waters units, through the Heathkit Cantenna, to the inexpensive units described in the various amateur publications.[1] The Bird and Waters units have the advantage of a direct readout wattmeter movement, whereas the cheaper units are dummy loads only. A dummy load serves as a constant impedance load while keeping the signal from interferring with other amateurs. When a wattmeter or relative output meter is added, the dummy load becomes a very useful piece of equipment.

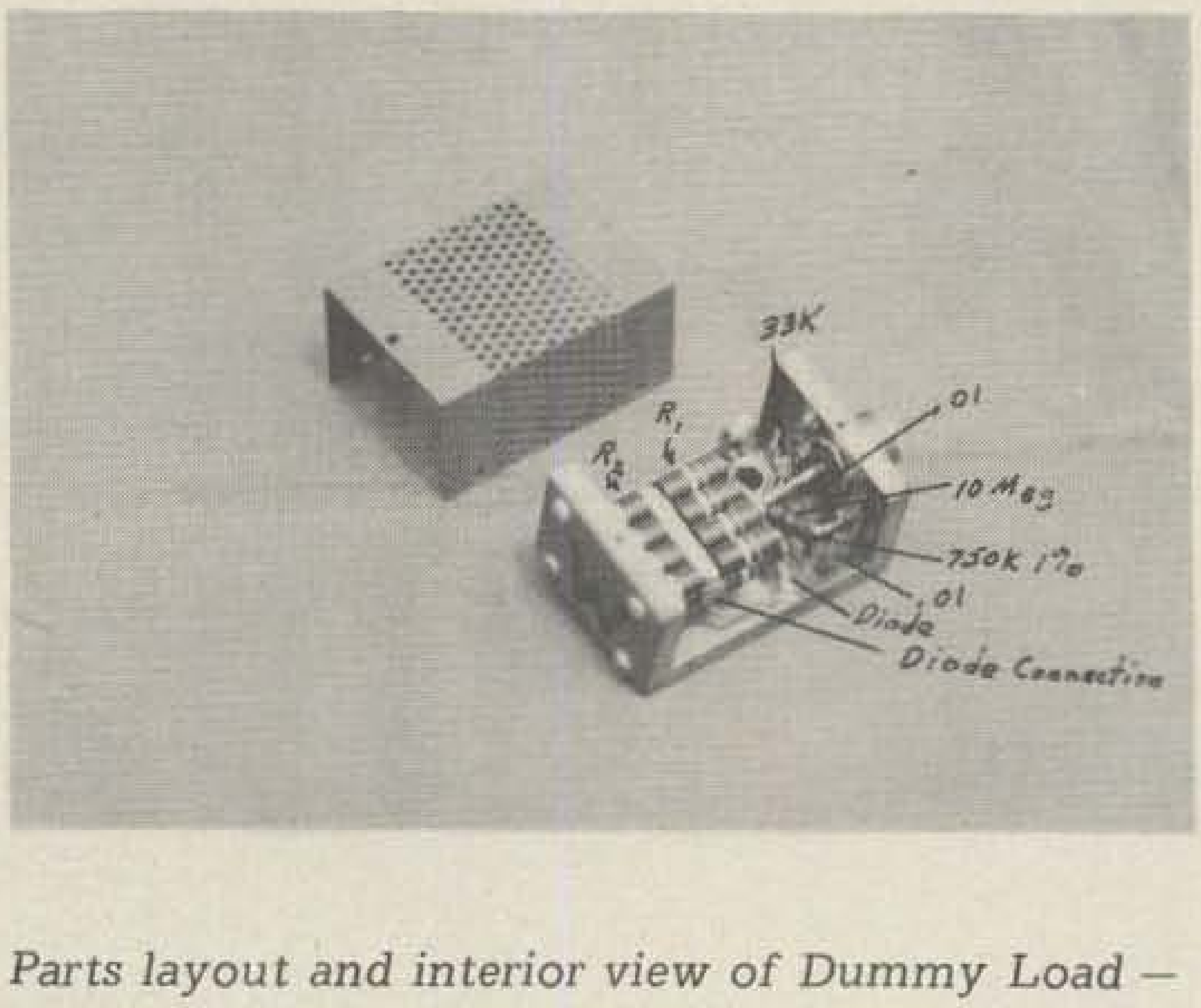
The unit

The unit described herein is similar to some 60 watt units which may be found around many commercial two-way radio shops. This dummy load has provision for connection to an external relative output meter. This external output meter may become an accurate wattmeter if the following criteria are met:

1. Frequency bandwidth of ±10% of calibration frequency.
2. RF output kept within power dissipation of dummy load.
3. Accurate initial calibration.

These criteria may be easily met in amateur vhf operation if only one band is considered for each set of calibration data. Since most vhf amateurs operate on 50 mhz, 144 mhz or 432 mhz, the ± 10% frequency limitations may be easily met. This limitation gives a 10 mhz bandwidth at 50 mhz, 29 mhz bandwidth at 144 mhz, and 86 mhz at 432 mhz. The limitation to the power ratings of the dummy load is only common sense, for if a resistive network is overloaded, the impedance may be drastically increased, caused by damage to the load resistors. The calibration limitation may be overcome if a standard, previously calibrated unit, or commercial unit is used.

The unit may be built for less than six dollars (less meter movement) if all new parts are purchased from Allied Radio, or at much less if a little scrounging takes place. The unit consists basically of 16 220 ohm resistors in a series parallel arrangement. The metering circuit consists of a germanium diode pickup with necessary *rf* filtering. The meter movement is generally a vom, but any 50 μa meter movement should suffice. Exact physical



Parts layout and interior view of Dummy Load – Wattmeter

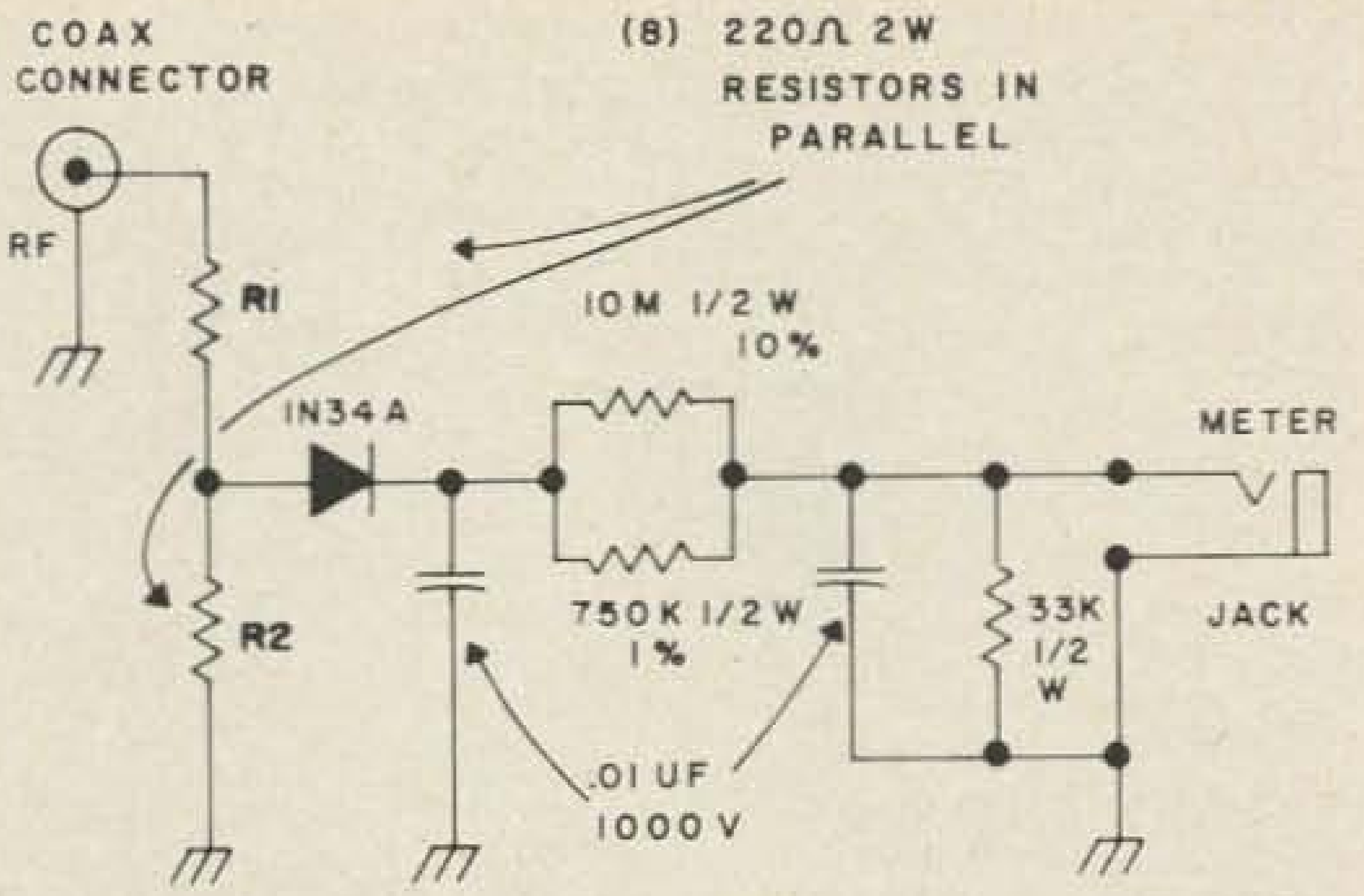


Fig. 1. Schematic. R1 and R2 consist of eight resistors each, in parallel.

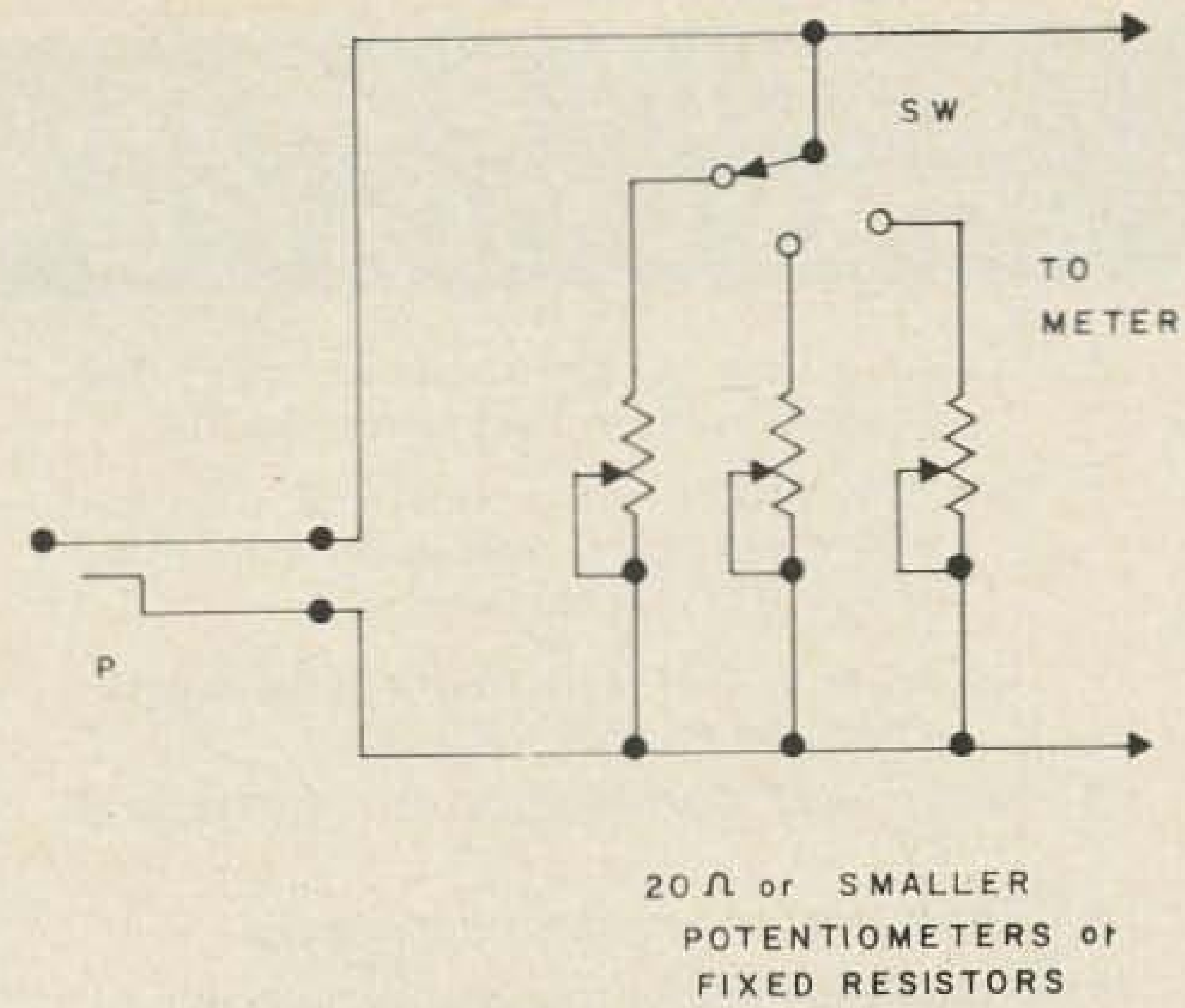
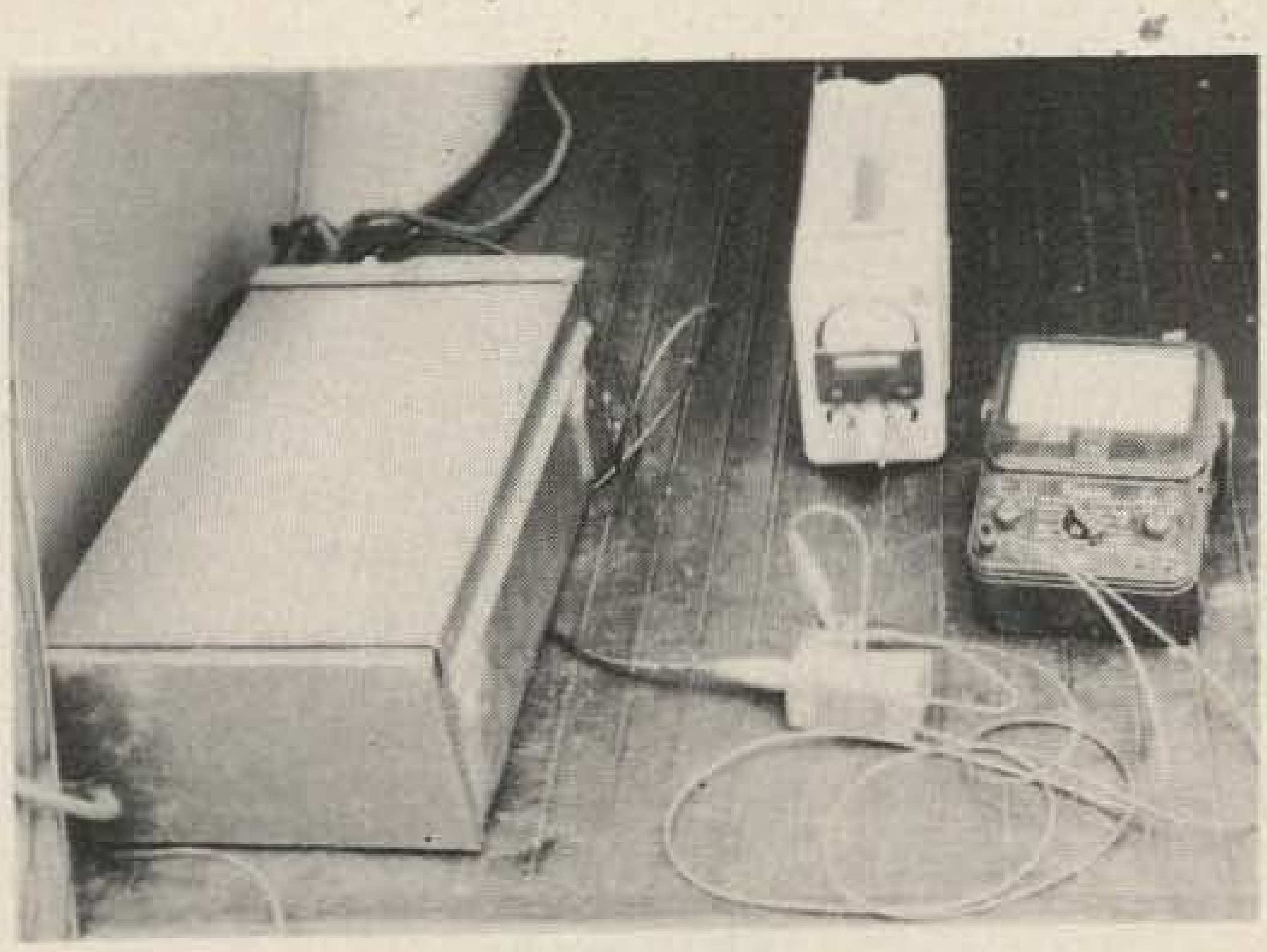


Fig. 2. Metering shunts.

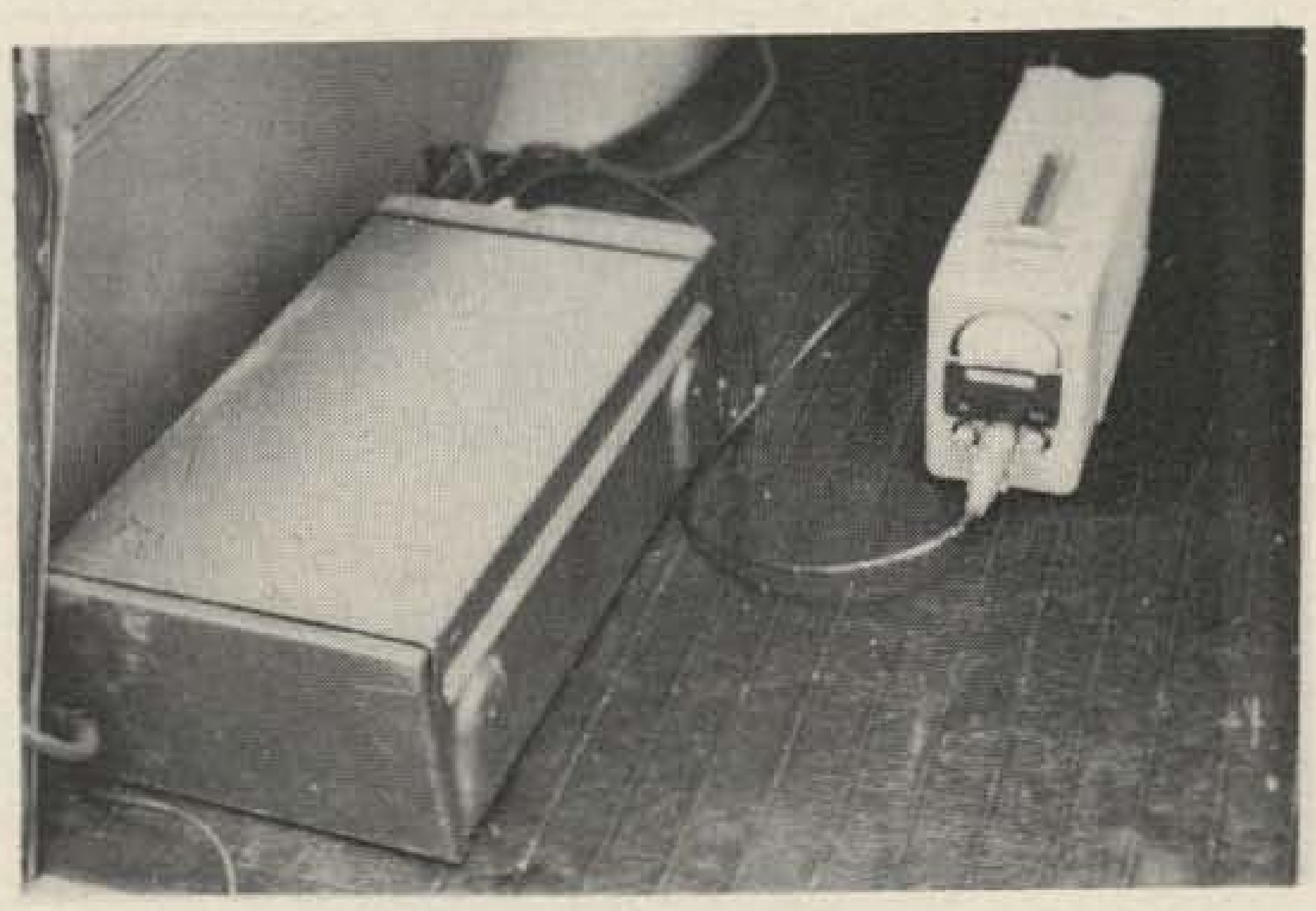
layout is not extremely critical, but it is suggested that the layout be made similar to the unit shown in the accompanying photographs. This unit is acceptable for 60 watt output transmitters without modification. The power capability may be increased to about 200 watts if the resistive network is suspended in 1 quart of oil. If this is done, care must be taken to keep the metering circuit out of the oil. The lead from the diode to the resistive network must, of course, be partly submerged, but keep the diode itself out of the oil. I do not personally use this arrangement, but I know of two units which have been in use at a large Southeastern two-way radio shop for several years. The same shop has incorporated a range switch with several meter shunts for various maximum scale power readings. This feature is especially useful to the amateur vhf fm operator who may be working with equipment of from ½ to 250 watt outputs. The schematic appears as **Fig. 1**, and the basic circuit for various meter shunts as **Fig. 2**.

Calibration

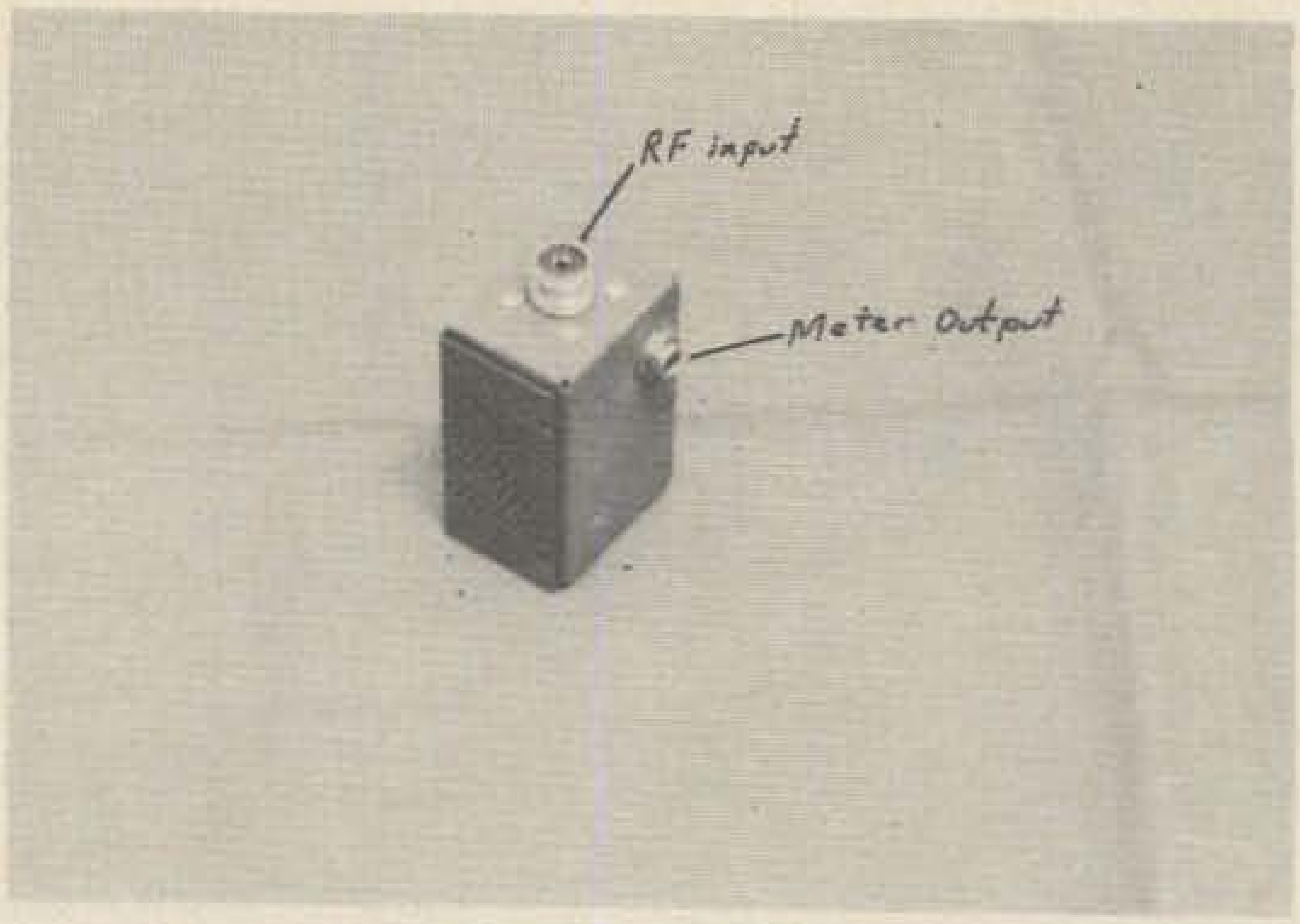
Calibration is best accomplished by using a Bird "Thruline" or similar commercial vhf inline wattmeter. Second choice is a Bird "Termaline" or similar dummy load-wattmeter. In both cases, a graph should be created by plotting meter divisions on the horizontal axis, and power on the vertical axis. The meter shunt should be placed at minimum resistance and increased to give maximum reading at the desired power level (this holds primarily true for units using the metering circuit of **Fig. 2**) or, if a vom or vtvm is being used the range switch should be placed on a high voltage setting and reduced a setting at a time until the desired reading is obtained. The transmitter should be adjusted for various power levels on the standard wattmeter and the voltage or current reading on the new meter recorded on the graph. In the case where the standard meter is of the dummy load-wattmeter type, it will be necessary to switch the coax from one unit to the other. Do not retune the transmitter, for each unit will present almost the same load to the transmitter (50 ohms). Take the reading and record as with an inline type of meter. The points on the graph should now be connected with a smooth curve (use of a draftsman's



Using a Bird "Termaline" to check output of FM unit.



Using the Dummy Load – Wattmeter to check output of FM unit.



External view.

range switch is used, it will be necessary to calibrate for each switch position. Also, if multi-band use is expected, the graphs must be made for each band. Use of the wattmeter now requires only the connection to the transmitter, setting of range switch to the proper level, and reading the graph.

Uses

The uses of this dummy load-wattmeter are as varied as the amateur mind can devise. One very important use is determining the losses of 50 ohm coax. Measure the output of the transmitter at the transmitter. Then measure the output at the end of the length of coax. The losses in the line become apparent. The loss in db may be calculated by the standard power ratio formula, 10 $\log_{10}$ Power out of coax/Power into coax.

Another use is the determination of efficiency of final amplifier stages. This efficiency may be calculated by Power out (measured by dummy load-wattmeter)/Power in (measured by plate current/plate voltage meter) x 100%. A third use is determining once and for all which amateur really has the most output. This list may be expanded by the builder to suit his own tastes.

Conclusion

This dummy load-wattmeter is not a Bird "Termaline" nor should it be regarded as a substitute for any other laboratory equipment. However, with a little care in calibration, (assuming a 5% accuracy standard is used for initial calibration) the accuracy should be within 10%, and this, my friend, is not bad for a wattmeter costing less than $10.

...K9STH

Bibliography

Johnson, Neil–A $2 200-Watt Dummy Load; 73 Magazine; May 1967; p. 66.

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An Experimental Sweep Oscillator

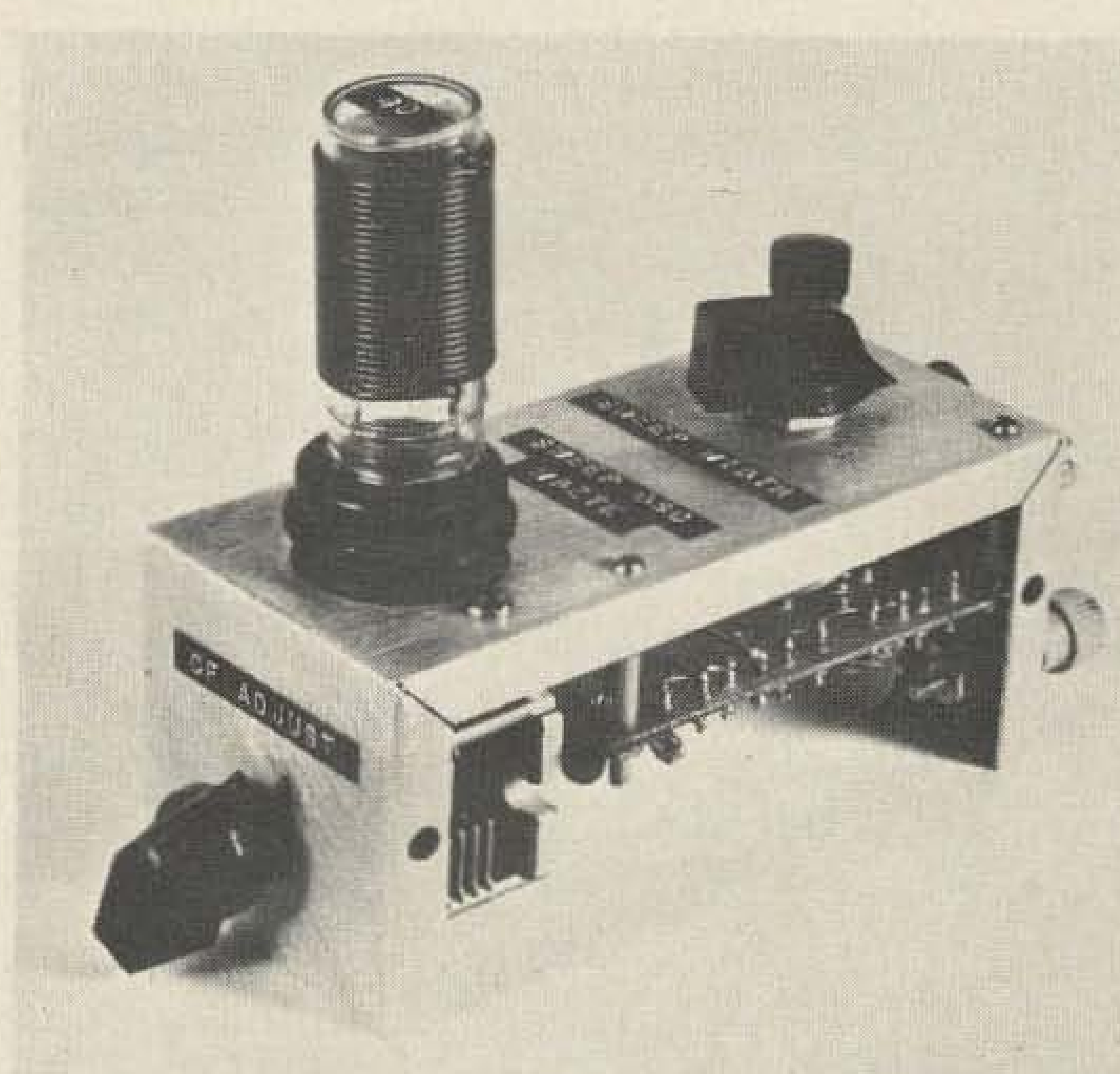
This article describes a sweep frequency oscillator that was put together to gain some experience before tackling a more sophisticated instrument to be used in a specific application. The unit described is relatively simple and can be used to sweep a signal across all or any portion of the ham bands below ten meters.

The heart of this device is a special diode called a varicap. All diodes exhibit some capacitance across their terminals when they are reverse biased; i. e. when a positive dc potential is applied to the anode with the cathode returned to the negative side of the supply. Varicaps are fabricated by special processes to make their capacitance in the reverse biased condition vary in proportion to the amount of bias voltage applied. A plot of the capacity variation with voltage is shown in **Fig. 1**. While the curve is not linear, it can be seen that from about 2 volts on up it does not vary too much from a straight line. Also, not much capacity change occurs above 5 volts bias, so the range from about 2 to 5 volts is the most useful part of the curve.

The curve in **Fig. 1** is normalized to unity capacity at 4 volts bias because nominal varicap capacities are specified at this bias level. To use the curve, the nominal value of the diode to be used is multiplied by the factor on the vertical scale at the bias applied to determine the capacity at that bias level. For example, the varicap used in this sweep oscillator has a nominal value of 12pF. If the bias voltage were 2 volts, the multiplying factor from the curve is about 1.4, so the capacity at 2 volts bias is 1.4 x 12 or 16.8pF. At 6 volts bias the factor is about 0.82 and the capacity at this voltage is 0.82 x 12 or just a little under 10pF.

Before beginning this project, some theoretical plots were made to see how a sweep oscillator with a varicap in the tuned circuit should function in terms of sweep widths with diodes of different increasing nominal values. These curves are shown in **Fig. 2**. The 80 meter band was selected for the calculations with 12, 33, 47, and 68pF diodes in the tuned circuit of the oscillator. The curves were set up so that the oscillator is on the same frequency at 4 volts bias no matter which diode is in the circuit. The total tuning capacity at this point was assumed to be 100pF. As the curves show, the entire 80 meter band could be covered with a 47pF varicap with reasonably good linearity. By limiting the voltage variation with the 47 and 68pF diodes, any portion of the band could be covered. On the basis of these curves at 3.5 MHz, the higher bands, where less capacity change is required for a given frequency shift, should present no problem.

To make an elementary sweep oscillator it is then necessary to provide the frequency determining circuit of the oscillator with a varicap as part of the capacitive element and



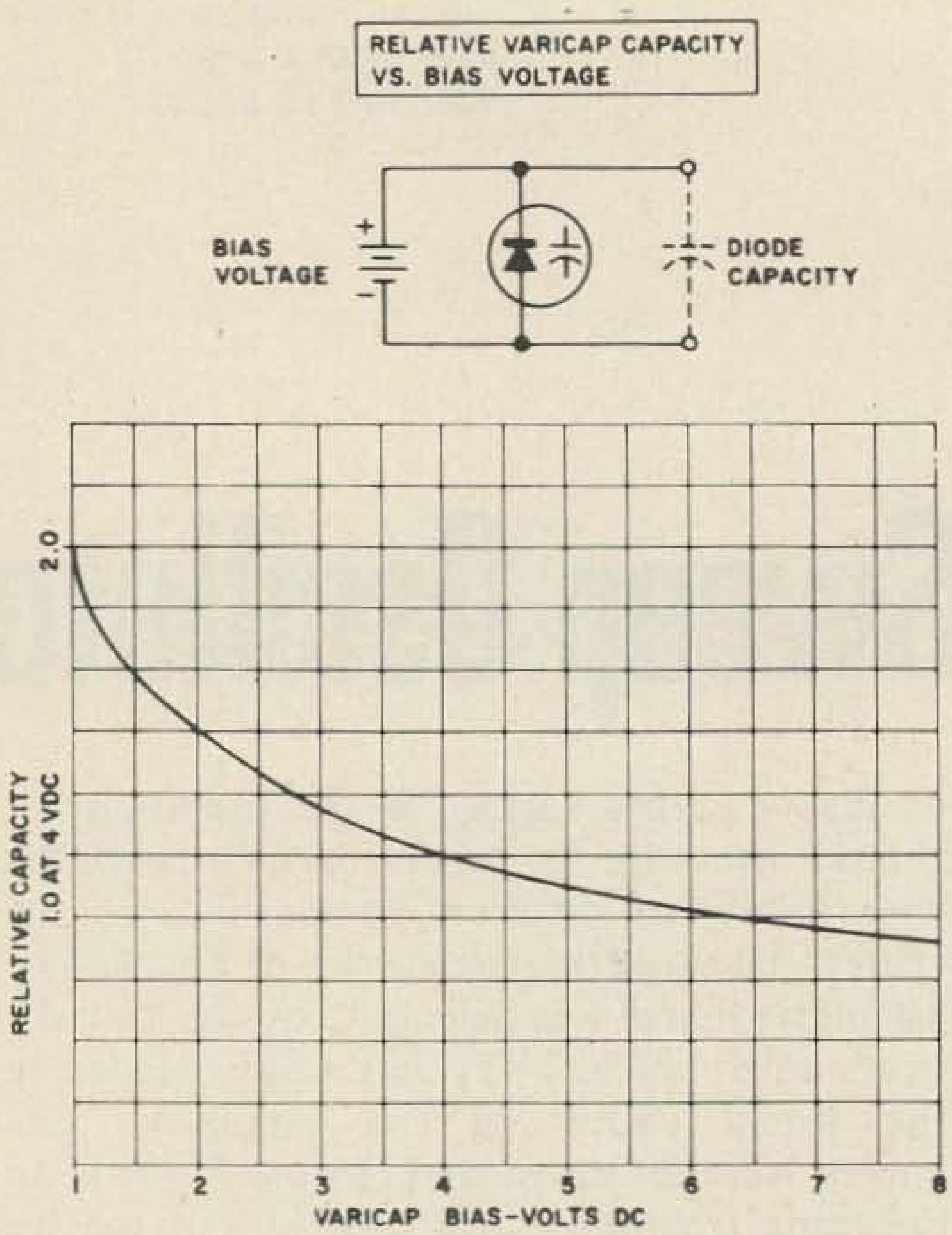


Fig. 1.

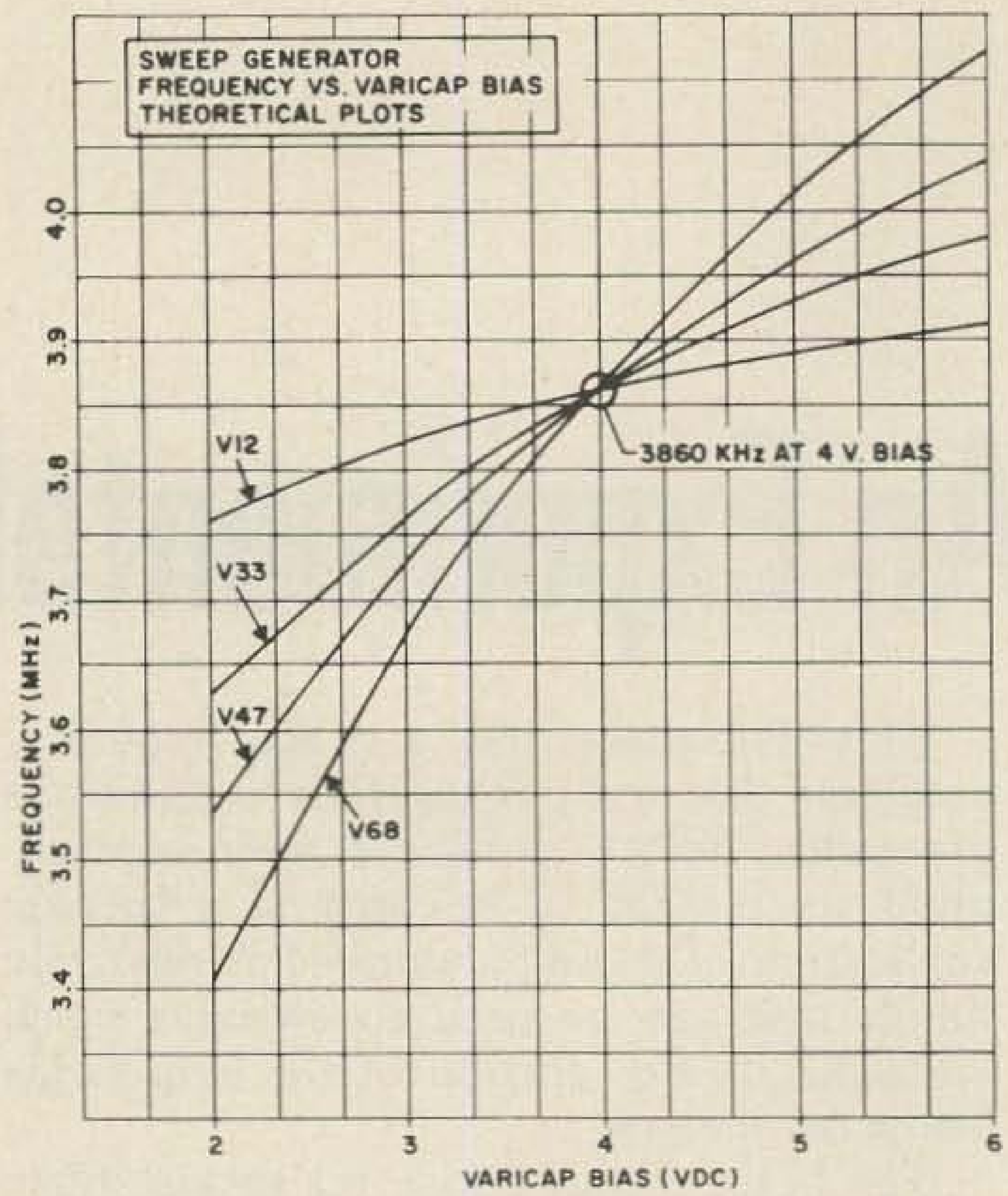


Fig. 2.

find some way to vary the dc potential across the varicap repetitively. The schematic diagram is shown in **Fig. 3.**

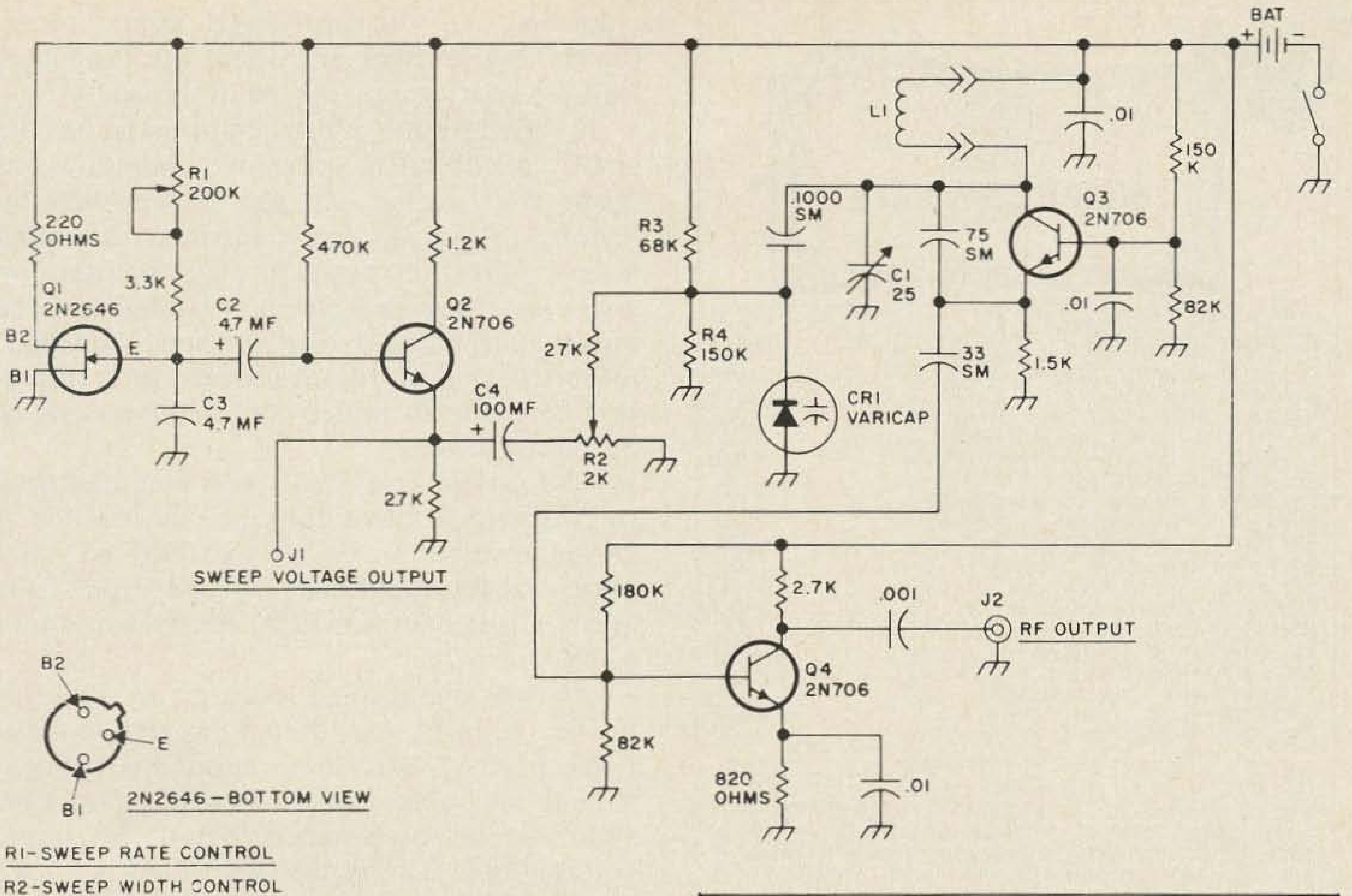
Q1 is a unijunction transistor relaxation oscillator that generates a sawtooth waveform. This sawtooth is used to provide the voltage variation across the varicap to provide the sweep function. The potentiometer R1 sets the sweep speed and can adjust the sweep rate from under one sweep per second up to about 50 sweeps per second. The sawtooth from the unijunction is coupled into Q2 which feeds the varying dc voltage to the varicap. Q2 also provides a sweep output that can be applied to an oscilloscope as will be described later. Potentiometer R2 adjusts the amount of voltage variation applied across the varicap which controls the amount of frequency shift or sweep width.

The oscillator section is straightforward. The 25pF air variable capacitor C1 is used to set the center frequency around which the oscillator is to be swept. The frequency set capacitor is kept at a small value so that the relatively small variations in varicap capacity have a sufficient effect on the frequency and thus the sweep width. At the higher frequencies not much capacity variation is required, and the width of sweep can be adjusted by R2 if it becomes too great.

Q4 is used as a straight amplifier to boost the output signal to a usable level and to provide isolation between the oscillator and whatever load might be applied. The unit described provided about 2.5 volts rms on the 40 meter band and about a volt rms on 20 into a high impedance load.

The unit shown in the photograph was built in a 2¼ x 2¼ x 5" Minibox. As was mentioned earlier, this project started out as an experiment and a larger enclosure might have been better since the parts became rather crowded after several additions and modifications were made. The center frequency adjust capacitor C1 is mounted on the front apron of the box with an octal socket for the plug in coils mounted immediately above it on top. The sweep width potentiometer R2 is mounted on top toward the rear. On the rear apron are the sweep rate control R1, a BNC *rf* output connector and a universal binding post for the external sweep output connection. Originally it was planned to use a fixed sweep rate, but when a variable rate was found to be useful the rate control took the spot that was intended for an on-off switch for an internal battery. As a result, two binding posts were mounted for connection to an external battery or power supply.

The circuit is wired up in typical transistor construction fashion on a phenolic board. The unijunction circuitry is toward the rear and the oscillator/output amplifier



COIL TABLE		
FREQUENCY	DIAMETER	WINDING
7 MHz	7/8"	26 TURNS – 1 1/8" LONG
14 MHz	7/8"	7 TURNS – 1/2" LONG

Fig. 3. Schematic.

GENERAL NOTES ON SCHEMATIC – FIG. 3

ALL FIXED RESISTORS ARE 1/4 WATT COMPOSITION
.001 AND .01 CAPACITORS ARE DISC CERAMIC
CAPACITORS MARKED "SM" ARE SILVER MICA R1
AND R2 STANDARD CARBON ELEMENT POTENTIOMETERS
C2, C3, AND C4 ARE ELECTROLYTICS-25WVDC OR MORE

toward the front near the center frequency capacitor. The board is supported on 1" pacers from the top of the minibox.

The plug-in coils are wound on plastic coil forms (I used pill bottles) 7/8 inch in diameter. Winding data is given in the table. After the turns have been adjusted to cover the desired range the forms are cemented to octal plugs. The only coils wound for this experimental version were for the 40 and 20 meter bands.

Amateur bands were chosen for ease in checking sweep widths with the bandspread scales on a receiver. When the oscillator is functioning it can be heard sweeping across the band in use. By tuning across the band, the upper and lower limits of the sweep range can be found when the thumps as the oscillator goes by can no longer be heard. With the circuit shown it was possible to sweep all but about 30 kHz of the 40 meter band, and on 20 meters the sweep width was a little over 400 kHz, covering more than the whole band. Minimum sweep width on both 20 and 40 was between 10 and 20 kHz. No attempt was made to calibrate the center frequency capacitor because this can be found by the receiver calibration. Also, the center frequency depends somewhat on the sweep setting, as is explained later.

Applications for this device will probably suggest themselves to anyone interested in trying such a gadget. Of course it can be used in conjunction with an oscilloscope to get a visual display of the frequency response of the tuned circuits in an *rf* amplifier by connecting the external sweep output to the horizontal input of the scope and the amplifier output to the vertical channel. Also, by just using the external sweep connected to the horizontal input, sweep speeds lower than provided by the usual garden variety scope can be obtained.

In conclusion, a few comments on the circuit might be in order. No provision was made for turning off the sweep; but by turning the sweep rate control to its maximum resistance position, the unijunction stops and thus the sweep. I found that the signal, with the sweep stooped, sounded rather coarse in the receiver; but this is probably due to noise, etc., being picked up by the varicap.

The varicap used is a V12E manufactured by Pacific Semiconductors. This series is available values from 7pF to 100pF so wider sweep ranges could easily be achieved. They are available from Allied Radio for about $3.00.

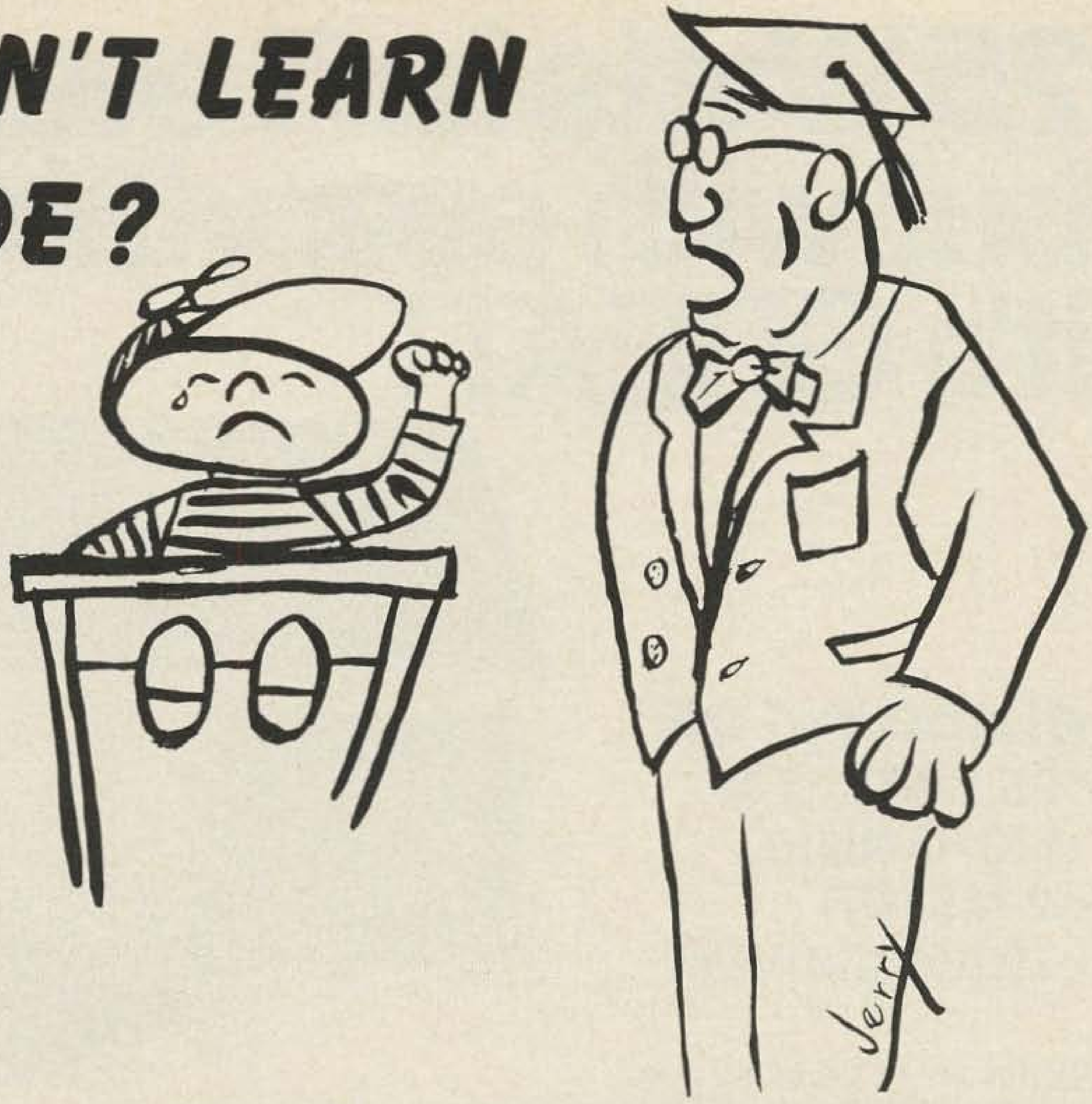
As was mentioned before, an external power source was used. Supply voltages from 12 to 18 volts are about right, but it should be pointed out that the resistors R3 and R4 must be adjusted to suit the supply voltage used. These resistors (along with R2 and the 27K resistor feeding the sawtooth to the varicap) form a voltage divider which sets the static bias on the varicap. To set this up, set the sweep rate at a low speed and connect a vtvm across the varicap. As the voltage divider R3 and R4 is adjusted the vtvm will swing back and forth slowly with the sweep. The divider should be adjusted so the meter swings around approximately 3.5v as a center point. Since the sweep width control R2 is in parallel with R4 through the 27K resistor, changing the sweep width will also change the center frequency slightly because the static bias level on the varicap will be changed.

The curves of Fig. 2, while being theoretically sound, cannot be duplicated on 80 meters with the circuit shown because the voltage shift across the varicap is not enough to produce the shifts shown.

Although this generator is rather simple, it proved to be a very interesting project and much was learned. The general circuit shown, with varicaps of larger value and suitable coils, should be capable of providing any desired shift at any frequency. An obvious application would be to build this sort of device to tune 455 kHz (or other if frequencies) for receiver alignment purposes. A different oscillator circuit would be required and plans are under way to try this in the future.

. . . W9ZTK

WHO CAN'T LEARN THE CODE?



R. B. Kuehn WØHKF
1212 Bellows St.
St. Paul MN 55118

I'd give anything to get an amateur license, but I'm one of those people who just can't learn the code." It seems there are more of these unfortunates each year swirling around the fringes of ham radio. Let me tell you how this supposed inability to absorb an elementary skill all began.

Many years ago there was no such thing as a person who couldn't learn the code. With equal enthusiasm young Johnny Ham tackled learning the code and how to build and operate his station. The required code speed in those days was only 10 words per minute for the General Class license, but then the only reason the FCC has since raised it to 13 wpm, I understand, was in response to the widespread conviction that the present generation has at least 30% more on the ball than the preceding one.

Then along came WWII with its urgent demand for far more military CW operators than amateurs could possibly supply. The armed forces set up radio schools and one of the entrance requirements was to pass a "code aptitude" test. Fellows with recent exposure to military methods can vouchsafe that even today the armed forces are not notably successful in placing men in the areas of their greatest talent and interest.

Imagine then how it was 30 years ago in the hurry and confusion of an approaching war. Great numbers of would-be radio operators were told they had no code aptitude and were summarily sent off to become cooks or hospital orderlies – for which they probably had no aptitude either.

With war's end and the resumption of amateur radio it didn't take long for the miliary radio school dropouts to spread the idea that many people lack the wits to learn the code. Nonsense.

Anyone who has learned that when he hears the three syllables ' dou-ble-you" pronounced it represents the letter W can also learn that three other syllables, "dit-dah-dah" represent the same letter in Morse code. If one letter can be learned so can the others – it's that easy. Building up speed is then a simple matter of repetition just as in any other subconscious skill, like tying your shoes, for instance.

Is there a valid argument to the contrary? If there is, I've never heard it!

. . .WØHKF■

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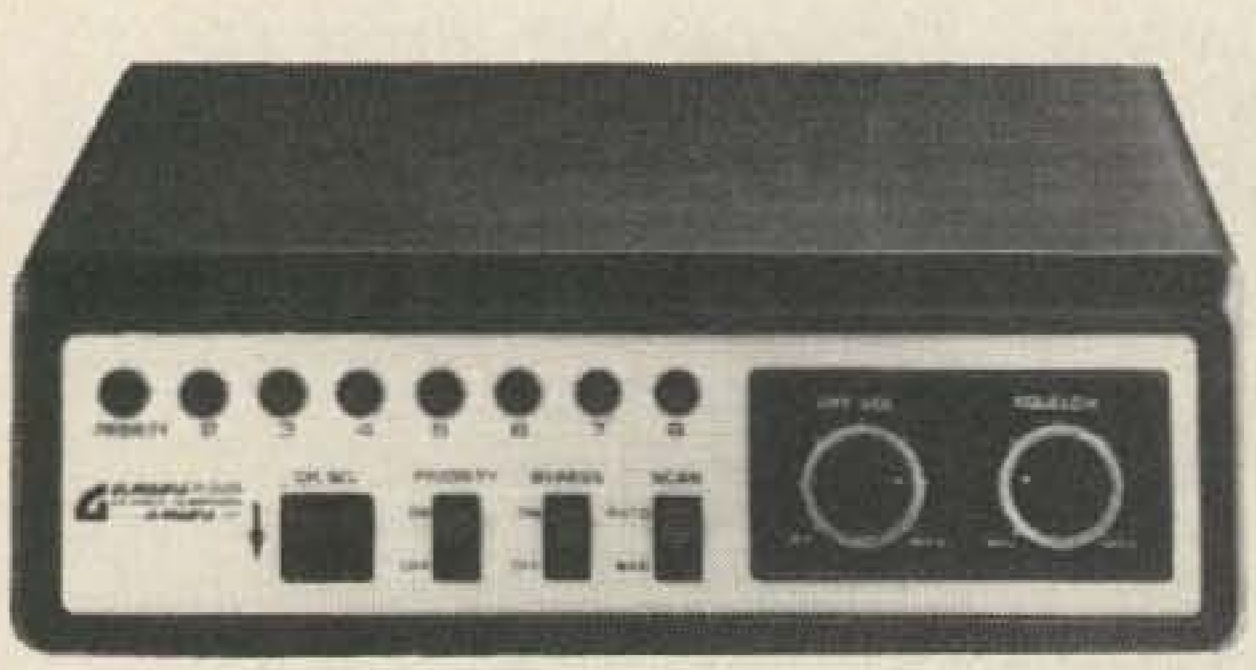

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The Greater Dipper

Introduction

To the uninitiated, a grid dip oscillator is neither glamorous nor exotic, even if it does happen to be transistorized. But to those who have ever tried to put a coil on frequency, one is worth its weight in microcircuits.

The original model of the *Great Dipper* proved to be a versatile, if unexciting, grid dip oscillator. Intended to be used mostly at VHF, the dipper was limited to frequencies above 28 MHz. To those who seldom operate above 10 meters, the lack of frequency coverage below 28 MHz was a definite handicap. Expanding the frequency coverage downward extends the dipper's usefulness considerably.

Component changes made were not extensive, nor were the physical dimensions of the unit changed. The schematic diagram of the modified circuit is shown in **Fig. 1**, and the pictorial diagram of **Fig. 2** is included to supplement the photographs printed in the original article.

Modification

First, the oscillator circuit board should be rotated 90 degrees from its original position so that transistor substitution or replacement can be made easily. A microwave diode might be substituted for the original glass computer-type diode; this results in better performance at VHF, but its effect cannot be accurately predicted. A 1N21 or 1N23 diode could be used in place of the D4900 called for in the schematic. Best oscillator performance over a wide frequency range results from using a 5 pF capacitor as the collector feedback coupler, but this was a compromise value. If operation is likely to be confined to either the HF or VHF segments of the radio spectrum, some experimentation with this capacitor should result in improved performance over that particular range. For experimentation, use a 3-12 pF or 4-30 pF trimmer.

To perk up meter amplifier performance, replace the 2N918, a relatively high gain, low leakage transistor. Meter amplifiers are not difficult to construct, and more information on them can be obtained from articles published in 73 Magazine.[2,3]

Although the change was not made in this unit, a 6-100 pF (MAPC-100) variable capacitor could be substituted for the existing 5-50 pF unit. As can be seen from the full-size scales, frequency coverage is narrow on the 13-23 MHz plug-in coil. Those who

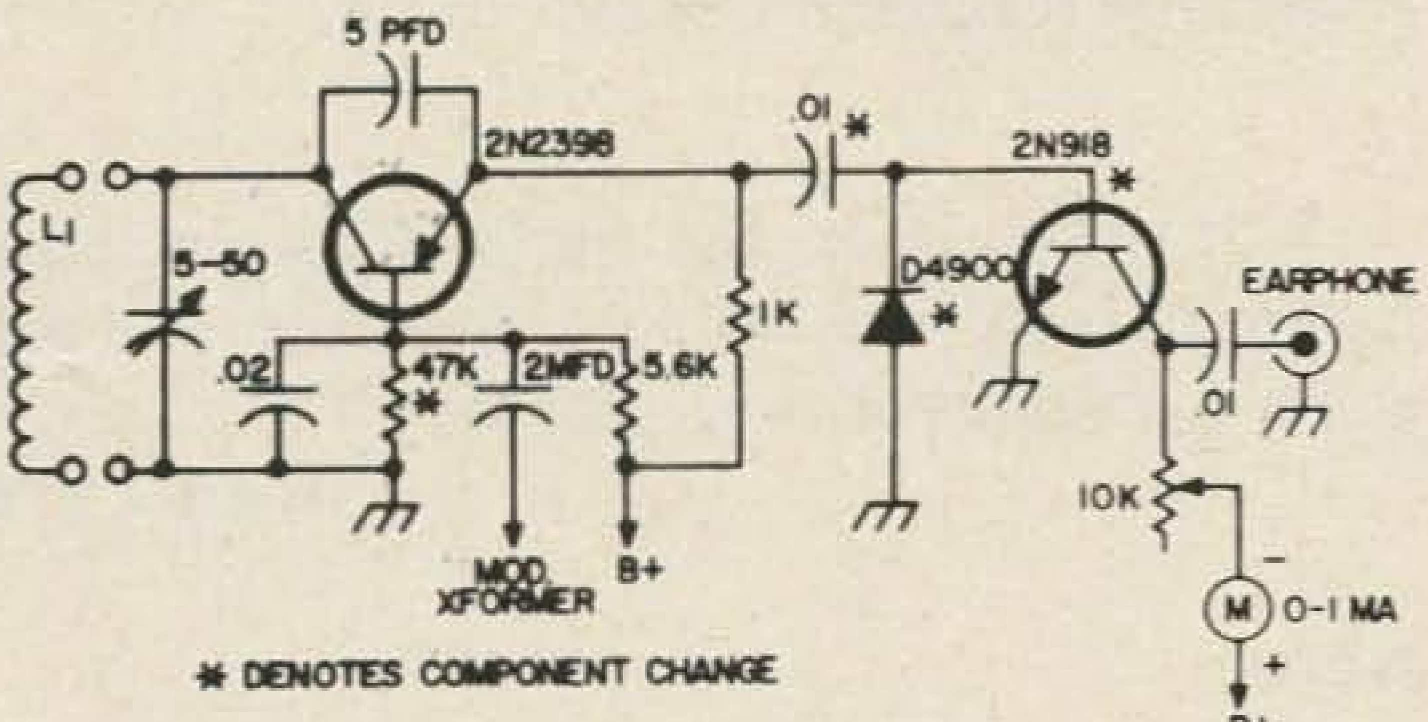

*Fig. 1. Schematic of modified circuit, with component changes indicated by *. L1: 13-23 MHz, 14½ turns No. 20; 22-44 MHz, 5¼ turns No. 24, 45-90 MHz, 1½ turns No. 24; 90-195 MHz, 2½ x 3/8 in.*

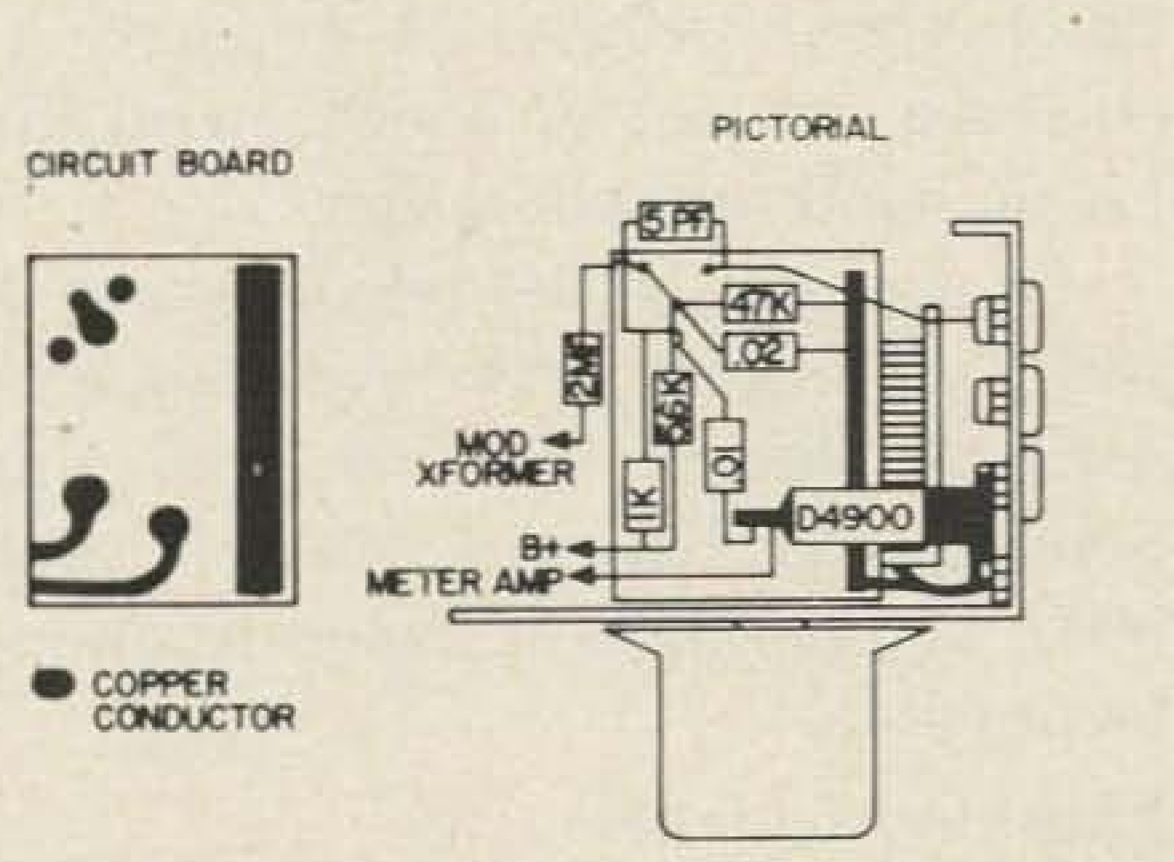

Fig. 2. Pictorial view of the dipper and its circuit board.

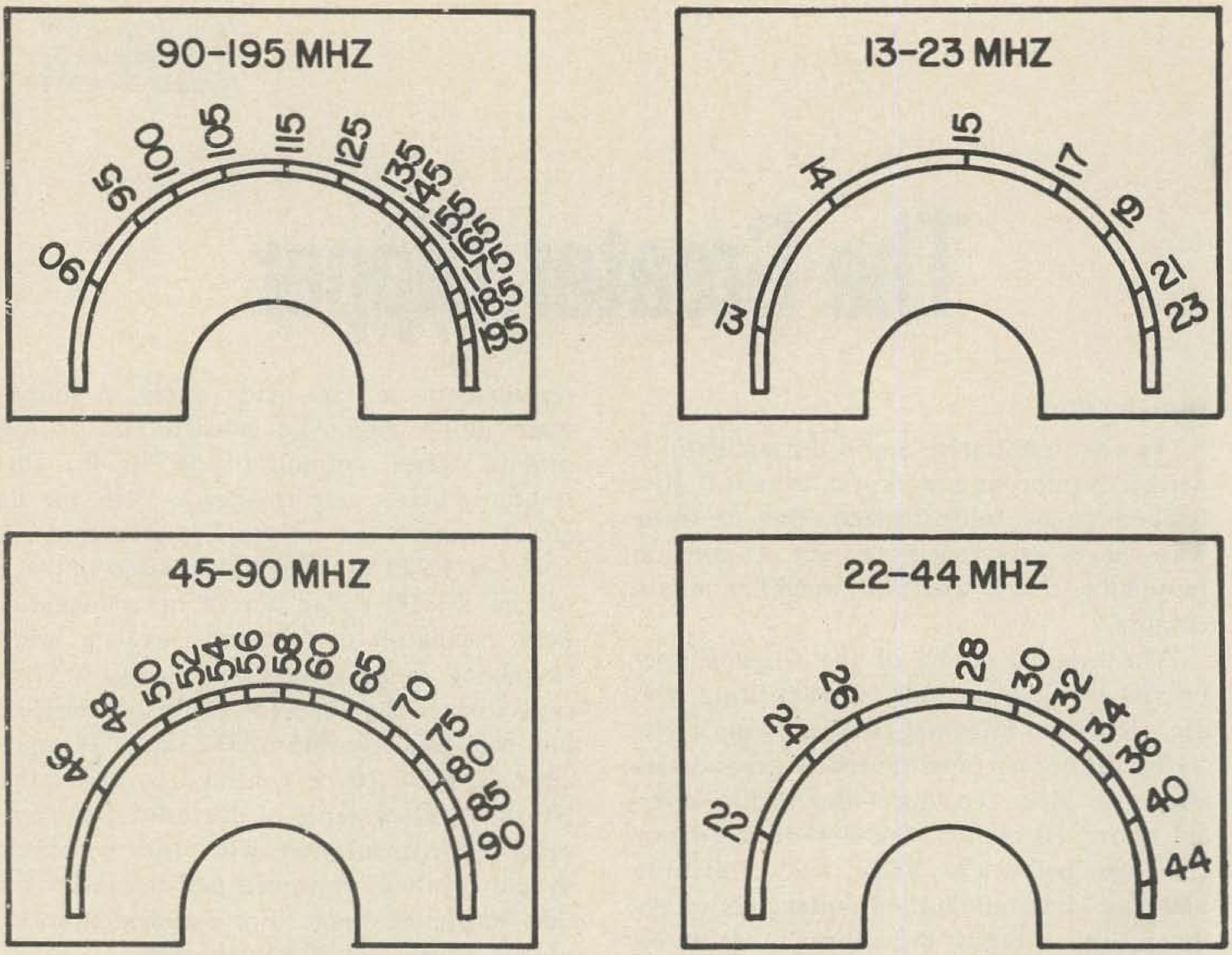

Fig. 3. Dial designs for the various MHz ranges, full size.

frequently construct HF gear might benefit from the substitution.

Operation

Operation of the dipper is the same as before, except the frequency range is greater. Another coil must be wound for the 10-25 MHz range, but existing coils were not modified. Calibration is now different from before; full-size scales are included with this article for those who do not have a general-coverage receiver or another grid dip oscillator on hand for calibration.

Oscillation is still vigorous at 13 MHz, which indicates lower frequencies may be reached with a suitable coil plugged in. Similarly, oscillation is still noticeable at 195 MHz, so operation at higher frequencies may be possible.

Finishing Touches

Appearance of the dipper was improved after enlisting the help of a draftsman. The dial and meter scales were professionally inked. **Figure 3** provides full-size copies of these scales.

To improve the legibility of the labels and scales, they were inked on yellow cards rather than on conventional white paper. It's a small point, but for those who use test equipment frequently, the black-on-yellow technique results in less eye strain.

Pull the plug on the rig; in its stead, plug in your trusty (rusty) soldering iron and get started on this small project.

. . . WAØ AYP■

Notes:

1. "The Great Dipper," John Boyd WAØAYP, August, 1967, 73 Magazine, p. 42.
2. "Transistor Meter Amplifiers," Jim Fisk WA6BSO, January, 1966, 73 Magazine, p. 44.
3. "73 Useful Transistor Circuits," Jim Fisk W1DTY, $1 from 73 Magazine, p. 31A.

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Mt. Edgecumbe AK 99835

CQ DX on ½ WATT

If someone had told me that one day I would be getting out on the air *too* well I would have administered a well-placed kick and gone back to grumbling about TVI, ignition noise, tower restrictions, and the like. Well, here I was on an isolated Coast Guard station far from TV and motor vehicles. I had a full kilowatt and a tower topped with a three-element beam. And I was bored.

In the first six months on the island I had worked DX as I had never done before. I operated USB, LSB, DSB, and NO SB (CW) – and the DX poured right in. Before long, however, the novelty began to wear mighty thin and, since I am not a certificate collector, I began to cast around for something new.

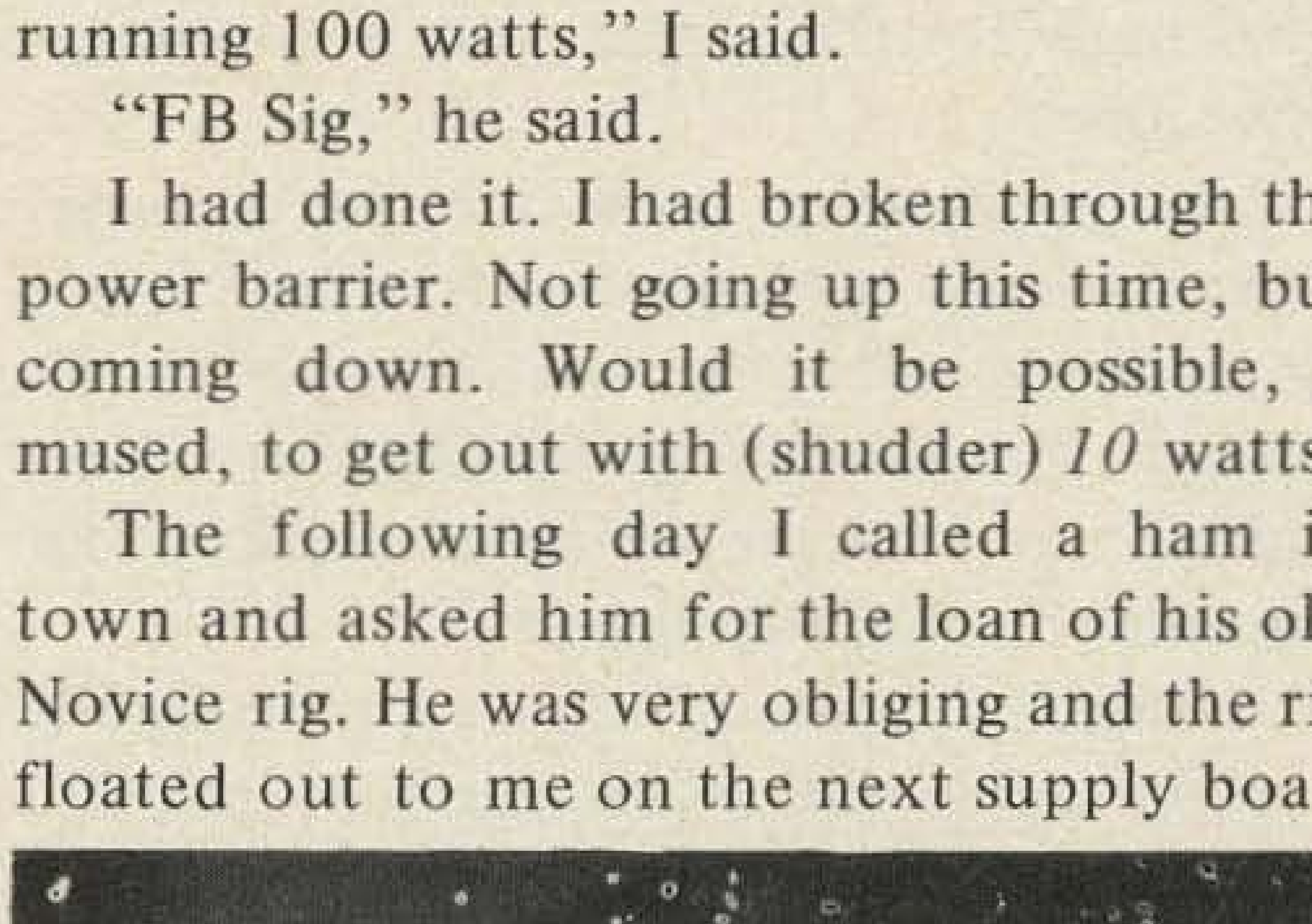
The idea of QRP operation ("low power," if you're not in the know) came by accident as I listened around the band one night. There at the low end of 20 was a UA9 calling CQ. Deftly, I zeroed in on him and keyed back the usual short, confident reply. As I rapped out *KN*, I realized that in my haste I had neglected to flip the plate switch on the Thunderclap XVII. Without the big rig, I was naked – a defenseless victim for QRN, QRM, and QSB. I would never get through. But what was this? An answer!

My hand shook on the key: "Rig is running 100 watts," I said.

"FB Sig," he said.

I had done it. I had broken through the power barrier. Not going up this time, but coming down. Would it be possible, I mused, to get out with (shudder) *10* watts?

The following day I called a ham in town and asked him for the loan of his old Novice rig. He was very obliging and the rig floated out to me on the next supply boat.



A 6AG7 in working condition for the tube and a clean board for the chassis.

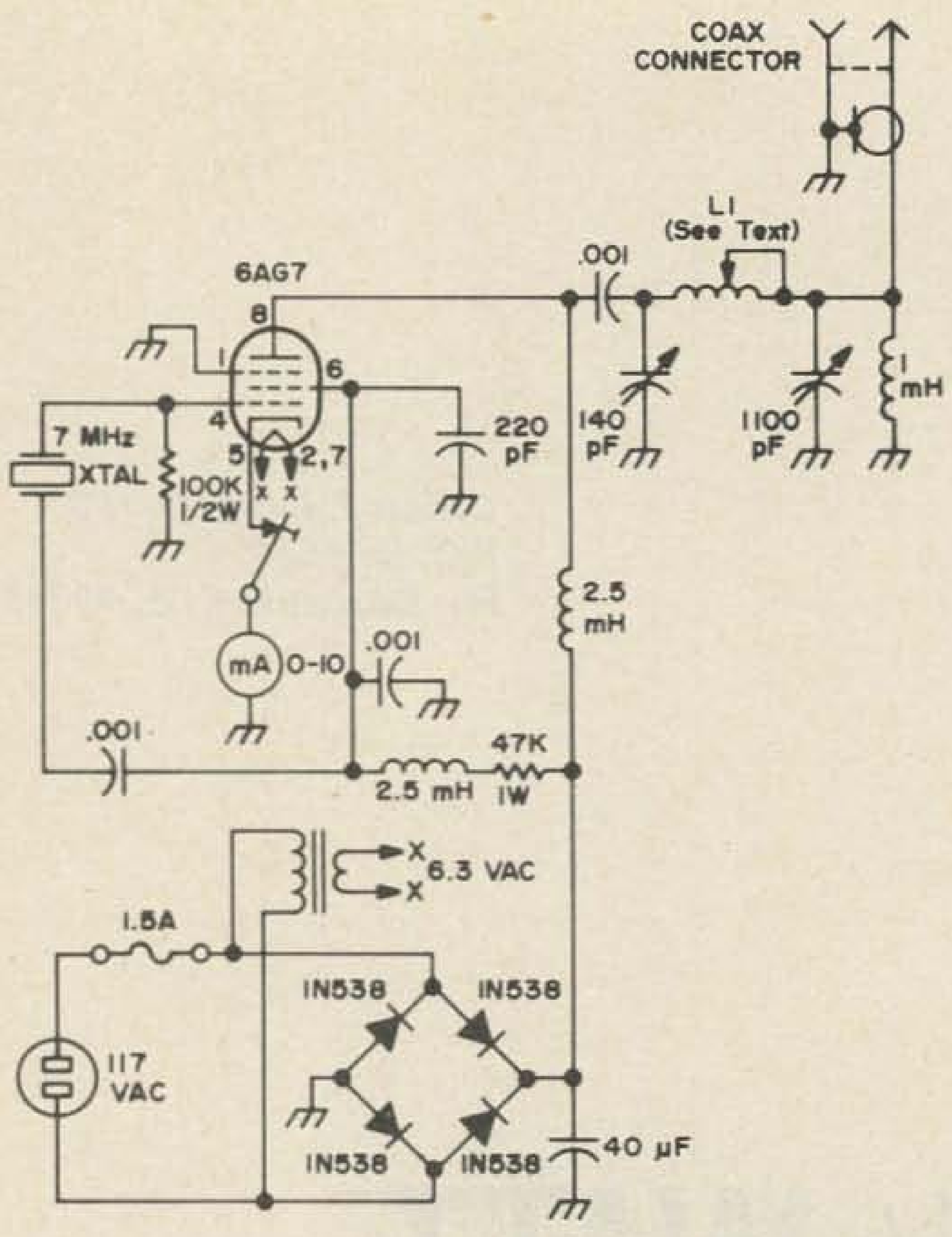


Fig. 1. This "monster" really works. 1.2W input but lots of contacts. This is real QRP.

I set it up and measured the input. Eleven watts – almost. It was close enough! And it was crystal controlled! I put it on the air, and within a week I had accounted for 14 states and 3 countries. What next?

The inspiration took me by surprise. One moment I was moping over the Novice rig and the next I was digging busily through the junkbox, pulling out likely looking components for a rig to end all rigs (and maybe all QSOs too).

Could I, I mused, build a rig using one receiver tube and junk parts of the TV variety? Could I nail them all to an old board and still make a contact? Could I?

Well, a 6AG7 in working condition was the tube, and a clean old board the chassis. I could not find a transformer anywhere, so line voltage would have to do. I did find a filament transformer after a mighty search. I was really sweating the vision of a big bank of resistors or a long string of do-nothing tubes to drop the line to 6.3V.

All went well and Fig. 1 shows the result of my labors in low-class circuit design. Some of the component values I figured out by use of formula but, as many have found, it just doesn't want to work that way. So I was forced to resort to put-it-in-and-try-it techniques. If you have a grid dip meter around you've got half of it licked right there.

The rig is a funny sort of Pierce oscillator and amplifier all in one metal-cased tube. I put in a pi network to match the 50Ω transmission line impedance. The key and meter are in the cathode lead (she'll chirp like a bird, I thought).

The tank coil is a wonder. You can't help but wonder why it is so big. Why would anyone in his right mind want to put a 500W coil in a 500 mW rig? Well, it seems that in the junk heap I came across this nice shining 12-gage wire; and since I didn't have any small coil forms anyway, what the heck! I spaced its 11 turns with hunks of rubber so that I came out with about three turns to the inch and a length of about 4 in. I rolled it on a partly empty roll of Teletype paper so the diameter just happened to come out to 3½ in. I drilled holes in the side of my wooden chassis and hammered the ends of this little beauty into them so it is mounted nicely on the side of the rig. An alligator clip provides for tuning but as it turned out, the coil works best without any of it shorted.

This monster really works. The tube runs at 150V and 8 mA when dipped (10 mA not dipped). This figures out to about 1.2W input and, considering the efficient design, I would imagine about 500 mW or below ever sees its way to the antenna. It is barely enough to move the pointer on my swr bridge more than half an increment – and you have to look closely to see it move!

When the plate is dipped carefully there is no chirp, and the rig puts out a fairly clean signal. Because I am keying the oscillator, I always monitor with the receiver to make sure there is no chirp or frequency drift.

After a week of operation on 40m with a dipole 10 ft up, the rig turned in great reports from everywhere. So what next? I wonder how a souped-up version of the 2N107 would work out?

. . .KL7FSX■

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20-60w 1-4 BAND TX

It is indeed easy to build a transmitter which will run 20–60W on 7, 14, 21, or 28 MHz with excellent efficiency. Figure 1 is the circuit, and this is so well proved that it would be difficult to find any snags; and the constructional work could scarcely daunt anyone. Probably few other circuits can give so much with so little complication. You can even connect a modulator if you like – either for screen grid, or both plate and screen (high-level) voice working.

The 5673 is a crystal oscillator able to provide output on the crystal frequency, or multiples of this. As an example, a 7 MHz crystal will allow working on 7, 14, and 21. This type of oscillator is astonishingly easy to get going.

L1 is the plate coil, tuned by C1. L1 is for the band on which output is required from the transmitter, so that the power amplifier works straight through on all frequencies. The final is a 6146, and running up to 100 mA at 600V (60W input), it is well within its ratings. As a 6146 can easily cook itself with its own juice off-tune or without bias, and bias is obtained by grid current through R3, a 5

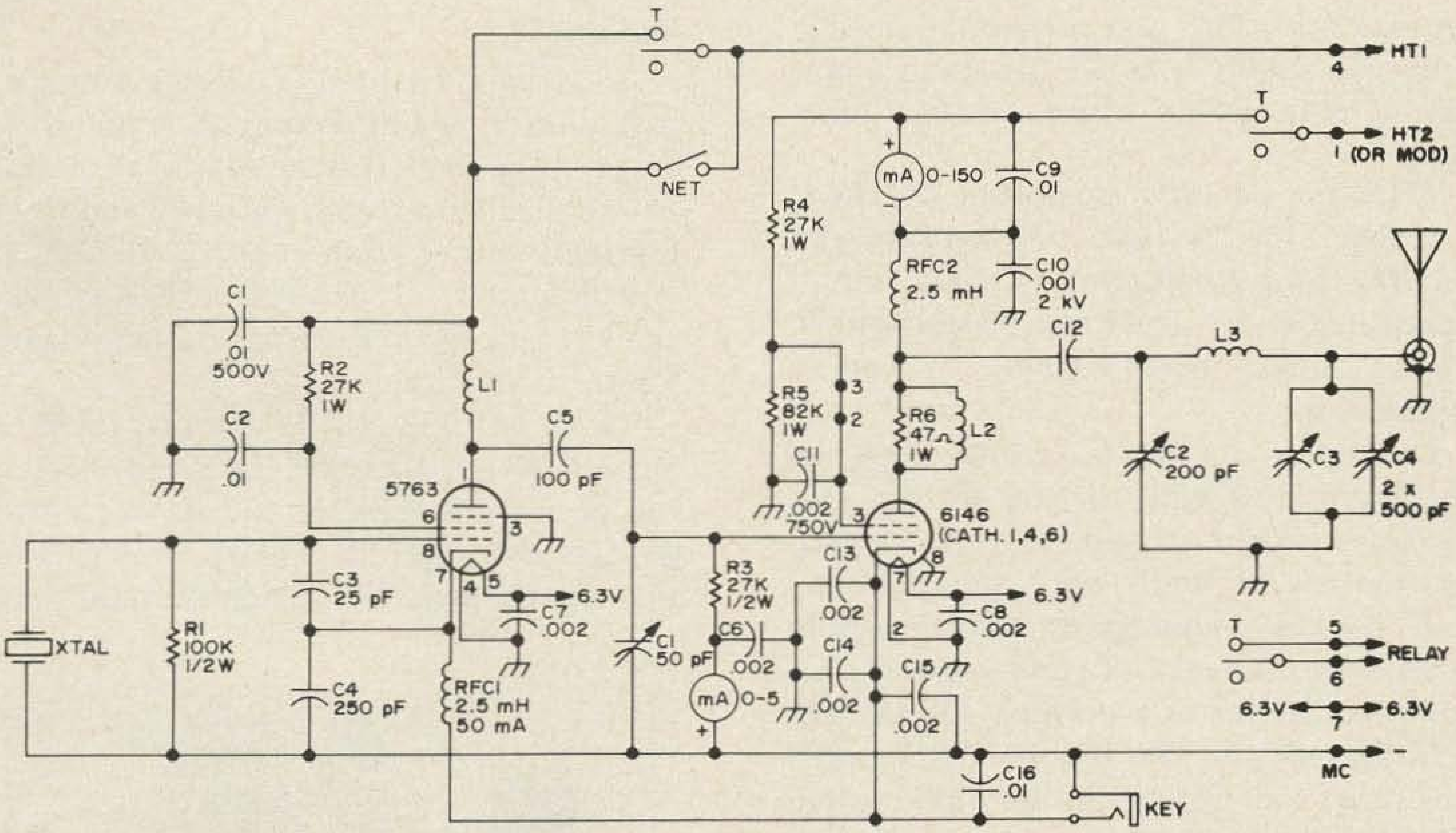


TABLE 1–DATA				
BAND	DIAMETER	NO. OF TURNS	GAUGE	LENGTH
7–L1	1/2 in.	40	24	—
L3	1-1/4 in.	22	18	2 in.
14–L1	1/2 in.	20	24	—
L3	1-3/4 in.	10	16	1-1/8 in.
21–L1	1/2 in.	9	22	—
L3	1 in.	11	16	1-1/4 in.
28–L1	1/2 in.	9	22	—
L3	1-1/4 in.	5	14	1 in.
NOTE – L1 ALWAYS HAS TURNS SIDE BY SIDE				

Fig. 1. Circuit of 1–4 band transmitter.

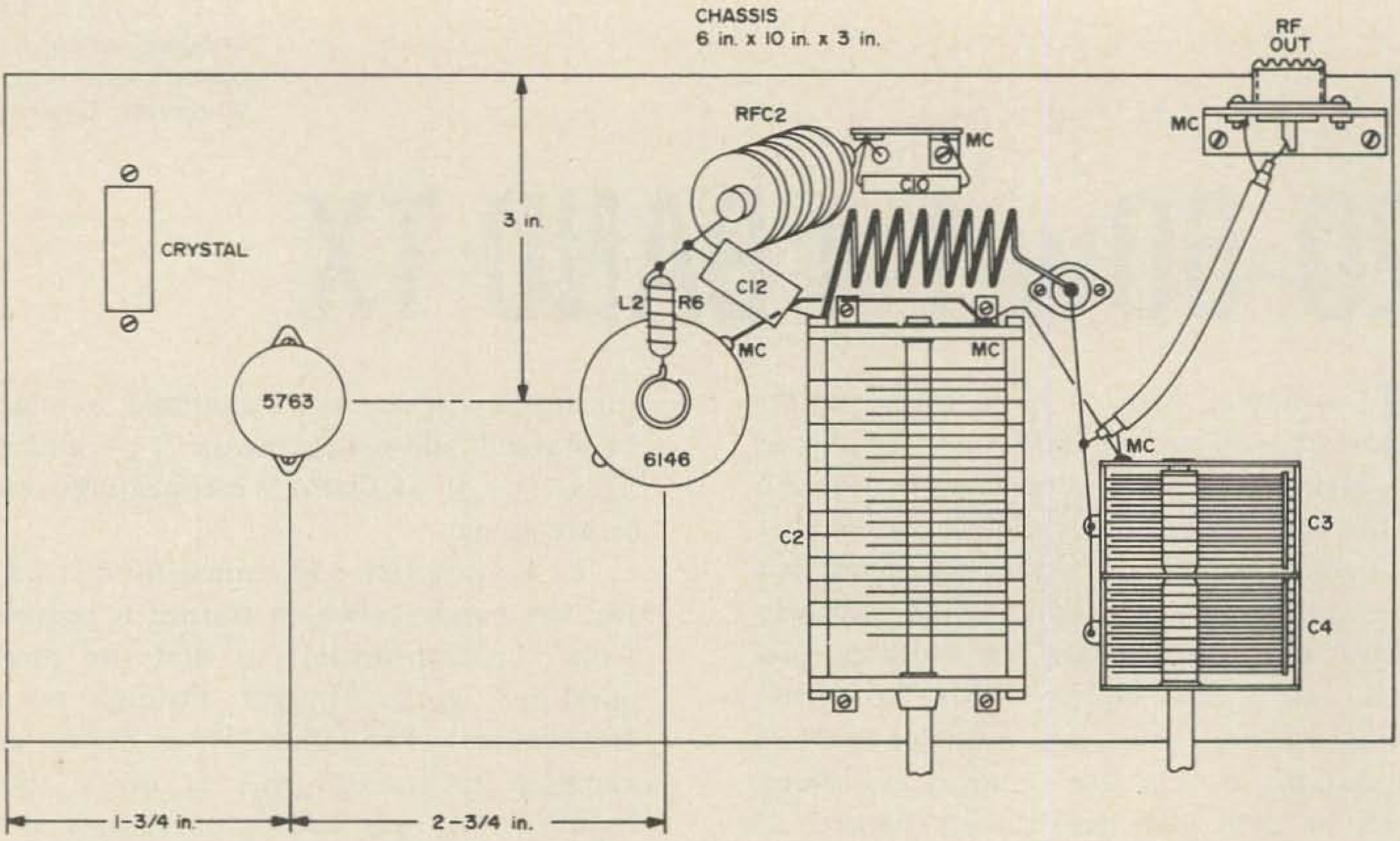


Fig. 2. On top of the chassis.

mA meter monitors grid current. So on any band, you simply tune C1 for about 2 mA grid current, giving about 54–65V grid bias.

After the parasitic suppressor (L2/R6), rf reaches the pi tank L3, with power amplifier tuning capacitor C2, and output capacitor CE–4. This will match into a dipole and useful range of other impedances.

Keying is via both cathodes, giving complete cutoff with the key up. R5 and R7 are to keep screen-grid and cathode voltages within limits with the key up. With the key unplugged, the key jack closes, for tuneup of grid current or amplitude modulation working. Closing the NET switch puts B+ on the 5763 only. This gives an indication of the crystal frequency with the receiver, and will also allow tuning for grid current.

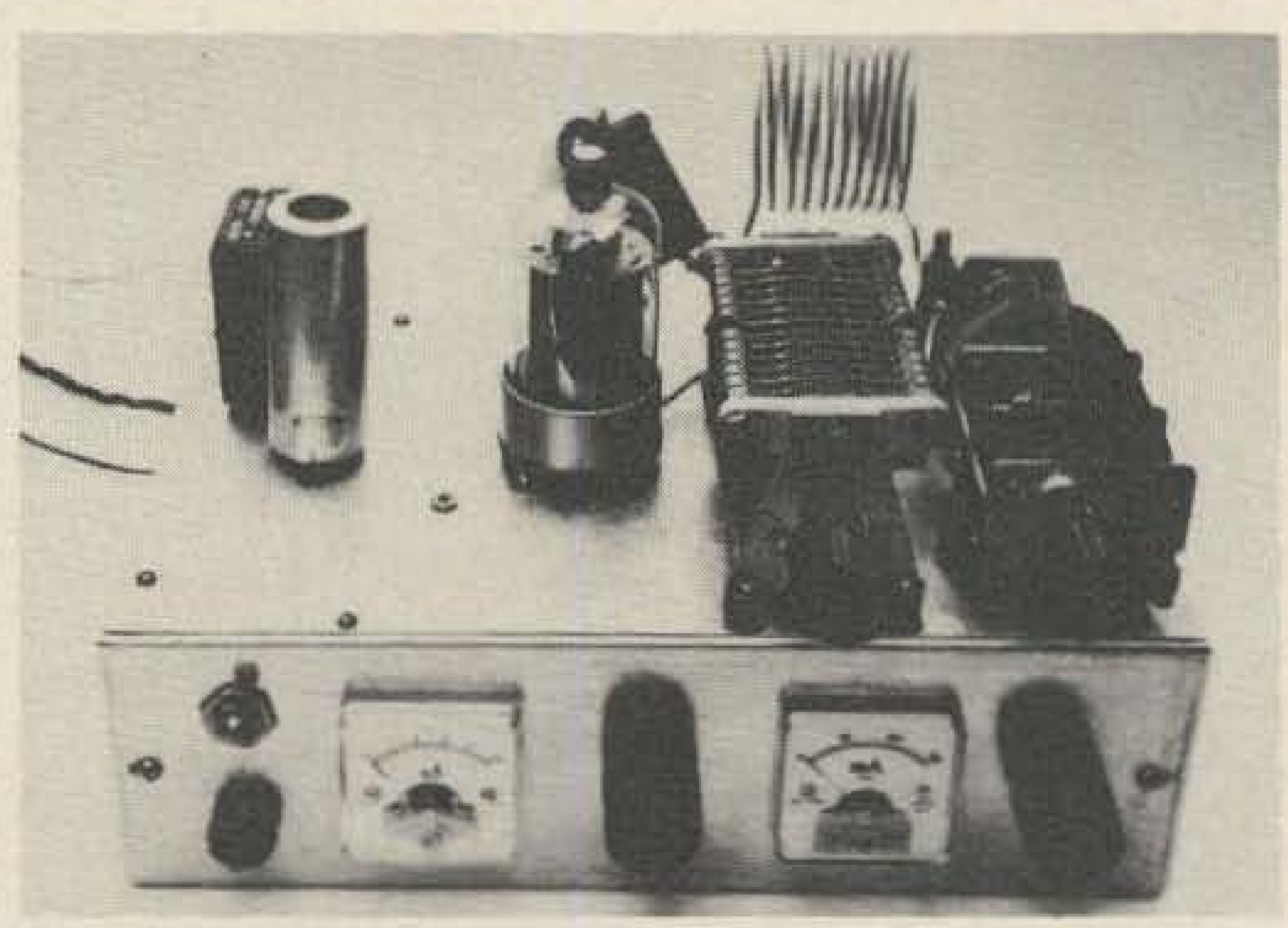
When the transmit/receive switch is at transmit, B+ reaches both stages. Turning this switch to receive takes B+ off. Spare contacts can operate the antenna changeover relay. This is useful for phone contacts because this switch can control modulator B+, transmitter, antenna, and receiver muting circuits through a relay.

Building It

A chassis 10x6x3 in. seems suitable, with pi tank and other output components on top (Fig. 2). To obtain a short rf return, a stout lead joins rotor tabs of C2 and C3/4 together, and to a tab at the 6146 holder.

The meters, C1, Net switch, T/R switch, and key jack fit on the front runner. Figure 3 is the underchassis.

Leads not intended to carry rf (those to heaters, B+ circuits, key jack and meters) run against the chassis. Bypass capacitors go directly from the holder terminals to the chassis lugs. In particular, have very



Chassis carries grid and plate meters on front. The 6146 PA runs 20–60W input.

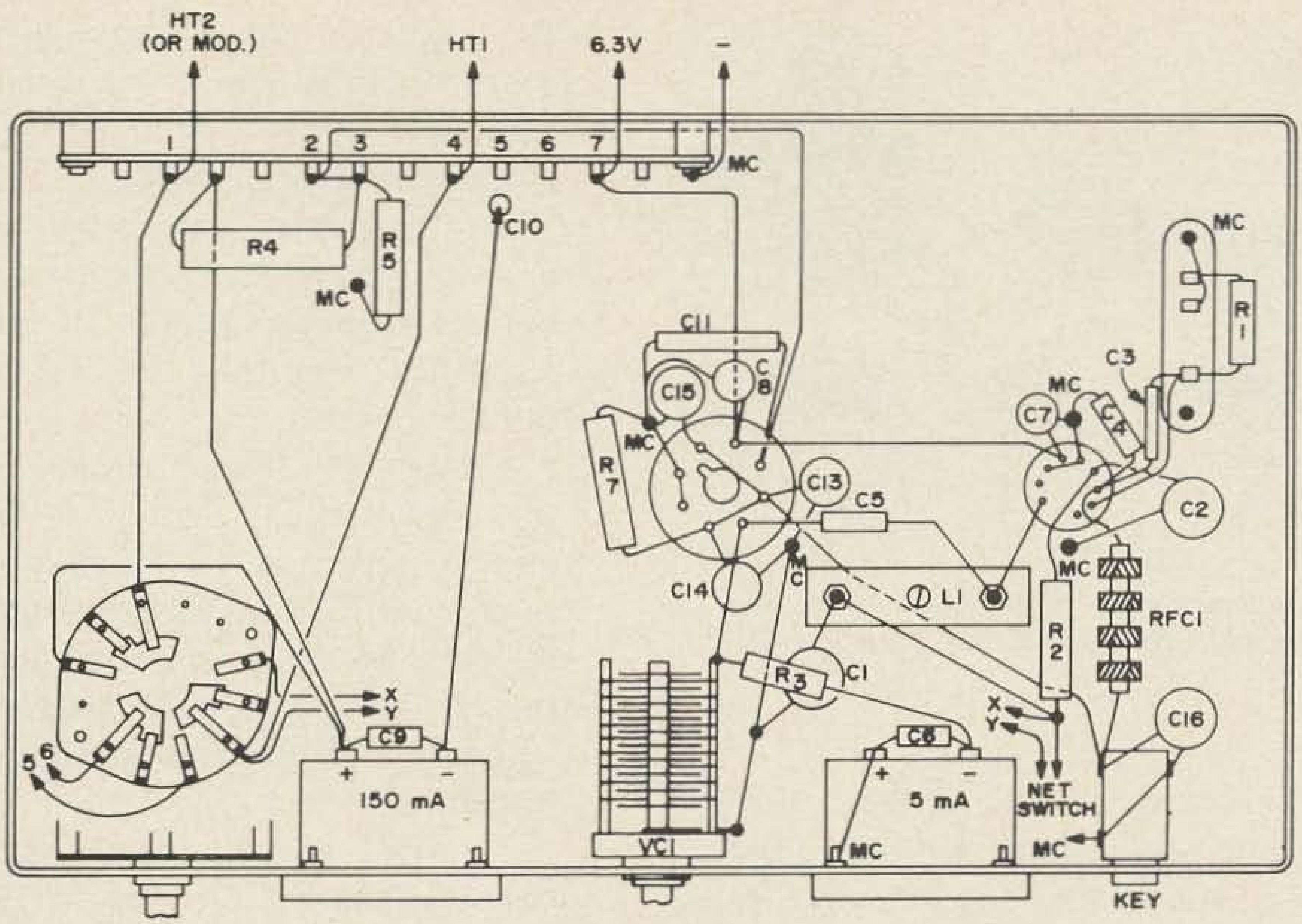
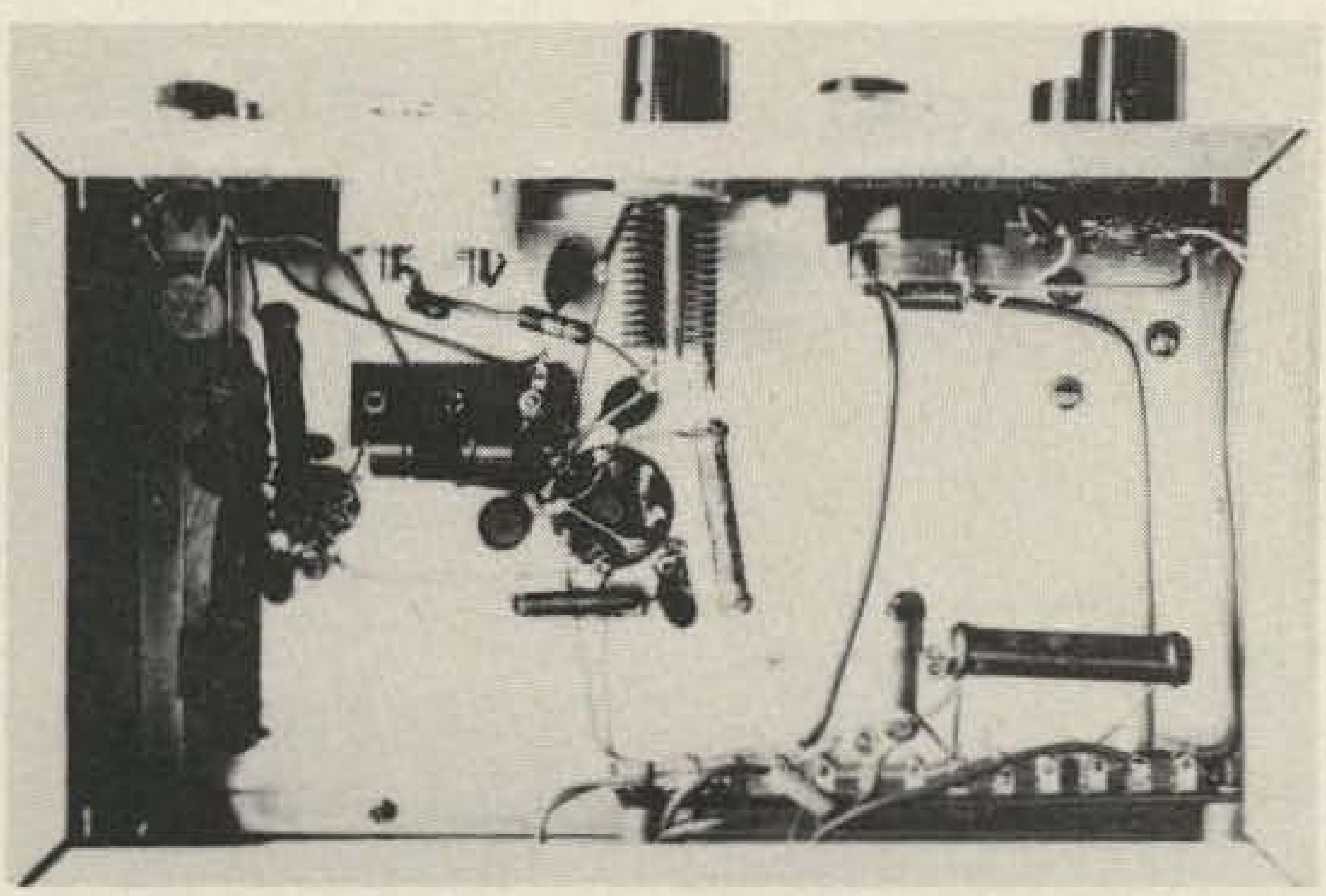


Fig. 3. Under the chassis.

short leads from the 6146 to C13, C14, C15, and C11, and to chassis.

The B+ circuits must be well insulated, especially for the higher voltage. Should you practice high-level modulation of the 6146 with a 600V supply, the peak B+ swing will be 1.2 kV; hence, the need for insulation for this voltage, and the use of high-voltage reliable mica capacitors for C10 and C12.

A terminal strip anchors power and other leads (Fig. 3). For high-level modulation, bring modulated B+ to terminal 1. The modulator should give about 30W of audio, for 60W power amplifier input. To modulate the screen grid, the single 6BW6 or similar output stage will do. Remove the jumper between terminals 2 and 3. Modulate at terminal 2. Be sure switching cannot apply screen-grid voltage when B+ is not on the other circuits.



Underneath. The 5763 oscillator coil attaches to two bolts on insulated strip for bandchanging.

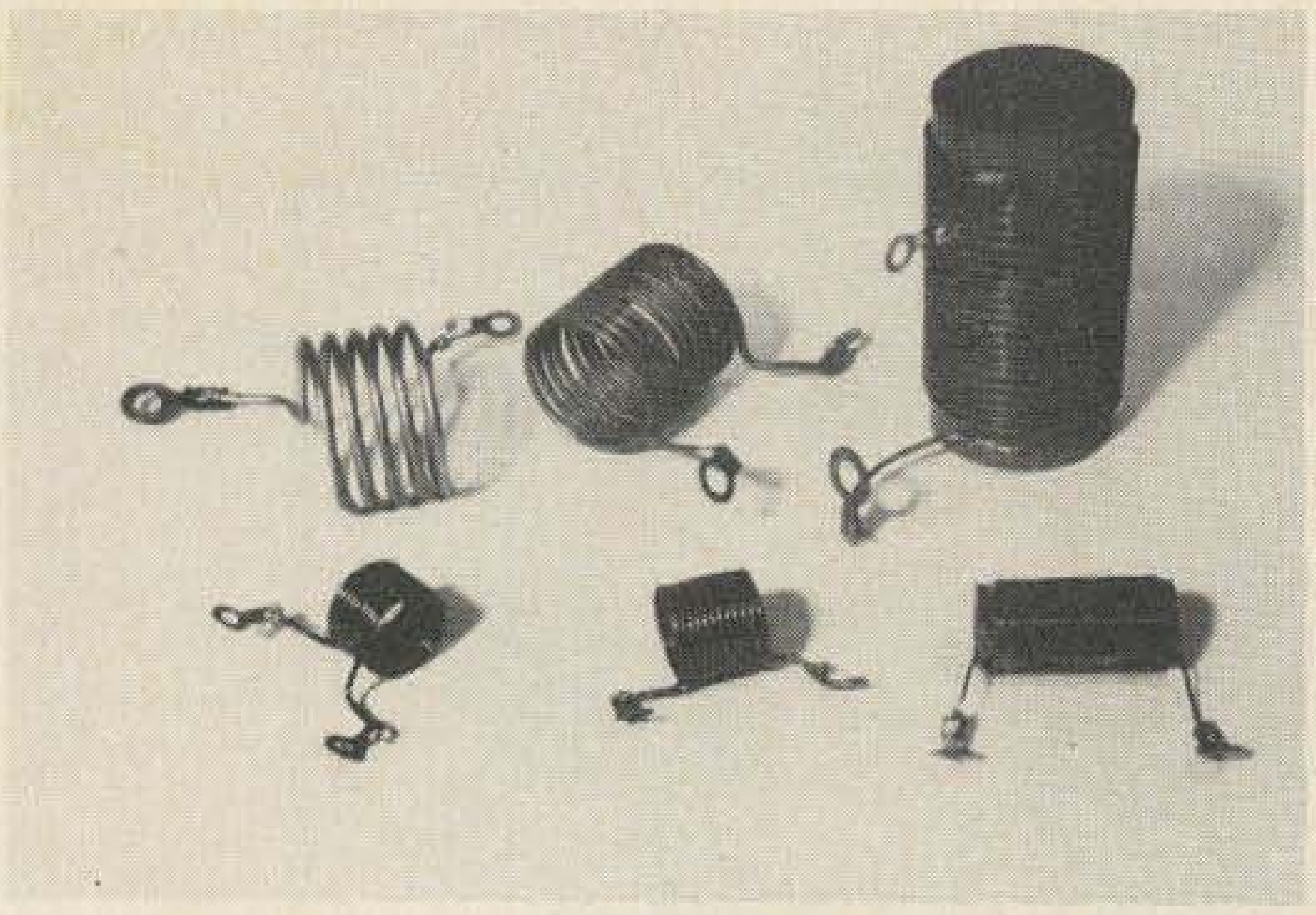
Power Requirements

The heaters need 2A at 6.3V. The 5763 crystal oscillator will work with about 200–300V. It draws 30 mA at 300V. A separate receiver type power supply is good for this stage, though it is possible to work with a single supply for both stages.

The 6146 supply may depend on what is available. Good results at a lower input rating are obtained with 300–400V, though 500–600V will naturally give more input and output power.

Though any usual supply is practical, the best type will have a choke input from the rectifier, with bleeder current consumed by a resistor across the B+ line. Then the voltage will not soar during intervals when the transmitter is not drawing current.

A capacitor-input power pack gives more voltage from a particular transformer secondary, but unless quite a heavy bleeder current can be spared, the voltage rises badly "off load."



Oscillator and output tank coils for 28, 21 and 7 MHz. Pair of coils for 14 MHz are on transmitter.

Inductors

L2 is 5 turns of 18-gage, 3/8 in. outside diameter and 5/8 in. long, with R6 inside. L1 and L3 are fitted in pairs. Changing them simply needs four nuts to be removed. This lets you work one band if that is all you want, or use other bands if you wish.

Coils for L1 can be close-wound on insulated tubing, or self-supporting for 28 and 21 MHz. If turns are as in Table I, wrong harmonics are not likely to be tuned. It is as well to check the band tuned by L1 with an absorption wavemeter, which will cause a dip in grid current (shown by the transmitter grid meter).

L3 tank coils are self-supporting for the HF bands. Though the 6146 will double, this is bad practice. So L1, and grid drive, is always on the wanted output frequency.

Operating Procedure

Those crystals which multiply up into the wanted part of a band can be used where they provide enough grid current. So some low-band crystals will allow working on one or more HF bands as well. As an example, a 3.55 MHz crystal will do for this frequency, and also 7.1 MHz. Similarly, a 7.05 MHz rock would do for 7.05, 14.1 and 21.15 MHz. A 3.5 MHz crystal gave better than 4 mA grid current on 14 MHz, and a 7 MHz crystal about 4 mA on 21 MHz. Grid current is greater at the fundamental, or with only 2X multiplication.

Always tune for at least 2 mA grid current,with the NET switch putting B+ on the oscillator only. If enough grid current is not obtained, the crystal is unsuitable. A 3.5 MHz crystal will not give enough output on 21 or 28 MHz.

A 60W domestic lamp as load will check rf output from the transmitter, but not for keying, due to changes in cold and hot resistance. For this, a 75Ω dummy load can be connected.

Close C3/4. Tune for grid current. Open the NET switch. Switch to transmit and immediately tune C2 for minimum current as shown by the meter. Increase B+ input by opening C3/4 while readjusting C2 for the HT dip. As this proceeds, plate current will rise, and the lamp will light with good brilliance.

Check grid current as necessary, readjusting C1. The 6146 is not neutralized, and tuning its plate circuit causes some change in grid current, especially on the higher frequencies. This has no great effect on results, as grid current is always seen and easily adjusted.

When loading the transmitter to an antenna, tuning up can be as described. A dipole cut for the wanted band is probably a good antenna with which to start. With other types, if adjustment of C3/4 does not allow satisfactory loading, then the antenna impedance is outside the range of the transmitter. The best solution is to add a match box.

The 6146 should not be left operating in conditions in which it has a high dc input, but little rf output, because the power is then dissipated *inside* the tube. This is avoided by always having at least 2 mA grid current, and dipping C2 for minimum B+.

To use a vfo, remove the crystal and C3. C4 can be 0.002 μF. Take the vfo output through a screened coax lead to the 6763 grid. Plugs in the crystal sockets will do this and ground the coax shield at the transmitter. It is usually best to apply drive at a frequency which lets the 5763 multiply. For example, at 7 MHz for 14 and 21. A two-stage vfo with fundamental operation on 1.75 and 7 MHz was found to do for all bands, 3.5 to 28 MHz.

. . .G3OGR■

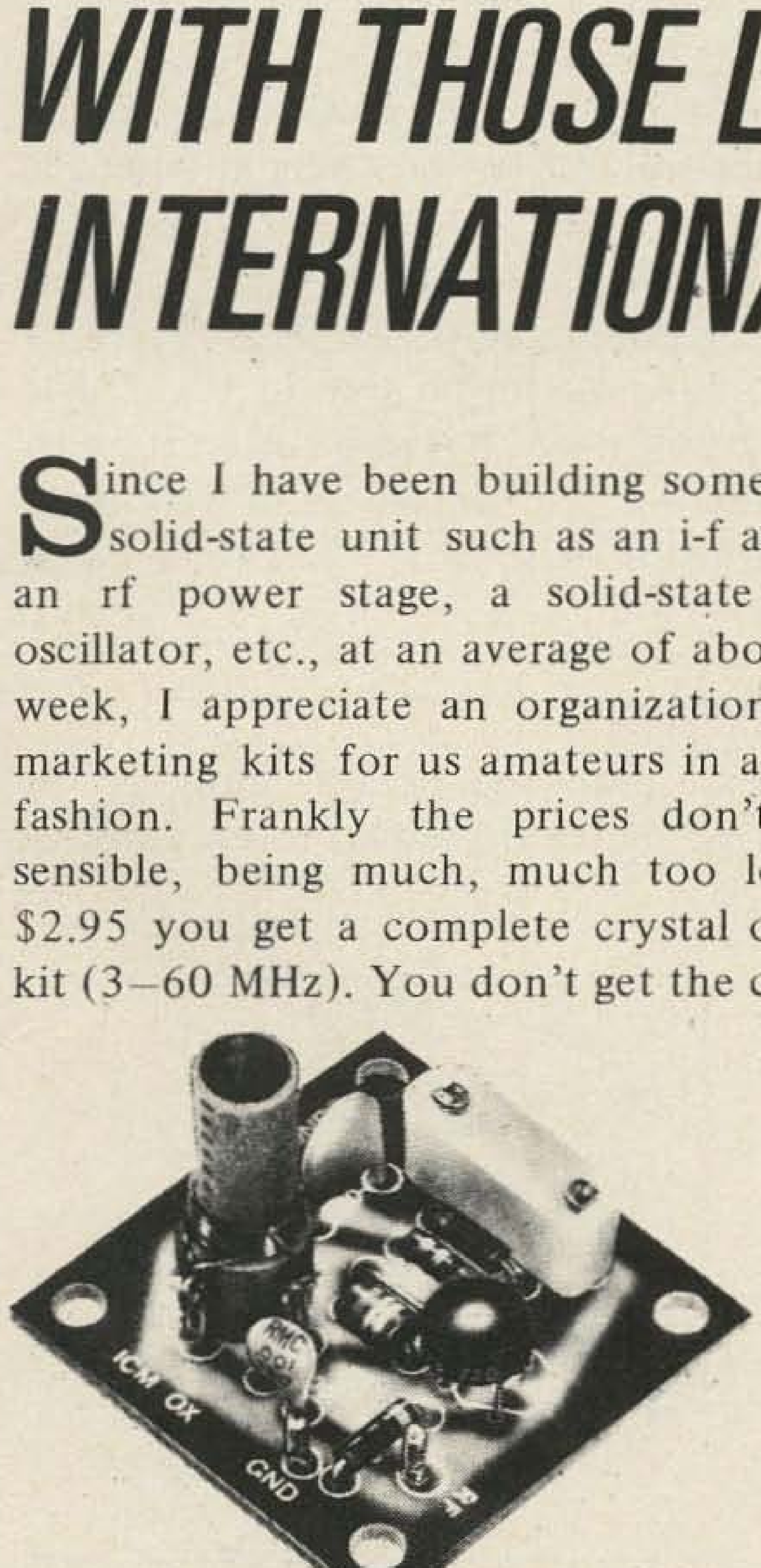
Bill Hoisington K1CLL
Far Over Farm
Peterborough NH

JUST LOOK AT WHAT YOU CAN DO WITH THOSE LITTLE INTERNATIONAL CRYSTAL KITS!

Since I have been building some kind of solid-state unit such as an i-f amplifier, an rf power stage, a solid-state X-band oscillator, etc., at an average of about one a week, I appreciate an organization that is marketing kits for us amateurs in a sensible fashion. Frankly the prices don't appear sensible, being much, much too low! For \$2.95 you get a complete crystal oscillator kit (3–60 MHz). You don't get the crystal at that price, but you do get the transistor, and the oscillator works right off the bat.

You can follow the oscillator with an rf power amplifier for \$3.75 that puts out 200 mW up to 30 MHz and will light a pilot lamp brightly. Any time you can light a bulb you can have QSO's. With a 201A and 90 volts of B battery I used to work all up and down the East Coast every night. Of course I was in Bermuda, parked just *outside* the American band, and it was 1925. I'll bet it can still be done today.

The nice thing with these kits is that you can put them on the front seat, either with dry cells or the car battery and drive up on any hill, put a small beam on top of the car, and away you go. Don't just go up there with a halo or a whip, please! Try something with a little more sock to it. Battery operation plus a hill plus VHF equals DX.

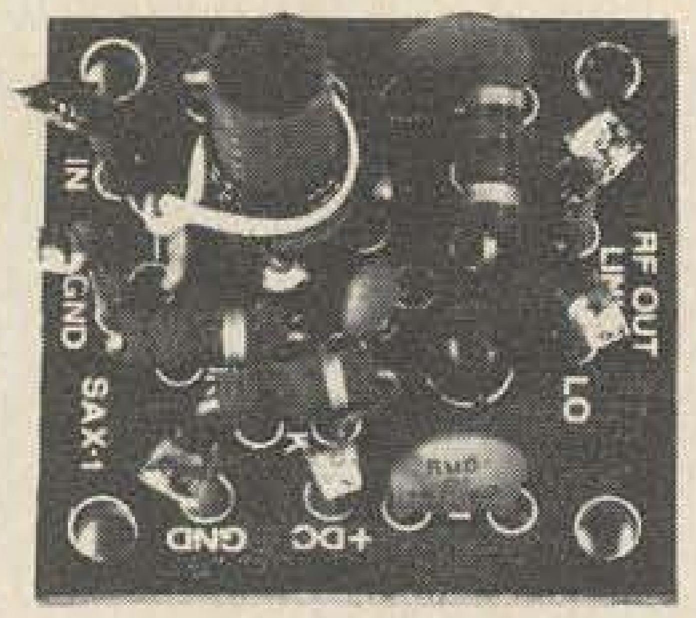


SPECIFICATIONS:

1. Frequency Range	LO—3000 KHz to 19999 KHz HI—20000 KHz to 60000 KHz
2. RF Output	.2 volts rms into 50 ohms (min)
3. DC Power Required	6 volts at 20 ma (operates 4 to 9 volts)
4. Frequency Tolerance with OX and EX Crystal	.02%
5. Operating Temperature Range	0 to 50 Degrees Centigrade
6. Frequency Change with 1 Volt Supply Change	.001% (max)
7. Output Level Change with 1 Volt Supply Change	2 DB (approx)
8. Size	1½" x 1½" x 1¼"
9. Mounting	4 holes with spacers or fits over 1¼" chassis hole

Complete Kit (less crystal) \$2.95

Fig. 1. OX oscillator kit specs.



OX-oscillator

You probably know by now that my fun begins on six meters and goes on up, so I'm mostly talking 50 MHz to start with. If I did try one of those little rigs on 40 or 20 who knows what I could work?

The OX Oscillator Kit.

There is a certain fascination about these little kits that grows on you. It could be due to the absence of cerebration needed, something like a vacation for me, as most of the work I do on this well-worn bench does require at least a little.

When you get the kits you receive a four-page instruction folder with good, simple dope and the circuit. You also get a very neat little copper-clad phenolic board which not only has the actual circuit on the copper side, but clear and well-printed names of the components on the other side. It is *almost* impossible to go wrong. I did. If I had read every word on that little four-page sheet I would have been fine, but I hurried a little too much. There is a just slightly tricky spot if you don't read it all over carefully. This is where it says on page 2, "the remaining parts (R, L, and C) are selected according to the frequency range from the chart below." What they mean is that this particular selection is done at the parts packing stage in Oklahoma City. And it was done exactly right for the "OX-HI" kit I ordered. Just read every word and think it out with the aid of the board and the schematic and you won't go wrong. Also check all the parts in the bag, recheck with the circuit on page 4, and you'll have it correct the first time.

Be sure of this, because it is *not* handy to replace or change parts that are soldered in place. Plan to do any experimentation *outside* the board.

As soon as I got those little parts "selected according to frequency" installed (my fault entirely on that one) and threw the battery switch, bingo, 3V dc output on the meter of my trusty old 25 to 75 MHz tuned diode receiver-rf meter.

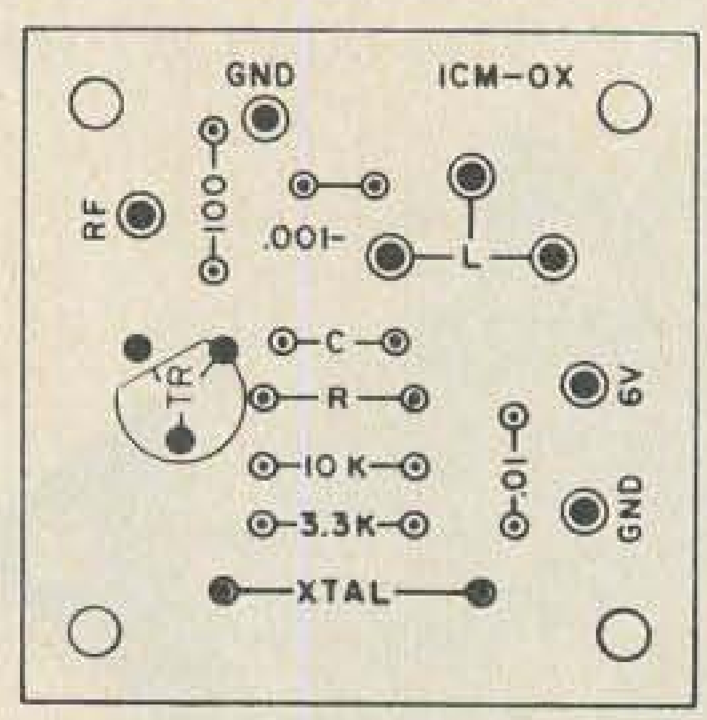
One actual omission in the instructions did show up. I've just read everything over again once more to be sure this one wasn't my fault also. Several loose connections showed up as intermittent oscillation, and these were in "the connector pins that have been staked into the board at the factory" department. As soon as I *soldered* them onto the copper circuit, operation was steady as a rock and has been since then.

The instructions are pruned down to exactly the minimum possible number of words and still get the correct ideas over. The exact quantity of all the parts needed, including "1 jumper wire, No. 24, 1½ in."

The circuit , as can be seen in Fig. 2, has everything you need. It will be interesting to see just how far you can go up in frequency and power using these little planks exactly as they are.

Planned Systems

My first intention is to build up a complete six meter rig similar to my faithful



OX Hole Layout

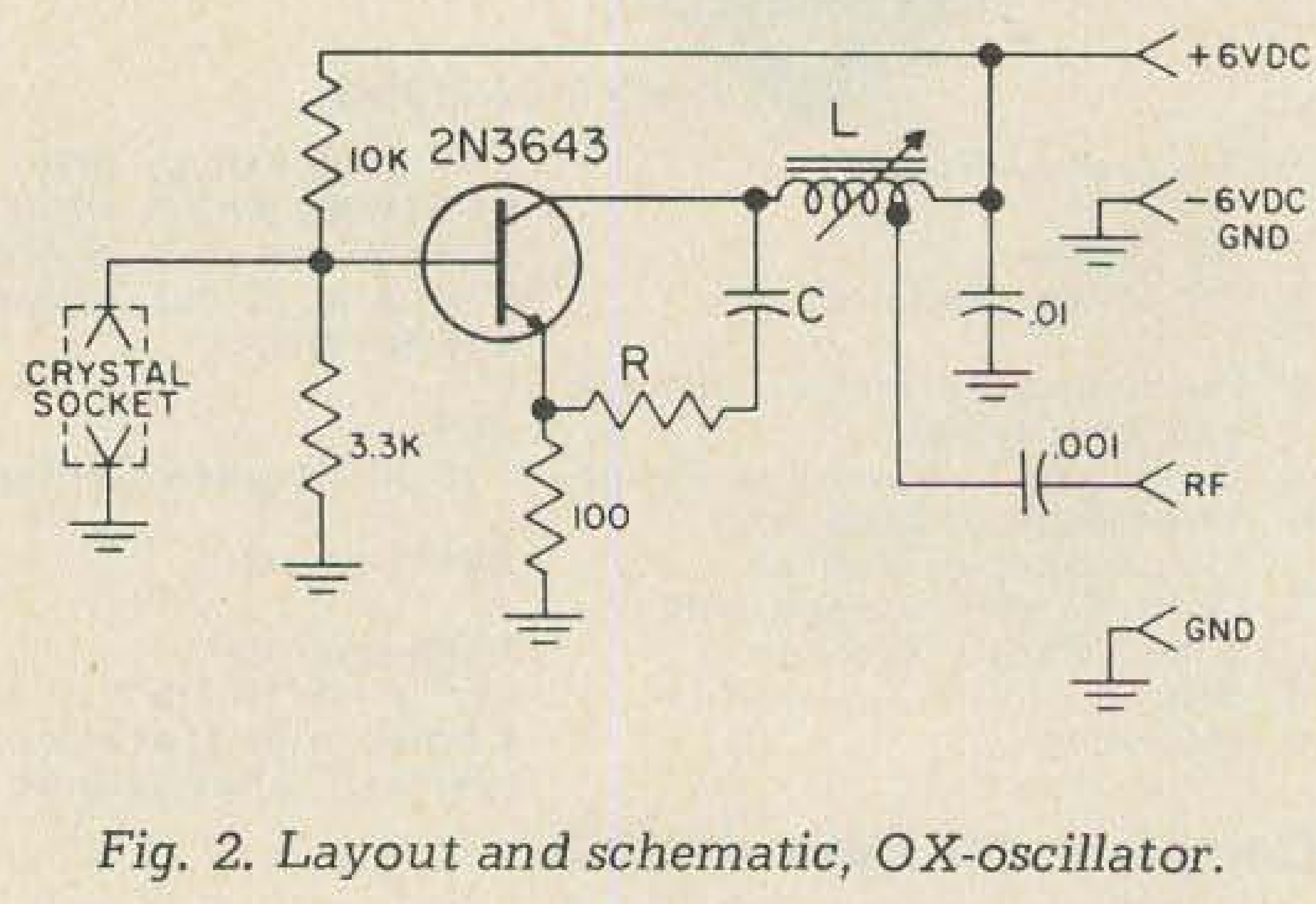


Fig. 2. Layout and schematic, OX-oscillator.

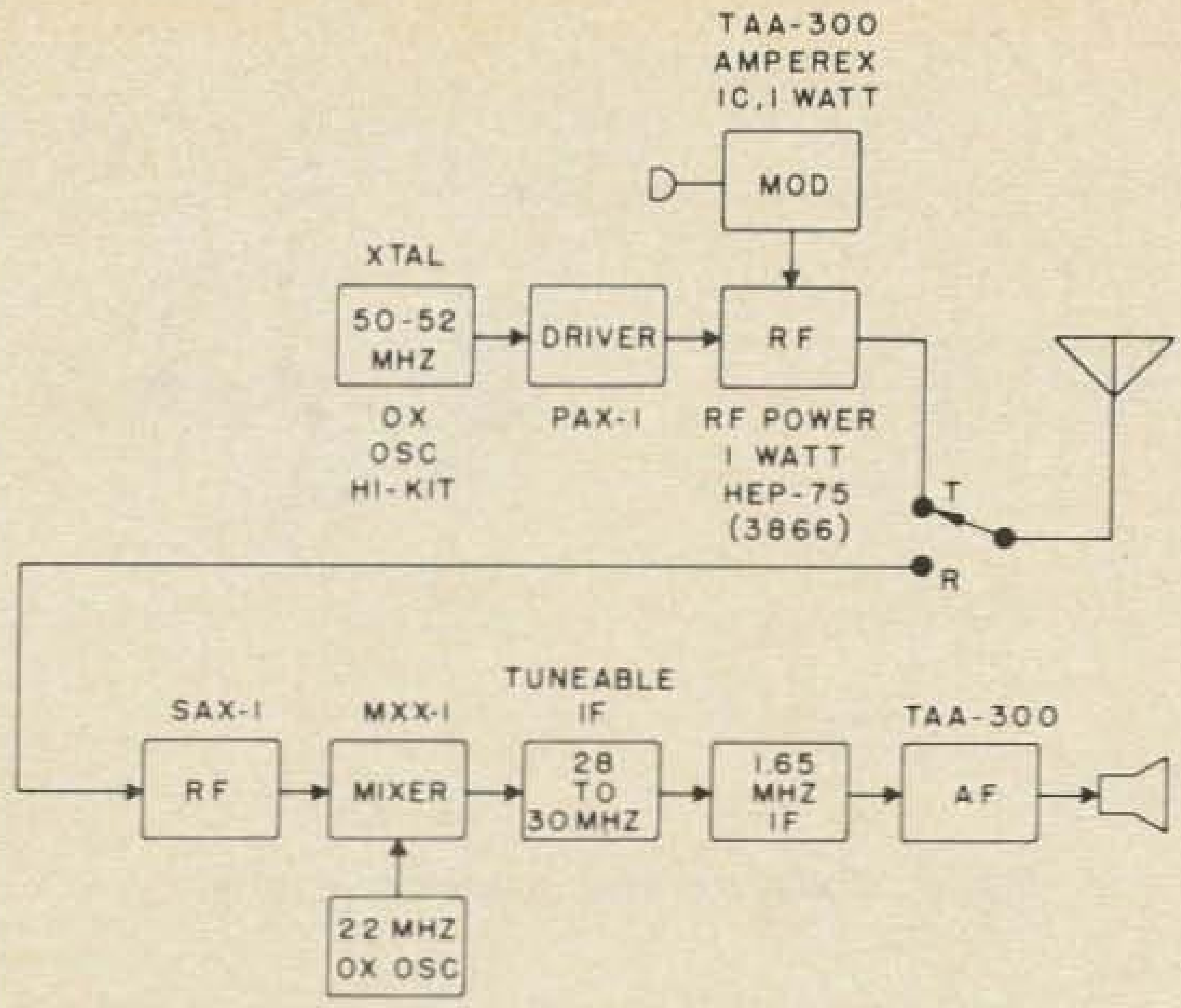


Fig. 3. Diagram subject to revision

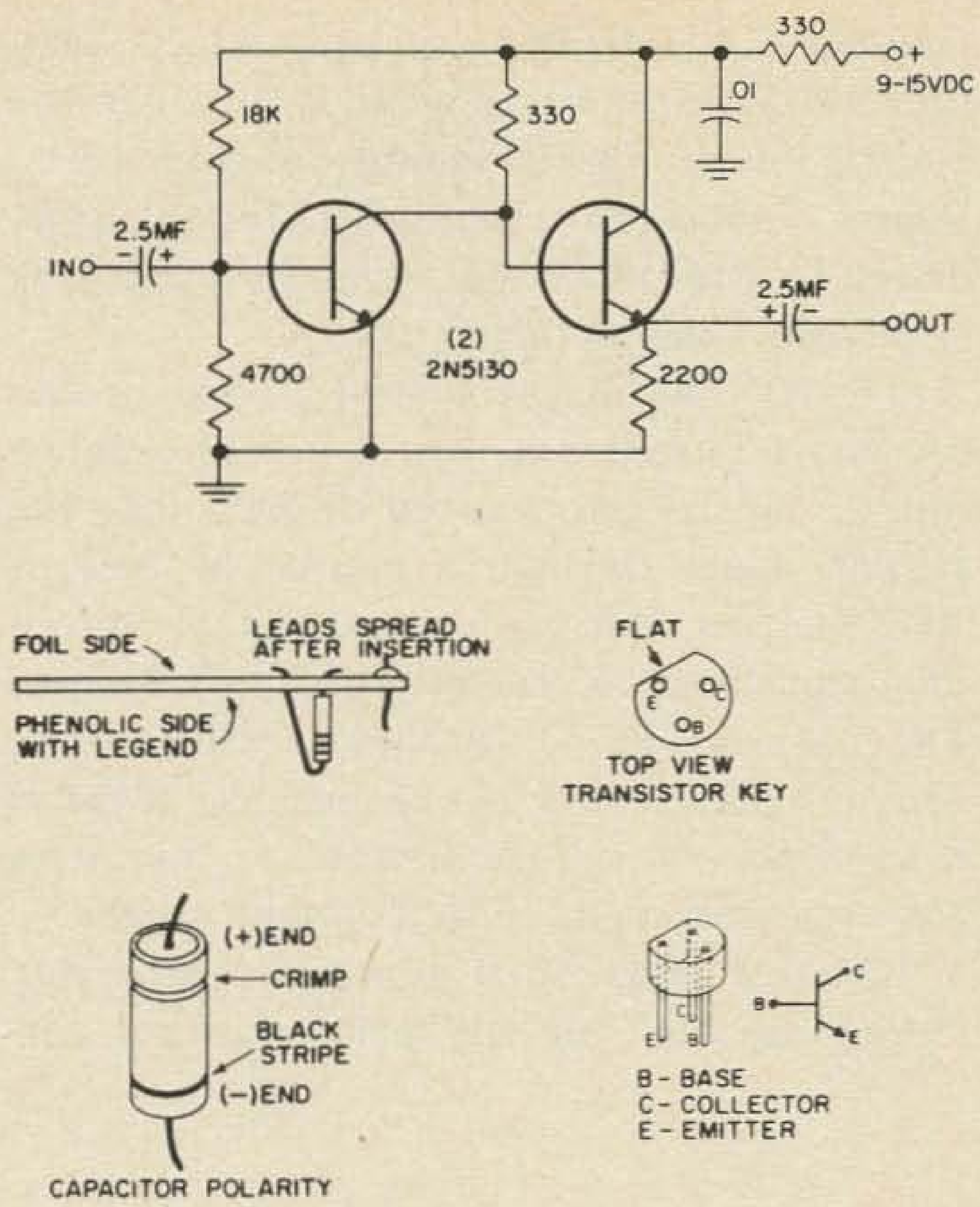


Fig. 4. Broadband amplifier BAX-1.

old Gonset Three (Fig. 3). The biggest mistake I ever made in radio work was to sell that unit. Plugged into the ac at home or into the 12V battery in the car, mobile or mountain top, I could listen to all the lads on the air and could contact them. So maybe now I'll have a solid state replacement for it. I sure hope so.

There is a slight hiatus coming up though, because the power amplifier kit, PAX-1, says it only goes to 30 MHz. There is also the broadband kit, the BAX-1, to work with, which claims to go to 150 MHz with 6 dB gain (it does).

The receiver should go well with the small signal amplifier, mixer, and oscillator kits. There doesn't seem to be any frequency-multiplier kit. How come? Maybe the BAX-1 will triple? It will probably do well as an i-f amplifier also. Plenty to do, as you can see.

The Broadband Kit, BAX-1

This little gem (they're only 1½ x 1½ in.) was tried with the 50.5 MHz input from the OX oscillator kit. No good. Like the instruction sheet said, it is limited. I should confess right here and now that I'm not exactly a broadband type. With a scope a broadband amplifier is not only good, it's a necessity. And this little plank does amplify small signals, and well, too. I checked it out with my signal generator and it really does amplify, several hundred times, just as they claim. I'm sure going to try it out in the i-f stages when I come to that part of the receiver for the complete six meter rig.

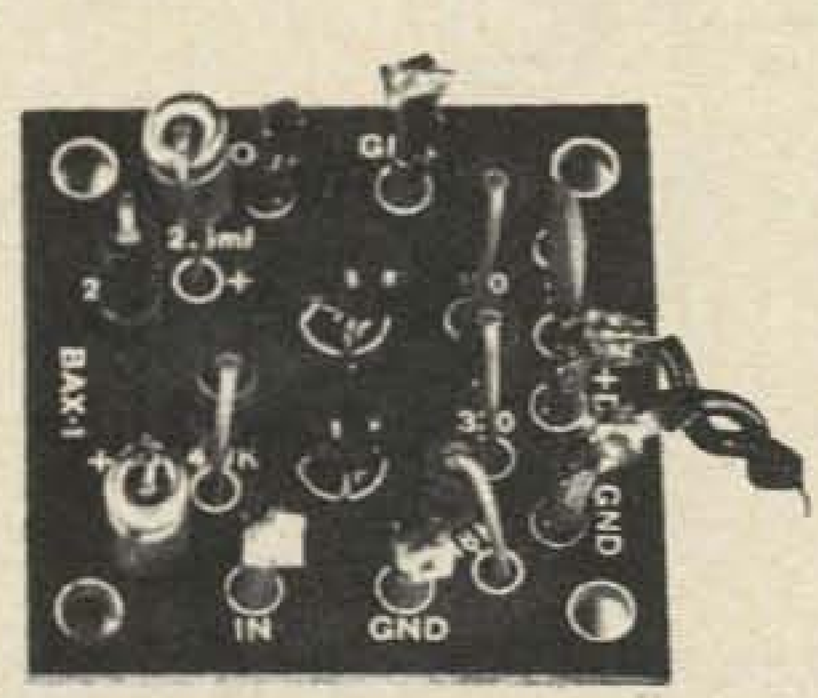
They ought to say whether or not there is any nuisance feedback in it for such an application. This is the thing called "reverse transadmittance" by the engineers in charge of such things in big companies.

I might add that it took me less than an hour to solder in the parts and have it working.

When you consider that it does amplify whatever signal you put into it, over a tremendous range, without inductors and without tuning, it's quite a nice little unit. I'm sure I will find a use for it soon, other than as an i-f.

The rf Power Stage on Six

Since International Crystal did not have an output stage on six, I threw a Motorola

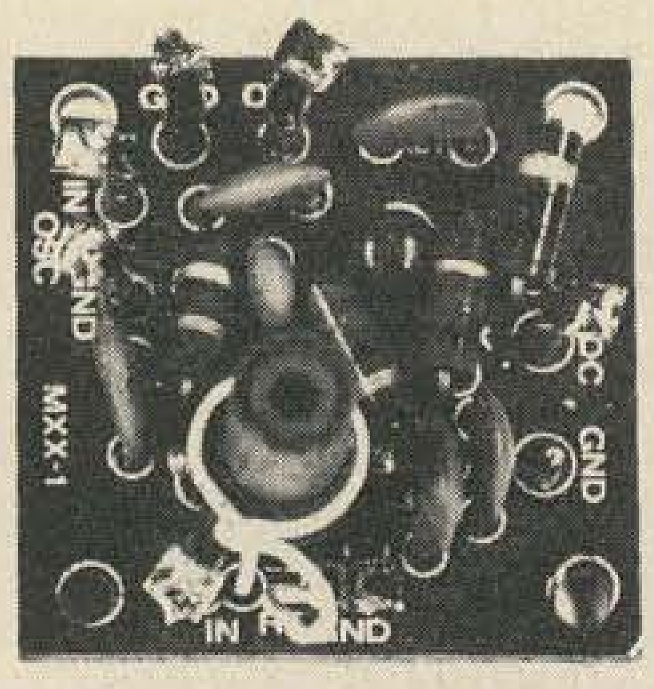


BAX-1

transistor, the HEP 55 at only $1.20 amateur net, into the breach, and it took off like a little black plastic bandit on 50.5 MHz. Figure 5 shows the circuit, breadboard style, driven by the OX crystal oscillator exactly as is! Figure 7 shows the layout.

The OX oscillator on 50.5, one of the crystals I picked out, has a low impedance output tap so this was fed directly into the HEP55 base, through a couple of feet of RG8/U, two "phono" plugs, and J1, into a .001 capacitor, to preserve the base's dc bias. The base is fed dc through a 1K resistor, which I prefer to a choke because there is less chance of self-oscillation. So far none has appeared, so leave well enough alone!

The low value final emitter resistor was "snuck up on" in the usual fashion em-



"MXX-1" Transistor rf mixer

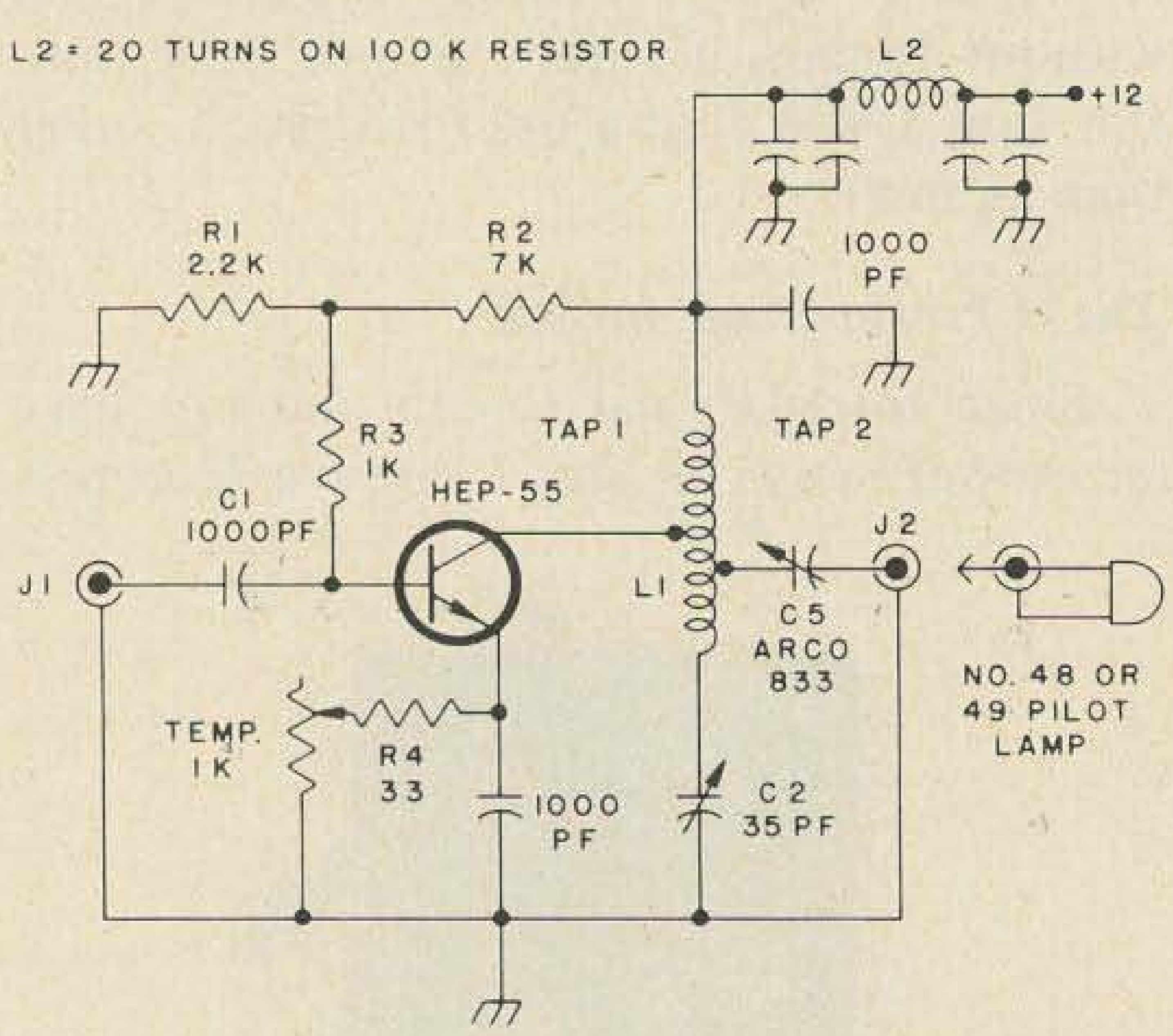


Fig. 5. Motorola HEP55 six meter amplifier. L1 = 12 turns, airwound, 6 per inch, 5/8 O.D. Tap 1 = 5 turns from cold end. Tap 2 = 6 turns from cold end.

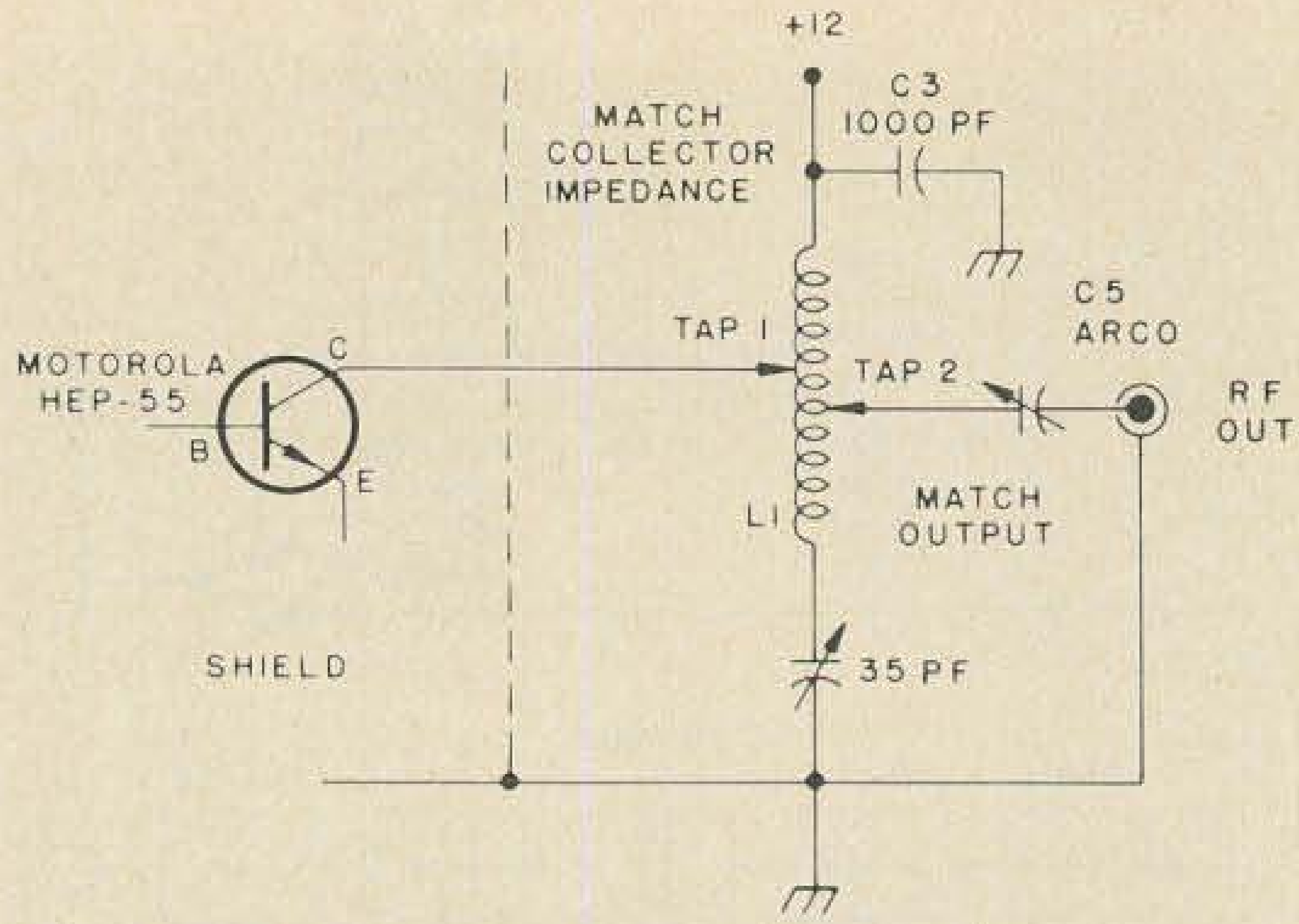


Fig. 6. Collector and output maching.

ployed here, a 33Ω series limiting resistor, along with a temporary 500Ω pot. When everything is tuned up and properly matched and loaded, but not before, you can tie the 33Ω resistor down to ground and leave out the 500Ω pot. Until that happy all matched point is reached, the rf output will tend to drop off with less than 100Ω or so. You'll see what I mean as soon as you try it.

The collector tap as well as the output tap was determined by the "empirical" method, otherwise known as "cut and try."

You should see the complicated equations indulged in by various types of engineers to get rf circuits running today! After ten pages of this stuff they announce, "The circuit was then built and tested." Results count, so don't be scared off. The above circuit using the OX oscillator drive as mentioned puts out 180–190 mW on six, from a $1.20 transistor. After all the HEP55 is only rated at 310 mW dissipation. The dc used was 15V and the mils 25, for 375 mW dc power, and thus a little over 50% efficiency on 50 MHz. What more do you want?

Figure 6 shows details of the breadboard tuning up method for the collector and the output circuit taps, which handled perfectly. As the collector was brought nearer the cold end and tuning became sharper, and the power rose. The output matching is done with a tap and a series capacitor to match the number 49 or 48 bulb impedance at six meters.

This match may change a little for use with a 50Ω cable going to a beam, but for now it loads the final in good style, for either overloading or underloading or just right for 180 mW to the No. 48 bulb.

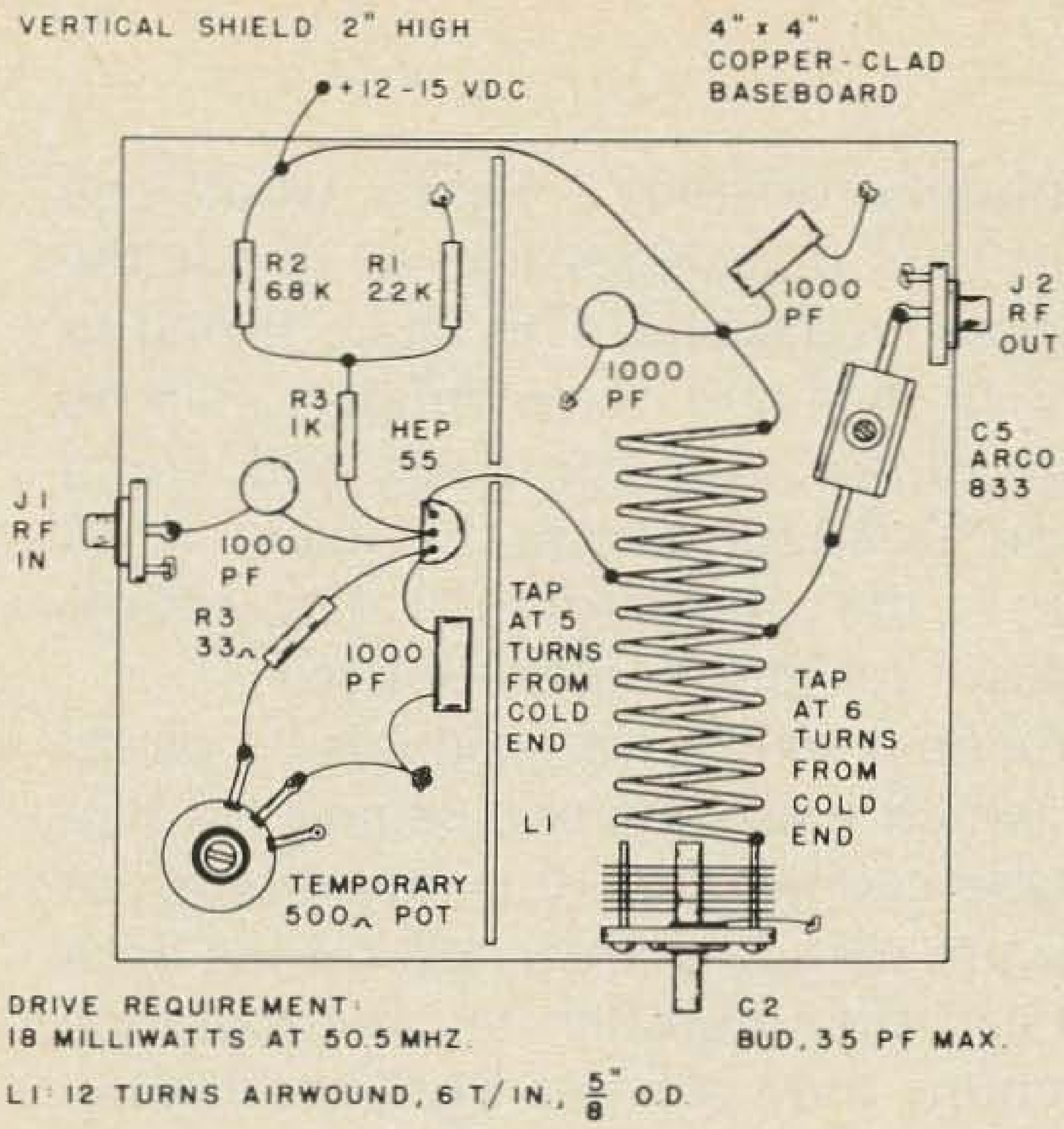


Fig. 7. Layout, six meter, HEP55 power amplifier.

Note that when you have maximum output with the desired loading and tuning, you will also have a good match. They go together like peaches and cream. This does *not* mean the maximum without varying both taps 1 and 2, referring to Fig. 6. It *does* mean that when both taps, tuning, collector loading and current, have been run through in combination several times and no more gain and power out can be obtained, *then* you are matched.

Pushing the OX Oscillator (Just a little!)

Busy tuning up the HEP55 final I noticed that the output of the OX crystal job, when pushing it along with 9V (sometimes 10 or 11 I'll admit) seemed almost enough to light a bulb, but I couldn't quite see a glow, even with the lights out. This is the good old 2V-60 mil pilot light No. 48 screw base type, or the 49 bayonet type, which starts to glow a dull red around 17 or 18 mW. So, after swearing that I would not touch that gem of a circuit by ICM, I gave in and lowered the emitter resistor a shade. See Fig. 2. It only needed just a touch, like down to around 75 Ω to light that bulb. When I can *see* the rf I feel much better.

A little later I tuned up the "L" better with the slug and found that I could light

the bulb with the exact circuit of Fig. 2 without changing the 200Ω resistor. I also find that I have about 11V dc on it. ICM says 4 to 10, so maybe that's a little too much. After all, if you want more power, add a power stage, which is of course just what the HEP55 is in there doing, so don't push that one tiny little oscillator transistor off the shelf!

Conclusion

Everything going fine so far . . . next comes modulation, size reduction, then the receiver, a mobile six meter beam idea, and then a little mountain topping to try the rig out.

Lots of interesting extras can be dreamed up for this one, too, like; A, adding a Motorola HEP75, which is their version of the famous 2N3866 for only $2.95, "suggested net," with a 3 to 5W dc input capability that works good at 432 so no knowing what it will do at six, but I'll soon find out; B, a low noise input rf stage; and C, a narrowband i-f following.

. . .K1CLL

"My advertising money was absolutely wasted!" That's what one manufacturer who tried ads in all four ham magazines told us about the results he got from one old and well-known magazine. This chap, trying to launch a new product of interest to VHF men and home builders, had no money to waste on advertising that didn't pay for itself and could ill-afford a setback like that. You'll find his ad running in this issue . . . 73 paid off for him and paid off well . . . the others didn't! The results elsewhere ran from "absolutely worthless" to "didn't pay for itself."

This chap is lucky, in a way, because he is selling his products by direct mail and he found out immediately which magazine was selling for him and which was just using up his valuable capital, slowly running him out of business. Pity the larger manufacturers who buy their ads on the basis of how old a magazine is, how much gall the publisher has at circulation swearing time, or how much of a discount they can get from the regular rates. He passes along this tremendous waste of money to his customers in higher prices and then wonders where the profits went.

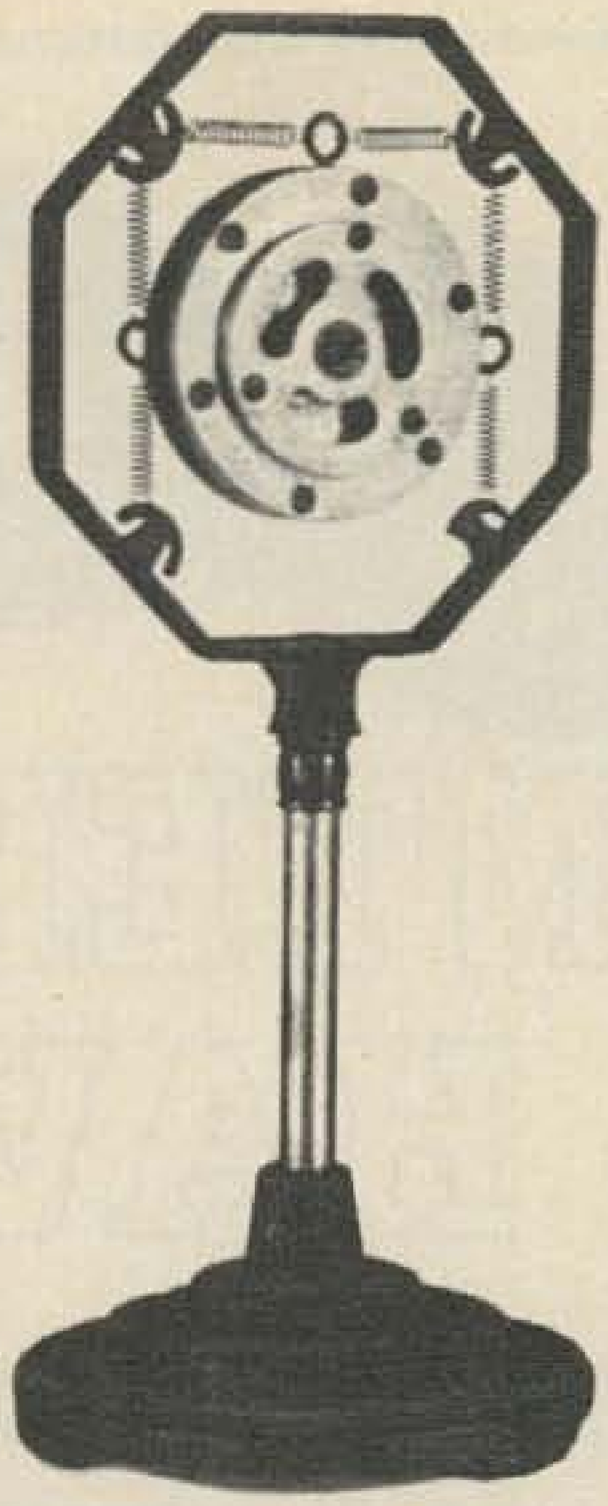
Does it make any sense that 73 readers buy more ham gear than the readers of the other magazines? Just think over the general slant of the four ham magazines for a moment and see which seems most slanted toward the probable active and buying amateur. How about one aimed at kids and certificate hunters? Will they be good buying customers? Will a magazine aimed at conservative old-timers be a rouser at the cash register? How about one that interests engineering-type home builders marching to the tune of "build, don't buy!"

Only 73 is edited and published by an active amateur . . . a ham who is on the air daily and who has worked with enough different aspects of the hobby to write books on several of them . . . a ham who has represented the U.S. at Geneva at the I.T.U. . . . a ham with over 30 years of hamming behind him. Only 73 has a sense of humor, realizing that amateur radio is a hobby and is for fun . . . as soon as the fun goes out of it the hobby will die. Only 73 carries the ball when new developments turn up . . . 73 pushed sideband when it was new . . . pioneered transistors years before the other magazines . . . pioneered ICs . . . pioneered RTTY . . . pioneered ATV . . . and now is publishing more FM info than all other ham magazines combined, times two . . . and watch 73 for SSTV developments! Only 73 has newspages for the non-technical amateurs so they can keep up with current amateur events.

It's true that QST still has more circulation than 73 . . . but for how long? Our special book offer circulation drive is keeping us busy and the circulation is going up faster than ever before . . . watch out QST! Activity of the readers means a lot more than sheer numbers, as the mail order advertisers have discovered . . . which is why they are advertising in 73 . . . many of them ONLY in 73!

Send for our ad rates if you're coming out with a new product. We'll do more to help you get started solidly in business.

Wayne . . . W2NSD/1



W. Edmund Hood W2FEZ
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The Saga of Mikes and Earphones

Late in the 1870s, a Boston inventor was so stunned by Bell's creation of the telephone that he suffered with insomnia for a whole week. "If Bell had known any more about electricity," he fumed, "he could never have invented the telephone." In one sense he was right. Electrical knowledge of the day was restricted to make-and-break devices. Strict obedience to what in that day was thought to be hard and fast rules would have rendered telephones absolutely impossible. As is generally the case in the birth of any major device, Bell was not primarily an electrician, and so was not hampered by convention.Bell knew one thing, however, that the electricians of his day did not know. That was the exact nature of human speech. His father had been an expert in the subject before him. Moreover, Bell had actually made tracings of the vibrations of speech by connecting a diaphragm to a movable pen which rested on a paper strip. He knew what to shoot for before he started, a current which could vary exactly as the air pressure varied when transmitting sound waves.

The big idea came to him through a lucky accident while working on a multiple telegraph system. A series of metal strips, each tuned to vibrate at a different frequency, would be set into motion in the field of an electromagnet and caused a similarly tuned strip to vibrate at the other end. Bell's assistant, Thomas Watson, was having difficulty at the transmitting end. His struggling with a jammed reed set up a racket in the receiver which Bell was smart enough to interpret. "Don't change a thing!" he shouted to the startled Watson, and began scrutinizing the apparatus. The infant idea was developed and a a patent granted nine months' later. Bell's first telephone consisted of a diaphragm which vibrated a piece of soft iron within the flux of an electromagnet. The changing flux allowed the current flowing through the electromagnet to undulate. It worked, although very faintly. Bell also tried attaching the diaphragm to a rod immersed in a container of acid. The vibrations of the diaphragm moved the rod in and out of the conducting acid. A battery connected in series with it saw an undulating resistance, therefore, an undulating current. It was over this monster that the famous distress cry ("Mr. Watson, come here. I want you.") was delivered. Bell had spilled some acid and was in pain from it. Now Bell was not an American citizen at the time, and so he did not have the option of filing a *caveat*, or declaration of intention to invent the device.

He had to patent a working invention or forget it. Two hours after his patent had been entered on Bell's behalf by his future father-in-law, another inventor filed a caveat for an almost identical device. Elisha Gray did not invent the telephone at the same time as is commonly believed. He merely served notice of his *intention* to do so. In fact, Gray was later part of a committee that honored Bell, and quite glad to do so.

It's a sad thing to note, but in that day it was common for one company to pirate the rights of another and try to beat it in the courts by bribery or by out-and-out fraud. Bell found himself pitted against some of the largest corporations of his day, and, at one point, he had to fight it out with an ex-governor, a number of congressmen, and the United States Attorney General. This kind of piracy was unusual in only one way. Bell won.

With the introduction of the telephone to the public, Western Union interests nearly panicked, and for several years there was quite a bitter feud between the two. Bell and Western Union pirated one another freely. To compete with the telephone, Western Union had hired a clever young man named Thomas Edison. Edison replaced the electromagnet with a container of carbon granules. The varying pressure of the sound waves on the diaphragm caused the resistance of the carbon granules to vary. Edison's microphone was far more sensitive than Bell's. Bell used Edison's mike while Western Union used Bell's earphone. Nothing like reciprocal piracy, is there?

The battle between the two raged both in the U.S. and abroad. In England, the British patent office forbade Western Union from using Bell's earphone. Edison's patent on the microphone was useless by then since a man named Berliner had, after fourteen years of litigation, managed to prove that he had invented the same thing before Edison. He finally got patent rights, although Edison still had rights to his model. Berliner sold his patent to Bell. In England, then, both parties could use the carbon microphone, but only Bell could use the earphone.

The British rivals of Bell's company frantically cabled Edison. "Hang on," the inventor replied, and went to work on it. The answer came in the form of an "electromotograph." This forgotten child of Edison's genius consisted of a rotating chalk roller which kept a tension on the end of a rod. The rod was connected to the diaphragm. A sponge kept the roller wet. Edison had discovered that the slipperiness of wet chalk would change when electric current passed through it. As the slipperiness of the chalk roller varied, so did the tension of the diaphragm, and the diaphragm vibrated. The electromotograph had originally been invented for another application, and here it still had a lot of bugs, but it worked well enough to get a patent.

Finally, Western Union and Bell merged. The Western Electric company was formed to construct telephone equipment, and for a number of years it had a monopoly on communications. Then came radio. In 1906, Dr. Ernest Fessendon made his first radiotelephone transmission, and startled the entire world. By the end of World War I, radio was becoming more and more available to the public. KDKA, which, by the way, had begun as an amateur station, started the first scheduled broadcasting and the rush was on.

Carbon buttons were the first microphones used in broadcasting, which is natural enough, since they were the only kind available. But carbon buttons have their disadvantages. Frequency response is restricted. Also, the necessary current offers a high noise level. First to be attacked was the frequency response. Western Electric used a stretched diaphragm to raise the resonant frequency

This meant lower output, but that was no problem. It was partly compensated by using a carbon button on either side of the diaphragm. For a few years the double button carbon mike was the standard symbol of broadcasting.

Western Electric kept a firm grip on the patent rights to the stretched diaphragm microphone until, in Watertown, Mass., Delano Co. started making them. It was a small company, and Western Electric sued. Their strongest point was the stretched diaphragm raising the resonant frequency.

Delano showed that the African savages, for years, had been stretching the diaphragms of their drumheads for the same effect. He won the case.

At the receiving end, the electromagnetic earphone had been there right from the beginning. It was, after all, a fundamental thing. To this day, it's still essentially the same instrument Bell invented. When radio became a public medium, manufacturers simply put a large horn on the output of the earphone, something like a megaphone. In the mid-20s Nathaniel Baldwin attached a diaphragm to a lever which, in turn, was connected to the earphone diaphragm. By simple lever action it magnified the motion, thereby giving a louder sound.

In the late 20s, scientists found an answer to the biggest drawback of the carbon microphone. The current through the mike caused a very high noise level – so high, in fact, that a whisper or a soft voice was simply lost in the mud. (Incidentally, this defect was responsible for the downfall of a lot of the stars of silent movies as "talkies" came into vogue.) Clearly the need was for a microphone that would have a low noise level.

The answer came in the form of the condenser microphone. The vibrating diaphragm would cause a capacity change between it and a back-plate a few thousandths of an inch away. A high voltage was connected across the capacitor, and as the capacity changed due to the varying spacing between the diaphragm and the back-plate, it would alternately gain and lose charge. Consequently, a minute alternating current would be present which exactly followed the audio. This current was detected in the form of a voltage drop across a series resistor. The output was so low that two or three amplifier stages had to be built right into the case. Nonetheless, the condenser microphone was and still is unsurpassed for fidelity and frequency response. It was put into wide use around 1934 when NBC started broadcasting.

In the meantime, loudspeakers were introduced by Jensen. The Jensen unit was an electromagnetic dynamic driver feeding a horn, and first saw light of day in the early 20s. Loudspeakers such as we know them were introduced in the late 20s as the paper cone replaced the horn. The magnet was an electromagnet until the mid-30s with the introduction of Alnico. Electromagnetic speakers remained in use for quite a while, however. I can remember seeing them in the early 50's as I took apart old radio sets. I recall that one of the more popular means of exciting the electromagnet was to use it as a filter choke in the power supply circuit.

Until the condenser microphone was introduced, Western Electric was without competition. Then they suddenly found themselves competing with a microphone that was much better suited for broadcasting. They responded with the dynamic microphone, which had a good frequency response, low noise level, and a high output. It was also far less sensitive to moisture than the condenser microphone, and needed no high voltage power supply.

About the same year as the condenser microphone was invented, an engineer at RCA named Harry Olsen produced still another microphone. This one used a thin metallic ribbon suspended between the poles of a magnet. It was the velocity of the sound waves that actuated it, rather than the pressure. While the output of the velocity microphone was lower than that of the dynamic, it had a wide, flat response.

The microphones were manufactured with two ribbon elements at right angles to one another. By connecting them in or out of phase you could alter the directional pickup pattern. This helped the broadcasters to get by one very sticky problem. The problem was best expressed in an old cartoon which showed a microphone placed at the head table of a highly publicized banquet. The voice of the guest of honor was being drowned out by the other head table guests who were loudly downing their soup. An exaggeration, maybe, but extraneous noise was a major problem in the early days of broadcast, and a directional pickup was a welcome answer. So much so that the housing of the velocity microphone, in its familiar diamond shape became an unofficial symbol of broadcasting, and still is to this day. . . .W2FEZ

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QUICK AND EASY PNP/NPN TRANSISTOR SORTER

A simple tester that quickly sorts out unknown transistor types (NPN or PNP) and can be used to give an indication of relative gain for each type.

There are numerous sources of bargain transistors, such as surplus computer boards but, invariably, the transistors are marked with production numbers rather than standard 2N numbers. So, one cannot simply look in a handbook to determine the transistor type (NPN or PNP), or any of its operating parameters. Usually, however, the only characteristic of immediate interest is whether the transistor is of a NPN or PNP type, since the transistor is usually intended for experimental usage, or as a "pot-luck" replacement for another transistor in a non-critical circuit. It would be false economy, generally, to search among surplus transistors to find a unit to use in a circuit where a specific transistor is used because of its known and stable gain characteristics, noise characteristics, etc.

The simple tester or sorter described here is designed to simplify the rapid sorting out of PNP or NPN transistors while not causing any damage to the transistor under test when the test voltage polarities are reversed from those applicable to a transistor type. It provides an aural indication when a transistor corresponds to the type to which a test switch is set, so one does not have to interpret meter scales or other displays. The transistor is used in a dynamic circuit so that when the type is found, one can also have confidence that all the transistor junctions are undamaged.

Once one is familiar with the usage of the tester, transistors can be sorted out at the rate of 5–10 a minute. This is quite an improvement over the laborious VOM testing techniques used by many amateurs where one also runs the risk that excessive current flow generated by the VOM can damage the transistor under test.

Circuit

Figure 1 shows the complete circuit of the tester. It is about as simple a circuit as one can imagine, but yet it does the job. The circuit is basically that of an audio oscillator where the split primary transformer winding provides feedback coupling for oscillation. The frequency of oscillation is determined by the transformer characteristics, as well as by the time constant of the RC network in the base lead. The components used for the RC network were carefully chosen so a large value resistor could be used since it limits the base-emitter current flow when that junction is variously biased during the testing of a transistor. If one follows the polarity of the battery terminals to the various transistor terminals, it will be seen that the correct biasing of the transistor junctions (collector-base junction back biased and emitter-base junction forward biased) only

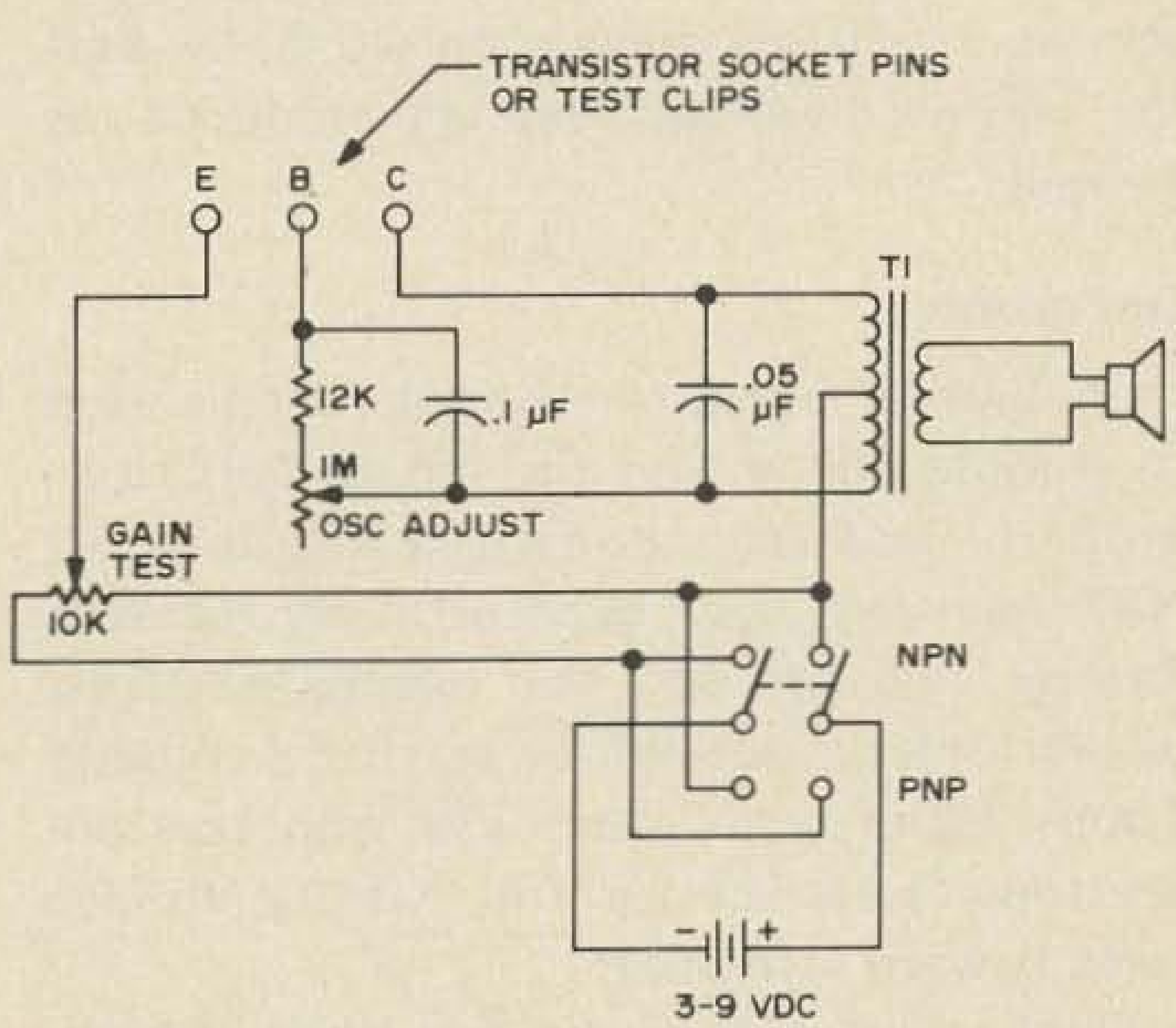

Fig. 1. Diagram of transistor type sorter. "T" is a miniature 400Ω centertapped to 4Ω transistor output transformer costing about 98¢.

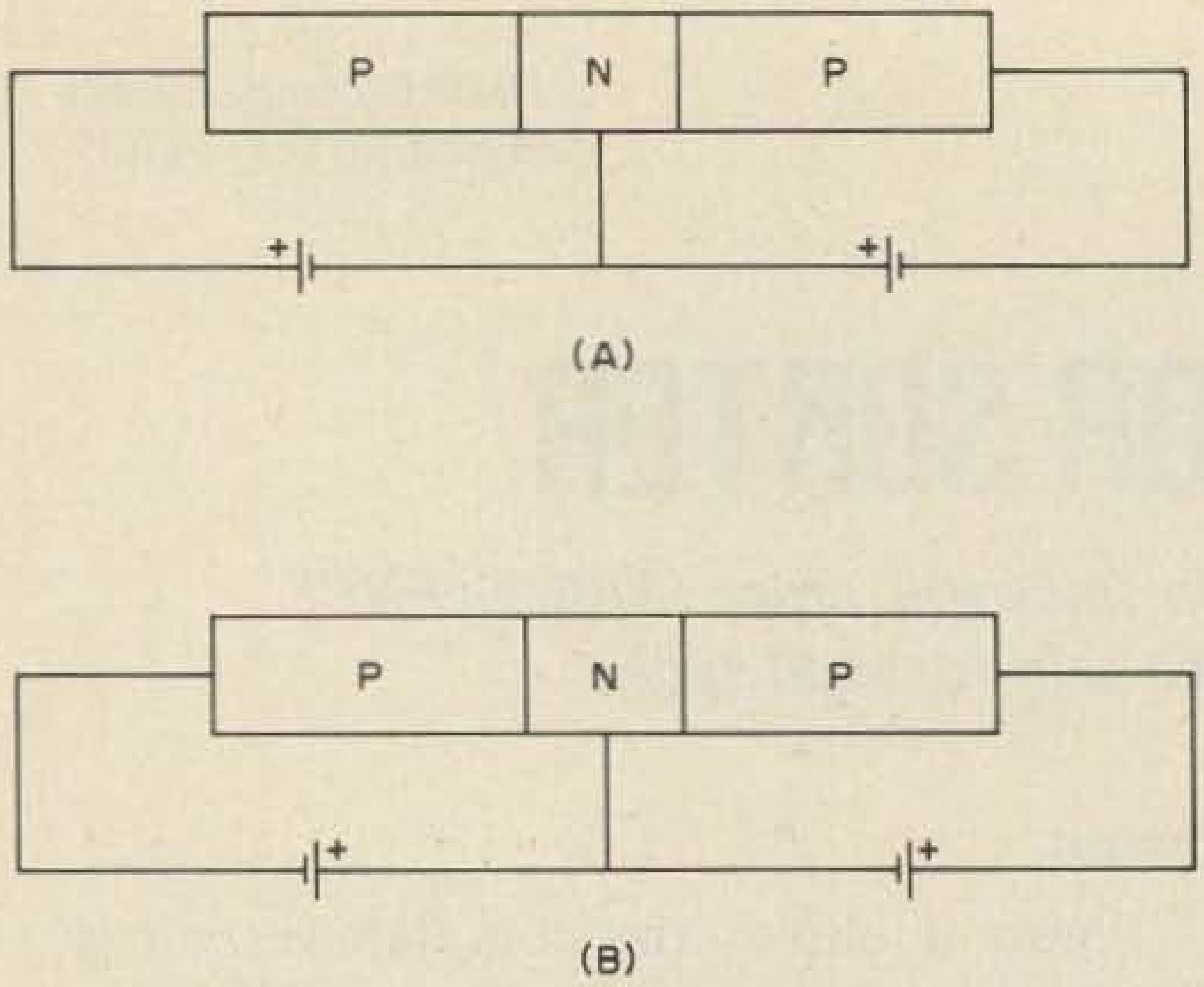

Fig. 2. Junction bias polarities must be correct for a transistor type to oscillate in the test circuit. (A) shows correct arrangement while (B) is false (for a PNP type). Sufficient base lead resistance prevents damage to transistor when improperly biased.

exists when the switch position corresponds to the correct transistor type. Only then will the circuit oscillate. Figure 2 also illustrates this point.

The combination of the low battery voltage used plus the high resistance used in the base lead insures that no damage will result to even a low power transistor during the testing process. We tried deliberately reversing the polarity a number of times on the lowest power plastic case transistor we could find without causing any damage to the unit. This was even done using a 9V battery supply.

The "gain test" potentiometer simply acts as a voltage divider network, so that the supply voltage can be reduced as desired.

Operation

A known transistor should first be used to double check that the circuit functions properly and that the switch positions for NPN and PNP have been properly marked. During this process, the oscillator adjust potentiometer should be set for a roughly 1000–1500 cycle tone. The gain test potentiometer is set for full battery voltage (arm toward left end).

Unknown transistors are then simply tested by connecting them to the tester and noting in which switch position they oscillate. The oscillator tone will vary with transistor type, but this is not important. If a transistor fails to oscillate in either switch position, the oscillator adjust potentiometer should be varied from its reference position, trying each switch position. If the transistor still fails to oscillate, the overwhelming chances are that it is defective and should be discarded.

A crude gain check can be made among a group of similar transistors by noting how much the battery voltage can be reduced, by means of the gain test potentiometer, before the transistor stops oscillating. During this check, however, the oscillator adjust potentiometer must also be adjusted so that oscillation (regardless of frequency) is sustained as long as possible.

Construction

The circuit can simply be breadboarded if only a temporary need exists to sort out a batch of transistors, or it can be packaged nicely into a minibox enclosure as a permanent test unit. In the latter case, if a DPDT switch is used which has a center-off position, it can also function as a power on-off switch for the unit since the gain test potentiometer will drain the battery supply even when a transistor is not being tested.

The idea may come to mind to utilize a code practice oscillator or CW monitor unit already existing as a test unit. Such units can work but one should be sure that the circuit utilized is similar to that shown, particularly with a high value of resistance in the base lead. Circuits with low resistance value voltage *divider* bias network for the base circuit, including most simple RC oscillators, are particularly unsuitable.

The circuit shown has performed extremely well in sorting out transistor types ranging from low power RF amplifier types to surplus digital board types to large power types. Somewhat like a VOM, it soon starts to become an invaluable test instrument for anyone dealing with transistorized equipment since even when transistors are conventionally marked, one does not always have immediately at hand the necessary handbook data to determine transistor types.

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Self-Contained Reflected Power and CW Monitor

The average amateur, especially the CW enthusiast, uses only his receiver as a monitor for the outgoing signal from his transmitter. The amateur receiver usually becomes overloaded in this application and does not truly reflect the outgoing keyed signal. Also, irritating key clicks which are present only in the immediate ham shack are detected by the receiver. Not only does the receiver give out an erratic CW tone but these irritating clicks also.

If the transmitter oscillator stages are allowed to run continually to prevent chirp, the keyed signal can hardly be detected in the average receiver. The transmitter oscillator signal – being the same as that of the final – allows no distinguishable difference in the keyed tone. It is essential then that we directly sample the outgoing power and utilize this as an example of the keyed signal.

Not only is it essential to monitor our fist but also to observe the reflected power ratio. The reflected power ratio gives us an idea of how well the power leaving the transmitter is being accepted by the antenna. There is no such thing as a perfect match to the antenna and some power, no matter how small, will be reflected. The main objective is to achieve the lowest reflected power with maximum forward power. This indicates that power is being radiated by the antenna rather than generating heat within the transmitter or transmission line.

The CW monitor uses very inexpensive and easily obtainable components. The tone generating device is merely a transistor oscillator that requires only a very small amount of current to function. In theory, the oscillator requires only 1½V at 8–10 mA to function.

A small rf sample is extracted from the coaxial line going to the antenna. A 1N34 or similar diode rectifies this rf and the resultant is a dc component. Rf is prevented from coming into the oscillator section by the 470 pF capacitor connected from the plus side of the diodes to ground.

The dc that we have generated is adequate to power the entire transistor oscillator. The rf necessary to generate this dc does not necessarily have to be taken from the transmission line. A small pickup loop may be assembled and placed near the tank circuit of your transmitter. The pickup loop would take the place of the line placed inside the coax.

The audio emanating from the oscillator is at quite a low level so must be amplified to drive a speaker or headphones. An inexpensive imported transistor amplifier

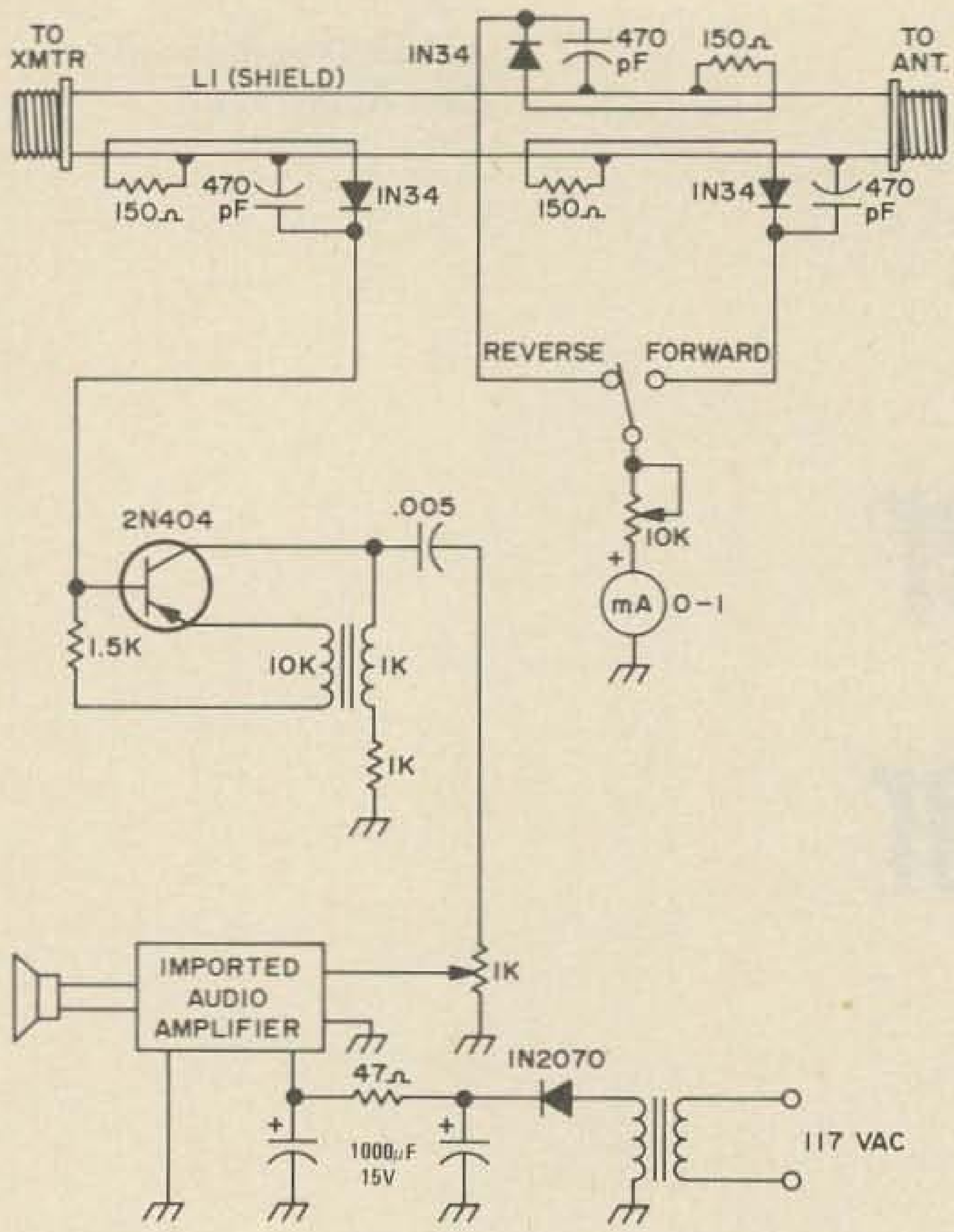

Fig. 1. Schematic diagram. L1 is a 12 in. section of RG-11/U coax with plastic cover removed. Coaxial fittings attached to each end. 5 in. pieces of #20 insulated hookup wire inserted under shield for pickup loops.

with about one watt output power was used in this application. This amplifier boosts the low level audio from the oscillator to speaker level.

The tone oscillator does not put out a pure sine wave but produces one that is rich in harmonics. This actually lessens operator fatigue over extended operating periods.

Rather than operate the transistor audio amplifier with batteries, we decided to construct a simple ac power supply. This eliminates the need for battery replacement at regular intervals. An ordinary 6.3V filament transformer was used with good results.

With the reflected power meter in the FORWARD position, the oscillator may not operate because of consumption of power by the meter circuit. When operating, leave the meter in REVERSE and the oscillator will function properly.

The heart of the reflected power meter is a 12 in. section of RG-11/U coaxial cable. All of the plastic insulation must be removed leaving only the copper braid. The sampling loops are made of 4 in. pieces of insulated hookup wire. There are three of these. One samples energy to power the oscillator and the other two are for the reflected power meter. These 4 in. pieces are inserted under the braid of the coax and the ends are left exposed about ¼ in. It is especially important that the two loops used for the reflected power meter are exactly opposite each other and are symmetrical.

If you will notice in Fig. 1, the 150Ω resistors are soldered directly to the groundshield of the coax. The opposite end goes to the diodes.

In using this device, the coaxial lead from the transmitter is attached to the transmitter end of the reflected power line and the antenna is attached to the opposite, or antenna, connector. The transmitter is then keyed and tuned properly. The calibrate pot is adjusted for full scale deflection of the meter in the forward mode. Once this is completed, switch to the reflected mode and the amount of reflected power will be indicated. If you have a good match between the transmitter and antenna, the reflected reading should be quite low. Maximum forward and minimum reflected is your goal.

When you have completed the previous steps, the monitor section can now be activated. 117V ac is applied to the power supply. This will place the audio amplifier in operation. Each time that the transmitter key is depressed, an audible tone should be heard in the speaker indicating that the oscillator is working and that there is sufficient dc to trigger the oscillator. The volume control should be set for ample volume at this point.

It is interesting to note that the frequency of the oscillator will change as the transmitter is tuned. It therefore becomes an aural tuning device also.

This dual purpose device should provide you with many pleasurable operating hours and also make the proper tuning of your transmitter much easier.

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USING and IMPROVING the TEN-TEC TRANSCEIVER MODULES

A detail discussion of module circuitry, circuit improvements, transceiver packaging and operating experiences.

When the Ten-Tec series of low-power transceiver modules appeared on the market, I purchased them more out of curiosity than with any great expectations that they would be very useful. This thinking goes back to about 1950 when my "large" 100W rig became inoperative, leaving only a 3W vfo–exciter available for QSOs. I had so much fun with the 3W rig on 40 and 20 CW that there followed over the years a continuous desire and search for the circuitry and components to build a truly portable low-power CW transmitter/receiver.

Of course, with tubes, one problem followed the other of trying to keep the battery drain low while still achieving a reasonable power output, trying to extract stable performance from a regenerative receiver on the higher-frequency bands, compromising on crystal-controlled transmitter operation instead of vfo because of oscillator stability problems, etc. The result was never very satisfying, nor economical. Even some of the best "spy" type HF transmitter/receivers built in WWII never resolved all the problems involved, as became apparent later when some of the more widely produced types found their way to the surplus market or into museums.

So, with this background in mind it was very surprising to experiment with the simple and inexpensive Ten-Tec modules in

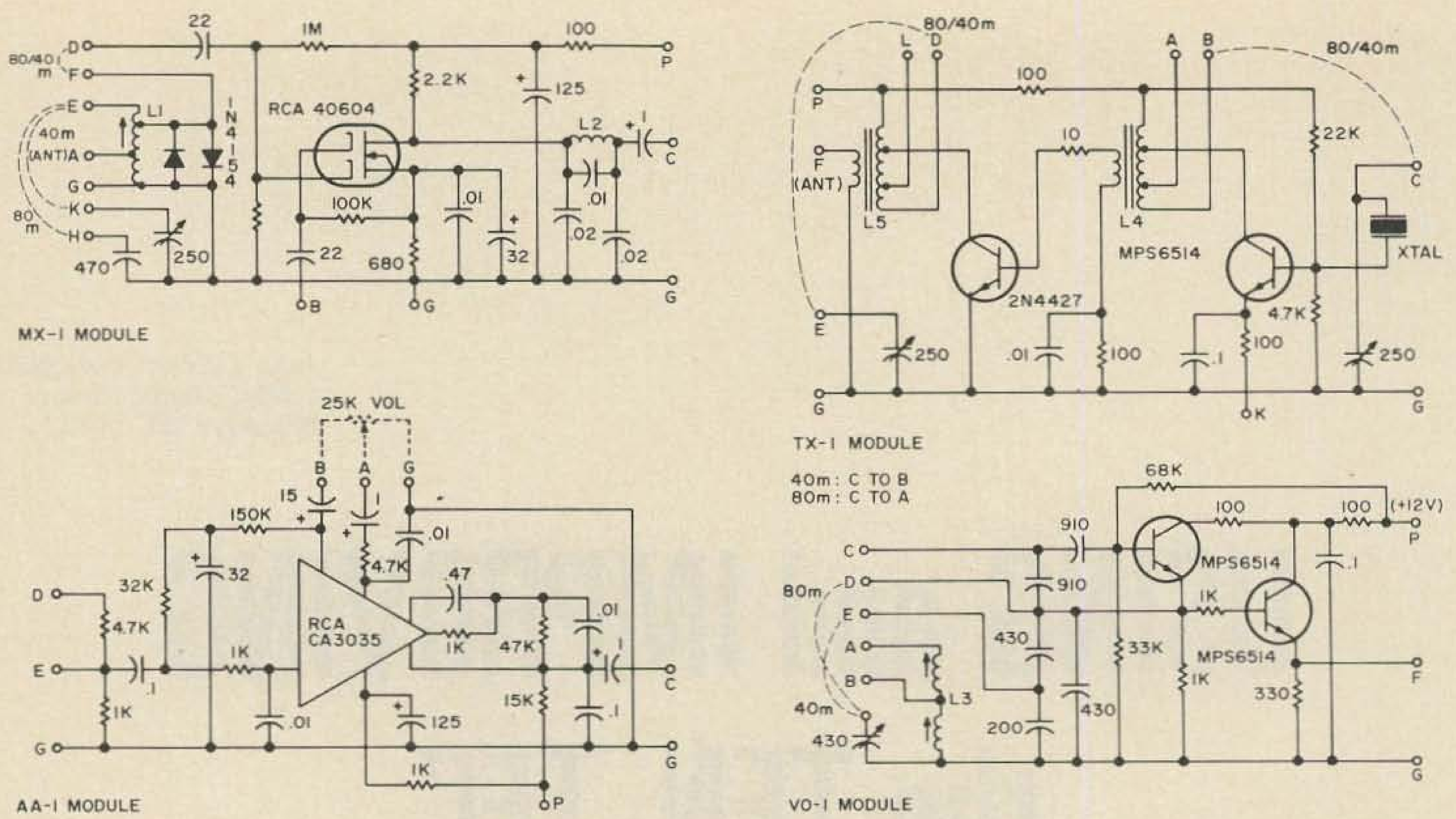


Fig. 1. Diagrams of the original unmodified four modules for the Ten-Tec 80/40 meter transceiver.

an attempt to build a truly compact transistorized and portable CW transceiver and to find that they performed amazingly well. Of course, low-power operation will remain low-power operation regardless of whether tubes or transistors are used. No 2W transmitter is going to sound like a 100W rig regardless of how good it keys, etc. Nonetheless, with a change of operating habits tailored to low-power operation, and that is probably the key to enjoying low-power operation, many satisfying QSOs can be had.

Basic Modules

Figure 1 shows the schematic of the transceiver modules with their actual PC board terminal designations so one can easily understand the interconnection points for the circuit modifications described later. The individual modules are the VO-1 vfo which can be wired for either direct output on 80 or 40 meters and consists of the basic oscillator stage and a direct-coupled buffer output stage.

The TX-1 is a two-stage transmitter which can either be crystal-controlled or driven by the VO-1 at approximately a 2W input level with a 12V battery. The TX-1 can be set for straight-through operation on 80, 40, 20, or 15 meters by means of the coil taps provided. The MX-1 is a dual-gate MOSFET product detector circuit with an approximate 2 kHz audio filter for selectivity in its audio output channel. As with any product detector, it requires an injection voltage (bfo) at its operating frequency which in this case can be provided directly by the VO-1 module on 80 and 40 meters. The taps on the input circuit of the MX-1 allow it to be set for 80, 40, or 20 meters. Operation of the MX-1 below 20 meters is not recommended by the manufacturer because of its greatly lowered sensitivity. Of course, a converter can be used ahead of the MX-1 to bring another band down to 80, 40, or 20 for use with the MX-1. The AA-1 module is simply a very high-gain (100 dB) audio amplifier that provides enough gain to drive any headphone in the 0.1–2 kΩ category to ear-splitting volume.

80 and 40 meter Operation

The interconnection of the modules for operation on 80 or 40 meters is quite simple by following the manufacturer's instructions. The VO-1 feeds the TX-1 and

MX-1 modules simultaneously. The original interconnection instructions called for a 50 pF capacitor from the VO-1 output (terminal F) to the TX-1 (base of the MPS6514 via the lower contact on the crystal socket). Latter instructions call instead for only a 3.3 kΩ resistor since the TX-1 when keyed was found to pull the frequency of the VO-1 quite a bit. The manufacturer now recommends this change. The antenna used is switched back and forth between the TX-1 and MX-1. No tone can be heard in the headphones during transmit because the product detector is always tuned to the same frequency as the transmitter. However, to eliminate the annoying thumps heard, terminal E on the AA1 can be grounded during transmit. Switching of the 12V supply to the AA-1 to quiet it, does not work well because the large capacitors used cause a time delay when the unit is switched on before the gain comes up.

One of the most immediately noticeable difficulties in operation is the limited bandspread provided by the VO-1 module. It covers far more than the entire 80 and 40 meter bands in one half-turn of the vfo capacitor. It is unlikely that most users will require this sort of coverage if they are interested in just the CW portions of the band. The solution is quite simple. The 430 pF vfo variable capacitor is replaced by a 150 pF capacitor fully meshed, the slug of the 80 meter vfo coil (bottom slug in coil can) is adjusted to place the vfo output at 3500 kHz and the slug of the 40 meter vfo coil (top slug in the coil can) is used to place the vfo output at 7 MHz. In this manner, just the CW portions of either band is covered and the ease of tuning is greatly improved. If one were to also add a 6:1 gear reduction drive to the tuning, such as that provided by the inexpensive ($1.50) Jackson Bros. reduction drives, a really excellent tuning system would result. A further modification to the VO-1 would be to regulate the supply voltage to the unit. Although regulation is not required when using fresh batteries to power the transceiver, after some hours of operation the internal resistance of two series-connected 6V batteries, or three series-connected

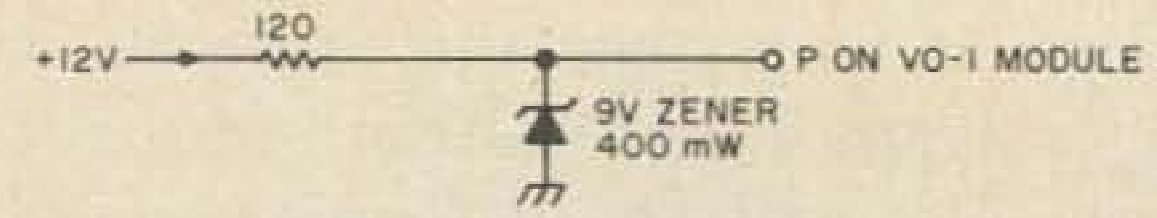


Fig. 2. Simple zener regulator improves transceiver stability greatly when battery supply starts to become "soft" after several hours use.

4.5V batteries, does build up and vfo chirp during keying becomes apparent. The simple solution is a 9V zener regulator for the VO-1 module, as shown in Fig. 2. Reducing the operating voltage of the VO-1 to 9V from its nominal 12V did not produce any noted reduction in output of the TX-1 module, nor in the receiving sensitivity of the MX-1 module.

Another simple addition to the modules when they are used on either 80 or 40 meters is a keying monitor and a transmitter rf output level indicator. The manufacturer does produce a keying monitor in two forms. The AC-2 module is just a keying monitor, but it is a bit elaborate and expensive as compared to the other modules for the purpose of providing just basic sidetone.

The AC6 module is a better value since it contains for about the same price not only a sidetone oscillator, but a VO-1 doubler (discussed later). However, the doubler circuit is not needed for basic 80/40 meter operation. The AC-6 keying monitor is also of the phase-shift type which produces a very good sine wave output, but is a bit superfluous when only

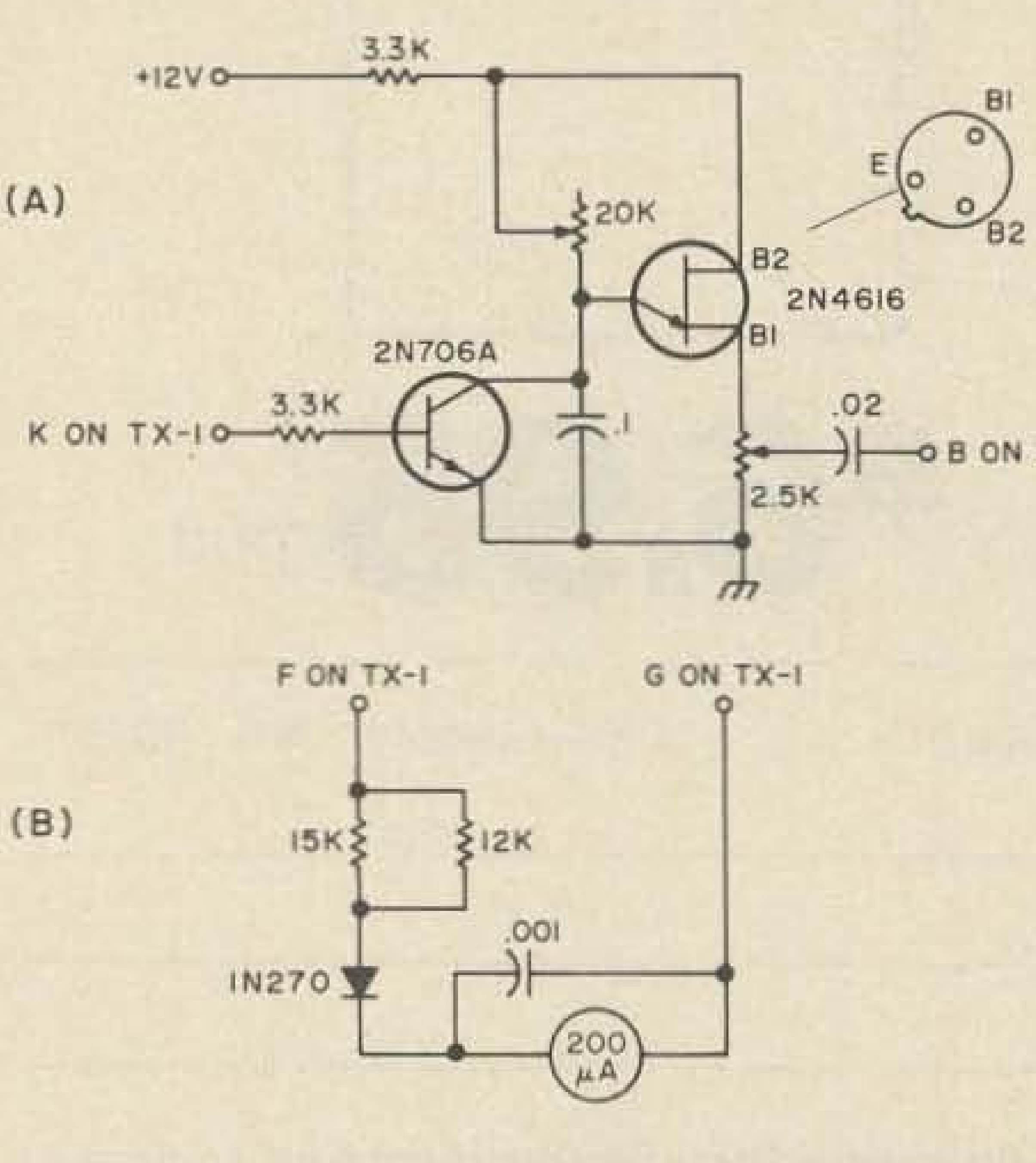


Fig. 3. CW monitor (A) with adjustable tone and volume and rf output level circuit (B).

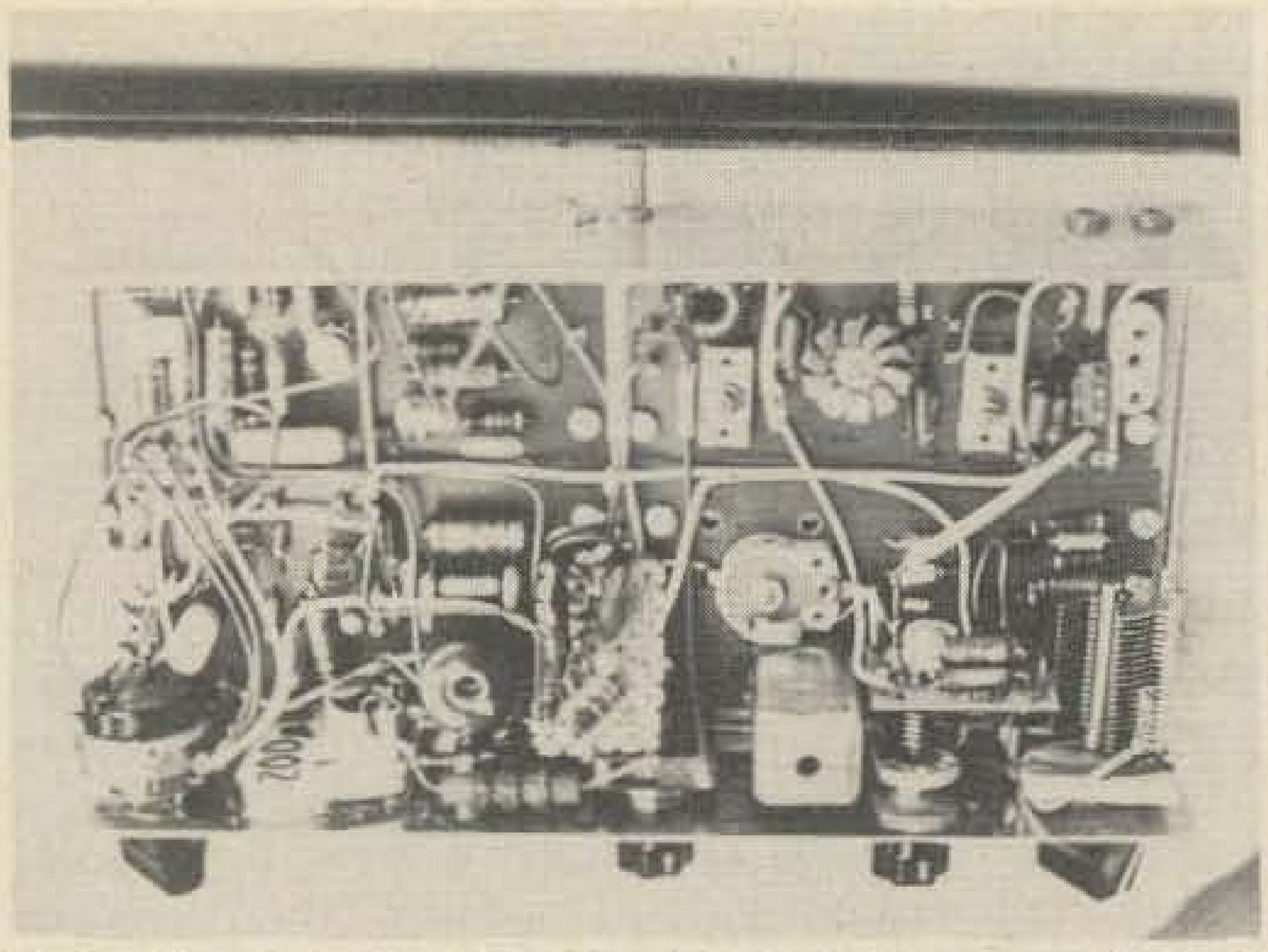
basic sidetone is required for a portable transceiver. The use of a 300 mA meter in the battery supply lead for tuning purposes, as recommended by the manufacturer, is certainly easy to use and does give a continuous indication of the input level to the TX-1 module. However, when dealing with such a low-power unit, it does appear advantageous to instead have a tuning indicator which shows that the maximum possible power output is being obtained.

Figure 3 shows the CW monitor developed by the author, as well as a simple rf level output monitoring circuit. The CW monitor, if one disregards the 2N706A, is seen to be a very simple unijunction sawtooth oscillator. The output is fed to the AA-1 module, but beyond the point where the volume control for the AA-1 module has effect. Thus, the sidetone volume will remain constant regardless of how the AA-1 volume control is changed during receiving. The 2N706A stage operates as a switch controlled by the TX-1 keying terminal voltage. Under key-open conditions, about 3V is developed across the key terminals. This voltage applied to the base of the 2N706A causes the transistor to "short" the .1 μF capacitor in the 2N4616 emitter lead and that stage cannot oscillate. Under key-down conditions, the 2N4616 stage is free to oscillate. The monitor circuit produces a very cleanly keyed sidetone because of the 2N706A switch. The output frequency is adjustable by varying the 20 kΩ potentiometer in the emitter lead and the output level by varying the 2.5 kΩ potentiometer in the base 1 lead. The rf output level circuit is simply a series rectifier circuit employing a sensitive 200 μA meter connected across the link output of the TX-1. The high series resistance used insures that the circuit will have no effect upon the low impedance output loading of the TX-1. It is used the same as any rf output level circuit, with the tuning capacitors in the TX-1 both simply being adjusted for maximum output level on the meter.

The performance of the transceiver on 80 and 40 meters, once the above modifications have been made, is very satisfactory. Keying is good and the stability during receive is excellent. SSB reception can be done quite easily with the expanded bandspread tuning. The CW reception is really surprising and one wonders how so many signals can be heard with even the simplest of antennas using such a simple receiver. The answer is perhaps not hard to find when one considers the high conversion efficiency and low noise factor of the MOSFET used in the MX-1 module, plus the extremely high gain of the AA-1 module. The mating of the MX-1 and AA-1 modules is very well designed. A 1.0 μV or less signal on CW can be copied quite easily. A comparison of the MX-1 and AA-1 combination to any expensive communications receiver will, of course, demonstrate the superiority of the latter. However, the comparison of the modules to several of the medium price range receivers, or receiver portions of inexpensive transceivers, is rather disturbing. Not only does the module combination seem to perform just as well on CW but the freedom from spurious mixer responses, images, etc. provided by the module combination is really refreshing on the extremely crowded, BC infested lower frequency bands. It is a rather new experience to again be confident that what one is hearing is really on the frequency being received, rather than the creation of poor receiver design. The CW selectivity of the modules is not adjustable since it is determined by the audio filter in the output of the MX-1 module. However, one can adjust the slug in the large inductor (L2) of the MX-1 to vary slightly the audio frequency filter bandpass to a setting more suitable to individual preference. The audio gain of the AA-1 is so great that a sharp audio filter such as the surplus and inexpensive FL-8 can easily be added between the MX-1 and AA-1 when space is available to provide extreme audio selectivity without any additional circuitry.

Operation on 20 and 15 Meters

The first inclination when one investigates the usage of the modules on 20 meters is to be a bit critical of the manufacturer. The TX-1 and MX-1



Top view of the four basic modules as packaged by the author into a single band transceiver. Details of modifications made are discussed in the text.

The power supply for the author's portable transceiver consists of three 4.5V flat batteries held in the top cover of the transceiver enclosure.

modules cover 20 meters with their tuned circuits but the VO-1 module output must be doubled to provide drive to the TX-1 and an injection voltage for the MX-1. It would seem that better design of the VO-1 could have provided this simple feature. However, some consideration of the modest cost of the modules must also be included.

The manufacturer does provide a module (AC-6) which contains a frequency doubler for the 40 meter output of the VO-1, plus a CW monitor. However, a simple frequency doubler can be constructed, as shown in Fig. 4, which will also

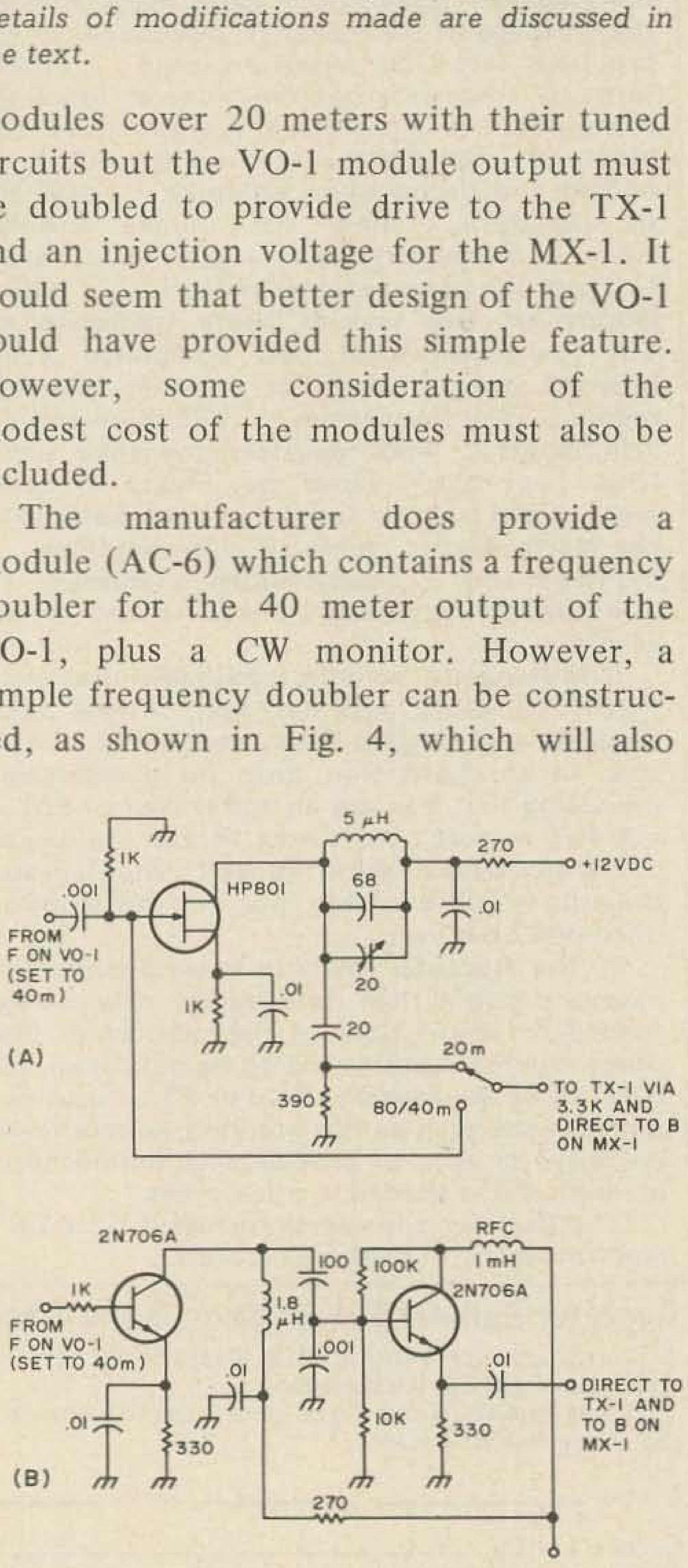


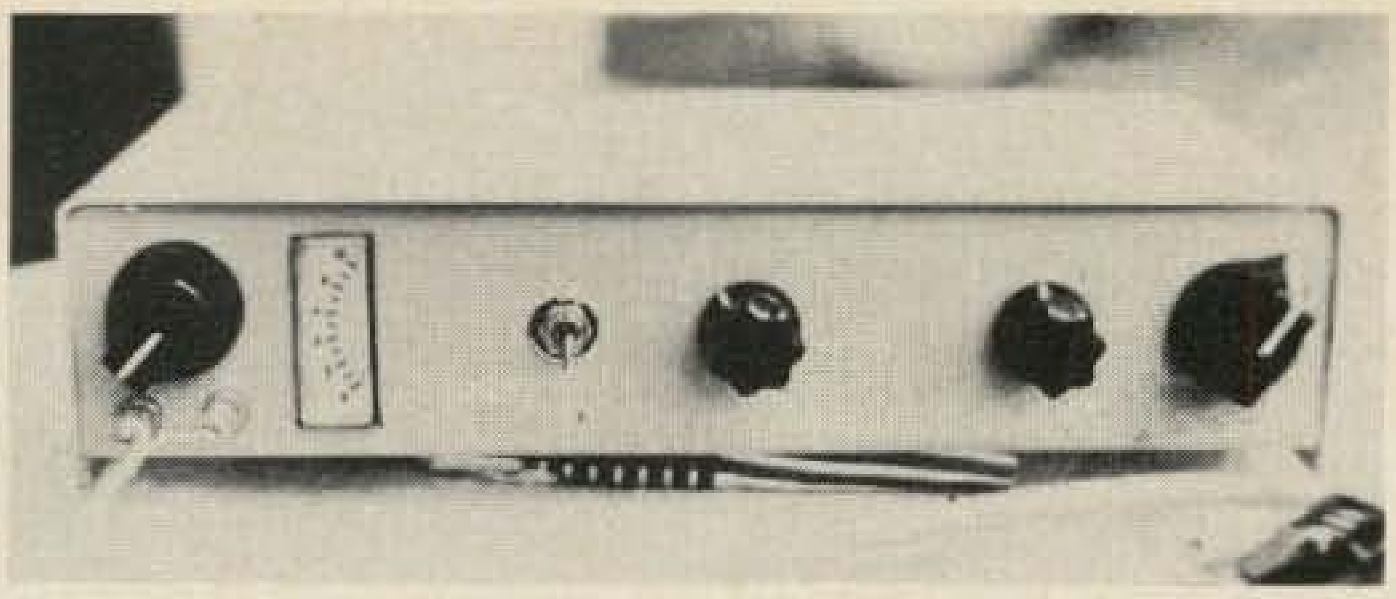
Fig. 4. FET doubler circuit (A) to convert 40 meter VO-1 output to 20 meters. Dual stage circuit (B) provides better vfo isolation and can also be used as tripler for 15 meter operation.

serve the purpose. The FET doubler shown in Fig. 4(A) provides about 2V at 14 MHz which is more than adequate for the TX-1 and MX-1 modules. However, even when using this FET circuit there was found to be noticeable "pull" on the frequency of the VO-1 unless the drain circuit of the FET was carefully tuned so that the output frequency of the TX-1 remained the same under key-down conditions and under key-up conditions when only the feed-through of the VO-1 and the doubler could be heard in a receiver. A less critical circuit is shown in Fig. 4(B). This two-stage doubler provides a broadband doubler, plus a buffer stage, so pull on the VO-1 is eliminated when the frequency of the latter is doubled from 7 to 14 MHz.

Operation of the modules on 15m becomes a bit more complicated in that if vfo operation is desired, the 7 MHz output of the VO-1 has to be tripled, but the MX-1 cannot operate on 15m and requires a down-converter to translate 15m to 40m. Of course, the necessary circuitry can be provided and one can use the circuit of Fig. 4(B) as a tripler by changing the value of the inductor in the 2N706A collector lead. The manufacturer recommends crystal controlled TX-1 operation on 15m. A rough check indicated that the TX-1 output dropped at least 50% on 15m as compared to its 40m output.

Packaging the Modules

After experimenting with the modules on various bands, I decided to package



Front view of the complete book-size transceiver package. Controls on front (left to right) are volume with headphone sockets underneath, meter, send/receive switch, final tuning, bandspread tuning, and main tuning.

them into a truly self-contained, compact and portable single-band transceiver. I decided on 20 meters as the best compromise band for reasonable performance, portable antenna size, DX possibilities, etc. However, the construction described can certainly be applied to usage of the modules of any other band, or even for multiband usage.

The first photo shows the placement of the four basic modules in the bottom section of an 8 x 4 x 2 in. enclosure (similar to BUD CU-592). The modules are all mounted on the enclosure bottom plate with the standoff hardware provided with the modules. The VO-1 module is at top left, the MX-1 module at top right, the TX-1 module at bottom left and the AA-1 module at bottom right. The placement of the modules in this fashion was deliberately done so the low-profile modules would be to the rear. This allowed the accommodation of the battery supply in the rear upper half of the enclosure, as shown in the photos. In the first photo, you can see the main tuning capacitor (150 pF) at the upper left hand corner. This capacitor was used to replace the 430 pF variable removed from the VO-1 module. Next to it is a 25 pF variable wired in parallel to the 150 pF variable and used as bandspread tuning. The bandspread tuning was added because no reduction drive was used for the main tuning capacitor. It allows far easier tuning to be done over a narrow frequency range, especially under heavy QRM conditions. The VO-1 doubler circuit is mounted on perforated board stock immediately to the rear of the bandspread capacitor and to the left of the VO-1 inductor can. The CW monitor circuit is mounted on board stock and visible in the top center between the VO-1 and MX-1 modules. The tone and volume potentiometers are PC board types and are not brought out as front panel controls. Once adjusted, they can be left as set. Somewhat hidden behind this board is a 500 pF paper variable capacitor of the transistor radio type. It is used for peaking the 2N4427 output and is connected between ground and terminal L on the TX-1 board for 20m. Terminal E on the TX-1 board is then left unconnected. It was found not to be necessary to tune the MPS6514 stage, nor the input circuit of the MX-1 via front panel controls when operating over a 100 to 150 kHz band segment. These stages are peaked with the components already provided on their PC boards. The 200 μA meter is clearly visible and next to it is the 25 kΩ volume control with on/off switch.

The transmit/receive switching circuitry is a bit more elaborate as that previously described and is detailed in Fig. 5. The circuitry allows battery level monitoring and rf output level monitoring, as well as the usual transmit/receive transfer functions.

Operation of the transceiver on 20m has been both rewarding and challenging. There is little more to do with the transceiver in operation except to peak the front panel final tuning capacitor for maximum rf output level on the meter. A 20m dipole cut to frequency provides excellent loading.

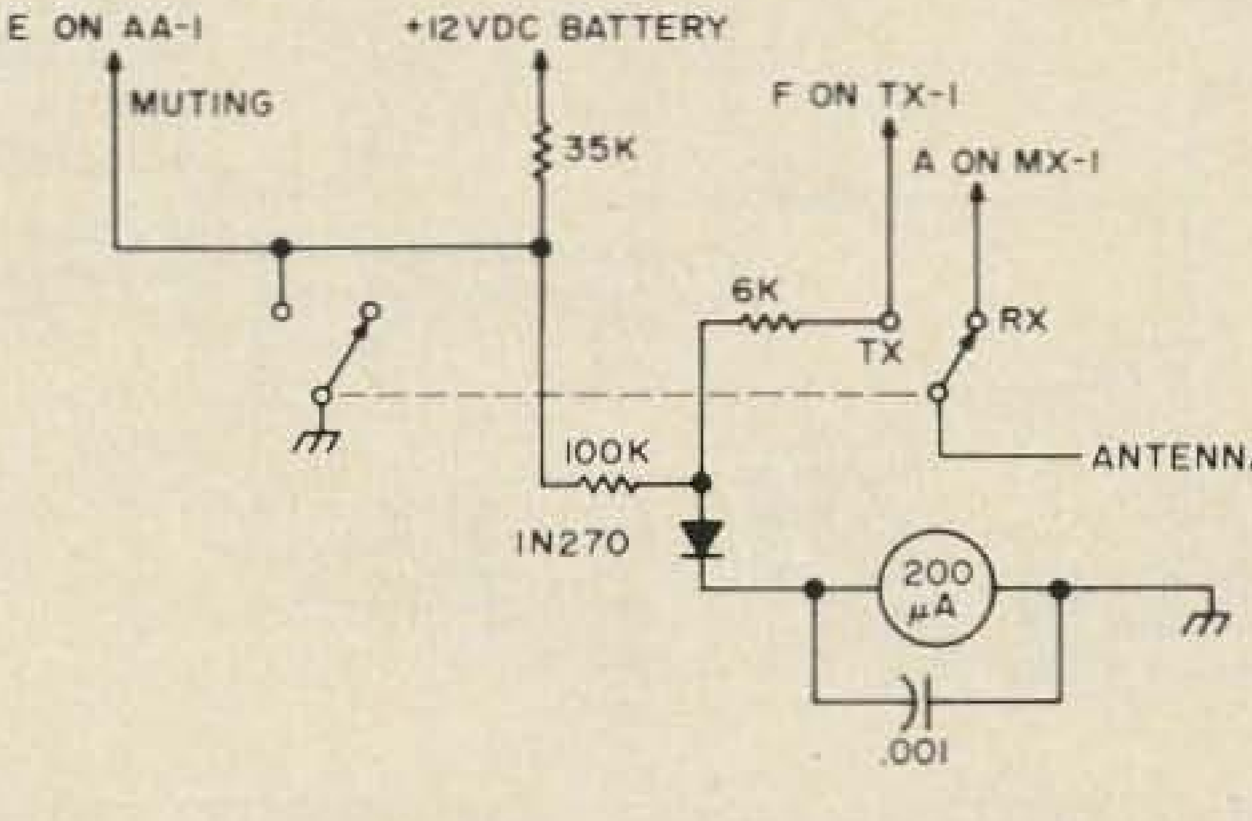


Fig. 5. A more elaborate send–receive switching circuit which provides antenna switchover, receiver muting during transmit, meter indication of battery level during receive, and meter indication of rf output level during transmit.

The operating rules for a transceiver of this power class can probably be expressed in two phrases:

1. *Never* call CQ as it is a complete waste of time.

2. When answering a CQ, wait first to hear if any strong sounding station replies also. If so, do not attempt to call the station, unless he later sends a QRZ and cannot apparently establish contact with the first station who called. The rules are simple to state and difficult to follow. But, QSOs will result instead of discarding low-power operation as a waste of time.

Further Improving Performance

The modules themselves work so nicely for their intended purpose that there inevitably follows the desire to use them as the basis for more elaborate equipment. Particularly in the case of the MX-1, there is considerable value to this idea as with some additional circuitry the MX-1 can be transformed into an excellent and inexpensive CW receiver that could rival any of the cheap-to-moderate priced receivers on the market.

Figure 6 shows an FET preamplifier stage that provides a good boost to the MX-1 sensitivity by complementing its existing low-noise FET characteristics. It is not recommended that other types of transistorized preamplifiers be used before the MX-1 since very few will have the noise characteristics necessary. Broadband,

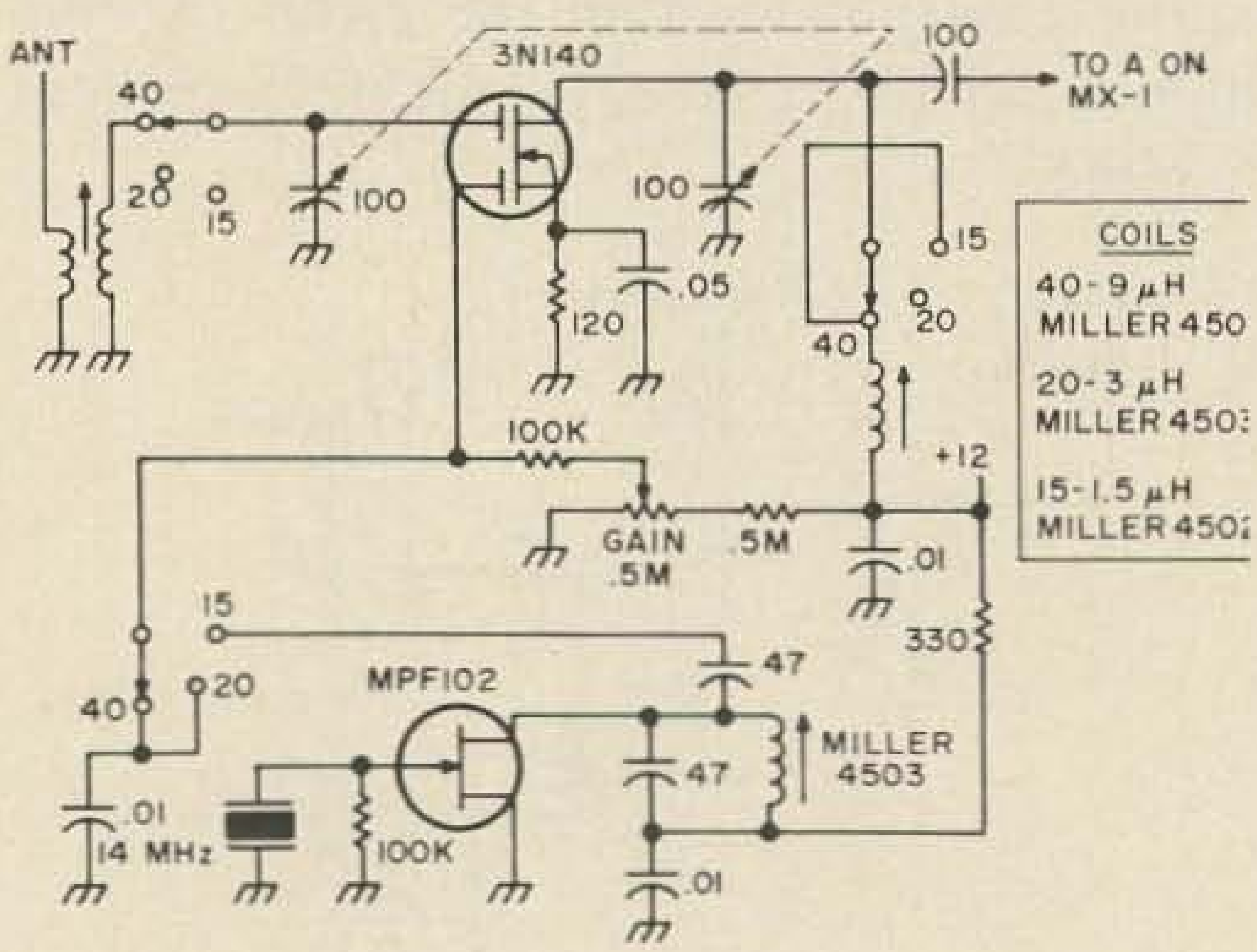


Fig. 6. Improved receiver performance can be achieved by a simple MOSFET preamp. Circuit shown can be built as a single band preamp if desired. As shown, it functions as preamp on 40 and 20m and as a down-converter to 40m for 15m input signals.

untuned amplifiers are particularly unsuitable. The circuit shown provides two additional tuned circuits before the MX-1 for added front-end selectivity. In fact, one could carry this sequence further by adding more preamplifier stages with high-Q tuned circuits in the style of the old trf receivers with 2 to 4 rf amplifier stages. One additional preamplifier stage increases the sensitivity to about 0.1 μV on CW. The circuit of Fig. 6 can function also as a mixer on 15m to down-convert 15m into the MX-1. Used in this manner, it will perform very well as a complement to the TX-1 on 15m. If one wanted to increase the 15m sensitivity further, however, an additional 3N140 amplifier stage should be used ahead of the circuit shown with 15m coils used in both the gate and drain tuned circuits. As was mentioned before, the AA-1 module provides so much gain that an additional audio filter can be used between the MX-1 and AA-1 units. A surplus FL-8 type is very suitable and L2 on MX-1 should be shorted out for this purpose. Another approach is to use a transistorized notch filter between the MX-1 and AA-1 without disturbing the audio filter on the MX-1 board.

Even if one totals up the cost of the components necessary to provide preamplification, improved audio selectivity and vernier oscillator tuning for the MX-1/VO-1 combination on 80, 40, or 20 meters, it will be far less than the expense of any commercial superheterodyne receiver. However, "clean" reception due to the lack of spurious responses and the superior overload characteristics of the FET MX-1 and FET preamplifier will make reception much more enjoyable.

The TX-1 performance can be improved by the addition of another transistor PA stage. However, there is probably not too much value to increasing the power level for portable operation to the 5–20W category. Successful operation at these levels is almost 90% a question of operator techniques. The minimum power level which probably should be aimed for if one wants to boost the TX-1 level to a really useful value is 50–70W.

. . . W2EEY ■

Albert H. Coya WB4SNC
1710 SW 83rd Ct.
Miami FL 33155

HAM HOSPITALITY a la LATIN

The muffled sound of the telephone bell awakened me. My hand reached out in the dark trying to locate the phone. I had just fallen asleep a few minutes earlier.

"Hello?"

"Albert, I'm sorry to wake you up at this time, but you are flying tomorrow morning to Nicaragua."

"What? What is going on in Nicaragua?"

"A volcano is erupting, and we need aerial pictures of the volcano and a first-hand story on the refugees and damages."

When you are a press photographer and you work for the largest newspaper in the South of the United States, this conversation is not unusual. I am the only Spanish-speaking photographer on the staff of *The Miami Herald* so every time something is cooking in Latin America it is a good bet they will send me down there. The mud of the Puerto Rican floods was still fresh on my shoes.

"We have reservations for you at Lanica Airlines, 8:00 AM," instructed my boss' voice.

"Okay, I'll be at the airport on time."

I looked at the clock. It was midnight. I had not been in Nicaragua before, and I needed some fast information on what was going on there. My thoughts went to my ham rig lying there in the shack. Anyhow, I could not go back to sleep, and the XYL was already looking for my light suitcase.

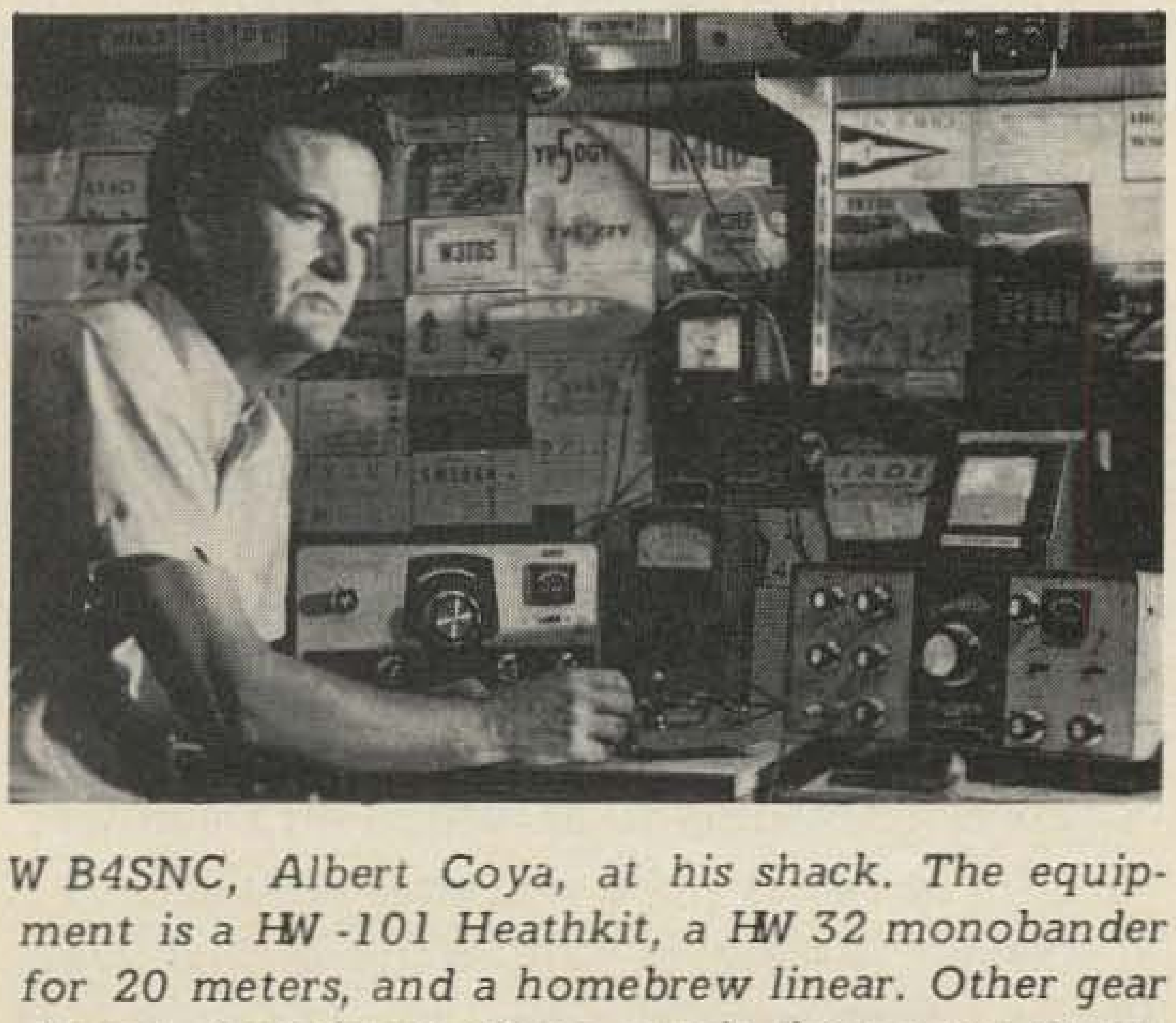
While the coffee pot was getting hot, I went down to the shack and turned on the rig.

The familiar rushing noise came from the speaker. I tried 20 meters and to my surprise I found it was still open and a few QSOs were going on. I stopped the dial in the spot where a conversation in Spanish was in progress. After listening a few minutes, I hadn't heard any identification, so I decided to break in.

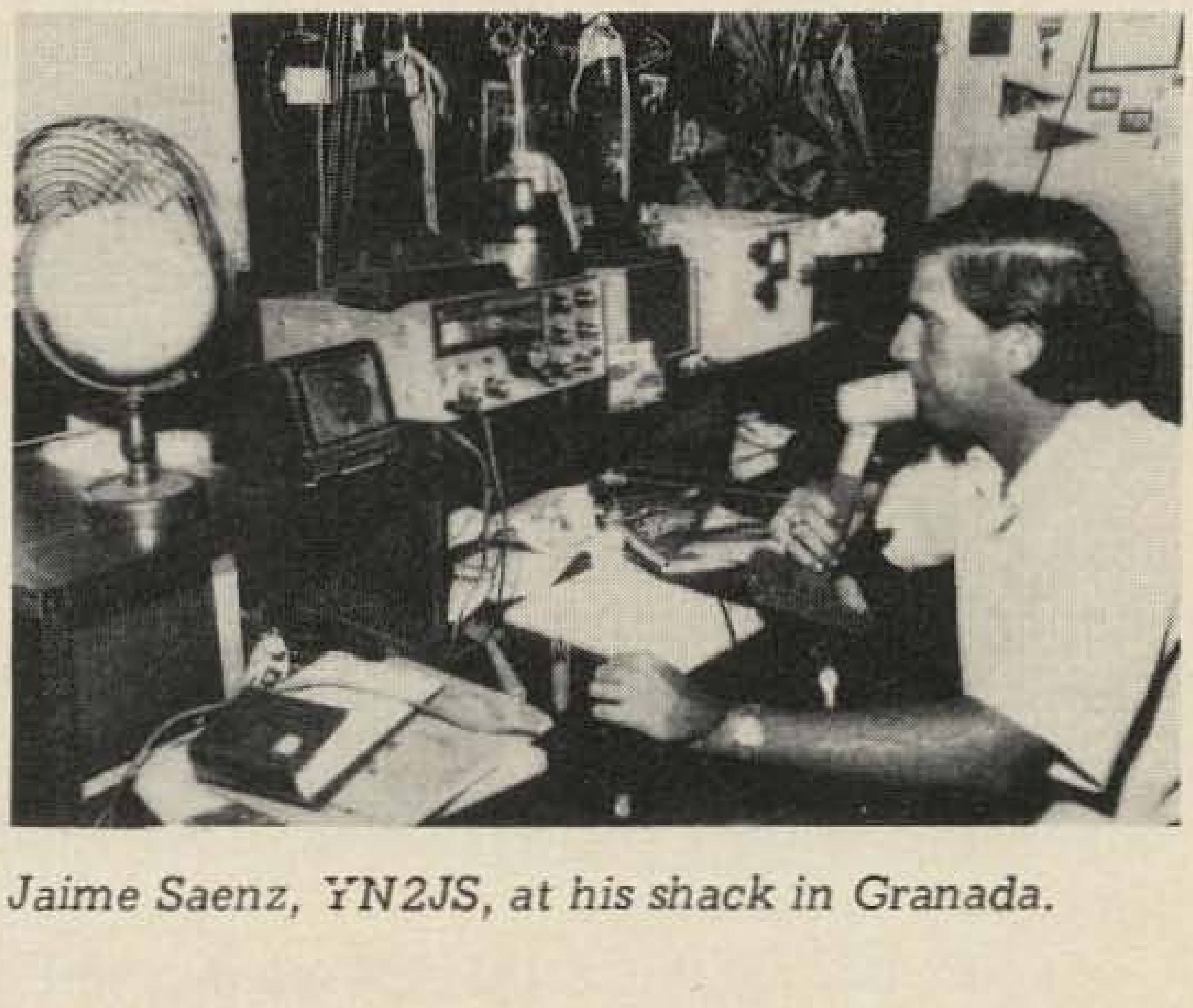
"Break, break, this is WB4SNC in Miami, looking for Nicaragua – is Nicaragua on the frequency, please?" I said in Spanish.

"A station from Miami is breaking in, Carlos . . . " said one of the voices in Spanish.

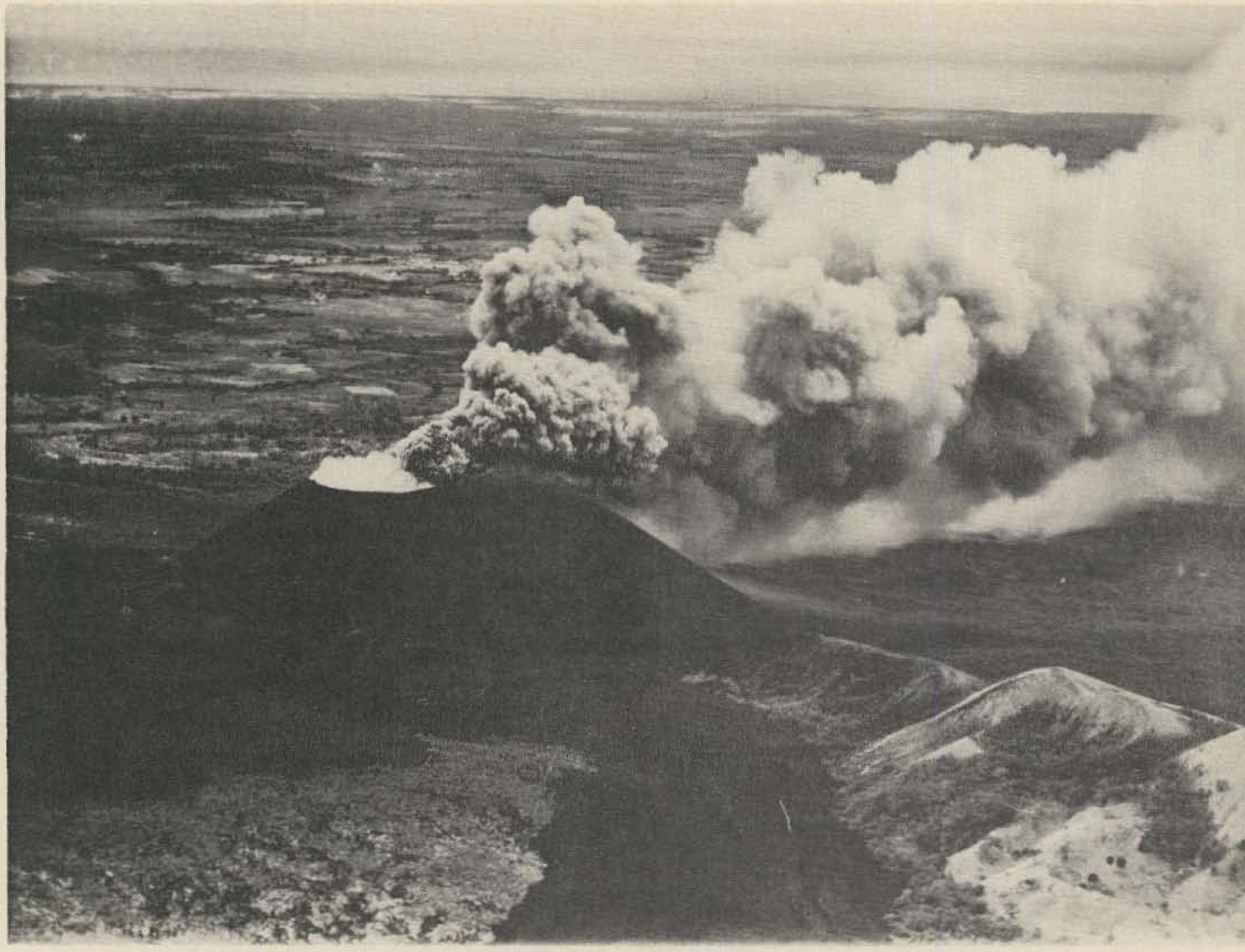
"I am looking for Nicaragua, amigo. I need some information on the volcano eruption."



W B4SNC, Albert Coya, at his shack. The equipment is a HW-101 Heathkit, a HW 32 monobander for 20 meters, and a homebrew linear. Other gear shown: homebrew phone patch, frequency counter, keyer, SWR meter, monitor scope, and power supply for both rigs.



Jaime Saenz, YN2JS, at his shack in Granada.



"Hey, Jaime, that call is for you!" another voice said.

I couldn't believe it. My first try, and there it was: a Nicaraguan station!

"Hello, this is YN2JS, in Granada, Nicaragua. The name here is Jaime Saenz. Can I help you in any way, amigo?"

"Wow! Boy, I am lucky! Jaime, this is WB4SNC, in Miami – the name is Alberto. I am a newspaperman and I have to fly to Nicaragua tomorrow morning to cover the eruption of the volcano Cerro Negro, and I need some information on what is going on. Is your city affected by the eruption?"

"Oh, no, we don't have any problems here. The volcano is in the west side of the country and the most affected city is Leon. The damages are estimated in many thousands of dollars, and the refugees are pouring out of the vicinity of Cerro Negro. At what time are you coming?"

"I am taking the 8:00 AM plane, and I will be there before noon."

"Okay, I will wait for you at the airport."

"What?"

"Do you copy me?" Jaime said, "There is no QRM in this side; I repeat – I will wait for you at the airport."

I thought I was having trouble again with my lousy dipole. I blamed myself again for not putting that quad up the previous weekend.

"Hola, this is WB4SNC in Miami, do you still copy me, Jaime?"

"Si, go ahead."

"You said you will wait for me at the airport, I believe. But, Jaime, you don't have to do that. I only need some information on the volcano, so I will know where to go from the airport. You don't have to wait for me. Of course, it will be very nice of you, and I will have the pleasure to shake your hand, but I don't want to bother you . . . YN2JS, this is WB4SNC in Miami, go."

"It is no bother at all, old man. I will wait for you at the airport, and that is final."

"Okay, Jaime, if you want it that way. Please, rent me a jeep or a four-wheel traction truck for rough terrain. Money is no problem. Probably I will have to rent a

Cleaning the streets.

plane, but there's a good chance the government will let me use military transport. I must take some aerial pictures of the volcano before we go by land in the jeep."

We said "hasta manana" with the usual courtesies, and I went to bed to grab a couple of hours of sleep.

I reached the Lanica counter at 7:00 AM.

"Sorry, senor, the plane departed five minutes ago."

"What? They told me the flight was scheduled for 8:00 AM."

"Last night's clerk made a mistake, and we are very sorry about it."

I grabbed a phone and called the editor.

"Postpone everything, Albert, maybe you'll be able to take another plane in the afternoon," he said.

I went back home. I wanted to call Jaime and tell him not to wait for me.

Again to the shack, looking at 9:00 AM for a Nicaraguan station. I have only thirty minutes to contact Jaime. After trying for ten minutes, a YL voice in Spanish answered my call.

"This is HC2NA, In Guayaquil, Ecuador, old man. I have a sked with Nicaragua in one hour, and maybe I can relay the message. The handle here is Nena."

I told Nena the story and asked her to tell Jaime to wait for me at noon on 15 meters around 21.280 kHz.

Back in the office, the editor's secretary gave me a ticket for a Pan American flight that afternoon. Things looked better then, and I went home to contact Jaime and get my suitcase.

The sked was on time and YN2JS answered my call.

"New arrival time, Jaime – I think I will be in Managua around 6:00 PM. 73, and I will see you later. Hasta luego."

"Muy bien, Alberto, I will be waiting for you."

But something was against my plans. The Pan Am flight was not direct to Nicaragua, and the first stop – San Pedro Sula, Honduras – was diverted because of bad weather, and the plane landed in Guatemala.

The last news said that the volcano was losing power, and I knew the only chance I had to take pictures of the action was flying there the next morning; not later.

Somebody up there must like me, because my prayers were answered and Pan Am sent a plane to pick up the passengers to Nicaragua.

The 707 landed in Managua at 9:45 PM, and I was worried about Jaime waiting all that time. I thought I wasn't going to find him there, but I was wrong, and a young, smiling, tall fellow extended his hand to me.

"You must be Alberto, WB4SNC . . . "

"And you are Jaime, YN2JS . . . "

We shook hands. The jeep with the driver was waiting for me. This was my first test of what the international brotherhood of ham radio is.

We had a typical Nicaraguan meal, with "churrasco" (thick steaks broiled on charcoal) and country beer.

The next morning Jaime had the jeep and the driver waiting for me at the hotel, and from there we went to the military airport. After some red tape, we used a government plane and finally flew over and took pictures of the volcano. It was a very impressive spectacle!

After returning to the airport we drove the hundred miles to Leon, and started looking for refugees and signs of destruction.

The city of Leon was covered by a thick blanket of black volcanic dust. Red Cross, civic institutions, and radio operators had joined in a well-coordinated net to help the refugees.

Every time the winds blew, the microscopic dust got airborne and made us cough and sneeze. After six hours in the place I felt as though I had sinus trouble.

Talking to the refugees, I realized all the tragedy of these poor people driven from

Little refugee with the dust of the volcano on her face.

their small farms with only a few belongings over their shoulders.

We went back to Managua after visiting places accessible only by jeep. Jaime insisted that I check out of the hotel and go to his home and meet his family and friends in Granada. He lives in a palatial home with his parents and eight brothers and sisters. The house was very appropriate for a big family – a two-story green building, with a quad antenna one hundred feet in the air. A typical Spanish home with a central patio, and the flavor of the old country, complete with real hospitality, Latin ham style.

After dinner that night, Jaime took me to the Jockey Club to meet his friends, a group of radio amateurs alerted by him of my presence in Granada. Of course, we talked radio, and they made me feel at home, forgetting how tired and sleepy I was.

We called Miami and made a contact on 75 meters with WA4ZZG, Rafael Estevez, who ran a phone patch with my XYL at one o'clock in the morning.

This is the story of my fast trip to Nicaragua and my first contact with what really exemplifies the brotherhood of ham radio: an unwritten code of gallantry and courtesy.

. . .WB4SNC

GENERAL CLASS LICENSE STUDY GUIDE

Questions & Answers Part I

For a little over three years, we have been presenting a more-or-less continuous series of study courses for the General, Advanced, and Extra class licenses, which avoided the "question-and-answer" format so popular with many license courses in favor of explanation in depth of the theory behind the questions.

Content of these courses has been determined by the "study questions" made available by the FCC for would-be applicants. We refrained from using the Q&A format in the belief that it would lead toward memorization of the material rather than toward learning of the processes involved – and in a conviction that actual understanding of the theory was of far more importance to future enjoyment.

However, we recognize that some readers can comprehend the material more rapidly by a Q&A technicue than by our extended technical discussions, and also that anyone can make use of a checklist against which to test his understanding.

We must emphasize that for some questions a number of answers may be correct, and our answers do not attempt to provide all the possible correct responses. In some cases, the study questions are so phrased that no "correct" answer is possible (for instance, question 1 below). In these cases, we simply indicate the source or sources from which material satisfying the question may be obtained.

Many of our answers contain references in parentheses. These references are to installments of our previous study courses, and indicate where detailed discussion of the principles involved may be found.

The study list for each class of license is far longer and more detailed than is the actual examination. In addition, most of the questions in the actual exam are of the multiple-choice type, in which you select the right answer from several (usually five) possibilities, while those in the study list call either for direct specific answers, or for discussion. Both these differences are apparently designed to help assure that anyone who can answer all the questions on the study list accurately will have little difficulty with the actual examination.

1. Questions based on Part 97 of the Commission's rules.

This is not a specific question and so cannot be answered directly. It is intended to indicate that the actual exam will contain a number of questions dealing with permissible subbands, operating procedures, and so forth, all of which are spelled out in Part 97 of the FCC Rules and Regulations. A copy of Part 97 may be otained from the Government Printing Office, or found in some of the larger public libraries. Be sure to check the latest edition; the rules change with sufficient rapidity to make this caution necessary.

2. Of what use is a bleeder resistor in amateur equipment?

A bleeder resistor is an integral part of a power supply, and serves two primary purposes. From a technical point of view, its primary purpose is to provide a definite minimum load upon the power supply and thus improve regulation and filtering. From the viewpoint of operator safety, its primary purpose is to "bleed" off the energy stored in the filter capacitors and so prevent electrical shock. However, resistors can open-circuit without warning, so that a bleeder resistor should never be trusted when you work on a power supply; this makes the safety purpose somewhat deceptive.

3. Define skin effect. How can this phenomenon be minimized?

"Skin effect" is the tendency of radio-frequency energy to travel on the surface of a conductor rather than uniformly throughout the conductor's volume. This causes the rf resistance of a conductor to be greater than its dc resistance. The effect can be minimized by using conductors with large surface area (strips or tubes rather than solid wire), and by using "litz" wire which consists of many small strands of wire so braided that each is on the outer surface for the same percentage. (General course, Part IIB)

4. List some operating procedures which can be employed to minimize interference and congestion of the amateur bands.

Avoid excessively long transmissions, always listen before transmitting (to be certain that the frequency is not already occupied), speak clearly and distinctly to reduce the need for repeating information, and do your operating when the bands are least heavily occupied. (General course, part XII)

5. Describe the operation and usage of a cathode follower.

The cathode follower is a vacuum-tube amplifier circuit in which the plate is grounded (so far as signals are concerned) and output is taken from the cathode. As the grid voltage is varied by the input signal, current through the tube also varies. The current variation appears as voltage variation across the cathode resistor. This variation in cathode voltage opposes the change in grid voltage, producing very high input impedance for the circuit and a voltage gain always smaller than 1. High current is available, however, and the high current and low voltage of the output result in low output impedance. The cathode follower is frequently used as an impedance transformer or "isolation" circuit because its high input impedance imposes little load on the driving circuit, and its low output impedance makes it relatively insensitive to loading by the circuit which it drives. (General course, part V)

6. How does frequency tolerance affect band edge operation?

The existence of a "tolerance" implies possible errors, and in order to be certain that one is operating whtin the limits of a band it is necessary to add the maximum possible error permitted by frequency tolerance to the supposed frequency, when at the upper band limit, or subtract the maximum possible error, at the lower band limit. If this is not done, the error may put your actual signal outside the band limit, which is illegal. (General course, part VIII)

7. What is impedance matching and why is it important?

Impedance matching is the name given to the process of assuring that each of two separate components in a signal chain is operating under the conditions for which it was designed. These conditions are normally specified in terms of "impedance"; and when impedances are matched, power transfer is most efficient. In ham parlance, "impedance matching" is usually applied to discussions of matching antennas with feedlines and feedlines with transmitters. In this case, an approximate match is necessary to achieve satisfactory power transfer or "loading" and to minimize undesired radiation by the feedline. (General course, parts IV and XI)

8. How is the plate circuit efficiency of a vacuum tube determined?

Divide the measured signal power output of the tube by the measured dc power input. The result will always be a fraction smaller than 1. It is normally expressed as a percentage. (General course, part V)

9. What is amplitude modulation (AM)? How is the intelligence conveyed in an AM signal?

Amplitude modulation is a technique for conveying information by varying the amplitude or strength of the transmitted signal. It is the most commonly employed form of telephone communication. In AM, the intelligence is conveyed in a pair of symmetrical sidebands, one on each side of the carrier wave. The sideband energy mixes with the constant energy of the carrier wave to vary the amplitude of the composite signal envelope. (General course, part IX)

10. What is meant by the ripple frequency of an ac power supply voltage?

"Ripple" in the output of an ac-operated power supply refers to the alternating component which remains in the dc output after filtering. "Ripple frequency" is the rate at which the ripple alternates. Ripple frequency is related to the frequency of the ac input power. With half-wave rectification, ripple frequency and input frequency are the same. With full-wave, ripple is at twice the input frequency. (General course, part VII)

11. What is a third party agreement?

International regulations, to which this nation is a party, absolutely forbid international transmission of messages between amateur radio stations on behalf of any person except the two operators involved. Such messages are known as "third party" traffic. The regulations permit the rule to be suspended by special agreement between the two nations involved, however, and such a special agreement is known as a third party agreement. The U.S. has third party agreements with a number of other nations (but not all), and third party traffic may be handled with those nations. (General course, part XII)

12. How does a zener diode operate and of what use is it in amateur equipment?

A zener diode operates by means of the "zener effect" in specially constructed semiconductor junctions, which maintains a constant voltage drop across the junction regardless of the current through it (so long as the device is not burned out by excessive current). The zener diode is used as a voltage regulator, and as a source of reference voltage for electronic regulator circuits. (General course, part VII)

13. Define standing wave ratio (SWR). How can the SWR of a line be determined? How are the SWR of a line and its characteristic impedance related? Name some factors that affect the characteristic impedance of an air-insulated parallel-conductor transmission line.

Voltage standing wave ratio, to give it its correct name, is defined as the ratio of maximum voltage to minimum voltage along a feedline or other conductor which is supporting a standing wave of rf energy.

The swr of a line can be determined by measuring rf voltage along the line, determining maximum and minimum readings, and dividing the smaller into the larger. Alternatively, it may be determined by doing the same with current rather than voltage measurements. Commercial "swr meters" usually measure forward and reflected components of power, and convert the resulting "reflection coefficient" into "swr" by means of their calibration.

The swr of a line is not directly related to its characteristic impedance, but is directly related to the ratio between the impedance of the line and of the load. Swr is equal to the ratio of these impedances. Additionally, swr modifies effective line impedance between limits determined by multiplying line impedance by swr to obtain the upper limit, and dividing by swr for the lower limit.

Factors affecting the characteristic impedance of an air-insulated parallel-conductor transmission line are the spacing between conductors and the conductor diameters. A less important factor is the dielectric constant of the air, nominally 1 but varying with humidity and temperature from day to day. (General course, part XI)

14. What is meant by the maximum plate dissipation of a vacuum tube?

The maximum plate dissipation of a vacuum tube is a rating, normally given in watts, of the amount of heat which the tube's structure can withstand. It is the difference between the dc input power and the output signal power when the tube is dissipating all the power which it is capable of converting into heat. (General course, part V)

15. What is a decibel?

A decibel is one-tenth of a bel. The bel is the unit of power *ratio*. A power ratio of one bel means that one power level under consideration is ten times the other, regardless of the actual level. The bel is the logarithm of the actual power ratio, so that 2 bels represent a 100-to-1 ratio, 3 bels a 1000-to-1 ratio, and so forth. (General course, part III)

16. What is a harmonic? List ways of minimizing harmonic generation in frequency doublers, vacuum tube amplifiers, transmission lines, and antennas.

A harmonic is an rf signal at two, three, four, or some other whole multiple, times the frequency of the original or "fundamental frequency" signal. Harmonics are generated only in non-linear circuits, and may be minimized by avoiding non-linearity where possible.

The purpose of a frequency doubler is to generate the second harmonic of its input signal. However, odd harmonics may be minimized by use of a push-push circuit.

Harmonics cannot be generated by transmission lines or antennas unless corroded joints are present to introduce nonlinearities. Keeping the antenna system in good physical condition, therefore, will prevent harmonic generation there. (General course, part III)

17. What is a crystal resonator?

A crystal resonator, more frequently called simply a crystal, is a thin slice from a quartz crystal used to determine the frequency of an rf oscillator by means of mechanical resonance. Frequency is determined by the shape and size of the crystal. (General course, part VIII)

18. How do electrolytic capacitors operate and why are they widely used in power supply circuitry?

The electrolytic capacitor is composed of two plates of metallic foil, with a moist electrolyte separating them. Chemical action of the electrolyte forms an insulating compound on the surfaces of the plates. This is the dielectric of the capacitor. Because such an electrochemical dielectric can be much thinner than any conventional dielectric, electrolytic capacitors provide large values of capacitance in relatively small packages, and for this reason are widely used in power supply filter circuits. (General course, part VII)

19. What symbols does the Commission use to designate how the main carrier of a signal is modulated?

The FCC uses the alphabetic symbols "A" for amplitude modulation, "F" for frequency or phase modulation, and "P" for pulse modulation, together with numeric suffixes: "0" indicates absence of any modulation, "1" indicates telegraphy without accompanying audio modulation, "2" indicates telegraphy by the keying of a modulating audio frequency or by keying a modulated signal, "3" indicates telephone (voice) signals, "3a" indicates SSB, "3b" indicates two independent sidebands (NOT DSB), "4" indicates facsimile signals, "5" indicates video signals, and "9" indicates signals not classifiable under the remaining codes. Thus "A1" is on-off keying of an unmodulated carrier, "A3" is AM voice, "F1" is frequency-shift keying of an unmodulated carrier, and "F3" is FM voice. "A0", "F0", and "P0" all indicate unmodulated signals, but "A0" is usually used in preference to the other two.

20. What are some possible causes of excessive plate current in a class C power amplifier?

Some of the possible causes of excessive plate current in a class C amplifier are (1) mistuning of output circuit, (2) excessive coupling between output circuit and load, (3) loss of drive (if self-biased) or loss of grid bias voltage (if externally biased), (4) excessive operating voltages on plate, screen, or both, and (5) gassy tube in amplifier. (General course, part VI)

21. List several characteristics of a vertical quarter-wavelength antenna.

If operated against actual ground or an effective ground plane, the vertical quarter-wave antenna has a feed-point impedance of approximately 37Ω and a low vertical angle of radiation. The low angle of radiation makes this antenna effective for skip signals at maximum range, and in the VHF bands, prevents loss of energy at unusably high angles. The horizontal directional pat-

tern is omnidirectional. Radiation from this antenna is vertically polarized. Finally, the quarter-wave antenna is the shortest conductor which can be used as a resonant antenna; any shorter structures must be loaded to an electrical quarter-wave in order to achieve resonance. (General course, part XI)

22. What is TVI? How can it be remedied if the amateur station is at fault? If the TV receiver is at fault?

"TVI" stands for "television interference," or interference to television reception caused by radio signals. Any radio signals may cause TVI; hams are not the only offenders. If the amateur station is at fault, TVI may be reduced by assuring that no rf energy escapes from the amateur station except within ham bands. This is accomplished by shielding and filtering equipment, and by proper adjustment of the transmitter and antenna. When the amateur station is emitting no energy except in assigned amateur bands, any remaining TVI must be due to faults in the TV receiver. Not all these can be overcome, but in general, installation of a high-pass filter in the TV antenna feedline to reject amateur signals, together with (if necessary) tuned traps to specifically reject signals from the interfering station, may reduce the problem. (General course, part XII)

23. How can transistors be used in electronic equipment? What is the beta of a transistor? Compare the elements of a transistor to a vacuum tube's.

With notable exceptions due to power limitations, transistors may be used in electronic equipment in almost any place that a triode vacuum tube can be used. The major exception is that transistors are not yet capable of handling both high frequency and high power simultaneously, although they can outperform tubes both at high power with low frequencies, and at high frequencies with low power.

The beta of a transistor is its dc current gain, measured as the change in collector current for a specific change in base current with both base-emitter and collector-emitter voltages held constant, in the common-emitter configuration.

The emitter of a transistor corresponds to the cathode of a vacuum tube, the base to the grid, and the collector to the plate. (General course, part IV)

24. What is meant by percentage of modulation? What is the maximum legal limit to which an amateur transmitter can be modulated?

The modulation percentage of any transmitter, AM or FM, is defined as 200 times its modulation index. The modulation index is defined differently for AM and for FM. With AM, modulation index is defined as the peak amplitude of the modulating signal, divided by the amplitude of the unmodulated carrier, and is usually calculated by dividing the difference between "crest" and "trough" levels of the output signal by the sum of "crest" plus "trough" to produce a fraction between 0 and 1. For FM, modulation index is equal to maximum deviation divided by maximum modulation frequency. In all cases, amateur signals are limited to a maximum of 100% modulation. (General course, part IX)

25. Describe briefly how oscillators operate. What are the most common types of oscillators and how do they differ from each other?

Oscillators generally consist of an amplifier, a resonator, and a feedback circuit so arranged that output of the amplifier is returned to its input in the proper phase to provide adequate input level and maintain maximum output. Any of these components can be varied to produce a different type of oscillator. Some common oscillator types are the Hartley, which has its feedback network connected in the cathode circuit through a tapped coil; the Colpitts, which employs a capacitive voltage divider for its feedback network; and the Armstrong, whose feedback network is in the plate circuit. (General course, part VIII)

26. Why is a centertap return connection employed on the secondary of a transmitting tube's filament transformer?

To prevent or at least reduce amplitude modulation of the output signal by the ac voltage applied to the filament. (General course, part VII) . . .Staff

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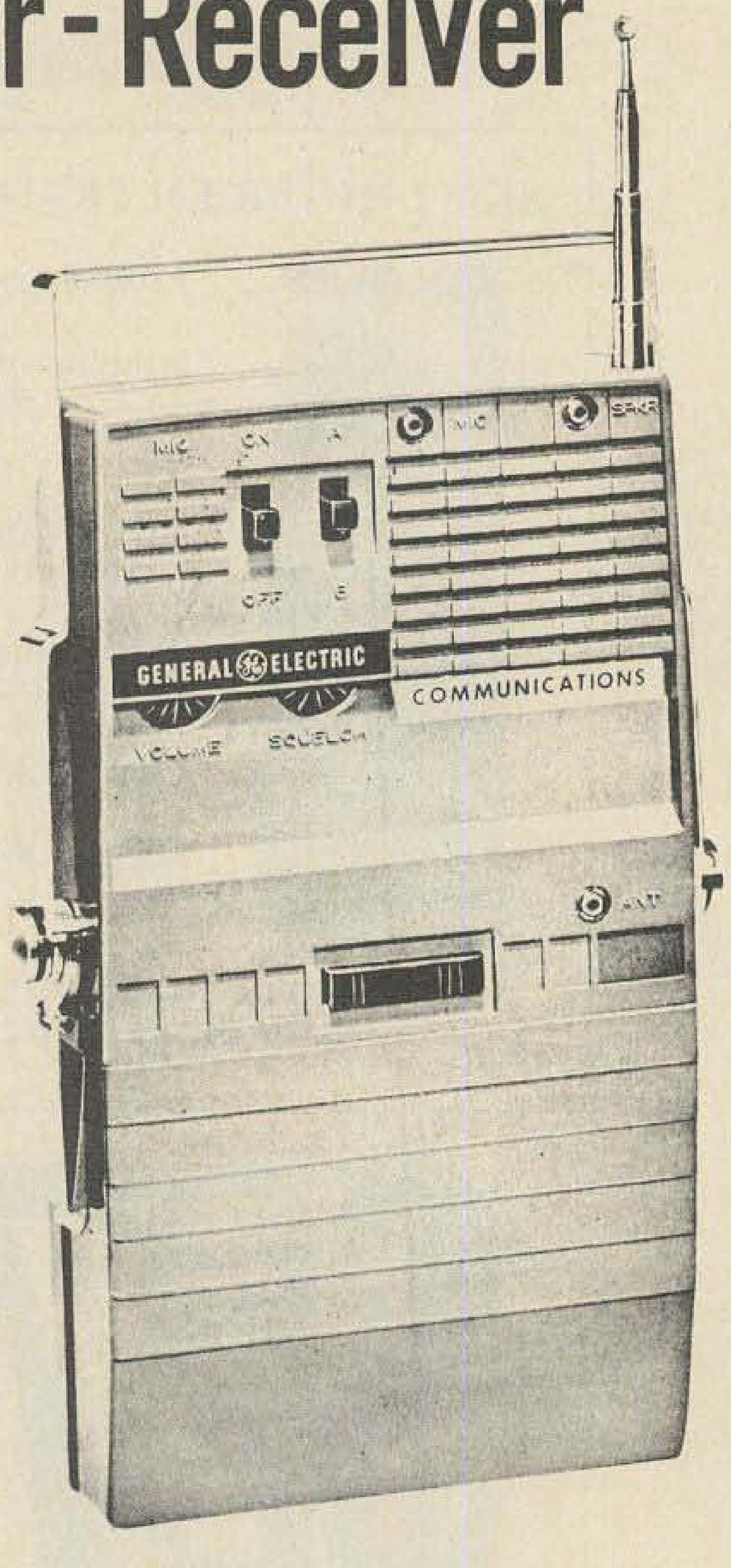

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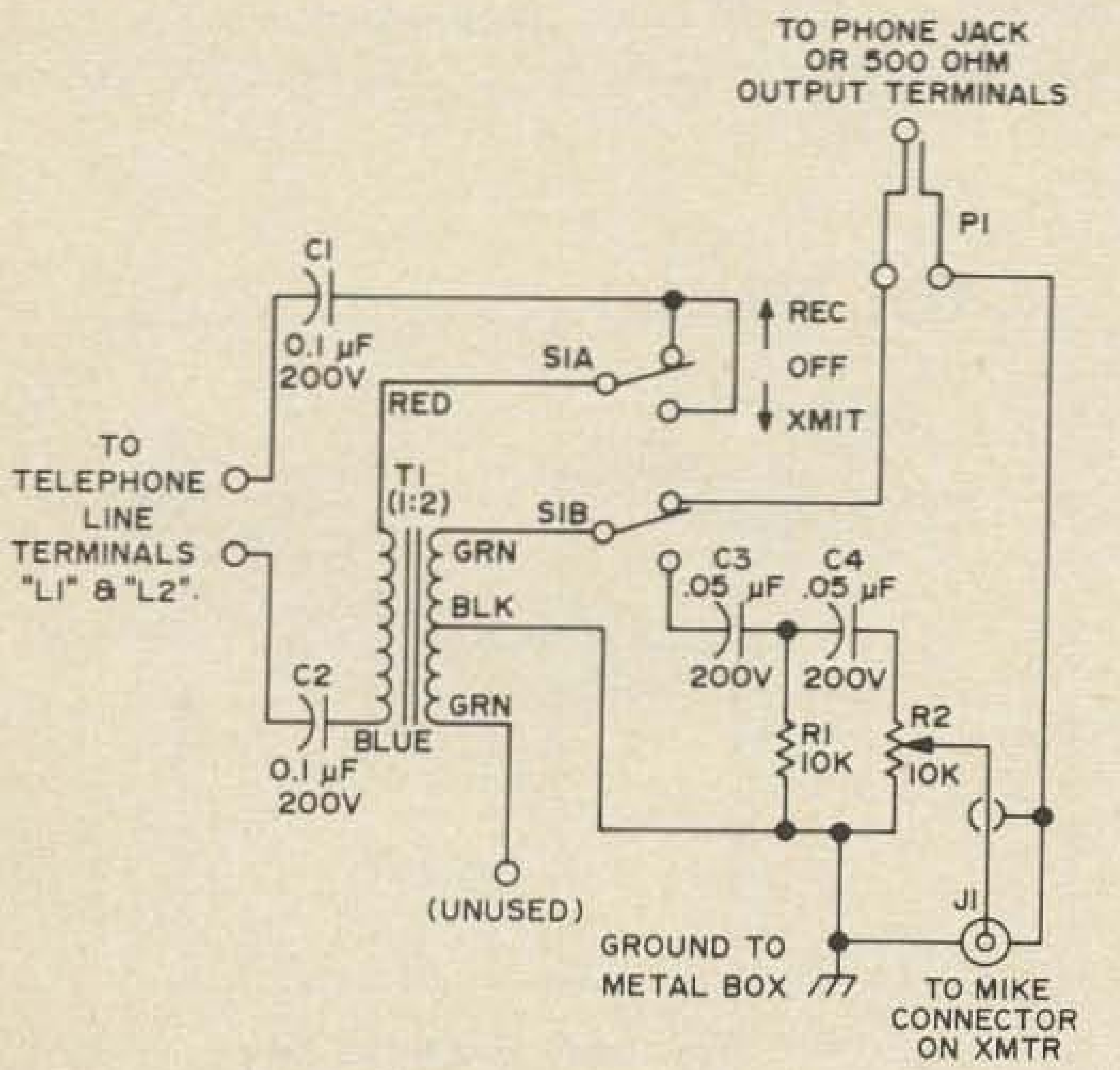
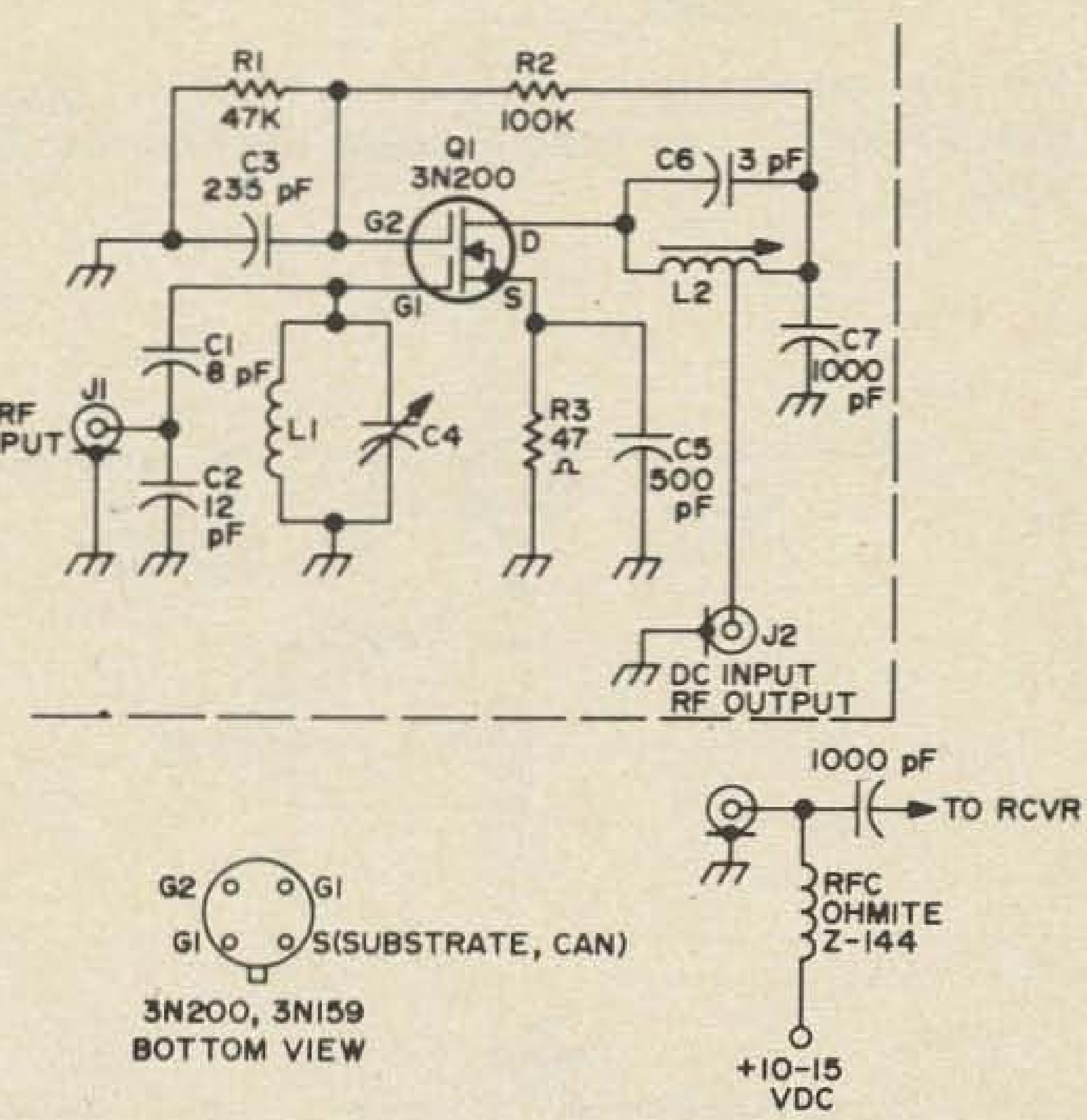
The following circuits have appeared in the referenced books, magazines, application notes, etc. While we try to reproduce all of the information that should be needed by an experienced constructor, readers may want to avail themselves of the original sources for peace of mind.

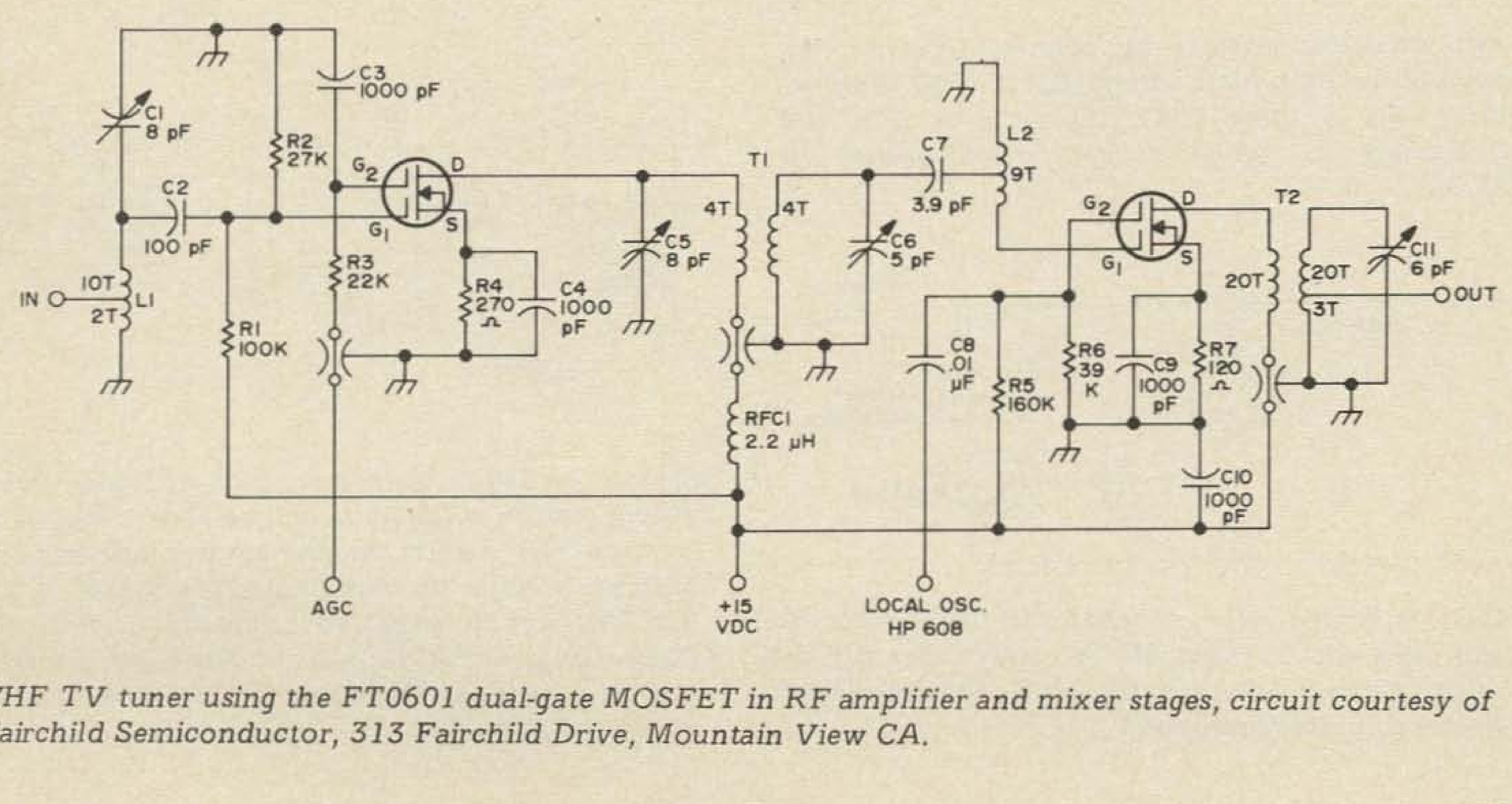
Readers are requested to pass along any interesting circuits that they discover in sources other than U.S. ham magazines. Circuits should be oriented toward amateur radio and experimentation rather than industrial or computer technology. Submit circuit with all parts values on it, a very brief explanation of the circuit and any additional parts information required, give the source and a note of permission to reprint from the copyright holder, if any, and the reward for a published circuit will be a choice of a 73 book. Send your circuits to 73 Circuits Page, 73 Magazine, Peterborough NH 03458.



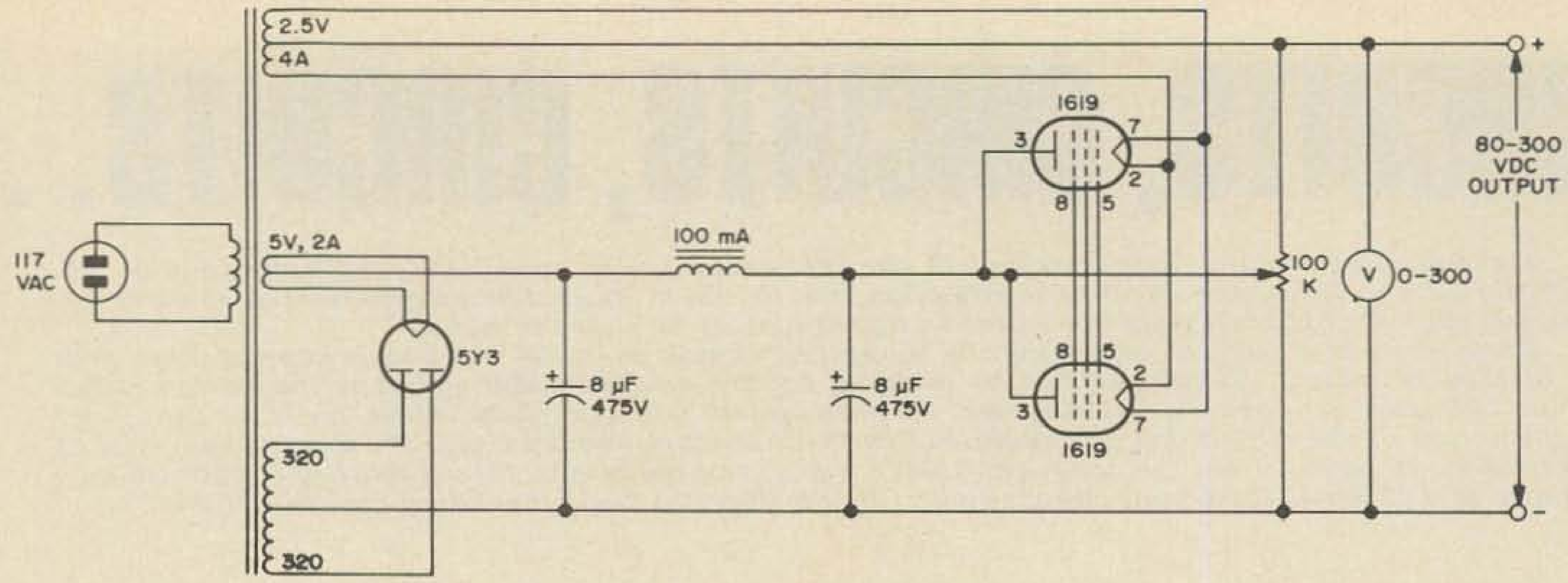
A simple and efficient phone patch, by Herbert S. Brier W9EGQ, from an article by that title in the December 1960 issue of 73. Still as simple and efficient as ever!



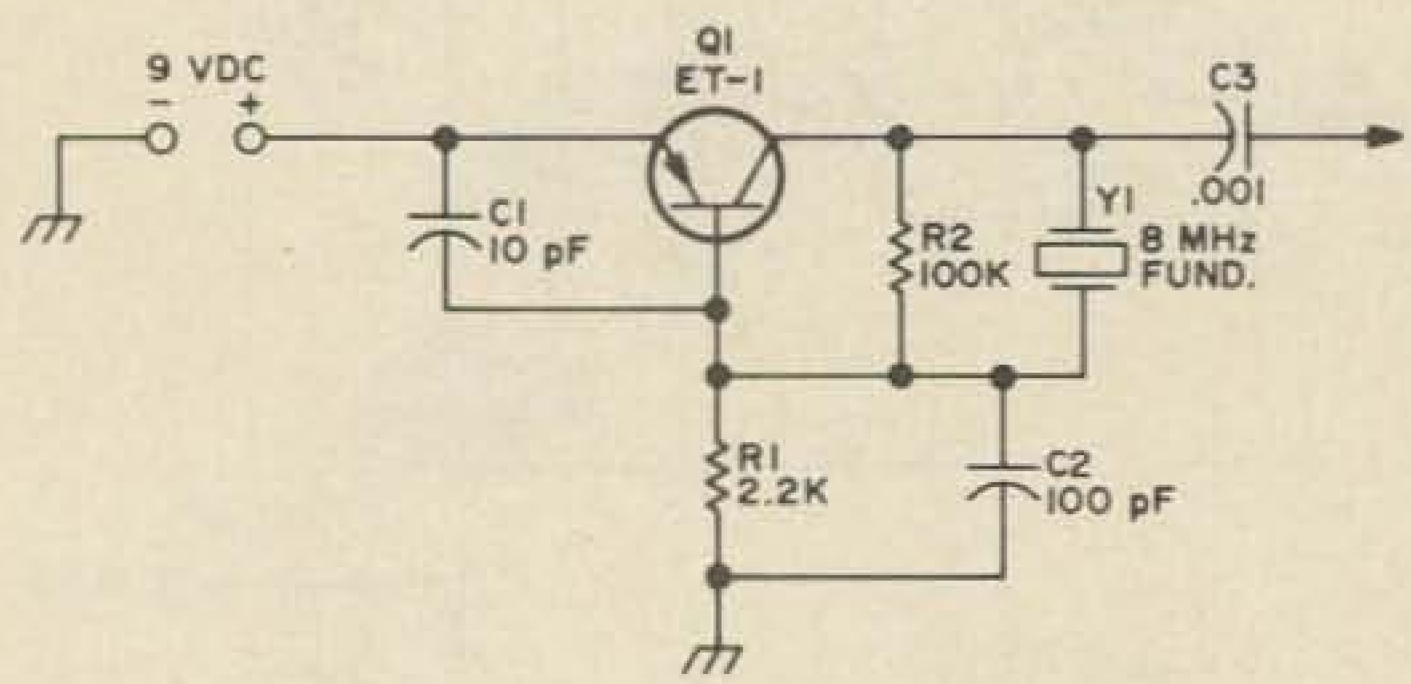
Two meter preamplifier, MOSFET. C4-5 are button micas and support transistor leads forming resonant circuit. L1 is JFD LC374 tank circuit which contains C1. L2 is 6T #22 enamel on 5 mm slug-tuned form, tap at 1 turn. 3N159 will also work in circuit. Circuit courtesy of RTTY Journal, P.O. Box 837, Royal Oak MI 48068. Circuit by W8BBB.

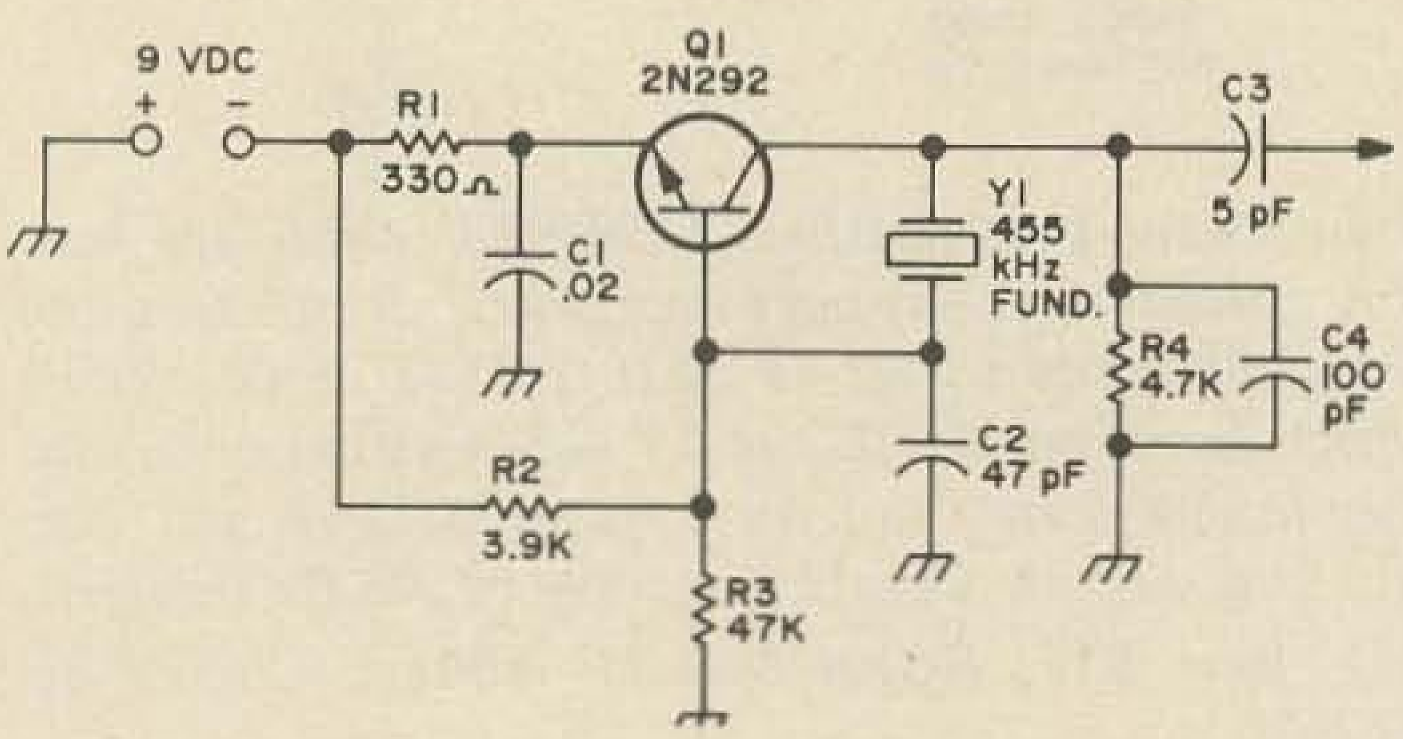


VHF TV tuner using the FT0601 dual-gate MOSFET in RF amplifier and mixer stages, circuit courtesy of Fairchild Semiconductor, 313 Fairchild Drive, Mountain View CA.

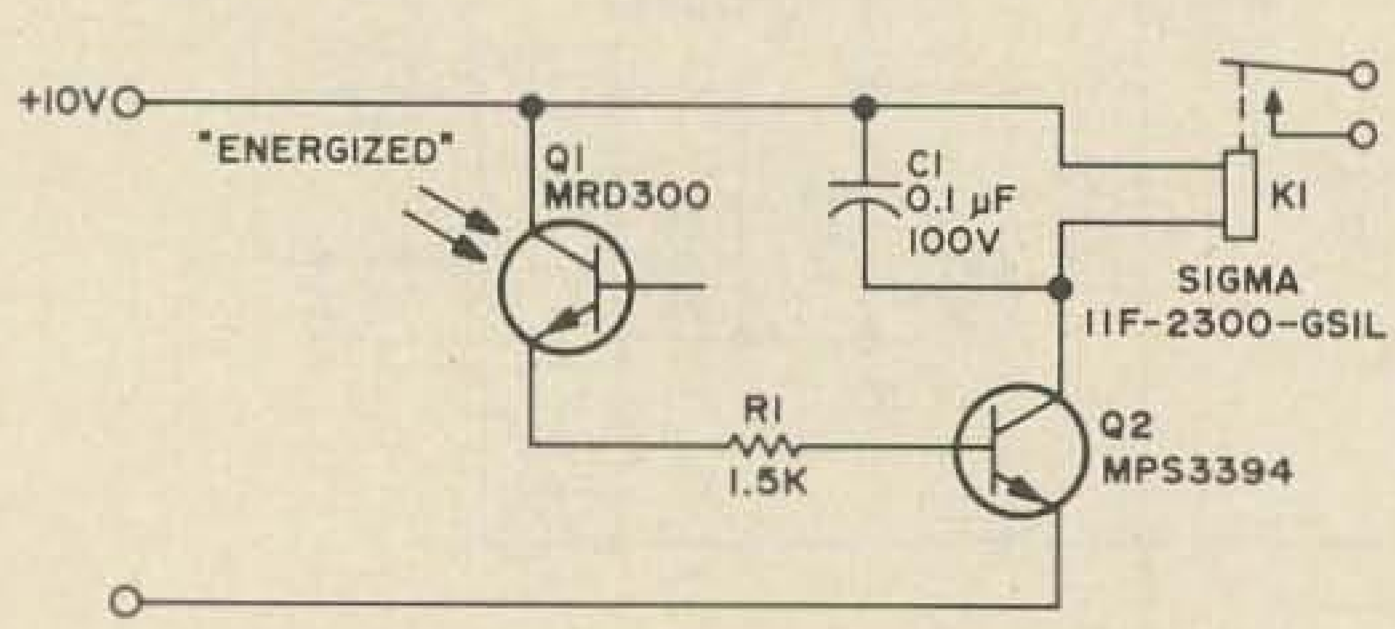


Variable power supply. Here's an oldie but goodie submitted by W4IOI and taken from a 20-year-old Heath flyer. If you keep in mind the filament requirements you can use 6L6s, 6Y6s, 1619s, 807s, 1625s, 837s, etc.

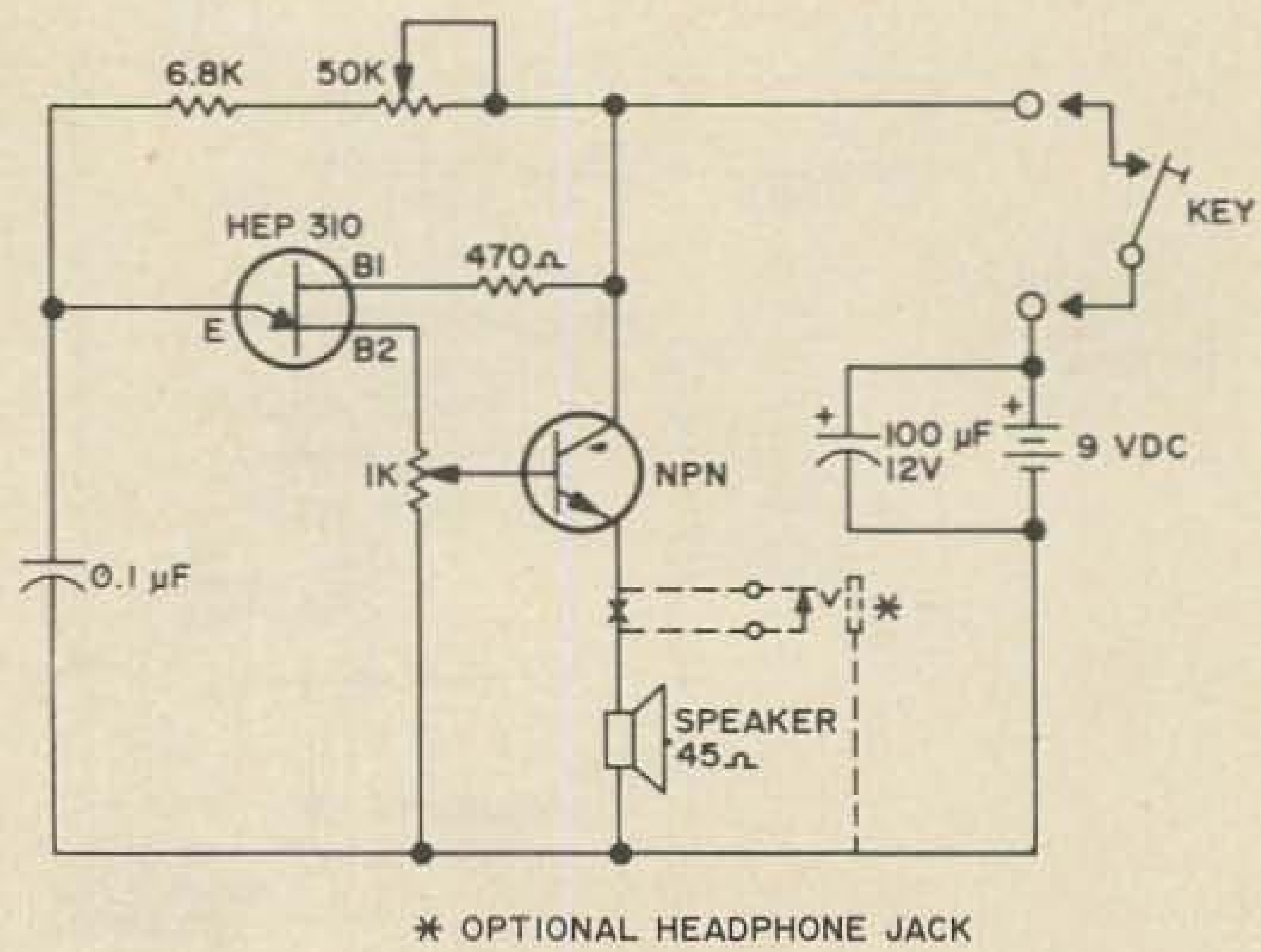




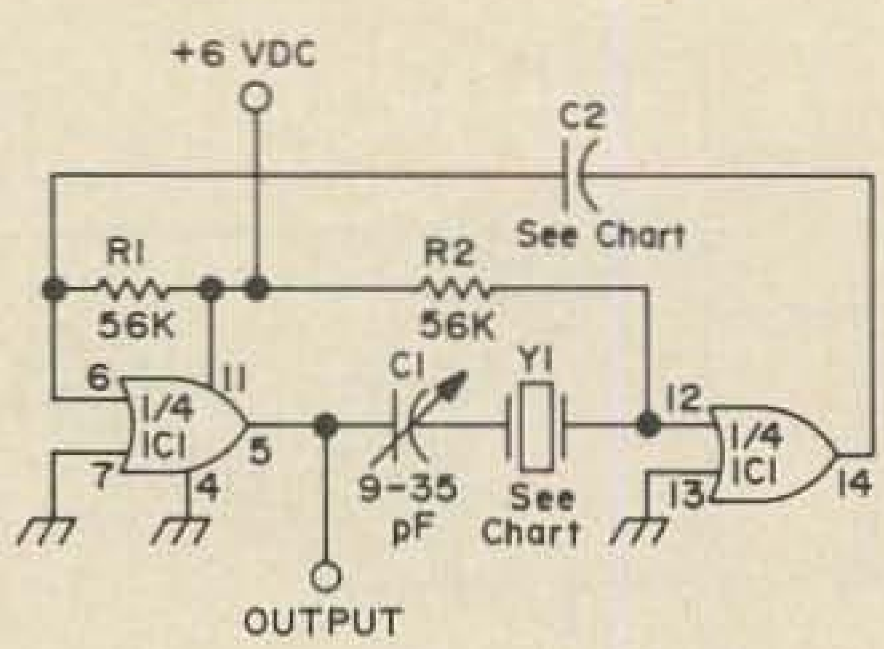
Two oscillator circuits for aligning receivers, anonymously presented, originally, in FM Bulletin, Vol.I, No. 5, June 1967, reprinted in 73's "FM Anthology I," available from 73 Magazine for $3.00.



Light operated relay. It takes 220 foot candles to turn this on. Turning off the light turns off the relay. Circuit courtesy Motorola Semiconductor Power Circuits Handbook.



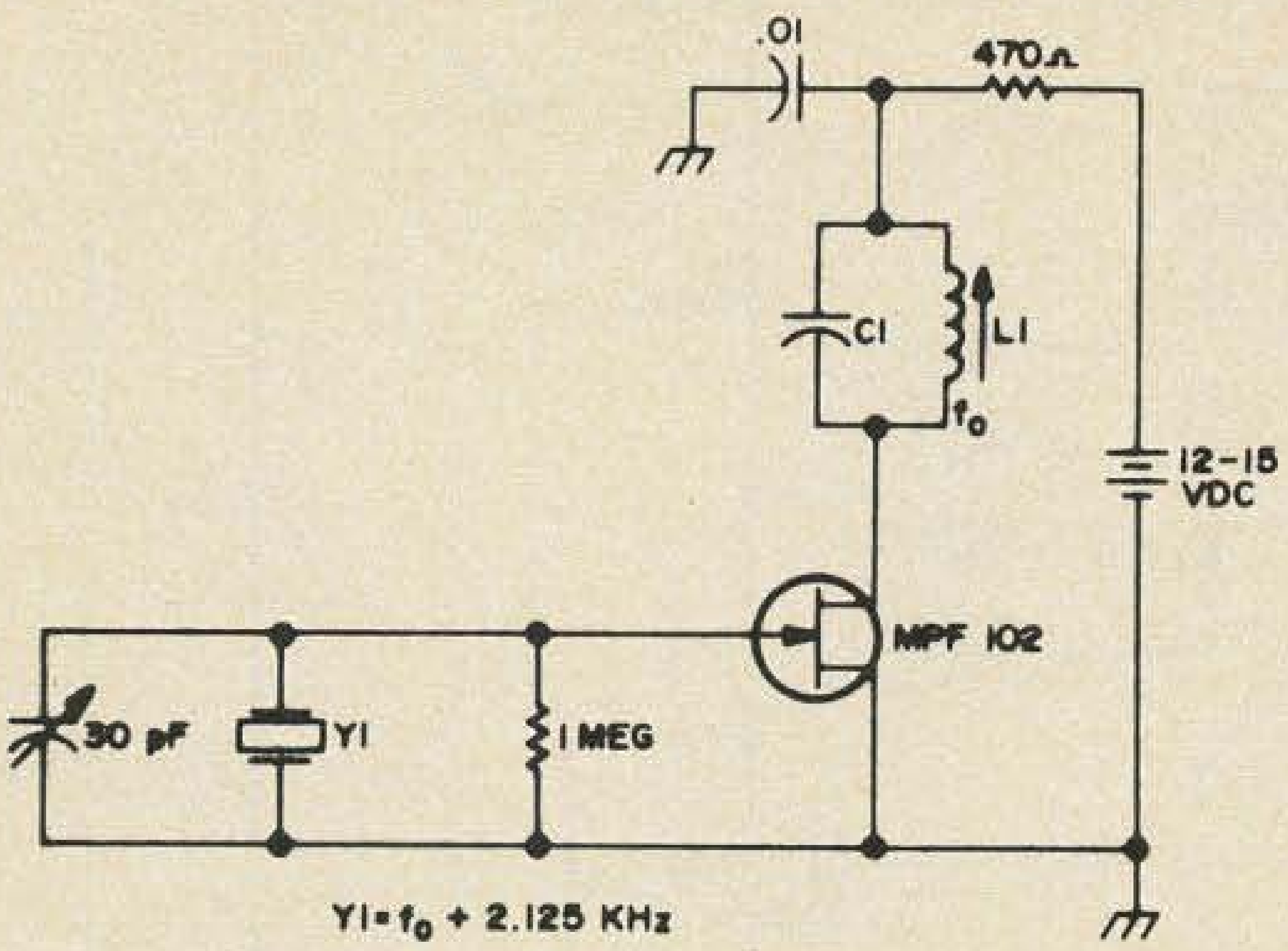
Code practice oscillator or perhaps a noisy alarm for the home, boat or car. Circuit courtesy Calectro Handbook ($.50, GC Electronics, 400 S. Wyman, Rockford IL 61101). NPN transistor is a Calectro #K4-506.



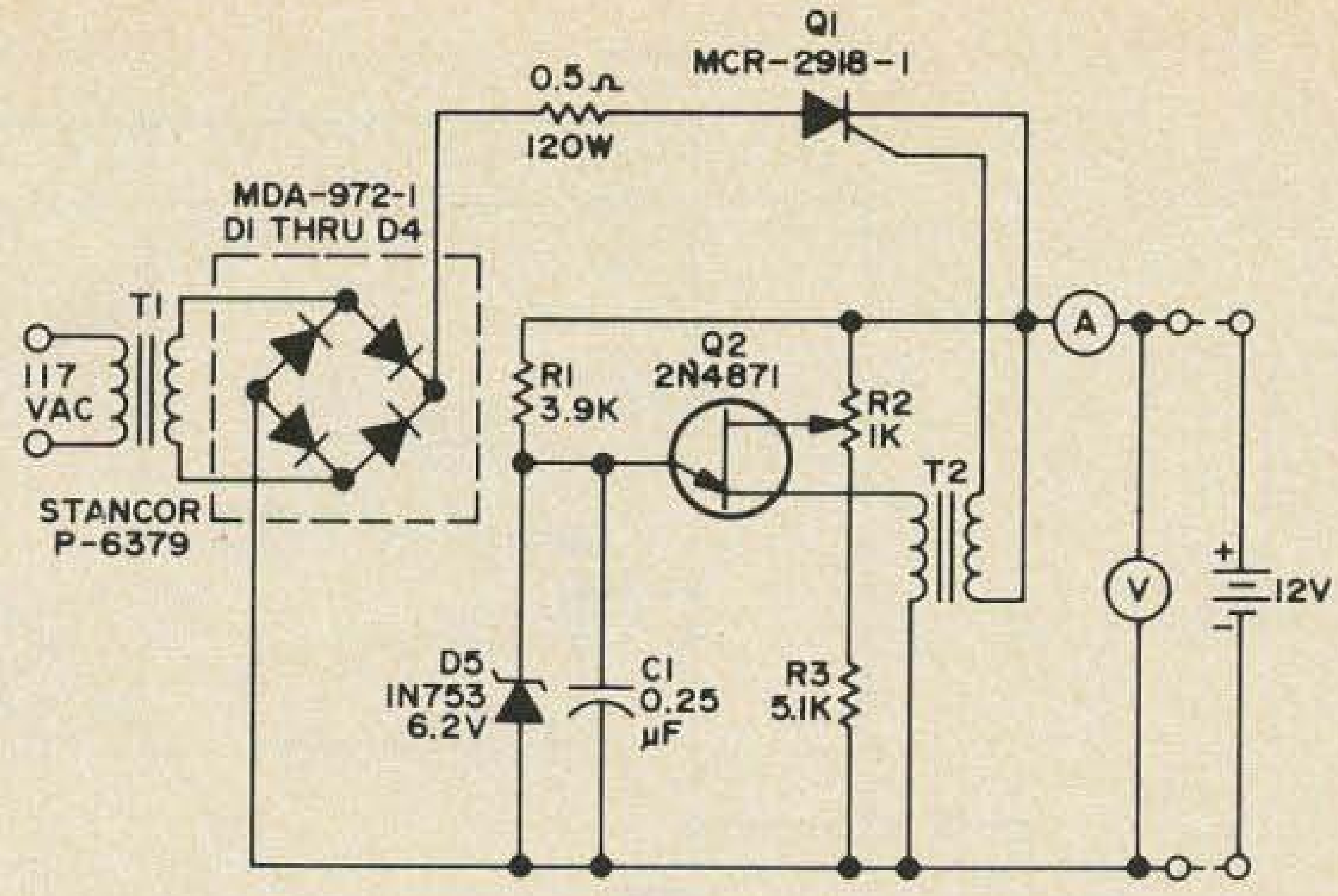
CRYSTAL FREQ	C2 pF
100 KHz	1000
500 KHz	430
1 MHz	39

IC1 – HEP 570

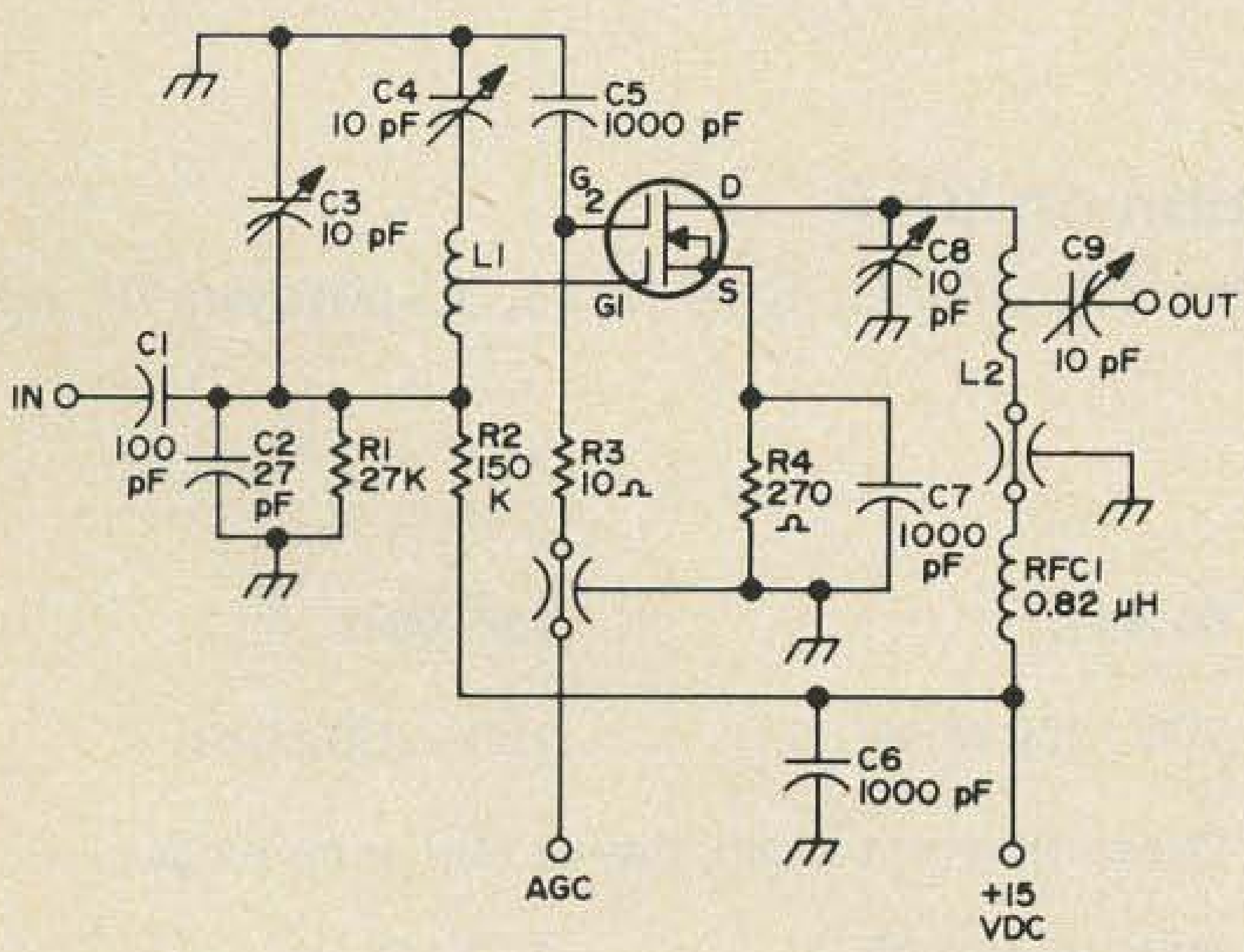
Crystal oscillator calibrator, high in square wave output (which means you will be able to hear it up into the VHF bands), which may be made into two calibrators since the circuit uses only half of the IC. This circuit appeared originally in HMA-36, Radio Amateur's IC Projects by Motorola, available free by writing Department 73, Box 20924, Phoenix AZ 85034.



Crystal oscillator for receiver direct conversion. This oscillator will beat against an incoming signal and stay right on frequency even though yuur receiver may drift a bit. Great for RTTY autostart, net operation, and fixed frequency biz. Circuit courtesy W9ZTK, W9YPS and the RTTY Journal, Box 837, Royal Oak MI 48068. Crystal frequency = net frequency + 2.125 kHz for TT autostart. A 7075 surplus FT2243 crystal can be ground up a couple of kHz so the end result will be autostart on 7075 kHz.

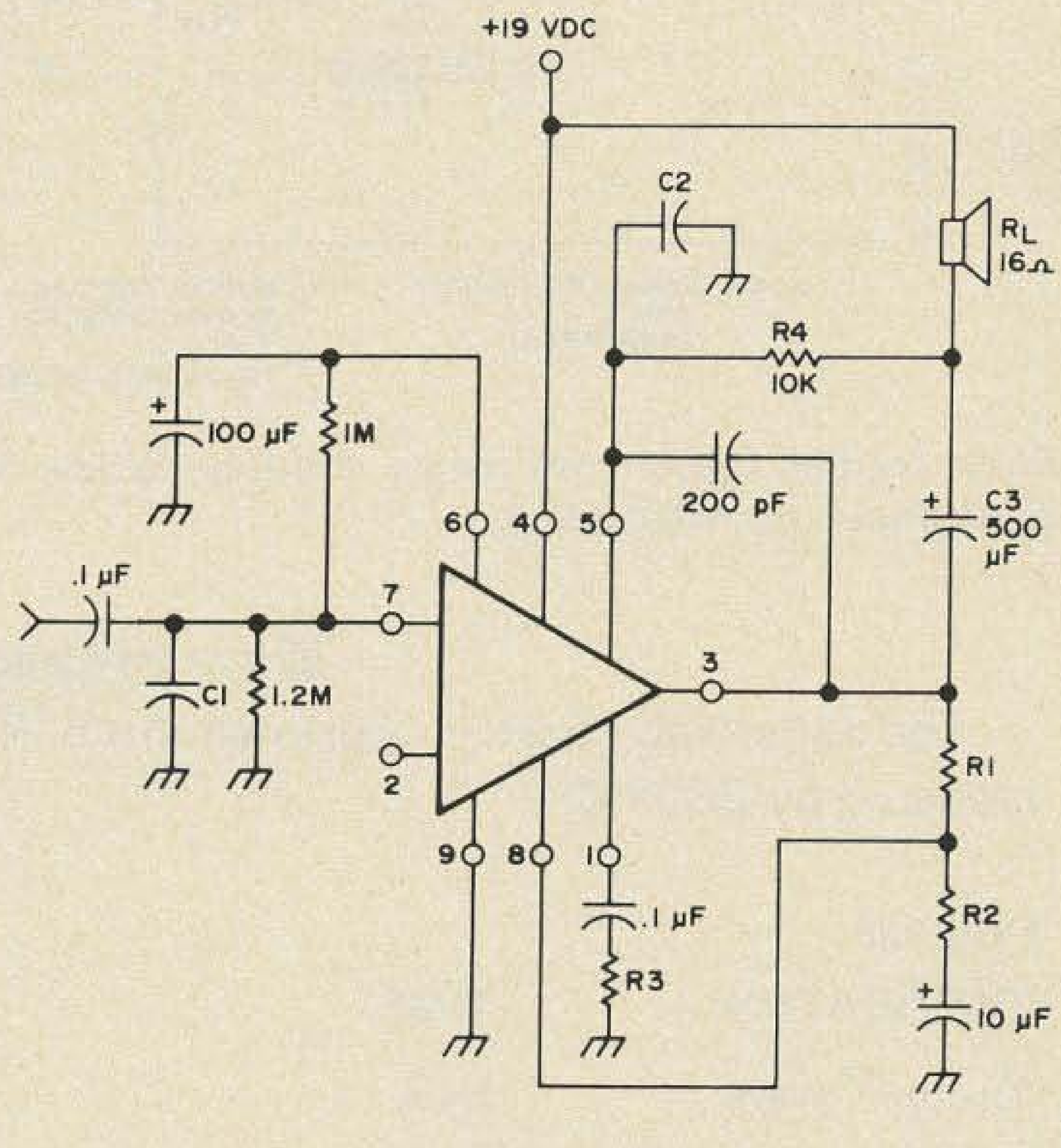


Foolproof Battery Charger. T2 is a Sprague 11Z12. Protects battery against overcharging or reverse charging, also protects itself against shorting or hurting another supply. Will supply 16A. Circuit courtesy Motorola Semiconductor Power Circuits Handbook.

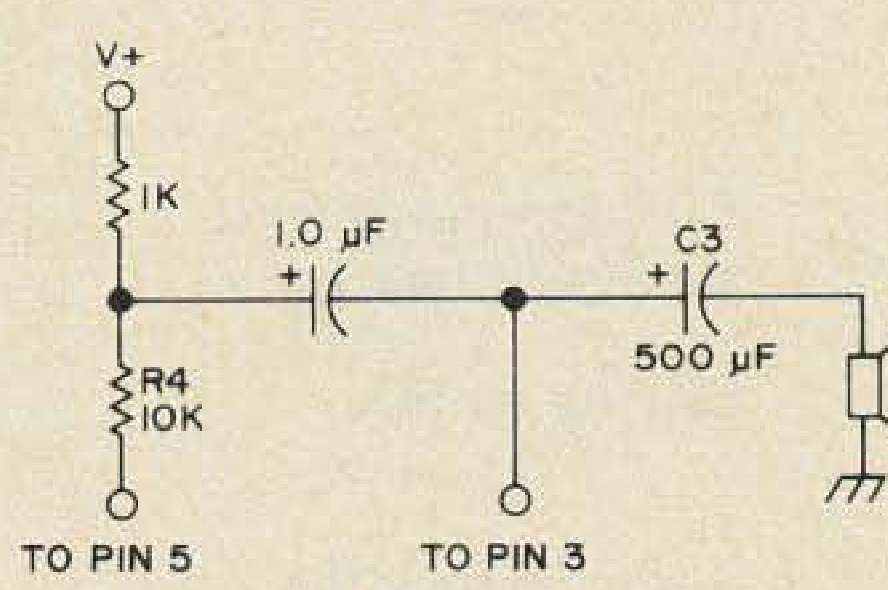


VHF amplifier used to measure gain, noise figure and AGC performance of the Fairchild FT0601 MOSFET. For AGC operation, dual-gate MOSFETs have a built-in advantage owing to their separate gates, especially in the VHF region. Amplifiers such as this one eliminate cross-modulation distortion, decrease receiver noise and avoid shifting of the receiver's center frequency. Schematic from Fairchild Semiconductor Application Note APP-189.

L1 = 15/64 ID, 0.8" long, 5T #18 s.p. wire, tapped at 2.5T.
L2 = 15/64 ID, 0.8" long, 4T #22 s.p. wire, tapped at 2.5T.

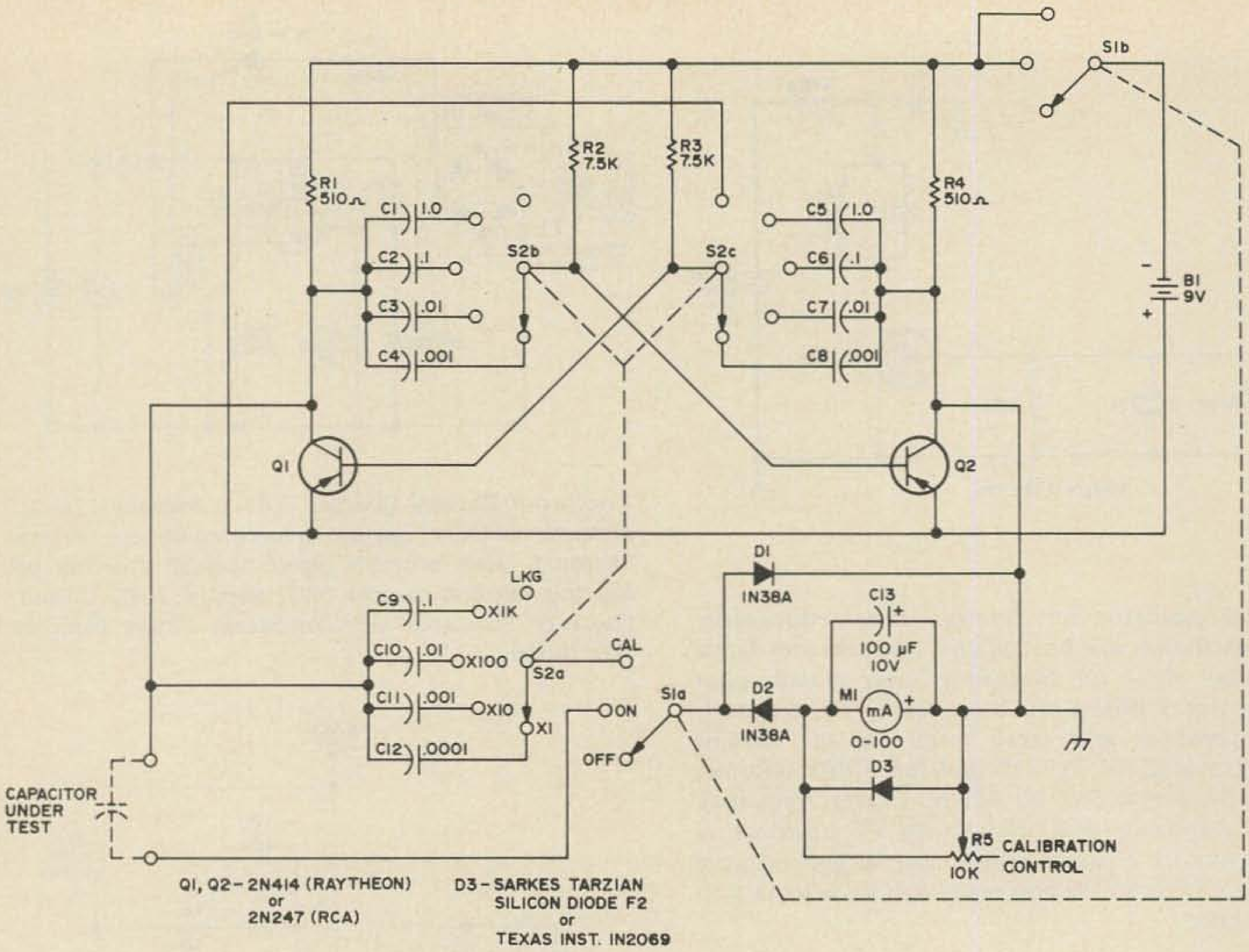


SENSITIVITY FOR 1 WATT mV	C1 pF	C2 pF	R1 k OHMS	R2 OHMS	R3 OHMS
400	0	0	10	1.0K	82
10	100	100	51	100	2.2K



Alternate connection to permit connecting speaker to ground instead of to V+.

Typical circuit for a 1-watt audio power amplifier, using Motorola's Functional Circuit MFC8010. Circuit and data from Motorola's Functional Circuits book of application notes.



Direct-reading capacitance meter. From an article by Roy A. McCarthy K6EAW, in the very first issue of 73 Magazine, October 1960.

Wave Propagation on VHF

The following chart is reprinted from Radio ZS, SARL, Box 3911, Capetown. It was prepared by ZS2FM.

TYPE OF PROPAGATION	TIME	50 MHz	144 MHz
"Ground" Wave	Daily	200–300 Miles	150–200 Miles
		Depending on terrain, power and antenna gain.	
Sporadic E	Summer months Mornings & Evenings	400–2500 Miles	1000 Miles
Tropospheric Bending. (Temp. Inversion.)	Watch the weather	400–1500 Miles	500–2500 Miles
Aurora	During ionospheric storms at night.	1300 Miles	1000 Miles
Meteor Reflection*	During meteor	1500 Miles	1500 Miles
Ionospheric Scatter*	Summer months	1400 Miles	1400 Miles
F_2 Layer	At peak of sunspot cycle	1200 Miles	

***Requires high power and high gain antennas at both ends of circuit.**

HEATHKIT MODIFIED HW-16 CW TRANSCEIVER

John N. Edgerton WA3PRV
129 Robinson Drive
New Castle DE 19720

Having built two Heath kit HW-16 CW transceivers for friends and hearing such successful reports, I decided to purchase one myself. I ordered the kit and, while it was enroute, borrowed a manual for the HW-16 from a friend.

After studying the manual and evaluating performance standards, I decided to make a few refinements. Upon its arrival, I had an outline of modifications as shown below.

- Change final tuning.
- Add variable antenna load instead of fixed load.
- Add variable selectivity.
- Add fine tuning.
- Improve transmit oscillator.
- Incorporate constructional refinements.

The fine tuning feature came as an afterthought. Because of the variable selectivity, I needed to retune my present receiver after changing from one selectivity position to another. The fine tuning also helps tune more accurately if the band is crowded.

Change Final Tune

I found that on 3.7 MHz, the HW-16 would not tune to a peak; that is, the plate tune capacitor (C28) would have to be turned to its extreme clockwise (open) position to get good output. I reduced the capacitance by changing C27 (150 pF, 4 kV capacitor) to a 100 pF, 4 kV capacitor, as shown in Fig. 1.

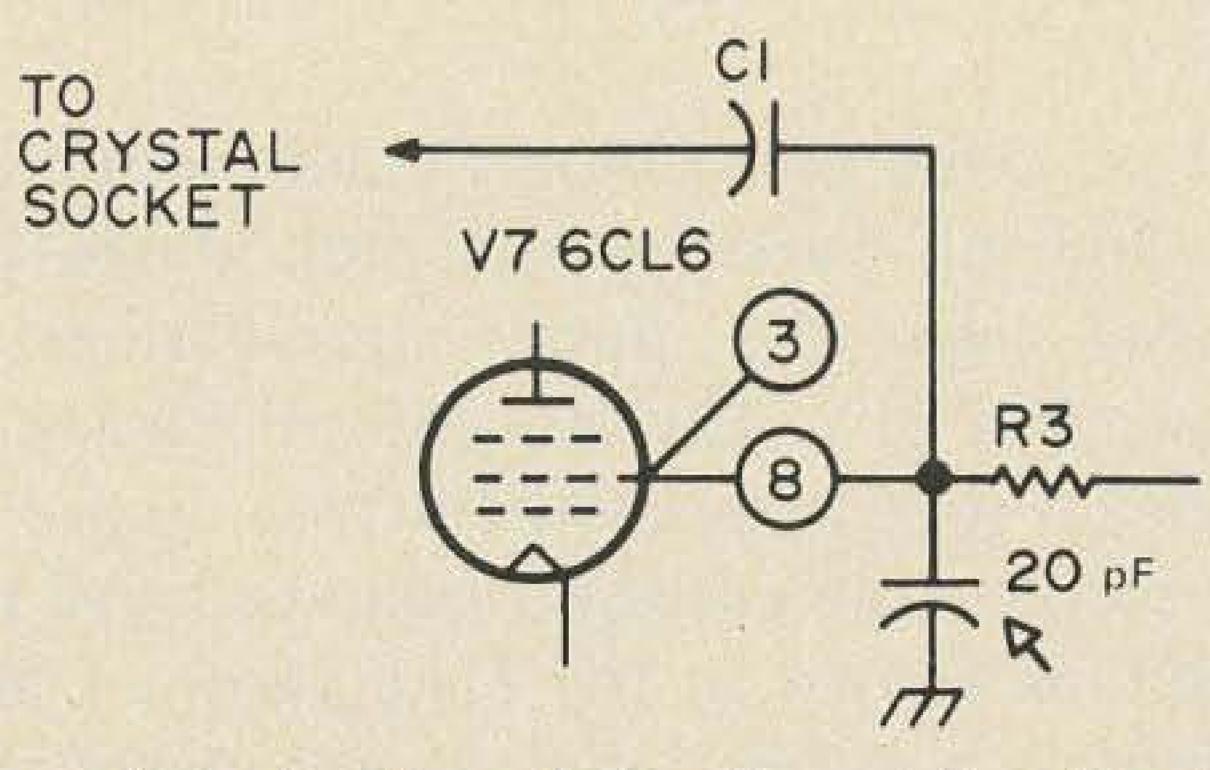


Fig. 1. Substituting a 100 pF capacitor in place of the original 150 pF value will extend the HW-16's tuning range.

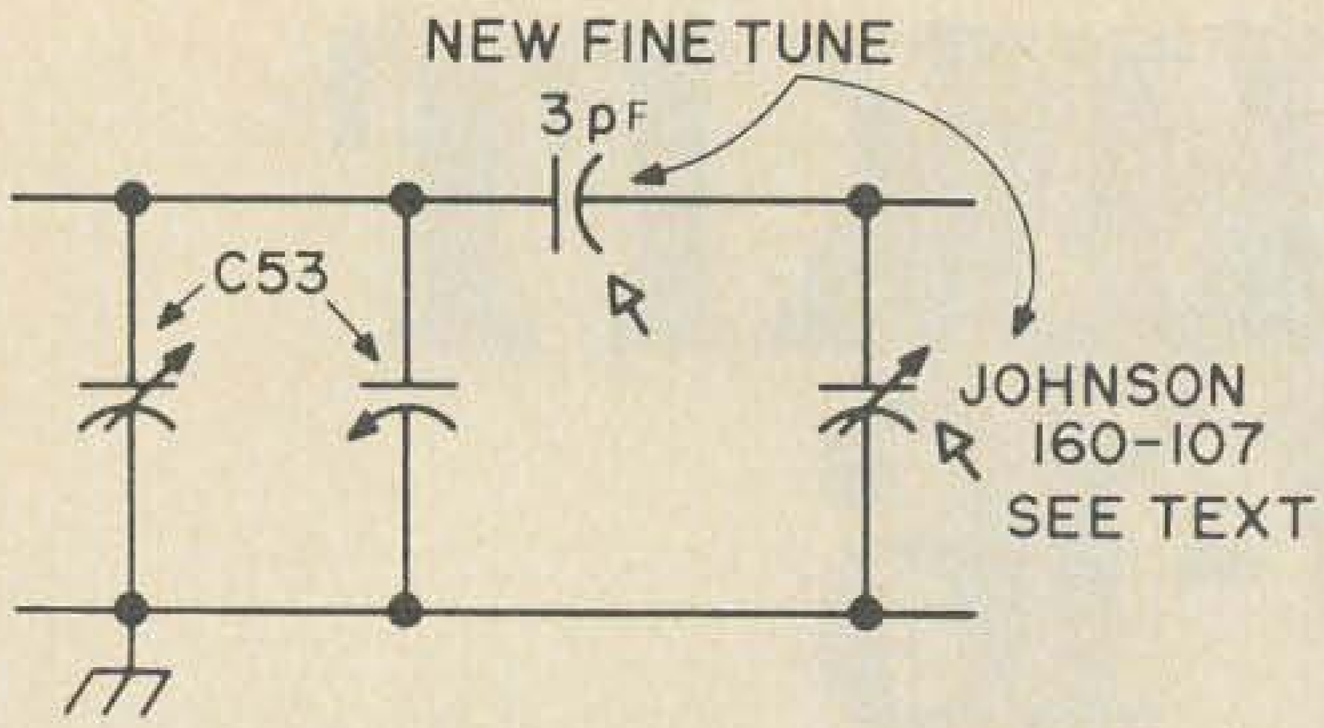
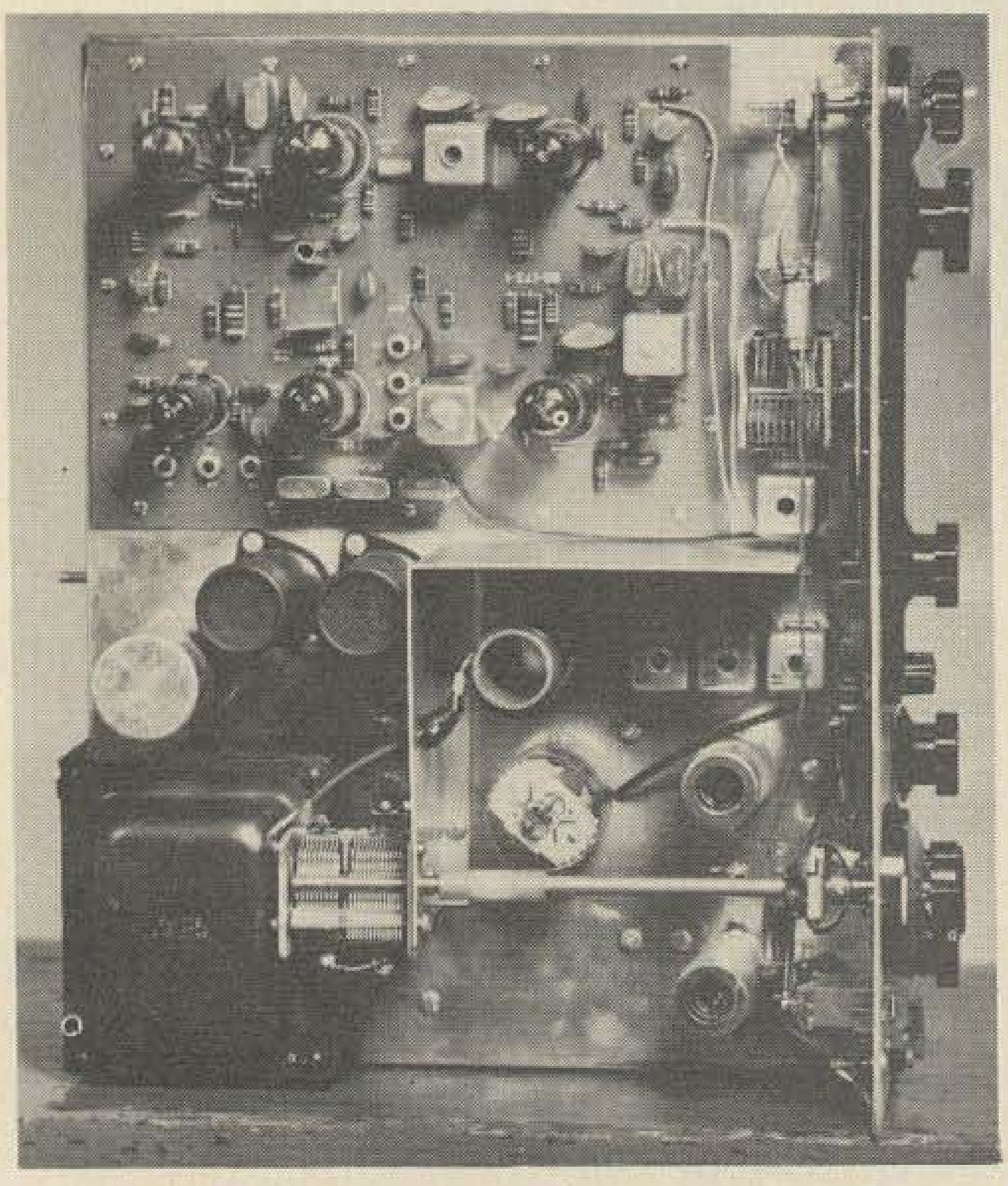


Fig. 2. A 365 pF variable from a BC radio is an ideal substitute for the original 390 pF fixed load, and allows a wide degree of antenna load adjustment.

Antenna Load Control

The HW-16 comes with fixed load on all bands. Capacitors C29, C30, and C32 comprise the loading on the HW-16 antenna circuit.



A 365 pF variable from a BC set improves the antenna loading, but it involved moving the panel meter to accommodate the vernier control.

I removed C32 (390 pF) and mounted a 10–365 pF variable capacitor above the chassis near the power transformer as shown in Fig. 2. The 10–365 pF capacitor, from a 5-tube table model BC set, improves the load to the antenna. I had to move the meter as shown in the lead photo. I also mounted a vernier dial to the panel and used a flex coupling and a plastic half flat coupling to get back to the antenna load capacitor. The center conductor of the RG-58 I used for hook-up is connected to both sets of stationary plates; the other end goes to the top terminal of the tank coil (the shield is grounded). The fact that the new variable capacitor is 25 pF less than the original does not seem to make any difference.

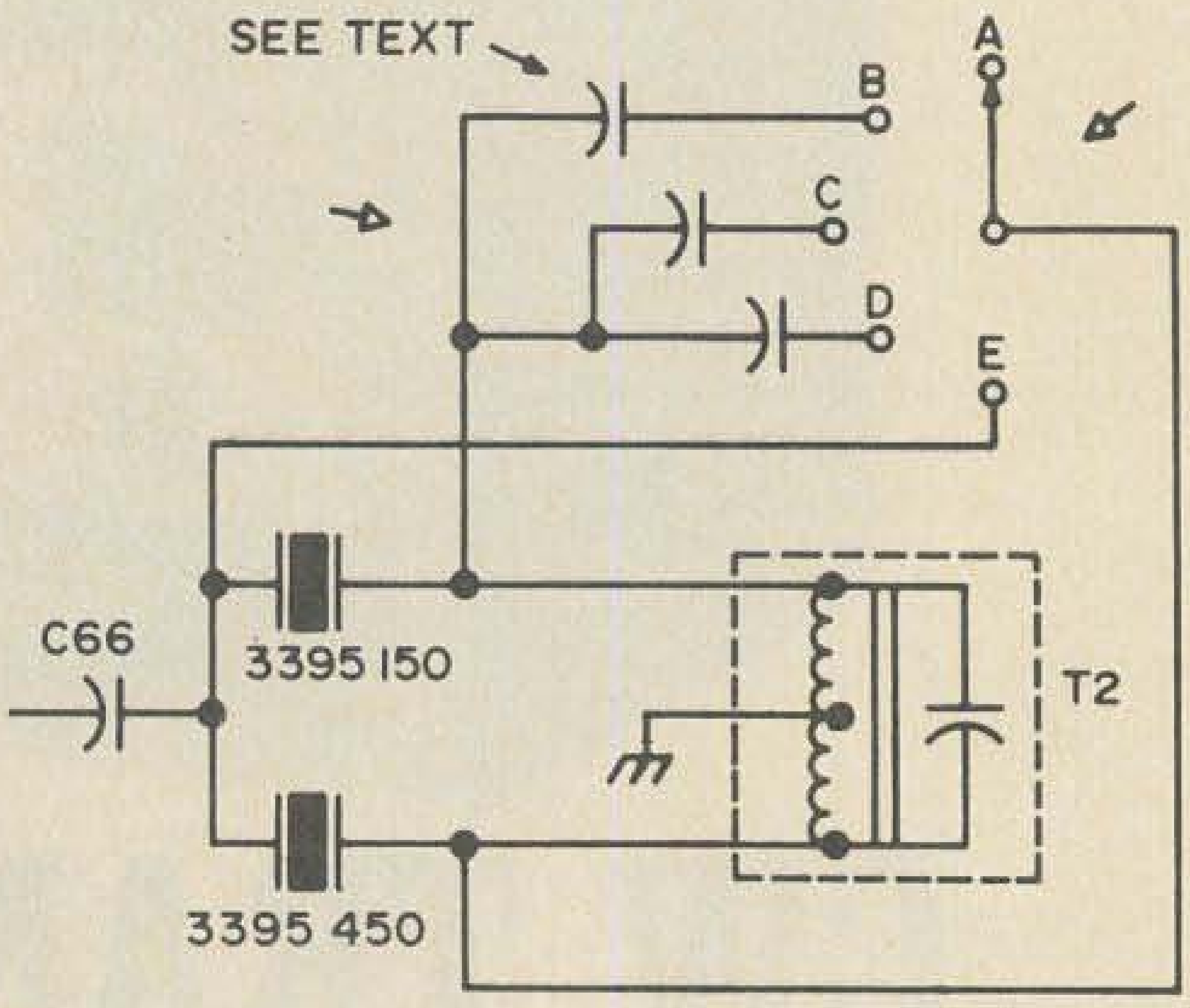


Fig. 3. A multiposition wafer switch can be used to obtain a variety of selectivity bandwidths.

Variable Selectivity

Ever try to copy CW on 40 at night? I do! Even with 500 Hz selectivity it is hard. To make this possible, I installed a 5-position selector switch at the lower right cover of the front panel. The first position (0.5 kHz selectivity) is not used (position A of Fig. 3). The second (B) puts a 15 pF capacitor across the i-f transformer. The third (C) puts a padder (which came out of my junkbox unmarked) across the i-f transformer output, and the fourth position (D) connects a .002 μF capacitor in like man-

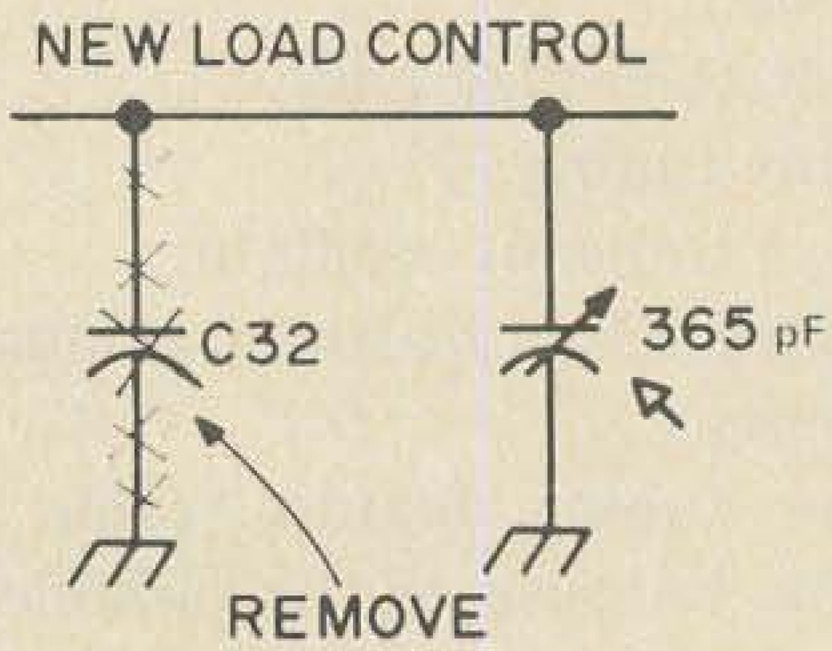


Fig. 4. A little "fine tuning" capacitor compensates for vfo shift resulting from selectivity switching.

ner. Position E puts a shunt across the 3395.150 kHz crystal, allowing me to copy a very weak station when the band is quiet. I can also copy the upper 50 kHz of 40m sideband.

Fine Tuning

I found that by switching selectivity, the receiver calibration would vary a little. I installed a Johnson 160-107 capacitor (bolted to a bracket on the pilot light support behind the main dial), and connected it as shown in Fig. 4. It is driven by a small vernier dial. The capacitor connecting the vfo capacitor (C53) and the new fine tuning capacitor is a 15 pF ceramic. I had to realign my vfo a bit after the above modification.

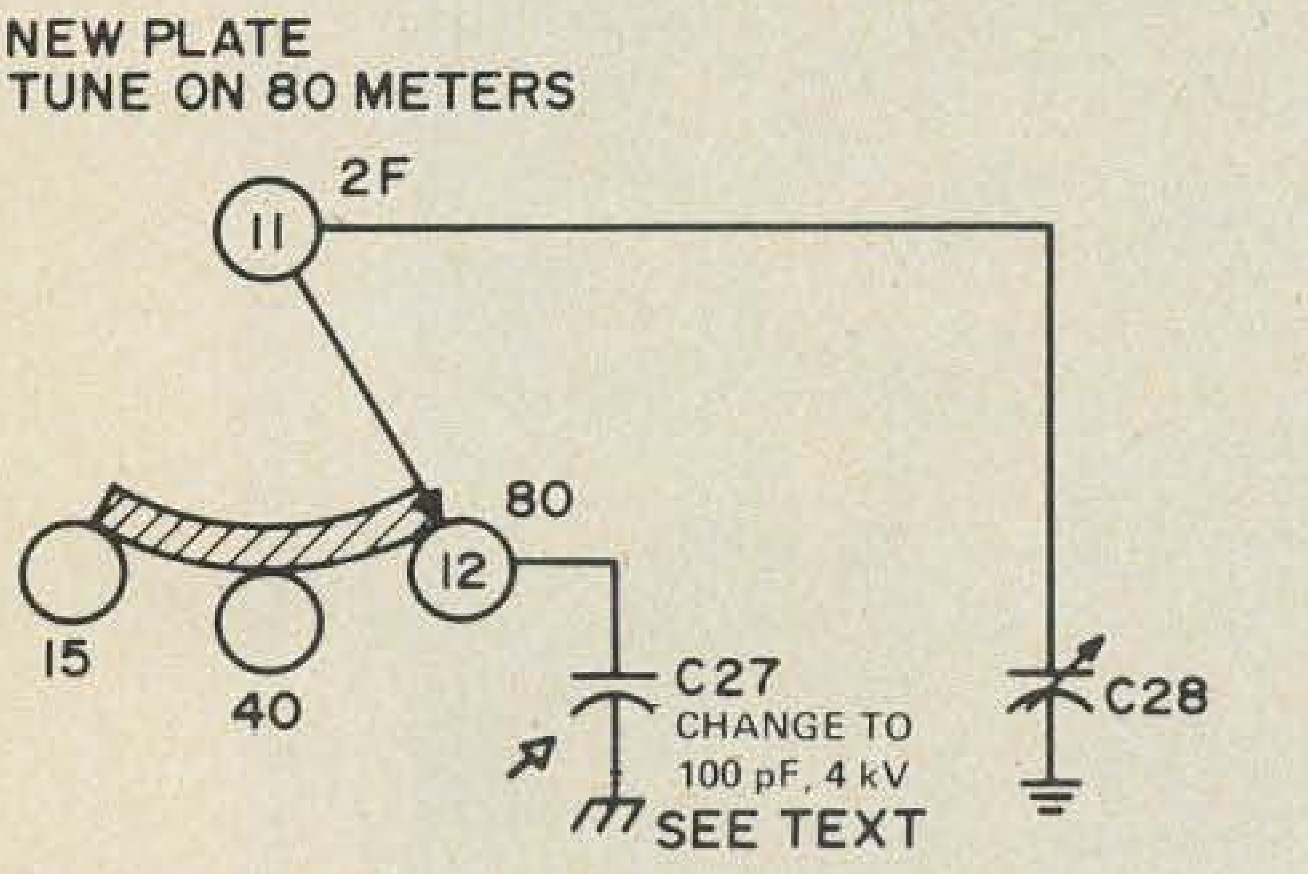
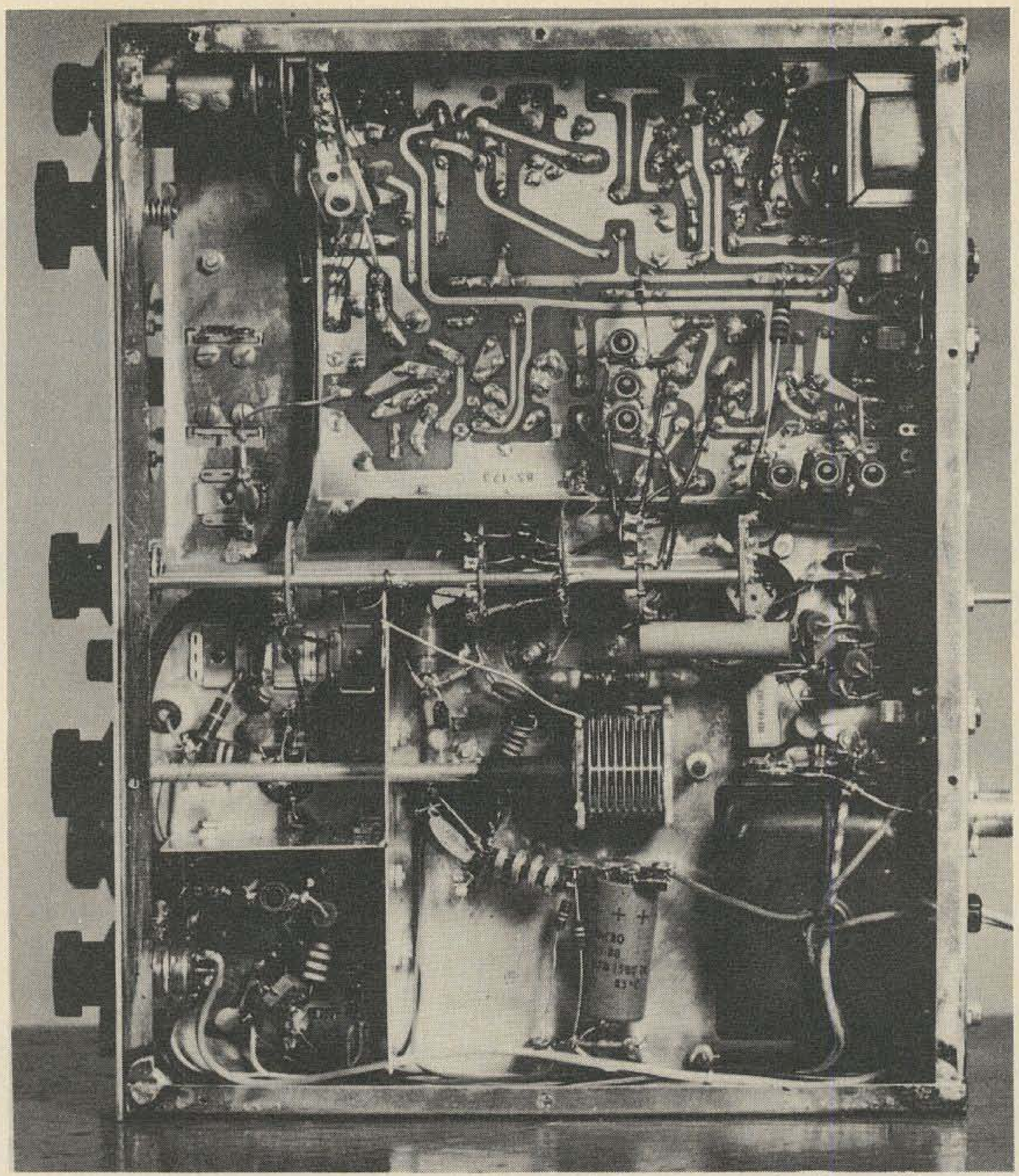


Fig. 5. A 20 pF capacitor on the HW-16 oscillator cured the problem of occasional inoperation.

The chassis corners are darkened from brazing that was done to make the chassis sturdier.

Crystal Oscillator Improvement

Periodically, the HW-16 rigs have been known to fail to oscillate when the key is closed. Occasionally it would also hesitate long enough to make a very short "dit." To



Heavy wires between the shield and the bandswitch help to maintain a solid ground and also serve to add support to the switch.

overcome this, I put a 20 pF mica between pin 8 of V7 and ground (Fig. 5). No more oscillator malfunction!

Constructional Refinements

If you look at the chassis photo, you will notice the corners are darkened. This is from brazing to stiffen the chassis . . . and it works. I cut out the antenna connector hole to 5/8 in. and installed an SO-239 coax connector. I also changed the speaker jack to a standard phone jack. I bolted all terminal strips and tube sockets in place, and with a 300W soldering iron, I resoldered all ground lugs and did the same with the C204 metal wafer plate.

I found that supporting the bandswitch at the rear made it much sturdier. I silver-soldered a brass nut to the chassis between C202 and C203 in line with the bandswitch and filed a small groove in the nut to support the bandswitch exactly parallel to the chassis. At final assembly, I soldered the bandswitch to the brass nut.

In the underchassis photo, you will notice extra ground wires soldered between the bandswitch and the shields. They also help to sturdy the bandswitch.

I wish to express my gratitude to Mel (W3KET), who helped me a great deal with technical advice – also to Donaghey Brown, a photographer with the News-Journal Co., Wilmington, Delaware, who did the photo work for this article.

. . . WA3PRV■

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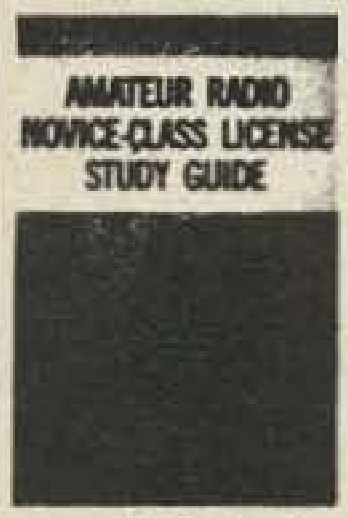

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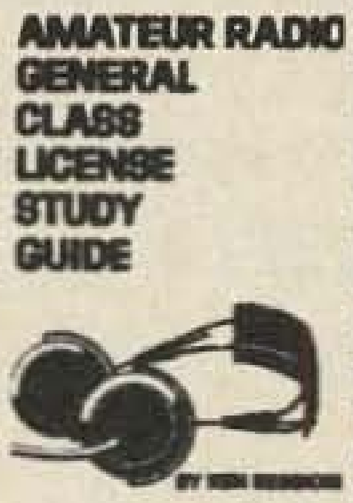

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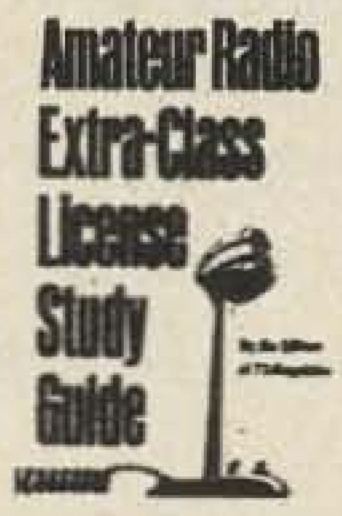

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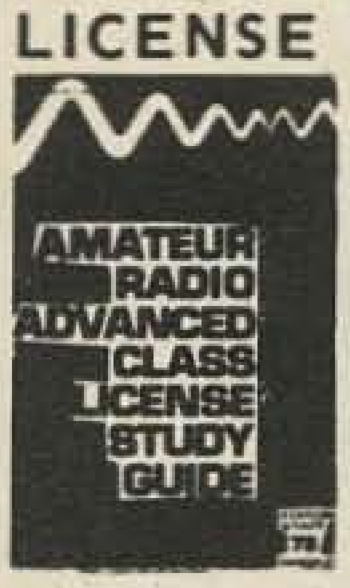

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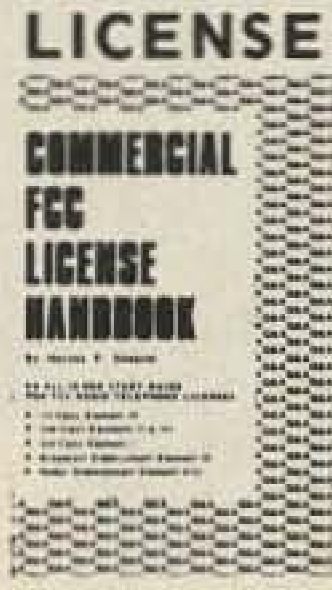

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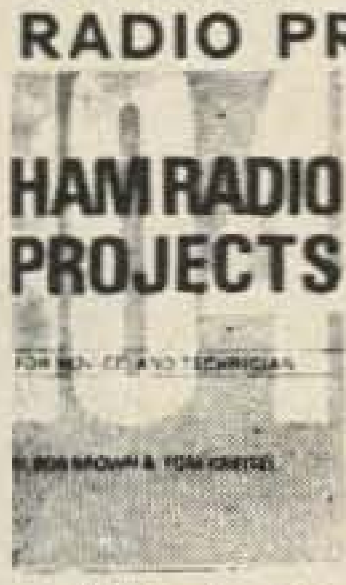

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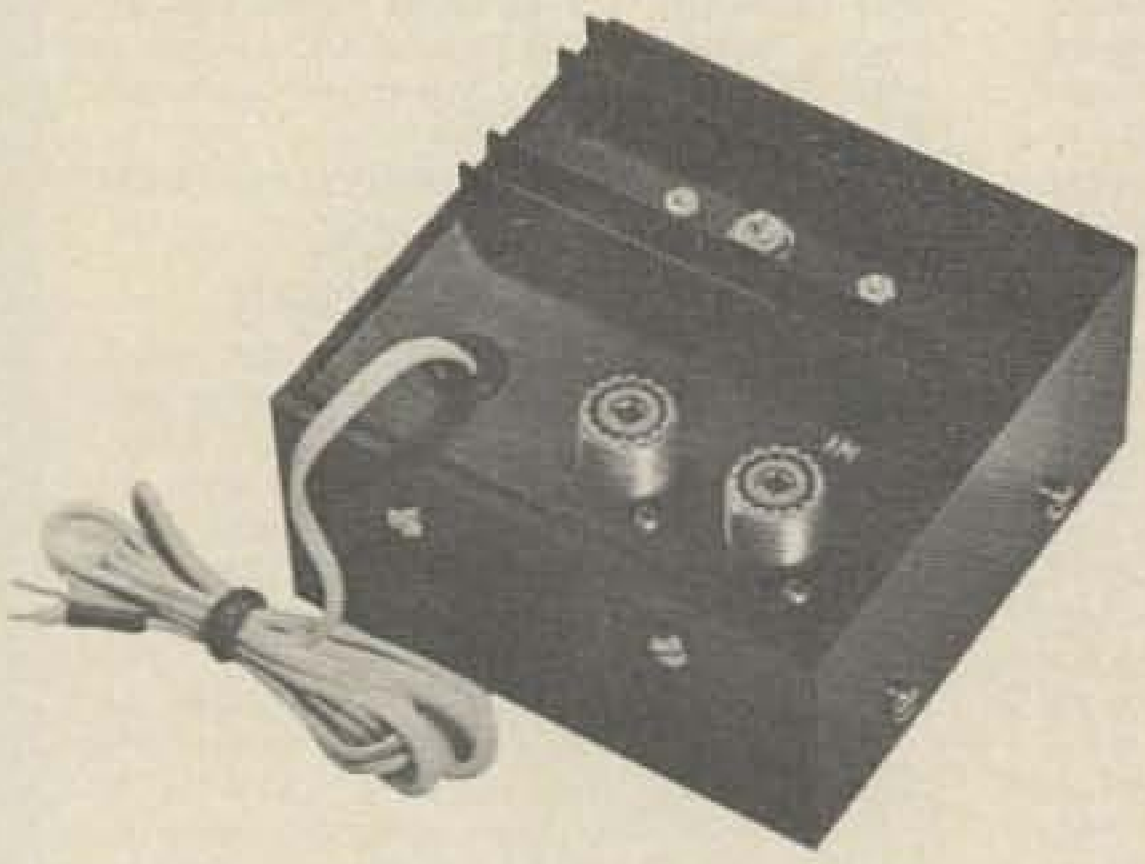

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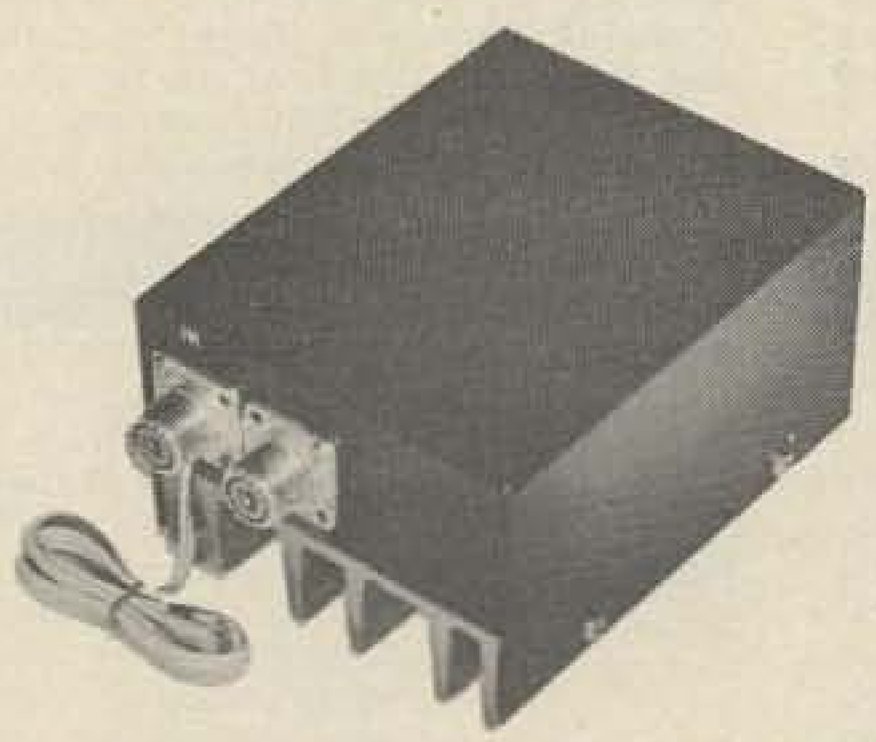

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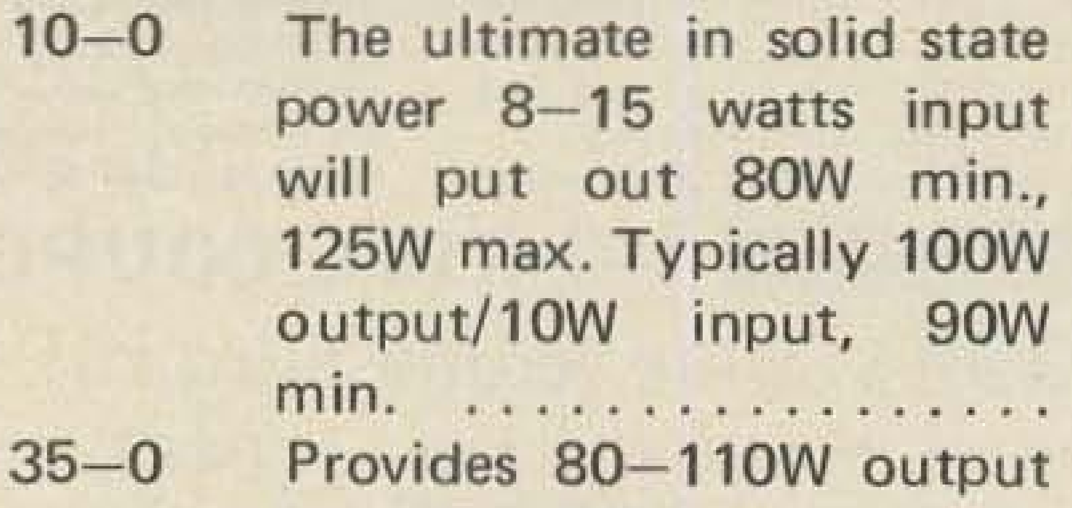

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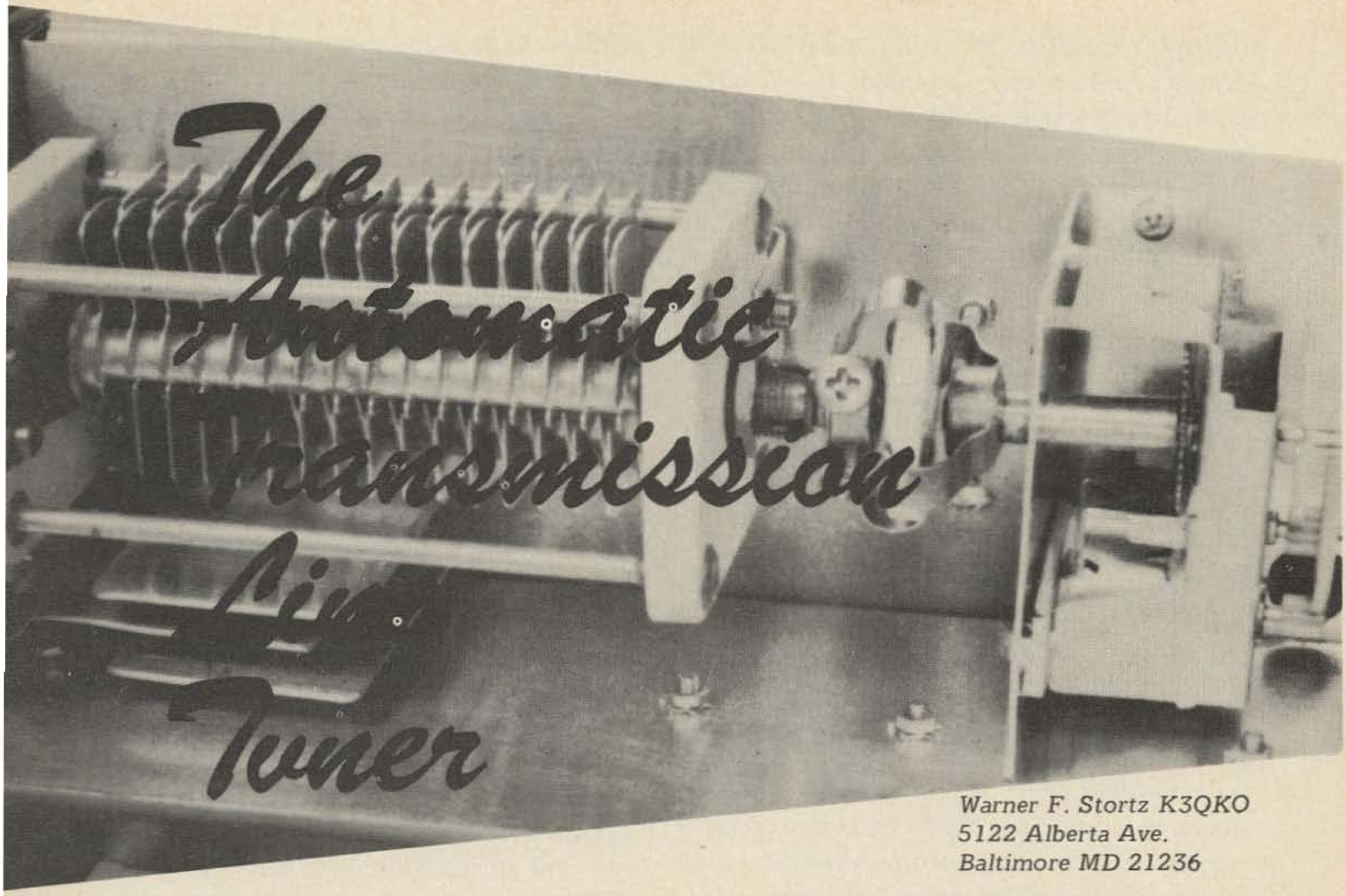
The Automatic Transmission Line Tuner



Warner F. Stortz K3QKO
5122 Alberta Ave.
Baltimore MD 21236

Reducing aggravations around the shack is a job that keeps the average homebrewer happily scheming and building throughout his hamming life. At the top of the "bother" list is the matchbox that must be readjusted after you make a large frequency change within a band, and the box is located on the other side of the power lines, in your garden tool shed. Anyone that has put up with this problem for years, must have wondered as I did, if you could tell your hand which way to turn the knob on the matchbox by watching the vswr meter, why can not the signal that deflects the meter do the job for you.

While working on the problem of getting the meter to twist the knob, it was soon discovered that the mismatch defying adjustment at the transmitter is the one that causes a reactive current to appear at the load end of the transmission line. A resistive mismatch as large as 3:1 causes little fuss and can be tuned out with ease. For this reason, the change in the resistive load presented by the same antenna at different locations in a given band is not large enough to require an adjustment, so one setting of the matchbox input loading capacitor is good for the entire band. This is not true of the output capacitor. It must be reset to bring the antenna–transmission line combination back into resonance, or a large inductive or capacitive phased current will be reflected back to the transmitter along the coaxial cable. It then follows that only one shaft requires adjustment after a frequency change is made, and if any change in the phase relationship of the current to the voltage in the coaxial cable at its load end could be detected and converted into a dc voltage, this signal could become the start of the automatic control that we are looking for. Such phase changes can be detected and converted into rotary motion!

The automatic transmission line tuner, whose name we will shorten to ATLT, is designed as an outboard unit to work in conjunction with a simple matchbox of the fundamental type described in most handbooks. Figure 1 shows how it is used in a typical antenna feed system. The matchbox consists of a small input coil that has a loading capacitor in series with it and ground, inductively coupled to a large parallel-tuned coil which has the balanced transmission line fastened to it by means of taps. The ATLT uses a variable capacitor connected across the matchbox output to make any corrections that might be required to maintain resonance as the transmitter frequency is varied. It will maintain the coaxial cable vswr to better than 2:1 and will operate in the 80, 40, 20, and 15m bands. Transmitter inputs can be as small as 90W, or as high as its variable capacitor will handle. The highest power used during tests was 800W, the top input of my rig. The unit is battery powered and the design is such that no current of a magnitude that can be detected on a 50 μA meter will flow without the presence of an rf signal. This feature allows unattended operation in remote locations with battery life going into months. The servomechanism is not made in a machine shop. It came out of a battery-powered toy automobile and works like a million dollars instead of two.

The way the ATLT circuits work could be called clever, but never complicated. There is an element designed to pick up the coaxial cable current (L1, Fig. 2) and transform it into a useful signal that can be summed with the cable voltage, much reduced in amplitude. The resultant of these two signals, detected by diodes, produces a dc voltage that is positive, negative, or zero, depending upon the phase relationship of the current to the voltage. This circuit is known as a phase-sensitive demodulator and is the ATLT nerve center.

Current coil L1 is a laterally wound coil that encircles the coaxial cable inner conductor. When the alternating current through the cable increases, decreases, and then reverses direction, an expanding and contracting magnetic field is produced, inducing a potential across this coil. This voltage is 90 degrees out of phase with the cable current because of the electrical law stating that magnitude of a voltage induced into a conductor by an electromagnetic field is directly proportional to the rate of change of this field. When the current, alternating from its peak negative to its peak positive value passes through the zero point, the rate of change is at its maximum and is displaced by 90 degrees from either current peak.

Without the voltage signal present, the rectified currents out of the ends of L1, through CR1 and R2, CR2 and R1, and back to its centertap, will be equal in each circuit branch. This produces a zero potential difference across the R1-R2 divider. The primary voltage signal path is through R3, to the centertap of L1 and out its ends, through CR1 and CR2 to ground. C1 provides an ac ground to both ends of the R1-R2 divider, plus smooths the pulsating dc. The secondary path through R4, R5, and C2 reduces the voltage applied to L1 and allows small phase corrections to be made to it. When the voltage signal is present, it will add to or subtract from the current signal, depending upon their phase relationship. If the voltage and current signals are directly in phase, then across one coil of L1 they will add while across the other they will subtract. Unequal currents will flow through R1 and R2 creating a potential difference across the divider. If the phase is changed 180 degrees, this potential will be of the same magnitude but of opposite polarity. When the signals are phased 90 degrees to each other, right in the center between 0 and 180 degrees, equal currents again flow and there is no potential difference. The voltage signal, applied to this phase-sensitive demodulator, is not shifted from its original phase, while the current produces a signal that is shifted 90 degrees. Therefore, when the coaxial cable voltage and current are in phase (unity power factor) there will be no demodulator output measurable across J3 and J4. Any small change in this phase relationship will result in an output that will be either positive or negative, depending upon whether the angular difference is leading or lagging.

The demodulator output is applied between the base and the emitter of Q1 and Q2. Q1, being an NPN transistor, will be switched on when the output is positive, and Q2, a PNP, will turn on when it is negative. Both transistors are operating class C and require about 0.5V of signal before either will conduct. Q1 and Q2 are direct coupled to Q3 and Q4. Either one or the other can be switched on, actuating K1 or K2, depending upon the state of the demodulator output. K1 and K2 are high-resistance, low-coil current relays with their contacts wired so that a high-current positive or negative, 3V dc output is made available to operate the servo motor, which positions variable capacitor C4. C4 is connected across the matchbox output and will automatically be repositioned every time the power factor in the coaxial cable changes from unity, bringing the antenna system back into resonance.

The reversing switch (S2) is used to eliminate the construction problems that would be brought about by trying to keep all phases and outputs aligned so that the servo motor will turn in the correct direction when called on to make an adjustment of C4. A complicated switch of this type is not needed if C4 does not have stops and will rotate 360 degrees. This is because C4 can be turned in either direction to its correct location.

A homemade fixed capacitor (C5) is used during 15m operation to prevent "hunting." Hunting is the oscillating motion of the servomechanism about null that takes place when variable capacitor C4 coasts through the null point after the motor power drops to zero, causing the demodulator to produce an output that drives the motor in the opposite direction, where it coasts past null again repeating the whole process. Series connected C5 makes it necessary for C4 to move a reasonable number of degrees to make an effective adjustment.

The ATLT is assembled on a 2 in. chassis of about 5 by 7 in. area. The front and rear panels are across the narrow ends of the chassis and are 5 in. high with rounded corners. The cover is a wrap-around type that snaps in place by holes in its lower side picking up the protruding heads of screws mounted in the chassis. Easy cover removal is necessary unless some sort of dial is provided to indicate the rotor position of capacitor C5. The front panel controls are: *phase* potentiometer R4; *amp* and *servo* switches S1 and S2; *demod* and *sig gnd* jacks J3 and J4.

Connections to the fixed and variable capacitors (C5 and C4) are brought through the rear panel using high-voltage ceramic feedthrough insulator posts. A shield, run down the center of the chassis, provides a place to mount the battery holders. The one for the 9V batteries is made of thin aluminum, while the 1.5V cells are held in the battery box removed from the toy auto which also provided the necessary motor gearbox assembly.

The current pickup coil details can be seen on Fig. 3. A piece of RG-8/U coaxial cable is cut so that it is long enough to be

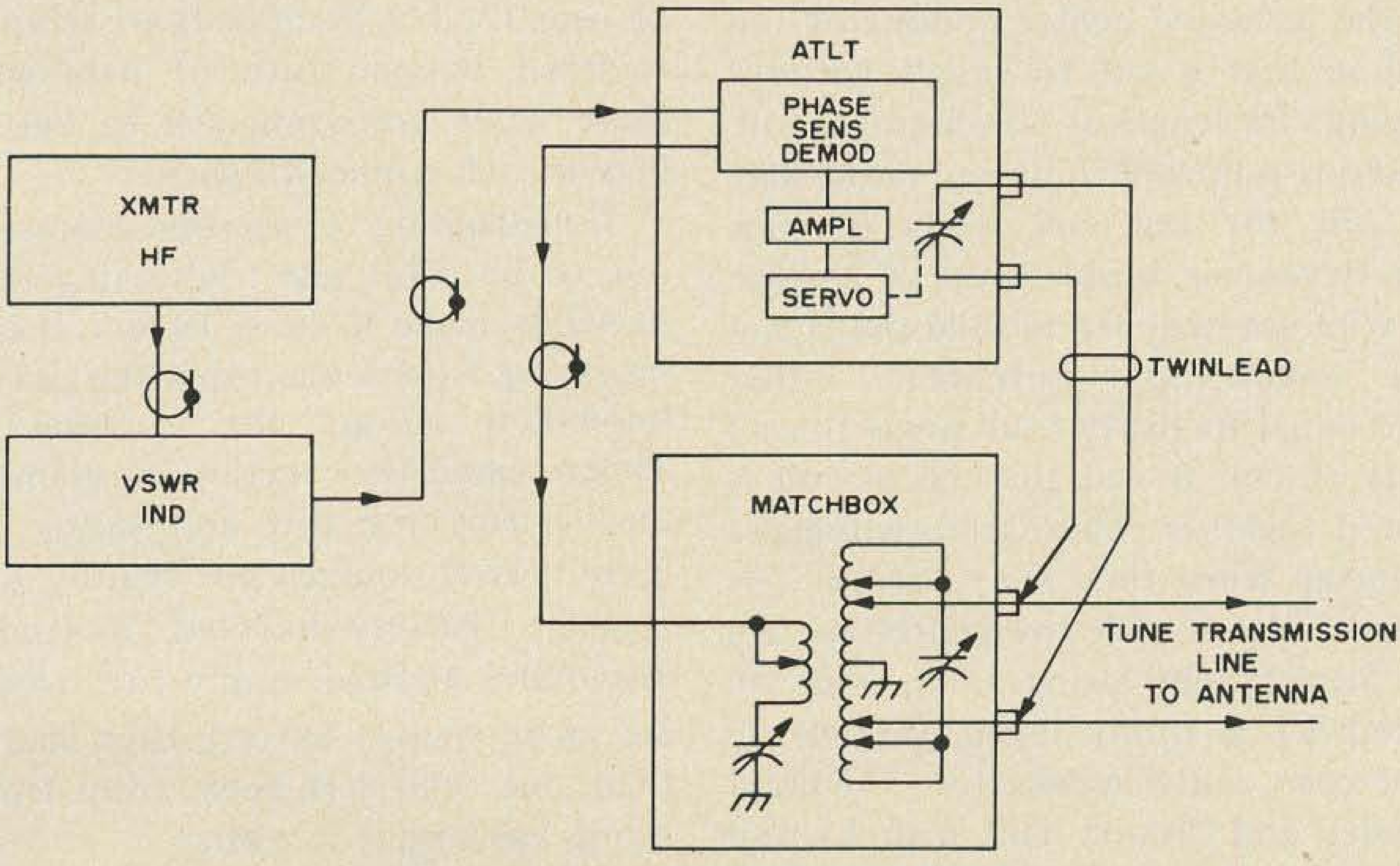


Fig. 1. Block diagram.

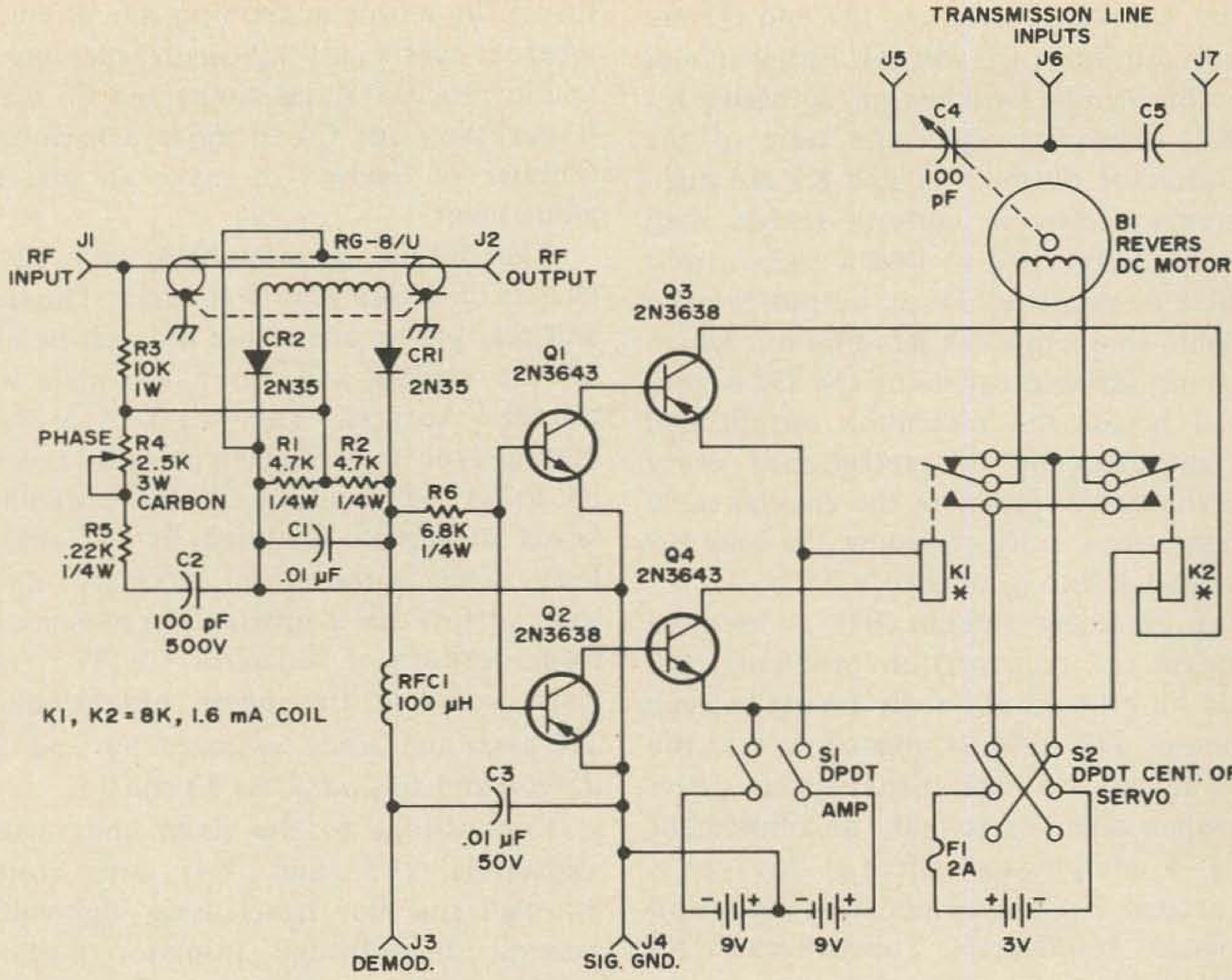


Fig. 2. Schematic – ATLT Unit

soldered between box connectors J1 and J2, located either side of the chassis at the back. The outer insulating jacket is slit lengthwise and peeled off in one undamaged piece, because it will be used for a form for L1. The braid is also pushed off undamaged so it can be later replaced. The outer jacket insulating material is wrapped around the insulated center conductor and trimmed so that it will fit snugly without overlapping. Its length is trimmed to 2 in. and a hole is punched in its end either side of the slit for the coil leads to pass through. Seventeen bifilar turns of 28-gage enamel wire are wrapped around the jacket material lengthwise. (Seventeen bifilar turns are equal to thirty-four single turns.) The start of coil B and the end of coil A are twisted together. These leads will make the centertap when they are soldered. The other leads, along with the centertap, are slipped into an insulating tube, and the completed L1 is thinly taped around the insulated coax center conductor. The braid is expanded and slipped back over L1 and the center conductor, fishing the L1 leads out through a hole worked into it about ¾ in. from one end. The whole thing now looks like a short piece of RG-8/U without its outer jacket, and a small lump where L1 is located under the braid. The tubing, with the L1 leads in it, will be coming through the braid at one end of this lump, and when the current pickup assembly is soldered to the box connectors, this end will be near J2. The braid ends are wrapped and soldered to one turn of bare wire, and these wires are connected to two ground lugs at each connector shell.

Constructing a servomechanism turns out to be a lot less frightening than first thoughts make it seem. In fact, it is quite a satisfying experience using the old Yankee know-how to get the machine to run. Timer assemblies make excellent servomechanisms for this application, but require power sources not readily portable. Luckily, battery-powered motor-gearbox assemblies abound in any toy store. There are more snappy battery toys made today than one who has been away from such things has a right to realize.

There is no reason for not being selective about picking out a toy that operates rather slowly, and has an easy to-get-at drive assembly. I settled for a model of a Ford Mustang. The complete title on its box is "*Non-Fall Mystery Bump'n Go Ford Mustang GT-41*". It is an all-metal model, and runs relatively slow to the edge of a table and then, before dropping off to the floor, it turns itself around and proceeds back over the table again as if it had eyes.

The metal construction makes it easy to take apart, because it is held together with metal tabs bent over here and there. The motor and gearbox, along with the rubber drive wheel, comes out in one piece after straightening a few tabs. It will require minor modification before a ¼ in. shaft can be mounted to it.

The electronics is built on a perforated Vector board and arranged to look neat. The transistor types can be changed to practically any silicon NPN and PNP type and still work fine. The balanced 2N35 diodes are rather old-fashioned and can be replaced by other types if you pick a pair that have equal conduction. I do not know the brand of the scrounged relays, however, they have 8 kΩ coils and will operate with 15V across them. The circuit board is mounted on spacers under the chassis and wired to the switches, jacks, L1, and signal ground (which is a point on the coax braid over the center of L1); R3 is connected to the center conductor of J1.

C5, the homemade fixed capacitor, is made from a U-shaped square (1½ in.) of aluminum. The top of the "U" end is trimmed ¾ in. deep so only the lower ½ in. of it is left. This portion is drilled and bolted to the 15m (bottom) feedthrough post. The center plate is a 1½ x 2 in. right angle shape with a ½ in. flange. The lower portion of the flange is trimmed like the "U" so it will clear the 15m feedthrough post. The tab that is left is connected to the center post that also feeds the stator of C5. The plates of the capacitor are bent until they are spaced ¼ in. from each other.

Before operating the completed ATLT, a few precautions should be taken. The plate spacing of C5 is about .070 in. This makes it necessary that the length of the tuned transmission line be selected so that a very high voltage will not wind up at the matchbox output. Remember, a quarter-wave line inverts the load connected to it, and a half-wave line will repeat it. Be careful that rf does not get into the unit from the test meter, or indications will be erratic. Check that the transistors do not have a current flow before an rf signal is present. Keep in mind that the ATLT will detect and correct *only* reactive power conditions in the coaxial cable, so the vswr indicator can be indicating a high vswr of a resistive nature that will not be seen by the ATLT. The resistive mismatch must be tuned out with the matchbox input capacitor, but only one time for each band.

After the above checks are made, connect the ATLT in series with the coaxial cable running to the matchbox input, along with a vswr indicator ahead of it. Connect C5 across the matchbox output using a short piece of TV twinlead, and set the rotor halfway open. Load the matchbox with a lamp so that its output capacitor

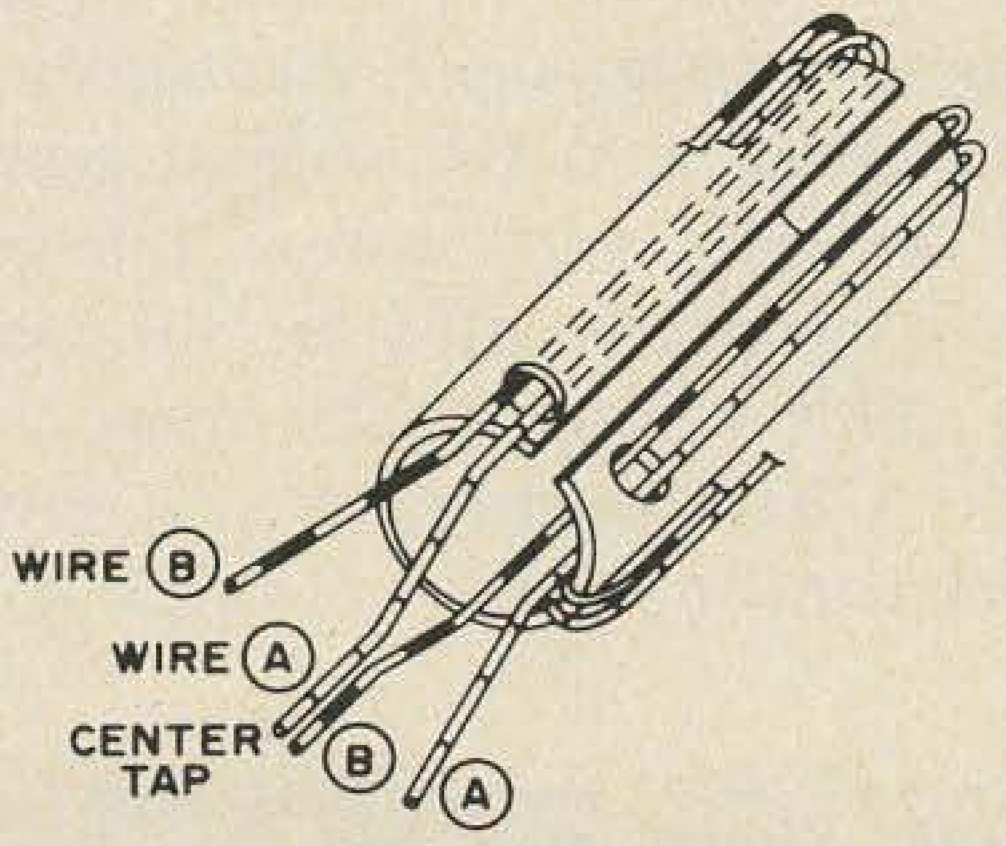
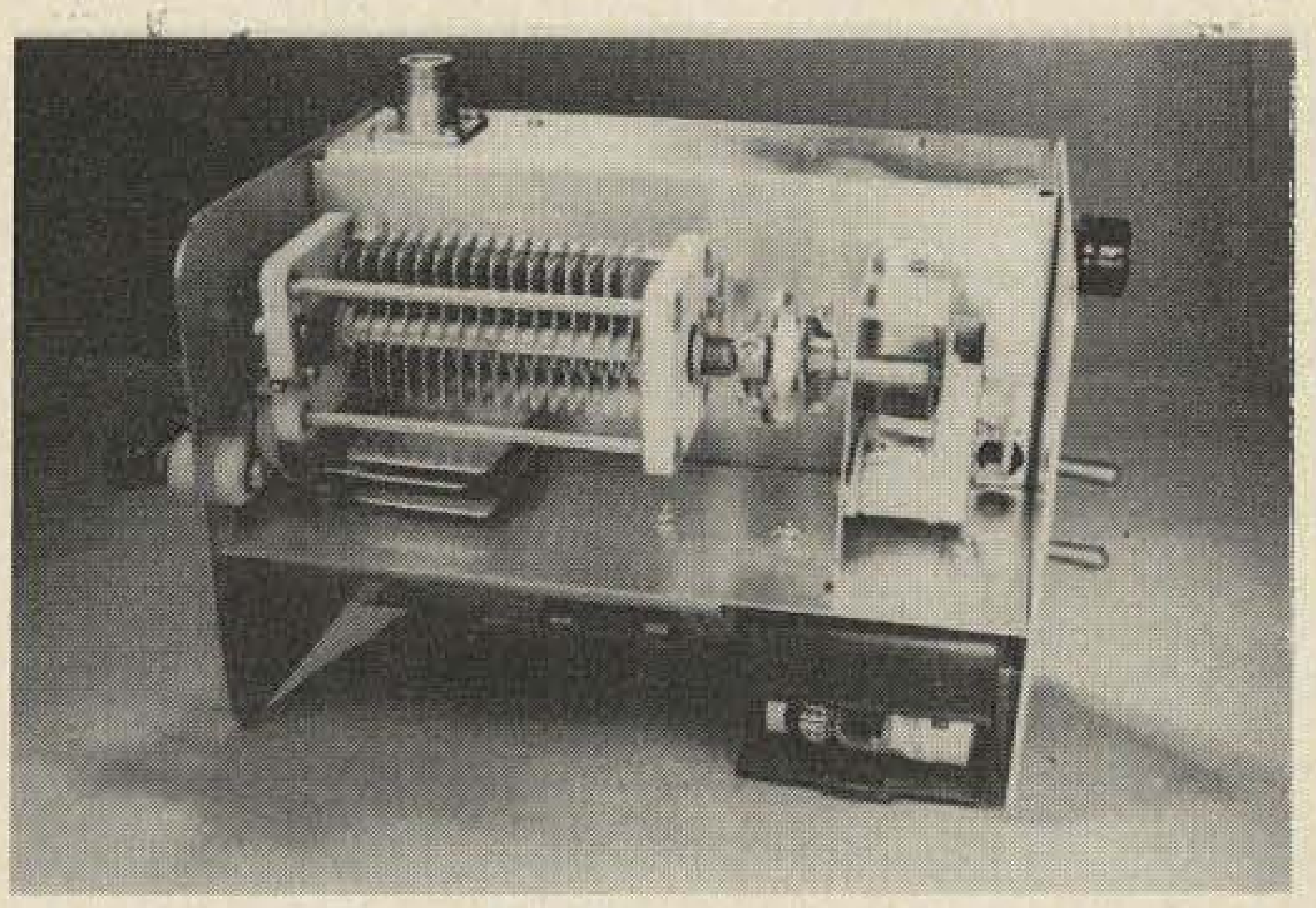
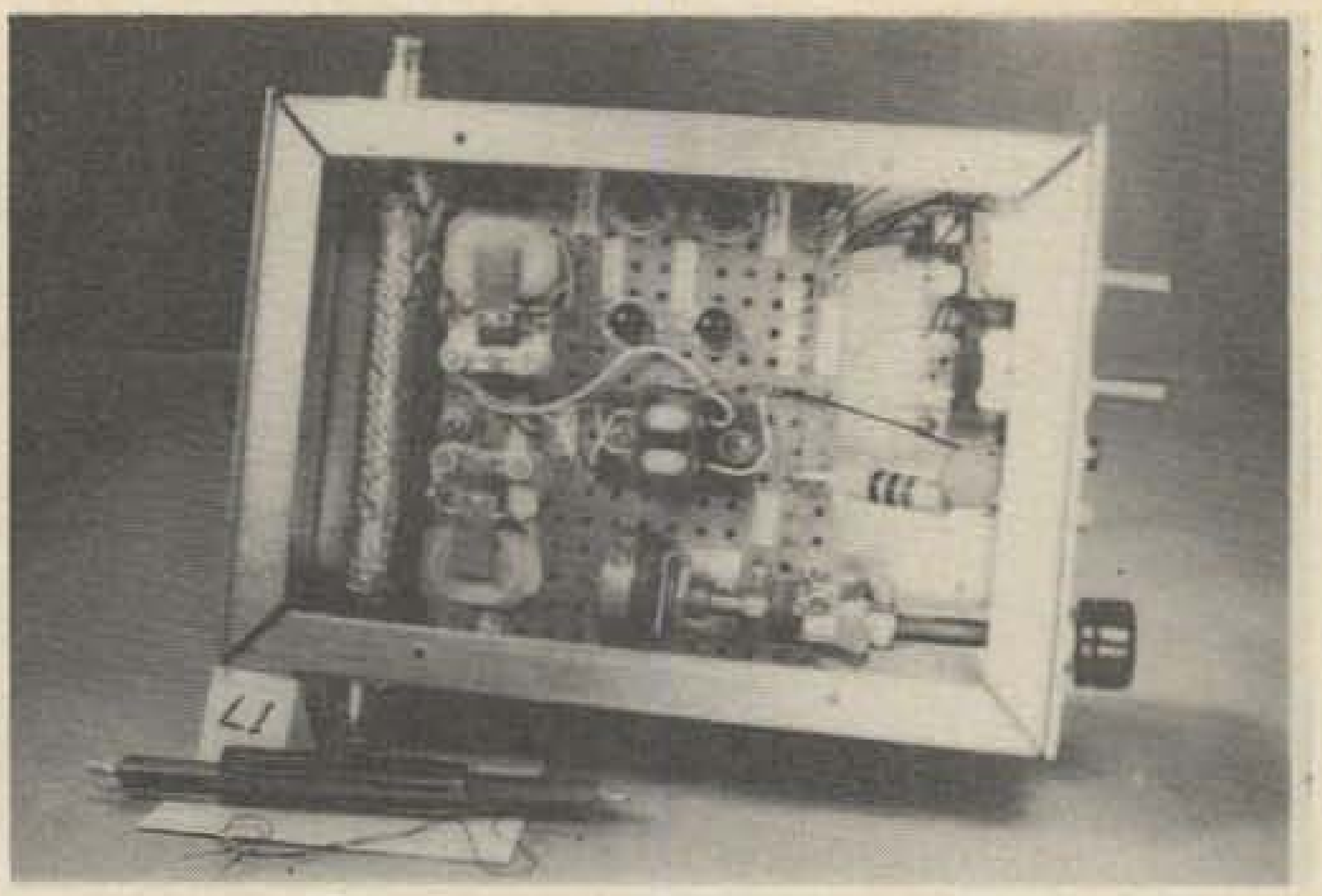


Fig. 3. L1 construction is on 2 in. long RG-8/U casing; 17 turns (lengthwise) of 28-gage enamel wire.



The automatic transmission line tuner connect to the matchbox.

The ATLT, top view.



The ATLT, bottom view.

will tune rather sharply (coil loaded to a medium Q). Set all ATLT switches off, and apply a 40 or 80m signal to the setup. Adjust the matchbox for optimum output.

Rotate *phase* control R4 to the center of its travel. Measure the demodulator output between J3 and J4 using a 20 kΩ/V meter, and readjust the *phase* control for a null indication. Move the matchbox output capacitor slightly one way and then the other from the set position and the meter will indicate a potential, a null when returned to set, and an opposite polarity potential when on the other side of set. Place the *amp* switch S1 on. K1 and K2 will click on and off as the capacitor is rotated through null.

Place the *servo* switch S2 on and the servomechanism will relocate variable capacitor C4 to compensate for these position changes. If C4 drives against one of its stops, set the *servo* switch to its other position and the motor will drive in the correct direction to produce a demodulator null. When the transmitter frequency is changed, C4 will be driven open or closed as the frequency is increased or decreased, and the vswr indicator will indicate a low ratio.

C4 is not a large capacitor and with some matchboxes it might not be capable of adjusting throughout the entire spectrum of the lower bands, but it most certainly will cover whole CW or phone portions. Try the setup on the other bands, using C5 in series with C4 on 15m. If trouble is encountered, the ATLT may be tested like a vswr indicator by connecting a dummy load to coaxial box connector J2. Under this condition the demodulator output should be less than 0.5V.

After these tests are completed, the ATLT is ready to be connected to the antenna feed system as shown in Fig. 1. It will operate just like it did during bench tests, correcting for all transmitter frequency changes large enough to cause objectionable standing waves along the coaxial cable.

This method of antenna tuning, to my knowledge, is new but as reliable as a vswr indicator. It is tuning a center-fed 33 ft antenna for me with wonderful results on all bands. (The 33 ft distance is the space between two nicely positioned trees and not meant to be some magic length that produces red hot results.)

I guess that it is obvious by now that C5 could have been a roller inductor at the base of a short vertical antenna, continuously adjusting it over the whole band, or the servomechanism could be rotating the matchbox capacitor instead of an outboard unit. What may not be obvious is that this idea can be expanded to include the automatic tuning of tank circuits by placing L1 in one of the circuit leads and shifting the voltage signal 90 degrees before it is summed with the current signal. By using varactors and motors I believe an entire transmitter could be automatically tuned. This is one of the most exciting projects I have worked on: real automatic fedback control of rf. ...K3QKO■

The 2N3643 (60¢) and 2N3638 (50¢) are available from Circuit Specialists Co., Box 3047, Scottsdale AZ 85257. Please add 25¢ for shipping.

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The Button Box

An automatic morse code generator driven by a keyboard for better sending by everybody

The *button box* is another version of a keyboard code generator, and discloses no new and startling techniques. In presenting the button box, I intend to introduce you to digital logic, describe the logical operations involved in generating the code, and give you some ideas for building your own. Nothing in the descriptions or drawings is sacred or critical, and were intended not for duplication but rather to arm you with enough information to combine your ideas with mine and build a unit that will fulfill *your* requirements.

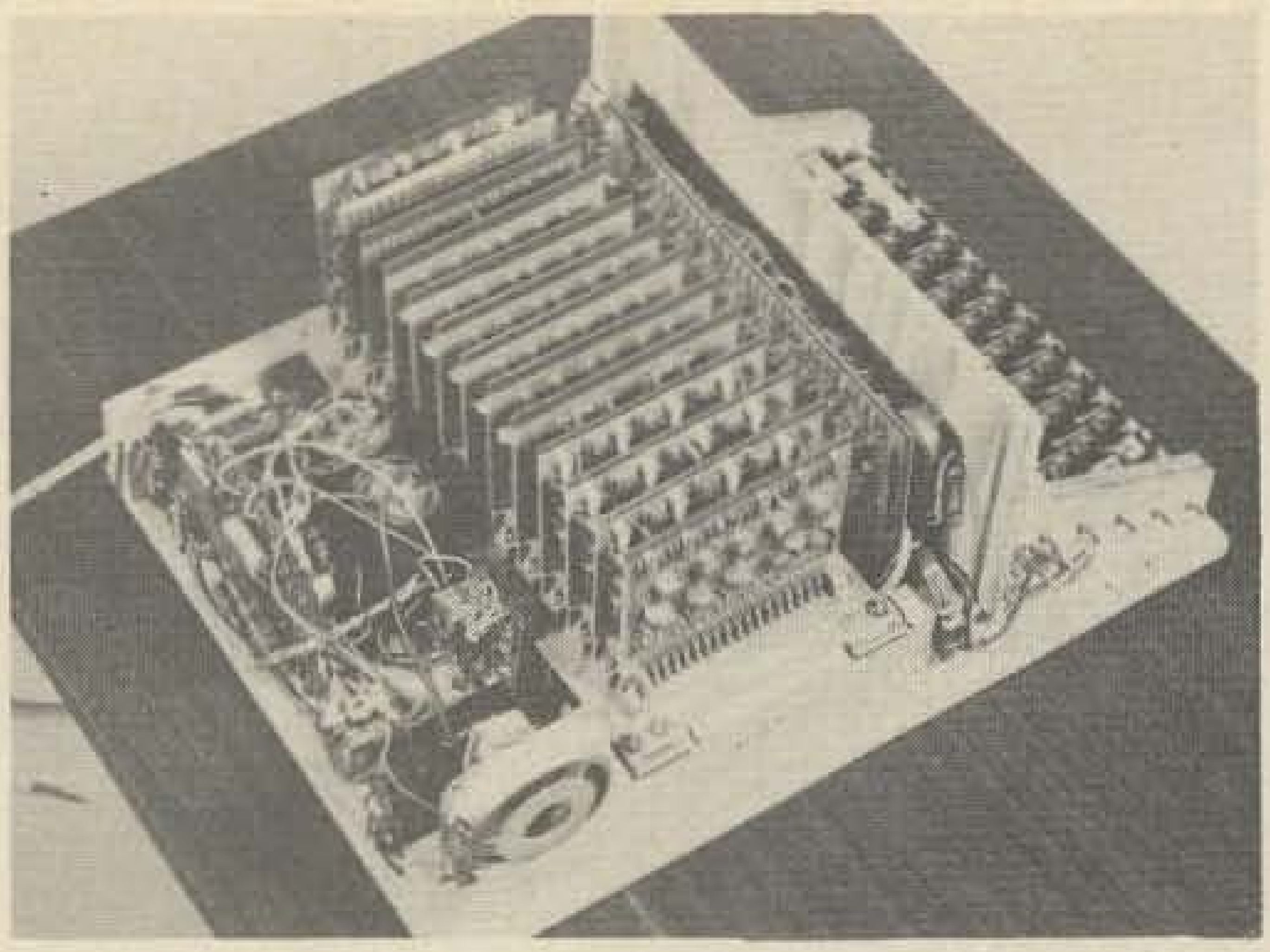
THE BUTTON BOX

Keyboard articles by Horowitz (QST, Aug. '64 and Oct. '68), Granberg (CQ, Sept. '64), and Bryant (QST, July '69) are all excellent and recommended reading. Each of the keyboard units described in these articles has its advantages, and perhaps by combining portions of each, one could devise the ultimate in compactness and versatility. However, I find it difficult to use components that I do not understand well, and prefer to use old "tried and true" discrete components. By using these, I can get by without a scope (in most instances), and can measure almost any point in the logic with my voltmeter.

In dreaming up the button box, several problems confronted me: First, money was not too plentiful. The bargain ads consulted for components revealed that surplus computer cards could be bought quite reasonably and either used as-is or stripped for the components.

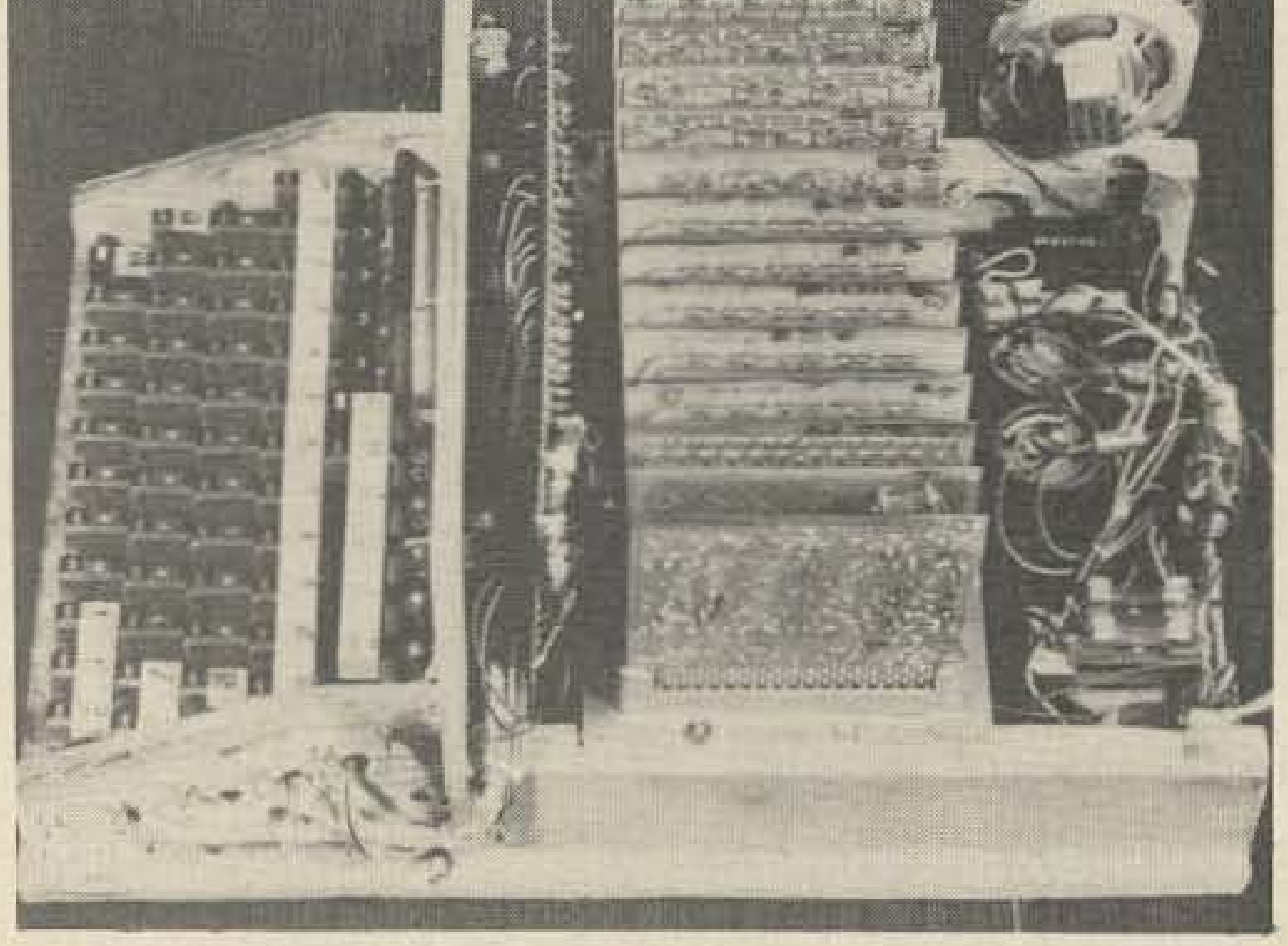
Secondly, I am no craftsman, and had only a few hand tools to use in building the keyboard. I used plywood to build the button box, but Masonite, aluminum, or whatever your favorite material is, could be used. The keyboard switch problem has been solved a number of ways, but I took the easy way out when I found a bargain sale on "micro" switches.

Last, but far from least, I wanted the logic to be straightforward, and the parts mounted so they would be accessible for repair or modification. I have justified this approach by making a number of changes



In this view of the button box, the discrete components are shown on their plug in PC cards. The power supply and speaker, not modular, are shown at the back of unit.

and circuit additions that I would not otherwise have been able to make. Most of the additional circuitry is for station control and does not affect the button box itself, so will not be discussed here. Each button controls an encoder gate that uniquely defines the character to be generated. This approach, although using additional diodes, simplifies the tracing of troubles in case a component becomes defective. Since the last bug was tracked down and slain in April 1968, only one problem has developed to test this theory. A transistor in an input *nand* gate proved to be sensitive to the heat of our July, and was promptly located by listening to the errors caused in the code. Verification that the culprit had been found was made using an ohmmeter, and a lighted cigarette as a spot heat source. Replacing the transistor took but a few minutes, and no troubles have developed since that time.



Detail of keyboard and wire routing method.

Advantages

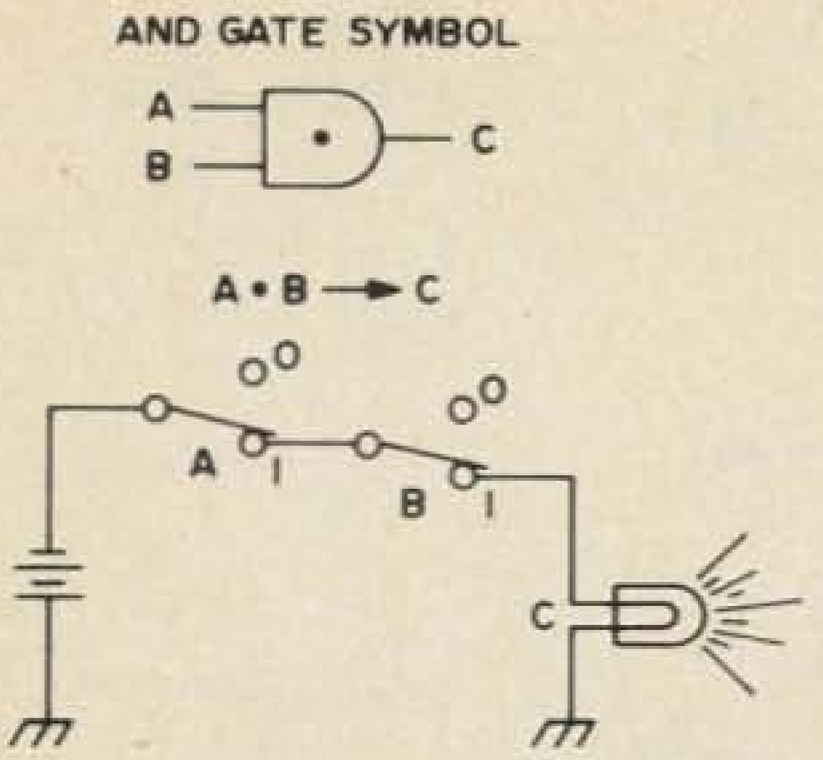
Expending so much time and even a little money just to build a unit to replace the hand key hardly seems justifiable, and may appear somewhat ridiculous to the uninitiated. Even if that was the sole reason, it would be worth the effort to put better, more readable CW signals on the air, but there are other uses for the button box which have little to do with on-the-air operation.

It is great for code practice sessions, either on or off the air. The built-in monitor can be made loud enough for room use, or feed separate jacks for use with headphones. Individuals, or groups, can learn the code without any prior training or CW knowledge, because as each button is pushed, a character is generated. The sound of that character is associated with the legend inscribed on the button, so there is little chance for error. Any speed wanted can be accommodated, and double characters, repeats, or combinations can be sent without the problems associated with disk or tape recordings.

An advantage not to be overlooked, and one that is important to me, is that those of us with an infirmity or physical defect that makes it difficult to use a straight key, bug, or keyer-paddle can now send beautiful code by using only one finger if necessary. Loss of the thumb on my paddle-wielding hand curtailed my CW activity until I completed the button box. Now I get compliments on how nice my "fist" sounds, and I enjoy CW more than ever.

Who???

NNGT is often heard on the CW band. No – this is not a ship at sea operating on the wrong frequency, but is what all-too-frequently passes for CQ when the fellow sending has a really swinging fist. Or, how often do you hear NST? Of course he really means TEST, but then, everyone knows that – or do they? Poor CW is always a problem with the *other fellow* – never ourselves. With a button box you can be certain that you are not the *other fellow* but the one who actually "sounds better than tape."



TRUTH TABLE

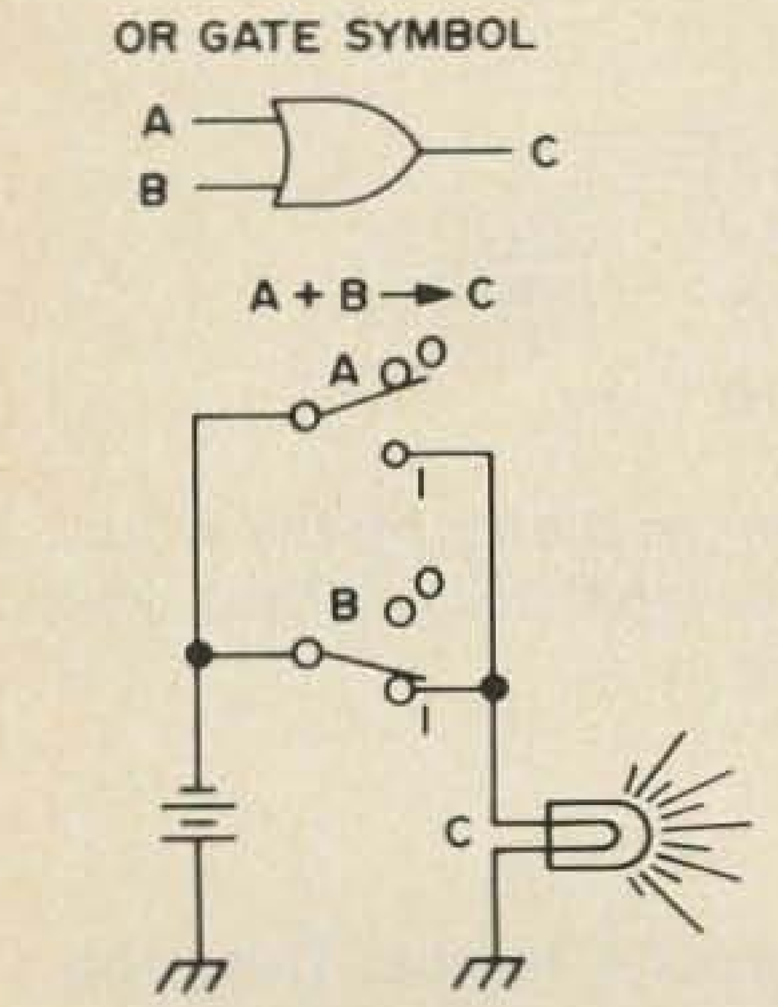
A	B	C
I	I	I
O	I	O
I	O	O
O	O	O

Fig. 1. The switches show the mechanical equivalent of a typical and *gate.*

Introduction to Logic

If you have read this far, you are seriously interested in building a button box, so let's review the logic elements that are used as building blocks and dispel the aura of mystery that seems to surround these computer circuits.

In the discussion of a specific circuit design, it is necessary to define logic levels in terms of voltage. However, when using logic symbols and describing logical operations, only two conditions concern us: (1) either a statement is true; (2) or a statement is false. The binary system consists of only two states, and is regularly applied in daily life. For instance, a light bulb is either on or off, it is day or night, or a door is open or closed. "The light is on" is a statement of fact, and we can assign a symbol such as A to indicate that the bulb is indeed on. However, if the bulb is not on, we do not need another symbol to say so, but we should define the condition when A is not true (false). We can do this



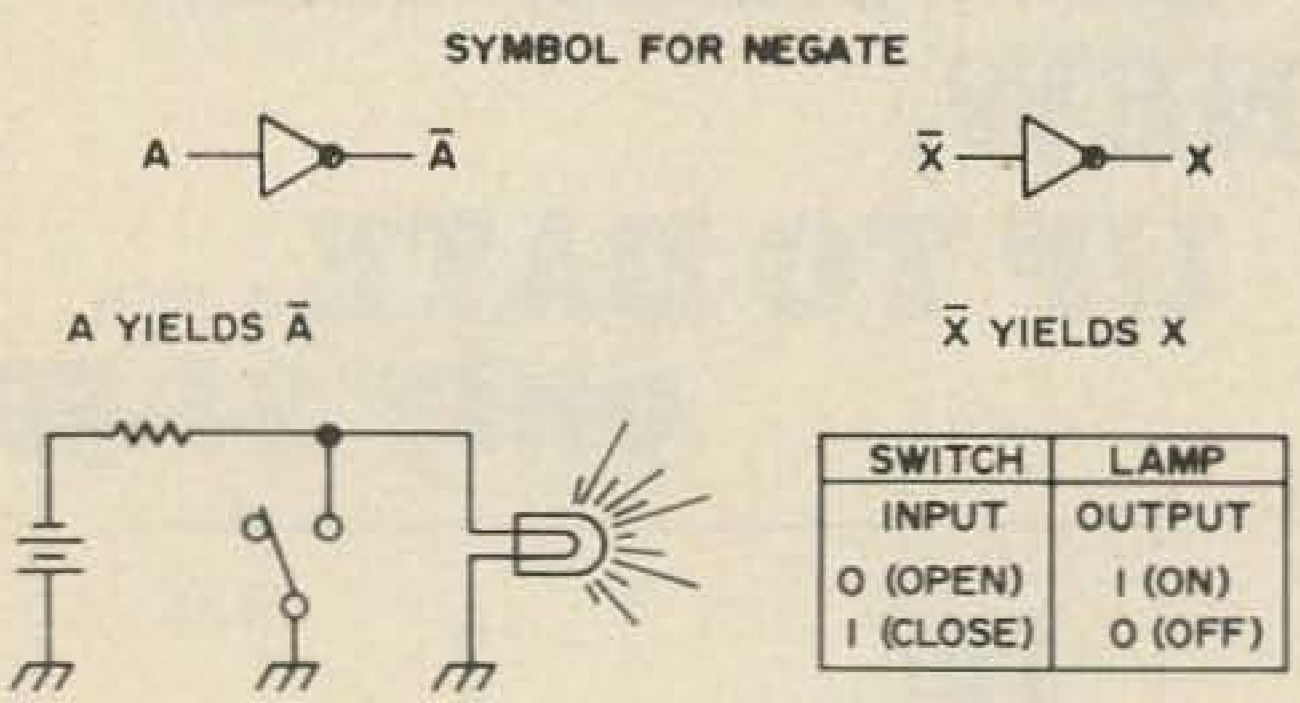
TRUTH TABLE

A	B	C
I	I	I
O	I	I
I	O	I
O	O	O

Fig. 2. Paralled switches make a mechanical equivalent of the or *gate.*

by putting a bar over the A and saying $\bar{A}$ (read as "A not") means the bulb is not on. We have defined the two possible states of the bulb as A for on; $\bar{A}$ for off.

We can apply this logic to any fact and make a statement that is true (A) or false ($\bar{A}$). It is easy to decide which state exists in binary notation if we use the figure one (1) as the true state and we use zero (Ø) as the false state. This binary notation allows A to assume either the 1 or Ø state, and $\bar{A}$ will be the negation, or inverse. If we were to say, "The light (A) is on," and the light is really on, the statement is true and A equals 1. However, if the light is really off, then the statement is false and A equals Ø.



SWITCH INPUT	LAMP OUTPUT
O (OPEN)	I (ON)
I (CLOSE)	O (OFF)

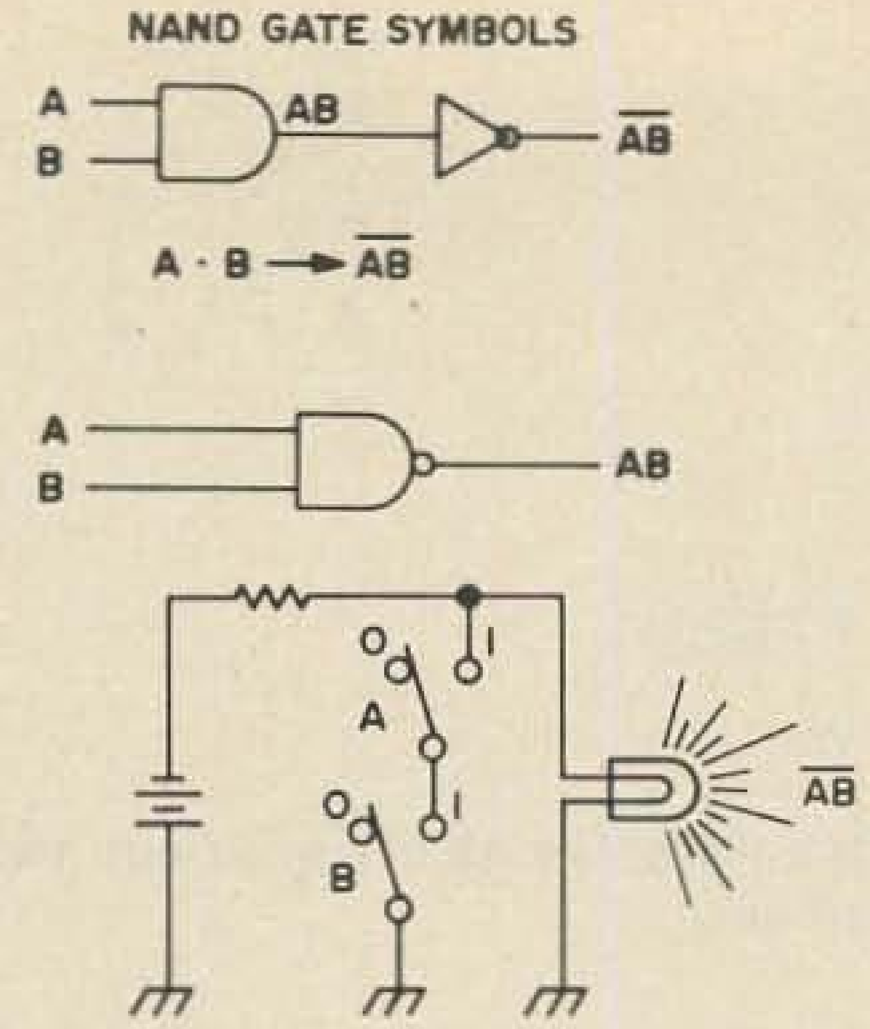
Fig. 3. A simple inverter can be used to negate a logic function.

We may also make a statement of negation. By saying, "The light is not on," the statement will be true when the light is off, and $\bar{A}$ will be equal to 1. These terms, once defined, are often used interchangeably in describing logical operations.

By combining logical conditions in gates, we can produce an output at any time, or in any sequence that we may desire. We can amplify, invert, combine, store, or compare logic levels by using gates and flip-flops. Logic symbols and operations will be described before we get into the operation of the button box, so if at present you are thoroughly confused, don't despair, for now that we know what a logical statement is, let's see how we can shorten it to symbols that when interconnected can tell us how something works.

The AND Gate

An *and* gate must have all of its inputs true in order for the output to be true. If we combine soil "A" and water "B", the result is mud "C". This statement may be



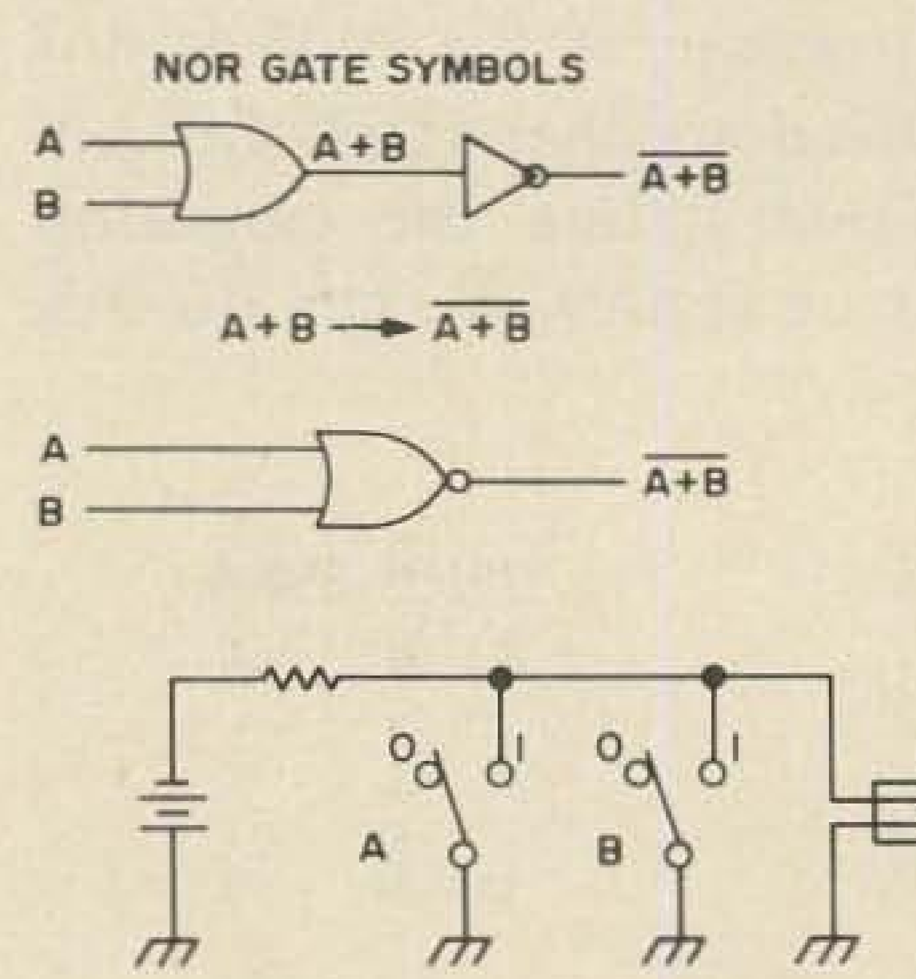
TRUTH TABLE

A	B	AB	$\overline{AB}$
I	I	I	O
O	I	O	I
I	O	O	I
O	O	O	I

Fig. 4. The nand *gate is an* and *gate whose output is negated. The switch arrangement shows a mechanical circuit equivalent of a typical* nand *function.*

written as A•B→C, or simply AB→C, and is read A and B yields C. Switches can be used to more clearly show the operation of an *and* gate (see Fig. 1). Conditions of the inputs and outputs in the truth tables show the relationships.

Examination of Fig. 1 will show that only when switches A and B are both closed will the light C be turned on. We can say then that in *and* gates, the key word to remember is *all* and that all inputs must be at the true (1) level to produce a true (1) output. Also, the *control* for the *and* gate is Ø, since any Ø at the input will cause the output to be false (Ø).



TRUTH TABLE

A	B	A+B	$\overline{A+B}$
I	I	I	O
O	I	I	O
I	O	I	O
O	O	O	I

Fig. 5. The nor *function, as shown by the switch assembly, produces a negated result (light goes out) when any input is at 1.*

The OR Gate

The *or* gate performs a logical function by allowing a true output whenever one or more of the inputs are true. The *or* function is designated by the + sign. The statement A + B → C is read A *or* B yields C. Operation of the *or* gate can also be seen by examination of the relationship of the inputs to the output in the truth table of Fig. 2.

It can be seen in Fig. 2 that when either, or both, of the switches close, the light will be on. We can say of the *or* gate that *any* is the *key word*, and that if *any* of the inputs are at the true (1) level, the output will be at the 1 level. We may also say that the *control* is a 1, since any 1 at the input will cause the output to be a 1.

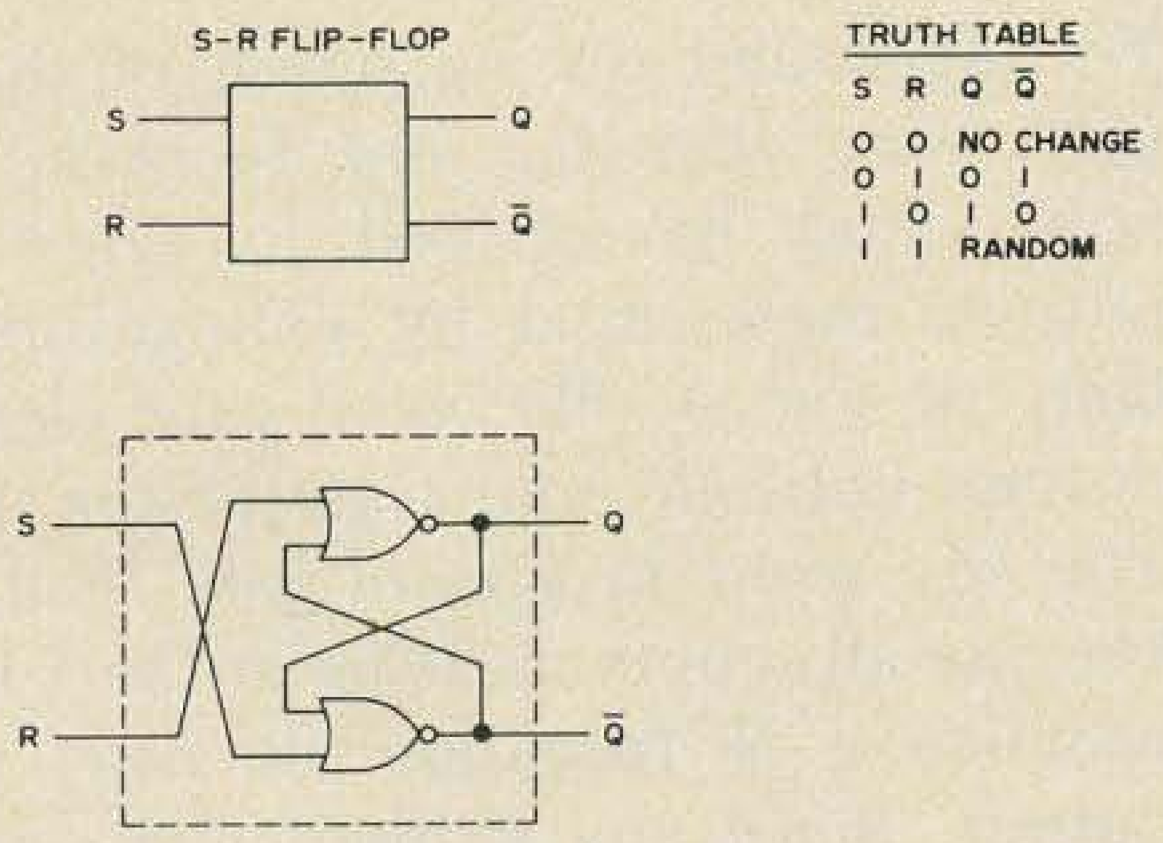


Fig. 6. Cross connected inverting gates form flip-flops that operate similarly to the manner of a latch relay.

Invert/Negate

To negate a function, an inverter is required. If A is the input to an inverter, the output will be $\bar{A}$. The symbol and function are shown by Fig. 3. Quite a few of the logic boards available on today's surplus market do not use the direct *and/or* functions, but have an inverter following the gate. If the function is not understood, these can cause problems in implementing the logic to create the desired output.

The NAND Gate

The *nand* function is the *and* function negated, or the contraction of "*not and*".

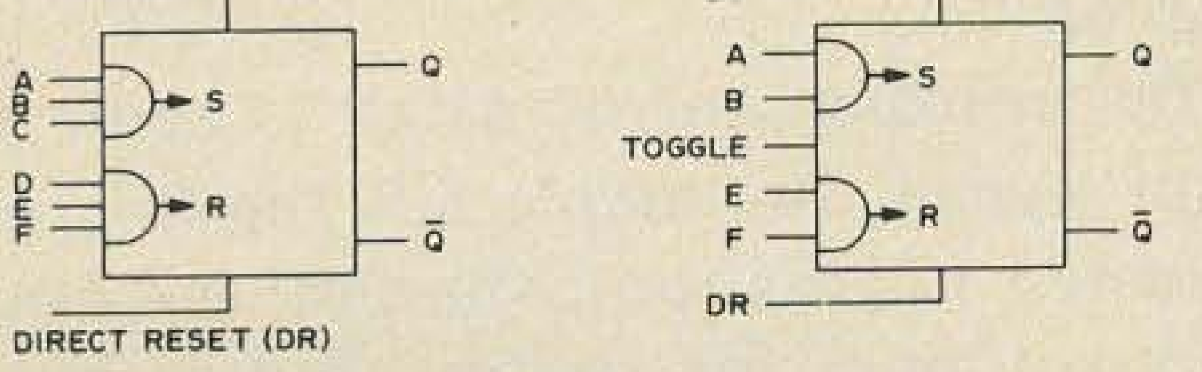


Fig. 7. Multipurpose flip-flops may have a number of triggering inputs, selected to match the requirements of specific circuits.

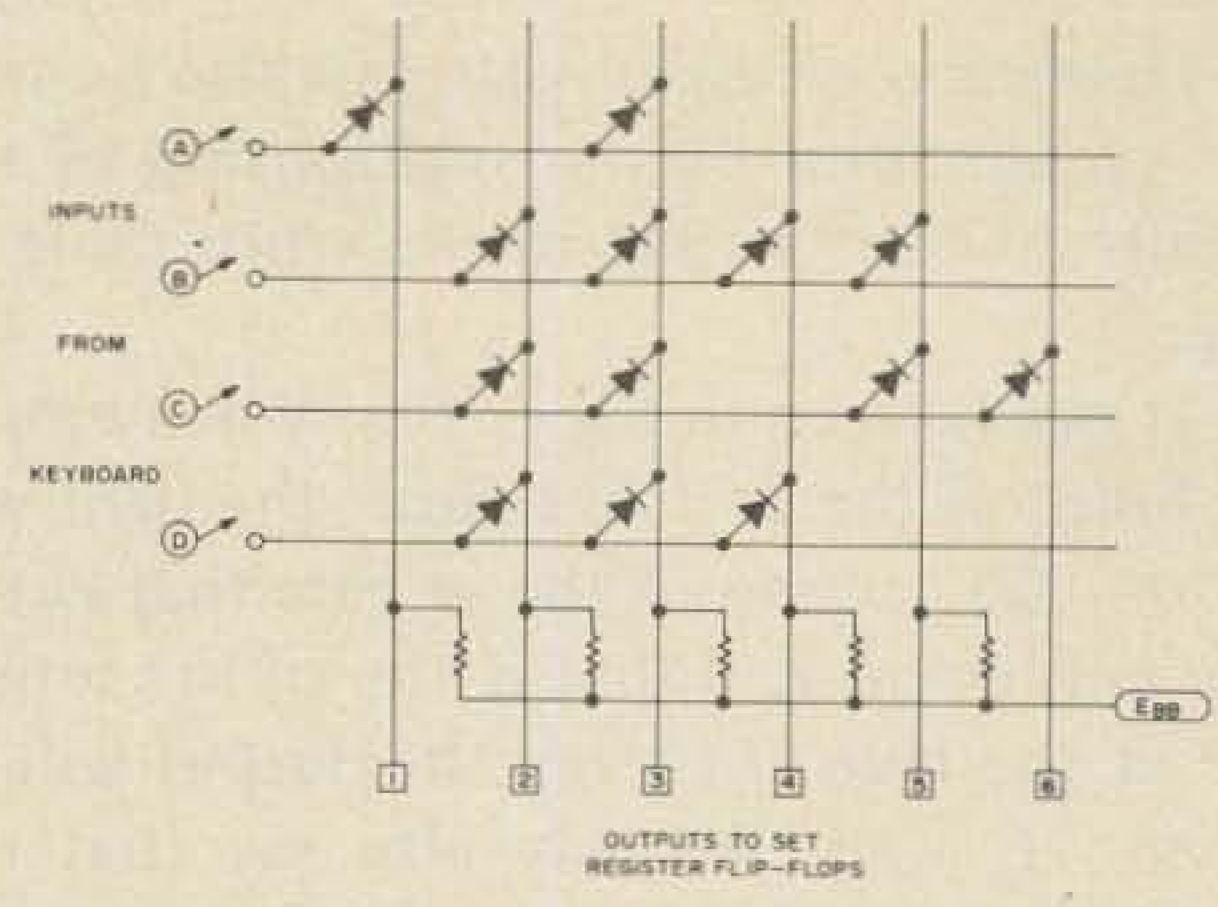


Fig. 8. The encoder, or matrix, causes simultaneous outputs with but a single input signal.

To understand the operation of the *nand* gate, note that the *and* function at the input must be satisfied to cause the Ø output, represented by extinguishing the lamp of Fig. 4. The *nand* gate yields a 1 output until *all* inputs are at the 1 level. The *key word* in a *nand* gate then, is all, because all inputs must be at the 1 level to produce a Ø (negation of *and*) at the output. Since any Ø input will cause the output to be a 1, the control is a Ø.

The NOR Gate

The *nor* function is the *or* function negated, or the contraction of "*not or*." In Fig. 5; note that when the *or* function is satisfied, the *nor* output of Ø is indicated by extinguishing the lamp. The *nor* gate yields a Ø output until none of the inputs are at the 1 level. The *key word* in a *nor* gate then, is *none*, and since any 1 will yield a Ø output, the *control* is a 1.

Flip-Flops

Nor gates and *nand* gates are often cross connected to form a stable set-reset (S/R) flip-flop. An input pulse to either the S or R inputs will cause a condition in the output that will not change with additional input pulses applied to that same input line (Fig. 6).

By utilizing *and/or* gates to route the input signals, the simple S-R flip-flop may become a multipurpose flip-flop and can be used not only for storage, but as binary dividers, counters, shift registers, and other uses, such as oscillators, phase shifters, etc. The symbol for a multipurpose flip-flop differs from the S-R only by the number of inputs shown (see Fig. 7). Flip-flops can be series connected and used for serial shift registers, such as the one used in the button box.

Encoder

An encoder is variously called a matrix, an expander, a coding gate, and other names – but regardless of terminology, the function is to cause simultaneous events on a multiple output with a single input signal (Fig. 8). A single input, such as closing the switch for the letter C, will cause outputs on corresponding lines – in this case, lines 2, 3, 5, and 6.

The layout for the diode matrix board used as an encoder in the button box is shown in Fig. 9. Each of the encoder inputs comes from a separate keyboard switch. Closure of any switch will cause an output on one or more of the ten lines feeding the input gates to the shift register (*and* gates in Fig. 10; *nand* gates in Fig. 12). Setting a stage of the shift register tells the code generator (CG) when to turn off.

The matrix board can be etched at the kitchen sink (send the wife to the movies while you do this), and holes drilled to pass the diode lead through the board for gate wiring, or you can use predrilled Vector board. A sheet of either is adequate as long

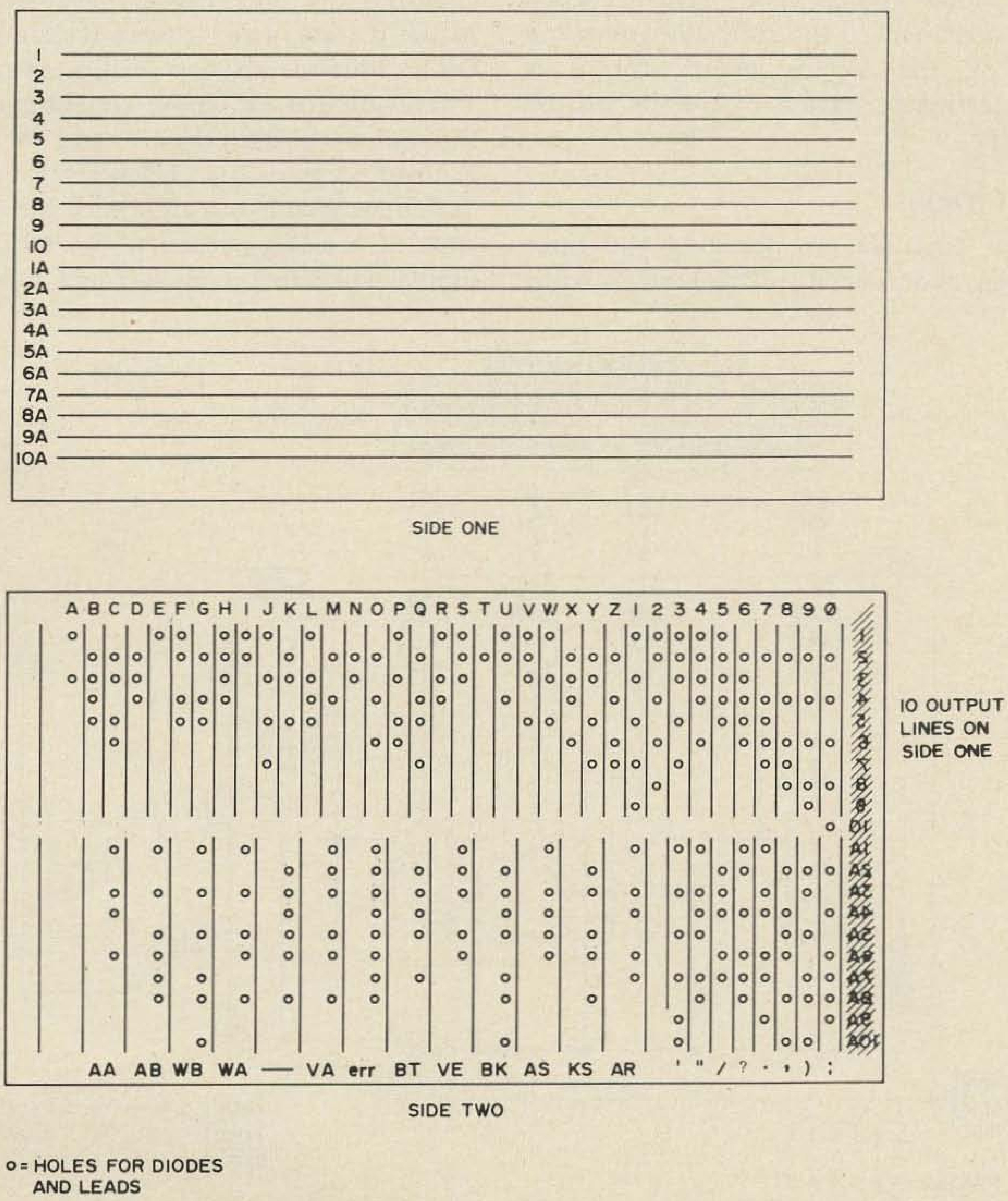


Fig. 9. Diode matrix for button box.

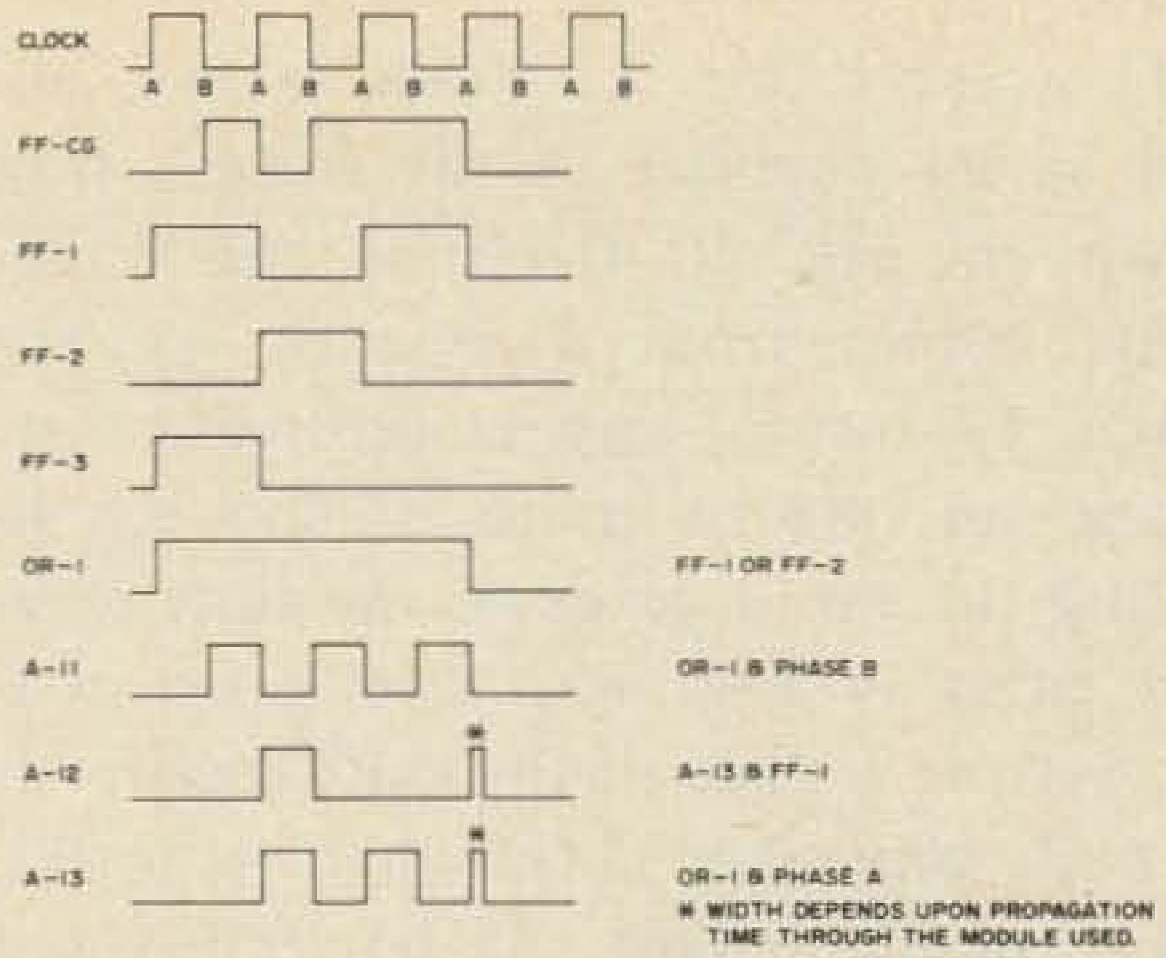


Fig. 11. Timing signals for button-box logic elements.

as there are at least 20 holes across the width and 32 along the length. Hole spacing is determined by the physical size of the diodes you use. Use a heatsink when you solder them to the etched board or the wires on the Vector board, for it is disconcerting to have a bad diode on the first check.

How It Works

Now that we are speaking the same language, and understand the basic building blocks used in this keyboard, or for that matter in any other digital device, let's see what sequence of events must occur in generating CW characters. Examine the simplified logic diagram shown in Fig. 10, and follow the sequence of events on the timing diagram, Fig. 11, for the generation of the letter A in Morse code. When the button of the keyboard is pressed corresponding to the letter A, the encoder output will cause a 1 level to be seen at the "b" inputs to *and* gates A-1 and A-3. For these inputs to appear at the output of the *and* gates, two other conditions (a and c) must be met. Input "a" will be at the 1 level only when all of the flip-flops which comprise the shift-register have been reset to the Ø state. This causes a Ø output from OR-1, which is inverted in I-2, and places a 1 level on the "a" input to *and* gates A-1 through A-10. With the "b" and "a" inputs enabled on gates A-1 and A-3, but only the "a" input enabled to all others, the appearance of a clock phase "A" to all the "c" inputs will allow gates A-1 and A-3 to set

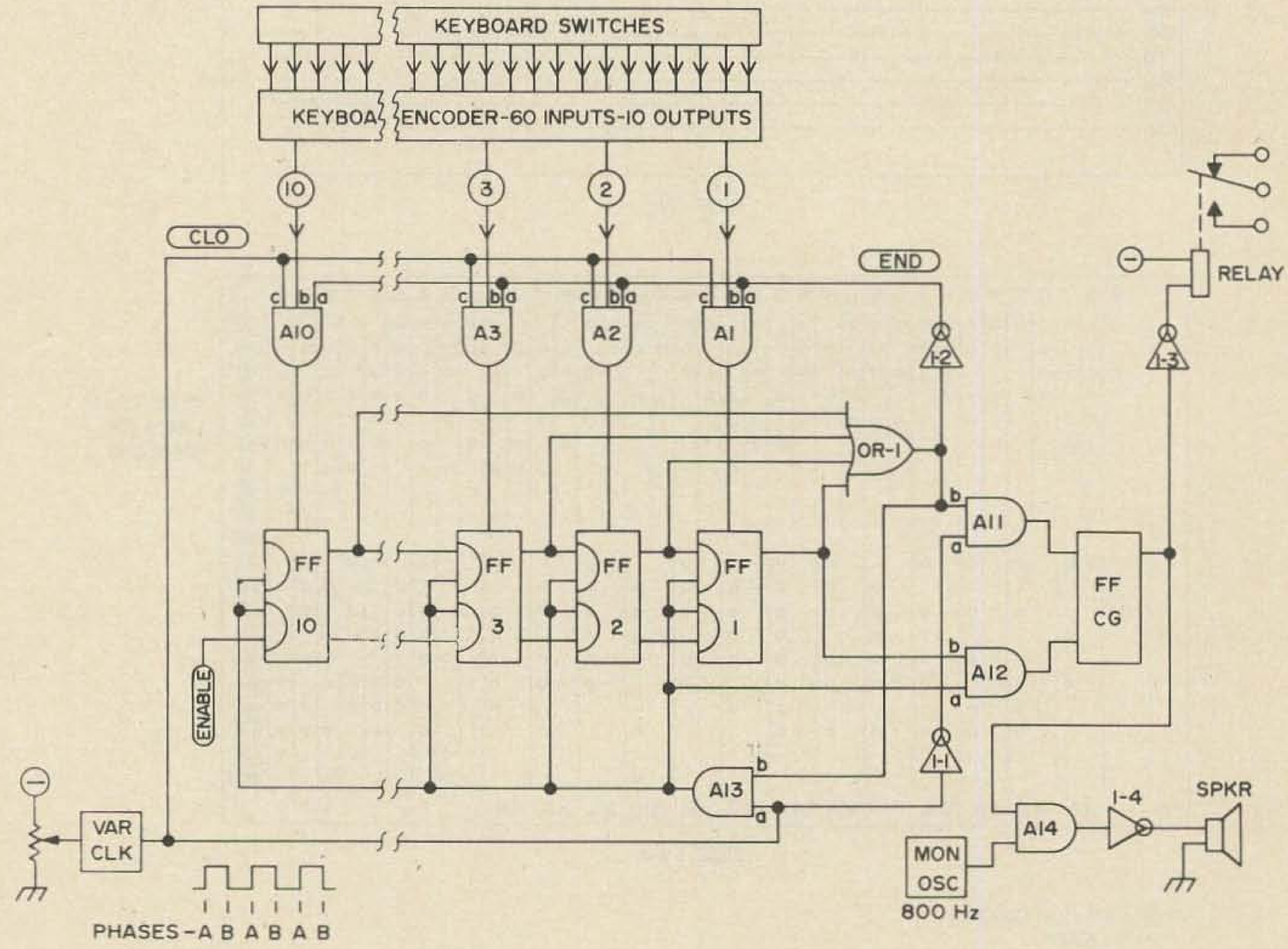


Fig. 10. Logic scheme of keyboard encoder.

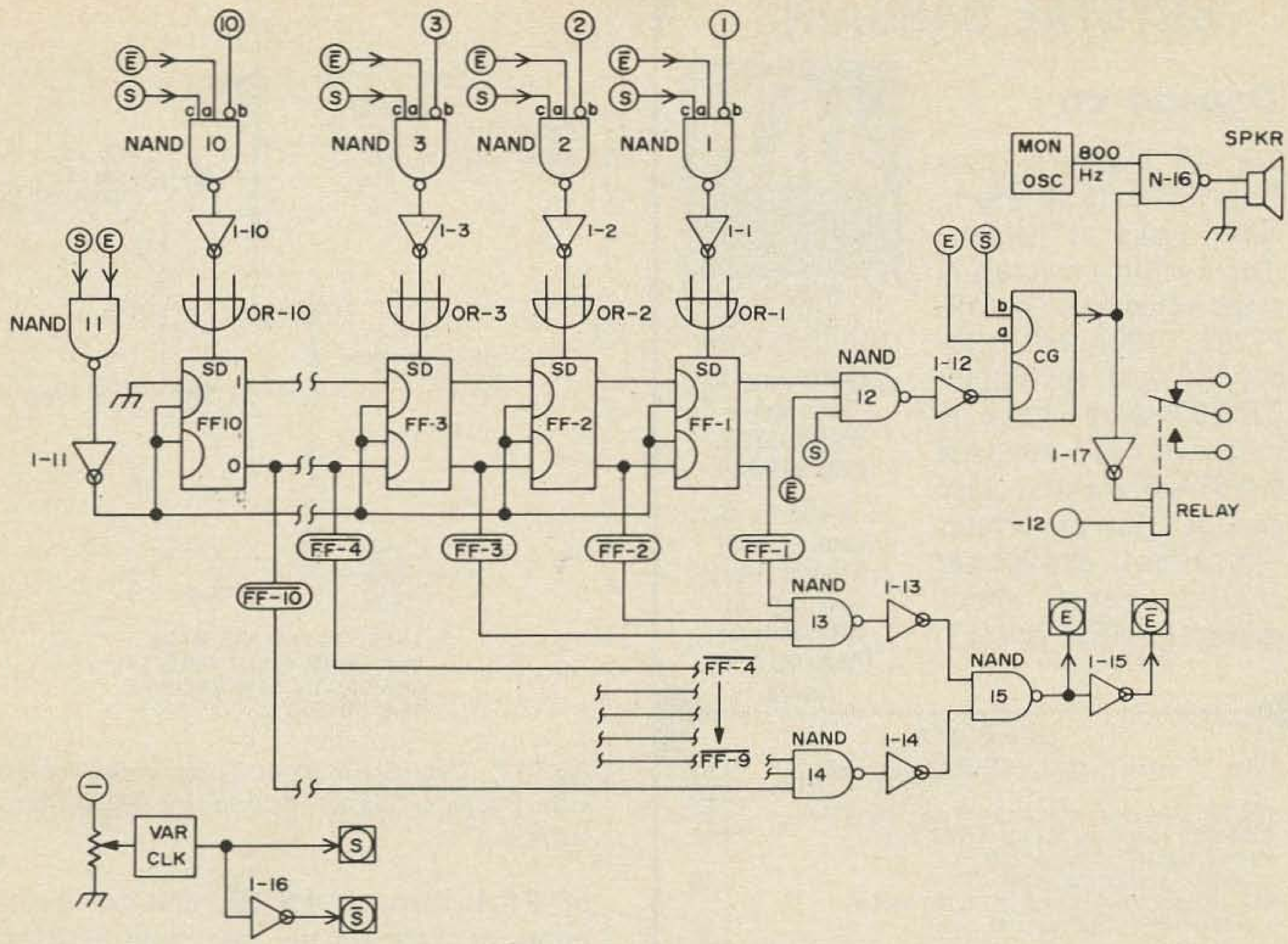


Fig. 12. Nand *logic equivalents for button-box inputs and shift register.*

flip-flops FF-1 and FF-3 to the "1" state. As soon as FF-1 and FF-3 are set, the "1" output of OR-1 causes I-2 to place a "Ø" level on "a" inputs to the *and* gates A-1 through A-10, thus inhibiting further input from the keyboard until we have completed transmitting the letter "A" that we just placed into storage.

We now have a 1 stored in FF-1 and FF-3, input "b" of A-11 and input "b" of A-13 enabled by the 1 output of OR-1. The first clock phase "A" leading edge allowed the register to be set, but did not get through A-13, since the "b" input was not enabled at the time clock phase "A" arrived, so no shift occurs. Clock phase "B" leading edge now arrives at I-1, is inverted and is applied to "a" of A-11 which is already enabled by the "b" input. The output of A-11 triggers FF-CG to the set state, keying the output I-3 and the monitor A-14, allowing the monitor oscillator to be amplified by I-4. The inverter amplifier I-3 is shown as a relay driver, but could as easily be the transistor keying unit of a transmitter.

Meanwhile, back in the keyer logic, we now have FF-CG set, a 1 stored in FF-1 and FF-3, OR-1 is still enabling A-11 and A-13 on the "b" inputs, A-1 through A-10 are inhibited by the action of I-2, and all is in the proper condition for the arrival of the next clock phase "A".

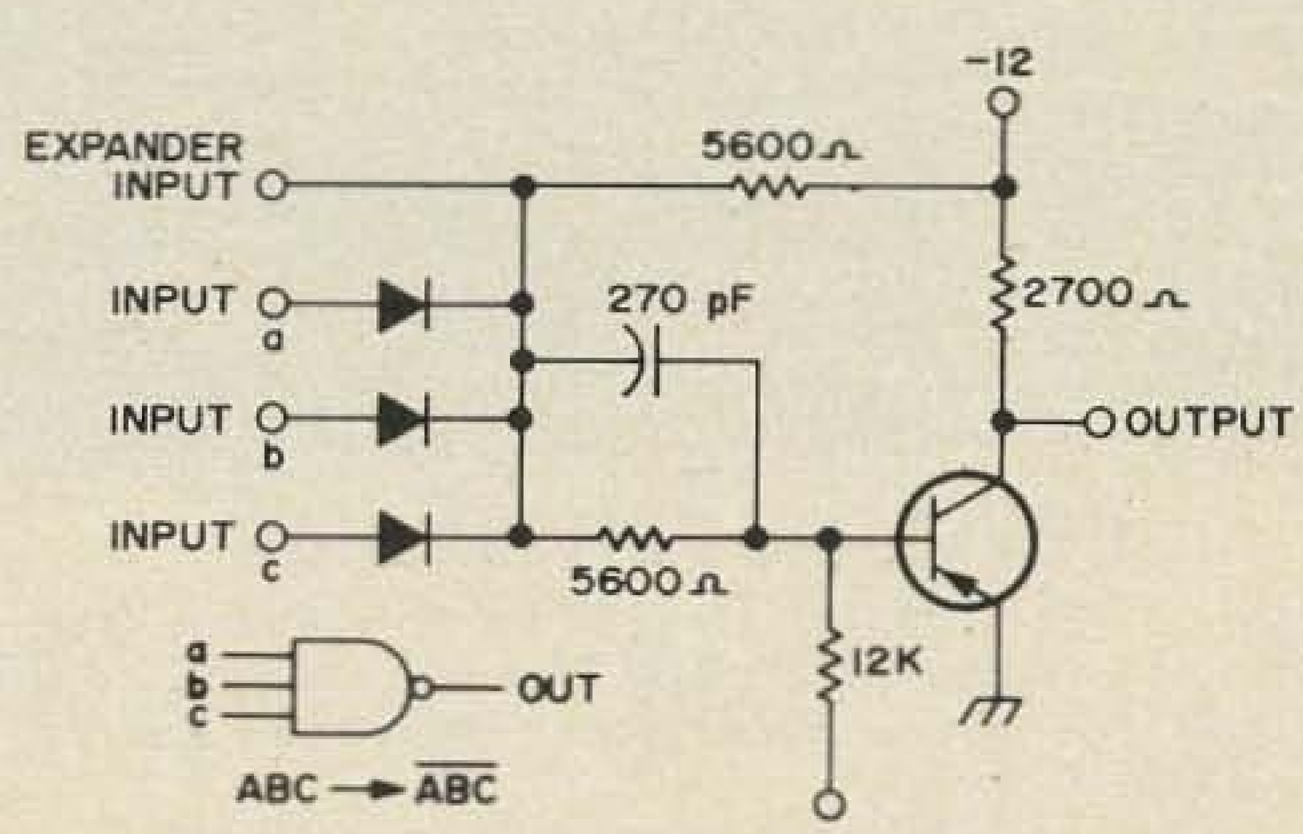


Fig. 13. Typical nand *gate.*

When clock phase "A" goes to the "1" state, here is what happens: A-11 is inhibited by I-1 and goes to Ø thus closing the set side of FF-CG. The leading edge of clock phase "A" also affects A-13, input "a", and is passed through to the trigger inputs

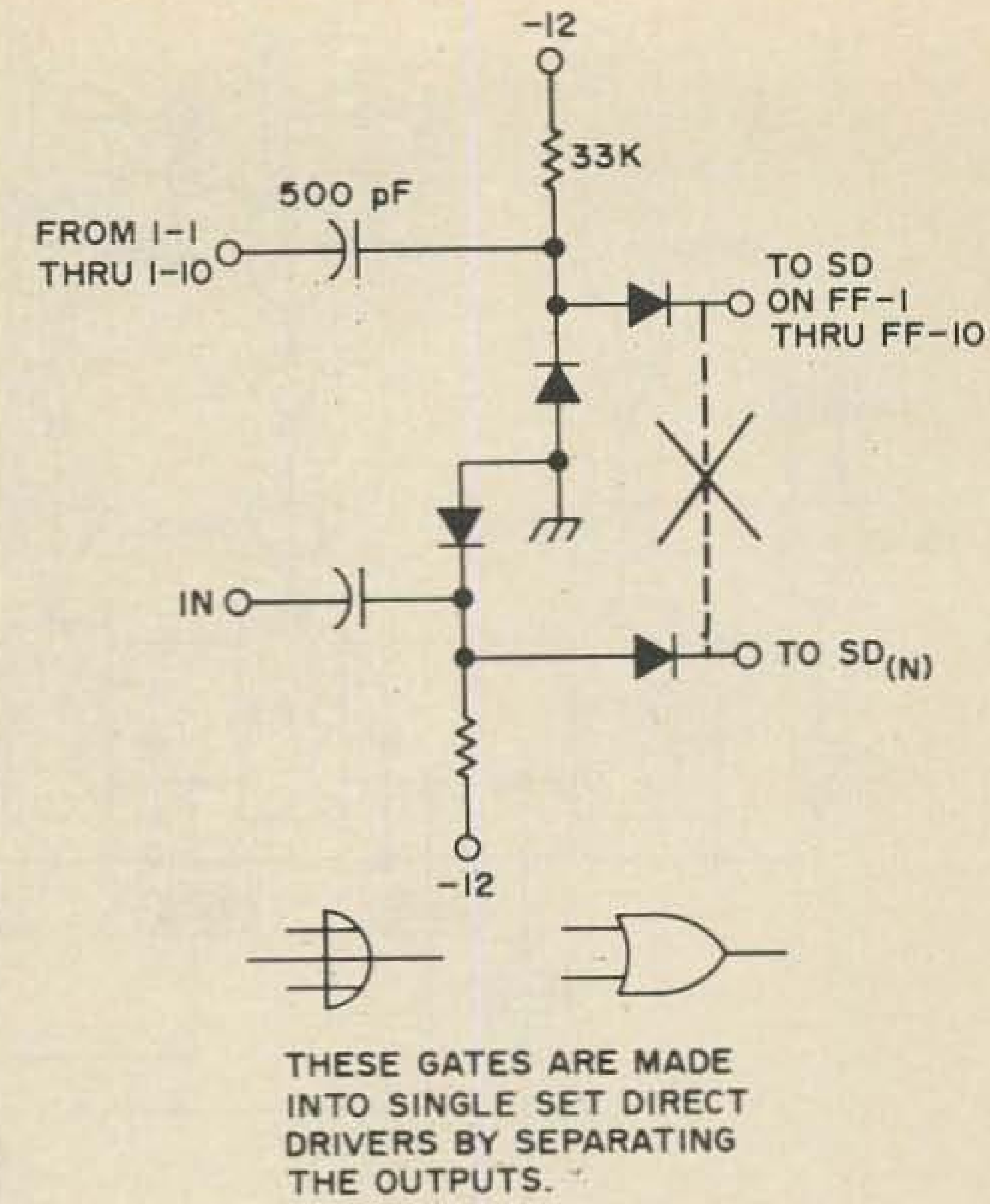


Fig. 14. Typical OR *gate. These gates are made into single set-direct drivers by separating the outputs.*

of FF-1 through FF-10, and to the "a" input of A-12 on the reset side of FF-CG. Input "b" of A-12 is enabled by the "1" standing on the output of FF-1, and the output of A-12 causes FF-CG to reset, or go to a "Ø" state at the output, completing the first dot, and releasing both the monitor and keying unit.

At the same time that FF-CG is reset, all information stored in FF-1 through FF-10 is shifted toward FF-CG one position. FF-1 is now in the "Ø" state, FF-2 assumes the "1" state from FF-3, and FF-3 through FF-10 are now in the "Ø" state. Notice that the reset gate of FF-10 is enabled. This is

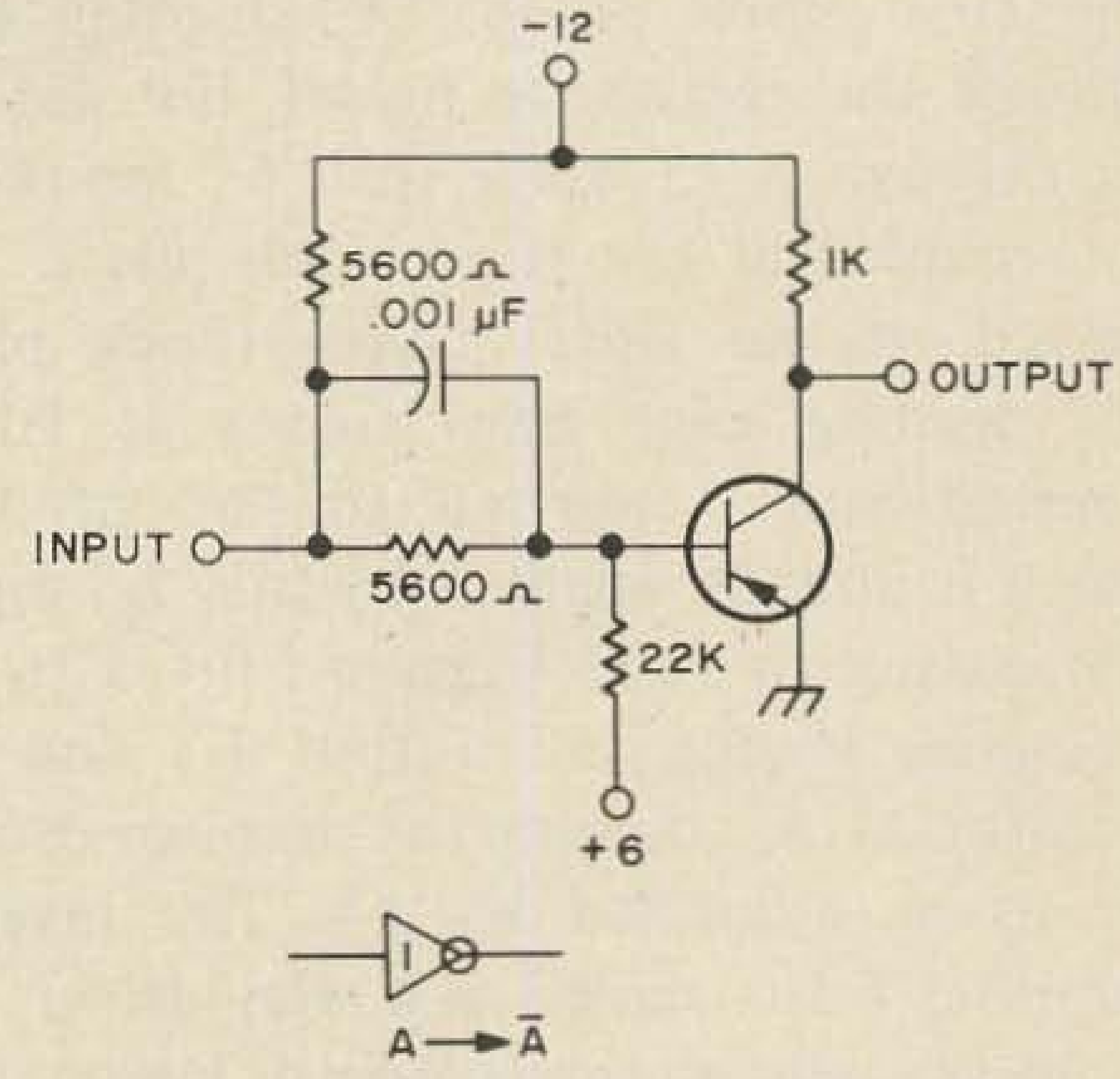


Fig. 15. Typical inverter.

to assure that the shift register will fill up with "Ø" as the shift sequence occurs, and will tell us when a character is complete.

Output levels will now be in the following states: A-1 through A-10 at Ø; A-11 at Ø; A-12 and A-13 at 1; FF-1 at Ø; FF-2 at 1; FF-3 through FF-10 at Ø; FF-CG at Ø; A-14 at Ø; and I-3 open (unkeyed). These conditions remain until the arrival of clock phase "B".

Clock phase "B" follows the same sequence as before; that is, it inhibits A-13, enables A-11 and sets FF-CG to a 1. Generation of the dash has now started, and nothing else occurs until arrival of the next clock phase "A". Let's see how the dash is made the proper length.

When clock phase "A" arrives, I-1 inhibits A-11. At the same time, A-13 is enabled and triggers FF-1 through FF-10, and tries to reset FF-CG through gate A-12. But now FF-1 is in the Ø state and is inhibiting the "b" input of A-12, so that

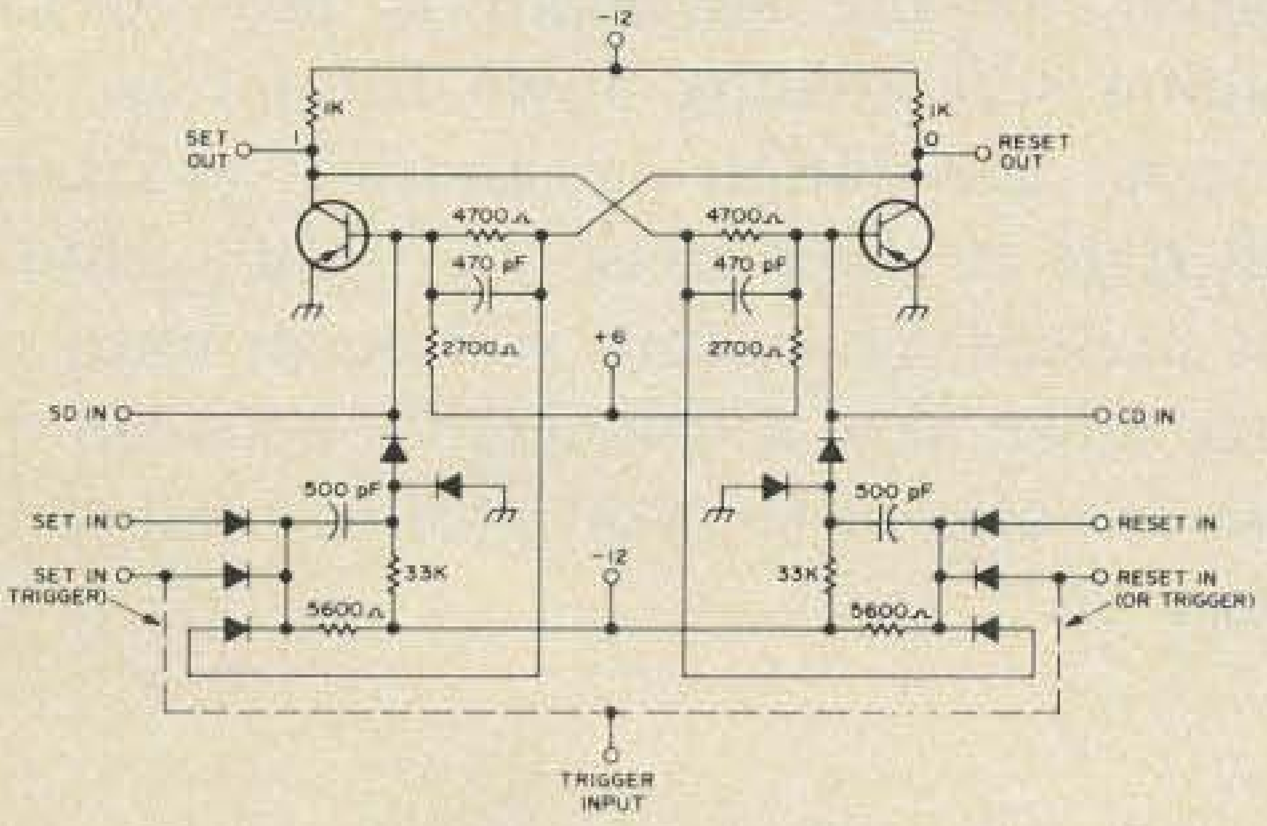


Fig. 16. Typical flip-flop.

the clock phase "A" does not reset the FF-CG. The output remains keyed and we have generated the first one-third of the dash, and at the arrival of the next clock phase "B" will have generated the second one-third of the dash. All that clock phase "B" can do upon arrival is enable A-11 and inhibit A-13. Nothing else will be affected because FF-CG is already in the 1 state, and removal of the 1 level from the trigger inputs to FF-1 through FF-10 causes no action. The output is still keyed, and two-thirds of a dash has been generated, and nothing will change until the arrival of the next clock phase "A".

When clock phase "A" arrives, I-1 will inhibit A-11, A-13 will be enabled, placing a 1 on the "a" input to A-12. A-13 will trigger FF-1 through FF-10, and the 1 that

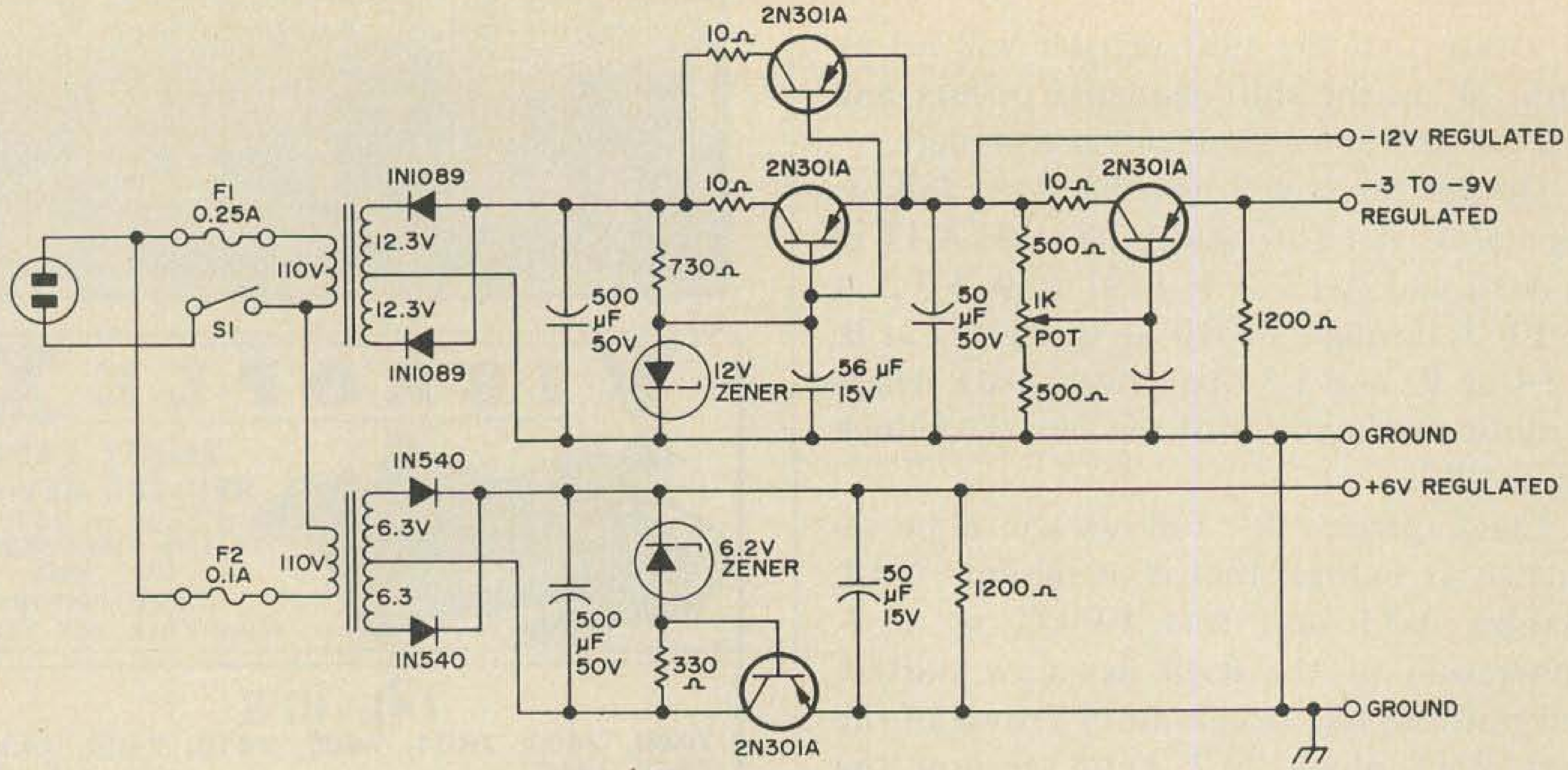


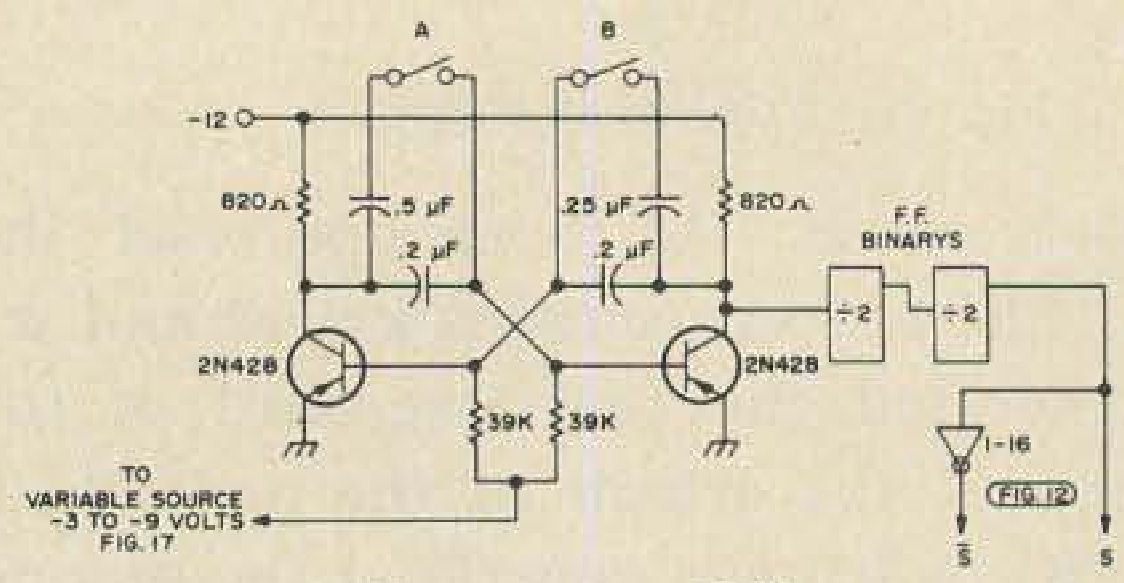
Fig. 17. Regulated power supply.

was stored in FF-1 will be seen at the "b" input of A-12, causing a 1 on the output to reset FF-CG. When FF-CG resets, the monitor gate A-14 is inhibited and I-3, the drive for the relay is removed, thus opening the keyed output. One dash, three times the length of one dot, has now been generated, but we are not yet complete, even though we have ended the transmission of the dash. What happens now?

If you will think back to the start of this sequence, we allowed the shift register to accept an input at clock phase "A", but did not actually begin transmitting until we set FF-CG at clock phase "B". This delay is part of the space required between characters. The length of a space is the same as a dash, and we have already generated one-third of the space at the beginning of each character, so let's complete the sequence and see how we generate the other two-thirds of the required spacing.

Now, look closely at the logic diagram and examine the conditions awaiting the arrival of clock phase "B". Gate A-11 is inhibited because OR-1 is now at the ∅ level, since all the 1 levels stored in the register have been used and shifted out. OR-1 does not allow clock phase "B" to set FF-CG. The only tricky part of this arrangement is the loop propagation time through A-13, FF-1, OR-1, and with the clock speeds used here (4–100 pps) any propagation delay up to approximately 100 μsec is all right.

Since the arrival of clock phase "B" had no effect on the output (still unkeyed), the next clock phase "A" may or may not start the generation of another character, depending upon the input encoder. If any button on the keyboard is pressed (including still holding down the letter "A" button) generation of another character will start at clock phase "A". If a button is not pressed, no output will occur until we once more have a coincidence between the encoder output (button pushed) and clock phase "A".



SWITCH		versus SPEED	
A closed	B closed	1 slowest	≈ 5–12 WPM
A closed	B open	2 slow	≈ 10–22 WPM
A open	B closed	3 fast	≈ 20–33 WPM
A open	B open	4 fastest	≈ 30–45 WPM

FOR HIGHER SPEEDS REDUCE CAP. VALUES

Fig. 18. Variable clock.

In summary, the following is the sequence of events in generating a character: A button is pushed, encoding a character; phase "A" transfers the character into the shift register (memory) and generates one-third of a letter space; phase "B" sets the code generator; phase "A" resets the code generator, dependent upon the state of FF-1, and shifts the stored word one place

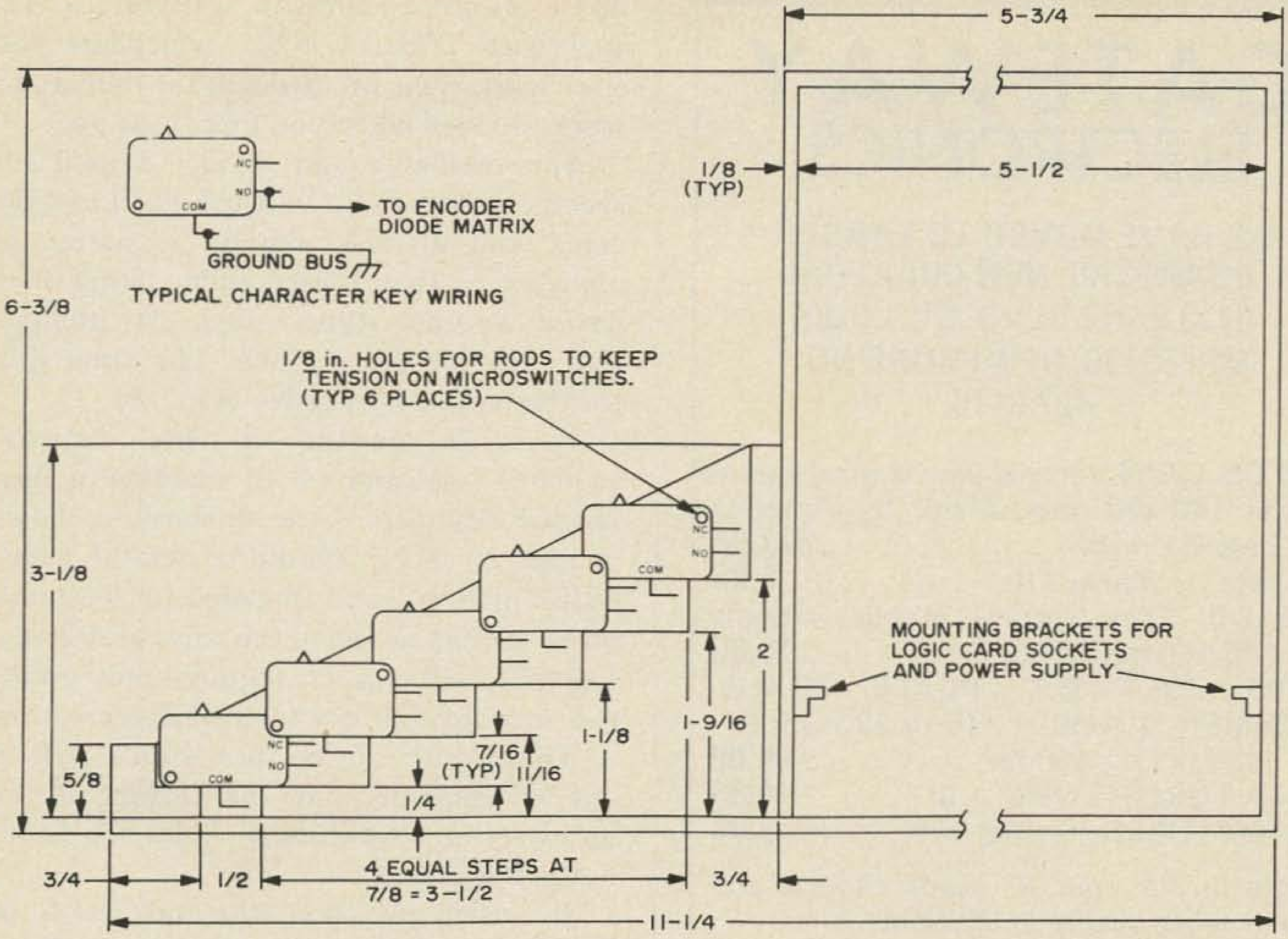


Fig. 20. Side view of button box, with dimensions.

(bit); upon emptying the register, OR-1 and phase "B" generate two-thirds of a letter space.

While the description does get rather involved, it is far simpler to make the button box work than to describe what goes on inside.

Gate Reduction

With possibly some decrease in reliability, gate OR-1 could be reduced to a two-input gate. I don't recommend doing it, but in case someone wants to reduce the number of gate inputs, here is the reasoning for doing so.

Since either FF-1 or FF-2 are set during the generation of any character, it is only necessary to examine the state of these two flip-flops to determine either that the shift register is clear or that a character is being transmitted. As long as either FF-1 or FF-2 is set to a 1 state, the keyboard input gates are inhibited, and the shift gates are enabled. When both FF-1 and FF-2 are in the Ø state, further clock pulses are inhibited from setting the code generator or shifting the register, but the keyboard transfer gates are enabled for input of another character from the keyboard.

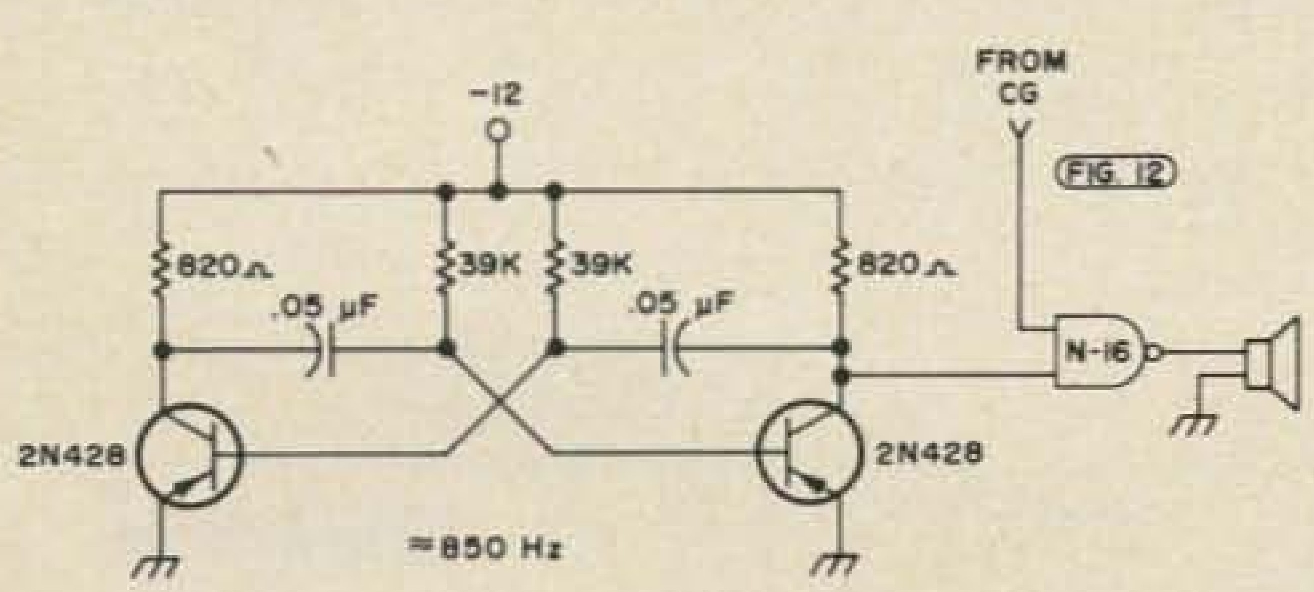


Fig. 19. Monitor oscillator.

Further Notes

Logic cards available at surplus outlets, as well as most of the integrated circuits being sold at bargain prices seem to contain *nand* gates as the standard. Figure 12 shows the implementation of the button box using *nand* logic.

Schematics of typical circuits (i.e., the ones I used) are shown in Figs. 13–19. Let me repeat – there is nothing sacred about these, so if you have some different circuits, and the logic levels are compatible, don't hesitate to substitute. If you use ICs, stay with DTL or RTL, whichever you start with, right on through, for they don't work too well when you mix them up.

The oscillator and divider I used for speed control is a bit unusual, but I had the cards and it was simply a matter of expediency that I used them rather than devise another type – such as unijunction – to use for a clock. The same goes for the monitor oscillator (Fig. 19).

If you decide to use "micro" switches – as opposed to building or buying the keyboard – the dimensions shown in Figs. 20 and 21 should be helpful. I used eighth-inch drill rod threaded for 6-32 nuts on both ends to fasten the rows of switches together, with spacers required only on the top and bottom rods for switch separation.

The dowels can be turned on a lathe if one is available, but the turning is not necessary if large enough holes are drilled in the top plate.

By using plywood, the only tools required are generally available to anyone. A handsaw, a rasp, a screwdriver, a drill, a few tears shed after finding a board still too short after already sawing it off twice, and some glue are all you need to fasten the button box together. Your own ingenuity will tell you how to make plug-in sockets for your cards.

Be sure you leave some extra space for additional cards and switches, because you will probably want to make another encoder board for Teletype transmission, controls for the station, a timer, or some other goody. One thing I do not recommend adding – and that is an additional memory. I find that staying right with – or

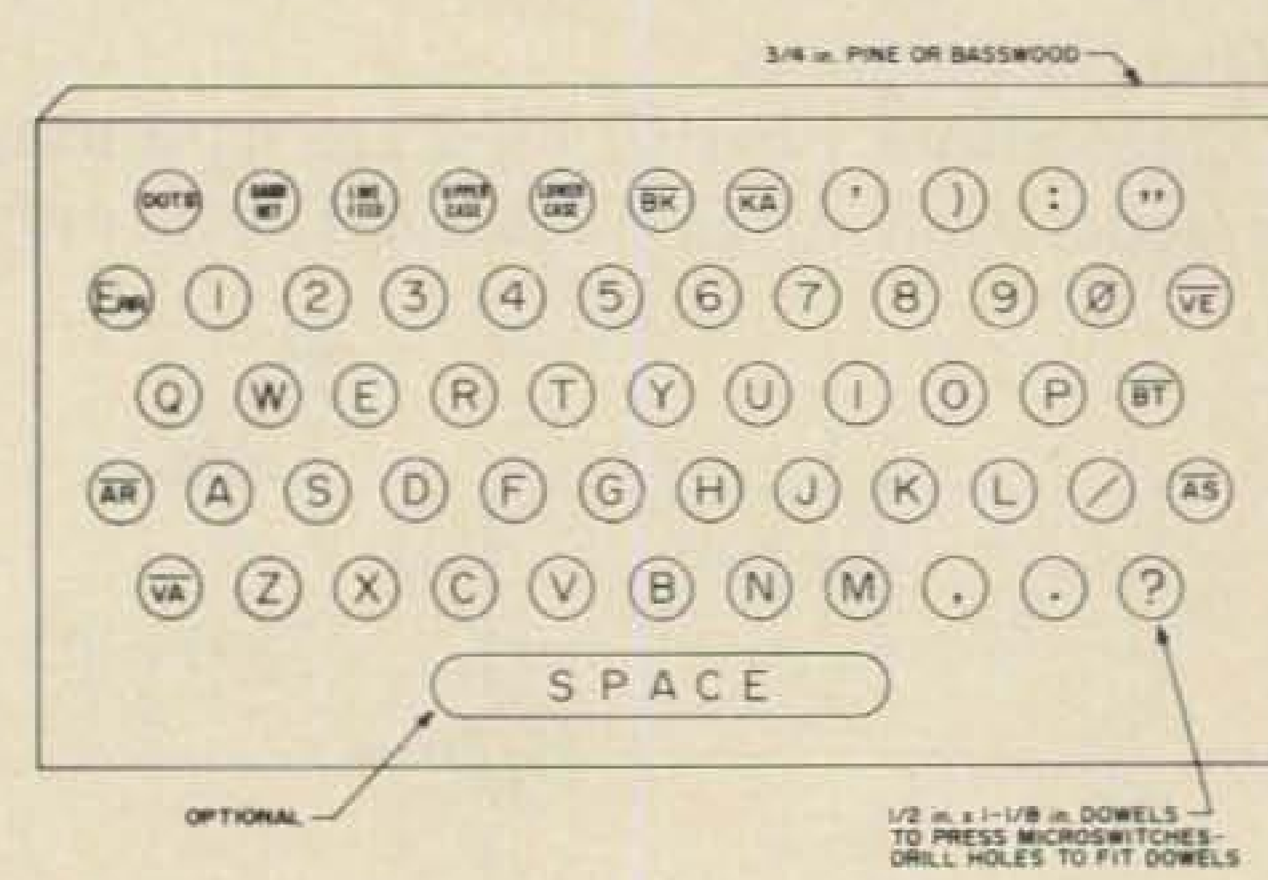


Fig. 21. Keyboard layout.

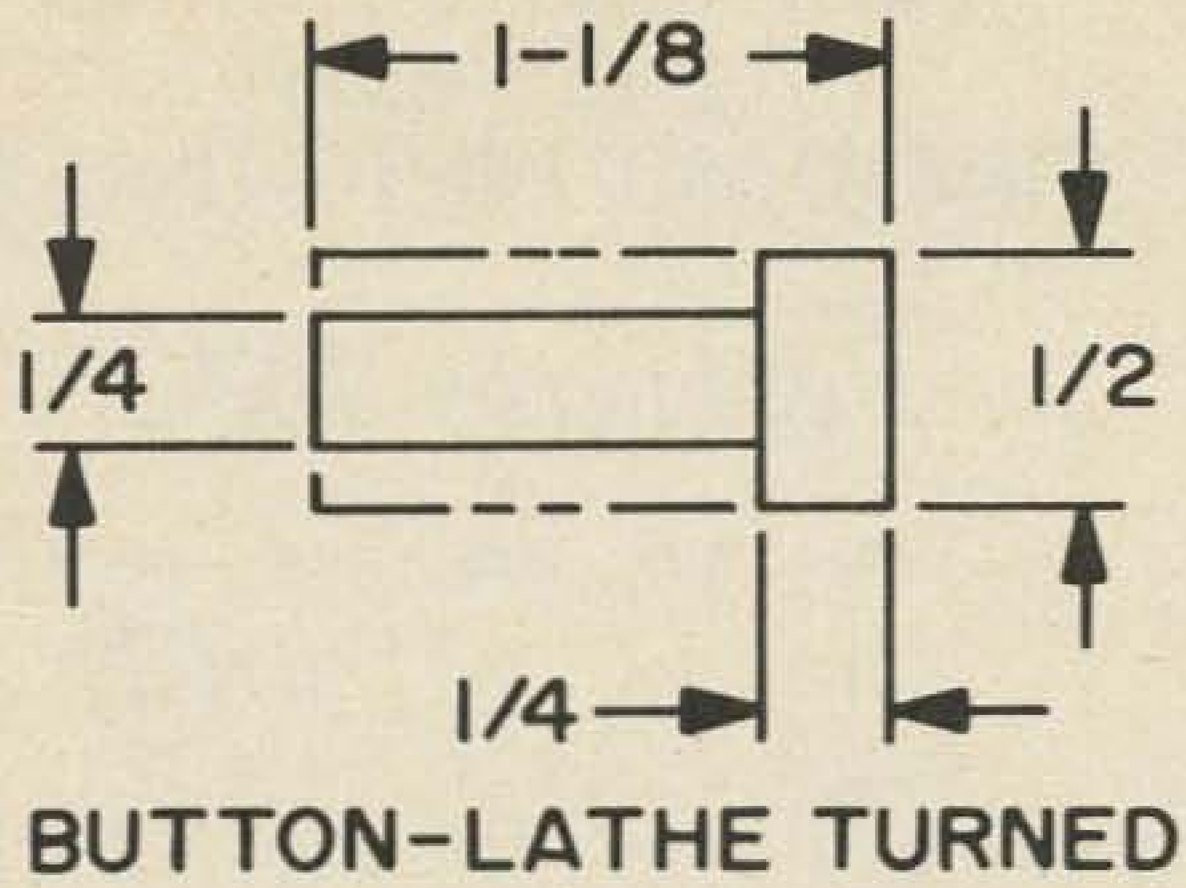


Fig. 21a. Detailed view of button.

half a letter ahead of the letter being transmitted is not difficult, but trying to type something, and listen two or so letters behind the letter you are typing is directly opposite the method used to copy code. To say the least, it is very disconcerting. But additional memory can be added without much problem.

Build one of these button boxes, practice a few minutes to get the hang of it, and hit the airways prepared to enjoy a brand of CW that is more enjoyable than any you have encountered before. Oh yes, you should buy a bigger hat before you start using it on the air, because you are sure to get a swelled head for all the compliments on your fine fist.

. . .W5VFZ■

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PHILIPPINES	21	21	14	7B	7B	7B	7	7	7	7	7B	14
PUERTO RICO	14A	14	7	7	7	7	7	13	21	21	21	21
SOUTH AFRICA	14	7	7	7	7B	7B	7B	7B	14A	21	21	14A
U. S. S. R.	7B	7	3A	3A	3A	7B	7B	7B	7A	7B	7B	7B
EAST COAST	14A	14	7	7	7	7	7	14	21	21	21	21

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

IN CASE YOU'VE FORGOTTEN. . .

There still is a 2 Meter AM Band . . . and the only way to go 2 Meter AM is with the improved CLEGG 22er MKIII

- Improved VFO Design
- Improved Receiver Sensitivity
- Improved Transmitter Design
- Improved Mobile P/S Reliability
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