WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

AMATEUR RADIO 73

ACE $1.00

No. 116

EMPHASIS: MOBILE OPERATION

Features:

FCC:
REPEATER DOCKET
(WITH COMMENTS)
page 20

4-LETTER WORDS
page 2

ACTUAL
SIZE

BUILD THIS 3/4 INCH MICROMINIATURE SIX METER TRANSMITTER

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73 MAGAZINE

#116 May, 1970

Features

STAFF

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Amateur Radio News Page

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FCC SAYS NO WORDS ARE NO-NO'S

The FCC questioned CB'er Richard Tallman's qualifications to hold a Technician-class amateur license because of his prior violations of rules pertaining to: (1) hobby-type use of his CB station, (2) failure to identify his station properly, and (3) transmission of "allegedly obscene, indecent, or profane language, words, or meaning." In scheduling a hearing for the case, the constitutional issues raised by the FCC's rule against profanity were noted by Commissioner Nicholas Johnson.

Johnson concurred that a hearing should be held to determine the applicant's qualifications to become a ham, but he emphasized that the "profanity" issue should be dismissed. "I believe a license renewal hearing on the basis of the first two alleged violations is clearly warranted," he said; but then he added, "...when we revoke licenses for the *content* of the speech...we enter an area of constitutional law which is hedged with important restraints against the power of government to curtail freedom of speech." Because of a recent supreme court decision involving the impact of the First Amendment on broadcasting, Johnson said, the Federal Communications Commission cannot punish—"by fine, license revocation, one-year re-

"Agh! By golly – by golly!"

'vagueness' and 'overbreadth.' See, *e.g., Zwickler v. Koota*, 389 U.S. 241, 249 (1967); *Columbia Broadcasting System (WBBM-TV)*, 18 F.C.C. 2d 124, 143, 150 (1969) (dissenting opinion). It might easily constitute a prohibited 'establishment of religion' as well."

"Webster's Dictionary defines the word, 'indecent,' as 'not proper and fitting; unseemly; improper,' or 'morally offensive; immodest; obscene.' Again, unless 'indecent' is narrowly limited to the technical definition of

Ham Wins Test Case

A Chesapeake, Virginia ordinance against transmitters and towers was defeated in the courts recently by Gay Milius W4NJF, who was acting as attorney for Ted Anthony K4OQB, in a civil case that tested the legality of the regulations.

Tri-State Hamfest

by WA9WCE

The Tri-State Amateur Radio Society is holding its twenty-third annual hamfest on Sunday, July 12, 1970, at the 4–H Rural Youth Center on Highway 41 North, Evansville, IN. Advance registration $1.50; and $2.00 at the door. For details contact Jack Young K9LAU, Box 492, Evansville, IN 47703.

British Carnival Rally

by G3BID

By permission of the United States Third Air Force, the Amateur Radio Mobile Society will be holding a carnival rally on 5 July 1970 at Alconbury, United States Air Force Base in

Cook Bicentenary Award

The Wireless Institute of Australia has a nice certificate available for anyone contacting fifty AX stations during 1970. Send a list of the stations you have contacted in order of call signs by call areas plus the date, time (GMT), band, mode, and report for each contact. Have this list certified by two other licensed amateurs plus a statement to the effect that they have seen the entries in your log. Send your application (no QSL's) to Awards Manager WIA, Box 67, East Melbourne, Vic., 3002, Australia. Add eight IRC's if you would like the certificate by airmail.

Western Illinois Hamfest

The Western Illinois Amateur Radio Club is holding its 10th Annual Hamfest on June 7th, 1970, at the Adams County Fairgrounds located North and newal or other sanction"–a licensee "for speech which is protected by the First Amendment."

In his in-depth statement (published by the FCC as an appendix to Docket 18804), Commissioner Johnson gave detailed reasoning behind his controversial stand:

"The Commission has promulgated guidelines for forbidden speech in Rule 95.83 (a) (3). The Rule's prohibitions of "obscene, indecent or profane language, words or meaning" are apparently taken from 18 U.S.C. § 1464. Each of the three elements in Rule 95.83 (a) (3) warrants consideration, for I am increasingly of the belief that one or more of them are unconstitutional abridgements of the freedom of speech.

"The concept of 'obscenity' has been defined by the Supreme Court in the famous case, *Memoirs v. Massachusetts*, 383 U.S. 413,419 (1965). The Court has not, however, to my knowledge, ever said that particular *words* are 'obsene' *per se*. On the contrary, the Court has always stressed the *context* in which the words appeared, asking whether the dominant theme of the material 'taken as a whole' appeals 'to a prurient interest in sex.' Individual 'four-letter words,' so-called, may arouse a number of emotions in the listener; but I rather doubt that a 'prurient interest in sex' is one of them. Presumably the hearing examiner in this case will address this question – along with such other constitutionally required questions as whether Mr. Tallman's speech was 'utterly without redeeming social value.' A study of the function of 'four-letter words' in our society, for example, might be useful, or necessary, component of this latter inquiry. 'profane' as 'showing disregard or contempt for sacred things; irreverent.' Any attempt by this Commission to punish for 'contemptuous' or 'irreverent' speech would almost certainly, in my mind, suffer from unconstitutional 'obscenity,' there is little doubt in my mind that its breadth and vagueness make it unconstitutional. In *Interstate Circuit, Inc. v. Dallas*, 390 U.S. 676 (1968), for example, the supreme court cited with approval an earlier case, *Holmby Productions, Inc. v. Vaughn*, 350 U.S. 870 (1954), which declared unconstitutional a statute containing the words, 'cruel, obscene, indecent, or immoral.' And just last year in *Williams v. District of Columbia*, No. 20, 927 (D. C. Cir., June 20, 1969) (en banc), the United States Court of Appeals threw out a statute with wording almost identical to Commission Rule 95.83 (a) (3). The invalidated District of Columbia statute also contained the words, '. . .profane language, or indecent or obscene words.'

"My essential point is that this Commission has designated a license renewal application for hearing pursuant, in part, to Commission rules which appear unconstitutional on their face. I am concerned that the Commission takes this step without attempting to formulate precise standards for permissible speech over the broadcast medium – assuming *any* such standards could withstand constitutional scrutiny. I concur in today's action, however, solely because grounds exist for possible license revocation which are completely independent of the allegations raised under Rule 95.83 (a) (3), and because the Commission will have the opportunity at a later date to review the policy and law in this difficult area."

Slow-Scan Hams Active Worldwide

by WA7LQO

A world-wide slow-scan TV net has been meeting between 1800 and 2000 GMT weekdays. Stations in Alaska, Belgium, Sweden, U.S.S.R., Italy, as well as the U.S. and Canada have been sending pictures.

Huntingdonshire, England.

Any inquiries regarding the rally or regarding reciprocal licensing arrangements should be addressed to:

BCM/ARMS, London, W.C.1.

Application forms for British reciprocal licenses can be obtained from:

Ministry of Posts and
Telecommunications,
Telecommunications and Radio
Regulatory Division
Amateur & Special Licensing Branch
Waterloo Bridge House
Waterloo Road, London, S.E. 1.

The cost is £3 for a fixed license or £1.10 Od. for a Mobile License. Amateurs can apply for both, or either, but a separate mobile license is necessary in Britain for mobile operation.

1970 Ham-of-the-Year Award

The Federation of Eastern Massachusetts Amateur Radio Associations is now requesting nominations for the "Ham of the Year" award for 1970. Only amateurs in the first call district are eligible and the ham selected will be the top "good neighbor" among hams – the one who has performed an outstanding public service.

Anyone may nominate a ham for the honor. Winner of the award will be chosen for the ham activity which brings the greatest benefit to an individual or group and for the amount of ingenuity and personal sacrifice displayed in performing the service.

Nominating letters should include the candidate's name, address, call letters and complete description of the service performed. Letters must be sent to the chairman of the FEMARA awards committee, Eli Nannis W1HKG, 37 Lowell St. Malden, Mass. 02148 before September 1, 1970.

The winner will be presented with a plaque and a cash award at the ARRL National Convention, Statler-Hilton Hotel, Boston, Mass. on September 26, 1970.

East of Quincy, Illinois.

Calling frequencies will be 3.910 MHz, 7.258 MHz (Mid-Cars) 146.94 MHz and 146.34 MHz 2 meter FM Repeater.

Swap-shop, prizes, games, lunch, ALL-COVERED FACILITIES. Event will be held rain or shine. Camping facilities are available on the fairgrounds.

For further info contact WA9ARG, Marshall Goins, 2316 Van Buren St., Quincy, Ill. 62301.

SYRIAN MARATHON OPERATION PLANNED

Rasheed YK1AA and Hikman YK1AM are planning a round-the-clock three week operation for October 1970, with extensive friday operations from then on through February 1971. The details of equipment are being worked out with Stu Meyer W2GHK/4 (DXpedition of the Month) and they should be on all bands with good signals. This ambitious operation should take Syria off the rare list for a long time to come. All it takes is one good effort like this to do it.

A copy of the 73 DX Handbook has been sent to Rasheed so he will have information on how to best handle the pileups of stations calling. Using the techniques described in this book he and Hikmat should be able to contact three to five a minute, even when their signals may not be too strong.

FCC Proposal Will Shoot Down Ham Satellites

The proposed Docket 18803 for regulating amateur repeaters has a serious hooker in it. . .a proposal that repeaters not be permitted to repeat other repeaters. If this gets passed, then a set of synchronous satellites for 450 MHz is out the window. This could be the most severely restrictive legislation yet for the future of amateur radio.

The rapid development of FM repeaters plus the amateur satellites means that the time is not far off when we can put a series of three synchronous satellites in orbit which will permit any amateur in the world to contact any other on 450 MHz. Imagine what a change that will make in our hobby! Armchair copy signals without QRM from anywhere in the world. This could be the biggest step ahead for the hobby since its inception. . .if 18803 does not go through as proposed.

Rear back and fight this one out. Send in your comments. . .get your club to comment. . .your friends. . .the fellows on the air. . .leave no stone unturned. Get your congressman to complain about this. . .your senator. . . get Barry Goldwater to help kill this provision. . .maybe even the ARRL.

Penn-Central Hamfest

by W3GPR

The seventh annual Penn-Central Hamfest by the Williamsport and Milton clubs will be held Sunday, June 7, 1970 starting at 12:00 noon at the Union Township Volunteer Fire Grounds on Route 15, Winfield, Penna. Informal, picnic style, snack bar handy or bring your own lunch – come and go as you please. Auction, contests, swapping, free parking, with both indoor and outdoor facilities provided. A $2.00 registration fee may be paid at the gate. XYL and children admitted free. Exhibits welcome. For information contact Al Schramm, 311 E. Mountain Avenue, South Williamsport, Penna. Phone - 717-323-5576.

1970 ARMED FORCES DAY COMMUNICATION TESTS

Each year on the third Saturday in May, the Department of Defense sponsors the observance of Armed Forces Day. As a part of this observance the Departments of the Army, Navy and Air Force annually conduct communication tests designed to demonstrate to the world the close partnership and mutual respect enjoyed between U. S. amateur radio operators and the U. S. military. This year's program will be conducted on Saturday, May 16, 1970, and all licensed radio amateurs are encouraged to participate.

The radio amateur's contributions to communication training, international goodwill, military morale and emergency services are recognized by every echelon of the military services. The Armed Forces Day communication tests are designed to be a tangible demonstration of the firm and long-standing Department of Defense policy to encourage and support amateur radio activity. On this twenty-first observance of Armed Forces Day, all radio amateurs are invited to participate and demonstrate to the world the close partnership and mutual respect that U. S. amateurs and U. S. military enjoy.

Once again this year, several military radio stations will participate in communication tests which include military-to-amateur crossband operations and receiving contests for both CW and RTTY modes of operation.

Special QSL cards confirming crossband communications will be forwarded to those amateurs who establish two-way contact with participating military stations. Certificates will be awarded to those who aptly demonstrate their operating ability and technical skill by receiving a perfect copy of the Secretary-of-Defense-originated CW or RTTY message transmitted during the receiving contest portion of the communication tests.

Military to Amateur Crossband Test

Military radio stations WAR, NSS, NPG and AIR will be on the air from 16/1400 GMT to 17/0245 GMT. During this test of crossband operations, the military stations will transmit on specified military frequencies while amateur stations will transmit in the indicated portions of the amateur bands. Contacts will consist of a brief exchange of locations and signal reports. No traffic handling will be permitted.

CW Receiving Contest

A "CW" receiving contest will be conducted for any person capable of copying International Morse Code at 25 words per minute. The "CW" broadcast will consist of a special Armed Forces Day message from the Secretary of Defense addressed to all radio amateurs and other participants. The schedule for this broadcast is as follows:

STATION	MILITARY FREQUENCY	EMISSION	APPROPRIATE AMATEUR BAND (MHz)

TIME	TRANS. STATION	FREQ. (kHz)

News, Reviews, Announcements

IOWA PICNIC

by WØRJZ

The Iowa 75 meter phone net annual picnic will be held on the second Sunday in August – August 9, 1970 – at Anson Park in Marshalltown, Iowa. All amateurs and their families are cordially invited. Each should bring a covered dish and his own service. Festivities will begin around noon. Prizes will be offered and a swap table will be available.

Floridafest

The ST. PETERSBURG AMATEUR RADIO CLUB, INC. will hold its annual Hamfest at Lake Maggiore Park, entrance gate at 9th Street South and 38th Avenue, St. Petersburg, Florida, Sunday May 17. All hams and guests cordially invited. This is an oldfashioned hamfest with picnic lunch, swap table and prizes.

OLD OLDTIMERS GET NEW OFFICERS

Andrew L. Shafer W8TE is the new president of the Old Old Timers' Club, Inc. with William B. Gould K2NP as the new Vice President.

Ray Meyers W6MLZ has been appointed Executive Secretary-Treasurer and Editor of "Spark Gap Times" official magazine for the OOTC.

Directors serving the ten U.S. Call Areas are:

	District
Walter S. Rogers W1DFS	1
William B Gould K2NP	2

	kHz unless otherwise noted		
WAR (Army Radio, Wash., D.C.)	4001.5	CW	3.5 - 3.65
	4020	CW	3.65 - 3.8
	6992.5	CW	7.0 - 7.1
	7325	CW	7.1 - 7.2
	14405	CW	14.0 - 14.2
NSS (Naval Communication Station, Wash., D.C.)	*3385	CW	3.5 - 3.65
	4012.5	RATT	3.65 - 3.8
	*4040	LSB	3.8 - 4.0
	6970	LSB	7.2 - 7.25
	**7301	CW	7.1 - 7.2
	**7336	LSB	7.25 - 7.3
	7380	RATT	7.0 - 7.2
	7385	CW	7.0 - 7.1
	13940	RATT	14.0 - 14.1
	14385	USB	14.2 - 14.35
	14400	CW	14.0 - 14.2
	21500	CW	21.0 - 21.25
	***49.692 MHz	AM	50.1 - 54.0
	***143.820 MHz	AM	144.0 - 145.5
	***150.090 MHz	FM	144.0 - 147.9

*To be operated from 16/2200 GMT to 17/0245 GMT.

**To be operated from 16/1400 GMT to 16/2200 GMT.

***Provided it is consistent with operational and training commitments, this frequency will be keyed from a U.S. Navy aircraft flying between Washington, D. C., and Brunswick, Maine, between 16/1200 GMT and 16/1430 GMT. The aircraft will depart Brunswick, Maine at 16/1730 GMT and fly westerly to Akron, Ohio, Southerly to Morgantown, West Virginia, and return to Washington, D. C. at approximately 16/2100 GMT. The call sign NSSAM will be utilized from the aircraft.

NPG (Naval Communication Station, San Francisco, Calif.)	4001.5	LSB	3.8 - 4.0
	4005	CW	3.5 - 3.65
	4016.5	RATT	3.65 - 3.8
	7301.5	LSB	7.2 - 7.3
	7347.5	RATT	7.0 - 7.2
	7365	CW	7.0 - 7.1
	7495	CW	7.1 - 7.2
	13922.5	RATT	14.0 - 14.1
	13975.5	CW	14.0 - 14.1
	14356	USB	14.2 - 14.35
	14375	CW	14.1 - 14.2
	20954.5	CW	21.0 - 21.25
	21600	USB	21.25 - 21.45
	#143.700	AM	144 - 148
	##148.410	FM	144 - 148
AIR (Air Force Radio, Wash., D.C.)	3347	CW	3.5 - 3.8
	4025	LSB	3.8 - 4.0
	6997.5	CW	7.0 - 7.2
	7305	LSB	7.2 - 7.3
	7315	RATT	7.0 - 7.2
	13995	CW	14.0 - 14.2
	14397	USB	14.2 - 14.35
	20994	CW	21.0 - 21.1

#Provided it is consistent with operational and training commitments, this frequency will be keyed from a U.S. Navy aircraft flying between San Diego, California, and Seattle, Washington during the major portion of the time allotted for military to amateur crossband contacts. The call sign NPGAM will be utilized on the aircraft.

##To be operated from Mt. Diablo

16 May 1970		
17/0300 GMT	WAR – Army	3347, 6992.5, 14405
16/2300 EDST	NSS – Navy	3385, 7385, 14400, 21500
16/2000 PDST	NPG – Navy	4005, 7495, 13975.5, 20954.5
	AIR – Air Force	3397.5, 7315, 13995
	A6USA – Army Radio San Francisco	6997.5

RTTY Receiving Contest

A radioteletypewriter receiving contest will be conducted for any individual amateur or station possessing the required equipment. This is a test of the operator's technical skill in aligning and adjusting his equipment, and serves to demonstrate the growing number of amateurs becoming skilled in this method of rapid communications. The "RTTY" broadcast will consist of a special Armed Forces Day message from the Secretary of Defense to all radioteletypewriter enthusiasts. The message will be transmitted at 60 words per minute in accordance with the following schedule:

TIME	TRANS. STATION	FREQ. (kHz)
16 May 1970		
17/0335 GMT	WAR – Army	3347, 6992.5, 14405
16/2335 EDST	NSS – Navy	4012.5, 7380, 13940
16/2035 PDST	NPG – Navy	4016.5, 7347.5, 13922.5
	A6USA – Army Radio San Francisco	6997.5
	A5USA – Army Radio Fort Houston TX	4025

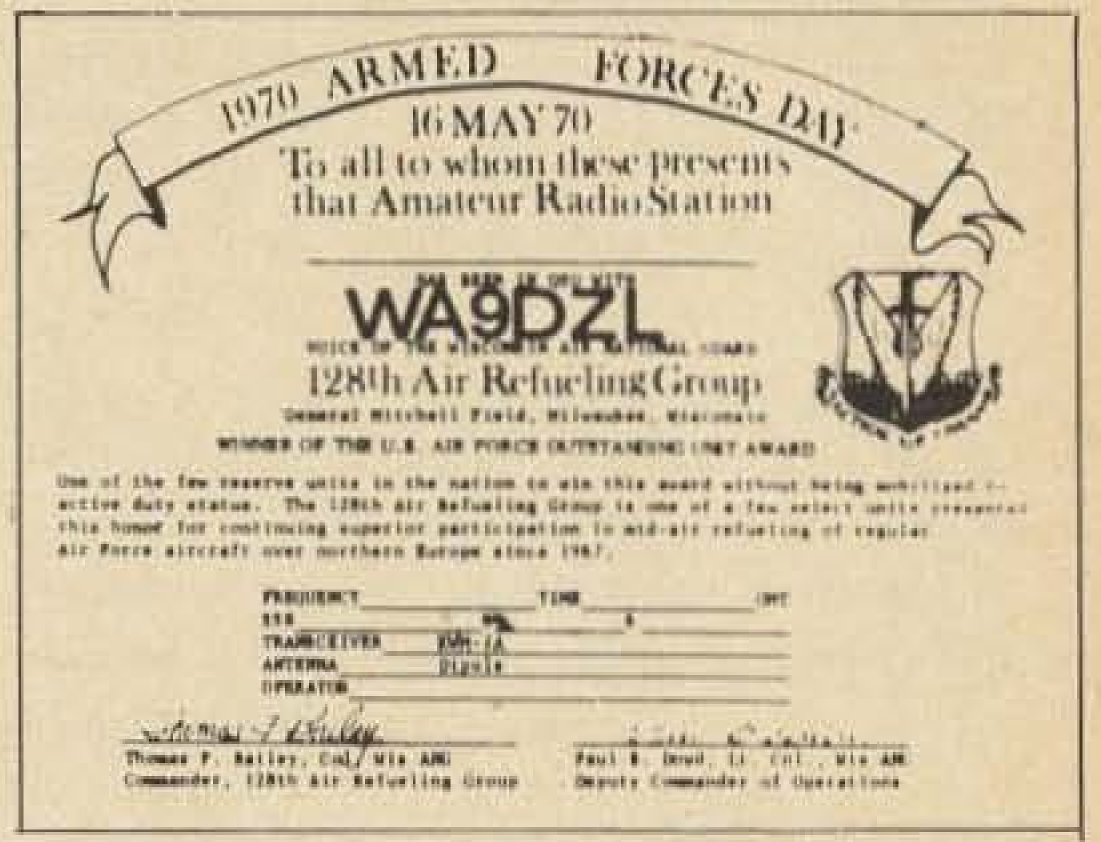
Submission of Competition Entries

Transcriptions should be submitted "as received." No attempt should be made to correct possible transmission errors.

Time, frequency and call sign or the station copied as well as the name, call sign (if any) and address of the individual submitting the entry must be indicated on the page containing the text. Each year a large number of perfect copies are received with insufficient information, thereby precluding the issuance of a certificate.

Completed entries should be submitted to the Armed Forces Day Contest, ATTN: AFOCCOM, Room 3E099, James Forrestal Building, 1000 Independence Ave., Washington, D. C., 20330, and postmarked no later than 31 May 1970.

Thomas Appleby	3
Raymond F. Guy W4AZ	4
Walter M. Hammond W5BN	5
Robert Holly W6DRV	6
Lawrence S. Linville W7DH	7
Andrew L. Shafer W8TE	8
G. Lane Eldred W9SG	9
Ed. Freeman WØMOA	10



Military Hams to Award Armed Forces Day Certificates

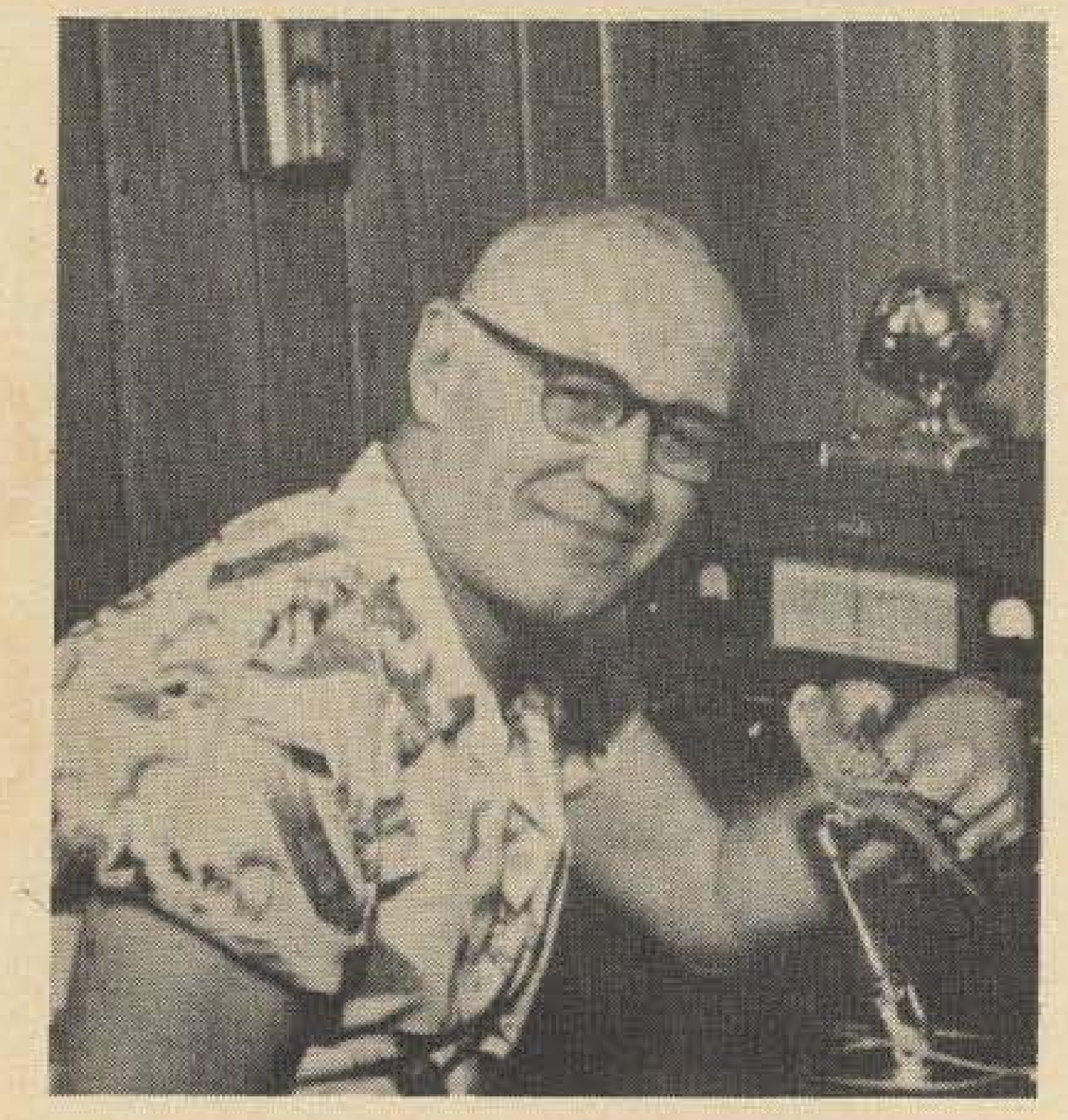
by WA9NVO

On Saturday, May 16, 1970, WA9DZL, amateur station of the 128th Air Refueling Group (TAC), Wisconsin Air National Guard will place radio equipment on the ham bands in conjunction with Armed Forces Day. An attractive commemorative Armed Forces Day certificate will be mailed to all hams who contact WA9DZL on this day. The operating schedule is as follows:

14.297 MHz	1300 GMT – 2100 GMT
7.280 MHz	1300 GMT – 1730 GMT
28.650 MHz	1730 GMT – 2100 GMT

It is anticipated that all states and continents will be contacted. To qualify for a certificate, just make a two-way contact with WA9DZL and send in your QSL card to WA9DZL, 128th Air Refueling Group (TAC), General Mitchell ANG Base, Milwaukee, Wisconsin 53207.

Editorials



DXer's Death is Loss To All Ham Radio

by W. R. Lathrop W4PR

The amateur radio fraternity lost one of its great citizens on March 7, 1970 when E. C. Atkerson died unexpectedly of a heart attack. Ack – hardy, robust, energetic – had his first warning last fall when he was hospitalized from a serious heart attack. He recovered quickly, continued under doctors' orders, dieted, took care of himself, and alowed his active business pace. However, there came a second attack on Saturday and Ack died instantaneously.

Ack loved amateur radio. He began in 1921. He dovoted himself, over the years, not only to enjoying this fascinating hobby but in using his facilities in service to his country as well as the general public. His profound self-taught knowledge of electronics, for example, was voluntarily put to use in the last world war. The country then with a client. Yet, let a child walk in, whose head perhaps didn't reach far above the counter, one who professed an interest in becoming a radio amateur and Ack would "give him the store." Despite the rush of business, he would take time out – sometimes for hours to explain, advise, and lead the youngster toward his goal. More often than not the youngster would walk out with needed equipment even though he did not have the money to pay for the items wanted. He never lost interest in these children, and he continued to help and advise throughout their amateur careers. Ack was particularly generous in donating equipment new and used. He was instrumental in providing most of Alabama's civil defense equipment in the early days. Since Ack never talked about what he did and to whom he sent equipment, there is no telling how much gear he packaged and sent at cost or free of charge to needy hams, missions, and the like.

Ack particularly loved animals of all kinds. Out of hundreds of such stories illustrating his kindness to the animal kingdom, one should suffice which fully illustrates this trait. One day he found a pigeon with a broken wing outside his store. He personally took it to the veterinarian, had it treated, nursed and treated it back to health. He footed the bill and freed the bird on its recovery. He never spoke of what he had done.

Virtually the whole DX fraternity knows and appreciates Ack's interest and help in his efforts in this direction. Few know, however, of the tremendous difficulties, the sweat, the hard work, and the time involved in doing the necessary to receiving permission for Gus, W4BPD, to operate from the various exotic places that he visited. Nor do few know the personal expense, the vexation, the many problems met and solved or of the thousand and one other details carried on by Ack in connection with Gus' travels. It was Ack's idea, thinking of the small Propagation Study Association were available when Don's partner, Chuck Swain, was lost at sea. He did much to keep the search going until hope was finally abandoned.

Then came again a second Gus Browning expedition with all the work and effort which Ack shouldered without hesitation. These three well known expeditions tell part of the whole story. Ack's personal interest, his energy and drive were, however, lent to countless expeditions. Financial help, on Ack's suggestion, sometimes came from the World Radio Propagation Study Association. Ack personally contributed his own money and equipment and help in countless sorts.

Although there is much more, let one more example of Ack's influence and interest suffice. Through a longtime radio communications correspondent and friend, N. Chhwana, a high official of the Bhutan government, Ack arranged to have the king invite Gus to visit that country. As a result of that visit a strong friendship was developed and knowing, through Gus, of the Bhutan's needs of radio equipment, Ack shipped much equipment to the government of Bhutan, much of it at his own expense. Then through personal appeals to many radio friends and appeals through the World Radio Propagation Study Association, Ack collected and shipped a tremendous amount of radio equipment to Bhutan – all donated.

Yes, amateur radio lost a devoted, amazingly helpful citizen when W4-Echo-Charlie-Ida's cheerful voice was silenced! We all owe him much. Truly Ack deserves a top spot in amateur radio's Hall of Fame.

Bermuda Phone/CW

change reports with U.S., Canadian and VP9 stations only. U.S. and Canadian stations may not exchange reports with another U.S. or Canadian station; likewise U.K. stations may not exchange reports with other U.K. stations.

Points

Each contact must be complete and will count three points.

Scoring

The score for U.S., Canadian and U.K. stations will be the number of completed contacts times three points, times the total number of Bermuda Parishes worked on all five bands, i.e. a U.S. or Canadian station having made a total of 500 contacts with U.K. and Bermuda stations and the following Bermuda Parishes: 28 MHz - three Parishes; 21 MHz - six Parishes; 14 MHz - three Parishes; 7 MHz - two Parishes; 3.5 MHz - two Parishes, the score would be 500 contacts times three points = 1,500 points times 16 Parishes = 24,000 points final score. A U.K. station completing 500 contacts with U.S., Canadian and V P 9 stations would score in exactly the same manner.

Equipment

Any number of transmitters and receivers will be allowed and competitors may use the maximum power permitted. However, all stations participating must be single operator only.

Awards

A trophy will be presented to the winner of each mode. A certificate signed by His Excellency The Governor of Bermuda will be sent to the highest scoring station in each call area as follows:

U. S. A. and Canada: W1 through WØ and VE1 through BE7 including VO.

U. K.: G, GD, GM, etc.

Presentations

Round trip air transportation for two plus one week's accommodation at had need of a tremendous number of technicians to operate the radio gear used during that war. Ack volunteered to teach and to train technicians. He did so during the war period. All along before and after the war he used his facilities wherever possible for traffic handling. On the second Byrd expedition to the Arctic in 1939, Ack established and maintained constant contact with the expedition. Interestingly enough, the expedition was split into two camps some 1800 miles apart. There was an eastern location and a western location and they took radio equipment along to maintain contact between the two camps. Little was known about propagation in the Arctic in those days and much to Byrd's dismay the contact between the two camps was impossible with the equipment on hand. Ack could copy, however, both camps. He therefore linked the two together by maintaining twice-daily contact. He handled all the communications between the two units until suitable radio equipment was sent in. During the period of the Byrd expedition he handled thousands of personal messages from those with Admiral Byrd to their families throughout the United States.

Again in prewar days he established contact with the Kenner–Green scientific expedition to Peru. He was their main contact with the outside world for that expedition deep in the jungles of this South American country. Ack later rendered tremendous service to families throughout the United States when a volcano in Hawaii blew its top causing untold damage and destruction. Ack's station was the principal radio link.

Ack's interest in amateur radio caused him to found Ack Radio shortly after the last world war. Ack was an alert, capable, hard working, imaginative, "tough" businessman, and Ack Radio grew and thrived. He might well have been abrupt and business-like amateur without funds, who insisted on QSLs for everyone regardless of their contribution.

The World Radio Propagation Study Association also was Ack's idea. Not only did this organization act as a recipient of, and a disposal medium for the contributions from thousands of amateurs, but the analysis of Gus' logs and the propagation conditions pertaining to it were studied to provide benefits for amateurs the world over, the governments visited and various commercial interests. These studies were made and distributed.

After Gus' first extended travels, the World Radio Propagation Study Association backed and sent Don Miller on a similar expedition. Ack saw to it that funds from the World Radio

160m DX

by W8ANO

During November 1969, Stewart W1BB came out to the 8th district to see what was making all the racket on 160 meters. Here is what he found: Three 8s very interested in 160 meter DX. I have worked the following 160m DX since Nov: ZS, HR3, PJØ, KP4, VP9, KV4, HR2, ZL1, G3, GW3, DL9, KL7, G2, G8, KS4, VK5, VO1, VK3, KH6.

Contest

by Jim Sayer VP9BY

Bermuda hams have been active participants in the realm of amateur radio since well before the inception of the Radio Society of Bermuda in the late forties. Several of the old single-letter calls are still to be heard. In 1959, in honor of the Bermudas' 350th Anniversary it was decided to hold a contest embracing amateurs in the United States, Canada, and Bermuda. This proved to be such a resounding success that it was continued in 1960 and has been a yearly feature of hamdom since that time.

In 1969, the 10th anniversary of the contest, it was decided to celebrate by having a phone weekend and a CW weekend. This decision was met with equally resounding success and it was agreed to continue the same this year and to invite the U. K. amateurs to participate.

Contest Period

PHONE: 0001 G.M.T. June 20th to 0200 G.M.T. June 21st.

C. W.: 0001 G.M.T. July 18th to 0200 G.M.T. July 19th.

Bands

The following amateur bands will be used: 3.5, 7, 14, 21, and 28 MHz.

Exchanges

Amateurs in the U.S., Canada and the U.K. will transmit a two figure number representing the R S report plus their State, Province or County. CW participants will transmit a three figure number representing the R S T report plus their State, Province or County. V P 9 stations will give R S or R S T reports plus Parish.

U.S. and Canadian stations may exchange reports with U.K. and VP9 stations only. U.K. stations may ex-

The Top of the Town Hotel will be provided to enable the overall winners to attend The Radio Society of Bermuda's Annual Banquet to be held on October 22nd to receive their awards.

Log Instructions

Keep all times in GMT and all contestants to compute their own scores and check logs for duplication to assist the Contest Committee. Print name and Call on each Log. All contestants must sign a statement that the rules and regulations have been observed. Official Log sheets can be had by dropping a card to Contest Committee, Radio Society of Bermuda, P.O. Box 275, Hamilton, Bermuda.

Should there be a tied score, the decision of the Contest Committee will be final. All Logs must be received by the Contest Committee of the Radio Society of Bermuda NOT LATER THAN August 15th, 1970.

The following abbreviations of Parishes will be used on CW.

SANDYS	SAN.
DEVONSHIRE	DEV.
PEMBROKE	PEM.
WARWICK	WAR.
SOUTHAMPTON	SOU.
SMITHS	SMI.
HAMILTON	HAM.
PAGET	PAG.
ST. GEORGE	GEO.

RaRa HAMFEST

The Rochester Amateur Radio Association invites you to the 1970 Western New York Hamfest and VHF Conference. Organizing the Hamfest is an all-year effort by a good many of the members of RaRa, a Rochester ham club. Special tables can be reserved for clubs and groups. Check at the registration desk to see where your group can be seated.

An impressive program is planned for the occasion, and special activities are being scheduled for FM enthusiasts.

Classified

Caveat Emptor?

Price — $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agencydiscount. 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. . .

Tristate Hamfest

by K9VAT

The Western Illinois Radio Club composed of radio amateurs in the tristate area, is sponsoring a hamfest at the Adams County Fair Grounds, Mendon, Illinois on June 7, 1970. A fine program of an entertainment nature is planned for radio amateurs and their families. Seven-hundred people attended the last hamfest and family picnic.

It has been more or less traditional at these events to give away door prizes as attractions to improve attendance and participation. In the past years the various manufacturers and distributors have been very generous and gracious in donating an assortment of prizes frequently used by radio amateurs.

Certificates...

For the Ham Who Has Everything

RRCC — Real Rag Chewers Club.

This certificate is available to amateurs who furnish a signed statement that they have had a continuous radio contact lasting over six hours with one other amateur station. Continuous means just that. . .no time out for anything. On your application, list starting and ending time and date. Please include $1 to cover the costs of handling and mailing.

WAAS — Worked Almost All States.

This certificate is available to amateurs who furnish QSL cards proving two-way radio contact with 49 states. This will greatly ease the anguish of not being able to get that last state. Please include $1 to cover costs of handling and mailing.

FM MOBILE TRANSCEIVER 450 MHz, 2-Channel trunk mount RCA rig in perfect condition. Fully duplexed and operating as a mobile telephone. Includes transmit crystals for 442.12 and 442.05; receive crystals for 448.82 and 448.85. Crystals are from Sentry and are enclosed in ovens. Complete less control head and cables: $100. Will throw in two 4 dB Com Prod mobile gain antennas. Ken Sessions K6MVH/1, RFD 2, Peterborough NH 03458.

FM MOBILE/PORTABLE TRANSCEIVER 2 meters. Varitronics FDFM2. Perfect for repeaters. Six crystal-controlled channels included: .34—.94, .94—.94, .34—.76, .31—.88, .22—.94, .28—.76. Crystals are International. Includes 12V battery pack, mobile battery cable w/connector. $200. Ken Sessions K6MVH/1, RFD 2, Peterborough NH 03458.

FOR SALE: Heathkit DX100 (B) $55; Hallicrafter HT40 $45; National NC98 RCVR $50; Homebrew 2 Watt 2 Meter Transceiver $25. J. Middleton, 132 Forest Hill Road, W. Orange NJ 07052. WA2GVQ.

COMPLETE SET 73's for sale & singles from 1961. Make offer to Art Becker, 535 Clyde Apt. 29, Calumet City IL 60409.

ELECTRONIC ORGANS Transistorized, known brand, electronic assemblies, two manual spinet. $60.00 f.o.b., send SASE for particulars. W9YCB, Rural Route 2, Box 52A, Angola IN 46703.

MOTOROLA BRICK (H 23-DCN) with Nicad and case, on frequency .34—.94 and .94—.94, $300. ITT 30W 12DC mobile, complete with all accessories, less crystals, $100. Budelman 17-A frequency-deviation meter, crystal controlled with crystals for 146.94 and 52.525 with manual, $75. Philip Dater, WA5JDZ, 9006 Crestwood, Albuquerque NM 87112.

CAPACITORS, SPRAGUE 125 uF 450V 59¢, 40 uF 450V 29¢ 12V transistor. Inverter Transformers, 670V @ 250 ma $3.95. Minimum Order $5.00. N.M.E. P.O. Box 1306, Newport Beach CA 92663.

ALL MY HAM EQUIPMENT: HE 45B 6 meter Transceiver; Eldico 2 meter transmitter; Navy receiver with converter; complete with power supplies; 16 element Telerex antenna. $150.00 complete. WB2HPS Hicksville NY 11801.

TONE DECODERS: Touchtone-Digital-Burst. Solid-state, modular, plug-in unit, 2 x 2 x 3 in., $22.50 postpaid. ITT 12-button tone dial, $27.50. Write Digitone, Box 116, Portsmouth OH 45305.

SPECIAL OF THE MONTH RG 11A/U Coaxial Cable, 1st quality, Brand New—12¢ a foot or any length to 2500 feet. Antennas, Inc. Dept. B, 512 McDonald Road, Leavenworth KS 66048.

HOT CARRIER DIODES: New HP 2800, 90¢ 12/$10 pp. H A L 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-top, 90¢ each. Guaranteed. Add 15¢ postage. H A L Devices, Box 365L, Urbana, IL 61801.

OP AMPS: Texas Instruments SN72 709N (DIP) $2.00 each, 6/$10.00. Add postage. H A L Devices, Box 365L, Urbana IL 61801.

GREENE: center dipole insulator with . . .or. . .without balun. . .see November 73, Page 107.

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.

SRRC HAMFEST—June 7, Come to 4-H Fairgrounds Southwest of Ottawa, Illinois via Route 71. For data contact W9MKS, RFD 1, Oglesby IL.

MINT COND: Apache and SB-10 SSB Adaptor, plus cables and mike-Reasonable offers considered. J. Weatherly K1ZYG 473 Auburn, Newton MA.

SALE—teletypes Model 15-$60; Model 19—$90; AN/FGC-IX audio converter $25; Hornet TB-3B Tri-band beam $40; Mosley A-92-S (2 mtr) Beam 110' twin lead -$15; ASAHI-PENTAX 35mm, fl. 8-55mm, fl.8-85mm with cases $150; want Central Electronics 20A; WA4TNW 29482.

SWAN 240 TRANSCEIVER Swan AC and Mobile Power Supplies. $250. Excellent condition. David D. Kaufman, 9458 Loch Avon Dr. Pico Rivera CA 90660.

FOR SALE: Heathkit Mohawk receiver $100, DX-60 $50, and HG-10 $25, or $150 for all FOB Bakersfield CA. John Parker 5008 Greenbrier Ave. Bakersfield CA 93306.

TRANSISTOR PROJECTS: send for free list. EDI, 1918A 49th E. Palmetto FL 33561.

LIN AMP for Swan 250 with two 4 x 150 Complete Power Supply, instructions, etc. $125.00 WAØNAO, 7393 Flora, Maplewood MO 63143.

SWAN 250 complete with SKR-PS instructions, etc.$200.00 WAØNAO, 7393 Flora, Maplewood MO 63143.

430 MC RECEIVER or transceiver wanted, supereg preferred home made or mfg. Give price if in working order. Box 8352, Savanna GA 31402.

10 FOOT PARABOLIC DISHES—Spun Aluminum. Some in original crates. Frequency range 450 MHz to 8.5 GHz. No feeds available. Feeds available from the manufacturer or can be fabricated. $100. FOB Topeka FM Engineering, 3501 Croco Rd. Topeka KS 66605.

SOMERSET COUNTY HAMFEST The 5th SCARC Annual Hamfest will be held Sunday June 7 at the Casebeer Grove 4 miles north of Somerset, Pa. on US Route 219. Registration starts at noon. Rain or shine — Free tables indoors for swap-shop. Write K3YVS, 719 Division Street, Berlin PA 15530.

ROCHESTER, N.Y. is the location for the 37th Annual Western New York Hamfest and VHF Conference, the weekend of May 16th. Location is Bristol 50 Acres, Rte. 15 just south of Thruway Exit 46. Advance registration and banquet only $6.75. Advance sale closes May 9th. Send check to Western New York Hamfest, Box 1388, Rochester, N.Y. 14603. Activities start Friday night followed by full day of technical programming with outstanding speakers. Special activities include MARS, AREC, and QCWA meetings, YL program, code contests and huge flea market.

AUDIO BANDPASS FILTERS for improved receiving or phone patch. Top grade commercial units made by Stancor and UTC. Sharp cutoff below 300 Hz and above 3000 Hz. 600 Ohms in, 10K out, use them back to back for even better results or impedance match. 20 watts max. Postpaid 2 for $5.00. Charter Electronics Box 88, Gladwin MI 48624.

PRECISION TOROIDS, wound to mil spec on high grade tape cores. 1½ in. dia. not potted. Choice of 250, 500, 850, or 1000 MHy. $1.00 each or 6/$5 postpaid. Charter Electronics, Box 88, Gladwin MI 48624.

CHC – Certificate Haters Club.

This certificate is available to any amateur who sends a statement saying that he has never enjoyed receiving a certificate, that he hates certificates, and that should he ever by chance receive a certificate in the future he will hate it. Please include $1 to cover handling and mailing costs.

DXDC – DX Decade Club.

One hundred countries is a bit much for Novices, on six meters, on 160 meters, and other esoteric bands, so we have this certificate available for any amateur who furnishes QSLs proving contact with ten countries on the official WTW country list. A dollar bill should cover costs admirably.

WAZP – Worked All Zones Promised

Though interest in the Worked All Zones certificate has dwindled substantially in recent years, every now and then a DXer comes along who wants to try for this award. A statement to the effect that you promise to try and work all 40 zones plus $1 for handling and mailing will bring you this handsome certificate.

Who will be the first amateur to win all five of these handsome awards?

73 MAGAZINE
PETERBOROUGH
N.H. 03458

STATION CLEANING—Sell six'er with P.T.T. $45, 4-400 $20, 4-250 $15, much more. Send S.A.S.E. for big list. 3 Barry Ave. Bay Ridge MD 21403.

MANUALS—TS-173/UR, TS-174/U, SP-600-JX, $5.50 each; R-390/URR, R-390A/URR, $6.50 each. Many others. List 20¢. Manuals wanted. S. Consalvo, 4905 Roanne Drive, Washington DC 20021.

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.

NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

FCC Figures Revisited

A little over a year ago (February and March 1969) I gave the graphs of the FCC figures on the total number of amateur licensees and the Extra and Advanced class licensees. At that time, with Incentive Licensing just a few months old, it was obvious that there was an increase in the Extra and Advanced class licenses, but we couldn't tell whether it was the start of an upward curve or not. The start was certainly extremely disappointing to anyone that expected some response from the amateurs to the new Incentive Licensing rules.

We have had an awful lot of talk about Incentive Licensing, but what is really happening? What has been the result of the November 1968 and November 1969 band changes as far as upgrading of licenses is concerned. . .and that is supposed to be what this is all about, is it not?

The figures in early 1969 seemed to indicate a massive rejection of the entire principle of Incentive Licensing. Beyond the oldtimers who were grandfathered into the Extra class license, only a handful bothered to go for Extra. . .or at least only a handful made it.

Now that the figures are in through February 1970, what do they show? Has that handful become a mob going for Extra? Were those few stragglers who went for the Advanced class license the forerunners of a horde to come? Is the principle of Incentive Licensing finally being accepted by the rank and file? Has QST managed to get this bitter pill swallowed?

Not exactly.

During February 1970 the FCC issued exactly 73 Extra class licenses. This compares with 278 the previous February. Perhaps this February was somehow different from last February. . .snow or something. . .so let's take an average of five months and see how that compares with a year ago. The average, centered on January 1969 (October through February) is 107 Extra class licenses a month. The year before it was 226, over double!

No wonder the FCC stopped the expansion of the Extra class CW bands!

What about the Advanced class license? Is that where the action is?

Not exactly. In the five months centered on December 1968 an average of 759 Advanced class licenses were issued. In May 1969 the average was down to 329, less than half! It has not picked up substantially since then. The February 1970 figure was under 400.

This should tend to cool off those enthusiasts who have been talking wishfully about the acceptance of Incentive Licensing. It has not been accepted. It *has* been rejected. Let's not let anyone try to fool us about this. Perhaps, now that the vote is in where it really shows, we can prod the FCC into some action to get things back where they were before and set up a more realistic program for encouraging amateurs to progress. The punishment type of incentive as proposed by the ARRL and put into law by the FCC under pressure from ARRL has been the biggest trauma ever to hit our hobby. Psychologically it was doomed to failure from the start. . .punishment as a means for forcing action never succeeds like rewards.

Perhaps it is about time to go back and do what should have been done in the first place. . . consult the amateurs as to what they think should be done. Few amateurs are not in agreement that we need some incentives to urge us to progress. Maybe it is time for the active amateurs to take a hand in their future instead of leaving it to a small unchosen few who have had little active ham experience in years to make the decisions for us from their ivory towers.

What can be done? Well, since you have no representation or lobby in Washington to speak for you, you have to speak for yourself. Get your club to send a petition to the FCC requesting a halt to the Incentive Licensing band allocations . . .get them back where they were in October 1968. Get as many members to sign this petition as you can and send it to the FCC. Be sure to double-space it when it is typed up and don't forget the lousy 14 copies (plus the original). You might make a 15th for me. . .and a 16th for QST. Have the original notarized and send the works to the Secretary of the FCC, Washington, D.C.

Once we get back where we were before this big ARRL production, we can start working on a reasonable incentive system that will reward instead of punish.

The FCC figures put the lie to ARRL's insistence that everything is really all okay and that most amateurs are accepting Incentive Licensing with good grace and getting their higher grade license. They have tried to maintain the fiction that the opposition to this was by a handful of malcontents and rabblerousers. 73 Extra class licenses in February out of a pool of 130,000 General and Conditional licensees tells the story.

Bright Side. The total number of amateurs, which virtually stopped growing in 1963 (the time of the ARRL Incentive Licensing proposal), has been edging upward again. In 1967 it was down 2%, in 1968 it swung positive to about 0.01%, in 1969 it was up to 0.5% growth, and in 1970 it is up to 2.4%! This is not up to the 10–12% of the pre-1963 growth, but it is certainly encouraging.

FCC Railroading Fee Hike

The FCC announcement of the proposed license fee hikes reached 73 after the April issue had already gone to press. We did manage to quickly insert a little bit about it gleaned from a phone call, but not nearly enough to make it possible for amateurs to be fully informed and comment intelligently on the docket. The closing date for comments was set for April 10th, meaning that by the time we could present the entire docket in the May issue, the official deadline for comments would be long gone. I immediately sent in a petition to extend the closing date and it was quickly denied. For some reason the FCC wants this one to go through with as little opportunity for the amateurs to know what is happening as possible.

Docket 18802 proposes that the amateur radio license fees be increased from $4 to $9. The basic idea is to put the FCC on a cash basis, paying its way with license fees. While I like the idea of a government agency operating in the black, I am about as anxious to help pay for much of the FCC doings as I am to pay for that lovely war in Vietnam.

I can see where it might cost around $4 for the FCC to make up, print, administer, grade, and process a license application and issue the license, but I can't see it costing $9, even considering the inefficiency and waste of the government running the program instead of our ham clubs.

The $9 bite wouldn't be so bad for the older amateurs, fellows who are working and making a living, but it could be a severe blow for the young kids in school and could even prevent many of them from applying for a license. Since most fellows fail the exam the first time through, the bill would run a lot higher than $9. I seem to remember an FCC release which mentioned that it takes 2½ tries to pass the ham license, which would put the ticket around $20 for the first license. One of the last things we need now is a further discouragement for new licensees.

May I propose a compromise? I would be willing to go along with even the $9 fee if the FCC would waive the fee on the first license issued to each amateur. This would permit the youngsters to start out in amateur radio without being heavily penalized and then they would make up for the first free ride later on at renewal time or when they stepped up to a higher license. Presumably they would be in a better financial condition after five years than they would at first.

If you have any thoughts on the matter you had better send them in to the FCC immediately. Though the date for comments on 18802 is now past, I am reliably informed that they will accept comments and put them with the file until the Commission makes its decision. Head your letter as being comments on Docket 18802 and give all of your recommendations as well as your reasons for them. The additional 14 copies will help, if you have a copier handy. Even without, your letter may count. Send it to the FCC, Washington DC 20554.

Do We Need Representation?

Our ignoring of the problems of the ghettos resulted in an escalation of problems, not in their going away. Our ignoring of the growing problems in the schools has had a similar result. I wonder if we are going to continue trying to ignore the problems besetting amateur radio?

The FCC is about to more than double the license fee for us, is on the verge of passing new rules for FM repeaters which could virtually stop the growth of this phase of our hobby and prevent amateur satellite development, and has just slugged us with the most extensive revamping of our bands in the history of amateur radio. When are we going to stand up and say that things have gone far enough?

The blacks decided to do something about their problems. . .and have had success. The students have started making themselves heard . . .with success. You, the amateur who is being done in, have yet to speak out and make yourself heard. How long are you going to take it? Things don't have to go this way and you know it. As long as you continue to play the game with the same marked cards you are going to come out the loser.

We need representation in Washington and we need it right now and we need it badly. We need someone who can protect the interests and rights of radio amateurs. . .someone who can talk turkey with senators and congressmen. . .who can talk with the FCC staff and find out why we are getting dumped on and what can be done to stop it. We need someone who can talk with the military and get them to help us in our battles. They need us and should be reminded of this now and then. We do not have this now. . .we need it.

DX Pileups

An article by G3BID proposed that pileups "attract" and are self-inflating. Obviously he has something there. DXers tuning across the band listen carefully for pileups as a method of finding rare DX. Often they will leap into the pile without even knowing who they are calling. This comes out when they make the contact and have to ask in embarrassment for the call of the DX station they are working.

Pileups are caused by poor operating on the part of the DX operator. It is disappointing that so few DX operators avoid the time-consuming and frustrating pileup process. The system for getting the most contacts in the least time, using only one frequency and virtually eliminating pileups, is simple, but when was the last time you heard anyone using it?

Control of the situation is in the hands of the DX operator. Those wishing to contact him will follow his instructions as best they can in order to get that cherished contact. The op must be *absolutely inflexible*. He must set down the rules for getting through to him and then stick to them without exception. If he once breaks his own rules, then he has failed all of those who have been obeying them and they will have every reason to be resentful and even spiteful.

The DX operator should set down his rules and repeat them every few minutes for the newcomers. Rule number one is that all calls must be on the frequency of the DX operator. Rule two is that all calls must be just once, one five-second phonetic spelling of the call of the calling station and no wasting time by giving the call of the DX station. Rule three is that calls will come in the order specified by the DX operator, with no exceptions whatever. It might even bind the cheese better to announce that anyone calling out of order will be placed on a lid list and will be contacted after all others calling are worked.

The problem for the DX op is to get the call letters through the interference. If the calls are spread thin enough this is no problem. Let's say that the band is open to the U. S. and you are the DX op starting a series of contacts. It usually starts slowly with one sharp operator noticing your signal and calling you. When you finish a short contact with him, two or three are calling. You work them faster and by that time there are tail–enders, breakers, and every type of ogre known to the rare DX op. Now is the time to swing into contest style operating. Announce your rules. Then stand by for a specific call area. If the one call results in nothing but a mess, ask for WA1s. This will psychologically prevent W1s and K1s from calling you. If you ask for W1s, you will get all three prefixes. One WA1 should stand out enough to get some of the call. The fast breaks permit you to get this done very quickly. Work K1s next, then W1s. Finish up by asking for any other 1s such as hams from other areas operating "/1"; then you might ask for any DX calls with a 1 in them. Next start in on the 2s. You can check the 2s en masse first, then split them into WB2s, WA2s, K2s, and finally W2s. Don't forget to ask for DX 2s too – they will probably be there. If you forget them you will start hearing them breaking in and botching things up for you.

This system is the fastest one for DXing yet devised. It also is great in that everyone listening to the frequency knows just what is going on and you will find that the dozens or hundreds waiting to get through to you will help you enforce your rules. It only takes one single frequency so you are not hashing up 100 kHz as some inconsiderate DXers do. Also, you are making it easy for the op who does not have a split-frequency system with the callers spread out up and down the band, jamming dozens of contacts for others. Being fast, the calling stations get worked much quicker and few ever have to wait more than 10 or 15 minutes for a contact. The fast activity on the frequency is as much a red flag for the DXers as a pileup, so you never run out of callers while the band is open.

The next time you hear some poor soul struggling with split frequency or tail enders, why not take the time to tell him how to operate. You would do the same for a lid in the U. S., wouldn't you?

The DX op should remember to pass along the QSL information every few minutes and to give his call frequently, phonetically. If things slow down a bit, it doesn't hurt to add a few comments about the country you are visiting for the assembled multitudes.

One other benefit of this super-fast system is that even the low-power stations will be able to get through since you get right down to complete quiet at the end of working each call area. The op will find himself working even mobiles and transistor rigs, making it more fun for all concerned.

European ops can be handled in exactly the same way. Split them up into countries and then, if required, prefixes. With any kind of opening the DLs and SMs will have to be cut very thin to be sorted out.

The split-frequency rubbish was perpetuated all too long because one well known DXer used it. It now appears that he used it because it permitted him to avoid contact with some ops rather than because it was fast. Let's bury this wasteful relic of the past.

The Post Office Mess

Isn't it more than strange that in 1970 we are sending letters just about the same as they were sent in colonial times? In this electronic age it is nonsense for us to have to write on a piece of paper and then send that piece of paper to someone else for them to get the message.

Sure, there are some things that go well on paper. . .legal items such as wills, mortgages, etc., need some permanence, but most of our communications are read and then thrown out. Or, if they are kept, they take up a lot of filing space.

At 73, we get some 200 subscriptions a day by mail. Two hundred envelopes, two hundred letters and two hundred checks. Add to this another fifty or so letters to the editor and other items. Over 80% of the mail in our country is

(continued on page 111)

Mr Virgo Himself

Editorial by Ken Sessions

Ironic as it may seem, I think the biggest stumbling block to the advancement of amateur radio is a lack of communication between the people who make the rules and the people who follow them. Consider that infamous anti-repeater docket, the product of a small group of nervous and suspicious individuals within the FCC.

There are restrictions posed by Docket 18803 that can be explained with no rationalization other than the simple fact that the FCC is worried that amateurs will misuse spectrum, thereby creating more headaches for the Commission by virtue of a possible rash of intra-fraternity complaints of interference and the like. I suspect Docket 18803 is geared first to forestall any such misuse and second to keep the ham radio operation within the realm of the Commission's archaic understanding.

The plain truth is that the FCC has precious little understanding of ham radio. This fact casts no aspersions of ineptness on the good people in Washington, for they certainly mean well. But consider the breadth of their jurisdiction: the billion-dollar broadcasting market, the interstate use of phone lines, the pathetically misused citizens' band, the pay-TV snake barrel, the crowded commercial, industrial, and governmental spectra. Is it any wonder the handful of men in Washington have no real feel for what's doing with the comparatively trouble-free minority group of ham radio?

Paradoxical, yes, but fact: Those well meaning fellows in Washington are painfully ignorant as to the capabilities and limitations of radio as we know it. Attesting to this is the FCC's answer to Wayne Green's recent request for an extension to the deadline for filing comments about the license fee increase. Wayne's reasoning was that more time was needed to disseminate the information. The ham journals needed time to publicize and editorialize; ham groups needed time to plan meetings and have discussions before filing comments. Reasonable? To you and to me, yes – but not to the FCC. The FCC told Wayne that amateurs in particular needed time the least, since hams all have communications capability.

Obviously, the FCC has the idea that if one ham makes an on-the-air announcement, all others will immediately get the word. (And I guess most of us thought that way before we became hams.) The unfortunate thing is, however, that the FCC's official reason was less than no reason at all, and served only to illustrate the communications breakdown between the rule-passers and the rule-followers.

I must admit, albeit reluctantly, that the communications gap is not strictly limited to failings on the part of the Washington bunch. I myself was guilty of misinterpreting when, in a rush to make deadline for the last issue of 73, I published opinions on a docket I hadn't yet seen. I based my comments on a verbal description of Docket 18803, which resulted in my erroneous assumption that remote operation would be illegal (because of the crossband restrictions). Everett Henry called me from FCC headquarters shortly after the magazine came out to set me straight.

I'm confident the FCC doesn't trust us. The people in Washington are wary of saying yes to anything because they're afraid of unleashing another holocaust like CB. As a result, the FCC undoubtedly pores over every petition about repeaters with exasperating caution.

But are we any better? I traveled several hundred miles a few weeks ago to attend one of the many special meetings that are taking place across the country because of Docket 18803. The purpose of the meeting was to examine the FCC proposal, determine what action to take, and make a decision as to how best to act – collectively or individually. *We spent more than three hours discussing such simple trivia as how the proposed rules were worded!* More than one of those amateurs attending the meeting was convinced that the FCC was trying to nail us with subtle wordings. And the result was that we spent our time trying to interpret sentences whose *intent* was pretty plain at a glance. We got nowhere and proved nothing except the fact that we don't trust the FCC, either.

Now, more than ever, I wish I were a sharp attorney. I'd like to present our case intelligently before the FCC, then listen to comments in opposition. I think I'd point out that ham radio needs policing the least of any radio service. Yes, I know the FCC has probably received more complaints about repeaters than any other ham mode – but repeaters have never been legally recognized, so they have always been a subject of controversy. But the real case for repeaters is the case for public interest, convenience, and necessity. More than any other aspect of our hobby, repeaters fill this requirement. Rare is the repeater that has no public service ties. And more and more common is the repeater that is relied upon by local civil defense and other emergency organizations.

I would appeal to the FCC to put 18803 in abeyance, and adopt Docket 1542 as an interim measure, in the same manner as the government of our Canadian neighbors has done. Let us prove our worth. Let us have the opportunity to do what we're licensed for – to serve our purpose to the best interest of the public. There is no clear and immediate need for a tight set of restrictions. Even the FCC can see where the proposed restrictions are detrimental to public interest. What we really need is relaxed restraints so we can develop and grow, and prove even more valuable to the communities in which our repeaters are situated.

. . . K6MVH ■

For The Experimenter!

International EX Crystal & EX Kits

OSCILLATOR / RF MIXER / RF AMPLIFIER / POWER AMPLIFIER

Type EX Crystal

Available from 3,000 KHz to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is ±.02% when operated in International OX circuit or its equivalent. (Specify frequency)

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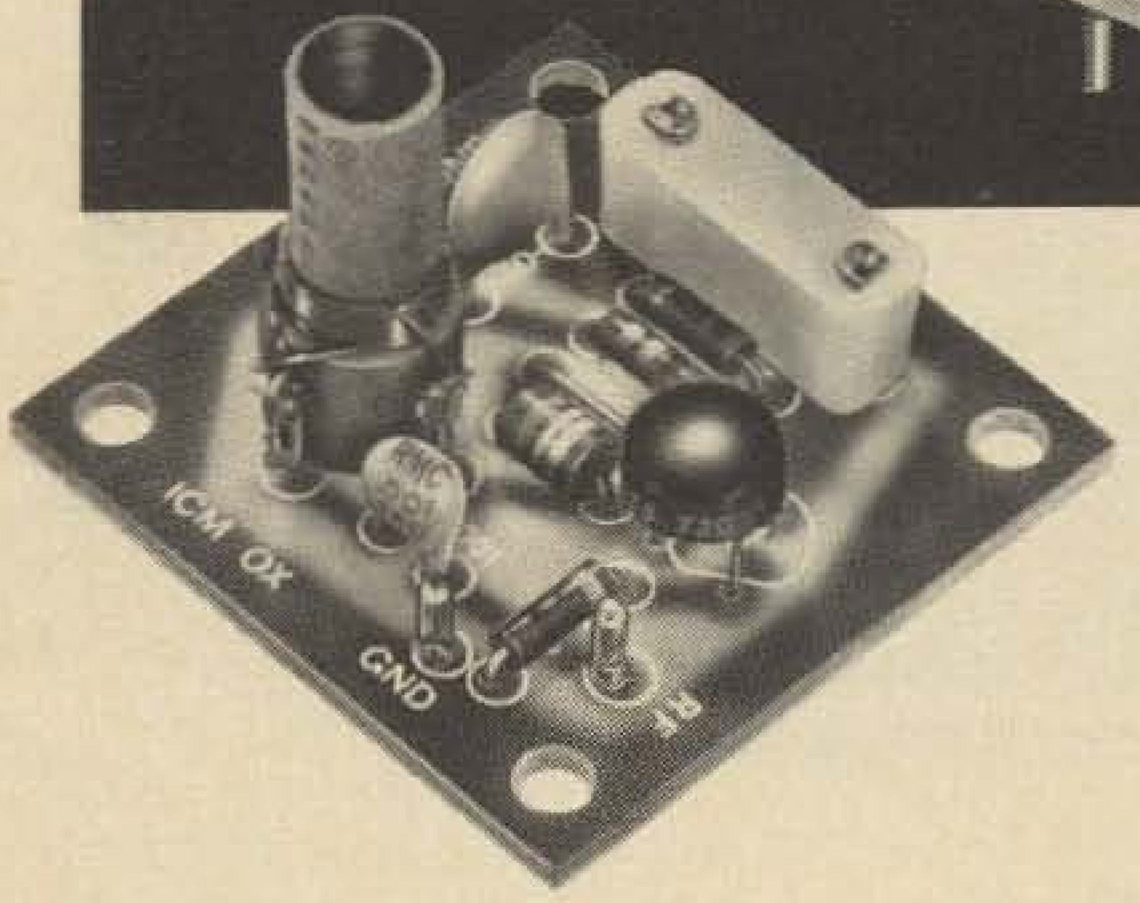

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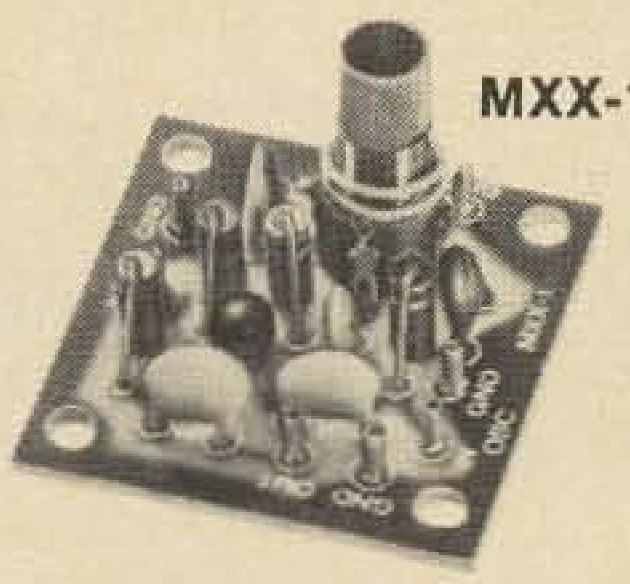
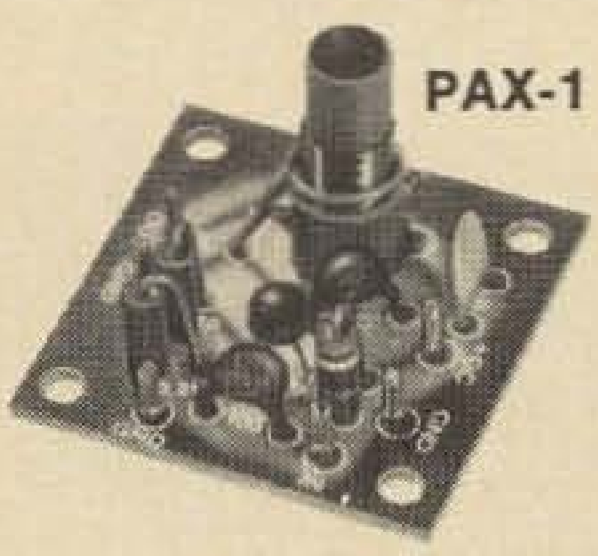
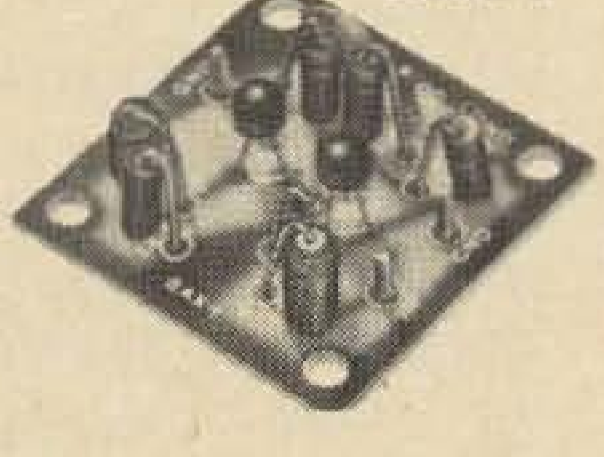


SAX-1

PAX-1



BAX-1



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Leaky Lines

AN EDITORIAL by DAVE MANN K2AGZ

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I find it incomprehensible, listening to the remarks of some hams, otherwise quite placid and mild mannered, when the subject gets around to fellows who wear their hair longer than most of us do. There would appear to be a hidden spring of sadism which wells up to the surface and overflows, and it requires very little stimulus to start this unreasoning thing a-going. But after all, let's face it: long hair does not a "hippie" make.

A certain party I've always liked was heard to expound on this subject. "If I'd had a pair of scissors in my pocket, I'd have given some of those guys a haircut!" Now, of course, this is silly, because a chap's haircut is no index to his political persuasion or anything else. If you doubt that, just turn your memory backward and visualize the late Senator Everett McKinley Dirksen. If ever there was a man with a more disreputable looking mop of kapok on his noggin, I'd like to know who. Yet no one ever faulted old Ev. Leastwise, not about his leonine tonsure. Matter of fact, that unruly hairdo was one of his most notable characteristics, second only to the mellifluous foghorn, that voice with which he spoke the best English extant. . .unique and famous the world over.

On the other hand, in the first days of the Russian Revolution every Bolshevik in good standing shaved his pate clean. I presume that this was proof positive that he had undergone the delousing process regarded as *de rigueur* at that time in that unhappy land. So far as I know (and I couldn't care less) they still need the delousing!

You cannot tell anything about someone's political or social persuasions on the strength of physical appearance. Unfortunately there are some reds who wear the cloth. And there are Cosa Nostra torpedoes who look like bankers and members of the Union League. And I remember a highly successful female film star who made the list of the ten best dressed women several times. Actually, she needed a bath so badly she stank to high heaven!

Now that I reflect upon it, I don't think my friend would really attack anyone with a pair of scissors. As I visualize his all-too-evident head full of pink, shiny skin, drawn as tightly as a snaredrum head, I think it was probably just a case of pure green-eyed envy.

That's all.

Nobody asked me, but . . .

. . . Why do some would-be "control stations" try to set up net-style operations during ordinary, roundtable ragchews? They grandiloquently announce, "John, you give it to Joe. Joe will turn it over to George; George, you pass it to Pete; Pete will give it to Charlie, and Charlie will turn it back over to me." If they're so all-fired anxious to act like traffic cops, why don't they join the police department?

. . . Why is it that when the band is almost devoid of activity, and you're having a nice quiet chat with an old friend, some thoughtless creep starts counting, "One, two, three, four, four, three, two, one. Testing, testing, testing," right on your frequency, or even worse, 500 Hz away? Why is it?

. . . How come some guy in contact with a rare DX station will start to describe his shack, the color of his wallpaper, the ages of all his six kids, his wife's operation, his bursitis, why he switched from vox back to push-to-talk, and who was the King of Albania when he got his first license? And how come this always happens when there are 479 other guys trying to get a contact, especially when the signals are starting to fade into the rising noise level. How come?

New Math

As a public service, and to uphold the dignity of us fuddy-duddies of the older, more benighted generation, I'd like to say a few words about the so-called "new math" that some of the kids are bringing home from school these days. It is disconcerting, doubtless, to hear seven- and eight-year-old tykes uttering mystifying and formidable terms such as "sets, subsets, commutative and associative properties" and the like. In our day, and I blush to admit it, plain old plus and minus were obstacles enough, and I distinctly recall that it took me weeks to learn my multiplication tables.

The essential thing about the new math is that it seeks to be precise, and also avoids the use of misleading inaccuracies of the past. I remember being told, "You can't subtract 9 from 7," for example, and then making the discovery that I could indeed subtract, obtaining minus 2 as the answer. Nowadays kids are taught the essential structure of the subject. . .the why, rather than the how. . .through plane geometry, algebra, number lines, binary arithmetic and sets. They

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are also being introduced to analytic geometry, probability, and Boolean algebra. . .all of which were previously restricted to college level courses.

The new teaching, called the discovery method, is worlds removed from the old teaching by rote. By means of a sort of Socratic question-posing technique, children are steered into investigating for themselves the world of numbers. The premise is that what is absorbing and intellectually intriguing is fun, and consequently learned more quickly and more lastingly.

Many parents, unwilling to relinquish the old methods which they learned in school, are finding it difficult to catch on to the new math. Because one of the most important roles of father and mother continues, in spite of changes in attitudes, to be the preservation of a sense of respect for elders in their offspring, this is getting to be a problem. The kids cannot seem to generate much respect for elders who cannot seem to grasp intellectual concepts which they themselves find logical and understandable.

There is an interesting little book, published by the American Book Company, entitled "What About This Modern Mathematics Business?" (A Handbook for Parents.) This book, simply written, explains in clear terms the material which is covered in these new school programs. I recommend it to you earnestly if you are puzzled about this subject.

After all, what are you going to tell your youngster when he asks, "Gee, Dad, will you help me make a Mobius Strip to take to class tomorrow," or, "Say, Mom, what's the difference between the decimal, duodecimal, and binary numeration systems?"

Atrophy

I write a semiweekly column for a suburban newspaper in the area where I live. In casting about for subject matter (I am not restricted in any way), it struck me that I might discuss ham radio. In my column I pointed out that this would be a splendid opportunity for channeling the energies of youngsters in a meaningful and constructive way. I pointed out that there were no acid-heads or glue sniffers. . .no hubcap thieves or child molesters. . .and probably very few radicals or revolutionaries in ham radio.

I also pointed out that apart from the enjoyable aspects of the hobby and the opportunities to perform public services in many ways, participation could also unlock the doors to very rewarding careers in electronics. I closed the column by inviting inquiries, and stated that I would refer all such to regional and local amateur radio clubs, so that the matter of license and equipment could be dealt with.

As a result of the appearance of this column I received several dozen replies. There appeared to be an enthusiastic body of area residents, most interested in becoming involved. This included many adult persons in addition to young people. In three instances the queries involved entire families, both parents and children. This large response was extremely gratifying, and I was sure that in a short period there would be some new amateurs in this area, a most desirable development from every standpoint.

I am chagrined to have to report that I was not able to find too much club activity here. The nearest club to me has been *hors de combat* for the past two or three years. There do not appear to be any truly active radio clubs anywhere in the immediate vicinity, outside of some which are specifically slanted toward individual ham activities such as DX or VHF. Consequently, I have had to combine my own personal efforts with those of some ham friends, in order to get these folks oriented, trained, licensed, and equipped. I have not been able to find a single active radio club functioning here. This is a sorry state of affairs, particularly since there was a great deal of club activity hereabouts in prior years.

The high schools, a natural place for the formation and growth of such clubs, are almost totally devoid of any interest in the matter. One of the main reasons for this is the failure of school boards to provide any funds for this type of activity, and, since the budgets do not call for any expenditures in this area, there are few teacher-hams who could be expected to stand the cost personally, much as they would like to do so. It is unfortunate that while there are always enough funds to purchase footballs, twirling batons and hockey pucks, somehow the schools do not seem able to buy the most inexpensive pieces of used radio gear, so that radio clubs can be activated where they might do some good.

I should like to urge all the readers of Leaky Lines who live in communities where a similar situation exists to instigate programs of their own, in order to awaken interest in amateur radio among area residents. Where the school boards appear to be unenthusiastic in their response to the idea, public demand for such programs may possibly inspire a change in direction. I am confident that there is not a science department in a single school which does not include a teacher who would be willing to assume the trusteeship or leadership of a ham radio club. Offer your services and make yourself available to such people so that your neighborhood school may become a spawning ground for future hams. If we address our energies to such projects there is no doubt that many clubs can be activated.

We all owe a debt to this hobby we love so well. I suggest that one of the most concrete ways in which we can repay it is to see that our enthusiasm is passed along to the youth. If we can institute and maintain a viable, ongoing process of ham recruitment, we will not only be supplying our hobby with a vital flow of new blood, but we will be contributing toward our nation's health by helping to provide constructive, positive and meaningful channels of activity for our youngsters. What could be more important than that?

. . . K2AGZ ■

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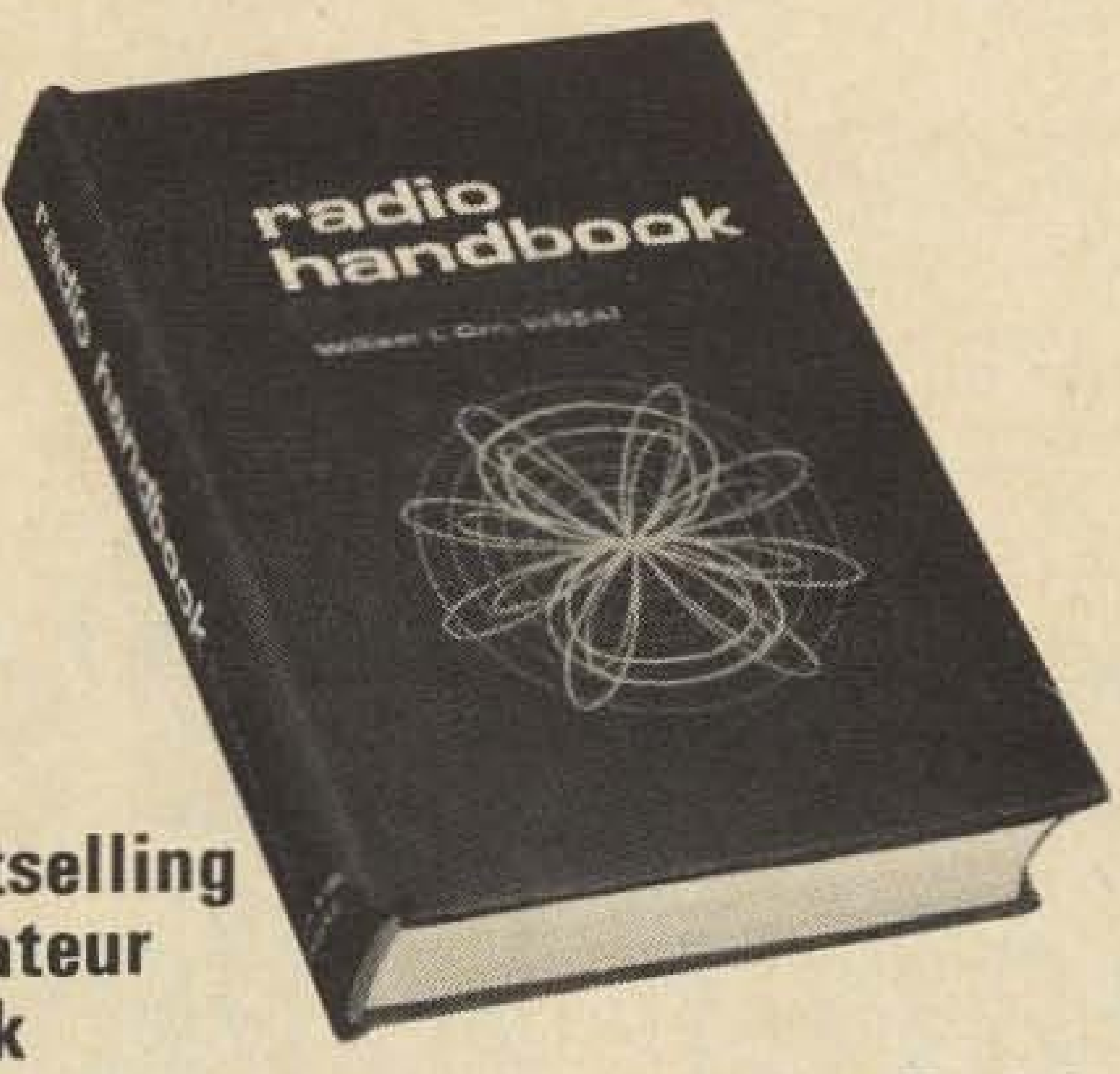

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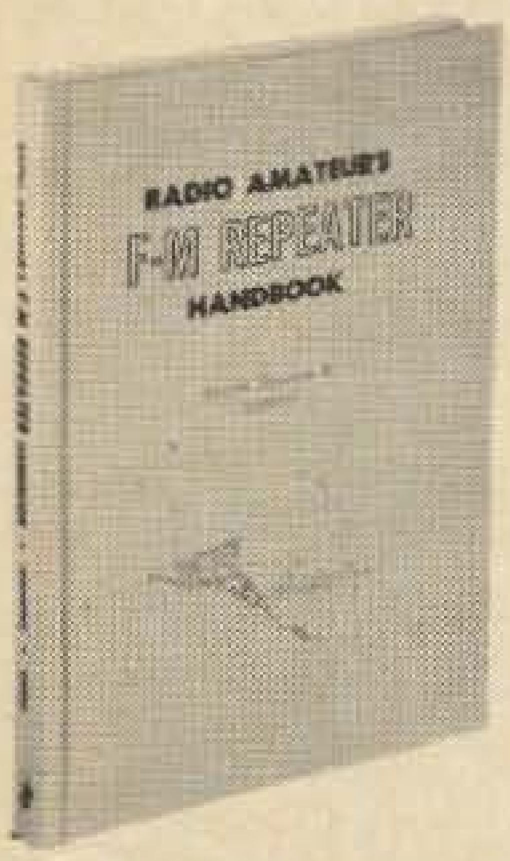

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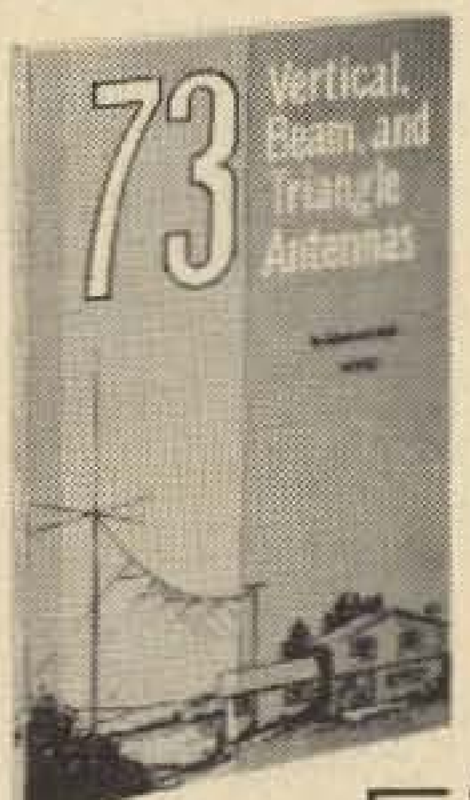

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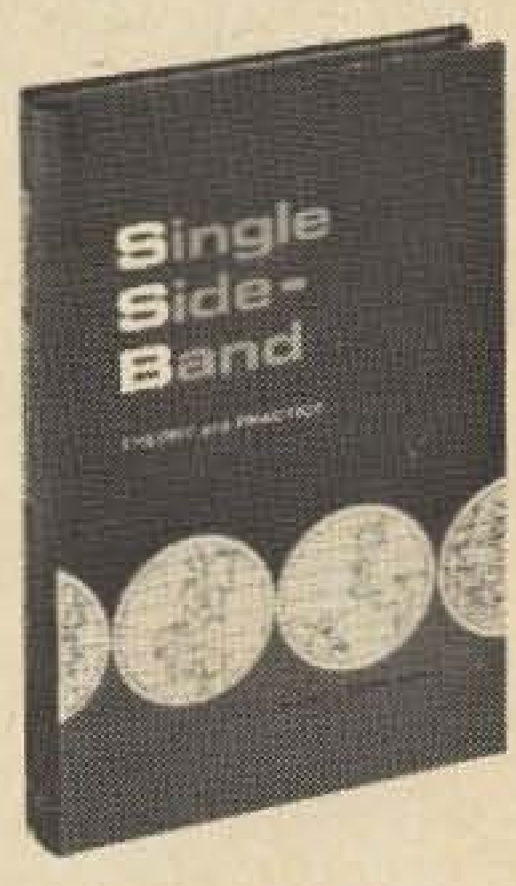

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SPECIAL REPORT

73 Comments on FCC's Proposed Repeater Rules

Many of us by now have had the opportunity to study Docket 18803 carefully. For the benefit of those who have not, I think it is safe to say that this proposal is the most important since incentive licensing, and more devastating to the future of VHF amateur radio than any rule change bid in our history. For repeaters, the proposal changes are stiflingly restrictive and growth-stopping. For remote operation, the proposed rules are disastrous. With these rules, there can be no satellite translators, no mobile remote control operation, no city-to-city links, no cross-country systems. Docket 18803 spells instant death for remote operation as we know it, and imposes complex repeater hardships – and this is no exaggeration. Every radio amateur – VHF'er or low-band operator, repeater owner or not, remote devotee or CW enthusiast – owes it to ham radio to do everything in his power to stop this proposal from getting passed. To do this, here is what *you must* do: Read the FCC-proposed rule changes reprinted here, then write your comments. Send the original and 14 copies of your comments to the FCC in Washington, D.C. *before May 15*. This is absolutely essential. You *must send all 15 copies before May 15*.

The FCC Proposal (Docket 18803 Appendix) is printed in italics below. The comments of the 73 editorial staff are incorporated in close-spaced bold-face type. Your comments may or may not coincide with those of 73. At any rate, you have the chance to see what we think of each item in the proposed rule changes. Make your own comments independently if you like; or, if you feel as we do, tear our comments out, sign it, then make 14 copies and send the whole works to Washington.

If you're involved in a repeater that has public service ties, get affidavits and supporting documentation from your local government authorities. Remember – they, too, have the right to make comments, since their operations are directly affected by the proposed changes, and they do represent the public, whose interest is supposed to be served by amateur radio.

DOCKET 18803 APPENDIX
RULE CHANGE RECOMMENDATIONS OF FCC
(with editorial comments in bold type)

1. In § 97.3, a new paragraph (i) is added to read as follows:

§ 97.3 Definitions

(i) Amateur Repeater Station. An amateur station at a specified fixed location used to automatically retransmit signals of other amateur stations.

2. Section 97.41 is amended by adding a new paragraph (b) as set forth below, and redesignating former paragraphs (b) and (c) as (c) and (d).

§ 97.41 Application for station license.

(b) Each application for a remotely controlled station shall be filed on FCC Form 610 or FCC Form 610-B, as appropriate, and must include a supplementary statement giving the address of the remote control point and indicating whether control will be by wire or radio. If remote control is by radio, complete information must be furnished showing how the transmitter is controlled and what means will be used to prevent unauthorized operation of the transmitter. Data on control frequencies, the function of all relays, timing devices used for control, directional transmitting and receiving antennas in the control system, and other pertinent details must be included.

3. A new § 97.42 is added to read as follows:

§ 97.42 Station location.

Every station must have a fixed transmitter location. Only one fixed transmitter location, which will be designated on the station license, will be authorized unless the station is authorized to be operated by remote control.

4. Present § 97.43 is deleted and new § 97.43 is added to read as follows:

Amateur Remote Stations

§ 97.43 Remote Control of an Amateur Station.

(a) Remote control of an amateur station other than an Amateur Repeater Station from a point or points specified on the station license may be authorized provided:

(1) The remote transmitter is so installed and protected that it is inaccessible to unauthorized persons.

(2) That in addition to complying with § 97.85, a photocopy of the Amateur Station license is posted in a conspicuous place at the remote transmitter location.

(3) The emissions of the transmitter are continuously monitored at the control point.

(4) The radiation from the transmitter can be immediately suspended from the control point when there is any deviation from the terms of the station license or the requirements of this part.

(5) The station is so designed and installed that the transmitter can be activated only from the authorized fixed control point.

Such exclusive activation restricts the operation of a remotely controlled station to the detriment of the public interest, convenience, and necessity. No mobiles, for example, would be allowed to access the remote station, which is at present perhaps the most valuable type of installation for public service applications, would be restricted in such a manner that it would be virtually worthless for all uses except the relaying of signals to and from the control operator's base.

One life–at least–was saved already because of an amateur's ability to access his remote transmitter and phone patch from his car. On a stretch of freeway near Los Angeles, a motorcycle officer had a heart attack and spilled. Motorists stopped but no one could help. Don Milbury W6YAN didn't even stop. He accessed his remote autopatch as he passed the scene, and called an ambulance and the local authorities. The policeman might have died without the prompt medical aid that came as a direct result of Don's call. Amateur radio paid its way that day, and no one could say that Don Milbury's brand of radio is not in the best public interest. If this part of the FCC proposal gets through, operation of a remote station from a car will not be legal.

On another occasion, two amateurs in Pomona, California saw a hit-and-run accident, and telephoned the police from their car using the remote control facilities of K6MVH. The two hams followed the suspect car while they kept up a running conversation with the police dispatcher, who radioed update location data to patrol vehicles in the vicinity. Within minutes, the suspect vehicle was intercepted. The local police were impressed with the hams' communications capability. It is doubtful that this local government considers amateur radio to be a TVI-generating nuisance, as so many others do.

As a suggested alternative rule change for the above-proposed item, how about this:

(5) The station is so designed and installed that master control can always be effected from the fixed control point, and access from the fixed control point shall at all times be capable of overriding all other input signals.

This suggested alternative proposal leaves the door open to operate and control a remote station from a hand-held, portable, or mobile unit, as long as an authorized monitor has the capability of exercising master control from the fixed station.

(6) That if remote control is by radio, the control link is direct, without intermediate relay.

Here, again, is a rule portion that does not appear to be in the public interest. *Master* control of the remote transmitter, of course, *should* be "direct" without intermediary relay. But there should be no rule against indirect control as long as the direct control is maintained from the fixed site. Many remotely controlled stations are situated in such a manner that "direct" control from a low-power station is impossible because of distances, terrain, etc. To circumvent the problems, an intermediary station is set up so that user stations can transmit signals that can be relayed to the remote transmitter. Back-to-back repeater stations are examples of indirect control of a remote facility; they allow installation of phone patches even when there are no phone facilities at the basic remote location. They allow range extension when the users live out of the area where most of the FM action is taking place. In addition, they offer the only means whereby users of one remotely

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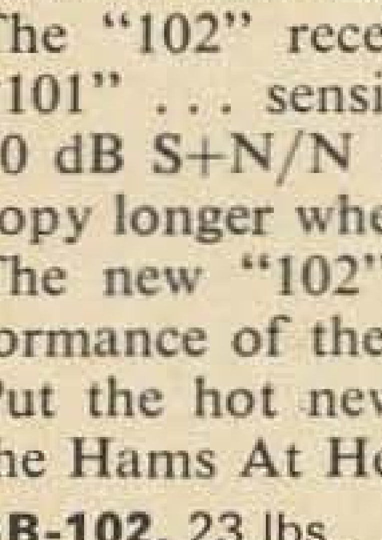
SB-102 SPECIFICATIONS — RECEIVER SECTION — Sensitivity: Better than 0.35 microvolt for 10 dB signal-plus noise to noise ratio for SSB operation. **SSB selectivity:** 2.1 kHz minimum at 6 dB down, 5 kHz maximum at 60 dB down — 2:1 nominal shape factor — 6:60 dB. **CW Selectivity:** (With optional CW filter SBA-301-2 installed) 400 Hz minimum at 6 dB down, 2.0 kHz maximum at 60 dB down. **Input impedance:** Low impedance for unbalanced coaxial input. **Output impedance:** Unbalanced 8 and 600 ohm speaker, and high impedance headphone. **Power output:** 2 watts with less than 10% distortion. **Spurious response:** Image and IF rejection better than 50 dB. Internal spurious signals below equivalent antenna input of 1 microvolt. **TRANSMITTER SECTION: DC power input: SSB:** 180 watts P.E.P. continuous voice. **CW:** 170 watts — 50% duty cycle. **RF power output:** 100 watts on 80 through 15 meters; 80 watts on 10 meters (50 ohm nonreactive load). **Output impedance:** 50 ohms to 75 ohms with less than 2:1 SWR. **Oscillator feedthrough or mixer products:** 55 dB below rated output. **Harmonic radiation:** 45 dB below rated output. **Transmit-receive operation: SSB:** Push-to-talk or VOX. **CW:** Provided by operating VOX from a keyed tone, using grid-block keying. **CW side-tone:** Internally switched to speaker in CW mode. Approx. 1000 Hz tone. **Microphone input impedance:** High impedance. **Carrier suppression:** 50 dB down from single-tone output. **Unwanted sideband suppression:** 55 dB down from single-tone output at 1000 Hz reference. **Third order distortion:** 30 dB down from two-tone output. **Noise level:** At least 40 dB below single-tone carrier. **RF compression (TALC):** 10 dB or greater at .1 ma final grid current. **GENERAL: Frequency coverage:** 3.5 to 4.0; 7.0 to 7.3; 14.0 to 14.5; 21.0 to 21.5; 28.0 to 28.5; 28.5 to 29.0; 29.0 to 29.5; 29.5 to 30.0 (megahertz). **Frequency stability:** Less than 100 Hz per hour after 10 minutes warm-up from normal ambient conditions. Less than 100 Hz for ±10% line voltage variations. **Modes of operation:** Selectable upper or lower sideband (suppressed carrier) and CW. **Visual dial accuracy — "resettability":** Within 200 Hz on all bands. **Electrical dial accuracy:** Within 400 Hz after calibration at nearest 100 kHz point. **Dial mechanism backlash:** Less than 50 Hz. **Calibration:** 100 kHz crystal. **Audio frequency response:** 350 to 2450 Hz ±3 dB. **Phone patch impedance:** 8 ohm receiver output to phone patch; high impedance phone patch input to transmitter. **Power requirements:** 700 to 800 volts at 250 ma; 300 volts at 150 ma; —115 volts at 10 ma; 12 volts at 4.76 amps. **Cabinet dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.



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In California, New England, and Nevada, for example, experiments have been performed and systems are currently being built that allows repeater groups to access the repeater facilities of other repeater groups by mutual consent. The UHF control facilities for the WB6SLR remote station in California could be used to interrogate the control system for the K7TDQ remote station in Las Vegas. If K7TDQ is willing to allow his repeater to be an input/output terminal, he could electrically command his system to respond to the control signals of the WB6SLR machine in California. The result is a Los Angeles to Las Vegas repeater system interconnected by a controllable 450 MHz link.

Similar cooperative efforts have taken place along the eastern seaboard when Gordon Pugh K2GHR exercised control of several repeaters in New England and Canada from his own remotely controlled station.

Repeater expansion along the lines of metropolitan interconnections – currently being planned between northern and southern cities of California, between Tulsa and Wichita, San Diego and Phoenix, Los Angeles and Las Vegas, and perhaps 50 other places in the country – cannot take place without allowing "indirect" control of a remotely situated station.

(7) That if remote control is by radio, the control transmitters operate on frequencies within a band above 220 Mc/s.

(8) That if remote control is by radio, a timer is provided to automatically limit transmission to a period of three minutes in the event of failure of the radio control link, capture of the control receiver by an undesired signal, or other technical malfunction.

Amateur Repeater Stations

(b)Remote control of an Amateur Repeater Station may be authorized provided:

(1) The installation and operation of the station complies with paragraph (a) of this section.

(2) The station is provided with an automatic timer to limit a single uninterrupted transmission to a period of not more than three minutes. This circuit may be so designed that it will automatically reset but will not permit use of the transmitter until receipt of a properly coded signal.

The last sentence in this segment should be replaced with: "This circuit may be so designed that it will be automatically reset but will not permit reactivation of the repeater until receipt of a properly coded signal." The wording differences between this and that proposed by the FCC are quite subtle, but the reason will be clear when the comments to (4) below are understood.

(3) The station is so designed and installed that overriding control of the station is maintained from an authorized remote control point.

(4) The station is so designed and installed that the transmitter can be used only upon receipt of a coded tone signal after the transmitter has been activated from the control point.

There are two major types of coded repeater control in very common use, both of which offer the protection from inadvertent interference that is the purpose of such control methods. The first type of control is "tone burst entry," where a coded tone is required of each repeater user at every transmission in order for his signals to be repeated. The second type, single-tone activation, is commonly known as "whistle-on," and allows the repeater to be activated for uncoded carrier operation when the user whistles on the input frequency. In the whistle-on system, the repeater continues to operate on a carrier-operated basis as long as the repeater is in constant use. When a short time goes by with no input signals, the repeater automatically deactivates, and must be "whistled on" before it can be again activated. The rule as proposed by the FCC does not provide for this very functional form of subcontrol, and places an undue burden on all repeater operators to the effect that ALL users must equip their units with tone generators. The intent of the rule can be satisfied without the necessity for all operators installing tone-burst equipment if the rule in question were to be modified as follows:

> The station is so designed and installed that the repeater can be used only upon receipt of a coded tone signal after the transmitter has been activated from the control point; or, in the case of a whistle-on tone system, the repeater can be energized for carier operation provided that a means is incorporated for automatically deactivating the repeater within 3 minutes after the last signal is received. Reactivation after this period can be achieved with a tone from the repeater input frequency only if the repeater has been properly activated from the control point.

(5) The station is so designed and installed that the transmitter will be silenced within five seconds after cessation of the output of its associated receiver.

5. In § 97.61, the introductory text of paragraph (a) is amended, and a new paragraph (c) is added to read as follows:

§ 97.61 Authorized frequencies and types of emissions.

(a) Following are the frequency bands and associated emissions available to amateur stations, other than Amateur Repeater Stations, subject to the limitations stated in paragraph (b) of this section and § 97.65. Frequency bands available to Amateur Repeater Stations are shown in paragraph (c) of this section.

(c) Amateur Repeater Stations must receive and transmit in the same frequency band. Simultaneous transmission in two or more frequency bands is not permitted. The following frequency bands and the emissions authorized in those bands in paragraph (a) of this section are available for Amateur Repeater Stations:

52.50 - 52.70   53.00 - 53.20

Input (Receiving) Mc/s	*Output (Transmitting) Mc/s*
52.50 - 52.70	*53.00 - 53.20*
146.30 - 146.60	*146.90 - 147.20*
223.10 - 223.30	*224.10 - 224.30*
447.70 - 448.90	*449.10 - 449.30*

Any amateur frequency above 1215 Mc/s

The intent of this part of the proposal is to lessen the congestion caused by multiple transmissions of repeaters and to minimize the interference caused by crossband operation, where monitoring of the output before transmission is difficult and impracticable. The outlawing of 6-to-2-meter systems seems reasonable, because both bands are active, often crowded, and are in general use by amateurs using a variety of modes.

But who could deny the attributes of a crossband system between 2 meters and 220 MHz, or between 6 or 2 meters and any of the UHF bands, or between one UHF band and another? Is this not the next logical step in amateur repeaters? And is this not the only practicable method by which amateur orbiting satellite translators and repeaters can evolve?

In the interest of furthering the development and natural growth of amateur radio, there should be no restrictions between crossbanding on these higher frequencies, where the bulk of the activity is already provided by the individuals who inhabit the spectrum for the sole purpose of exploring and exploiting the capabilities of advanced communication forms.

The frequency restrictions of the above subband allocations are also unduly restrictive. Not only would these allocations render a large number of existing repeaters illegal, but they pose problems to the repeater users that are only questionably solvable within the existing state of the art (such as the narrow spread in the 450 MHz region).

There are obvious advantages to restricting repeaters to specific portions of the spectrum, and virtually every VHF operator knows this; for this reason, amateur 2 meter FM operators – including repeater owners and users – have unanimously agreed to populate only frequencies above 146.04 MHz, and then only those frequencies that are spaced at multiples of 30 kHz from one another. In highly congested areas where there is an abundance of FM activity, operators have made unwritten agreements to reduce deviation levels to ±5 kHz at least on alternate channels, and in many cases they have reduced deviation to narrowband standards on all FM channels. Since channelized operation is universally accepted in the United States (and Canada), there would seem little need to establish discrete band portions for transmitting and receiving. Rather, it would seem in the best public interest as well as in the interest of amateur radio, to allow FM repeaters to be established on existing channels, depending on the activity, operating conditions, and individual requirements of the areas where the repeaters are to be used. In some cases, the repeater input should be higher in frequency than the output; in others, the reverse would be more locally suitable. And in some instances, as in separated sites, the transmitting and receiving portions of the repeater could best be placed on the same frequency (as has been done successfully in several installations).

6. Section 97.67 is revised to read as follows:

§ 97.67 Maximum authorized transmitter power.

(a) Transmitter power is the d.c. power input to the final r.f. amplifier. If the final amplifier is of the r.f. grounded-grid of r.f. grounded-base type, the transmitter power also shall include the d.c. power input to the stage which immediately precedes the final r.f. amplifier.

(b) Except as limited by §97.61 (b) transmitter power shall not exceed:

(1) 600 watts for transmitters used at Amateur Repeater Stations.

Since the difference between 600W and the 900W maximum legal limit of remotely operated transmitters represents but a barely noticeable amount (less than 2 dB), little is to be gained by this restriction. An amateur repeater should be allowed to operate with the same power restrictions faced by other amateur stations.

(2) Two kilowatts for single sideband radiotelephone transmitters and other amplitude modulated radiotelephone transmitters using reduced, suppressed, or controller carrier when measured during maximum peaks of modulation;

(3) One kilowatt for all transmitters other than those covered by subparagraphs (1) and (2) of this paragraph.

(c) Equipment capable of operation with transmitter power in excess of 90% of any applicable power limitation shall have installed a means for accurately measuring transmitter power.

7. Section 97.79 is revised to read as follows:

§ 97.79 Operator Requirements.

(a) An amateur station may be operated only by a person holding a valid amateur operator license issued by the Federal Communications Commission and only in the manner and to the extent provided by the class of license held by the operator or the station licensee, including the trustee of a club station, whichever is the lesser.

(b) The licensed operator required by paragraph (a) of this section must be on duty at the transmitter location or at an authorized control point.

(c) An amateur station licensed as a military recreational station may be operated only in the manner and to the extent provided by the class of amateur license held by the person operating the station.

(d) When an amateur station is used for telephony or radioprinter transmissions, any person may transmit by voice or teleprinter, provided a licensed amateur operator is present at the operating position, continuously monitoring the transmissions and maintaining supervisory control of the station, including turning the carrier on and off for each transmission and signing the station off after communication with each station has been completed.

8. In § 97.87, new paragraphs (e) through (h) are added to read as follows:

§ 97.87 Station identification.

(e) In lieu of the requirements of paragraph (a) of this section, an Amateur Repeater Station may be automatically identified by radiotelegraphy at intervals not to exceed three minutes by keying on audio tone superimposed on the voice transmissions. The code speed shall not exceed 20 words per minute, and the modulation level shall be sufficient to be readable through the voice transmissions.

This should be modified to permit automatic identification by telegraphy or recorded voice.

(f) A station licensed to an individual may be identified by its assigned call only when operated by or under the immediate supervision of the station licensee. If the station licensee, who is the owner of the equipment, is not present, the operator must identify his transmissions by using his own call sign with the appropriate portable indicator.

Should also state: An Amateur Repeater Station will be identified only by its designated call regardless of which authorized control licensee is monitoring from an authorized control point.

(g) A club station may be identified by its assigned call only when operated under the supervision of the trustee or an authorized club member.

(h) A military recreation station may be identified by its assigned call only when operated by a member of the Armed Forces of the United States who holds a valid amateur operator license.

9. Section 97.89 is amended to read as follows:

§ 97.89 Points of communication.

(a) Amateur stations may communicate with:

(1) Other amateur stations.

(2) In emergencies or for test purposes, and on a temporary basis, with stations in other services licensed by the Commission and with United States government stations.

(3) Any station, other than an amateur station, which has been authorized to communicate with amateur stations.

(b) Notwithstanding the provisions of paragraph (a) of this section, an Amateur Repeater Station shall not repeat the transmissions of another Amateur Repeater Station.

It is absolutely essential to the growth and technological development of UHF and VHF amateur radio that such restrictions are not imposed. Dual repeaters are invaluable for some applications, such as public service functions outside the area normally served by a repeater.

As an example, the Wichita repeater is heavily depended on by the local government to provide early warning for maximum evacuation effectiveness. Like any other repeater group, the Wichita repeater users have mobile units and hand-held transceivers, which are used in conjunction with the repeater to provide an effective communications system. But what happens when the alert is out of the area of immediate coverage of the repeater? With the FCC restriction of no multiple repeaters, civil defense usefulness suffers, because the mobiles and hand-held units of the group are worthless without the repeater – the heart of the communications system.

On the other hand, if multiple repeaters were not illegal, the repeater crew could take a portable UHF repeater to the scene to act as an intermediary system, extending the range of all low-power units so that the immovable repeater in Wichita could still be used as if the disaster point were actually in Wichita. The intermediary repeater could be no more than a temporary setup designed to operate from emergency power or from the power source of an automobile. This is how such a system works:

Hand-held units transmit on 146.34 MHz and receive on 146.94 MHz, frequencies compatible with the permanent repeater. The intermediary repeater receives on 146.34 and retransmits on the UHF control frequency for the permanent repeater. The control receiver at the permanent site relays the UHF signal to 146.94 and to another frequency in the UHF range. The intermediary repeater accepts the UHF signal and retransmits to 146.94, thereby allowing all low-power user stations to communicate through the permanent repeater by virtue of the dual relay.

Interlinking of repeaters is a vital step in VHF progress, and is one of the most attractive features we have to offer municipalities when we try to show them our communications potential. Using a multiple repeater system, it is now within the state of the art to set up a system of links so that user stations in one city could actually select, via a special access link, repeater interconnections in other cities. With the advent of communications satellites, UHF dial-a-city could become a very common practice – and it could be designed so as to be completely compatible with existing systems on a noninterference basis.

The proposed rule stated in (b) above should be reworded as follows:

> **Notwithstanding the provisions of paragraph (a) of this section, an Amateur Repeater Station shall not repeat the transmissions of another Amateur Repeater Station** *except by mutual consent of the responsible principals of all repeaters to be affected by such a multiple relay.*

10. Section 97.103 is revised to read as follows:

§ 97.103 Station log.

(a) Each licensee of a station other than an Amateur Repeater Station shall keep a log of station operation which shall include the following:

(1) Except when operating mobile, the date and time of each transmission or the beginning and end of a series of transmissions.

(2) When operating mobile, the date and time station operation commences and ends.

(3) Call sign of the station called.

(4) If the transmissions are made through a repeater station, the call sign of the repeater.

(5) The signature of each licensed operator who operates the transmitter from the transmitter location or control point and the date and time of such operation.

(6) The name of any person other than the operator who directly or by recording transmits by voice or transmits by radio teleprinter.

(7) The input power to the transmitter.

(8) The frequency band or subband used.

(9) The type of emission used.

(10) The station location.

(11) If record messages are handled, a copy of each message sent and received shall be entered in the station log or retained on file for at least one year.

(b) The licensee of an Amateur Repeater Station shall keep a log of operation which shall include the following:

(1) The date and time station operation commences and ends.

To avoid misunderstanding, this should state ". . .the date and time repeater is placed in service and is accessible by user stations who comply with access requirements."

(2) The entries specified in subparagraphs (5), (7), (8), (9), and (10) of paragraph (a) of this section.

(3) A record of all installation, service, or maintenance work performed which may affect the proper operation of the station.

(4) The entry required by subparagraph (3) of this paragraph shall be made, signed, and dated by the licensed amateur operator who supervised or performed the work.

(c) The entries required by subparagraphs (5), (7), (8), (9), and (10) of paragraph (a) of this section need only be entered once until there is a change in the required entry.

11. In § 97.193, the introductory text of paragraph (a) is amended, and a new paragraph (e) is added to read as follows:

§ 97.193 Frequencies available.

(a) Except as provided in paragraph (e) of this section, the following frequencies and frequency bands and associated emissions are available on a non-exclusive basis to the indicated classes of stations or units of such stations in the Radio Amateur Civil Emergency Service.

There should be no subband restrictions above 51 MHz.

(e) A repeater in the Radio Amateur Civil Emergency Service may operate on any frequency and associated emission above 50 Mc/s listed in paragraph (a) of this section.

There should be no subband restrictions above 51 MHz.

END

WHAT WILL BECOME OF CW ?

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If you look all the way back to the beginning of ham radio and then trace its development up to the present day, you will see some very interesting trends. For purely academic reasons it is interesting to see where we have been. It's like studying history. In addition, by noting the various trends that have occurred, we may be able to predict where we are going. I think that one of the most interesting trends to look at is the use of the various modes like CW, AM, SSB, and RTTY. Statistics are hard to come by here to verify these trends, but I believe we can still make some general and useful observations without them. One particularly interesting phase of this is the history of CW. Let's take a look at the mode trends over the years to see if we can predict what will happen to CW.

When ham radio first began, all we had was CW, first by spark then by normal means as we know it today. As the technology of radio and electronics developed, we soon had radiotelephone by amplitude modulation. The convenience of voice communications made AM popular among hams even though it was more expensive to use, would cover less distance, and was more succeptible to noise. FM came along soon after; it too gained some followers. These gains in radiotelephone work were made at the expense of CW. Those operators that used to work CW, were now working phone or some of both. So as the years passed and radiotelephone became more widely used, CW activity decreased.

I believe it is safe to say that ever since ham radio began, there has been a continued decrease in the use of CW. The major reason for this is simply the continued and increased use of radiotelephone techniques as they are introduced or become more perfected. The introduction and rapid increase in the use of SSB no doubt has taken its toll of CW operators as well (AM operators too for that matter). The equipment manufacturers have helped by making many reasonably priced radiotelephone transceivers, some of which have absolutely no provision for CW operation. That's progress, brother.

There are also other factors that have no doubt influenced the trend of decreased CW activity. For example, in the early fifties the FCC did away with the "Class A" license phone privileges and opened the 75 and 20 meter phone bands to all amateurs. This seemed to have an almost immediate effect of increasing phone operation and correspondingly decreasing CW activity. The increased use of the VHF and UHF bands has probably caused a similar but rather indirect decrease in CW work. As more hams go to these higher frequencies, CW activity tends to decrease. Who uses CW on the VHF and UHF bands anyway?

By just listening to the various CW bands you certainly wouldn't think that CW activity has decreased much. But the somewhat overcrowded conditions are the result of an increase in the total ham population. CW activity as a whole has increased because the total number of hams has increased, but *percentagewise* it has decreased. Today CW is probably in the 30 to 40% usage bracket while phone is in the 40 to 50% range. The total doesn't add up to 100% because some hams use both modes, of course. This overlap plus some of the special modes like TV, RTTY, pulse, etc. make up the difference.

Having noted the trend of decreased CW activity, what can we say about the future? Will CW continue to decrease in popularity or what? What do you think? I'll give you my prediction here.

I sincerely feel that the incentive licensing plan now in effect will produce a slight increase in CW activity. The exclusive band segments are a big incentive for a ham to bone up on his code to get his extra class license. As most everyone knows, one of the best ways to get your code speed up is to get back on the air and work some CW. In fact, this is by far the easiest way. Regular and intense practice with code records or W1AW will get you there faster, but it will be more difficult.

The extension of the Novice license term to two years may also cause a slight increase. With more Novices on for longer periods of time, CW activity just may increase. After all, Novices work CW exclusively.

The slight upward trend will probably only be temporary or will show up perhaps just as a less rapid decrease in CW activity. I think that it is safe to predict a continued decrease over the long term. We'll just have to wait and see.

The Case for CW

Frankly I hate to see CW on the down swing. All things considered it's probably the best mode of communications available to us. It is cheaper and simpler to use than any other mode. Using it, you can cover more distance with less power under noisy and crowded conditions than any other mode. And it's the only way to handle normal and emergency traffic. These obvious advantages are continually overlooked because it's so much easier to just talk. It requires less concentration and skill to operate phone. I don't think most hams give CW a chance. Most consider it little more than a nuisance, something they have to learn in order to pass the license exam. Once they have to learn it well enough to pass the exam, it is virtually forgotten until renewal time. If hams would consider CW in a different light, we might see more activity. Don't look at CW as a necessity or a drudge. Look at it as a rare, if not unique, skill that most other people do not have, and be proud of this skill.

Another point is simply that CW becomes easier and more fun the more you use it. It's like anything else unfamiliar. The more we use it, the more comfortable we become with it and the more we will tend to use it. Get in the habit of using CW and I bet that in a short time you will like it. Your code speed will go up, you will be more adept at tuning and copying, and soon it will all become automatic, like driving a car. You won't consciously think about doing it.

I have found that two items really help to increase the pleasure of operating CW. One is a good electronic keyer and the second is a good selective receiver. With an electronic keyer you can send nearly perfect code. This is particularly appealing to a CW man. A good sounding "fist" really stands out. It's a definite mark of accomplishment. In addition, the keyer itself is intriguing. It takes a little skill and practice, of course, to master one, but yet it isn't so difficult as to cause frustration. Most hams, being incurable gadgeteers, find electronic keyers fun to play with and a challenge to use. If you are not now on CW, buy or build yourself an electronic keyer. You'll go nuts until you can get on the air and use it.

Electronic keyers make a good cheap and easy home project if you are inclined to do things yourself. There has been at least a jillion articles on them over the past ten years or so in the ham magazines, so you shouldn't have any trouble locating a suitable design to build from. On the other hand, if you don't like do-it-yourself projects, there are numerous good commercial units available. Get an electronic keyer and enjoy some CW.

The other item that helps to make CW more enjoyable is good receiver selectivity. The key to good CW reception is to have a receiver capable of separating stations operating near the same frequency. Nothing is more annoying than to lose a good contact to QRM even if his signal strength is very high. An adjacent station can easily wipe him out. However, if your receiver is selective enough, you can probably separate the two interfering stations and carry on a decent QSO.

If your station receiver isn't selective enough, you might consider an outboard Q multiplier or tunable audio filter. These are easy to add and do a good job in providing the needed selectivity. Neither requires extensive receiver modifications. If you plan to operate a lot of CW, it will pay to invest in the most selective receiver you can find to begin with.

What's in Store for CW?

Changes over the years have helped to cause a decline in CW interest. As AM, FM, and SSB became popular and more perfected, CW probably suffered some from loss of interest. However, this is not to say that all of the technological changes going on didn't have some effect on the business of CW itself. It most certainly did. The electronic keyer is certainly one development that we can point to. Not only do we have small, exotic, integrated circuit keyers, but also pushbutton, typewriter-like keyers are available. These offer improved convenience in that no CW sending skill is required. Just push the button and out comes the perfectly formed dots and dashes for that letter.

The opposite of a pushbutton keyer is a device that receives the code and automatically converts it into a visual display easily read by an operator. Such devices do exist, but they are complex and expensive. Their big advantage, like their pushbutton keyer counterpart, is that absolutely no CW skill is required. If you know your ABCs, you've got it made. Numerous code receivers like this have been developed for commercial and military use. They are so expensive that they are virtually impractical for ham use. Nevertheless, I guess if they were available, some hams would buy them. Perhaps with modern integrated circuits, an inexpensive unit could be built.

Even though pushbutton keyers and automatic code receivers are entirely possible, I'm not too sure that they are the answer to the CW question. Since no skill is required, there is really no challenge involved. Of course, this is the way it is with phone operation, so maybe such devices could really go over big. If these units could be made available to everyone at a reasonable price, the FCC could do away with the code test and we could all still operate CW without even knowing it. Transmitters would have built-in keyboards while the receivers would contain CRT, Nixie tube or some other form of alphanumeric readout displays.

In the not-too-distant future, perhaps we will see such things in common use. It will be a sort of RTTY, only using electronic means entirely and the standard international code instead of mechanical devices and the Baudot code. It will be sort of like using a computer. We can put the data in and interpret the output even though we don't know how the computer actually works internally. (Is that the definition of an "appliance operator?")

Somehow I just can't see much of this in ham radio. This takes away the pride and the skill of sending and receiving. And I feel that this is still important.

In conclusion, I say we will continue to see a gradual decline in CW activity. The incentive licensing thing may help to hold it up for a while but in the long run we will see less of it. I get the impression that people feel that it is a thing of the past, an inconvenient, cumbersome, and obsolete method of communicating. Perhaps so, but there is still a feeling of tradition and pride that will help it to hang on for years to come. You'll never experience this feeling yourself unless you work CW for a while. Give it a try. Get yourself a keyer and a selective receiver and have a go at it. You might like it. If you really want to be a pioneer, try CW on 6 or 2 meters. There is less QRM up there, more room to move around in, and CW seems to be ideal for these bands. Since propagation essentially restricts the range you can cover, it makes good sense to use CW to help you reach as far as you can. CW will go a lot farther than phone up at these frequencies. See you there. . . . W5TOM ■

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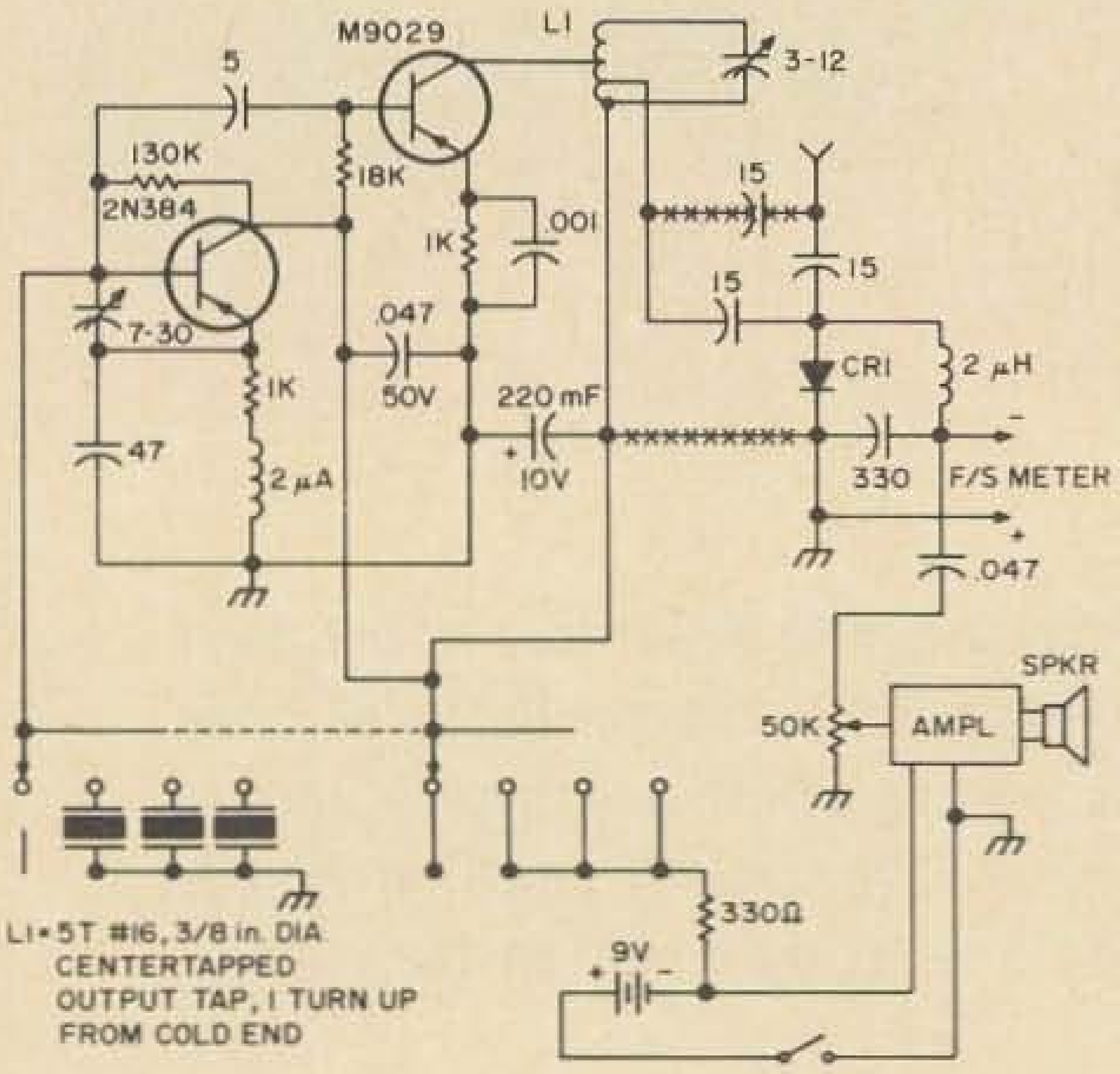
FM-AM Transmitter-Receiver Aligner

Many articles and ideas have been published in recent months which have been slanted toward the VHF FM'er. Most of them have been directed to the attention of the receiver. Little mention has been made of the transmitter.

I have been using receiver peaking and aligning generators for several years now, and since I am in the FM communications business as a profession, I have often wished that I had a small transistorized instrument that would take care of transmitter frequency and loading adjustments along with the receiver peaking.

The gadget I have conceived cannot be construed to be a precision test instrument; however, it does fulfill most of the requirements of the average VHF FM operator.



Basically, it starts off with the usual peaking generator, (a crystal oscillator and multiplier) followed by a diode mixer/ detector and an audio amplifier with enough power to drive a small speaker.

The peaking generator, while generating a small signal for receiver alignment, also provides enough signal to the diode mixer to heterodyne with a signal from the transmitter which, when amplified in the audio section, may be used to align the transmitter to the receiver frequency – or any other preset crystal frequency. Simply tune the transmitter oscillator for zero beat in the speaker.

The circuitry also provides for connection of a relative field strength meter.

In addition to its VHF applications, it works equally well in the HF bands. In my unit, I included a crystal for our local 40 meter MARS net frequency.

I chose to use PNP transistors because I had a 5 pound box of them. In the oscillator, I used a 2N384 and it took off strongly as soon as I applied battery voltage to it.

I tried several unmarked transistors in the multiplier and some of them worked pretty well, but the one I wound up using was a Motorola M9029. Upon checking it out, I found that it is commonly used as an rf amplifier in some VHF receivers. I could find no equivalent 2N number for it.

For the multiplier coil, I used 5 turns of 16 AWG centertapped for the collector and an output tap one turn up from the cold end.

The diode mixer/detector was arrived at by "cut and try" also. I still don't know what the number is because there were no markings on it – not even the usual color bands. However, it works well at VHF frequencies and delivers enough output current to drive my field strength meter to the pin (500 µA) at some distance from the transmitter.

For the audio section, I used one of those little Japanese 1W units I got from Allied Radio for $4.95, but I could have used the audio portion of one of those little pocket receivers.

. . . W3JKL/DL4UC ■

5/8 WAVELENGTH VERTICALS

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Many articles, manuals and even full-length books are devoted to antennas in general and as specifically applicable to the amateur radio service. Unfortunately, one of the most effective simple antennas for both local ground-wave and long-haul DX communications on the higher frequency bands is almost invariably conspicious by its absence. Consequently, few amateurs are familiar with the characteristics, design, or construction of the 5/8-wavelength vertical antenna.

It will be immediately apparent to most amateurs that the 5/8-wavelength vertical antenna will provide an omnidirectional radiation pattern and a vertically polarized signal. And the antenna itself will be 2½ times as tall as the more familiar ¼-wavelength vertical or groundplane. What will not be so obvious, to the uninitiated, is the even lower angle of vertical radiation, the gain obtainable and an additional improvement in reception due to increased capture area over the conventional ¼-wavelength antenna.

These characteristics have made the 5/8-wavelength antenna very popular in the land mobile services and in amateur 2 meter FM operations where omnidirectional vertically polarized ground-wave communications with low-power mobile stations are desired on a full-time basis.

Vertical antennas, almost invariably of the ¼-wavelength variety, have been widely employed in the amateur radio service for DX communications where their low angle of radiation (assuming an adequate ground system) has proved very effective. Since the polarization of radio signals is generally rotated significantly in the process of reflection, cross-polarization losses are seldom a consideration in sky-wave communications.

Unfortunately, the additional advantages of the 5/8-wavelength antenna have seldom been employed for normal amateur communications. True, a 150 ft vertical for 75 meters or 80 ft for 40 meters is beyond the facilities of most amateurs. However, a 30 ft antenna for 15 meters is well within amateur capability, and 50 ft (20 meters) is within the realm of reason.

Theory of Operation

As a short grounded vertical antenna is increased in length, the radiation lobe narrows, increases in intensity, and the angle of maximum radiation lowers toward the horizon. As the length exceeds ½ wavelength, a secondary lobe of radiation at high vertical angles develops; but the low-angle radiation continues to increase until a height of 5/8 wavelength is reached (Fig. 1). With no equalizing factor, as the

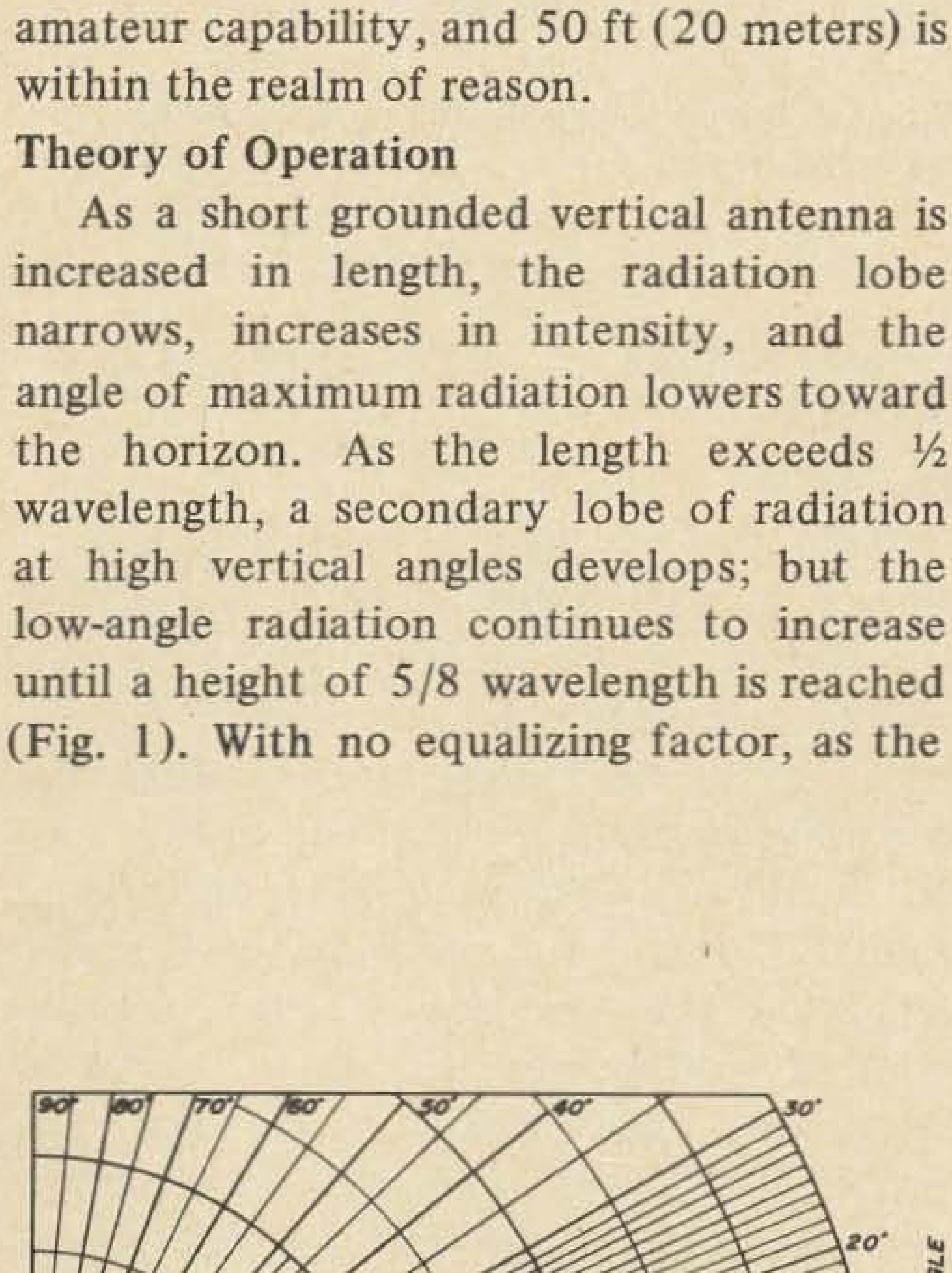

Fig. 1. Low-angle radiation increases as antenna length increases up to 5/8 wavelength.

length is increased beyond 5/8 wavelength, the high-angle radiation increases and the low-angle radiation decreases.

Since the 5/8-wavelength antenna is nonresonant, it presents a highly reactive load impedance unsuitable for direct feeding. At least three basic methods are available to transform this impedance to a 50Ω nonreactive feedpoint.

Probably the simplest method is use of a small series inductance as shown schematically in Fig. 2. The inductance can be

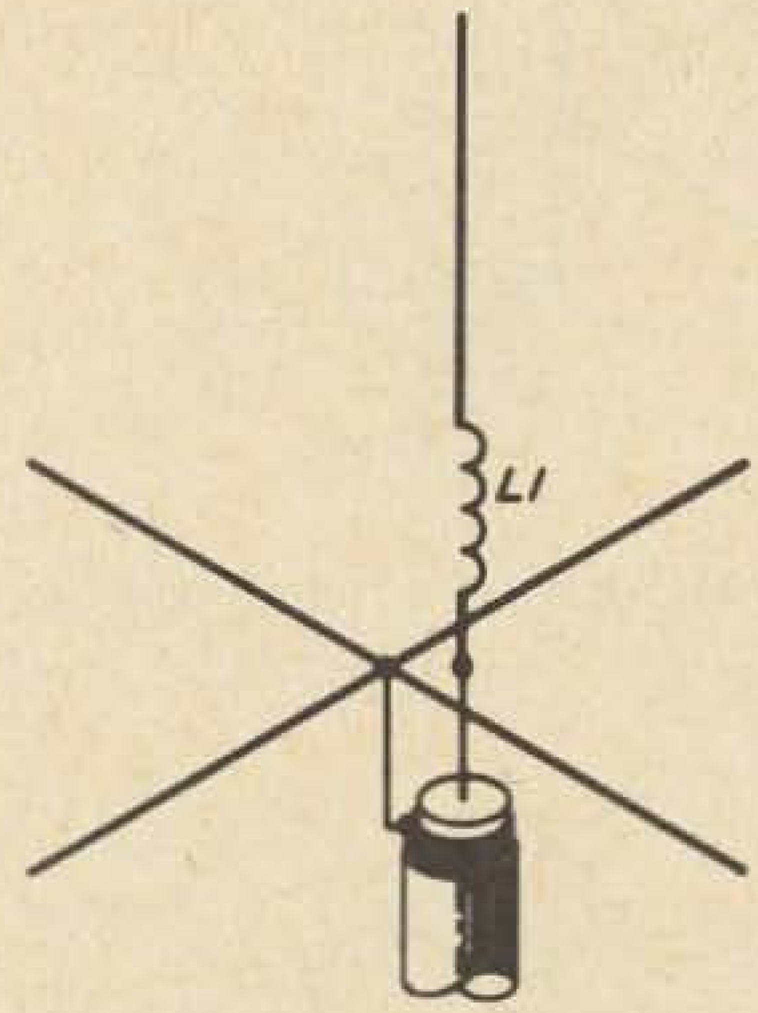

Fig. 2. 5/8-wavelength vertical base-loaded to 3/4 wavelength with series inductance.

considered as base loading the antenna to 3/4 wavelength (with no change in the radiation pattern). This is a resonant length which will present a feedpoint resistance of approximately 50Ω, a very close match to RG-8/U or RG-58/U coaxial cable. Adjustments to the loading coil should provide an swr of less than 1.2:1. In the groundplane configuration, some additional improvement in swr can be obtained by dropping the radials. Approximately 30° below the horizontal will be about optimum with a resulting swr of less than 1.1:1. This configuration has the advantage in simplicity and ease of construction and tuning. It will also be relatively broadbanded when fabricated of materials of adequate strength.

The second feed method utilizes a parallel-resonant circuit tuned to the operational frequency with the feedpoint tapped at a low impedance point on the coil, as shown in Fig.3. This arrangement may be considered as providing high-impedance feed to the base of the radiating element and a direct ground connection to minimize ignition noise and provide a

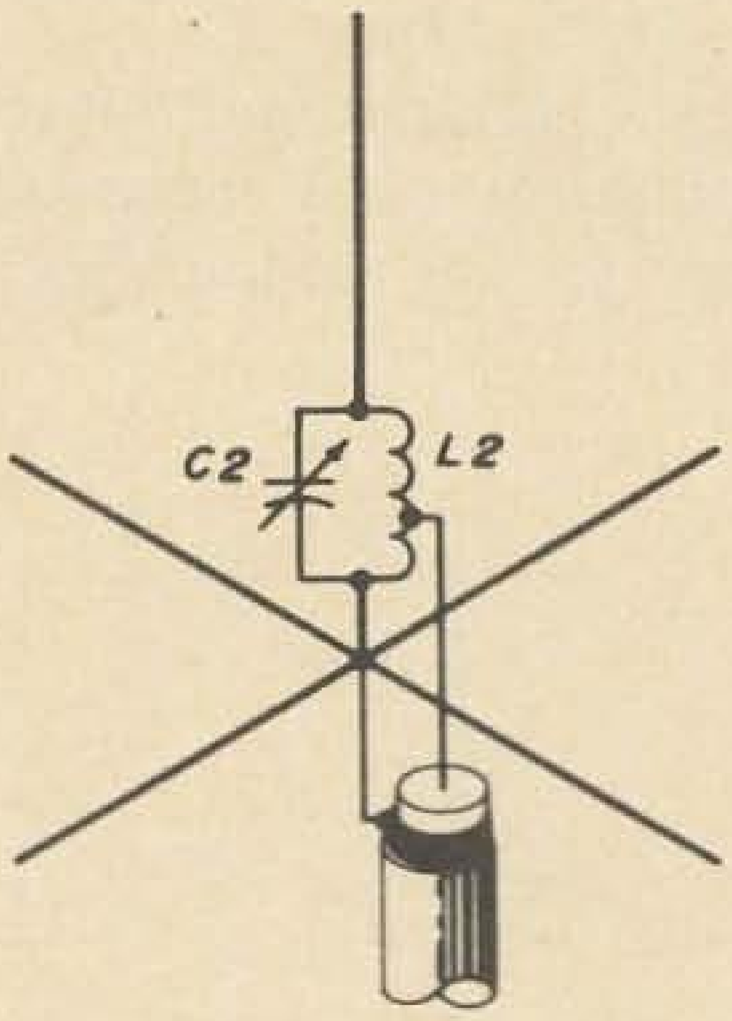

Fig. 3. 5/8-wavelength vertical using parallel-tuned -circuit feed.

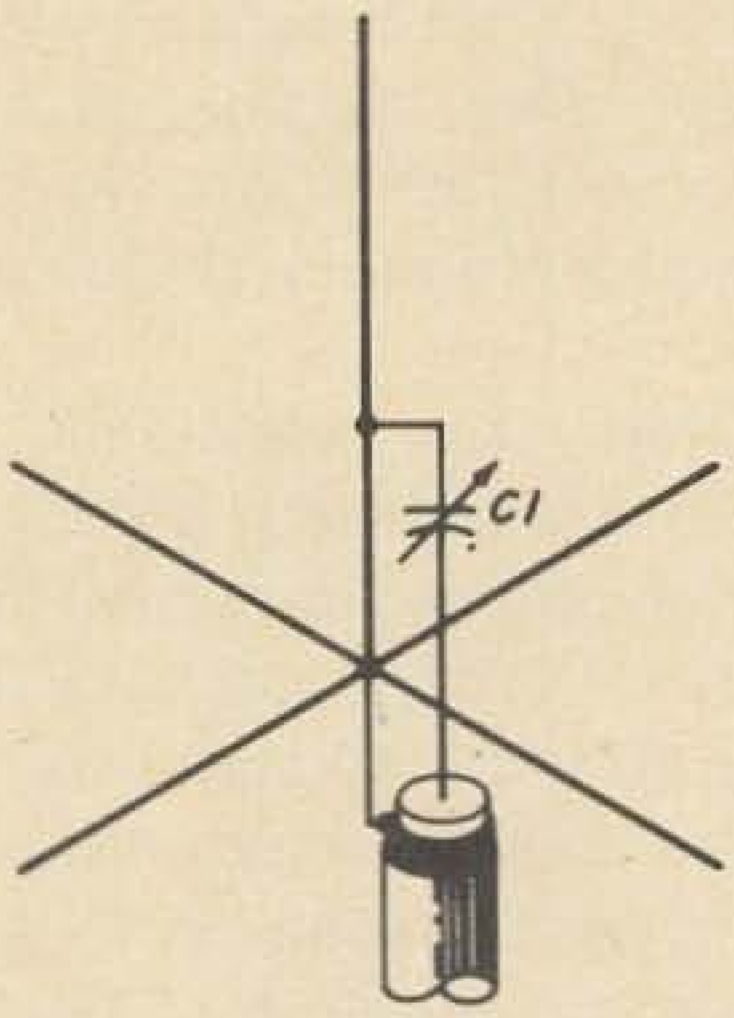

Fig. 4. 5/8-wavelength grounded vertical with gamma match feed.

degree of lightning protection. Coaxial feedpoint tap adjustments in conjunction with minor tuning changes can provide nearly a 1:1 swr at the operating frequency.

The tap point and tuning adjustment interact slightly and initial adjustments are slightly more time-consuming. However, the coil–capacitor combination can be grid-dipped to the approximate frequency on the bench so that only minor touch-up is required.

This configuration has the additional advantages of providing a very low swr without decoupling-radial droop or when mounted on a mobile installation. It will not normally be quite as broadbanded as the first.

A third method of feeding is through the familiar gamma match, as shown in Fig. 4. Here the radiator itself is grounded and the feedline is tapped onto the radiator through a series capacitance. This arrangement also provides a direct ground connection for minimization of ignition noise and a reasonable degree of lightning protection. Feedpoint tap variations combined with series capacitor adjustments can provide nearly a 1.0:1 swr at the operating frequency.

This configuration is particularly adaptable to feeding existing grounded towers as ground system of heavy radials will be required.

Design

The 5/8-wavelength vertical radiator should be reasonably close to a full 5/8 wavelength at the desired frequency but should preferably be no longer. Consequently, the decoupling radials should be a 5/8 wavelength at the high end of the band of operation. Conversely, the decoupling radials should be a minimum of ¼ wavelength at the low end of the operating band. The following formulas are based on reasonable velocity factors for materials probably available in amateur construction and should prove adequate for preliminary design purposes.

$$\text{Radiator length, in.} = \frac{7020}{\text{f in MHz}} \quad \text{or}$$

$$\text{Radiator length, ft} = \frac{585}{\text{f in MHz}}$$

$$\text{Decoupling radial length, in.} = \frac{2880}{\text{f in MHz}} \quad \text{or}$$

$$\text{Decoupling radial length, ft} = \frac{240}{\text{f in MHz}}$$

Using these dimensions, the coupling circuit can then be selected to resonate or provide minimum swr at the desired operating frequency. Though theoretically any coil or coil–capacitor combination which can be resonated at the desired frequency would work, it is important that good tank-circuit design principles and full weather protection be considered to minimize circuit losses and provide for maximum energy transfer. In general, this implies that all coils be space-wound with large wire or tubing and that length-to-diameter ratios be less than 4:1 (and preferably 2:1). Capacitors should be high quality, ceramic insulated or wide air-spaced variables for ease of circuit adjustment and reasonable power handling capability.

The coaxial feed tap point will vary with different constructional methods and materials and the optimum point must be determined experimentally for each installation. It will invariably be quite close to the ground end of the coil, varying from approximately 1 turn on 2 meters to possibly 3 or 4 turns on 20 meters.

Construction

While this is not intended as a "hardware" style construction article, a few approaches possibly worthy of further consideration have been accumulated.

Conventional TV masting or aluminum tubing is readily available, rugged and inexpensive, although insulation and installation are more difficult than with some other materials.

Of course, the surplus whip antenna segments and their matching insulators are relatively inexpensive, free standing to heights approaching 20 feet; they are relatively light in weight and are available from numerous sources.

Insulated (or even grounded) antenna towers should make effective radiators for the lower frequency bands, providing an adequate ground radial system is incorporated.

On 2 meters or even 6, a fiber-glass fishing pole covered with shield braid from RG-8/U and RG-58/U makes an ideal radiator. Of course, 1/8 in. welding rod works adequately on 2 meters or higher bands also.

Although this antenna will probably not compete with a good beam or quad at optimum elevations above ground, it is a very effective antenna, readily and economically fabricated with minimum facilities.

. . . WAØNGV ■

The Intelligent Use of 2 Meters FM

Like canned sardines, today's repeater users are finding themselves cramped for operating time and spectrum.

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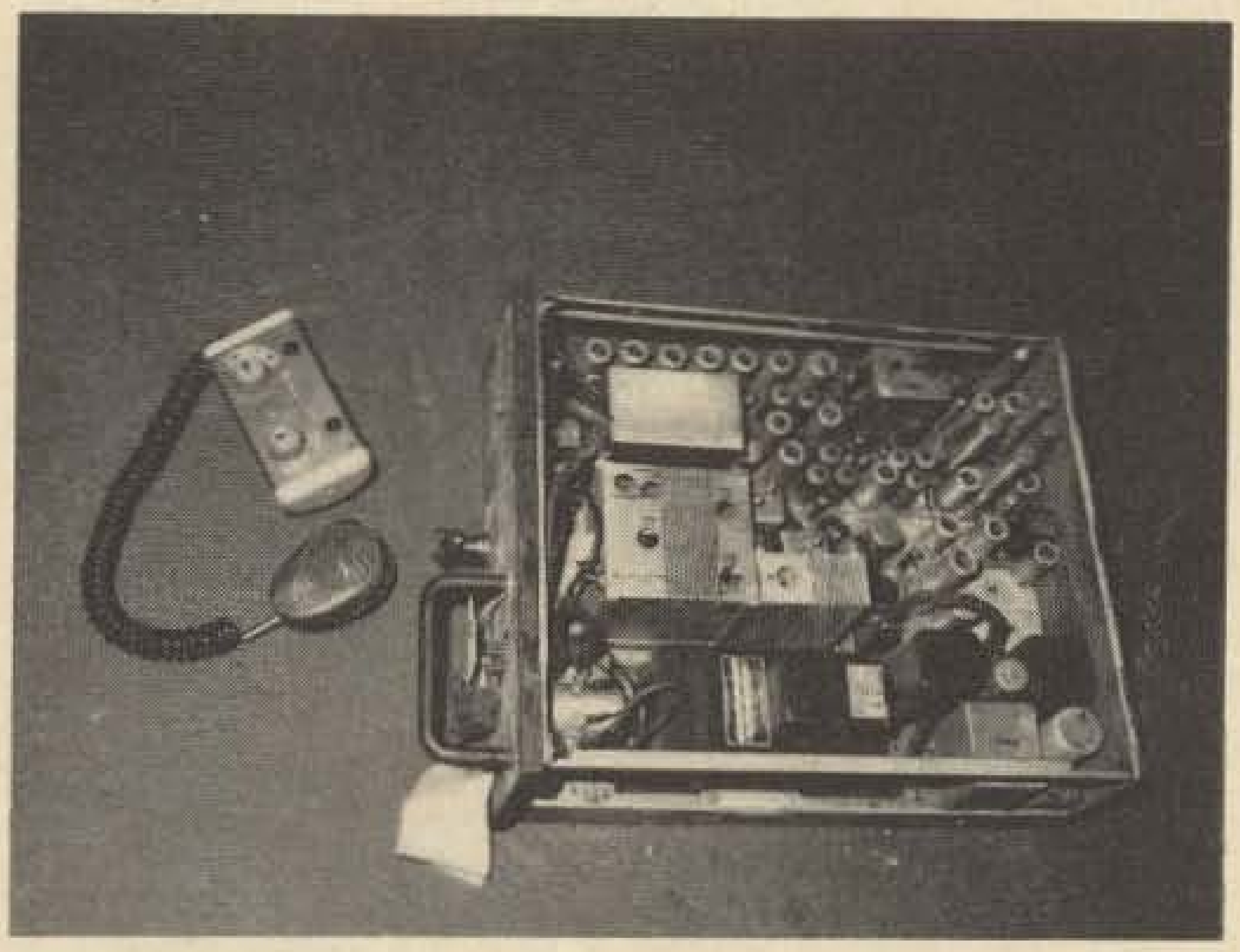
The FM mode may have been shelved with the spark-gap had it not been for an FCC action concerning the commercial FM mobile service. Years back when the commercials were growing by leaps and bounds, it became obvious that the available channels were overcrowded. Since spectrum space was at a premium, narrower FM bandwidths were adopted in order to create more channels. Now the wideband equipment had to be converted over to narrowband at a cost which often exceeded the equipment value, or it was junked in favor of new equipment. Many progressive outfits went the latter route. This increased the "surplus" trickle of FM gear to a torrent. And amateurs, the ingenious scavengers that they are, scooped the units up at bargain prices. Realizing the potential use of this equipment, many hams converted the units for 6 or 2 meters or to the 432 MHz region (FM'ers call it "450"). Clubs and individuals got together and fired the units up on the unused higher band edges and thus a major change was born. These units were fixed frequency and the new concept of "channelized" communication was brought into amateur radio. Unlike the equipment used by the early pioneers, the fixed frequency was new to hams and proved to be an advantage.

After a while across the country standardized channels were adopted by the various groups. As more gear appeared on the market, more amateurs got on FM. Still the growth was only moderate. It was spurred onward by word of mouth and by curious amateurs who found something besides images on the higher two megahertz of their "Gooneybirds."

Hams, using FM for mobile work, followed the commercials' lead and set up repeaters to extend the range of communications. At first these groups numbered between 3 to 20 hams as a rough average. Then FM started to receive the attention it deserved in the various amateur publications. This brings us to the topic of "The Intelligent Use of 2 Meters FM."

Ed Tilton (ARRL, QST official) once said that repeaters "are self-defeating." There can be a lot of truth in these words, but it doesn't have to be so. What would prompt a statement of this sort? Well, during the last few years FM has been growing in drastic proportions. In the last few years magazine articles on FM increased interest and many repeater groups found their systems filled to overflowing with new traffic. Many systems fell apart or moved to less populated channels. So it seemed the blessing of channelized communication was actually a curse. This unforeseen problem seems to be more of an operator problem rather than a space problem in most cases. One fact is that an



This Motorola trunk-mount rig is characteristic of the two-way units of the '50s. A built-in dynamotor powers the transmitter, while the receiver is driven with a vibrator supply. The control head, shown with mike attached, connects to the unit with a long cable.

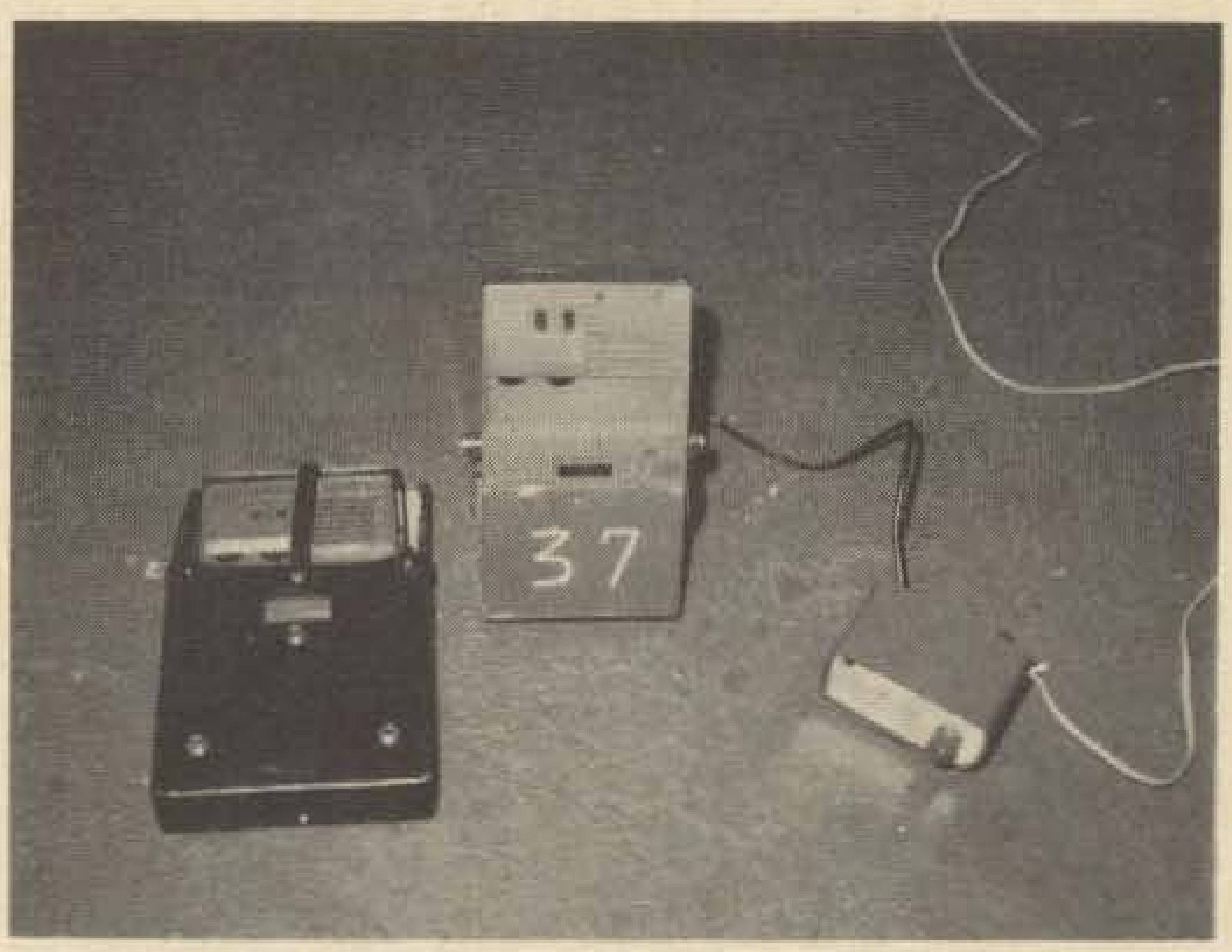
amateur obtaining a surplus FM unit rarely equipped it for anything but the repeater input frequency on his transmitter and the local repeater output frequency on his receiver.

Ideally, a ham using a repeater should be able to transmit on the repeater output frequency as well as the input, allowing "direct" operation without using the repeater. The use of a repeater to ragchew with a lone ham across town is stupid. The use of a repeater located 20 miles outside of town to talk across town is equally stupid, and both instances are examples of a lack of courtesy to fellow system users.

Few FM'ers seem willing to upgrade the receiving portion of their unit. They feel that if they can hear the repeater that is all that there is to it. Period. Case closed. What nonsense! Most units at best are only passable for repeater use and almost useless for extended direct work. One interesting point which has not been made is the "capturing effect" where a strong signal will take over a weak one on an FM receiver. The stronger will usually take over the limiters and the weaker is unheard. Let's use our imagination and explore this point further. Suppose we have four hams on an FM channel using identical equipment. Hams A and B live in Getown; and 10 miles away C and D live in Reaville. Between both towns is a repeater on a slight knoll. Ham A can talk to B, and C can talk to D with no interference to each other because of relative signal strengths. Suppose B and A decide to talk to each over the repeater. Certainly A and B can converse via the repeater, but C and D were blasted off channel by the needless use of the repeater!

Please don't get me wrong. I have nothing against repeaters. A well thought out and maintained one is not only a joy to use, but a pleasure to listen to. A repeater requires careful attention for the channels used, and the technical problems would fill this magazine. In many areas the standard channels are so crowded that it would be impossible for a new repeater to go into operation without interference to itself or others. It takes only one lid to reduce a system to shambles.

A ham just getting into the FM game finds a new and strange world when he's first



In the early '60s, transistor units made their appearance. The two shown here are GE "Voice Commanders." The unit out of its holster is getting a battery charge from a GE supply built into a control head housing.

introduced to a repeater. All that is needed to be successful is common sense and some knowledge of the operating procedure used. For instance, you should never hear a CQ called. Common practice would be, "This is K1ZJH mobile monitoring '94' direct" or "K1ZJH repeat via W1BNF monitoring 94." This is all that is needed–if any of the group is around you will "break" their squelch with your call; and if they feel like chatting, they'll let you know. Contacts through a repeater are kept short, especially during "busy" hours when everyone is on the road, say on the way to or from work.

Some of the early portable units, such as this Motorola P33, used "hybrid" circuits, with tube-type transmitters and transistor receivers. The lower half of the unit shown is a ni-cad battery pack, and can be replaced with the ac supply shown at left.

A QSO is thrown back and forth like VOX operation, to a lesser degree. Monologues are frowned upon. This allows a breaker to join or the party to bow out if he has arrived at his destination. Many (indeed, most) repeaters have dropout timers that will shut the system off if a continuous signal stays on the input for over a specified period (usually 3 minutes). Generally speaking, there is no time limit for the use of repeater. It is left up to the intelligent use of the user; the system is left in your hopefully responsible hands.

One very irritating thing new system users seem to enjoy doing is keying the repeater on and listening to it "come back." (Some can sit back and do this for hours.) While most outgrow this habit before long, the repeater operators get "up tight" when they hear someone playing games with their system. If you practice such tactics, you will be labeled as a trouble source.

A prospective FM'er will find, while browsing through the lists of available FM units in the ham magazines, a bewildering array of letter prefixed multidigited units listed with no other description present. The best way to find out what would best serve your needs and pocketbook would be to contact an FM'er who has had some experience. While everyone has his own brand of preference, generally Motorola, GE, and RCA gear are best bets since (1) they are still in business, (2) technical data is easier to come by for these units, and (3) there will always be someone around town familiar with their circuitry. Also, there are schematic sourcebooks on the markets for GE and Motorola gear at present.

Once you select and buy your unit, learn how it works and get familiar with working on it. The number of new hams who can fix the guts of the equipment in their car trunk is sadly deficient. This is one item which cannot be crated up and sent back to Heath!

The first rig you will want to acquire will most likely be a mobile unit for the car. A good mobile starts at $75.00 and units converted to the ham band generally run $25.00 to $50.00 more. Try to do the conversion yourself with the aid of an experienced ham. That will help you learn about the unit. Generally, only a retuning is needed, and sometimes some of the coils may have to be padded to bring them into correct range. The mobile unit might well be considered as your major piece of gear. The quarter-wave whip mounted on the trunk lid or roof of the car is widely used. Higher gain coaxials or 5/8-wavelength verticals rate second and are moderately expensive.

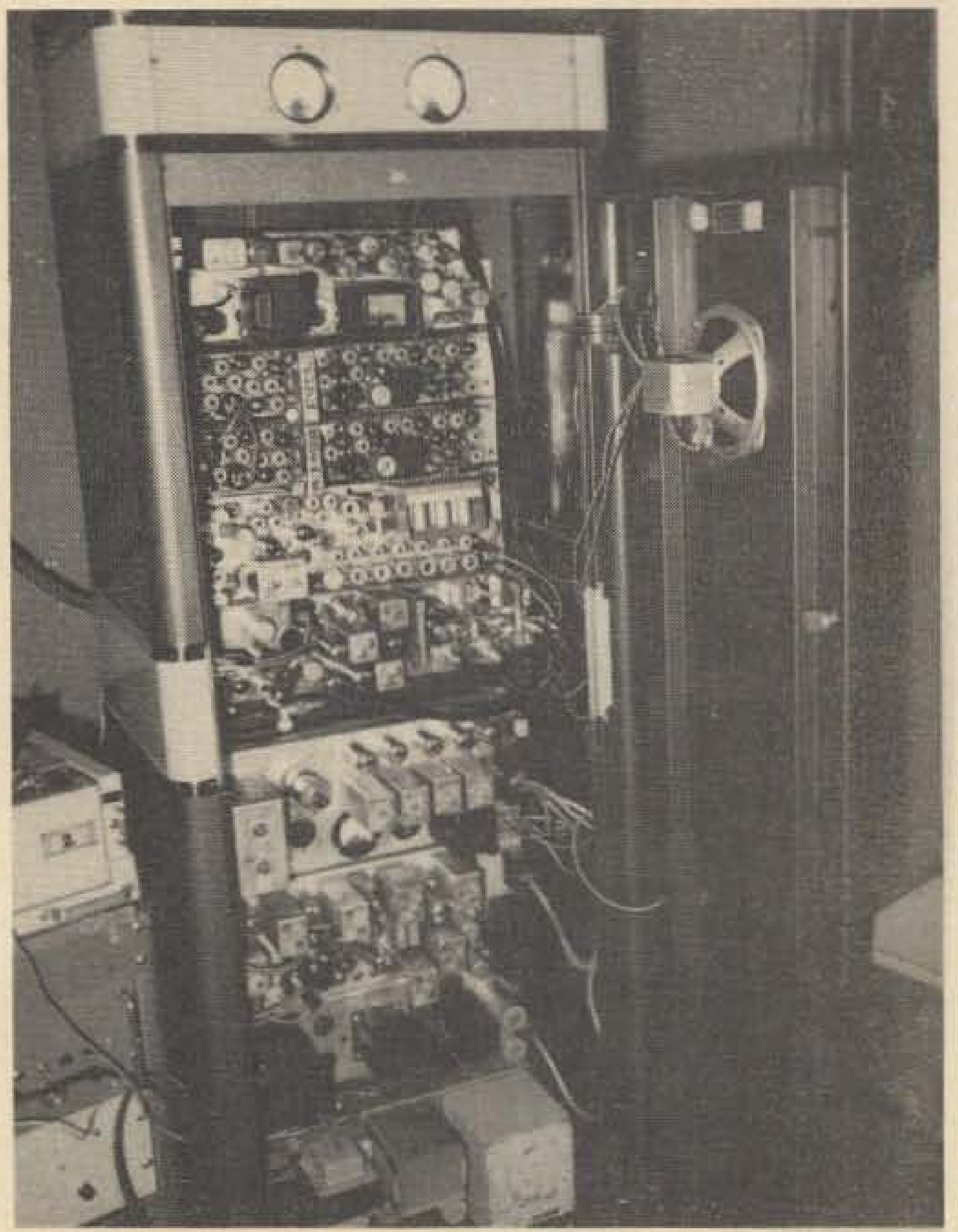
Various stunts can be used to improve the transmitter. Eliminating the dynamotor with a transistor supply and swapping 6146s for 2E26s is a typical modification. Since the average mobile receiver has a sensitivity of 0.7 μV (at a quieting factor of 20 dB), your best investment is a preamp. A Nuvistor job

will bring a 0.7 μV receiver down to 0.5 μV or better in most cases. Reworking the front end will get you down to 0.3 μV or better with a little effort.

If you do a lot of traveling, you may desire to work into the repeater systems in the areas you travel through. The hope for a network of repeaters all on a national input and output is unfortunately impractical. With the number of 2 meter stations currently operating, there would always be someone from system A getting into system B and vice versa. Cooperating between groups has not always been in the ham spirit Paul Segal wrote about, either. The frequencies of 146.34 MHz in and 146.94 MHz out seem to be the most commonly used for repeaters (see Repeater Directory in this issue). On 6 meters, 52.525 MHz is considered to be the main repeater output channel.

W1BNF, the repeater which serves Central Connecticut, recently added a 146.37 to "98" repeater system. The 146.37 MHz channel had to be created because there were no more available channels in the populous New England area! What this boils down to is that you may have to "multichannel" your unit so that you can take advantage of all of the systems you will want to use or have access to. To do this, some hams stop their cars, go to the trunk, and manually change crystals as they get into different repeater areas. This is acceptable so long as you don't have to do so often or on superhighways. Crystal switching can be done by diode networks, relays (reed relays are ideal), or remote oscillator decks. Commercial units having more than two crystal positions for the receiver or transmitter are rare and expensive.

Most hams, after being on FM a while, eventually desire a base station for home use. Base stations which do get into the ham market command high prices; however, converting a mobile unit for base use is relatively easy since the power supply is the only major modification to be made in such instances. Motorola has provisions for separating its series into three discrete sections: receiver, transmitter, and power supply. A receiver may be removed from a mobile unit and used as a base receiver. Several months later it may be used as a mobile unit by simply inserting it into the mobile case. These "strips" (as they are often called) are



The large base stations usually have sufficient room to contain not only a complete repeater, but the control equipment and UHF gear as well. This rack contains 2 and 6 meter FM equipment as well as power supplies and "link" equipment.

available for quite reasonable sums. Since Motorola (and some others) generally uses the same series of crystal frequencies for their entire line of transmitters, it might be advisable to employ the same make unit in the base as the car. Receiver crystals don't always follow this rule because of different i-f configurations.

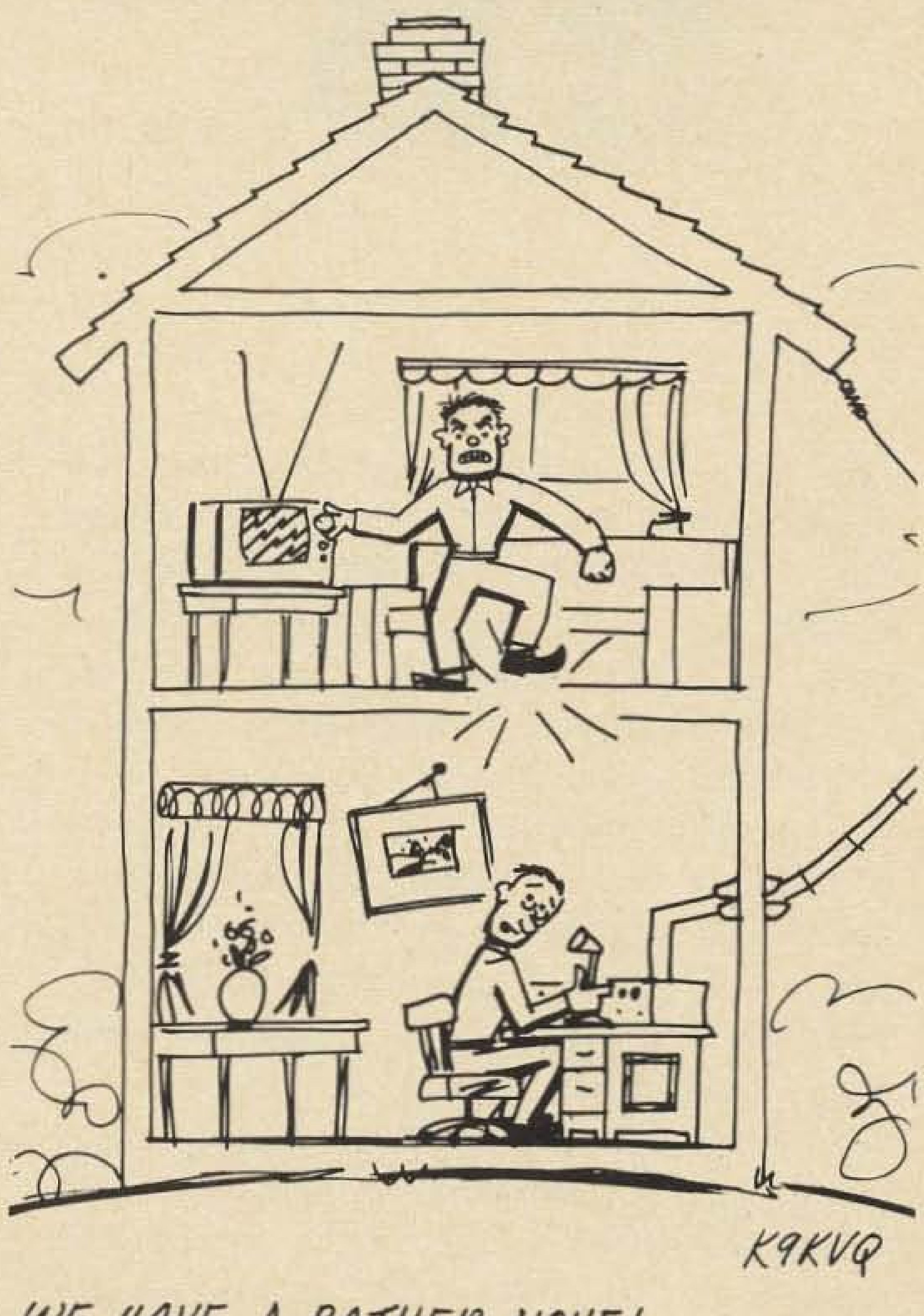
In the past few years, a series of handheld units (dubbed "bricks" because of their size and shape) have been hitting the market. These solid-state wonders are very popular among hams because they were made surplus in commercial service by the advent of even smaller units, containing integrated circuits. The bricks sell in the $300.00 bracket and are made by Motorola. These units make ideal second rigs because of their portability and convenience. But without a repeater, their utility would be sharply reduced. At any rate, the brick can be a lot of fun if some of your friends jump on the bandwagon with you.

High-power solid state mobile gear made by all the big manufacturers is now hitting the ham market in small quantities (but usually at prohibitive prices). Watch for price breaks in the next few years on these items. (I was going to get one, but it was worth more than the car.)

As a final note, I should mention the equipment which has come out in the past year for ham use. These units are generally all solid state and sport multifrequency, small size, battery operation, and several other features. The price is around $300.00 for the latest one I have seen. The Galaxy people have marketed a unit for under $200.00 which, besides all of its other extras, offers variable speech clipping!

This article should familiarize the uninitiated with at least the basic rudiments of FM operation. I hope I have helped the beginner avoid some of the common pitfalls which he might have otherwise stumbled into.

. . . K1ZJH ■



WE HAVE A RATHER NOVEL SWR INDICATOR HERE, OM...

Neil Johnson W2OLU
74 Pine Tree Lane
Tappan NY 10983

...plus 10 dB...

A lot of ham operators toss around the decibels quite knowingly, but behind this facade of glib gab, there remains the simple fact that some of the best talkers really don't know what's going on. You can hear it on the air every day, "You're 40 over S9, old man, and this receiver has a very scotch S-meter." In case you don't completely comprehend all this, please don't feel too badly, for there are quite a few young hams – and a few oldtimers – who don't dig this "dB" stuff too well. Years ago, when I was a newcomer to amateur radio, the subject appeared fascinating, and equally incomprehensible.

For simplicity's sake, let us confine our remarks to decibels (dB, to abbreviate correctly) that deal with power ratios. Decibels expressed in voltage ratios may be of interest to phone company personnel, but most ham operators are thinking of their rf output, or lack of it, and that's measurable in watts. We can generalize by stating that the decibel is a nonlinear, or logarithmic, concept. Let's take a specific example. A 100W signal shall be our norm. On this basis we can run up the signal by +10 dB, and we now have a 1000W signal. Okay so far? By the same token if we reduce power to 10W from our 100W norm; we have gone down by 10 dB.

A little bit of history in the matter may set things into better perspective. The bel is a sound power unit, originated by the telephone company people. Clumsy in size, it got cut down to a more reasonable size of 1/10 bel, or *deci*bel. One decibel is the smallest amount of difference in sound power that can be recognized by the trained ear on a wire circuit having normal characteristics. Generally speaking, the rf transmission of power through the air involves fading, atmospherics and interference. Due to this combination of QSB, QRN, and QRM it is generally acknowledged that it takes 3 dB of power change (either up or down) to be noticeable. A 3 dB change in power can be noticed by an experienced operator; this would involve a 2 to 1 change in power, that is either in increase or a decrease.

After reading all this jazz in textbooks, handbooks, and hearing about it over the air, I grabbed hold of a war-weary surplus Variac, and one of the 40 meter ARC-5 "Command" transmitters. I then proceeded to contact a friendly ham about 8–10 miles away. This was strictly groundwave stuff, and to make sure of stable conditions, the QSO was held at 2:30 in the afternoon of an early summer day. The DX was all of 10 miles maximum, as previously mentioned, and most of this was over water. With a little patience, we spotted a clear frequency, and proceeded to run the power level up and down. The ham at the other end was very helpful. You know what happened? He consistently gave me reports which closely agreed with all that stuff in the theory books. All the results were written down in an old logbook, almost twenty years ago.

With respect to RST reports, just remember that most hams agree that one S-unit involves a power change of roughly 6 decibels. That is, a 100W rig would have to go up to 400W to get a 6 dB change upward. Each time the power doubled, we add 3 dB to our calculations. The first increase from 100 to 200W netted a +3 dB, and doubling again from 200 to 400W added another 3 dB to the signal. Results: power quadrupled, and signal reports up by one S-unit. Sometimes it makes you wonder if antenna work might not pay off better, doesn't it?

Another way of looking at the whole darned argument is to think about the big money makers in radio, the broadcasters. When a station owner or manager has the opportunity to increase his power, does he go for an increase of 100%? He does not! He wants to be noticeably louder, so that he can sell all those prospective sponsors the idea that he is now "much louder." The way it's generally done is to run the 1 kW broadcast rig up to 5 kW – or the 10 kW outfit goes to 50 kW. These station management people are in it for money – that's the name of the game – and to make a "noticeable improvement" in their signal strength, they usually go up in power by approximately 5 times. This roughly coincides with our illustration above, whereby the 100W ham rig is increased to 400W to get an S7 signal report up to S8.

A quick summary. Doubling (or halving) power gives us a 3 dB change. Making a 4x change – either way – gives us a 6 dB change, or one S-unit. Running a 100W rig up to 1 kW will give a 10 dB gain in power. This amounts to an increase in S-meter reading of about 1.6 units. To put it in a humorous vein, the poor little ham with 100W of power is way behind the commercial station running 10 kW. . .or is he? Look at it this way: There is a difference of 10 dB between 100W and 1000W. Another 10 dB difference between 1000W and 10 kW. That's a 20 dB total difference. But in S-units it only figures out to be about 3.3 S-points on our meter (that is, if you figure 6 dB to each S-meter unit). This may seem startling, but that's the way it is!

. . . W2OLU ■

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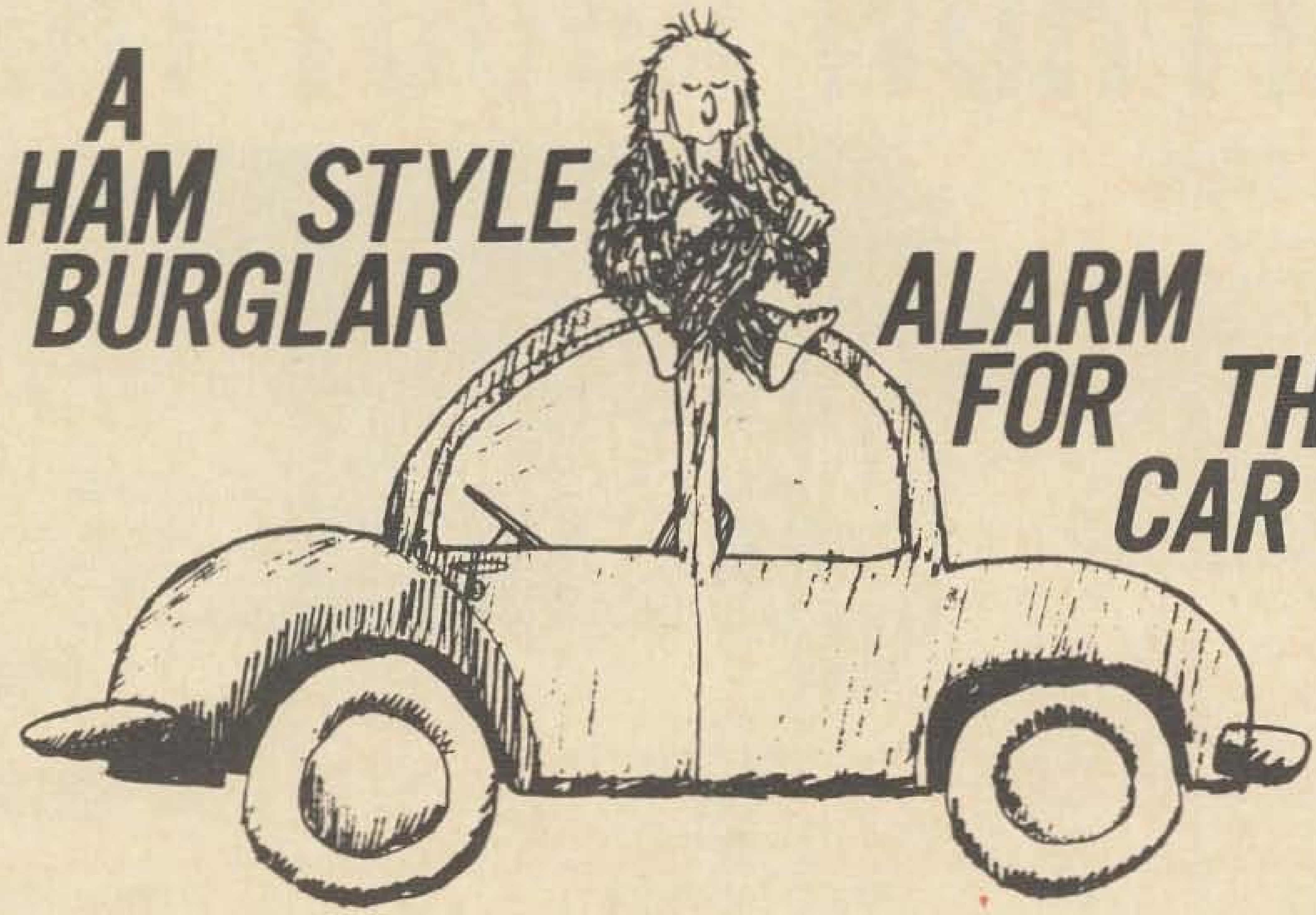
Bayside NY 11361

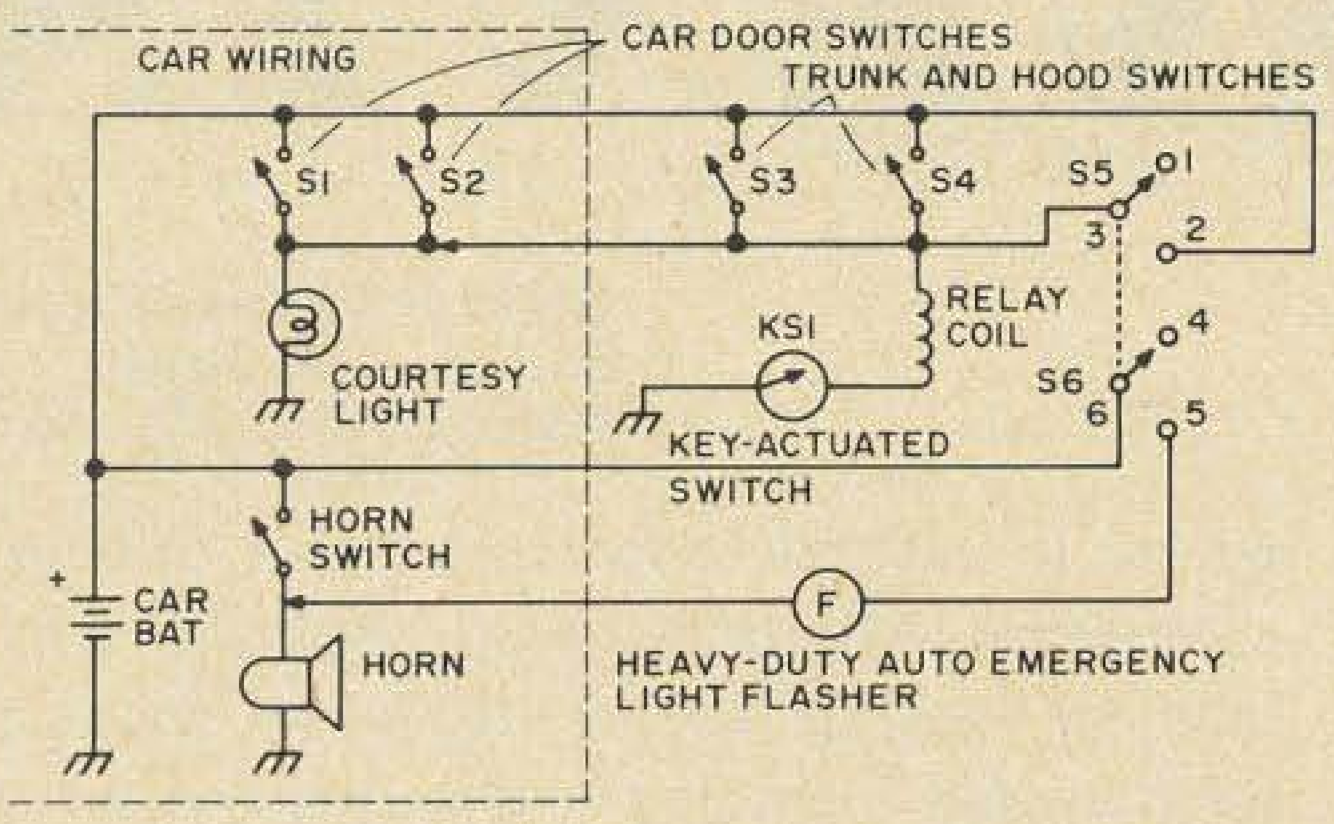
A HAM STYLE BURGLAR ALARM FOR THE CAR



Each month I see announcements about stolen mobile rigs. Until recently the only deterrent to auto burglars which I used, was a warning sticker and a fake key-actuated switch on the side of my car. Several weeks ago I took the mobile rig into the shack for a much needed overhaul, leaving a Heath swr bridge on the floor of the car, where it couldn't be easily seen. The car was parked right in front of my house, and I confidently went about working on the transceiver knowing full well that no self-respecting thief would bother my four-door hardtop for the price of an swr bridge. The fact that my car needed greater protection was brought home to me the next morning when I discovered that my bridge was gone. The crook had wedged a coathanger between the front and rear door windows and used it to pry up the door-locking button. I installed the alarm described in this article, and it has proved very satisfactory to date. It can be duplicated for about $5 (and even less if you have a well stocked junkbox). The alarm will cause your car horn to beep on and off if a door or the hood or trunk compartments are opened, and the horn will continue beeping until you reset the alarm.

The sensing devices used are the car's own door light switches. The contacts of these switches are easy to reach and provide a convenient place to tap power for the alarm. These switches can turn on your alarm and still be used in their intended manner. If your car's rear doors are not equipped with these button switches, you may add them by drilling the appropriate sized holes, and mounting them by the rear doors in the same way as the front switches. At the same time you should mount one in the hood compartment and one in the trunk and wire these in parallel with the others. They should, of course, be positioned so that they are controlled by opening and closing these compartments. These switches cost about 50 or 60 cents at your favorite auto supply shop. You will have to unscrew some of your car's interior molding or trim, and feed the wires under the carpeting of the car. When you are done, opening any of the doors, the trunk, or the hood should cause the interior lights to go on.

The master control on/off switch is usually a key operated one, and may be purchased from Lafayette radio for a few dollars. It should be mounted convenient to the driver's door, and it is best to locate it so that is is covered on the inside by some sort of trim, so that one cannot just open the door and rip out the wiring. I was lazy and installed mine in the trunk compartment, but this is not a good practice. If you are super cheap you can use a single-pole toggle switch and mount it inside the door to the gas filler cap, where it won't be seen. Some people have suggested that a spark from the switch could ignite gas fumes, but 99% of the time there is no current going through the switch when it is being thrown. (*But stand by for that last hundredth. – Ed.*) A popular spot for the key-actuated switch is behind the head-lights on the front fender.



S1, S2	*Car door switches*
S3, S4	*Additional switches for trunk and hood*
S5, S6	*Relay contacts.*
KS,	*Key-actuated switch*
F	*Heavy-duty auto emergency light flasher*

And now, about the circuit. As you can see from the diagram, the door light switches will supply 12V to the interior lights when the car door is opened. They can also provide 12V to turn on the dpdt relay. Contact with these switches is best made by removing one of the switches from its mounting and tapping into the wires connected to it, using wire nuts. When the relay is actuated by these switches, one set of its contacts closes and is connected so as to provide continuous voltage to the relay coil even after the door switch is turned off. Only turning off the main switch will release the relay. The other set of contacts on the relay goes in parallel with the horn switch. The wires from this switch can be traced from the steering column. When the relay is activated the horn will go on. The heavy-duty emergency flasher is used to make the horn blast on and off, a distinctive sound which will tell you that you are hearing your car, and not just another irate motorist.

Any type of 6 or 12V dpdt relay will serve this purpose, providing the contacts aren't too small. I used one which was mounted on an octal base, and mounted the whole assembly on an L bracket under the dashboard. There is nothing critical about the construction. Details of feeding the wires through the car and opening your car's interior moulding will vary with the particular car.

There are several drawbacks to this particular system, the main one being that if your car is tampered with and you aren't around, chances are good that you'll wind up with a dead battery. But, into each life a little drain must fall. It's very easy, of course, for the thief to open your hood and disconnect the two horns when he hears them go off. With a little ingenuity you can make this inconvenient for him. Or, buy a used horn from your local junkyard and mount it in or under your trunk, and wire it in parallel with the others. Your unwanted friend will go crazy trying to find it, and this will also make a good warning signal for those nasty people who are always standing in back of your car when you have to back up. Some bad guys like to get under your car and cut your battery cable before the alarm goes off. You can cover your battery cables with shielding from BX cable. It is flexible and can only be cut with a hacksaw. Only the very hippest auto burglars carry hack-saws.

There are many other variations and sophistications for this alarm system, including a tape-recorded message which tells the guy what you think of him. With a little effort all the headlights can be made to go on and off. To complete the job, a few warning stickers can be added to your windows and the door-lock buttons can be changed to smooth cylindrical types which can't be pried up from the outside. There is practically no limit to what you can do. But remember, no matter what you design, there is a thief somewhere who, if he really wants to, can still get around any alarm system.

. . . K2JLD ■

POWER SUPPLIES from SURPLUS COMPONENTS

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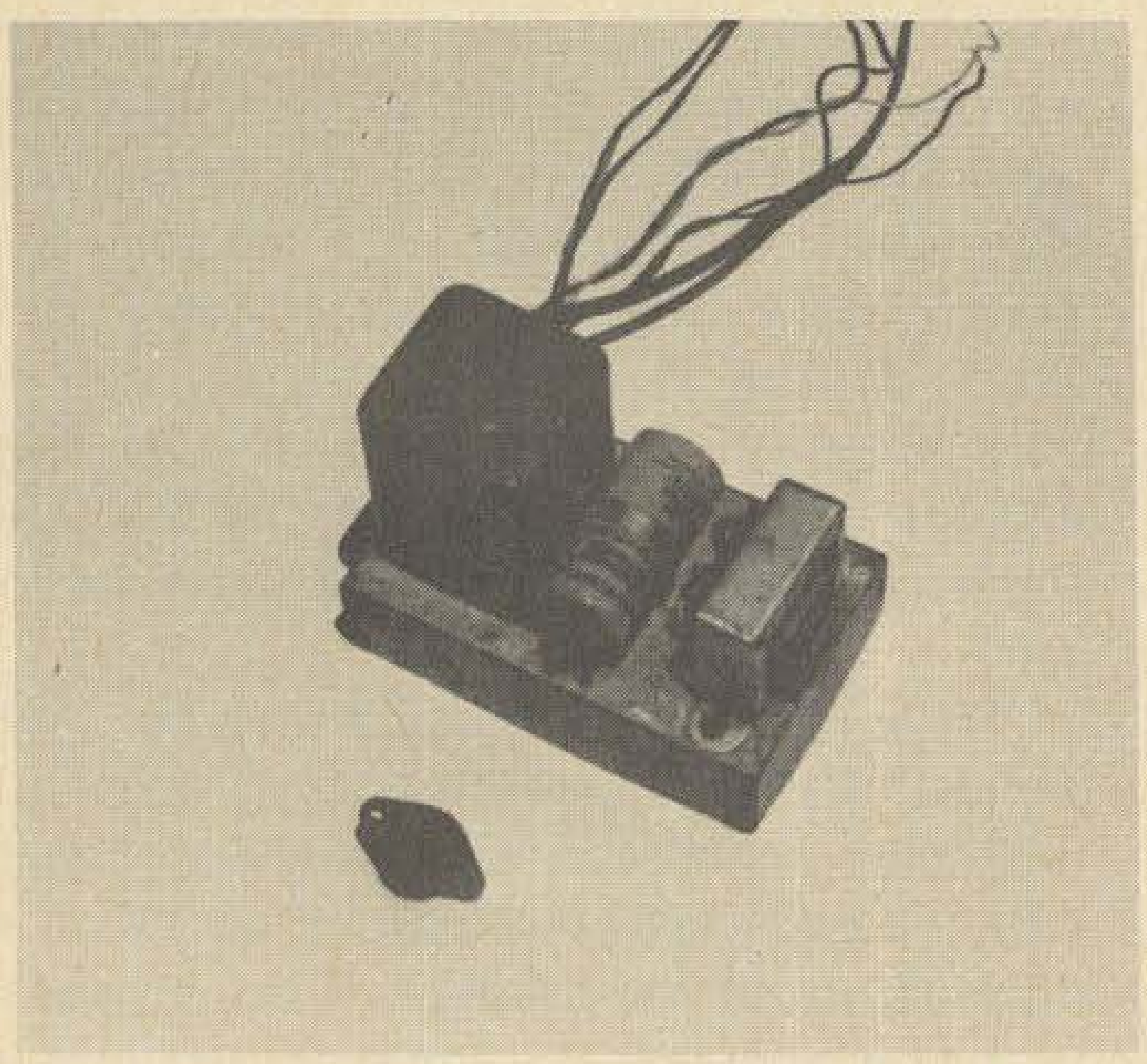
520 Division Street
National City, CA 92050

This article originally began as a brief description of a small power supply intended to deliver 22½ volts at a few milliamperes for a transistorized preamplifier. However, because of the wide variations of the components available and the desires of builders, it was decided to extend this article into as complete a description as



possible of power supplies in general. The main objective, of course, is to allow the builder to design his own power supply to fit his own needs. However, it is strongly felt that most readers will want to know what they are doing, even if they can do it quite well. It is for this purpose that all attempts have been made to include explanations or derivations wherever it is possible, especially where a concept is so logical and uncomplicated that it is easier to simply know why or how it works rather than to memorize meaningless formulas or circuits. So, actually this project had a much earlier beginning, with the destruction of about ten dollars' worth of silicon diodes. Its final success was achieved after a college course in electronics engineering, and the most useful information is described in this article.

The Transformer

If the builder has an adequate power transformer for the desired project, he might skip this section. However, the desired voltages at the desired prices are not always available, and if the power requirements are

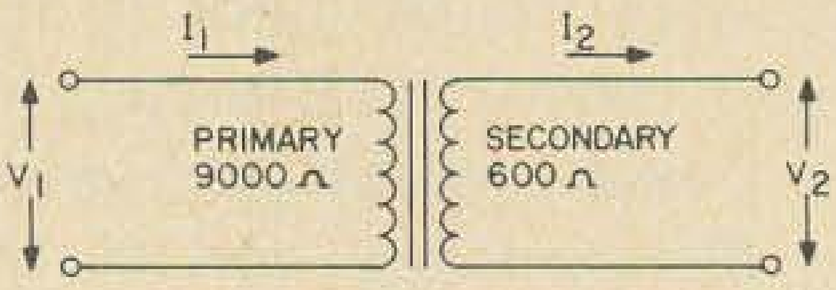


Fig. 1. Schematic of a typical audio transformer and its parameters.

small, an interesting substitution can be made.

Several audio output transformers were obtained from surplus, but they all had a 600 ohm output impedance, and were unfit for driving a speaker. At the same time a six transistor audio preamplifier was hungrily earing up 22½ volt batteries. It soon became apparent that the cost of replacing batteries could easily exceed the cost of the preamp. Store-bought power transformers are also costly, compared to the low priced epoxy transistors. It was finally decided to try an experiment.

A schematic of a typical transformer and its parameters is shown in **Fig. 1.** By assuming the transformer to be 100% efficient, we write the equation for the power in the primary and secondary.

$$P_1 = P_2 = I_1{}^2 Z_2. \qquad (1)$$

The subscript 1 indicates primary, and the 2 indicates a secondary parameter. Equation one says that the power in the primary equals the power in the secondary, which is

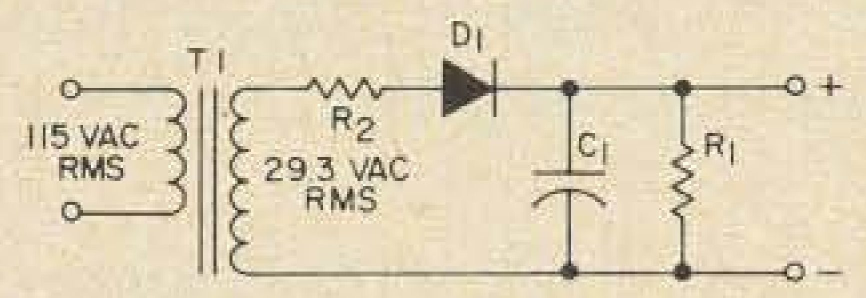


Fig. 2. Half-wave rectifier circuit.

equal to the current squared multiplied by the impedance. If we now use algebra, and divide equation one by Z_1 and $I_2{}^2$, equation two will result.

$$\frac{I_1{}^2}{I_2{}^2} = \frac{Z_2}{Z_1} \qquad (2)$$

Now the impedance ratio is expressed in terms of the currents. Since we know that current is voltage divided by impedance, a substitution can be made for I_1 and I_2.

$$\frac{I_1{}^2}{I_2{}^2} = \frac{\frac{V_1{}^2}{Z_1{}^2}}{\frac{V_2{}^2}{Z_2{}^2}} = \frac{Z_2}{Z_1} \qquad (3)$$

By manipulation of equation three (dividing it out), equation four is obtained.

$$\frac{V_1{}^2 Z_2{}^2}{Z_1{}^2 V_2{}^2} = \frac{Z_2}{Z_1} \qquad (4)$$

If equation four is now divided by $Z_2{}^2$, and then multiplied by $Z_2{}^2$, the final result is obtained.

$$\frac{V_1{}^2}{V_2{}^2} = \frac{Z_1}{Z_2} \qquad (5)$$

Now that equation five is established, it is possible to find the voltage ratio in terms of the impedance ratio.

This derivation was given to show how equation five could be obtained if it were forgotten or was unavailable. This is assuming Ohm's law is known and a knowledge of basic algebra is available.

Equation five can be made more useful by dividing both sides by $V_1{}^2$, and inverting the result.

$$V_2{}^2 = \frac{Z_2 V_1{}^2}{Z_1} \qquad (6)$$

To obtain V_2, we take the square root of both sides of equation six.

$$V_2 = \sqrt{\frac{V_1{}^2 Z_2}{Z_1}} \qquad (7)$$

Equation seven is the final result, and the output voltage of our transformer can now be found.

V_1 is 115 volts, the line voltage, and Z_2 and Z_1 are 600 and 9,000 ohms, respectively. Plugging these values into the formula we get:

$$V_2 = \sqrt{\frac{(115)^2\,(600)}{9{,}000}} = 29.3 \text{ volts} \qquad (8)$$

Thus, if 115 volts is put into the primary, 29.3 volts will come out the other end, and it can be rectified and dropped down to 22½ volts.

Designing the Rectifier

There are two primary factors that work together to destroy silicon diodes; excessive voltage and excessive current. An example of each of the most common circuits will be discussed, and the ratings required for the diodes will be determined.

The simplest rectifier is the half-wave circuit shown in **Fig. 2.** Assuming that the reader is familiar with this circuit, we shall proceed to find the *peak inverse voltage,* or PIV required for the diode. Since the RMS, or effective voltage, is given for the transformer, the peak voltage must be found. The reader must remember that this is a sinewave voltage where the voltage varies from zero to some positive peak value, goes back to zero, goes to a negative peak value, and finally back to zero sixty times each second. A complete mathematical proof would require the use of calculus which is beyond the scope of this article, but a reference is given.[1]

The peak voltage at the secondary of the transformer is the effective voltage multiplied by the square root of two.

$$\sqrt{2} \times V_2 = 1.414 \times 29.3 = 41.4 \text{ volts peak.} \qquad (9)$$

Let's assume that R_1 in Fig. 2 has so high a resistance that C_1 charges up completely to the peak voltage, 41.4 volts, and does not discharge. Also, we shall assume that the top of the transformer secondary winding has reached its peak negative value of -41.4 volts. By adding the voltages, we can obtain the equivalent circuit of Fig. 3,

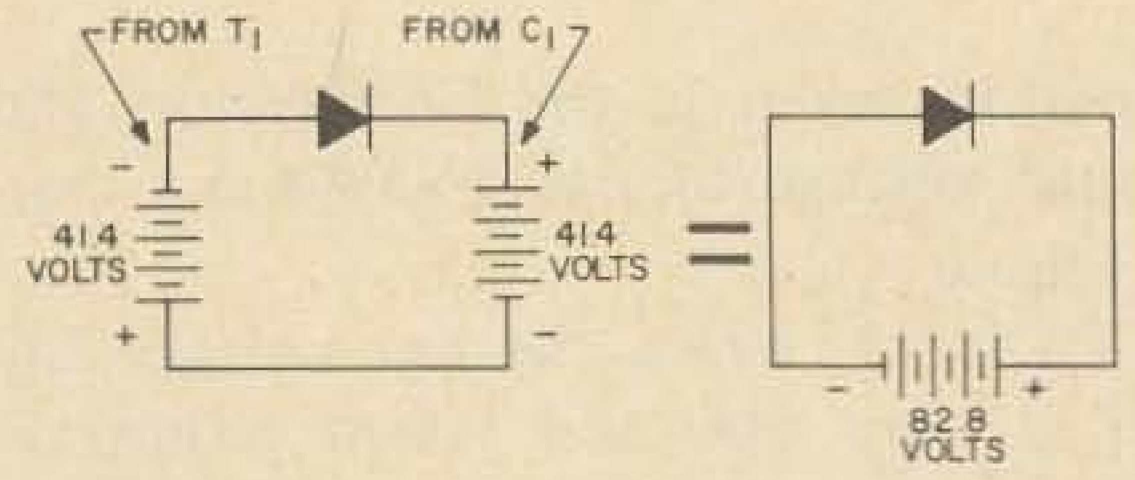


Fig. 3. PIV equivalent circuit.

with 82.8 volts across the diode in the reverse direction. Recall that conventional current is from + to - in the circuit connected to the voltage source. Since current flows in the diode in the direction of the arrow, if current were flowing in the diode, it would be in the reverse, or inverse direction. This indicates a peak inverse voltage of 82.8 volts in this case. To survive, the diode would have to have a PIV of 82.8 or more volts. We always design equipment with a safety factor to prevent unexpected changes. If a safety factor of 50% were used, 50% or 82.8, or 41.4 would be added to 82.8, giving 124.2 or more volts as the desired voltage requirement.

The current rating that is most often given for a silicon diode is for the current that it will be passing under normal continuous operation. A safety factor should also be included here, but there are much higher currents that are present only for a short period of time. Suppose now, that the circuit of Fig. 2 has been turned off for a long period of time. C_1 will be completely discharged by R_1. Assume that the circuit is turned on at the instant in the ac cycle so that a positive peak voltage suddenly appears at the top of the secondary winding of T_1. Since we know that the voltage across a capacitor cannot change instantaneously, the capacitor will appear as a short circuit for an instant. In effect, R_2 and D_1 will be in series across 41.4 volts for a very short period of time. If R_2 is a small resistance, a high current will be forced through the diode. This is the reason a resistor is usually seen in series with diodes in a power supply. Since the internal resistance of the diode is usually very small, it is assumed to be zero, and a resistor is inserted in series to take up the surge. The resistance is determined by Ohm's law, with knowledge of the peak secondary voltage of T_1, and the allowable surge current. R_2 is usually somewhere between 20 and 40 ohms, so by picking a value, say 30 ohms, we can find the allowable surge current. By plugging values into the following formula we get:

$$I = \frac{V}{R} = \frac{41.4}{30} = 1.38 \text{ amperes surge.} \quad (10)$$

Now, this is a relatively low surge current because diodes with a few hundred milliamperes of continuous forward current rating can have a surge current of ten to twenty amperes or more.

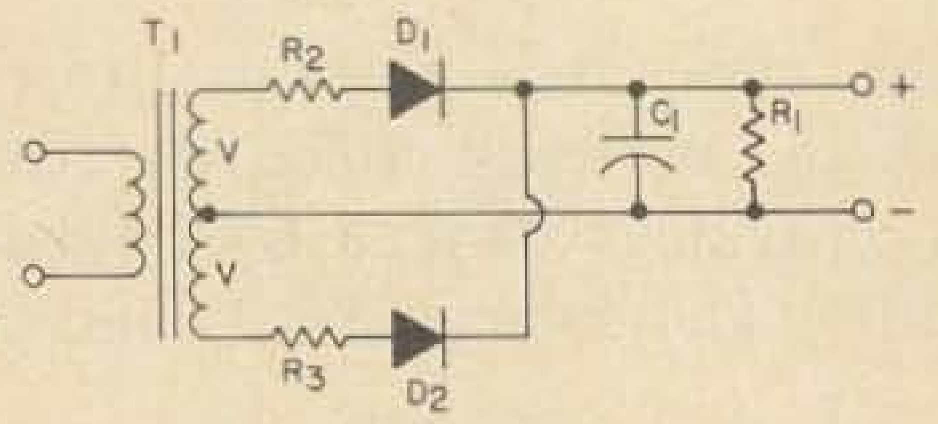


Fig. 4. Full-wave center-tapped rectifier.

Figure 4 shows the full-wave rectifier. Of course, this circuit can only be used with a center tapped secondary, so it would be useless with the transformer that was available. It gives a smoother output waveform that is easier to filter, and a short discussion of the PIV should be included.

Figure 4 is a familiar circuit, and just a glance will show that it is actually two half-wave rectifiers fed 180° out of phase by the transformer. The output is connected in parallel across C_1 and R_1. As in Fig. 2, the peak inverse voltage is twice the peak value of each half of the secondary plus a safety factor. The reader should go through Fig. 4 as we did with Fig. 2 to satisfy himself that the result for the PIV is correct. Also, the surge current can be determined in a similar manner as was done for the circuit of Fig. 2.

Now, we turn to the circuit of **Fig. 5**, which is the circuit most likely to be used for the application we desire. In order to

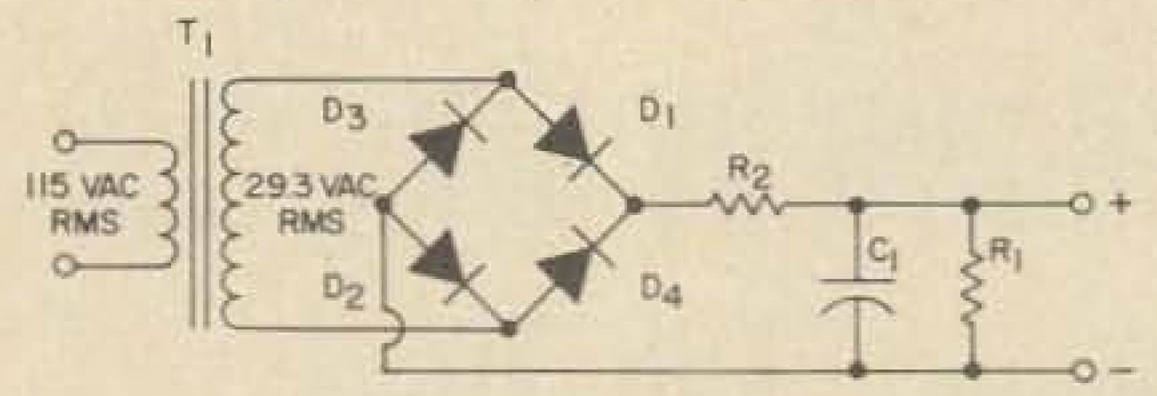


Fig. 5. Full-wave bridge rectifier.

study this circuit it will have to be divided into two parts, one for the positive, and one for the negative half-cycle of the ac voltage.

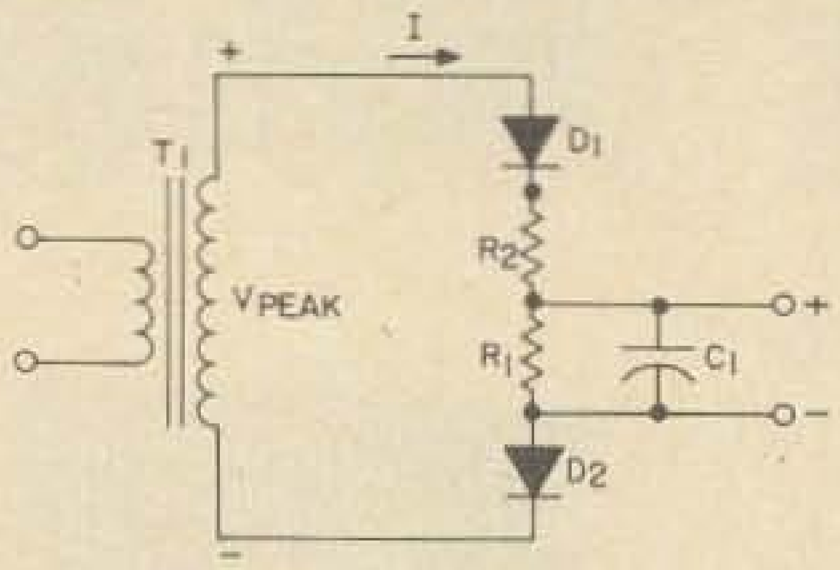


Fig. 6. Positive half cycle of the full-wave bridge rectifier.

Fig. 6 shows the half-cycle in which the top of the secondary of T_1 is positive. Note that the diodes that do not conduct are omitted from **Fig. 6** because they act as open circuits. We now have a much clearer simplified circuit that will show how the full wave bridge works. R_2 is the surge limiting resistor and will have a value of:

$$\frac{V_{peak}}{I_{surge}} = R_2 \text{ (surge resistance).} \quad (11)$$

V_{peak} is the peak voltage at the secondary of T_1, and since the diodes act as direct shorts, a current, I, will flow through the diodes, R_2, and R_1, and C_1. Also note that C_1 is considered to be a short circuit for the surge calculations as was done before. I_{surge} is the allowable surge current that passes through the diodes if the circuit is turned on at a voltage peak. The reader has probably noticed that since the diodes offer a short circuit during the half-cycle that is being described, a dc voltage will be generated across R1 and C1 that will become the output voltage, V_{dc}. Now, take a look at Fig. 7, the negative half-cycle simplified circuit. If the reader traces the path that the current travels through D_3, D_4, R_1, and R_2, it is easy to see that this is the correct equivalent circuit. In fact, **Fig. 7** is just **Fig. 6** turned upside down when the transformer polarity changes and the diodes act as a double-pole double-throw switch to keep the

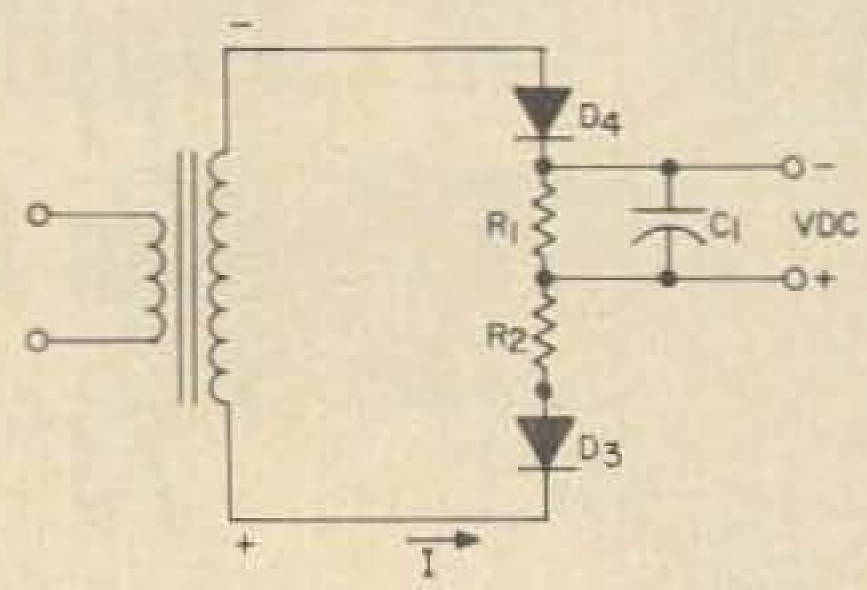


Fig. 7. Negative half cycle of the full-wave bridge rectifier.

current flowing through the load (R_1 and C_1) in the same direction in both half-cycles.

To find the PIV for each diode, assume that the secondary of T_1 in **Fig. 7** is at its peak voltage in the opposite polarity. Also assume that C_1 is charged to the peak voltage of T_1, and there is no voltage drop in the diodes or R_2. The voltage drop will be small because the current is small. Now, showing only the diodes and the voltages, we have the equivalent circuit of **Fig. 8**. This shows how the voltages add to make up the maximum peak voltages across the diodes in the reverse direction. Since there are two diodes, the voltage divides equally between them[2], and the voltage across them is V_{peak}. This is one-half of the voltage of the diodes in **Fig. 4**, so lower PIV diodes may be used, but twice as many are needed.

If the same transformer is used, the peak voltage (from equation nine) is 41.4 volts plus a 50% safety factor. The PIV would have to be at least 41.4 + 20.7=62.1 volts peak.

If diodes are to be placed in series to obtain a higher overall PIV rating, something must be done to equalize the voltage drop across each diode. All diodes are different, and one will pull more current than another, resulting in one diode having a large voltage across it which causes it to break down and short out, throwing all the voltage across the other diode, or diodes, and eventually the whole string of diodes is destroyed. This was a common happening when the builder was unaware of the real meaning of PIV. Since they short out rather than burn open, the transformer can be burned out if it is not fused.

To prevent this, voltage dividers can be placed across the diodes to provide equalization. Since the diode is operating in its reverse direction, (very, very small current flow) the internal resistance of each diode is very high, and resistors between 100K ohms and 500K ohms can be used across the diodes to provide equalization. 220K ohms is a typical value. Capacitors across the diodes can also be used, but can be more expensive. One should be careful to calculate the required power or voltage rating for the type of equalization system to be used. It should be noted here that it is often less expensive to use higher PIV diodes and fewer resistors, particularly when inexpensive surplus diodes are used.[3] Determine the cost per PIV ratio for each kind of diode, and be sure to include the cost of equalizing resistors when making the choice.

Filters

The value of filter capacitors and chokes, and the size of the load will in general determine the output voltage and ripple content. This is, of course, depending upon the type of circuit and transformer used. It is possible to calculate these values, but a number of factors are listed that would preclude a detailed discussion of this.

1. Very precise results are usually not necessary in amateur work.
2. Any parts that are available will probably be used if they look as if they will work, regardless of their values.
3. The actual value of a commercially made electrolytic capacitor may vary by as much as 60% from its marked value (check the label).
4. No serious damage will result from experimentation so long as the voltage ratings are adequate.
5. It's easier to put it together and try it than figure it out, in most applications, and more reliable (no math errors).

Also, it should be noted that charts and graphs are available which can give a rough idea of what the ripple content from a certain type of rectifier will be.[4]

Final Comments

The circuit of Fig. 5 was used in the power supply shown in the picture. The filter system used a capacitor input system with capacitances of 40 μF and a choke of unknown value. The diodes were 1N92s with a PIV of 200 volts and a 25 ampere surge rating. The continuous current rating was 100 mF, so all ratings were adequate. It works very well.

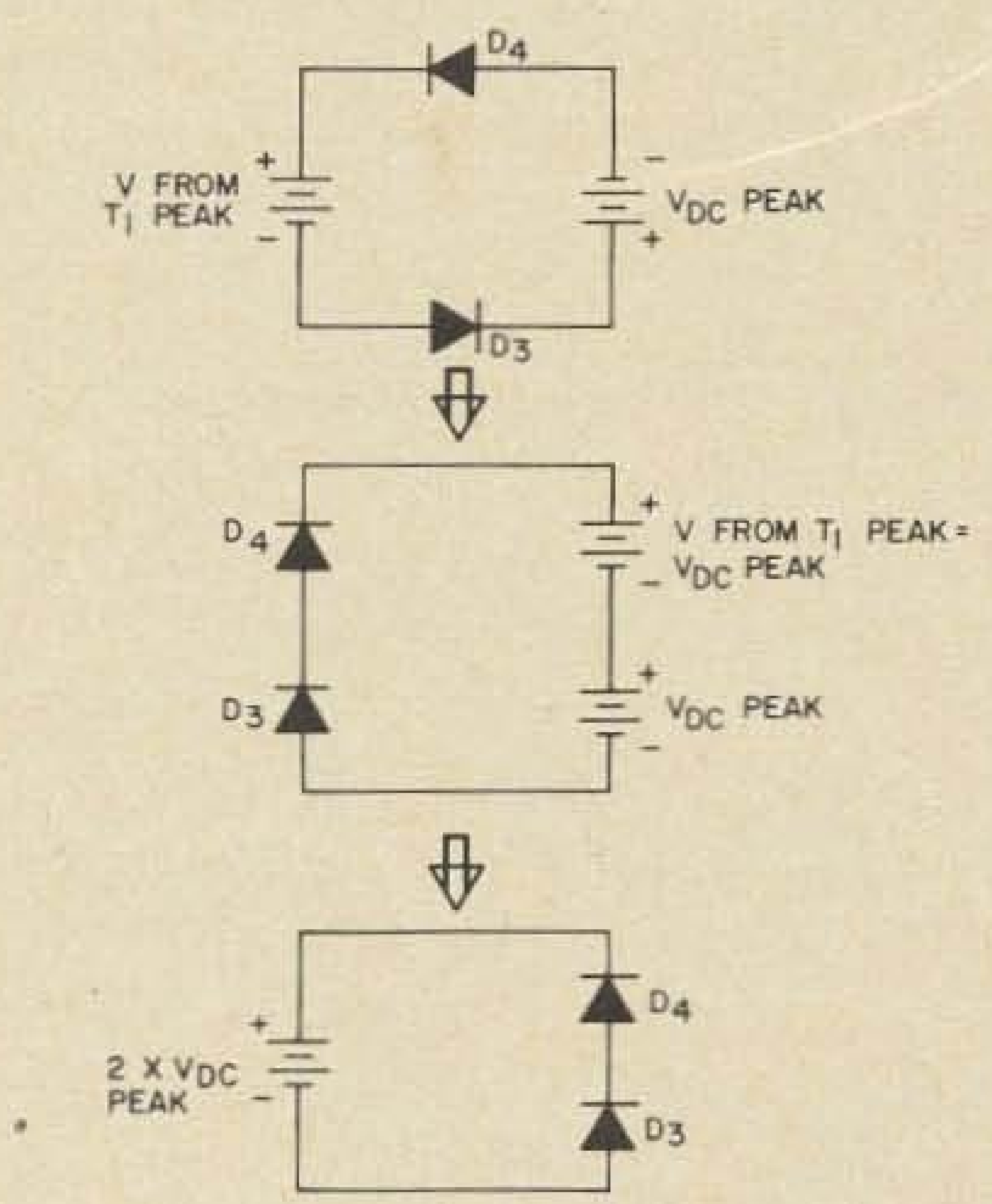


Fig. 8. PIV equivalent circuits.

The main objective of this discussion has been to provide information that can be used to safely construct any type of power supply from whatever components are available, and little emphasis was placed on any particular circuit or design. It was decided to use this approach to allow the reader to design his own power supply rather than having to dig through countless articles to find one that will give him what he wants that he can build with the components that he has on hand. Also, the reader appreciates the satisfaction to not only design his own equipment, but to actually know how and why it behaves as it does.

. . . WB6BIH ■

References:

1. Fitzgerald, Higginbotham, and Grabel, *Basic Electrical Engineering*, McGraw-Hill. See page 138 to prove equation nine.
2. If resistors are placed across each diode. Go back and keep reading.
3. Such as Solid State Sales or Poly Paks. See the ads in the back of this issue after going back to read the rest of the article.
4. *ARRL*, The Radio Amateur's Handbook, Newington, Ct. See page 307 for filters.

Selectivity has come a long way.

Today we take for granted shape factors and ultimate rejection figures that were considered either impossible or extremely expensive twenty years ago. Practically all single sideband equipment has a pretty good filter network in the I. F. system to establish the selectivity pattern. It may be a high frequency crystal lattice network, or the lower frequency mechanical type.

There are three factors about the I. F. filter that determine how well it will do its job. The one most commonly recognized is the width of the passband, usually measured at a point 6 db down from minimum attenuation.

This bandwidth is what determines the audio frequency range you can transmit and receive through the filter. The wider the passband, the wider the range of A.F. It becomes necessary, of course, to choose a happy compromise between a narrow bandwidth to help reduce QRM, and a wide bandwidth which will provide more natural sounding voice quality. You'll find that the Swan filter has a 2.7 kc bandwidth. This gets us into another subject which we'll discuss another time.

Shape factor is the next consideration in measuring a filter's quality. This is the ratio between bandwidth at 60 db and 6 db down, and is a measure of how steep the attenuation curve is outside the passband. This factor is often referred to as "skirt selectivity." The narrower the passband at 60 db down, the better the filter will attenuate strong adjacent channel signals. A good crystal lattice filter will have a shape factor of 1.7 to 2.0 depending on its center frequency. Best shape factors are achieved right around 5 mc, which is one of the important reasons for Swan's I. F. system being at 5.5 mc. On the other hand, the lower frequency mechanical filters don't have quite as good a shape factor as high frequency crystal filters, a fact which isn't very well known, and may come as a surprise to many.

Ultimate rejection is the third, but certainly not the least important measure of how good the filter is. All filters eventually "flare-out" at the base of their attenuation curve. This tells you how much the filter will attenuate signals which are 10 or more kilocycles outside the passband. If you have a base attenuation level which is down 80 db, for example, a strong local signal may very well come through the receiver over quite a large portion of the band, and it won't be his fault! There's no point in telling him how broad he is if it's your filter that's falling down on the job. A good high frequency crystal filter having 6 or 8 poles will reach ultimate rejection levels of 100 db, or more. Here again, filters in the 5 mc region are better. So, all you happy Swan owners may as well know the facts and blow your horn a little. CF Networks has made that beautiful precision filter that's installed in your rig, and it's really a dandy.

The accompanying graph illustrates clearly what we've been talking about. But so far we've only been discussing the "standard" Swan filter, and comparing it with other typical 9 mc crystal filters and 455 kc mechanical filters. In case you hadn't noticed, there's a tall, skinny curve on the graph that's all alone. This is the new SS-16! Made exclusively for Swan by CF Networks, this 16 pole quartz filter network establishes a new standard of comparison. Shape factor of 1.28, ultimate rejection greater than 140 db! A giant QRM killer, the SS-16 wipes out strong adjacent channel interference with unprecedented attenuation. And in transmit mode, unwanted sideband and carrier suppression are both increased greatly. For a new experience in Super Selectivity, install the SS-16 in your Swan Transceiver. They are available for the current 5.5 mc, I. F., or the earlier 5.175 mc I. F. system. Installation and adjustment is quite simple, and our famous customer service department is, of course, available for assistance if required.

Sorry, the SS-16 is only available for Swan transceivers.

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RF RIVIERA STYLE

Being an electrical engineer and a ham, I have for many years maintained the one-eyed "Gooneybox," Gonset 6 meter Communicator in my cars, changing every year or so to a newer model car and with the change, moving all the ham gear into the new car.

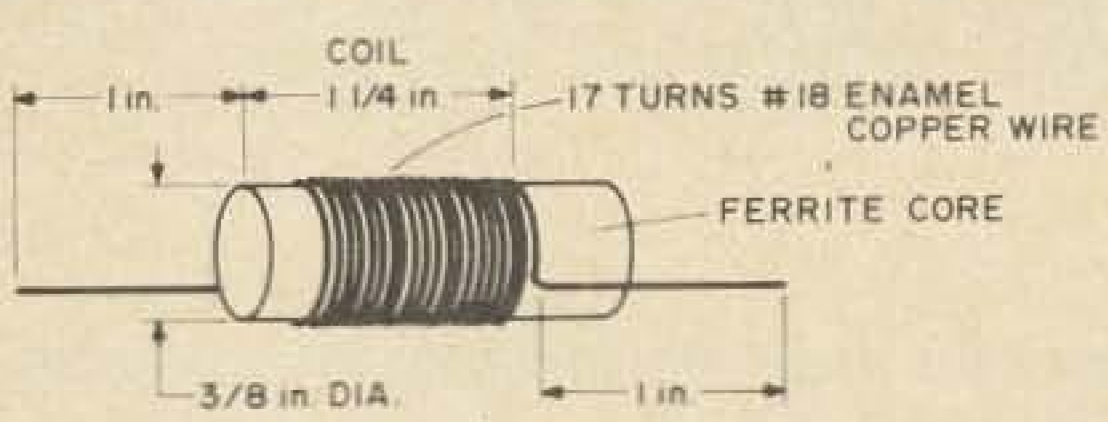
For years, I had no trouble changing the rig from one car to the next until last December when I leased a 1969 "loaded" Buick Riviera. This car is truly a beautiful "mechanism" and I could hardly wait till I could transfer the "Halo," install the Communicator, and start transmitting. The Communicator fitted well over the hump of the transmission – and, after attaching the coax, I started up the engine and turned on the rig. I was greeted with a noise level like nothing I had heard before. I might as well sit beside the battleship Wisconsin while she fires a broadside. I was unable to hear a thing! I was getting hash which sounded like it was about 80–100 Hz. There must be something wrong with my rig, I deduced! After all the years it has been in use, it probably has blown its cool. I turned off the engine and the noise level went away. Nothing serious. Something probably was not grounded properly.

For the next five days I bonded, sealed, and tightened every possible joint and connection. But the noise was still there when I turned the engine on.

Several months passed and it was in the spring that I finally wrote the Buick people explaining my problem. It took 1½ months for them to come up with an answer which I had already tried. I had reached an impasse!

Again, I surveyed the entire car and tested for various "leaks," searching with a "sniffer." Sure, I could pin down the area of the noise; but now, while the engine was running I had, one-by-one, disconnected just about everything – yet the noise persisted.

More months went by and by this time I was getting old and feeble and my "Riv" still had not stopped "generating" a noise. Then, sitting down in the car one day, I started the rusty brain clicking. Why was my car different? What did my car have that made it so different? What was it that pulsed or vibrated even when the alternator, voltage regulator, and everything that could be disconnected *had* been dis-



connected? The answer came on me like a flash flood.

Buick had done us Riviera owners a big favor: to justify increased costs, they gave us all a big fat juicy electric fuel pump. Now all I had to do is find that stupid pump – the one remaining electrical apparatus I hadn't checked out. In years gone by, the purchaser of a car would receive a book that would tell the grease points, wear points, ignition points, etc.; so, easing my hand into the glove compartment (it is so small you have to *slide* your hand in), I grabbed my instruction book with the tips of my fingers and slowly pulled the book out so as not to tear off the top skin of my hand. I scanned the book. No index, and no mention of a fuel pump, either electrical or vacuum.

I called all my engineer friends over to the house for beer and help, and we all started to slowly circle the car, each trying to come up with a solution. Where was that furshlugginer pump? Here we were, six engineers – and no one could even suggest where we might find the fuel pump. Finally, someone suggested it might be under the trunk floor – only as a desperation move, we looked. And sure enough, there it was. . . a black Bakelite cap with a blue and a brown wire coming from it and heading in the general direction of the front of the car.

Back down into the shack we went to make up a low-impedance coil, but here we had one problem. By this time, the brew had us slightly staggering and no one could read the grid dip meters. But after a couple of hours we did manage to make up a coil. After it was installed, I started the engine and turned the Gooneybox on . . . Voila! It worked, and I immediately made a contact with a ham about 30 miles away. No more hash!

But where are the 6 meter hams? The band is dead here now!

. . . K9BDJ ■

KEEP 'EM COOL IN "KPO CANS"

Douglas Byrne G3KPO
Jersey House
Eye, Peterborough, England

Tubes get too hot for comfort, burn themselves up aplenty . . . what to do? Keep 'em cool, boy, keep 'em cool!

Easier said than done, for while tubes get smaller, nobody has yet succeeded in miniaturizing the watt. Of course, you can use a blower, but that brings with it problems of vibration and noise, both mechanical and electrical.

So let's see if we can't get that unwanted heat away much more efficiently by the normal method of radiation and convection—with the aid of flappy tailfins! No noise, nothing to wear out, and best of all—no cost . . . here's how.

Heat is extracted from the tube by a special heat-dissipating shield made up of a series of individual tin plates shaped as shown in Fig. 1. End D has direct thermal contact with the tube body, extracting heat by conduction, transferring it to end E, where the heat is removed by radiation and convection of the circulating air.

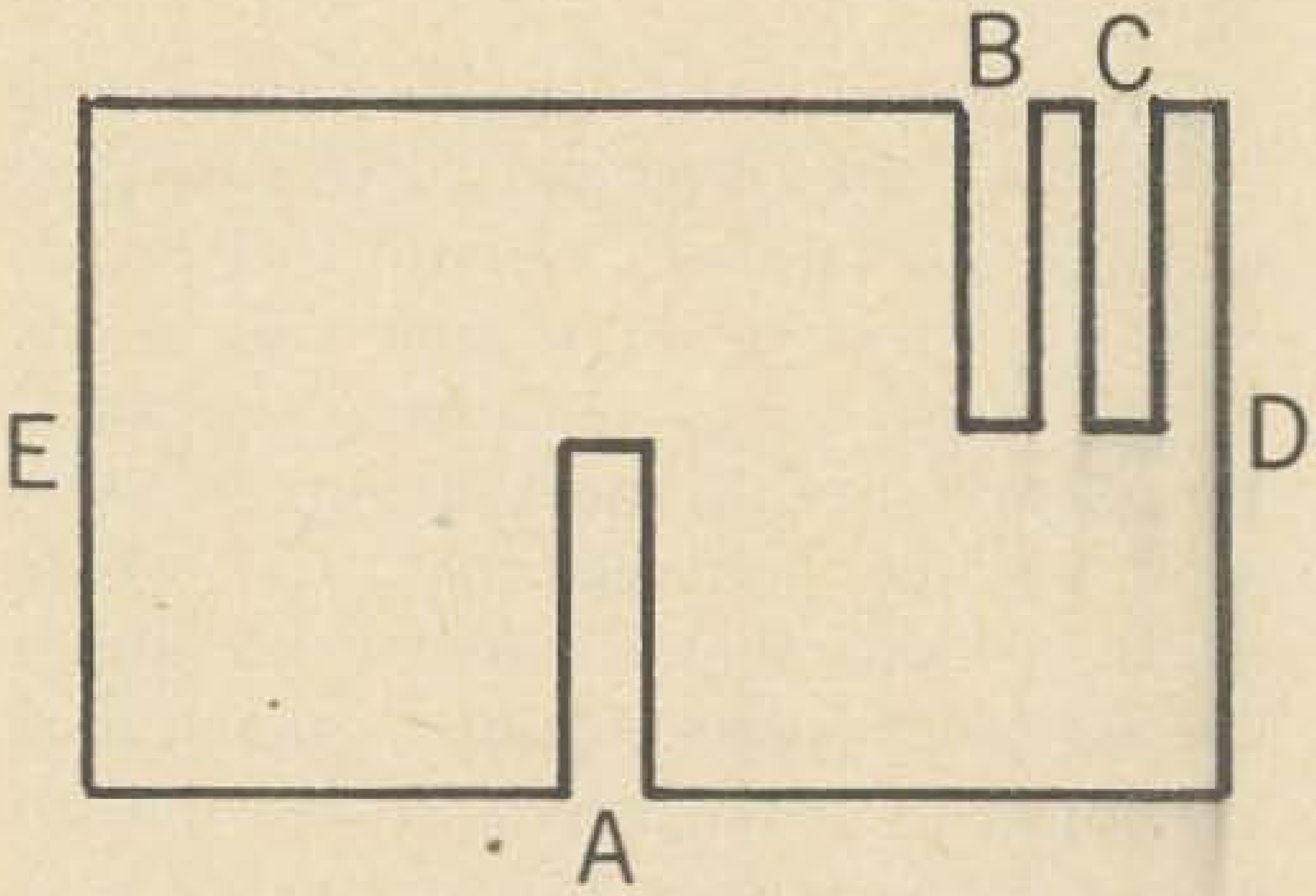


Fig. 1. An individual plate.

To make, you need to cut a half-dozen or so small sheets of fairly flexible sheet metal (2½ x 4 in. will be about the right size for the usual PA tube).

Snip a slot in each plate as at A in **Fig. 1**, and a few more as at B and C—cut each slot sufficiently wide and deep for A of one plate to slide easily in B or C of the next, the bottom and tops being level with each other.

To assemble the thing, slide slot A of one plate into slot B or C of another. Continue until you have a circle of plates, with an opening in the center for the tube and the flappy tailfins sticking out all around.

Paint all fins flat black. Black has a heat-absorption characteristic and will enhance the overall efficiency of your dissipator.

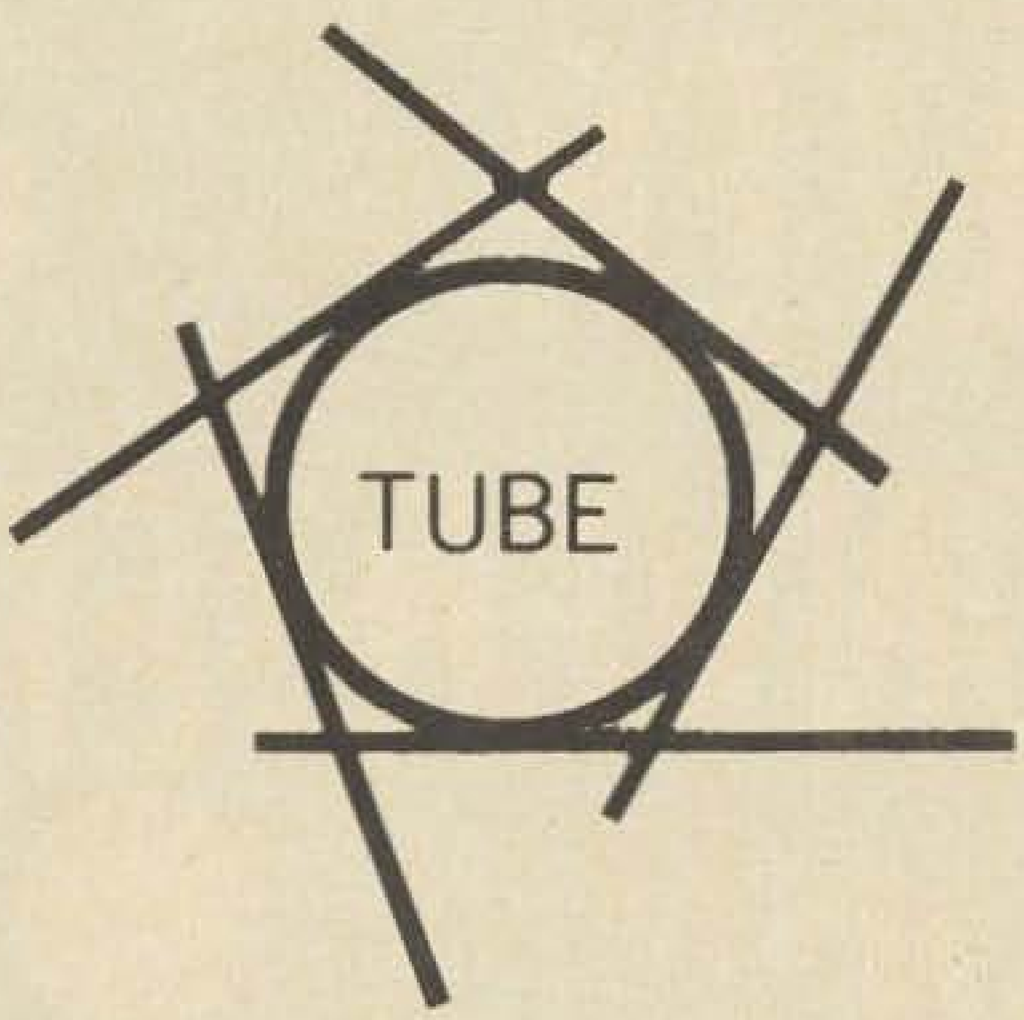


Fig. 2. Plan view of complete shield on tube.

Now try it on for size. If slightly out, select slots B of C as appropriate. If much too large, cut a new slot. Slide over tube and bend or cut tailfins to avoid nearby components.

A secondary benefit of the shield is that it will reduce direct radiation of heat onto such things as vfo coils and electrolytic capacitors, where it is definitely NOT wanted.

A good point to remember is that not all circuits will be able to tolerate the tube capacitance introduced by the shield. Some experimentation is warranted in most cases. Retuning will be required in virtually every case.

... G3KPO ■

TOWARDS AN IDEAL SOLID-STATE I-F FOR AMATEURS

PART 2 I-F FILTER, CONVERTER, AVC

. . . Breadboarding the complete IC system.

William Hoisington K1CLL
Far Over Farm
Peterborough NH 03458

This second part of a two-article series on a reasonable cost, portable "ideal" i-f for the amateur homebrewer describes the design method and working breadboard model of the 1.65 MHz to 135 kHz converter module, a 135 kHz i-f filter which really cuts the mustard, an avc module for use with the Motorola HEP 590 IC i-f amplifier, and the results when using the whole i-f system. If you like plenty of lows when listening on the bands, this is the unit for you; the bandwidth is between 3 and 4 kHz, which is cutting it pretty close for good voice quality. Of course, when the going gets real tough, you don't care about quality, but you do care plenty about understanding what your contact says. That's when a narrow bandwidth really helps.

The possibilities for the homebrewer with this double-frequency i-f seem quite interesting; indeed, I'm anxious to get one packaged for myself, along with a tunable packaged 10 meter front end for use with VHF and UHF converters.

Overall System

Figure 1 shows the block diagram of the complete triple-conversion portable receiver. Previous articles have described detailed construction of various portions of this system. This section is concerned with the 1.65 MHz to 135 kHz converter, the avc module, and the 135 kHz filter.

article. Of course, you do have to add an extra winding or so, but the coil form, adjustable center threaded core, tuned winding, outer powdered-iron core, and the aluminum case are all there.

On the subject of mixers, be sure to read the "trouble" section, where it shows what happens when you put a high Q coil in the collector circuit of a lively mixer and leave the emitter only partly tied to ground. In this condition, you're in grave danger of very strong oscillation on 1.65 MHz (if that is the frequency of the output circuit).

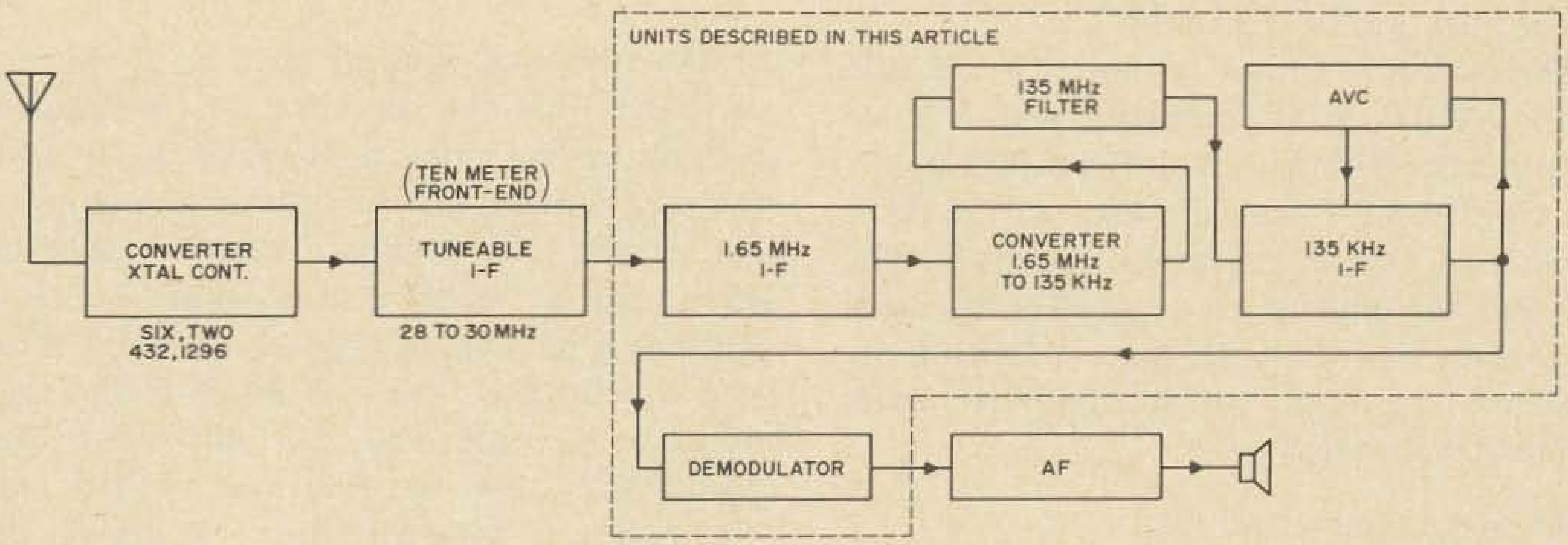


Fig. 1. Block diagram, ideal i-f system.

Instead of the first crystal-controlled converter followed by the tunable 10 meter front end, you can use a tunable 6 meter job if you wish, resulting in a double-conversion receiver. You can even use it that way on 2m, but tuning gets pretty touchy then. The crystal oscillator in the VHF–UHF converters relegates the tuning business further down the line to the 28 MHz region, where it can be done in a reasonable fashion.

Once the i-f system is packaged and installed in a little carrying rack along with the desired converter and companion solid-state transmitter, it should make an extremely interesting and useful addition to portable amateur equipment —and at reasonable cost for the homebrewer.

Mixer

In the past I have described several 1.65 MHz mixers, but this is the first using ready-made coils that you can buy on the market; that is, these are the Miller series, described in detail in the first part of this

Various types of oscillator injections were tried, and the one shown in Fig. 2 is the result. It uses straight link coupling from the oscillator inductor to the mixer base coil, and has the nice feature that the amount of coupling is easily adjusted for the best

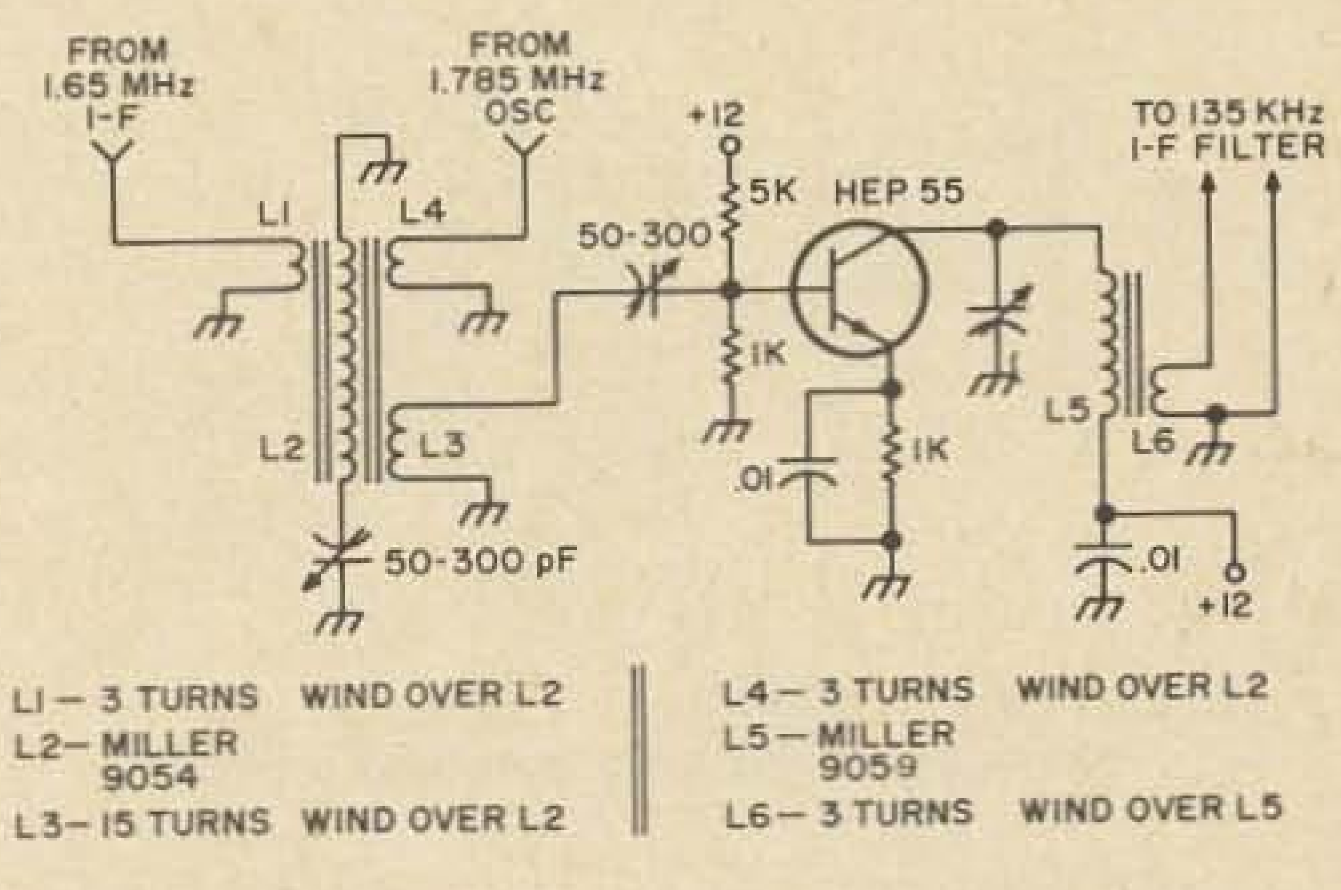


Fig. 2. 1.65 MHz to 135 kHz converter mixer detail.

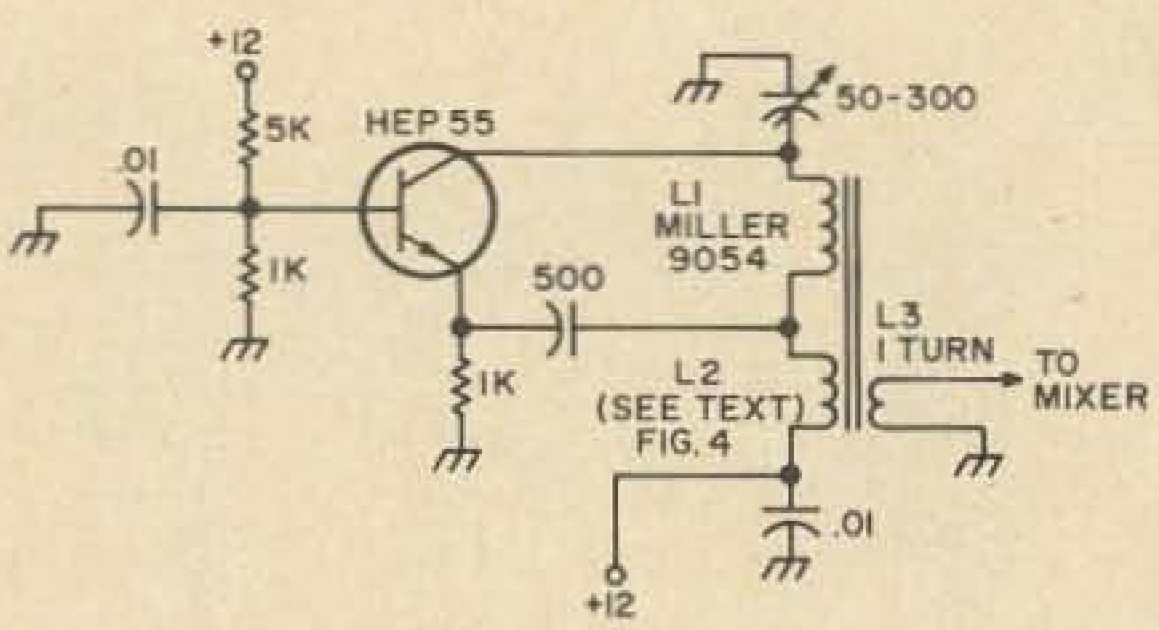
effect. This is useful because if you undercouple you lose gain, and if you overcouple you can get frequency "pulling"; unwanted harmonic power rises also. You will notice several windings of only 3 turns or so, which is a small number at an intermediate frequency. This is possible because of the powdered-iron cup core used, which increases the magnetic coupling and the Q of the coils. Figure 2 shows the mixer circuit using the Miller coils.

Here's how it works: Signal energy from the 1.65 MHz i-f module comes in on L1 and is transferred selectively to L2, and from there to L3, which is matched to the base input of Q1. Oscillator energy at 1.785 MHz is supplied also to Q1 via L4, and the two signals are mixed, or beat, in Q1, to furnish a collector output on 135 kHz.

The collector circuit is tuned to 135 kHz with a Miller 9054 inductor and a mica compression trimmer of 100 to 500 pF. A link of 3 turns is wound on top of the 9054 winding to couple energy to the filter. The base and the emitter are treated in the usual fashion for dc bias, with the emitter heavily bypassed to ground, which effectively eliminates self-oscillation.

1.785 MHz Oscillator

The basic circuit of this oscillator has not been changed from that described in the first article, but this time it uses coils that are readily available. The Miller 9054 unit works fire with the addition of only 6 turns of wire to create an emitter feedback tap, as in Fig. 3, and a pickup link to transfer the needed energy over to the mixer.



L1 = Miller, 9054
L2 = Add-on winding, see text and Fig. 4.
L3 = 1 turn.

Fig. 3. Converter, local oscillator, 1.785 MHz.

How to do it. Remove the aluminum can from the Miller 9054 coil by bending back the little tabs holding it in place, and make sure that the outer cup core stays in place inside the can. Figure 4 shows the oscillator winding details. You *must* get the direction

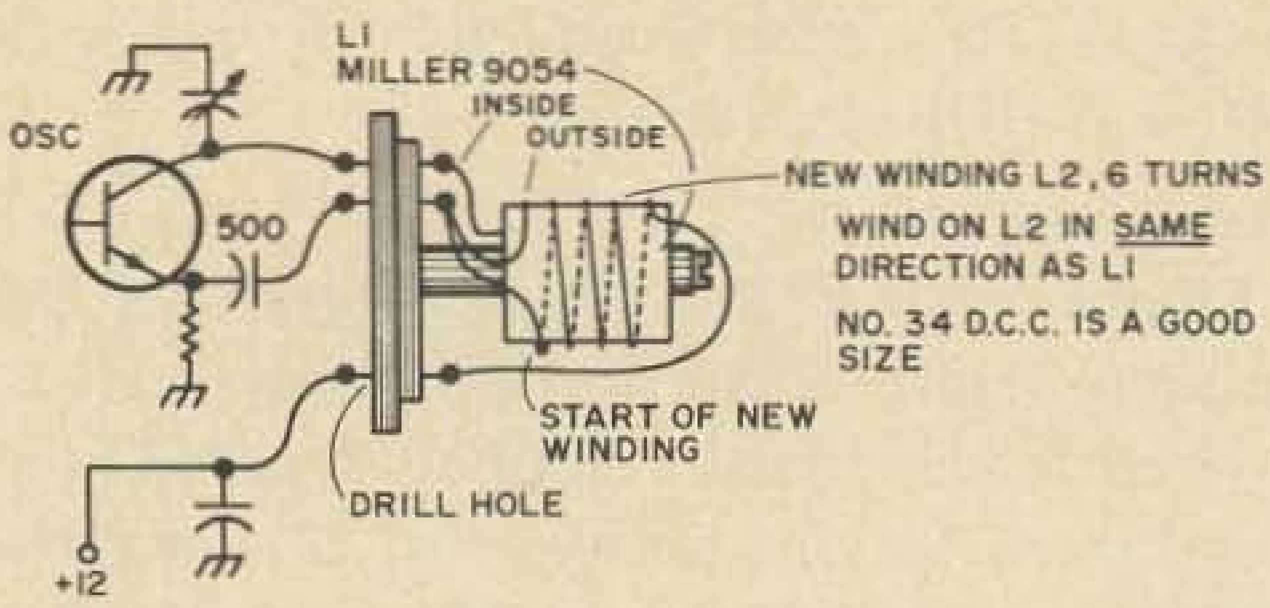


Fig. 4. Oscillator coil detail, 1.785 MHz.

of the feedback winding right or it will not oscillate. Find the direction of the winding making up the original 9054 by looking for the wire coming off the outside and going to one of the two terminals. Then wind on an additional 6 turns in the same direction without changing L1. Figure 4 should show you exactly how this is done. Join the start of L2 to the outer end of L1 at the pin. This point will now become the emitter tap connection as shown in Fig. 3. Bring out the finish of L2 and connect it to the B+, bypassed by C3.

Wind on one turn for L3 on top of L1 and L2 (a little coil dope helps hold them on). I use coil wax for easy changing, due to my experimental work, but coil dope cement is all right once the circuit is working correctly.

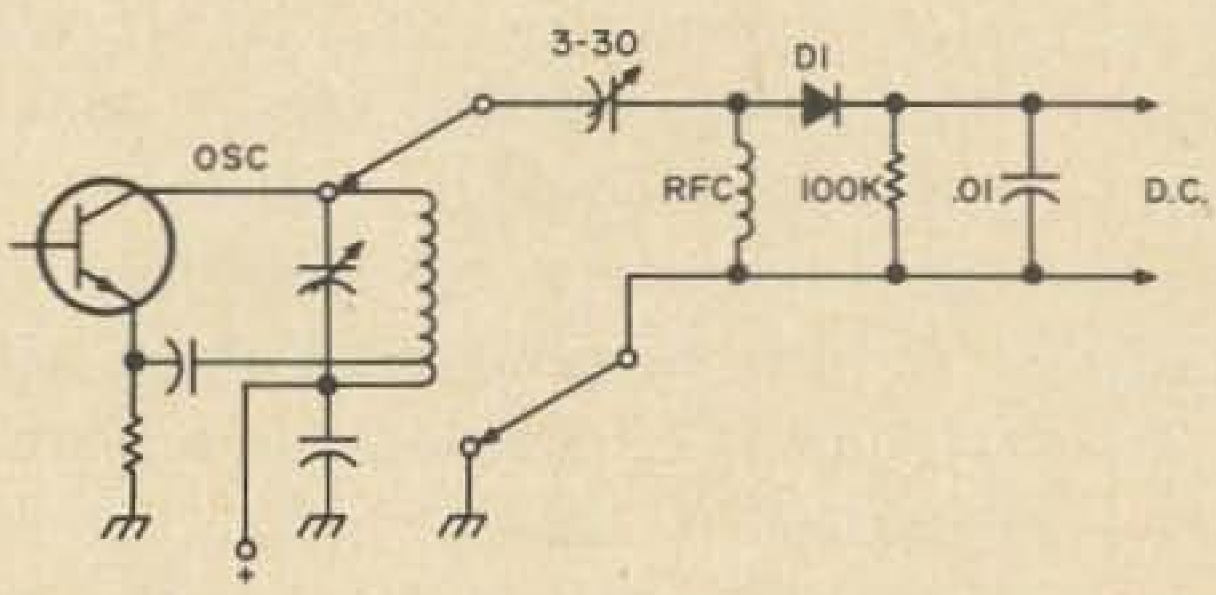
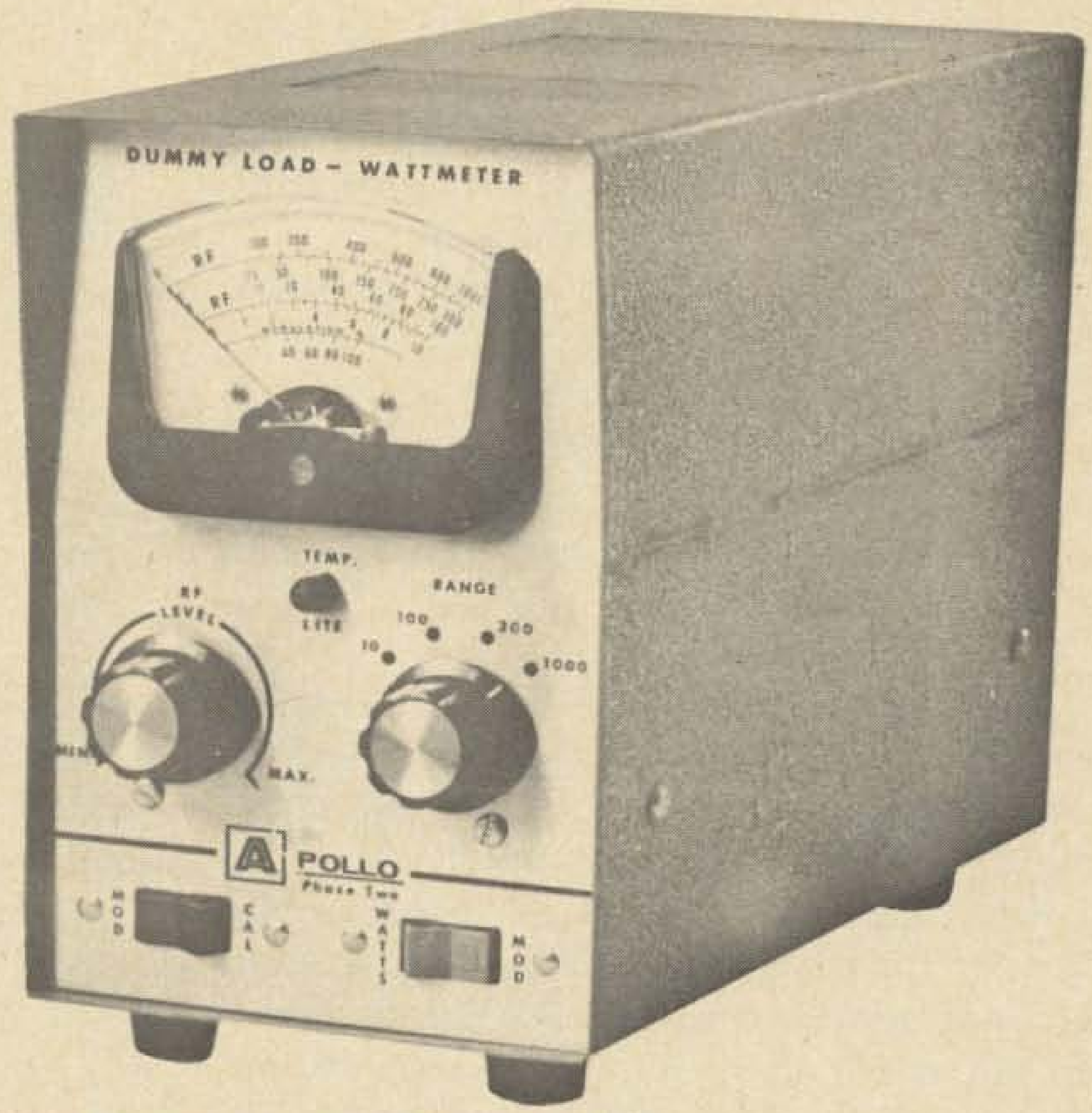


Fig. 5. Diode rf tester.

And that's it. You can clip on an rf detector as shown in Fig. 5 for a check on power and frequency. Use an absorption wavemeter or a dipper in the diode position for this test to find the fundamental. Then you can trim up to an exact spot with your receiver.

Sensibly priced for the maximum number of Hams.

TUNE UP WITH AN APOLLO



DUMMY LOAD WATTMETER

only *$99.95*

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.

HERBERT W. GORDON COMPANY

HELPING HAMS TO HELP THEMSELVES

Woodchuck Hill Road *Harvard, Mass. 01451*

PHONE: 617 456 3548

Use the least amount of power needed to drive the mixer. This will cut down on 1.785 MHz harmonics and "birdies" from getting into the front end of your complete receiver. The value of shielding cannot be overemphasized. Keep any and all rf out of the battery leads, and keep closed-in cable connections to your beam antenna lead.

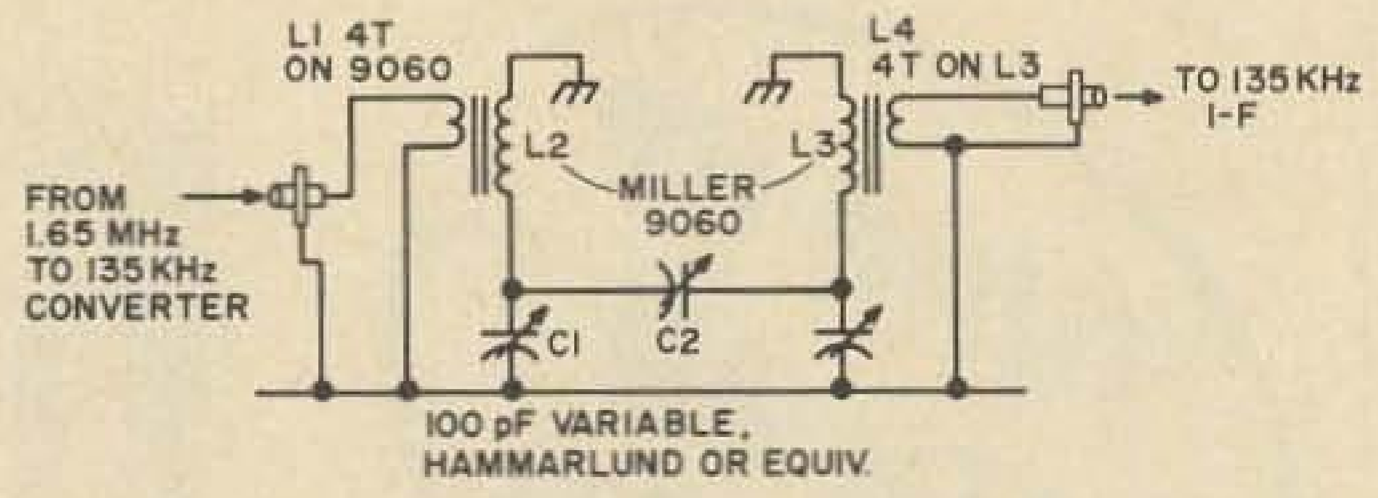
The best things for elimination of birdies can thus be listed as follows:

- Reduce oscillator power.
- Carefully shield the oscillator and mixer, and filter the battery leads.
- Shield the front end from nearby pickup.

Note that the birdies are 1.785 MHz harmonics and are not i-f leakage, which is pickup of signals on 1.65 MHz. I-f leakage is much more troublesome up front in a receiver, such as on 10 meters, between the 28 MHz tuner and the VHF or UHF converter. In times past I've been startled to hear a W9 calling CQ on 2m, only to find he was on 29 MHz. Plenty of VHF converter output swamps such pickup, and good cabling and front-end shielding help to minimize that type of leakage.

Do-It-Yourself-Filter

As mentioned in the diode section (later) on demodulation, the more tests I make, the more I like the diode across the entire inductance; however, the selectivity suffers a little as a result. Looking for that sometimes-elusive 3-4 kHz bandwidth, I decided to check the operation of a filter. I'm not always particularly impressed with the way some designers use filters. They have a tendency to use just one filter and a lot of amplification along with it, and it doesn't always sound right in operation. So this one was started with plenty of reservations; but after several days of trial and retrial it turned out to be a real goodie. That is, when used in *conjunction with* three other other tuned circuits as well as on 135 kHz. Figure 6 shows the circuit which is a simple "top-coupled" two section job. There are several methods of coupling filter sections, such as link, mutual induction, and magnetic (wound on the same core but spaced). The one shown worked out best and is fairly easy to adjust, with one caution: With a given number of link-coupling turns, maximum transfer of energy may be 10 dB or so down, even with the best adjustment of C. It is a



L1 = 4 turns wound on 9060
L2 = Miller 9060
L3 = Miller 9060
L4 = 4 turns wound on L3

Fig. 6. 135 kHz filter.

combination of the proper number of link-coupling turns (L1 and L4) that produce the happy result of low transfer loss and minimum usable bandwidth.

Theoretical design of filters is a very complicated affair mathematically, with no place in this article. Just make it as shown in Fig. 6 and it will do fine. The entire i-f is already too sharp for a hi-fi AM tuner right now, and does cut the highs noticeably. You could add another filter with possibly another HEP 590 in between but then you might not be able to use it on AM voice.

This filter, in combination with the three other tuned circuits, has been put to use here for several days, changing back and forth between 10 meters, the BC band, and the signal generator. This BC band can be quite informative when used with the signal generator and the amateur bands, because you do want to be able to understand the other party to a QSO even though you're looking for a lot of selectivity. When you have 8 to 10 kHz of flat-top bandwidth, you can do pretty well on the clear channel stations. This clear channel business concerns the FCC's frequency allocations and does not take into account the ideas of Canadians, Mexicans, and Cuban broadcasters, to mention a few. The best thing to do for this test is to check your location and the frequency allocations for a strong local and a not-too-distant next-channel station in the daytime. Incidentally, look out for those BC stations that use *over* 100% modulation. The most powerful one in Massachusetts does just that!

When I check on the signal generator, using the filter, and measure ±1.5-2 kHz for about 6 dB down, I've got a good communications set bandwidth. This shows up on the BC band with definite cutting of highs. Bear in mind we are not talking about a $600 set, which can afford bandwidth switching. This is just a good homebrew filter job that can be put together on your bench for a few dollars, plus more than just a few days.

For best results this unit should be installed in a Minibox, although it also handled well on a copper-clad 5 x 8 in. baseboard. You can also switch the filter in and out, with suitable care, as in Fig. 7.

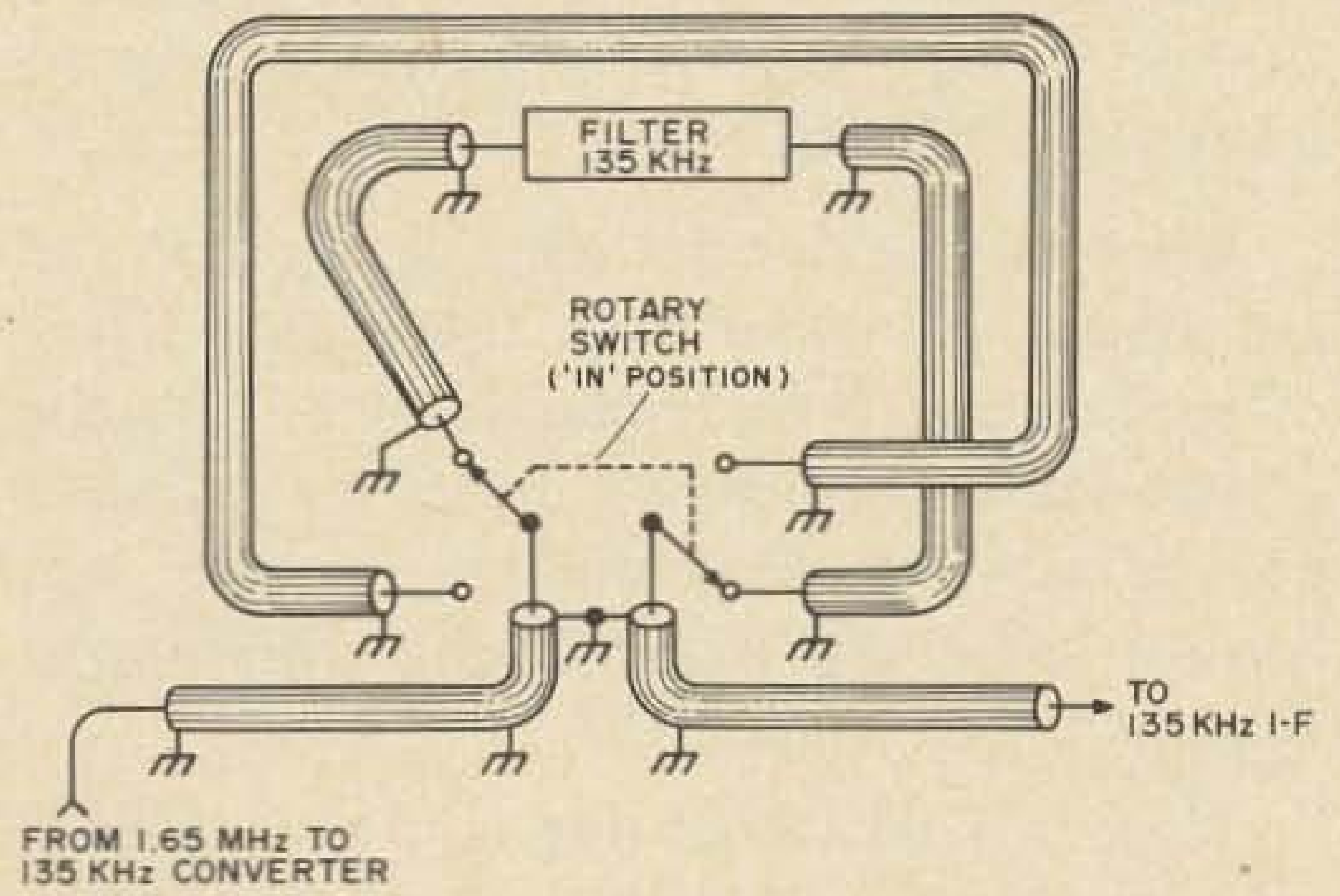


Fig. 7. Bandwidth switch, 135 kHz filter.

Demodulator

I spent lots of time on the demodulator, most of it in conjunction with the bandwidth determination and the filter operation, as these all go together to produce the desired results. The avc system is also tailored to fit in with the demodulator.

Believe it or not, those of you new readers who have yet to experience hours-long DX work on VHF or UHF, the "rushing" sound of the noise made by the receiver itself can be important. It should not be a shrill hiss; it should be a "businesslike" roar, of low tone, and the slightest hint of a signal, even the smallest fraction of a microvolt, should be detectable (by ear as well as on the S-meter). You can see the logic of this when you consider the bandwidth of noise itself. With this i-f system, demodulator, filter, and af, the above is what happens. Of course, you *do* need a low noise front end also and this need automatically becomes greater as you go from 6 to 2 meters, and on up.

Figure 8 shows the best circuit found for the important function of demodulation. With this one you *will* hear that signal, the af

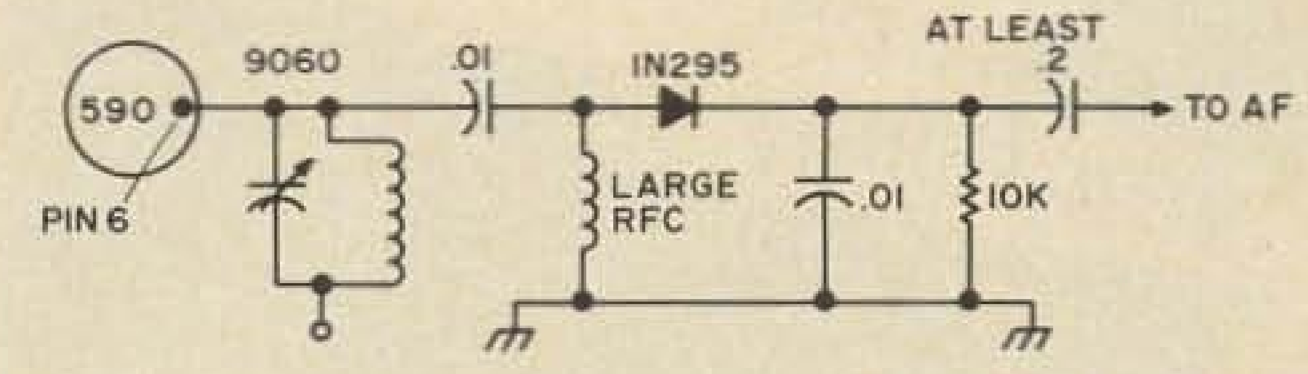


Fig. 8. Best demodulator circuit.

quality will be good, and your chances of enjoying those QSOs will be best.

It should be followed by a good tone control circuit and a good af amplifier such as the Amperex TAA-300, and a good speaker. You need some lows in there to punch through the QRN.

AVC Circuit

The use of the Motorola HEP 590 as an i-f amplifier results in considerable advantage, but it also changes the avc requirements, as you will see.

Referring to Fig. 9, pin 5 of the HEP 590

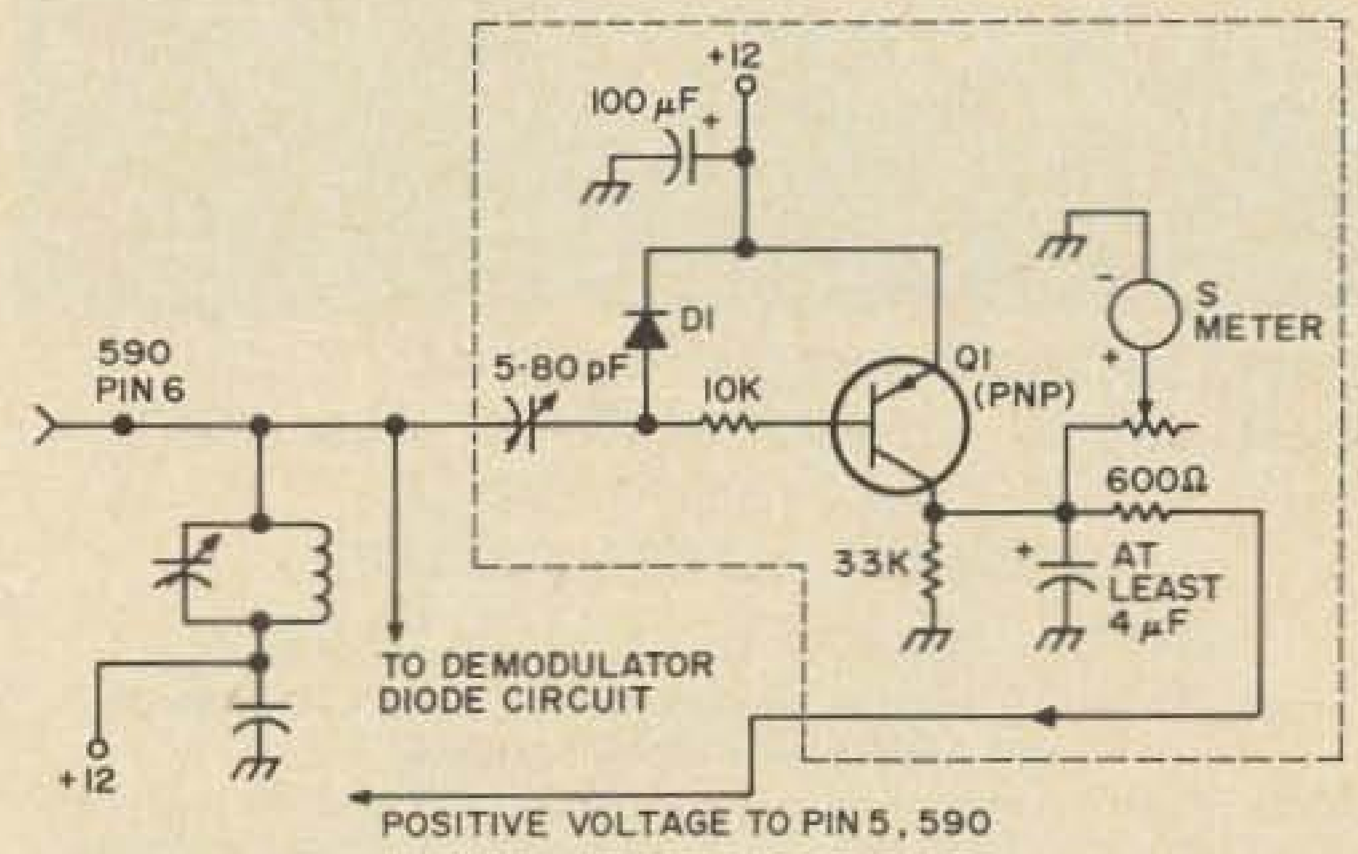


Fig. 9. AVC module.

is the avc connection. When pin 5 has 6V or more of positive voltage, the current of Q1 is shunted through Q3, and taken away from Q2 which reduces the gain of the entire circuit. The big advantage with the IC is that avc can be applied to the last i-f stage, which is also the same stage that is driving the avc system. With a single transistor amplifier stage, this is not normally recommended, but with the HEP 590 it works fine. Another advantage is that you now have places to install an S-meter that reads forward. This is across the avc amplifier collector resistor (Fig. 9).

Figure 9 shows the final circuit which holds the rectified dc voltage down to less than 1V–even on those Texas kilowatts. A *PNP* transistor is used in an "upside-down" fashion as the avc amplifier. An advantage of the use of an avc amplifier is that very little of the i-f energy is needed to operate the avc system, and no noise at all is contributed by it to the signals.

When testing this out on a signal, with the avc module removed from the IC, the effect of connecting or disconnecting C1 from the i-f was hardly noticeable. I may be a fanatic on conserving demodulator power and quality, but it sure pays off when listening to those DX UHF stations!

When testing this out on a signal, with the avc module removed from the IC, the effect of connecting or disconnecting C1 from the i-f was hardly noticeable. I may be a fanatic on conserving demodulator power and quality but it sure pays off when listening to those DX UHF stations!

How it works. Referring to Fig. 9, a small portion of the 135 kHz i-f energy is taken off the IC output inductor through the trimmer C1 and fed to diode D1. Capacitor C1 is a very handy place to adjust the amount of avc action. With a meter checking the dc output of the demodulator, backing off on C1 drops the avc output and raises the diode voltage to a point where D2 overloads. Increasing C1 raises the avc output and drops the voltage on D2 to less than 1V on the loudest signals. You can set this to suit your own fancy.

The i-f voltage on D1 causes negative voltage to appear at the base of Q1 (a PNP connected upside-down), which then conducts, driving the collector towards the +12V. This positive output is filtered by C3 and applied to pin 5 of the IC amplifier where, as soon as the 6V level is reached, it begins to cut down on the gain of the HEP 590. On a very strong signal, like a W5 on 10m with an ordinary band opening, this voltage may reach plus 7½V or so. It is perfectly possible to apply the avc voltage to the HEP 590 used in the 1.65 MHz i-f also, but this is taken up later, when the whole system gets packaged into its 99% "ideal" form, in Miniboxes.

Don't be worried about the upside-down PNP. This is a usual practice nowadays. Just "stand" on the +12V bus as though it were the ground, along with the emitter, and look at the ground as though it were the battery voltage for the collector. It works!

Complete System Tuneup and Operation

This is where you can really take it on the chin as you first turn the entire rig on, with unbelievable sounds coming from the speaker. Too much gain, birdies, low-frequency burble, high-frequency oscillations, broad-tuning squeals, and assorted tunable hisses are some of the things that can assault your ears when you connect an antenna, the 10 meter front end, the first i-f, the second converter, the filter, the second i-f, demodulator, af, and speaker—and switch on the battery. (The overall circuit, incidentally, is shown in Fig. 10.)

Table I. Coils for "ideal" i-f system.

L	Number of turns or coil type	Notes
1	1 turn	Wind on 9054
2	Miller 9054	
3	4 turns	Wind on 9054, L2
4	9054	
5	3 turns	Wind on 9054, L4
6	3 turns	Wind on L7
7	9054	
8	3 turns	Wind on L7
9	15 turns	Wind on L7
10	Miller 9059	
11	3 turns	Wind on L10
12	9054	
13	6 turns	Add on to L12 (text)
14	1 turn	
15	4 turns	Wind on L16
16	Miller 9060	
17	Miller 9060	
18	4 turns	Wind on L17
19	5 turns	Wind on L20
20	9060	
21	10 turns	Wind on L20
22	9060	
RFC	Large	Self-resonant below 100 kHz

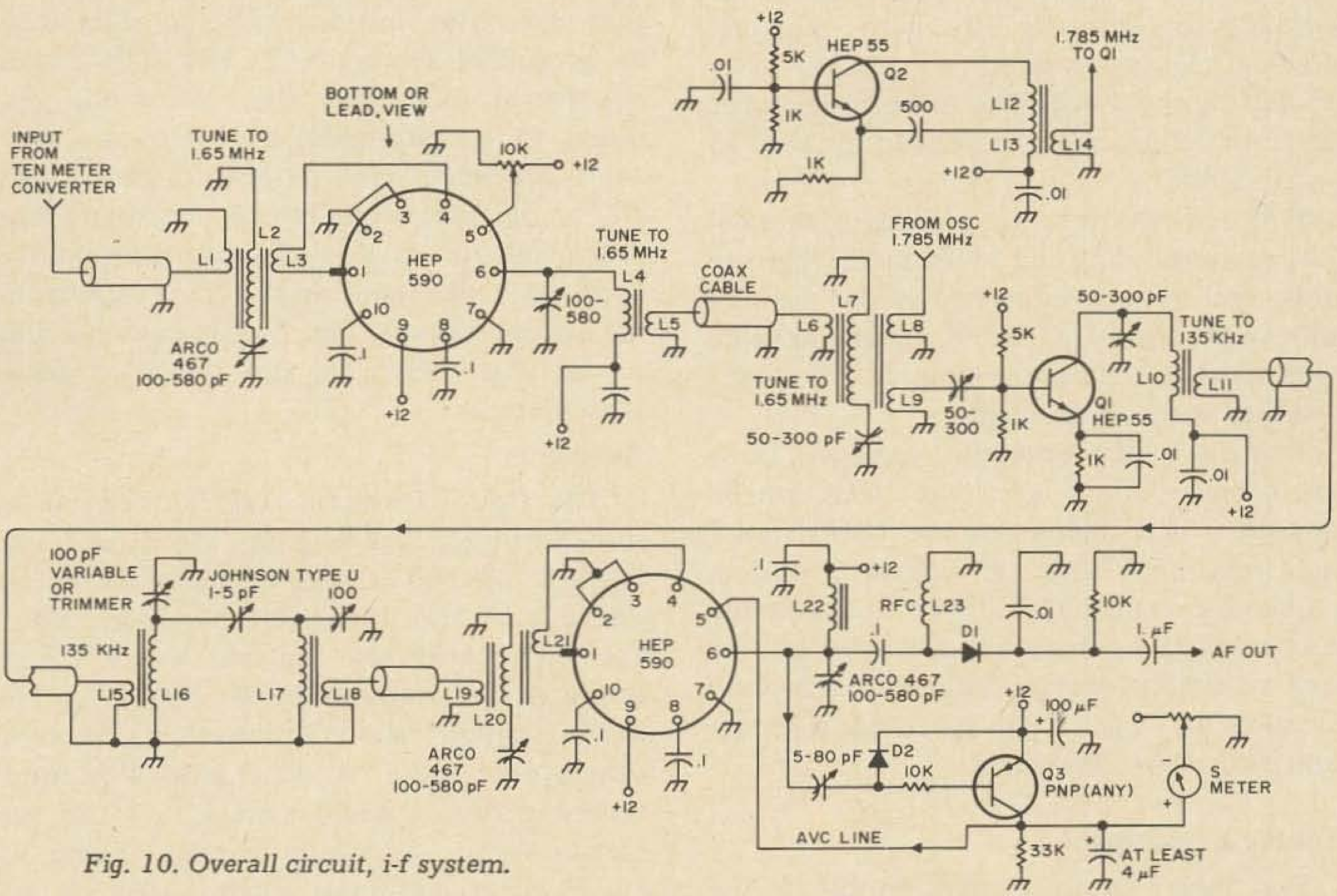


Fig. 10. Overall circuit, i-f system.

In commercial receivers you often see items such as a 300Ω resistor in series with the mixer collector, going to the i-f output transformer, or a large bypass capacitor to ground on a mixer emitter which at the same time is supposed to receive oscillator injection. It does apparently, but only in spite of all known electrical laws! Such fixes can be considered legitimate in that they do allow the system to operate in a satisfactory manner, but in my work I feel that the readers deserve to be told the truth—if it can be found! It is not always easy to dig down to the basic troubles, though—especially in cases like birdies in the front end from a second local oscillator (or third, when triple conversion is used). It also takes space because when your breadboards are spread out over two benches (see block diagram, Fig. 1) your i-f, af, and speaker wires can sometimes radiate just enough spurious to get back into the antenna wires or front end, with high gain and loud signals—that is, if shielding, closed connectors, and coax cables are not used. A beam, or at the very least a coax-connected antenna outside the shack, is very useful.

Mixers in particular are always suspect for my money. I have recently changed from my favorite mixer circuit over to one in which the mixer emitter is firmly tied down to the ground plane, rf-wise. This whole system performed in fine shape as soon as the mixers received the above-outlined treatment and avc was applied. The work on the demodulation proved especially valuable, allowing plenty of good i-f voltage to be handled by the diode. This in turn makes for good avc action, which has been detailed in the avc section.

You can also see that packaging of each unit, removal of rf and i-f from the battery wires, and proper interconnections can be quite important. The use of a shielded cable going to at least a two-element beam outside the shack is recommended.

You *do* want a powerful, selective, portable receiver, don't you? One that can be used on 6 or 2 meters or the UHF bands? And in a nice little carrying rack with a companion transmitter? With quite a lot more work to come in the packaging bit, we hope to finally provide you with the plans for such an "ideal" rig, of reasonable size and cost, for use anywhere.

Trouble Department

You might think a mixer would be the last item in a receiver to develop real trouble. After all, it is supposed to just sit there, and is not supposed to oscillate or amplify, although some of them do have quite a lot of conversion gain. What would you say about one that oscillated about 5V worth all by itself?. . .cut off the local-oscillator drive, remove any input and still it oscillates? Well, it happened here and it could happen to you. So here I tell it like it is and I hope it will help you to avoid at least that trouble. It cost me days and a burned out HEP 590 too.

Figure 11 shows the circuit that did it. DO NOT USE IT! It so happens that to make an oscillator, you ground the base, put a tuned circuit in the collector, and lift the

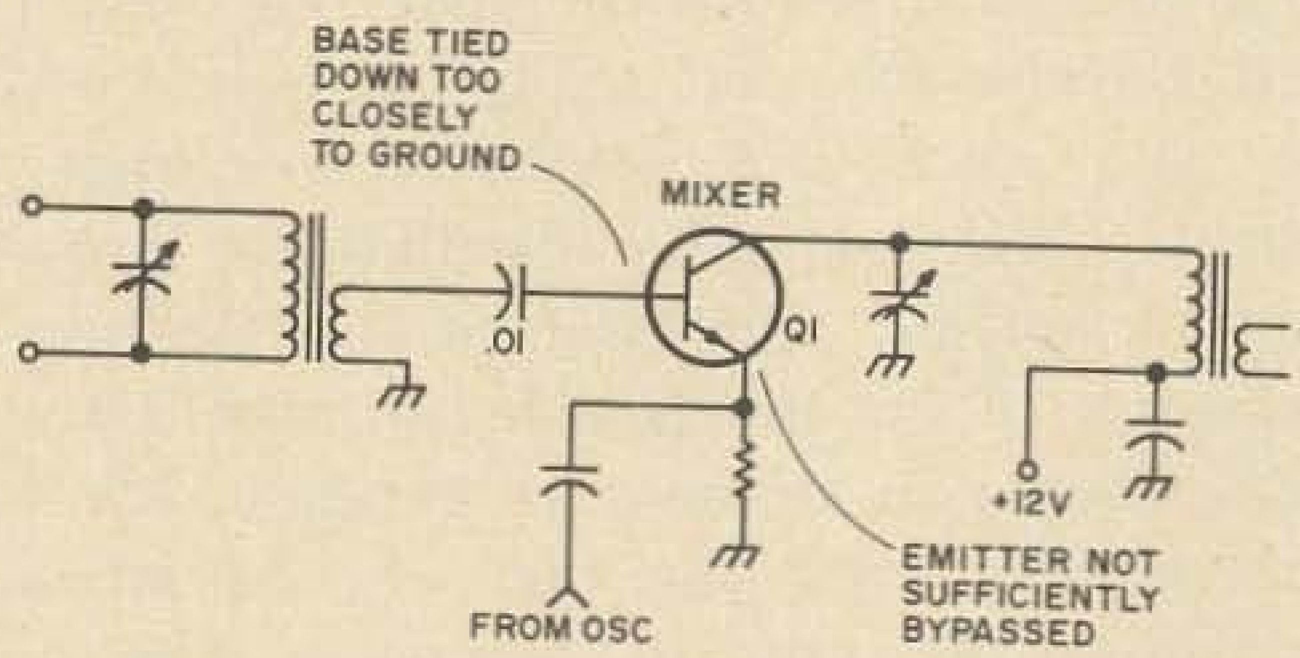


Fig. 11. Trouble-prone mixer circuit. (Do not use.)

emitter off *ground*. See the resemblance? In that mixer the emitter can be considered to be grounded through C2, but it is *not* a *positive* ground. Also, the base is not supposed to be grounded, but there is a very short low-impedance path through C1 and L1, or the base input tap on the rf collector coil. Well, to cut the sad story short, it *did* oscillate. . .like mad! So the circuit shown in the mixer section, Fig. 2, was installed and so far *this* mixer has not oscillated since then. Period.

Results

The finished system was hooked up as shown in the block diagram, Fig. 1, with my faithful old 100 ft wire attached to the 10 meter front end. Being early in the morning, the first station on the dial was a ZS in South Africa, pushing the S-meter around in lively fashion, soon followed by lots of others over there. A little later W5s came booming in to provide checks on the avc section with extra-loud signals. Some of these latter produced nearly 10V of demodulator diode output with the avc off. This overloads it, of course, and it is not used in this condition. With the avc connected it held nicely to 1V or lower, adjustable by the 5-8 pF avc coupling capacitor. Manual control is applied to pin 5 of the 1.65 MHz IC amplifier, as indicated in

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73 Magazine

Peterborough, N. H. 03458

the first part of this article, to regulate the overall sensitivity and the amount of receiver noise. The results of using an excellent demodulator, the Amperex TAA-300 "baby hi-fi" amplifier, and a good speaker now showed up in a pleasing fashion. Advancing the af gain as for use in mobile work or in a large noisy room, etc. did *not* result in tinny audio or distortion, but produced good quality audio which was a pleasure to the ears.

The avc swallowed up 90% of the QSB, even 100% of everything that could reasonably be called Q5. As mentioned in the avc section, the small trimmer coupling capacitor bringing i-f energy over to the avc module provides excellent adjustable regulation of the amount of avc you may prefer.

The use of a good dial in the tunable i-f on 10 meters is imperative for an i-f of this bandwidth. The Miller MD-4 two-speed dial does a good job in that unit.

If you want to "steal a march" on my work here, install a bandwidth switch in front of the filter to cut it in or out. Figure 7 shows this unit, but mind you, I haven't installed it yet, so you're on your own. I have plugged and unplugged the filter though, many times, so I know what will happen if you beat me to it. There is an increase in bandwidth when you cut the filter out. This is good for non-DX contacts and locals. For real DX, switch to the 3–4 kHz bandwidth position, which cuts it down to the minimum noise condition.

Conclusion

Design methods, breadboard circuits, overall tests, and results have been detailed for you, trending well on the way towards an "ideal" battery-operated i-f system with low image and high selectivity, which, when packaged, will be a very useful piece of equipment for the active VHF–UHF amateur.

This will soon be matched up with the packaged, single-dial, three-gang tuned 10 meter i-f for use with any VHF–UHF converter, homebrew or store-bought. You will then have an excellent, portable, solid-state receiver that cannot be bought ready-made on the market today.

. . .K1CLL ■

epoxies for electronics

Elliot S. Kanter W9KXJ
3242 W. Hollywood Ave.
Chicago IL 60645

With the wealth of new materials and devices available to the ham today, it seems a shame to keep on building with worn out and antiquated methods. I am speaking of soldering, a process that has changed little since the days of heating a soldering iron over an open flame and then melting wire solder. This progressed to electrically heated irons or guns, but the basic principle remained the same: heat the solder and the terminal.

Until recently this was about all we could use and we tried to make the best of it. Heatsinks had to be used to protect our semiconductors, and of course, we had to be sure we didn't overheat the PC board and lift a conductor.

Well, there *is* a way to get around the problems of cold solder joints and heat-damaged components: *epoxy*! Not the usual form of epoxy, mind you, but an altogether different form—one which is electrically conductive, that can be cured at room temperature. I dashed off a line to Emerson & Cuming in Canton, Mass., and received a wealth of information on the world of epoxies. I learned that there are epoxies which are thermally conductive, yet still electrical insulators, and that a product called Eccobond Solder 72C was the IC manufacturer's answer to the solder of yesterday.

I sent away for some of this "solder" and followed the simple mixing instructions. A test circuit was put together using the liquid solder as a conductor between a battery and a small lamp. It worked like a copper wire, and during the cure period could be moved or removed with ease. Ohmmeter checks showed that it has low resistance and remains stable regardless of the applied voltage.

Next, I tried to solder dissimilar metals together (a copper wire to an aluminum chassis) and found it would not only provide a solid electrical bond, but had good mechanical properties as well. A friend borrowed some and proceeded to wire his new transceiver using the epoxy solder in place of regular solder. His report: no cold solder joints, no heatsinks needed, and—best of all—no heat-damaged components.

The epoxy solder in one form or another has found acceptance with many manufacturers of electronic equipment since it allows good reliable connections by unskilled personnel and in many cases does away with heatsinks.

Looking further into the catalog and spec sheets, I discovered thermally conductive epoxies which allow you to use the chassis as a heatsink. All you have to do is squirt a glob on the chassis and press the transistor into it. The epoxy presents a thermally conductive bond which is still an electrically isolated one.

All of the various forms of epoxies are available from the major electronics distributors and may be found in their industrial catalog section. Say goodbye to burned fingers and soldering irons and move up to conductive epoxies. The component packaging specialists did it a long time ago.

. . . W9KXJ ■

FET Preamplifiers FOR VHF FM

Earnest A. Franke WA4WDK/2
108 Matawan Terrace
Matawan NJ 07747

A grounded-gate FET preamplifier for 6 or 2 meters offers high gain, simplicity of construction and ease of tuning.

Many amateurs come to the point where they need an extra preamplifier for wider coverage with their mobile FM operation. I have constructed several field effect transistor amplifiers for 6 and 2 meters which yielded many interesting results. Approximately twice as much gain may be achieved when using a field effect transistor in the grounded-source arrangement as compared with the grounded-gate configuration for the same bandwidth; however, neutralization is almost always required. By using a field effect transistor in the grounded-gate configuration, the amplifier was simple to build, gave adequate gain and bandwidth with a low noise figure and ease of tuning. The low feedthrough capacitance eliminated any need for neutralization. The only tuning after construction is to peak the two tank circuits for resonance. When the preamp is used in mobile operation, the supply voltage may be taken from the car battery.

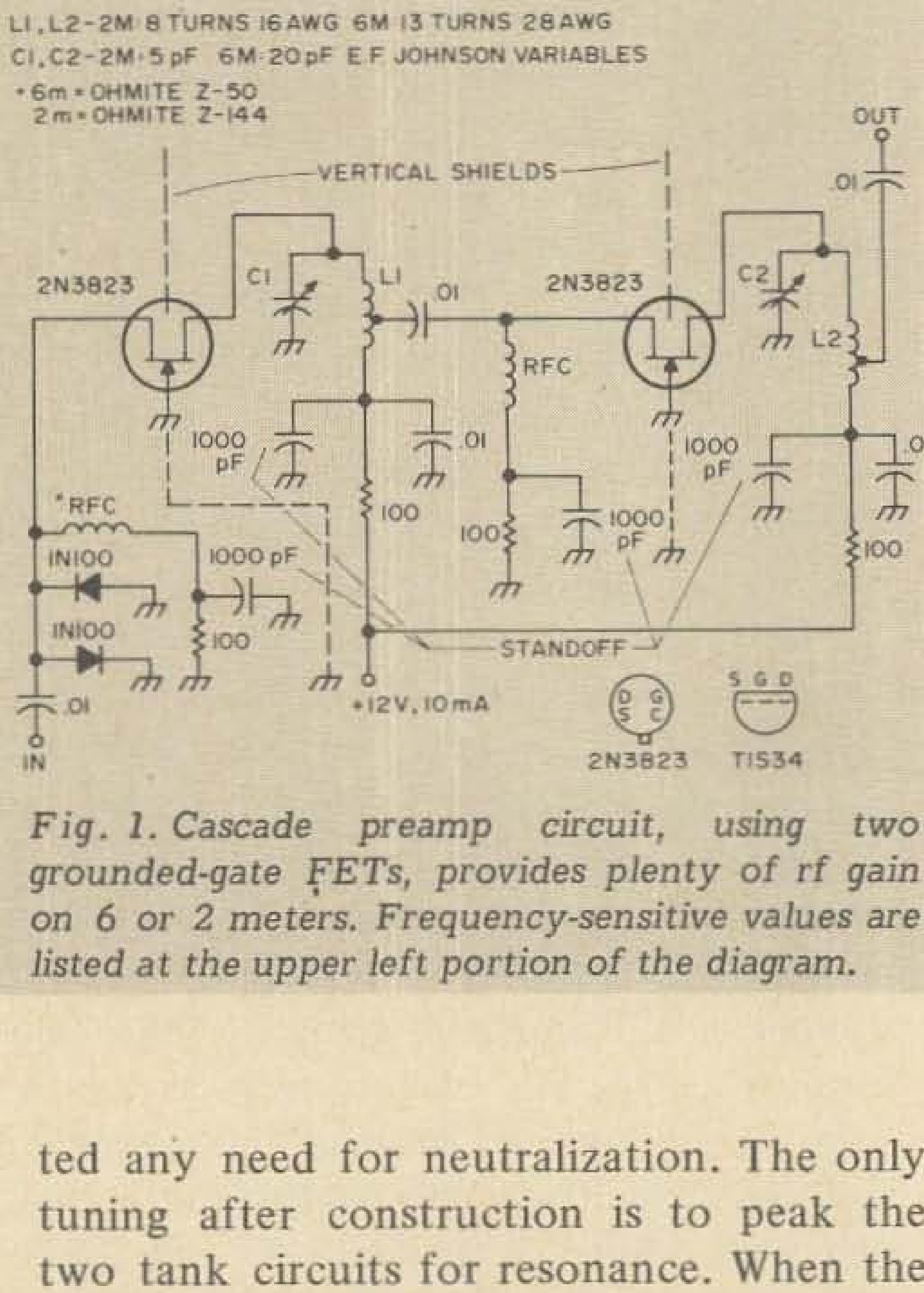

Fig. 1. Cascade preamp circuit, using two grounded-gate FETs, provides plenty of rf gain on 6 or 2 meters. Frequency-sensitive values are listed at the upper left portion of the diagram.

The schematic of Fig. 1 shows the 2N3823 (or TIS 34) field effect transistor cascaded in the common-gate configuration. An input tank circuit was tried and replaced by a simple rf choke to provide the rf input load. The low input impedance into a grounded-gate configuration tends to broaden or swamp any input tank circuit. The biasing resistor is bypassed to provide the rf ground. Two 1N100 diodes were placed back-to-back at the input connector to prevent possible overload damage. Poor isolation, especially in the antenna relay, could easily destroy the input transistor.

Construction

The amplifier was mounted on a piece of copper-clad printed circuit board. The board, with the copper on but one side, is cut to length and drilled as shown in Fig. 2. The general layout may be increased if parts appear too cramped. Notches must be cut in the vertical shields for the transistor sockets. The boards and component leads are then cleaned with steel wool to prepare a good soldering surface. After the sockets are mounted, the vertical shields are soldered in place neatly and evenly using a small soldering iron. The standoff button bypass capacitors are soldered firmly to the board. All ground connections are made by directly soldering the part down on the copper.

The 2 meter coils are wound on a ¼ in. diameter rod using 8 turns of 16 AWG enamel-coated copper wire. The coils are spread to ¾ in. long and tapped 2 turns from the supply voltage end. Each 6 meter coil is wound on a 3/8 in. diameter rod using 13 turns of 28 AWG wire, tightly spaced and tapped 2½ turns from the cold end. Care must be taken when soldering the leads to the Johnson capacitors. The stator plates are held in position by solder during manufacture and may fall apart when heated. Maximum capacitance values of 5 pF for 2 meters and 20 pF for 6 meters were chosen for the variables so that they would be in their mid-position at resonance. The output tap may be varied to determine bandwidth and gain. The positions shown here are not critical, but are a compromise for broad bandwidth.

A CU-2101A Minibox is drilled to allow passage of the connectors, sockets, and capacitor shafts. The printed circuit board chassis is then bolted to the Minibox top and labeled with dry transfers or decals.

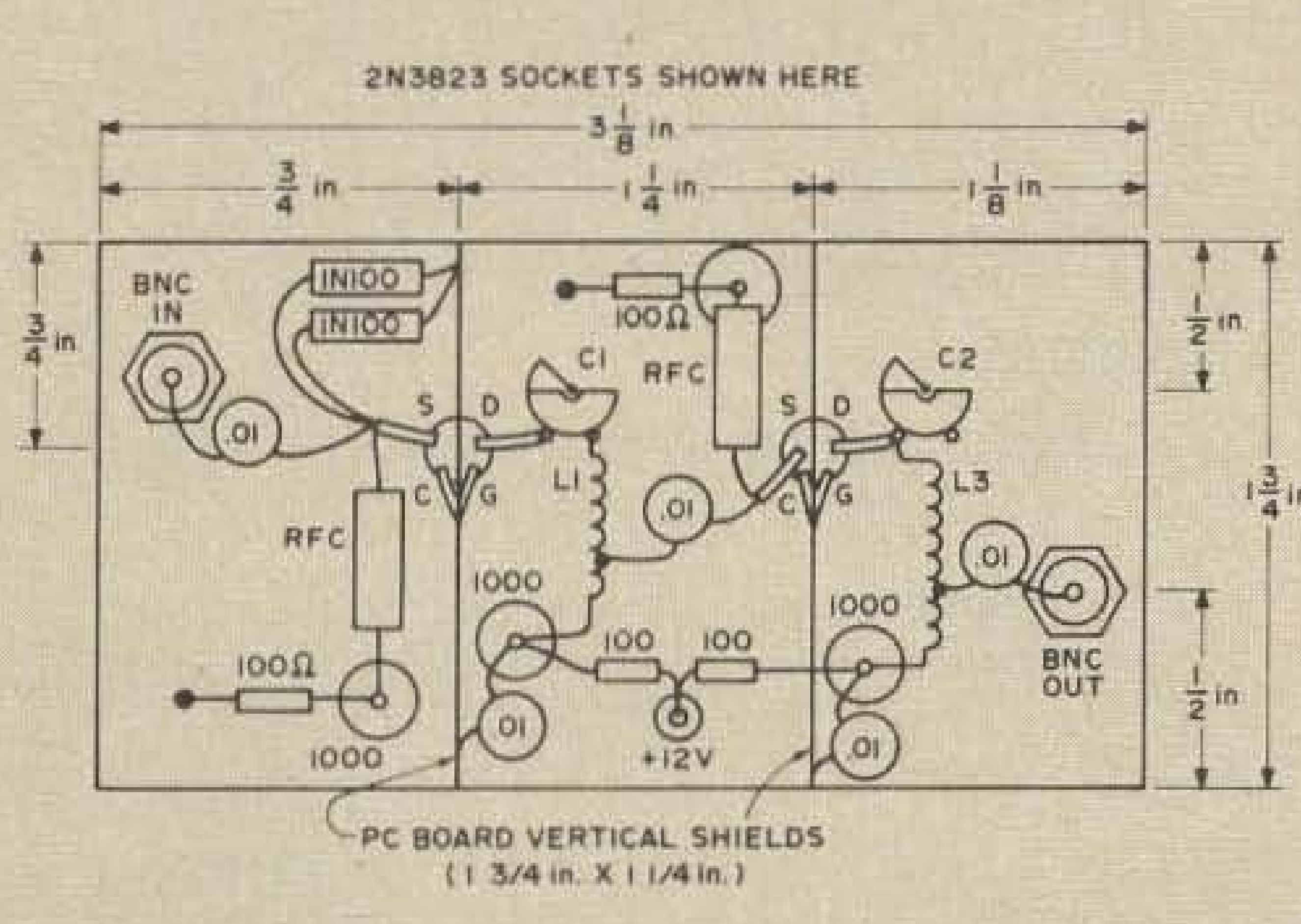

Fig. 2. Sketch shows layout of FET preamp. Note use of shield walls between stages.

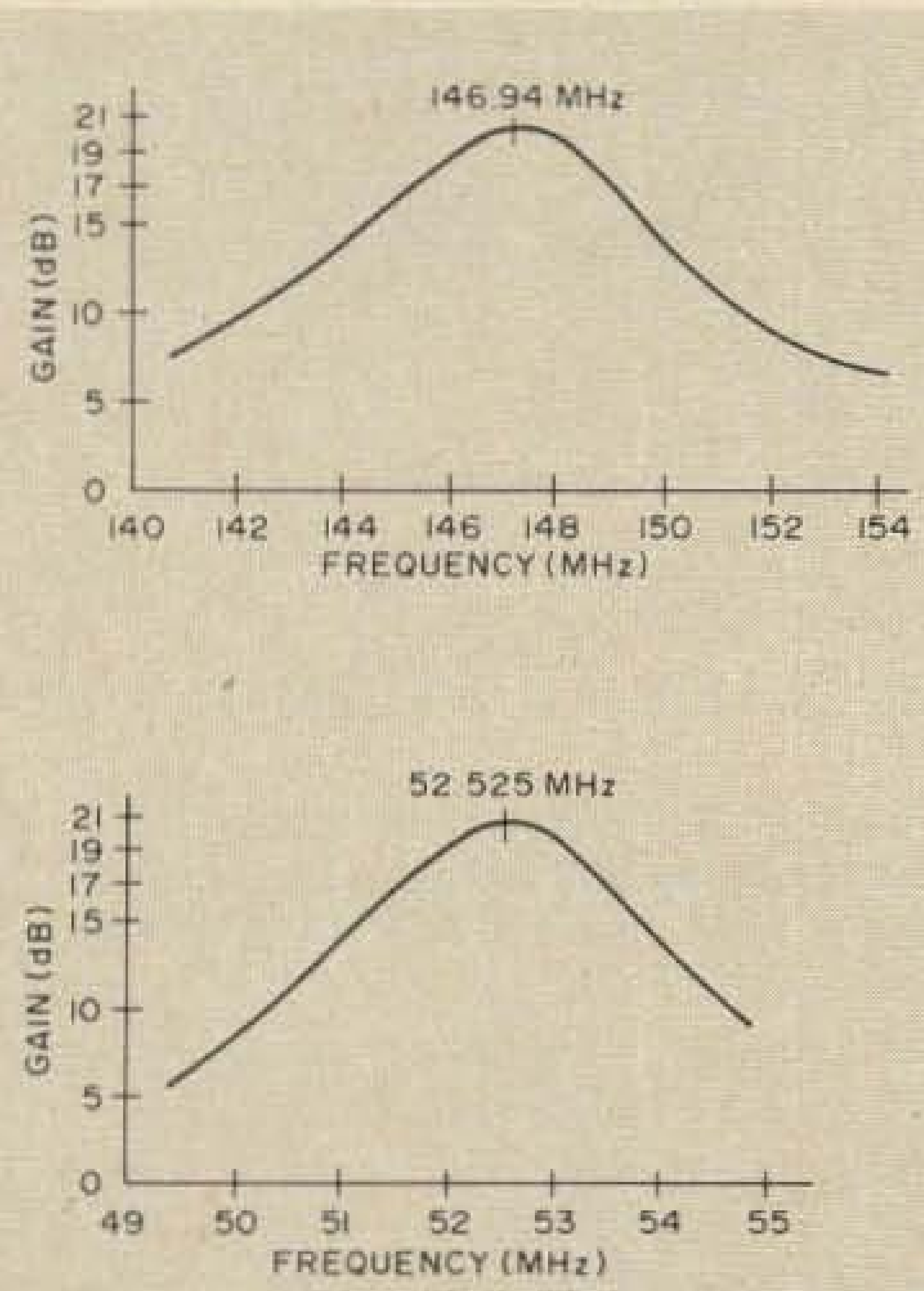

Fig. 3. Gain-bandwidth curves for 2 and 6 meter versions of the FET preamps. Note that gain peaks at about 20 dB in both instances.

Performance

With a 12V supply, the preamp draws about 10 mA total current. The two capacitors are tuned to resonance simply by peaking on noise. Figure 3 shows the response characteristics of each preamp. From the results shown, the 2 meter

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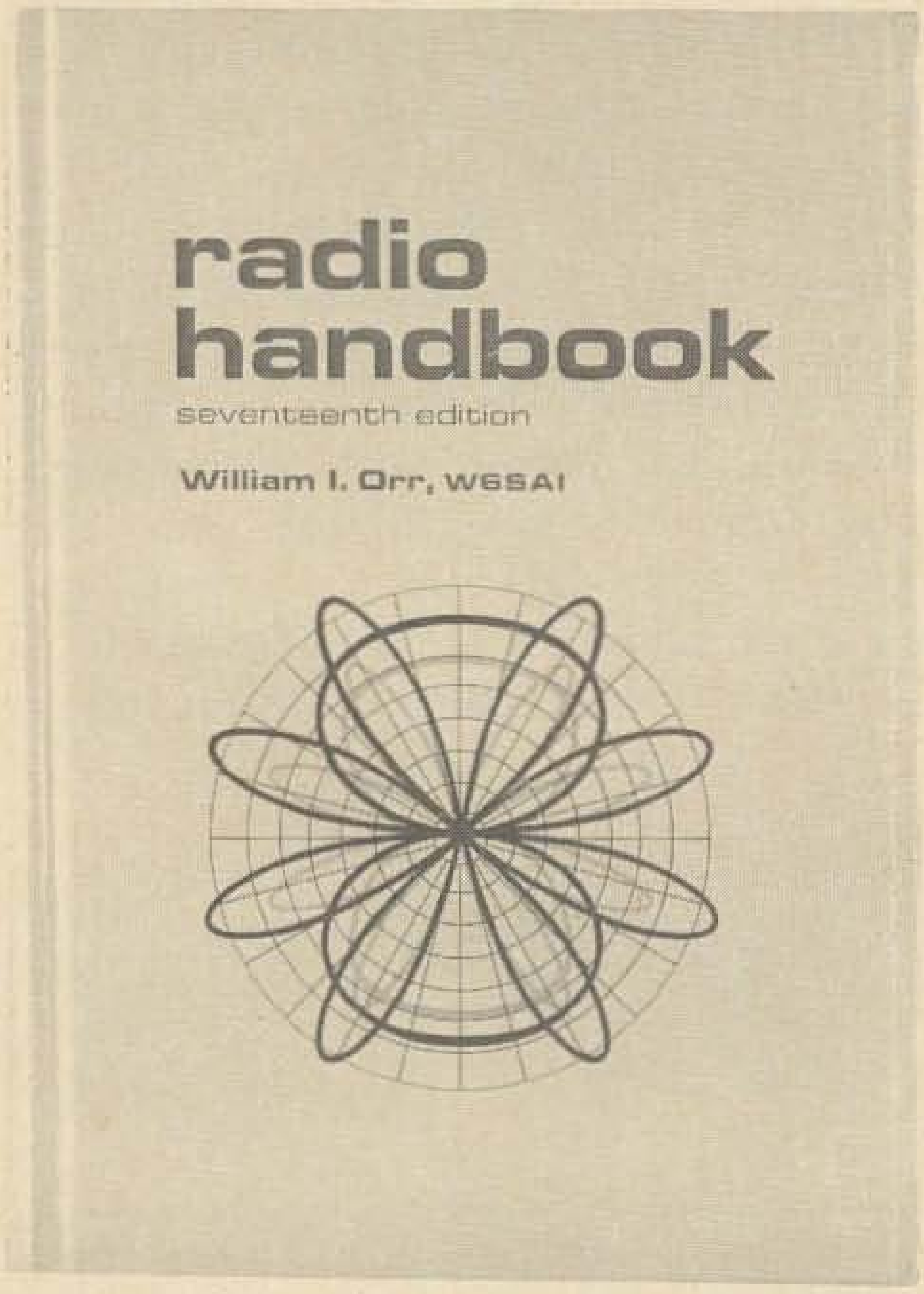

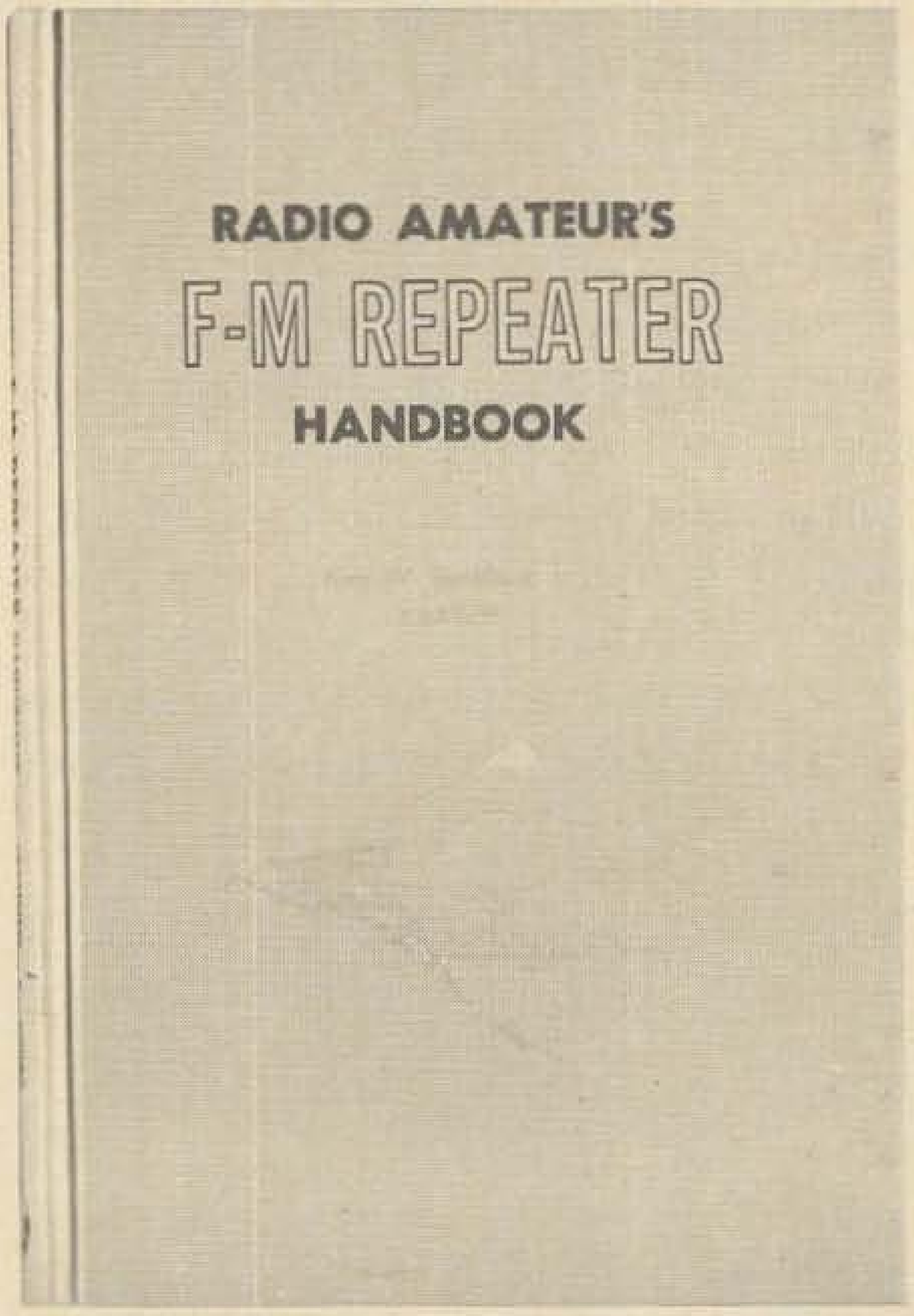

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ted FM channels, for 20 dB gain. With a 3 dB bandwidth of approximately 3 MHz, the amplifier has at least 16 dB gain over the entire 2 meter band when peaked near 146 MHz. The 3 dB bandwidth of the 6 meter amplifier is only 2 MHz. When peaked at 52.525 MHz, the amplifier will have greater than 20 dB. The addition of either preamplifier should help to solve many of the sensitivity problems, especially with the older equipment.

. . . WA4WDK/2 ■

EDUCATED

The warning or "idiot" lights provided as replacements for dashboard meters in most modern automobiles leave a lot to be desired. Two of their more obvious shortcomings are: (1) they may be illuminated for some time before being noticed, especially on a bright sunny day; or (2) they may burn out without warning, leaving the driver with no warning at all.

Taking a leaf out of the aircraft designers handbook, what is needed is a method of drawing the driver's attention to the lamps as soon as they light, as the malfunction may be serious enough to require immediate attention. The device to be described will cause the illumination of any idiot light to sound an audible alarm. The immediate disadvantage to such a system is that if the light remains on for some time (as, for example, if you have to drive some distance to a service station), the continuous sounding of the alarm could become dangerously distracting. To prevent this, an "override" switch has been incorporated to disable the alarm once it has served its purpose. However the circuit incorporates an automatic reset feature which will reset the alarm once the fault is corrected, so that the next time an idiot light comes on it will sound again without the need for any action on the part of the driver. An added feature of this circuit is that if the fault is not corrected, the alarm will come on next time the car is started: also, each time the car is started, the alarm will sound for a moment as an automatic test of its readiness.

The alarm itself (see Fig. 1) consists of a 12V buzzer, and the reset circuit is composed of a small spdt relay and a momentary-contact spst pushbutton switch. The alarm is connected to the idiot lights through a number of diodes which serve to allow the different light circuits to trigger a single alarm without shorting all the lights together.

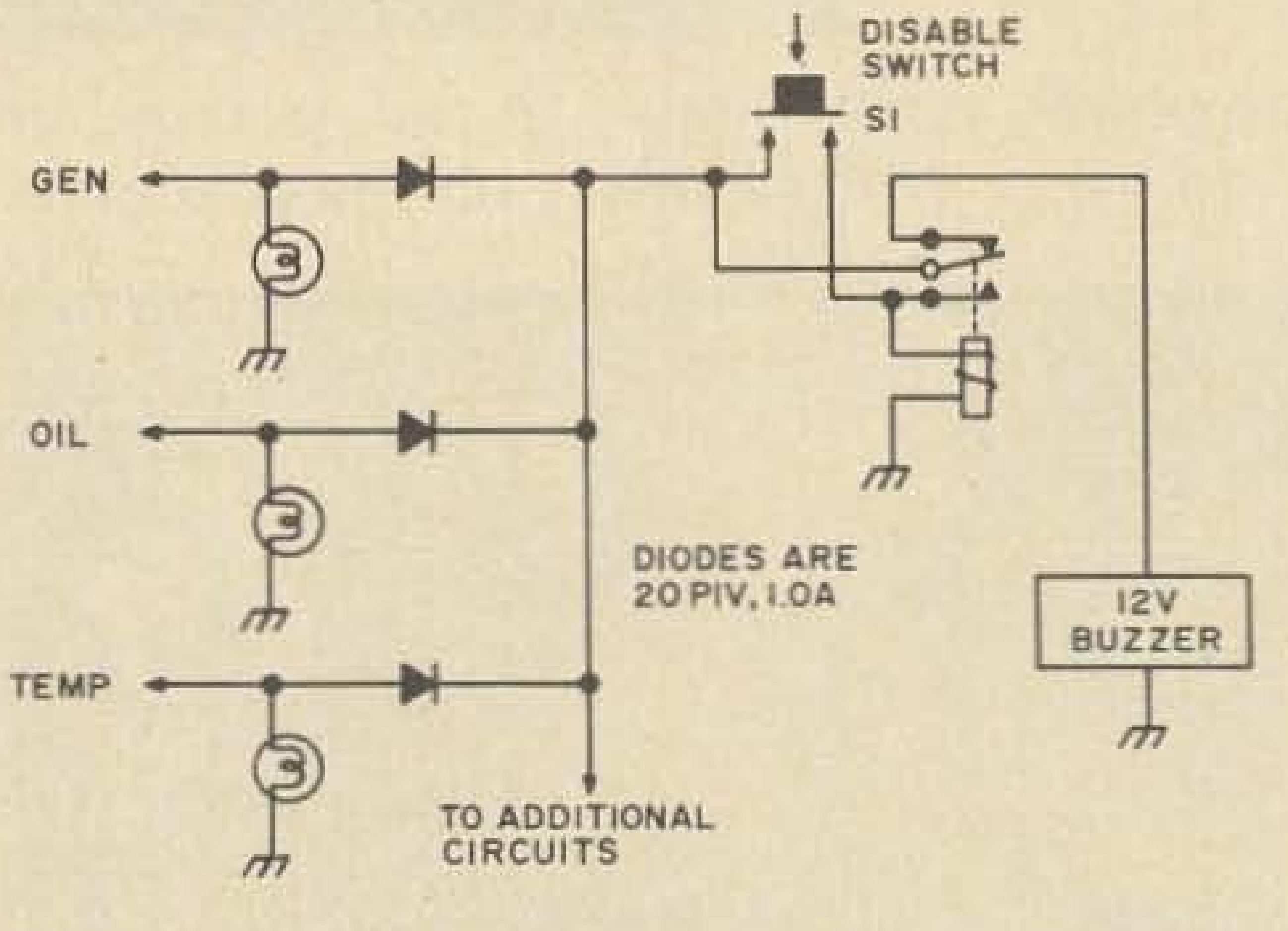


Fig. 1: Circuit diagram of audible "idiot light" alarm.

When one of the idiot lights comes on, the voltage is passed through the appropriate diode, through the relay contacts, and on to the alarm buzzer. When the driver wishes to silence the alarm he pushes the switch; this shorts the normally open relay contacts, and results in the current being diverted from the buzzer to the relay coil. The relay is now energized and holds the contacts closed, leaving the buzzer disconnected. When the fault is repaired and the light goes out, the relay is no longer energized and returns to its normal

IDIOT LIGHTS

D. J. Holford
RR 1, Enfield
Hants County
Nova Scotia, Canada

position, resulting in the buzzer again being connected to the input ready to sound off next time a light is illuminated.

The alarm is not restricted to just those functions provided by the idiot lights, and can warn of any situation capable of being indicated by an electrical signal. For example, it could be used to warn of lights being left on when the ignition is off by use of a suitable circuit.

Fig. 2. Suggested mounting method and panel layout.

The diodes and buzzer can be concealed out of sight under the dash (Fig. 2), and the only item which needs to be exposed to view is the pushbutton disable switch; however, I prefer to have an integrated warning panel which saves having to look around to see which light is lit. I duplicated all the normal warning lights, plus others for the additional circuits which can trigger the alarm, and installed them all in a small master warning panel together with the disable switch.

There are a number of suitable locations for such a panel. The easiest and most obvious is under the dash, but items under the dash have a habit of getting in the way of knees. I preferred to make a small panel and install it in the center of the roof above the rear-view mirror, where all I have to do is glance up to see what happened. Another good place for those who have given up smoking is to make a small box which will fit in the ashtray space, and paint it to match the dash. Since there are very few parts, and they can all be miniature, it does not require much space.

I have not included detailed layout and construction plans as the design can be easily customized to your own car and personal desires. The circuits will all be basically the same, but the placement of components will vary. Also some may want duplicated lights and a custom warning panel, while others will conceal the buzzer under the dash, and only the switch will show.

Any small 12V spdt relay will do, plus a 12V buzzer, a pushbutton switch, and the required number of diodes. The diodes are not critical as long as they can handle about 1A at 15–20V. There are a multitude of diodes and relays available at low prices so the constructor should have no problem obtaining parts.

Construction and installation can be easily accomplished in one evening, and the result is an impressive and effective addition to any automobile.

If you decide to add the duplicate lights, you can obtain small self-contained 12V pilot lights at the local radio store for a small sum. One final point to remember: The diodes must be insulated from ground, as both sides are carrying 12V.

. . . D. J. Holford ■

POSTAGE STAMP TRANSMITTER FOR SIX

BILL HOISINGTON K1CLL

Honest Injun . . . you can build one in your cigarette lighter!

You can really hide this one, even in the skin of a bear! It's only ¾ x ¾ x 1/8 in., is crystal controlled, puts out up to ¼ watt on 6 meters, and can be used for biological work, survival units, etc. With a 6 in. antenna I've heard it out to 15 miles.

This article describes what can be done on VHF today with off-the-shelf subminiature items. Of course you do have to look hard for some of those shelves – but they *are* available.

The Crystal

As far as I know McCoy is the sole manufacturer of a suitable crystal less than 1/8 in. thick. McCoy has a special glass blower (from the Old Country?) who encloses the tiny little crystals in glass. These gems work, and work extremely well. I've even run 15 mW through the crystal itself and so far no trouble.

Figure 1 shows a sketch with dimensions of this jewel in its Type MM glass package. Of course they don't just give them away, but where else can you get one 110 mils thick? There is still the next size up, the M20, with a "tin can" holder which is 183 mils thick, if you have the room.

I recently acquired two of the MM units and they both worked immediately in the circuit shown in Fig. 2 and have continued to work ever since; so they aren't just pieces of costume jewelry.

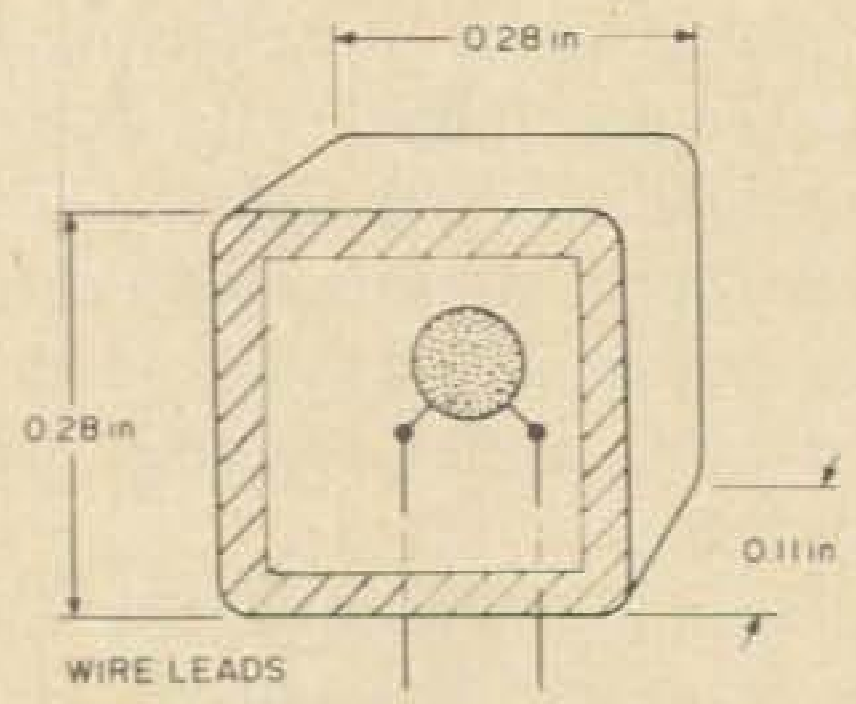
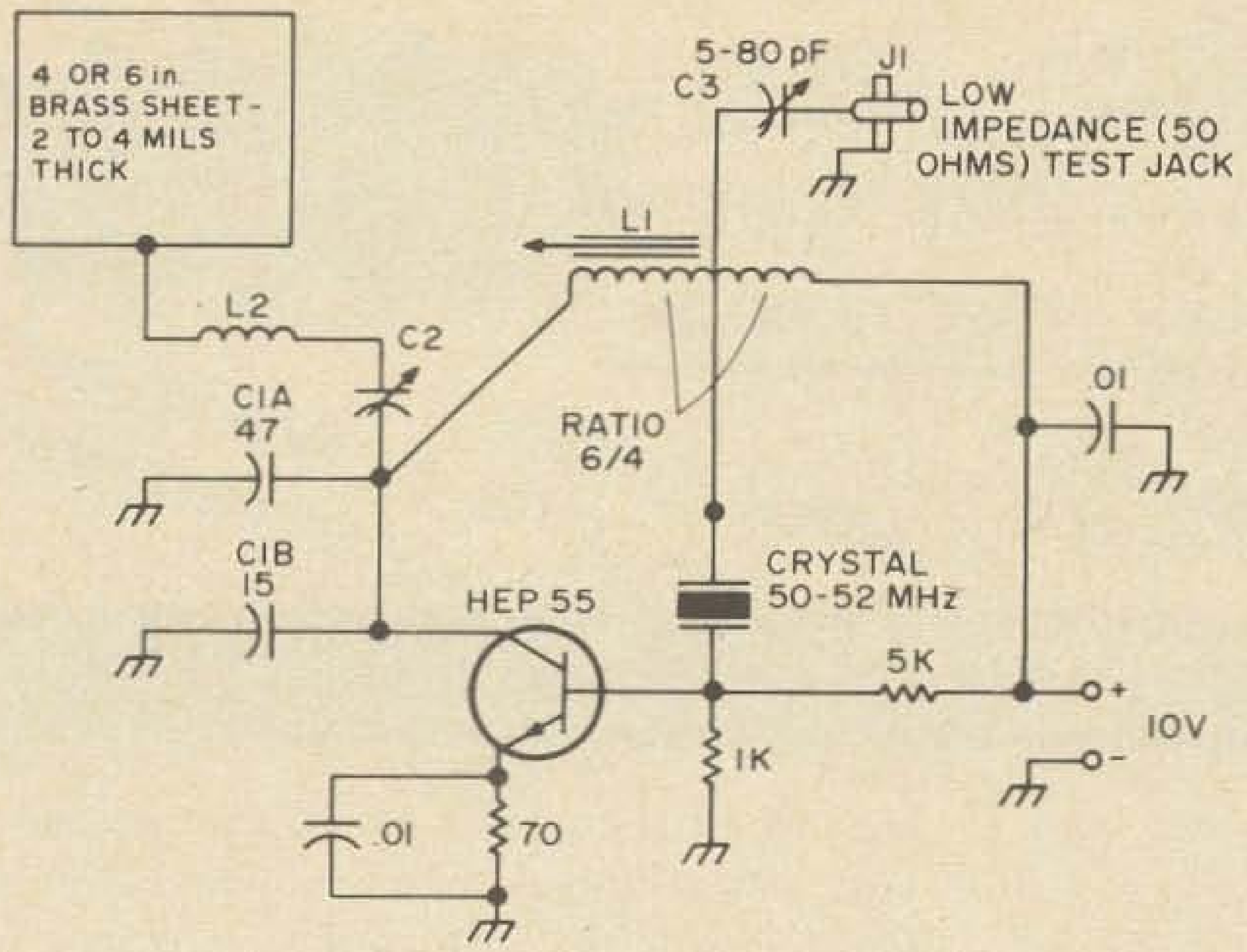


Fig. 1. McCoy's Type MM crystal is an incredibly small element enclosed in a tiny glass package not much larger than a thick-film capacitor chip. Less that 1/8 in. thick, the area of the crystal is about ¼ in. square.



NOTES:

1. "Ground" is the copperclad baseboard plus the battery.
2. J1 should light a No. 48 or 49 pilot light bright.
3. L2 will vary with antenna size.
4. Check final tuning carefully with C1A and C1B compared to a No. 463 Arco mica trimmer, 10 to 180 pF.

Fig. 2. Even though the transmitter packs down in density to about the size of a postage stamp, the circuit is straightforward and without surprises for the builder.

Transistor

Just for fun you might say, I soon tried the Motorola HEP 55, but after checking against others of the same size or smaller, I stayed with it. After all, it's only $1.20, it is plastic, and can easily be filed down to the desired 1/8 in. thickness. The plastic takes up about a third of the overall thickness of these little powerhouses, so you can easily file down to .125, a little on each side. I also checked out several dozen of them for "activity" in the circuit of Fig. 3,

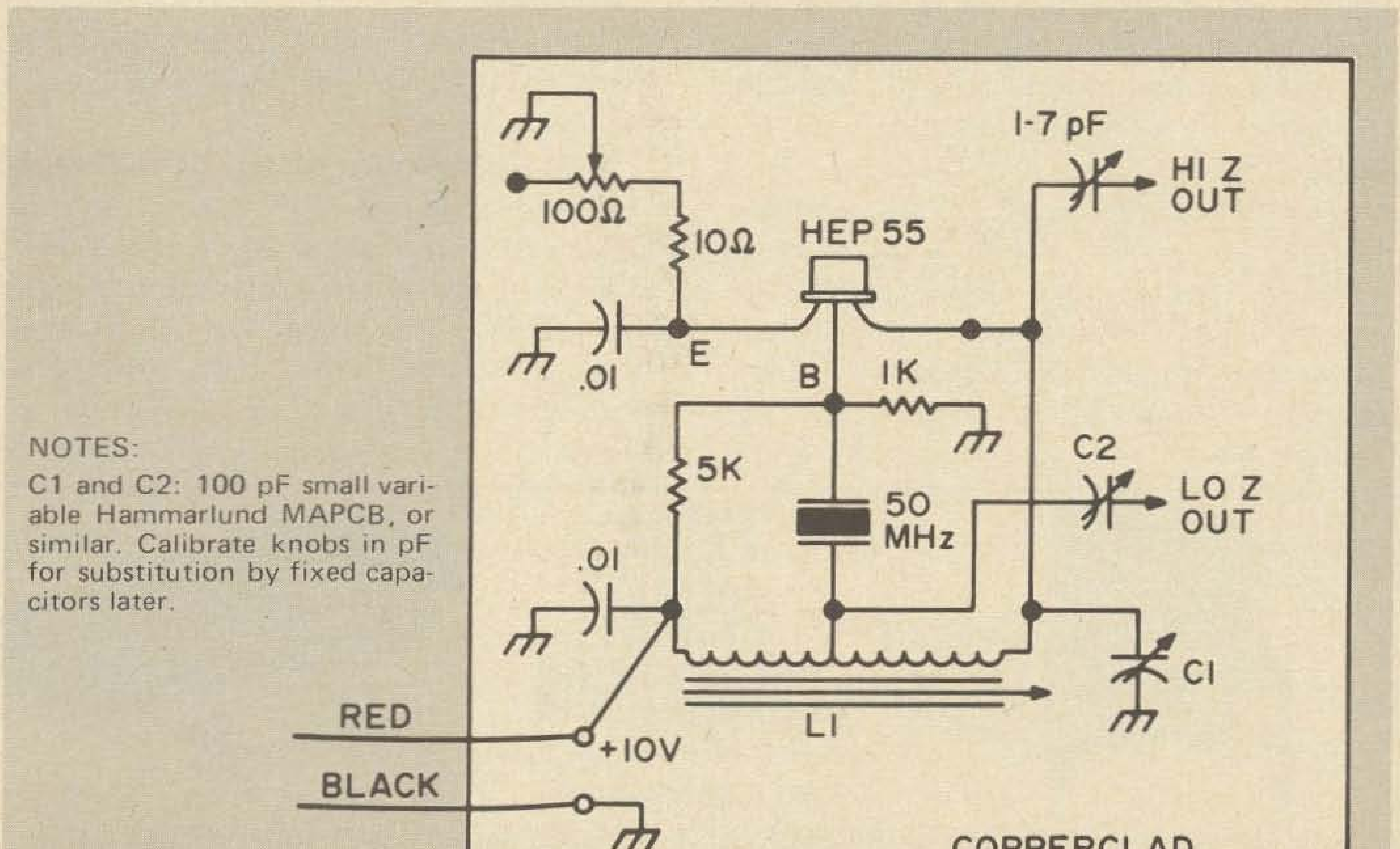


Fig. 3. Breadboarding the transmitter into a test configuration with regular-size component will give you the chance to get the "feel" of the circuit and its capabilities.

by grading them as *very good, good,* and *fair*. I got about 10 in the *very good* category. The rest go fine in i-f circuits, so that settled that question.

I have run 45 mA at 10V for hours at a time, getting over 200 mW output of rf with no trouble of any kind; so there's no need to fear pushing a little if you have a few extra on hand.

Coils

There are two coils, one of which is for loading the 6 in. antenna. Made by Piconics, a suburban Boston company, the coils are tunable and tiny (less than 1/8 in. thick). The tunable feature is one of the major advantages of these coils because, as far as I know, there are no variable capacitors in existence less than 1/8 in. thick.

Just to see what effect the tiny coil size had on the power output, I cut it down and kept cutting down until I reached the size of a piece of spaghetti about 80 mils diameter, wound with 34-gage wire. Even though I squashed it almost flat, the output power remained the same. When the circuit is properly tuned and loaded the coil really doesn't make much difference. Once again, the influence of the matched circuit and the loaded Q! If the proper amount and phase of feedback is there, which it is in this case, the rf output almost burns out a No. 48 bulb.

The circuit tunes broad but correctly and smoothly, and stays exactly on 50 MHz, or 50.4, or on whatever frequency the crystal is ground for. It also stays on the air, which is very important. As usual with any crystal oscillator, load it up to where it does go *off* the air, and then unload it so that it stays *on* the air with whatever battery voltage you may choose to use as the end of the battery life.

Breadboard Test

Use the test jig of Fig. 3 with large variable capacitors for tuning up and checking out the subminiature components *before* you mount and solder them into the tiny "chassis." I found that 15 turns of wire (32 or 34 AWG) with the crystal feedback tapped on at 5 turns from the low end was very good. Ten turns of 26

AWG on a threaded paper form was handy to start with, and sure-fire for use on 6 meters.

If you calibrate the knobs on the variable capacitors you can then substitute fixed values later when you get down to the subminiature size, and do the tuning with the Piconics coil. This tiny wonder, shown in Fig. 4, actually has a core which moves in and out by means of threads in its nylon holder. Don't forget, you've got to tune *something*. It is possible to substitute fixed values of capacitors and make it work, but I'm assuming you've handled enough transmitters to know the value of tuning up. A good Piconics coil for 6 meters is the one labeled B121K713Y1. That's quite a mouthful, but it not only indicates the inductance but the ratio of the tap position as well – just be happy

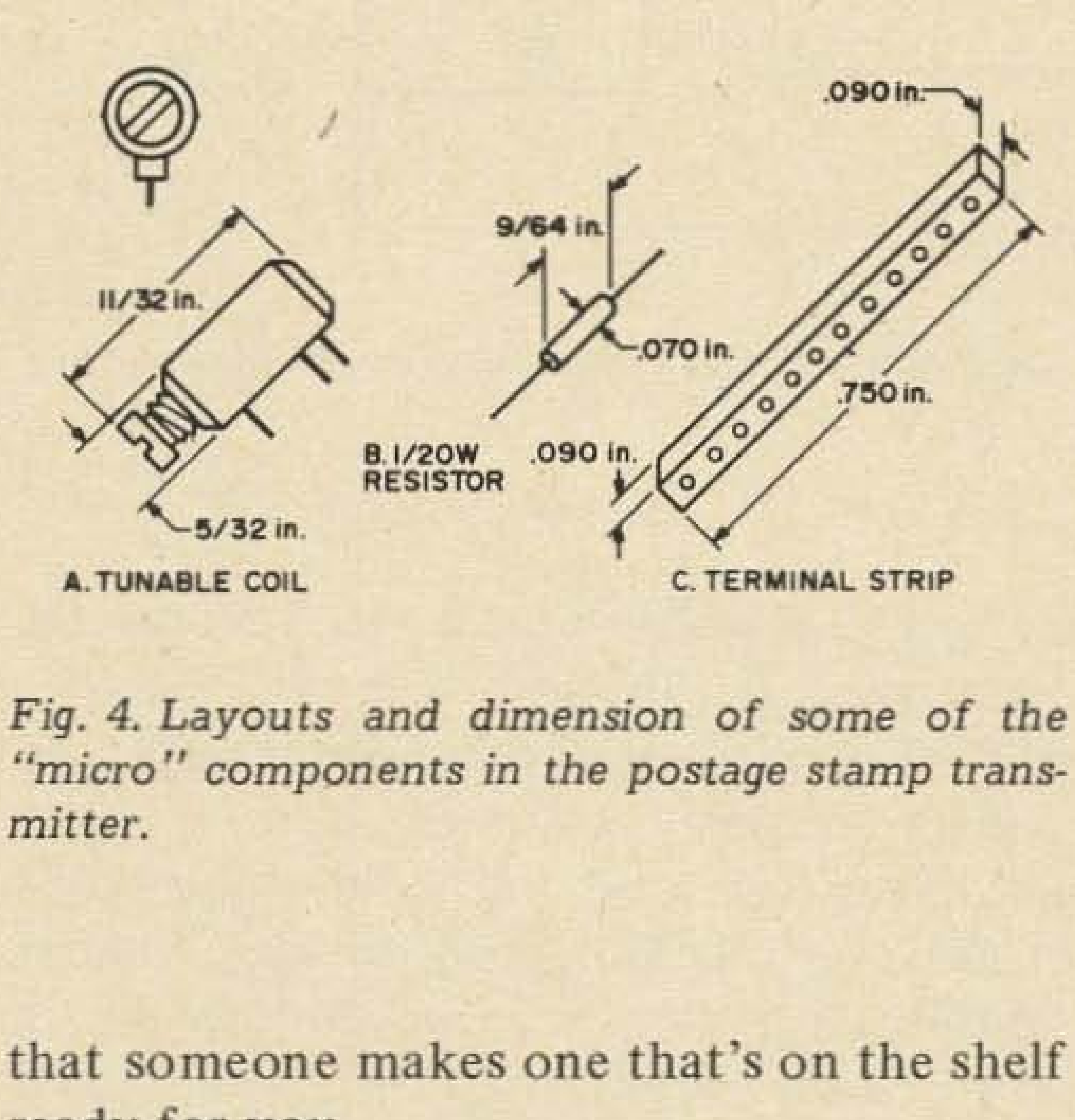


Fig. 4. Layouts and dimension of some of the "micro" components in the postage stamp transmitter.

that someone makes one that's on the shelf ready for you.

Resistors

Sprague Electric, Nashua, N.H., makes good 1/20 watt resistors. They are precise and tiny, and they work. Figure 4 shows dimensions. 'Nuff sed.

Capacitors.

Republic Electric makes capacitors up to the .01 μF value used here. They have a maximum diameter of 60 mils. That's under 1/16 in., in case you haven't been in a machine shop lately. Every one of these skinny cylinders has worked properly. I don't know how they do it but I'm going to find out soon with a visit down into the wilds of Patterson, N.J. to see for myself.

Mounting Strips

I really had to turn on the old imagination for this one. Past readers may recall my frequent use of .021 "common pins,"

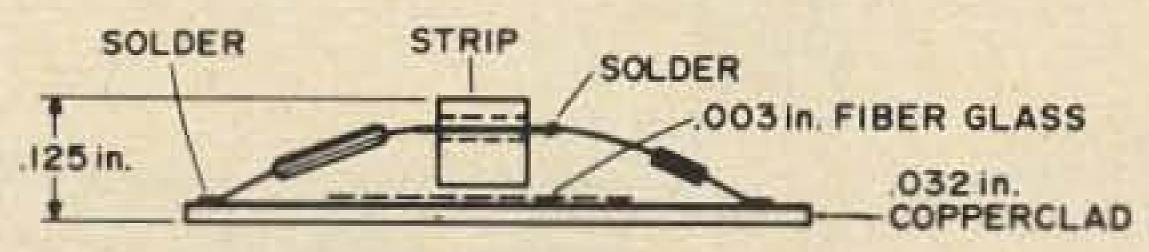


Fig. 5. Side view shows terminal strip utilization and mounting technique.

brass, nickel plated, for terminal strips, hammering them into 20-mil holes in fiber glass strips or linen-base Bakelite. Well, these are too big for this job! So I cut up some of the linen-base Bakelite stuff into square cross-section rods and drilled through the sides of them, as in Fig. 4C.

Figure 5 shows the drilled strips, or "logs," with a small strip of 1½- or 3-mil fiber glass under it for security against ends of components or wires shorting to the base plate, and examples of components used. You can drill as many holes as you have wires or solder two or more wires together on one side of the strip.

Chassis

Figure 6 shows the baseboard cut out to receive the major components, which are the coil, the crystal, and the transistor. As these units are over 100 mils thick they cannot be mounted on top of the baseboard but do very well in the cutouts with coil cement or other types of embedment added later. Although I am showing one example of a circuit with the 1/8 in. thick technique, you can of course use the same method for other circuits. I have gone up to 432 MHz with this type of construction, so various things can be done at the 1/8 in. thickness. After mounting and soldering, you can also use high-temperature coil wax for a test unit which you might want to change later. This can also be used for a "next to final" model.

Batteries

In my quest for a really tiny battery (1/8 in. thick), I found that only two qualified

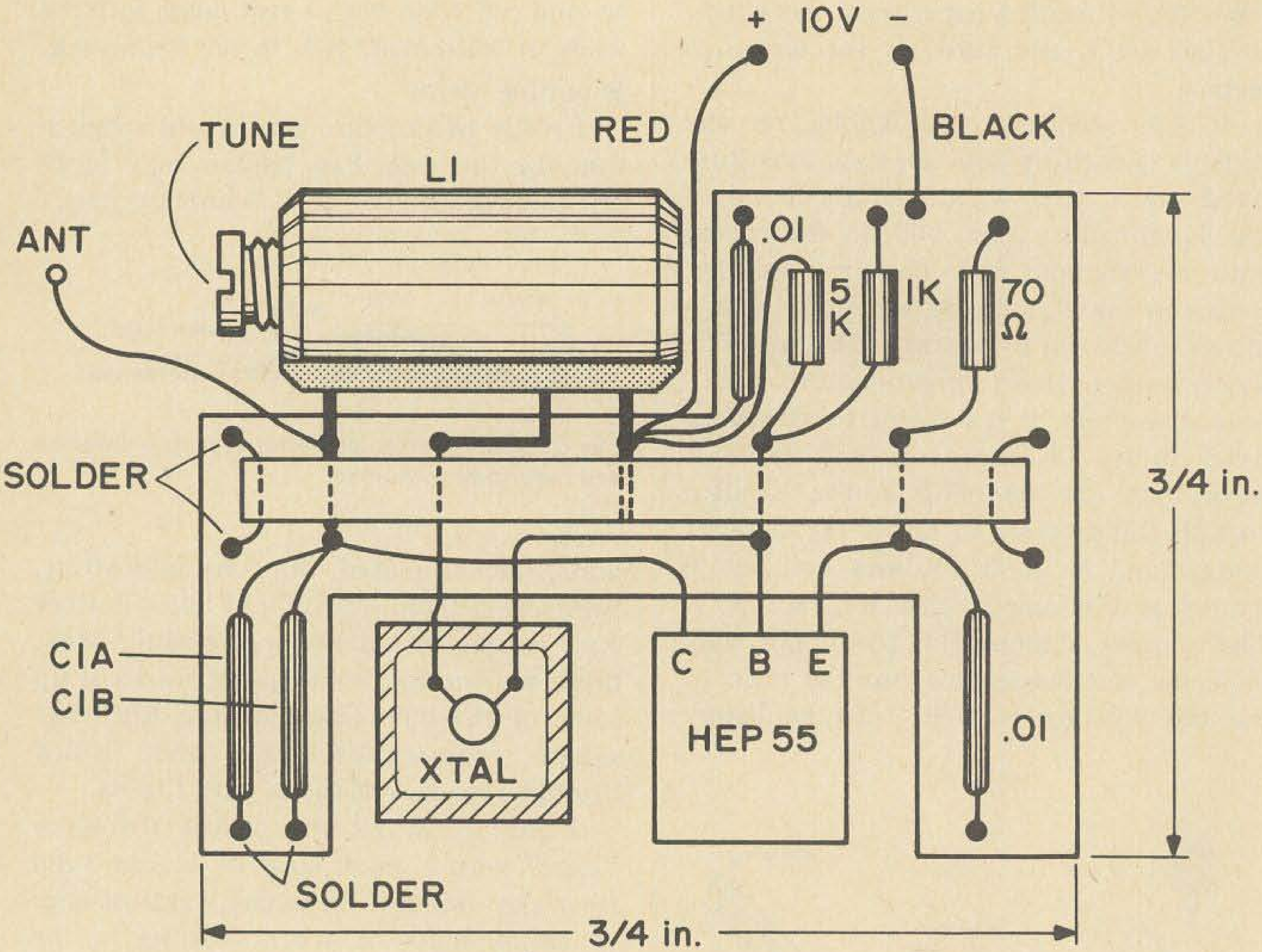


Fig. 6. Blowup top view shows layout of subminiature oscillator. Actual physical size of unit will be 3/4 in. square.

as "desirables," and one of these was ultimately eliminated by testing. The two candidates were the *silver oxide* and the *mercury* types. The dimensions of the smallest is shown in Fig. 7. For up to about 100 mW output, with a battery drain of about 20 mA at 10V, a check was made on the above types. The silver oxide battery lasted 30 minutes and the mercury battery 65 minutes. Of course, these tiny power sources are *not*, absolutely *not*, sold for any such use. In fact, the engineering department heads of the two largest battery companies tend to either raise their voices or hang up the phone, or both, when they find out what you really want out of their little aspirin pill batteries.

There are two immediate solutions: reduce power, or reduce the time on the air. For some uses – such as continuous monitoring with voice or other sound modulation – you have to reduce power for any reasonable life at all. This can be done very simply by using less battery voltage or increasing the resistance of the emitter resistor, or both, and a slight amount of retuning. For some other types of uses, such as biological tracking, hidden transmitter hunts, etc., you can turn the rig on for short periods only; for example, 10 msec out of every second for an increase in battery life of *better* than 100 times. (There is nothing worse for battery life than a constant heavy drain.) This type of automatic keying is, as usual, another story. The tiniest little transistors, the Microtabs by GE, can be used for this service in a multivibrator circuit to drive another one of them in a simple on–off switch type of hookup.

For the battery pack, a 1/16 in. sheet of soft plastic such as PVC (polyvinylchloride) can be used to hold the batteries in a pack of four, six, or eight (or even ten if you like "high power") as shown in Fig. 7. If you order a large quantity, Mallory will *weld* tabs on each pill-size battery and you can then solder them together to make up a pack. Count on no more than 1.0V per cell, regardless of the drain you may expect, because they will soon enough reach this level, or even lower, unless you operate in a pulse mode.

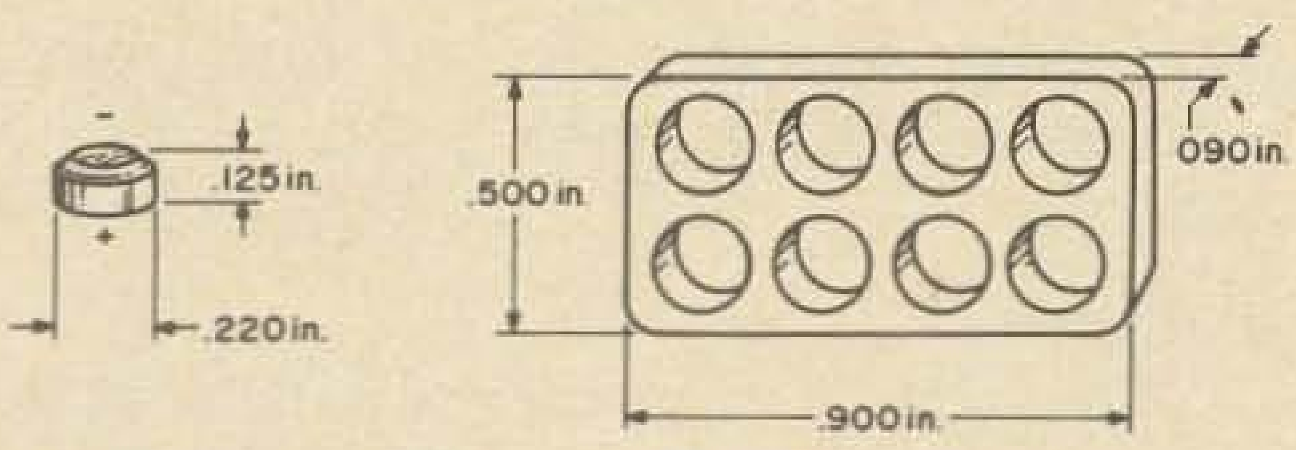


Fig. 7. The tiny battery can be used with other batteries if a holder is constructed from PVC as shown here. (Holder shown accommodates eight batteries.)

For test operations I did solder leads onto them, much against the advice of the engineering departments of the battery companies. So far, no ill effects, but you have to do this *very* carefully. I used a 25W iron well cleaned and tinned, shined up the battery case first, and then tinned it. A touch of perhaps less than one second does the trick, also using very-small-diameter solder. I am *not advising* this method, just mentioning that I did use it! Also, use flexible subminiature wire such as multiple strands of 34 AWG, for example, with Teflon insulation. These batteries can be purchased where hearing aids are sold and in many radio stores. Naturally, use the largest size you can put into your project. The "aspirin" size will only give a life of 12 mA-hr at something like a 1 mA drain – *not* enough to operate the oscillator. It will run at around 4 mA, though. This power level is easily adjustable by the emitter resistor, as mentioned before. You can generally expect about 50% efficiency for dc input to rf output power with the circuit shown in Fig. 2.

Circuit

When I first made up this design I was looking for a foolproof crystal circuit, one that would not take off on any frequency other than the one marked on the case. The circuit shown achieves this goal; after working with it some time, I find that it can be a very powerful oscillator as well – stable and reliable. In a later 73 article (*Solid-State Power on Six*) you will see it running at over a watt, with up to 500 mW output!

How it works

Referring to Figs. 2 and 3, when the collector is tuned to 50.4 MHz, for example, by C1 and L1, with 10V in, a volt or so on the base, a bypassed resistor from the emitter to ground, and a 50.4 MHz crystal connected between the base and the tap on L1, it *will* oscillate. It's a law of nature! Note that the feedback looks as though it was degenerative, or negative. It only looks that way though, because the crystal reverses the phase of the feedback voltage going to the base. This is a fact of life very difficult for some engineers to swallow but it works! Even the Curies in France in the last century knew that much about peizo-electric crystals.

The result is advantageous. With positive feedback coupling, the oscillator can be quite critical for the right amount of feedback, tuning, and loading. With negative feedback coupling, it will only oscillate when the crystal reverses the phase, which of course occurs only on its proper and marked frequency. Just how many half-waves of sound are standing across the crystal is the concern of the manufacturer, as long as these sound waves inside produce 50 MHz electromagnetic waves on the outside, and vice versa of course.

Crystal Power

I think this is a matter to be decided by usage because, while the makers talk about 2 or 3 mW of power in the crystal circuit, I found that a small pilot bulb in series with a 50 MHz crystal lights up a little on the 1W oscillator. In the CW mode you will not run that much, but with pulsing you may well go over it. About 10 to 12 mW is required in the transistor base–crystal circuit for about 500 mW out at the collector circuit. You can see that the gain of the transistor is important also.

In the "Good Old Days," a pilot light was regularly installed in series with the crystal. Granted, those were big fat crystals, on 160 meters, etc., while we're talking here about a real skinny one, for 50 MHz. After all, a wave, even if it's a slowpoke one like a sound wave, doesn't go very far if it has to stop after one fifty-millionth of a second. So you can take your choice as to the power you run. You can see that the more lively the transistor, the more power you can run from an oscillator with a given crystal's *rf milliwattage*.

Antenna

The tiny 6 in. antenna's performance was a surprise to me even after half a century in radio. Using the antenna and loading circuit shown in Fig. 8, I left the rig in a house in Jaffrey, N.H. and could still hear it in Francestown, more than 15 miles away. On 6 meters, this is an antenna of about 1/36 wavelength long. You can be surprised or not, as you please. I was. The

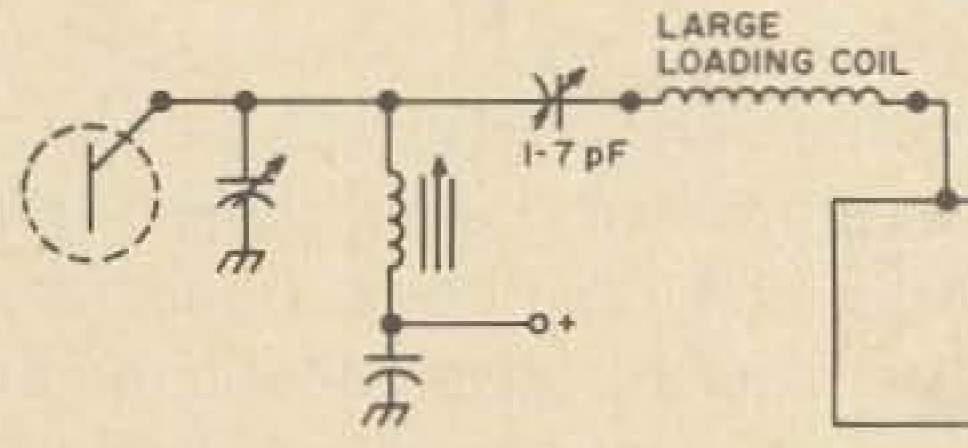


Fig. 8. Although several antennas and loading techniques were tested, the approach shown here proved significantly superior.

only disadvantage of the antenna loading technique shown is that you need close to the right number of turns on L2; other loading techniques may be less critical, but experiments have shown that they are not as efficient when it comes to rf radiation.

Receiver 1

First, you need a diode field strength meter for use at a fixed distance, say a foot or so to start with, in order to tune up and compare radiated power. I soon found that the best setup was another short antenna clipped onto the diode detector's tuned circuit about halfway up the coil (Fig.9). For meter indication at maximum distance, the length of the whip and its contact position along L1 are important.

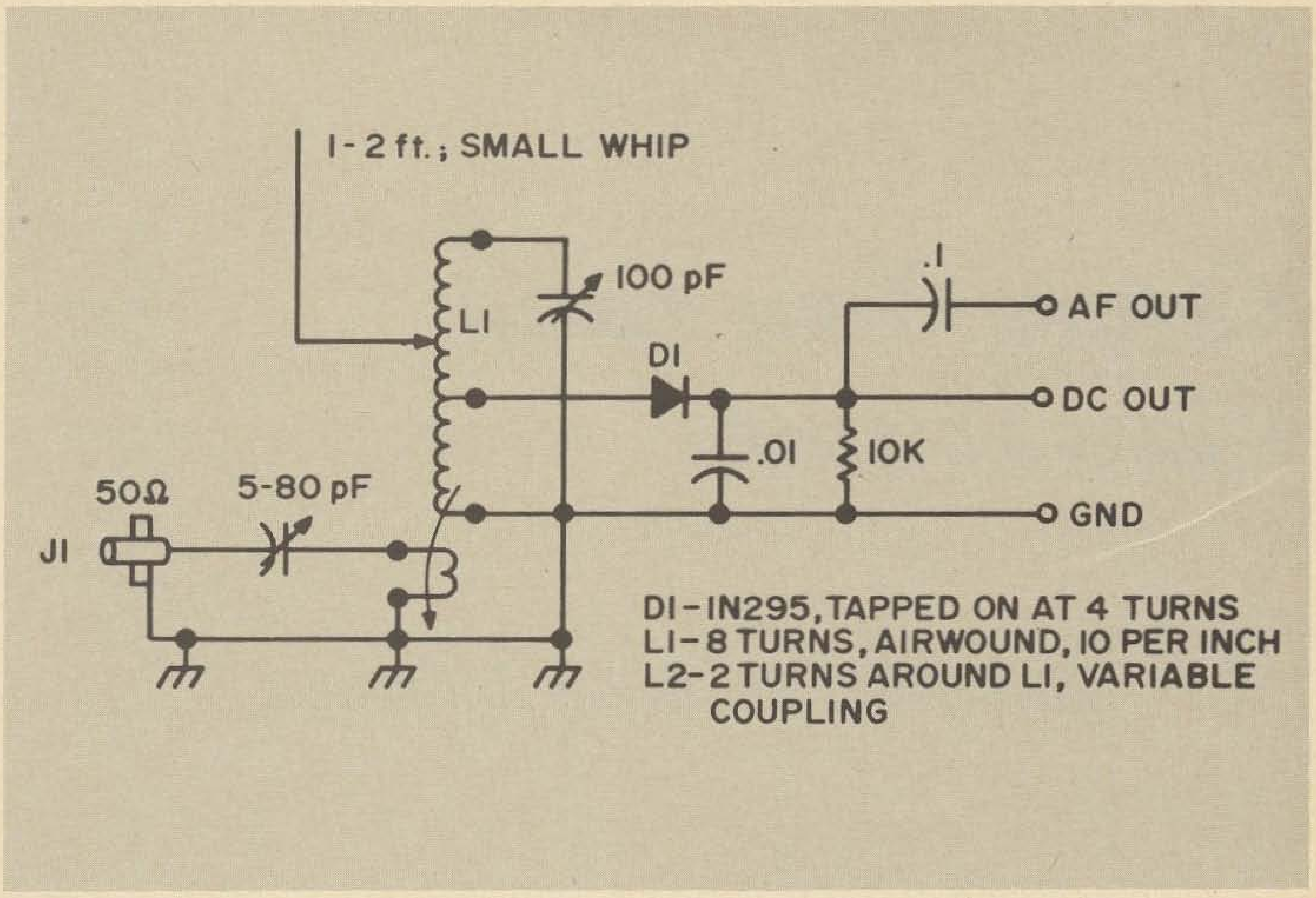


Fig. 9. A diode detector makes a convenient and useful receiver for checking the performance of your postage-stamp transmitter while it's on the bench.

Figure 9 shows the circuit I used, which is also a good frequency meter for checking to see if you *are* on 50 MHz and not on some harmonic. *Never* rely on a high-gain receiver for this basic fact. Use it to check for noise, hum, stability, etc. once the frequency has been determined.

Polarization can also be checked with the diode receiver by using a regular 50 MHz dipole (or beam if you can handle it physically) across the room, or outdoors if needed, with its matched cable plugged into J1 (Fig. 9).

Receiver 2

I put some tone modulation on the rig to identify it because at a distance of 15 miles I wanted to be *sure*; but of course you can use plain CW with a bfo if you like. Either way, the signal comes in great with a regular receiver and beam on 6 meters.

For a particular purpose in mind I did build up a good hand-carried receiver for use with these little rigs. This is a semi-fixed-tuned job with small knobs on the tuning capacitors for test purposes – it tunes over the band in great style. The front end has a 1.7 dB noise figure, which is very useful because you can take it to absolute "hermit" locations, where such performance really *counts*. But, of course, that is a completely different story, and will be published later.

List of Component Manufacturers

Transistor: Motorola HEP 55
Coil: Piconics, Tyngsboro, Mass.
Crystal: McCoy Electronics, Mt. Holly Springs, Pa.
Capacitors: Republic Electronics Corp. 176 E. 7th St., Patterson, N.J.
Resistors: Sprague Electric, Nashua, N. H.
Insulation: Insulating Fabricators, Inc., Watertown, Mass.

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Getting Your Extra Class License

STAFF

Part XVI: RF Power Amplifiers

In the previous installment of this Extra Class study course, we began a discussion of some points of transmitter operation included on the official FCC study list of questions. This time, we'll conclude our look at the subject of transmitter operation.

In the process, we'll examine the following FCC questions:

40. How can the output circuit of a transmitter be adjusted to increase or decrease its coupling to the antenna system?

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

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

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

78. Give some proven methods of harmonic reduction in transmitters.

We'll follow our usual practice, and rather than providing specific answers to these specific questions, rephrase the questions into new queries with broader scope so that the general principles underlying the details can be brought out.

These five questions group into three broad subjects–harmonics, antenna circuit interaction with the transmitter, and effect of losing grid bias.

And as it happens, all three subjects are parts of the general subject "What Goes On In The Final Amplifier?"

Unfortunately, *that* subject is much too broad for us to examine in any detail, so we'll have to strike some medium. We can start by asking "How Can Harmonics Be Controlled?", which will wrap up FCC questions 61 and 78. This will also tie directly into another question, "How Does the Antenna Circuit Affect the Final Stage?", which will take care of FCC questions 40 and 62 among other points. Now we have only the FCC question 50 to cover, and we can get it by asking "What Happens in a Modulated Amplifier?" Actually, a large part of this question was answered in our previous installment, but question 50 is one which can be rather tricky as it has no single specific answer, so it's worth going into again.

By this time, we'll assume that you have been following this course for some time, and we'll assume that you already have a pretty fair idea of what goes to make up the final rf stage of an AM, FM, or CW transmitter. What we have to say here also applies, with some exceptions, to SSB linears—but we've already discussed them as a species apart.

Ready to explore the depths of the harmonic problem? Let's get under way.

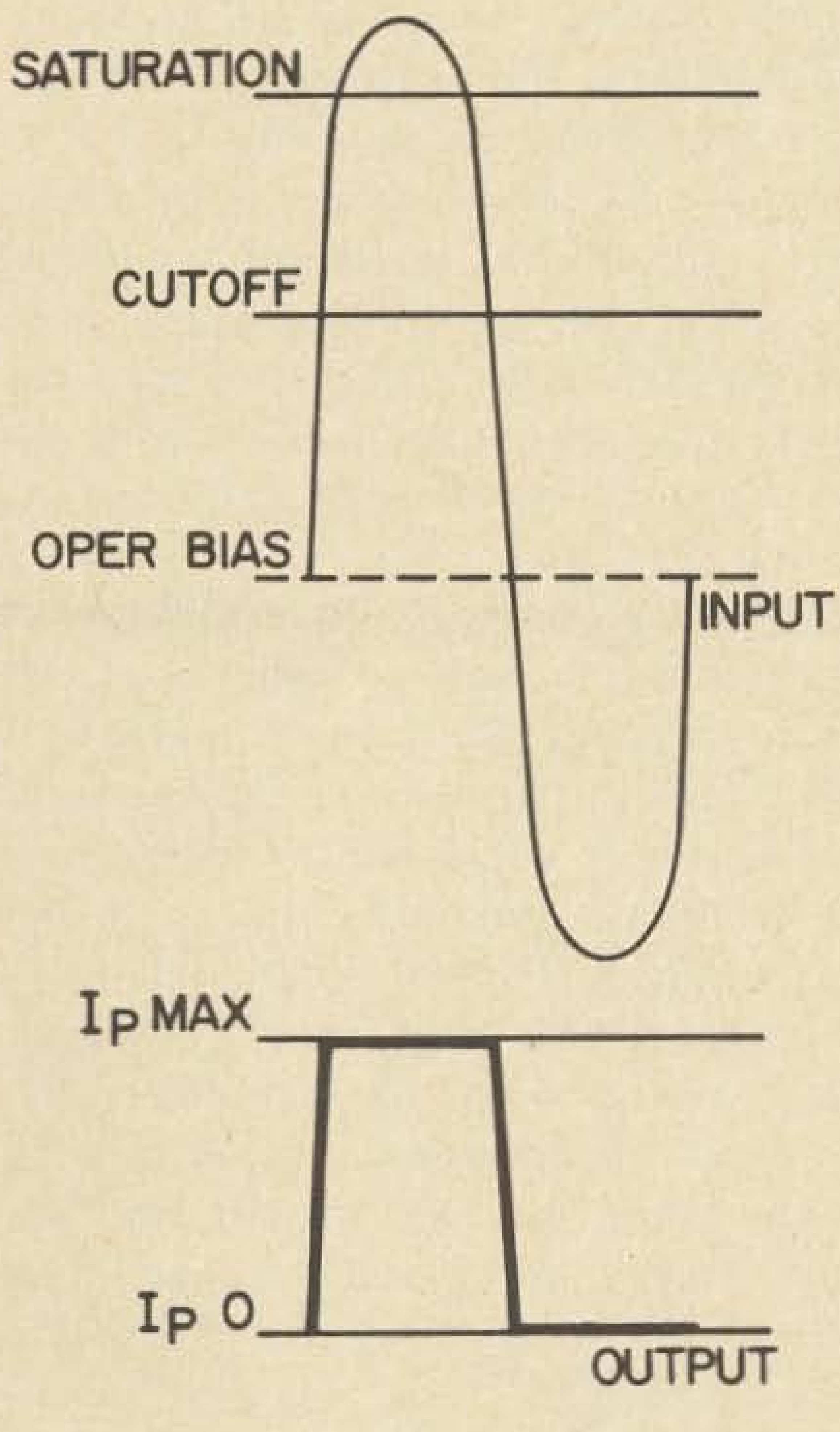


Fig. 1. Class C waveforms.

How Can Harmonics Be Controlled? We have only two avenues of attack in any effort to control harmonics—one is to prevent them from being created in the first place, and the other is to prevent them, once created, from getting out of our transmitters.

It might appear simple, at first, to operate an amplifier in such a manner that no harmonics were generated. And it might actually be simple, if there were any such thing as a *perfect* amplifier. We, however, must get by with imperfect amplifiers and their resulting distortion—and any form of distortion involves the creation of at least a small amount of harmonic signal.

Even if we had perfect amplifiers, the only possible harmonic-free amplifier would be one operating in Class A. This would, in itself, rule out the harmonic-free amplifier for any appreciable power level in transmitters, because Class A amplifiers are only about 25% efficient at best. To produce large amounts of rf energy and stay within our power limits, we must use Class B or Class C circuits.

And by the nature of their operation, Class B and Class C amplifiers are prolific generators of harmonics. The Class C amplifier, in particular, clips off its input signal sharply at the bottom when cutoff level is reached, and equally sharply at the top when the amplifier's saturation point is reached (**Fig. 1**). The result is that only a small pulse from the original input signal gets through the amplifier. Any pulse with sharp corners contains a large amount of harmonic energy; the sharper the corners, the more high-order harmonics are present (the limiting case of this is a perfect square wave, which contains the fundamental and all the odd-order harmonics out to the umpty-umpth).

If we reduce the level of the input signal to avoid saturation, and decrease the grid bias so that cutoff isn't reached quite so rapidly, we can reduce the sharpness of the clipping action. But while we're doing so,

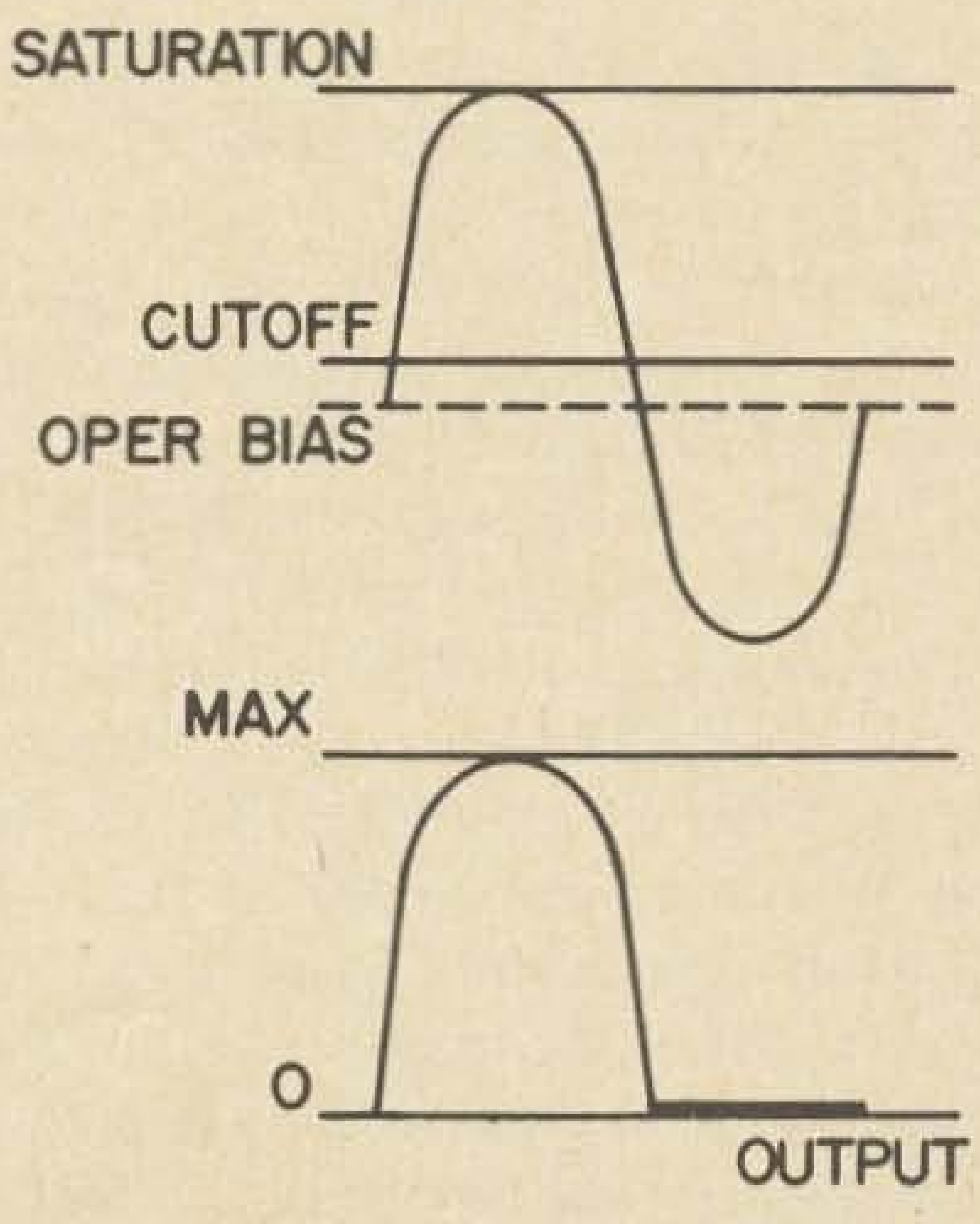


Fig. 2. Class B waveforms.

we're changing the amplifier from Class C to Class B operation (Fig. 2) and reducing its efficiency. When we have completely eliminated the saturation-point clipping, and moved the cutoff clipping point down so that we get the positive-going half-cycle of input signal through to the output and lose only the negative-going half-cycle, we have a true Class B operation.

If we keep reducing bias until no clipping at all occurs, we can get rid of much of the harmonic energy—but we will have converted our amplifier to Class A (Fig. 3) in the process and our efficiency is virtually gone.

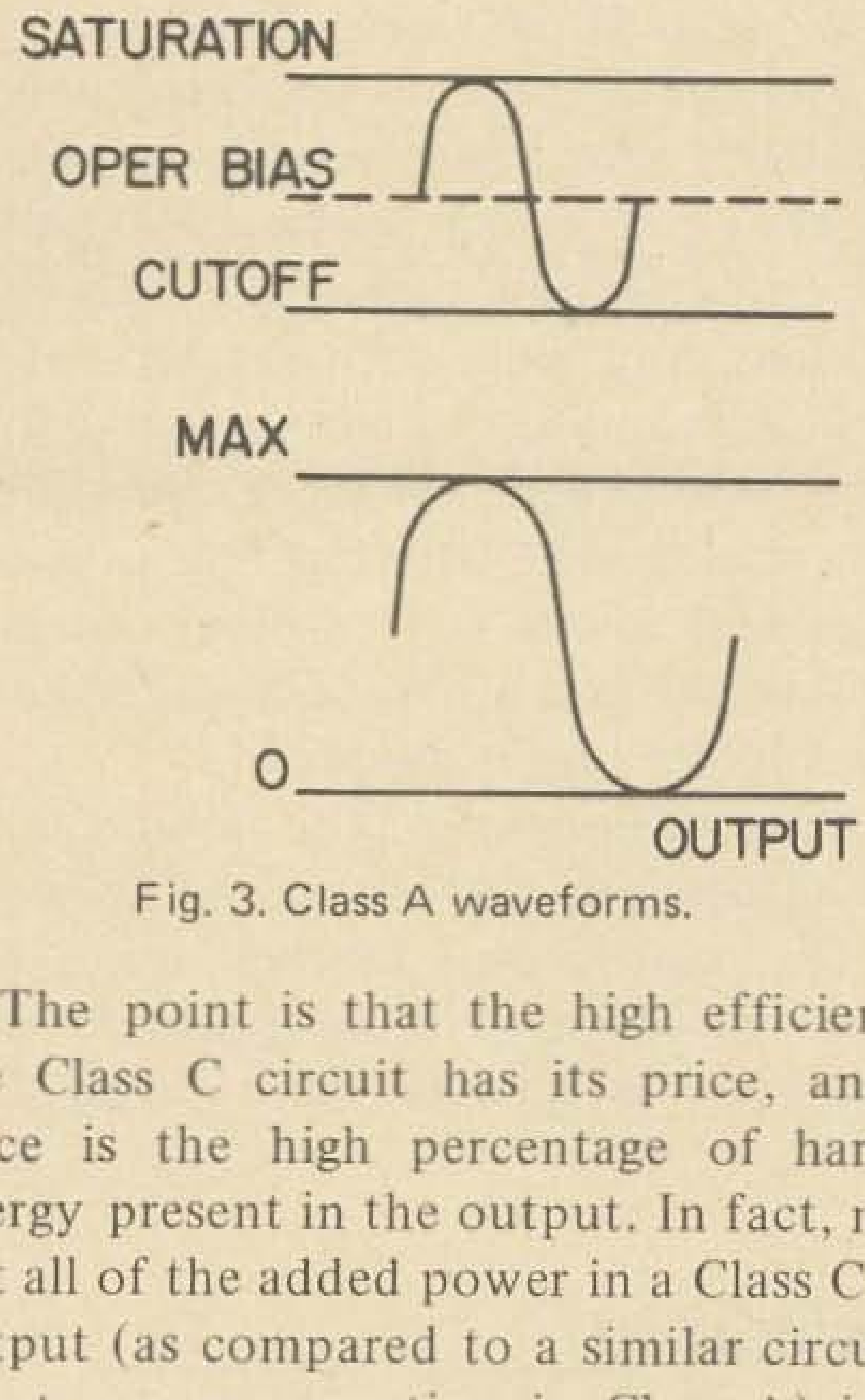


Fig. 3. Class A waveforms.

The point is that the high efficiency of the Class C circuit has its price, and that price is the high percentage of harmonic energy present in the output. In fact, most if not all of the added power in a Class C amp's output (as compared to a similar circuit and input power operating in Class A) is composed of that harmonic energy!

What saves the day for us and makes the Class C circuit practical is the selectivity of the plate tank circuit. Like any other tuned circuit, the plate tank rings readily at its own resonant frequency, and tends to bypass all other frequencies. In the process of bypassing the harmonic energy, it is temporarily stored in either the magnetic or electric field of the tank, and adds to the output power at the fundamental frequency.

When we use the phrase "fundamental frequency" here, we mean the frequency to which the plate tank is tuned, which is not necessarily that of the input signal.

A case in point is the "frequency multiplier" circuit so necessary to VHF and UHF transmitters. This is, in essence, just a Class C amplifier in which the output tank is tuned to some harmonic of the input frequency rather than to the input frequency itself.

The efficiency of the frequency multiplier is low, compared to that of a "straight-through" amplifier, because as the harmonic order rises, the amount of that harmonic present in the plate waveform falls. Thus a two-time multiplier is about half as efficient as a straight-through circuit, a 3-time multiplier about a third, and so forth.

To get the maximum efficiency out of a multiplier, we change its operating conditions just a little from those for a straight-through circuit. The most major change is to increase the grid bias. This increases the clipping action at cutoff, and boosts the harmonic content of the output by making the clipping more sharp.

We can take a trip from this to find ways of reducing the harmonic content of a Class C amplifier's output. Reducing the grid bias to the lowest level that will permit desired operation will help cut down the harmonics, as will trimming grid drive back to the lowest necessary level. And by all means, we should make certain that our plate tank circuits are tuned to the desired frequency. It's not too uncommon for Novices to accidentally tune to the wrong dip, but that's not what we're talking about so much as the possibility of an unwanted additional resonance at or near some high-order harmonic such as the seventh, ninth, or eleventh. Such a resonance can result in a surprising amount of harmonic output from an otherwise clean transmitter. Careful probing of tuned circuits with a dipper is the best test for such goings on.

Since the selectivity and flywheel effect of the plate tank circuit in a Class C amplifier is the only thing standing between you and an overdose of harmonics, the tank circuit itself is a key factor in harmonic prevention.

For best selectivity, and the companion condition of minimum harmonic energy, the Q of the plate tank should be high. Like the matter of circuit efficiency versus harmonic generation, though, this is only one side of a tradeoff. High Q in a tank circuit means that the current circulating in the circuit will also be high; the circulating current in any tank with appreciable Q is equal to Q times the current going through the circuit to outside. That is, if your final is operating with a rms rf current of 100 ma (relatively low for a transmitter, since with a 600-volt supply this is only about 60 watts of rf), then if the tank circuit Q were equal to 100 the *circulating* current in the tank would be 100 x 100 ma, or 10 *amperes*. If the resistance of the coil were only 0.1 ohm, the power lost in this resistance would be I^2R, or 10 x 10 x 0.1 watts, which works out to 10 watts—or nearly half of the total power produced by the amplifier!

Reducing the tank circuit Q to 10 in the preceding example would reduce circulating current to 1 amp, and the lost power would drop to 0.1 watt; cutting Q to 1/10 its original value trimmed the loss to 1/100.

So for minimum loss in the tank circuit, Q should be low, but for minimum harmonics, Q should be high. In practice, the Q of the tank is chosen as a compromise between these conflicting requirements, and normally lies in the range from 10 to 20 (Fig. 4). A Q of 10 is about the minimum capable of providing decent harmonic rejection, but at frequencies above 21 mhz it often proves impossible to get down this low and a figure as high as 20 must frequently be accepted as the minimum possible value.

Note that these Q figures are the *loaded* Q of the complete tank circuit; don't get them mixed up with the Q ratings of the tank coil alone. The *coil*'s Q must be as high

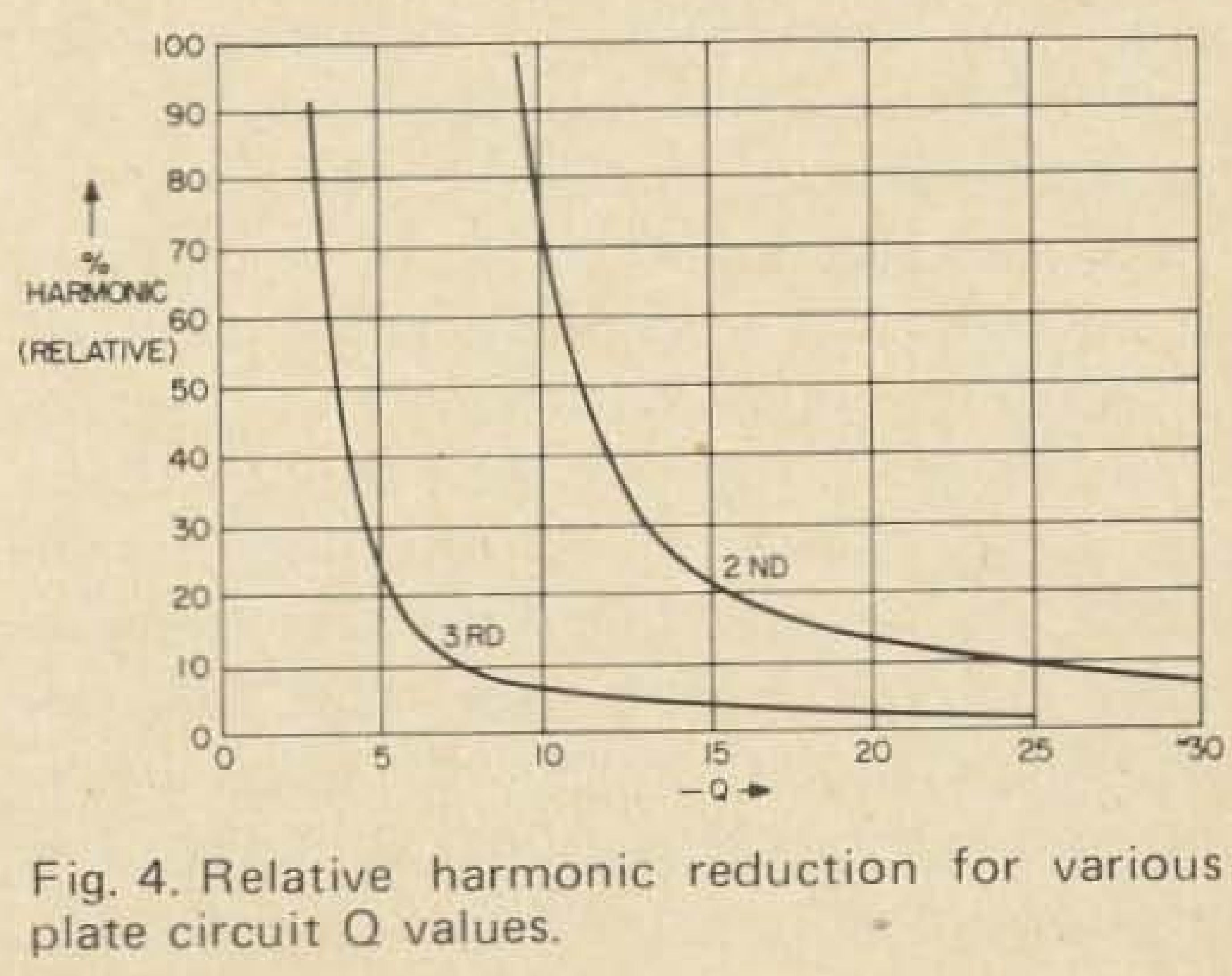


Fig. 4. Relative harmonic reduction for various plate circuit Q values.

as possible in order to keep losses down. When the entire circuit is hooked up and loaded to the desired output level, it behaves as if a resistor were connected in parallel with it. This resistor (fictional, of course) is how the output power is accounted for in the circuit equations, and the "loaded Q" about which we're talking is the ratio of this fictional resistor and the reactance at resonance.

If loaded Q is too small, harmonic problems are not the only troubles to be expected. The circuit will also prove difficult to couple to a load. Loaded Q can be increased by reducing the inductance in the circuit, or increasing the capacitance. The loaded Q of a final-amp tank will also vary with the coupling to the antenna; all calculations are based on the assumption that the amplifier is delivering its intended output power level. If more lightly loaded, Q will be higher, and if overloaded, Q will drop.

Since each tuned circuit adds additional rejection of off-frequency signals while having little effect on signals at the resonant frequency, the more tuned circuits you have, the smaller will be the harmonic content of the output. This is an excellent reason for use of antenna tuners. Harmonic filters, about which we'll have more to say a little later, are in the final analysis merely special kinds of tuned circuits.

Because additional tuned circuits offer additional harmonic rejection, any transmitter making use of frequency multiplier stages (which means, in practice, almost any transmitter except a sideband rig) should have the multipliers as early in the lineup as possible. This permits the maximum number of tuned circuits to follow them, thus attenuating the unwanted harmonics produced by the multipliers while strenghtening the desired output frequency.

The multipliers should also be operated at the lowest power level practical for them; all power gain should be achieved in straight-through stages if possible. At VHF and UHF, this is not always practical, due to the difficulties of attaining large amounts of power amplification at these high frequencies, but in hf transmitters the rules are to keep the multipliers early in the lineup, and operate them at low power.

So far we've examined only the theoretical and design considerations involved in minimizing harmonics. Construction practices, however, are of at least equal importance. Since it's impossible to avoid having at least a little harmonic energy inside a transmitter, and the theoretical cures are based on keeping it inside without permitting it to be radiated, the construction must contribute to keeping the harmonics sealed up.

One of the first steps is to employ adequate and carefully installed bypass capacitors on all signal return paths, since the unwanted harmonic energy must flow through a complete circuit and a poor bypass may permit the harmonic to find an easier path out by means of the normal output circuit. If the lead inductance of these bypass capacitors cannot be made negligible by reducing lead length to almost zero, then it should be adjusted to form a series resonant circuit to ground at the frequency of the most troublesome harmonic. This will minimize that one harmonic, at least.

A companion step, equally necessary, is to shield all rf stages adequately. To be adequate, the shielding must be complete. No gaps must exist through which harmonic energy may leak outside the rf section. This means not only that meter holes and the like must be shielded, but that all joints in the shielding enclosure be rf-tight. Finger stock or metallic sponge is usually necessary at all doors or other openings in the enclosure in order to meet this requirement.

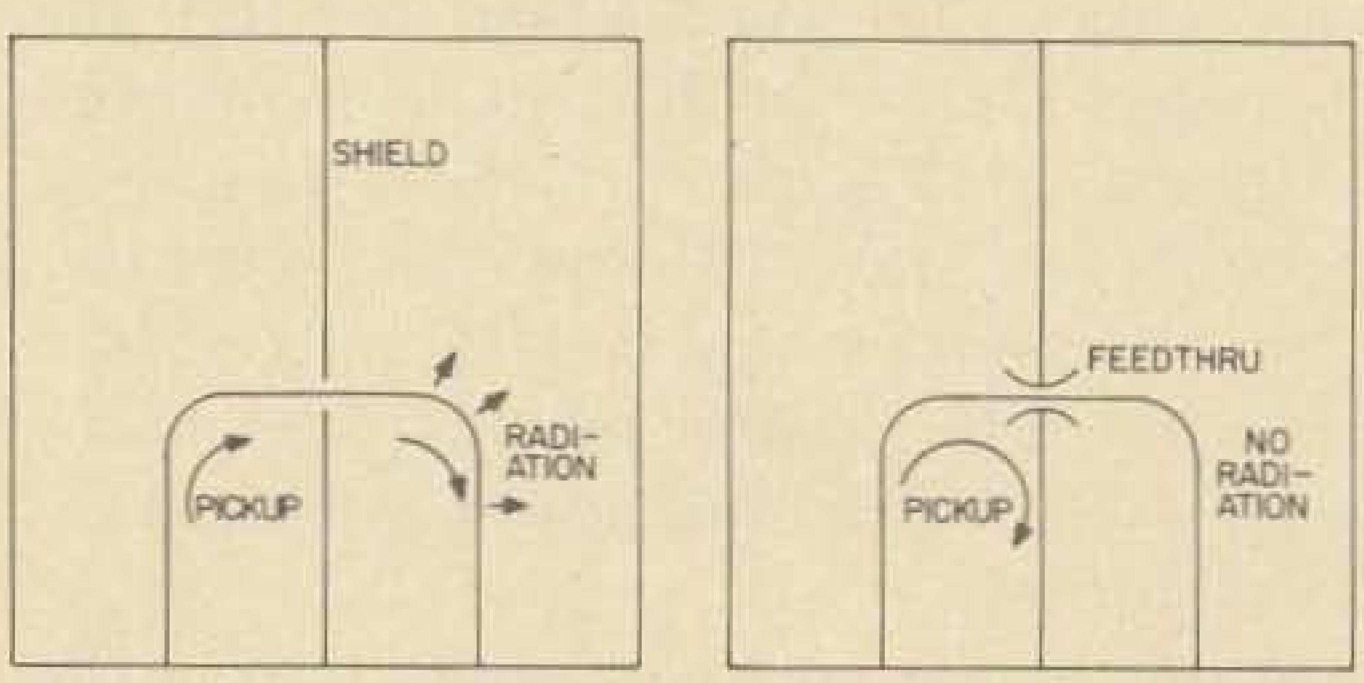


Fig. 5. How wires through shielding defeat the shield, and how to cure them.

Before shielding can be considered complete, all sources of leakage through the shielding must be plugged. This includes all wires going through the shielding (Fig. 5). Any lead passing through the shield should be appropriately filtered to be certain that it carries only the *desired* energy through, and that all *undesired* energy remains trapped inside the shield. This means careful bypassing of all dc and power conductors (often using coaxial or feedthrough capacitors where the conductor passes through the shield), and appropriate filtering of signal leads.

When shielding is complete, nothing but dc and power can get into an rf enclosure, and nothing but rf at the desired output frequency can get out. What is more, the only way this rf can get out is through the antenna connector (even the antenna connector is considered to be a gap in the shielding–the shielding is kept complete by the coax shield when coax feedlines are used).

Complete shielding helps keep a transmitter from radiating harmonics through undesired ports, but does nothing in itself to reduce the quantity of harmonic energy present in the output signal. To reduce the amount of harmonic energy going out through the antenna connector, several more points of circuit design and construction should be considered:

The various stages can be coupled by any of several means. One of the most convenient, and so one of the most often used, is "capacitor coupling" where an rf choke or a tuned circuit offers high impedance to the signal in the output circuit of the preceding stage, and a capacitor provides a low-impedance route for this signal to the input circuit of the following stage. This circuit, shown in **Fig. 6**, is one of the least desirable

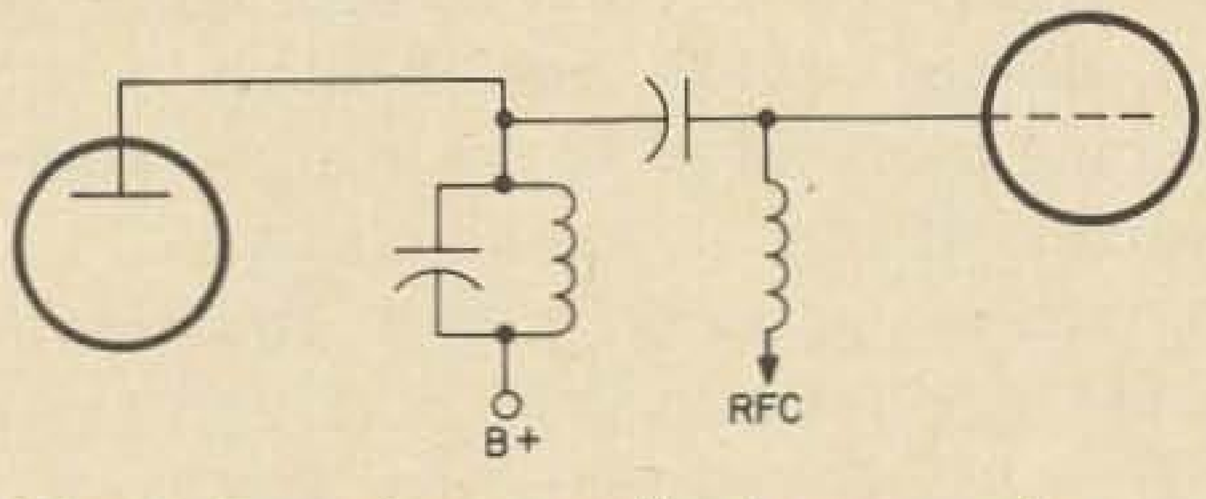


Fig. 6. Capacitor coupling between rf stages.

of all means of coupling so far as harmonics are concerned, because harmonics can couple from one stage to the next even more readily than can the desired signal when capacitor coupling is used.

Several other means also exist for coupling stages. One is "link" coupling, where the output of the preceding stage is coupled to a pickup link which is in turn connected to a second link, and the second link couples to the input of the following stage as shown in **Fig. 7**. This circuit discriminates against harmonics, because the coupling is most effective only at the frequency to which the two tuned circuits are tuned.

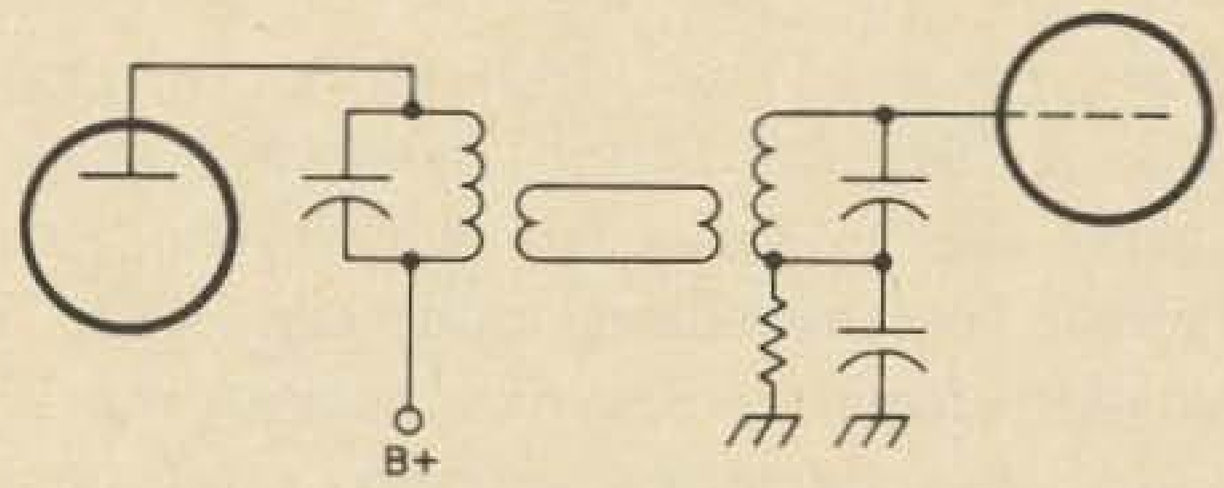


Fig. 7. Link coupling.

Another method is shielded inductive coupling, shown in **Fig. 8**. Here, the two tuned circuits are coupled directly to each other rather than through links, but an electrostatic shield between them (the "Faraday screen") blocks any capacitive transfer of harmonics from one to the other.

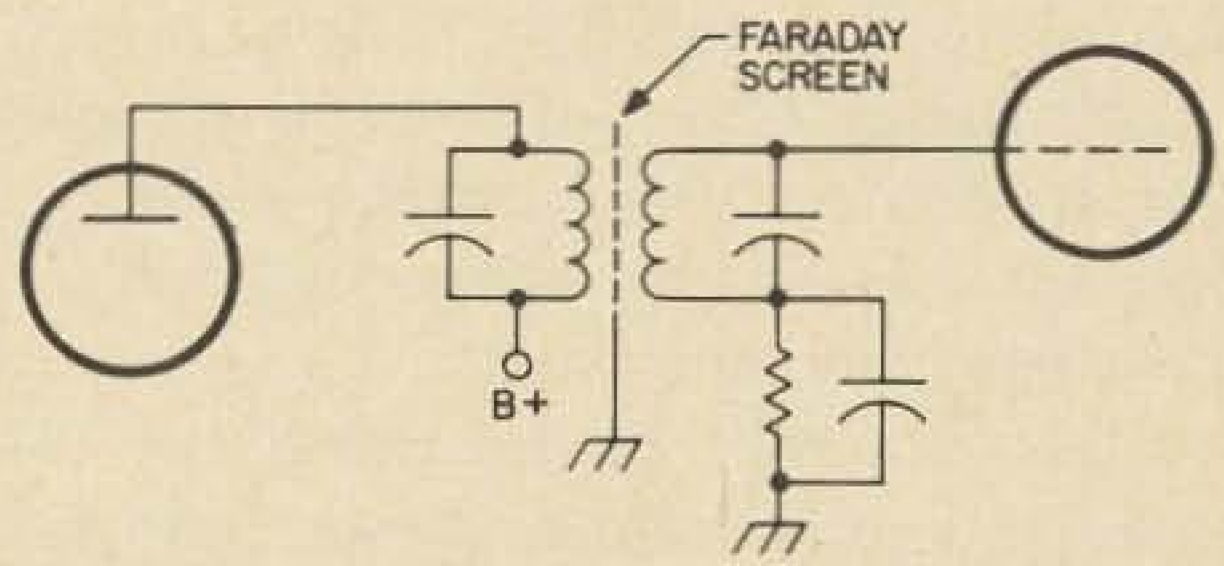


Fig. 8. Electrostatically shielded inductive coupling.

Combining these two methods gives us "shielded link" coupling, which is particularly effective against harmonic transfer. It is the same as link coupling, except that each link is electrostatically shielded from its associated coil. Unfortunately, this technique is often considered too cumbersome for ham use.

Possibly the most effective of all interstage coupling schemes, so far as harmonic rejection is concerned, is the use of a pi-network as shown in **Fig. 9**. The pi-network is, in essence, a low-pass filter and so it tends to actively filter out all harmonics. At the same time, it provides an effective coupling path for the desired signal. If designed properly, it can provide as effective coupling as any other system. However, it does require careful design or it will not transfer as much signal energy as the

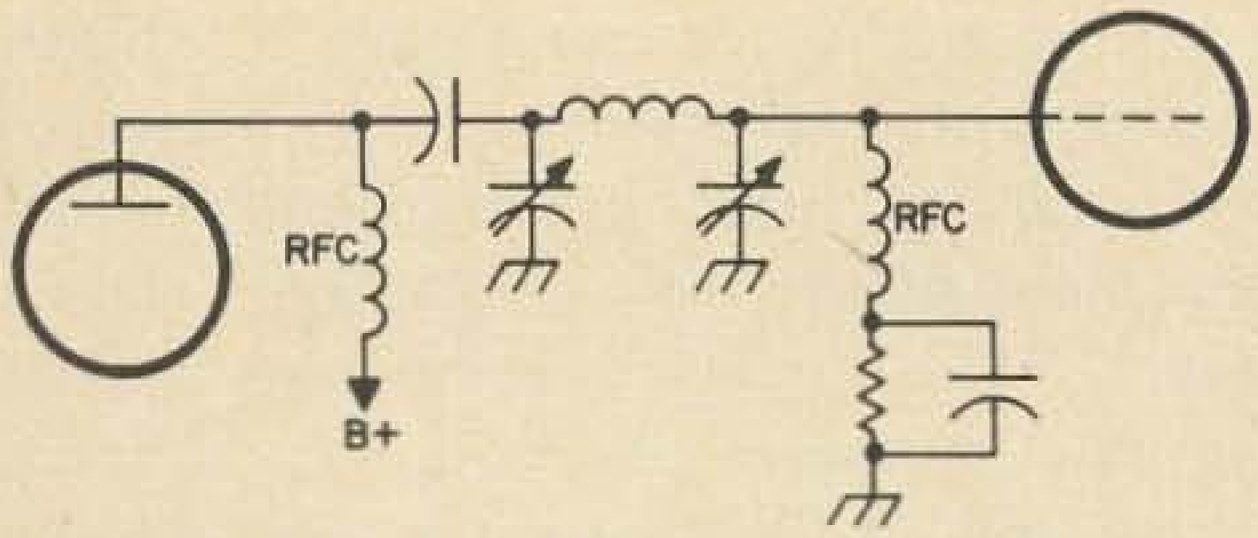


Fig. 9. Pi-network interstage coupling. Note resemblance to low-pass filter circuit.

simpler forms. This apparently the main reason it has not found more use in ham circuits, the majority of which use either capacitor or inductive coupling with no particular effort to minimize harmonics.

Once the harmonic energy reaches the output connector of the transmitter, it's still not too late to keep it from being radiated. Adding tuned circuits by means of antenna couplers will reject some harmonic energy. Most hams, however, use low-pass filters in the feedline. These filters reject all energy above their cutoff frequency.

Low-pass filters of the most common design are effective against those harmonics which cause TVI, but have little or no effect on such things as out-of-band harmonics at lower frequencies (such as the second harmónic of a 3990 khz phone signal at 7980 khz, outside any ham band).

A less common design called the "Harmoniker" consists of a half-wave trap filter, and works very much like a set of tuned circuits to pass only the fundamental signal and block all other harmonics. The disadvantage, to the operator, of such a filter is that each such filter is effective for only a single band. When the band is changed, a different filter must be put into the line. The ordinary low-pass filter, with its cutoff frequency in the neighborhood of 45 mhz, permits all signals in the hf ham bands to pass and so need not be changed for operation from 3 to 30 mhz.

No discussion of harmonic control could be complete without some examination of the final "filter" in the transmitter system—the antenna itself.

An ordinary dipole antenna is effective only for the band for which it is cut (although the ordinary dipole is also usable to a lesser degree at the third-harmonic frequency as well). Many other antenna designs share the "single-band" characteristic of the half-wave dipole. Use of such single-band antennas provides a final filtering action against unwanted harmonics, since even if they are generated and get through all the other filters and tuners up to the antenna itself, they still will not radiate efficiently.

Multi-band antennas, on the other hand, offer no such filter action. Since the ham bands are in harmonic relation to each other in the hf region (even 21 mhz is the 3rd harmonic of 7 mhz), any antenna capable of radiating efficiently on all hf ham bands must be able to radiate on at least one harmonic and frequently on several harmonics of any particular operating frequency below the 10 meter band.

Thus, when maximum control of harmonics is required, the transmitter must be designed to minimize them in the first place, then constructed with complete shielding and bypassing, operated with proper bias and drive to keep harmonics low, and connected to a single-band filter. Few ham stations require this extreme degree of control—but it *can* be achieved.

How Does the Antenna Circuit Affect the Final Stage? We all know that in any transmitter the antenna circuit plays a large part in the operation of the final rf amplifier stage. Any troubles or problems in the antenna or feedline usually manifest themselves in the form of problems in the transmitter as well. What we're setting out to discover here is *how* this interaction between antenna and final rf stage occurs, and why.

To do so, let's begin by looking not at the final rf stage, but at some earlier stage. It doesn't matter which one, because what we're going to examine is the general working principle of an rf power amplifier.

The purpose of any rf power amplifier is to accept an input signal of some sort, together with dc power from the power supply, and to produce from these two input ingredients an output signal which is a magnified copy of the input signal, identical in all respects except at a greater power level (if the amplifier happens to be modulated, the output won't be identical—but it will depend on the rf and af input signals in that case).

The input signal comes from some driving source, and the output signal is delivered to some "load." Until the output signal gets to the load, it can't be considered as "output" because it hasn't yet left the amplifying stage.

The normal load for an rf amplifier in the driver stages of a transmitter is still another rf amplifier. To get the signal from one state to the next, the two stages must be coupled together by some means. The normal means uses tuned rf circuits.

These tuned rf circuits also play a part of the role of the "load" for the driving amplifier, so far as the tube itself is concerned. The plate tank circuit has some specific value of impedance, and this value of impedance furnishes the load against which the plate current of the amplifier tube "pushes" to develop the output power.

But tuned rf circuits are rather tricky things; their impedance isn't so easy to define as is that of a simple resistor, because the impedance of a tuned rf circuit involves such things as transformer action between input and output, stray capacitance, self-inductance, and the amount of power taken out of the circuit (which acts, effectively, as resistance inserted into the circuit, and modifies the circuit Q).

For this reason, the *driven* stage influences the operation of the *driving* stage. We say that the two stages are not isolated from each other, or that they interact. We may find, for example, that adjusting the plate tank of one stage may change the plate current of some earlier stage. We are almost certain to discover that a change in the grid tuning of one stage will affect the plate tuning of the previous stage.

This interaction between coupled stages is true of all rf power amplifiers. Some circuits provide less interaction than others (notably the grounded-grid arrangement), but it's always present to some degree.

Now let's go back to the "final" stage. It still must furnish power to a load, but now the load is an antenna circuit rather than being just another amplifier stage.

The interaction, however, is still with us. Any change of impedance in the antenna circuit reflects back into the final tank circuit of the transmitter, and affects its adjustment. The effects may be minor, or they may be catastrophic—it all depends upon the particular situation.

For any rf power amplifier to operate as designed, the operating conditions intended by its designer must be present. One of these operating conditions is the appropriate value of load impedance.

If the load impedance is too low, or too high, the amplifier won't operate as intended. Too high a load impedance prevents as much of the power getting out of the circuit as was meant to, and may cause severe damage. For example, operating a beam-power stage into an open-circuit load produces extremely large swings of plate voltage in the tank circuit. These swings affect the plate-screen voltages in such a manner as to greatly increase screen current, and it's not uncommon to find the screens of such tubes vaporized by any extended period of zero-load operation.

Too low a load impedance pulls down the Q of the final tank circuit and reduces the effective impedance seen at the plate of the tube. This removes the only limiting factor determining plate current, and again the tube may be destroyed; the main difference is that it's either the plate or the cathode which goes in this case.

These are, of course, extreme examples. But excessive swr on antenna feedlines, caused by improper feedline termination, can approach these conditions. The resulting improper operation can pop coupling or bypass capacitors, cause tuning components to arc over or melt, and burn out tube elements.

The direct means by which the antenna gets into the act at the final amplifier is because it provides the "resistance" into which the final's output power is accounted for. So long as the antenna acts as a pure resistance (or at least acts thay way at the point where the transmitter sees it), the transmitter can be adjusted to deliver its intended output power. If the transmitter is designed to operate into a 50 ohm resistive load and the antenna looks like 50 ohms of resistance, all is well.

If the transmitter expects a 50 ohm load and the antenna looks like 100 ohms of resistance, then only half as much power as expected can be transferred *at the design settings* of the transmitter.

But increasing the coupling between antenna and plate tank circuit, by either changing the number of turns of the position of the coupling link, or changing both inductance and capacitance values if the transmitter uses a pi-network output circuit, can produce the intended impedance transformation and restore normal operation.

If, on the other hand, the antenna appears to be a 25 ohm resistor, then the coupling must be decreased by moving the coupling link farther from the tank coil, using fewer turns on the link, or again changing values in a pi-net.

A more satisfactory solution to either situation is to use an external antenna coupler to transform the antenna's resistance into the 50 ohms of resistance the transmitter expects.

If the antenna does not look like pure resistance, but has either inductance or capacitance as well (it cannot have both L and C, because the larger will cancel out all of the smaller), things get more complicated. The reactance of the antenna will be coupled back into the final tank circuit, because the coupling means between final tank and antenna is essentially a transformer and transformers work both ways. This will detune the final tank to one side or the other of the desired frequency. When the tank is retuned to cancel out the antenna reactance, the coupling may no longer be correct, and when the coupling is changed, more detuning may occur. The net result is, at best, a compromise.

Even if the antenna itself is a pure resistance at the operating frequency, a mismatch between feedline and antenna will produce reactance in the line. The reactance may be either inductive or reactive, depending entirely upon the length of the feedline in terms of wavelength.

If the antenna itself has inductance, or capacitance, at operating frequency, then the feedline cannot match it. Line reactance in this case, though, depends upon the reactance of the antenna as well as upon feedline length and cannot easily be predicted.

No matter how much reactance is present in a feedline, it will look like a pure resistance at a series of points 1/4 wavelength apart along its length. If the antenna is a pure resistance but mismatched in resistance value to the line, these points will be every 1/4 wavelength back from the antenna. If the antenna has reactance, then the location of the first point cannot easily be predicted—but once it is found, the resistive points will recur every 1/4 wavelength back toward the transmitter.

The resistance at these points, in either case, may be very high or very low. It will never be equal to the line's rated impedance unless the line is matched to the antenna—and in this case every point along the line will show that same resistance.

For instance, a 50 ohm line connected to a 100 ohm antenna will have a vswr or 2 to 1. One quarter wavelength back from the antenna, the resistance will be 25 ohms. Another quarter-wave back, the 100 ohm antenna resistance will repeat. From there on back to the transmitter, the 25 ohm and 100 ohm values will alternate. The rule is simple in such a case; at the antenna, the antenna resistance occurs. This defines vswr as Ant/Line or Line/Ant, whichever provides a result greater than 1. Let's assume that the antenna resistance is greater than that of the line, so we use Ant/Line.

A quarter wave back, the resistance equals line resistance divided by vswr. A half wave back (two quarter waves), the resistance is that of the line multiplied by vswr. Thus at odd multiples of 1/4 wavelength, the effective resistance is that of the line divided by vswr, and at even multiples (or half-wave multiples), it is that of the line multiplier by vswr.

The same rule applies even if the antenna is reactive. The resistive points will be either at line resistance divided by vswr, or line resistance multiplied by vswr, depending upon their distance from the first resistive point and its relation to the line resistance. **Fig. 10** illustrates this rule.

Now let's consider a 50 ohm line with a 10-to-1 vswr. The pure-resistive points will be either 5 or 500 ohms. Both these values approach the extremes of short-circuit or zero-load conditions, if they appear at the

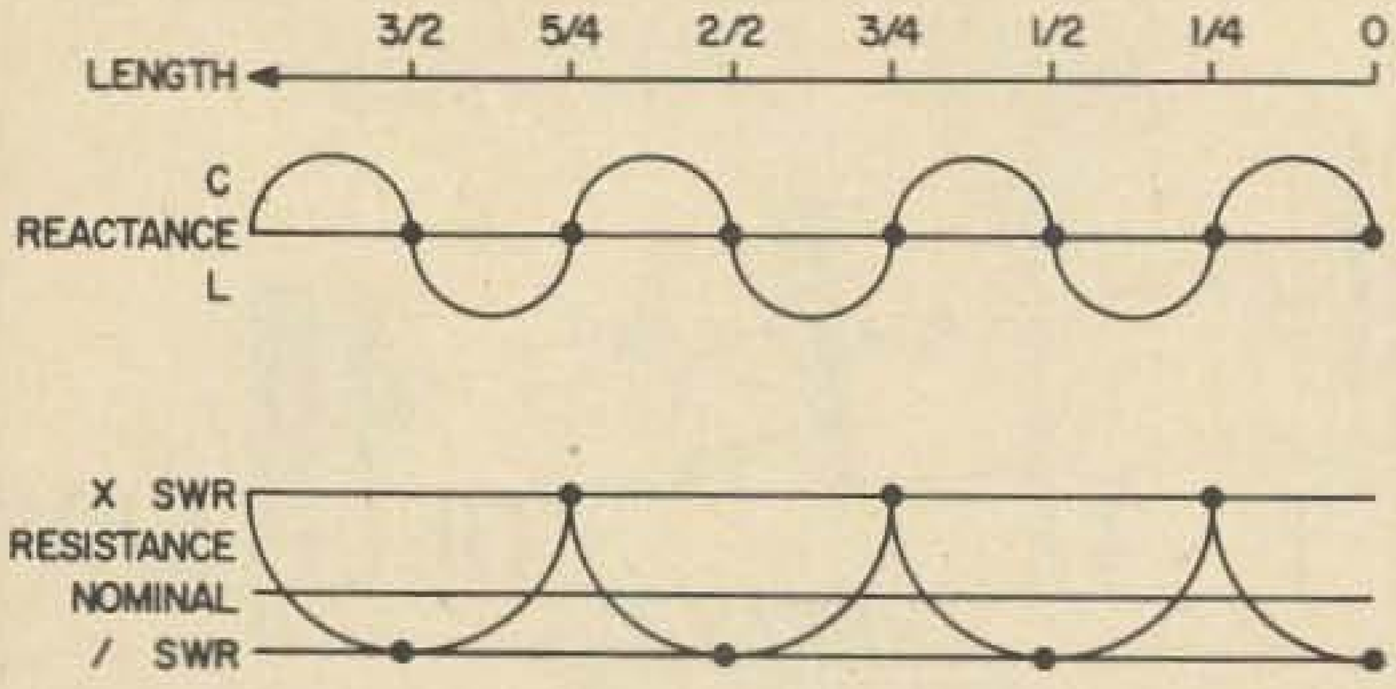


Fig. 10. Relation of feedline impedance to length of feedline.

antenna connector of our transmitter. Component damage is most likely.

In practice, we normally avoid such extremes by "pruning" the feedline so that its resistive component is somewhere near that for which the transmitter is designed, and then accepting the detuning effect of the accompanying reactance. This often works well. Again, an antenna tuner or coupler is better practice, because no detuning results.

In some cases, and with some final-amplifier output circuits, even a very small value of swr is adequate to upset circuit operation. Most affected by swr, surprisingly enough, is the popular pi-network output circuit.

The pi-network is billed as being capable of matching feedlines from 10 to 600 ohms when designed for 50 ohm operation, and this is true enough if the feedlines are resistive. However, the pi-network is a rather complex device which acts by transforming impedances, and one of its critical parameters is the capacitance present in the output side of the circuit. This parameter, in fact, establishes the value of the impedance transformation, which allows it to be used as a "loading control."

If the feedline contains reactance, the reactance may be either inductive or capacitive. If the reactance is inductive, it will cancel out a part of the output-capacitor's capacitance, and thus increase the loading. Such a feedline appears to load quite readily on a pi-net rig, and if the effect is not too severe this may be no disadvantage at all. However, a little too much inductance here may make it impossible to get loading *down* to design value.

If, on the other hand, the feedline reactance is capacitive, it will add to that of the output capacitor and thus reduce the loading. In this case, it may not be possible to make the antenna accept the full power output of the transmitter.

The cure in either case is simple; remove the reactance from the feedline. This can be done either by pruning to some different length (while this may not remove the reactance, it will certainly change it and the change may help), or by using an antenna tuner.

Now that we've seen how the antenna circuit can interact to change the operation of the transmitter's final stage, let's look again at that final stage operation. The stage was designed by someone, originally, who had some definite operating conditions in mind for it. Even if you designed it by taking a published circuit and varying things here and there to fit the content of the junk box, whoever did the original design behind the published circuit had definite operating conditions intended.

Some of these operating conditions include grid bias, grid current, driving power, plate voltage, plate current, screen voltage, screen current, and output power.

Because of the interaction of the antenna, especially in its effects upon output power, plate current, and screen conditions, almost all designs include provisions for varying the coupling between final stage and antenna. These range from a simple variable link which may be adjusted to be near the final coil (maximum coupling) or far away (minimum coupling), through the combination of a link and tuning capacitor (in this case the capacitor often serves as a coupling control and the link position is fixed), to the more complex pi network which may have one, two, or three adjustments. The coupling is intended to be adjusted as a part of the operating procedure, to provide the proper load for the final amplifier tube.

This leads immediately to the question "How do we know when coupling is correct?", but the answer is simple—correct coupling produces the design levels of input and output voltages and current, with the design level of input power and the rated output power. In other words, whenever everything else is right, you know the coupling is right also—and if the coupling's wrong, something else will be wrong to show you.

What Happens in a Modulated Amplifier? In our previous installment, we examined the goings-on inside a modulated amplifier in considerable detail. We did not, however, delve very deeply into what happens in case various power supplies were to be suddenly short-circuited.

In some cases, of course, shorting of a power supply would simply lead to rather spectacular fireworks (particularly if the plate supply of a full kilowatt rig were to be shorted out, and to a lesser degree with the plate supply for any other device, or any screen supply).

In others, though, and especially if the power supply were intended to provide voltage rather than power, the effect upon the power supply itself might be negligible. The question then would become what would happen to the amplifier, and how would the short affect its operation.

The particular case we're studying is, of course, that cited in the FCC study list—shorting out the grid bias supply of a Class C modulated amplifier. The principles, however, apply to all supplies in which similar conditions prevail.

As we saw last time around, the bias requirements for a modulated Class C amplifier vary from moment to moment during the modulation cycle. Since the requirements are changing so rapidly, it's not possible to manually adjust the bias voltage for optimum conditions at each instant. The way around this problem is to make the bias self-adjusting, by using grid-leak bias to provide a major part of the operating bias voltage.

But when this is done, the fixed bias supply assumes a subsidiary role. Its major purpose, now, is merely to provide protection for the amplifier circuit in case the drive should be removed and so take away the grid-leak bias voltage.

When such a combination of fixed "protective" bias and grid-leak-derived "operating" bias is involved, the effect of shorting out the fixed bias supply will depend entirely upon the ratio between fixed and grid-leak bias. If the fixed bias is a small portion of the total operating grid voltage, loss of the fixed bias supply would have almost no effect upon the circuit's operation so long as drive was available to the stage. The only way, in fact, that its loss could be noted would be to remove drive and watch plate current skyrocket out of bounds.

If, on the other hand, the fixed bias provides an appreciable portion of the total operating grid voltage, with only enough extra bias derived from the grid leak to provide a measure of self-adjustment, then loss of the fixed bias supply would quite probably totally upset the amplifier's operating conditions and might even move its operation from Class C down to the Class B region. This would result in horribly distorted output, due to the drastic change in amplifier operating conditions.

Damage to the bias supply itself caused by a sudden short would depend upon the amount of current limiting designed into the supply. Most rectifiers will stand a very small momentary overload; to prevent long-term overloads, current-limiting resistors are generally connected in series with them. In supplies intended to deliver large amounts of power, these limiting resistors are small. In supplies delivering voltage but little power, the resistors are often much larger, specifically to protect against accidental shorting of the output.

The actual lack of necessity for fixed bias at all on a modulated Class C amplifier is demonstrated by the number of amplifier designs which completely omit fixed bias from all stages. Operating bias is obtained entirely from grid-leak resistors, and circuit protection is provided (if at all) by "clamp tubes" which act to drag screen voltage down to safe values if drive is lost and grid bias disappears. In an amplifier of this design, the whole question concerning bias-supply short-circuits becomes rather meaningless.

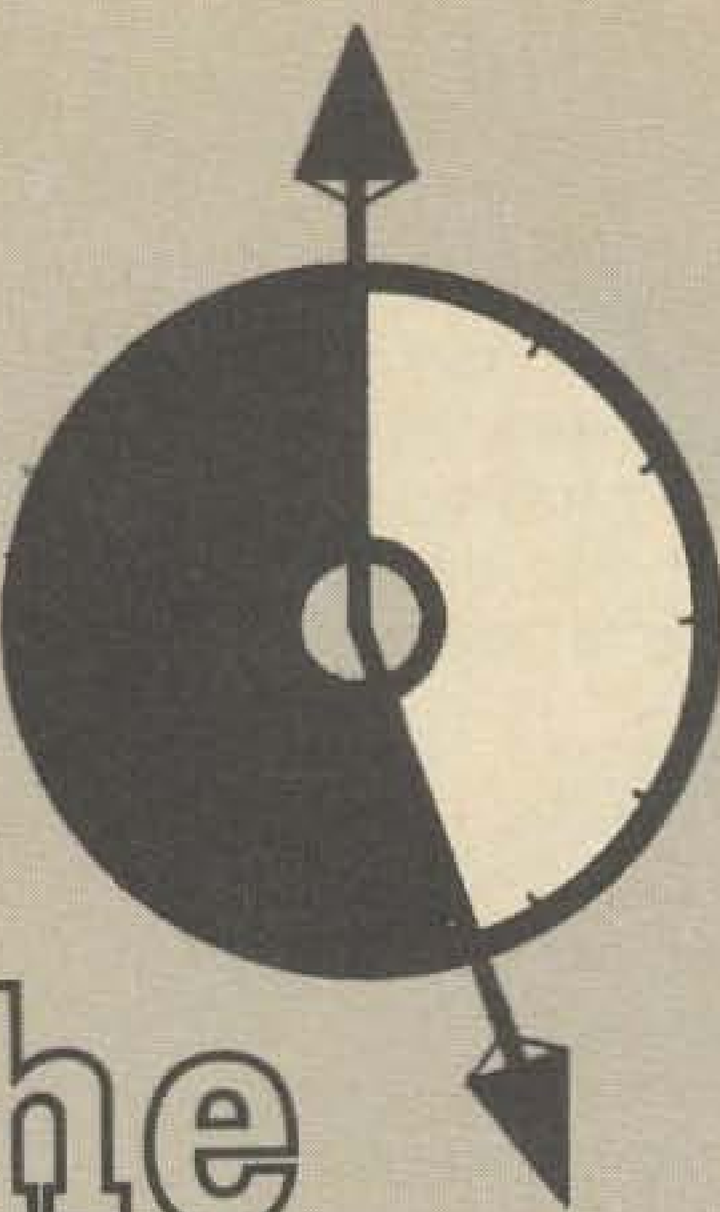
In a broader sense, though, the question still applies even if no fixed bias supply is present. Failure of the grid-leak resistor, or loss of drive, for example, can cause the operating bias to be sharply reduced or even to disappear.

When this happens, the effect upon circuit operation is catastrophic. If drive is lost, then no output can be expected and the entire transmitter is dead. If the resistor fails completely, the same situation occurs. If the resistor suddenly changes value, the transmitter may continue to operate but the operating conditions in the output stage have been completely changed and the chances of satisfactory operation are small.

The effects upon circuit components in such a case are at least as catastrophic. In a Class C amplifier, grid bias is normally the only factor limiting current in either the plate or the screen circuits. When bias disappears, both plate and screen current shoot skyward. Unless extremely rapid-action fuses are included in the circuit (and sometimes even then) the least you can expect is damage to the plate and screen milliammeters, ranging from bent needles to total burnout. If the overcurrent is allowed to persist for any appreciable period of time, and if fuses or meter burnout does not interrupt current flow, the tube itself will be damaged or destroyed. Along the way, any resistors, rf chokes, or coils in the path of the excessive current are also subject to damage.

In the absence of either fixed protective bias or clamp tubes, one scheme remains available to help protect things in case of bias loss. This is to provide a small amount of fixed bias by means of a cathode resistor. While cathode biassing is conventional practice in audio circuits, it is seldom employed in rf amplifiers for one major reason—in order for an rf power amplifier to operate properly, the cathode must be at ground potential. With a cathode bias resistor, feedback between grid and plate circuits is inevitable unless extremely effective bypassing is present. And as it happens, it's almost impossible to get bypass capacitors effective enough to work with cathode bias, since the bias resistance is relatively small and a bypass, to be effective, should have less than 1/10 and preferably less than 1/100 the impedance of the element being bypassed. Rather than attempt to develop capacitors with impedances below 0.1 ohm, most designers simply avoid cathode resistance in rf power circuits.

. . . Staff

The  27-Minute

Even with the large choice of SSB gear on the market today, there are still many amateurs who enjoy transmitting and receiving a well modulated AM carrier. This is especially true in the field of mobile radio.

A quick check of 10 meters will show that AM QSOs are available in number, and that most are from mobiles running low power. If you haven't done so lately, listen in around 29 MHz, and then sit back and recall when you used to be in there with the best of them.

For the ham who enjoys "rolling his own," AM mobile is a natural. It's even more so nowadays, what with printed circuits and ICs, because they can reduce the size of the gear. Each of us has his favorite transmitter and converter circuits, and the old reliables for antenna switching and control circuits. However, the one area that usually gets short-changed, or simply avoided, is noise limiting.

When you scan through today's ham journals, you quickly discover that the basic methods for noise suppression haven't changed too much over the years. Limiters for converters work well in general, if you're willing to pay the price of modifying the car BC set. This usually involves tearing out the detector stage, rewiring it, and then somehow stuffing the added parts into the BC set wherever you can find the space.

Just about the time I had almost given up on the idea of 10 meter mobile, because I'd have to install a series limiter, I ran across an *old* copy of Editors and Engineers Handbook. In it was a circuit that looked like it would do the job, be inexpensive to build, and above all, would be easy to install. Oldtimers will recognize the diagram as the Bishop noise limiter.

Being a shunt-type limiter, it simply hangs across the last i-f stage in the BC set. It's self-biased and automatically adjusts to the degree of modulation. The bias-circuit time constant is determined by C1 and the shunt resistance, which consists of R1 and R2 in series. The plate resistance of the last i-f tube and the capacity of C1 determine the charging rate of the limiter. It can be disabled by opening S1, which allows the bias to rise to the value of the i-f signal.

So much for the little theory involved, because as we all know, the big question is how well is it going to operate under individual circumstances? In my installation, a tube-type converter is used ahead of the car radio. With the limiter in the circuit, and engine speed at about 25 miles an hour, the noise limiting was better than I expected.

However, when the cruising speeds of 60 or 70 mph were reached, the limiter was "swamped out." It couldn't handle the incoming pulses fast enough. As you've probably guessed, the problem was quickly cured by changing the R/C time factor. This is indicated by R_X, where I paralleled two more 270 kΩ resistors. These values, of course, were needed in my limiter, and

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Mobile Limiter

the resistance will probably differ for yours. With that minor change, the limiter works as effectively at 70 mph as it does while waiting at a traffic light.

As for the title of this article, it took about 27 minutes to install and wire the parts for the limiter. I've never been able to install a series limiter in that small amount of time. The author would like to thank Bob, K7JSD, for his help during the "cuss and solder" stage of work. Bob is known locally for the crafty way in which he sweat-solders 7-pin sockets!

Parts installation couldn't be much easier. I punched a hole in the rear lip of the BC set for the 12AL5, so that the tube could be installed after the set is back in the dash. Inside the receiver is a four-lug tie strip, on which the few parts are mounted. If you buy everything new, it'll cost about $3, including the 12AL5.

Semiconductor diodes of the computer family were seriously considered at first, and we thought about using 1N658s. However, they are more expensive, and I have a strong respect for the back resistance of the 12AL5 for this kind of application.

There are many "peanut whistle" rigs on the high end of 10 meters nowadays, and it has been a pleasant experience to rediscover the fun of AM mobile. The limiter I've described will really help pull those other mobiles out of the noise level. You may even find that after you've finished reinstalling that old mobile AM gear, you can kick the sideband habit!

. . . W7SOH ■

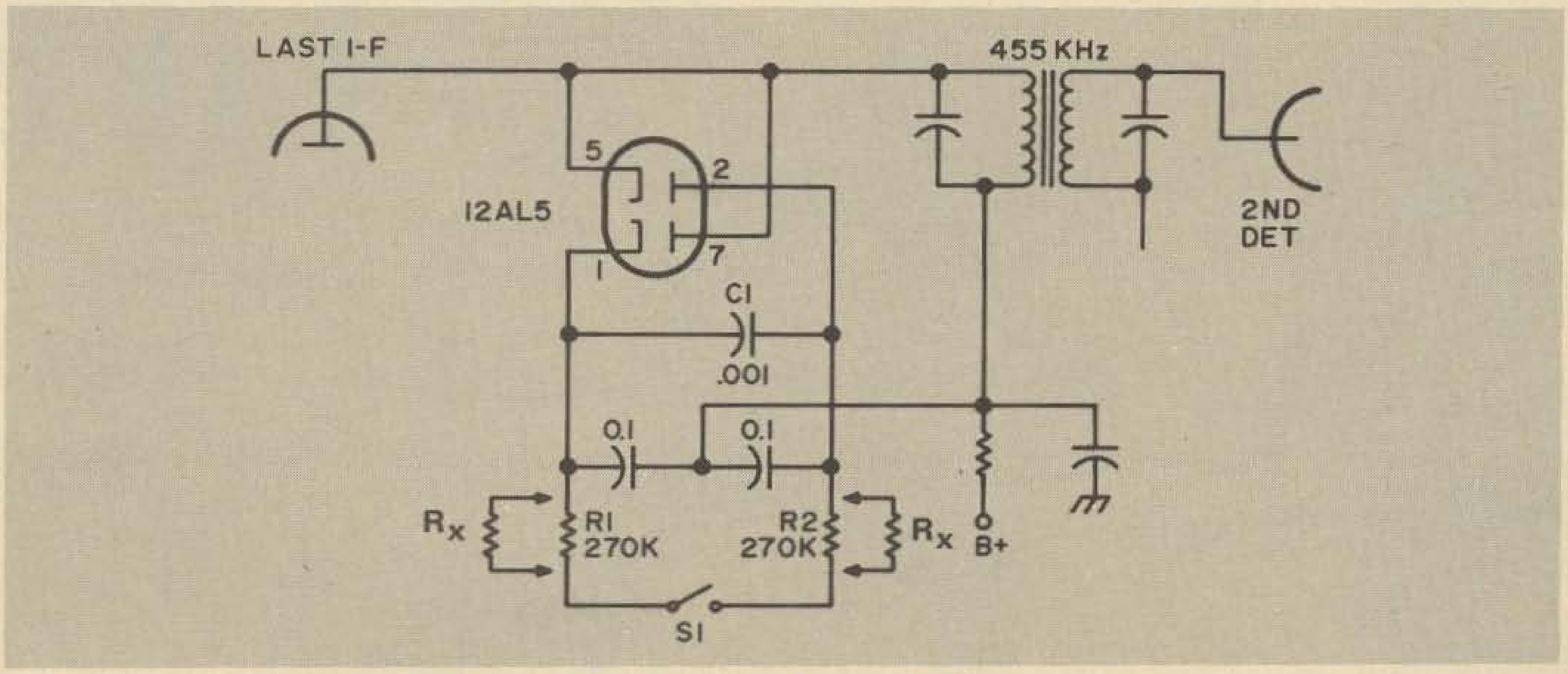
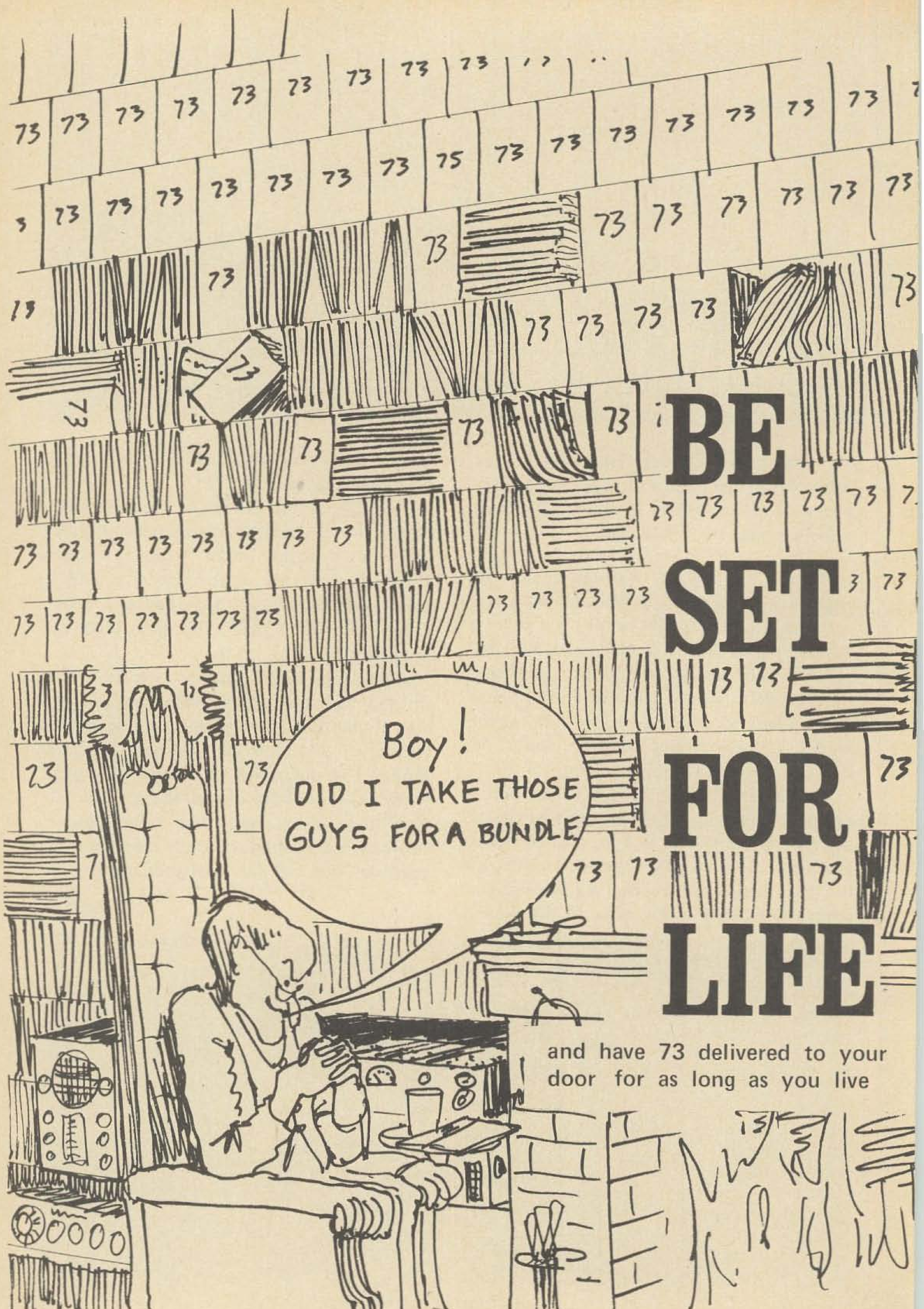


Fig. 1. Bishop i-f noise limiter.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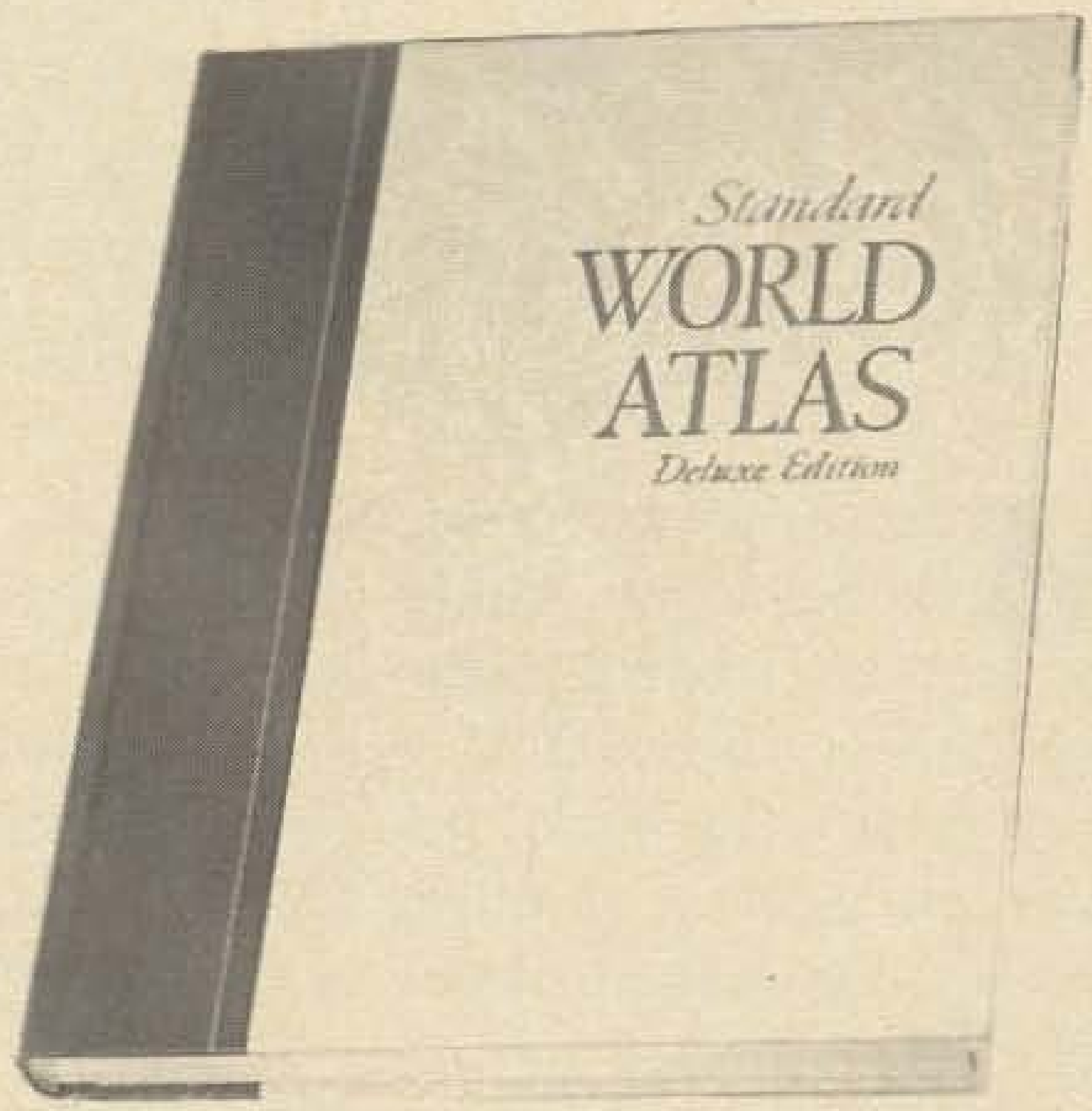

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A LOW BAND POLICE MONITOR

With the spectrum being shared by such agencies as state police, highway patrol, and the sheriff, there should be a lot to listen to . . .

Monitoring police and emergency communications channels can provide fun and excitement. For effective monitoring, the receiver must be stable, sensitive, cover several channels, and have a squelch. There are several monitor receivers on the market ranging from about twenty dollars to well over a hundred.

Typical "Doghouse" receiver before modification.

Fortunately, for those short of money, a good receiver can be had for a few bucks and a little work – at least for the 30–50 MHz band. "Doghouse" type receivers covering this band are still found in surplus stores for around $15. These receivers are all quite similar, having been built by Motorola, or to Motorola prints by various subcontractors. These sets use 13 octal tubes. Typical model numbers are R-237/B-VR, P-8028, and FMR-13. They all have a first i-f of 4.3 MHz and a second i-f of 455 kHz. They are wideband (±15 kHz), single-channel, crystal-controlled units and nominally cover 30–40 or 40–50 MHz. Typically the front ends use 6SD7s or 6SG7s for oscillator, first mixer, and rf amplifier.

The conversion consists of building an ac power supply, connecting the local controls, and converting the crystal oscillator to a tunable type. Depending on the frequency to be monitored, the rf and mixer coils may require pruning.

First, remove the vibrator power supply by taking out the three large screws holding it to the chassis, disconnecting the red and yellow plugs, and lifting the supply off. The power supply shown in Fig. 1 is then built

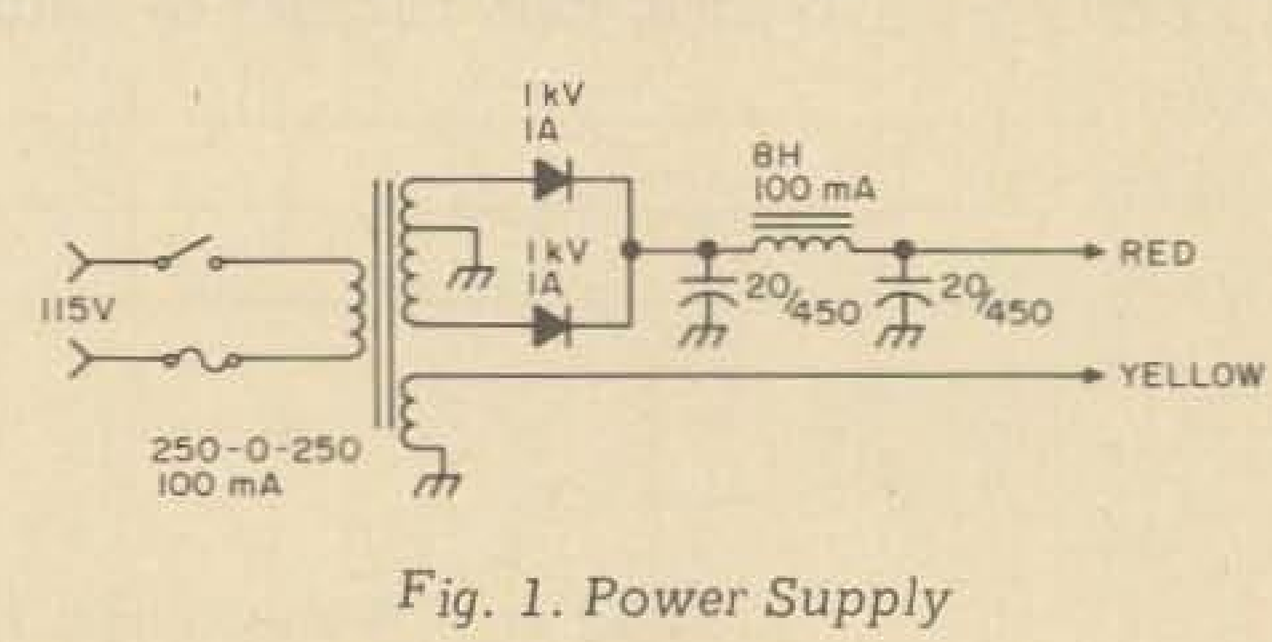


Fig. 1. Power Supply

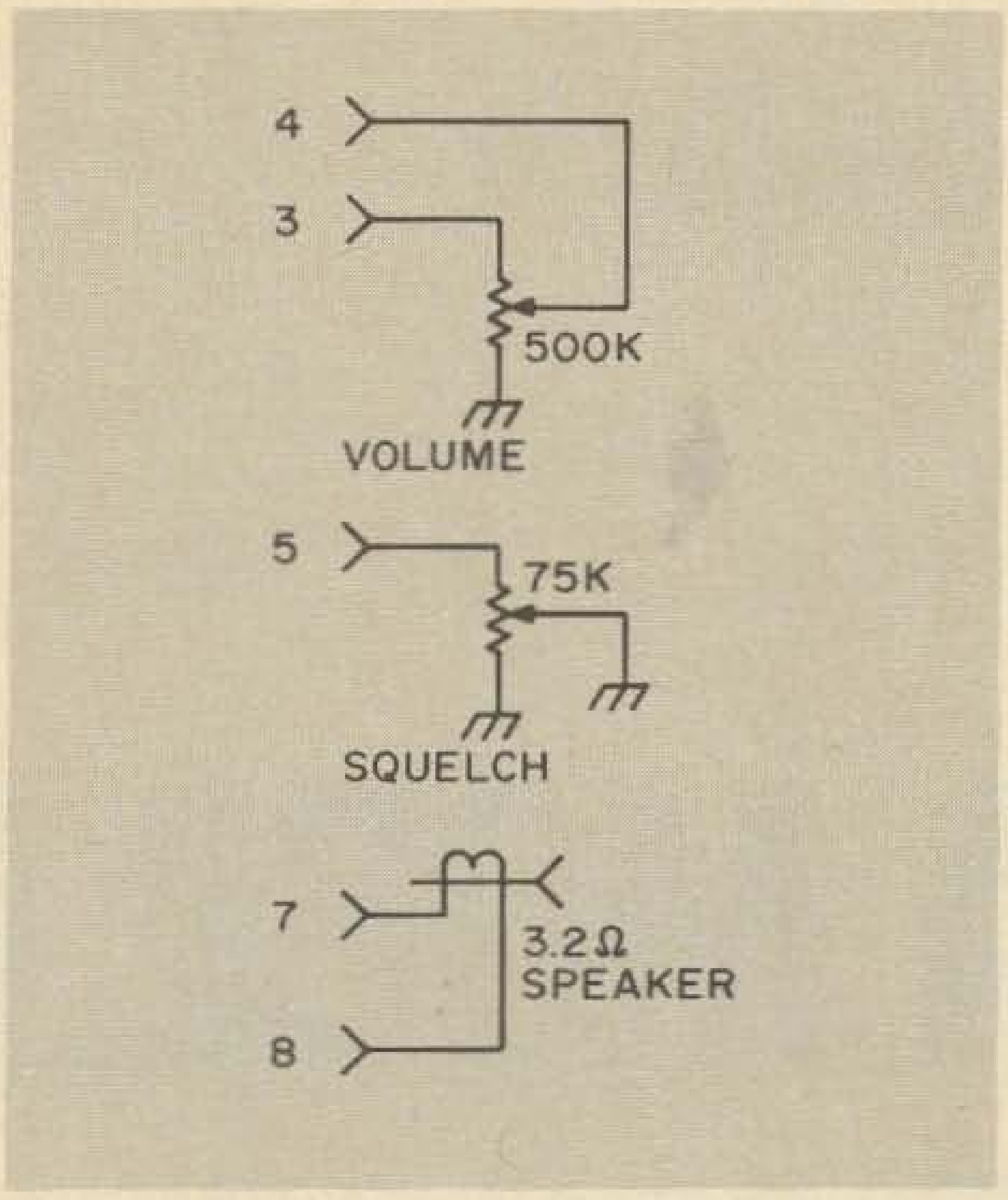


Fig. 2. Control Connections

on the chassis in the space vacated by the vibrator power supply.

The controls shown in Fig. 2 are then wired in. At this point it is advisable to "smoke-test" the set. Turn it on and check to see that the squelch and volume controls are operating properly. If you have a signal generator, feed a 4.3 MHz signal into pin 4 of the first i-f to see if all the low-frequency stages are operating properly. Frequently the conversion crystal is missing. If so, the replacement crystal frequency is 4755 kHz.

Figure 3 shows the before and after modifications made to the oscillator. At this point, a word is in order about frequency allocations. Most areas seem to group the local frequencies quite close together. In Orange County, California, for instance, most of the channels of interest lie between 45.1 and 45.7 MHz.

The front end of this set is good and broad, so rf tuning is not needed. In operation, the slug of the oscillator coil is positioned so that the tuning range of the oscillator is centered in the band of interest. A station in the center of the band is tuned in and the trimmers of L2 and T2 are peaked for best reception. Since all police transmissions are now narrowband, some improvement can be made by clipping the loading resistors from the primaries of T3, T4, and T6. The i-f's are then peaked.

If you have a 30–40 MHz receiver and want to cover the high end of the band, it will be necessary to remove one turn from L2 and T2.

Once you have the receiver working, you are ready for some serious monitoring. A well located antenna is a must. And omnidirectional coverage with vertical polarization is very desirable. A good approach is to buy a CB base station antenna and trim the elements to your frequency of interest.

This brings up the problem of how to find out what frequencies are in use in your local area, and the codes. There are two ways to do this. The first is to visit your local police or sheriff's communication center and ask. If you are too timid, you can invest in a good listening guide. There are a number commonly available.

. . . W6JTT ■

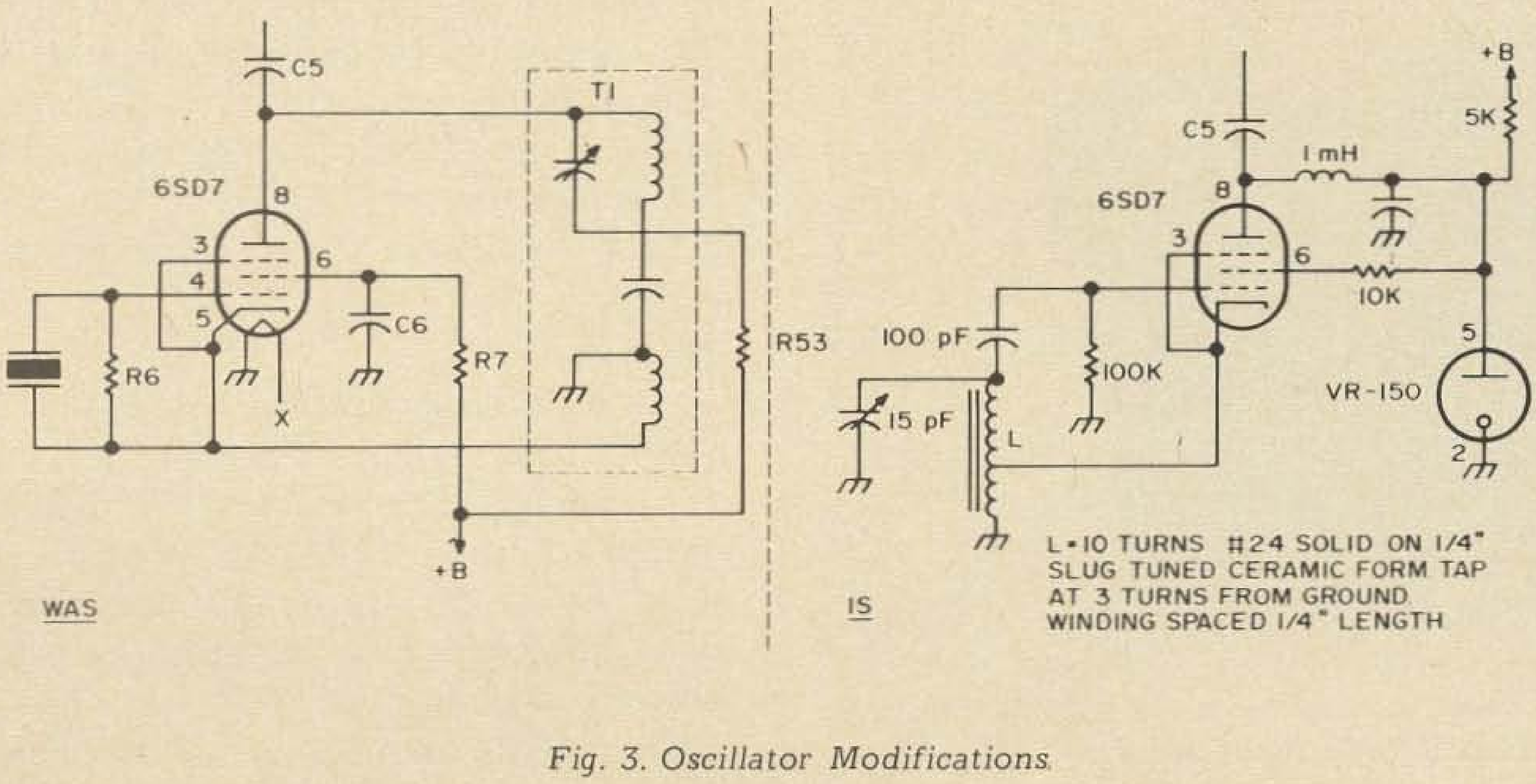
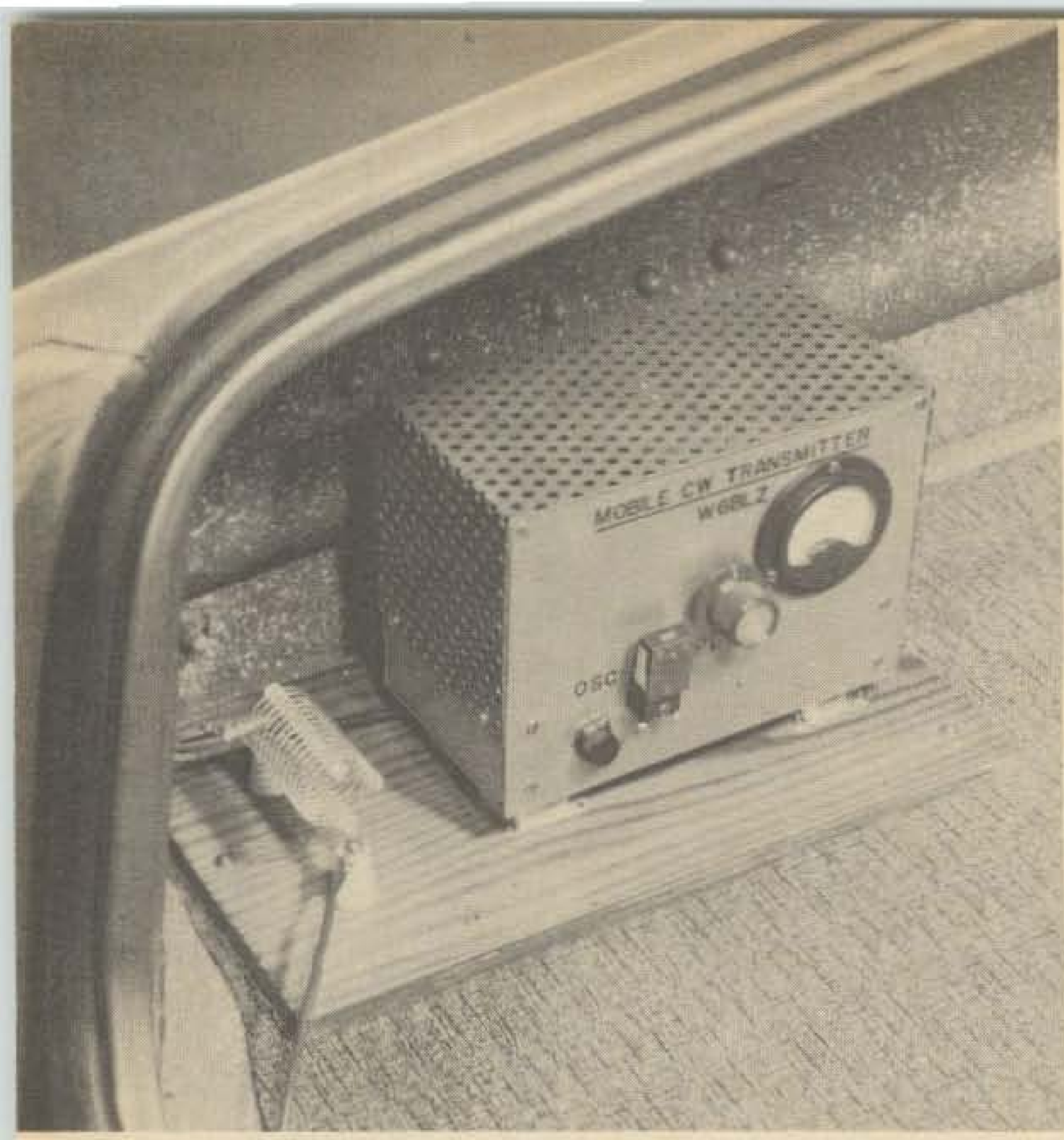
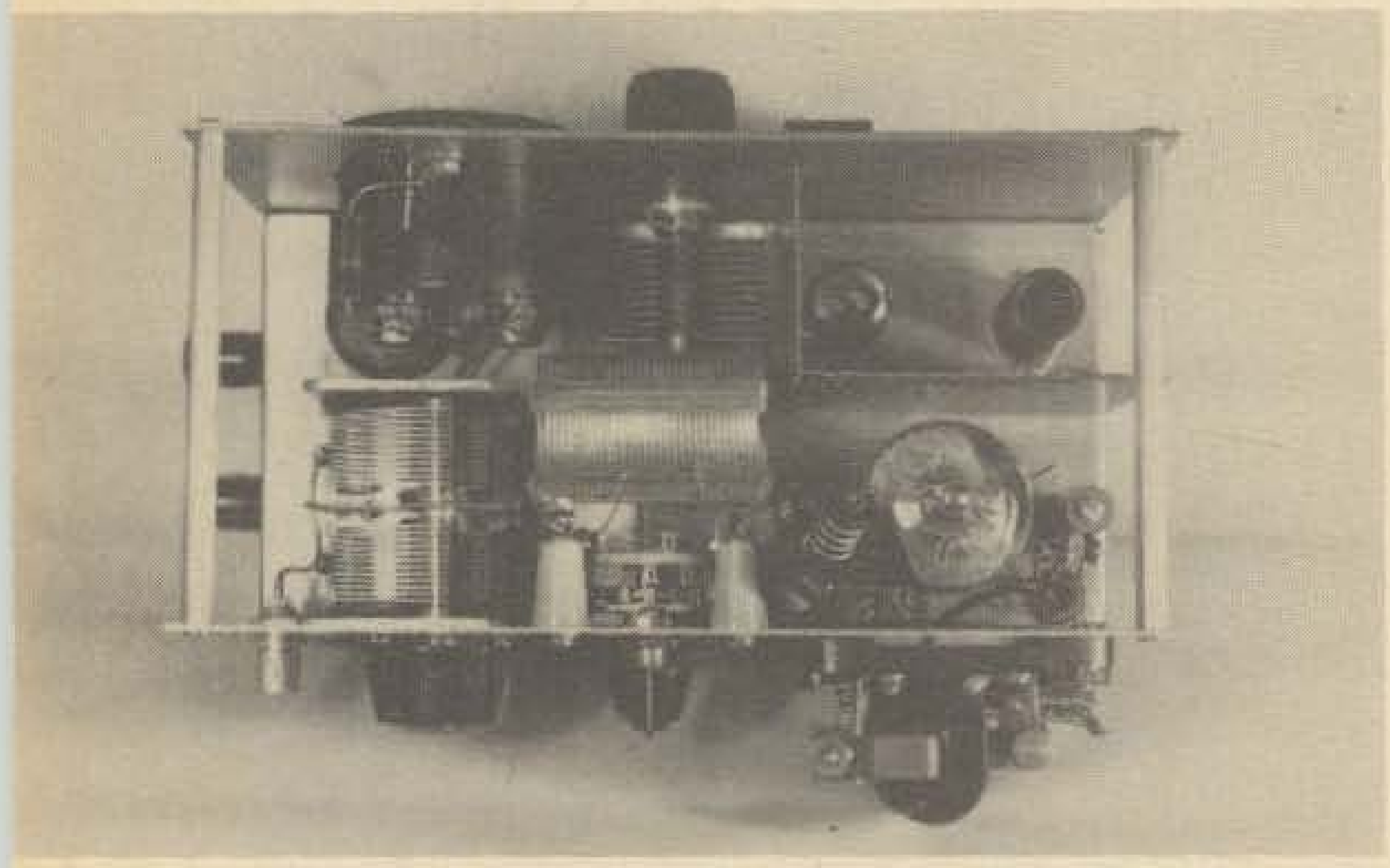


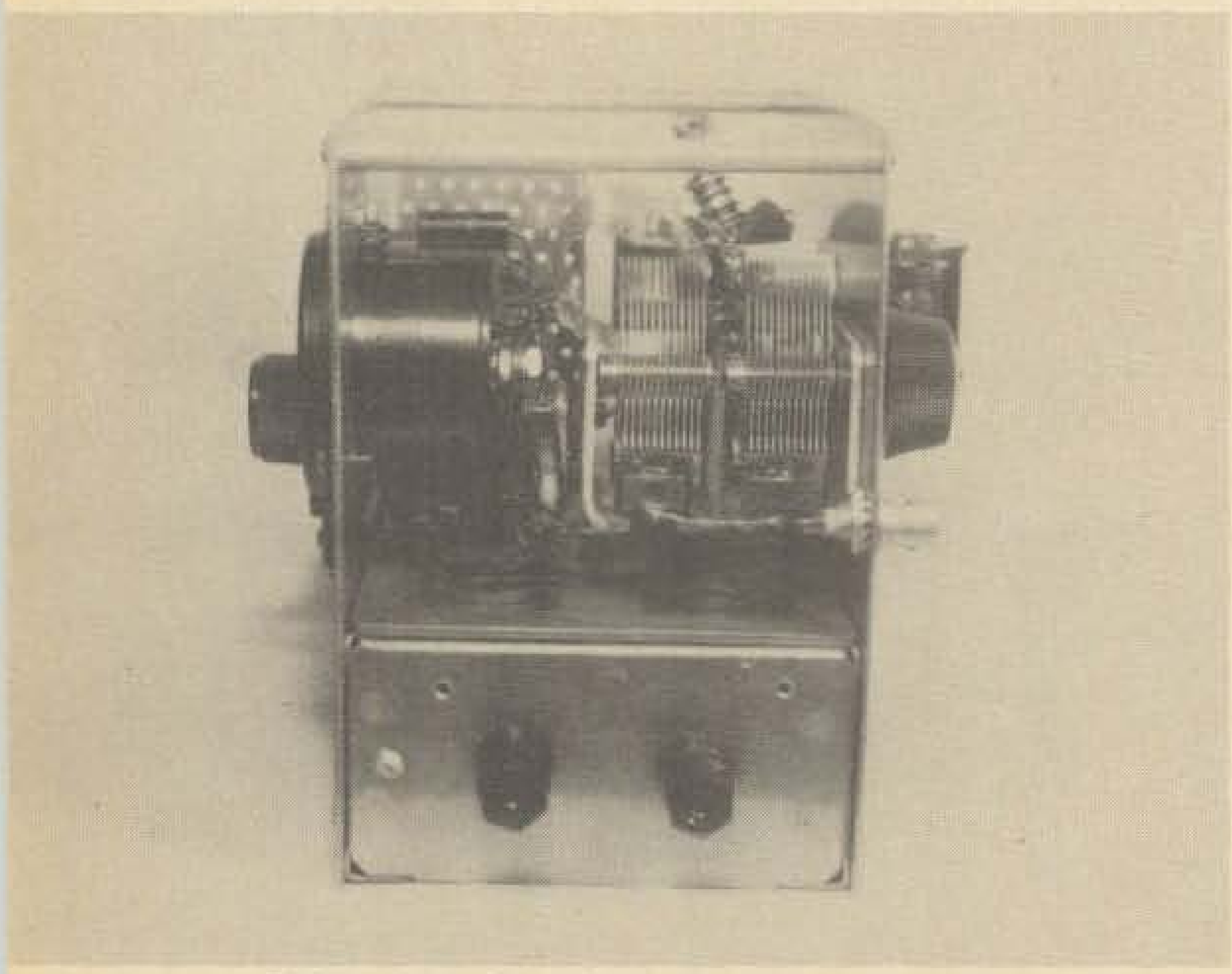
Fig. 3. Oscillator Modifications



Mobile rig installed in the back of the car and showing antenna coil mounting.



Top view showing the output coil and tuning capacitors.



Side view showing the power supply transistors and General Radio input terminals.

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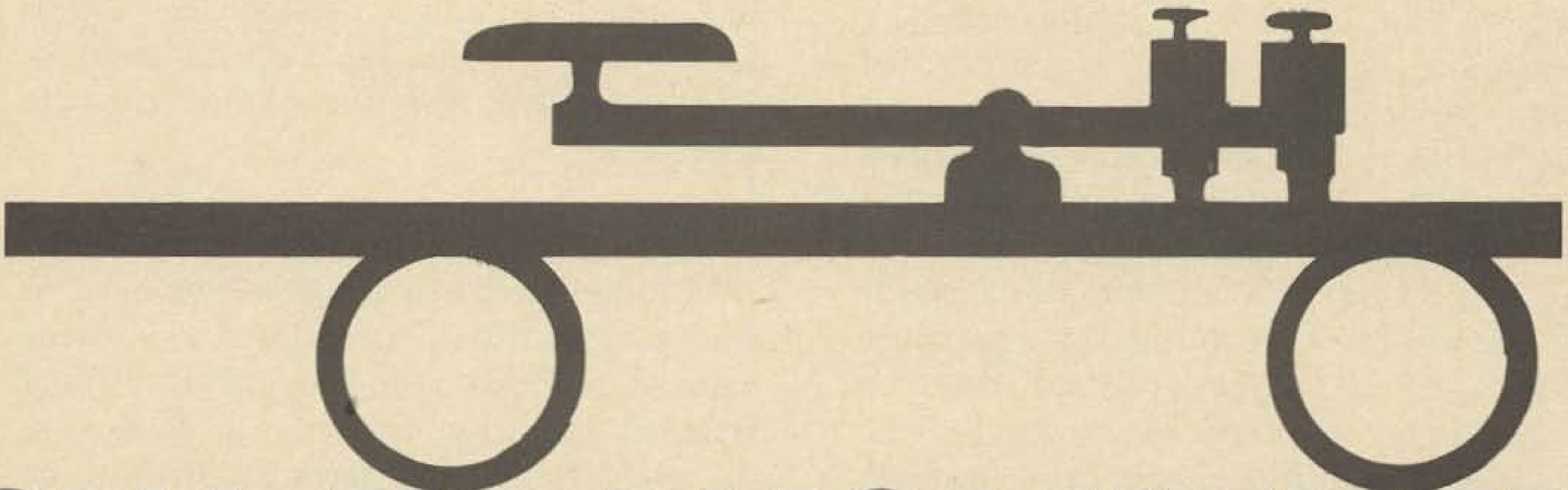
A MOBILE

This is a description of a 50W (output), self-contained, mobile CW transmitter, for the 80-40-20 meter amateur bands. The basic idea for a simple CW rig was to have it available, and installed in the trunk of the car out of the way.

The output power is sufficient to hold regular schedules back to home base, even on long trips when you can shift to the 14 MHz band. For simplicity, plug-in coils were used for the oscillator, and a shorted coil for the output. Changing bands is not as difficult as it may first seem once the rig has been tuned up previously on each band. The cover is slipped off, the switch turned, and the coil exchanged for the other band and the knobs reset to the marked bands. The transmitter power can be turned on from a heavy-duty switch or by using a 12V dc relay from the driver's seat. A key can be mounted in the driver's compartment or strapped to the steering wheel. If a 5–10 kΩ dc relay coil is used, a low voltage battery of 15-22V will actuate it with the key, or you can tie into the car battery.

Theory

The crystal-controlled oscillator is a 12BY7 tube, and the filament heats up in 11 seconds. The oscillator has plenty of output to drive a 12DQ6 on all bands. This tube also heats very rapidly and both are more available and cheaper than quick heater filament type tubes in the 12V variety. The cathodes of both tubes are



CW TRANSMITTER

opened for keying so that the rig could be turned on just before the contacting station signs his call; thus with the tube's cathode open the oscillator does not interfere. A 100Ω resistor and .01 capacitor across the key acts as a filter.

To operate the set on 20 meters, a 7 MHz crystal is inserted in the oscillator and the plate circuit tuned to 20m works as a doubler. Normal operation on 40m would be to use a 7 MHz crystal, or you could use a 3.5 MHz crystal with the plate tuned to 40m. Both work satisfactorily. If 80m operation is intended, a set of 80m crystals that will double into the 40m CW band will work out fine.

The power supply uses a Triad toroid oscillator transformer which operates in the audio range, making filters very easy; no heavy choke is required. The whole rig and the 400-250V power supply fits on the chassis without crowding.

Construction

The transmitter and power supply are built on a California Chassis A-147, 4 x 8 x 2 in. General Radio terminals are sanded down to make a tight fit on the end of the chassis to receive the 12V from the car battery. Once these terminals are in place, the power supply parts can be fitted under the chassis and wired before building the rest of the rig.

It is best to get the power supply working before proceeding with the rest of the wiring. All parts were mounted using lock washers and then dabbed with Glyptal varnish to keep the nuts and bolts from vibrating on bumpy roads. The rig was also mounted on load mounts to help absorb some of the shock since this rig was intended to stay mounted in the car.

The oscillator plug-in coil forms were snagged from a plastic sack hanging in the radio store listed as "Calectrocorp, low-loss plastic coil forms, Cat. 1-899P." The sack with a socket and coil form was listed as 1-898-A. It took 30 turns of 28 AWG enamel for the 80m coil, 19 turns for 40m and 9 turns for 20m. The coils are terrific, they plug in and out easily, and the base will unscrew to make wiring into the prongs easier. The pi-network coil was 16 turns per inch, 1¼ in. diameter No. 1416 Air-Dux bulk coil. If your local parts store doesn't have it, it can be obtained from Western Radio, India St., San Diego, California.

Tuning

In most instances, neutralizing was not found necessary with the 12DQ6 tube; however, the circuitry was included. A wire was soldered to the bottom of the oscillator coil and the junction of the 270 pF capacitor to a feedthrough insulator. On the top side, 4 in. of 18-gage wire was soldered vertically alongside the tube. To neutralize, turn on the oscillator and remove both the plate and screen voltage from the 12DQ6 by unsoldering the wires. Pick up the feedthrough voltage in the plate tank circuit with a grid-dipper in diode position. Now push the vertical neutralizing wire back or cut off in small nips until the feedthrough voltage reaches the minimum possible. The tank should be connected to a 50Ω noninductive resistor and peaked for 40m during this procedure by using the grid-dipper as an indicator.

Generally the best way to adjust the transmitter is to first feed it into a dummy load made up from noninductive resistors. Once tuned to this 50Ω output, the transmitter knobs are left almost untouched, and the output coax run to the coil. The braid is fastened to ground at the same place the coil is grounded and the tap moved back and forth, adjusting for maximum radiation. Closing the trunk door will have some effect on the antenna adjustment, and if possible tune with the door closed.

Battery Cable

A long length of 12-gage rubber-covered wire was used to go from the trunk to the battery. I drilled a hole in the trunk and fastened the wire with plastic clamps on the body frame to a terminal strip in the engine compartment. A 12V relay was used to operate from a toggle mounted on the dashboard for turning on the power; however, if you can run the wire inside the car, a good heavy duty 15A switch will suffice.

. . . W6BLZ ■

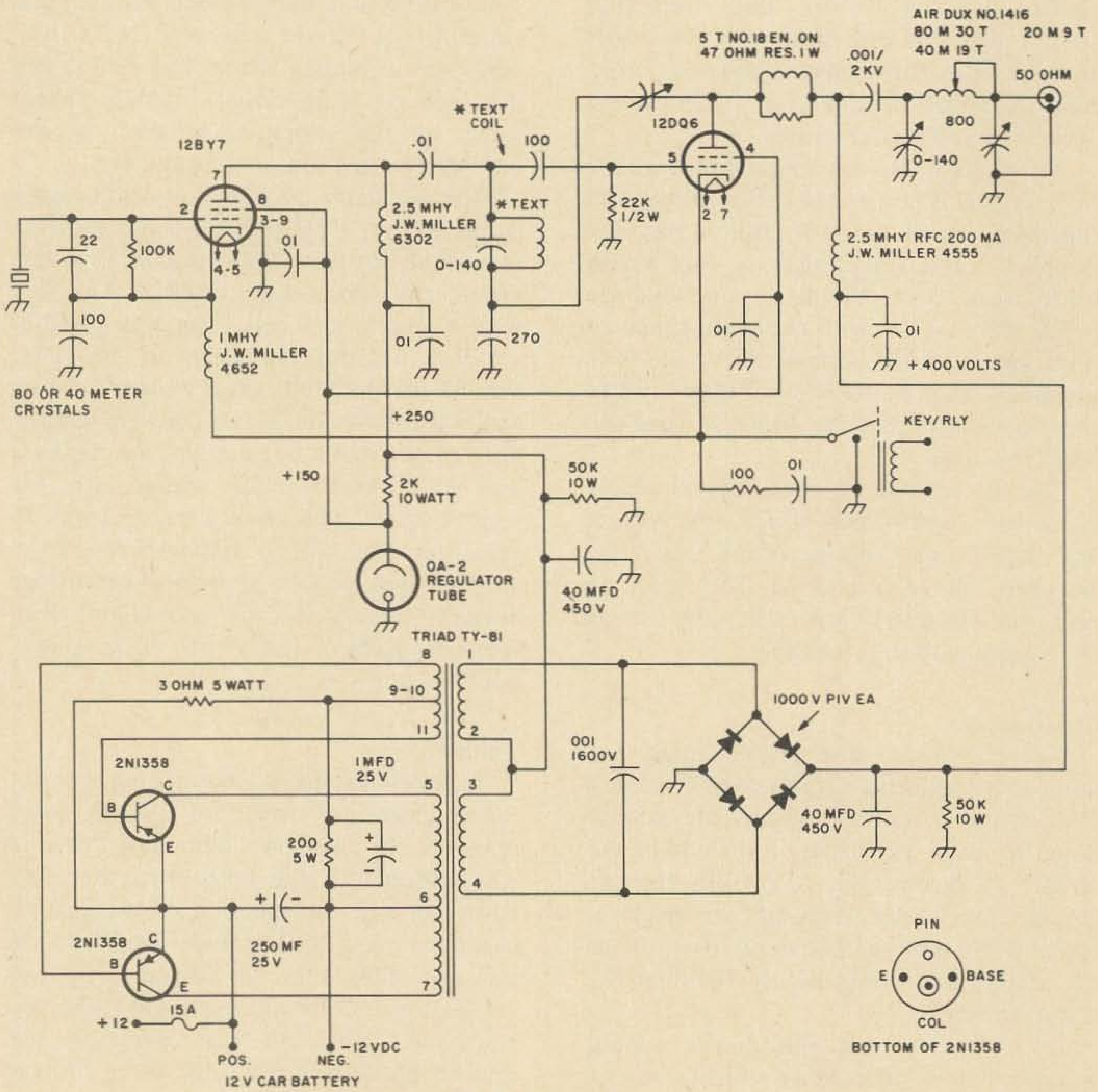


Fig. 1. Schematic.

(continued from page 13)

business mail like this. Little of this really has to be done on paper or to be physically sent in an envelope.

Picture a small typewriter with a built-in tape recorder. IBM has just such an item that we use for typesetting, so there is nothing basic left to be invented, just compromises to be made for mass production and cost-cutting. For not a lot more than the regular phone service a unit such as this could be rented and connected to the phone lines. All businesses have phones, and all but a few homes have them, so a service using this existing facility would get just about everywhere.

Your tape-typer would correct mistakes merely by back spacing and retyping over. Instead of paper it could print out on a small television screen. When the message is completed it could be addressed to a phone number and, with the push of a button, sent on its way. You want a copy? Another button would put it on a permanent tape for your file, coded for fast retrieval.

The phone would not be tied up with this system since it could operate while the phone is being used normally.

The phone lines are already all in, so all that would be needed for this system would be the tape-typers and the automatic routing equipment in the phone company exchanges.

The cost per message should be a fraction of the present cost of sending letters. And think of the saving in paper, stamps, typewriters, ribbons, and shoe leather for the postmen. Even at that, the mailmen won't be out of business by any means, for they will still have to struggle through the sleet and hail to bring you magazines and ads for Florida property.

Incoming messages would be taped and could be read at your leisure. Permanent copies can be made of important messages on tape cassettes.

If we can reduce the mail load by 80% perhaps they will be able to get the magazines through in better time? And wouldn't it be nice to be able to send letters again for 2¢ and have them delivered within seconds of being sent? That would be better than the old two deliveries a day we used to have a few years back.

73,
. . . W2NSD ■

"Not that kind, dummy!"

Pat Cabell WA7EMM
79 Newcomer Road
Richland WA 99352

A little FM unit that should be available in two surplus markets – commercial & military . . .

An FM "Best Buy"

Now that you have read all the fine articles in 73 Magazine about the fun of FM, let's talk a bit about the kind of mobile gear you are going to get. This surely deserves a lot of talk, for there are some surprises in store for the unwary.

You hear about a fine piece of gear made by Motorola or GE, and you take a look – and you generally see a monstrous contraption too big to get into the seat or the trunk of a small car – with enough tubes in it to stock an electronics distributor for life – and a circuit so complicated that some of us have been known to faint dead away at the idea of even taking off the cover! Maybe you like vast puzzles – but some of us don't.

So you try for a little one: a "handie talkie" sounds like a great idea – and in some ways it is. Take one of the older low-priced models: Has just a little power – has a headset like a telephone that gets very tiring to hang on to – has a small number of tubes, but they are in some cases so old and rare that you will have better luck searching for spares in the Egyptian pyramids than in your electronics catalog. And if you want to go ac powered you have some rare and refreshing problems in rigging up a power supply to handle your antique curiosity.

There are some modern, compact FM transceivers, and I won't knock them at all – they do a real great job – particularly when you realize that with a repeater you only need about one watt output to have a tremendous signal on the band.

But if you are like me and don't have a lot of spare cash lying around, then you will want to look at something a little lower priced. So, how would you like to get a small, compact transceiver – with power up to 50W out; that is neat, dependable, reliable – that's proved itself throughout the world for maybe 25 years, that's used in all types of state and federal aircraft and at airports, that is a proved performer in Coast Guard service, that did a bang-up job at the South Pole in Operation Deepfreeze, and that in rugged service in Alaska stood up better than far more complex and sophisticated units? How would you like a transceiver that is old and moderately priced, but with tubes that you can still find in the 1970 Allied catalog? And how about a unit with absolutely no trick circuits, with plain, conservative, simple design and layout for easy maintenance, a unit so simple in fact that this old horseracing writer can, with his feeble knowledge of electronics, partially understand the thing in at least a dim and groping way?

We are talking about the equipment made by Combo, in Coral Gables, Florida. And we are talking about their old tube-type equipment. (They, of course, now put out a modern line of solid state gear at the usual industrial price levels, but we are not talking about that!) My own set is an old Model 275, which was made some time before 1950. I paid the huge sum of $10 for it. It still puts out a tremendous signal – 10W out (in commercial practice they use watts *out* to measure power – 10W out is equal to maybe 20W *input*).

No, I don't own any stock in Comco. Nor do I have any of their gear to sell. (Fact is, my only contact was when I wrote for information on the Model 275 – I got a prompt answer, but no information!)

We will talk mostly about the Model 582. This is a good rig, and represents the kind of equipment they made in the past. There are lots and lots of other units they make that are suitable for amateur service – I have listed them in B, Table I. There is my Model 275, with a single channel, a 6V mobile unit. It's a handy 2 meter rig. Model 580 is good for the 6 meter band – it can have all kinds of power supplies and may have one or two channels, and an output of 25–50W. Model 680 is for the 6 meter band, and can run 1 to 4 channels with up to 100W out. A lot of power there. Model 906 is a somewhat advanced piece of gear that would also be very fine on the 6 meter band.

For the 2 meter band, we have Model 582, which gives you one to two channels, and 18–25W out. Model 682, another fine 2 meter rig, will get you up to four channels and 75W out. Model 800 is a sophisticated hand-held transceiver of the modern generation, and Model 900 is a modern transistorized portable rig – both are great on 2 meters. Also for 2 meters there is quite a range of military equipment (Table II). These have a bewildering variety of power supplies to meet military needs! The AN/FRC-70 and 70A run 50W on 2 meters, the AN/VRC Models 42, 51, 51X, and 52 run 25W on 2 meters. These are dandy rigs, and require no appreciable retuning for use at 144–148 MHz. The AN/VRC-58 is another excellent 2 meter rig.

Some of the military rigs will hit 10 meters with little trouble. The AN/FRC Models 52, 52A, and 52B will give 50-60W out. The AN/VRC 33 and 33A are single-channel mobile units (at 35W out) and won fame in Project Deepfreeze. And, for 10 meters, the AN/VRC-60 works great with a 12V power supply and gives out a good 25W.

Or maybe you would like to try the popular amateur UHF region (called 450 by FM'ers). Try Model 684 shown in Table I; you get 10 to 25W out in the 450 MHz range with no tuning problems.

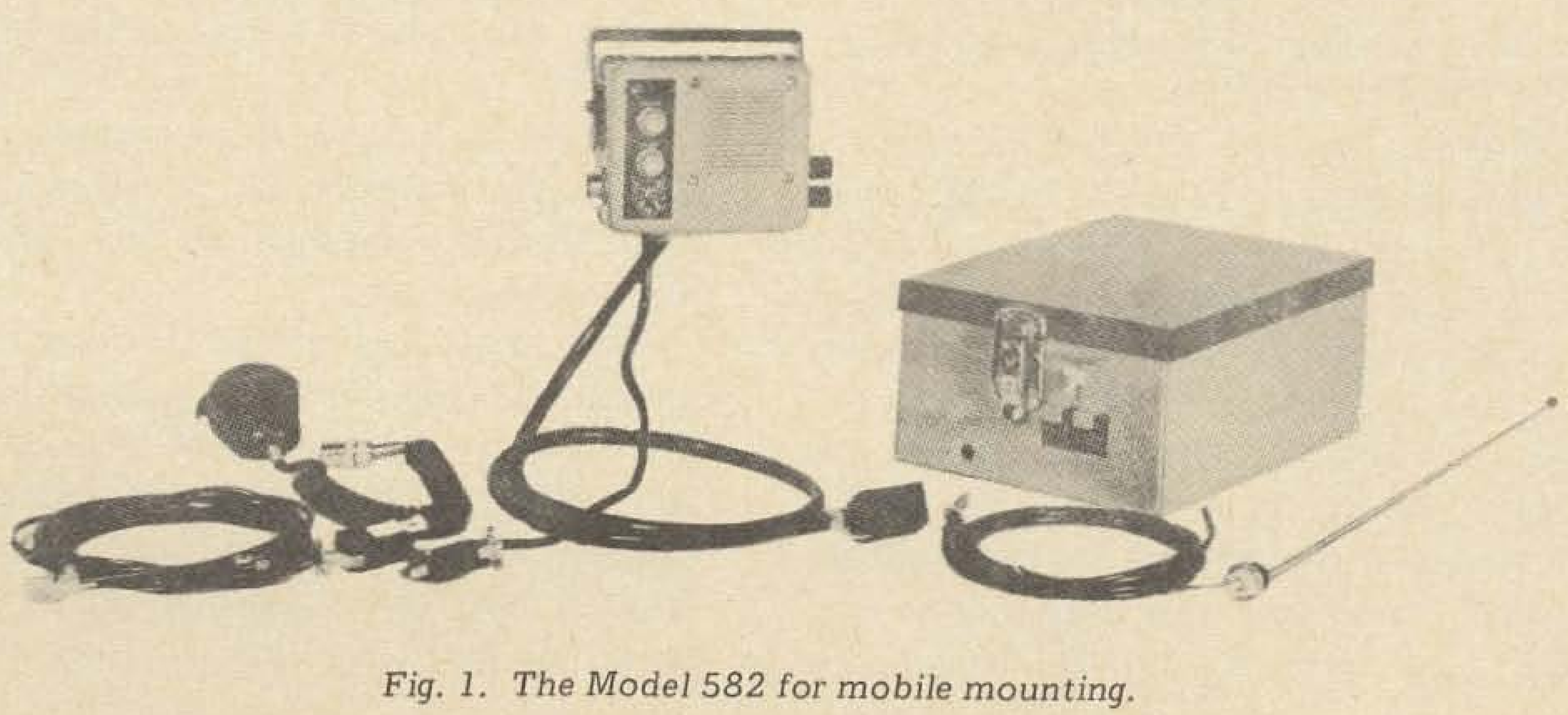
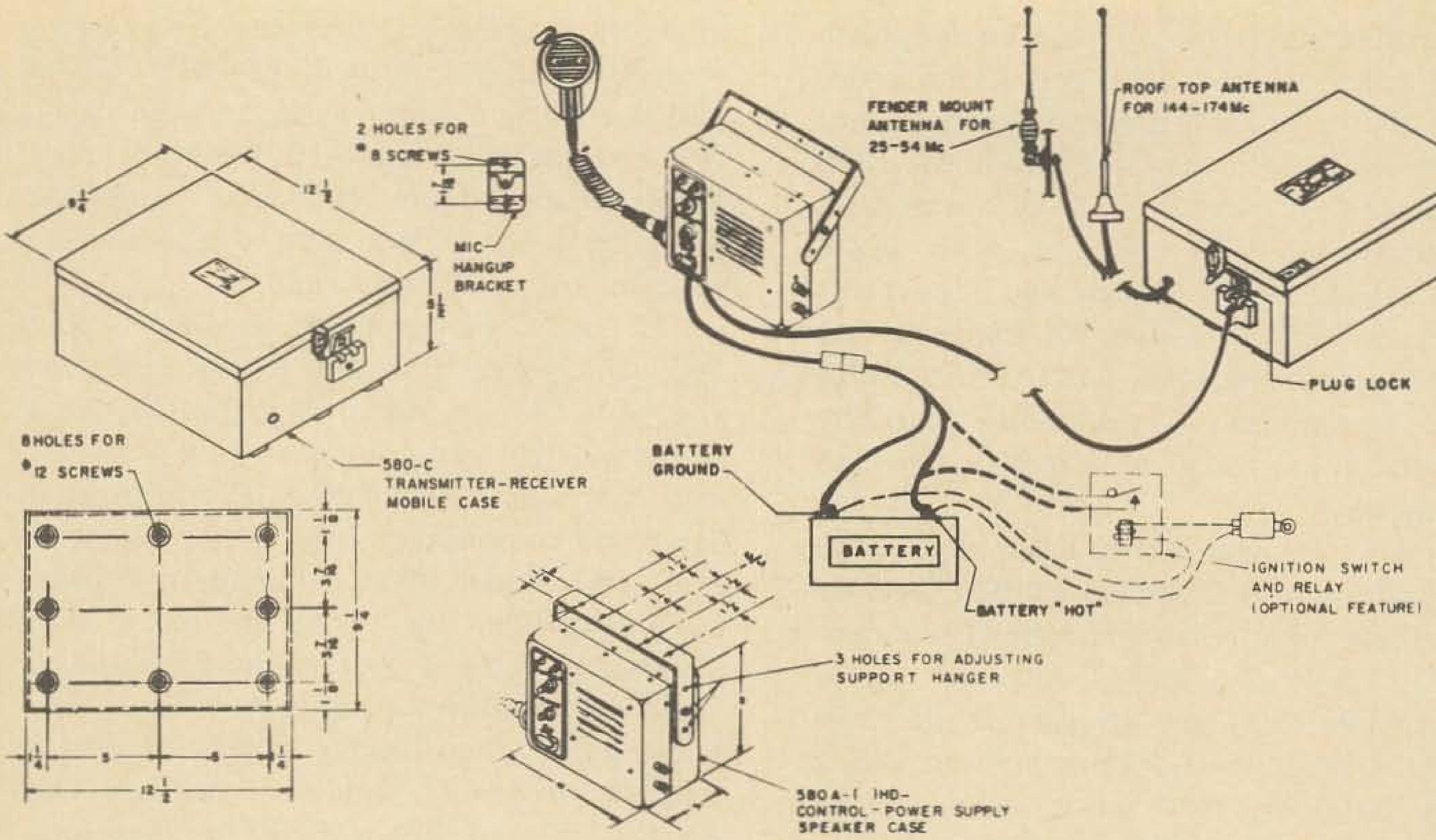


Fig. 1. The Model 582 for mobile mounting.



• Fig. 2. Mobile hookup for the Model 582.

Let's look at some pictures. Figure 1 shows the 582 set up for mobile mounting. The little case, about the size of three reams of typewriter paper, will fit anyplace. The control head, speaker, and mike go under the dash. Figure 2 shows the mobile setup. upstairs. Or, with some of the beatup, cobweb-covered battle-scarred veterans of other wars you find in surplus stores, it is best to dig a hole and give the whole thing a burial rather than to clutter up the living room or study with it.

Fig. 3. Model 580/582 hand-held portable rig with an output up to 50W.

Fig. 4. The Model 582 makes an elegant base station.

Figure 3 shows the 582 made up in a battery powered hand-held rig. This is no toy transceiver – it's got a good speaker and good mike – and a solid 50W output! It has an ac/dc power supply, is just about the handiest rig you could get hold of.

Now let's talk about the base setups. On some of those big, black rigs we mentioned earlier, you will use up half a room to store it and get some unhappy looks from the XYL if you even think of bringing it

But we don't have these troubles with the 582. Figure 4 shows how it makes an elegant base station, suitable for just about any room in the house.

Now, let's sort of flit through the block diagram in Fig. 5. The transmitter section multiplies 16 times for 144 MHz output and will take crystals in the 9 MHz range. Starting at the front, we have the oscillator feeding into the "phase modulator" tube. Don't let that term "phase modulator" scare

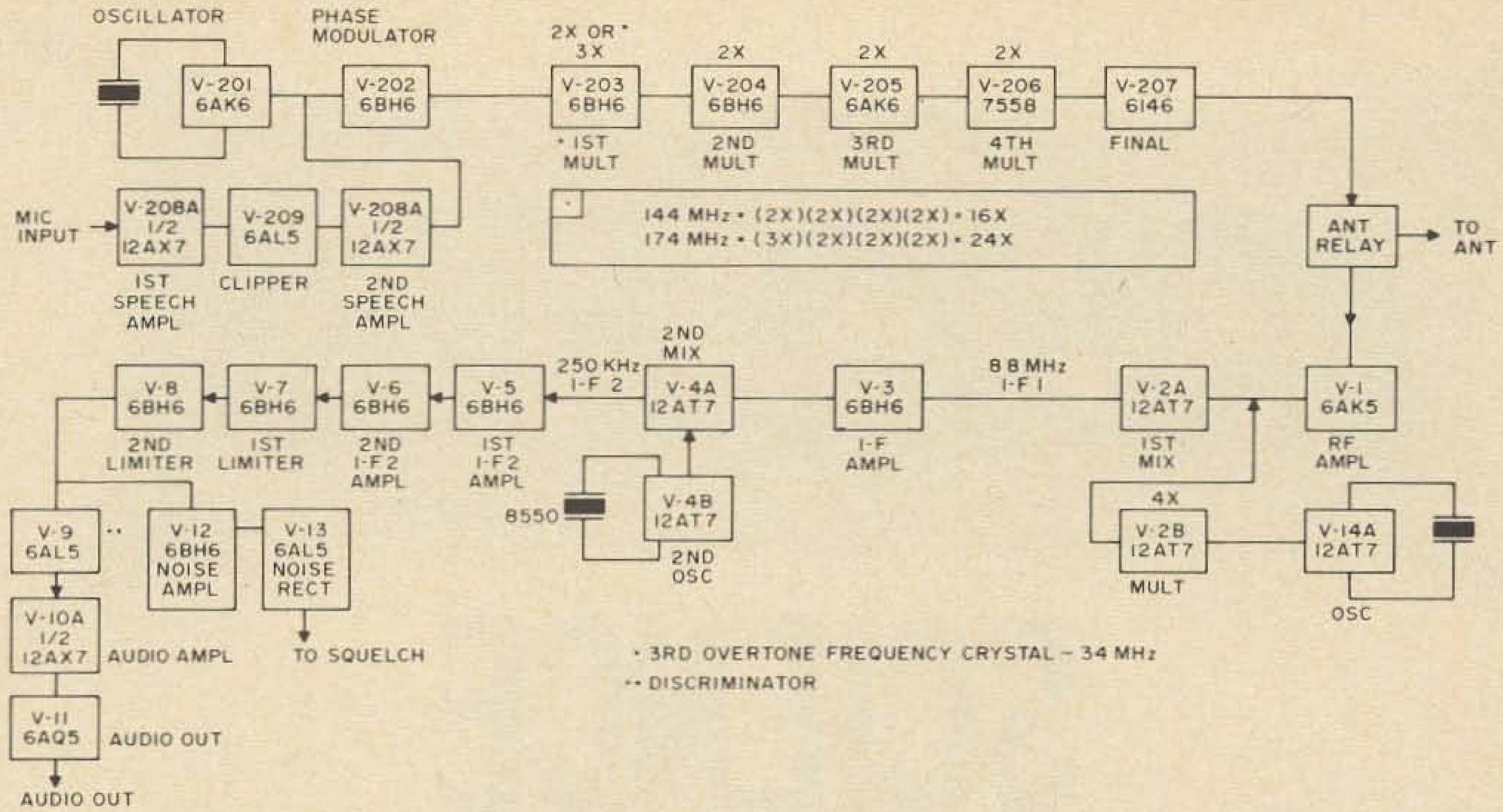


Fig. 5. Block diagram, typical 144–174 mc transmitter-receiver, 582 type.

you. All it means is that we are modulating *after* the oscillator, instead of at the oscillator. This allows a wider flexibility in control of "deviation" (Modulation) and is otherwise undetectable from frequency modulation per se.

How the thing works is not important – and I don't believe half the stuff I read about how the electrons gallop around anyhow – but it *is* important to know that any variation on the plate voltage of the modulator tube will modulate the signal, whether you want it modulated or not! So keep a sharp lookout for loose connections, intermittent shorts in capacitors, and the like.

From then on you multiply out all the way. One big advantage of FM (we call it that, anyway) is that any of the signals getting out–such as the lower harmonics–will be less likely to tear up your neighbor's TV reception. I have a friend who had nothing but neighbor trouble with a flea-power AM outfit, then he switched to a 30W FM outfit and there has been nothing but joy in the neighborhood since. By the way, he has demonstrated that he can take his 2 meter FM gear and trip our local AM repeater, and I can hear him great on my AM "Twoer"–guys with sets not a megahertz wide in front can copy him easily, too.

Now let's see what we can do with the receiver. The stuff comes in at, say, 144 MHz, and there is a stage of rf amplification. Then you have to convert it to the first i-f of 8.8 MHz. That works out to about 34 MHz in the oscillator, multiplies four times to about 136, and there we are. Only there ain't no crystal which we can afford at 34 MHz, so we buy a third overtone crystal and we're in business.

Then we have an 8.8 MHz i-f amplifier and another mixer. We feed the mixer with an 8.550 MHz signal from our crystal oscillator, and here we are at the second i-f of 250 kHz. That makes for nice selectivity. We run that through two amplification stages.

Now we hit two "limiter" stages. The idea here is to remove any AM components (such as noise) from the FM signal. The limiter chops off any high peaks and the whole thing comes out at a constant level.

Now the discriminator looms up before us. This is simply the same kind of a function as the "detector" gives us in an AM set. Next comes an amplifier and squelch circuit, designed to make life easier for the listener.

That's about all there is to it. And it's why I say that the best buy in mobile FM gear is surely the Comco Model 582 or one of its brothers. Many, many thousands of such FM models have been made – you should be able to locate one without too much trouble. Good luck!

. . . WA7EMM ■

SCIENCE FAIRS

SCIENCE EDUCATION?

by Fred Mocking
Science Editor
Radio Today

Every year, many of our grammar schools and high schools participate in "science fair" programs. The purpose of these fairs is to stimulate interest in science and to provide experience in working on science projects. Students who enter the fair do indeed gain worthwhile experience and knowledge. Many of them are fortunate in having guidance and help from parents with technical skills, or help from parents or other adults with access to unusual technical facilities. Although science fair regulations attempt to rule out this type of help, the students do, nevertheless, benefit from it. Indeed, if they were to depend solely on their own resources, many students would be unable to enter projects at all.

In spite of the positive values present in science fair activities, many thoughtful observers have questioned the basic premise that science fairs stimulate interest in science. This may astound those who have visited these fairs and who have seen the truly outstanding accomplishments of our youngsters. Yet the skeptics state that the students who receive the maximum encouragement and assistance are those who have the greatest interest and ability in science and thus who are least in need of help. Without doubt, science fairs help *them*, but what about the rest of the students? Are they better off, worse off, or unaffected by the fair?

Another question that has been raised, and moreover that has been raised by student entrants and by student winners is the fact that the "spectacular, flashy" exhibit wins. Many students believe that this is so and thus deliberately choose a project, not on the basis of their own interest or the intrinsic value of the project, but on its potential ability to impress the judges. As a consequence, we have students who will enter a laser or a Tesla coil exhibit while at the same time having no conception at all of the more elementary principles involved in electrical circuits. Thus, superficiality is encouraged at the expense of a firm understanding of basic principles. Is it not surprising that activities sponsored by educational institutions should drift so far from sound educational principles?

A closer look at the science fair itself will provide some insight into this state of affairs. The primary objective of most students who enter is to win! Those who progress through the local, district, and state fairs may win one of the valuable scholarships offered and, after graduation from college, many are offered jobs by leading technical companies. In other words, the science fair program provides a simple, straightforward technique for "skimming the cream" of the scientifically able students and steering them into the technical fields that are vital to our national progress.

Now, I have no quarrel whatever with people who "skim off the cream" but I cannot accept this as a process that results in "enriching the milk." Our nation has a vital need for people in many fields who have sound backgrounds in science and we cannot afford the luxury of haphazard dependence on the relatively small group whose interests *happen* to lie in the science area.

A number of educators have become dissatisfied with science fairs for this and other reasons and have discontinued science fair activities in their schools. Other educators simply have a vague feeling that something is wrong without being able to identify it more specifically.

If we are to improve this situation, let us accept as a basic premise that *some* of the science fair activities should result in some positive return to the schools involved, that is, some benefit for all the students, and perhaps even for the teachers, who put forth so much effort towards making these fairs successful. This could lead to the following guides for new categories of science fair activities:

1. Science fair activities should, in part, result in equipment that may be used in the schools, and be relevant to the existing science curriculum. (Few teachers would complain that they already have *too much* equipment.)
2. Reduce the emphasis on *original* research by providing for projects based on hardware that simply and effectively demonstrates *known* principles incorporating student "feedback." This area has hardly been touched and in itself offers many opportunities for creative work.
3. Encourage projects that lead to simple experimental equipment that can be duplicated in classroom quantities in the school shops. Thus school laboratories can acquire equipment for each child rather than a single demonstration apparatus for the entire classroom.
4. Eliminate the need for concealing or apologizing for parental aid. If the student can bring to bear unusual resources in technical aid and equipment for the benefit of the school, why rule it out?

Other rules may be suggested, but the four items above are sufficient to show what the potentialities of science fair activities may be, once we choose our objectives properly.

Schools have been criticized for a lack of contact with important new concepts in technology and science. This problem is not the fault of educators, it is the result of a total lack of two-way communication between educators and the scientists and engineers who are familiar with current technology. Item 4, listed above, can be used to provide one framework for such communication by means of projects based on the very technology and devices that the schools would otherwise be unable to obtain. Anyone familiar with modern industry realizes that creation of a sound design takes considerable time and effort, but once such a design is created, it can be readily duplicated and made available for many users. Why should such a basic economic fact of life be excluded from our educational institutions?

Science has given us techniques to achieve almost any technological goal we may care to establish. It is time that we rethink our objectives in science education and write rules that will get us to our goals. To do any less is, to say the least, unscientific. ■

The Wichita Autopatch

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Tied in with the local repeater, this phone patch received approval from Ma Bell . . .

The purpose of this article is to give a description of the automatic telephone patch system developed for the two Wichita 2 meter repeaters. The features include mobile dial control, giving the mobile radio amateur access to the landline telephone system, as well as making other functions available to him. Many methods of remote control have been developed; most use one or more tones transmitted simultaneously or sequentially, but the method used at Wichita is a modified "Secode" type, or interrupted "single tone."

Secode systems transmit a tone of fixed frequency, interrupting the tone with no-tone pulses, created by the contacts of a standard rotary telephone dial. The decoding units sense the presence of tone and count number of "holes." When the proper sequence of pulses (holes) are received, the decoder unit will make a set of contacts for a short period (momentary "make"). A single decoder unit can be set to select from one to five functions at the remote location. We use separate functions to turn the telephone patch on and off.

The Encoder

The diagrams shown in Figs. 1 and 2 are almost self-explanatory. The output link is wound on the 88 mH toroid, using as many turns as needed. (See Fig. 3.) For high-impedance microphone circuits, 10–15 will be required; for low-impedance microphone circuits, 30 turns should be about right. The dial can be almost any type, but must have a set of open contacts that "make" when the dial is rotated "off-normal." I personally prefer the Stromberg-Carlson dial, which has extra contacts and is indicated in the drawings. To use the more conventional Western Electric or Kellogg dials, the two diodes make a simple

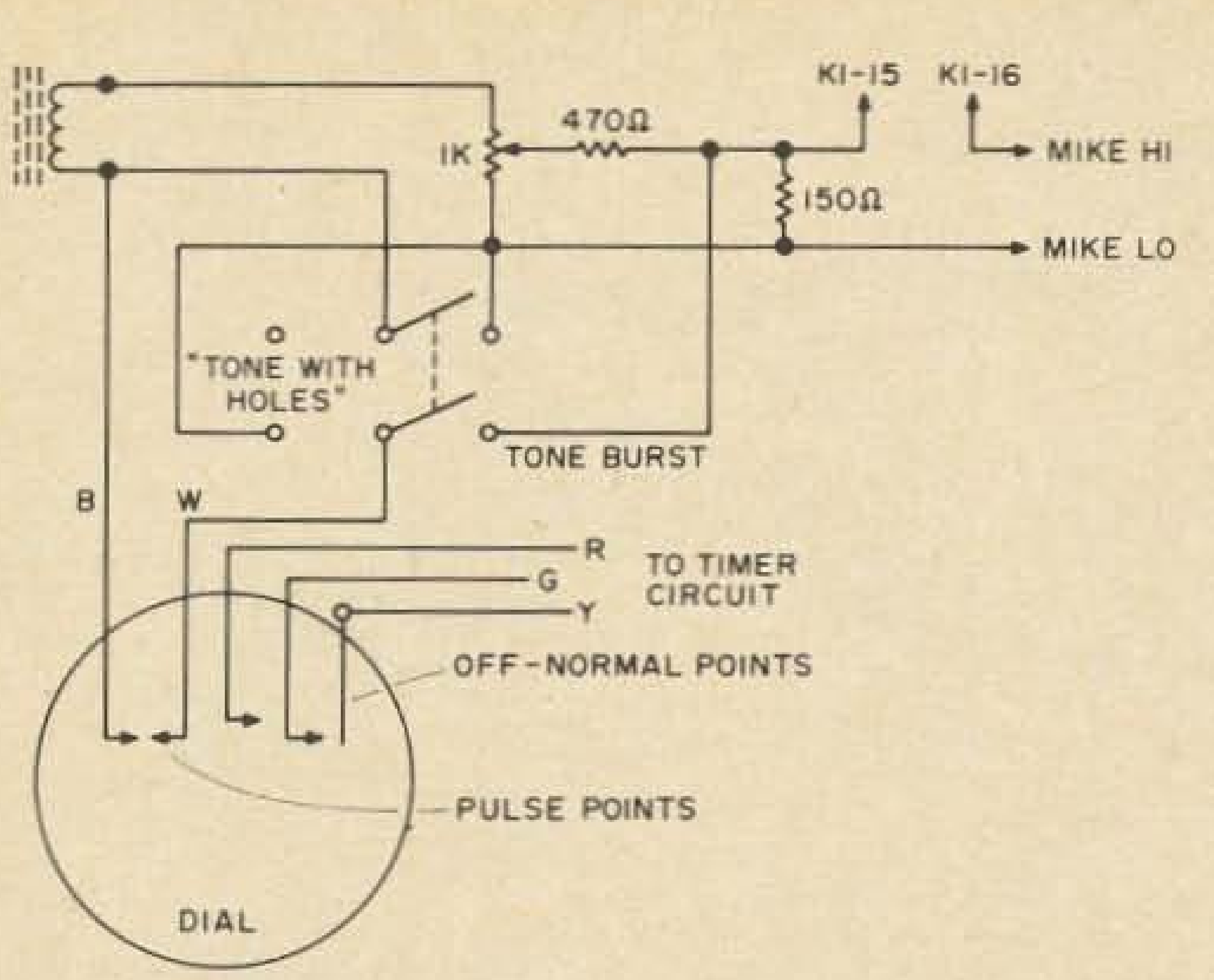


Fig. 1. Schematic showing output portion of dial encoder.

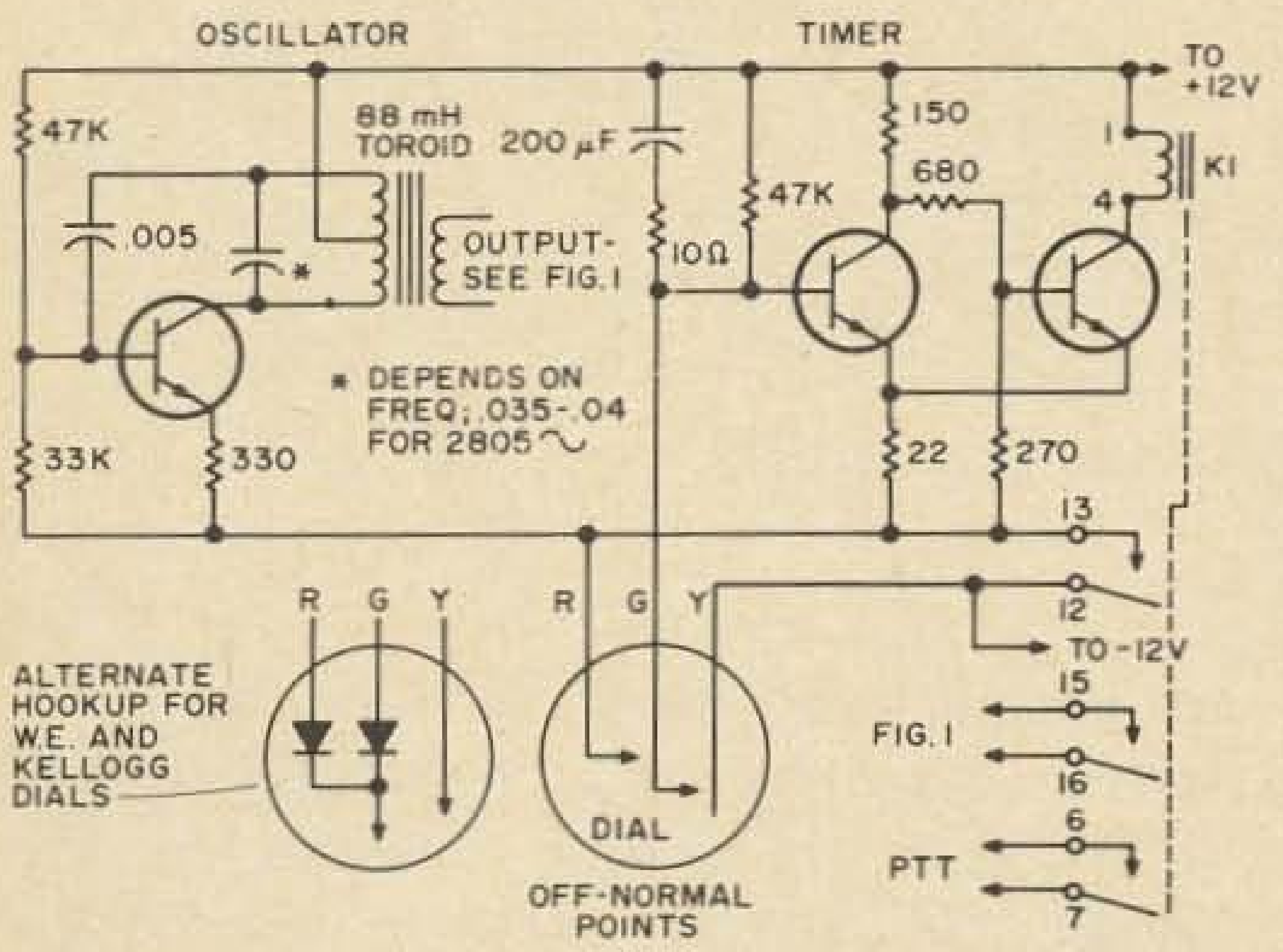


Fig. 2. Schematic showing oscillator and timer portions of tone encoder.

"and" circuit. Note: the dials from "Trimline" telephones are small and pretty, but they do not have the "off-normal" points and cannot be used. The dial pulses *must* have the correct speed and make–break ratio. Checking dial speed and make–break ratio is not difficult; one of the easiest ways is a 15 ips tape recorder with editing facilities. First, make a recording of WWV and the time ticks. At 15 ips the time ticks should be spaced 15 in. apart. This verifies your tape speed. Next, record the output of your tone encoder transmitting the digit "zero." Careful use of a grease pencil or nylon point pen to mark the on and off spaces will show you the speed of the dial and the make–break ratio. In our area, we require 10 pulses per second, and the open or "break" time should be 60%. In other words, ten pulses should take 15 in. and of the 1½ in., the pulse points on the dial should be open about 9/10 in.

Once you have one or more encoders checked out, transmit the tone through the decoder to test the pulsing relay. Adjust spring tensions, air gaps, and residual screws as necessary to obtain the same make–break ratio as transmitted by the encoder. The timer circuit holds the transmitter energized during the "interdigit" time. The 200 μF value is nominal, and can be varied. The relay shown in the diagram is a common item, but not critical. To hold the tone frequency to ±5 Hz, use of Mylar capacitors is recommended.

The Decoder

The equipment used in the channel A repeater (146.34 to 146.94 MHz, WØDKU) is a modified Secode RPD-612 with ac power supply (Fig. 4). At first, we used a single five-function selector, model 49HS-5. We later added a model 70 selector with a five-function kit added. We now have ten functions we can select and know of no reason why more selectors could not be added. An additional stage (Fig. 5) is "tapped in" at the transformer lead feeding the neon bulb. This additional stage consists of one NE-48 lamp, a pair of diodes, capacitors, resistors, a tube, and a relay with a set of normally closed contacts. This set of contacts is used to pulse the telephone network and should be tested and adjusted to give the 60% break when used with the encoder in the "tone burst" mode. The relay we used was salvaged from junk telephone relays at the local surplus emporium. Note that this relay operates

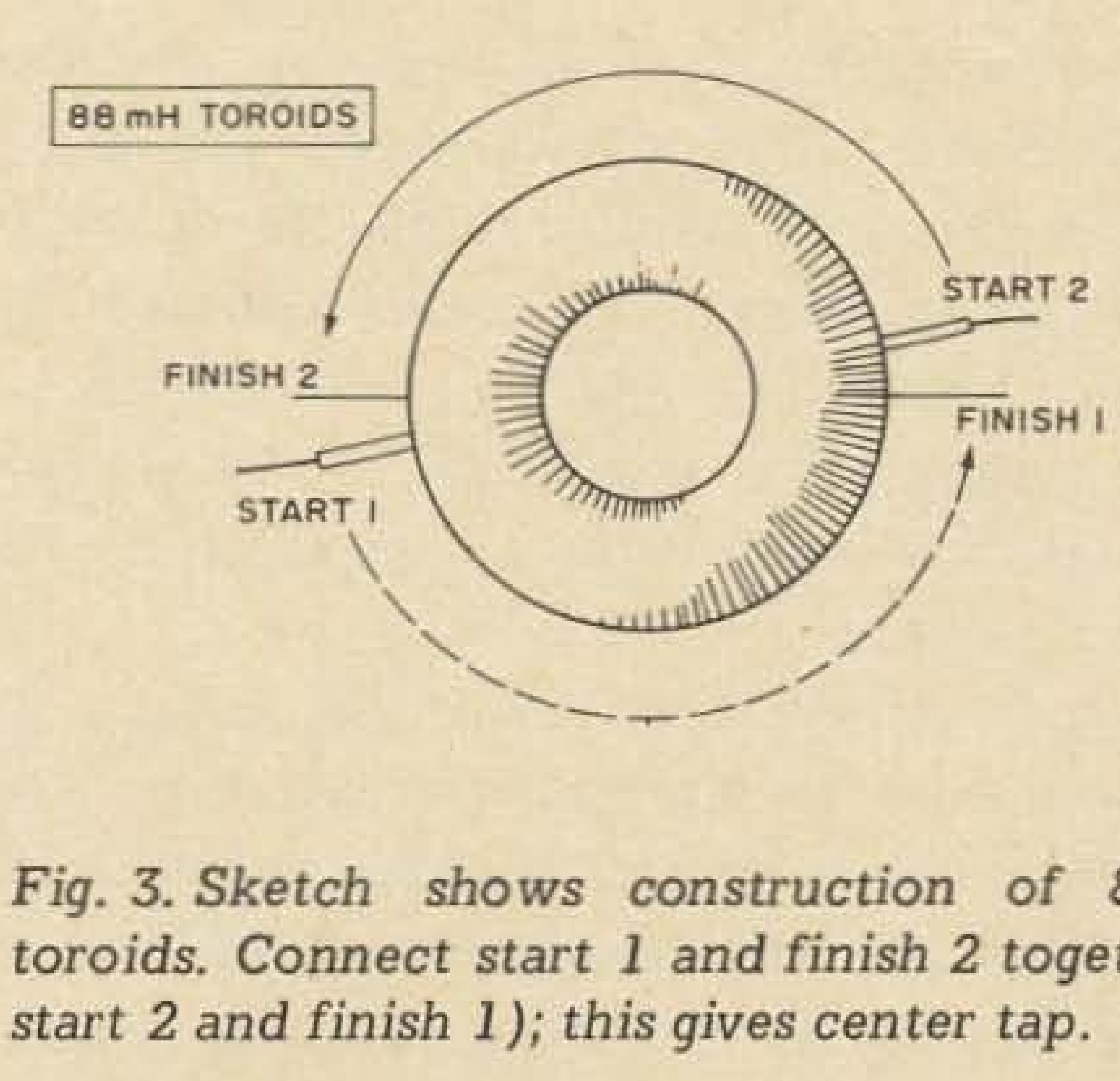


Fig. 3. Sketch shows construction of 88 mH toroids. Connect start 1 and finish 2 together (or start 2 and finish 1); this gives center tap.

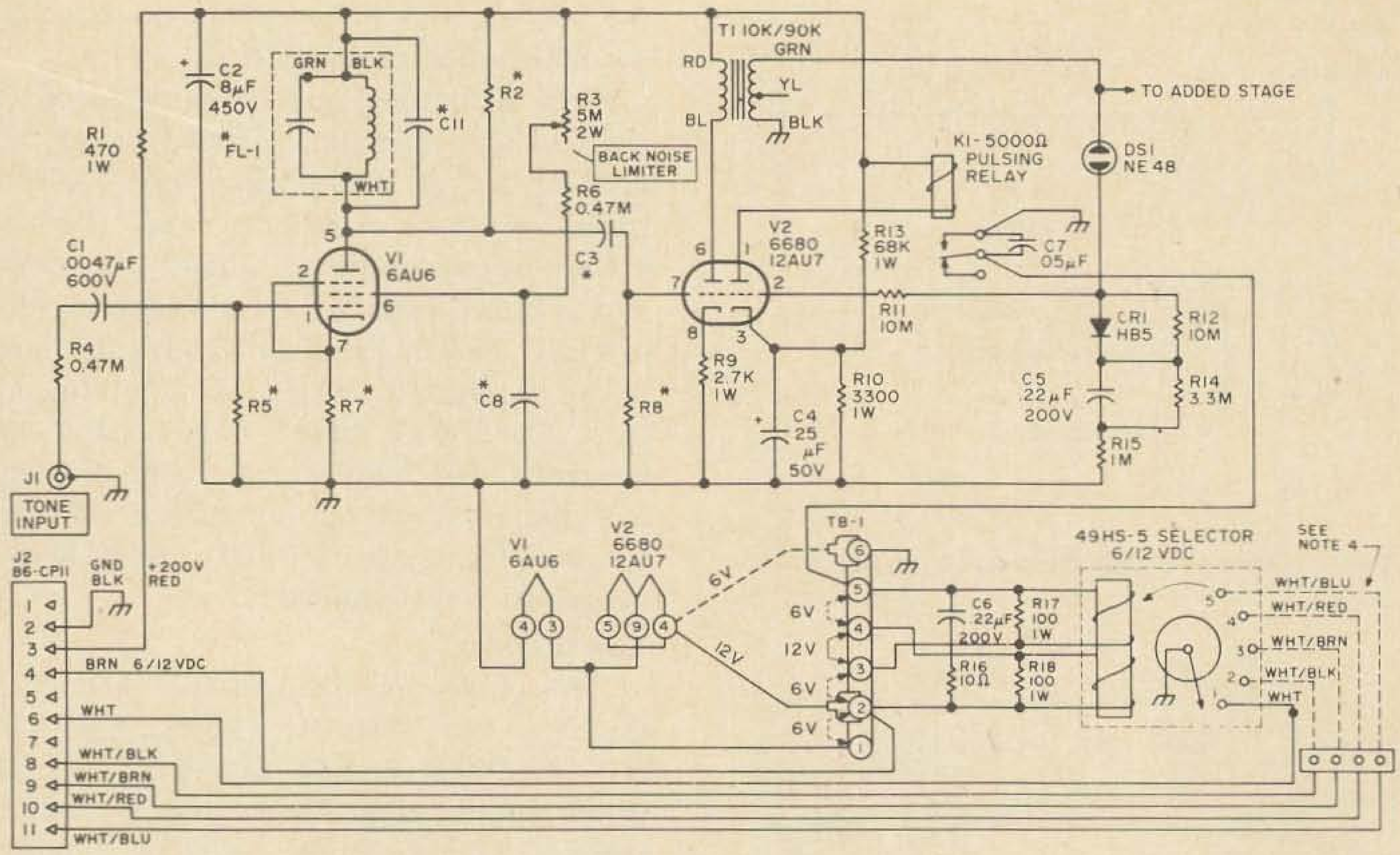


Fig. 4. RPD-612 schematic, digital decoder type 1859.

(the contacts open) any and every time that tone is transmitted to the decoder. Also note that due to the difference of tone on and tone off times in the two modes of encoder operation, the stepper unit in the selector will not operate when "tone burst" is being used.

The equipment used in the channel B repeater (146.22 to 146.82 MHz, operated by Don Pryor, WØIPB) uses the same principles but consists of a modified RPD-650 Secode decoder (transistors and mechanical selector). The Schmitt trigger stage collector load resistor (R22), 4.7K, was replaced by a relay, and the emitter resistor was reduced in value from 180Ω to 100Ω. Since the Schmitt trigger transistor (Q5) is normally conducting with no input signal, we used normally open contacts for our pulsing relay. The model 70 selector was modified by adding the five-function kit and the operation is the same as the other repeater.

Some "tinkering" was necessary to adjust spring tensions in the selector. This tightened the tolerance on the make–break ratio to prevent stepper action during "tone burst." In the RPD-612, the sensing of the make–break ratio is in the electronic circuitry. In the RPD-650 and RPD-650A, the spring tensions of the model 70 selector must be altered to obtain this effect. (The RPD-650 and RPD-650A are made to operate with 75–25 or 25–75 make–break ratio and all variations in between.)

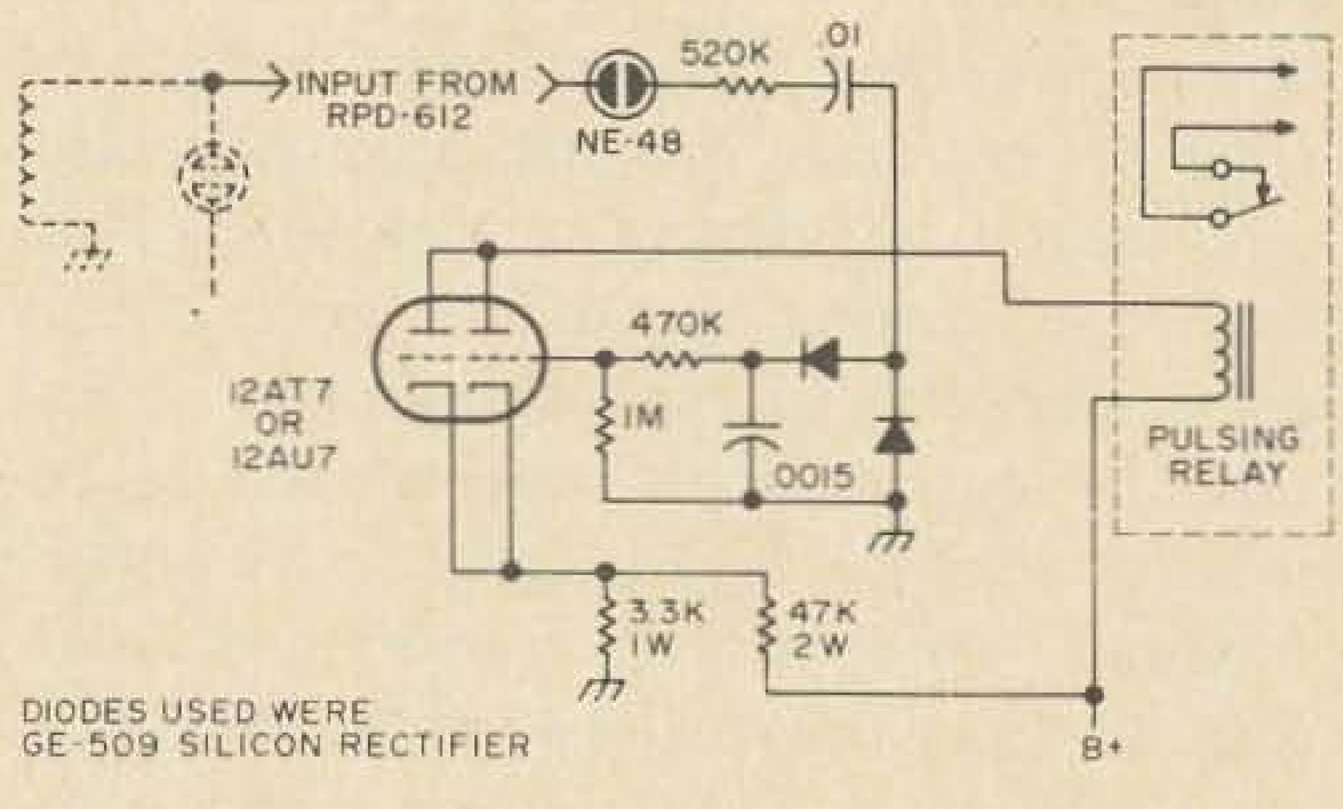


Fig. 5. Secode unit is "customized" for the Wichita repeaters by adding a separate stage for dial pulsing of the phone line.

The Telephone Patch

The first reaction of radio amateurs when they see the circuit diagram (Fig. 6) is usually "where is your hybrid balance adjustment?" Quite simple, since the patch doesn't use hybrid circuitry and is not intended for simultaneous duplex operation. Since any repeater must have some type of carrier-operated switch, we use the carrier switch to change from transmit to receive. This has a "bonus" – if the radio amateur wishes to interrupt the person on the landline, he simply pushes his microphone button and the landline is no longer transmitting. Very useful to prevent outbursts of unbecoming language from being transmitted. After all, how many two-meter mobiles are equipped for simultaneous duplex operation?

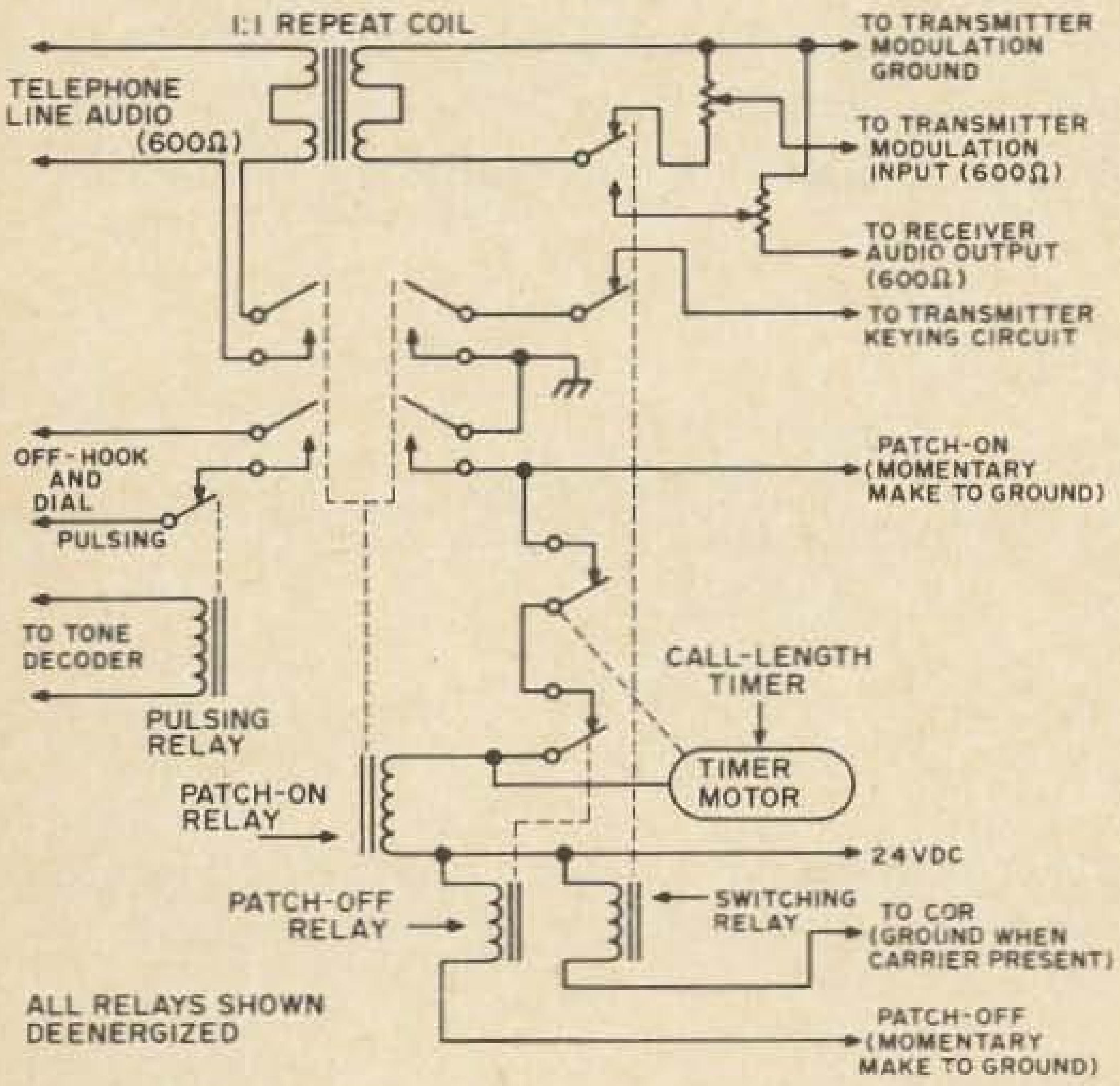


Fig. 6. Schematic diagram of Wichita autopatch radio/telephone interface.

An examination of the schematic diagram shows a pulsing relay, a switching relay, the patch-on relay and the patch-off relay, plus the call-length timer. The pulsing relay is controlled by the presence or absence of tone. The points are closed unless tone is received by the decoder. The call-length timer, a motor-driven unit, opens a set of normally closed points after a preset time interval. The timer begins operation when the patch-on relay is operated; it is returned to zero when the patch-on relay is deenergized. The patch-on relay is held on by a set of points on its own point stack. In the event of power failure the patch-on relay drops out and releases the telephone line. The call-length timer and the patch-off relay momentarily interrupt the power to the patch-on relay, again deenergizing the relay. The switching relay is operated by the carrier-operated relay in the receiver.

When no carrier is coming into the repeater, one set of contacts holds the transmitter keyed on while a second set of contacts connects the audio from the telephone line to the transmitter. A transmission by a mobile unit operates the carrier-operated relay in the repeater, which in turn operates the switching relay in the patch. When the switching relay operates, the telephone line is switched from the transmitter input to the receiver output. The contacts used to hold the transmitter on are opened and allow the telephone patch to be used in two ways.

If the patch-on relay is wired to disable the normal repeater keying circuit, the telephone patch operates in a semiprivate mode. The conversation from the telephone to the mobile goes out on the channel, but when the mobile transmits, the repeater transmitter goes off the air (not shown on the diagram). The way we normally use the patch, the carrier-operated relay keys the transmitter in the normal way and both sides of the telephone conversation are transmitted over the repeater channel. Since the "pulsing relay" is open at any time tone is being transmitted, practically no tone is ever transmitted over the telephone line.

Both the channel A and channel B repeaters are General Electric Progress Line repeaters, and are equipped for 600Ω audio input and output. Our phone patch transformer is a salvaged telephone company one-to-one repeat coil obtained from the local surplus emporium.

System Levels

Overall system performance will depend on how carefully everything is set up in the first place. The Wichita repeaters are both wideband. We limit audio levels to 12 kHz for the mobile units. By setting the transmitted tone levels to 9–10 kHz, we do not have chopping to contend with, and the decoders work reliably even when the voice audio is just barely understandable. In most cases, the audio becomes too poor for phone patch quality before the decoder reliability enters the picture. Keep in mind that hard limiting or volume compression will degrade the performance of the decoders. It is extremely helpful if a signal generator with external FM capability is available for testing the system. We have verified that the system is erratic at the 5 kHz deviation level, and is very reliable at any deviation level above 6.5 kHz.

2805 Hz filter

We retransmit the tone through the repeater as we plan to locate muted monitor receivers in various locations to alert needed persons in emergencies. Regular listeners who do not like to hear the tone can use simple filters such as the one shown in Fig. 7 to virtually eliminate the tone. Insertion loss is less than 3.0 dB, with tone attenuation well over 20 dB. We use two of the filters – one at the input to the first audio amplifier stage, and one at the input to the second audio amplifier stage. We use the 88 mH toroids tuned to 2805 Hz with a capacitor and a balance potentiometer. Adjust the potentiometer for the deepest null while checking that the frequency is correct by slight variation of your audio generator frequency. Replace the potentiometer with a fixed resistor and install in your receiver. Possibly higher- or lower-inductance coils would work better – we haven't tried since these are satisfactory.

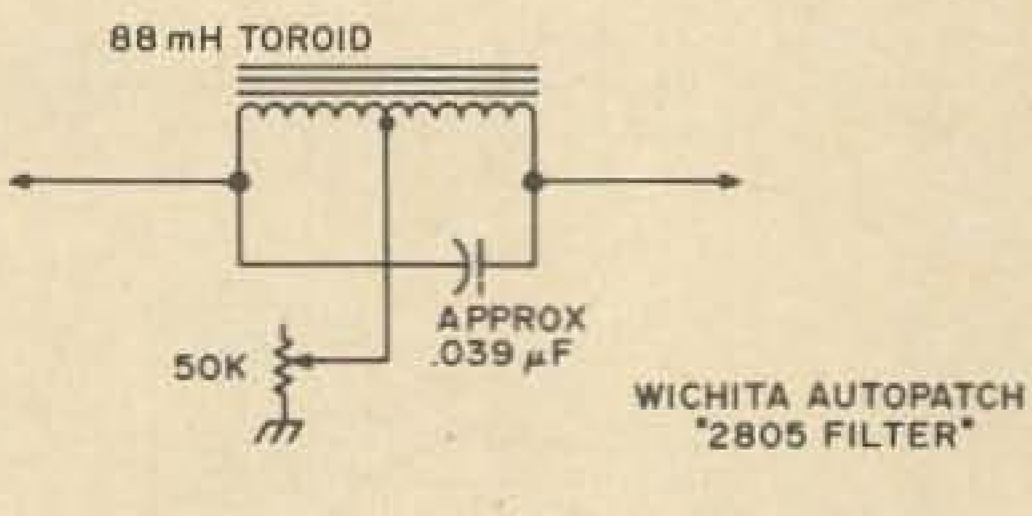
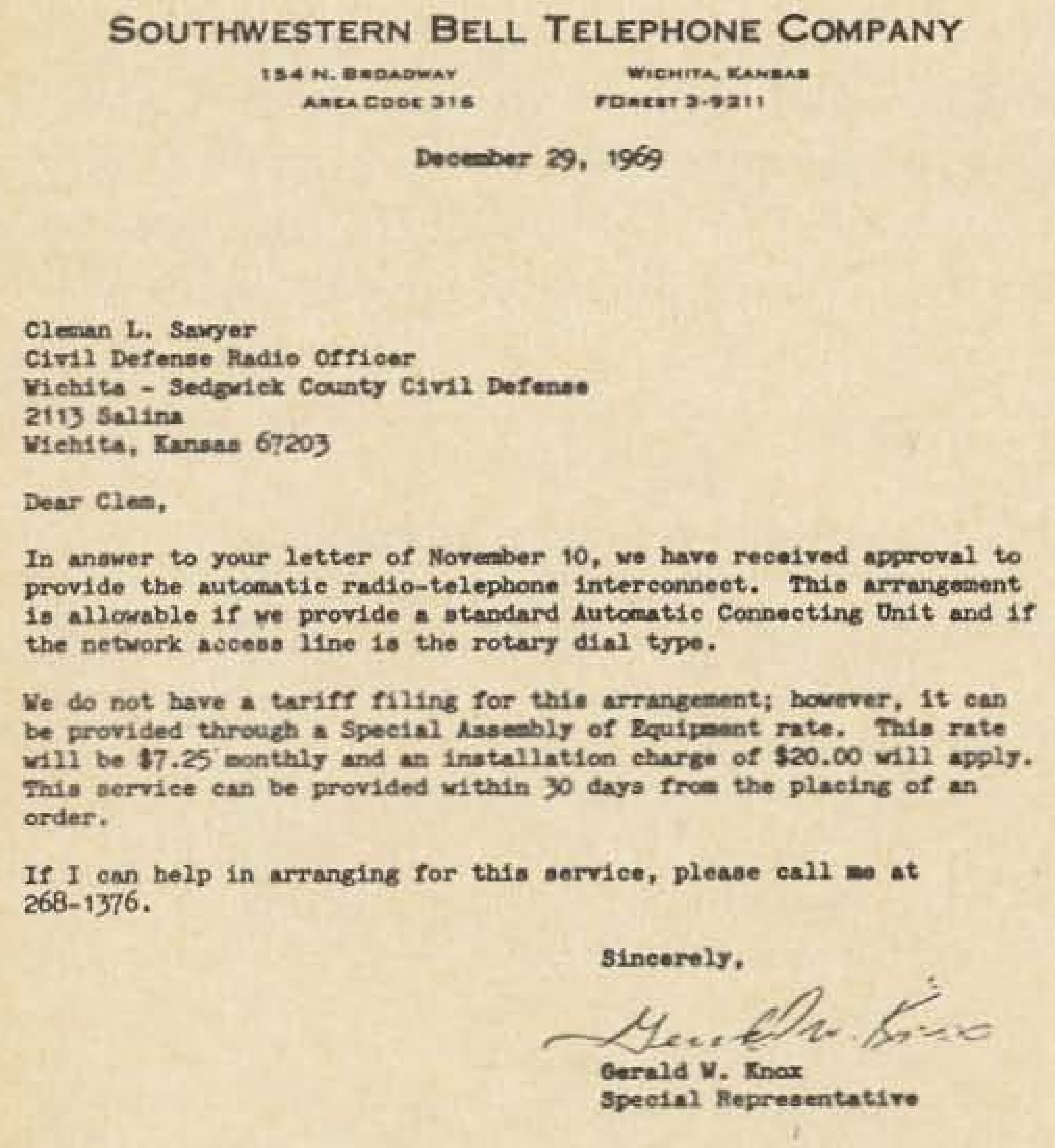


Fig. 7. Toroids can be used as 2805 Hz filters to remove unwanted tone signals from receivers.

Negotiating Permission to Interconnect

This system requires a telephone line or interface at the repeater site. (In the case


SOUTHWESTERN BELL TELEPHONE COMPANY

154 N. BROADWAY WICHITA, KANSAS
AREA CODE 316 FOREST 3-9211

December 29, 1969

Cleman L. Sawyer
Civil Defense Radio Officer
Wichita - Sedgwick County Civil Defense
2113 Salina
Wichita, Kansas 67203

Dear Clem,

In answer to your letter of November 10, we have received approval to provide the automatic radio-telephone interconnect. This arrangement is allowable if we provide a standard Automatic Connecting Unit and if the network access line is the rotary dial type.

We do not have a tariff filing for this arrangement; however, it can be provided through a Special Assembly of Equipment rate. This rate will be $7.25 monthly and an installation charge of $20.00 will apply. This service can be provided within 30 days from the placing of an order.

If I can help in arranging for this service, please call me at 268-1376.

Sincerely,

Gerald W. Knox
Special Representative

Fig. 8. Letter from Bell granting permission to connect a "foreign attachment" to telephone line. Note that Bell provides the interface connection — for a fee.

of a split location, it will work at either one.) I made verbal and written inquiries, but for a long time I received no answers. As time dragged on, I made a direct connection to the telephone line, expecting to goad the telephone company into saying yes or no. After several weeks of operation, the Sedgwick County Civil Defense Radio Officer, Clem Sawyer (KØYER), and I mounted a new attack using Civil Defense prestige as a lever. It took six weeks to obtain the permission we sought (Fig. 8). If you wish to connect directly to the telephone line without the telephone company interface equipment, connect the *off-hook* and the *telephone audio* lines in series, connect to L1 and L2 inside the telephone instrument.

Summation and Afterthoughts

Detailed theory of digital pulse encoders and decoders is out of place in this article. Repeater groups wishing to build similar facilities into their repeater should try to locate a friend in the two-way radio business who services this type of equipment. Information on setting codes, multifunction decoders and simple explanations of how the equipment works can be found in the instruction books for General

Electric EJ-18A,B,C, and D digital tone decoders, (all solid-state, no relays) and Secode Corporation SD-30 and SD-40 (also solid-state). The General Electric "Datafile" has several folders on Secode encoders

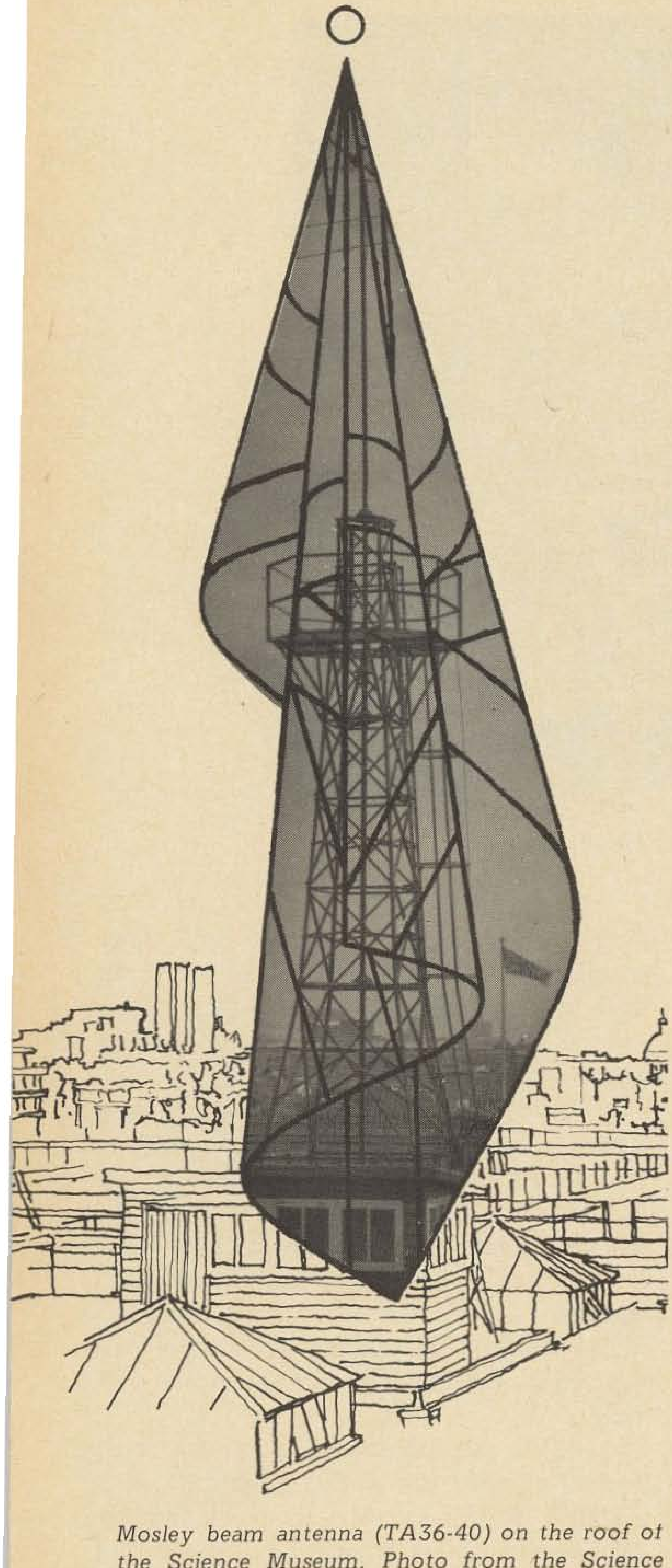
Parts List

1 – Dial, Stromberg Carlson or equiv., or W.E. or Kellogg dial, alternate.
1 – 88 mH Toroid, w/added winding, 20–50 turns.
1 – Dpdt Switch
1 – Relay, 4 pdt, allied control #T-154 Series CC-CC, 12V, 185Ω Coil
1 – 1 kΩ potentiometer (output lever)
3 – NPN transistors (2N2712)
1 – 200 μF 15V capacitor
1 – .005 μF Mylar capacitor
1 – Capacitor, vary to place on freq., (.035-.04 for 2805 Hz)
2 – 47 kΩ
1 – 33 kΩ
1 – 680Ω
1 – 470Ω
1 – 330Ω
1 – 270Ω
2 – 150Ω
1 – 22Ω
1 – 10Ω

and decoders. Local sales and service outlets for Secode Corporation can obtain information for you regarding single and multifunction models of their RPD-673 (12V, for mobile use) and RPD-674 (117V, for station use). Similar types of encoders and decoders are available from Scantlin, among others. Now that a large number of Wichita area amateurs are equipping themselves with the necessary encoders, we are adding features like selectable loose or tight squelch settings, tone key to energize the repeater during skip conditions or temperature inversions (normally the repeaters are to be carrier-energized, but during mild band openings things get hectic), and many others. We may be wiring up more selectors any day now. Transient 2 meter mobiles are welcome to use our autopatch facilities, but they must request the current on and off codes and meet the specifications as given in this article.

. . . WØDKU ■

Bruce Ellison
San Francisco
Casas de Binicalaf
Menorca (Balearic Isl) Spain



Mosley beam antenna (TA36-40) on the roof of the Science Museum. Photo from the Science Museum, London.

London's Science Museum Demonstration Station

Few hams can boast of a shack about 35 x 35 feet, two stories high, packed with equipment, most of it lent or donated, and logging between five and ten thousand contacts a year.

In London, England, though, the Science Museum runs just such a station – GB2SM, operating from the second floor of the museum's rambling building in London's fashionable Kensington area.

GB2SM is on the air twice daily – at 11:30 a.m. and 4 p.m. London time (1030 and 1500 GMT) demonstrating the principles of radio communication to an often-eager crowd.

As the station's QSL cards indicate, GB2SM operates with a Mosley TA36–40 beam antenna (on 40, 20, 15, and 10 meters), and Collins KWM–2 SSB transceiver and 30L–1 (500 watt PEP) linear amplifier. Three receivers are in use, and their signals can be put out through two large ceiling speakers.

Part of the main console of GB2SM, the Science Museum demonstration in London.

The station exchanges more than 3000 QSL cards annually.

GB2SM is not strictly an amateur station, as its somewhat unusual call sign indicates. Technically, the operation is a "demonstration station." Call signs in Britain beginning with GB are normally reserved for things like radio shows or conventions, and then on a temporary basis. The museum station is the only one in Britain with a permanent GB call.

Operations were started in August, 1955, to provide a means of getting young people interested in radio communication. Many of the more than 2 million annual visitors to the museum are under 21, and a good proportion of these can be found standing, fascinated, listening to conversation between GB2SM and other parts of the world.

"We know of quite a few young people," says the museum official in charge of the station, "who now hold licenses, and who tell us that their interest was first awakened here." To which staff operator Geoff Voller adds, "I worked a man some time ago who told me that he'd been waiting for a contact with us for years. He said he first got interested in ham radio here and had wanted the contact ever since he got his license."

Voller, a full-time museum staff member, and himself a licensed amateur (G3JUL) runs many of the museum's ham demonstrations. On weekends, and on holidays and vacations, he is assisted by a small group of specially invited British amateurs. Because of the "demonstration station" status of GB2SM, all use the station call sign when operating, never their own call letters.

GB2SM maintains regular contacts with several parts of the world; a schedule with ZD9BM in lonely Tristan da Cunha is probably the most interesting of these. The museum station has occasionally proved a valuable auxiliary communications link during emergencies in Tristan.

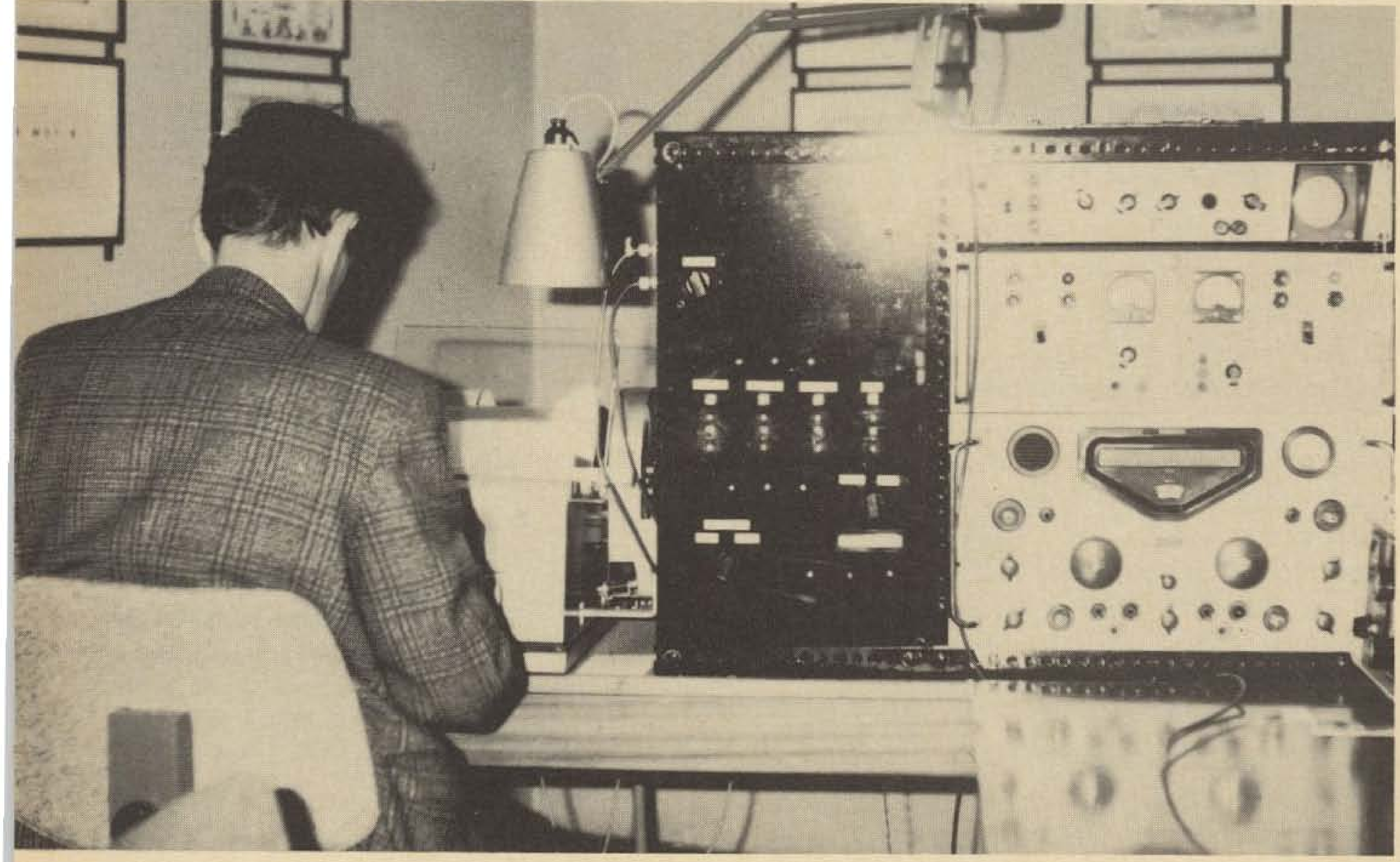
During a recent morning demonstration, a contact attempt with ZD9BM was unsuccessful. In short order, however, the station logged QSOs with 9VØPA in Singapore and with WA8RIS in Cleveland, who was calling CQ at the time. A brief contact with WAØITW (also CQ), and with OK2PJ in Czechoslovakia completed the half-hour operation.

Another morning Voller was "talking" with a friend in Holland via teleprinter, a form of amateur communication much more common in Europe than here. GB2SM maintains a teleprinter schedule with PE2EVO, a demonstration station in Eindhoven, Holland, home of the giant Philips electric firm.

The Science Museum's shack has walls covered with awards. The station enters about two contests a year, each of which requires a high degree of organization and logistic support ("we have to make all kinds of special arrangements to get people into the closed museum at 2 a.m. Sunday – that sort of thing – and keep an urn on the boil somewhere all weekend," says one museum official).

The museum's ham operator, Geoff Voller, adjusts teleprinter equipment during a contact with PE2EVO, in Eindhoven, Holland. ▶

Geoff Voller at work on his teleprinter during "conversation" with Holland. Note awards on the walls. ▼



GB2SM, London, at work. Operator Geoff Voller makes log entries at the conclusion of a half-hour demonstration. Station operates at 1030 and 1500 GMT daily, demonstrating principles of radio communication for a crowd in the Science Museum.

Despite the logistics, GB2SM has more than its share of awards. It boasts such citations as the Keystone award from the Harrisburg, Pennsylvania Radio Club, for being "the first station in England" to work more than 100 hams in Pennsylvania; the ARRL DX Century Club award, and the League's WAS award.

The Radio Society of Great Britain has given the station its "Empire DX Award" for contacts with 50 dominions and colonial areas on 14 MHz, and 50 additional contacts on the remaining bands.

Although the station can operate with code, voice, or teleprinter, most contacts are made with voice because they are the most meaningful to the ever-present audience.

Amateurs visiting Britain are invited to stop in the Science Museum to see the station at work. Its operators rarely see in person any of their thousands of contacts, and are glad of the chance to do so.

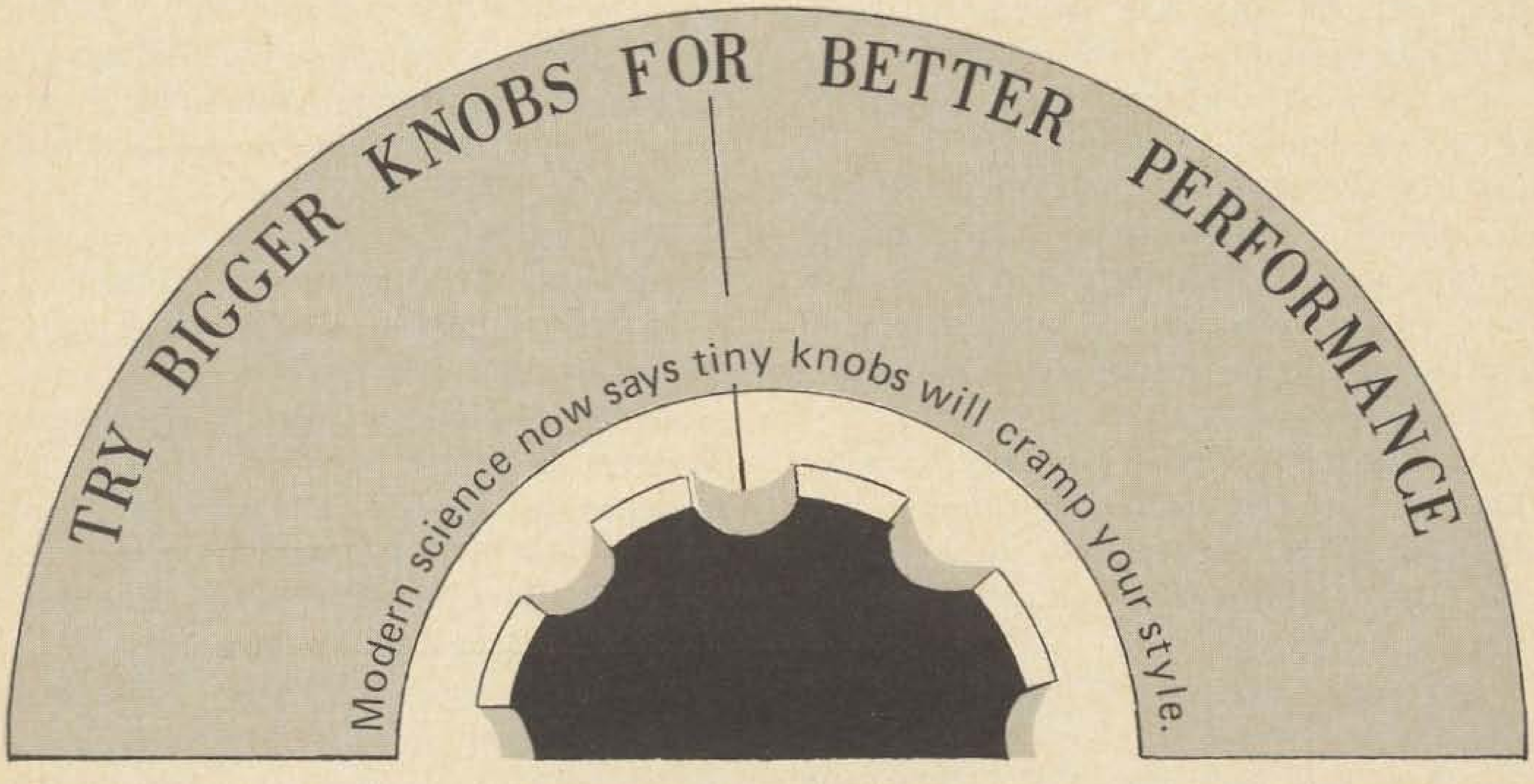
There is one restriction, though. GB2SM is not a "public" station, and is not open for use by any visiting amateur. You are most welcome, but the rule must be "please look, but please don't expect to operate."

. . . Bruce Ellison ■

Charles J. Vlahos WB2ICV
15 Indian Drive
Woodcliff Lake NJ 07675

TRY BIGGER KNOBS FOR BETTER PERFORMANCE

Modern science now says tiny knobs will cramp your style.



Hardly an issue of 73 goes by without some articles devoted to miniature equipment. Test equipment, receivers, and even transmitters are rapidly going the miniature route. Smaller and compact rigs have much to offer, of course – not only in terms of reliability, stability, and instant warmup because of solid state design, but because they take up less space in the shack.

Yet, for some time I have found an irritating fault with miniature equipment. Indeed, it even goes to standard size equipment. Call it instead an annoyance, or a discomfort. My complaint? Operating knobs are just too small to be comfortably manipulated with efficiency.

I much prefer large, massive knobs on all my gear – whether they be on my tube-type receiver and transmitter or on that little solid state, homebrew transistor checker I often use. So where I can, I install knobs to about twice conventional size.

It's true that some manufacturers (like Hallicrafters, National, and Heath) generally use large knobs (about 1 in. diameter or more) on functions other than the main tuning dial. But most don't. Look at the new lines of transceivers and you'll see what we mean. Most come equipped with tiny, delicate knobs, seemingly designed for a feminine touch.

I'm not much of a contest buff, but if I were, I could offer a couple of strong reasons for large operating knobs. For one thing, larger knobs would eliminate groping, fumbling, or accidental manipulation of the wrong function during hectic QSOs. For another, they would allow you to make critical adjustments with ease (the turns ratio would be in your favor).

Why, then, the trend to small knobs? A hasty conclusion might be the limiting factor of the equipment's basic size. But upon looking over many catalogs and advertisements, you'll find that this just isn't the case. There is usually more than adequate space to double present knob size. So we can conclude that size of rig is generally not a factor.

One valid consideration might be cost. But here again, a check in the current

Lafayette catalog shows the difference between a ¾ in. plastic knob and a 1 in. knob of the same material and design to be a mere 3¢. Fluted knobs, commonly found on most commercial rigs and some well-designed homebrew rigs, have a price span of 4 to 5¢, from the smallest to the largest diameters. So the cost differential that we're talking about is really negligible.

On the face of it, then, there appears to be no meaningful justification for tiny operating knobs. Therefore, if you feel as we do, you can modify your present equipment with larger knobs at a nominal cost. And as for homebrew jobs, there isn't any sound reason for going the miniature route all the way.

At this point you're probably thinking that this entire business of optimum knob size (and shape) is not nearly as important and meaningful as I've indicated. But it is – and here's why:

The space age has ushered in a whole new science called "human engineering" that deals with this very subject. Believe it or not, there are hundreds of engineers around the country who devote their entire time to such things as scientifically determining what size knob, dial, toggle switch, lever, pedal, etc., is best, what material and color it should be, and where it should be best located on a particular piece of equipment. The findings of human engineering have been so revealing to space technologists that even industry is beginning to take a hard look at these results – all in the interest of getting maximum production from machines. The whole idea is to make manipulation of controls as easy and as effortless as possible for humans that have to operate machines of any kind. In other words, it is a science devoted to lessening human fatigue and thus optimizing production.

The implications of human engineering to amateur radio are obvious. The amateur fraternity is always striving to improve, update, and streamline equipment with a view to improving operating conditions. The technical articles in the various ham magazines attest to this. So it appears that knob size is one detail that serious amateurs should not overlook.

An important question to ask at this point, then, is: What is the best knob size? Has human engineering made studies in this area? Have conclusions been reached?

Since an operating knob is basic to virtually all electronic gear, one can rightfully conclude that studies in this direction have, indeed, been made. The findings are particularly interesting and support the author's view that knobs for amateur gear are – in the main – too small.

The August 1969 issue of Human Factors magazine contained an article by J. V. Bradley on "Optimum Knob Diameter." Essentially, Mr. Bradley stated that when frictional resistance is heavy, the best knob diameter is about 2 in. Actually, he described a range of diameters (relating turning time to knob diameter) for such applications to be between 1¾ and 2 in. Anything over and under these diameters is "significantly inferior." What constitutes heavy frictional resistance is something else again. But if we were to classify main tuning dials on receivers and vfo's as those having heavy frictional resistance, then it would appear that both homebrew and commercial rigs adequately meet these specifications.

But Mr. Bradley's article goes on to say that when frictional resistance is reduced to a minimum level, specifications change. Here, human engineering recommends diameters from 1 to 3¼ in. Bradley concludes by saying that these findings are valid over a wide range of rotary inertias.

It isn't often you see rf gain, audio, bandswitching, bfo tuning, or final tuning controls that meet this lower tolerance limit. At one time, when receivers and transmitters came in large packages, they did. But nowadays they rarely do, especially transceivers. Result: smaller knobs and dials.

The next time you put together a homebrew rig of any kind, give some serious thought to large knobs and see if you don't feel a bit more comfortable with them. Or better yet, try installing larger knobs on those appliances you have now. You'll see what we mean.

. . . WB2ICV ■

NEW PRODUCTS

Low-Cost Function Generator

Phase Corporation is marketing, as a kit or wired and tested, its low-cost solid-state test oscillator, which generates square waves, pulses, or sawtooth waveforms from 0.1 Hz to 100 kHz. Portable and compact, the package contains FET and unijunction circuitry to cover the operating spectrum in six continuous ranges. In the kit form, which sells for $34.95, all parts are included: transistors, diodes, switches, etched and drilled printed-circuit board, custom cabinet with screened and punched

front panel, and easy-to-follow assembly instructions. The Model 01K designates the kit; 01W is the completed package, which sells for $54.95. (Both prices include postage within the continental United States.) Specifications for the Model 01 test oscillator are as follows:

Output 8V p-p, all ranges
Output Z 5 kΩ
Freq.
Sawtooth and pulse: 0.1–100,000 Hz
Square: 0.05–50,000 Hz
Risetime
Square and pulse: 0.5 μsec
Pulsewidth
1 μsec at 100 kHz
5 msec at 2.5 sec/Hz

Phase Corp. is located at *315A Boston Ave., Medford, Mass. 02155.*

Four-Trace Oscilloscope Preamp

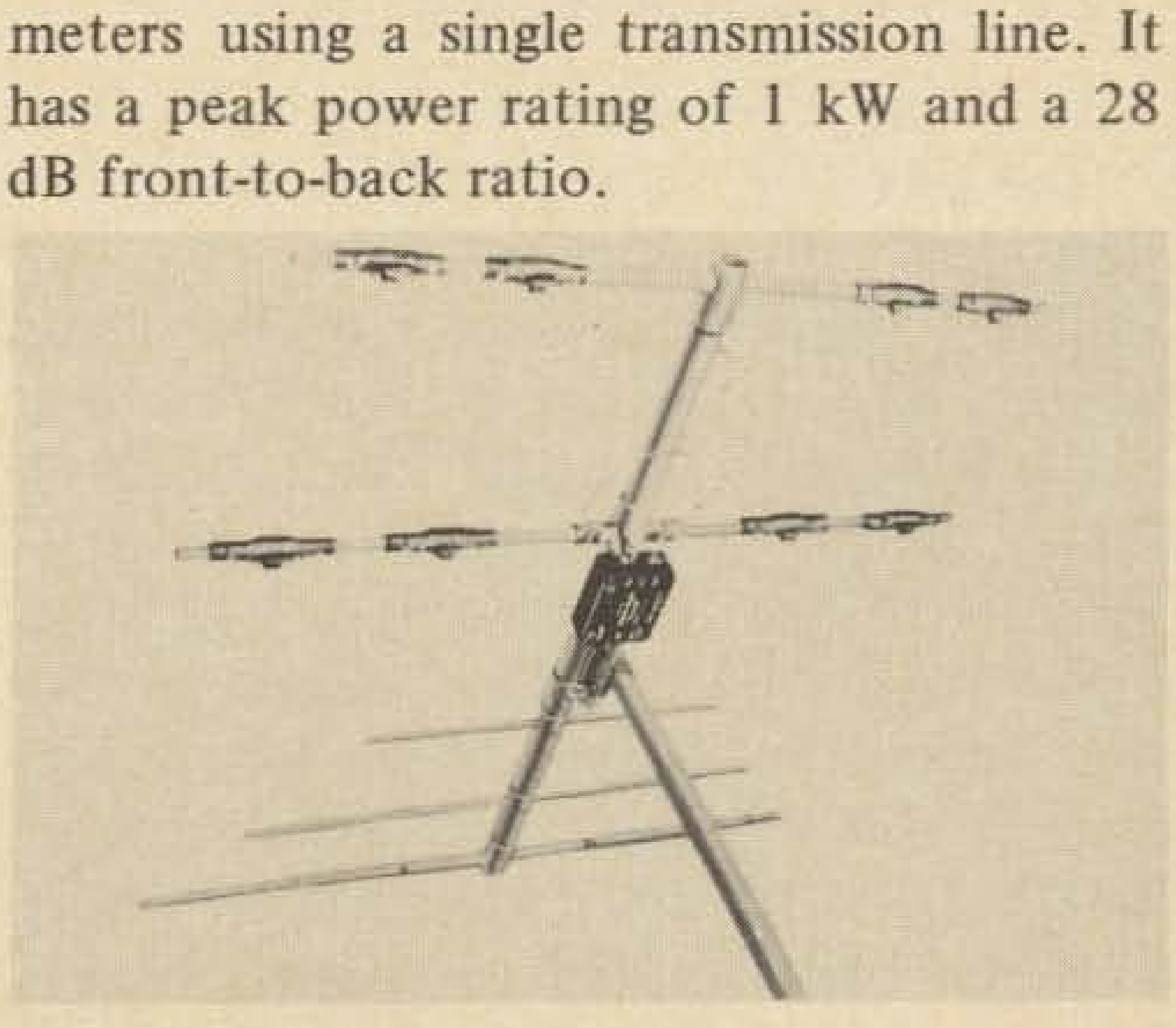
A four-trace oscilloscope preamplifier, the first in a new line of kits, has been announced by the *Phase Corp*. The preamp is designed for use with any ac or dc oscilloscope, providing the capability of observing as many as four waveforms simultaneously. Individual centering control is provided for each of the four inputs to the preamp. With an input impedance of 1 megohm/channel, the sen-

sitivity of the preamp is limited only by the sensitivity of the scope with which it is used. The preamp is compact, facilitating mounting inside the scope housing or in an optional case. The circuit of the preamplifier employs four FETs and nine silicon transistors. Included in the kit is a printed circuit board that comes etched and drilled.

Phase Corp., 315A Boston Ave., Medford, Mass. 02155.

Challenger Beams Are Design Innovation

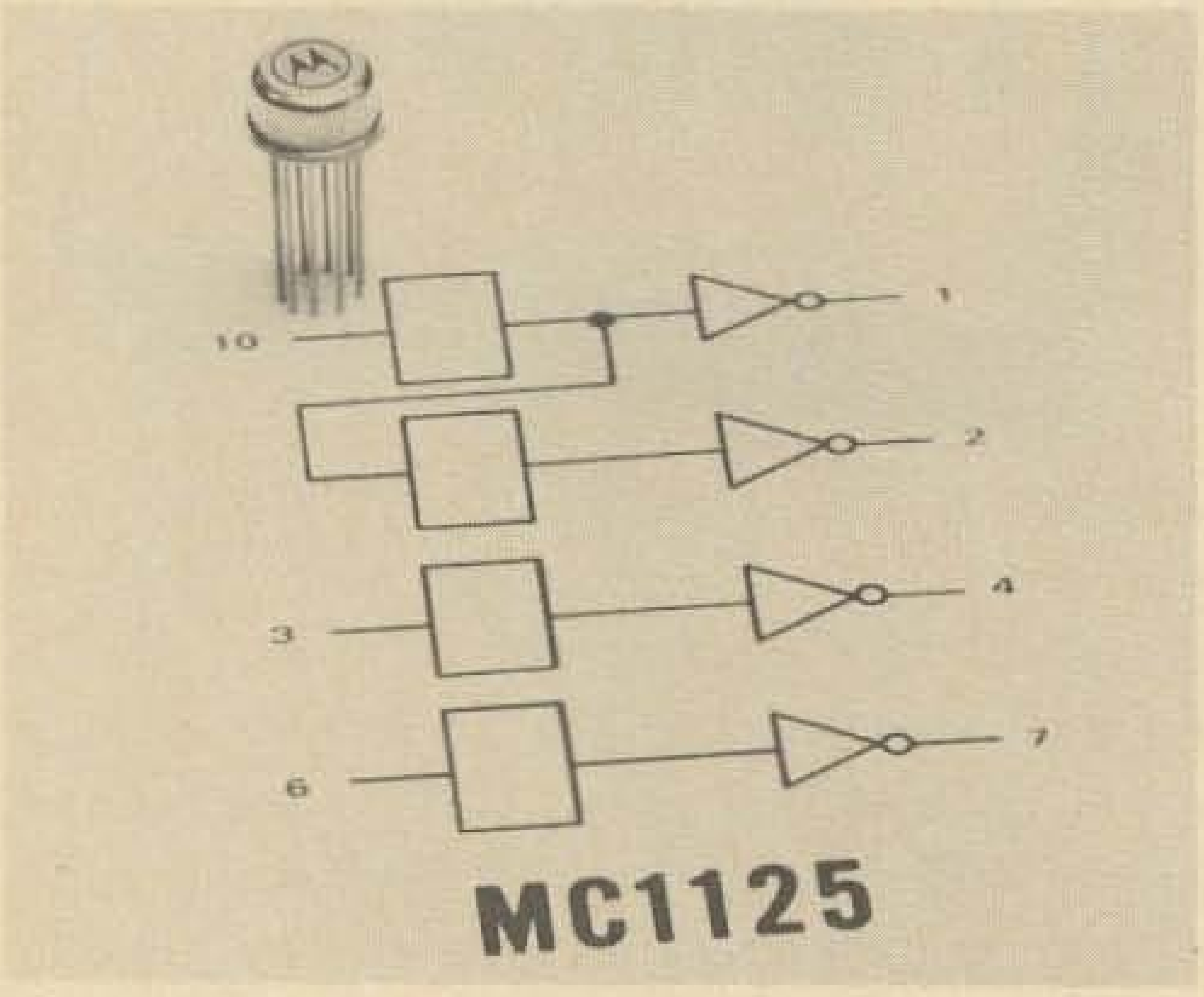
The Challenger line of antenna systems feature a balun-fed, 5-element Tri-Band array for operation on 10, 15, and 20 meters using a single transmission line. It has a peak power rating of 1 kW and a 28 dB front-to-back ratio.



Other Challenger models range from 3/4 through 80 meters. The entire line, as well as other Telrex antenna systems, are described in Catalog PL70 which is obtained free by writing to *Telrex Labs, Asbury Park, N. J. 07712.*

Monolithic Synthesizer MOS

Motorola's MC1125G is a monolithic, quad MOS device consisting of four toggle-mode flip-flops with buffered Q outputs that use no standby power when driving capacitively coupled loads. Typical power dissipation is a low 75 mW and operation is from dc to 1 MHz. The MC1125G also



features a typical input capacitance of 2.5 pF and a crosstalk figure under 1%. The MC1125G is recommended for frequency synthesis, as required in organ circuits, digital dividers, and counters. *Motorola Semiconductor Products Inc., PO Box 20912, Phoenix AZ 85036.*

FM Receivers Have Built-in Decoder

Two FM receivers for operation in the 50 and 144 MHz bands feature a complete assortment of optional equipment, including a sequential tone alarm decoding facility. The radios are available in four model designations. Model TM II-H1 has a single-channel, narrowband reception capability in the 144–172 MHz band. TM II-L1 is the same for operation in the 30–50 MHz range. List price for both models has been set at $115.00, including crystal. Models TM II-H2 and L2 feature 6-channel reception capability in the respective fre-

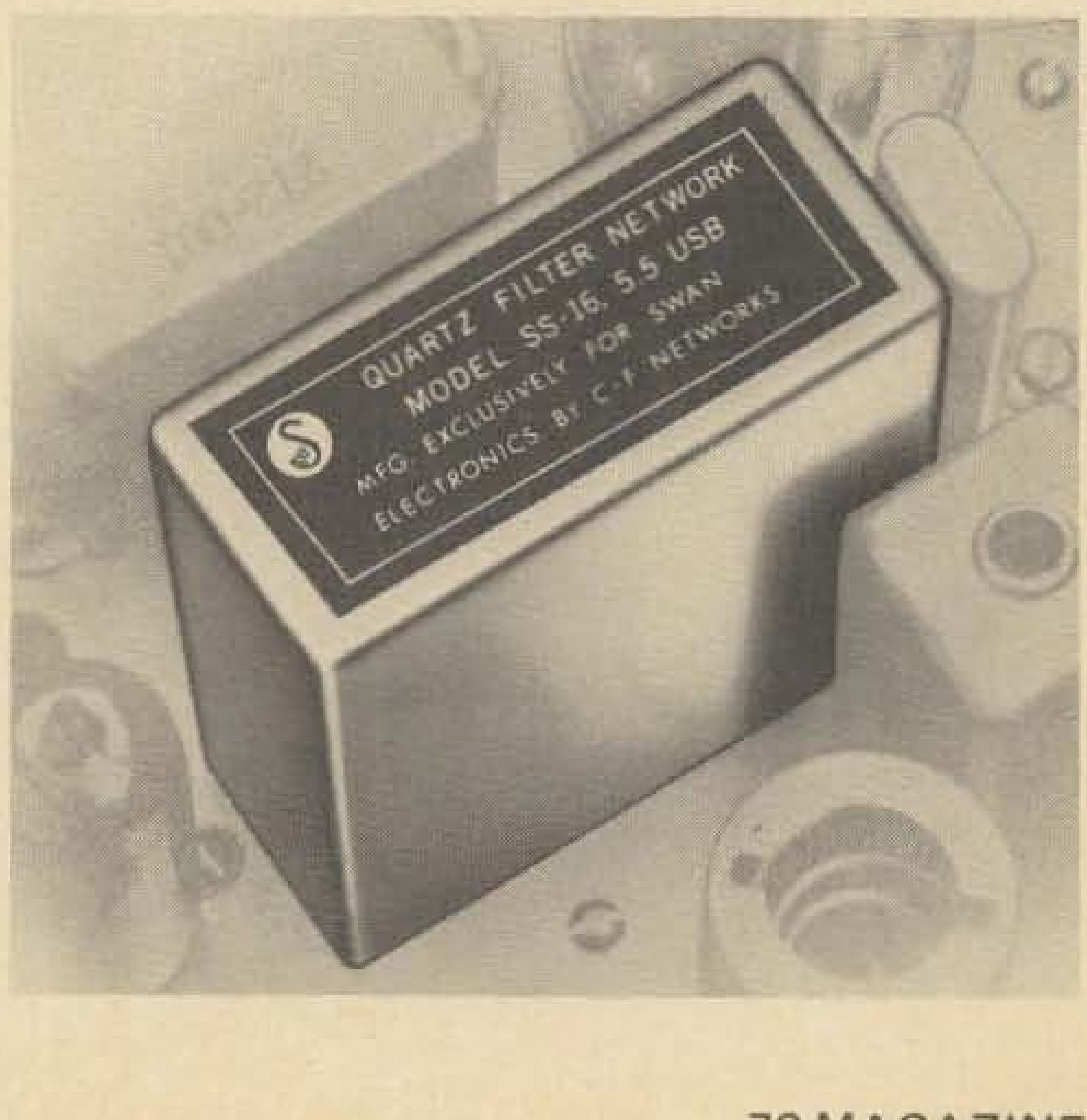
quency ranges at list price of $130.00, including 1 crystal. (Additional crystals are priced at $4.95 each.)

The receivers are being built as replacement units for the original TM series. New circuitry, however, enables the radios to deliver better performance without price increase.

Sensitivity for all models is rated at 0.5 μV. Selectivity is set at 50 dB at ±15 kHz. The receivers operate on 117V with accessories for 12V dc or internal ni-cad battery power supply. *Regency, 7900 Pendleton Pike, Indianapolis IN 46226.*

Quartz Filter Offers Super Selectivity

Made exclusively for Swan by CF Networks, an all-new 16-pole quartz filter network establishes a dramatic standard of comparison. Shape factor of 1.28, ultimate rejection greater than 140 dB! A giant QRM killer, the SS-16 wipes out strong adjacent channel interference with unprecedented attenuation. And in transmit



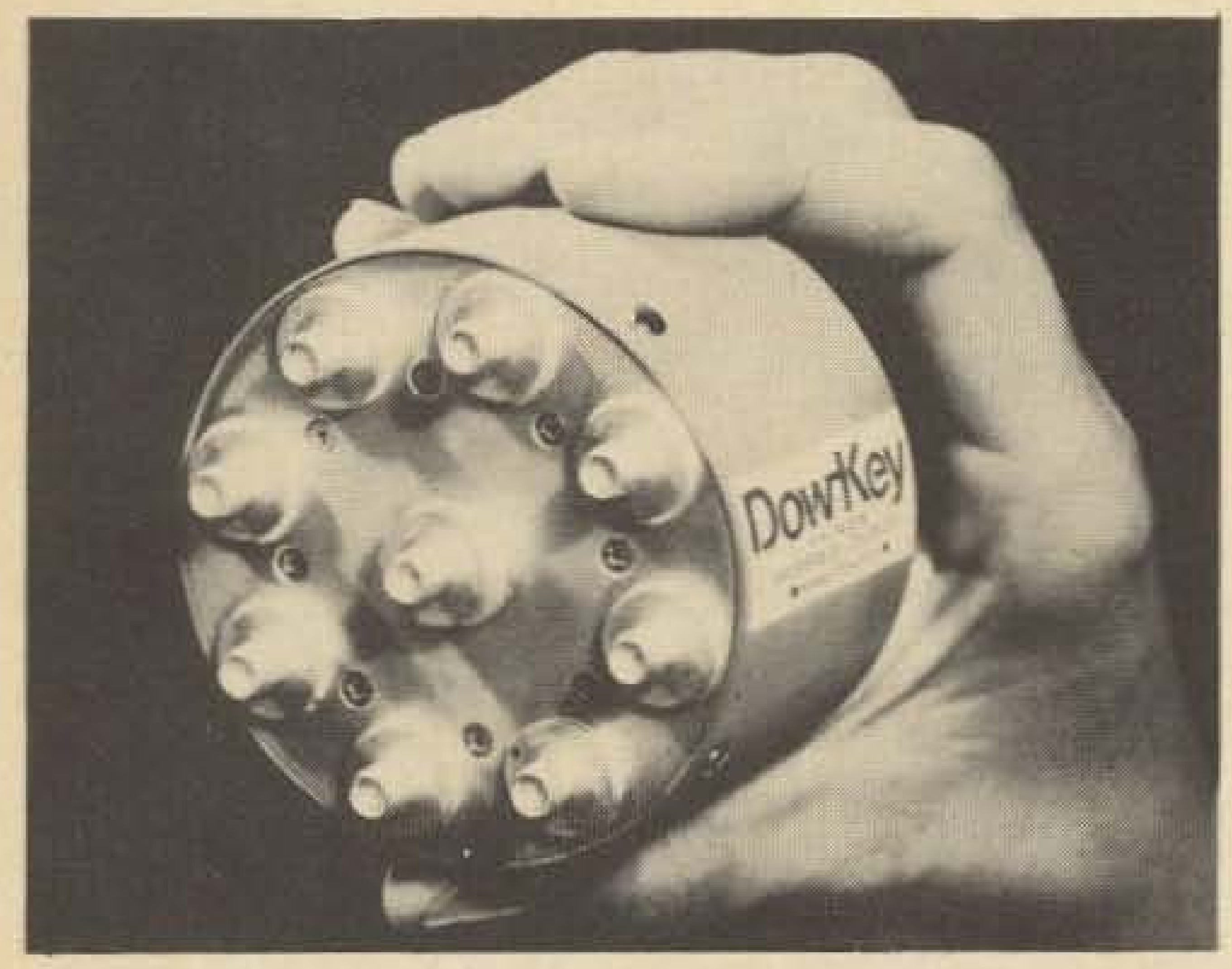
mode, unwanted sideband and carrier suppression are both increased greatly. Available only for Swan transceivers, they are made for the current 5.5 MHz i-f, or earlier 5.175 MHz i-f system. Installation and adjustment are simple. Specifications are as follows:

- 2.7 kHz bandwidth at 6 dB down.
- Shape factor 1.28.
- Ultimate rejection: 140 dB.
- 16 poles. 16 precision crystals in a lattice filter network.
- Sideband suppression: 80 dB.
- Carrier suppression: 45 dB with the filter alone, plus approximately 40 dB more from the balanced modulator.
- Mounting: Same as standard Swan filter, but taller.

Swan Electronics, 305 Airport Road, Oceanside CA 92054.

Remote-Controlled 8-Position Coaxial Switch

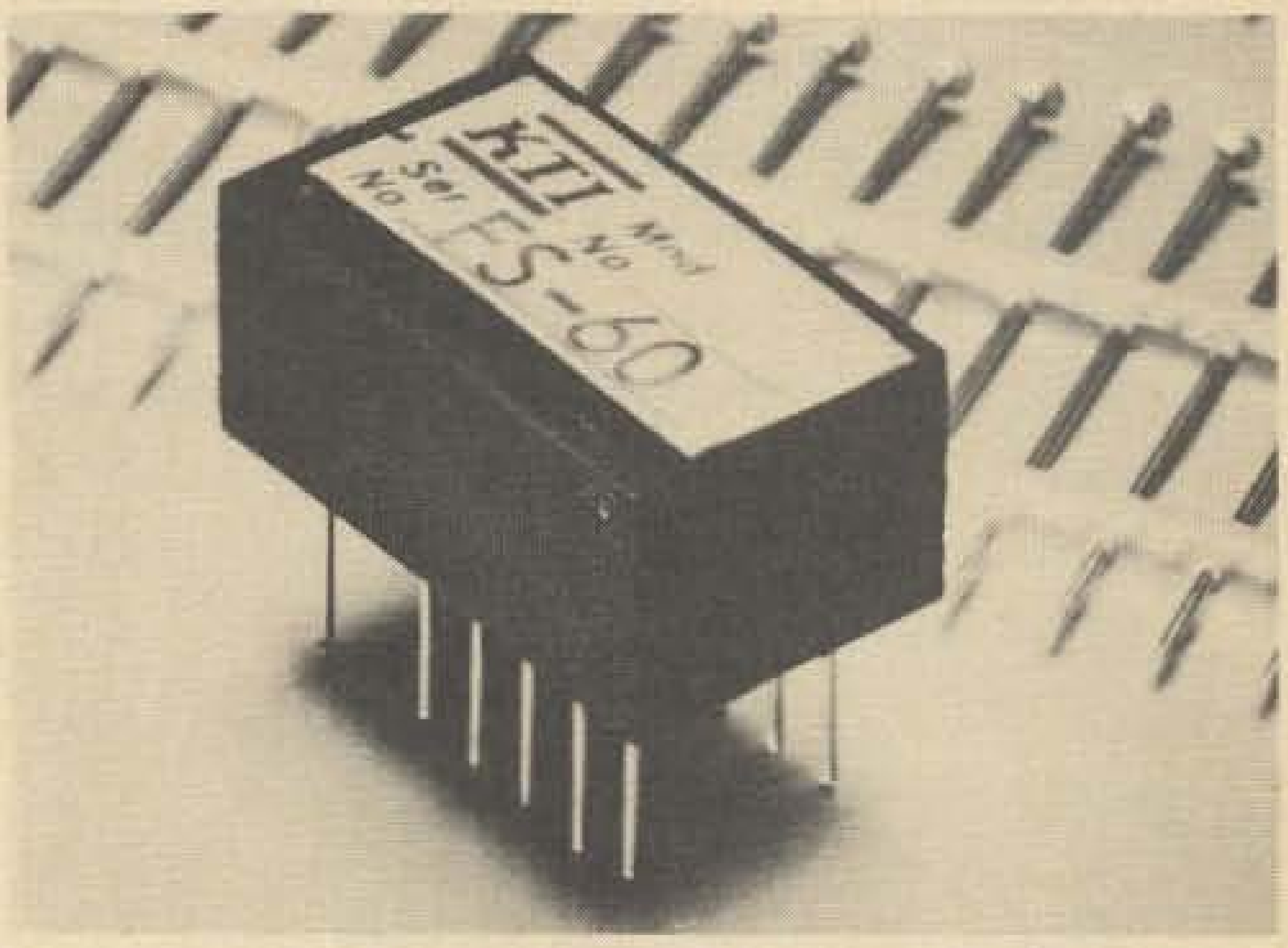
The Series 74 coaxial switch is intended for use in 50Ω circuits at frequencies up to 2 GHz, where the multiple sources are switched to a common output. To provide maximum isolation, all unused terminals of the new switch are



grounded. In standard configuration with type OSM connectors, the switch measures 3 in. diameter by approximately 2¼ in. deep. Other connectors available include types BNC, TNC, 27 series, and MB. The switch is normally supplied for operation at 26V dc. Other voltages available are 6, 12, and 120V dc. *Dow-Key Co., Box 348, Broomfield CO 80020.*

Active Filter Features Low Power Consumption

A new hybrid active filter, the Model FS-60, requires only 0.3 mW of power at ±2V, making it particularly suitable for use in battery-operated equipment. The unit sells for $10 in large quantities. Operating in the frequency range from dc to 10 kHz, the FS-60 features multiloop negative feedback for high stability and a Q range from



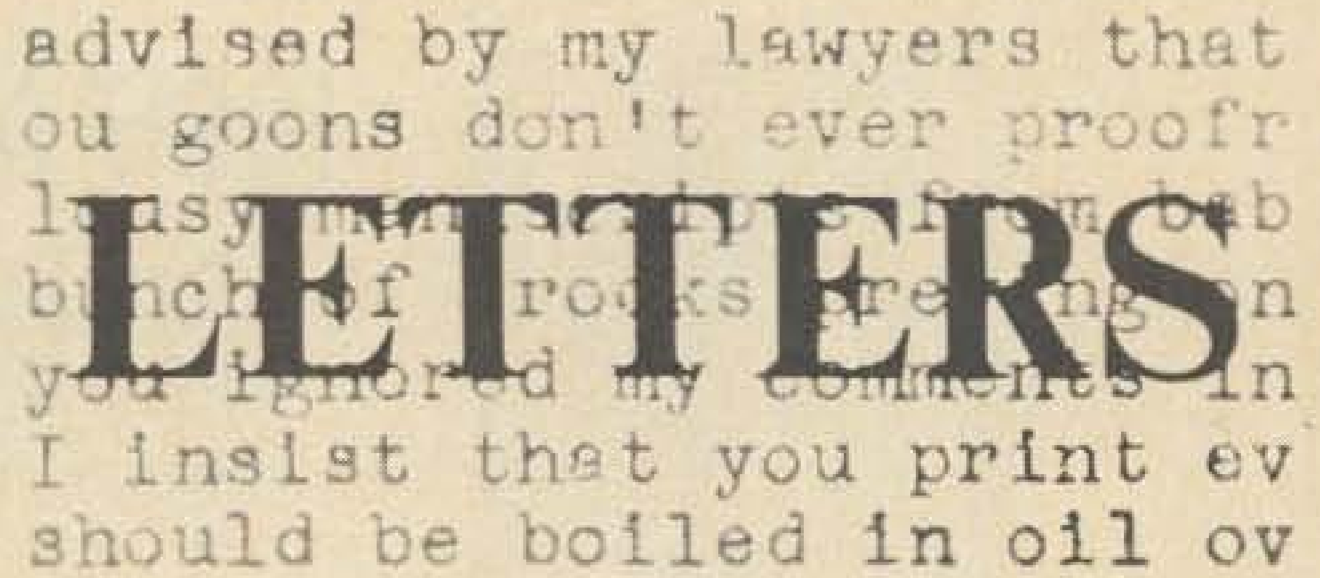
0.1 to 500. Other key specifications include a voltage gain adjustable to 40 dB and the ability to attain complex zeros anywhere in the S-plane. Bandpass, highpass and lowpass outputs are available simultaneously. The filter employs encapsulated hybrid circuit construction and is housed in a 14-pin dual in-line package measuring 0.804 x 0.336 x 0.474 in. Complete specifications and additional pricing data are available from *Kinetic Technology, Inc., 3393 De La Cruz Boulevard, Santa Clara, Calif. 95051.*

Those DGP Maps

The three-dimensional maps that DGP Company is distributing make the normal topographical maps look like junky gas station maps. These not only are a great help to anyone working on VHF, they are about the last word in a fancy wall map. Businesses are grabbing these up for decorating their walls, they are going up on hamshack walls, and they are being used as gifts for sportsmen.

The detail on these maps is hard to believe. They get right down to even the little dirt roads! Each map covers an area about 100 miles by 70 miles and every mountain is clearly shown both with contour curves as with the topographical maps, but also by being raised. The raising is exaggerated by a three-to-one factor to make the mountains really stand out. These are the most detailed maps ever produced and were done from actual 3D aerial surveys.

Any time you find yourself stuck for a great gift for a friend (or yourself), one of these 3D maps will make a lasting impression. *DGP Company, Box 431, Jaffrey NH 03452.*



Army Manual

The "Tech Manual" format for March is the best yet! Kudos to whoever thought that one up!

Fritz WB4MSJ

There were many comments from our ham-type technicians regarding your March issue on the front cover. All in all, they thought was a darn clever idea and they also made many nice comments regarding the quantity and quality of technical articles. I thought the amateur radio news page in the March issue was most interesting and I have removed these two pages and put them on the company bulletin board.

R.A. Kobold
Manager, Cust. Svc.
Galaxy Electronics

Cover Award March 1970	
Originality	10
Color	10
Copy	10
Type	10
Layout	10
Design	10
Content	10
Technical	10
Paper Stock	10
Appearance	10
Total	100

Congratulations
de WA4NED

Re – the March issue – clever cover. The "NOT-TOO-TECHNICAL MANUAL" bit is especially right. Did you check pages 62 through 67? The guy (Bob Manning K1YSD) must be sick.

Everett G. Taylor W6DOR
4100 Worthington Dr.
North Highlands CA

Y?

A couple of things. First, as a professional communication engineer, I am enjoying those Extra Class articles. But tell me, what little gremlin, or type lice, made off with the letter Y in Table 1 on page 101 of the February issue???? Especially since RY is one of the favorite test letters on the circuits, along with the quick, brown fox.

Next, the February issue was delivered here in San Diego on 20 February, so those announcements of events happening before then were of only historical interest (whatever that may be). Looks like you should insist on a longer lead-time if the item is to be of value.

Les Harlow WB6ZNW
5015 Cape May Ave.
San Diego, California

My question is: Y?

You left it out of the RTTY list on page 101 of the February 1970, 73 Magazine.

And 'Y' is so important – it's the other half of 'RY' one of the most familiar terms in RTTY.

C.L. "Bob" Engelbrecht VO1BL
31 Cowan Avenue
St. John's, Newfoundland

Yoiks! Y is coded 1-3-5 and it most assuredly is one of the important letters for TT'ers.

. . . Wayne

League Representation

As a relative newcomer to amateur radio and a subscriber to your magazine I am only disappointed in one thing, that your magazine doesn't come more often. I feel as I'm sure most of your subscribers do, that you are the only ham amgazine which truly represents the amateur.

By all means amateur radio should have a lobby in Washington, if the ARRL doesn't push for a lobby we should ask who are they representing, amateur radio or their own little station in Conn. If the ARRL doesn't react on this it's time everyone reacted on them. I myself am not a member of the ARRL and do not intend to be until I feel they would be representing me and not their own interests.

As I have mentioned previously I am truly in love with your magazine. There has not been one article which I have left unread and undigested. It's truly worth every cent of it's price, even if you have raised the price. Now I'd like you to listen to one of my gripes. Even though I am a Novice I do spend most of my time scanning across the phone bands. And I must say I'm very disappointed with the general conversations. Now don't get me wrong – listening to a ham tell another how he gets such great modulation excites me just as must as the latest hit record, and I'll have some fish stories to tell too when I get my General, but is this all hams have to talk about? When is the last time you heard an on the air debate about the latest FCC proposal or some discussion over an amateur lobby? What I propose is this, a net be established to talk over these things, a place where some meaningful discussion might take place. 73 and other magazines might keep the net informed of latest developments and an FCC-net hotline might be established. Wayne and other writers might have some on-the-air editorials to promote discussion. Other subjects might be discussed which generally bring to harsh a reaction from the general ham population, such topics might include, SEX, RELIGION, and POLITICS. Anyone could therefore tune in on the net and find out what's happening on the amateur scene today. Some amateurs who don't subscribe to 73 aren't even in the right decade. I think that the net would be especially inspiring to SWLs contemplating becoming hams and Novices interested in becoming Generals.

Tim Rulon WN2KQD
12 Morahopa Rd.
Centerport NY

Urgently request your leadership in promotion of FM thruout amateur world. In my humble opinion FM has the potential to nullify CB, restoring Amateur Radio to its rightful place in public service. The excellence of FM as a communications mode for civil defense, etc. will bring about a revision of trends and policies,

"All sunshine makes a desert."

swinging public service back from CB to ham radio. Only hope the League isn't too blind to see this obvious fact nor too set in their ways to realize FM's potential to rescue amateur radio. I am confident in you and your staff to provide interim leadership and technical information until Newington's Ponderous Pachyderm starts to move. Can anything kill their apathy?

M.N. DeBlasio WA2HCD

We agree that FM has the potential to nullify the inroads made on public service by CB – which could prove highly beneficial to amateur radio.

. . . Ken

Big Brother

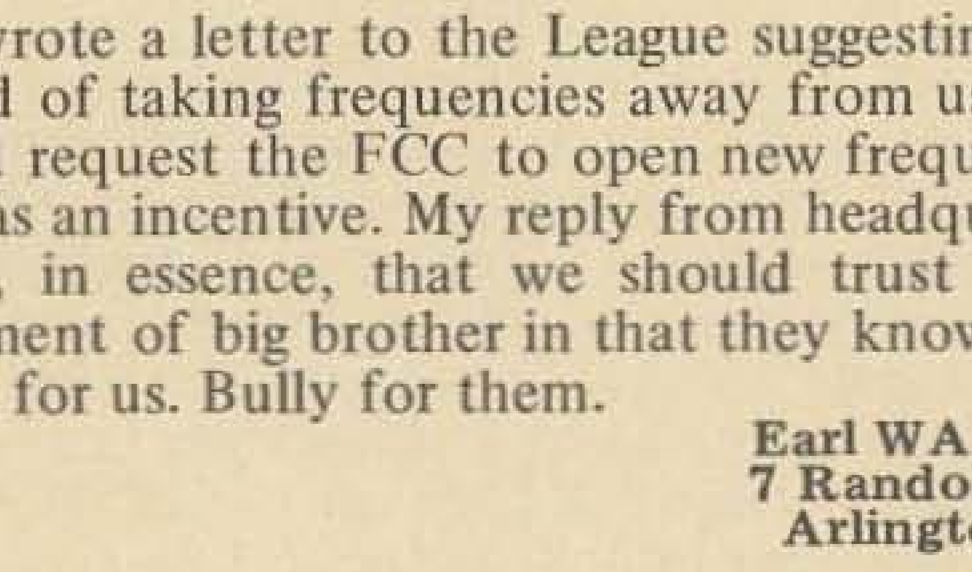
I wrote a letter to the League suggesting that instead of taking frequencies away from us, they should request the FCC to open new frequencies to us as an incentive. My reply from headquarters stated, in essence, that we should trust in the judgement of big brother in that they know what is best for us. Bully for them.

Earl WA1KYW
7 Randolph St.
Arlington MA

Killing the Big Thump

For better than two years now I have been fooling with an 813 GG linear (two in parallel). It is built entirely of surplus *junk* (and I mean that in the strictest sense of the word!).

One of the biggest problems was the power supply which is made up of a 2500–0–2500 power transformer, 866 filament transformer, 1616 rectifiers (I used to have 866A's. . .they are directly interchangeable), and two *gigantic* oil-filled filter capacitors. With power supply turn-on I'd get the "big thump" and the most beautiful flash in the 1616s! It would then proceed to blow the 10A slo-blow's in the line plug *plus* the 20 amp circuit breaker in the shack!



I went through 6-866A's, and 4-1616's and kept thinking it was *scrounging* soft or bad rectifiers. The fact is, they couldn't handle the terrific surges!. I became aware of this fact after reading an article by R.T. Brackman and M. Weinschenker (73, Page 77, Jan, '70) on silicon rectifier diodes. I never realized there could be that much surge. In the Jan. '69 issue of 73 Mag. on page 22, W9VEY offered a solution. I didn't like this simply because I did't have a spare relay and the 20W, 5 kΩ resistor.

So. . .in my power supply I wired in permanently a 150W light bulb in series with one of the primaries. This is turned on first and then after a few seconds is shorted out to let the full 2500V in. This serves two purposes. . .one-it got rid of the "big thump" and the ensuing "big blow" by fuses, and two-I now have a 800V low voltage supply built in!

The light bulb is mounted in a plplug-in type light bulb socket so that if I have to change bulbs, all I have to do is unscrew the old one and screw in the new one. It is mounted on a rotary switch.

Wayne Jinske WA9SSH
Custer WI

I wonder if it is not possible that Wayne's editorial stand concerning the League is not having some undesireable side effects.

Have you listened to W1AW code practice lately? Could it be that some of those who like to tune up on top of the code session or come slipping in from the Northeast over it might feel they are in their own way supporting Wayne in his battle with the league? I do not think 73 wants that sort of support. Perhaps these individuals do not listen to anyone or any publication. In any case I, in behalf of others who use the code practice service, would appreciate your help.

Bob Cutler WNØYED
Glenwood Springs CO

The FM Route

My wife and I just got back from a vacation trip of 2 weeks on the newest of highways: the new 146.34-146.94 open repeater FM highway.

I have been an amateur for many years, but never enjoyed anything as much as this trip on the highway open to the amateur today. As soon as we got 50 miles from Bloomington, Ill., I took the mike and said, "This is W9JFP/9 mobile." From there on, I had company all the way to California and back with the open repeaters on .34–.94 FM. Made hundreds of contacts – all so friendly I couldn't believe this was amateur radio. I was 60 miles from Tulsa and listening on .94 and a very pleasant voice broke squelch with: "This is WA5LVT, Tulsa Repeater; the time is 6:00 a.m." This was heard every ten minutes for the time I was in range, which was about 60 miles either side. Near San Diego I called but heard only a few stations and no responses, because this was an exclusive tone operated closed group; same story in Los Angeles, but on the way home, when we were 60 miles from Las Vegas, I got a reply from the open repeater in Las Vegas; and all the way back to Milwaukee, for 2200 miles of driving, I had company almost continuously thanks to my trusty 4Iv (which is old enough to retire) and the open repeaters on 146.34/146.94 FM. When we got within range of Chicago again in the exclusive area, couldn't make a contact because the repeaters were not open. All I can say is thanks to you and the 2 meter FM open repeaters.

Vic Weissbrodt W9JFP

The Chicago repeaters are open to transients, Vic. But the output there is 146.75 MHz because .94 is too active on a simplex basis. The stations you heard in San Diego were undoubtedly the same ones you heard in Los Angeles – Remotes Operated By Insociable Nets (or "Robin," as it's called in California.)

. . . Ken

FM Fringe Area

I have enjoyed your magazine ever since I started mooching off a local fellow ham. We have decided that I need my own subscription, especially since I tend to retain the FM articles, which I find excellent.

Mid-Missouri is a fringe area of VHF, but it's coming along, especially on FM (146.94). Keep those VHF articles coming and congrats on a fine magazine; the March issue was beautiful!

Jos. McGrew III WAØZIK
Eldon MO

On Spectrum Utilization

I have just recently returned to stateside 40 meter operation and found the QRM level near that experienced overseas. So I would like to pass on to you my thoughts on the usage of amateur frequencies by broadcast stations. Here are two possible avenues of attack to remove some of the congestion from the air.

First and probably the most likely to show results in cost versus listener audience. I should think that the SWBC cost of transmission far exceeds the justification by number of listeners.

With the present budget cuts, the time seems right for amateurs to point out the cost of broadcast compared to that of amateur radio. On the transmitting end, broadcast is expensive and amateur radio costs practically nothing – and on the receiving end, SWLs pay nothing, while amateurs pay to be licensed.

Now the second course, by the very presence of broadcast stations in our bands, it would seem that they are not concerned by the interference we cause. When you consider the difference in power levels between amateur and government transmitters we can do them little harm; therefore, I suggest some joint frequency usage. In the 21 MHz band (above 21.450) hams could easily squeeze in contacts if cost reductions took some transmitters off the air and hams were allowed to fill in the gaps. I admit we would be competing with those who "come up on any clear freq" but we live with them now.

Stephen Miller WB6TVT (KA2SM)
San Diego CA

Dockets

The FCC has recently issued a notice of proposed rulemaking concerning, among other things, (1), Amateur radio license fees, and (2), VHF repeaters. I have the following objections:

(1) The increase in license fees would be in direct opposition to the Federal Government's anti-inflationary policy. An increase in fees to the suggested level would make the cost of a license prohibitive for many amateurs, and when the fees are further increased in the future, as would inevitably be the case, amateur radio might possibly become a thing of the past owing its demise to being "licensed right out of existence."

(2) Regarding the propositions to (a) eliminate crossband links on VHF repeaters, (b) confine the repeaters to specific segments of the 6 and 2 meter bands, and (c) limit the power output to 250 watts, I am in direct opposition to all three proposals. Since VHF repeaters are amateur stations licensed to amateurs as remote control transmitter locations, the proposals named above, (a), (b), and (c) are all in direct conflict with amateur licensing rules and operator privileges as stated in the FCC rules and regulations. Amateur operation is permitted on the bands according to the class of license held by the operator and method of modulation employed, NOT according to type of operation. This cannot be regulated in the proposed way

unless the current rules and regulations concerning operator licensing and privileges are greatly altered. Hence, the proposals to confine VHF repeater operation to certain segments of the authorized bands and limit their power output is in direct violation of the current rules and regulations.

The proposal to eliminate crossband links on repeaters would greatly inhibit repeater activity and growth, and would make it impossible for many repeaters now present to continue operation. This provision also violates all previous FCC policy because crossband operation (AØ) is presently acceptable on all bands above 51 MHz according to the current rules and regulations.

The inhibiting of VHF repeater activity and future growth would present a great setback to emergency communication networks, and thus the FCC, by adopting these proposals, would be greatly reducing the ability of amateur radio to serve the public interests, which is also in obvious conflict with present FCC policy.

Thomas McLaughlin WB4NEX/9
N. Manchester IN

Open Letter to Hams Everywhere

Dockets 18802 and 18803 endanger the existance of amateur radio as we know it today. Individual and group action on these dockets can help, provided that both individuals and clubs respond in the form of comments to the FCC *and* cards and letters to congressmen and the White House.

Note that the ARRL has not been a party to Docket 18803 other than to verbally support the Buffalo petition. Unfortunately, the only part of the Buffalo petition that filtered into Docket 18803 has to do with logging and tone access. ARRL is opposed to 18802 on grounds that the amateurs do most of the work in licensing and policing the bands themselves.

Three steps should be taken immediately. . .

1. Request an additional 30–60 days for reply comments on Docket 18803. The mechanics of obtaining comments filed – in order to file reply comments – requires more time for reply comment filing.
2. File individual and group comments on Docket 18802 as soon as possible.
3. Write to your Senator, Representative, and the President expressing your feelings on these dockets. (This pressure will also be felt back at FCC.)

Copies of comments should be retained for future use – it will do no harm to send a copy to ARRL also. In this way you let them know your stand.

Need a Xerox? FCC needs the original plus 14 copies of everything you send them. The New England FM Repeater Assn. will make copies of comments from individuals only – if the original is sent to us.

Gordon Pugh W1JTB

Two-Party System?

With advent of incentive licensing, I sort of lost interest in ham radio and let my subscriptions to the four mags lapse. Recently, I came across your Dec. '69 issue and after having read your remarks on the ARRL and reviewed the other material in it, my interest was stimulated to the extent that I am herewith renewing my subscription for three years. I would like to see another group form similar to the ARRL, but with more progressive ideas and better representation of the amateur body. Certainly others in hamdom must entertain this idea. You have the vehicle in 73 to bring them together – why not do something in a positive direction about it? We have a two-party system in government – why not the same in ham radio?

Dick Dunn W1BPM

Wayne – In your article "ITU Conference: Who lobbies for Ham Radio?" I think you have made a statement that is in error. If I interpret it correctly, you say ARRL is a "tax-free" organization because it is a "non-profit" organization and you state that they cannot legally register a lobbyist to represent them with congress.

I base my reasoning that you are mistaken in this matter on the fact that the March 1970 issue of the American Rifleman, the Official Journal of the National Rifle Association of America, states that it "is an independent nonprofit organization supported by membership fees" and, in an article titled "A Statement" by the president of the National Rifle Association, it is stated that "We do have a representative registered under the Federal Lobbying Act for the purpose of necessary contacts on national legislation affecting the rights of gun owners."

Hence, Wayne, if it is legal for the NRA to have a lobbyist would it not also follow that it would be legal for ARRL to do likewise, if it wished to?

Clayton C. Gordon W1HRC
P.O. Box 85-West Main St.
West Millbury MA

Nonprofit does not mean tax-free. You will find that the NRA is not *tax-free, that they are paying their way like any other business even though they are nonprofit. The ARRL saves thousands of dollars a year by being tax-free and this means that they cannot by law register as a lobbyist in Washington for amateur radio.*

. . . Wayne

Democratic?

Would you perhaps like to mention in a future column that while ALL licensed amateurs are eligible for "FULL" membership in the ARRL, only those holding a general or higher class license are eligible to hold office. A quick look at the breakdown of licensees in the callbook will convince you that the ARRL is not by any meaning of the word a democratic organization. As a number two punch you might look into the awarding of the Ø QSL bureau. I understand that this situation stinks to high heaven too.

Col. D. Lester W1AER

The League system of government is comforting to those in charge and a frustration to any members who are concerned over League HQ actions. The March 1970 QST editorial tells members not to write to HQ, just to their directors, if they have a complaint. The feeling, right or wrong, is that writing to the director is futile since this "representative" appears at HQ but one or two days a year of highly structured routine meeting work. This means that the possibility of any individual being represented is virtually nil. The boss that comes to work one or two days a year has no real idea of how the business is really going, no idea of the competence of the employees, and no opportunity *whatever to hire and fire employees, no matter how bad things may get. The employees are the ones running the company in this situation, not the bosses (directors).*

. . . Wayne

Printed Circuits

I have just finished reading with some interest the PCB article by Ken Sessions, and would like to pass along a few additional hints for the benefit of those readers who are not familiar with circuit board fabrication. I have used these methods both for "homebrew" projects and also for the building of several items which have flown in NASA sounding rockets and other space-qualified hardware, they have worked out quite successfully with high resolution boards. We have achieved, at best, conductor widths of .02" and spacings of .05" under conditions which most amateurs can duplicate using conventional photo methods. However, back to the hints for use with the Bishop system.

A "bug light" of 60 to 100 watts is quite satisfactory for a safe working light while working with sensitized boards, and gives quite adequate light levels.

A low-cost UV exposure light can be made from a desk-type fluorescent lamp by replacing the normal bulb with a "blacklight" lamp that emits light primarily in the violet and near-UV. Hope these additions to the info already given will be of use to someone wanting to turn out some home built gear. There are too few builders left on the ham bands.

Jack Dugan W2IAX/2
209 Catherine St.
Scotia NY

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May 1970

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3	(4)	(5)	(6)	(7)	(8)	9
(10)	(11)	(12)	13	(14)	(15)	(16)
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EASTERN UNITED STATES TO:

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AUSTRALIA	21	21	14	14	7B	7B	14	14	14	14	21	21
CANAL ZONE	21	14	14	14	14	7	14	21	21	21	21	21
ENGLAND	14	7	7	7	7	7A	14	14	14A	14A	14A	14
HAWAII	21	21	14	7A	7	7	7	14	14A	21	21	21
INDIA	14	7A	7B	7B	7B	7B	14	14	14	14	14	14
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PUERTO RICO	14	14	14	7A	7	7	14	14A	21	21	21	21
SOUTH AFRICA	14	14	7B	14	14	14A	21	21	21	21	21	21
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WEST COAST	21	21	14	14	7	7	7A	14	14A	14A	21	21

CENTRAL UNITED STATES TO:

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ARGENTINA	21	21	14	14	14	7A	14	21	21	21	21	21
AUSTRALIA	21	21	21	14	14	14	14	14	14	14	21	21
CANAL ZONE	21	21	14	14	14	14	14	21	21	21	21	21
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PHILIPPINES	14	14	14	14	7B	7B	7B	7B	14	14	14	14
PUERTO RICO	21	14	14	14	7	7	14	21	21	21	21	21
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WESTERN UNITED STATES TO:

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ARGENTINA	21	21	14	14	14	7A	7A	21	21	21	21	21
AUSTRALIA	21A	21A	21	21	14	14	14	14	14	14	21	21A
CANAL ZONE	21	21	14	14	14	14	14	14A	21	21	21	21
ENGLAND	14	7B	7	7	7	7B	7B	14	14	14	14	14
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A = Next higher frequency may be useful also.
B = Difficult circuit this period.

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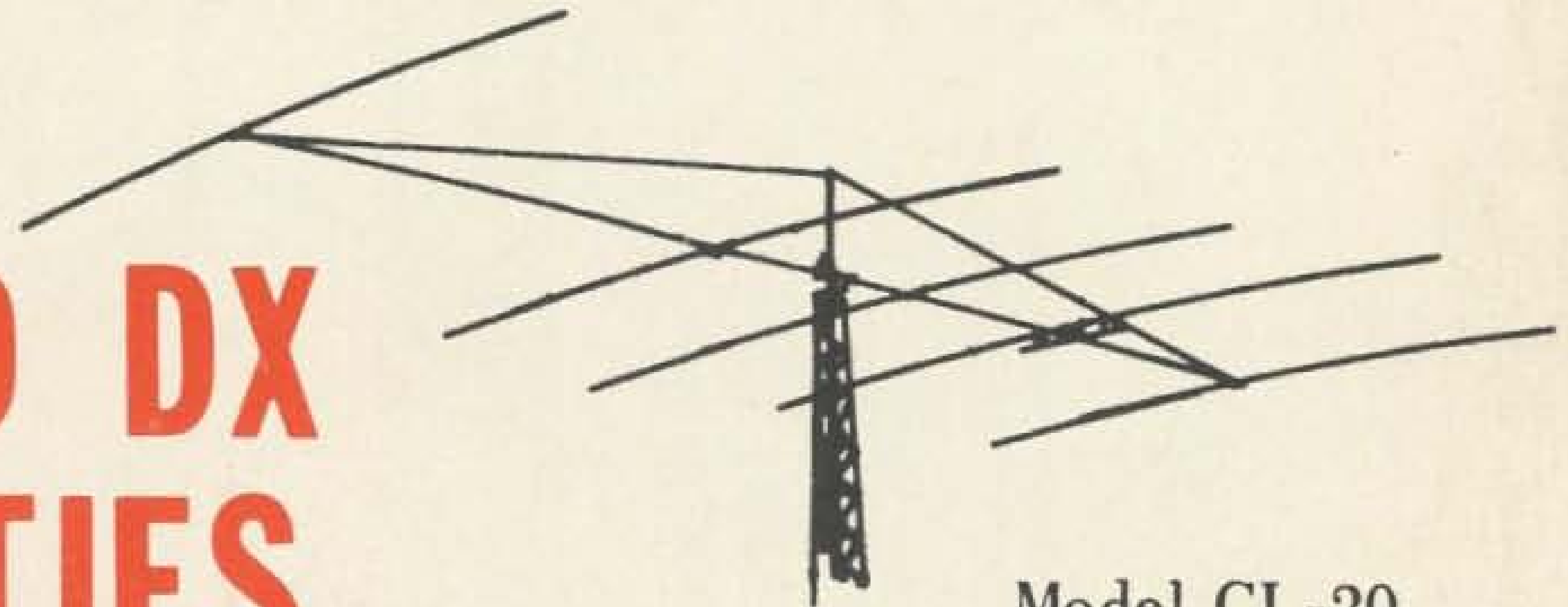

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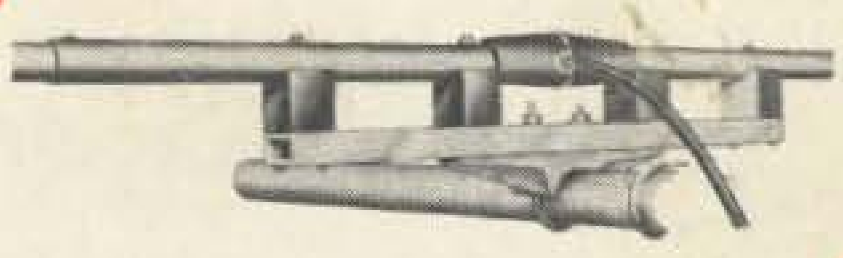

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