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WORLD RADIO

3415 West Broadway
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73 MAGAZINE

#115 April, 1970

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The Cover

The cover this month shows what may well be one of the nation's highest repeater sites. Atop 10,700 ft Sandia Crest in New Mexico, the Sandia Crest repeater, WA5JDZ, provides coverage from Santa Fe to Socorro and interlinks with two other repeaters, WA5DMQ and WA5KUI.

Amateur Radio News Page

April XIXLXX | Monthly Ham News of the World | 73 Magazine

FCC ASKS FOR LICENSE FEE INCREASE

An increase in fees for licenses, applications and other services, totaling $20 million has been proposed by the Federal Communications Commission. In a notice of proposed rulemaking (Docket 18802) the Commission asked for comments on a fee schedule that would raise approximately $24.5 million dollars – the amount of the Commission's 1971 budget request. (Under present schedules, fees bring in about $4.5 million.)

In making its proposals, the Commission said that the Bureau of the Budget had urged higher fees schedules and pointed out, in addition, that the House Appropriations Subcommittee had stated that fees should be adjusted to assure that FCC activities would be "more nearly self-sustaining." The Committee had asked for a report on action in this respect by the time of 1971 budget hearings.

Fee increases are proposed for the amateur service, for broadcasting, common carrier, and other safety and special radio services. CATV and equipment testing and approval areas which presently are not subject to fees, are included in the proposed schedule.

Fees in the broadcast services would be substantially higher and would be based on market location, type of application filing service, hours of operation,

Foreign experience counts as Extra Class credit

Requirements for holding amateur Extra license have been broadened to recognize the operating experience required under a foreign amateur license, in an amendment to the rules adopted by the Commission, effective March 23, 1970.

The Commission action, amending Sections 97.51(a) and 97.9(a)(1) of the rules, makes an amateur Extra class licensee who was first licensed at least 25 years earlier by a foreign government, eligible for a two-letter call sign (a call sign having two letters following the numeral, such as W1AA), and gives an Extra applicant credit for foreign operating experience toward the two-year waiting period for the license.

Present rules provide for issuance of a two-letter call sign to an Extra licensee first licensed by the Commission at least 25 years prior to the date of his application, but do not recognize a license issued by a foreign government for the same period of time. Existing rules require that an applicant for the Extra license must have held a Commission-issued amateur license of other than Novice or Technician for at least two years, and do not now give credit for prior holding of a license issued by a foreign government. The Commission stated that the purpose of the present two-year rule is to help assure that Extra applicants have acquired practical operating experience for a reasonable time at a Conditional class level or above, but that one effect of the rule has been to deny recognition of operating experience acquired under amateur licenses from other countries.

Three parties submitted opposing comments stating that there are not enough two-letter call signs available to satisfy all the amateurs who may request them, and that the examination standards of foreign countries are lower than those of the United States. The Commission rejected both contentions, finding the number of two-letter call signs available more than adequate, and determining that the amateur standards of foreign governments are not relevant, since the licensee in each case must pass a Commission-administered amateur examination.

SAROC DRAWS RECORD CROWD

by K6MVH

Several thousand amateurs surprised Las Vegas townspeople (who have learned to accept the unusual) by showing up *en masse* for the annual SAROC funfest and third annual FM convention. The turnout this year exceeded that of all previous meetings in spite of the fact that it was held in a new hotel (the Stardust instead of the conventional Sahara), and a record number of rooms were occupied by convention attendees.

Highlighting the convention were daily "cocktail parties" sponsored by Ham Radio, Galaxy, and Swan. It was fun to relax and watch all the old conservatives let their hair down and sing along with Leo Meyerson, who kept the liquid and the music flowing.

The FM portion of the convention was a bit of a letdown in that fewer repeater people attended than in previous years. The fun was marred even further by a couple of hard cases who got out of hand and gave the hotel management a hard time by playing radio with their handie-talkies a little too near the hard-and-fast action of the casinos.

The one element that tended to make the whole affair worthwhile was the "hospitality" suites, one for the FM'ers and authorized power. In addition to increases in current fees, new fees are proposed for grants of construction permits, assignments and transfers, pay-TV authorizations and various other types of applications. Ham fees would be more than double the present rate, the FCC said.

Because of the high number of licenses in the Safety and Special Radio Service, the Commission said it was impracticable to establish separate filing and license fees. Increases are proposed, however, in single fees. Safety, local government, emergency, and closed-circuit educational TV are among services that are not now required to pay fees and which will continue to be exempt. But ham license fees would be hiked to more than double the present rate, the Commission said.

The Commission first adopted a schedule of application fees in 1963 with the initial fee schedule taking effect on March 14, 1964. The action was upheld in a court test in 1964.

Comments on the rulemaking are due on or before *April 20, 1970*, with reply comments due May 11, 1970.

DX'ERS CONGREGATE IN FRESNO

by A. F. Iverson WA6ZCQ

The big guns from W6-land met in conclave during the weekend of February 1 at the Del Webb Towne House in Fresno, took a good hard look at those they have been in mortal combat with during the preceding year, and decided that they weren't such bad fellows after all. All in all it was a tremendous turnout; 225 people showed up and most took rooms at the hotel. It was a cold, dry and foggy day in Fresno, but with all the activities on the program and especially the "happy hour" just before the dinner drove out all thoughts except having a good time. The talks, the slides, and the fine comradeship expressed between each other – coupled with an exceptionally good dinner – made the whole thing a big success.

Congratulations to the officers of the Northern and Southern California DX clubs, and especially Frank Cuevas W6AOA, who spent many hours putting the program together and securing Bill Rohrer W7ZFY (Heard Island) as the main guest speaker.

As a footnote we would like to see other ham groups have get-togethers such as this to improve their personal relationship and then to read about it in the various publications around the country.

VHF FM/AM HAMS ASSIST IN OKLAHOMA INOCULATION PROGRAM

by WA5JGU

Bob Cunningham, the Oklahoma City Civil Defense Radio Officer, requested amateur assistance for the Rubella inoculation drive Sunday, February 1.

20 to 25 clinics were set up in Oklahoma County. Mobiles, 6 meter AM and 2 meter FM stations were set up at clinics to coordinate activities. The VHF club and the FM repeater group covered the entire county.

WA5HWN and K5SKA were net control on 50.50 MHz. W5GGB, the Explorer Scout Post 5 station, served as net control for FM activity on 146.94, and another for MARS enthusiasts. Thanks to Tom K7TDQ, Squeak K7RBM, and a few other local FM ops, the FM suite was kept open on an almost continuous basis, and it was kept fully stocked with all the condiments one comes to expect from such places.

A considerable amount of praise is due Leonard Normad for the tremendous amount of work he puts out each year to make SAROC a success. And all indications are that he is already hard at work planning the next big shindig, nearly a full year away.

QSL Cards for Belgian Stations

The UBA asks all IARU member societies that QSL cards for Belgium be sent to the only official QSL bureau: UBA, QSL Bureau, Post Box 634, Brussels 1. The UBA has asked the editor of the US Callbook that this address be reinstated immediately in future editions. Its omission follows the action of a small private group of Belgian amateurs. UBA asks that all member societies of the IARU publish in their journals the correct address of the UBA QSL bureau.

From "IARU Region 1 News":

Ham radio in Roumania

In Roumania, amateur radio is apparently under the control of the national countil for physical education and sport, an organization supported by the government. There is a council of some 40 members, mainly from around the Bucharest area but the administration is mainly conducted by an executive bureau of eleven persons. The president is also the minister responsible for pots and telecommunications.

A paid general secretary YO3JP, together with a secretariat, is responsible for a central office. Roumania is split up into 40 administrative countries, and each country has a paid administrator who is the secretary of the radio club in that area.

Three classes of license exist in Roumania. The Novice class permits operation on the 3.5 and 7 MHz bands, with a maximum licensed power of 25 watts, and on the 28 MHz band with a maximum licensed power of 5 watts. Normal class licensees are allowed to use 100 watts on the 3.5–28 MHz bands with all normal modes of emission and 25 watts on 2 meters and other VHF bands.

With the submission of information on the results obtained, it is possible to obtain an Advanced Class license, which permits the use of 400 watts input power. Some 35 operators apparently have these facilities. The address of the Central Radio Club is Box 1395, Bucharest 5, Roumania.

Reciprocal Proliferations:

WA2's short-call try backfires...

DXers have been startled recently by the appearance of some new and strange call letters on the bands. This is going to do nothing but get worse. Reciprocation has hit the Caribbean heavily and it is now possible to obtain an operating permit in virtually every one of the islands if you have along your FCC license and proof of citizenship.

Sam Laine W2BKU arrived in Antigua shortly after the new regulations went into effect and applied for a license. Since he was the first one to get the new type of license they offered him VP2AA1. Sam threw up his hands in horror . . . imagine trying to get an unusual call sign like that through the QRM! Okay, says the Communications Director, if you don't like that we can use your initials. That sounded better and the license was duly issued. When Sam opened it he found that he had VP2AASL. He is not at all sure that this is an improvement over VP2AA1.

The same day Bill Williams WA2GQT applied for a license on Antigua and received VP2AAMW, another mouthful.

The French have decided to permit reciprocation in their "departments." This means that the old rule that we could get a license to operate in France, but not in other French possessions has been changed and now the way is clear for us to hit all those juicy and little used areas such as FL8, FO8, FK8, FP8, FM7, FG7, FS7, and even FY7.

ARRL Handbook

The 1970 edition of the ARRL's "Radio Amateur's Handbook" represents a definite step forward for the League, which has been having trouble in the past keeping the book apace with the rapidly expanding and ever-changing technologies that move and advance the hobby of ham radio. Numerous updated construction projects are included, among which are power supplies from 3V to 3 kV, solid-state receivers and transmitters, plus several new VHF and UHF converters. Two new linears are described in the transmitting chapter, and the UHF/VHF chapters have been blessed with a variety of new projects.

For the first time in the history of the Handbook, a complete chapter has been devoted to VHF FM. Though just a smidgen more than three pages are devoted to this phase of the hobby, the amateur FM activity in the U.S. is surprisingly well covered. Since the material was prepared by a knowledgeable FM'er (W6GDO), I suspect that the two or three technical errors in the FM section were edited in by Doug DeMaw, the league principal responsible for publication of the Handbook. This edition contains 710 pages, including catalog section and index. There are over 1300 illustrations, many of which have been revised, and an inordinately large number of tube-base diagrams. Price is $4.50 in the United States and Possessions, $5.00 in Canada, and $6.00 elsewhere. As always, it is also available in a hard-covered clothbound edition.

Licensee "Hamworthiness" Questioned by FCC

Applications by John A. Abernethy, licensee of Amateur radio station K4OKA, Hickory, North Carolina, for renewal of General class amateur radio license and for an Advanced amateur radio license have been set for hearing by the Commission.

The Commission said there was a

BIRMINGHAMFEST
by W4FKG

The Birminghamfest this year will be on May 3 at the Armory on Oporto Avenue (just off U.S. 78 East - near Eastwood Mall). For entertainment, prizes, contests, net meetings, eyeball QSOs and fun for the entire family, plan to attend. For further information contact the Birmingham Amateur Radio Club - W4CUE Box 603, Birmingham AL 35201.

WABASH COUNTY FEST

Wabash County Amateur Radio Club's second annual Hamfest will be Sunday, May 24, 1970. Rain or Shine. Held at the Wabash County 4-H Fairgrounds. Activities will include door prizes, Bingo for the XYLs, fleamarket, technical session on the Fort Wayne VHF repeater. Tickets $1.00 at the door. For further information write Bob Mitting, 700 Centennial St., Wabash, Indiana 46992.

Long Island club makes plans for FM repeater

A group of FM enthusiasts within the Long Island Mobile Amateur Club organized a meeting of a steering committee which would plan and implement a repeater system designed to enhance L.I. mobile and emergency communication. The meeting was held at the home of Ed Piller W2KPQ on 15 January 1970 to discuss the existing repeater situation and to generate plans for a Long Island Mobile Integrated Communication System (LIMICS).

Harry Dannals W2TUK, ARRL director (Hudson Division) appeared as an observer; also present were Fred Brunjes K2DGI, Section communication manager ARRL NYC-LI section; Jim Fahnestock W2NM, member Suffolk County Radio Club (SCRC); Art Raunch W2DID, treasurer SCRC; Van Field W2OQI, radio officer for Civil Defense and emergency coordinator of Suffolk County and member SCRC; Gerry Harrison W2ZGA, member LIMARC FM committee and SCRC; Ed Pores WA2ZBV, vice president LIMARC and member SCRC; Jules Rivman W2TD, vice president of Hudson Amateur Radio Council and member LIMARC FM committee and SCRC; and Ed Piller W2KPQ, LIMARC director, chairman LIMARC FM committee, and member SCRC.

As 146.34 and 146.76 MHz are being adopted more and more nationally as service area. Contact will be made with other surrounding repeater groups using these frequencies so as to minimize cochannel interference problems. Technical standards are to be as outlined below:

Input frequency:	146.34 MHz
Output frequency:	146.76 MHz
Output power:	10W minimum
Deviation:	15 KHz (narrowband)
Tone coding:	Initially open; may be tone-coded later
Control point:	Minimum of two and as designated
Operating Hours:	Continuous
Site location:	To be designated
Transmission cutout:	After predetermined interval
Logging:	Automatic logging

FOURTH ARIZONA QSO PARTY

The fourth Arizona QSO Party is sponsored by the Saguaro High School Amateur Radio Society. The contest begins at 2100 GMT Saturday, April 25, 1970, and ends at 2100 GMT Sunday, April 26, 1970. All bands and modes may be used. Stations may be worked twice per band, once on CW and once on phone. Arizona stations send contest number, RS(T), and county. All others send number, RS(T), and ARRL section or county. The call will be CQ Arizona or CQ Test de (call) Ariz K. Arizona

News, Reviews, Announcements

. . .Way Down in Columbus, Georgia:

The annual Columbus, Georgia hamfest will be held April 5 at the Fine Arts Building behind the Municipal Auditorium at the fairgrounds. For information, write John Laney K4BAI, 1905 Iris Drive, Columbus, Georgia 31906.

HAM HOSPITALITY

NEW YORK - Dana Polan WA2JLV offers overnight accommodations to Stateside and foreign DXers. Write to: RFD Box 44A, Putnam Valley NY 10579 or call: 914-528-3759. Richard H. Eckhouse, Jr. WA2CVL also offers overnight accommodations: 87 Lincoln Road, Amherst NY 14226.

NEW HAMPSHIRE - Jean Pierre Catala F2BO/W1 welcomes one or two U.S. or DX hams for overnight stays. Accommodations are modest (couch), but languages are no barrier if you speak English, German, or French. Address: H1 Forest Park, Durham NH 03824 or call: 603-868-2847.

ATTENTION HAMS WHO VISIT OR TAKE IN VISITORS:
How are you making out with Ham Hospitality? Tell 73 about your visits with fellow amateurs – what you did, what you saw, whom you met, the language barriers, the fun . . .Write to Hospitality Editor, 73 Magazine, Peterborough NH 03458.

Georgia QSO Party

Starts: 2000 GMT, Sat., May 9, 1970
Ends: 0200 GMT, Mon., May 11, 1970

substantial question as to the applicant's qualifications to hold an amateur operator and station license due to the nature of communications he has allegedly transmitted over his station in the past.

The issues to be determined at the hearing include: the facts concerning communications transmitted over K4OKA by Abernethy on or about November 13, 1965; January 11, April 27, October 30, November 4, 1967; January 14, 1968; October 28 and 29 and December 14 and 26, 1969; and January 1, 1970; whether the communications transmitted on those dates were consistent with the basis and purpose of the amateur radio service as outlined in section 97.1 of the rules; whether the communications were contrary to the terms and conditions specified on the applicant's license and otherwise contrary to the public interest, convenience, and necessity; whether Abernethy transmitted unidentified signals and willfully or maliciously interfered with radio communications, in violation of section 97.123 and 97.125 of the rules; and whether Abernethy possesses the requisite qualifications to be a licensee of the Commission.

From "The RaRa Rag":

Two Meter FM Group Organized

The Rochester repeater group has received the club call WA2UWQ, which will be used for a repeater. Charlie Mills K2LDU is trustee. Initially, it is planned to install a repeater at Charlie's home; later, that repeater may be installed at a remote site.

John Plumeri W2KZD is heading up a group that is hard at work installing a repeater at a Pinnacle Hill site. When both repeaters go into operation, it will put Rochester into the FM "major leagues" with two repeaters.

The repeater at Charlie's home will be set to operate on 146.28 MHz in and 146.88 MHz out. The unit on Pinnacle Hill will operate on 146.34 MHz in and 146.94 MHz out. When both are in operation, it will give Rochester local and national repeater coverage.

open input and output repeater frequencies, it was decided that it would be desirable to occupy these frequencies for repeater coverage of Long Island. W2OQI indicated that he could also use the 146.76 MHz output frequency in conjunction with his repeater at Manorville, N.Y. in the future.

Tone Coding vs Open Repeaters

Discussion of tone coding resulted in a decision to use open repeaters so that visitors from out of town could operate them. On the other hand, as chaotic conditions could arise with open repeaters in a high-population area, some simple type tone coding or whistle-on technique may be desired. This is still an open question and final resolution was shelved pending further study.

Repeater Standards

A narrowband system will be employed and the effective radiated power will be as low as possible consistent with adequate service within the designated

Somerville To Issue Special Award

by K1YUB

The Somerville Mass. Amateur Radio Club (WA1MHN) will be operating from the summit of Mt. Washington, the highest point in the northeast, on the weekend of May 23–24, 1970. Operation will be on both days from 1800–2000 GMT on the following schedule:

Band	Mode	Freq.
15	SSB	21.375
10	SSB	28.650
6	AM	50.274
2	AM	145.470
UHF	FM	449.050

Any station establishing two-way contact with WA1MHN on two different bands will be eligible for a special certificate upon receipt of a request for it and 25¢ to cover printing and mailing. Address inquiries to Civil Defense Department, Somerville MA 02145.

stations score 2 points per QSO multiplied by the number of ARRL sections worked. All others score 5 points per QSO multiplied by the number of Arizona counties worked (maximum of 14). Suggested frequencies: (CW) 3575 7075 14075 21075 28075, (phone) 3950 7275 14285 21375 28600, (novice) 3735 7175 2110. Certificates will be awarded to the top scorer in each section. When 4 or more logs are received from one section, a second place certificate will be awarded. Logs must show date and time in GMT, stations worked, bands, modes, and information exchanged. Please enclose an s.a.s.e. with your logs if you wish to receive a copy of the results. Send logs to Bob Wright, WA7ISP, 4725 N. 70th Street, Scottsdale AZ 85251 before May 25, 1970. All stations must submit a statement that all regulations have been followed and that decisions of the contest committee will be accepted as final.

Alaska okays Amateur call plates

For a mobile amateur radio station for which special registration plates are issued, the applicant, in any recognition of his service to the public, shall not pay any additional charge for special registration plates, provided he annually files his registration before November 1; in addition to the requirements of sec. 50 (a) (5) of this chapter, the station must be satisfactorily proved capable of being utilized 24 hours a day, must have a transceiver capable of operating on 75 through 10 meters, must have an antenna, and must have a power supply and wiring as a permanent part of the vehicle; the transmitting unit may be removed from the car for service or dry storage; the annual license tax is $1 for (other authorized) mobile amateur radio station vehicles, provided the annual registration is filed before November 1.

The ninth annual Georgia QSO Party is sponsored by the Columbus Amateur Radio Club, Inc. (W4CVY).

There are no time or power restrictions and contacts may be made once on phone and once on CW on each band with each station.

Exchange: QSO number, RS/RST report and QTH: County for Georgia stations; State, Province, or Country for others. (Georgia to Georgia contacts permitted.)

Scoring: Each complete contact counts 2 points. Georgia stations multiply their total QSO points by number of different states and Canadian provinces worked. DX stations may be worked for QSO points, but do not count as multipliers. Out-of-state stations will use the number of Georgia counties for their multiplier (a possible total of 159).

Awards: Certificates to the highest scoring station in each state, province, country, and Georgia county. Second and third place awards will be made in sections where additional recognition is deemed to be warranted. A plaque will be presented to the Georgia station submitting the highest overall score. Plaques will also be awarded to the highest scoring out-of-state entry, to the Georgia club with the highest aggregate score, and the highest scoring portable or mobile entry from a station operating outside his home county.

Suggested frequencies: CW: 1810, 3590, 7060, 14060, 21060, 28060. SSB: 3975, 7260, 14290, 21410, 28600. Novices: 3725, 7175, 2110.

Your log should show: date and time of contact in GMT, station worked, exchange sent and received, band used, type emission, and multipliers claimed.

Include a signed declaration that all contest rules and operating regulations have been observed and mail your entry to Columbus Amateur Radio Club, Inc., Attention of John T. Laney III K4BAI, 1905 Iris Drive, Columbus GA 31906. A large self-addressed stamped envelope will be appreciated.

Entry should be postmarked no later than June 8, 1970.

HAM FEE HIKES PLANNED BY FCC

by Ken Sessions K6MVH

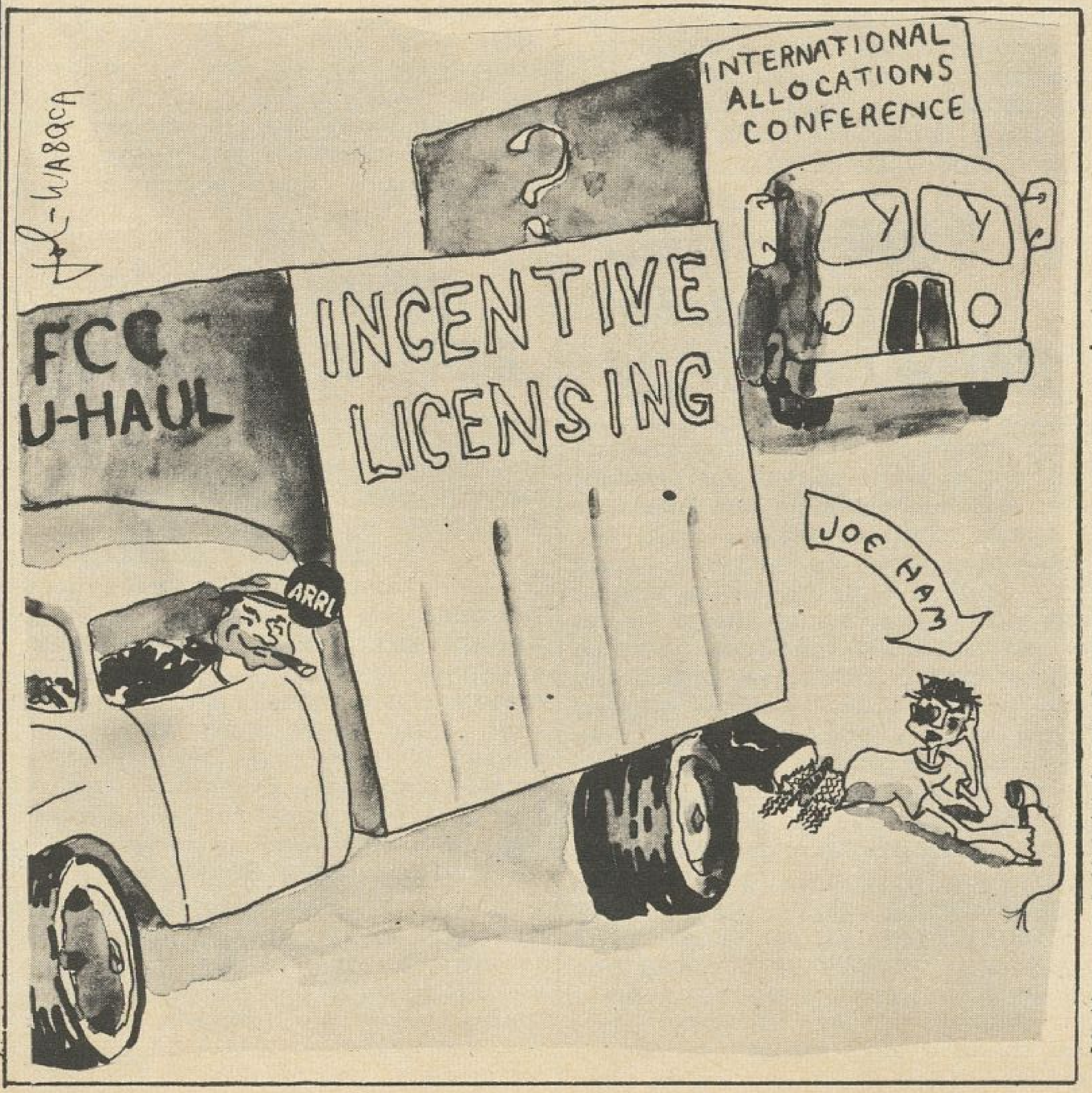
The FCC is holding up a glistening shaft on which it hopes to impale virtually all of the radio services. In response to a suggestion from top government officials, the Commission seeks now to increase the fees of license applicants as an attempt to balance a projected 1971 budget. Hardest hit by the move will be the broadcasters, whose lobby will doubtless resist the action with all the force it can muster. But the amateur service, with no protecting arm in Washington, will be at the mercy of the federal fund-raisers.

If the FCC has its way – which is usually the case – each amateur who wants to renew his station license will have to pay a fee of $9 – more than twice the amount now imposed. Clubs and individuals who want to apply for a special callsign will be required to pay $25 (rather than the $20 fee now levied).

The Commission's quiet announcement about the proposal (Docket 18802) said that comments were invited with regard to the planned rulemaking actions; but the kicker was that such comments were required on or before April 20 – which left nowhere near the amount of time needed to spread the word to amateurs who might want to protest the docket.

Wayne Green, publisher of 73, submitted a formal petition to the FCC requesting that the deadline for comments be extended for an additional 60 days. This request, he said, would give the major amateur journals enough time to publish pertinent facts and gather comments from interested amateurs. Green submitted his counter-petition on the same day the FCC served notification of the proposed rulemaking. No word has come from the FCC yet as to whether or not Green's postponement request was accepted.

Amateurs everywhere should make their individual voices known to the Commission. An amateur lobby would tackle this problem for us, but we are not blessed with Washington representation. It thus becomes necessary for *individuals* to protest the actions proposed on Docket 18802. Write today to the FCC, Washington, D.C. 20554. Don't plan on getting the extension. Make sure your comments are in the hands of the FCC well before the April 20 deadline. And get the word to members of your club just as fast as you can. This is an important issue, and we'll have no time to spare.



Editorials

Teletype Relay Outputs on FM Repeater Freq.

The Los Angeles area is being "served" by the WA6ITC radio repeater Teletype station. The repeater operates with an input frequency of 146.58 MHz and regenerates Teletype tones on the Los Angeles FM repeater frequency of 146.70 MHz.

According to Martin Geisler, licensee of the RTTY repeater, the transmitting and receiving equipment is situated atop the Santa Monica Mountains at an altitude of 2400 ft. As most of the local FM repeater users will sadly attest, the RTTY repeater has excellent coverage over the Los Angeles basin. Geisler says good signal reports have been received from as far south as San Diego and he has high hopes for extending the range north into Santa Barbara.

As many as 15 stations have used the RTTY repeater as a fully automatic message system. Geisler says he wants to encourage more users. Though not popular with the 100-odd people who use the W6FNO FM repeater, which shares the same output frequency, Geisler expects his system "will become popular with message handlers accepting trunk traffic from the low bands" who will find it useful for trunking the traffic locally. Since the RTTY equipment is crystal controlled, automatic operation is effected without the presence of an operator at the receiving end.

Conflict

The real story of the WA6TIC RTTY repeater is a great deal more complex and detailed than might at first seem. The output frequency was established on 146.70, which was already in use by the

With respect to the additional assessment for license fees, 73 feels that the contributions of amateur radio to society more than offset the cost of license processing. The electronics technologists in this country, for example, in large part are taken from the ranks of amateurs or former amateurs. And the communications capability of amateurs, so exploited during the war when operators were drafted *en masse,* has always added significantly to the "peace of mind" of the government. This is reinforced by the continously improving organization of amateur groups who provide an instant-readiness to serve local governments at the first hint of a need.

It seems incongruous that the amateur radio service should fall prey to the FCC's revenue drive – particularly in view of the fact that amateur radio falls within the official category of "Public Safety and Special Services," set up for the benefit and convenience of the nation.

What has ham radio meant to the United States? Well, try these for openers:

1. Every ham is a goodwill ambassador to the otherwise unreachable citizenry of foreign countries.
2. Amateur radio provides the ideal medium for getting young people interested in pursuing the vital field of electronics and related technologies.
3. Amateur operators provide the only fully organized mobile communications force that is *always* ready to be used in any disaster or emergency situation.

The points mentioned above are so important to this nation that 73 feels a strong case could be made for requiring the government to actually subsidize ham radio – furnishing the gear and paying the operators. Not that we expect that or want it. But it is difficult to see how the FCC can justify added fee assessment when, by the FCC's own admission, the real worth of the hobby is its value to the country.

ITU CONFERENCE: Who lobbies for ham radio?

by Wayne Green W2NSD/1

If the amateur shortwave allocations are to survive the next ITU frequency allocation conference in a recognizable form we need to have some basic changes made in the instructions given to the delegates – U.S. and foreign.

This sorts itself out into two projects, getting the support of the U.S. delegation and getting the support of all of the foreign delegations. Neither of these is going to be easy.

The U.S. delegation can be worked on at many levels. It is made up of representatives of the many radio-using services, a good proportion of them government run. The basic approach to changing governmental thought is to work through the mechanism set up for this: congress. Congress has considerable influence since it watches over the governmental departments with committees and it hands out the yearly allowances.

Since the only legal way for any amateur organization to approach congress is by means of a representative who is registered with congress to lobby, we have a serious problem. A tax-free organization cannot lobby . . . ARRL is tax-free . . . thus, unless ARRL changes its tax-free status, no employee or representative of the League can risk even talking to a senator or representative. ARRL cannot change to a tax-paying basis without radical changes in its management, so it is extremely unlikely that this will take place.

One man with the time and money probably could make a profound change in the attitude of the U.S. delegation to the ITU. It would take time, to be sure, for he would have to sit and wait to see busy senators and representatives, see top brass military, FCC commissioners, and on down the line. The end result would be that the delegates sent to Geneva would be instructed by their superiors that amateur bands are to be kept intact, even if their particular service suffers a loss. In the past we have had large quantities of lip service paid to the amateurs, but when it got down to a loss of frequencies for any service, they looked to the nearest amateur band for replacement.

Foreign delegates can be reached through high government officials. Amateur radio is of critical importance to every country for it provides one of the best ways for them to interest youngsters in a technical education. No country can keep pace or development without large numbers of electronics and communications men. Without amateur radio, how can the thousands needed be interested in turning to this field?

One man could have a profound effect on this whole situation if he had the time to see government officials and make them aware of the importance of our hobby. This is needed mostly in Africa and Asia where new nations are trying to bridge the gap into the modern world of computers and satellites. These same countries hold the critical votes at the ITU.

The amount of money needed to apply pressure at home and abroad is minuscule to any large business or club . . . probably a mere $50,000 a year could make the difference between our having a healthy and expanding hobby in the future instead of a gradually emasculated hobby. ARRL has the 50G to burn, but has not the will to use it. No one else has the 50G. What do we do now?

Los Angeles area FM 2 meter repeater. As a result, when radioteletype signals are fed into the WA6ITC machine, the local FM repeater, principally a mobile relay facility with more than 100 users, is virtually forced out of service.

Even though 146.70 MHz was a "vacant" channel when the FM repeater was installed, the RTTY enthusiasts (5 in number) rallied to save the "national" RTTY channel from being usurped, and eventually had put up the RTTY repeater so the output would "capture" the local FM repeater. Perhaps the FM'ers were shortsighted in putting up the repeater on a channel recognized nationally as a radioteletype frequency. And perhaps the five RTTY men were rambunctious in their selection of an already-in-use channel for their base-to-base communications. Certainly, there are two sides to the issue. Since there is no compatibility between the two modes, the FM group has offered to put the controversy before the ARRL-affiliated Los Angeles Area Council of Amateur Radio Clubs for arbitration. If the RTTY repeater group agrees to allow the council to act as arbiter, the next few months could see a new repeater forming and a shift by either the RTTY stations or the FM crowd.

REPORTERS WANTED

Write for the 73 Amateur Radio News Page under your own byline! The News is looking for items of general interest . . . hamfests coming, hamfests just happened, expeditions, emergencies, special events, anything of special interest that might have happened on any band, new records, moonbounce news, FM repeater openings, unusual club activities, whatever turns you on.

Reporters whose items are selected for publication will receive a special press card which may help them get into places closed to the general public, making the reporting of emergencies and special events a lot easier.

The deadline for all reports is the 15th of the month. Reports received earlier will get preference as there can only be room for a few last-minute items.

NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

How Fast Can You Work 100 Countries?

When I first put in my present station five years ago it took me a good two weeks to work 100 countries. By way of proving I'm not sure just what, I took advantage of the first weekend of the ARRL DX phone contest this year to see if I could make WTW–100 all in one weekend on 20 meters.

Feeling a bit overconfident, I started over an hour late...but, after all, it was the first night out for dinner since the baby arrived a month ago, so I didn't want to strain family relations by rushing too much. Wives have a hard enough time getting used to seeing just the back of your head on your weekend at home without starting things off badly.

South America and Africa came through fine for about three hours and then the band folded for the night. With the exception of 9N1RA and FR7ZC, none of the 33 countries contacted were particularly rare. Jinny has certainly been active from Nepal and her signal was outstanding.

When I got up the next morning the band was busy with Europeans. By afternoon I was up to 73 countries and had hopes of getting the hundred within 24 hours. Three hours later, with only three more countries added, it was obvious that this was going to take much longer than I expected. I had a leisurely dinner, watched some television, and helped mind the baby before going back to the band.

It was definitely hard going. I had worked just about everything in Europe except the hard ones such as HV, 9A, 3A, HBØ and the like. I tried not to make too many duplicate contacts, but every now and then a pileup would prove irresistible and I would plunge in for an extra VU2, CT2, UW9, or something reasonably rare. I went to bed with 87 worked and the band dead at midnight. Thirteen more shouldn't be all that hard the next day, right?

A 5:30 start netted me a few new ones, starting with my good friend Chet PJ2CC down at the Beachcomber Hotel in Curacao. By 9:00 a.m. I was up to 93, but the band was full of nothing but unrare Europeans, so I went back to bed. Pierre F2BO/W1, his wife and twin babies arrived at noon for a visit. I got back to the rig about 3 p.m. and, when the band finally opened to Africa again, worked my way up to 99. With two hours to go that shouldn't be a big problem. It was, and I snagged 6Y5AV out of a horrendous pileup with just seven minutes in the contest to go, making it 100 exactly.

My total operating time came to only 17 hours, so I had a great time without getting too tired. Some of the fellows who had been chasing DX on four or five bands, making 1500 to 2000 contacts, were pooped for fair. I made only 132 contacts. Three of the countries were new for me, but for the most part I was surprised at the lack of rare countries in the contest. Two of the three new ones were not really in the contest, but just happened to be around. The activity in Africa was extremely sparse, with less than ten stations giving the contest much effort. The band was open to Africa quite a bit, but all that I could hear were three CR6s, a couple of ELs, a couple of ZSs, and 5H3LV. North Africa didn't open up much at all, with 9H1CD complaining of sitting there hearing the Ws weakly for seven hours before he was able to make his first contact.

One thing was very obvious...the General class licensees didn't have a chance in the world of seriously getting into the contest. Only during rare high points of activity would the action spread on up to 14.275. A General might just as well forget working DX on 20 meters.

My station, for those picturing mammoth beams on top of a mountain, along with a room full of equipment, consists of a five-year-old transceiver, one of the least expensive made, a Henry linear amplifier (2K, not 4K), and a simple three-element beam up 70 ft in downtown Peterborough.

Leaky Lines vs Technicians

When the February LL column arrived I read it to a Tech and he turned livid. I knew we had a winner. Even the gentlest discussion of cheating on the Tech exams makes most Techs fighting mad, with those who cheated to get their ticket having an edge on the degree of ferocity.

The cheating that takes place is generally done in friendship, though it leaves both parties feeling guilty afterward. We had the same problem with the Conditional license and that had a lot to do with the virtual elimination of that license class.

Cheating is a problem and it is not one that will go away if we refuse to discuss it and try and work out some reasonable solutions. It is extremely difficult to discuss because of the emotional factors. Those who were absolutely honest on their exam and code test are affronted at the suggestion that they might have been helped. Those who were helped are feeling guilty and would prefer that something else be talked about.

One solution that I have proposed in the past is a little change in the rules which would make it necessary for exams to be given by three licensed amateurs instead of one, figuring that it is a whole lot more difficult to get four people to agree to something dishonest than two.

Let's give some thought to the Tech license. The Tech license differs in two quite basic ways from the General: There is the difference in code speed, 5 wpm opposed to 13; and there is the manner of administration of the license exam, with the General having to face an FCC examiner – and the Tech, his friendly local licensed amateur.

In considering the matter of code speed, the philosophical arguments about the usefulness of code are irrelevant. The fact is that under the rules now existent you do have to learn to send and receive the Morse code at 13 wpm if you are going to get a General license.

How much of a barrier does the code present? How much of a difference between getting the General and the Tech licenses is due to the problems of learning code? Amateurs who have helped thousands to get their General license tell me that *anyone* can learn the code and pass the General exam. Some people take longer than others, of course, but apparently no one can honestly plead an inability to learn code. Once the decision is made that the code will be learned, the process takes amazingly little time, from mere days to, at worst, weeks.

On the face of it, the code would not seem to be enough of a problem to prevent anyone from getting the General license.

Which brings us to the FCC examiner. Now, I recognize that it is entirely possible to copy 15 wpm perfectly the night before the exam and still fail miserably just from the tension and panic of taking the FCC exam. I've not only seen it happen, I've experienced it myself. But eventually you do calm down enough to copy enough letters to get through the code test and you are ready for the technical exam.

The written part of the test should be about the same, whether you are with a friend or at the FCC emporium, unless you need help with the hard spots, in which case the FCC could be more difficult.

Code Requirement: Dirty Words?

Many a CB'er, SWL, and even Novice amateur has had good cause to curse the Morse code. I hope you will not turn off if I suggest that there may be a very good reason for keeping the code requirement for the amateur licenses.

Yes, I think I know all of the arguments against the code. It is an anachronism. It is a relic of the past. I agree with that, but I don't agree that that is all it is. Yes, I know that teletypewriter and radioteletype have made devastating inroads into the commercial use of code. I know that the military uses it very little any more.

One of the principal users of Morse code is the amateur, I suspect. Code is still alive in many of the ham bands–and not just the Novice bands, where the operators are limited by law to that mode of emission. There is a lot of ragchewing going on in the code-only portions of the bands, a lot of DXing, and a lot of traffic handling around the dozens and dozens of traffic nets organized by the ARRL. But even this is not a good reason in my mind for the insistence that all amateurs know the code. I figure that those who like it will develop their ability to use it, and those who don't can just go ahead and use phone. Whatever turns them on, I say.

The fellows who are using code tell me that it is fun, that they enjoy it enormously. If this is so, then I'm not sure that I can agree with those amateurs who feel that we must insist that every newcomer learn the code to get his license because if he can get a license without learning the code he will never try it. I suspect that communication by dots and dashes might just be a whole lot more popular if it weren't jammed down our throats. I am pretty sure that my own antipathy to code is a result of my having to learn it, whether I liked it or not. I resented that and reacted to it negatively. I enjoy things a lot more when I do them of my own free will.

There is a basic difference between having to pass the written technical exam and the code. I could see where the technical exam was important as an eliminating factor for those fellows who do not have enough knowledge to properly operate an amateur station. That made sense. But why code? I had no need of it if I was going to operate phone, so why force me to develop a skill, as opposed to a technical understanding? An unneeded skill, at that!

Some amateurs argue that in times of emergency code might be the only mode that could get through. Balderdash! Forty years ago, maybe. But today most of the emergency rigs are mobile phone rigs, usually sideband. And I have yet to see many cases where sideband can't get through just about as well as code. That is a very weak argument to me.

So what possible reason is there left for the excruciating and frustrating process of code-learning being part of the amateur license? And not just *a* part of it, but by far the most difficult part to master. The technical end is considered by most amateurs as being terribly simple. Virtually any EE college graduate can walk into an FCC office and pass the amateur General exam with just a few hours' study of the rules. Why, when amateur radio is supposed to be a technical hobby, is it in reality a skill hobby instead? The technical end seems to fade into insignificance compared to the skill aspect.

The answer should be getting obvious now. Anything easily obtained is not treasured or appreciated. I suspect that the very difficulty of the code requirement is one of the basic reasons for the legendary ham spirit . . . the pride of being a ham. It is most definitely an accomplishment to pass this hurdle, particularly in this day when virtually no one else is using the code. This means that the code has to be learned specially for the ham ticket by *everyone*.

Show me one person, if you can, who is not proud of his ability to copy code. Sure, I know thousands of hams who haven't been using code for years, but I don't know one who doesn't swell a bit with pride when talking with nonhams over his having passed the code exam.

RM-1456

It seemed to me that one of the problems facing the Techs is their isolation from CW and that if they had more of an opportunity to use it they might be inclined to go for their General. The code, as I said before, is not difficult to learn once you make up your mind to have at it. In spite of the nice special CW band at the low end of 6 meters, the Techs have so far almost completely avoided any contamination with CW. So, even if a Tech wants to get on and try to improve his CW ability, he is frequently stuck for someone to work with. So I proposed that Techs be permitted to use all Novice bands. This petition was sent to the FCC and given the number RM-1456. Nothing further has been heard of this petition except one letter from WAØLIK in support of it. If you think the idea is a good one you might send a letter to the FCC in support.

Phone operation on 6 meters is a good hobby, I grant. So is 2 meter FM and the other pursuits of the Technician licensee, but it is a real shame for the code to stand in the way of the fun and aggravation to be had on the lower bands. I enjoy 2 meters a lot, but I would be resentful if I were forced to stay there and not permitted to get on 20 meter phone.

A Solution to the Code Problem?

Since anyone who wants to can learn the code, it seems to me that a whole lot of Techs could be encouraged to become Generals if we first of all try hard to get them to improve their code speed, and secondly make it as easy as possible for them to do this.

How do we make it easy? We can step up the code classes in our radio clubs and get every 2 and 6 meter member to scrounge around the bands looking for Techs to get in the classes. Don't forget the coffee and doughnuts after the code sessions. Further, any operators on 2 and 6 can easily spend an hour or so a week sending code practice sessions on the air.

What do you send? I suggest that you look into the commercially prepared tapes since they are perfect code and of known speed. Move up into the band where you won't drown out regular contacts and set up a schedule of code practice sessions nightly or whatever you can handle. Keep them inflexibly on schedule so you don't lose the audience that you gradually build up. W1AW isn't the only station that can send code practice, you know.

Since a great many ops depend a lot more than they should on memorizing of the license manual to pass the exam, it won't hurt at all to begin each club meeting with a short tech session to help the members better understand the theory. Understanding gets you through the exams a lot better than memory.

Is your club doing everything it can to help its members up their license grade? Is your club honestly trying to recruit new Novice and Tech members and help them? Or is it like many that I have known, run by a handful of oldtimers who discourage newcomers? Don't look to the ARRL to suddenly start a nationwide PR campaign for the hobby...decide that you and your club will swing into action in your area to get more hams and move all members up at least one license grade.

73,
. . . W2NSD ■

Mr Virgo Himself

Editorial by Ken Sessions

My February editorial with respect to the new interim regulations for Canadian amateur repeaters has brought an unexpected spurt of responses from Canadians who feel that insufficient credit for the rules was given the Canadian repeater organizations. This is a point I certainly should have brought out, and I take this opportunity to do so. The rules adopted by the DOC (Canada's FCC) were a direct result of suggestions supplied by the Toronto FM Communications Association and the Ottawa Amateur Radio Club (and perhaps others). The point that was meant to be made in the earlier editorial was that the rules were based on the Buffalo petition – which is still a fact. The Buffalo petition served as a foundation from which a new draft was formulated by Paul Hudson VE3CWA and others. The draft became the DOC interim requirements for repeaters.

My apologies to the Canadian amateurs for my neglect. And a hearty well done to them for taking an issue and getting something done about it. We U.S. amateurs could learn something from this sequence of activities and cooperative efforts, I think.

A.E. Blick VE3AHU writes:

". . .note that these are interim regulations and will not become formal regulations until they have been assessed as to their worth. Incidentally, you omitted to include the first regulation, which states: 'Applications for Amateur automatic repeaters will be considered on a case-by-case basis, as in the past.' This means that such stations will not be automatically licensed providing they meet the other requirements. Also, that the DOC has already been asked to drop the requirement that only the licensee be enabled to reset the repeater and consideration be given to an automatic device such as you mention."

C.H. Harrison K2QPF writes:

". . .I feel you're taking issue with the Canadian interim FM repeater regulations 3-minute timeout requirement without complete analysis. The purpose of the automatic shutdown timer required by the regulation is obvious – to disable the transmitter in case of failure in the normal operational control circuitry. This requirement is desirable, and it should require reactivation only by the licensee. Your analysis overlooks the use of a second timer circuit which is part of the operational circuitry, and set for example at 2 minutes. It would terminate the carrier as in the usual sense, and reactivate automatically when our longwinded friend finally let go of the mike. The 3-minute timer would function only as it should; to completely disable the repeater until the licensee could analyze the cause of the malfunction, make necessary repair or adjustment, and return the repeater to service. The two-timer approach meets both the usual operational interruption of the longwinded channel hogger and the necessary safeguard requirements to reliably disable a malfunctioning repeater."

* * *

Since I always have a great deal to say but very little space in which to say it, I try to cut my editorial verbiage down to the barest essentials. As a consequence, I cannot always philosophize and ramble the way I'd like. And besides, with Dave Mann's Leaky Lines, 73 has about all the philosophy it can handle in any one month. But it seems to me that it is high time for at least a teensy bit of maundering, in defense of my position and 73's after Dave Mann's comments about the chastity of Technicians in general (February, Leaky Lines).

It is first prudent to say that I am editor – not a censor. Dave Mann's editorial material does not necessarily have to coincide with my opinions to be accepted for publication. He is entitled to speak his mind freely when he writes, regardless of how much I may disagree with the statements he makes. Which is as it should be.

Last-Minute Flash!

The FCC has prepared a "proposed rulemaking" set of constraints with respect to operation of repeaters on the amateur bands, and is asking for comments before May 15, 1970. The complete text of the docket is not yet available, but an FCC representative listed the major points under consideration. They include relaxed logging requirements, automatic ID at 3-minute intervals, no repeaters below 50 MHz, mandatory tone control or whistle-on activation – all of which were recommended in RM-1542, a petition submitted in December.

But the FCC has gone a bit further by recommending that no links be allowed, no more than one transmitter be activated from a single receiver, no crossband operation, and no unattended repeater operation. The implications carried by these last items are weighty indeed, and warrant the immediate attention of every repeater owner, remote control operator, and prospective repeater/remote operator. If crossband operation is disallowed, there can be no city-to-city repeater interconnects. There can be no remotely controlled amateur stations, because all radio-controlled transmitters and transceivers involve UHF portions to link signals to and from the remotely controlled equipment.

The FCC deserves credit for making the effort to get repeater operation into the rules and regulations. But repeater progress will come to a complete standstill if the crossband and multiple-output recommendations of the FCC are upheld. The May issue of 73 will carry the complete text of the FCC's recommendation along with proposed alternative actions. Whatever you do, don't fail to get the May issue to see what's happening with repeaters. And if you have comments, you will have until May 15 to get them into the FCC office. 73 also will be filing a list of comments on this docket; these, too, will be published in the May issue.

If you plan on making comments on this important docket, don't do it yet. Start thinking about what you want to say. Discuss it at your next club meeting. Make notes. But read the FCC's recommendations before you file your comments. If you're an FM'er and you fail to comment on this vital issue, you'll have no one to blame but yourself if the FCC docket gets through unscathed.

* * *

There is a fairly common myth that I am beginning to hear more and more frequently quoted as truth. Since the myth affects me (and you), it's up to someone to talk about it. I don't know where it started, but I know it is known nationally. Worded in any of a dozen ways, it goes like this: *Amateurs who are not members of the League have no right to complain about the ARRL, its workings, policies, people, tactics, or structure.*

Now, I wouldn't worry if this were merely someone's misplaced ideology. I think it began as some League member's defense of League actions. But this month you will see it cited in Leaky Lines by Dave Mann, who has a reputation for "calling 'em right."

Lest the adage get perpetuated as a verisimilitude, I will risk sounding anti-League by debunking it. Whether I agree with the ARRL or its policies is immaterial. The fact remains that what the League does, what the League decides, what the League recommends – it does so not on behalf of its membership but on behalf of *the amateur radio community as a whole.* Since every nonmember is affected by every major ARRL decision, every amateur, member or not, has the right – and the duty – to be concerned with and get involved in League affairs.

Let's take the incentive licensing thing as an example. The League originated the proposal; but did it affect only League members or did it hurt us all? And how about the current Technician spectrum gift: Does it apply only to ARRL members or will all amateurs have to comply with any FCC decision based on the proposal? And the ARRL's repeater recommendations: Will they end up as League-only rules, or will all repeater owners and operators be forced to live with them as well?

As long as the ARRL's actions affect you as an amateur, you have an obligation to know what the League is doing and when. Your responsibility is not so much to get in the League, but to make your voice heard. As a nonmember, your right is even more intrinsic than it would be if you were a member. A League member pays his dues, which serves as that individual's approval of the way the League does things. His money (in dues) is a vote of confidence for "the system." Since the member is supporting the system, he has scant right to complain when he's knifed by the system – after all, he shares responsibility for its existence.

Ah, but the nonmember is another story. *He* does not back the system. He does not approve of the system. He does not believe in the system. Who, then, has *more* right to complain about being plowed under by the system?

If anyone ever tells you that you should join the League so that you could "effect change" from the inside, don't you believe it. Hams have been trying for years without success. But it doesn't take a genius to figure out that if every dissatisfied ham dropped his membership, the ARRL would either change or drop out itself. Your most powerful voice is NOT your ARRL membership. Rather it is the absence of it.

Don't make the mistake of labeling me anti-League, because I'm not. Neither do I appreciate the power of the League, however, to speak for hams who don't believe in the ARRL. I simply believe that *all* amateurs, League members or not, should have the right to vote on issues that affect all amateurs. Doesn't that seem reasonable?

. . . K6MVH ■

Leaky Lines

AN EDITORIAL by DAVE MANN K2AGZ

1 DANIEL LANE, KINNELON NJ 07405

According to Yankee Legend, if you should encounter the ghost of Daniel Webster, he would ask just as in life, "How goes the Union, neighbor?" If there are truly shades and spirits, and I am not one to deny it, perhaps those which quickened the mortal coils of our hobby's pioneers might be asking, "How goes amateur radio, Old Man?"

Regrettably, the answer would not ring out so confidently and affirmatively as would our reply to old Dan'l. The state of amateur radio is not so sound as the state of the Union, despite irrationally optimistic claims to the contrary. Of course, all is not completely hopeless; things seldom are. But there is an air of demoralization which seems to be widespread, and this is evidence that we are disturbed and hagridden. We seem to be in an apprehensive mood, waiting for disaster to strike, from who knows what quarter. Like Tennyson's Light Brigade, there are "guns to the right of us, guns to the left of us," and we know not whence will come the volley and thunder.

Newly emerging nations eye our frequencies with covetousness. Commercial users intrude into our spectrum in blatant defiance of the assignment regulations. The communications facilities of our own armed forces create interference on the ham bands with impunity, and so does Voice of America. Municipalities devise pernicious covenants and restrictive codes, limiting or altogether prohibiting towers and antennas, and they sometimes even enact ordinances against our right to operate at all. It seems that although we are guaranteed the freedom to pursue happiness, this sometimes excludes the operation of a ham station!

In addition to all this harassment from outside sources, we are inwardly divided into sects and contending factions. After over fifty years of existence we find ourselves cloven into angry splinter groups, snarling and yammering at one another. At a time when we need desperately to be united, we are being hopelessly split asunder.

"How goes amateur radio, Old Man?"...Not so well, I'm afraid. We have witnessed dramatic changes in both the direction and character of ham radio in the past several years. This hobby started out as the sole province of the serious science-minded. It is now being contended that it has become the playtoy of entertainment seekers, just fiddling around with a novel and intriguing gewgaw. It is said that for every ham who is genuinely motivated by theoretical and technical aspects of the hobby, there are scores who possess only the most meager and sketchiest idea of what it's all about...who are capable only of plugging the rig into a wall receptacle, turning on a switch, and talking into a microphone.

This is an abominable situation, if it is true. If untrue, then it is a slander and a damnable libel. As for my own opinion, I tend to think it's untrue. There are literally thousands of amateurs deeply involved in the development of science and technology. The large laboratories at Bell Telephone, Bendix, ITT, Sperry, IBM, GE, and countless others, are engaged in a universally burgeoning program of research and scientific inquiry. And in every area of this rapid proliferation, on every level, conspicuously and meritoriously recognized for their contributions, there are radio amateurs. These people do not leave their knowledge and ingenuity outside the door to the hamshack.

Advances in the techniques of communications science, as in most other fields, have been accomplished largely by a select, determined group of innovators, far in advance of their contemporaries. A case in point: single sideband. Bell Telephone was involved in this field around the time of the first world war. Except for a tiny circle of knowledgeable hams, sideband remained practically unknown on the bands until the end of the thirties and the beginning of the forties. It did not become a practicality until after World War II. And even now, in 1970, it is not yet universally recognized as an acceptable form of communications. There are still hams who are resisting the mode and trying to shoot it down, because they view it as a newfangled fad which will never catch on. After almost four generations, imagine, single sideband is still regarded in some circles as a passing fancy, totally devoid of merit or value! Does this mean that the entire amateur community is decaying? Not at all. It simply signifies that some people resist change more tenaciously than others. It certainly does not entitle those who accept new ideas with eagerness and alacrity to feel contempt for those who do not do so.

We often hear of the impossibility of changing human nature. While this popular cliche enjoys wide acceptance, it is only a half-truth. The human being has been in a constant state of change throughout his entire history. The changes have been slow and all but imperceptible. Yet they have occurred. There is a mighty inertia, no one can deny it, which prevents people from accepting change willingly. This is a personality characteristic, more pronounced in some than others. Even the introduction of inducements or penalties does not make it any the easier for people to accept change. In India, where there is unspeakable poverty coupled with tremendous overpopulation, the government sought a solution by offering a handsome incentive. They offered a significant monetary reward to all married men who would submit to an operation called a vasectomy. This is usually a painless and harmless procedure, requiring no hospital stay, and relatively simple. Despite the urgency of the situation and notwithstanding the great need for the money, very few men have come into the public health clinics for vasectomies. Incentives, like deterrents, are rarely successful. The death penalty, invoked for centuries in all the countries of the world as a deterrent to capital crimes, has rarely, if ever, prevented a murder!

There is slim likelihood that the entire ham population of the United States can be transformed into a community of scientifically motivated electronics specialists. We might as well demand that everybody who buys a piano must learn to tune and regulate it. Or that every driver must learn to service and repair his own automobile.

Well, what about this tendency of some amateurs to be contemptuous and disdainful toward the so-called "appliance operator?" First of all, we must expunge from our consciousness the idea that the standards of amateur radio are becoming degraded simply because some of us are not brilliant enough to homebrew our own stations. Those in the vanguard of the hobby are every bit as creative as their counterparts of yesteryear. It is merely that we have grown mightily in numbers since then, and the proportions have become altered. It is proper for hams to be made to conform to minimum standards of competence. But we must guard against the tendency to raise those standards to an unrealistic level. This road leads to the establishment of an elite caste; an aristocracy. And it's a certainty that no one, not the FCC, nor the ARRL, believes that all hams can become Extra Class operators.

In far too many circles there is a growing sentiment that a stigma attaches to anyone without an Extra Class ticket. It should be borne in mind ,that a licensed amateur, apart from the frequency restrictions specified by his grade, is just as good as any other amateur, whether he is an electronic genius or just a chap who is in the hobby for the sheer pleasure of it. If we fail to remember this, we are very likely to witness the loss of one of our most prized possessions; the wonderful cameraderie which has characterized amateur radio from its very beginning. And that would indeed be a tragedy.

* * * * *

As long as we are told that we are on such good terms with the countries of Latin America, through the "Good Neighbor Policy," and all the other huge spending programs that are helping to keep the ordinary people of our own land impoverished, I'd like to make a proposal.

Of course, I do not think it likely that this proposal will meet with strong approval in these countries, because I do not happen to believe we are on such good terms after all...in spite of all the fancy claims and contentions. I believe in that old saw about actions speaking louder than words. And I recall vividly the way Mr. Nixon was spat upon in South America...how the ships and property of American firms were seized...and many other manifestations of "antigringoism" in recent years. Mr. Rockefeller's recent factfinding mission was surely no exception either. It is clear that our stock is pretty low, unofficially anyway, south of the border.

Still, there appears to be a certain detectable cordiality between the hams of Latin countries and the hams of the United States. Because of this rather inconsistent ray of sunlight in the otherwise impenetrable darkness, I should like to suggest that someone try to prevail on our Latin American neighbors to stop running those ubiquitous phone patches on the low end of our 20 meter phone portion. This is probably the worst single source of QRM on our best DX band. And one of its most annoying features appears to be the constant participation of poorly modulated female voices, which frequency-modulate all over the place. When one of those gals starts delivering that rapid-fire Español, you might just as well forget about working anything within at least five kilohertz.

Since all South and Central Americans have privileges below 14.200, how about getting ITU or ARRL to make overtures to LABRE, RCV, RCP, RCB, etc., to get some sensible phone patch frequency recommendations, which will confine this troublesome annoyance to a more reasonable portion of the band.

Of course, I've noticed that about half the patches are made to the Miami area, and that rather complicates matters. I have a swell idea on that situation too, but I'm not going to dare to suggest it. I might find a line of bearded pickets, wearing fatigues, parading up and down in front of my house!

73, K2AGZ ■

Robert Grenell, ex W8RHR
3926 Beech Street
Cincinnati OH 45227

a NOISE BLANKER that works

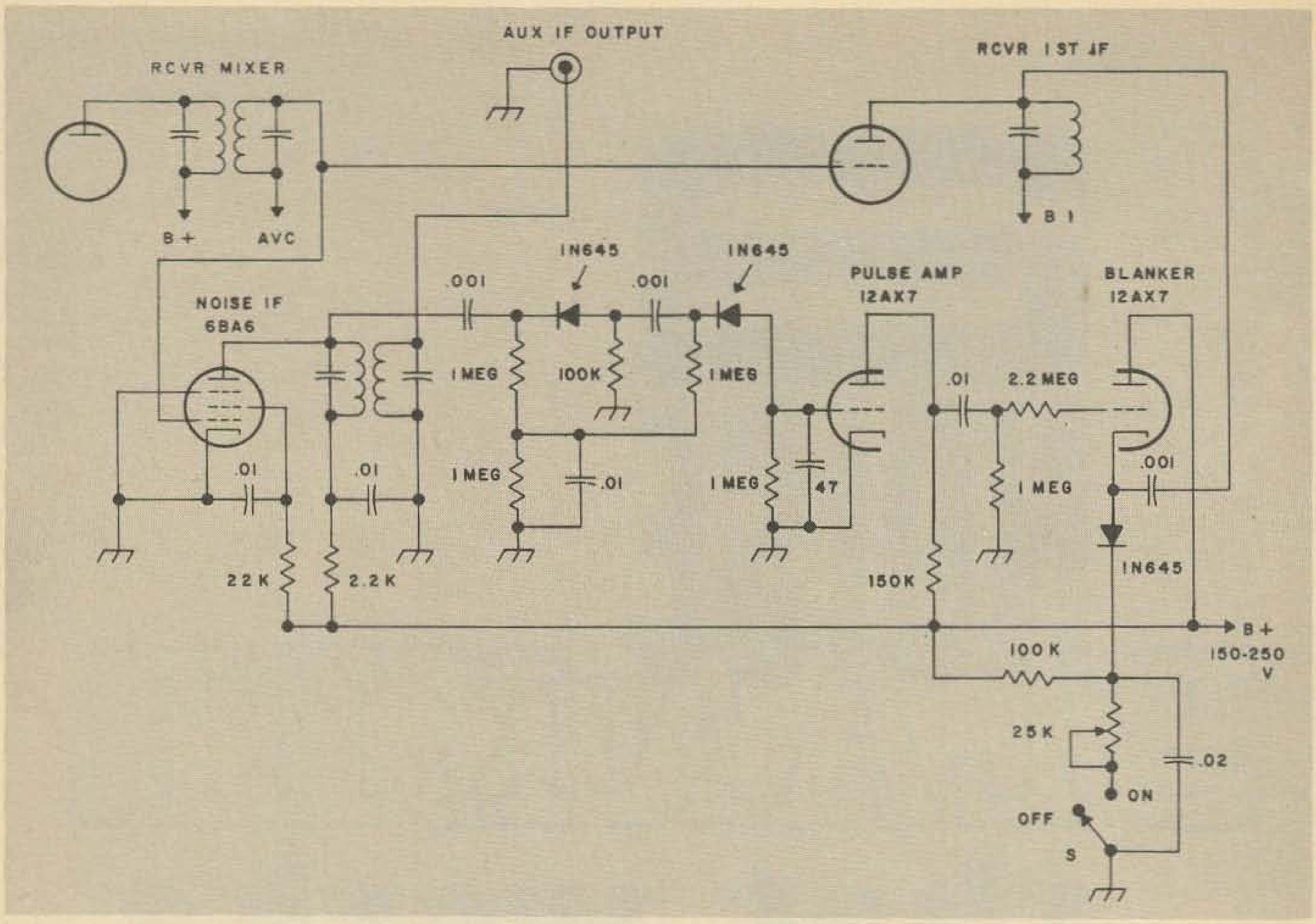
For pulse-type interference, there's no substitute for a blanker. Here's one that can be built up for less than five dollars...and it can be left in the circuit at all times without degrading normal receiver performance.

For several months now I've been experimenting with every imaginable type of noise reduction circuit. The result of extensive work with audio and i-f limiting and clipping was a growing conviction that the way to achieve truly effective noise reduction was to develop a blanker. Audio limiters and clippers all share one failing: they introduce harmonic distortion which reduces intelligibility and makes for extremely fatiguing listening over the long haul.

I-f limiting and clipping invariably reduce the signal level. Apparently, the more effective this kind of circuit is, the more loss it introduces. If it was to be necessary for me to build an extra i-f stage to compensate for this loss, why not go the route and develop a full blanker? The extra circuitry necessary would not amount to that much more than a clipper and extra i-f stage.

I came up with the following list of basic requirements after analyzing present commercial blankers. as well as a couple of circuits in the ARRL handbook.

1. Blanking must take place ahead of the selective stages to reduce ringing.
2. A minimum of 30 dB of blanking is a prerequisite, based on the performance of current commercial blankers, and



the claims made for other published circuits.

3. Compactness, simplicity, and ease of adjustment are obviously desirable.
4. The blanking action should not materially affect the signal.
5. The blanking action should be inversely proportional to the strength of the received signal.

All in all, five different circuits or combinations of circuits were breadboarded and tested. In most of them it was very difficult to secure a sufficiently low time constant to prevent audible "holes" from being punched in the signals in the presence of noise. In others, serious distortion of strong signals resulted from the inability to secure satisfactory inverse control of the blanking action, proportional to signal strength. Of all the circuits I built up, only one satisfied all the requirements adequately: R. L. Drake's blanker circuit as used in the R-4 series receivers. The purpose of this article is not to set forth an original circuit of mine, but to explain how this exceptionally fine blanker works, can be homebrewed, and integrated into existing equipment.

How It Works

An avc controlled 6BA6 amplifies the incoming *rf* signal from the first mixer and it is detected at D1. The avc control helps ac- pulse detector D2 proportionally to the strength of the incoming signal. D2 detects noise pulses exceeding the amplitude of the incoming signal, and the resultant negative pulses are used to cut off the first section of the 12AX7 instantaneously for the duration of the noise pulse received. This produces a positive pulse at the plate which in turn is used to turn on the second section.

When the second section is turned on, it draws current, forward-biasing the diode (D3) in series with its cathode for the duration of the noise pulse. When the diode conducts, it grounds the plate of the receiver's first i-f stage, instantaneously cutting off the signal while the noise pulse is present. Noise is literally chopped right out of the signal, while the signal itself remains virtually unchanged in its audible form, though it's really full of infinitesimal "holes." A piece of RG-58 is used to make the connection between the first i-f plate and the 12AX7 cathode through a .001 μF disc ceramic. When the blanker is off, diode D3 is heavily reverse-biased, preventing blanking or random clipping. The 25 kΩ pot is used to complish the desired inverse ratio between signal strength and blanking action. More control is derived from detection at D1; a portion of this voltage is used to reverse-bias control the level at which blanking action begins. I have used the secondary of the i-f transformer in the blanker to take off the i-f signal for a monitor scope.

Adjustment and Operation

There are no tricks to getting the blanker to work properly, and, if you've wired it correctly, you should find that it works perfectly as soon as three simple adjustments have been made.

1. Make sure that the blanker is off, and tune in a strong carrier – – your crystal calibrator will do nicely. Repeak the first receiver i-f to compensate for the connection to the blanker.
2. Remaining tuned to the carrier, adjust the i-f transformer in the blanker for maximum positive voltage at A.
3. Now find a signal of medium strength which is difficult to copy through heavy noise. (Perhaps you can have someone start your car and rev the engine to create some noise, if necessary). Adjust the 25 kΩ pot for sufficient blanking to enable you to copy the signal easily. You may be able to make the noise disappear entirely. This step requires some judgment, and you may want to repeat it several times under various conditions to be sure you've optimized the blanker's performance.

Once the above steps have been accomplished, you should find that you have better than 30 dB of blanking, probably more – plenty for even the worst conditions – without distorting the signal.

Now, get everything back together again, and be prepared to copy signals that you've never heard before. My QTH is a half block south of some high-voltage power lines. I guess I don't have to tell you what that does to weak groundwave signals on 6 meters . . . it obliterates them! Using the blanker, however, enables me to copy just about everything anyone else does, and a lot of it cannot even be detected (let alone copied) without the blanker.

The nature of this circuit is such that it can be left on at all times, if you wish, without degradation of receiver performance. It's only active in the presence of noise. It's very nearly foolproof, and it shouldn't take you more than an hour to build and install it. On top of that, it's plenty cheap. If you have any kind of junkbox at all, the whole works shouldn't cost more than three or four dollars. You'll find that this blanker will repay this minimal outlay of money and time many times over – and you'll be amazed at what you can dig out of the "mud" with its help.

A few afterthoughts and suggestions are in order. I built the detection circuitry entirely on a piece of Vectorboard which is mounted to the chassis by a small angle bracket. I recommend this approach to save space, as well as for convenience, since this circuitry is quite awkward to mount on the usual tie-lug strips. It is important to retain the exact values of resistance and capacitance shown in the detector and blanking circuitry. Changing them could result in an increased time constant which might cause audible "holes" to be punched in the signal.

The method of applying avc to the blanker *if* may vary from receiver to receiver. This makes no difference, as long as a direct connection is made from the grid of the receiver's first i-f stage to the grid of the blanker's i-f stage. This will couple both signal and avc voltage to the blanker. Diodes D1, D2, and D3 can be nearly any general purpose silicon diode; but D3 must have sufficiently high ratings to handle the voltage drop and current through the 12AX7.

. . . W8RHR ■

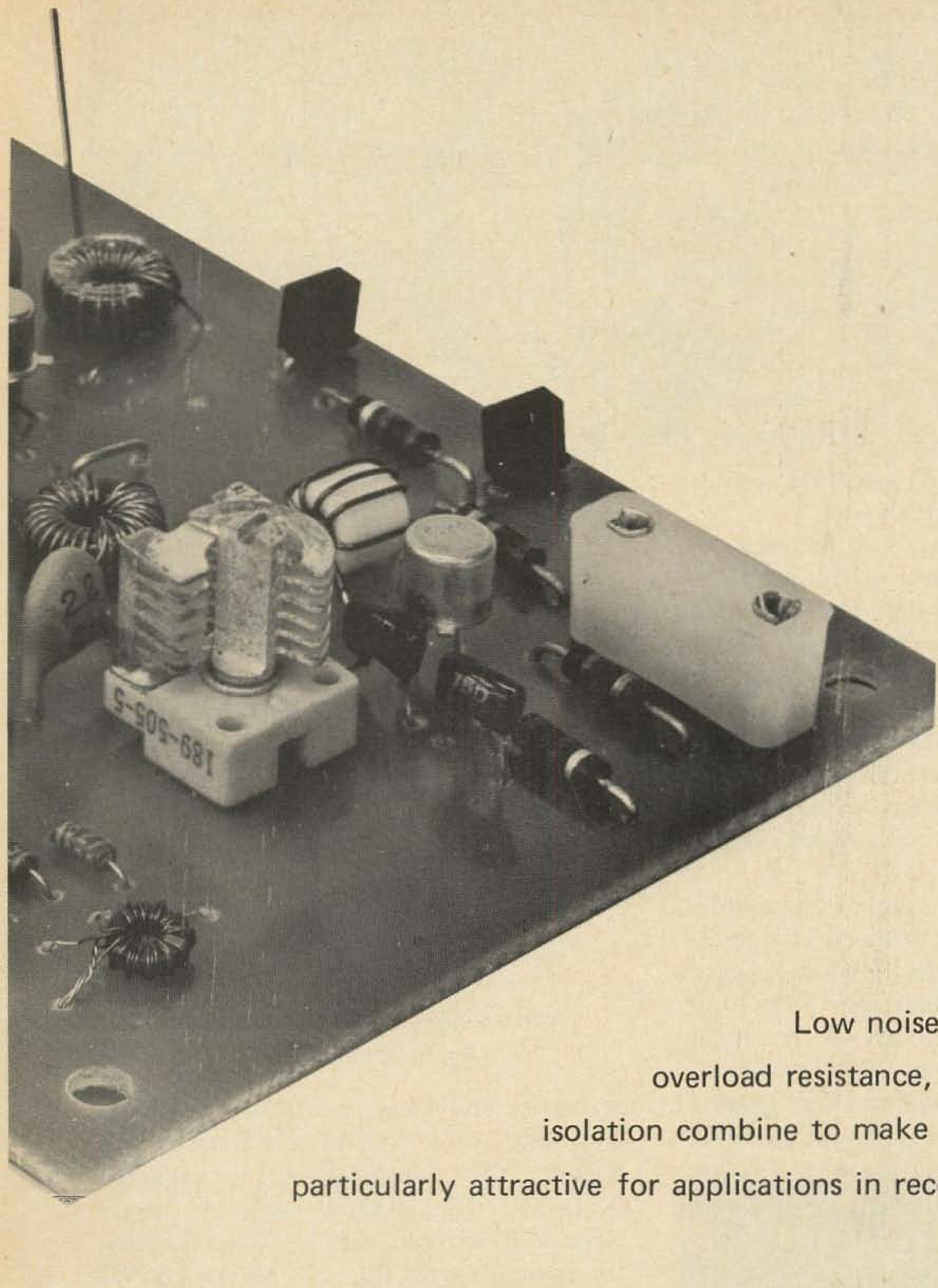
Hot Carrier Diode Mixer/Converter For 2 Meters

The double-balanced diode mixer using hot carrier diodes is enjoying widespread acceptance in commercial and military communications equipment. When properly applied, these mixers offer the designer many advantages compared to the conventional bipolar or field effect transistor approaches. The main advantages are:

- Very good overload resistance
- Low crosstalk and intermodulation products
- Good noise figure
- Excellent local oscillator isolation
- Construction simplicity and ease of duplication
- Can be made into a wideband device

This article describes an easily duplicated 2 meter converter which offers the latest in design concepts.

The detailed workings of the hot carrier diode and its operation in the double-balanced mixer can be found in the references. Briefly, the hot carrier diode is constructed using a PN junction joined to a metal barrier as shown in Fig. 1. This construction technique provides a diode with many advantages over the conventional point contact or silicon PN junction diode. These advantages include low turn-on voltage (410 mV), high UHF rectification efficiency, low diode noise, extremely fast switching times, and excellent diode-



William Ress WA6NCT
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Mountain View CA 94040

Low noise, high gain, excellent overload resistance, and a high degree of isolation combine to make the hot carrier diode particularly attractive for applications in receivers and converters.

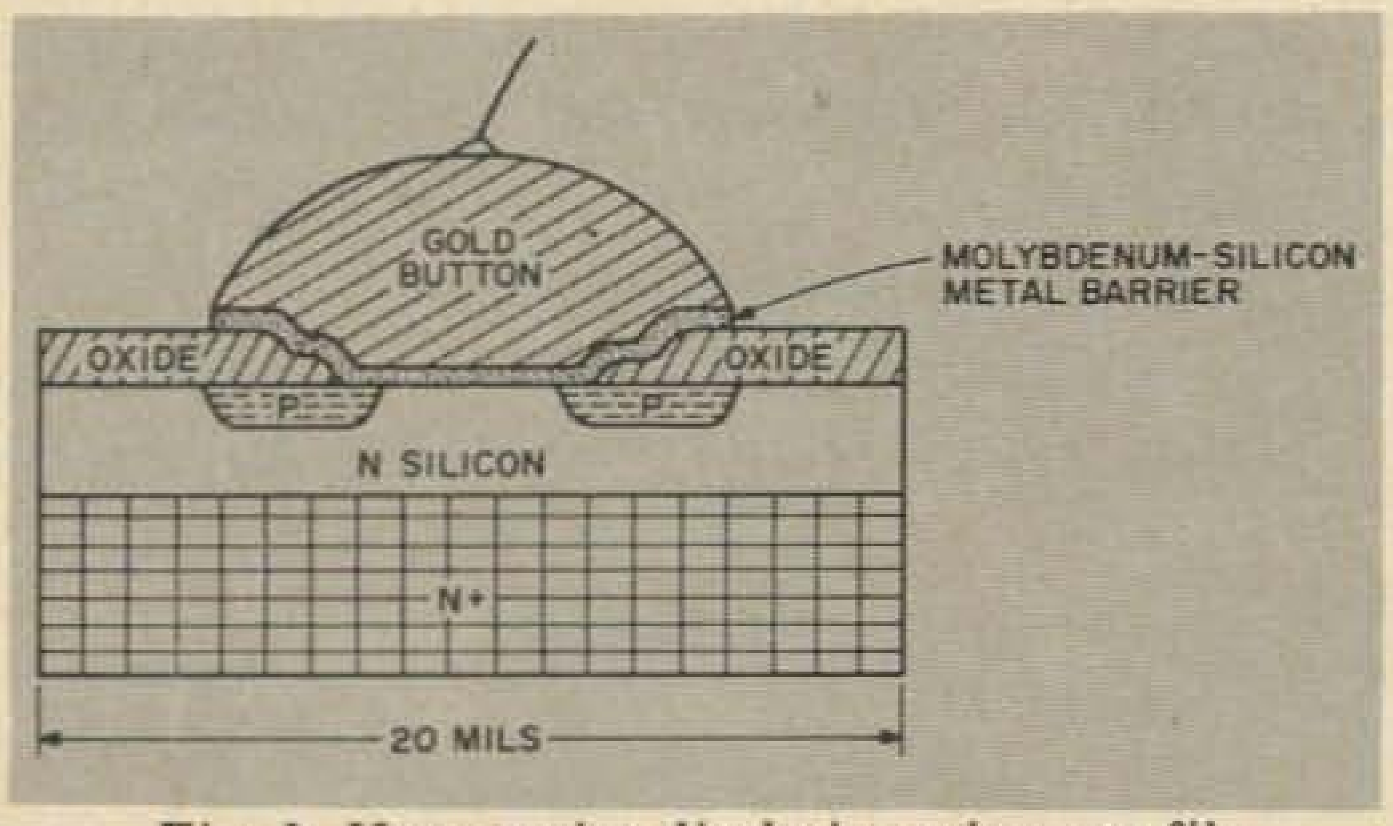


Fig. 1. Hot carrier diode junction profile.

to-diode uniformity.

The double-balanced diode mixer uses the variable resistance of the diode's on and off state to perform the mixing action, and offers excellent port-to-port isolation by using electrically balanced centertapped transformers. The noise contribution due to the local oscillator is also greatly reduced due to the electrical arrangement of the transformers. Since the diodes and the local oscillator offer no significant noise contribution to the mixing operation, the mixer is essentially a noiseless passive device which has a conversion loss. This conversion loss (typically 5–7 dB for mixers of this type and frequency range) appears as a resistive attenuator when used in a down-converter application. This mixer is a broadband device; therefore, to change the i-f output frequency to suit your requirements, only the local oscillator

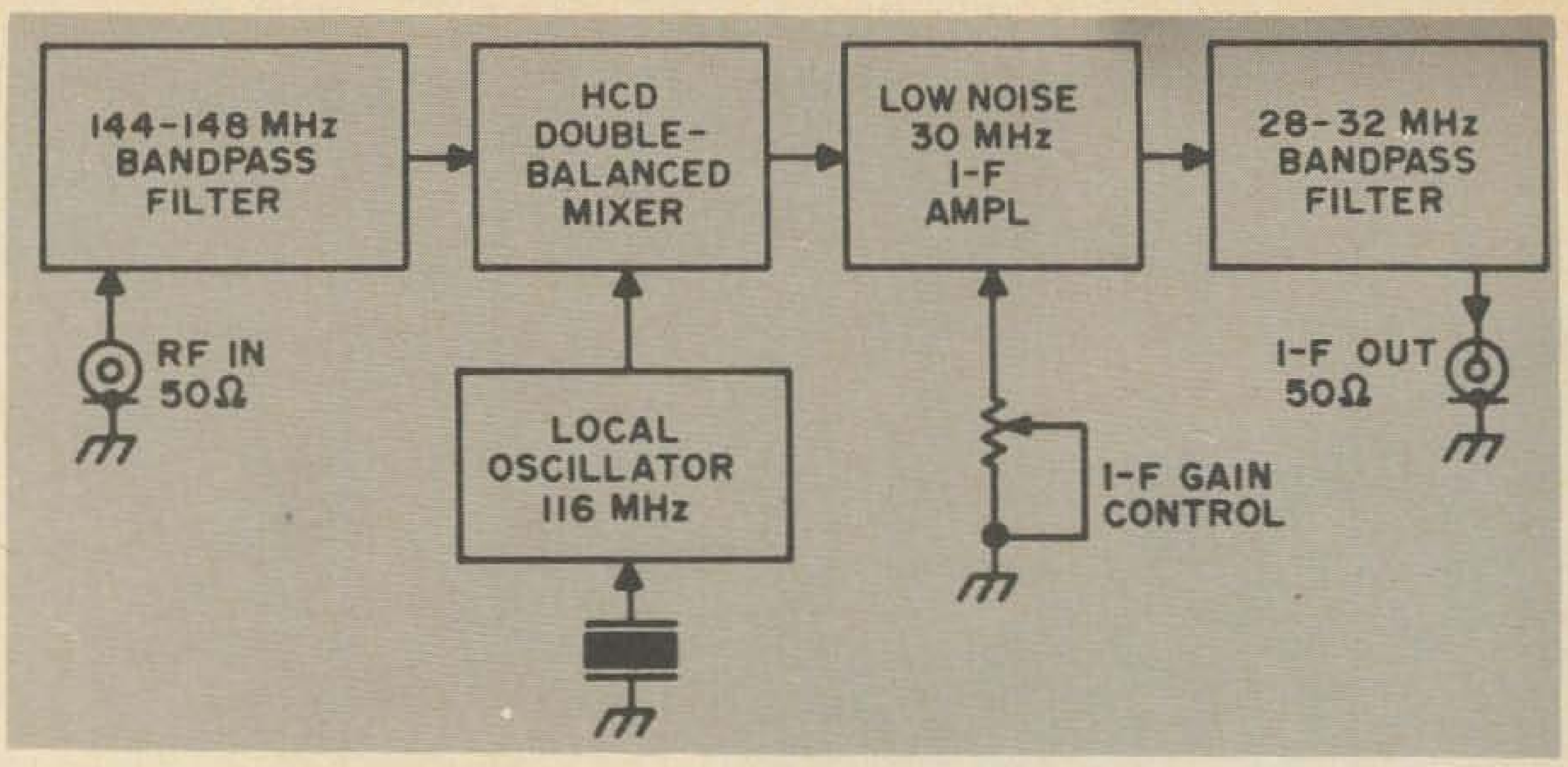


Fig. 2. 2 meter converter block diagram.

frequency and the i-f amplifier center frequency need be modified.

The block diagram of the converter is shown in Fig. 2. It starts with a bandpass filter centered at 146 MHz. This filter is a critically coupled double-tuned circuit which provides a bandwidth of 6 MHz and an insertion loss of 1 dB. It is necessary to use a bandpass filter ahead of the broadband mixer to eliminate the noise power that would be contributed by the images. The response of the filter is shown in Fig. 3.

Following the input filter is the double-balanced diode mixer. It uses a computer-matched diode quad; the Hewlett Packard HPA-5082-2805 available from your local HP-Neely sales office for $4.40. The quad is composed of selected HPA-5082-2800 diodes which can be used and are available for 99¢, but the matched quad will provide

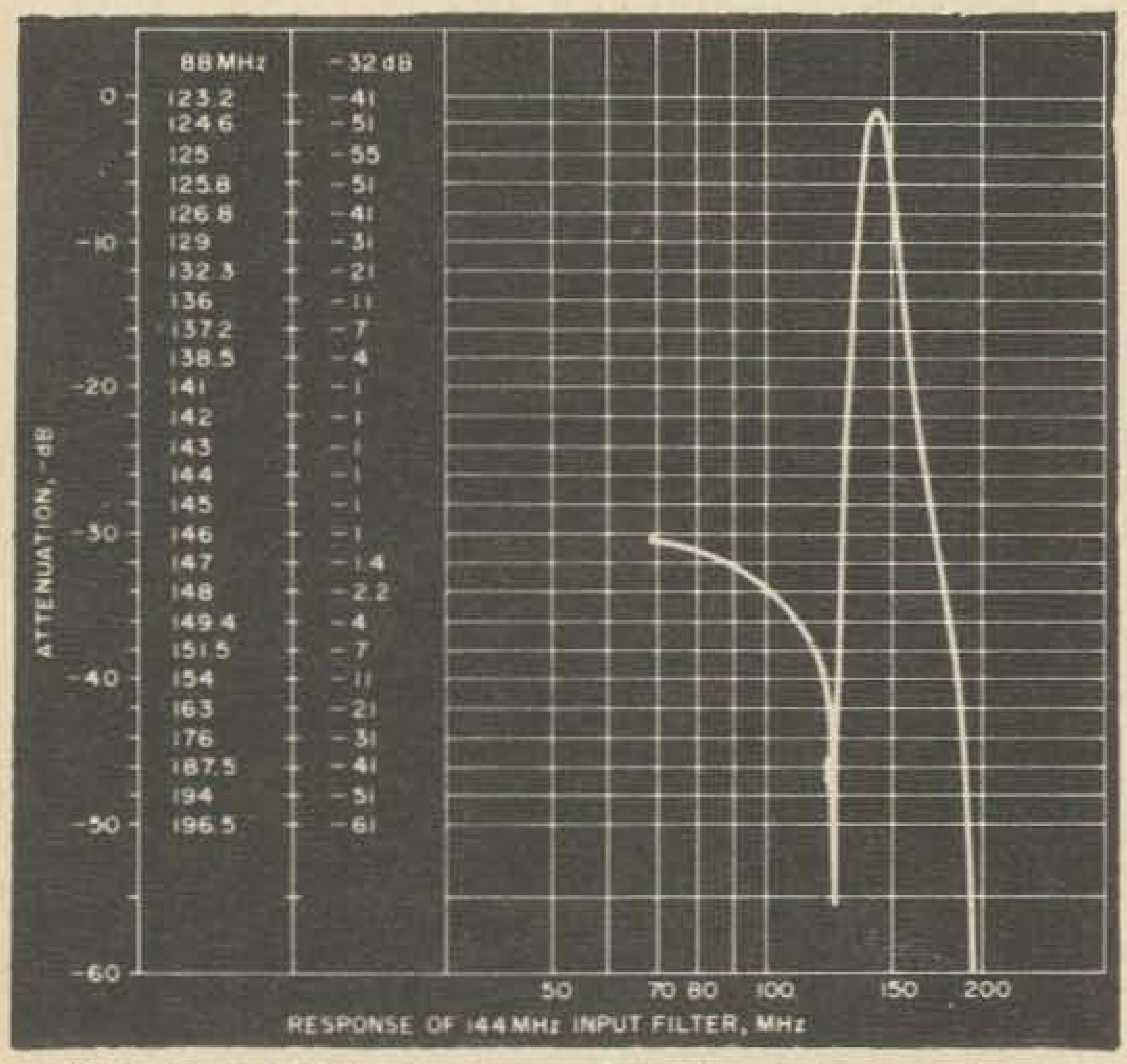


Fig. 3. Response curve showing attenuation vs frequency.

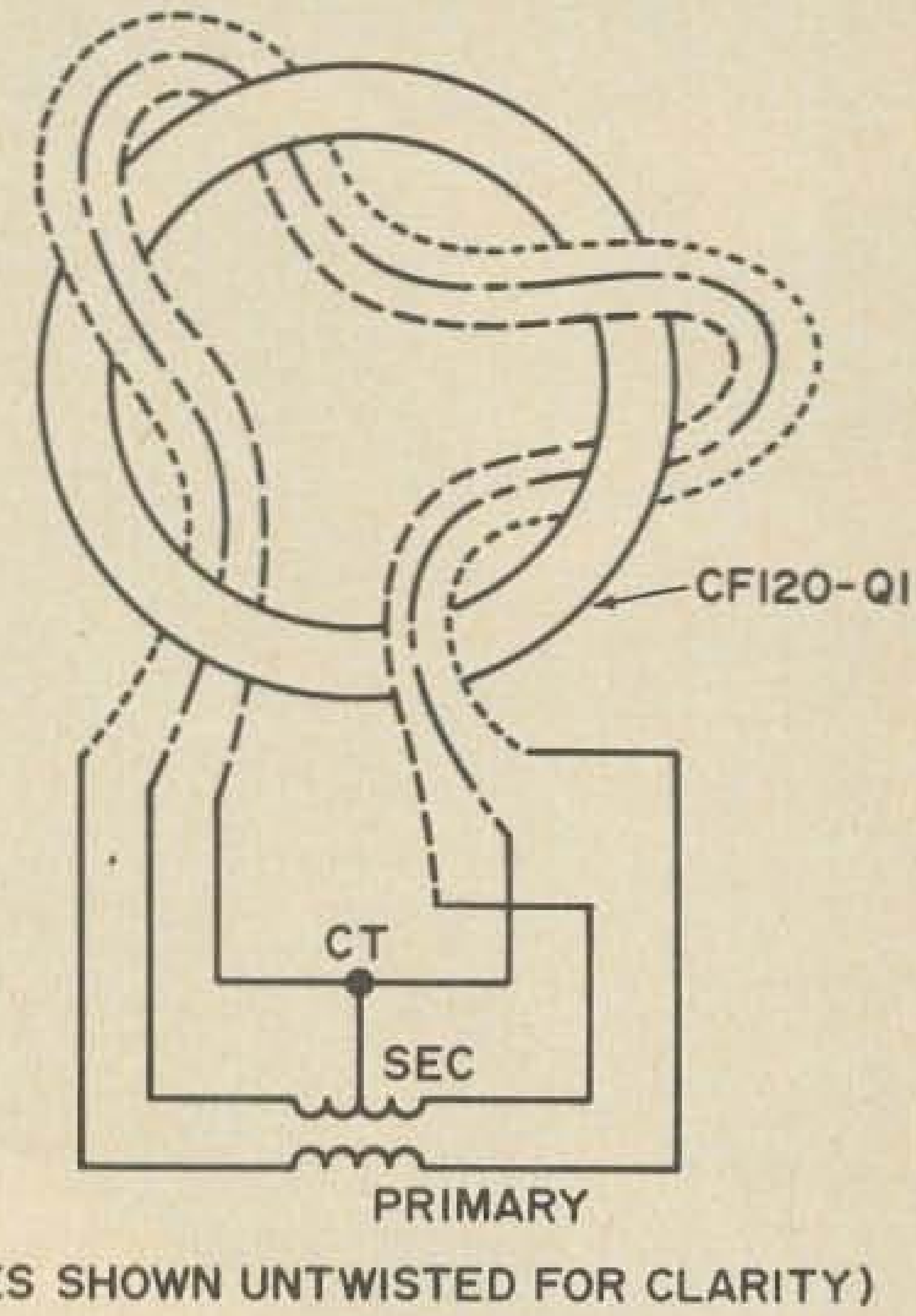


Fig. 4. Toroid winding.

better mixer balance and a lower conversion loss, so it will be worth the extra money. The toroids used are Indiana General CF-120-Q1's available from Newark Electronics for $1.20 each. They are wound with 30, 32, or 34 (AWG) enamel wire. The windings on the toroid are shown in Figs. 4 and 5. Care should be made to insure that the proper winding interconnections are made.

The 30 MHz i-f amplifier following the mixer is a low-noise FET stage. It uses the

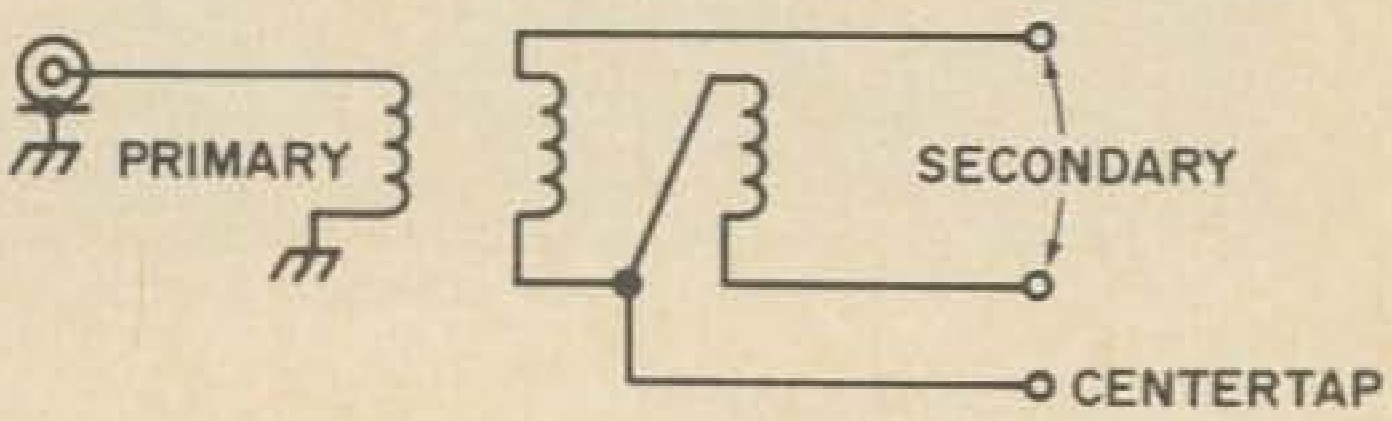


Fig. 5. Schematic of the trifilar toroid connections. (The three windings should be twisted together before winding onto the core.)

RCA 40602 dual-gate FET which exhibits high gain, low noise, and very little reverse capacitance. This low reverse capacitance allows you to build a high-gain amplifier at this frequency without having to neutralize. The second gate provides a convenient way of varying the stage gain so that the converter can be properly matched to your receiver i-f. The gain of this stage is 28 dB with the i-f gain control at maximum and 0 dB at the minimum position. The output of the FET is a double-tuned circuit centered at 30 MHz. It provides a flat response from 28 to 32 MHz with high skirt selectivity. It should be noted that the i-f amplifier following this type of passive mixer must have the lowest noise figure possible as it will directly add to the overall converter noise figure. The use of the FET in the i-f amplifier also allows one to take advantage of the FET's overload capabilities and low crosstalk and intermodulation products.

The mixer's oscillator injection is obtained from a "no multiplication" local oscillator. It uses a seventh overtone crystal at 116 MHz in a common-base Colpitts oscillator circuit. The cost of the crystal is about $7.50, but it eliminates the multiplication stages and tuneup required for the tripled 38.666 MHz approach. The "no multiplication" approach also eliminates many undesireable harmonics from being fed into the mixer which would cause unnecessary image and "birdie" problems. This oscillator circuit is easy to get started and it will supply the mixer with about 10 mW of drive. This circuit has been used with crystals from various manufacturers

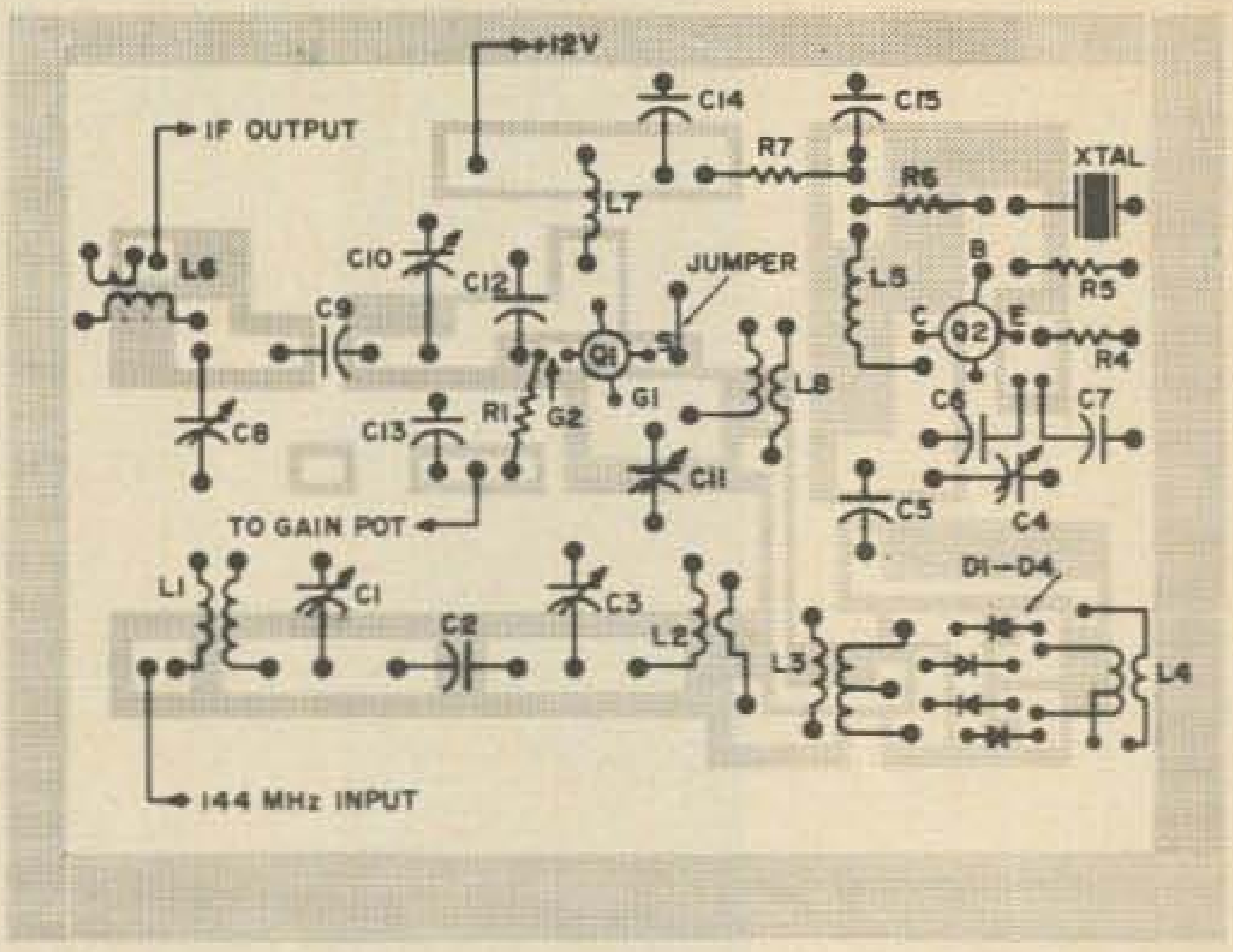


Fig. 6. PC layout (component side of board).

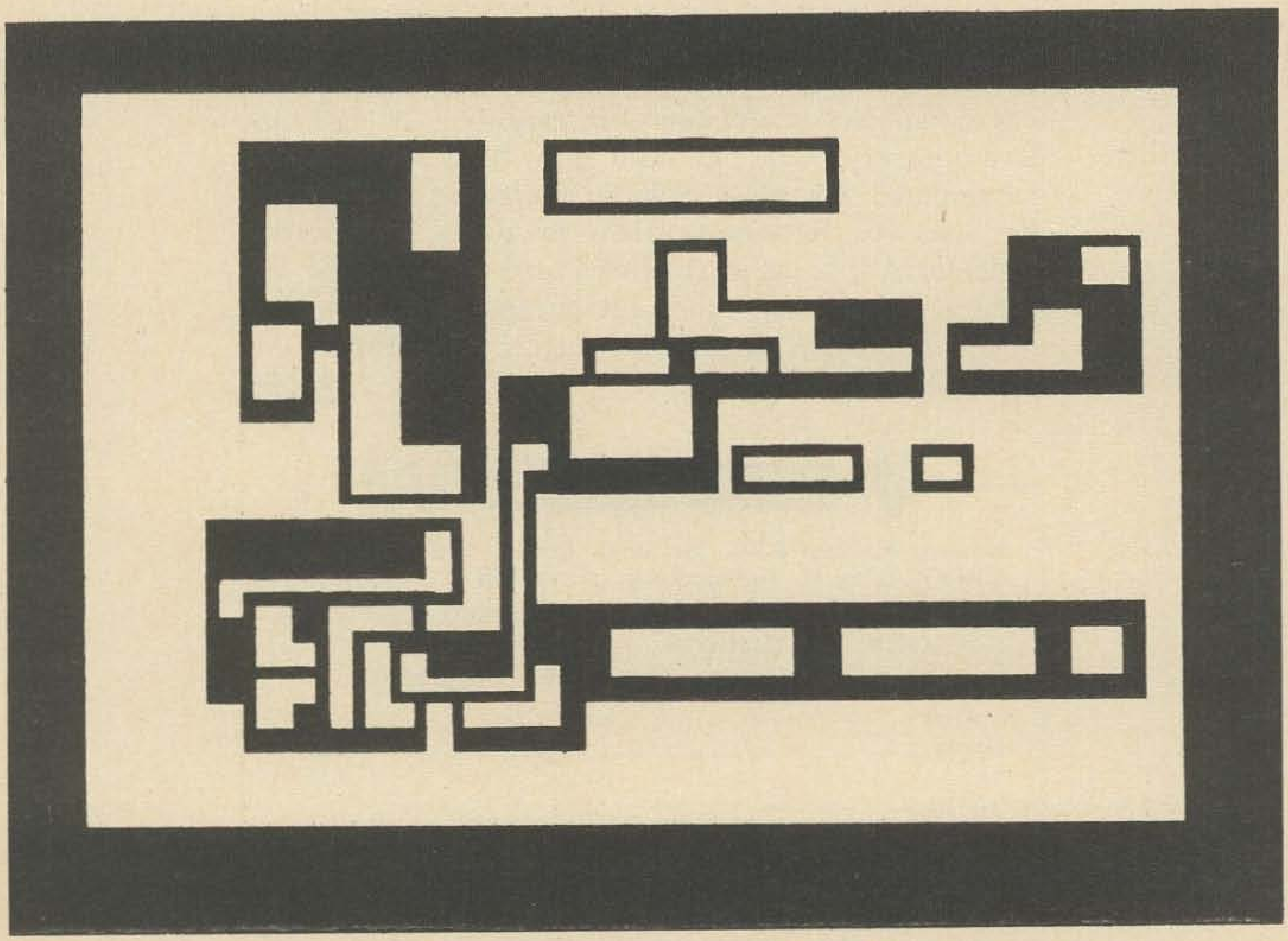


Fig. 7. PC layout (copper side of board)

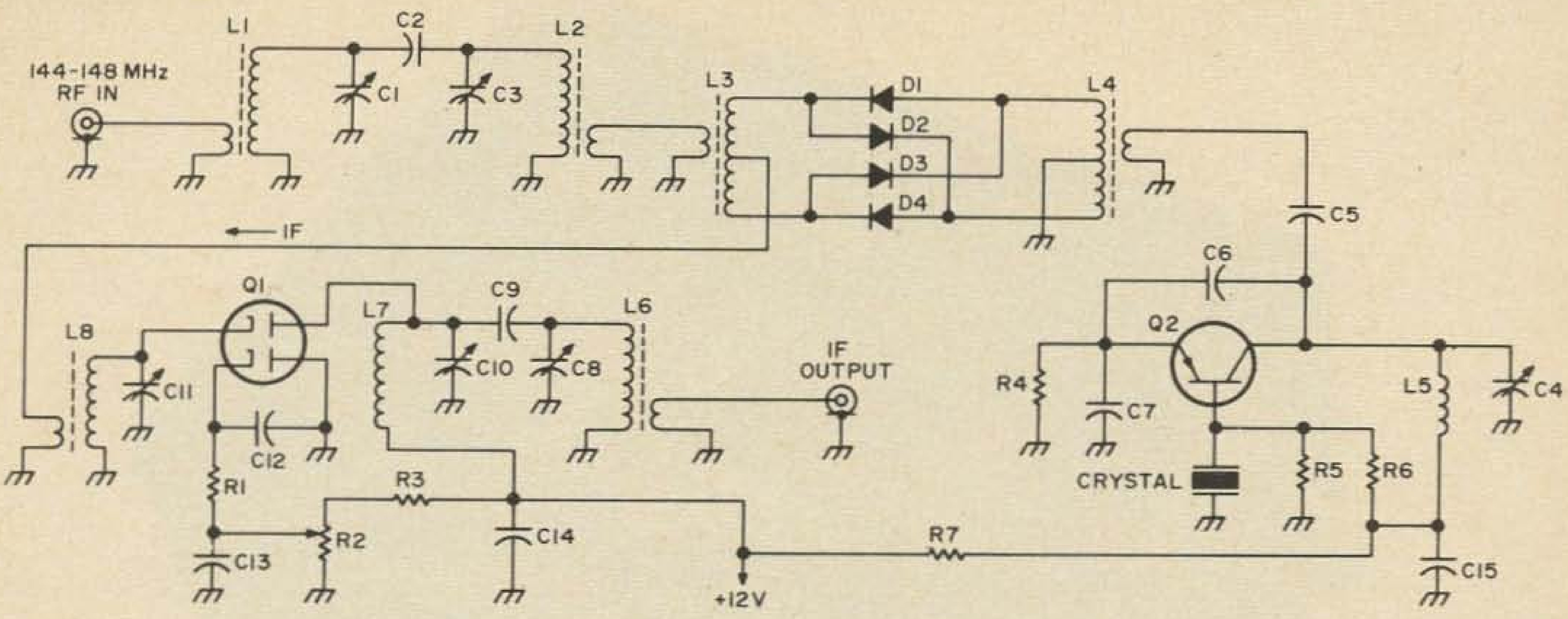
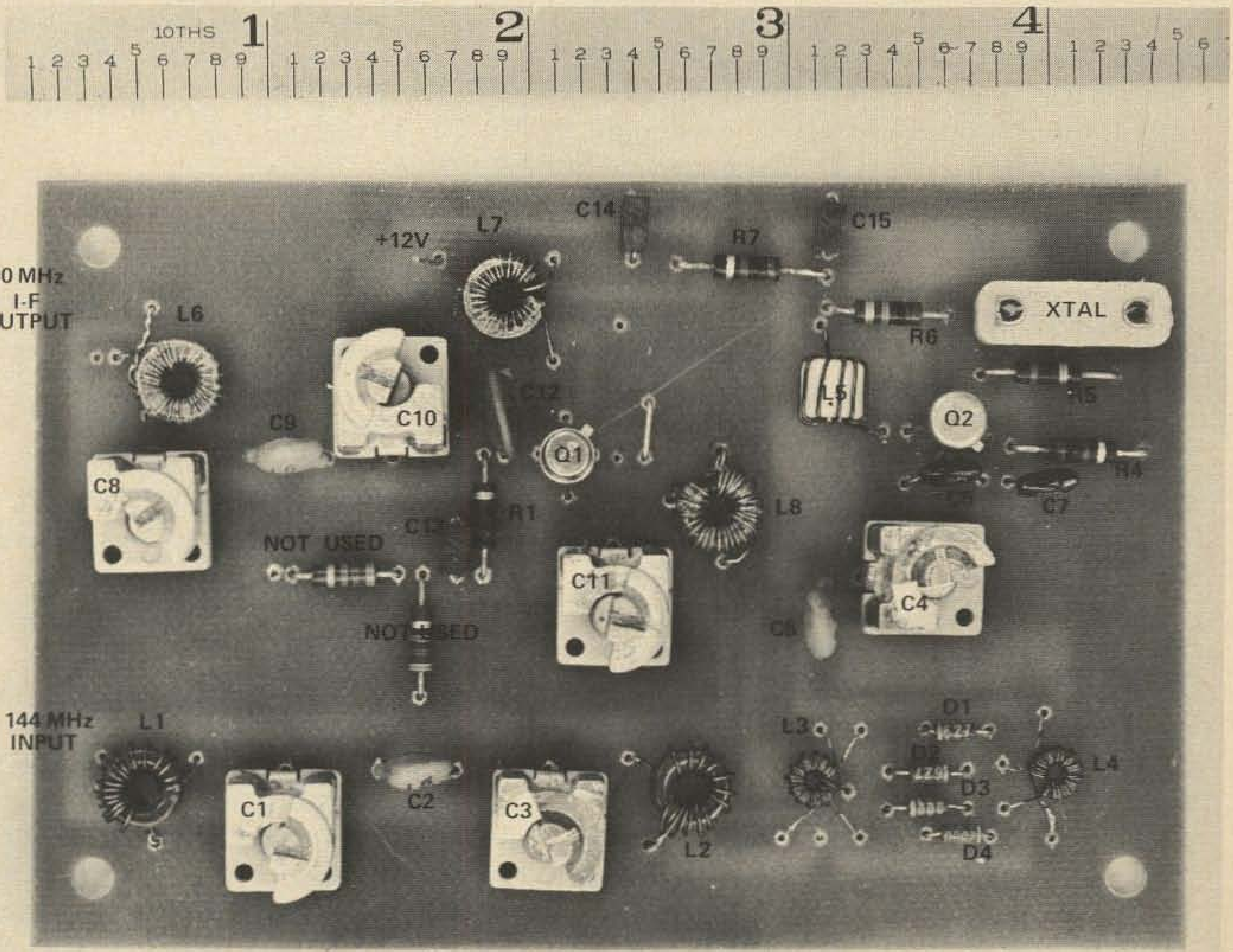


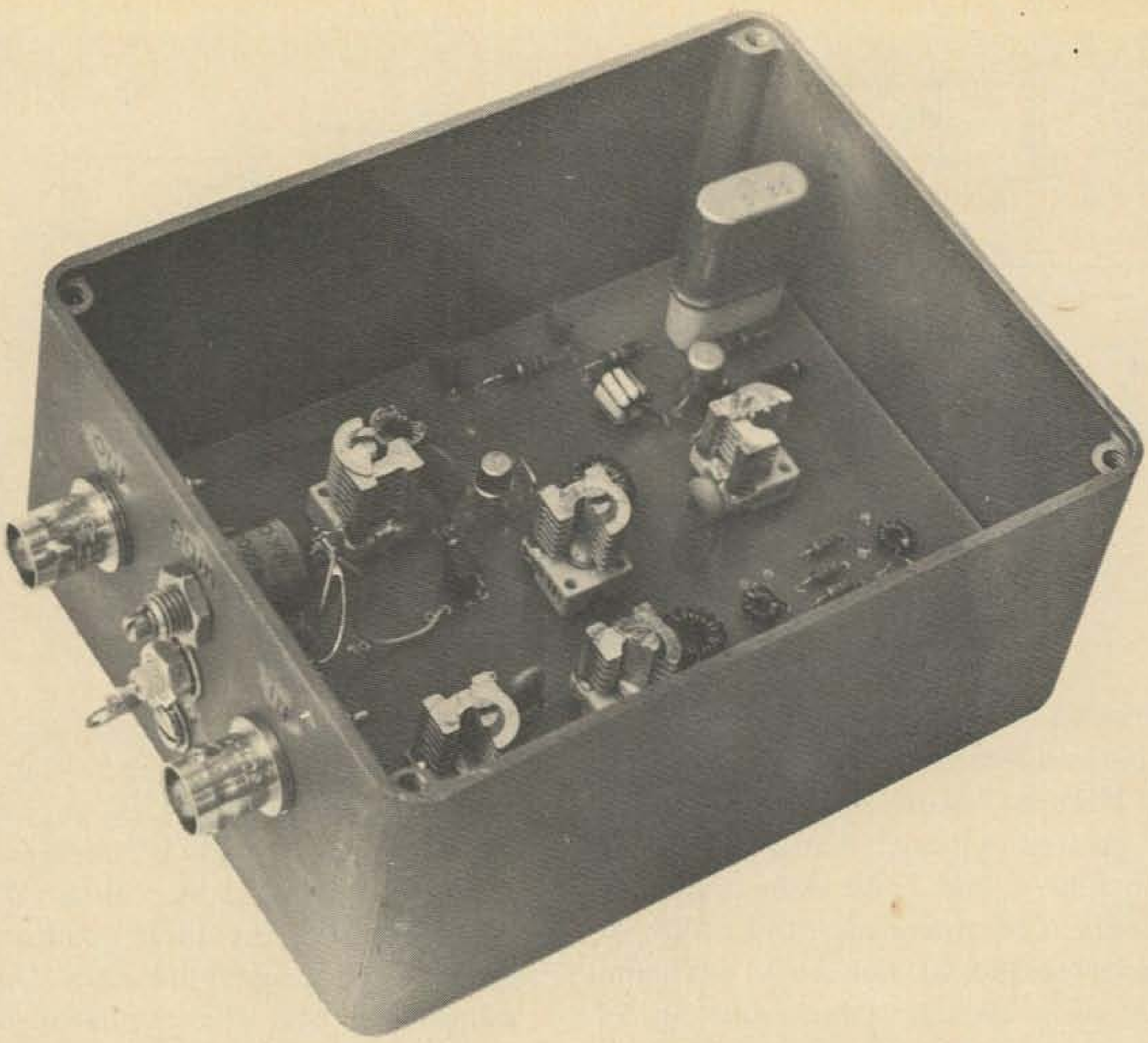
Fig. 8. 2 meter hot carrier diode converter.

and by others in their converters and it always plays right off. So don't fear getting this 116 MHz oscillator circuit to work.

The printed circuit board layout is shown in Figs. 6 and 7. By using it and the components recommended, duplication of this converter should not be a problem. The use of a passive mixer and an i-f amplifier that doesn't require neutralization makes tuneup very simple.

Alignment of the down converter is a simple matter. First, get the oscillator working and then peak the input filter and the i-f amplifier with a 2 meter signal. The oscillator is started by tuning C4 and using a wavemeter or the diode position on a grid dip meter as a signal indicator. Once you've established that the oscillator is running, feed a 2 meter signal into the converter input and peak the input filter and the i-f





amplifier for a maximum S-meter reading on your receiver. Optimum flat bandpass characteristics can be obtained for the input filter and the i-f amplifier if a sweep generator is available. Once the circuits are tuned, the i-f gain control is adjusted until the converter noise just overrides the receiver's noise.

Noise Figure

Since we are dealing with passive devices, which have insertion loss instead of gain, this loss is treated like an attenuator. The input filter, with insertion loss of approximately 1 dB, is followed by another device, the mixer, which has an insertion loss of about 6 dB (for a total of 7 dB). The noise figure of the i-f amplifier is 2 dB and, since a total of 7 dB attenuation appears ahead of it, the overall noise figure of the converter is 2 dB noise plus 7 dB attenuation – or 9 dB total.

The completed converter has a noise figure of approximately 10 dB, which will be more than adequate for local ragchewing, mobiling, and FM repeater work. Naturally, for weak-signal work it will be necessary to put a low-noise rf preamplifier ahead of the converter. The image rejection is determined by the input filter and for the worst-case image band of 84–88 MHz, it will provide 30 dB rejection. All other images are down better than 50 dB.

PARTS LIST

C1, C3, C4, C8, C10, C11: 1.7-14.1 pF; EF JOHNSON 189-505-S; 60¢ each.
C2, C9: 1.5 pF NPO Ceramic
C5: 2.2 pF NPO Ceramic
C6: 3 pF Silver Mica
C7: 15 pF Silver Mica
C12, C13, C14, C15: 1000 pF Disc Ceramic
R1: 2.2K ¼W
R2: 50K Potentiometer
R3: 47K ¼W
R4: 100K ¼W
R5: 2.7K ¼W
R6: 10K ¼W
R7: 1K ¼W
L1, L2: PRI 10 turns No. 26 on Micrometals; sec 4 turns No. 26 on cold end.
L3, L4: 12 turns No. 34 Tri-filar on Indiana General CF-120-Q1.
L5: 7 turns No. 26 on Micrometals
L6, L7: 24 turns No. 28 on Micrometals; L7 has a secondary winding of 3 turns.
L8: 24 turns No. 28 on Micrometals; primary 7 turns No. 28 on cold end.
D1, D2, D3, D4: Hewlett Packard HPA-5082-2805 diodes.
Q1: RCA 40602
Q2: RCA 2N5187

The converter will form an excellent base around which a top performing and versatile weak signal system can be built. You'll be pleasantly surprised by the clean quality of the converter. There will be a scarcity of birdies and images and it will be harder for strong nearby signals to overload the converter. ... WA6NCT ■

EXAMINING FM REPEATER OPERATION

Robert Kelty WB6DJT
2661 Carol Drive
San Jose CA 95125

Interest in amateur FM repeaters has grown in less than ten years to be a significant segment of VHF activity to which even diehard traditionalists are now turning. Hardly a major community exists around the country in which there is not some FM operation; and now, equipment suppliers are beginning to give serious attention to FM'ers. Repeaters grew up under regulations not originally envisioning such operation, yet were recognized in general as remotely controlled stations. Traveling around the country, one readily sees that each operates in a slightly different manner, with groups tailoring their nets to their own requirements.

Until late 1968 the ARRL, amateurdom's "official voice," hardly knew what a repeater (or remote base) was, and League publications carried little more than occasional mention. Meanwhile growth and interest has continued. Operation of remotely controlled equipment for group benefit has a certain cost reality; a successful repeater calls for organized support, often in club form, to insure permanency. In California a relay council was organized as early as 1966 to administer matters such as frequency coordination, standards, and to do advance planning at a level that would benefit all repeaters. Throughout the country individual groups began interfacing or providing means to tie to each other and the ARRL Board of Directors saw that repeater people were serious about what they were doing and had the finances and organization to continue growth almost without limit. The publication of an FM Repeater Handbook[1] in

[1] Radio Amateurs FM Repeater Handbook, Ken W. Sessions, Jr., Editors and Engineers, New Augusta, Indiana.

1969 gives adequate evidence that remote operation by VHF and UHF amateur operators from rf-advantageous permanent locations is indeed here to stay.

The importance of a large new segment of amateur interest was wisely recognized by ARRL directors almost belatedly and, seeing that the "Buffalo Petition" was a seriously considered necessity, they moved in 1969 to appoint a special committee to study repeater activity with an eye toward recommending FCC rules changes that would both correct inadequately written sections and enhance operation. In addition, the board voted for ARRL involvement at headquarters and for inclusion of a chapter on repeaters in the yearly handbook to stimulate interest. A separate League VHF handbook is still under consideration.

In 1970 the committee's final report and recommendations will be released and hopefully rules changes will be implemented to permit operation closer to realities which have often been discussed by "repeater people." It is to these proposed changes that we now turn our attention.

Getting the License

Licensing of a remotely controlled station has never been a major hangup, the procedure being almost adequately described in section 97.43 of Regulations. The applicant conforms in part by checking certain blocks on his standard form 610B and by submission of block diagram and description of proposed means of controlling the installation to prevent operation not in compliance with regulations.

For the most part, systems run cleanly and the intent of regulations is not circumvented purposely to the detriment of the service. Still, repeater operation is more closely comparable to PSIT[2] radio services rather than to "ham" type activity. Fixed, portable, and mobile operation on fixed frequencies naturally became abbreviated to the point that callups, logging, identifying, and control methods are somewhat different from that in which an operator hunts for a QSO with someone he may not know. Net operation always seems to be a cohesive that fosters good operating procedures because of the necessity of a good "net image" in the eyes of outsiders. The occasional maverick soon finds himself unwanted.

One of the rule sections being carefully considered by the repeater advisory committee has been licensing. It has been agreed in repeater circles that the present "remotely controlled station" category has too many implied restrictions.

In essence, a remotely controlled station is not described as a mobile relay (repeater), one which is used to extend mobile-to-mobile communications range. It appears that this valuable and now very popular application of equipment was not considered in original rulemaking and that the authors only thought in terms of remote base operation by individuals. The Commission has nevertheless considered applications on individual merit, granting licenses where the intent and presentation was in order. Hundreds of such installations are now in operation on prime coverage sites serving many thousands of VHF and UHF enthusiasts.

It is difficult to imagine that there are any licensees who don't recognize that the letter of the rules under which they operate is not being complied with. Many have tried to minimize this enigma by licensing as many as 38 individual control points,[3] licensing wives who are at home most of the day, placing control stations at places of business where monitoring can be accomplished, relying on an unlisted telephone which will deactivate the transmitter when dialed, or via a primary power control switch arrangement at a 24-hour answering service which can be turned off by an unlicensed operator on request. All are honest attempts to comply as closely as practical. All are clever interpretive applications.

[2]Public Safety, Industrial, Land Transportation, often called "commercial" land mobile.

[3]Grizzly Peak VHF Amateur Radio Club, Richmond, California (WB6AAE).

Properly licensing and operating a station is even more involved when one considers not only the VHF mobile relay but interfaced UHF, interconnection to other stations, extension to multiple pickup receivers, or selectively keying transmitters. Configurations take many forms.

A workable solution and one which the California Amateur Relay Council endorses is to establish two additional categories of station under Section 97.3, Amateur Unattended Station and Amateur Repeater Station, then license on a per case basis as described under 97.43 (with certain modifications), submitting proposed configuration as at present. Licensing procedures would thus be preserved more realistically.

Control Methods

Maintaining control of unattended transmitters has been a handicap to licensees because of rules rather than equipment. Monitoring of the emissions of remote transmitters from the licensed control point(s) plus provision of a 220 MHz (or above) control path (or wireline) places restraints on a system unnecessarily. Unattended-station users have reached a point of proficiency and sophistication to allow control on the VHF input channel above 50 MHz with adequate protection against stuck transmitters, deviations from terms of license, or undesired radiations. Timeout devices, carrier coding, or other similar devices are this protection. Although station responsibility must remain with a "trustee of license," he can easily record individual stations who normally use the remote station in his log once or the occasional transient at each occurrence.

Currently popular methods of insuring that only authorized stations perform the control function (placing the remote transmitter on the air) include "dial up" for the period of use, number sequencing known only by authorized stations, and "per transmission" coding (pulse tone or continuous subaudible). Occasionally rumblings are heard concerning discrimination against outsiders or maintaining "closed" relays but trustees are merely maintaining control while insuring that cost sharing is in effect. Purists new to VHF repeaters seldom see that the co-op station is a relatively new concept borrowed from "business radio" until they realize dollar investment in equipment, maintenance, and club costs.

As for suspending radiation in the event of deviation from terms of license, a means can be provided and described in license applications. Certainly a trustee is clever enough to meet this requirement in his own way when held responsible. Amateurs are marvelously self-policing by nature and it has been proved repeatedly that the willful violator has no regard for rules, ethics, or propriety no matter what constraints are placed on him. Responsibility can be enforced should such need arise by virtue of the trustee's application, license grant, and terms of license.

Identification

Despite relaxation of identification requirements in the past two years, many amateurs, especially those who have operated below 30 MHz for long, tend to dual identify, give location, and identify again. At one time this may have been practical and of some value, but today – especially when operating through remote VHF equipment, which usually is devoid of marginal signals – there is little need to prolong the callsign ritual. Operators who feel insecure or wish to prove to listeners their superb range will continue to take opportunities to give mobile locations frequently but the practice seems merely for display. Ragchewing will still be popular but has taken a slightly different hue and those operators who are still yearning for a wall certificate for staying on the air for extended periods have found that laudatory rewards are hard to come by on FM.

Repeater people have discussed extensively the time interval that should be required between callsigns and it is generally felt that 10 minutes is not asking too much. Still, the operator who becomes engrossed in multiple-party exchanges sometimes lets one of these intervals slip

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The newly designed Apollo is sensibly priced for the maximum number of hams – not outrageously beyond their reach. It is an invaluable instrument for tune up or testing of all amateur and low powered RF devices through to 200 MHz. Scaled 10/100/300 and 1000 watts at 52 ohms, the Apollo is unique in that a solid dielectric heat sink is used instead of the pesty liquid variety. Moreover, the large easy to read meter is zener protected in case you apply high power to a low power range. The load itself is rated 350 watts in dry air, is made of non-inductive Carborundum and when packaged in the Apollo can take up to 2KW on a ICAS basis. Additional protection is provided with a thermostatically controlled warning light adjusted to operate when the internal temperature reaches 175°F.

Additionally, this device enables a direct percentage of modulation readout on the 10 watt scale (for low powered transmitters).

One more fact, the Apollo load is flat through 40 MHz and usable with ±10% error up through 200 MHz. With full instructions and carrying handle on top it measures overall 11-5/8 x 5" wide by 7-3/4 in height inclusive of rubber feet.

Save money, know where you are at, and what power you are putting out. Tune up by means of the Apollo Dummy Load only $99.95 FOB Harvard.

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by. The fluid pattern of who is talking to whom is often difficult to confine in time frames.

Identification of remotely controlled transmitters at intervals, in voice or electromechanically is another area describable in shades of gray. A remote base can be identified without confusion, as can a repeater; however, when several people operate the station, who gives the assigned call? Or on a remote base with a UHF "up" and "down" link, is identification of the down link to be made? Or for that matter is it to be continuously monitored? Another level of interpretation is added when more than one station is operated simultaneously or interfaced. Most of us just tend to throw in a series of callsigns and let it go at that, for better or worse.

In "preliminary study committee" discussions, three-minute ID of repeaters has even been proposed for rules although saner types still feel little need to identify equipment to death unless they feel insecure among their listeners. The FM Magazine petition, a year in the making, is now before the FCC as RM-1542. This petition suggests a three-minute ID, too, but on a slightly different – and more reasonable – basis: it would have the ID take place after each three minutes of actual on-the-air time, rather than each three minutes of overall operation. But I think the most practical procedure would be to authorize "no announcement of callsign when station is operated as a repeater or unattended station," similarly to other land mobile licensees who request this attachment to their terms of license. We identify our own stations during exchanges, and the remote equipment carries this intelligence along with adequate indication to the ear that one is listening to a remotely controlled transmitter. Making identification permissive rather than mandatory, as Jay O'Brien (ARRL repeater advisory committee member) suggests, still leaves a group with the ability to advertise who they are. Or if they really like to fool around with identification, there probably isn't anything wrong with interesting "canned" announcements done by well known amateur voices as some Southern California addicts like to do. This type of creeping "Hollywoodism" is native to Southern California where it somehow seems fitting.

Station Logging

Log requirements for unattended stations are not defined in FCC Rules, Part 97.103 except that one could contend that a control station should comply with each subsection and record time of each sequence of communications, signature of operators using the station, and location of stations transmitting. To anyone who has listened to a repeater, even briefly, this is a tall order. Actual logs that might be examined reflect a very liberalized application of our outmoded rules for this type of operation, where several mobiles might be involved at any one time, traveling various routes. Hand-carried portables are becoming quite popular and present another variation. Minimizing of logging requirements is certainly in order.

It is close to universally agreed that recording time of retransmission capability, technical parameters such as power, frequency, and emission, date and time of changes of items to be logged, and signature of operator making adjustments comprise an adequate log. Redundancy of items that appear in individual logs should be eliminated. RM-1542 would have a "maintenance" log only, filled in during periods when the repeater site is visited for service or repair.

The ARRL study group has done a comprehensive job of evaluating the amateur repeater picture, drawing from its members as well as from discussions with repeater groups around the country. While this review reflects quite closely the interim reports of that committee, final report has not been completed and probably won't be until early spring.

We who have been involved with repeaters for the past decade look forward to rule changes by late summer of 1970 with the realization that by so doing the FCC will be formally recognizing the importance of this dynamically growing segment of amateur activity.

. . . WB6DJT ■

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Nashville TN 37214

a REPEATER CONTROLLER

The myriads of mechanical contrivances that repeaters inevitably wind up with can be replaced with transistor equivalents...with a resulting increase in system reliability and decreases in headaches for the repairman.

After operating an amateur repeater for several years it became quite apparent that the majority of our repeater failures were caused not by a malfunction of either the receiver or the transmitter, but by a failure of the carrier-operated relay (COR), the three-minute mechanical timer, or the *hang-in timer.*

We have been using the standard Motorola tube-type COR with a Telechron drive three-minute timer and an Agastat dash-pot timer for hang-in. We often had trouble with the Agastat mechanically shaking things loose in the repeater and middle-of-the-night wife-type complaints about the noise, particularly when a mobile was putting in a "picket fence" signal at 2 a.m. It's like waking up to a machine-gun.

In an attempt to eliminate the problem associated with these mechanical devices we began to work toward a solid-state system. Our objective was to reliably key the transmitter on both weak and strong signals, without any buckshot, and to provide carrier hang-in, automatic tone CW identification and a three-minute timer. We accomplished this with a Schmitt trig-

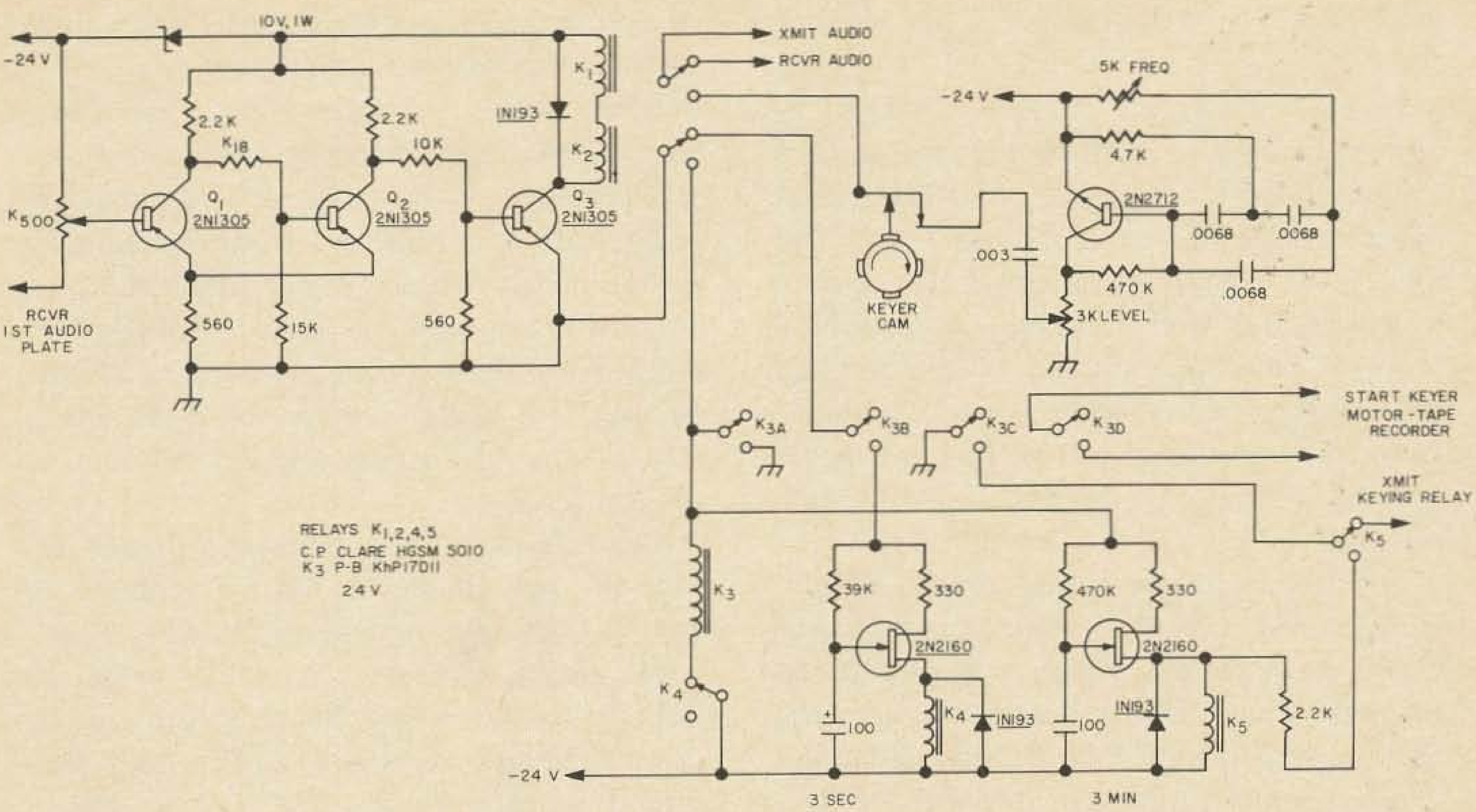

Fig. 1. Schematic diagram of repeater controller circuit.

ger operating from the change in plate voltage of the first audio amplifier in our GE Progress Line receiver.

The Schmitt trigger requires only a 2V change in a negative direction to switch on properly, due to the regenerative feedback of the direct emitter coupling. (Refer to Fig. 1.) Once it has switched, Q3 sees the 8V change on the collector of Q2 and turns on, causing series-connected relays K1 and K2 to close. This circuit and the relays have the capability of switching at speeds up to 20 kHz. Once K2 has closed, K3 latches itself closed through contacts K3A. When this occurs, the transmitter is keyed via K5 and K3C.

Since relay K3 is latched closed, when the received carrier drops out it cannot open and let the transmitter turn off; however, when relay K2 opens, voltage is applied to the three-second timer via K3B and K2, which causes the 100 μF capacitor to charge through the 39K resistor. When the capacitor charges to the breakover voltage of the 2N2160 unijunction transistor, it then discharges into the coil of relay K4 causing its normally closed contacts to open momentarily and allow relay K3 to reset.

In the interim period after K2 opens, K1 has switched the transmitter audio input from the receiver to the CW keyed tone for identification purposes. This provides an automatic "ident" every time a mobile releases his microphone. It also eliminates the squelch-tail noise burst from the reeciver since the Schmitt trigger will reset faster than the receiver squelch.

In the event an input signal is present in the receiver for longer than three minuts, another unijunction transistor timer — which starts its timing cycle as soon as the transmitter is keyed — will time out and latch relay K5 closed. This shuts down the transmitter until such time as the input signal is removed and the three-second timer times out and resets relay K3. When relay K3 opens, both timers are instantly reset (no waiting for the gears to unwind in a mechanical timer).

The tone oscillator frequency is set to 1800 Hz to allow its use for actuating other devices in the control link system on 450 MHz. A potentiometer can be bridged from the tone oscillator output to the transmitter audio input to provide a 1 Hz deviation of the transmitter on top of the receiver audio. This tone can then be used to key a 450 MHz link to another site.

In our system we utilize a 2 meter receiver feeding a 450 MHz transmitter (which keys a second 450-MHz-to-2-meter transmitter at a remote site). The tone gives us tone control of the remote transmitter as well as auomatic identification of both transmitters. We can also control the remote site by use of 450 MHz from our control points; in fact, we occasionally operate crossband to 450 MHz mobiles.

Our repeaters were built by using old, wide-drawer, GE MTS units and replacing the vibrator transformers with ac transformers. The controller mounts where the Secode was installed originally. It makes a nice compact repeater that can be carried in one hand.

Construction

The PC board can be laid out by first cutting the board to size and then drilling the required holes at the proper locations. Then, using the *rub-on* PC board decals, the proper circuit layout can be made easily right on the copper. If you have relays which are electrically similar to the photo of Fig. 2, simply drill holes and position the layout to fit your parts.

After laying the board out, wipe the board with a cotton sponge soaked in mineral spirits to remove the excess adhesive (which tends to ooze out from around the rub-on decals. This will give much sharper lines after etching in ferric chloride. To remove the decals after completion of the etching, we used a piece of steel wool (which also cleans the copper and makes soldering easy).

The board layout (shown full-size in Fig. 3) was made to fit an Amphenol 143-015-04 edge connector; however, the wires to the repeater can be soldered directly to the circuit board if desired. It does facilitate servicing and testing the unit if a connector is used. Figure 4 is a reduced drawing of the component side of the board.

The circuit diagram shows a 5K potentiometer in the tone oscillator to adjust the frequency; this is really not necessary unless you are going to use a tone decoder in the system that requires a specific frequency. In our system, we used a fixed resistor selected to produce 1800 Hz. Also, you will note that there are no connec-

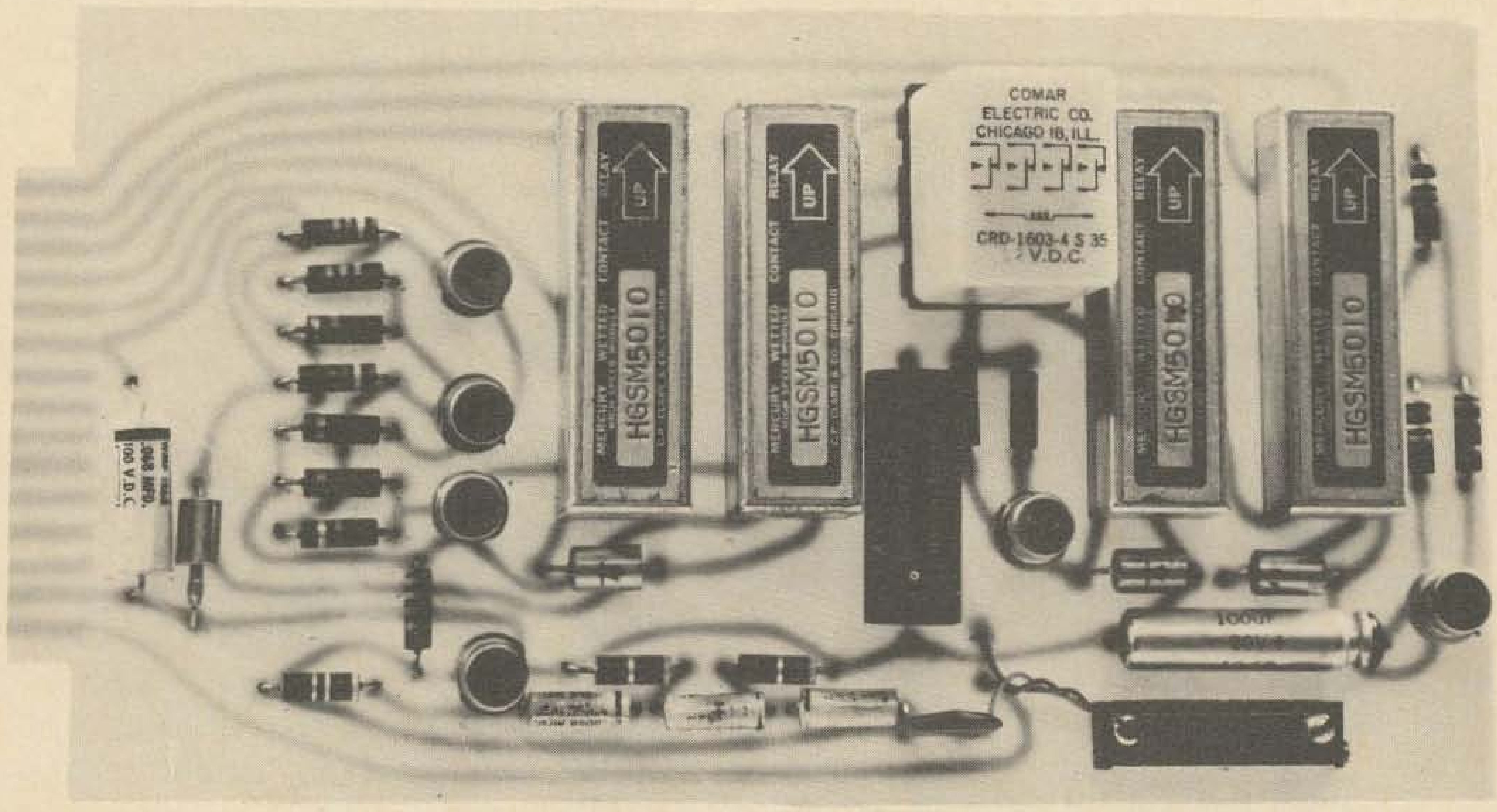

Fig. 2. A single circuit board holds all relays and other components of repeater controller.

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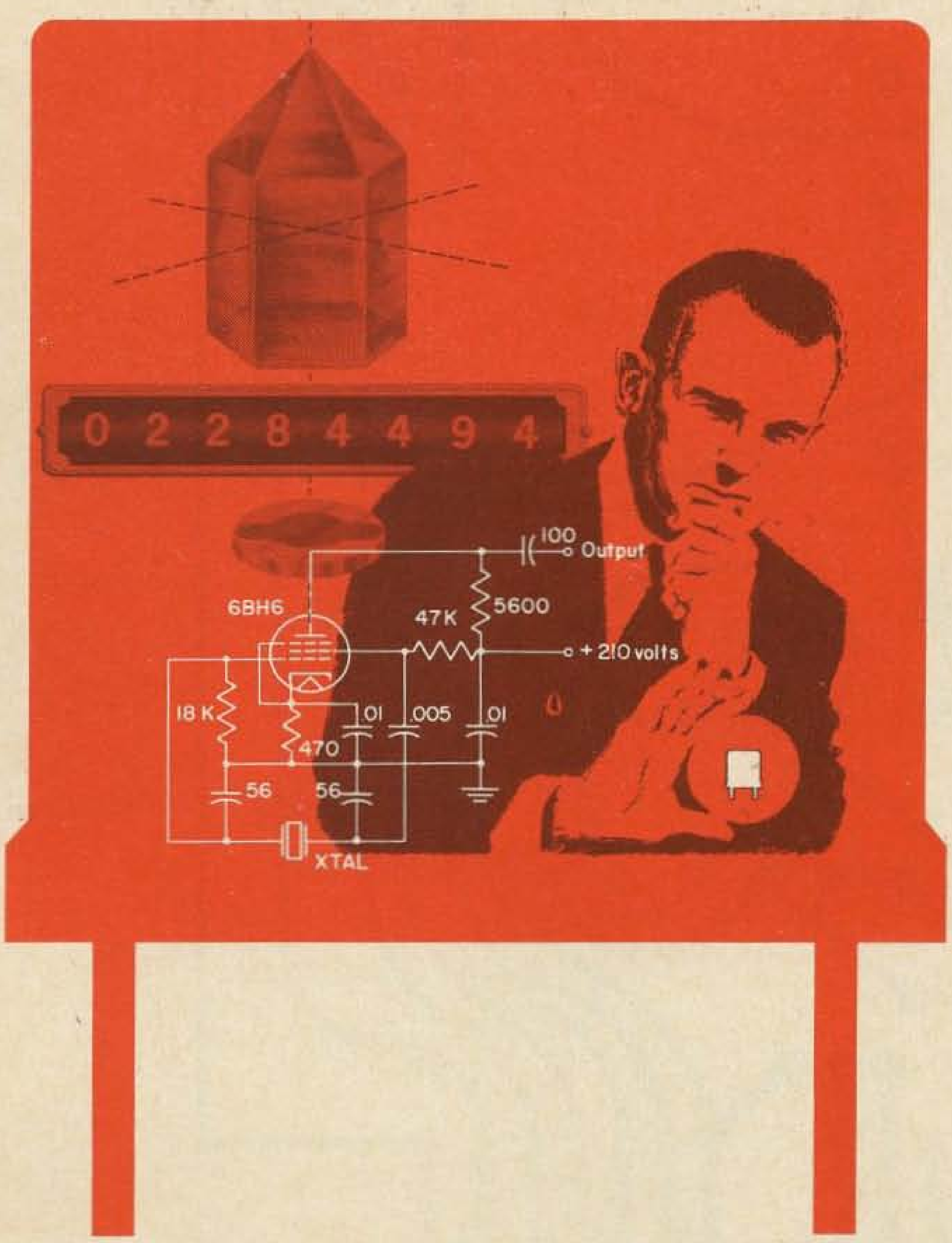

Space age communication equipment demands a crystal that meets all standards of technical advancement. Crystals that were acceptable some years ago do not meet present day specifications. As a general rule, your crystal must be selected from the best quartz . . . (no throw off cuts). Tight tolerances demand selected angles of cut. The x-ray is important in making this selection. The crystal should be preaged with stress cycling. It should be checked for frequency change vs temperature change. It must be checked for optimum spurious response. It should be calibrated to frequency with the correct oscillator. International Crystals are manufactured to meet today's high accuracy requirements. That's why **we guarantee all** International crystals against defective materials and workmanship for an unlimited time when used in equipment for which they were specifically made.

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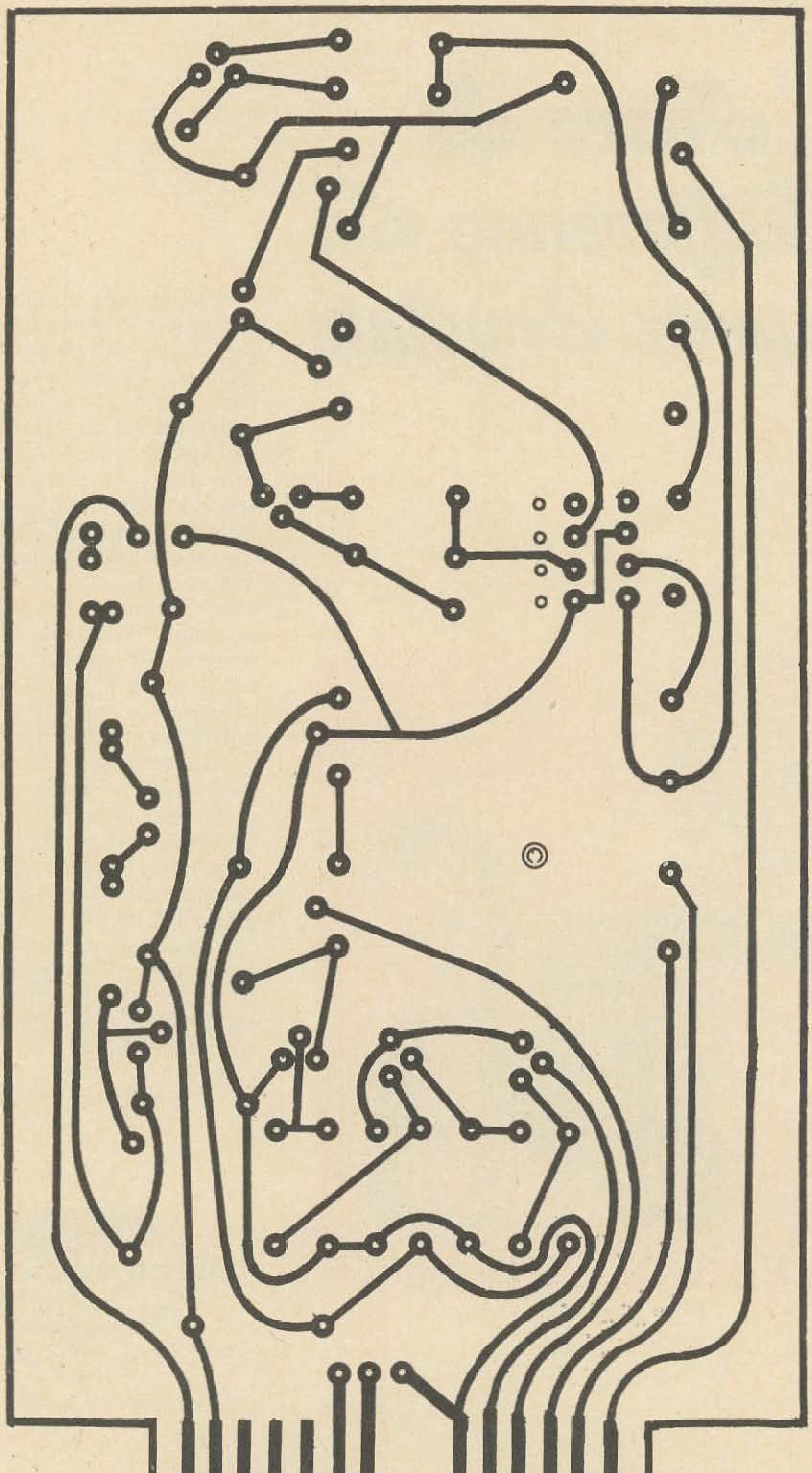


Fig. 3. Full-size layout of repeater controller printed circuit board.

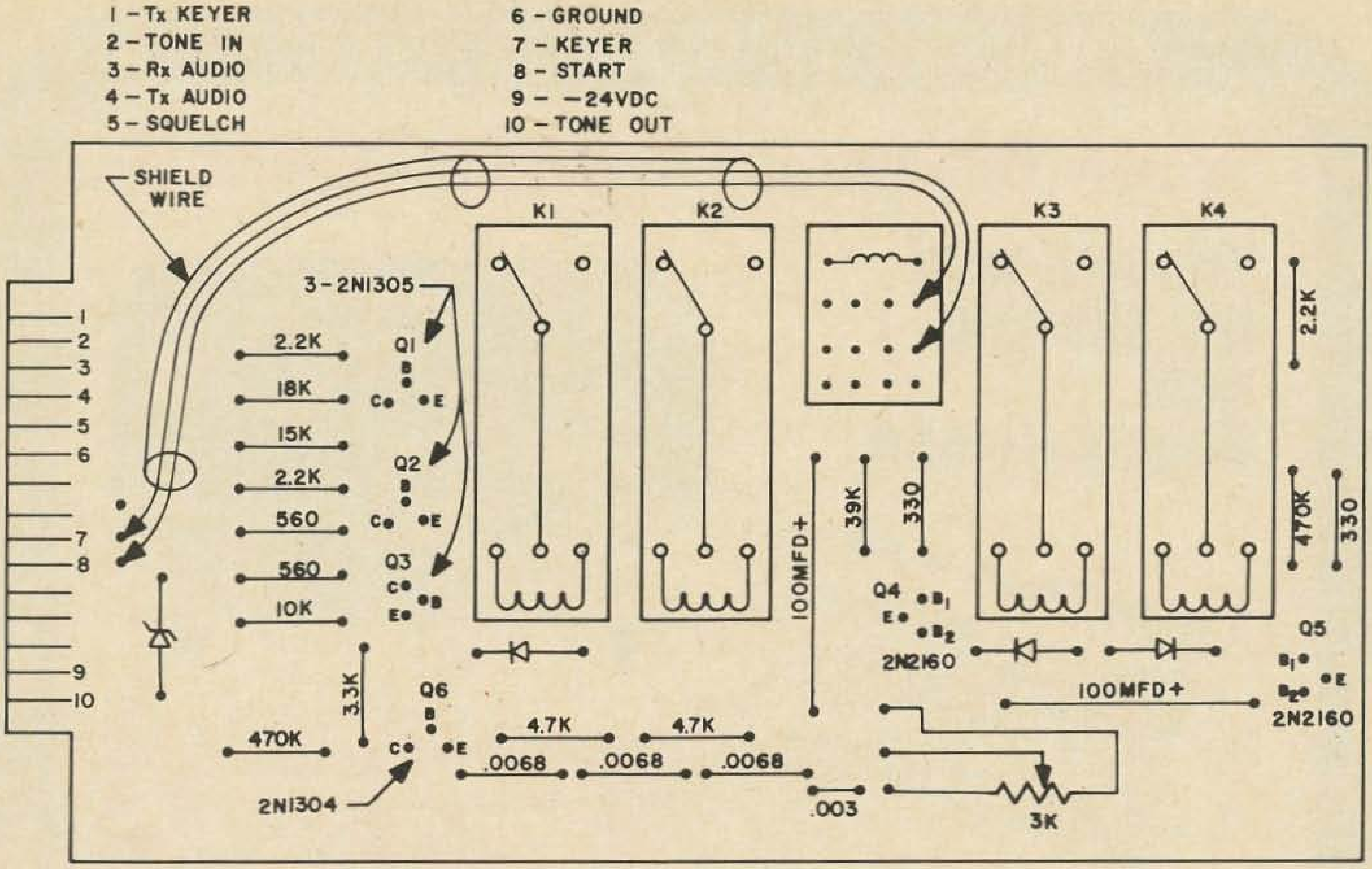


Fig. 4. Proportionately reduced sketch of board shows coding for components and wiring interconnects.

tions from section D of relay K3 to the edge of the PC board. Since this set of contacts switches commercial 115V power, we found it necessary to use a two-conductor shielded wire directly from the relay to the edge connector to eliminate hum pickup in the transmitter audio.

The controller can also be used in continuous-tone-squelch (CTS, Private Line), repeater systems where it is desired to key the repeater with the continuous tone transmitted by the mobiles, by using the circuit shown in Fig. 5. In this operation, When the reed contacts close, the 0.05 μF capacitor charges to the 24V supply, which is then applied to the base of input transistor Q1. This transistor then operates the controller and keys the transmitter. The time constant of the *RC* network is long enough to prevent the controller from following the momentary-contact closure of the reed. Since some reeds have a tendency to remain vibrating longer than others after removal of the input signal, you may wish to vary the value of the 0.05 μF capacitor as well as the input

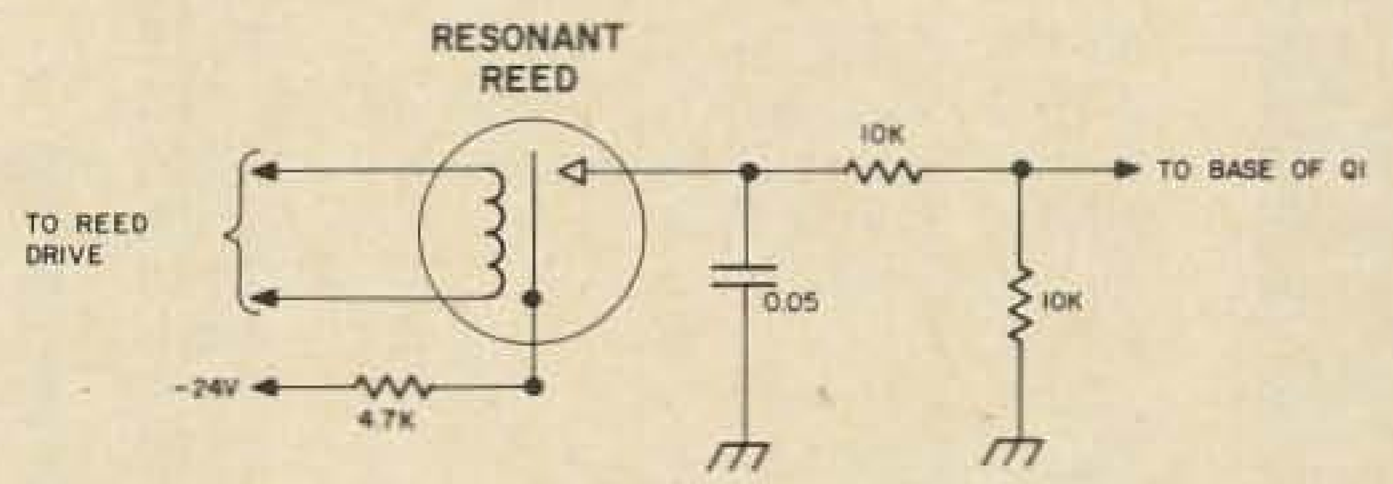


Fig. 5. PL-reed interconnections for use with continuous-tone carrier-squelch systems.

drive to the reed coil so that the repeater audio will be switched to the tone oscillator input in as short a time as possible after the tone input is removed from the reed. This will prevent receiver squelch noise from being transmitted momentarily at the end of each mobile transmission. This problem is minimized if your mobiles are equipped with a squelch-tail eliminator circuit, which provides a short burst of tone 180 degrees out of phase with the normal transmitted tone at the end of each mobile transmission, thus providing a damping action on the reed relay to stop its vibrations.

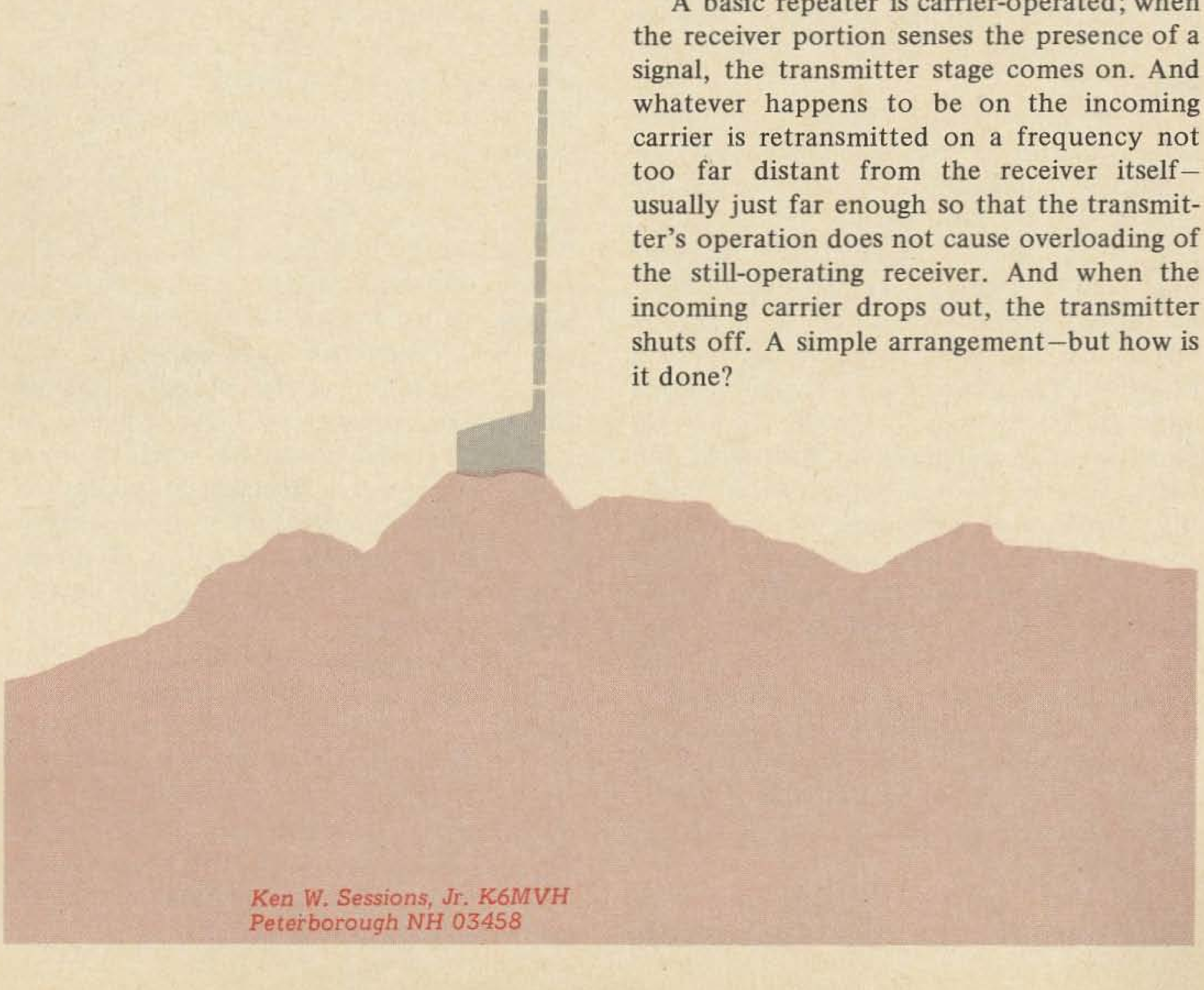
. . . WA4YND ■

UNDERSTANDING THE CARRIER-OPERATED REPEATER

The complicated repeater is not really so complex after all...it's only a matter of understanding the simple operations that are taking place when somebody transmits on the input frequency.

In spite of what the local repeater talent would have you believe, the big machine up there on the hill—or on the top floor of the city's biggest building—is really a pretty simple arrangement of gear. That is not to say that it hasn't been sophisticated, with the incorporation of perhaps a remotely controlled telephone, some sexy control devices, or maybe an automatic input-frequency switching and selection system. But strip off all the chrome and there's not much dazzle left. A repeater is something anyone can build—and without as much effort as you might think.

A basic repeater is carrier-operated; when the receiver portion senses the presence of a signal, the transmitter stage comes on. And whatever happens to be on the incoming carrier is retransmitted on a frequency not too far distant from the receiver itself—usually just far enough so that the transmitter's operation does not cause overloading of the still-operating receiver. And when the incoming carrier drops out, the transmitter shuts off. A simple arrangement—but how is it done?



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Peterborough NH 03458

Understandably, a repeater is a bigger mystery to the devoted AM operator. His thinking is limited generally to the workings of the typical AM receiver, and he finds it difficult to see how a receiver can be easily and cheaply made to operate next to a transmitter on the same band without "blocking." He may also have trouble understanding how the transmitter of a repeater can be made to come on without fail when a signal appears, yet NOT come on when noise and garbage are present on the repeater input channel. Which brings us to the reasons why VHF repeaters are virtually always FM.

It is not within the scope of this article to get involved with AM versus FM in terms of operational performance. There are many convincing arguments for FM on that basis alone, but they are, after all, just that: arguments. The prime reasons that repeaters are made to operate in the FM mode are that FM receivers are inherently less susceptible to the normal interferences of the amateur bands and FM receivers are factory-equipped with electronic switches capable of reacting to the presence or absence of legitimate signals.

As it happens, the typical interference noises that occur on the VHF bands are amplitude-modulated. Fortunately, FM receivers are, by their nature of operation, deaf to AM signal components. FM receivers have built-in limiters that reject amplitude-modulated signals. When the AM signal is riding on a healthy carrier, the FM receiver filters out the audio completely and permits only the rf to come through. If the AM signal is weak and noisy to start with, the FM's electronic switch doesn't even believe it's a signal at all, so nothing gets through to the speaker—not even the noise.

The electronic switch is a squelch. To the wives of hams, it is perhaps the greatest invention since earplugs. The squelch on an FM receiver keeps the audio amplifier (and, thus, the speaker) shut off unless a definite signal is present. The big difference between the squelch on an FM receiver and one on an AM receiver is that the FM squelch can't be fooled by noise.

The fact that FM squelches are trick-proof makes them particularly adaptable to repeater applications. If the squelch is used to trigger the transmitter when a signal is sensed, and to turn the transmitter off when the signal goes away, the mysteries of carrier operation begin to disappear. An AM repeater operated by the squelch typically found in AM receivers would keep the repeater transmitter keyed every time the noise level at the repeater site rose a bit. And if the repeater were adjusted to compensate for the noise, half the signals on the input frequency wouldn't be capable of actuating the repeater.

This can be explained on the basis of another phenomenon: For more reasons than those already cited, weak FM signals are virtually noise-free while weak AM signals must compete with the noise. (This statement is made with the assumption that the listener is receiving on a receiver designed for the mode. Many would-be FM'ers never quite made it over from AM to FM after comparing AM signals with those of FM and deciding that, watt for watt, AM was better. But they made their judgments based on comparisons made with their AM receivers! All the noise that was there—but unhearable by the FM receivers—probably all but wiped out those "band-wasting" FM stations.)

Where repeaters are concerned, noise works to the advantage of the FM'er, even though to the detriment of the AM'er. The reason: FM squelches are noise-operated; the higher the noise level on the band, the less apt the repeater will be to get keyed on. A signal, regardless of its strength, has the peculiar characteristic of quieting the noise. And with carrier operation, when the noise goes, the repeater transmitter comes on. Since noise is always present in the absence of a signal, the transmitter of a carrier-operated repeater cannot be keyed unless a signal is present.

A typical FM squelch circuit is actually a very simple device. Its formidable appearance on a receiver schematic is attributable to the Rube Goldberg manner in which it operates. Consider the block diagram of Fig. 1, where the last four stages following the low i-f of a General Electric Progress Line FM receiver are pictured across the top. The audio-carrying low i-f signal is fed from the second limiter to the discriminator, which separates the af from the rf, and feeds the audio to the amplifiers and speaker. By electronically turning the audio amplifier on and off, the signal reaching the speaker can be controlled. And this is precisely the function of those elements shown below the four top blocks.

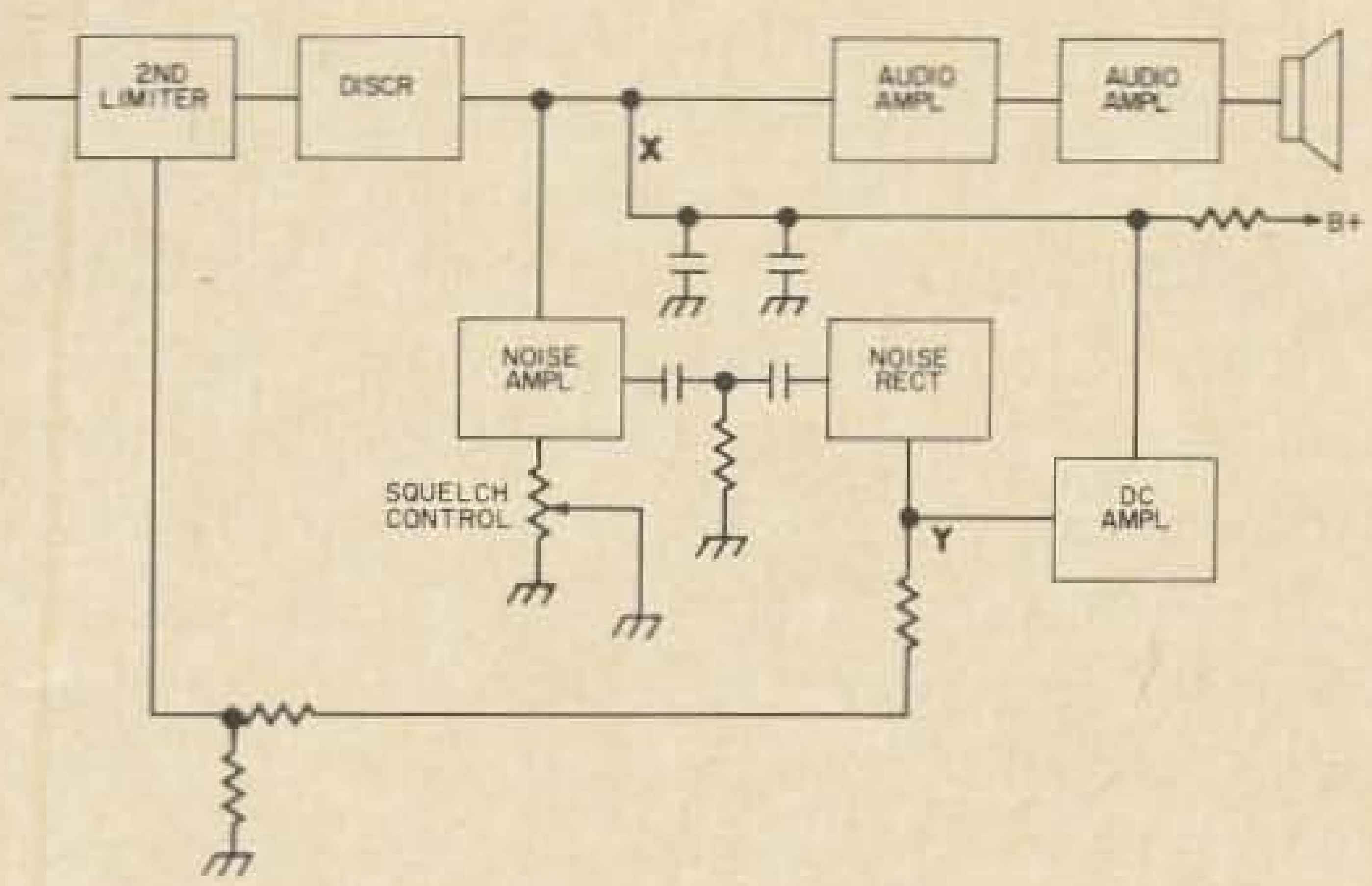

Fig. 1. Combination schematic and block diagram showing squelch arrangement in typical FM receiver.

The object of the network of components in the squelch train is to provide a negative voltage at point X when no signal is present. This negative voltage keeps the audio amplifier cut off so the speaker is silenced. The B+ applied to point X through the series resistor keeps the signal biased positively unless the dc amplifier is conducting. And the dc amplifier will not conduct unless there is no signal present. Or, stated more simply, the dc amplifier does not conduct when a signal is sensed by the receiver.

The audio signal from the discriminator, as previously mentioned, always bears noise unless a signal is on hand to quiet the audio line. This noise is amplified to the extent required for effective squelch action (adjusted by the squelch control), and rectified. The positive output voltage is fed to the dc amplifier along with a negative signal from the second limiter.

The second limiter grid supplies the negative signal through critical balancing resistors. The signal here is relatively stable because the limiter operates in a state of near saturation even when no carrier is present. Since the noise rectifier supplies a positive signal, the dc amplifier sees the balanced sum of the two supply points. An imbalance exists when the noise rectifier output increases to the point that causes the dc amplifier to conduct.

The capacitors along the X line are included in most receivers to hold the squelch open for a short time after the carrier drops out. This prevents rapid on-off fluttering of the repeater transmitter when a weak station is operating on the input frequency. The squelch "tail" can be lengthened by raising the value of these capacitors (thus increasing the charge time), and almost eliminated completely by removing them altogether.

Getting a transmitter to turn on and off in response to an incoming signal is simply a matter of applying the squelch principle to an additional stage. The carrier-operated relay schematic shown in **Fig.** 2 is a modified version of the type GE used on its nontransistorized commercial repeaters, and it is perhaps the most popular single circuit in use by amateurs today.

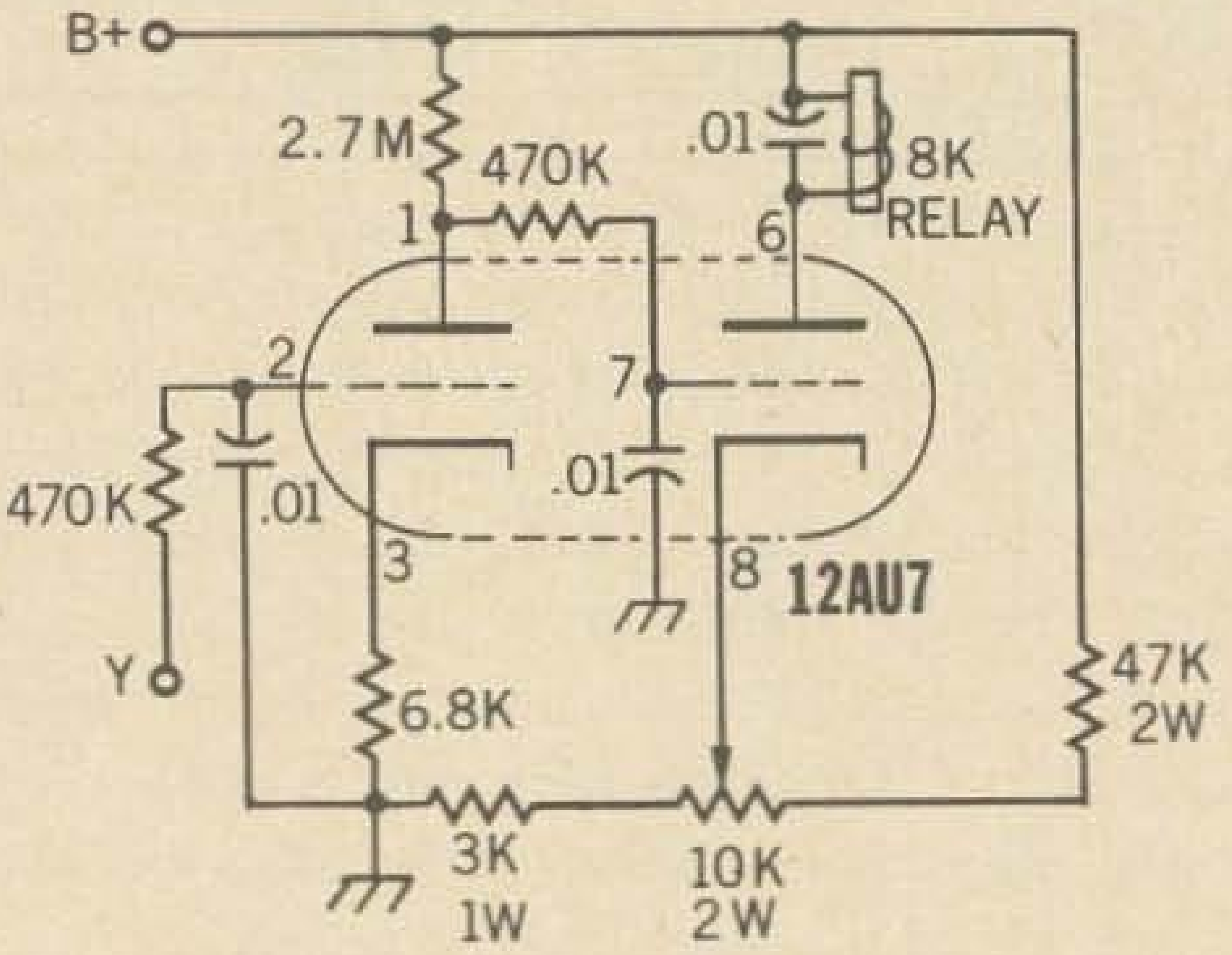

Fig. 2. Carrier operated relay.

Undoubtedly, a number of prospective repeater builders will look at the circuit and be appalled by the fact that it is not solid-state. Well, there's a good reason. Solid-state carrier-operated relays are available and easy enough to build, but the amateur world isn't quite ready for them yet. Solid-state devices require low-voltage dc; most repeaters are tube-type. And it is a lot simpler to build a tube-type relay circuit for a tube-type receiver (with its already available power supply) than it is to build a solid-state relay and be saddled with the task of building up a special power supply to drive it.

The signal input to the 12AU7 grid of **Fig.** 2 is provided from the point marked Y on **Fig.** 1. The mechanical relay in the plate circuit of the second half of the tube is a current-sensitive relay with a coil resistance of 8–10 kΩ. The push-to-talk circuit of the repeater is keyed indirectly by the contacts of this relay.

The 10 kΩ pot in the cathode circuit should be rated for 2W and should be a wirewound type. This pot sets the threshold of the audio squelch.

Just one last word or two about carrier-operated repeaters: The relay shown in **Fig.** 2 should never be used to perform direct switching of push-to-talk circuits. The contacts of these sensitive relays are generally quite delicate and are thus easily fouled. Regardless of a repeater's inherent simplicity, the plate relay should always be made to drive a "slave," which should be a heavy-duty type with as many contacts, both normally open and normally closed, as possible.

In one way or another, a carrier-operated relay figures into just about every automatic operation of a repeater, for active as well as passive applications. The normally closed position allows disconnection of functions during transmit, removal of voltages during control selection, and operation of timers for automatic shutdown when the repeater is unused for predetermined periods. The normally open position allows audio and push-to-talk switching, timer keying for automatic shutdown on excessively long transmissions, and initiation of functions that must occur during the presence of a carrier. To be universally applicable to any possible control function, the carrier-operated relay slave should have several sets of unused contacts in addition to contacts which provide these basic logic signals:

- Ground when signal is present on repeater input and only then.
- Control voltage available when signal is present and only then.
- Ground when no signal is present and only then.
- Control voltage available when no signal is present and only then.

. . .K6MVH ■

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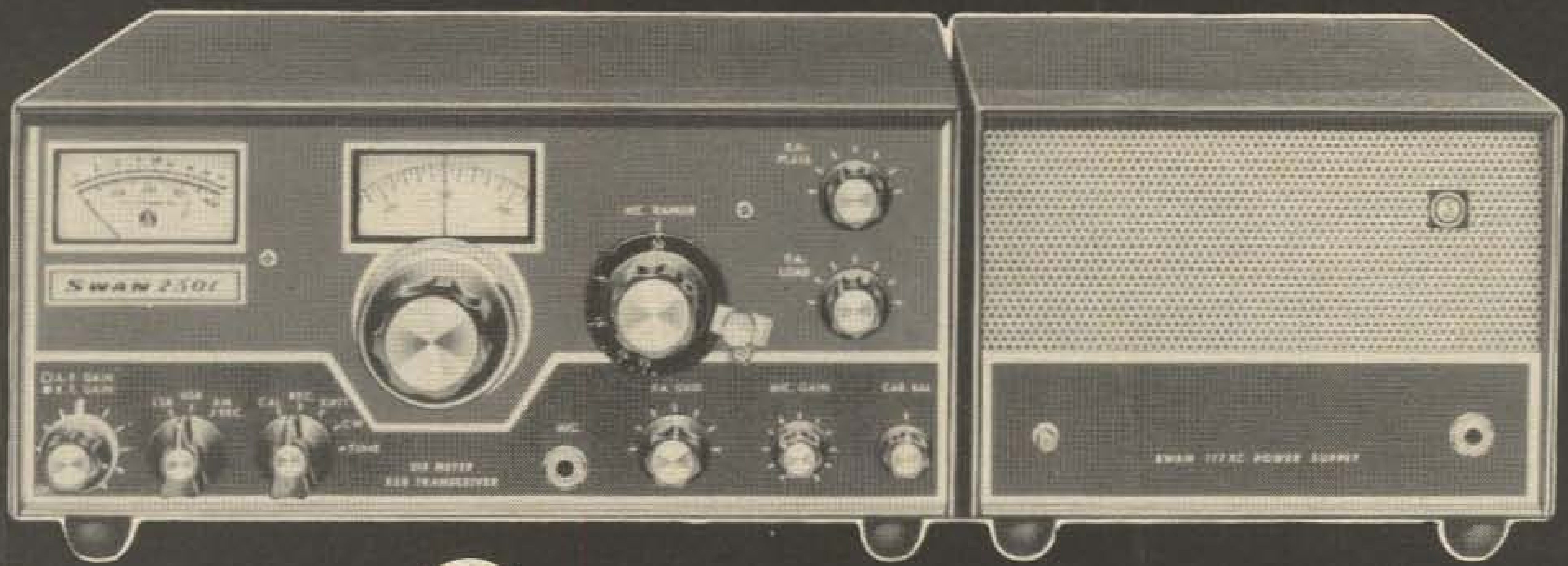

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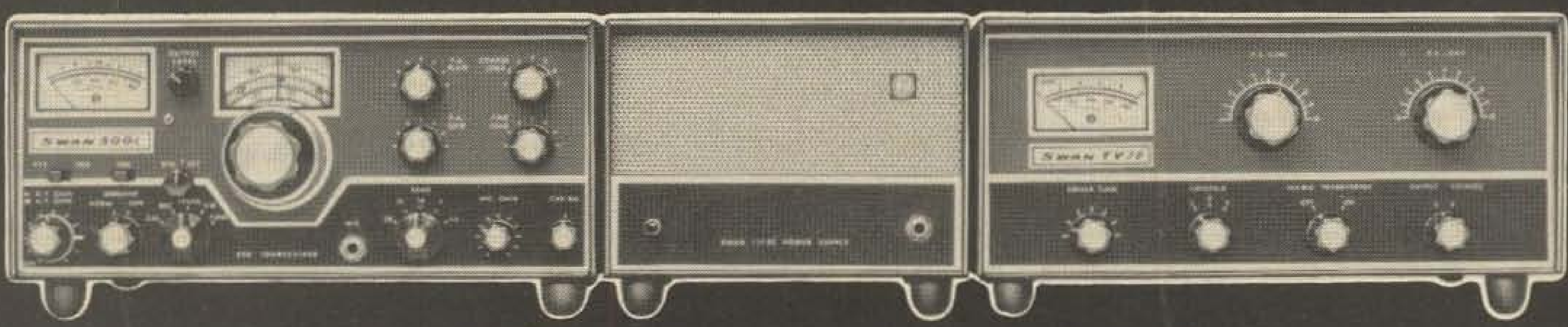

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EVALUATION

STANDARD SR-C-806M SOLID STATE 2 METER NBFM 12 CHANNEL TRANSCEIVER

A short time ago I had a large assortment of antiquated surplus police and utility company wideband FM communication equipment. Suddenly all of this changed! I became the proud possessor of a Standard SR-C 806M 2 meter transceiver. But I'm getting ahead of myself.

My 2 meter FM activity was quite varied; mobile (repeater and simplex), base station, and a Handie-Talkie to take on frequent trips out of the immediate area. The investment in this hodgepodge of miscellaneous gear was no small amount. Nor would the size and appearance of the equipment win any beauty contests!

I was also motivated by the fact that I was about to take delivery on a new 1970 Buick Riviera. The available trunk space was ridiculously small. Dash mounting of a control head also presented serious space problems. Consequently, the introduction of the new line of completely solid state 2 meter FM transceivers for amateur use prompted me to close the obsolescence gap.

The clincher which guided me to the Standard was the 12 channel feature, the three levels of power available (with the external amplifier), and its small size and weight. The Standard SR-C 806M appeared to satisfy all of my requirements. There are several repeaters functioning in the San Francisco area and its environs. My trips take me to other areas that have repeaters operating on different frequencies. I also desired to operate "simplex" on 146.65 and 146.94 MHz and use "reversed" crystals on WB6AAE, the repeater operated by the club to which I belong. Reversed crystals are sometimes useful when the repeater is out of order or when a group is out in the "boonies" and out of range of the repeater. Consequently, my window shopping came to an end when Standard announced a ham version of its marine transceiver. (I had recently seen the Standard SR-C 801 SAR VHF rig developed for the new marine band, and was impressed with its small size, workmanship, and operating characteristics.)

I ordered the rig, hoping to coordinate its arrival with the new car. The car arrived a month after the rig, but this gave me the chance to try out my other objective; namely, to try the rig in several vehicles. I found that I could unpack it and its accessories from my attache case, plug the power cord into the cigar lighter socket, put the magnetic-base antenna on the car roof, complete the hookup and be on the air in less than five minutes!

I went "whole hog" by also getting the ac power supply and the 25W rf amplifier. The rig came with a microphone and connecting cables. The price of the rig also included crystals for four channels. I also ordered crystals for the out-of-town repeaters and had jumpers put in to provide other input/output combinations without the need for additional crystals. This is easy to arrange by using the same crystal for more than one channel "pair."

The semipermanent installation in the new car took a little longer. I had forgotten that I had ordered a tape deck stereo. This precluded mounting the rig under the dash. The size of the rig is 2¼"H x 6"W x 9"D and weighs in at just over 4 lb. The obvious place was under the tape deck and attached to the "hump." The shop foreman where I work helped build the custom mount shown in the photo. The external power amplifier was tucked under the dash but out of the direct blast from the heater ducts. A GAM type TG-2R antenna was mounted near the leading edge of the trunk lid. The deck area immediately behind the window was not accessible because of the rear window ventilation equipment and ductwork. The encoder and tone burst control was placed in the mike line. Standard provided me with extra plug and socket which I wired into the tone box. This permits the option of plugging the mike into either the tone box or directly into the rig. A simple modification to the rig provided the optional ability of automatic tone burst whenever the transmit key is depressed. There is a fourth wire in the mike receptacle to bring the receiver audio out for the handset option. Since I do not use a handset, I used this terminal for the "switched on B+" necessary to operate the automatic tone burst.

The internal 2½ in. speaker is a square type with exceptionally good audio. I also have the 4 x 6 in. oval speaker for shack use. When the latter is plugged in, the internal speaker is muted. The small speaker has plenty of output to fill the car with easy copy.

I have had some difficulty with alternator whine getting into the transmitter and going out on the air along with the audio. This appears to be a function of the car being used and how hard the alternator is working. Standard is coming out with a filter to go in the supply line but I have not seen it yet.

Standard's SR-CL25 power amplifier has been very useful when operating in fringe areas. Whenever someone reports that my signal is a little "scratchy," I boost the power to the top and become full quieting. It was also interesting to see how often I could drop the power to the 800 mW output position and still be heard!

The receiver has been excellent in its operation. The published specs on this rig stated a 0.3 μV threshold sensitivity, and the results bear this out! Squelch action is also good. If I did not want to listen to the ragged edge I would tighten it a little, thereby raising the threshold, and eliminate the squelch scratch.

The operational manual has been a problem because it is written in Japanese. The phonetic characters (Katakana and Hirugana) I could translate because I was a "guest" of the emperor for three years during WW2. The Kanji or picture language was too much for my meager knowledge of their language. Standard has informed me that there will be an English translation available at about the time this article appears in print.

The control knobs are a little crowded. I have had some difficulty turning the channel selector knob because of its proximity to the mike jack. Two sets of pressure transfer numbers were provided to identify the channels. I preferred to mark the channels with the large numbers 1 through 12 rather than the very small numbers which post the frequencies in MHz. The large channel numbers can be easily seen while mobiling whereas the small frequency numbers are too small to see at arm length. A quick glance while driving is all that is needed to know what channel is being monitored. In almost no time I was able to remember which channel did what. Also, if I ever change the relative location of the crystals or add more to work other frequencies I will never have to touch the channel selector dial.

Warranty. So far it has been good. I have had some problems but that is understandable because the serial number on my rig is # 001. In fact, it was somewhat of a prototype or engineering model. After about 6 weeks of fairly rugged use the 10W power level became inoperative. It was quickly repaired by the local rep. Later on, the power selector switch developed a problem in that it would not properly shunt out the limiting resistor which was the method used to raise the power from 0.8 to 10 watts. I recommended to the factory rep that Standard install a "dump rectifier" to limit arcing at the switch contact in case power level was changed during transmissions. So far, I can say that the warranty has been backed with satisfaction.

Overall satisfaction. For my purposes the rig has come up to my expectations. With my other rigs I was unable to transmit or receive from many locations. These areas are now solid copy. For example, "Zero Microvolt Valley" just north of San Rafael, Calif. provided a challenge for my rig which was clearly conquered. A large traffic tunnel which used to be a total blackout for me now provides good two-way coverage; I can copy throughout its length and be heard by the repeater except for a few hundred feet at dead center.

This article does not take the space to list the information on the manufacturer's data sheets or specifications. These can be obtained from Standard Communications Corp. or its local representatives.

. . . W6QGN ■

The editors and Engineers Radio Handbook is by far the biggest and the best handbook in print. Here is your chance to get this great book at a substantial discount, if you act fast. We have just 500 copies on hand and when they are sold that will be the end of the bargain. You either will get one of these 500 or else have to pay the full price to buy this fabulous handbook.

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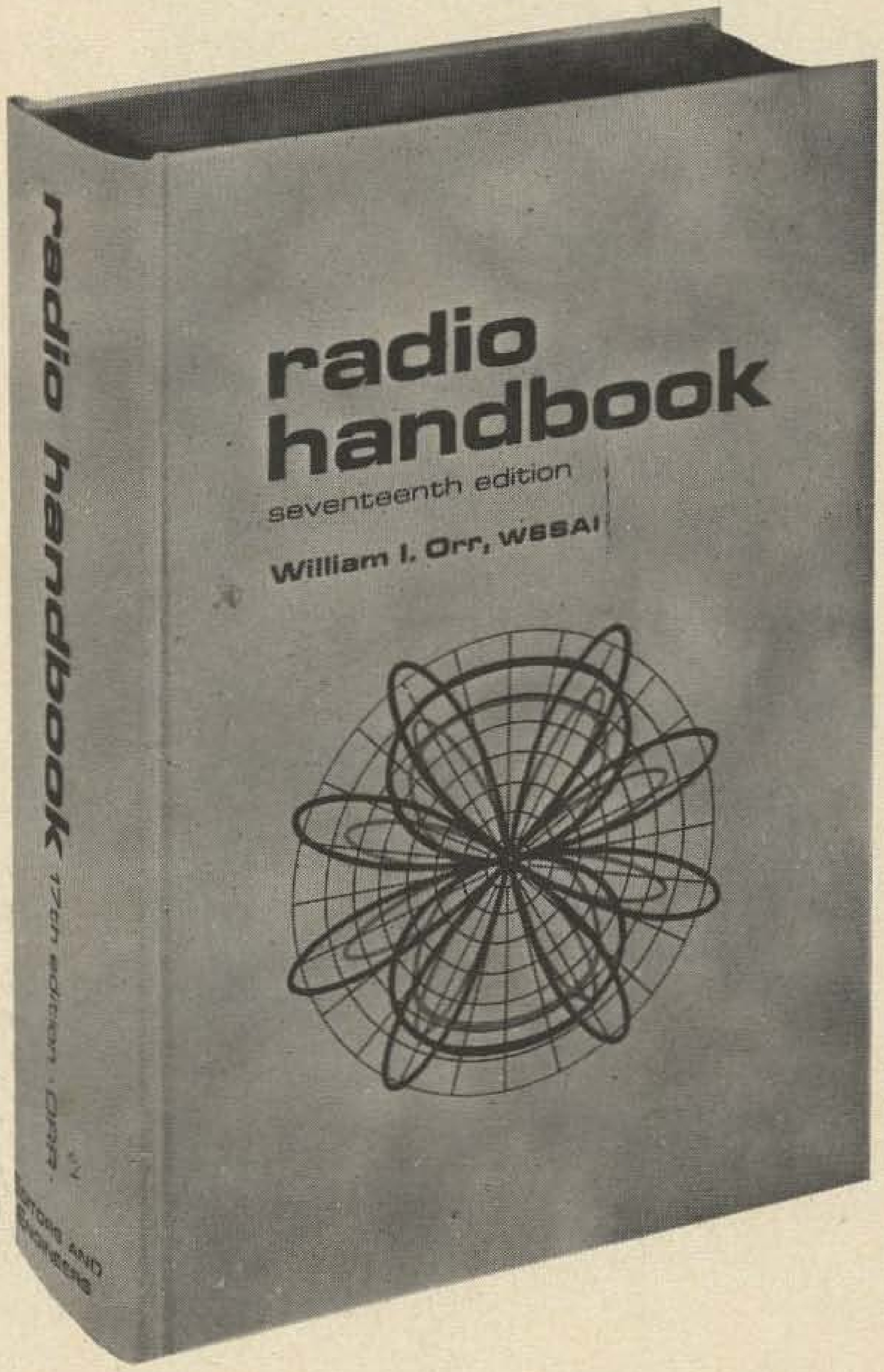

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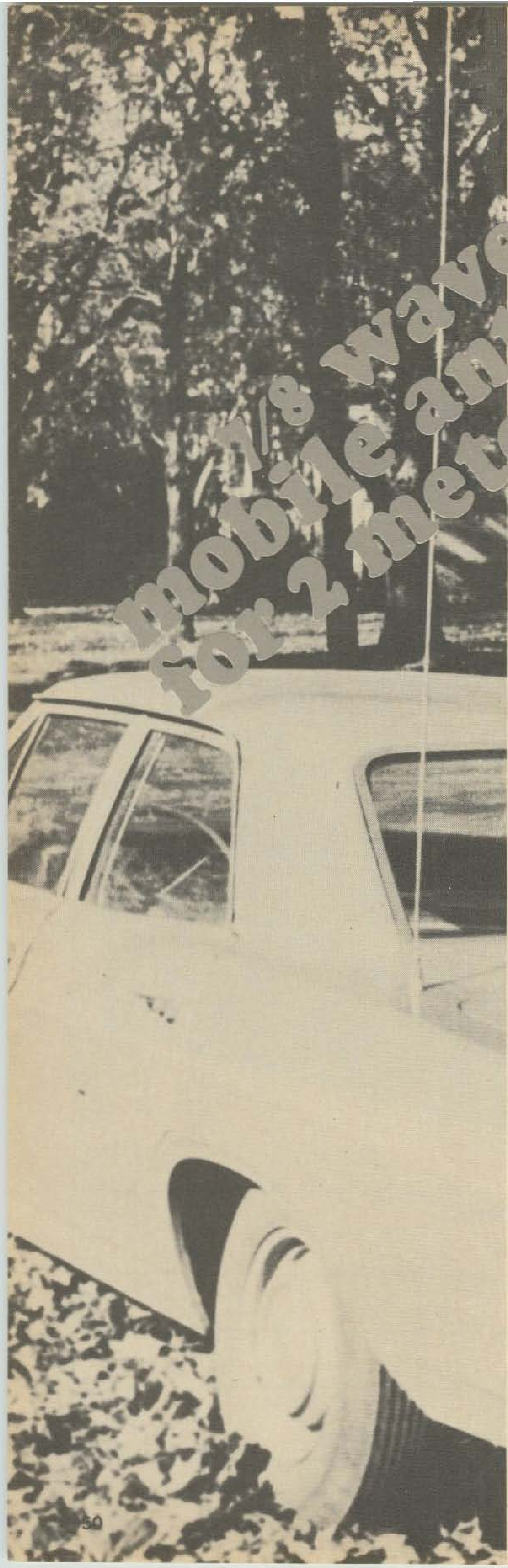
5/8 wave mobile antenna for 2 meter FM



Gilbert Boelke W2EUP
505 Main Street
West Seneca NY 14224

In the Buffalo area, this antenna has held the FM mobile gain record since 1967.

A few years ago, a group of the Buffalo FM mobile enthusiasts ran some comparative tests with different types of mobile antennas. This article describes our testing procedures, gives the results, and describes an improved version of the 5/8-wave antenna.

Horizontal vs Vertical Polarization

As long as antenna polarization is matched at opposite ends of a path, there is little to choose between horizontal and vertical propagation. Although man-made noise pickup is higher on a vertically polarized receiving antenna, the inherent noise rejection afforded by FM tends to offset this disadvantage. The big advantage in going vertical for mobile operation is that antennas with substantial gain can be built with reasonable size and neat appearance. Fortunately, vertical polarization has been standardized for channelized FM communication.

Table I shows relative antenna gain, referenced against a dipole, illustrating the gain advantage. Gain figures were obtained in the literature cited in the first four references at

Table I. Relative gains of various antennas under ideal conditions. All verticals measured over a perfectly conducting ground plane.

TYPE	POLARIZATION	GAIN[1]	GAIN[2]	COMPARATIVE POWER
1/2λ dipole	horizontal	0 dB	0 dB	100W
1/4λ whip	vertical	0	0	100
1/2λ whip	vertical	+1.8	+3.6	44
5/8λ whip	vertical	+3	+6	25
3/4λ whip	vertical	-1	-2	160
Big Wheel	horizontal	0	0	100
Turnstile	horizontal	-3	-6	400
Halo	horizontal	-2 to -4	-4 to -8	250 to 630W
7/8λ phased	vertical	+4.2	+8.4	14.5W

[1] Test antenna at one end of path.
[2] Test antenna at both ends of path.

the end of this article, except for the 7/8-wave phased vertical, which was measured against a 5/8-wave antenna. Just to emphasize the effect on mobile-to-mobile operation, the fourth column in Table I shows the relative performance when both stations use the same antenna type. The last column converts the relative gain figures to power levels, indicating the power each station would need to realize the same signal-to-noise ratio for the different antennas, referenced to 100W using dipoles.

It must be recognized that there are gain variations —depending upon the shape of the car body, the position in which the antenna is mounted, and the direction of measurement. Our tests tended to verify the handbook figures except in the case of the 3/4-wave whip. Theoretically, the gain of this antenna at the horizon should be about 1 dB below a ¼-wave whip, but in the tests it proved to be almost the equal of the 5/8-wave whip. This anomaly is attributed to the fact that the car body is not really a flat infinitely conducting ground plane. It might be interesting to see how it behaves when located at the center of the roof, a test we did not conduct.

We tested 1/4-, 5/8-, and 3/4-wave whips, two phased collinears of different types, and the 7/8-wave phased antenna to be described. In the listening tests, two antennas were mounted on the same car on opposite sides or on cowl and roof, etc. A coaxial relay was used to switch between them. Testing operators would switch antennas while in motion, saying "antenna A," then switching to the other antenna, saying "antenna B" many times in rapid succession. On the average, a clear difference could be discerned between antennas, despite the fact that for each individual comparison either antenna might have shown up better.

The cars were driven in all directions relative to the receiving sites in average terrain in western New York.

Receiving stations were not told what antennas they were hearing or which was which. Even on the same pair of antennas, the letter designations were sometimes scrambled to prevent any possibility of prejudiced responses due to psychological fixation. It was most impressive to find that the reporting station operators could not find any difference between two identical antennas tested as a control.

Each antenna was carefully matched for a 1:1 swr, and the feedlines were cut to the same length, except in the roof-mounted installations. In this case 5 additional feet of RG-58/U cable were deliberately included, since the extra line is needed anyway in a practical installation. A 5 ft length of RG-58/U coax exhibits a loss of about ½ dB (depending upon age) at 147 MHz. This difference could account for the fact that the 5/8-wave antenna behaved identically on the roof and the cowl.

Table II lists the tests and the results. It was concluded that the 5/8-wave antenna offered the best performance. It is also one of the easiest antennas to build. The other

Table II. Test results (in order of decreasing effectiveness).

ANTENNA TYPES COMPARED AND MOUNTING LOCATIONS	TEST CRITERION	RESULTS
7/8λ phased on cowl vs 5/8 on same mount	Measurement	7/8λ shows 1.2 dB more gain
5/8λ on one cowl vs 5/8 other cowl	Listening test	No difference
5/8λ cowl vs 5/8 on roof	Listening test	No difference
5/8λ on one cowl vs 3/4 on other cowl	Listening test	5/8λ has slight edge
5/8λ on cowl vs 1/4 on roof	Listening test	5/8λ superior
1/4λ on roof vs 1/4 on cowl	Listening test	Roof mount superior
5/8λ on cowl vs 3 el. collinear on other cowl	Listening test	5/8λ better
3 el. collinear vs 1/4λ on roof	Listening test	Collinear better

collinears had the same performance, so only one collinear is mentioned. In one case it turned out that the power loss in the collinear partly offset its gain, since it heated up when appreciable power was applied.

The 7/8-wave phased antenna came about as an attempt to improve on the 5/8. It was reasoned that the 5/8-wave antenna was not the maximum length that could be tolerated on a car, and that making it longer must make it better, if only the current flow could be maintained in the same direction throughout its length. Current distributions are shown in Fig. 1 for a 5/8-wave, a

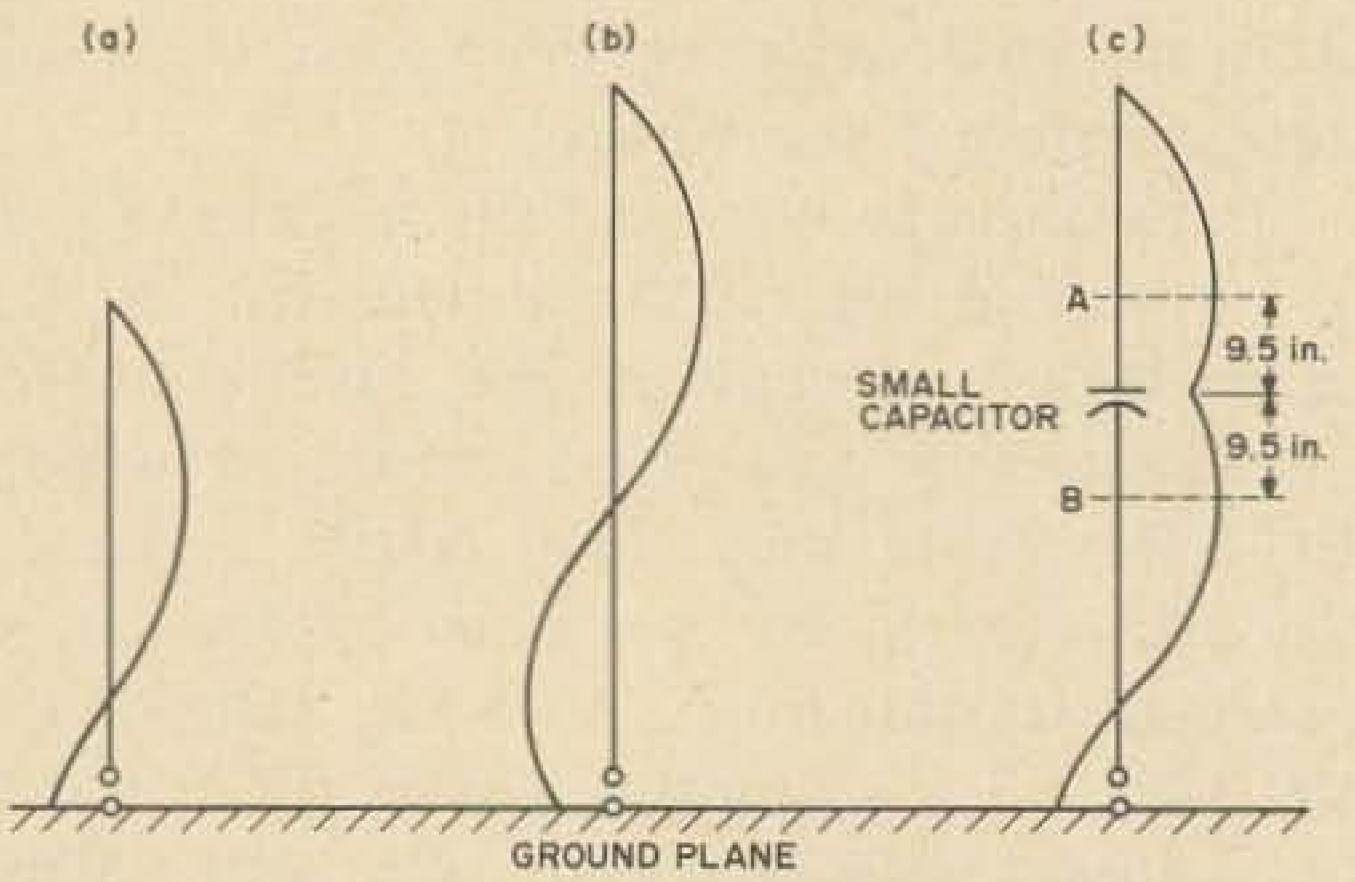


Fig. 1. Current distributions of 5/8-wave whip (a), and 7/8-wave whip (b). A series capacitance 3/8 wavelength from the top changes the current distribution as shown in (c).

continuous 7/8-wave whip, and the modified current distribution resulting from the insertion of a series capacitance at a point 3/8 wavelength from the top. The capacitor method of phasing meets the conditions of simplicity and efficiency.

An antenna of this type was constructed and adjusted to exhibit the current distribution shown. It was found that the feedpoint impedance was little changed from the standard 5/8-wave antenna. Because of this similarity, a different test method was used to evaluate it in an effort to obtain a quantitative comparison.

A 5/8-wave whip was installed in the test position on the car. The matching L section was adjusted to null out any reflected power and the power level to the antenna was adjusted to exactly 20W. Signal strength was noted on a meter at a station about 7 miles away. The 5/8-wave antenna was removed and the 7/8-wave antenna was substituted. The L network was then trimmed to null out some slight reflected power. Received signal strength was reported to be higher! Power was then reduced in small steps until the received signal strength was exactly the same as it was with the 5/8-wave antenna with 20W. The power then read 15.1W – for a difference of 1.2 dB. This procedure was repeated with the car moved to another spot. This time the power had come down to 14.8W, for a difference of 1.3 dB.

Other tests were made to determine whether the capacitance value was optimum, verifying that it was. If it is assumed that the published value for a 5/8-wave antenna (3 dB gain) is valid, the gain of the 7/8-wave job must be at least 4 dB!

Construction

My antenna consists of a 39 in. length of ¼ in. diameter Dural rod for the base section, and a 29 in. length of 3/16 in. Dural rod as a top section. The two sections are joined with a piece of 3/8 in. diameter

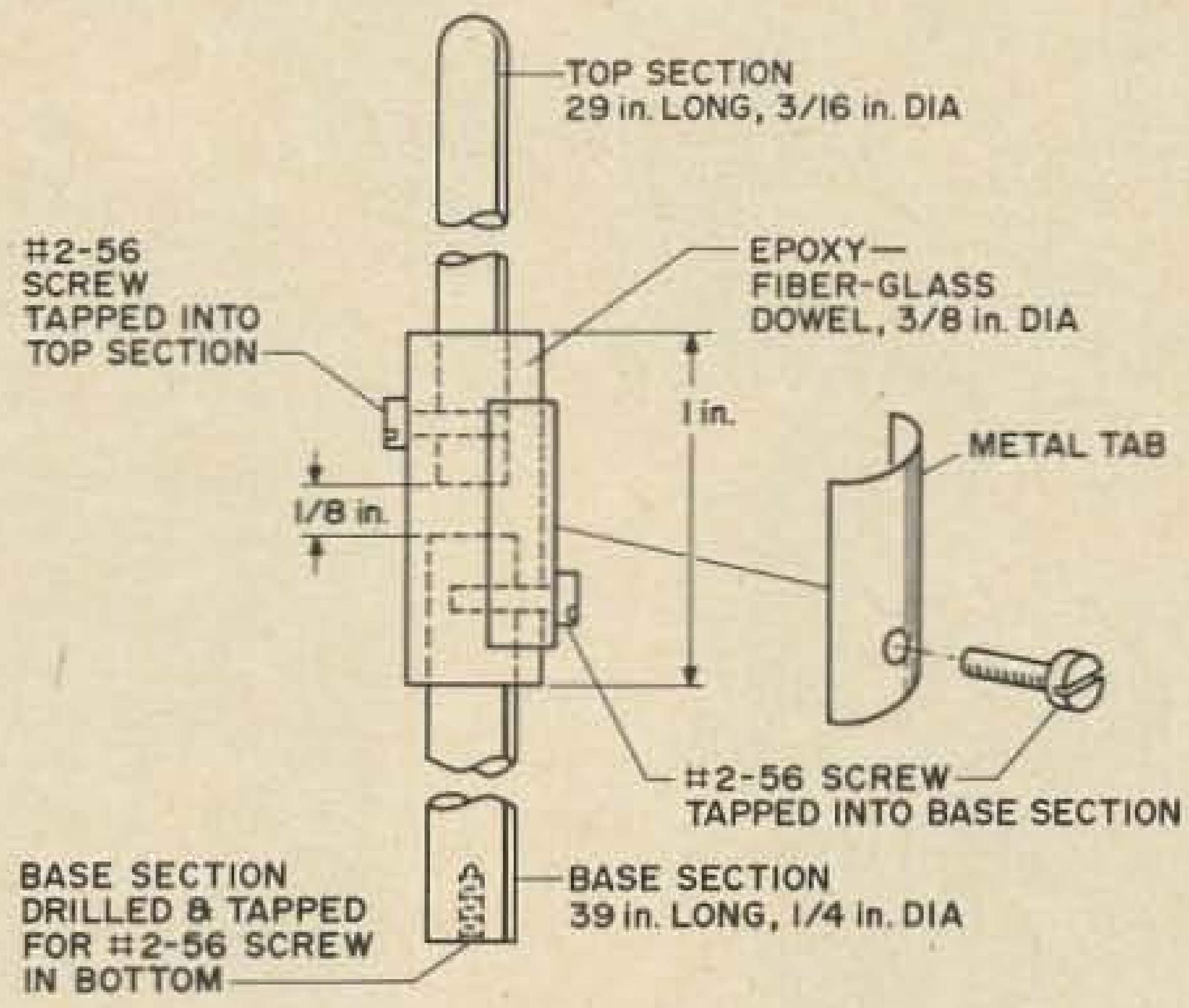


Fig. 2.

epoxy–fiberglass rod as shown in Fig. 2. A small metal tab is fastened under the screw connecting to the bottom section, and is trimmed to obtain the proper amount of capacitance between the top and bottom sections. Epoxy is used to hold the parts together rigidly and permanently.

The base mount consists of a high-voltage potentiometer-insulating fitting, made of epoxy–fiberglass with a ¼ in. shaft bushing on one end and a shaft lock on the other. Clamping the shaft lock on the base section holds the base of the antenna in place. Removal is quick and easy by loosening the shaft lock. Connection to the base section is accomplished by attaching a short Teflon-insulated wire to the end of the base section by means of a #2–56 screw tapped into the end. This wire is stripped and tinned on the bottom and a small alligator clip is used to connect into the matching network.

Impedance Matching

Due to the similarity to the 5/8-wave antenna, this antenna can be matched with a coil at the base as indicated in previous articles (Ref. 5). However, for the most accurate match, an adjustable matching network at the base of the antenna inside the car offers three advantages: (1) Extra selectivity is added to the antenna system, minimizing interference problems on both receive and transmit; (2) other antennas may be substituted on the same mount and brought to a match with little trouble; (3) the system can be accurately matched to 1:1 swr.

A schematic and a sketch showing a suggested construction and mounting method are shown in Figs. 3 and 4. Each trimmer is adjusted for minimum swr alternately until an exact match is obtained. If C1 reaches minimum capacitance before a match is achieved, reduce the inductance of L1 slightly. If more than half the capacitance of C1 is used at the null point, increase L until it tunes near minimum capacitance.

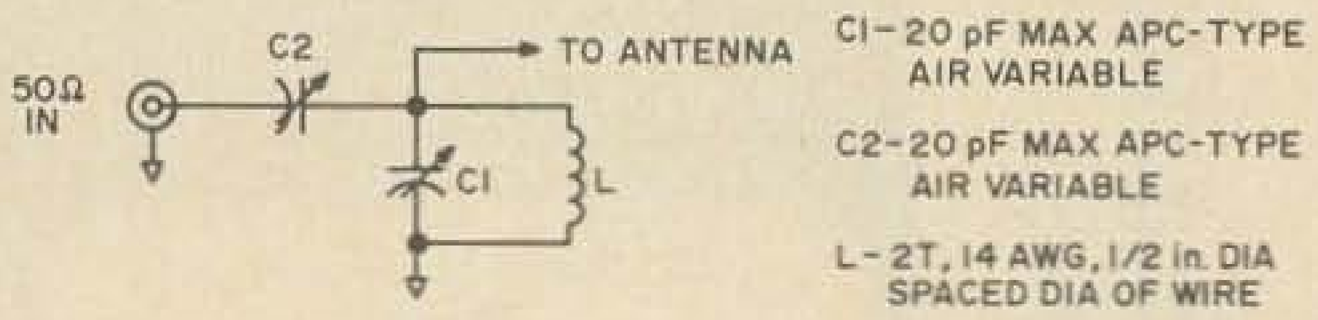


Fig. 3.

This procedure assures maximum coupling efficiency.

Adjustment of Current Distribution

Feed at least 20 or 30W of rf to the antenna, adjusting for an impedance match as outlined. Hold a neon bulb against the tip of the antenna until it fires, then slowly slide it down the top section. Exactly ¼ wave from the top (19 in.) it should go dim or

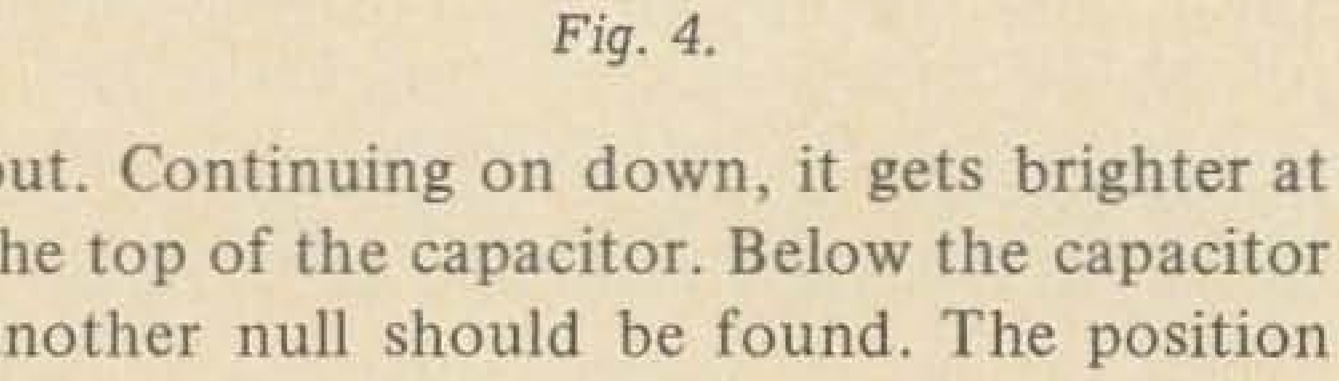
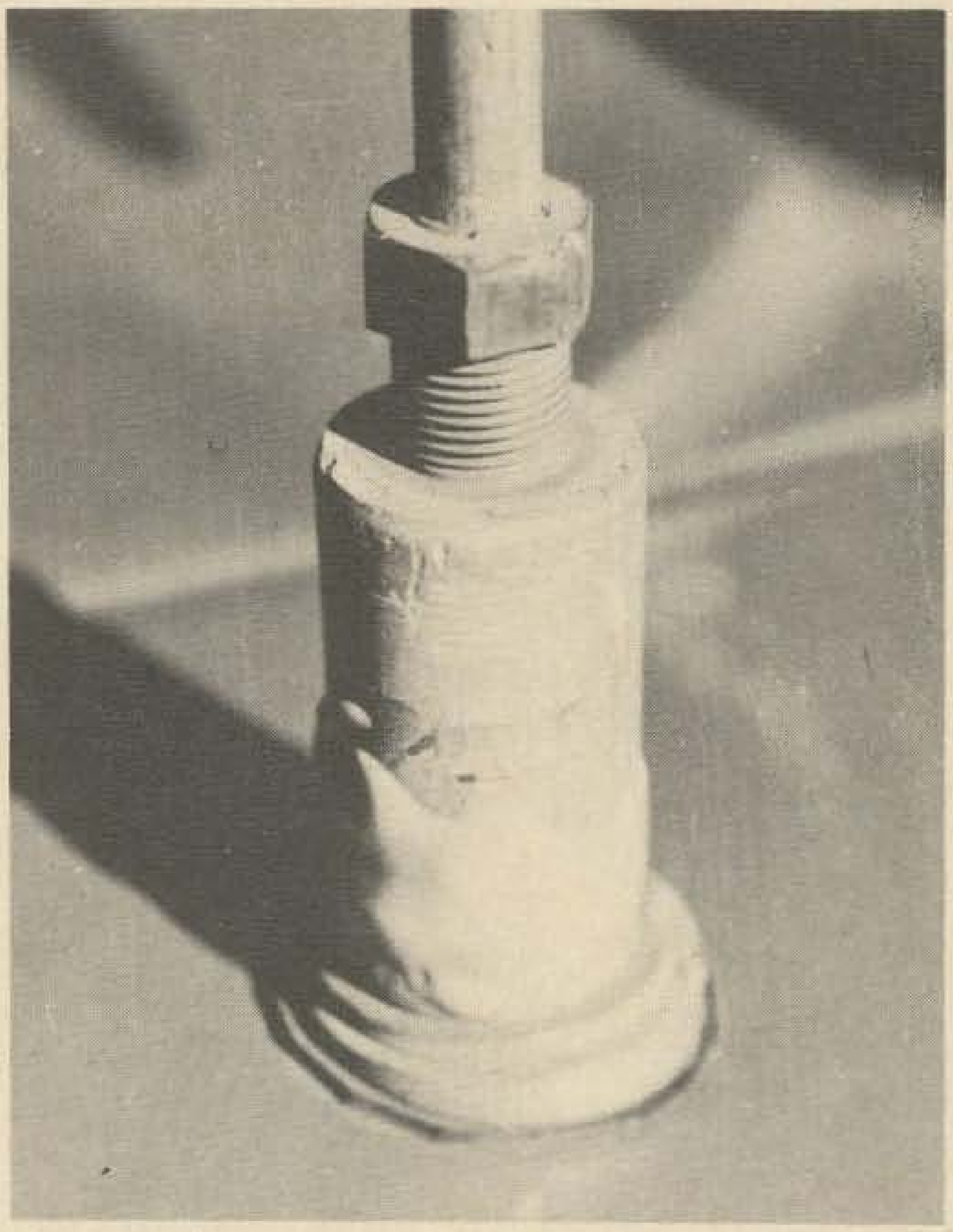


Fig. 4.

out. Continuing on down, it gets brighter at the top of the capacitor. Below the capacitor another null should be found. The position of this null moves up if the capacitance is increased, and down if it is decreased. Point B in Fig. 1c is the proper position for this null. If it is too high, reduce the capacitance in small steps by trimming the metal tab on the insulator with a pair of tin snips. As the null moves down it tends to get broader and less distinct. If doubt exists about its position, attach a paper clip to the tab to move it up to where you can see it. Then reduce



A base mount was fashioned using a high voltage potentiometer mount from an old oscilloscope.

capacitance slowly, observing the null carefully as you go. When the proper adjustment is found, epoxy the rods, the tab, and tape up the insulator.

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. . . W2EUP ■

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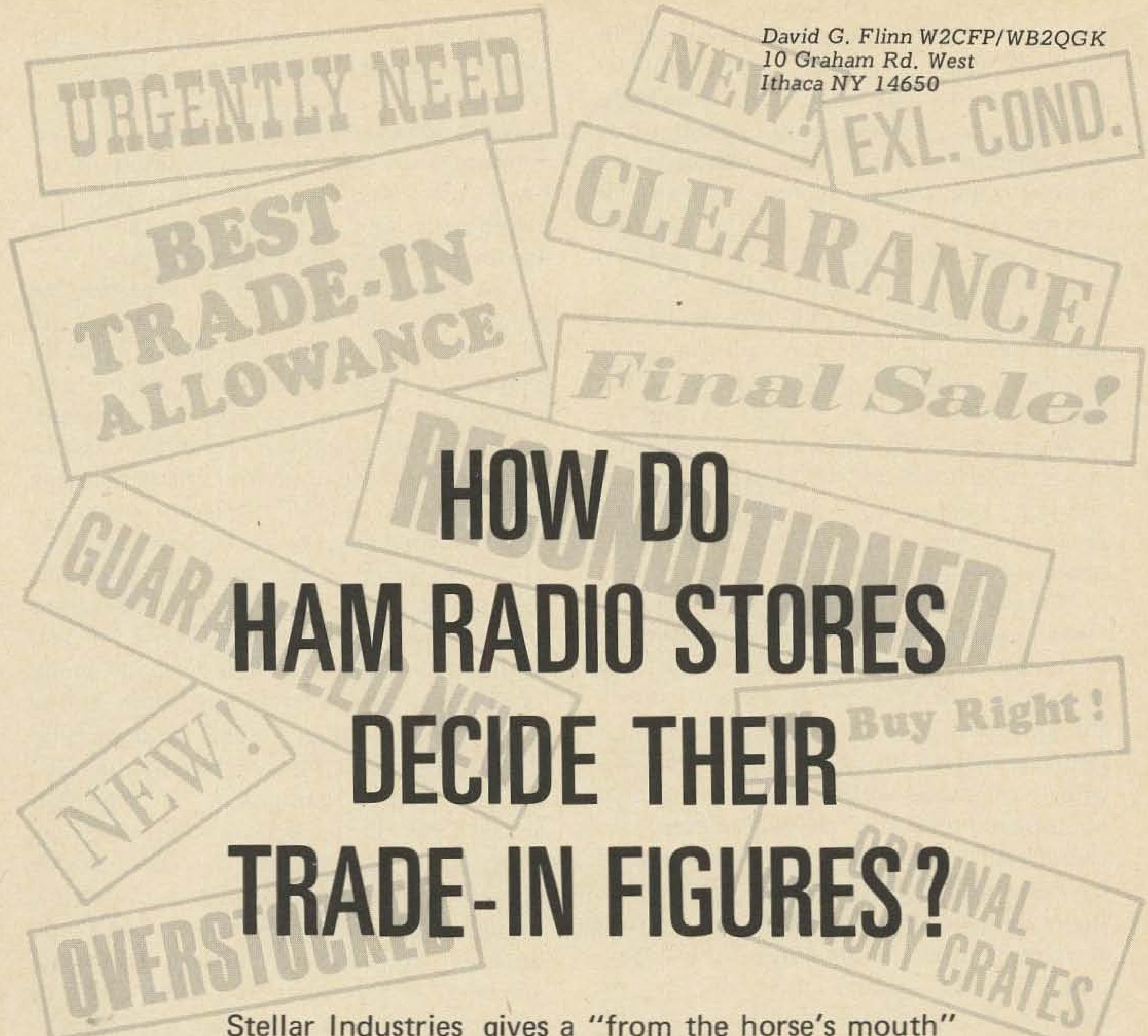

HOW DO HAM RADIO STORES DECIDE THEIR TRADE-IN FIGURES?

Stellar Industries gives a "from the horse's mouth" rundown on the way prices are figured in the ham business.

In a letter to the editor of this magazine published in the November 1969 issue, W4GJW suggested several topics for articles for the magazine. The subject of this article is one of those suggested. Some members of the ham fraternity seem to want to know how ham equipment dealers arrive at trade-in allowances, and as a ham equipment dealer myself, I will try to answer the questions that arise. The procedure that is followed in my organization may not be precisely the same as that followed by others, but I imagine it is fairly typical.

First of all, it is necessary that we make a few assumptions. Primary among these is that the dealer has to have a potential resale market for the item or items. Consequently, in order for this market to exist, in most cases the equipment must be in working order. Most reliable dealers recondition all the used equipment they take in, in order to insure that it is working. Occasionally, it is not worthwhile to recondition a piece of equipment. When that happens, the dealer sells it at a reduced price "as is." Naturally, if a piece of equipment has to be sold "as is" the trade-in allowance cannot be as great as when the equipment needs very little reconditioning. Of course, the cost to the dealer to do the reconditioning must be taken into account in figuring the allowance, too.

Generally speaking, a given piece of equipment to be traded in, if it is in reasonably good condition, will bring approximately the same dollar value to the customer in his allowance, no matter what new piece of gear is purchased. However, in extreme cases, pricewise, there will be some upward or downward adjustment in the allowance. I will cite an example that, in itself, is extreme, but will serve to illustrate the point. If you have an old receiver that is worth, on the average, $75.00 on a trade-in, and you decided to trade it for a complete Collins S line, selling for around $2,000.00, the dealer would probably up the allowance to around $100.00 or more. On the other hand, if you wanted to buy a $100.00 power supply, the allowance would drop down to around $50.00. Furthermore, if all you wanted to buy was a $60.00 preamp, it wouldn't be worth your while or the dealer's to even consider a trade.

The way my firm operates in figuring trade-in allowances is to follow roughly the procedure I am going to outline. First, we determine the price we think we can sell the unit for if it is in good condition. This figure is arrived at by looking at our own prior experience with the same or similar equipment. and also making reference to the prices charged for this used equipment by other dealers. Incidentally, most of the major suppliers who advertise in 73 have a relatively current used equipment list available for the asking. Next, we try to estimate the cost of reconditioning. If this cost is extremely high (such as in the case of extremely old items with hard-to-get parts) we usually plan to resell the merchandise "as is." Third, we make an educated guess about how long the used equipment will remain on our shelves before it is sold. The longer it remains in the inventory, the less salable it becomes and storage costs are a part of our overhead, of course.

Obviously, we are in business to make money, overall. Contrary to what some customers, who consider themselves sharp traders, may feel, we don't make a bundle on ham gear – new or used. In fact, in figuring trade-ins, we calculate all the factors mentioned above, and make the allowance based on a break-even figure. Our reason for this is that we plan to make our profit on new equipment and give trade-in allowances primarily as a service to our customers. As a matter of fact, if we cut allowances to a point where we could make a reasonable profit on used gear, we wouldn't have any used gear to sell. Our customers would find it more to their advantage to sell the old equipment on their own and pay cash for the new equipment, and in some cases this is the best way for all concerned anyway.

To pin trade-ins down to a percentage figure, I would say that, on the average, our trade-in allowances would be 75 to 80 percent of the price for which we hope to resell the gear. So you see, your friendly neighborhood ham dealer is neither "out to get you," nor to lose his own shirt being nice to you; but he is merely operating under normal good business practices.

While we're on the subject, this might be a good time to say a few words about used ham gear in general. Those of you who are oldtimers in ham radio don't really need to be told much, but some of the newcomers coming along undoubtedly wonder whether to invest their hard-earned money in used equipment, or wait that much longer until they can afford the new. Many good bargains can be found if you shop around. A wide range of equipment is available from World War II vintage "boat anchors" to some of the most up-to-date sideband transceivers. Of course, some of the real old stuff won't get on SSB, but with a bit of resurgence in CW work that has come about since incentive licensing went into effect, a lot of it can be quite useful. Of course, the lower power transmitters and older receivers are excellent beginners' rigs for young Novices with limited financial resources. Probably the two cautions which should be noted most in buying used ham gear are: First, buy from a reputable dealer or individual whom you know, and second, look over the wiring carefully when considering used kit-built equipment. Other than that, the world of used ham equipment can open up all sorts of possibilities for you. In fact, some people feel the same way about used ham equipment that they or others do about used cars: Let someone else work the bugs out and get hit with the rapid depreciation for the first year or two.

. . . W2CFP ■

BERYLLIA

The Lethal Refractory

J. K. Bach WB2PAP
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Walden NY 12586

Take another look at those tube boxes on your shelf.
Those ceramic jobs that are made with beryllia could be dynamite.

In the near future you are going to see ceramic-insulated vacuum tubes with the following notice on the carton, or on the tube, or both: "WARNING–BERYLLIA–POISON–DISCARD–SAFELY!!" What does it mean?

It means exactly what it says. The ceramic, or more properly *refractory*, is beryllium oxide, and it looks like any other ceramic: white, opaque, textured like an eggshell, not shiny, and hard enough to scratch glass. Yes, it is poisonous–*very* poisonous–but after fabrication is amply safe to use.

But children have a devilish ingenuity when it comes to smashing things, and their own reasons for doing the unthinkable. If a child or an uninformed adult got his hands on a discarded tube of this sort–! He might fracture it and cut himself on a shard of the material, thus getting particles into his blood stream. He could be in serious trouble. Or if he ingested the particles on his luncheon sandwich, say, he certainly *would* be in trouble. If any of it powdered and he inhaled even a small quantity, he very probably would die unless he got immediate medical help. The powder has the same effect on the lungs as phosgene, one of the basic war gases.

Exactly how poisonous is it? What is the exact fatal dose? Odd as it might seem, nobody knows–though it is at *least* as poisonous as arsenic, and perhaps much more so. The reason is that some people are unusually susceptible to a certain poison, while others are nearly immune to what would ordinarily be a fatal dose. Arsenic is a very good example of this–the fatal dose is given as more than so much and less that such-and-such. But peasants in Tyrol and in Syria practice arsenicophagy, which is salting food with scrapings from their chimney flues, which contain an arsenic compound deposited there by burned fuel. The practice is illegal, but they have done it for generations and will probably continue. Arsenic has been prescribed from the earliest times for skin ailments. And those Tyroleans do have beautiful clear skin! The Borgias used arsenic in their brand of politics, and it is still used in medicine. Mountain climbers take a tiny amount to increase their resistance to fatigue. And at one time a Swedish chemical plant sunk excess arsenic in the ocean to get rid of it. Sound familiar?

But beryllium is a different cat altogether. It is not used in medicine in any amount or form. It finds more uses in industry every day; airframes for high-speed aircraft, moderators for nuclear reactors, windows for X-ray tubes, as well as an alloying element for many metals, principally but not exclusively copper. This last

we all know—2% beryllium and the copper spring never breaks. Hazard? Not after fabrication.

Beryllium is not simply an irritant—industrial safety men claim that it is a "protein poison" which in some way poisons the body cells directly. It finds its way into the bone marrow, where it affects the hemoglobin. Once in the body, it is eliminated very slowly, and it causes damage to the lymph nodes and the liver. It produces granulomas, which are grainy tumors. Convinced?

Inhalation of the dust is by far the most serious hazard; introduction by ingestion or puncture is comparatively rare. After manufacture, powdering the stuff would be fairly difficult, though children and some adults might manage it. If you think it's easy, try it on an ordinary porcelain insulator! So while the hazard is fearfully real, it is remote so long as you treat it with the same respect afforded arsenic, cyanide, or radioactive substances. I don't like radiation either, but I don't hesitate to wear a luminous-dial wristwatch. Knowledge is safety, ignorance is danger.

And speaking of ignorance—remember the warnings about the original fluorescent lamps? Did you take them seriously? I didn't! Oh, I knew that the stuff was probably irritating, but it never occurred to me that a little powdered phosphor from just one broken lamp could kill me. That phosphor was beryl zinc silicate, no longer used. After lawsuits and investigations, the maximum safe dust contamination was determined to be from one to two (that *spread* again!) *micrograms* per cubic meter! I'm sorry, but today this sounds like fresh, pure mountain air to me.

So what *is* beryllium, exactly? It is a light metal, brother to aluminum, but it melts at a much higher temperature, 1284 degrees C. It conducts electricity about a third as well as copper and is a good heat conductor. It is not ductile and is difficult to form into sheets. A billet of beryllium costs from $50 to $100 per *pound*, and if you want the 100-proof stuff it will set you back $2700 per pound. When shipped, it must by law bear a poison label. Chemical handbooks warn you not to taste even the smallest quantity of any beryllium compound to see if it is really sweet, but to just take their word for it. Chemists used to do this. The original name for the metal was glucinium, from glucose, a sugar.

You wouldn't do anything so foolish? I hope not. Once I had a refrigerator that released a quantity of sulfur dioxide gas in my apartment—smelled like a chicken house. When I got through coughing, I moved back in and breathed residual gas absorbed by drapes, bedding and rugs. I would have done much better camping in the street—I had bowel and stomach upsets that persisted for well over a year. But I have learned from the experience. Now when a selenium rectifier stack breaks down and stinks up the place, I'm the first one out of the room. Selenium in the ground is absorbed by growing grass which is eaten by cattle which abort and breed monsters ("selenism") and poisons people who consume the meat and milk. A brother to sulfur, it's poisonous enough, but not in a class with our new friend.

So why use the damned stuff? First, it is perfectly safe if treated intelligently. The second reason is that it will make possible a new breed of high-power, high-frequency, high-performance tube.

Combine beryllium with oxygen, BeO, and the conductivity for electricity drops to zero, since there are now no unbonded electrons. But the heat conductivity which is pretty good for a metal is utterly *fantastic** for a refractory, and the melting-point is practically doubled: 2450°C. Red heat is only a little more than 1000°C. The low coefficient of expansion helps too, but the heat conductivity is the real reason that tube men are getting excited over its possibilities. They don't care how hot the refractory gets so long as the seal holds, but if the heat can be readily conducted through it (imagine!) the other electrodes will run cooler, or dissipate larger amounts of power, or both. At high frequencies where tube capacitances are a vital factor, a "hotter," smaller tube is possible.

So you use an 807 or 6146? Fine! They don't have or need beryllia. But you may

*Twenty times that of quartz, 62% that of copper, and even higher than metallic aluminum, which is only 55%. Fantastic is right!

wind up in a broadcast station which does use the new tubes, and you will then need to know how to handle them. Which is, with the same care you use with *any* tube. The stony stuff won't rub off on your hands; no amount of handling or exposure could possibly affect you. It must at all costs be kept out of your body in *any* quantity! If you handled a broken tube as if it were radioactive, that would be about it. Make sure that all the big pieces are collected. Then get up the smallest fragments—use a rag made tacky with shellac, varnish, grease, whatever will work. If the tube was really crushed, beware dust—turn up the airconditioning, or open windows and doors, and stay clear until you are sure it has dissipated. Put the fragments together with the tack-rag into a plastic bag, and make plans to return the package to the manufacturer, or to bury it in the back yard.

If you get a sliver in your skin, remove it completely, *make the wound bleed* by *gently* squeezing it to flush out any particles remaining, and consult a doctor at once. Probably you are in no danger, but why take a chance? Feeling foolish is better than feeling dead.

You have got a new tube that maybe has beryllia insulators? Send now to know which types have it; if it ain't on the carton, they will not tell thee. Appearance means nothing but heat conductivity does. Put a soldering iron on the plate and a finger on the grid ring. With glass or ceramic, you can hold it there a long time. If you have to remove the finger almost immediately, you have beryllia there. The stuff is unique—it couldn't be anything else if it is a good insulator and a good heat conductor in thick sections. If you have beryllia, treat it with respect and you will be perfectly safe.

Beryllium. Beryllia. What makes the name so familiar? Beryllium copper? Maybe, but nature makes a compound of beryllium:

$$Be_3Al_2(SiO_3)_6$$

occurring in hexagonal crystals of almost unlimited size, with various hues due to trace impurities. These are called beryl and are semiprecious stones. But if the stone is perfect, and you have just the right amount of chromium in your beryl, you have a natural emerald!

. . . WB2PAP ■

STAFF

Getting Your Extra Class License

Part XV: Spurious Radiation

Amateur radio operators operate radio transmitters.

This may sound like an obvious observation, but it implies directly that *good* amateur radio operators operate their transmitters well—and that means that they must know *how* to operate them. Consequently, the FCC examination for the Extra Class license contains a heavy proportion (1/9 of all the questions on the study list cover this subject) of items intended to test the applicant's knowledge of transmitter operation.

Because of the number of questions and the many items contained in them, we'll devote not one but two sections of this study course to the subject of transmitter operation. This time, we'll deal with the following questions from the FCC study list:

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

72. What radiotelephone transmitter operating deficiencies may be indicated by a decreasing antenna rf current during modulation of the final rf amplifier?

75. What may be the cause of a decrease in antenna current during modulation of a class B rf amplifier?

77. How can parasitic oscillations be prevented?

87. How can the final amplifier of a transmitter be tested for self-oscillation?

As usual, we won't attempt to deal directly with these specific questions. Instead, we'll rephrase them into more general queries, covering the same subjects but in broader scope.

These five specific questions divide into two broad groups, one dealing with self-oscillation and other spurious signals in a transmitter and the other dealing with problems during modulation. Let's break each of these groups up into a couple of questions to aim at the major subjects.

First, let's find out "What are the causes of spurious signals?" such as self-oscillation and parasitics. Then let's ask "How can we find and fix spurious-signal problems?" That should take care of questions 53, 77, and 87 adequately.

Turning to modulation problems, let's find out "What does antenna current tell us about modulation quality?", and then move on to ask "What causes modulation problems?" Having found out the probable causes we can ask finally "How can modulation troubles be cured?"

That should be enough to take care of us for one chapter. Ready to start?

What Are The Causes of Spurious Signals? Ideally, the output of a radio transmitter should consist of only a single signal (which may be merely a carrier, one or two sidebands only, or a carrier plus sidebands). Normally, any signals in the output which are *not* an integral part of this single desired signal are called "spurious" signals.

Thus the list of possible spurious signals includes harmonics, modulation distortion products, parasitics, and off-frequency signals such as those generated by self-oscillation of one or more amplifiers in the transmitter.

Since we're going to deal with several questions concerning harmonics in the next installment of this course, we'll leave them out right here. Similarly, we won't concern ourselves too much with buckshot, splatter, and other modulation-connected spurious signals, since we'll meet them later in this installment. The major types of spurious signals left for us to examine here, then, are those caused by parasitics, and those caused by self-oscillation.

Actually, parasitics are only a special type of self-oscillation, and the causes for both are extremely similar. The major difference between a "parasitic" oscillation and the condition usually called "self-oscillation" is that a parasitic occurs at a frequency far removed from the intended operating frequency of the transmitter, while "self-oscillation" occurs at or near the intended operating frequency.

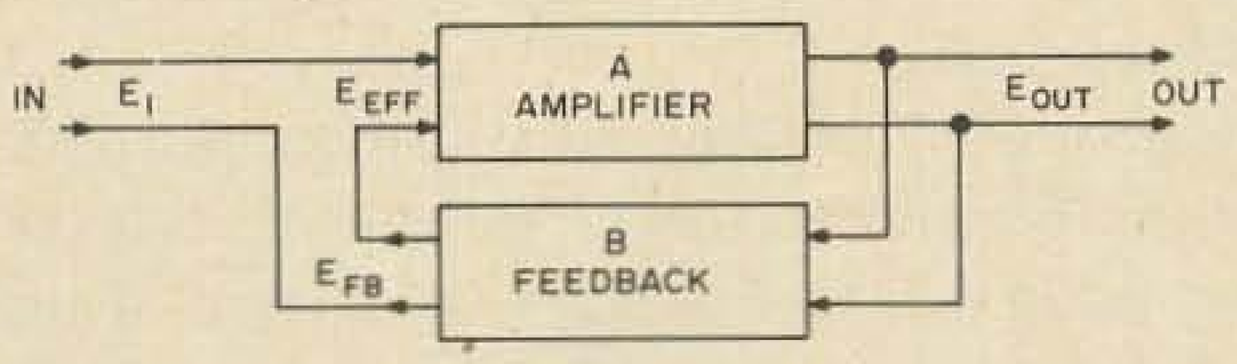


Fig. 1. Oscillation criterion depends upon both loop gain and phase shift of feedback as shown here. If quantity (1-GAIN$_B$) is equal to zero, effective gain becomes infinite and circuit will provide output with no input; this is the definition of an oscillator. Any time that this condition is satisfied, a circuit must oscillate. If it is not satisfied, oscillation is not possible.

There is, of course, only one possible cause for any kind of oscillation, if we go far enough down toward the basics of theory, and that is the fact that a closed feedback loop exists with a phase shift around the loop of zero degrees and a loop gain equal to or greater than one. This pair of conditions—unity loop gain and zero phase shift—are known as "Barkhausen's criterion" for oscillation, and unless both conditions are present oscillation cannot exist.

Unfortunately, this basic cause is so basic that it doesn't help us much in many practical instances. The feedback loop in any practical transmitter is almost always accidental; it may be due to stray magnetic coupling, to lack of shielding at some critical location (which usually does not appear to be critical for any obvious reasons), or even due to reradiation of some of an amplifier's output through power-supply leads.

If the spurious signal is near the intended operating frequency, and so falls into the category of "self-oscillation," the cause is probably directly due to an unintentional feedback path from output to some earlier stage. This feedback need not be from the actual transmitter output stage; it may be from the output of any earlier stage to that same stage's input or to any lower-level stage.

The most common causes for this type of problem are stray coupling between resonant circuits in different stages, feedback through power-supply leads, and feedback through the tubes or transistors themselves. If any stage is neutralized, misadjustment of the neutralization is always a primary suspect should self-oscillation occur.

The stray coupling between resonant circuits may be either electrostatic (which means simply inadequate shielding) or electromagnetic (improper placement). Most common in homebrew rigs is electromagnetic coupling; a commercially designed transmitter seldom suffers self-oscillation unless a neutralizing adjustment is off.

Feedback through power supply leads may occur either on the high-voltage leads because of inadequate decoupling between stages, or on filament leads by pickup and reradiation.

A less common cause of self-oscillation is existence of a "ground loop," in which the ground returns for a stage are made to several different locations on the transmitter chassis. The currents flowing between the various ground points may develop enough

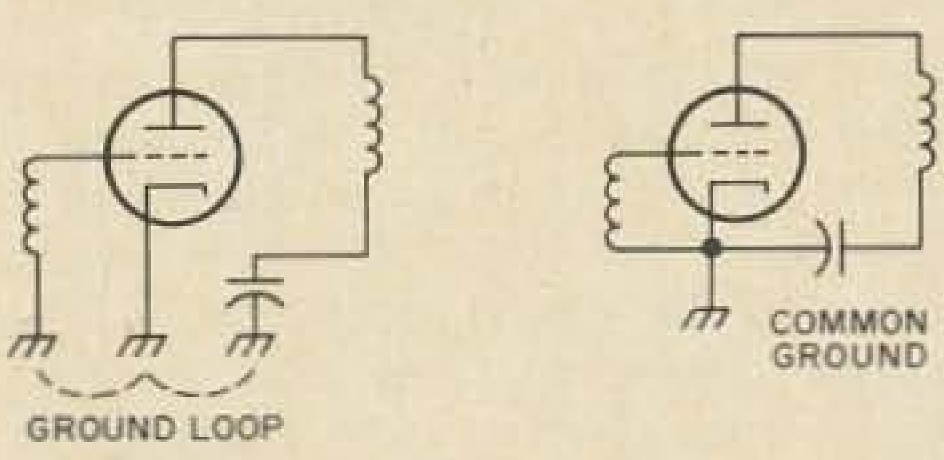


Fig. 2. Ground loop as contrasted with single-point grounding. If grid and plate currents flow exactly as shown by dotted lines at left, ground loop causes no trouble; however, if both flow through same portion of chassis, feedback may occur. For this reason single-point grounding is recommended for all construction, to prevent possibility of ground-loop occurence.

voltage to produce unwanted feedback? they may also radiate enough energy to be picked up by some lower-level stage.

Any conductor carrying a current is surrounded by a magnetic field, and so it's not possible to completely eliminate all rf feedback in any amplifier because the magnetic fields of the various conductors provide some small degree of inductive coupling between inputs and outputs.

However, proper placement of wiring can reduce this unwanted coupling to a minimum, and it's not usually a factor in self-oscillation of a well-designed transmitter or amplifier.

"Parasitic" oscillation is another case entirely. The unavoidable small coupling between conductors—both the inductive coupling we just mentioned and the equally unavoidable capacitive coupling through the air separating the conductors—means that it's always possible to get a closed feedback loop. Since the amount and type of coupling will introduce some phase shift, which will vary with frequency, it's also always possible to find some frequency at which the phase shift around this closed loop is zero. And that means that one of the two conditions required for oscillation can always be met. If anything permits the other condition to also be met, oscillation is unavoidable—and that's where parasitics come from.

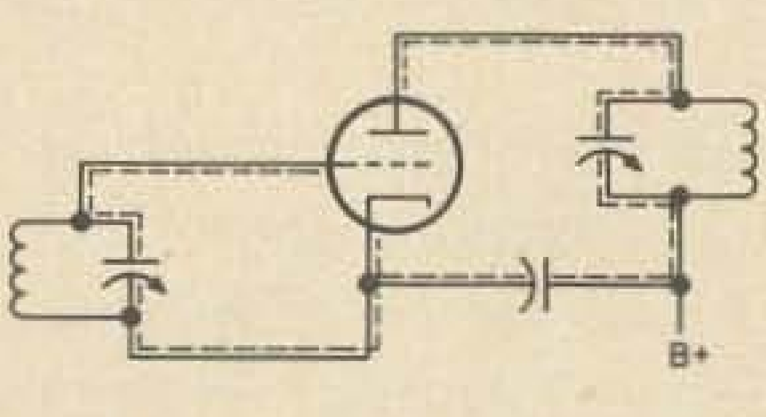


Fig. 3. This simplified schematic shows how parasitics happen. Solid lines show expected flow of signal current through entire resonant circuit. At some high frequency, though, inductors of resonant circuits act as chokes, and self-inductance of connecting leads shown in dotted lines provides a substitute for the coils so that another resonance occurs. Circuit then acts like tune-plate-tuned-grid oscillator at this higher frequency. Suppressors kill parasitics by loading down the vhf resonance while leaving the desired tuned circuits alone.

For any amplifier to produce gain, it must work into a load impedance. In general, a vacuum-tube amplifier will produce a gain which is directly related to the value of the load impedance; the higher the impedance (within limits), the greater the gain.

The designer of an rf amplifier almost always intends that the amplifier be operated at only one frequency at any given time. He designs the circuit to provide the desired load impedance at only that frequency. The amplifier stage may still have gain at other frequencies—particularly frequencies close to the operating frequency—but not as much. And at frequencies far removed from the operating frequency, the load impedance is supposed to be virtually zero, permitting no gain at all.

At the intended operating frequency, the unavoidable coupling from input to output is usually overcome by the process known as neutralization. This amounts to introduction of just enough deliberate feedback, in the opposite phase to the unwanted but inescapable stray feedback, to cancel its effects out so that the amplifier is essentially feedback-free.

A properly neutralized amplifier normally remains neutralized over approximately the same band of frequencies at which it has appreciable gain. The idea is that, for any frequency at which gain is greater than unity, the feedback be zero. If gain is less than one, the amount of feedback is immaterial insofar as the possibility of oscillation is concerned, because *both* the gain and phase conditions must be met for oscillation to occur.

Unfortunately, the intended operating frequency is usually *not* the only frequency at which an amplifier exhibits gain. While the designer may have intended for load impedance to be negligibly low at all other frequencies, the fact remains that a length of straight wire has both inductance and capacitance, and at some frequency cannot help behaving as if it were a tuned circuit.

In addition, the grid and plate structures of tubes themselves also have enough L and C to act as tuned circuits at some frequency, and the designer's carefully planned output tank circuit may exhibit resonances at more than the single frequency he intended.

At any frequency for which the impedance of these unintentional tuned circuits is sufficiently large, the amplifier will in consequence have greater than unity gain. If a zero phase shift also exists at this frequency in the unavoidable feedback loops, oscillation must result.

We call such oscillations "parasitic" because they are like parasites; they were never planned into the scheme of things, and they can exist only when the amplifier is operating in an otherwise normal fashion.

Frequently, a parasitic may not appear when an amplifier is being tested under moderate-power conditions with a steady signal, but will blossom forth in all its obnoxiousness when full power and modulation are applied. The change in amplifier operating conditions increases gain just enough (or possibly modifies the coupling slightly) to permit the oscillation. A variation of this behavior is the type of parasitic which exists only for a few dozen cycles at the peak of each cycle of intended-frequency signal, and is absent at all other times.

In almost all cases, the cause of the parasitic is an unsuspected load impedance in the amplifier's output stage which permits amplification at unintended frequencies. Normally, the frequency of a parasitic is much higher than that at which the amplifier is intended to operate. Amplifiers intended for the 3-30 MHz range usually have VHF parasitics, VHF amplifiers exhibit UHF parasitics, and so forth.

This rule does not always hold true. In some cases, parasitics may occur at frequencies far *below* the intended operating range. The phenomenon, known as "motorboating" in af amplifiers, is typical of a lower-than-operating-frequency parasitic. It occurs when the feedback loop encompasses the entire chain of amplifiers and includes substantial time delays. This type of parasitic in rf amplifiers, occurs only rarely. When it does, the feedback path and undesired load impedance producing the unwanted gain are usually to be found in either the power supply or the power wiring, rather than in the signal circuits of any individual stage—and when these conditions exist, self-oscillation is much more likely than is a lower-frequency parasitic.

Another type of spurious signal which afflicts only radiotelephone transmitters is that produced by rf feedback into the audio circuits. This can produce symptoms very like those of parasitics. What happens is that some of the modulated rf output of the transmitter is finding its way back into the audio circuits of the modulator or preceding audio stage, and is there being detected to produce an audio signal which is a feedback signal. The feedback loop is closed by a path through the modulation process, and so both the audio and the rf signals are affected.

In addition to the fact that their radiation is illegal because of the uncontrolled interference which they cause, these spurious signals are to be avoided at all times because they can easily result in severe damage to the transmitter. Parasitics, in particular, can lead to amazingly high levels of reactive volt-amperes in even moderate-power transmitters, because the signals which are generated are predominantly confined to the transmitter (they are coupled to the antenna only by accident). The multi-kilovolt levels which result can pop coupling capacitors, melt down polystyrene coil spacers, and even vaporize tube elements by forcing the tube to improper operating points.

How Can We Find And Fix Spurious-Signal Problems? Now that we've looked at the causes of spurious-signal problems, it's time to look a little deeper and discover how to find and fix them. While there's always one easy way to find out that you have a spurious-signal problem, it's not recommended—for one thing, FCC pink slips are most upsetting to the tranquility of most of us, and while you're waiting for one to come along you may be clobbering untold QSOs or possibly even emergency traffic!

So it's best to check out any new transmitter, whether it's a homebrew rig or a store-bought outfit, to be certain that it's free of spurious signals, before ever putting it on the air.

While the checkout is a virtual necessity in the case of homebrew and kit-built equipment, it's also most important in the installation of completely factory-wired gear as well. Bad design or construction is *not* the sole reason for spurious signals, as we have seen. Misadjustment can also cause them, and even the most reputable rig *can* be misadjusted between the factory pre-shipment inspection and its arrival on your operating desk!

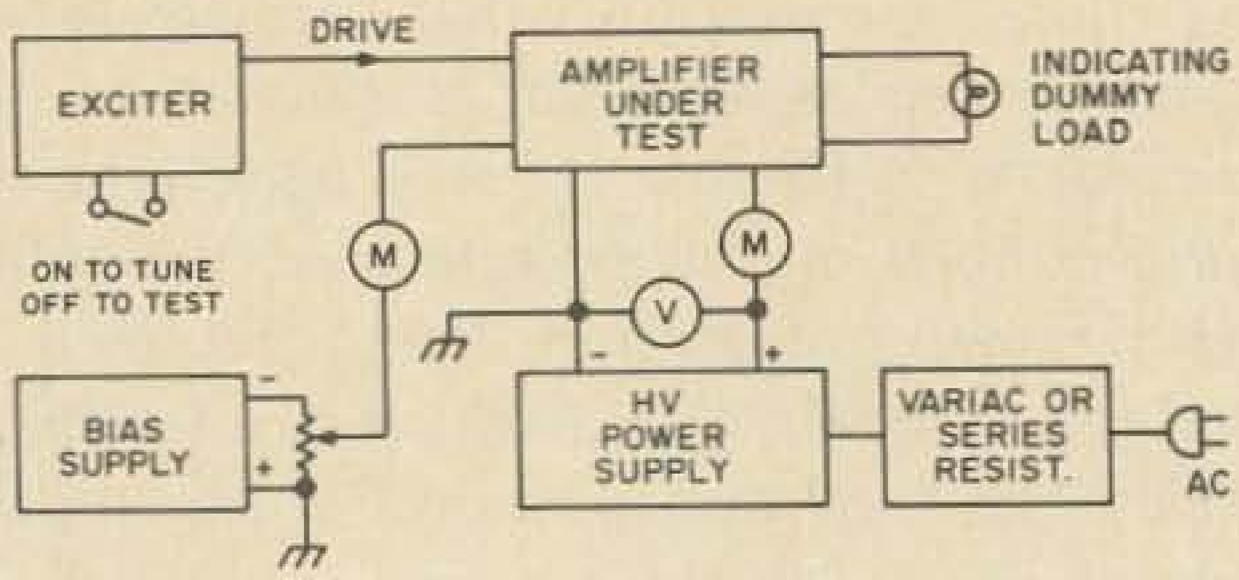


Fig. 4. This test setup can be used to test an amplifier for both self-oscillation and parasitics. Exciter is used only to provide drive while initially tuning amplifier under test. Output should disappear when exciter is switched off, and remain absent for all settings of amplifier controls. Any output indicates spurious signals; their cause should be traced out and eliminated.

The procedure in testing for self-oscillation is relatively simple. Connect the transmitter to a dummy load, preferably with some type of power indicator (a light bulb coupled to the load will suffice if nothing more exotic is available). Remove any drive by removing the crystal (don't use a vfo for the checkout). Fire up the rig, but keep plate voltage off until everything is warmed up.

Now apply plate voltage briefly and swing each tuning capacitor across its range while plate voltage is ON. You have to be fast, if the rig doesn't include fixed protective bias, to avoid tube damage due to the lack of grid bias. Any output indication at all must come from self-oscillation, since the normal oscillator stage has been disabled by removal of the crystal.

If the transmitter has many stages, it may be necessary to perform this test on only one stage at a time in order to limit the power-on time. The main thing to watch out for is permitting excessive plate current to flow for more than a very few seconds. Some of the more modern screen-grid power tubes can completely melt out their screens in less than 30 seconds under zero-bias operation!

To be absolutely safe, it's best to provide normal operating bias for each stage. This bias can be supplied from one or more small transformer-operated power supplies, adjusted to provide the desired dc output and connected to the grid of each stage through rf chokes for isolation. If this is done, keep in mind that the added grid-bias leads may, in themselves, introduce feedback unless you're extremely careful. However, with all stages properly biased, you can leave power on long enough to test all settings of the adjustments. Also, a change in bias conditions may permit oscillation during the test which would not occur during normal operation.

A quick indication of self-oscillation is the capability of tuning to a dip in final plate current at two points in the tuning range which are *not* harmonically related. Of course, if you're operating at 3.6 MHz and tune the final to 7.2 MHz you can get a dip, and this does not indicate self-oscillation. But if you get a normal dip at 3.6 MHz and, without changing frequency of the oscillator, tune a little higher to the neighborhood of 5 MHz and find another dip, this is a pretty fair indication that you have self-oscillation around either 2.5 or 5 MHz. Should this happen to you, be sure to run the full self-oscillation checkout.

Having discovered a case of self-oscillation, how do we fix it? The first step is to determine which stage in the transmitter is oscillating. If it's convenient to remove plate and screen voltage from individual stages, this is the easiest way to find out. Start at the next-to-final stage and remove both plate and screen voltage. If the oscillation is still there, it must be in the final stage alone.

If the oscillation disappears, restore power to the driver stage and remove power from the stage preceding. Reappearance of the oscillation indicates that no stage ahead of the driver is involved. To find out whether it's the combination of driver and final, or merely the driver alone, remove power from the final and couple some sort of rf indicator to the driver's output. If both stages are involved, the oscillation will disappear. If it persists, the trouble is in the driver stage only.

If the oscillations fail to reappear when power is applied to the driver, move back another stage toward the oscillator and repeat this procedure. Keep going until the trouble has been isolated to a single stage or group of stages.

CAUTION—Never remove plate voltage from a tetrode or pentode tube without also removing screen voltage. Otherwise the tube is almost certain to be destroyed by excessive screen dissipation.

When the stage or stages have been isolated, apply the things we've already learned about the causes of self-oscillation. Look particularly for coupling between input and output circuits, and for misadjustment of any neutralization components. Also check all bypass capacitors to be certain that they're doing their job. In severe cases, it may be necessary to virtually redesign the offending stage to eliminate coupling from input to output by relocating components.

After each correction is made, repeat the test procedure to determine whether the spurious oscillation has been eliminated.

Detection and elimination of parasitics is a much more bothersome business. Most circuit designers prefer to simply assume that parasitics will be present unless they are suppressed, and design in parasitic suppressors to do away with them.

A parasitic suppressor consists, essentially, of an additional tuned circuit broadly resonant at the frequency of the anticipated parasitic, and swamped down with a composition resistor of low value to kill any effective load impedance. For tubes in the 100-watt power output class, a 47-ohm 2-watt resistor with 3 or 4 turns of wire wrapped around it does the job normally. This suppressor is connected in the plate circuit, as close as possible to the tube's plate terminal (that is, one lead of the resistor is soldered to the plate-cap clip with as short a lead as physically practical, just as bypass capacitors are installed). For higher power levels, the same idea works but higher power ratings are needed.

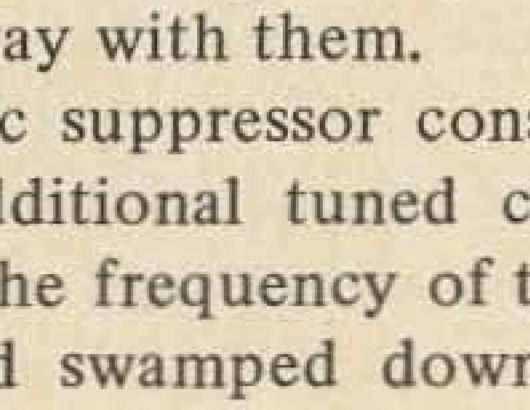


Fig. 5. Typical parasitic suppressor consists of 6 turns of number 18 wire spaced out to occupy the full length of a 47-ohm 2-watt composition resistor. This suppressor is adequate for hf rigs up to the single 6146-807-6DQ5 class; for higher power rigs, use several resistors in parallel to provide higher power capabilities. For vhf rigs, reduce coil size to 3 or 4 turns, again spaced out to full length of resistor.

The parasitic suppressor works by concentrating any stray inductance or capacitance which might form a parasitic's load impedance into a known location, and then loading that impedance down with such a low-valued resistor that its Q is far less than unity.

If, despite parasitic suppressors, you suspect that parasitics are present in a rig, perform the same test as for self-oscillation except that normal drive signal can be applied. Output at any except the oscillator frequency or a harmonic of it can be attributed to parasitics.

Probing with a neon tube can help locate parasitics, also, if (as they usually are) they happen to be VHF or UHF oscillations.

The glow of a neon tube excited by rf pickup through its glass walls is normally orange, just as is a normal neon glow. The signals produced by parasitics, however, usually make the neon glow purple rather than orange. The change in color is not due to the frequency, but to the amount of power picked up. The neon will pick up more power from a VHF or UHF signal than it will from one of lower frequency, because it is of fixed physical size and the pickup is governed by the tube's size in relation to the signal wavelength. With excessive power applied, the neon glows purple rather than orange.

Another handy guide to parasitics, surprisingly enough, is standard equipment for most operators—a pair of ears! When a parasitic is running wild in a transmitter, it frequently causes a high-pitched whining sound. It's the same phenomenon that makes a transformer with a loose core lamination "buzz" when power is applied; in the case of the parasitic, anything which may be capable of being vibrated by it is—not at the rf frequency, but at some audio subharmonic of the parasitic's actual frequency. Occasionally, too, the power unleashed by the parasitic will cause arc-over of a tuning capacitor, and this too can be heard (and seen).

If parasitics occur in a rig which has supposedly been parasitic-suppressed, suspect failure of the suppressors first. If they are all good (check by replacement), then check for presence of ground loops and especially for common impedance in both the grid and plate circuits. A few inches of hookup wire is sufficient common impedance to develop a quite respectable UHF parasitic. And in the attempt to find and fix parasitics, keep always in mind that patience is the most important parameter!

What Does Antenna Current Tell Us About Modulation Quality? While many experts will tell you—and we won't disagree —that the only way to get a really good measure of modulation quality is to use an oscilloscope and either a trapezoid (for AM) or bow-tie (for sideband) display, the fact remains that antenna current alone, as measured by either an rf ammeter, a sampling device such as an swr meter, or even a lamp bulb coupled to the transmission line, can tell quite a bit about modulation. At the very least, it can indicate the presence of some troubles which may not be so apparent in the final-amplifier plate-current readings.

The reason that the antenna current is an indicator of modulation quality is simple. Almost any kind of modulation except for FM will result in a variation of the power applied to the antenna. Since antenna impedance is relatively constant, at any one operating frequency, the only way in which the power can vary is for the voltage and current in the feedline to vary.

With normal, high-level, 100-percent AM, and a sine-wave modulating signal, the output power *with* modulation should be 1-1/2 times as great as that *without* modulation. Since the power varies as the square of the current, to obtain this 150% power variation the current must vary about 122%. That is, the power as indicated on an rf ammeter should increase by 22 percent when 100-percent sine-wave AM is applied to the signal.

Note that this figure is true only for one special case of modulation. If modulation percentage is less than 100 percent, the current increase will be less. If some process other than high-level modulation is used, the current increase may be less (although it should not be more). And if the modulation is a voice signal rather than a sine wave, anything can happen and usually does!

Because of the great variations possible when the test signal is anything other than a

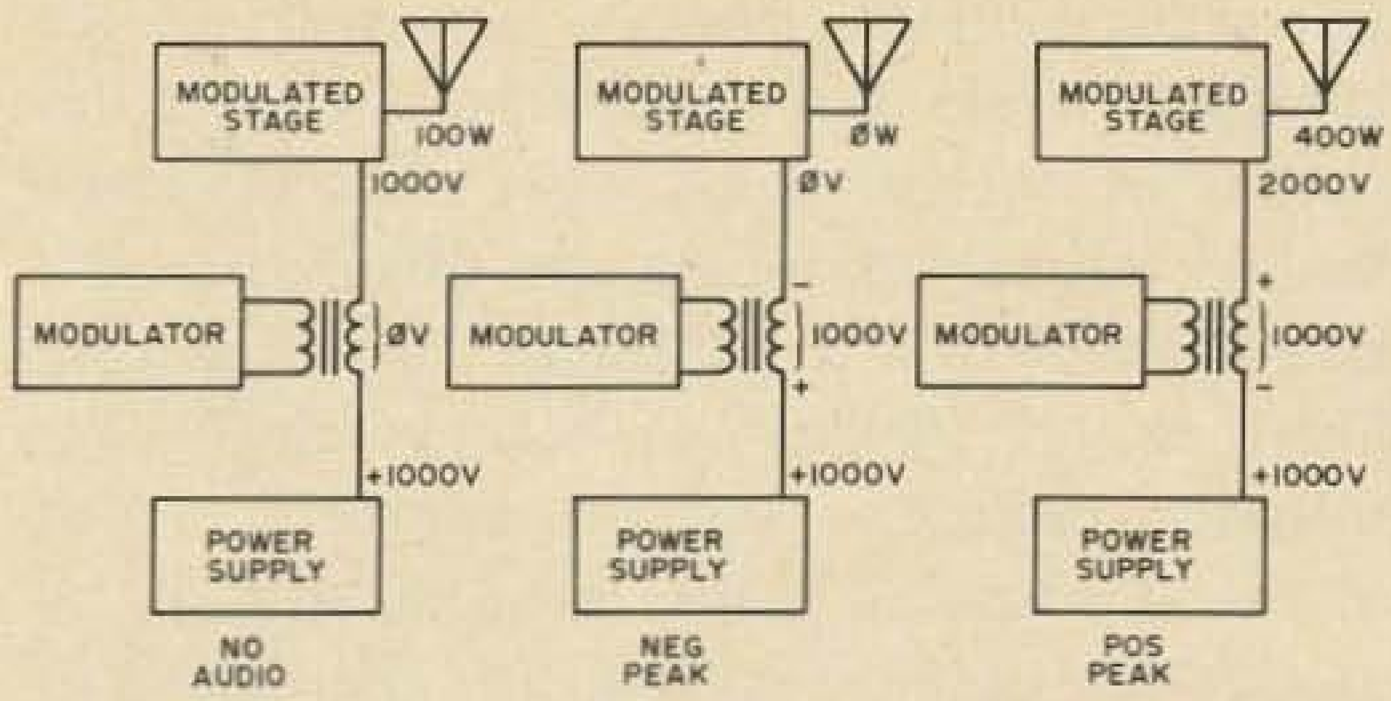


Fig. 6. Principles of high-level AM are shown here. At left, with no modulating signal, modulator output is zero volts and full voltage of power supply goes to modulated stage, providing normal output level. At center, on negative peak for 100-percent modulation, modulator output exactly cancels out power supply voltage. Modulated stage gets zero volts and output momentarily drops to zero. At right, on positive peak of signal, modulator output adds to power supply level to double voltage to amplifier and produce four-time power level. Failure to meet these conditions means modulation trouble is present.

sine wave, virtually all discussion of the effects of antenna current in modulation assumes that only sine-wave modulation is used. This turns out to be most confusing to most of us, when we attempt to put it into practice to monitor our modulation, and that's one of the reasons that the experts recommend scope monitoring—it's one of the very few forms of modulation monitoring which is equally effective on both voice and sine-wave signals.

But if we do have a sine-wave signal, as we would have if we were attempting to check out a modulator by measuring antenna current, then we can confidently look for that 22-percent increase in power when the modulation is applied.

Should the power remain constant, or decrease, it indicates something is not going right in either the modulator or the modulated stage. One possible cause of lack of power variation (constant power) might be a power-supply deficiency which reduced carrier power whenever the modulator was supplying any power. This would, of course, cause distortion by making the modulation percentage vary widely through the course of a single audio cycle.

A decrease in power or antenna current when modulation is applied, on the other hand, indicates a misadjustment of the modulated stage. Most high-level modulation schemes operate by varying the supply voltage available to the modulated amplifier. When the supply voltage is raised, the modulated stage is supposed to deliver the additional power. If its drive is insufficient, or if it is operating at the wrong point on its grid-bias curve, the additional power may not be available to be delivered. In this case, the increased supply voltage causes an actual decrease in power.

Either insufficient or excessive loading on the modulated stage, also, can cause a wrong-way power variation. We'll look at the possible causes of modulation troubles in more detail a little later; right now, the point is that failure to obtain the expected increase in antenna current does indicate problems, and may give you an idea as to the approximate type of problem which exists.

So far, we've discussed only high-level AM amplifiers. Similar reasoning applies in the case of linear amplifiers, whether they be Class A, Class AB, or Class B. When modulation is present, the antenna current readings should increase. The increase should never exceed about 22 percent from the carrier-only readings, however, with sine-wave modulation (voice may provide readings as great as twice the carrier level, in certain circumstances).

Screen-modulated stages, and those using other forms of "efficiency modulation," should also give the same normal readings. These types of modulated amplifiers, however, often exaggerate the "problem" indications of the antenna-current measurement. That is, any problem which would cause a slight decrease in antenna current with high-level modulation may cause an extreme drop in antenna current with an efficiency-modulated stage. The difference is not due to any difference in the measurement; rather, it's because these types of modulation are so much more sensitive to the particular types of problems which show up most readily in an antenna-current measurement. The degree of misadjustment which would be only negligibly off in a high-level stage may easily be intolerably out, in an efficiency modulated rig.

While the antenna current measurement can pinpoint several kinds of trouble and their probable causes, it is totally useless in attempting to troubleshoot many other kinds of problems. For instance, antenna current cannot reveal directly the presence of distortion, nor spurious outputs such as parasitics occuring only in the presence of modulation. Neither can measurement of antenna current reveal much about sideband suppression. To spot these troubles, the scope offers the only quick way (careful probling with a selective receiver, used as a spectrum analyzer as we discussed in the previous installment, can also spot such troubles, but is much more tedious).

It's for this very reason that the measurement of antenna current has given way to scope monitoring of output, for many hams. But since the antenna current measurement *can* tell us much, and *is* one of the classic means of locating some types of modulation problems, the FCC requires that candidates for the Extra Class license know something about it. After all, a little history and tradition is just as necessary as is a knowledge of the latest state-of-the-art techniques and theories.

Now that we've seen what the antenna-current measurement can tell us about modulation quality, and what it can't, let's move on to determine the major causes of the modulation problems which our tests may reveal.

What Causes Modulation Problems? "Modulation problems" is a label covering a multitude of symptoms. In the first place, we have three distinct major types of modulation (amplitude, frequency-phase, and pulse), and a number of sub-classes within each of these types. What turns out to be a problem for one particular sub-class of one type may be desired operation for some other variety.

To illustrate this point in a bit more depth, let's look at several quick examples. If the signal's apparent center (or carrier) frequency changes when modulation is applied, is this a problem? With AM, it's a serious problem—so serious that it falls into the class of prohibited emissions! But if you're using FM, it's the desired result.

Another case: The "carrier" power level increases when modulation is applied. We're not talking about the "extra" power supplied by the modulator; we're assuming that the measurement devices are sufficiently selective to pick out only the carrier component of the output signal, and this component alone increases in strength with modulation. Is it a problem? For high-level AM it is, and we call it "carrier shift." Its presence indicates that the operating point of the modulated stage is being shifted by application of modulation, and distortion of the output signal is likely. But if we're using a controlled-carrier modulation technique, which is a common design for screen-modulation systems, then the increase of carrier power with modulation is again the desired operation.

So what is a modulation problem? Basically, it's anything connected with the production of a modulated rf signal that produces results other than those you intended to achieve.

That's such a wide field that it would take several volumes to answer our original question in complete detail for all cases. You would also get much more information than you probably will ever want about modulation problems. So for the purposes of this question, we're only going to talk about the common problems of the common types of modulation—primarily high-level AM, since we've looked at FM and sideband in other installments of this course.

To know when we have a problem, we must first find out what results we intend to achieve when we attempt to apply high-level AM to an rf signal. Several concepts for describing the amplitude modulation process exist, and all have their uses. We can look on the process as a mixing action which translates a voice signal into the rf range, or as a control action in which the voice signal modifies the gain of an amplifier to produce a signal of constant frequency but varying strength. While the first is closer to what actually goes on, the second is often useful in examining modulation problems.

If we look on the desired output signal as being a single rf signal which varies in strength (assuming 100-percent modulation with a sine wave) from zero to double the carrier-only voltage levels, we know immediately that the modulated amplifier must be capable of putting out a voltage level at least twice that produced in normal operation without a modulating signal.

In order to do this, the amplifier must have adequate drive available to generate the double-voltage output with no change in driving signal, and it must be working into an impedance level which will permit it to develop the double-strength output. If either of these conditions is not met, we will have a modulation problem because the output cannot do what it is expected to do.

With the most conventional form of high-level modulation, the modulating audio signal is placed in series with the dc supply to the modulated stage. If the audio signal exactly cancels out the dc supply on its negative-going peak, this will take care of reducing the output signal level to zero at that time because without plate and screen voltage, an amplifier cannot produce output.

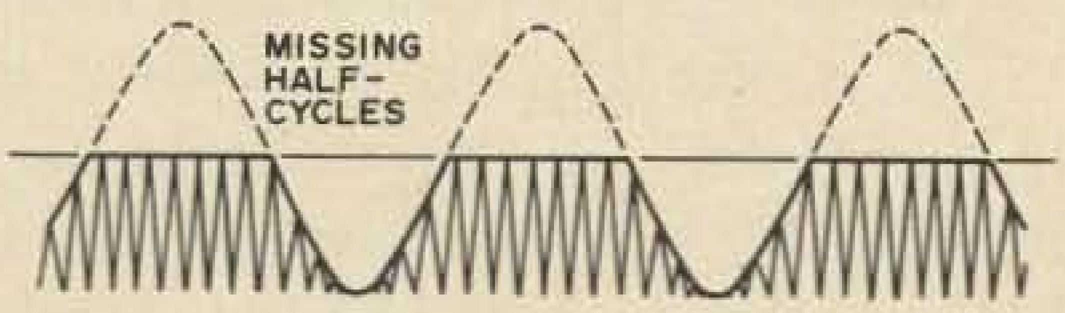


Fig. 7. If modulated stage is unable for any reason to increase its output level above that for no-modulation case, result is output waveform shown here. Negative-going half-cycles of audio signal are modulated nicely, but positive-going half-cycles are missing. This problem shows up as "downward modulation" or decrease in antenna current when modulation is applied. It causes severe distortion, but often such signals show no apparent distortion when received because action of receivers restores missing half-cycles.

But to produce the desired results, the modulated stage must produce double the normal output voltage on the positive-going peaks. The supply power is effectively doubled at this time, because the audio power from the modulator is aiding rather than bucking the dc from the power supply. If the operating point of the modulated stage is held constant, though, the doubled supply voltage cannot result in doubled output voltage—because the efficiency of the amplifier will vary with the change in supply voltage.

To avoid this problem, most modulated amplifiers are made to be self-adjusting by use of grid-leak bias. As the voltage supplied the tube goes up, the bias will shift slightly, and the amplifier's efficiency will remain approximately constant. The result will be the desired doubled output voltage.

The zero-to-double swing we've been talking about is, of course, in terms of peak-to-peak values. A properly modulated rf amplifier looks to the modulator like a resistive load, so when the voltage goes up the current goes up in the same ratio. Doubled voltage and doubled current would indicate four times the power—which is absolutely right, except that the four-time figure is for instantaneous peak input power. Since rms values are only 0.707 times as great as peak values, and 0.3535 times as great as peak-to-peak values, the rms power of the modulated signal is only 1.5 times as large as that of the unmodulated carrier.

Now what are some of the common problems with high-level AM? One of the most frequent is that known as "downward modulation," in which the antenna current or output power decreases rather than increasing with application of modulation. "Carrier shift" is another. Simultaneous AM and FM is a rather common complaint at vhf and uhf, and is not unknown at lower frequencies. And "mushy" or distorted modulation seems, at times, to be the rule rather than the exception—but it's a problem too. Let's look for the causes of each of these.

The basic cause for downward modulation is simple enough. Something in the modulated stage is not right, so that when the modulator changes the supply voltage the amplifier does not respond by increasing its output. In many cases, a scope examination of the output signal reveals that it is modulated only by the negative-going half-cycles of the audio, and that the positive-going portions of the audio signal are having no effect. Since we are getting the less-than-carrier-level parts of the modulation okay, but are failing to get the greater-than-carrier-level parts to make up for them, the net result is a decrease in output power.

Strangely enough, such a signal may be perfectly readable, and often has only slight distortion. Regardless, this is still a problem, and should be cured.

The cause can be anything which prevents the modulated stage's output from going up. It may be insufficient grid drive, so that there's just nothing left from which to supply more output. It may be a poorly chosen operating point (more likely too much grid bias rather than not enough, or too little screen voltage) for the modulated stage, so that the tube is simply saturated before it can reach the double-output condition. And it may be improper adjustment of the tuning and loading controls, so that the tube is not working into a proper impedance to permit it to develop the increased output power. In this case, the problem is more likely to be under-loading under carrier conditions, rather than being loaded too heavily.

Carrier shift is deliberately introduced into TV signals to indicate brightness information, but for normal audio and high-level AM it's a problem. The effect is that of having a dc component in the modulating signal. That is, the carrier level when modulation is present is higher than when modulation is absent. The normal cause of carrier shift is simply overmodulation, which does introduce a dc component by rectification of the excess modulator power. A less common reason for this problem would be poor design of the modulated stage, so that the changes in operating point which accompany modulation would drastically change the stage's performance.

Carrier shift is introduced into "controlled carrier" systems, and is in fact the carrier control which gives such systems their name. The normal manner of introducing the shift is to control screen voltage on the modulated stage with a signal obtained from the rectified *envelope* of the modulating signal rather than with the modulating signal itself. When the modulating signal is weak or absent, screen voltage becomes low, reducing carrier level. This action reduces the dissipation in the modulated stage during no-modulation periods, and permits smaller tubes to be used than would otherwise be the case. It is seldom used with high-level modulation; the most common use of controlled-carrier techniques is with screen modulation, where the power level is limited primarily by tube dissipation and anything which reduces dissipation permits higher output power from the same tubes.

Simultaneous AM and FM is a problem in any type of system, because it's prohibited by FCC regulations. While a delicate adjustment of modulation percentages can produce single sideband (with carrier) from simultaneous AM and FM, in all other cases the presence of both types of modulation at the same time simply results in excessive use of spectrum space and often results in signals which cannot be copied on any kind of receiver.

Since frequency is controlled exclusively by the oscillator, while amplitude is controlled only by the final stage or stages in high-level AM, the only possible cause of FM and AM at the same time is for the modulating signal to be getting back to the oscillator to change its frequency. This can happen if the oscillator's supply voltages are taken from a power supply which also supplies the final, the modulator, or any part of the speech amplifier, and are not sufficiently well regulated, and this is in fact the most frequent cause of this problem.

Running a close second for the title of most-frequent-cause is inadequate isolation between the oscillator and the modulated stage, so that the varying load imposed by the modulated stage under modulation reflects back into the oscillator circuit and changes its frequency. The problem has been traced to this cause in vhf transmitters through as many as five isolating stages; it usually won't occur with that much isolation between oscillator and modulated stage, but it can.

A final cause for simultaneous AM and FM might be rf feedback from the transmitter output to the oscillator. This would be indistinguishable, in practice, from reflected loading, but would succumb to different cures (which we'll examine a little later).

Mushy modulation, or distortion, is a problem which can have many causes. Overmodulation is a frequent cause. Probably the most common reason for modulation distortion, though, is what is known as "nonlinear modulation." It's essentially the same problem we already met in connection with downward modulation, but in a less severe form. The modulated stage is unable to supply the double-voltage output level, but does supply some power increase. When it gets as far as it can, it gives up. This flattens out the positive peaks of the modulated signal, which introduces severe distortion.

Non-linear modulation has many causes. One of the easiest to understand, if not to do something about, is brought about by the use of fixed bias on the modulated stage. If the bias is held constant, and enough drive is supplied to permit full upward modulation, then grid current will be excessive. The reason for this is that a large driving voltage is required to produce full upward modulation, but at the lower supply voltages present when the modulating signal falls to carrier level or even below (the modulation "trough"), this large driving voltage produces a large flow of grid current. At the peaks, when the high voltage is needed, much of it goes on through the stage and less grid current flows.

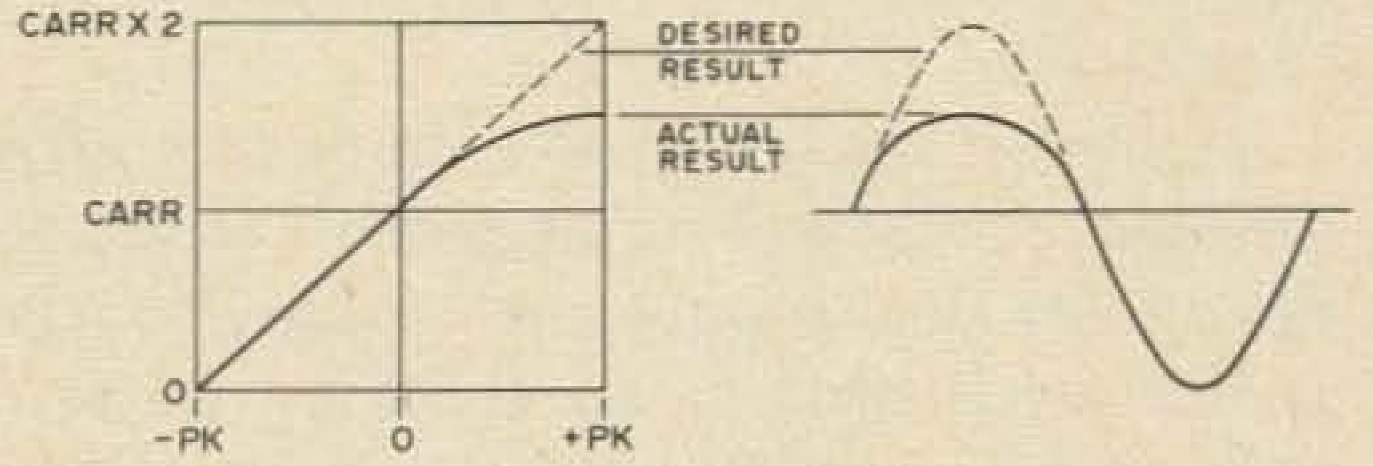


Fig. 8. If output power of modulated stage is able to increase some during positive half-cycles, but not as much as it should, the result is "non-linear modulation" as shown here. Dotted lines show the desired operation, while solid lines show what happens if modulated stage output power is limited to a maximum of 2 times carrier level rather than the necessary 4-time increase. Waveform of modulation signal is significantly distorted. This problem may be cured by increasing drive or loading, but sometimes requires redesign of the modulated stage.

Unfortunately, the grid current under these conditions is so great that tube damage can easily occur. If, then, the drive is reduced to obtain a grid-current reading within reasonable limits, there's not enough drive to supply the peaks.

It's for this reason that most high-level modulated stages are designed to use a small value of fixed or "protective" bias, and obtain most of their operating bias voltage from grid-leak bias. Together with this, the driver stage is deliberately designed to have very poor output-voltage regulation. That is, its output voltage is designed to drop off whenever much current is drawn.

Under these conditions, at modulation peaks the driver supplies full voltage because the modulated stage draws very little current from it. As the modulation cycle moves on to carrier level, the driver is required to supply more current. It can do so only by pulling down its voltage output. The grid-leak bias increases bias on the modulated stage as grid current increases, requiring a higher voltage. The result is that the driver is always struggling to supply the required drive power, and just barely succeeding in doing so. Average grid current, as indicated on a meter, remains moderate, but actual drive levels are great enough to provide linear modulation.

If, however, the driver is adjusted to supply too little drive power, full upward modulation still cannot occur. Similarly, if the modulated stage output circuits are improperly adjusted, the full upward modulation power levels cannot be achieved in the antenna.

Improper design of the modulator itself can also be a source of distortion. Unless the modulator can supply the required output power levels distortion-free, it's a waste of time trying to trouble-shoot the total system. Possible causes of distortion in the modulator include an improper impedance ratio for the modulation transformer, improper grid bias on the modulator itself, or improper performance of the audio driver stages ahead of the modulator.

Locating the source of distortion in a radiotelephone transmitter is a job which virtually requires a scope. First, the modulator must be checked out to assure that it is capable of delivering the power. Then the modulated stage must be checked, and finally the complete system.

Lacking a scope, however, it is still possible to determine the modulation capability of the transmitter. To do so, we start by assuming that the modulator can deliver at least a small part of its audio essentially distortion-free, and apply a very low percentage of modulation to the carrier. We then use our receiver as a spectrum analyzer, looking for side frequencies at twice, three times, four times, and other higher harmonics, the frequency of the modulating tone removed from the carrier. If all is working properly, these side frequencies should be absent.

Next, we crank up the audio gain of the modulator until large amounts of distortion are present, as indicated by downward modulation of the antenna current or flicker of the final-stage milliammeter, and again look for the second-harmonic side frequency. This time, it should be easily detectible.

Finally, leaving the receiver set on the side frequency, we reduce the percentage of modulation until the side-frequency signal disappears. We then search for other harmonics; if the transmitter is working properly, all other side-frequency harmonics should be absent when the second-harmonic side frequency disappears. All we need do now is to determine the percentage of modulation being applied, and that's the maximum modulation capability of this transmitter.

If other side frequencies are present, distortion within the modulator audio stages is indicated. Non-linear modulation normally causes second-harmonic distortion to appear in the envelope before any higher-order distortion products show up, while intermodulation in the audio stages more often results in third- or fifth-order distortion products.

To measure the modulation percentage, when the modulating signal is a sine wave, we can use a peak-to-peak indicating ac voltmeter connected across the modulation transformer secondard (DANGER–high voltage, be sure all power is off before connecting the meter!) and compare the peak-to-peak ac reading thus obtained with the dc voltage applied to the modulated stage. For 100 percent modulation, the p-p ac reading should be exactly double the dc value. For 50 percent modulation, the two readings will be equal. To get the percentage for any two readings, multiply the p-p ac reading by 50 and divide the result by the dc reading; the result will be the modulation percentage, directly.

How Can Modulation Troubles Be Cured? We've met a number of modulation problems and their causes, now. The logical final question for this installment is how to cure them.

In almost all cases, a cure can be effected simply by removing the cause of the trouble. This may, however, in the case of some forms of distortion, amount to a complete redesign and rebuilding of the modulator. Let's concentrate on some of the simpler troubles for a start, and leave redesign of the equipment until some other time.

To cure the troubles evidenced by downward modulation of antenna current, or by downward fluctuation of the final plate current meter, try first increasing drive to the modulated stage (unless it is already running with maximum rated drive). Increasing the grid bias on the modulated stage may help also, especially if drive is already at maximum. Next, check the coupling of modulated stage to antenna or other load. Increase loading as necessary to remove the trouble. Ideally, a modulated stage should be loaded to the point that the plate-current dip is barely perceptible—unless this overloads the tubes, in which case bias should be increased and screen voltage decreased as necessary to keep plate current within reasonable limits while maintaining the loading heavy.

Be certain that the dc plate voltage to the modulated stage does not exceed ratings for the tubes involved; if it does, reduce it to the rated limit and see if the trouble persists. Also, check the final tubes for weak cathodes, which can cause this problem.

Insufficient modulation of the screen-grid along with the plate can cause this trouble; increasing the percentage of modulation to the screen is the normal cure. If screen voltage is taken from the plate supply via a dropping resistor, this cure normally is not applicable.

Finally, the output filter capacitors in the power supplies feeding either the modulated stage, the modulator itself, or both, may be too small, resulting in poor voltage regulation and a consequent inability to supply the necessary power peaks. Increasing the value of these capacitors is always a good idea; they can hardly be too large. If electrolytic capacitors are used (relatively common in the 100-watt class of rigs), they may have aged so that actual value is much less than the marked value. Such capacitors should be replaced.

The preceding suggested cures apply to plate-modulated AM transmitters. In addition to most of the above, the following are also applicable to any type of grid-modulated AM rig:

Too much rf drive can cause downward modulation, just as can too little. With grid modulation, the drive level is critical and must be adjusted carefully to obtain optimum results.

Too light loading; this is much more critical with grid modulation than with plate modulation. Grid-modulated transmitters should be loaded so heavily that the resonance dip is not perceptible at all. When modulation is absent, the tube will be dissipating maximum power. Application of modulation then increases efficiency of the modulated stage to produce the additional output power required.

If the plate-current needle flickers upward when modulation is applied, any of several problems may be present. The problems and their cures are:

Overmodulation—cure this by turning down the audio gain or speaking more softly. This is applicable to any type of modulation.

Incompletely neutralized modulated state—cure by neutralizing the stage more completely.

Parasitics in the modulated stage—eliminate the parasitics.

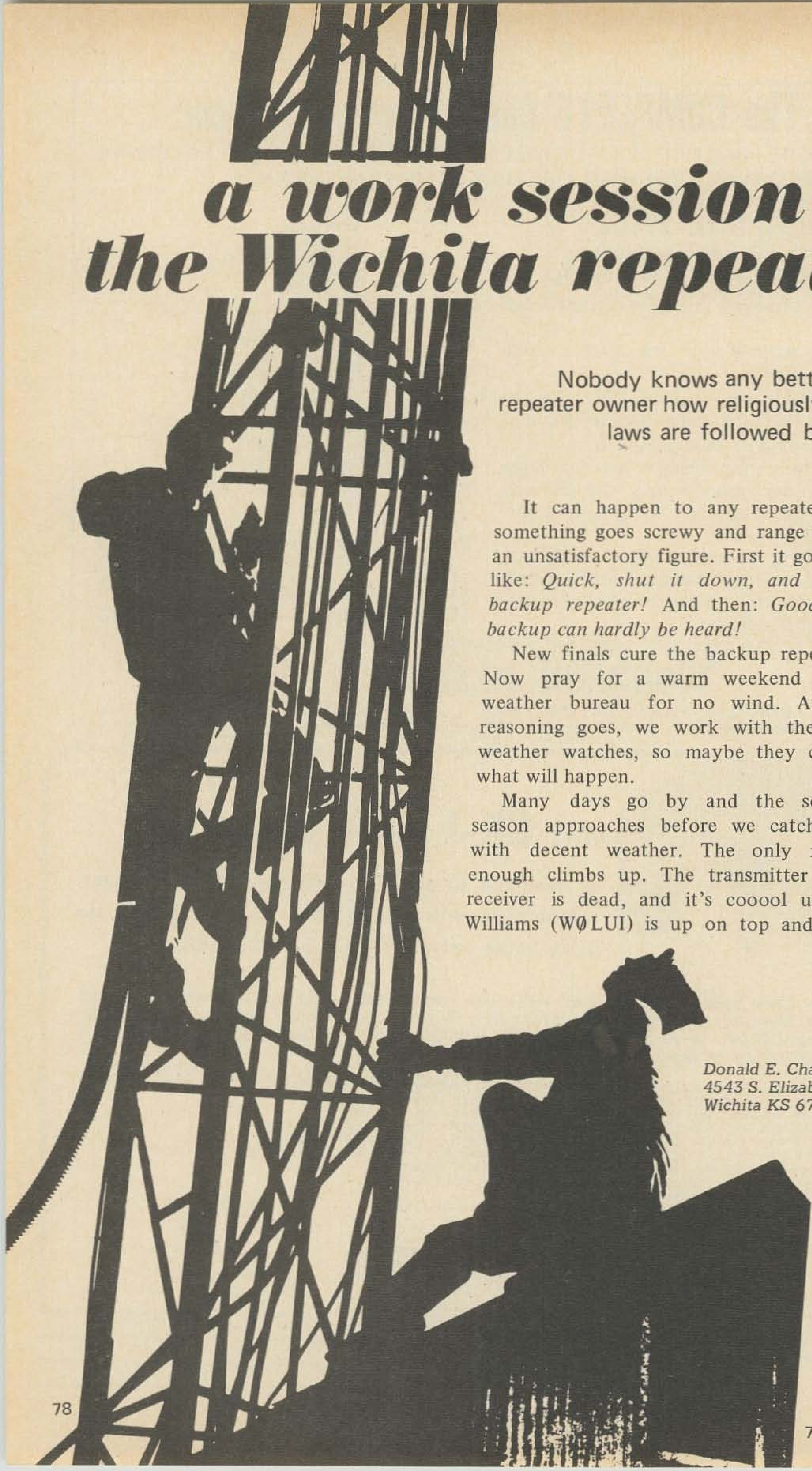
When screen modulation is used, screen voltage too low—cure by increasing screen voltage.

When control-grid or suppressor modulation is employed, too much grid bias—reduce grid bias.

While all these problems and cures depend largely on the indications obtained by antenna current measurement or by observation of the final-stage plate meter, a steady plate meter or upward-modulating antenna current does not necessarily indicate good modulation. It's quite easy to get a set of conditions in which one kind of distortion on positive half-cycles of audio balances out an opposite kind on negative half-cycles, so that the current measurements look good but the modulation is really m*u*dulation. The scope provides the only certain check on this. However, for any specific rig, the scope is necessary only once; after initial adjustment, the plate-current or antenna-current measurements can be used to spot minor departures from desired operating conditions.

Next Time. We're only halfway through our examination of tr.ansmitter operating techniques. In the next installment, we'll be looking at the problems of control of harmonics and of coupling transmitters to the antenna system, among other things.

. . . Staff



a work session on the Wichita repeater

Nobody knows any better than the repeater owner how religiously Murphy's laws are followed by Nature...

It can happen to any repeater – suddenly something goes screwy and range is reduced to an unsatisfactory figure. First it goes something like: *Quick, shut it down, and turn on the backup repeater!* And then: *Good Grief! The backup can hardly be heard!*

New finals cure the backup repeater trouble. Now pray for a warm weekend and ask the weather bureau for no wind. After all, our reasoning goes, we work with them on severe weather watches, so maybe they can influence what will happen.

Many days go by and the severe-weather season approaches before we catch a weekend with decent weather. The only man healthy enough climbs up. The transmitter is dead, the receiver is dead, and it's cooool up there. Jay Williams (WØLUI) is up on top and the 6-meter

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repeater is okay, but – Wow! The 2-meter machine needs much fixing before it can go back on the air.

New tubes are sent up via the hoisting cable, but before long the bad news is

One thousand feet of eighth-inch aircraft cable is permanently mounted to the tower. This picture shows Don Patterson (KØKN), left, and Glen Brasch (WØHYR) as they start a load up to the top. The building on the right houses the 10 kW output of KEYN-FM and microwave remote control equipment. The building on the left houses two low-band and two high-band quarter-kilowatts, two low-band and remote control stations, and two 450 MHz mobile relay stations. Also inside is the Wichita repeater identification equipment and terminal equipment for the telephone

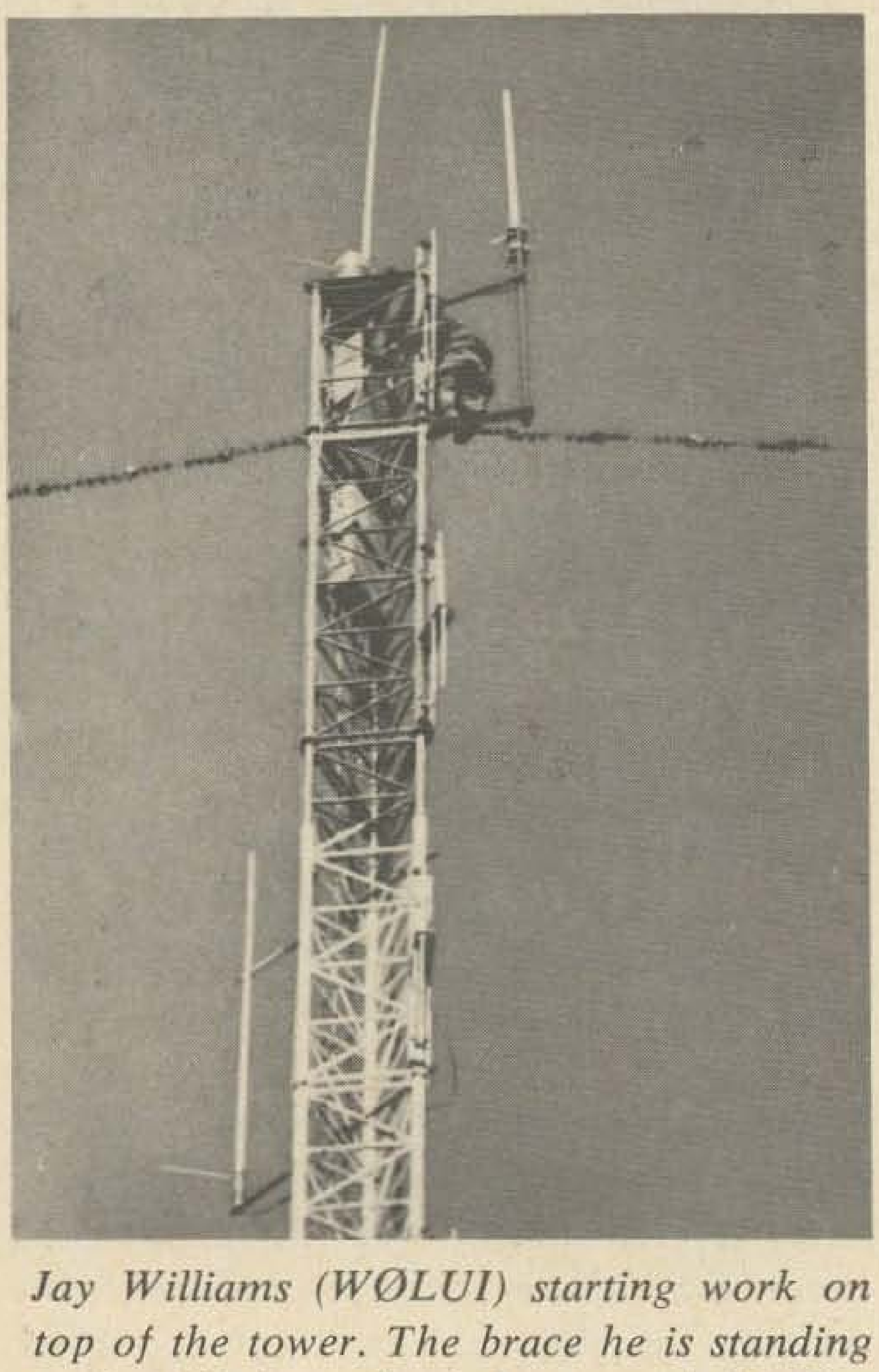
discovered: A 6-inch piece of wire works better than the receiving antenna. The equipment is in working condition, but an antenna replacement is necessary.

We can't replace it today, but this is the second time in three and a half years of repeater operation we have lost an antenna. A pair of decisions are made. First, the replacement antenna will be side-mounted some 6 feet *below* the top of the tower. Let someone else be the lightning rod. Second, if possible, obtain enough low-loss feed line to bring the equipment down to the ground.

A few days go by. On friday, the weather bureau advises that Saturday will be calm, warm, an ideal day for tower work. Grab a side mount kit and a replacement antenna, and check who is available. Pushover Chase is the fall guy, as the other tower workers have to work Saturday. Don Pryor (WAØIPB) and Vic Thomas (WAØYBM) are available for ground work.

There is no substitute for having the needed part in case of trouble. This is a complete operating SPARE repeater, ready to go, in case any or all major assemblies need to be replaced. If the man on top wants any part, any portion can be hoisted up on the cable. This site, by the way, is the location of the Wichita repeater, 6400 North Hillside in Wichita. In addition to a commercial FM broadcast station, several commercial two-way radio users are on the tower along with the Wichita 2- and 6-meter amateur radio equipment. The amateurs have a 12-pair Neoprene-jacketed messenger cable running from the top to the bottom of the tower. This is used to control various functions, such as interconnecting two repeaters, carrying 600Ω audio down for monitoring, etc. When we told the local telephone once we wanted the termination for the phone line up on top, they informed us they would be happy to do it as long as they could keep one foot on solid ground. We agreed to a termination inside the building, and the local hams obtained and installed the line from ground level to the top.

All meet and have a quick cup of coffee before heading out to the tower site. It's slow work when only one man is on top but the new (well, *almost* new) antenna is checked out on the ground with vswr meters and sent up the cable.



Jay Williams (WØLUI) starting work on top of the tower. The brace he is standing on is 440 feet off of the ground. He has just opened the 2-meter repeater cabinet, getting ready to replace the final tubes. The antenna fastened to the brace he is standing on is a 450 MHz business rig. The upper left antenna (looks like it sticks out of the beacon light) is the receiving antenna for the repeater. At the lower left, the transmitting antenna is a few feet out from the tower. The antennas for the 6-meter repeater are not visible; they are side-mount types, mounted on the far leg. Several 450 MHz log periodic beams are also mounted on the far leg.

The first decision is implemented by side-mounting. The cable from the old antenna shows signs of moisture. Fifteen feet of replacement cable and all is well.

Or is it? Program material from KEYN-FM is suddenly showing up on the repeater. Careful checks of all shields, grounds, and antenna positions show that the clearance between receiving and transmitting antennas is only about 8 feet. A quick mental review of system calculations comes up with a recommended minimum separation of 20 feet. Some work with the muscles, aided by wrenches and a quantity of words (none of them the type allowed on the air) and the bottom of the transmitting antenna is now at the 380-foot level, and the receiving antenna starts at the 428-foot level.

It's getting cool, so all is given a final check, the repeater is buttoned up, and the tower jockey starts down. This takes a little while, as my muscles are tired, and I'm not quite as young as I pretend to be. But Don Pryor awaits with a cup of coffee poured and ready. As we leave the tower we enjoy the fruits of our labor. We talk to one of the hams in Mulhall, Oklahoma, one in Enid, Oklahoma, one in Hesston, Kansas, and one in Kingman, Kansas. All is truly well, the tall tower is back in service and we'll see if the weatherman is good next weekend. We now have 800 feet of foam feedline.

Now if the weatherman will give us another good weekend . . . . . . WØDKU ■

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Inexpensive New Semiconductors For The Ham

A whole flock of new semiconductors that should interest the ham have recently appeared. They include both discrete devices and integrated circuits; this article will discuss the discrete types other than rf power transistors.

While it's obvious that no manufacturer of semiconductors makes any devices designed just for the amateur, transistors and other parts made for other uses are often perfect for his projects. High performance combined with low prices provide the proper combination for the builder.

All of the products described here have been introduced recently. All are manufactured by Motorola, the world's largest producer, and as such, are readily available from the wide network of Motorola distributors including Allied and Newark. The approximate single-quantity prices are listed. For more information on any device, consult the Motorola Semiconductor Data Book or write for a copy of the individual data sheet: Technical Information Center, Motorola Semiconductor Products Inc., Box 20924, Phoenix AZ 85036.

The schematics are taken from the Motorola Application Note listed. They are available from the same source.

Dual-Gate MOSFETs TO-72

A real boon to the rf designer is the dual-gate MOSFET, unmatched for low noise, high gain, low cross modulation, and resistance to overloading in VHF and HF amplifiers. The MFE3006 ($1.50) features 25 dB typical gain at 100 MHz; it's also ideal for lower frequencies. The MFE3007 ($1.62) features 21 dB gain, 3 dB noise figure at 200 MHz. The MFE3008 ($1.29) is similar, but specified for mixer use. All have exceedingly low feedback capacitance (0.02 pF typical), so don't have to be neutralized in normal applications. Incidentally, these MOSFETs, like all made by Motorola, feature silicon nitride passivation and are not superdelicate like most other MOSFETs.

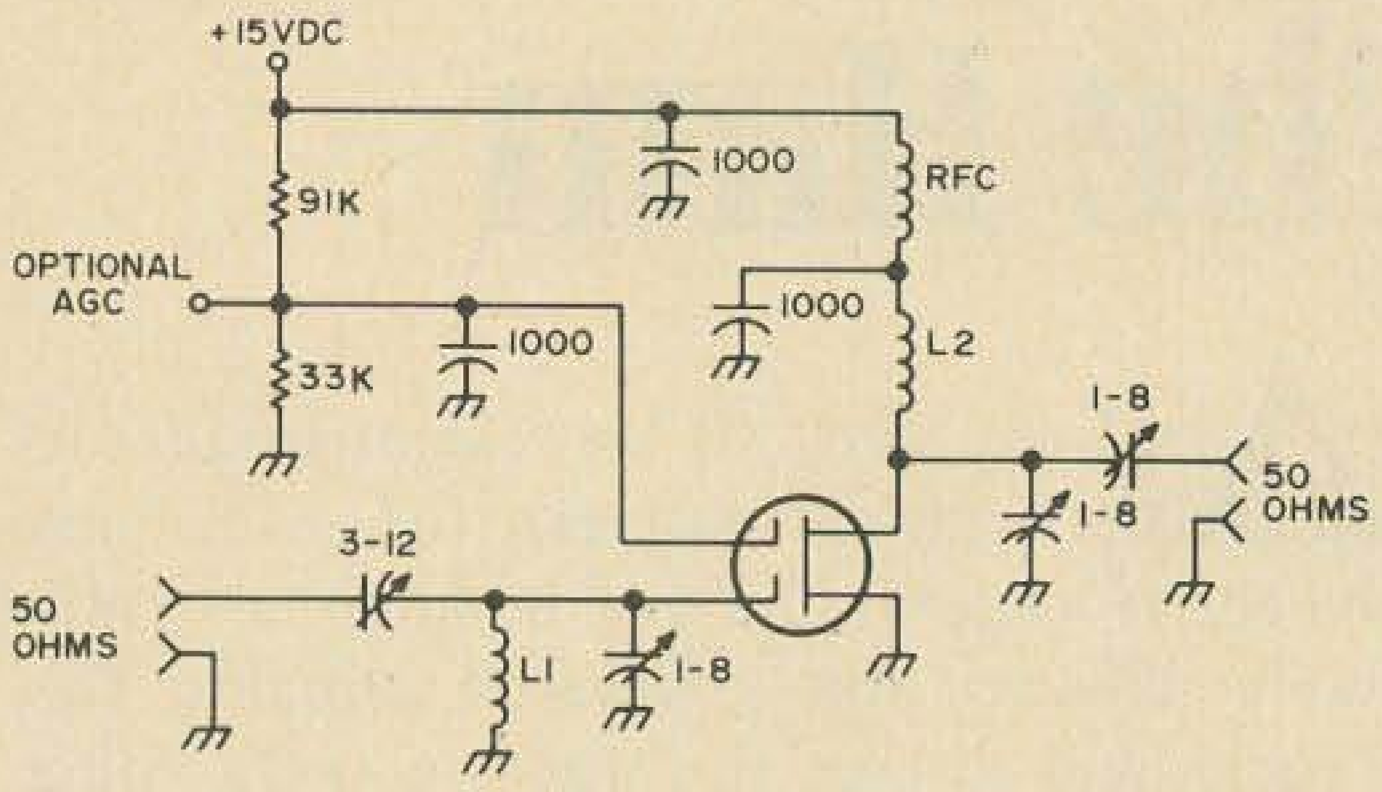


Fig. 1. Typical VHF amplifiers using MFE3007 dual-gate MOSFET. Taken from Motorola Application Note AN-478.

Typical 100 and 200 MHz amplifiers are shown in **Fig. 1** (TO-72 case).

Cheapies but Goodies

A new approach to inexpensive transistors is found in the NPN MPSA10 (29¢), NPN MPSA20 (33¢), and PNP MPSA70 (38¢). Instead of being falloffs from more expensive types, these new transistors are prime devices designed to be inexpensive. They use small dice, simple processes, and are specified to have optimum yield. All of these contribute to the low cost.

The three transistors are ideal for all general audio and low rf applications. They have BV_{CEO} of 40V, h_{FE} of 40 to 400, C_{ob} of 4 pF maximum and minimum f_T of 50 MHz (MPSA10) or 125 MHz (MPSA20, MPSA70). The data sheets are very complete for such inexpensive parts (TO-92 case).

For even lower prices, the transistors are offered in kits containing three, five, or nine transistors of a type with various h_{FE} selections. For instance, the MPSK12 costs $2.07 and contains nine MPSA10s: the cost per device is only 23¢.

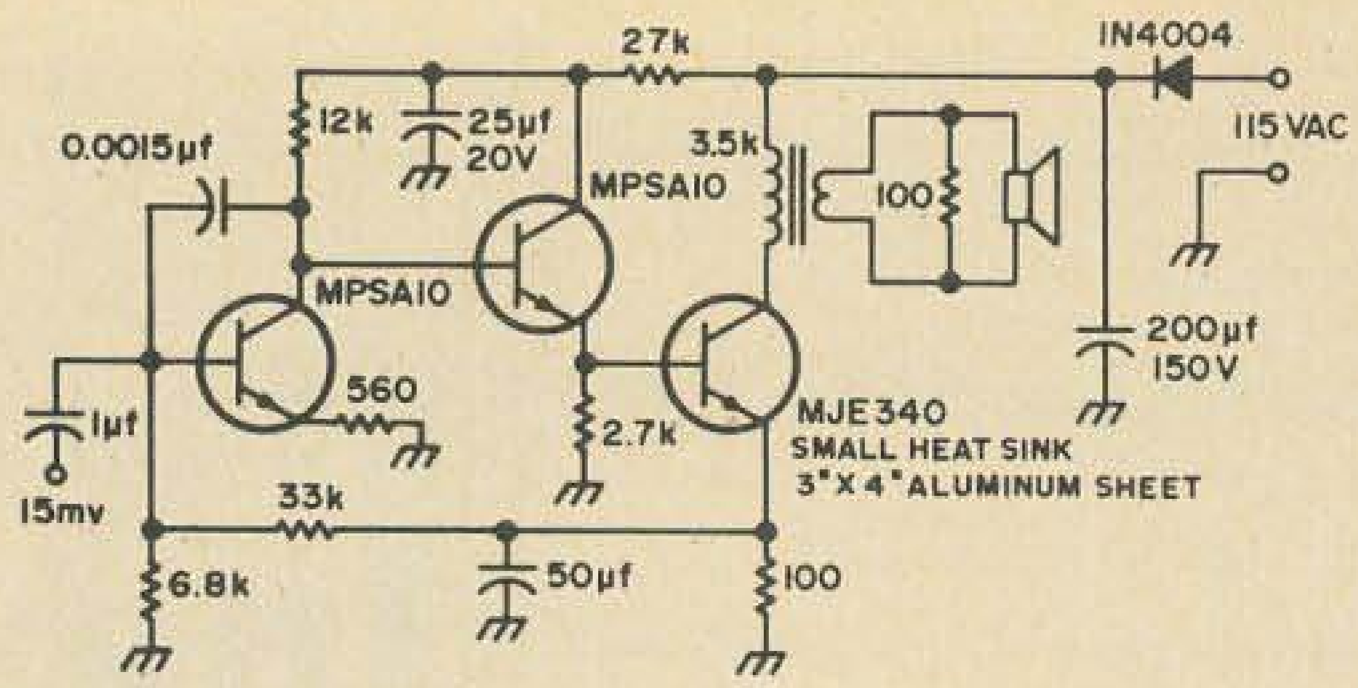


Fig. 2. 2½W line-operated amplifier. Motorola Application Note AN-426A.

A typical application is shown in **Fig. 2**, a line-operated 2.5W amplifier using a "solid-state 50L6," the 300V MJE340 silicon power transistor ($1.06).

Darlington Amplifiers

New plastic Darlington-connected amplifying transistors offer exceptionally high gains in single packages at low prices: MPSA66 (PNP, at 63¢, 75000 minimum h_{FE}), MPSA12 (NPN, 67¢, 20000 h_{FE}), MPSA13 (NPN, 47¢, 5000 h_{FE}) in TO-92 case. A 2W amplifier using an MPSA12 as a preamplifier is shown in **Fig. 3**.

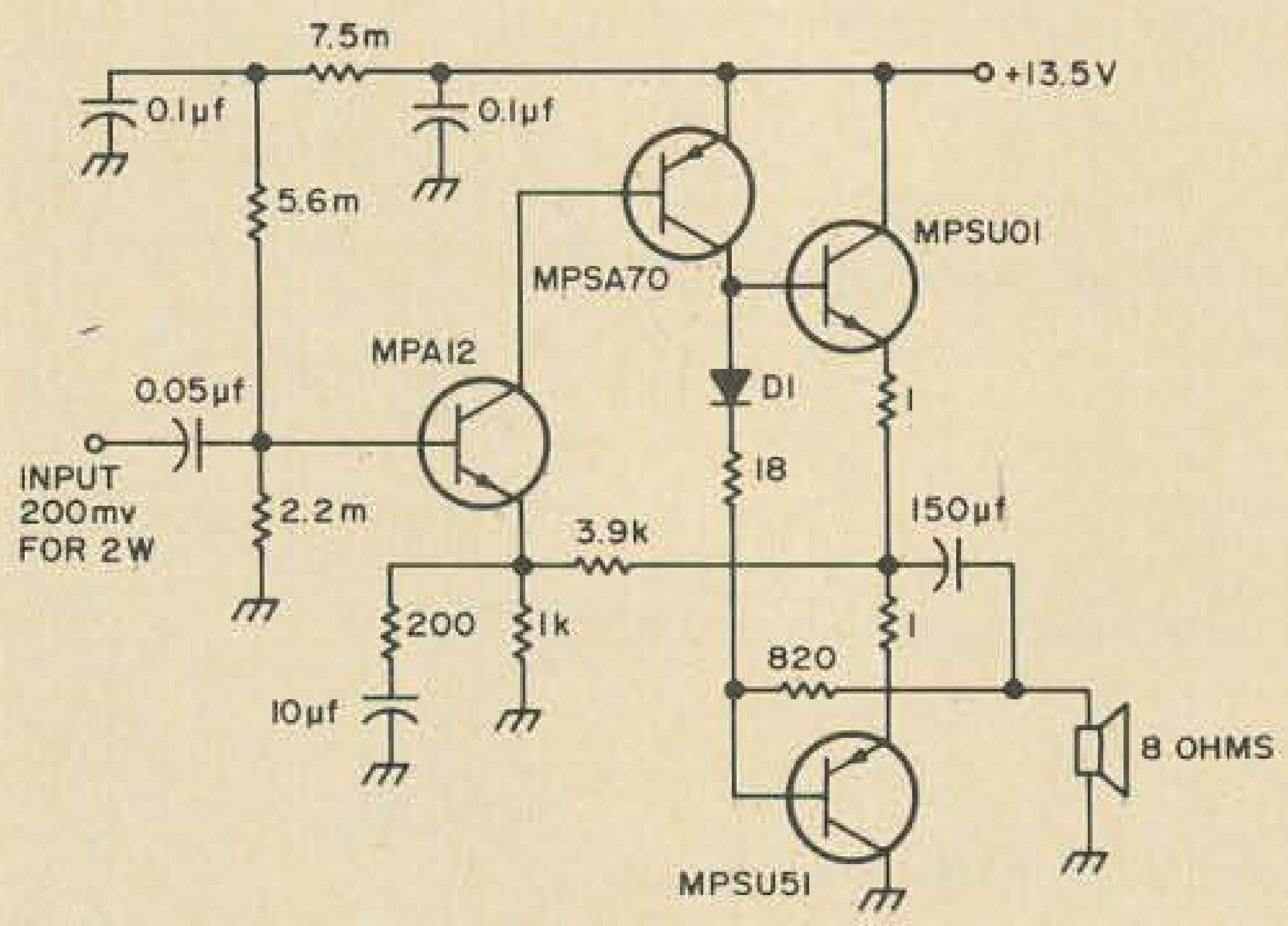


Fig. 3. 2W Audio amplifier. Motorola Application Note AN-426A.

UHF Oscillator

A new plastic transistor, the MPSH10, is designed for use as a UHF and VHF oscillator in TV sets. It's also excellent for ham use as a free-running or crystal oscillator. The MPSH11 has high f_T (650 MHz minimum), complete Y-parameter specs, and costs only 49¢ (TO-92 case).

Uniwatt Transistors

A new case for intermediate-power transistors is the Uniwatt plastic package (case

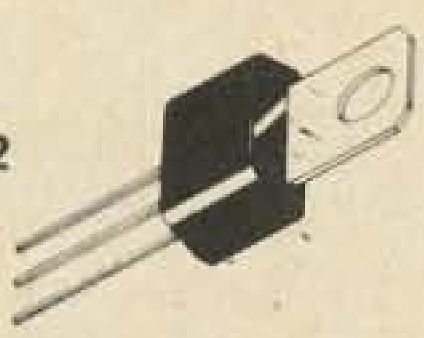
152). It is similar in construction to small-signal plastic transistors, but is larger and the metal tab on which the transistor chip is mounted is extended out of the plastic. The tab can be mounted on a heatsink for dissipation of up to 8W (the value depends on the specific transistor). The Uniwatt package was developed for use in consumer equipment such as complementary audio amplifiers and video drivers, so the transistors using it are inexpensive.

A useful complementary pair of Uniwatts are the NPN MPSU01 ($1.15) and PNP MPSU51 ($1.33), suitable for audio amplifiers with up to 5W of output.

A useful general-purpose Uniwatt is the NPN MPSU02 (99¢), similar in characteristics to the popular metal-cased 2N2219. It has a BV_{CEO} of 40V, h_{FE} of 50, typical C_{ob} of 2 pF, and a minimum f_T of 150 MHz (typically 400 MHz). Though it's designed for general-purpose use such as audio, it has been found useful for many rf applications as well.

Information on mounting and heatsinking Uniwatts is found in Motorola's application note AN-472.

High-Voltage Drivers and Amplifiers 152



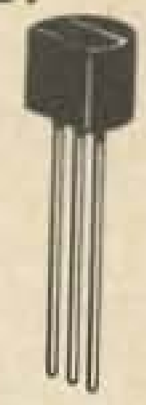
Three new high-voltage transistors are excellent for use as Nixie or neon-tube drivers, scope tube drivers, or general-purpose high-voltage applications. The NPN MPSL01 (59¢, 120V BV_{CEO}) and PNP MPSL51 (61¢, 100V BV_{CEO}) are small, TO-92 case transistors with gains over 40, f_T over 60 MHz, and C_{ob} of 8 pF maximum. They have very complete data sheets.

The MPSU10 is a Uniwatt transistor (case 152) with a 300V breakdown rating, dissipation of up to 5W, h_{FE} of 40 minimum at 10 mA, f_T of 60 MHz minimum, and a C_{cb} of 3 pF maximum. And it costs only $1.50.

Power Transistors

The most popular silicon power transistor is the NPN 2N3055, a metal-cased device that costs about $2.05. A new plastic version, MJE3055, has similar specifications, yet cost only $1.41. And a PNP complement is also available (MJE2955, $2.90). Both have V_{CEO} of 60V, h_{FE} of 20 to 70 at 4A, power dissipation of 90W and f_T of 2 MHz minimum (case 90). The MJE3055 is ideal for general amplifying and switching use.

The Cheapest Transistors TO-92

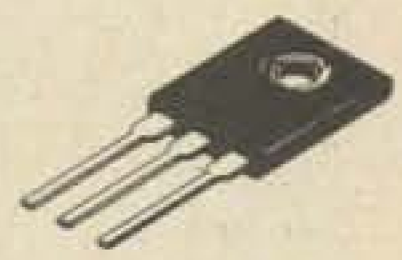


The bottom of the price list is occupied by the 2N5223 at 21¢. While it does not feature great specs, it is satisfactory for many general-purpose applications: BV_{CEO} = 20V, P_D = 310 mW, h_{FE} = 50 to 800 and f_T = 150 MHz minimum (TO-92 case). The MPS5172 has the same price.

Voltage-Variable Capacitance Diodes 182

Voltage-variable capacitance diodes (varactors) are very useful in FM modulators, test equipment, afc, low-level frequency multipliers and RTTY frequency shift. Four new varactors cost only 53¢ apiece: MV2201 (6.8 pF), MV2203 (10 pF), MV2205 (15 pF) and MV2207 (33 pF). They have Q up to 300 and tuning ratios of about 2 at voltages of 1 and 10. Similar varactors with better even specs and capacitances up to 100 pF (MV2101 through MV2115) cost only 90¢ (case 182).

Thyristors 90



Four new silicon controlled rectifiers—MCR407-1 (30V, 82¢), MCR407-2 (60V, 97¢), MCR407-3 (100V, $1.05) and MCR407-4 (200V, $1.20)—are 4A thyristors with small turn-on requirements (case 90).

High Voltage Rectifiers

59

High-voltage silicon rectifiers have been relatively expensive in the past, making it necessary to use many devices in series in most practical applications. A new family of rectifiers offers PIV up to 5000V at relatively low prices. Examples are the MR990A rated a 1 kV and costing only 35¢; and the MR996A, 5 kV and $1.35. All are rated at 250 mA forward current and are in small plastic packages (case 59).

. . . WA7KRE ■

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RENOVATING SURPLUS METERS

A test or two, and maybe just a dab of opaque white paint . . . and presto!

Even today, many years after World War II and the Korean conflict, the surplus market is flooded with meters of all shapes, sizes, and ranges. Many are calibrated in *pps*, *QXR/2*, or *squitter*. This terminology means something to someone but doesn't mean much to you when you want to read plate current. Some surplus dealers have been kind enough to include the actual scale in their advertising, while others let you take a chance of getting something truly useful for your money.

In either case, several steps are necessary to convert the scale to understandable terminology. When your bargain arrives, arrange a test setup to determine exactly what you have. Probably the easiest way to find the full-scale calibration is a series circuit as in Fig. 1. The series resistance is adjusted to a full-scale indication on the tested meter and the value is read on the known meter. This is the sensitivity. A resistance decade or pot is then added in parallel with the meter and adjusted to half-scale indication. The value of the parallel resistance is equal to the internal resistance of the meter. Both the sensitivity and internal resistance should be scribed on the case for future reference. Obviously, it would be in the best interest of

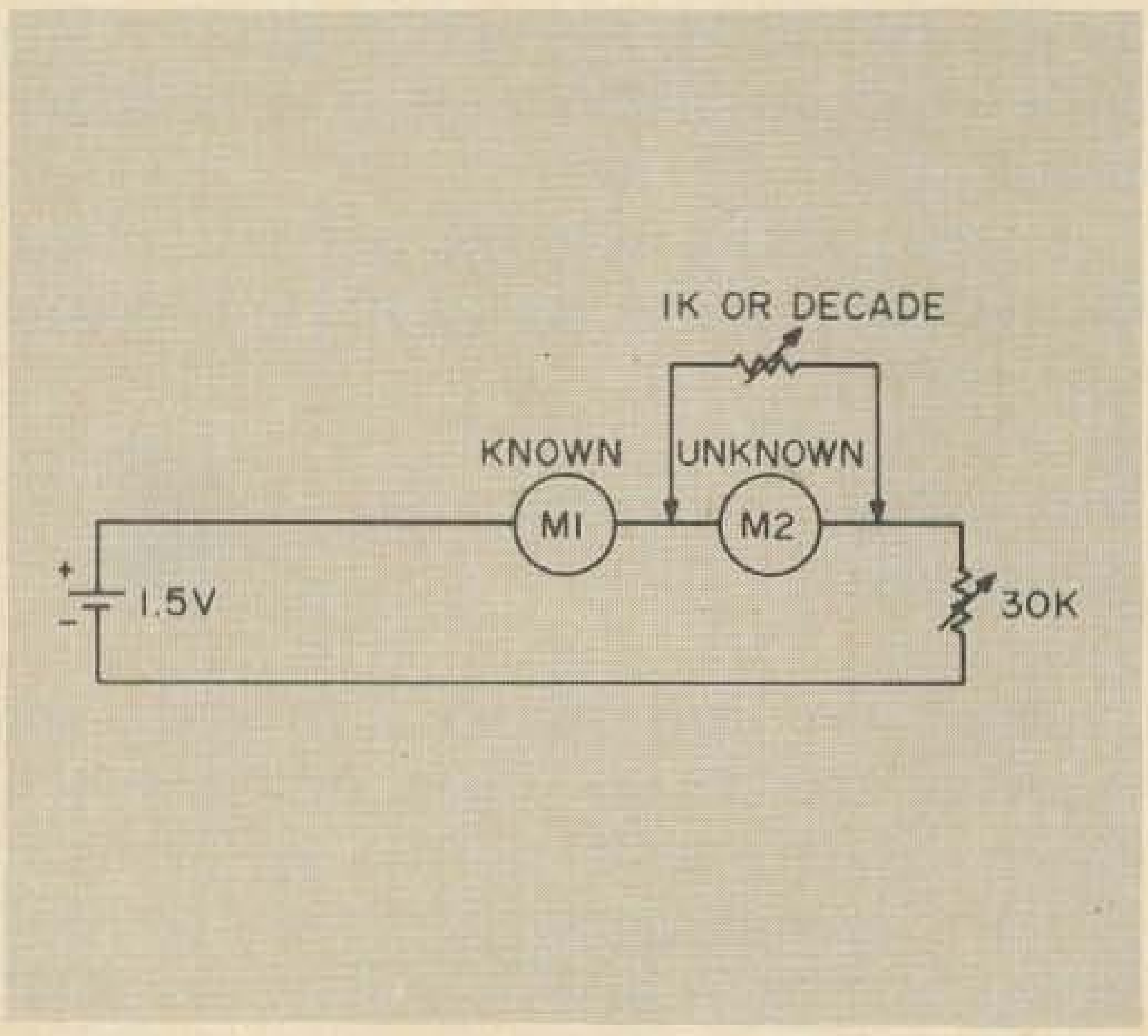

Fig. 1. Check the internal resistance of the meter by adding a variable parallel resistance across the unknown meter. Removal of the resistance gives an indication of meter sensitivity.

both meters to start with a high series resistance and a high known meter scale.

Once you know what you have you are in a much better position to put it to use. The meter must now be disassembled; commonly, this is done by removing three screws around the rear circumference of the body or two screws on the back. The holes may have been sealed, in which case the sealing compound must first be removed. Slide the movement onto a clean, white, lint-free surface. Immediately check for the presence of an internal shunt or multiplier which may have caused false readings during the earlier tests. If a shunt is found, remove it. A multiplier should be shorted. In either case, recheck as previously described.

It is a relatively simple matter to change the scale. It may be as simple as marking out the legend with typing correction fluid. The existing scale can often be used by removing the old numbering as above and re-marking with decals or transfers either of the standard type or ones made especially for meters. For any work more elaborate than removing a legend it would be best to carefully remove the scale. This is normally accomplished by removing two small screws, one on each side of the scale and usually in line with the meter pivots. Use only a jeweler's screwdriver and exercise caution to slide the scale out without touching the needle or hairspring.

Perhaps your meter has only "good–bad" markings and no calibrations. All is not lost. After the scale has been removed, paint the scale area with a good coat of flat white paint and allow to dry thoroughly. Measure the length of the needle excursion using either the old scale or the needle itself. Cut and apply a new set of graduations from the variety included in the meter and panel marking transfer set available from dealers for *Letraset* transfers. Add whatever legend and calibrations you need and carefully reassemble. The cost of the transfers is rather high for conversion of only one meter but when several are to be done the cost per unit is quite reasonable.

. . . WAØABI ■

A Simple Bias for Linear

Shunt regulation for bias supplies offers the advantage of low constant-current

With the exception of those circuits using zero bias tubes, class AB2 and class B operation of linear amplifiers appears to have been largely neglected by the radio amateur. The reason for this is not hard to find. The little literature which is available on the subject invariably shows bulky and elaborate regulated bias supplies, often containing five or six tubes, being used to maintain the bias voltage at a steady value while the grid current surges to 100 mA or more with each transmitted syllable. Some form of regulation is, of course, essential, for the bias voltage would otherwise swing wildly with each surge of grid current. But this regulation can be provided so simply using semiconductors that it need no longer influence the choice of amplifier type.

The regulator described in this article possesses the following features: (1) It contains only five small components, costing approximately $3, and requiring about two cubic inches of space. (2) It is a two-terminal device which is connected to the amplifier at the point where regulation is required. No separate power is needed. (3) The bias voltage may be adjusted by the turn of a knob to any value between 40 and 100 volts (other ranges are available by changing the component values). (4) It can be used for any class of amplifier, radio or audio frequency, whether grid current flows or not, but as described above, it is of particular value for class AB2 or class B amplifiers. (5) It will hold the bias voltage within 1.0V of the selected value during grid current excursions up to 100 mA, or within about 4V for a current up to 400 mA. (Closer regulation could be obtained with additional components but is not necessary.) (6) It can be used in conjunction with almost any bias supply of suitable voltage, and only a small current is taken from the supply, regardless of the value of grid current to be handled.

Bias regulation differs from the more common use of regulators in power supplies in that grid current flows backwards into the supply instead of drawing current from the supply. The shunt type of regulator is ideal for this application because it can be designed to draw only a very small constant current from the bias supply and yet accommodate a heavy flow of grid current from the linear amplifier while maintaining

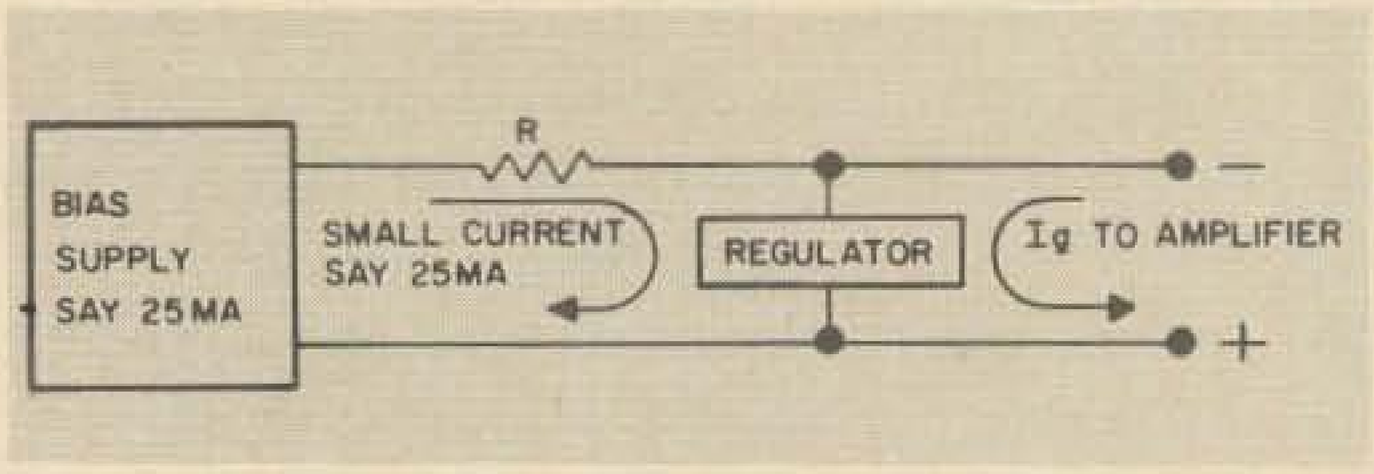

Fig. 1. Shunt regulation.

the bias voltage constant (see Fig. 1). The more commonly used series regulator does not possess this property, but must be set up for a power supply drain greater than the peak grid current to be catered for (see Fig. 2).

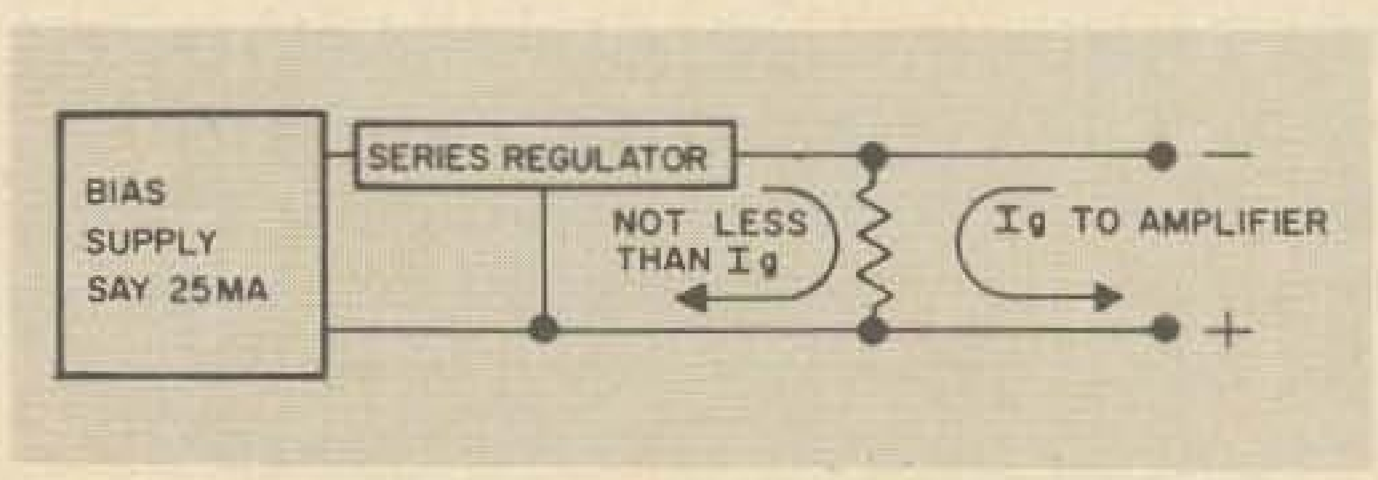

Fig. 2. Series regulation.

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Regulator Amplifiers

drain, and it can be used with the neglected class B and AB2 linear amplifiers.

I have therefore based my design on the use of shunt regulation, and evolved the simplest possible circuit that will give adequate regulation plus an adjustable voltage. The practical circuit is given in **Fig. 3.**

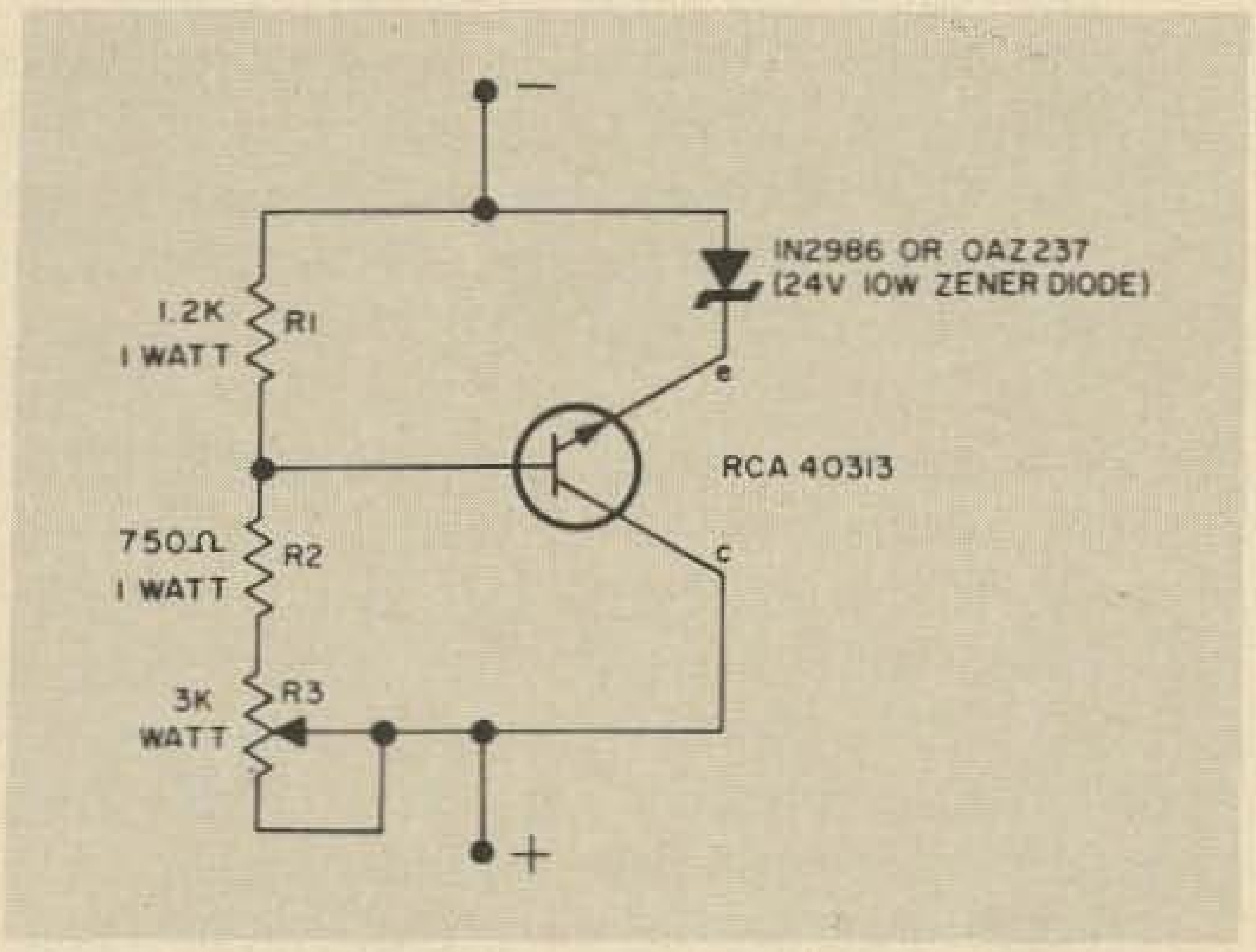

Fig. 3. Practical regulator circuit.

Resistors R1, R2, R3 form a voltage divider which applies a fraction of the total voltage to the base of the transistor, while the emitter voltage is fixed by means of the zener diode. The device regulates in such a manner that the voltage between base and the negative terminal just exceeds the zener voltage. Any further increase in voltage is then opposed by the heavy increase in transistor current which results. The voltage at which the device regulates is changed simply by altering the ratio of the base dividing resistors. The base could be connected to the moving arm of a potentiometer, with fixed resistors from either side of it to the plus and minus terminals, but if this were done, the bleeder current would increase needlessly as the regulated voltage was increased. With the circuit shown, the bleeder current (through R1, R2, R3) remains constant as R3 is varied. To allow for different bias supply units, the series resistor R (**Fig. 1**) should be chosen so that a current of between 15 and 20 mA flows into the regulator when it is set for maximum voltage (i. e., R3 at maximum). As the regulated voltage is reduced, the voltage drop across R will increase and cause an increase in the current through it and through the regulator. This is of little consequence unless the bias supply is rated at less than 30 mA, in which case R could be made adjustable and coupled to R3; or, alternatively, R could be replaced with a constant-current device. These refinements, however, will not generally be necessary or desirable. The bias power supply unit itself need not possess good regulation; in fact, a poorly regulated supply giving a drooping voltage-versus-current curve is desirable to minimize the current changes described above.

If it is desired to substitute other components or alter the range of the regulator, watch the following points:(1) The higher the zener voltage the better the regulation, but it must be less than the required minimum regulated voltage. (2) The transistor must have an adequate voltage rating. (The RCA 40313, with a 300V rating, is good for the highest bias voltages likely to be required.) (3) Watch the dissipation – transistor and zener both carry the full grid current. (4) Determine the maximum base current (maximum grid current divided by beta). (5) Select the base divider resistors to pass between 10 times the base current.

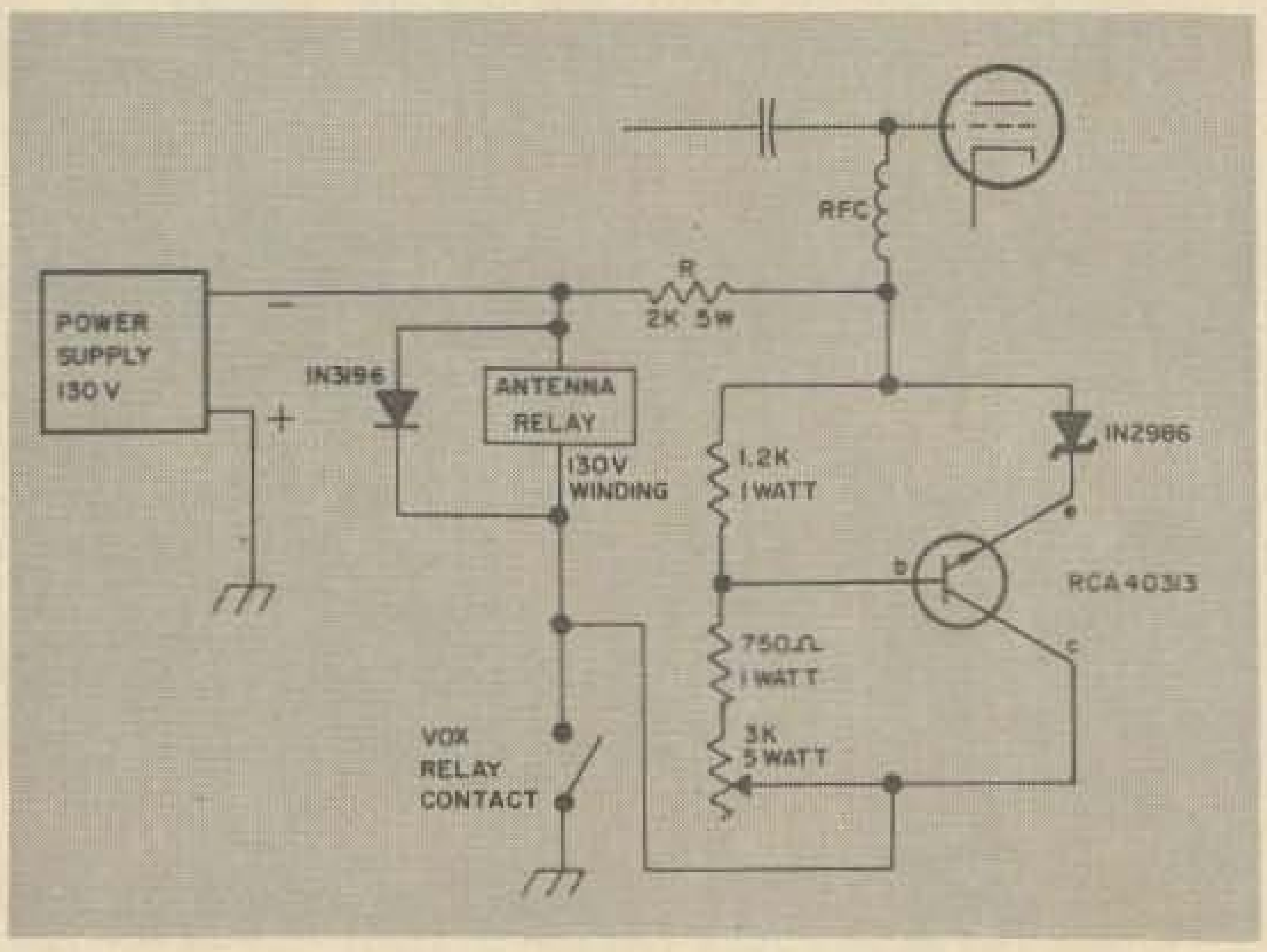

Fig. 4. Biasing the linear amplifier.

Figure 4 shows the regulator in a practical circuit for a linear radio frequency amplifier.

With the VOX relay open, maximum bias voltage is applied to the amplifier to bias it off. When the VOX relay operates, the bias falls to the value set by the regulator, and the antenna relay changes over. The diode shunting the relay coil is to avoid damage to the regulator, due to the "kickback" of the relay winding. Should the "slugging" effect of this diode cause the relay to release too slowly, the diode could be placed across the regulator unit instead. The positioning as shown has the advantage, however, of preventing sparking at the VOX relay contact due to the relay inductance.

If the antenna relay arrangement is not required, simply omit relay and diode from the circuit. If the provision for biasing back the amplifier during standby is not required, the positive end of the regulator should be earthed directly and the transistor case may in fact be bolted to the transmitter chassis without any insulating washer.

I have shown a 130V power supply, but this could be considerably higher (or lower if only a reduced voltage is required). In either case, choose the series resistor R as described earlier.

The circuit of Fig. 4 has been designed to handle a considerable amount of grid current, but the same circuit without any change whatever may be used for class AB1 or other amplifiers which do not draw grid current.

. . . ZL2ANG ■

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DESIGN FOR A HIGH PERFORMANCE I-F AMPLIFIER AND AGC SYSTEM

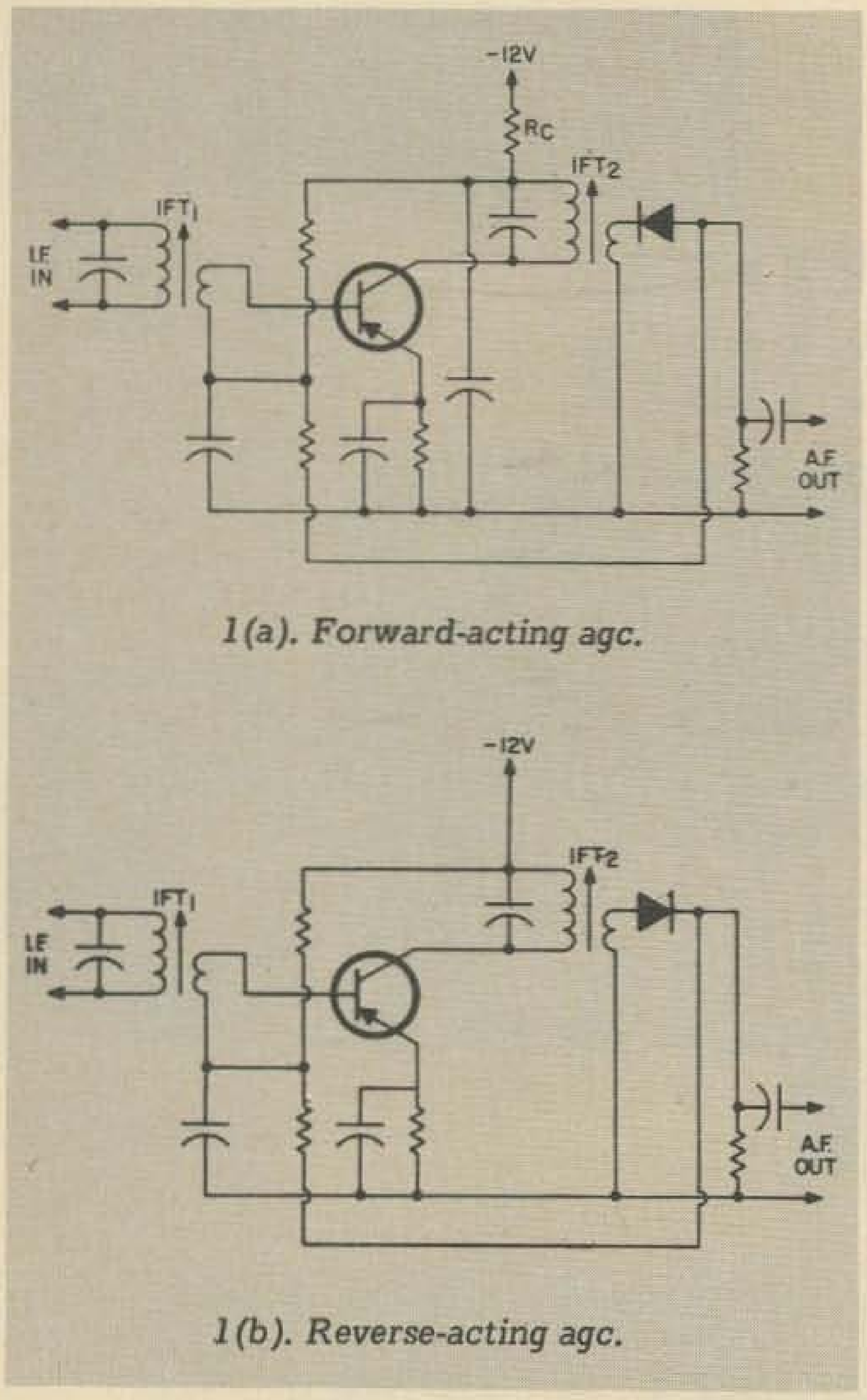
For CW or SSB work, you'll find this system hard to beat with its fast-attack/slow-decay characteristics. A wide latitude of stage gain is assured with both forward- and reverse-acting agc circuit elements.

This paper describes the design and operating conditions of an i-f amplifier which is intended to be part of a complete SSB/CW receiver or transceiver project. It uses modern components and techniques and has extremely good agc characteristics.

The circuit also offers high gain and is ideally suited for both CW and SSB applications, since a fast-attack and slow-decay agc characteristic is available. Although this particular amplifier was designed and tested for use at 9 MHz, the design is equally suitable for any i-f between 50 kHz and 10.7 MHz.

Transistors and AGC Circuits

When transistors were first introduced into rf and i-f circuitry it was generally observed by amateurs that although high stage gains could be readily achieved the circuits did not offer a very good agc performance. Most of the circuits employed simple forward- or reverse-acting agc circuits, offering limited range of gain control.



1(a). Forward-acting agc.

1(b). Reverse-acting agc.

Fig. 1. Simple agc circuits.

Figures 1a and **1b** show simple forward and reverse agc circuits. It will be seen that in the reverse-acting agc circuit, the detected i-f signal is fed back as a dc control voltage to bias the transistor amplifier off, reducing the collector current and hence the stage gain. In the forward-acting agc circuit, the dc control voltage biases the transistor on, increasing the collector current. However, due to the presence of a resistance in the collector circuit the collector voltage is decreased, resulting in a reduced stage gain.

The prime disadvantages of such a system, particularly when CW or SSB reception is required, are–

- Limited range of stage gain control
- Excessive agc attack time
- Bfo voltage introduces unwanted agc voltage.
- Detector linearity reduced by agc loading, introducing unwanted audio distortion.

To overcome these difficulties, the circuit described below was developed. It employs both forward- and reverse-acting agc circuitry to obtain a wide range of stage gain control.

Design Considerations

To insure adequate sensitivity in a receiver using an rf amplifier stage, it is generally necessary to have at least 50 dB of gain available in the i-f amplifier. The figure may be estimated by considering the overall receiver gain required from the antenna input to the demodulator stage for a 1 μV input signal.

Assuming a 10 mV signal is required at the product detector, the overall gain required is

$$dB = 20 \log \frac{10 \times 10^{-3}}{10^{-6}}$$

$$= 80 \text{ dB}$$

This gain is shared between the receiver front end and i-f stages and it is reasonable to expect about 30 dB gain from the former, leaving 50 dB to be made up in the latter. It should be noted that these figures include transformer and filter losses in the circuit. Thus, with a 1 μV input signal the i-f amplifier receives an input signal of about–

$$\mu V = \text{antilog} \frac{dB}{20}$$

$$= \text{antilog} \frac{30}{20}$$

$$= 32 \mu V$$

The ability of a receiver to hold its audio output level constant under conditions of signal fading is determined by the agc characteristics. **Figure 2** shows the ideal receiver agc characteristics in which the

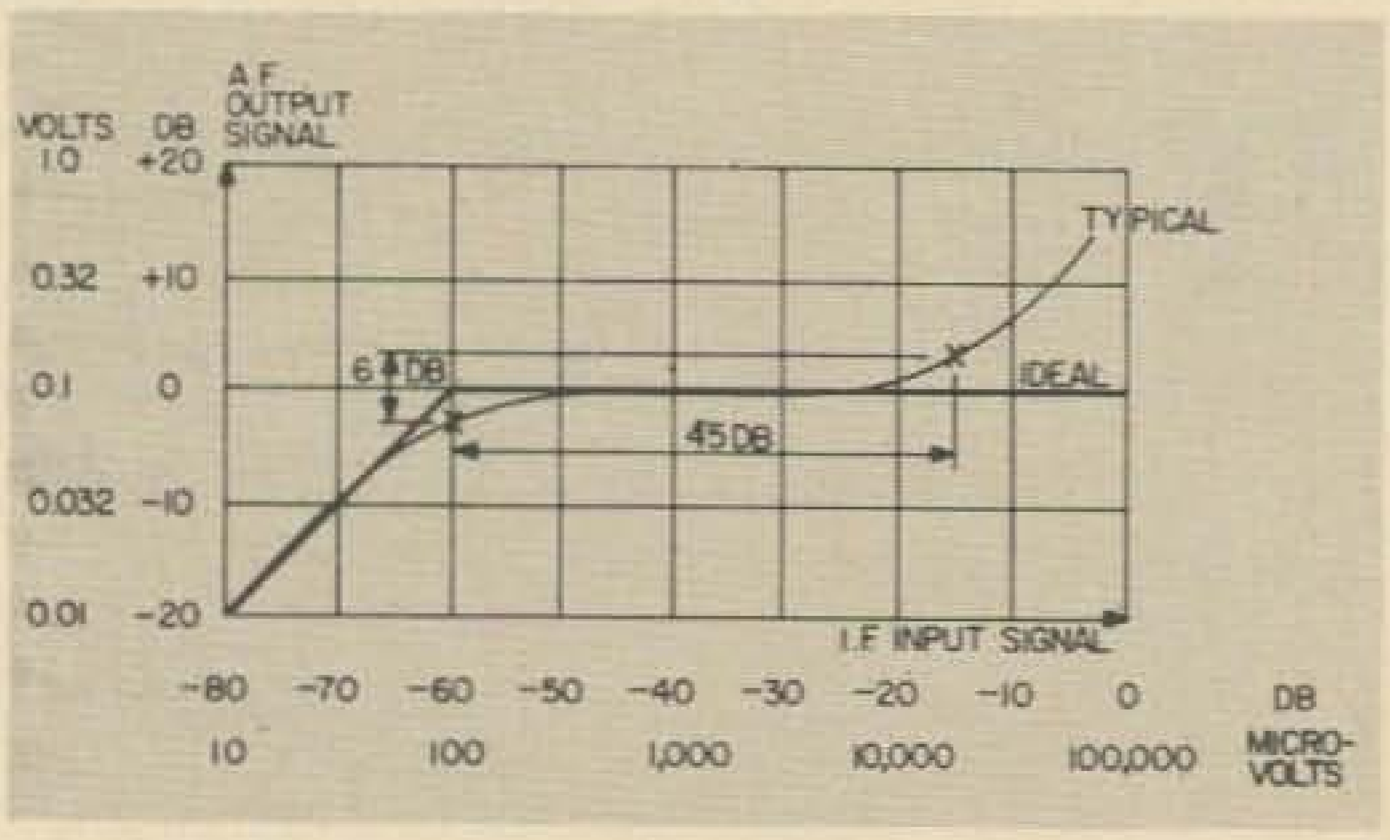


Fig. 2. Ideal and typical agc characteristics. The typical curve shown is that measured for the circuit described in the text.

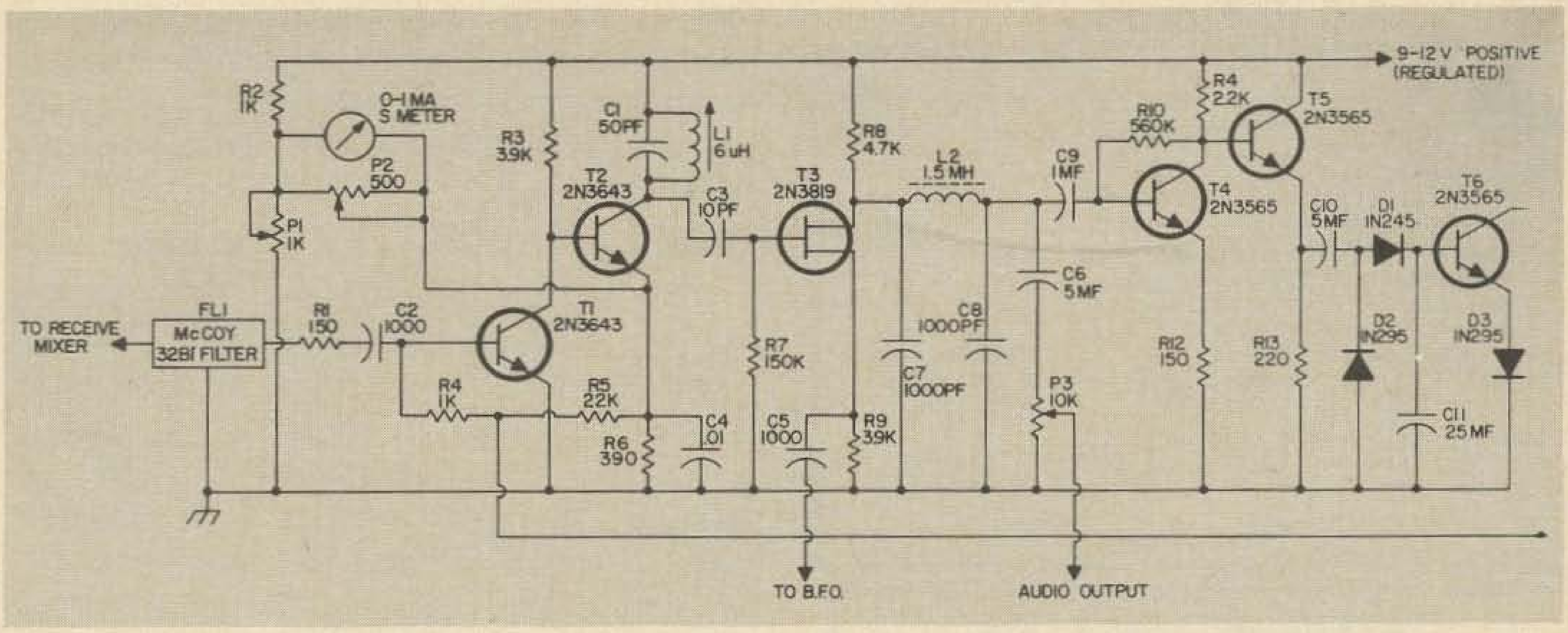


Fig. 3. Circuit diagram of the i-f amplifier, product detector and agc system.

audio output level should increase linearly with increasing signal input from zero up to some threshold level, whereafter the agc becomes effective and holds the audio output level constant even though the input signal level increases. Such a characteristic, particularly if the threshold level is correctly chosen, makes for comfortable operation of the receiver and reduces listening fatigue.

The threshold voltage level is generally chosen to be just above the level of voltage which appears at the detector input due to amplified band noise. Thus, with a front end gain of 30 dB, and assuming a band noise level equivalent to an input of, say, 1.5 μV, the i-f amplifier should have a threshold set to permit agc action on signal levels of greater than, say, 2.5 μV. This represents an input signal of 80 μV into the i-f amplifier, or 25 mV into the product detector before the agc system becomes effective.

I-f Amplifier and Product Detector

The complete i-f amplifier circuit with associated product detector and agc system is shown in **Fig. 3**. The i-f amplifier consists of dc-coupled transistors T1 and T2, the former of which is an untuned amplifier while the latter employs a tuned collector load. Direct-coupled negative feedback is applied over both stages from the emitter of T2 to the base of T1, insuring stable operation of the amplifier. The overall selectivity of the i-f amplifier is solely determined by the preceding filter unit (FL1). The output is capacitively coupled to the gate of the FET product detector whose high input impedance offers a negligible loading on the collector tuned circuit of T2. A bfo injection voltage of about 2V peak is fed to the drain of the product detector. This stage will handle input voltages up to 1V peak-to-peak before any distortion becomes evident. Since the agc system is effective in reducing any received signal to a level of less than 1V at the product detector input, no i-f gain control is required. The audio output is filtered by C7, C8, and L2 before being applied to the audio volume control and the agc amplifier.

The AGC System

The audio signal from the product detector is amplified by T4 and transformed to a low-impedance source by emitter follower T5. This enables capacitors C10 and C11 in the voltage doubling agc rectifier circuit to charge quickly to speech syllables, giving a fast agc attack time. The rectified audio appears as a positive voltage which is applied to the base of dc amplifier T6 causing it to conduct. Conduction in T6 reduces the base bias applied to i-f amplifier transistor T1 introducing, in effect, reverse-acting agc action.

Due to the direct coupling between T1 and T2, as T1 is reverse biased by the agc action, the collector current decreases, permitting the collector voltage to rise and thus forward bias T2 introducing, in effect, forward-acting agc action in the second stage.

The rectified agc voltage decays across capacitor C11, which determines the agc release time.

Circuit Construction and Adjustments

The i-f amplifier/agc system is ideally suitable for assembly on a printed wiring board. Layout is not critical so no detailed construction data is required. The overall gain of the i-f amplifier may be altered by changing the value of R3, increasing the value to reduce the gain and vice versa. The agc decay time may be raised by increasing the value of capacitor C11. It is important that the complete circuit be tested or used, fed from a well decoupled power supply source. It is recommended that a regulated power supply be employed to meet this end.

Circuit Performance

When preceded by a single conversion receiver front end and a crystal filter, the complete circuit gives excellent performance on both SSB and CW signals. AM is of course tuned in the SSB mode by selecting either the upper or lower sideband. Even on the strongest signals likely to be encountered, no overload of the product detector is evident in the nature of a distorted output signal, showing the effectiveness of the agc system.

The complete circuit was subject to laboratory evaluation and the following table summarizes the measured prime specifications—

Parameter	Value
Maximum i-f gain	50 dB
I-f input signal required for agc threshold	100 μV
I-f input signal required for detector overload	250 mV
Change in i-f input signal for 6 dB change in audio output signal	45 dB
Af output signal voltage	100 mV (peak-to-peak)
Agc attack time	12 msec (calculated)
Agc decay time	1 sec

... ZL2BDB ■

73 Books For Hams

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An invaluable reference book. Covers rectifiers, mixers, detectors, modulators, FM detectors, noise limiters, AGC, BFO/'Q-multiplier, AFC, Varicap tuning audio clippers, balanced mods, field-strength meters, RF probes, zeners, control circuits, etc. 111 different circuits. **$1**

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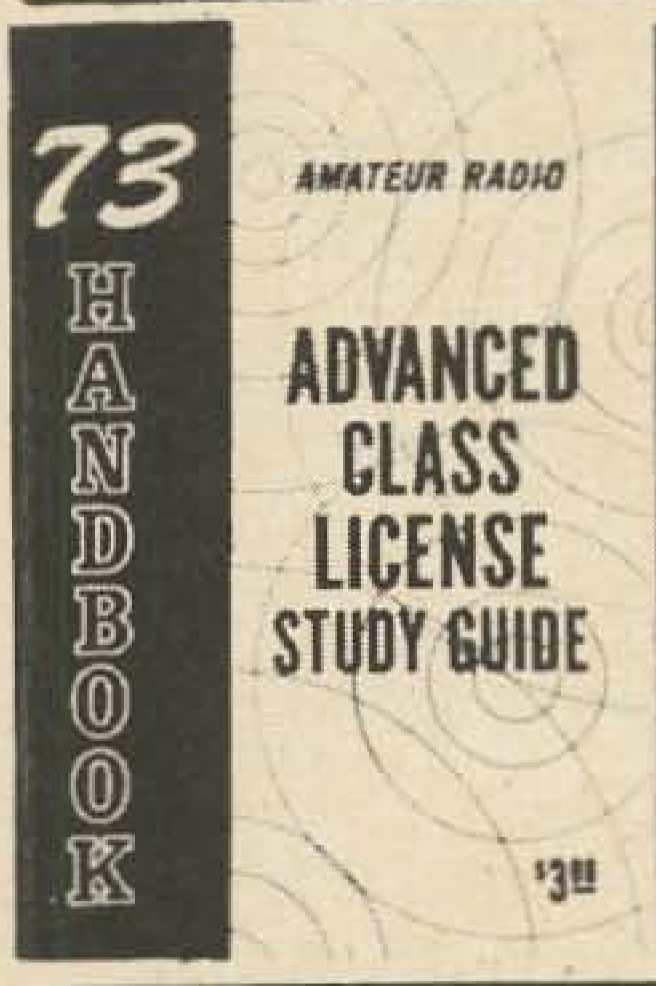

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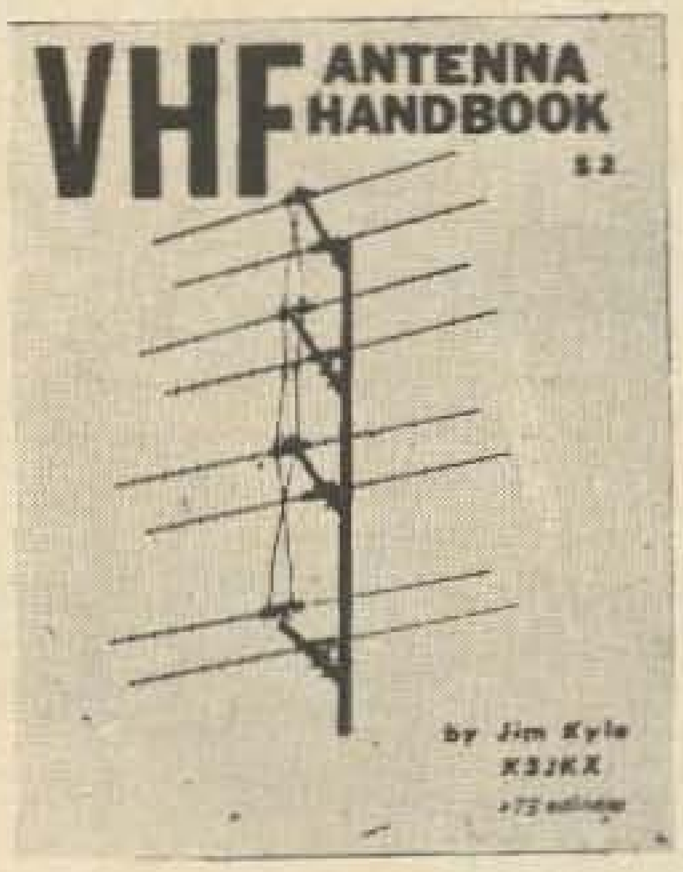

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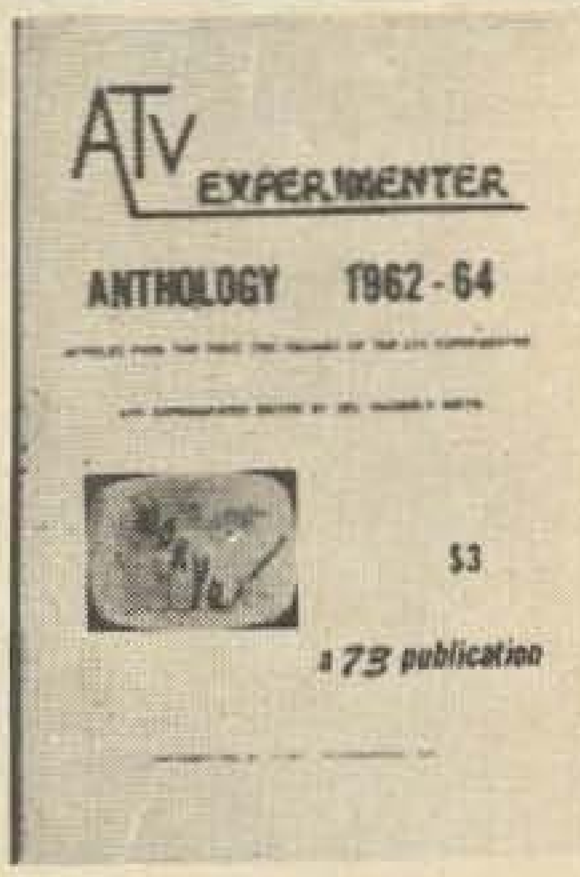

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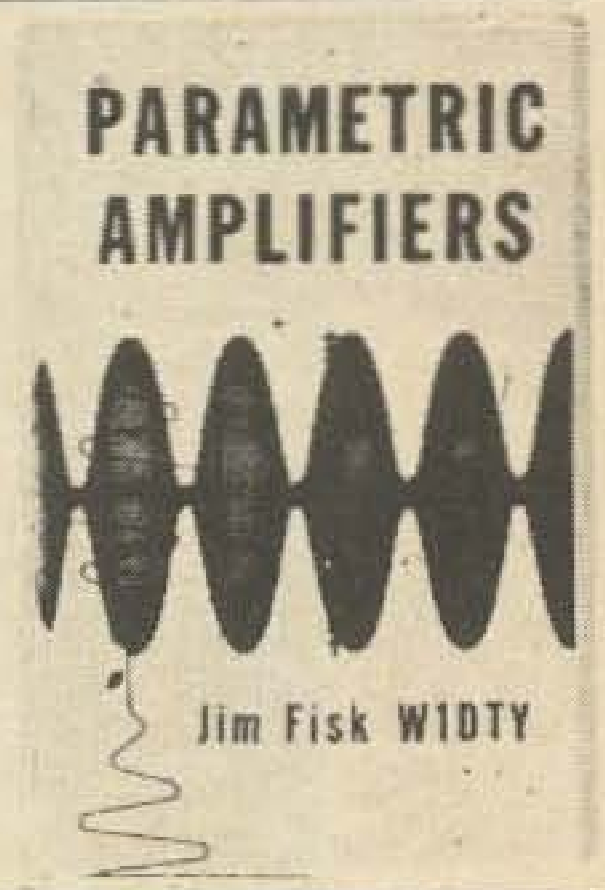

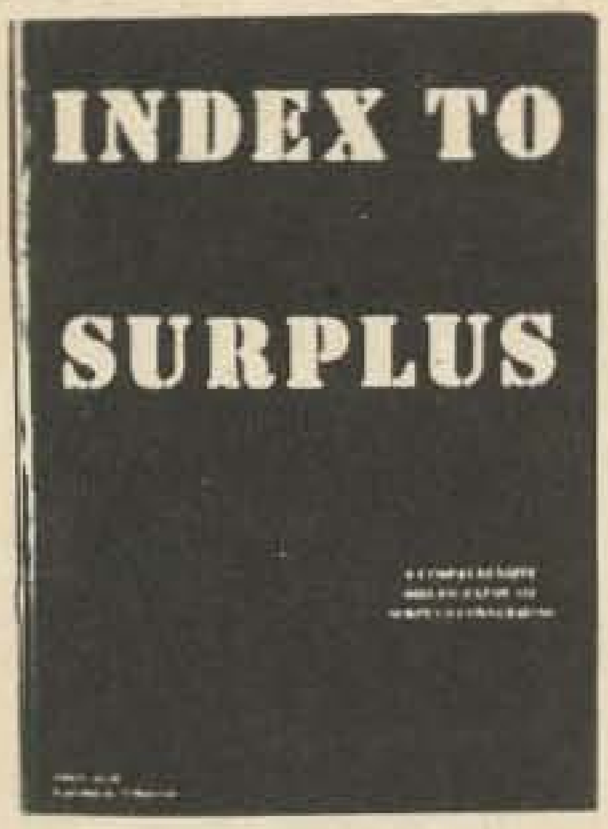

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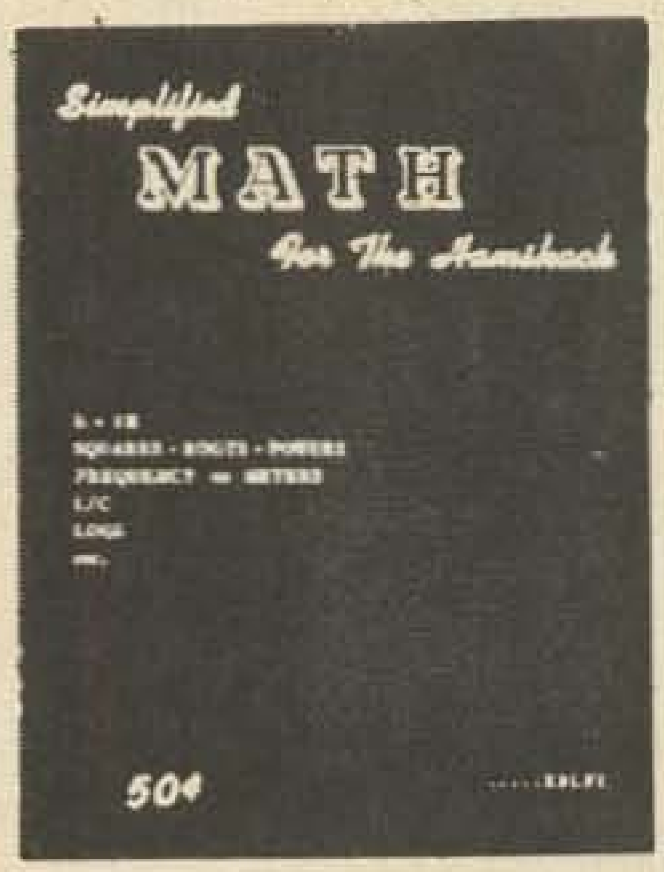

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Single Sideband on the All Wave Radio

A miniature tunable oscillator provides an ideal source for a beat-frequency signal, and allows you to hear code and sideband on any selective receiver without making modifications to your store-bought gear.

R.E. Baird W7CSD
3740 Summers Lane
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Currently on the market there is a large selection of AM/FM all-wave receivers ranging from solid-state portables for less than $50 to some well over $200. None of these provide for SSB reception. A neighbor of mine recently bought a $200 model for listening to AM, FM, short-wave broadcast, which he thought could be used as a ham receiver for his teenage son. After due experimentation, the gentleman commented, "I paid $200 for this set and I still can't hear what I want to hear!" He was referring to the "monkey chatter" of single sideband without the proper system of detection.

One solution to this problem is the installation of a bfo oscillating at the i-f, but this involves undesirable modification of circuitry and interconnecting wires. This led to development of a modification that solves the problem at the input with no electrical receiver connections. The circuit shown in Fig. 1 is primarily a stable vfo operating at the signal frequency of the SSB station or on a harmonic of its low-frequency fundamental.

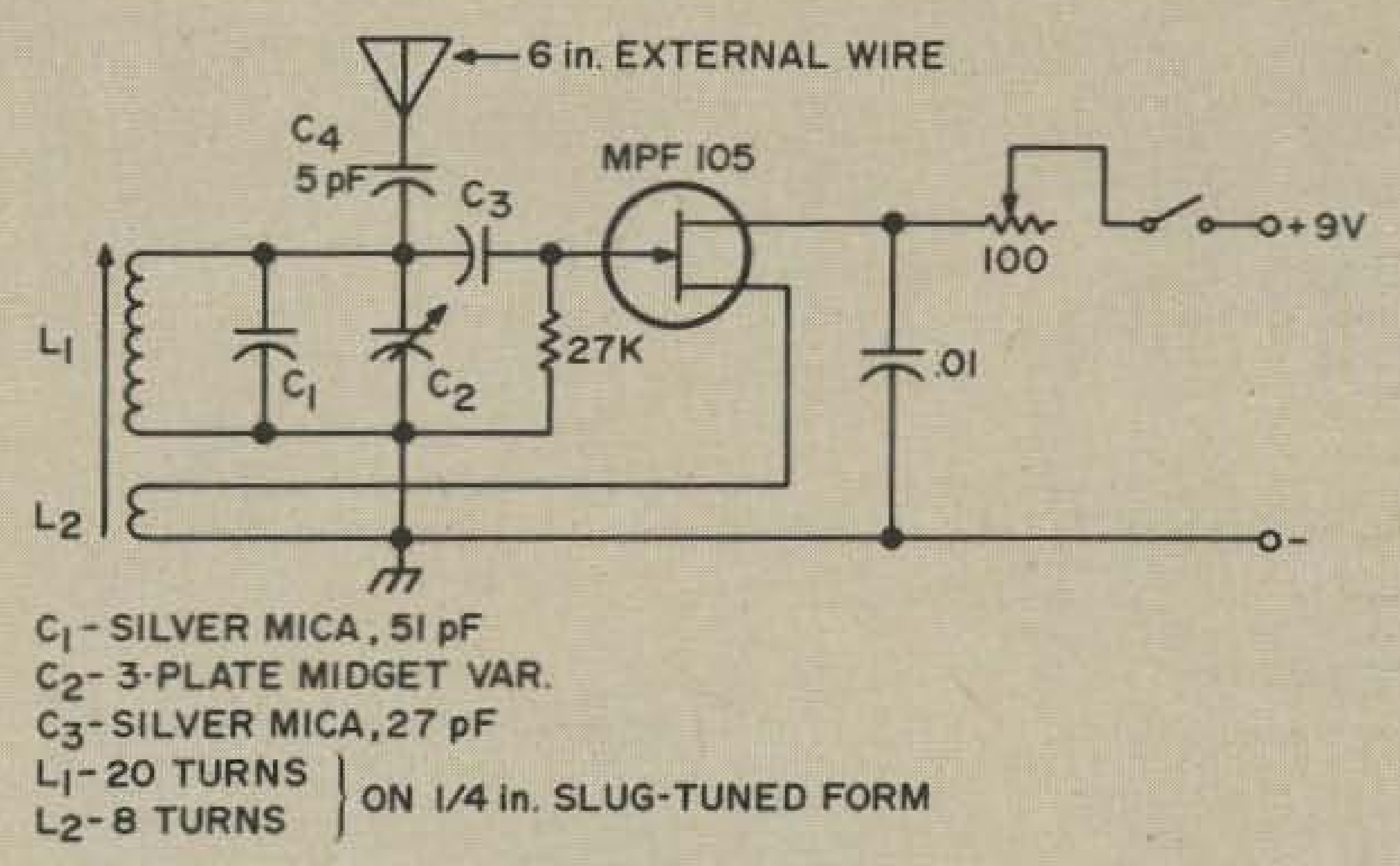


Fig. 1. The tiny oscillator circuit operates from a standard 9V battery. A small hunk of wire provides an antenna sufficient to assure healthy output for several feet. Placed close to a conventional all-wave receiver, the unit provides sufficient carrier injection for copying single sideband and CW.

Since the user was principally interested in the higher frequency amateur bands, the oscillator is designed for the 7 MHz region. It was found that the harmonic content on 14 and 21 MHz was sufficient to deliver the necessary amount of carrier injection for satisfactory reception of SSB signals. This oscillator is designed to supply the missing carrier to the SSB signal, so stability and ease of tuning were of prime concern. At the same time I naturally wished to use junkbox parts as far as possible.

Construction Features

The size of the unit is dictated by the size of the vernier dial used. In my case an old 4 in. vernier dial was resurrected from antiquity as was also the small aluminum box. With a smaller dial the box could be reduced in size materially.

When building a stable vfo, a certain amount of experimenting always seems to be necessary. Cookbook directions are not very helpful. Actually the coil used was a surplus one from which half the turns were removed, leaving L1. L2 was added on the other half of the form in the same direction. (In case the circuit fails to oscillate, reverse the L2 leads. I had to do this because I wasn't sure which way the lacquered L1 was wound.)

In any event, the combination of L1, C1, and the slug may need to be adjusted to cover 7.0 to 7.3 MHz. A silver mica for C1 gives good stability after initial warmup and permits monitoring of SSB signals for extended periods on a basically stable receiver without adjustment. If even better stability is needed, a small disc ceramic, maybe 5 pF, might be reset in parallel with C1. This would yield stabilization by causing drift in the opposite direction. Capacitor C2 is any small midget available.

Operation

After first locating the wanted signal without the bfo, zero in with the bfo. You are trying to tune to within a few hertz and, even with a good vernier dial, this is difficult at 7 MHz. You can easily get approximate tuning. Now the R2 potentiometer comes into play. It was found that drain voltage affected the frequency to some extent, so a 100-ohm pot was placed in series with the +9V and the drain. This seems to provide a very handy fine-tuning device. With this front panel knob you can tune with some precision. If perfect tuning is in the center of the range you will have a quarter of a turn either way for the intelligibility range. With a little practice you will learn how to set the main control for the proper sideband and make final adjustment with the fine tuning.

This device was tried with several all-wave radios which ranged from a 1936 Zenith (the one with the dinner-plate dial), to a cheap transistor set, to a good $200 one. In the case of the Zenith and the $200 Jap job, reception was good enough for serious amateur reception. The cheap transistor set was not too stable itself and requires a bit of signal chasing. Certainly the outboard oscillator was better than the local oscillator in the set.

In general, very satisfactory sideband reception is possible using this front end bfo. And it works equally well for 7, 14, and 21 MHz. . . . W7CSD ■

VACUUM TUBE LOAD BOX

by Jim Ashe

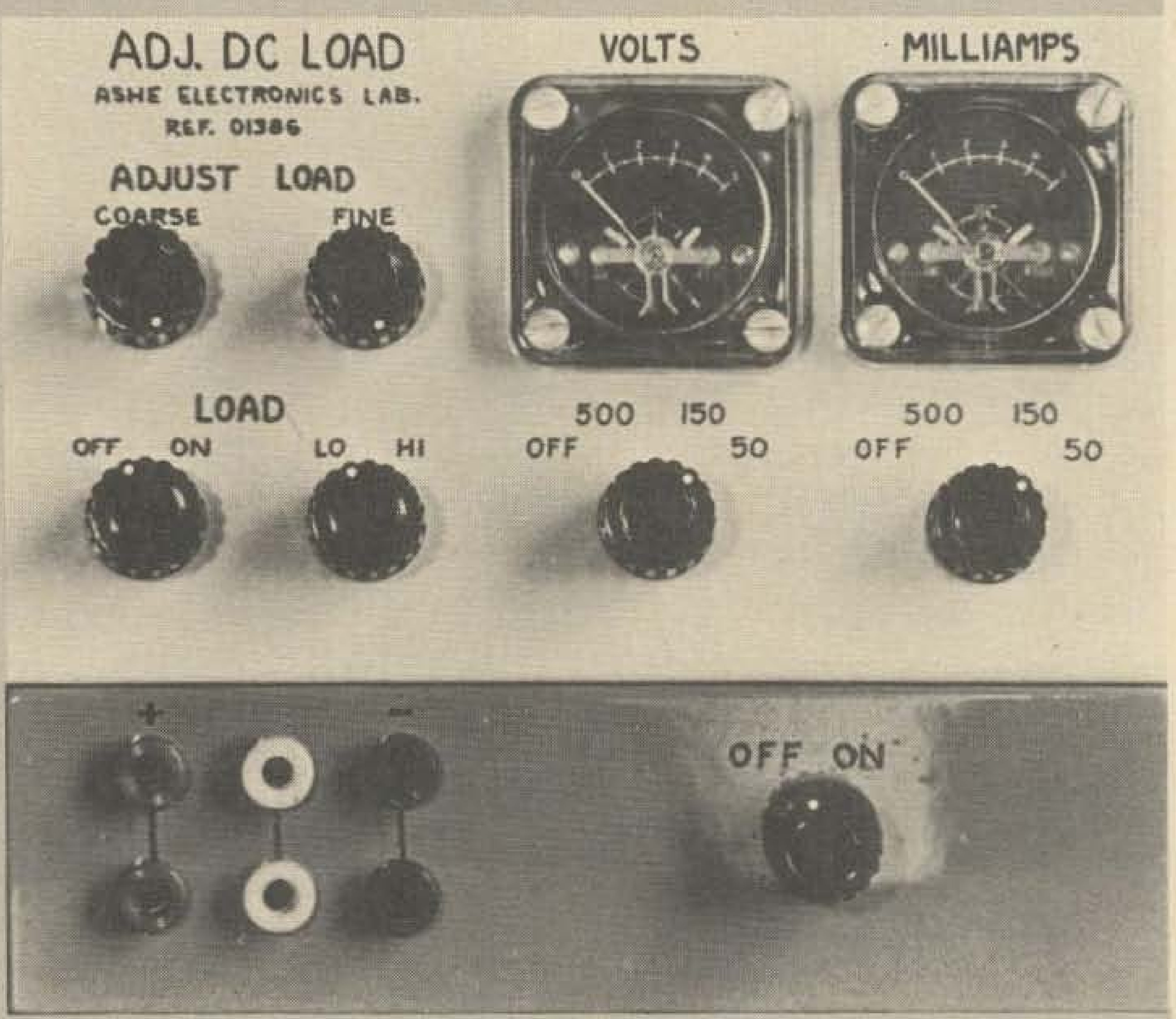


Fig. 1. Front view.

How do you test a power supply? By asking it to supply power. Put it to work, and check its output voltage for various load conditions, its hum characteristics, and its overload performance. These simple, informative tests should be easy, but usually they are not. How about something which will make them nearly as straightforward as testing resistors?

The very simple load box described here uses a pair of 6GE5's as variable resistors to dissipate the supply's power. Its minimum resistance is roughly 1000 ohms and it will load supplies at as low as 30 or 40 volts. The rated dissipation of 35 watts may be exceeded by a factor of two or three for brief tests.

A small part of the power dissipated by the load box goes to heat resistors in the load circuit. Most of it appears at the 6GE5 anodes and is thrown away as heat radiation.

The triode-connected 6GE5's are capable of passing very heavy currents but are restrained to useful loads by an adjustable negative grid bias. The grids draw no current, so large powers can be controlled by adjusting a 2-watt pot. A second pot, in series with the first, serves as vernier and for control of grid voltage at near-zero bias.

Two cathode resistors weaken the dependence of tube currents upon grid bias by adding a little self-bias. This also serves to stabilize and equalize tube loads. By switching two additional resistors across the two permanently installed ones, somewhat higher currents may be drawn for low-voltage test work.

A simple power supply provides heater voltage for the 6GE5's and a well-filtered bias potential. The thorough filtering and neon regulator guarantee that ripple observed in the loaded supply's output originates in the supply rather than the load.

Ballpark accuracy is sufficient for most amateur purposes. Two inexpensive meters of unknown origin serve to indicate voltage and current. The voltmeter multiplier resistors were estimated from the roughly known meter resistance, and then chosen by bench test.

The milliammeter circuit is based upon a 10-ohm wirewound resistor. The current is measured as a small voltage appears across

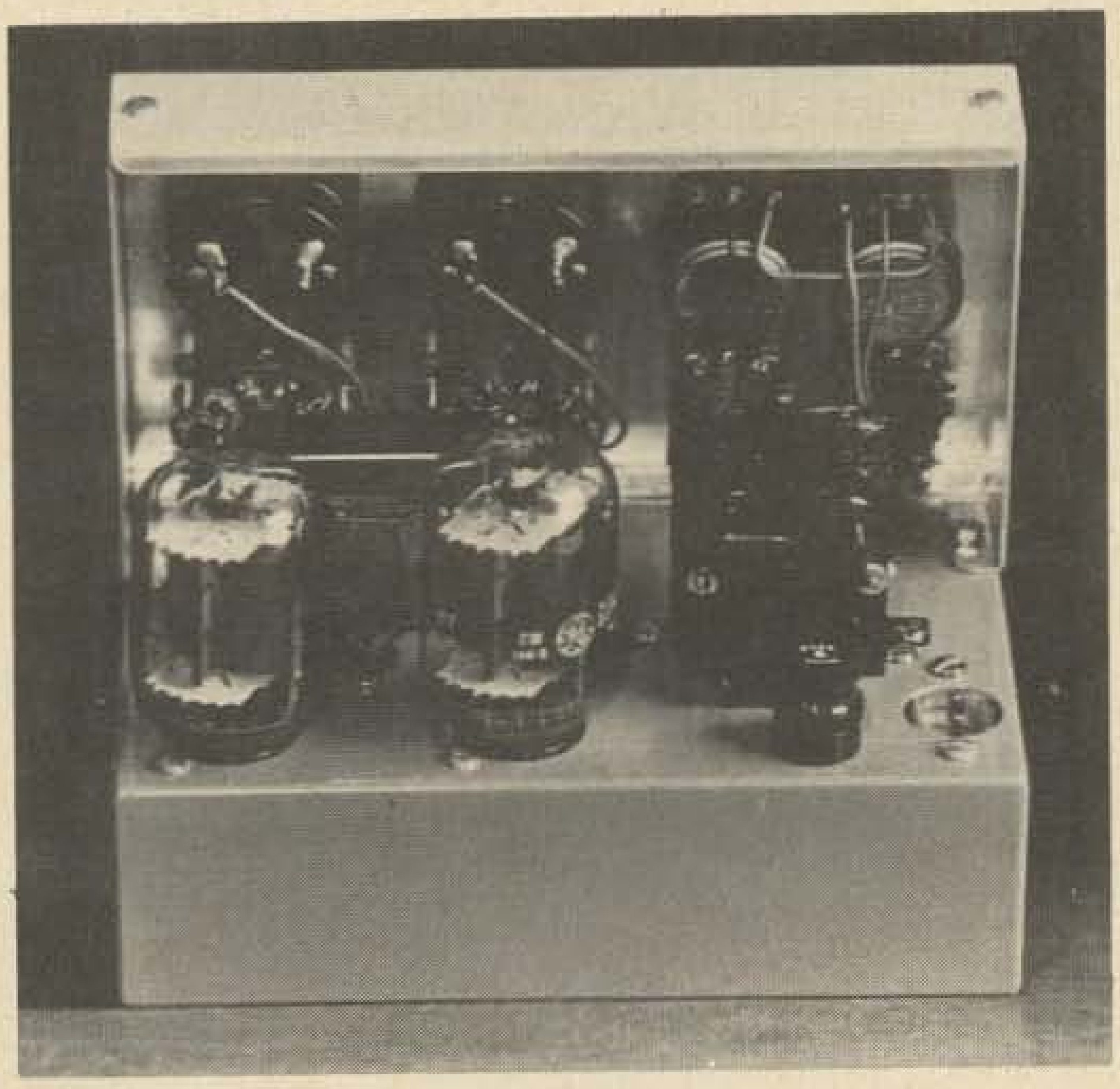


Fig. 2. Back view.

this resistor. Multipliers were chosen to read the voltage, a slight departure from usual practice. A 500 ma range, which may seem a little high, helps avoid pinning the meter when setting up for a test.

When the grid bias is near zero at high anode voltages, relaxation oscillations may occur. Their cause is not apparent. The cathode and anode resistors minimize the nuisance value of these oscillations, which occur only under extreme operating conditions.

Construction

A 5" x 7" x 2" reinforced aluminum chassis provides just enough room for construction. The 6GE5's are placed to the rear, not too close together, for best ventilation. The 4" x 7" front panel was made of .050 sheet aluminum by a local sheet metal shop. It was bent square with a ½" lip at the bottom and a 1¼" lip at the top, bent over again at the back. See Fig. 2. This arrangement makes a very convenient handle. During construction the right angles were adjusted for a rearward tilt of about 5/8". A pair of 1" strips at the sides serve as panel braces.

After completing the metalwork, all parts were cleaned in strong detergent, roughened with wet sandpaper and spray-painted with Rustoleum enamel. Hand lettering with waterproof India ink was covered by a finish coat of clear enamel. The complete process is described in the May issue of *73* Magazine.

Parts arrangement is not critical, except for one circuit. The high-impedance 6GE5 grid wiring should be kept well clear of the ac lines to avoid imposing 60 hz hum on the load box's resistance characteristic. Five lug strips bearing a total of 37 tie points were mounted under the chassis, and 23 points were used in construction.

High voltage dc is hard to turn off without a special switch. This load box used an ordinary rotary switch, and if this switch were opened to break a heavy current, it would arc. A ceramic HV switch is indicated for this application.

Using The Load Box

The load box is very useful for new work, debugging, and for servicing. When initiating

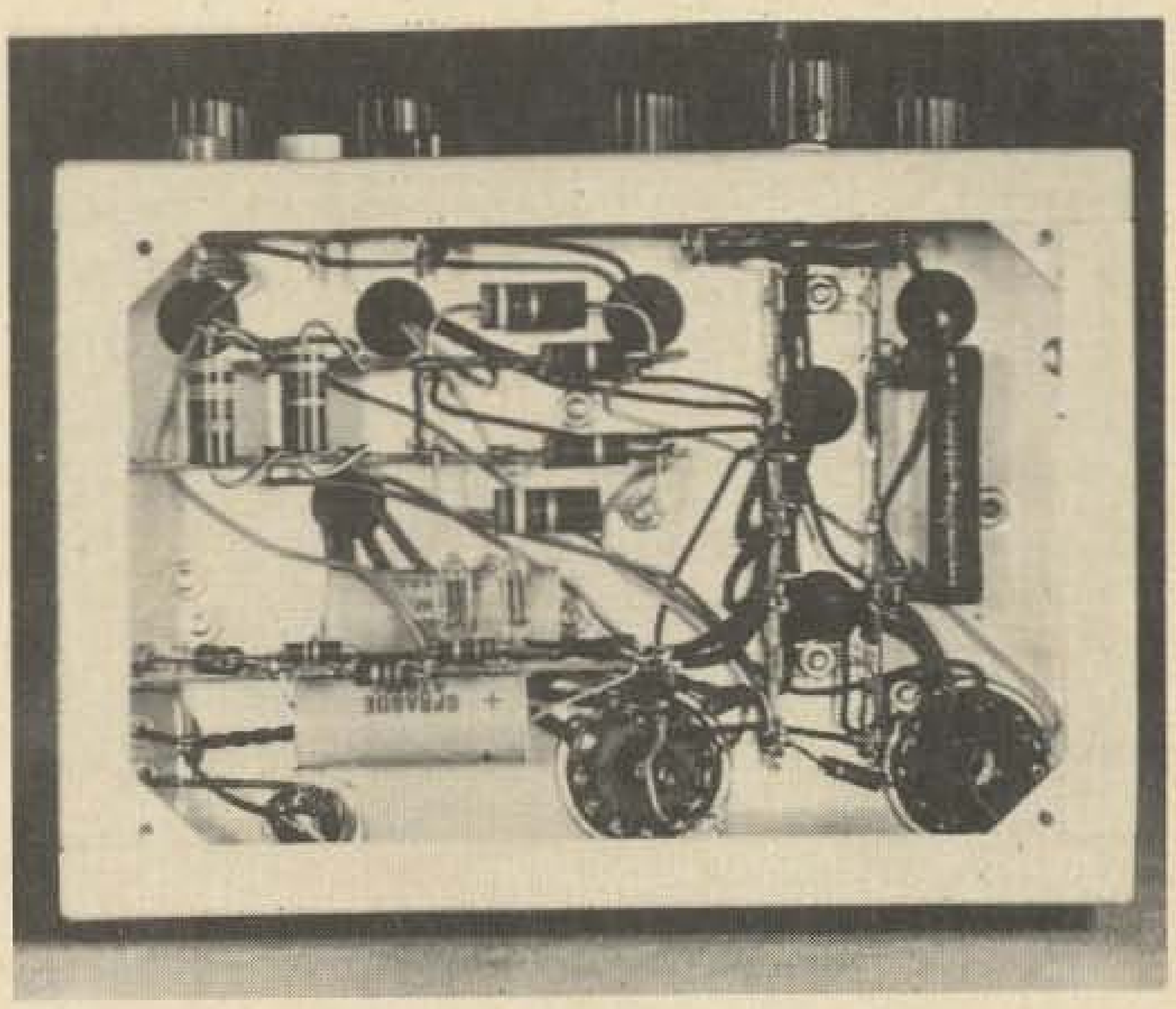


Fig. 3. Bottom view.

a new project, the power supply can be stuck together on the bench and subjected to realistic loads and overloads. When it finally goes into the chassis it can be trusted. If you missed this simple step you may still

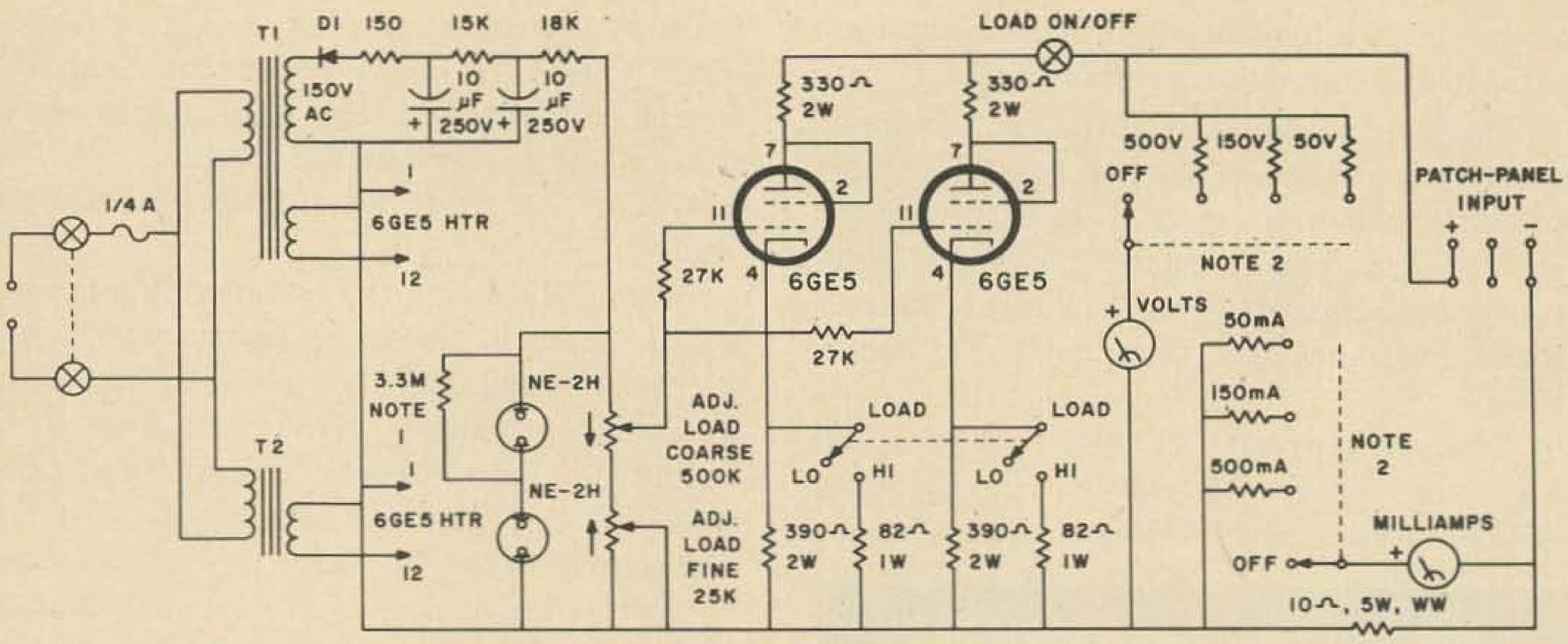


Fig. 4. Schematic.

come out ahead if you use the load box to seek out weaknesses in a supply already built. And it's good for service work too.

If necessary, disconnect the supply from its normal load while the load box is warming up. Choose meter ranges for higher voltage and current than the supply is expected to produce. Turn both adjust controls full anticlockwise, and attach the load box to the power supply.

Turn on the supply, and the voltmeter should indicate the supply's voltage. Turn on the load switch and advance the coarse load control until the milliammeter indicates a current is flowing. An unregulated supply's output voltage should fall as load increases. Make appropriate corrections to meter ranges, and proceed with the test.

If very accurate results are required, the patch-panel input arrangement simplifies the connection of outside meters. These terminals are also handy for attaching an ac voltmeter or an oscilloscope.

The fine load control is used at very low supply voltages, and for zeroing in on preferred voltage or current values when making tests with accurate instruments.

Fig. 5 shows the results of a power supply test. It was a good workout for the load box too, which was used far beyond its ratings.

The upper line is the voltage found at the rectifier output terminal. Regulation here is not good. The lower line shows the regulating circuit output. The regulator tube's 26 watts maximum dissipation will not be

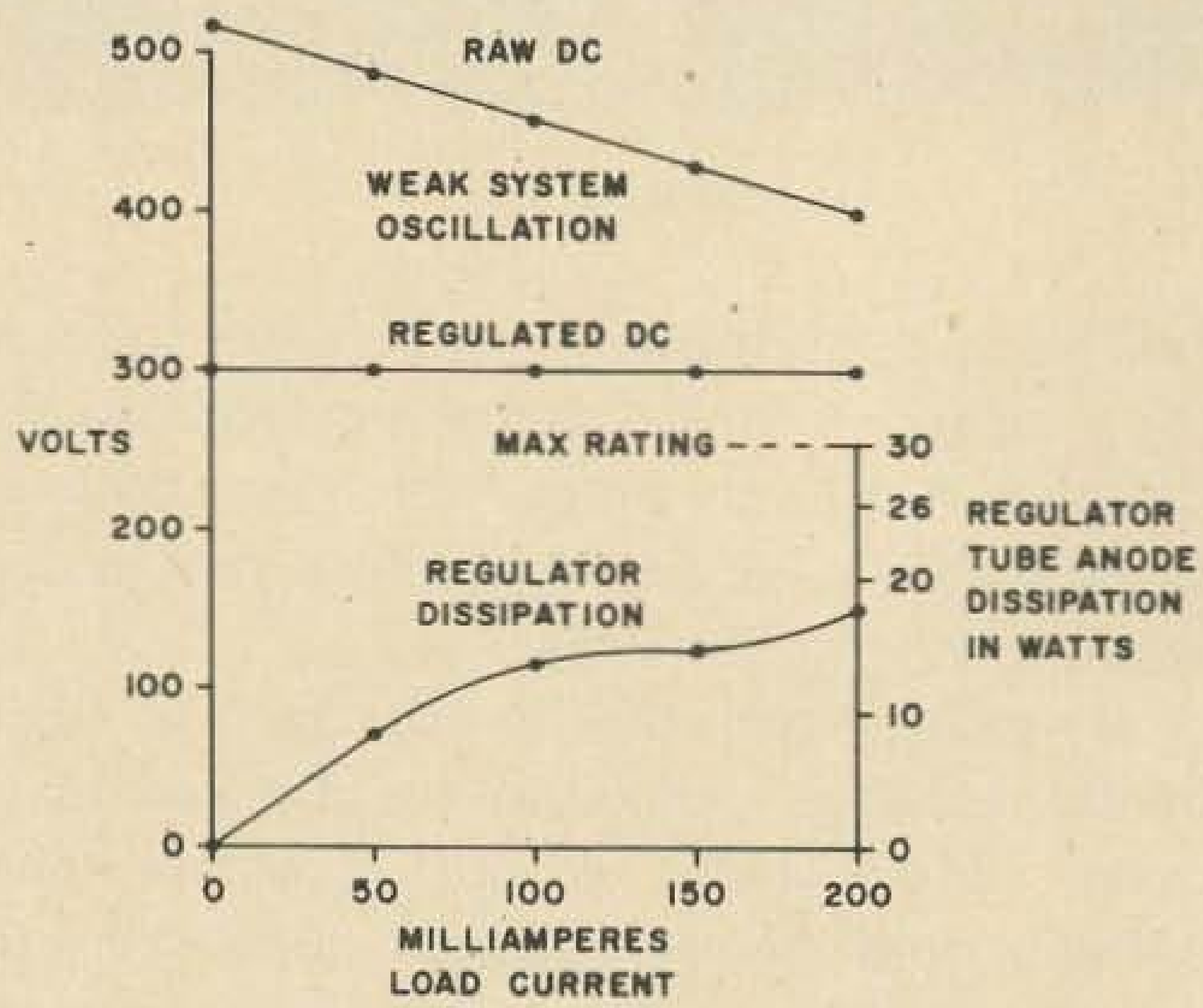


Fig. 5. Test results taken from a regulated power supply, showing regulator dissipation, and regulation well into the anticipated overload region. A few minutes work!

exceeded in normal operation (150 ma), and there is reserve against aging and overload. Looks like this supply should be reliable for long periods of time.

Well, now I guess I'll have to make up a solid state load box!

. . . W1EZT■

A Directory of American Open Repeaters

An up to date listing of all the open repeaters from coast to coast with information about access requirements where applicable.

Editor's Introduction

For some time now, several people have been independently working toward the preparation of a complete and accurate listing of open VHF FM repeaters in use throughout the U.S. and Canada. As the recent editor of FM Magazine, I have been busy for the past year gathering information by mail from repeater owners who mailed news of their accomplishments to me for incorporation into that journal's periodic directory. Then, a few months ago, I had the opportunity to make several trips across the country by car–which allowed me to personally check the status of repeaters far and wide.

Before starting on my cross country jaunt, I equipped myself with a high-power Varitronics rig and lots of blank paper. Then I proceeded to travel from California, through Nevada and Utah, and returning down through Colorado and other routes through Wyoming, Utah, and Nevada. A week later, going through Arizona, New Mexico, Texas, and Oklahoma, I stopped in Oklahoma City to get a variety of crystals from Sentry for my Varitronics unit, then proceeded through Kansas, Missouri, Indiana, and Illinois.

A short time later, I left the Chicago area and traveled east through Michigan, parts of Canada, New York, and many of the New England states. As a result of these ventures, I was able to glean a great deal of first-hand information about repeaters. The culmination of the records I kept on the trip is reflected in the following repeater directory, which is itself a detailed work containing (1) updated information from FM Magazine, (2) the results of a 73 Magazine survey, and (3) the dedicated contributions of Rick Zach WB2AEB.

Last Minute Notes:

1. The two Hartford area repeaters are off the air due to continuous malicious interference. A 450 repeater will replace the two defunct 2 meter machines . . . W1VVK.
2. Add this repeater to directory:
   WA2UWC Greenbrook, NJ 146.34 to 146.94.
   Machine has sexy female voice for ID . . . WB2AEB.
3. At Potters Peak,near, Wilkesboro, NC, a 6 meter repeater (W4DCD) is now in operation:
   52.78 input get you a 400W signal on 52.525 MHz.
   A 2 meter system is cross connected so that 146.42 MHz is repeated to 52.525 and 52.525 is repeated to 145.05. No tones required. Coverage is 125 miles, unit-to-unit.

by Rich Zach WB2AEB

a word about repeaters

The trend for the future seems to be to use a compatible deviation of both narrowband and wideband rigs by using a wideband receiver and an 8 kHz transmitter at the repeater site.

Many amateurs would like to get involved in FM repeater operation but cannot do so due to a lack of information on local repeaters. We would like to remedy this situation, and thus this directory of open American repeaters is being published. Following is a list of a good number of FM repeaters in the U.S. and Canada. If you know of any other repeaters, or have corrections or additions on the listed ones, please send this information to the editor, to be used in the next update. When giving a report on a repeater, please include the following information (for *open* repeaters only, please):

- ★ Repeater call letters
- ★ Location of repeater
- ★ Elevation of antennas
- ★ Whether wide or narrowband or both
- ★ Inputs and outputs
- ★ Coverage area
- ★ Other features such as open dial or touchtone autopatch, tone burst (CTS will not be listed because this qualifies repeater as being closed).

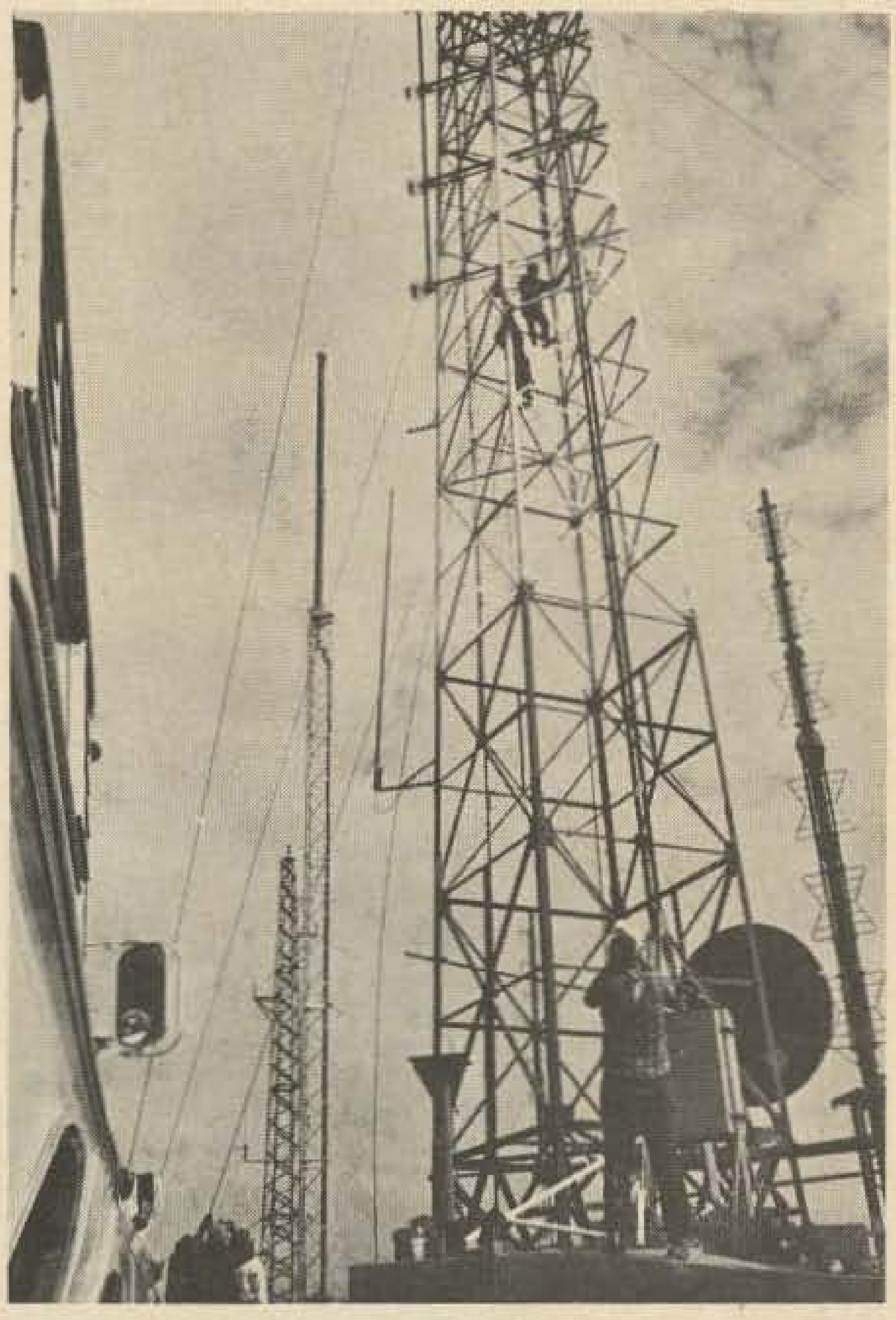
Please be absolutely sure your information is correct and that the repeater is open for use by all radio amateurs. If you see a closed repeater listed, please notify the author immediately.

Needless to say, this directory will be useful not only to the new FM ham, but it will be a good tool for repeater organizations. Much thought on regional and national trends goes into the design of a repeater.

In contributing to this directory, I have found some similarities, some contrasts, and some interesting trivia about FM and repeaters which is not shown on the list itself. You will find that different areas have different repeater outputs and deviation settings. As an example, Florida and Pennsylvania are strongly for narrowband repeaters with .76 out; New York, New England, and most of the rest of the country are strongly for .94 out and wideband. In a metropolis like New York, a ".94 out" repeater would not even be considered due to heavy simplex traffic in that area. Seven-six is used here. Canada tends to favor another input frequency: 146.46 MHz.

The trend for the future seems to be to use a compatible deviation for both narrow and wideband rigs by using a wideband receiver and an 8 kHz transmitter at the repeater site. There is a strong trend for the use of Touchtone autopatch (automatic phone patch) and dial autopatch to a lesser degree. The linking up of repeaters (via UHF "trunk lines") is gaining popularity but not as fast as autopatch. An east coast repeater link-up is slowly growing, but it will not be completed for a few years yet. Another popular practice is to use half-second tone bursts to activate the repeater. Due to geographical overlap of two repeaters' inputs, you may select which repeater you go through by simply using different tones.

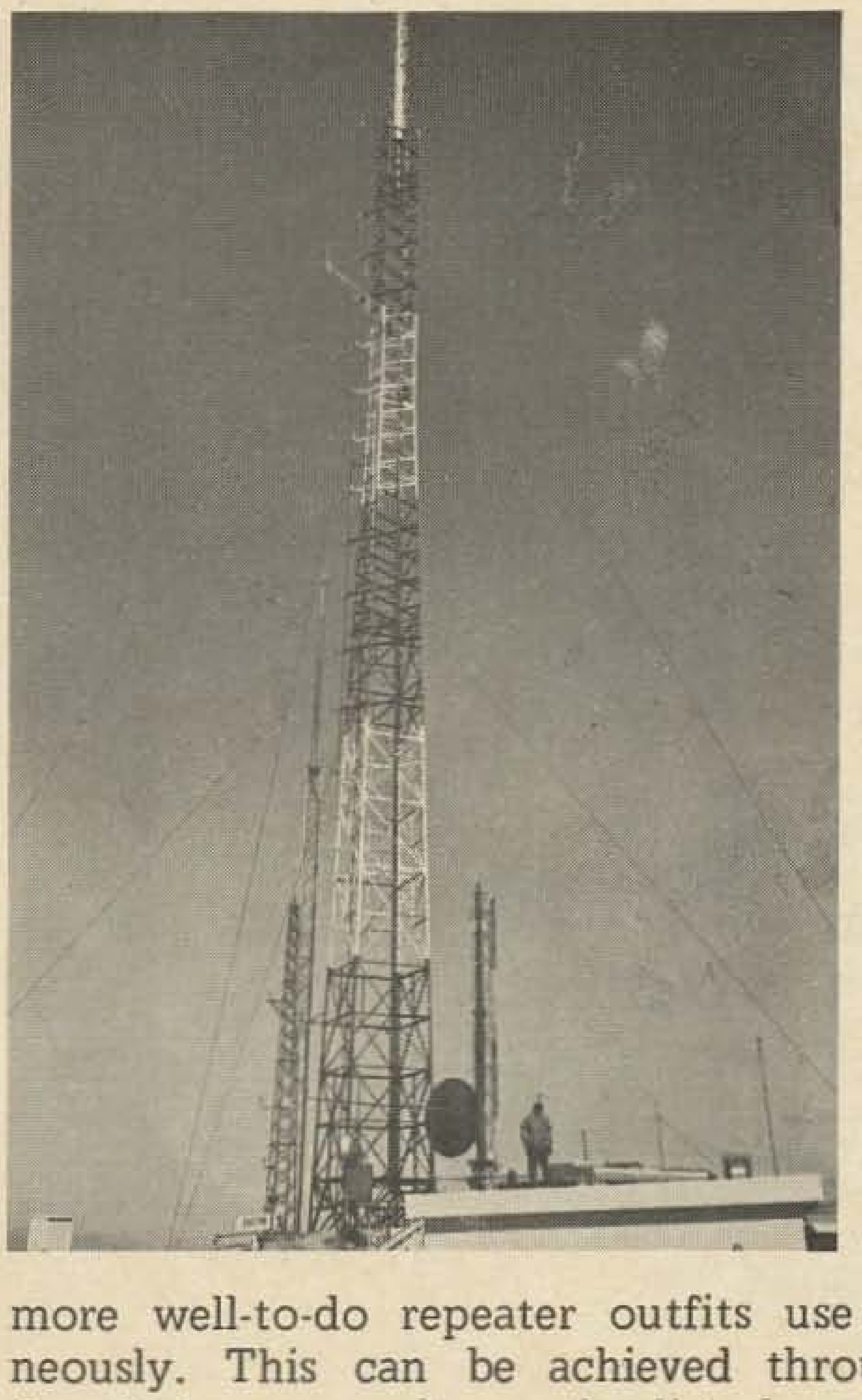
In Chicago, you can pick any of several remote receivers for the big repeater by switching tones. Tulsa has a number of remote receivers for its repeaters, too. However, it uses an automatic receiver voting system which selects the strongest signal then links it up to the transmitter site on top of the National Bank of Tulsa. This is purely a diversity system and tone bursts are not used here.



In some areas, quiet hours are observed. The Albany area is a case in point. It is mutually understood that no repeater transmissions should be made after 2300 hours so that 24-hour-a-day monitoring can be achieved. Other areas use a system similar to this but use a tone burst to open up the monitor's receiver. Many volunteer fire departments use this type of monitor receiver in each of their members' homes.

If you're interested in trivia, the average trustee of a repeater holds an Advanced Class license with Technician class running a close second.

If you like to do things a bit out of the ordinary, take a lesson from two other FM'ers. K2GUG[1] has installed a repeater in a Cessna 180 and W5DFQ has his repeater in a Jeep. K2GUG's is an independent repeater while W5DFQ's can either feed into the Tulsa system or act as a separate repeater.



When it comes to the actual makeup of a repeater, it seems as though GE Progress Line gear is used just a hair more than similar Motorola equipment. This point is the subject of a number of friendly on-the-air rivalries, but in all honesty, this is what a recent poll brought out. Antenna systems are almost always the same. The bigger repeaters tend to use either the Omni-6 by Prodelin the Super Stationmaster by Communication Products Company. These antennas are the undisputed kings of 2 meters FM (with both going for over $160, they had better be!). They are 20 ft omnidirectional antennas which provide 5.8 dB gain in *all* directions. When a repeater group cannot afford one of these gain antennas, generally they use an antenna similar to the Diplomat by Mosley. This type of antenna is a 5/8 wavelength groundplane which provides 3.5 dB gain.

Some repeaters use one antenna for receiving and another for transmitting, but the more well-to-do repeater outfits use the same antenna for both functions simultaneously. This can be achieved through the use of diplexer cavities. You guessed it. . .diplexers aren't exactly dirt cheap!

[1] *QST*, August, 1969, Vol. LIII, No. 8, p. 89 (Bill Smith's "The World Above 50 MHz")

AMERICAN REPEATERS (OPEN)

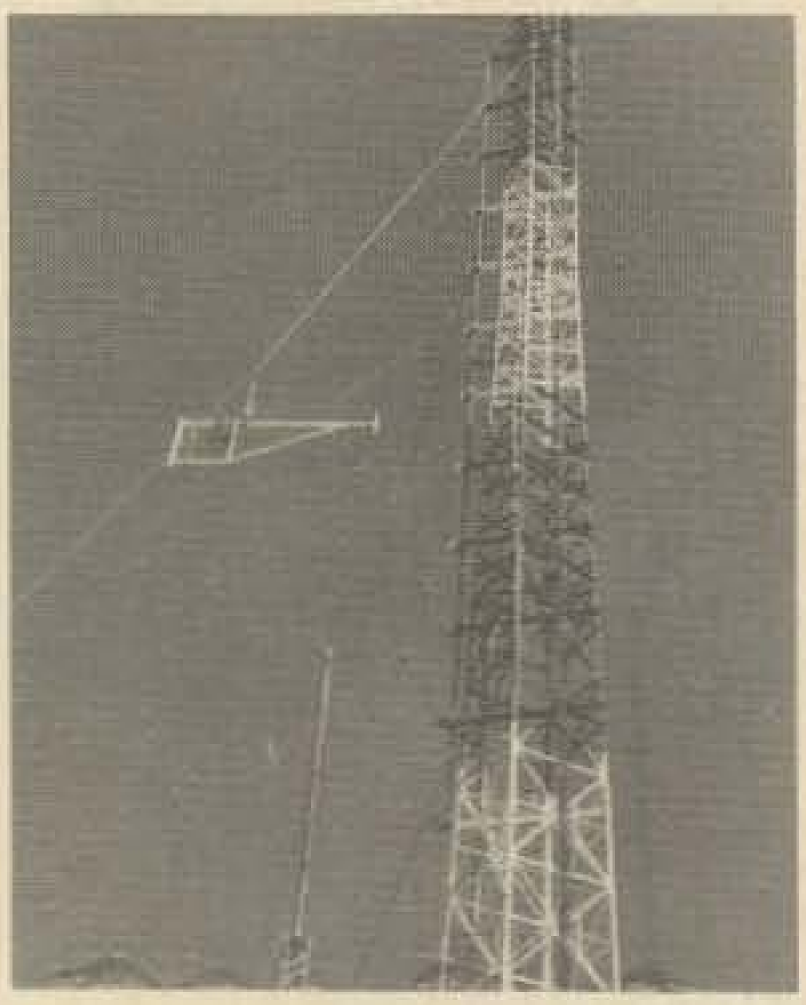
Listings in this directory are alphabetical by state, area of coverage. This concept (as opposed to a listing by actual repeater location) allows mobile operators to determine with ease the repeaters available for use along any cross-country route.

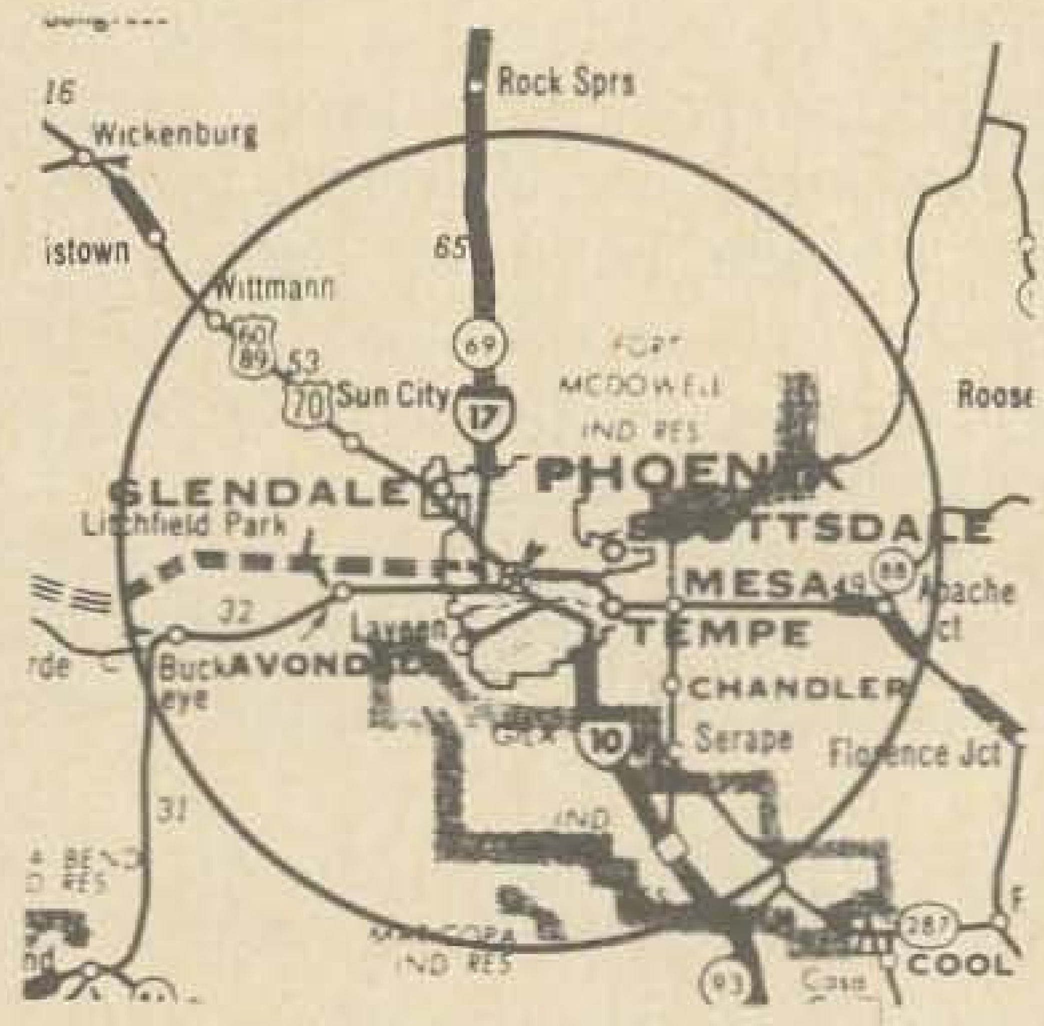
ALABAMA

W4RFR (wideband)	146.34	146.94
W4VO (Northeast Alabama, Northwest Georgia)	146.34	146.94

ARIZONA

Prescott area		
W7AJU (wideband)	146.34	146.94
Phoenix area and extended regions adjacent thereto		
WA7CEM (wideband)	146.34	146.94
Ariz. Rptr. Assn.		
Sierra Vista		
WA7KYT (wideband)	146.34	146.94
Cochise Amateur Radio FM Assn.		





In this photo, a tower arm is being hoisted to the top of the commercial tower where the W7CEM repeater (Phoenix) is located. The arrow shows the almost microscopic figure of one of the braver hams of the repeater group, who will affix the antenna to the arm and fasten the arm brace securely to the tower. The Phoenix "machine" gives a range of approximately 50 miles. (See coverage map.)

ARKANSAS

WA5SNO (Fayetteville; narrowband)	50.50	50.40
W5DI (Little Rock and vicinity; narrowband)	146.30	145.50

CALIFORNIA

Los Angeles area

W6FNO (Radio Ranch) — 146.82 146.70

Wideband. Transmissions limited by timer to one minute each. Covers San Fernando Valley, San Gabriel Valley, Pomona Valley, Paradise Valley, most of Los Angeles County, Orange

The Radio Ranch repeater (146.82 to 146.70) in the Los Angeles area has a wide range of coverage with a pattern shaped like a wedge. Terrain features make limits sharp, so that signals drop off suddenly, regardless of mobile power and antenna type.

County, parts of Riverside County, and southern third of San Bernardino County. Elevation: 3000 ft. Separate receive and

transmit sites. 35W out. User must whistle (1750 Hz) to activate repeater initially; carrier-operated unless input channel vacated for three minutes.		
WA6UJS (Radio Ranch)	52.76	52.525
Narrowband; 3 kHz in/out. Link planned for coverage from Northern California to Mexican border.		
WA6VFO	146.52	147.18
WA6MPV	145.12	146.90
WB6GUA (Lancaster–Palmdale)	146.34	146.94
Whistle-on		
San Diego area		
WB6DSL	146.34	146.94
Extended Southern California area		
WB6WYM (Twin Peaks)	50.75	52.525
Narrowband. Transmissions limited by timer to three minutes. Covers Lucerne Valley and all of Southern California with the exception of areas shielded by Mt. Baldy, such as San Fernando Valley and some parts of Los Angeles. Elevation: 6000 ft. 100W out. Input deviation: 3 kHz; output deviation: 15 kHz. (Repeater temporarily inactive.)		
No call yet (Tulare Co.)	145.22	146.88
San Bernardino County		
WA6TLL (Bishop)	146.34	146.94
Eastern High Sierra Amateur Radio Society. Can link with Las Vegas and Los Angeles through WB6UGT, WB6SLR, and W6FHF.		
Northern California		
WB6DGT (Humboldt)	146.34	146.94
WB6AAE (Grizzly Peak) Oakland area	146.20	146.80
WB6TSO (Central coastal region)	146.20	146.80
W6NCG (Meadow Lakes, Fresno)	146.85	147.71
	146.12	147.71
WA6YCZ (Mt. Umunhum)	146.85	147.71
W6DOO (Mt. Allison)	146.85	147.71
W6AQU (Mt. Toro)	146.85	147.71
W6AEX (Mt. Vaca)	146.20	146.85
WA6UGY	146.34	146.94
W6CX (Walnut Creek)	147.80	147.06
K6JIM (Central Valley)	146.00	147.70
WB6QEO (San Francisco, east bay)	51.20	51.00
WB6QVV (Placer County)	51.20	51.00
WB6LJR (Santa Clara and vicinity)	51.624	51.024
K6GUE (Sausalito)	145.10	146.60
No call (Solano County)	51.624	51.024
WB6NDJ (Alameda and vicinity)	51.70	51.075
WB6WLV (Narrowband. San Diego Amateur FM Radio Assn.)	146.34	146.85
WA6UGR (Alder Springs)	146.34	146.94
WB6NOJ (East Bay)	51.7	51.075
WA6UGS (Grass Valley)	146.34	146.94
Santa Barbara		
WA6RYX (Narrowband)	146.30	146.995

CANADA

British Columbia		
VE7CAP (Kimberley)*	146.46	147.33
VE7BTU (Nelson)*	146.46	147.33
*Info supplied by East Hootenay ARC		
VE7MQ (Vancouver to Seattle)**	146.34	146.58

VE7BUZ (Vancouver)	146.34	146.94
VE7AFG (Prince George)	146.58	147.33
VE7APU (Vancouver to Seattle)**	146.33	146.58
**Univ. of British Columbia; precedence given to 146.34 input.		
Quebec		
VE2MT (Mt. Royal, Montreal)	146.46	147.06
	146.46	146.94
VE2RM (Mt. Rigeau; covers Montreal and western portions)	146.40	147.18
VE2OM (Mt. Belair) wideband	146.46	146.94
VE2AT (Mt. Carmel) wideband	146.46	146.94
VE2TA (Mt. Orford; Quebec and northern Vermont)	146.52	147.50
VE2XW (Mt. St. Bruno; Montreal and vicinity)	146.70	147.60
VE2CRA (Ottawa)	146.46	146.94
VE2CTR (Trois Rivieres)	146.46	146.94
VE2FZ (Sherbrooke)	146.46	146.94
VE2CLA (Montreal)	146.10	147.30
VE2CAT (Montreal)	146.18	146.64
VE2PY (Montreal)	146.28	146.88
VE2ZO (Montreal)	146.46	147.06
VE2CRS (Chicoutimi)	146.46	146.94
VE2CSL (Matane)	146.46	146.94
	146.34	146.94
VE2JE (Eastern Montreal)	146.52	147.50
VE2JE (Drummondville)	146.46	146.94
VE2VD (southern Quebec)	146.52	147.50
VE2VD (Quebec City)	146.46	146.94
Ontario		
VE3NPS (Niagara Falls)	146.22	147.24
VE3OSH (Oshawa)	146.40	147.12
VE3RPT (Toronto and extended area)	146.46	146.94
Has secondary output on 147.06		
VE3SIX (St. Catherine)	146.22	147.24
VE3SSM (Sault Sainte Marie; coverage into northern Wisconsin)	146.34	146.94
VE3KSR (Kitchener-Stratford)	146.34	146.94
VE3DRW (Hamilton)	146.16	146.76
VE3NRS (Niagara Falls)	146.22	147.24
VE3STP (Ottawa)	146.34	147.06
VE3PBO (Peterboro)	146.34	146.94
VE3KCR (Chatham)	146.46	146.94
VE3BSQ (Kingston)	146.46	146.94
VE3LCR (Grimsby)	146.52	147.42
VE3MOT (Toronto)	146.58	147.18
Manitoba		
VE4XK (Winnipeg and extended area in southern region)	146.46	146.94
Newfoundland		
VO1GT (Covers all of Cape)	146.46	146.94
Nova Scotia		
VE1ARC (Halifax)	146.46	146.94
VE1VH (Moncton)	146.46	146.94
Saskatchewan		
VE5SS (Regina)	146.46	147.33
Alberta		
VE6AUY (Calgary)	146.46	147.00
VE6WQ (Edmonton)	146.46	147.33

COLORADO

Colorado Springs		
No call given (Cheyenne Mountain)	146.34	146.94

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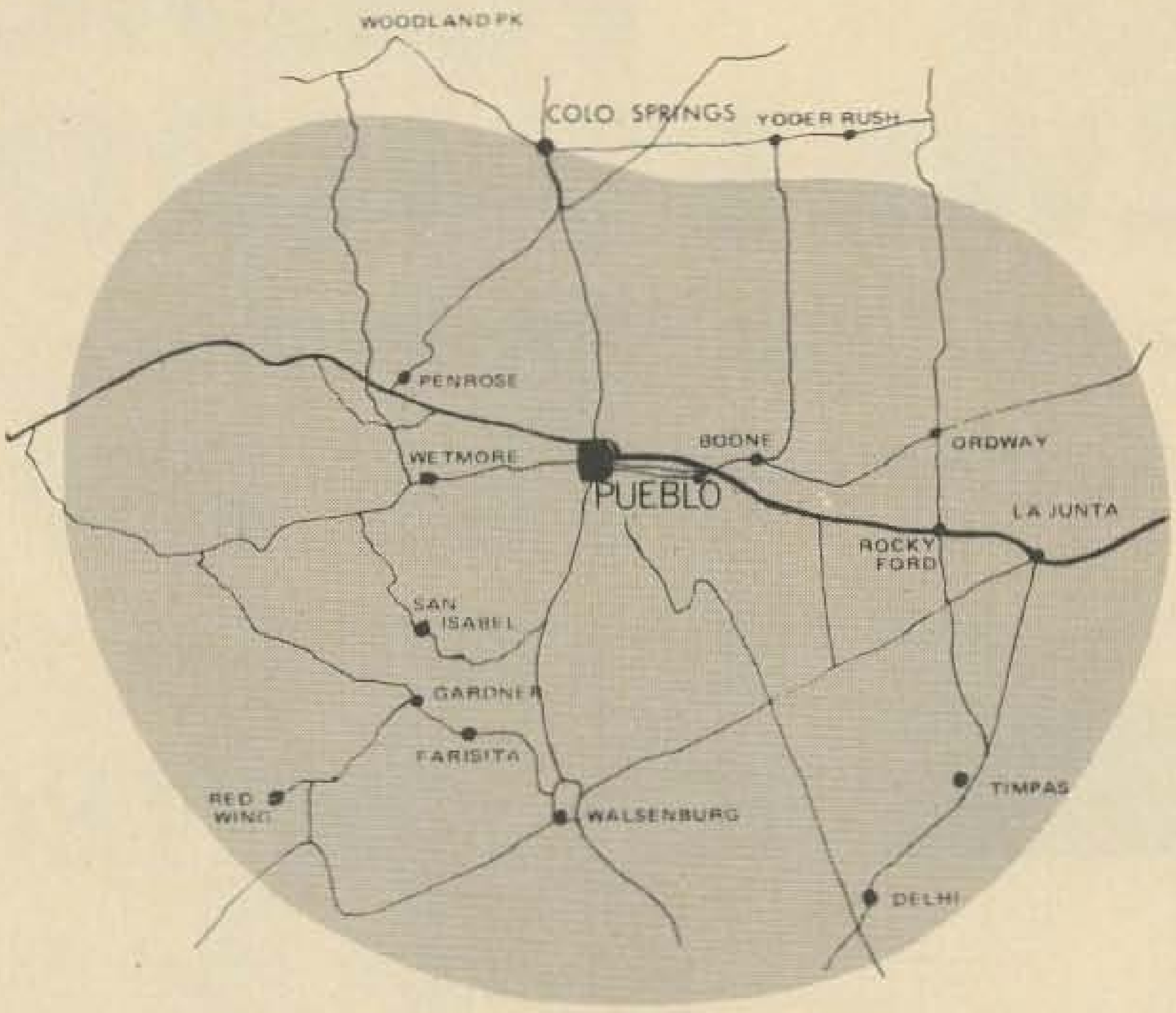
Northern Colorado		
WØWYX (Denver)	146.34	146.94
WØWY-X (Denver)	146.88	146.94

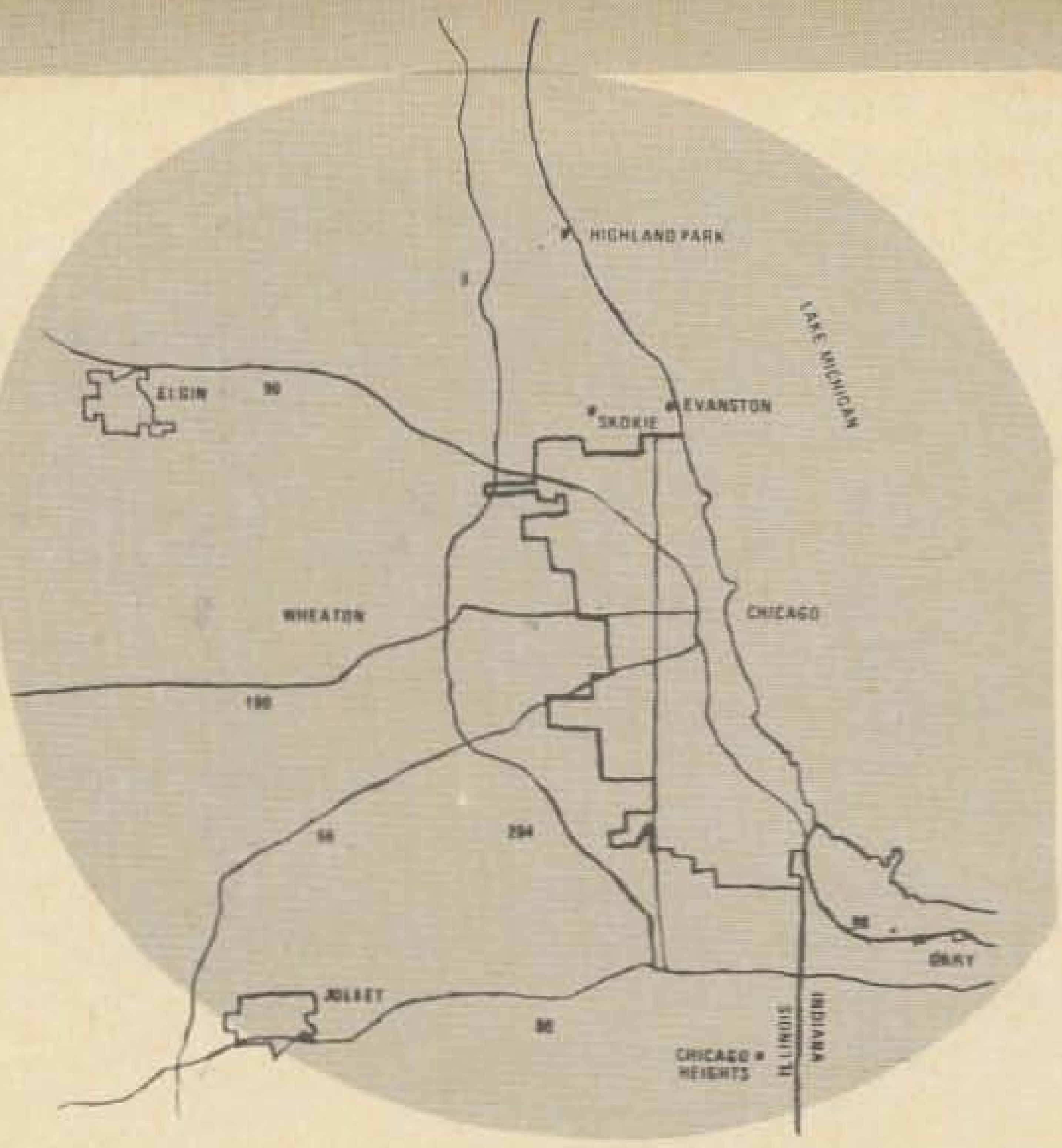


From a high peak in Colorado, the Pueblo repeater provides mobile coverage that transients often find hard to believe. Mobiles have been known to key the machine from as far south and east as New Mexico and Oklahoma.

Western Colorado		
WØPXZ (Grand Junction)	145.32	146.94
Repeater controlled from Grand Junction, deployed at Grand Mesa at height of 11,000 ft. (Highest repeater in the U.S.) Provides coverage over western part of state and into eastern border of Utah.		
WØRRZ (Grand Valley)	145.32	146.94
Used as local backup for Grand Junction repeater; controlled by WØPXZ.		
Pueblo		
WAØSNO (Extended coverage of central portion of state)	146.34	146.94
CONNECTICUT		
K1IIG (Avon Mountain)	146.28	146.94
W1BNF (narrowband)	146.37	146.98
Covers Southern Massachusetts and Eastern Long Island, N.Y., plus much of Connecticut. .94 repeater is tone-burst (1800 Hz).	146.34	146.94
WA1JTB (Bridgeport)		
Covers Southwestern Connecticut. Narrowband	146.31	146.88
W1VVK (Avon)		
Coverage south to Newhaven and East Long Island, N.Y., north to Greenfield; serves as double repeater (prime talkback)	146.94	52.92
K1TKJ (Bantam, Litchfield area)	146.31	146.88
With secondary repeater	146.88	52.98
	53.10	146.31
WA1KFX (Mt. Snow, Vermont)	146.31	146.88
FLORIDA		
Northern Florida		
No call given (Starke)narrowband	146.34	146.94

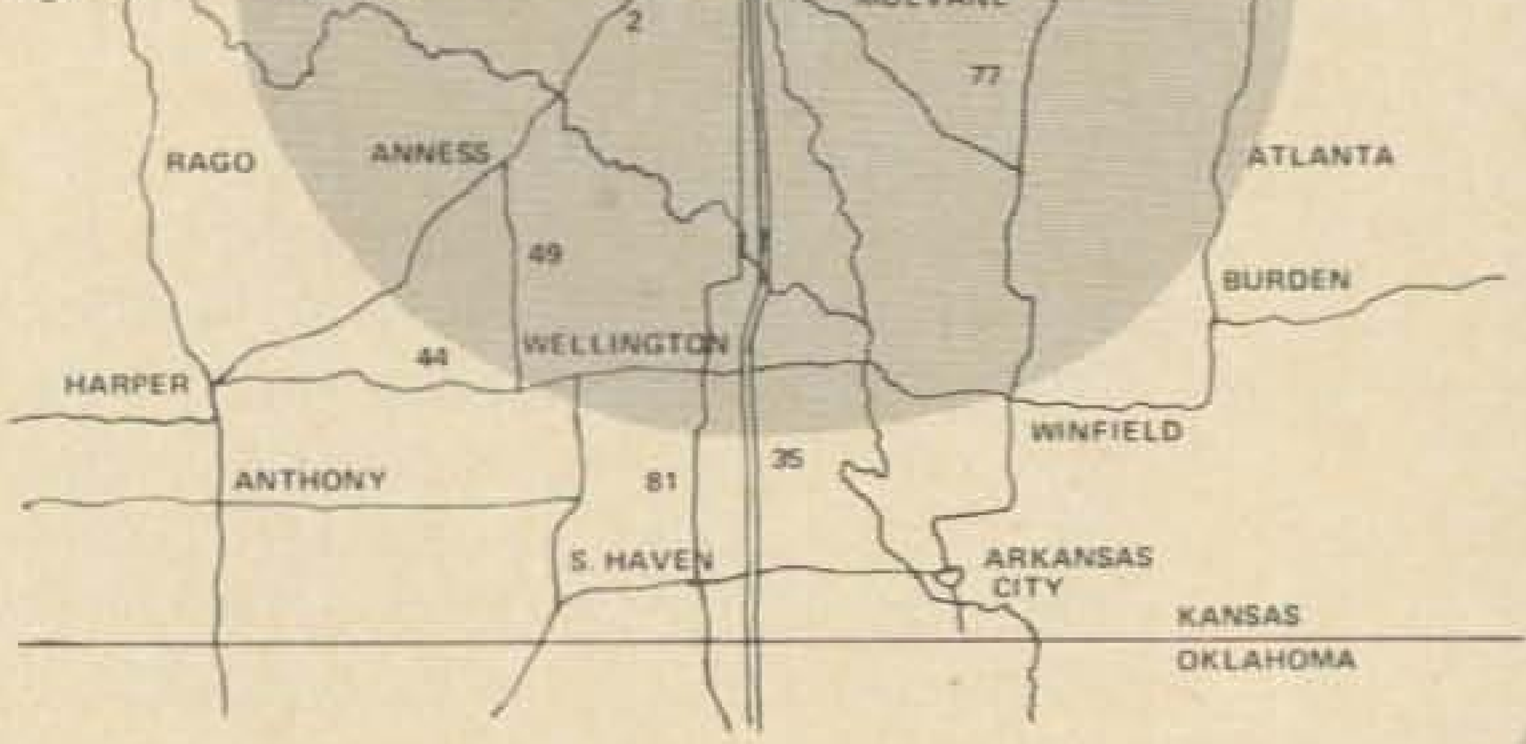
Central Florida		
WB4HAE (Tampa; narrowband)	146.34	146.76
WB4GLK (Okeechobee)	146.34	146.94
Repeater covers central as well as eastern central portion of state; narrowband; repeater functions as double-output, crossed-input system.		
W4CYE* (Cocoa Beach)	146.34	146.76
*Brevard Repeater Assn., Palm Bay, Fla.		
W4IKB (Chipley)	146.34	146.94
W4GGU (Panama City)	146.34	146.76
Northwestern Florida		
W4UC** (Pensacola and vicinity; wideband)	146.34	146.76
**Five Flags ARS, Inc. Has secondary output on 146.94		
WA4EVU (Destin)	146.34	146.94
Has secondary output on 146.76		
Southern Florida		
Miami; narrowband	146.34	146.76
Trustee K4ANW Ted		
GEORGIA		
Northwest Georgia		
W4VO (Rome; Mt. Alto)	146.34	146.94
The input and output on W4VO remains the same but because of being almost halfway between Atlanta and Chattanooga, repeater was experiencing a great amount of interference from both cities on .34, so W4VO went to a broadband decoder with a center frequency of 1750 Hz and a bandwidth of approximately 300 Hz. This has eliminated most of the congestion except for an occasional voice falsing it on. Very good coverage for the terrain in this area, about 60 to 65 miles to mobiles in all directions except to NE Alabama where the receiver antenna is shaded by the tower the antenna is mounted on. Whistle-on system. (NW Georgia Amateur Rptr. Assn.)		
WB4NST (Atlanta; narrowband)	146.34	146.76
HAWAII		
Diamond Head		
KH6EQF (narrowband)	52.525	53.52
(wideband)		146.20
KH6EQF (AM in, wideband FM out)	147.00	146.80
ILLINOIS		
Northern Illinois		
W9YRB (Aurora)	147.40	147.81
W9ZND (Waukegan)	146.46	146.88
Central Illinois		
WA9GCK (Bloomington) Whistle-on system	146.34	146.94
WA9EAM (Petersburg)	146.34	146.94
WA9EAT (Joliet)	146.28	146.98
Chicago and vicinity		
WA9ORC (Chicago FM Club)	146.34	146.76
1800 Hz tone burst for northside receiver; 2 kHz for southside receiver. Wideband. Timer limits transmissions to 2 min. Two receiver sites. North side tone burst requirement is 1800 Hz. South side burst is 2000 Hz. Coverage includes Waukegan, La Porte, Indiana, Wheaton, Chicago Heights. 60W transmitter at 400 ft level in downtown Chicago. Member ALRA. WA9EAE.		

Chicago's CFMC repeater gives an almost perfect circular pattern, and provides highly reliable coverage by virtue of selectable receivers strategically placed in Chicago loop.



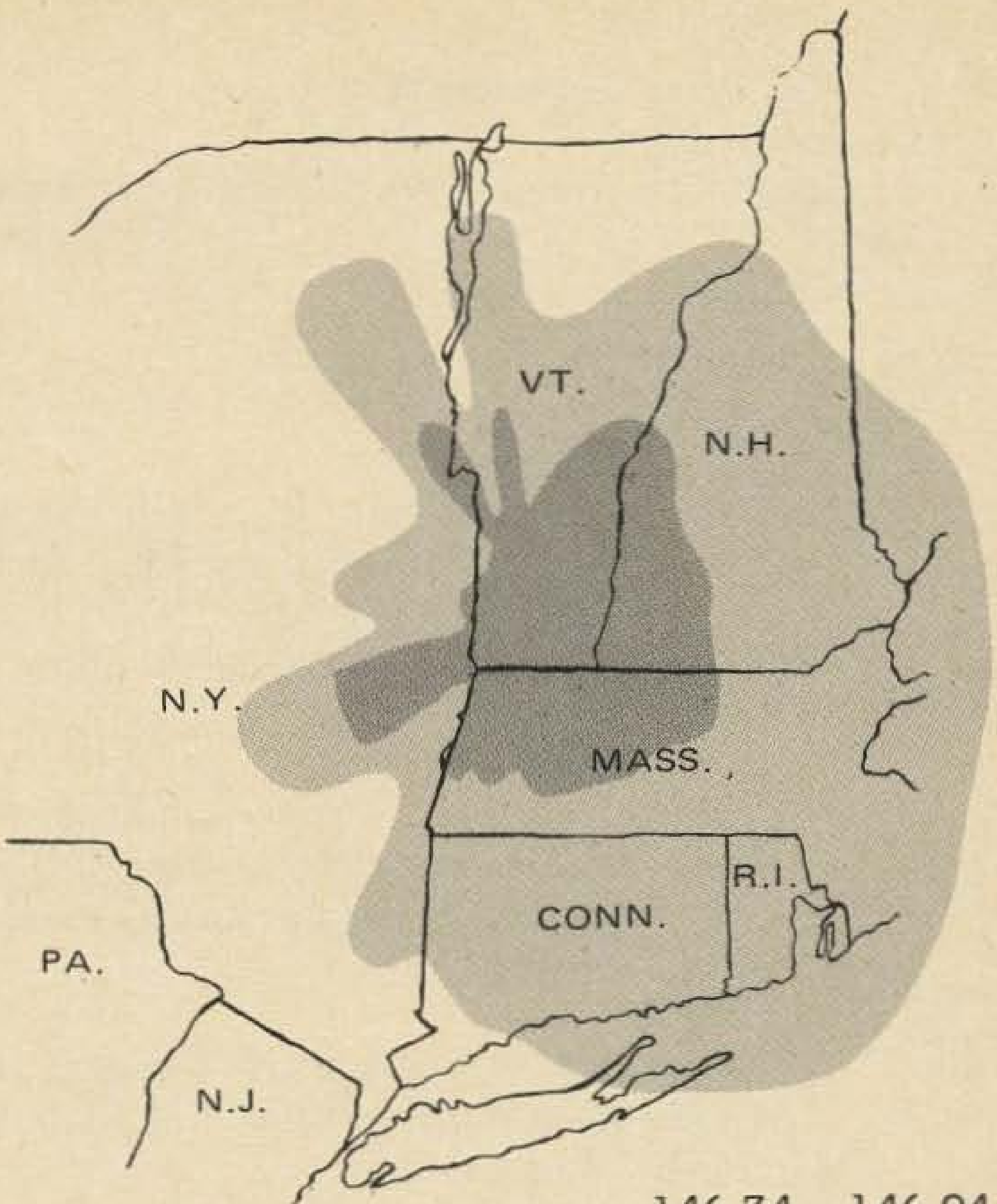
WA9EAE	146.46	146.88
WA9ORC (no tone required)	52.760	52.525
W9NGI (SRO CFAR)	147.45	147.75
Rock Island; no call given	146.34	146.94
INDIANA		
Fort Wayne		
WA9EAU (Member ALRA) Ft. Wayne Rptr. Assn.	146.34	146.76
WA9YJV (Member ALRA)	146.46	146.88
WA9YJV	52.640	52.88
South Bend area		
WA9GOP	146.46	146.88
No call given	146.94	52.525
Schererville		
W9EHZ (Midwest Repeater Assn.) 100 ft tower, 250W transmitter	146.34	146.94
IOWA		
Clinton area		
K9ITW (Open system, but privately owned)	146.34	146.94
WA8PUD (Two-site system)	146.34	146.94
KANSAS		
Northeast Kansas		
WAØSNP (Topeka; wideband repeater)	146.34	146.94

The famed Wichita repeater is used by local government as a quick-responding emergency communications system. The well-trained repeater users monitor continuously, and provide valuable tornado warning services by strategic deployment of mobiles throughout the coverage area.



WAØOFH (Kansas City; wideband)	146.34	146.94
Under same call, but narrowband	52.70	52.525
Central Kansas		
No call given (wideband)	146.34	146.94
Coverage from Canton extends to McPherson, Kansas. Member ALRA		
WAØCJQ (Salina)	146.34	146.94
Southeast Kansas		
WØDKU (Wichita)	146.34	146.94
Covers southeastern and south central portion of state. Input continuously monitored. If output is not operational, a request on the input frequency will bring activation. Narrowband.		
WØIPB (Wichita)	146.22	146.82
KENTUCKY		
W4MOP (Louisville, Jeffersontown)	146.34	146.94
LOUISIANA		
Alexandria		
K5URH	146.34	146.94
Baton Rouge		
WA5RTZ	146.34	146.94
Galliano		
W5MCC	146.34	146.94
	146.94	146.76
MARYLAND		
Baltimore and extended ranges surrounding		
WA3DZD (Harmans)	146.34	146.76
WA3DZD	52.525	146.82
No call given	146.22	52.525
W3JCN (Silver Springs)	146.34	146.76
MASSACHUSETTS		
W1ELU (Marlboro)	146.34	146.94
	146.22	146.94
No call given (Lenox; Eastern Mass.) Mass. FM Assn., Inc.	146.25	146.94
(Same system, 2100 Hz tone burst or whistle)	146.34	146.94
W1VAK (New Bedford)	146.34	146.94
W1ALE (Concord, N.H.)	146.34	52.525
Covers northeastern portion of Massachusetts; timed for periodic duty cycles.	146.34	146.94
W1BL (Princeton)	53.54	50.50
No call given (No. Adams)	146.34	146.94
MICHIGAN		
Detroit		
K8PZL (Wideband; not open to base stations)	146.34	146.76
Great Lakes Repeater Assn. Member ALRA		
Pontiac – Rochester		
No call given	146.46	146.94
Kalamazoo		
K8TIW	146.34	146.94
Grand Rapids		
WA8PUD	146.34	146.94
MINNESOTA		
WØPZT (Hennepin County)	146.54	146.85
MISSISSIPPI		
WA5UEG (Bay Saint Louis; wideband)	146.34	146.94
MISSOURI		
Kansas City area		

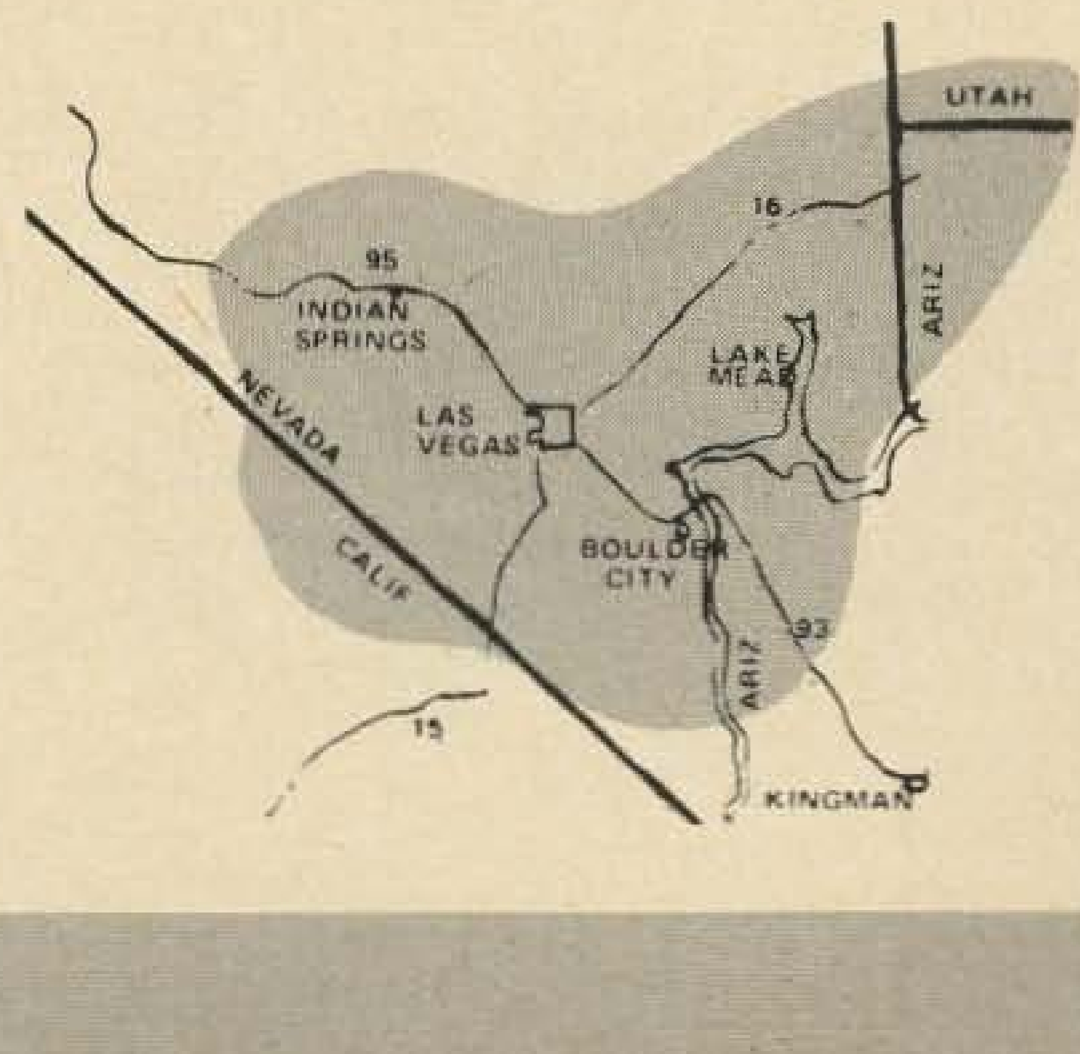
Large shaded area shows approximate base station coverage of K1KFX repeater at Mt. Snow. The smaller shaded area shows the 75% coverage limit for typical mobiles using the repeater (.31 to .88).



WAØOFH (KC, Mo. and Kansas)	146.34	146.94
	52.70	52.525
KØOKI	52.88	52.525
WAØAMR (KC, Mo. and east)	146.34	146.94
KØFRA (Occasionally active)	52.70	52.525
Saint Louis		
WAØCJW	146.34	146.94
MONTANA		
Butte; Anaconda		
No call assigned yet	146.34	146.94
NEBRASKA		
Omaha		
WØEQU*	146.34	146.94
*Ak-Sar-Ben Radio Club		
NEVADA		
W7AKE	53.175	52.525
W7AKE (9,000 ft, Angel's Peak)	147.18	147.84

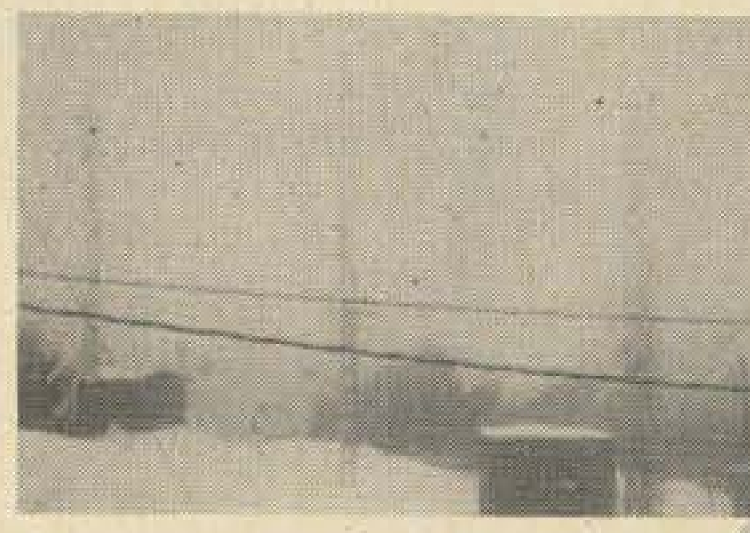
All inputs and outputs are normally in an "on" state at all times, and are automatically selected by keying the input desired. No "lockout" devices are used...the machine is a completely open repeater at all times. Elevation: 8989 ft.

The Las Vegas repeater provides mobile coverage in four states, but its California range is sharply limited by a mountain range near the border.



K7TDQ	146.34	146.94
W7DDB (intermittent)	146.94	147.84
Boulder City		
Gradual upswinging whistle turns on; downswing whistle turns off	146.34	146.94
Reno		
K7UGT	146.34	146.94
NEW HAMPSHIRE		
Manchester		
WA1KFV	146.25	146.76
Whistle on. Covers southern New Hampshire, northeast Massachusetts, south to Boston, west to Worcester. (Member NHFMA and ALRA.)		
WA1KFV (Whistle-on. Coverage as above.)	52.88	52.525
W1ALE (Concord)	146.34	146.94
	146.46	52.525
Covers Southern New Hampshire, Southeast Vermont, Northeast Massachusetts. Timed for periodic duty cycles. Both listed repeaters located at same site. (Member ALRA.)		
WAINR (Derry)	146.19	146.85
	146.34	146.94
Whistle on. Coverage is same as that listed for W1ALE. Wideband. New Hampshire FM Assn. (Member ALRA.)		
WA1KFV (Manchester)	146.34	146.94
WA1KFX (Mt. Snow)	146.34	146.94
Covers South Vermont, Southwest New Hampshire, Northwest Massachusetts, and Albany, N.Y. Operated by Northeastern FM Assn.		
Tone-burst 1800 Hz	146.31	146.94
Tone-burst 1950 Hz	146.34	146.94
Tone-burst 2250 Hz	146.34	146.88
NEW JERSEY		
WA2UWO	146.70	52.64
	52.56	146.76
	146.28	146.76
	146.34	146.76
Provides coverage throughout northern area of state	146.34	52.64
Call not given (Brunswick)	146.34	146.94
Provides coverage throughout state.		
W2CVT	146.37	146.76
NEW MEXICO		
WA5KUI (Alamogordo)	146.34	146.94
WA5JDZ (Albuquerque)	146.34	146.94
WA5GFS (Portales)	146.34	146.94

Atop 10,700 ft Sandia Crest in New Mexico, Dr. Phil Dater takes a day off from his medical practice to hang a 450 MHz antenna in 20-below weather. The Sandia Crest repeater, WA5JDZ, provides coverage from Santa Fe to Socorro and interlinks with two other repeaters, WA5MQ and WA5KUI. The coverages of the three are shown in the map.



IF YOU'VE EVER USED A REPEATER,

If you haven't already received a copy of our **NEW 1970** Catalog of Precision Quartz Crystals & Electronics for the Communications Industry,

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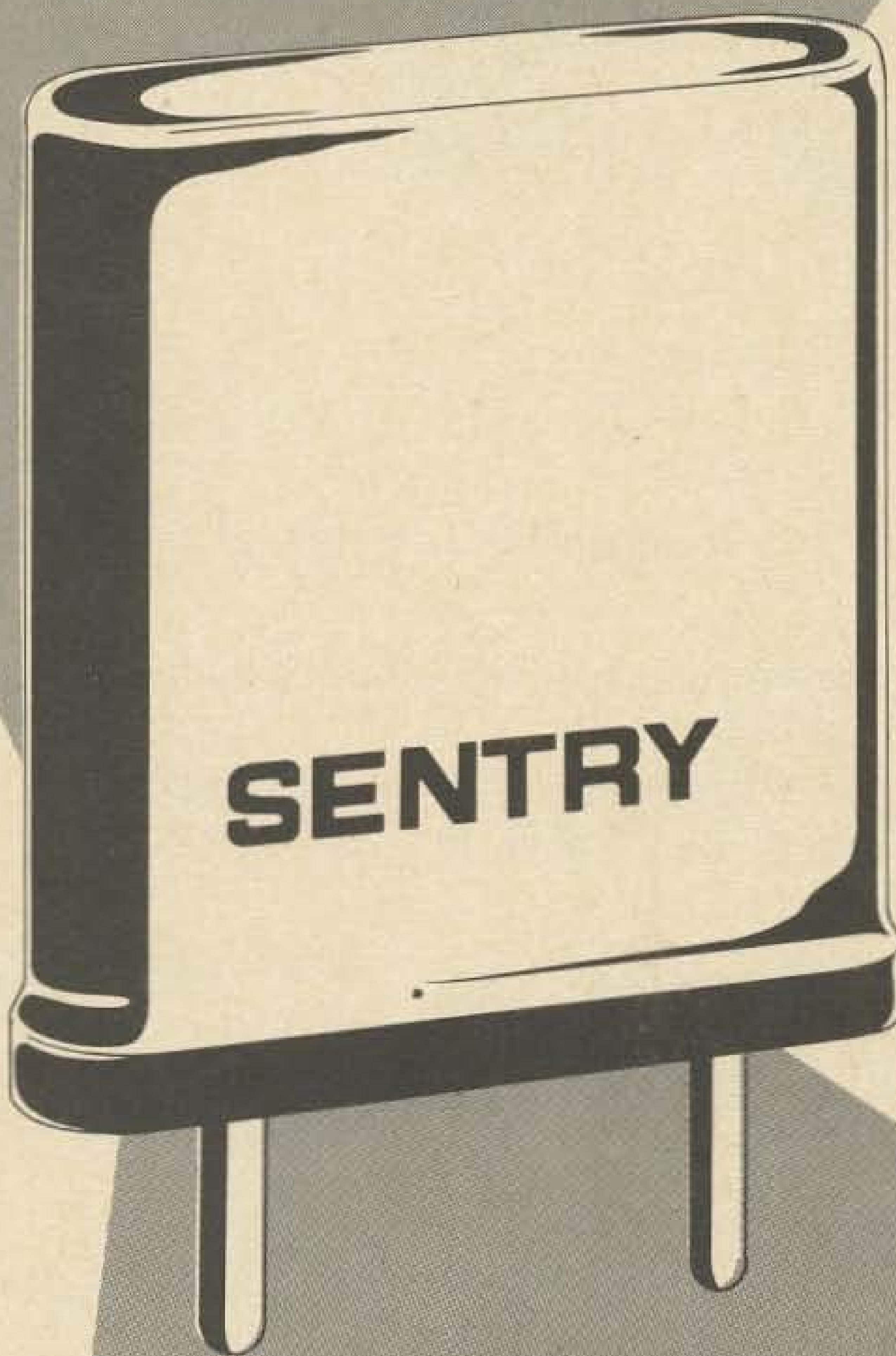

Somewhere along the line, in virtually every ham repeater in the world, you'll find a couple of Sentry crystals.

Repeater owners and FM "oldtimers" don't take chances with frequency—they can't afford to. A lot of repeater users depend on a receiver to be on frequency, rock stable...in the dead of winter or the middle of July. The repeater crowd took a tip from the commercial "pros" a long time ago—and went the Sentry Route.

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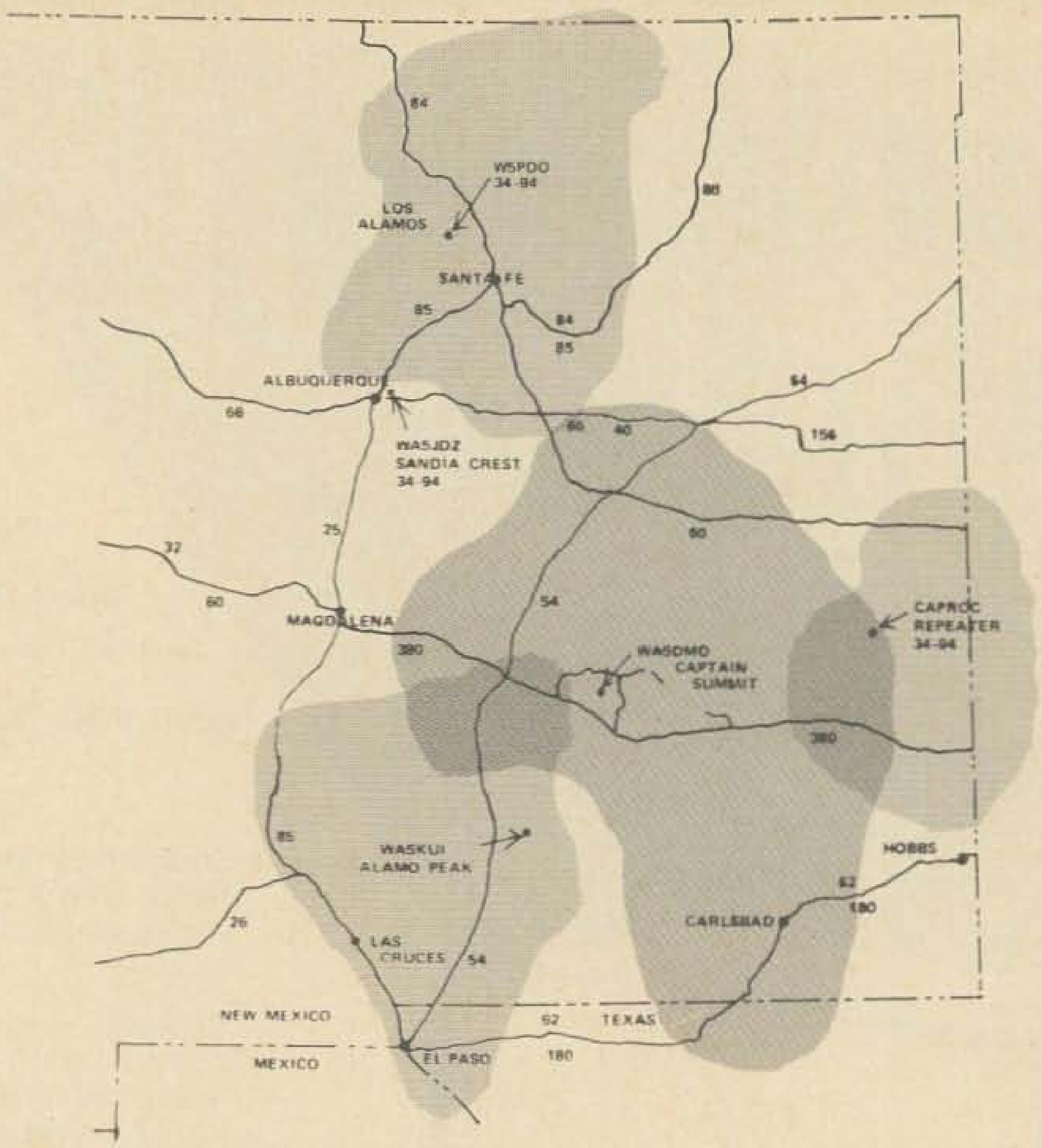


K5CQH (Albuquerque)	146.46	147.06
WA5DMQ (Roswell)	145.50	146.50
W5PDO (Los Alamos)	146.34	146.94
No call given (Caprock)	146.34	146.94

All New Mexico repeaters are free access (no tones) and narrowband FM.

1: New Mexico Repeater System – three repeaters linked to give almost border-to-border coverage.

WA5JDZ, Sandia Crest (near Albuquerque); 146.34 MHz in and 146.94 MHz out; owned by Philip H. Dater M.D., Albuquerque.

WA5DMQ, Sierra Blanka (near Roswell), 145.5 MHz in and 146.5 MHz out; owned by Ken Letcher, W5YFN, Roswell.

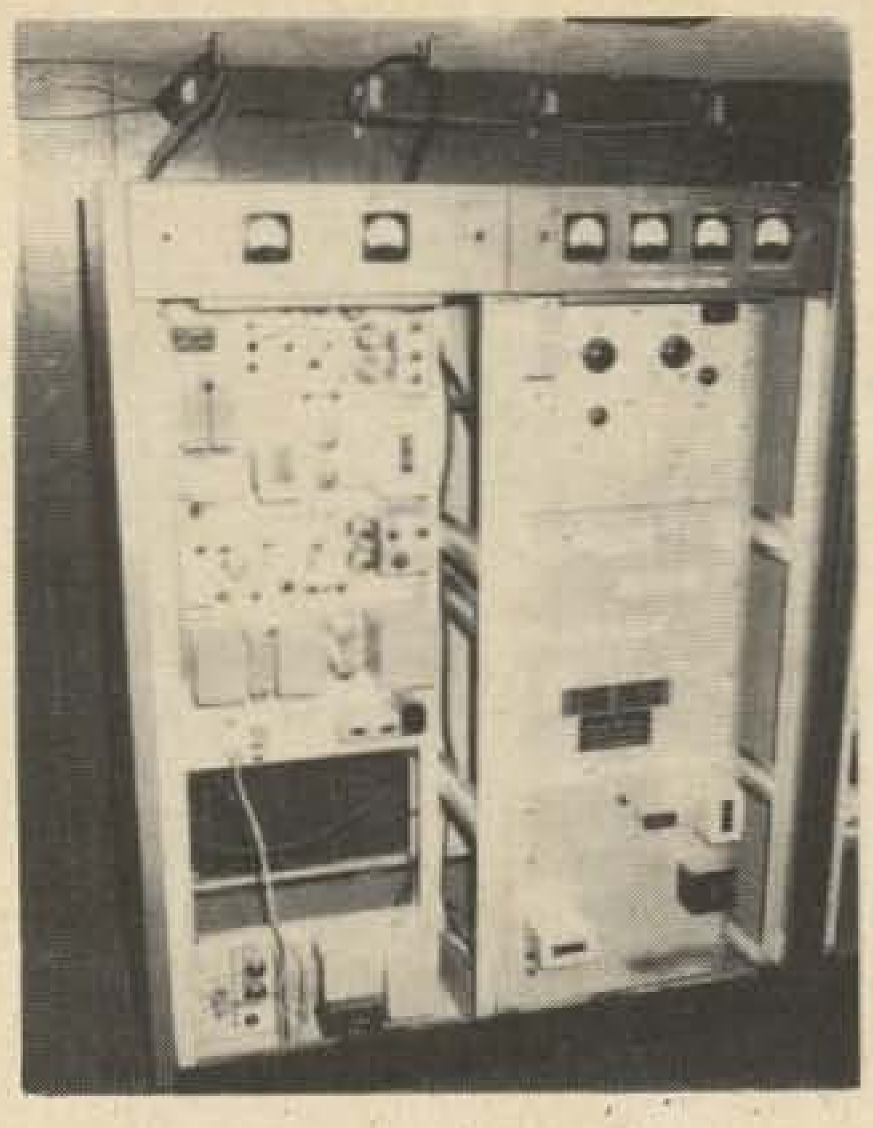
WA5KUI, Almo Peak (near Almogordo), 146.34 MHz in and 146.94 MHz out; owned by Donald Scott, Alamogordo.

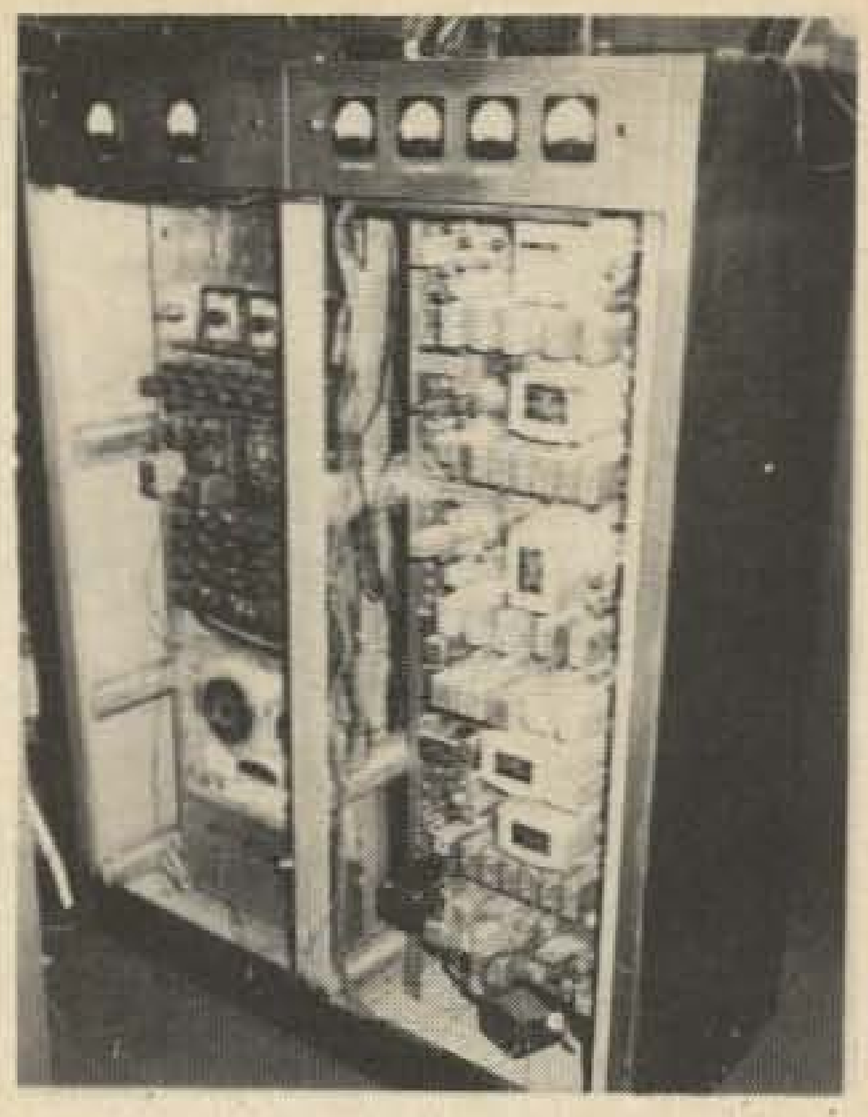
2: W5PDO, club station, Los Alamos Radio Club, 146.34 MHz in and 146.94 MHz out; covers 50 mi. radius of Los Alamos.

3: WA5VKY, club station, Amateur Radio Caravan Club of New Mexico, located at Sandia Crest (10,600 ft elevation), 146.46 MHz in and 147.06 MHz out; covers presently about 50 mi. radius of Albuquerque; however, the transmitter is copyable throughout New Mexico and into adjoining states. A better diplexer and remote receivers should give the repeater better ears and extend the coverage to about 200 mi. radius.

4: K5CQH, located in the Monzano Mountains (7730 ft elevation) about 20 miles southeast of Albuquerque, 146.46 MHz in and 147.06 MHz out – backup for WA5VKY in case it blows up. Also 147.06 MHz in and 147.72 MHz out. This one picks up a few canyons close to Sandia Crest that the Crest signal squirts across and not into.

The transmitters, amplifiers, and power supplies of the WA2UWO repeater are shown in the photograph at left. The other two-bay cabinet, pictured at right, contains the system receivers, relays, control elements, and log recorder. The ready-made commercial cabinets have the advantage of providing built-in meters for measuring all the important parameters of the repeater transmitters and receivers. The equipment shown is 100% General Electric.





NEW YORK

Long Island		
W1BNF (Connecticut; narrowband)	146.37	146.98
Northern New York		
No call yet (Whiteface Mountain) N.A.R.A.	146.22	146.76
W2CVT (Mt. Beacon) (local)	146.34	146.76
(wide area)	146.37	146.76
Albany		
W1JTB	146.31	146.94
East New York		
K2AE (Schenectady)	146.46	146.94
Operates from approximately 7 a.m. until 11 p.m. daily, under the auspices of the Schenectady Amateur Repeater Club.		
WB2NNZ (East Central N.Y.)	146.34	146.94
Operated by the TELCO Club		
W1KOO (Mt. Mansfield, Vt.)	146.37	146.94
	146.34	146.94
Operated by the Burlington, Vermont Amateur Radio Club.		
W1ABI (Killington, Vermont)	146.34	146.94
Whistle on. Operated by the Northeast Vermont FM Rptr. Assn. Member ALRA.		
Central New York		
K2GVI (Utica-Rome)	146.34	146.94
WB2NNZ (Troy)	146.34	146.94
Also covers eastern part of state. TELCO club.		
W2DEG (Grafton)	146.22	146.76
W1ABI (Killington; whistle on.)	146.34	146.94
WA2VNU Cross-connected system	146.34	52.72
	52.80	146.76
Syracuse		
W2RIL	146.46	146.94
W2YRL	146.46	146.94
Lockport		
W2RUI	146.25	146.82
Buffalo		
K2GUG	146.34	146.94
WB2TLJ	146.34	146.94

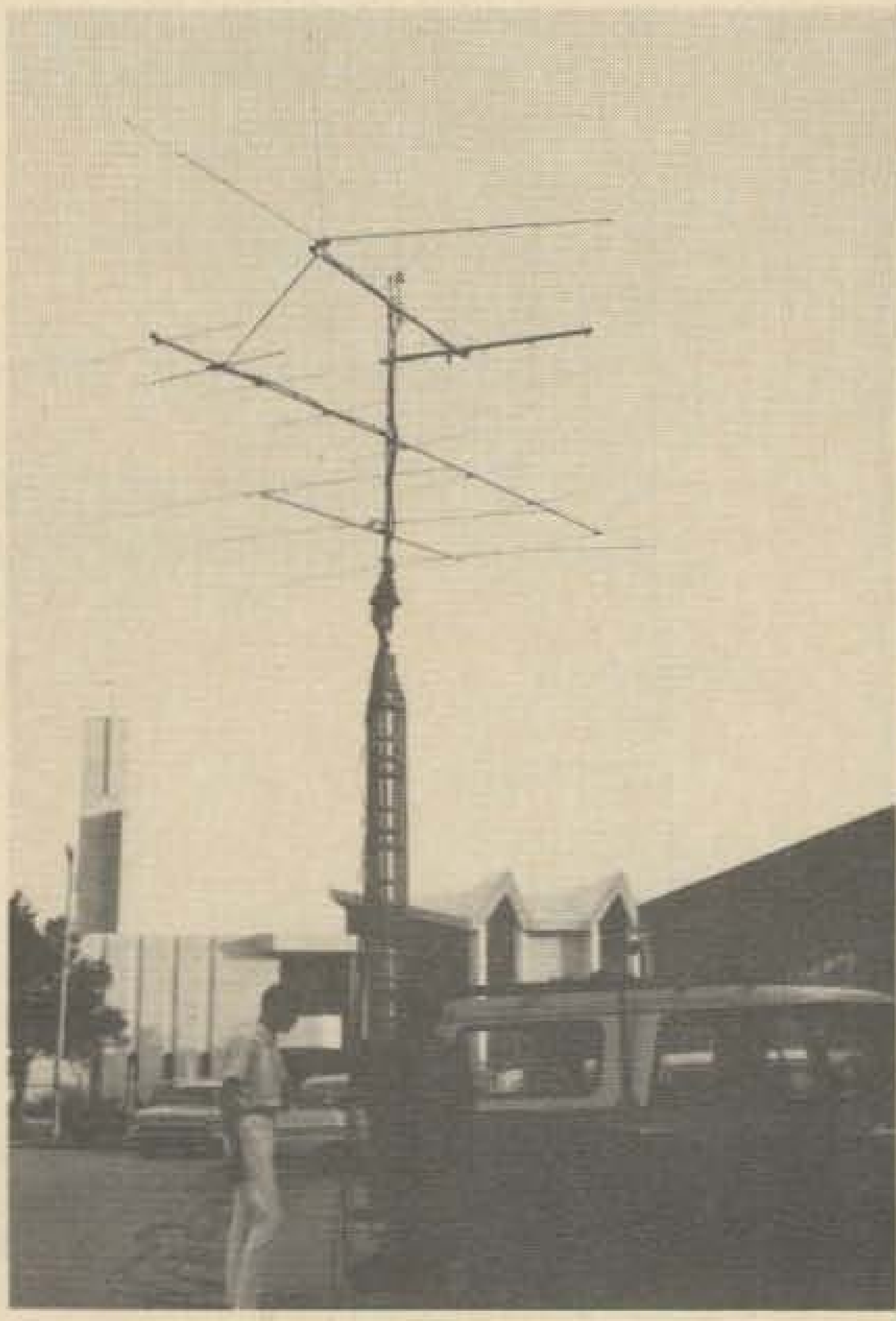
NORTH CAROLINA

North Central area		
WA4FYS (Burlington)	52.76	52.525
Has secondary output on 146.98		
Western area		
W4WID (Lenoir)	52.76	52.525
W4DCD (N. Wilkesboro)	52.525	146.90
W4DCD (Secondary of cross-connected system)	52.78	52.525

OHIO		
Dayton (all of Montgomery County)	146.34	146.76
Delaware County		
W8AIC	146.34	146.94
Has secondary output on 146.76		
System is a wideband type and may be actuated with a whistle on the input. Replaces W8LGL.		
W8QLS	145.62	146.97
Civil Defense repeater; G. Cryder (W8LGL) operates.		
Toledo		
Call unknown (wideband)	146.34	146.94
Youngstown		
W9IOO	146.34	146.76
Cleveland		
WB8CQR	146.34	146.76
WB8CRV	146.88	146.40
Other areas of state		
No call given (Lorain, tied in with WB8CRU)	146.52	146.76
WB8CRU (Newcomerstown)	146.34	146.76
No call yet (Pittsburgh)	146.34	146.94
OKLAHOMA		
Central/Eastern Oklahoma		
WA5LVT (Tulsa)	146.34	146.94

The repeater has its main transmitter at the National Bank of Tulsa Building with a satellite transmitter just installed at Bartlesville, Oklahoma operated by K5YZO. Main transmitter output is 450 watts. Satellite transmitter power is 15 watts. The system receives on 3 remote receivers located around the area. The highest receiver site is on the Channel 6 TV tower north of Sand Springs, Oklahoma. Other sites are Fort Gibson

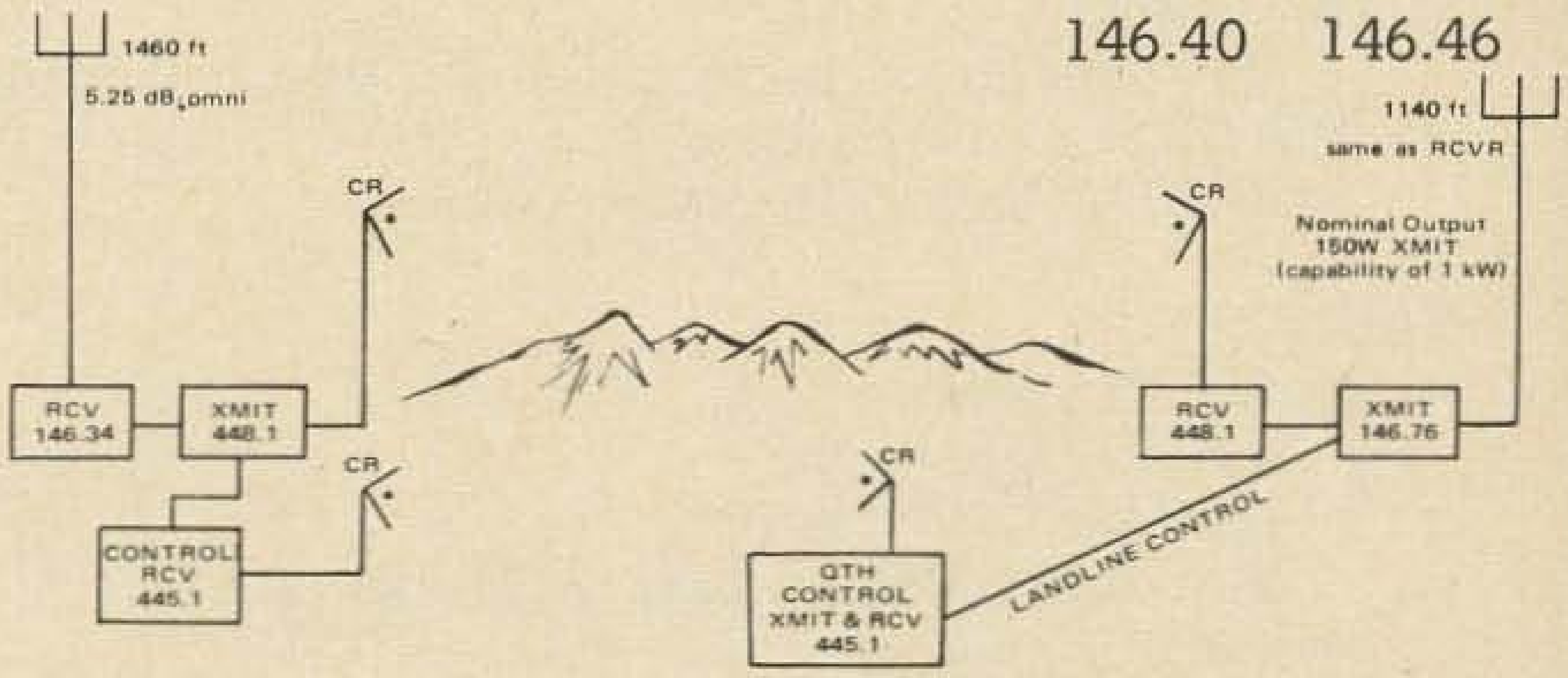
(below)
WA5QGN and WA5QMZ work on the package containing the control link receivers and transmitters, at the 250 ft levelof the local television station's tower. The 450 MHz control equipment is mounted at the 250 ft level. The gear for the 2 meter repeater is up a breathtaking 500 ft.



(right)
Not all repeaters are fixed-site types. More and more amateurs are putting together portable repeaters capable of operating from emergency power sources. Not only does this concept provide an attractive "package" for local Civil Defense and disaster teams, but it serves as an ideal "backup" system in the event something goes wrong with the regular local repeater. This setup is the W5DFQ repeater, and includes a 30 ft crank-up tower outfitted with directional and omni antennas for 6 and 2.

lake near Wagoner and South of Tulsa on a water tower. There is also a standby receiver and transmitter located at the Trustees house in southeast Tulsa. All sites are interconnected and controlled on 440–450 MHz.

Oklahoma City		
No call assigned yet	146.34	146.96
Bartlesville		
WA5LDB	146.34	146.94
OREGON		
W7DBS (Euqene)	146.34	146.94
W7VS (Portland)	146.34	146.94
K7UGN (Extended coverage over Portland and neighboring cities)	146.76	146.58
No call given (Newport)	146.76	146.94
No call given (Dalles area, from Mt. Livingston)	53.46	52.92
No call given (Pendleton area, Mary's Peak)	146.34	146.76
No call given (La Grande area)	146.34	146.76
W7OFY (Medford area; King Mountain)	146.34	146.94
PENNSYLVANIA		
Philadelphia		
WA3BKO	146.34	146.76
WA3IGS Cross-connected system	52.80	52.72
	146.28	146.76
Coatsville (PL required)		
K3ZTP	146.22	146.82
Pittsburgh		
K3UQD	146.34	146.94
Alternate system:	146.34	146.76
Other areas		
K3PQZ (York)	146.34	146.76
WA3ICC (Harrisburg)	146.34	146.76
WA3KUW (State College)	146.34	146.76
No call given (Sayreville)	146.40	146.46



Control and deployment of WA3ICC repeater in Harrisburg, Pennsylvania. All QSOs are taped and time is automatically logged from 24 hr. tape, which advances every min. Time is logged only after QSO.

RHODE ISLAND		
Providence		
W1CDO	146.34	146.94
Has secondary output on 52.525		
SOUTH CAROLINA		
Call not given (Central portion of state)	52.76	52.525
Call not given (Central portion of state)	146.34	146.94
TENNESSEE		
Memphis		
W4CV (Tri-State Am. Rptr. Assn.)	146.34	146.94
Nashville		
No call given (Double repeater system)	146.22	146.94
No call given	146.94	146.20
Chattanooga		
WB4KLO*	146.34	146.94
*Chattanooga Tri-State FM Assn., Inc.		
Shelbyville		
W4IWV	146.34	146.94

TEXAS

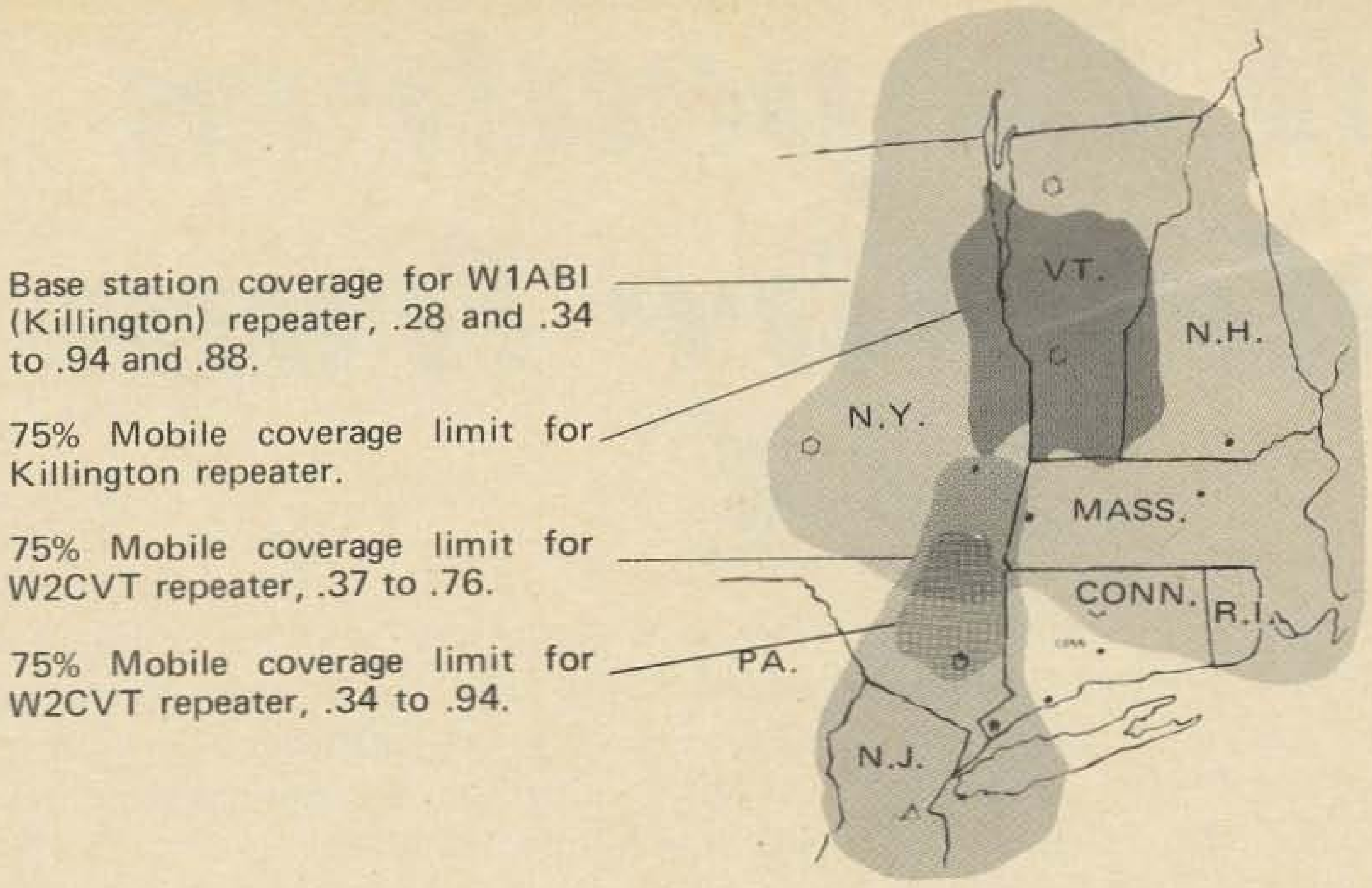
Fort Worth and vicinity		
No call given	53.05	53.15
WA5KTO (Texas VHF FM Soc.)	146.34	146.94
Lubbock	146.16	146.76
W4FXC/5	146.34	146.94
W5YUO	146.16	146.76
Dallas		
No call given	146.22	146.82
No call given	52.85	52.95
No call given	146.34	146.94
Houston		
WA5QLA	146.28	146.88
Austin		
W5NFC	146.34	146.94
San Antonio		
No call given	146.34	146.94
Amarillo		
W5CBT	146.34	146.94
Other areas		
WA5LDL (Tyler)	146.34	146.94
No call given (Port Arthur)	146.34	146.94
No call given (Midland)	146.34	146.94
No call given (Abilene)	146.34	146.94

UTAH

East border		
WØPXZ	145.32	146.94
Provides coverage from 11,000 ft site at Grand Mesa, Co.		
Salt Lake City (intermittent)		
WA7AKI	146.34	146.94
Provides coverage over Northern Utah and Southern Idaho		
K7OEP (Southern Idaho)	146.34	146.94
WA7GTU (Cedar City; narrowband)	146.34	146.94

VERMONT

Central Vermont		
W1ABI (Killington)	146.34	146.94
1800 Hz Tone burst	146.28	146.88
Northeast FM Rptr. Assn. 2100 Hz tone burst	146.34	146.88
Southern Vermont		
WA1KFX (Mt. Snow)	146.31	146.88
Provides coverage over southwestern part of state		
W1ALE (Concord, N.H.)	146.34	146.94
Provides coverage over south and southeast portion of state, overlapping with other states. Repeater timed for periodic duty use.		
Alternate system	146.46	52.525
K1MNS (Derry)	146.25	146.76
Southeast and south part of state		
Northern Vermont		
VE2TA (Quebec repeater)	146.52	147.50
W1KOO (Mt. Mansfield)	146.34	146.94
2400 Hz tone-burst entry. Covers northern portions of Vermont and northeastern regions of New York. Operated by Burlington Amateur Repeater Club.		
No call assigned yet (Northern Vermont)	146.22	146.82
No call assigned yet (Northwestern Vermont)	146.22	146.76



VIRGINIA		
Lynchburg		
WB4HCX (Lynchburg ARC; GE employees)	146.34	146.94
Repeater operates wideband input, narrowband output.		
W4GCE	146.22	147.42
Has secondary in/out on .941.76)		
Other areas		
K8SXO (Ridgeley)	146.76	52.525
Cross-connected double repeater	52.525	146.76
W4DXC (Richmond)	52.72	52.640
WASHINGTON (STATE)		
Northern Washington		
VE7MQ (British Columbia repeater)	146.34	146.58
Provides extended coverage in northwest part of state		
VE7APU (British Columbia)	147.33	146.58
Provides coverage in northwest, Seattle to Vancouver		
No call given (Seattle)*	146.34	146.58
	146.76	146.58
W7PUG (Seattle)	146.34	146.76
*Seattle repeaters interlinked with precedence to 146.34 input.		
K7KSZ	52.525	53.290
W7AJF (Upper state)	146.58	146.76
Eastern Washington		
W7AAG (Spokane)	146.34	146.76
Other areas		
W7DAQ (Longview)	146.76	43.290
Intermittent operation; precedence given to 146.76 input; double repeater		
No call given (Richland)	52.525	53.290
No call given (Yakima)	146.26	147.21
WASHINGTON, D.C.		
WA3DZD	146.34	146.76
WISCONSIN		
W9ROM (Milwaukee)	146.34	146.76
K7SDD (Sherman Hill)	146.16	146.76
Linked to WA7EGK and Denver's WØWYX on Casper Mt.; includes Touchtone autopatch.		
W7LVU (Casper Mt.)	146.34	146.94

FM Repeaters under fire from FCC

An FCC move feared by all FM'ers since it was first publicized in FM Magazine back in March 1968 has finally happened: The FCC has docketed a set of repeater rulemaking recommendations that are so constricting as to destroy half the repeaters in the country. What are these earthshaking comments?

1. No crossband operation. Period. This means that no one will be able to operate through his repeater from 450 MHz. This means that remote operation of transceivers will be illegal. This means that site-to-site links will be illegal, unless they are interconnected via a wire line.
2. Only one transmitter can be energized per receiver, and signals cannot be re-repeated. This means no multiple-output repeaters; no links, no cross-connected repeaters, and no cross-country systems.
3. Transmitters and receivers of repeaters will be authorized on specific subbands only. Here are the catastrophic subbands proposed:
   - 6-meter repeaters must receive between 52.5 and 52.7, and must retransmit the signals between 53.0 and 53.2.
   - 2-meter repeaters must receive between 146.3 and 146.6, and retransmit the signals on the frequency range of 146.9–147.2.
   - UHF repeaters must receive in the range of 447.7–447.9, and retransmit in the range of 449.1–449.3.

The implications of the foregoing are obvious. Prime repeaters are okay on .94, but all the .76 systems will be defunct. Talkback repeaters will be completely wiped out. The UHF transmit-receive spread is only two megahertz, which will all but eliminate all but multiple-site, wireline interconnected repeaters.

There are a number of other restrictions, such as a 600W power limit, mandatory tone access, relaxed logging. Most of the other restrictions can be lived with, but repeaters cannot survive with the restrictions as noted above.

The FCC will accept comments from individuals interested in repeater rulemaking until May 15. Let no grass grow under your feet. If you haven't already made in issue of this, do it now. Call your club together for an emergency meeting and start putting together your comments formally. Mail them (and 14 additional copies) to the FCC in Washington, D.C.

Urge the FCC to accept RM-1542 without change. It is reasonable constricting, but in the best interest of amateur radio. It, too, requires mandatory tone control, for example, but only as an alternative to continuous monitoring from the UHF control frequency. RM-1542, submitted in December 1969, asks that the FCC relax logging in favor of a "technical log." It asks that control of the repeater be permitted by tones from the frequencies of use INSTEAD of requiring a UHF monitor at a fixed control point. RM-1542 is a good proposal and it is in the best interest of the public and the amateurs. If the FCC would accept RM-1542 without change, and reject the recommendations offered in Docket 18803, repeater operation would grow and thrive, and optimum use of the spectrum would be assured.

. . . K6MVH ■

the fine points of FM Operation

Richard J. Zach WB2AEB
22 Pike Place
Mahopac NY 10541

Another installment in a continuing series of FM "beginner" articles.

After you get set up on FM, you'll find that you will be doing a lot of monitoring. To the seasoned HF operator this may seem quite futile. However, with simultaneous signals FM receivers have a property of receiving the stronger and almost completely rejecting the weaker one with little or no heterodyne. Also, all FM communications receivers (except for a few pocket pager types) have a rather sophisticated squelch circuit. When it comes to receiving a weak FM signal, the modulation does not steadily decrease with the signal strength, but is nearly "armchair copy" to a critical point. Once the signal gets below this point, it drops completely out of the picture and the squelch will close. Roll all these properties into one receiver and monitoring will be a joy. When a signal is received, chances are that it will be just one clear, fully modulated voice. When there is no signal you will hear nothing but silence . . . no QRM or static, just silence.

This all sounds like an ideal situation, and it is. However, the transmitting station must do his part too. His signal must conform to certain standards. His center frequency must not be far above or below the accepted channel; deviation must not be far above or below the accepted value in that area, as well as other criteria. The only way that we can keep the operating channels clean is to continuously monitor each other's transmissions and give constructive criticism. Actually, this is not very different from other modes.

The equipment used to analyze FM transmissions is either superexpensive or extremely cheap. If you have ever priced digital frequency meters or deviation meters, it is not hard to tell which method is the expensive one. The inexpensive method is quite simple and accurate and I claim no originality for it. The equipment described (except for the oscilloscope feature) is in operation in about 90% of all the metropolitan New York base stations. As you can see in Fig. 1, it is nothing but a switchable meter to read limiter current (signal strength) and discriminator current (frequency).

If the discriminator reads zero, the received signal is exactly on your frequency. The meter can be calibrated in kHz off frequency by experimentation. For the initial setup you should use a good frequency meter or a station that is the frequency standard for your area (usually a repeater). However, make sure you know that your frequency standard is actually on frequency. Also, when giving off-frequency reports, make sure that you are on frequency, too. If the discriminator-meter needle wiggles, the received station's modulation is asymmetrical (swings more in one direction than the other) and should be corrected. Without the meter you might think that his deviation is too high due to distortion on the peaks.

The limiter current reading is only a reading of relative signal strength and should not be compared with other receivers. As an example, a typical GE Pre-Progress Line (Pre-Prog) receiver may give a reading in the teens for an excellent signal. A Progress Line receiver may show a 100 μA reading for the same signal. These readings vary even in identical receivers. In other words, become familiar with your receiver's meter and express the signal's figure of merit accordingly. When receiving a strong signal, check to see if the limiter current changes with the modulation. If it does, this is a sign of AM'ing and should be looked into.

Walt Guderian (WB2RAA) showed me a nice little trick using the oscilloscope. Almost any inexpensive scope will work. Connect the vertical input to the discriminator jack and put a slow (under 100 Hz) sweep on the horizontal plates. When no signal is received, you will see a pattern like in Fig. 2a. This is just noise on the discriminator. Receive a full-quieting carrier and you will see a flat line. If you see sine waves like that of Fig. 2b, this can be a low frequency MCW ID on a repeater or hum in a transmitter. Through Lissajous figures you can also try to determine the frequency of the audio signal. Its most important function, however, is to help locals to roughly set their deviation level. Again, a standard for calibrating your

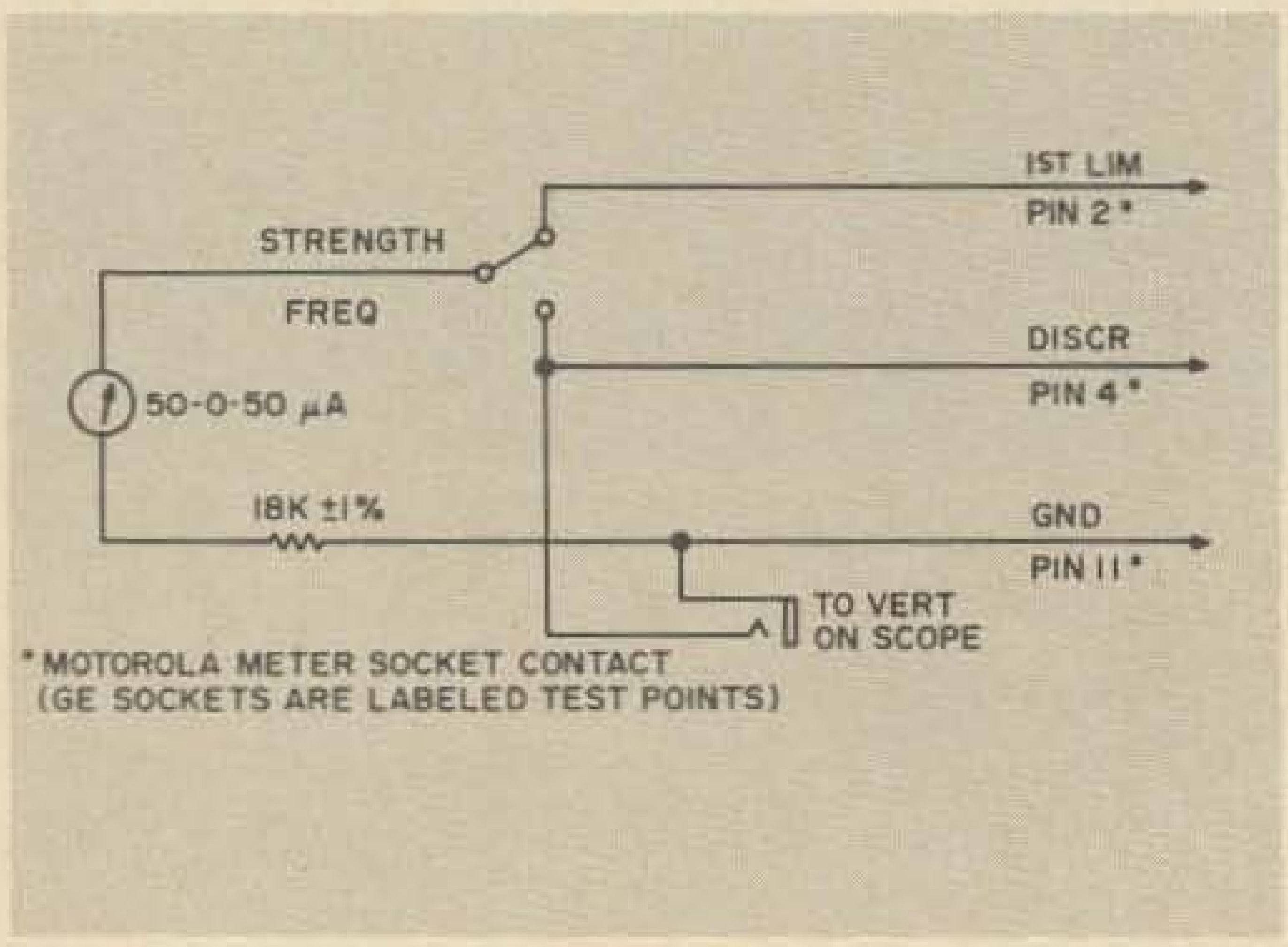


Fig. 1. A zero-centered, sensitive meter can be switched from discriminator to limiter test points to monitor frequency and signal strength. Scope output monitors discriminator continuously.

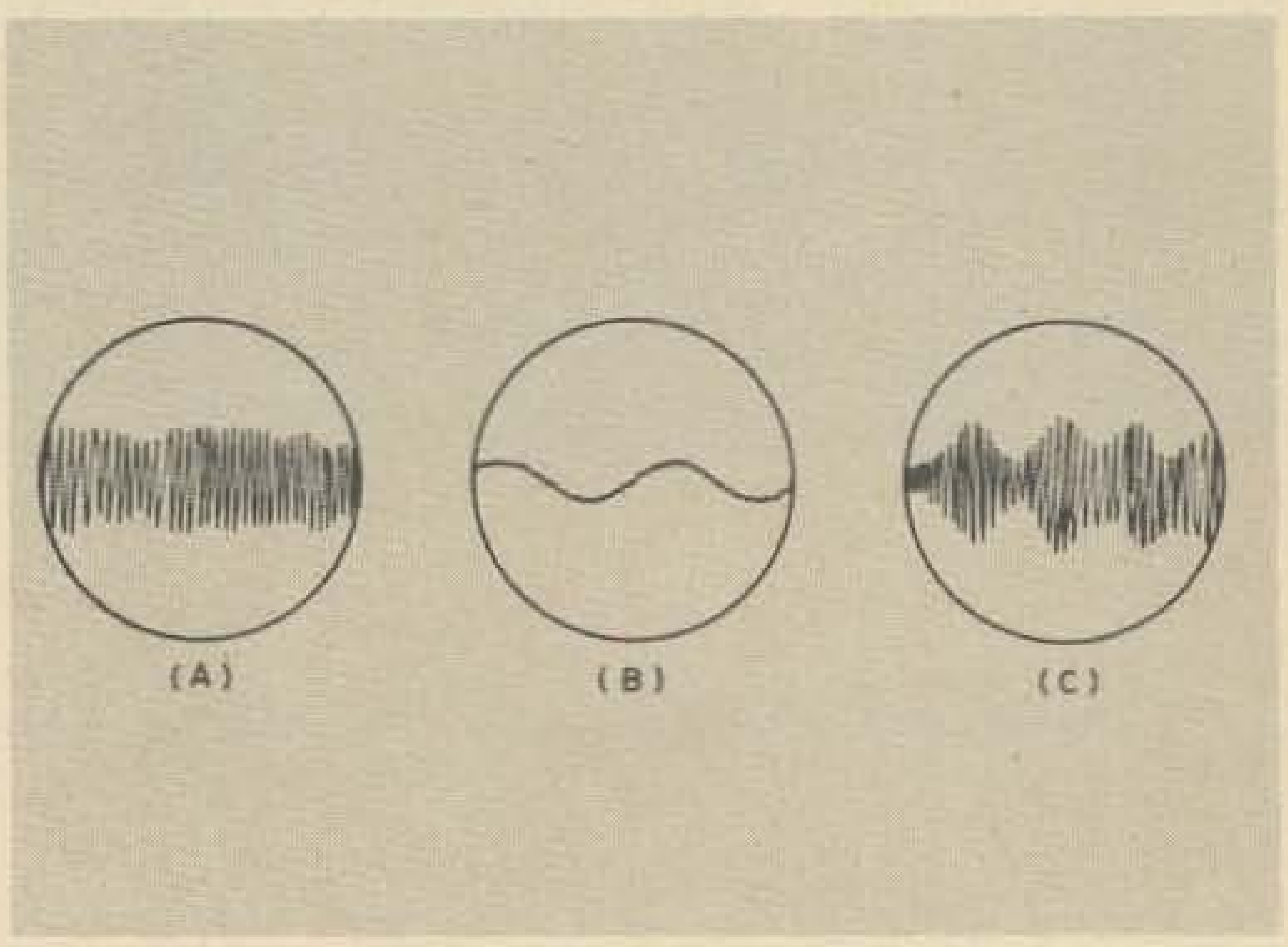
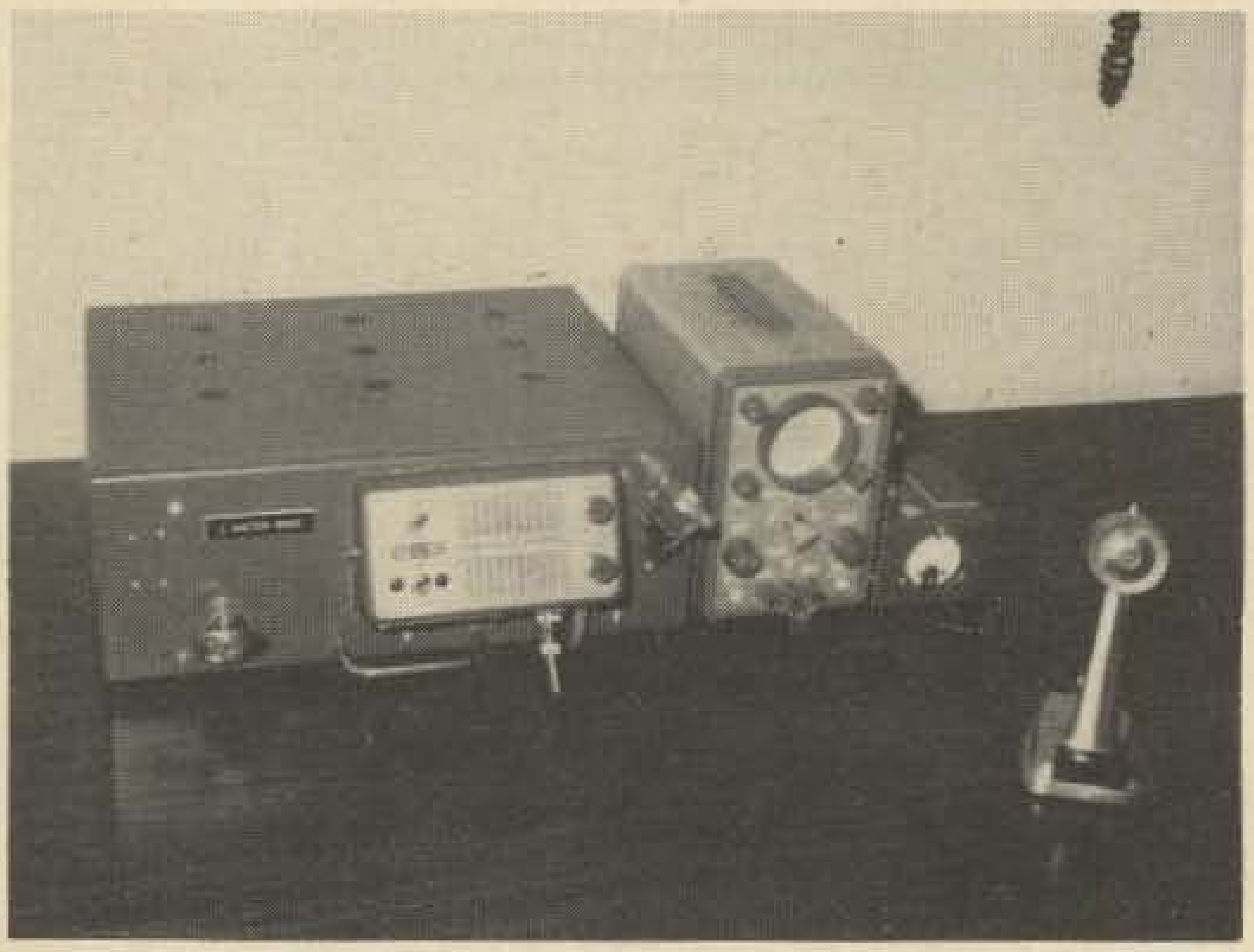


Fig. 2. Swept scope traces show discriminator noise (a), low-frequency products, such as PL, on a signal (b), and a fully modulated, strong signal (c).

scope could be a fully modulated repeater output signal. Knowing that a repeater has been set up for 12 kHz deviation, for example, you would adjust your vertical gain so that 12 kHz would read 3 cm (4 kHz/cm) on the CRT while a fully modulated signal is being received. It should be noted that by "fully modulated" we mean modulated to the deviation limits acceptable by the repeater. By approximation, you can estimate the unknown deviation being transmitted. A



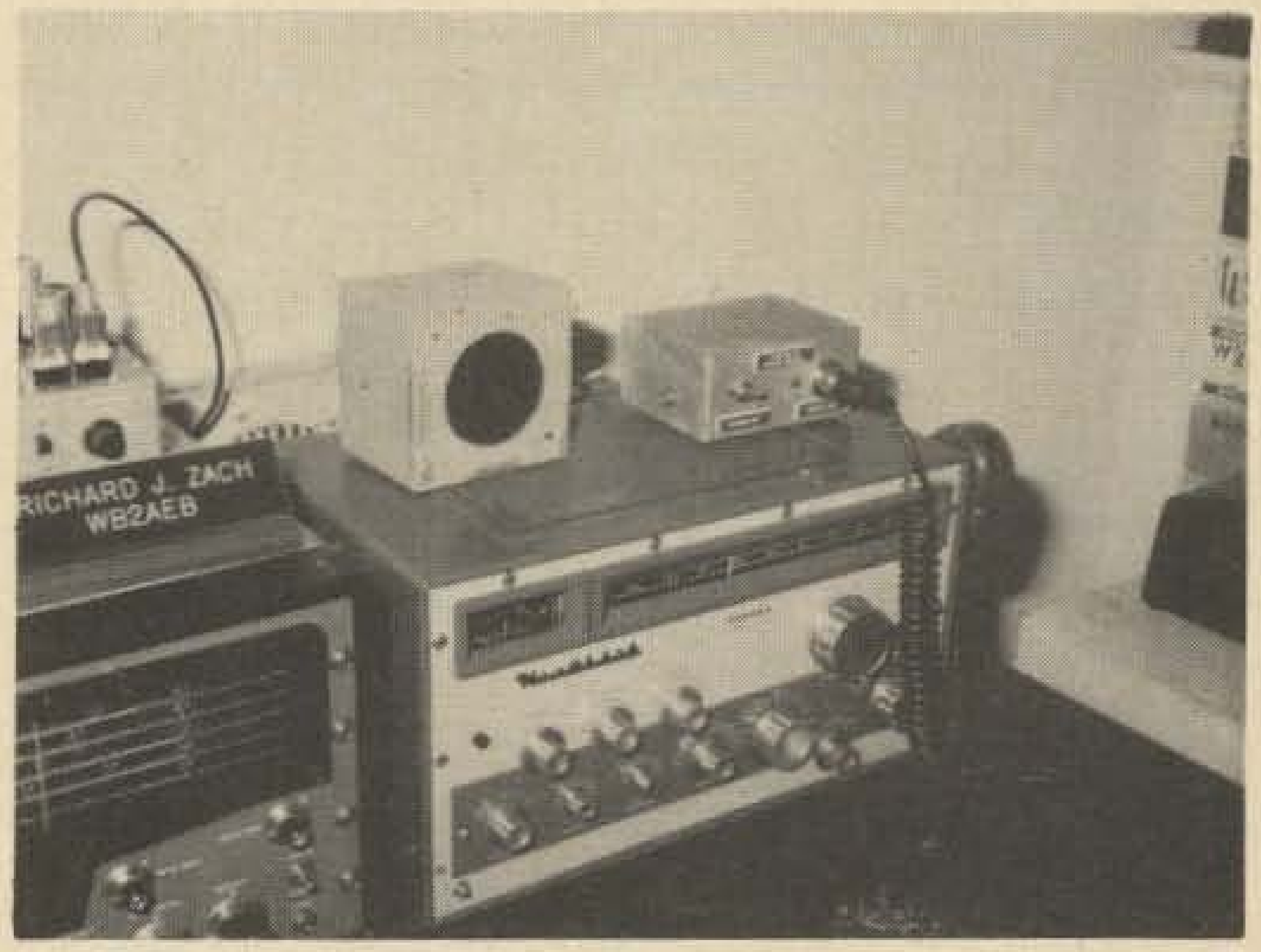
The complete VHF–FM base station in use at WB2AEB. Note added muting switch on side of control head and external metering jacks.

full-quieting signal with good modulation should look something like Fig. 2c.

Another gadget which quite a few FM hams employ is a remote control unit. Many a non-FM ham at one time or another has thought of doing this, but abandoned the whole idea due to receiver drift and the need for many controls. To remote an FM rig by wire, it is simply a matter of bringing out the mike, PTT, and speaker leads. With Motorola and GE, this is a "no holes" modification if it can even be called a modification. I remoted my GE Progress Line through the microphone jack. The basic modification to the 4EC29A front-mount control head is to connect a 2.2 kΩ half-watt resistor from pin 4 on the microphone jack to pin 11 on P701.

As an optional convenience, install a small SPDT switch on the side of the control head. In case you want to hear only the remote speaker and not the local, this switch disconnects the local speaker and puts a resistor load across the output transformer. Since I had an abandoned rotor wire already going from the rig to the shack, I used that. The 100 ft length did not cause any loss or hum problems. The connections on the GE microphone jack are the following:

- Pin 1 - mike low (grounded in transmitter), voice coil low
- Pin 2 - mike high
- Pin 3 - PTT high
- Pin 4 - voice coil high
- Socket - ground



The remote unit can be tucked into even the most crowded shack. Note remote speaker muting switch (quite handy).

To transmit, ground pin 3. To remote a Motorola rig, the procedure is the same but the leads can also be brought out from the power and metering jacks. (These might vary from rig to rig so consult a schematic for connections.) As you may have guessed, the squelch and channel selection must be made at the rig itself, but with work these can be remoted too.

In your own area, a special or unique feature might be in operation. Some groups have a system where when a special audio tone is received, an alarm is set off denoting a communications emergency. Other outfits have an automatic phone patch (called autopatch) built into their repeater. Many autopatch-equipped repeaters are now converting to Touchtone because of its versatility for dialing and control. As you can see, the needed accessories can vary widely.

Although not usually considered accessories, manuals, schematic digests, and other literature are vital to the FM ham. Since these rigs were designed for business usage, many different versions of the same rig can exist. Without a schematic digest, even the seasoned FM ham can get lost in a rig. Generally speaking, these manuals are of excellent quality and are quite reasonably priced. One such book is the *FM Schematic Digest* by Two-Way Radio Engineers, a 73 advertiser. This contains Motorola schematics, crystal information, pictures, block diagrams, FM theory lessons, alignment information, and more. The information contained is for older-vintage Motorola rigs. If your Motorola rig is a comparatively recent model, try writing to your local Motorola Parts Depot. There are six depots:

1170 Chess Drive
San Mateo CA 94404
415-349-3111

2333 Utah Ave.
El Segundo CA 90245
213-644-1101

1875 Greenleaf Ave.
Elk Grove IL 60007
312-439-7150

3320 Belt Line Road
Dallas TX 75234
214-241-2151

15-00 Pollitt Drive
Fair Lawn NJ 07410
201-791-1700

Lake Mirror Road
Forest Park GA 30050
810-751-3185

If you own a GE rig of the Pre-Prog era (1949 to 1955), General Electric has two books available which were written especially for the amateur. Volume I covers low-band (25 to 50 MHz) and mid-band (72 to 76 MHz) rigs. Containing information akin to the Motorola book, this publication has the GE number LBI-3883. Volume II (LBI-3884) has information on high-band (150 to 174 MHz) and UHF (405 to 475 MHz) rigs. Both books are $4.50 each and are obtainable directly from General Electric Company, Box 4197, Lynchburg VA 24502. If you want a Progress Line manual, it will cost less than $2 and is written for your specific rig. General Electric also publishes "Datafile" bulletins. These are excellent booklets on such topics as "Fundamentals of Solid-State Logic Circuits," "VHF and UHF Propagation," "Radio-Frequency Interference in Two-Way FM Radio," and others. I would heartily recommend getting Datafile Bulletin 10006-6, "I-F Alignment of Two-Way Radio FM Receivers." This book takes the "twiddling" out of the ticklish job of FM i-f alignment. Undercoupled, critically coupled, and overcoupled i-f filter alignment are discussed. Of the Datafile series, this is the most expensive volume, with a price tag of $1.50.

For a complete listing of all GE publications of interest to the ham, write for list ECP-227. It's free.

Howard Sams puts out the *Communications Equipment Schematic Manual.* This covers mostly late model transistorized rigs, and is divided into five sections: Basic Theory, FM Transmitters, Double Superheterodyne Receivers, Power Supplies, and Alignment Procedures. The $3.50 book is obtainable from your local radio store. For those of you who are getting serious about putting up a repeater, Ken Sessions (K6MVH), editor of 73, has written the *Radio Amateur's FM Repeater Handbook.*

Until recently there was also a magazine which specialized in FM operation (called *FM Journal.*). This magazine is no longer in business, but the editor and publisher have joined the 73 staff – a fact which should serve to keep this magazine in the forefront of the FM activity. ... WB2AEB ■

John J. Shultz W2EEY/1
40 Rossie Street
Mystic CT 06355

HOW TO "MEGGER" YOUR ANTENNA

A simple, proven way to periodically check the performance of a transmission line/antenna system which can uncover faults not indicated by SWR measurements.

Meggering of antenna arrays and rf transmission lines is a procedure frequently performed by commercial and military activities during the construction or preventive maintenance cycles. It is rarely done by amateurs, and yet the procedure and equipment are relatively simple and the test can reveal a great deal about the condition of an installation. It is not a simple ohmmeter check as it may appear to be at first glance. This article explores what function a "megger" check accomplishes, how to perform the check, and the details of some equipment which can be used.

Insulation Resistance and Cable Quality

Rarely does any amateur have a station installation where the transmitter output (or receiver input) is directly wired to the antenna transmission line which, in turn, is directly wired to the antenna. More typically an installation will look somewhat like **Fig. 1** if one traces in detail the signal flow throughout. Obviously, a great many more connectors, switches, and accessory items are involved than is readily apparent. Also, in any real installation, the cabling goes through many bends, and outdoors, is exposed to a variety of environmental factors.

Most amateurs rely upon an swr meter to give them an indication of how the overall

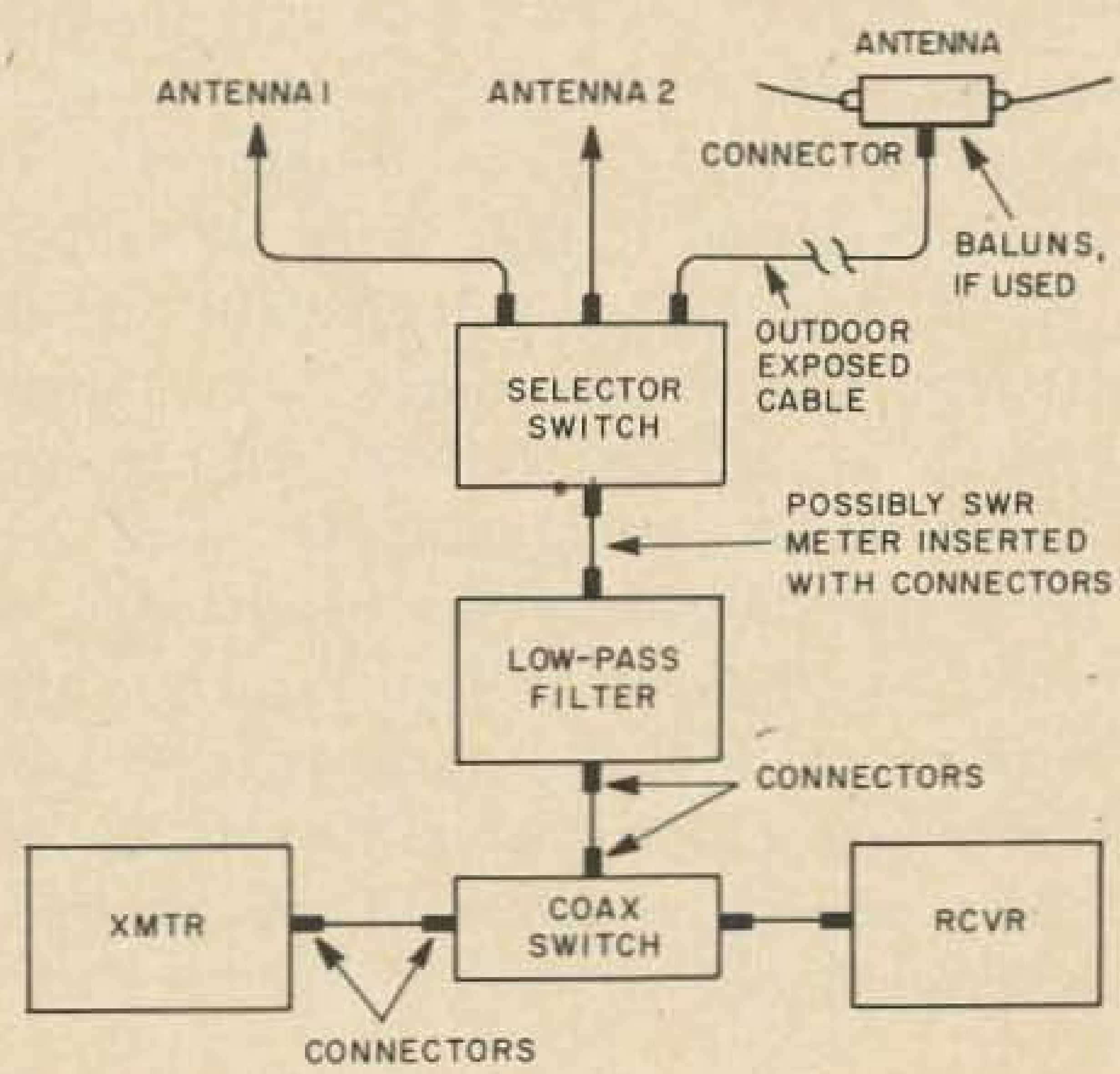


Fig. 1. Actual transmission path in usual installation can involve going through a number of connectors and accessory devices.

antenna system is performing and whether any damage to the system has taken place. On a day-to-day basis, the use of the swr meter for this purpose is probably valid. Ideally, one should also have a method for constantly checking the overall signal *attenuation* throughout the antenna system. It must be remembered that an swr meter, depending upon its method of operation, measures only the impedance ratio or current/voltage phase relationship in a transmission line. Attenuation can build up through cable deterioration, connector losses, leakage resistance, and component deterioration in accessory or switching devices—and this buildup will never be apparent on the swr meter reading. More than one amateur operator (and even quite a few professionals) have read a 1:1 swr at the transmitter and gone happily, but often unsuccessfully, operating when the swr at the antenna was quite high.

To measure attenuation correctly, one should inject a signal of known amplitude in the transmission line system and then measure the output at the terminated end of the system. Such a measurement is generally made when a commercial installation is initially put into operation, and it would be a good idea for amateurs to follow the same practice.

Unfortunately, such measurements are not convenient to make and one hardly wants to be continually faced with the problem of gaining access to the antenna end of the transmission line to connect a signal generator or terminated voltmeter to it. There is no simple in-line form of meter, such as a swr meter, which will check attenuation. The megohmmeter (or "megger" as it is incorrectly but commonly called), however, is commonly used to detect the change in insulation resistance in a transmission line system. Decreasing insulation resistance is a positive sign that leakage resistances and other dissipative effects are developing which can increase the attenuation in the system.

Megohmmeter Usage

The megohmmeter is simply connected between the two terminals of the transmission at the transmitter. The antenna end of the transmission line must not present a closed circle. This is no problem if a dipole antenna is used; nothing must be done; it is simply left connected. If a loop type of antenna is used, one of the two transmission line connections must be broken to effect an open dc loop.

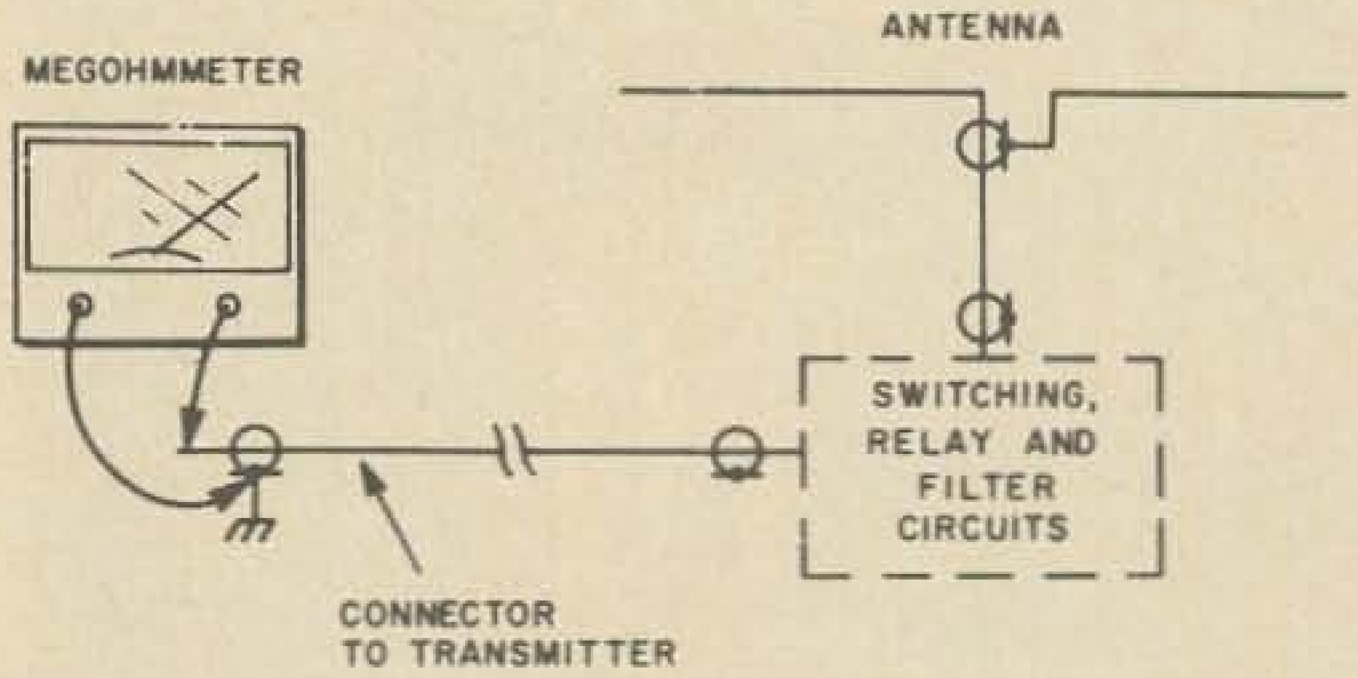


Fig. 2. Megohmmeter check is performed as simply as an ohmmeter check, but its meaning should not be confused with that of a simple ohmmeter check.

At first glance, the procedure used may seem to be that of a simple ohmmeter check (**Fig. 2**), and indeed that would be the case if an ohmmeter were used. The megohmmeter differs from an ohmmeter in several respects, although it is basically also a simple instrument. The maximum resistance range on the usual ohmmeter is a few megohms. The ohmmeter impresses a relatively low voltage across the resistance to be measured (perhaps 1-3V when used to measure a megohm). The megohmmeter, on the other hand, reads resistance ranges higher than 1 GΩ (1 gigohm, or 1000 megohms), and impresses a voltage across the circuit being tested equal to or above the voltage at which the circuit actually operates.

In practice, megohmmeters which place 50-500V across the output terminals are used to test rf transmission lines. Various leakage resistance effects can be present which will not be apparent unless at least such a value of voltage is used. No harm can usually be done using these voltage levels since even small cables such as RG-58/U are rated at 1.9 kV. However, one must also take into consideration the maximum voltage rating of the relays, filters, etc. present in the entire transmission line system. Usually, these voltage ratings will be found to be the limiting factor, although rarely will they not allow the use of up to a 500V megohmmeter.

What insulation resistance or megohmmeter reading should a good transmission line system present? Ideally, one should "megger" a system when it is initially installed and when actual attenuation measurements are made. With a good dry system, insulation resistance readings of at least 100–200 MΩ should be possible. Then, if readings are taken periodically–monthly or whenever some problem is expected–one has a reference reading to compare subsequent readings against. If no attenuation readings are taken, the minimum insulation resistance which should be considered satisfactory is 50–100 MΩ. During wet weather or damp conditions, resistance readings may drop to the low end of this range. However, readings much below 50 MΩ or, especially, a continuing series of decreasing readings which are taken under similar conditions indicate that some component in the transmission line system is going bad or that some connections were poorly made and moisture is entering the line.

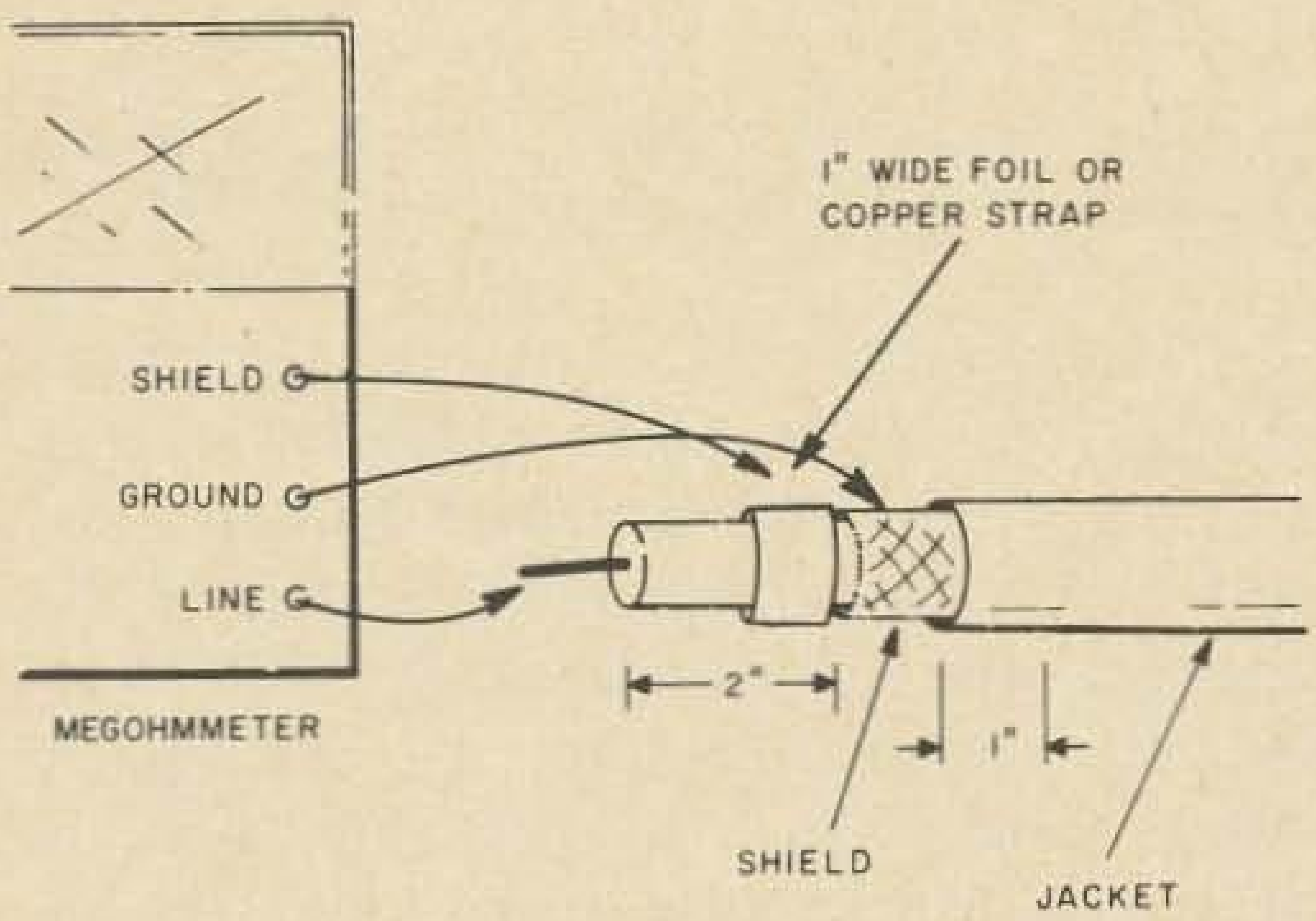


Fig. 3. Megohmmeter connections as set up for accurate insulation resistance measurement on coaxial cable. For most amateur purposes, shield connection is not necessary.

Megohmmeter Construction

A megohmmeter presents a potential of 50-500V across the circuit to be tested, but its internal resistance is in the order of megohms and little current flows in the circuit under test. Aside from this, a megohmmeter operates on the same principle as a regular ohmmeter.

There are both mechanical and electronic megohmmeters. The former type uses a hand crank to turn a dc generator and it incorporates a special differential meter movement. New instruments of this type are somewhat expensive but if one can be found on the surplus market, it would certainly prove to be a complete, self-contained test unit. Three terminals will be found on these instruments, labeled *ground, line,* and *shield,* as shown in **Fig. 3**. Normally, the ground connector is simply joined to the shield of a coaxial cable and the inner conductor of the cable to the "line" terminal. If, however, accurate readings *over* 100 MΩ are desired, a leakage shield must be placed around the cable end as shown. This shield is insulated from both conductors of the cable under test and connected to the *shield* terminal on the megohmmeter. It prevents surface leakage at the end of a cable that influences the taking of accurate readings above 100 MΩ.

Many forms of electronic megohmmeters are available and utilize ordinary meters rather than special differential types. One such megohmmeter, manufactured by Reiner Electronics (which also may be available on the surplus market), type CALN-60089, is schematically shown in Fig. 4. The circuit is relatively simple, the batteries make the unit portable, and the 50V test voltage level is suitable for most amateur needs.

A 67.5V battery supplies the current to the circuit under test into the grid of the amplifier tube. The meter responds to the total cathode current which flows in the tube. Since the tube is operated in a positive grid current region, the meter response to the current flow will follow a logarithmic response. Thus, the following meter readings in microamperes will correspond to the following resistance values: 0 μA to infinity, 3 μA to 10 GΩ, 20 μA to 1 GΩ, 27 μA to 100 MΩ, 50 μA to 10 MΩ, 70 μA to 1 MΩ and 100 μA to 0.0Ω.

Operation is simple: The ground and test terminals are shorted directly together and the *zero adjust* potentiometer is used to set the meter at 100 μA or 0Ω. The switch in series with the battery may be a pushbutton type if desired since the tube is an instant heating type. Other high-gain tubes may also be used but the meter scale will then require recalibration by using resistors of known value. The meter itself may be any conventional 100 μA type or even a similar range on an existing VOM. Some initial difficulty may be found in obtaining the one 500 MΩ resistor called for in the circuit. The resistor can be built up from a series group of lower value units, but ordinarily resistors up to 22 MΩ are available. With some diligence, however, resistors with values of 100-300 MΩ can be found, especially from the larger supply houses. Some suitable types are Aerovox CE500 series, Caddock MG780 series, and Dale MC-2 series.

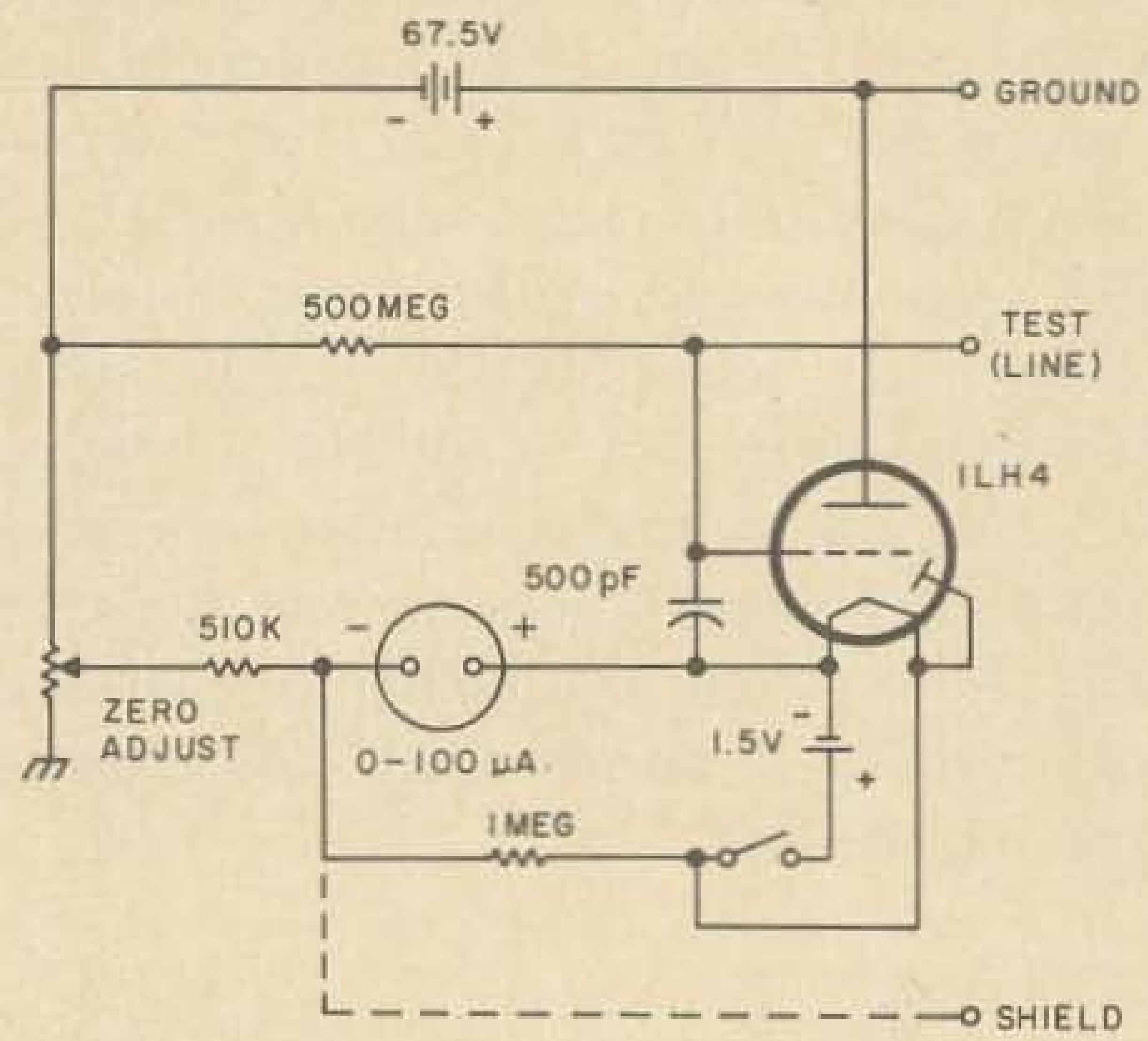
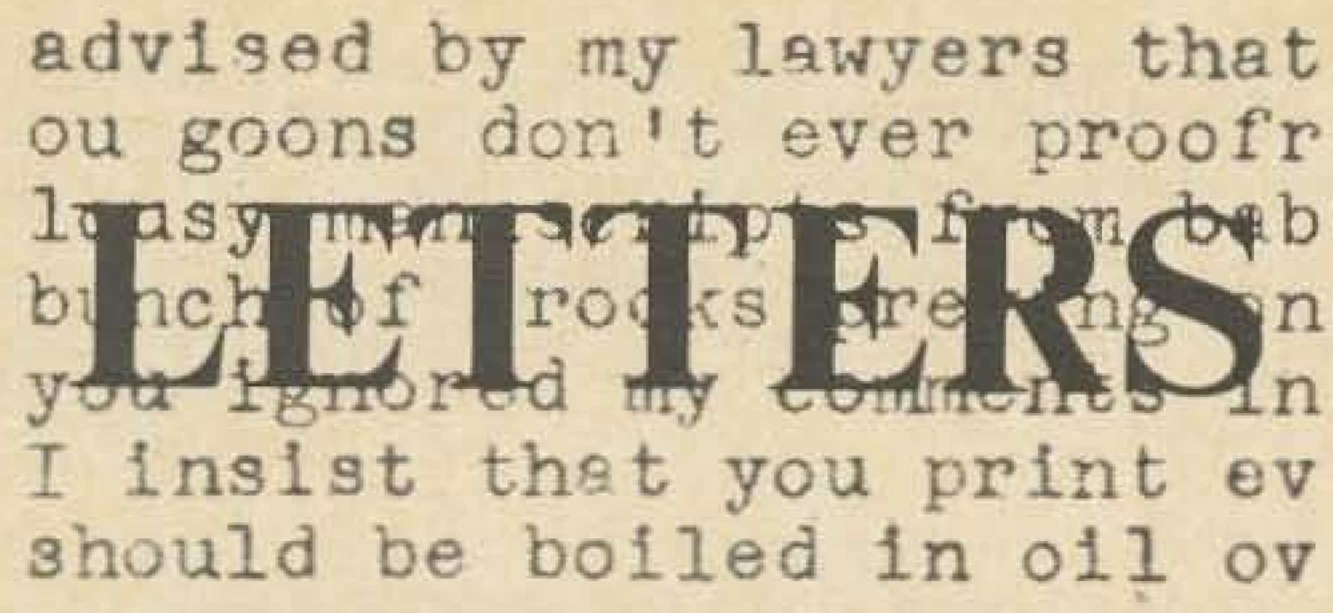


Fig. 4. Schematic of simple portable electronic megohmmeter which will measure up to 1 GΩ.

A *shield* terminal can be brought out, if desired, from the negative meter terminal as shown in **Fig. 4**. As explained before, however, such a connection only has value if one wants accurate readings above 100 MΩ. Generally, relative readings and particularly noting their change as periodic tests are performed will suffice. If the unit is constructed in a metal enclosure, the *test* terminal must be a good quality feedthrough; otherwise its leakage resistance will parallel that of the circuit being tested. A Teflon insulator is preferred.

Lastly, one should never hold the test prods, if such are used, across the circuit tested; they should be clipped on. Not only is this a safety precaution, but body resistance can drastically affect readings when one is performing measurements in the high-megohm range.

. . . W2EEY/1■



Toned Repeaters

I enjoyed the article *Encoding and Decoding in FM Repeaters* in the February issue of 73. In areas with overlapping coverage from one or more repeaters some sort of tone coding certainly would be desirable, but I fear we might end up with incompatible systems if we don't agree on some master tone system soon. What good are repeater crystals without the proper entry tones?

Touchtone is certainly going to become even more of a standard than it is today. Why not use the four tones from the Touchtone high group for tone-burst systems. Anybody traveling from area to area would then need only his Touchtone pad rather than an audio VFO!

For your repeater list the only machine operating in the greater Vancouver area is VE7ACS 146.34 to 146.94.

Darrell Wick WB6MAY/VE7
President B.C. F.M.
Communications Assoc.

There should be standards for Touchtone as well as tone-burst entry. The TBE standards are already reasonably well established. See, for example, "A Look at Amateur FM Standards," by Robert Kelty WB6DJT, 73 Magazine, March 1970.

I have written a letter to Robert Booth, Jr. of ARRL, as follows:

> "Please be advised that I am not a member of the ARRL for specific reasons. Consequently, I wish to specifically point out that any inference that I am represented by the ARRL in petitions to the FCC for rule changes is not in order.
>
> "I believe it would be appropriate for the ARRL to specify the number of LICENSED MEMBERS represented by the ARRL in each petition tendered to the FCC."

This was brought about by the latest idiocy of the ARRL, to open all of the 2 meter band to the Technician, as well as a part of the 10 meter band. What kind of thinking is this? Incentive licensing to upgrade the amateur and now a program to reverse the process and made even the General license of reduced value. Looks like the ARRL circulation has fallen off badly.

Of course I have written to the FCC to this latest ARRL petition, but the way things have been railroaded I suppose it is too late to do anything about it.

I have pointed out to the FCC that petitions presented by ARRL should specify the current number of licensed members represented by them. The number should not include libraries, business corporations, SWL and other clients who do not have an interest in the matter.

William J. LaHiff W2IVT

Death of a Friend

I have a homebrew linear amplifier that runs 3 kV on the plates of the finals. Last night I left the back cabinet door open to make a bias adjustment. What I didn't know was that the contacts on the plate supply relay welded shut. About an hour before I came down to adjust the 80 meter tank, I heard a tremendous commotion downstairs. My father ran down, saw my rig smoking and popping horribly. He ran into the utility room and popped the 220 breaker to the B+ supply. I ran to the linear, looked inside, and saw my cat splattered all over the inside of the cabinet. The whole house was pervaded with a sickening smell for days. That cat looked like she had been napalmed; she was really roasted. It took three hours of nauseating work to clean the rig out. Burnt hair and flesh don't clean off well.

What would have happened if I had grabbed the plate caps working on the rig? A quick word: *Don't* use a toggle switch to control the plate supply! Use interlocks! Use some kind of high voltage indicator!

With several thousand volts, *you don't get a second chance!*

A Sorry W9

Apollo 12 Special Certificate

Here is a copy of the Apollo 12 special certificate which our club station is issuing to all amateur stations contacted during launch day. A total of 1285 QSOs were made on the 80, 40, 20 and 15 meter bands. Seven transmitters were utilized in the CW and SSB modes.

Our club station is located approximately 10 miles south of the Apollo launch pad. This affords us an excellent view of the liftoff. Transmissions from the club station start shortly thereafter. This activity started with the launch of Apollo 7 and we have mailed out thousands of similar certificates. It is the club's way of sharing with other "hams" the events of that day.

Operators at this station consist of NASA, Air Force, and contractor personnel. This station is often activated on weekends and can be found at approximately 21.340 MHz.

Roy J. Durso K4DJN/W2KTG
Box 21073
Kennedy Space Center FL

Advanced Class Course

I want to add my thanks to you for the excellent series of articles you have had in the past two years on advanced radio theory. I got started in ham radio as a Novice with my high-school age son in January 1967. In December 1968, having studied your articles, I made the Advanced. Last December I passed the Extra.

With your articles, anyone can pass the theory for these higher class licenses. They not only will get a better (?) license, but they will know theory that they can apply in the fascinating aspect of building and repairing ham gear.

In addition to using your articles for the license exams, I have used them as a basic text for the course in advanced theory I have been teaching for our radio club.

The higher code speed came easy through my activity in the Army MARS program. Once again, thanks!

Bob Malmquist WA9TTS
605 Vine Street
Morris IL

The Truth Hurts

Once again 73 magazine has set a new standard for an amateur oriented magazine: truth in advertising!!! I refer to the "30 Back Issue Bonanza." When you said the issues were packed in sloppy bundles, you certainly weren't fooling! I got my bundle today, the box was split down the seams, and wrapped in old bailing wire. The box (?) was also marked "Received Damaged–Kansas City, Mo." I have received numerous packages that have been promised to arrive in good condition and haven't–but this is the first time I have been told to expect a bundle in bad condition. 73, I salute you for truth in advertising! By the way, I think the mags. are great. They're worth their weight in gold!

Russ Williams WA6MWY
1312 Lawrence St.
El Cerrito CA

A Political Approach

Have you listened to the 7200–7300 kHz area of the forty meter band lately at about 0300 or 0400Z, especially on a weekend? It has become an international shortwave broadcast band at times in the evening hours.

Allow me to introduce myself. I'm one of those terrible young whippersnappers who think they know everything. Seriously, I'm 16 years old and fed up with that mess on the upper end of the 7 MHz band. It has fewer and fewer amateurs and more and more broadcasters almost every week, which is no way to run an airline, or to convince the next ITU conference on allocations that we really need those frequencies either.

It is rapidly becoming apparent that the ARRL Intruder Watch, while it proved that these schnooks were beaming at the U.S. and lying through their collective teeth when they said they weren't, did next to or absolutely nothing towards convincing officials to do anything about it. Doubtless most officials have forgotten about it (albeit with effort) to take some decisive action towards getting a few bureaucratic types to stand up and maybe even do something, for the first time in their lives. Decisive action must be taken if we are to be able to really use this part of the forty meter band.

Political action has more effect on government-involved people (including FCC and the international organization known as International Telegraphy Union) than any other kind. And of the most effective of political action is to indulge in the freedom of the individual in this country, which, if I may add, happens to be the best on this earth, bar none. This method is simply *writing*. If every other amateur in the country wrote ITU and FCC, each would receive about 150,000 letters. Imagine the impact of that! Or write Barry Goldwater. He would appreciate the situation, being a ham.

But a massive write-in program needs publicity. So, why don't 73, CQ, Ham Radio, and QST publicize it? No reason against it at all. In fact, Mr. Green, if you used "de W2NSD" and Mr. Huntoon used his editorial column, a great deal of publicity could be obtained, as both columns are controversial and tend to be widely read.

An all-out effort by all these magazines providing a united front of amateur radio to the world, and a vast write-in campaign such as I suggested would lend quite a bit to the appearance of amateur radio in the world. It certainly would promote a lot more respect of amateur radio. And isn't it simply for a lack of respect for the amateur bands that these broadcasters can do this?

Mark Hinton WA3IVW
2404 Stratton Drive
Rockville MD

CB vs Hams

As I'm writing this letter, several people are out in the damp, foggy night and are hunting for a three year old boy. It is 1:30 a.m. The child has been missing since 4 p.m. yesterday. The following is an actual account of what happened only a few hours ago.

As you can see from this letterhead, I attend Lehigh University in Bethlehem, Pa. I was studying calculus (we all don't get drunk on Saturday night) when one of my schoolmates knocked on my door and asked me if I knew where the Lehigh Valley Shopping Center is. He told me that a three-year-old had been lost there, and he and another fellow were going to see if they could be of any assistance to the search party. I volunteered to go with them.

Since we were all strangers in town, we had to call the police to determine where the shopping center is (we all don't hate cops, either). It turned out to be four miles away, and since we couldn't find anyone with a car, we decided to walk.

After about an hour and a half, we reached the shopping center. The first thing I noticed was the abundance of CBers. The CB–ham rivalry never actually hit me because I was concerned with the child's being lost.

The police had just finished searching the department store the child was last seen in and they gave out the general areas to be searched. Our group took one area and we combed several square blocks. About 1 o'clock the walking search was given up. All the area within a 1½ mile radius of the shopping center was searched with no luck, so the search was to be resumed at dawn.

Since it was past one in the morning, and we had a four-mile walk back to the dorm, we bummed a ride with someone high up in the CAP. While riding back, the CAP official made use of his radio, a converted CB rig.

I can't help thinking that if there had been better organization, the child would have been found. There was no radio communication with the majority of walking groups. The CAP seemed to have the most effective communications. The only other groups were the police and CB. If someone could have coordinated these different services there would have been a good chance of finding the child.

By now you are probably wondering what role ham radio played in this. As far as I can tell, there were no hams present. What good does all that operating skill do with no hams there to use it? The ham magazines print plenty of stories telling how hams help in emergencies. What about his instance?

What I am proposing is two different types of emergency nets. The first is a long distance net on or near 20 meters (I say near because the FCC might give us a few channels above 14.5 MHz if we can prove we have an effective emergency system). The second would be a local net in the 10 meter band. This net would provide mobile and most especially portable equipment, which is converted CB equipment. Let's face it, ham radio is lacking in the portable equipment area.

Both nets would incorporate tone signal alert type equipment. Both systems would use crystal control or at least be fixed. The clincher; the frequencies would be kept clear at all times (now you know why I said *near* 20 meters).

I'm not proposing these measures for the betterment of amateur radio—I'm merely stating that I think it should come up to what is morally obligated to do, and then worry about contests, ragchewing, DX and all the fun.

Anthony A. Parise WA3HRL

VHF FM appears to be solving the problems you mention. It has three things going for it: availability of equipment, portability of equipment, and fully channelized operation.—Ed.

Credits

In your February editorial you stated that the Department of Communications used the Buffalo petition as a foundation for Canadian repeater regulations. This is not true, and you gave Buffalo all the credit, completely ignoring the fact that it was the Toronto FM Communications Association, especially Paul Hudson, VE3CWA, who drew up a brief, using some of the information in the Buffalo petition, and submitted it through the Radio Society of Ontario and the Canadian Amateur Radio Federation to the D.O.C. in the spring of 1969.

To back up my statements, I have enclosed a reprint from the November 1969 issue of the Ontario Amateur, which is the publication of the R.S.O.

I hope that your statements will be corrected in the next editorial.

Jim McCullough VE3CSO
Treas., Toronto FM
Communications Assoc.

Neglecting the contributions of the Toronto group — and particularly the efforts of Paul Hudson — was my error. I knew that Paul had formulated the original petition, but I also knew that he did it in conjunction with Gil Boelke, and the work was based on the already-submitted Buffalo petition. Just so you will know my position, Paul Hudson is one of my dearest friends, and he is the one who informed me of the petition's formulation, as far back as January of 1969. He spent a few days with my family in California at the time and gave me a complete rundown on what was happening in Canada. (See **Mr. Virgo Himself**, *this issue.)*

Servicing SSB

Re Boos and Hisses (February 73): I am glad to see you print the pros and cons of the issue.

As one who has been a ham for years but due to lack of time, money and energy trying to keep up with a trade and raise a family, I was not able to keep up with the state of the art in ham radio as I would like to have done (namely single sideband).

W4NVK's article in December 73 and WA8ASQ's letter are thought-provoking to say the least and will make the study of this stick in my mind better than anything else could.

I think WA8ASQ was entitled to the $35 charge to fix this man's equipment, since he has the ability to do the job and spent his hard earned money for all those goodies of test equipment. After all, maybe some of these fellows who can't fix their own gear are experts in some other field, and when WA8ASQ calls for their services, things will swap back.

Orville Gulseth W5PGG
1435 King St.
Clarksdale MS

English Spoken, American Understood

In 73s new feature "DX Corner", K2AGZ, said that German, Czech or Russian Amateurs speak such good English, and comments that American Amateurs sometimes speak poor English, and finds this "downright humiliating".

To a Englishman this is a somewhat surprising statement, not that he has not observed this phenomenon, but rather that the British always imagined that the differences between the language spoken in the United Kingdom and that spoken by some Americans was deliberate on the part of the Americans. A deliberate gesture of independence, a deliberate decision to speak differently from the British, and this does not refer to accent, but to the use of words.

This deliberate difference shows in several ways if you listen on the air. There are those who are deliberately so careless, or appear to wish to give the impression of a slovenliness in their speech which makes one feel that they are saying "we aren't going to take the trouble to stick to all the silly rules that an old-fashioned grammar once laid down. We are going to speak just as the words come into our mouths and be modern."

This is particularly noticeable in the use of the adjective where an Englishman would automatically use the adverb. "Your antenna is working real good" whereas the Englishman would say – "Your antenna is working really well". The use of "good" whereas we should use "well" is a typical example.

But another and much more interesting school of thought uses additional words which the British omit. Thus an American "visits with a friend" whereas an Englishman "visits a friend."

To an Englishman the verb "to visit" is a transitive verb which is followed immediately by the object. It can also be an intransitive verb. But why complicate the issue? Since it is transitive we just "visit people" and see no need to add the extra word "with".

If an Englishman visited George yesterday, he would say "I visited George yesterday". The insertion of the word "with" would only be used if he were accompanied by someone else. Thus – "I visited George yesterday". "Were you alone?". "No, I visited him with Mary", meaning that he and Mary visited George yesterday.

Another example is the expression "For free". If an Englishman finds he can get something without paying for it, he says he "got it free". The American finds it necessary to add the word "for" before free and he says "I got it for free"

Originally, one imagines the addition of the word "for" was a joke, intended to lead the listener to expect a price after the word "for". Thus the listener could expect "I got it for five dollars", and he is suddenly surprised to find that no price follows the word "for". But what may have begun as a joke or a method of emphasis has by now become part of the language.

What is perhaps surprising is that the American language frequently adds extra words. Surprising because the Americans pride themselves on a slick and snappy language. There is the occasional short snappy phrase such as "at" at the end of a transmission instead of "over" – one syllable instead of two. But, in general, the American language becomes longer. What to an Englishman is a "Lift" is an "Elevator to an American. What to an Englishman was a "tram", was a "trolley-car" to an American.

Another and, of course, well known phenomenon is the use in America of words and phrases which were used in England several centuries ago but have died out in England. They are still in common usage in America and are then often re-adopted several centuries later again in England. The classic example is, of course, the Englishman says – I've got a cold". The American often says – "I've gotten a cold". "Gotten" was current usage in England in the 17th centufy, but it has died out now. The American may even say – "I've gotten me a cold", adding the extra word as in "visiting with" or "for free"

Edgar Wagner G3BID
London, England

Ban the Book

I have been receiving 73 for several years and generally appreciate the articles. I know that you are always interested in reader opinion, so I am sending this belated note to give my reactions to an article you carried last fall. Due to my schedule, I was only able to jot a note to myself to write when I have time.

In the October 1969 issue of 73, on page 34, you have an article written by Robert Manning, K1YSD. I believe this person writes some technical articles quite frequently. This article, "Vidiots That Have Known Me." was quite shocking in its vulgar language and its general low caliber of thought. I feel that it was entirely out of place in your otherwise fine magazine.

I am not the type to hastily drop my subscription, but I would request that you please exercise more care in the selection of manuscripts in the future. I realize that humorous stories liven up a technical magazine, and I appreciate them, but please, let's keep it clean and above the belt. Thanks.

Jim Wagner
Brecksville OH

RM-1429

How about spreading the word about my proposed rulemaking RM-1429 before the FCC which, in essence, asks for authorization to use F4 (FM Facsimile) emission on the 2 meter band. I understand that the proposal is still under consideration by the FCC (at least the FCC hasn't denied it yet). Any and all interested parties should write to the FCC using acceptable FCC form, i.e. 8½ x 11 plain paper, typed double spaced, 1½" left hand margin, 1 original and 14 copies, etc., and offer their comments. In this way, I feel, sufficient interest shown by the amateur population will help stir the Commission to act on the proposal.

Jim Turrin WA8DCE/NØPCF
PO Box 245
New Philadelphia OH

The Buck

Having two days ago jumped from Tech to Advanced I decided it apropos to subscribe to a ham mag, and being familiar with the dynamic duo (Ken and Mike), I bought a copy of 73 (although I was floored by the $1 price). I have found it not only interesting and educational, but the projects are all of the type the "modern" ham would enjoy; what more can one ask for – ICs, FM, apartment dweller antennas, and an RTTY article far surpassing any I have read previously.

Congratulations to Dave Mann and his "Leaky Lines." The article was superb. Among other things, the ARRL has had their comeuppance coming for a long time.

Thus enclosed is a check for $12 for a three-year subscription. I have to get back and finish reading the issue. A very deserving "well done" to you all!

Stephen W. Gundlach WA3DJH
State College PA

I would like to say first of all that I have found 73 mag at the top of the list. But that's not what I'm writing about. I have had my Novice ticket for six months and am planning to get my General soon; and to tell you the truth, I can't wait to get out of the Novice bands. Ham radio is supposed to be the hobby of friendship. Well, not in the Novice bands. On 40 meters you get chewed alive by higher powered rigs of General and Advanced class ops. On 15 meters the chances of being chewed alive are a lot less, but what about those Novices who leech off you. I mean Novice ops that have other rocks but would rather try to get that weak piece of DX from you, rather than move to another rock or stand by.

If ham radio is to be the hobby of friendship, why not show it.

Robert S. Damrou WN1LOT
Clinton CT

You can tell the guys who have a hard time reading code, like for instance HC2RP. If those fellows spent the same amount of time studying the code as they do thinking up excuses on why we don't need it, they would have it down pat in no time at all. I am sure HC2RP would be copying CW and enjoying it if he took the same time and effort learning the code as he spent composing that almost one page letter. Mr. Romo, I am no genius, but I learned the code almost 50 years ago and I still enjoy pounding brass. Incidentally, I also work SSB and enjoy it also. Cheer up, Edgar, knuckle down and practice and you could be copying CW along with the best.

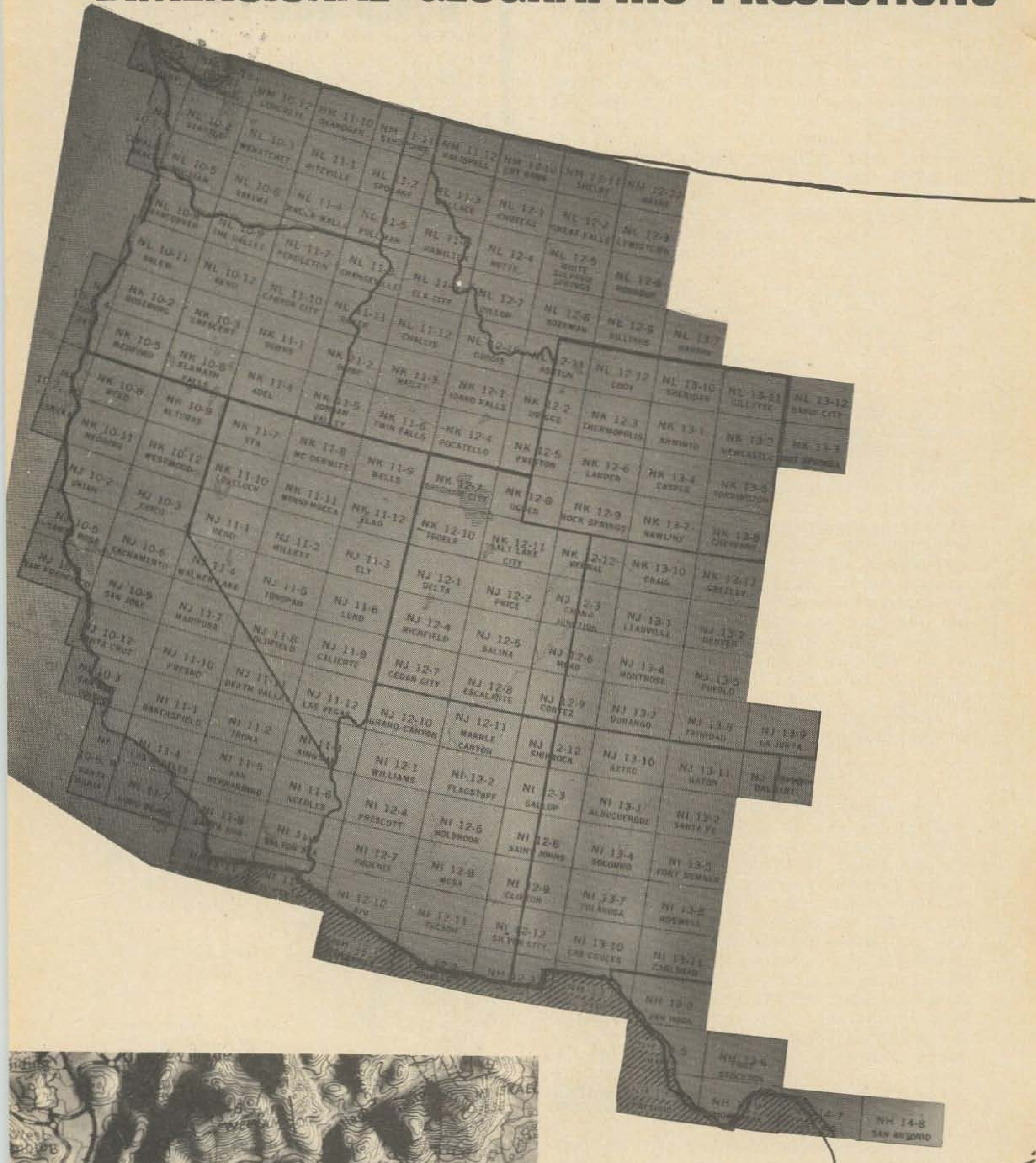
T.E. Burmeister W8BSS
Cleveland OH

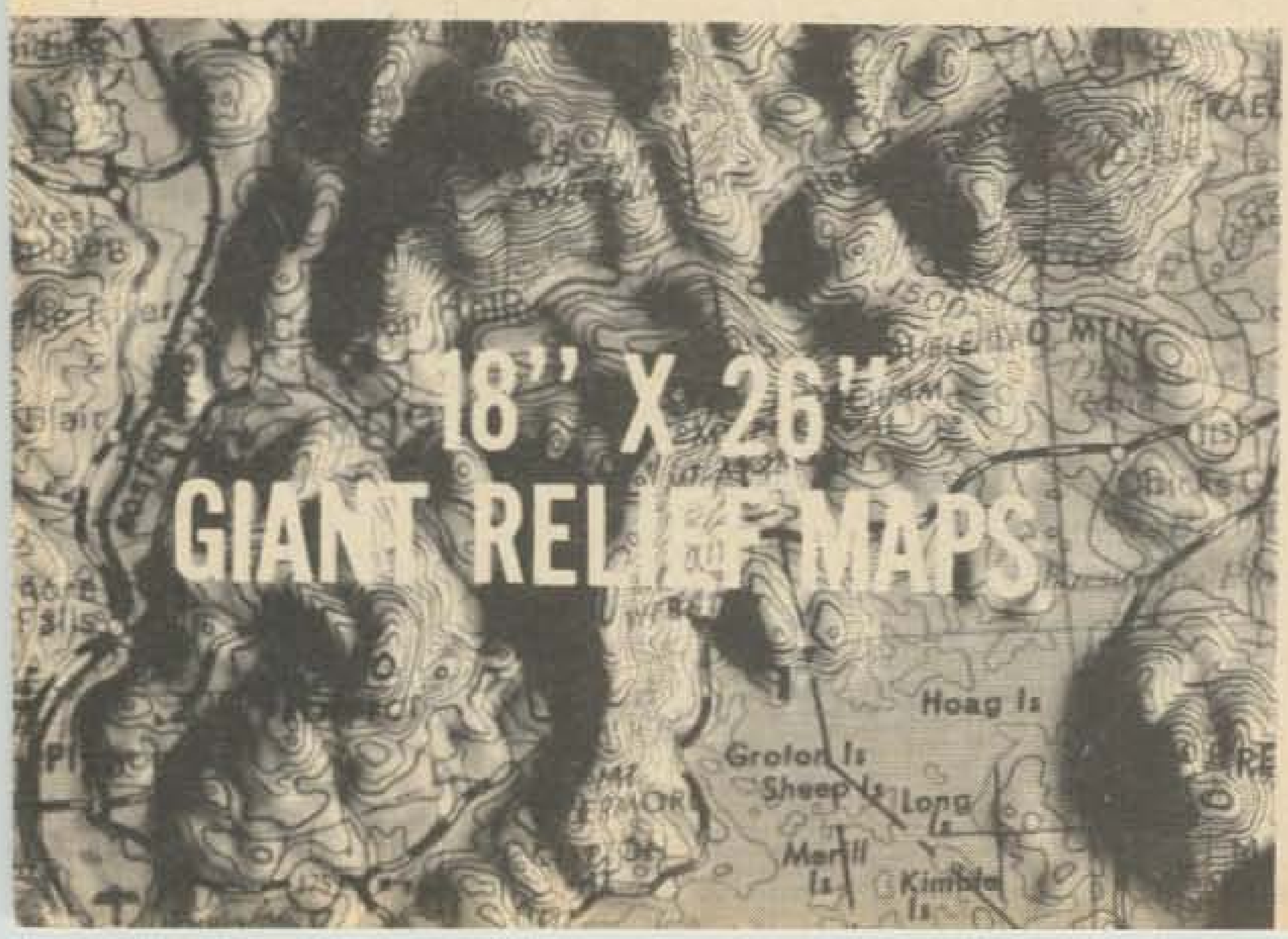
If Jefferson and his peers had spent the same amount of time paying taxes to England as they did thinking up excuses on why we didn't need it, we'd still have a queen.

Thanks for a really fine ham magazine.

Looking through January edition which just arrived here, I find an editor's note referring to Radio Amateur's FM Repeater Handbook." Checking with the biggest local booksellers I found that they will not obtain a copy for me.

DIMENSIONAL GEOGRAPHIC PROJECTIONS





I would appreciate more information regarding the cost and address of the publisher, so that I can send for a copy direct.

For information, here in VK4 there is quite a good deal of activity on 2 meters FM, in keeping with the rest of VK.

For simplex work three national channels are 146.146 MHz, 146.00 MHz, 145.854 MHz.

There are also agreements on frequencies to be allocated to repeaters.

ch 1	146.1 in	145.6 out
2	146.2 in	145.7 out
3	146.3 in	145.8 out
4	146.4 in	145.9 out

The equipment in use is predominantly surplus gear from the commercial mobile bands 148–174 MHz and 72–85 MHz.

John Edwards VK4IE
Queensland Australia

FM Repeater Handbook available from Editors and Engineers, Ltd., New Augusta, Indiana 46268. Price is $6.95 ppd.

Author Talkback

This reply will try to straighten out much of the misconception WA8ASQ read into the Carrier Suppression article on Pg 22, Dec issue, as obvious from his comments in "Boos & Hisses" letter, Pg 12, Feb issue.

First, I find it most interesting that this repairman makes his bucks fixing amateur gear. The fact that he charged a fellow ham 35 bucks to adjust his carrier suppression to a below 40 dB level tells me a lot more about the kind of operation he must run than does his whole letter, which reveals an awful lot. For analogy, the $35 represents at least 10% of the new cost of a transceiver. For analogy, this simple procedure is about as difficult as adjusting the headlight aiming of an auto. Can you visualize a bill for 10% of the car value, $3000 for aiming the headlights? While I can't claim such prodigious credentials as "repairman," I am a registered electronic engineer that did design some of the latest tactical communications systems for Vietnam, so maybe we can talk OK.

Seriously, though, most anyone can tinker a set into tremendous carrier suppression on the bench. My article didn't say this couldn't be done; it said that a very good set will *consistently* have carrier suppression of only about 40 dB. Take one of his tinkered specials into an environmental chamber, vary temperature, voltage, and bang it about some, and see where his carefully nurtured 60 dB ends up. Or, just let the rig cycle in a typical ham shack for a few months; same end result.

The comments about final bias and carrier leakage are a severe case of not reading what is written. Please reread the actual article, with bias filters removed OM.

The $2 mike mentioned works as claimed. I suffer no problems of receiver alignment as I used a rather elaborate audio frequency spectrum analyzer to show the actual spectrum coming out of the transmitter with expensive mikes and others, to find there is no discernible difference, in fact, after passage through a 2 kHz SSB filter. What I said may make a guy that peddles expensive mikes to unwitting SSB set owners unhappy, but facts seldom make merchants happy.

The article makes no claim that 200 PEP is equal to 100 CW, although this interpretation by the critic is not so farfetched as his other comments. My apologies for condensing the writing so much that this lumping occurred to insinuate these two are equal. Actually PEP has no real universally accepted meaning except when using a two-tone test and as a rating on equipment. Even then it means little since the distortion limits on ham gear are never mentioned. Raise the distortion limits you are willing to permit, and you can raise the PEP rating of any rig. However, since Mr. Kirsch is interested in edification, let me proceed. I have a linear that deliberately uses very unregulated voltage on the plates to give a form of audio compression. The absolute maximum the power supply puts out on CW is 900 watts input. However, on voice peaks, it puts out well over 2000 PEP, and this sounds fine because the collapse rate of the input DC voltage is about the same as the rate of compression allowable in successful audio compressors. This of course is a design of my own, which takes advantage of the characteristics of voice waveform compared to sine waves.

I'm sorry that my factual and practical article may steer some Novice hams away from Mr. Kirsch's $4000 repair bench, but that's life. I can understand his position, but that doesn't make me forgive him. Incidentally, a single spectrum analyzer adequate to measure SSB spectrums costs about $5000, so his bench does not awe me. I'll pass, but say that any ham that worries over a carrier suppression that is only 40 dB down is either a Novice or he's playing around, and has little better to occupy his time.

E. Dusina W4NVK

On QRM and Passing Exams

Frequently I cannot agree with some of your "advanced" thinking; but I am only an ordinary person. However, your excellent suggestion to use some brain power and go "where the QRM isn't" seems like excellent common sense. Like any brilliant idea, it makes the rest of us wonder why we didn't think of that instead of just growling at the ills of the ham world.

Your magazine's excellent articles on taking the higher class license, case history and cure for common TVI and audio TVI help ham radio. If only the growlers would put their energies to building themselves up rather than howling at the moon, how much faster we hams would progress in all phases. I was always zero in math and had nothing to do with electronics but when the rules of the game were changed I studied, boned up on the CW, and got the Extra. CW may be a "dead science" but it is a good mental discipline and test which any serious ham can pass. In fact, it is about the only practical "barrier" to the Memory Experts who know nothing about ham radio but memorize the Q and A, pass the nominal CW speed, buy a packaged station, and get on the air as legalized "diddlers." For those who feel the ham rules are unfair, there is always CB or tiddledy winks.

Keep throwing "out the sparks" even tho we may throw water at you!

K.A. Fichthorn W1FK
Southington CT

In the February 1970 issue, page 10-Letters-TVI Case-Daniel G. Willis, SSgt. USAF wrote an inquiring letter about Grid W4GJO's TVI suit. There are without any doubt many hams and others interested in the status of this most interesting case. Your answer was brief and incomplete. Do you know how this case stands at present? Your issue was scanned but no other article was found referring to this case.

The case has been dropped, but Grid is holding the bag for a good many hundreds of dollars due to the lawyers for preparative information to defend him. This kind of a lawsuit could be filed against any of us with the present condition of the laws.

Grid needs or could use the help of all those interested; first, to balance the present account, and second, to build up a condition where others will be protected from some crank.

We heard a pretty complete report by Grid at the Sarasota Amateur Radio Association meeting on January 20th. Grid will accept any contributions from individuals, publications, and manufacturers. The amount received over that necessary to pay the lawyers will be placed in escrow to cover expenses for their future plans.

This much information should be published and any further information can be furnished by Grid himself. His address is The Ham Shack, 1966 Hillview St., Sarasota, Florida 33579.

A. Howard Ettinger WN4NJJ
Sarasota FL

Thanks for keeping us posted. 73 wants to know all the details of all such lawsuits. The more they're publicized, the easier help will be to come by.

Just finished reading the February issue of 73 for the umteenth time and I must say you sure can put a lot of printed material in such a small magazine. I am in the hospital and have all the time to read that I want and I have learned a lot.

I would like to state my thoughts on the incentive licensing. I am not in favor of it at all. There are many operators who are physically handicapped as I am and amateur radio is a grand hobby to be interested in to help one relax. Due to my physical condition I am unable to go and take an examination for a higher class of a license. I don't think it is fair to take so much away from those of us who are unable to get a better license. I have listened on all the bands and there is a clear shot without QRM on those "special people" bands and where us ordinary folk get crowded in together and have a rough time. ~~Dayton~~ OH

Samuel F. Warnock K8NLM
Dayton OH

Re: Jan. 1970 Issue

After reading "Fascinating Fundamentals: Volta and His Piles" (ZAP), I am naturally looking forward to your next article which, surely, will be entitled "How to make your own Atomic Bomb – right in your own back-yard." (ZAP!)

I am sure that if your science editor had reviewed the ms before passing it, he would have made two recommendations: (1) Be sure that your friendly gas man sells you a battery mixture and not a jar filled with sulfuric acid and (2) he would have recommended the purchase of hydrometer (which the friendly gas man also sells).

I think also that your science editor should have inserted the following precautionary note: The author mentions both "a battery-mix" and sulfuric acid in the same breath. He undoubtedly means a diluted solution of distilled water and the acid which can be checked as to its specific gravity with the hydrometer, which should read: 1.84 for a proper mixture. Also: Concentrated sulfuric acid should be mixed with water by pouring the acids *slowly into the water.* Never pour the water into the concentrated acid as a large quantity of heat will be liberated. The acid may thus splatter and be dangerous. Please remember this when you issue the article on the making of the bomb; Some simple precautions must also be taken because the bomb could also splatter and become dangerous.

D. Alexander

Probably the only reason our science editor didn't take care of all these details is because we ain't got no science editor.

Rape of Frequencies

I have always been in line with your thinking, but your latest promulgation (do away with all sub-bands) I consider preposterous! You're the guy that supposedly rebels at the mere mention of being *forced* to do something, and then you come forth with this. I would rather imagine the appliance operators would be real pleased! You speak as though all hams are situated as yourself—with all kinds of ultramodern, very expensive equipment, which perhaps can cope with a chaotic condition. But think of the ordinary ham with ordinary equipment. Where does it leave him, were this to come about? Strikes me you're advocating a wrong course. I never see anything advocated in getting whole segments of unused frequencies occupied. Appears to me that Johnny Q. Ham is an ornery critter, squawking very vociferously only after something drastic happens. I never hear anything above the first hundred kHz on 10 or 20 cw, and the top 3 MHz on 6 are pretty barren. And the rape of 40 meters is pretty disgusting. Back in the 5 meter days I had a rig on approx. 59.8 MHz because everyone seemed to hug 56 MHz. I had no trouble making contacts. How many rigs will be found on, say, 53.8 MHz? CW on 2 way up on the tip is just a joke (another example of brainy planning?). Let's not compound a bad situation.

Iver Paulsen W1OL
Woburn MA

If you look again at 6, you'll find considerable activity above 52 MHz. 52.525, 53.68, and others have become national FM channels.—Ed.

The Toilet Float Revisited

I enjoyed W3KNG's article "The 20 meter DX copper ball antenna" on page 40 of the January 1970 issue.

I have found the answer to his toilet float problem and also, by the way, solved many others at the same time.

The people that copper plate baby shoes can copper plate the new plastic floats. Of course, when you buy the plastic float you must ask for a low-loss type (perhaps Teflon?). If the 32 ft counterpoise is replaced with a mobile whip with a 40 meter resonator on it, it will still be an electrical 32 ft but much more convenient in size. Finally, if the entire shebang is water-proofed with plastic sandwich wrap, everything can be left in its normal place, which doesn't disable the facilities.

This takes care of people with a General or higher class license, but what about us poor Novices? I'm an 80 meter man myself, I was thinking about having the baby shoe people copper plate the entire toilet but my folks are becoming very down on amateur radio. Perhaps with your greater facilities you could carry the ball (no pun) and develop this idea to its full potential. Maybe you could develop a band–switching version of this antenna.

Clifford Major WN2KDO
599 Foch Boulevard
Williston Park NJ

Massive write-in campaigns have been flops in the past in every instance that I can remember. About the only event that has brought out the vote, so to speak, was the incentive licensing proposal, and that mass of letters was entirely ignored by the FCC.

There are things that can be done to help get that mass of QRM off 40m, and I have written of them in my past editorials. Since deliberate interference to the offending broadcast stations is illegal, it is difficult to come out strongly in favor of this in an editorial. This might have an effect. A more likely attack on the problem would be through the tourist department. If the American amateurs started writing to the heads of tourism of the governments jamming our 40m phone band we might have a chance of some favorable action. We could then get friends and neighbors to send letters, write about it in the papers, talk about it over the broadcast stations, etc. This could carry a lot of weight. Copies of the news clippings and copies of the letters should be sent to the officials of the airlines serving the countries...or their national airlines, if they come here.

This may sound like a lot, but one single person could organize it, if he decided to take the matter into his own hands.

I am sure that we could come up with a lot more good ideas which would put pressure on the SWBC stations.

Please let me know what you hear from Huntoon. I would love to be pleasantly surprised by a favorable reply from him to your suggestion. I do not expect to be surprised.

. . . Wayne

SCOOP!

Watch for Linear Systems' all-new SB-35 transceiver, to be unveiled at the Harrison Show this month. Diane Shaw, 73 Advertising Manager, got a "sneak preview" of the transceiver recently when David Bradley gave her a tour of Linear Systems' Watsonville, Calif. facilities.

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

END CARD PROBLEMS Frame, protect, store or display 200 QSL's in 20 card plastic holders for $3.00, prepaid and guaranteed. Tepabco, Box 198, Gallatin, Tennesee.

SB–300 just reconditioned–$200; T-60–$25; Eico 722 VFO–$25; D-104 with G stand–$25; Lightin' Bug–$15; Gotham V-80 vertical with roof stand–$12; Instructograph with tapes–$25. Chris Bagby, 792 Techwood Drive, Atlanta GA 30313.

SWAN 250 AND SW117-C power supply. Shure 444T mike, S.W.R. bridge, Squale, coax. All excellent condition, never mobile. $275. f.o.b. Chicago. Tim Sullivan, 8757 W. 85th St. Justice, Illinois 60458. 312-594-6180.

TECH MANUALS TS-173/UR, TS-323/UR, TS-175/U, SP-600-JX, $5.50 each; R-390/URR, R-390A/URR, OS-8C/U, R-274/FRR, $6.50 each. Many others. List 20¢ S. Consalvo, 4905 Roanne Drive, Washington DC 20021.

10 COMPUTER GRADE ELECTROLITICS $6.50 postpaid values on hand 1000 mfd 150VDC, 1250 at 180, 3000 at 40, 500 at 200 and 250 at 350. **8 assorted PC Boards** $2.25 postpaid. Lots of Diodes, Transistors etc. **1 455 KC IF Transformer or 1 LCU-3B Filter** Part for BC-603 or 683 Receiver) $1.25 postpaid. James T. Crawford, 712 E. Park Ave., Charlotte NC 28203. Check W/Order.

DTL INTEGRATED CIRCUITS new-guaranteed gates 90¢, buffers 95¢, f/f $1.05, dual f/f $1.50. Add 20¢ postage. xistor heatsinks-low prices. Complete lists available. Mitch-lan Electronics Co. Box 4822 Panorama City, Calif. 91402.

HW100/SB101 OWNERS New solid state preamp module boosts mike gain for more effective ALC $3.95ppd, 25kHz frequency divider module $5.95ppd. Reiss, RFD 1, Storrs CT. 06268.

ROCHESTER, N.Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, N.Y. 14603 for program and information.

DOW KEY #60, 12 vdc, new, $10. TR-108, $85. DX 60, $35. V-44, $10. WA9BYR, 627 Dundee Ave., Barrington IL 60010.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland CA 94610.

NOVICE CRYSTALS: 40-15M $1.33, 80M $1.83. Free Flyer. Nat Stinnette Electronics, Umatilla FL 32784.

GET YOUR "FIRST!" Memorize, study—"1970 Tests-Answers" for FCC First Class License. plus-"Self-Study Ability Test," Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd PA 19004.

SUPER GAIN (R) ANTENNA much gain, makes exciter sound like linear. See pgs 8 & 144, Oct.73. GUERILLA (R) high efficiency ant. See pgs 57 & 113. June 73.

"TOWER HEADQUARTERS!" 11 brands! Heights aluminum 35% off! Strato crank-ups, low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog—$.20 postage. Brownville Sales Co., Stanley WI 54768.

GREENE. . .center dipole insulator with. . .or without balun. . .see 73, November '69, page 107.

5 x 8" PC BOARD, 1542 labeled solder points, Twin-tracks, 39 Rows, 3 Power loops, YOURS, Postpaid. $2.95 with order No.1-2-1000. Bert Adams Enterprises P.O. Box 101 Miami FL 33152.

INDIANA'S MOST PROGRESSIVE HAMFEST Sunday, May 24, rain or shine. Sponsored by Wabash Co. Amateur Radio Club. Write Bob Mitting, 700 Centennial, Wabash IN 46992.

SALE: Clegg Zeus $300 and interceptor $325; Drake TR4 with power supply $500 and R4B $325; Olson "6" with Lafayette 6 & 2 VFO $100. All mint condition, factory manuals and cartons. Any reasonable offer considered. Barney Scholl, 1655 Kimberly Road, Sharon PA (412-342-4462).

AUCTION, NORTH JERSEY really different; new equipment booths, prizes; food and drink and bargains galore. Sunday afternoon (April 19) from 1 p.m. til dark, at the Arbor Inn, Rock Ave. and 7th, Piscataway NJ. Easy to reach from Rt.

22 turn south on Rock Ave. 1½ miles; sponsored by Tri-Country Radio Club.

RAGS hamfest Syracuse, New York, April 11, 1970 at Song Mountain. Box 88, Liverpool NY 13088.

WANTED: Used Drake TR-4, blanker preferred, AC-4 and DC-4. Perfect operating condition wanted. State price. W1FTE Skip Colton, 222 North St. Windsor Locks CT 06096.

TWO REMINGTON SYNCHRO TAPE MACHINES for sale. Price for both $240, plus shipping. No instruction manuals. R.Lee K4BAP, 660 Poinsettia Ave.,Titusville FL 32780.

WIRELESS SHOP—new and reconditioned equipment. Write, call or stop for free estimate. 1305 Tennessee St., Vallejo CA 94590 (707-643-2797).

FOR SALE Drake 2B, 2BQ, 2AC, All crystals, mint condition. $210 postpaid. Jim Gysan, 53 Lothrop St. Beverly MA 01915.

AN—APR 4Y AM-FM RECEIVER converted 120 Volts $39; CV-253/ALR tuner 38-1000mc $129; TN 19-APR4 tuner 975-2200 MC $29. Package $150. Will trade. Richard E. Mann, 3209 Melanie Dr., Des Moines IA 50322.

WORLD RADIO'S used gear has trial-guarantee! DuoBander 84 $99.95; HW22 $79.95; HW32 $79.95; NCX3 $159.95; Swan 250 $199.95; 350 $279.95; Galaxy 300 $139.95; HT32 $199.95; 200V $399.95; SX101 $159.95; HQ170 $179.95; Drake 2A $159.95; 2B $179.95; HRO50 $129.95. Free "blue-book" list for more. 3415 West Broadway, Council Bluffs IA 51501.

HOT CARRIER DIODES: New HP 2800, 90¢, 12/$10 pp. HAL Devices, Box 365L, Urbana IL 61801.

INTEGRATED CIRCUITS: New Fairchild Micrologic, epoxy TO-5 package. 900 buffer, 914 gate, 60¢ each. 923 J-K flip-flop, 90¢ each. Guaranteed. Add 15¢ postage. HAL Devices, Box 365L, Urbana IL 61801.

OP AMPS: Texas Instruments SN72 709N (DIP) $2.00 each, 6/$10.00. Add postage. HAL Devices, Box 365L, Urbana IL 61801.

WANTED: Eico 751 supply. Sell: B & W 850A, DB23 preselector, UTC S-47 plate, Thordarson T21M64 mod. xformer 7' teletype rack. Make offer. Jim Alley, Troutman NC 28166.

SPECIAL OF THE MONTH RG 11 A/U Coaxial mtrs, plus power supply/spks. Model no. 751, in original factory cartons, $710. Steven J. Bartha, 9 Dixon Ct., Sea Cliff, L.I. NY 11579.

FM MOBILE – Motorola FM TRU140D 12V, DC, 60W Out; 146.94 Simplex 146.34-146.94 Repeat, complete with Xtals, Controlhead, cables. $135.00. Pick up only. 201-462-6327. K2LIU.

73 Readers' DOUBLE BONUS

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□ Coaxial Relays
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□ Equipment Dist.
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□ Keys, Keyers
□ Linears
□ Oscillators (code)
□ Oscillators (rf)
□ PC supplies
□ Preamps
□ Receivers
□ Receivers (FM)
□ Surplus Elec.
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MAIL TO 73 Inc., Peterborough NH 03458

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Address ______________________________

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PROPAGATION CHART

J. H. Nelson

Good O Fair (open) Poor □

April 1970

SUN	MON	TUES	WED	THUR	FRI	SAT
			(1)	2	(3)	(4)
(5)	(6)	[7]	8	(9)	(10)	(11)
12	13	14	(15)	(16)	17	(18)
(19)	(20)	(21)	(22)	23	[24]	25
26	(27)	(28)	(29)	(30)		

EASTERN UNITED STATES TO:

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

CENTRAL UNITED STATES TO:

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

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	21	14	7A	7	7	7	7	14	14	21	21
ARGENTINA	21	21	14	14	14	14	7B	14A	21A	21A	21A	21A
AUSTRALIA	28	28	21A	21	14	14	14	7B	14	14	21	21A
CANAL ZONE	21A	21	14	14	14	7	7	14A	21A	21A	21A	21A
ENGLAND	14	7B	7	7	7	7	7B	7B	14	21	14	14
HAWAII	28	28	21	21	14	14	14	7	14	21	21A	21A
INDIA	14	21	14	7B	7B	7B	7B	7B	14	14	14	14
JAPAN	21A	21	21	14	7B	7	7	7	14	14	14	21
MEXICO	21	21	14	7	7	7	7	14	21	21A	21A	21
PHILIPPINES	21A	21A	21	14	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	14	14	14	7	7	14	21	21	21A	21A
SOUTH AFRICA	14	14	7	7B	7B	7B	7B	14	21	21A	21	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	7B	14	14	14	7B
EAST COAST	21A	21	14	7A	7	7	7	14A	21	21	21	21A

A - next higher frequency may be useful
B - difficult circuit this period