January 1978 $2.00

73 AMATEUR RADIO

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(see page 5)


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NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

ARRL BRAGS AGAIN

The League recently sent a newsletter to God-knows-who bragging about the ARRL defeat of the 220 MHz CB proposal. There are many areas where the ARRL can rightfully claim credit, so it ill befits them to step in and bray about things where they were minor participants, at best.

One of the key moves which blocked the attempted grab of 220 by the CB industry was the stiff opposition to it by both Canada and Mexico. I note that the ARRL gives no credit to the ham who spearheaded the responses from these countries.

Another important blocking move was the proposed Communicator class license which was filed with the FCC as an alternate to the CB use of 220. The ARRL makes no mention of this or the ham who filed it.

Probably the most important factor in ending the 220 MHz CB threat was the serious wounding of the CB industry by its own greed. This helped shut off the free-flowing funds to the EIA, thus reducing the lobbying pressures on the FCC and the OTP. This was largely a battle of money and political influence, and much less one of practical right and wrong.

Another factor was the removal of Prose Walker from heading the amateur and CB division of the FCC, and here the ARRL has nothing to brag about. They refused to speak up in any way, no matter how outrageous Walker's dictatorial rules became. They even refused to participate in the first ham hearing before the FCC which was set up to protest the repeater rules specifically and the strong move toward over-regulation in general. One of the important points made during this hearing was the amateur opposition to CB use of 220 MHz . . . and the need for a Communicator license . . . which the ARRL at first opposed vigorously.

No, none of these events or the people who made them happen are given any credit . . . only the ARRL and its 3/4-pound official filing.

GREATEST THREAT?

The ARRL newsletter, written by Baldwin, shows where ARRL priorities are when he states that "one of the greatest threats to amateur radio today comes from the use of ham gear by unlicensed people." Baldwin is not even worried about the ITU and WARC – only about a small handful of bootleggers, numbering in the dozens.

If the facts were to be known, I wouldn't be surprised if there isn't a lot more pirate operation by licensed hams than by CBers. The chaps getting caught and arrested for profane language on the ham bands are licensed amateurs . . . even Extra class amateurs. Hams are even being caught lousing up the CB channels with profanity . . . Extra class hams.

There is nothing happening in the way of bootlegging on our ham bands by CBers that we can't handle all by ourselves. Sure, we need to get busy and come up with some direction-finding circuits and equipment . . . and we need to learn how to use them. We need to swap ideas on how to convince bootleggers that they really should take the trouble to get a ham license. I think we're smart enough and have enough interest in our hobby to be able to do that and prove to the FCC and even to the ARRL that we are self-policing.

ARRL CREDITS

The League undoubtedly helped in many ways to defeat the CB on 220 MHz proposal, but how much nicer it would have been if they had gone out of their way to give credit to some of the hams who spent a lot of time and effort fighting that fight . . . and winning it . . . rather than try to put everyone else down and grab all the credit for the League. The Red Cross has developed a reputation for this, and I think it has hurt them a lot. Let's tell the ARRL directors to cut out this rot. It is a mark of insecurity and inferiority to brag and exaggerate like that.

ARRL DELAYS 21103

One of the most basic philosophical gaps between me and League supporters has to do with motivation. The League almost invariably wants to use punishment and more laws as a way to force people to do what they think best. I believe that responsibility and reason will do better in the long run. I have psychology on my side.

The League wanted hams to go for higher classes of license, so they pushed the FCC into "incentive licensing." This beaut took away about half of the phone bands from General class hams and forced them to get an Advanced class to get the bands back. Punishment. This was undoubtedly the worst debacle in the history of amateur radio. Amateurs dropped out or got so mad they stopped buying ham gear for almost ten years . . . and the growth of the hobby stopped cold for the same period.

Old-timers will remember firms such as Hallicrafters, National, Johnson, B&W, etc. These were the biggies of the 50s. They're all gone now as far as amateur radio is concerned, driven out or killed by incentive licensing.

The deregulation of two meters looks to me to be a good thing. Sure, if we don't act responsibly, we can make a mess of it. We can louse up satellite signals, experimental repeaters, weak signal experimenters, etc. I say it is time amateurs were treated like adults instead of children. We showed we could handle ourselves when we had repeater problems . . . we solved them . . . and we were all the better for it. The ARRL is saying to the FCC that amateurs are unable to cope with responsibility and must have laws to force them to do what the League thinks best. I disagree, and think the FCC should continue with its deregulation.

TEN COMES BACK

With the return of some sunspots to our lives, we will be seeing more and more skip on ten meters.

And with the ban on selling 23-channel CB sets after January first (unless there is an extension by the FCC), we may see a lot of instantly-converted CB sets appearing which have been moved up 2 MHz and are now 10m rigs. The prices should be right and, as long as we insist on talking only to amateurs, we'll have a benefit.

Ten meters can use all the activity we can muster, so these low-cost AM transceivers are a good deal. With them converted to exactly 2 MHz above the CB band, the low-powered signals will be starting at 28.965 MHz and going up to around 29.255. This is well above the sideband part of the band and the DX portion, so there should be little interference from the

Continued on page 161

KENWOOD

. . . pacesetter in amateur radio

Here's a new and versatile accessory from Kenwood that belongs in every station. The AT-200 is an antenna tuner, but it's also much more. It's an antenna switch, an SWR bridge and an in-line wattmeter. The AT-200 reduces the clutter and increases the operating efficiency of your station . . . and at a surprisingly moderate price.

The AT-200 features a seven position rotary switch that selects 1 of 3 antennas and connects it through the antenna tuner circuit or directly to the transceiver. The 7th position allows you to connect a dummy load directly to your transceiver for tune up and testing. Two of the antenna inputs are fitted with SO-239 type coax connectors. A third input allows for easy hook up of a wire antenna with an inpedance of 10 to 500 ohms. The AT-200 may be used on all HF amateur bands from 160 to 10 meters. It's handsomely styled to match the TS-820S and TS-520S Series (and TS-820 and TS-520), but can also be used with any HF transceiver or transmitter with less than 200 watts output.

Frequency Coverage: Amateur bands 1.8 to 30 MHz • Input Impedance: 10 to 500 Ohms • Maximum Power Capability: 200 watts • Insertion Loss: 0.5db • Power Meter: 20 watt/200 watt full scale • SWR Meter measures up to 10:1 • Dimensions 6-1/2" W x 7-3/8" D x 6-9/16" H • Weight: 6.2 lbs.

AT-200 WITH THE TS-820S

The MC-50 dynamic microphone has been designed expressly for amateur radio operation as a splendid addition to any Kenwood shack. Complete with PTT and LOCK switches, and a microphone plug for instant hook-up to any Kenwood rig. Easily switched for high or low impedance. (600 or 50k ohm).

The TS-820S . . . still the Pacesetter. It has proven itself to be the performer we promised, proven itself through thousands of hours of operating time, worldwide and under the most difficult conditions. Unique features, superb specifications and top quality construction . . . all hallmarks of Kenwood amateur products are eminently displayed in the TS-820S. But then, you've probably heard all that on the air by now.

Trio-Kenwood Communications Inc.
1111 W. Walnut, Compton, CA 90220.

LETTERS

BEATING THE DRUM FOR 10

I read W2NSD/1's editorial in *73* (Oct. 1977), in which he said he had served aboard the submarine *USS Drum*. I want to be sure that he knows that we have the *Drum* here in Alabama. It, along with the battleship *USS Alabama*, is visited by many tourists each day. The ships lie in Mobile Bay, just east of Mobile. I felt that he knew this, but he did not indicate it in his editorial.

I am a new ham of just 14 months, and I enjoy your magazines very much. I especially enjoy the technical amateur radio articles, the editorial, and the letters to the editor. I also enjoy the ham-related human interest stories.

I am in favor of 10 meter AM operation on 28.965-29.255 as stated in the letter from W8LSS. I have acquired an old Johnson Messenger Two and am waiting to see where everyone is going on 10 AM before buying $110 worth of crystals. I will not, however, install crystals which will interfere with frequencies now in use by SSB, as I am a 10-10 net member and intend to stay on 10 meters SSB.

S. K. Hillman WA4TYH
E. Brewton AL

Yes, the Drum *crew holds a reunion every year on the old boat. It's fun to go aboard and remember the interesting times we had on her . . . over 30 years ago. The two MHz higher plan for converting CB to the ham 10m band seems to be winning out, so let's modestly call that the "73 Plan." Standard Communications is now making a conversion of their great Horizon 29 for this band . . . as is Bristol Electronics. Who knows, we may end up with tens of thousands of 10m mobile hams. I would suggest that we plan on channel 1 as a calling channel . . . 28.965 MHz. This system is good because it puts the low-powered CB rigs above the hurly-burly of 10m DXing in the 28.5 to 28.9 MHz part of the band . . . and still it avoids the satellite part of the band, too, up around 29.4. — Wayne.*

ANOTHER ORGANIZATION?

For over a year now, I have read editorials by you criticizing the ARRL, the FCC, and probably others I cannot recall. I have also read, with a great deal of interest, your comments on various aspects of amateur radio regulation.

Sometimes I wonder if anyone will find a way to solve some of the problems. Perhaps you could find a way to exercise your leadership even more. To a relative newcomer to amateur radio, such as myself, the uproar seems both confusing and useless — a lot of discussion but no real solutions. Many of your ideas seem valid, but what good are ideas if they are not implemented?

I am a member of the ARRL and am active in teaching Novice classes. To be honest, what alternative is there? No other large organization represents hams, and when the ARRL tries to do something, they are whipped down. (Witness Dick Cowan's complaint to the FCC regarding the "code of ethics," and the communications attorneys service proposed lawsuit.) It seems almost impossible to get anything done. You say that the ARRL is only a publisher (a competitor, no less!), but aren't they attempting to become more? Is there something wrong with *trying* to represent amateurs? (Possibly unsuccessfully?)

Perhaps you should start another organization.

That's OK, and many, including myself, would probably join if it would help.

Perhaps you could organize a lobby to get some teeth into the law and the enforcement machinery (nonexistent except to punish amateurs; apparently everyone else does what he wants, or so it seems).

Personally, I just wish someone would do something. If I had time and money, I would try to do something myself. It is extremely frustrating to work for that hard-to-earn ticket in order to be able to use a band, and then find illegal CBers (or whatever they're called) using that band with impunity — and manufacturers selling them the gear with which to do it.

For my part, I do not understand why the manufacturers have to be under a code of ethics. If I made or sold ham equipment and needed to make a buck more, I don't think I would feel right about selling to unlicensed operators. If the business is that marginal, then they should get out of it or, better yet, diversify into the CB radio business and try to persuade CBers to get ham tickets. Perhaps I just don't understand greed.

The entire matter is upsetting and leaves one with a feeling of hopelessness. I am probably missing some points because I am only a newcomer (licensed about 1½ years) to amateur radio, but perhaps if I express my feelings, my naiveté will be overlooked and someone will find a way to *do something!*

Jim Clark N5RO
Houston TX

Oddly enough, Jim, the more you know about the situation, the more upset you are. My own problems are much the same as yours . . . a lack of time and money. I did, a few years ago, organize a lobby for amateur radio, but I found that I was unable to outspend the League to keep this going. The League appears to be willing to spend any amount necessary to put down any possible second group that might get started . . . they've got over $1 million available . . . just in case you ever wondered for a minute why there is one and only one national ham organization. — Wayne.

"WHY NOT?"

A couple of comments on the practice tapes.

I picked up a 14 wpm tape a few months ago when I decided to get my license back and equip myself to use the autopatches. It's been a real help in recovering my rusty reflexes, though I still confuse B with 6, especially when my attention wanders or I start copying a couple of letters behind.

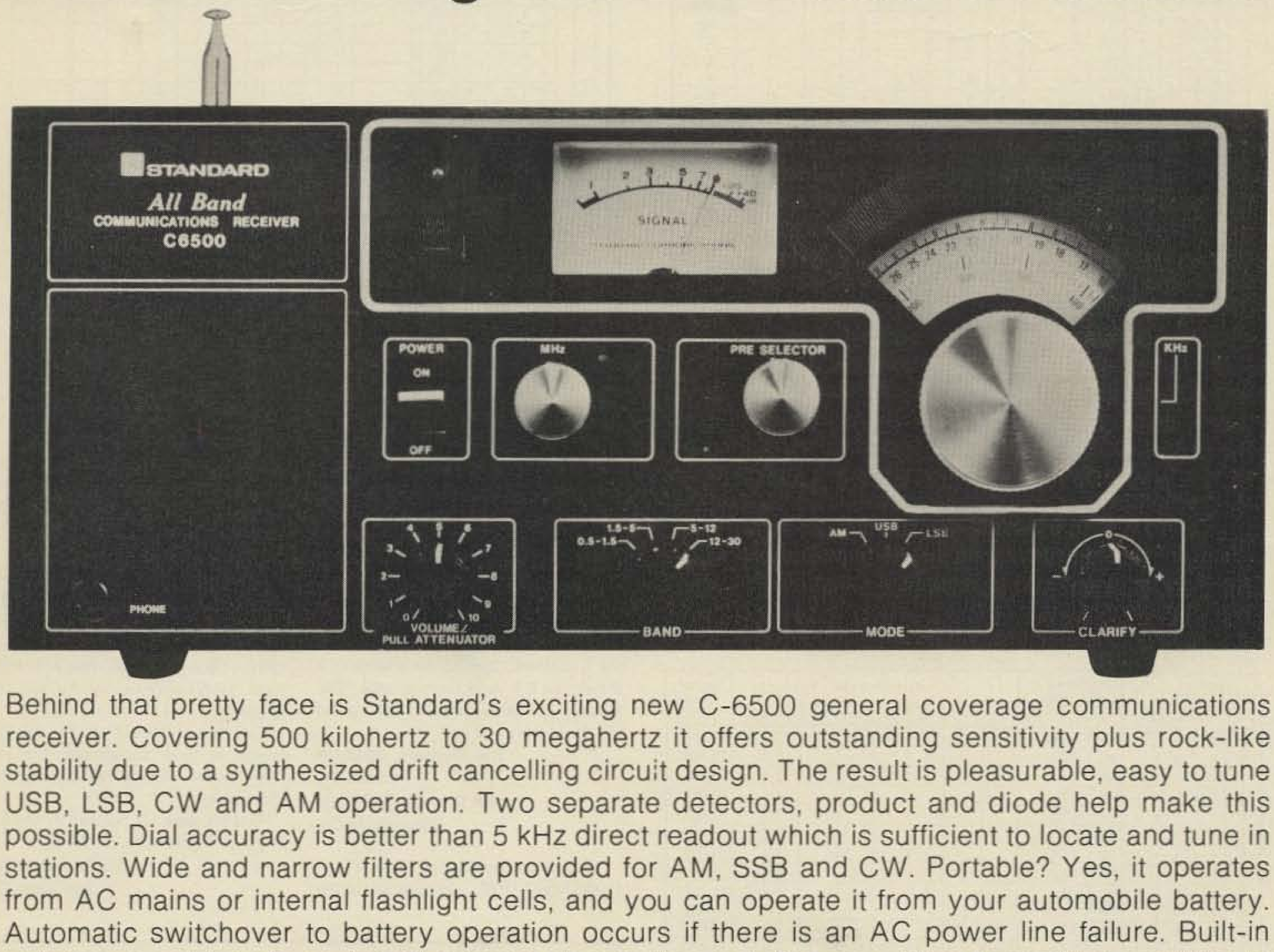
At any rate, at about the time I got so I could copy the tape pretty near solid (except for those pesky Bs and 6s), I took another pass through the study material and the rules as a last review before going in for the Advanced. On the spur of the moment, I decided to take a look at the Extra material as well. Hmmm. Not really all that rough. Hmmm. So the next time I was in Tufts Radio, I got a 21 wpm cassette and started it just to see how hard it was. I was very surprised (make that astonished) to find that I

Continued on page 175

The crew of the USS Drum *at their 1977 reunion. W2NSD/1 is at far right, second row. (Photo by Dave Hamby.)*

...a new STANDARD of PERFORMANCE!

Introducing Standard's new C-6500 General Coverage Communications Receiver!



Behind that pretty face is Standard's exciting new C-6500 general coverage communications receiver. Covering 500 kilohertz to 30 megahertz it offers outstanding sensitivity plus rock-like stability due to a synthesized drift cancelling circuit design. The result is pleasurable, easy to tune USB, LSB, CW and AM operation. Two separate detectors, product and diode help make this possible. Dial accuracy is better than 5 kHz direct readout which is sufficient to locate and tune in stations. Wide and narrow filters are provided for AM, SSB and CW. Portable? Yes, it operates from AC mains or internal flashlight cells, and you can operate it from your automobile battery. Automatic switchover to battery operation occurs if there is an AC power line failure. Built-in antenna, provisions for external antenna plus muting jack for use with a transmitter combine to make this receiver the top of its price class. Price? Just $349! See it at your dealer now or write us for a complete spec sheet.

P.S. Don't forget our VHF 146A 2 meter handie-talkie . . . it's tops too!

Standard Communications

Standard Communications Corp.
P.O. Box 92151
Los Angeles, CA 90009

S18

Corrections

Regarding "ASCII To Baudot Converter," *73 Magazine*, February, 1976: Tables 1 through 3 are listings of the PROM programs for the U4, U5, and U6 PROMs (respectively) used in the ABC-1 article. 82S23 PROMs may be used instead of the specified 8223. However, the 82S23 may be programmed with a slightly higher programming voltage. See the manufacturers' data sheets.

EDI no longer supplies PCBs or programmed PROMs for this unit, and no other source for boards is known at this time. Vectorboards and wire-wrap techniques provide a good alternate method of construction for the ABC-1.

Cole Ellsworth W6OXP
Garden Grove CA

ADDRESS (ASCII INPUT)				DECIMAL ADDRESS		OUTPUT DATA (BAUDOT)								USER'S CHARACTER
A8	A7	A6	A5 A4 A3 A2 A1	& ASCII CHR		B1	B2	B3	B4	B5	B6	B7	B8	
			0 0 0 0 0	000	@									BLANK
			0 0 0 0 1	001	A	1	1	0	0	0				A
			0 0 0 1 0	002	B	1	0	0	1	1				B
			0 0 0 1 1	003	C	0	1	1	1	0				C
			0 0 1 0 0	004	D	1	0	0	1	0				D
			0 0 1 0 1	005	E	1	0	0	0	0				E
			0 0 1 1 0	006	F	1	0	1	1	0				F
			0 0 1 1 1	007	G	0	1	0	1	1				G
			0 1 0 0 0	008	H	0	0	1	0	1				H
			0 1 0 0 1	009	I	0	1	1	0	0				I
			0 1 0 1 0	010	J	1	1	0	1	0				J
			0 1 0 1 1	011	K	1	1	1	1	0				K
			0 1 1 0 0	012	L	0	1	0	0	1				L
			0 1 1 0 1	013	M	0	0	1	1	1				M
			0 1 1 1 0	014	N	0	0	1	1	0				N
			0 1 1 1 1	015	O	0	0	0	1	1				O
			1 0 0 0 0	016	P	0	1	1	0	1				P
			1 0 0 0 1	017	Q	1	1	1	0	1				Q
			1 0 0 1 0	018	R	0	1	0	1	0				R
			1 0 0 1 1	019	S	1	0	1	0	0				S
			1 0 1 0 0	020	T	0	0	0	0	1				T
			1 0 1 0 1	021	U	1	1	1	0	0				U
			1 0 1 1 0	022	V	0	1	1	1	1				V
			1 0 1 1 1	023	W	1	1	0	0	1				W
			1 1 0 0 0	024	X	1	0	1	1	1				X
			1 1 0 0 1	025	Y	1	0	1	0	1				Y
			1 1 0 1 0	026	Z	1	0	0	0	1				Z
			1 1 0 1 1	027	[									BLANK
			1 1 1 0 0	028	\									BLANK
			1 1 1 0 1	029	]									BLANK
			1 1 1 1 0	030	^	1	1	0	1	1				FIGS
			1 1 1 1 1	031	DEL	1	1	1	1	1				LTRS

Table 1.

ADDRESS (ASCII INPUT)				DECIMAL ADDRESS		OUTPUT DATA (BAUDOT)								USER'S CHARACTER
A8	A7	A6	A5 A4 A3 A2 A1	& ASCII CHR		B1	B2	B3	B4	B5	B6	B7	B8	
			0 0 0 0 0	000	NULL	0	0	0	0	0	0	1		BLANK
			0 0 0 0 1	001	SOH							1		BLANK
			0 0 0 1 0	002	STX							1		BLANK
			0 0 0 1 1	003	ETX							1		BLANK
			0 0 1 0 0	004	EOT							1		BLANK
			0 0 1 0 1	005	ENQ							1		BLANK
			0 0 1 1 0	006	ACK							1		BLANK
			0 0 1 1 1	007	BELL	1	0	1	0	0	1	0		BELL
			0 1 0 0 0	008	BS							1		BLANK
			0 1 0 0 1	009	HT							1		BLANK
			0 1 0 1 0	010	LF	0	1	0	0	0	0	1		LINE FD
			0 1 0 1 1	011	VT							1		BLANK
			0 1 1 0 0	012	FF							1		BLANK
			0 1 1 0 1	013	CR	0	0	0	1	0	0	1		CR RTN
			0 1 1 1 0	014	SO							1		BLANK
			0 1 1 1 1	015	SI							1		BLANK
			1 0 0 0 0	016	DLE							1		BLANK
			1 0 0 0 1	017	DC1							1		BLANK
			1 0 0 1 0	018	DC2							1		BLANK
			1 0 0 1 1	019	DC3							1		BLANK
			1 0 1 0 0	020	DC4							1		BLANK
			1 0 1 0 1	021	NAK							1		BLANK
			1 0 1 1 0	022	SYN							1		BLANK
			1 0 1 1 1	023	ETB							1		BLANK
			1 1 0 0 0	024	CAN							1		BLANK
			1 1 0 0 1	025	EM							1		BLANK
			1 1 0 1 0	026	SUB							1		BLANK
			1 1 0 1 1	027	ESC							1		BLANK
			1 1 1 0 0	028	FS							1		BLANK
			1 1 1 0 1	029	GS							1		BLANK
			1 1 1 1 0	030	RS							1		BLANK
			1 1 1 1 1	031	US							1		BLANK

Table 2.

ADDRESS (ASCII INPUT)				DECIMAL ADDRESS		OUTPUT DATA (BAUDOT)								USER'S CHARACTER
A8	A7	A6	A5 A4 A3 A2 A1	& ASCII CHR		B1	B2	B3	B4	B5	B6	B7	B8	
			0 0 0 0 0	000	SP	0	0	1	0	0	1	0		SPACE
			0 0 0 0 1	001	!	1	0	1	1	0	0	1		!
			0 0 0 1 0	002	"	1	0	0	0	1	0	1		"
			0 0 0 1 1	003	#	0	0	1	0	1	0	1		# (H)
			0 0 1 0 0	004	$	1	0	0	1	0	0	1		$
			0 0 1 0 1	005	%							1		BLANK
			0 0 1 1 0	006	&	0	1	0	1	1	0	1		&
			0 0 1 1 1	007	'	1	1	0	1	0	0	1		' (J)
			0 1 0 0 0	008	(	1	1	1	1	0	0	1		(
			0 1 0 0 1	009	)	0	1	0	0	1	0	1		)
			0 1 0 1 0	010	*							1		BLANK
			0 1 0 1 1	011	+							1		BLANK
			0 1 1 0 0	012	,	0	0	1	1	0	0	1		, (N)
			0 1 1 0 1	013	-	1	1	0	0	0	0	1		- (A)
			0 1 1 1 0	014	.	0	0	1	1	1	0	1		. (M)
			0 1 1 1 1	015	/	1	0	1	1	1	0	1		/
			1 0 0 0 0	016	0	0	1	1	0	1	0	1		Ø
			1 0 0 0 1	017	1	1	1	1	0	1	0	1		1
			1 0 0 1 0	018	2	1	1	0	0	1	0	1		2
			1 0 0 1 1	019	3	1	0	0	0	0	0	1		3
			1 0 1 0 0	020	4	0	1	0	1	0	0	1		4
			1 0 1 0 1	021	5	0	0	0	0	1	0	1		5
			1 0 1 1 0	022	6	1	0	1	0	1	0	1		6
			1 0 1 1 1	023	7	1	1	1	0	0	0	1		7
			1 1 0 0 0	024	8	0	1	1	0	0	0	1		8
			1 1 0 0 1	025	9	0	0	0	1	1	0	1		9
			1 1 0 1 0	026	:	0	1	1	1	0	0	1		: (C)
			1 1 0 1 1	027	;	0	1	1	1	1	0	1		; (V)
			1 1 1 0 0	028	<							1		BLANK
			1 1 1 0 1	029	=							1		BLANK
			1 1 1 1 0	030	>							1		BLANK
			1 1 1 1 1	031	?	1	0	0	1	1	0	1		?

Table 3.

After reading my article, "Title Your Pix With A Micro," in the October, 1977, *73 Magazine*, I noted that I failed to include an important point. The character dot spacing is controlled by a delay constant. The constant may have to be modified for 50 Hz (Europe) operation or with different 6800 systems. The constant is: Location 1B30 = 50 Hex.

Clay Abrams K6AEP
San Jose CA

Please note two corrections to our article, "Receive CW With A KIM" (November, 1977). First, in Table 1, the 7-segment code for the character 9 should be E7. And second, page 104, column 2, line 42, should read: "press 'G'. Hold the *hand* key".

Bob Shattuck WB3GCP
Gillett PA
Bill Schmidt WB8VQD
Miamisburg OH

One correction for my "FCC Math" (November, 1977). On page 21, in the middle of the second paragraph from the bottom of column 4, the sentence that begins "If you're not quite sure how . . . " should read: "If you're not quite sure how we got rid of those last 3 zeros at the *end* of each number, go ahead and divide with the zeros left in and you'll find you get the same answer as you would without those zeros. This kind of simplification always works providing you drop the *same number . . .* "

John F. Leahy WB6CKN
Gonzales CA

Re my article in the November, 1977, issue ("Track OSCAR With Your SR-52 — requires the PC 100 option"):

The title is misleading. The PC 100 option is most convenient, but the "bare bones" SR-52 can use the program easily.

And on page 60, column 4, line 42, 703.77.07 should be 70377.07.

Art Burke W6UIX
San Diego CA

Ham Help

Our volunteer ambulance service needs information on where to obtain surplus commercial FM equipment. Any help would be greatly appreciated.

Central County Ambulance Service
c/o Don Mock
222 Wilson Ave.
Clarion PA 16214

Help! I'm going for my Novice exam in 3 weeks. The *73* code tapes have solved my code problems, and I've got the theory licked, but other complications have arisen. I'm trying to set up my station (a Hammarlund HQ-170 and a Hallicrafters HT-37), but somehow the owner's manual has gotten "mislaid." If some helpful person could send me an HT-37 manual (or a copy), I would be forever grateful. I'll be glad to pay any reasonable expense, so feel free to send it C.O.D. if you want. I need the information to set up my T-R hookup.

Michael D. Ward
3653 Lora St.
Ft. Myers FL 33901
(813) 694-6655

RTTY Loop

Marc I. Leavey, M.D. WA3AJR
4006 Winlee Road
Randallstown MD 21133

Perhaps if your interest in this series has been more than academic, by now you have a TTY machine in a working local loop. You may even have a TU under construction or on line. Hopefully, your appetite is now thoroughly whetted and you *want* to get on RTTY. With the discussion of transmitting techniques this month, I hope to get at least some of you on the air.

Let's step back for a few seconds to review. There are presently two methods currently in use to transmit amateur RTTY: Frequency Shift Keying (FSK) and Audio Frequency Shift Keying (AFSK). I will try to discuss these separately, only slightly interdigitated.

Remember that FSK involves changing the frequency of what is essentially a CW signal in step with the marks and spaces of a TTY signal. The convention presently observed on most amateur circuits is to shift the frequency *downward* for the space. In order to etch this into our minds, the following memory jog has arisen: LSMFT = LOW SPACE MEANS FINE TELETYPE. If there is anyone among you to whom "LSMFT" is a totally foreign string of letters, you are free to devise your own acronym. Thus, we will regard the frequency of an FSK signal as the mark frequency. The space frequency will be lower than the mark, the difference between them being the *frequency shift*. By law, the frequency shift must be less than 900 Hz. As a practical matter, hams long ago chose 850 Hz shift as a "standard." Over the last several years, so-called "narrow" shift, 170 Hz, has risen in popularity, and is rapidly replacing the old "standard."

In many respects, AFSK is analogous to FSK. Here, an *audio* tone is set at a mark frequency, and is shifted for space. Of course, AFSK is not a legal mode on the HF bands, but, as discussed a few months ago, it reigns supreme in the VHF spectrum. Interestingly, because of the evolution of AFSK techniques from FSK, shift convention is reversed from FSK. Here, the space is *higher* in frequency than the mark. Also, because no clear advantage arises from using narrow shift AFSK, 850 Hz shift AFSK is still rather common, with 2125 Hz mark and 2975 Hz space used most often. Now let's look at some circuits.

The frequency-determining circuits of most HF transmitters use an L-C network in the vfo. The most direct means of shifting the rf oscillator frequency is by changing, in small increments, the capacitance in the L-C network. With this in mind, the venerable shift-pot circuit evolved. A diode switch is used to connect or isolate a small capacitor in parallel with the main tuning one. By keeping the diode reverse biased, the keyboard is used to short forward current to ground during mark. Capacitance is added during space, giving a low space, high mark (LSMFT, remember?). Originally, the diode was a tube, such as the 6AL5, but, as the state of the art progressed, the 1N34 became a household word. The most popular version of the shift-pot circuit is shown in Fig. 1. The regulated voltage is normally available in any tube-type vfo, and the entire circuit is easily constructed on a small terminal strip. For a detailed discussion of the shift-pot circuit, see the May, 1965, issue of *QST*.

If a pure sine wave of a given audio frequency is transmitted on single sideband, the resultant rf output will be a CW signal, below or above the suppressed carrier, depending on whether the transmitter is producing lower or upper sideband, respectively. The difference frequency between the suppressed carrier and the CW signal will be the frequency of the original audio tone and, if a pure sine wave was used, there will be no spurious emissions. By extension, then, if a good quality AFSK generator is fed into an SSB transmitter, the output would be FSK! Since AFSK convention dictates low mark, use of lower sideband would produce normal, low space, FSK. If you are contemplating using this technique, however, remember that the transmitter must be scrupulously "clean" and free of carrier or unwanted sideband — and that the AFSK generator must produce pure sine waves without harmonics or "glitches."

Several modern transmitters lend themselves to FSK by relatively simple routes. Although the SB-303/401 combination by Heathkit sports a "RTTY" position on the function switch, this is not practical, as transmission and reception will be on different frequencies. A better way to use the Heathkit on FSK was covered in my article in the August, 1976, *73*. The circuit is also reprinted in *73*'s *New RTTY Handbook*, and is shown here in Fig. 2, if you missed it. WB8DMC shows how to adapt the shift pot to the Drake T4X-B, and W6OJF does the same for the Yaesu FT-101, both in the special "RTTY Edition" of *73* (September, 1977).

For those of you looking to get on AFSK, such as on two meters, suitable generators are simple and inexpensive. The requirement for pure sine wave emission is not as strict, and Fig. 3 diagrams a practical starting point. Originally published in *73*, January, 1972 ("AFSK Revisited," by WA3AJR), this circuit and article have also been reprinted in the *New RTTY Handbook*.

Next month, I'll go over some on-the-air procedures and answer questions. For those of you who have asked, I normally have a printer on the 80 meter W1AW bulletin frequency, 3623.2 kHz mark, 170 Hz shift, on autostart 24 hours a day. If I am home, I'll be delighted to QSO.

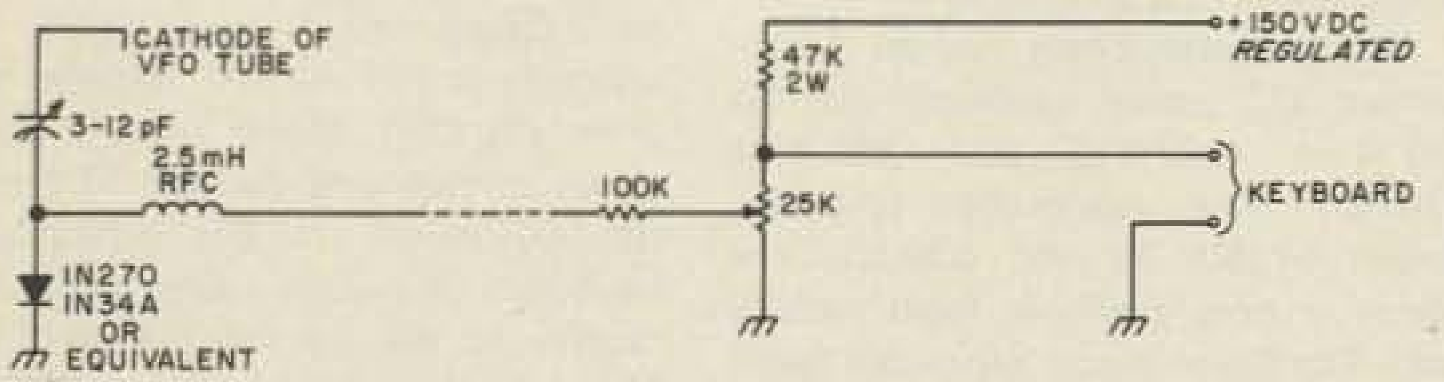


Fig. 1. Shift-pot circuit.

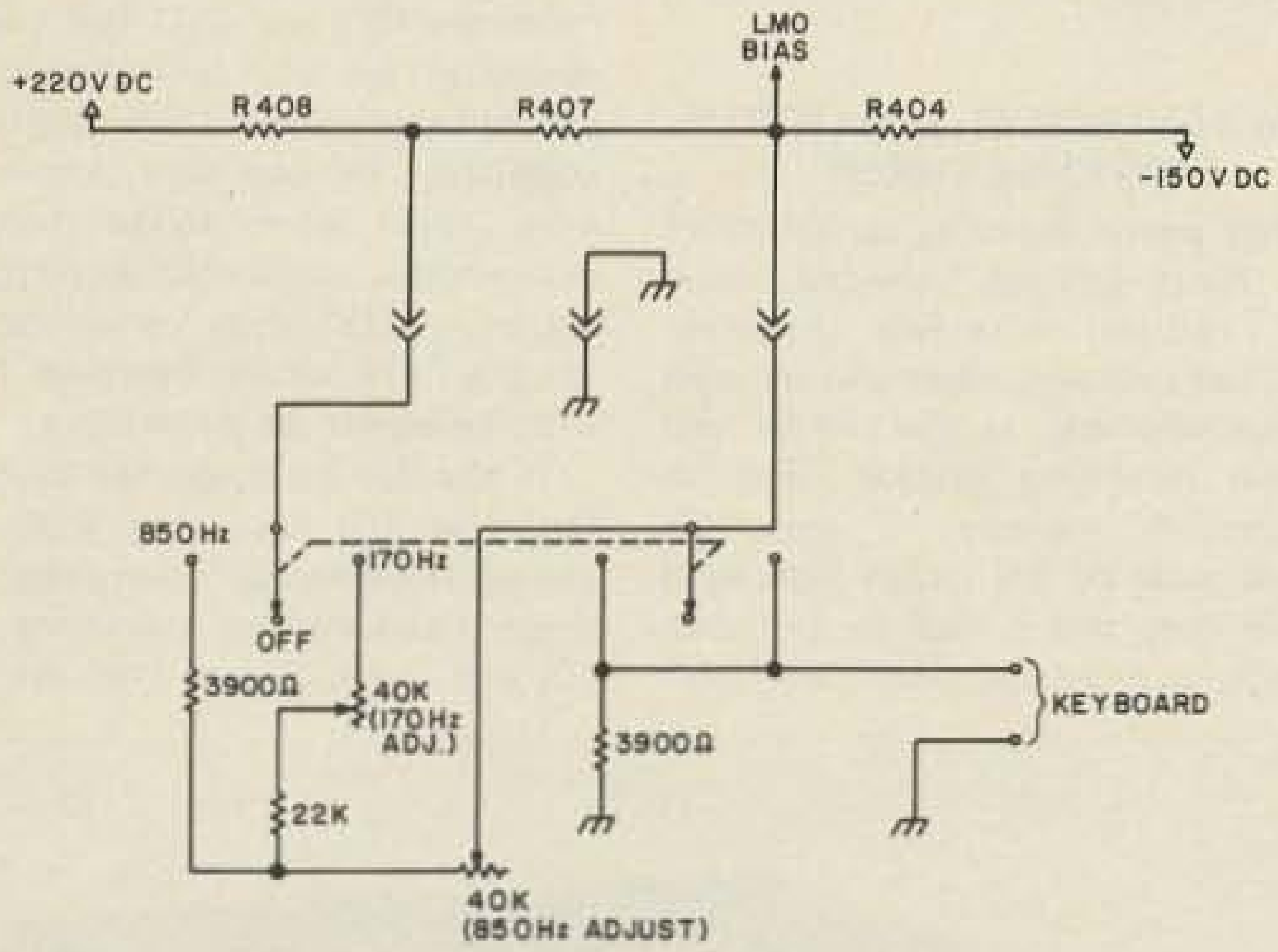


Fig. 2. Heathkit FSKer.

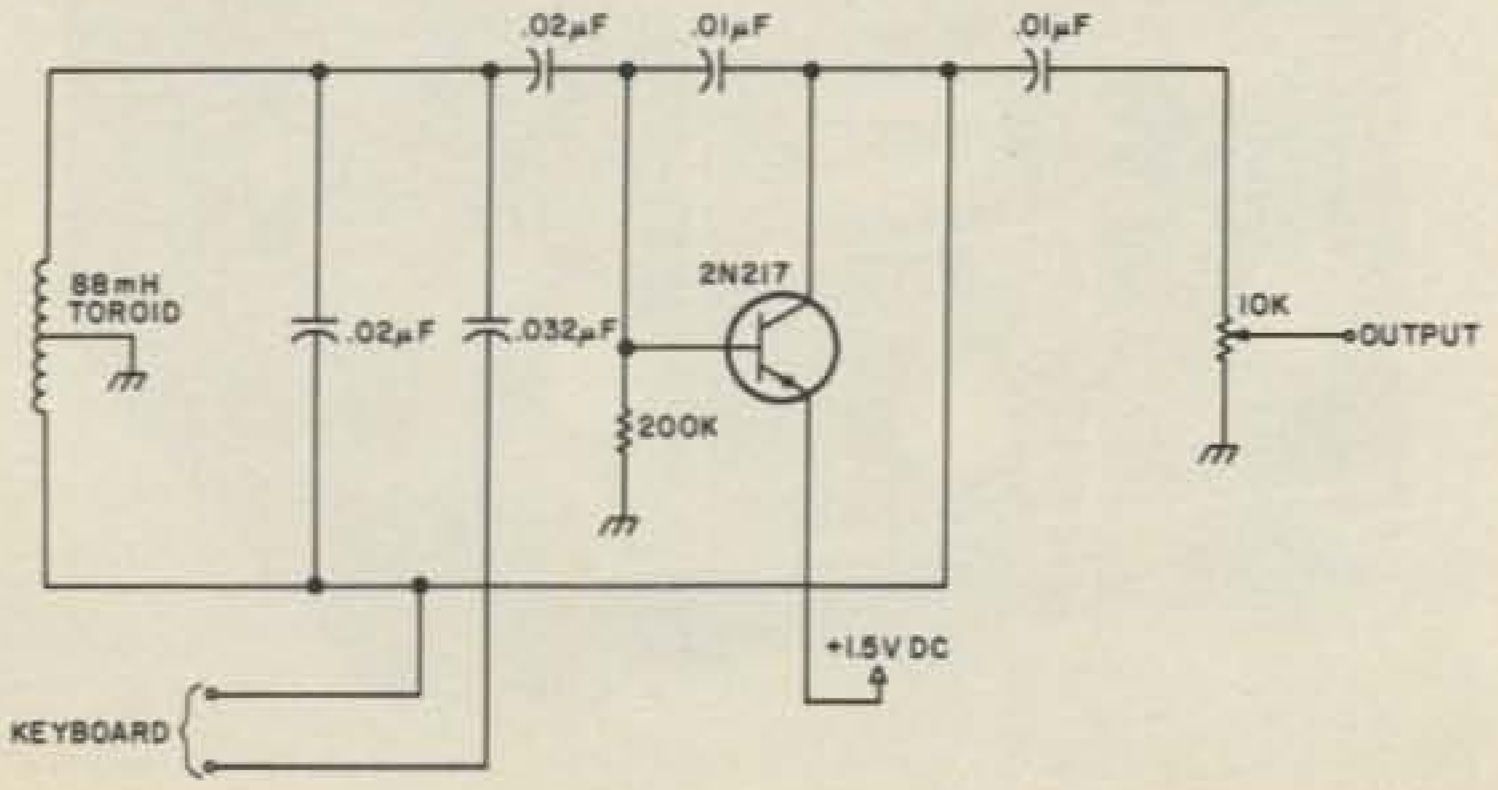


Fig. 3. AFSK generator.

AMSAT

Ross W. Forbes WB6GFJ is now serving as AMSAT QSL Manager for OSCAR cards in the United States. US users should send several #10 (business-size) SASEs with their callsign, in large letters, in the upper left-hand corner. One callsign per SASE, please. Each SASE should have only one ounce of first class postage affixed, and will be mailed when full. Outgoing DX OSCAR QSLs will be forwarded at a rate of 6¢ per card, or 20 cards for $1.00. Domestic OSCAR QSLs will be sorted and processed through the AMSAT-OSCAR QSL Bureau. Domestic OSCAR QSLs can be sent in bulk. For more detailed information concerning the AMSAT-OSCAR QSL Bureau, drop a note, with an SASE enclosed for the reply, to WB6GFJ, PO Box 1, Los Altos CA 94022, or call (916)-673-7677 (weekdays) or (916)-742-0572 (evenings/weekends).

Tracking the Hamburglar

STOLEN: Heath HW-2036 2 meter transceiver. SS No. etched on back. Contact Bobby Sorrow WA4GBM, 130 Sunset Dr., Athens GA 30606, (404) 548-6691, or the Athens police, (404) 543-1431.

RIPPED OFF: Atlas 350XL with DDG-XL digital dial, s/n 877025, and ac power supply for the Atlas, s/n 877104 DS. Taken on October 1, 1977. Jay A. Leonard W5TSM, Rt. 1 Box 32A, Pottsville AR 72858.

New Products

YAESU FT-901 DIGITAL TRANSCEIVER

Yaesu Electronics Corporation has revealed the newest addition to its extensive line of amateur radio equipment, the FT-901 Digital 200 Watt input transceiver with plug-in circuit boards.

The FT-901D covers the amateur bands of 160 through 10 meters, with provision for any new amateur bands that may occur as a result of the upcoming World Administrative Radio Committee's meeting in 1979.

Frequency readout to six places is accomplished by large red-colored LEDs, supplemented with a conventional analog dial. A unique feature is the built-in "memory," which allows split frequency operation without an external vfo. An optional memory unit expander allows many more specific frequencies to be stored and recalled at the operator's command.

A controllable i-f passband allows the operator to adjust i-f width from 100 Hz to 2.4 kHz, continuously. The famed Yaesu rejection tuning is also featured in the FT-901 series, as are sturdy 6146B finals, using an unusual rf negative feedback system to improve linearity. *Yaesu Electronics Corporation, 15954 Downey Ave., Box 498, Paramount CA 90723, (213)-633-4007.*

NEW MULTIFREQUENCY TONE ENCODER/DECODER

American Microsignal Corporation is offering its newest single- or multi-frequency subaudible tone encoder/decoder, model 592.

The unit is available in three configurations — the 592B for direct retrofit in Motorola Motrac, Mocom, and Micor radios, the 592D for General Electric Master Pro, Executive, and Royal radios, and the 592F for use in RCA solid state radios.

The AMC unit is completely compatible with all of these Motorola, General Electric, and RCA subaudible tone systems and is available in either standard or special frequencies, from 20.0 Hz to 250.0 Hz. Provision has been made to accommodate up to six tone frequencies, which may be electronically switched if required. The unit also has the capability of automatic revert for common encode or common decode configuration. The multifrequency circuitry can be provided from the factory or added in the field. Complete step-by-step instructions are provided in a comprehensive installation and service manual.

Applications engineering assistance is available from the AMC customer service department. For more information, contact *American Microsignal Corporation, 8431 Monroe Ave., Stanton CA 90680, or call (714) 761-1222.*

PROM PROGRAMMER

Oliver Audio Engineering now has a new low-cost series of piggyback PROM programmers. For example, the PP-2708/16 PROM programmer plugs directly into any 2708 or TMS-2716 memory socket. The PROM to be programmed is placed in the zero-insertion force socket, and the data is dumped over the 8 lower address lines, using OAE's proprietary interface technique (pats. pending). No additional power supplies are required, and all timing and control sequences are handled by the programmer. Because of this simple interfacing technique, only a short software routine is required to give you the power of even the most expensive programmers. In addition, multiple programmers may be connected in parallel for gang programming.

Each unit comes complete with a dc-to-dc switching regulator, 10-turn cermet trimmers for precise voltage and pulse-width alignment, and a zero-insertion force socket. The unit is packaged in a handsome black anodized aluminum case for tabletop operation. A 5-foot flat-ribbon cable interconnects the programmer with the read-only PROM socket via a 24-pin plug.

The kit price is $249.00. Assembled, tested, and aligned, it's $295.00. (For a limited time, OAE is shipping the assembled, tested, and aligned unit for the kit price!) *Oliver Audio Engineering, Inc., 676 West Wilson Avenue, Glendale CA 91203.*

ALL-GOLD METALLIZATION PRODUCES RUGGED VHF POWER TRANSISTORS

Dissimilar metal interfaces, which can impair the reliability of military-grade rf power transistors, are eliminated in Motorola's new MRF314-317 series of VHF devices. Gold chip metallization, gold wire-bonds, and gold-plated package interfaces produce ruggedness suitable for new, wideband, multimode VHF systems. The 28-volt, 30-to-100-Watt series offers gains from 9 to 10 dB guaranteed at 150 MHz, and is characterized from 30 to 200 MHz. Ruggedness is assured by 100% testing to withstand a load vswr of 30:1 at rated output power.

The 30-Watt MRF314 and MRF314A, in stripline opposed emitter packaging, are priced at $11.00 in 100-piece lots. The similarly-packaged MRF315 and MRF315A, rated at 45 Watts, are 100-piece-priced at $16.50.

Higher-power types, in the "Controlled Q" power package, are the 80-Watt MRF316 and 100-Watt MRF317, at respective 100-piece prices of $34.50 and $39.50. The series is now available from factory and distributor stock. *Motorola Semiconductor Products, Inc., PO Box 20912, Phoenix AZ 85036, (602)-244-6900.*

NEW DENTRON JR. MONITORTM ANTENNA TUNER

With power handling capability of 300 Watts through balanced, coax, and random-wire-fed antennas, DenTron's newest tuner also includes a relative-power output meter and mobile mounting bracket. The Jr. MonitorTM measures a mere 5½ inches wide by 2¾ inches high by 6 inches deep and is ideal for portable, mobile, or fixed operation. DenTron's latest is also ideal for SWLs. Designed to handle virtually any transceiver or receiver-transmitter combination, the Jr. MonitorTM is priced at $79.50. *DenTron Radio Company, 2100 Enterprise Parkway, Twinsburg OH 44087, (216)-425-3173.*

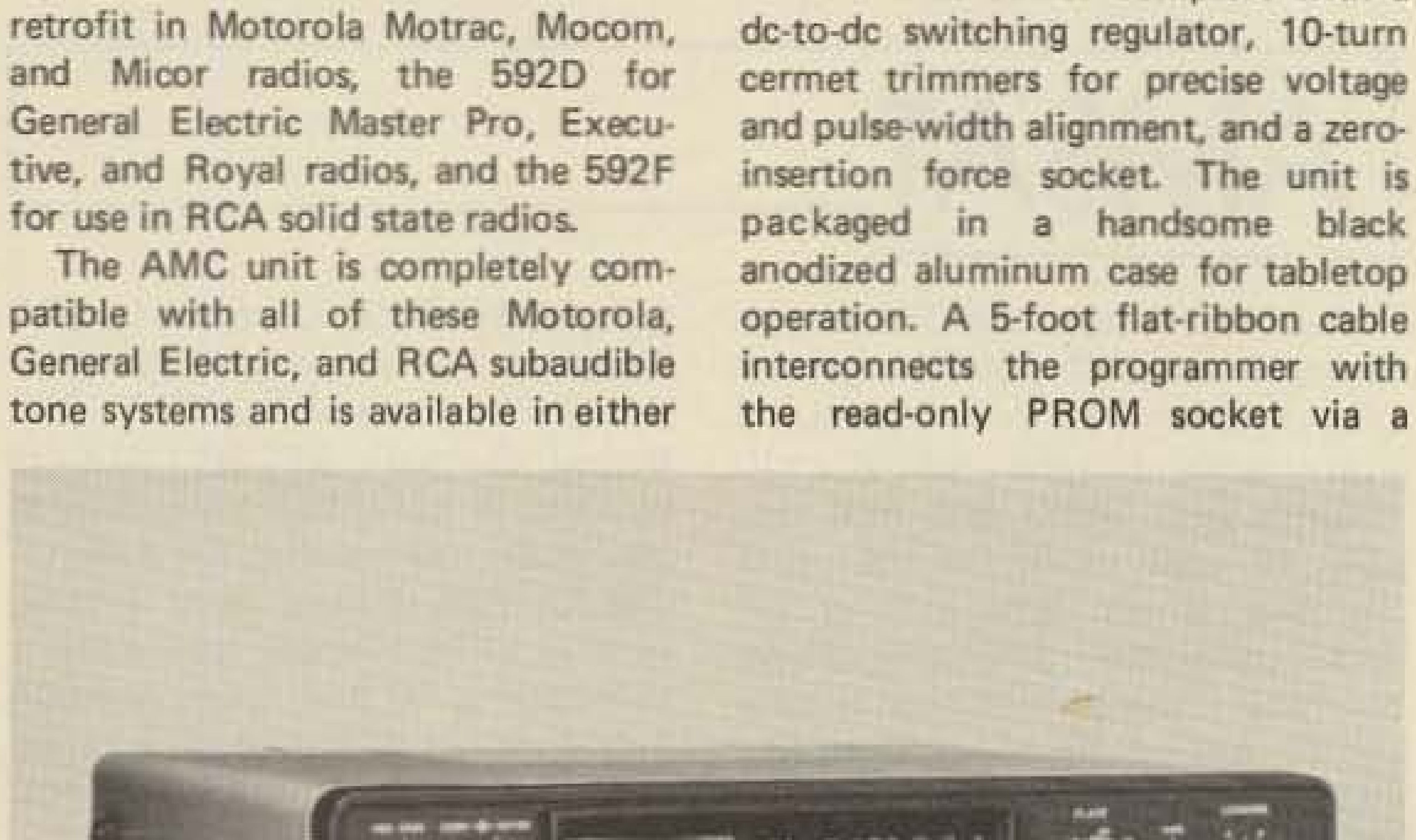
NEW HAMTRONICS CATALOG

Hamtronics, Inc., announces publication of a new expanded 1978 catalog crammed with goodies for VHF/UHF and OSCAR enthusiasts. The 40-page catalog features a new line of VHF and UHF receiver converters, new VHF and UHF FM receiver kits, receiver preamps, FM transmitter kits, power amplifiers for VHF and UHF, test-probe kits, power supplies, tone pads and tone-encoder microphones, antennas, and many more items of interest to the active ham! For your copy of the new 4 x 5½-inch catalog, send a self-addressed stamped envelope to *Hamtronics, Inc., 182 Belmont Rd, Rochester NY 14612.*

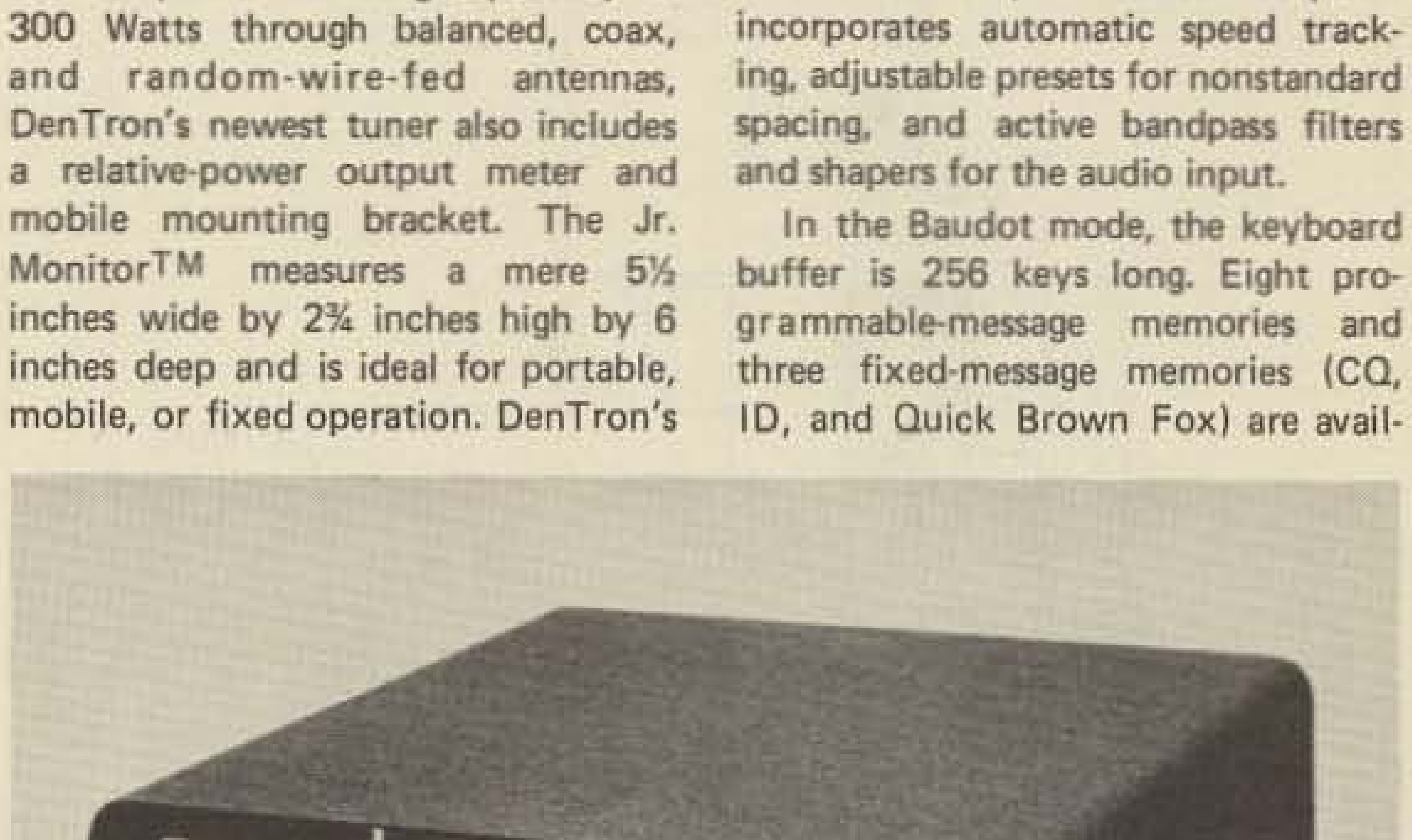
HAM COMPUTER PROCESSES MORSE AND BAUDOT

A complete computerized Morse and Baudot operating system for the amateur radio operator was released recently by Curtis Electro Devices, Inc. Called the System 4000, the instrument will receive, decode, and print via CRT Morse code (10-100 wpm) or five-level Baudot TTY code (60-100 wpm). It also serves as a keyboard or paddle keyer, with CRT display of the transmitted text. The Morse keyboard provides a 500-key buffer, eight programmable-message memories, and two fixed-message memories (CQ and ID). The message memories are also available in the paddle-keyer mode. Code speeds are adjustable in one-wpm increments from 10-99 wpm. Morse reception incorporates automatic speed tracking, adjustable presets for nonstandard spacing, and active bandpass filters and shapers for the audio input.

In the Baudot mode, the keyboard buffer is 256 keys long. Eight programmable-message memories and three fixed-message memories (CQ, ID, and Quick Brown Fox) are avail-

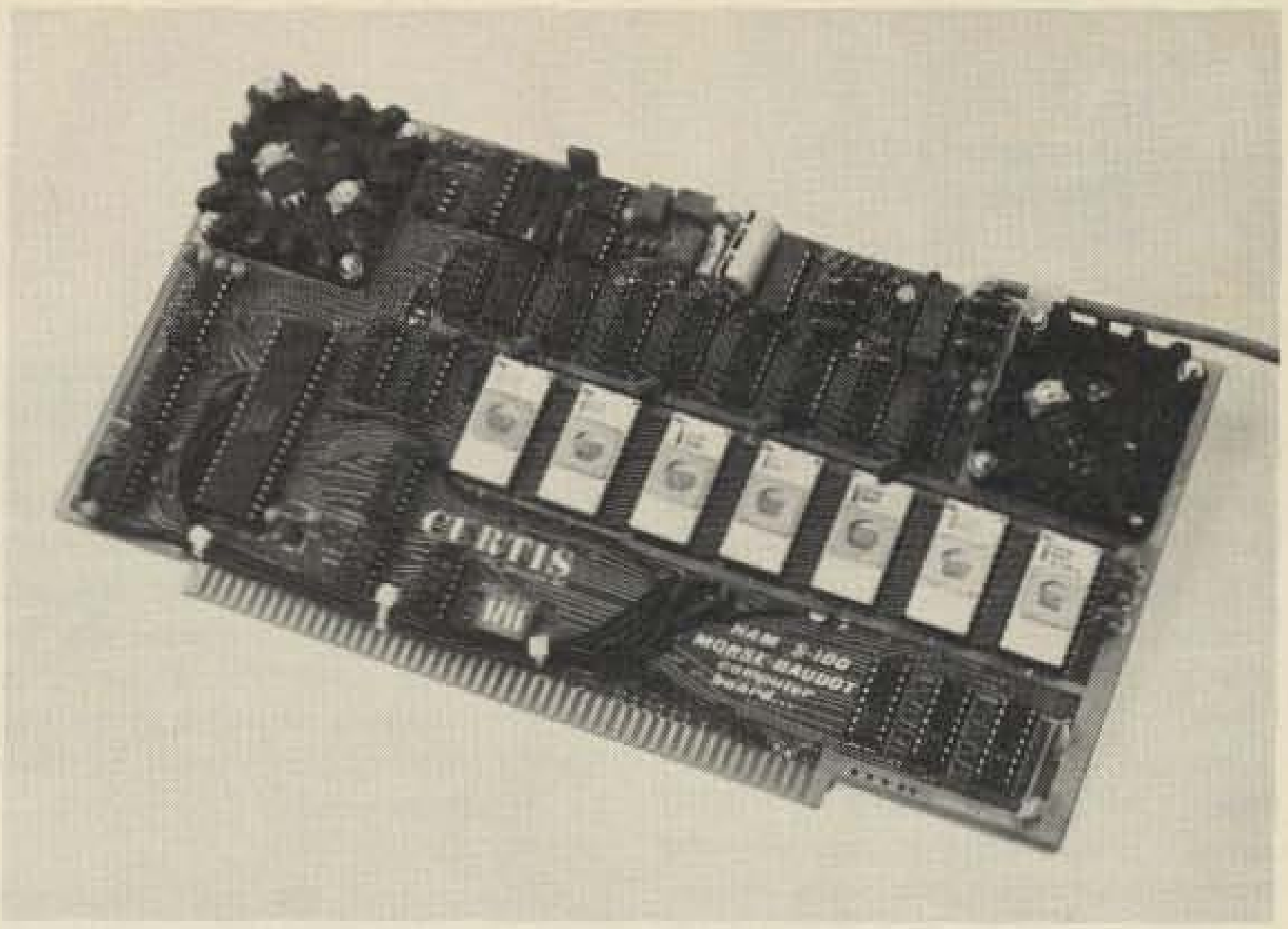


The Yaesu FT-901D transceiver.

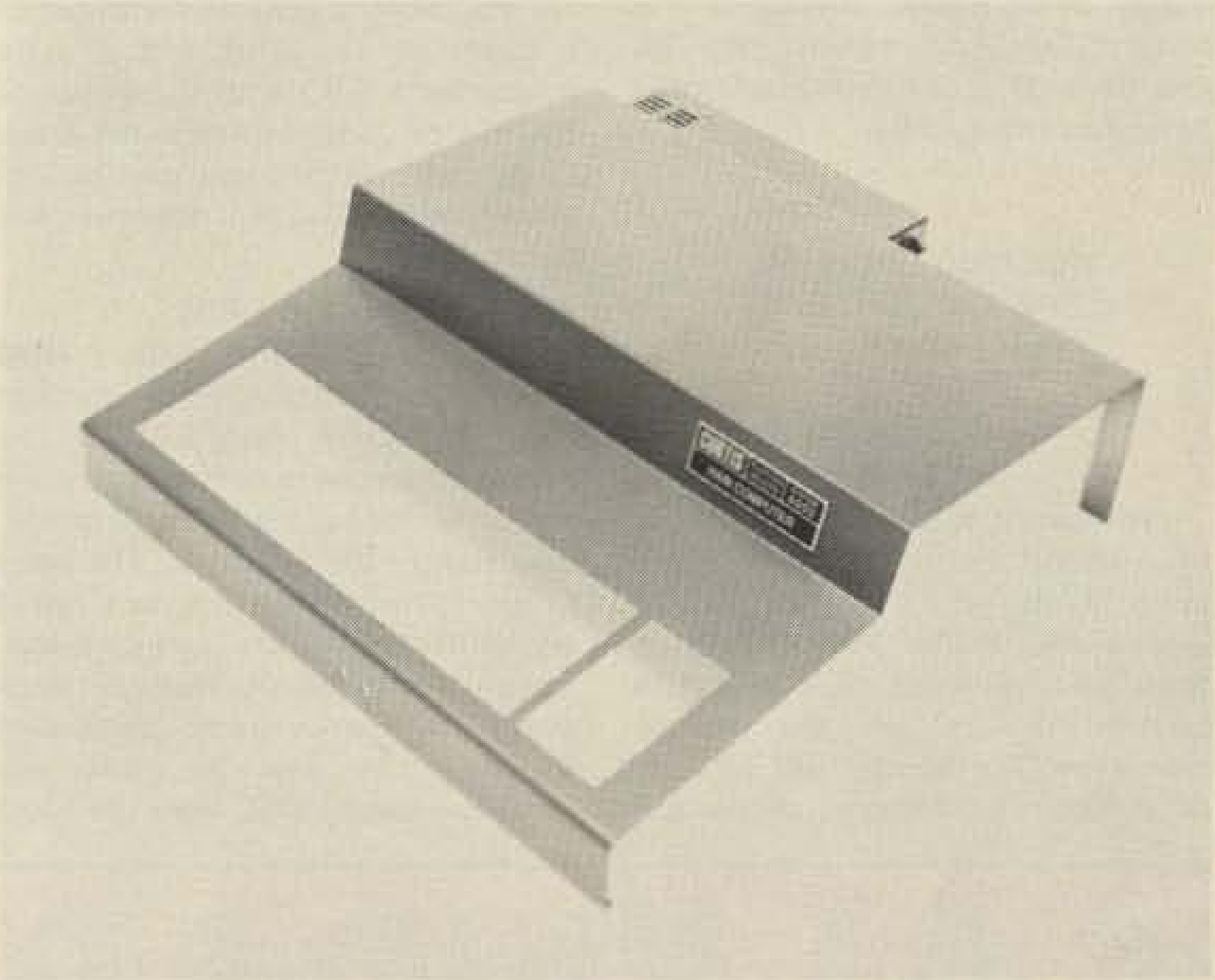


DenTron's Jr. MonitorTM antenna tuner.

Curtis Electro Devices' TI-100 interface box.



Curtis Electro Devices' HAM S-100.



Curtis Electro Devices' RFI kit.

able, along with CW identification. Other operating conveniences, such as LTRS fill, start-up diddle, automatic carriage return and line feed, are included to make a smoothly-operating Baudot terminal.

The System 4000 is designed to be added onto the popular Processor Technology Corporation's SOL-20 Terminal Computer. It can also be adapted to any S-100 bus 8080 hobby computer by simply adding I/O patches to the user's video driver and console keyboard. No user memory is required.

The System 4000 consists of three parts:

The heart of the system is an S-100 bus plug-in card carrying the operating program in seven 8K EPROMs, 1K of RAM, the Baudot serial interface, parallel interface for station controls, and an audio processor for CW reception. This card, called the HAM S-100, is a stand-alone system, except for the station interface circuitry.

This interface circuitry is available in a unit called the TI-100, which contains relays for the transmitter PTT and keyline plus a standard 60 mA 175 V Baudot receiver and driver. In addition, a monitor sidetone amplifier and speaker are provided together with volume control, paddle-key jack, and a high-low baud rate switch.

The last item, called the "RFI kit," consists of a one-piece special steel cover for the SOL-20 and interface electrical filters for incoming and outgoing RFI suppression.

Conversion of a SOL-20 computer to the System 4000 requires the three items described here and can be accomplished in about thirty minutes. Computer operation remains unaffected.

Price for the HAM S-100 is $699.95; the TI-100 is $149.95; and the RFI kit is $99.95. Delivery is from stock directly from the manufacturer. (The SOL-20 currently is priced at $1100.00 in kit form, $1,500.00 built and tested, and is available from most computer stores.) For further details, write *Curtis Electro Devices, Inc., Box 4090, Mountain View CA 94040, or call (415) 964-3136.*

Ham Help

I am a retired broadcast engineer who would like to meet active hams, on the air, who are interested in the historical processes of photography such as carbro, oil, bromoil, etc., for the purpose of exchanging data on the air with the hope of working together to preserve the knowledge of these beautiful processes for future generations of ham-photographers. I work all bands, 2 through 160 meters, AM or SSB. For sked info please contact me.

Tracy Diers W2OQK
58-14-84th Street
Elmhurst NY 11373

I am trying to obtain the schematic and service manual for a Hammarlund SP-600 receiver.

John A. Poplawski WB2GFR/5
PO Box 1708
Killeen TX 76541

I would like to find out if anyone has any open wire insulators. I am not able to get any here, and would appreciate any help along this line. The insulators should have a spacing of ½" for 300 Ohms. I would like to get as many as possible for future use.

Norm Gorcey VE3FRO
101 Haslam St.
Scarborough, Ontario
Canada

I am in need of the schematic for a Bogen Pagemaster receiver, model TR54A (models TR54B & TR54C will also work). These are "pocket pager" units which operate in the 35 MHz range, using a four-reed assembly. I will gladly pay for a photocopy.

Robert L. Leftwich WA4MVA
1926 Langdon Road, SW
Roanoke VA 24015

CONTESTS

Editor:
Robert Baker WB2GFE
15 Windsor Dr.
Atco NJ 08004

A quick note from W1YL at ARRL headquarters indicates a possible rule change for the VHF Sweepstakes in January, with point values for QSOs on higher bands, and also some possible adjustments to the July Radiosport rules. Watch QST for announcements on rule changes as they become final.

As yet, very little contest information has been received for the 1978 season. Please send all contest and award information, including results, as soon as they are official and ready for publication. All information should be addressed directly to my home QTH. Any material sent via Peterborough is only delayed while being forwarded to me.

HUNTING LIONS ON THE AIR CONTEST
Starts: 1200 GMT, January 14
Ends: 1200 GMT, January 15

The contest is sponsored by Lions International and coordinated by the Lions Club of Rio de Janeiro (Arpoador), Brazil. Participation is open to all licensed radio operators except members of the contest committee. The contest will be separated into two sections, phone and CW, with points counting separately and participation allowed in both modes. All bands 80 through 10 meters may be used, with each station being contacted no more than once per band and mode. When contacts are made between Lions and Leos, the name of the Lions Club or Leo Club contacted should be noted in the log. Confirmation of contacts will be made by log comparisons.

SCORING:

QSOs within the same continent count 1 point each; between different continents, 3 points. Bonus points: 1 extra point for a QSO with member of a Lions or Leo Club and 5 extra points for a QSO with a member of the Rio de Janeiro (Arpoador) Lions Club. Contacts between members of the Arpoador Club will not count any bonus points.

ENTRIES AND AWARDS:

Lions International will present first, second, and third place awards in two categories — phone and CW. The first place winner in each category will receive a trophy, the second a medallion, and the third a plaque. The Lions Club of Rio de Janeiro will award additional vermillion award medallions to the fourth through tenth place winners. Each participant making more than 20 points will receive a special QSL from the Lions Club of Rio de Janeiro. Logs should be sent to the contest committee no later than 30 days after the contest: Lions Club of Rio de Janeiro (Arpoador), Rua Souza Lima n. 310 — Apt. 802, Rio de Janeiro 20.000, ZC-37 Brazil.

ARRL VHF SWEEPSTAKES
Starts: 1400 your local time, Saturday, January 21
Ends: 2400 your local time, Sunday, January 22

Complete rules for the 30th VHF Sweepstakes can be found in the December issue of *QST*; please check for new scoring this year. Briefly, the rules are as follows:

All amateurs operating on or above 50 MHz are invited to participate. Contacts between stations in different time zones can be counted only when the contest period is in progress in both zones. Foreign stations may only work stations in ARRL sections. Crossband work and retransmitted signals (repeaters) are not allowed. Contacts with aircraft mobiles cannot count for section multipliers. Official logs may be obtained from the ARRL. Send contest logs and summary sheet to: ARRL, 225 Main Street, Newington CT 06111.

CQ WW DX 160 CONTEST
Starts: 2200 GMT Friday, January 27
Ends: 1600 GMT Sunday, January 29

Sponsored by *CQ Magazine*, this is a CW-only contest with no crossmode contacts allowed.

EXCHANGE:

RST plus three-digit QSO number and state or province; DX should send RST and QSO number only.

SCORING:

W/VE/VO score 2 points per QSO with other W/VE/VO stations, 10 points per DX contact. All other countries score 2 points per QSO with stations in same country, 5 points in other countries, 10 points with W/VE/VO. Multipliers for all stations are number of states, VE provinces, and DX countries worked. Final score is total QSO points times sum of multipliers.

ENTRIES & AWARDS:

Violation of rules, regulations, etc., may be deemed sufficient cause for disqualification. Certificates to top scorers in each state, VE province, and DX country. Log sheets may be obtained from *CQ* by sending a large SASE. Mail entries and log requests to: *CQ* 160 Contest, 14 Vanderventer Ave., Port Washington NY 11050.

Note: please check *CQ Magazine* for any last minute rule changes!

FRENCH CONTEST
CW
Starts: 0000 GMT, January 28
Ends: 2400 GMT, January 29
Phone
Starts: 0000 GMT, February 25
Ends: 2400 GMT, February 26

All contacts must be made on 160 meters CW (or 1,826 MHz for F stations). All entries must be single operator.

EXCHANGE:

CALENDAR

Jan 1	ARRL Straight Key Night
Jan 7-9	ARRL CD Party — Phone
Jan 14-15	Hunting Lions On the Air
Jan 21-22	ARRL VHF Sweepstakes
	ARRL CD Party — CW
Jan 27-29	CQ Worldwide 160 Contest — CW
Jan 28-29	French Contest — CW
	ARRL Simulated Emergency Test
Feb 4-5	ARRL DX Contest — Phone
Feb 4-12	ARRL Novice Roundup
Feb 11-12	10-10 International Net Winter QSO Party
Feb 18-19	ARRL DX Contest — CW
Feb 25-26	French Contest — Phone
Mar 4-5	ARRL DX Contest — Phone
Mar 18-19	ARRL DX Contest — CW
Apr 1-3	QRP QSO Party
Apr 8-9	ARRL CD Party (Open) — CW
Apr 15-16	ARRL CD Party (Open) — Phone
June 3-4	IARS/CHC/FHC/HTH QSO Party
June 10-11	ARRL VHF QSO Party
June 24-25	ARRL Field Day
	REF TEN Day
July 4	ARRL Straight Key Night
July 8-9	IARU Radiosport Competition
Sept 9-10	ARRL VHF QSO Party
Oct 14-15	ARRL CD Party — CW
Oct 21-22	ARRL CD Party — Phone
Nov 4-5	ARRL Sweepstakes — CW
Nov 18-19	ARRL Sweepstakes — Phone
	REF TEN Day
Dec 2-3	ARRL 160 Meter Contest
Dec 9-10	ARRL 10 Meter Contest

RESULTS

RESULTS OF THE 1977 MICHIGAN QSO PARTY

WA8MOA	Calhoun county	66,160 points
WA8WWM	Leelanau	65,760
W8PBO	Macomb	54,960
WB8IOT	Saginaw (multi-op)	32,376
WD8DRF	Oakland	32,120
WA8CZH	Washtenaw	28,672
W8GLC	St. Clair	18,480
K8DAC	Saginaw (multi-op)	16,244
W8YL	Lenawee	10,505
W8QGP	Hillsdale	5,633
WD8DQV/8	Osceola	5,590
WB8NSF	Berrien	3,960
WA8CZH/8	Wayne	1,920
K8CJF	Saginaw	1,700
W8VSK/m8	(6 counties)	1,020
WB8BUQ	Wayne (QRP)	230
WB8FEZ	Genesee (VHF)	1,102

The Club trophy went to the L'Anse Creuse ARC, which had 139,547 points. The top out-of-state scorer was WA4KKP in VA with 4,814 points; second place went to W5KLB in TX with 2,884 points; and third place went to W8KSB/3 in MD with 2,236 points.

RESULTS

AMERICAN RESULTS OF THE 1977 FRENCH CONTEST

CW:		
W1MDO	20880	120
W1OPJ	27	9
WA2EJZ	396	12
W3ARK	6336	66
W3FCI	1425	25
W3EUJ	432	24
WB4OGW	36087	208
WA4ZHU	15048	170
WB4FHI	4143	47
K4OAQ	3159	39
N4MM	2687	39
WB4WHE	216	9
W8VSK	13884	89
K8CW	10260	76
WA8KME	1377	17
K8LUU	3645	47
WB8WTD	810	18
W9OHH	23166	132
WA9VOL	5994	55
WØPRY	10662	79
WØBK	1684	33
SSB:		
WA1WFS	11244	84
F2YS/W2	12069	107
WA2EJZ	356	15
LU1BAR/W3	7401	72
W3FCI	4785	39
W3AKD	1485	15
N4MM	17286	87
WA4SHL	9408	70
K4KZP	3276	44
WA4LOF	3207	27
WB4OGW	4017	52
WB5MSU	225	5
WA9FZQ	1876	59

RESULTS

1977 YLRL HOWDY DAYS RESULTS

YLRL Members:		Score
Christa Elksnat	DJ1TE	103
Vera Klecowsky	WA1JYO	61
Onie Woodward	W1ZEN	51
Ione O'Donnell	WA2DMK	22
Phyllis Shanks	W2GLB	52
Lia Zwack	WA2NFY	69
Ernestine Boerner	WA2VIE	37
Doris Bedford	K4AOH	53
Patricia Williams	WB4PRM	72
Irma Weber	K6KCI	71
Jane Willis	K6RLR	74
Sandi Heyn	WA6WZN	62
Marion Dixon	WA7TLL	19
Eva Karnatz	WA8AHU	86
Marilyn Backys	WB9TDR	46
Lovelle Pedersen	WBØJFF	49
Martha Shirley	WØZWL	44
Anny Schwager	DF2SL	61
Ella Grindel	DJ5UAC	34
Paula Blomen	DJØEK	33
Margot Semkat	DK5TT	71
Ursula Burger	DL3LS	25
Clare Dixon	EI7CW	75
Renee Chassard	F5RC	28
Dr. Greta Hubacher	HB9ARC	44
Berit Nesse	LA3RN	31
Karin Jensen	OZ1AVV	20
Diana Vanderzande	VE7DTO	32
Non-YLRL Members:		**Score**
Darleen Magen	WD5FQX	90
Juliane Schuhegger	DJ1EIC	53
Ursel Weiskirchen	DF2KG	85
Juliane Schuhegger	DF3RF	17
Elfi Butterstein	DF3TE	40
Alice Rudolph	HB9BIR	23

RS(T) and QSO number.

SCORING:

Score 3 points for each F or overseas French department or territory contacted in your own continent (10 points if in another continent). Multipliers are each F department (95) and FFA (DA), each DOM (FG, FM, FY, FR), each TOM (FB8W, FB8X, FB8Y, FB8Z, FK, FO, FP, FU, FW, FH-Mayotte Is.), and each other country of the DXCC list. French stations will give their department number after the call. Example: F6ZZZ/67 and FFA will give DA. . ./FFA. Final score is the sum of the QSO points times the sum of multipliers. Send logs only to the REF Traffic Manager, 2, Square Trudaine, 75009 Paris, France.

FLAMINGO NET 25TH ANNIVERSARY AWARD

Beginning on January 1, 1978, in celebration of its 25th anniversary, the Flamingo Net of Miami, Florida, will be offering a special 25th anniversary seal to be attached to the Flamingo Net certificate.

To qualify, a certificate holder is required to have worked 10 other certificate holders, exchanging certificate numbers, callsigns, names, and locations. A non-certificate holder, during the anniversary year, may make contact with 20 certificate holders, collecting their certificate numbers, callsigns, names, and locations. The non-certificate holder will receive a certificate affixed with a 25th anniversary seal. During 1978 *only*, *all* persons holding Flamingo Net certificates can exchange certificate numbers to assist others in obtaining the Flamingo Net certificate and anniversary seal.

All contacts will take place on 10 meters. A $1.00 fee will be charged to cover the cost of handling. All applications are to be sent to Walter Dixon W4DWN, 820 NE 123rd Street, Miami FL 33161. This offer will end on December 31, 1978.

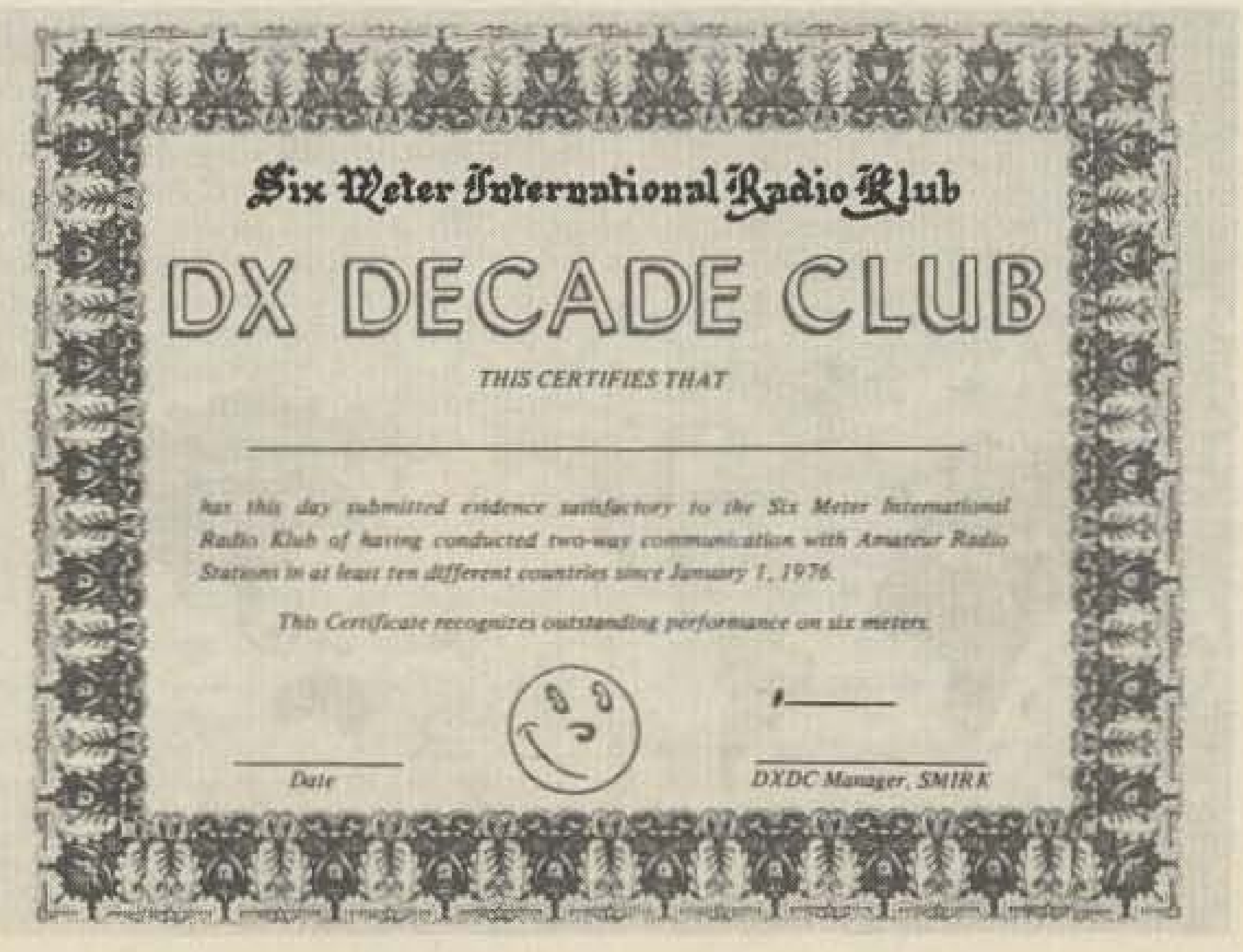
DX DECADE CLUB (DXDC) AWARD

This award is available to any amateur who can present confirmed proof of contact on the 6 meter band with 10 foreign countries (including US) from the ARRL country list. All contacts must have been made on or after January 1, 1976. The cost of the award will be $3, payable to SMIRK. Money made from this award will be used to finance "DXpeditions" and equipment for use by hams in foreign countries who would like to operate on 50 MHz. Additional endorsements for every 5 countries over the original 10 are available for $1 each. Send an SASE for application forms to: J. Chipman WA1KYH, DXDC Manager – SMIRK, 18 Laurel Dr., Medfield MA 02052.

WAB BRITISH COUNTIES AWARD

Sponsored by the Worked All Britain (WAB) Organization, the award is available in two classes: Class 2 is for any 55 UK counties, Class 1 is for all the UK counties and Scottish regions, plus one GC/GJ (Jersey), one GC/GU (Guernsey, Alderney, or Sark), and one GD. Contacts with UK amateurs since May 1, 1974, count. No QSLs are required with the application – only a certified list showing date, time (GMT), county of UK station, RS(T) reports, and callsign of station worked.

Cost of award and postage worldwide is $2.00 (USA) or 20 IRCs. Cost of further claim to upgrade Class 2 to Class 1 is $1.00 or 10 IRCs. Claims to Alec Brennend G4AVA, 76 Deneley Avenue, Todmorden Via, Lancashire, England.



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FEDERAL COMMUNICATIONS COMMISSION

[Docket No. 19759; RM-1633; RM-1656; RM-1747; RM-1761; RM-1793; RM-1841; FCC 77-682]

[47 CFR Part 95]

TERMINATION OF PROCEEDING CONCERNING CREATION OF A NEW CLASS OF CITIZENS RADIO SERVICE

AGENCY: Federal Communications Commission.

ACTION: Termination of Rulemaking Proceeding (Memorandum Opinion and Order in Docket 19759).

SUMMARY: The FCC is terminating Docket 19759, in which we had proposed a new Class "E" Citizens Radio Service in the 220-225 MHz frequency range. Since the 1973 release of our proposals the character of personal radio communications has undergone radical change. We believe any further allocation of frequencies for personal radio communications should be the subject of a new rulemaking proceeding.

ADDRESS: FCC, Washington, D.C. 20554.

SUPPLEMENTARY INFORMATION:

MEMORANDUM OPINION AND ORDER

(PROCEEDING TERMINATED)

Adopted: October 5, 1977.

Released: October 18, 1977.

By the Commission: Chairman Wiley not participating; Commissioner Lee absent.

In the matter of: The creation of a new class of Citizens Radio Service and the reallocation of frequencies between 224 and 225 MHz in the band 220-225 MHz now allocated for shared use by stations in the Amateur Radio Service and Government Radiolocation Stations for that purpose; Docket 19759, RM-1633, 1656, 1747, 1761, 1793, 1841.

1. In June 1973, the Commission issued a Notice of Inquiry and Notice of Proposed Rule Making in which it proposed to allocate spectrum in the 220-225 MHz band for a new Citizens Radio Service to be designated as Class E. This new radio service was to be similar to the then established Class D service, but was to operate under new rules and enforcement procedures.[1] The proceeding stemmed primarily from a petition of the Electronic Industries Association (EIA).[2] The petition stated that there was a "demonstrated strong, current and growing need for personal two-way radio communications for both safety and convenience of individual citizens in conducting their daily activites of both a personal and business nature." Support for the petition came from potential manufacturers of Class E equipment and from land mobile users groups, who viewed the new frequency allocation as a possible source of relief from crowded land mobile channels and high equipment costs.

2. In issuing the June 1973 proposal, the Commission noted that it had always recognized that the 27 MHz region was not ideally suited for the CB Radio Service because of the sporadic long distance transmission characteristics of this band. It was further noted that the purpose of the Class E proposal was to better meet the requirements of the general public for improved radio communication services, and to relieve the concentration of stations at 27 MHz.[3] Therefore, the Commission requested comments directed to these specific topics:

a. Services and types of operations which should be provided.

b. Economic, sociological, and other possible public interest benefits.

c. Effects on CB operations at 27 MHz.

d. The nature and probable impact of limitations resulting from interagency and international objections.

e. Detailed technical parameters, including recommendations on the amount of spectrum needed, channeling, power antennas, receivers, et al.

f. Automatic transmitter identification (ATIS).

g. Licensing methodology and record keeping.

h. Continuation vs. elimination of 27 MHz CB operation.

i Confiscation of illegal equipment.

3. Several thousand Comments and Reply Comments were received. A careful analysis of the comments revealed no consensus of opinion on any issue. The largest volume of comments came from amateur service licensees who protested that the proposed reallocation would, in effect, be penalizing their service to reward CB violators. Many comments from CB licensees opposed the proposal because they feared it might result in their loss of the present 27 MHz allocation. Although EIA, E. F. Johnson, other manufacturers, NABER, and other land mobile user groups supported the essence of the Class E proposal, they disagreed among themselves on what the specific characteristics of the new service should be.

4. Subsequent to the adoption of the Class E proposal, the Commission conducted tests which indicated that a personal radio service operating in the 220-225 MHz band might generate serious interference to television reception on the VHF channels. The Commission does not yet know how severe this interference might be, or whether this interference might be prevented. This has delayed all further rule making in the docket. In the meanwhile, a number of major changes have occurred:

a. The number of CB licensees has increased dramatically, to 10,406,828 as of May 1977. Accompanying this growth has been a change in the nature of how the service is used.

b. In February 1976, the Commission formed the Personal Radio Planning Group (PRPG) to conduct a broad-based, in-house study of personal radio services. In April 1976, the Commission solicited the assistance of the industry and users by establishing the Personal Use Radio Advisory Committee.

c. In July 1976, the Commission provided interim relief from congestion at 27 MHz by increasing the number of authorized CB Radio Service channels from 23 to 40.[4]

d. In April 1977, the PRPG completed the initial phase of its frequency evaluation study.[5] The results of this study, together with other information available to the Commission leads to the conclusion that other frequencies as well as the 220-225 MHz band should be considered as a possible location for a personal radio service.

5. As a result of these and other developments, the comments and reply comments received on this docket have become obsolete. Further, the Commission believes that the specific topics set forth in the June 1973, NOI/NPRM are no longer adequate to lay the basis for authorization of a personal radio service. New rule making will have to be framed with information which has been developed recently, and which will be developed in the next few months. Leaving this docket open may only mislead the public about the Commission's intention to fully investigate the future of personal radio. For these reasons, the Commission has determined to terminate Docket 19759, and to address the issue of new personal radio services in some future rule making.

6. In view of the foregoing, we believe that the public interest, convenience, and necessity is best served by termination of this proceeding. Accordingly, pursuant to authority contained in Sections 4(i), 303 of the Communications Act of 1934, as amended, it is ordered, that this proceeding is terminated.

FEDERAL COMMUNICATIONS COMMISSION,
VINCENT J. MULLINS,
Secretary.

[1] The Class D Service has been redesignated the Citizens Band (CB) Radio Service.

[2] RM-1747, filed on February 5, 1971.

[3] The number of licensees had increased from 49,000 in 1959 to 836,924 in June 1973.

[4] Docket No. 20120, Second Report and Order, Adopted July 27, 1976.

[5] The report, entitled Spectrum Alternatives for Personal Radio Services was released to the public for comment by News Release April 25, 1977.

[Docket No. 21418; FCC 77-715]

AMATEUR RADIO SERVICE

Inquiry Into Alleged Improper Issuance of Licenses and Call Signs; Order

Adopted: October 13, 1977.

Released: October 19, 1977.

By the Commission: Chairman Wiley not participating; Commissioner White concurring in the result.

1. The Commission has under consideration information indicating:

(a) That certain applicants and licensees in the Amateur Radio Service have made payments of cash or other consideration in connection with issuance of licenses, upgraded licenses, or call signs for which they were not qualified.

(b) That certain applicants and licensees in the Amateur Radio Service have received licenses, upgraded licenses, or call signs for which they were not qualified without any payment.

(c) That certain applicants and licensees in the Amateur Radio Service have received call signs in a manner inconsistent with the Amateur Radio Service Rules then in effect.

2. The above-described practices may be in violation of law and/or Commission Rules. Participation in such practices may raise serious questions regarding qualifications to become or to remain Amateur Radio Service licensees.

3. Therefore, *it is ordered*, on the Commissions own motion, pursuant to Sections 403 and 409 of the Communications Act of 1934, as amended, that an inquiry is hereby instituted to determine whether applicants or licensees in the Amateur Radio Service have engaged in the above-described practices and, if so, the extent and circumstances of such practices.

4. *It is further ordered*, pursuant to Section 5(d)(1) of the Communications Act of 1934, as amended, that, for the purpose of this inquiry, authority is hereby delegated to the Chief Administrative Law Judge of the Commission to require by subpoena the production of books, papers, correspondence, memoranda and other records deemed relevant to the inquiry, to administer oaths and affirmations, subpoena witnesses, compel their attendance, take evidence, and to perform such other duties in connection therewith as may be necessary or appropriate to the compilation of a complete record concerning the subject matter of this inquiry.

5. *It is further ordered*, That the Chief, Administrative Law Judge is specifically authorized to designate a Presiding Judge to exercise the authority conferred by this Order, and to require witnesses to testify and to produce evidence under authority of, and in the manner provided in, Section 409 of the Communications Act of 1934, as amended, when requested to do so by Commission counsel.

6. *It is further ordered*, That the subpoena powers delegated by this Order shall be exercised in accordance with Sections 1.331 through 1.340 of the Commission's Rules. Motions to quash or limit subpoenas shall be directed to the Presiding Judge in accordance with Section 1.334 of the Rules. Applications for relew of the Presiding Judges rulings on such motions may be filed with the Commission within ten (10 days) after the issuance by the Presiding Judge of such rulings.

7. *It is further ordered*, That the provisions of Section 1.27 of the Commissions Rules shall apply to the production of oral and documentary evidence under subpoena.

8. *It is further ordered*, That, pursuant to Section 5(d)(1) of the Communications Act of 1934, as amended, the authority to decide the question of when the public interest would be served by holding non-public sessions in this proceeding is hereby delegated to the Presiding Judge.

9. *It is further ordered*, That upon conclusion of the inquiry ordered herein, the Presiding Judge shall certify the record thereof to the Commission for appropriate action.

FEDERAL COMMUNICATIONS COMMISSION,
WILLIAM J. TRICARICO,
Acting Secretary.

(Docket No. 21033; RM-2664; RM-2780)

PART 97—AMATEUR RADIO SERVICE

Simplifying Licensing and Operation of Complex Systems of Stations and Modifying Repeater Subbands

ACTION: Final rules.

SUMMARY: The FCC is editorially amending its Amateur Radio Service Rules to correct several errors and omissions contained in its recent Report and Order in Docket 21033, 42 FR 52418 (September 30, 1977).

EFFECTIVE DATE: November 7, 1977.

SUPPLEMENTARY INFORMATION:

In the matter of deregulation of Part 97 of the Commission's rules to simplify the licensing and operation of complex systems of stations and modify repeater subbands in the Amateur Radio Service; Docket 21033, RM-2664, RM-2780.

Adopted: October 25, 1977.

Released: October 26, 1977.

1. In a Report and Order in Docket 21033 released September 27, 1977, 42 FR 52418 (1977), the Commission substantially revised its Rules concerning the licensing and operation of stations in repeater operation in the Amateur Service. In so doing, we made a number of errors and omissions, which were not intended to become part of the final rules adopted in this proceeding. We are therefore editorially amending the Amateur Service regulations, as follows:

a. In Section 97.3(n), we are adding a second sentence to the definition of control to bring the definition into conformity with the former definition. We are renumbering the definition of automatic control as it was previously numbered.

b. We are rewording Section 97.61(a) to eliminate an ambiguity.

c. We are correcting Section 97.67(c) to change the maximum effective radiated power for stations in repeater operation operating on 144.5 MHz and above from 200 watts to 100 watts, the prior standard.

d. In Section 97.84(d), we are adding a line over the letters "DN" to indicate the telegraphy signal for the fraction bar.

e. In Section 97.88(a)(2) we are eliminating the reference to "control station", because control stations were deleted by the Report and Order in this proceeding.

2. Authority for this action is contained in Sections 4(i), 5(d) and 303 of the Communications Act of 1934, as amended. Because these amendments are editorial in character, intended merely to correct previous errors and clarify existing rules, the prior notice and public procedure provisions of the Administrative Procedure Act, 5 U.S.C. 553, are not applicable.

3. Accordingly, it is ordered that Part 97 of the Commission's Rules is amended as set forth below effective November 7, 1977.

(Secs. 4, 5, 303, 48 Stat., as amended, 1066, 1068, 1082 (47 U.S.C. 154, 155, 303).)

FEDERAL COMMUNICATIONS COMMISSION,
R. D. LICHTWARDT,
Executive Director.

Part 97 of Chapter 1 of Title 47 of the Code of Federal Regulations is amended, as follows:

1. In § 97.3(n), the definitions of control and automatic control are amended to read, as follows:

§ 97.3 Definitions.

* * * * *

(n) *Control* means techniques used for accomplishing the immediate operation of an amateur radio station. Control includes one or more of the following:

* * * * *

(3) *Automatic control* means the use of devices and procedures for control so that a control operator does not have to be present at the control point at all times. (Only rules for automatic control of stations in repeater operation have been adopted.)

* * * * *

2. § 97.61(a) is amended to read, as follows:

§ 97.61 Authorized frequencies and emissions.

(a) The following frequency bands and associated emissions are available to amateur radio stations for amateur radio operation, other than repeater operation and auxiliary operation, subject to the limitations of § 97.65 and paragraph (b) of this section: * * *

* * * * *

3. In § 97.67, paragraph (c) is amended to read, as follows:

§ 97.67 Maximum authorized power.

* * * * *

(c) Within the limitations of paragraphs (a) and (b) of this section, the effective radiated power of an amateur

Continued on page 185

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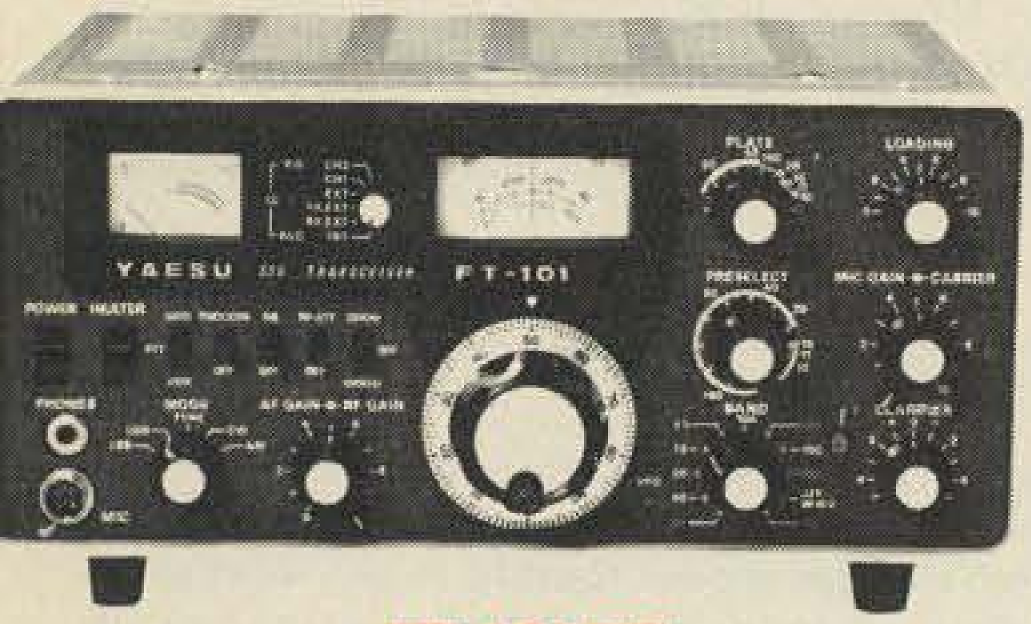

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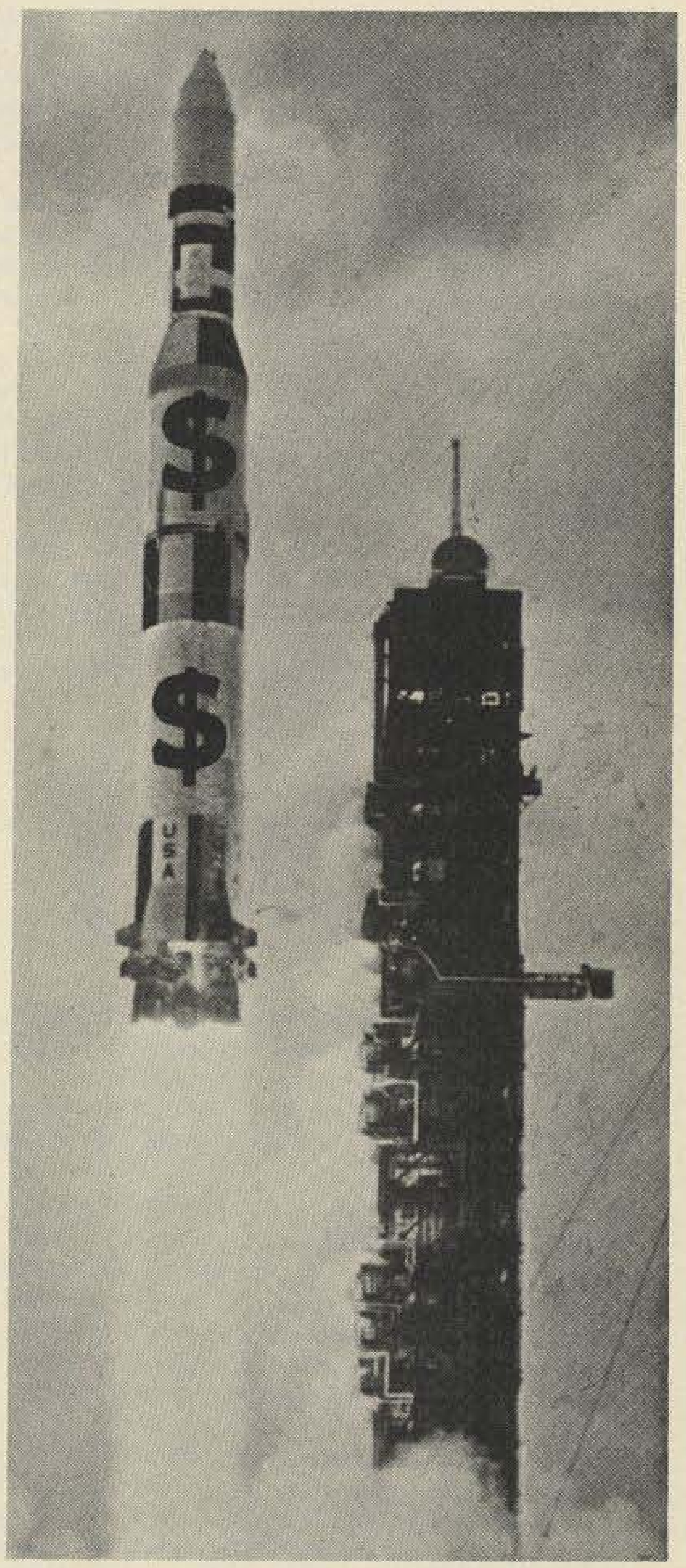

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FCC Math

John F. Leahy WB6CKN
P.O. Box 539
Gonzales CA 93926

In the previous two installments we've played around with frequency and wavelength and Ohm's Law. We've also seen something of prefixes, abbreviations, decimals, units of measurement, and a bunch of other goodies. In this installment, we'll tie up some more loose ends and then launch ourselves into handling some of the *monstrous* numbers of electronics through the use of a tool called "powers of ten." If you're familiar with powers of ten and all, you might want to skip this installment. But if it's new to you, a careful study of these pages will reward you with a powerful tool for handling difficult computations with ease, if that isn't a contradiction in terms.

First to the loose ends. We reviewed decimal division, among other things, last time. Now let's put some logic into the rules we learned and, in the process, pick up a few more tricks for handling fractions.

You recall the kind of Ohm's Law problem we posed and solved? For example: 19 mA at 27 V, what's the resistance? The fraction here is 27/0.019, which, as we saw, is handled: $19\overline{)27{,}000.}$ At the time, you may have asked yourself, "What gives one the right to move decimal points around like that? Where's the logic involved? Or do we just kind of sneak into these rules because they happen to work?"

Actually, there's very little sneaking done in math and science these days (unless it's to the cookie jar, whatever form that takes nowadays). As a matter of fact, the logic of this process is usually covered in the 5th grade — in modern schools, that is.

So here's a 5th grade problem: Add 2/7 + 2/3. It's usually done vertically:

$$\begin{array}{rr} & \frac{2}{7}\cdot\frac{3}{3}=\frac{6}{21} \\ + & \frac{2}{3}\cdot\frac{7}{7}=\frac{14}{21} \\ \hline & \frac{20}{21} \end{array}$$

The dot between fractions means multiply. The question is, where do that 3/3 and 7/7 come from? You no doubt recognize both as hidden 1s. 3 ÷ 3 = 1 and 7 ÷ 7 = 1. Of course, multiplying by 1, even if that 1 is in a weird form like 7/7, still just gives that same something we started off with, though with a different look. 6/21 definitely looks different from 2/7, though they sure enough equal each other.

Now, that's actually one of the powerful tools I've been talking about. You can get a number into just about any form you want just by multiplying by 1 in some form or other. You can't add 2/7 + 2/3 directly, but multiply both by 1 (in a well-chosen form) and we get things we can add together easily.

But back to our fraction 27 V/0.019 A. Multiply by 1 in the form 1000/1000 and we get 27,000/19, which is, of course, $19\overline{)27{,}000.}$ So now you see how that decimal point got moved where it did. And why did we choose 1000/1000 as the form of 1 to use here? Simply because that's what was needed to move the decimal point to the right of the 9 — thereby, for all practical purposes, eliminating the decimal problem altogether. Note how that works. When using 100, 1000, 10000, etc., as multipliers, the result is the same as if you just moved the decimal point one place to the right for each zero in the 10, 100, 1000, or whatever. Here we multiplied by 1000, so we moved the decimal three places to the right (and added three zeros to the 27). The same kind of thing is true of division, only now you move to the left. Division by 100 means move two places to the left. 4,100/100 = 41.

Thus, for an Ohm's Law problem like 800 V/7000 Ω, we can divide both top and bottom by 100, giving 8/70. You still have the division $70\overline{)8}$ to perform, but most people find that easier than $7000\overline{)800}$.

That's also how we derive formulas from λ = 300,000,000/f(in Hertz) for working directly with kilohertz and megahertz. Suppose our signal is at 3.740 MHz. What's the wavelength? We have 300,000,000/3,740,000 using the formula with Hertz. But divide top and bottom by 1000, and we have 300,000/3,740. Note that 3,740 is our frequency as it looks expressed in kilohertz. Divide by 1000 again and we get 300/3.740, where the 3.740 is our frequency in megahertz. So the formula works directly with Hertz, kilohertz and megahertz. You just have to remember how many zeros go after the 3 in the top. λ = 300,000,000/f(Hz), λ = 300,000/f(kHz), and λ = 300/f(MHz). We got those variations just by dividing by 1 in the form 1000/1000.

A similar bit of reasoning allows us to use Ohm's Law directly with milliamps and kilohms, and microamps and megohms. Back to that example we used earlier: Given 19 mA and 27 V, what's the resistance? Divide 19 into 27,000 and we get 1400 (with two-digit accuracy). That's 1.4 kilohms. But dividing 19 into 27 simply, we get the same 1.4. Thus, dividing milliamps directly into volts (without first changing to Amps) gives kilohms for an answer (surprise, surprise). And the other: 75 microamps at 110 volts, what's the resistance? The fraction is 110 V/0.000075 A. Multiply top and bottom by 1,000,000 (because we need to move the decimal point six places to get it to the right side of the bottom number), and we get 110,000,000/75, which divided out is 1,500,000 Ohms, 1.5 megohms. But divide 75 into 110 simply and you get the same 1.5. Voilà! Microamps into volts produces megohms. And the other way around is true. Megohms into volts gives microamps. And kilohms into volts produces milliamps.

Now here's a little exercise. See if you understand what we've done. Work and answers to exercises are at the end of the column.

Exercise 1:

(1) Multiply by 1 (in some clever form) to get rid of decimals:

(a) $\frac{780\text{ V}}{0.085\text{ A}}$ (b) $\frac{35\text{ V}}{0.000090\text{ A}}$

(2) Convert the Amps of problem 1 into milliamps and then microamps.

(3) Work (a) using milliamps directly and (b) using microamps directly.

(4) Find the wavelength of each directly:

(a) 21.250 MHz

(b) 3825 kHz

(c) 60 Hz

POWERS OF TEN AND STUFF

We've already seen some pretty monstrous numbers in electronics, what with those pico and micro and mega prefixes and all. And I've indicated that computations with such numbers are the rule rather than the exception.

A rather basic computation is that of reactance. The reactance of a capacitor, X_C (its resistance to the flow of current at a given frequency), is found from the formula: $X_C = 1/2\pi fc$. We'll get into this formula later on, but for now it'll suffice to look at the kind of computation that formula implies. π, the Greek letter pi, equals about 3.14. Say the frequency, f, is 14.200 MHz, and the capacitance, C, is 13 nF (13 nanofarads). This is the computation we'd have to do:

$$\frac{1}{2(3.14)(14{,}200{,}000)(0.000000013)}$$

The parentheses in the bottom mean you multiply each of those numbers together. And this is by no means the most difficult computation you might run into on an FCC exam (Tech class and above). Needless to say, we've got to learn some additional tricks or we're going to have one heck of a time handling these things. Fortunately (math to the rescue), scientists aren't any more fond of such torture than the rest of us and have come up with classy (and relatively easy) ways of doing problems of this sort. So let's follow along with some of their thinking.

You're no doubt familiar with squares. You find them all over the place, heads buried in books, etc. Well, that's not quite the kind I have in mind right now. If you have a calculator in the house somewhere, perhaps one of its buttons deals with the kind of square we want here. Enter a 7 into your calculator and push the x^2 button. You get 49. Obviously 7^2 (seven squared) equals 49, and the small 2 must mean that two 7s are being multiplied together. Similarly, 5^3 (called five cubed or five to the third) means 5 x 5 x 5 or 125. The small 3 written above and to the right is called an exponent. It tells you how many of the number are being multiplied together. Thus 8^5 means 8 x 8 x 8 x 8 x 8, or 32,768.

You can see right away that there's some shorthand involved here. If 8^5 equals 32,768, then we can use two digits to express a five digit number, even if the form is not terribly useful for computations.

But using exponents with *10* proves to be very useful, *especially* for difficult computations. Consider some powers of ten (as they are called). 10^2 = 10 x 10, or 100. 10^3 = 10 x 10 x 10, or 1000. 10^4 = 10 x 10 x 10 x 10, or 10,000. First, note that the exponent and the number of zeros after the 1 in each number are the same. 10,000 is 10^4. There are four zeros and the exponent is 4. That's important to remember. It makes changing to powers of ten and back very easy for our computations.

Admittedly, this is not terribly enlightening. But now watch. 10,000,000 ÷ 1000 = (remember we move the decimal point three places to the left) 10,000. Let's see that with powers of ten. 10,000,000 is 10^7 (there are seven zeros). 1000 is 10^3. 10,000 is 10^4. In other words, $10^7 \div 10^3 = 10^4$. Note that 7 - 3 = 4. That's it! There you have the first important simplification with powers of ten. To divide with powers of ten all you have to do is subtract exponents. Take another example, 10,000,000,000,000 ÷ 100,000,000. That's 10^{13} (ten to the thirteenth) ÷ 10^8 (ten to the eighth). The answer is 10^{13-8} or 10^5, which is 100,000. Wow, look at that, huge numbers divided just by subtracting small numbers in your head!

Big deal! How often do we just use powers of ten in our computations? There's a big difference between 1000 and, say, 3025. Obviously, most computations involve digits other than 1 and 0. So now let's see what we can do about putting what we just learned together with other digits.

We'll start by doing some multiplying. 3.25 x 1000 (10^3) = 3,250. So, going in reverse, 3,250 = 3.25 x 10^3. Again, 8.65 x 100,000,000 (10^8) = 865,000,000. (Remember how we do that. Move the decimal point one place to the right for each zero in the 100,000,000.) So, going backwards, 865,000,000 = 8.65 x 10^8.

You don't need to go through many of these before you realize that any number larger than one (we'll get into numbers smaller than one next time) can be expressed as something times a power of ten. 578 can be expressed as 5.78×10^2. 2,183,000 can be 2.183×10^6, etc., etc. Now it may not seem terribly smart to change 578 to 5.78×10^2, something that takes up more room than the original number, but when you see how easy multiplication and division become by changing every number into a form like that, you'll probably welcome the idea.

We'll get back to that in just a minute, but first let's see what happens when we multiply powers of ten (we've already seen what happens when we divide, how the exponents subtract).

Take 1000 x 10,000, for example. That's 10,000,000. In powers of ten it's $10^3 \times 10^4 = 10^7$. Notice how 3 + 4 = 7. That's very significant. To multiply powers of ten you just add exponents! Try another. 1,000,000 x 100. That's $10^6 \times 10^2$. Answer? Why, 10^8 or 100,000,000, of course. Notice how we're handling big numbers quite easily. And keep in mind that the prefixes of electronics, kilo, mega, etc., mean times 1000, times 1,000,000, etc.

Now let's put some of that together. Suppose I'm multiplying 47,000 Ω and 250 mA. (My answer will be in millivolts since I'm not changing the milliamps to Amps.) With powers of ten, it's $(4.7 \times 10^4) \times (2.5 \times 10^2)$. It doesn't make any difference what order we multiply numbers in, so we can rearrange to get 4.7 x 2.5 and $10^4 \times 10^2$. 4.7 x 2.5 = 11.75 and $10^4 \times 10^2$ is 10^{4+2} or 10^6. Putting them together, we have 11.75×10^6 mV (11,750,000 millivolts). (Can you change this to volts and kilovolts? The answer is at the bottom of this column.*)

Here are the two simple rules for converting numbers to the power of ten equivalent. Rule 1: Move the decimal point to the right of the extreme left-hand digit (remember, if you see no decimal point, it's at the extreme right, invisible, but definitely there). Rule 2: The exponent is the number of places you moved the decimal point. Note that these rules apply to numbers larger than one. Smaller numbers will be covered in our next installment.

Let's apply those rules. What's the power of ten equivalent of 87,100? Rule 1: 8.71 (we drop unnecessary zeros). Rule 2: 10^4. Put them together, and we have 8.71×10^4. Could you do that one in reverse? Just move the decimal point four places to the right, and you get the number we started off with, and drop the 10 and its exponent.

Finally, let's do a huge computation without units of measurement, just to see what we are now capable of doing, using powers of ten.

$$\frac{41{,}728{,}000 \times 8{,}140 \times 612{,}000{,}000{,}000 \times 89}{241 \times 18{,}360 \times 875{,}000}$$

First, convert to powers of ten:

$$\frac{(4.1728 \times 10^7) \times (8.14 \times 10^3) \times (6.12 \times 10^{11}) \times (8.9 \times 10^1)}{(2.41 \times 10^2) \times (1.836 \times 10^4) \times (8.75 \times 10^5)}$$

Now, rearrange (add exponents):

$$\frac{(4.1728 \times 8.14 \times 6.12 \times 8.9) \times (10^{7+3+11+1})}{(2.41 \times 1.836 \times 8.75) \times (10^{2+4+5})}$$

*11,750 volts or 11.75 kilovolts.

Multiply top and bottom (three-digit accuracy):

$$\frac{1850 \times 10^{22}}{38.7 \times 10^{11}}$$

Now, divide $38.7\overline{)1850}$ and subtract exponents (10^{22-11}) to get our final answer of 47.8×10^{11}, which is 4,780,000,000,000 (remember that the decimal point goes 11 places to the right).

If you followed along this far without too much trouble, you should have little difficulty with the exercise below. Oh, incidentally, we'll be solving that reactance problem posed at the beginning of this section in our next installment, after we've learned how to handle *very small* numbers.

Exercise 2:

(1) Convert these numbers using 10 and exponents:
(a) 37,700 (b) 64,870,000,000,000,000

(2) Convert these back to our decimal system:
(a) 3.71×10^9 (b) 29.6×10^1

(3) See if you can work this problem all the way:

$$\frac{248 \times 3{,}214 \times 75{,}000{,}000}{9{,}600{,}000 \times 73}$$

WORK AND ANSWERS TO EXERCISES

Exercise 1:

(1) (a) $\frac{780}{0.085} \times \frac{1000}{1000} = \frac{780{,}000}{85}$

(b) $\frac{35}{0.000090} \times \frac{100{,}000}{100{,}000} = \frac{3{,}500{,}000}{9}$

(2) (a) 0.085 A = 85 mA = 85,000 μA (b) 0.000090 A = 0.09 mA = 90 μA

$\begin{array}{r} .389 \\ 90\overline{)35.000} \end{array}$ MΩ or 389 kΩ or 389,000 Ω

(3) $\begin{array}{r} 9.18\text{k} \\ 85\overline{)780.00} \end{array}$ or 9,180 Ohms

(4) (a) $21.25\overline{)300} = \begin{array}{r} 14.1 \\ 2125\overline{)30000.0} \end{array}$ meters (b) $\begin{array}{r} 78.4 \\ 3825\overline{)300000.0} \end{array}$ meters

(c) $\begin{array}{r} 5000000 \\ 60\overline{)300000000} \end{array}$ meters (5,000 km)

That last one's interesting. The wavelength of 60 Hertz house current is thus about the distance from New York to Los Angeles!

Exercise 2:

(1) (a) 3.77×10^4 (b) 6.487×10^{16}

(2) (a) 3,710,000,000 (b) 296

(3) $$\frac{(2.48 \times 10^2) \times (3.214 \times 10^3) \times (7.5 \times 10^7)}{(9.6 \times 10^6) \times (7.3 \times 10^1)}$$

$$= \frac{(2.48 \times 3.214 \times 7.5) \times 10^{2+3+7}}{(9.6 \times 7.3) \times 10^{6+1}}$$

$$= \frac{59.8 \times 10^{12}}{70.1 \times 10^7}$$

$$= 0.85 \times 10^5 \text{ or } 85{,}000$$

Ham Help

Toss me a line!

Up here in the puckerbrush of northern Vermont, there doesn't seem to be too much chance of finding what I need, but here it goes: I need someone to help me get started. Simple? I've been through all phases of CB, SSB, AM, repair, etc., but the urge to work skip and to be able to find a little peace and quiet has always gnawed at my insides. Amateur radio has always interested me. I'm sure I could struggle through the technical portion of the exam, but the code . . .? Won't someone give me a shot of CW and a good kick in the stern to send me on my way?

Joe Vicere
Box 55-A
Upper Notch Road
Bristol VT 05443

I have a problem! I am the proud possessor of a Patterson model PR-15 communications receiver that I am attempting to rebuild. I have no idea where to find any information on this manufacturer, and I need schematics and the service manual for this unit before rebuilding.

E. W. Clede
6811 Spring Forest
San Antonio TX 78249

I need help on two items. The first is a Hallicrafters Super Skyrider, for which I am trying to obtain an operating manual and schematic, or any information on where this information can be obtained.

The second is a DuMont-type 304A scope, for which I need a schematic and/or manual. Also, I could use any information on a 3-14 regulator tube for the above. I would like to convert this tube, since I have not been able to find a replacement this past year.

Neil Van Oost, Jr.
RD #1, Box 301P
Waretown NJ 08758

I really need some help to obtain my Novice license. In my spare time I have studied all the guides, but I have a lot of problems (with which I think a ham class or a ham operator could help me very much). I have a handicap which makes it difficult for me to be a ham — I stutter. I want very much to be a ham, but am afraid to ask any of them. I have the winter and spring off. I am a pipeline worker and also would like any pipeliner who is a ham operator to contact me for the purpose of forming a net after I get my license.

Dale T. Fontaine
2309 So. 22nd St.
Grand Forks ND 58201

I need to contact anyone who was part of a group that set up a ham station on the Isla del Coco, off the coast of Costa Rica, several years ago.

Jere F. Welch
TUSLOG Det-8
Box G
APO NY 09294

see page 220

Looking *West*

Bill Pasternak WA6ITF
24854-C Newhall Ave.
Newhall CA 91321

I guess I do not have to tell you that we are in a time of change, a time that is going to write new pages in the history book about amateur radio, especially the part dealing with FM relay communication on two meters. There are many of us who feel that there is really no need for more FM repeaters, especially at the expense of already existing activity, and others who feel that nothing is any more important than obtaining a maximum number of such systems in operation regardless of the overall environmental impact. As you are already aware, my feelings on this matter lie someplace in between, leaning more toward no FM repeater expansion into the area between 144.5 and 145.5 MHz. Relay-type communication, yes, but of a type that meets two important criteria. It must be totally compatible with existing narrowband activity and, even more important, it must signify a step forward in communication technology attributable directly to the amateur service. Right now, we need the latter a heck of a lot more than we need more FM repeaters. I'll get back to this later on, but since this is currently a rather emotional subject, let's let it cool for a moment and discuss something that is a close cousin to amateur radio, international shortwave listening – in particular, a station known as Radio Nederland.

In the not-so-long-ago "old days" – the days before solid state and transceivers the size of a loaf of bread – the average station consisted of a separate receiver and transmitter along with the necessary associated goodies. It mattered not if you were involved in HF or VHF; the separate receiver and transmitter combination was the rule rather than the exception. If you were one of the fortunate ones, you owned a "ham-band-only" receiver that gave you the ability to change bands with a minimum of effort. If you were like me and most of my cohorts of the early 1960s, and were involved in a piece of spectrum known as six meters, your state-of-the-art station might have consisted of a Hallicrafters SX-99 receiver, a Tech-craft CC-50 converter, and maybe a Globe Scout transmitter. At least that was the gear I used back in Brooklyn at the WA2HVK location.

The SX-99, now long gone, was not only my station receiver, but more. That single conversion black, grey, and silver box opened the whole world to me. It gave me a chance to hear many of the world's people and get to know a bit about them without ever leaving my bedroom. I often wonder how many of today's new hams have ever spent a few hours listening to the spectrum that contains the voices of so many people around the globe or, for that matter, how many even know that such a world exists. In many ways the ham of today with his super-sophisticated ham-band-only station does not realize that he is missing a whole lot. Sure, many of us have that ability because we want it, but I get the feeling that "we" are a minority.

I must admit that for a number of years I fell into the same trap. As I became more and more involved in VHF repeaters in the late sixties, the SX-99 got traded off for some RCA and GE radios and the past was filed away in memory. There were repeaters to build and SSB DX to be worked on six. Time passed quickly and memories began to fade. Then, about six months ago, it happened. I was attending a meeting of the Lockheed Amateur Radio Club in Burbank, and, as luck would have it, it was a night that the club was holding a mini-auction. Among the goodies going on the block was a piece of nostalgia, a general coverage receiver from literally out of my childhood. I had to have it, this S-38D, if for no other reason than as an excuse to reminisce. Twenty dollars and about an hour later, with my grey box under my arm, I was on my way out to the parking lot and en route home. Would it work? Soon I would find out . . .

The switches and controls were a bit noisy, but everything lit up . . . Hmmm . . . the Dodgers are winning . . . let's see . . . band 2 . . . 75 is alive though the bfo is not really stable enough to tune in anything . . . it's a good table radio if nothing else . . . band 3 seems OK . . . there's WWV right at . . . err . . . about 5 MHz . . . that carillon sounds familiar . . . wait a minute . . . could that be . . . it was, and the S-38D has sat there ever since. I am once again thankfully hooked on Radio Nederland.

International shortwave broadcasting is the one way that a nation has to bring its thoughts and ideas to the rest of the world's peoples. Virtually every nation on this globe has such an entity operational on a regular or irregular schedule. Many nations use this worldwide broadcast ability simply as another tool in their particular political repertoire, while others have taken to using it to entertain and educate those who listen. Three stations in the latter category stand out in my mind: the Voice of America, the BBC World Service, and Radio Nederland.

Want to know what the top 40 tunes are in Europe? Want to hear no-holds-barred yet tasteful discussions of world problems and possible solutions? Maybe you might want to learn the secrets of better DX SWLing. Radio Nederland offers all that and more. Calling themselves the "Friendly Little Station In Hilversum," they seem to go all out to live up to the reputation that this title entails. Over any given seven-day period, you are bound to run into at least a half a dozen programs that interest you, and soon you will find yourself in front of a typewriter writing a letter to ask about this or that – probably thinking yourself silly writing to a radio station in another country and wondering if they will ever bother to read what you wish to convey. Surprise – they sure do, as I have personally found out. They really care what their audience thinks, and if you write to them, they write back. Send them a reception report, and a QSL like the one pictured comes back. In many ways, Radio Nederland is the epitome of "two-way interactive radio." They are obviously proud of their operation and, after listening a while, that pride will most likely rub off on you. Soon you find yourself more than just a listener, but rather a part of a worldwide community of human beings involved in a listening and learning experience.

It matters not if you are lucky enough to hear a direct transmission from Hilversum or listen as I do via one of their two relay transmitters located in Madagascar and Bonaire. After but a few evenings, I have a feeling that you may find yourself addicted to Radio Nederland – and what you hear can lead to some rather interesting topics for QSOs later on in the evening. This month, "Looking West" salutes the people of that fine "Friendly Little Station In Hilversum" for their ongoing efforts to bring quality and entertainment to DX shortwave broadcasting.

Radio Nederland QSL, showing Jacob Borenstein, Alfonso Montealegre Moure, and Dick Speekman, producers of Radio Nederland's DX programs: Radio-Atividade (Portuguese), Espacio DX-ista (Spanish), and DX Juke Box (English).

I hope you enjoyed this sidelight to "Looking West" this month; if you want more on this or any other specific topic, let me know. These days there is little difference between the cost of a 40-channel CB radio and a portable shortwave receiver. Some of you may be planning to give your kids a CB set as a Christmas present. Think again. For the same fifty bucks, you can give your kid the world, and that's the kind of gift that will last him or her a lifetime. Now on to FM, repeaters, deregulation and the like.

Don't be complacent. The FCC may have killed 220 MHz Class E CB for now, but the proponents of this service are sure to try again and again to make it a reality. There is money, lots of money, to be made, and don't think they don't know this. There is only one way I know to insure the sanctity of 220 or any amateur band, and that is to populate it so heavily nationally that the FCC would be hard put to attempt to take any sliver away. There is absolutely no excuse for avoiding 220. It's far less crowded than two, there is room in most areas to put a repeater up without much fuss and, most important, the equipment available from both Midland and Clegg is of high quality and reasonably priced. Both the Midland and Clegg radios convert into fine repeaters with little difficulty, and seem to work admirably even in high rf environments. The 220 system I am on was built from just such a radio, and it's been percolating for almost a year without a failure.

In a similar manner, we must also populate six meters and ten meters before someone gets the idea that one of those places would be dandy for their particular interest to acquire. Don't think that six is safe just because of the TVI problems peculiar to that band. If someone wants it, the present low national level of activity could easily justify such a power play. Even worse, one of these days some bright-eyed entrepreneur might realize that six would be an "ideal" (?) place for a new CB-type operation and . . . zap . . . TVI not withstanding . . . four megahertz of "10-4 Good Buddy." Remember, even mass-produced, it's still cheaper to manufacture a six meter radio than a 220 or UHF radio. Ten, six, and 220 . . . use them or lose them!

ELECTRONIC JOURNALISM COMES TO AMATEUR RADIO

"The following is a QST. This is Jim Hendershot in Los Angeles and this is the Westlink Amateur Radio News." By now, many of you have probably heard these words issuing forth from your radio's speaker as your favorite repeater takes a few minutes out to bring you the most important happenings in the amateur world, happenings that affect each of us.

The Westlink Amateur Radio News is produced weekly by the Western

Continued on page 137

Years Ahead With Yaesu!

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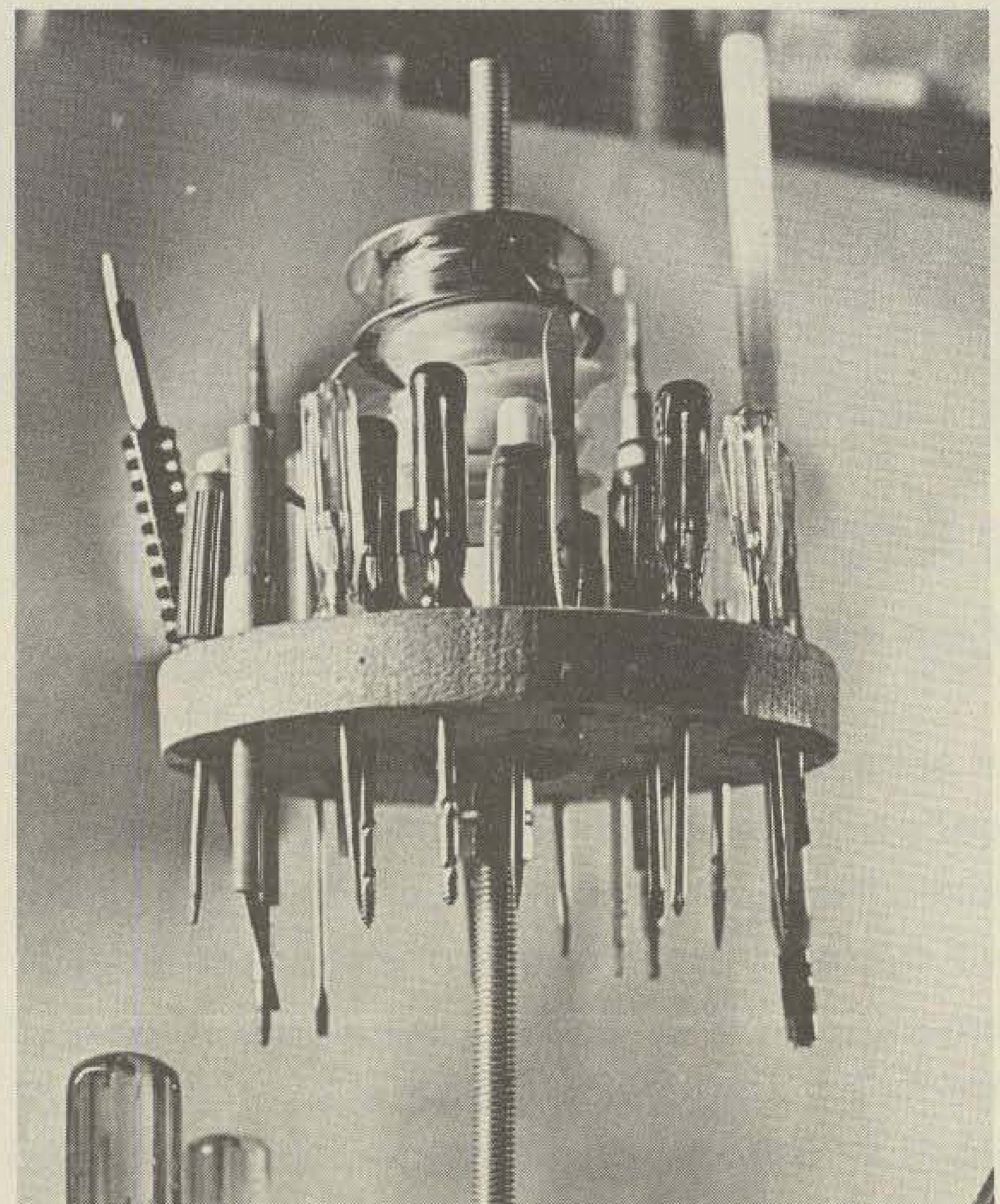
The Unbeatable Base-Loaded Three-Element Rotary Vertical

Photos by WA3PTC



Allan S. Joffe W3KBM
1005 Twining Road
Dresher PA 19025

This masterpiece can be considered truly universal, as any ham, on any band, running any power, with any mode, can obtain a real gain. You all are quite aware of how tricky figures can be, so I will make no comparisons to an isotropic source or even a rock-filled water bucket . . . like most of the good things in life, you build it to see if it works as advertised.

The beautiful part of this project is that there can be no "mail-order lag," and reasonable substitution of materials and design can be made freely . . . within the limits of

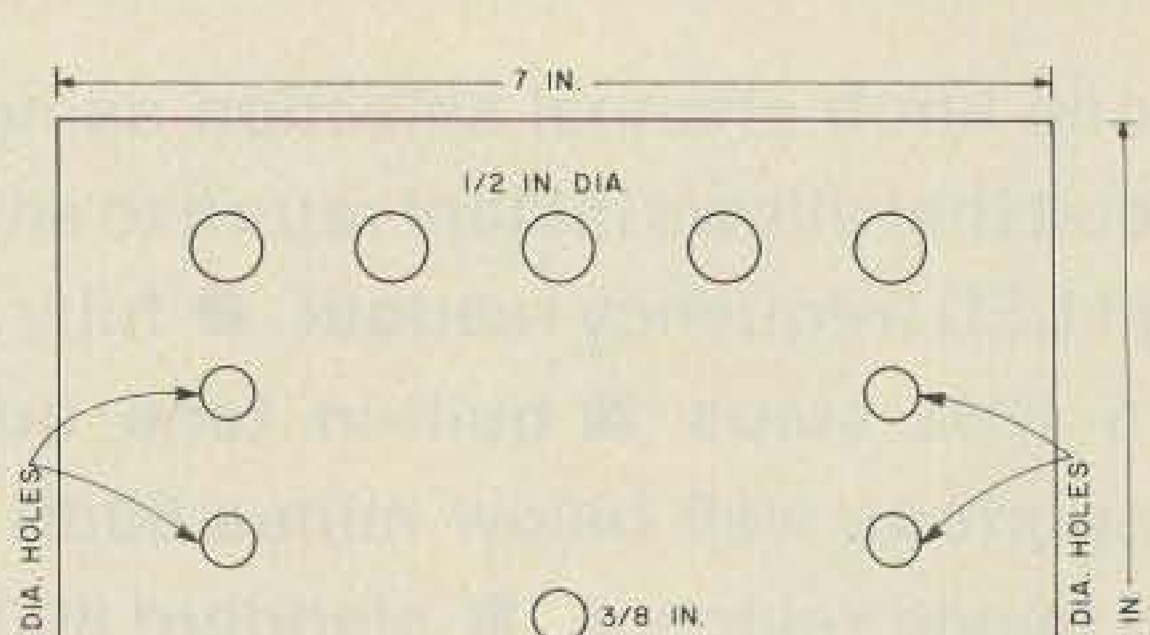


Fig. 1. Bottom and middle elements.

compromising mechanical integrity.

The backbone or boom, if you will, consists of a length of 3/8-inch-diameter threaded rod approximately 20 inches long. Some 14 matching nuts and a half dozen lock washers plus six flat washers make up the bulk of the hardware.

For the purists in the crowd who might be tempted to sneer at the length of the boom, this length seemed to give ideal spacing to the elements to be mounted on the boom. Two of the elements are identical in size, being made of white pine 1 inch thick and seven inches square. These are carefully drilled, as per Fig. 1, to allow for subsequent insertions. While some deviation from this prescribed pattern is permissible (and even encouraged), care should be taken to avoid impedance mutual coupling between the elements to avoid entangling insertions or hindering the desired rotary action.

The third element is made of the same material as the first two, but is made circular, about six inches in diameter, and drilled as per Fig. 2.

The auxiliary base loading is made from a piece of ¼-inch-thick iron plate about six inches on a side. A 3/8-inch hole is drilled dead center to allow passage of the boom, which is locked to the base with suitable nuts and lock washers. It has to be perfectly obvious that the multiplication of the square area of this loading plate by the density of the programmed material will allow considerable loading latitude without producing undue boom tilt.

Fig. 3 shows how it all fits together, with details of how the rotary elements are fixed to the boom so that they retain the capacity to rotate. Put into words, each element has a sandwich of two nuts and a lock washer below it to form a mechanical stop. Then we add a large plain washer to provide the requisite bearing surface. Next, the element goes on the boom and is topped off by another plain washer and the two nuts plus a lock washer to hold the element in place snugly but freely enough to allow for the alluded-to rotary motion in the horizontal plane.

It is obvious that, with such freedom of rotation, any discussion of front-to-back ratios is rather academic. Having suddenly become very aware that the English language has the capacity to lead one astray, let me say, in closing, that this tool rack (who said anything about antennas?) is a fine addition to anyone's work bench. ■

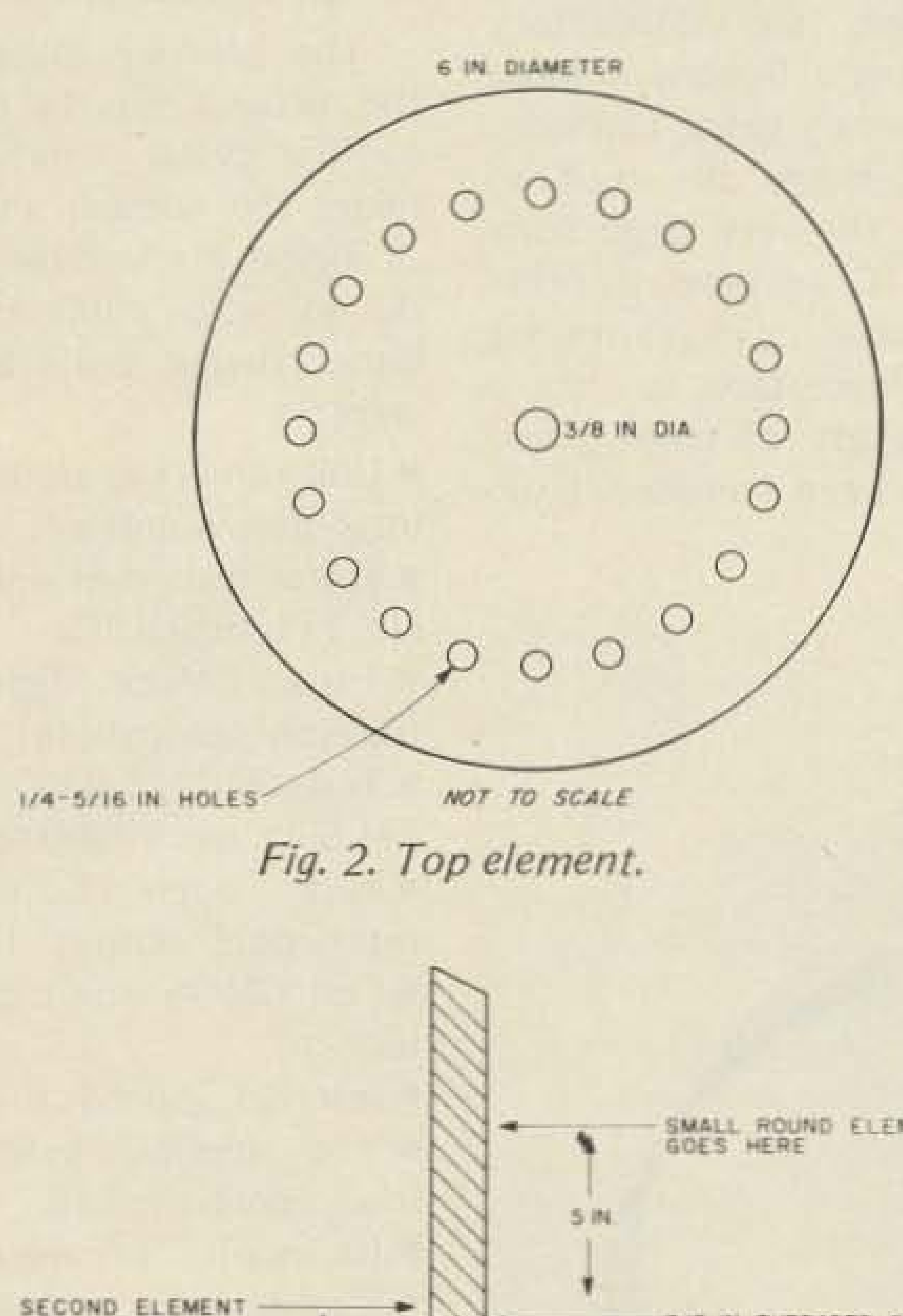


Fig. 2. Top element.

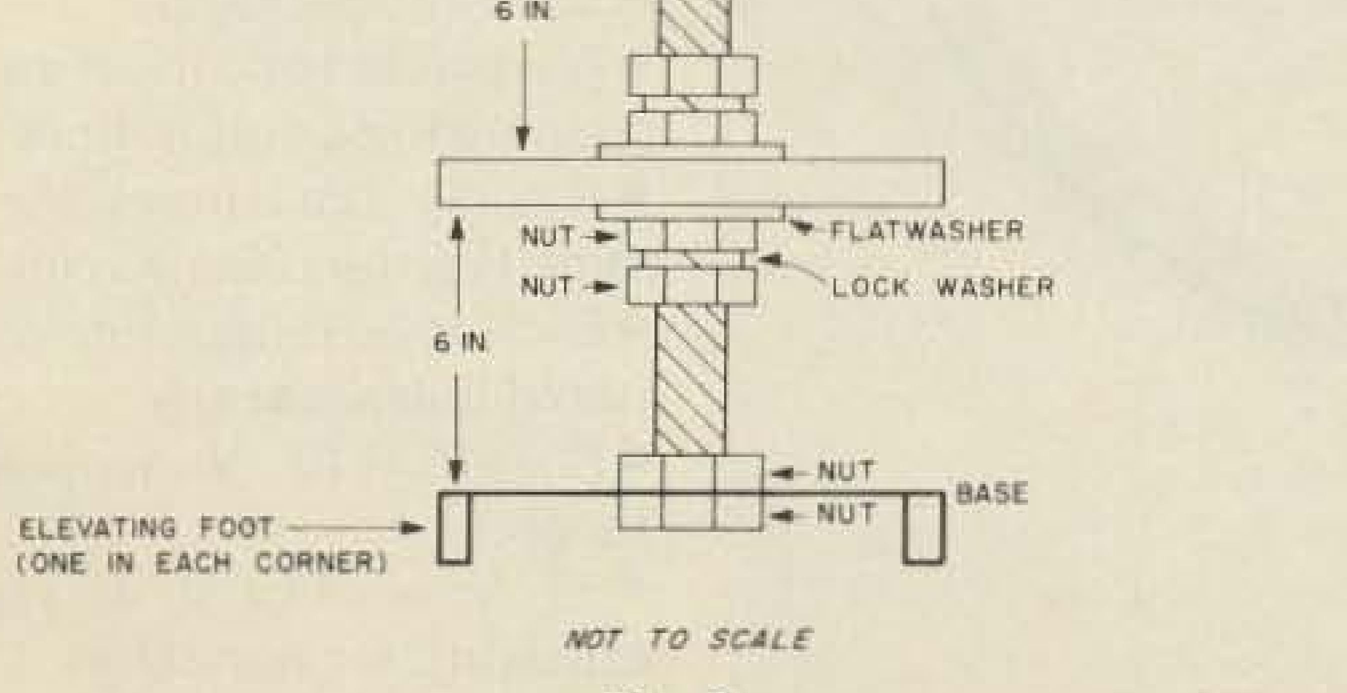
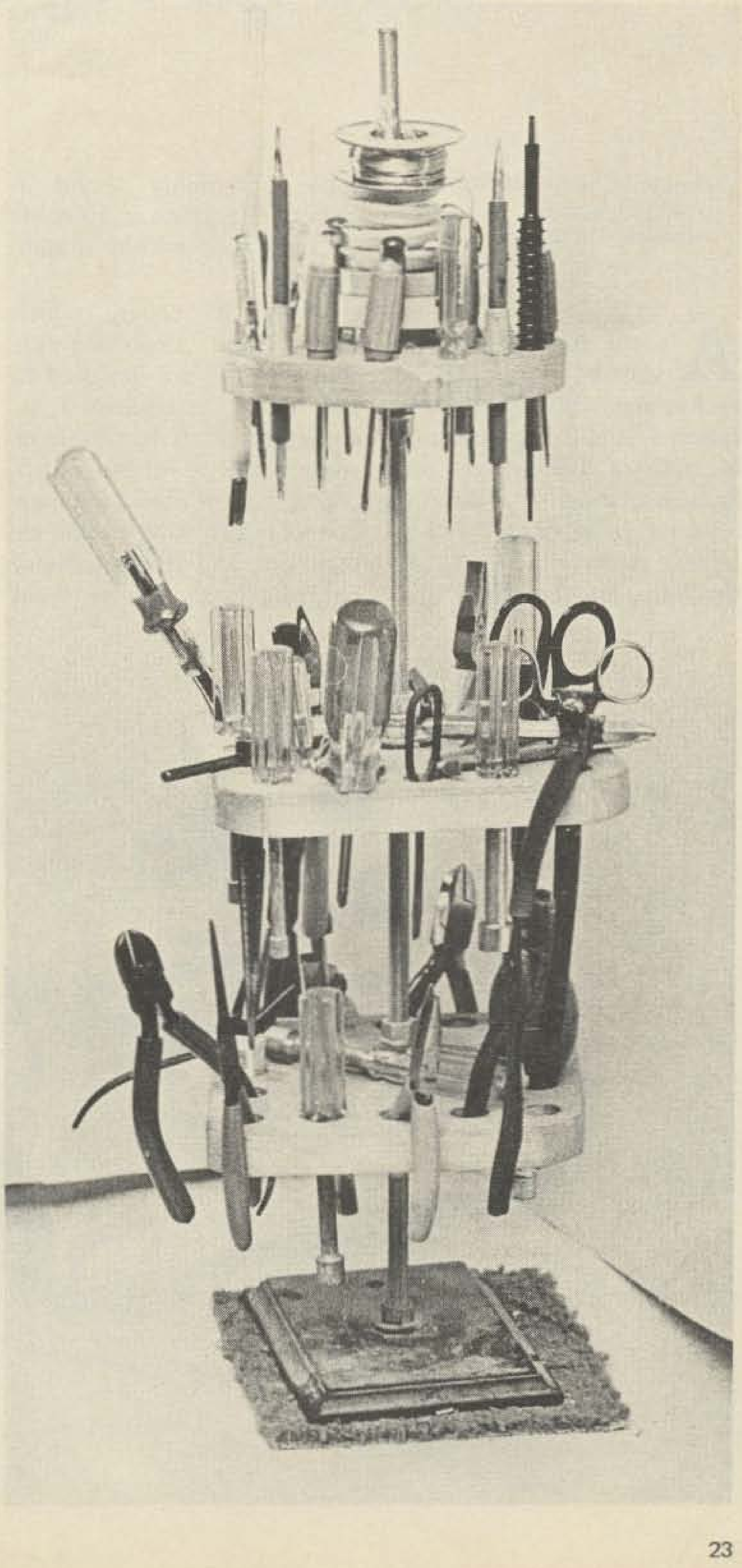


Fig. 3.



Test Those ICs!

-- what to do when the bug dies

Howard F. Batie W7BBX/4
12002 Cheviot Dr.
Herndon VA 22070

As the number of construction articles proliferates, and the sophistication of the logic chips used in state of the art projects increases, there is a definite need for an integrated circuit tester with much greater flexibility and capability than those commonly found in current literature or available commercially within reasonable cost.

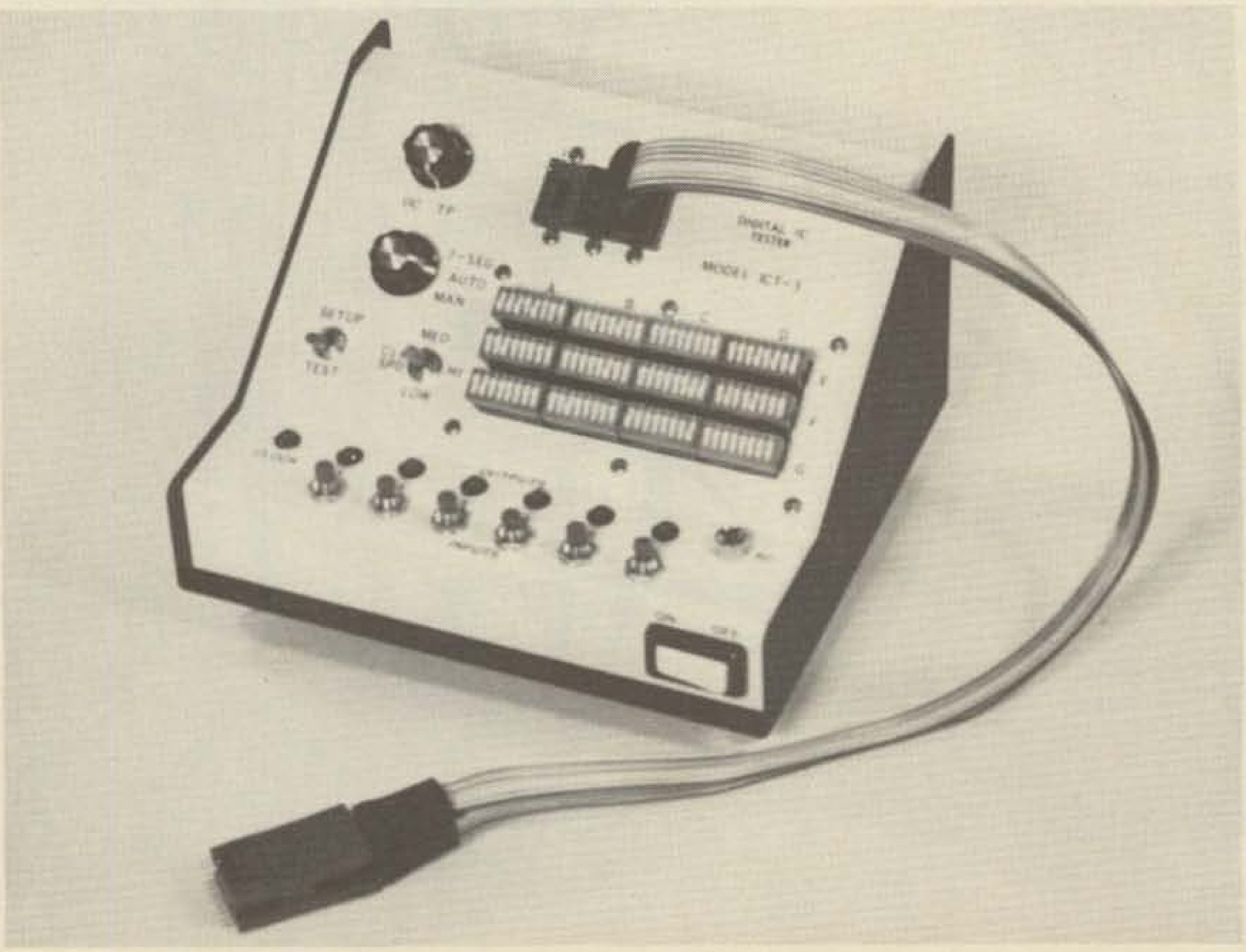
Many IC testers which have been described recently[1,2,3,4] are designed to use either a dedicated IC socket for each IC tested, or some form of hardware programming device to interconnect Vcc, GND, logic in, logic out, and other necessary control signals. Other types of testers commercially available employ multiple-pole slide or rotary switches for programming. Although both approaches are satisfactory for testing a limited number of elementary gates, counters, and flip-flops, the cost to dedicate the very large number of IC sockets or other hardware programming devices necessary to test a great variety of chips generally has been considered too prohibitive; as a result, the testers previously described have a limited number of ICs they can test.

The IC tester described here is capable of testing a very wide range of DTL, TTL, and CMOS digital logic functions, including single and multiple-input gates, inverters and buffers, flip-flops, counters, shift registers, latches, one-shots, pulse synchronizers, multiplexers/encoders, demultiplexers/decoders, arithmetic logic functions, switch debouncers, priority encoders, true/complement elements, parity generators, and many others. Specific TTL and CMOS ICs which are testable are listed in Table 1. Others may be added to the list, but have not been investigated.

Design Considerations

The primary objective of this project was to design a quality tester which maximizes the number and types of digital ICs testable, and to do so with minimum cost. Other design goals achieved were:

- Unit can act as an in-circuit, logic-state monitor
- Tester tests over 450 different TTL digital ICs
- Tests CMOS digital ICs (directly compatible)
- Tests 7400, 74H00, 74L00, 74LS00, and 74S00 series
- Tests open-collector and totem-pole output TTL ICs
- Full CMOS input gate protection
- Internal 3-speed clock
- Vcc applied before any logic signals applied
- Icc monitor provided
- Rapid, easy programming
- Tests both 14- and 16-pin dual in-line packages
- 6 separate logic input and 6 separate logic output lines
- Rapidly tests many ICs of same type by using IC clip
- Each logic output line monitored independently
- Built-in 110 V ac power supply
- +9 V or +12 V dc input capability for portability
- Convenient size, attractive



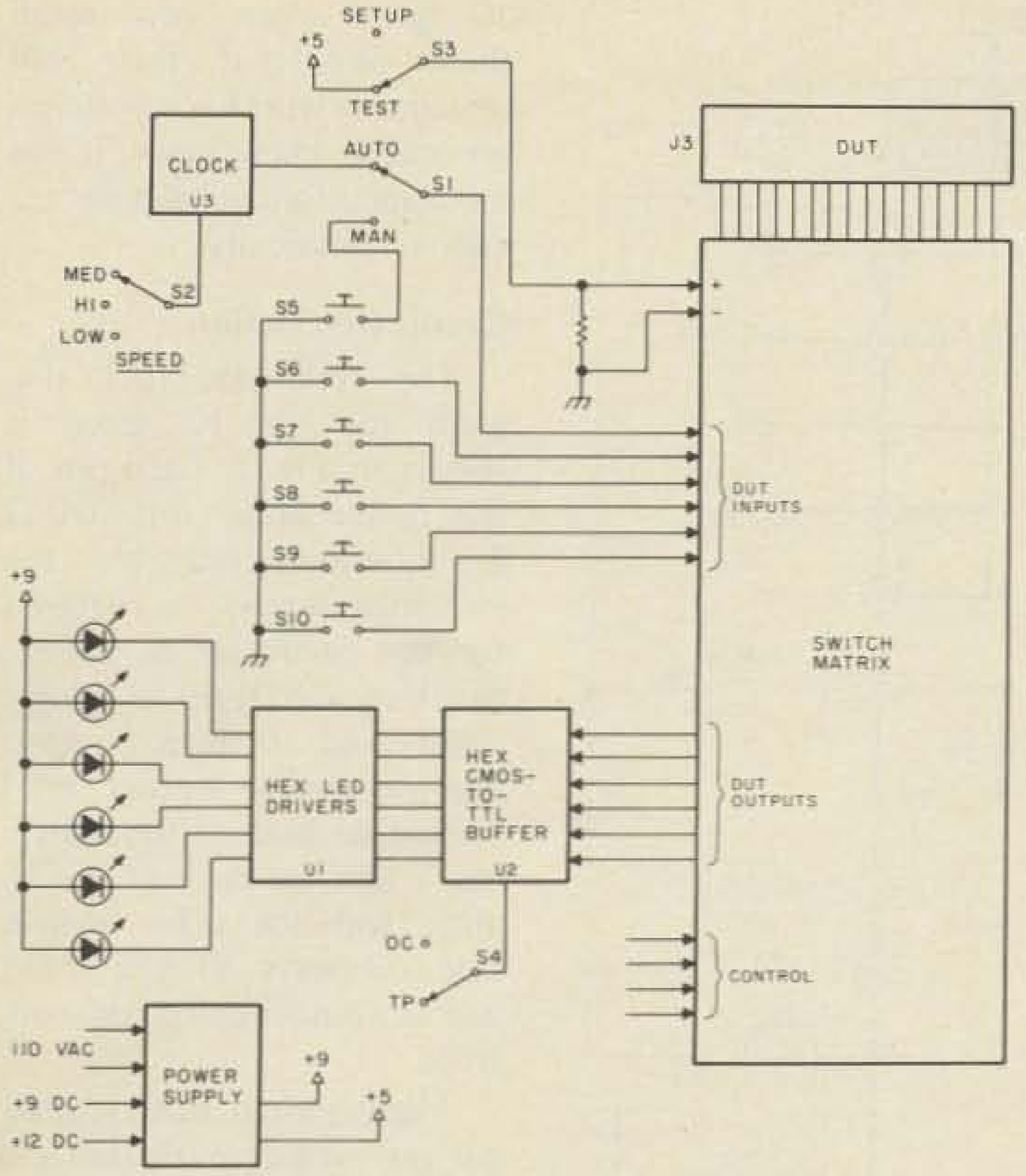
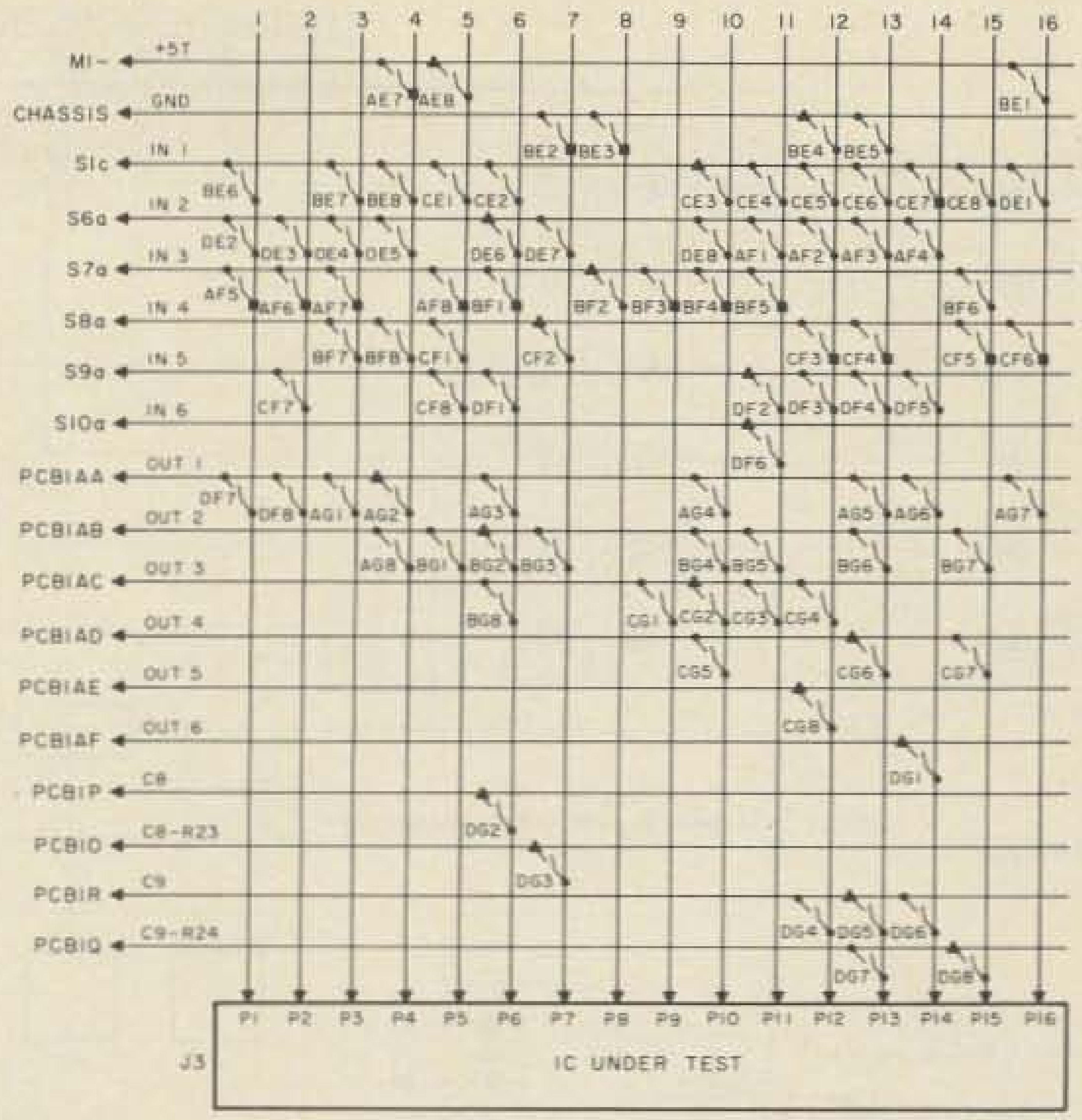


Fig. 1. IC tester functional block diagram.



▲ THIS POINT CONNECTED TO INDICATED J3 PIN.
■ THIS POINT CONNECTED TO INPUT/OUTPUT LINE INDICATED TO LEFT.

Fig. 2. DIP switch matrix.

TTL (Includes N, H, L, LS & S series of 5400 and 7400 family ICs)
00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 22, 25, 26, 27, 28, 30, 32, 33, 37, 38, 40, 46, 47, 51, 54, 55, 64, 65, 71, 72, 73, 74, 75, 76, 78, 80, 86, 87, 90, 92, 93, 102, 103, 106, 107, 108, 109, 110, 111, 112, 113, 114, 120, 121, 122, 123, 128, 132, 133, 135, 136, 140, 153, 155, 156, 157, 158, 164, 165, 174, 175, 176, 177, 183, 190, 191, 192, 193, 196, 197, 260, 266, 278, 279, 280, 290, 293, 298, 386, 390, 393, 490.

CMOS (4000 family)
00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 33, 37, 40, 41, 42, 49, 50, 66.

Table 1. ICs known to be testable.

case

The above features, and the logical design of the IC tester circuit, were arrived at by seriously examining the required parameters to be tested on the various IC chips. Two basic categories of parameters are normally specified for digital ICs — dynamic and static. Table 2 summarizes the basic differences between static and dynamic testing.

Dynamic parameters of digital logic chips include gate propagation delay, maximum clock toggling frequency, output rise and fall times, and other properties designed into the chip which specify input and output conditions at very high clock input rates. Basically, dynamic testers determine how well the IC works.

Static parameters include the Vcc and Icc required and the fundamental ability of the logic chip outputs to correctly follow the various logic inputs for that chip, according to its respective truth table, i.e., "Does the chip work?"

Since ICs are manufactured to stated minimum and maximum specifications (reflected in their dynamic and static operating parameters), there is a very good degree of assurance that the IC will function properly in a circuit, if its static operation is correct and it is not required to operate above its minimum guaranteed operating frequency or otherwise outside its specified dynamic operating characteristics. The great majority of applications for digital TTL or CMOS ICs do not require near-maximum performance of the chip (except, perhaps, for VHF or UHF prescalers, and gigabit logic applications, where ECL or other newer technologies are used). Therefore, a static tester will be quite adequate, since, if the chip does work correctly, it can be expected to meet at least its minimum dynamic operating characteristics in a particular design application.

Since it is terribly frustrating and time-consuming to either debug a logic circuit prior to getting it working or troubleshoot the circuit to find out why it has stopped working, a few simple quality-control procedures taken before installing the IC can save many headaches later. The easy to perform burn-in process, described later, followed by static testing with the tester detailed below, will give you a very high measure of confidence that the ICs you use

	Static testing	Dynamic testing
Type of testing	Functional Truth table compliance Icc (quiescent drive current)	Full parameter Propagation delay Max toggle frequency Noise immunity Min. clock pulse width Fan-out/Fan-in
Clock frequency	Low to medium	Near maximum rated
Complexity	Simple — switches and logic indicators	Very high — normally special-purpose or custom-designed ROM or microprocessor-controlled
Commercial cost	\$500 — \$1000	\$1500 (benchtop) to over \$50,000 (production line)

Table 2. Static and dynamic testing comparison.

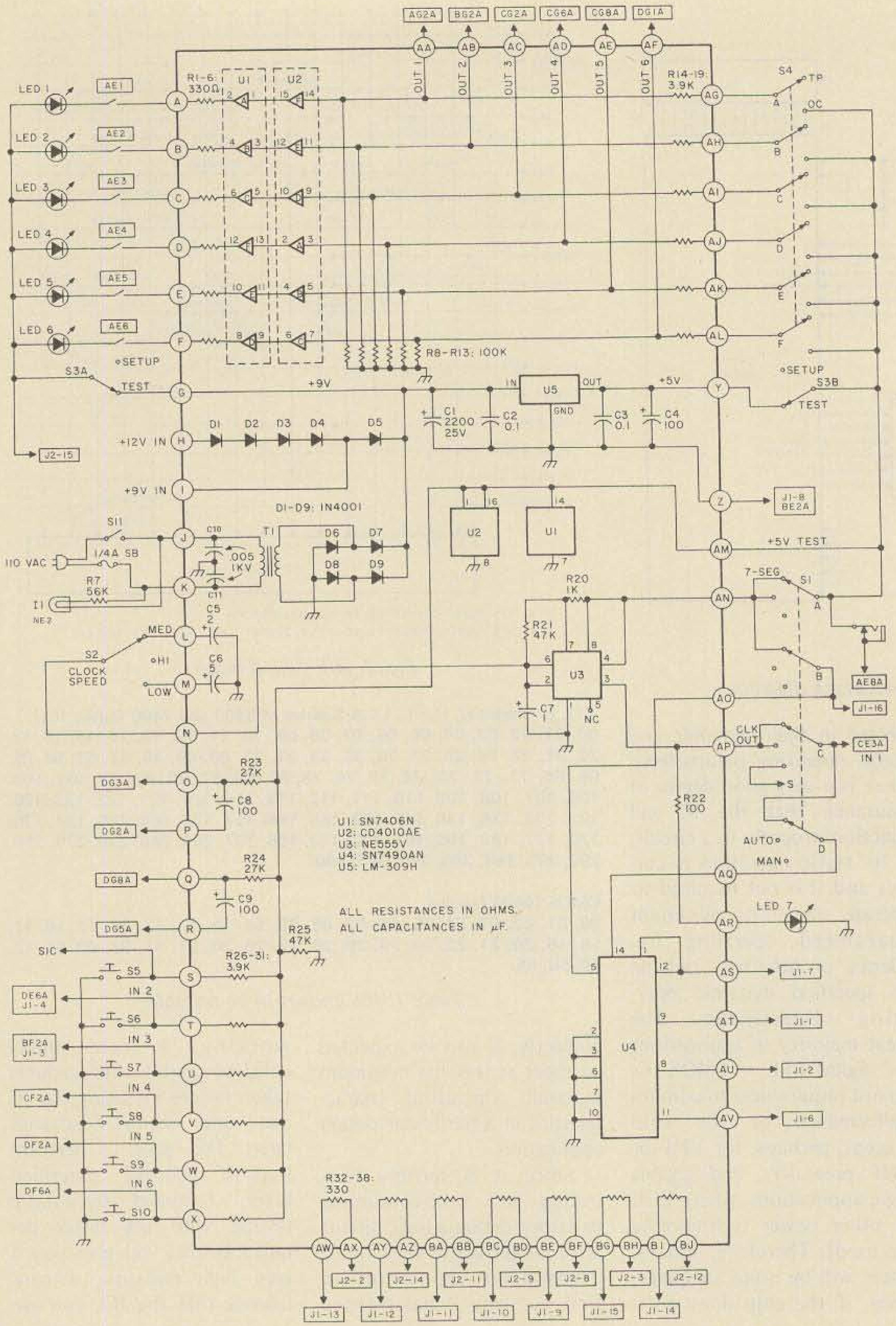


Fig. 3. Logic board (PCB-1) schematic diagram. Connection points inside rectangular boxes refer to external jacks (J1-6 = pin 6 of jack J1) or PCB-2 switch matrix connection points (DF6A = pin A of DIP switch DF6). N.B. Insulate jack from chassis.

are good when you install them and that they will remain in working condition for many, many years, if not subsequently damaged electrically or physically.

Circuit Description

The function block diagram for the IC tester is shown in Fig. 1. Each pin of the device under test (DUT) is interconnected by the switching matrix, as required for the particular IC tested, to +Vcc, GND, up to 6 logic input and 6 logic output lines, as well as 4 other signal lines. One side of the matrix has a line for each of the 16 pins, and the other matrix side connects to the input and output circuits and controls.

Many switch matrix alternatives were evaluated in terms of cost, physical size, and switch capacity required. The 20 x 20 pin-plug matrix board was discarded as both too bulky and costly. A programmable solid state switching array was found to be possible, but not practical, in terms of components and supply current required. A miniature jack and jumper pin matrix suffers the same problems as the plug-pin matrix and, additionally, introduces the requirement to store many jumper wires. Matrix cost and size were minimized by using an array of twelve 16-pin DIP switches, each containing eight SPST rocker switches. However, with only 96 switches available, they must be utilized to the very best advantage to interconnect the inputs and outputs of those ICs most likely to be tested.

The particular matrix

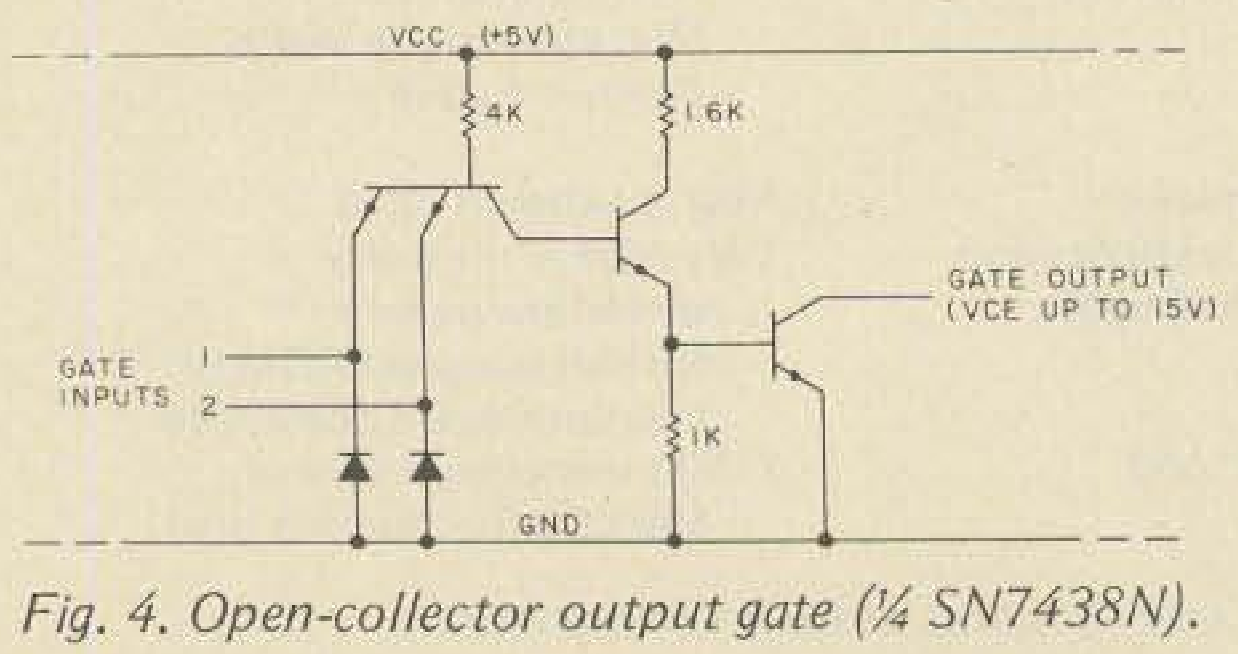


Fig. 4. Open-collector output gate (¼ SN7438N).

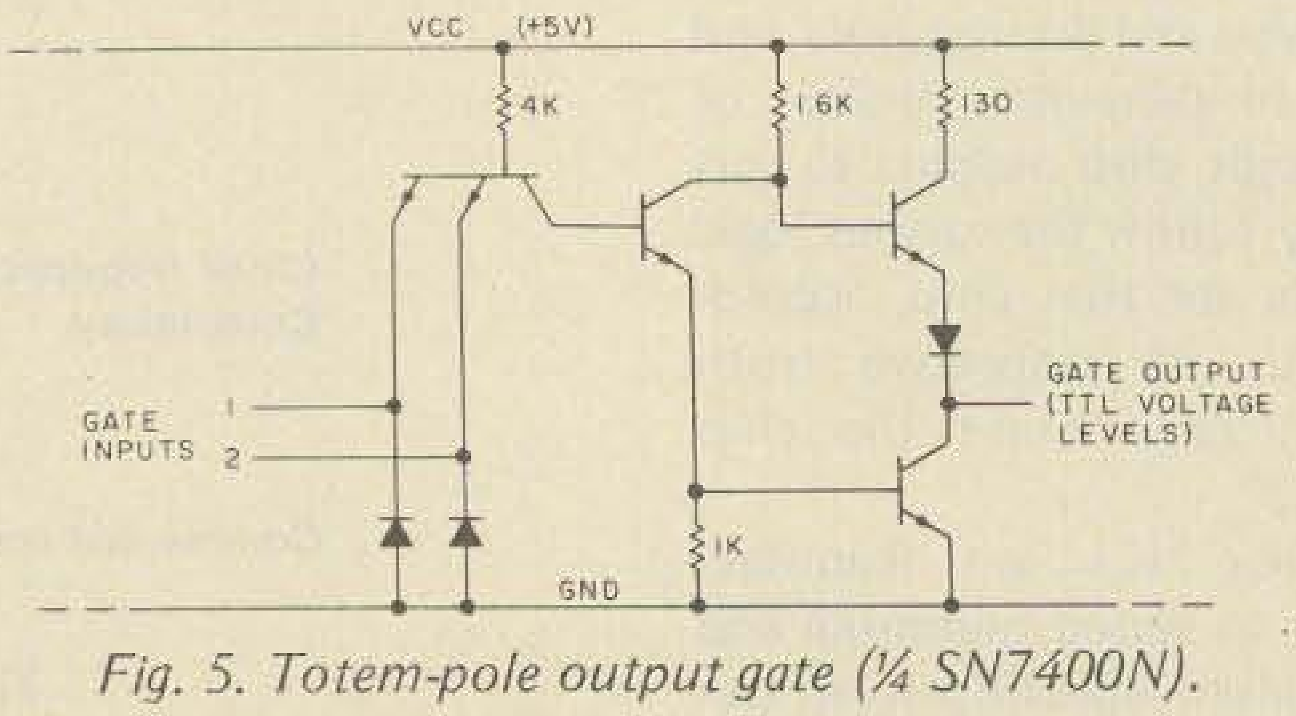


Fig. 5. Totem-pole output gate (¼ SN7400N).

organization, shown in Fig. 2, was painstakingly selected to allow the maximum number of ICs to be tested with a convenient number of DIP switches. If desired, additional DIP switches can be added to increase the number of matrix crosspoints interconnected, consistent with the panel space available. Although it is apparent that many matrix crosspoints are not provided an interconnection by one of the switches, with only a very few exceptions, all input and output logic lines for the ICs listed in Table 1 are testable with this matrix arrangement. For those ICs having more than 6 input or output lines (e.g., an 8-bit multiplexer), the DIP switch matrix can easily be reprogrammed to test those logic lines not tested with a single DIP switch setup.

Input logic signals to the DUT are generated by depressing the correct combination of push-button switches, in conformance with the logic input requirements specified in the truth table – up = logic 1, down = logic 0. In addition, an internal clock can be supplied as a logic input signal for input #1, and fed through the switch matrix to the selected input pin of the DUT. Three clock speeds have been incorporated – a slow speed (1 Hz) for monitoring latching operations, a medium speed (3 Hz) for toggling most gates, and a high speed (10 Hz) for clocking multi-bit counters, shift registers, etc.

The +5 V Vcc (Vcc and Vdd for CMOS), GND, and other input signal lines are also connected to the proper pins of the DUT, via the switch matrix. Monostable multivibrators (e.g., 74121, 84122, 74123) require timing resistors and capacitors for proper operation; these are R23, C8, R24, and C9 in Fig. 3, and have been selected to give approximately a ½-1 second low-high-low indication at the respective output monitor.

Output logic states of the DUT are led from the switch matrix, through a hex CMOS-to-TTL buffer, to individual LED drivers for display. A high output logic level (logic 1) from the DUT lights the LED, and a low output logic level (logic 0) is indicated by an unlit LED. Unused output LED indicators remain unlit.

During setup, S4 is placed into either the OC or TP position, depending on whether the DUT is of the open-collector or totem-pole output variety. This action connects or disconnects a pull-up resistor to each logic output pin of the DUT. The pull-up resistors are required only for open-collector ICs, since the output transistor collector is uncommitted (Fig. 4) for high-voltage or high-current applications, whereas the totem-pole output transistor collector is connected internally to another transistor (Fig. 5) to provide direct TTL output levels without the requirement for an external pull-up resistor.

Power Supply

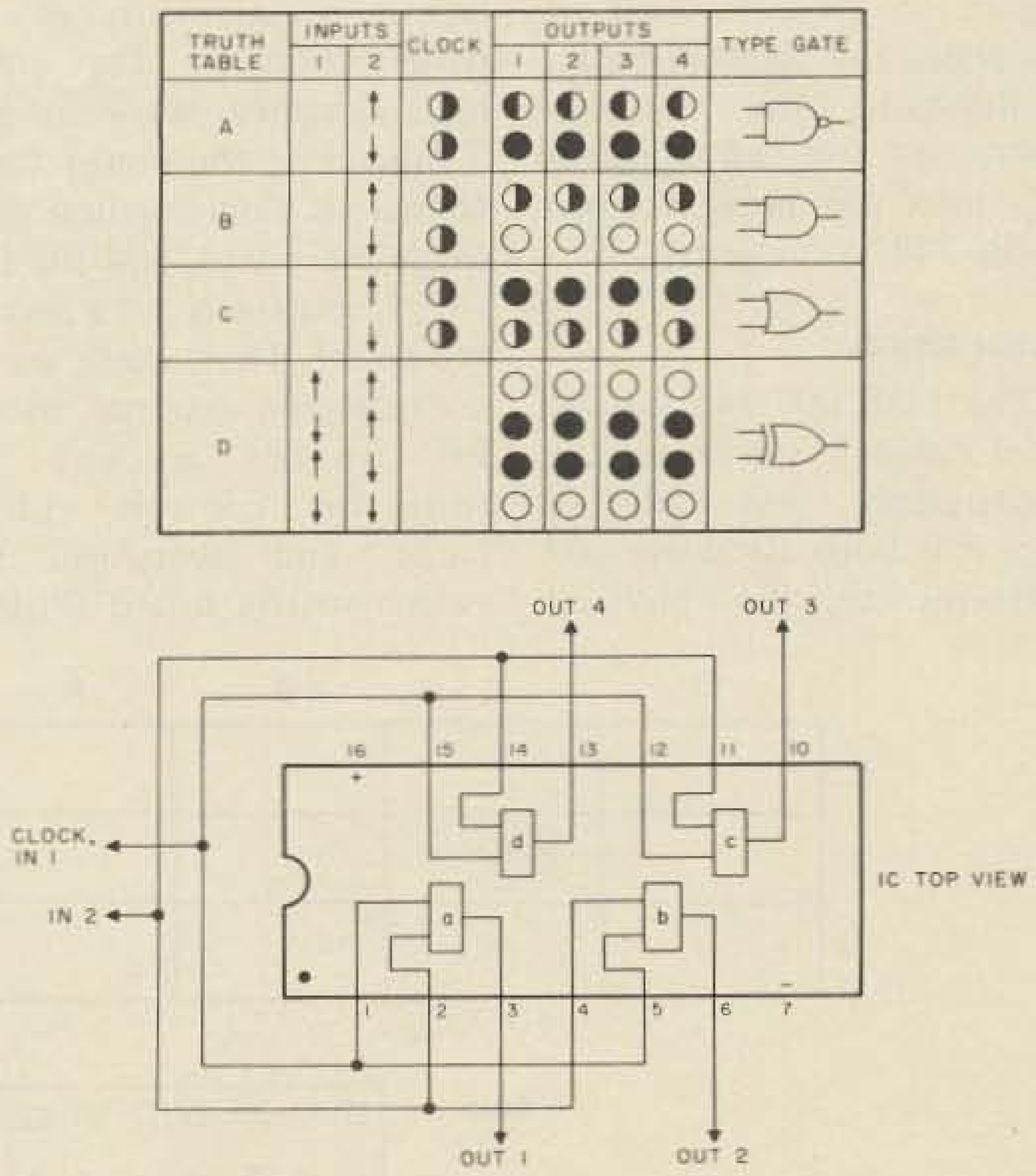
A conventional full-wave rectifier bridge (D6-D9) and a +5 V regulator (U5) are included to power all logic circuitry, as well as the DUT. A separate +9 V/+12 V dc input jack may be installed by those desiring complete portability. The external battery supply voltage is dropped to about +8 V by D1-D4, to reduce the voltage drop across and, hence, the amount of heat dissipated by U5. The diodes also provide battery polarity protection. The +5 V supply line powers the DUT and the tester circuitry only when S3 is in the TEST position; this prevents inadvertent application of input logic levels prior to application of Vcc to the DUT, since the input logic levels are themselves derived from the same +5 V line. With S3 in the SETUP position, all input, output, and Vcc lines to the DUT socket are returned to ground. An optional 0-100 milliammeter can be inserted in the Vcc line to the DUT to monitor the current required, or the Vcc line can be run to a closed-circuit 3-way jack, to permit external monitoring with your VOM.

7-Segment Decoder-Driver

Special provisions have been included on the logic printed circuit board to allow the popular SN7447A 7-segment decoder-driver to be tested. The output pulse stream from U3 is fed to an internal dedicated BCD counter, U4, and the four binary output lines are led directly to J1. Since this IC socket is dedicated for testing only the 7447A, the input and output lines required can be hardwired to J1 and J2, and a common-anode 7-segment display can be permanently installed at J2. When testing the 7447A, S1 is set to 7-SEG, and J1 is used as the test socket instead of J3. U4, J1, and J2 are optional, but considered very useful, to extend the tester's capabilities to the ubiquitous 7-segment decoder so popular in digital displays, counters, DVMs, etc. The internal BCD counter, which is hardwired to J1, allows the 7-segment

O = Off
● = On
◑ = Off-on-off
↑ = Up (Steady)
↓ = Down (Steady)
X = Up or Down (Don't care)
⌠ = Release
⌊ = Depress

Table 3. Truth table notation.



ICs	Settings	Truth table
7400, 74H00, 74L00, 74LS00, 74S00	auto TP	A
74H01	auto OC	A
7403, 74L03, 74LS03, 74S03	auto OC	A
7408, 74LS08	auto TP	B
7409, 74LS09	auto OC	B
7426	auto TP	A
7432, 74LS32	auto TP	C
7438, 74LS38	auto OC	A
7486, 74LS86, 74S86	man TP	D
74132, 74S132	auto TP	A
74136, 74LS136	man OC	D

Matrix: AE1, AE2, AE3, AE4, BE1, BE2, BE6, CE1, CE5, CE8, DE3, DE5, AF1, AF4, AG1, BG2, CG2, CG6.

Fig. 6. Sample truth table. See Table 3 for explanation of notations.

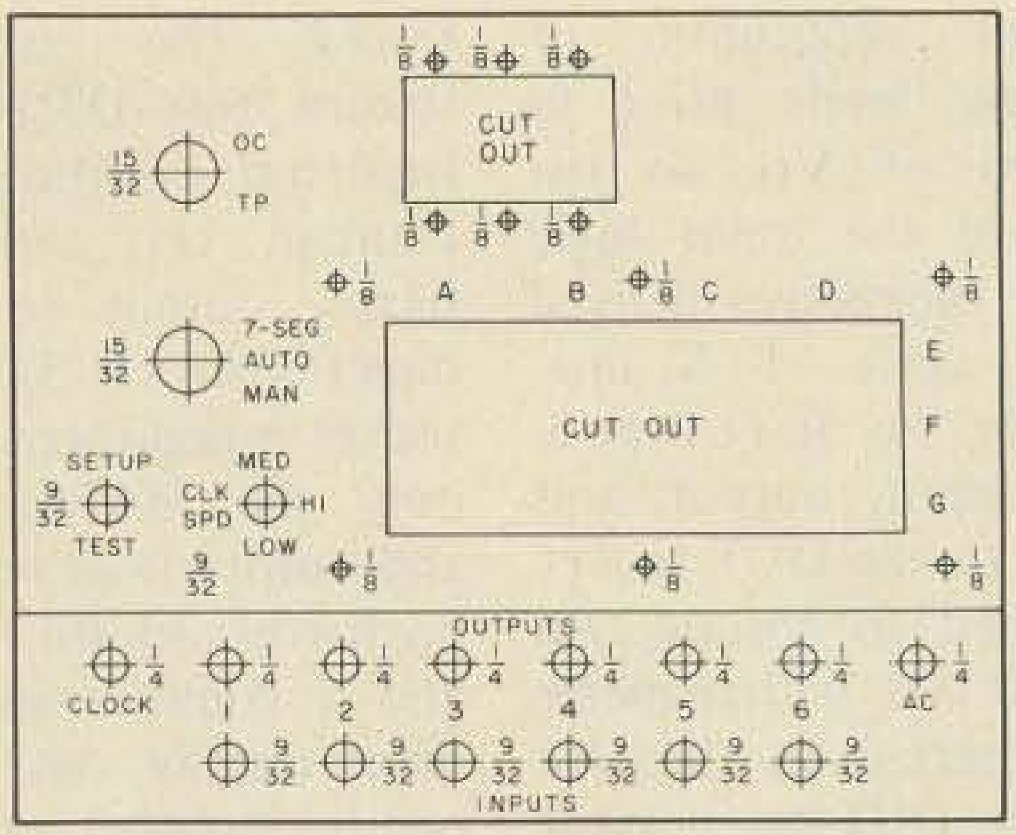


Fig. 7. Front panel.

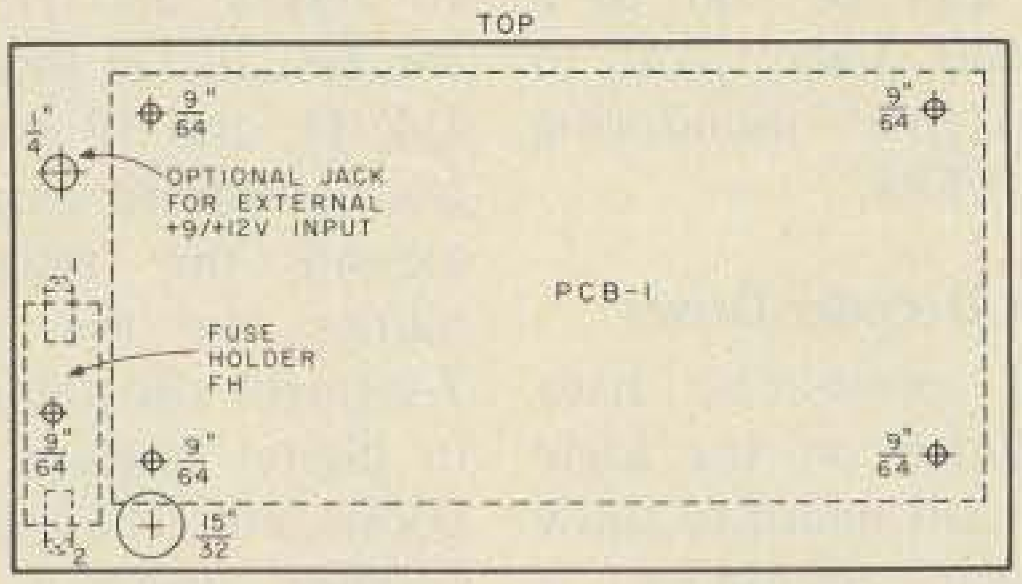


Fig. 8. Rear panel.

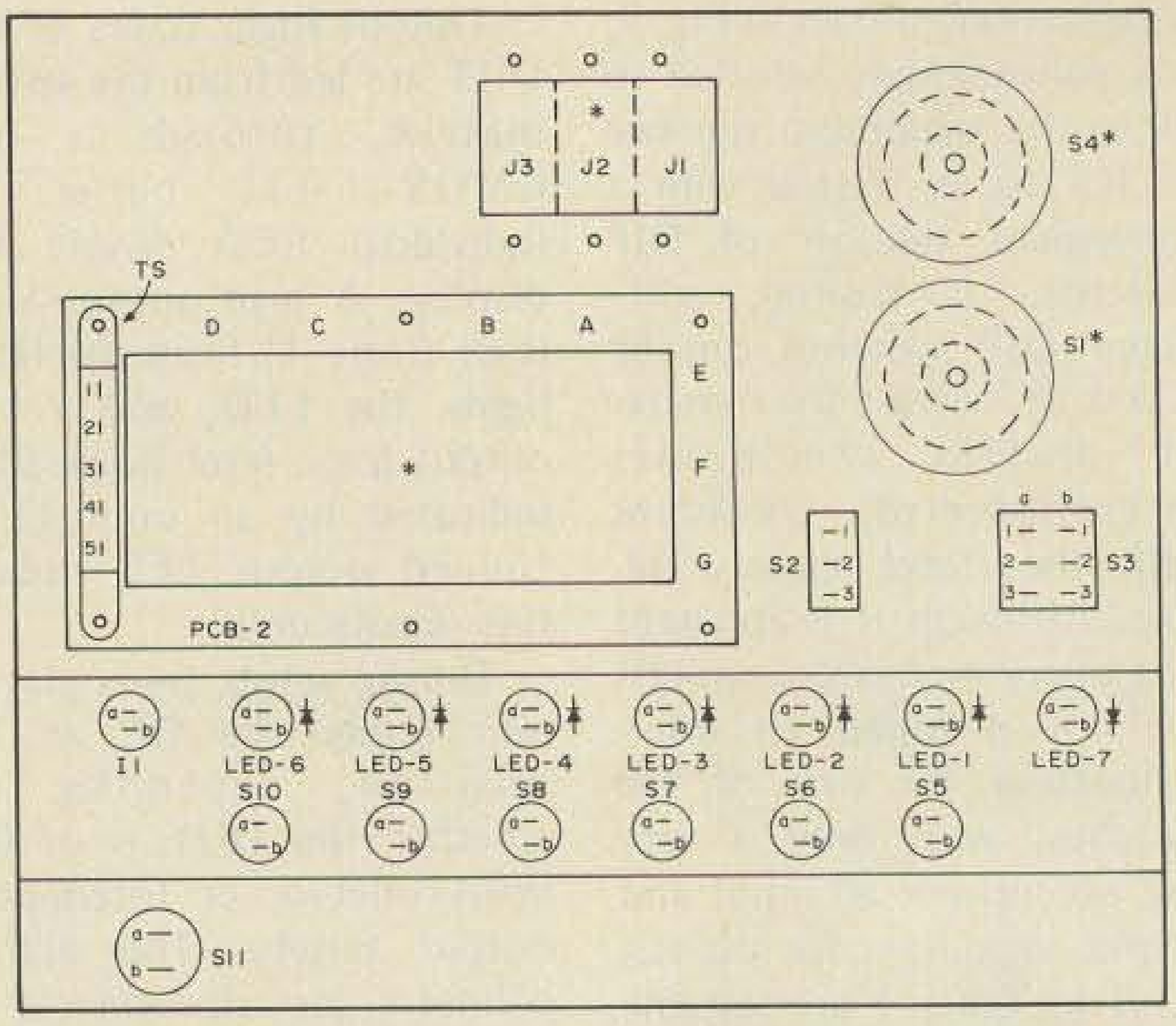


Fig. 9. Front panel interior parts placement. *See Fig. 10.

display to cycle through all numerals 0-9 continuously. Additionally, the "all segments on" and "all segments off" tests can be performed on the 7447A under test.

Construction

The LMB 007-746 sloping panel cabinet, shown in the photograph, was selected since it is both attractive and conforms to the physical layout requirements of the panel controls. The entire logic circuitry, shown in Fig. 3, including the power transformer, is implemented on a single PC board, and the DIP switch matrix is on a second PC board. Thus, there are no components external to the PC boards except the required controls, LEDs, jacks, and switches. The switch matrix board (PCB-2) is wired (wire-wrap or point-to-point) prior to installation, to reduce interconnection time required between it, the main logic board (PCB-1), and the panel controls. The use of IC sockets on PCB-2 permits the DIP switches to be removed temporarily for other uses, if desired. PCB-1 is laid out to accept IC sockets for each IC, although the use of sockets is not mandatory. Ribbon cable is used to interconnect the PCBs and controls, although a combination of wire-wrap and point-to-point wiring can be used, if desired.

A significant measure of flexibility can be added to the tester by using an IC clip and ribbon cable which connects to J3. This permits very rapid testing of many ICs of the same type, and also greatly extends the lifetime of J3. Either 14- or 16-pin ICs can be tested directly, since the DIP switch matrix programming accounts for pinout differences as long as pin 1 of the IC clip lead (or J3) is always connected to pin 1 of the 14- or 16-pin DUT when testing.

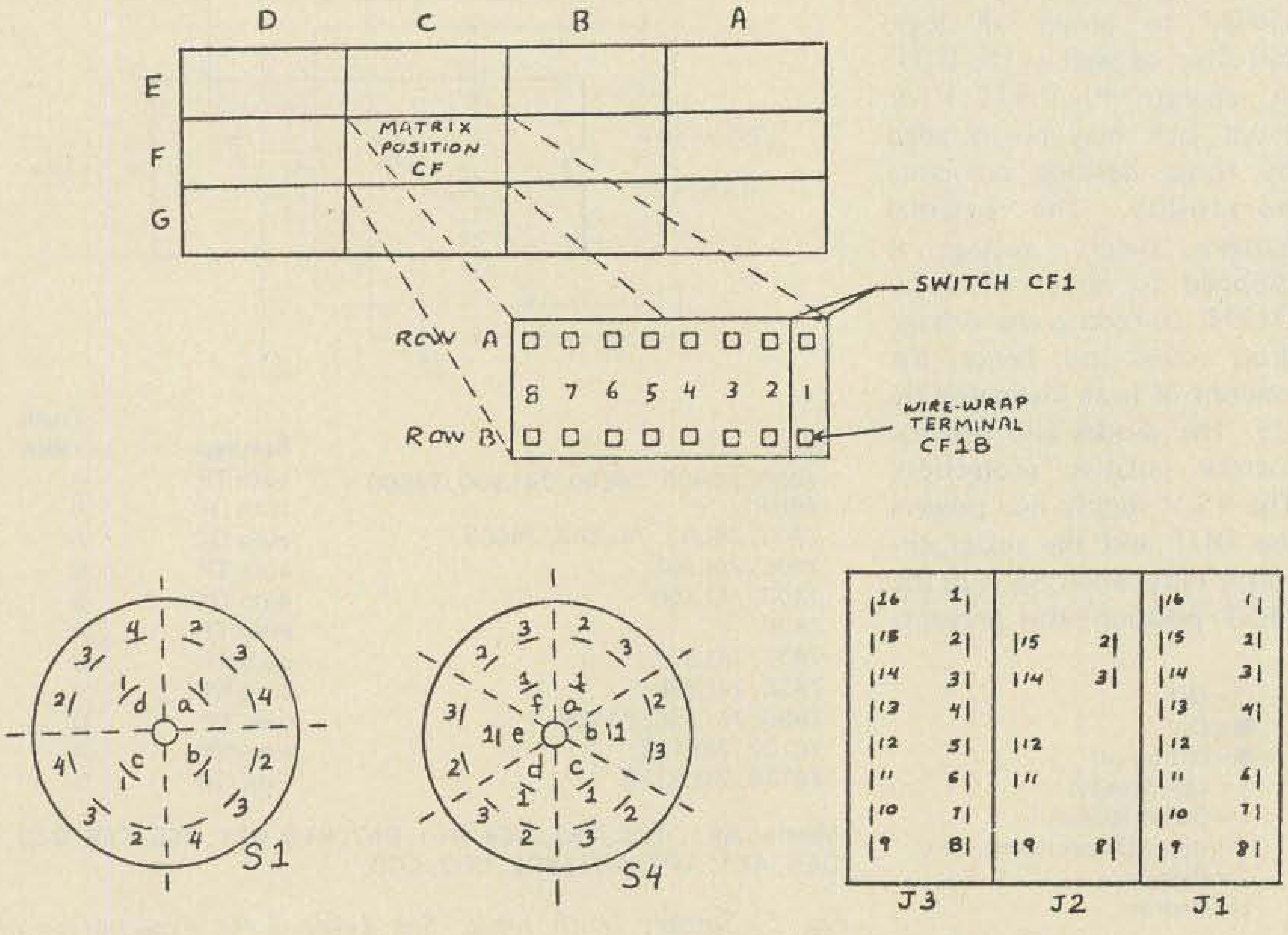


Fig. 10. Expanded views of matrix, S1, S4, and J1-J3.

Operation of the IC Tester

Due to the wide variety of IC functional pinouts, it is necessary to set up the DIP switch matrix to interconnect the input/output signal lines to the proper IC pins for each different functional pinout, but not necessarily for each different IC. For example, Fig. 6 shows a sample truth table page, which can be used for testing many IC types. There are four related parts to each page — the listing of ICs testable by the matrix settings on that page, the matrix settings, the truth table, and, for easy reference, the pinout configuration for each IC listed on that page.

To test an IC (e.g., SN74LS08N), the switch matrix and other required panel controls should be properly set before inserting

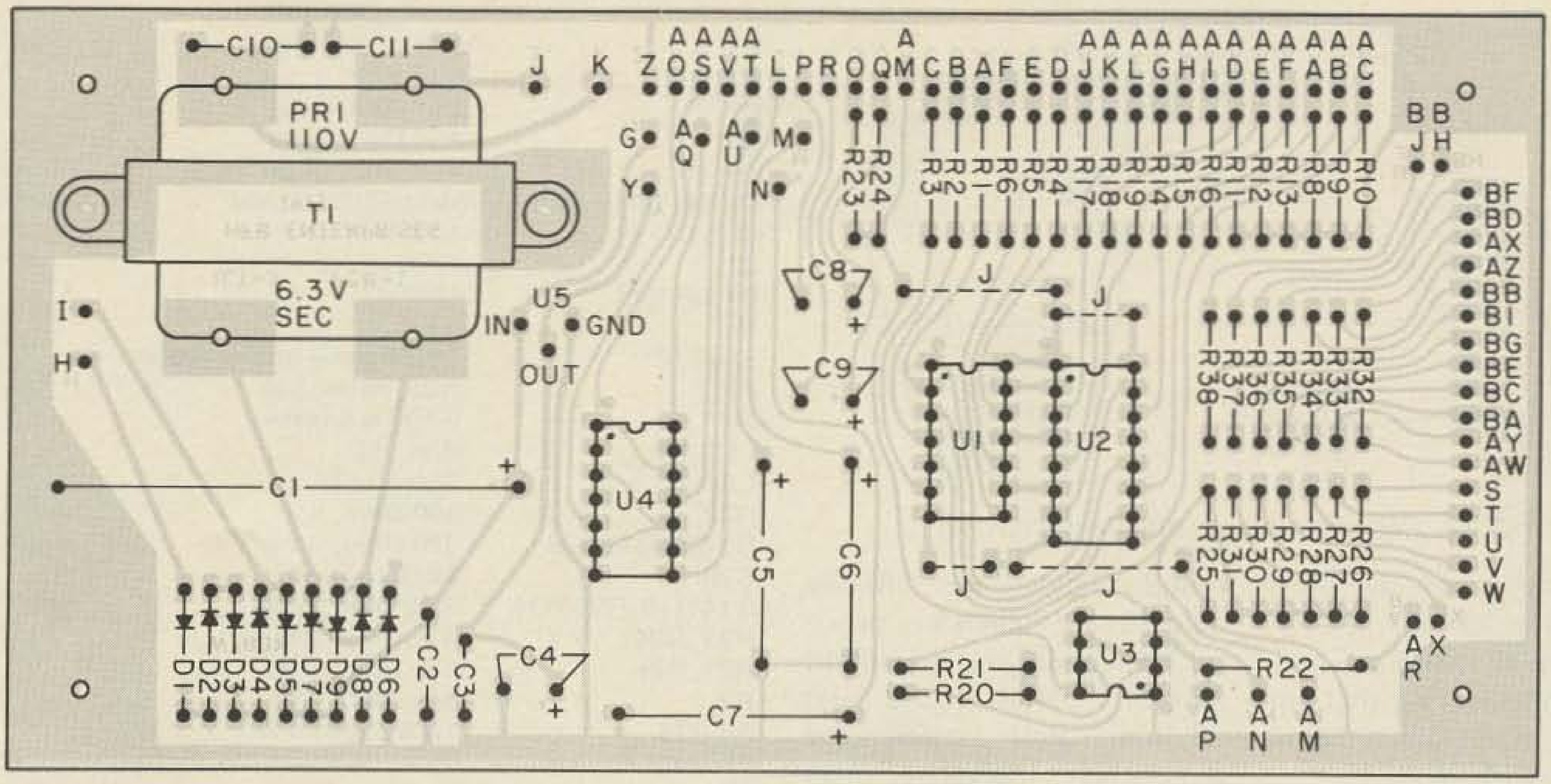
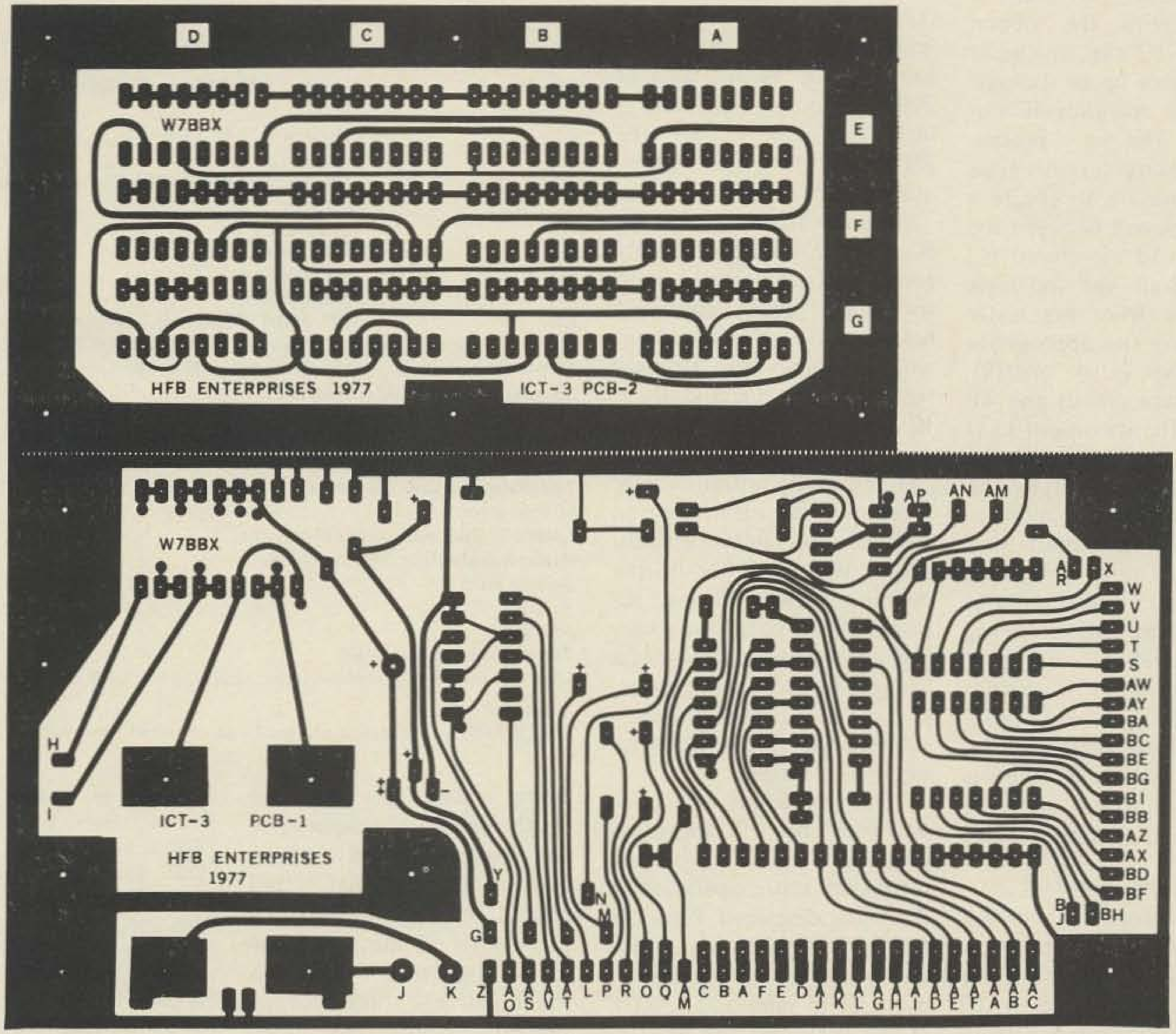


Fig. 11. PCB-1 parts placement.



the DUT into J3. S3 is first put into the SETUP position, S4 is set to either OC or TP, and the DIP switch matrix is programmed. S3 is then placed to TEST, and the operations called for in the input portion of the truth table are then performed. Each gate output is monitored separately on (in this case) output LED indicators 1-4. If three outputs agree with the truth tables and the fourth does not, the pinout diagram will tell you how that gate is being tested by which inputs. You may want to remove the pins to and from the defective gate and use the three functional gates later in another application.

To prevent the possibility of damage to the IC under test, return S3 to the SETUP position prior to removing the IC from the test socket or IC clip. No other precautions

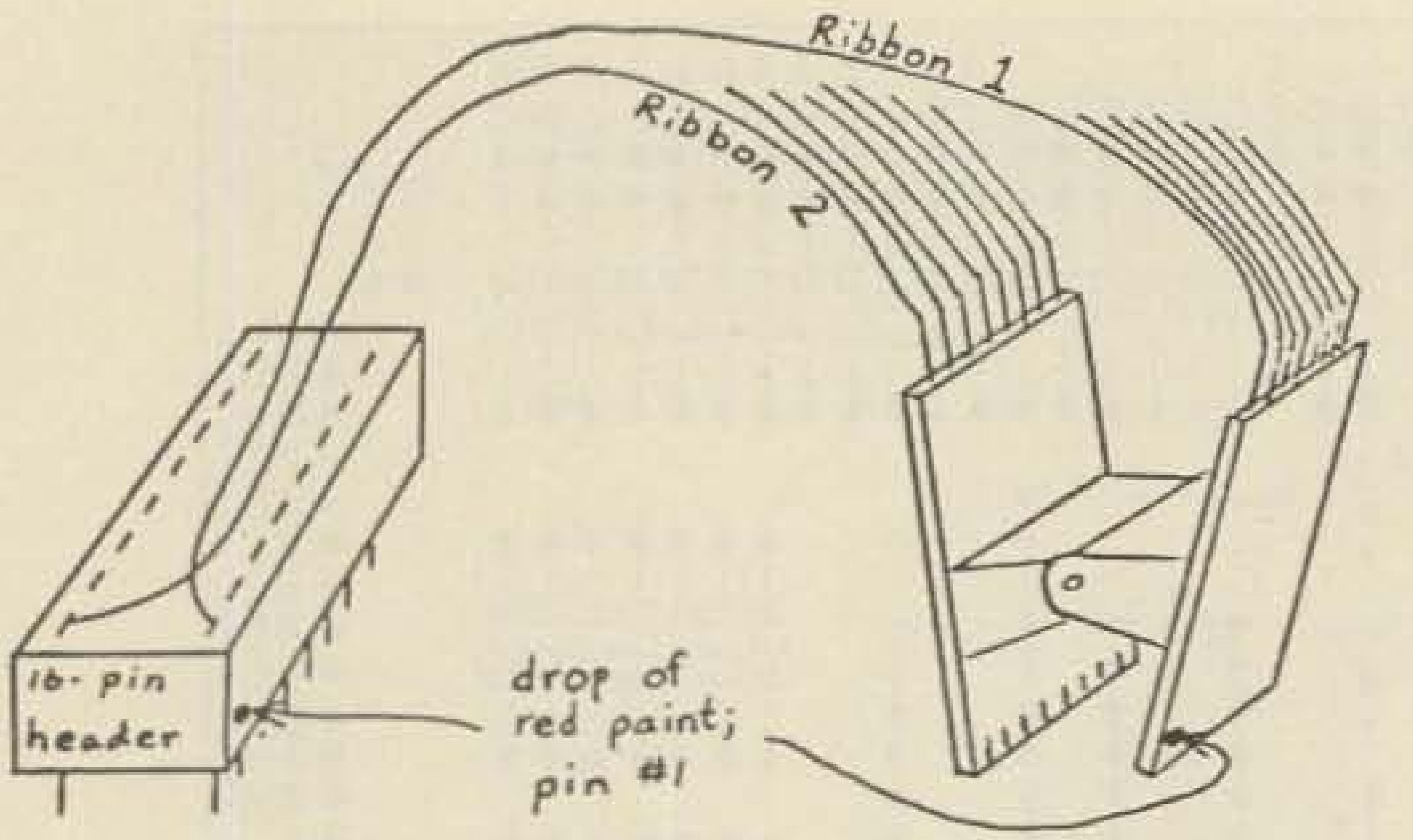


Fig. 12. DIP clip ribbon cable connections.

Parts List

C3	0.01 uF/25 V disc
C2	0.1 uF/25 V disc
C7	1 uF/10 V axial
C5	2 uF/10 V axial
C6	5 uF/10 V axial
C4, C8, C9	100 uF/10 V radial
C10, C11	.005 uF/1 kV disc
C1	2200 uF/15 V axial
D1-D9 (5*)	1N4001
I1	NE-2
J1-J3 (2*)	16 pin panel mount socket
J4*	RCA phono jack
M1*	0-100 mA meter
LED 1-6	Red LED
LED 7	Green LED
R22	100 Ohm, ¼ W
R1-R6, R32-R38	330 Ohm, ¼ W
R20	1k Ohm, ¼ W
R14-R19, R26-R31	3.9k Ohm, ¼ W
R23, R24	27k Ohm, ¼ W
R21, R25	47k Ohm, ¼ W
R7	56k Ohm, ¼ W
R8-R13	100k Ohm, ¼ W
S1	(Calectro E2-168 or equivalent) 4P3T rot. sh.sw.
S2	(Archer 275-325 or equivalent) SPDT on-off-on switch
S3	(Archer 275-1546 or equivalent) DPDT on-on switch
S4	(Calectro E2-169 or equivalent) 6PDT rot. nsh. sw.
S5-S10	(Archer 275-1547 or equivalent) SPST MC NO PB sw.
S11	(Archer 275-611 or equivalent) SPST on-off rock sw.
T1	(Archer 273-1384)** 6.3 V @ 300 mA transformer
U1	SN7406N
U2	CD4010AE
U3	NE555V
U4*	SN7490AN
U5	LM-309H (7805 is an acceptable substitution)

SPST DIP rocker, 16 pin (12 required) (Grayhill 76B08 or equivalent)
16-pin wire-wrap IC sockets (13 required) (1*)
16-pin low profile IC socket (1*)
14-pin low profile IC sockets (2*)
8-pin low profile IC socket (1*)
16-pin DIP clip (Pomona 3916 or equivalent)
7-segment display (Opcoa SLA-1 or equiv.) (1*)
Miscellaneous:
LMB 007-746 sloping panel cabinet
Ribbon cable (8 or 16 conductor)
Ac line cord
Knobs
Hardware
Term. strip cinch CJ2005
Min. 3½ mm 3-way closed-circuit jack (Calectro F2-844 or equivalent)*

*optional
**PCB laid out to accept physical size of transformer listed

are necessary to use the tester for CMOS or TTL ICs, except for proper IC handling procedures and ensuring that pin 1 of the IC is always connected to pin 1 of J3.

A very flexible property of this IC tester is that, if equipped with the ribbon cable and IC clip, in-circuit monitoring of up to six logic lines of an operating IC can be done. The only precautions necessary for this type of operation are to ensure a common ground between the IC tester and monitored IC, to remove all Vcc and logic input lines from the tester (by opening the appropriate DIP switches in the matrix), and to place S4 in the TP position. The six output LED monitors, however, can be connected, as desired, by the DIP switch matrix to monitor either input or output lines on the IC. The IC tester uses a CMOS-to-TTL hex buffer in the output monitoring circuit; therefore, loading of the monitored IC, whether TTL or CMOS, is not a problem, since the typical buffer gate input current of 10 pA is low enough to not alter the fan-out of the monitored IC.

IC-QC (Quality Control)

The procedures outlined above will test an IC to determine if it is working now, but cannot guarantee that the IC will not fail 10 minutes from now. Digital ICs are fairly well standardized and spot sample tested prior to shipment by most manufacturers. However, even in "prime quality" lots, a certain percentage may be found which are initially defective or which are prone to failure during the infant mortality period of use (first 48 hours under power). The percentage defective may vary widely between IC types of the same family; for instance, combined initial and infant mortality has been found to be as low as 1 in 200 for the SN7400N, and as high as 1 in 15 for the SN7473N, for the "prime quality" lots tested.

In order to ensure that the ICs used in your projects are good, and will remain good for many years, the easy bake-in and testing sequences which follow are strongly recommended, particularly if IC sockets are not used in your projects. These procedures, while not absolutely foolproof, can identify up to 95% of the faulty or fault-prone ICs for 90% of the common failure modes. ICs passing these tests have a very high probability of a useful lifetime in excess of 20 years, if not subsequently subjected to undue electrical or physical stress.[5]

The procedure is accomplished by temperature-stressing the IC, and then testing its static operation in the tester described. Place the ICs to be tested on a cookie sheet, and bake them in your oven for 15 minutes at 250°F (120°C); remove and place in the coldest freezer you have for 15 minutes; rebake and refreeze a second, third, and fourth time. Finally, bake the ICs at 250°F for 48 hours. After they cool, visually inspect each for casing cracks, and test them on the tester. My experience has been that only about 1-2% of the ICs that tested good before the baking process failed the post-bake-in testing; these were the "failure-prone" ICs, which probably would have failed later in the operating circuit and required troubleshooting of the circuit. ■

References

[1] Richard McMahon, "Identify Those Unmarked ICs," *73*, December, 1973, p. 73.

[2] Kenneth H. Leiner, "TTL IC Tester," *Ham Radio*, August, 1976, p. 66.

[3] Silas Smith, "A TTL Tester," *73*, October, 1976, p. 10.

[4] J. S. Worthington, "A Simple TTL Test Panel," *QST*, December, 1976, p. 25.

[5] Lucinda Mattera, "Component Reliability, Part I," *Electronics*, October 2, 1975, p. 91.

PCBs for this tester, along with comprehensive assembly and operating instructions, truth tables, and matrix settings, are available for $15 postpaid (US and Canada) from HFB Enterprises, PO Box 667, Herndon VA 22070.

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Salt Lake City UT 84112

Negative Numbers On A $9 Calculator

With the proliferation of calculators on the market, coupled with the low prices to which they have sunk, most people have found an excuse to buy one by now. One such reasonably-priced calculator is the Texas Instruments TI-1200, very good for basic math, and at $9 I thought it would be a handy thing to have around the house. After buying one, I found that doing any math involving negative numbers was difficult, as there was no convenient way to enter a negative number from the keyboard. The only excuse for this was, "What do you want for 9 bucks?"

This inconvenience remained until the other night, when out of sheer curiosity I opened up the case of the calculator. My attention was caught by the keyboard arrangement, as the buttons and the rest of the keyboard are not all one unit. The plastic buttons are separate and press down to close contacts on a sealed pad. The contacts in the pad are visible as disk shaped outlines. On close inspection, it appeared that there was one more disk contact in the pad than the number of plastic buttons could account for. This set of contacts is normally situated right under the gap in the keyboard which is between the "clear" and "%" keys. Fig. 1 points to these areas on the keyboard and contact pad.

Fig. 1.

It turns out that this extra set of contacts is for a change of sign key. When depressed, it will put a negative sign, or take it away from, in front of any number about to be keyed into the display or already on it. When any number is made negative (or positive) in this way, it will behave in any calculations as a negative (or positive) number should, with the answer on the display being appropriately positive or negative. No regular functions of the calculator are altered.

Any sort of button assembly can be improvised and mounted in the gap on the keyboard to be able to push on the set of contacts in the pad. The calculator is much more versatile this way, although you may not wish to add the button until the warranty has expired. But even so, this makes a cheap, handy little calculator even handier. ■

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Think You Understand SSB?

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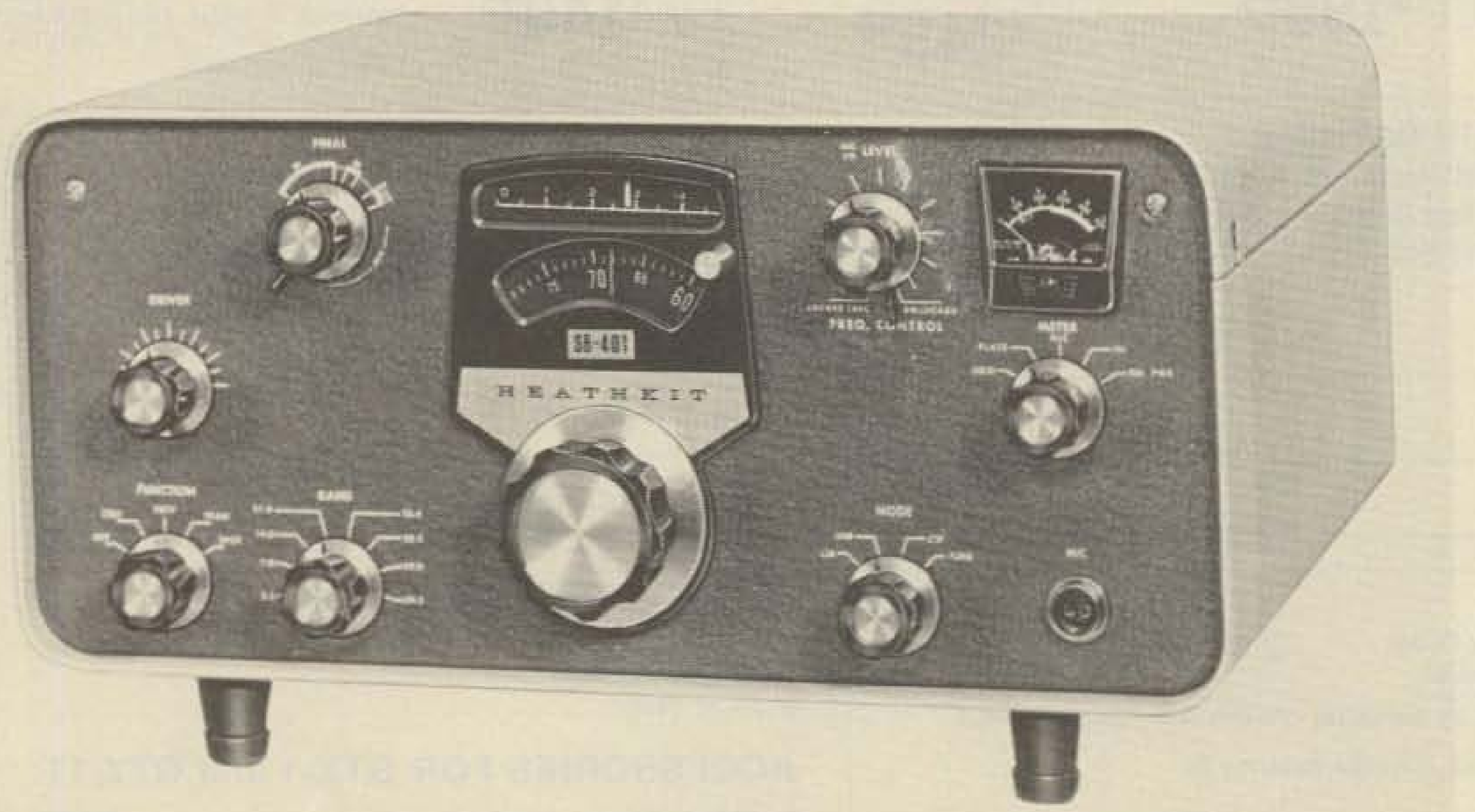
Suppressed carrier, single sideband transmission has so completely overtaken amateur radiotelephony on the lower frequency bands that AM signals are a rarity. In fact, many stations aren't even equipped to tune in an AM signal. The advantages of single sideband are well worth the trouble of acquiring the more precise and complex equipment needed to produce and properly receive these signals. It does, however, burden the Novice with having to learn much more today than he might have needed twenty years ago, in order to reach an average level of understanding in the communications art.



This popular amateur transmitter uses tubes all the way through, rather than solid state. Nonetheless, it serves as an excellent example of an SSB transmitter using the filter method to generate an SSB signal. Although presently superseded by solid state units, this model is still quite popular, and brings a good price at hamfests and in the want ads. (Photo courtesy of Heathkit.)

When voice modulation of a radio signal was first accomplished, it was believed that the level of the signal was modulated, or caused to vary, at a rate corresponding to the frequency and amplitude of the voice. By the late twenties or early thirties, this had been disproven, although the theory continued to be taught for many years afterward and the term "amplitude modulation" persists to this day. (See Fig. 1.)

The technique for producing an amplitude-modulated signal results in the complex waveform of a carrier and sidebands of which we now know an AM signal is composed. When we dissect an AM signal and examine it component by component, we discover that the carrier remains constant in its level. We also find that a narrow band of spectrum above and below the carrier frequency is occupied by a rather complex pair of signals resulting from the combination of the carrier with the voice.

When *any* two signals are combined in a nonlinear device, the output of the device usually contains the original two signals and two new signals, whose frequencies are the sum and the difference of the frequencies of the original two signals. For example, if we take a signal at 3.9 MHz and combine it with a 1 kHz signal, we obtain the original two signals *plus* a signal at 3.901 MHz, resulting from the addition of 3.9 MHz and 1 kHz; we also find a signal at 3.899 MHz, resulting from the subtraction of the 3.9 MHz and 1 kHz signals. If we were to attempt to radiate these signals, the 1 kHz would not, of course, radiate, but the other three would. We would have a 3.9 MHz carrier and a sideband at 1 kHz above and below it. This is an AM signal of a 1 kHz tone.

Now, suppose the carrier were eliminated and just the two sidebands transmitted. If we were to insert a carrier at the receiver, it would combine with the 3.899 MHz and 3.901 MHz signals to reproduce the 1 kHz tone. The carrier, then, is not really needed to recover the 1 kHz tone. (See Fig. 2.)

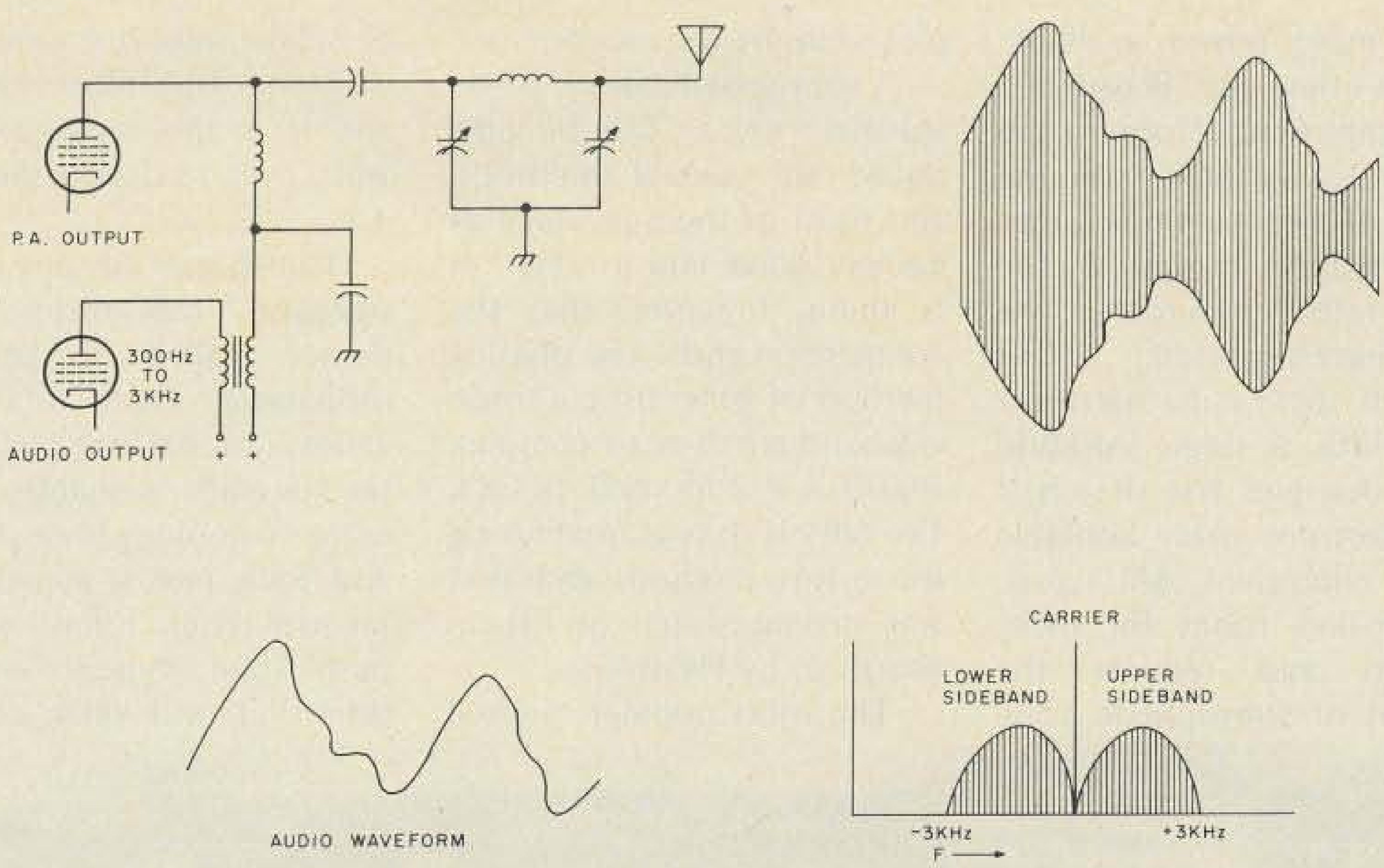


Fig. 1. Here is a typical means of amplitude modulation (upper left). The audio waveform (lower left) is imposed in series with the transmitter's output. Audio power must equal rf power. The waveform at the upper right resulted. It looks as if the amplitude of the rf really was being modulated. A closer analysis, at lower right, proved that the carrier remained constant, while sidebands, representing the audio, appeared above and below the carrier. Sidebands each represent 25% of the transmitter's power, for a total of 50%.

We can also eliminate either one of the sidebands and still recover the 1 kHz tone. Whether we eliminate the upper or the lower is simply a matter of preference. If, instead of the 1 kHz tone, we were using sidebands representing the complex waveform of the human voice, we can, just as long as we insert a carrier at the correct frequency in the receiver, recover the voice. This has two big advantages over an AM signal, and just one small disadvantage. The disadvantage is that the receiver must be very stable and must have an oscillator to generate the carrier. In bygone years, this feature only existed in the more expensive shortwave receivers. The advantages greatly outweigh this one disadvantage.

When an AM signal is transmitted, the overall signal would cover a portion of the spectrum 6 kHz or more wide. The transmitter power would be divided, half of it producing the carrier and half of it producing the two sidebands (one quarter of the power to each sideband). Now the carrier doesn't do anything, except help the receiver demodulate the signal. If we get rid of it, we have twice as much power available to transmit the sidebands, which contain all the information in the signal. Now, if we get rid of one of the sidebands, there is that

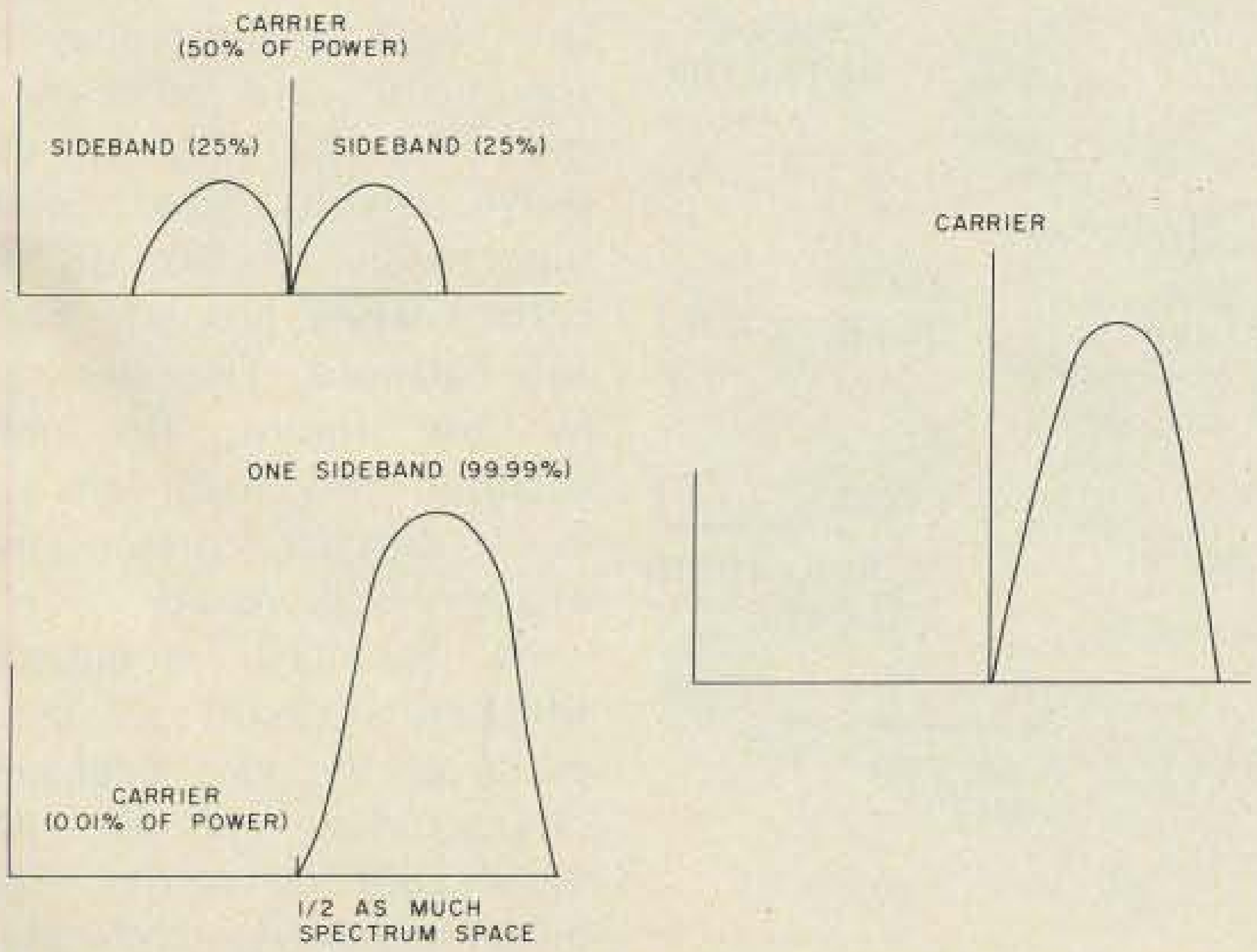
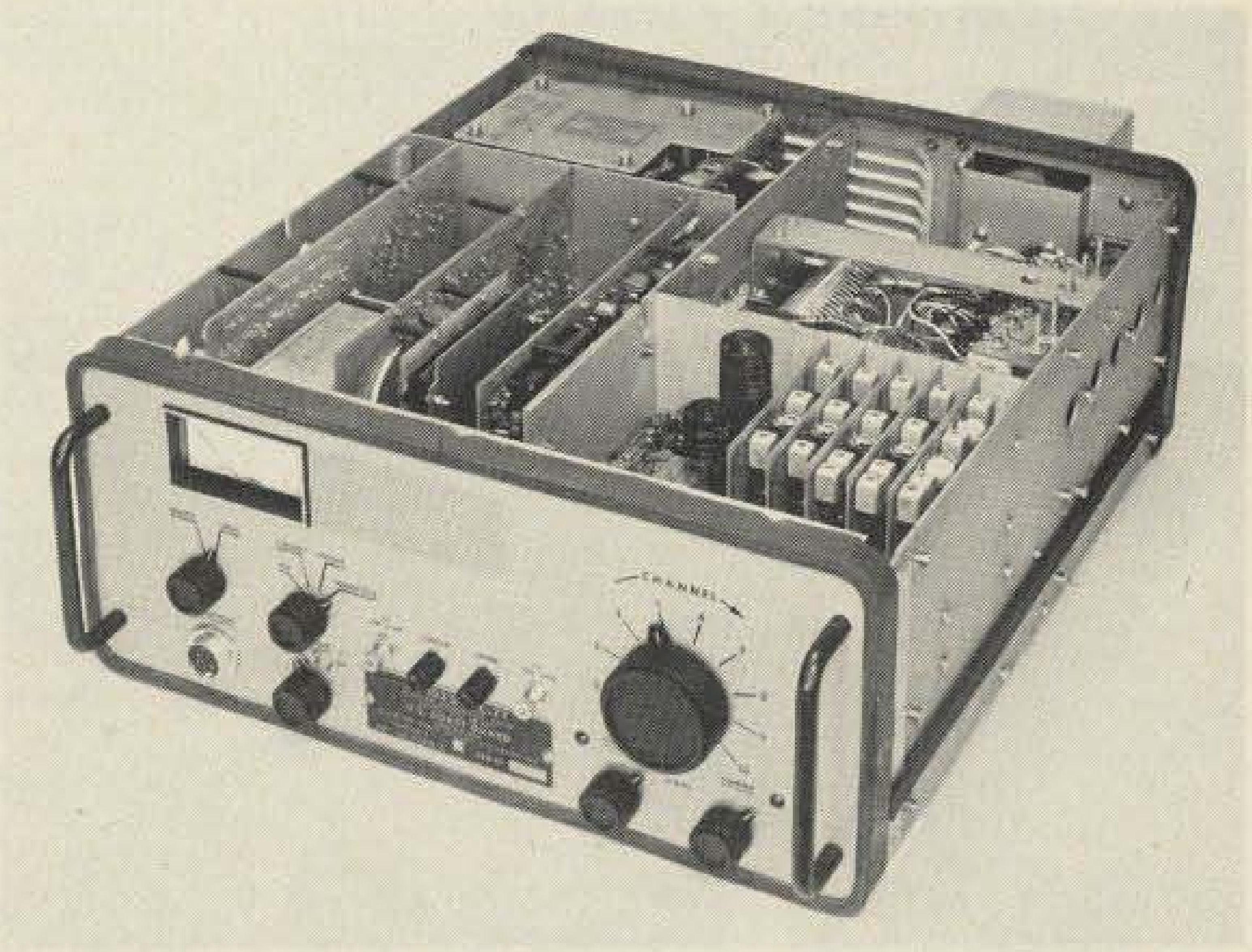


Fig. 2. Instead of transmitting the carrier and both sidebands (upper left), you transmit a single sideband (lower left). At the receiver, you insert a carrier (right), which allows you to demodulate the signal.



Here is a commercial parallel to the amateur transceiver. It averages about 150 Watts PEP, and has a frequency accuracy of better than 1 part per million, if carefully tuned. It is much more complicated than an amateur unit, since each channel is pretuned. A ten-channel duplex unit has over 150 adjustments in the alignment procedure. (Photo courtesy of Scientific Radio Systems.)

much more power available for the other one. Because of the complex waveform of the sidebands, we only have the effect of two to three times the effective power in the signal, rather than four, as we might have expected.

Then there's the narrower bandwidth. A single sideband signal occupies less than half the spectrum space available to an equivalent AM signal. This makes room for more stations and reduces the amount of atmospheric noise picked up by the receiver.

A suppressed carrier, single sideband signal can be produced by several methods, and most of them produce an equally good end product. It is there, however, that the comparison ends. The phasing method of generating a single sideband signal is so complex that it is seldom used. In fact, I've only seen one amateur rig using this method, and that was produced ten or fifteen years ago by Heathkit.

The most popular method of single sideband generation is called the filter method, and it is this method that I will cover in detail. (See Fig. 4.)

The heart of any single sideband transmitter is a device called a balanced modulator. There are a wide variety of balanced modulator circuits available, some more complex than others, and each one is somebody's favorite. While I don't wish to push one type over the others, I will only cover a sampling here. A balanced modulator, incidentally, is also often used in a receiver to mix the incoming signal with that of the local oscillator to produce the i-f signal.

Here is one of the easier to understand balanced modulator circuits. (See Fig. 5.) Note that the audio is fed to the two transistors in a push-pull arrangement. The carrier, however, is fed to the transistors in parallel. At the output, the carrier is of the same amplitude and polarity at opposite ends of the winding. Thus it cancels itself out, leaving only the two sidebands. Any small amount of carrier that gets by, due to unequal characteristics of the transistors, is eliminated by adjusting the balancing potentiometer.

The four-diode ring modulator circuit needs no balancing potentiometer, so long as the diodes are well matched in their characteristics. (See Fig. 6.) Its operation is a bit more difficult to explain, but it operates by being thrown in and out of balance by the audio signal. It enjoys its greatest popularity as a radio frequency mixer circuit. The two transformers are broadband toroids, and, in receivers employing this circuit, they are small enough to fit on your fingernail.

The two-diode balanced modulator is an easy one to make and often represents the best compromise in simplicity and efficiency. (See Fig. 7.) Any of the above circuits have carrier suppression of 50 dB or better, when properly built and balanced. They are not, by any means, the only balanced modulator circuits in use, but are representative of a very wide variety.

A balanced modulator, whichever circuit is used, produces the two sidebands characteristic of an AM signal, but no carrier. This brings us halfway to our goal. Now we must eliminate one of the sidebands. This is done with a very selective filter, hence the name "filter

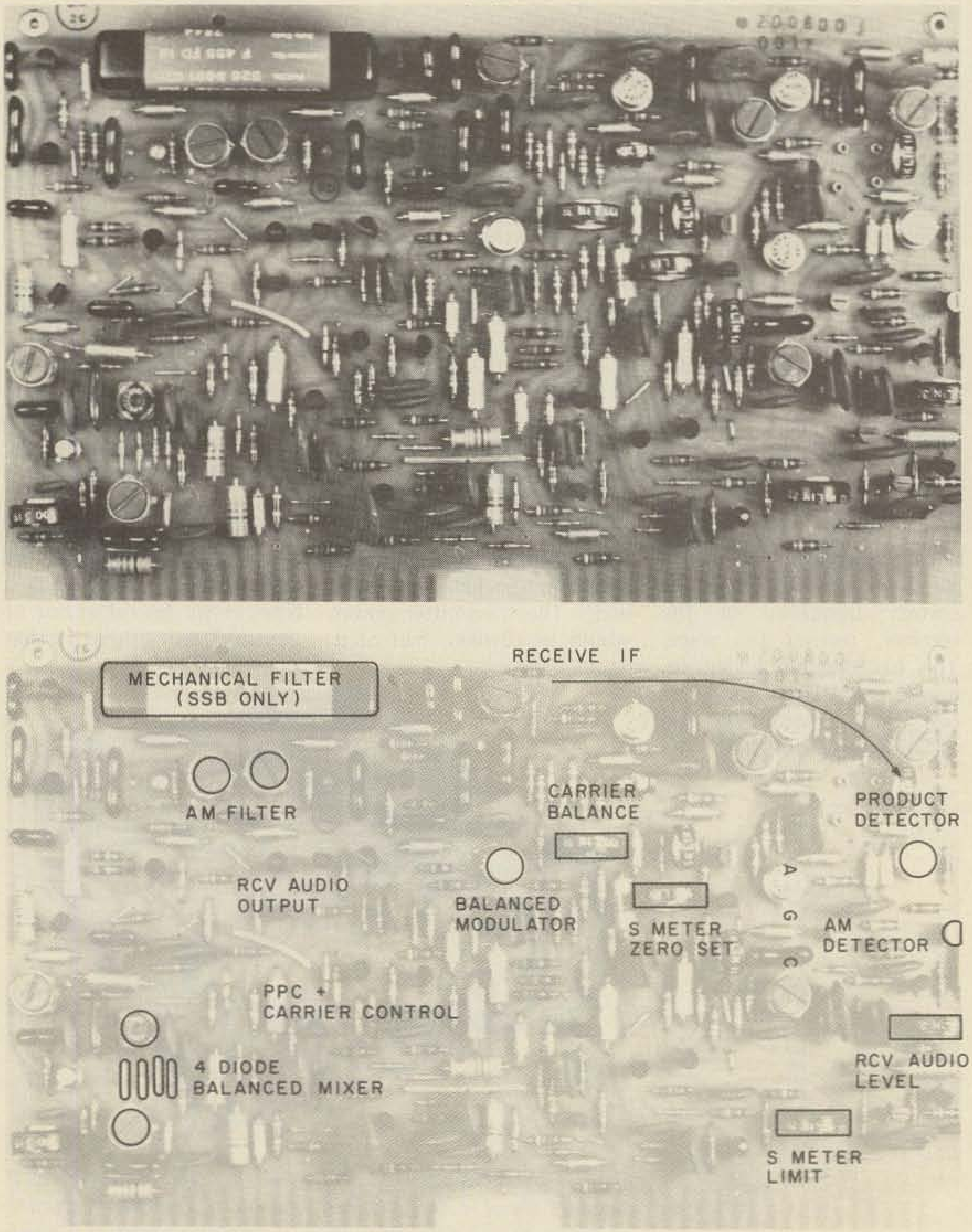


Fig. 3. This PC board is the heart of the commercial SSB transceiver. Note the location of the different circuits, as shown on the diagram. It is, in fact, a complete SSB exciter in itself, except for the oscillators and the final conversion. This board alone retails for several hundred dollars. (Photo by W2FEZ, with permission from Scientific Radio Systems.)

method." Two kinds of filters enjoy great popularity in this application. One is made using quartz crystals of the proper frequencies, connected in a lattice or similar arrangement. (See Fig. 8.) The other consists of two magnetic transducers, and a number of mechanically resonant discs. Mechanical filters, generally made by Collins, are more popular in commercial systems and in the more expensive amateur transmitters.

Whichever type of filter is used, it must pass a band of frequencies about 3 kHz wide and must reject all frequencies outside that band, with a very high amount of attenuation. (See Fig. 9.)

The frequency of the radio frequency signal fed into the balanced modulator is selected to be just outside the passband of the filter. The filter passes the desired sideband almost without loss and eliminates the other sideband and any residual carrier. The selection of either the upper or the lower sideband is accomplished by changing the carrier frequency from one side of the filter passband to the other.

Single sideband signals are usually generated at a fairly low frequency and then converted to the desired frequency. This is accomplished by mixing the low frequency signals with one of a higher frequency and then tuning out the unwanted products. In one brand of commercial unit, for example, the signal is originally generated in the neighborhood of 455 kHz and then mixed with a signal close to 1955 kHz. This results in a signal at 1500 kHz and another at 2410 kHz. The 1500 kHz signal is selected and the other rejected by the tuned circuits. This signal is amplified and then mixed with a still higher frequency. If, for example, we wanted the final product at 3.9 MHz, we could obtain it by combining the 1.5 MHz signal with a 5.4 MHz signal. We can note here that, each time we mix and use the difference frequency, rather than the sum, the sidebands invert. That is, the upper sideband would become a lower one and vice versa. It's okay to do it this way, as long as we are aware of this phenomenon.

Once we have the signal converted to the proper frequency, all we have to do is amplify it to the desired power level. Here again, we have to be careful what kind of amplifier we use. Amplifiers are classed according to the way the grid of the tube or the base of the transistor is biased. The most efficient of the radio frequency power amplifiers is biased as class C. This means that the voltage on the grid or the base is set so that current flows only during the peaks of input voltage. This is all right for CW operation, but wouldn't work very well with a single sideband signal due to the distortion that would occur.

A class B amplifier is biased so that current flows only during the positive half of the input cycle.

A class A amplifier is biased so that current flows at all times. It is the least efficient, but produces the least amount of harmonic distortion. Amplifiers biased at class A, class B, or in between are known as linear amplifiers, and this is the only kind that can be used

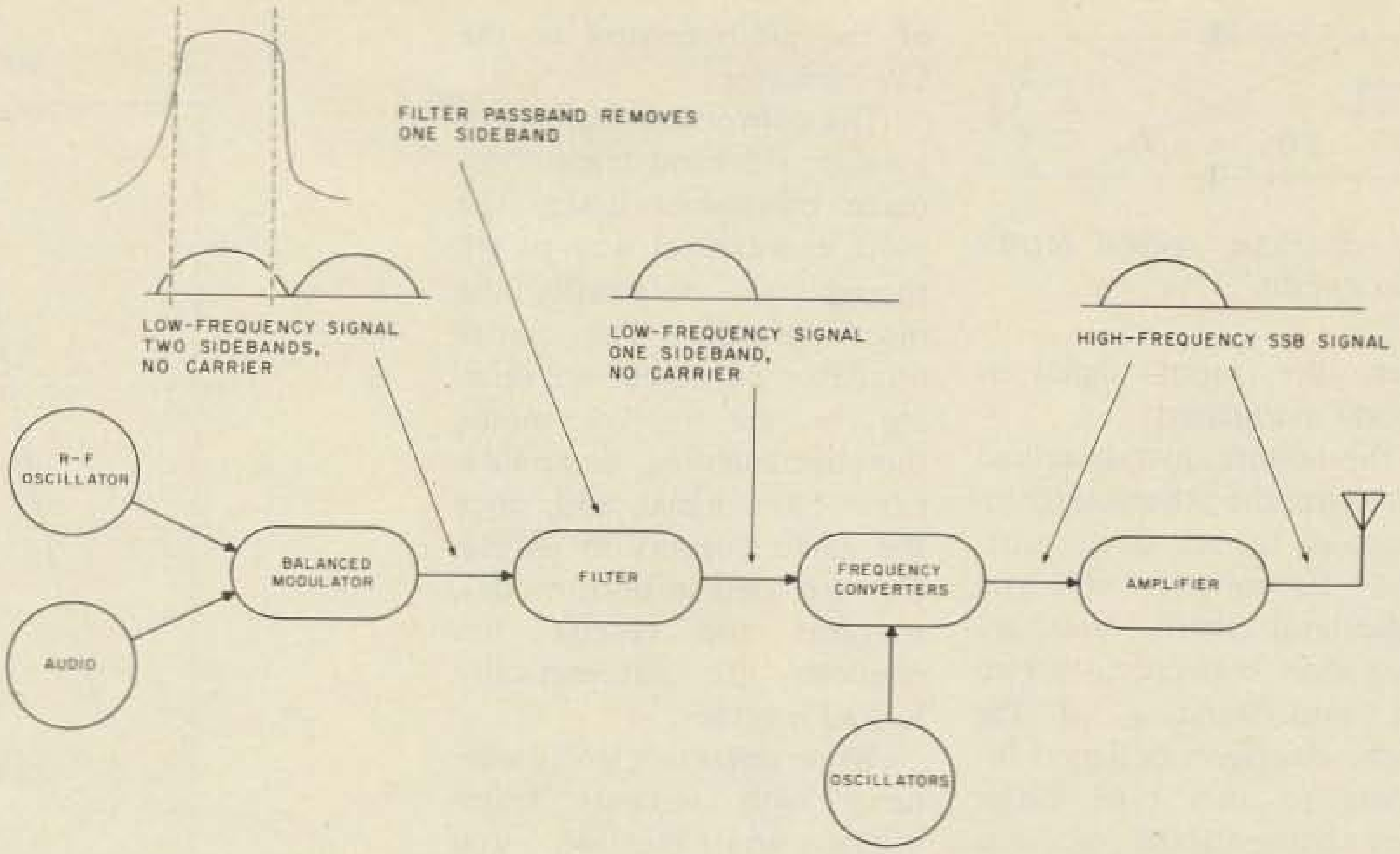


Fig. 4.

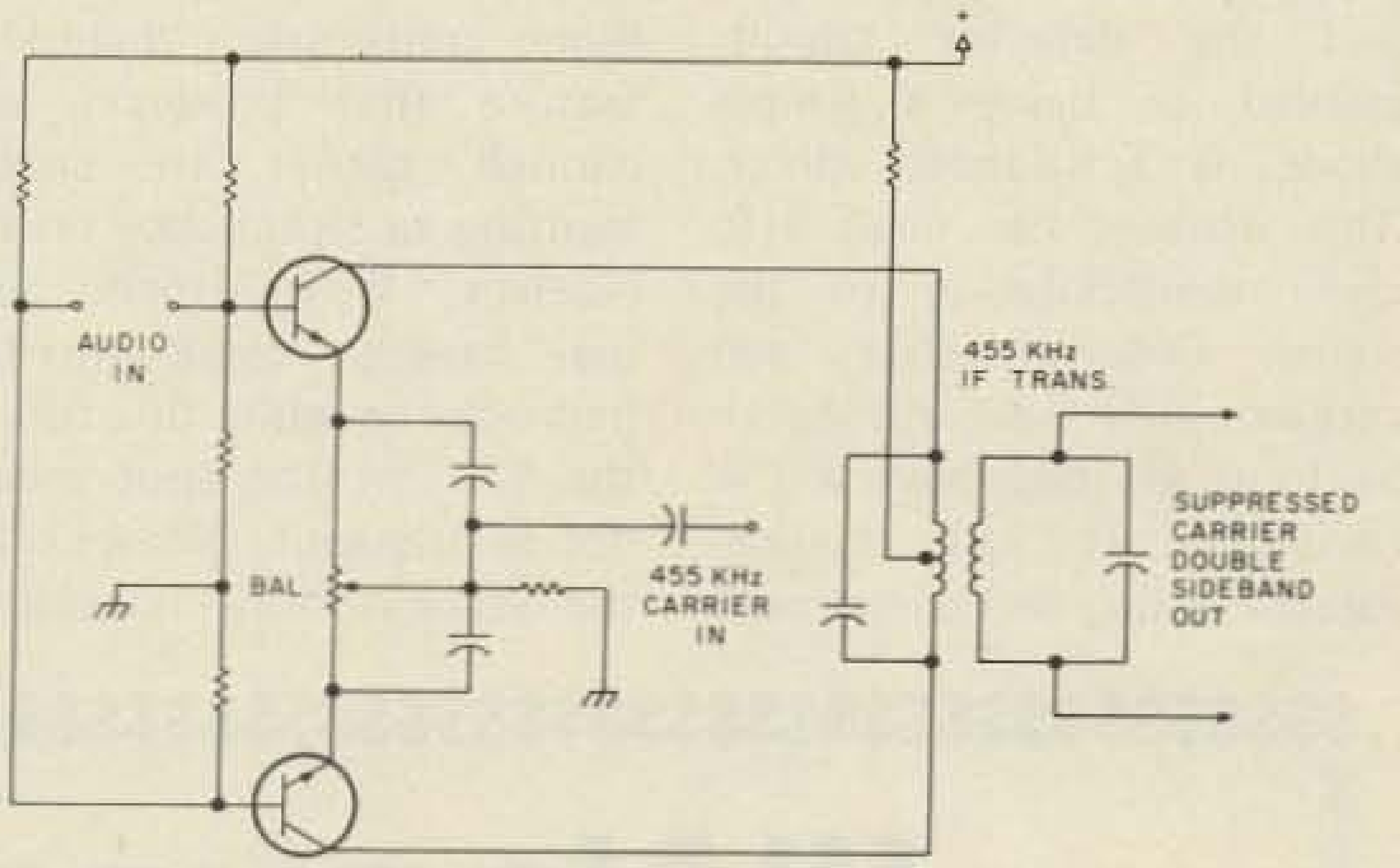


Fig. 5.

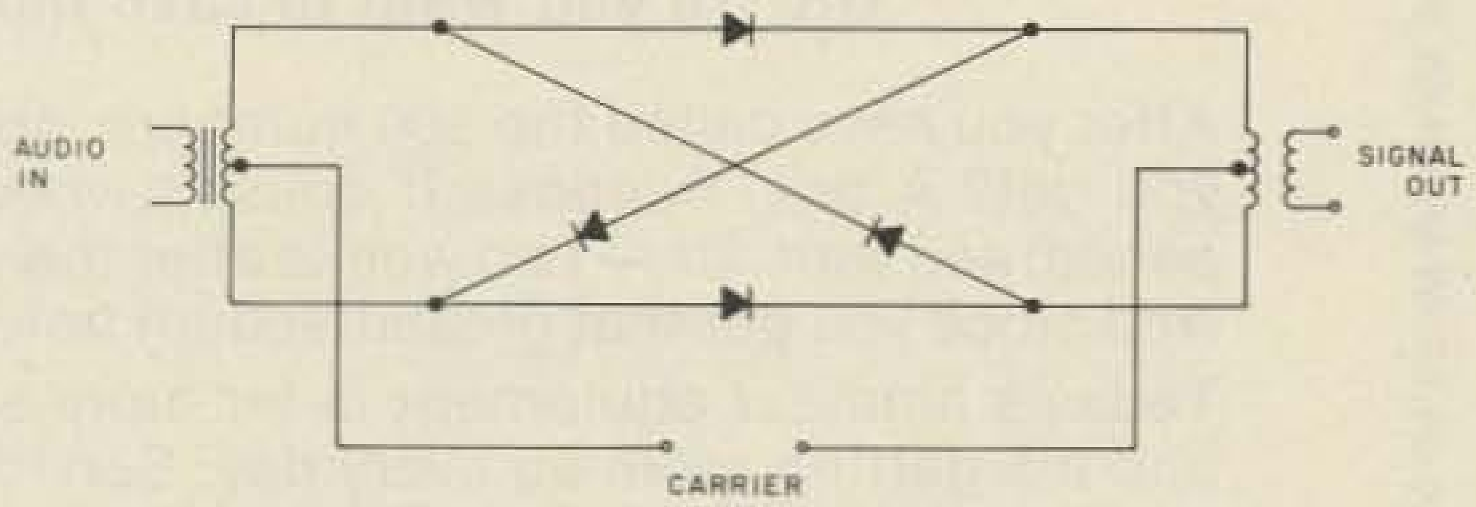


Fig. 6.

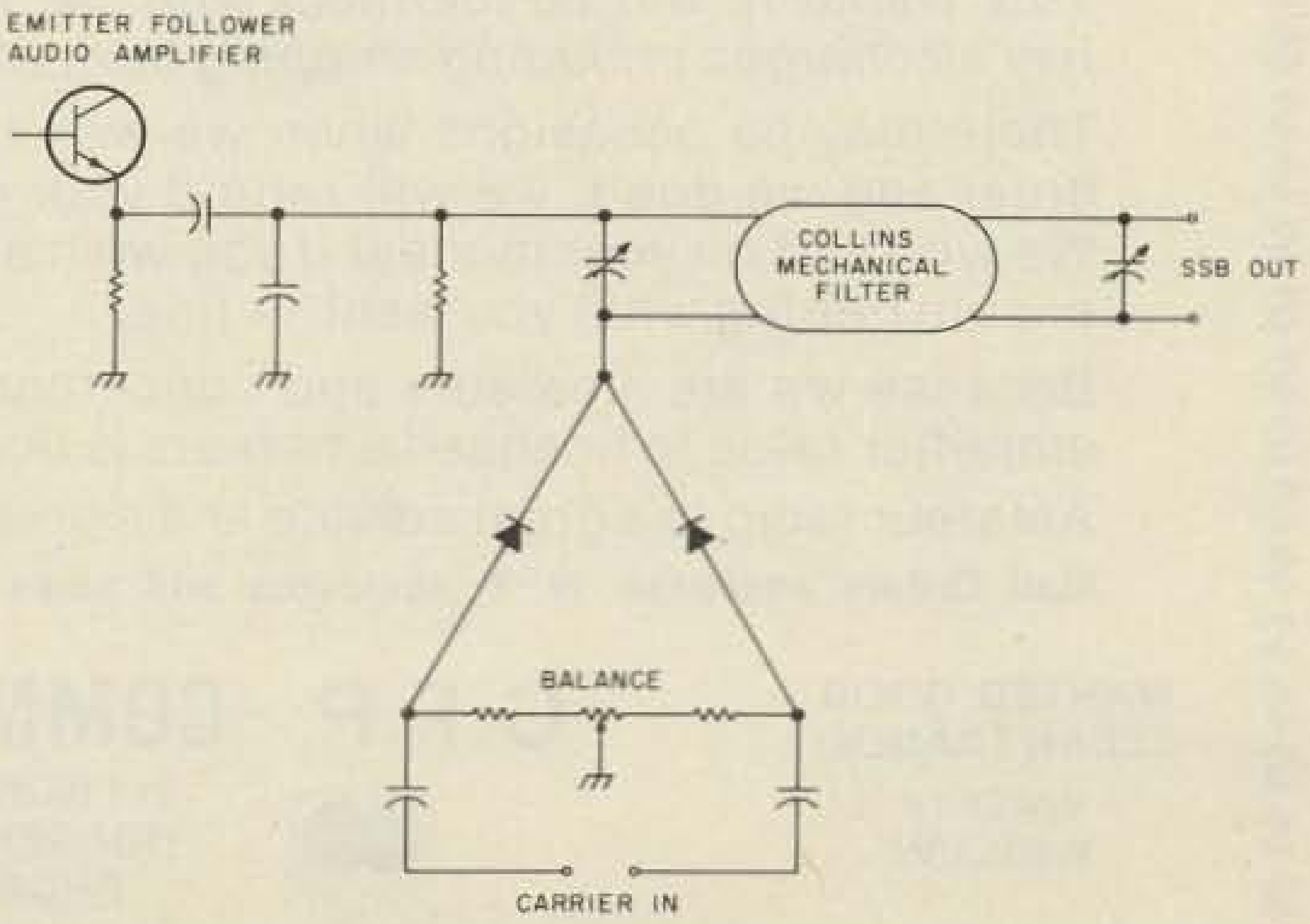


Fig. 7.

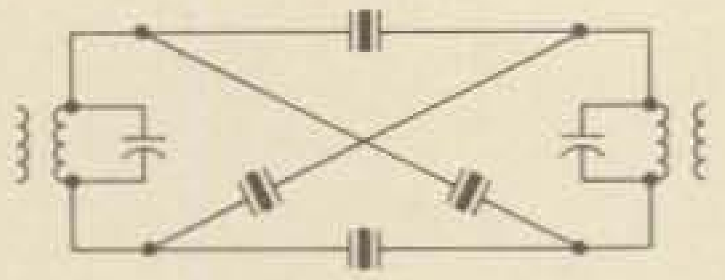


Fig. 8. Basic crystal lattice filter circuit.

when the input signal is already modulated.

The features just described represent the characteristics common to all single sideband transmitters. If you understand them, you are more than halfway to a general understanding of the mode. Receivers designed for signals of this type differ from conventional receivers only in that they are more selective than their ancestors, and the detector circuit, instead of being a simple diode, is a balanced mixer. This enables the most efficient demodulation of the signal. Older receivers can receive single sideband signals as long as they have a CW oscillator. It just requires careful tuning and adjustment of the pitch control or the CW oscillator.

The conversion features of a single sideband transmitter make transceiver design the most economical way to go, though not necessarily the most versatile. The carrier oscillator continues to operate in the receive mode, thereby enabling demodulation of the signal, and, since the same conversion oscillators are used in both modes, transmit and receive frequencies are automatically locked together.

When operating single sideband with separate transmitter and receiver, you should remember that very careful tuning is essential. Some transmitters include a feature that produces just enough carrier to enable spotting the frequency on the receiver. With others, you may have to speak into the microphone while fine-tuning the vfo (in the spot mode, not in transmit, please) until the voice sounds natural in the receiver. Do this after having first tuned the receiver to the desired signal.

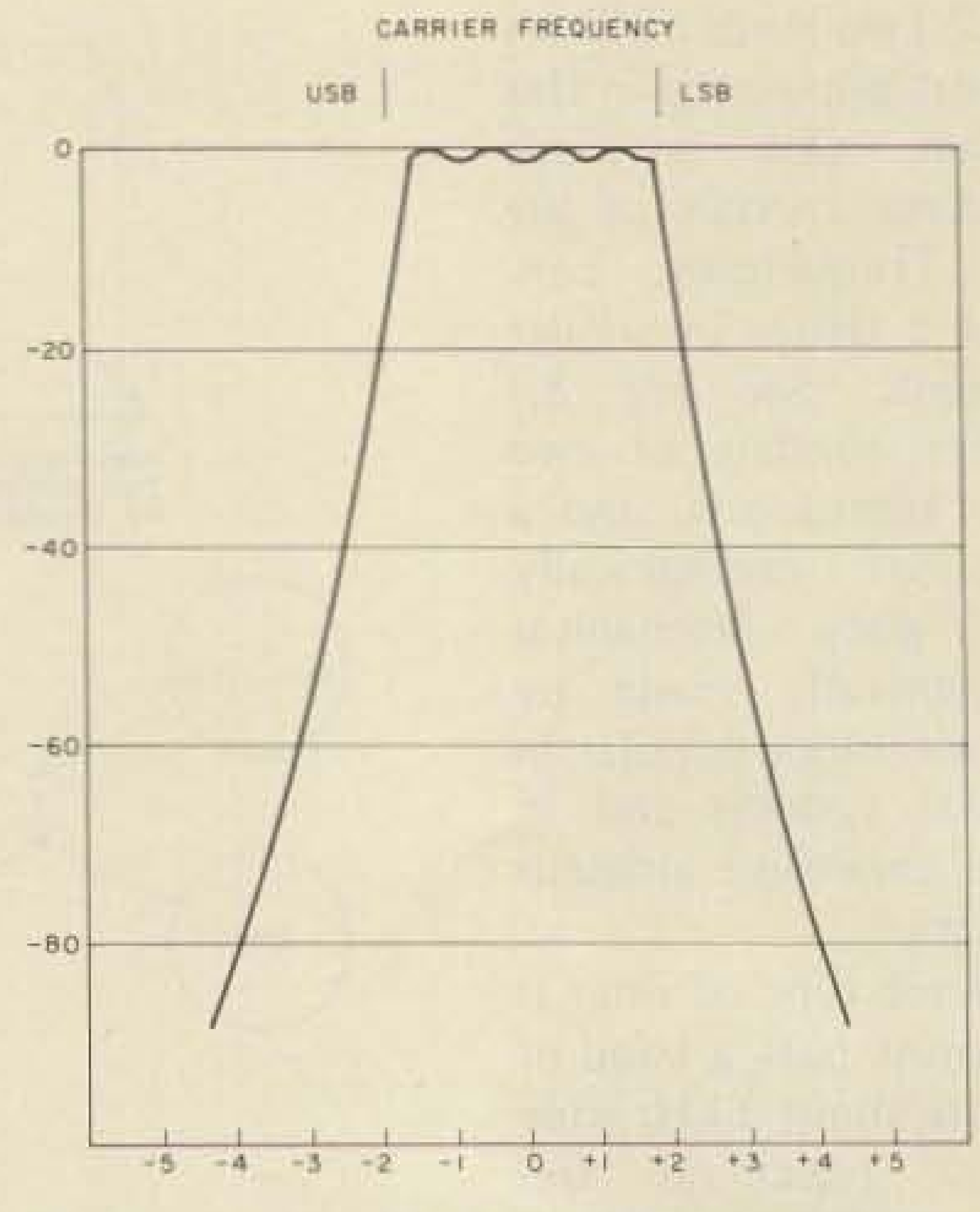


Fig. 9. Typical mechanical filter passband.

Upper sideband is generally preferred on twenty meters and above, while lower sideband is commonly used for forty and below. Other than custom, however, there is no rule dictating which sideband to use. A little practice, and the Novice should very quickly be joining us after he gets that General ticket. This article hasn't covered the entire extent of single sideband operation, but I hope that it has, at least, helped to get the beginner over the hump. ■

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IC Timer Review

-- nanoseconds to hours

Howard M. Berlin W3HB
519 Dougfield Rd., Scottfield
Newark DE 19713

This article is an introduction to the various integrated circuit timers that are now available. Although just about everyone is familiar with the popular 555 and 556 "time machines," other lesser known timers, such as the 554, XR-320, XR-2240, LM322, LM3905, 74121, 74122, and 74123, are not so commonly understood.

The 555 and 556 Timers

Created by H. R. Camenzind, the 555 timer is perhaps the best known and most widely used, if not the most versatile. Many articles have been devoted entirely to describing its characteristics and applications,[1-5] and now there is even a book about it.[6]

For those of you who may have been in the dark for the last five years, the 555 timer is a monolithic integrated circuit, capable of monostable one-shot timing periods and astable frequencies, both requiring only a few external components. As shown in Fig. 1, the 8-pin timer can be internally represented by a simplified block diagram. For monostable operation, as

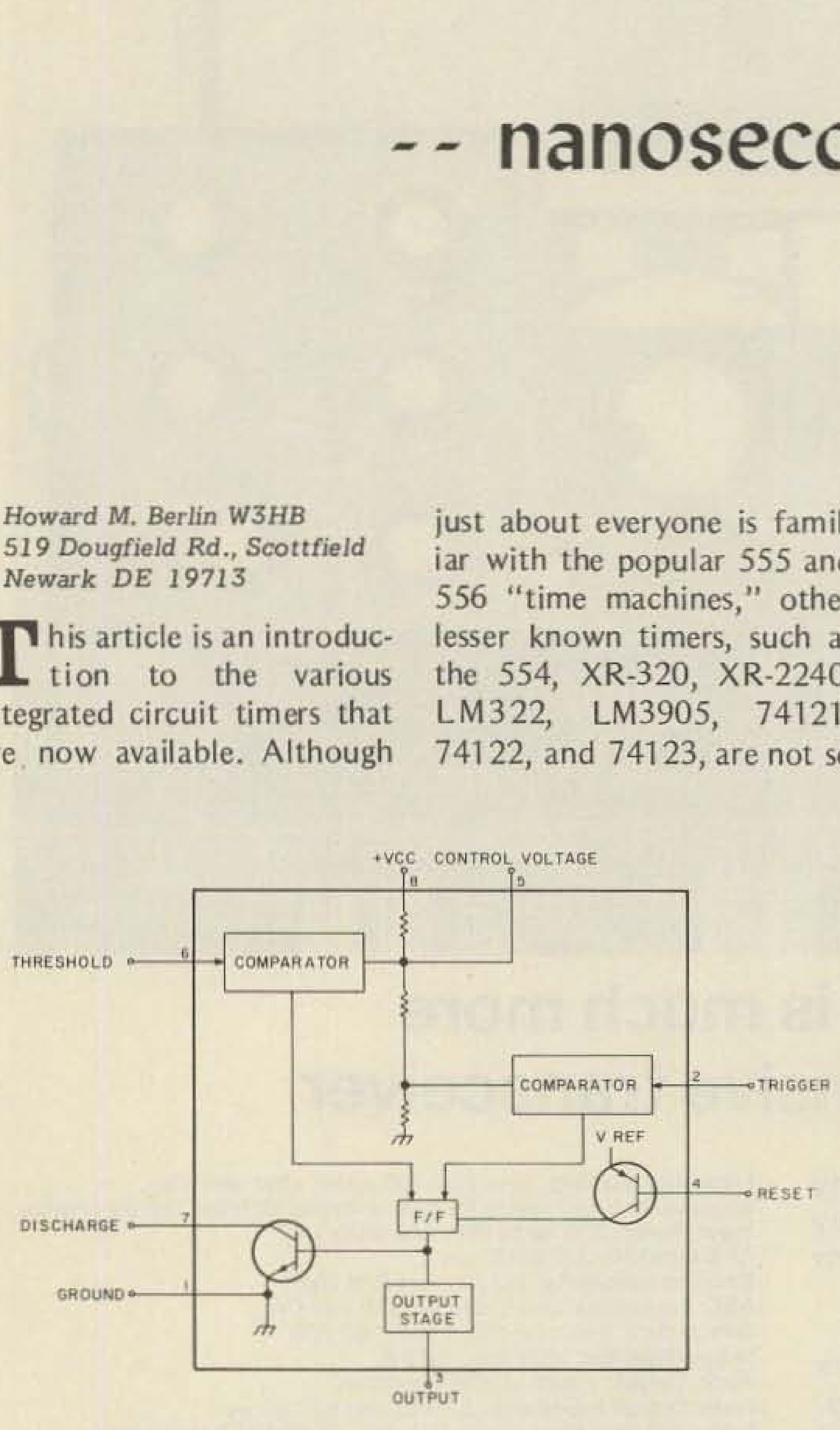

Fig. 1. Functional diagram and pin connections for the 555 timer.

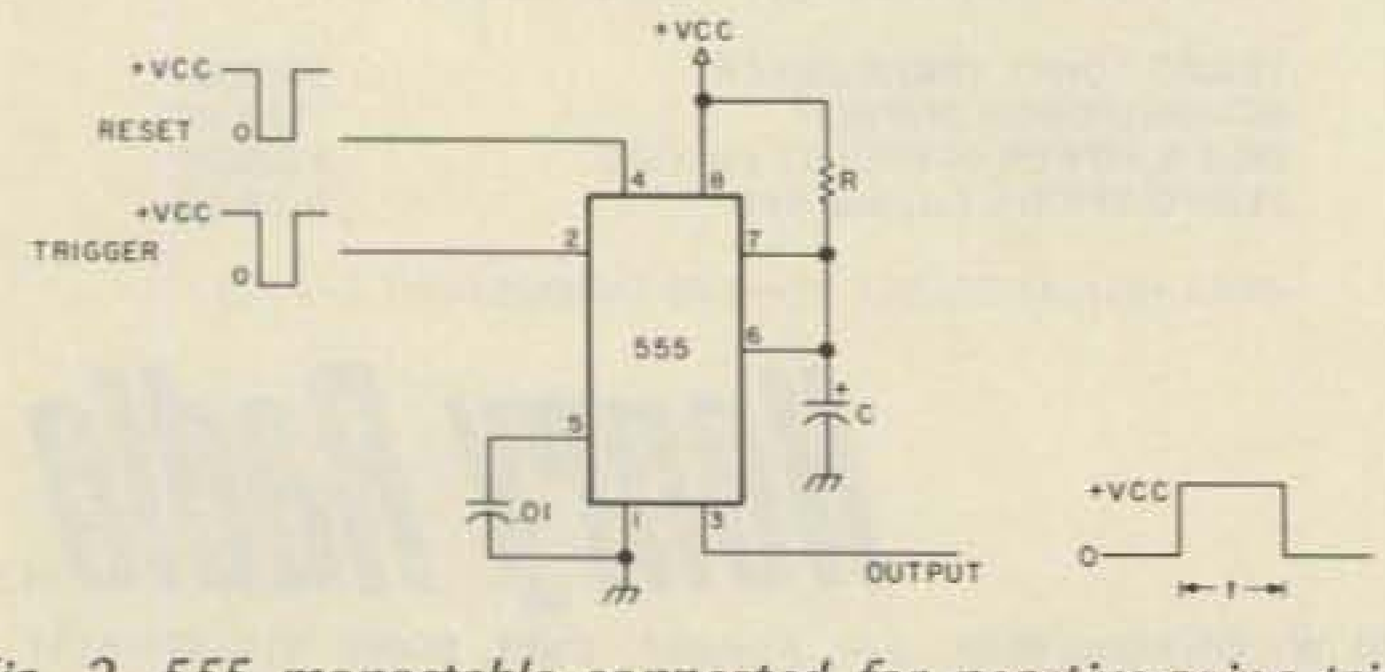

Fig. 2. 555 monostable connected for negative-going trigger pulse with positive output pulse.

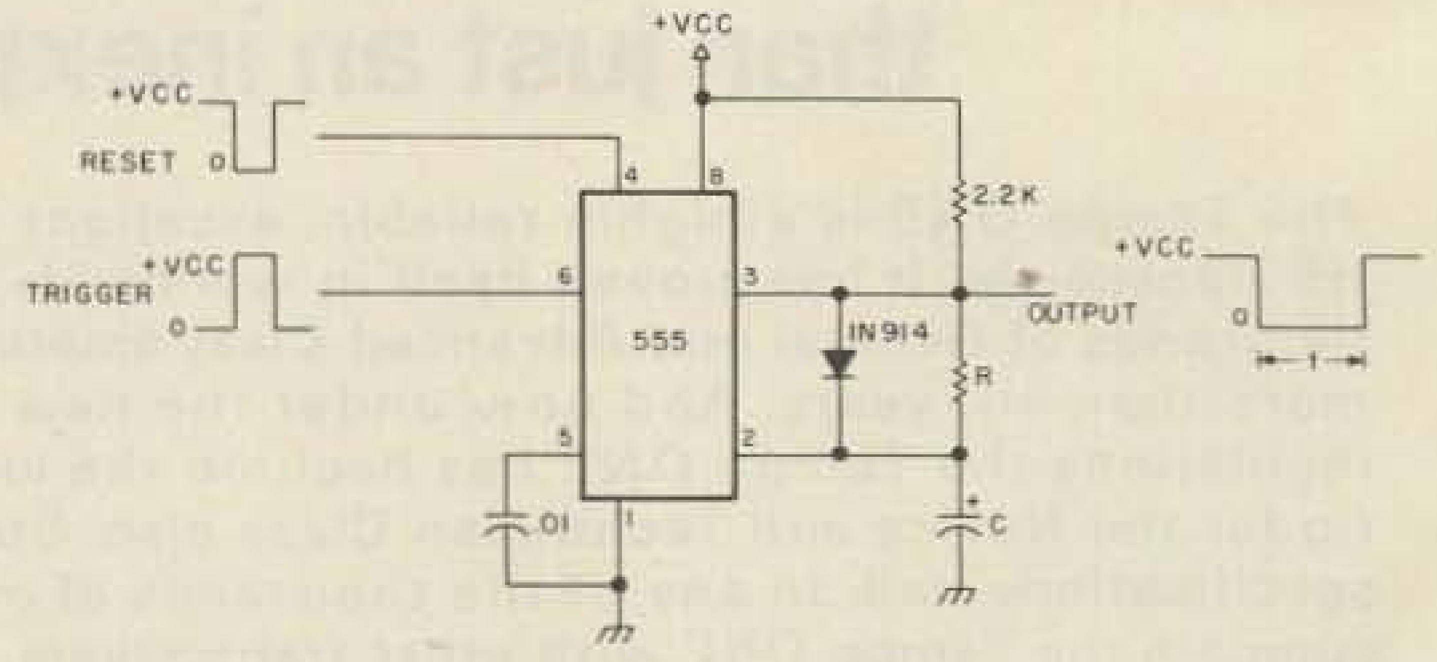

Fig. 3. 555 monostable connected for positive-going trigger pulse with negative output pulse.

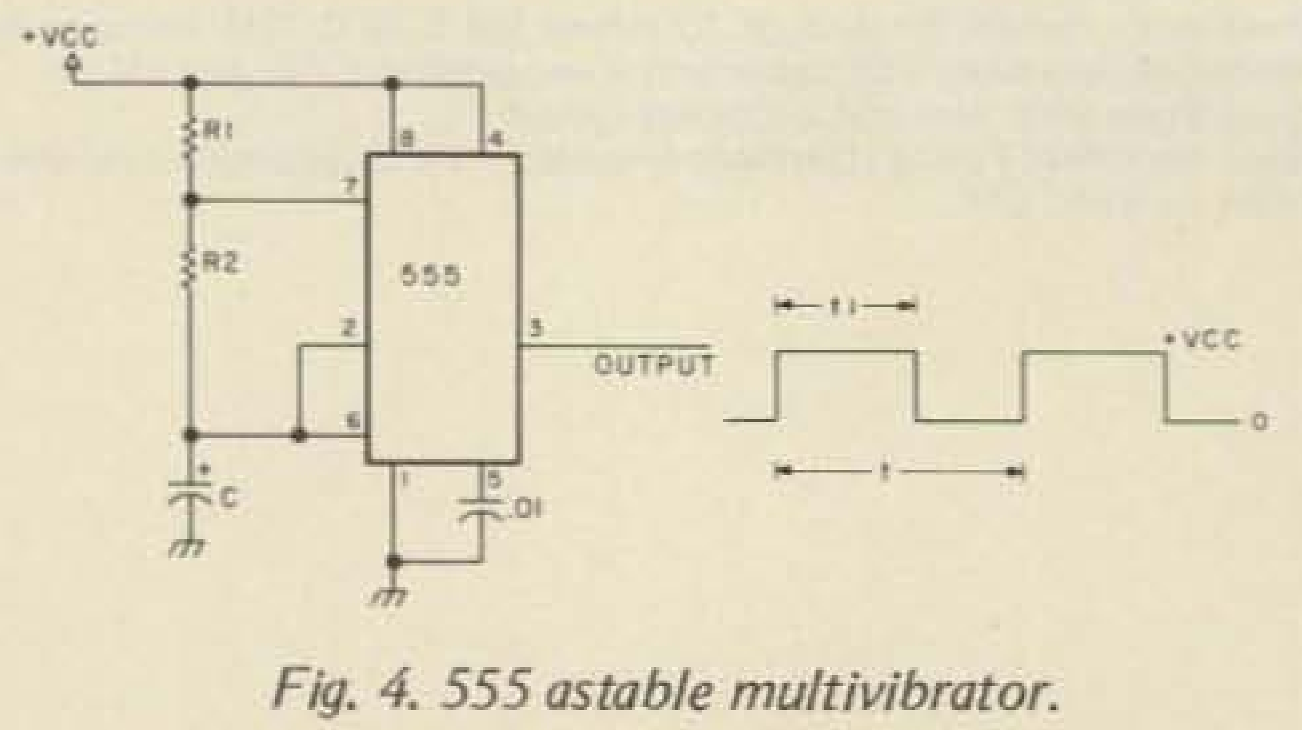

Fig. 4. 555 astable multivibrator.

shown in Fig. 2, the timer is triggered by a *negative-going* pulse to give a *positive* output pulse width, so that: t = 1.1(RC), in seconds.

In addition, the 555 timer may be also wired so that a *positive-going* trigger pulse results in a *negative* output pulse, as shown in Fig. 3. The above equation is still used.[7] The input pulse width, whether positive- or negative-going, must be shorter than the output pulse width.

The reset pin acts as an inhibit. When momentarily grounded, the output immediately returns to its stable state. For the circuit of Fig. 2, the output goes to ground, while the output returns to +Vcc for the circuit of Fig. 3.

By externally varying the control voltage (pin 5), the time period can then be made independent of the RC timing network.[6]

For astable operation, the 555 timer is connected, as shown in Fig. 4, to produce a repetitive rectangular output, whose frequency is given by:

$$f = \frac{1.443}{(R_1 + 2R_2)\,C}\text{, in Hz}$$

The duty cycle of the rectangular output is the ratio of the time that the output is at +Vcc (high) to the total cycle, given by[6]:

$$\text{duty cycle} = \frac{t_1}{t} \times 100$$

$$= \frac{R_1 + R_2}{R_1 + 2R_2} \times 100.$$

For the circuit of Fig. 4, R_2 has to be much larger than R_1 to obtain nearly a 50% duty cycle. Otherwise, the duty cycle will normally range from 51-99%.

The 556 timer is simply two independent 555 timers in a 14-pin package, as shown in Fig. 5.

The 554 Monostable Timer

The type 554 timer, made by Signetics,[8] is a quad monostable timer in a 16-pin package (Fig. 6), with each section represented by the functional diagram of Fig. 7.

The timer is connected for monostable operation (one section) in Fig. 8, and the output pulse width is given by: t = RC, in seconds.

As with the 555 timer, the negative-going trigger pulse width must be shorter than the output pulse width. As shown in Fig. 9, several 554 timers may be cascaded to give a sequential series of output pulses. It should be noted that, unlike the 555 timer, no coupling capacitors are required, since this timer is *edge-triggered*. In addition, a negative reset pulse simultaneously resets all sections of the 554 timer. The control voltage pin can be used to vary the timer's output period, but all sections are affected simultaneously.

For astable operation, two sections of the timer must be

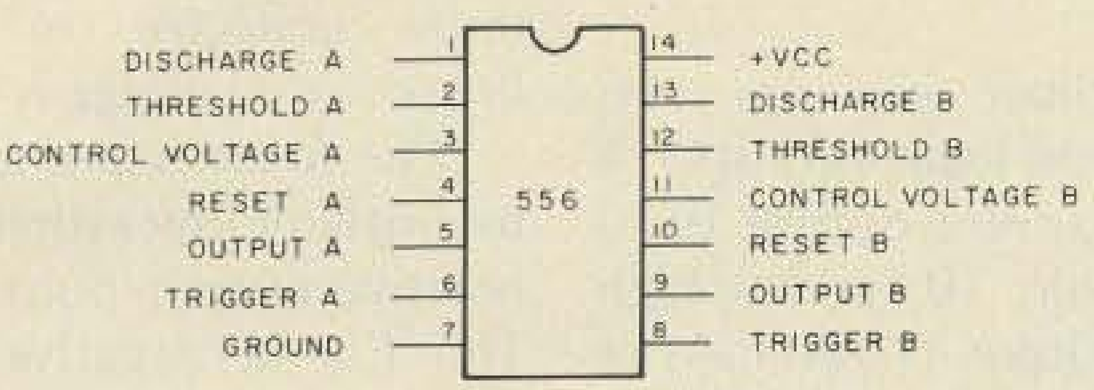

Fig. 5. 556 dual timer.

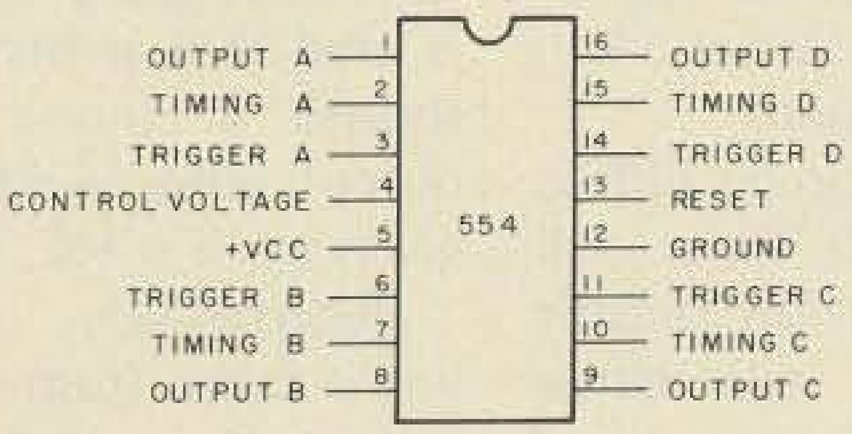

Fig. 6. 554 timer pin connections.

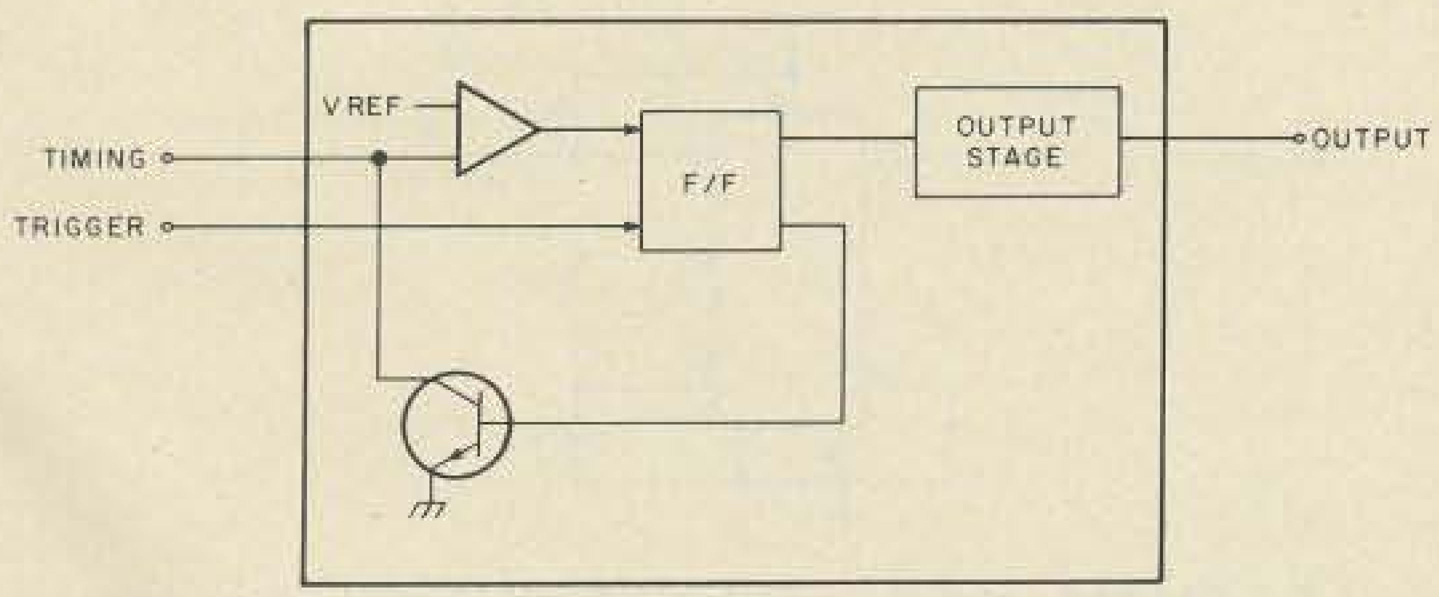

Fig. 7. Internal function diagram of the 554 timer.

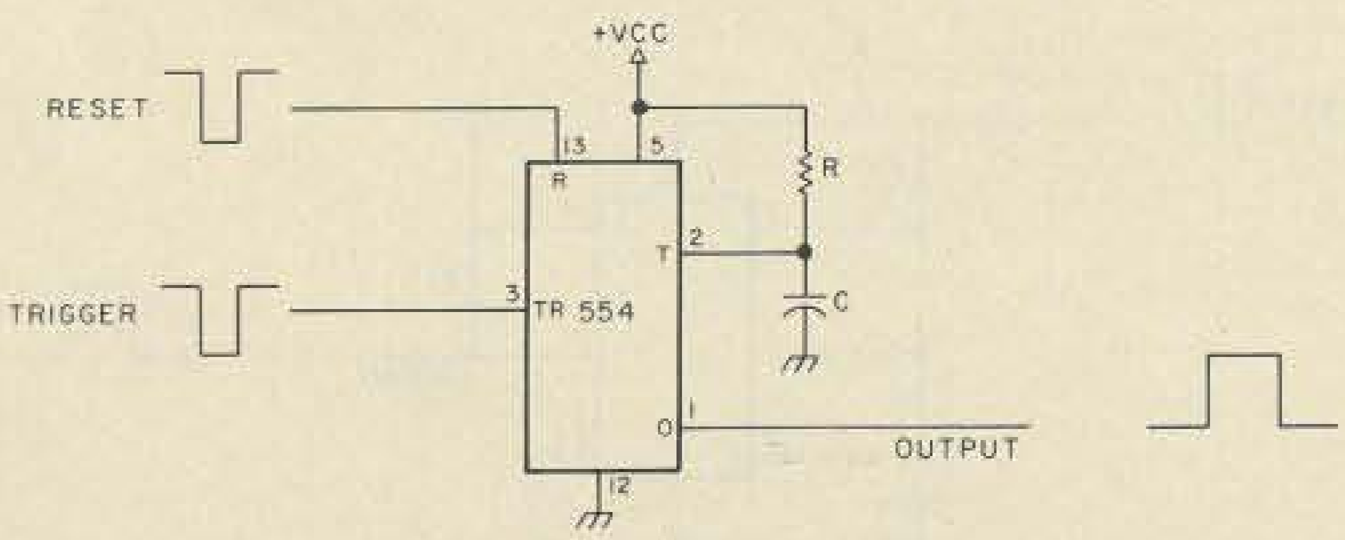

Fig. 8. 554 monostable, connected for negative-going trigger pulse.

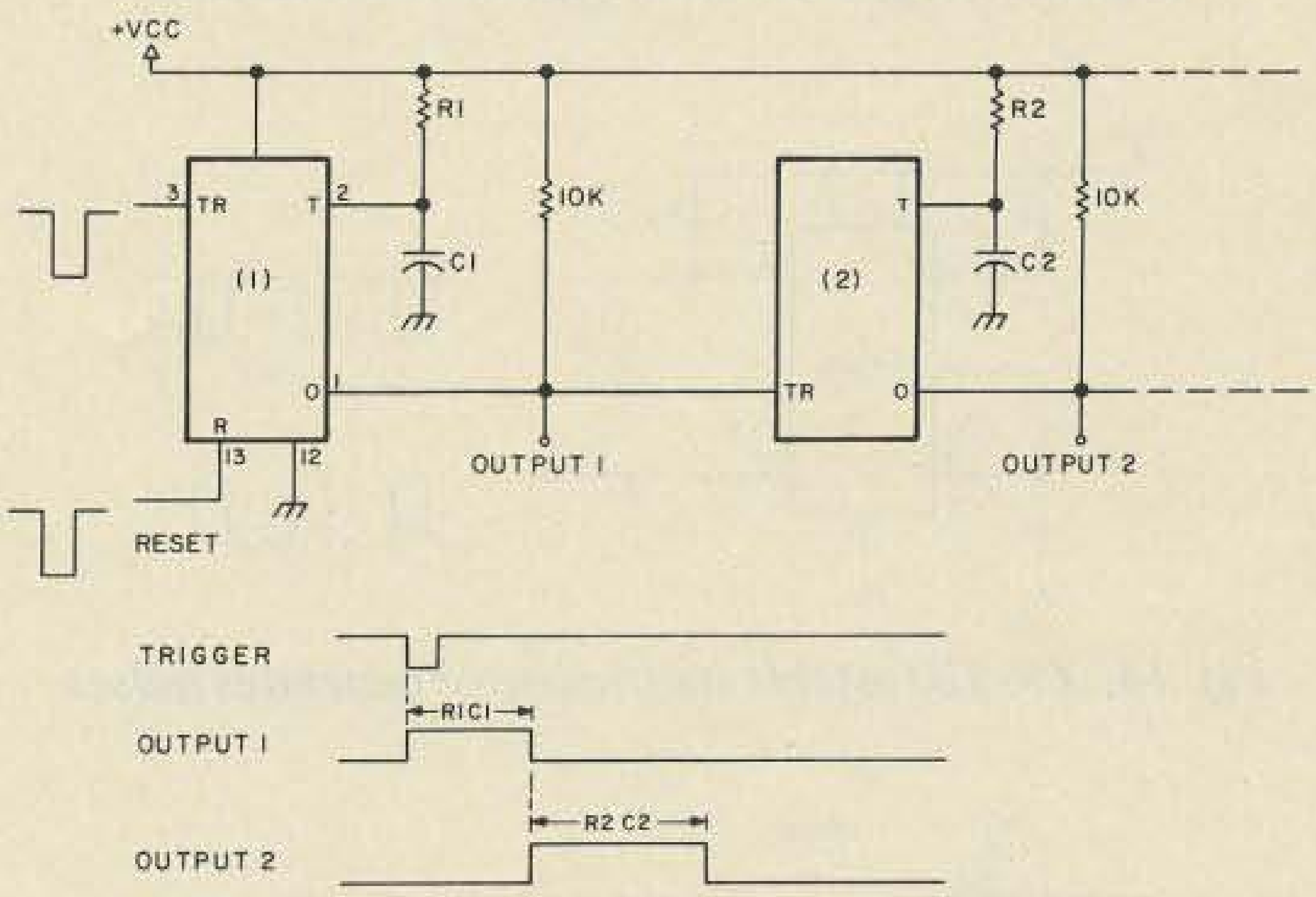

Fig. 9. Sequential output pulses.

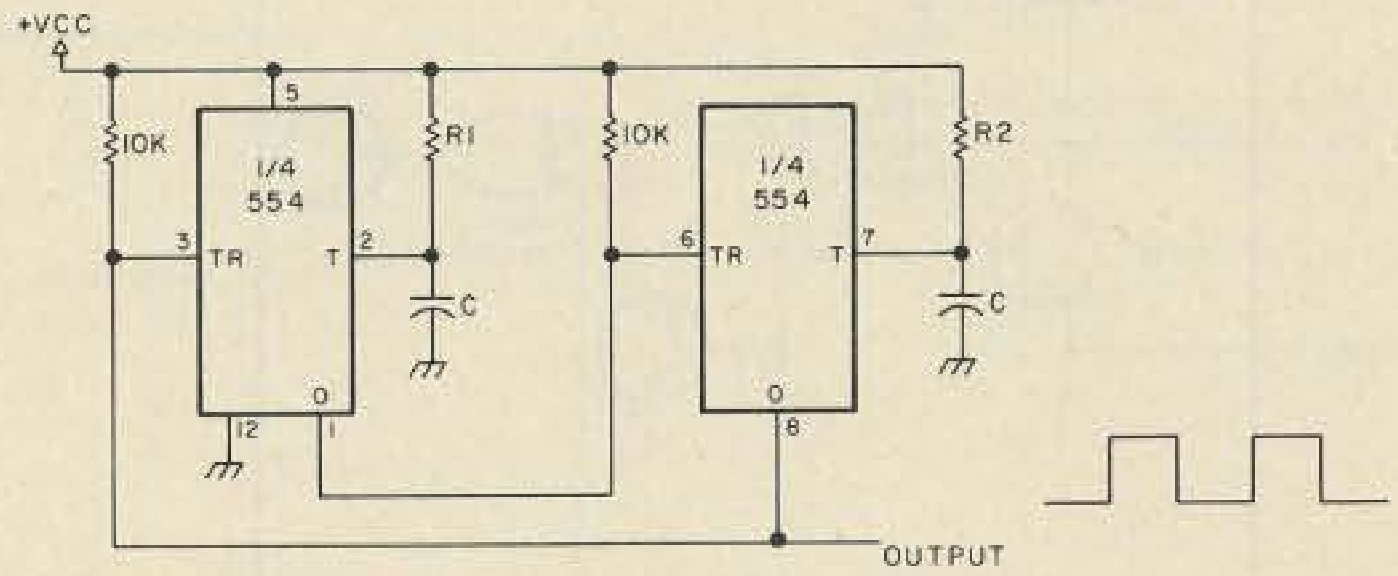

Fig. 10. 554 astable multivibrator.

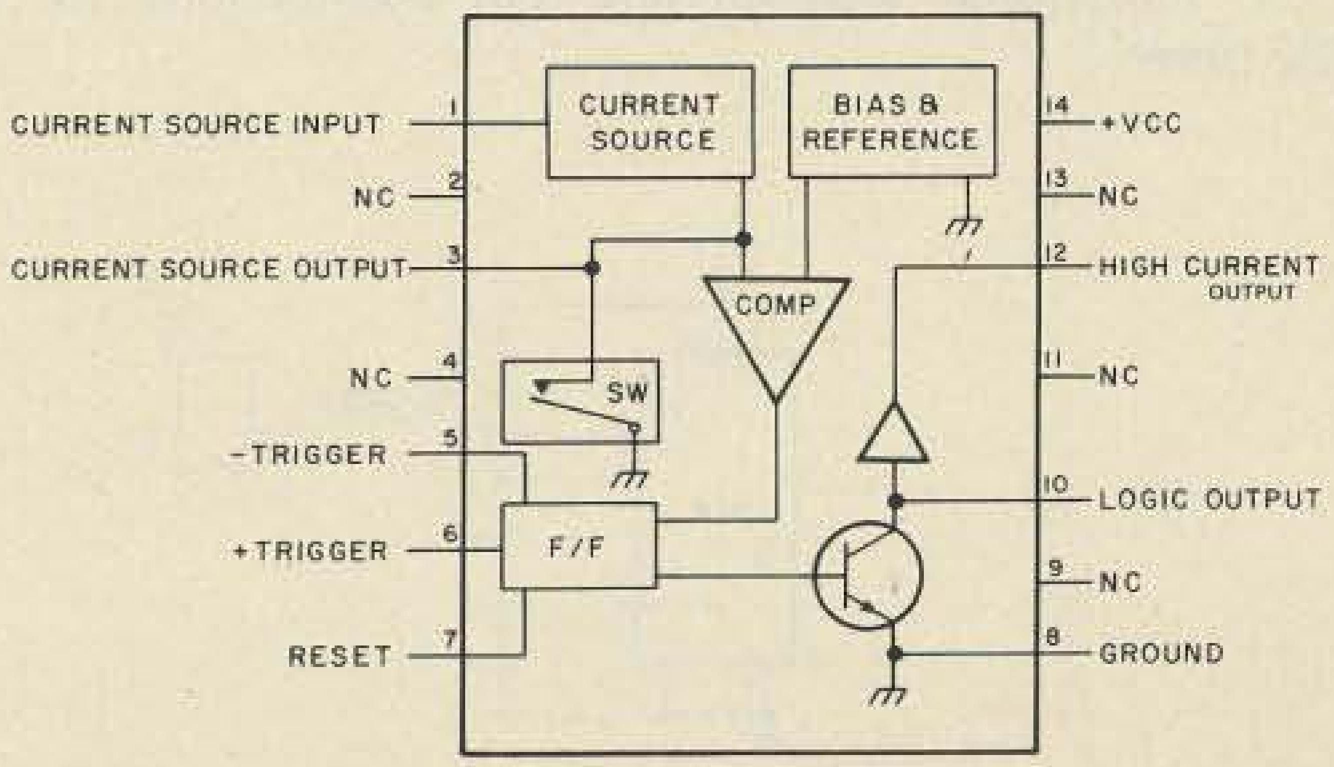

Fig. 11. Functional diagram and pin connections for the XR-320 timer.

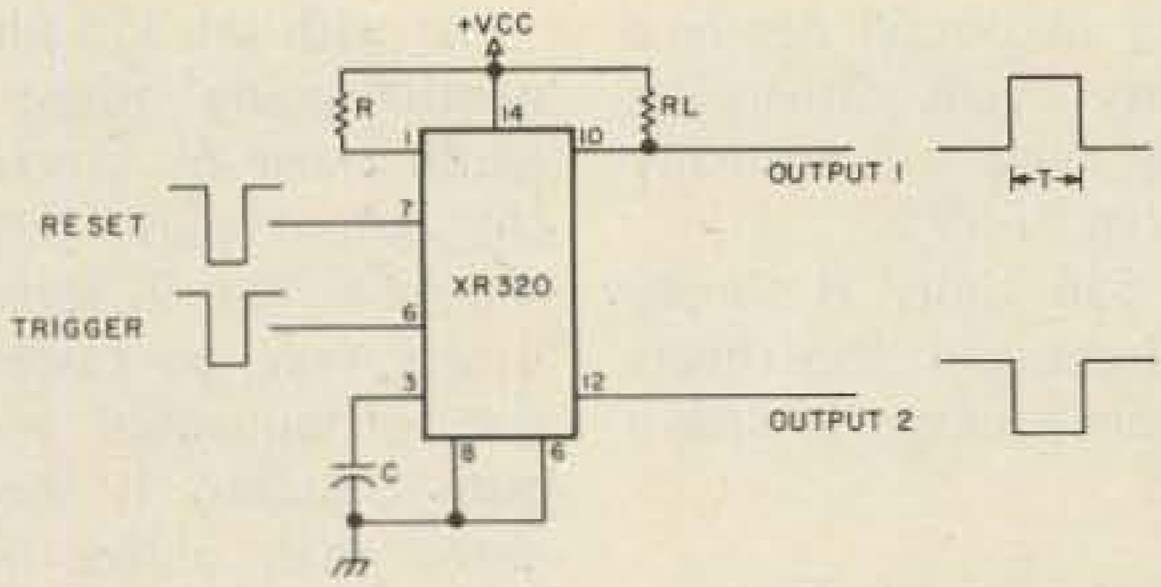

Fig. 12. XR-320 negative-triggered monostable.

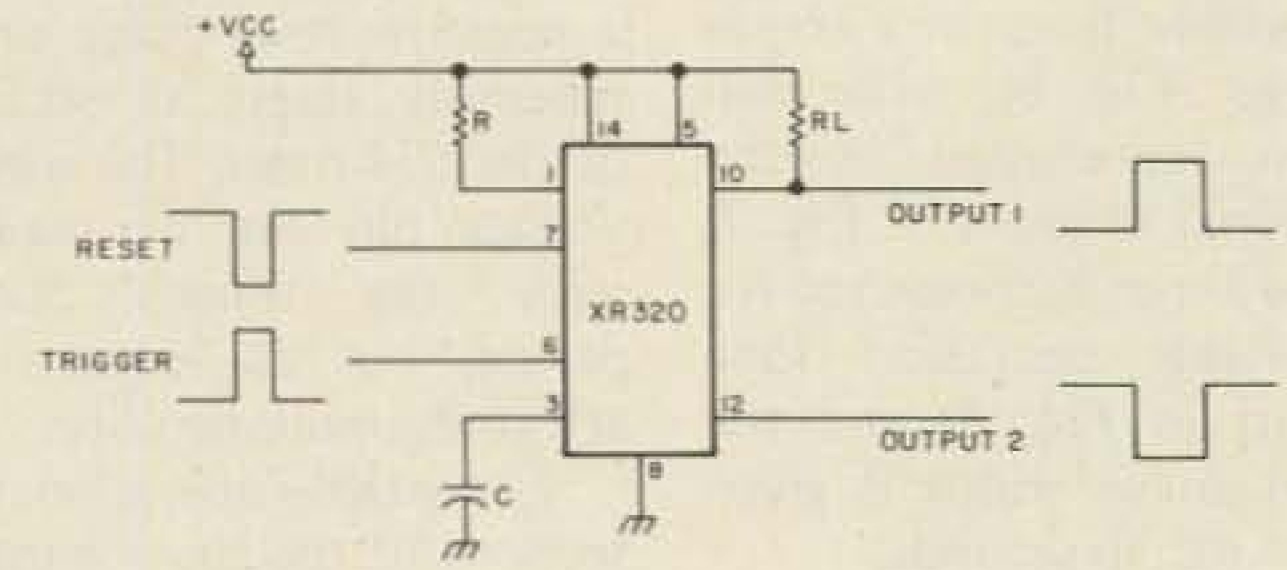

Fig. 13. XR-320 positive-triggered monostable.

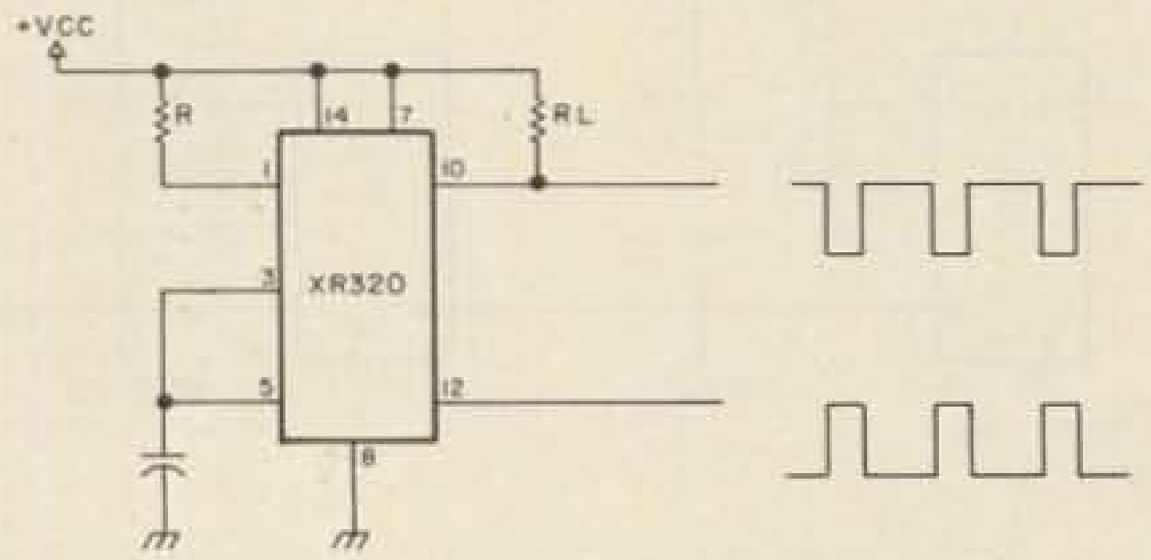

Fig. 14. XR-320 astable multivibrator generates pulses.

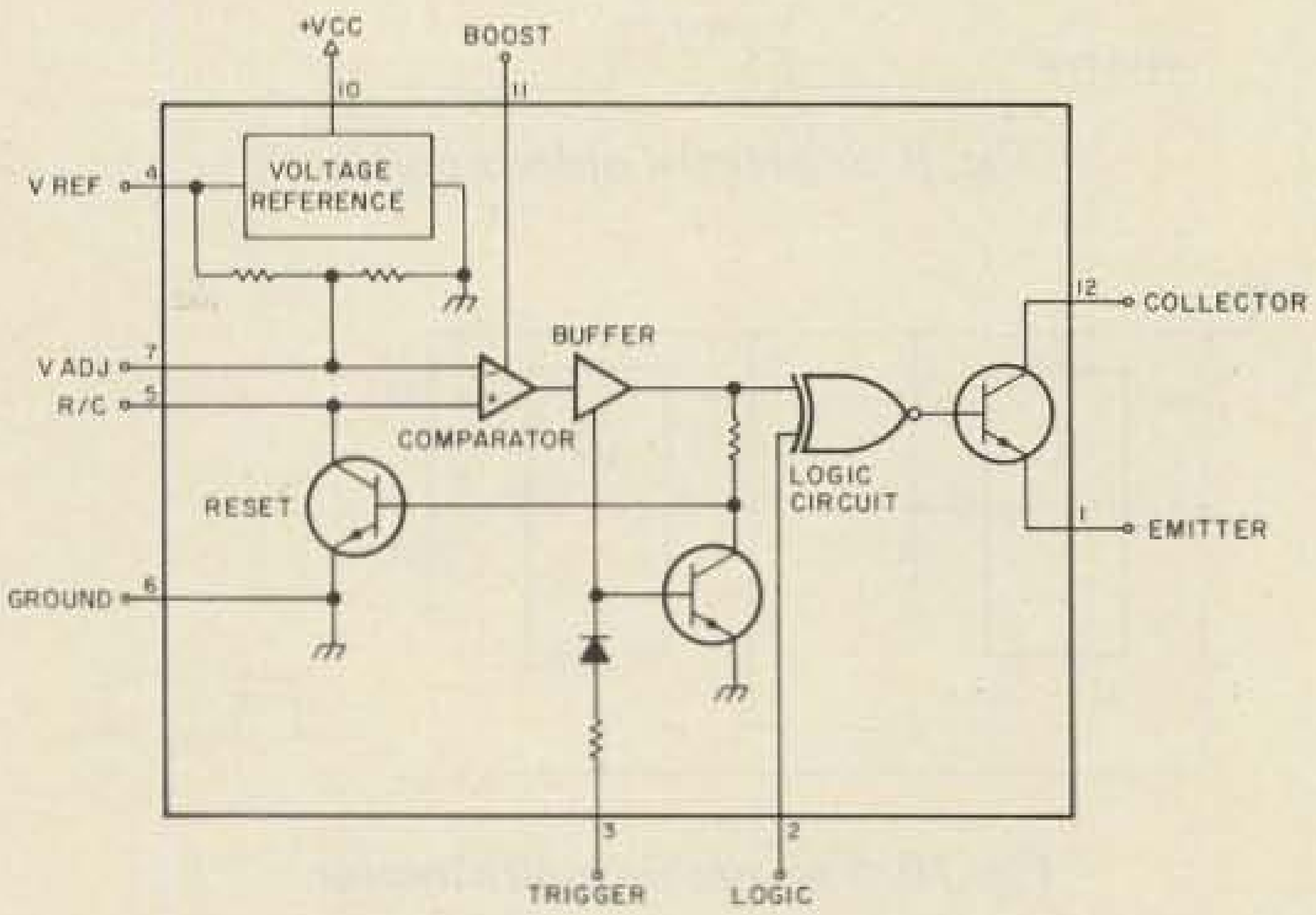

Fig. 15. Functional diagram and pin connections for the LM322 timer.

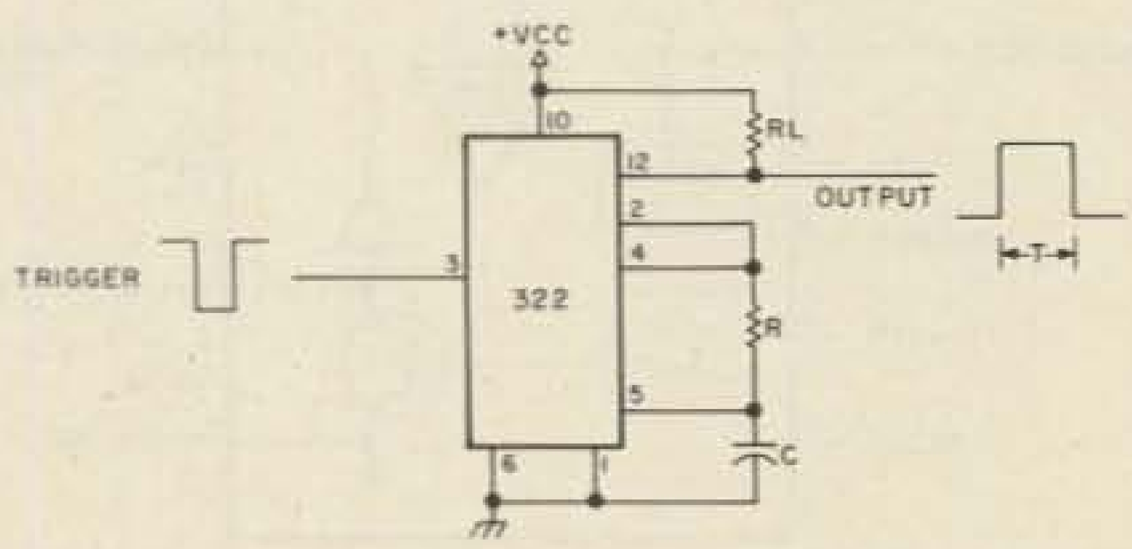

Fig. 16. LM322 timer connected as a negative-triggered monostable with positive output pulse.

used, as shown in Fig. 10. The output frequency is given by:

$$f = \frac{1}{(R_1 + R_2)C}, \text{ in Hz.}$$

and the output duty cycle is:

$$\text{duty cycle} = \frac{R_2}{R_1 + R_2} \times 100.$$

Consequently, by making R_1 equal to R_2, a symmetrical square wave is obtained.

The XR-320 Timer

The XR-320 timer, made by Exar,[9] is a single monolithic timing circuit in a 14-pin package (Fig. 11), and can be triggered either by a negative-going pulse (Fig. 12) or a positive-going pulse (Fig. 13). In either case, the input pulse width must be shorter than the output pulse width, given by: t = 2(RC), in seconds.

This timer provides two independent logic outputs – a medium current output (<10 mA) at pin 10, and a high current output (<100 mA) at pin 12. The output at pin 10 is of the "bare collector" type, which requires an external pull-up resistor, R_L, for proper operation.

By using the circuit of Fig. 14, the XR-320 timer will also operate as an astable pulse generator, with either positive or negative pulsed outputs, whose frequency is approximately equal to:

$$f \cong \frac{1}{2(RC)}, \text{ in Hz}$$

The LM322 and LM3905 Timers

The type LM322 timer, made by National Semiconductor,[10] is a single 14-pin package, shown by the functional diagram of Fig. 15. An internal 3.15 V reference is included as part of the timer to reject supply voltage changes and provide a reference for applications other than the basic timer. However, it can only drive loads up to 5 mA. As with the 554 and 555/556 timers, this timer's output period can be externally varied via the V_{ADJ} pin. The emitter and collector outputs of the LM322 can be treated like any transistor whose minimum collector to emitter breakdown voltage is 40 V.

The timer is connected for monostable operation, with a positive output pulse, in Fig. 16. For a negative output pulse, the circuit of Fig. 17 is used. For both circuits, only a positive-going trigger pulse is used, but it may be either shorter or longer than the output pulse width, which is given by: t = RC, in seconds.

Alternatively, if the output is taken from the *emitter output*, R_L is tied from pin 1 to ground, while pin 12 is tied to +Vcc. As with the

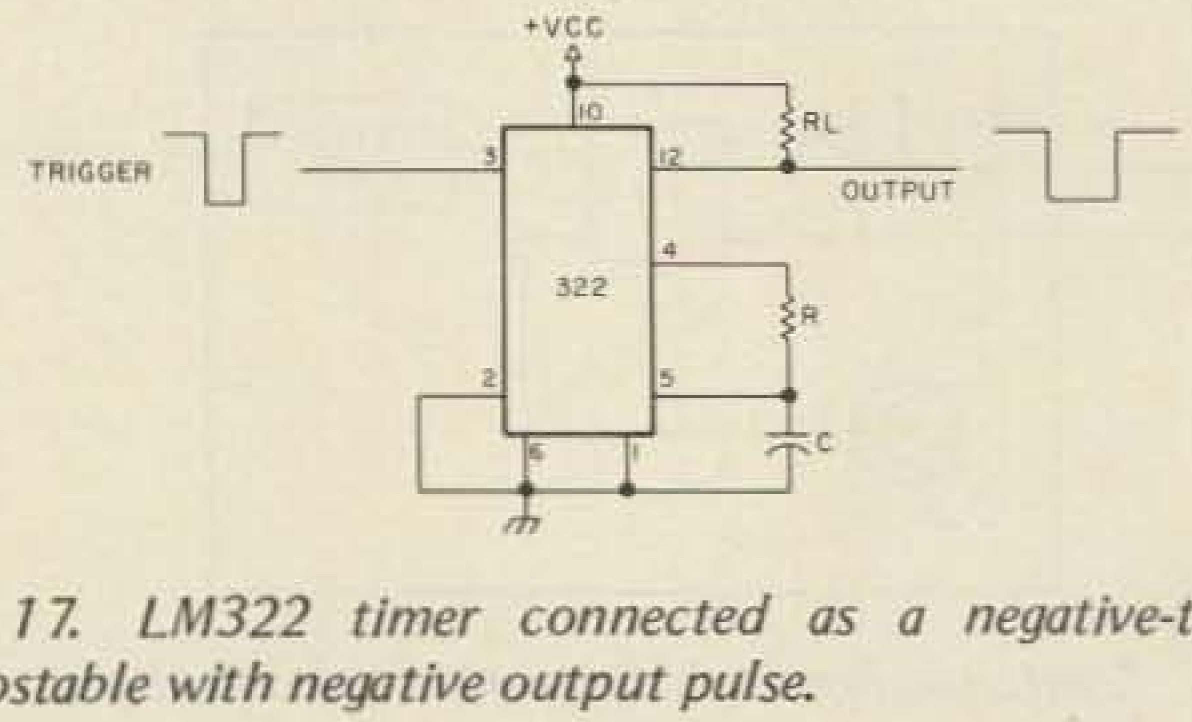

Fig. 17. LM322 timer connected as a negative-triggered monostable with negative output pulse.

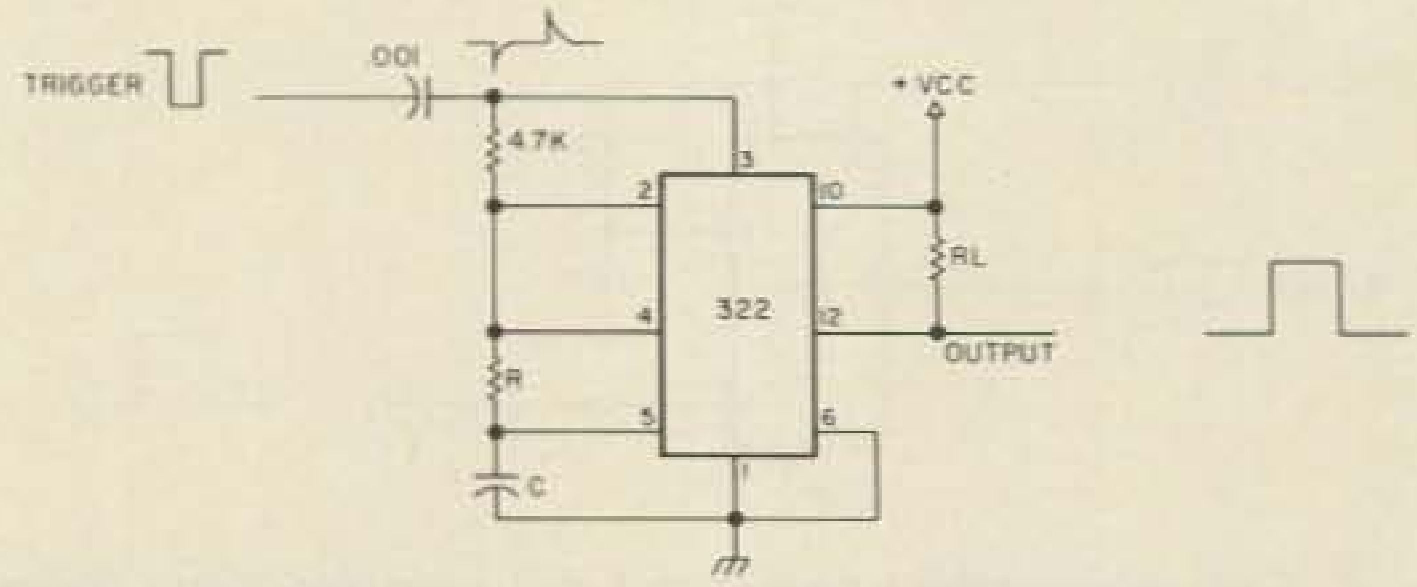

Fig. 18. Triggering with negative edge.

collector output circuits of Figs. 16 and 17, either a positive or negative output pulse width may be obtained during the timing cycle.

The boost terminal (pin 11) is used to increase the speed of the timer's internal comparator, since it is normally operated at low levels of current for the lowest possible input currents. In the unboosted state, timing periods down to 1 ms are obtained. In the boosted state, timing periods of several microseconds are possible. The output pulse may be reset during the timing cycle by momentarily shorting the timing capacitor to ground.

Although this timer is triggered by a positive-going pulse, as shown in Fig. 18, a differentiator tied to a normally high trigger pulse will result in a negative-edge triggered monostable. However, there is a delay in the appearance of the output pulse when the timer is negative-edge triggered, approximately in the range of 0.5 to 1.5 (RC).

As with the 554 timer, several LM322 timers may be cascaded to give a series of sequential output pulses without any coupling capacitors. Fig. 19 is used for collector outputs, and Fig. 20 is used for emitter outputs. Both circuits are triggered by a positive-going pulse.

For astable operation, the circuit of Fig. 21 is used, and the timer's output frequency is:

$$f = \frac{1}{(R_1 + R)C}, \text{ in Hz.}$$

The output is a narrow negative pulse, whose width is approximately: $t_1 \cong 2(R_2C)$, in seconds.

The LM3905 timer is identical to the LM322 timer, except that the boost and V_{ADJ} functions are not available, and the LM3905 comes in an 8-pin package, as shown in Fig. 22.

The 74121 Monostable Timer

The 74121, shown in the pin diagram of Fig. 23, is a 14-pin monostable timer and is probably the most used monostable, after the 555 timer. Unlike the previous ICs already discussed, its supply voltage must be +5 V (±5%).

In Fig. 24, the 74121 functions as a *negative-triggered* monostable. In Fig. 25, it is *positive-triggered.* In both cases, complementary output pulses are available, whose widths are: t = 0.693(RC), in seconds.

Once triggered, the outputs are independent of any

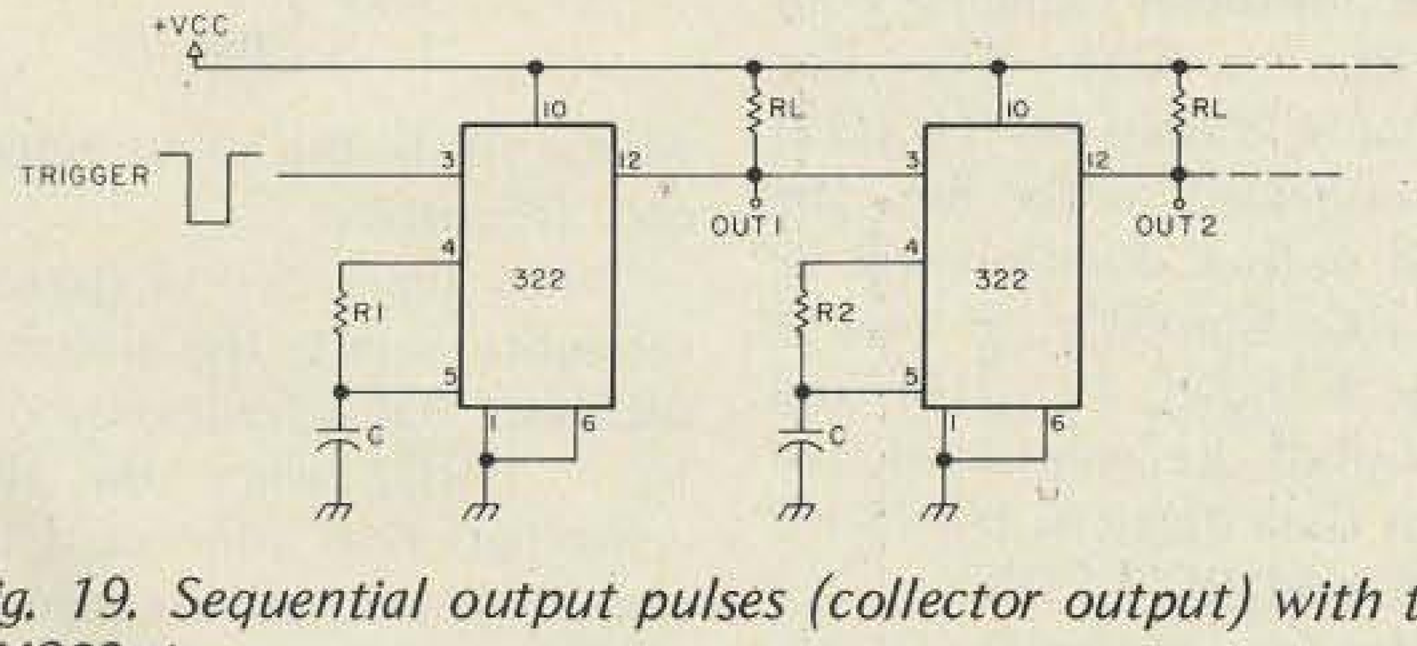

Fig. 19. Sequential output pulses (collector output) with the LM322 timer.

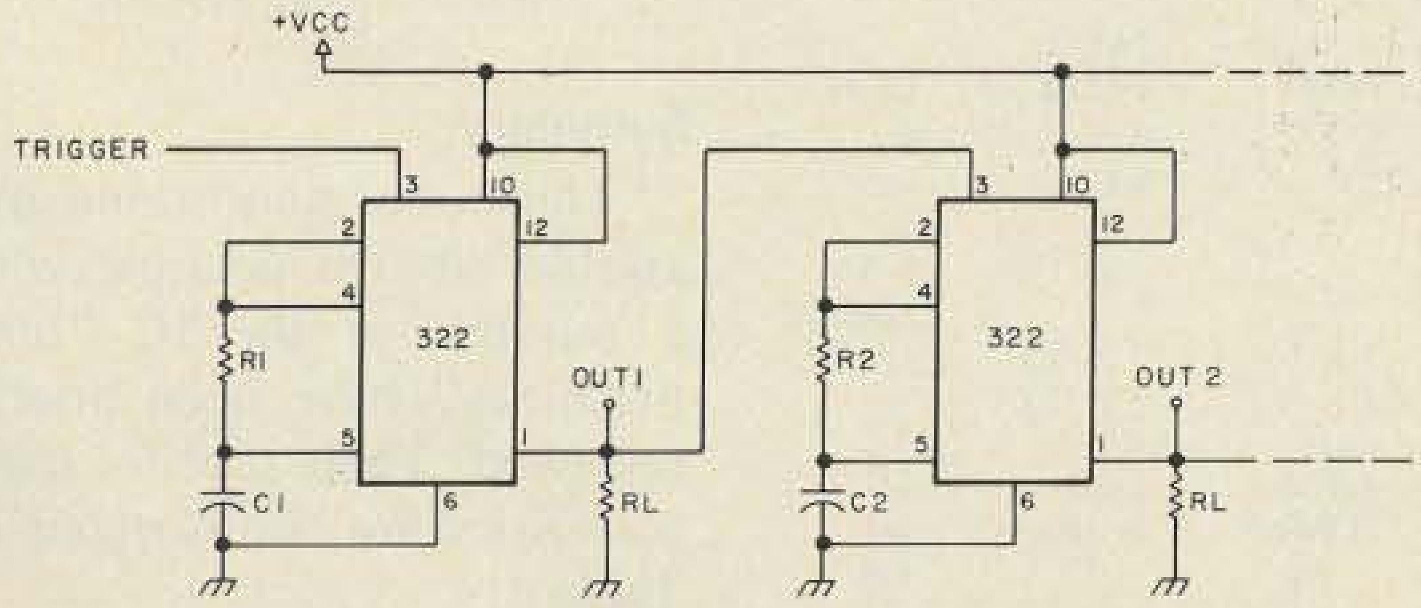

Fig. 20. Sequential output pulses (emitter output) with the LM322 timer.

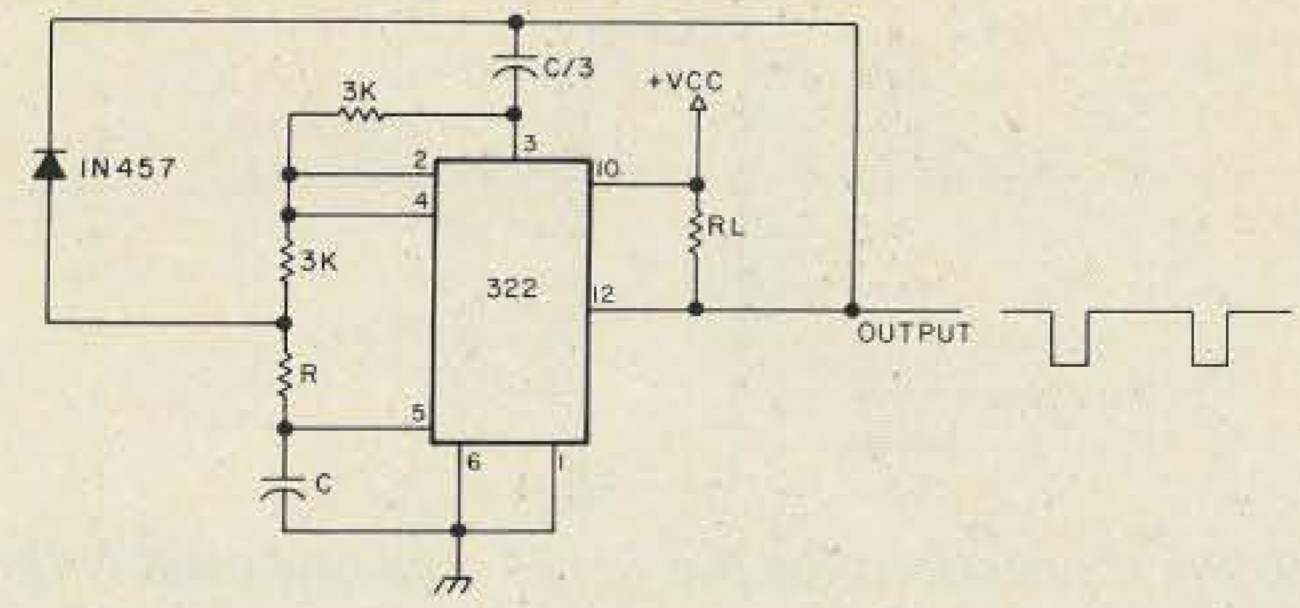

Fig. 21. LM322 timer connected as a pulse generator.

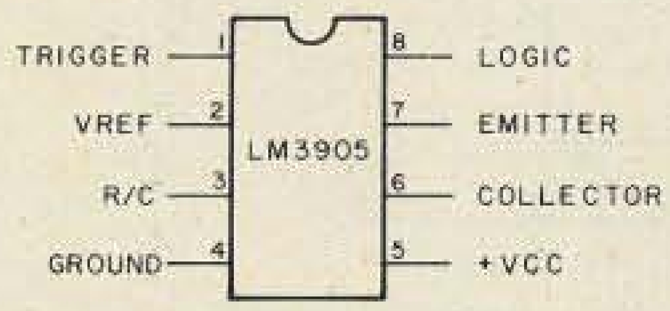

Fig. 22. Pin connections for the LM3905 timer.

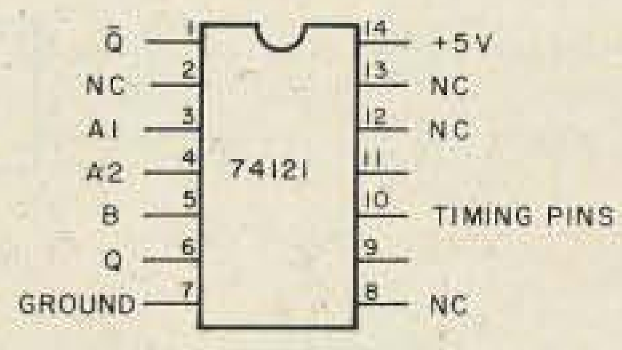

Fig. 23. Pin connections for the 74121 monostable.

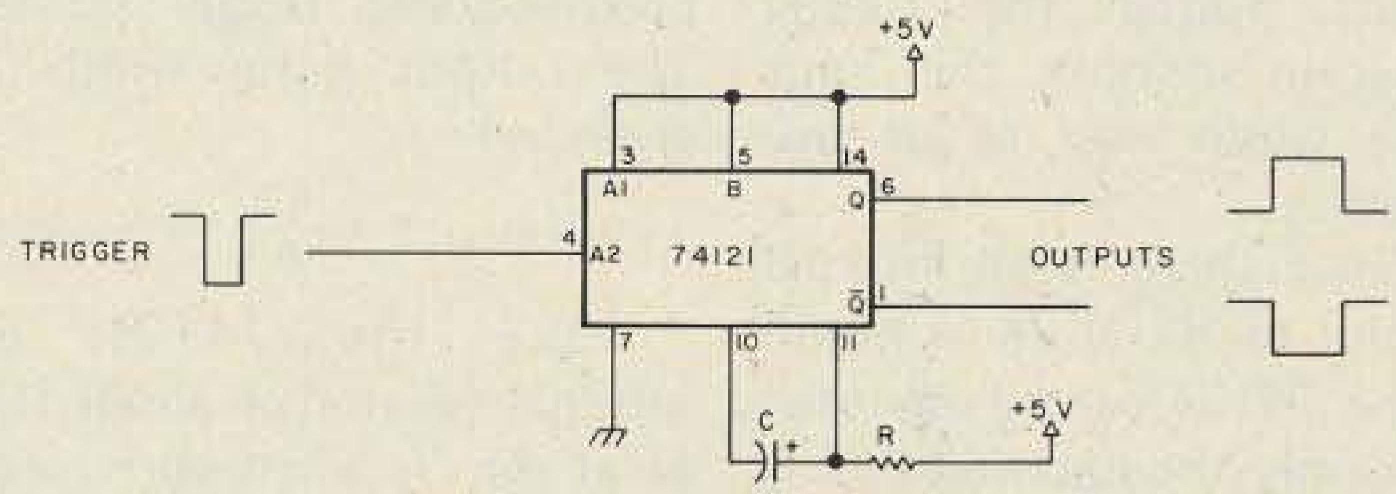

Fig. 24. 74121 monostable connected for negative-triggered output.

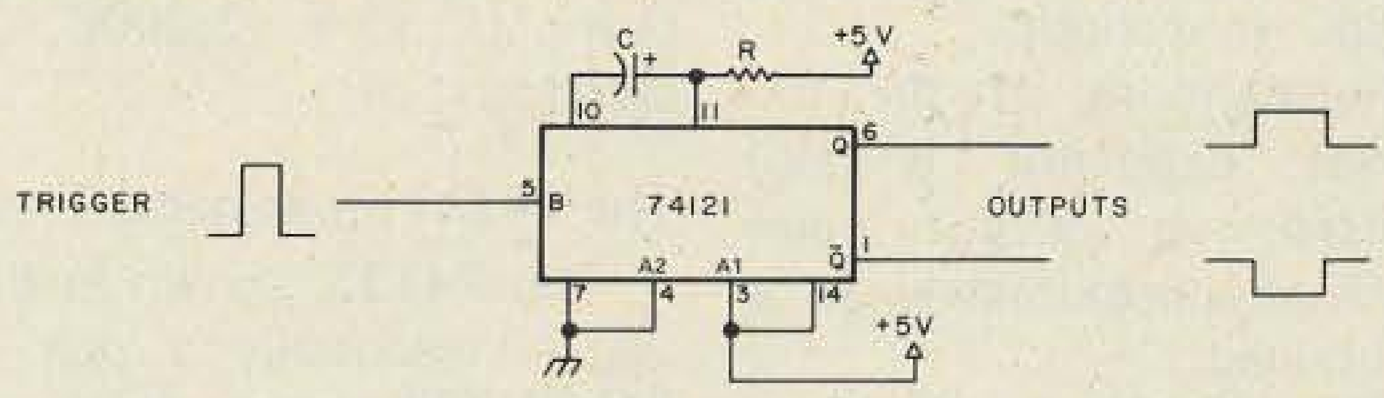

Fig. 25. 74121 monostable connected for positive-triggered operation.

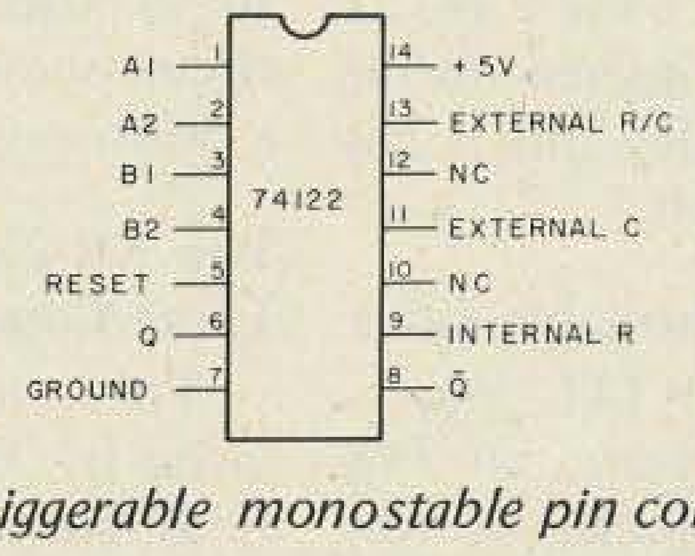

Fig. 26. Retriggerable monostable pin connections.

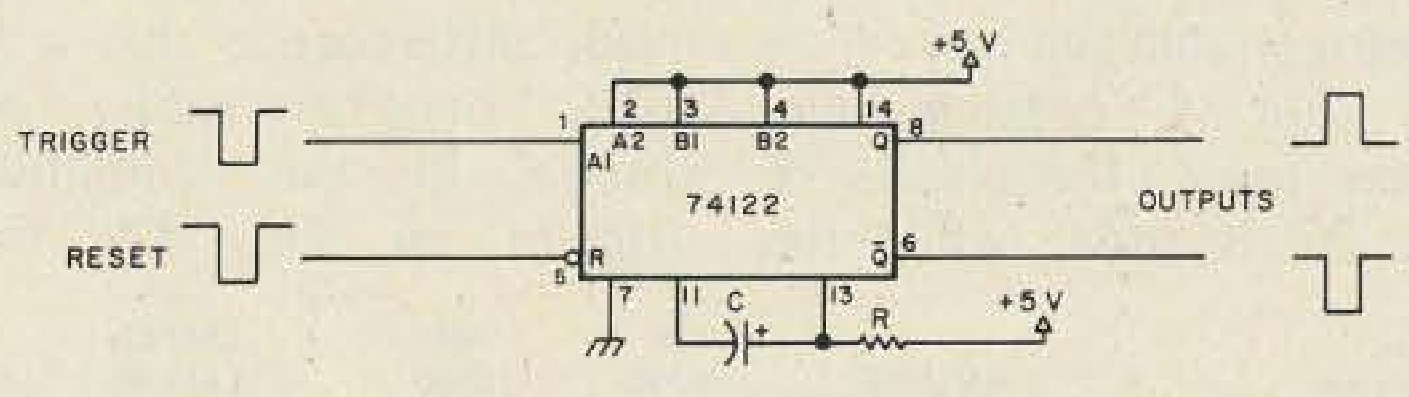

Fig. 27. Negative-triggered monostable.

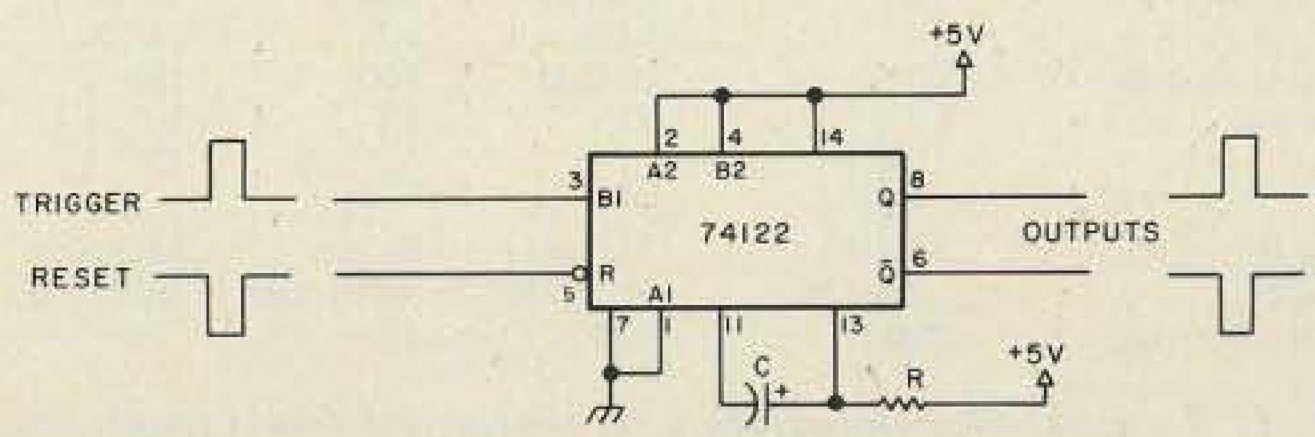

Fig. 28. Positive-triggered monostable.

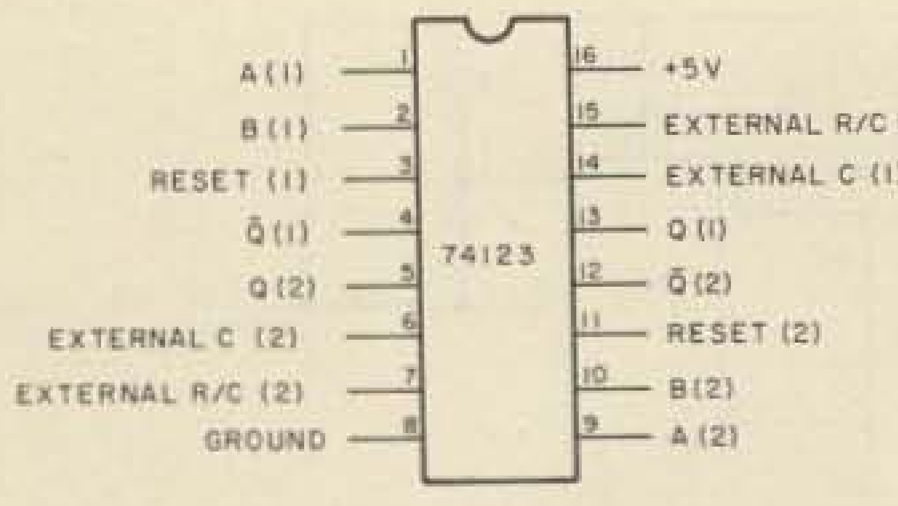

Fig. 29. Pin connections for the 74123 dual-monostable timer.

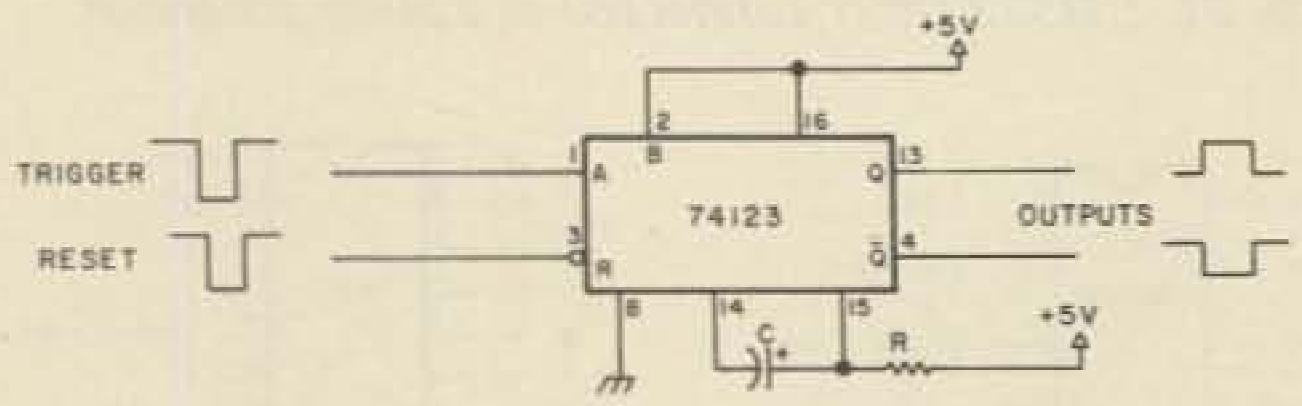

Fig. 30. Negative-triggered monostable (one section).

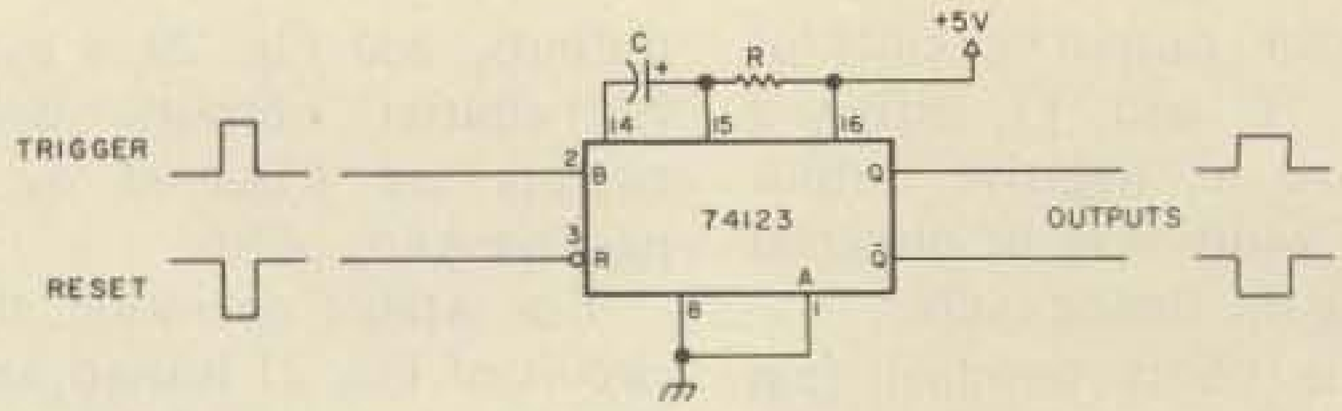

Fig. 31. Positive-triggered monostable (one section).

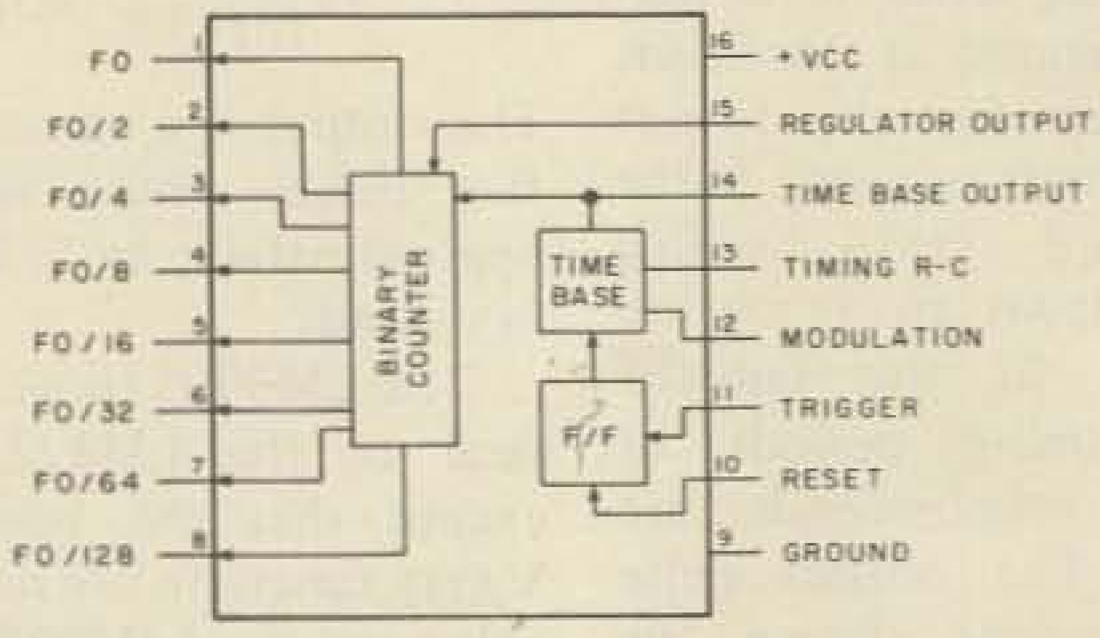

Fig. 32. Pin connections for the XR-2240 programmable timer/counter.

further input changes or transitions during the timing cycle. In addition, the input pulse width may be of any duration.

Since there is an internal resistor of about 2k Ω at pin 9, the 74121 can be operated with only the external timing capacitor by connecting pin 9 to +5 V. Consequently, the output pulse width is: t = 1.386C, in seconds.

Furthermore, if the external capacitor is also omitted, an output pulse width of approximately 30 ns is obtained.

The 74121 is preferred over the 555 timer for monostable periods less than 10 ms; however, the 74121 cannot be retriggered during the timing cycle, and it has no reset function.

The 74122 Monostable Timer

The 74122 TTL monostable timer, shown in Fig. 26, is very similar to the 74121, except that the 74122 is retriggerable and has a reset pin. For a negative-going trigger pulse, the circuit of Fig. 27 is used, while the circuit of Fig. 28 is used for positive-going trigger pulses. The output pulse width is given by:

$$t = 0.32RC \left[1 + \frac{0.7}{R} \right], \text{ in seconds.}$$

Like the 74121, an internal resistor of about 10k Ω at pin 9, when connected to +5 V, permits operation with only an external capacitor, so that the output duration is: t = 3,200C, in seconds.

The 74123 Monostable Timer

The 74123, shown in Fig. 29, is essentially a pair of 74122 TTL monostables in a 16-pin package. For negative-triggering, the circuit of Fig. 30 is used; otherwise, the circuit shown in Fig. 31 is for a positive-going trigger pulse.

The XR-2240 Programmable Timer/Counter

This integrated circuit, made by Exar, is a type of timer entirely different from those already discussed. The major difference is that it is fully programmable. As shown in the simplified diagram of Fig. 32, the XR-2240 features a timebase oscillator, control logic, and an 8-bit binary counter. A good review of its many functions is given in an issue of *Popular Electronics.*[11]

The basic circuit shown in Fig. 33 is used for both monostable and astable operation. With S_1 closed, the circuit functions as a programmable monostable. By connecting appropriate outputs to the "common output" bus, the output pulse width will be a multiple (in binary) of: t = RC, in seconds.

Consequently, with an 8-bit binary counter, we can have time delays ranging from 1 RC to 255 RC. For example, if only pin 6 ($f_o/32$) is connected to the bus, the total output duration will be 32 RC. Similarly, if pins 1 (f_o), 2 ($f_o/2$), 5 ($f_o/16$), and 7 ($f_o/64$) are connected, the total time delay is: t′ = (1 + 2 + 16 + 64)RC = 83RC.

Astable operation is obtained by opening S_1, so that the astable frequency is: f = 1/t, in Hz, where t′ is a multiple of RC from 1 to 255.

Although there are many possible applications for this device,[11,12,13] perhaps the most interesting is that the XR-2240 is capable of frequency synthesis[14] with the circuit of Fig. 34. This circuit can simultaneously multiply the input frequency by a factor of M and divide the input frequency by a factor of N+1, where M and N are selectable integer values. The output frequency is given by:

$$f = f_R \left[\frac{M}{1+N} \right]$$

$$1 \leq M \leq 10$$
$$1 \leq N \leq 255$$

where f_R is the input reference frequency.

When there is no external reference input, the circuit's oscillator has a frequency of: f_S = 1/RC, where the RC combination is connected to pin 13. The output frequency will be:

$$f = f_S \left[\frac{1}{1+N} \right], \text{ in Hz.}$$

Summary

The basic monostable and astable circuits possible with a number of the IC "time machines" have been briefly reviewed. Their specific characteristics are summarized in Table 1.

Since this article is not meant to be a compilation of

Parameter	555/556	XR-2240	XR-320	LM322/LM3905	554	74121	74122/74123	Units
Supply voltage, Vcc	4.5-16	4-15	4.5-20	4.5-20	4.5-16	5	5	V
Supply current	3-10 *	4-13	4-14	2.5	18-22 *	23	23 *	mA
Timing accuracy	1.0	0.5	1.0	0.2 ††	1.0			%
Supply drift	0.1	0.08	0.1	0.005	0.03			%/V
Temperature drift	50	80-200	100	100	150			ppm/°C
Triggering	⊔ | ⊓	⊓	⊔, ⊓	⊔, ⊓	⊔	⊔	⊓, ⊔	
Output	⊓ | ⊔	⊔	⊔, ⊓	⊓, ⊔	⊓	⊓, ⊔	⊓, ⊔	
Reset	⊔	⊓	⊔	⊔	⊔ †	none	⊔	
Timing R	1k-10m	1k-10m	6k-1m	3k-100m	2-100k	2-40k	5-20k	Ω
Timing C	.001-100	.01-1000	.0001-100	.0001-100	- **	≥10 pF	>10 pF	µF
Max. astable freq.	200	130	10	- **	-	-	-	kHz

*Table 1. Typical characteristics as obtained from manufacturers' data sheets. *Each section; ** not known; † all sections simultaneously; †† estimated.*

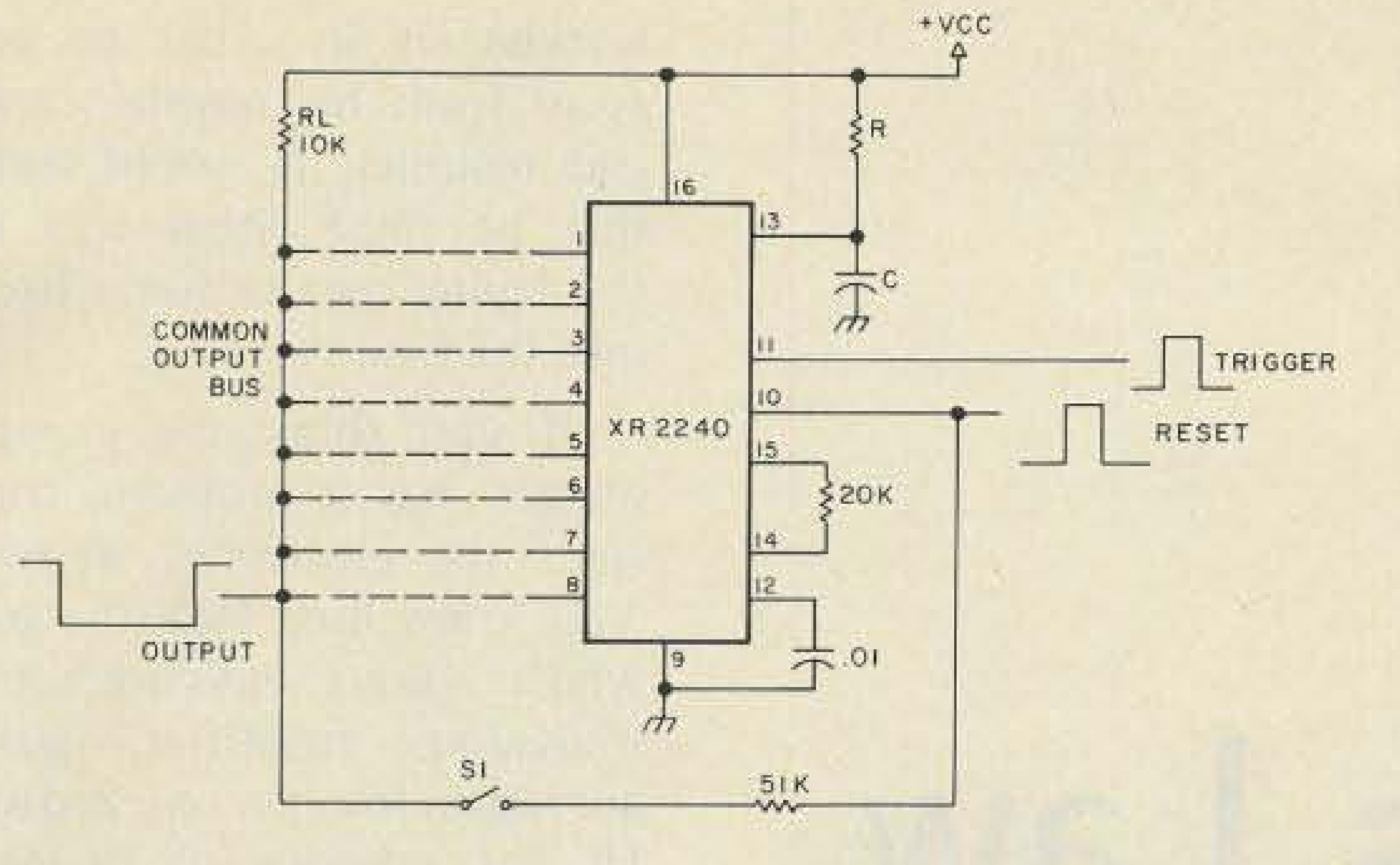

Fig. 33. External connections for the programmable timer/counter. For astable operation, S1 is left open. For monostable operation, it is closed.

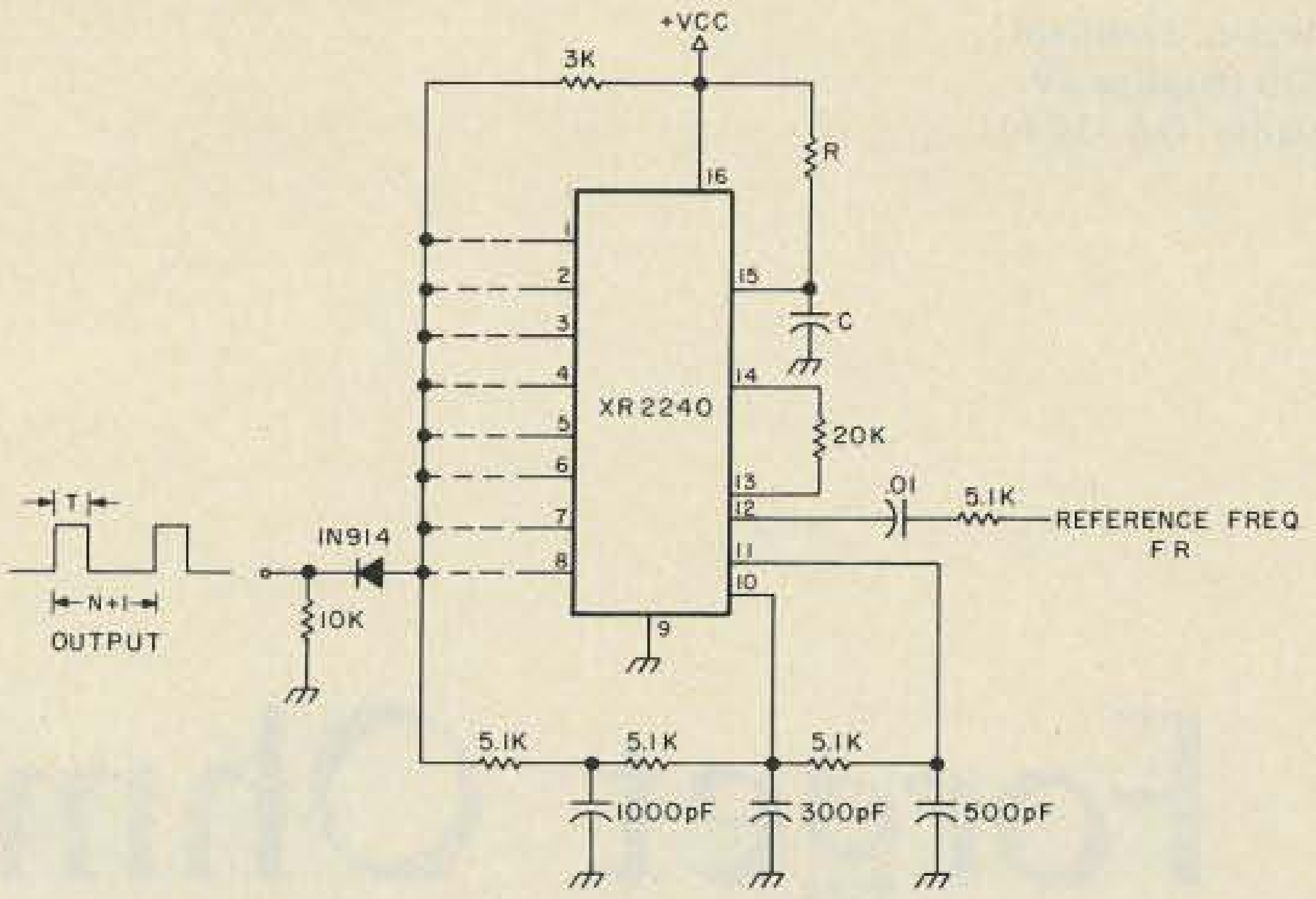

Fig. 34. The use of an XR-2240 programmable timer/counter to give frequency synthesis.

the many techniques and applications that are possible with these timers, but is meant to be a "timer primer," to coin a phrase, I recommend that you obtain application notes from the various manufacturers, in addition to some of the references listed below. ■

References

1. D. Blakeslee W1KLK, "Time-IC Controlled," *QST*, June, 1972, page 36.
2. E. Mooring W3CIX, "Simple Timer," *Ham Radio*, March, 1973, page 38.
3. W. G. Jung, "The IC Time Machine," *Popular Electronics*, November, 1973, page 54.
4. W. W. Schopp, "Versatile IC Timer," *Popular Electronics*, July, 1973, page 98.
5. R. F. Scott, "555 Timer IC Applications," *Radio-Electronics*, Part I – February, 1976, page 40; Part II – March, 1976, page 62; Part III – September, 1976, page 63.
6. H. M. Berlin K3NEZ, *The 555 Timer Applications Sourcebook with Experiments*, E&L Instruments, Derby CT, 1976 (available from *Ham Radio* Books, Greenville, New Hampshire 03048).
7. W. G. Jung, "555 One-Shot Circuit Features Negative Output with Positive Triggering," *Electronic Design*, August 16, 1976, page 98.
8. Signetics Corporation, 811 East Arques Avenue, Sunnyvale CA 94086.
9. Exar Integrated Systems, Inc., 750 Palomar Avenue, Sunnyvale CA 94086.
10. National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara CA 95051.
11. F. M. Mims, "A Programmable Timer/Counter," *Popular Electronics*, October, 1975, page 102.
12. J. Hanisko, "Timer/Counter Functions as a Phase Locked Loop Component," *EDN*, March 20, 1976, page 98.
13. R. Zwicker, "Phase Locked Loop Circuit Multiplies Frequencies by 2 to 256," *Electronic Design*, May 24, 1976, page 94.
14. D. T. Pohlman, "Timer/Counter Chip Synthesizes Frequencies and It Needs Only a Few Extra Parts," *Electronic Design*, June 21, 1974, page 114.

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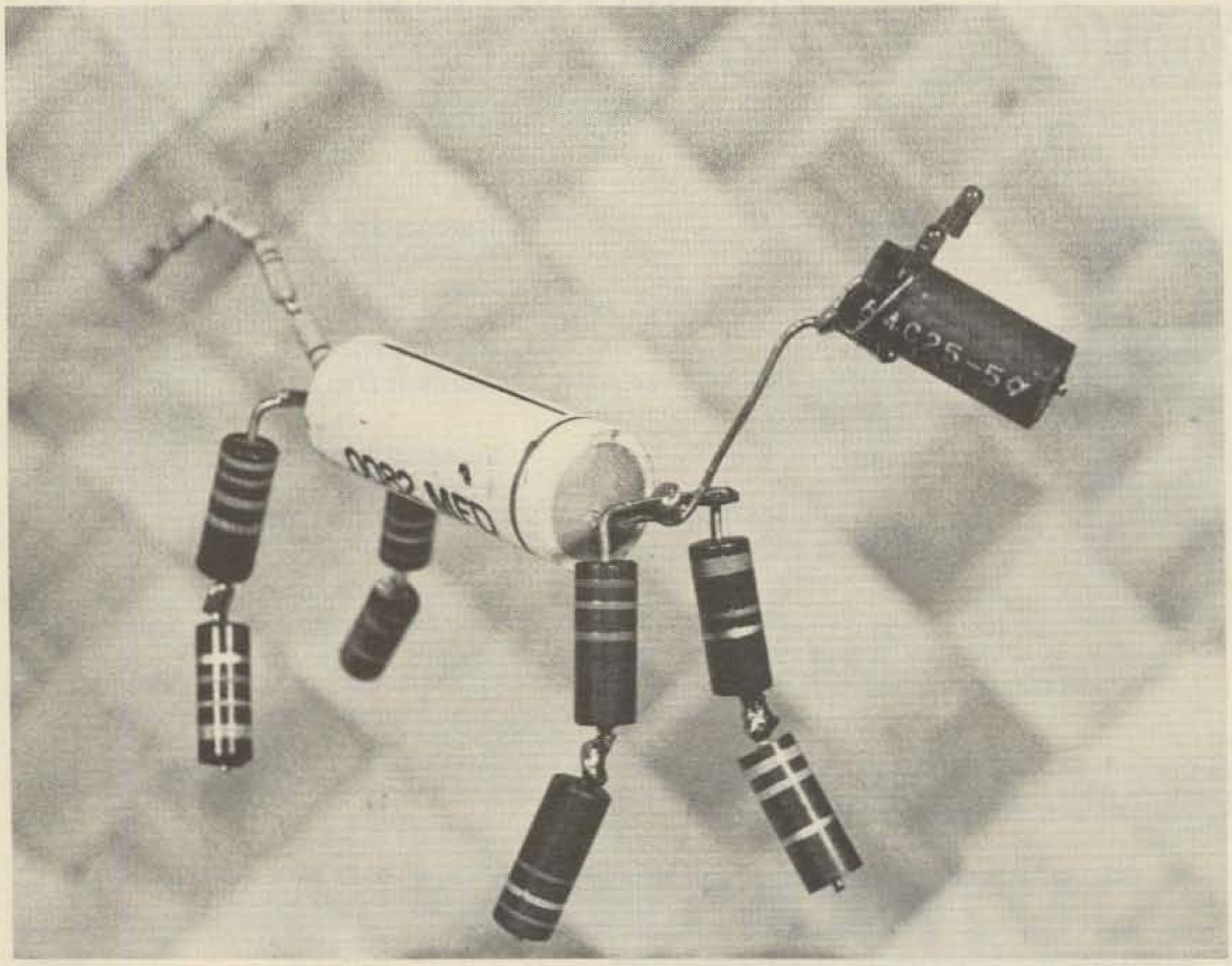
Forget Ohm's Law

-- be creative instead

Pushing electrons is a lot of fun, but it tends to keep you thinking. While this isn't harmful, it can lead to monodetached personality or tired brain. In other words, even the most dedicated experimenter needs time off. But, since he retired to his workbench in order to get away from his normal cares and troubles, it would seem that he must either stay in the frying pan or jump back into the fire.



Take my word for it, this is a horse. His ears are LEDs, and, to tell the truth, I haven't the faintest idea what the series resistance of his tail might be.

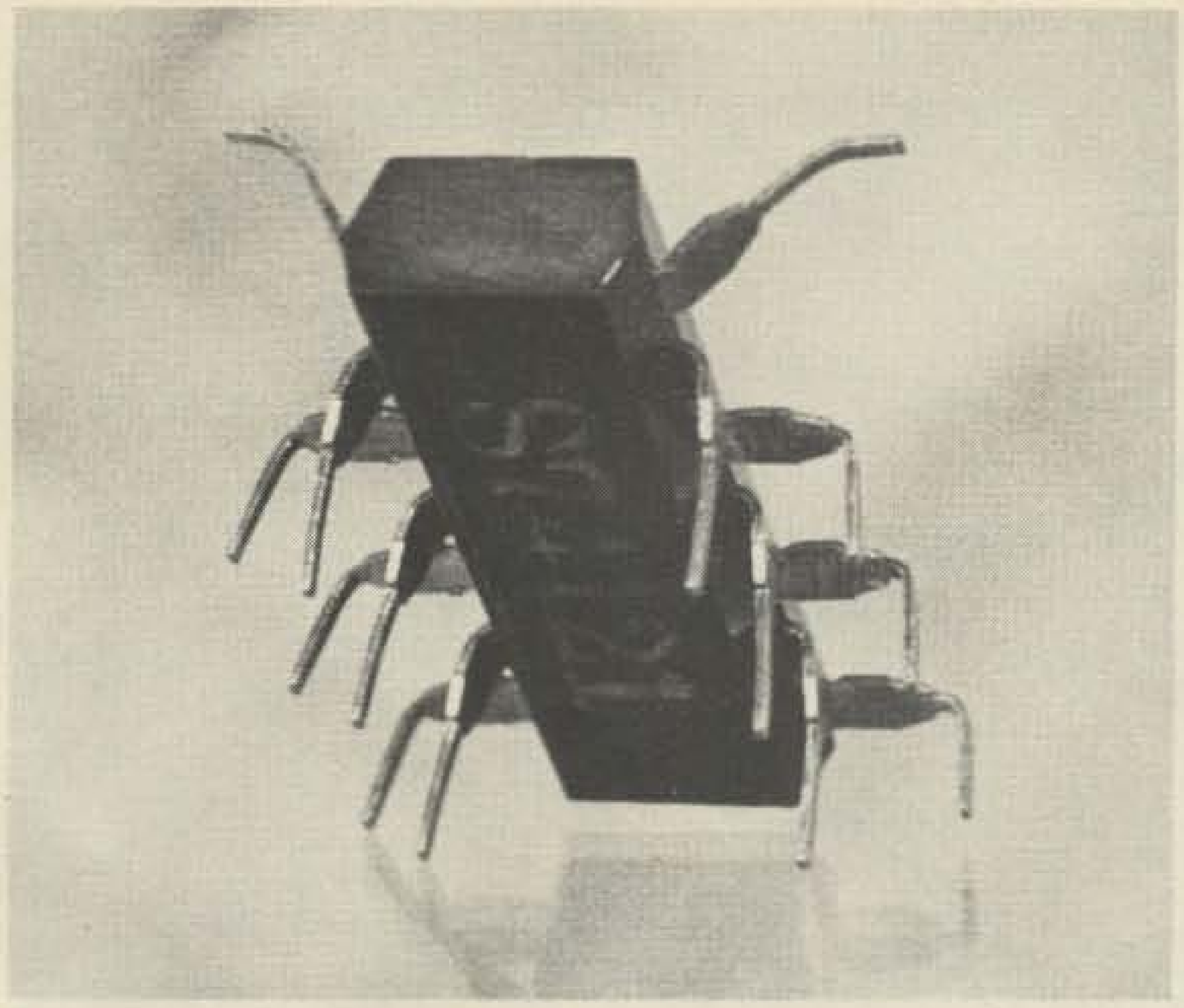
If you think the experimenter has a problem, consider the electronic weirdo. You know him. He's the guy who's always building some marvelous mystifier, guaranteed to impress one and all. He has a house full of electronically guided frogs, automated picture straighteners, and an alarm system that uses delayed subatomic particle identifiers.

His problem is diminishing returns. When he started his career, he could get unlimited amounts of attention with a few blinking lights. But people have gotten used to his act, and now it takes an armful of sophisticated odds and ends to produce anything that merits more than a casual, "That's nice." Ever-increasing amounts of time and money are required to produce these gadgets, while the interest they generate steadily becomes less and less.

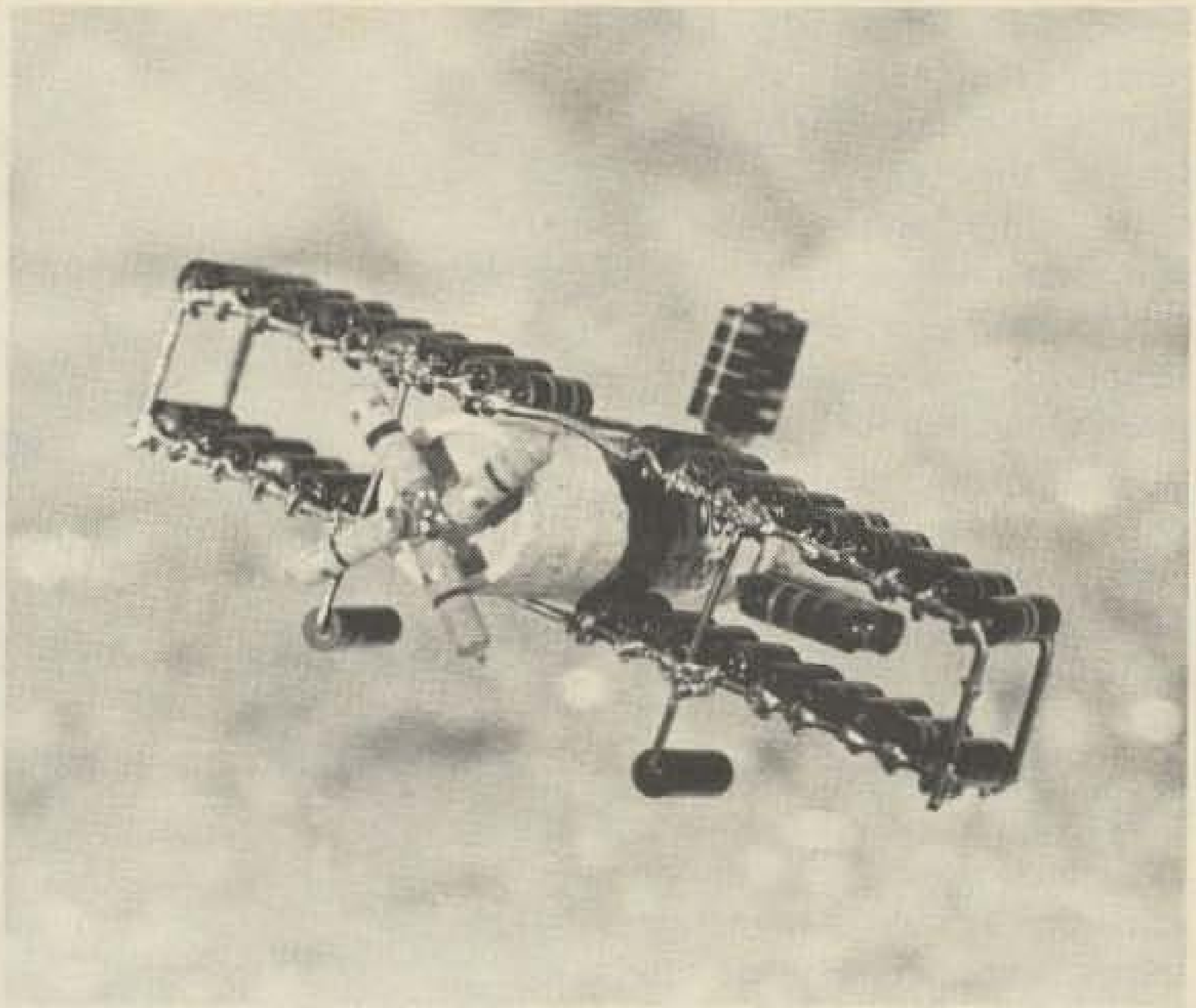
Finally, we come to the larger group of less fanatic, but quite active, electronics students, technicians, and hobbyists. They try to keep current by reading a couple of magazines a month. When they see a project that interests them, they may hesitate to give it a try, unless it's something they can whip together in an evening or two for about three dollars.

Since I'm a combination of all the types listed above, I feel that my method of dealing with these problems can be used by almost anyone interested in electronics. As the accompanying photos show, I sometimes fashion small figures out of resistors, capacitors, and other components that catch my eye. While I make no claims to artistic success, I don't feel compelled to hide my efforts in a cellar.

I won't promise you fame

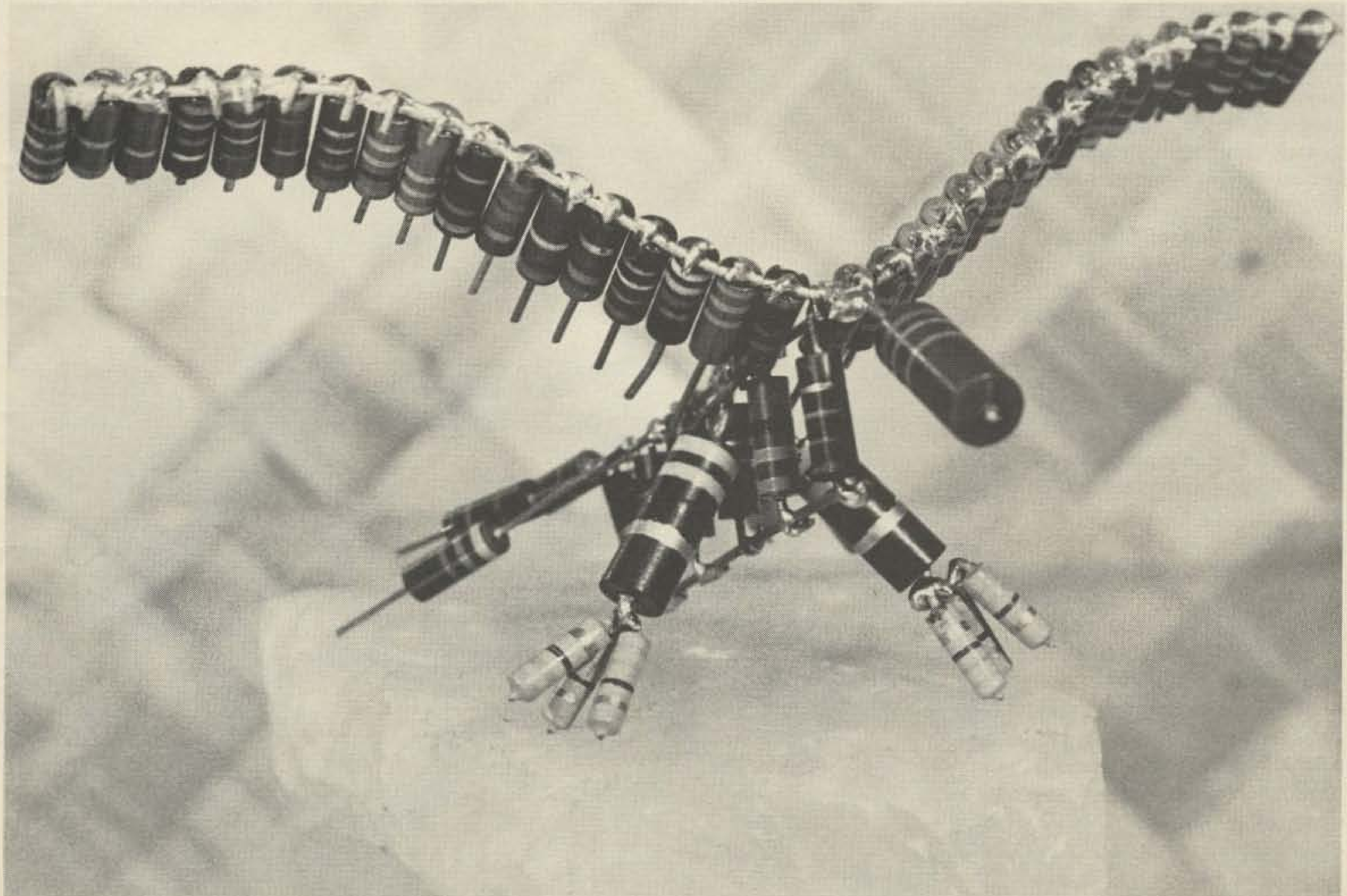


This strange little bug can be fashioned from an ordinary 14-pin integrated circuit in a matter of minutes. Though small in size, it can stir up a large reaction when left on some unsuspecting person's desk.



This little seaplane has been flying for three weeks on one charge of its capacitor. As soon as it comes down, I'm going to charge it with ac.

and fortune if you try making some of these figures, but I honestly feel that the time you invest will be of benefit to you. We all receive a sense of satisfaction whenever we successfully complete a project, and, in comparison to most electronics projects, these figures are a snap. They can usually be completed in a couple of hours, so you're not going to be tied down for an extended period of time.



Somehow a project that started out to be a chicken ended up as an eagle. The next time you hear that America is no longer the land of opportunity, remember Eric the Eagle.

Since even those who have never even heard of electronics can appreciate these figures, they can be used as gifts, sold as art, or serve as conversation pieces.

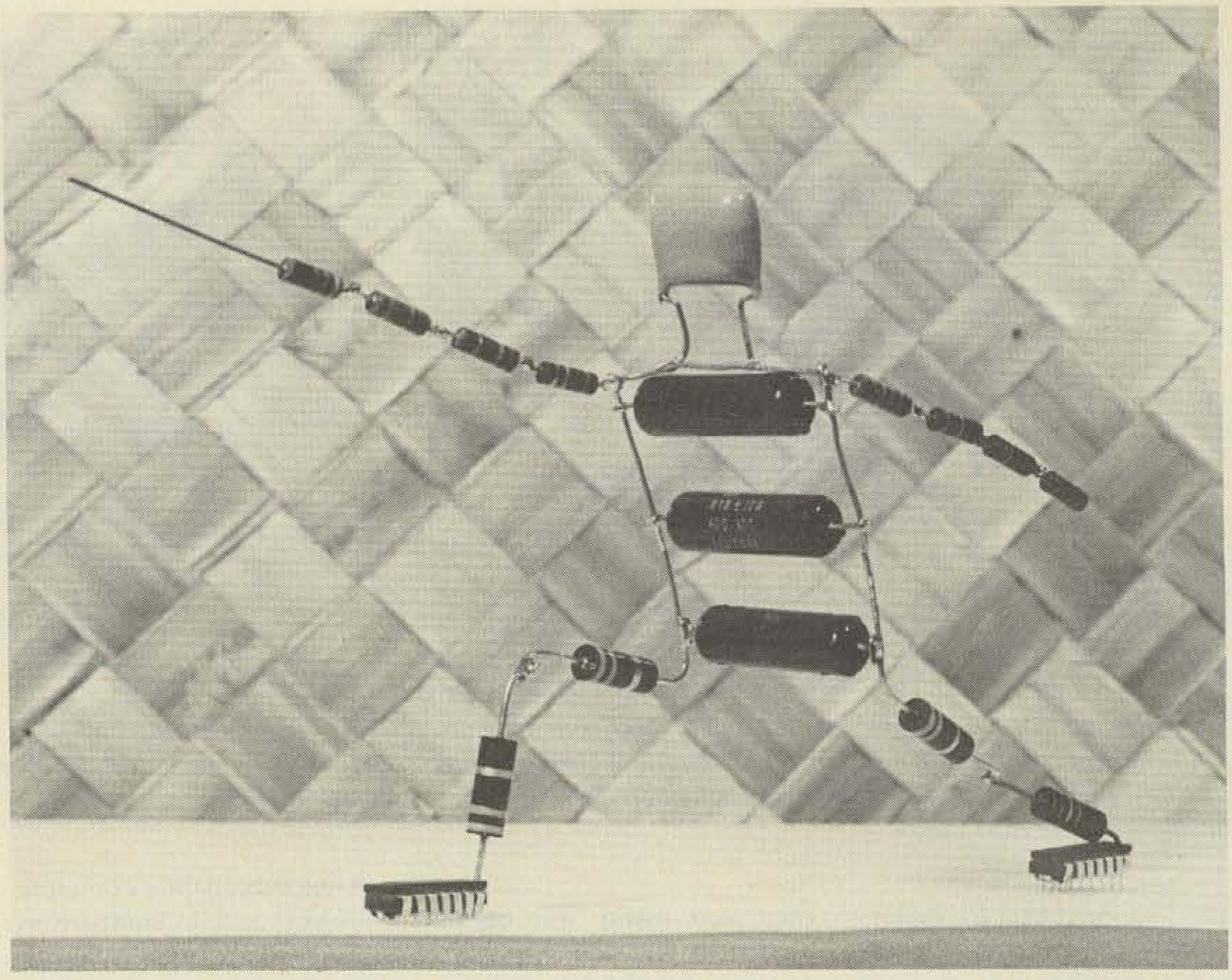
I won't give explicit instructions for making these figures, but I will offer a few suggestions. To start with, I only use genuine electronics parts. This means no beer cans, bottle tops, or wood screws. If you don't like this rule, break it.

As a matter of personal taste, I always try to produce a figure most people can identify. I stay away from things like *Serenity of the Spirit, Part Four* or *Oneness with the Wholeness of Oz.* If you feel the urge to create these things, I wish you unification of the natural order.

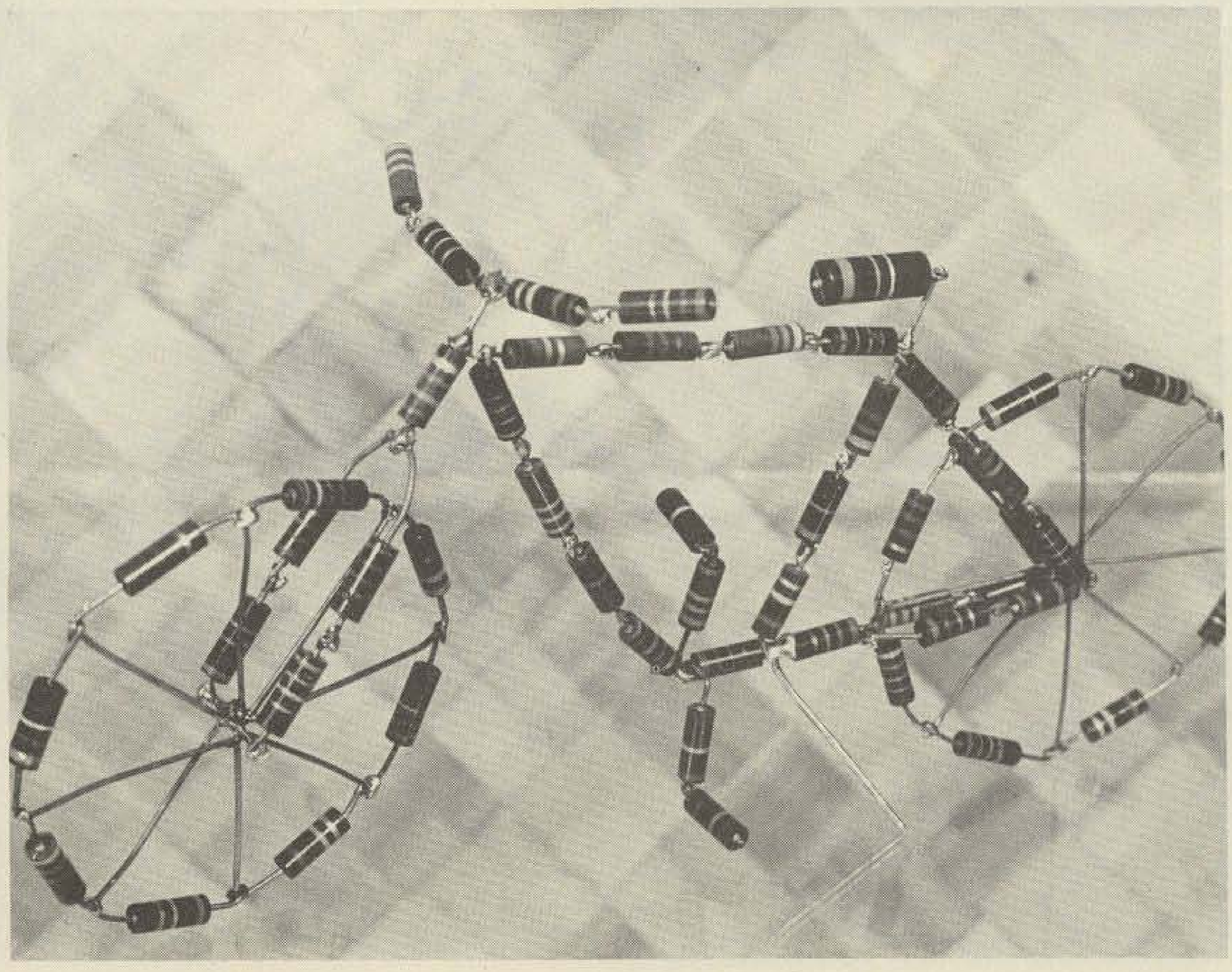
In all cases, I use solder to join the various pieces together. I have used strips of masking tape and sheets of cardboard to hold pieces in alignment until I could get them soldered. At other times, my fingers served the same function. I've never used any of the miracle glues to tack components together, but my feelings won't be hurt if you do.

I know that resistors and capacitors can cost a bundle if they are purchased one at a time. Therefore, I recommend that you shop around for packages of mixed parts. Bags of 200 resistors for \$1.98, or 98 capacitors for \$3.00, are widely available. A few of these assortments will provide enough parts to make many figures.

I've intentionally made these suggestions pretty vague, as I feel too many rules would be restrictive. If you need rules and procedures, make them up. Try to keep in mind that the point of doing these figures is to enjoy yourself and perhaps share that enjoyment with others. If you want to copy or modify any of the figures shown in the photos, do so. I hope that you will then want to do some of your own design. ■



This fencer gave me a lot of trouble. Every time I tried to solder on another part, his sword would jab my finger.



While the tires on this bicycle have never gone flat, they tend to give a rough ride. As soon as I work that out, I'll sell a million.

73 Magazine *Staff*

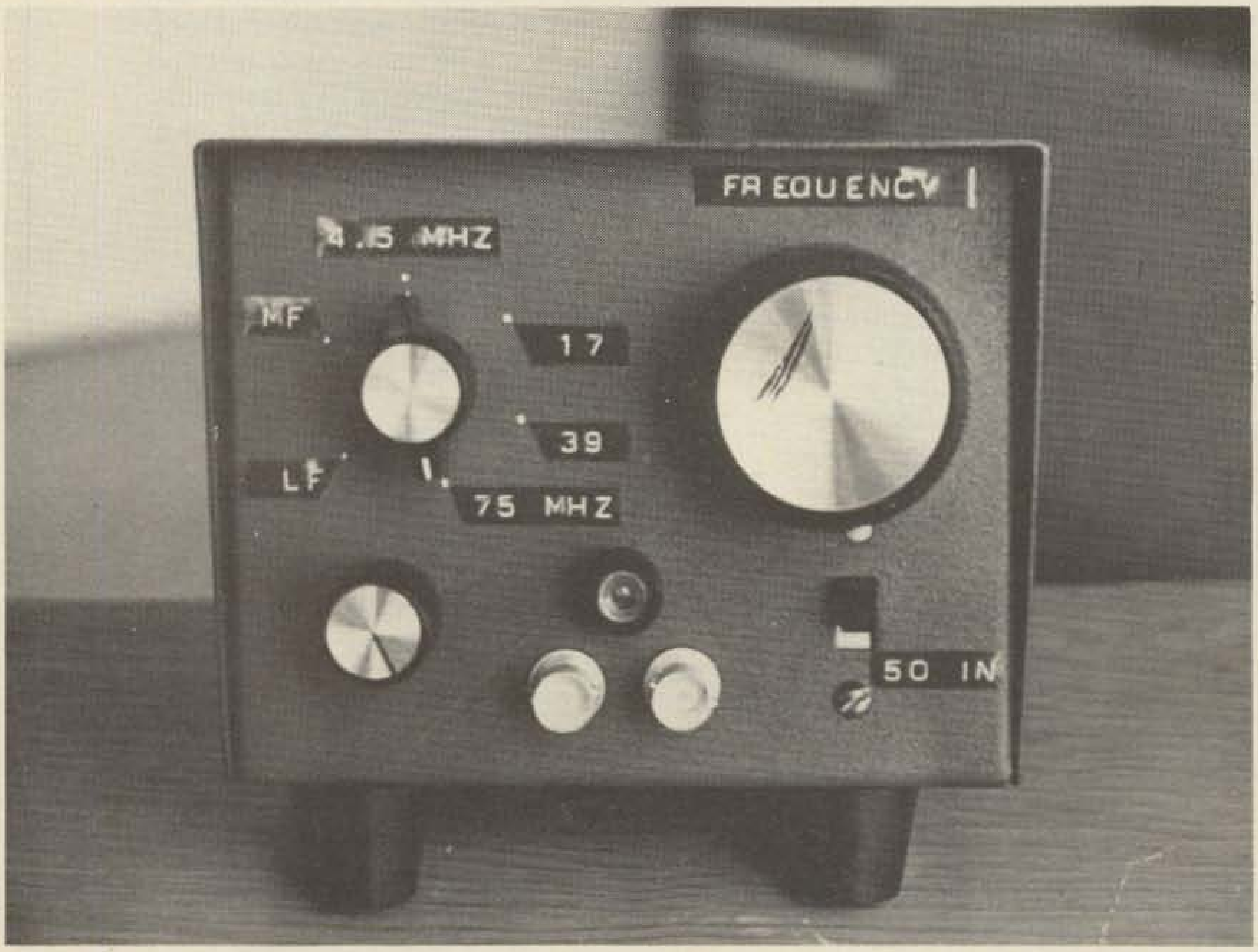
Brew Up A Signal Generator

-- required test gear

For certain aspects of equipment testing and alignment, as well as for circuit experimentation, a good rf signal generator is a must. Yet, many amateurs do not own such a generator because of the cost of one and because it is not as frequently needed an instrument as, perhaps, a scope or a VTVM. This article describes a simple rf signal generator that covers from 100 kHz to about 75 MHz in six bands. It is useful for checks of low frequency i-f circuits on up to VHF circuits (using harmonics up to 220 MHz).

The cost of the unit can be as low as $5, if one has an exceptionally well-equipped junk box, or it can cost up to about $20-25, in the average case. Still, it is relatively inexpensive for a wide range transistorized and portable signal generator.

The basic generator puts out a CW signal only over its operating range. Various optional circuits can be added to provide tone modulation and a sweep frequency capability. But we would suggest that these circuits be added later, once the basic generator is functioning properly.



The rf signal generator has no frequency readout scale, for reasons explained in the text. Two BNC output connectors are used — one for the actual signal output, and one for connection to a counter.

One of the first things to notice about the generator is that there is no frequency readout dial scale. There are several reasons for omitting it. Usually, the frequency readout scale on most inexpensive generators is more fiction than truth. To do any meaningful alignment work today, one needs a counter to set any signal generator correctly — even some very expensive commercial units. One doesn't need a calibrated scale just to sweep past a 455 kHz i-f or to determine that the front end of an HF or VHF receiver is basically functioning. Lastly, the lack of the not-so-useful scale allows the unit to be far more economically and compactly constructed.

The electrical circuit of the generator is shown in Fig. 1. One FET is used as the basic oscillator in a Hartley-type circuit. The second FET is lightly coupled through the 5 pF capacitor in its gate lead to the oscillator. This stage functions as source follower isolation stage. The last stage, the 2N3866, is designed to boost the signal level up to about 1 volt output on most bands. This level is far more than what is required for most receiver-type work, but the increased level comes in handy when doing transmitter exciter work, where the generator might substitute for a vfo. The output of the 2N3866 stage can be regulated by the 500 Ohm carbon potentiometer, which will provide about a 30 dB variation in output level. A 47 Ohm resistor can also be switched in across the output, so a true nominal 50 Ohm generator source impedance can be simulated for tests such as receiver sensitivity. The switching in of this resistor also serves as a high-low output level selector for the generator.

Although the generator is not complicated electrically, its true potential will not be achieved unless it is carefully constructed. Fortunately, no elaborate construction work is required, but attention should be paid to the few details mentioned here. All of the circuitry is mounted on a single-side copperclad board measuring about 2½ by 2½ inches, as shown in the photograph of the generator without the bandswitch installed. The board is wired point-to-point, using the isolated pad technique, starting with the oscillator stage toward the back panel of the enclosure and progressing forward to the 2N3866 stage towards the front panel. There is nothing critical about the wiring, whatever technique is used, but the circuitry should just be stretched out to provide maximum separation between the oscillator and 2N3866 output stage.

The heart of the signal generator lies in the bandswitched oscillator coil assembly and the variable tuning capacitor. The tuning capacitor is readily available broadcast receiver type, which contains a single section AM section of about 300 pF and a single section FM section of about 25 pF. Such capacitors can often be found with built-in tuning shaft drive reductions of 3:1 to 6:1. The Burstein-Applebee catalog is one source for such a capacitor, although various similar types should be available from Radio Shack, Lafayette, and the mail order suppliers. A simple alternative to the AM/FM type is the even more readily available standard dual section AM type, where one section, designed for local oscillator usage, has fewer plates. Remove more plates from the oscillator section, so it is left with 4 stator plates and 3 rotor plates.

The coils for the six bands can either be purchased or constructed from a mixture of home brew and commercial coils. As a completely purchased set, one can use the Conar CO-69 through CO-74 series, at a total cost of $4. These are replacement coils for an old-fashioned National Radio Institute tube-type signal generator, but they work just fine in the FET

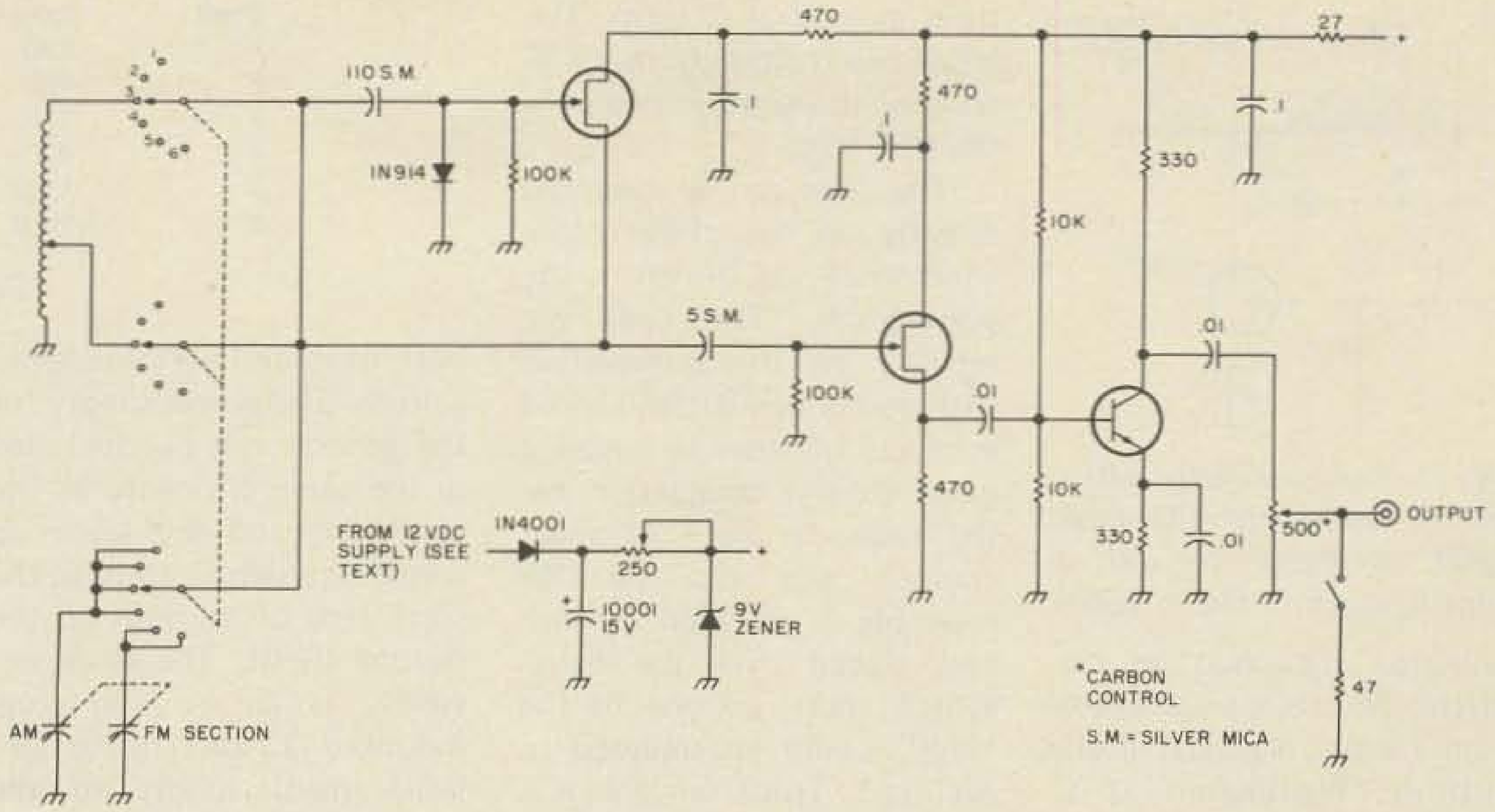
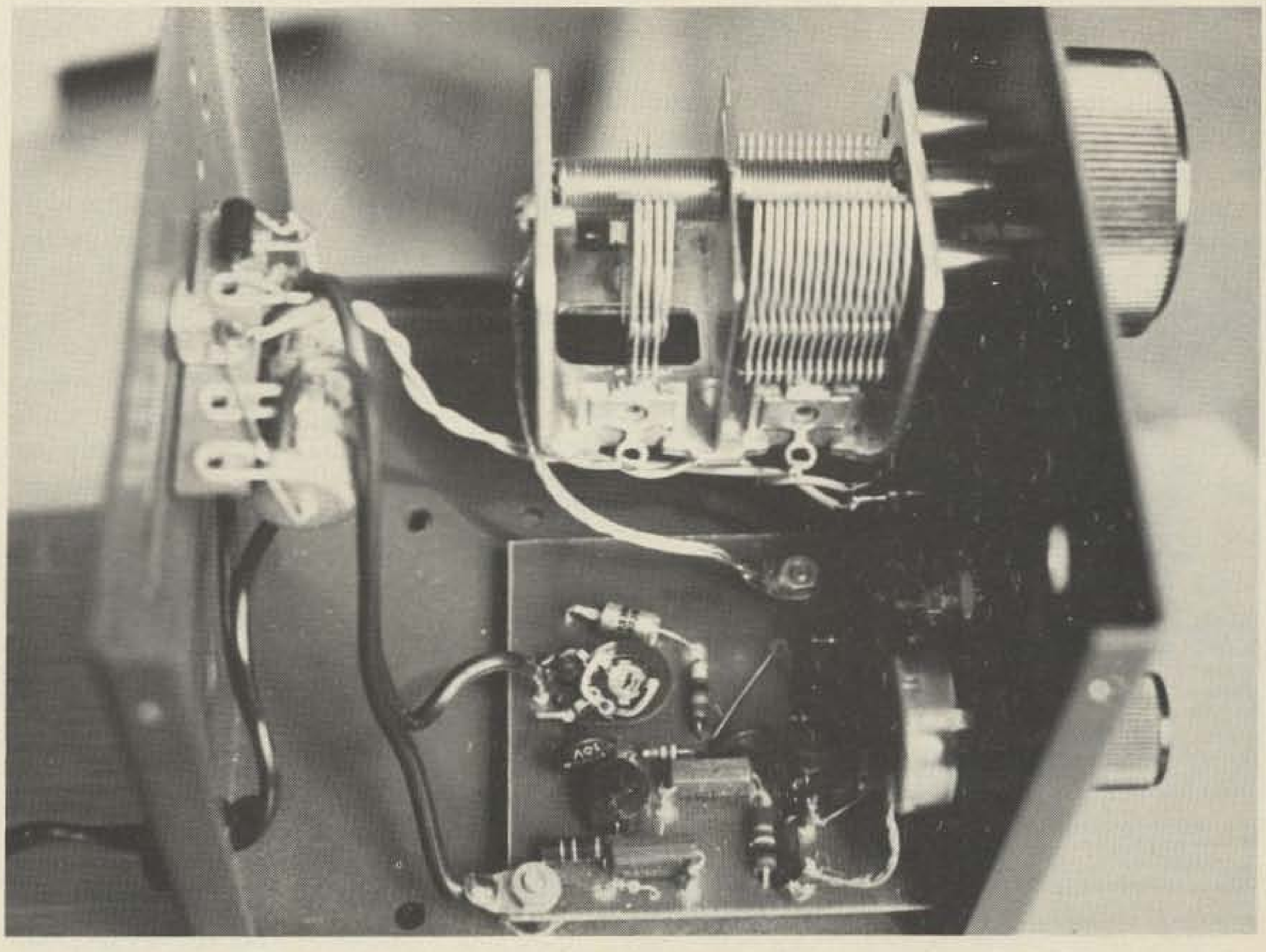


Fig. 1. Schematic of the generator. Only one of the six oscillator coils is shown for clarity. The FETs are HEP802 or MPF102 types. The output transistor is a 2N3866 or 2N706. Other details are covered in the text.



The oscillator circuitry is mounted on a 2½-inch square circuit board, and the components associated with the zener regulator are on a terminal strip on the rear panel of the enclosure. At this point, the bandswitched coil assembly has not been installed.

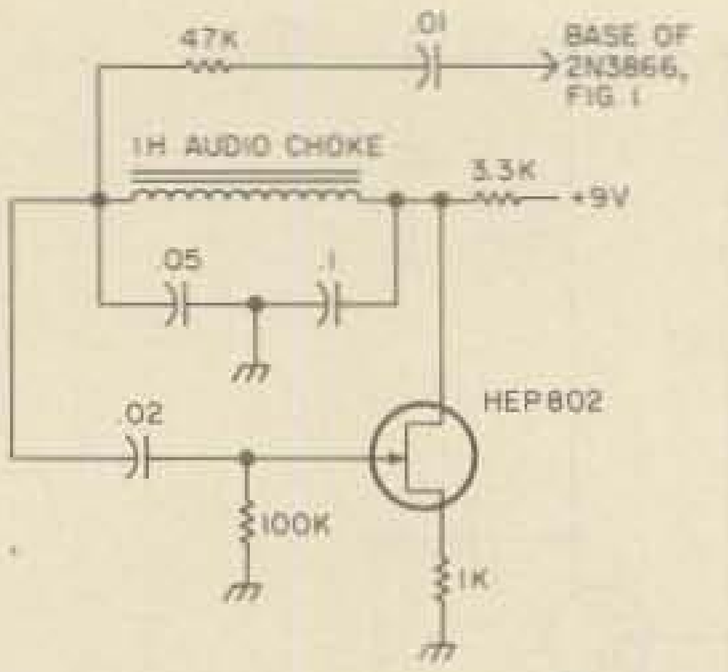


Fig. 2. Audio oscillator which can be added to the basic signal generator to aid in identification of the rf signal.

oscillator described in this article. The coils are available from Conar, National Radio Institute, Washington, D. C. 20016.

Another alternative is to just purchase the coils for the lower frequency bands, which would be almost impossible to home brew, and wind the other coils. In this case, for the first three frequency ranges one can use prewound J.C. Miller-type coils, which have the necessary tapped windings. The types are 9015, 9013 and 9013. For the highest three frequency ranges, one can self-wind the necessary coils on 3/8" diameter slug-tuned forms. The windings necessary and the tap points for each of the three coils are as follows: 15 turns tapped at 4 turns from the ground end; 7 turns tapped at 3 turns; and, 4½ turns tapped at 2 turns. The latter coil is wound using #18 wire while the other two coils use #24 wire.

The coils can be mounted directly on the 3P6T rotary bandswitch, as shown in the photograph. The coils are secured to the bandswitch with epoxy cement and wired in place. In order to ensure a good ground connection for the coils, a piece of sheet copper was cut out to resemble a 6-legged starfish and placed over the bandswitch shaft, so one of the "legs" could be soldered to each coil. This arrangement is probably a bit overdone. Ground connections from the coils to several ground lugs, equally spaced around the shaft of the bandswitch, should suffice just as well.

The generator is assembled in a standard commercial enclosure, which measures about 5 inches on each side. The dimensions were based on the size of the bandswitched coil assembly, tuning capacitor and circuit board. With a bit of effort, one should be able to fit the generator into the more readily available 4" x 5" x 6" aluminum enclosure.

The generator can be powered either from the ac line or from a 12-volt battery source, making it ideal for both fixed and portable applications. The power supply for the generator is *not* included in the same enclosure as the generator, and this seems to contribute significantly to the total lack of ac hum on the output signal. The ac power supply is an ac wall plug-mounted 12-volt dc battery replacement supply of the type commonly sold to power transistor radios.

The bandswitched coil assembly is preassembled and then mounted in place. Individual coils are fastened to the switch by epoxy cement and wired in place.

Band	Low end	High end
1	100	570 kHz
2	400	1400 kHz
3	1.2	4.5 MHz
4	4.1	17.0 MHz
5	15.0	39.0 MHz
6	25.0	75-80 MHz

Table 1.

Within the generator enclosure, and as shown on the schematic, there is only a diode to protect against reverse voltage polarity, a 1000 mF filter capacitor, and a 9 V zener regulator. For portable application, 12 V from a battery pack, or even 9 V from a transistor radio-type battery, can be used. The 250 Ohm variable resistor before the zener is adjusted for the maximum resistance value that still allows the zener to maintain a constant 9 V output.

Because of the lack of a frequency readout scale, there is not the usual need to try to adjust the low and high frequency range excursions on each band. However, they should be checked with a counter to see that sufficient overlap exists between ranges. The slug tuning of the coils suffices to correct the tuning on each range. Although one has some latitude to adjust the frequency coverage on each band to suit individual preferences, Table 1 shows a typical arrangement, starting with the lowest frequency band.

The stability of the oscillator proved to be good enough on all ranges except the highest, so that temperature compensation was not needed. This is probably due to the low power operating requirements of the circuit and to the fact that the power supply is mounted externally to the generator. Since the highest band was not used extensively, it was not temperature compensated. But, by selection of small value NPO capacitors placed across the small section of the tuning capacitor and by watching the output frequency change on a counter, it should be possible to achieve excellent frequency stability on the highest range also.

Tone modulation can be added to the generator by the circuit shown in Fig. 2. The circuit provides a single frequency tone modulation, which is useful to identify the presence of the rf signal when working with a receiver having only an envelope (AM) detector. By placing the output of the audio oscillator on the gate of the second FET (instead of on the base of the 2N3866 as Fig. 2 indicates), a slight FM modulation of the oscillator will occur. So, the signal generator can be utilized with SSB/CW, AM or FM receivers.

A sweep frequency capability can also be added to the generator, by means of a varactor diode connected across the gate terminal of the oscillator FET to ground, and driven by a suitable sawtooth of triangular waveform. The 5 for $1 varactor diode selections available from Poly Paks (*see 73 ads*) are very suitable for this purpose.

This article has tried to present the basic construction information needed to put together a very good wide range rf signal generator. The generator should make a useful addition to any amateur radio station for general testing purposes, regardless of whether one's operating interests are concerned with "top band" or OSCAR. ■

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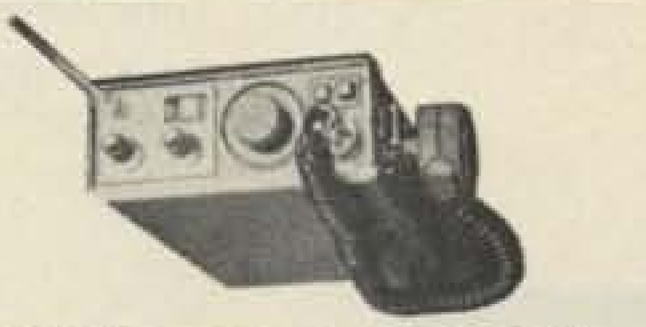

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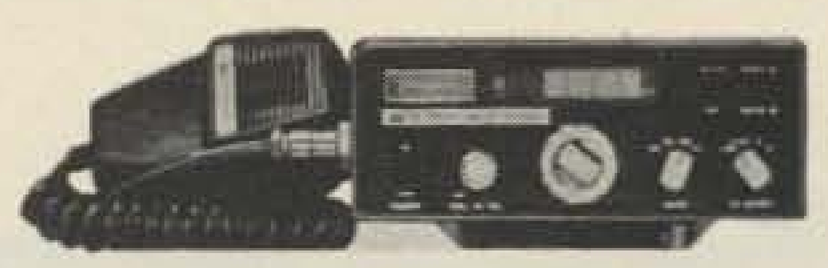

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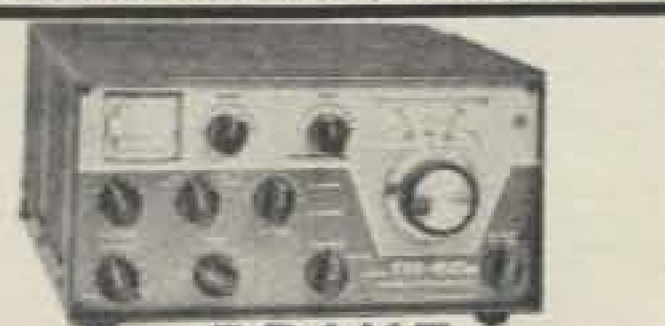

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Reprogram Your IC-22S

-- 300 channels in a 22-channel rig?

Nate Shaphran W6UTE
P.O. Box 3002
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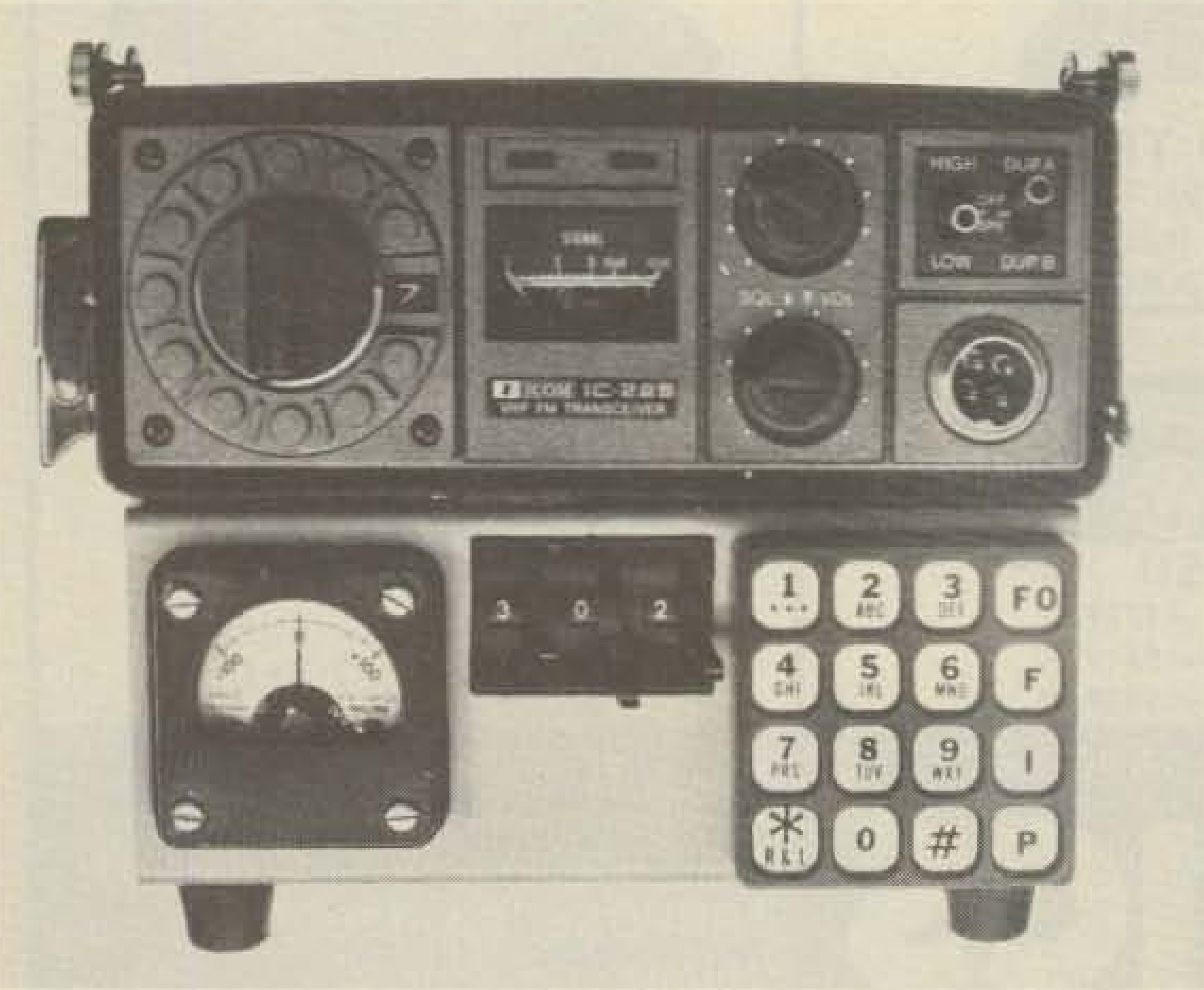
The Icom IC-22S is unique in that it is the only 22-channel 2 meter transceiver on the market at this time which uses a programmed synthesized approach and operates with discrete channel selection.

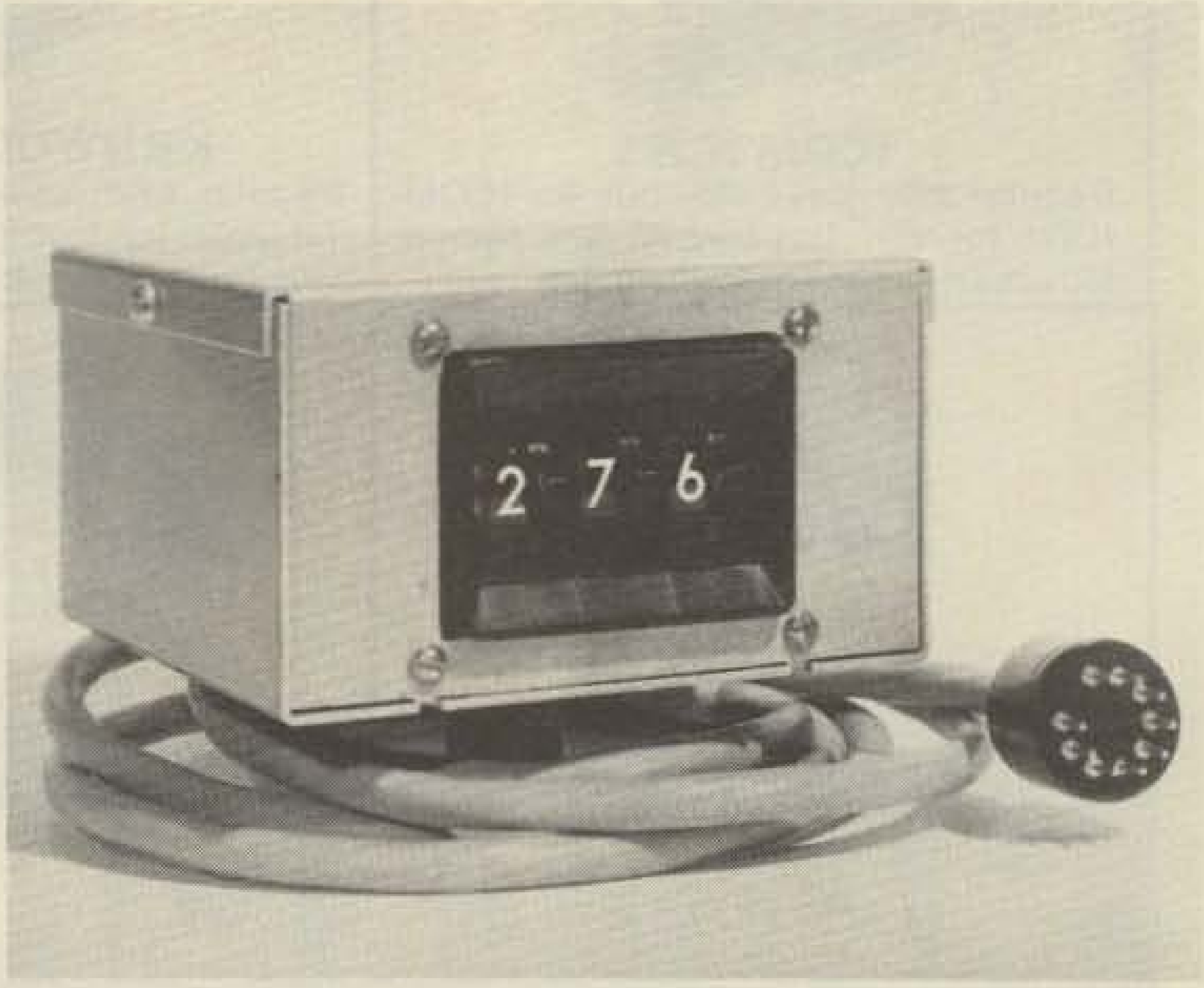
As purchased, it comes with the first five channels already programmed. The diodes and instructions are provided for the purchaser to select and program the other 17 channels.

Examining the instruction manual and data which came with the rig showed that it would be a simple matter to extend wires through diodes to the accessory plug and use eight external SPST switches to select the correct diodes which would put the rig on a desired frequency. This method worked, but it proved awkward to set a desired frequency without referring to a complete programming chart. (It could be done mathematically by using the binary number for a known frequency and adding or subtracting 1 digit for each 15 kHz from the known frequency.)

I then decided to try a single octal BCD switch, and that worked fine. But there was a drawback. Using one switch required that 17 of the 22 channels be utilized to cover all frequencies. This only left 5 positions for programming favorite frequencies, which may be fine for your area, but not for southern California.



IC-22S with an accessory panel attached to the radio mounting bracket. Three lever-style switches can be seen mounted in the center of the panel.



Frequency control switches, with a four-foot extension cable terminating in a nine-pin connector to plug into the accessory socket on the back of the rig.

Next, two switches were used. This only required the use of 3 channel positions and left 19 available for programming. This method proved excellent, as long as I did not object to using the channel selector switch together with the external switches to set frequencies. Since I wanted to program as many of the channels as I could, I went to the three switch method.

The three switch approach has decided advantages. More channels are available for programming, and once you have set the channel selector switch to the external programming channel, all of the frequency setting is done at one spot.

The three approaches will be described and you can select the one that fills your needs best.

One Switch Method

Since the rig comes with the first five channels programmed and since it will require the use of 17 of the channels to work with the one switch approach, it may be necessary to reprogram some of the first 5 channels to operate on your favorite frequencies. Program 17 adjacent channels according to the chart for one switch operation. Connect a wire to the selector switch common arm or to the +9 V point on the matrix board, and run the wire to an unused pin on the accessory socket. This method keeps the external programming switch hot at all times. Connect the BCD 1, 2, and 4 common lines on the matrix board through three diodes to other pins on the accessory socket. Wire the external programming switch to the accessory plug in accordance with the schematic for one switch operation. One caution to be observed when using this method is to remember to keep the external switch in the zero position when using any of the first five programmed channels, because

Channel Number	Program Frequency	"N" Number	128	64	32	16	8	4	2	1
6	145.95	104		X	X		X			
7	146.07	112		X	X	X				
8	146.19	120		X	X	X	X			
9	146.31	128	X							
10	146.43	136	X				X			
11	146.55	144	X			X				
12	146.67	152	X			X	X			
13	146.79	160	X		X					
14	146.91	168	X		X		X			
15	147.03	176	X		X	X				
16	147.15	184	X		X	X	X			
17	147.27	192	X	X						
18	147.39	200	X	X			X			
19	147.51	208	X	X		X				
20	147.63	216	X	X		X	X			
21	147.75	224	X	X	X					
22	147.87	232	X	X	X		X			
* 23	147.99	240	X	X	X	X				

*Table 1. Matrix board programming for Icom IC-22S using one BCD eight-position. *Note that the highest frequency using channels 6 to 22 is 147.975 MHz. 147.99 MHz can be obtained by using channel 23 and programming it for 240. A wire must also be run from the common to the selector switch.*

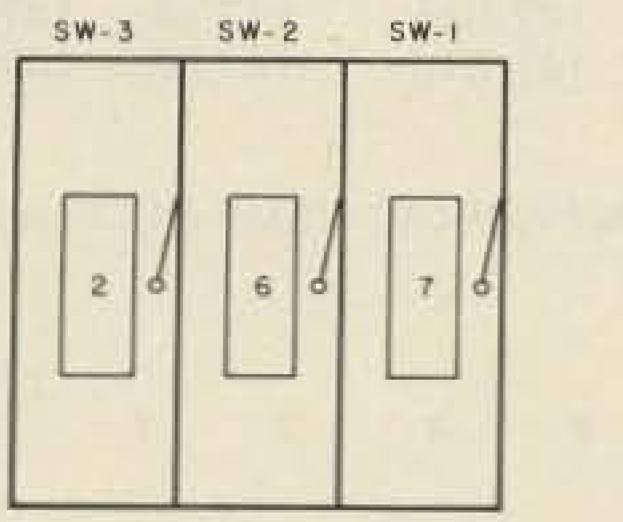


Fig. 1. Front view — three switches.

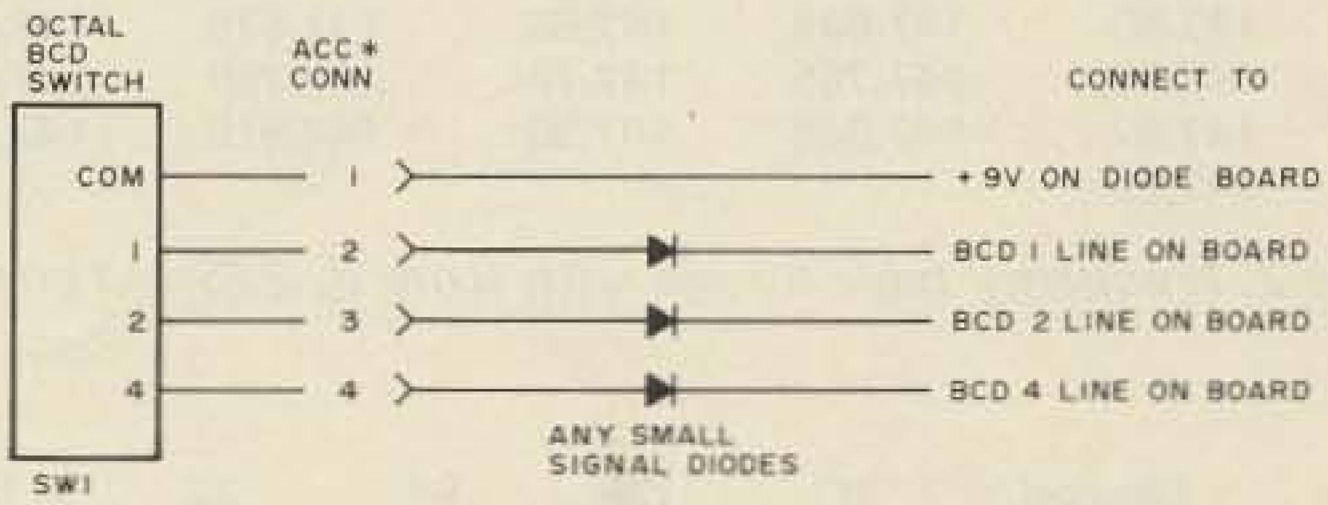


*Fig. 2. One switch method. Program channels 6 through 22 (or any 17 adjacent channels) according to the programming chart. *Any unused pins on accessory socket can be used.*

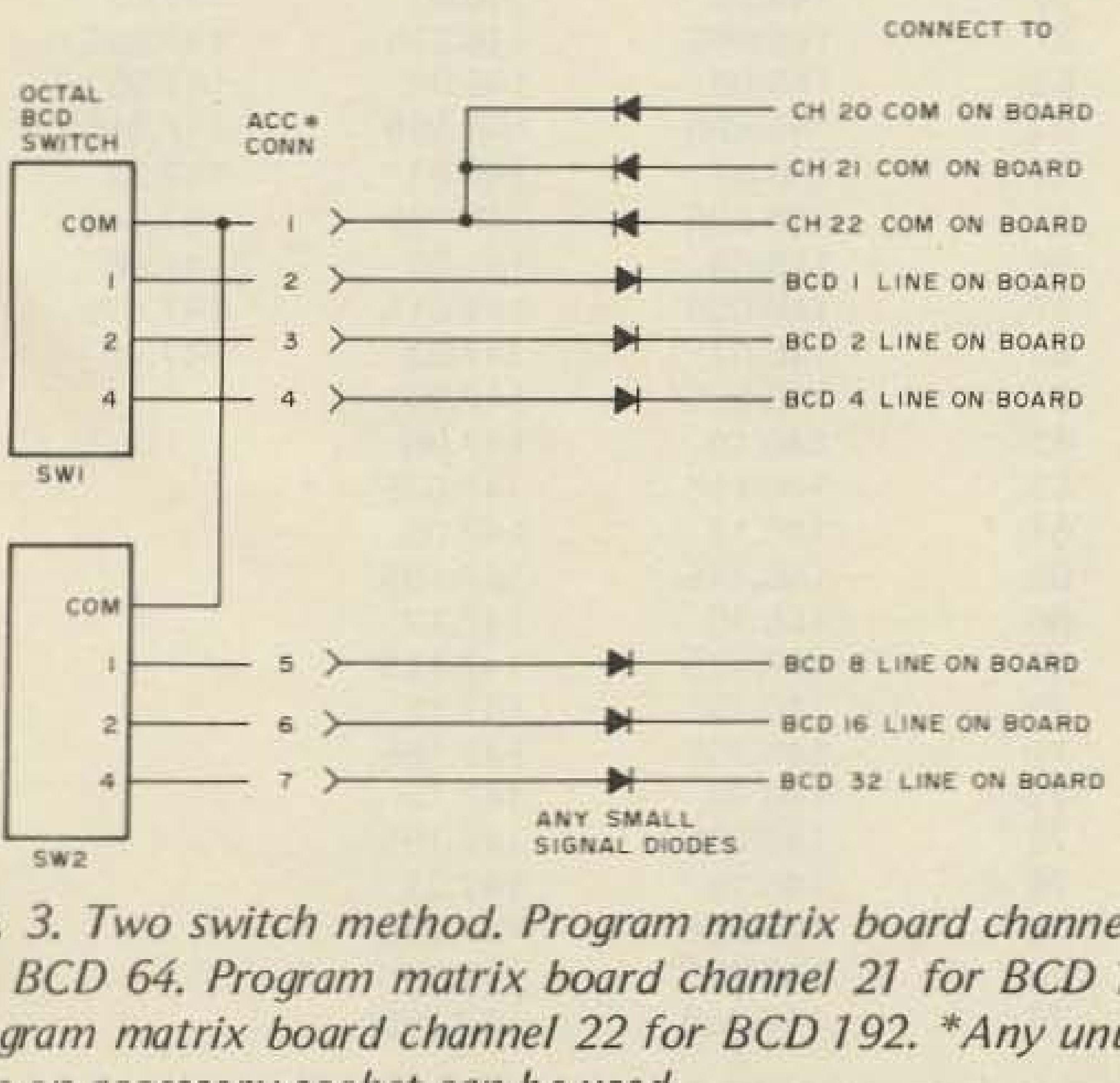


*Fig. 3. Two switch method. Program matrix board channel 20 for BCD 64. Program matrix board channel 21 for BCD 128. Program matrix board channel 22 for BCD 192. *Any unused pins on accessory socket can be used.*

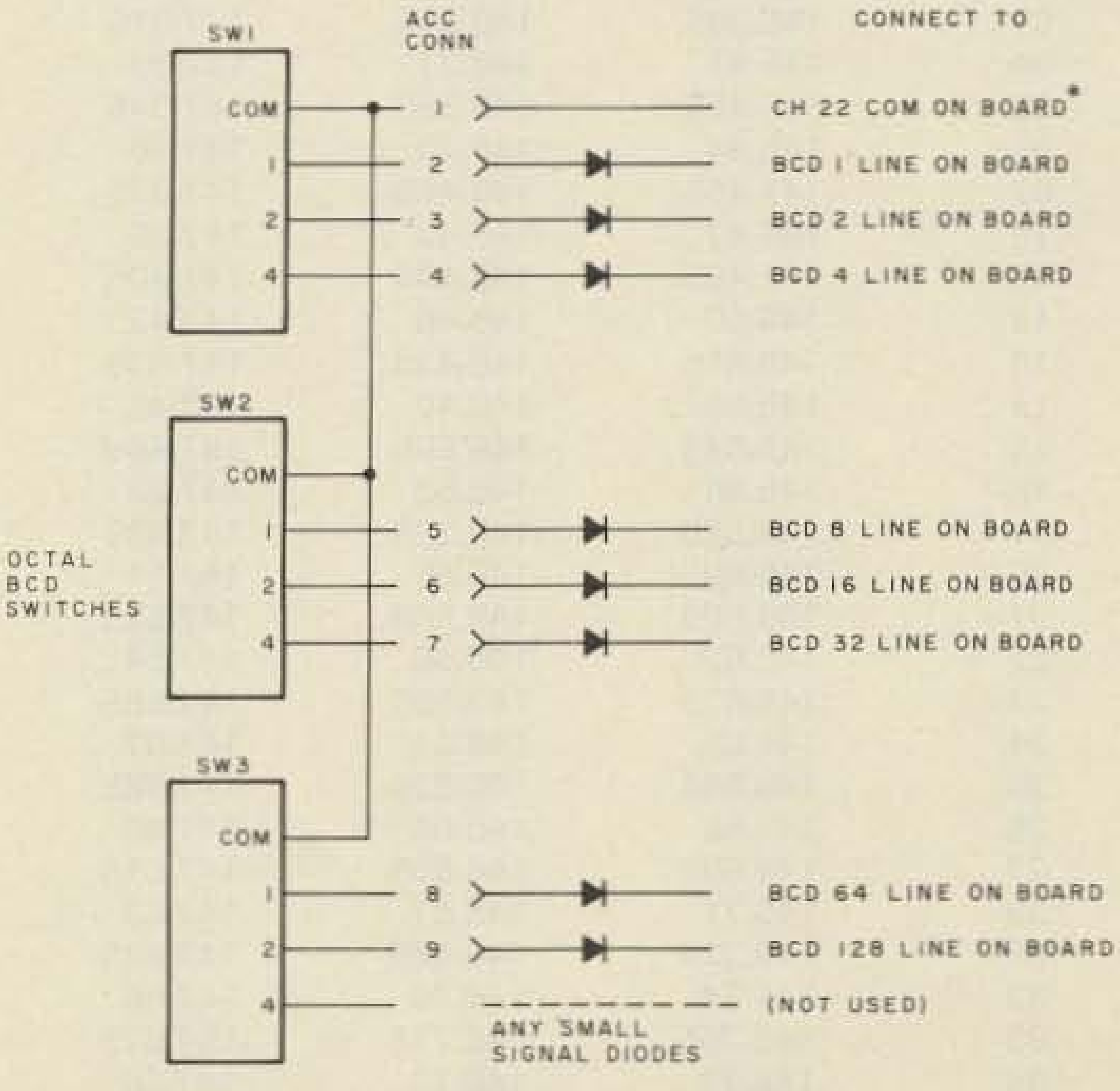


*Fig. 4. Three switch method. Note: Remove discriminator output and ground from the connector. *Any selected channel can be used.*

the switch will also affect those frequencies. Refer to the frequency chart for one switch operation to determine the resulting frequency for any combination of the 17 positions of the selector switch and the external programming switch.

Channel Number	0	1	External 2	Switch 3	Position 4	5	6	7
1								
2								
3		These are programmed to your favorite frequencies						
4								
5								
6	145.95	145.965	145.98	145.995	146.01	146.025	146.04	146.055
7	146.07	146.085	146.10	146.115	146.13	146.145	146.16	146.175
8	146.19	146.205	146.22	146.235	146.25	146.265	146.28	146.295
9	146.31	146.325	146.34	146.355	146.37	146.385	146.40	146.415
10	146.43	146.445	146.46	146.475	146.49	146.505	146.52	146.535
11	146.55	146.565	146.58	146.595	146.61	146.625	146.64	146.655
12	146.67	146.685	146.70	146.715	146.73	146.745	146.76	146.775
13	146.79	146.805	146.82	146.835	146.85	146.865	146.88	146.895
14	146.91	146.925	146.94	146.955	146.97	146.985	147.00	147.015
15	147.03	147.045	147.06	147.075	147.09	147.105	147.12	147.135
16	147.15	147.165	147.18	147.195	147.21	147.225	147.24	147.255
17	147.27	147.285	147.30	147.315	147.33	147.345	147.36	147.375
18	147.39	147.405	147.42	147.435	147.45	147.465	147.48	147.495
19	147.51	147.525	147.54	147.555	147.57	147.585	147.60	147.615
20	147.63	147.645	147.66	147.675	147.69	147.705	147.72	147.735
21	147.75	147.765	147.78	147.795	147.81	147.825	147.84	147.855
22	147.87	147.885	147.90	147.915	147.93	147.845	147.96	147.975
23	147.99							

Table 2. Frequency table for use with Icom IC-22S and one external eight-position BCD switch.

Channel Number	"N" Number	128	64	32	16	8	4	2	1
20	64		X						
21	128	X							
22	192	X	X						

Table 3. Matrix board programming for Icom IC-22S using two eight-position BCD switches.

Two Switch Method

The two switch method requires the use of three channels of the 22 available and isolation diodes to prevent interaction to the other channels. Connect three unused adjacent channels through diodes to an unused pin on the accessory socket. Program the three channels according to the table for two switch operation. Connect the 1-2-4-8-16-32 common lines on the matrix board through a diode (6 total) to other unused pins on the accessory socket. Note that a total of seven pins are required on the accessory socket for programming; therefore, the discriminator meter wires need not be disturbed. The other 19 channels can be programmed as desired. Wire the external switches as shown to the accessory plug. Resulting frequencies are shown in the table for two switch operation.

Three Switch Method

The three switch method uses only one position of the channels. It is convenient, because once you have

BCD Sw.	Chan. 20	Chan. 21	Chan. 22
00	145.35	146.31	147.27
01	145.365	146.325	147.285
02	145.38	146.34	147.30
03	145.395	146.355	147.315
04	145.41	146.37	147.33
05	145.425	146.385	147.345
06	145.44	146.40	147.36
07	145.455	146.415	147.375
10	145.47	146.43	147.39
11	145.485	146.445	147.405
12	145.50	146.46	147.42
13	145.515	146.475	147.435
14	145.53	146.49	147.45
15	145.545	146.505	147.465
16	145.56	146.52	147.48
17	145.575	146.535	147.495
20	145.59	146.55	147.51
21	145.605	146.565	147.525
22	145.62	146.58	147.54
23	145.635	146.595	147.555
24	145.65	146.61	147.57
25	145.665	146.625	147.585
26	145.68	146.64	147.60
27	145.695	146.655	147.615
30	145.71	146.67	147.63
31	145.725	146.685	147.645
32	145.74	146.70	147.66
33	145.755	146.715	147.675
34	145.77	146.73	147.69
35	145.785	146.745	147.705
36	145.80	146.76	147.72
37	145.815	146.775	147.735
40	145.83	146.79	147.75
41	145.845	146.805	147.765
42	145.86	146.82	147.78
43	145.875	146.835	147.795
44	145.89	146.85	147.810
45	145.905	146.865	147.825
46	145.92	146.88	147.84
47	145.935	146.895	147.855
50	145.95	146.91	147.87
51	145.965	146.925	147.885
52	145.98	146.94	147.90
53	145.995	146.955	147.915
54	146.01	146.97	147.93
55	146.025	146.985	147.945
56	146.04	147.00	147.96
57	146.055	147.015	147.975
60	146.07	147.03	147.99
61	146.085	147.045	
62	146.10	147.06	
63	146.115	147.075	
64	146.13	147.09	
65	146.145	147.105	
66	146.16	147.12	
67	146.175	147.135	
70	146.19	147.15	
71	146.205	147.165	
72	146.22	147.18	
73	146.235	147.195	
74	146.25	147.21	
75	146.265	147.225	
76	146.28	147.24	
77	146.295	147.255	

Table 4. Frequency table for use with Icom IC-22S and two external eight-position BCD switches.

Sw.	Freq.						
020	144.63	107	145.455	200	146.31	270	147.15
021	144.645	110	145.47	201	146.325	271	147.165
022	144.66	111	145.485	202	146.34	272	147.18
023	144.675	112	145.50	203	146.355	273	147.195
024	144.69	113	145.515	204	146.37	274	147.21
025	144.705	114	145.53	205	146.385	275	147.225
026	144.72	115	145.545	206	146.40	276	147.24
027	144.735	116	145.56	207	146.415	277	147.255
030	144.75	117	145.575	210	146.43	300	147.27
031	144.765	120	145.59	211	146.445	301	147.285
032	144.78	121	145.605	212	146.46	302	147.30
033	144.795	122	145.62	213	146.475	303	147.315
034	144.81	123	145.635	214	146.49	304	147.33
035	144.825	124	145.65	215	146.505	305	147.345
036	144.84	125	145.665	216	146.52	306	147.36
037	144.855	126	145.68	217	146.535	307	147.375
040	144.87	127	145.695	220	146.55	310	147.39
041	144.885	130	145.71	221	146.565	311	147.405
042	144.90	131	145.725	222	146.58	312	147.42
043	144.915	132	145.74	223	146.595	313	147.435
044	144.93	133	145.755	224	146.61	314	147.45
045	144.945	134	145.77	225	146.625	315	147.465
046	144.95	135	145.785	226	146.64	316	147.48
047	144.975	136	145.80	227	146.655	317	147.495
050	144.99	137	145.815	230	146.67	320	147.51
051	145.005	140	145.83	231	146.685	321	147.525
052	145.02	141	145.845	232	146.70	322	147.54
053	145.035	142	145.86	233	146.715	323	147.555
054	145.05	143	145.875	234	146.73	324	147.57
055	145.065	144	145.89	235	146.745	325	147.585
056	145.08	145	145.905	236	146.76	326	147.60
057	145.095	146	145.92	237	146.775	327	147.615
060	145.11	147	145.935	240	146.79	330	147.63
061	145.125	150	145.95	241	146.805	331	147.645
062	145.14	151	145.965	242	146.82	332	147.66
063	145.155	152	145.98	243	146.835	333	147.675
064	145.17	153	145.995	244	146.85	334	147.69
065	145.185	154	146.01	245	146.865	335	147.705
066	145.20	155	146.025	246	146.88	336	147.72
067	145.215	156	146.04	247	146.895	337	147.735
070	145.23	157	146.055	250	146.91	340	147.75
071	145.245	160	146.07	251	146.925	341	147.765
072	145.26	161	146.085	252	146.94	342	147.78
073	145.275	162	146.10	253	146.955	343	147.795
074	145.29	163	146.115	254	146.97	344	147.810
075	145.305	164	146.13	255	146.985	345	147.825
076	145.32	165	146.145	256	147.00	346	147.84
077	145.335	166	146.16	257	147.015	347	147.855
100	145.35	167	146.175	260	147.03	350	147.87
101	145.365	170	146.19	261	147.045	351	147.885
102	145.38	171	146.205	262	147.06	352	147.90
103	145.395	172	146.22	263	147.075	353	147.915
104	145.41	173	146.235	264	147.09	354	147.93
105	145.425	174	146.25	265	147.105	355	147.945
106	145.44	175	146.265	266	147.12	356	147.96
		176	146.28	267	147.135	357	147.975
		177	146.295			360	147.99

Table 5. Frequency table for use with Icom IC-22S and three external eight-position BCD switches.

switched to that channel, all frequency selection is done with the external programming switches without again touching the selector switch. Connect the channel that you wish to use for external programming (it must be an unused channel) to a pin on the accessory plug. Connect the BCD common lines through diodes (8 required) to the other pins on the accessory plug. (Since all nine pins are used, it will be necessary to remove the discriminator meter wires from the accessory plug.) Wire the external programming switches in accordance with the circuit for three switch operation. The other 21 channels can now be programmed as desired. The table for three switch operation shows the switch settings and resulting programmed frequencies.

There you have it. Remember that you are setting the programmed frequencies with the external switches, and you must still select simplex and transmit 600 kHz up or receive 600 kHz up using the mode selector switch (just as you must do with all other channels).

Using the three switch method, I have been able to operate simplex on every 15 kHz increment from 147.99 MHz down to 144.66 MHz. In addition, it is simple to select any of the fifty-four 600 kHz split repeater frequencies and operate conventional or reverse.

The switches are available as catalog items from several manufacturers. (A ten-position can be utilized, but the eighth and ninth positions would not be used because of the octal binary programming.) One closing comment is in order. Icom has designed the rig to operate between 146 and 148 MHz. Although the phase locked loop in every IC-22S with this type of external programming that I have checked will operate fine down to at least 145.35 Hz, an occasional one may not lock up below this frequency. ■

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Try the ID VIP Method

-- surefire troubleshooting technique

The average electronics buff, after a short while pursuing his hobby, accumulates a variety of tube and solid state equipment. If his interests encompass amateur radio, citizens band radio and microcomputers, the amount of gathered gear grows in quantity and complexity. Budgetary considerations often necessitate acquiring used equipment. Dealings may place test equipment, receivers, transmitters and such in one's possession which function poorly or not at all. This discussion is presented for those who would like to attempt repairing their recalcitrant equipment, but lack basic troubleshooting technique.

Repair of faulty electronic circuits in entertainment, communications, test and computing equipment is a broad area. Technicians who commercially pursue such employment usually specialize in families of gear. The television tech encounters variations on basic television circuitry. Marine technicians see similar designs in shipboard electronics. Communications equipment repairmen and digital circuitry troubleshooters bring specialized techniques to solve their problem machines. For an individual to attempt to troubleshoot a wide variety of equipment, particularly when motivated by a hobby interest, is a challenging and rewarding experience.

Some sources estimate 95 percent of successful electronic equipment repair is diagnosis of the problem. The remaining 5 percent represents the effort to replace defective parts or circuit alignment necessary to restore normal operation. While these figures may be inaccurate for the professional who may instantly recognize a circuit fault, then spend a good deal of time effecting repair because of equipment location or other logistics, these time increments should be realistic for amateur efforts. Hobbyists attempting their own repair jobs have one advantage over the professional – time. The commercial technician is selling his time. He finishes one job and hurries to the next. The amateur who wants his equipment operating well can take the necessary time to achieve this goal.

Any troubleshooting situation should first be approached with the head, then the hands. Reasoning from the symptoms indicated to the malfunction involves a logical pursuit through the circuitry toward an over-narrowing objective. This procedure is used successfully by professionals. With practice, the various steps become reflexive and swift.

Fig. 1 illustrates a simple, effective troubleshooting procedure. Inspect, diagnose, verify, isolate, and pinpoint constitute the procedure of investigation for the defect. Mnemonically, ID VIP may be helpful when first using this method. This technique, as others, becomes personalized with practice.

Inspection is the first step in the repair process. Obvious defects should be noted and related to the symptoms. Frayed line cord, broken connections, corrosion on switching contacts, overheated or burned resistors, swollen electrolytics, lingering odor of overloaded transformer windings, vacuum tubes with the tell-tale whitish clue of envelope leakage are typical items a careful inspection may discover.

Diagnosis of the symptoms follows the inspection. It is aided by the inspection as evident faults are eliminated. Reasoning from the effects observed (symptoms) to the causes is a complex mental judgment. Knowledge of basic electronics, familiarity with the particular circuit under consideration, awareness of how the equipment functions normally, and past experience all influence the original diagnosis.

Analysis of the problem is aided if the manual on the equipment is available. Of particular interest for beginning troubleshooters is the block diagram. This drawing indicates various sections of the equipment, signal flow, interconnections between sections, and other useful data. Logically going from effect to cause will localize the malfunction to one or more sections of the block drawing. Consulting the schematic will reveal individual stages within the suspected section(s). For example, the block stating audio functions may actually contain six or more individual transistor stages (transistors and related components).

When conclusions are reached as to probable causes of the equipment failure, verification of these judgments is pursued. Verification involves the next two steps, isolation and pinpointing, in the repair technique. The fault is isolated to the suspected section. Next it is narrowed to a stage within the section. Finally, steps are taken to pinpoint the defective part(s) which caused the equipment failure. As verification procedures are followed, new diagnoses may evolve. It is not uncommon for one's original diagnosis to be incorrect. Testing each diagnosis will eventually lead to the fault. By following confirmation techniques, especially when several interrelated sections appear at fault, areas of the equipment which function properly are eliminated from the search.

Corroborating the diagnosis practically requires the use of test instruments to extend the senses. For realistic, effective troubleshooting, three basic test items are required: volt ohmmeter, service type oscilloscope, some type of signal generator. The VOM preferred because of its accuracy and portability is the transistorized model (TVOM). Its high input resistance is particularly useful in solid state servicing. The scope need not be an expensive laboratory quality instrument; a 3 inch CRT service type scope is adequate. For a signal generator, any type of oscillated signal rich in harmonics which will provide sufficient signal amplitude for the scope to discern is sufficient. One can inexpensively be fabricated from an IC and a handful of parts which will provide sine, triangular, and square wave outputs. Lacking a scope is an impediment. However, a crude signal tracer in such a situation can be some type of high impedance earphone. This substitute tracer's use is limited to audio and video circuits beyond the detector stage.

The symptoms encountered will dictate which instrument approach to use when verifying the diagnosis. If the fault is thought to be in the power supply section, the VOM can normally be used to track down the culprit. If signal path disturbance is evidenced, the scope can be employed to quickly isolate the area(s) of fault. Signal tracing stages within the isolated section should narrow the investigation to a simple circuit area in the equipment. At this point the VOM is used to pinpoint defective component(s). Most stages will involve less than a dozen components, so it would not be that difficult to check each part in the stage. However, voltage and resistance measurements will generally lead to the individual item causing the fault. Isolation procedures are varied. The particular symptoms encountered will suggest certain approaches. Some examples using the ID VIP system may prove helpful.

Case 1. Inoperative receiver portion of ham band transceiver; prior reports of poor quality audio on transmit. Very low level signal now coming from speaker on receive mode with gains open maximum. Inspection yields no abnormalities. Study of the block diagram in the manual indicates an audio section common to both transmit/receive. This area diagnosed as the trouble spot. Schematic print reveals four transistor stages in this section. Verifying the diagnosis, the tech first touches center contact of audio pot; loud signal from the speaker absolves the signal path between this point and the speaker from blame. Using a service type oscilloscope, signals are traced from the audio control backwards toward the detector area. (This could be reversed to go from detector toward speaker; personal preference and intuition influences this judgment.) At the second stage, a signal is found on the base, but nothing at the collector. Diagnosis confirmed; stage isolated. TVOM used to check for bias (.5 to .7 volt on bipolar transistors measured between emitter and base). Nothing. Transistor not working. Bias components check ok. Replacing the small signal transistor effects a cure. Transceiver tests bring reports of good audio on transmit, normal volume and quality levels on receive. Evidently the situation developed gradually. First reports of abnormal audio quality on transmit went unheeded; slightly distorted receive audio was compensated for by the operator's ear. When the transistor failed completely, drastically affecting receiver operation, the unit was scheduled for service.

I NSPECT – obvious physical damage to line cord, resistors, corrosion, etc.
D IAGNOSE – manual, block diagram schematic print, symptoms evidenced, "effect to cause" logic
V ERIFY – use of test instruments to
I SOLATE – narrow fault to section, then to stage(s) within section
P INPOINT – check components within stage for defects

Fig. 1. ID VIP Technique.

Case 2. Readout of digital frequency counter missing part of segment display on all six digits. Small circuit board with only a few components showed no observed evidence of fault. Study of schematic indicates "B" segment not working on display. Diagnosis is either the IC (7208), current limiting resistor R3 (470 Ohms), or display is defective. It is unlikely that all digits are defective in the same area; the diagnosis centers on the R3 resistor. Verifying this judgment involves checking the resistor with the TVOM. It tests intermittent – make, break type of fault. Replacement of the resistor restores normal operation. The ID VIP system was modified in this application. Since few components form the total circuit, isolation is quickly achieved. In dealing with circuits using ICs, the isolating technique is to determine operating voltages, input/output signals. If the voltages are correct and an input signal is present but no output signal, replacement of the device is indicated (it is the only thing between these two points).

Case 3. Service type oscilloscope: trace intermittently fades and disappears. Careful inspection of the circuit board, CRT connections, controls, etc., yields no clues. Block drawing in the manual narrows this fault to something upsetting the dc voltages on the cathode ray tube. This diagnosis verified by using the voltage callouts in the schematic as comparison against actual readings taken with the TVOM at the CRT socket. All voltages within tolerance. New diagnosis formed that CRT is defective. No tester available, so with some misgivings, a new CRT ordered. (Putting money where judgment is!) Later installing the new tube restores normal operation.

Each troubleshooting situation demands a little different approach based on the same reasoning process. Familiarity with test instruments bolsters faith in findings as signal tracing techniques quickly isolate. A growing knowledge of how components behave will aid judgments when pinpointing faulty parts. Ohm's law is constantly at work in circuits offering clues to normal or abnormal operation. Use of some type of signal injector becomes a necessity when tracing from detector stages towards the rf circuits in receivers. In these areas, signals get progressively smaller and harder to detect on a scope. A good amplitude signal produced by the signal oscillator will not only be more easily viewed, but also will often force itself through defective stages. The decreasing gain will indicate a poorly functioning circuit. Rapid isolation in a dead or weak symptom concentrates on checking for any type of signal getting from stage to stage. The quality of signal can be considered later. The point at which the signal is lost is a good area of further investigation for faulty components.

Components

Any component in electronic gear is subject to failure. Fortunately, soft areas have been observed. Occasional lapses in quality control will turn out quantities of resistors, capacitors, ICs, etc., which exhibit definite weaknesses. These parts often show up in certain serials of commercial equipment. For example, TV chassis runs may use some of these parts. Professional techs after "ID-VIPing" a few such sets will remember these cases and do speedy repairs when similar models show up for service.

Small wattage resistors usually do not fail or change value unless some trauma (shorted bypass capacitor or solid state device) puts undesigned pressure on them. Larger wattage resistors are always subject to current stress and may change value or open.

Electrolytic capacitors are a problem area. Large value electrolytics commonly found in power supplies may develop high power factors, leakage, and general deterioration. Inspection will often uncover gross leakage. Overheating occurring in electrolytics is always a clue suggesting replacement. The smaller electrolytic capacitors associated with solid state circuits can cause troubleshooting headaches. Careful evaluation of ohmmeter readings will evaluate the condition of these parts. Small value capacitors often used in bypass applications can be checked with a scope to see if they are doing their bypassing job. Signals found where they should be shunted to ground indicate a capacitor fault. Likewise, coupling capacitors can also be tested.

Inductances respond to conventional testing methods. Ohmmeter readings are not helpful in problems with small coils having part(s) of their windings shorted. There is a method of testing such devices with a scope by observing the damped oscillations when a sawtooth signal is applied. This advanced technique and others are material for a future article.

Thus, for the hobbyist to troubleshoot a wide variety of his equipment is a challenge. Armed with basic test instruments, an organized troubleshooting plan and some technical information (at least a schematic) on the faulty gear, success can be expected, especially if the virtue of perseverance is present. ID VIP approach is one method of making a complex electronic assembly manageable. Information supplied by the symptoms, by the properly operating circuits, and by knowledge of electronics narrows the area of investigation to a specific point with only a few parts involved. Proficiency is gained with experience. ■

1. Work carefully and slowly on crowded circuit boards.
2. Don't hesitate to "lift" a component for testing. Time spent worrying about doing it can be used to do it and arrive at a definite judgment on its condition.
3. Work one component at a time. Do a neat, thorough soldering job.
4. Multiple defects are rare. Should several symptoms be encountered, particularly if some are "weird," check power supply performance carefully.
5. Unless exact replacement devices are used in some circuits, notably oscillator applications, some "alignment" of coils or capacitors may be required to re-establish proper operation.
6. Peaking "i-f" and "rf" adjustments should never be attempted without proper equipment. FM audio circuits may be accurately "touched-up" by "ear"; however, casual adjustments to i-f/rf circuits do more harm than good.
7. Be aware of lethal voltages present in some types of equipment. Safety practices such as using isolation transformers, discharging filter capacitors, wearing protective gear when handling cathode ray tubes and such should be followed.

Fig. 2. Helpful Hints.

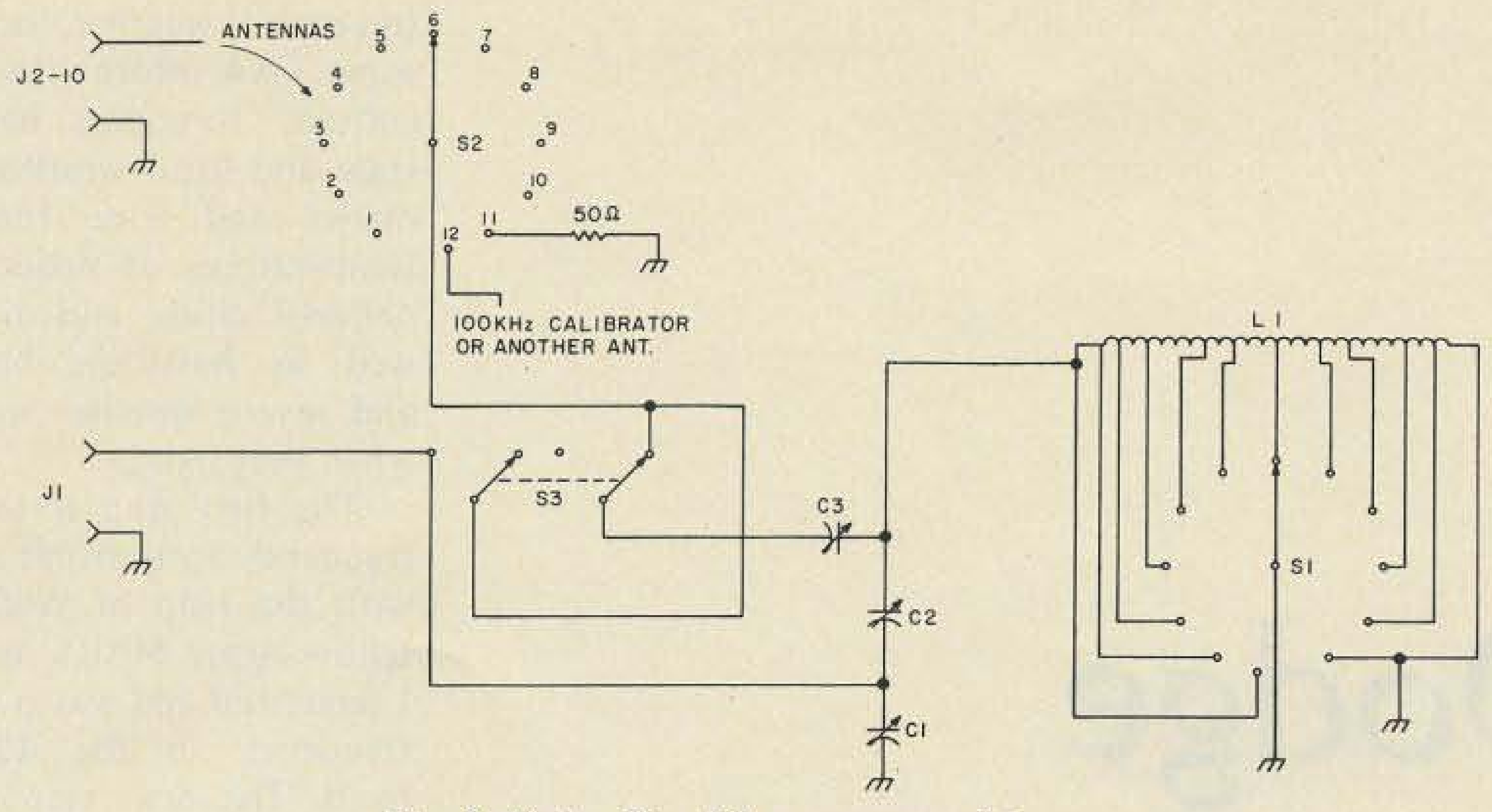

Fig. 1. Note: Tap L1 every several turns.

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Build A Deluxe QRP Transmatch

-- make every milliwatt count

I have found that QRP has many advantages. High voltage components are unnecessary, bringing the cost of components down to a reasonable range.

Because of my low budget and the low cost of the Argonaut 509, it was love at first sight. The Argonaut has many advantages. At present I have no plans to use a linear, so I have no worries about an antenna switch or a tuner.

Fig. 1 shows a complete schematic of the circuit. The tuner can be switched in or out of the circuit. At position 11 of the switch, I have provided a 50 Ohm dummy load. This can be left out, if not needed. If used, it should be capable of handling your transmitter's output. Position 12 is left unused on my setup, to provide the option of a 100 kHz calibrator.

The tuner circuit was taken from the *Radio Amateur's Handbook*.

L1 could be a roller inductor, but that would drive up the cost of the circuit. The tuner works well on 80-10 meters.

Fig. 2 shows the layout of my circuit. Extra room was provided for the calibrator option.

For compactness, I used miniature 365 pF variables. C1-C2 could be a gang tuned capacitor, but that would cost more and take up more space.

The phono plugs should be the shielded type, to prevent unwanted radiation.

The cost of the unit should be 16 or 17 dollars, depending on the cost of the case and what options are used. ■

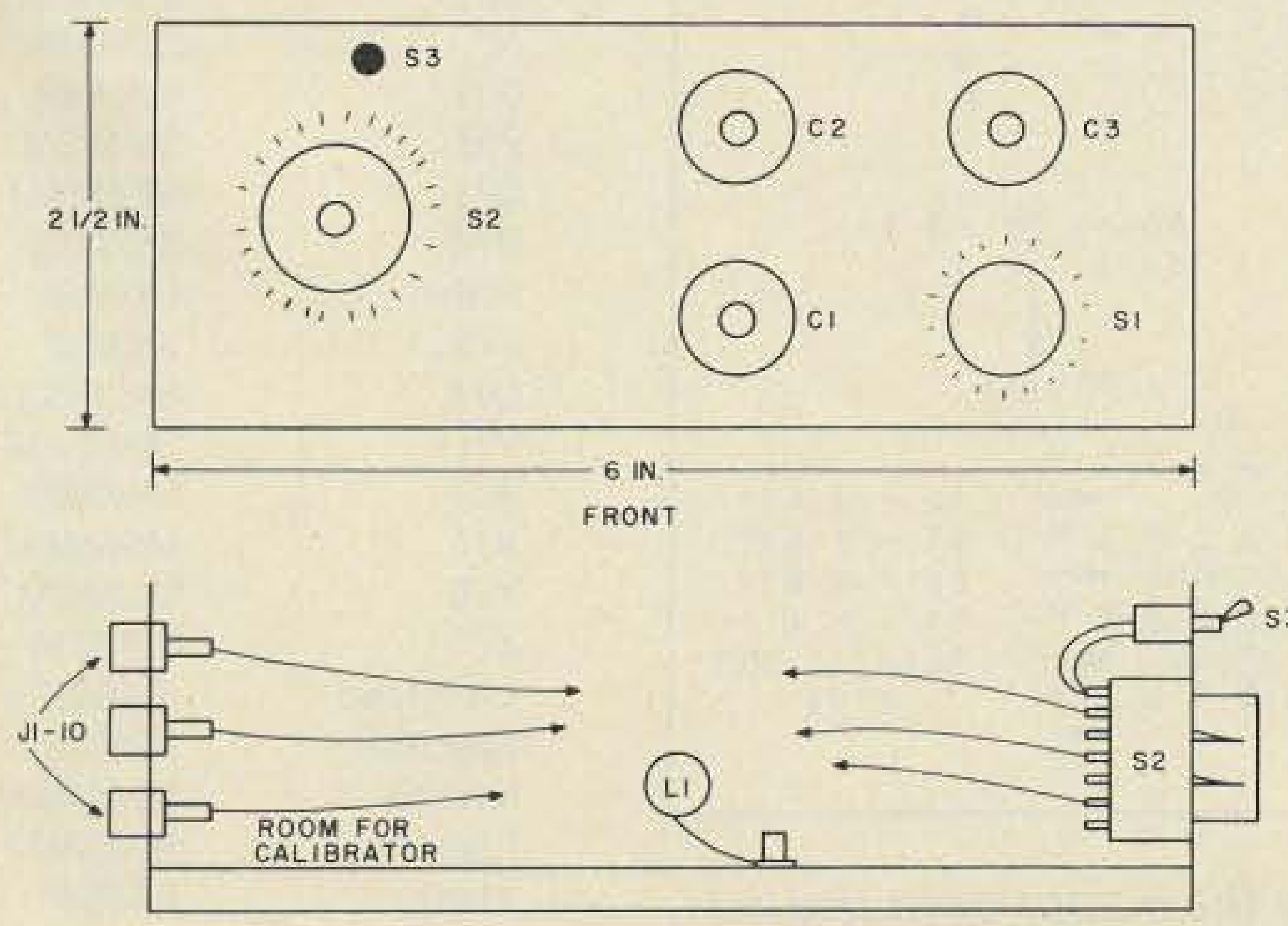


Fig. 2.

Parts List

C1-C3	365 pF variable capacitors (Radio Shack 272-1341 or equivalent)
L1	B & W 3012
S1, S2	1 pole, 12 position (Radio Shack 275-1385)
S3	DPDT (Radio Shack 275-1546)
J1-J11	Single hole phono jack (Radio Shack 274-346)

Parts List

AFSK keyer board

R1		1k trimpot
R2		1.2k
R3		1.2k
R4		1.2k
R5		6.8k Ω
R6	4 ea.	560 Ω
R7		1800 Ω
R8		330 Ω
R9		330 Ω
C1		.05 mF
C2	4 ea.	33 pF
C3		56 pF
Crystals		
Y1		2295 kHz
Y2		2975 kHz
Y3		2225 kHz
Y4		2125 kHz
IC1		7400
IC2		7400
IC3		7400
IC4		7400
IC5		74151
IC6		7490
IC7		7490
IC8		7490
Q1		SK3020 RCA or similar NPN

All resistors are ¼ Watt, except R1, a vertical mount circuit board pot.

RTTY ID board

R1	5-10k pot*
R2	1 meg ¼ W
R3	100k Ohm ¼ W
R4	1 meg ¼ W
C1	.01 mF
C2	150-200 mF
C3, 4, 5	.01 mF (bypass cap)
D1	1N914 or almost any diode
U1	7408 quad two-input AND
U2	7493 counter
U3	8223 256-bit ROM
U4	7493 counter
U5	74151 mult.
U6, 7	555 timer
U8	7430 8-input NAND gate

*circuit board pot, upright type; a 5 or 10k pot can be used with R2.

tions already have a loop, so be sure to check this prospect.

My next step was to construct an AFSK keyer and assemble an FM transmitter. The star of this weather station system is the AFSK keyer that I developed. The keyer, of course, is not limited to this system and can be used in place of the many far less accurate keyers now in general use.

Anyone who operates amateur RTTY is aware of the inaccurate shift of some keyers. It's time that we move up to the state of the art. AFSKs with plus or minus 25 Hz tones are obsolete. A TTL AFSK keyer system is simply the least

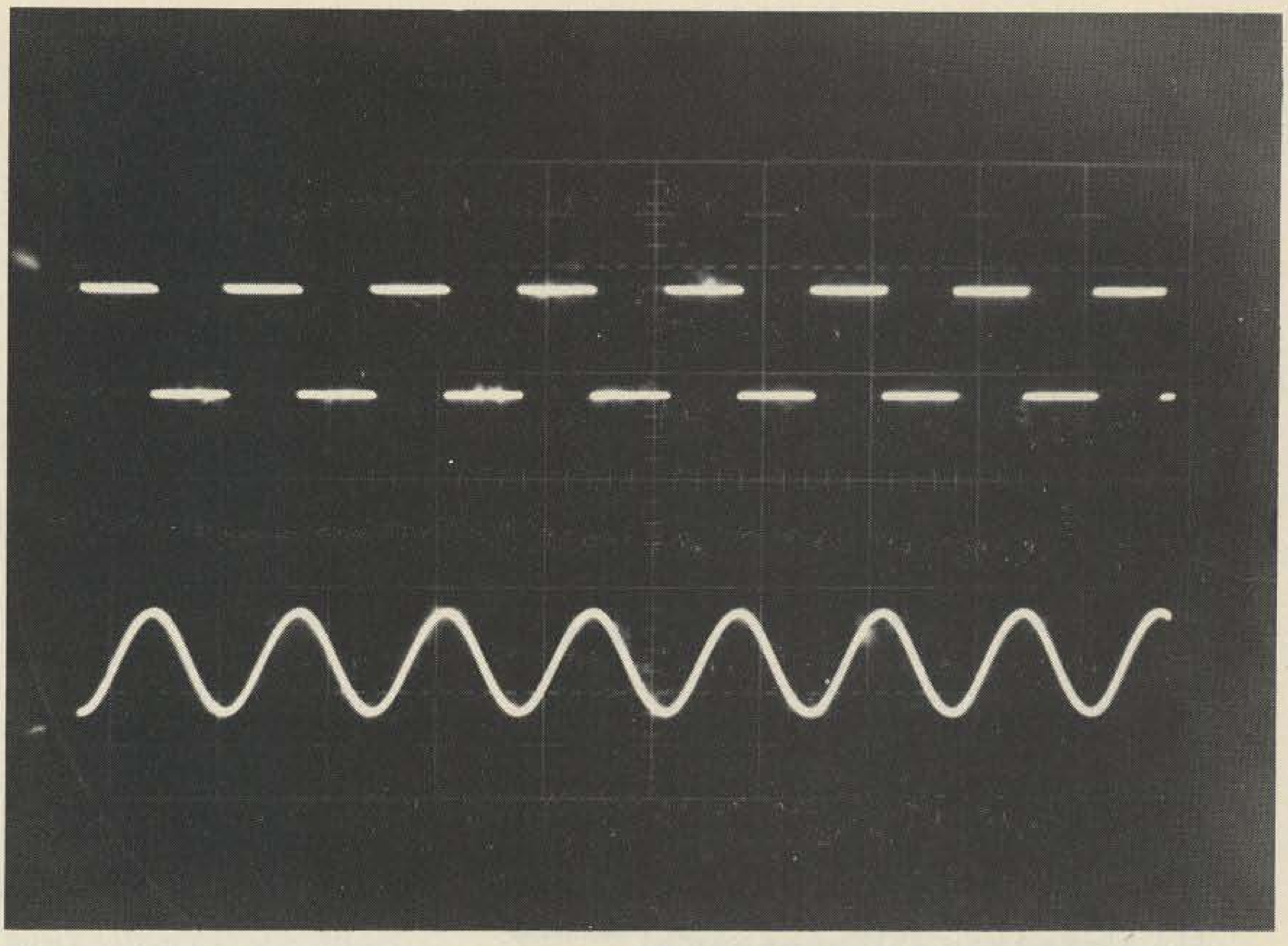


Photo A. Scope patterns. A (bottom) — sine wave output from low pass filter board. B (top) — square wave output from AFSK keyer. Patterns are displayed on a Tektronix 545-B dual trace scope.

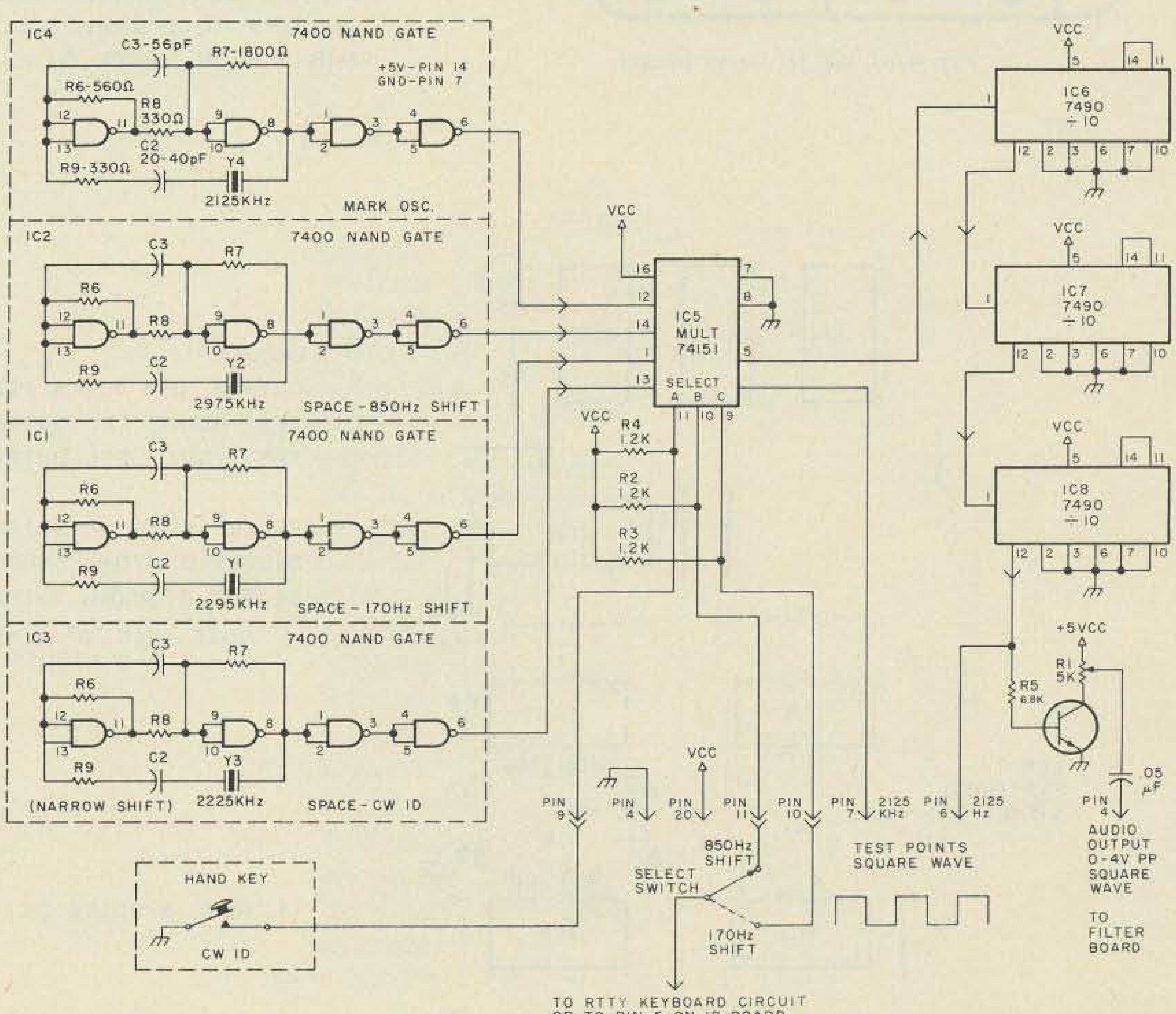


Fig. 3. AFSK keyer schematic.

expensive way to achieve highly accurate RTTY tones. The best accuracy comes from crystal control, and this AFSK keyer utilizes 2 MHz crystals to assure high precision. You will be pleasantly surprised at how inexpensive this keyer is when you begin to add up the costs. The divide-by-ten 7490 chips have been advertised as low as 45¢ each; the 7400s, for 16¢ each; the multiplexer, for 79¢; and the crystals, your biggest expense, will run between $3.00 and $4.50 each. The total cost will be in the neighborhood of $25.00 for an AFSK keyer, with an 850 Hz shift, a 170 Hz shift, and a narrow shift CW ID, with plus or minus 1 Hz frequency tolerance that requires no calibration. Not bad, huh?

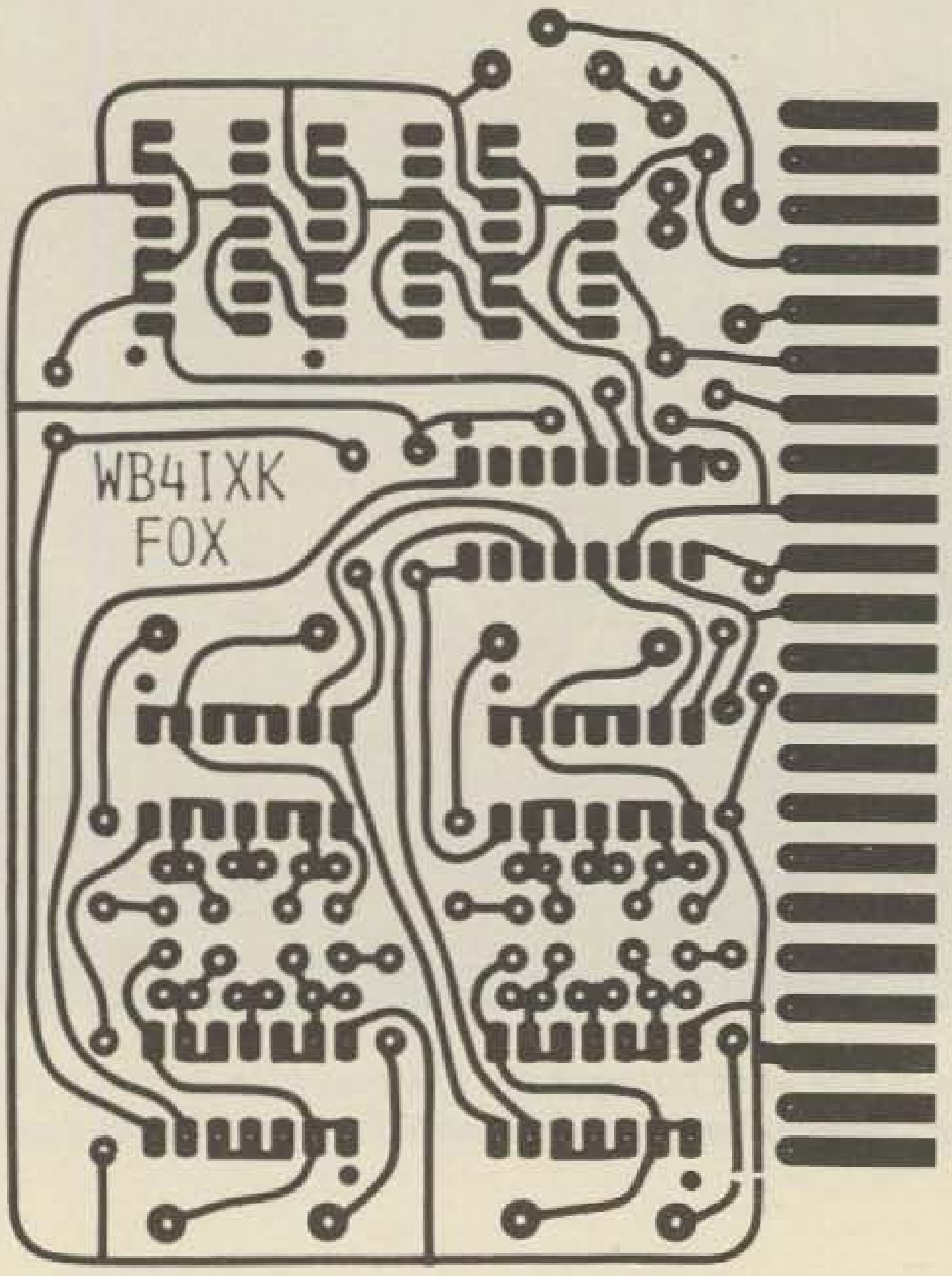


Fig. 4(a). AFSK keyer board.

The heart of the AFSK keyer is the crystal oscillator. I chose a 7400 quad NAND gate crystal oscillator for its simplicity and because it worked the first time I built one. The circuit requires only three gates, but I used the fourth gate as a buffer. I have forgotten where I got this circuit, but there are many similar circuits in use. (Jan Crystals lists a couple in their oscillator data sheet, which tells you to order AT cut crystals with a 32 pF load for these types of oscillators.) This circuit will work with almost any HC-6/U crystal, and on-frequency adjustment can be made, if necessary, by choosing a higher or lower value for C2. Although only two oscillators are needed for the weather station, I have laid out four crystal circuits – one for mark, one for 850 Hz shift, one for 170 Hz shift, and one for narrow shift CW ID. The output of each of these oscillators (pin 6) is connected to one of four inputs of the 74151 multiplexer. With all select inputs high (2.8 to 5 V), the mark oscillator frequency will appear at the multiplexer's output. When select input B is taken low (0 to .8 volts), the multiplexer will switch its output from the mark frequency to the selected space frequency, in this case 2975 kHz. Note: If A and B are taken low, no signal appears at the multiplexer output because an unused input will be selected. The output of the

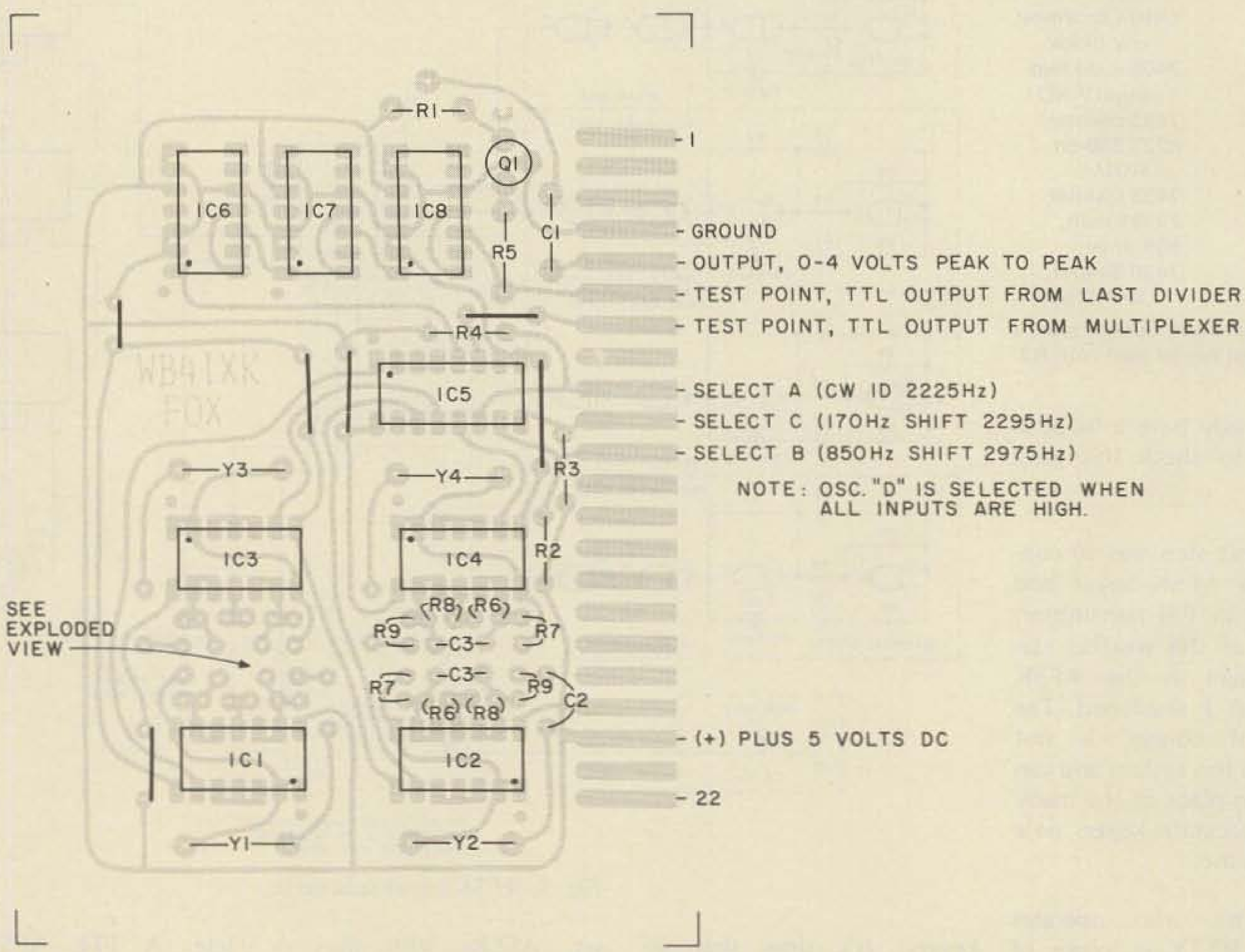


Fig. 4(b). Component layout, AFSK keyer board.

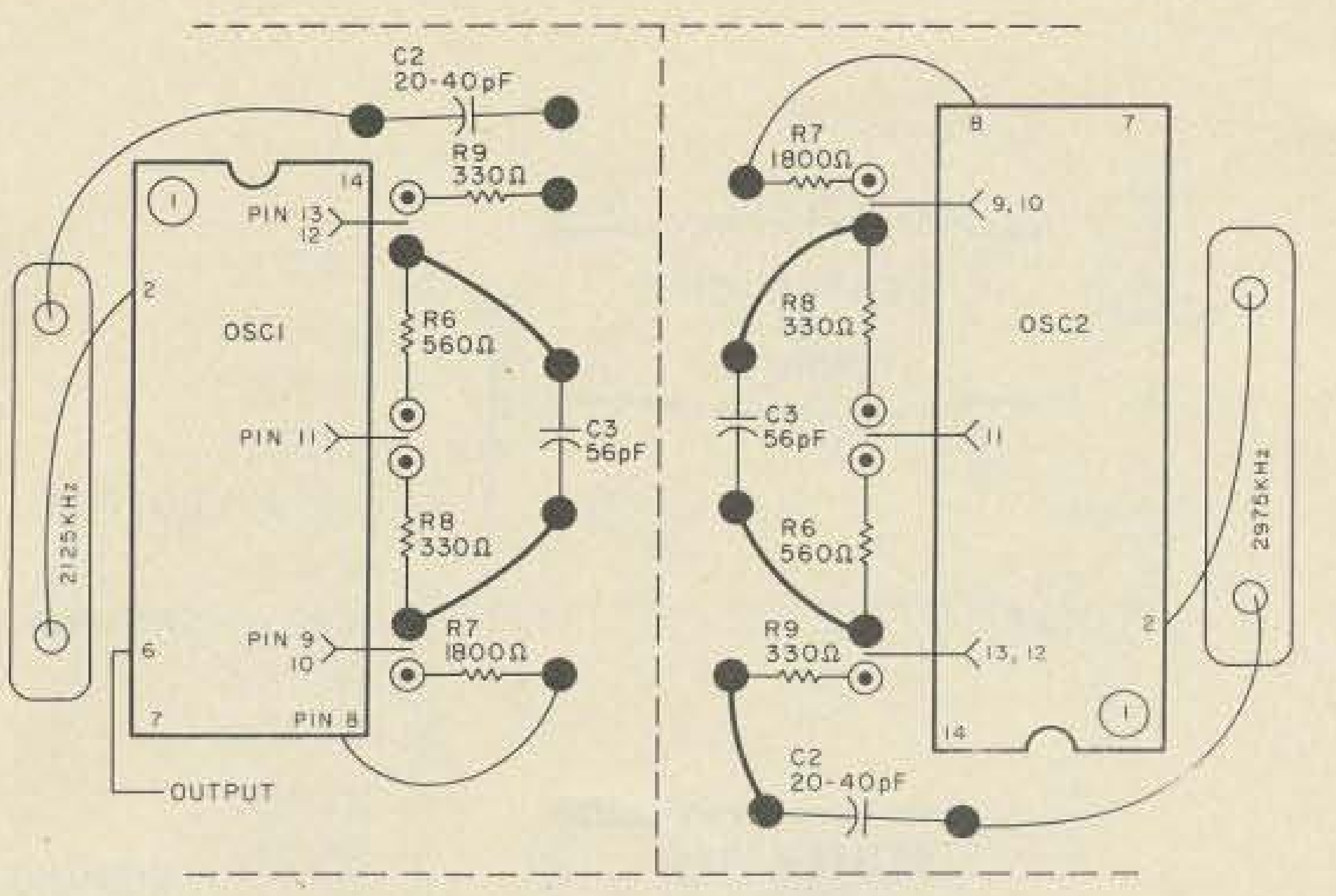


Fig. 5. A pair of the oscillator circuits from the AFSK keyer board (exploded view from component side of board).

multiplexer (pin 5) is connected to the divide-by-1000 dividing chain. The 2125 kHz signal at the dividing chain input will appear as 2125 Hz at pin twelve of the last 7490. A note here will explain why calibration is not required. The 2125 kHz crystal with its extreme tolerance of .005% would produce a frequency of 2125.106 kHz which, when divided by 1000, would net out to 2125.1 Hz. Even if the oscillator was one kHz off frequency, the output would only be one Hz off. The output from the last 7490 is buffered by Q1, and a variable signal level of 0 to 4 volts peak-to-peak is obtained from R1. This output is a square wave and must be filtered to produce a pure sine wave, especially if used to AFSK modulate an SSB exciter.

In order to filter the square wave from the AFSK board, a low pass filter is used. A circuit I found in a *Ham Radio* article by OD5CG does a fine job of removing the third and fifth harmonic, leaving a pure sine[1]. (See scope patterns A and B in Photo A.) As can be seen from the schematic, this filter requires minimum tuning (tune by selecting the proper value for C1, 2, 3, 4) and contains only eight components. The cutoff frequency, with the components shown, is about 5000 Hz, or about 1400 Hz below the third harmonic of the lowest frequency used (2125 x 3 = 6375 Hz). If lower tones for mark/space are considered, the .05 mF capacitors should be changed so that the cutoff frequency is lower than the third harmonic of the lowest frequency. For example, use a .1 mF capacitor for a cutoff frequency of approximately 3500 Hz, so that the third harmonic of 1275 Hz (3825 Hz) is above the cutoff.

The output from the low pass filter is adjusted by R1, located on the AFSK board, to a signal level necessary to drive whatever transmitter is used. For the GE Progress Line that I used, I adjusted the output for one volt p-p as suggested by the manual and inserted the signal at the mike

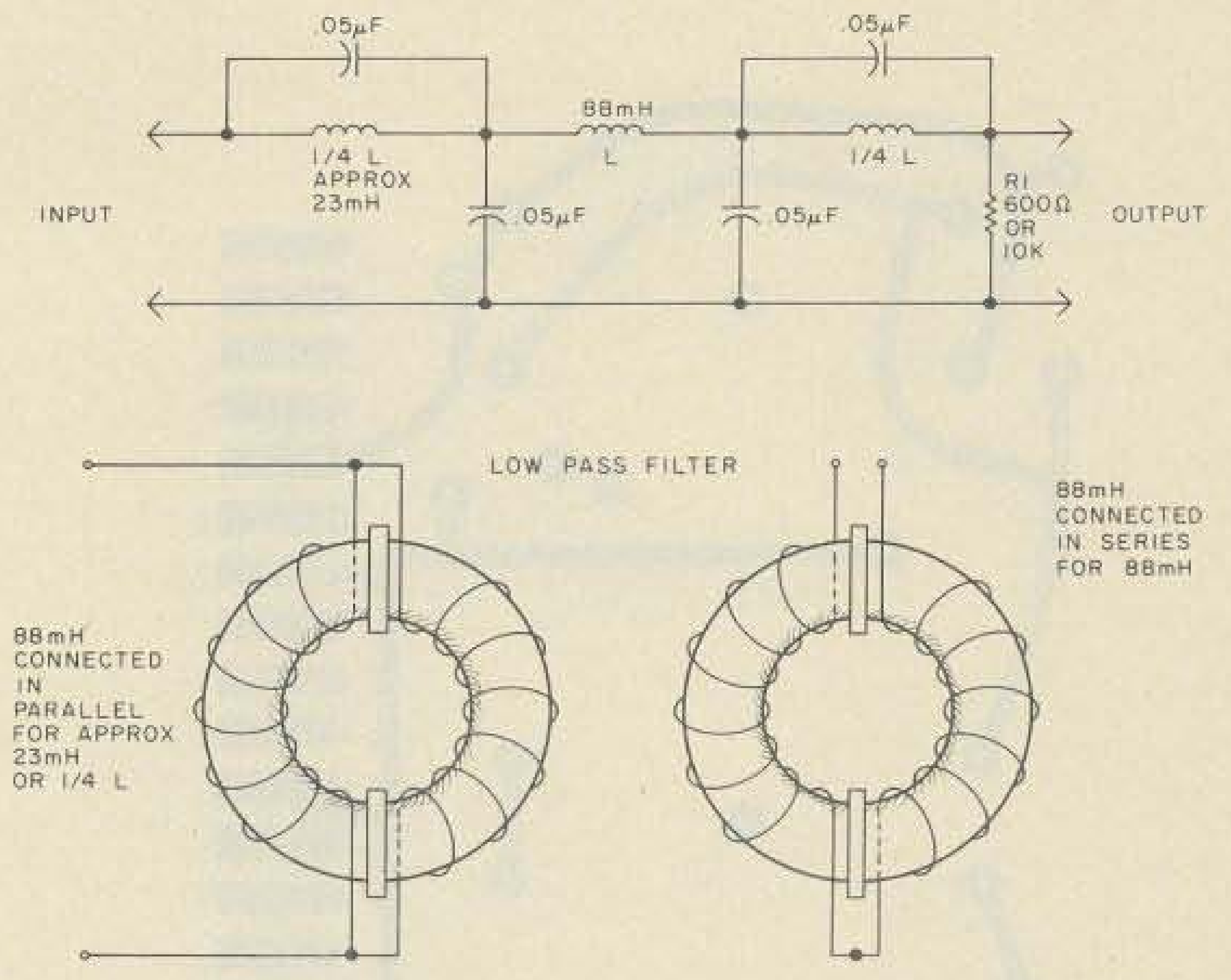


Fig. 6. Low pass filter schematic (by Frank Regier OD5CG).

input. (A dynamic mike input will require far less signal.) Deviation was adjusted to 5 kHz by the deviation control, and all other transmitter adjustments were made in accordance with the manual. The only modification I made to the GE transmitter was to form the antenna relay bracket so that the armature would remain closed. I used a mobile strip and, therefore, had to build a power supply, keeping in mind that it was to be keyed continuously, 24 hours a day.

I got the idea of using a PROM from an article by W6LLO, but, unlike his design, my circuit will automatically start and stop itself, and ID in teletype instead of CW[2]. As usual, I laid the circuit out with 22-pin edge connectors, for serviceability. The circuit uses a 555 mini-DIP timer (the RTTY pulse generator) for clocking the 7493s that address the memory at a teletype speed (for example, 18 ms pulses, negative-going to negative-going, for 75 wpm). Another 555 IC is used for a start/reset timer, which is allowed to time out when a steady mark for approximately 20 seconds is present on the loop. When this timer times out, its output will go low (0 to .8 volts) and allow the 7493s to address memory at the rate of the clock pulses.

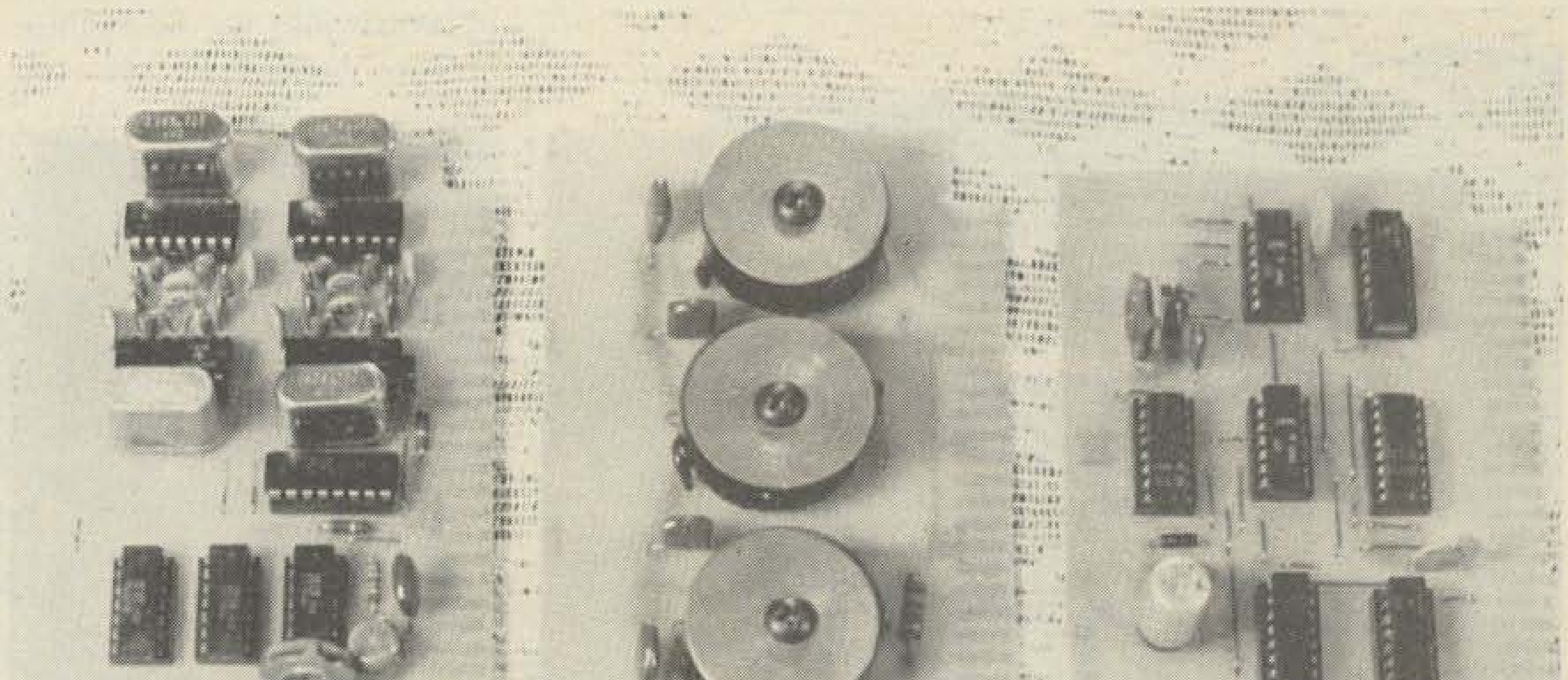


Photo B. The three circuit boards used in creating the AFSK tones and ID. Left — AFSK keyer; middle — filter board; right — ID board.

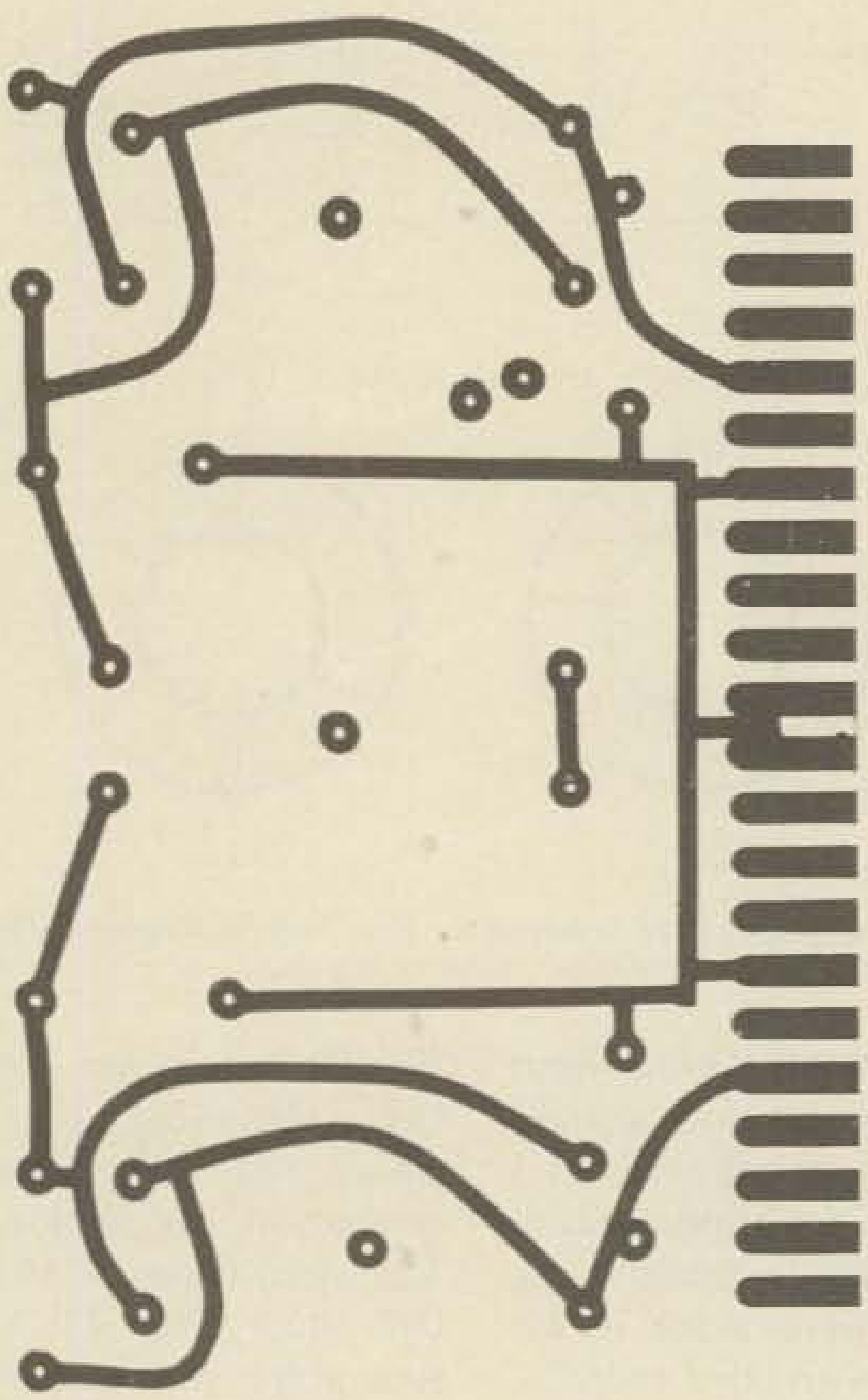


Fig. 7(a). Low pass filter board.

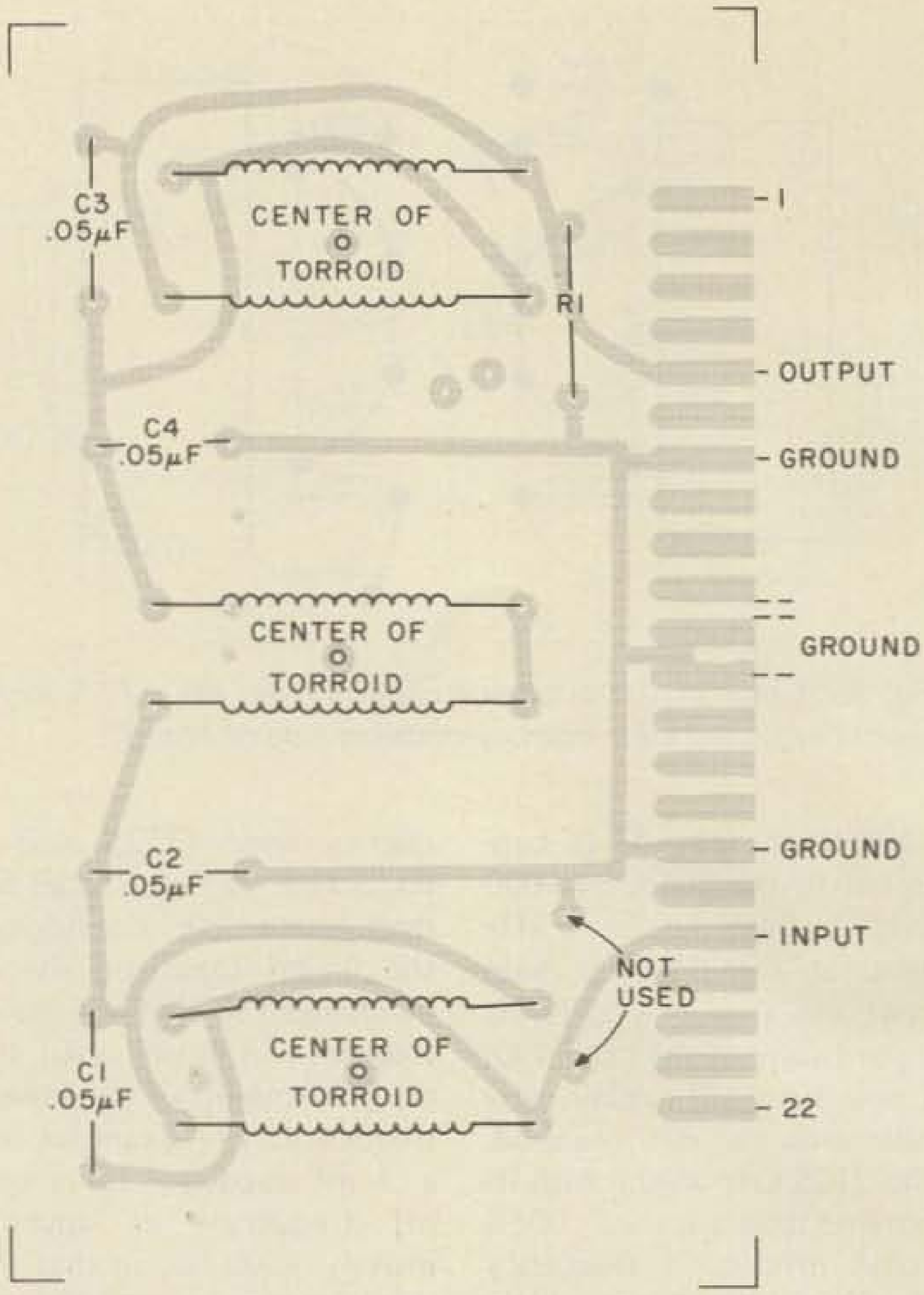


Fig. 7(b). Component layout, low pass filter board.

This timer will remain in its timed out state until it receives a pulse to reset it. This reset pulse will come from either the 7430 eight-input NAND gate that signals the end of memory or from any space from the landline teletype loop. In other words, a steady mark of 20 seconds or longer will start the ID, which will repeat itself every 20 seconds until a space comes over the loop. Even if the ID is partially into its cycle, a space will reset the address ICs to zero. Note: The zero position of the 8223 memory chip should be a mark.

Instead of programming the memory chip for a CW ID, I wanted to print the ID in teletype, mainly because CW ID is not required on the MARS frequency. By simply clocking the address ICs at the rate of a teletype pulse and programming the entire RTTY character into memory, we have a nifty message generator. If we divide the 256-bit memory into eight-bit words, we can write 32 words into the 8223 chip.

The breakdown of the eight-bit word is: bit 1, a space, the beginning of every RTTY character; bits 2 through 6, a mark/space combination determining the RTTY character or function; bits 7 and 8, the stop pulse, a mark required to be at least one and one half times the length of a RTTY pulse.

The outputs of the 8223 are at a low state when purchased, so I used mark as low,

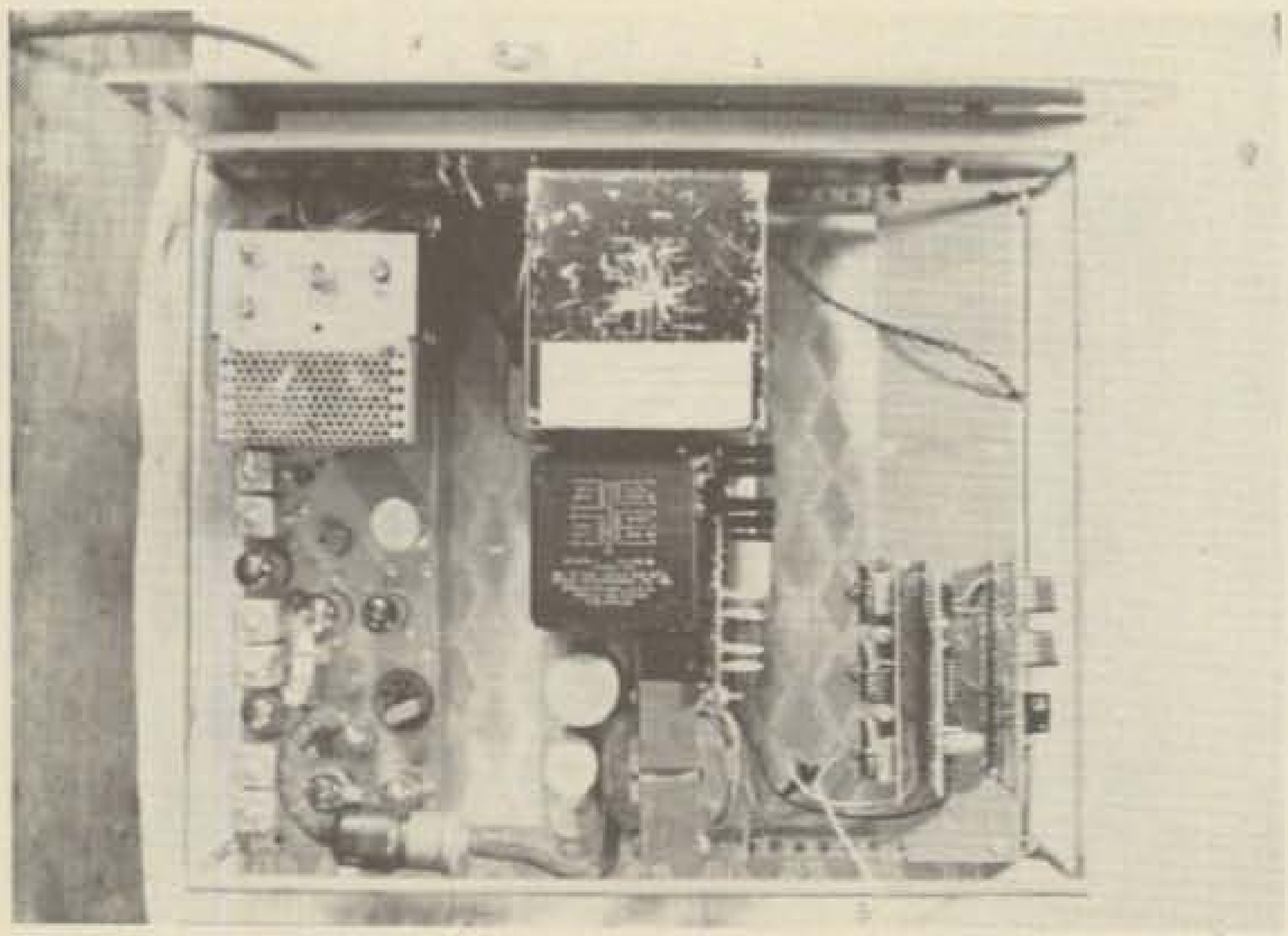


Photo C. Top view of completed transmitter, showing Progress Line 50 MHz strip at left, power supply at center, and AFSK keying boards on the right. Empty space in front of the boards houses the blower, which is mounted on the top cover.

Photo D. Top view showing transmitter, power supply, and circuit boards. Note: AFSK board (outside) is a prototype.

```
ADM4IXK/A
        FLA WEAZIJNM
ADM4IXK/A
        FLA WEAZIJNM
ADM4IXK/A
        FLA WEAZIJNM##AX

ZCZC
FXUS8 RWRB 281315
-TBW
PENINSULAR FLORIDA FARM AREA MINIMUM TEMPERATURE FORECAST
NATIONAL WEATHER SERVICE TAMPA BAY AREA RUSKIN FL
1015 AM EST MON FEB 28 1977

TONIGHT    FAIR NORTH AND CENTRAL...DECREASING CLOUDINESS SOUTH.
LIGHT NORTHERLY WINDS WITH PERIODS OF CALM.  TEMPERATURES TO FALL
RAPIDLY NORTH AND CENTRAL ZONES AFTER SUNSET AND MORE SLOWLY
THEREAFTER.  OVER THE SOUTHERN ZONES TEMPERATURES WILL FALL
GRADUALLY THROUGHT THE NIGHT.  MINIMUM TEMPERATURES TO OCCUR NEAR
SUNRISE.

LOWEST TEMPERATURES

ZONES 6 7                 28 TO 32 FROST

ZONES 8 AND 9             30 TO 34 FROST

ZONES 10 11  12           34 TO 38 EXCEPT 32 TO 34 IN THE POCKETS
                          SCATTERED FROST

ZONES 13 14 15 16 17      36 TO 40 PATCHY FROST

ZONES 18 19 20            38 TO 44

ZONES 21 22               40S AND 50S

OUTLOOK    SLIGHTLY WARMER ALL ZONES TUESDAY NIGHT.  CHANCE OF FROST
NORTHERN ZONES WEDNESDAY MORNING.

NNNN##
ADM4IXK/A
        FLA WEAZIJNM
ADM4IXK/A
        FLA WEAZIJNM
ADM4IXK/A
        FLA WEAZIJNM
##A
ZCZC
SDCA1 KMIA 281544
SDXX1 RWRB 281544

RADAR SUMMARY
NATIONAL WEATHER SERVICE MIAMI FL
1031AM EST MON FEB 28 1977

AT 1031AM EST...LARGE PATCHES OF RAIN WITH A FEW EMBEDDED VERY
HEAVY SHOWERS CONTINUED ALONG AND WELL OFFSHORE THE EAST COAST
FROM VERO BEACH TO WEST PALM BEACH.  OTHERS WERE OCCURRING JUST
NORTH OF THE LAKE AND NORTH OF PUNTA GORDA.  THIS ACTIVITY WAS MOVING
TOWARDS THE NORTH EAST AT 12 MPH.

SCATTERED SHOWERS CONTINUED IN PORTIONS OF DADE AND BROWARD
COUNTIES...FLORIDA BAY...AND THE GULF BETWEEN THE LOWER KEYS
AND DRY TORTUGAS.  MOVEMENT OF THIS ACTIVITY WAS TOWARDS THE
EAST AT 12 MPH.

MAX TOP 26 THSD FT.
```

Sample copy.

since there are more marks than spaces. The first step in programming is to make a chart, such as the one in Fig. 1. Next, fill in the characters you want in the spaces provided. Consulting the RTTY character chart (Fig. 2), fill in the appropriate mark/space combination. Then, following programming instructions, simply program the spaces by writing a logical "1" for the spaces. This data is from the *Signetics Digital-Linear-MOS Data Book.*[3]

Proceed as follows:

1. Ground pins 8 and 15, and remove Vcc from pin 16. Remove any load from the outputs.
2. Address the bit to be programmed by applying a logical "1" (5 volts) or a

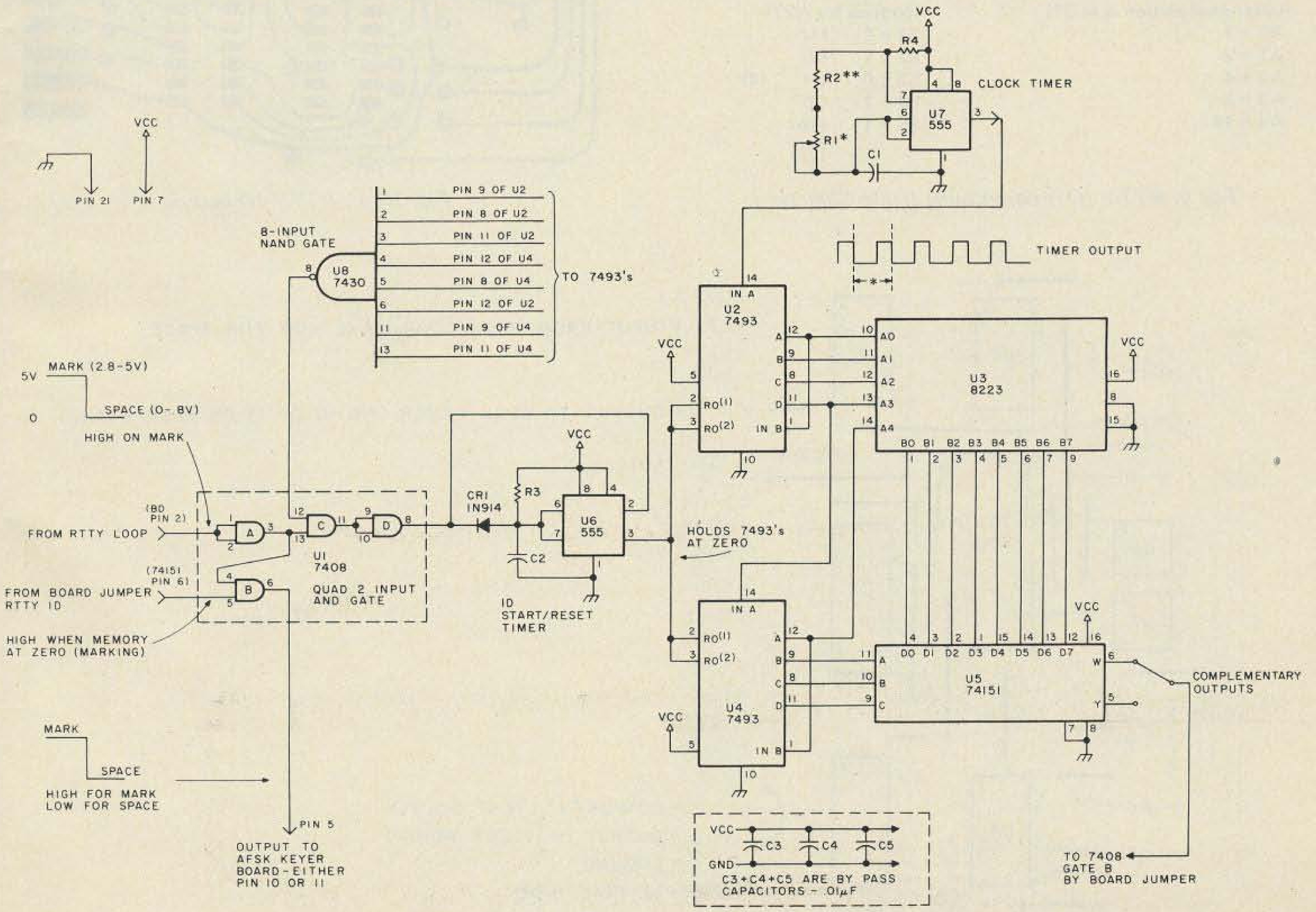


*Fig. 8. RTTY ID schematic. *Adjust R1 for a pulse width of 11 ms for 60 wpm, 18 ms for 75 wpm, 22 ms for 100 wpm (neg.-going to neg.-going). **R2 is used to extend range of R1 for easier adjustment of pulse width.*

logical "0" (0 – .4 volts) at the address lines: A0, A1, A2, A3, A4.

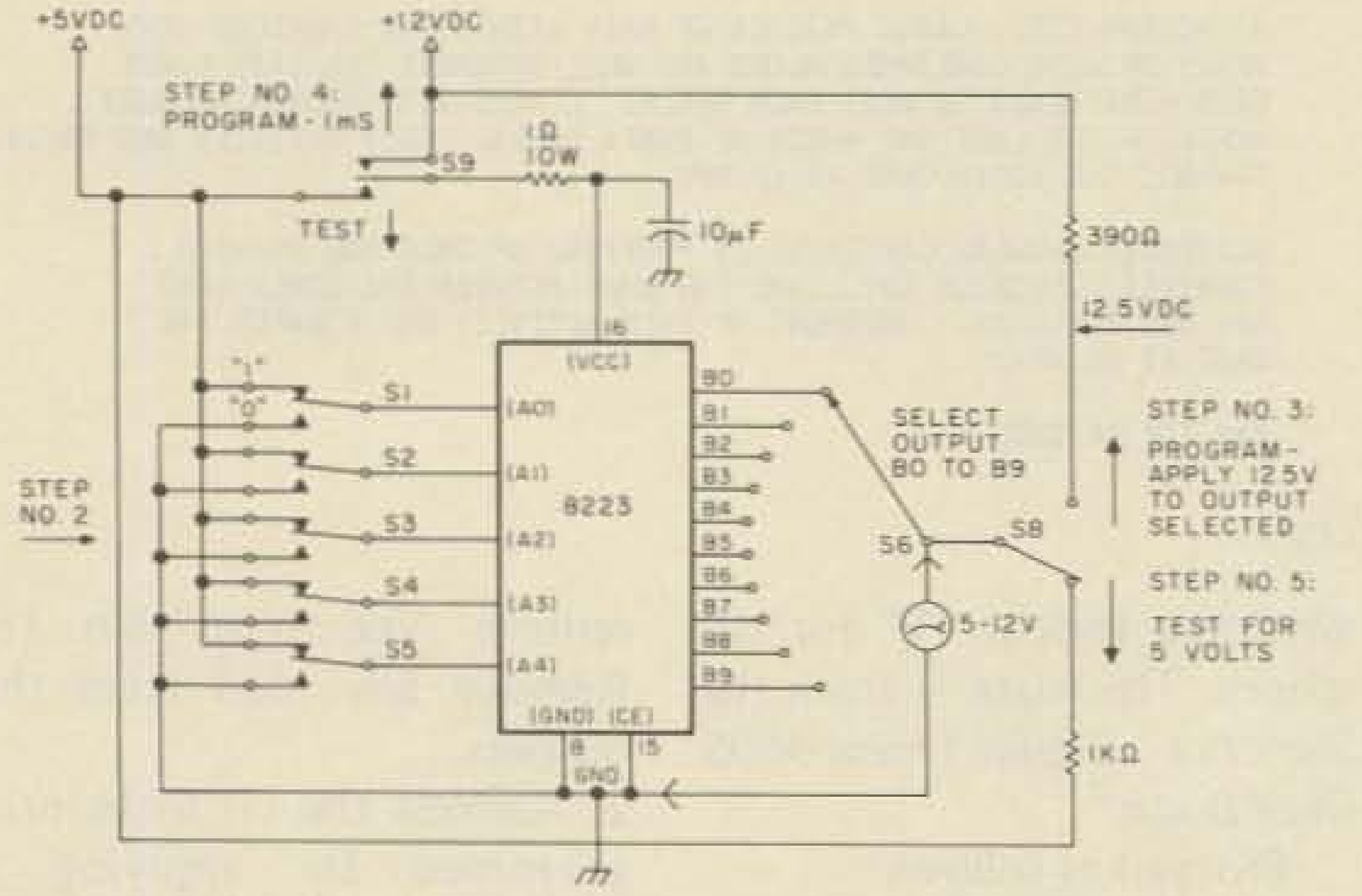
3. Apply 12.5 volts ± .5 volts to the output, to be programmed through a 390 Ohm resistor. Then apply 12.5 volts to Vcc (pin 16) for 1.0 ms.

4. Remove the 12.5 volts from the output. Check the output by placing 5 volts through a 1k resistor at the output, and place 5 volts at Vcc. There should be 5 volts at the output. If 5 volts are not present, repeat.

5. Repeat steps 2, 3, and 4 for each output to be programmed.

These chips are also available preprogrammed. If this is your choice, I recommend filling out the chart that accompanies this article and, then, transferring the information to the supplier's order blank.

Since there are a variety of keying methods to choose from, I will leave that part of the project up to you – you know what you have to work with. I do recommend that you familiarize yourself with interfacing circuits, such as these I have obtained from Fairchild Semiconductor's *TTL Applications Handbook*. You also should investigate the optoisolating circuits that are available, if isolation of high voltage (100 plus) circuits from low voltage (5



Address notes
(addressed psition is at 31)
A0 = 1
A1 = 2
A2 = 4
A3 = 8
A4 = 16

Example
(address bit #27)

S1 = 1	**(1)**	
S2 = 1	**(2)**	
S3 = 0	**( )**	**(4)**
S4 = 1	**(8)**	
S5 = 1	**(16)**	
	= (27)	

Fig. 9. RTTY ID programming (from Signetics).

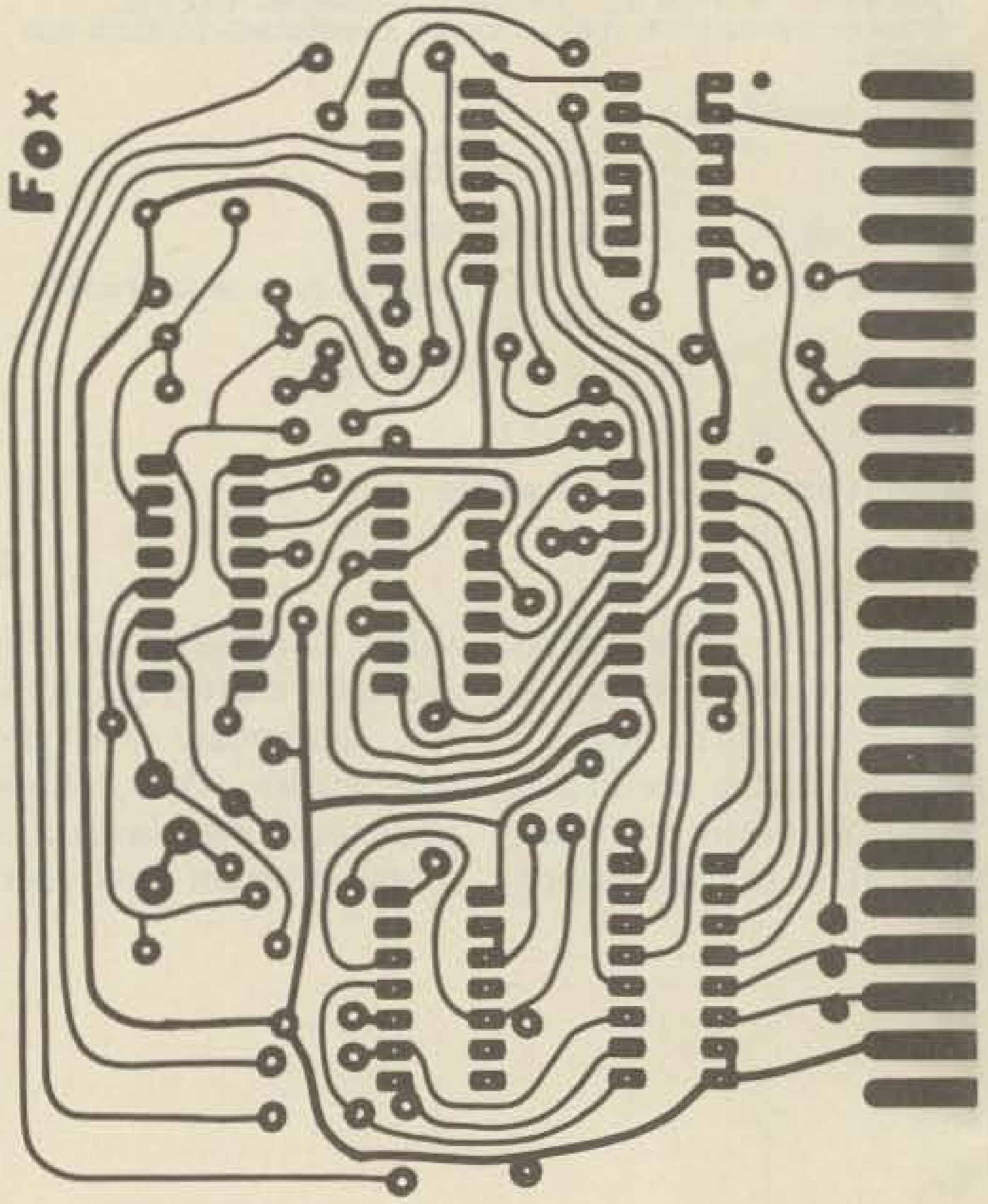


Fig. 10(a). RTTY ID board.

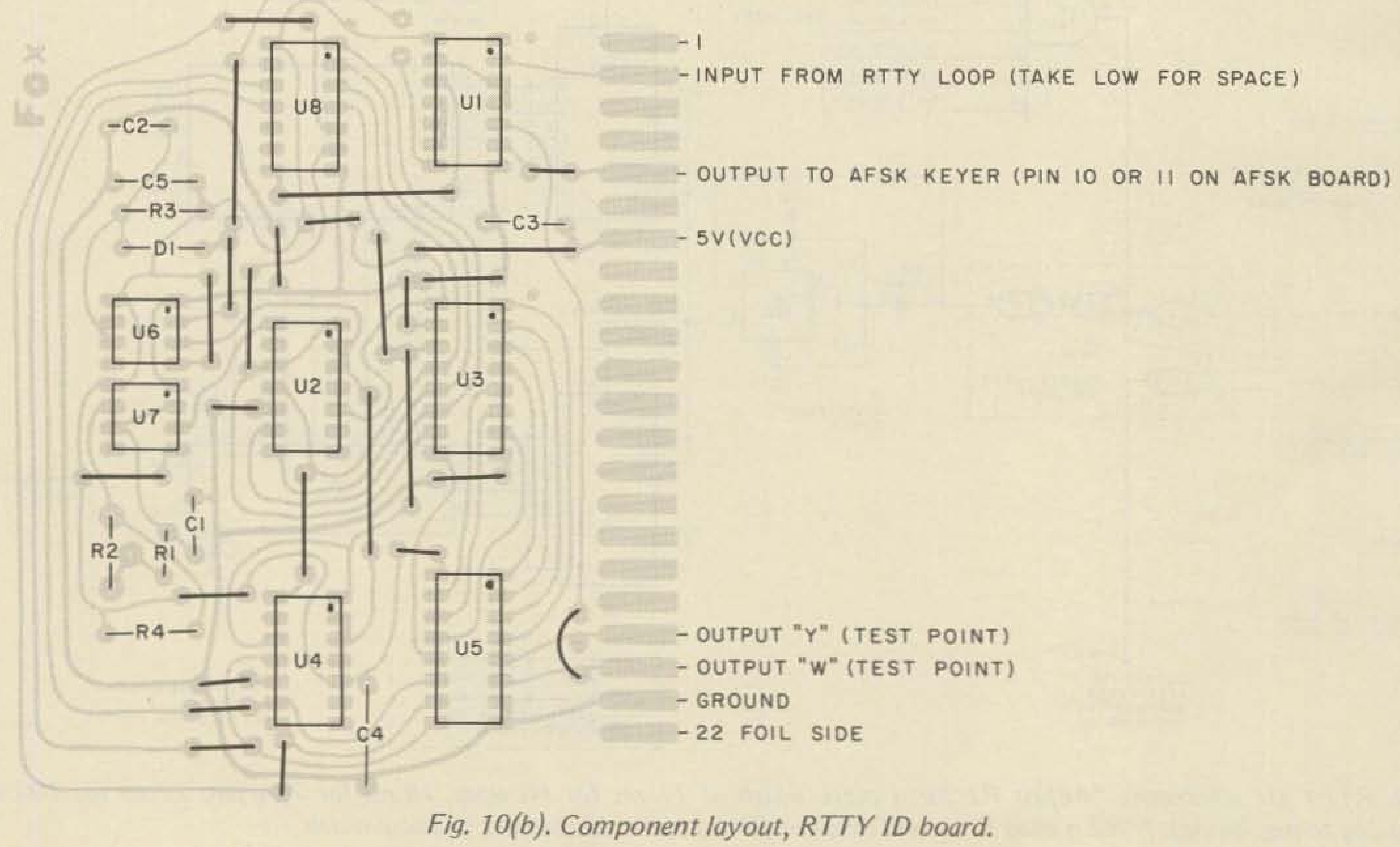


Fig. 10(b). Component layout, RTTY ID board.

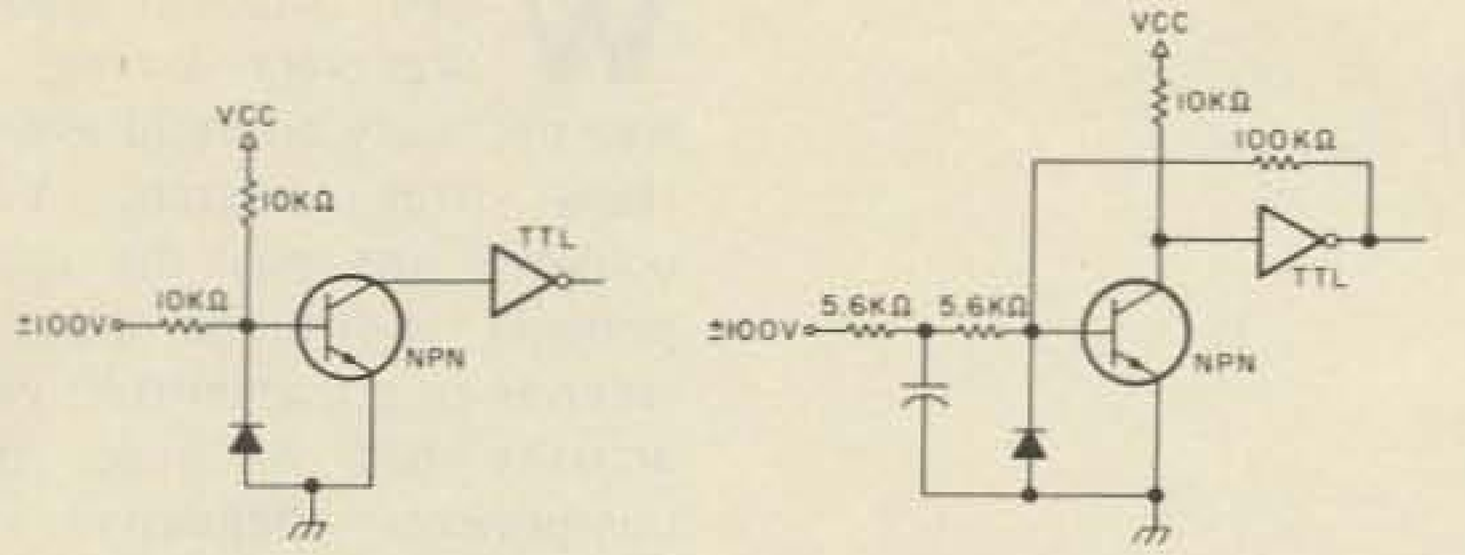


Fig. 11. Interfacing, transistors driving TTL (from Fairchild). Right-hand example includes RC filter to suppress noise.

volts) circuits is desired.

My station has been on the air for the last year and a half, and I have not had any failures with the TTL circuits. However, I have had considerable problems keeping the 6146s in the GE Progress strip from burning out screens. Special care, including cooling and proper tune-up, is needed for any transmitter keyed 24 hours a day. I am currently working on a solid state version to replace the GE tube transmitter.

In conclusion, I would like to thank Bob Ghormley WA0UVX, for his inspiration, and my wife, Linda WA4UIM, for her perspiration, in helping me get this article together. ■

References

1. Frank Regier OD5CG, "Simple Lowpass Filter for Audio," *Ham Radio*, January, 1974, page 54.

2. Howard L. Nurse W6LLO, "CW Memory for RTTY Identification," *Ham Radio*, January, 1974, page 6.

3. Signetics Corporation, *Signetics Digital-Linear-MOS Data Book*, Lexington, Massachusetts, copyright 1974, pages 4-9 through 4-11.

4. Peter Alfke and Ib Larson, *The TTL Applications Handbook*, Fairchild Semiconductor, Mountain View, California, August, 1973, pages 15-15 through 15-17.

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Guilty? Or Not Guilty?

-- an indictment of some 2m and 75m ops

Amateur radio has given us much to be thankful for and many good friends. But a certain segment of the hobby has really "turned me off" during the past year. Much of what I dislike about amateur radio can be found on 2 meters and 75 meters. Let me give you a few examples:

How about some of the local repeater organizations?

It seems to me that some of these groups have evolved into what is almost a political "machine." Among some of these groups there is constant "infighting" for more clout in the group, attempts at "one upmanship" through personal attacks on other amateurs, and a general disregard for the opinions of those who make the repeater groups viable – the general membership. Accusations are made against various groups and individuals without regard to the personal feelings and character of the individuals involved.

Another disheartening part in all of this is that there is such a small minority of these same amateurs who are willing to assist other amateurs and non-amateurs when it is needed. It is almost universally true that the loudest voices heard in various "political" maneuvers or in the "down-talking" of another's viewpoint or character fall silent when there is a call for help. Surely this is the antithesis of what the amateur spirit *should* be.

How often have you heard an amateur make disparaging comments about CBers, using trite phrases that we've all heard? How many of these same amateurs have really ever been of assistance to another when it was needed? Are we as willing to trouble ourselves to help another as so many of the CBers are? We tend to be great talkers – but are we doers?

And what about attracting new amateur radio operators? How can this be effectively done when so many of the experienced amateurs spend so much of the time settling personal vendettas and listening to their own voices?

So much of what we say on the radio is heard by so many people – including non-amateurs – and the type of behavior that is most remembered is the type so often found on portions of the 75 meter and 2 meter bands. It is a sad commentary on the amateur service.

We are involved in both a hobby and a *service*. We are not involved in amateur radio to bludgeon other individuals with our personal gripes, interpret regulations and bylaws to suit our personal needs, throw ourselves into every "political" situation within a group that may better our own position, or to flaunt our super egos over the radio under the cover of such phrases as "... Well, *we've* been a ham for forty years ..."

A good amateur listens more than he talks, so let's listen. Listen to Novices and relearn about what enthusiasm really means. Listen to the CBers – when the "chips are down" they often have some fine things to say (and they are *doers*).

Listen to yourself – *LESS*!

Listen to reason – *MORE*! ■

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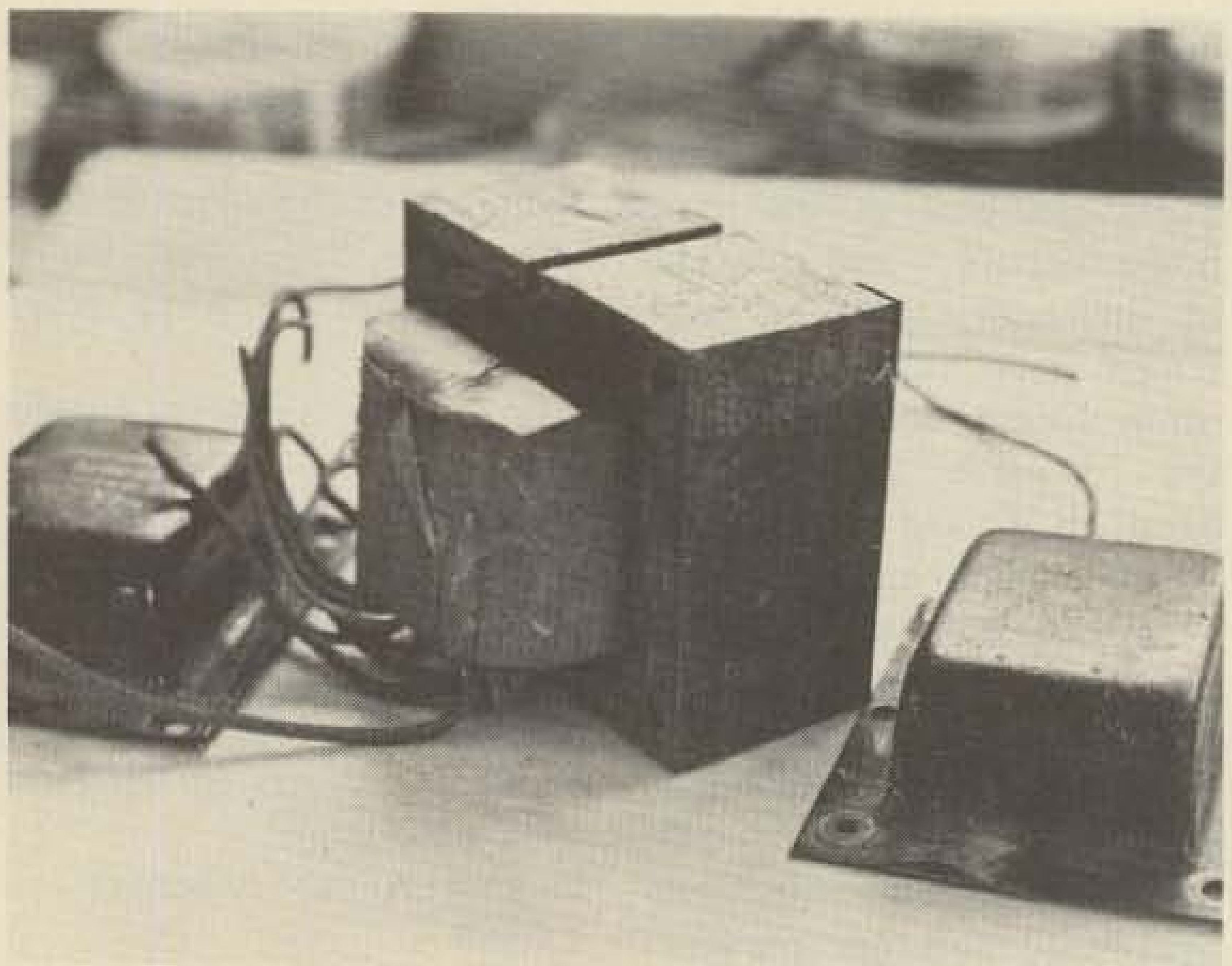
New Life For Old Transformers

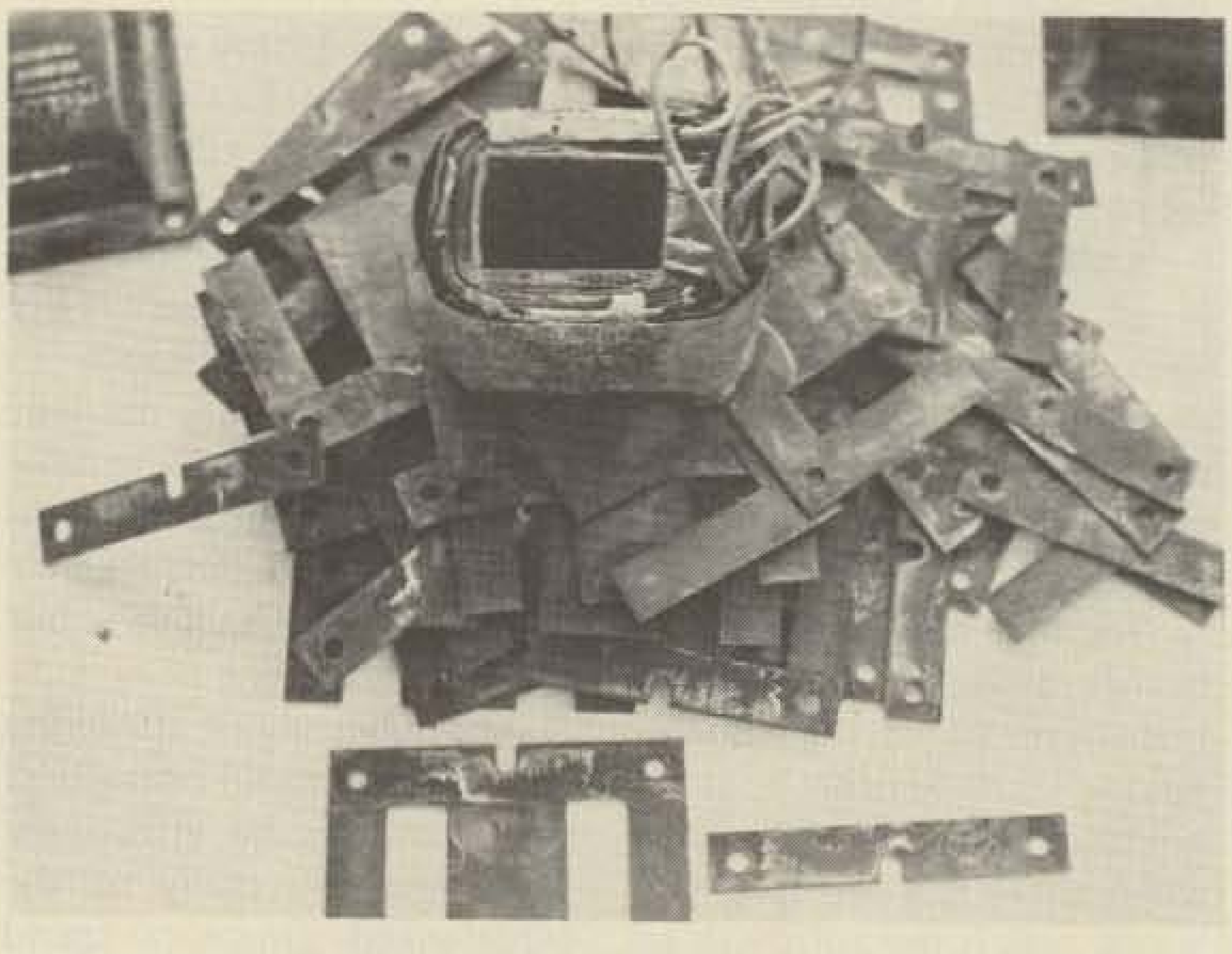
When amateur radio was very young, it was necessary to build everything from scratch. You couldn't just buy the components and home brew a receiver or a transmitter; you actually had to make the components themselves. If you needed a coil, you wound one on an oatmeal box. Rectifiers were jars of some foul-smelling electrolyte with the anode and cathode inserted. Capacitors were built up and so on. The reason was, of course, that the necessary parts were not available.

Today, kit-building is popular among hams and computer hobbyists for economic reasons and not because assembled units are hard to get. Building is great fun, and I enjoy it, and the money savings certainly enter into the fun. I'm not suggesting that everyone start fabricating their own ICs or keyboards, but I think that some might find the following information useful.

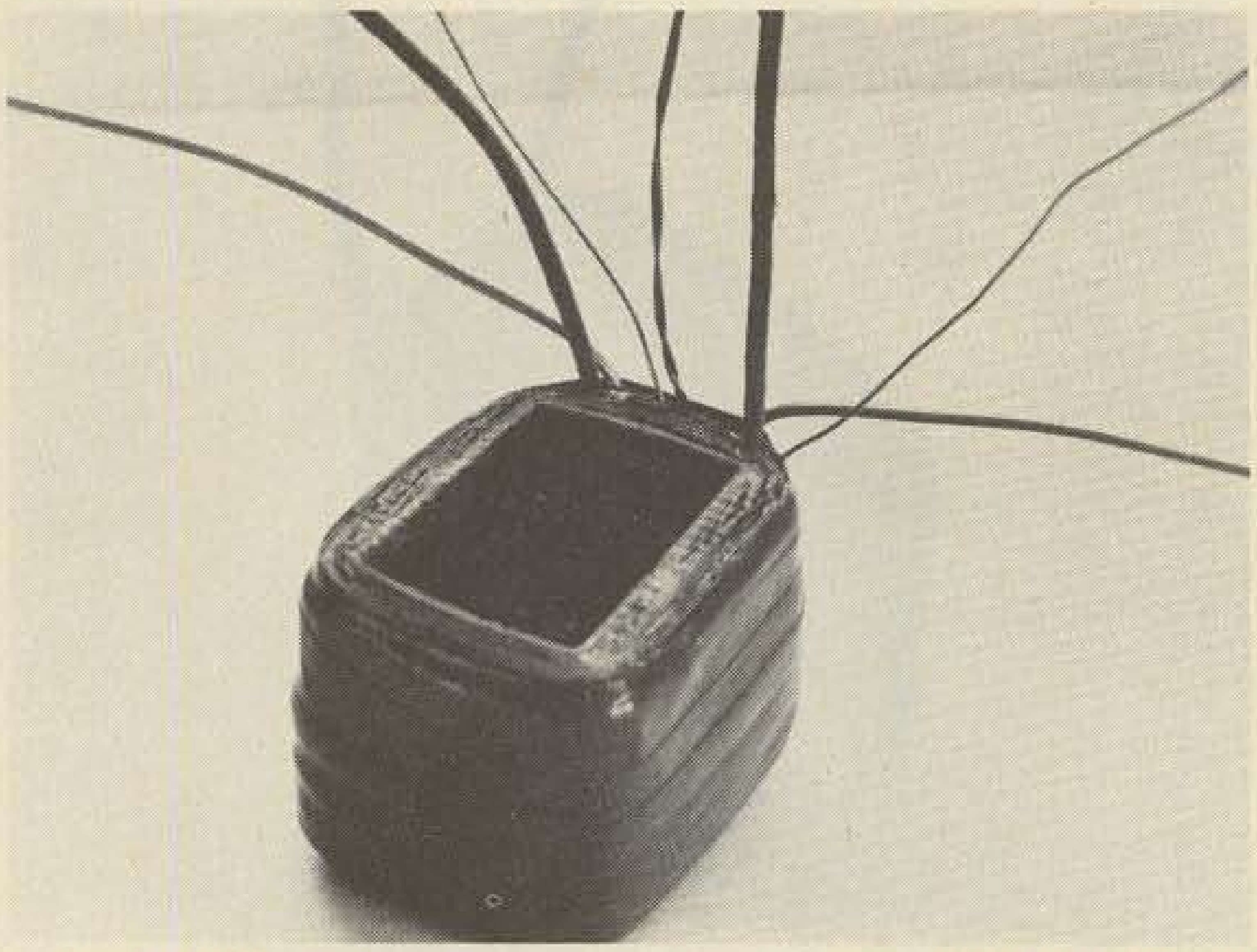
When I decided on the Processor Technology SOL System, I ordered only the PC board kit in order to stay within my budget. This is a complete microcomputer on a board with video and keyboard interfaces, cassette controller, serial and parallel I/O ports, RAM and ROM, and much more. All I needed to get it flying, other than the



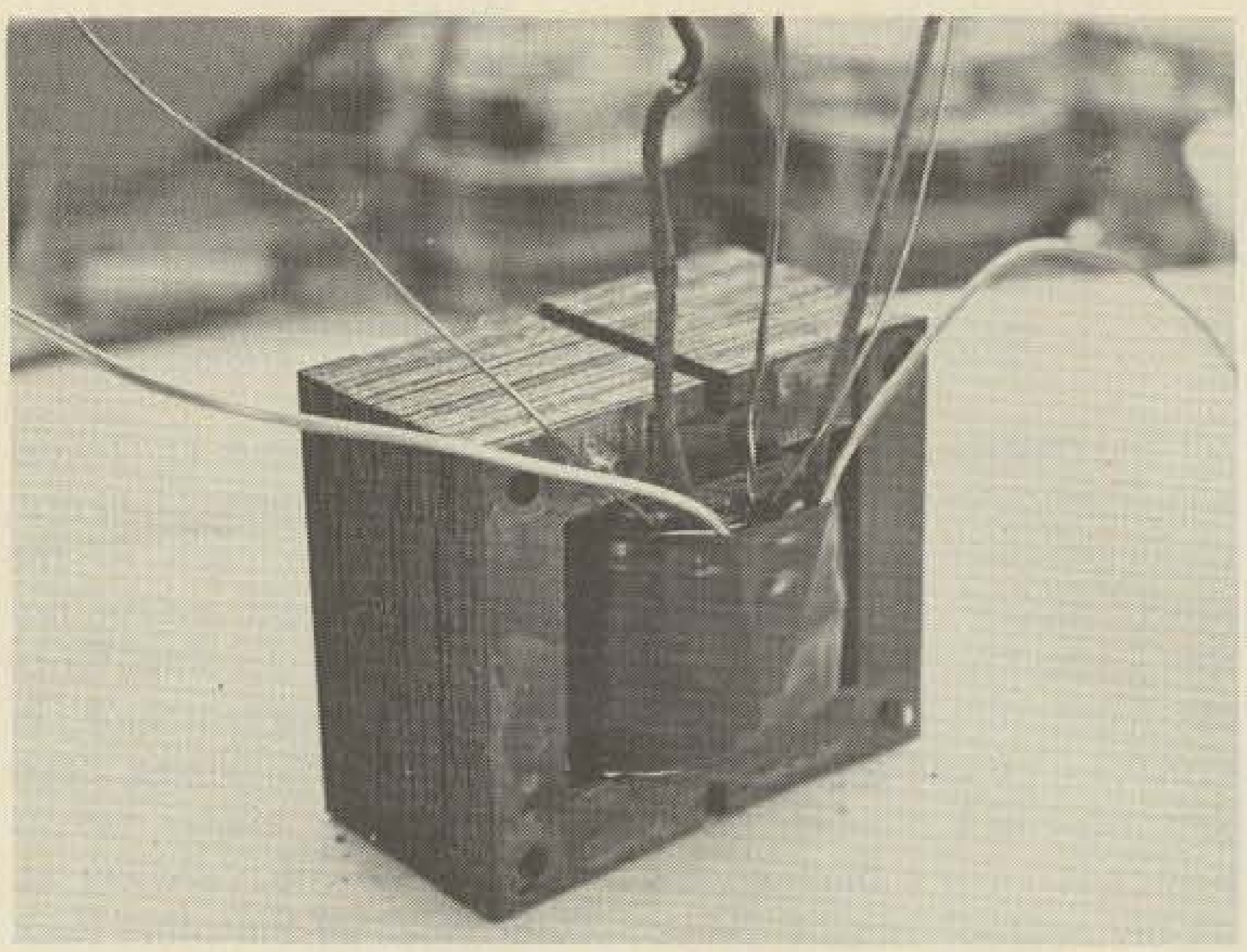
Retired television transformer with the covers removed.



The winding pileup of the transformer sitting on top of the E and I segments.



The winding form completely rewound, taped, and ready to be mounted back in the core.



The transformer reassembled. It has been said that the segments should be shellacked before reassembly, but that seems like a messy job, and I haven't found it necessary. All that remains is to insulate the leads and replace the covers.

be easily removed. Use the blade or one of the I segments under the top E segment all the way around and through the middle of the winding, and it should pull out with a pair of long-nose pliers. Wiggling it back and forth while pulling should do the job. Once the first segment is out, the rest can be loosened and pulled out without problems.

You want to get rid of all of the windings except for the primary, which you'll reuse. It should be closest to the center of the winding pileup. You can determine this by tracing the leads you identified earlier. Starting from the outside, unwind the layers one at a time until you get down to the level you identified as the 6.3-volt filament winding. As you unwind this layer, count the turns of wire carefully. This is important! This tells how many turns each of the new windings must contain.

Mine had 12 turns, which means that this transformer was designed to have two turns of wire per volt. Using the simple ratio formula P/S = VP/VS, where P is the number of turns in the primary, S is the number of turns in the secondary, VP is the voltage in the primary, and VS is the voltage in the secondary, it is possible to determine how many turns each of the other windings had, but it isn't necessary. All you want to know is how many turns per volt your transformer has. If you were building transformers from scratch, you could use whatever value you desired, but two seem to be standard, as it has been the same on all of the transformers I've rewound.

Remove all the rest of the windings except the primary, and, if it is covered with a copper foil shield, leave it in place. Wrap the primary winding with tape, and you're ready to start rewinding.

Rewinding

The number of turns needed for each winding is the turns per volt times the desired voltage. Fig. 2 shows how I rewound my transformer. For the 16-volt windings I used #16 Formvar insulated wire, which will handle more than 3 Amps (Table 2). Plastic or enamel insulated wire or smaller sizes can also be used if your current requirements are lower.

Wind the higher voltage winding first, leaving a foot or so for a connecting lead. Wind tightly and neatly until you reach the center tap (32 turns on a 2 turns-per-volt transformer), leave a loop about a foot long for the center tap, and then wind the second half of the winding with another one-foot lead at this end. If all of the turns won't fit on one layer, double back toward the beginning. Wrap this winding with tape.

Wind the 8-volt winding next, using wire large enough to carry the required current (Table 2). I didn't have any #10 but did have plenty of #16, so I used 3 strands of #16 loosely twisted together, which should handle more than 10 Amps. Slip some insulation over the leads, and tag them for identification. I used plastic insulation removed from lengths of regular house wiring. Shrink tubing or tape can also be used.

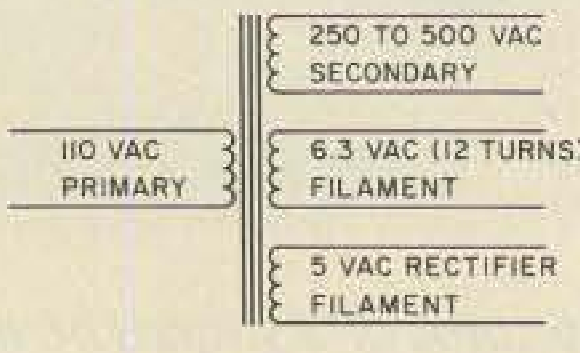


Fig. 1.

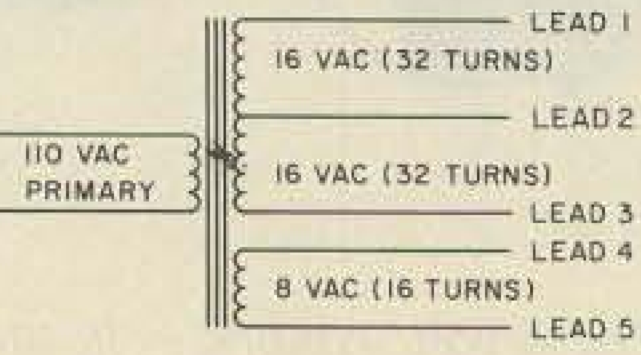


Fig. 2.

#10	14.8 Amps
#12	9.3 Amps
#14	5.8 Amps
#16	3.7 Amps
#18	2.3 Amps
#20	1.4 Amps

Table 2. Current-carrying capacity of wires in transformers.

Reassembly

Put the segments back together in the windings by alternately stacking them just the way they came out. A hammer and a small block of wood may be necessary to drive in the last segment or two. Do not use the hammer directly on the segments — you'll flare the edges and they will not fit together closely. Make sure that the holes in all of the segments are lined up, and replace the covers and any insulating material they may have contained. Tighten the bolts good and tight. The first transformer I rewound had an audible hum until I really clamped the segments together.

Now you've done it and can check the voltages with a meter. They may differ from our design voltages a little, but, after rectification and filtering, you'll have plenty for your regulators. See "Heavy Duty Power Supply," by Will Cattey, in *Kilobaud* #4, page 78.

All of this may have sounded complicated and difficult, but it isn't really. It took me longer to tell this than to do it. Now I can start building my SOL System. ■

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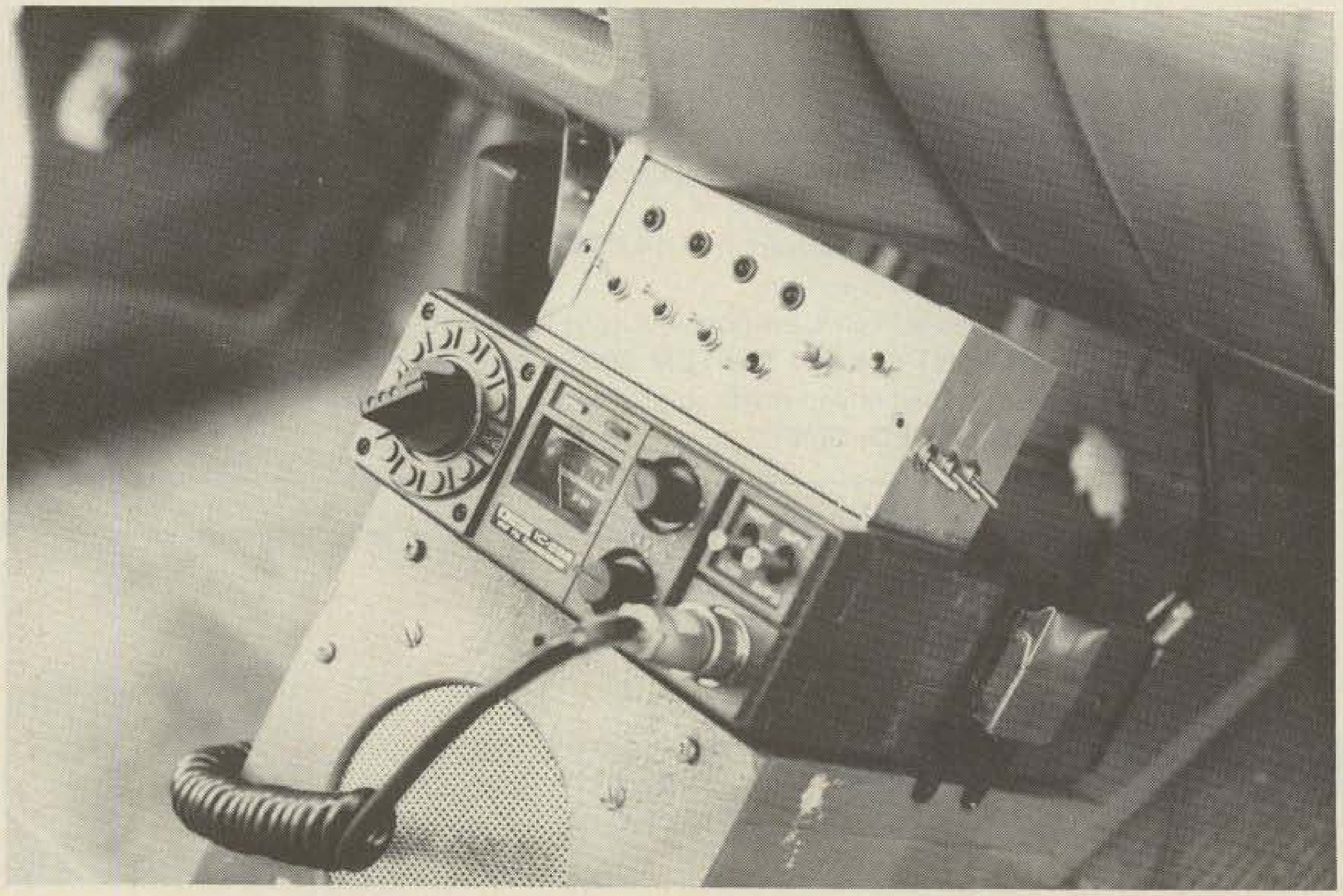
Simple Scanner For the IC-22S

After using the Icom 22S for a time, I found that although it was easy to change channels, I wanted a scanner. A study of the ham literature produced several articles on scanners. Since a small, simple and inexpensive unit was what I wanted, I planned a circuit which used a minimum number of parts, avoiding expensive or difficult-to-obtain ones.

Due consideration was given to TTL devices, but I chose CMOS, because the diode matrix in the Icom operates on 9.7 volts, and my car and home power supplies are 12/13.8 volts. Using TTL devices would necessitate a drop to 5 volts and associated dissipation and loss. The use of CMOS devices fits right into place, because they provide the right voltage to interface and no critical voltage regulator is needed.

Study of the matrix circuit for synthesizing a channel in the Icom 22S showed that only a single-pole switch is used and that only plus 9.7 volts is applied through this switch. Searching for electronics to do this, I found that the CMOS CD4017 decade counter/decoder with its inhibit gate fulfilled the requirements so well that it might have been specifically designed for this project. A CD4022 divide-by-8 counter would serve just as well, but was not on the local dealer's shelves. The counter portion provides the timing pulses. The decoder portion provides the proper sequential scanning pulses.

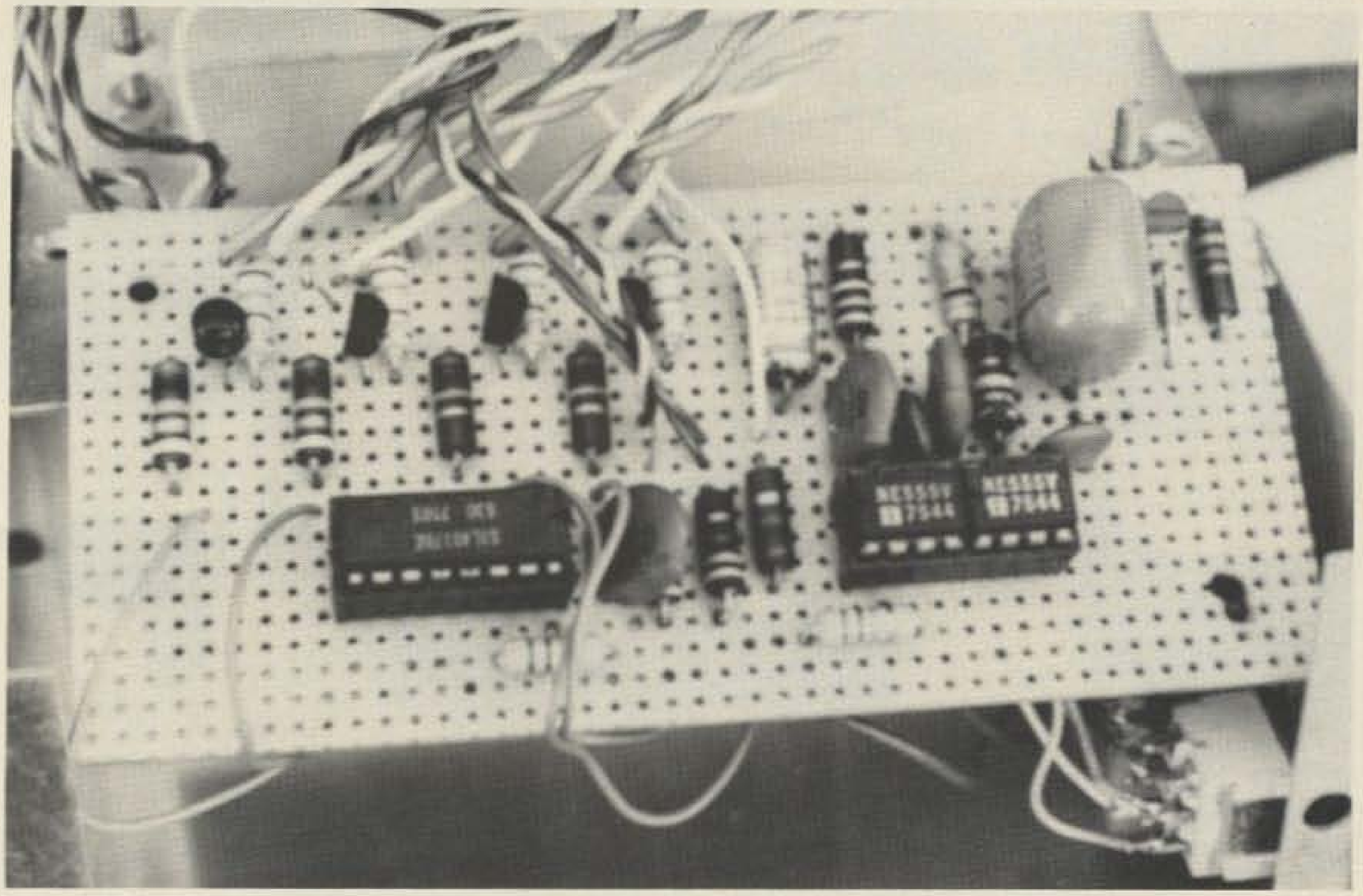


The 10 decoded outputs are normally low, and go high only at their respective decimal time slots. The simple reset allows you to choose any number of scans per cycle. I chose four, as that covers the main statewide repeater, a local island repeater, a local open private repeater with autopatch, and the municipal repeater. To get four scans, the 4th pulse is fed back to the reset terminal. There is an SPDT switch on each channel so that another set of four channels could be scanned (or any combination of channels desired). This system works well here, as the normal repeaters drop out when you travel to the opposite side of the island, and other repeaters come within range. I generally switch one of the quieter channels to monitor the 52 simplex frequency.

An explanation must be made here. During normal operation with the switch in the Dup A position, the regular frequency matrix table cannot be used for 146.520 MHz. For true simplex operation, the switch must be moved to the center position. Although this could be done with added circuitry, I felt that it would be too involved for the simple scanner I had in mind. Fortunately, KH6IEL came to the rescue at this time and reported that he had experimented and found that his 22S could be programmed down to 145.350 and up to 148.200 and still maintain lock. With this information, a channel was programmed for 145.920 which, with the switch in the Dup A position, gave a receive frequency of 146.520 MHz. This position is used for receive only. The scanner can then monitor 52 without an added circuit to control the Dup A switch. However, when answering on 52, the scanner is disabled and the transceiver is switched to a channel that is programmed for 52 in the normal manner (and is operated in the normal manner).

A big plus for the CD4017 in this unit is that the decoded outputs are normally low and go high only at their respective decimal times. It is thus possible to directly activate each scanned channel with the decoded output without need for further electronics or relays. The simple reset circuit allows you to choose any number of scanning positions up to 10. There is an inhibit gate, which is what is needed to stop the scanning on receipt of a signal. The whole scanner is built around this one chip. A second chip with dual 555 timers completes the unit. I used two 555 timers in a 16-pin socket. One timer is used as an oscillator to create the timing pulses and the other is used as a holding delay timer so that the scanner does not start between transmissions.

The unit is constructed on a piece of 2 x 4½-inch perforated board with .1-inch spacing. This is packaged in a 2¼" x 2¼" x 5" minibox and attached to the top of the transceiver. The 4 LEDs indicate the channels and the scanning rate. One switch below each LED permits switching to an alternate channel. The push-button is used to advance the scanner when it it locked to a station. The last toggle switch is used to stop the scanning and to



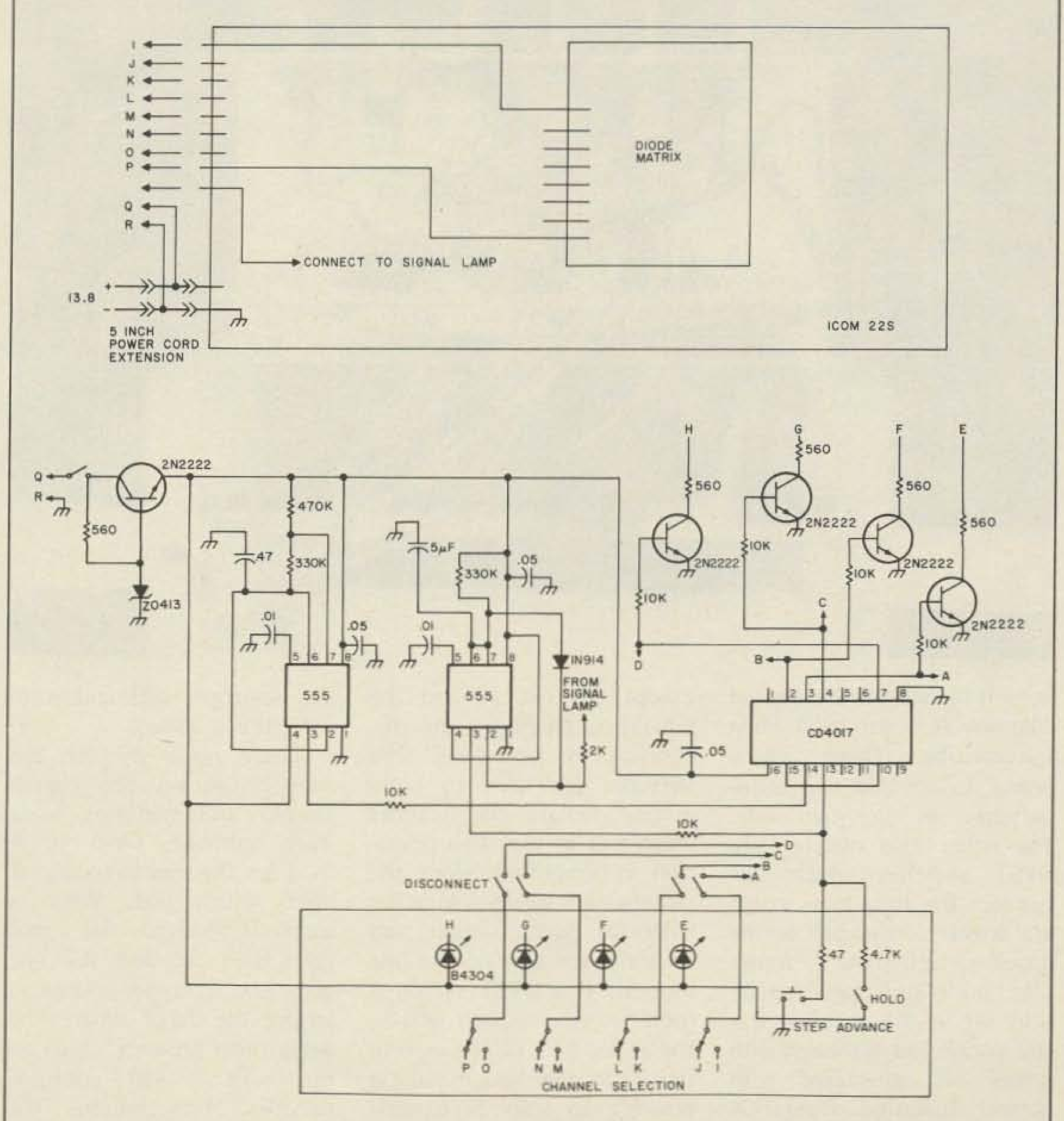
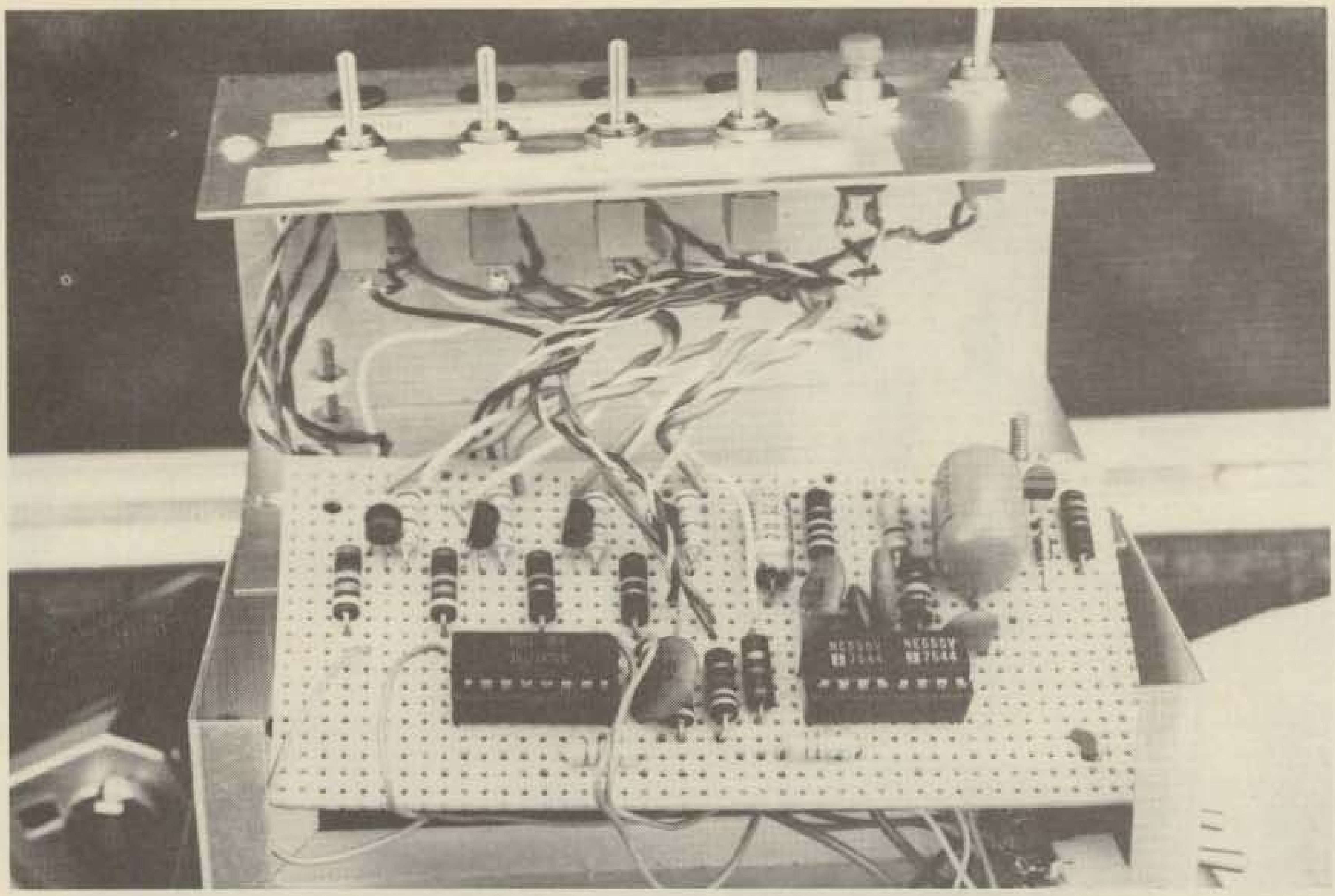
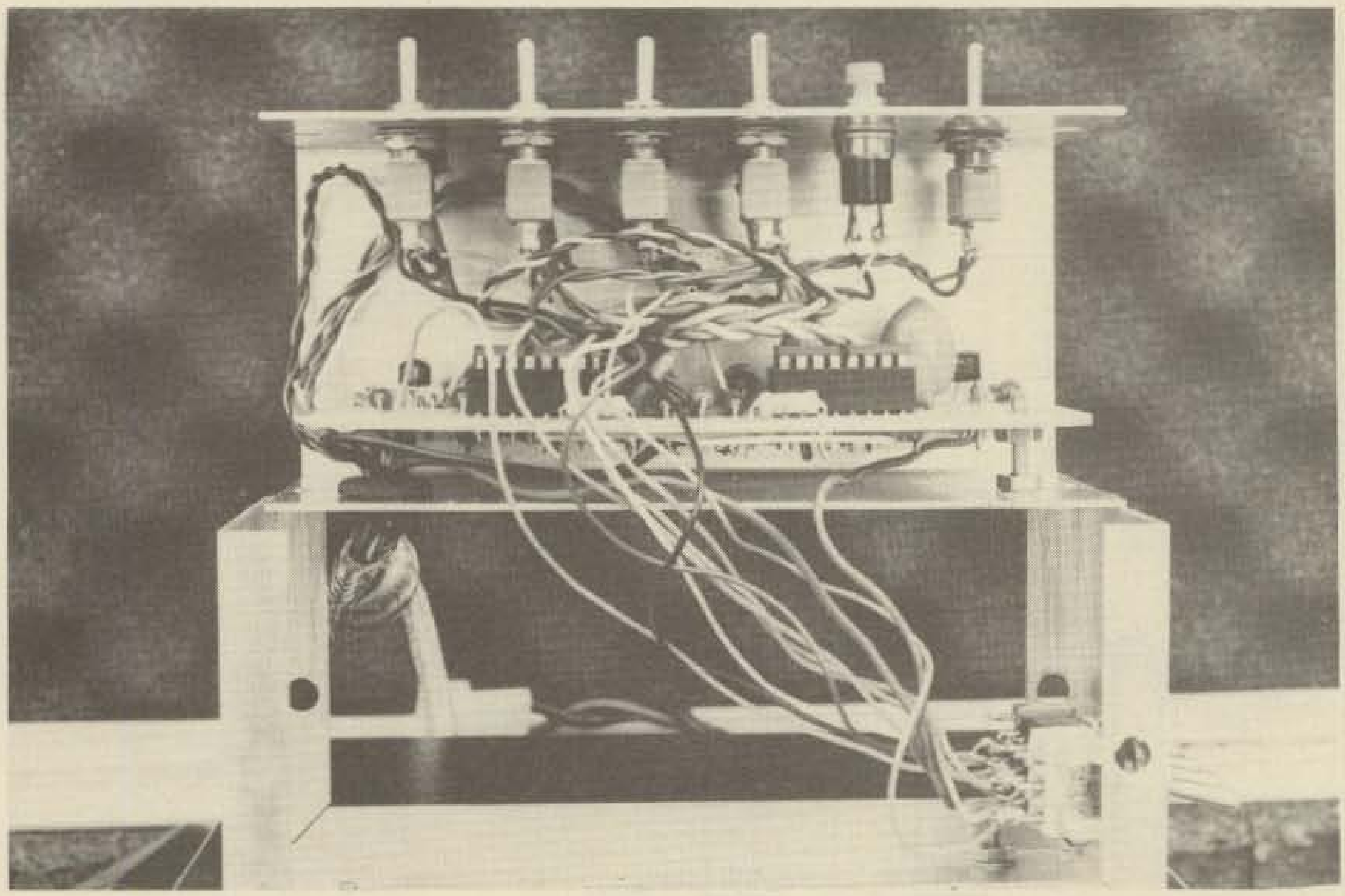


Fig. 1. Scanner.





keep it locked on the desired channel. It is also used when transmitting. There are a power switch and two other switches on the right side. The other two switches are DPST switches which disconnect the four lines which are directly connected to the decoder terminals. I found that going to regular operation while the scanner was still connected, although with power off, interfered with normal operation. Operation is okay with the scanner on channels tied to the scanner, except 52. On 52 and the remaining channels, the disconnect is necessary. The switches are used to completely isolate the scanner when not in use. This operation is simplified, since the switches are grouped together with the power switch, and all three are operated in one motion. If a DPST switch is used for the power switch, the added pole can be used to switch another line, making it possible to scan 5 channels and disconnect. Of course, the reset must be changed and another LED and transistor driver added.

There are 9 pins on the accessory socket. The original ground and metering leads were removed. One pin is used for the lead to the signal light return line. When a signal is received, the signal light goes on, and the line goes low. This low is used to trigger the delay timer. The delay timer presents a high on pin 13 of the 4017 counter/decoder. This inhibits the counter and stops the scanning. The 8 pins are used to bring the 8 desired channels on the diode matrix board out to the scanner.

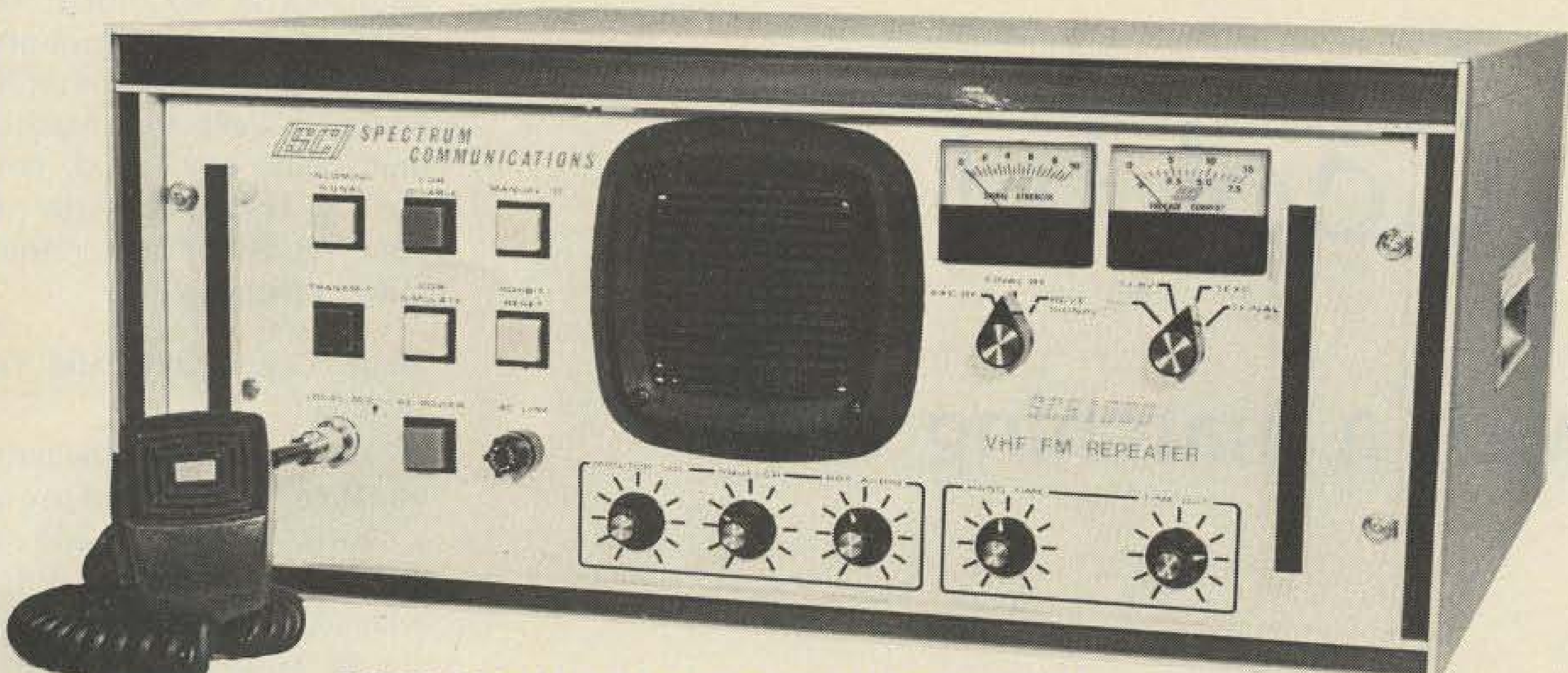
Prior to the construction of the scanner, a short 5-inch extension was made for the power cable. It was difficult to plug in the power cable each time the transceiver was moved from house to car and vice versa. With the extension, it is a simple matter to grab the two pieces and push them together. The power leads for the scanner were taken from this extension, since it remains with the transceiver. It might be mentioned that there are two more possible connections for lines, as the power plug has two unused positions. Just add the pins which you would have if you bought the plug package to make the extension cable. The leads between the scanner and the transceiver are enclosed in a shield obtained by stripping a short length of RG-58 cable. The step advance jumps, but, with practice pressing at the approximate scanning rate, movement is fairly consistent. An alternate method would be to hold the button down, scan a full cycle, and release at the desired position. With the R and C values installed, the duration of scan on each channel is slightly less than ½ second. The delay after a carrier goes off is slightly over 2 seconds.

When the power switch and the two companion disconnect switches are turned to the off position, the 22S is returned to its original unaltered condition with all 23 frequencies, switches, etc. operating normally as though nothing was ever done to it.

I wish to thank KH6IEL for his encouragement and help. He provided the information on the expanded frequencies and the method of actuating the delay circuit of the 555 timer. His enthusiasm made it possible for me to complete this project in record time. I also wish to thank Jan Kaneshiro, one of KH6IEL's co-workers, for taking the photographs. ■

SCR 1000

State of the Art in VHF FM Repeaters



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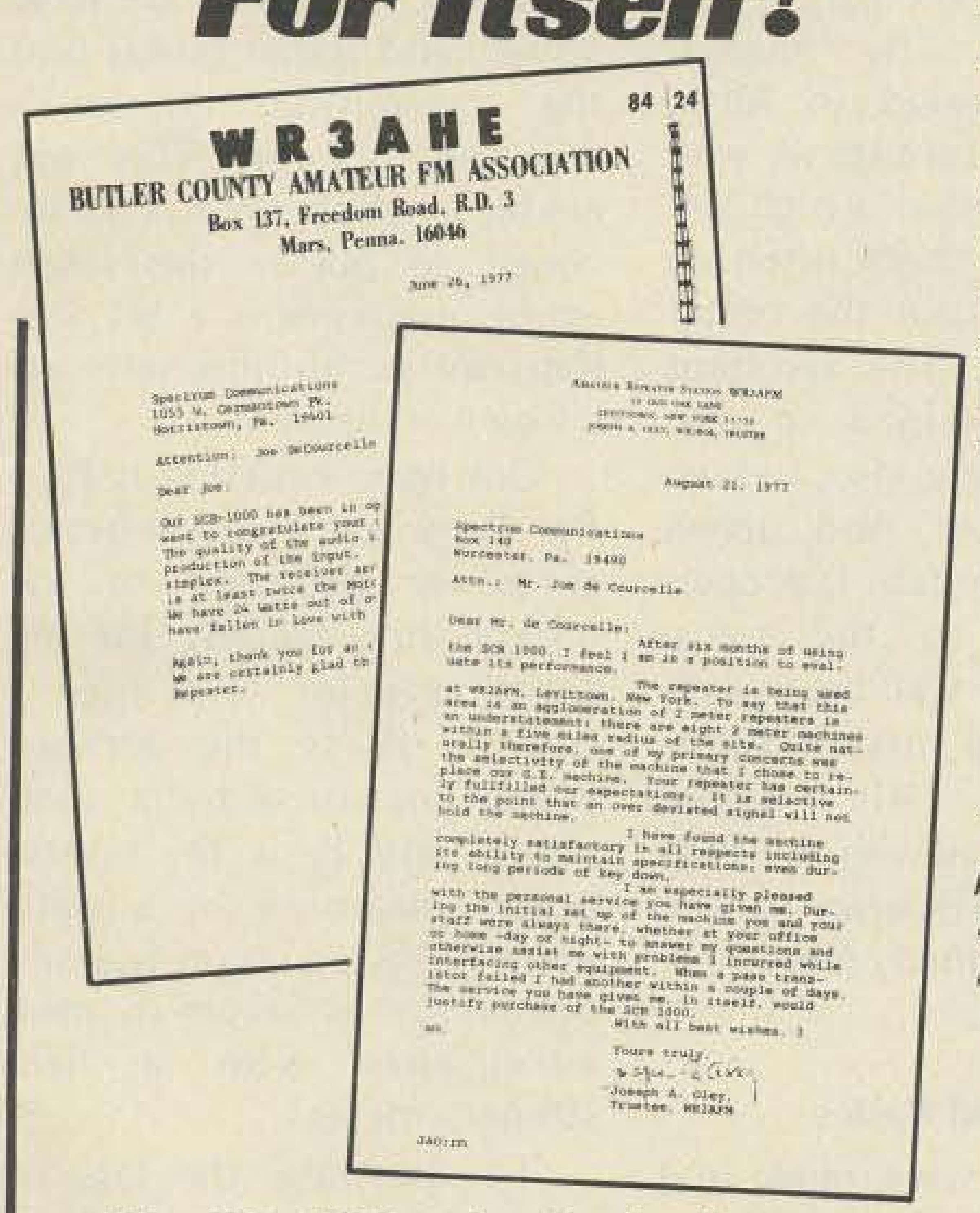

"... The quality of the audio is unbelievable — a true reproduction of the input. It really does sound like simplex. The receiver sensitivity of our Spectrum system is at least twice the Motorola system we had in service. We have 24 Watts out of our Sinclair Duplexer. We all have fallen in love with your machine ... Again, thank you for an excellent piece of equipment. We are certainly glad that we purchased a Spectrum 1000 Repeater."

Jim Wood W3WJK
Trustee WR3AHE
Butler County Amateur
FM Assoc.
Mars PA 16046

"The Model SCR100 Receiver has proven to be a fine unit. We have had it in operation for nearly a year and it has been entirely troublefree."

H. Townsend
Stone Harbor Amateur
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Cool It!

-- with a matching unit

Having had the unique distinction of being told I was an idiot during my first day at school, I sort of feel I'm a bit simple, and, as such, need things simply explained. That's why a very erudite and learned article titled, "Another Look at Reflections," which appeared in the August, 1976, issue of *QST*, had me unglued again. The author, M. Walter Maxwell, is listed as Engineer, Chief of Space Center Antenna Laboratory and Test Range, Astro-Electronics Division, RCA Corporation. Both the tone of the article and its technical content had me a bit confused. My own feeling about such articles is that technical complexity can often mask basic principles and understanding.

So as an old-time ham, I thought it might be interesting to review, in perhaps a different manner than that taken by M. Walter Maxwell, some of the basics of swr, reflections, the matching unit, and transmitter efficiency, as culled from experience and a few simple equations.

The Experimental Approach

There are often times when a simple experimental approach to a problem will clearly illustrate basic principles. This is evident in the somewhat complex mathematics of a nonresonant antenna, a transmission line, forward and reverse power, swr, and the impedance matching network required to obtain maximum power output with the best transmitter efficiency. And, with the proper use of a matching unit, your rig will run a lot cooler.

Of the ham bands from 160 to 10 meters, 80 meters has the highest frequency bandwidth to the center band frequency. This is easily calculated as being (4.0 - 3.5)/3.75 x 100, which equals 13.3%. The frequencies are indicated in MHz. This high percentage is why we generally have a high swr at these band edges when we are resonant near the center of the band. The resultant mismatch obtained at the band edges leads, also, to high reflected power. And, unless the antenna system is properly matched to the transmitter, there will be a considerable drop in transmitter efficiency. This simple experiment will show that this loss of efficiency can be easily determined, measured, and corrected.

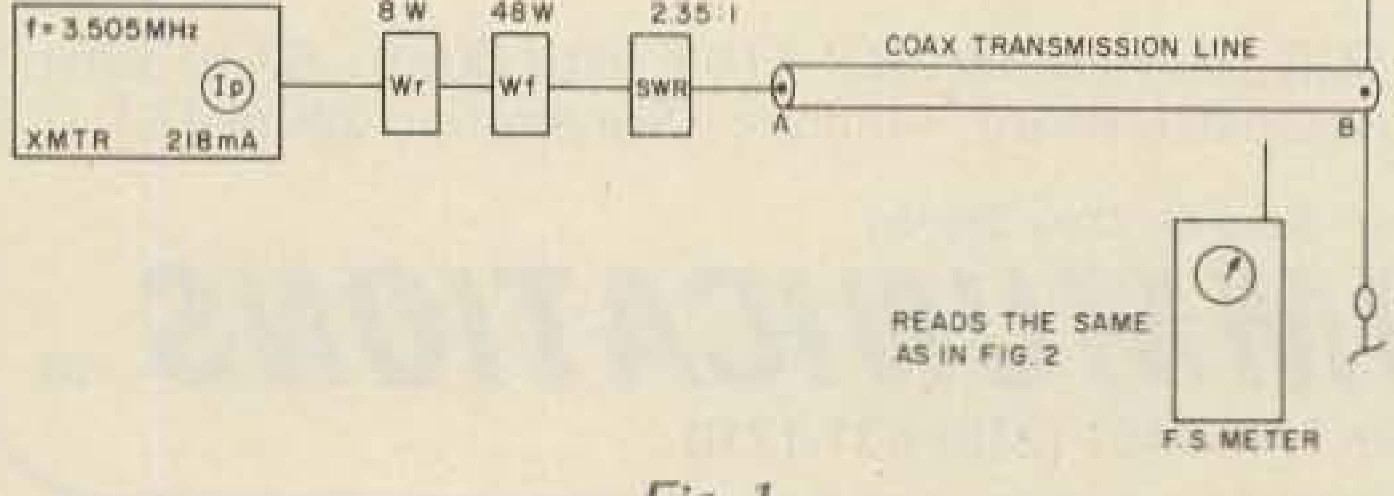

Fig. 1.

Equipment and Basics

The tests were made and data obtained using my Yaesu FT-101B, a couple of Swan WM-1500 wattmeters, capable of reading both forward and reverse power, and an swr meter borrowed from an amateur friend. A home brew rf bridge and a simple field strength meter were used to cross-check results, but these two items are not necessary to do the tests outlined. It is necessary to read the final amplifier cathode current meter for all conditions of test.

My own 80 meter inverted vee dipole is quite typical of the kind of antenna in general use by many amateurs. After a certain amount of pruning, my antenna system was resonated at 3.75 MHz. The resonant resistance measured very close to 50 Ohms on my bridge. I built the matching unit, but any good commercial unit will show the same results of better transmitter efficiency.

Math, Calculations, and Test Criteria

The only mathematics you'll really need and use are a basic equation and an efficiency calculation. But, as addenda, I'll show a couple of simple equations that relate swr, forward power, and reverse power. And I'll also include a small chart showing the relationship between forward power, reverse power, and actual power into the transmission line as a function of swr. This will enable anyone who is so inclined to pursue this interesting experiment a bit further, by performing tests on his own equipment.

Our basic equation is $P_o = P_f - P_r$, where P_o is the actual rf power delivered to the coaxial line feeding the antenna at point A of Figs. 1 and 2. P_f is the forward power measured by a wattmeter, and P_r is the reverse power measured by a wattmeter. This equation is easily proven by a couple of measurements with a field strength meter.

To illustrate the loss of efficiency when a matching unit is not used, the curve of Fig. 3 shows a plot of percentage of extra power required against swr for a constant power output to point A from the transmitter. A point on this curve is completely calculated, using my measurements. This technique will enable anyone to duplicate this experiment and validate his own results.

Always adjust the system so that you get a true power output of P_o equals 40 Watts at point A. For every reading, always properly load the transmitter by adjusting for the minimum cathode current, using the tuning and load control knobs on the transmitter. The matching unit will also always be properly adjusted whenever it is the circuit. The transmitter output of 40 Watts can readily be adjusted by controlling the amount of rf drive to the final output stage amplifier.

The Experiment

The transmitter and meters are connected to the configuration in Fig. 1. The transmitter is set to the resonant frequency of the antenna. In my case, this was 3.75 MHz. At resonance, as you would expect, the swr is 1:1, and the reverse power is zero. I adjusted the power output, as read on the wattmeter reading forward power, to 40 Watts. The cathode current on the transmitter reads 160 mA. Now, still using the configuration in Fig. 1, the transmitter is set to a frequency of 3.505 MHz. The transmitter is tuned for minimum cathode current and adjusted to give 40 Watts of rf power to point A on Fig. 1. However, from the basic equation of $P_o = P_f - P_r$, you can see that you have to adjust the drive until $P_f - P_r$ is equal to 40 Watts. This occurs for my own setup when P_f is equal to 48 Watts and P_r is equal to 8 Watts. The swr meter reads 2.35:1.

Here is where the surprise comes in. The cathode current, at its minimum dip, reads a whopping 218 mA. Could this much higher cathode current be caused by a higher power loss in the transmission line? The answer is no. First of all, we are measuring the rf input to the transmission line at point A in both cases, and it was 40 Watts each time. And, interestingly enough, the wattmeters don't even know that there is any loss on the transmission line. Secondly, a look at loss charts for coax lines

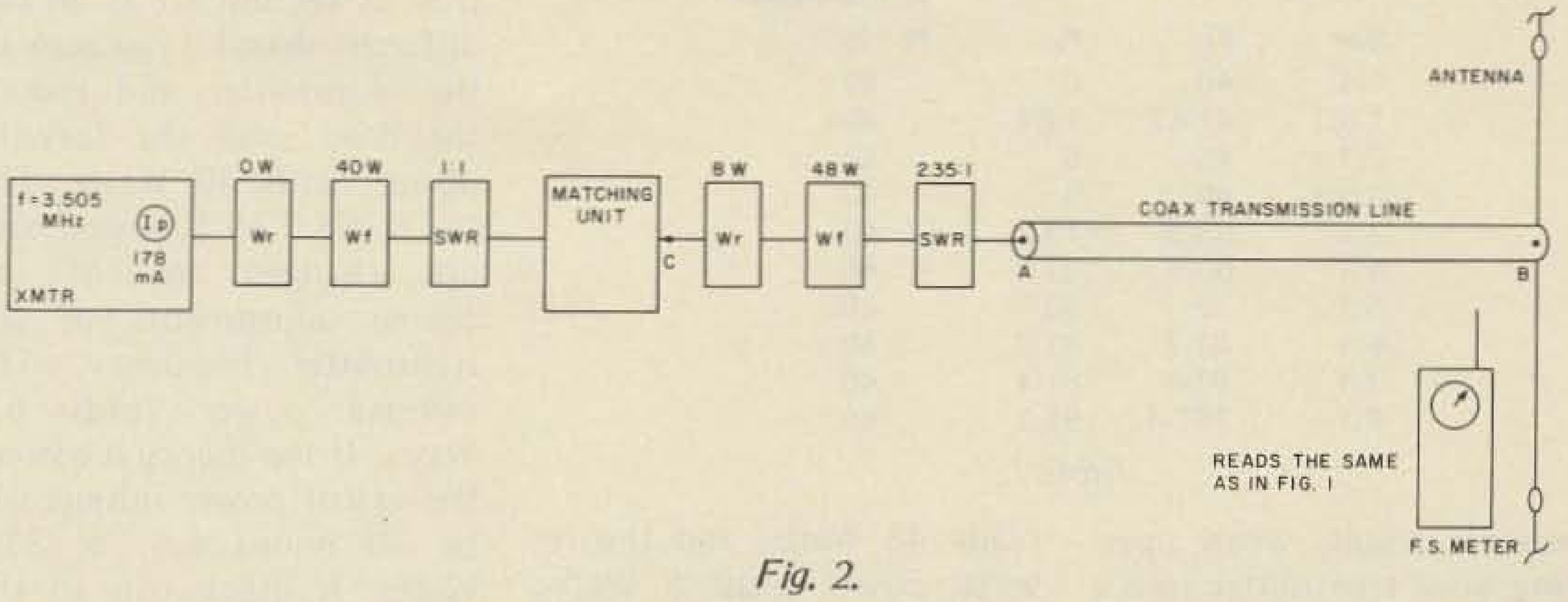

Fig. 2.

from the *ARRL Antenna Handbook* shows the following: For a 100-foot length of RG-8/U cable at 3.5 MHz, the loss, at an swr of 1:1, is .3 dB. At an swr of 2.35:1, the total loss increases to .43 dB.

When these dB loss figures are translated into transmission line power loss referenced to our 40 Watt level, we find the transmission line losses are quite low. The total power loss, at an swr of 1:1, is 2.7 Watts, and the total loss, at an swr of 2.35:1, is 3.8 Watts. This shows that the difference in loss between an swr of 1:1 and an swr of 2.35:1 is only 1.1 Watts. This small difference is not what causes our cathode current to rise to such a high value at an swr of 2.35. This high current, with the resulting loss of transmitter efficiency, occurs because the transmitter is not operating into the 50 Ohm resistive load it was designed to operate into. In other words, the transmitter is not matched to its load.

To increase transmitter efficiency, all you have to do is to look at Fig. 2, where I have inserted a matching unit. The function of the matching unit is to take whatever impedance is seen at point A of the transmission line and transform it into a 50 Ohm resistive load at the transmitter rf output connector. The matching unit, when properly adjusted, effects a conjugate match at point C of Fig. 2, to obtain maximum power transfer from the transmitter to the coaxial line/antenna system.

In Fig. 2, I have also added a couple of wattmeters and an swr meter to the right of the coupling unit to prove that reflected power is not a transmission line power loss.

Using the configuration in Fig. 2, and with the transmitter set to 3.505 MHz, start loading out. By simultaneously adjusting the tuning and load controls of the transmitter, and properly adjusting the matching unit, you easily obtain an swr of 1:1 on the swr meter to the left of the matching unit. The associated wattmeters are read for forward and reverse power. The reverse power meter reads zero. Now the transmitter drive control is adjusted until the forward power meter reads 40 Watts. And, as P_r reads zero, P_o, or true output power, is read on the forward power meter and reads 40 Watts. Now read the cathode current meter. It reads only 178 mA. This is certainly a lot lower than the 218 mA we read without the matching unit being in, for the same rf power output of 40 Watts to the coax cable at point A.

It's easy to calculate how much extra power you use percentagewise when comparing the two cathode current readings. Knowing that power varies as the square of the current, simply divide 218 mA by 178 mA and square it, which equals 1.49. Then subtract 1 from 1.49, and you obtain .49. Now multiply .49 by 100, to get 49%. What this says is that, without the matching unit in at 3.505 MHz, you need 49% more power to get the same 40 Watts of true rf output, as compared to when the matching unit is in. This is not theory, but is based upon actually-measured values. And this 49% extra power only heats up your transmitter that much more. This is one of the basic reasons why most transmitter manufacturers tell you not to operate their transmitter into a high swr load. Another un-

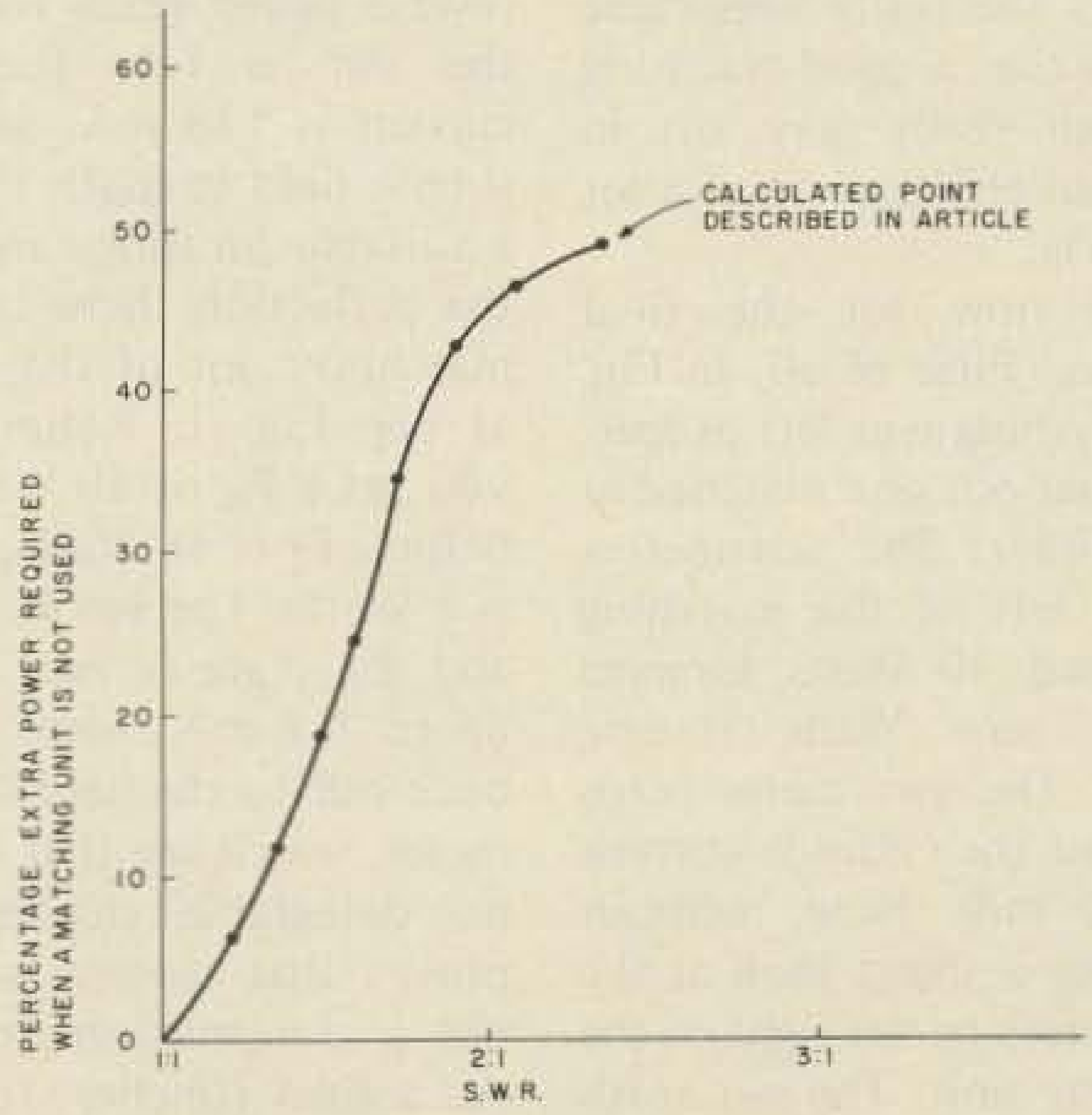

Fig. 3. Swr/extra power curve.

Swr	P_f	P_r	Actual Power $P_f - P_r$
1:1	40	0	40
1.5:1	41.67	1.67	40
2:1	45	5	40
2.5:1	49	9	40
3:1	53.3	13.3	40
4:1	62.5	22.5	40
5:1	72	32	40
6:1	81.7	41.7	40
7:1	91.4	51.4	40
8:1	101.3	61.3	40

Table 1.

desirable result, when operating your transmitter into a high swr load, is that higher rf voltages are developed in your transmitter for the same true power output. These higher voltages and currents can easily cause considerable damage to your rig.

Efficiency Curve and Final Surprises

The 49% excess power at an swr of 2.35:1 is one point on the curve of Fig. 3. It is easy to complete the curve by taking various frequencies between 3.505 and 3.75 MHz and measuring swr and cathode currents with and without the matching unit in the system. The efficiencies were calculated the same as in the example just cited. As expected, at the lower swr values the swr decreases along with the reverse power measured. At 3.75 MHz, the cathode current reads 160 mA at an swr of 1:1, whether or not the matching unit is in the circuit. This is the resonant point of the antenna, and no matching unit is needed. The really important thing is that a good matching unit can really pay off in increased efficiency and a lot cooler rig.

And now for the final surprises. First of all, in Fig. 2, everything was left properly loaded out and matched at 3.505 MHz. The wattmeters to the left of the matching unit read 40 Watts forward power, zero Watts reverse power. The swr meter reads 1:1, and the cathode current is 178 mA. Now, without touching a thing, look at the wattmeters to the right of the matching unit. The swr reads 2.35:1, the forward power reads 48 Watts, and the reverse power reads 8 Watts. And 48 minus 8 is equal to 40 Watts, which is the actual power going into the coaxial line at point A. This is the actual power available to the antenna, less the small transmission line loss that we calculated earlier.

The actual power at the antenna at point B is 40 minus 3.8, or 36.2 Watts at 3.505 MHz. The antenna power at 3.75 MHz is 40 minus 2.7, or 37.3 Watts. The difference is only 1.1 Watts, as seen earlier. The 1.1 Watt difference was so small that I could not detect it using my field strength meter for the measurements I'm going to talk about now.

The last step is to prove that $P_o = P_f - P_r$, and that reverse power is not a transmission line power loss. With the transmitter set up at 3.505 MHz, load up for 40 Watts rf output with the matching unit in the circuit. On the meters to the left of the matching unit the forward power reads 40 Watts, reverse power reads zero, and the swr is 1:1. The plate current is 178 mA. Set up a simple field strength meter at a suitable location, and note the deflection. Now take the matchbox out of the circuit, as per Fig. 1. Retune until you get a P_o of 40 Watts. As before, P_f is 48 Watts, and P_r is 8 Watts. The swr is 2.35:1, and the plate current is back up to 218 mA. When you go back out to the field strength meter, you'll see that there is no detectable change. This proves that reverse power is not a transmission line loss. As a final clincher, to prove that forward power is not true power output at an swr different than 1:1, go back to the transmitter and reduce the drive until the forward power reads 40 Watts. The swr is still 2.35:1, as you have not changed any of the tuning adjustments of the transmitter frequency. The reverse power reads 6.5 Watts. If the theory is correct the actual power output will be 40 minus 6.5, or 33.5 Watts. A quick trip to the field strength meter indicates exactly such a drop in field strength. The field strength meter had originally been cross calibrated, in terms of relative power output, for this experiment. This final step proves that $P_o = P_f - P_r$.

Addendum

It should be noted that some amateur transmitters are able to both tune their final stage and provide a matching action at the same time, over a generally limited frequency and swr range. This is a function of transmitter design. It can readily be checked by, first, loading up into a proper dummy load, and measuring the cathode current. Then, without changing frequency, the transmitter is loaded into the antenna system without the use of the matching unit, as per Fig. 1. If the cathode current at this time reads the same as it did for the dummy load, and you have the same power output P_o, where $P_o = P_f - P_r$, the transmitter is acting as its own matching unit, even though the swr is not 1:1.

However, this type of matching, from my own personal experience, is the exception rather than the rule. My own Yaesu FT-101B, and other somewhat similar transmitters, indicated that a good matching unit is essential to obtain the best efficiency, when tuning into a nonresonant antenna system. And as we mentioned earlier, a good matching unit will also protect your valuable transmitting equipment from dangerous voltages and currents.

A final and interesting point can also be noticed – At high swr values, both the forward and reverse power can be larger than the true power output of the transmitter.

Table 1 shows an actual power output of 40 Watts, along with forward and reverse power tabulated for values of swr from 1:1 to 8:1. This tabulation also shows that forward power readings alone, at high values of swr, can be very misleading. For example, from the chart, at an swr of 5:1, we would read forward power as 72 Watts. Although we might think we were getting 72 Watts output, this is not the case, as, at this swr, the reverse power is 32 Watts, and our actual true power output is the difference, or only 40 Watts. We also see that, at any swr of more than 6:1, both our forward and reverse powers are actually more than the true power being delivered. The basic equations relating swr, forward power, and reverse power are as follows:

$$\text{Swr} = \frac{1 + \sqrt{\frac{P_r}{P_f}}}{1 - \sqrt{\frac{P_r}{P_f}}}$$

$$P_r = P_f \left(\frac{\text{swr} - 1}{\text{swr} + 1}\right)^2$$

These equations are useful in the event that a wattmeter, which reads only forward power, and an swr meter are available. The reverse power can easily be calculated.

I hope that this simple experiment will enable you to better understand the more rigorous mathematical approach, which often, unfortunately, complicates a basically simple problem. And for the purist in these matters, it is to be understood that there are some very minor second order effects that in no way affect the basic validity of this experimental approach. ■

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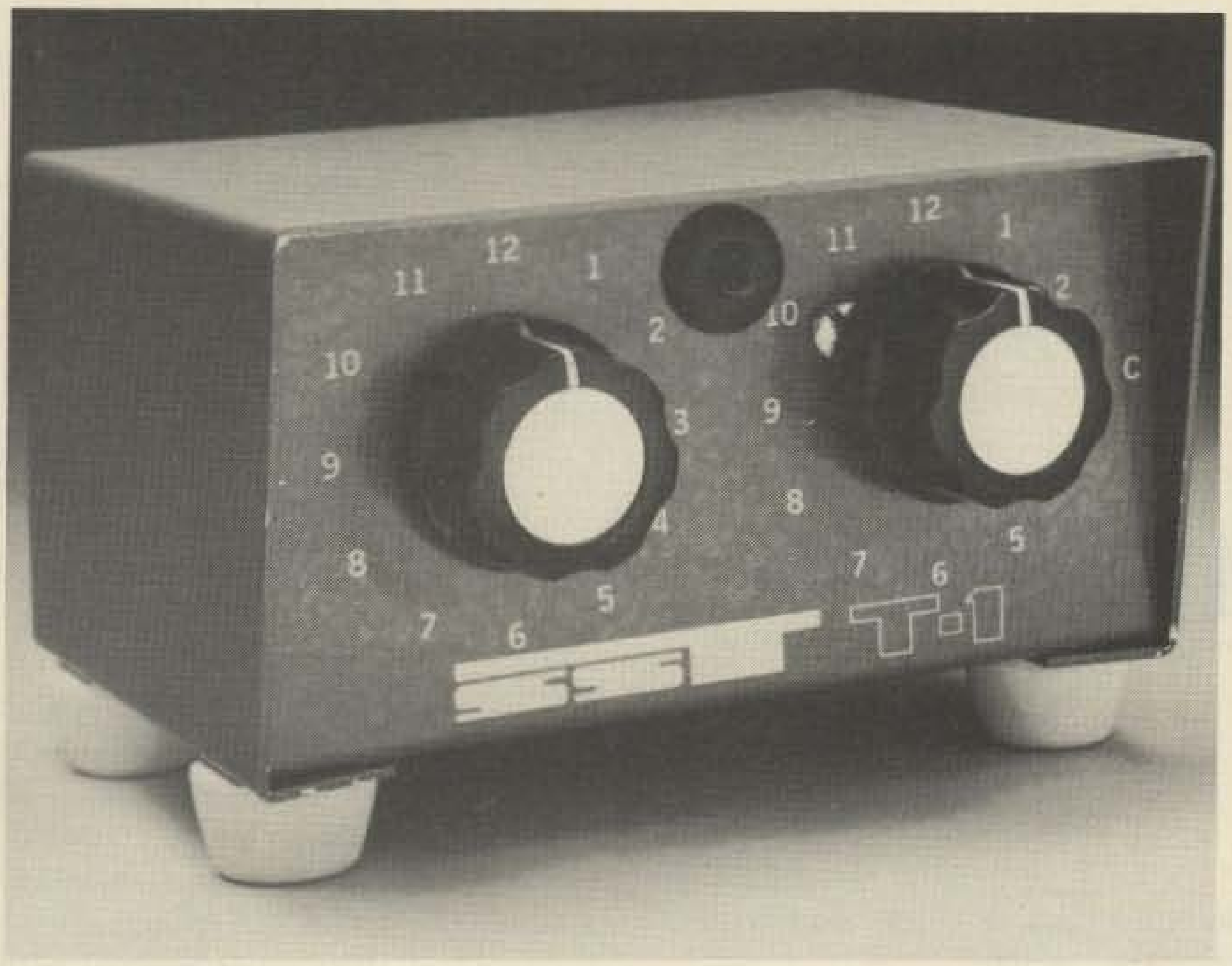

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Weather Satellite Pix Printer

Several articles have been published in the past describing various readout devices for weather satellite photographs. They were basically divided into CRT or drum recorders. This article deals primarily with the latter, although the video circuitry may be used in conjunction with a CRT display.

	3000 Hz cutoff	5500 Hz cutoff
C1	.028 uF	.015 uF
C2	.084 uF	.046 uF
C3	700 pF	382 pF
C4	.153 uF	.064 uF
C5	.80 pF	98.6 pF
C6	.053 uF	.03 uF
C7	668 pF	365 pF
C8	.028 uF	.016 uF
C9	.0063 uF	.035 uF

Table 1.

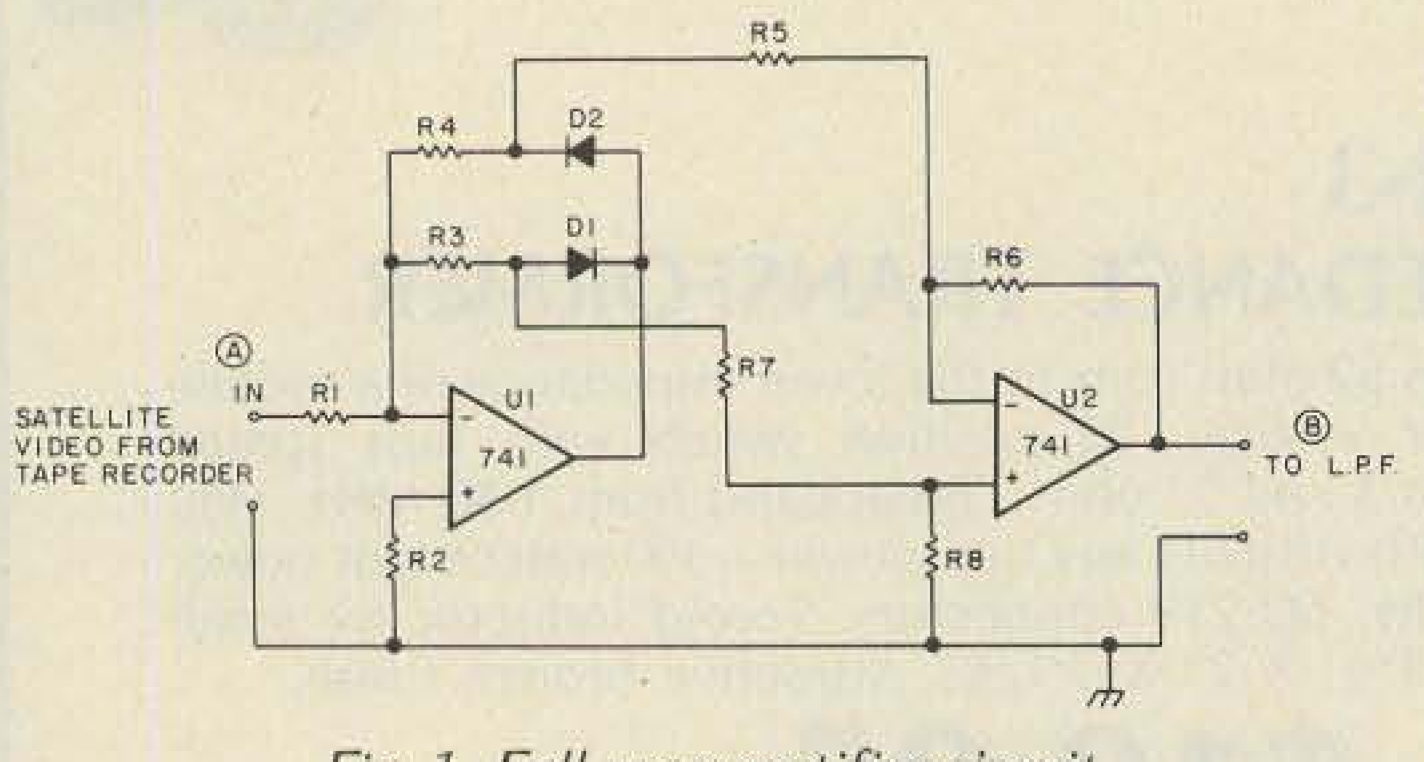


Fig. 1. Full wave rectifier circuit.

It was interesting to follow the changes in circuitry from that in K2RNF's device to that in WB8DQT's series published in this magazine.[1,2]

I tried several circuits, with some measure of success, before I decided on what I considered optimum. WB8DQT's 12AU7 amplifier was replaced with an op amp. The full wave transformer detector and the lamp driver, normally a 6CL6, was replaced with a straightforward transistor circuit. Another op amp and IC hybrid chip make up the drum driver, which normally weighs in the neighborhood of thirty pounds with its large choke, transformers, and 12AU7/6550 tube complement. Another novel circuit change was to replace the satellite subcarrier filter with a state-of-the-art active filter, instead of using the choke/capacitor combination that has been used in the past. As a final touch, Cawthon designed a lamp carriage drive with pulleys and stainless steel wire to replace the threaded rod method, which completely eliminates line pairing, a bane to the perfectionist.

Construction

I preferred to use modular construction for its ease of testing after completion. The modules were divided into preamp and full wave precision rectifier, low pass filter, dc amplifier and lamp driver, and, finally, the drum motor amplifier. The modules were constructed on PC boards using standard techniques, with molex pins for the ICs. The amplifier hybrid chip was mounted with Dow 340 on a .09-inch perforated aluminum plate for a heat sink, and then bolted over a 4-inch square cutout in a chassis. A muffin fan is used to further cool the arrangement – it will run for several hours without heating. A good grade of capacitor is recommended for the low pass satellite subcarrier filter, since we are using a ninth order, .5 dB ripple, Chebyshev filter. Since I ended up with strange values of capacitance, due to the formulas involved, the final capacitance, in most cases, was arrived at by paralleling two or more. The higher the order (number of poles) involved, the more likely you are to run into failure. A fifth order filter, consisting of two op amps, should work nearly as well.

Circuit Description

The first op amp in the full wave rectifier circuit is a conventional half wave rectifier, with the output of each diode opposite in phase. The two out-of-phase outputs are fed into the second op amp, which has the function of a summing amplifier. The output will be a symmetrical full

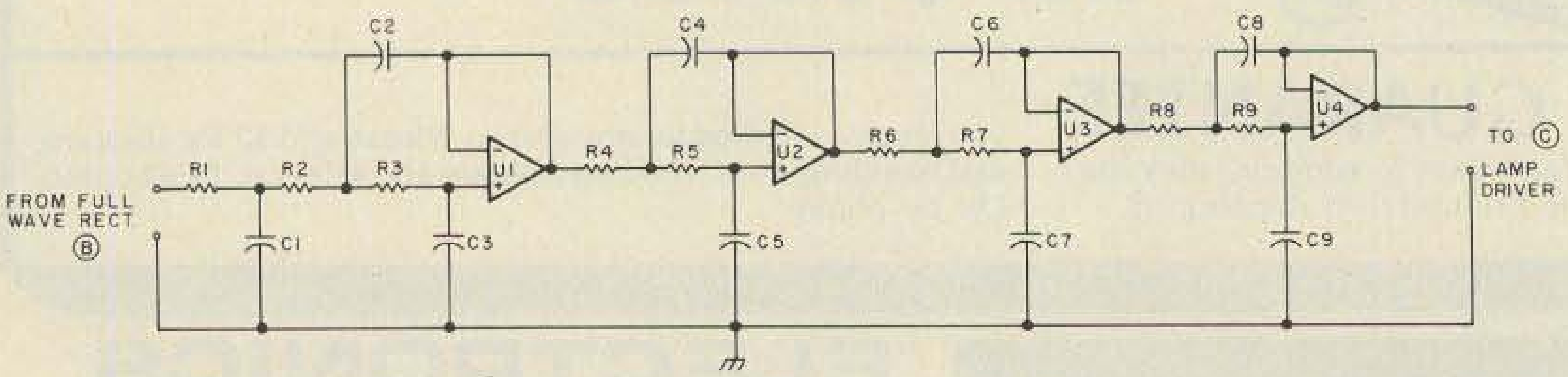


Fig. 2. Noninverting, unity gain, low pass, .5 dB ripple, Chebyshev ninth order satellite subcarrier filter.

wave, if all resistors associated with the summing amplifier are equal. The video information from the satellite is 0-1500 Hz, with the blacks being low and the higher end of the spectrum corresponding to white.

After rectification, the video becomes 0-3000 Hz, and the satellite subcarrier doubles to 4800 Hz. By designing an active low pass filter with low ripple and a sharp cutoff near or above 3000 Hz, we can effectively eliminate the subcarrier. Since Cawthon and I operate fundamentally on two different modes, it was decided to use two filters – one with a cutoff near 3000 Hz, and the other with a cutoff near 5500 Hz. The reason for the latter is that my equipment is operated on playback at 192 rpm (a multiple of four times the present NOAA scan rate), which effectively cuts down on the time needed to reproduce a picture and allows for a large format with line blanking. I record a pass at 3-3/4 ips and play back at 7-1/2 ips. Cawthon uses the 240 lpm scan rate associated with SMS GOES WEFAX transmission, using format compatible with the older ESSA-8 and ATS geosynchronous satellites, where pictures were normally three minutes long and no line blanking was required.

With this method, playback at unity, the lower frequency filter will suffice. At twice the playback speed, the higher frequency filter is required. The preferred method is to build both and switch them for station flexibility. Table 1 provides capacitance values for both modes of operation. The resistors in all cases are 10k 1%.

The dc amplifier following the low pass filter provides gain and isolation to the 2N3440 transistor lamp driver. In the first stage, some gain was required and could be controlled by the value assigned to R2. Some experimentation was required to determine where to place the line blanker pulse for interlace operation. Through trial and error, I found that the -10 volt pulse does a good job at the inverting input of the first stage at the junction of R1 and R2. In the quiescent state, the 2N3440 is biased to draw maximum (black) current through the adjustment of R10. I use an R1166 glow modulator tube, which has a slightly larger crater size than the R1166 and requires slightly more current. This circuit has a dynamic range of about 10 mA swing and works very well with Kodabrome FH paper.

The drum driver amplifier consists of a novel arrangement in that the input stage is tuned for the desired output frequency, rather than a large value high current choke in the final stage, as was used with the 12AU7/6550 or 6DQ5 arrangement. Two values are included, for either 48 Hz or 60 Hz operation. The sine wave output is fed to a Sanken hybrid amplifier of your choice (they range in wattage from ten to fifty with corresponding prices), amplified, and fed to the drum motor through T1. Unless you decide to stick with one mode of operation, a duplicate system should be built for the lamp carriage drive. Synchronous motors will grind, at half speed, at 30 Hz.

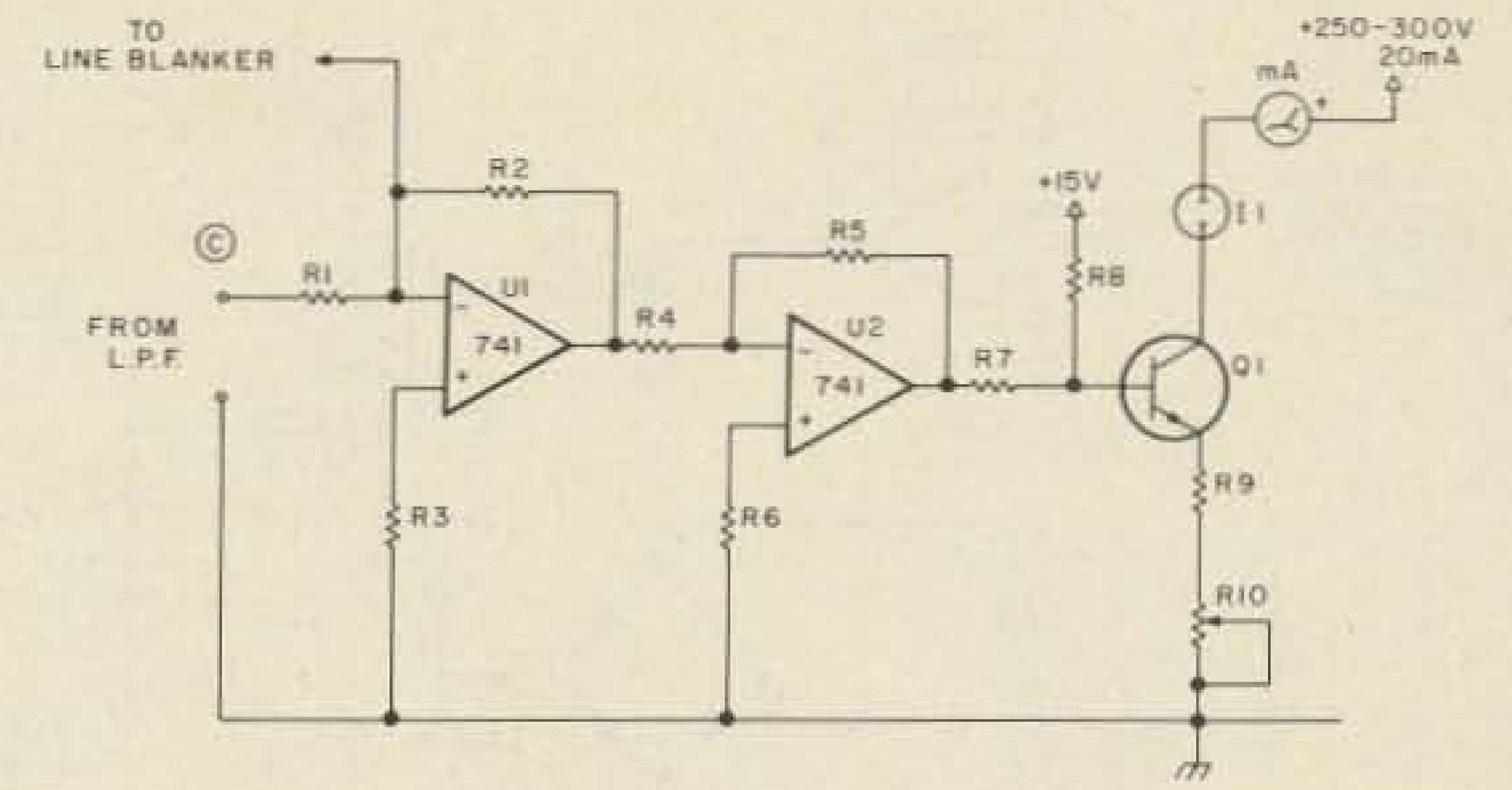


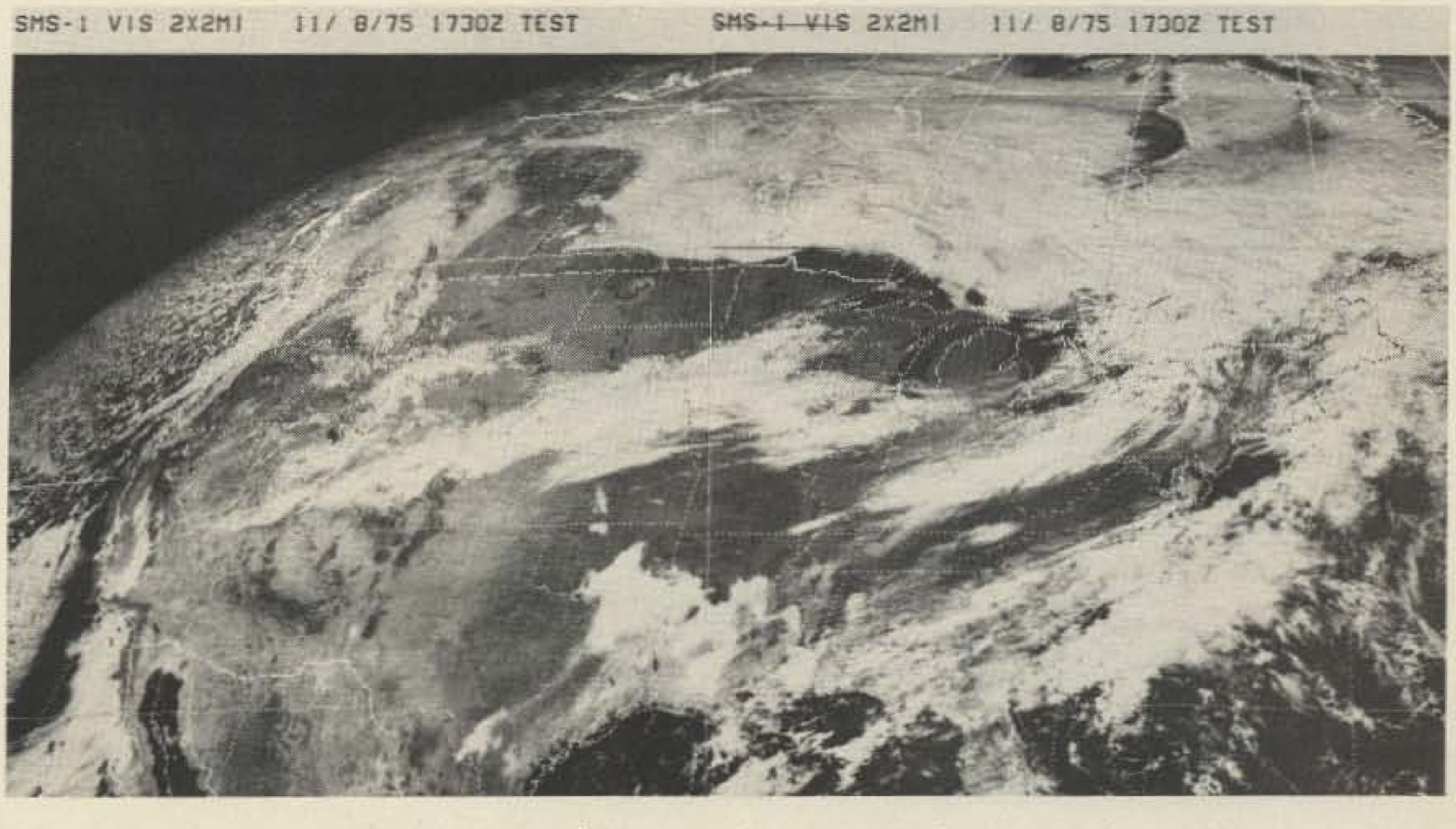
Fig. 3. Dc amplifier and lamp driver.

Operation

Adjust R10, the 1k pot in the lamp driver circuit, for desired maximum black current. The satellite signal is fed from the tape recorder to the input of the rectifier circuit. Depending on the signal level from the recorder, a variable gain 741 op amp may have to be added to optimize the signal level. If possible, monitor the dc signal level at the base of Q1 or the junction of U1 or U2 at the inverting input. If a dc scope is not available, watch the lamp current meter for fluctuations to average the midscale between maximum black and maximum white. This should provide a starting point. The 2N3440 runs hot enough to leave a scar on the index finger at 15 mA, even when heat sinked, so don't leave it in this condition for more than a few seconds when testing. For the sake of brevity, reference oscillator circuits, phasing circuits, and line blanker have been omitted, since they have been described adequately in previous articles. Notice the absence of gamma correction circuits. For those lucky enough to receive data from SMS GOES, no gamma correction is necessary. For the polar-orbiting NOAA variety, the daylight visible spectrum transmissions need little or no correction. Night or day IR are seldom recorded at this station.

Some More Ideas

The circuits described are



Cawthon print. Note the absence of lines or line pairing. Drum speed – 240 rpm. No line blanker.

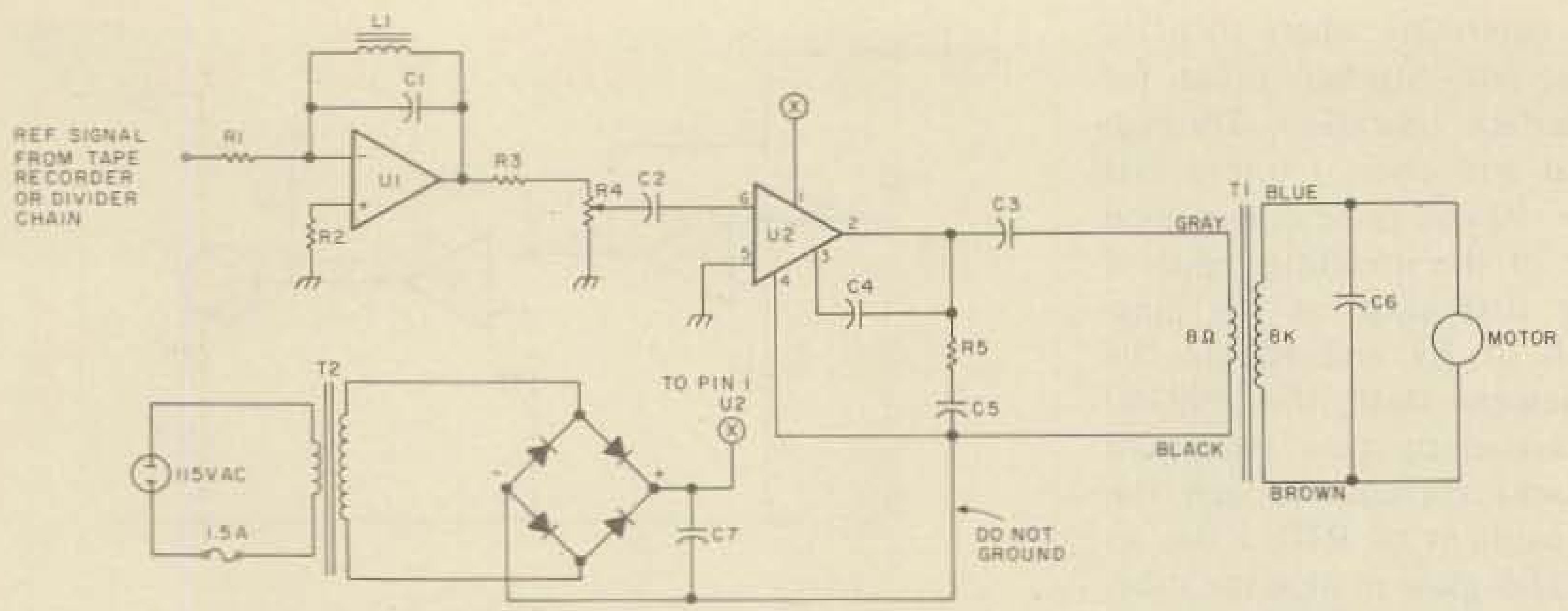
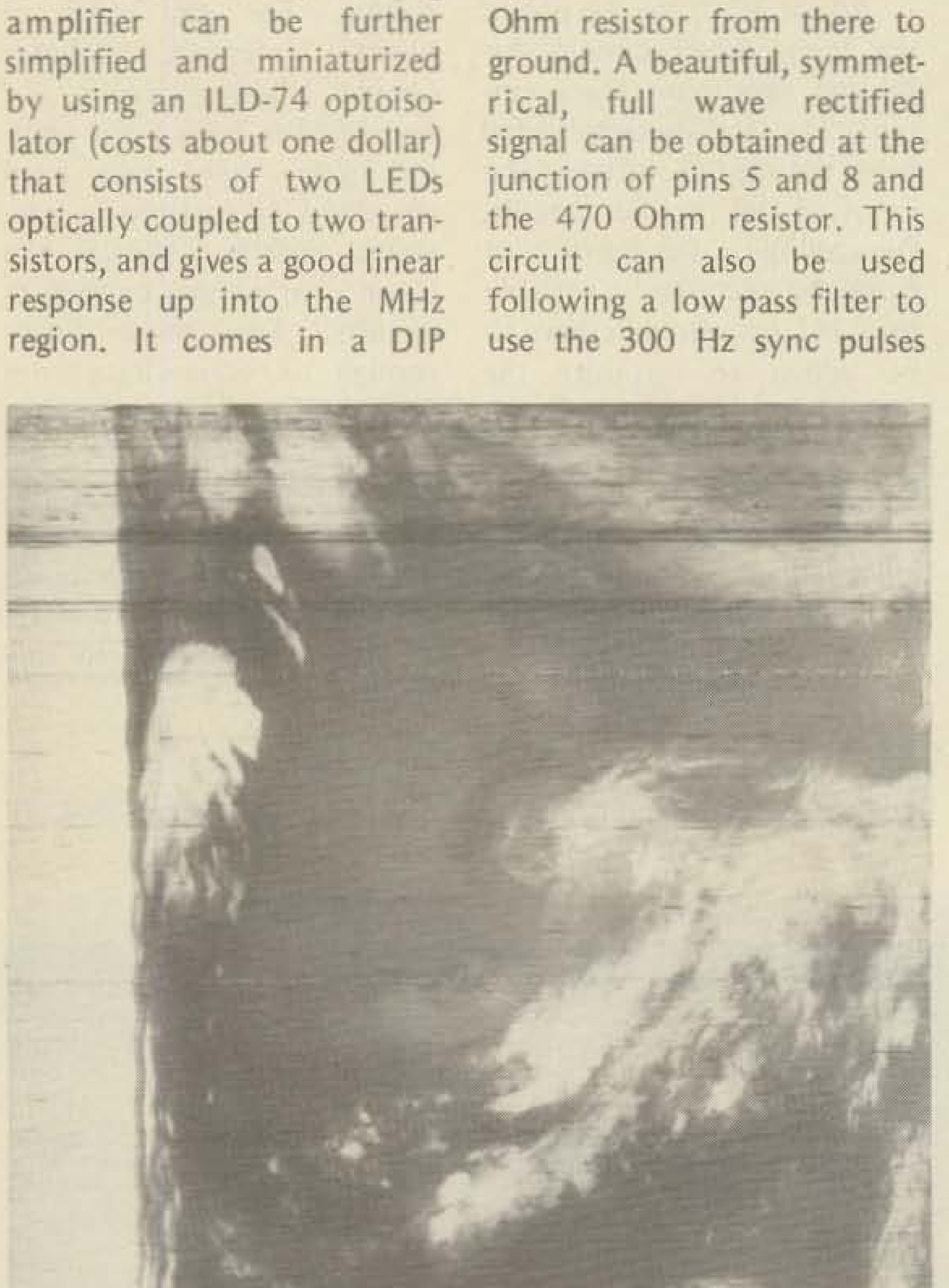


Fig. 4. Drum/carriage motor drive circuit.

by no means the ultimate, although they appear to shove the tube circuits further out of the picture and should encourage some new ideas. The rectifier/summing amplifier can be further simplified and miniaturized by using an ILD-74 optoisolator (costs about one dollar) that consists of two LEDs optically coupled to two transistors, and gives a good linear response up into the MHz region. It comes in a DIP package. Tie pins 2 and 4 together for signal input, and ground pins 1 and 3. Tie pins 6 and 7 together and connect to Vcc (5 V). Tie pins 5 and 8 together and use a 470 Ohm resistor from there to ground. A beautiful, symmetrical, full wave rectified signal can be obtained at the junction of pins 5 and 8 and the 470 Ohm resistor. This circuit can also be used following a low pass filter to use the 300 Hz sync pulses from the satellite for an auto-phase system, to eliminate manual phasing. I noticed some laser diodes on the market, selling for about eight dollars, that are capable of high currents when pulsed. Although I am not sure how IR light will affect photographic paper (it is normally insensitive to red, amber, and green light), a laser diode with a fairly high duty cycle may have some application in this respect. The high cost of a glow modulator lamp ($49.50 at this writing) would have some of us look into a less expensive light source.

With the coming generation of geosynchronous satellites operating in the GHz region, I would welcome some ideas from the UHF gang on a 1691.0 MHz to 137.5 MHz simple converter to access the current SMS GOES daily WEFAX broadcasts. Cawthon had the first and only amateur 1691.0 MHz station in existence. The front end, however, consists of commercially-built or modified commercial equipment. Reception is by a ten foot aluminum spun dish at fixed azimuth and elevation. I will be happy to answer questions pertaining to the project, but please be good and send an SASE, or arrange a sked with me on any band except 160 meters. ■



Night IR shot. Note Hurricane Belle in lower portion of picture (with pronounced eye).

References

[1] "Amateur Reception of Weather Satellite Picture Transmissions," Anderson K2RNF, *QST*, November, 1965.

[2] "A Satellite Fax System You Can Build," Taggart WB8DQT, *73*, Sept., Oct., 1975.

[3] "A Satellite Receiver in the Home," Ruperto W3KH, *Scientific American*, Jan., 1974.

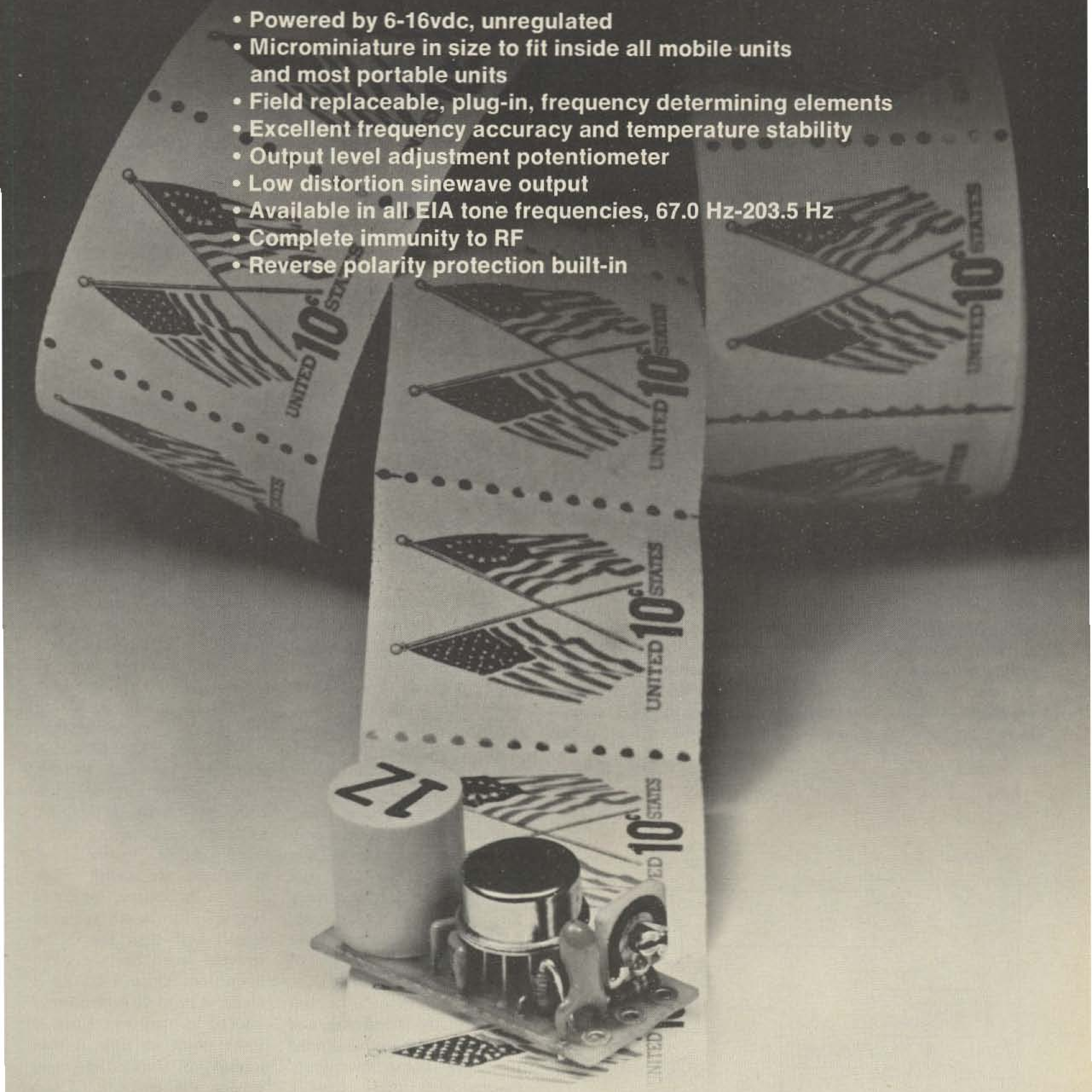
[4] "Tables Speed Design of Low Pass Filters," Farouk-Al-Nasser, *EDN*, March 15, 1971.

Parts List

Fig. 1:	
R1 through R8	10k, 1% ¼ Watt
U1, U2	741
Fig. 2:	
All resistors	10k, 1% ¼ Watt
Fig. 3:	
R1 through R5	10k, ¼ Watt
R7	2.2k
R8	3.3k
R9	330 Ω
R10	1k pot
U1, U2	741
Q1	2N3440
I1	R1166 or R1168
mA	0-25 mA milliammeter
Fig. 4:	
R1, R2, R3	10k, ¼ Watt
R4	5k pot
R5	10 Ω, ¼ Watt
C1*	1.8 uF
C2	.1 uF
C3	2200 uF, 50 V
C4	50 uF, 50 V
C5	.05 uF
C6	motor cap
C7	2200 uF, 50 V
T1	Stancor A-25, 8 Ω PRI, 8k sec, 10 Watts
L1	4 H

*For 60 Hz; for 48 Hz – 5.2 uF.

ME-3 microminiature tone encoder



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operation occurs many times throughout the program run. Notice that many previous choices can become unacceptable. As the program proceeds we are, in effect, refining the decision-making process.

An Example Program

A crossword puzzle, although suited to a backtracking solution, is too extensive for small systems, and the needed heuristics are almost impossible to program anyway. My specific example is, then, a program that will set up an ordinary addition of two four-digit numbers. Obviously, the sum must contain either a four- or five-digit number. If the sum, indeed, has five digits, the most significant digit (the leftmost digit) is always a one. Try it. This is always true.

The input to the program is a series of letters, such that the sum row obeys the rule of addition. A specific letter can never represent more than a single number and vice versa. The program as presented here will generate all the solutions to a problem if, in fact, any do exist! Look at this example:

```
  SEND
+ MORE
 -----
 MONEY
```

This has only one solution (i.e., M = 1, O = 0, N = 6, E = 5, Y = 2, R = 8, S = 9, D = 7). Then the program will output:

```
  9567
+ 1085
 -----
 10652
```

This specific puzzle, by the way, consumed over 9 CPU seconds on an IBM 370/168 running Dartmouth BASIC.

How It Works

Except for some fine points, the program's operation can be seen in the flow diagram. The P$ array contains the letters representing the problem. It is a 5 x 3 rectangular array, and, therefore, the most significant digit of each addend must be a blank. The leftmost digit of the sum must be input either as a blank or a letter. The T array is a stack that corresponds to the P$ array in the following manner: If a letter has been assigned a number in the P$ array, a 1 is stored in its corresponding position in the T array. The S array is the answer stack and is printed out whenever a solution is complete. The I, U, and V arrays are used to determine acceptability.

The program substitutes digits for letters in columns only. The rightmost column is processed first, and the processing proceeds to the left until all columns are accepted. If a choice eventually leads to a dead end, the previous column is deleted (popped off the answer stack). This is analogous to

```
001 REM -- AN EXAMPLE OF A BACKTRACKING ALGORITHM IN NON-RECURSIVE
002 REM -- FORM.                                DON LANG : 5/77
003 REM
010 DIM P$(15),T(12,5),S(4,5),I(3),U(3),V(3)
020 Q=0
030 F=0
040 C=0
045 REM -- READ PROBLEM
050 FOR M = 1 TO 3
060  INPUT P$(M+12),P$(M+9),P$(M+6),P$(M+3),P$(M)
070 NEXT M
080 FOR J = 1 TO 4
090  FOR M = 1 TO 5
100   FOR N = 1 TO 3
110    S(J,M)=0
120    T((J-1)*3+N,M)=0
130   NEXT N
140  NEXT M
150 NEXT J
160 IF P$(15) <> " " THEN 810
170 Q=1
175 F=1
180 REM -- INITIALIZE SELECTION
190 J=-1
200 REM -- SELECT NEXT
210 J=J+1
220 K=-1
230 K=K+1
240 I(1)=J
250 I(2)=K
260 I(3)=I(2)+I(1)+C
270 E=I(3)
280 IF I(3) < 10 THEN 290
285 I(3)=I(3)-10
287 REM -- CHECK CHOICE FOR ACCEPTABILITY
290 IF Q < 4 THEN 340
300 IF P$(15) = " " THEN 330
310 IF E < 10 THEN 650
320 GOTO 340
330 IF E >= 10 THEN 650
340 A=1
350 IF A=4 THEN 410
360 IF T((Q-1)*3+A,Q) = 1 THEN 390
361 IF Q <> 1 THEN 363
362 IF P$(15) = " " THEN 374
363 D=Q-1
364 IF Q <> 1 THEN 366
365 D=1
366 FOR M = 1 TO D
367  FOR N = 1 TO 3
368   IF Q = 1 THEN 371
369   IF I(A) = S(N,M) THEN 650
370   IF P$(15) = " " THEN 372
371   IF I(A) = 1 THEN 650
372  NEXT N
373 NEXT M
374 A=A+1
380 GOTO 350
390 IF S(A,Q) = I(A) THEN 374
400 GOTO 650
410 FOR A = 1 TO 3
420  V(A)=0
430  U(A)=0
440 NEXT A
450 FOR A = 1 TO 3
460  R$=P$((Q-1)*3+A)
470  FOR B = 1 TO 3
480   IF A=B THEN 500
490   IF R$ <> P$((Q-1)*3+B) THEN 500
495   U(B)=1
500  NEXT B
510 NEXT A
520 FOR A = 1 TO 3
530  W=I(A)
540  FOR B = 1 TO 3
550   IF A=B THEN 570
560   IF W <> I(B) THEN 570
565   V(B)=1
570  NEXT B
580 NEXT A
590 FOR A = 1 TO 3
600  IF U(A)=V(A) THEN 620
610  GOTO 650
620 NEXT A
625 REM -- END ACCEPTABILITY CHECK
630 GOTO 740
640 REM -- CHOICE IS NOT ACCEPTABLE
650 IF K <> 9 THEN 230
660 IF J <> 9 THEN 210
664 REM -- IF K AND J NOT = 9,9 THEN SELECT NEXT ELSE
665 REM -- POP ANSWER STACK (CHOICES EXHAUSTED)
670 Q=Q-1
680 IF Q <= 0 THEN 950
690 K=S(2,Q)
700 J=S(1,Q)
701 IF Q <> 1 THEN 710
702 C=0
703 GOTO 650
710 C=S(4,Q-1)
720 GOTO 650
730 REM -- CHOICE IS ACCEPTABLE
740 C=0
750 IF I(1)+I(2)+C < 10 THEN 760
755 C=1
756 REM -- PUSH COLUMN ON ANSWER STACK
760 FOR M = 1 TO 3
770  S(M,Q)=I(M)
780 NEXT M
790 S(4,Q)=C
800 IF Q = 4 THEN 970
810 D=Q+1
815 G=Q+1
816 REM -- SEARCH STACK FOR ASSIGNED LETTERS AND SET THEM
820 FOR M = 1 TO 3
830  FOR X = G TO 5
840   FOR N = 1 TO 3
850    IF F <> 0 THEN 860
855    M=3
860    IF F <> 0 THEN 870
866    Q=5
870    IF P$((Q-1)*3+M) <> P$((X-1)*3+N) THEN 891
880    T((D-1)*3+N,X)=1
882    IF F = 1 THEN 885
883    S(N,X)=1
884    GOTO 886
885    S(N,X)=I(M)
886    D=D+1
890    IF D <= 4 THEN 880
891    IF F <> 0 THEN 900
892    Q=0
900    D=Q+1
910   NEXT N
920  NEXT X
925 NEXT M
930 Q=Q+1
932 IF F <> 0 THEN 935
933 Q=1
935 F=1
940 GOTO 190
950 PRINT " "
952 PRINT "END OF SOLUTIONS"
960 STOP
965 REM -- SOLUTION FOUND
970 PRINT " "
975 FOR M = 1 TO 3
980  PRINT S(M,5);S(M,4);S(M,3);S(M,2);S(M,1)
990 NEXT M
992 GOTO 650
993 END
```

erasing a word in a crossword puzzle when a down word doesn't match some intersecting letter of an across word. Feedback occurs whenever the answer stack is popped, since a previous column is then remembered, and the next choice is dependent on this remembrance.

For those of us who are in the habit of conserving TTY paper, and wish to generate only one solution, assuming one does exist, line 992 should be replaced with a STOP statement. Many of these puzzles have hundreds of solutions!

Puzzles that have few solutions will cause the program to execute for comparatively long periods of time. In fact, the run time before a solution is found to be inversely proportional to the number of solutions. I include this as a warning to people who expect an output immediately after depressing the return key. I've run a problem in which each letter in the P$ array was different. The program ran for more than 2 minutes before the message END OF SOLUTIONS was printed! In general, whenever this message is printed without any solutions before it, then no solutions exist.

Some Thoughts

I've seen (and written) a number of backtracking programs applied to chess. One such program is known as the "knight's tour." In this case the program reads the knight's coordinates on a chess board and generates a combination of 63 legal moves so that the knight visits every square on the board exactly once.

In 1850 the great mathematician C. F. Gauss investigated what has been called the "Eight Queens Problem." It fundamentally consists of the placement of eight queens on a standard chess board, such that no queen checks against another queen. That is, no queen can be in the same column, row, or diagonal as another queen. Needless to say, even a great genius such as Gauss could not, and did not, generate all the solutions. However, since the advent of the digital computer, and by the use of the backtracking algorithm, it has been found that 92 such solutions exist. Try doing that by hand!

So far, we've seen that backtracking is great for playing games, suggesting that the method is short of practical application. Quite contrarily, this algorithm will find solutions to problems that characteristically defy analytic solution.

Consider a large number of switches connected together in some haphazard series and parallel fashion. Say you have some input signals (telephone transmitters) on one side of the switching array and a finite number of outputs (telephone receivers) on the other side. The problem is to connect one of the inputs to an output device of your choice. The input signals become active randomly (whenever the telephones are dialed). A computer programmed to backtrack could find a path to make such a connection. If no connection is possible, because other signals are using the needed switches, a busy signal could be generated. In this case the acceptability clause is very simple to program, since we simply test whether the switches are open or closed.

As a final note, I'd like to point out that learning programs have been the domain of computer scientists. One reason for this is because such algorithms are usually implemented by languages that can be recursive (a process that BASIC must simulate). I hope I have prompted more hobbyists to utilize this most interesting problem-solver. ■

```
RUN

BKTRK         16:47    05/18/77  WEDNESDAY

?" ",X,Y,N,D
?" ",X,Y,R,E
?" ",X,Y,U,L

END OF SOLUTIONS

TIME 152 SECS.

RUN

BKTRK         18:26    05/16/77  MONDAY

?" ",S,O,U,N
?" ",L,I,K,E
?N,A,N,C,Y

 0      2      3      3      1
 0      7      8      6      4
 1      0      1      9      5

 0      3      8      8      1
 0      6      2      9      4
 1      0      1      7      5

 0      5      4      4      1
 0      6      7      3      9
 1      2      1      8      0

 0      6      4      4      1
 0      5      7      3      9
 1      2      1      8      0

 0      6      7      7      1
 0      8      3      4      9
 1      5      1      2      0

 0      8      7      7      1
 0      6      3      4      9
 1      5      1      2      0

END OF SOLUTIONS

TIME 7 SECS.

RUN
```

Sample runs.

References

[1]Wirth, Niklaus, *Algorithms + Data Structures = Programs,* Englewood Cliffs NJ, Prentice-Hall, Inc., 1976.

[2]Ruch, F. L., and Zimbardo, P. G., *Psychology and Life*, 8th Edition, Glenview IL, Scott, Foresman and Co., 1971.

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Vertical Input: x1-10mV/div to 10V/div in four ranges, each continuously variable. x2-20mV/div to 20V/div in four ranges, each continuously variable. x5-50mV/div to 50V/div in four ranges, each continuously variable. Accuracy is 3%
Input Impedance: 1M ohm shunted by 50 pF
Input Voltage: 350 volts peak
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Internal Calibrator: 1.0V (±5%) peak-to-peak square wave at 10-20 kHz
Graticule: 4 div Y by 5 div X; 1 div = 0.25 inch. Viewing area: 1.1"H x 1.35"W.

X Axis
Horizontal Input
Bandwidth (3 db points): DC to 200 kHz
Input Impedance: 1M ohm shunted by 50 pF
Sensitivity: 1V/div, 100V peak maximum input.
Time Base: x1, uS-0.1uS/div to 100 uS/div. x 2, uS-0.2uS/div to 200 uS/div. x5, uS-0.5uS/div to 500 uS/div. x1, mS-0.1mS/div to 100 mS/div. x2, mS-0.2mS/div to 200 mS/div. x5, mS-0.5mS/div to 500 mS/div. all in four ranges, each continuously variable. (Range increments are .1, 1, 10, 100.) With vernier in full clockwise position, calibrated time measurements are possible. Accuracy is 3%.

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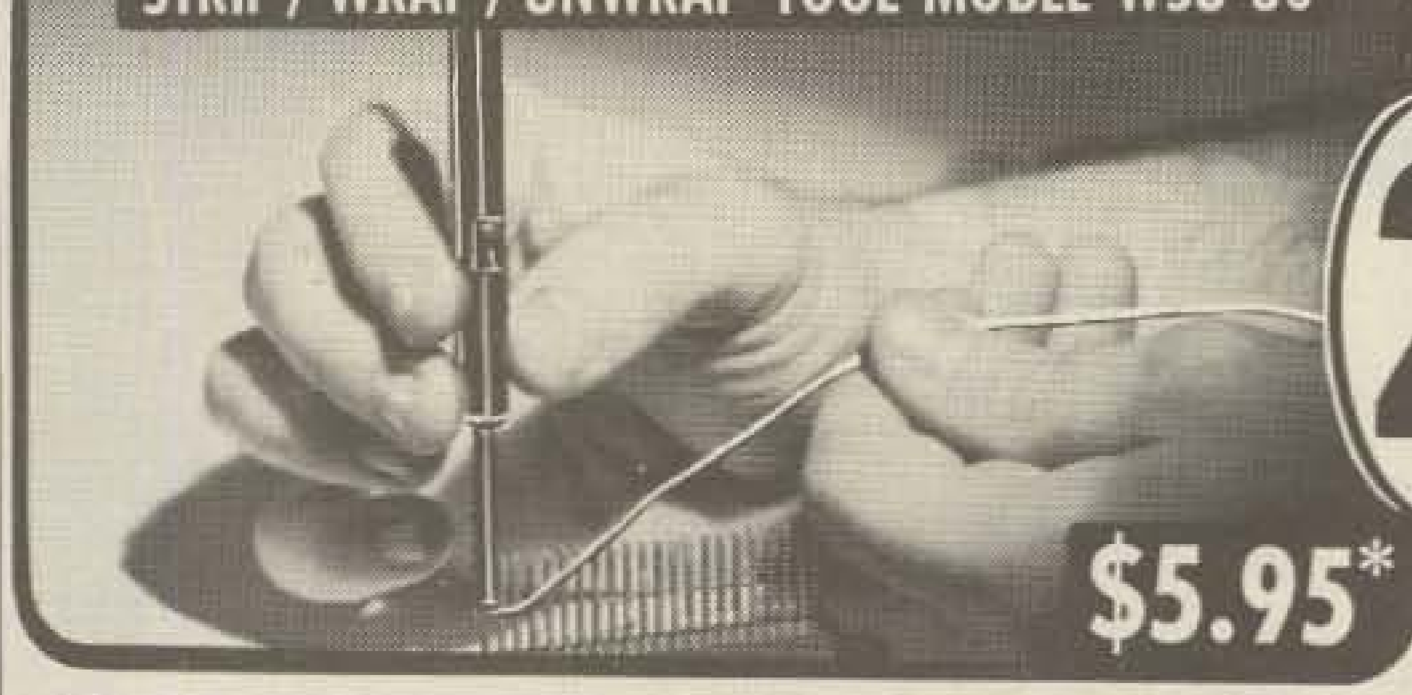

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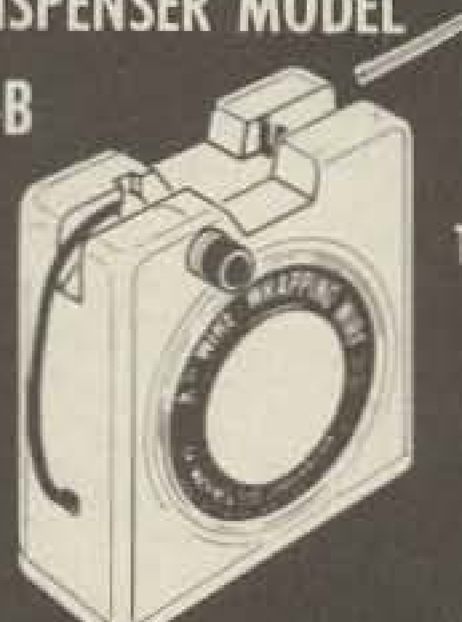

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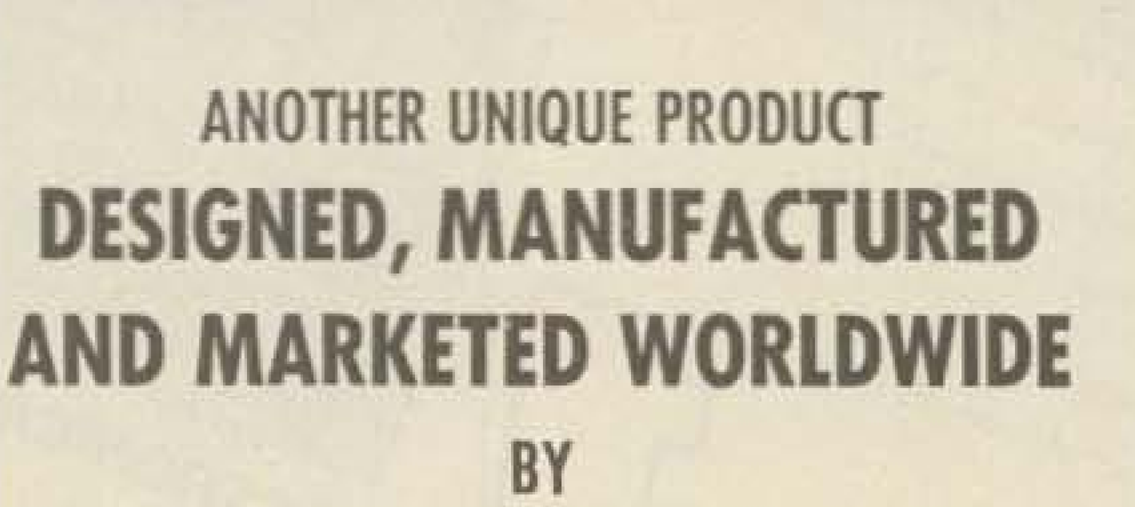

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A-13 hand installing tool $2.80

SLIT-N-WRAP

Wraps insulated wire on .025 square posts FOUR TIMES FASTER than regular manual wrap-post tools

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NO PRE-STRIPPING • NO PRE-CUTTING • SPOOL-FED WIRE •

"The spooled wire passes through the tool past a slitting edge next to the wrap post. A narrow longitudinal cut is made in the insulation where it presses the square post corner, the bared copper is indented by the sharp edge (7 turns = 28 contacts). Insulation is slit where wrapped but not between terminal posts when wire led straight out of the tool."

P180 with two 100' spools of 28 ga. wire $24.95

P160-4T includes charger, wire $75.00

"Daisy-chain" runs. Reliable and easy to use. Manual or power operated.

Buy P180 and get 1 package of wire for 1¢

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Just plug in any components with leads to .032'' dia. Interconnect with solid wire up to 20 ga. Assembled models too!

ACE Model No.	Tie Points	DIP Capacity	No. Buses	No. Posts	Board Size (inches)	Price Each
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208 (assem.)	872	8 (16's)	2	2	4-9/16 x 5-9/16	29.95
201-K (kit)	1032	12 (14's)	2	2	[illegible]	24.95
212 (assem.)	1224	12 (14's)	8	2	4-9/16 x 7	34.95
218 (assem.)	1760	18 (14's)	10	2	6-1/2 x 7-1/8	46.95
227 (assem.)	2712	27 (14's)	28	4	8 x 9-1/4	59.95
236 (assem.)	3648	36 (14's)	36	4	10-1/4 x 9-1/4	79.95

Gold-plated aluminum base/ground, non-corrosive nickel-silver terminals, 4 rubber feet.

Model 236

16 K EPROM

TMS 2716

PRIORITY ONE ELECTRONICS is first to bring you FACTORY PRIME T.I. TMS-2716JL 16K EPROM programs like a 2708.

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MICRO-KLIP for .042 dia. holes (all boards on this page)

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T42-1 pkg. 1000 $11.00

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Features include: • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands). • The FM-7 utilizes an LED readout, providing 7-digit resolution. • The SC-5 is accurate to one part per million. • Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included. • Dimensions of each are 1.9'' H x 2.7'' W x 3.9'' D. • The units may be obtained separately or as a Frequency Duo. • Parts & Labor guaranteed 1 year.

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2708 8K 450 ns EPROM FACTORY PRIME

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24 PIN DIP PLUGS WITH COVERS

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.042 dia holes on 0.1 spacing for IC's

Phenolic PART NO.	SIZE	PRICE
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Epoxy Glass PART NO.	**SIZE**	**PRICE**
64P44-062	4.5 x 6.5''	$1.70
84P44-062	4.5 x 8.5''	$2.10
169P44-062	4.5 x 17''	$4.30
169P84-062	8.5 x 17''	$6.39

100 K Joypot

$4.95

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	1-24	25-49	50-99
8 pin	.47	.42	.37
10 pin	.45	.41	.37
14 pin	.39	.38	.37
16 pin	.43	.42	.40
18 pin	.75	.68	.62
22 pin	1.00	.97	.95
24 pin	1.00	.94	.75
28 pin	1.09	.98	.84
36 pin	1.59	1.45	1.30
40 pin	1.49	1.39	1.29

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CM4019AE	4 / 1.00
CM4020AE	3 / 2.00
CM4022AE	1.00
CM4023AE	8 / 1.00
CM4024AE	3 / 1.00
CM4025AE	5 / 1.00
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TC 14	3 IN	923696	4.50
TC 16	3 IN	923700	4.75
TC 16 LSI	5/6 IN	923702	8.96
TC 18	3 IN	923703	10.00
TC 20	3 IN	923704	11.56
TC 22	4 IN	923705	11.85
TC 24	5/6 IN	923714	13.86
TC 28	5/6 IN	923718	15.25
TC 36	5/6 IN	923720	18.86
TC 40	5/6 IN	923722	21.00

3682 9.6'' x 4.5'' $10.97

3682-2 6.5'' x 4.5'' $9.81

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3677 9.6'' x 4.5'' $10.90

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Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16'' 44 pin con. spaced .156

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Practical Computer Projects

-- for your house

Are you planning to have a computer run your house? Will your computer monitor inside and outside temperatures, tell you if it is raining, or check that the doors or windows are open at a particular time? Do you wish to have a fire and burglar alarm system or keep tabs on the water level in the basement? If you do, you will want your electronic marvel to do something useful with the information. Your computer must be able to turn on the sump pump and regulate the furnace, air conditioner, or attic fan. You may want to make certain alarms active for only part of the day or only on certain days of the week. You might want the coffee pot or electric frying pan turned on to have your breakfast ready when you get up, or you may want your stereo to be shut off at 2:00 a.m., in case you forget. The list of possible uses for your computer is limited only by your imagination.

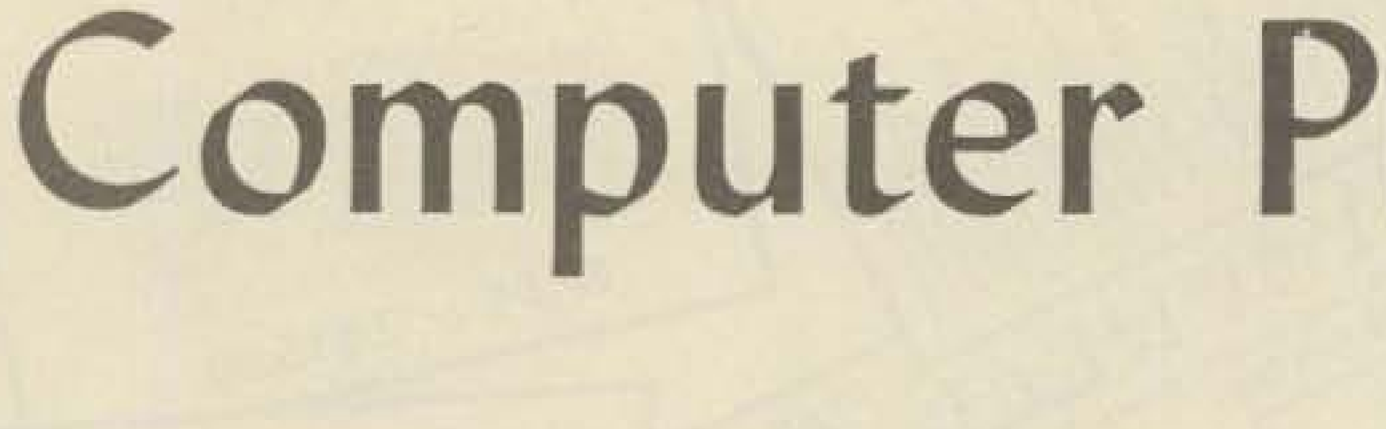


Fig. 1. A bridge rectifier allows full current through an optoisolator.

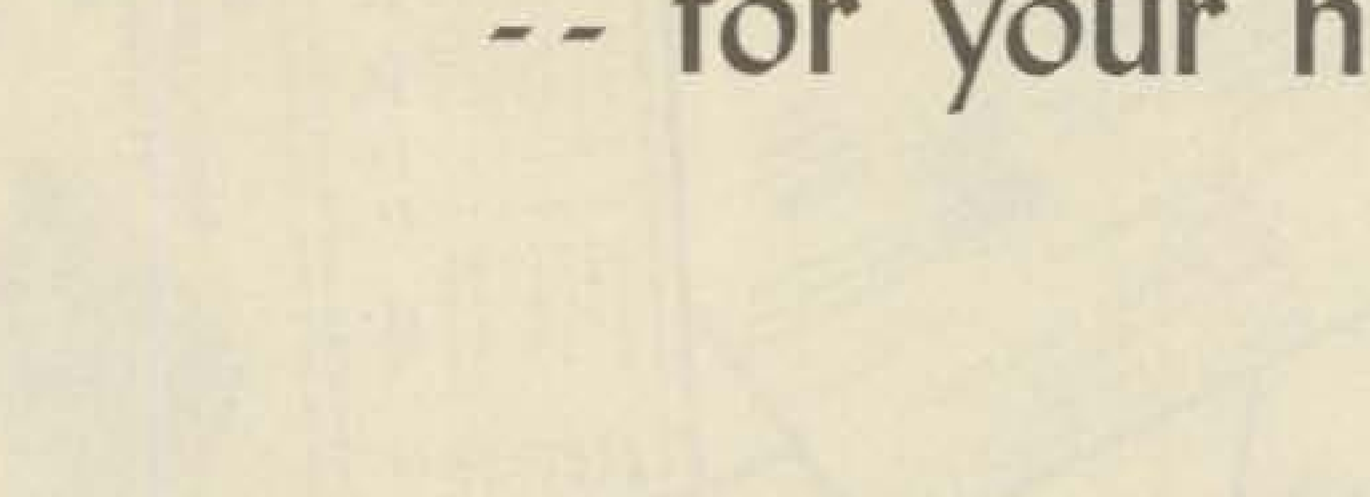


Fig. 2. Driving a heavy-duty SCR from a low-level I/O port.

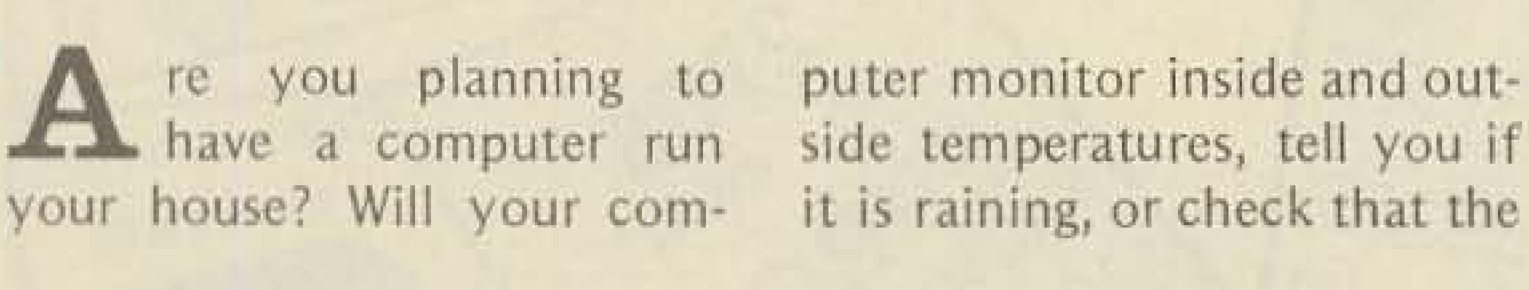


Fig. 3. No optoisolators? Roll your own.

How can you do all these wonderful things? The following is a set of basic hardware circuits which will allow you to get started. Every reader knows that his thoughts are generally worth cold, hard cash. For this reason, you won't find a dissertation on computer control of a 440 V 3-phase overhead crane. What I am giving to all *73* readers is a set of simple circuits which you can use directly to control your house appliances. All the designs in this article are entirely my work.

Most of the units or appliances in your house are 120 V ac and range from a few Watts to a couple thousand. One common exception is the furnace. The best place to turn your furnace on and off is the thermostat line. On most furnaces this is a 24 V ac line. Regardless of the voltages involved, the basic ideas are the same.

In Fig. 1, you can see a simple way in which the H74C1 optoisolator can be used to pass full current to the load. This means that your bulb will burn at full brilliance. I would like to mention that, if the device lives up to published specs, there would be no problem in driving a 25-Watt bulb at full brightness.

Obviously, 25 W is not enough for a coffee pot or a washing machine. In Fig. 2, I have designed a circuit that can handle a much higher load. By using the LASCR side of the optoisolator to trigger a larger SCR, of the 25-Amp range, you can switch loads up to 3000 Watts. Now we're talking! You should remember that, if the load is inductive, like a pump or a motor, it will most likely draw three times as much current in order to get started as it does after it gets up to normal speed. For this reason, allow yourself a working margin to keep parts from going up in smoke. If a 25-Amp SCR is used, limit the inductive-type loads to 1000 W, or about 8 Amps. Toasters, coffee pots, electric frying pans, and light bulbs

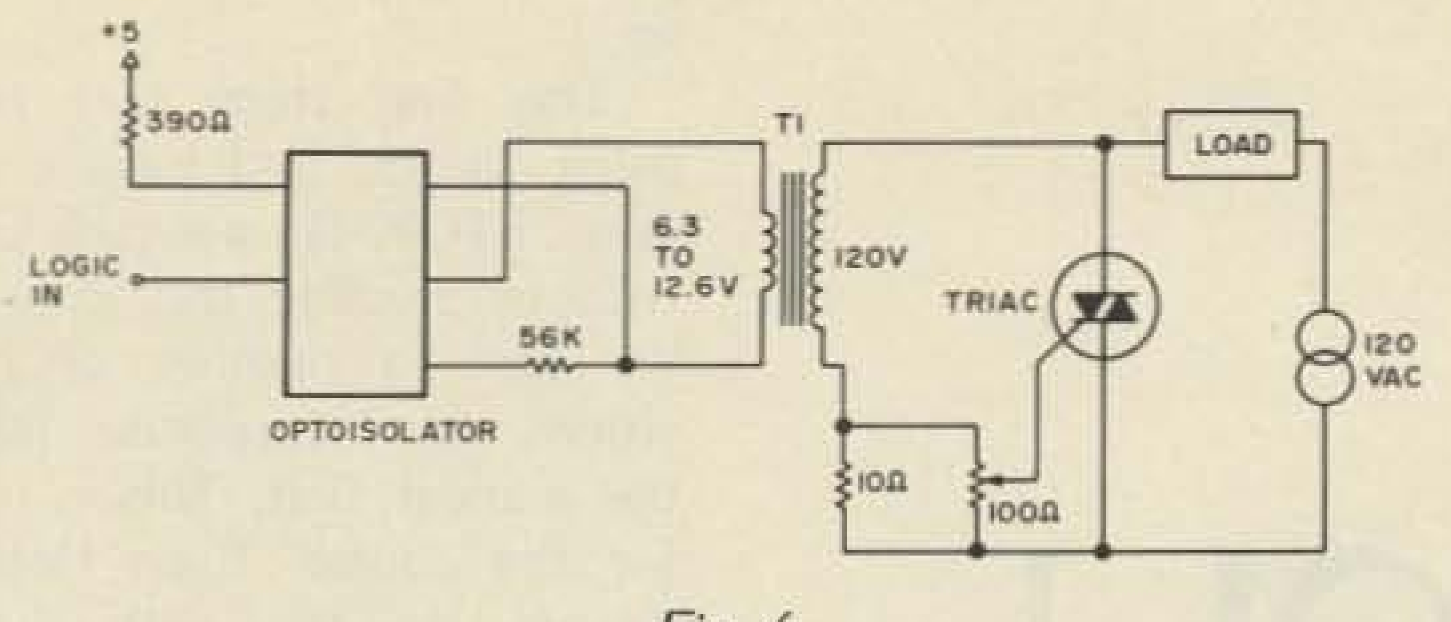


Fig. 4.

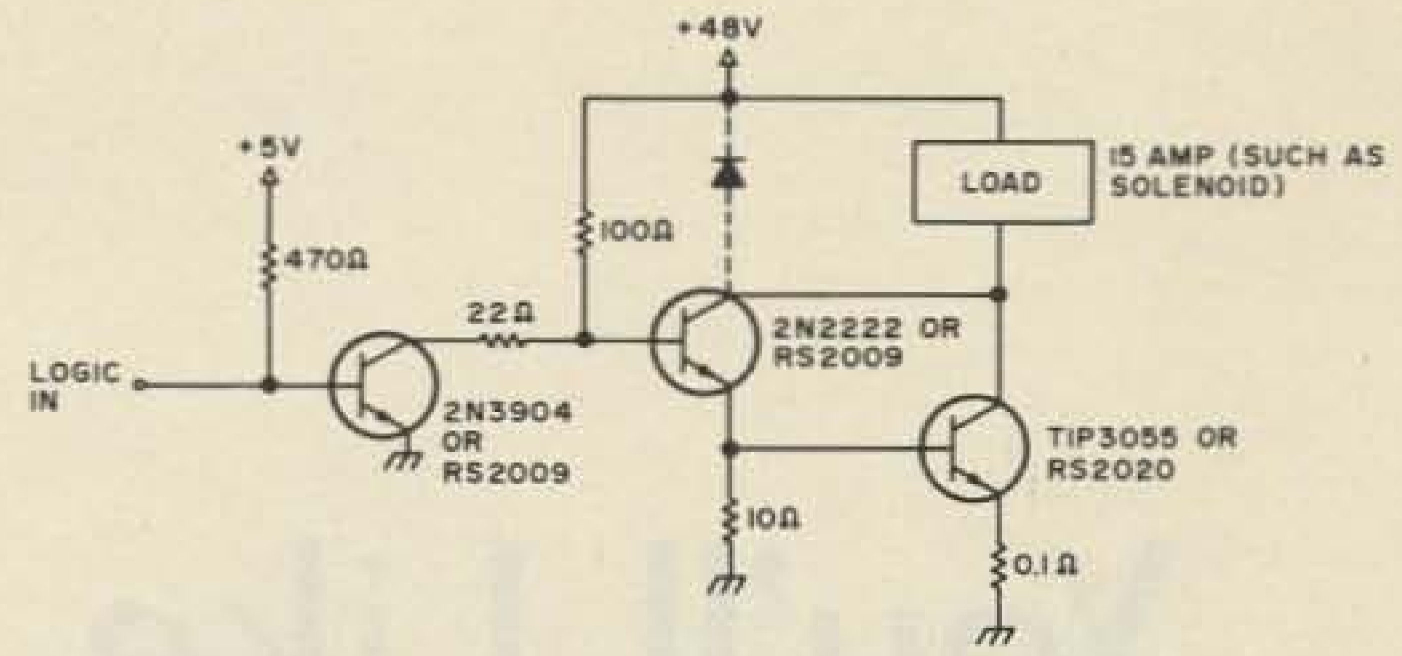


Fig. 5. Drive a 15-Amp load on a 48-volt line.

are noninductive and can go the full 3000 Watts.

If you can't find an H74C1 optoisolator, have no fear – it is quite easy to make one. Light-activated SCRs are available from Radio Shack and many other places. LEDs and heat-shrink tubing are very common also. By slipping an LED and an LASCR into a piece of heat-shrink tubing so that they touch, and then heating the tubing, you end up with a home brew optoisolator which will work just as well as the prepackaged type. Watch the maximum currents and voltages for which your LASCR was made. Stay within those limits, and you will get satisfactory performance. If you can't find the dark opaque tubing, a little flat black paint over the outside will keep your unit from being triggered by background lighting.

As you see in Fig. 4, I have given you another alternative to ac control. Using the saturation characteristic of a common filament transformer allows you to trigger a full-wave triac on or off. The transformer can be anything from a 6.3- to a 12.6-volt secondary. The potentiometer will allow enough adjustment so that parts values are not critical. Be certain that the primary of the transformer is towards the triac. To set this circuit for proper on-off action, ground the data input. A ground at this point will light the LED. With the ground in place, adjust the pot, so the load is turned on. Remove the ground, and the load should be switched off. This is the setting at which you will leave it. Now try it from your I/O port. Remember that the logic 0 turns the device on; logic 1 turns it off.

I know there could be special cases where you would like to power a heavy load from a dc line. An example of this would be driving a solenoid or an electromagnet from a 48 V dc supply. This can be used for stopping the paper tape in your new home brew high speed reader. I have provided for just that contingency with the circuit in Fig. 5. In this one, I allowed a 0 logic to again be the level to trigger the load on, but I am including the opposite type, also. A 0 level at the input turns the first transistor off. This allows the base of the next transistor to go high, and that transistor turns on. In turn, this switches the final transistor on, allowing the load to pull full current. The low-value resistor in the emitter lead prevents thermal runaway.

As I promised, for the person who wants a 1 level to activate his outboard equipment, it is as simple as adding an inverter to the other circuits. In Fig. 6 is a one-transistor inverter, which can be inserted between the I/O port and the logic-input lead of the other circuits I have mentioned. An IC inverter will work equally well at this point, providing it is one with a TTL fanout of 10 or more.

The siren driver in Fig. 7 is just the ticket to add to the fire and burglar alarm you are planning. I am showing the siren powered by 9 volts, as I believe this is common to many of the available modules. Notice, however, the similarity to Fig. 8. The same driver may be used with a variety of voltages at the output. The only limit is the maximum voltage of the second transistor.

The last diagram shows you how to drive a relay from your low-powered I/O port. With the contacts of the relay, it does not matter if the furnace, door-lock solenoid, or toaster you are switching is ac or dc, nor does it matter what the voltage is or what current is being drawn, as long as you do not exceed the ratings of the contacts. I indicated that you should use a 12 V dc relay, as most of the home computers already have a 12-volt supply. The diode across the relay coil is reversed to the current flow and is there to cut transients caused by the inductive load. If you have an inductive load in the circuit in Fig. 5, which I said can be used as a solenoid or relay driver, a reversed diode should be added to it, also. This removes the possible transients of voltage which can zoom to several hundred volts and cause transistor failure.

I can picture it all now. You can rise in the morning to the sound of your computer-driven electronic chimes. Addressing the new voice-entry input of your home marvel and friend, you tell it to hold the eggs – you are only having coffee and toast this morning. Flawlessly, the circuits to your coffee pot and your toaster are turned on, so the food will be ready when you are. Leaving the door, you tell the computer, which may even respond to a name, that you will be gone all day. It shuts down the coffee, toaster, and furnace. It arms all burglar alarms, and, if any windows are unlocked, it locks them by solenoid. The fire sensors are always on, but, instead of a local siren, they will now dial the fire department. As your car backs out of the driveway, the house is already cooling down to save on fuel bills. To amuse itself while you are gone, the home computer begins to print out checks and letters to friends, so you can sign them when you get home. ■

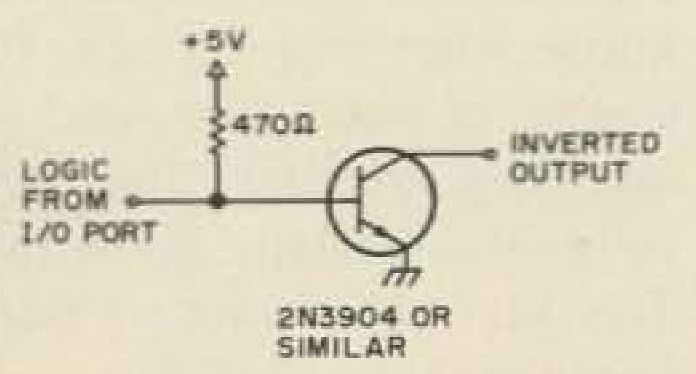


Fig. 6. Basic inverter.

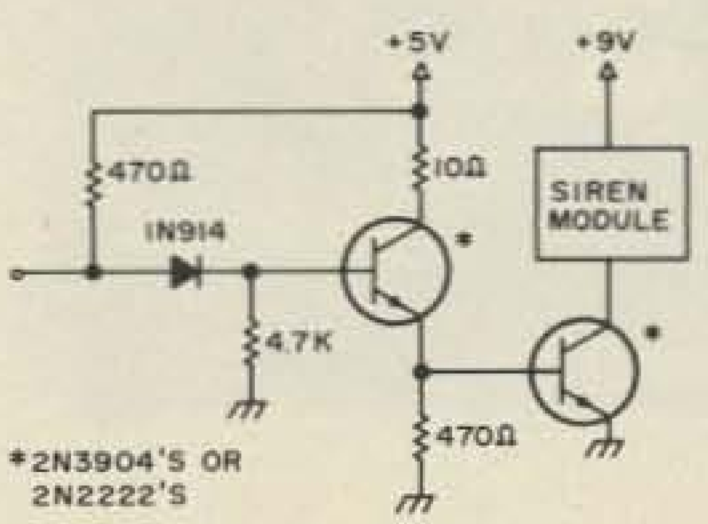


Fig. 7.

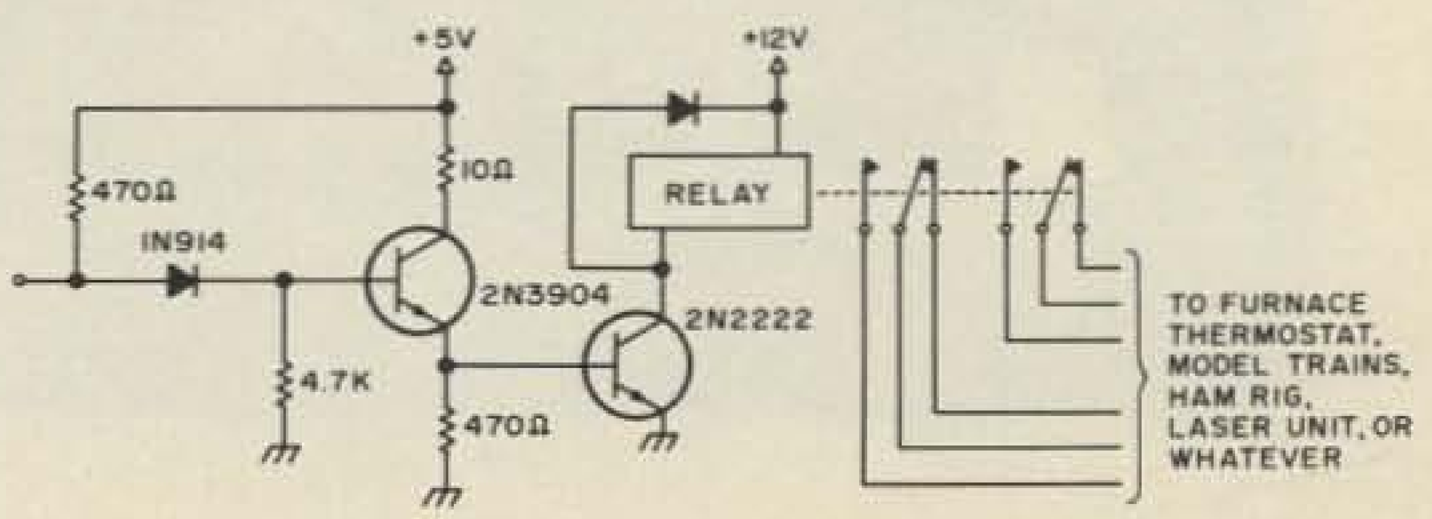


Fig. 8.

You'll Like SOL!

George Young WB6JYK
Sierra High School
Tollhouse CA 93667

The shipping carton measures 18 x 18 x 13 inches and checks in at about 40 pounds. It will fit in the car nicely for the trip home. I would suggest that the gals let the salesperson place the carton in the car for them. You can wrestle the thing into the house after you get it home.

If you have been waiting for Heathkit to get their act together before you take the plunge, you can stop waiting. This one puts the whole show together and packages it in a neat console, just a little larger than the typewriter that put the words on this manuscript.

Shipping Carton Packaging

One of the things that I look for in kits is how well the manufacturer packages his kit. All kinds of things can be inferred from this information. The ham or computer nut on the receiving end wants the kit components well protected. After all, he has already paid for them. How well the contents are protected also reflects how much the manufacturer thinks of his product. He should want to get it to the buyer without any damage whatsoever to the contents.

This kit is exceptionally well packaged. Inside, there is ample packing material, and each individual item is protected from its neighbors, so there is no chance of components rubbing and bumping together. Short of dropping the shipping carton from a height of 4 feet onto a concrete floor, you can't hurt things at all. Normal shipping handling should not affect this carton's contents.

Unpacking

When you slit the top tape holding the upper flaps closed, the first thing you see is the thick binder. This is exactly the way it should be. Leave the rest of the kit packed, and take the binder out of the carton, relax in the easy chair, and read it. (We kit builders always do this before we build a kit, don't we?)

The first thing you are going to see is a page that says "STOP! Do not pass Go without reading this page." We have a number of revisions to incorporate into the manual first. This is par for the course. Even Heath has to do this with their products for awhile, until all the kit builders feed back the necessary information to get all the errors out of the assembly manual before the second printing of the manual. (Sometimes, it's the second or third printing before you get an error-free manual to work from.) Don't panic. The revisions are quite minor and already reflect some of the feedback from the kit-building fraternity.

Manual Revisions

I want to revise the assembly manual even further, but this revision has to do with the nature of the kit builder rather than any errors that I uncovered. In Step 3 of the revision page, add an (aa) before the manual's Step 1. For the (aa) step put in: Go to section VI, page VI-9. What I want to do is to get you to the part of the manual concerning the finishing of the walnut side panels at the very start. These solid walnut side panels have to be finished with some type of protective coating, and this will take some time. It could take several days to put on the finish of your choice. If you don't have them all done, finish dry, and ready when you get to that particular assembly step, they will probably end up getting put on without any finish whatsoever, and you'll make the excuse that you'll take them off later and finish them. If this step is not taken at the onset of the construction process, then we kit builders know what will happen. (Of course, if you really read the assembly manual that carefully, you already knew this. The kit manufacturers don't know us kit builders very well, do they?)

Completed SOL.

Assembly Tools and Test Equipment

A list of tools and necessary test equipment is given at the beginning of each section. Almost all of these tools will already be on hand for any serious kit builder. A good #2 Phillips screwdriver is an absolute must. A good volt ohmmeter is a must. An oscilloscope is desirable, but Processor Technology Corporation (hereinafter called PTC) shows you how to build an rf probe from some of the kit parts to bypass the scope, if you don't have one.

One of the things you are going to have to get for your computer system is a video monitor. In fact, you are going to have to have one for the assembly of this kit. This can be a commercial monitor or a modified TV set. If you modify a TV set, then modify one that has a transformer in it. Don't even try to use a so-called "transformerless" set. These are often called "hot-chassis sets" and rightly so. A transistorized black and white TV is around $100. Since you are going to have more than a kilobuck invested in your system, it is not economically sound to try and use a hot-chassis TV set with the possibility of destroying your $1000 investment. The details on how to convert a TV to make yourself a good monitor are in the back of your binder.

The assembly of the power supply and what PTC calls the Personality Module will not require the video monitor. As soon as you start the assembly of the main board, you will need it. PTC is going to have you assemble and test the built-in character generator chip and all its associated circuits at the beginning, to make sure they work before you proceed with the microprocessor section. This is sound procedure, and, after you see the entire character set displayed on the screen, you will be feeling quite good about your decision to build the SOL.

So, as soon as you place your order for your kit, get shopping for your monitor. Until the kit arrives, you can enjoy the little black and white transistorized TV in its more conventional application.

Problems

This usually turns out to be the longest portion of my kit building articles. This time I am going to have to stretch this section and get picky on the tiniest details, because I had no problems. I suppose a good deal of this lack of problems could be contributed to luck. However, Murphy usually doesn't treat me any differently than he treats you.

The first unit assembled is the power supply module. It went together smoothly and without problems. A test of the assembled power supply module showed all the right voltages in the right places, except one. I'll get to that incorrect voltage in a moment. PTC even includes a spare fuse in case you aren't as lucky as I was. This unit now has a spare fuse.

There is one feature in the power supply that I feel is needed and is state of the art. This is the inclusion in this power supply of overvoltage protection. Consider what will happen to all your precious chips, throughout the entire computer, if the series pass regulator transistor fails. The most common failure is a collector-to-emitter short. Such a failure places unregulated dc on all chips connected to the +5 volt line. TTL chips don't like to see anything over about 5.5 volts. They are most unhappy with 8 volts applied to them. There are a lot of TTL chips in this computer.

This power supply has overvoltage protection built in, and this feature is often called "crowbar overvoltage" protection. I feel that this feature is so important that I deliberately left this circuit "energized," or operational, to make certain the overvoltage circuitry was functional. By leaving out R2 on the power supply, you can leave the overvoltage circuit functioning, and you will not have +5 volts out of the power supply. Since R2 is involved in one of the modifications that PTC is going to have you make, it is relatively simple to leave out R2 and the modification, to insure that the circuit will offer the desired protection. This is why I had one incorrect voltage, as stated above. It was not because I had a problem; it was because I deliberately introduced a problem, so I could test something. It involves a little extra work on your part, but I feel that it is worth the extra work.

Assembly

I implied earlier that this was a kit that was comparable to a Heathkit. I still wish to imply that you do not need to wait for Heathkit to come out with their product. This one comes close to their line in simplicity of assembly. You should have assembled several Heathkits, including some of their more complicated ones. This is not an easy kit and certainly not one that you should try to cut your teeth on. Assembly time for me ran to 40 hours, and I had no problems. With any problems, you should plan on at least twice that much time. The factory charges $500 more for the assembled kits. So that is how much you are going to save (earn?) by assembling your own kit. That's what I would charge to put one together for you, and I would be earning every penny of it, too.

You need to be able to solder and solder very well. You need to be able to make a good solder connection

Kit contents, with some still wrapped in their packaging.

quickly, with no more heat than is necessary to do the job correctly. You need a good, temperature-controlled soldering iron with a small point. If you don't have one, then I suggest that you allow an extra $50.00 for your system and purchase one. That's only 5% of your investment, and I can't see how you can get around it.

This kit will challenge all the skills you have built up assembling all the other kits. It is extremely well designed mechanically. They have squeezed an awful lot into that package, and I am still amazed at how all the parts fit. Somebody there at PTC has a lot of skill in the mechanical engineering department.

Problems? I couldn't find one transistor. I couldn't find the tape that goes in the finger wells. (The tape is packaged in with the plexiglas in the lid.) I won't say that the transistor was not in the kit. I suspect that I lost it somewhere here on the workbench. With several thousand parts in the kit, a track record of just one missing item tends to make me think I was at fault and not PTC. I replaced the missing transistor from my own stock and did not even ask PTC for it. Thus, with no missing parts, my assembly was not held up at all. (The walnut end panels still don't have any finish on them.)

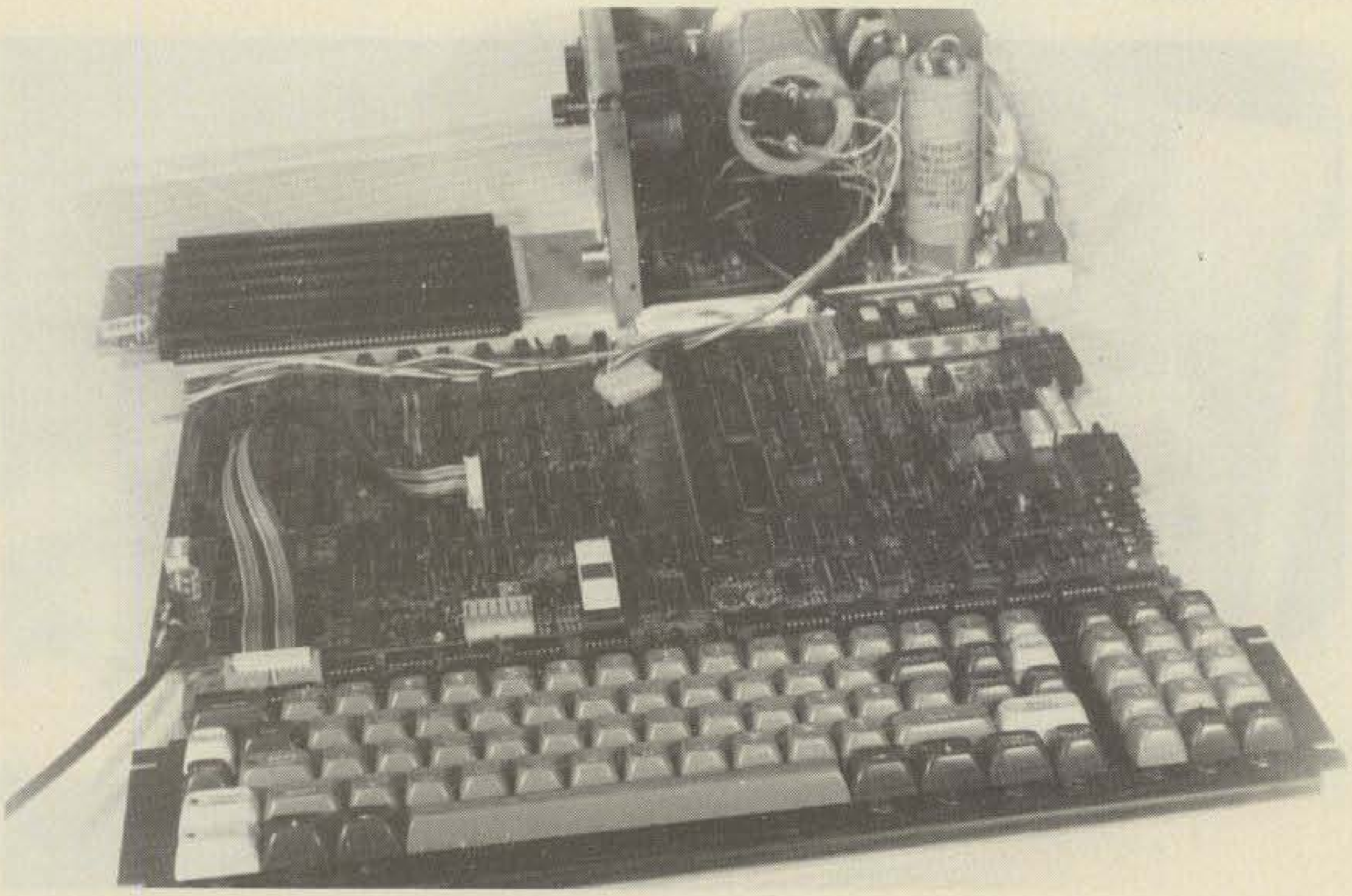
The Keyboard

I really like this keyboard. It has everything on it, and I especially like the way it is constructed. The keys have what appears to be aluminum foil bonded to a spring-type sponge pad. As you press down on a key, this foil shorts two contacts on the keyboard PC board under the key. This is my kind of circuit – simple, effective, and almost foolproof. If you don't buy the SOL, buy the keyboard (if PTC will sell you one separately). It's a winner. The feel is almost perfect. The keys are arranged beautifully and functionally.

The Video Display

If you assemble any computer, or even if you buy one already assembled, the first thing that you will find when you finish assembly is that you can't do anything. You have to have some way to get data into the machine and some way for the machine to get data back out to you. The keyboard takes care of the data input. I have already indicated that you'll have to have a video monitor in order to assemble the SOL. You would have made it the first purchase after assembling SOL anyway, so you already have the output device on hand. The video monitor circuitry is built into SOL, and you have verified its operation during assembly. All you need to do now, to be up and running, is to connect the video monitor to the machine. The assembly sequence and testing procedures also assure you that, after you get the kit all put together, it will do something immediately.

The video display is based on the 6574 character generator chip, and this gives you the full ASCII character set, both upper- and lowercase letters and all the other symbols. Provisions are made for your choice of letters as well. You can have black letters on a white background or white letters on a black background. And you can have combinations of the two options. You will not have the Greek alphabet with the character generator, but I doubt that this lack will dismay very many of us. The lowercase letters are offset. That is, the descenders, such as on the letter "p", extend below the line the way they are supposed to. The display is 64 characters wide, and, although this crowds the letters a little on my 5-inch monitor, each character is clean and quite readable. On a larger screen, the characters are better separated and more legible. I like this video monitor display.



Four major modules of the kit.

Input/Output and Expansion Capabilities

A serial data input/output port is built in. A parallel data input/output port is built in. All the circuitry to control these ports is built in. A cassette input/output port and its associated circuitry are built in.

There are only five slots in the card cage. Is this going to be a limiting factor? Every function that you want your machine to perform requires the filling up of a mother board slot. Most computers have as many as 20 or even 22 slots for you to plug cards into to get these functions. Only having five available slots may seem to be quite a limitation, at first. But, if you stop and think for a moment, PTC has built in almost all the circuitry that you need for almost all the functions you are going to want immediately. One of those slots is going to get either an 8K or 16K memory board. As soon as it is filled, you can load PTC BASIC via the built-in cassette recorder circuitry and begin programming in BASIC. Another slot can be filled with a floppy disk controller. A third slot can contain the interface circuitry for a hard-copy printer, if you can't interface either through the serial I/O or parallel I/O circuitry that you already have. You may just have to *hunt* (or wait until something else is invented) for something to fill those other empty slots in the card cage.

What Will It Do?

A better question might be: What won't it do? Attach

Jan 1978

the monitor and apply power. Inside, a small plug-in board that PTC calls their Personality Module, which contains 4 EROMs, provides the firmware to get operational. The board is a small one, but it's big on performance and takes the place of still another one of those boards that would normally go in a mother board slot. When you order your kit, get their best Personality Module, which PTC calls SOLOS™. It does everything.

Software Support

PTC has indicated that a full line of software support will be available as soon as all the bugs are out. That's nice – most of us would much rather wait a little longer for them to debug in exchange for the time it would take us to debug. In the meantime, since this is an 8080-based machine, all the 8080 software that has been written can be loaded from cassette and we can do anything with this computer system that we can get into programming. The speed of this machine is optimum. Running a machine at 4 MHz costs dollars. We have to use memory that is very fast and, therefore, costs more money. By running the system at a slower speed, we save money on almost every device that we want to add to the system. Most of the time that a computer system is operating is spent waiting for a cassette to load, the printer to print out, or the operator to program. For the home computerist, there is seldom a time that running at 4 MHz is cost effective. The trade-off of speed versus dollars is still very much on the side of dollars. My system uses a 750 kHz clock. It waits 90% of the time for me. I am the factor that limits the speed of my system.

Operation

As soon as you complete assembly, connect the monitor, and apply power, you can do something. Power on produces auto reset, the prompt character appears, and the system awaits your instructions. Typing *DU*mp followed by the entire address range from 0000 to FFFF will cause the entire contents of memory to flash by on the screen. The addresses change so fast that the last two hexadecimal digits are nothing but blurs, and the entire screen is nothing but data in hexadecimal form. In a couple of minutes, the entire 65K of addressable memory is dumped. If a high speed printer were hung on the parallel data port, the paper in the printer would literally fly out of the printer and across the room.

Many other commands are already programmed into the EROM firmware. You'll have to get yourself a SOL with SOLOS and see for yourself.

Summary

Been waiting for Heathkit to come out with their kit? They are too late. Processor Technology has stolen the ball game. If you have already built several kits, and at least one of the more complicated kits, and you can solder quickly and well, then wait no longer. Write: Processor Technology Corporation, 6200 Hollis Street, Emoryville CA 94608; or call them at (415) 652-8080, and get the scoop. Get yourself a video monitor or a small black and white transistorized TV set that has a transformer in it, get a schematic for the thing, modify it, assemble the SOL, and you will have an operational computer system. Add 8K of BASIC via the cassette input already provided, and you can start programming in BASIC immediately. Add a floppy and a floppy controller, and you can have the whole ball game on the road for about $2k with enough memory to play all the games and even do the books for the corporate business. ■

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How To Keep Your Computer Happy

Congratulations! Through a lot of hard work, blood, sweat, and tears, not to mention a few expletives that weren't deleted, you have made a computer system. Even if it is just a couple K of memory and practically no I/O, you have a right to be proud of your accomplishment.

Let's face it, there have been a lot of articles written on special software, games, debug programs, and such, as well as a lot of ideas for incorporating some special hardware or improving existing system hardware in others. This article does neither. Hopefully, this article will help you to achieve long periods of time between failures, minimize flakes (intermittent problems), and, in general, keep things running smoothly. Some of the suggestions given may seem like small things, but small things do add up. Following the suggestions in this article may not entirely prevent down time, but it will better the odds. Take the word of a field engineer who has seen many data processing centers — the well-maintained center is easier to work in and requires the least amount of work.

Keep It Clean!

Two of the worst long-term enemies of computers (and other pieces of electronic gear) are dirt and heat. Static is also a danger, but usually that causes immediate problems. It will either destroy or confuse the logic, thus making the problem solid. Dirt and heat, on the other hand, can cause intermittent problems, excessive current drain, and, in general, cause a long-term degradation of your system.

Let's discuss dirt. I once had a problem with a high-speed paper tape reader interface that caused the reader to run backwards. The cause was an accumulation of dirt on one section of the board which changed the logic. In this case, a thorough scrubbing with alcohol was all that was needed to clean it up, but the fact remains that it could have been avoided.

Preventative maintenance does just that; it prevents the need for maintenance. If your computer cabinet has a filter, keep it clean. If it doesn't, put one on. When you put one on, put it on where the air is drawn in. There's no sense in filtering the air leaving the cabinet, since this just turns it into a vacuum cleaner. If your computer doesn't have a cabinet, look into making or buying one.

Other areas where dirt causes problems are board contacts and plugs. There have been many times when just reseating a board or cleaning its contacts helped bring a system back on its feet.

How often you clean things up depends on how much you value your equipment, how often you use it, and how large a system you have. If you use your system (or have it turned on) for 8 to 16 hours a day, you may want to take fifteen minutes each week to inspect things.

Here are some dos and don'ts:

1. Vacuum your filters. A clogged filter does not allow good air circulation and will cause overheating. If you don't have filters, make sure

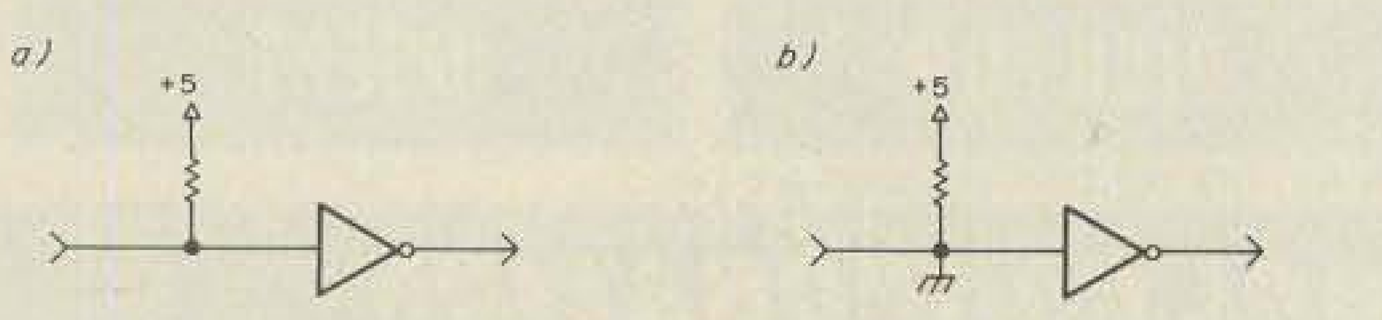

Fig. 1. (a) This is what a circuit may be meant to look like. (b) Because of dirt, the circuit may be changed to look like this.

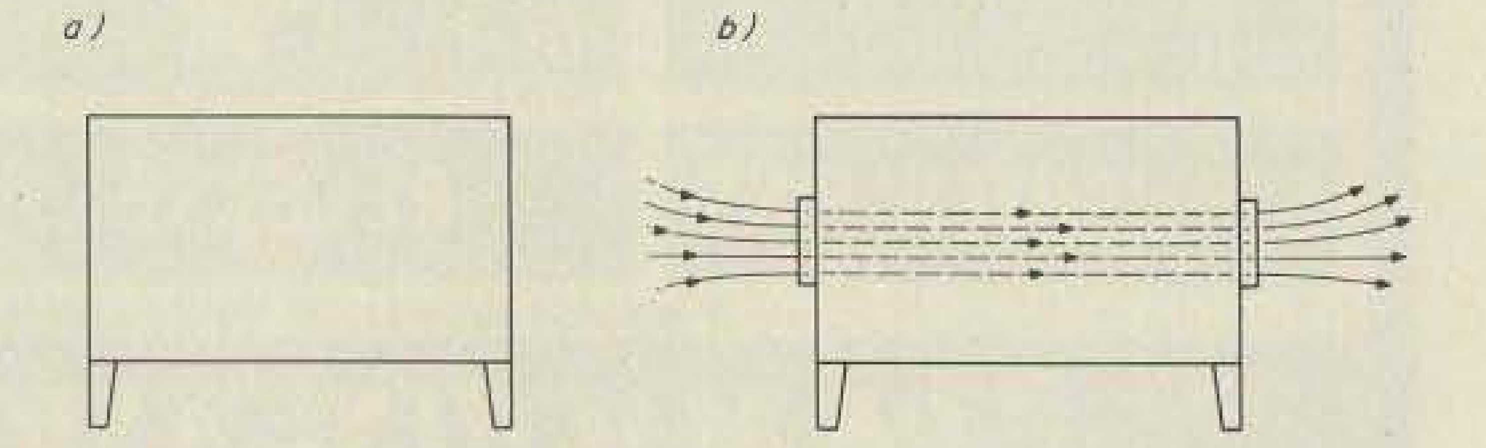

Fig. 2. (a) Without a fan, the heat stays in the cabinet. (b) With fans, air is forced through the cabinet.

you keep the boards free of dust.

2. If you want to clean the contacts on your printed circuit boards, you have two choices. If the problem is just dirt, use some isopropyl alcohol. If the contacts have oxidized, however, use a pink eraser. Let me point out that even gold contacts will oxidize. Never, never use sandpaper or steel wool, as they are too abrasive. If you have gold-plated contacts, and you use steel wool or sandpaper, you'll soon find them not to be gold plated. Continue on, and you'll soon find you don't have any contacts. Steel wool also sheds particles that can find their way into a lot of places and can cause more problems than dirt.

3. Either use a vacuum cleaner or blow very hard on plugs (the type used for circuit boards) to get all dust out of them. This is also a good method, if you are careful, to get stuff out of high-density wire-wrapped boards.

4. It is common practice in data processing centers to clean tape drive heads and transports every day (more than once a day in many cases). You may not need to do it quite as often, but, if you are experiencing some problems now, you may want to try cleaning the heads. As with board contacts, use isopropyl alcohol. This is available in most drug stores, and I recommend 95-99%. Do not use rubbing alcohol, however, as it contains mineral oil. The oil stays as the alcohol evaporates, and it's pretty obvious what can happen.

Keep It Cool!

Now that you have beaten the dirt to death, let's talk about heat. Heat can be both a friend and an enemy. For general purposes, you want to keep things as cool as possible. A chip may work great at 72° F, become intermittent at 75° F, and go completely dead at 78° F. So, if you want to force a failure quickly, use a blow dryer, or turn off the fans and close off the vents. This is a good troubleshooting technique and makes for a good burn-in test. With all this talk about cabinets, you may think they're too much of a bother. You may be thinking of just throwing the case away, and then you'll be sure it will be well ventilated. Do it, but you will soon see that cabinets are necessary and perform many useful purposes (besides being a place for your coffee cup to sit on). First of all, they make your area safer. There is less shock hazard if untrained hands go probing amongst the wires. Remember, it's not so much the voltage as it is the current that causes shock and death. Second, cabinets make fragile components less prone to damage from falling screwdrivers or such. Third, they keep out dirt and therefore prevent some of the problems talked about earlier. Last, but certainly not least, your equipment can stay cooler. A well-constructed cabinet with fans will ensure even cooling. The air is pushed in or pulled through and forced to cool the width of the cabinet. The number of fans needed varies with the application, but at least one should be used.

Summary

I hope this article has helped you see a few ways you can make your system more reliable. They are little things, but it is the little things that are important, and ignoring them can cause big headaches. If you want logical reasons for keeping your system up to snuff, consider this: You're about to show off your pride and joy to your buddy. When you turn it on, he is hit with a cloud of dirt and steel wool dust. He drops to the floor gasping for air and dies of suffocation. You wouldn't want that on your conscience, would you? ■

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The Bionic Clock!

Many microcomputer applications require that the current time be available for display or printout, either on demand or when certain events occur. A time system of this type is known as a "real-time" clock, as distinguished from the microprocessor clock used for internal timing. One can think of at least a dozen applications for a real-time clock. For RTTY operation, the current time can be sent at the beginning or end of a transmission, included as part of a contest message when required, and used as a 10-minute timer for CW identification. Others may find the clock useful for such things as logging, satellite tracking, and timing in conjunction with repeater control, just to name a few.

A practical microcomputer real-time clock is not really a very difficult project. At the time I needed one, however, I could not find much information in the available literature. A system using timing loops was described by Hogenson in the December, 1975, issue of *Byte*, but this uses a dedicated program and cannot be run concurrently with other programs. I had considered interfacing a clock chip such as the MM5312 or 5313 to a 6820 PIA, but

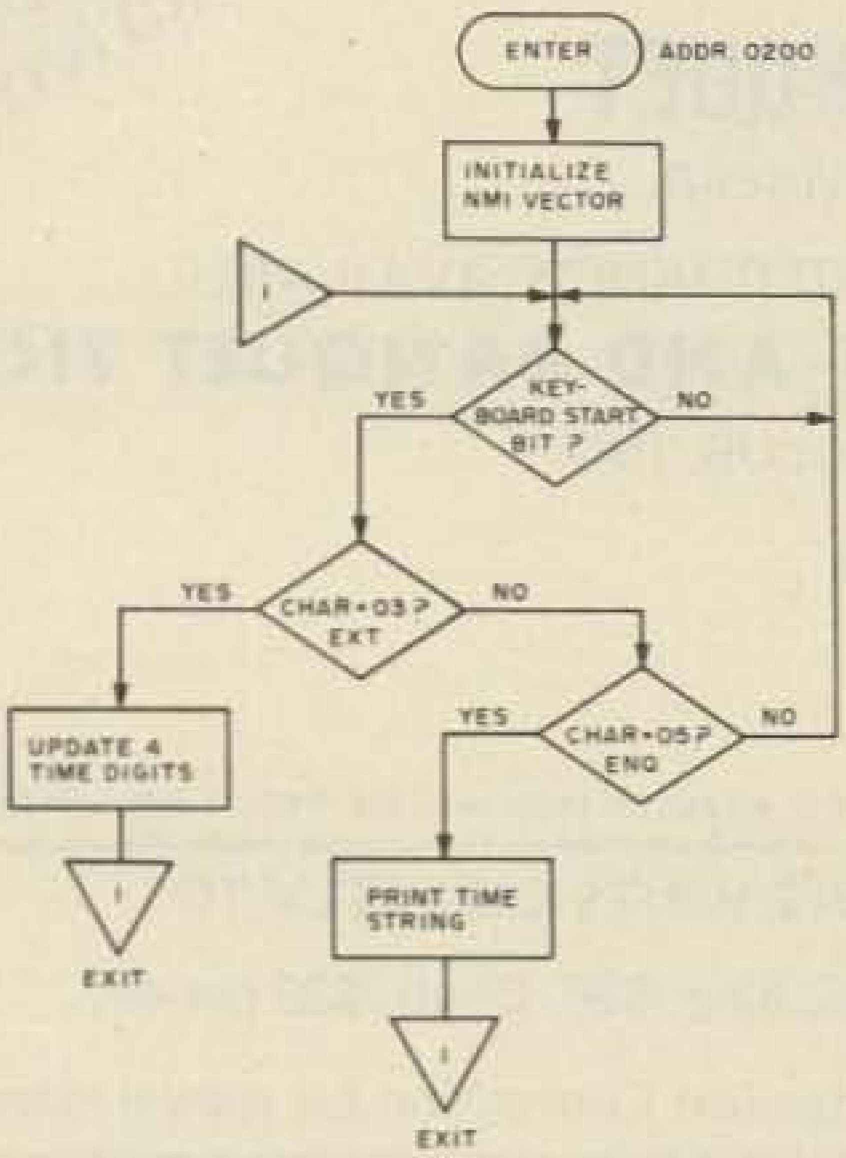

Fig. 1. Flowchart — wait loop, time update, and print time routines.

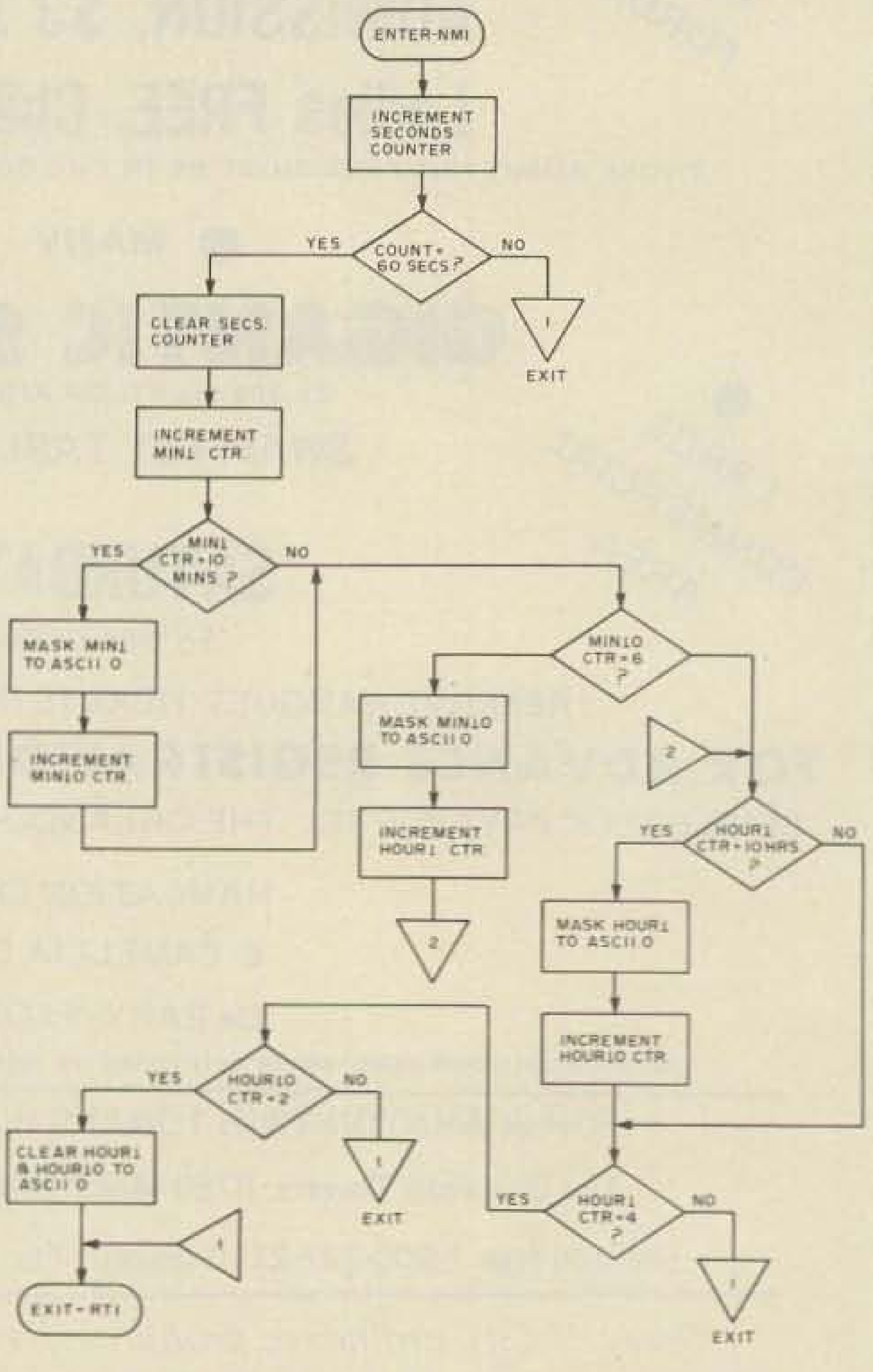

Fig. 2. Flowchart — NMI real-time clock routine.

```
0200 CE 02 3D    START    LDX    #$NMI  INITIALIZE NMI VECTOR
0203 FF A0 06             STX    NMIV
0206 7D 80 04    WAIT     TST    PIA ORA LOOK FOR KBD START BIT
0209 2B FB                BMI    WAIT
020B BD E1 AC             JSR    INEEE (MIKBUG)  GET CHAR.
020E 81 03                CMPA   #3    ETX = TIME UPDATE CTRL CHAR.
0210 26 04                BNE    RDTIME
0210 8D 0E                BSR    STTIME
0214 20 F0                BRA    WAIT
0216 81 05       RDTIME   CMPA   #5    ENQ = READ TIME CTRL CHAR.
0218 26 EC                BNE    WAIT
021A CE 02 34             LDX    #$HOUR10  TIME STRING ADDR.
021B BD E0 7E             JSR    PDATA1  (MIKBUG)  PRINT TIME.
0220 20 E4                BRA    WAIT
                                 UPDATE TIME FROM KEYBOARD
0222 CE 02 34    STTIME   LDX    #$HOUR10
0225 7F 02 8E             CLR    COUNT   RESET SECONDS COUNTER.
0228 BD E1 AC    TIMEIN   JSR    INEEE   GET DIGIT FROM KBD.
022B A7 00                STA    0, X
022D 08                   INX
022E 8C 02 38             CPX    #$MIN1+1
022F 26 F5                BNE    TIMEIN
0233 39                   RTS           RETURN TO WAIT LOOP
0234 30          HOUR10          0
0235 30          HOUR1           0
0236 30          MIN10           0
0237 30          MIN1            0
0238 20                          SPACE
0239 55                          U
023A 54                          T
023B 43                          C
023C 04                          EOT
                                 NON-MASKABLE INTERRUPT ROUTINE
023D 7C 02 8E    NMI      INC    COUNT   COUNT 1 SEC.
0240 B6 02 8E             LDAA   COUNT
0243 81 3C                CMPA   #$3C    60 SECS?
0245 26 46                BNE    EXIT
0247 7F 02 8E             CLR    COUNT
024A 7C 02 37             INC    MIN1
024D B6 02 37             LDAA   MIN1    COUNT 1 MIN.
0250 81 3A                CMPA   #$3A    10 MINS?
0252 26 08                BNE    TENMIN
0254 84 30                ANDA   #$30    MASK TO ASCII ZERO.
0256 B7 02 37             STAA   MIN1
0259 7C 02 36             INC    MIN10
025C B6 02 36    TENMIN   LDAA   MIN10
025F 81 36                CMPA   #$36    60 MINS?
0261 26 08                BNE    ONEHR
0263 84 30                ANDA   #$30
0265 B7 02 36             STAA   MIN10
0268 7C 02 35             INC    HOUR1
026B B6 02 35    ONEHR    LDAA   HOUR1
026E 81 3A                CMPA   #$3A    10 HRS?
0270 26 08                BNE    TENHRS
0272 84 30                ANDA   #$30
0274 B7 02 35             STAA   HOUR1
0277 7C 02 34             INC    HOUR10
027A 81 34       TENHRS   CMPA   #$34    HOUR1 = 4?
027C 26 0F                BNE    EXIT
027E B6 02 34             LDAA   HOUR10
0281 81 32                CMPA   #$32    HOUR10 = 2?
0283 26 08                BNE    EXIT
0285 86 30                LDAA   #$30    IF HRS=24, CLEAR TO 00.
0287 B7 02 34             STAA   HOUR10
028A B7 02 35             STAA   HOUR1
028D 3B          EXIT     RTI
028E             COUNT
```

Fig. 3. 6800 real-time clock program.

neither was on hand at the time. One manufacturer is currently advertising a real-time clock board kit and software for about $100. This is not quite my idea of a cheap clock!

The system I finally decided to use operates on an interrupt basis, using a crystal-controlled timebase and dividers to produce one pulse per second. This is connected to the microprocessor nonmaskable interrupt (NMI) line. The IRQ input can also be used, if not otherwise required by the other programs. Component cost is less than ten dollars, and the programs require only a nominal amount of memory. The programs to be described were developed for use with a 6800, using the Mikbug™ monitor and the KIM-1 6502 system. Adapting the programs to other systems should offer no great problems.

In addition to the clock routine, we must have a routine to store the address of the clock routine in the interrupt vector locations, a routine to initialize the clock "digit" locations from the terminal keyboard, and a routine to read out the time. A flowchart to do all this is shown in Fig. 1. For the purpose of demonstrating the program, a wait loop is used, so the program is waiting for a keyboard command to either store or read the time.

To start the clock, select the Store Time control character, type in only the four digits for the upcoming time in 24-hour format, and turn on the clock pulse generator at the exact minute. To read the current time, select the Print Time control character. The keyboard control characters can, of course, be changed to any others, as you desire.

A flowchart of the NMI routine is given in Fig. 2. Figs. 3 and 4 list the programs for the 6800 and 6502, respectively. When the time locations are initialized with the current time, the seconds counter location is cleared. After the clock generator is started, each pulse causes the program to vector to the interrupt routine, and the seconds counter is incremented by one. When 60 seconds are counted, the units/minutes digit is incremented, and the seconds counter is cleared again. The other digits are updated in essentially the same manner, following ordinary clock logic. Since the 24-hour format is used, the hours locations are cleared to zeros when the time increments to 2400 hours.

One note of caution: The clock generator must be off when you are in the system monitor. Until the program is loaded and executed, any interrupt will cause the monitor program to go berserk. After the program is loaded, you can safely return to the monitor if necessary.

If you don't use Universal

```
0200 D8          START   CLD
0201 A9 50               LDA   #$50     INITIALIZE NMI VECTOR
0203 8D FA 17            STA   NMIV (LO)
0206 A9 02               LDA   #$02
0208 8D FB 17            STA   NMIV (HI)
020B 2C 40 17    WAIT    BIT   SAD (KIM)  LOOK FOR KBD START BIT.
020E 30 FB               BMI   WAIT
0210 20 5A 1E            JSR   GETCH (KIM)  GET KBD CHAR.
0213 C9 03               CMP   #$03     ETX=TIME UPDATE CTRL CHAR.
0215 D0 06               BNE   RDTIME
0217 20 27 02            JSR   STTIME
021A 4C 0B 02            JMP   WAIT
021D C9 05       RDTIME  CMP   #$05     ENQ=READ TIME CTRL CHAR.
021F D0 EA               BNE   WAIT
0221 20 3A 02            JSR   PRTIME
0224 4C 0B 02            JMP   WAIT
0227 A9 00       STTIME  LDA   #0
0229 8D A5 02            STA   COUNT    RESET SECONDS COUNTER.
022C A2 00               LDX   #0
022E 20 5A 1E    TIMEIN  JSR   GETCH (KIM)
0231 9D 48 02            STA   HOUR10, X  STORE 4 DIGITS.
0234 E8                  INX
0235 E0 04               CPX   #$04     =SIZE+1
0237 D0 F5               BNE   TIMEIN
0239 60                  RTS
023A A2 00       PRTIME  LDX   #0
023C BD 48 02    PRSTR   LDA   HOUR10, X
023F 20 A0 1E            JSR   OUTCH (KIM)  PRINT CHAR.
0242 E8                  INX
0243 E0 08               CPX   #$08     =SIZE+1
0245 D0 F5               BNE   PRSTR
0247 60                  RTS

0248 30          HOUR10        0
0249 30          HOUR1         0
024A 30          MIN10         0
024B 30          MIN1          0
024C 20                        SPACE
024D 55                        U
024E 54                        T
024F 43                        C

                               NON-MASKABLE INTERRUPT ROUTINE
0250 48          NMI     PHA            SAVE A.
0251 EE A5 02            INC   COUNT
0254 AD A5 02            LDA   COUNT
0257 C9 3C               CMP   #$3C     60 SECS?
0259 D0 48               BNE   EXIT
025B A9 00               LDA   #0
025D 8D A5 02            STA   COUNT    RESET SECONDS COUNTER.
0260 EE 4B 02            INC   MIN1
0263 AD 4B 02            LDA   MIN1
0266 C9 3A               CMP   #$3A     10 MINS?
0268 D0 08               BNE   TENMIN
026A 29 30               AND   #$30     MASK TO ASCII ZERO.
026C 8D 4B 02            STA   MIN1
026F EE 4A 02            INC   MIN10
0272 AD 4A 02    TENMIN  LDA   MIN10
0275 C9 36               CMP   #$36     60 MINS?
0277 D0 08               BNE   ONEHR
0279 29 30               AND   #$30
027B 8D 4A 02            STA   MIN10
027E EE 49 02            INC   HOUR1
0281 AD 49 02    ONEHR   LDA   HOUR1
0284 C9 3A               CMP   #$3A     10 HRS?
0286 D0 08               BNE   TENHRS
0288 29 30               AND   #$30
028A 8D 49 02            STA   HOUR1
028D EE 48 02            INC   HOUR10
0290 C9 34       TENHRS  CMP   #$34     HOUR1 = 4?
0292 D0 0F               BNE   EXIT
0294 AD 48 02            LDA   HOUR10
0297 C9 32               CMP   #$32     HOUR10 = 2?
0299 D0 08               BNE   EXIT
029B A9 30               LDA   #$30     IF HRS=24, CLEAR TO 00.
029D 8D 49 02            STA   HOUR1
02A0 8D 48 02            STA   HOUR10
02A3 68          EXIT    PLA            RESTORE A.
02A4 40                  RTI
02A5             COUNT
```

Fig. 4. KIM-1 (6502) real-time clock program.

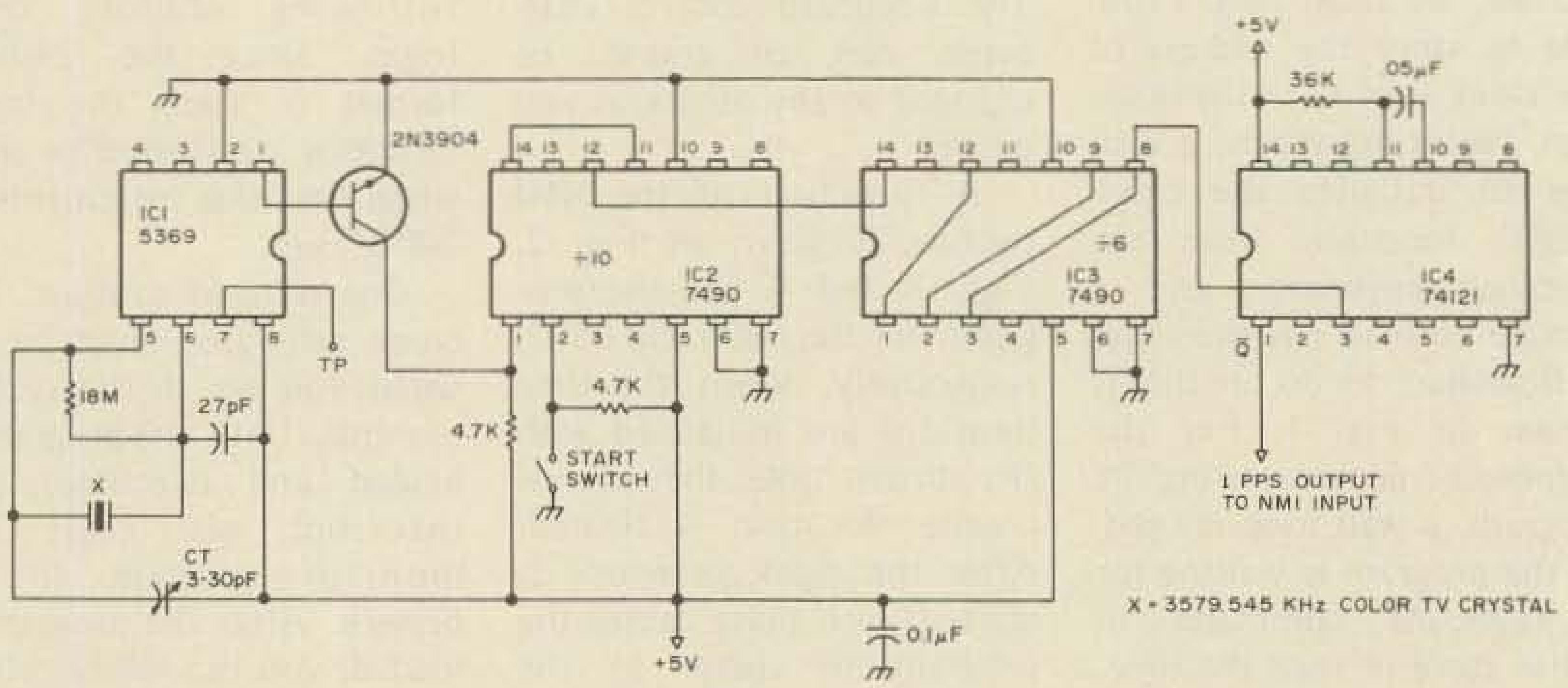

Fig. 5. Schematic diagram of the one PPS generator for the microprocessor real-time clock.

Coordinated Time (UTC), you can change the time zone to anything else, such as EST, PST, etc. With program modification, the time string can include other data.

A schematic of the clock generator is shown in Fig. 5. The timebase reference uses components from a $4.95 60 Hz crystal timebase kit. The 5369 is interfaced to the divider string TTL logic level with nearly any small switching-type NPN transistor. The two 7490s form the divide-by-60 function,

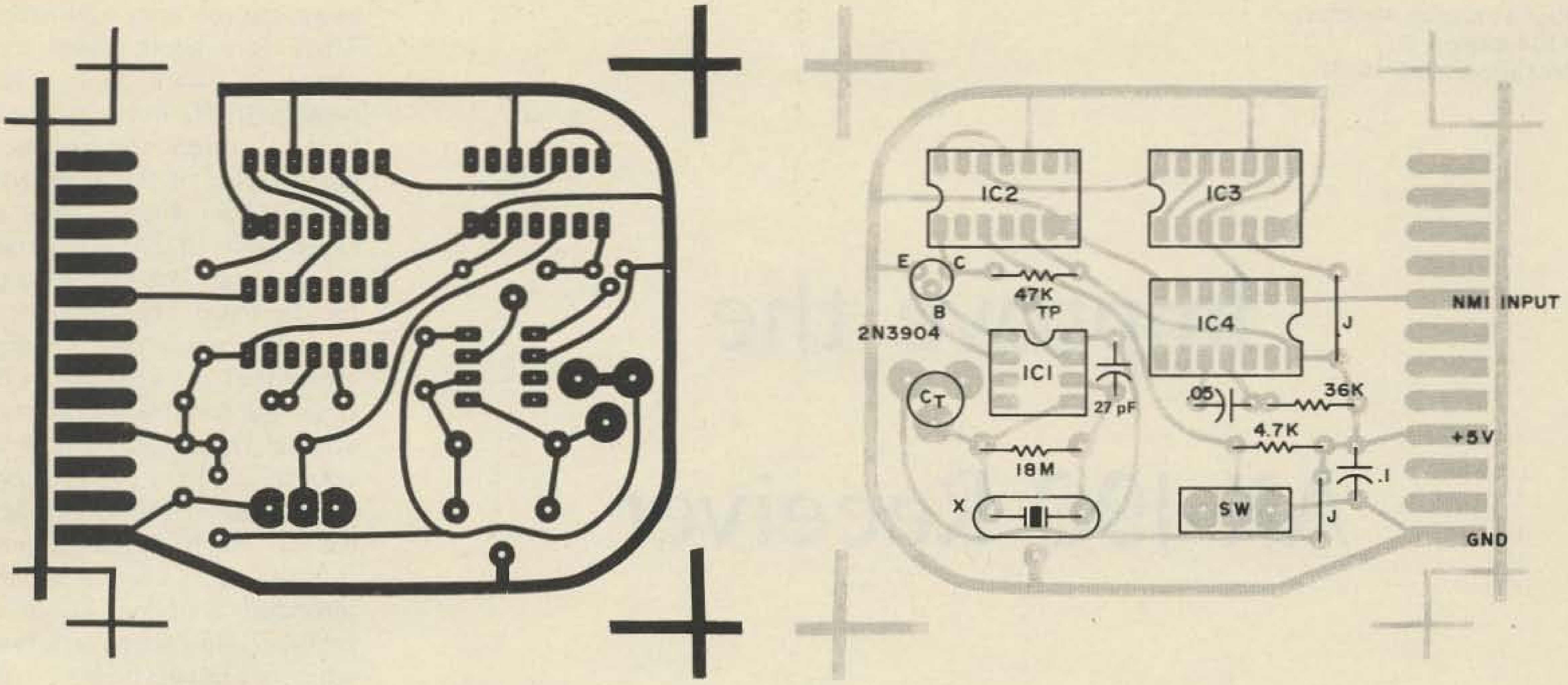

Fig. 6. PC board.

followed by a 74121 one-shot, to produce a pulse of approximately one ms. The pulse width is not critical, however, since the interrupt operates on the negative edge of the pulse. To reduce current drain, IC2 and IC3 can be replaced by 74LS90s. I could have used 74C90s, but I did not have a CMOS substitute for the 74121.

I discarded the small PC board that came with the timebase kit and made another board for the entire circuit. You can build the circuit on a piece of perfboard, mounting the timebase components on the PC board supplied. Artwork and component layout for the PC board I used are shown in Fig. 6.

The real-time clock has proved to be a real aid to RTTY operation. It's foolproof and reliable, and its accuracy is as good as any digital clock I have used. If your microcomputer needs a clock, try this one. ■

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Improve the AX-190 Receiver

From 1970 to late 1971, the Allied Radio Shack Co. had a very nice little receiver on the market. The AX-190, as it was called, was a very respectable ham band receiver. It was priced fairly reasonably, too. Possibly you have one of these gems floating around the shack. Maybe you have the SX-190, the SWL cousin, designed for the shortwave broadcast bands. Both of these receivers are pretty much the same except for their hfo crystals. Performance-wise, the AX-190 series receiver is a cut above the average SWL or Novice receiver. It has a crystal high frequency oscillator, a very stable linear vfo, and two mechanical filters which give it excellent adjacent channel rejection. Add to this a visual dial accuracy of 1 kHz, along with a 100 kHz and 25 kHz crystal calibrator, and you have a receiver that comes very close to the better ham band receivers that are currently available.

The weak spot of the AX-190 series receiver is the rf amplifier. The receiver is an excellent performer on the low bands below 10 MHz. The weak spot begins to show up from 20 to 30 MHz. It is here that the lack of gain in the front end shows itself as a lack of background noise. This, then, is the point of my article. We're going to make that AX-190 (or SX-190) of yours into a very sensitive set of ears. So sensitive, in fact, that you'll hear the 15 kHz horizontal oscillator of every TV set in your neighborhood. Now maybe you don't care to hear every TV set near you, but think how nice OSCAR 6 and 7 will come in if the gooney boxes are peaking S-9!

The conversions to the receiver itself are basically simple. They amount to changing but a few parts here and there on the rf printed circuit board. The real improvement comes with the addition of a two stage outboard rf preamp. And best of all, the preamp can be installed right in the receiver itself. This is the best way to go since the external amplifier uses tuned circuits which already exist in the receiver. Grab your manual and follow along with me. Since we'll be making our changes on the rf circuit board only, use the large circuit diagram provided in the manual. If you don't have a diagram, don't despair. All of the mods can be had with only the information in this article.

The AX-190 has a cascode rf amplifier consisting of Q2 and Q3, two JFETs (junction field effect transistors). We're going to replace them with MOSFETs (metal oxide semiconductor field effect transistors). These replacement transistors are not as expensive as their name implies. They can be purchased in single lots from ads in *73 Magazine* and will cost from \$.75 to \$1.00 each. The 40673 MOSFETs used are lead-for-lead compatible with the original transistors, except that they have an extra lead. This fourth or extra lead is the control or bias gate. Two tiny holes will have to be drilled in the circuit board to accept the extra lead of each transistor. There is a good reason for changing transistors. The original JFETs in the receiver have a listed transconductance rating of 2,000 microohms. The 40673[3] has a rating of 12,000, all else being equal. Without getting too technical, this difference of transconductance simply means that our 40673s have 6 times the possible gain of the original transistor. (Wouldn't you say that's a good reason to use them?) Our 40673 also has a much higher input impedance, which makes interstage coupling less of a problem. Now that you know why, let's discuss how.

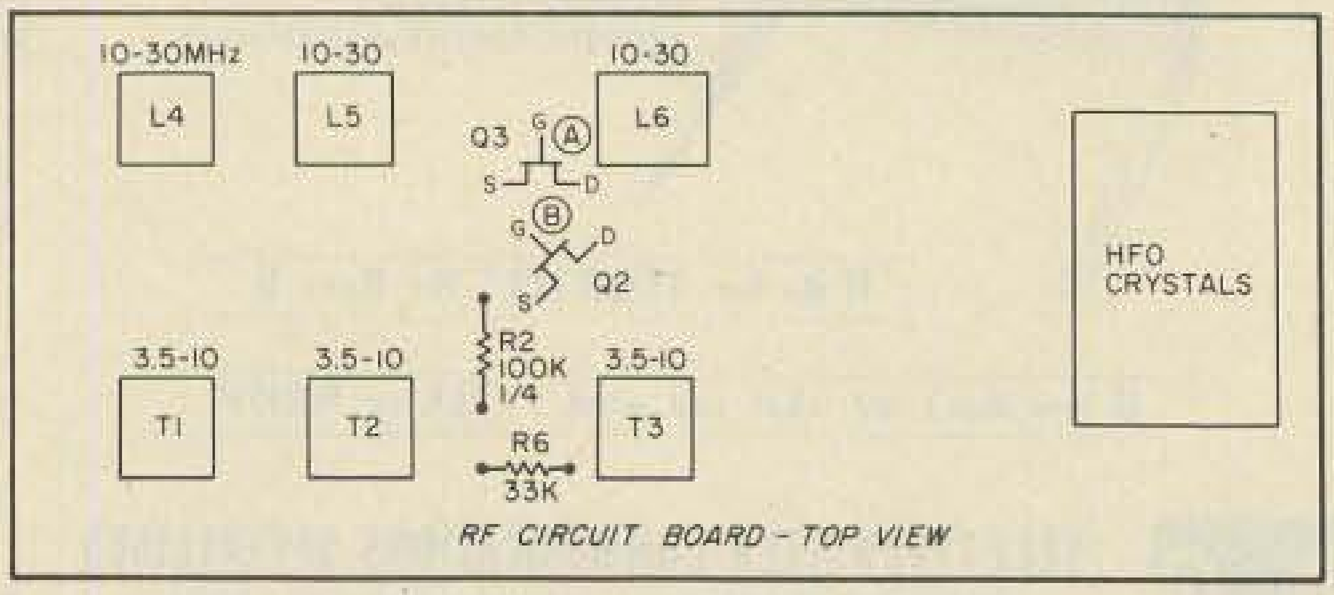

Fig. 1. View of rf circuit board from the top. The A and B marks next to Q2 and Q3 show the spots where the extra holes are to be drilled. Shown also are the locations of R2 and R6.

With both top and bottom covers removed, stand the receiver on its side with the component side of the circuit boards to your left. The rf board will be the one near the bottom. It can be identified easily by the 12 hfo crystals tucked toward the front panel. Refer to Fig. 1 and locate Q2 and Q3 on the board. Carefully remove them by touching a small soldering iron to their foil pads. Once they are removed, clean up their mounting holes and foil pads with a solder sucker. Now using Fig. 1 as a guide, drill two holes with a printed circuit drill, one hole at Q2 and one at Q3.

After drilling, make sure that you haven't pierced any circuit board foil. The transistor leads that will go through these holes will be hand-wired on the bottom of the board. Now slip a 40673 into each position, making sure all four leads of both devices go through the board. The tab on Q3 should be pointing down and the tab on Q2 pointing to the lower right-hand corner. Solder the three leads of each device that have circuit foil on them. *Don't cut off* the fourth lead of each transistor. We want it as long as we can get it.

Fig. 2 shows the components that are to be added to each transistor. The post that is referred to on the diagram is a tie point for the

9 volt supply bus to the receiver rf amplifier. As you can see, a resistor goes from the post to each bias gate. From there, a 50k Ohm to ground is paralleled by a .001 bypass capacitor. Do not omit this capacitor, as it keeps rf off the bias voltage. When soldering, be especially neat, as solder splashes are hard to find and can cause endless troubles.

Now, referring to Fig. 1 again, locate R2, a 100k Ohm resistor, and replace it with a 1 megohm. This change puts the MOSFET gate at a higher potential above ground. Also locate R6, a 33k Ohm resistor, and replace it with the 100k Ohm you removed in the preceding step. This last change improves the sensitivity of the agc gate transistor. This in turn lets the rf amp run at almost full gain on noise or weak signals. The end result will be a compression effect similar to the compressors used on SSB transceivers. The credit for this last modification belongs to Bruce Mackey.[1] In his article which appeared in a past issue of *CQ Magazine*, Mr. Mackey describes modifications to the AX-190 agc circuit.

With the MOSFETs installed, a noticeable increase in sensitivity will be realized. This will be especially true on 28 MHz, where background noise becomes an index of rf gain. You may wish to stop here.

You have added about 9 dB of gain with the modifications to the rf stage. But if you're as much a purist as I am, you'll want to build up the circuit in Fig. 3. With this little two stage preamp, you'll add an extra 20-25 dB of gain ahead of whatever gain you already have. With this circuit, your rf gain control will do something instead of just sitting there at full clockwise. A look at Fig. 3 will disclose 2 more 40673s. These devices, like the ones in the receiver, are hooked up in cascode. This means that the first device uses its gate as the input, the normal situation, while the second device runs with its gate at rf ground. In this case, the source becomes the input with rf output taken at the drain. Because the second MOSFET is run the equivalent of common base (grounded grid), the amplifier does not require neutralization.

Construction of the preamp will be more or less up to you. I used a piece of glass perfboard about 1 in. x 2 in. If you build the preamp to these dimensions, it will be small enough to fit right in the AX-190 antenna compartment. Just solder a piece of strip copper to the preamp at a right angle to the plane of the board. The copper strip can then be soldered to the receiver tin shield. This method provides a dc ground, but more important, a good rf ground. The dotted line of Fig. 2 will give you an idea of where the preamp board should go.

As mentioned earlier, the preamp has no tuned circuits of its own. Its input and output are tuned by 2 ganged circuits which are actually a part of the receiver preselector. T1 of the preselector becomes the input of the preamp, and T2 the output. We can use this arrangement because T1 is the antenna trim in the receiver and is only a passive stage; it has no active devices. T2 is shared by the preamp output and the receiver rf amplifier input. All we have done is take an empty resonant circuit and give it some gain, about 25 dB worth.

To put the final touches on things, you'll want to peak up all the coils on the rf circuit board. Set the bandswitch to 3.5 MHz and get about a 3 S-unit reading from the calibrator. Peak up T1, T2, and T3 for maximum meter reading. Back off on the rf gain if the S-meter goes above S-7. Now switch to 28.5 MHz with the same procedure and peak up L4, L5, and L6. It might be necessary to repeat both procedures at least one time since the coil banks interact with each other. To make a quick test of the preamp, set the bandswitch to 28.5 MHz (or the highest band on the SX-190). With the rf gain control backed off one-third from maximum, there should still be a few S-units of noise on the meter. With gain turned up full, the meter will be near pinned from background noise. For best listening, set the rf gain until you get a noise level of about 2 or 3 S-units. Don't worry about signals that are too strong, because the alc will do its thing and maintain an audio output that will stay within 6 dB from noise to full quieting.

One final comment is necessary. You may find that at certain frequencies, the preamp will oscillate. Oscillation can be confirmed if you can tune the receiver by moving the preselector. If this is the case, simply detune either T1 or L4 very slightly. If you have trouble between 3.5 MHz and 10 MHz, detune T1. Between 10 MHz and 30 MHz, detune L4 slightly until the oscillation stops and the preselector peaks up normally. That's about it. You now have a much improved AX-190. The extra gain is really unnecessary most of the time. But, if you chase DX or OSCAR, it will really come in handy. I hope that these modifications will make your AX-190 into a really fine set of ears. ■

References

[1] "Improved Agc for the Allied Radio Shack 190 Receivers," Mackey, Bruce L., *CQ Magazine*, July, 1973, Vol. 29, No. 7, page 55.

[2] *Allied AX-190 Instruction Manual*, page 20, "Schematic Diagram of rf Amp." Copyright '71 by Allied Radio Shack.

[3] *RCA Top of the Line Replacement Guide*, Copyright 1968 by Radio Corporation of America.

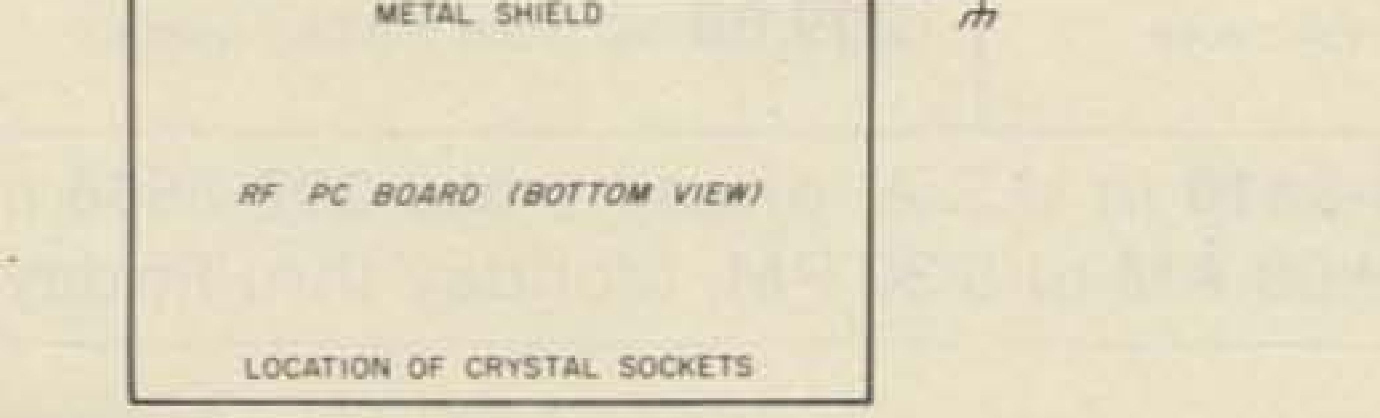

Fig. 2. Rf circuit board, bottom view. On both Q2 and Q3, the G2 connection is the second gate. G2 leads must not touch any circuit board foil. Also shown is the placement of the preamp board with its connections to the main board.

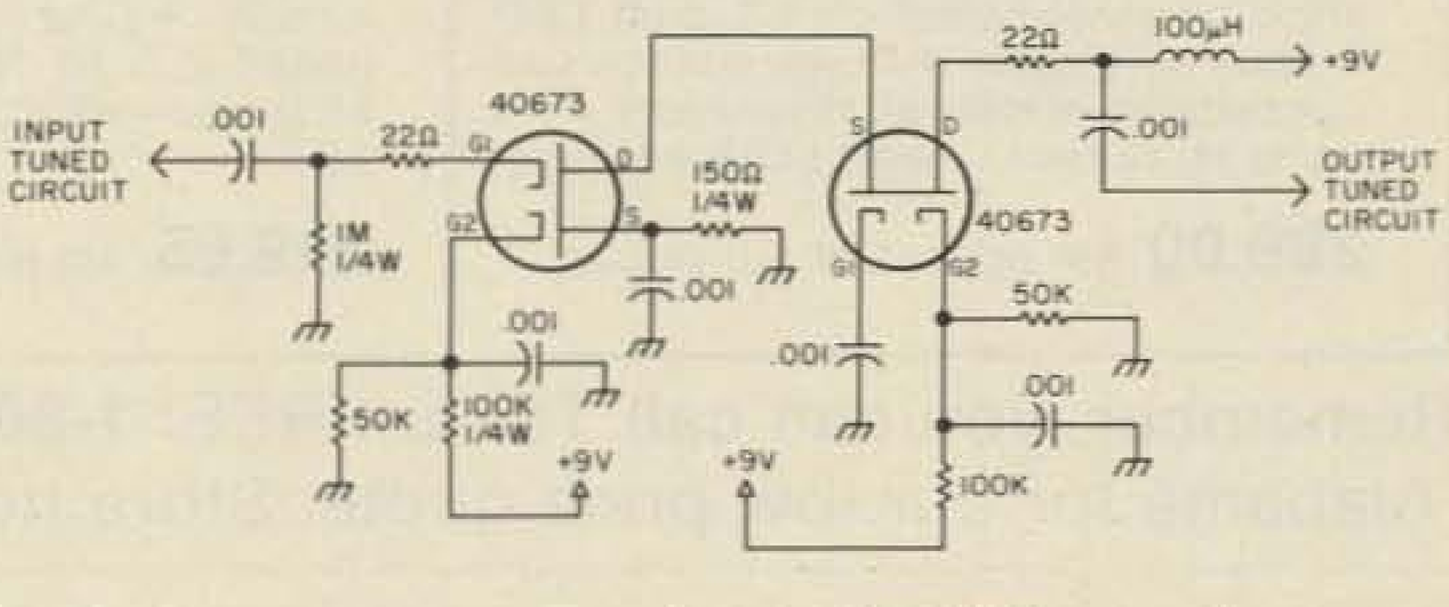

Fig. 3. Preamp circuit. Two RCA MOSFETs provide an extra 20 dB gain when used ahead of the AX-190. Note that input and output tuned circuits are actually a part of the receiver preselector on the rf circuit board. Connections to them are made with No. 18 stranded wire and kept as short as possible.

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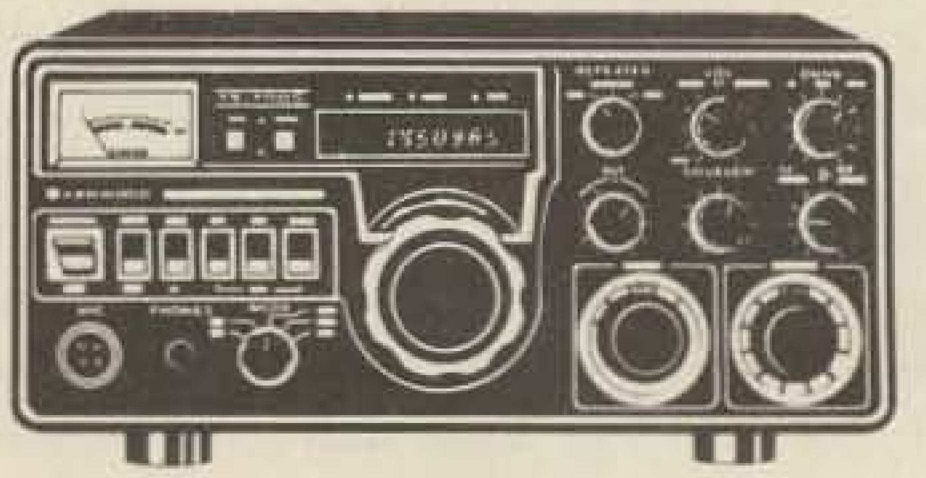

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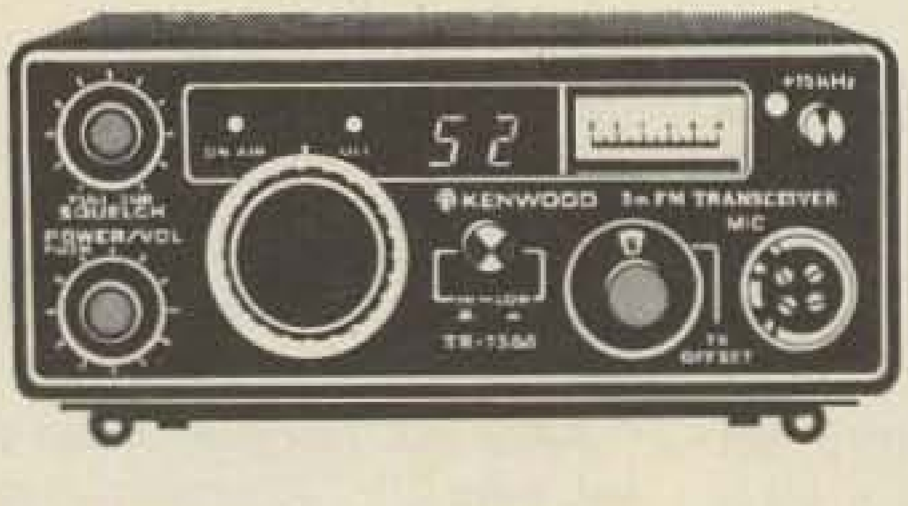

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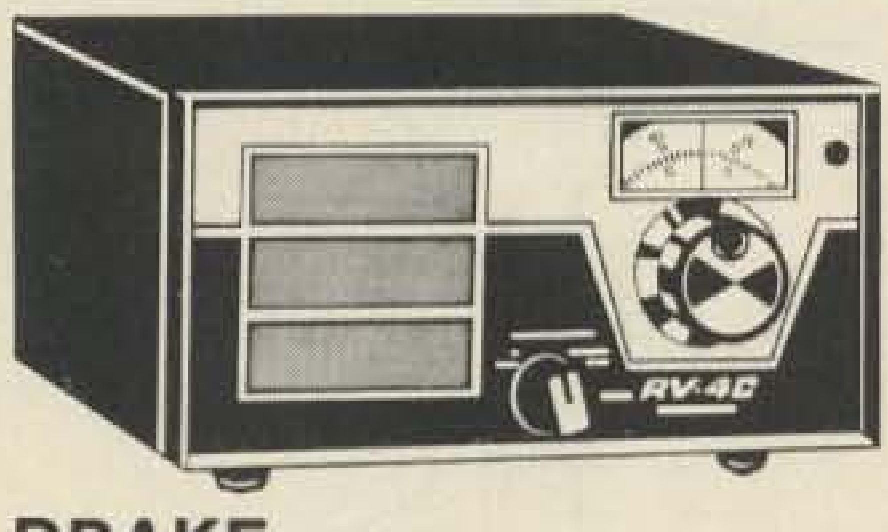

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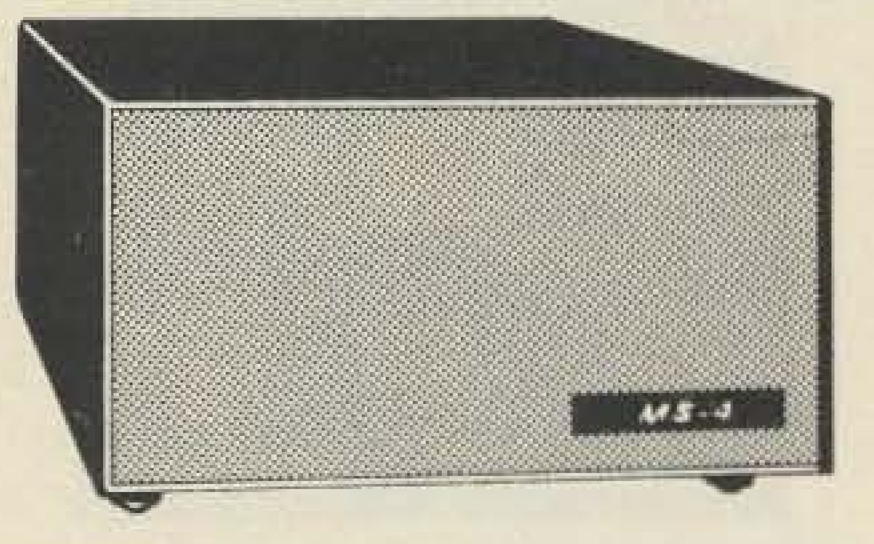

DRAKE MS-4 matching speaker

The Drake MS-4 matching speaker is designed for use with the Drake R-4C, R-4B, R-4A, and R-4 receivers. It has space inside to house the Drake AC-4 power supply or the AC-3 power supply. The 8-ohm speaker will always come through loud and clear.

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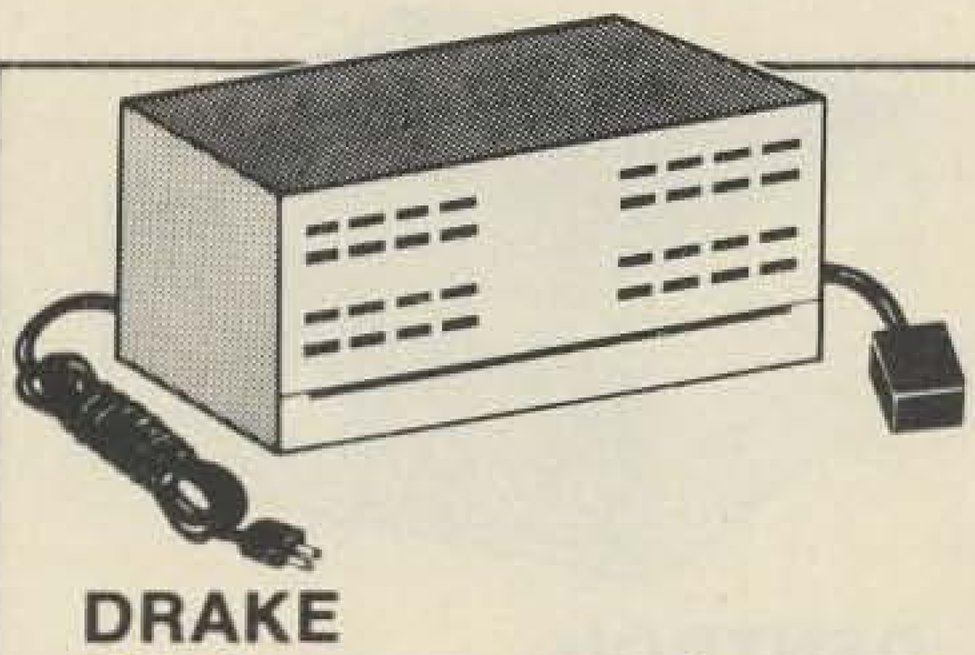

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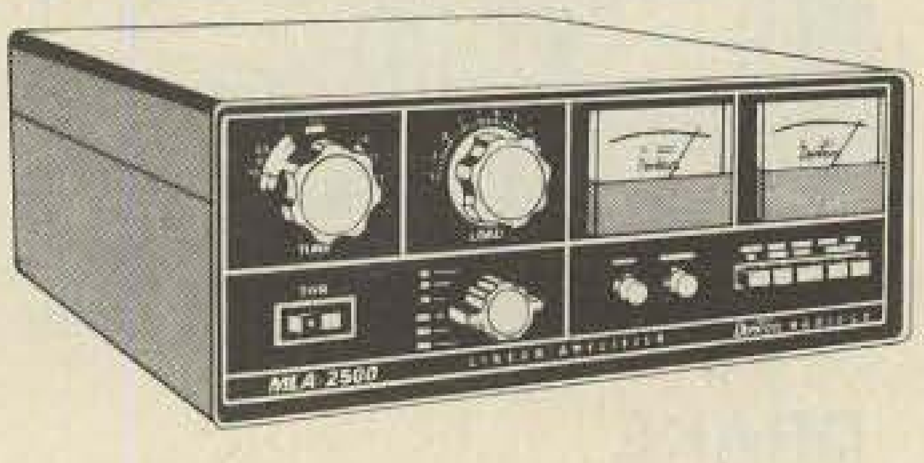

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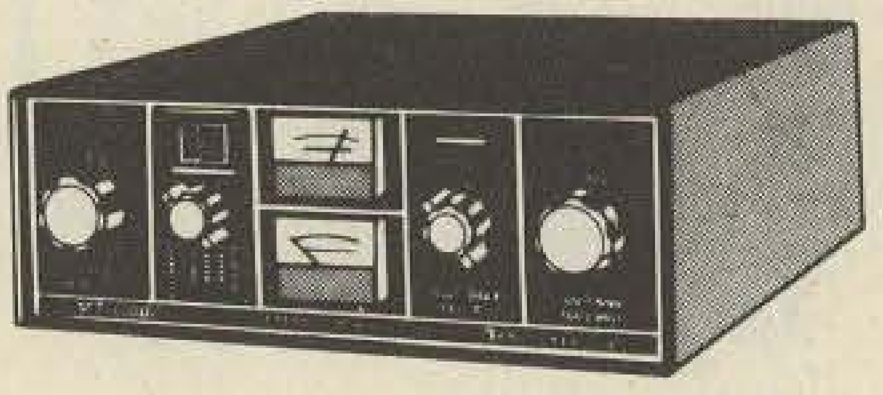

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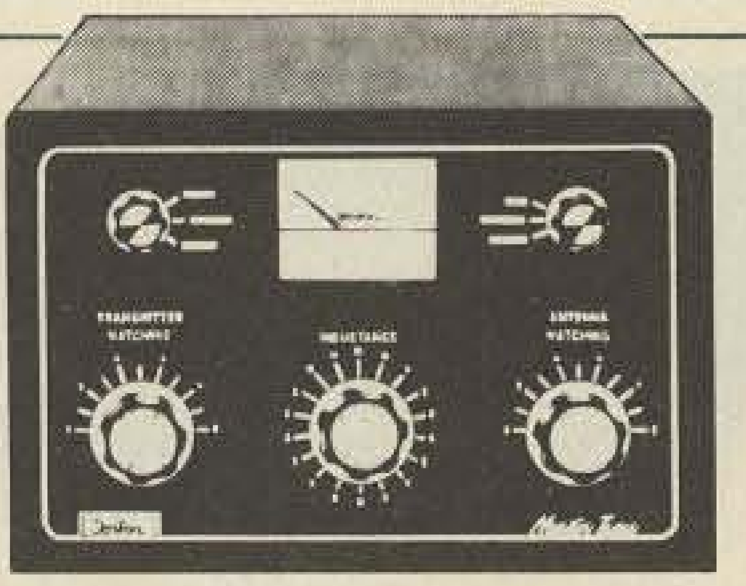

DENTRON 160-10MAT monitor tuner

The 160-10MAT features: • Built-in watt meter • Continuous tuning 1.7-30 mc • Antenna inputs are front panel switchable • Handles 3 KW PEP • Built-in heavy-duty Balun (3½" dia x 3" high), 3 core • Harmonic attenuation • Capacitor spacing 6000 volt.

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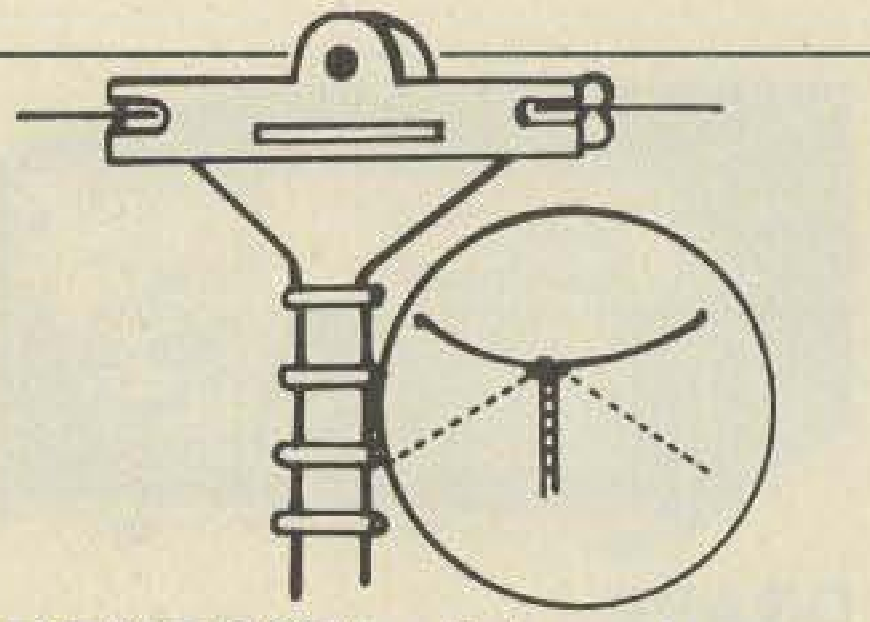

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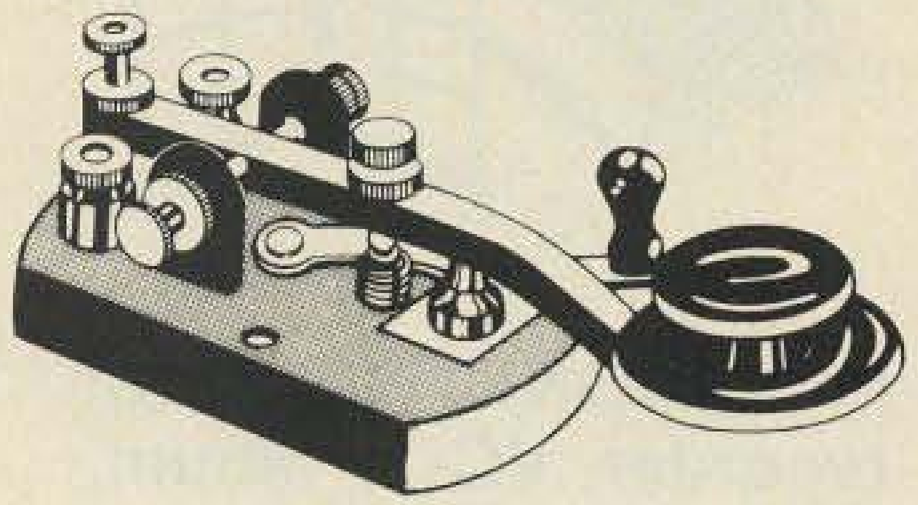

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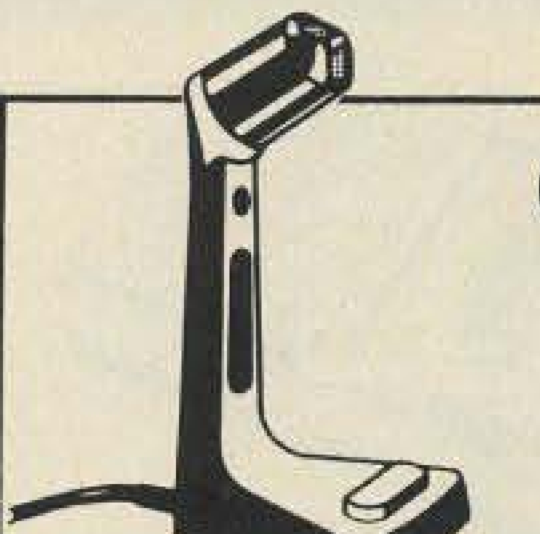

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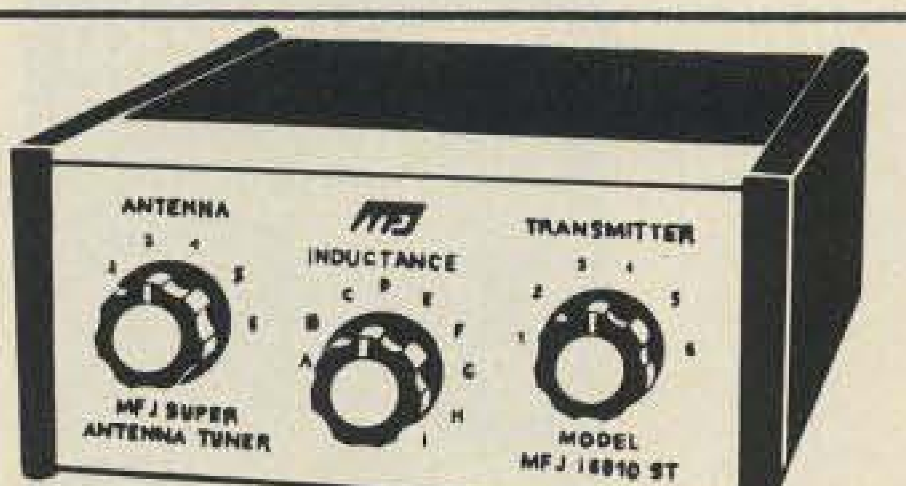

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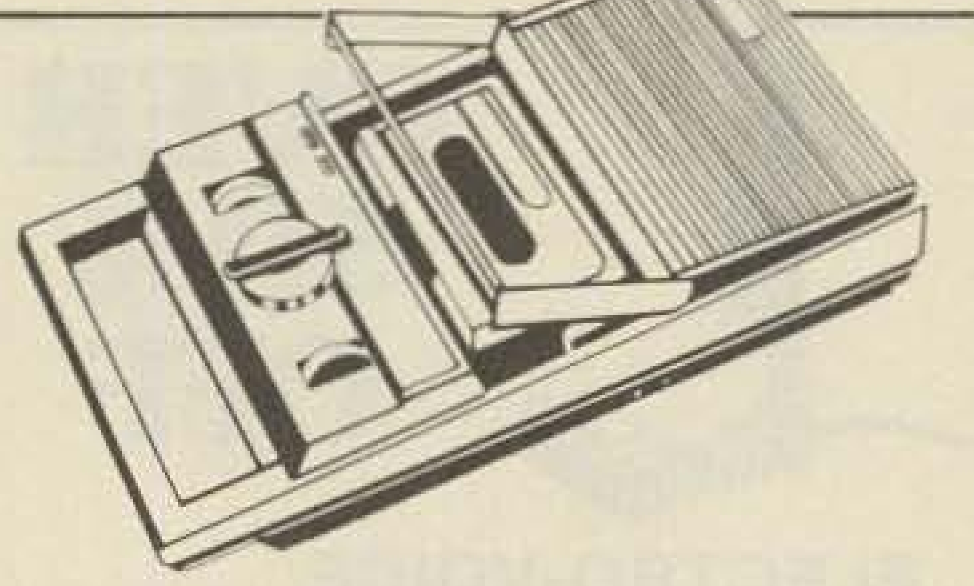

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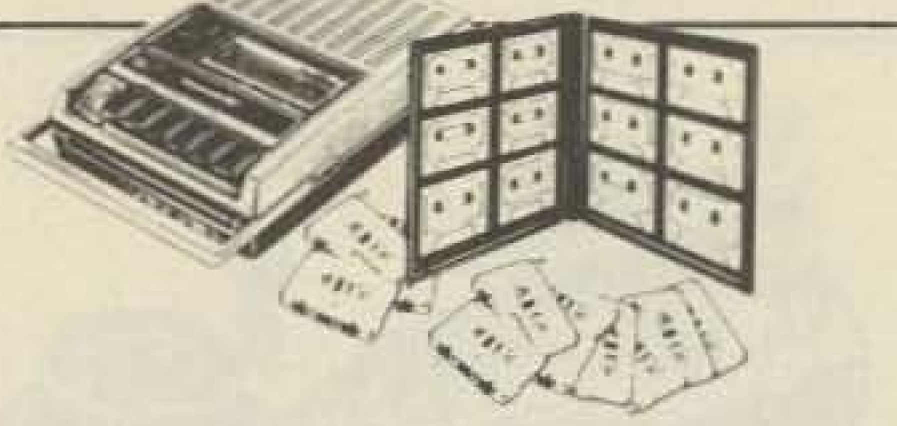

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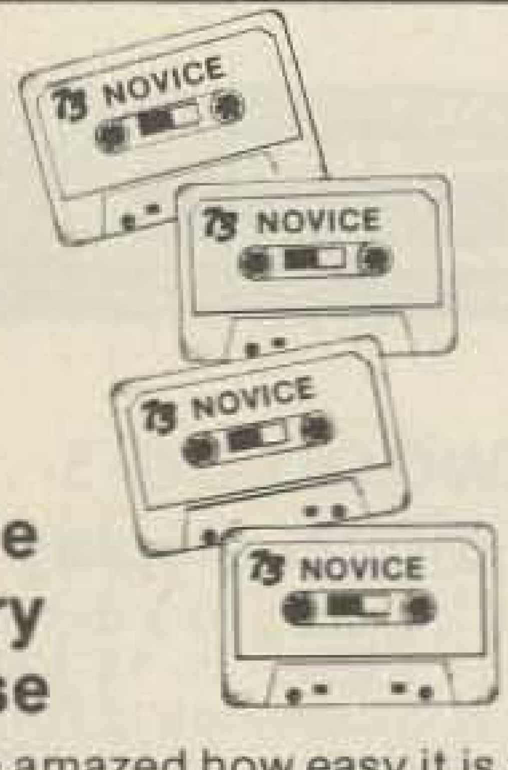

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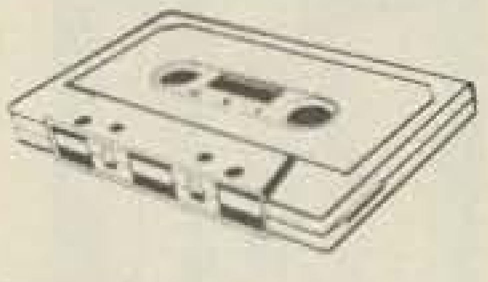

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The idea began in the teachers' lounge one day. Several teachers were discussing the problems that occur with the kids during the summer months and on weekends during the regular school year. We all agreed that there were not enough activities for young people in our small town of 14,000 people.

After the discussion, I decided that kids could have a lot of fun if introduced to the world of electronics and computers with a mini class during the summer or on a few weekends during the regular school year. There would be no grades or book work, just fun.

Students hooking up a circuit to experiment with switches and motors in the Electronic Recreation Program at Lake Havasu High School. (Left, Andy Nellis; center, Dan Mastroluca; right, Mark DiBlasi.)

Getting Started

I contacted the Lake Havasu Recreation Program about the idea. We agreed that 2 hours a day for 10 days would be about right for the summer program, and 4 hours on Saturday for 4 weekends would be sufficient during the regular school year. Advertisements were put in the newspaper and on the local radio station to let people know about the program. Three weeks later, we had two groups signed up and ready to go. Each group had 14 kids in it. Group one would meet from 1:00 to 3:00 in the afternoon, and the second group would meet from 7:00 to 9:00 in the evening. Group one ages were from 8-12 years old, and group two ages were from 13-18.

Before the classes started, I made up an outline for the material that would be covered during the sessions. I wanted it to be fun and interesting for the kids. I did not want it to be like school, with tests, grades, and specific requirements. The students did not have any background in electronics, so I had a wide area of material to select from. After several hours of planning, I decided on the following areas:

A. Electricity
  1. Voltage
  2. Current
  3. Resistance
  4. Static
B. Magnetism
  1. Permanent
  2. Electromagnets
C. Radio Communications
  1. Broadcasting
  2. Shortwave Radio
  3. Amateur Radio
D. Computers
  1. Operation
  2. Binary
  3. Hexadecimal
  4. BASIC
  5. Programming
  6. Games

Here We Go

The first day that we met, I introduced simple series and parallel circuits. Switches were then introduced, along with lights and resistors. All topics were handled as demonstrations in a lab area. As questions would come up, I would answer and demonstrate. This was very important to keep the fun in it. It does not help a program with kids 8-12 years old to have them sit at desks for 2 hours and lecture them about series and parallel circuits. Let them get their hands on the circuits. Let them discover what happens. I let the students experiment for the last hour of class with the circuits we had discussed.

The second day I demonstrated static electricity with a Tesla coil. It generates about 125,000 volts of static electricity and is great for demonstrations. I held a neon lamp about 6 inches from the coil, and it started to glow. Then the lights in the classroom were turned off. My hand and the lamp were both glowing a bright orange. The kids went wild. They loved it and wanted more. Next I used a fluorescent lamp, and it started to glow when I held it 6 inches from the coil. I then placed the lamp about 2 inches from the Tesla coil, and it created an arc between the lamp and the coil. The lamp will keep discharging as long as you hold the lamp close to the coil. It makes a bright blue arc when the lamp discharges, and the kids loved it.

The next demonstration was on heat and static electricity. I held a piece of paper between the arcing lamp and the coil. It took about 2 seconds for the paper to catch fire with a small flame. I quickly blew it out, and then the questions started flying. We discussed current flow, size of wires, ionization of gas in a neon and fluorescent lamp, lightning and its effects. The two hours were gone before we knew it.

The third day we discussed magnets and how they work. Several demonstrations were used with iron filings to show magnetic fields, and coils were used to demonstrate electromagnets. The students were then given the remaining hour and a half to experiment with the Tesla coil and magnets.

While the students were working, I went into the radio room to set up a demonstration I would do the next day on amateur radio. While I was setting everything up, I was thinking how well everything was going.

"Fire, fire!" someone screamed.

"Get the fire extinguisher," another student yelled.

I ran out of the radio room to see what was going on. Standing next to the Tesla coil was a 9-year-old with a piece of paper going up in flames in his hands. He was staring at the paper, not quite believing that it was going up in flames. I told him to drop it on the floor. He started blowing on it to try to put it out. Needless to say, it was burning pretty well by now, and he just kept blowing on it trying to put it out. The flames were getting close to his fingers now, and he decided it would be best to drop it. Three kids stomped on what was left of the paper to put out the flames.

We spent the next 20 minutes discussing safety and the correct procedure for doing experiments. We had spent some time at the beginning talking about safety, and this was an excellent time to reemphasize it.

I then took a few minutes to find out why the piece of paper had caught on fire. The student was trying to do the same thing I had demonstrated with the Tesla coil and paper. The only problem was, the paper really got started burning before he could get it out. Lesson well learned. Experience is the best teacher.

Radios, Radios, Radios

The fourth and fifth days were spent on radio communication. I used an oscilloscope and a mike to demonstrate voice and frequency. Then a frequency generator was used to show the effect of different frequencies and what they looked like on the oscilloscope.

Our discussion covered radio waves, detectors, amplifiers, mixers, and commercial radio broadcasting. I was amazed at the questions the kids had. They were really interested in how things worked and wanted to know more about the equipment.

Amateur Radio

"CQ twenty, CQ twenty. This is WA7RTM, Lake Havasu, Arizona, calling and standing by." I gave a general call on 20 meters for the demonstration. I hoped someone would come back who was quite a distance away.

"WA7RTM, Lake Havasu, Arizona, this is WØVPR, Liberty, Missouri."

"Hey, that guy is calling you!" the kids yelled.

Their eyes were as wide as silver dollars. There was so much excitement in the room, the kids could not contain themselves. I let each of them say a few words with the mike, and they were hooked.

We spent the next hour talking about amateur licenses and what was necessary to get one. The advantages of ham radio over CB were pointed out, along with how much more fun the kids could have with a ham license, if they would study a little.

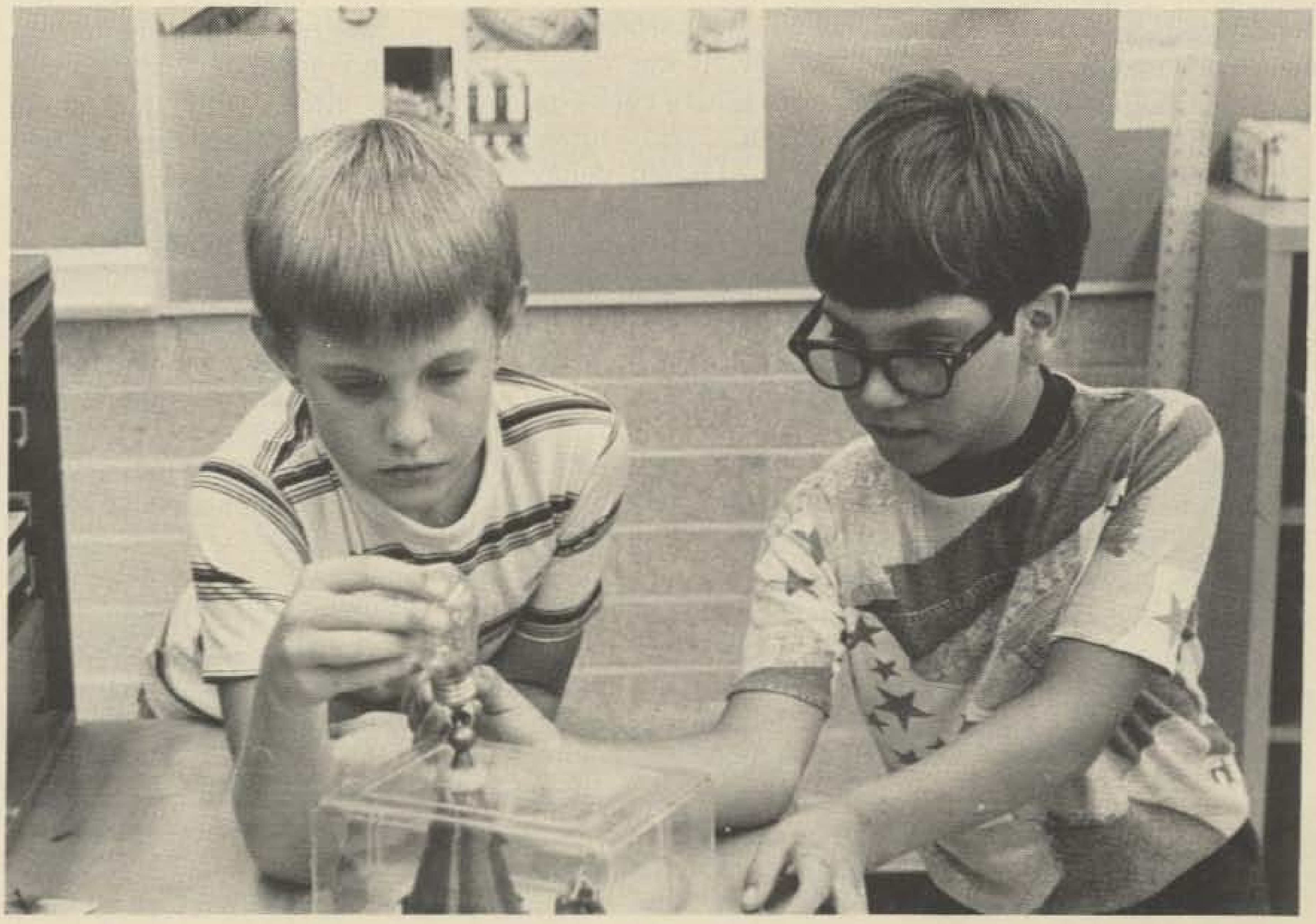
I then set up a 2 meter demonstration through the local repeater in Lake Havasu and then the repeater in Kingman, Arizona. With a repeater sitting on a mountaintop at 8,600 feet, you can make a few contacts. Contacts were made from Lake Havasu to Las Vegas, Los Angeles, Phoenix, and Prescott. The distances ranged from 5 miles to 300. The kids were really amazed at what you could do with amateur radio and how much better it was than CB.

We have a group of local amateurs who are teaching code and theory classes twice a year for anyone interested in becoming a ham. I made arrangements for the kids who were interested to get into the classes.

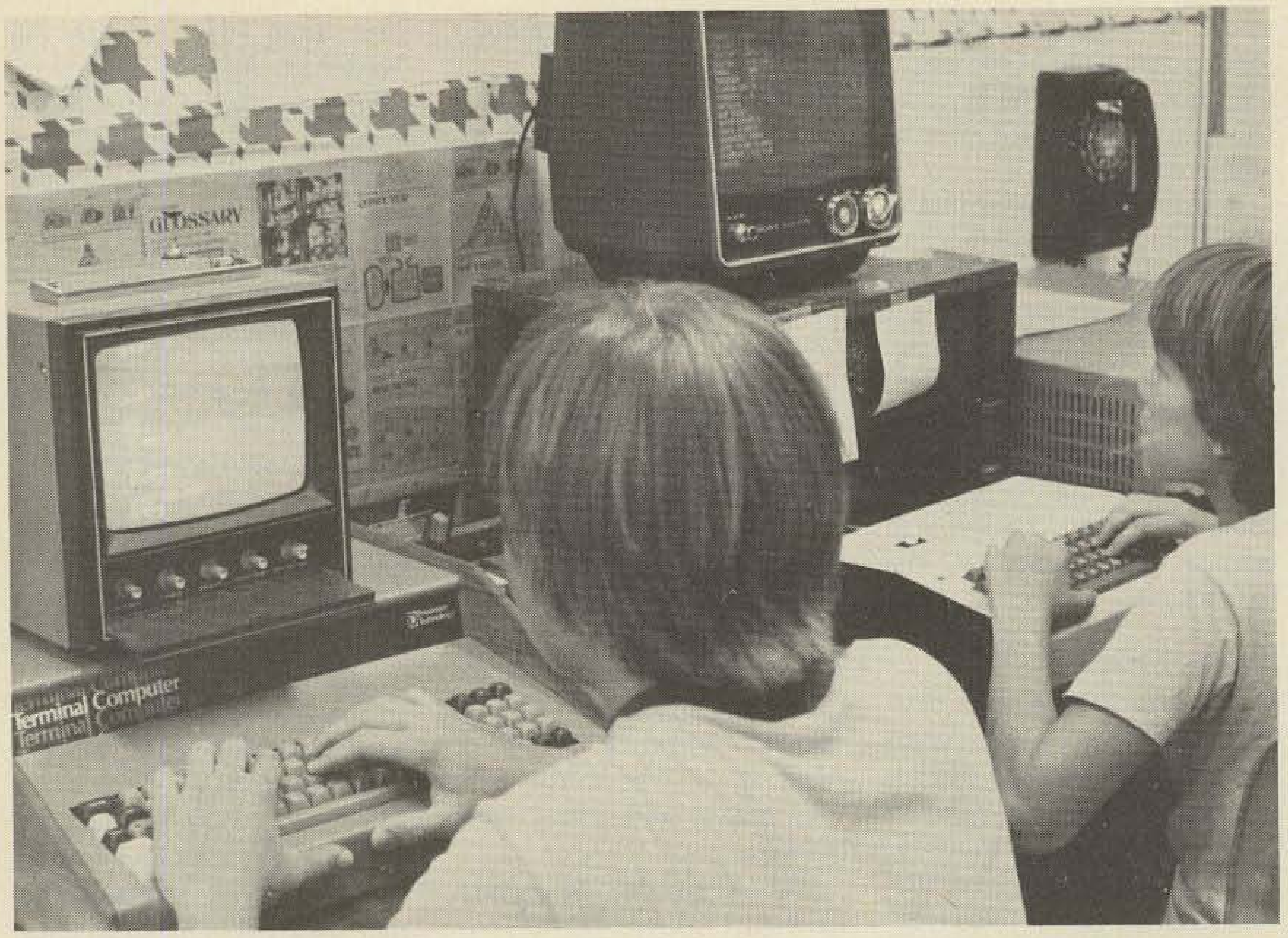
I had about 15 minutes left and demonstrated how to use the shortwave receivers so that they could listen to amateur radio broadcasts and shortwave broadcasts.

Computers

The second week started, and we began with a film about computers. I was able to get several excellent films from Modern Talking Picture Service. Their main office is located in New York, and they



Steve Marshal (left) and John Gustov (right) find out about static electricity using 100,000 volts to light a neon lamp.



Dan Mastroluca (left) and Tim Murphy (right) run their computer programs on the SOL and IMSAI during the computer segment of the program at Lake Havasu High School.

have several other offices located around the country. Most school districts make use of their film service because there is no charge for the films, except postage to return the film back to them. The main address in New York is: Modern Talking Picture Service, 2323 New Hyde Park Road, New Hyde Park, New York 11040.

Clubs and service organizations can get a copy of the films available by writing and asking for the folder on free films available. Subjects range from computers to electronics to farming and everything in between.

After the film, we introduced binary counting and how the computer uses it. The kids had a lot of fun with the binary alphabet I showed them how to use. We wrote the binary numbers from 1 to 26 and then put the letter A next to binary 1 and B next to binary 2, etc. Here are a few samples:

16 8 4 2 1

0 0 0 0 1 = A

0 0 0 1 0 = B

0 0 0 1 1 = C

0 0 1 0 0 = D

0 0 1 0 1 = E

0 0 1 1 0 = F

After we had the code made up, the kids experimented with secret messages in binary. It was a good way to learn binary counting.

BASIC was introduced with chalkboard demonstrations and discussions. I only spent about 20 minutes with the introduction of BASIC statements. We talked about let, goto, if-then, print, and input statements.

I am an avid believer in games and simulations on the computer. I have used computer games to get interested students started on the computer, and it has worked very well. They are very quick to ask why it works that way, or what would happen if I did it this way. My answer is, "Try it and see what happens." The great thing about the games and simulations is that they allow the students to make decisions and take chances and make a mistake. They learn a lot from the mistakes they make.

I start with a simple program of a number-guessing game. There are many programs in computer game books, like "Guess," "Stars," "Trap," "Hi-Lo," and several other versions. Any one of them can be used for examples. I start by letting each student play the game a few times with the others watching. They then switch, and a new student plays the game on the computer. After each one has had a chance to play a few times, we go back to the chalkboard and go through the program step by step and discuss what is happening. Then the pieces of the puzzle start to fit into place. Statements start to make sense.

Computer Equipment

Our high school purchased a SOL-20 and IMSAI in the spring of 1977. My electronics students assembled the kits, and thus saved about $800.00 between the two kits. We also built four Seals 8K Random Access Memory Boards to be used in the SOL-20 and IMSAI. All of our equipment has been purchased from the Byte Shop in Phoenix, Arizona. I would suggest to anyone who is considering purchasing any microprocessor equipment that you find a good computer store and deal with them. When you have problems, you can go back for help. You may pay a few dollars more for a piece of equipment, but service is very important in a new field such as microprocessors. We have had several problems using the equipment, and Alan Hald and his staff at the Byte Shop in Phoenix have helped us each time. The problems were not with the equipment. The problems were with the people not knowing how to correctly use the equipment. When you have a place to call for help, it is very comforting to know someone will be there to help you.

Finishing Up

For the remaining three days, we spent time exploring different game programs and running them on the computers. I had the students write a few small programs of their own and then run them. They learned how to debug programs very quickly. They were amazed at how just one letter could cause a problem in a program.

I tried to keep the students taking turns with the computers, as it is very difficult to have 14 kids use 2 units and all get equal time.

Do It Again, Sam

Was the program successful? You bet. When the kids were finished, they did not want to stop. They would have gone for another two weeks. I was impressed with how much they had learned. They all found out that learning can be fun. It all depends on how the material is presented.

Did I have any problems? Yes.

How do you get 14 kids to go home every day? ■

cold fingers and the like, when done in mid-winter. A feedpoint for the gamma rod was selected at 8 feet off the ground to minimize shock hazards for the children. With this dimension fixed, numerous combinations of gamma rod length, diameter, spacing to tower, and gamma/omega capacitors were tried. The conclusion: An swr of 1:1 could always be obtained and no differences in on-the-air reports were noticed. Bandwidth between 2:1 swr points was 100 kHz for any given set of values. Since the antenna performed well and met all of my criteria, further experimentation was deferred and mechanical considerations took hold. The length of the gamma rod was left at 32 feet as measured from the top of the tower to the feedpoint. Spacing was one foot at the bottom. Since the tower tapers, the spacing varies with height since the rod was kept perpendicular to the ground.

The gamma rod was constructed of ½-inch aluminum tubing which was on hand, and the right angles were made via adapters available at a local hardware store. Joining the tubing was done as shown in Fig. 1.

The support insulators were made from ¾-inch PVC water pipe and T-fittings. PVC cleaner and cement were used to join the parts and stainless steel hose clamps were used for clamping the insulators to the gamma rod and tower. The number of insulators was 5 in order to offer structural integrity.

After the initial value of gamma capacitor was determined to be 80 pF at 4.0 MHz, an attempt was made to lower the resonant frequency to 3.5 MHz via the use of added gamma capacity or via an omega capacitor. Both worked with the same amount of change in resonance occurring for a given capacity, whether it was used as a gamma or omega capacitor.

The omega configuration was chosen since the frame of the variable omega capacitor could be at dc and rf ground, thus avoiding the need for an insulated coupling for the shaft. The value needed for the omega capacitor was found to be 50 pF, but 100 pF was used in case the added capacity was needed for 160 meters. The fixed gamma capacitor consisted of two Centralab type 857 NPO 15 kV capacitors in parallel, while the variable omega capacitor had ¼-inch plate spacing. All connections were made with No. 8 copper wire. One should consult the junk box, hamfests, and surplus dealers, whatever is convenient. It would be wise to use whatever is handy to experiment with at low power levels and then search for the big final ones after the values are known. No arcing was observed with the above units when maximum legal power was used, even on wet or humid days.

The tuning mechanism for the omega capacitor is an automatic TV rotor which was on sale for $30. This was a bit high, but it offered set-and-forget convenience with no experimenting needed. One can merely type the resonant frequencies onto gummed labels and affix them to the rotor control. The rotor should be oriented so that the end of rotation stop doesn't occur anywhere in the 180 degrees needed for the omega capacitor. The rotor I purchased has a solid output shaft. Coupling it to the capacitor shaft was done with flexible shaft coupling components available at a local electric motor supply house.

The tuner housing was made from an aluminum mailbox with the excess hardware removed. The bottom was fabricated from 1/8-inch aluminum stock to offer needed support for the rotor.

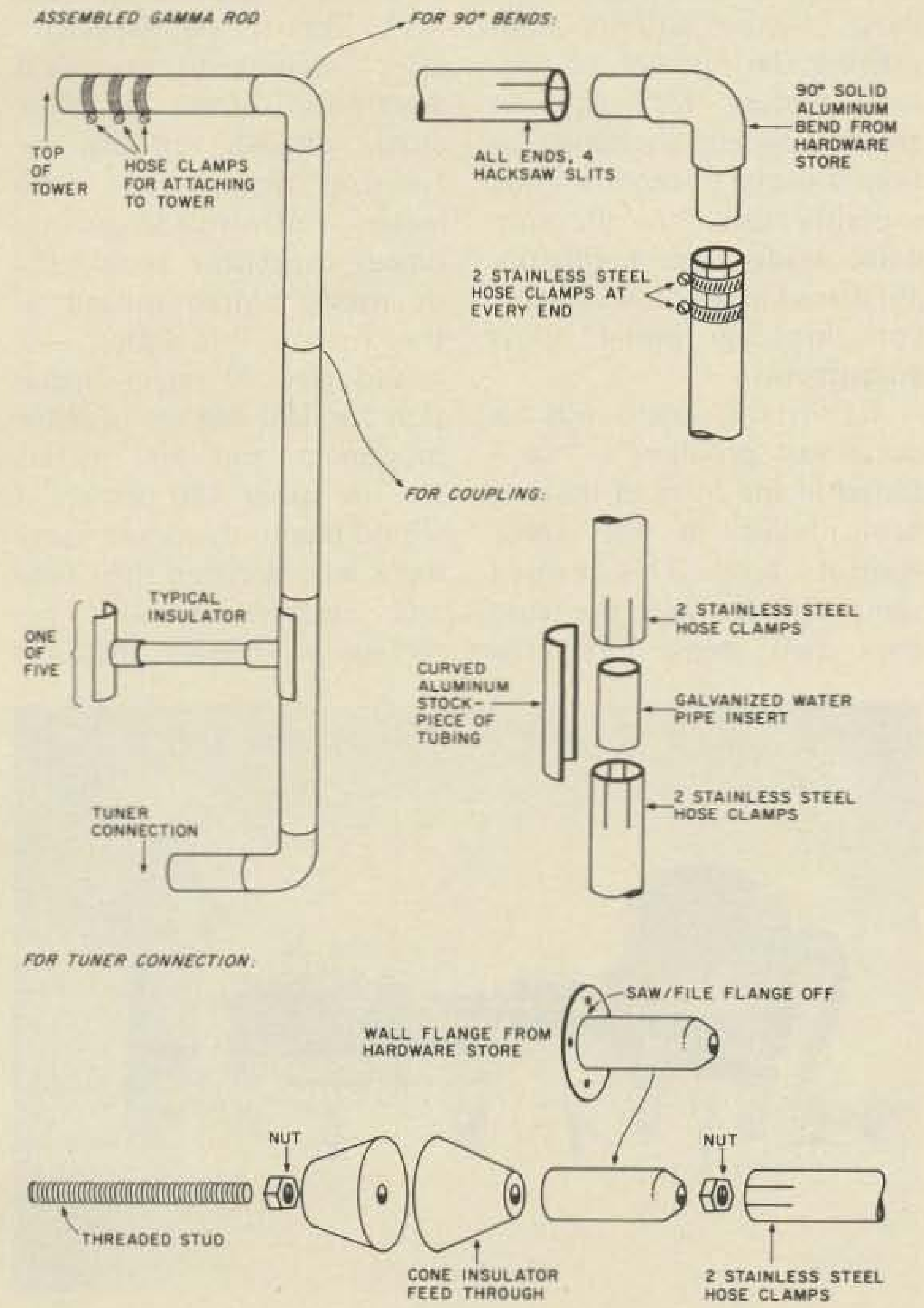


Fig. 2. Gamma rod assembly.

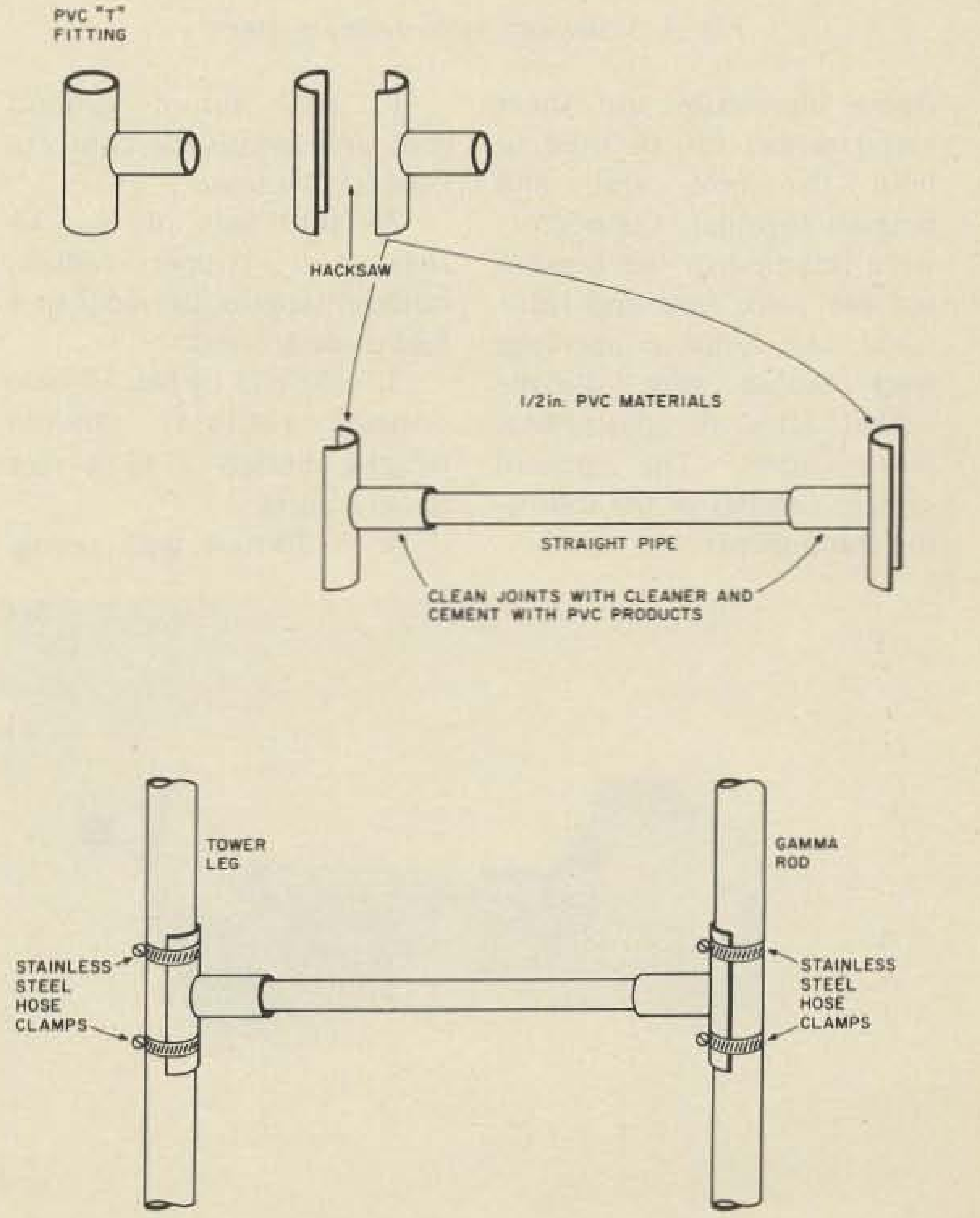


Fig. 3. Insulators for gamma rod.

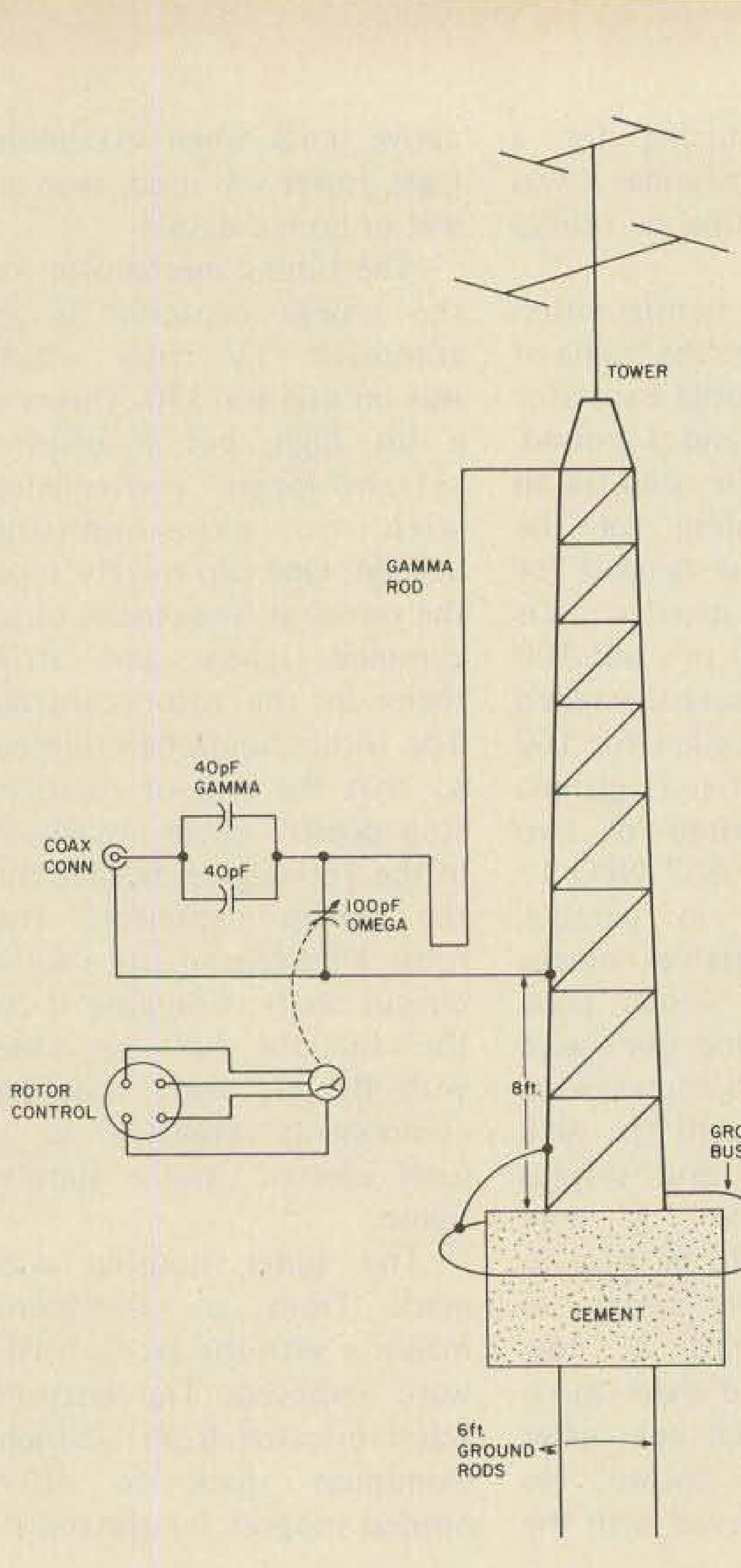


Fig. 4. Schematic of antenna system.

Angle aluminum and sheet metal screws can be used to hold the box, end, and bottom together. Connectors were installed in the bottom for the coax feed and rotor cable. All housing openings were sealed with silicone rubber after all adjustments were made. The ground system consists of the following components:

1. Two 6-foot ground rods underneath the concrete base for the tower.
2. 1000 feet of No. 14 insulated copper radials, random lengths, buried 2 to 4 feet underground.
3. 500 feet of No. 14 bare copper radials, random lengths, buried 2 to 4 feet underground.
4. A 70-foot well casing.
5. The house water system.
6. Electrical ground wires of the house, only via an indirect route through the rig's power cord.

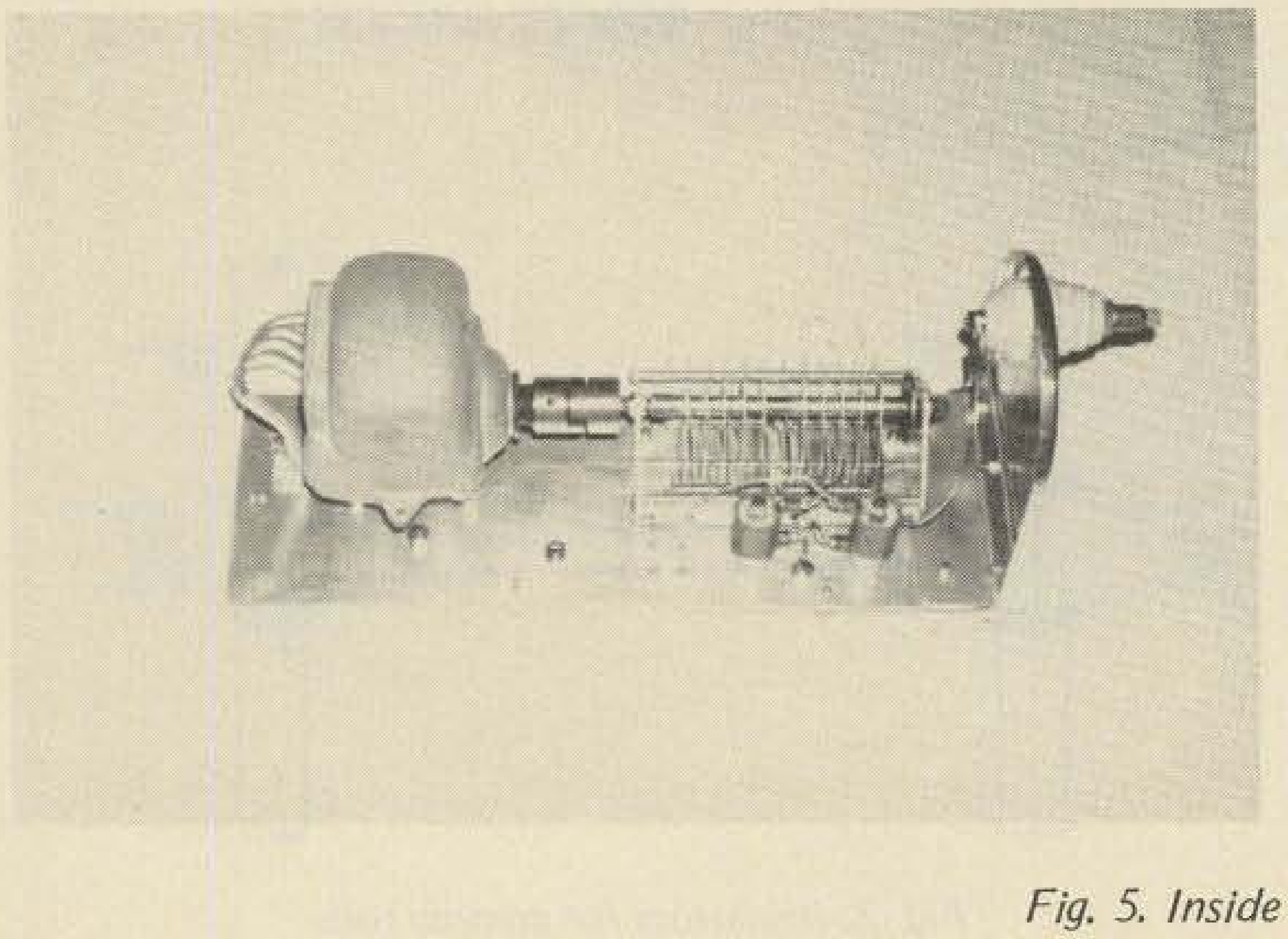
A No. 8 bare copper wire forms a square ground bus around the base of the tower. The radials were soldered to the bus, which is connected to the tower via two pieces of ½-inch tinned copper braid held in place by stainless steel hose clamps. All ground connections were sprayed with clear plastic, taped, and resprayed. The radial system was installed as space permitted, which was only about 15 feet for those radials facing south. The longest radial is about 90 feet.

Results and Comments

The initial adjustment of the system was indeed time-consuming, especially since none of the combinations of gamma rod dimensions and capacity values approximated those of other authors. Considering the number of relevant factors for such an antenna system, each installation is likely to require some experimenting. A Palomar noise bridge was eventually purchased and was invaluable for making initial gross adjustments.

Rf in the shack was an occasional problem as manifested in the form of flashing neon bulbs in the rotor control box. This caused some damage and the cure took two steps. First, the excess rotor cable, coiled against the tower and in the shack, was removed. Second, a relay was added with normally open contacts to break the leads from the rotor cable as they entered the control box. Activating the relay thus permitted normal operation of the rotor. No more problems with the rf were observed.

The results using the system have been most rewarding! They were well worth the effort. I enjoy primarily rag chewing, but the Bicentennial WAS caught my interest. This antenna was used to work Alaska, Hawaii, and almost all the other states on 75 phone, not to mention the Bahamas. This was very exciting! The system works fine on local contacts, but really pans out for distances over 200 miles. What was once considered a "second best antenna" is now considered more than adequate. But, most importantly, the XYL likes it too, especially after listening to my vivid description of a 75 meter quad, phased verticals, or full-size dipole. For 160 meters, I plan to add gamma/omega capacitors via a relay or rotary switch ganged to the rotor. This latter idea would give 80 meter operation for 180 degrees of rotor movement and 160 meters for the other 180 degrees. I would like to thank the many hams who donated their time and cooperation with numerous on-the-air checks. ■



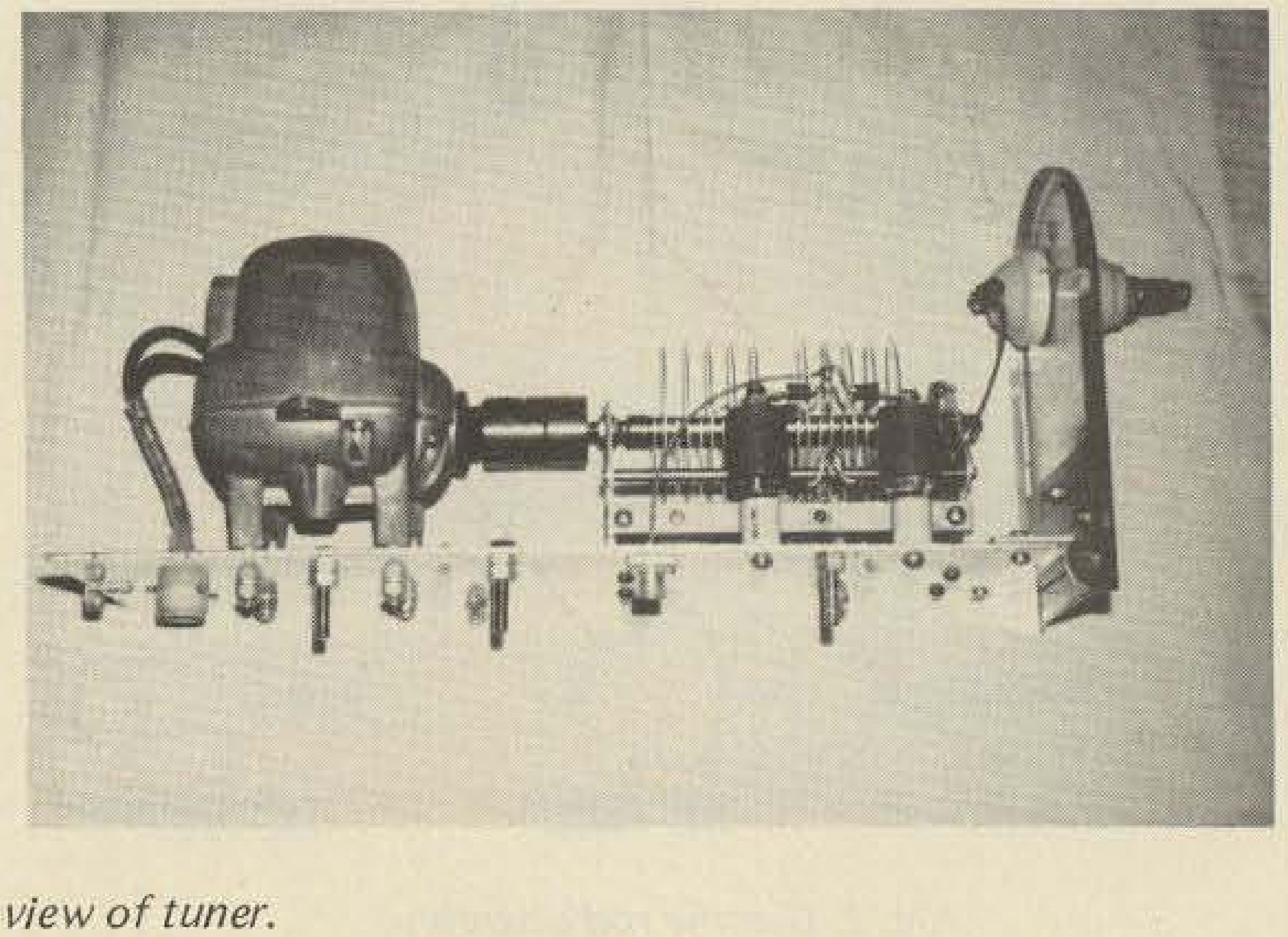


Fig. 5. Inside view of tuner.

model 333
dummy load
wattmeter

Favorite Lightweight Portable—250 WATT RATING—Air Cooled

Ideal field service unit for mobile 2-way radio—CB, marine, business band. Best for QRP amateur use, CB, with zero to 5 watts full scale low power range.

▪ specifications

Frequency Range	DC to 300 MHz
VSWR	Less than 1.3:1 to 230 MHz
Power Range	250 watts intermittent
Wattmeter Ranges	0–5, 0–50, 0–125, 0–250
Connector	SO-239
Size	4" x 7" x 8"
Shipping Weight	2 lbs.
Price	$98.50

model 374 dummy load wattmeter

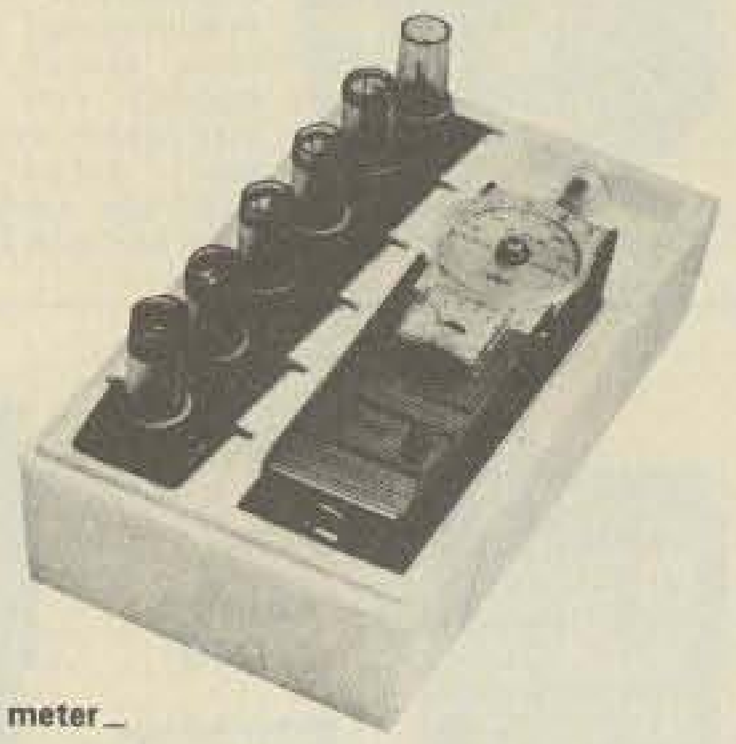
Top of the Line—1500 WATT RATING—Oil Cooled

Our highest power combination unit. Rated to 1500 watts input (intermittent). Meter ranges are individually calibrated for highest accuracy.

▪ specifications

Frequency Range	DC to 300 MHz
VSWR	Less than 1.3:1 to 230 MHz
Power Range	1500 watts DC intermittent. Warning light* signals maximum heat limit.
Wattmeter Ranges	0–15, 0–50, 0–300, 0–1500
Input Connector	SO-239 (hermetically sealed)
Size	4-3/4" x 9" x 10-1/4"
Shipping Weight	12 lbs.
Price	$215.00

LITTLE DIPPER



model 331A

transistor dip meter_

Portable RF single generator, signal monitor, or absorption wavemeter. Lightweight (1 pound, 6 ounces with all coils), battery-powered unit is ideal for field use in testing transceivers, tuning antennas, etc. Can also be used to measure capacity, inductance, circuit Q, and other factors. Indispensable for experimenters, it is easily the most versatile instrument in the shop. Continuous coverage from 2 MHz to 230 MHz in seven ranges.

Unit consists of a transistorized RF dip oscillator and 100-microampere meter circuit. Meter circuit uses a single-transistor DC amplifier with a potentiometer in the emitter circuit to control meter sensitivity. A 3-position slide switch connects the meter circuit to the oscillator for dip measurements, to a diode for absorption wavemeter peak measurements, or provides audio modulation of the RF signal.

Frequency dial has a calibrated reference point for Q and bandwidth measurements. Each coil has its own frequency dial: there's no confusion with multiple markings or small, hard-to-read scales near the center of the dial.

▪ specifications

Frequency Coverage	2 MHz to 230 MHz in 7 overlapping ranges by plug-in coil assemblies: 2 MHz–4 MHz, 4 MHz–8 MHz, 8 MHz–16 MHz, 16 MHz–32 MHz, 32 MHz–64 MHz, 50 MHz–110 MHz, 110 MHz–230 MHz
Accuracy	±3%
Modulation	1000 Hz, 25% to 40%
Power	9-volt transistor battery, Burgess 2U6 or equivalent
Size	7" x 2-1/4" x 2-1/2"
Shipping Weight	1 lb., 6 oz.
Price	$120.00

B&W BARKER & WILLIAMSON, INC.

Economy High Power Load—1500 WATT RATING—Oil Cooled
model 384 dummy load

For high power when all you need is the load.

▪ specifications

Frequency Range	DC to 300 MHz
VSWR	Less than 1.3:1 to 230 MHz
Power Range	1500 watts intermittent. Warning light* signals maximum heat limit.
Connector	SO-239 (hermetically sealed)
Size	4-3/4" x 9" x 10-1/2"
Shipping Weight	12 lbs.
Price	$94.50

High Power—1000 WATT RATING—Oil Cooled
model 334A dummy load wattmeter.

Our most popular combination unit. Handles full amateur power. Meter ranges individually calibrated. Can be panel mounted.

▪ specifications

Frequency Range	DC to 300 MHz
VSWR	Less than 1.3:1 to 230 MHz
Power Range	1000 watts CW intermittent. Warning light* signals maximum heat limit.
Wattmeter Ranges	0–10, 0–100, 0–300, 0–1000
Input Connector	SO-239 (hermetically sealed)
Size	4-3/4" x 9" x 10-1/4"
Shipping Weight	12 lbs.
Price	$174.00

WIDE RANGE ATTENUATOR

Model 371-1

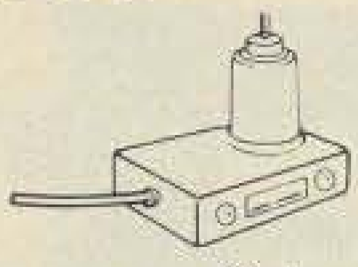
Protect your receiver or converter from overload, or provide step attenuation of low-level RF signals from signal generators, preamplifiers, or converters. Seven rocker switches provide attentuation from 1 dB to 61 dB in 1-dB steps. Switches are marked in dB, 1-2-3-5-10-20-20. Sum of actuated switches (IN position) gives attenuation. With all switches in OUT position, there is NO insertion loss. Attenuator installs in coaxial line using UHF connectors.

▪ specifications

Power Capacity	1/4 watt
VSWR	1.3:1 maximum, DC to 225 MHz
Impedance	50 ohms
Accuracy	1 dB/dB, DC to 60 MHZ 0.1 dB/dB +0.5 dB, DC to 160 MHz 0.1 dB/dB +1.0 dB, DC to 225 MHz
Size	8-1/2" x 2-1/2" x 2-1/4"
Shipping Weight	1-1/2 lbs.
Price	$49.50

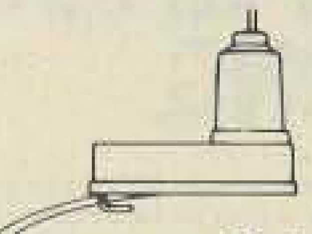
• Handle full 200 watts • low-low V.S.W.R. • Deliver 3 dB gain and more! • Pick the one that best fits your needs:

Larsen Kūlrod® Antennas



MAGNETIC MOUNT
stays put even at 100 mph!

MM-JM-150 for 144 MHz use
MM-JM-220 for 220 MHz use
MM-JM-440 for 440 MHz use
Only **$38.50** complete



TRUNK LID MOUNT
No holes and low silhouette too!

TLM-JM-150 for 144 MHz use
TLM-JM-220 for 220 MHz use
TLM-JM-440 for 440 MHz use
Only **$38.50** complete

And 1/4 wave antenna for trunk and magnetic mount — $18.50

ROOF or FENDER MOUNT
Goes on quick and easy in 3/8" or 3/4" with fewest parts.

JM-150-K for 144 MHz use
JM-220-K for 220 MHz use
JM-440-K for 440 MHz use
Only **$31.50** complete

And 1/4 wave antenna for roof and fender mounts $11.50

Above antennas all complete with mounting hardware, coax, connector plug, allen wrench and complete instructions.

Model 372 — $27.50

model 372 CLIPREAMP

Get maximum legal modulation without danger of splatter. Solid-state speech preamplifier and clipper for transmitters, public-address systems, and tape recorders needs no external power.

• specifications

Input Impedance	100,000 ohms
Input Levels	5 millivolts to 20 millivolts
Voltage Gain	10 dB
Output Level	60 millivolts
Ouput Impedance	50,000 ohms
Power	9-volt transistor battery, Burgess 2U6 or equivalent
Size	2-3/4" x 3" x 4-1/2"
Shipping Weight	7 oz.
Connectors	Terminal strip

COAXIAL ANTENNA CHANGEOVER RELAY

model 377

Model 377 — $17.95

Economical and reliable. Can be operated from VOX circuit for completely automatic operation or from PTT or manual T/R switch. Receiver input is automatically grounded when the relay is in the Transmit position. Wide AC operating voltage range and low operating current.

• specifications

Power Rating	1000 watts CW (2000 watts SSB)
VSWR	Less than 1.15:1, DC to 150 MHz
Power Requirements	0.015 Ampere, 48 to 130 volts AC
Connectors	UHF Type SO-239
Dimensions	3-1/2" x 1-1/2"
Shipping Weight	1 lb.

UNIVERSAL HYBRID COUPLER II PHONE PATCH

model 3002W and model 3001W

Connect your station to the telephone lines. Five switch-selectable modes give complete flexibility for patching the station to the line and for tape recording and playback to or from the line or the station. The hybrid circuit provides for effortless VOX operation of the phone patch. A built-in *Compreamp* speech preamplifier/limiter (in Model 3002W) increases the level of weak phone signals and also prevents overmodulation when the local telephone is used as the station microphone. (The *Compreamp* also functions as a preamplifier/limiter with the station microphone, if desired.)

• specifications

Inputs from:		
	Line	600 ohms
	Receiver	4 ohms
	Microphone	High impedance (50,000 ohms) crystal or dynamic
	Tape Recorder	4 ohms
Outputs to:		
	Transmitter	50,000 ohms
	Receiver Speaker	4 ohms
	Tape Recorder	0.5 megohm
Size		6-1/2" x 7-1/2" x 3"
Shipping Weight		3-1/2 lbs.
Power		9-volt battery, Burgess 2U6 or equivalent
Connectors		Phono

Model 300 2W with *Compreamp* — $125.00

Model 300 1W without *Compreamp* — $85.00

B&W

BARKER & WILLIAMSON, INC.

Model 359 — $37.50

Dealer Programs NOW Available

Increase your transmitter's effective speech power up to four times. Or use it with your tape recorder or public address system for improved performance. This two-stage, transistorized Audio Preamplifier/Limiter can be used with all types of transmitters. Powered by a long-lasting dry-cell battery—no external power needed. Installs without any wiring changes in your transmitter. Just connect the *Compreamp* between your microphone (50,000-ohm dynamic or high-impedance ceramic) and your transmitter's microphone input connector. Front-panel rocker switch lets you bypass the *Compreamp* when you want to. Compression level is adjustable, too.

• specifications

Input Impedance	100,000 ohms
Input Level	5 millivolts to 20 millivolts
Voltage Gain	10 dB
Output Level	60 millivolts
Output Impedance	50,000 ohms
Power	9-volt transistor battery, Burgess 2U6 or equivalent
Size	2-3/4" x 3" x 4-1/2"
Shipping Weight	6-1/2 oz.
Connectors	Terminal strip

COAXIAL SWITCHES AND ACCESSORIES

for antenna selection and RF switching

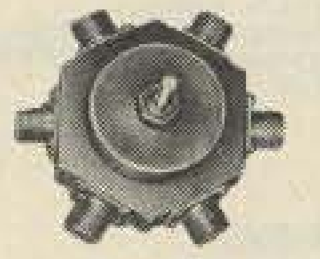
These high-quality switches have set the standard for the industry for years. Ceramic switches with silver-alloy contacts and silver-plated conductors give unmatched performance and reliability from audio frequencies to 150 MHz.

B&W coaxial switches are designed for use with 52- to 75-ohm non-reactive loads, and are power rated at 1000 watts AM, 2000 watts SSB. Connectors are UHF type. Insertion loss is negligible, and VSWR is less than 1.2:1 up to 150 MHz.

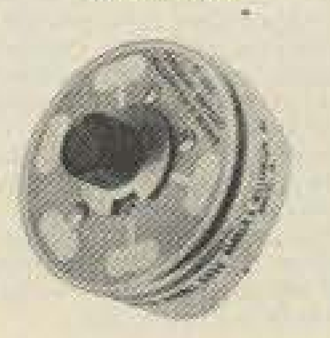
Crosstalk (measured at 30 MHz) is -45 dB between adjacent outlets and -60 dB between alternate outlets.

Models are available for desk, wall, or panel mounting, and with or without protective grounding of inactive outputs. Radial (side-mounted) connector models can be either wall or panel mounted, axial (backplate-mounted) connector models are for panel mounting only, save panel space.

Use the selector chart below to choose the models you need.


Model 550A


Model 590


Model 590G


Model 551A


Model 592


Model 595

COAXIAL SWITCH SELECTOR CHART

Model	PRICE	Outputs	Connector Placement	Mounting: Panel	Mounting: Wall	Mounting: Desk	Automatic Grounding	Dial Plate	Remarks
375	18.95	6	Axial	x			x	Supplied	PROTAX switch. Grounds all except selected output circuit.
376	18.95	5	Radial	x	x		x	Supplied	PROTAX switch. Grounds all except selected output circuit. Sixth switch position grounds *all* outputs.
550A	14.00	5	Radial	x	x			DP-5	
550A-2	12.50	2	Radial	x	x			DP-2	
551A	17.50	2	Radial	x	x			DP-2	Special 2-pole, 2-position switch used to switch any RF device in or out of series connection in a coaxial line. See figure (over).
556	.95	–	–		x			–	Bracket only, for wall mounting of radial connector switches.
590	17.95	5	Axial	x				DP-5	
590G	17.95	5	Axial	x			x	Supplied	Grounds all except selected output circuit.
592	16.50	2	Axial	x				DP-2	
595	18.50	6	In-line		x	x	x		Grounds all except selected output circuit.


Model 376


Model 375

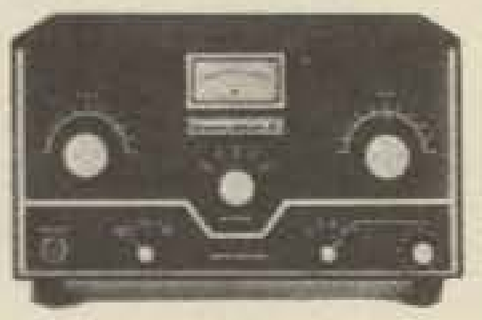

Model 550A-2

SWAN 1200X LINEAR AMPLIFIER. TALK LOUD FOR A SONG.

Everybody likes power and nowhere can you get more of it for $349.95 than with our Cygnet 1200X linear amplifier.

With 100 watts of driving power you're on the air with a solid 1200 watts PEP input and most people won't be able to tell you from somebody operating full bore.

Linearity on the 1200X is excellent, efficiency is outstanding, 117/230 A.C. power supply is built in, and features like provision for external ALC give you the flexibility you need to get the most out of your rig.



Mark II for power and glory, too. But if you've got your heart set on block-buster power we've also got the right linear amp for you.

It's the Mark II, the proven unit everybody thinks of when you talk about workhorse linear amplifiers.

The Mark II dominates the bands with all the power that's allowed—2000 watts PEP—and a clean, linear signal that's music to your ears.

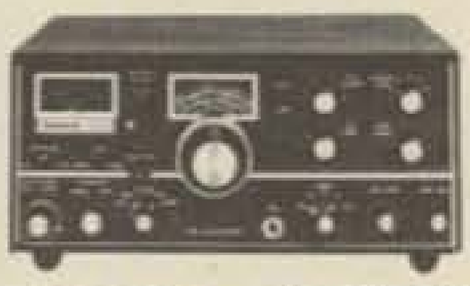
The Mark II features a separate, matching power supply, big, quiet blowers for both the RF deck and the power supply, all bands from 10 to 80 meters and all you need to enjoy it is 100 watts driving power.

Get a Swan 1200X or Mark II linear amplifier today and stop letting people shout you down. Use your Swan credit card. Applications at your dealer or write to us.

Cygnet 1200X 1200-watt linear amplifier complete with built in 110/220V power supply $349.95

Mark II 2000-watt linear amplifier complete with separate 117/230 VAC power supply and two 3-500Z tubes $849.95

NEW TRANSCEIVERS



750 CW — $679.95

If you're ready for 700 loud-talking watts, you're ready for the new 750CW.

- 700 watts P.E.P. input on SSB
- 400 watts DC input on CW
- CW audio filter selectable 80 or 100 Hz.
- CW sidetone monitor with adjustable pitch and volume control
- 80 through 10 meters, USB, LSB, CW
- Selectable 25 or 100 KHz crystal calibrator
- Standard 5.5 Mhz, 2.7 Hz bandwidth crystal filter or optional accessory 16 pole filter available with 140 Db ultimate rejection.

Accessories
- VX-2 Vox
- MK-II Linear amplifier
- DD-76 Digital Dial

The 750CW is a CW man's dream come true. What's more there's a long list of accessories you can add later for increased performance.

350A — $599.95

- 300 watts P.E.P. input SSB
- 200 watts DC input on CW
- 80 through 10 meters, USB, LSB, CW
- 5.5 Mhz, 2.7 KHz bandwidth crystal filter
- Oscillators are solid state and IC regulated for stability
- CW sidetone monitor with adjustable pitch and volume
- CW audio filter 80 and 100 Hz selectable
- Built in 117 VAC power supply and speaker. (220 VAC power supply available on special request)

Accessories
- VX-2 Vox
- 14A DC Converter
- 1200X linear amplifier
- Crystal Calibrator (350A only)

350D — $699.95

- Same basic features as 350A except added feature of:
- 6 Digit LED frequency display with readout to 100 Hz

Both the 350A and the 350D are compatible with the same line of Swan accessories that has built a reputation for reliability and performance that's second to none. Including linear amplifiers to boost your power to the legal limit.

So they're perfect for novices or anyone else because you can build capability as you need it.

OUR NEW M-34 EXPANDABLE MOBILE ANTENNAS

The M-34 mobile antenna gives you 10, 15, and 20 meters and great performance in a tough, rugged design for only $52.75.

Then whenever you want it you can buy the optional 160, 80 or 40 meter coil and top section for $20.00 to $25.00 depending on the band and make a full-capability four-bander out of it. One that never needs coil changes or adjustments after initial tuning.

What's more, at no extra cost you get features like 500 watts PEP, low standing wave ratio at resonance, independent resonance adjustments on each of the four bands, exceptional bandwidth and a neat, clean, low-wind-resistance profile that also goes great with mobile homes, motor homes and apartments.

That's the kind of innovative, problem-solving thinking that goes into Swan mobile antennas. Not just the M-34 but these, too:

742 Automatic. Swan automates mobile antennas with the 742 tri-band antenna. Work 20, 40 or 75 meters with your 742 without need for coil change or other adjustments after initial tuning. A high Q mobile antenna designed for maximum efficiency capable of 500 watts PEP $109.95

Mobile 45. This switch-adjustable 5-band antenna features a Swan HI-Q coil and positive-stop, 9-position switch with GOLD-PLATED contacts. Select 10, 15, 20, 40 plus five positions for 75 meters and go to work knowing this rugged antenna is doing its job $119.95

SWAN® ELECTRONICS
A subsidiary of Cubic Corporation

AMERICAN RADIO RELAY LEAGUE PUBLICATIONS

- THE RADIO AMATEUR'S HANDBOOK 1978 Edition ($8.50 Retail)
- THE RADIO AMATEUR'S HANDBOOK 1978 Edition Cloth Bound ($13.50 Retail)
- ARRL ANTENNA BOOK ($5.00 Retail)
- UNDERSTANDING AMATEUR RADIO ($5.00 Retail)
- THE RADIO AMATEUR'S V.H.F. MANUAL ($4.00 Retail)
- FM AND REPEATERS ($4.00 Retail)
- ARRL ELECTRONICS DATA BOOK ($4.00 Retail)
- SINGLE SIDEBAND ($4.00 Retail)
- ARRL HAM RADIO OPERATING GUIDE ($4.00 Retail)
- SPECIALIZED COMMUNICATIONS TECHNIQUES FOR THE RADIO AMATEUR ($4.00 Retail)
- A COURSE IN RADIO FUNDAMENTALS ($4.00 Retail)
- RADIO AMATEUR'S LICENSE MANUAL ($3.00 Retail)
- GETTING TO KNOW OSCAR ($3.00 Retail)
- HINTS AND KINKS ($2.00 Retail)
- LEARNING TO WORK WITH INTEGRATED CIRCUITS ($2.00 Retail)
- SOLID STATE DESIGN ($7.00 Retail)
- TUNE IN THE WORLD WITH HAM RADIO ($7.00 Retail)
  Packages to be sold as a unit consisting of: Workbook, Tape Cassette, Call Area Map
- ARRL CODE KIT ($8.00 Retail)
- ARRL MAP ($3.00 Retail)
- QST BINDER ($5.00 Retail) for 6½ x 9½ QST
- LOG BOOK ($1.50 Retail)
- MINILOG ($.75 Retail)
- L/C/F CALCULATOR, Type A ($3.00 Retail)
- Pads of MESSAGE BLANKS ($.50 Retail)

THE SWAN METER SHOWCASE.

Sniffs out radiated power wherever it is. This little unit is so compact it could measure relative radiated power in your pocket. Telescoping antenna and a frequency range of 1.5 MHz all the way to 200 MHz. **FS-1 Field Strength Meter** $10.95

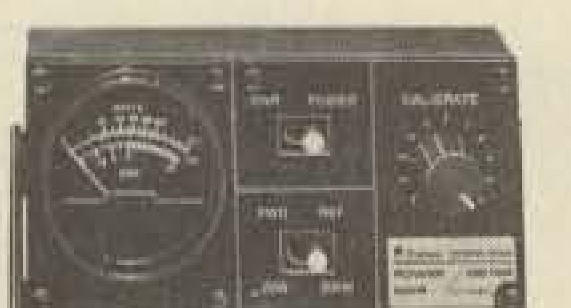
Easy-on-the-pocket pocket SWR. Mighty mite SWR meter with high accuracy, SWR-3 gives you 1:1 to 3:1 SWR at 50 ohms on frequencies from 1.7 to 55 MHz. Precision PC board directional coupler makes it a solid value at a rock-bottom price. **SWR-3 Pocket SWR Meter** $12.95

SWR bridge bridges the price barrier. This little jewel gives you relative forward power and SWR on two 100 microampere meters at a remarkably low price. Indicates 1:1 to infinity VSWR of up to 1000-watt signals on frequencies from 3.5 to 150 MHz. With low insertion loss, it's great for mobile operations, too. **SWR-1A Power Meter and SWR Bridge** $25.95

At last. A precision wattmeter for the 6 and 2-meter man. We design the WM-6200 for the upper-band man who needs to know with ± 7% accuracy. Reads power of 50 to 150 MHz signals on two scales to 200 watts plus SWR on expanded range scale from 1:1 to 3:1 with ± 3% accuracy. **WM-6200 In-Line Wattmeter** $59.95

Put your power up in lights. The new WMD-6200 does everything our WM-6200 does and ends guesswork, interpolation errors and eyestrain besides with a 4-digit readout. 50 to 150 MHz, power to 200 watts with an accuracy of ± 10%. SWR from 1:1 to 19.99:1 with ± 3% accuracy. **WMD-6200 Digital SWR Power Meter** .... $199.95 (requires AC source)

Everything you need to know for $84.95. The new WM-200A does it all. As an in-line wattmeter it gives you power to 200 watts on two scales plus SWR from 1:1 to 3:1 for signals from 50 to 150 MHz. And as a peak reader it reads true peak envelope power of your voice modulated signal. Flat response forward or reflected power on scales to 200 watts in switch-selected RMS or peak. **WM-200A Peak Reading Wattmeter** $84.95



Nifty little meter just for VHF mobile. This brand new, easy-to-install swivel-mount unit is the perfect illuminated wattmeter for 2-meter mobile. Compact and capable, it gives you two scales, 0-20 watts and 0-200 watts at 10% accuracy. SWR from 1:1 to 3:1. Frequencies from 50 to 150 MHz. **WMM-200 SWR Power Meter** $39.95

THRULINE® RF Directional Wattmeter model 4431

Power Rating	5000 watts - 2 to 30 MHz; 1000 watts - 30 to 1000 MHz*
Impedance	50 ohms nominal
Insertion VSWR (with N Connectors)	1.07 to 1.0 max.*
Insertion Loss	0.1dB Max. (2 - 512 MHz); 0.2dB Max. (512 - 1000 MHz)*
RF Coupling	15 to 70 dB
Accuracy of Wattmeter	± 5% of F.S.
RF Coupling Connector	Female BNC
Primary Line Connector	Female N (Normally Supplied) (Other QC Connectors can be supplied)

Price: $175. Elements $36 — $75

- **Model 43 Power Measurement Versatility**
- **Variable RF Signal Sampler (built-in)**

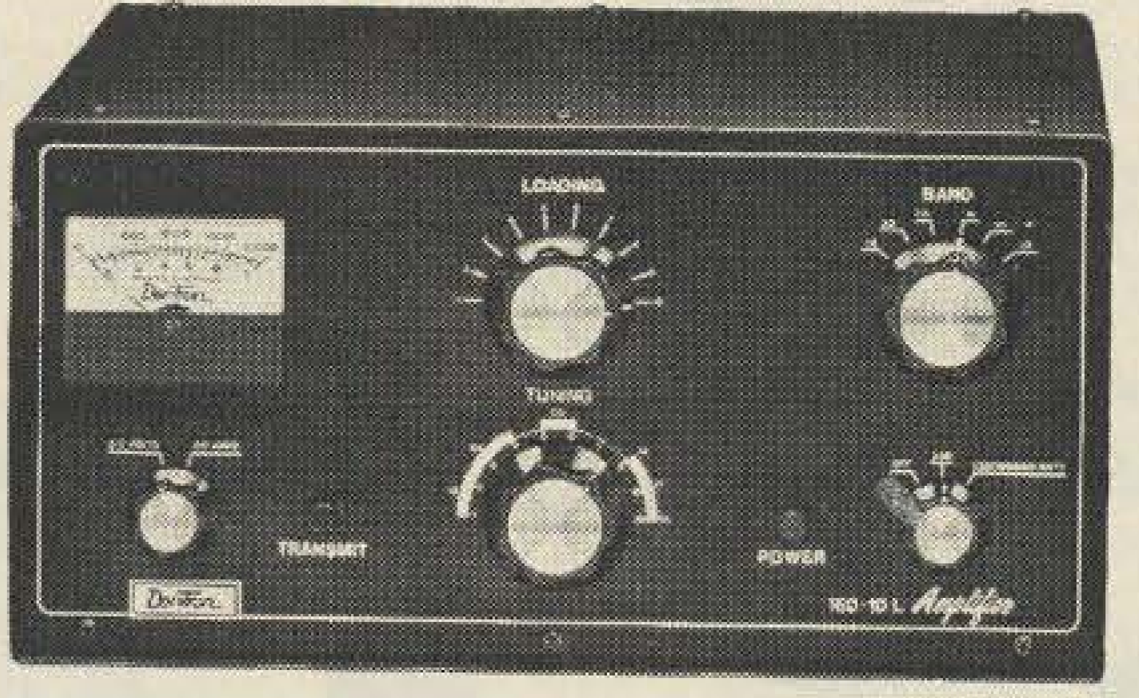
Model 4431 provides an RF signal sample for use with counters, oscilloscopes, spectrum analyzers, etc., at the same time a power measurement is made.

Amplitude of the RF sample is adjustable by depth-of-insertion control knob on the front of the wattmeter.

Model 4431 uses the same Plug-in Elements as the Model 43 (within its frequency and power limitations).

SUPERAMP

from DenTron



If the amplifier you're thinking of buying doesn't deliver at least 1000 to 1200 watts output, to the antenna, you're buying the wrong amplifier.

Our New Super Amp is sweeping the country because hams have realized that the DenTron Amplifier will deliver to the antenna, (output power), what other manufacturers rate as input power.

The Super Amp runs a full 2000 watts P.E.P. input on SSB, and 1000 watts DC on CW, RTTY or SSTV 160-10 meters, the maximum legal power.

The Super Amp is compact, low profile, has a solid one-piece cabinet assuring maximum TVI sheilding.

The heart of our amplifier, the power supply, is a continuous duty, self-contained supply built for contest performance.

We mounted the 4-572B's, industrial workhorse tubes, in a cooling chamber featuring the on-demand variable cooling system.

The hams at DenTron pride themselves on quality work, and we fight to keep prices down. That's why the dynamic DenTron Linear Amplifier beats them all.

$574.50

Match everything from 160 to 10 with the new 160-10 MAT

NEW: The Monitor Tuner was designed because of overwhelming demand. Hams told us they wanted a 3 kilowatt tuner with a built-in wattmeter, a front panel antenna selector for coax, balanced line and random wire. So we engineered the 160-10m Monitor Tuner. It's a lifetime investment at $299.50.

$299.50

Meet the SuperTuner

The DenTron Super Tuner tunes everything from 160-10 meters. Whether you have balanced line, coax cable, random or long wire, the Super Tuner will match the antenna impedance to your transmitter. All DenTron tuners give you maximum power transfer from your transmitter to your antenna, and isn't that where it really counts?

1 KW MODEL **$129.50** 3 KW MODEL **$229.50**

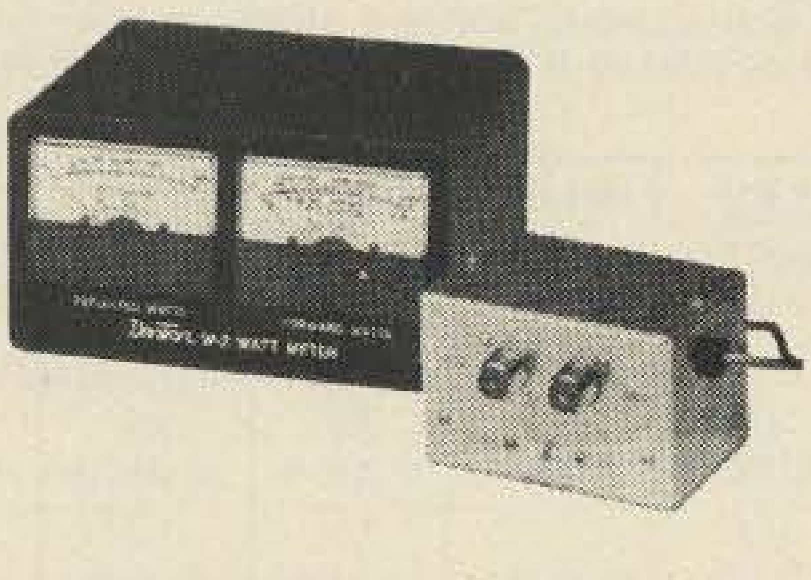
The 80-10 Skymatcher

Here's an antenna tuner for 80 through 10 meters, handles 500 w P.E.P. and matches your 52 ohm transceiver to a random wire antenna.

- Continuous tuning 3.2 - 30 mc
- "L" network
- Ceramic 12 position rotary switch
- SO—239 receptional to transmitter
- Random wire tuner
- 3000 volt capacitor spacing
- Tapped inductor
- Ceramic antenna feed thru
- 7" W. 5" H. 8" D., Weight: 5 lbs.

$59.50

Read forward and reflected watts at the same time



Tired of constant switching and guesswork?

Every serious ham knows he must read both forward and reverse wattage simultaneously for that perfect match. So upgrade with the DenTron W-2 Dual in line Wattmeter.

$99.50

Introducing Dentron's NEW

Jr. Monitor Antenna Tuner

$79.50 Retail

SPECIFICATIONS

- Continuous Tuning 1.8–30 MHz
- Forward reading relative output power meter
- 300 watt power capability
- Built-in encapsulated balun
- Mobile mounting bracket
- Ceramic Rotary Switch 12-position
- Capacitor spacing 1000 volts
- Tapped toroid inductor
- Antenna inputs:
  - a. Coax unbalanced SO239
  - b. Random wire
  - c. Balanced feed line 75–660 Ohm
- 5¼" w. x 2¾" h. x 6" d.
- All metal black wrinkle finish cabinet
- Weight: 2½ pounds

DenTron

DRAKE TVI FILTERS **High Pass Filters for TV Sets** provide more than 40 dB attenuation at 52 MHz and lower. Protect the TV set from amateur transmitters 6-160 meters.

Drake TV-300-HP
Model No. 1603
For 300 ohm twin lead
Price: $10.60

Drake TV-75-HP
Model No. 1610
For 75 ohm TV coaxial cable; TV type connectors installed
Price: $13.25

DRAKE TV-3300-LP
1000 watts max. below 30 MHz. Attenuation better than 80 dB above 41 MHz. Helps TV i-f interference, as well as TV front-end problems. Price: $26.60 Model No. 1608

LOW PASS FILTERS FOR TRANSMITTERS have four pi sections for sharp cut off below channel 2, and to attenuate transmitter harmonics falling in any TV channel and fm band. 52 ohm. SO-239 connectors built in.

DRAKE TV-5200-LP
200 watts to 52 MHz. Ideal for six meters. For operation below six meters, use TV-3300-LP or TV-42-LP. Model No. 1609 Price: $26.60

DRAKE TV-42-LP Model No. 1605 is a four section filter designed with 43.2 MHz cut-off and extremely high attenuation in all TV channels for transmitters operating at 30 MHz and lower. Rated 100 watts input. Price: $14.60

TELEX®

PROFESSIONAL HEADPHONES & HEADSETS

BOOM MIC HEADSETS

For the ultimate in communications convenience and efficiency select a boom mic headset. Long-time favorites of professional communications, boom mic headsets allow more personal mobility while always keeping the mic properly positioned for fast, precise voice transmission. Boom microphones are completely adjustable to allow perfect positioning. And, boom mic headsets leave both hands free to perform other tasks.

All models are supplied with "close-talking" microphones to limit ambient noise pick-up and provide superior intelligibility. Each model has a convenient, inline push-to-talk switch, which can be wired for either push-to-talk relay control or mic circuit interrupt for voice operated transmitters. The switch may be used as a momentary push-button or it can be locked in the down position. All models have tough, flexible, 8 foot cords which are stripped and tinned, unterminated. Communication grey with black trim.


MODEL CM-1320


MODEL C-1320


MODEL C-1210

MODEL C-610


Dealer Programs NOW Available


MODEL CM-1210


MODEL CM-610


MODEL CM-1320S

MODEL C-610 Economical, dual receiver magnetic headphone. Delivers clear reception. Lightweight and comfortable yet ruggedly constructed for daily use. Earcushions seal out distracting noise and are removable for cleaning. Price: $9.95

MODEL SWL-610 Similar to Model C-610 but with 2000 ohm impedance. Ideal for shortwave receivers requiring high impedance headphones. Price: $9.95

MODEL C-1210 Medium priced, dual receiver dynamic headphone. Precise sound reproduction. Deluxe foam-filled earcushions are extremely comfortable for those long sessions. The removable cushions reduce ambient noise penetration and concentrate signal strength. Great for noisy environments or for digging out weak signals. **Price: $28.30**

MODEL C-1320 Our finest communications headphone. Audiometric-type dual dynamic receivers assure the ultimate in reception and performance stability. Extremely sensitive receivers provide high output levels even from weak signals. Luxurious foam filled circumaural earcushions are removable for cleaning. **Price: $37.90**

DUAL MUFF HEADPHONES

The following headphones offer outstanding sound quality and superb comfort for long term wearing. All the models have circumaural earcushions to seal out distracting ambient noise and concentrate the signal at your ear. Foam filled vinyl earcushions on Models C-1210 and C-1320 add an extra margin of comfort. Adjustable headbands and self-aligning earcups assure proper fit. All models are equipped with a five foot cord terminating in a standard .250" diameter phone plug and have 3.2 to 20 Ohm impedance. Communication grey with black trim.

MODEL CM-610 Lightweight, dual receiver magnetic headphone (similar to Model C-610). Ceramic boom microphone with -51 dB output. Can be used with any mobile or base station with high Z mic input and 3.2 to 20 ohm audio output. Price: $42.80.

MODEL CM-1320 Deluxe dual receiver dynamic headphone with audiometric-type headphone elements (similar to Model C-1320). Ceramic boom microphone with -51 dB output. For use with any mobile or base station requiring high impedance mic input and 3.2 to 20 ohm audio output. Price: $68.30.

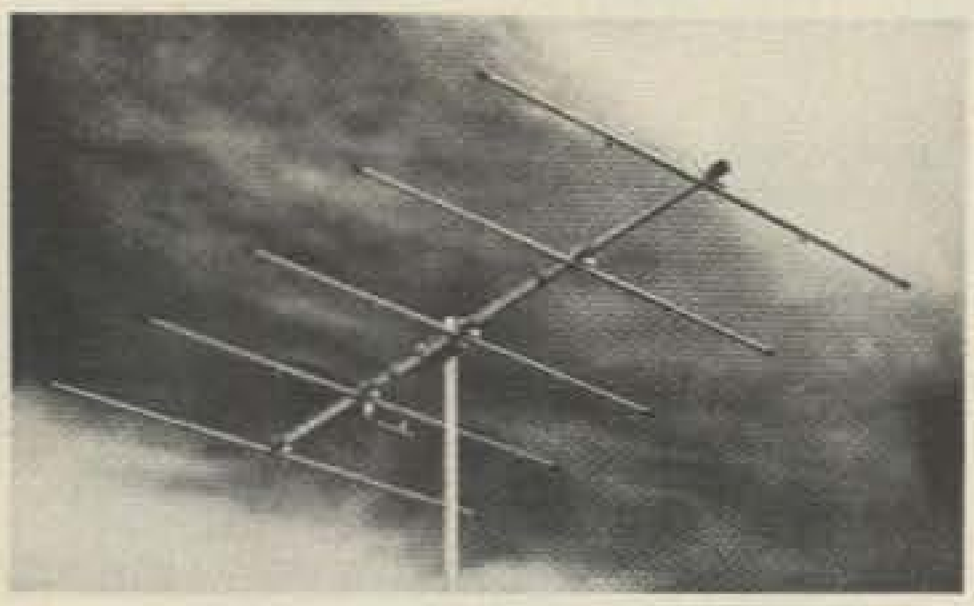
MODEL CM-1210 Rugged, reliable, dual receiver dynamic headphone (similar to Model C-1210). Ceramic boom microphone with -51 dB output. For use with any mobile or base station with high Z input and 3.2 to 20 ohm audio output. Price: $56.90.

MODEL CM-1320S Deluxe single receiver dynamic headphone with audiometric-type headphone element (similar to Model C-1320). Ceramic boom microphone with -51 dB output. For use with any mobile or base station requiring high impedance mic input and 3.2 to 20 ohm audio output. Price: $54.50.

MODEL	C-610	SWL-610	C-1210	C-1320	CM-610	CM-1210	CM-1320	CM-1320S
Headphone Sensitivity Ref. .0002 Dynes/cm² @1mW input, 1kHz	103dB SPL ±5dB	103dB SPL ±5dB	103dB SPL ±3dB	105dB SPL ±5dB	103dB SPL ±5dB	103dB SPL ±3dB	105dB SPL ±5dB	105dB SPL ±5dB
Headphone Frequency Response (useable)	40-15,000 Hz	40-15,000 Hz	20-20,000 Hz	20-20,000 Hz	40-15,000 Hz	20-20,000 Hz	20-20,000 Hz	20-20,000 Hz
Headphone Impedance	3.2-20 ohms	2000 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms	3.2-20 ohms
Microphone Frequency Response	—	—	—	—	50-8000 Hz	50-8000 Hz	50-8000 Hz	50-8000 Hz
Microphone Impedance	—	—	—	—	High	High	High	High
Microphone Sensitivity Below 1 volt/microbar at 1kHz	—	—	—	—	−51dB ±5dB	−51dB ±5dB	−51dB ±5dB	−51dB ±5dB
Cord	5'	5'	5'	5'	8' (2.4m)	8'	8'	8'
Plug	.250" dia.	.250" dia.	.250" dia.	.250" dia.	unterminated	unterminated	unterminated	unterminated
Gross Weight	8 oz. (227g)	8 oz.	12 oz. (341g)	15 oz. (426g)	12 oz.	15 oz.	18 oz. (511g)	12 oz. (341g)
Catalog Number	61630-063	61630-062	61210-031	61320-012	61630-064	61200-058	61320-013	61320-015

TUFTS RADIO CATALOG TUFTS RADIO

6 METER BEAMS



3 - 5 - 6 - 10 ELEMENTS

Proven performance from rugged, full size, 6 meter beams. Element spacings and lengths have been carefully engineered to give best pattern, high forward gain, good front to back ratio and broad frequency response.

Booms are .058 wall and elements are 3/4" - 5/8" .049 wall seamless chrome finish aluminum tubing. The 3 and 5 element beams have 1 3/8" - 1 1/4" booms. The 6 and 10 element beams have 1 5/8" - 1 1/2" booms. All brackets are heavy gauge formed aluminum. Bright finish cad plated ubolts are adjustable for up to 1 5/8" mast on 3 and 5 element and 2" on 6 and 10 element beams. All models may be mounted for horizontal or vertical polarization.

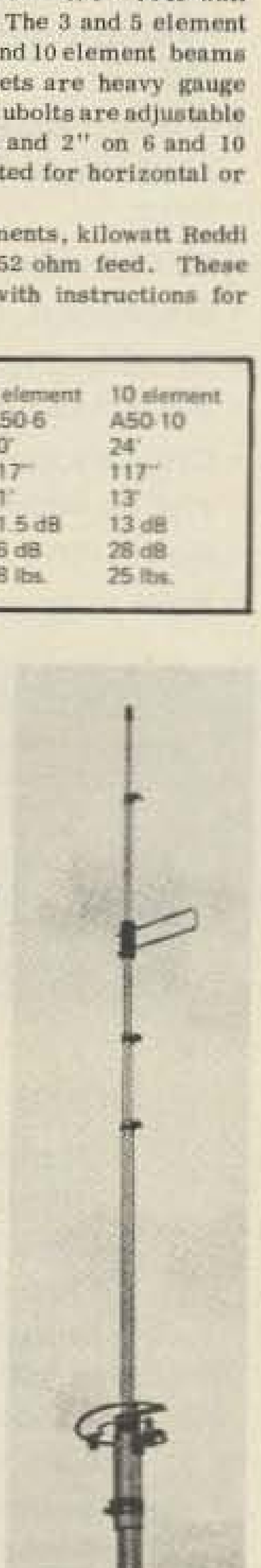
New features include adjustable length elements, kilowatt Reddi Match and built-in coax fitting for direct 52 ohm feed. These beams are factory marked and supplied with instructions for quick assembly.

Description	3 element	5 element	6 element	10 element
Model No.	A50-3	A50-5	A50-6	A50-10
Boom Lngth	6'	12'	20'	24'
Longest El.	117"	117"	117"	117"
Turn Radius	6'	7' 6"	11'	13'
Fwd. Gain	7.5 dB	9.5 dB	11.5 dB	13 dB
F/B Ratio	20 dB	24 dB	26 dB	28 dB
Weight	7 lbs.	11 lbs.	18 lbs.	25 lbs.

COAXIAL DUAL STACKING KITS

Double your effective radiated power by stacking 6 meter beams. Cush Craft coaxial stacking kits provide a simple and efficient method for realizing 3 db additional gain while maintaining the superior characteristics of our single beams. The stacking kits are complete with RG-59/U cable and preassembled fittings for direct 52 ohm feed.

MODEL NO.	FOR STACKING	AMATEUR NET
A535-SK	A50-3 or A50-5	$15.95
A561-SK	A50-6 or A50-10	$17.95



new

RINGO RANGER for FM

4.5 dB* – 6 dB**
Omnidirectional GAIN BASE STATION ANTENNAS FOR MAXIMUM PERFORMANCE AND VALUE

Cush Craft has created another first by making the world's most popular 2 meter antenna twice as good. The new Ringo Ranger is developed from the basic AR-2 with three half waves in phase and a one eighth wave matching stub. Ringo Ranger gives an extremely low angle of radiation for better signal coverage. It is tunable over a broad frequency range and perfectly matched to 52 ohm coax.

ARX-2, 137-160 MHz, 4 lbs., 112"
ARX-220, 220-225 MHz, 3 lbs., 75"
ARX-450, 435-450 MHz, 3 lbs., 39"

* Reference ½ wave dipole.
** Reference ¼ wave whip used as gain standard by many manufacturers.

Work full quieting into more repeaters and extend the radius of your direct contacts with the new Ringo Ranger.

You can up date your present AR-2 Ringo with the simple addition of this extender kit. The kit includes the phasing network and necessary element extensions. The only modifications required are easy to make saw slits in the top section of your antenna.

ARX-2K CONVERSION KIT

2 METER FM ANTENNAS

A-FM RINGO 3.75 dB Gain (reference ¼ wave whip). Half wave length antennas with direct dc ground, 52 ohm feed takes PL-259, low angle of radiation with 1-1 SWR. Factory preassembled and ready to install, 6 meter partly preassembled, all but 450 MHz take 1¼" mast. There are more Ringos in use than all other FM antennas combined.

Model Number	AR-2	AR-25	AR-6	AR-220	AR-450
Frequency MHz	135-175	135-175	50-54	220-225	440-460
Power—Hdlg. Watts	100	500	100	100	250
Wind area sq. ft.	.21'	.21'	.37'	.20'	.10'

B-4 POLE Up to 9 dB Gain over a ½ wave dipole. Overall antenna length 147 MHz — 23' 220 MHz — 15', 435 MHz — 8', pattern 360° = 6 dB gain, 180° = 9 dB gain, 52 ohm feed takes PL 259 connector. Package includes 4 complete dipole assemblies on mounting booms, harness and all hardware. Vertical support mast not supplied.

AFM-4D 144 - 150 MHz, 1000 watts, wind area 2.58 sq. ft.
AFM-24D 220 - 225 MHz, 1000 watts, wind area 1.85 sq. ft.
AFM-44D 435 - 450 MHz, 1000 watts, wind area 1.13 sq. ft.

D-POWER PACK The big signal (22 element array) for 2 meter FM, uses two A147-11 yagis with a horizontal mounting boom, coaxial harness and all hardware. Forward gain 16 dB, F/B ratio 24 dB, ½ power beamwidth 42°, dimensions 144" x 80" x 40", turn radius 60", weight 15 lbs., 52 ohm feed takes PL-259 fitting.

A147-22 146 - 148 MHz, 1000 Watts, wind area 2.42 sq. ft.

D-YAGI STACKING KITS VPK includes horizontal mounting boom, harness, hardware and instructions for two vertically polarized yagis gives 3 dB gain over the single antenna.

A14-VPK,	complete 4 element stacking kit
A14-SK,	4 element coax harness only
A147-VPK,	complete 11 element stacking kit
A147-SK,	11 element coax harness only
A449-SK,	6 + 11 element coax harness only

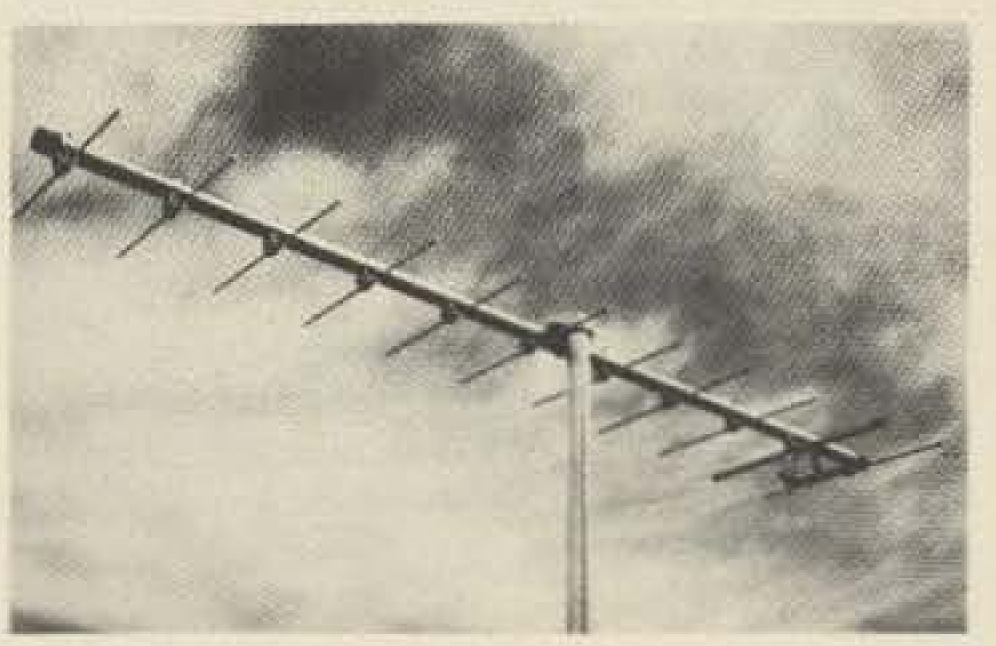
E-4-6-11 ELEMENT YAGIS The standard of comparison in VHF-UHF communications, now cut for FM and vertical polarization. The four and six element models can be tower side mounted. All are rated at 1000 watts with direct 52 ohm feed and PL-259 connectors.

Model Number	A147-11	A-147-4	A449-11	A449-6	A220-11
Boom/Longest ele.	144"/40"	44"/40"	60"/13"	35"/26"	102"/26"
Wght./Turn radius	6 lbs., 72"	3 lbs., 44"	4 lbs., 60"	3 lbs., 18"	5 lbs., 51"
Gain/F/B ratio dB	13.2/28	9/20	13.2/28	11/25	13.2/28
½ Power beam	48°	66°	48°	60°	48°
Wind area sq. ft.	1.21	.43	.39	.30	.50
Frequency MHz	146-148	146-148	440-450	440-450	220-225

F-FM TWIST 12.4 dB Gain: Ten elements horizontal polarization for low end coverage and ten elements vertical polarization for FM coverage. Forward gain 12.4 dB, F/B ratio 22 dB, boom length 130", weight 10 lbs., longest element 40", 52 ohm Reddi Match driven elements take PL-259 connectors, uses two separate Feed lines.

A147-20T 145 - 147 MHz, 1000 watts, wind area 1.42 sq. ft.

HIGH PERFORMANCE VHF YAGIS



3/4, 1-1/4, 2 METER BEAMS

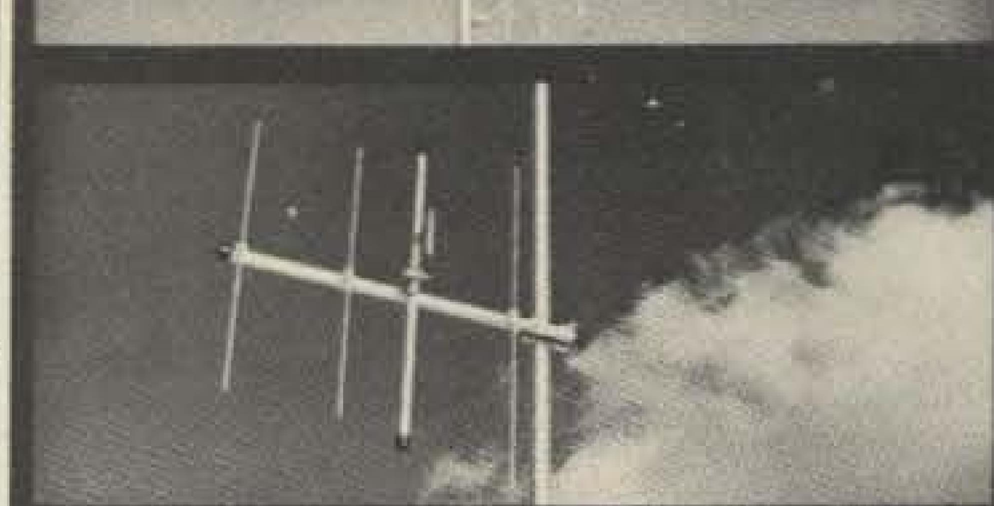
The standard of comparison in amateur VHF/UHF communications Cush Craft yagis combine all out performance and reliability with optimum size for ease of assembly and mounting at your site.

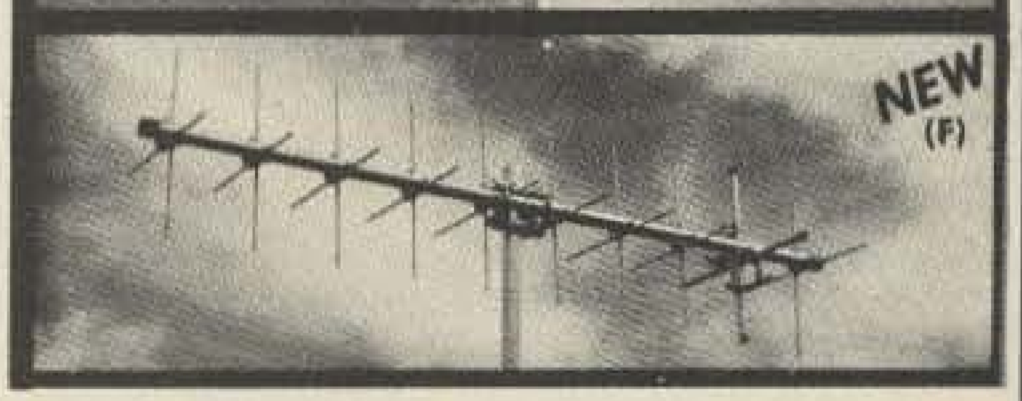
Lightweight yet rugged, the antennas have 3/16" O. D. solid aluminum elements with 5/16" center sections mounted on heavy duty formed brackets. Booms are 1" and 7/8" O. D. aluminum tubing. Mast mounts of 1/8" formed aluminum have adjustable u-bolts for up to 1-1/2" O. D. masts. They can be mounted for horizontal or vertical polarization. Complete instructions include data on 2 meter FM repeater operation.

New features include a kilowatt Reddi Match for direct 52 ohm coaxial feed with a standard PL-259 fitting. All elements are spaced at .2 wavelength and tapered for improved bandwidth.

Model No.	A144-7	A144-11	A220-11	A430-11
Description	2m	2m	1¼m	¾m
Elements	7	11	11	11
Boom Lngth	98"	144"	102"	57"
Weight	4	6	4	3
Fwd. Gain	11 dB	13 dB	13 dB	13 dB
F/B Ratio	26 dB	28 dB	28 dB	28 dB
Fwd. Lobe @ ½ pwr. pt.	46°	42°	42°	42°
SWR @ Freq.	1 to 1	1 to 1	1 to 1	1 to 1

cushcraft CORPORATION





VHF/UHF BEAMS

A50-3	$ 32.95	A144-7	21.95
A50-5	49.95	A144-11	32.95
A50-6	69.95	A430-11	24.95
A50-10	99.95		

AMATEUR FM ANTENNAS

A147-4	$ 19.95	AFM-44D	54.95
A147-11	29.95	AR-2	21.95
A147-20T	54.95	AR-6	32.95
A147-22	84.95	AR-25	29.95
A220-7	21.95	AR-220	21.95
A220-11	27.95	AR-450	21.95
A449-6	21.95	ARX-2	32.95
A449-11	27.95	ARX-2K	13.95
AFM-4D	59.95	ARX-220	32.95
AFM-24D	57.95	ARX-450	32.95

Description:	144 MHz. Model:	Price:	220 MHz. Model:	Price:	432 MHz. Model:	Price:
20 Element DX-Array	DX-120	42.95	DX-220	37.95	DX-420	32.95
Frame & Harness (40 E.)	DXK-140	59.95	DXK-240	54.95	DXK-440	39.95
Frame & Harness (80 El.)	DXK-180	109.95	DXK-280	89.95	DXK-480	79.95
1-1 52-ohm balun	DX-18N	12.95	DX-28N	12.95	DX-48N	12.95
Vert. Pol. Bracket (20 El.)	DX-VPB	9.95	DX-VPB	9.95	DX-VPB	9.95

C – LINE AMATEUR EQUIPMENT DRAKE —COMMUNICATIONS RECEIVERS—

Drake R-4C

Solid State Linear permeability-tuned VFO with 1 kHz dial divisions. Gear driven dual circular dials. High mechanical, electrical and temperature stability.

Covers ham bands with crystals furnished. Covers all of 80, 40, 20 and 15 meters, and 28.5-29.0 MHz of 10 meters.

Covers 160 meters with accessory crystal. In addition to the ham bands, tunes any fifteen 500 kHz ranges between 1.5 and 30 MHz, 5.0 to 6.0 MHz not recommended. Can be used for MARS, WWV, CB, Marine and Shortwave broadcasts.

Superior selectivity: 2.4 kHz 8-pole filter provided in ssb positions. 8.0 kHz, 6 pole selectivity for a-m. Optional 8-pole filters of .25, .5, 1.5 and 6.0 kHz bandwidths available.

Tunable notch filter attenuates carriers within passband.

Smooth and precise passband tuning.

Transceive capability; may be used to transceive with the T-4X, T-4XB or T-4XC Transmitters. Illuminated dial shows which PTO is in use.

Usb, lsb, a-m and cw on all bands.

Agc with fast attack and two release times for ssb and a-m or fast release for break-in cw. Agc also may be switched off.

New high efficiency accessory noise blanker that operates in all modes.

Crystal lattice filter in first i-f prevents cross-modulation and desensitization due to strong adjacent channel signals.

Excellent overload and intermodulation characteristics.

25 kHz Calibrator permits working closer to band edges and segments.

Scratch resistant epoxy paint finish.

Price: $699.00

Drake T-4XC

Solid State Linear permeability-tuned VFO with 1 kHz dial divisions. Gear driven dual circular dials. High mechanical, electrical and temperature stability.

Covers ham bands with crystals furnished. Covers all of 80, 40, 20 and 15 meters, and 28.5-29.0 MHz of 10 meters.

Covers 160 meters with accessory crystal. Four 500 kHz ranges in addition to the ham bands plus one fixed-frequency range can be switch-selected from the front panel.

Two 8-pole crystal lattice filters for sideband selection.

Transceives with the R-4, R-4A, R-4B, R-4C and SPR-4 Receivers. Switch on the T-4XC selects frequency control by receiver or transmitter PTO or independently. Illuminated dial shows which PTO is in use.

Usb, lsb, a-m and cw on all bands.

Controlled-carrier modulation for a-m is compatible with ssb linear amplifiers.

Automatic transmit-receive switching. Separate VOX time-delay adjustments for phone and cw. VOX gain is independent of microphone gain.

Choice of VOX or PTT. VOX can be disabled by front panel switch.

Adjustable pi network output.

Transmitting agc prevents flat-topping.

Meter reads relative output or plate current with switch on load control.

Built-in cw sidetone.

Spotting function for easy zero-beating.

Easily adaptable to RTTY, either fsk or afsk.

Compact size; rugged construction. Scratch resistant epoxy paint finish.

Price: $699.00

Drake SPR-4 – $699.00

- **Programmable to meet specific requirements: SWL, Amateur, Laboratory, Broadcast, Marine Radio, etc.**
- **Direct frequency dialing: 150-500 kHz plus any 23 500 kHz ranges, 0.5 to 30 MHz**
- **FET circuitry, all solid state**
- **Linear dial, 1 kHz readout**
- **Band-widths for cw, ssb, a-m with built-in LC filter**
- **Crystals supplied for LW, seven SW, and bc bands**
- **Notch filter**
- **Built-in speaker**

Drake DSR-2 – $3200.00

- **Continuous Coverage 10 kHz to 30 MHz**
- **Digital Synthesizer Frequency Control**
- **Frequency Displayed to 100 Hz**
- **All Solid State**
- **A-m, Ssb, Cw, RTTY, lsb**
- **Series Balanced Gate Noise Blanker**
- **Front End Protection**
- **Optional Features Available on Special Order**

Power Supplies

Power Supplies for T-4, T-4X, T-4XB or T-4XC (The AC-4 can be housed in an MS-4 speaker cabinet).

Model No. 1501 Drake AC-4 $150.00
Model No. 1505 Drake DC-4 $165.00

Drake MS-4

Drake MS-4 Matching Speaker for use with R-4, R-4A, R-4B and R-4C Receivers. (Has space to house AC-3 and AC-4 Power Supplies)

Price: $33.00

Accessories

DRAKE MICROPHONES

Wired for use with Drake transmitters and transceivers, for either push-to-talk or VOX. Type of operation is determined by the VOX control setting of the transmitter.

Desk Type Model No. 7075

• **Type:** Heavy Duty Ceramic Desk Top • **Cable:** Four Foot, 3-Conductor, One Shield • **Output Level:** Minus 54 dB (0 dB = 1 volt/microbar) • **Frequency Response:** 80-7000 Hz • **Switching:** Adapts to either push-to-talk or VOX. **Price: $39.00**

Hand-Held Type Model No. 7072

• **Type:** Ceramic, hand held • **Cable:** 11" Retracted, 5' extended, PVC 3 Cord, 1 shielded, Coil Cord • **Case:** Cycolac • **Finish:** Grey • **Output Level:** Minus 65 dB (0 dB = 1 volt/microbar) • **Frequency Response:** 300-3000 Hz • **Switching:** Adapts to either push-to-talk or VOX.

Price: $19.00

Drake FS-4 Digital Synthesizer – $300.00

The new solid state Drake FS-4 Synthesizer opens the door to a new world of continuous-tuning short wave! Combines synthesized general coverage flexibility with the selectivity, stability, frequency readout and reliability of the Drake R-4C or SPR-4 Receivers.

• Interfaces with all R-4 series receivers and T-4X series transmitters: (R-4, R-4A, R-4B, R-4C, SPR-4, T-4, T-4X, T-4XB and T-4XC), without modification. • MHz range is set on FS-4, with kHz readout taken from receiver dial. • Complete general coverage—no range crystals to buy. • T-4/T-4X series transmitters transceive on any FS-4 frequency, when used with R-4 series receivers. • Readout 1 kHz with Drake PTO.

Price: $250.00

KLM RF Power Amplifiers

- A simple, add-on-immediately RF amplifier.
- Merely coax-connect amplifier between antenna and transceiver.
- No tuning! Efficient strip-line broad band design.
- Automatic! Internal RF-sensor-controlled relay connects amplifier whenever transmitter is switched on. Manual, remote-position switching is optional.
- Models for 6,2,1¼ meters, 70CM amateur bands plus MARS coverage.
- Two types: **Class C** for FM/CW. **Linear** for SSB/AM/FM/CW.
- Negligible insertion loss on receive.
- American made by KLM.

Highest quality, American-made "brand" transistors are fully protected for VSWR, short and overload, reverse polarity. Highly effective heat sinking assures long life, reliable performance. Black anodized containers...exclusive KLM extrusions, **have seven, full length fins on both sides!**

FREQ. (MHz)	MODEL NUMBER	PWR INP. (watts)	NOM. PWR OUT.(watts)	NOM. CUR. (amps.)†	SIZE	PRICE
50-54	PA4-80AL	4	80	10A	C*	164.95
144-148	PA2-12B	1-4	12	2	A	59.95
"	PA2-70B	1-4	70	10	C*	159.95
"	PA2-70BL◇	1-4	70	10	C*	169.95
"	PA2-140B	1-4	140	20	D	229.95
"	PA10-40B	5-15	40	5	B	83.95
"	PA10-40BL◇	5-15	40	5	B*	94.95
"	PA10-70B	5-15	70	8	C*	139.95
"	PA10-70BL◇	5-15	70	8	C*	149.95

FREQ. (MHz)	MODEL NUMBER	PWR INP. (watts)	NOM. PWR OUT (watts)	NOM. CUR. (amps.)†	SIZE	PRICE
144-148	PA10-80BL◇	5-15	80	10	C*	159.95
"	PA10-140B	5-15	140	18	D*	199.95
"	PA10-140BL◇	5-15	140	18	D*	215.95
"	PA10-160BL◇	5-15	160	22	D*	229.95
"	PA30-140B	15-45	140	15	D*	179.95
"	PA30-140BL◇	15-45	140	15	D*	189.95
219-226	PA2-70BC	1-4	70	10	C*	169.95
"	PA10-60BC	5-15	60	8	C	149.95
"	PA30-120BC	15-45	120	15	D*	189.95

FREQ. (MHz)	MODEL NUMBER	PWR INP. (watts)	NOM. PWR OUT.(watts)	NOM. CUR. (amps.)†	SIZE	PRICE
400-470	PA2-40C	1-4	40	7	C*	149.95
"	PA10-35C	5-15	35	6	B*	119.95
"	PA10-35CL◇	5-15	35	6	B*	139.95
"	PA10-70C	5-15	70	13	D*	229.95
"	PA10-70CL◇	5-15	70	18	D*	249.95

SIZES: Inches: *A. 2.25×5×2 *B. 6.5×5×2 *C. 6.5×7.5×2 *D. 6.5×10×2
MM: 57×127×50.8 165×127×50.8 165×190×50.8 165×254×50.8
◇LINEAR AMPLIFIER †At 13.5VDC.

TEMPO

Dealer Programs NOW Available

THE TEMPO 2020

- Phase lock-loop (PLL) oscillator circuit minimizes unwanted spurious responses.
- Hybrid Digital Frequency Presentation.
- Advanced Solid-state design...only 3 tubes.
- Built-in AC and 12 VDC power supplies.
- CW filter standard equipment...not an accessory.
- Rugged 6146-B final amplifier tubes.
- Cooling fan standard equipment...not an accessory.
- High performance noise-blanker is standard equipment...not an accessory.
- Built-in VOX and semi-break in CW keying.
- Crystal Calibrator and WWV receiving capability.
- Microphone provided.
- Dual RIT control allows both broad and narrow tuning.
- All band 80 through 10 meter coverage.
- Multi-mode USB, LSB, CW and AM operation.
- Extraordinary receiver sensitivity (.3u S/N 10 db) and oscillator stability (100 Hz 30 min. after warm-up)
- Fixed channel crystal control on two available positions.
- RF Attenuator.
- Adjustable ALC action.
- Phone patch in and out jacks.
- Separate PTT jack for foot switch.
- Built-in speaker.
- The TEMPO 2020...$759.00.
- Model 8120 external speaker...$29.95. Model 8010 remote VFO...$139.00.

ATLAS 350-XL

- ALL SOLID STATE
- SSB TRANSCEIVER
- 350 WATTS P.E.P. OR CW INPUT
- 10 THROUGH 160 METER COVERAGE

Illustrated with optional AC supply, Auxiliary VFO, and Digital Dial.

The all new Atlas 350-XL has all the exciting new features you want, plus superior performance and selectivity control never before possible. Price: $995.00

● 10-160 METERS

Full coverage of all six amateur bands in 500 kHz segments. Primary frequency control provides highly stable operation. Also included is provision for adding up to 10 additional 500 kHz segments between 2 to 22 MHz by plugging in auxiliary crystals.

● 350 WATTS

P.E.P. and CW input. Enough power to work the world barefoot!

IDEAL FOR DESKTOP OR MOBILE OPERATION

Measuring just 5 in. high x 12 in. wide x 12½ in. deep, and weighing only 13 pounds, the Atlas 350-XL offers more features, performance and value than any other transceiver, regardless of size, on the market today!

- 350-PS matching AC supply — $195.00
- DD-6XL plug-in digital dial readout $195.00
- 305 plug-in auxiliary VFO — $155.00
- 311 plug-in crystal oscillator — $135.00
- DMK-XL plug-in mobile mounting kit — $65.00

TEMPO VHF/ONE PLUS

The Tempo/ONE PLUS offers full 25 watt output or a selectable 3 to 15 watt low power output, remote tuning on the microphone, sideband operation with the SSB/ONE adapter, MARS operation capability, 5 KHz numerical LED, and all at a lower price than its time tested predecessor... the Tempo VHF ONE.

The Tempo VHF/One Plus is a VHF/FM transceiver for dependable communication on the 2 meter amateur band ● Full 2 meter coverage, 144 to 148 MHz for both transmit and receive ● Full phase lock synthesized (PLL) ● Automatic repeater split — selectable up or down ● Two built-in programmable channels ● All solid state ● 800 selectable receive frequencies with simplex and +600 kHz transmit frequencies for each receive channel. Price: $399.00

TEMPO ONE HF Transceiver. 80-10M. USB, CW & AM — $399.00
AC/ONE Power supply for TEMPO ONE — $99.00
VF/ONE External VFO for TEMPO ONE — $199.00

TEMPO SSB/ONE

SSB adapter for the Tempo VHF/One

· Selectable upper or lower sideband. · Plugs directly into the VHF/One with no modification. · Noise blanker built-in. · RIT and VXO for full frequency coverage. · $225.00

TUFTS RADIO CATALOG TUFTS RADIO

TUFTS RADIO CATALOG — TUFTS RADIO

Tufts Radio Electronics • 209 Mystic Avenue • Medford MA 02155 • (617) 395-8280

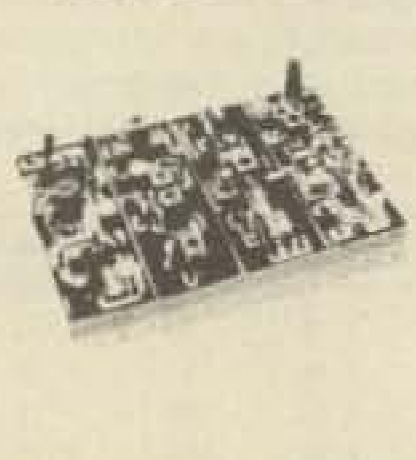
WORK ALL REPEATERS WITH OUR NEW SYNTHESIZER II

The Synthesizer II is a two meter frequency synthesizer. Frequency is adjustable in 5 kHz steps from 140.00 MHz to 149.995 MHz with its digital readout thumb wheel switching. Transmit offsets are digitally programmed on a diode matrix, and can range from 10 kHz to 10 MHz. No additional components are necessary!

Kit . . . . $169.95 Wired and tested $239.95

Also available for 220 MHz!

RECEIVERS

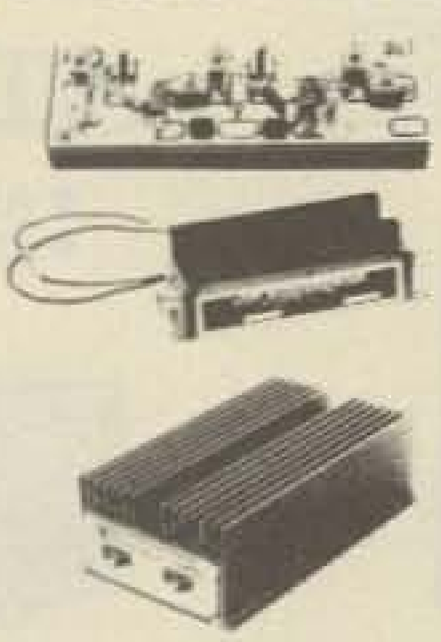


RX28C	28-35 MHz FM receiver with 2 pole 10.7 MHz crystal filter	$ 59.95
RX28C W/T	same as above–wired & tested	104.95
RX50C Kit	30-60 MHz rcvr w/2 pole 10.7 MHz crystal filter	59.95
RX50C W/T	same as above–wired & tested	104.95
RX144C Kit	140-170 MHz rcvr w/2 pole 10.7 MHz crystal filter	69.95
RX144C W/T	same as above–wired & tested	114.95
RX220C Kit	210-240 MHz rcvr w/2 pole 10.7 MHz crystal filter	69.95
RX220C W/T	same as above–wired & tested	114.95
RX432C Kit	432 MHz rcvr w/2 pole 10.7 MHz crystal filter	79.95
RX432C W/T	same as above–wired & tested	124.95
RXCF	accessory filter for above receiver kits gives 70 dB adjacent channel rejection	8.50
RF28 Kit	10 mtr RF front end 10.7 MHz out	12.50
RF50 Kit	6 mtr RF front end 10.7 MHz out	12.50
RF144D Kit	2 mtr RF front end 10.7 MHz out	17.50
RF220D Kit	220 MHz RF front end 10.7 MHz out	17.50
RF432 Kit	432 MHz RF front end 10.7 MHz out	27.50
IF 10.7F Kit	10.7 MHz IF module includes 2 pole crystal filter	27.50
FM455 Kit	455 KHz IF stage plus FM detector	17.50
AS2 Kit	audio and squelch board	15.00

TRANSMITTERS

TX50	transmitter exciter, 1 watt, 6 mtr.	39.95
TX50 W/T	same as above–wired & tested	59.95
TX144B Kit	transmitter exciter–1 watt–2 mtrs	29.95
TX144B W/T	same as above–wired & tested.	49.95
TX220B Kit	transmitter exciter–1watt–220 MHz	29.95
TX220B W/T	same as above–wired & tested	49.95
TX432B Kit	transmitter exciter 432 MHz	39.95
TX432B W/T	same as above–wired & tested	59.95
TX150 Kit	300 milliwatt, 2 mtr transmitter	19.95
TX150 W/T	same as above–wired & tested	29.95

POWER AMPLIFIERS

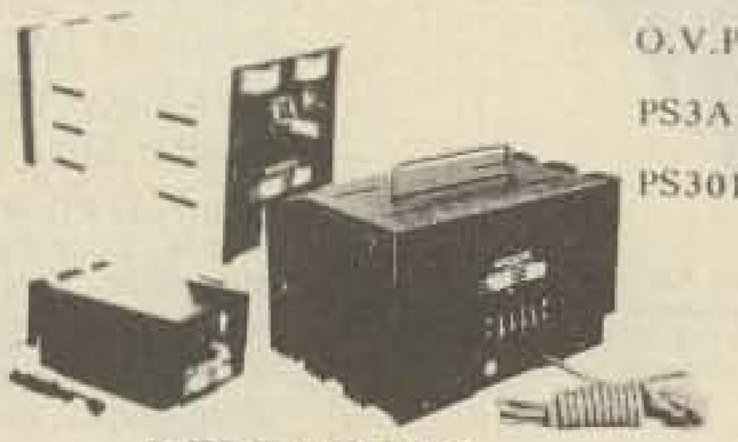


PA2501H Kit	2 mtr power amp–kit 1w in–25w out with solid state switching, case, connectors	59.95
PA2501H W/T.	same as above–wired & tested	74.95
PA4010H Kit	2 mtr power amp–10w in–40w out–relay switching	59.95
PA4010H W/T.	same as above–wired & tested	74.95
PA50/25 Kit	6 mtr power amp, 1w in, 25w out, less case, connectors & switching	49.95
PA50/25 W/T	same as above, wired & tested	69.95
PA144/15 Kit	2 mtr power amp–1w in–15w out–less case, connectors and switching	39.95
PA144/25 Kit	same as PA144/15 kit but 25w	49.95
PA220/15 Kit	similar to PA144/15 for 220 MHz	39.95
PA432/10 Kit	power amp–similar to PA144/15 except 10w and 432 MHz	49.95
PA140/10 W/T	10w in–140w out–2 mtr amp	179.95
PA140/30 W/T	30w in–140w out–2 mtr amp	159.95

Blue Line . . . RF power amp, wired & tested, emission–CW-FM-SSB/AM

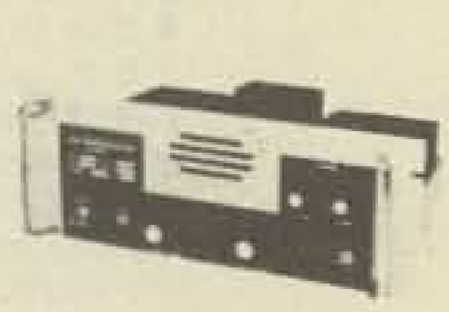
Model	Frequency	Power Input	Power Output	
BLB 3/150	45- 55MHz	3W	150W	TBA
BLC 10/70	140-160MHz	10W	70W	139.95
BLC 2/70	140-160MHz	2W	70W	159.95
BLC 10/150	140-160MHz	10W	150W	259.95
BLC 30/150	140-160MHz	30W	150W	239.95
BLD 2/60	220-230MHz	2W	60W	159.95
BLD 10/60	220-230MHz	10W	60W	139.95
BLD 10/120	220-230MHz	10W	120W	259.95
BLE 10/40	420-470MHz	10W	40W	139.95
BLE 2/40	420-470MHz	2W	40W	159.95
BLE 30/80	420-470MHz	30W	80W	259.95
BLE 10/80	420-470MHz	10W	80W	289.95

POWER SUPPLIES



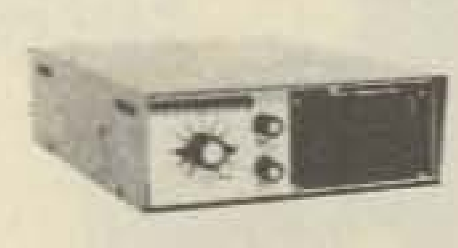
PS15C Kit	15 amp–12 volt regulated power supply w/case, w/fold-back current limiting and overvoltage protection	79.95
PS15C W/T	same as above–wired & tested	94.95
PS25C Kit	25 amp–12 volt regulated power supply w/case, w/fold-back current limiting and ovp	129.95
PS25C W/T	same as above–wired & tested	149.95
PS25M Kit	same as PS25C with meters	149.95
PS25M W/T	same as above–wired & tested	169.95
O.V.P.	adds over voltage protection to your power supplies, 15 VDC max.	9.95
PS3A Kit	12 volt–power supply regulator card with fold-back current limiting	8.95
PS3012 W/T	new commercial duty 30 amp 12 VDC regulated power supply w/case, w/fold-back current limiting and overvoltage protection	239.95

REPEATERS



RPT50 Kit	repeater–6 meter	465.95
RPT50	repeater–6 meter, wired & tested	695.95
RPT144 Kit	repeater–2 mtr–15w–complete (less crystals)	465.95
RPT220 Kit	repeater–220 MHz–15w–complete (less crystals)	465.95
RPT432 Kit	repeater–10 watt–432 MHz (less crystals)	515.95
RPT144 W/T	repeater–15 watt–2 mtr.	695.95
RPT220 W/T	repeater–15 watt–220 MHz.	695.95
RPT432 W/T	repeater–10 watt–432 MHz.	749.95
DPLA50	6 mtr close spaced duplexer	575.00
DPLA144	2 mtr, 600 KHz spaced duplexer, wired and tuned to frequency	379.95
DPLA220	220 MHz duplexer, wired and tuned to frequency	379.95
DPLA432	rack mount duplexer	319.95
DSC-U	double shielded duplexer cables with PL259 connectors (pr.)	25.00
DSC-N	same as above with type N connectors (pr.)	25.00

TRANSCEIVERS

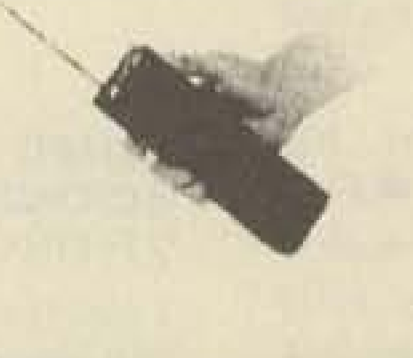


TRX50 Kit	Complete 6 mtr FM transceiver kit, 20w out, 10 channel scan with case (less mike and crystals)	249.95
TRX144 Kit	same as above, but 2 mtr & 15w out	219.95
TRX220 Kit	same as above except for 220 MHz	219.95
TRX432 Kit	same as above except 10 watt and 432MHz	254.95
TRC-1	transceiver case only	19.95
TRC-2	transceiver case and accessories	39.95

SYNTHESIZERS

SYN II Kit	2 mtr synthesizer, transmitt offsets programmable from 100 KHz–10 MHz, (Mars offsets with optional adapters)	169.95
SYN II W/T	same as above–wired & tested	239.95
MO-1 Kit	Mars/cap offset optional	2.50
TO-1 Kit	18 MHz optional tripler	2.50

WALKIE-TALKIES



HT 144B Kit	2 mtr, 2w, 4 channel, hand held receiver with crystals for 146.52 simplex	129.95
NICAD	battery pack, 12 VDC, ½ amp.	29.95
BC12	battery charger for above	5.95
Rubber Duck	2 mtr, with male BNC connector	8.95

OTHER PRODUCTS BY VHF ENGINEERING

CD1 Kit	10 channel receive xtal deck w/diode switching.	$ 6.95
CD2 Kit	10 channel xmit deck w/switch and trimmers	14.95
CD3 Kit	UHF version of CD1 deck, needed for 432 multi-channel operation	12.95
COR2 Kit	carrier operated relay.	19.95
SC3 Kit	10 channel auto-scan adapter for RX with priority	19.95
Crystals	we stock most repeater and simplex pairs from 146.0-147.0 (each).	5.00
CWID Kit	159 bit, field programmable, code identifier with built-in squelch tail and ID timers	39.95
CWID	wired and tested, not programmed	54.95
CWID	wired and tested, programmed	59.95
MIC 1	2,000 ohm dynamic mike with P.T.T. and coil cord	12.95
TS1 W/T	tone squelch decoder	59.95
TS1 W/T	installed in repeater, including interface accessories	89.95
TD3 Kit	2 tone decoder	29.95
TD3 W/T	same as above–wired & tested	39.95
HL144 W/T	4 pole helical resonator, wired & tested, swept tuned to 144 MHz ban	24.95
HL220 W/T	same as above tuned to 220 MHz ban	24.95
HL432 W/T	same as above tuned to 432 MHz ban	24.95

vhf engineering

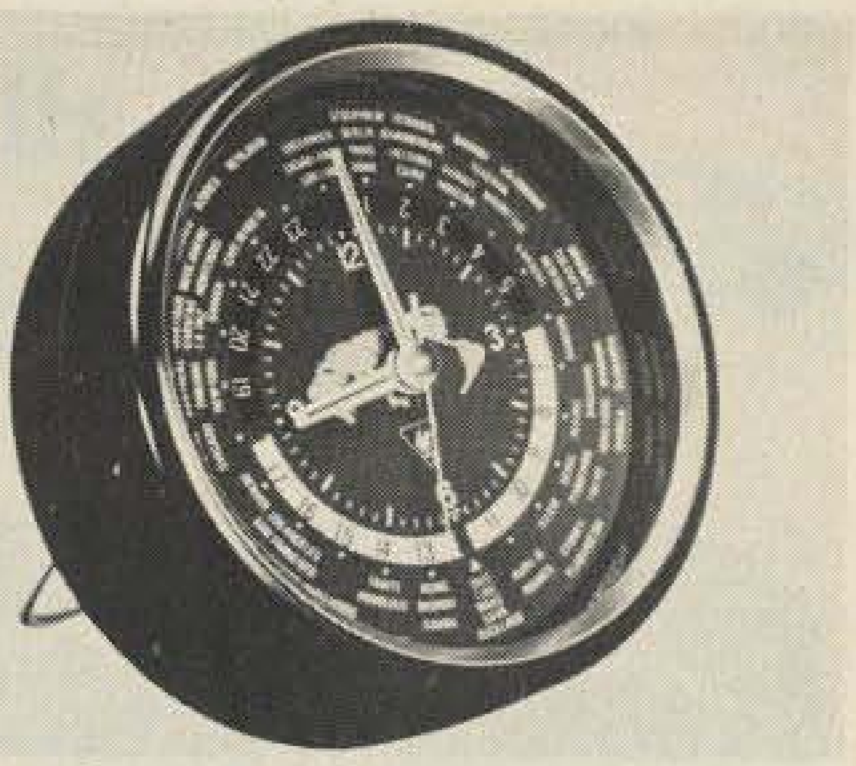
THE WORLD'S MOST COMPLETE LINE OF VHF-FM KITS AND EQUIPMENT

Dealer Programs NOW Available

Tufts Radio Electronics • 209 Mystic Avenue • Medford MA 02155 • (617) 395-8280

A new precision clock which tells time anywhere in the world at a glance, has been announced by **Yaesu Electronics Corporation**. The time in any principal city or time zone can be simultaneously coordinated with local time on a 24 hour basis. After the initial setting, as the clock runs, a Time Zone Hour Disc advances automatically, showing correct time all over the world without further adjustment. The clock is especially designed to withstand shock and may be hung on a wall or placed on its desk mount. The clock will run an entire year on a single 1.5 volt flashlight battery and the mechanism starts as soon as the battery is inserted. It measures six inches in diameter by two and one half inches deep. An excellent item for the business office, ham radio operator, short wave listener, boat owner, and others who want an accurate dependable clock.

Price: $30.00 Amateur net.



NYE VIKING CODE PRACTICE SET

No. 114-404-002

Get the RIGHT START!

With a NYE VIKING Code Practice Set you get a sure, smooth, Speed-X model 310-001 transmitting key, a linear circuit oscillator and amplifier, with a built-in 2" speaker, all mounted on a heavy duty aluminum base with non-skid feet. Operates on standard 9V transistor type battery (not included). Units can be connected in parallel so that two or more operators can practice sending and receiving to each other. List price, $18.50.

MOR-GAIN

Manufactured & Guaranteed by
MOR-GAIN
2200T South 4th Street
Leavenworth, Kansas 66048
(913) 682-3142

Fully Air Tested – Thousands Already in Use

#16 40% Copper Weld wire annealed to it handles like soft Copper wire – Rated for better than full legal power AM/CW or SSB-Coaxial or Balanced 50 to 75 ohm feedline – VSWR under 1.5 to 1 at most heights – Stainless Steel hardware – Drop Proof Insulators – Terrific Performance – No coils or traps to break down or change under weather conditions – Completely Assembled ready to put up – Guaranteed 1 year – ONE DESIGN DOES IT ALL.

MODEL	BANDS (Meters)	PRICE	WEIGHT (Oz/Kg)	LENGTH (Ft/Mtrs)
40-20 HD	40/20	$49.50	26/.73	36/10.9
40-10 HD	40/20/15/10	59.50	36/1.01	36/10.9
80-40 HD	80/40 + 15	57.50	41/1.15	69/21.0
75-40 HD	75/40	55.00	40/1.12	66/20.1
75-40 HD (SP)	75/40	57.50	40/1.12	66/20.1
75-20 HD	75/40/20	66.50	44/1.23	66/20.1
75-20 HD (SP)	75/40/20	66.50	44/1.23	66/20.1
75-10 HD	75/40/20/15/10	74.50	48/1.34	66/20.1
75-10 HD (SP)	75/40/20/15/10	74.50	48/1.34	66/20.1
80-10 HD	80/40/20/15/10	76.50	50/1.40	69/21.0

NO TRAPS – NO COILS – NO STUBS – NO CAPACITORS

MOR-GAIN HD DIPOLES . . . • One half the length of conventional half-wave dipoles. • Multi-band, Multi-frequency. • Maximum efficiency – no traps, loading coils, or stubs. • Fully assembled and pre-tuned – no measuring, no cutting. • All weather rated – 1 KW AM, 2.5 KW CW or PEP SSB. • Proven performance – more than 15,000 have been delivered. • Permit use of the full capabilities of today's 5-band xcvrs. • One feedline for operation on all bands. • Lowest cost/benefit antenna on the market today. • Fast QSY – no feedline switching. • Highest performance for the Novice as well as the Extra-Class Op.

EXCLUSIVE 66 FOOT, 75 THRU 10 METER DIPOLES

NOTES

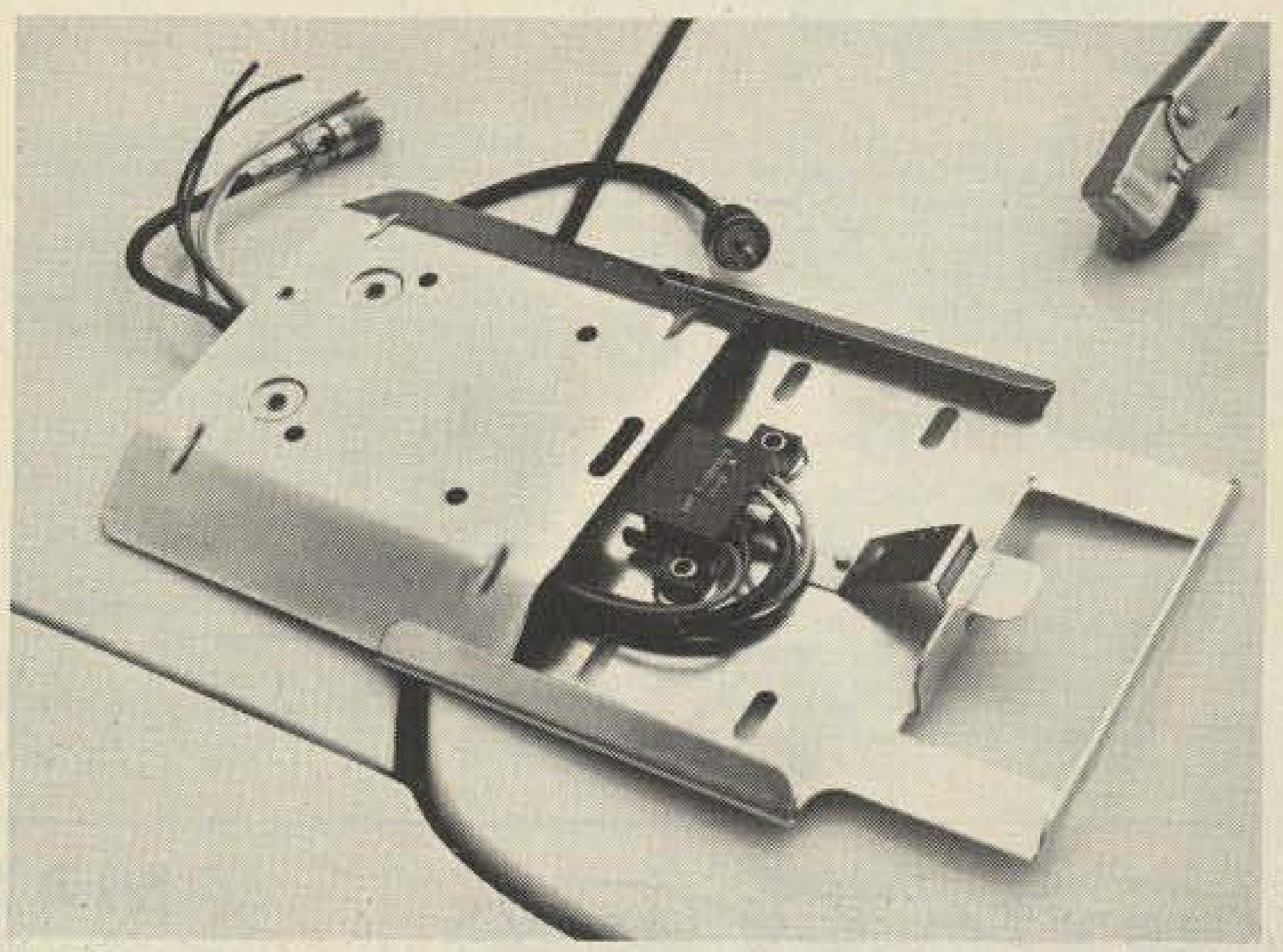
1 All models above are furnished with crimp/solder lugs.

2 All models can be furnished with a SO-239 female coaxial connector at additional cost. The SO-239 mates with the standard PL-259 male coaxial cable connector. To order this factory installed option, add the letter 'A' after the model number. Example: 40-20 HD/A.

3 75 meter models are factory tuned to resonate at 3950 kHz. (SP) models are factory tuned to resonate at 3800 kHz. 80 meter models are factory tuned to resonate at 3650 kHz. See VSWR curves for other resonance data.

STOP A THIEF!

SAVE YOUR RADIO!



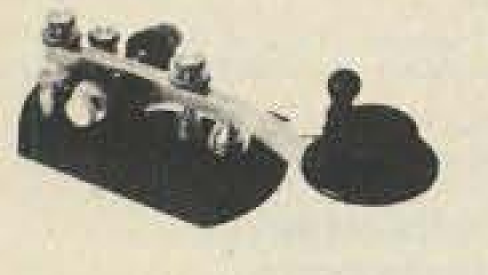
DESIGNED FOR COMMERCIAL USE UP TO 1000 MHZ.

The **TUFTS SAVE-YOUR-RADIO** bracket can save you a bundle . . . and a lot of hassle. Why worry about rig ripoff? The **TUFTS SYR** bracket mounts quickly and easily in your car and makes it possible to snap your rig out of its bracket when you park and put it out of sight.

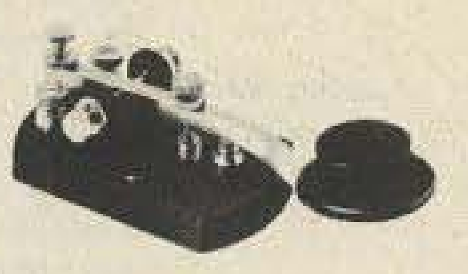
The connector system has a special coaxial cable connector which will provide you with a lossless connection right up to 1000 MHz! No loss! In addition to the quick coax connector there are also four power and accessory connections which are made automatically when the rig is slid into its bracket . . . just what you need for feeding power and loudspeaker connections to the set.

This is a rugged bracket and connector system . . . it'll take a beating. There is a hole on each side of the 16 gauge steel plate for a padlock in case you want to leave the rig for short periods in its bracket. They'll have to rip out the dash to get it . . . and it won't be the first time for that.

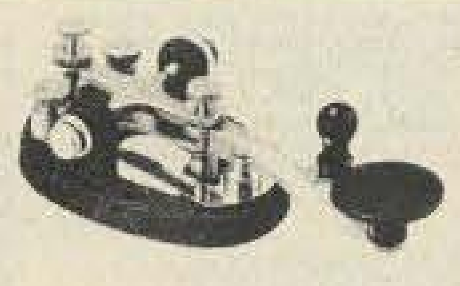
With two of these brackets you can bring the mobile rig into the house and use it in seconds. On trips you can take an AC supply for the rig and use it in your hotel room. Price: $29.95



No. 114-320-003 – $9.90
No. 114-322-003 – Brass – $10.30



No. 114-320-001 – $8.30
No. 114-322-001 – Brass – $8.65



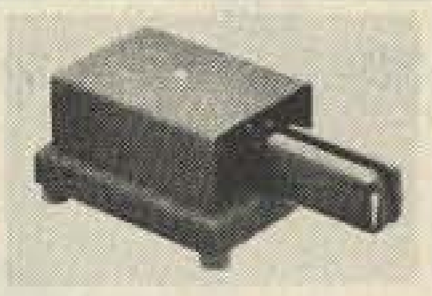
No. 114-310-003 – $8.25
No. 114-312-003 – Brass – $8.65

NYE VIKING SPEED-X KEYS

NYE VIKING Standard Speed-X keys feature smooth, adjustable bearings, heavy-duty silver contacts, and are mounted on a heavy oval die cast base with black wrinkle finish. Available with standard, or Navy knob, with, or without switch, and with nickel or brass plated key arm and hardware.

Pamper yourself with a Gold-Plated NYE VIKING KEY!

Model No. 114-31C-004GP has all the smooth action features of NYE Speed-X keys in a special "presentation" model. All hardware is heavily gold plated and it is mounted on onyx-like jet black plastic sub-base. List price is $50.00.



No. SSK-1 $23.95
No. SSK-1CP-Chrome – $29.95

NYE VIKING SQUEEZE KEY

Extra-long, finger-fitting molded paddles with adjustable spring tension, adjustable contact spacing. Knife-edge bearings and extra large, gold plated silver contacts! Nickel plated brass hardware and heavy, die cast base with non-skid feet. Base and dust cover black crackle finished. SSK-1 — $23.45.

SSK-1CP has heavily chrome-plated base and dust cover. List price, $29.95.

CODE PRACTICE SET

You get a sure, smooth, Speed-X model 310-001 transmitting key, linear circuit oscillator and amplifier, with a built-in 2" speaker, all mounted on a heavy duty aluminum base with non-skid feet. Operates on standard 9V transistor type battery (not included). List price, $18.50.

PHONE PATCH Model No. 250-46-1 measures 6-1/2" wide, 2-1/4" high and 2-7/8" deep. List price, $36.50. Model 250-46-3, designed for use with transceivers having a built-in speaker, has its own built-in 2" x 6" 2 watt speaker. Measures 6-1/2" wide, 2-1/4" high and 2-7/8" deep. List price, $44.50.

For all you hams with little cars ...

We've got the perfect mobile rig for you.

The Atlas 210x or 215x measures only 9½" wide x 9½" deep x only 3½" high, yet the above photograph shows how easily the Atlas transceiver fits into a compact car. And there's plenty of room to spare for VHF gear and other accessory equipment. With the exclusive Atlas plug-in design, you can slip your Atlas in and out of your car in a matter of seconds. All connections are made automatically.

BUT DON'T LET THE SMALL SIZE FOOL YOU!
Even though the Atlas 210x and 215x transceivers are less than half the size and weight of other HF transceivers, The Atlas is truly a giant in performance.

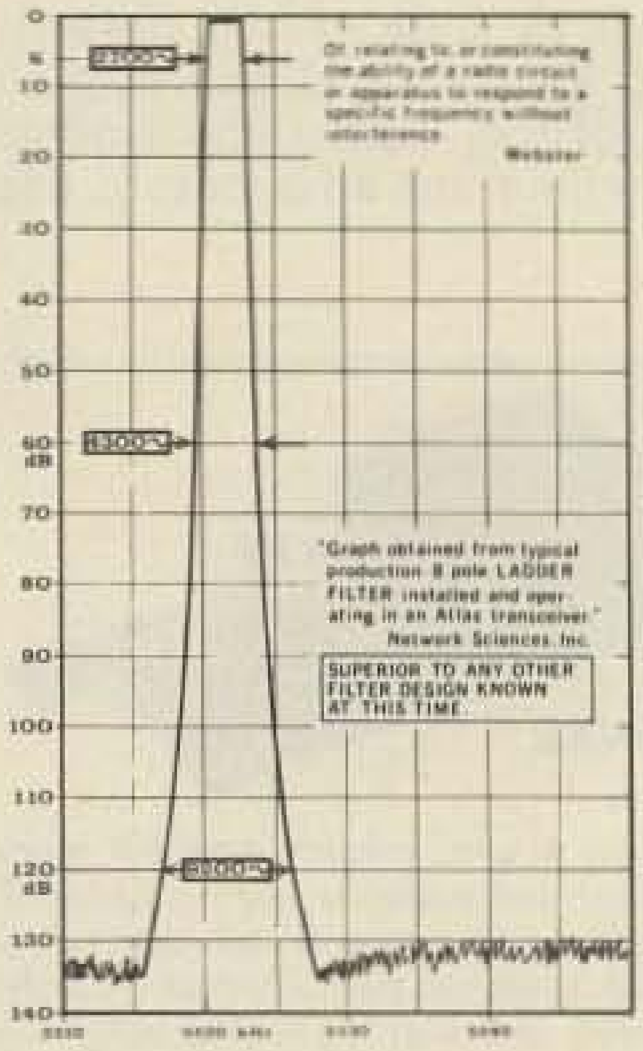
200 WATTS POWER RATING!
This power level in a seven pound transceiver is incredible but true. Atlas transceivers give you all the talk power you need to work the world barefoot. Signal reports constantly reflect great surprise at the signal strength in relation to the power rating.

FULL 5 BAND COVERAGE
The 210x covers 10-80 meters, while the 215x covers 15-160 meters. Adding the Atlas Model 10x Crystal Oscillator provides greatly increased frequency coverage for MARS and network operation.

NO TRANSMITTER TUNING OR LOADING CONTROLS
with Atlas' total broadbanding. With your Atlas you get instant QSY and band change.

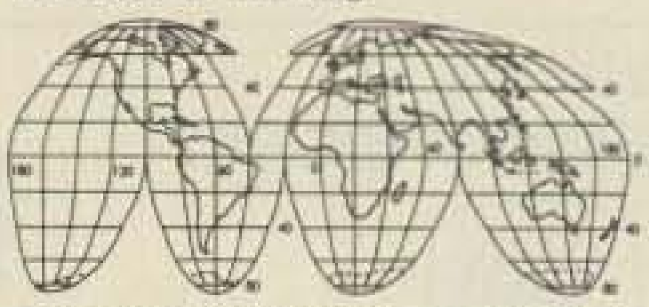
MOST ADVANCED STATE OF THE ART SOLID STATE DESIGN
not only accounts for its light weight, but assures you years of top performance and trouble free operating pleasure.

PLUG-IN CIRCUIT BOARDS
and modular design provides for ease of servicing.



PHENOMENAL SELECTIVITY
The exclusive 8 pole crystal ladder filter used in Atlas transceivers represents a major breakthrough in filter design, with unprecedented skirt selectivity and ultimate rejection. As the above graph shows, this filter provides a 6 db bandwidth of 2700 Hertz, 60 db down of only 4300 Hertz, and a bandwidth of only 9200 Hertz at 120 db down! Ultimate rejection is in excess of 130 db; greater than the measuring limits of most test equipment.

EXCEPTIONAL IMMUNITY TO STRONG SIGNAL OVERLOAD AND CROSS MODULATION. The exclusive front end design in the receiver allows you to operate closer in frequency to strong neighboring signals than you have ever experienced before. If you have not yet operated an Atlas transceiver in a crowded band and compared it with any other receiver or transceiver, you have a real thrill coming.



A WORLD WIDE DEALER NETWORK TO SERVE YOU.
Whether you're driving a Honda in Kansas City or a Mercedes Benz in West Germany, there's an Atlas dealer near you.

Atlas 210x or 215x	$675.00
W/Noise Blanker	719.00
ACCESSORIES:	
AC Console 110/220 V	$147.00
Portable AC supply 110/220 V	100.00
Plug-in Mobile Kit	48.00
10x Osc. less crystals	59.00
Digital Dial DD-6B	229.00

For complete details see your Atlas dealer, or drop us a card and we'll mail you a brochure with dealer list.

ATLAS RADIO INC.

HUSTLER®

AMATEUR ANTENNAS

"the home of originals"

STANDARD GAIN MOBILES

Two Meters

- 5/8 wavelength — 3.4 db gain over 1/4 wave mobile
- Frequency coverage—143 to 149 MHz
- Power rating—200 watts FM

BBLT-144

MODEL BBLT-144
47" antenna complete with easy to install, no holes to drill, trunk lip mount, impact spring and 17' MIL SPEC RG-58-U and PL-259. Antenna removable from mount.
Price: $33.75

BBL-144

MODEL BBL-144
47" antenna mounts on any flat surface, roof, deck or fender in ⅜" hole. Includes impact spring, 17' MIL SPEC RG-58-U and PL-259. Antenna removable from mount.
Price: $31.65

HUSTLER "BUCK-BUSTER"

MODEL SF-2
51" two meter, 5/8 wavelength, 3.4 db gain over 1/4 wave mobile. Designed with ⅜"-24 base to fit your mount or a wide selection of Hustler mobile mounts. (Mount or cable not included)
Price: $9.00

SF-2

SUPER GAIN MOBILES

Two Meters

- 5.2 db gain over 1/4 wave mobile antenna
- Frequency coverage—143-149 MHz
- SWR at resonance—1.1:1 typical
- Power rating—200 watts FM

TWO AND SIX METERS—TRUNK LIP MOUNT
MODEL HFT
Four section telescopic antenna permits separate adjustment for simultaneous resonance on two and six meters. Operational height: 40". Complete with trunk lip mount, 17' MIL SPEC RG-58-U and factory attached PL-259.
Price: $22.55

HFT

VHF/UHF ANTENNA—ROOF MOUNT
MODEL UHT-1
Field trimmable radiator for 1/4 wave operation on any frequency from 140 to 500 MHz. Cutting chart included. Mounts on any flat surface, roof, deck, fender in ⅜" hole. Includes 15' RG-58-U.
Price: $9.95

UHT-1

CGT-144

MODEL CGT-144
Get big signal performance, superior receiving capability with this 85" colinear antenna. Easy installation on side or edge of trunk lip without drilling—complete with 17' MIL SPEC RG-58-U and PL-259.
Price: $41.30

CG-144

MODEL CG-144
Same characteristics as CGT-144 supplied with ⅜"-24 base to fit all mobile ball mounts—Length is 85". Mount and cable not included. **Price: $25.50**

VHF/UHF ANTENNA—TRUNK LIP MOUNT
MODEL THF
Field trimmable radiator permits quarter wave operation on any frequency from 140 to 500 MHz. Cutting chart included. Complete with trunk lip mount, 17' RG-58-U and PL-259. **Price: $16.55**

THF

SSM-2

QD-1

RESONATOR SPRING—STAINLESS STEEL
MODEL RSS-2
Installs between Hustler mast and resonator. Absorbs shock when antenna strikes overhanging obstructions. Supplied ready for easy installation. $ 5.95

RSS-2

STAINLESS STEEL BALL MOUNT FOR DECK, FENDER OR ANY FLAT SURFACE
MODEL SSM-2
Heavy 2" reinforced stainless steel 180° adjustable ball mount easily supports any amateur mobile antenna. Includes cycolac base, steel back-up plate and mounting hardware.
Price: $19.20

QUICK DISCONNECT—100% STAINLESS STEEL
MODEL QD-1
Remove antenna from mount with easy press and twist release. Compression spring and all parts 100% stainless steel. ⅜"-24 threads—female one end, male the other.
Price: $16.95

FEED LINE MODEL L-14-240
Get known performance, maximum shielding for minimum noise pick-up in this MIL SPEC 20' length of RG-58-U cable. Supplied with connectors attached for use with ball or bumper mount and transceiver.
Price: $6.55

L-14-240

FCC Accepted for Repeater Application

MODEL G6-144A — Deluxe, Two Meter Colinear for Repeater or any fixed station operation. 6 db. gain over a ½ wave dipole. Maximum radiation at the horizon! Shunt fed with D.C. grounding. Radiator: ⅝ wave lower section, ¼ wave phasing, ⅝ wave upper section. Height: 117". SWR at resonance: 1.2:1 or better. Power rating: 1,000 Watts FM. Wind survival: 100 MPH. Installs on vertical pipe up to 1½" O.D. SO-239 coax connector **Price: $67.55**

G6-144A

DELUXE MOBILE MOUNTS

For medium length, light weight antennas with ⅜" — 24 base.

TLM HLM GCM-1

MODEL TLM
Trunk lip mount for no holes installation on side or edge of trunk lid. Includes 17' RG-58-U connectors attached.
Price: $14.85

MODEL HLM
Deluxe trunk lip mount with 180 degree swivel ball for positioning antenna to vertical. Easy — no holes — installation. Includes 17' RG-58-U cable and connectors attached. **Price: $17.20**

MODEL GCM-1
Rain gutter mount fits all shapes, angles even latest trim line gutters. Includes 180° swivel ball. **Price: $9.00**

MM-1 TGM-1 C-32

MODEL MM-1
Cowl mount installs in 1" hole. Includes 180° swivel ball and SO-239 connectors.
Price: $7.50

MODEL TGM-1
Trunk groove mount installs in hidden area of groove under trunk lid. Mounting hardware included. **Price: $8.00**

MODEL C-32
Ball mount complete with mounting hardware.
Price: $8.20

All resonators are precision wound with optimized design for each band. Assembly includes 17-7 PH stainless steel adjustable tip rod for lowest SWR and band edge marker. Choose for medium or high power operation.

RM

RMS

STANDARD HUSTLER RESONATORS
Power Rating: 400 Watts SSB

Model	Band	Price
RM-10	10 meters	$ 6.50
RM-15	15 meters	6.95
RM-20	20 meters	7.30
RM-40	40 meters	13.20
RM-75	75 meters	15.50
RM-80	80 meters	15.95

SUPER HUSTLER RESONATORS
Power Rating: Legal Limit SSB
Supers have widest bandwidth

Model	Band	Price
RM-10S	10 meters	$11.30
RM-15S	15 meters	12.65
RM-20S	20 meters	13.00
RM-40S	40 meters	15.50
RM-75S	75 meters	30.00
RM-80S	80 meters	30.40

For 6-10-15-20-40-75-80 Meters

HUSTLER MASTS

Fold over mast for quick and easy interchange of resonators or entering a garage. When operating, mast is held vertical with shakeproof sleeve clutch. 54" mast also serves as 1/4 wavelength 6 meter antenna. Stainless steel base has ⅜"-24 threads to fit mobile ball mount or bumper mount.

The Majority Choice of Amateurs Throughout the World!

MODEL MO-2
For bumper mounting—Fold is at roof line 27" above base **Price: $22.00**

MODEL MO-1
For deck or fender mounting—Fold is at roof line 15" above base **Price: $22.00**

MO-1

MO-2

4-BTV

Covers 10 - 15 - 20 - 40 Meters
Only Hustler Gives One Setting for Whole Band Coverage

MODEL 4-BTV

- Lowest SWR—PLUS.
- Bandwidth at its broadest! SWR 1.6 to 1 or better at band edges.
- Hustler exclusive trap covers "Spritz" extruded to otherwise unattainable close tolerances assuring accurate and permanent trap resonance.
- Solid one inch fiberglass trap forms for optimum electrical and mechanical stability.
- Extra heavy duty aluminum mounting bracket with low loss—high strength insulators. Mounting hardware included.
- All sections 1¼" heavy wall, high strength aluminum.
- Stainless steel clamps permitting adjustment without damage to the aluminum tubing.
- Guaranteed to be easiest assembly of any multi-band vertical.
- Antenna has ⅜"-24 stud at top to accept RM-75 or RM-75-S Hustler resonator for 75 meter operation when desired.
- Top loading on 75 meters for broader bandwidth and higher radiation efficiency!
- Feed with any length 50 ohm coax.
- Power capability—full legal limit on SSB or CW.
- Mounting: Ground mount with or without radials, or roof mount with radials.

Length: 21' 5"
MODEL 4-BTV

Weight: 15 lbs.
Price: $99.95

This NEW MFJ Super Antenna Tuner . . . matches everything from 160 thru 10 meters: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balance lines, coax lines. Up to 200 Watts RF OUTPUT. Built-in balun, too!

With the NEW MFJ Super Antenna Tuner you can run your full transceiver power output — up to 200 watts RF power output — and match your transmitter to **any** feedline from 160 thru 10 Meters whether you have coax cable, balance line, or random wire.

You can tune out the SWR on your dipole, inverted vee, random wire, vertical, mobile whip, beam, quad, or whatever you have.

You can even operate all bands with just one existing antenna. No need to put up separate antennas for each band.

Increase the usable bandwidth of your mobile whip by tuning out the SWR **from inside your car.** Works great with all solid state rigs (like the Atlas) and with all tube type rigs.

Quality five way binding posts are used for the balance line inputs (2), random wire input (1), and ground (1).

It travels well, too. Its ultra compact size 5x2x6 inches fits easily in a small corner of your suitcase.

The secret of this tiny, powerful tuner is a wide range 12 position variable inductor made from two stacked toroid cores and high quality capacitors manufactured especially for MFJ. For balanced lines a 1:4 (unbalanced to balanced) balun is built-in. Made in U.S.A. by MFJ Enterprises.

This beautiful little tuner is housed in a deluxe eggshell white Ten-Tec enclosure with walnut grain sides.

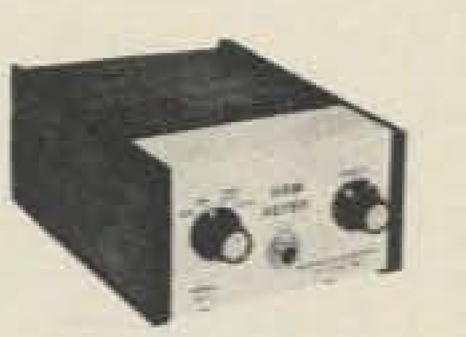
SO-239 coax connectors are provided for transmitter input and coax fed antennas.

Price: $69.95

THE HAM-KEY
NOW 5 MODELS

Dealer Programs NOW Available

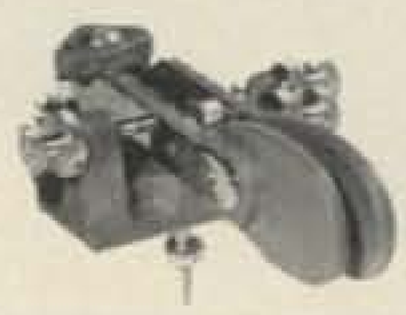
NEW MODEL HK-5 ELECTRONIC KEYER
$69.95



- Iambic circuit for squeeze keying.
- Self completing dots & dashes.
- Dot memory.
- Battery operated with provisions for external power
- Built-in side-tone monitor.
- Speed, Volume, tone & weight controls.
- Grid-block or direct keying.
- Use with external paddle such as HK-1.

Model HK-1 $29.95

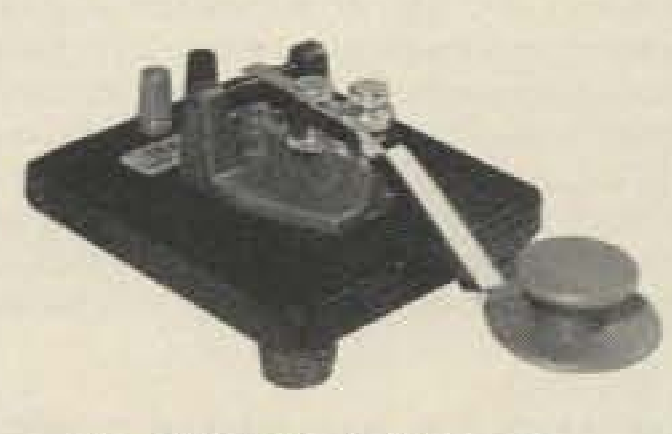
- Dual lever squeeze paddle.
- Use with HK-5 or any electronic keyer.
- Heavy base with non-slip rubber feet.
- Paddles reversible for wide or close finger spacing.



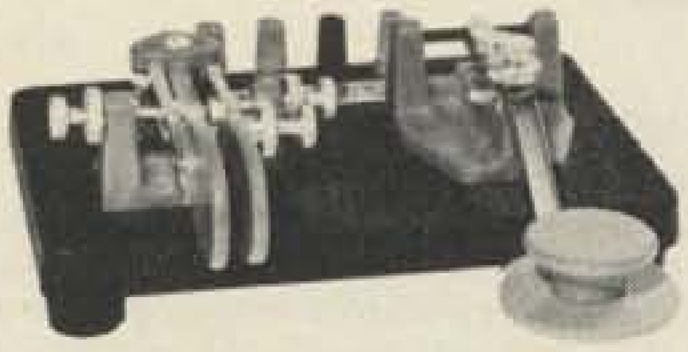
Model HK-2 $19.95

- Same as HK-1, less base for those who wish to incorporate in their own Keyer.

Model HK-3 $16.95



- Deluxe straight key.
- Heavy base, no need to attach to desk.
- Velvet smooth action.



Model HK-4 $44.95

- Combination on HK-1 & HK-3 on same base.

This Digital Alarm Clock is also an ID Timer. Assembled, too!

You can get an ID buzz every 9 minutes (up to one hour). Simply set the alarm time to the beginning of your QSO. Then tap the ID/doze button.

You can also set the alarm to the exact minute to remind you of a SKED or simply to wake you up in the morning automatically every 24 hours (no need to remember every night to set the alarm).

Four large .63 inch digits provide precise time to the minute. Seconds appear at the touch of the ID/doze button.

Pressing the ID/doze and fast set buttons reset and hold the seconds to zero for precise setting to WWV until the fast set button is released.

The separate AM or PM LED indicators blink at a 1 Hz rate if the power goes off momentarily. For longer power outs it resets to 12:00 AM and the AM LED blinks.

Setting the time and alarm is simple and fast with the fast and slow set buttons. Even the XYL will find it fun.

110 VAC, 60 Hz. 3-1/8 x 3-3/4 x 3-3/8 inches. One year warranty.

Price: $19.95

400% MORE RF POWER
PLUGS BETWEEN YOUR MICROPHONE AND TRANSMITTER

$49.95

LSP-520BX. 30 db dynamic range IC log amp and 3 active filters give clean audio. RF protected. 9 V battery. 3 conductor, ¼" phone jacks for input and output. 2-3/16 x 3-1/4 x 4 inches.

$59.95

LSP-520BX II. Same as LSP-520BX but in a beautiful 2-1/8 x 3-5/8 x 5-9/16 inch Ten-Tec enclosure with uncommitted 4 pin Mic jack, output cable, rotary function switch.

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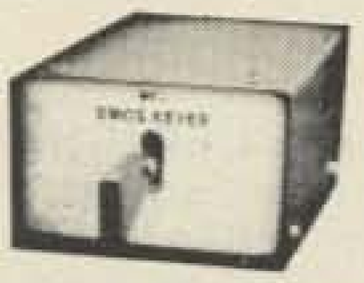

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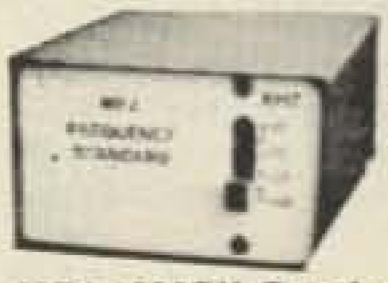

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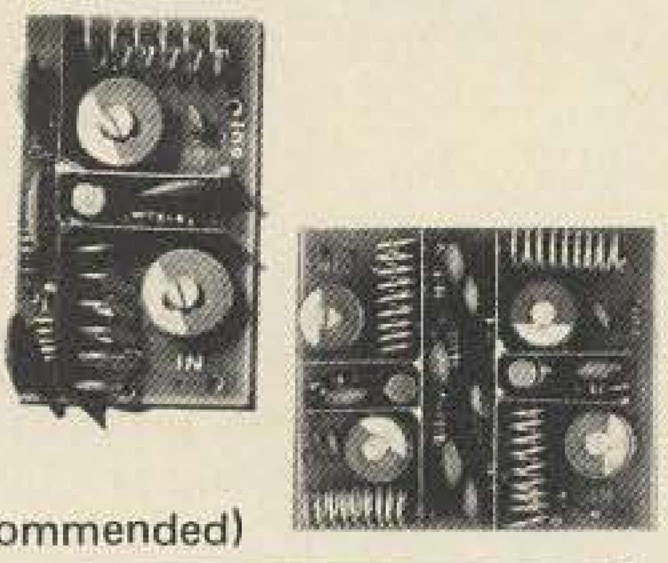

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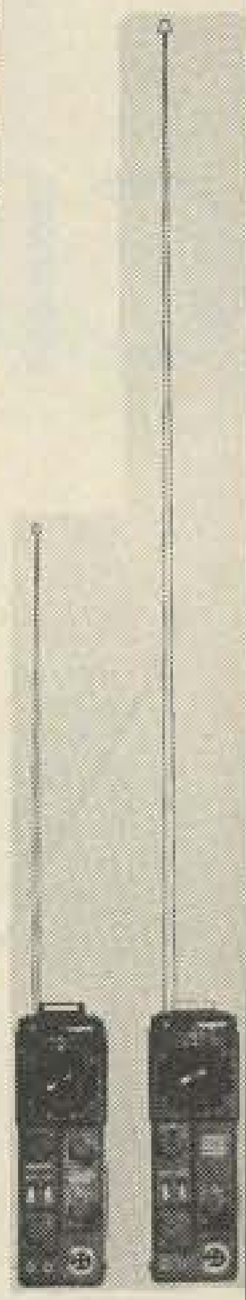

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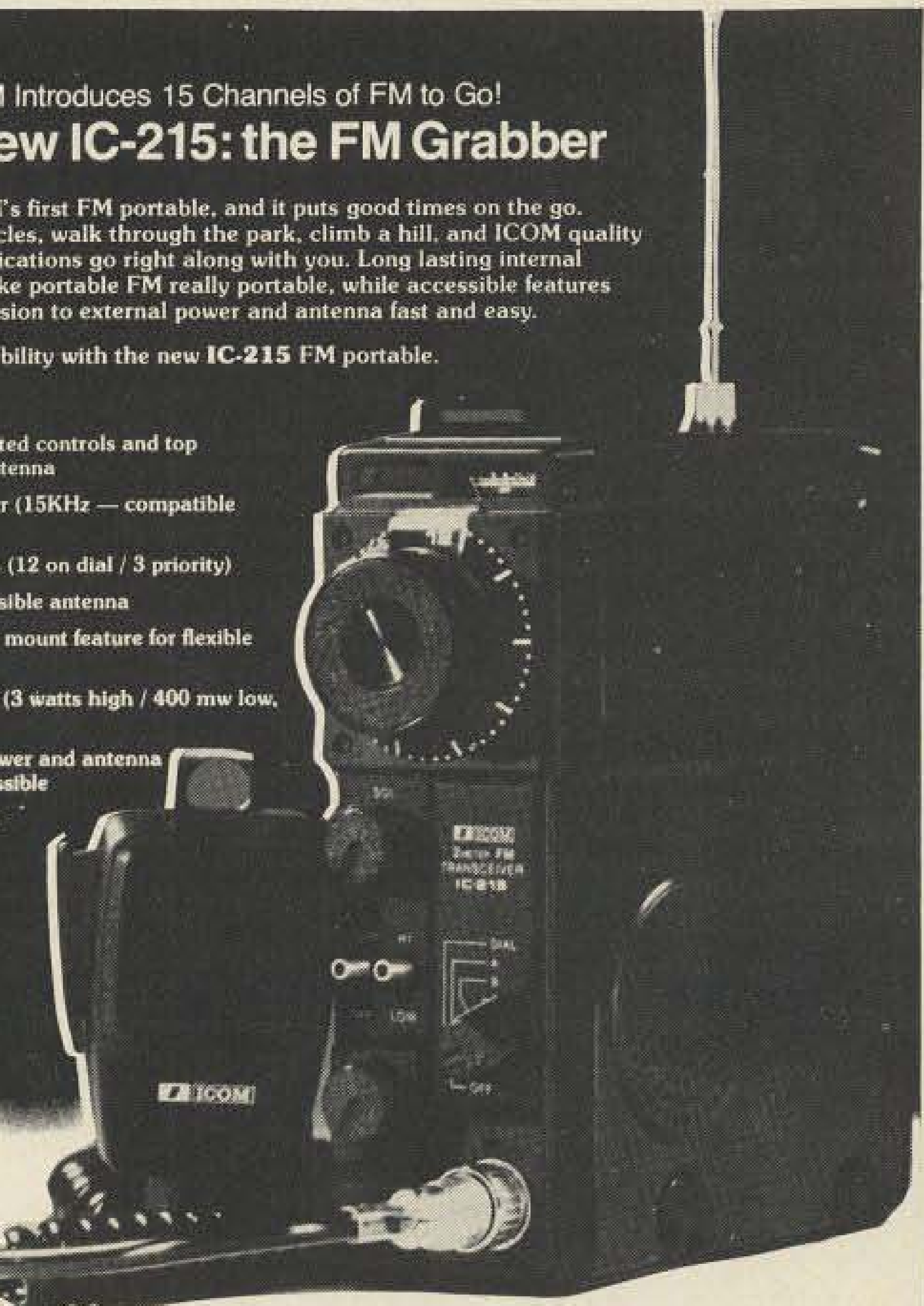

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TUFTS RADIO CATALOG TUFTS RADIO

73 Magazine Staff

Clean Up Your Act

-- with accurate SSB monitoring

One of the common things in most ham shacks in the old AM days was an off-the-air modulation monitor. Not much was required to construct such a diode receiver monitor, and it allowed one to obtain a final check on the sound of the transmitter's modulation. Such monitors cannot be so easily constructed for SSB monitoring because of the need to reinsert a carrier signal at the transmitter frequency to provide demodulation with a product detector. However, there are several points in the SSB transmitter modulation chain where one can monitor the signal to check for modulation quality using relatively simple circuitry. Ideas for such monitoring are described in this article, as well as circuits for off-the-air SSB modulation monitoring.

As shown in Fig. 1, there are two points within an SSB transmitter where the audio can be monitored and provide some useful information. The first point is after the microphone amplifier, just before the audio is fed into the balanced modulator. Any sort of simple audio isolation stage, such as that shown in Fig. 2(a), can be used to couple into the output of the microphone amplifier stage(s). Headphones can be used for monitoring, or a simple module-type audio amplifier can be used after the isolation stage for further amplification.

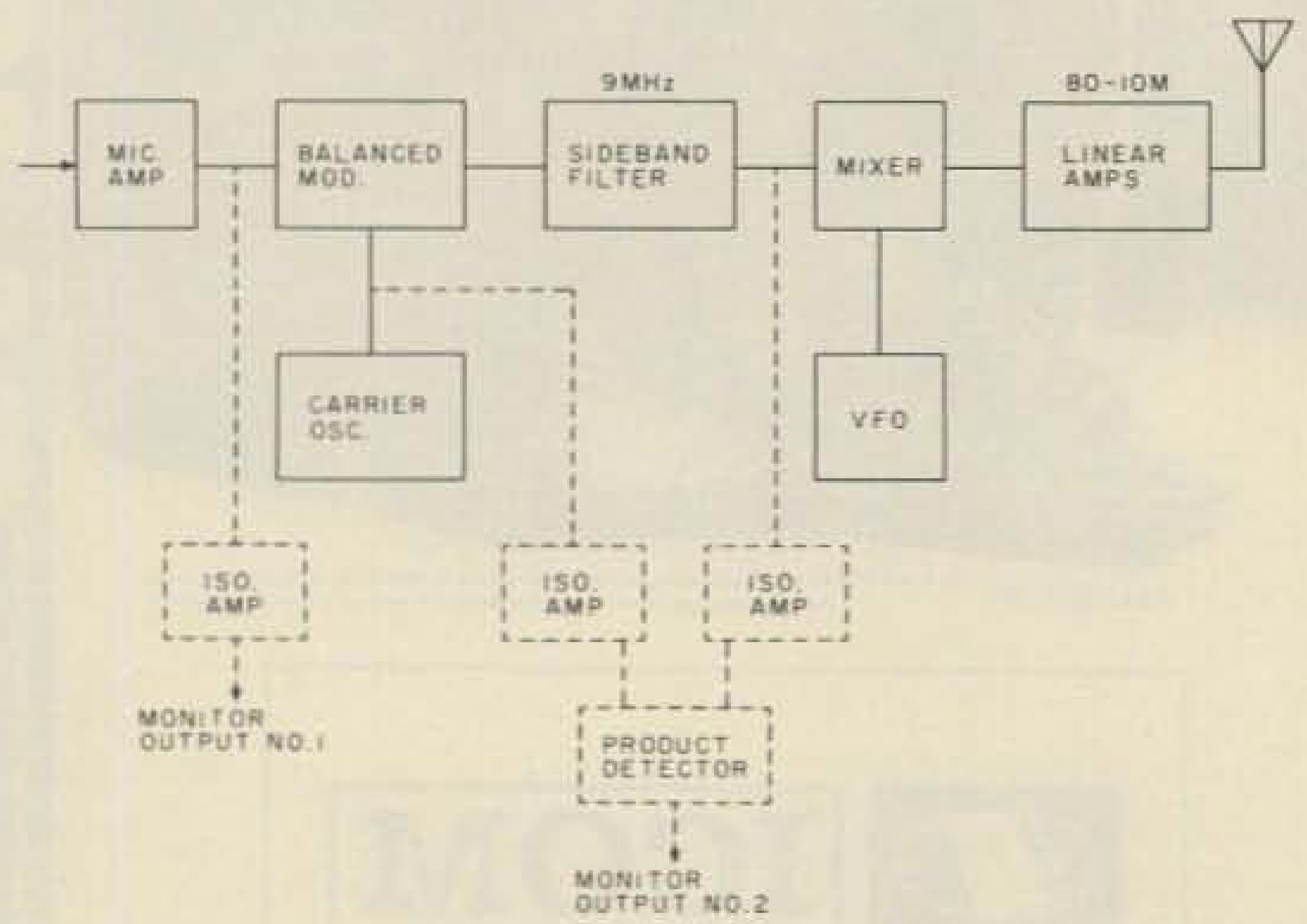

Fig. 1. Typical SSB transmitter block diagram showing two possibilities for audio monitoring.

Monitoring at this point is useful to check the settings on external audio processing equipment that may be used with a transmitter. It is not true modulation monitoring, of course, since the modulation process has not yet taken place. Much more useful information about modulation quality can be obtained, however, if one can access the second point shown in Fig. 1.

This is the point in the SSB generation chain after the sideband filter and just before the stage which translates the SSB generation frequency to a frequency within an amateur band. Monitoring at this point will give an indication of what the signal sounds like after audio processing and SSB generation has occurred. A bit more work is required, however, in that one must obtain a sample of the SSB signal and a sample of the carrier oscillator signal used for SSB generation and then go through a product detector for demodulation.

The circuit is not complicated, and a typical arrangement is shown in Fig. 2(b). An FET isolation stage is used to couple into the SSB signal chain and to the SSB carrier oscillator. The outputs of the stages go into a dual-diode product detector, and the resultant audio signal can be further amplified by any conventional means. The inputs to the isolation amplifier should be kept short and made with shielded wire. If the layout of components in a transmitter is too spread out to allow this, one could use separately installed FET source follower stages to sample the SSB signal and oscillator signal at the appropriate points in the transmitter. Then run shielded wire to the product detector/audio amplifier, which may be located internally or externally to the transmitter. The point to watch is that the monitoring circuitry does not allow the carrier oscillator signal to be coupled around the sideband filter and degrade the carrier suppression of the transmitted signal.

The ultimate way to monitor an SSB signal is, of course, off the air. There are several ways one can go about this, depending upon how much one feels it is worth and whether one just wants a spot monitoring capability or a continuous monitoring capability.

One obvious way to accomplish it, for those who use transceivers, is to buy a separate receiver. At first this may appear a fatuous statement, but there are available moderately priced portable radios which cover the shortwave bands. Adding a dual-diode product detector and a small bfo to them is relatively simple. A bigger problem, however, is their unshielded construction. In the presence of a transmitter, or if rf from the antenna is getting into the shack, they can be easily overloaded and provide a completely false indication of modulation quality. Some individual experimentation is necessary to get such a monitoring receiver to work. But, with shielding and/or experimenting with location, they can work nicely.

A single-frequency, off-the-air monitor can be constructed by combining a crystal oscillator with a product detector. Such a monitor is only good for audio checks at one point within a band. But, if the tuning and loading of a transmitter remain the same over the rest of the band one uses, there should be no reason for the audio quality to change. One such circuit, called the "Sideband Sniffer" by G3OGR, was described in the December, 1972, issue of *73*. Fig. 3 is a slightly modified version of the circuit. Fundamental mode crystals are used, and it can be used on any band for which a proper crystal can be obtained. The LC circuit in the 2N706 collector circuit needs to be resonated in the band being used. The oscillator signal from the oscillator is spotted using a transceiver in the receive mode, and then the transceiver can be monitored on transmit. The 200 pF BC-type variable allows a slight "rubbering" of the crystal to facilitate monitoring. The unit should be constructed in a shielded enclosure and just enough antenna used to get a clean audio output.

Although it was not tried, it should be possible to develop a multiband monitor along the "Sniffer" line without having to bandswitch a tuned circuit. An untuned Pierce crystal oscillator, followed by several stages of untuned amplification, should be sufficient to develop enough injection voltage for the product detector.

Going back again to Fig. 1, there are some transmitters, such as the 9 MHz SSB generation-type, which allow another method of simple, continuous off-the-air modulation monitoring. A few oscillator voltages have to be "borrowed" from the transmitter, and an external mixer circuit is necessary. Rf pickup is made of the transmitted signal, and this signal is combined with the vfo signal taken from the transmitter to produce a 9 MHz i-f signal. The 9 MHz i-f signal and a signal from the transmitter's carrier oscillator are fed into a product detector in the manner shown in Fig. 2(b).

It may seem that some of the foregoing has emphasized too strongly the limitations or difficulties of getting a monitoring scheme to work. This was meant as a help, rather than a discouragement. It is probably difficult for newcomers to realize the benefits of being able to monitor your own modulation. However, once you do have a suitable scheme working, you will quickly add it to your list of things that your station cannot do without. ■

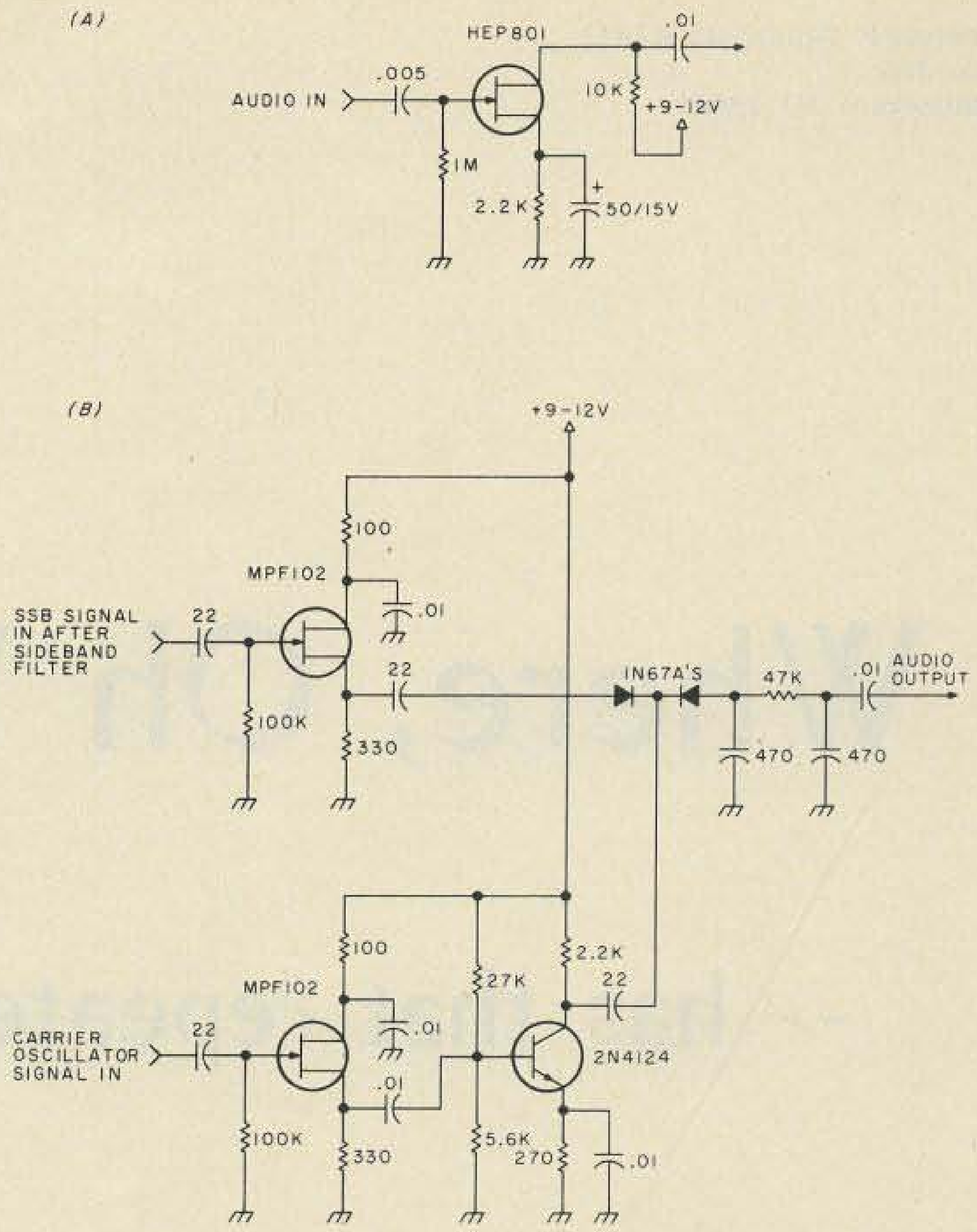

Fig. 2. Simple audio monitoring isolation stage (a). Part (b) shows isolation stages and product detector for monitoring after sideband filter transmitter.

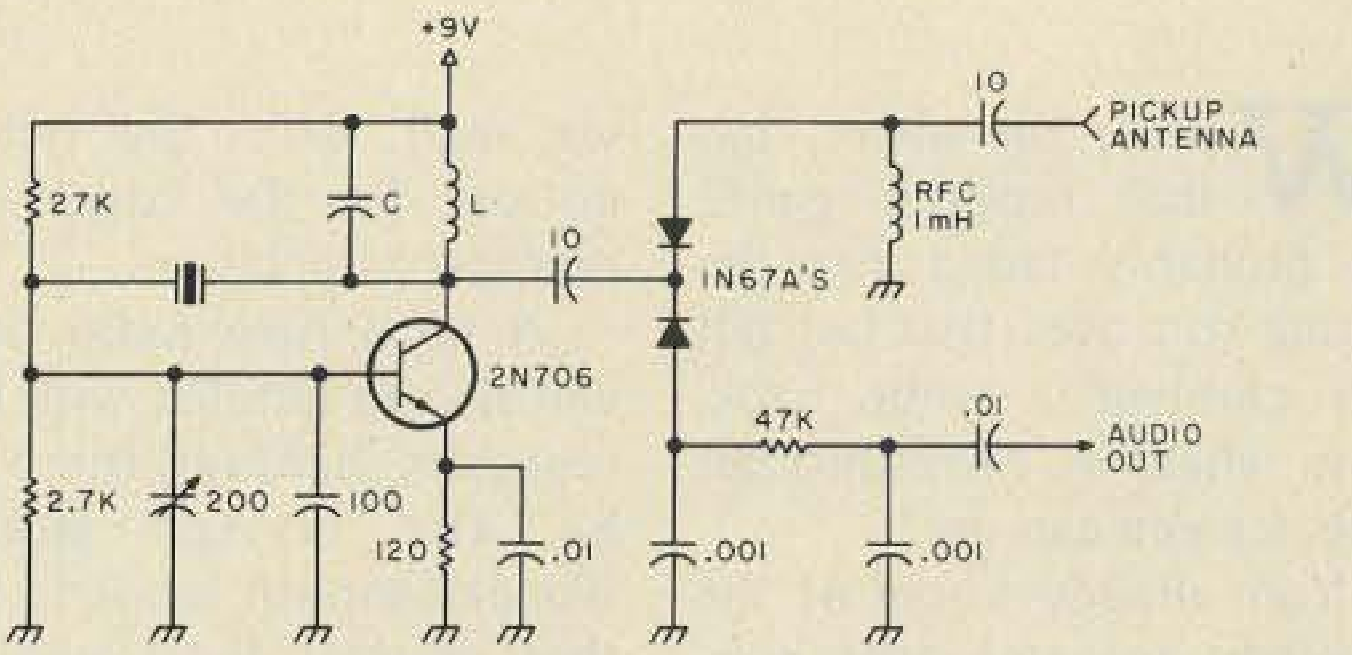

Fig. 3. Slightly modified version of G3OGR's "Sideband Sniffer."

Looking West

from page 20

Linking Service/Westlink Radio Network, and is a direct outgrowth of the understanding by a group of area amateurs that hams wanted to know what was going on and the best place to get this information to them was by radio. Out of this need and understanding has come the Westlink Newstape Service, free to all *repeaters* that furnish C-60 tape cassettes in SASE mailers.

It all happened at once. The report and order on repeater/remote deregulation, the unfortunate sudden illness of ARRL Southwestern Division Director John Griggs, the Personal Communications Foundation seminar, and a myriad of other things that the magazines with their two-month lead time are now just getting into. *HR Report* has done an admirable job in trying to keep up with all this, but two facts stand out. Space devoted to any given item in *HR Report* is limited by virtue of the publication's format, and not every amateur gets *HR Report.* How do you bring the feelings of the non-repeater operator to the attention of all amateurs? In the case of deregulation of repeaters, it would be almost a moot point by the time you read it here or in *QST*. But Westlink went to the average "Joe Ham" non-repeater person through its correspondent in Houston, Texas, and brought the feelings and ideas of the SSB operator on two meters to the forefront. When Charles Higginbotham of the FCC, Harry Dannals of the ARRL, and Lou McCoy of the ARRL's VRAC were at the recent Santa Maria ARRL Southwestern Division Convention, so were two Westlink reporters (armed with cassette tape recorders) to garner their views on the prime topic of the day.

The newstapes follow this format. First a QST callup, followed by a lead story, and so on. About every four minutes, there is a pause preceded by the cue line, "This is Westlink." During this five-second pause, a system has the opportunity to identify in order to meet FCC requirements (as of November 4, under new FCC regulations, the IDs have been spaced farther apart). Topics are covered one at a time, and wherever possible, either those making the news or experts on the topic under discussion are interviewed. No editorialization takes place, as this is better left for the printed page. And, as I said, to those repeaters supplying cassettes and prepaid addressed mailers, the service is free.

Continued on page 141

Thomas R. Sundstrom W2XQ
Box 205
Willingboro NJ 08046

Where, Oh Where

-- has that repeater gone ?

Where, oh where, has that repeater gone? It's probably faded into the setting sun over that last hill you climbed a while back. Now what? Is there another repeater you can use?

You already know of the excellent repeater atlas published by *73*. Can we improve on that? Yes, to a limited extent.

Other Sources

For better or worse, the ARRL publishes an annual repeater directory. The volume is not very useful because it does not adequately site the repeaters it does list, but recent editions do contain a few repeaters that have escaped the eagle-eyed staff at *73*.

Other sources of information could be your area frequency coordinator or a local ham radio outlet. Around here, the coordinator provides a by-frequency listing of repeaters, active and proposed, which is distributed via mail with the renewal notices for the largest area repeater association.

A local ham radio outlet will also be familiar with local repeaters because those will be the crystals stocked. Word-of-mouth tends to keep that counter list up-to-date.

As the *73 Repeater Atlas* continues to grow, the usefulness of these other sources will diminish. Depending upon the amount of time you have, it is worthwhile to run a quick check just in case.

Mapping Repeaters

The *73 Repeater Atlas* is the only volume that attempts to locate two meter repeaters on a state map. The volume of listings is immense and, no matter what precautions are taken, some errors are bound to creep in.

Rather than beat up the atlas in local use, mark up a road map. Most of us travel by car in a regional area, and a road map or two is always handy.

I found some relatively uncluttered road maps offered by the American Automobile Association, but no doubt some oil companies offer easy-to-read maps as well.

Both state and regional maps are useful in this exercise. With a fine-tipped felt pen — picking a visible color that is *not* used in the printing of the map — put the output frequencies on the map. Drop the prefix "146" or "147."

Those output frequencies with the suffix starting with a 6, 7, 8, or 9 have inputs in the 146 MHz range, and those commencing with a 0, 1, 2, or 3 have inputs in the 147 MHz range. The one exception is codification of either "40/00" or "60/00" for a repeater with an output on 147.00 MHz.

In the New York City area, all the 1 MHz splits except one have outputs in the 146 MHz range. With outputs ranging from .415 to .50, I coded the one exception with an "L" — for "low in" — tagged to the output.

In locating each repeater on the state or regional map, you will find a few problems. Sometimes the repeater location given in one of the listings doesn't correlate with a town or city, as the former may be known by a local "popularized" name. In such cases, use a conventional atlas and the *Radio Amateur Callbook* and site the repeater by the town or city given in the *Callbook*. In most cases, you'll be pretty close.

Advantages

This activity sounds more complicated than it really is. I marked up maps for the New York City/Long Island area, Pennsylvania, New Jersey, Delaware, Maryland, and the area around Washington DC in two hours or so.

From the base station, this homework was useful to actually learn where some of these far-distant repeaters are located, so that, with a beam antenna and when needed, my operational range could be extended. It is useful to learn about relatively unknown, quiet, open repeaters. Too often, many repeaters stand unused while a few of the larger "mouths" carry so much traffic that no decent conversation can be conducted. It's nice to be able to go off to one of the smaller repeaters — assuming you are out of simplex range — where your business can be conducted without "break . . . break."

By the way, it's not a bad idea when coming on a new repeater to ask for the control operator and check out your operating guidelines and the length of the timer. Some machines are "closed," unfortunately, so ask.

In the car, a knowledge of the smaller repeaters can be a boon. The larger repeaters cover a wide area and the odds of carrying on a conversation or getting directions diminish inversely with the radius of the grade A signal.

I have consistently found better directions and a willingness to help in solving a problem, or just to carry on a conversation, off on one of the local area repeaters.

In coding the map, I included all repeaters . . . even the closed ones. If I need directions in a particular spot and the closest repeater is denied to me because I lack the tone burst or PL tone, I just go reverse; the simplex range is good for 5 or 10 miles even in the worst terrain.

Conclusion

The road maps are useful in traveling and you'll have the entire repeater picture at a glance while picking your way around a locale on a weekend trip, or if you are a traveling salesman covering a territory.

If driving across country, this exercise may be of less value to you, but keep it in mind for any area that you intend to spend a few days in. Some of the motorist clubs offer strip road maps taking you from point A to point B, and these could be premarked with repeater outputs to save time.

There's one last benefit from this. You'll find some duplicates in the various repeater directories listing the same repeater under different towns, and you'll find some obvious typos on frequencies. Make a list of the problems and note the corrections, if known. If the problem is with the *73 Repeater Atlas*, send up the corrections for the next edition.

The *73 Repeater Atlas* is the most comprehensive listing around, and the staff should be commended for its attention to detail. The marked-up road maps just solve two problems — directions and repeater locations — quickly and easily. ■

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Power Supply Regulation

- - using common sense

Have you ever wondered why there are so many articles written on power supplies? Did you ever start building a new supply project only to discover that you don't happen to have a fifty Watt zener or a 19.5 volt center-tapped transformer? If these problems sound familiar to you, you must have read some of the same articles I have. The building of power supplies seems to have a deep cloak of mystery around it matched only by UFOs, ESP, and the contents of that hamburger you had for lunch! C'mon guys, they're really not that hard to understand. Don't QRT on me now. You don't have to be an engineer to understand how those little black boxes work. Read on and you'll see that common sense is all you really need to build a good regulated power supply.

Fig. 1 is a circuit that you've seen over and over again. It is the basis of numerous regulator designs in hobby publications. The circuit consists of a power transistor, a zener diode, and one current limiting resistor for the zener. The output of a filtered rectifier is applied to the collector of QI as well as the base via the limiting resistor RI. The zener diode clips the voltage at the base at a value called the zener voltage. This zener voltage appears at the base of QI. The output voltage at the emitter will be very close to the zener voltage, only differing about .7 volt. You can see that as we draw a heavy current from the emitter, the base voltage is held constant by the zener diode. Since the base voltage isn't changing, the output voltage doesn't either. This is the basis of operation of a transistor voltage regulator. Simple! Isn't it?

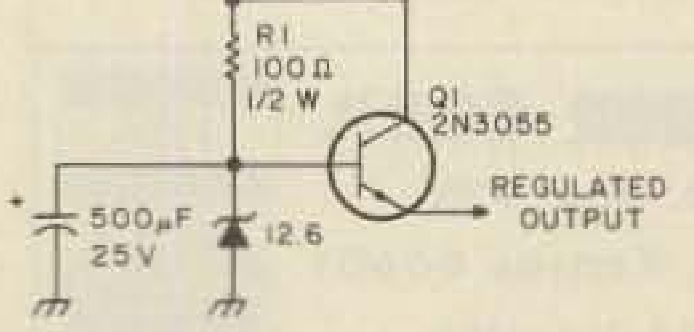

Fig. 1. Most often used regulator is the zener referenced pass transistor. This system lacks regulation at moderate currents.

The circuit of Fig. 1 works quite well if you play by its rules. Since we're only using one transistor to regulate the voltage, the quality of our regulation is pretty much dependent upon the gain of the transistor. Audio power transistors are most often used in this application. These devices have a dc gain of 40 to 50.

At this point, you may be wondering why gain is so important. Well, the more gain a transistor has, the less base current required for a given load current. In other words, a transistor with very little gain will not supply much load current before its base starts drawing quite a bit of current. This is bad news. When we reach the point of drawing considerable base current, the base voltage drops across the current limiting resistor. If we continue the process, we reach a point where the voltage drops below the zener operating voltage. Naturally, when this happens we no longer have a regulator. To lessen this effect, a current limiting resistor is chosen to do two jobs. It must be high enough in resistance to protect the zener diode from overheating and, at the same time, it must be low enough so that the base voltage won't drop too low. As shown in Fig. 1, a value around 100 Ohms is generally used as a compromise. If you have followed me so far, you can see that a regulator such as Fig. 1 has some pretty serious disadvantages. Regulation gets pretty bad if we try to draw a moderate current. For example, let's use a 2N3055 for Q1. We'll use a 12.5 volt zener. With a very light load, regulation will be fairly good and our output voltage will stay around 12 volts. But if we draw 2 or 3 Amps through this regulator, the base voltage drops due to base current, causing a high voltage drop across R1. Bye-bye regulation. Since most of us need a regulator capable of delivering several Amps for TTL or two meter transceivers, something else is clearly in order. Enter the Darlington.

In the previous discussion we learned that the more gain a transistor has, the more output current it can supply without losing its regulation. Since one transistor can't supply enough gain, we can use two. A Darlington pair is just that – two transistors. A Darlington pair has very high dc gain – in the neighborhood of several thousand. As you remember, an audio transistor only has a gain of 50 or so. Fig. 2 shows a typical

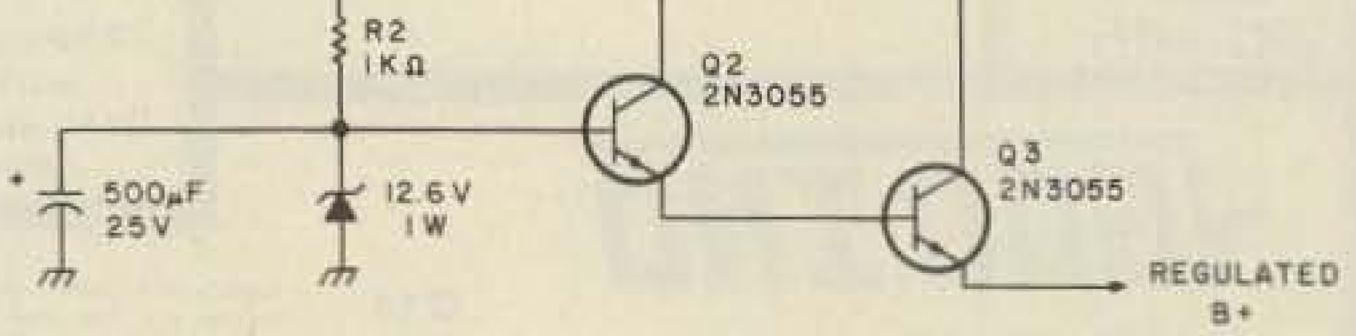

Fig. 2. The Darlington pair. With gain in the thousands, this circuit makes a very good high current regulator.

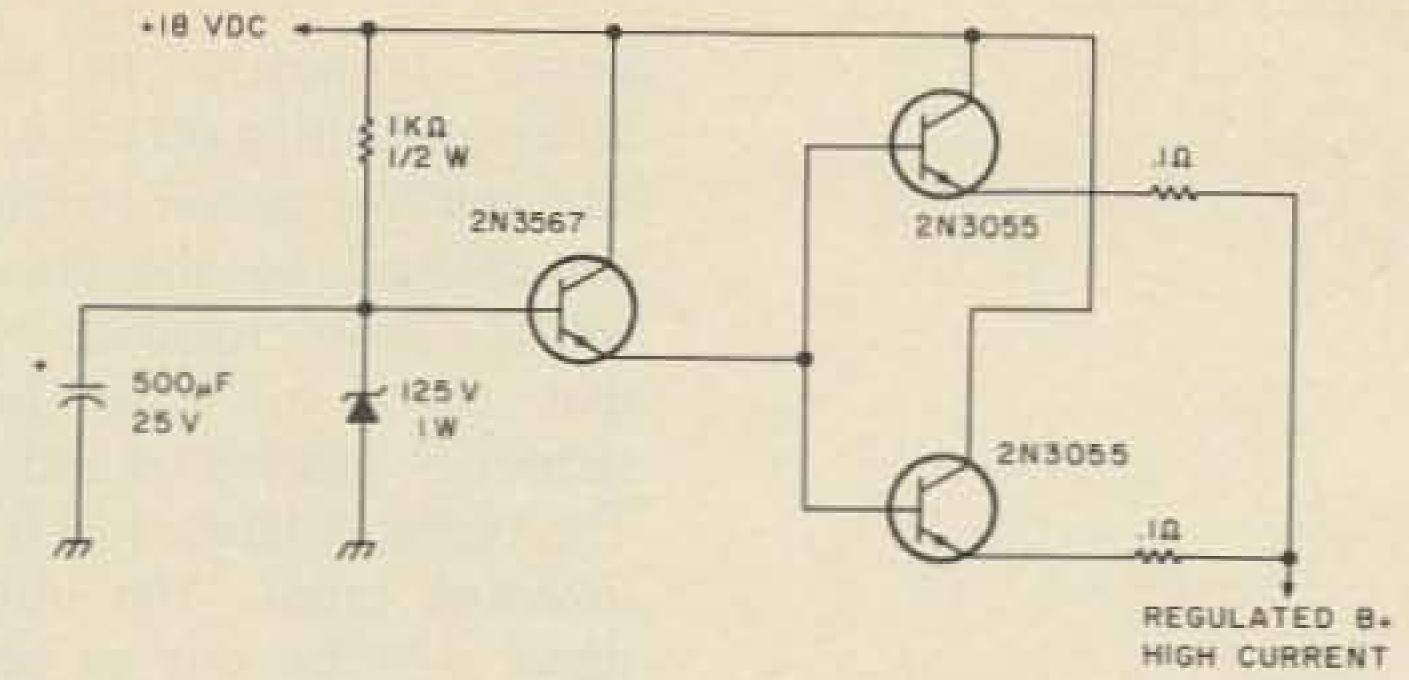

Fig. 3. A Darlington parallel arrangement. Currents approaching 10 Amps are possible with suitable pass transistors.

Darlington pair used as a voltage regulator. Q2 serves as the driver while Q3 handles the heavy current of the load. The collector current of Q2 is also the base current of Q3, since they are connected.

Since we have so much gain, we can use a fairly high resistance for R2 without affecting regulation. Since R2 is a fairly high value, our zener stays cool and does a better job of regulating. Using this Darlington arrangement allows us to draw several Amps of current while keeping the input base current of Q2 at a very small value. This in turn enables us to keep a cool zener. We get an added bonus from a Darlington. Putting a small value capacitor from the base of Q2 to ground adds additional filtering. This capacitance is multiplied by the gain of both transistors. If our capacitor is 500 uF and our total gain is 2000, the total effective filtering will be 500 times 2000, or a million uF. Yes, a million! That's a lot of filtering, and the dc will show it. As you can see, using a Darlington in place of a single pass transistor will give you as much as 5 Amps of power supply current while maintaining the output voltage at a few tenths of a volt. This is sufficient for most two meter rigs as well as most TTL projects. I'd like to make it clear that only the second transistor of the pair must be heat sunk. At a load current of several Amps, the driver only has to handle a few milliwatts of power. By using several Darlingtons in parallel, load currents in excess of 10 Amps are possible. Fig. 3 shows two Darlington pairs in parallel with a single driver for high current applications.

The last bench supply that I built ended up as a mass of sticky goo because I had felt that current limiting wasn't necessary. After I cleaned up the mess, I decided that a simple means of limiting current was in order. The system would have to limit supply current to a safe value for a reasonable time in case of a direct short. Well, after looking over numerous current limiter designs, I was ready to give up. Most of them used seven or eight transistors and required critical adjustments. There had to be a better way. There was.

A very effective current limiter can be made from one transistor. Fig. 4 shows the circuit I ended up with. It's based on the principle that every silicon transistor has a .7 volt drop across its base emitter junction. Now if you were to sense a .7 volt drop at some critical current value, this voltage could be used to turn on a transistor which could disable the power supply by dropping its output voltage low enough to keep the pass transistor cool. This is exactly what's happening in Fig. 4. R5 determines the amount of output current that will shut down the power supply. Q10 requires .7 volt across its base emitter junction to switch on. All we have to do is find that value of resistance that will have a .7 volt drop at the value of current that we want to limit the supply to. Only one Ohm's Law problem is required, so don't get discouraged now. Using the example in Fig. 4, let's set the circuit up for a current limit of 3 Amps. As per Ohm's Law, 3 Amps and .7 volt would give us .233 Ohms as a value for R5. In other words, there will be a .7 volt drop across a .233 Ohm resistor when 3 Amps flow through it. Connecting each end of the resistor to the base and emitter junctions will turn this transistor on when the current value of 3 Amps is reached. When Q10 turns on, it removes the drive of the pass transistor, which drops output voltage to that value which permits only 3 Amps to flow. That's all there is to it. Whenever a dead short draws more than 3 Amps, the power supply current is instantly limited to 3 Amps and no more. The pass transistor can handle this kind of current for quite a long time, thus eliminating the need to clean up another sloppy mess.

I hope some of the ideas I have presented will make your next power supply more fun to build as well as use. The topics I have covered are not new in any way, nor are they original. They have been around for quite a while. I think you'll find, as I did, that the humble power supply still captures the home brewer's attention much as it did when radio was new. Have fun. ■

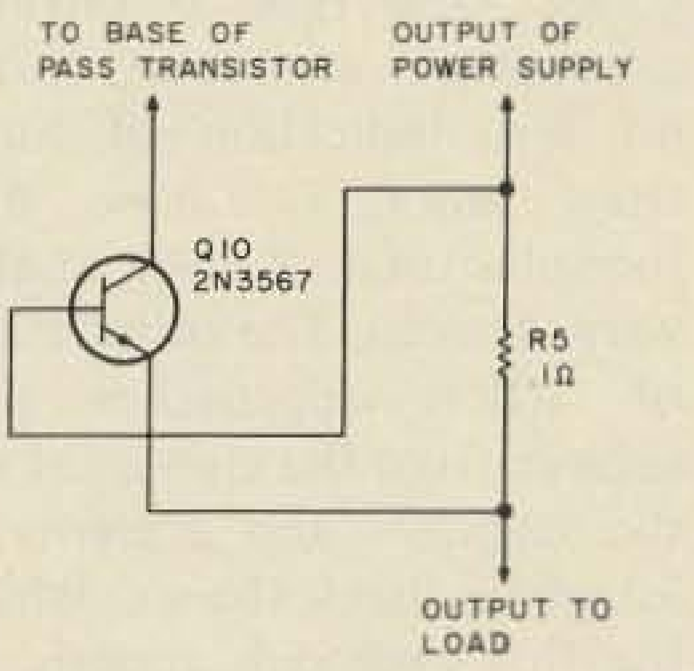

Fig. 4. A one transistor current limiter. R5 is chosen to produce a .7 volt drop across it when the desired current limit has been reached.

Looking West

rom page 137

Originally started by Jim Hendershot WA6VQP of Westlink and Wayne Rankin WA6MPG of the Los Angeles 220 Simplex Committee, the Newstape staff is now up to five, including Kent Marshall W5TXV of Houston, Texas, Otto Arnosht WA6RMX of Los Angeles, and, when time permits, yours truly. This does not count about another dozen or so contributors scattered all over the nation who provide additional input.

Further information on this new concept of news dissemination can be had by dropping a note to Westlink, 12731 Rajah Street, Sylmar CA 91342. For those wishing to contribute items for the service, this can be handled in one of two ways. If it's of a timely nature, you can call (213)-367-7228 after February 1 and leave a message of any duration on the answering machine that takes your call. As long as you keep talking, it will continue to take a message. For now, however, record your news item either on standard ¼-inch tape at 7½ ips or on a tape cassette, and send it to the above address. Be advised that if you want your tape returned, postage must be included. That's the Westlink story to date: amateurs of goodwill devoting their time and talents freely to all amateurs — and in this fast-paced day and age, that's almost a rarity.

NARC PLAN WINNING NATIONAL ACCEPTANCE

As more and more reports begin to filter in to us, it's beginning to look as if the 144.5 through 145.5 MHz band plan originated by California's Northern Amateur Relay Council is gaining in popularity nationally. As I said when I detailed it last month, to date it's the most sensible approach — other than perhaps translators — to populating this newly-released relay spectrum. In a note from Doug Barker WA4HQL, Georgia Repeater Frequency Coordinator, I have learned that they support this as well as the inverted tertiary plan for the upper two megahertz of two meters. Kent Marshall W5TXV, who visited Los Angeles this past week, informed me that the Central States Committee held a directors meeting by telephone and endorsed the NARC plan — with the proviso that the ARRL commit itself to obtaining Technician class privileges down to 144.0 MHz. He also told me that his area of Texas, coordinated by the Texas VHF Committee, has taken a different attitude

Continued on page 151

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Op Amp Insights

-- part I

In the amateur and hobbyist press, articles on operational amplifiers seem to fall into two distinct categories. One type is merely a collection of circuits with no real indication of how they work or how the formulas used (if given at all) were derived. The other class of article approaches the subject from the viewpoint of the engineer and presents a lot of feedback theory. While the first approach appeals to the casual tinkerer, and the other to the engineer's professional needs, they offer little to the middle-level amateur and hobbyist who wants more than the casual introduction to operational circuit design. In this article I will examine the gross properties of the operational amplifier and the derivation of the design equations using only Ohm's and Kirchhoff's Laws.

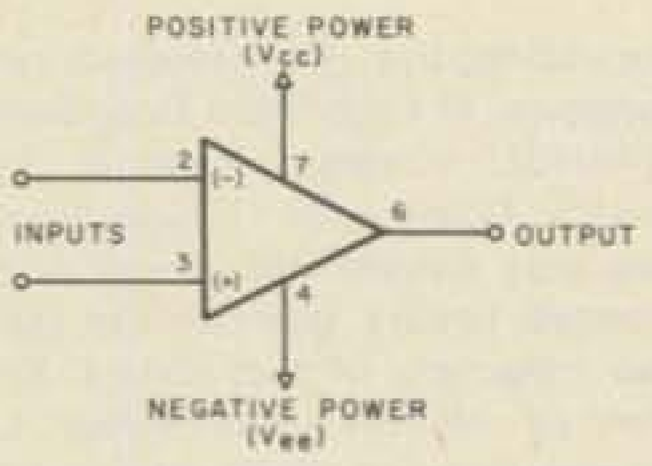

Fig. 1. Basic operational amplifier symbol. Note: Pin numbers are shown for the 741 minidip and metal can packages and are considered "industry standard," but check any non-741 minidips with the spec sheet before using.

One of the profound beauties of the IC operational amplifier is its simplicity when viewed from the outside. Of course, the internal workings are often very complex, but they need not concern us here. We examine the properties of the operational amplifier as if it were the proverbial black box, and that allows for a very simple analysis in which we relate the output voltage to the input voltage and how the op amp affects this relationship.

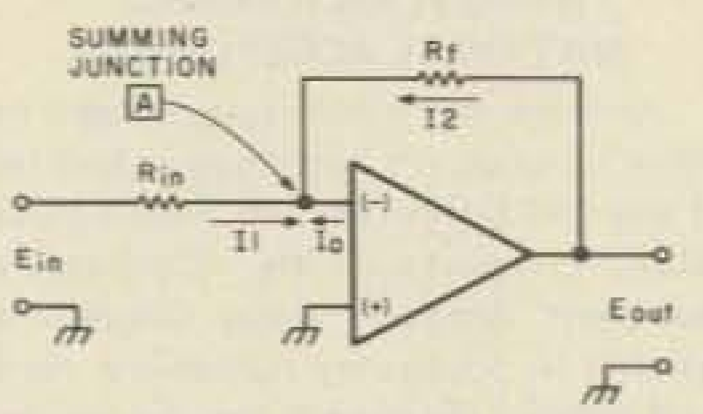

Fig. 2. An inverting follower circuit.

Ideal Op Amp Properties

An ideal operational amplifier is an IC gain block, or black box, that has the following general properties:

1. Infinite open-loop (no feedback) voltage gain (A_{vol} = infinity).
2. Infinite input impedance (Z_{in} = infinity).
3. Zero output impedance ($Z_{out} = 0$).

Of course, we do not seriously expect real operational amplifier IC devices to meet these ideal specifications, but, if we read "infinite" as very, very high, and "zero" as very, very low, our approximations are very nearly correct.

Differential Inputs

Fig. 1 shows the basic symbol for common operational amplifiers, including power terminals. In many schematics using op amps, the Vcc and Vee power terminals are deleted, so the drawing will be less crowded. Note that there are two input terminals, labeled (-) and (+). The terminal labeled (-) is the inverting input. The output signal will be out of phase with signals applied to this input terminal. The (+) input is a noninverting input, so output signals will be in phase with signals applied there. It is very useful to realize that these input terminals have equal open-loop gains, so they will have equal but opposite effects on the output voltage.

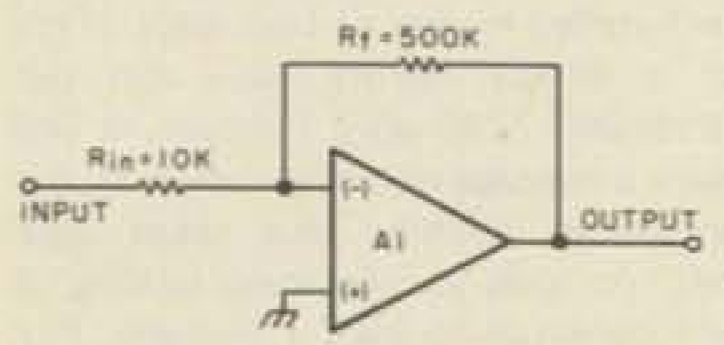

Fig. 3. Gain of 50 inverting follower.

At this point, let's add one further property to the list above: 4. Differential inputs tend to follow each other. This means that they will tend to behave as if they are at the same potential under static conditions. In Fig. 2 we see an inverting follower circuit in which the noninverting input (+) is grounded. The fourth property allows us to treat the inverting input as if it were also grounded. Many texts like to call this phenomenon a "virtual ground," but that is a term which merely serves to confuse. It seems better to accept as axiomatic that the (-) input will appear grounded if the (+) is really grounded, for purposes of calculations.

Using Kirchhoff and Ohm

We know from Kirchhoff's current law that the sum of all currents entering and leaving a point in a circuit must be zero. The total current flow into and out of point A in Fig. 2, then, must be zero. Three possible currents exist at this point: input

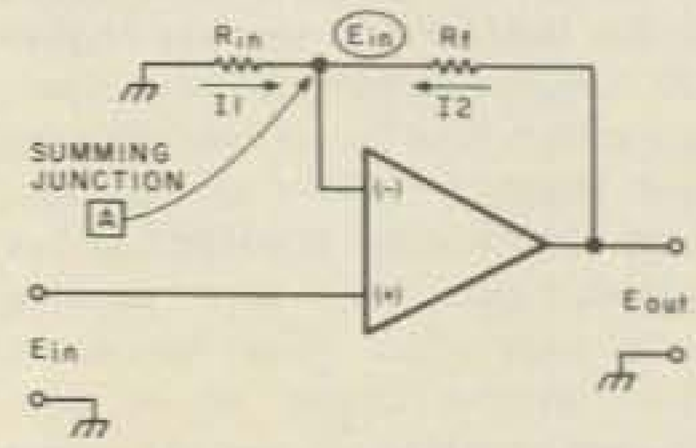

Fig. 4. A noninverting follower circuit.

current, I1; feedback current, I2; and any current flowing into or out of the (-) input of the operational amplifier, I_o. But, according to ideal property #2, the input impedance of this type of device is infinite. Ohm's law tells us that by:

$$I_o = E/Z_{in}, \quad (1)$$

current I_o is zero ($E/Z_{in} = 0$). So, if current I_o is equal to zero, we conclude that I1 + I2 = 0 (Kirchhoff's Law). Since this is true, then:

$$I2 = -I1. \quad (2)$$

We also know that:

$$I1 = E_{in}/R_{in}, \quad (3)$$

and:

$$I2 = E_{out}/R_f. \quad (4)$$

By plugging (3) and (4) into (2), we get:

$$I2 = -I1, \quad (5)$$

$$E_{out}/R_f = -E_{in}/R_{in}. \quad (6)$$

Solving for E_{out} gives us the transfer function normally given in op amp articles for an inverting follower amplifier:

$$E_{out} = -(R_f/R_{in}) \times E_{in}. \quad (7)$$

The term "R_f/R_{in}" is the voltage gain factor and is usually designated by the symbol A_v:

$$A_v = -(R_f/R_{in}). \quad (8)$$

Sometimes (7) will be written using (8):

$$E_{out} = -A_v E_{in}. \quad (9)$$

When designing simple inverting amplifiers using op amps (such as the low-cost 741 device), use equations (7) and (9). Let's look at a specific example. Assume that we want an inverting follower with a gain of, say, fifty. Furthermore, we want to drive this amplifier with a source that has an output impedance on the order of 1000 Ohms. By the rule of thumb normally used, we would want an input impedance of not less than 10k. This last requirement sets the minimum value of R_{in} at 10k Ohms.

$$A_v = R_f/R_{in}, \quad (10)$$

$$50 = R_f/10{,}000, \quad (11)$$

$$500\text{k Ohms} = R_f. \quad (12)$$

Our gain of 50 amplifier will look like Fig. 3.

Noninverting Followers

The inverting followers of Figs. 2 and 3 suffer badly from low input impedance, which is limited to the value of R_{in}. This problem becomes especially acute when we try to get even moderately high gains from low-cost devices. There are some costly IC operational amplifiers which will allow use of 0.5 - 1.0 megohm input resistances, but these are not altogether economical for amateurs. The noninverting follower of Fig. 4 remedies the input impedance problem nicely, because it has a very high (ideally, infinite, remember?) input impedance.

We can again resort to Kirchhoff's Law to derive the transfer equation from our four properties. By property #4, we know that the inputs will tend to follow each other, so the (-) input can be treated as if it were at the same potential as the (+) input, which is E_{in}, the input signal voltage. We know that:

$$I1 = I2, \quad (13)$$

$$I1 = E_{in}/R_{in}, \quad (14)$$

$$I2 = (E_{out} - E_{in})/R_f. \quad (15)$$

Plugging (14) and (15) into (13) results in:

$$I1 = I2, \quad (16)$$

$$E_{in}/R_{in} = (E_{out} - E_{in})/R_f. \quad (17)$$

Solving (17) for E_{out} gives us the transfer function normally given for a noninverting follower. Multiply (17) by R_f:

$$R_f E_{in}/R_{in} = E_{out} - E_{in} \quad (18)$$

Add E_{in} to both sides:

$$R_f E_{in}/R_{in} + E_{in} = E_{out} \quad (19)$$

Factor out E_{in}:

$$E_{in}\,[(R_f/R_{in}) + 1] = E_{out} \quad (20)$$

In this discussion we have arrived at both commonly given operational amplifier transfer functions, using only the four most basic defining properties of the device, Ohm's Law, Kirchhoff's Law, and an assumption that the operational amplifier is merely a feedback device that generates a current to cancel the input current. Fig. 5 gives a synopsis of the characteristics of the most popular operational amplifier configurations. The unity gain noninverting follower of Fig. 5(c) is a special case of the circuit in Fig. 5(b), in which $R_f/R_{in} = 0$. That makes the transfer equation equal to:

$$E_{in}\,(0 + 1) = E_{out}, \quad (21)$$

$$E_{in}\,(1) = E_{out}, \quad (22)$$

$$E_{in} = E_{out}. \quad (23)$$

Op Amp Power Supplies

Although almost every circuit using operational amplifiers published in one amateur publication has a power supply of single polarity, the device is designed to operate from bipolar supplies. The design policy above is given ostensibly so projects can be used in mobile applications, but, recognizing that the amateur world need not revolve around mobile operation, I prefer to use the power supply arrangement intended by the manufacturer. There are two power terminals on the IC op amp case marked "Vcc" and "Vee". The Vcc is to be connected to a supply that is positive to ground, while the Vee is to be connected to a source that is negative to ground. This is shown in Fig. 6. Keep in mind that, although batteries are shown, regular power supplies may be used as well. Typical values for Vcc and Vee range between ±6 V dc and ±18 V dc, with most being ±9, ±12, or ±15 V dc. There is also one further

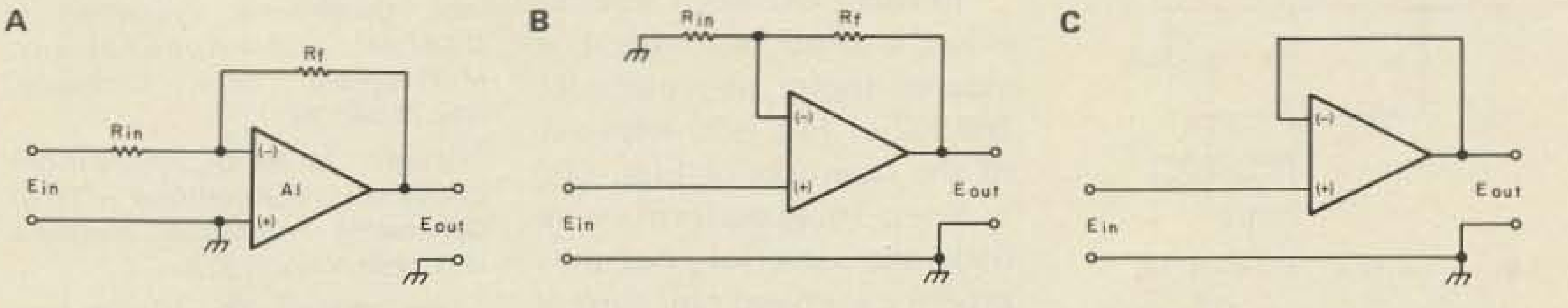

Fig. 5. Synopsis of op amp amplifier configurations: (a) inverting follower: $E_{out} = -E_{in}(R_f/R_{in})$. $Z_{in} = R_{in} \parallel R_f$. $Z_{in} \approx R_{in}$ (if $R_{in} < R_f$). Voltage gain: Open loop (A_{vol}): ∞; Closed loop (A_v): $-R_f/R_{in}$. *In real operational amplifiers, this is actually very high, not infinite. Values between 20,000 and more than 1,000,000 are typical, depending upon type; (b) noninverting follower with gain: $E_{out} = E_{in}\,[(R_f/R_{in}) + 1]$. $Z_{in} = \infty$ (well, almost); (c) unity gain noninverting follower: $E_{out} = E_{in}$. $Z_{in} = \infty$ (well, almost).*

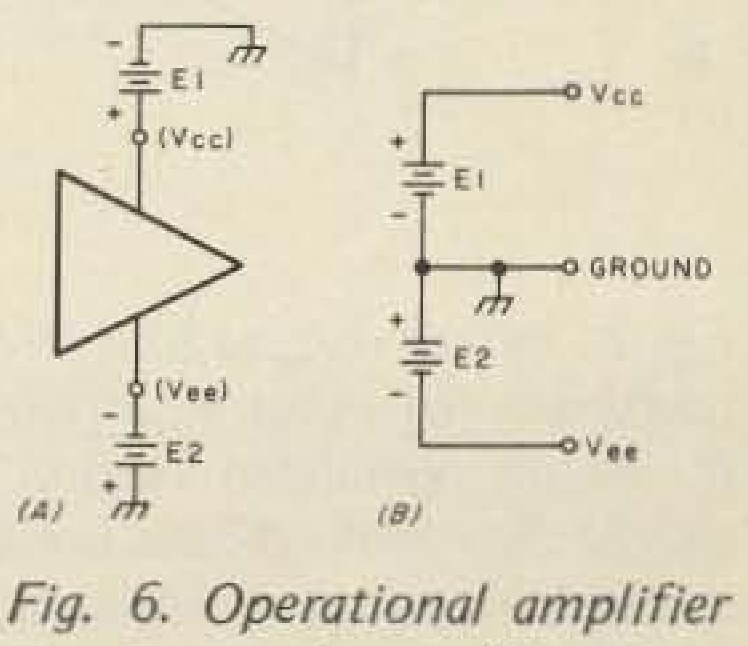

Fig. 6. Operational amplifier power supply configuration.

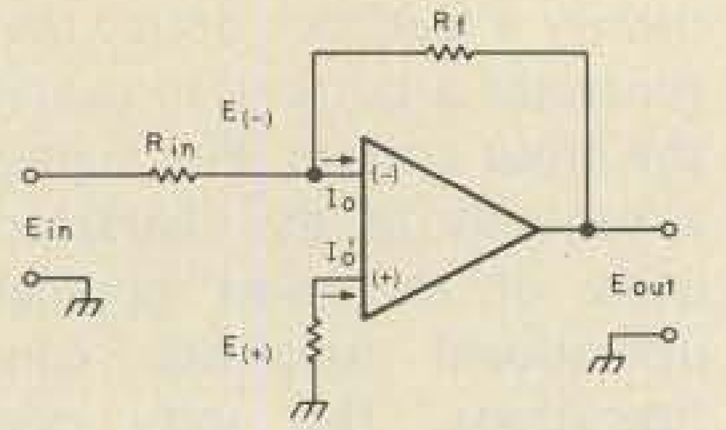

Fig. 7. Compensation resistor (R_c) is used to eliminate the effects of the offset currents. This resistor has a value equal to the parallel combination of R_{in} and R_f. $I_o = I_o'$; $E_{(-)} = (R_{in} - R_f)\, I_o$; $E(+) = R_c\, I_o'$; $E_{(-)} = E_{(+)}$.

restriction placed on some IC operational amplifier power supplies, and that is that Vcc - Vee must be less than some specified voltage, usually 30 volts. So, if Vcc is +18 volts, the maximum allowable value for Vee is 30 - 18 volts, or 12 volts, negative with respect to ground, of course.

Real Op Amps: Some Problems

Before we can apply IC operational amplifiers, we must learn to appreciate certain limitations placed on certain of the real-world devices. Operational amplifier ICs have price tags that vary from less than half a dollar to many dozens of dollars each. The 741 and those devices in the same family (747, 1458, 1456, etc.) typically sell for a dollar or less and are suited for most amateur applications. Three main problems exist: offset current, offset voltage, and frequency response.

In real op amp devices, the input impedance is typically very high, but it is nowhere near the infinite impedance of the ideal op amp. This implies, then, that a small current exists to flow either in or out of each input. In other words, I_o of Fig. 2 is not zero, so it will produce an output voltage equal to $-I_oR_f$. The cure, shown in Fig. 7, is to place a compensation resistor between the non-inverting input and ground. This works because the currents in the respective inputs (I_o and I_o') are approximately equal. Since resistor R_c is equal to the parallel combination of R_f and R_{in}, it will generate the same voltage drop as appears at the inverting input. The resultant output voltage is zero, because the two inputs have equal but opposite effects on the output.

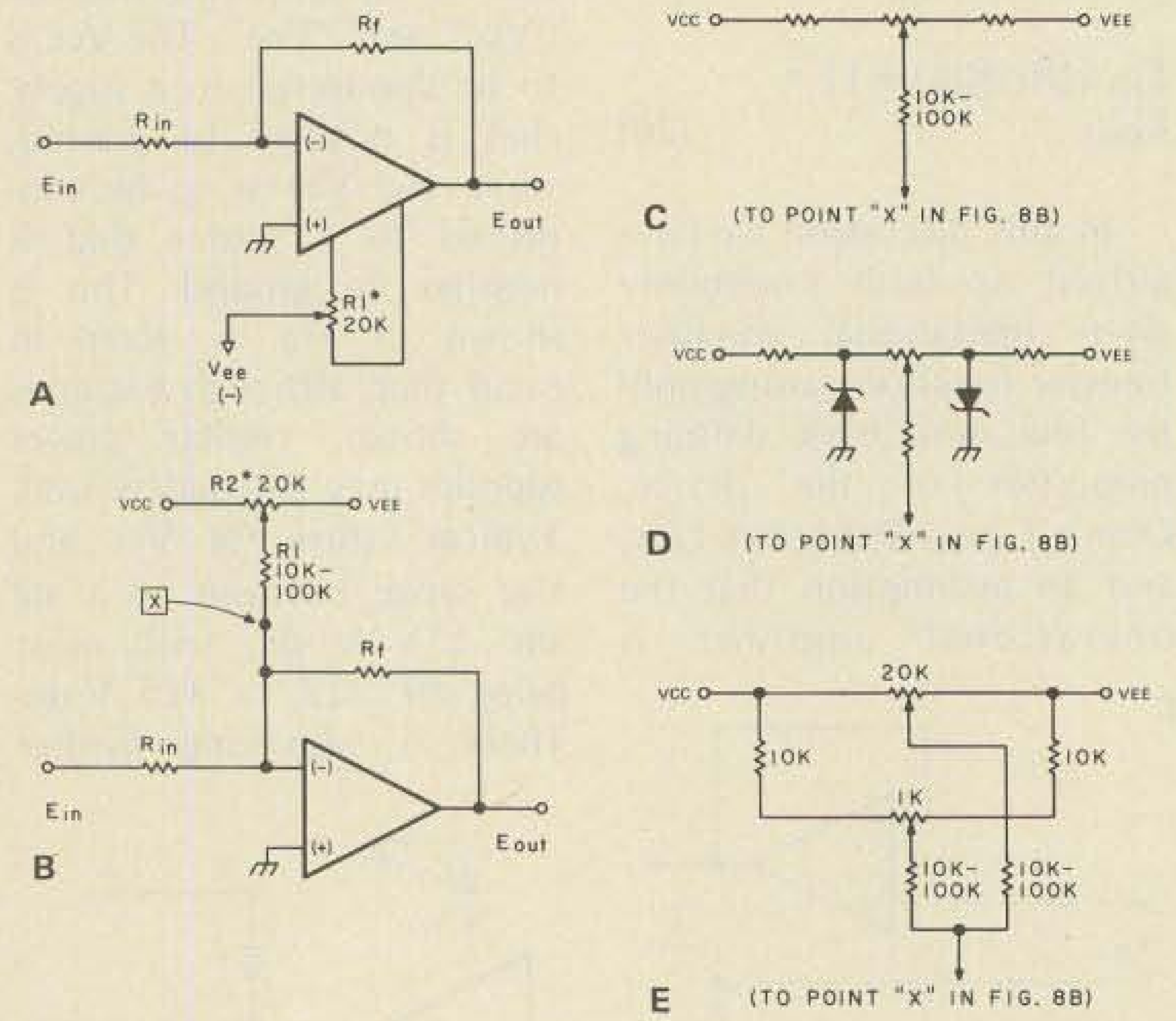

*Fig. 8. Offset voltage null circuits: (a) using the op amp's null terminals; (b) using a current applied to the inverting inputs; (c) better resolution version of (b) and (c), similar to (c), except that zener diodes are used; (e) use of two parallel null controls to produce coarse and fine adjustment. *Should be 10-turn trimpot.*

Output offset voltage is the value of E_{out} that will exist if the input end of R_{in} is grounded ($E_{in} = 0$). In the ideal device, E_{out} would equal zero, but, in real devices, there may be some offset voltage present. This output potential can be forced to zero by any of the circuits in Fig. 8.

The circuit in Fig. 8(a) uses a pair of offset terminals found on many operational amplifier ICs. Many IC op amps use this technique, but, for those which lack the terminals, we may use the circuit of Fig. 8(b).

The offset null circuit of Fig. 8(b) creates a current flowing through resistor R1 to the summing junction. The offset current may flow into or out of the op amp input, so the null control must be able to supply currents of either polarity. Because of this requirement, the ends of potentiometer R2 are connected to Vcc and Vee.

In many cases, it is found that the offset is small compared with normally expected values of E_{in} and E_{out}. This is especially true of low gain circuits, in which case the nominal offset current will create such a low output error that no action whatever is taken. In still other cases, the offset of each stage in a cascade chain may be small, but their cumulative offset, when multiplied by the gain of succeeding stages, is large. In that situation, it is usually sufficient to null only one stage late in the chain, possibly the output stage, or the stage that contains any gain or "sensitivity" controls that might be used.

In those circuits where the offset is small but critical, it may be useful to replace R1 and R2 of Fig. 8(b) with one of the networks of Figs. 8(c) to 8 (e). These perform essentially the same job, but they produce a limited null current range for a large change of potentiometer setting. That is to say, they have smaller range but greater resolution per turn, provided that a ten-turn potentiometer is used. In the example of Fig. 8(c), the total resistance of the network is approximately the same as in Fig. 8(b), but most of it is taken up in fixed resistors. Although these are shown as 10k Ohms in the figure, it is frequently necessary to experiment with these values and the value of the potentiometer in order to optimize performance. The circuit of Fig. 8(d) is essentially the same as that of Fig. 8(c), except that a pair of zener diodes are used to set the lower voltages appearing at the ends of the potentiometer. In most cases, these diodes will have equal zener voltage ratings, but, in some instances, there are needs for different positive and negative extremes.

The last circuit, shown in Fig. 8(e), uses two null networks. One is for coarse and the other for fine adjustment of the null. The coarse control is not unlike that of Fig. 8(b), while the fine more closely resembles Fig. 8(c). The coarse control is used to bring the offset into the ball park when the fine control is set to the approximate middle of its range. The fine control is then varied to optimize the null. ■

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PREAMPS

HIGH GAIN • LOW NOISE

30 dB power gain, 2.5-3.0 dB N.F. at 150 MHz, 2 stage, R.F. protected, dual-gate MOSFETS. Manual gain control and provision for AGC. 4-3/8" x 1-7/8" x 1-3/8" aluminum case with power switch and your choice of BNC or RCA receptacles. Available factory tuned to the frequency of your choice from 5 MHz to 350 MHz with approximately 3% bandwidth. Up to 10% B.W. available on special order. Requires 12 VDC @ 10 mA.
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20 dB MIN. POWER GAIN

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HF & VHF
40 dB GAIN 2.5-3.0
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2 RF stages with transient protected dual-gate MOSFETS give this converter the high gain and low noise you need for receiving very weak signals. The mixer stage is also a dual-gate MOSFET as it greatly reduces spurious mixing products — some by as much as 100 dB over that obtained with bipolar mixers. A bipolar oscillator using 3rd or 5th overtone plug-in crystals is followed by a harmonic bandpass filter, and where necessary an additional amplifier is used to assure the correct amount of drive to the mixer. Available in your choice of input frequencies from 5-350 MHz and with any output you choose within this range. The usable bandwidth is approximately 3% of the input frequency with a maximum of 4 MHz. Wider bandwidths are available on special order. Although any frequency combination is possible (including converting up) best results are obtained if you choose an output frequency not more than 1/3 nor less than 1/20 of the input frequency. Enclosed in a 4-3/8" x 3" x 1-1/4" aluminum case with power and antenna transfer switch and your choice of BNC or RCA receptacles. Requires 12 VDC @ 25 mA.
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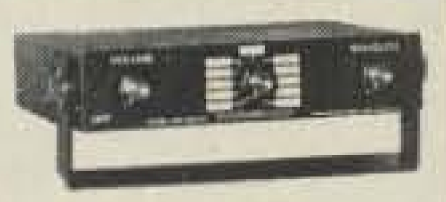
Prices include .005% crystal. Additional crystals $8.95 ea.

UHF
20 dB MIN. GAIN
3 TO 5 dB MAX N.F.

This model is similar in appearance to our Model 407A but uses 2 low noise J-FETS in our specially designed RF stage which is tuned with high-Q miniature trimmers. The mixer is a special dual-gate MOSFET made by RCA to meet our requirements. The oscillator uses 5th overtone crystals to reduce spurious responses and make possible fewer multipliers in the oscillator chain which uses 1200 MHz bipolars for maximum efficiency. Available with your choice of input frequencqes from 300-550 MHz and output frequencies from 14-220 MHz. Usable bandwidth is about 1% of the input frequency but can be easily retuned to cover more. Requires 12 VDC @ 30 mA.
Model 408 price $59.95
.005% crystal included

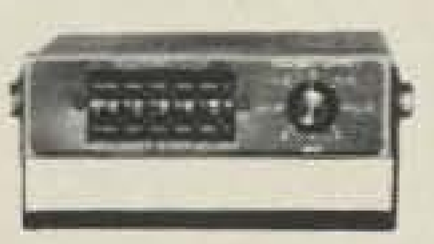
VHF RECEIVER



11 crystal controlled channels. Available in your choice of frequencies from 135-250 MHz in any one segment from 1-4 MHz wide. I.F. bandwidth (channel selectivity) available in your choice of ±7.5 kHz or ±15 kHz. 8 pole quartz filter and a 4-pole ceramic filter gives more than 80 dB rejection at 2X channel bandwidth. Phase locked loop detector. Frequency trimmers for each crystal. .2 to .3 microvolt for 20 dB quieting. Dual-gate MOSFETS and integrated circuits. Self-contained speaker and external speaker jack. Mobile mount and tilt stand. Aluminum case, 6" x 7" x 1-3/8".
Model FMR 260-PL price:
135-180 MHz $149.95
181-250 MHz $159.95
Price includes one .001% crystal. Additional crystals $8.95 ea. This receiver is recommended in Dr. Taggart's Weather Satellite Handbook.

SYNTHESIZERS

FOR ALL TRANSCEIVERS



The STR series synthesizers are available for any transceiver operating from 20 MHz to 475 MHz that uses crystals in the 5 to 85 MHz range. It has a thumbwheel dial calibrated for your operating frequency plus a selectable transmit offset of plus or minus 600 kHz, plus or minus 1 MHz, and 2 spare offsets that you can add later. Frequency accuracy is .0005% and spurious outputs are 60 to 70 dB down. To process your order we must have the crystal formula of your transmit and receive crystals. If your transceiver uses 1 crystal for both transmitting and receiving (like the Motorola Metrum II), you can use our receive synthesizer described to the right. Maximum tuning range per synthesizer is 10 MHz above 100 MHz and proportionally less at lower frequencies. Dial increments are in 1 kHz steps from 5 to 30 MHz and 5 kHz steps above.
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Price: Model SR-140D-05 .... $179.95

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BY MAIL: Send your order to Vanguard Labs, 196-23 Jamaica Avenue, Hollis, NY 11423 and include remittance by postal money order, cashiers check or certified check. Personal checks are also accepted, but banks now require 3 weeks for checks to clear, therefore this will delay your order. Include sales tax if you reside in New York State.
PURCHASE ORDERS: We accept purchase orders from US and Canadian government agencies, universities, and AAA rated corporations. Our terms are Net 30 days.
FOREIGN ORDERS: Must remit payment in full in US funds plus postage and insurance fees. If complicated customs forms are required, please forward your order to an import-export agent.
SHIPPING: We ship all our merchandise by insured parcel post or air mail. Special delivery is also available. Prices include shipping by regular parcel post if you remit with your order. For air mail shipping add $1.00. Postage will be added on all CODs, purchase orders, and foreign orders.

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Home Brew An Elephant!

John W. Kuivinen WB6IQS
3426 Duke Ave.
Claremont CA 91711

Cal Poly's award-winning 1977 microprocessor-equipped Rose Parade entry was aided by amateur radio. It's not easy to move a sixteen-foot high, forty-foot long, thirteen-ton elephant from Cal Poly University at Pomona to Pasadena's Rosemont Pavilion. The twenty-seven mile trip required a month of planning and special permits from all the cities along the way.

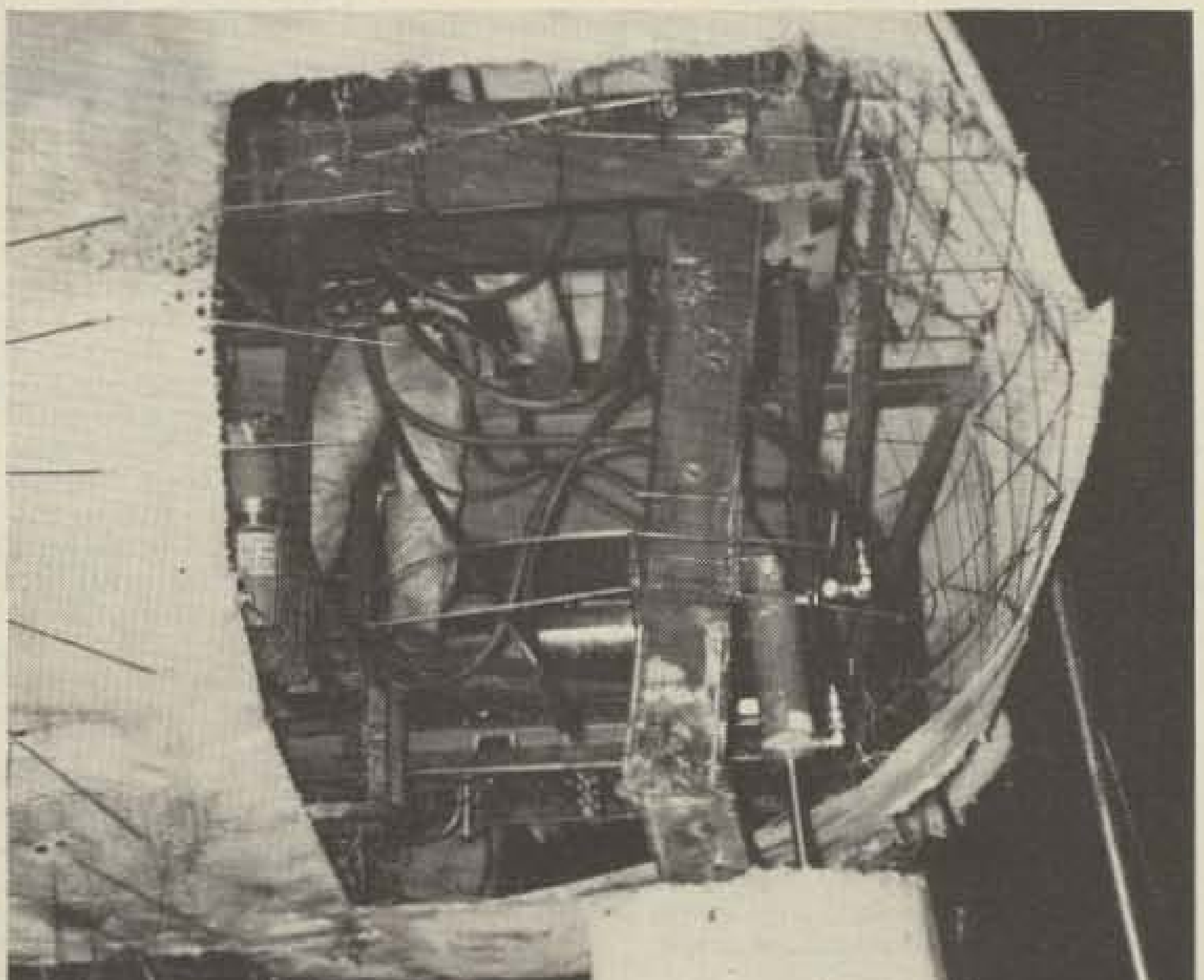
The move was aided by local hams in the long trek to the final assembly site. WR6ACD hams volunteered for the "duration," leaving Pomona on December 23, 1976, about 1:00 am and arriving in Pasadena at 8:30 am. Numerous breakdowns and difficulties with the hydraulic system delayed the arrival of the float until the early morning rush hour was well under way. The hams used 94 simplex to keep communications between the police escort, float, and convoy vehicles.

Many donations were necessary to make this float a reality. The two front legs were loaned by Northrop Aviation and were originally designed to be F-5E landing gear for a jet fighter. Rockwell International donated a set of PPS-4 microprocessor chips and developmental hardware to use in controlling the animation and monitoring the instrumentation on the float. There is a very long list of donors for the 1977 Rose Float; it would be impossible to list them all.

The project was entirely a student-run volunteer effort by the joint campuses of Cal Poly Pomona and San Luis Obispo. Most of the flowers were grown on the campuses

Hams needed for the move to Pasadena. The sign says "Hams do it with more frequencies."

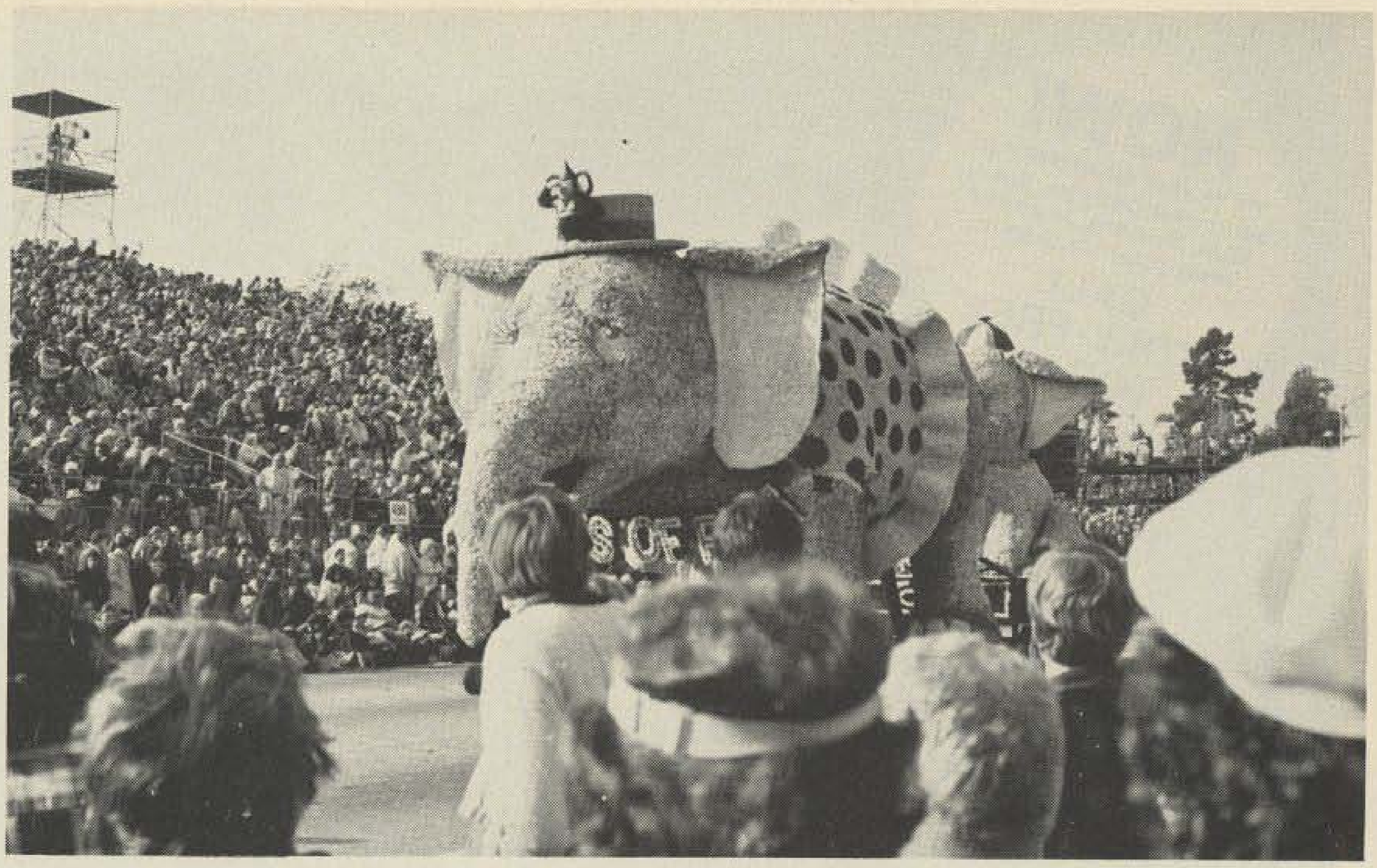
Access door to the operator's positions.



Construction of the mother elephant's hip.

and money was raised by the students through the sale of flowers, raffle tickets, and various community activities.

The float was unique in several ways. One: There was not a pod under the elephant. In most floats, the pod hides the main drive motors and supports the structure; however, Cal Poly's entry had the legs standing directly on the ground. The main drive power was through hydraulic motors in the rear legs with the front legs used to steer. Two: The forty-five second animation sequence was controlled by a system containing the microprocessor, a Master Animation Controller (MAC), and manual controls. The float used limit switches for feedback to signal the end of a particular unit's travel.



Mother elephant and baby going down the parade route.

The animation was very complex, requiring twenty channels of information, including motions for both elephants' heads, eyes, and ears, the mother's trunk, the baby's legs, and both propellers on the baby. Originally, the plans called for the mother elephant to roller skate down the parade route. Joints were placed at the shoulders, hips, and knees for hydraulic rams to be activated by a series of programmed leg motion commands to simulate a kind of smooth walking motion. Unfortunately, the lack of time and suitable hydraulic equipment prevented these motions from being completed.

Many thanks to the following hams: WA6CYY, WA6HFF, WB6EAP, WB6BKA, WA6UZP, WB6 OOQ, and WA6RJN. ■

Social Events

ROYAL OAK MI
JAN 8

The Oak Park Amateur Radio Club's Ninth Annual Swap n' Shop will be Sunday, January 8, 1978, at the Frost Junior High School in Oak Park (north of Nine Mile on Scotia). Talk-in on 52/52. Admission is \$2 – ample table space. Hours are from 8 am to 3 pm. Prizes and refreshments. For further into, write to: Lee Ricelli WA8RNB, 118 South Pleasant, Royal Oak MI 48067.

SOUTH BEND IN
JAN 8

A Swap & Shop will be held January 8, 1978, at the New Century Center in downtown South Bend by river on U.S. 31 Oneway North across from St. Joseph Bank Building. Half acre in one large room at ground level of entrances and loading dock. Four lane highways to door from all directions. Talk-in on 52-52 and area repeaters.

RICHMOND VA
JAN 15

The Richmond, Virginia, Winterfest will be held on January 15, 1978, at the Bon Air Community Center, sponsored by the Richmond Amateur Telecommunications Society. ARRL coordinated. Technical symposium, drawing, home brewers contest – 2 divisions, over 18 and under – with framed certificate to winners with Most Original Idea, Best Mechanical and Best Electrical Construction. FCC exams will be administered, starting at 10 am – to take exam, mail Form 610 at least five days prior to Fest to address below. Send SASE if you need Form 610. Commercial exhibits, indoor flea market, \$2.00 (table included), outdoor frostbite tailgate flea market, \$1.00. Admission \$2, children under 12 free. RATS members excluded from contest and drawing. Talk-in on 28-88 and 52 simplex. Richmond Amateur Telecommunications Society, PO Box 1070, Richmond VA 23208.

WAUKESHA WI
JAN 21

The 6th Annual Midwinter Swapfest of the West Allis Radio Amateur Club will be held Saturday, January 21, 1978, starting at 8 am, at the Waukesha County Expo Center. Directions: I-94 to Waukesha Co. F, south to FT, west to Expo Center. Tickets are \$1.50 in advance, \$2.00 at the door; reserved tables are \$1.50 in advance. Write: WARAC, PO Box 1072, Milwaukee WI 53201.

FORT WAYNE IN
JAN 22

The annual Fort Wayne Winter Hamfest will be held on January 22 at Shiloh Hall, north of Fort Wayne, from 8 am until 4 pm local time. Early parking is available and 28/88 and 52/52 will be monitored. This yearly event is sponsored by the Allen County Amateur Radio Technical Society (AC/ARTS). Admission is \$2.00 at the door. Table space is available at \$1.50 per half table (about 4 feet).

WHEATON IL
FEB 5

The Wheaton Community Radio Amateurs will hold their 16th Annual Midwinter Swap & Shop on Sunday, February 5, 1978, from 8 am to 5 pm, at the DuPage County Fairgrounds on Manchester Road (near County Farm Road) on the west side of Wheaton, Illinois. Some tables will be provided, but bring your own if possible. The WCRA invites anyone with an interest in buying or selling new or used electronic equipment to attend this hamfest, which will be inside four large heated buildings at the fairgrounds. Advance tickets (available until January 23) are \$1.50, and tickets at the door are \$2.00. Checks should be made payable to the club. Write Don Snyder WB9VFC, 623 Meadows Boulevard, Apartment 3C, Addison IL 60101.

Oscar Orbits

Oscar 7 Orbital Information

Orbit	Date (Jan)	Time (GMT)	Longitude of Eq. Crossing °W
14311 Bbn	1	0038:32	65.2
14324 Bbn	2	0132:50	78.8
14336 Abn	3	0032:10	63.7
14349 Bbn	4	0126:27	77.3
14361 Bbn	5	0025:48	62.1
14374 Abn	6	0120:05	75.7
14386 Bbn	7	0019:26	60.5
14399 Bbn	8	0113:43	74.1
14411 Abn	9	0013:03	59.0
14424 Bbn	10	0107:21	72.6
14436 Bbn	11	0006:41	57.4
14449 Abn	12	0100:58	71.0
14461 Bbn	13	0000:19	55.8
14474 Bbn	14	0054:36	69.4
14487 Abn	15	0148:53	83.0
14499 Bbn	16	0048:14	67.9
14512 Bbn	17	0142:31	81.4
14524 Abn	18	0041:51	66.3
14537 Bbn	19	0136:09	79.9
14549 Bbn	20	0035:29	64.7
14562 Abn	21	0129:46	78.3
14574 Bbn	22	0029:07	63.2
14587 Bbn	23	0123:24	76.7
14599 Abn	24	0022:45	61.6
14612 Bbn	25	0117:02	75.2
14624 Bbn	26	0016:22	60.0
14637 Abn	27	0110:40	73.6
14649 Bbn	28	0010:00	58.4
14662 Bbn	29	0104:17	72.0
14674 Abn	30	0003:38	56.9
14687 Bbn	31	0057:55	70.5

John Pilson K1UZ
PO Box 27
Saunderstown RI 02874

Transistor Primer

I have found that, in many cases, hams are unaware how transistors really work. Although it might only be necessary in some cases to memorize what an NPN or a PNP transistor looks like, understanding how they work can be extremely beneficial.

This article should help the beginner who does not have much of an inkling of how these solid state devices perform their magic. It will not go into all those fancy names like CMOS, MOSFET, etc. I chose not to do this for only one basic reason, and that is that I do not have the knowledge, at this time, to get into a full-fledged highly technical article on this subject.

Don't stop reading now and put this article off, unless you know your stuff about transistors. You Novices and would-be Novices, pay attention. There are a few questions on the higher class exams relating to transistors, so it might pay to refresh yourself before you take the "big step."

The Transistor

In a transistor of common variety, there are three elements which do the work. They are the emitter, the base, and the collector. If it helps you, these correspond to the cathode, grid, and plate of a vacuum tube. Thus, the terms of tube amplifiers have corresponding transistor terms; e.g., grounded grid becomes grounded base, cathode follower becomes emitter follower, and so on.

The transistors we are dealing with are of two basic types, NPN and PNP. They are shown in Fig. 1. As can be seen, the only difference between NPN and PNP drawn schematically is the direction of the little arrow inside the transistor. This arrow points *opposite* to the direction of current flow, which is shown in the circuit by the two arrows outside the transistor.

How They Work

Take a look at Fig. 2(a). It shows a transistor (NPN in this case) amplifying the sound from the microphone and delivering it to a speaker. The power source is a battery, with the polarity marked.

What happens in this circuit is that, when activated, the microphone *pulls* electrons from the base region in this transistor, allowing a flow of electrons from the emitter to the collector. How loud the sound is that the microphone picks up controls how much flow of current from the battery there will be, and, consequently, how much sound there will be radiated by the speaker. Thus, an accurate reproduction of the original signal is achieved. This idea is demonstrated in Fig. 2(b). Bear in mind that this circuit is a simplified one, and, in actual practice, there will be some other components thrown in to confuse you — but the theory of operation is the same.

Now that wasn't so tough, was it? All that happens is that some electrons are pulled out of the center (base) region, and that allows current to flow between the other two regions (emitter and collector). The current from the battery "adds" to the signal, hence the amplifying effect.

Recommended Reading

It would be very helpful for you, at this point, to read further about how transistors work and are made. One book that I have found to be very good at explaining what I've just tried to explain, and which does so in great detail, is *Understanding Solid State Electronics*, which is put out by Texas Instruments and can be found at most Radio Shack stores. Much of the basic information contained in this article was taken from that book.

Conclusion

You now understand how the basic transistor works. It's absolute simplicity. Of course, you will certainly meet harder terms as you learn more about how different types of transistors work, such as: overlay effect, forward biasing, alpha cutoff frequency, etc. But, for now, you don't care about that, since you know what makes the simple NPN tick, and that's good enough ... for now at least. ■

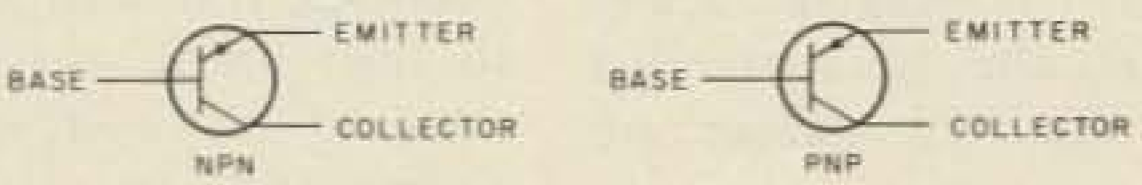


Fig. 1. The two basic types of transistors.

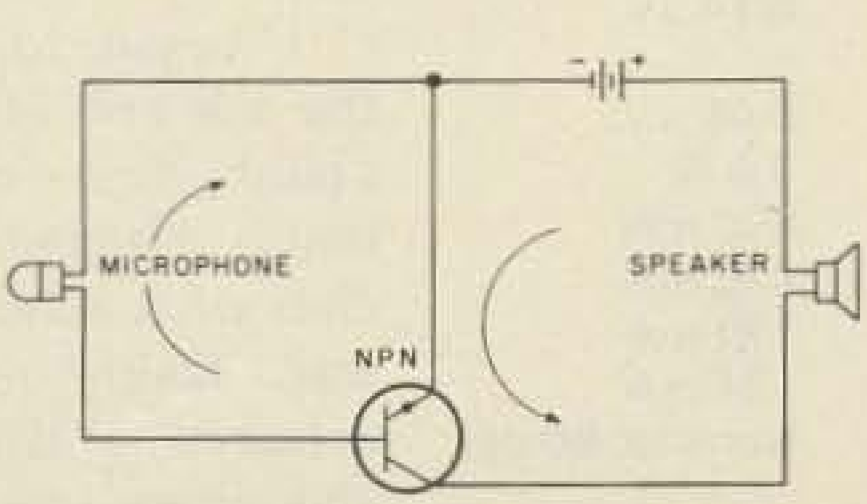


Fig. 2(a). NPN transistor as a simple audio amplifier.

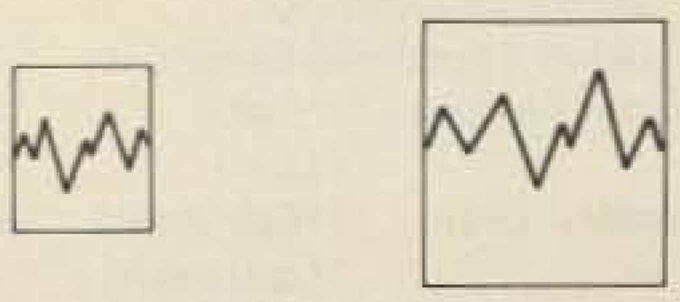


Fig. 2(b). Comparison of the original signal (left) with the signal after amplification.

C. Richard Sealey, Jr. WA4HVH
3722 Rolling Road
High Point NC 27260

I Love My GTX-I

- - user report on the Genave HT

With the advent of VHF-FM and repeater operation a few years ago, keen interest in extremely portable, reliable and convenient local communications took a big upsurge. Manufacturers followed suit by introducing a greater variety of equipment to entice the desk-bound ham into increasing his operating time and combining this new-found fun with activities heretofore not associated with hamming.

All sorts of equipment is now available, ranging from moderately sized vfo and synthesized multi-mode units to relatively small, crystal controlled, channelized hand-held units, and rigs slightly larger, such as the TR-22, the Icom units and others. And it's these last two categories to which I am directing my attention.

A couple of years ago I bought a Drake TR-22 with the idea of using it as a combination mobile and hand-held type of unit. It worked rather well from the car, but proved to be much too cumbersome as a hand-held. There is nothing quite like walking around with a mobile rig strapped to your shoulder, your arm tangled up in the mike cord, the telescoping antenna poking you in the eye, and all the while exclaiming, "Boy, oh boy, isn't hamming fun!" Somehow, this wasn't "where it was at." Also, I noticed a creeping paranoia which was besetting me, and it was especially noticeable whenever I left the rig unattended in the car. CB thieves are everywhere and hamming *is* supposed to be fun, free from both worry and filing forms with the local authorities.

Meanwhile, a friend of mine had recently purchased a used HT-220 slimline which had been converted to the 2 meter band. In it were crystals for the two local repeaters, the maximum number of frequencies it could hold. This rig seemed to be the way to go. It was small, lightweight, convenient, and worked like a champ. However, for my preference, the frequency limitations proved to be too restricting, and besides, with a few rare exceptions, those things are damn expensive. And if you want more frequencies, you need to convert to the "omni" version. This adds to the cost, size, and weight. So, it seemed that further searching was necessary.

I began to scrutinize all the ads and other material I could find on hand-held units. Meanwhile, the ham club of a school at which I was taking some courses acquired a Wilson 1402-SM and allowed me to use it for a while. It worked very well. It had a solid 2.5 Watts output, the receiver was extremely sensitive, and it had good selectivity and intermod rejection. But there were certain things I didn't really like about it – like not being able to see anything but the speaker grill while transmitting. I never could understand why they put the mike element at the bottom of the case. It certainly is no telephone receiver. Also, the unit was too large. It just wasn't particularly comfortable to carry, especially if you don't have "King Kong" hands. So my search continued.

After looking at just about everything that everyone makes in hand-helds for the amateur market, there seemed to be only one that might meet the criteria which I had set for myself – the Genave GTX-1T. The specs looked good and the size was rather small as compared with everything else on the market except the HT-220 slimline. But, the price was a little high relative to some others. So I considered it, and pondered over it, and tried to find someone that owned one. But, alas, no luck. They were too new to the market, and all everybody wanted was a Wilson, anyhow. So, one day I impetuously decided to take the plunge. Off to the bank I went, forcing myself to think only of the great fun and operating pleasure I was going to experience with my new "mini hand-held." (That's what Genave calls it.) So I mailed my order and waited.

After about a three week wait, I woke up one morning and asked myself, "Why am I waiting?" After all, I had sent them a certified check for a GTX-1T, 4 sets of crystals, and a leather case. And their ad had boasted, "Hurry! Still time for Christmas delivery." Well, Christmas had just passed and I sure as hell wasn't waiting until the following Yuletide season. So I utilized the services of "Ma Bell" and gave them a call. The very nice people at Genave advised me that they

		Factory	My Results
Receiver Sensitivity (20 dB of quieting)		0.15 uV	0.14 uV
Squelch Threshold Sensitivity		0.07 uV	0.05 uV
Power Output	(High)	3.5 W	3.3 W
	(Low)	Not Given	800 mW
Battery Drain	(High xmit)	Not Given	470 mA
	(Low xmit)	Not Given	170 mA
	(Squelched Rcve)	Not Given	34 mA
Spurious Output		Not Given	None to -60 dB

Table 1.

were making some production changes and circuit modifications to my unit and it would be a couple of weeks before they shipped. Again, I waited. Finally, after one more phone call and a little more waiting, it arrived. I unpacked it and carefully inspected it for damage — none! So I inserted eight "AA" nicads into the battery pack (that's right, it uses only eight) and put the pack into the rig. I turned the unit on, adjusted the squelch, selected a local repeater frequency and "hit" the button. "Whadyaknow, it works." And it sounded pretty good, too. So for the next test I gave a friend of mine a call and asked for a report. He said it sounded good, with very good audio quality, but the level might be a little low. Apart the unit came and an adjustment of the deviation control corrected the low audio.

After a few weeks of operating, all subsequent reports were favorable. And everyone wanted to know the "scoop" on the unit. And, of course, I wasn't about to let them wander off in ignorance. After all, I had done a great deal of detective work prior to my purchase, and I wanted everyone to know I had done well. And I had, too. The darn thing is small, about an inch longer than the HT-220 slimline but otherwise near the same dimensions. In other words, it doesn't require both hands to grip it. It is thin (1.25 inches, except for the speaker area), not too wide (just slightly greater than 2.5 inches), and comfortable. It's a shame the ad pictures make it appear larger than it is. The only possible physical drawback may be its weight: approximately 2.25 pounds. But, I guess we all need a little more exercise.

Aside from being a handy size and very attractive, the GTX-1T performs very well, meeting or exceeding all factory specs. And it boasts some nice features as well. It has provisions for 6 crystal control channels, a high/low power output switch, a tremendously sensitive receiver, good audio quality both in and out, and a clean signal. Genave also included a quality control lab test report with my rig. This included specifications information of my individual unit. Now, how long has it been since you've seen that with a piece of ham gear you bought?

One day I decided to get together with some test equipment and really check the unit against the factory specs. Most of the gear was Hewlett-Packard and the way things tallied is shown in Table 1.

I should also include that the unit features a dual conversion superhet receiver with standard 10.7 MHz and 455 kHz i-fs and a six pole crystal filter. And since the unit is really their commercial handheld tuned to the 2 meter amateur band, there are other niceties such as shielded pots, a sealed rotary switch, G-10 glass epoxy boards, and rugged construction.

Although component density is rather high, general maintenance and service are eased, somewhat, by incorporating two printed circuit boards, the transmitter board and the receiver board, oriented component side to component side, sandwich fashion. Accessibility to them is gained by snapping the back off the unit, which exposes the battery pack and the bottom of the receiver board. Five screws are then removed from the board and the board lifted from the case and moved laterally to extend beyond the edge of the case. Two screw holes on the right side of the board are aligned with the two retaining tabs on the left side of the case, two screws are inserted and tightened, and the board is secured for servicing with easy access to the component side of both boards and the foil side of the receiver board. Getting to the foil side of the transmitter board requires further surgery.

Well, there you have it, the whole kit and kaboodle. I've had the unit for eight months, in constant use, and have experienced no problems. I got the built-in touchtone encoder with mine and it works very well. You can have it either way: the GTX-1 without the encoder, and the GTX-1T with the encoder. Included with either rig is an exceptional owner's manual, very complete and informative.

So, if you are in the market for a 2 meter handheld of high quality and excellent performance that's thin enough to stick in your back pocket, you might consider doing as I did and get a GTX-1T. ■

Looking West

from page 141

and at present was only going to commit itself to coordination of three of the prime 60 kHz channels and see what type of activity develops. Pat Corrigan KH6GQW informed me through Bill Orenstein KH6IAF that Hawaii was solidly behind the NARC plan, and I have received similar input from the New York/New Jersey area and New England. Finally, if the rumors we received at Santa Maria are any indication, the ARRL is also squarely behind the NARC proposal, and it would surprise me to see them adopt anything else. In short, it looks as if the guys and gals up in Northern California have come up with a winner, and have done so with very little time to work up the proposal. Finally, and for what it may be worth, unless something far better comes along — a plan that provides relay communication without FM repeaters — I, too, endorse the NARC plan as being the most logical approach to solving a rather difficult situation. I'm also grateful to Jay O'Brian W6GO, for putting us in the position of being one of the first to detail it to you.

What about the non-repeater people, those involved in weak signal, long-haul SSB, EME, AM, and other narrowband modes? By and large they are far from happy, and many have already made it publicly known that they do not believe the promises of a non-channelized, non-FM segment between repeater inputs and outputs. They doubt the ability of any council or individual to enforce such a restriction. They cite the fact that synthesized FM equipment is channelized and the spectrum in question is technically open for anyone to use regardless of mode. They doubt if an amateur will QSY two megahertz just to get a simplex QSO, and figure that, councils and coordinators not withstanding, the spectrum will eventually channelize itself *unless they act to protect it.* In general, those now using this spectrum feel that repeaters and FM have no business whatever down there and, as for what the future holds . . . well, your guess is as good as mine. One thing is certain — the people there now have no intention of being kicked out, no matter the cost; many have made this quite clear. As one caller to the "Looking West" answering machine put it, "Promises are cheap . . . it's keeping them that's not possible."

NOT WITH IT DEPARTMENT

Since the technical committee

Continued on page 153

How It Was

- - the early days of radio

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In my more than 65 years of association with radio (started in 1909), I've run into some more or less extraordinary and odd published angles, and it occurs to me that many readers of this magazine would also enjoy them.

As far as I have been able to learn, the very first printed article about radio in the United States appeared in the December, 1898 issue of *Frank Leslie's Popular Monthly*. It was a 7 page write-up entitled "Space Telegraphy" and had more than a half-dozen pictures and diagrams. It certainly makes fascinating reading!

After the construction of a coherer (about the earliest detector), it says, " . . . metallic filings form a detector for electric vibrations of the greatest sensibility." Then it goes on to say: "Dr. Lodge has suggested the name 'coherer' for this piece of apparatus, and his investigations, together with those of a number of other scientists, have developed its possibilities and refined its sensitiveness until it exceeds all other instruments as a detector of electrical oscillations."

The final paragraph of this 1898 write-up appeals to me as being doubly interesting. It questions the future of wireless in some ways, but also does some interesting prophesying: " . . . the Marconi apparatus cannot direct the waves it evokes and must expend at the sending station sufficient energy to fill to repletion the sphere of space of which the transmitter is the center and the receiver but a mere point on the surface. Applied to transmission over long distances, such an expenditure of energy becomes commercially appalling, so that unless some present unknown means of giving the waves in a predetermined direction shall arise, the reliable old wire along which the electric pulsations conveniently slip promises to remain a familiar object. In special cases, such as intercommunication between ships at sea, the transmission of signals between moving objects, as railway trains, or army corps, or in the emergency of a broken cable, wireless telegraphy may, and probably will, prove itself of immense value; but these are the exceptions rather than the rule . . . Yet, the coherer is one of the great discoveries of the age."

Another interesting item appeared in *The American Monthly Review of Reviews* for June, 1899. In it is an article about Marconi by his engineer, Dr. Erskine Murray, who said: "Our messages seem to carry best in fog and bad weather; thunderstorms and electrical disturbances do not interfere in the least. The Earth's curvature makes no difference at all; these Hertzian waves follow around smoothly as the Earth curves. Messages can be sent to any distance given a sufficient height of wire – if you double the height of your mast you can send a message four times as far – the range of distance increases as the square of the mast's height. A horizontal wire, placed at whatever height, is of no value in sending messages – all that counts is the vertical component."

An item appeared on page 133 of *Radio Journal* for September, 1923, saying: "A prominent aircraft engineer, who conducted radio tests during a balloon race, insists that there is no static at an altitude of 3000 feet or over." It concludes: "Most of us can't live there, however."

One of the biggest "boo boos," I think, was published in *Radio Doings* for the week of Oct. 24-30, 1926. Under the general heading of "October in Radio History," this appeared: "1914. E. H. Armstrong was issued a patent covering the regenerative circuit, also known as the superheterodyne circuit." – Gosh!

In the issue of December 31, 1927, this same magazine had a full page advertisement headed up "Why Radio is Better with Battery Power." It went on to say, "A well-made B battery is the best form of 'b' power supply for all radio receiving sets. Best in quality of reproduction, more dependable, lower in cost, more economical in operation and most convenient . . . the pure current (direct current) of the 'B' battery permits clear, rounded tones to come from the receiver. . . . Radio is more dependable with battery power . . ."

This one comes from page 77 of *Radio Doings* for Aug. 16, 1925: "The new flat cell 'B' battery recently announced by the National Carbon Co., makers of Eveready batteries, utilizes the new principle of patented battery construction by substitution of flat cells for cylindrical cells. More than 30,000 of these batteries have already been tested by users in actual service and from 30 to 52% longer life has been obtained under the same conditions of service as compared with any cylindrical cell batteries of the same external dimensions."

On page 75 of *Radio Doings* for July 19, 1925, this advice appeared: "If you live in a so-called 'dead spot' – that is, where you cannot receive certain stations – take off the ground connection on your receiver. This will make local reception better, at least."

The literature shows how even our greatest scientists and inventors can have wrong ideas. For example, Michael I. Pupin (1858-1935) was sure that radio signals were possible only with a return circuit through the earth. Quoting from his autobiography: "Every now and then we are told that wireless signals might some day be sent to the planet Mars. (Pupin) considers these suggestions unscientific for the simple reason that we cannot get a ground on the planet Mars and, therefore, cannot take it into close partnership with our Hertzian oscillations. Without that partnership, there is no prospect of covering long distances."

With a radio receiver in practically every car on the road now, it's interesting to look back and see how they were regarded 45 years ago. This is what *Radio Broadcast* magazine said in what undoubtedly is an editorial, although it is headed "Professionally Speaking," on page 200 of the February, 1930 issue. " . . . We venture to offer an opinion on this business of radios for automobiles. It seems to us that there are several people to be considered – the automobilist, the innocent bystander already bothered with noise from autos and in danger of being run over by one-arm drivers, and finally the set manufacturer. The automobilist has about all he can do now to stay on the straight and narrow. Are we to have one-arm drivers to add potential sources of accidents? And we cannot see how anyone could enjoy much radio music while journeying about in an auto. The rumble of the motor and of other cars' motors would completely mask out any low frequencies, even if they could be obtained from the small loudspeaker that will be put in the car. The pedestrian or dweller by the roadside is already complaining about traffic noise. The din from autos that pass your house, if equipped with radio sets, would be worse than your neighbor's set which may be very loud – it usually is – but is tuned to one program. Instead you would listen to a dozen programs at once going up and down the street. It is our opinion that the only people who will benefit by radios for automobiles are those who make – and sell – the sets. The technical difficulties of building a high-quality set for installation within the confines of the average car are almost insurmountable. The loudspeaker cannot be very efficient at low frequencies because there is not sufficient space available."

On page 309 of the April, 1930 same magazine (*Radio Broadcast*), we read this: "New Hampshire State Commissioner of Motor Vehicles Griffin says: 'New Hampshire is against automobiles equipped with radios which can be operated while the car is in motion. This department is satisfied that the greater percentage of accidents is due to inattention of drivers, and where a radio is being operated while the car is in motion, it certainly would tend to divert the attention of the operator.' "

Perhaps on a slightly more constructive tone, here are a couple of magazine clippings. This announcement was in the July 4, 1926 issue of *Radio Doings*: "The U.S. Civil Service Commission announces competitive examination for Radio Engineer, \$3,800.00; Associate Radio Engineer, \$3,000.00; Assistant Radio Engineer, \$2,400.00." Perhaps we should explain these are annual salaries! Quite different from our present-day inflated figures!

This really interesting item was on page 80 of *Radio Doings* for Sept. 6, 1925: "A method of 'canning' radio broadcasts has been developed in Germany. The invention makes it possible to receive radio signals and retain them in the form received, so that they are accurately reproduced and released." How does this compare with our present-day instant reruns of TV?

To conclude, here are a couple of true comments on electrical matters, although not referring to wireless. The City of Los Angeles was first lit by electricity on its streets on the night of December 31, 1882. The Gas Company had vigorously opposed electric street lighting, and some of the arguments against it were pretty farfetched and ridiculous! It was claimed the electric lights attracted bugs, contributed to blindness, and had a bad effect on ladies' complexions!

And then this one on August 27, 1930, in an Oregon newspaper: "It is said that 25% of the telephones in the U.S. are now operated by dial system and that by 1940 the conversion will be complete. That is bad news, indeed. The change will throw a lot of people out of employment and add to the worries of phone users. To use a dial successfully, a man should be a graduate in electrical engineering and also know something about safe-cracking . . . Dial phones should not be permitted anywhere in towns under 500,000 people. In the larger cities people become accustomed to misery and a little more won't hurt them."

Anyhow, the world does move! But it's fun to glance back. After all, we're now having a huge national nostalgia binge – 200 years! So, it isn't out of order to indulge in a little wireless nostalgia along with the nation's. ■

Looking West

from page 151

meeting last week, I have been trying to find a nice way to put it, but for the life of me, I can't. In early December, the Two Meter Technical Committee of the SCRA will bring before the membership for ratification a proposed low megahertz band plan which places Southern California on the "even" channels, 10 kHz higher than the rest of the nation and with nineteen *potential* channel pairs. This whole situation places me between a stone and a hard spot for two reasons.

First, as many of you are aware, I happen to hold elective office in the SCRA, and second (and more important), after a lot of soul-searching I find myself in opposition to the decision of the technical committee.

Now, before I get a lot of irate and nasty letters from amateurs involved in emergency service communication networks, let me say from the outset that my sympathies and desires lie directly with them. I am not convinced that there is any need whatever for repeaters between 144.5 and 145.5 megahertz – not at the expense of all other activity, including emergency services. Nor do I feel that the SCRA's Two Meter Technical Committee has made a technical error. In fact, based on existing spectral activity, they made on a purely technical basis a logical decision for this area. However, coordination councils such as the SCRA have now, by virtue of the report and order on repeater/remote deregulation, graduated into individual spectrum management organizations that are in essence part of a yet-to-be-established national council.

For coordination to work on a national basis, it means that individual local needs must be handled as "special cases" on a case-by-case basis and in relation to a nationally-accepted standard. For everyone to go his own way and begin coordination efforts in this new spectrum on a haphazard basis, without any thought given to what the neighboring area is doing, will have to lead to chaos. Can you imagine what it would be like if three adjoining areas each chose a different band plan? If area A ran even 20 kHz, area B ran odd 20 kHz, and area C went with 30 kHz and 15 kHz splits? The situation would not be conducive to friendly relationships between areas.

Yet, in Los Angeles County, Ventura County, Riverside County, and in fact statewide, the emergency services network plan, one accepted

Continued on page 155

Build This FM Signal Generator

- - peak that rig for mode B use!

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The OSCAR amateur satellites have caused a renewed interest in VHF and 10 meter preamplifiers. Most of these preamps provide enough gain and noise improvement to allow them to be used with older general coverage receivers and surplus commercial "boat anchors." In order to be effective, however, the receiver used behind any preamp or converter must be properly aligned. Many available receivers employ a 455 kHz i-f section, which must be properly adjusted for optimum receiver performance. However, many hams do not possess the signal generator necessary to adjust i-f stages, and unfortunately, many older kit type generators do not remain stable long enough to complete the tune-up.

This article describes an easy to build FM fixed frequency signal generator for 455 kHz. It uses two readily available ICs, a 8038 function generator, and a 741 op amp (see ads at the back of this magazine). A deviation control and output level control are provided, but the frequency is calibrated at just one frequency. It is possible to change the value to work with any i-f under 500 kHz by simply changing resistance and/or capacitor values. Because of the use of ICs, the other parts required are relatively small. Even the power supply is optional if a good regulated 6 volt positive/negative supply is available.

The construction of a 2 meter receiver prompted the designing of this generator. The need for an FM signal generator had existed for several years, but this receiver construction forced the issue. A search of electronic catalogs showed that there really are no lower priced FM generators available, even in kit form. Next the government surplus list was reviewed with similar results. There are surplus units, but prices are very high, cover much wider spectrum than required, and have many modes of modulation. At that point, the design specs were set up with cost and availability of parts prime considerations.

Circuit Description

Some information has been written on the 8038 function generator, but really not enough. It is a very useful device putting out sine, square, and triangular waveforms of a quarter volt or more in amplitude. Frequency range is from a small fraction of a Hz to about 1 MHz. Only a few external resistors and a capacitor are required to finalize the generator. Since an audio generator was already available at this shack, it was decided to not make use of the full frequency capability of the 8038. Triangular output is available on pin 3 and the square wave by making the 10k resistor on pin 9 a pot. Details of these other outputs can be found in manufacturer literature and a limited number of articles.

The frequency of the generator is determined by the RC combination of C1, the 120 pF capacitor (mylar or polystyrene recommended), and the series resistance of R3 (500 Ohms) and the 680 Ohm resistor. The variation of R3 shifts the generator frequency over a range of about one hundred thousand Hz. The 500 Ohm pot across pins 4 and 5 sets the duty cycle or symmetry of the waveshape.

The generator output is taken from a voltage divider connected to pin 2, the sine wave output. An output of over 100,000 uV is available at this point. The output level can be modified by changing the ratio of the 10k and 4.7k Ohm resistors.

FM modulation of the 8038 is obtained by applying a small varying signal between pins 7 and 8 and the positive voltage supply. This modulating voltage is obtained from a simple audio oscillator using just one IC, a mini-dip 741. Other op amps can be used, but experience has shown the 741 is one of the easiest to work with and the cost is very low.

This oscillator uses a notch network from the op amp output to the negative input. The result is a sine wave oscillation at about 1000 Hz. This signal is applied to the generator through the interstage transformer after being reduced in level by the resistor network.

The power supply is a simple bipolar (positive and negative) supply which is zener regulated and well filtered. The transformer can be two separate 12.6 volt units or a single 25.2 volt unit with a center tap. The four diodes could also be a rectifier bridge with at least 100 volt piv rating. This power supply could be eliminated if a good 6 volt bipolar supply is available. However, in this case, since it appears much use will be made of the generator and since the power supply is quite inexpensive, it was built into the final unit.

Construction Details

In the original unit, the audio oscillator, frequency generator, and power supply were each mounted on individual perforated boards. This was necessitated by several design changes made along the way. Packaging seems to work out best with the oscillator and generator on the same board, with the power supply separate.

Generally, construction is not critical, but the usual good construction practices should be followed. The entire device, including power supply, was mounted in a 3" x 4" x 5" minibox. The output level control, R2, the deviation level control, R1, and the output connector (BNC type) were mounted on the front panel. Since the output frequency is set at 455 kHz, this pot was mounted inside. The power cord was brought in the back, the transformers were mounted on the bottom and, finally, the boards were mounted on brackets to the top and sides of the case.

Calibration

After checking all wiring several times, check it once more. This was learned through bitter experience and the purchase of a second 8038. Apply power to the generator and check to make sure that both plus and minus voltages are about 6 volts with correct polarity. With R1 set to the low end, look at pin 2 of the 8038 or the output of R2 with a scope. The correct setting for the 500 Ohm pot between pins 4 and 5 on the 8038 is about the midpoint. If the output is badly distorted or is missing, adjust that pot to obtain a clean looking sine wave.

The next step is to adjust the frequency with R3. The best method of adjustment is with a frequency counter or meter. While continuing to monitor the waveform on the scope, adjust R3 to the proper frequency, 455 kHz. There will be interaction between the 500 Ohm pot and R3. Continue to adjust back and forth until a good sine wave at 455 is obtained.

If a frequency counter or meter is not available, a receiver with known 455 kHz i-f could be used. By applying the generator output to an early stage (at low level) and measuring the output of the last amplifier stage, a peak in output would indicate the generator is set to the same frequency as the receiver i-f being used.

The only remaining item to check is the audio oscillator. Attach a scope or ac voltmeter across R1. There should be a good sine wave of several hundred millivolts present at about 1000 Hz (original model measured 924). The generator is now fully operational and the box can be closed up. To actually look at an FM signal, connect a scope to the output of the generator. With R2 at full output, slowly advance the deviation control, R1. The trace should spread or smear horizontally as the control is advanced. Notice that there is no increase in amplitude since this is strictly frequency modulation. The FM generator is now ready for use.

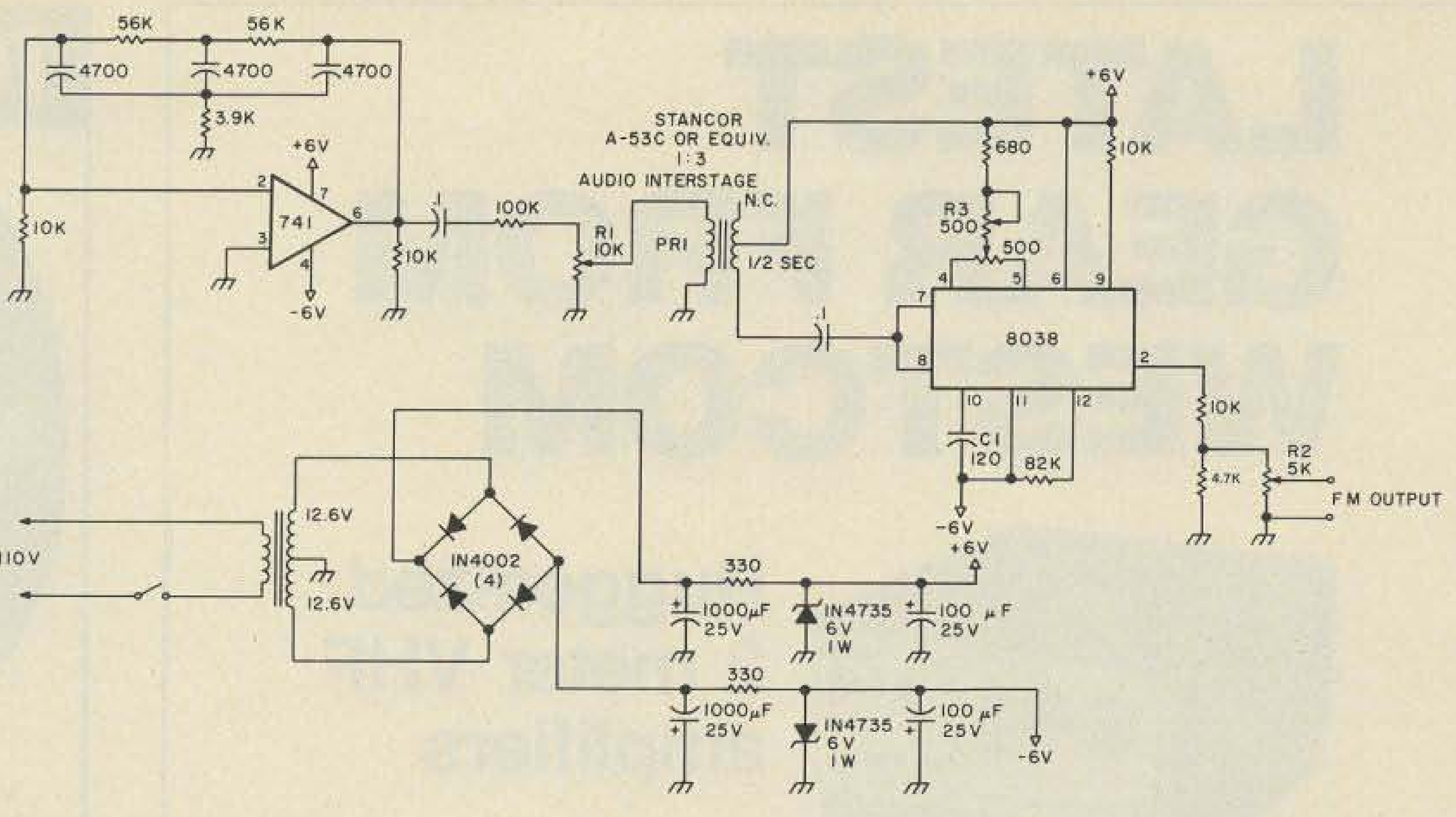

Fig. 1. One 25.2 V @ 300 mA CT or two 12.6 V @ 300 mA (primary in parallel, secondary in series). All fixed resistors ¼ Watt. Capacitors greater than 1 in pF, less than 1 in uF, unless otherwise marked.

Conclusions

The unit has been used to align the i-f amp and quadrature detector of an FM receiver under test. The unit is stable and provides more than ample deviation required for amateur work. The unit is also being used in the development of a simple deviation meter, but that is another article for another time. ■

Looking West

from page 153

by the government of the State of California, is based upon "even numbers" rather than odd. Based upon the needs of the emergency communications services, the statements by representatives of this service that it would be a virtual impossibility for them to recoordinate activities in less than 5 years and at monumental expenditures in time and money, and the fact that such operations have existed for more than nine years on the basis just described, the SCRA's Two Meter Technical Committee opted to consider local needs over national interest. Therein you see the problem. Which is more important, local or national needs? To this there is obviously no clear-cut answer. Those involved in each will be obviously biased toward their special interest and, to make matters worse for me, I do not want to see any change at all in current spectrum activity. Yet, if this or any other area is to coordinate systems into that spectrum, then I feel it is paramount that everyone be totally unified and compatible.

There is no doubt whatever in my mind that emergency communication services such as RACES and ARES are important. If I did not feel this way, I would not have devoted seven years or so to involvement in both when I still resided in New York. I was a RACES member (W2NEM/W2VYR 219) and also did my turn as NCS for the Kings County AREC and CD Net for quite a while. I firmly believe that it's the people involved in such services who are the backbone of what our hobby/service is all about. However, and this is a big "however," I also feel that the national interest far outweighs any local need. Whatever the cost, operations such as these must be brought into line with what the majority of this nation's amateurs want — and at present this seems to mean the NARC band plan.

After about three weeks of contemplating this matter, I am of the opinion that if we must put repeaters down there, at least we should do so in the same way as everyone else. For heaven's sake, let's do what the rest of the nation is doing, and handle the needs of the emergency services people on a case-by-case basis until such time as they can effect revision of their operational plan and relocate into the framework of an *accepted national plan*. While I realize that the opinions expressed herein may not make me very popular with two

Continued on page 159

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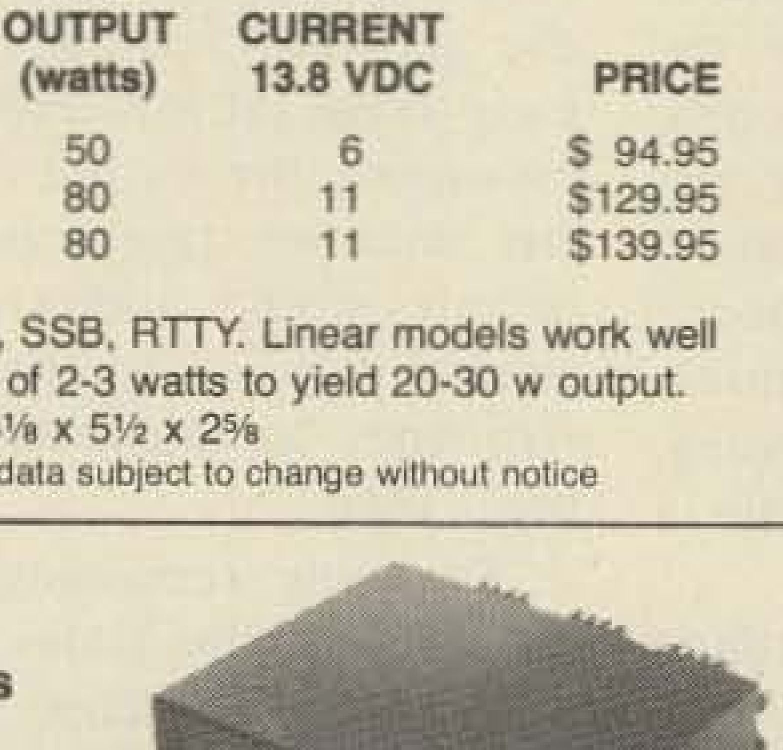

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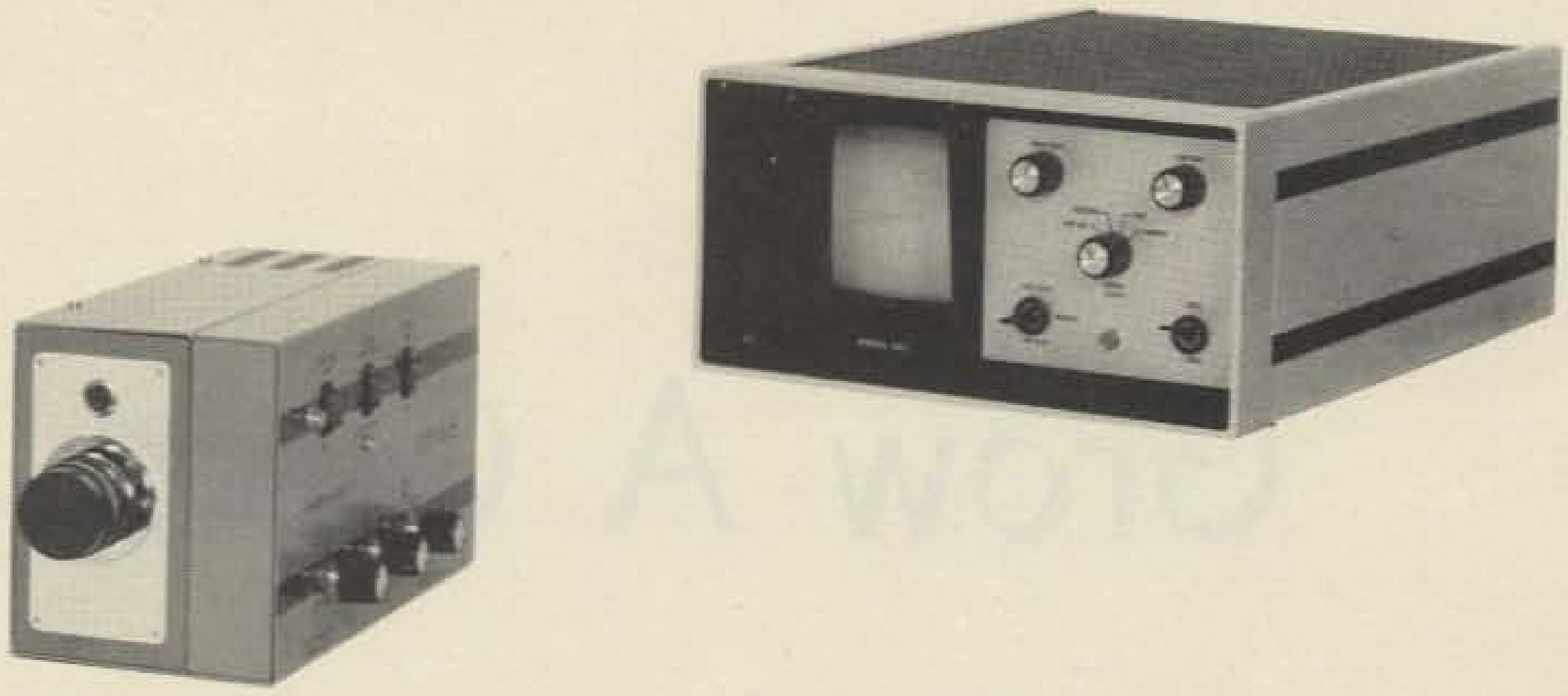

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Grow A Giant Junk Box!

-- tips and techniques

Every ham should have a junk box – the bigger the better. Not only is a junk box a handy and money-saving device for construction projects and repair jobs, it's educational as well. It will give you actual hands-on experience in testing and identifying various components and teach you much about which component substitutions will work in different circuits.

It's only fair to warn you, though, that junk boxing can become just as much a mania as any other aspect of ham radio. My junk box fills the better part of my shack and is overflowing into the backyard.

Of course, to enjoy the benefits of a junk box, one must have one. Now, how the heck do you go about getting one? Believe me, you don't without acquiring a reputation around the neighborhood as a weirdo of sorts. Passing the word among your neighbors and friends that you will be happy to take their electrical and electronic junk off their hands will soon result in goodies of all descriptions being made available. After the word gets around, stuff will start showing up from sources you'd never dreamed of. Also, an alert eye on roadside trash cans will yield many useful items. Far be it from the avid junk boxer to pass up an old TV just because there happen to be people around watching him pull it out of the trash can.

Old TV sets aren't the only source of goodies either. Transistor radios of all sizes, electrical appliances, and anything else that uses electricity, including toys, are fair game. If nothing else, they'll yield at least a battery holder or an ac line cord, plus some miscellaneous hardware.

After you've located your junk and hauled it home (it helps to own a station wagon or pickup truck), the next step is to plug it in and see if it works. Hold on now, we're building a junk box, what do we care if it works or not? Well, if it works or can be fixed easily, we fix it, clean it up, then sell it at a local flea market, swapfest, or any other place we can get hard cash for it. Then we have some of that hard-to-come-by green stuff to buy the parts we don't have in our junk box, some of that test equipment we need, or maybe a new piece of gear for the shack. Don't be bashful about doing this – you can always claim that you are simply conserving our natural resources by recycling useful items.

Don't waste too much time troubleshooting anything, though – just a simple once-over will do. The fuse and line cord can be checked with your meter. If you don't already have a meter, get one. Every ham needs at least one around the shack. Tubes can be checked at your local TV repair shop, drug store, supermarket, or any other place that has a tube tester available for public use. Even if you can't get the set working again, keep the good ones. Chances of using any of the weird tube types that show up in most TV sets in ham gear are small, but they will come in handy for fixing the next set you pick up.

If it doesn't work and can't be fixed easily, the next step in the case of a TV set is to defuse that bomb known as the picture tube. This isn't necessary, but it does wonders for your peace of mind when you get a little violent trying to get some stubborn component out of the cabinet. I evacuate the tube by laying the set face down outside and wrapping the entire tube, except for the very tip of the neck, in several layers of an old blanket or rug. Then I put on a long sleeved, heavy shirt or jacket, leather gloves, and safety glasses. Now, with a pair of pliers, I carefully break off the glass tip which protrudes from the base of the tube between the tube's pins. When it breaks off, you'll be rewarded by an inrush of air, and the tube is then safe for disposal. A few words of caution here – always wear the heavy clothing and safety glasses, leave only the minimum amount of tube exposed, and, if there's any question in your mind about how to do it, don't. I've never had one implode on me, so the process is quite safe if proper precautions are taken, but don't get overconfident and careless. Treat the tube like you would high voltage – with respect.

Now that everything is safe, clean up the equipment as best you can and remove the chassis, speakers, and anything else you spot from the cabinet. After you've removed the chassis, clean it again. Then you can go after the goodies. I usually cut out the components with long leads, remove the circuit boards from the chassis, and then go after what's left.

Don't throw anything away! Save all the nuts, bolts, screws, washers, etc. Don't forget the yoke from the picture tube and the flyback transformer. They'll provide many feet of wire for winding transformers, coils, and numerous other things.

Guess what comes next? Yep, we clean it all again. It's unreal how much dust, dirt, and grease get into electronic equipment. While you're cleaning the parts, give each one a good visual inspection, and throw out any that look doubtful. After you've cleaned and inspected each component, sort them by type – resistors in one box, capacitors in another, etc. It's a good idea to put anything you don't recognize in a separate box, so you can go through it later and see if you can identify anything. It's unreal how many components that you didn't previously recognize have acquired a name in a month or two.

Now that everything's segregated by type, you can sort them out by value. Resistors and capacitors are usually pretty easy because they are either color coded or labeled, but coils are a different story. If you own a dip meter or inductance bridge, you're in business and can measure them. If not, you can borrow or buy a dipper to check them with. (Remember the money we got from selling those goodies at the flea market?) Either way, I recommend buying a dip meter at the earliest opportunity. One is inexpensive in kit form and, next to a meter, is about the handiest piece of equipment in the shack. A book or two could be written on its uses.

Semiconductors are also usually labeled. If they're not, I throw them away, unless I happen to feel like spending an hour or two trying to figure one out. The ones I can identify I store in small boxes filed in alphanumeric order.

Chances of a project calling for the particular device you happen to have are small, but with a little ham ingenuity, you can usually find one that will work. What I do is keep a three by five card on each device with its number, type, power rating, and any other information I can locate listed on it. There are several sources for this information, but my favorite ones are Motorola's *Semiconductor Cross-Reference Guide and Catalog* and RCA's *SK Replacement Guide.* Both are available from the manufacturers or their dealers for about a buck each (and are worth every penny of it). Once you have your copy of these, all you have to do is look up your device and find the HEP or SK replacement device for it. Then turn to the listing in front of the book, obtain the specs on the HEP or SK device, and enter these on your card. These specs will not be exact for your particular device, but are close enough for most purposes.

As an example, let's look up a 2N652 transistor using the HEP cross-reference. First we look up 2N652 in the cross-reference portion of the book and find that a HEP 633 is the replacement for it. Now we turn to the front and check the description and packaging index portion for the HEP 633 and find that it is a germanium, PNP, general purpose audio amplifier. This is already quite a help, but we're not done yet. Now that we know the device's general type, we can turn to the catalog section and look in the low power germanium transistor portion and locate our HEP 633 again. We now learn the device's BV_{CEO}, BV_{CES}, I_C, P_T, T_j, f_t, h_{FE}, and I_{CBO}. Not too bad for a buck! There are manuals that give this information directly for each device, but you don't get them for a dollar a copy. The one I have was about twenty bucks, as I recall, and it doesn't do much better than the cheapies mentioned above.

Now that you have the above specs in your card file, when a project calls for a semiconductor that you don't have, go to your cross-reference guide and get its specs, using the procedure just outlined. Look through your card file and pull the card on each device with similar or better specs, and then try the one that matches what you need most closely. It works almost every time and lets you save your money for things you don't have in your junk box. Don't get the idea that I don't use a substitution guide, because I do. Quite often, though, the above method will find something that will work, when the substitution guide is of no help.

After you've gotten a good start on your junk box, don't be afraid to use it. If a project calls for something you don't have, but you think you have something that may work, try it. If it doesn't work, try to figure out why. Even if you burn up a part or two, it didn't cost anything except a little time and effort. If you figure out why it failed, you'll have learned a little about circuitry in a manner that insures a high retention factor.

Once again, don't throw anything away. Even transformers with unusual voltages can be rewound to provide almost any voltage you desire. This seems to be sort of a lost art, but it's simple, and there is at least one recent article on it.* More than once I've thrown something away because I either didn't know what it was or didn't think I would ever need it, and a year or so later I was very sorry indeed. Invariably the part was worth at least ten bucks or was some rare device that I now need and can't find anywhere at any price. ■

*McCoy, "The Ugly Duckling," *QST*, Nov., 1976.

Looking West

from page 155

groups, namely the emergency services people and the SCRA Two Meter Technical Committee, if given a choice, I elect to back the needs of the overall amateur community nationally over any one individual or group. It is my sincere feeling that any disunity at this time can only hurt us all. This time, the SCRA is wrong.

There are two points upon which I must commend the SCRA's technical people. Among their *recommendations* are that the 200 kHz between 144.9 and 145.1 be "recommended" (not falsely promised with no way to back up such a promise) for non-FM, non-channelized communication, and that an additional 100 kHz be withheld for at least 12 months, thereby giving SSB, CW, and AM additional spectrum even though this means fewer FM repeaters. Perhaps translators or SSB repeating stations will eventually occupy this spectrum, but for at least the next year, 144.9 through 145.2 is off limits to relay activity if the general membership goes along with this proposal. Unlike the decision to move up 10 kHz, these two recommendations can easily be initiated under the outlined structure of the NARC plan without drastic modification to it. This positive step at least gives non-relay operations now there an even break to some degree. Also, a formal commitment has been made to Baja for two clear channels in that spectrum, as well as a few others on a shared basis with US activity.

THE BEST WISHES TO W6KW CORNER!

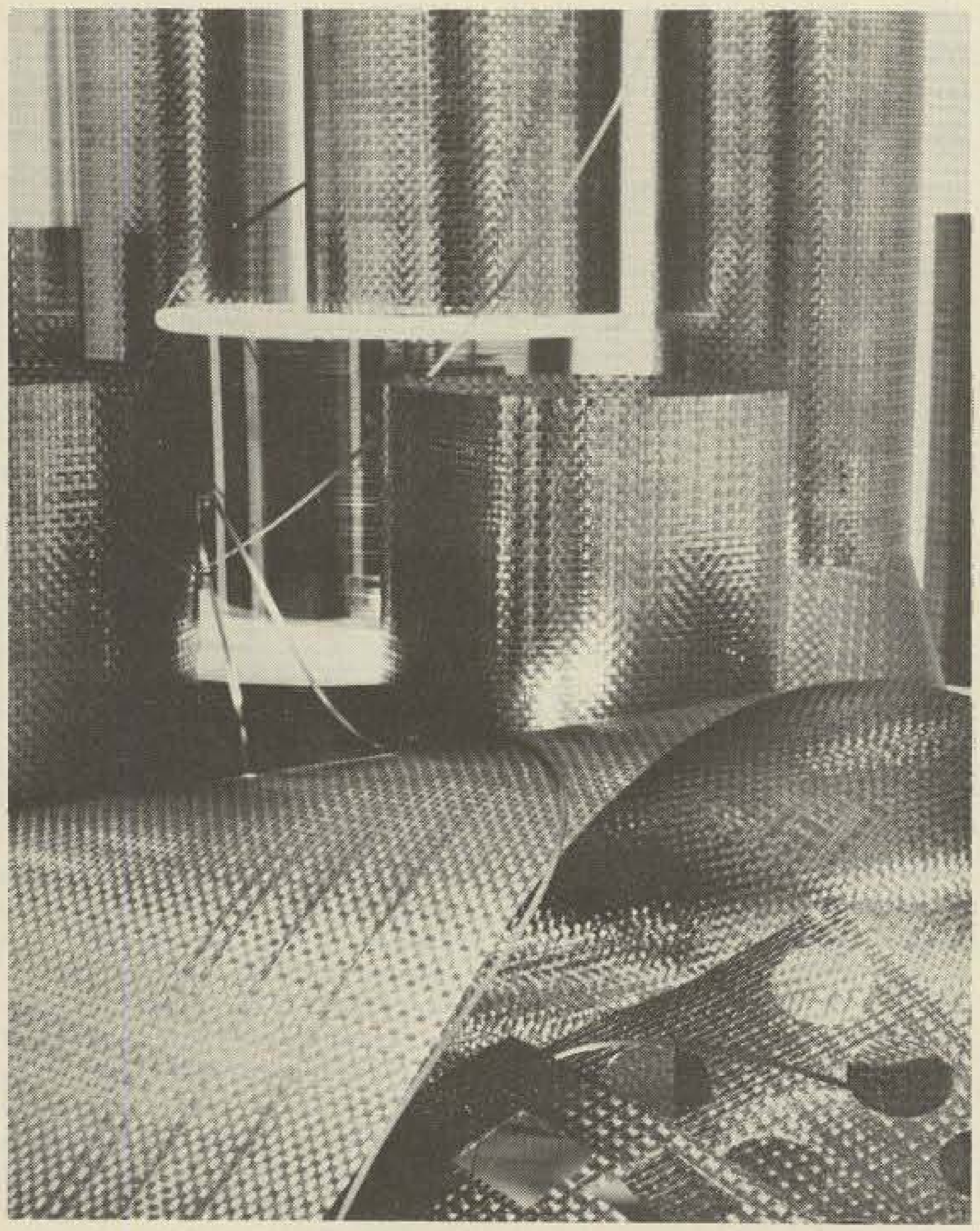
As many of you have probably heard by this time, on September 10, 1977, Southwestern Division Director John Griggs W6KW suffered a fairly severe stroke and has been hospitalized since that date. To a great many of us out here, John is far more than an ARRL Director. He is a person whom we love and respect. John Griggs is my friend and I am very proud to be considered one of his. I could spend pages upon pages telling you about John and his many accomplishments that literally span a lifetime, but suffice it to say that John, to those of us who live in Southern California, is Mr. Amateur Radio.

"Looking West" joins with all of John's other friends both inside and outside California in wishing him a fast recovery. We need the John Griggs's of this world.

Is It Glass . . . Or Iron?

-- a look at Metglas®

Alexander MacLean WA2SUT/NNN0ZVB
18 Indian Spring Trail
Denville NJ 07834



Metshield fabric, Allied Chemical Corporation's new magnetic shielding product, derived from Metglas amorphous metal alloy ribbon, can be cut or die-stamped into a variety of shapes. Presently available in 7-inch widths, Metshield fabric can be fabricated without loss of its magnetic shielding properties.

Allied Chemical Corporation has released a new metal alloy called Metglas®. While the process yields a number of specialized metals, the first commercial application for the process is a metal fabric, Metshield™, intended for magnetic shielding in electronic applications.

The name Metglas is derived from its manufacturing process, which results in some most unmetallic properties. The basic material of glass is sand, a crystal. Glass, however, is not a crystal. It is sand in a noncrystalline state. In chemistry, it's called an amorphous state.

When metal is cooled from its molten state, it crystalizes and becomes the metal substance that is its familiar state. This new metal is not allowed to crystalize, however. It solidifies in an amorphous, or uncrystalized, state — hence its similarity to glass.

This process gives the metal physical properties that it would not have in its usual state. Add to this the ability to take advantage of mixing the properties of several metals, alloying, and you get a whole new range of materials to work with.

The trick is how they get it to solidify without crystalizing. As it is made, the metal is cooled at an extremely high rate. It solidifies, but it does not have a chance to crystalize.

Woven into a fabric, it becomes Metshield, a competitor to the high nickle-iron materials, such as "Mu" metal. But there are several specific areas where the material has far different mechanical properties.

Mu metal, and the others like it, are sheet metal. They have to be worked, with the usual mechanical problems of working and shaping. One problem with them is that as they are worked, it affects their shielding capability. After shape fabrication, the metal has to receive a high temperature treatment to restore its shielding ability.

Here's where Metshield has an edge. While it has to be carefully handled to avoid cuts from sharp edges, it is far easier to work. It can be cut with shears and, being flexible, is easily formed into complex shapes. Joining edges or sections together is a snap. The material can be clamped, or even glued, together. You just have to make sure that there is sufficient overlap to prevent leakage.

Allied says that it may be possible to solder the material with an extremely low temperature solder, but this is not recommended. Heat will change the physical properties of the material, which might degrade the performance.

The material is reusable. Unless it has been cut into an unusable shape, it can be removed and reformed into a new shape.

Unlike the solid metals, this does not affect its performance. This makes it a strong contender for research and development uses, where a number of different bench configurations are to be tried and evaluated. It is also intended for post production uses, where it would be too late to incorporate a solid metal shield, but a field change, production change, or repair is needed in equipment.

There appear only a few areas where this might find application in the usual ham equipment, although, with exotic areas becoming more common, there may be wider application possibilities than are obvious.

In general, you would use it where you would use a Mu metal shield. This is commonly used with a CRT. Most scopes shield the CRT to prevent stray field pickup. This suggests it might also be useful for TVTs, RTTY converters, or other devices where you might want to shield the CRT. It is also recommended for photomultiplier, vidicon, and image tubes.

The important thing to keep in mind is that this is a magnetic shield. Most amateur shielding is for rf. The rf shielding capabilities of Metshield have yet to be explored.

While it was priced to compete with the solid metals, it will still come as a shock to most ham budgets, even though the price has dropped since it was first introduced. It is available in small quantities for experimental use, but at a premium price. So far it is being marketed only in seven-inch widths.

The preliminary prices, quantities, and delivery times break down as follows: 1 foot costs $25, 2-9 feet cost $18/ft. (both one week), 10-24 feet cost $14/ft. (3 weeks), 25-99 feet cost $10/ft., 100 feet+ cost $7/ft. (special order). As you can see, that is quite a hunk of change for a small hunk of Metshield. According to Allied, this compares favorably with the prices for the equivalent use of the solid metal.

For the amateur used to the surplus prices for metal scope shields, it is going to look steep. However, there aren't that many scope shields in the ads these days. But it still looks like a poor bet for most ham applications, because the price for a shield would be a major part of the overall cost of the project at that level. A ham would have to really want or need the particular properties that Metshield had to justify the cost in a ham project.

Research and development are another matter, though. As a commercial proposition, it would appear that any outfit working in an area using magnetic shielding should check out this material. It could save time, money, and inconvenience for some projects.

The same process can be used to fabricate materials with other properties. There were other possible uses for their new materials hinted at in Allied's literature. While it does not have the structural rigidity of sheet metal, the ribbon of metal itself has a very high tensile strength, an attribute that could be useful in applications of some of the other Metglas alloys.

Greg Sellers, applications physicist, demonstrates the ease with which Metshield magnetic shielding fabric can be cut. Metshield fabric is the first commercial product made from Allied Chemical Corporation's Metglas amorphous metal alloys, a new kind of engineering material.

As this whole field of metal alloys is a new and experimental area, Allied is working to find new uses and markets for the various alloys. A folder of technical data, giving a far more complex analysis of the chemistry and physics of the new alloys, is available. A note on your company letterhead should bring the information. I would think that any amateur who was prepared to pay the price for the material would have no trouble getting the literature either. I just called and asked.

For up-to-date technical, pricing, and delivery information, contact: Allied Chemical – Metglas Products, Attn: John P. Dismukes, Business Manager, 7 Vreeland Road, Florham Park NJ 07932, (201) 455-4031. ■

NEVER SAY DIE

...de W2NSD/1

EDITORIAL BY WAYNE GREEN

from page 6

regular 10m gang.

Even the 40-channel sets go only as far as 29.405, which is just high enough to be able to listen in on OSCAR 7, on the low end of its channel. These CB sets seem ideally designed to fit into a gap in amateur equipment ... I think they may be popular.

Let's set up channel 1, 28.965 MHz, as the official listening channel, and move to an unoccupied channel once contact has been made. If we are careful to always move up, we won't have to have a separate emergency channel and won't fall into the trap CBers did by not establishing an official calling channel. By not using the emergency channel for calling, there are often no ears listening.

The shortage of 10m mobile amplifiers is indeed disappointing. If we are going to get heavily into 10m mobile operation, we are going to have a big need for amplifiers. Those little 4-Watt signals don't go very far, and a pair of shoes to crank out 50 Watts would make a big difference. Sure, we can go the route of buying those damned CB linears, but almost every one of them is a disgrace. They have more spurious output than you can live with. The fact is that we have a growing need for some good ten meter linear amplifiers for legitimate ham use. Perhaps some readers can come up with some good clean amplifier

Continued on page 165

Compare the Atlas 350-XL with other transceivers . . .

TYPE	ALL SOLID STATE			HYBRID (VACUUM TUBE P.A.)			
MODEL	ATLAS 350-XL	TEN TEC	YAESU FT-301	DRAKE TR4-CW	HY-GAIN 3750	KENWOOD TS-820	TEMPO 2020
INPUT POWER	350 WATTS	200	200	300	200	200	180
BANDS	10-160M	10-80M 160M OPT	10-160M	10-80M	10-160M	10-160M	10-80M

. . . and see why it's your best buy!

Above is a chart comparing leading HF Transceivers that fall in approximately the same price range as the Atlas 350-XL. The Drake TR4-CW is least expensive, while the HY-Gain 3750 is the highest. Rated power input (SSB) and bands covered are listed in the chart, but below is a discussion on a number of other interesting comparisons which will help you choose the right transceiver for your station.

1. STATE-OF-THE-ART, ALL SOLID STATE

The first 3 transceivers listed above are all solid state. The real designs of the future! Having manufactured and sold over 12,000 of our little 210x/215x's, we can attest to the high performance and reliability of all solid state design. Tubes for the driver and P.A., with their tuning circuits and high voltage power supplies are rapidly becoming obsolete. As a result their resale value will be declining.

2.POWER RATING.

The higher power rating on the 350-XL provides you with a comfortable edge over the others. Running barefoot you can easily ride over the competition. If you're driving a linear you don't have to strain for every bit of drive from the transceiver. It can loaf along with ease. The 350 watt input rating is really very conservative. Typical input power runs upwards of 400 to 450 watts without flat-topping. Considerably more than the others.

3. BAND COVERAGE

Not only does the 350-XL cover the 10 through 160 meter bands (including all of 10 meters in four 500 kHz segments), but one of its exclusive features is that you can install up to 10 auxiliary 500 kHz ranges anywhere from 2 to 5 MHz, and from 6 to 23 MHz. This gives you great flexibility for MARS operation and possible future amateur bands. Crystals for Auxiliary Ranges are installed internally. In addition, the 350-XL provides reception of WWV at 5, 10, and 15 MHz, without having to add any auxiliary range crystals.

4. DIGITAL FREQUENCY READOUT

On the 350-XL, the optional Digital Dial can be installed, and you still retain the conventional analog dial, with the option of switching the digital dial off if you wish. With the Ten-Tec or Yaesu 301, you lose the analog dial if you purchase the digital dial model, making you totally dependent on the digital dial.

5. FULL BREAK-IN CW

Only two rigs offer this feature; the Atlas 350-XL and the Ten-Tec ! The others are all "semi-break-in". And the Atlas includes CW sidetone with pitch and volume adjustments.

6. NARROW BAND CW FILTER

This is another standard feature in the Atlas, optional on the Ten-Tec , Yaesu, and Kenwood. Ours is an I.F. filter with 500 Hz bandwidth, and shape factor of better than 3 to 1.

7. A.F. NOTCH FILTER

This 350-XL standard feature permits nulling out heterodynes and other interference. The Yaesu, Hy-Gain and Kenwood include a similar feature.

8.SPEECH COMPRESSION

The standard Atlas ALC system provides up to 20 dB of R.F. compression which increases your talk power and at the same time reduces "flat-topping" and splatter. An optional speech processor to provide up to 20 dB additional A.F. compression will be available soon for installation in the AC supply. The Hy-Gain, Kenwood, and Yaesu also provide some form of speech processing.

9. AUXILIARY VFO

All of the rigs listed offer an optional second VFO for split frequency operation. But Atlas is the only one with an Auxiliary VFO that is not an add-on box. The Atlas Auxiliary VFO plugs right into a space provided in the upper right hand corner of the front panel. Although miniature in size it tunes the same 500 kHz as the primary VFO, and does it smoothly with coarse and fine controls that have 10:1 planetary drives. Green, yellow, and red LED's let you know which VFO you have set up for receiving and transmitting. Very neat, and all self-contained.

An option to the Model 305 Auxiliary VFO is the Model 311 crystal oscillator that provides up to 12 crystal controlled channels. It also plugs into the front panel just like the 305. Vernier controls provide fine tuning of the crystal frequency.

10. MOBILE/PORTABLE OPERATION

The Atlas, Ten-Tec , and Yaesu, being solid state, are unique in that they will operate mobile or portable directly from a 12-14 volt DC battery. Also, the solid state rigs are considerably smaller and lighter weight than the hybrid rigs. The Atlas is unique in having a very handy plug-in mobile bracket for the 350-XL that makes it a simple matter to plug-in and go mobile.

11. OTHER 350-XL STANDARD

FEATURES include R.I.T., VOX, Crystal Calibration, ANL, and Noise Blanker.

Compare the Atlas 350-XL SSB-CW Transceiver with the others, and we think you'll agrea the Atlas has everything you'll ever need in a transceiver. And it's made in America.

And let us not forget to mention Our Customer Service which is second to none. Just ask the ham who owns one.

Model 350-XL (less options) . . . $995.
Model DD6-XL Digital Dial . . . . $229.
Model 305 Auxiliary VFO . . . . . $155.

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We're very proud that every Atlas transceiver is made right here in America, (as are the Ten-Tec and Drake). We think the American worker, and our employees in particular, are the most talented, industrious people in the world. The quality and versatility of our transceivers are proof of this.

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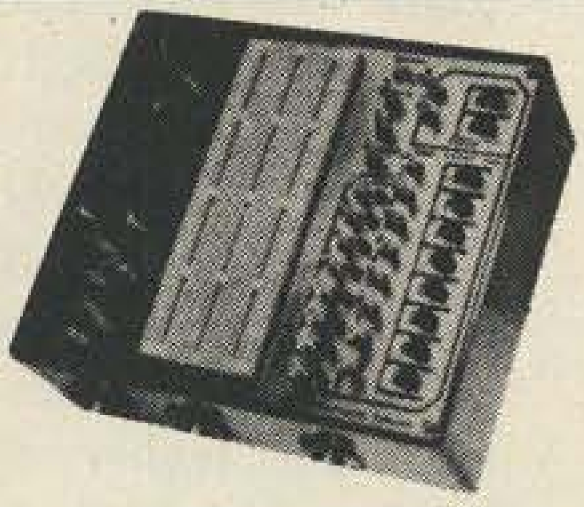

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FOR THE RADIO AMATEUR, THE STUDENT, THE EXPERIMENTER OR DESIGNER

SPECIFICATIONS: OUTPUT VOLTAGES: +5V, +12V, −12V; USABLE CURRENT: 750mA; % Regulation at 500mA: 0.2%; Short-circuit limited at 1.0 amp; Thermal overload protected. Power requirements: 117VAC, 60HZ, 40 Watts. Function Generator: Frequency range: 1HZ to 100 HZ in 5 bands. Amplitude adjustable from 0 to 10 VPP. DC offset adjustable from 0 to ± 10V. Waveforms: Sine, square, triangular and TTL Clock. TTL Clock 0 to +5V level, 200 ns rise and fall time, Frequency determined by Function Generator. Output impedance 1.2K ohm.
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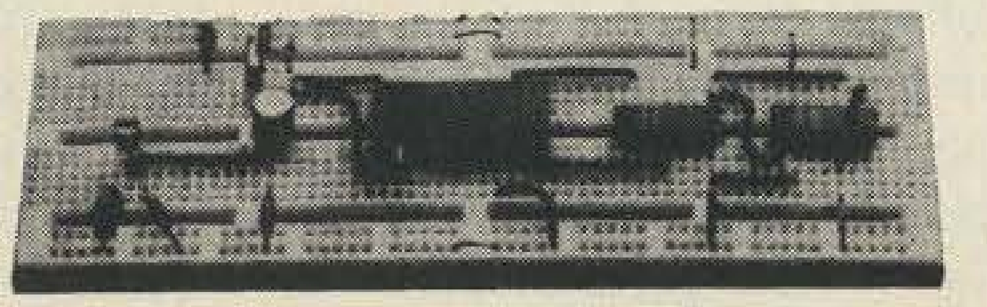

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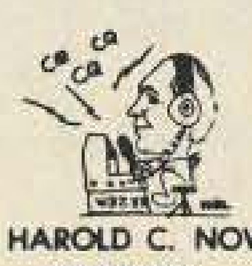

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Build A Simple Capacitance Meter

-- a useful weekend project

A time-honored and very practical supplier of components for the latest ham project continues to be the junk box. A well-stocked junk box not only reduces the cash outlay of a project, but also serves as a source of comfort and inspiration to the happy owner.

A major factor limiting the utility of these readily available goodies is the difficulty of identifying them properly. The number of articles describing transistor checkers, IC probes, and programs for identifying and checking ICs points not only to the popularity of the junk box source of supply, but also to the difficulty mentioned above.

Capacitors are a part of this problem. It seems that the original equipment manufacturers, the source of many of these components, delight in concealing the true value with an esoteric part number. And the military is even worse.

Cheer up! All is not lost. Described herein is an unbelievably uncomplicated and cheap device that will go far toward blowing the cover of all those mysterious micas, discs, and ceramics smirking at you from your hoard.

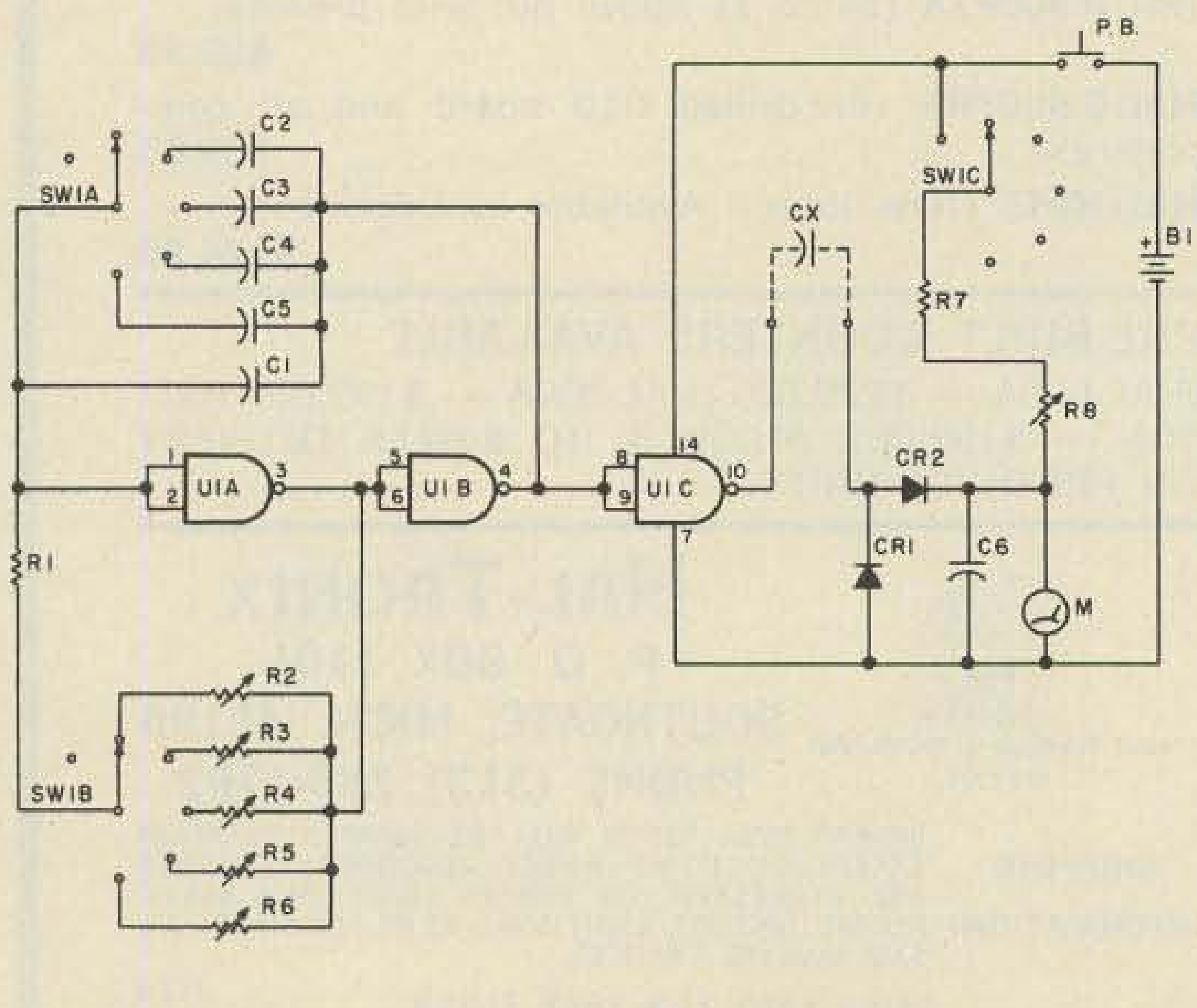

Fig. 1.

The Circuit

As advertised above, this little device is ridiculously simple and inexpensive. It consists of an oscillator and a rectifier, with a meter to indicate the value of the rectified current. Let's refer to Fig. 1 and be a bit more specific. U1A and U1B are two NAND gates of a CMOS quad two-input NAND gate. You can get one for 29¢ if you don't have one. These two gates are cascaded, biased in the linear mode by the resistor network, and caused to oscillate by capacitive feedback around the two gates. The output is a square wave which is buffered by the third gate U1C to insure an output of constant amplitude. We apply the output of the buffer to the diode rectifier through our unknown capacitor. If the unknown capacitor is small (has high reactance) in comparison with the frequency of the oscillator, it will pass a small pulse on each cycle which will be rectified by the diodes. The meter will read the sum, or integral, of these pulses. The larger the value of the capacitor, the larger the pulses, the greater the sum and the higher the meter reading. Simple, isn't it?

This is a basic counter circuit. With a given value of capacitor, if the oscillator frequency is increased, there will be more pulses per second, thus a higher integrated meter reading. This forms the basis for a very simple and useful counter which is linear over quite a few octaves. We are simply turning the circuit around to measure capacity instead of frequency.

Circuit Details

The circuit was set up to use a 1 mA meter movement. The values shown in Table 1 list the oscillator frequency, capacitor and resistor values for a 1 mA meter movement. There are five ranges arranged as decades. The lowest range is 0-100 pF, the next 0-1000 pF, etc. Each range is linear, so it is quite possible to read a 5 pF capacitor on the lowest range. The highest range then reads full scale on a 1 uF capacitor.

It would be inadvisable to use a meter with less sensitivity than 1 mA if the 0-100 pF range is desired. Note that with the 1 mA meter, the oscillator is running at a frequency slightly greater than 1 MHz. This is approaching the

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Simple Sequential Decoder

-- for uncomplicated repeaters

A local group recently came to me with a request for a simple controller for a single repeater. Their requirements called for a three digit control code, but the first two digits of the on code and the off code could be the same, such as 523 on, 524 off.

Since I would not need the entire 12 digits decoded, my previously described (*73*, April, 1976) decoder boards would fill the bill for the required digit decoding. Each one of the boards will decode two dual-tone digits in the same row or column and provide a logic output. This particular application requires four digits, or two of the decoder modules. By using these boards, I only had to design the function decoder circuit.

The group that had requested the decoder had also requested that I use TTL, so the design herein is standard TTL. The design would lend itself to use of CMOS with very little change in circuitry.

This article will not go into the digit decoders since 567 type decoders have been adequately covered in previous issues of this magazine by me and many others.

Circuit

The circuit is shown in Fig. 1. The digit decoders are not shown, but TTL compatible logic inputs are assumed, which go to a high state when a digit is decoded.

The four 1N914 diodes form an OR gate which triggers U3A, one half of a 74123 monostable, thus creating a clock pulse with each digit received. The 2.2 uF capacitor on the input of U3A is to eliminate the bounce or ringing on the digit decoder inputs.

The clock output is taken from the Q output of U3A, while the $\overline{Q}$ output is used to trigger U5, a 555 timer. The 555 timer is set for a period of about 8 seconds. At the end of that period, the timer triggers U3B, which in turn resets all of the logic except for the output stage. Going back to the input, coincidence of the logic high at D1 and the clock pulse cause the output of U1A to go high, enabling gate U4A. Now, if digit D2 is received, a high will appear on the D input of U1B and a clock pulse will set the output of U1B high. Note that if either D3 or D4 had been received instead, the resulting clock pulse would have had no effect on U1B and would have reset U1A to its low state. The high on the output of U1B enables gates U4C and U4D, making them ready for the third digit. If the third digit was D3, then U4D would have turned U2A on, while if the third digit had been D4, then U4C would have turned U2A off.

Even though both stages of U1 will wind up reset at the end of a three digit sequence, I provided an automatic reset timer mentioned earlier. I found in an earlier system, where the automatic reset had not been included, that the system would eventually turn itself on or off from noise or power glitches interpreted as digits. The timer consists of the 555 and the second half of monostable U3. At the end of the timing period, the 555 triggers U3B, which resets the flip-flop, U1A, B.

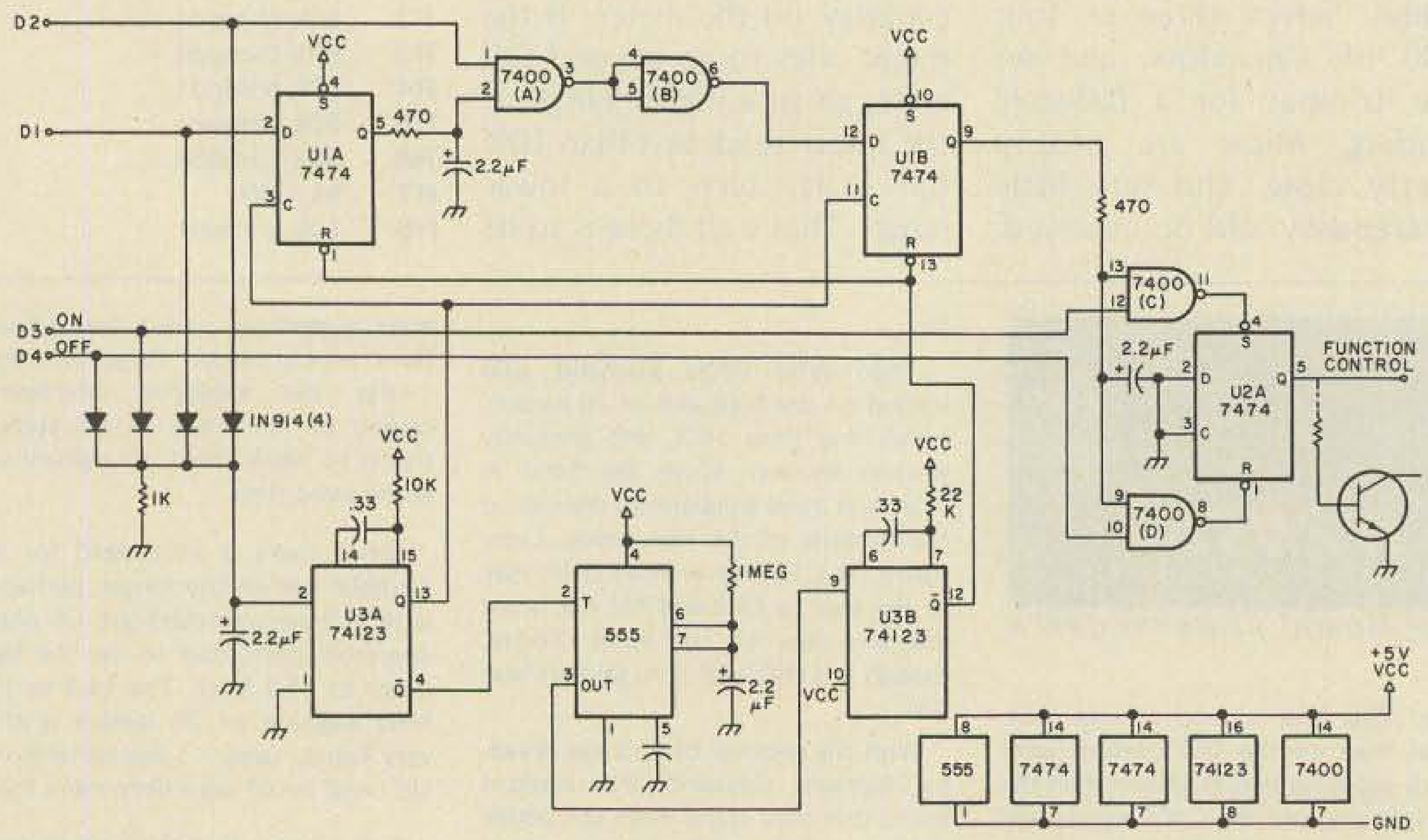

Fig. 1. Schematic diagram of the function decoder. Inputs D1-D4 are the digit decoder logic inputs which should go high when a digit is decoded. A 7805 regulator is not shown but was used. Transistor Q1 is meant to be representative of a typical output control circuit.

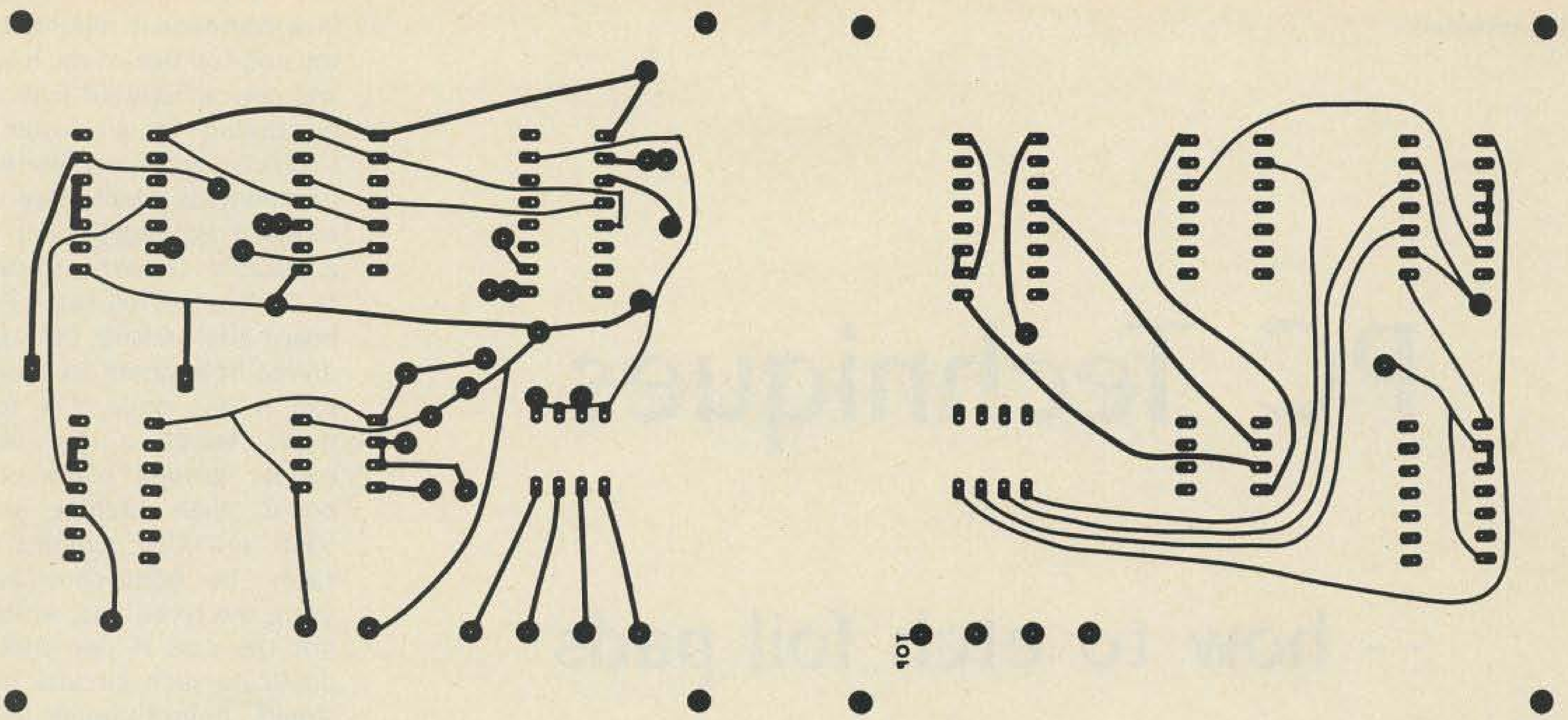

Fig. 2. Printed circuit board for the function decoder shown full size.

Although it is not shown on the diagram, I used a 7805 type voltage regulator to run the system from a 12 volt line. The digit decoder modules have built-in 5 volt regulators.

Conclusion

The function decoder has performed very well so far. If 567 decoders are used, you must be careful with the audio input level to prevent false decoding.

I made a printed circuit board for the function decoder and the artwork is shown in Fig. 2. A parts layout is shown in Fig. 3 and a parts list is included at the end of the article. Printed circuit boards and assembled units are available from Contact Electronic Research and Development, 35 W. Fairmont, Tempe AZ 85281. Write for pricing and availability. ■

Parts List

R1 — 1k
R2, 5 — 470
R3 — 10k
R4 — 1 meg
R6 — 22k
All ¼ W 10%

C1, 2, 4, 5 — 2.2 uF/10 V
C3, 6 — .33 uF/50 V

U1, 2 — 7474
U3 — 74123
U4 — 7400
U5 — 555

Diodes — 1N914 or 1N4148
PCB — Contact Electronic Research and Development, 35 W. Fairmont Dr., Tempe AZ 85281

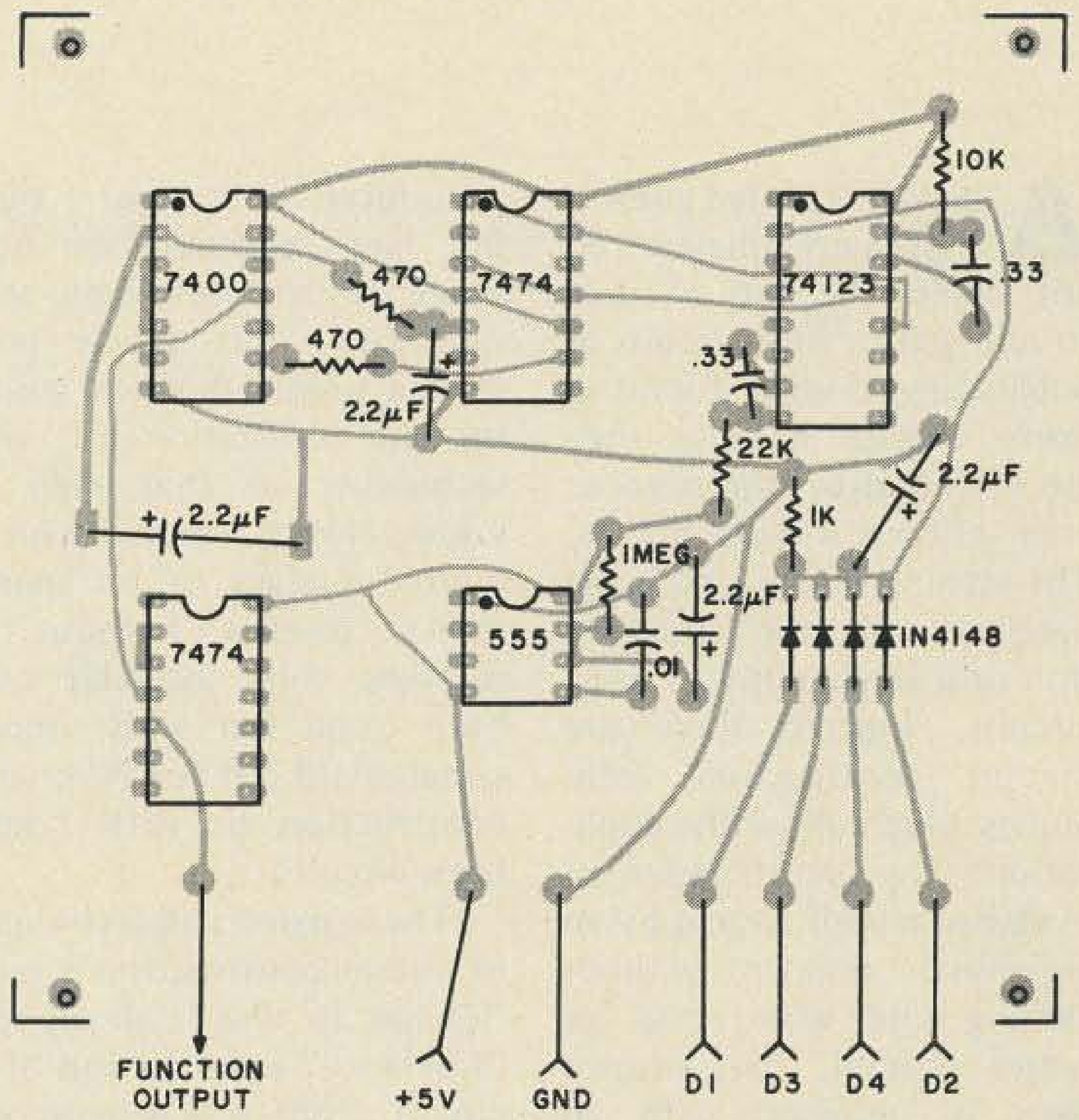

Fig. 3. Parts placement for the printed circuit board of Fig. 2.

EDITORIAL BY WAYNE GREEN

from page 165

serious a problem as it might seem at first thought. With the exception of Canadian stations, propagation manages to isolate the US from the rest of the world for many hours of the day. I've operated from countries all around the world, almost always using the US phone band, and I've seldom had any problem working anything I wanted to. During those few hours when the US was coming through, I had my choice of US or other DX . . . the rest of the time it was just other DX. It just wasn't a problem above 14.2 . . . so why should it be one below?

While I don't want to aggravate my many Canadian friends, I just wonder why they rate a special phone band. They seem to be running as much power as we are and be able to work out fine in the US phone band when they try. It doesn't seem reasonable to preserve this 100 kHz band of the most valued shortwave ham frequencies for one country . . . and that is about what it amounts to.

If any Canadian amateurs have some good reasons for this special treatment, I'll be interested in hearing from them . . . and will be glad to pass along their information. Otherwise, I think it is high time US amateurs entered a petition for the FCC to extend the phone band down to 14.1 MHz.

SIXTEEN VS. EIGHT

More and more 16-bit microcomputers are being brought out, and not a few readers are asking about them. Obviously, a 16-bit machine can do a lot more work than an 8-bit computer . . . and faster. Heath is giving us the choice of either 8-bit (H8) or 16-bit with their H11 (why not H16?), so the question of which is better may be an immediate one for a lot of incipient computer hobbyists.

First, before getting into any details on the relative merits of 16 vs. 8 bits, it might be worthwhile to explain just what the difference is between the two.

Most of the microcomputers are

Continued on page 169

73 Magazine *Staff*

PC Techniques

-- how to etch foil pads

A good calculated guess is that many amateurs do not enjoy the fun of constructing their own circuits or duplicating circuits found in many articles because they are inhibited by the need to etch printed circuit boards. The etching of a board is not necessary for the construction of a single copy of most circuits. Indeed, there are circuit construction techniques which allow the duplication of a circuit presented in etched circuit format by an individual builder without etching and with equal or better circuit performance than is obtained with an etched board! One of these techniques is the so-called isolated pad technique of utilizing single side, copperclad PC boards. The technique is not new, having been introduced several years ago. But most amateurs are not aware of its usefulness and simplicity. This article presents a simple, practical guide to the utilization of the technique, so that even a young Novice operating on a limited budget or an apartment dweller without a machine shop available can have some fun with simple circuits laid out for PC board construction or with home brew circuits.

The isolated pad technique of circuit construction is very flexible, in that it allows the "freelance" construction of a circuit from a schematic or the duplication of a simple etched PC board layout.

The basic idea of the isolated pad is illustrated in Fig. 1. A single side copperclad PC board is used, in which a hole (1 mm) is drilled where a connection point is to be made. See Fig. 1(a). Then, a special tool is used to remove the copper from the board around the hole, except for a "pad" of copper left immediately next to the hole. See Fig. 1(b). This "isolated pad" can then be used to wire in a component mounted on the non-foil side of the board, and several isolated pads can be drilled in a cluster to interconnect components. Components which have one terminal grounded have the applicable terminal soldered to the copper foil side of the board after passing through a drilled hole where an isolated pad is not made. The technique leaves a far larger copper ground plane on a board than etching does. VHF and UHF circuits can easily be home-constructed using the technique, which is not the case if one tries to duplicate such circuits using simple point-to-point wiring on plain perforated board stock.

When constructing a circuit from a schematic, the circuit can pretty well be laid

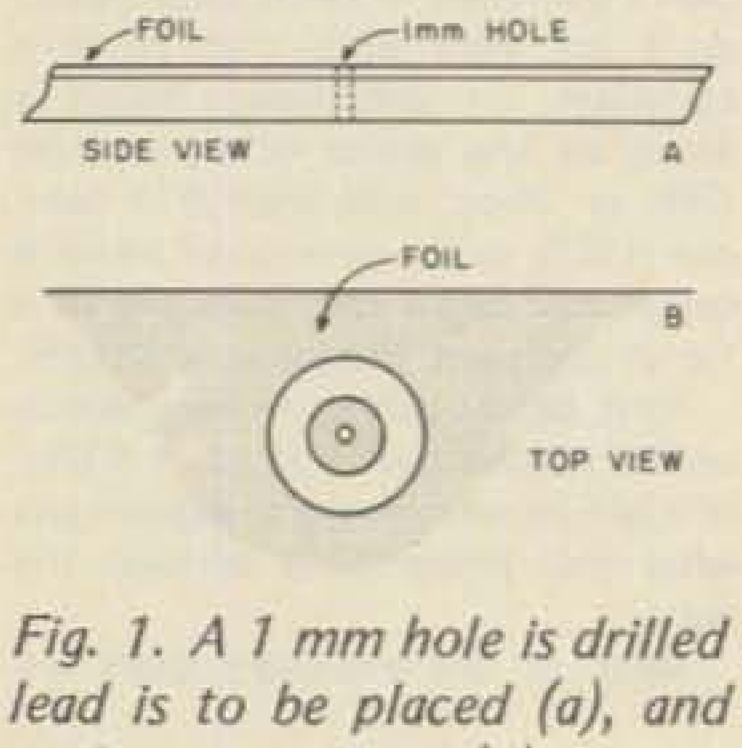

Fig. 1. A 1 mm hole is drilled in the board where a component lead is to be placed (a), and then the isolated pad is formed with a special tool (b).

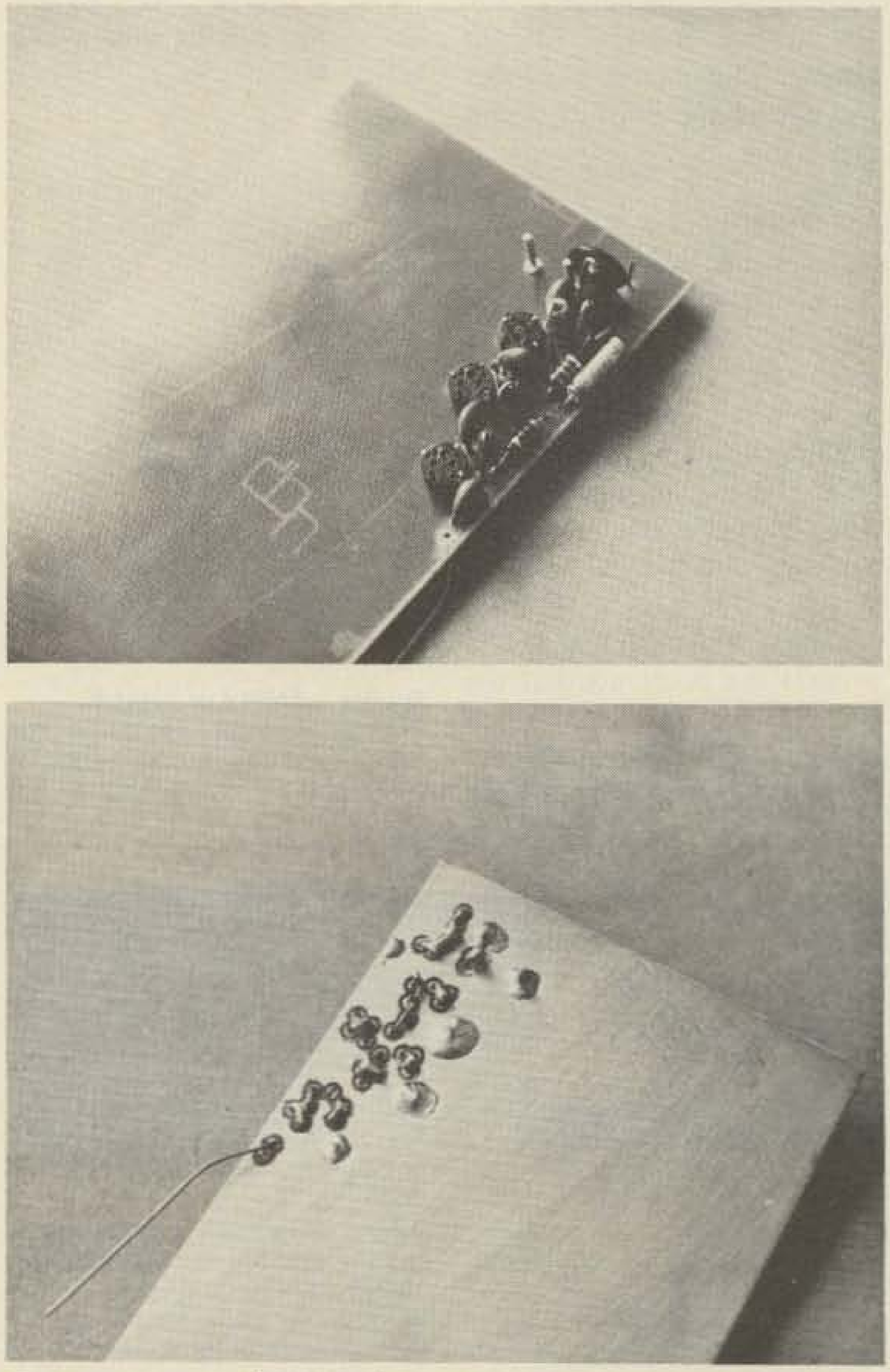

Fig. 2. The top (non-foil) side of a board containing a three stage amplifier, and the bottom (foil) side showing the isolated pad interconnection points.

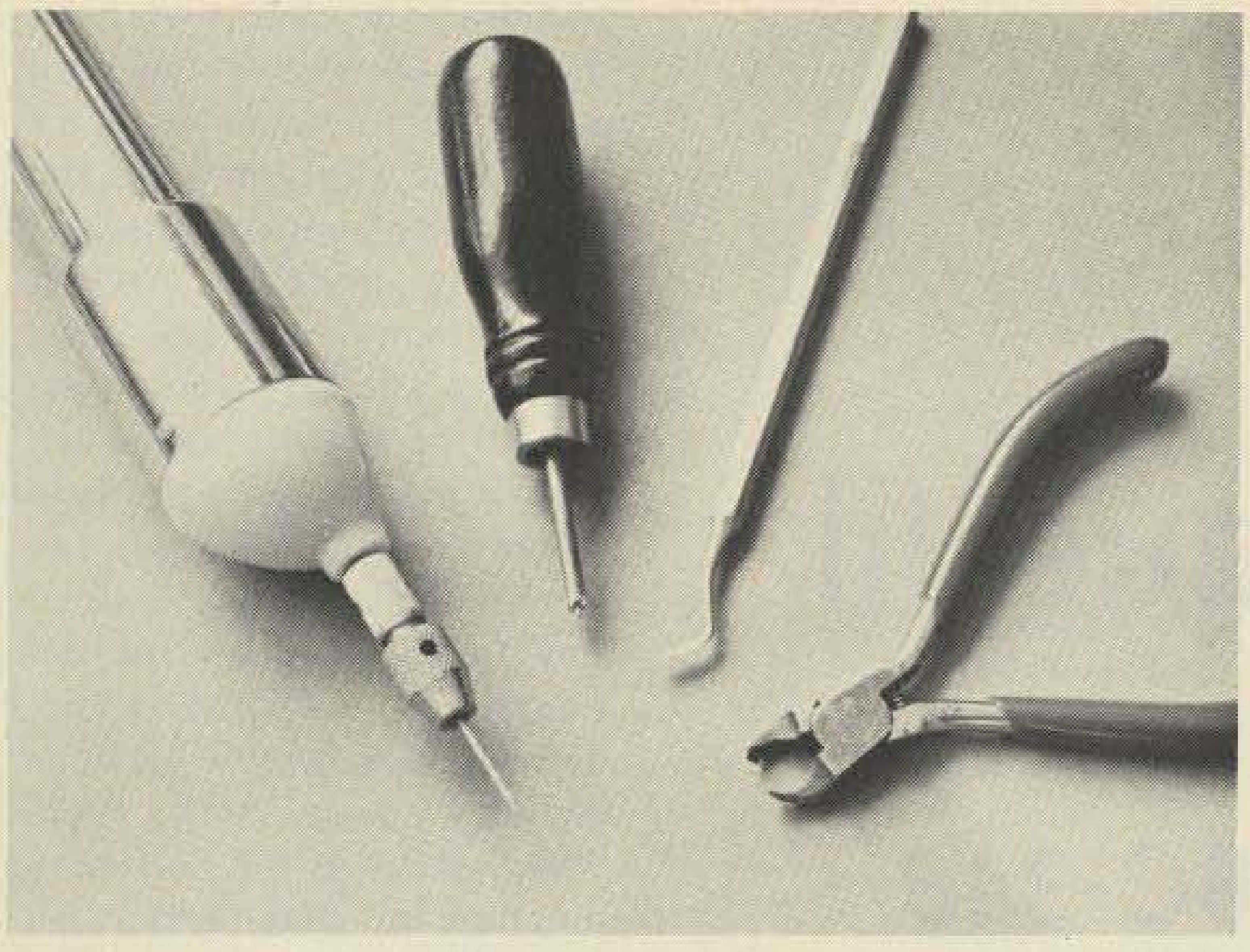

Fig. 3. A few special tools facilitate isolated pad wiring.

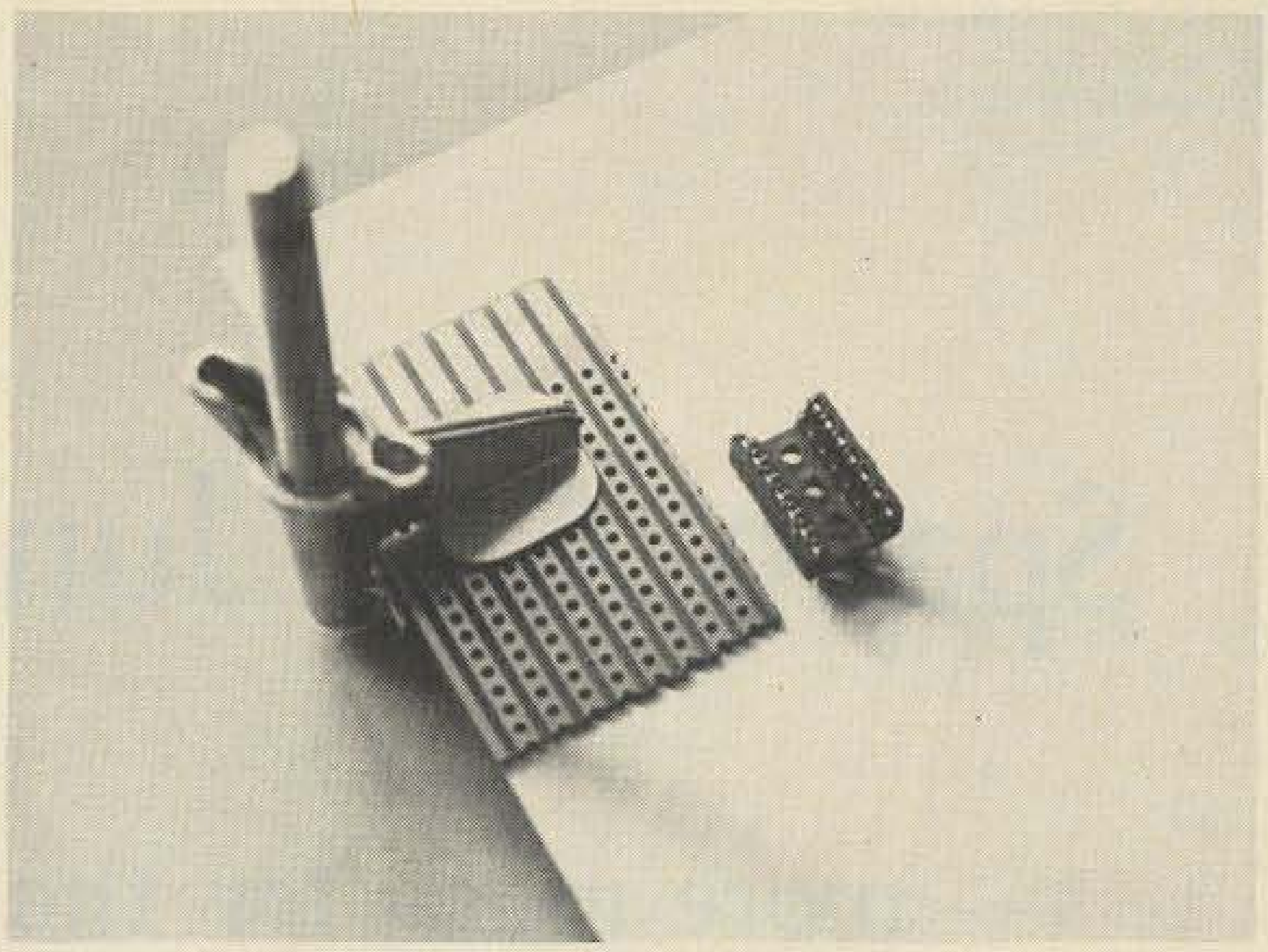

Fig. 4. A "mask" can be used as a drill guide for any special pattern. In this case, a piece of perforated board stock is used as a guide to drill holes for mounting an IC socket.

out by following the basic layout of the components as shown on the schematic. For instance, Fig. 2 shows both sides of a board which contains a 3 stage amplifier. The components are grouped around the transistor sockets much as they would be shown on the schematic. For more complicated circuits, one does, of course, have to do a bit more preplanning to avoid drilling excess holes and having jumper wires all over the board.

Simple etched PC templates can be duplicated by placing the template over the board and drilling holes at all the locations designated for component mounting. Then only those points which are not grounded are provided with an isolated pad and jumpers are used to interconnect points. In most circuits, one end of most components is grounded, so the work involved is not too great. The technique will not work, of course, to duplicate a PC layout with 10 ICs and interconnection lines running around like the L.A. freeway system.

A few simple tools and techniques make usage of the isolated pad technique simple and versatile. The main tools needed are shown in Fig. 3. A hobbyist-type battery-operated drill with a 1 mm bit is used to drill the board at the desired locations. If one lets the drill do the work and doesn't try to "push" it through the board, this simple drill will very readily work with any PC board. The isolated pad is cut with a commercial tool (Vector Co. type P138C or P138). These tools come in a version with a handle, as shown (P138C), or as a drill-type insert (P138) to be used with any small drill. There are tools available to cut various size pads, but the P138 pad size of .125" is just right for most work. Most large electronics supply houses stock Vector parts, or one can write to Vector Electronics, 12460 Gladstone Ave., Sylmar CA 91342, for distributor information.

The next tool in Fig. 3 is a small dental scraping tool. It is very useful for cutting away the bits of copper that might remain if two pads are cut with some overlap so a interconnection point can be made. An X-Acto-type tool with the proper blade can also be used, but the dental tool is superior. The latter are not available from electronic distributors, although your dentist might part with a used one after you pay your next dental bill. The last tool is a 45° flush cutter. It is much more useful than the usual diagonal cutter for trimming leads close to the board.

ICs and transistors in any type of case can be mounted on the board either directly or by using sockets. To drill the necessary hole pattern for the socket or device pins, a "mask" is used, as shown in Fig. 4. The mask is just a piece of perforated board stock which has the correct hole spacing for IC pins. A mask can be made for the round-type cases (T0-99, etc.) by removing the pin holders from a suitable socket and then using the socket as a mask.

The isolated pad wiring technique has its limitations, but it does allow a builder with a minimum of space and resources to build circuits in a manner that is electrically advantageous and as neat and compact as any small etched PC layout. ■

EDITORIAL BY WAYNE GREEN

from page 167

8-bit systems. They are designed to work with 8-bit microprocessor chips such as the 8080A, the Z-80, the 6800, and the 6500-series. Since it takes 16 bits to give the address of any memory location, the 8-bit systems have to take two cycles to handle each memory address. The address is split into a high order and low order address. Then it takes a third cycle to handle the 8-bit character which is in that address.

Why 16 bits for the address? If you get your fingers out and do some binary figuring, you'll see that it takes that many binary numbers to count to 65,536 . . .the number of memory locations most microprocessor chips are equipped to handle.

And why was 65,536 (also known as 64K) picked as an optimum memory for microcomputers? Given the choice of 256 bytes for one machine cycle, 64 kilobytes for two machine cycles, or 16 megabytes for three machine cycles, the two-cycle was the most practical. Most microcomputer programs can be handled within this amount of memory, so it is the most efficient.

A good BASIC interpreter requires about 16K. Add another 12K for a fair-sized program and you still have plenty of memory available for working. If you are processing a mailing list where each name and address requires 80 bytes of memory, you'll have room to handle two to three hundred names at a time for sorting, printing, etc.

A 16-bit system can handle the entire memory address in one machine cycle, and thus is a lot faster in operation than an 8-bit machine. On small jobs, this may not be a factor of any significance . . . but if you are interested in sorting out a 10,000-name list, then the time for handling each operation becomes interesting. Obviously, there has to be a reason that firms buy $100,000 computer systems instead of $2,000 systems, and speed is a big factor. The more expensive systems are also capable of

Continued on page 171

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Space Age Junque III

-- more mods for the BC-348

If you have been following parts I and II of this series of articles covering the modification of the BC-348 and like receivers, you will already know my end desire is to allow those of you lacking in funds (most of us?), or not having the corner radio store access of many U.S. hams, to build (or really rebuild) a receiver that will compete with the best on the market today. I assure you it is possible, because you can devote the necessary care and time to the receiver that mass production just won't allow.

The purpose of this part III is to add on two relatively simple circuits the BC-348 does not possess when purchased. Since they are somewhat dependent, I have included them both in one article and one circuit board. This circuit board and the assurance the circuit works in the BC-348 is really all I am providing in some parts of this series (this one), as the circuits are someone else's. I am only bringing together from many sources and, where possible, providing the how-to, a circuit board, the wire-in information, and help where possible by your follow-up mail. May I credit at this time the origin for this time's circuits. The audio-derived AVC is by EI4R in an earlier *73* issue, April, 1966. The S-meter is the best combination to date, and is by R. L. Winklepleck from *Popular Electronics*, February, 1963. The S-meter is really a simple VTVM as pointed out by the author.

Discussing the circuits for a minute, the audio-derived AVC is a necessity if you hope to be serious about SSB type reception. As we go along and add crystal-controlled type BFO (LFO) to the BC-348s we are working on, something obviously must be done to provide AVC during SSB reception. It is tough

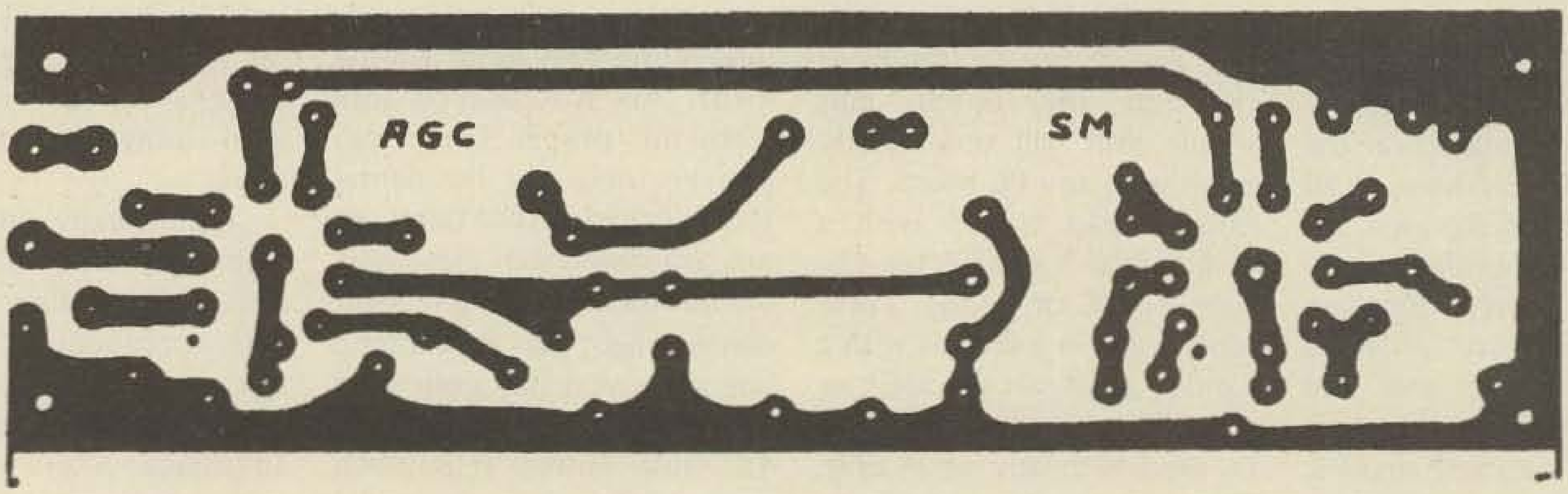


Fig. 1. PC board.

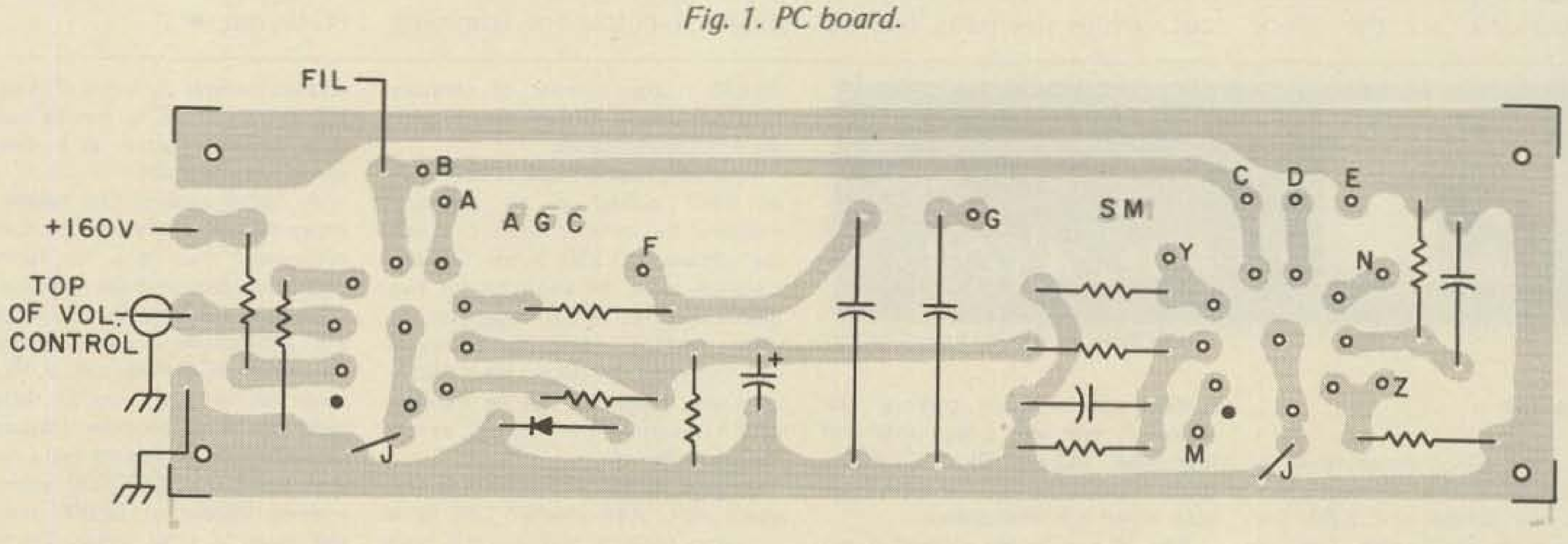


Fig. 2. Component layout (foil side view). J used on 6.3 V models; also jumper A to B, C to D. 28 V models: Omit (2) J; Fil to A; jumper D to E.

to get carrier-derived AVC out of a system that has no (little) carrier of its own upon reception. One half of the enclosed circuit board takes care of that. Since the S-meter works off of any AVC involved, I went ahead and put it on the same board. As usual in this series, some of the parts are left off the board for either size, convenience, or, as in some cases here, the desire to locate them where *you* want them (i.e., S-meter — panel, separate box, with the speaker enclosure, etc.).

The AVC circuit is really quite simple to build now that there is a circuit board, and just as simple to get running. The input is taken from the top (hot) end of the volume control (full volume at all times, regardless of volume control setting), and feeds the first tube's grid. The volume control forms the grid resistor, so do not ac couple at this point. The second half of the 12AU7 triode (dual) is used to allow separate time constants to be applied to the AVC line than are applied to the S-meter circuit. The switch S1 allows you to have more than one AVC constant for the receiver itself. It can just as easily be multi-position rotary, and many time constant choices be made available. On the other hand, the long constant presented in the second half grid circuit allows steady enough readings for the S-meter. The author stated "any crystal diode" for use in the cathode, and we have found the 1N60 specified in the schematic to work quite well for our purposes. That really sums up the AVC circuit, except how to connect it into the BC-348. Begin by any connection to pin 5 of V7 (6B8) going to either the 1.5 megohm resistor to ground (52) or the 220k resistor (53). Connect the AVC line into this point. The easiest and possibly most versatile way of doing this is to run the resistor junction point to the center tap of a DPDT switch (allowing for other use for second half of switch later), and wire pin 5 of V7 to one switch direction, and the new circuit output to the other direction. The switch can be marked AVC audio/carrier or something of that nature.

Continuing on with the S-meter circuit, it is even easier. I made the input connection for you on the board. All you need to do is add the external plate load resistors in the form of a 20k pot with the ends going to M and N and the center tap going to +160 volts. Also, you must add the meter and its series limiting resistor between Y and Z. Be sure to get the meter polarity right. The adjustment of this part of the circuit is quite easy. Warm up both the receiver and the new circuit (tubes have *one* disadvantage!), then remove the antenna from the input. Adjust the balance pot for a zero reading on the meter.

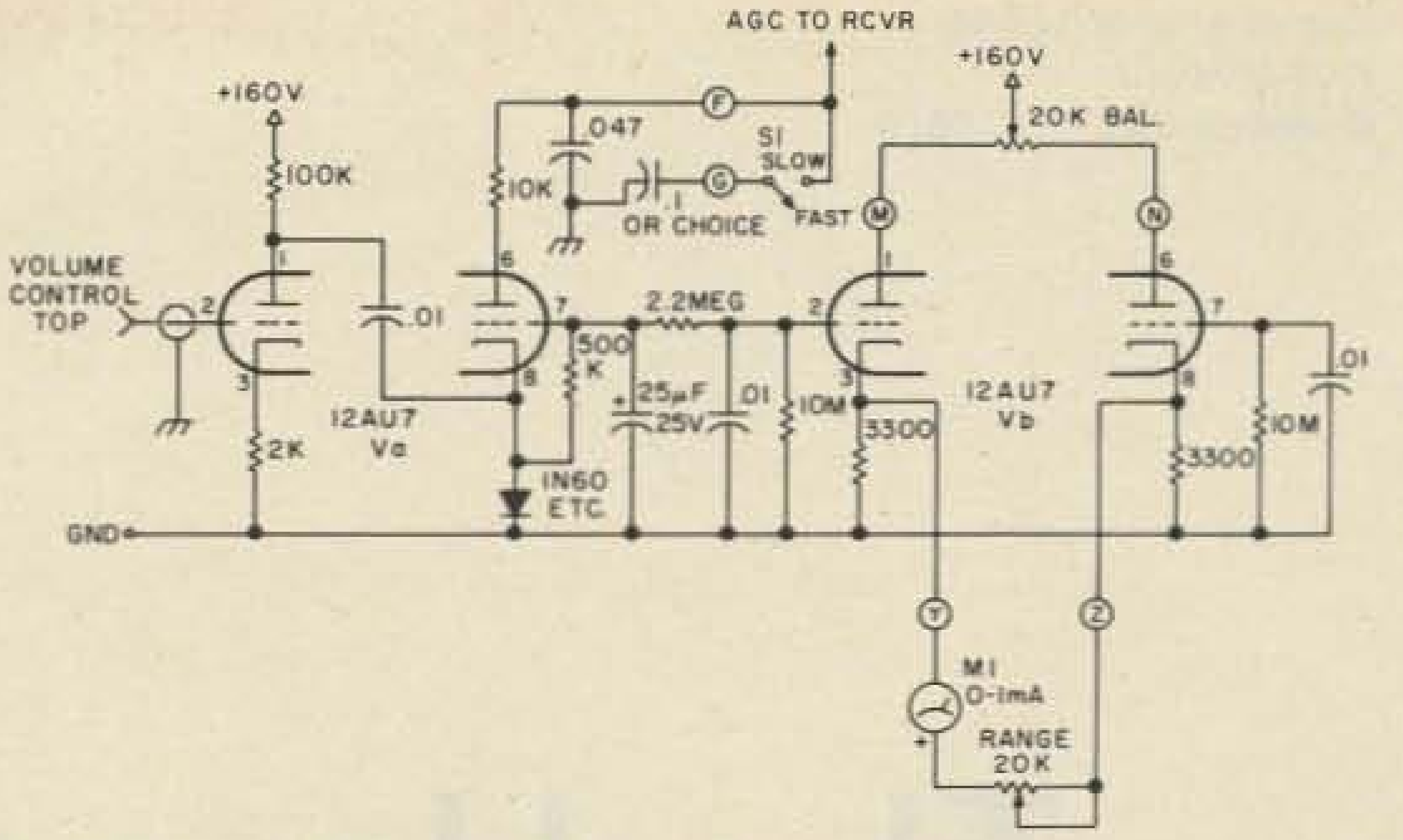


Fig. 3. Audio AVC on left (EI4R, 73, April, 1966). S-meter on right (R. L. Winklepleck, Popular Electronics, *February, 1963).*

Reconnect the antenna and tune in the strongest signal you can find and adjust the range pot for almost full scale reading. This gives about the accuracy of the average S-meter in any receiver (none), but will satisfy all but the purist, since the function of the S-meter is basically to compare relative signal strength anyway. For the more ambitious, we will go into a better calibration at a later date, as it requires you have more in the way of test equipment.

With a circuit board to work with, a loading diagram, and the circuit descriptions given, I believe I have about covered all you need to add these additions (our modification M-11) to your receiver. As with most of the modifications we are providing, you adventurers can add them to like or similar receivers at your own discretion. Just bear in mind I may have trouble helping you if you pick a receiver I am not familiar with, so you are on your own!

The only addition I can think of is, if you wish to use the S-meter on carrier-derived AVC as well, wire the board in accordingly. This involves removing the 2.2 megohm resistor from Va7 to Vb2 at the Va7 end only. Then run a wire from the center tap of the earlier mentioned switch (audio/carrier) back to the loose end of the resistor. This connects the S-meter to whichever AVC is in use instead of only the audio AVC output.

I will be back to writing again soon, and part IV will not be long behind this one. To wet your whistle, it includes a front end improvement (S-9er revisited), and sundry other "goodies." Until then, thanks for the 100% SASE rate so far (it sure helps!) and happy building! ■

EDITORIAL BY WAYNE GREEN

from page 169

handling several terminals simultaneously, each working on a different program . . . and this is because they work faster and use more memory.

Even an 8-bit computer can handle four to eight terminals and not tie up the users too badly if the computer is not going to be tied up with time-consuming calculations or sorting procedures. You have to fit the machine to the job you have for it.

As a rule of thumb, it is probably safe to say that few hobbyists or even small businesses actually need anything faster than an 8-bit computer. Mailing list sorts, which can tie things up, can be set to perk over night, rather than during prime time. In almost all cases the computer is going to be a lot faster than the operator, so it will be waiting for your input.

One other factor which has to be considered is the programs available for each of the systems. Now that the 8080 chip is three years old, there is a wide variety of programs which can be had for it. Don't sell the need for programs short. Sure, you can learn to write programs, but even when you are an expert you are going to want to buy a lot more programs than you are going to write yourself. It just takes too damned long to work out and perfect (debug) good programs.

While it *is* possible to write programs in machine language or assembler, you'll notice that few are being written that way. Too slow. The programs for microcomputers are being written in BASIC for the most part . . . and this is possible because there are BASIC language interpreters available for most of the computer systems on the market. Yes, I know there are dozens of different BASICs, but they are all similar and hopefully we'll gradually zero in on a standard BASIC. In the meanwhile, we're trying to publish BASIC-to-BASIC conversions in *Kilobaud* magazine.

Since 16-bit systems are new to the computer hobby world, there are few machine language programs available for these systems. As long as BASIC is

Continued on page 183

Dan S. Wise WA4BBU
P.O. Box 663
Bessemer City NC 28016

The Ham CBer

-- it could happen

We hear more and more every week about drafting some of the overly populated CB gang into the ham ranks. The idea here is that we would increase the number of amateurs, which would provide a better service. I, too, am in favor of helping potential hams get into amateur radio, but only to the extent that I believe it helps amateur radio. In fact, I would not be a ham myself if it weren't for the help of other hams. However, I had to sell myself to them first. I'm not sure I would be a good amateur if they had begged me, or if they had made it too easy for me. I think we should continue to draft CBers, but with quality in mind instead of quantity. In fact, I have personally written articles in the CB magazines explaining amateur radio.

Recently, I read in one of the ham magazines a proposal that the FCC allow amateurs to operate on the CB channels using their own call letters, the idea being that the amateur could help change the bad habits of the unlawful CBer, and help the FCC at the same time.

This reminds me of the preacher who tried to stop a group of church members from playing poker; however, while he was talking to them, he lost $53.67. I believe the amateur would be taking part in the unlawful operations instead of changing it.

I see a typical QSO as follows:

Ham: Hello CQ, Hello CQ, this is WA4BBU.

CBer: How 'bout that, ham; bring it on back one time to the Fat Albert.

Ham: Okay, let's see; I believe you said your handle was Albert, but I didn't get your call. The call here is Whiskey Alpha 4 Bravo Bravo Uniform. So back to you, old man.

CBer: (Difficult to understand this time; he has increased his power mike and is now overmodulating) How many pounds am I hitting you with? Kick it back.

Ham: Okay. Your signal strength here is 10 dB over S-9, Albert; we're running the Johnson Viking 23A here with 5 Watts input. So back to U, Albert; this is WA4BBU.

CBer: Okay ham, this is the Fat Albert back at U one time. We're running a converted Yaesu 101E with a slide channel switch and a SB220 flat out. What be your 20?

Ham: Okay, Albert. Fine business on the rig. We're located in Bessemer City, NC. I won't hold you any longer, but I still didn't get the call. So if you would pass it along to me on your final, 73 to U. This is WA4BBU.

CBer: We'll back-um on down. Have yourself a fine one. 3s and 8s upon you. Keep your eyes between the ditches and the Smokey out of your britches. It'll be the Big Bad Fat Albert; we're going to be down and out of it.

Another proposal I have read recently is to reduce the requirements for becoming a ham. My thoughts here are that if you don't work for it, you won't appreciate it. We as hams are allowed to talk anywhere in the world.

There are two main reasons for this: 1. Hams usually go by the rules and regulations, especially in overseas QSOs; and 2. The ham's ability to enhance international goodwill. I have read where CBers have killed other CBers because of one interfering with the other's conversation during a QSO. So if someone from another country talks over a CBer, let's just hope he cools off on the flight over, or we'll all have World War III on our hands.

I used the phrase earlier that we should look for quality instead of quantity. An example of this: During an emergency, would it be better to have 10 people answer the call who were not experienced in emergencies, or 1 answer the call who was? Another example: Most of us who are not involved in nets still give the nets plenty of room because we know it is a vital part of amateur radio. But would somone feel the same way if he were not so interested in the hobby that he had to pass a test at least as hard as it now is?

I am sure we can get great numbers into amateur radio. We can persuade CBers by begging them, cramming code into their heads, and cheating a little on the Novice test, etc. But have we helped amateur radio? Why not let things happen naturally? Let the CBer ask about ham radio, and then be sure he is interested. Maybe he's cut out to be a CBer; that could be his bag.

I'm all for making good hams out of CBers, and if he's as interested and willing as I was, I'll help him and I'll be very proud to be his first contact. ■

F. J. Soxman W3ZVT
PO Box 375
Shaw AFB SC 29152

Ham Shack Anthropometrics

-- maximize operating comfort !

Ever worked a long contest and left the shack feeling as though you'd wrestled three rounds with a grizzly? Are you operating more but enjoying it less? Maybe your shack needs a dose of anthropometrics! This technique is used in private industry to facilitate workplace design and ease worker strain during work. Anthropometrics recognizes body limitations and visual requirements and relates these to production requirements.

Most ham shacks are set up linearly, that is to say, equipment runs from right to left on the table. Usually it will be found that, reading from right to left, it's receiver, transmitter, and linear, with ancillary equipment either stacked about or below the main pile of equipment. Some stations just grow topsy-turvily; others remain relatively static. In practically all cases, station layout pays little heed to one prime factor, and that is operability by the amateur involved.

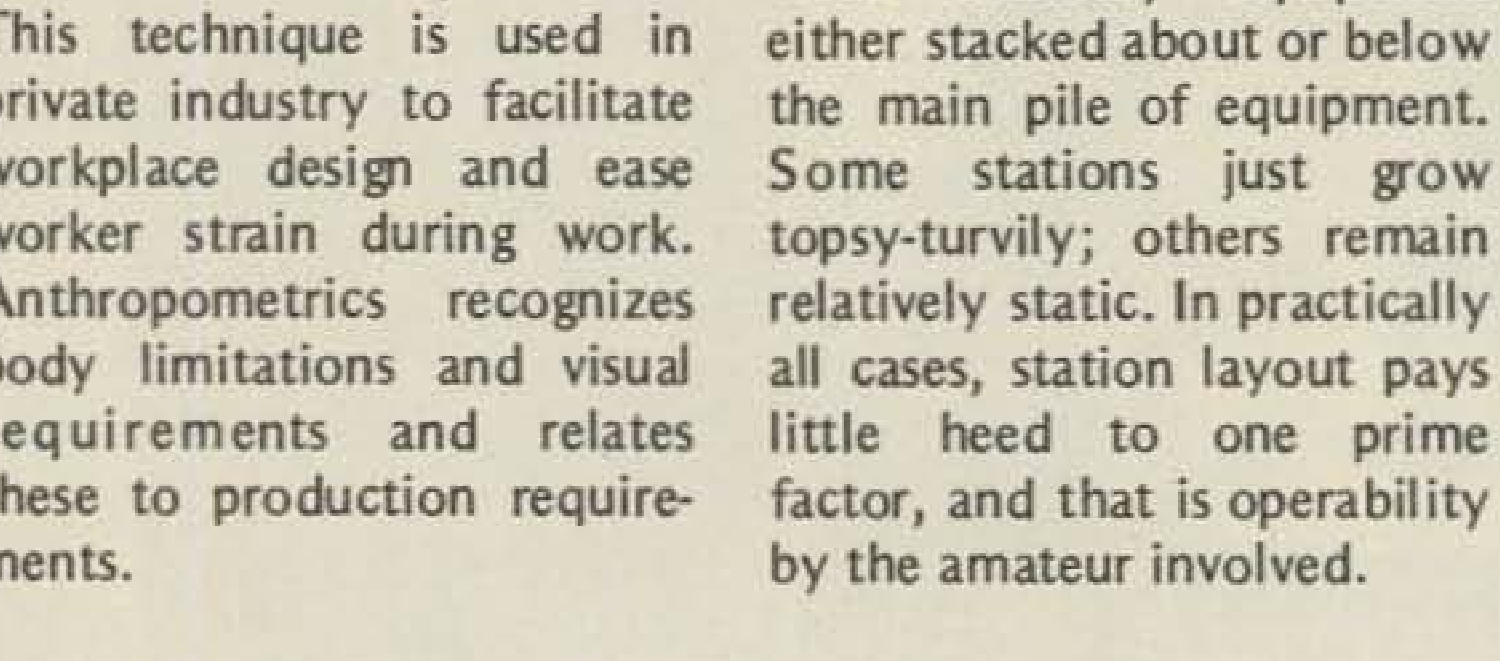


Fig. 1.

Fig. 1 is a diagram of reach for the average operator. Four arcs of reach are involved. The larger arcs are for the right and left arm at full extension; the smaller ones are arcs for the right and left arm using movements of the forearms only. It will be noted that these arcs are predicated on the trunk of the body being in a vertical position and not contributing to the reaching movements of the arms. This diagram indicates that the optimum reach areas are arcs with a radius of 30 inches which, taking body position into account, terminate 22 3/4" in from the edge of the operating desk. Forearm movements are restricted to 18" arcs with termination from the desk edge at 10 3/4". Fig. 2 is a side view showing arm movement in the vertical plane, again a 30" arc. A three dimensional drawing of both arcs would be an asymmetric portion of a sphere with the long axis on the horizontal plane and the short axis on the vertical (Fig. 3). This, then, is the optimum arm movement area at the operating desk that can be expected with the operator's trunk in an upright position. All equipment installed should be placed on these arcs to assure ease of operation with a minimum of body movement.

Another variable that enters here is eye fixation and head movements. Obviously there are areas of the arm arcs which, if followed by eye and/or head movements, would lead to discomfort in a short period of time. These areas, if used, should be given a lower priority than the more optimal areas.

When visual requirements are taken into account, the visual optimum arcs can be superimposed on the arm optimum arcs for a graphic presentation of the best visual/arm use areas (Fig. 4).

Now that the physical limitations have been defined, we can safely state that the optimum movement area consists of a 30 inch vertical arc in cross section and a horizontal shallow arc thirty inches deep and approximately 60 inches at its widest point.

The next task is to define the equipment used in frequency of use, visual requirements, and visual/manual requirements. Let's define each area:

1) Frequency of use – That equipment used the most, i.e., receiver vs transmitter, converters vs receivers, etc.
2) Visual requirements – The requirement to scan a visual display to gain information,

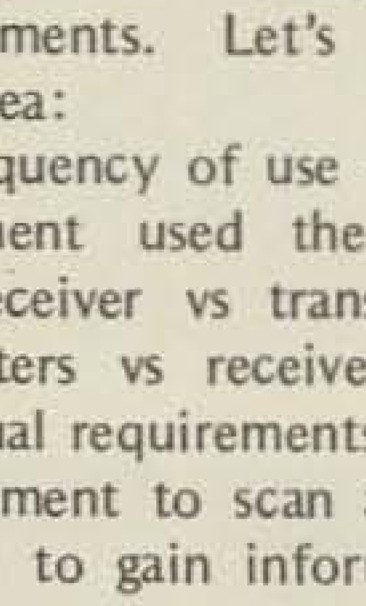


Fig. 2.

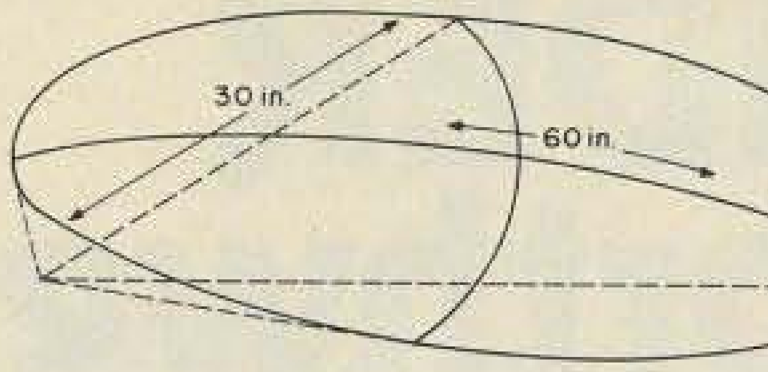


Fig. 3.

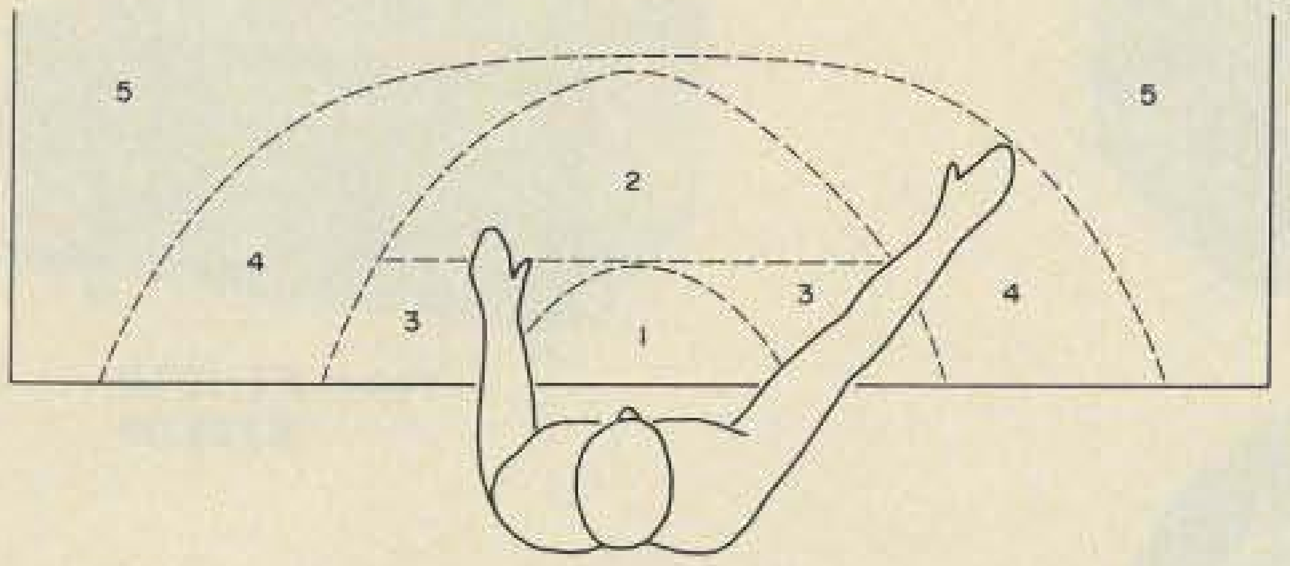


Fig. 4. Optimum areas for work requiring visual direction in order of priority. 1 — high priority, 5 — low priority.

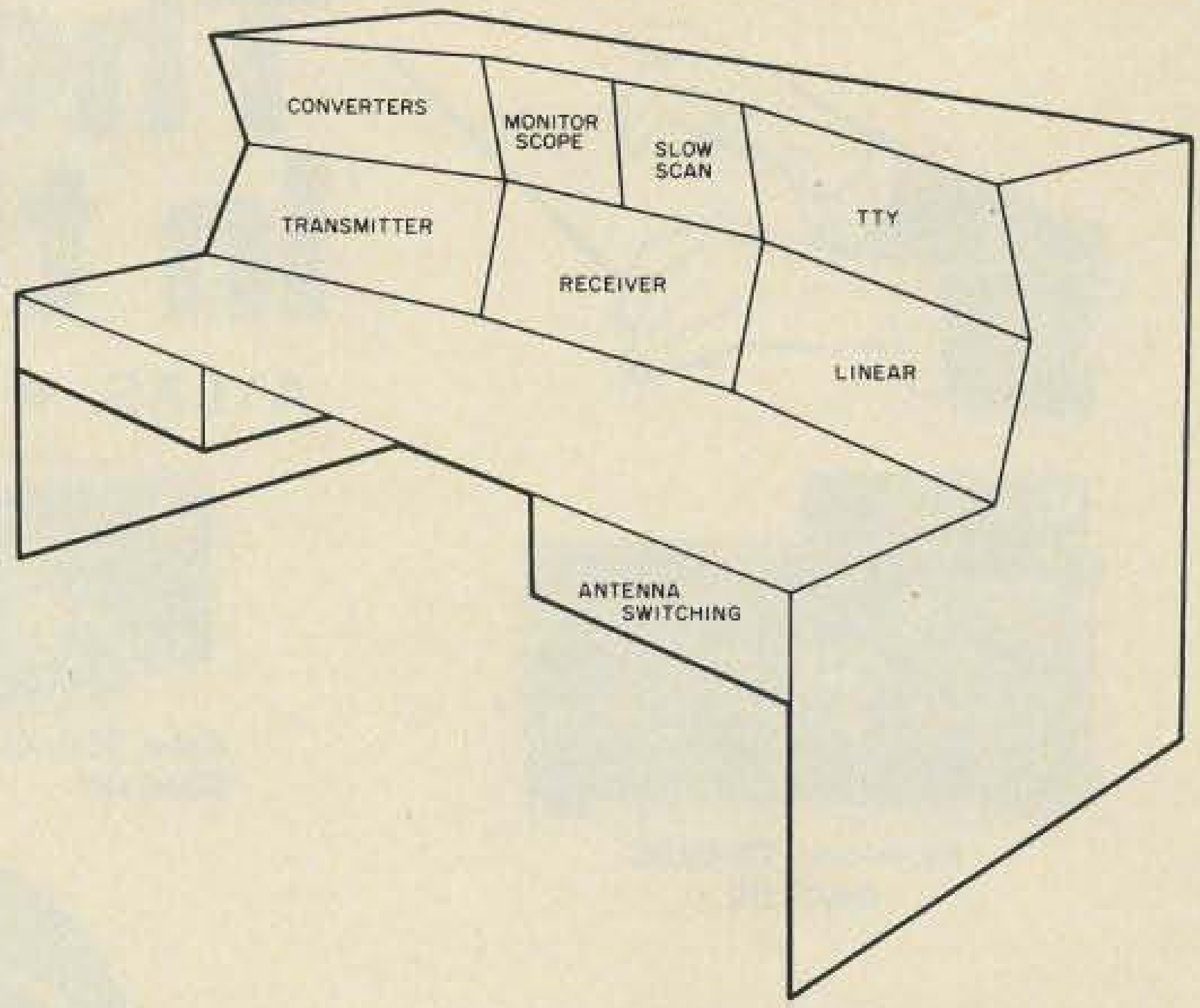


Fig. 5. Teletype/typewriter would be on the left or right side of the console.

i.e., swr bridge vs monitor scope, monitor scope vs slow scan display, clock vs any of the above.

3) Visual/manual requirements — The requirement to manipulate vs the requirement to see the results of said manipulation, i.e., speed key vs transmitter (tune-up), antenna option switching, etc.

Let's build a matrix of equipment vs these functions and see what we come up with. (See Table 1.) As you can see, the equipment is numbered in order of importance according to the various characteristics defined earlier. Of course the ranking given here may not reflect individual operator inclination or preferred modes of operation. The matrix provides a means of comparing the different attributes and uses of equipment to facilitate its final placement in relation to other equipment in these three defined areas. The sums of the equipment characteristics A+B+C are indicative of order of relative placement importance, while examination of the separate rankings define placement within each area. Should this information be utilized to design an operating position, it would look something like Fig. 5.

The use of these techniques and equipment analysis may be extended to larger stations where large amounts of equipment are involved. In some cases, where various modes of operation are identified for specific equipment, each mode may be treated as another station and a horseshoe shaped station arrangement may be required.

For individuals interested in furthering their knowledge and adapting other industrial engineering techniques to ham shack layout and design, the publications listed in the references will provide amplification of the principles outlined in this article. ■

References

1. *Industrial Engineering Handbook*, H. B. Maynard, McGraw-Hill Book Company.

2. *Motion and Time Study*, M. E. Mundel, Prentice-Hall, Inc.

Table 1.

EQUIPMENT	A FREQ. OF USE	B VISUAL	C MANUAL/ VISUAL	TOTAL A+B+C
Receiver	1	2	2	5
Transmitter	2	1	2	5
Linear	3	3	3	9
Monitor Scope	4	1	2	7
Slow Scan Monitor	4	1	1	6
Keyer	2	0	0	2
Antenna Switching	4	3	4	11
Converters	4	4	3	11
Typewriter	2	2	2	6
Teletype	2	2	2	6

LETTERS

from page 8

was getting about 60% of it right away, and began getting groups after the first 15 minutes. After three 15-minute sessions a day apart, I was getting 4 or 5 groups between misses. That decided me. If I'm going to have to take time off from work to go downtown for a test, I might as well do it once and be done with it; plans for getting an Advanced are hereby scrubbed. Unless I blow the code test, of course. Which I probably will, unless I get my iambic keyer designed pretty soon. Mild arthritis.

Meanwhile, I accidentally discovered an interesting way to use the tapes. I found that the fast tape got all my reflexes speeded up, so that I could recognize letters faster. This helped me with the slower tape, because now I didn't have to work hard and struggle frantically to keep up. That meant that I was on top of it most of the time, and when a character came along that I was still slow to recognize, I could lock my attention right onto it for an extra 100 milliseconds, and not get hopelessly lost. Not the proper strategy for taking a code test or copying a message, but just the thing for efficient learning. Then, jumping back to the fast tape, I was starting to catch the ones I'd missed completely before. The result is a ratchet action that helps me at both speeds, and I make faster progress than I would at either speed alone. Right now, I begin a session with a minute or so at 21, half a page at 14, then more 21 until I get tired and my miss rate goes up. A couple more weeks ought to do it.

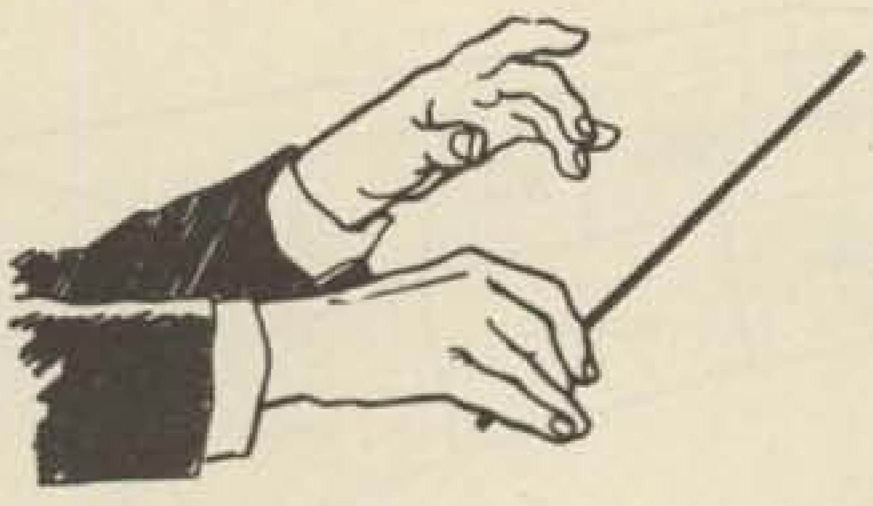
Well, keep up the good work. It's a pleasure to read a magazine that "thinks of what has never been, and asks, 'Why not?'"

John A. Carroll
Bedford MA

10 FEVER

I am interested in a national band

Continued on page 179



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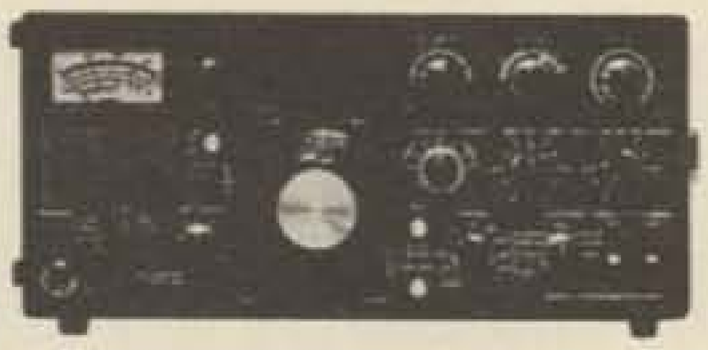

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Hands-free Mobile Mike

-- especially for four-speeds!

How many times have you wished that you didn't have to use a separate microphone when mobiling, or for that matter had your XYL complain about the noise from your rig's loudspeaker interfering with her bridge meeting, or for that matter wanted totally hands-free operation with your VOX? For those of you who share one or more of the above with me and countless other hams, the TELEX CB-88 lightweight headset seems to fit the bill and more.

Although it was primarily introduced to meet the growing Citizens Band marketplace, the nice fellows out at their plant haven't forgotten the first major consumers of their quality headphones, etc. – the hams. It just so happens that their single-sided aviation-style headset can be worn over either ear, or detached from the banded headset and placed directly on your eyeglass frames for the ultimate in comfort. The amplified, noise canceling microphone is magnetic, and is fitted on a pivoting boom which will allow you to adjust the microphone for the ultimate in comfort and placement. There's a push-to-talk switch, which makes it a natural for applications with 2 meter transceivers, as well as for wiring the microphone for use with SSB rigs, etc., which utilize VOX circuitry.

The unit looked too good to be true, so I acquired a Catalog No. 63388-003, which is listed as the special mike switching model for use with E. F. Johnson transceivers. The reason this model was specified was that interconnections were possible with the enclosed instructions to enable connections of interfaces with a majority of the rigs available today.

The microphone has an adjustable amplifier and noise-canceling, handled by a single IC, and a 7.0 V mercury battery which is included. The single side-mounted magnetic earphone reproduces sounds and channels them into the ear via a soft tubing arrangement; a total of three differently sized eartips are included, to fit any user. The microphone can be adjusted for maximum "talk power" while you are speaking at a normal conversational tone and level. The calibrated level control is adjustable, without the need for any tools.

The entire package can be worn over the right or left ear, and has a cable assembly eight feet long with a push-to-talk switch assembly, microphone amplifier unit with gain control, and a clip to hold it on your clothes if you utilize the push-to-talk feature.

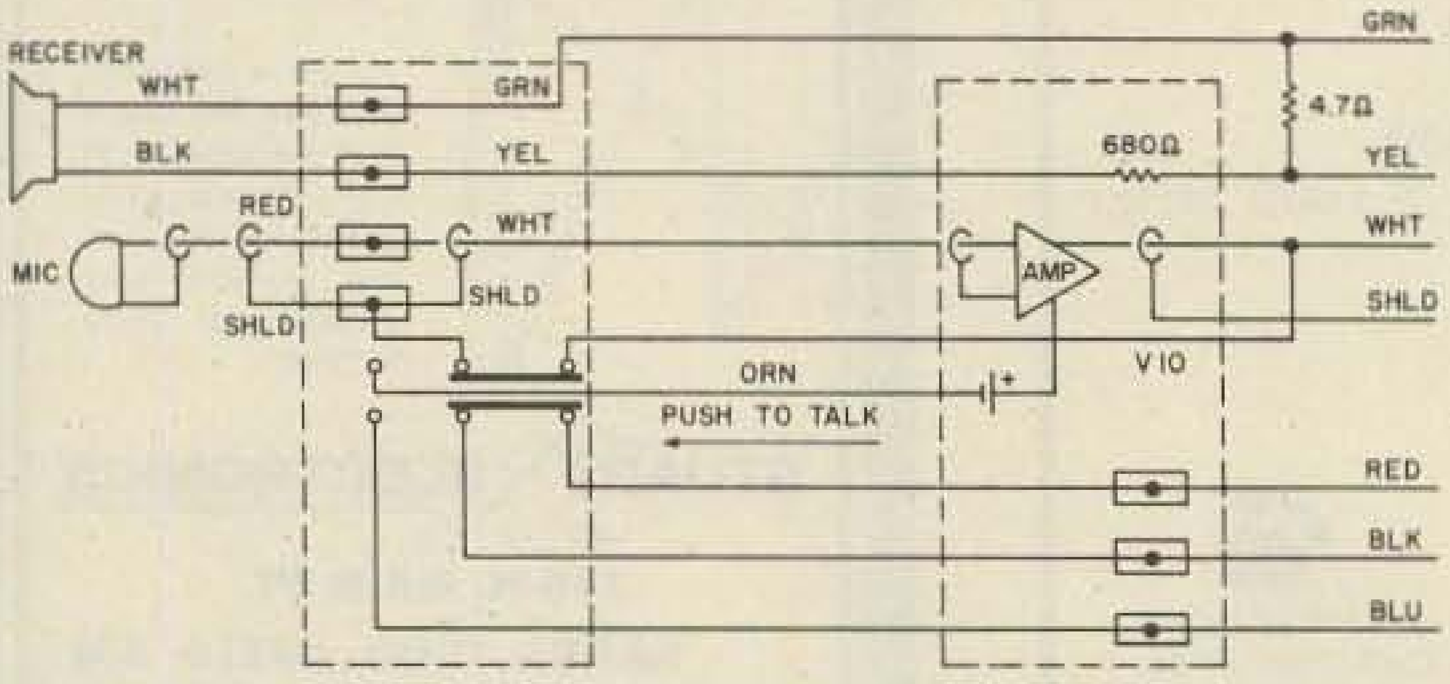


Fig. 1. Shorted mike switching.

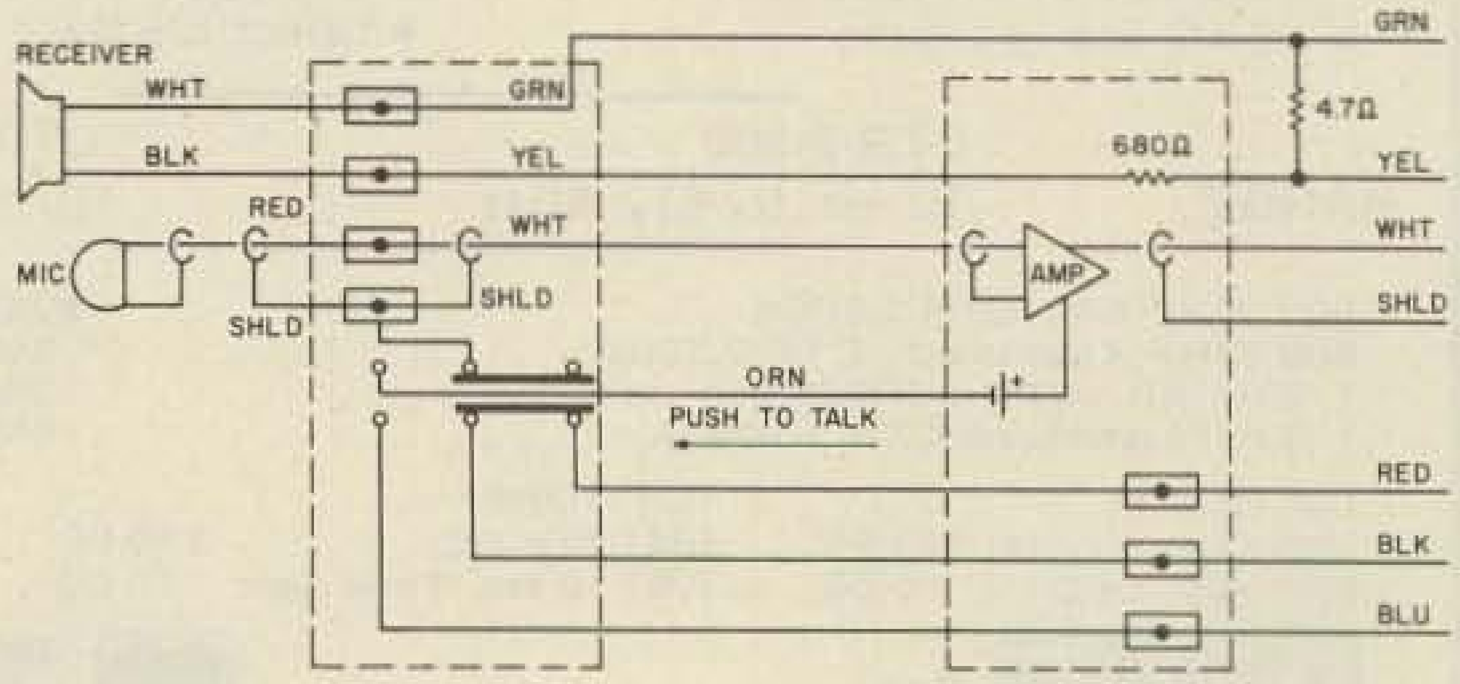


Fig. 2. Non-shorted mike switching.

INTERCONNECTION CHART

Manufacturer/Model Number	Headset	Green	Yellow	Blue	White	Shield	Red	Black
Drake TR-3, -4, 4XB	002	EXTSPKR	EXTSPKR	TIP	RING	SLV	N.C.	SLV
Genave GTX-100, GTX2, 200, 10 200T, GTX600	001	EXTSPKR	EXTSPKR	TIP	RING	SLV	N.C.	SLV
Heath SB-101, HW18	002	SPKR	SPKR	2/BLK	1/WHT	SHLD	N.C.	SHLD/RED
Kenwood TS520	002	EXTSPKR	EXTSPKR	2	1	4	N.C.	3*
Siltronix 1011C, B	002	EXTSPKR	EXTSPKR	TIP	RING	SLV	N.C.	SLV
Standard Communications SR-C830S50, Horizon 25,	002	EXTSPKR	EXTSPKR	3	2	1	4	1
C852S12B, C852S50, C807500,	002	EXTSPKR	EXTSPKR	3	1	2	4	1
C830550, src-8905	002	4	2	3	1	2	N.C.	2
Yaesu FT-101B-B$_2$	002	EXTSPKR	EXTSPKR	3	2	1	N.C.	1

User has the option of utilizing headset 003 with interconnection changes per wiring diagrams, or purchasing indicated headset for rig as noted above. * Note: Jumper white leads in switch.

For rigs not listed, you can send TELEX a wiring diagram of rig and they will furnish data and suggested headset number. Address queries to TELEX Communications, Inc., 9600 Aldrich St., South Minneapolis MN 55420, Attention CB Headset Product Support Manager.

The accompanying chart will allow you to connect the CB-88 to the microphone input circuits of the rigs listed. We are grateful to Mr. Sidney Kitrell, the Director of Marketing of TELEX's Aircraft/Professional/Industrial division, for permission to reprint this data. At a mere $69.95 and less than 3 ounces of weight, the CB-88 is a real asset to a station. I know it was to mine. The only minus feature I found was the light weight. I found myself walking away from the rig with microphone/earphone, etc., still attached to my glasses — I've got to put some note to remind myself not to do that again. If you do use the CB-88 and have any problems with RFI while operating mobile or "walking-mobile," TELEX has a service bulletin with the cures for your problems (available at no charge). Happy hands-free operating! ■

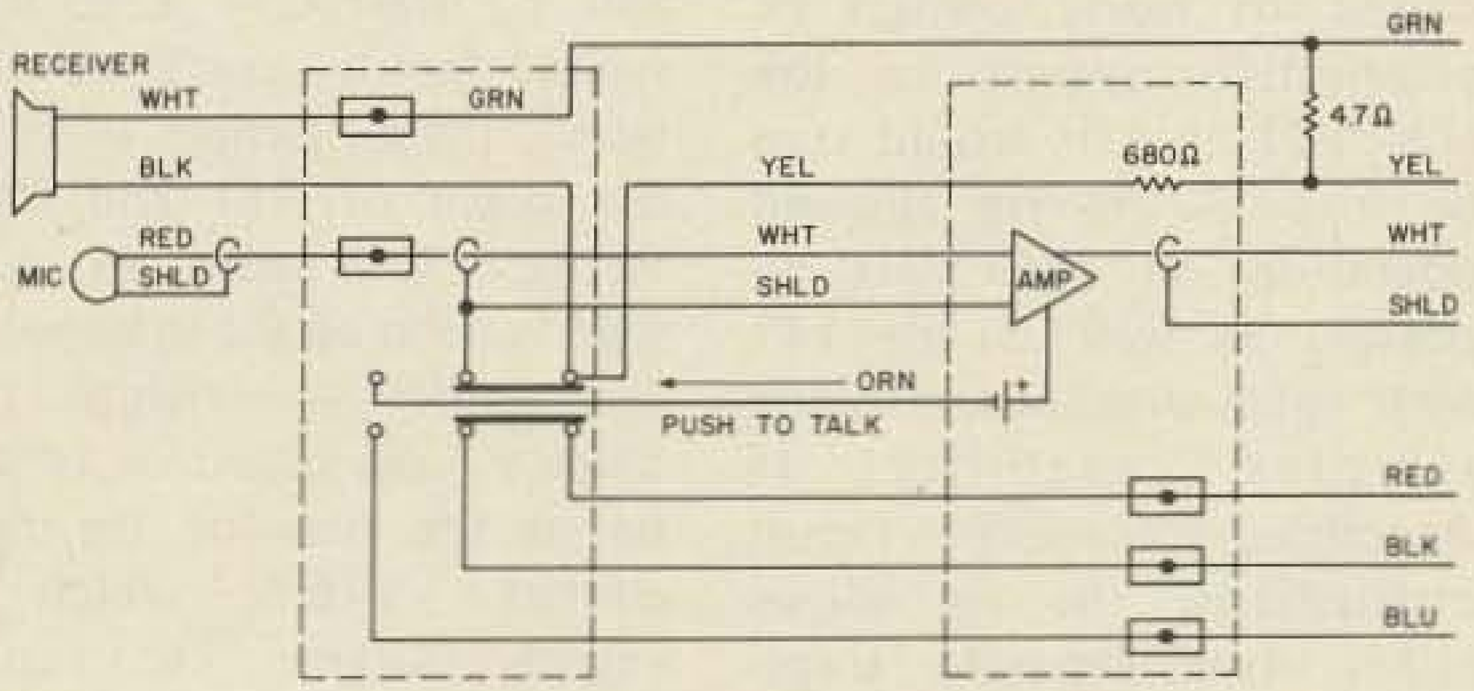


Fig. 3. Special mike switching.

LETTERS

from page 175

plan for 10m AM and SSB, using converted CB sets, and hope to start converting one as soon as a national plan is established.

Ten meter FM operation is very seldom ever mentioned in any of the ham magazines, yet it is definitely growing very rapidly. It seems that every day there are new stations just getting started. Simplex operation on 29.60 has gotten so crowded when the band is open that many operators are using alternate frequencies such as 29.64, 29.68, etc. Beacon stations, remote bases, and repeaters also add to the congestion, but everyone still has a really great time.

Equipment being used on 29.6 is mainly converted commercial gear, although a few people are using rigs like converted Regency HR-6s, Yaesu FT-101s, Gonset GSB-100s, Kenwood transverters converted to work from 6 to 10 (backwards), and now some of the PLL CB sets. A number of people have 1.5 Watt HT-200 HTs, and are working all over the country using the built-in 18-inch antenna.

Some groups around the country have tied a 29.6 MHz base station into their existing 2 meter repeaters, which gives HT-to-HT coverage over thousands of miles. It's really impressive to show it off!

With the new CB channels available to the consumer, a lot of excellent commercial equipment operating around 27.3 MHz has become available at reasonable prices, such as "Micors," "Motracs," and "Mast'rs," including base stations, mobiles, and portables.

A number of us on the west coast try to keep information on the active stations on 29.6 and any unusual equipment modifications. We most likely can put someone who might be interested in getting started on 29.6 in touch with someone fairly close to him, or refer someone to the right person for answers to questions regarding conversion of a particular piece of gear.

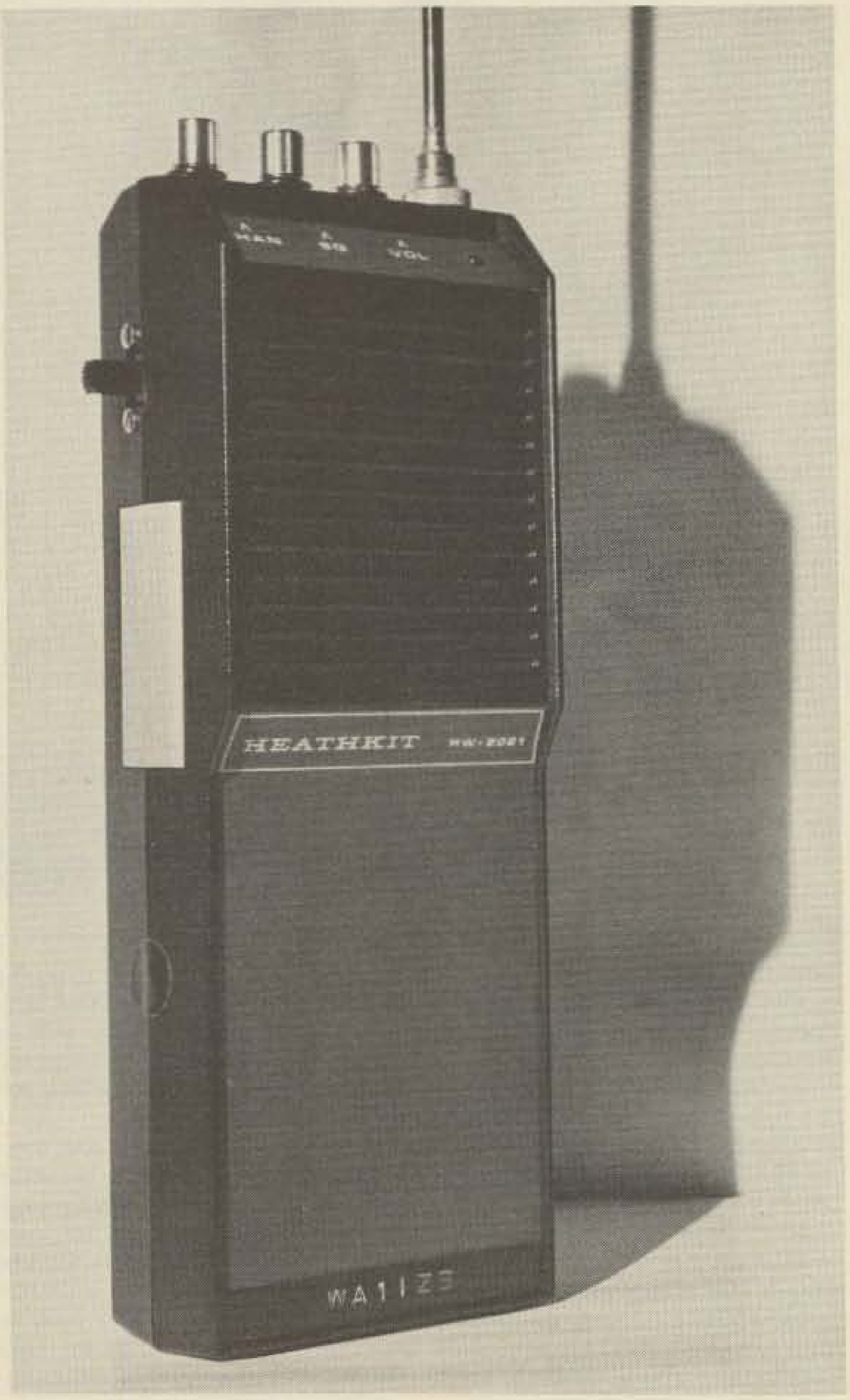
I have asked various hams running

Continued on page 181

Bob Wilson WA1IZS
11 Lowell Street
Arlington MA 02174

Heath HT Goodies

-- add a whip and offsets



How would you like to make a good 2 meter rig even better and more versatile at low cost? Sounds good? I thought so too!

This article will cover the modifications made to my Heath HW-2021 to allow *two* selectable transmit offsets as well as simplex operation at the flip of a switch. In addition, I've included a description of a simple yet effective ¼ wave telescoping whip you can make in minutes.

I'm sure it must have occurred to many owners or prospective owners of the HW-2021 that it would sure be nice if the rig allowed operation on 146 MHz repeaters as well as the 147 MHz splits without sacrificing simplex capability. If assembled according to Heath instructions, the rig allows either two separate transmitter offsets or one offset and simplex.

Theory of Operation

The transmitter employs a rather unique mixing chain operating at the same frequency as the receiver i-f (10.7 MHz). As supplied by Heath, the offset switch is a DPDT wired as an SPDT. This allows selection of either a 10.7 MHz crystal (for simplex operation) or a 10.1 MHz crystal (for -600 kHz offset).

All that is necessary for dual offset and simplex capability is a new switch, the appropriate frequency offset crystal, and a few wiring changes.

Construction

Although it should certainly be possible to add all these changes to an already assembled transceiver, it will definitely be easier to make them during initial construction as I did.

Rather than try and squeeze in an additional crystal socket for the extra offset, I chose to hijack one of the *channel* crystal sockets and rewire it. Referring to the Heathkit schematic, eliminate the gray wire to hole E, as well as C48, C54, R61, R62, and D7. Now, using a scalpel or similar instrument, cut the PC track between sockets Y6 and Y5 *after* C54 (keep that scalpel handy, you'll need it later). Install jumper wires in the place of R61 and C48. Replace C43 with an axial lead version of the same value and solder it *beneath* the main circuit board or it will be in the way of the new offset switch, which is slightly larger. That completes the wiring changes to the PC board, which may be set aside for now.

It's now time to wire and install the new offset switch. A double pole, three position

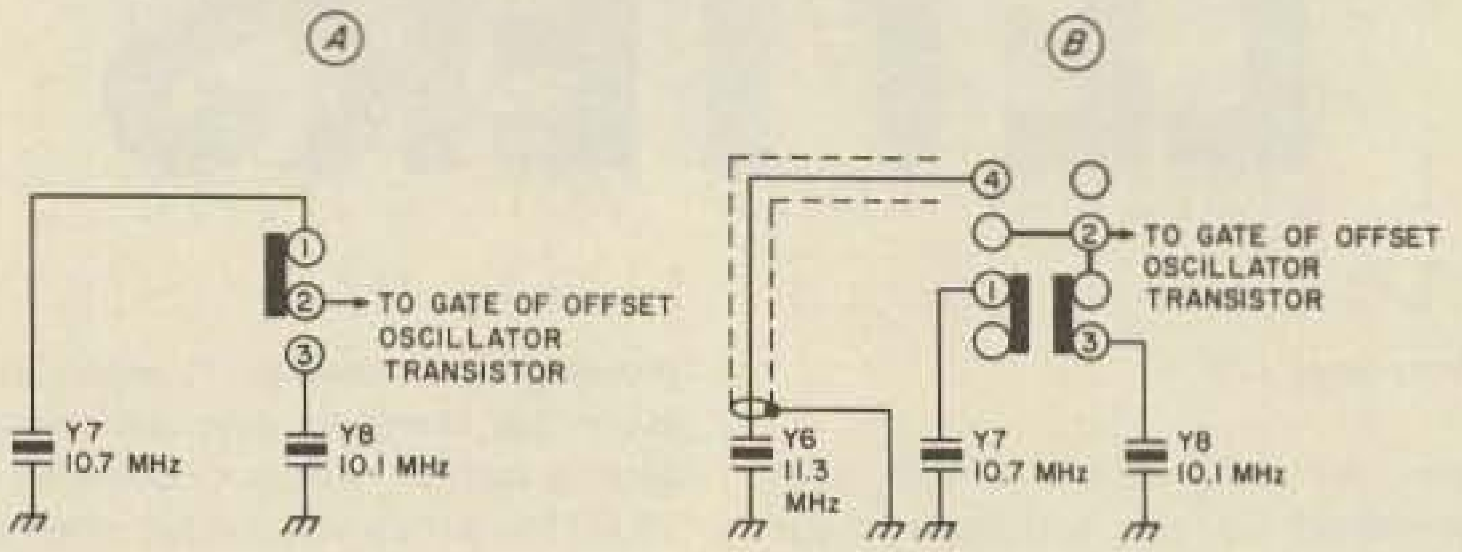


Fig. 1. Transmit offset switching. (a) As originally wired. (b) Modified with new switch and additional capability. Heavy lines indicate hookup wire at switch.

switch is called for here. In case you have trouble locating one, I purchased mine at four for one dollar ($1.00) from "Poly Paks" in South Lynnfield, Massachusetts (catalog #92CU2666). Once you determine what leads are necessary to wire it in accordance with Fig. 1(b), clip all the extra leads and protrusions flush. As is obvious from the photo of the two switches, the new replacement will require a slightly different mounting procedure. Take the scalpel you set aside previously and carefully trim away the mounting tabs from the inside of the lower case half. A flat file should now be used to enlarge the switch cut out, allowing for the extra travel of the three position switch. If you use the same switch I did, about 1/32" on each side should be right. Make sure you file slowly and at a slight inward angle so as to not remove too much plastic or have any raw edges showing. If you've gotten this far, you're almost home!

Draw a template of the switch front on a piece of paper indicating the location of the mounting holes. Tape this to the outside of the case exactly in the position you will be mounting the switch and drill out the two mounting holes. A drill press is advisable; however, a hand drill operated by a steady hand will do. Remove the template.

All that remains now is to mount the switch with two short screws and wire it up. A short length of RG/62 is recommended for the switch to board wiring. The outer braid is left floating at the switch end. The inner lead may be conveniently wired to the board at the lower hole formerly occupied by C54. I found it convenient to mount the switch so it simulated mechanically what was going on electrically, i.e., in the up position, the transmitter frequency is shifted up, etc. Plug the crystal for your desired offset frequency into Y6. Follow the crystal ordering information on page 61 of the Heath manual.

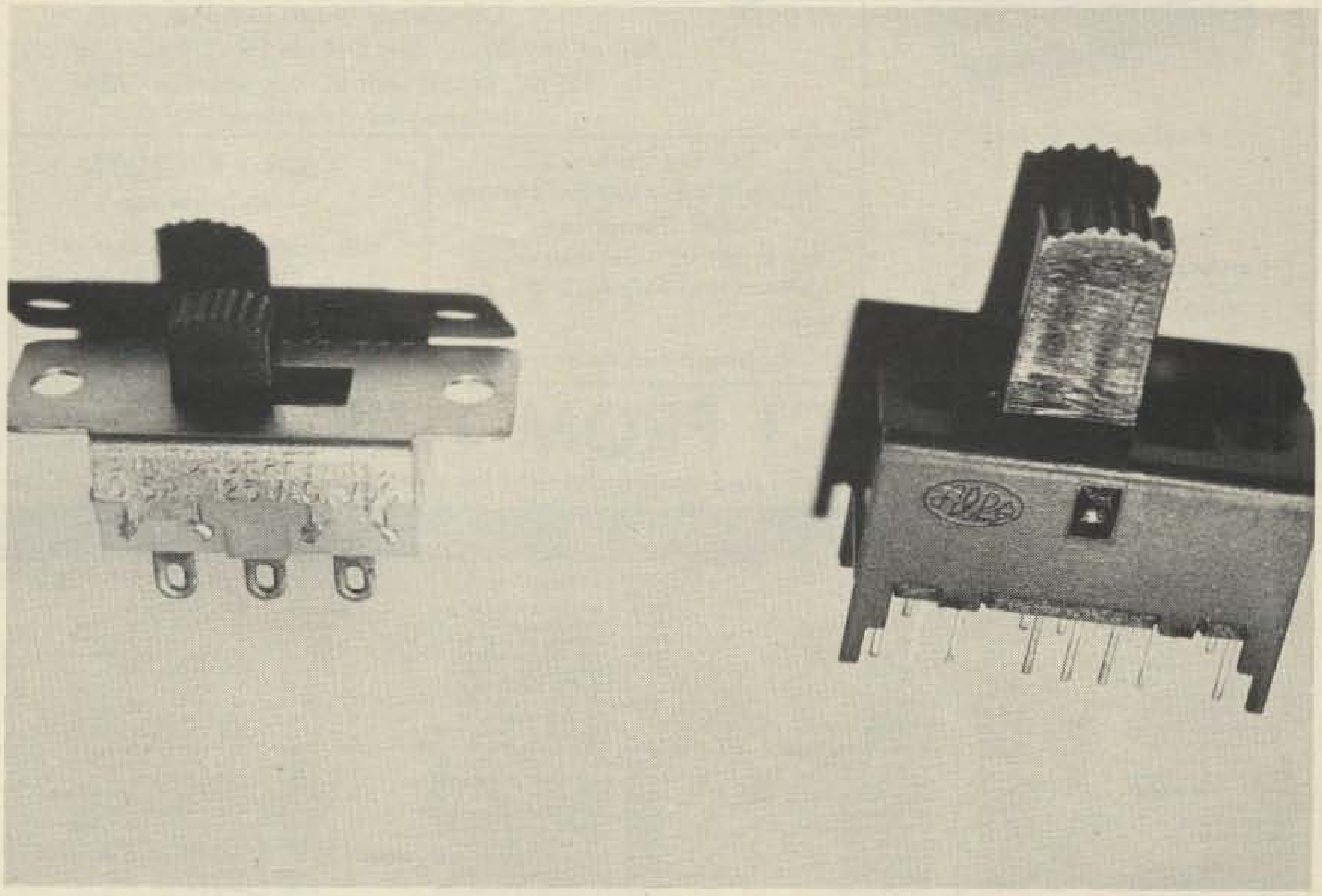
The Telescoping Whip

A telescoping whip can be easily added to the HW-2021 to increase its range in the field. Simply take a ¼" single-hole-mount phono jack and snip off the inner conductor solder lug since it won't be needed. To this you will mate a Philmore "TRA" whip. This whip comes with a removable thread adaptor and retails for about $1.50.

Temporarily secure or clamp the phono jack securely in an upright position. Place the adaptor slotted end up in the opening of the jack and solder. It is a close fit, so you won't need much solder. Screw the upper whip section into the adaptor and reinforce with a single drop of epoxy on each side of the slot.

Once the epoxy is thoroughly dry, your assembly is complete. Have fun!

My special thanks to WA1ZDE without whom I probably would never have finished this project (much less gotten it typed) and to WA1ION for his photographs. ■



View of the original switch and larger replacement. The longer extension of the slide on the new switch has the advantage of being more readily accessible when using the Heath accessory case.

LETTERS

from page 179

rigs which might be converted easily, such as CB sets, Yaesus, etc., to consider writing up an article for publication.

Larry R. Johnson K7VZH
29560 SW Brown Rd., Apt. 4
Wilsonville OR 97070

LEAGUE REPORTS

Did you know that the ARRL has yearly reports (their annual reports) printed and that they do not make this fact known to their own members? They just sent me their 1976 annual report, and I think that all hams interested in the ARRL should request the same from them.

I also think that all ARRL members should question why *QST* never mentions these reports or even publishes excerpts from them once a year.

Could it be that the ARRL does not want people to find out about all the stocks and bonds they own and how they could have sold some of these to finance their building addition (rather than raising dues to $12 yearly)?

Lawrence I. Cotariu
Skokie IL

Yes, I knew. As the editor of another ham magazine said after reading the report, "Who says QST *doesn't publish fiction?" — Wayne.*

A WORD FROM HUGHES

Your September, 1977, issue included an article by Michael I. Cohen on building "A Practical 2m Synthesizer." One of the components called out was the Hughes HCTR 0320 synthesizer. Your readers should be aware that they can get this part from one of our two distributors, namely Semiconductor Technology, Inc., 124-14 22nd Avenue, College Point NY 11356, or Calmarc Sales, 1651 E. Edinger, Suite 207, Santa Ana CA 92705.

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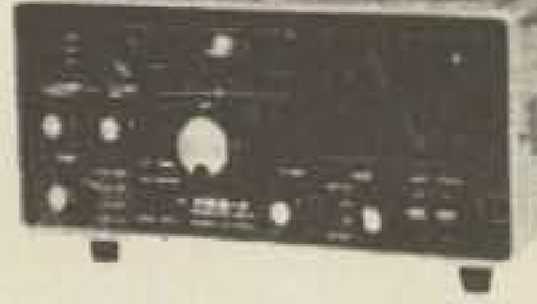

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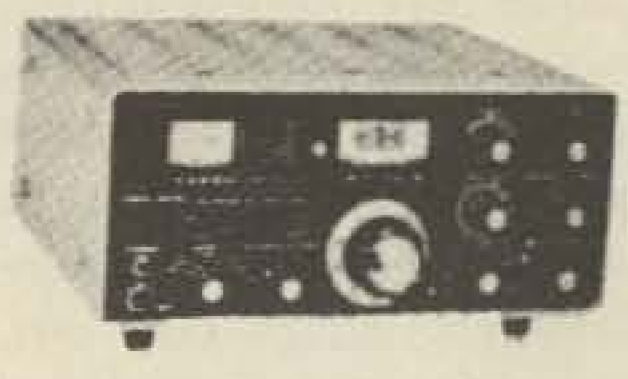

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EDITORIAL BY WAYNE GREEN

from page 171

available for the 16-bit machines, there is no problem. Heath provides BASIC with their H11, by the way.

Most of us involved with microcomputers have gone into the hobby for the fun of it, and we get a little edgy when people get insistent about what we are going to *do* with them. Oh, by now we have a long list of great things which *can* be done . . . they'll run repeaters and make incredible things simple with them . . . they'll translate Morse code, RTTY, slow scan . . . watch for the new Digital Group hamboard, just released. They let you play a lot of nice games . . . enough to keep any visitor involved for hours. More and more hams are using their computers instead of typewriters . . . I sure wish they would get typewriter-type printers instead of dot matrix printers for typing up articles for submission . . . dot matrix is *not* easy to read.

Not a few of us feel a deep need to keep up, and we realize that we aren't keeping up if we don't get in there and mess with computers. It isn't a matter of getting ready for a new career – it's one of pride in understanding what's coming down technically these days.

A lot of old-timers I've talked with recently are deeply involved with microcomputers. They're bound and determined that they are not going to try to avoid progress the way they did when transistors came along 15 years ago. They put off working with solid state until it was unavoidable. Now they realize that they missed a lot of fun. Was it only ten years ago that *QST* explained that the reason they had so little on transistors was that they would never replace tubes . . . that hams were tube people? How time flies.

Getting back to the bits and bytes . . . unless you have a lot of stuff for your computer to massage, you'll probably do just fine with an 8-bit machine. Of course, if you are rich and looking for ways to spend money, the 16-bit machine may be attractive. The Heath systems are not out of line . . . with the 8-bit system CPU (central processing unit . . . the heart of your computer) costing $375 and the 16-bit, $1295. That's a lot of extra bucks for extra speed . . . if you don't really need it.

Buying the 16-bit Heath system qualifies you to buy programs from Digital Equipment Corporation (DEC), which may or may not be a benefit. I've looked over their list of available programs and I'm not sure. Once I have an H11 and a chance to try out some of the DEC programs, I'll know better about this. If any readers can help us along this line, take typewriter in hand (no dot matrix printers . . . please).

ARTICLES ANYONE?

While articles on any of the microcomputers are of interest for publication in *73*, in particular I'd like to see material on using the Radio Shack TRS-80, the PET, and the Heath systems. I think we would all be interested in your evaluation of these systems while they are new . . . any ham uses you may develop . . . any modifications . . . accessories . . . programs.

I'll be working with these systems and letting you know how I make out. I already have a TRS-80 with a couple of the Radio Shack business programs . . . plus a great lunar landing game sent in by Ed Juge (remember Juge Electronics in Fort Worth?).

If you're thinking of writing articles for *73* or *Kilobaud*, you can send for the "How to Write For" instructions . . . or you can use your head, double space and generously margin, and include professional-quality pictures.

MAKE EXTRA MONEY, HAVE FUN, HELP AMATEUR RADIO GROW

How would you like to make some extra money in your spare time to help you build your ham station? Wouldn't you like to be able to get the latest in ham gear? The fact is that your hobby *can* pay for itself.

At the same time that you are making money, you will also be helping amateur radio to grow by helping to interest newcomers in the hobby . . . and we need all of the new amateurs we can get, as you know.

73 Magazine is looking for Area Representatives to distribute *73 Magazine* and *Kilobaud* to newsstands, bookstores, discount stores, supermarkets, drugstores, etc. In addition to distribution of the monthly copies of these magazines, Area Representatives would also sell magazines, books, and subscriptions at hamfests, ham auctions, and other local ham events. Radio stores, CB dealers, etc., can also be serviced by Area Representatives.

Here's a way to enjoy your hobby, to be a real part of it, and to make money while you are having fun. It sure doesn't seem much like work.

Area Representatives who are successful will be offered the opportunity to increase their business by taking on additional special interest magazines for newsstand distribution. The business can grow to any size you wish.

73 sells well on the newsstands. Tests in several areas show that even though every magazine rack in an area is stocked with copies of *73*, at least one or two copies are sold from even the smallest of racks. *73* interests hams, SWLs, CBers, experimenters, students, computer hobbyists, electronics professionals, technicians, etc.

If you are interested in details on how you can earn from $50 to $500 (or even more) a month, write to Sherry Smythe, Marketing Director, *73 Magazine*, Peterborough NH 03458. Once you sign up you'll get monthly shipments of magazines which are to be sold on consignment (the store only has to pay for copies sold, so the project costs them nothing). You report and pay for copies sold each month and keep back issues in stock for sale at hamfests, etc.

Just think, with a few hours work each month you might be able to have a fantastic ham station before the end of 1978. Drop Sherry a line and get started . . . if you are the kind of person who gets things done and can carry things through.

THE FATE OF THE LONE PIONEER

Many a pioneering effort in amateur radio has fallen on its face because the people doing the spadework were too busy to pass along news of their accomplishments. A handful of pioneers have been doing most of the serious work in UHF and microwave pioneering, but they are remaining few in number and progress has been slow because they have not recognized the importance of being published.

It takes state-of-the-art articles on pioneering efforts to attract more people. And it takes a lot of pioneers to result in any measurable progress. Thus, the ham builder who works up a really fantastic circuit for 1296 MHz and keeps it to himself or even restricts the information to a small circle of friends is really negating everything he has been doing.

A good article on a pioneering subject will fire up enthusiasm in many parts of the world and get more experimentally-minded amateurs working. If they in turn communicate their progress, the whole field can move ahead much faster.

Right now, I see a decided shortage of articles on developments in microwaves . . . in low noise VHF reception . . . in RTTY circuits . . . in repeater linking . . . in duplex operation . . . in narrowband transmissions . . . in microcomputer hamming, etc.

We've been living with DX pileups for all of our amateur lives, and nothing serious has been done to propose a solution to that problem. Oh, we've worked out list operating, and a bunch of systems for easing the problem, but nothing really fast and sure. How about some creative thinking along this line?

Could time multiplex be developed which would permit simulated duplex operation on one channel? As Uncle Don used to say . . . let's put on our thinking caps . . . and do a bit more pioneering . . . and write it up.

TURKEY HUNTING

We used to call it fox hunting, but in view of the current huntees, perhaps a more apt name is appropriate. We do need to get our ham act together for locating turkeys who insist on jamming our repeaters, who pop up on the low end of ten meters, or who may eventually start turning up on the ham-band-converted CB rigs.

The fact is that we need to have a lot of articles on the building of quick antennas for turkey hunts. We need to have clubs organize turkey hunts for practice. We need some designs for instant direction-finding. If the FCC vans can do it, so can we. When you come up with something that works well, be sure to write it up and send it in to *73* so we can pass the word along for everyone else.

There is a growing need for new ham products along this line, too . . . for those of you of an entrepreneurial nature. Once turkeys can be located quickly, we should have a lot less trouble with them.

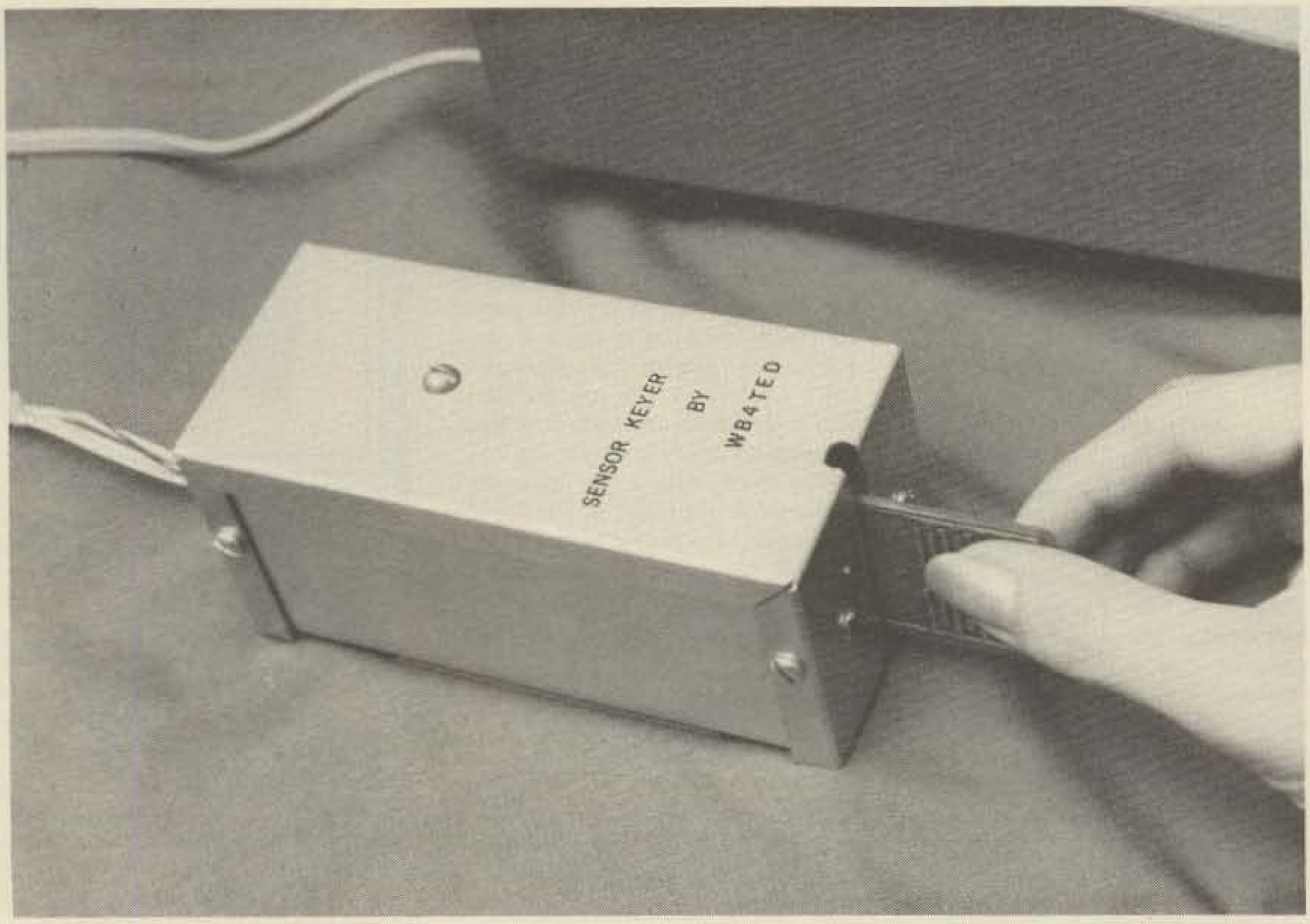
The recent ability of two hams to outwit everyone in their area for almost a year, kerchunking and cursing over local repeaters at will, points up the need for more ham responsibility in this area. The gang had to send for the FCC van to locate the bad guys. Tsk. Wouldn't you know one of the turkeys was an Extra class ham? The next time you're badmouthing a CBer, remember that at least two Extra class hams have been convicted of transmitting profanity over extended periods of time. One of them spent a lot of time on the CB channels, driving everyone crazy.

TESTED BY YOU

If you are one of those pioneer types who rushes out and buys the newest in ham gear, plan on taking a little extra time to write a letter to *73* outlining your experiences for the benefit of other readers. Tell us what you like about the rig . . . what you don't like. If you've made any modifications, let us know about them, too. Every reader wants to know what others think of the new ham rigs, and a simple checkout by me isn't all that helpful.

In case you haven't noticed, virtually the entire *73 Magazine* is written by the readers . . . you. This is a way for those of you who are doing things to let others know what you've done . . . what you like . . . don't like. So hold up your end of the deal by writing, whether it be articles on things you've built or letters about equipment you've tested.

The advertisers? They pick up the printing bill for you . . . so the more advertisers you encourage to use *73*, the more pages of articles and letters you'll have to read each month.



Tony Urbizu WB4TED
1159 46th Ave. NW
Fort Lauderdale FL 33313

Try A Sensor Keyer

-- almost pressure-free CW

After I assembled the Heathkit CW Keyer HD-10, I noticed that, because it uses 1 pair of microswitches, the sending was somewhat erratic. I discovered that this keyer has the versatility for hooking up an external paddle. The ones on the market are a little expensive, from $15.00 to $25.00, and some real fancy ones will go up to $40.00. The price of my keyer complete will run about $39.95; that will put the price at 100% of its value. This paddle also uses switches and contacts in order to produce the characteristic CW rhythm.

The state of the art calls for a transistor to be a switch.

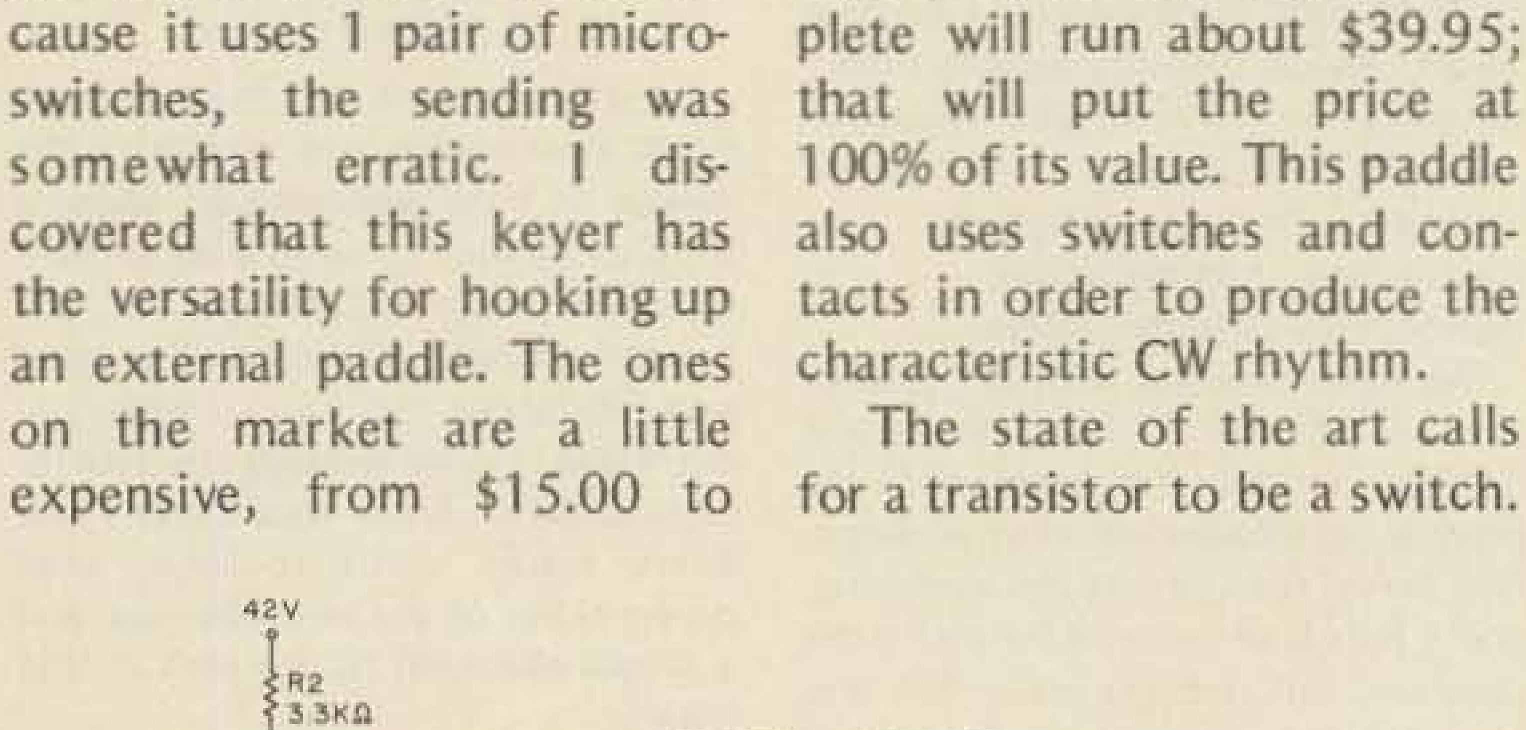


Fig. 1. R1, Re — 500Ω, ½ W; R2 — 3.3kΩ, ½ W; Q1, Q2, Q3, Q4 — 2N2222 or equivalent; ZD1 — 10 V, .5W 1N5240.

Keeping this in mind, the tool was laid to produce an all solid state paddle, without the need of switches or contacts.

Next I was to produce a circuit that would amplify by the touch of the finger and act as a switch. I decided to use a Darlington pair configuration. The gain on this amplifier is about 1000.

By experiments, we know that body resistance is about 10k Ohms at skin level. It will go lower in persons who have a high perspiration rate.

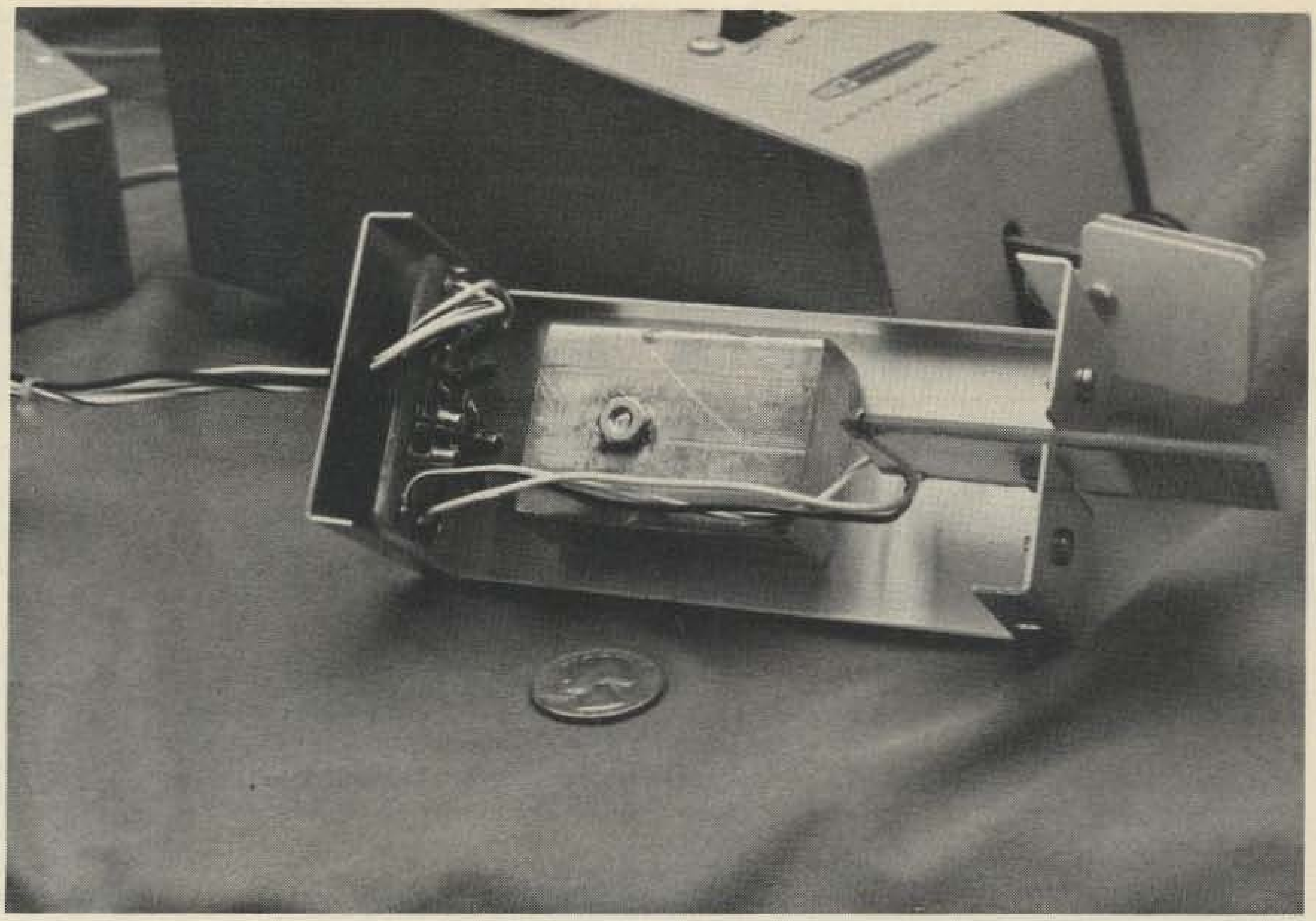
I then designed the pattern which was etched out on a printed circuit board. It resembled several letter Ts together and upside down (see Fig. 2). This will cause the finger to act as a resistor when placed over it. After the etching was done, a coat of solder was laid over the design to prevent the lamination from getting tarnished — high salt content will cause this. The etching was done on both sides, to cover one side for "dots" and the other side for the "dashes."

In the schematic, we see that the emitter of Q1 is connected directly to the base of Q2. As the finger is placed over the etched pattern, a little current flows over to the base (Q1). (Ohm's law: I = E/R; 10 V/10k = 1 mA.)

The gain of this transistor will drive Q1 close to saturation. At the same time, Q2 will be driven to saturation, causing it to act as a switch. Presto! We now have a CW paddle.

In order to provide some voltage to the unit from the

42 volts output, we brought it from the back of the Heathkit keyer and brought it into the paddle. A 3.3k Ohm resistor and a 10 V zener diode in series to ground was used, in order to produce a 10 volts bias to supply Vcc to the transistors.



Construction

Construction is made on a 2" x 5" x 2" high aluminum box. A slot about 1/8" was cut vertically on the front side, in order to allow the etched board to fit through the box. Two little brackets were formed from a 1/16" sheet of aluminum, and bent 90° and attached with a #4-40 ¼" screw. The same thing was done on the etched board. Be cautious when placing the etched board so it will not touch the chassis. This can be easily done with a pair of vise grips to hold it in place before you drill or punch the holes. Another PC board was etched to make the Q1, Q2, Q3, Q4, and regulating circuits. This was placed on the opposite side of the box in order to make room for about 1 or 2 pounds of lead. This is to make it heavier. (Good suppliers for lead are plumbing supply houses.) This lead was fastened to the center and attached with a #8-32 x 3" long bolt. The wire used to connect the back of the Heathkit keyer was #22 insulated stranded wire. To put on the finishing touches, 2" weather stripping was fixed to the bottom of the box so that it would have a better grip on the table or the surface where it will be placed. The XYL, WA4FUA, has been using it for some time now. At the beginning, she found it very sensitive to operate. She had a little difficulty in trying to get used to it, since there is no need for pushing or waiting for the switch to close. Just placing your finger over it will cause the transistor to close. I find it very easy to operate, and now I don't have that somehow erratic rhythm.

-·-·· ·-·-- ■

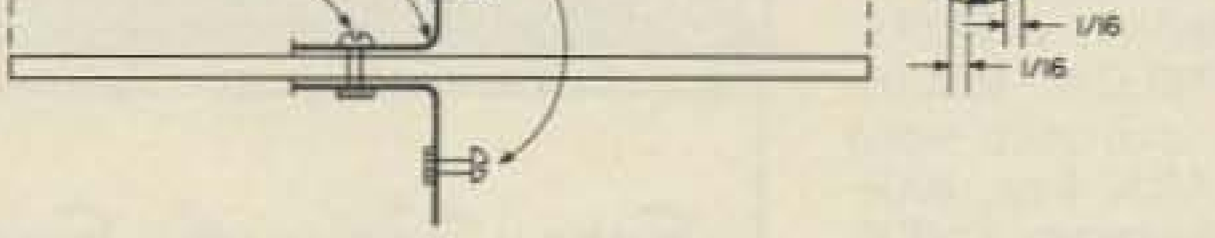


Fig. 2. Etch board on both sides.

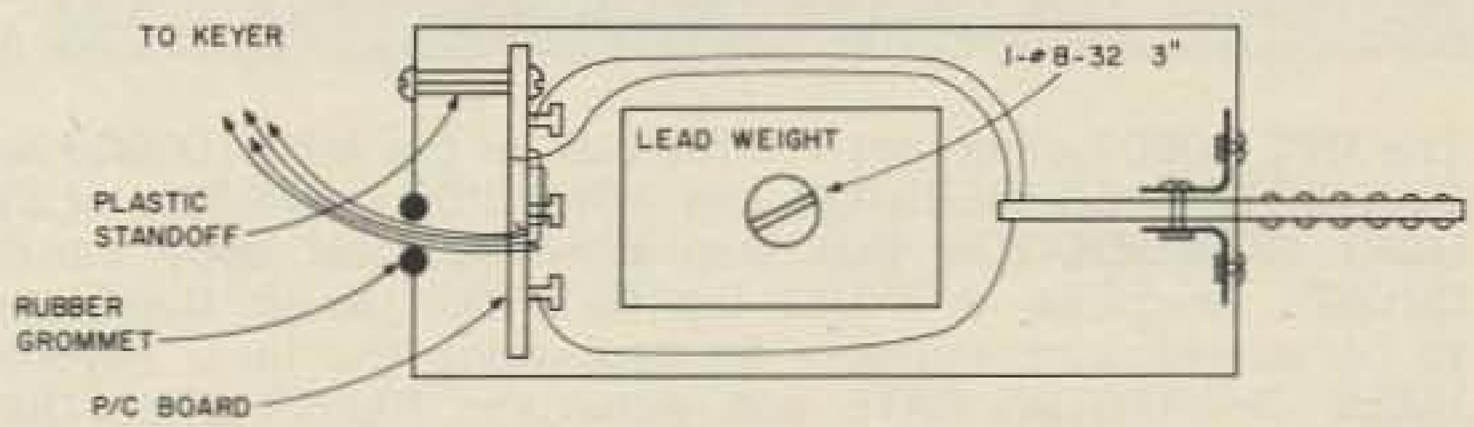


Fig. 3. Box layout, top of box looking up.

FCC

from page 16

radio station in repeater operation shall not exceed the power specified for the antenna height above average terrain in the following table:

[In watts]

Antenna height above average terrain	Maximum effective radiated power for frequency bands above:			
	52 MHz	144.5 MHz	420 MHz	1215 MHz
Below 50 ft.	100	800	(1)	----------
50 to 99 ft.	100	400	(1)	----------
100 to 499 ft.	50	400	800	(1)
500 to 999 ft.	25	300	800	(1)
Above 1,000 ft.	25	100	400	(1)

[1] Paragraphs (a) and (b).

4. § 97.84(d) is amended to read, as follows:

§ 97.84 Station identification.

* * * * *

(d) When an amateur radio station is in repeater or auxiliary operation, the following additional identifying information shall be transmitted:

(1) When identifying by radiotelephony, a station in repeater operation shall transmit the word "repeater" at the end of the station call sign. When identifying by radiotelegraphy, a station in repeater operation shall transmit the fraction bar, $\overline{DN}$, followed by the letters "RPT" at the end of the station call sign.

(2) When identifying by radiotelephony, a station in auxiliary operation shall transmit the word "auxiliary" at the end of the station call sign. When identifying by radiotelegraphy, a station in auxiliary operation shall transmit the fraction bar, $\overline{DN}$, followed by the letters "AUX" at the end of the station call sign.

* * * * *

5. § 97.88(a) is amended to read, as follows:

§ 97.88 Operation of a station by remote control.

An amateur radio station may be operated by remote control only if there is compliance with the following:

(a) A photocopy of the remotely controlled station license shall be:

(1) Posted in a conspicuous place at the remotely controlled transmitter location, and

(2) Placed in the station log of each authorized control operator.

PART 97—AMATEUR RADIO SERVICE

Simplifying Licensing and Operation of Complex Systems of Stations and Modifying Repeater Subbands in the Amateur Radio Service

ACTION: Memorandum Opinion and order staying regulations in Docket 21033.

SUMMARY: The Commission is staying regulations it adopted in a Report and Order in Docket 21033 (42 FR 52418, September 30, 1977) concerning the licensing and operation of repeater and associated stations in the Amateur Radio Service. We are taking this action in response to a Petition for Stay filed by the American Radio Relay League, Inc.

SUPPLEMENTARY INFORMATION:

In the matter of deregulation of Part 97 of the Commission's rules to simplify the licensing and operation of complex systems of stations and modify repeater subbands in the Amateur Radio Service (Docket No. 21033, RM-2664, RM-2780) MEMORANDUM OPINION AND ORDER (See 42 FR 52418).

Adopted: November 4, 1977.

Released: November 4, 1977.

Continued on page 189

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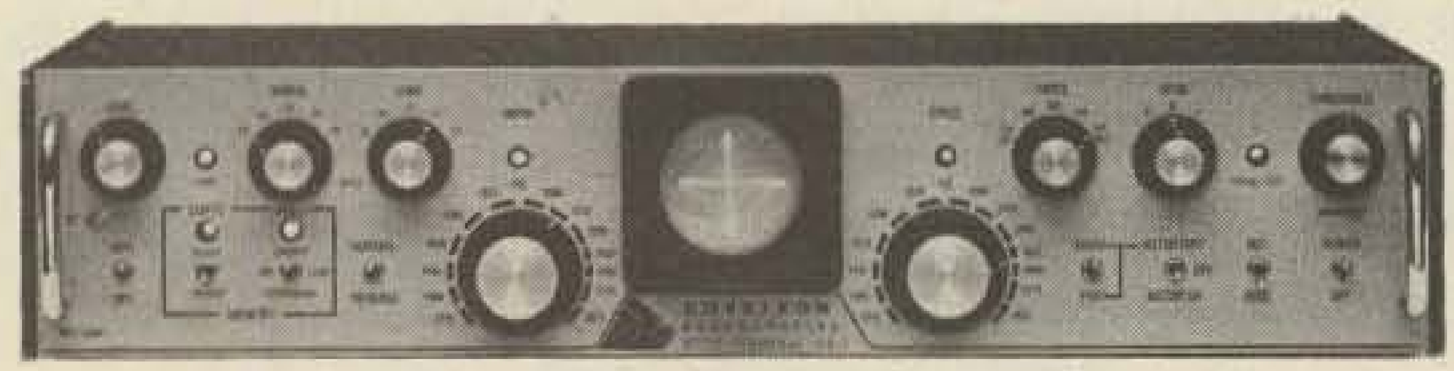

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Logical Logic

-- some basic tips

As anyone who has tried working with digital logic will attest, if a system of proper symbols is not used and understood, it is almost impossible to figure out what is going on. As a result, troubleshooting becomes a very difficult task. Industry has long recognized this problem, and has developed a standard system of symbols that allows anyone familiar with the system to see, at a glance, what is supposed to happen with a logic element. It is evident that many struggling experimenters do not know how the system works and are severely handicapped.

The intent of this article is not to present anything new, but to present the system used by the industry to the experimenter. This system complies with MIL-STD 806D, and should be kept handy as a reference until it is committed to memory. Believe me, once a person gets used to using the system, it can't be done without.

Gates

Most industrial schematics are drawn using functional logic symbols. The gate symbols, with a high level indicated by A and a low level by $\overline{A}$, are shown in Fig. 1, with their use indicated in Table 1.

The inverter shown in Fig. 1(e) is used when the asserted level of the input is high, while the inverter of Fig. 1(f) is used when the asserted level of the input is low.

This simply means that the desired output is determined by the level of assertion of the input and dictates the way the inverter is drawn. If the output of the gate described in Example 2 were to be inverted, the symbol shown in Fig. 1(e) would be used. (See Fig. 2.)

Now that we've seen how to pick the gate for a simple function, let's look at a more complicated circuit (Example 5) that combines several of these gates.

Notice that gates 1, 2 and 3 exhibit an "ANDing" function, and are drawn as such, using Figs. 1(c), 1(b), and 1(b) respectively. However, gates 4 and 5 are used in an "ORing" capacity, so Fig. 1(a) is used.

In any system there is some ambiguity, and the problem that is generated by using this system is illustrated by Example 6.

Notice that the output of gate 1 (a NAND) is used as the input of two gates. In gate 2 we want a low signal, and in gate 3 we want a high signal. Therefore, the symbol used should indicate both high and low outputs. This, obviously, is impossible. Therefore, the symbol is drawn in terms of the designer's signal flow, i.e., if A or B is low, then the gate 3 will be enabled. Otherwise, gate 2 will be enabled. It can be argued that the signal flow

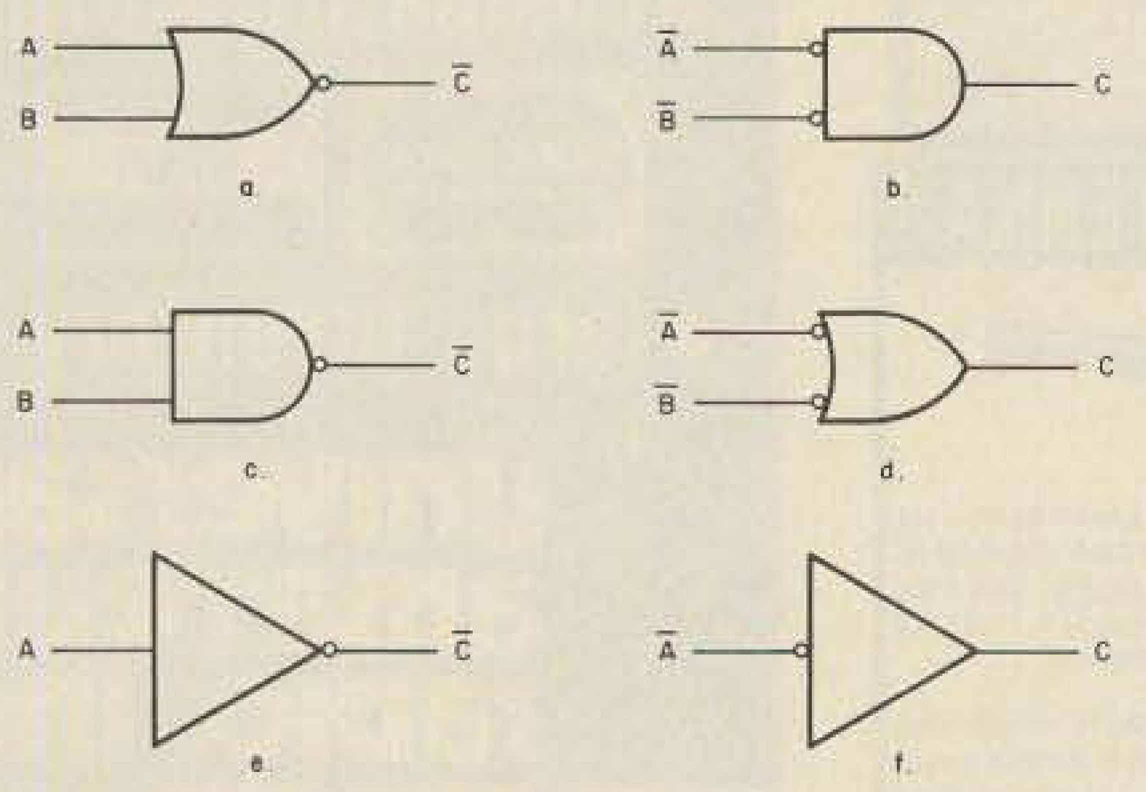


Fig. 1.

Fig.	Name	Boolean Expression	Level of Desired Output
1(a)	NOR	$\overline{C} = A + B$	low
1(b)	NOR	$C = \overline{A} \cdot \overline{B}$	high
1(c)	NAND	$\overline{C} = A \cdot B$	low
1(d)	NAND	$C = \overline{A} + \overline{B}$	high
1(e)	NOT	$\overline{C} = A$	low
1(f)	NOT	$C = \overline{A}$	high

Table 1. Note that, by De Morgan's theorem, it can be proven that the Boolean expressions for Figs. 1(a) and 1(b) or 1(c) and 1(d) or 1(e) and 1(f) are identical.

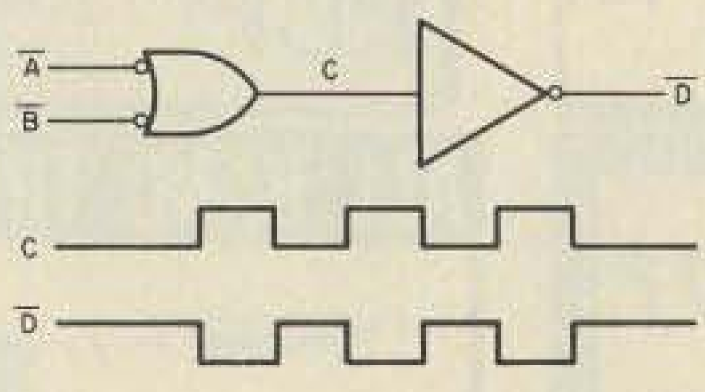


Fig. 2.

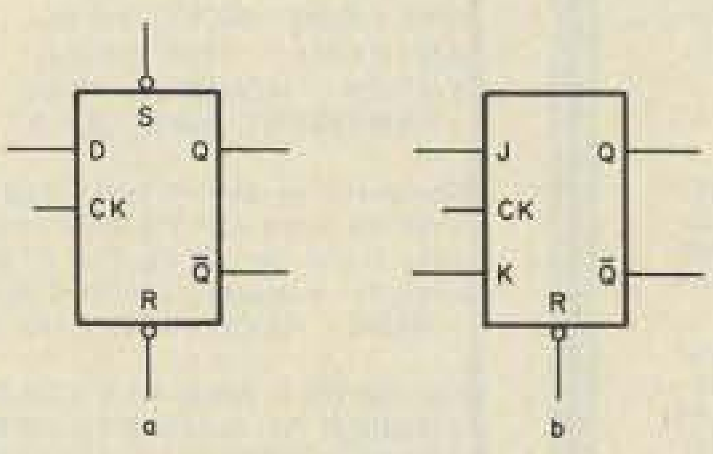


Fig. 3.

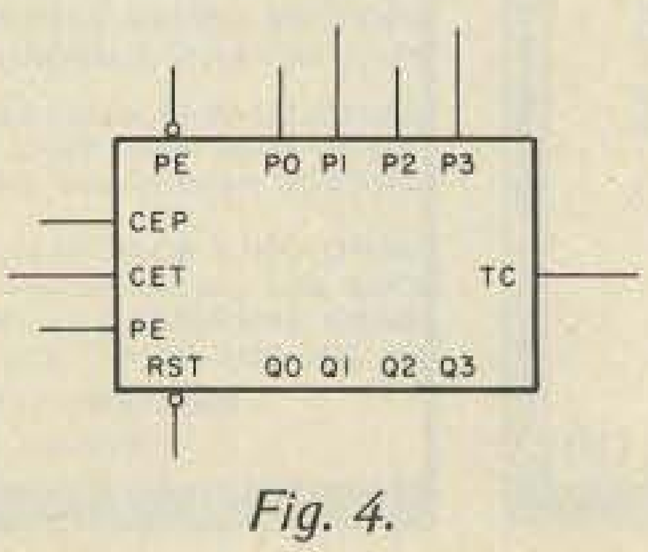


Fig. 4.

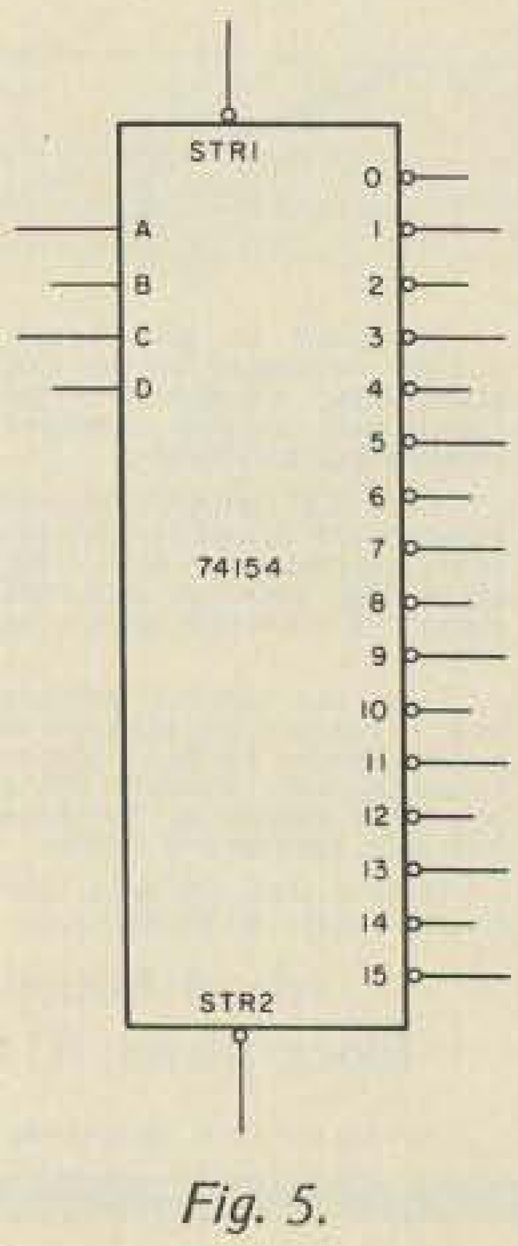


Fig. 5.

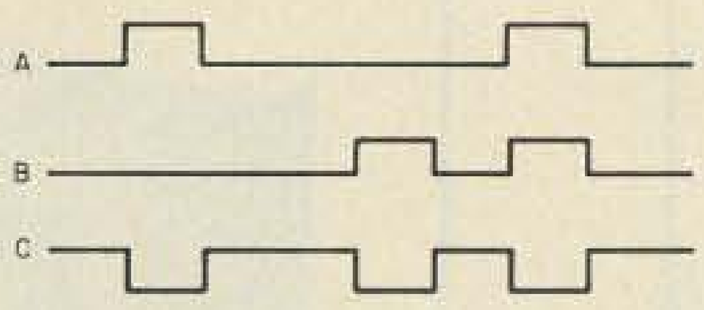
Example 1:

Verbal Description: Either input high should cause output of gate to go low.

Equation: $A + B = \overline{C} = \overline{A \cdot B} = C$

Gate Used: NOR, Fig. 1(a)

Waveforms:



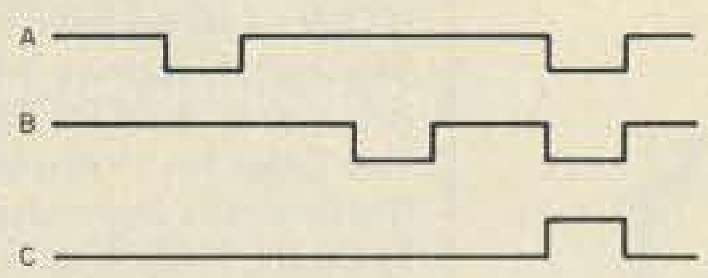
Example 2:

Verbal Description: Both inputs low "ANDed" cause the gate to go high.

Equation: $\overline{A} \cdot \overline{B} = C = \overline{A + B} = C$

Gate Used: NOR, Fig. 1(b)

Waveforms:



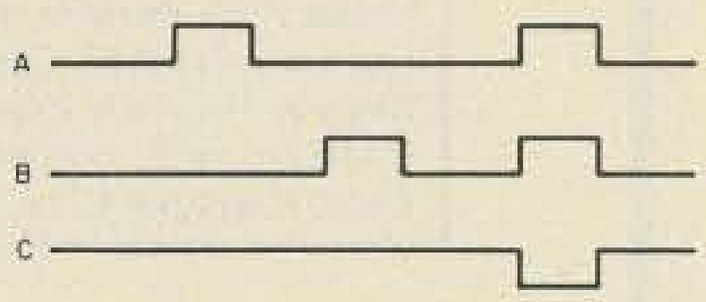
Example 3.

Verbal Description: Both inputs "ANDed" should cause the gate to go low.

Equation: $A \cdot B = \overline{C} = \overline{A + B} = C$

Gate Used: NAND, Fig. 1(c)

Waveforms:



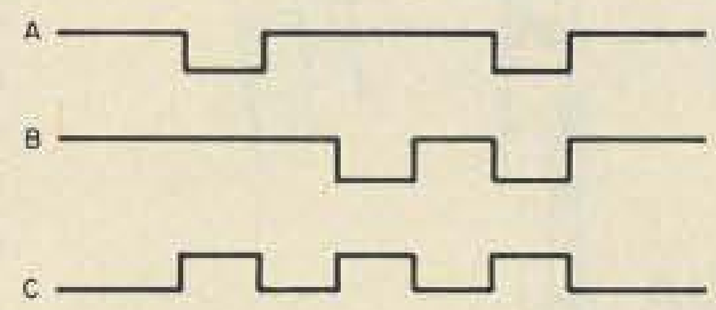
Example 4:

Verbal Description: Either input low causes the gate to go high.

Equation: $\overline{A} + \overline{B} = C = A \cdot B = \overline{C}$

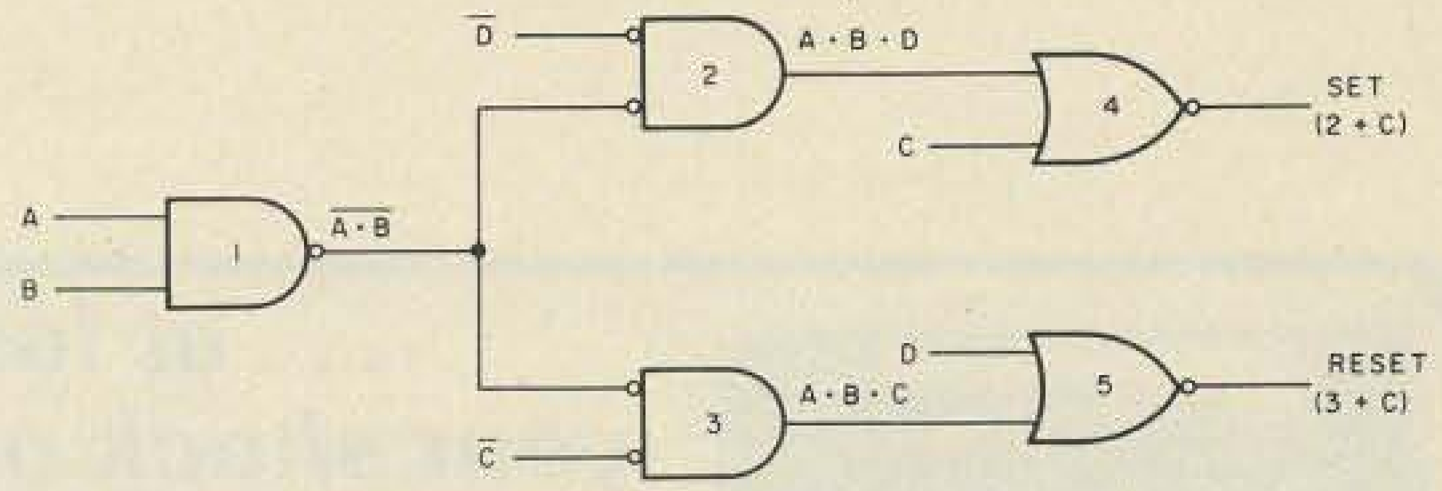
Gate Used: NAND, Fig. 1(d)

Waveforms:

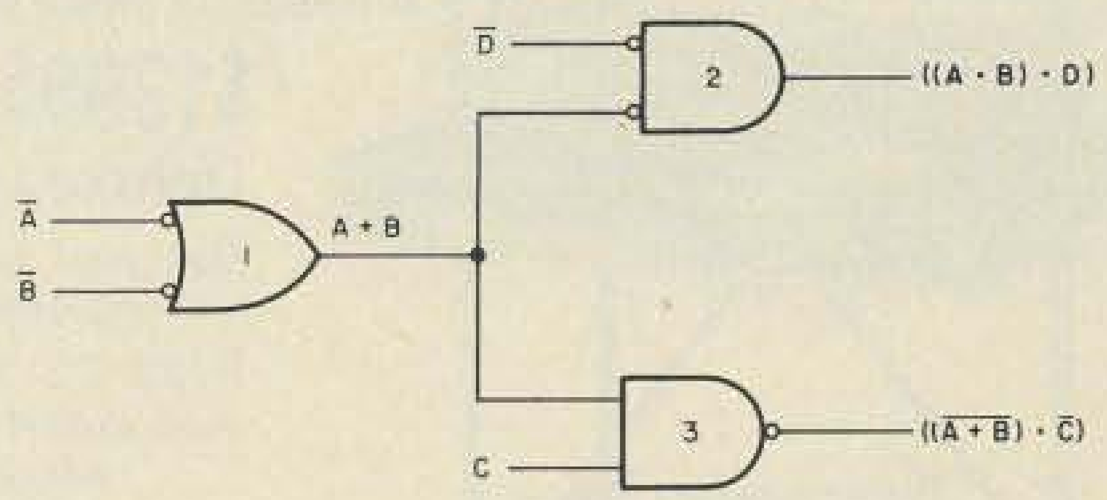


Example 5:

Verbal Description: If A and B are high and D low, or if C is high, set an R/S f-f. If A and B are high and C is low, or if D is high, reset the f-f. This f-f is activated by the "0" state on its input.



Example 6:



is "if both A and B are high, gate 2 will be enabled; otherwise, gate 3 is enabled." But it is clear that the two statements indicate a different thought process by the designer and hence one is the more correct. In this case, it is the former statement, and this is known due to the way that the circuit is drawn.

All flip-flops are drawn as rectangular boxes. The differences between D and JK f-fs are indicated by the labeling inside the rectangle – see Figs. 3(a) and 3(b) – and there is nothing on the clock line to indicate the direction (high to low or low to high) that the clock takes when triggering the f-f. The only indication of assertion level (circles on input) is on the asynchronous set and reset of the f-f. At the time of this writing, however, all D f-fs are positive edge-triggered and all JK f-fs are negative edge-triggered.

MSI

The Medium Scale Integration circuits are also shown as rectangular blocks, but are drawn larger due both to their large number of I/O and to distinguish them from the flip-flops. All the I/O pins are labeled internally and, unlike the flip-flops, all assertion levels are indicated – circles indicate negative assertion for both input and output. Examples of this are shown in Fig. 4, which is a 4-bit binary counter (Fairchild 9316) and in Fig. 5, which is a 4-line to 16-line demultiplexer (Texas Instruments 74154). ■

FCC

from page 185

1. The Commission has before it a Petition for Stay in Docket 21033, submitted by the American Radio Relay League, Inc. (ARRL), in accordance with Sections 1.44 and 1.429(k) of the Commission's Rules.

2. In a Notice of Inquiry and Notice of Proposed Rulemaking in Docket 21033, released January 6, 1977, 42 Fed. Reg. 2089 (1977), the Commission proposed substantial revisions of its rules concerning the licensing and operation of repeater and associated stations in the Amateur Radio Service. Final regulations, with an effective date of November 4, 1977, were adopted in a Report and Order released September 27, 1977, 42 FR 52418 (1977). Additional editorial amendments were made in an Order released October 26, 1977, mimeo 83536. Petitioner requests that the effective date of the regulations adopted in the Report and Order be stayed until 45 days after the Commission has disposed of a Petition for Reconsideration submitted by petitioner, as well as all other Petitions for Reconsideration filed with the Commission in this proceeding.

3. Petitioner states that a Stay is necessary to prevent irreparable injury to radio amateurs and the public interest. In particular, the ARRL alleges that amateurs engaging in satellite, moon bounce, and other forms of so-called "weak signal" communications will be harmed if the revisions of the repeater frequency subbands adopted in the Report and Order in Docket 21033 take effect as scheduled without additional consideration. Petitioner further claims that no one will be adversely affected by a Stay of the Docket 21033 Report and Order. Finally, petitioner states that there is a reasonable possibility that it will prevail on the merits of its Petition for Reconsideration, and that the effective date of the new rules should be stayed for that reason.

4. We believe there to be good cause (See Section 1.429(k)) for granting petitioner's request, namely, the potential for interference to amateur operations if the new regulations go into effect as scheduled. For this reason, we believe the new rules should be permitted to go into effect only after all the Petitions for Reconsideration submitted in this proceeding have been fully analyzed and considered. We will attempt to resolve the issues raised by the various Petitions for Reconsideration as quickly as possible, however.

5. Accordingly, the Commission orders that the effective dates of the regulations adopted in the Report and Order in Docket 21033 and the editorial Order of October 26, 1977 are stayed until further order of the Commission.[1] Further, in order to continue the efficient processing of other amateur radio operator and station license applications, the Commission orders a continuation of the "freeze" announced in the Report and Order in this proceeding on the filing of applications for new repeater, auxiliary link and control station licenses. Authority for this action is contained in Sections 4(i), 5(e) and 303 of the Communications Act of 1934, as amended.

FEDERAL COMMUNICATIONS COMMISSION,
WILLIAM J. TRICARICO,
Acting Secretary.

[1] We emphasize that this action also stays the effective date of the non-controversial provisions of the Report and Order in Docket 21033. For example, operators of so-called "remote base" stations may not operate their stations from portable and mobile control points until after the Commission has disposed of the Petitions for Reconsideration it has received. Additionally, Technician Class operators will not be permitted to use the new privileges authorized by the Report and Order.

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Pulses Galore!

A versatile low cost pulse generator can be made with just two ICs, a power supply, and some junk parts. Its PRF (pulse repetition frequency) can be made to operate from less than 1 Hz to over 10 MHz, with a pulse width variable from ≅50 nanoseconds to more than 500 milliseconds by adjusting only 2 components.

The device described here covers just a portion of this range. The heart of the generator is the Signetics NE562 IC. It was originally intended for use in phase locked loop synthesizers or FM demodulators. We intend to use only the VCO portion for our pulse generator, along with a 74121 monostable multivibrator to adjust the pulse width. The stability of the free-running frequency of the NE562 is comparable to more costly pulse generators.

Construction just involves stuffing the board with parts.

Front view of pulse generator.

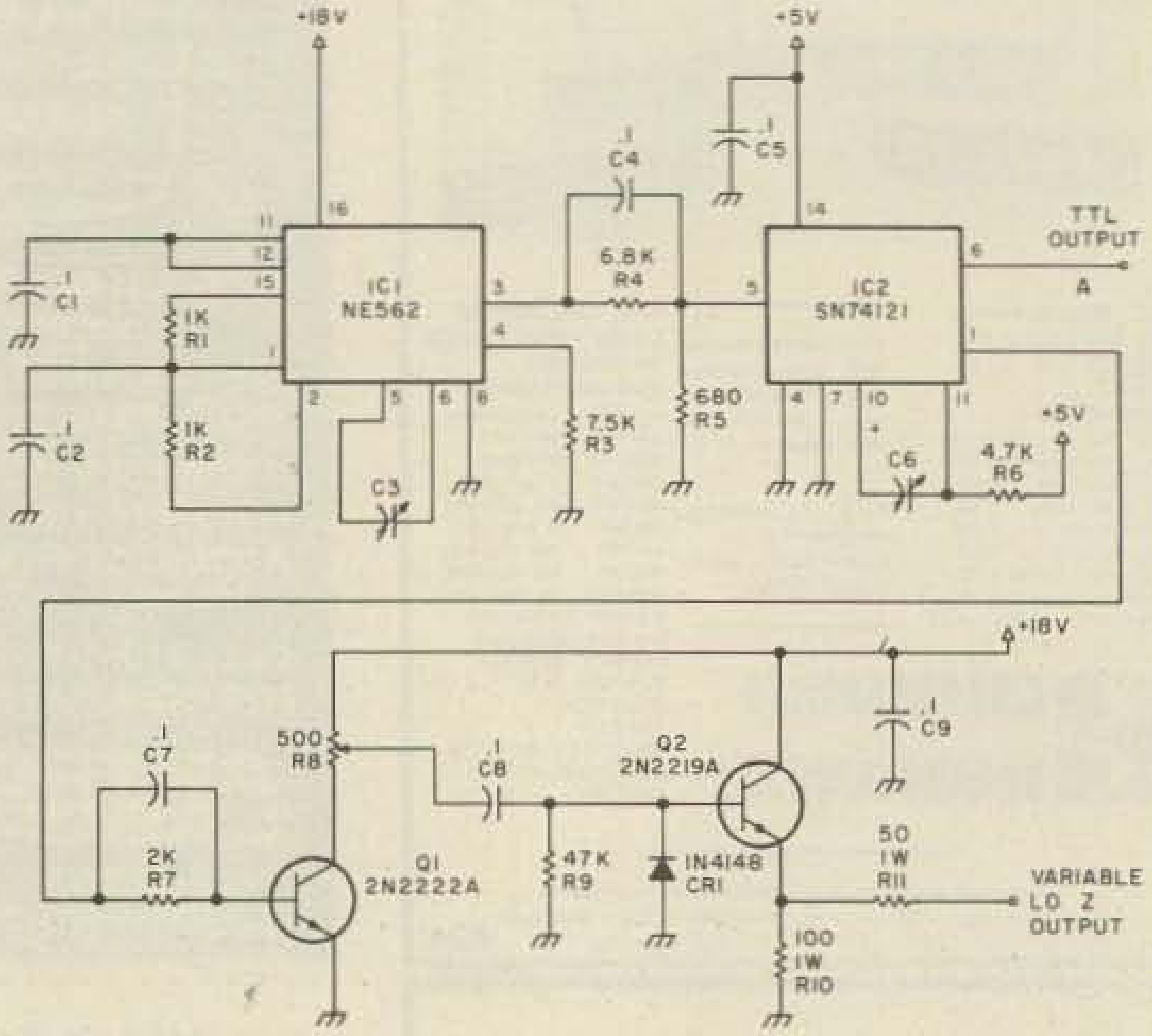
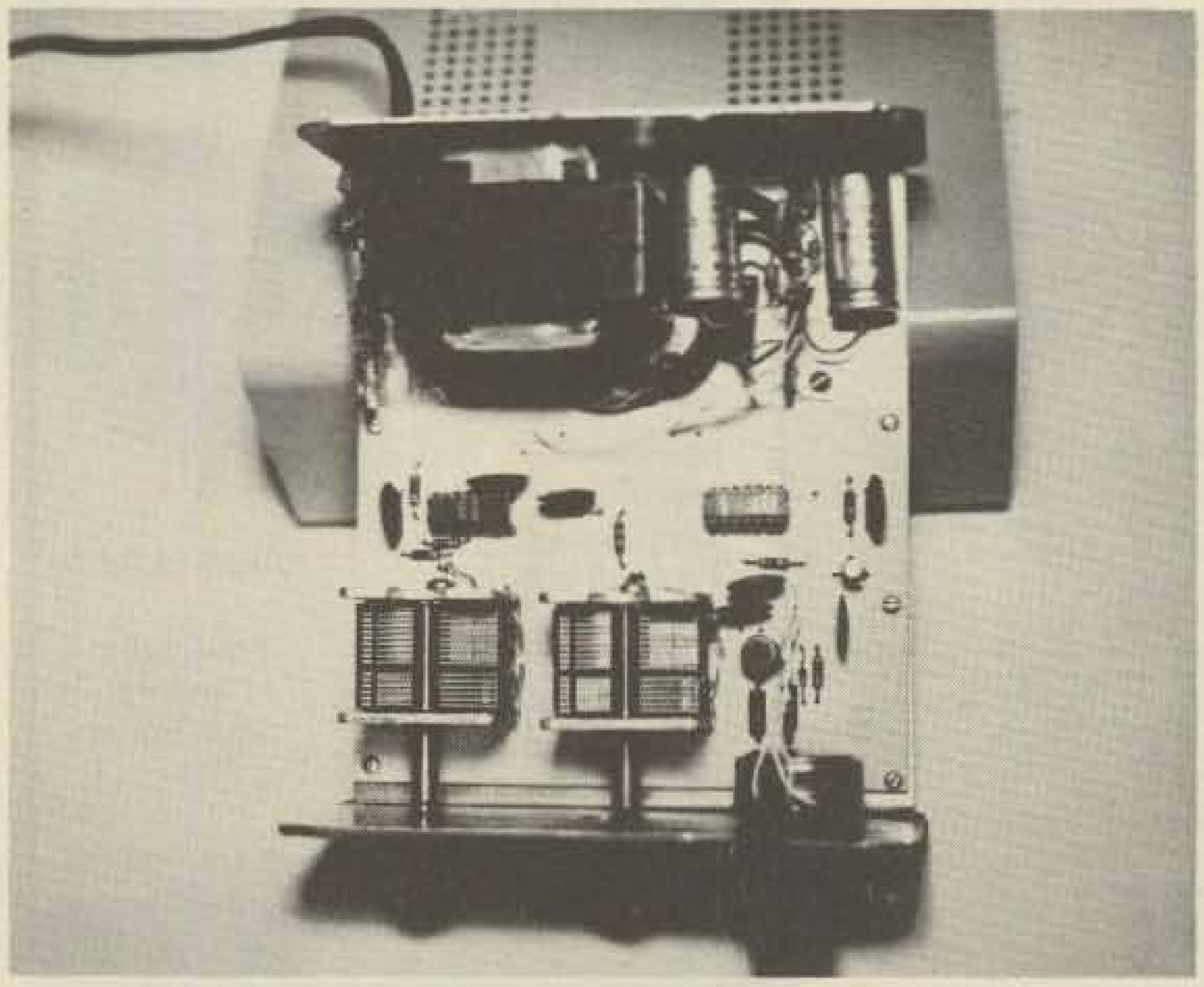
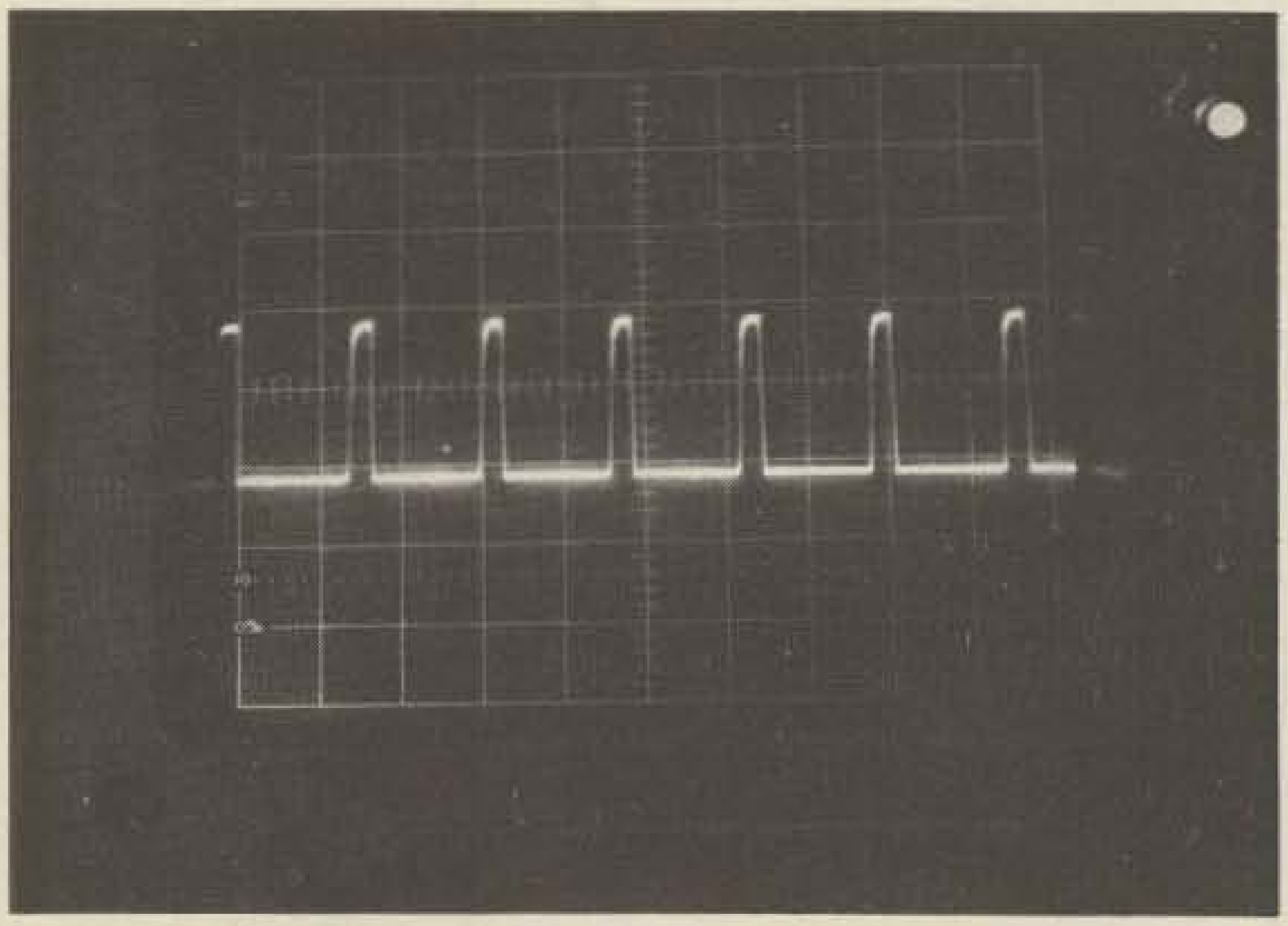


Fig. 1. Pulse generator schematic.



Internal view of pulse generator.



Typical output pulse: 5 V/cm vertical; .5 μsec/cm horizontal.

The two variable capacitors can be any surplus broadcast band capacitors. You can parallel the LO portion with the station tuning or switch them to provide a two range generator. The VCO will operate typically to 30 MHz, the limiting factor being the stray capacity and the minimum C of your tuning capacitor. The low end of the VCO is ≅1 Hz (C3 = 300 μF). The 74121 one-shot multivibrator also has an enormous range, from a pulse width of 40 nanoseconds to 40 seconds (C6 = 1000 μF, R6 = 40k).

One word of caution: Coupling capacitors will have to be increased as the frequency is lowered to preserve the waveshapes.

The frequency range of the device shown is from 900 kHz to 10 MHz; the pulse width is adjustable from 50 nanoseconds to ≅800 nanoseconds. You can select your frequency range of interest and change the variable Cs accordingly.

Operation

The VCO output IC1 is coupled to the one-shot IC2 through C4, R4, and R5. The output of IC2 has a TTL output (A) that has a fanout of 10. The inverted output (IC2, pin 1) is fed to Q1 base, where the output is variable to the emitter follower Q2. 1 Watt of peak power is available from this output into 50 Ohms (14 V peak unloaded). The current sinking capability is limited; however, it can be used to fire SCRs, pulse transformers, or where a larger output voltage is required, as for CMOS, etc.

To use the device, simply turn the pulse width to minimum, set the PRF, then adjust the pulse width as required. ■

Parts List

R1	1k
R2	1k
R3	7.5k
R4	6.8k
R5	680
R6	4.7k
R7	2.0k
R8	500 Ω pot
R9	47k
R10	100 Ω, 1W
R11	50 Ω 1 W
All ¼ W except as noted	
C1-C9	.1 μF disc, except C3, C6 are variables
IC1	NE562
IC2	74121
Q1	2N2222A
Q2	2N2219A
CR1	1N4148

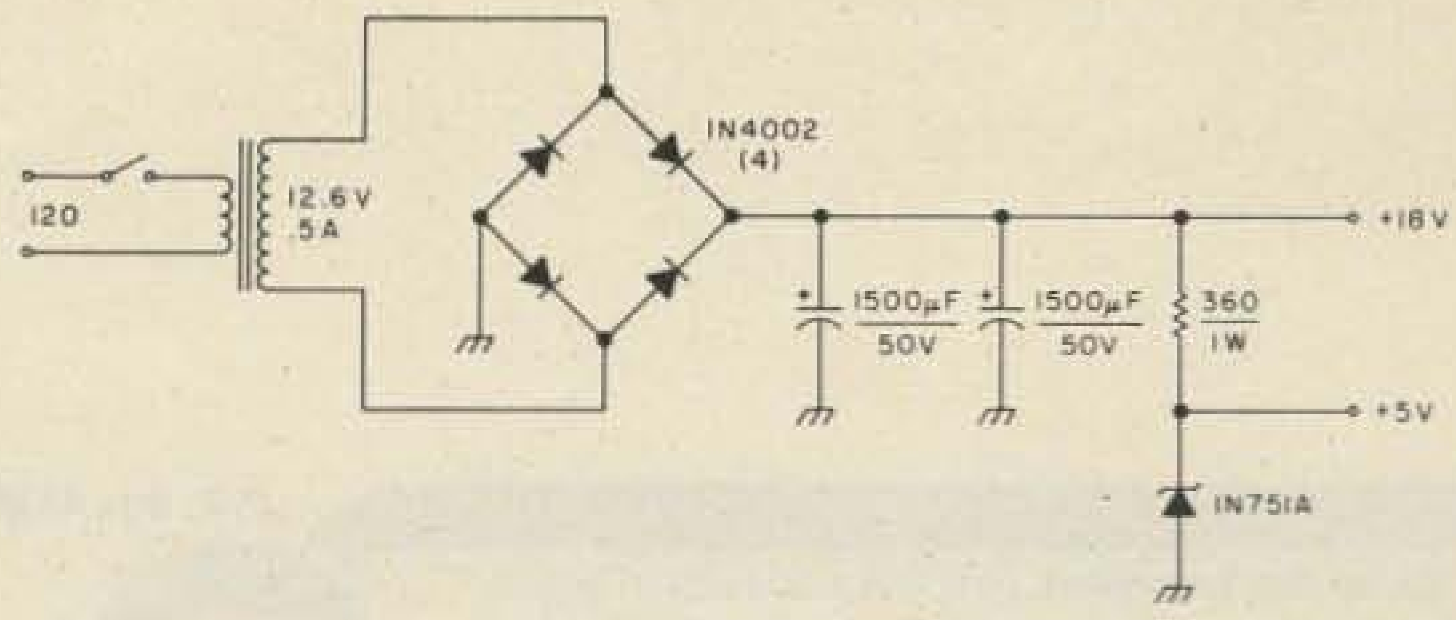
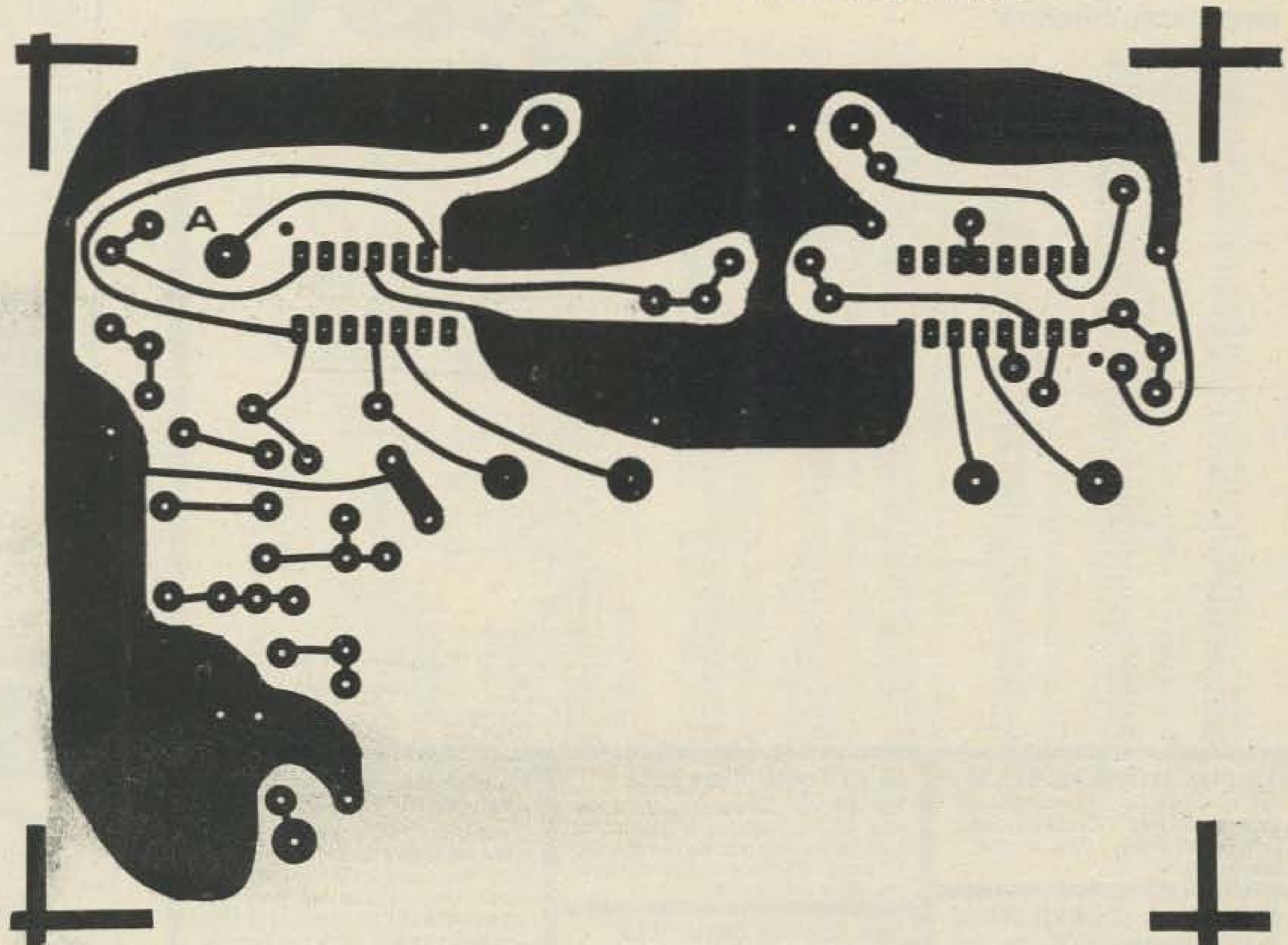


Fig. 2. Power supply.



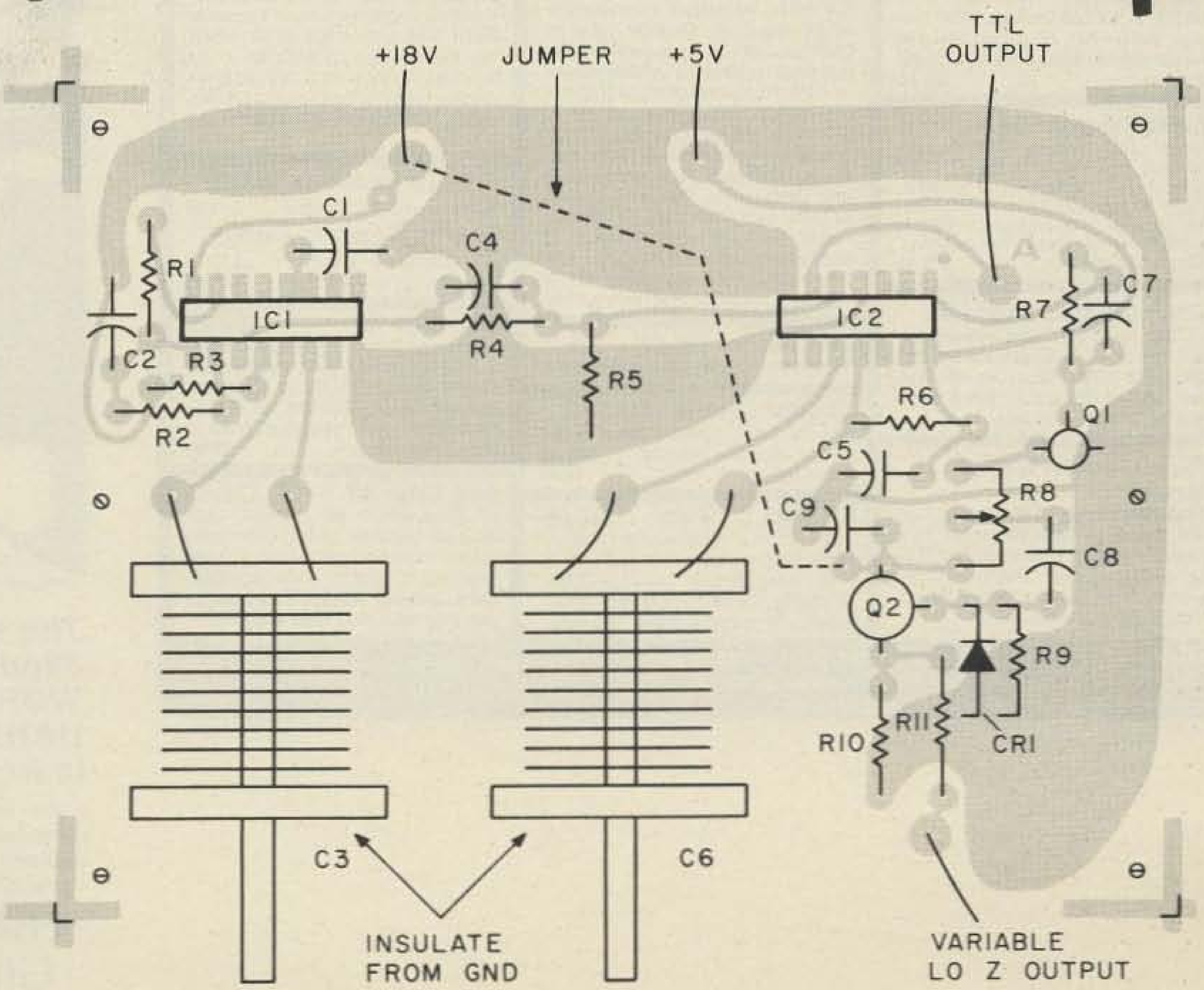


Fig. 3. Component layout.

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406	.19	7451	.25
407	.25	7453	.25
408	.25	7454	.25
409	.25	7460	.25
410	.19	7470	.25
411	.25	7472	.39
412	.35	7473	.39
413	.49	7474	.35
414	.79	7475	.49
416	.39	7476	.39
417	.39	7479	3.99
420	.19	7480	.79
422	.39	7482	.99
423	.39	7483	.99
425	.39	7485	.99
426	.39	7486	.49
427	.39	7488	3.40
428	.39	7489	2.79
430	.25	7490	.49
432	.39	7491	.99
437	.39	7492	.49
438	.39	7493	.49
439	.39	7494	.79
440	.39	7495	.79

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74120	1.79
74121	.39
74122	.39
74123	.69
74125	.59
74126	.59
74128	.49
74132	.99
74136	.89
74141	.99
74145	.99
74147	2.49
74148	1.99
74150	1.19
74151	.99
74153	.89
74154	.99
74155	.99
74156	1.29
74157	.99
74159	2.99
74160	1.19
74161	.99
74162	1.49
74163	.99
74166	1.19
74167	4.99
74170	2.49
74173	1.49
74174	1.19
74175	.99
74176	.99
74177	.99
74192	.99
74193	.99

CMOS

4001	.25
4002	.25
4006	1.99
4007	.25
4008	1.49
4009	.69
4010	.69
4011	.25
4012	.25
4013	.49
4014	1.49
4015	1.39
4016	.49
4017	1.29
4018	1.69
4019	1.79
4020	1.39
4021	1.49
4022	1.25
4023	.25
4024	1.19
4025	.25
4027	.69
4028	1.25
4029	1.99
4030	.69
4032	.49
4033	1.99
4035	1.69
4040	1.99
4041	1.49
4042	1.49
4043	1.49
4044	1.49
4046	2.49
4047	2.49
4049	.79
4050	.79
4051	1.99

MEMORY

1702A	4.95
82s23	2.95
82s123	2.95
2102	1.79
2102-1	1.89
21L02	1.19

CPU's

8080A	14.95
6800	24.95
Z80	39.95

CLOCK's

5314	2.95
5316	4.95
5375	3.95

LM741 $.09

300H	.79	340T-24	1.79
301H	.39	350N	.99
301CN	.39	351CN	.65
302H	1.29	370H	1.29
304H	1.29	370N	1.29
305H	.99	373N	3.19
307H	.49	377N	3.99
307CN	.39	380N	1.39
308H	.99	381N	1.79
308CN	.99	382N	1.79
309H	1.09	NE555v	.49
309K	.99	NE556	1.49
310H	1.19	NE565H	1.79
310CN	1.19	NE565N	1.79
311H	.99	NE566N	1.25
311N	.99	703CN	.45
312H	1.99	709H	.39
318H	1.79	709N	.39
318CN	1.49	710N	.79
319CN	1.29	711H	.39
320K-5	1.39	711N	.39
320K-12	1.39	723H	.55
320K-15	1.39	723N	.55
320T-5	1.75	725H	3.49
320T-8	1.75	733H	1.49
320T-12	1.75	733N	.99
320T-18	1.75	739N	1.19
320-24	1.75	741N	.09
324N	1.79	747N	.79
339N	1.69	748H	.39
340K-5	1.95	748N	.39
340K-8	1.95	1414N	1.75
340K-12	1.95	1458	.69
340K-15	1.95	1496N	.89
340K-18	1.95	2111N	1.95
340K-24	1.95	2901N	2.95
340T-5	1.79	3065N	.69
340T-12	1.79	3900N	.49
340T-15	1.79	3909N	1.19

factory prime
2114/4045 1K by 4 STATIC MEMORY
450nS. $11.95 650nS. $9.95

MICROCOMPUTER POWER SUPPLY KIT

Ideal supply for S-100 systems. Contains all the necessary components to produce 5 volts @ 10 A., ± 12 @ 2.5 A. (voltage actually higher). New surplus from Memorex Corporation.

Kit includes 117 ac. transformer, diodes, six computer grade electrolytics, chassis, circuit breaker and grounded power cord. Transformer has 5 output windings.

Include $9.00 shipping East of the Mississippi; $4.00 for Calif.; all other States $7.00.

$24.88 Plus Shipping

SPEAKERS

$.69 6 for $3.00

2¼" Miniature

Perfect for TV games, alarm systems, speech synthesizer or intercom. 8 ohms

5" HiFidelity $2.98

Thumbwheel switch

Ten position BCD

$1.39 ea.

10	50
$1.19	.89

MINIATURE SWITCHES

your choice

$.98

10	50	100	1k
$.88	.81	.73	.66

SPDT Miniature Toggles

7101 C&K — ON-NONE-ON
7107 jbt — ON-OFF(mnt.ON)
7108 CK — ON-(moment. ON)
Rocker JBT — DPDT
Rotary — 3P-4-Pos.
Rotary — 3P-6-Pos.
Push B (N.O.) $.39ea. 3/$1

TRIMMER POTENTIOMETERS

2K 5K 10K 50K

5 for $.98

20	50	100
16¢	14¢	12¢

CAPACITORS

ELECTROLYTICS

	ea.	10	50
4500/50v.	$1.49	1.35	1.19
1000/15v. axial	$.55	.49	.45
.1 disc	$.12	.09	.07
.01 disc	.06	.05	.04

DIP Switch

$1.75 ea.

10	25	100
$1.63	1.52	1.29

specify 7 or 8 pos.

SPST

32 Conductor RIBBON WIRE

SPECTRA-STRIP

$.59 Ft.

Power Adapter

6 vdc, 140mA $1.39
7 dc, 1.4 A. 5.50
9 vdc, 15mA. 1.19
9 vdc, 175mA. 1.95
12 vdc, 600mA 2.95

RELAYS

SPDT MINIATURE

$1.39 ea.

10	25	100
$1.15	1.04	.89

Coil 12 Volt dc.
7 Amp Contacts
P.C. Board Mount

Transistors

	ea.	10	50	100
2N2222A	.20	.18	.16	.15
2N3055	.69	.65	.59	.55
MJ3055	.79	.75	.69	.65
2N3772	1.59	1.49	1.39	1.29
2N3904	.15	.11	.09	.07
2N3906	.15	.11	.09	.07

Diodes

		10	25	100
1N4002	100v.	.08	06	.05
1N4005	600v.	.10	.08	.07
1N4148	signal	.07	.05	.04

jumbo red LED's — ea. 10 25 100 — $.15 .13 .11 .09

$.98

Output: 12v.ct. 175mA. TRANSFORMER

SOLAR CELLS

$1.19

10	100
$.98	$.85

125mA. at .43V. Ideal for powering radio receivers or charging batteries.

9 foot

$1.49

Heavy duty grounded power cord and mating chassis connectors.

Nicad

$.98

500mA "AA"

FAST CHARGE

DISCOUNT Wire Wrap Center

IC SOCKETS

pin	wire wrap ea.	25	50	low profile ea.	25	50
8	—			17¢	16	15
14	37¢	36	35	18	17	16
16	38	37	36	19	18	17
24	99	93	85	36	35	34
40	1.69	1.55	1.39	63	60	58

50ft. $.98 — KYNAR WIRE WRAP

500	1,000	11,000
$9.	$15.	$105.

Battery wire wrapping tool $34.95 $29.95

OK HOBBY WRAP-30 wire wrap & strip tool $5.45

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VISA — master charge

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Orders are shipped the same day received.
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California residents add 6% sales tax • Money back guarantee.
Sorry, no COD's • Foreign orders add 10%

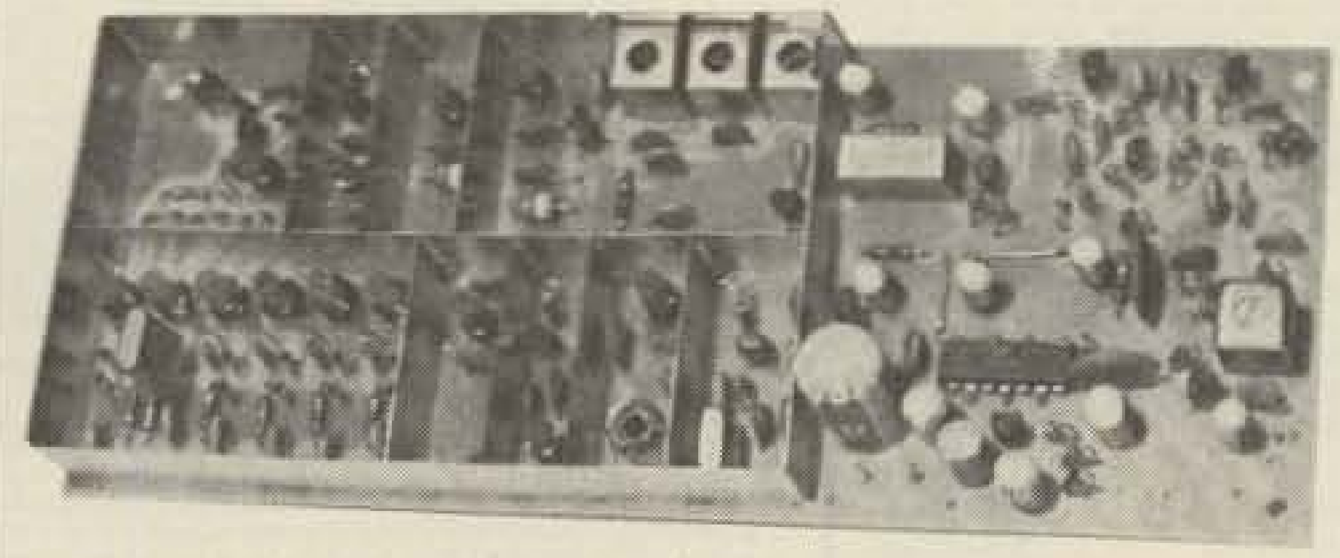
Reader inquiry card number C50

ANNOUNCING--A New Generation of VHF/UHF
FM RECEIVER KITS

More Sensitive, More Selective, Easier to Build, Smaller Than Ever Before!

CHECK THESE FEATURES-

- ✱ Lower system cost than ever before
- ✱ Better selectivity, 70-80 dB adjacent channel, over 100 dB with crystal filter option
- ✱ Six channels at no extra cost
- ✱ 60 dB image rejection
- ✱ Latest design — new easy-to-wind high Q coils, compartmentized shielding
- ✱ Easy to build, test circuits on board allow tune up with only sig gen & vtvm

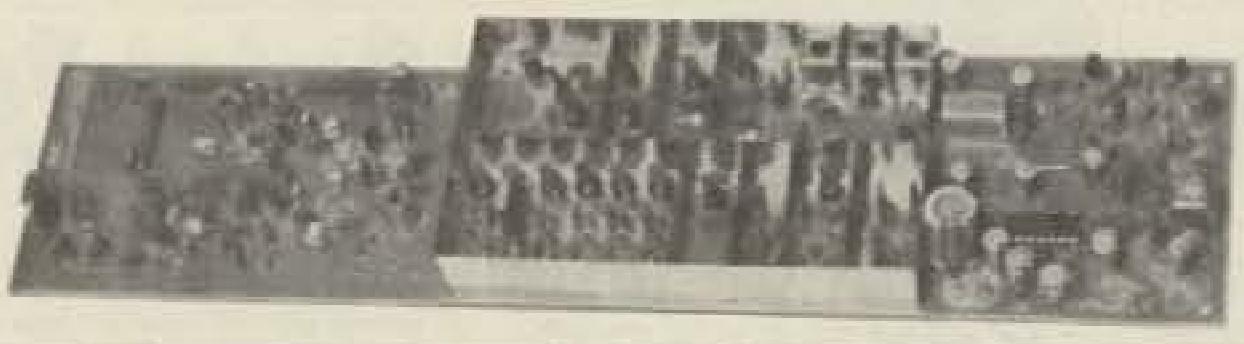


VHF MODEL R70 $69.95
- Available for 2M, 6M, 10M, 220 MHz, or com'l bands
- Sensitivity 0.4uV for 20 dB

Optional Crystal Filter Kit $10
Channel Crystals $5.95 ea

UHF MODEL R90 $89.95
- For any 2 MHz segment of the 380-520 MHz range
- Sensitivity 0.8uV

Optional crystal filter kit $10
Channel crystals $5.95 ea



These low noise PREAMPS let you hear the weak ones!

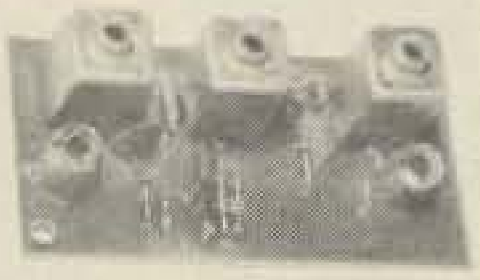
Great for OSCAR, SSB, FM, ATV. Over 8000 in use throughout the world.

P8 KIT $10.95
P16 Wired $21.95
Miniature model for tight spaces - only 1/2 x 2-3/8 inches

• 20dB gain • Covers any 4 MHz band in range

MODEL	RANGE
P8-LO	20-83 MHz
P8-HI	83-190 MHz
P8-220	220-230 MHz
P16 Wired	Give exact band

P9 KIT $12.95
P14 Wired $24.95
Deluxe model for applications where space permits.

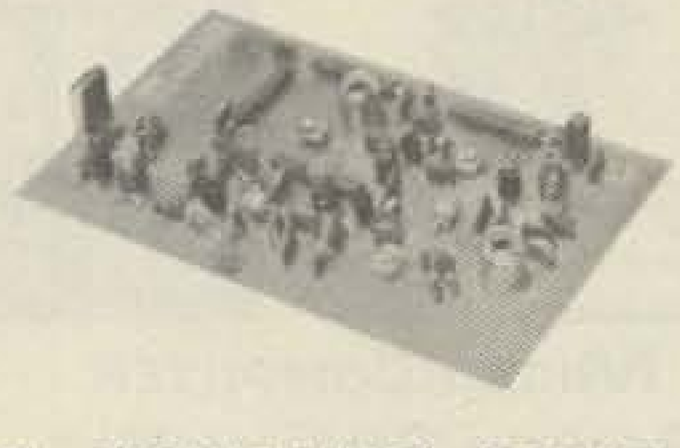


• 1-1/2 x 3 inches • Covers any 4 MHz band in range • Ideal for OSCAR • Diode protection • Connectors • 20 dB gain

MODEL	RANGE
P9-LO	26-88 MHz
P9-HI	88-172 MHz
P9-220	172-230 MHz
P14 Wired	Give specific band

P15 KIT $18.95
P35 Wired $34.95
- Covers any 6 MHz band in band in range of 380-520 MHz
- 20 dB gain

These new CONVERTER KITS
let you receive OSCAR signals and other exciting VHF & UHF activity on your present HF receiver.



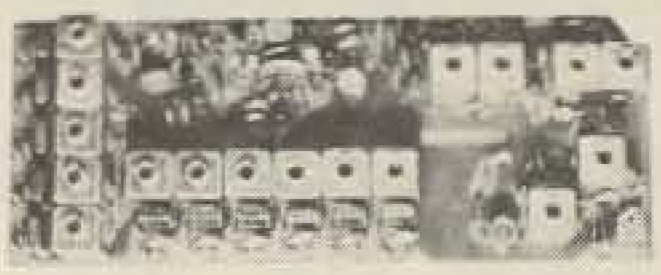
either one
ONLY $34.95
including crystal

MODEL	RF RANGE (MHZ)	IF RANGE
C50	50-52	28-30
C144	144-146	28-30
C145	145-147	28-30
C146	146-148	28-30
C220	p/o 220-230	28-30
Special	Other rf & i-f ranges are available on special request	

MODEL	RF RANGE (MHZ)	IF RANGE
C432-2	432-434	28-30
C432-5	435-437	28-30
C432-9	439.25 (ATV)	61.25
Special	Other rf & i-f ranges are available on special request	

An extruded aluminum case is available for vhf and uhf converters at $12.95, including connectors and hardware.

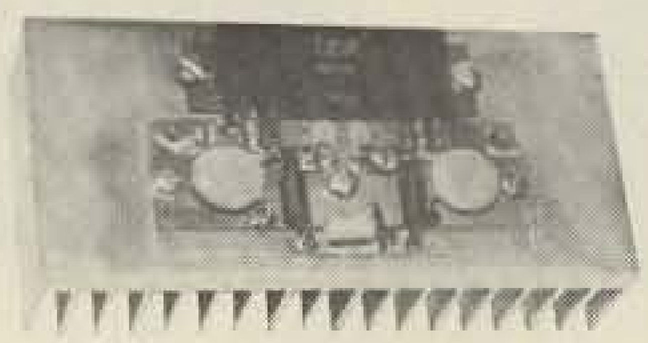
FM/CW TRANSMITTER KITS



200 MW EXCITER MODULE KITS

T40 Eleven Channel Exciter Kit for 2M or 6M band.......................... ...... $39.95

T20 Tripler/Driver Module Kit, 150 mW 2M input, 200 mW 450 MHz output $19.95



RF POWER AMPLIFIER MODULES

•NO TUNING •VSWR PROTECTED •COMPLETELY STABLE •150MW DRIVE

T80-150, 140-175 MHz, 20-25W output, wired and tested, simply connect your cables.. $79.95

T80-450, 430-470 MHz, 13-15W....... $79.95

TEST PROBE KITS

only $9.95 ea

Contain scope type probe, ground clip, cable, & all components except plug for test equipment.

TE-3	RF Detector Probe for vtvm; good from 100 kHz to over 500 MHz
TE-4	Direct Probe for ac/ohms, etc.
TE-5	DC Probe w/res for 11 meg input vtvm
TE-6	Blocking Capacitor Probe for counter, signal generator, etc.
TE-7	Wideband Detector Probe for scopes
TE-8	High Z/Low Capacitance scope probe

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FREE SHIPPING ON LARGE STOCK OF ANTENNAS!!! We now offer free delivery of Cushcraft, Larsen, & Hy-Gain antennas in the 48 states. Popular models such as Ringo Rangers, VHF & triband beams, magnet mount whips, hf verticals, rubber duckies, lightning arrestors, Reyco traps, W2AU & Hy-Gain baluns. Call or write NOW! We'll be glad to send free catalogs.

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- ◆Use credit card, COD, check, m.o.
- ◆Add $2.00 shipping & handling.

hamtronics, inc.

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Dealer Inquiries Invited H16

IN CANADA:
Send order to COMTEC; 5605 Westluke Ave.; Montreal, Que H4W 2N3 or call 514-482-2640. Add 28% to prices shown above to cover customs duty, exchange rate, and federal tax.

NEW

Frequency Counter

$79.95 kit

UTILIZES NEW MOS-LSI CIRCUITRY

You've requested it, and now it's here! The CT-50 frequency counter kit has more features than counters selling for twice the price. Measuring frequency is now as easy as pushing a button, the CT-50 will automatically place the decimal point in all modes, giving you quick, reliable readings. Want to use the CT-50 mobile? No problem, it runs equally as well on 12 V dc as it does on 110 V ac. Want super accuracy? The CT-50 uses the popular TV color burst freq. of 3.579545 MHz for time base. Tap off a color TV with our adapter and get ultra accuracy — .001 ppm! The CT-50 offers professional quality at the unheard of price of $79.95. Order yours today!

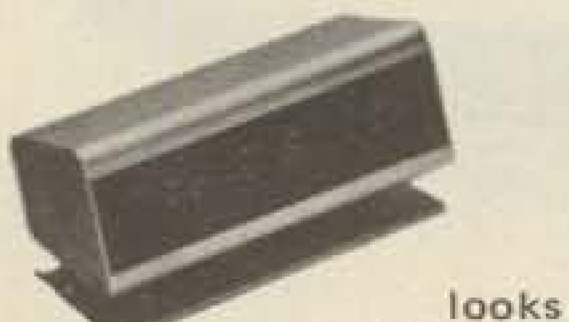
CT-50, 60 MHz counter kit $79.95
CT-50 WT, 60 MHz counter, wired and tested 159.95
CT-600, 600 MHz prescaler option for CT-50, add 29.95

SPECIFICATIONS

Sensitivity: less than 25 mv.
Frequency range: 5 Hz to 60 MHz, typically 65 MHz
Gatetime: 1 second, 1/10 second, with automatic decimal point positioning on both direct and prescale
Display: 8 digit red LED .4" height
Accuracy: 10 ppm, .001 ppm with TV time base!
Input: BNC, 1 megohm direct, 50 Ohm with prescale option
Power: 110 V ac 5 Watts or 12 V dc @ 1 Amp
Size: Approx. 6" x 4" x 2", high quality aluminum case

Color burst adapter for .001 ppm accuracy

CB-1, kit $14.95



CLOCK KIT
6 digit 12/24 hour

Want a clock that looks good enough for your living room? Forget the competitor's kludges and try one of ours! Features: jumbo .4" digits, Polaroid lens filter, extruded aluminum case available in 5 colors, quality PC boards and super instructions. All parts are included, no extras to buy. Fully guaranteed. One to two hour. assembly time. Colors: silver, gold, black, bronze, blue (specify).

Clock kit, DC-5 .... $22.95
Alarm clock, DC-8, 12 hr only 24.95
Mobile clock, DC-7 .... 25.95
Clock kit with 10 min ID timer, DC-10 ... 25.95
Assembled and tested clocks available, add $10.00

CHEAP CLOCK KIT $8.95

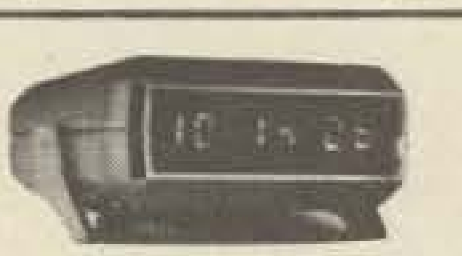
DC-4 Features:	Does not	PC Board
• 6 digit .4" LED	include board	$2.95
• 12 or 24 format	or transformer	Transformer $1.49

VIDEO TERMINAL KIT $149.95

A compact 5 x 10 inch PC card that requires only an ASCII keyboard and a TV set to become a complete interactive terminal for connection to your microprocessor asynchronous interface. Its many features are single 5-volt supply, crystal controlled sync and baud rates (up to 9600 baud), 2 pages of 32 characters by 16 lines, read to and from memory, computer and keyboard-operated cursor and page control, parity error display and control, power-on initialization, full 64-character ASCII display, block type see-thru cursor. Keyboard/computer control backspaces, forward spaces, line feeds, rev. line feeds, home, returns cursor. Also clears page, clears to end of line, selects page 1 or 2, reads from or to memory. The card requires 5 volts at approx. 900 ma and outputs standard 75 ohm composite video.

TH3216 Kit $149.95
TH3216, Assembled and Tested 239.95
VD-1, Video to RF Modulator Kit 6.95

CAR CLOCK KIT $27.95



12/24-Hour 12 Volt AC or DC
- High Accuracy (1 minute/month)
- 6 jumbo .4" LED readouts
- Easy, no-polarity hookup
- Display blanks with ignition
- Case, mounting bracket included
- Super instructions

Complete Kit, DC-11 $27.95

AUTO-DIMMER $2.50

Automatically adjusts display brightness according to ambient light level For DC-11 Car Clock

MINI-KITS

TONE DECODER KIT

A complete tone decoder on a single PC Board. Features: 400-5000 Hz adjustable frequency range, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK demod, signaling, and many other uses. Use 7 for 12 button touchtone decoding. Runs on 5 to 12 volts.

Complete Kit, TD-1 .... $4.95

SUPER-SNOOP AMPLIFIER

A super-sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as a general purpose test amplifier. Full 2 watts of output, runs on 6 to 12 volts, uses any type of mike. Requires 8-45 ohm speaker.

Complete Kit, BN-9 .... $4.95

FM WIRELESS MIKE KIT

Transmit up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9 V. Type FM-2 has added super sensitive mike preamp.

FM-1 ...... $2.95   FM-2 ...... $4.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music or voice. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300 watts. Great for parties, band music, nite clubs and more.

Complete Kit, ML-1 .... $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 Jumbo LEDs. Use for name badges, buttons, or warning type panel lights. Runs on 3 to 9 volts.

Complete Kit $2.95

POWER SUPPLY KIT

Complete triple regulated power supply provides variable ±15 volts at 200 mA and +5 volts at 1 Amp. 50 mV load regulation good filtering and small size. Kit less transformers. Requires 6-8 V at 1 Amp and 18 to 30 VCT.

Complete Kit, PS-3LT $6.95

SIREN KIT

Produces upward and downward wail characteristic of police siren. 5 watts audio output, runs on 3-9 volts, uses 8-45 ohm speaker.

Complete Kit, SM-3 .... $2.95

DECADE COUNTER PARTS

Includes: 7490A, 7475, 7447, LED readout, current limit resistors, and instructions on an easy to build low cost frequency counter.

Kit of parts, DCU-1 .... $3.50

600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity. Specify ÷10 or ÷100

Wired, tested, PS-1B $59.95
Kit, PS-1B $44.95

30 watt 2 meter Power Amp

The famous RE class C power amp now available mail order! Four Watts in for 30 Watts out, 2 in for 15 out, 1 in for 8 out, incredible value, complete with all parts, instructions and details on T-R relay. Case not included.

Complete Kit, PA-1 .... $22.95

CALENDAR ALARM CLOCK

Has every feature one could ever ask for. Kit includes everything except case, build it into wall, station or even car!

FEATURES:
- 6 Digits, .5" High LED
- 12/24 Hour Format
- Calendar shows mo./day
- Snooze button
- True 24 Hour Alarm
- 7001 chip does all!!
- Battery back up with built-in on chip time base

Complete Kit, less case, DC-9 .... $34.95

		LINEAR		REGULATOR		TRANSISTORS	
5314 Clock	$2.95	555	$ .50	78MG	$1.49	MRF-238 30W VHF	$11.95
74S00	.35	556	.75	309k	.89	NPN 2N3904 type	10/$1.00
74S112	.75	566	1.49	309H	.99	PNP 2N3906 type	10/$1.00
7447	.79	567	1.49	340K-12	.99	NPN Power Tab 40W	3/$1.00
7473	.35	1458	.50	7805	.89	PNP Power Tab 40W	3/$1.00
7475	.50	LED DRIVER		7812	.89	FET MPF-102 type	3/$2.00
7490A	.55	75491	.50	7815	.89	UJT 2N2646 type	3/$2.00
74143	3.50	75492	.50	7818	.89	2N3055 NPN Power	.75

SPECIAL

DIODES: 1KV,2.5A .... 5/$1.00   100V,1A .... 10/$1.00   1N914A type .... 50/$2.00

LED DISPLAYS

FND 359 ...... .75
FND 510 ...... 1.25
DL 707 ...... 1.25
HP 7730 ...... 1.25

Red Polaroid Filter ... 4.25" X 1.125" ... .59

741 OP-AMP SPECIAL

Factory prime mini dip with both Xerox and 741 part numbers

10 for $2.00

SOCKETS

14 PIN 5/$1.00
16 PIN 5/$1.00
24 PIN 2/$1.00
40 PIN 3/$2.00

FERRITE BEADS

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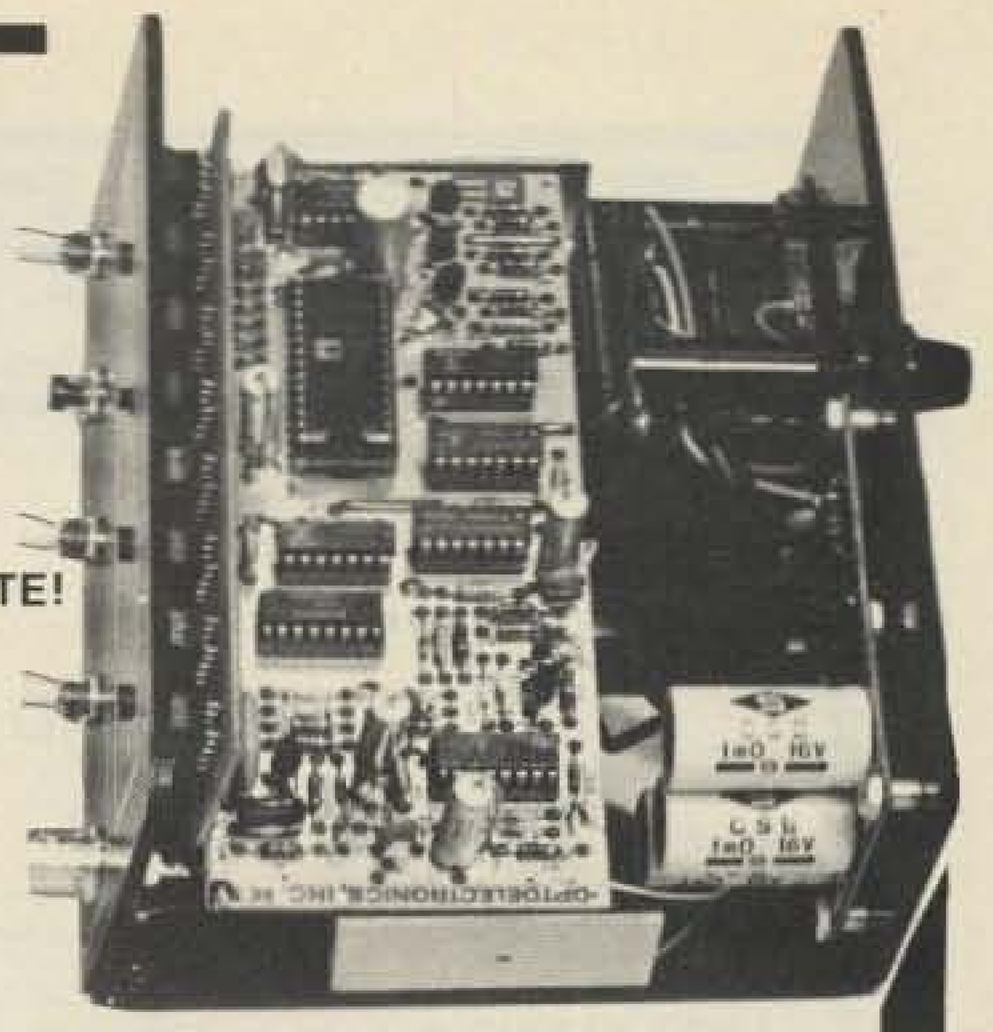
NEW LSI TECHNOLOGY

FREQUENCY COUNTER

TAKE ADVANTAGE OF THIS NEW STATE-OF-THE-ART COUNTER FEATURING THE MANY BENEFITS OF CUSTOM LSI CIRCUITRY. THIS NEW TECHNOLOGY APPROACH TO INSTRUMENTATION YIELDS ENHANCED PERFORMANCE, SMALLER PHYSICAL SIZE, DRASTICALLY REDUCED POWER CONSUMPTION [PORTABLE BATTERY OPERATION IS NOW PRACTICAL], DEPENDABILITY, EASY ASSEMBLY AND REVOLUTIONARY LOWER PRICING!

KIT #FC-50 C	60 MHZ	COUNTER WITH CABINET & P.S.	$119.95 COMPLETE!
KIT #PSL-650	650 MHZ	PRESCALER [NOT SHOWN]	29.95
MODEL #FC-50WT	60 MHZ	COUNTER WIRED, TESTED & CAL.	165.95
MODEL #FC-50/600 WT	600 MHZ	COUNTER WIRED, TESTED & CAL.	199.95



SIZE:
3" High
6" Wide
5½" Deep

FEATURES AND SPECIFICATIONS:

DISPLAY: 8 RED LED DIGITS .4" CHARACTER HEIGHT
GATE TIMES: 1 SECOND AND 1/10 SECOND
PRESCALER WILL FIT INSIDE COUNTER CABINET
RESOLUTION: 1 HZ AT 1 SECOND, 10 HZ AT 1/10 SECOND.
FREQUENCY RANGE: 10 HZ TO 60 MHZ. [65 MHZ TYPICAL].
SENSITIVITY: 10 MV RMS TO 50 MHZ, 20 MV RMS TO 60 MHZ TYP.
INPUT IMPEDANCE: 1 MEGOHM AND 20 PF.
[DIODE PROTECTED INPUT FOR OVER VOLTAGE PROTECTION.]
ACCURACY: ± 1 PPM [± .0001%]; AFTER CALIBRATION TYPICAL.
STABILITY: WITHIN 1 PPM PER HOUR AFTER WARM UP [.001% XTAL]
IC PACKAGE COUNT: 8 [ALL SOCKETED]
INTERNAL POWER SUPPLY: 5 V DC REGULATED.
INPUT POWER REQUIRED: 8-12 VDC OR 115 VAC AT 50/60 HZ.
POWER CONSUMPTION: 4 WATTS

KIT #FC-50C IS COMPLETE WITH PREDRILLED CHASSIS ALL HARDWARE AND STEP-BY-STEP INSTRUCTIONS. WIRED & TESTED UNITS ARE CALIBRATED AND GUARANTEED.

PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I
3"H,6¼"W,5½"D

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2½"H,5"W,4"D

Black, White or Clear Cover
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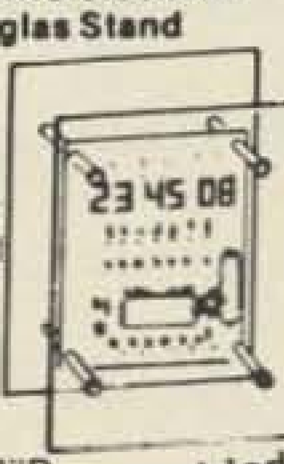
RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS
3"x6"x1/8" 95¢ ea. 4/$3

SEE THE WORKS Clock Kit Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr. time
- 3 set switches
- Plug transformer
- all parts included



Plexiglas is Pre-cut & drilled

Kit #850-4CP

Size: 6"H,4½"W,3"D

$23.50 ea. 2/$45. Assembled $29.95

60 HZ. XTAL TIME BASE

Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC.
1"x2" PC Board
Power Req: 5-15V (2.5 MA. TYP.)
Easy 3 wire hookup
Accuracy: ± 2PPM
#TB-1 (Adjustable)
Complete Kit $4.95
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SPECIAL PRICING!

PRIME - HIGH SPEED RAM

21L02-3 400 NS

LOW POWER - FACTORY FRESH

1-24	$1.75 ea.	100-199	$1.45 ea.
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1000 AND OVER			$1.29 ea.

6-DIGIT LED CLOCK CALENDAR KIT

DATE-TIME-SNOOZE ALARM & MORE... KIT 7001

FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM, SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

KIT - 7001B WITH 6 - .5" DIGITS $39.95
KIT - 7001C WITH 4 - .6" DIGITS & 2 - .3" DIGITS FOR SECONDS $42.95
KIT - 7001X WITH 6 - .6" DIGITS $45.95

KITS ARE COMPLETE (LESS CABINET)

ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

JUMBO DIGIT CLOCK

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC 12/24 Hr. time, PC Boards, Transformer, Line Cord, Switches and all Parts. Ideal Fit in Cabinet II

Kit #5314-5 $19.95 2/$38.

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Convert small digit LED clock to large .5" displays. Kit includes 6 - LED's, Multiplex PC Board & Hook up info.

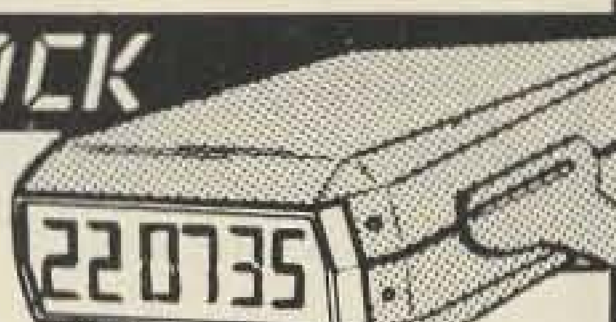
Kit #JD-1CC For Common Cathode
Kit #JD-1CA For Common Anode

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout.

Specify for 7001
B, C or X - $7.95

MOBILE LED CLOCK

12/24 HR .4" DIGITS!



MODEL #2001 — 12 VOLT AC or DC POWERED

- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
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- TOP QUALITY PC BOARDS & COMPONENTS - INSTRUCTIONS.
- MOUNTING BRACKET INCLUDED

KIT #2001 COMPLETE KIT $27.95 EA. 3 OR MORE $25.95 ea. 115 VAC Power Pack #AC-1 $2.50 EA.

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AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND. KEYLESS ALARM HAS PROVISION FOR POS. & GROUNDING SWITCHES OR SENSORS. WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN. KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH - REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED. CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED

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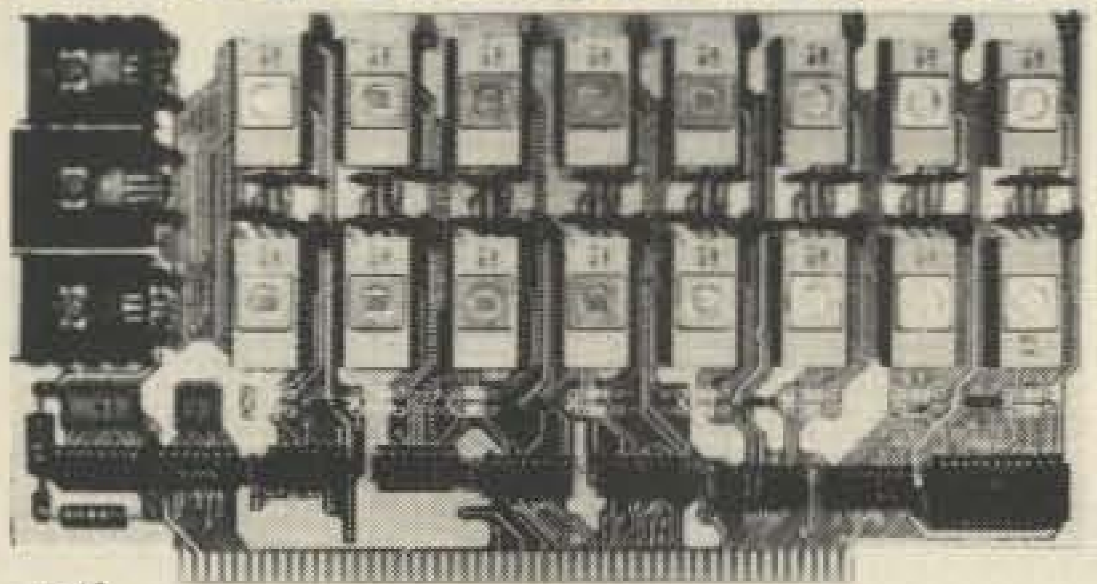
$69.95 (KIT)

S-100 (IMSAI/ALTAIR) BUSS COMPATIBLE



IMAGINE HAVING 16K OF SOFTWARE ON LINE AT ALL TIME!

KIT FEATURES:

1. Double sided PC Board with solder mask and silk screen and Gold plated contact fingers.
2. Selectable wait states.
3. **All** address lines and data lines buffered!
4. All sockets included.
5. On card regulators.

USES 2708's!

KIT INCLUDES ALL PARTS AND SOCKETS! (EXCEPT 2708's)

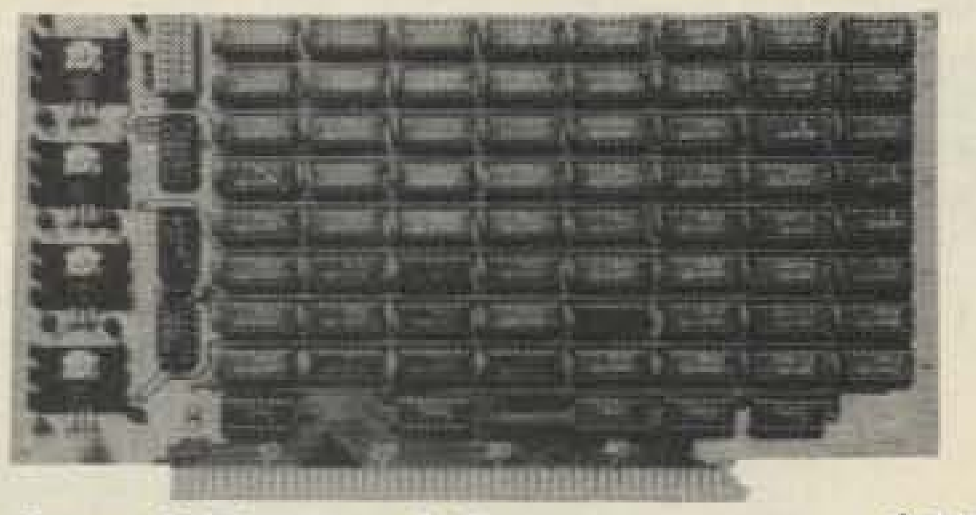
ADD $25 FOR ASSEMBLED AND TESTED

WOW! DEALER INQUIRES INVITED

SPECIAL OFFER: Our 2708's (450 NS) are **$12.95** when purchased with above kit.

FULLY STATIC! $149.00 KIT

8K LOW POWER RAM KIT!



USES 21L02-1 RAM'S.

KIT FEATURES:

1. Double sided PC Board with solder mask and silk screen layout. Gold plated contact fingers.
2. All sockets included!
3. **Fully** buffered on all address and data lines.
4. **Phantom** is jumper selectable to pin 67.
5. **FOUR** 7805 regulators are provided on card.

S-100 (IMSAI/ALTAIR) BUSS COMPATIBLE

PRICE WAR!
For a limited time only:
Buy two 8K Kits for **$129 ea.**

Fully Assembled and Burned In —	**$179.00**
Blank PC Board With Documentation —	**29.95**
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3W AUDIO AMP MODULE

Fully assembled and tested. With schematic. 4, 8 or 16 OHMS.

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New by G.E. Like MV5024 #SSL-22

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RCA HOUSE #2N3772

NPN Power Transistor. 30 AMP. 150 W. VCEO-60. TO-3. Vastly out performs 2N3055. Reg. List $3.04

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2114. The industry standard. 18 PIN DIP. Arranged as 1K X 4. Equivalent to FOUR 21L02's in ONE package! TWO chips give 1K X 8, with data.

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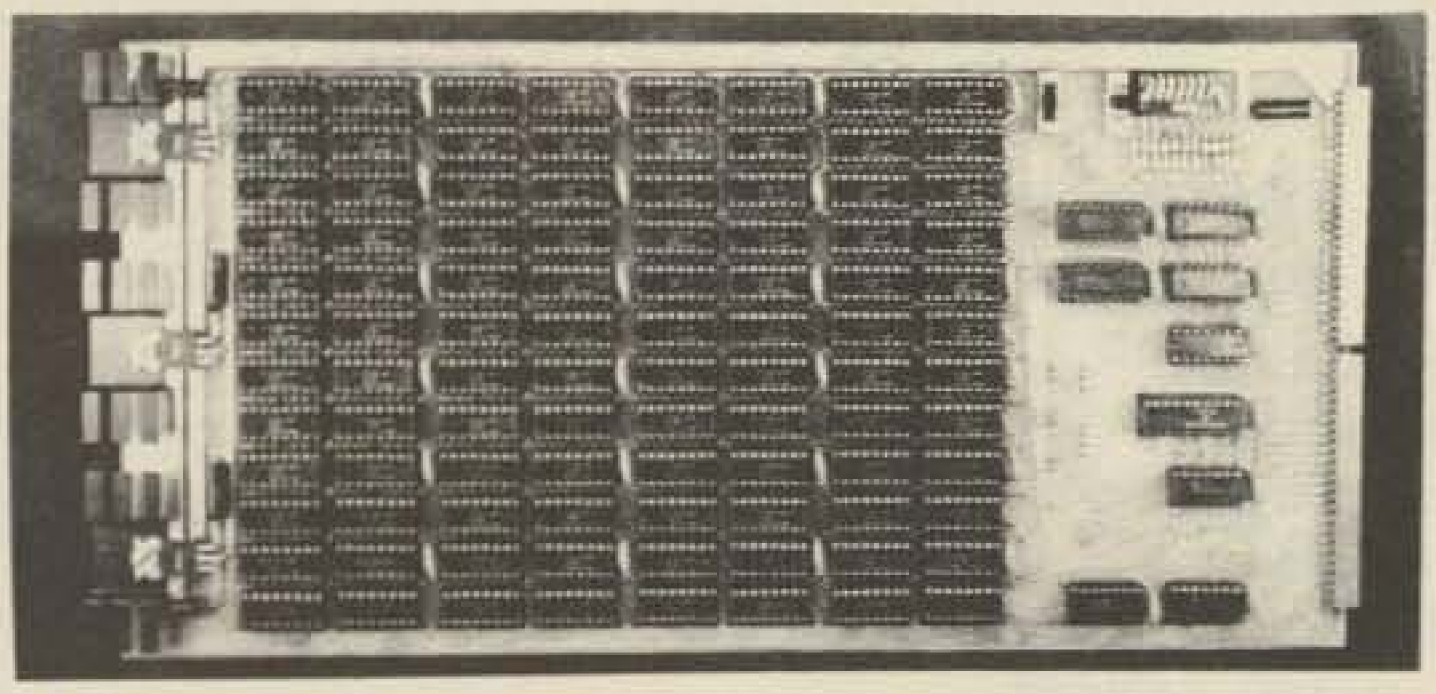


12Kx8 memory kit for the Heath H8

$235.00

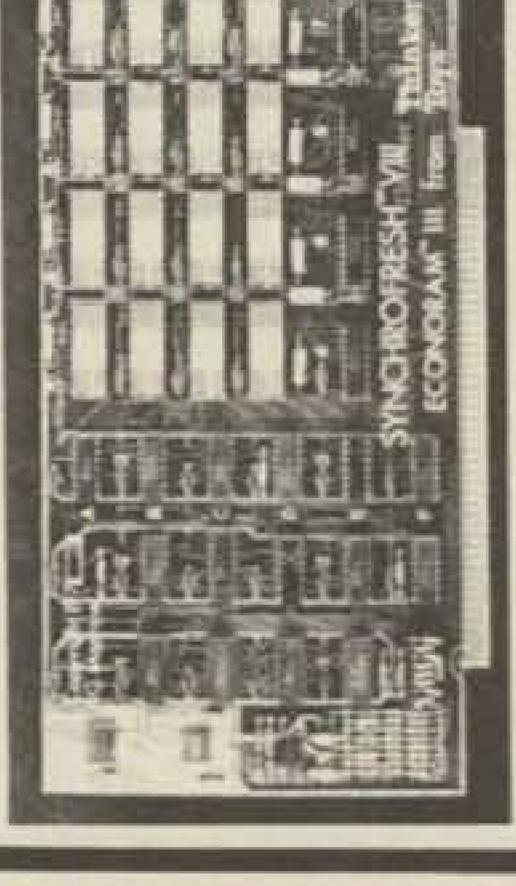
We proudly welcome our newest memory board family member, designed from the ground up for full compatibility with the Heath Company H8. Organized as two independent blocks for flexibility: one 8K block (locatable on any 8K boundary) and one 4K block locatable on any 4K boundary. Has the same basic features of our ECONORAM II™— all static design, dipswitch address selection, switch selected write protect and phantom, sockets for all ICs, full buffering—plus the required hardware and edge connector to mate mechanically with the H8. Now you can have our 12K board for the price of the Heath Company's 8K ... with the performance you've come to expect from products carrying the ECONORAM™ name.

Also available: H8 4K to 8K conversion kit ($90). If you have a Heath Company 4K memory, plug in these ICs and you'll have a full 8K. Kit includes eight TI4044 memories and matching sockets.

ECONORAM II™

This 8K x 8 static memory is a consistent winner, whether you plug into an Altair, IMSAI, or any other S-100 buss computer. Configured as two independent 4K blocks, with separate protect for each block and vector interrupt provision if you try to write into protected memory. Handles DMA devices. All address and data lines fully buffered. Tri-state outputs for use with bi-directional busses. Selectable write strobe (writes on either PWR or MWRITE), and dipswitch selectable address. We guarantee 450 ns speed, although many users report running this board in conjunction with 4 MHz Z-80s without using the on board wait state provison. The mechanical quality matches the design, with gold-plated edge fingers, legended and solder masked board, sockets for all ICs, and industrial grade or better components. Join the thousands who have made this our most popular computer board!

Kit form.. $130
Assembled, tested, 1 year warranty.............................. $150
Special! Four ECONORAM II™ kits............................ 4/$475



new and dynamic: ECONORAM III™

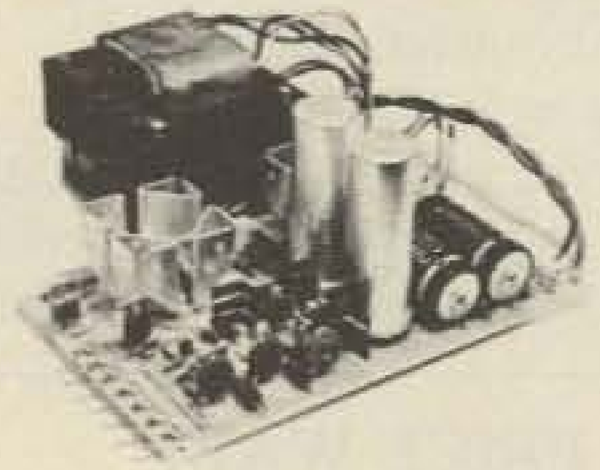
Here is the first 8K x 8 dynamic RAM that performs well enough to merit the ECONORAM™ name. Thanks to the SynchroFresh* timing process, refresh fits naturally into the timing of the S-100 buss ... now you can have half the power of statics, but without the traditional timing hassles you've come to associate with dynamic memories.

In addition to low power, this board runs at zero wait states with an 8080 CPU, and is configured as two separate blocks for maximum versatility. Not a kit: shipped assembled, tested and ready to plug into any S-100 buss computer (Altair, IMSAI, etc.). 1 year warranty.

Assembled 8K x 8 ECONORAM III™ $149.00

*SynchroFresh is a trade mark of Thinker Toys

CPU POWER SUPPLY ($50)



Gives a full 5V at 4A with crowbar overvoltage protection, along with +12V at ½A, -12V at ½A, and adjustable bias supply (5 to 10V at 10 mA). Although intended for use with small computer systems, this is also an excellent supply for bench and development work.

10 SLOT MOTHERBOARD ($90; 18 SLOTS $124)

Add one of these on to an existing S-100 system, or use as the nucleus of a stand-alone system. Both kits come with all edge connectors and include on-board active, regulated terminations to minimize crosstalk, overshoot, ringing, and other glitches that can occur with unterminated lines. Includes lots of bypass caps and heavy power traces.

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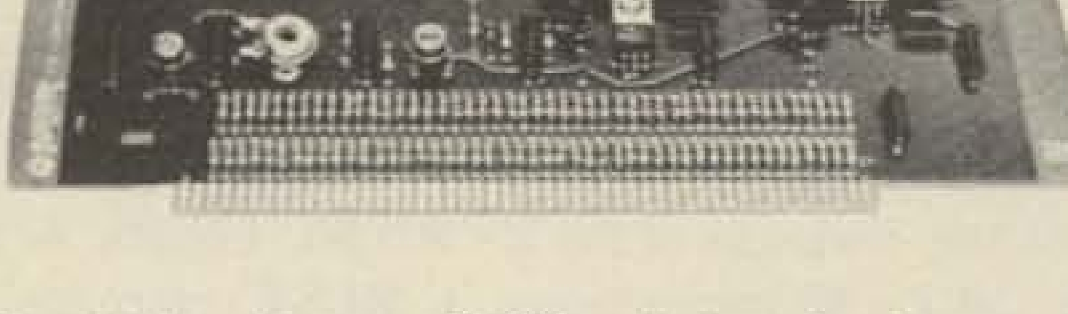

Plug this board into any S-100 motherboard to clean up the problems associated with unterminated lines. Uses the same circuitry as our Motherboards.

TERMS: Please allow up to 5% for shipping; excess refunded. Californians add tax. COD orders accepted with street address for UPS. For VISA® /Mastercharge® orders call our 24 hour order desk at **(415) 562-0636.** Prices good through cover month of magazine.

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The "Hand-Size" Triplett Model 3300 is a battery operated DVOM weighing only 10 ounces. Its combination of small size, light weight and battery operation makes it ideal for those "away from workbench" trouble-shooting and measurement requirements. This 5 function, 22 range DVOM includes HI/Low power ohms, auto-zeroing, auto-polarity and out-of-range display blinking. With the AC adapter charger, the tester has the convenience of battery or AC operation. Whatever your measurement needs, see the new Model 3300 DVOM at TRI-TEK!!!

*3½ Digit High intensity .3" LED display.
*5 functions, 22 ranges, single range selector switch.
*Single range selector switch is color coded.
*Typical DC accuracy is .5% Rdg.
*6 resistance ranges to 20M, 3 low power ohms.
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*Convenient "Snap - in battery pac.
*Includes Ni Cad batteries and AC adapter charger.
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*High impact thermoplastic case.

MODEL 3300..............................$175
Cat #10-2860 optional carrying case.........$16

Charge card telephone orders ($20 min.) will be accepted 9-5:30 P.M. except weekends. Telephone 995-9352. No collect calls please.

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*Drop-resistant, hand-size V-O-M with high-impact thermoplastic case.
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DC Volts: 0-3-12-60-300, 1,200 (20,000 ohms/volt.)
AC Volts: 0-3-12-60-300-1,200 (5,000 ohms/volt).
Ohms: 0-20K-200K-2M-20M(200 ohm center scale on low range).
DC Microamperes: 0-600 at 250mV
DC Milliamperes: 0-6-60-600 at 250mV.
Accuracy: ±3% DC; ±4% AC; (full scale).
Scale length; 2-1/8"
Meter: Self-shielded; diode overload protected; spring backed jewels.
Case: Molded, black, high impact thermoplastic with slide latch cover for access to batteries and fuse. 2-3/4" w x 1-5/16" d x 4-1/4" h.
Batteries: NEDA 15V 220 (1), 1½V 910F (1).

Complete with 42" leads, alligator clips, batteries and instruction manual.
MODEL 310.............................. $55
Cat # 10-1258 Optional carrying case........ $6.40

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CA3130 Bipolar/Mos-FET Op Amp	1.19
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ZIF-22 4.50
ZIF-24 4.85
ZIF-40 7.19

(Last two digits of part number show number of pins per socket)

Unique Features of the Welcon Zero Insertion Force Dual-In-Line Sockets . . .

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* Sturdy terminals that fit .025" diameter printed circuit board holes.
* "Zero" insertion, positive wiping contacts.
* "ZIF" eliminates costly damage to fragile LSI devices

Figure 1
Device before insertion

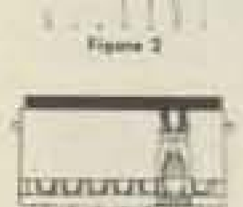

Figure 2

Figure 3

Figure 4

Why struggle to insert DIP's into sockets when you can do it the easy way . . . the Welcon way . . . with a new design concept that provides "zero insertion force" and positive wiping.

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I.C. SOCKETS

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8 pin	10/$1.50	100/$14.00	1000/$120.00
14 pin	10/$1.70	100/$16.00	1000/$140.00
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6.3 VCT, 1.2A Transformer F41X	2.49
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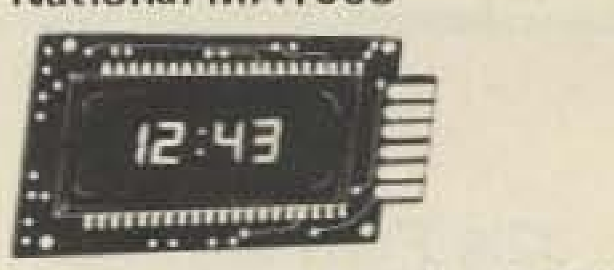

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BRIGHT .3 FLUORESCENT DISPLAY
Same unit supplied as original equipment in many new automobiles * 12 volt DC * Xtal time base * 12 hour format * completely assembled unit * dims to comfortable viewing when car lights are on * low standby power consumption. Only $19.95
PLUS–FREE 3 Push Switches & choice of green, blue, or amber filter.

also good for marine and aircraft use

CAPACITOR ASSORTMENT

5 pf to .1 Discs 50 for $1.49
.047 400 Volt Ceramic Radial $.10
50 MFD @ 150 VDC 3 for $1.00
3 MFD @ 12 VDC 15 for $1.00
.01 30 Volt Disc 25 for $1.00

SPEAKERS

2"	8 Ohm Round	$ .65
2¼"	8 Ohm Round	.75
2½"	8 Ohm Round	1.00
2½"	100 Ohm Round	1.25

add 10 cents per speaker shipping

100' Spool Green #30 wire
Wrap Wire $2.75
OK Wire Hand Tool
WSU 30 . . . . 5.95
WSU30M (modified wrap) . 6.95
Battery operated wire-wrap tool
BW 630 Wraps #30 wire 34.95
Uses 2 C Batt. not inc.
2 General Electric C Batteries and plug-in charger 11.95

● RECTIFIERS

2 amp 50 volt 20 for $1.00
2 amp 1000 volt 10 for $1.00
2 amp 1500 volt .5 for 1.00
10 amp stud 50 volt . . 1.50
10 amp stud 600 volt . 4.50
40 amp stud 50 volt . . 1.20
40 amp stud 750 volt . 2.05
100 amp. stud 200 v. 8.50

BRIDGES
2 amp T05 50 volt 35
2 amp T05 200 volt 50
2 amp T05 600 volt . . 1.25
3 amp. 50 volt 50
3 amp. 400 volt 1.10
25 amp. 200 volt 1.50
25 amp. 600 volt 5.50
25 amp. 1000 volt . . . 8.50

VOLTAGE REGULATORS

TO220 Package $1.00 each

Positive	Negative
7805	7905
7806	7906
7808	7912
7812	7915
7815	7918

LM309H TO5 . . . . $1.10
LM309K TO3 . . . . 1.10
LM723 14 pin or TO5 55

● FETS

40673 . . . . 1.55
MPF102 55
2N3819 35
2N5457 50
2N5458 50
2N5459 55
2N5485 50

● DARLINGTON

MPSA 13 80
MPSA 14 40
2N5306 50

● SCR

C 106A 55
C 106B 65
C 122B 85

LOGIC PROBE KIT

Aldelco is now the sole distributor of the DIGAPEAKE-A logic probe kit. Now you can buy direct and save. Probe measures logic 1, logic 0, and pulsing circuits conditions formerly sold for $14.95.
SPECIAL $11.95

ACCUKEYER KIT Similar to the famous ARRL Handbook version. Kit includes PC board, IC sockets, ICs, speaker switch and all parts and instructions.
ONLY $19.95

ACCUKEYER MEMORY KIT

Adaptable to many keyers. Can store 2 canned messages of 30 characters each. PC board IC sockets, ICs instructions and all parts. $19.95

CLOCK CHIPS

5313 . . . . 3.49
5314 . . . . 3.49
5316 . . . . 3.95
5375 . . . . 3.95
CT7001 . . . . 6.95

RF DEVICES

2N2876	18W	200 MHz	TO60	$12.35
2N3375	3.0W	400 MHz	TO60	5.60
2N3553	2.5W	175 MHz	TO39	1.40
2N3866	1.0W	400 MHz	TO39	1.25
2N3926	7.0W	175 MHz	TO60	6.30
2N4427	1.0W	175 MHz	TO39	1.35
2N5589	3.0W	175 MHz	MT71	4.75
2N5590	10W	175 MHz	MT72	7.80
2N5591	25W	175 MHz	MT72	10.25
2N5913	1.75W	175 MHz	TO39	1.70
2N6080	4.0W	175 MHz	MT72	5.40
2N6081	15W	175 MHz	MT72	8.45
2N6082	25W	175 MHz	MT72	10.95
2N6083	30W	175 MHz	MT72	12.30
2N6084	40W	175 MHz	MT72	16.30
2N6094	4.0W	175 MHz	X106 PNP	6.60
2N6095	15W	175 MHz	X106 PNP	8.50
2N6096	30W	175 MHz	X106 PNP	10.35
2N6097	40W	175 MHz	X106 PNP	20.00
GE28	12W	50 MHz	X51	2.15
GE46	6.0W	27 MHz	TO5	6.42
GE215	5.5W	50 MHz	TO220	4.65
GE216	15W	50 MHz	TO220	8.97
GE226	10W	50 MHz	X81	2.00

ZENERS

1N746 to 1N759	400 Mw	ea .25
1N4728 to 1N4764	1 watt	.28
1N5333 to 1N5378	5 watt	2.10
1N2970 to 1N3005	10 watt	2.40
1N3305 to 1N3340	50 watt	4.75

2N3055		.99
2N3904 or 2N3906		.25
2N5496 or 2N6108		.70
741 or 709 14 Pin DIP		.25
555 Timer		.49
1N914 1N4148	15 for	.99
1N34 1N60 1N64	10 for	.99
CA 3028 Dif. Amp		1.50
LM309K Volt Reg		1.10
2N5401 (rep 2N4888)		.95
2N2369		.20
2N6103		.89
LM709 or 741 Min DIP Op Amp		.45
14 or 16 Pin IC Sockets		.30

ALDELCO KITS

● NEW IMPROVED ALARM CLOCK KIT
Digital alarm clock ● Six big .5 display LEDs ● New on board AC Transformer ● 12 Hour format with 24 hour Alarm ● Snooze Feature ● Elapsed time indicator.
A natural for cars, campers and mobile homes. Use on 12 volt dc with optional crystal time base (not including cabinet)
$19.95

● CRYSTAL TIME BASE KIT $4.95

Cabinets In simulated walnut grain or black leather $4.95
Plastic Cabinets – blue, black, white or smoke $3.95
RED CLOCK FILTERS . . . . $.60

12 or 24 hour DIGITAL CLOCK KIT uses .5 display LED. 5314 clock chip fits our standard cabinet. Freeze feature $18.95

Blinky Flasher Kit

PC board, 555 & all parts works on 9 volts – $2.50. Mouse button – $1.00

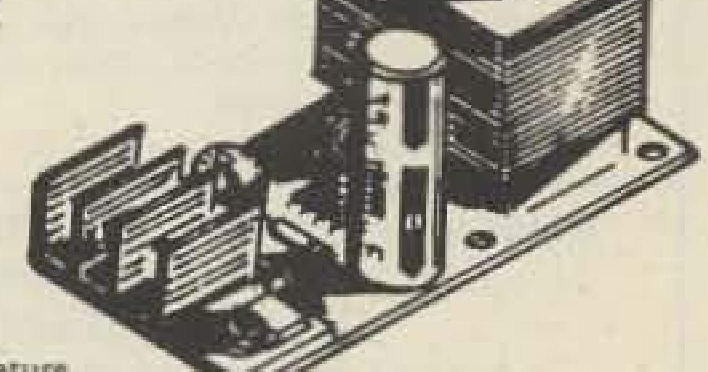
NOW!

2 Dual Digital 12-24 hour clock kits

MODEL ALD5:
Six big .5 display LEDs in an attractive black plastic cabinet with a red front filter. Great for a ham or broadcast station. Set one clock to GMT the other to local time. Or have a 24 hour format on one clock and 12 hour on the other. Freeze feature lets the clock be set to the second. Each clock is controlled separately. Cabinet measures 2¼" x 4½" x 9¼". Complete Kit $44.95.

MODEL ALD7:
Four bright .3 nixie tube display. Cabinet is an attractive deep blue including front filter. Will display seconds at the push of a button. An asset to any station. Cabinet size is 2¼" x 3" x 9¼". Complete Kit $34.95.

Variable Power Supply Kit



Specify:
5 to 15 Volt
or
12 to 28 Volt
unit

-500 mA regulators feature current limiting and thermal protection.

only $6.95 plus $1.00 shipping

NEW

Ham TV Converter use on regular TV set

Covers 420 MHz amateur band. Works on unused TV channel.
Kit $39.95
Assembled 49.95

Aldelco presents a NEW battery operated Frequency Counter & digital clock kit in one cabinet

Frequency Counter
Typical 100 Hz to 40 MHz
Accuracy .00005%

Using a 0.4 Display this unit is switchable from Clock to Counter while continuously keeping time. The clock can be wired either 4 or 6 digits and either 12 or 24 hour time. Small size makes this an attractive unit for Auto or Boat use. It operates on 12 VDC or from 8 AA Nicad batteries (not supplied) with a built-in battery charger. Optional Plug-In power supply allows charging and an operating source from 110 Volts AC.
Comes complete with Cabinet, Instructions and all parts.
Kit $99.95
Assembled 139.95
110 Volt AC Power Supply 5.95
8 General Electric or Gould AA Nicad Batteries 17.95
Frequency Counter with Memory in place of Clock same pricing.

ALDELCO

2281A BABYLON TURNPIKE, MERRICK NY 11566
516-378-4555

Add 5% Shipping. Add $1.00 for orders under $10.00. Out of U.S.A., Mexico or Canada add 15% shipping and certified check or money order in U.S. Funds

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P.O. BOX 28810 DALLAS, TEXAS 75228

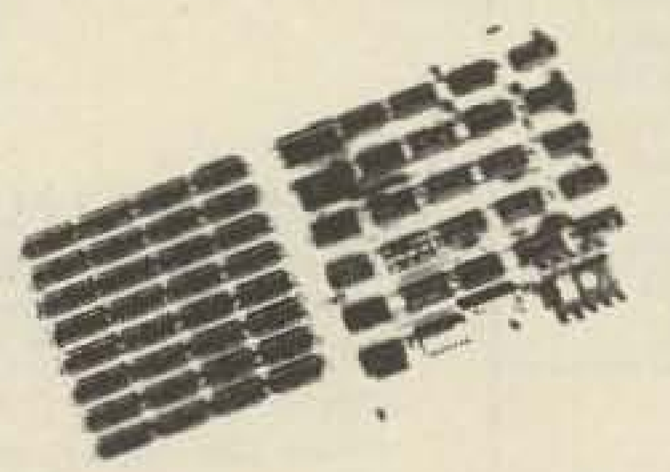
ORDER BY PHONE CALL TOLL FREE 1—800—527-3460 S2

EXPANDO RAM KIT

32K FOR $475.00

MEMORY CAPACITY
MEMORY ADDRESSING
MEMORY WRITE PROTECTION

8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection. Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted. Allow 6 to 8 weeks for delivery.



8K FOR $151.00

INTERFACE CAPABILITY
Control, data and address inputs utilizes low power Schottky devices.

POWER REQUIREMENTS
+8VDC 400MA DC
+18VDC 400MA DC
−18VDC 30MA DC

on board regulation is provided. On board (invisible) refresh is provided with no wait states or cycle stealing required.

MEMORY ACCESS TIME IS 375ns.
Memory Cycle Time is 500ns.

Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

PRICES START AT $151. FOR 8K RAM KIT
Add $108.00 for each additional 8K Ram

S.D. SALES NEW EXPANDABLE EPROM BOARD

16K or 32K EPROM **$49.95 w/out EPROM**

Allows you to use either 2708's for 16K of Eprom or 2716's for 32K of Eprom.

KIT FEATURES:

1. All address lines & data lines buffered.
2. Quality plated through P.C. Board, including solder mask and silk screen.
3. Selectable wait states.
4. On board regulation provided.
5. All sockets provided w/board.

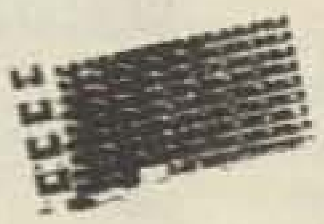
WE CAN SUPPLY 450ns 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

Z-80 CPU BOARD KIT — $139.

CHECK THE ADVANCED FEATURES OF OUR Z—80 CPU BOARD: Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply; always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board; parts plus seckets priced for all IC's. *Add $10 extra for Z—80A chip which allows 4MHZ operation. **Z—80 chip with Manual — $39.95**

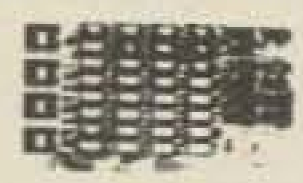
8K LOW POWER RAM — $159.95

Fully assembled and tested. Not a kit. Imsai — Altair — S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask. 8 pos. dip switches for address select.



4K LOW POWER RAM KIT

Fully Buffered — on board regulated — reduced power consumption utilizing low power 21L02 — 1 500ns RAMS — Sockets provided for all IC's. Quality plated through PC board. *Add $10. for 250ns RAM operation.



The Whole Works - $79.95

MUSICAL HORN

One tune supplied with each kit. Additional tunes — $6.95 each. Special tunes available. Standard tunes now available: — Dixie — Eyes of Texas — On Wisconsin — Yankee Doodle Dandy — Notre Dame — Pink Panther — Aggie War Song — Anchors Away — Never on Sunday — Yellow Rose of Texas — Deep in the Heart of Texas — Boomer Sooner — Bridge over River Kwai.

CAR & BOAT KIT	HOME KIT	Special Design
$34.95	$26.90	Case $3.50

Jumbo LED Car Clock Kit

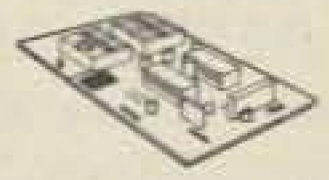
FEATURES:
A. Bowmar Jumbo .5 inch LED array.
B. MOSTEK — 50250 — Super clock chip.
C. On board precision crystal time base.
D. 12 or 24 hour Real Time format.
E. Perfect for cars, boats, vans, etc.
F. PC board and all parts (less case) inc.

Alarm option — $1.50
AC XFMR — $1.50

$16.95

DIGITAL LED READOUT THERMOMETER — $29.95

Features: Litronix dual 1/2'' displays. Uses Silicoaix LD131 single chip CMOS A/D converter. Kit includes all necessary parts (except case); AC line cord and power supply included. 0-149° F.



6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2'' displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Kit includes all necessary parts (except case). Xfmr optional. Eliminate the hassle.

AC XFMR — **$1.50 Case $3.50**

5 Digit Countdown Utility Darkroom Timer Kit

Features: Large LED 1/2'' displays oper. from 0.1 sec. to 59 min. 59.99 sec. 5A-115V. Relay included to control appliances. Operates on 115V AC. Displays can be turned off for total darkness while counting. All necessary parts included.

Special design case $3.75.

$44.95

6 Digit General Purpose or Computer Timer Kit — $29.95

Features: Large LED 1/2'' displays, Mostek 50397 counter display/driver, counts up to 59 minutes, 59.99 seconds with crystal controlled 1/100 second accuracy, operates on 115V AC or 12V DC supply. All necessary parts included. Special design case $3.75.

Bowmar 4 Digit LED Readout Array Full ½'' Litronix Jumbo Dual Digit LED Displays

4 JUMBO .50'' DIGITS ON ONE STICK!
WITH COLONS & AM/PM INDICATOR

$3.95

DL 722 - C.C.	DL 728 - C.C.
DL 721 8 C.A.	DL 727 - C.A.
99c	$1.29

NEW COMPETITION CHESS TIME KIT WITH TWO INDEPENDENT FIVE DIGIT 1/2'' LED DISPLAYS

The timers can be used independently or coupled. The timer can be set to 59 minutes 59.9 seconds at 0.1 intervals. Kit includes all necessary parts and an attractive woodgrain case.

$79.95 Complete Kit

Low Cost Cassette Interface Kit $14.95

Features: K.C. standard 2400/1200 Hz, 300 Baud, TTL, I/O compatible, phase lock loop, 22 pin connector. Feeds serial data via microprocessors I/O ports and from cassette tape recorder.
$14.95

RAM'S

21L02 - 500NS	8/11.50
21L02 - 250NS	8/15.95
2114 — 4K	14.95
1101A — 256	8/$4.00
1103 — 1K	.35
MK 4115 - 8K	19.45
74S 200 - 256	3.95

CPU'S

Z—80 includes manual	29.95
Z—80A includes manual	34.95
8080A CPU 8 BIT	11.95
8008 CPU 8 BIT	6.95

PROMS

1702A - 1K - 1.5us	3.95 or 10/35.
2708 - 8K intel - 450ns	14.95
5204 - 4K	7.95
82S129 — 1K	2.50
2708S 8 8K signetics 650ns	9.95

COUNTER CHIPS

MK50397 6 Digit elapsed timer	8.95
MK50250 Alarm clock	4.99
MK50380 Alarm chip	2.95
MK50396 6 digit up/down counter	12.95
MK5002 4 digit counter	8.95
MK5021 - Cal. chip sq. root	2.50

THERMISTORS MEPCO — NEW! 1.5K OHM **5/$1.00** *

TANTALUM CAPS 1 MFD. 20VDC. P.C. LEADS **15 for $1.00** *

FLAT PACK IC ASSORT. FLAT PACK 5400 SERIES. SPECIAL BUY FROM ITT. **20 Assorted Devices for $1.00** *

ELECTRICAL COIL 13T TYPE C 10T TYPE C YOUR CHOICE **12/$1** *

2 TRANSISTOR AUDIO amf. W/Specs. **6/$1** *

TRIMMER POTS 10K, 20K, 25K OHM. Mini for PC boards. **YOUR CHOICE 10/$1.** *

DISC CAPS FOR BYPASS .01 MFD — 100 WVDC. PC leads. **40/$1.** *

BALUM Used in TV Tuners Can be rewound for Ham freq. **6/$1** *

STANDARD COILS Use in TV Sets. 1.2 uh 5% and 1.5 uh 10%. Your choice. **12/$1** *

AUTO COIL TRANF. Ideal for the exper. **12!$1** *

NEW CAMBION JACKS PART # 450-4352 Gold Plated **50/$1** *

SILICON RECTIFIER Special! 1N4007. 1 AMP 1000 PIV. **PRIME UNITS 10/$1.** *

Photocell Asst. We bought almost 200K from a big US mfg. Three product families: small, medium and dual photocells. Perfect for all light sensitive applications. * **12/$1.00**

PLASTIC READ-OUT FILTERS Originally used in desk top calculators. Perfect for use with LED and other type readouts. **AMBER — 6 for $1.** *

TTL ASSORTMENT Contains a high yield of usable parts. **50/$1.50** *

RESISTOR Special! 22 Ohm. 1 Watt. Carbon Comp. 10%. Handy value. Parallel to make low ohmage power resistors. Help! We bought 100,000 pieces! * **25 for $1.**

DISC CAP ASST. PC leads. At least 10 different values; includes .001, .01, .05 plus other standard values. **60/$1.00** *

P.C. LEAD DIODES 1N4148/1N914 —100/$2.00 1N4002 - 1A — 100 PIV **40/$1.00** *

MICA TRIMMER PC 402 Miniature 1.5 — 20 P.F. P.C. Mount **4/$1** *

MICRO-DIP $1.95

New — Series 2300
The World's Smallest
Coded BCD Dual-In-Line
Switch! PC Mount
2300 02G BCD 1-2-4-8
2300 12G BCD 1-2-4-8
Compliment

JOY STICKS

FOUR 100 K-OHMS POTS
Ideal for electronic games

$3.95

STANDARD ANT. TER. Used for Ant. Hook-up on all TV Sets. **12/1** *

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8212 - I/O port	3.50
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8216 — Non Invert Bus	4.95
8224 — Clock Gen.	4.95
8226 — Invert Bus	3.95
PIO for Z—80	14.95
CTC for Z—80	14.95
8228 Sys. Controller	8.20
8251 Prog. comm. interface	10.95
8255 Prog. perp. interface	13.50
8820 Dual Line Recr	1.75
8830 Dual Line Dr.	1.75
2513 Char. Gen.	7.50
8838 Quad Bus. Recvr	2.00
74LS138N — 1/8 decoder	.99
8T97-Hex Tri-State Buffer	1.25
1488/1489 RS232	1.50
TR 1602B Uart	3.95

Z-80 PROGRAMMING MANUAL

IN DEPTH DETAIL OF THE Z-80 CPU MICRO-COMPUTER

S.D. Sales Special $9.95

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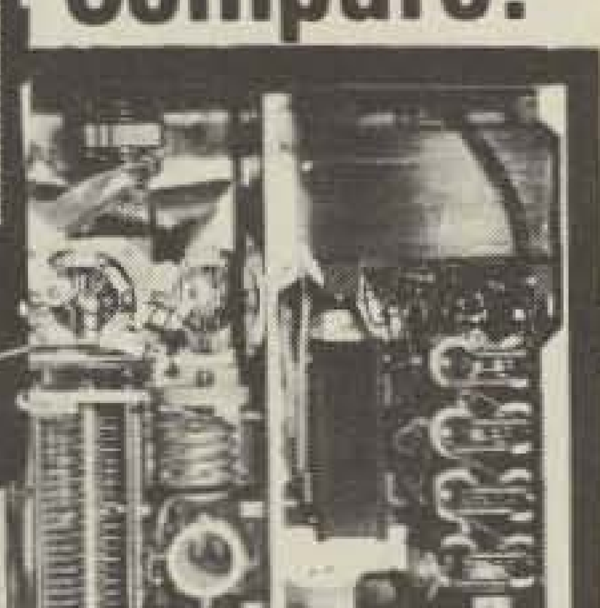
The New Sigma XR3000D Linear Amplifier Compare!



HOLIDAY SALE

$699

2 Day Air Shipment Anywhere in U.S.
Airport to Airport $35
Alaska and Hawaii Slightly Higher

Features:

Custom computer grade commercial components, capacitors, and tube sockets manufactured especially for high power use—heavy duty 10Kw silver plated ceramic band switches • Silver plated copper tubing tank coil • Huge 4" easy to read meters—measure plate current, high voltage, grid current, and relative RF output • Continuous duty power supply built in • State of the art zener diode standby and operating bias provides reduced idling current and greater output efficiency • Built in hum free DC heavy duty antenna change-over relays • AC input 110V or 220V AC, 50-60Hz • Tuned input circuits • ALC-rear panel connections for ALC output to exciter and for relay control • Double internal shielding of all RF enclosures • Heavy duty chassis and cabinet construction and much, much more.

- Full band coverage 160-10 meters including mars.
- 2000 watts P.E.P. SSB input. 1000 watts input continuous duty, CW, RTTY & SSTV.
- Two Eimac 3-500Z conservatively rated finals.
- All major HV and other circuit components mounted on single G-10 glass plug in board. Have a service problem? (Very unlikely) Just unplug board and send to us.
- Heavy duty commercial grade quality and construction second to no other unit at any price!
- Weight: 90 lbs. Size: 9½" (h) x 16" (w) x 15¾" (d).

HOLIDAY INTRODUCTORY SPECIAL!

New! Sigma Model AF250L Deviation/Modulation Meter

Fully Certifiable for Commercial Use

HOLIDAY SALE

$169

Features:

Extremely stable local oscillator for easy measurement of HF, VHF, and UHF bands employing negative feedback to insure extremely high stability ● Easy to read, accurate linear scale ● **Direct off the air signal measurement capability.**

Specifications:

Frequency: 1.8MHZ-520MHZ/3 range select (A, B, C, EXT), A range: 26.5 MHZ-40MHZ, B range: 48MHZ-60MHZ, C range: 140MHZ-156MHZ, EXT. range: 1.8MHZ-520MHZ (Need Signal Generator) • Generous overranges • Input level:(1) Through type input level: IW-200W (RF Input Terminal) (2) Direct input level: More than 80db/50ohm impedance • Amplitude modulation degree: 0-100% • Frequency deviation: 0-20KHZ • Accuracy: +/-3% of full scale • Intermediate frequency: 10.7MHZ • Local input frequency (EXT Range) • Measuring frequency +/-10.7MHZ • RF Attenuator: 0-60db variable • Audio signal oscillator: (1) Audio Frequency—1,000HZ (1 KHZ), (2) Output level—More than 1V RMS • Power Source: AC117V • Dimensions: H-5½" (140mm), W-10¼" (260mm), D-7¼" (184mm) • Weight: 7 lbs.

SIGMA RF-2000 SWR & POWER METER

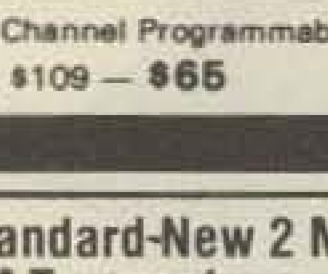
$29

Introductory Price

Cal PWR Scales 200W-2000W Freq Range 3.5-150 MHz. Please do not confuse the RF2000 with similar appearing lower priced units. RF2000 is an individually calibrated professional quality instrument. Unequaled at many times the price. Size 7" (w) x 2 1/3" (d).

SPECIAL SCANNER SALE

FOR KENWOOD TR-7400A



14 Channel Programmable
reg $109 — **$65**

FMSC-1 reg $169 — **$99**
7400 Scanner II Reg $189-$119

FMSC-1 Scanner for KDK FM 144 and 7400 Scanner II for Trio-Kenwood TR-7400A. ● Full scan 146 and 147 MHz consecutively or 1 MHz, or any MHz range ● Scan rate: 1 MHz/2 seconds (adjustable) ● Controls: Scan/Hold, Latch/Delay, 600 KHz offset (off, up, down), program 1 MHz ● Simple installation.

KDK SPECIAL SALE
FM 144 Accessories

FMTP-1	Touch Tone Pad	$59
FMTP-2	Touch Tone Pad with 10 Number Programmable Memory	$99
FMTD-1	Private Call Decoder for use with and Programmed by Any Touch Tone Pad	$75
SC-12A	Audible Tone Encoder Decoder	$65
FMSC-1	Scanner-Random Any Range	$99
MARS-CAP	Option Kit - Any Frequency, Any Split	$12
FMOF-1	Offset Option Kit - 2 Extra Positions, Crystals Required	$10
FMOF-2	+1 MHz Offset Option Kit (No Crystals to Buy)	$10
FMTE-1	Sub Audible Tone (100 Hz-Adjustable 67-203 Hz)	$15
	Owners Manual (Extra)	$5

FM 2015R Accessories:

FMPS-4R	Regulated AC PS	$49
FMMC-1	Microphone with Built-in Touch Tone Pad	$49
MARS-CAP*	Option Kit - Any Frequency, Any Split	$6
FMAT-1	½ Wave Portable Antenna for Hotel, Motel or Apartment	$7.95
	Extra DC Cord & Plug	$3.50
	Service Manual	$4.00
	Mounting Bracket (Extra)	$6.00

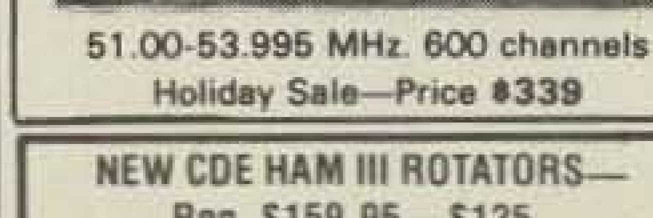
Standard-New 2 Meter FM Transceivers Model SRC 146A Special Sale

SRC 146A	$314
4 Xtals 34/94 and 94/94	NC
USA 2 Deluxe Base Charger	$47
PT3644 Leather Case	$12
AT 19 Rubber Ant and Whip	$10
N1-cads	$30
Reg.	$413

NEW!!! Touch Tone pad completely wired and ready to plug in-$69.00

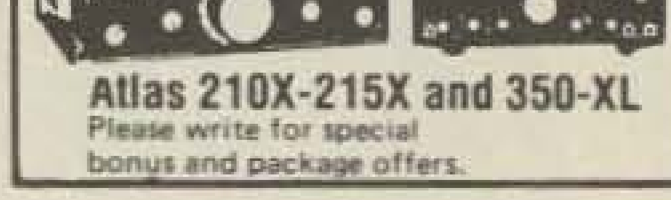
Our Price **$289**

NEW! 6 METER FM50-10SXRII



51.00-53.995 MHz. 600 channels
Holiday Sale—Price $339

NEW CDE HAM III ROTATORS— Reg. $159.95—$125



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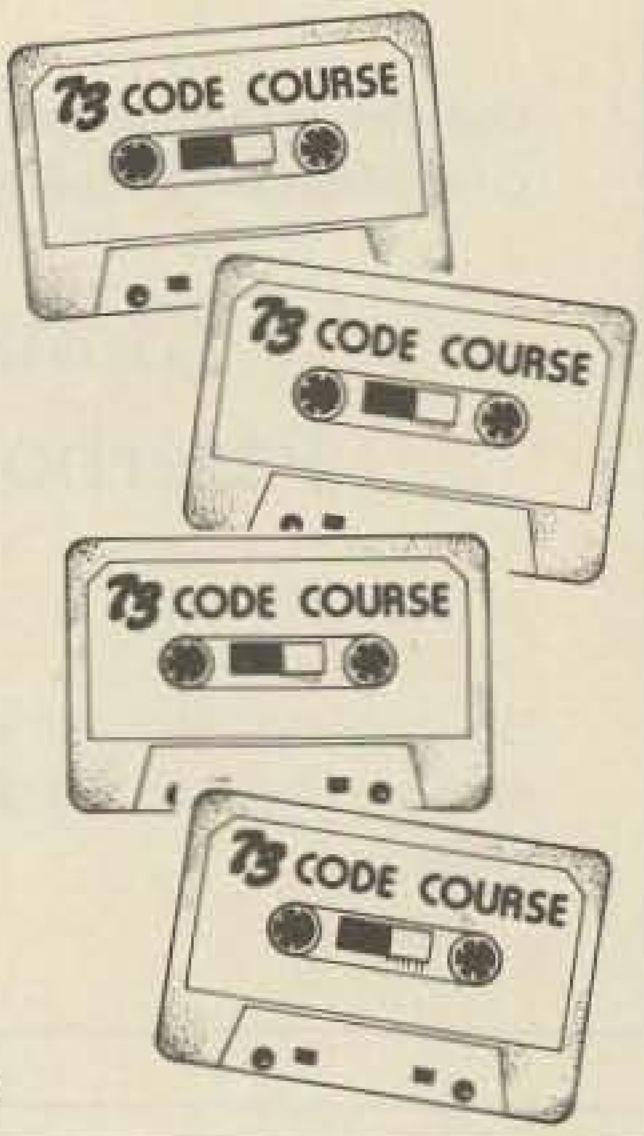

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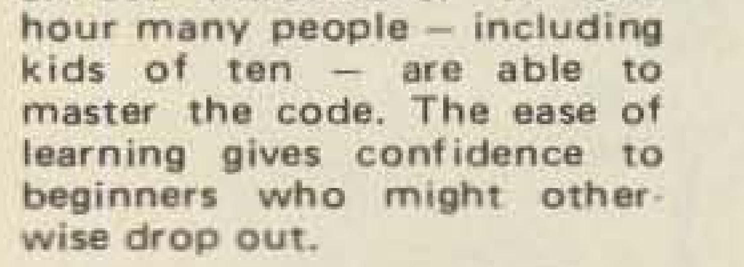

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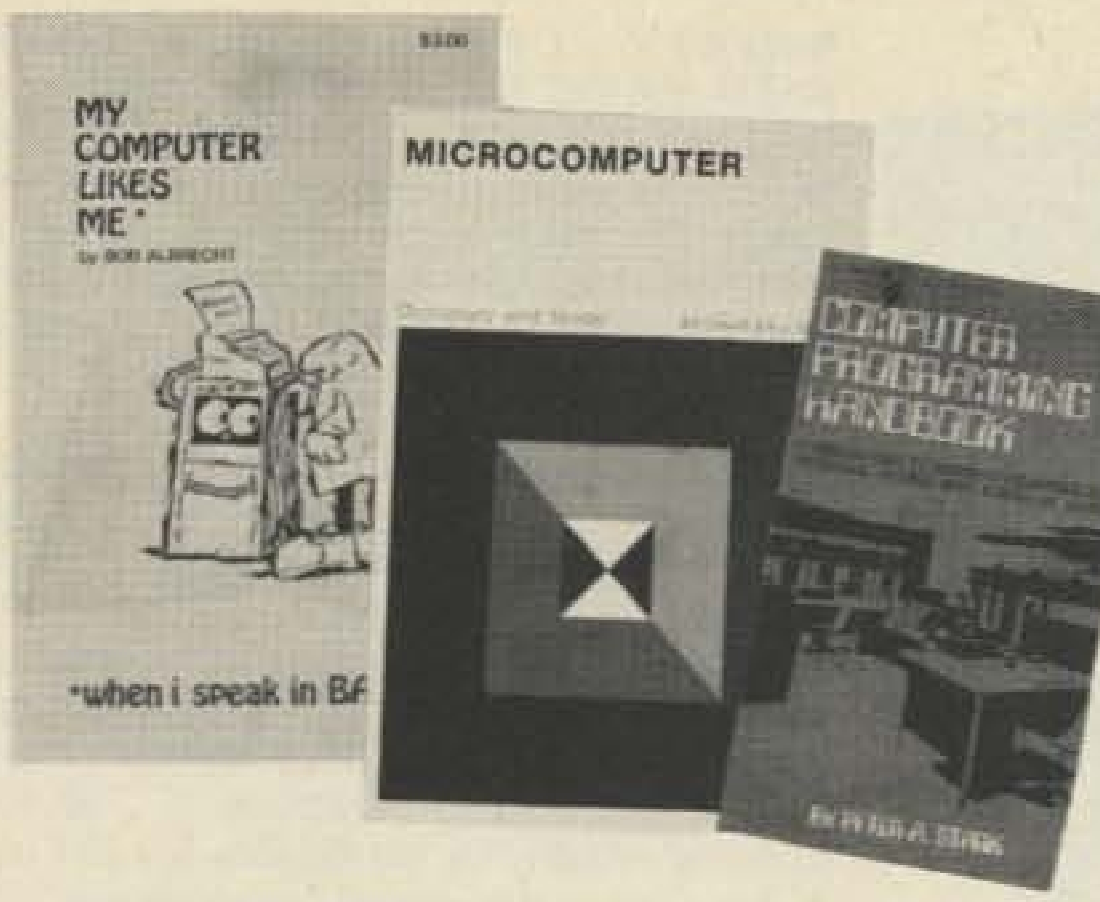

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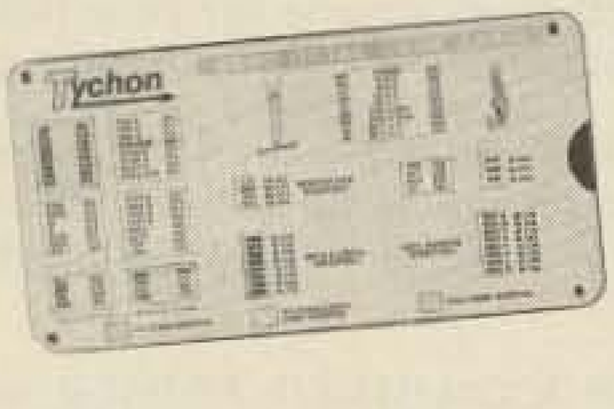

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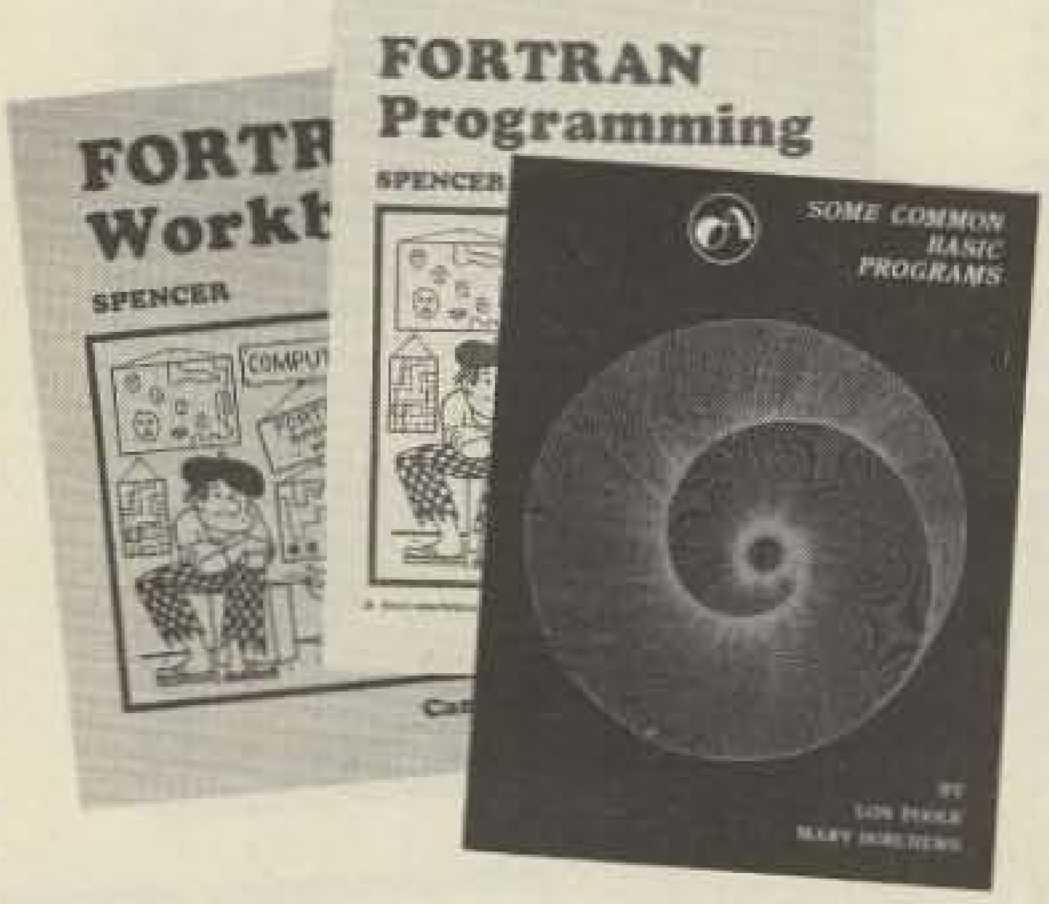

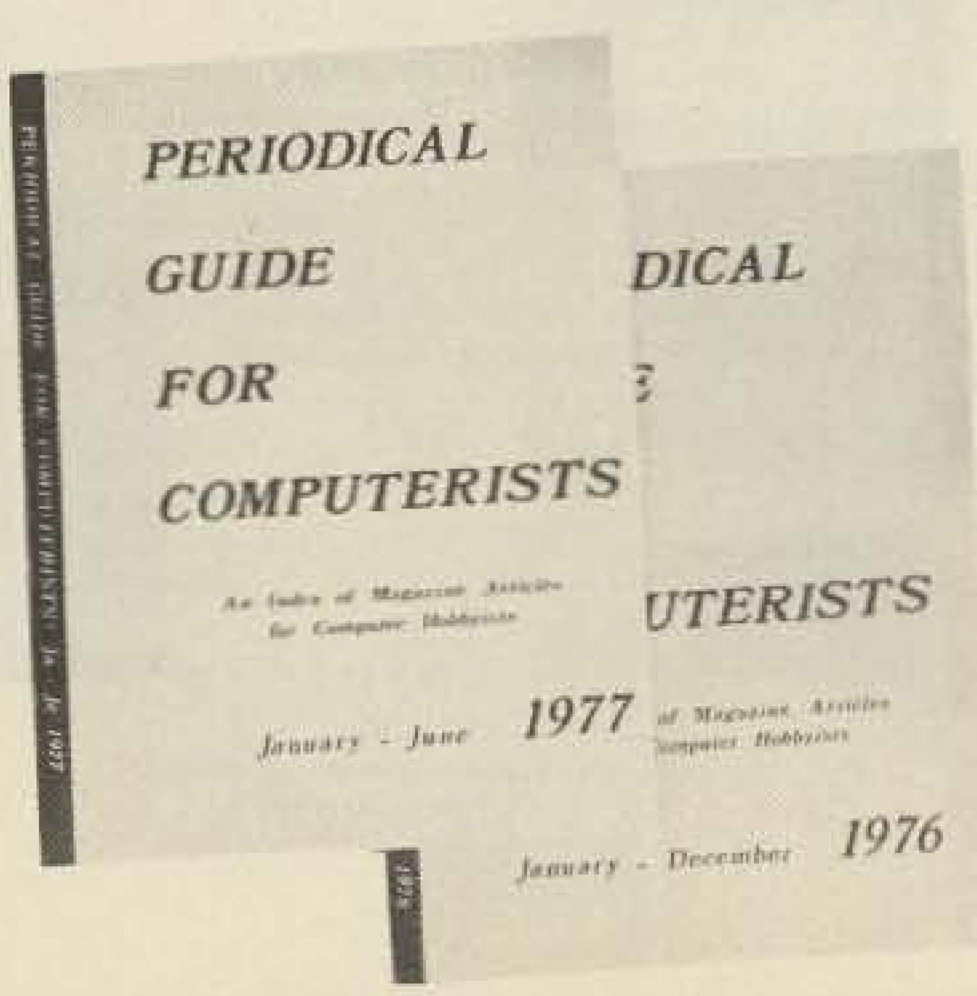

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AUSTRALIA	14	7B	7B	7B	7	7	3A	7	14	14	14	14
CANAL ZONE	14	7	7	7	7	7	7	14	14A	21	14A	14
ENGLAND	7	3A	3A	3	3	3	7A	14A	14A	14	7	7
HAWAII	14	7B	7	3A	7	7	3	3	7B	14	14A	14A
INDIA	7	7	7B	3B	3B	3B	7	14	7B	7B	7	7
JAPAN	14	7B	7B	3A	3	3	3	7	7	3A	7	7A
MEXICO	14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

CENTRAL UNITED STATES TO:

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

WESTERN UNITED STATES TO:

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

A = Next higher frequency may also be useful
B = Difficult circuit this period
F = Fair
G = Good
P = Poor

JANUARY '78

1 G	2 G	3 F	4 F	5 F	6 F	7 F
8 P	9 P	10 F	11 F	12 P	13 F	14 G
15 G	16 G	17 G	18 G	19 G	20 G	21 P
22 P	23 P	24 F	25 F	26 G	27 G	28 G
29 G	30 G	31 G				

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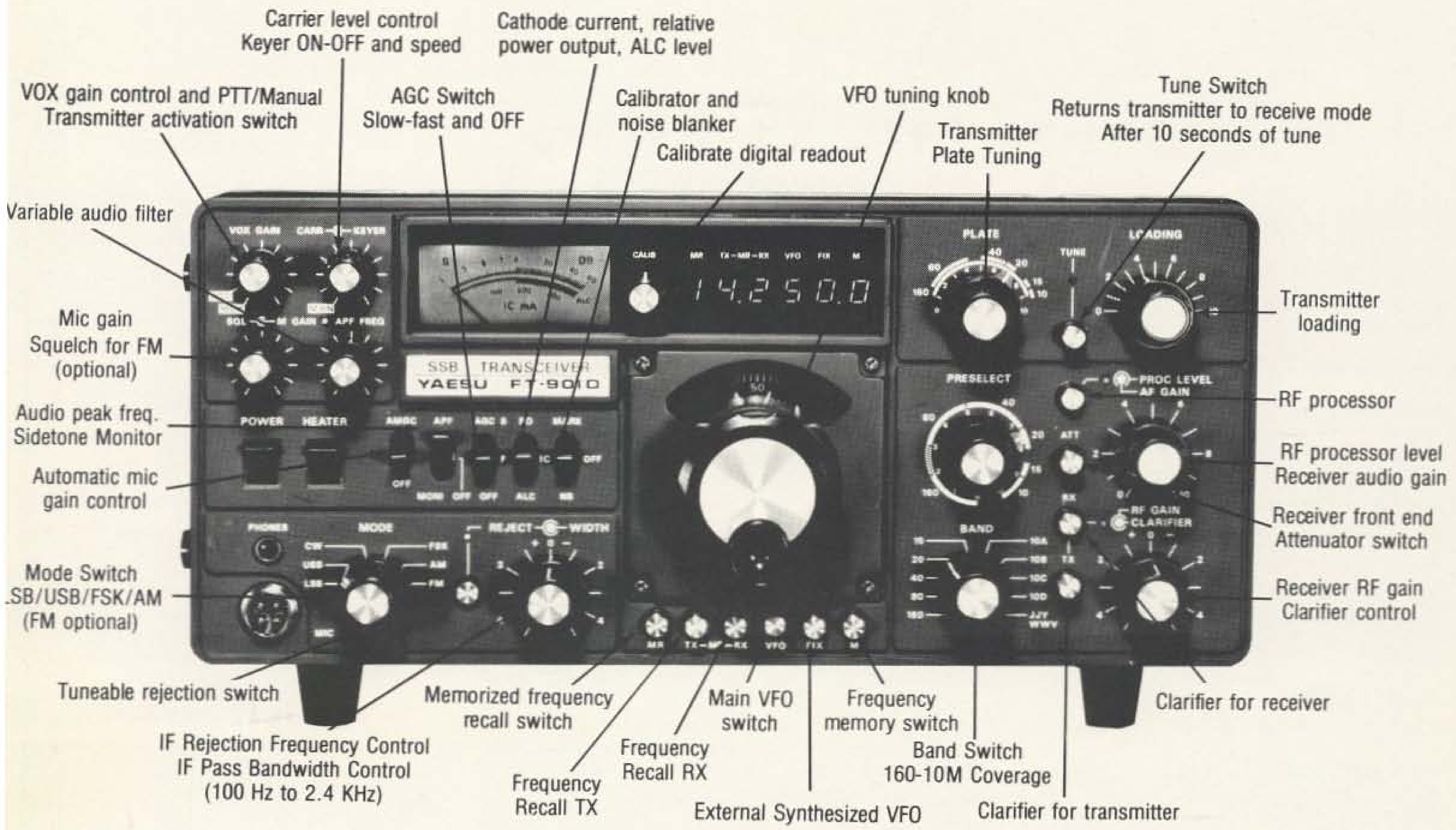
NEW SMART FT-901D–YEARS AHEAD WITH YAESU!



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1A78

TR-7400A

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• Unique continuous tone coded squelch system • Outstanding receiver performance.

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