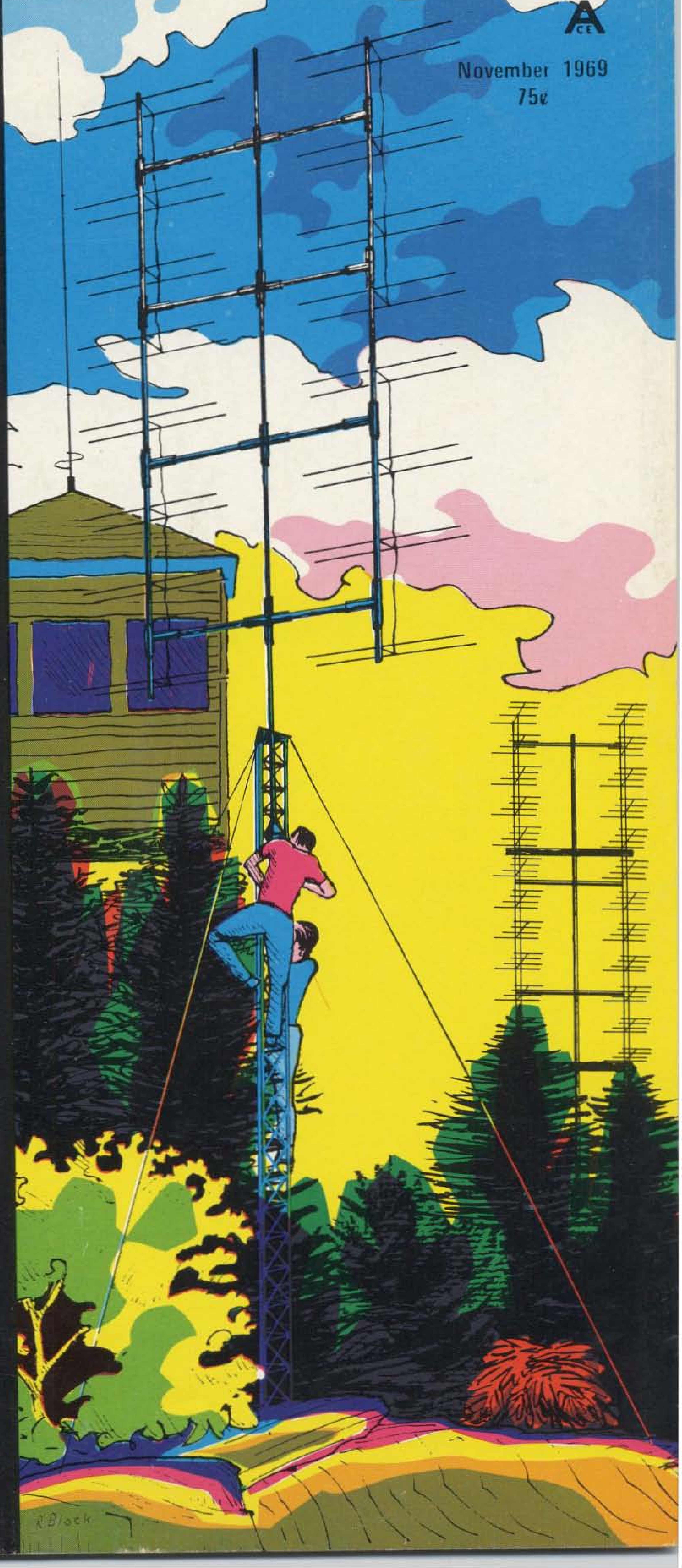
WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

November 1969

75¢

AMATEUR RADIO

73



6M XSTR Conv.

FM FM FM

RF Bridge

Mods - SBE - Heath - Swan

6M SSB Xcvr

Solid State 432'er

IF Notch Filter

Extra Class Course

Voltage SEXtupler

Color SSTV

73 MAGAZINE

PETERBOROUGH, NEW HAMPSHIRE 03458

73 Magazine #110, November 1969

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...de W2NSD/1

Wayne Green

The Cover

As I believe I have mentioned in the past, We are always on the lookout for an interesting cover illustration, whether it be a good color photo, a drawing, a painting, or whatever. The September VHF contest brought the old W1MHL group to the top of Pack Monadnock in New Hampshire using the call K1DC/1 and Roger Block, our Art Director, braved the swinging arrays with his sketchpad with the result you see on our cover.

Activity was down a bit this year, but still they did well on all VHF bands, running a small dish on 1296, 196 elements on 432, 32 elements on 220, 32 elements on 144, and a six element yagi plus a 16 element colinear on 6 meters. They all had a lot of fun, and that is the important part of it.

Advanced Class License Exams

Late in September I received a call from a distraught amateur who had just finished a commercial study course for the Advanced Class exam. He thought he was prepared, then he found that the new exams dwell heavily on transistors and sideband! He flunked, as did nine of the eleven that were there with him. He was bewildered and frustrated. His course and the text he used had failed him.

The 73 Advanced Class Study Course book ($3) seems to be the *only* study book on the market that covers the questions being used on the present day Advanced Class exams. Be prepared not to see one single tube on the new exams. Be prepared to draw transistor schematics for the Hartley, etc.

Let me say again that I think it is one hell of a note when amateurs who have been licensed and active for many years must go down to an FCC office and take a tough exam like this in order to continue to use the frequencies they have been using all these years. It is all the worse when the exam is so completely different from the older tests that it results in a high percentage of failures. Don't forget to let your QST director know what you think of this, pro or con.

November QST Board Meeting

QST is upset over the reaction to their Incentive Licensing rules and has called a meeting of the Directors for early November to see what can be done to keep the situation from deteriorating further. The FCC schedule, you remember, calls for the second and final re-arrangement of our bands to take place on November 22nd. Presumably then, QST expects the FCC to withhold its decision until it hears from the QST Board.

If all goes according to the original FCC timetable, we will see the Extra Class Only CW bands expand to cover 3500-355-, 7000-7050, 14000-14050, and 21.000-21.050. These are, needless to say, by far the best DX frequencies on these bands and their removal from the Advanced and General Class licenses will just about eliminate any further pursuit of DX as a hobby for all but a very small handful of amateurs in the U. S.

How about the phone bands? According to the schedule the Extras will have exclusive use (including CW too, apparently) of 3800-3825 and 21250-21275 khz. The Advanced will be able to use 3825-3900, 7200-7250, 14200-14275, and 21275-21350. Generals and Conditionals will be all stuffed into 3900-4000, 7250-7300, 14275-14350, and 21350-21450. That will be quite a stuffing job. You think you've had QRM before? Add to the General those Extras and Advanced that are obstinate enough to want to talk with their old friends and refuse to sit out there all alone in the big wide and frequently empty new bands.

Please pardon me if I don't even try and discuss the ridiculous mess on six meters. This makes little sense to anyone and I hate to dignify the allocations by even mentioning them.

If anyone is in favor of the second stage band

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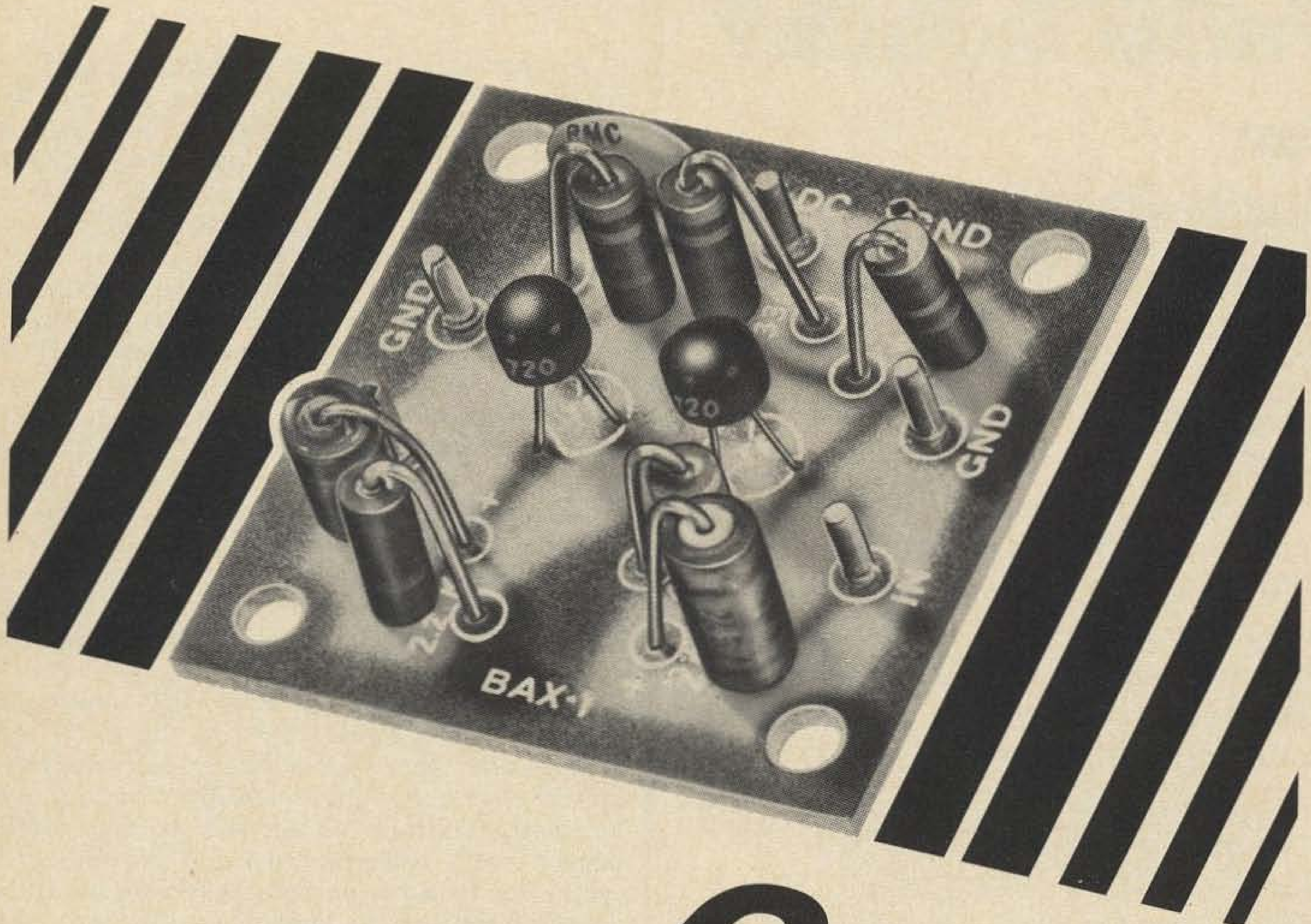

6 to 30 DB GAIN!

WITH ICM LOW COST BAX-1 BROADBAND AMPLIFIER (20 Hz to 150 MHz)

International BAX-1 Broadband Amplifier is a general purpose unit which may be used as a tuned or untuned amplifier in RF and audio application. For example: when used as untuned RF pre-amplifier connect between antenna and receiver antenna posts. Ideal for SWL, Experimenter or Amateur applications. Easy to build. Complete Kit........................**$3.75**

SPECIFICATIONS:

1. Power	9 to 15 volts dc @ 10 ma
2. Frequency Range	20 Hz to 150 MHz
3. Gain at 1 MHz	30 db
Gain at 150 MHz	6 db
4. Response ref 1 mhz	down 6 db at 50 hz . ±3 db 100 hz to 10 mhz down 15 db at 100 mhz down 24 db at 150 mhz
5. Operational Impedance	50 to 500 ohms
6. Noise	less than 10 microvolts rf across 50 ohms; audio less than .0005 volts
7. Maximum Input Level	.01 volts ac
8. Output at Maximum Input (at 1 mhz)	50 ohms — .1 volt 500 ohms — .5 volt
Size inches	1½" x 1½" x 1"
Mounting	4 holes with spacers

Write for complete catalog.

INTERNATIONAL

CRYSTAL MFG. CO., INC.

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Leaky Lines

An editorial in a recent issue of QST requests us to express our ideas, pro or con, to the Directors, concerning the first year of Incentive Licensing. We have been asked to put in our two cents worth, at long last. Why? There are good reasons for this sudden display of unaccustomed solicitude for our opinions.

Newington is finally commencing to realize the full implications of the coming implementation of the second phase of the restructuring program. If this goes through this November, as originally projected, thousands of hams, already disenchanted with the League, will surely drop from the rolls completely. We have already lost members in droves, are still losing them to this day, and will probably continue to lose them in the future, so long as the League persists in its refusal to admit that the original promotion of Incentive Licensing was, if not an outright mistake, at least an ill-timed miscalculation.

There can be no doubt that ARRL understood that most hams would object to the whole idea. That is why there were so many pep talks about individual responsibility, our debt to society, public service, state of the art, and so forth. Of the docket itself, however, we heard precious little, until after it had been broached to FCC without anything approaching public discussion. Oh, to be sure, we were assured that we could express our views to the Commission. Just send in 14 (or was it 114) copies of our comments to FCC, and they would take all views into consideration before making up their minds. Sounds good, doesn't it?

Evidently the Commission received very little in the way of cogent or valid objections. Or did they? We shall never know, probably. The Commission, most probably, believed that ARRL is the spokesman for *all* hams, a fond little palliative, administered in periodic doses to all League members, in order to dull their wits to the stark reality. . .about 75% of the ham population are *not* members!

The League, smarting a bit from the stream of invective that poured in, sought ways by which its unilateral action without preliminary discussion might be justified. We were bombarded with a craftily-tailored rationale. We were reminded that our image was badly tarnished ... needed a Simoniz job. We were told that an international frequency allocating treaty conference was in the offing, and that certain nations were out to get our bands away from us, at least in part. We were assured that the only way in which this painful exigency might be circumvented would be to upgrade our skills ... engage in more and more public service communications activity ... dispel the commonly held belief amongst non-hams that we are merely indulging in a meaningless pastime

(continued on page 114)

CENSUS OF AMATEUR RADIO LICENSES* in the U. S. A.

by classes, within states and call areas

Call Area	State	Novice	Tech-nician	Con-ditional	General	Advanced	Extra	Club	Military	State totals	YL's (Included in state totals)
#1	Conn.	221	741	801	1,827	824	202	77	8	4,701	141
	Maine	53	115	592	388	276	72	15	7	1,518	60
	Mass.	433	3,086	626	4,324	1,832	420	114	23	10,858	405
	N.H.	73	397	204	593	253	55	23	3	1,601	77
	R.I.	39	473	114	601	223	51	23	5	1,529	57
	Vermont	38	74	236	169	102	18	10	3	650	36
		857	4,886	2,573	7,902	3,510	818	262	49	20,857	776
#2	N.J.	645	3,415	410	5,324	2,356	538	156	15	12,859	313
	N.Y.	1,395	6,027	887	9,982	3,973	893	339	46	23,542	660
		2,040	9,442	1,297	15,306	6,329	1,431	495	61	36,401	973
#3	Del.	48	104	42	296	101	24	8	2	625	15
	Md.	316	879	316	2,271	1,108	282	65	28	5,265	129
	Pa.	934	3,795	877	6,290	2,321	526	208	32	14,983	427
	D.C.	30	89	29	261	143	36	22	6	616	12
		1,328	4,867	1,264	9,118	3,673	868	303	68	21,489	583
#4	Ala.	254	654	790	1,284	480	103	22	16	3,603	127
	Fla.	432	1,684	1,900	3,803	2,173	397	100	25	10,514	385
	Ga.	202	565	869	1,436	633	133	47	17	3,902	102
	Ky.	159	439	520	796	394	75	28	9	2,420	69
	N.C.	232	599	997	1,446	662	120	45	17	4,118	140
	S.C.	89	149	985	471	235	50	16	16	2,011	53
	Tenn.	288	1,066	642	1,456	690	137	41	5	4,325	126
	Va.	274	821	872	2,225	1,101	276	57	40	5,666	121
		1,930	5,977	7,575	12,917	6,368	1,291	356	145	36,559	1,123
#5	Ark.	166	272	416	523	294	54	25	9	1,759	78
	La.	214	377	720	1,134	522	100	36	17	3,120	79
	Miss.	82	136	498	513	242	36	7	4	1,518	34
	N.M.	98	144	601	376	328	76	15	15	1,653	72
	Okla.	218	652	519	1,075	622	103	35	40	3,264	126
	Texas	814	2,478	3,193	5,118	2,624	480	146	63	14,916	634
		1,592	4,059	5,947	8,739	4,632	849	264	148	26,230	1,023
#6	Calif.	2,231	8,212	3,842	15,212	8,263	1,449	482	125	39,816	1,321
#7	Ariz.	258	631	606	1,083	633	110	35	37	3,393	150
	Idaho	84	41	481	170	176	29	10	2	993	48
	Mont.	101	49	636	149	150	48	15	7	1,155	62
	Nev.	33	89	430	165	136	21	10	9	893	47
	Oreg.	369	552	864	1,534	794	127	51	16	4,307	206
	Utah	191	237	182	495	223	40	14	11	1,393	42
	Wash.	510	1,023	1,316	2,639	1,266	235	69	22	7,080	336
	Wyo.	54	33	238	101	61	16	12	3	518	24
		1,600	2,655	4,753	6,336	3,439	626	216	107	19,732	915
#8	Mich.	812	2,796	1,066	4,195	1,618	249	128	19	10,883	360
	Ohio	1,034	5,321	669	5,956	2,341	361	203	20	15,905	547
	W. Va.	158	390	193	719	221	55	17	5	1,758	44
		2,004	8,507	1,928	10,870	4,180	665	348	44	28,546	951
#9	Ill.	1,076	3,338	1,804	5,886	2,415	392	216	22	15,149	485
	Ind.	462	1,979	563	2,391	939	166	114	7	6,621	256
	Wisc.	330	779	927	1,635	818	137	73	15	4,714	112
		1,868	6,096	3,294	9,912	4,172	695	403	44	26,484	853
#10	Colo.	257	431	666	1,222	642	124	43	15	3,400	128
	Iowa	363	565	597	1,672	737	120	57	10	4,121	138
	Kas.	303	360	972	1,118	539	127	38	27	3,484	150
	Minn.	395	517	873	1,774	815	176	60	11	4,621	126
	Mo.	422	1,038	896	2,060	979	189	73	10	5,667	205
	Nebr.	173	290	492	724	361	50	32	6	2,128	86
	N.D.	36	11	440	64	96	21	8	7	683	28
	S.D.	68	45	259	236	138	21	12	3	782	40
		2,017	3,257	5,195	8,870	4,307	828	323	89	24,886	901
Grand total, 48 states and D.C. only		17,467	57,958	37,668	105,182	48,873	9,520	3,452	880	281,000	9,419

*Reprinted with permission of Radio Amateur Callbook Magazine, from the Fall 1969 issue.

An Approach to Six-Meter SSB Transceiver

Andrew J. Borsa, WA1FRJ
43 Burtt Street
Lowell, Massachusetts 01851

Having spent some time getting my feet wet on six meter AM, I developed an urge to join the "sidewinders" down on the low end. According to my way of thinking, a commercial six meter SSB transceiver was out because I did not care to spend so much on one band. The transverter approach was also discarded since I did not want to disturb my low band set-up. By some stroke of luck, I was given the opportunity to acquire an NCX-3 transceiver at about a third of the cost of a well-known commercial six meter SSB transceiver. I know, an NCX-3's output is far removed from 50 mhz, but a few weeks of spare-time work changed all that. The result was a SSB transceiver with the conveniences of built-in VOX or PTT, S-Meter, AM, CW, or SSB transceive operation, and all the other goodies which characterize low band operation. Power input to the final is 200 watts pep SSB, 200 watts CW, and 100 watts AM. Frequency coverage is 49.9 to 50.4 mhz.

With some effort applied to searching in classified ads, a ham should be able to come up with one of the older models of single or tri-band transceivers for less than $150. It doesn't even have to be in working condition, which would mean a lower price. The desirability depends upon your ability with a vtvm, grid-dip meter, and soldering iron. The cost of building a unit like this from scratch would be about the same with more, much more, work involved. If the job is done carefully it will have more resale value. Most of the added parts should be available in many junk boxes since they are all standard. As much use as possible was made of the original components in the transceiver.

Looking at the block diagram, **Fig. 1**, the 14 mhz output from the original transmit mixer is fed to the grid of the 6KE8 mixer/oscillator where it is combined with the 36 mhz signal from the triode section. The output of the pentode section is now 50 mhz SSB which is fed to the grid of the 6GK6 driver. A broadband tank circuit is used to couple from the driver to the grids of the parallel 6JB6's. The output matching circuit for the final is a conventional pi-network utilizing the original tuning and loading capacitors and ceramic coil form. The layout of the NCX-3 final amplifier compartment was well-suited to six meter operation. Do not attempt to use a mixer/oscillator combination other than the 6KE8,

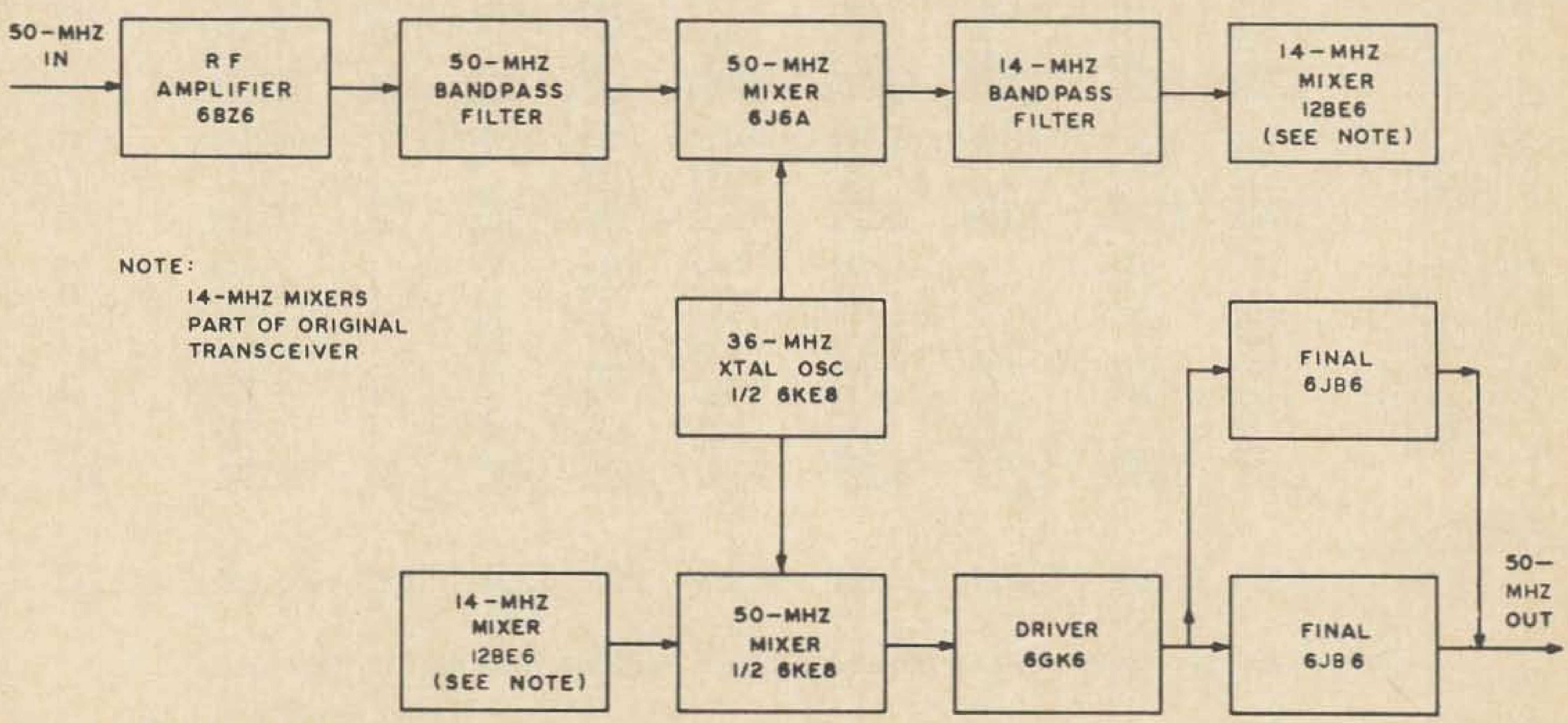
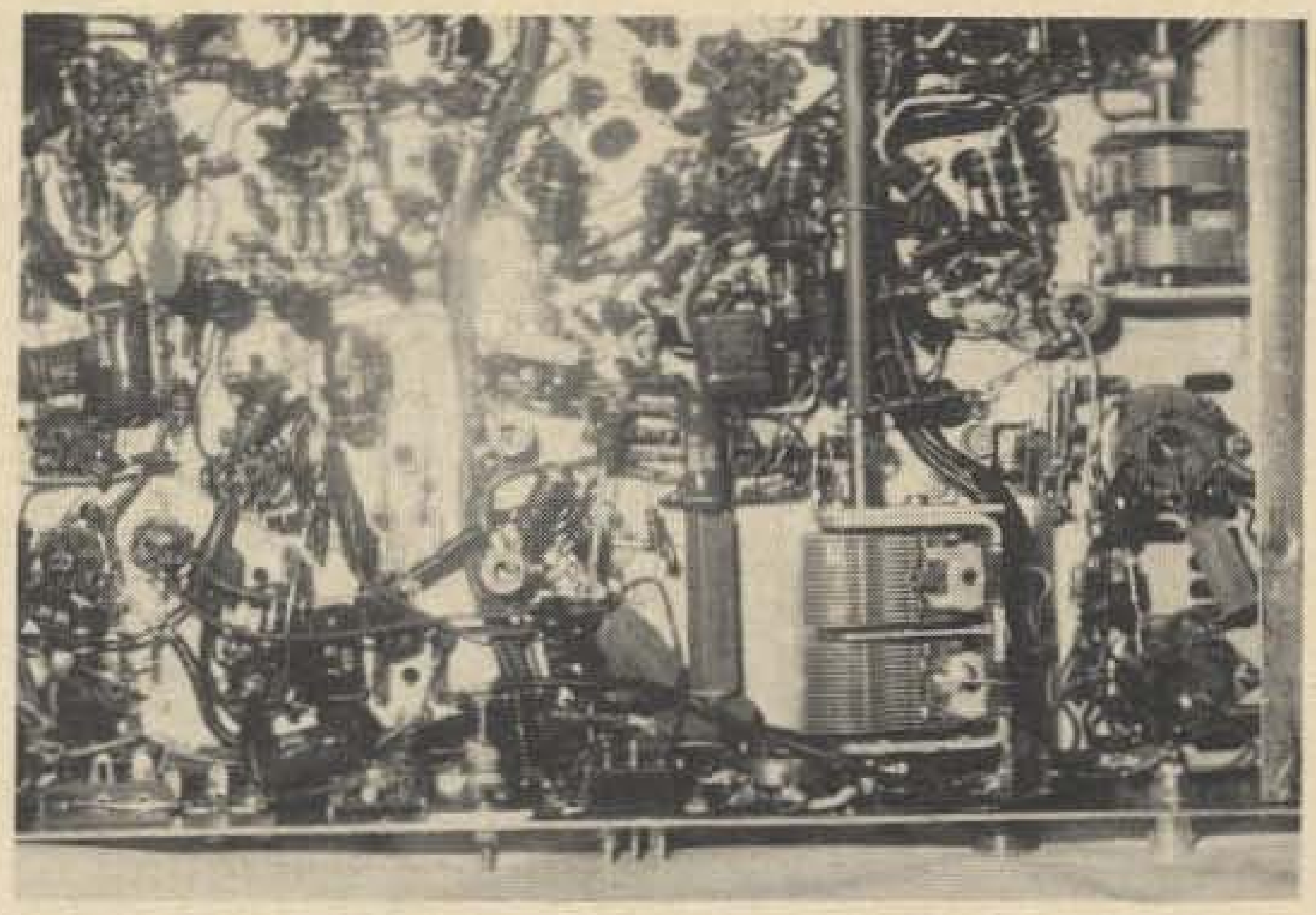


Fig. 1. Block diagram.

since this is the only tube I have found to possess enough transconductance to develop the required voltage at the grid of the driver. The mixer and driver plate coils are tapped to arrive at a better L/C ratio and improve efficiency. Tube input capacities are too large at these frequencies to permit coupling directly across a tank circuit and still maintain good voltage gain. For example, the total input capacity to the final amplifier is 60 pf. Figure the size of the tank coil to resonate with that, and you will see why an effective increase in voltage gain of about two can be realized by increasing the inductance by a factor of four and tapping half-way down.

The receiving section uses a 6BZ6 pentode in the *rf* amplifier which feeds a bandpass circuit coupled to one grid of the 6J6A mixer. The mixer output is fed through a 14 mhz bandpass filter into the grid of the original 12BE6 mixer. Someone will invariably ask why I didn't use a nuvistor front-end. There are a number of reasons why certain pentodes make better *rf* stages for six meters than nuvistors. Number one is that a pentode has an inherently higher signal-handling capability than a triode. With the amount of activity in this area, including a number of kilowatt sideband stations, the worth of a large dynamic range becomes immediately apparent, especially during band openings. I picked the 6BZ6 because it was especially designed to have low distortion characteristics. A 6EH7 frame-grid pentode would have been even better. Another reason is that agc control of a pentode is much easier than in a triode. The 6BZ6 is a semi-remote cutoff type, well suited to agc control.

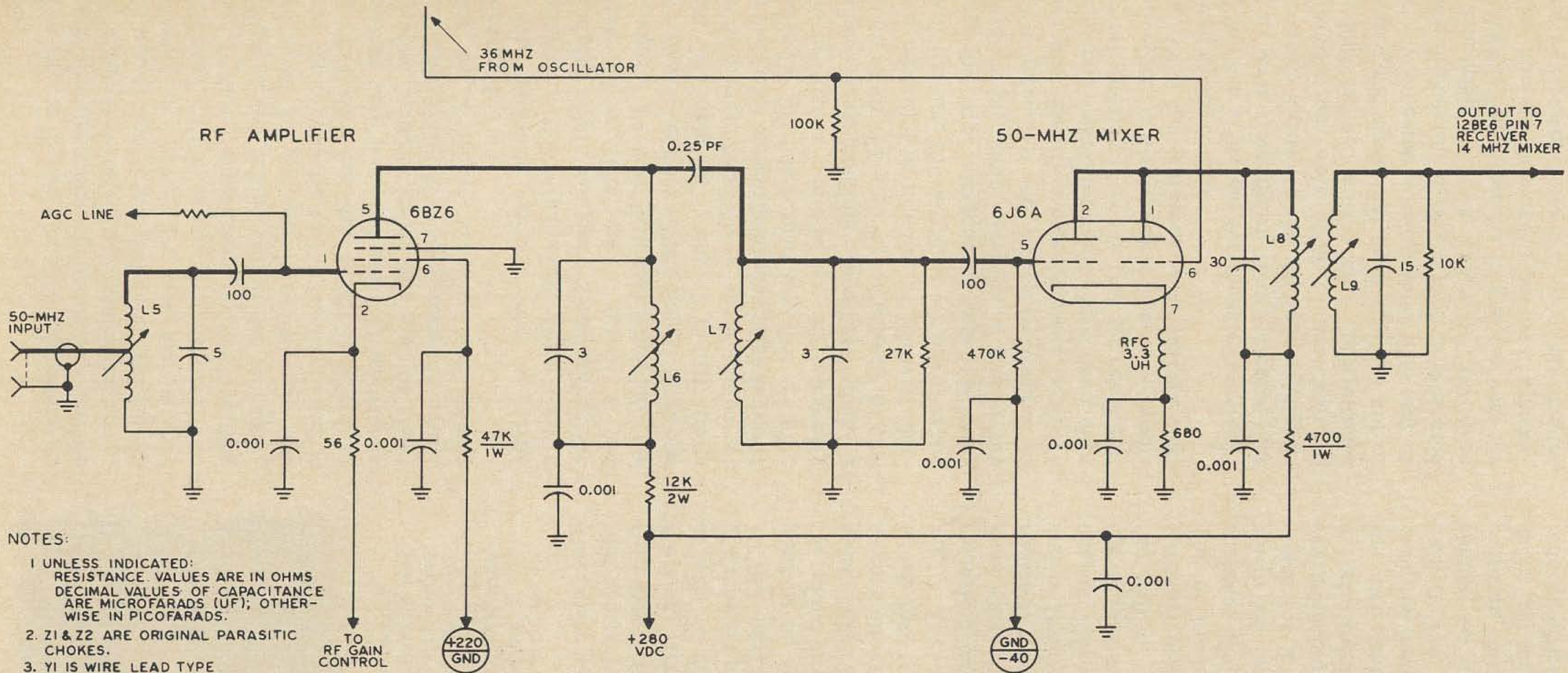
The last argument for the nuvistor would be its lower noise figure. Here I contend that the noise figure of the pentode is higher; however, just how good a noise figure is needed at 50 mhz? Most authoritative sources will agree that noise figure is not of utmost importance below about 100 mhz. A good discussion of this subject is presented in Rheinfelder's book, *Design of Low-Noise Transistor Input Circuits.* If you can hear the noise coming from your antenna, a reduction in receiver noise will be of no benefit.



Bottom view of the chassis. The driver and its plate coil are in the upper right corner to the left of the exciter-type capacitor. The 6KE8 mixer is just to the left of the loading capacitor shaft (note the crystal can). The 6J6A mixer is to the left of the 6KE8. Below it are L6 , L7 and the rf stage. L5 can be seen to the left of the power plug.

The performance of this front-end indicates that atmospheric noise is a good deal larger than the *rf* stage noise (even at 3:00 in the morning). The above considerations indicate, at least to me, that at 50 mhz a pentode is still a better performer than a triode.

The modification details will vary depending on the particular unit involved but the added circuitry should remain about the same. The layout I finally decided on seemed about optimum for the NCX-3. The added tube and coil locations are shown in Fig. 3. The original 12BA6 *rf* stage and its associated circuitry was removed and in its place went the 6J6A mixer. An OA2 voltage regulator occupied a socket a couple of inches from the 12BA6 at the rear of the chassis. This was moved to a cranny next to the audio output tube and in its place went the 6BZ6. The bandpass circuits are mounted just about in between the stages. The *rf* input coil is mounted on a plate covering the hole from the accessory socket which was removed. A BNC receiver *rf* input connector is mounted next to the original uhf connector for the transmitter. I use an external antenna relay for switching between the two lines. An internal relay can be mounted under the final tune capacitor if desired. The original NCX-3 used a method similar to that found in electronic tr switches, but I found this added too much shunt capacity to the final tank coil and reduced efficiency.



NOTES:

1 UNLESS INDICATED:
RESISTANCE VALUES ARE IN OHMS
DECIMAL VALUES OF CAPACITANCE ARE MICROFARADS (UF); OTHERWISE IN PICOFARADS.

2. Z1 & Z2 ARE ORIGINAL PARASITIC CHOKES.

3. Y1 IS WIRE LEAD TYPE SOLDERED DIRECTLY TO CIRCUIT UNDER CHASSIS.

4. ⊖ INDICATES CONTROL VOLTAGES: TOP=RECEIVE BOTTOM=TRANSMIT.

Fig. 2. Schematic diagram.

Coil Table

L1: 4½ turns no. 14, 2½ inches long on 1 inch dia. form.

L2: 8 turns no. 20, 5/8 inch long on Cambion 3/8 inch dia. form (white slug) tapped at 4 turns.

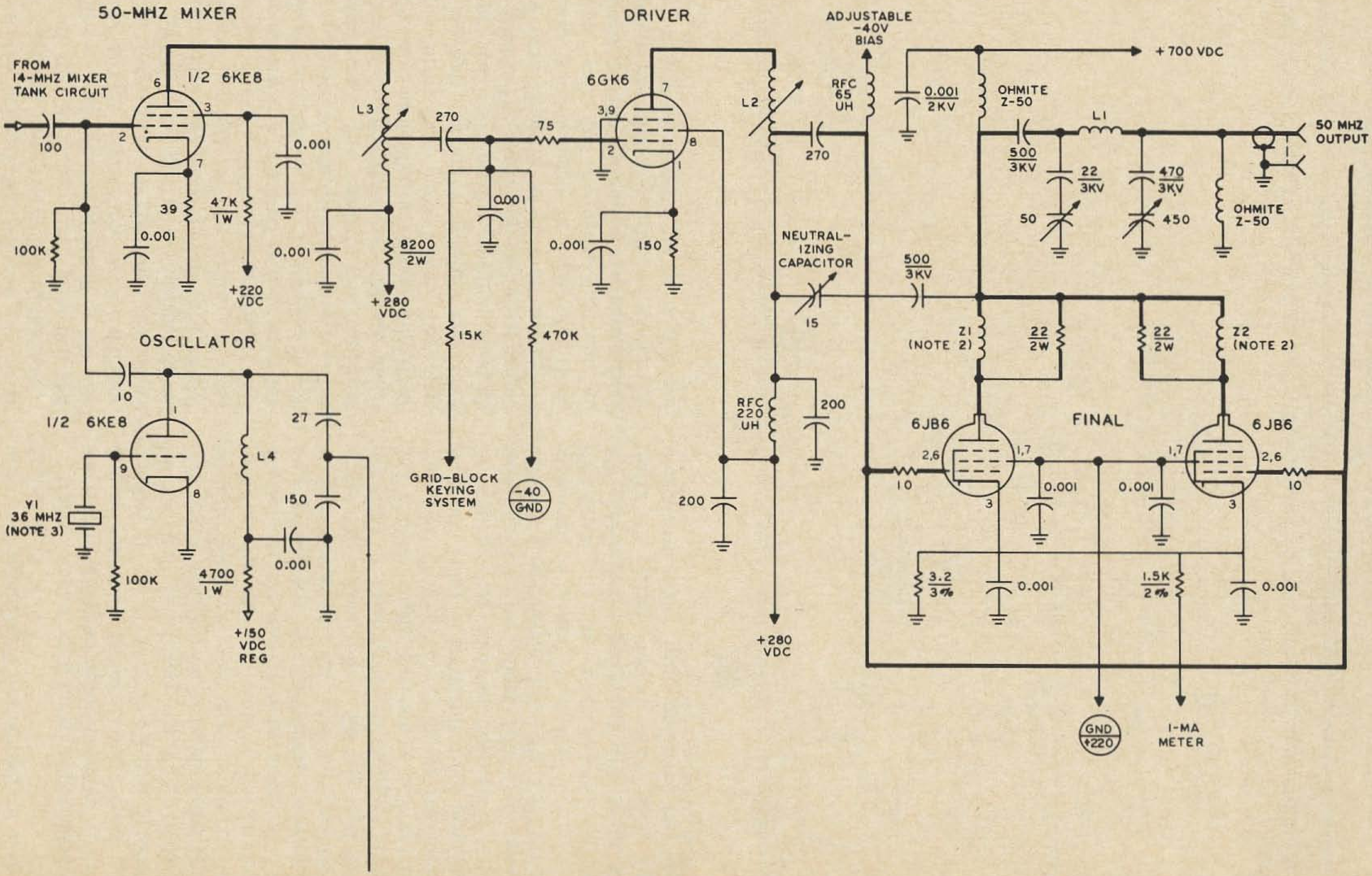
L3: 8 turns no. 26E, close-wound at top of Cambion 3/8 inch dia. form (white slug) tapped at 4 turns.

L4: 18 turns no. 26E, close-wound on ¼ inch dia. form (white slug).

L5: 8 turns no. 22E, spaced one wire diameter on Cambion 3/8 inch dia. form, tap 1½ turns from ground end.

L6, L7: 12 turns no. 28E, close-wound on ¼ inch dia. form (white slug).

L8, L9: 22 turns no. 26E, close-wound on Cambion 3/8 inch dia. form (red slug). Mount the coils in line with a center-to-center spacing of 13/16 inch.


50-MHZ MIXER
FROM 14-MHZ MIXER TANK CIRCUIT
1/2 6KE8
100
100K
39
0.001
47K 1W
+220 VDC
L3
270
0.001
8200 2W
+280 VDC
75
0.001
15K
470K
GRID-BLOCK KEYING SYSTEM
-40 GND
DRIVER
6GK6
3,9
150
L2
270
RFC 220 UH
200
+280 VDC
ADJUSTABLE -40V BIAS
RFC 65 UH
0.001 2KV
+700 VDC
OHMITE Z-50
L1
500 3KV
22 3KV
470 3KV
50
450
50 MHZ OUTPUT
NEUTRALIZING CAPACITOR
15
Z1 (NOTE 2)
22 2W
Z2 (NOTE 2)
6JB6
FINAL
10
3.2 3%
1.5K 2%
GND +220
1-MA METER
OSCILLATOR
10
1/2 6KE8
Y1 36 MHZ (NOTE 3)
L4
27
150
4700 1W
+150 VDC REG

All the original 80, 40, and 20 meter tuned circuits were removed with the exception of the 20 meter mixer plate coil and oscillator coil. The bandswitch is likewise removed. This leaves room to put the new 6GK6 driver closer to the final, and allows the 6KE8 to be put in the original driver socket. This also puts the 36 mhz crystal oscillator section of the 6KE8 in close proximity to the 6J6A. The original exciter tune capacitor is still used to tune the plate tank of the 12BE6 mixer. The final tank coil is wound on the original ceramic form and is conventional. The original final amplifier layout is quite satisfactory for six meter operation and no drastic changes were made here, other than parts values. The plate tuning and loading capacitors have their ranges decreased by the addition of series capacitors. The original .01 uf bypass capacitors were changed to .001 uf and the *rf* chokes were changed to ones more compatible with the frequency involved, an important point for anybody contemplating this type of conversion. Little things like this have a way of showing up as insufficient drive and instability if not considered in the beginning.

Upon completion of the rebuilding phase, the next step was to debug the circuits. The only problems encountered were some instability in the *rf* stage and a lack of drive for the final. The *rf* stage was stabilized by a little more isolation between plate and grid circuits, which is why the input coil is mounted on the rear wall of the chassis. This places the coil at right angles to the output coils and aids decoupling. A worthwhile idea might be the inclusion of a shield across the socket, but I did not find this necessary. A combination of the right tubes and experimentally determined bias conditions led to the correction of the drive problem. There is sufficient drive available to load the finals to about 300 mils of plate current. This gives about 200 watts input and 120 watts output into a 50 ohm load as measured on a Bird Termaline Wattmeter. The finals run class AB1 on SSB, AM, or CW. AM input is 100 watts with about 30 watts of carrier output. The tubes are overloaded under this condition, but the

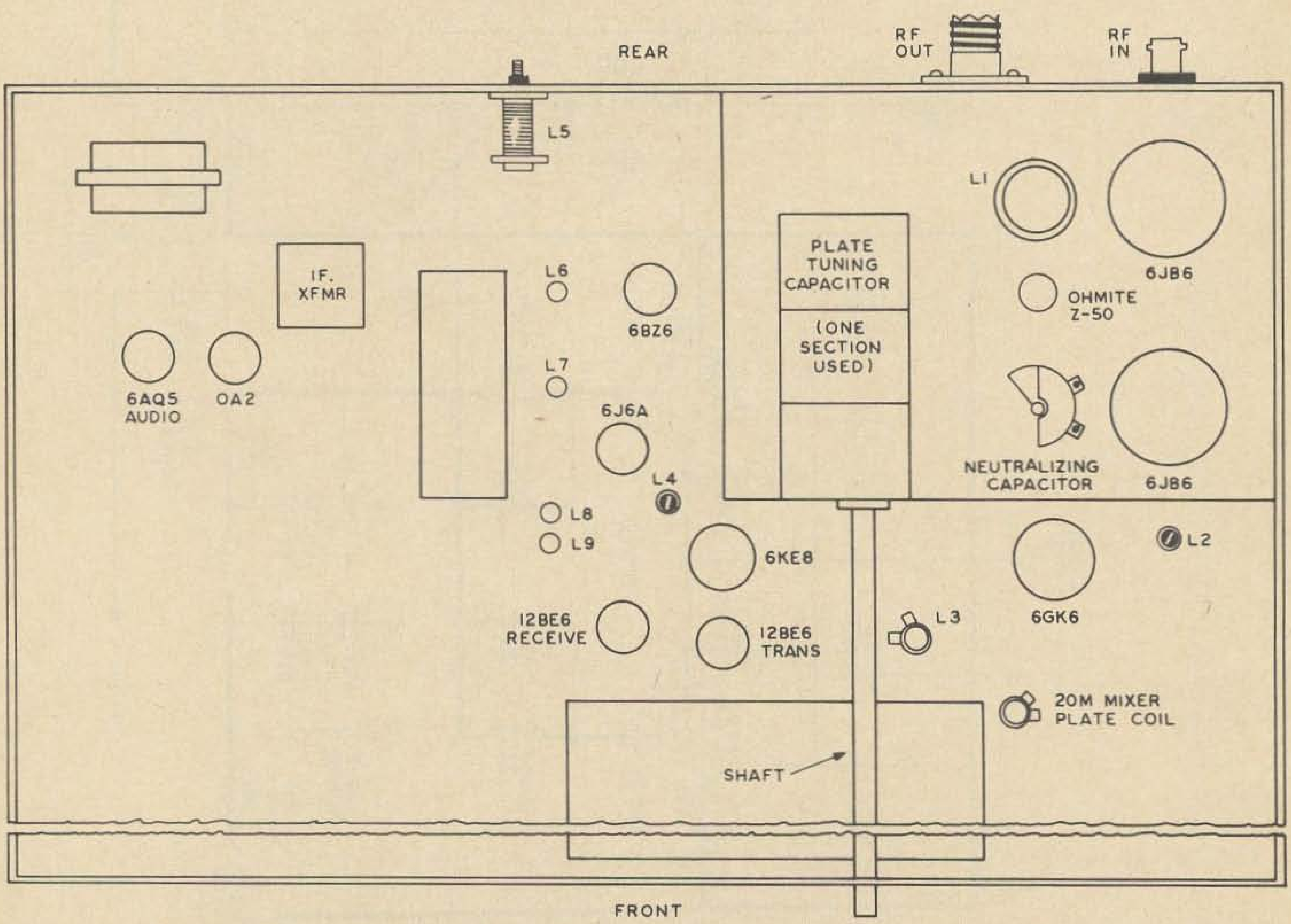
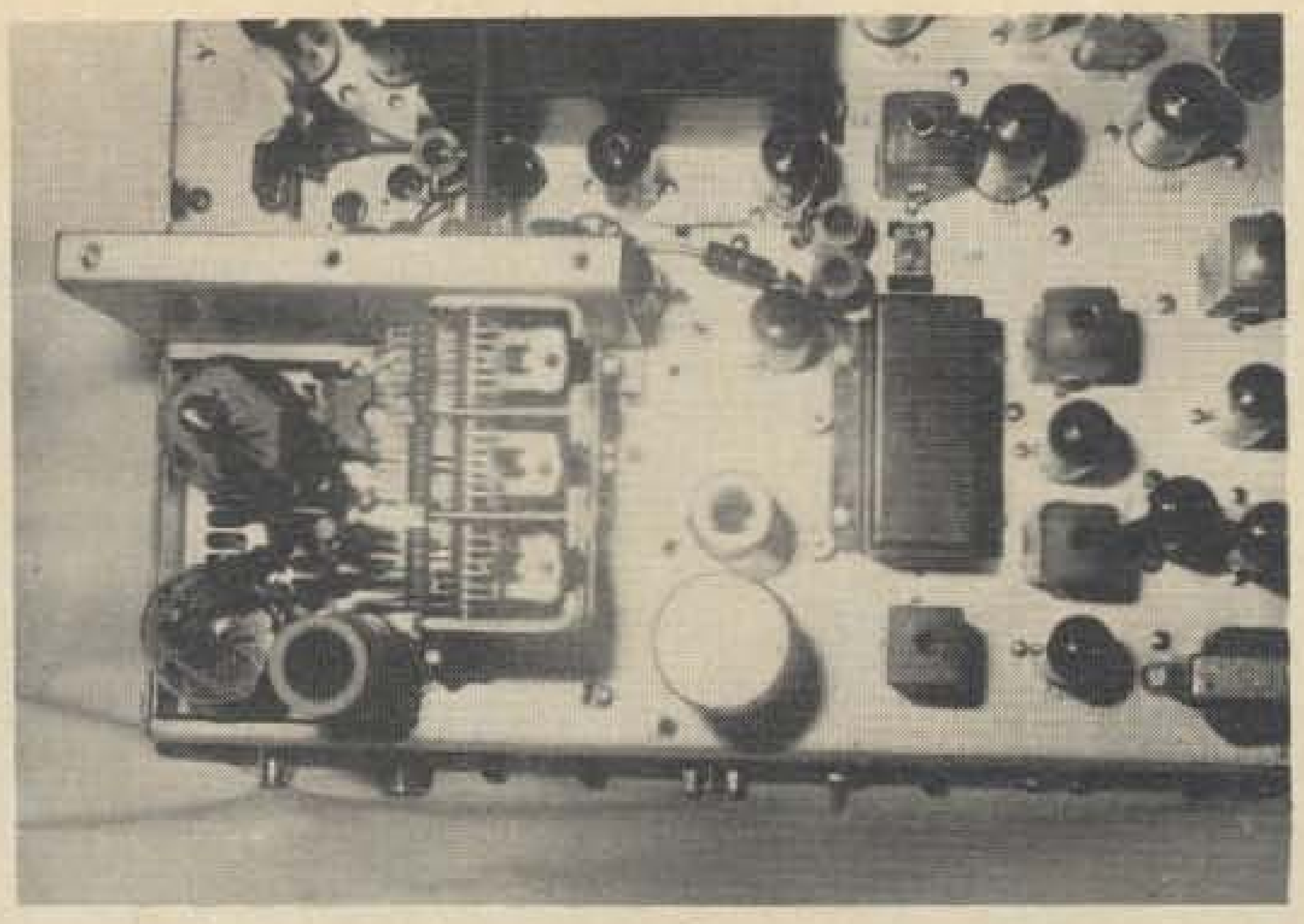


Fig. 3. Simplified drawing of the chassis top, showing the locations of the major added parts. L2, L4, L5, L6, and L7 are mounted under the chassis. L3, L8 and L9 are mounted on top.



Top view of the chassis. This photo should be compared with **Fig.3** to get an idea of the layout.

assumption involved here is that since PTT or VOX operation is involved, the carrier will be applied with modulation in which case (100% modulation) the efficiency will be about the same as with SSB. There is something to be said for these low cost TV sweep tubes in AB1 linear operation. 6146B's could have been used, but this would have required a socket change.

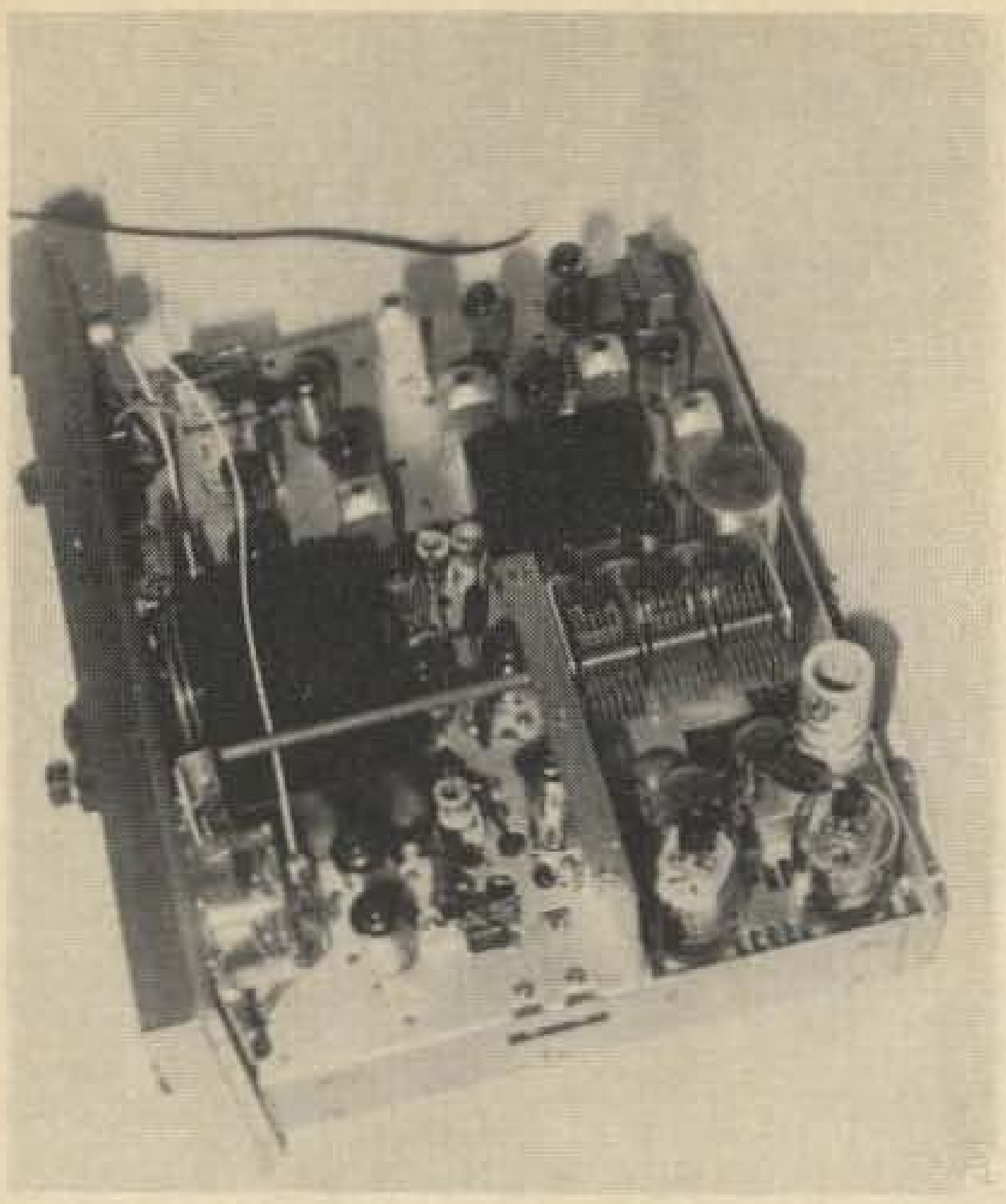
A word is in order about the efficiency of an AB1 linear. I have found that efficient operation requires enough driving voltage to swing the grid up to zero volts with the load resistance adjusted for maximum plate voltage swing. Under these conditions, an efficiency of 60 to 65% should be readily attainable. For the 6JB6 this means at least 70 or 80 volts peak-to-peak should be available at the grids. I would not recommend the use of speech compression with these finals since this would raise the average plate dissipation and the tubes are already running near the hairy edge. This would be allowable with 6146B's running at the same input.

The receiver alignment consists of peaking all the tuned circuits at 50.2 mhz which gives a uniform response from 50.0 to 50.4 mhz. Likewise, the 14 mhz bandpass filter between the 6J6A and the 12BE6 should be peaked at 14.2 mhz. The easiest way to peak the bandpass circuits is to first short one coil and grid-dip the other to the proper frequency. Next short the one you have just dipped, and dip the one which was previously shorted. The short should then be removed and the coils peaked up on an incoming signal in the middle of the tuning range. The short can be a piece of heavy bus wire tack-soldered onto the coil terminals. It is not necessary to use a signal for peaking. This can be done with atmospheric noise and the performance will be just as good. This is about all there is to the receiver section alignment.

For the initial transmitter alignment the final tubes should not be in their sockets. In all the following procedures the tuning indicator used is an *rf* probe coupled to the tank circuit through a small capacitor of .5 to 1 pf. A grid-dip meter operating as a wavemeter can also be used, but it is more cumbersome. The 20 meter 12BE6 mixer plate coil slug should be peaked with the tuning dial at 14.4 mhz and the exciter tune capacitor almost at minimum capacity. The crystal oscillator tank coil and the mixer and driver plate coils should be grid-dipped to 50 mhz to bring them into the right ballpark. The crystal oscillator tank circuit is peaked for maximum transmit mixer output which should be measured by the above method.

The driver plate tank should be dipped with a capacitor of about 60 pf temporarily connected from the tap to ground to simulate the final's input capacity. This will be removed when the finals are installed. The tuning dial should now be set at 14.2 mhz. The 6KE8 mixer and driver plate coils should now be peaked for maximum output. The 60 pf capacitor should now be removed and the final tubes placed in their sockets.

Some sort of dummy load at about 50 ohms is required for the final touch-up of the transmitter circuits. The final should be neutralized by any of the standard methods found in the handbooks. The final touching up is accomplished by turning on the transmitter for short periods of time (not more than 30 seconds at a time) and peaking the tuned circuits for maximum power out. Keep the pi-network tuned for maximum power output but don't exceed 300 mils of plate current. The 36 mhz oscillator plate tank should also be peaked again. If you have a wattmeter for this frequency it should indicate at least 100 watts output. It should also be noted that when the final is properly neutralized, maximum power will occur at the plate current dip. Adjust the neutralizing capacitor until this condition is



Overall angle view of the chassis. The driver, 6KE8 mixer and final amplifier compartment are more clearly identifiable.

attained. Resting current for the 6JB6's is about 50 mils. Once the unit has been adjusted, the tune-up procedure for normal operating is exactly the same as given in the manual for the low bands.

One question remains: What to do about the hole in the front panel where the bandswitch used to be? I solved the problem by mounting a BNC jack in the hole and running the 14 mhz *if* out to my 80 thru 10 meter receiver. This gives independent transmit-receive capability which is a great aid when working AM stations. The 14 mhz pickup is two turns of wire wound around the ground end of L9 and brought to the front panel by means of a length of miniature 50 ohm coax. This gives quite adequate injection for the external receiver. I suggest an external *if* receiver if much work is to be done on AM since the SSB selectivity of the crystal filter is a little too sharp for good AM reception.

On the air reports have been gratifying. The single sideband emission is clean, and the audio is crisp and clear. The AM mode also has produced good reports. 30 watts of carrier output is a good competitive signal on six meters. With this unit I am not afraid to try other circuits and improvements in it, since the purchase price was far below any similar commercial unit. In my estimation it performs as well as, if not better than, the comparable commercial unit.

. . . WA1FRJ

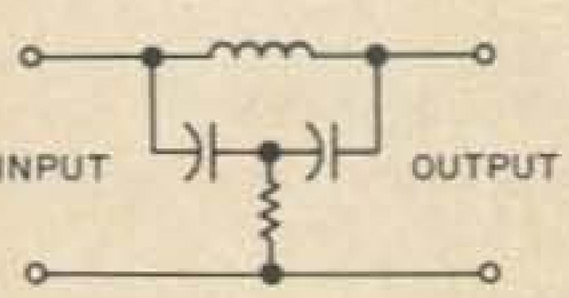
John J. Schultz W2EEY/1
40 Rossie St.
Mystic, CT 06355

IF Notch Filter

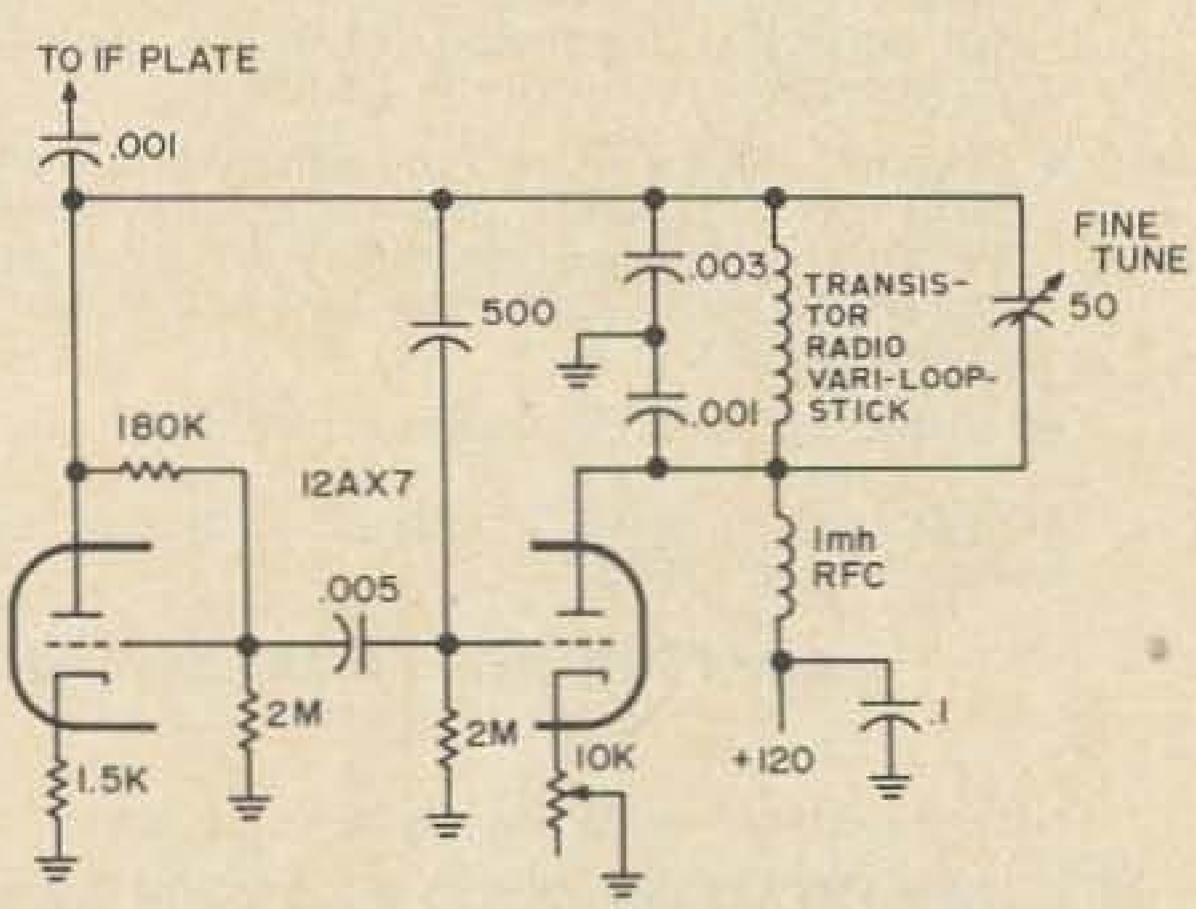
IF notch filters represent one of the last selectivity refinements possible in many SSB receivers. Found in many expensive receivers, they can be incorporated into most receivers or transceivers as an accessory.

Notch filters in the *if* amplifier chain of a receiver are not a new idea. The popular Q Multiplier could be made to function as either a peaking or notching filter simply by altering its feedback arrangement. However, in the days when the Q multiplier first became popular, the notch function was generally overshadowed by the peaking function since it was desired to mainly improve the selectivity of a receiver. As even less expensive receivers tended to use better selectivity devices, particularly crystal filters which provided good shape factors, the Q multiplier decreased in popularity. The bandwidth and steep skirts of the filters reached an optimum point for SSB reception and use of a peaking Q multiplier simply introduced distortion in selectivity. It was at this point that at least some operators discovered the very useful and somewhat forgotten notch function of a Q multiplier. Although it was no longer possible to eliminate QRM on SSB by reducing the *if* bandwidth in a receiver without severely losing voice identity and intelligibility, it was possible to eliminate narrow frequency bands where QRM was present without affecting voice intelligibility to any great degree. The situation is very similar to various combined voice/teletype transmission systems where a 80 to 150 cycle slot is placed in the 300 to 3000 cycle total bandwidth for teletype transmission.

The usefulness of a notching device across



(A)



(B)

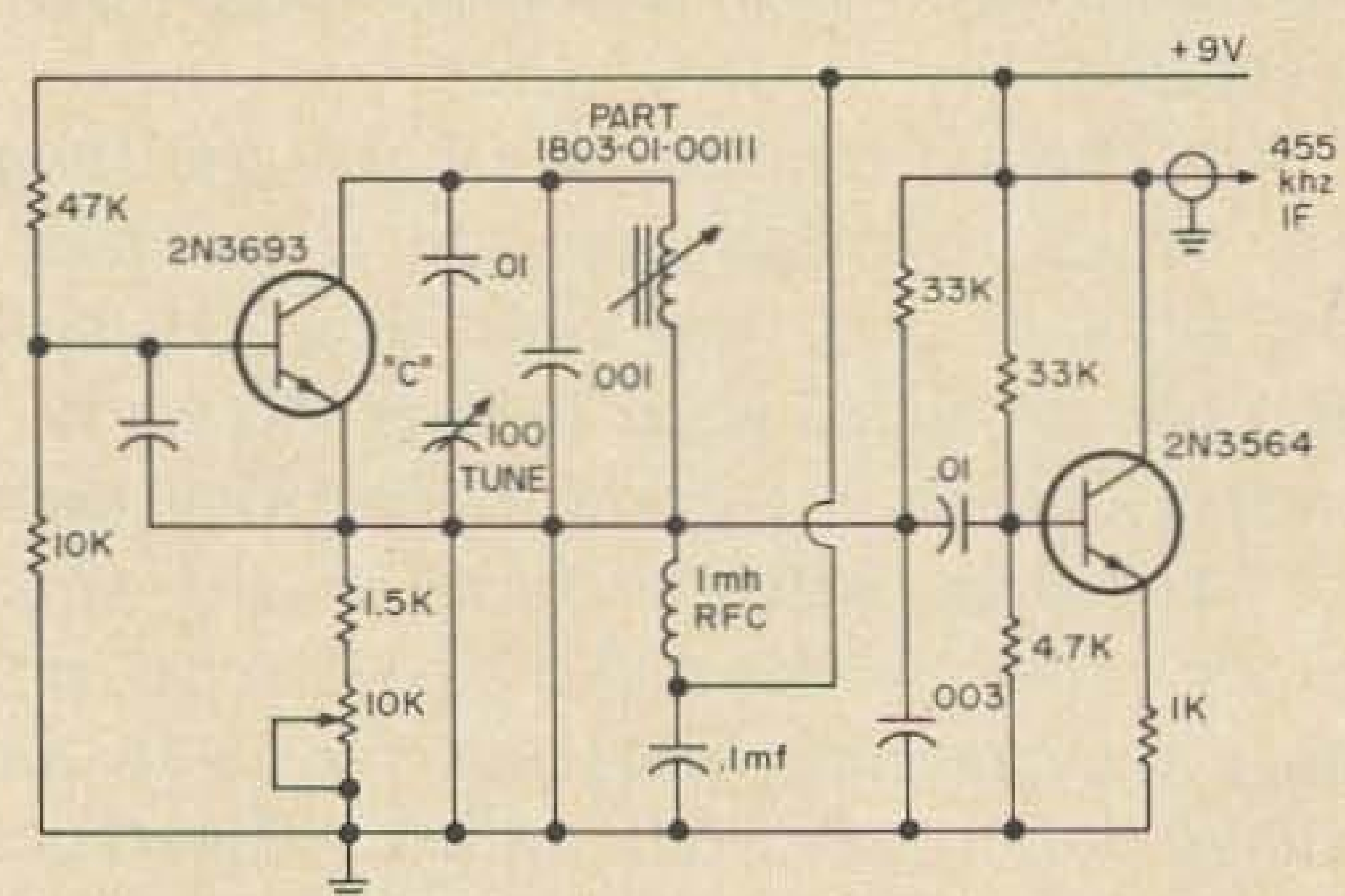


Fig. 1. Bridged-T network (A) is basis of most notch filters. Q multiplier in notch function uses network in feedback circuit. (C) varies notch frequency approximately ±6 khz from 455 khz center frequency.

the *if* bandwidth is indicated by the fact that many of the better and more costly receivers which already incorporate optimized *if* SSB filters also incorporate notch filters, since it is the only means left to eliminate QRM without causing distortion. Notch filters have been improved and simplified considerably in recent years. They can be a very useful accessory to add to a receiver or transceiver which already has a good *if* filter. They are a particularly appealing accessory to add to a transceiver which is used on both SSB and CW but which has only a SSB filter since they provide that extra bit of QRM rejection so necessary when a SSB transceiver is used on a crowded CW band.

This article surveys various notch filter configurations used in amateur receivers. The reader who wishes to should be able to adopt the various circuits to his own needs. The parts needed can all be purchased or fabricated. In place of the latter, some of the more critical components might be available direct from receiver manufacturers.

Basic Notch Circuits

Most notch filters are based upon the Bridged-T network shown in **Fig. 1(A)**. The network is balanced at the frequency at which it resonates and theoretically offers infinite attenuation between input and output terminals. At other frequencies, it is unbalanced and these frequencies pass through. The degree of attenuation at the notch frequency depends, in practice, upon the Q of the components used but can approach as high as 60 db.

The old Q multiplier notching amplifier **(Fig. 1B)** made use of a network in a feedback arrangement in order to enhance the Q of relatively simple components. At the resonant frequency of the network a high negative feedback occurs to the first section of the 12Ax7. The feedback drops its plate resistance to a very low value and, in effect, at the one frequency it shunts the *if* line to ground. It acts similarly to a frequency selective switch. Although the general tendency in notch filters has been to eliminate the need for active networks by using passive components of sufficiently high Q, the single point connection of the old Q multiplier circuit to the *if* circuit still gives it an unique advantage.

Notch filters can be built for any *if* frequency within the limits of achieving frequency stable circuits. With care they can probably be used up to frequencies of a few megacycles, although most designs have been made for frequencies below 1 megacycle. Fig. 1(C) is a good example of a transistorized notch filter design in a recent receiver design.

Typical Circuits

Fig. 2 shows three notch filter circuits which utilize only passive components. The filters may be placed at almost anyplace in the *if* chain but after the main selectivity (crystal or mechanical filter). The loss they introduce (at other than the selected notch frequency) is usually low enough so that no additional amplification need be provided as compensation.

Fig. 2(A) shows a tightly coupled *if* transformer used between the filter terminal. Instead of the common point of the transformer going to ground, however, it is coupled to the bridged-T network in slightly modified form. The impedance transfer is

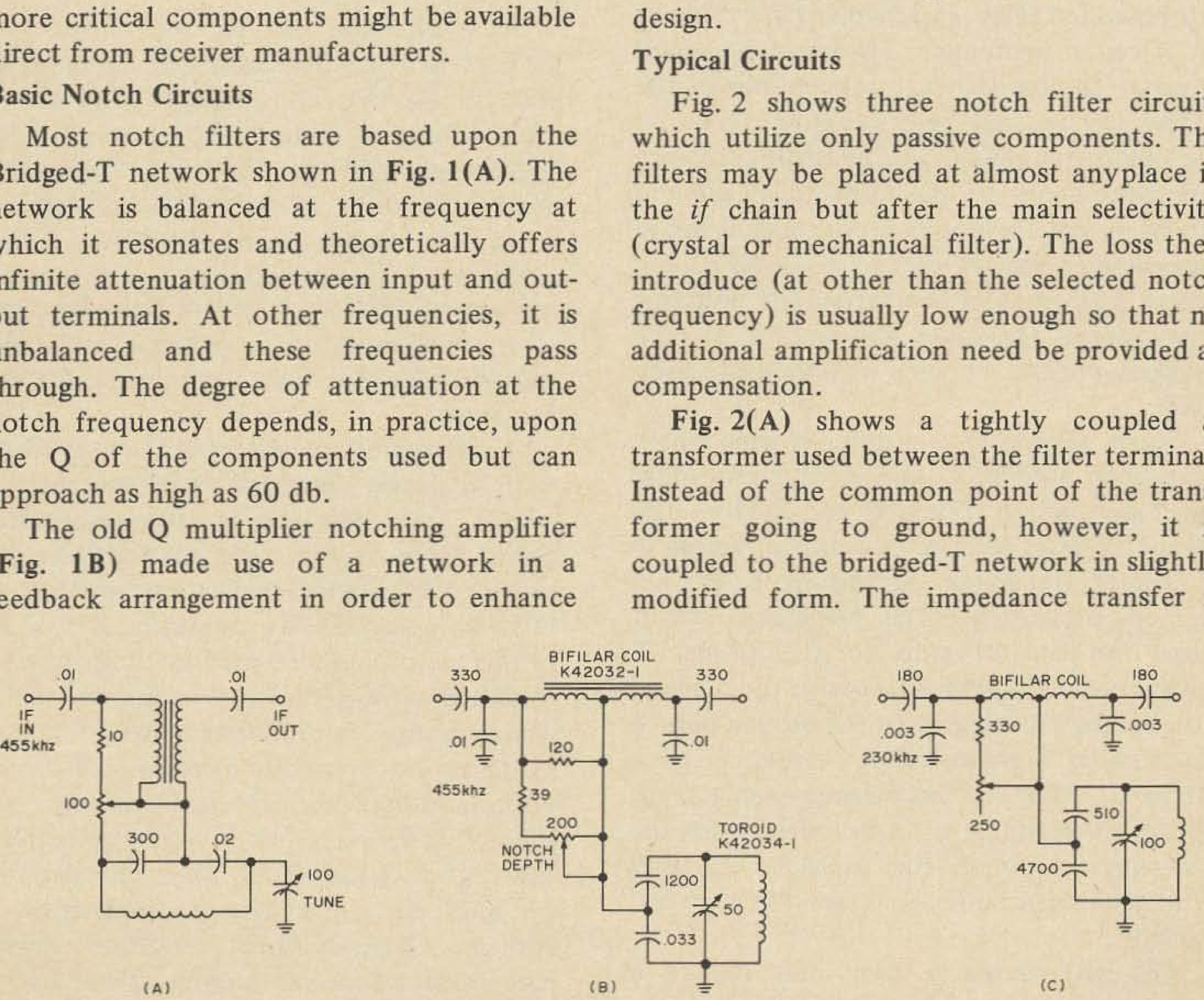


Fig. 2. Most receivers now use notch filters having only passive components. Basic circuits shown are from Davco DR-30 (A), Hammarlund HQ180 (B), and national HRO-500 (C).

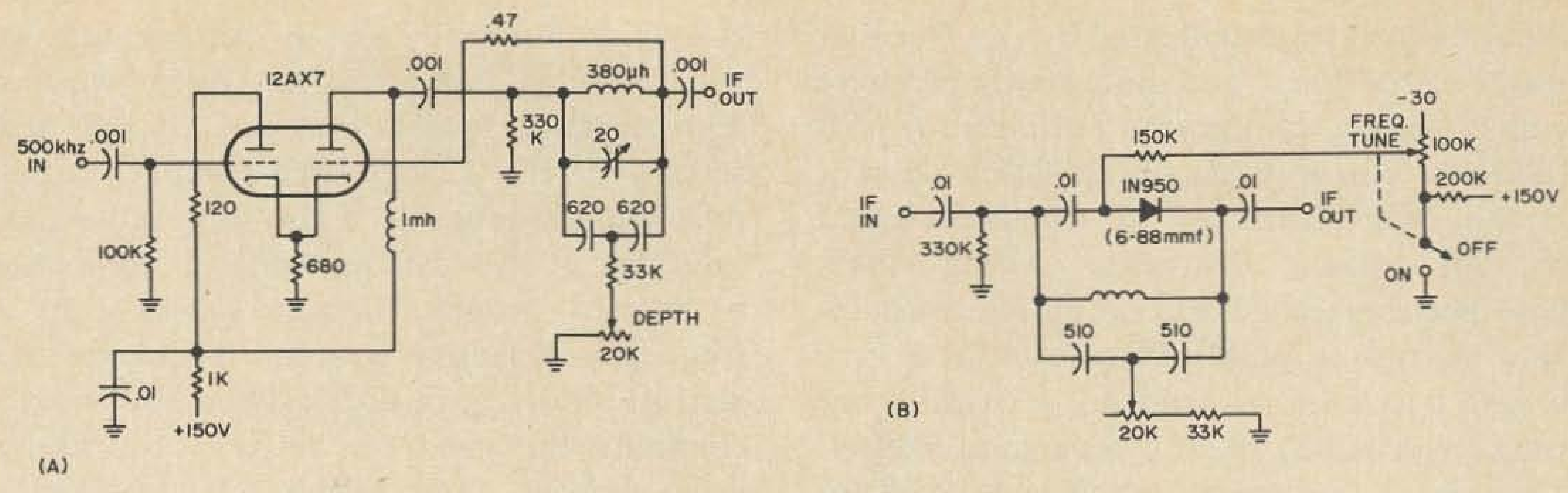


Fig. 3. Notch filter using a feedback amplifier to increase Q of series bridged-T network. Instead of air variable capacitor, varactor diode can be used (B) controlled by potentiometer.

low except at the frequency to which the filter is resonant. The sharpness of the notch depends a great deal on the Q of the coil used, which is wound on a ferrite core. **Figs. 2(B)** and **2(C)** are similar circuits except that they utilize bifilar wound coils to achieve close coupling. The tuning capacitors are chosen such that the notch frequency can be varied several kilocycles either side of the *if* center frequency. The resonant circuit presents an impedance to the center of the bifilar coil so that zero coupling occurs at the notch frequency. The resistors provide a resistive balance to the bridge network and can be varied for notch depth (usually set at maximum depth and left as a chassis adjustment). The value of the bypass and coupling capacitors at the input and output of each network provide a proper impedance termination.

Fig. 3 shows two notch circuits which have been used in Collins equipment. Only the basic circuit features are shown. The circuit of **Fig. 3(A)** is basically a simple Q multiplier feedback arrangement as explained previously. The feedback circuit from the output side of the bridged-T network (which is in series with the *if* signal flow) going to the grid of the second half of the 12A x 7 enhances the circuit Q by a factor of 2500. A mechanical arrangement on the filter tuning capacitor shorts out the 380 μh coil when the capacitor is fully rotated in one direction (for filter "out" control).

Fig. 3(B) shows a very nice use of a varactor diode in a notch filter which can be applied to other circuits as well. When the 100 K potentiometer is turned such that the switch is in its "off" position, the IN950 is forward-biased by the plus 150 volt supply. Effectively, its low forward resistance shorts out the notch filter. When the potentiometer is turned "on" reverse bias is applied to the IN950 and it functions as a capacity diode to tune the notch filter frequency.

Summary

A notch filter can be one of the most useful selectivity devices which can be added and still improve the receiving ability of even a good piece of equipment, especially a SSB transceiver with no CW filter option. By combining some of the ideas presented, it should be possible to come up with a solution for almost any situation. The use of a varactor diode to remotely tune (by means of a panel-mounted potentiometer) a filter should alleviate any component location problems.

A great deal of the effectiveness of the filter depends upon the Q of the resonant circuit used. The use of inexpensive transistor radio ferrite antennas (Miller 2000 series, for instance) solves many needs for low-frequency *if*'s. Those having Q's of 250 or less are suitable for use in circuits having a feedback arrangement to enhance the Q. Those having Q's of 400 or more can be used similarly or even alone in passive circuits with moderate success. However, for completely passive circuits, it would be better to use higher Q inductors. Such inductors can be built using litz wire on such forms as Indiana General Corp. ferramic cup-core assemblies which can provide Q's of 850 up to 500 kc. For higher frequencies, ferramic toroids can be used.

. . . W2EEY/1

Calibrate That Homebrew Dial

Glen Zook K9STH/5
818 Brentwood Lane
Richardson TX 75080

Whenever a new piece of homebrew gear is finished, it is often necessary to give a degree of reliability and resettability. However, the necessary laboratory equipment is not available to the majority of amateurs. Thus, makeshift methods are often attempted with a makeshift result. Although a simple method of achieving reliable calibration is available, many amateurs are not aware of it, or have forgotten how to use the method.

Older amateurs who are familiar with the old HRO series of receivers and various older pieces of test equipment will recognize the technique that I am going to outline. What is it? The use of a frequency versus logscale graph. The older HRO receivers had such a graph on each of the plug-in coil units. Reading of frequency consisted of reading the log scale on the receiver and referencing this to the graph. Such techniques may be used to create a graph for a piece of gear that has been recently constructed. This graph then can be used to accurately calibrate the final dial or retained for use with the log scale per the old HRO's. By the way, this technique does not apply just to receivers. It applies to any tuneable oscillator using any combination of L-C arrangements including permability tuned coils as well as the conventional fixed inductance variable capacitance oscillator tuned circuit.

The technique consists of using a series of known points such as crystal frequency, broadcast stations, etc. plotted on graph paper. The plot then can be used to create a dial with direct calibration points marked on it. Of course the more known points, the more accurate the final graph, but a small number is better than none.

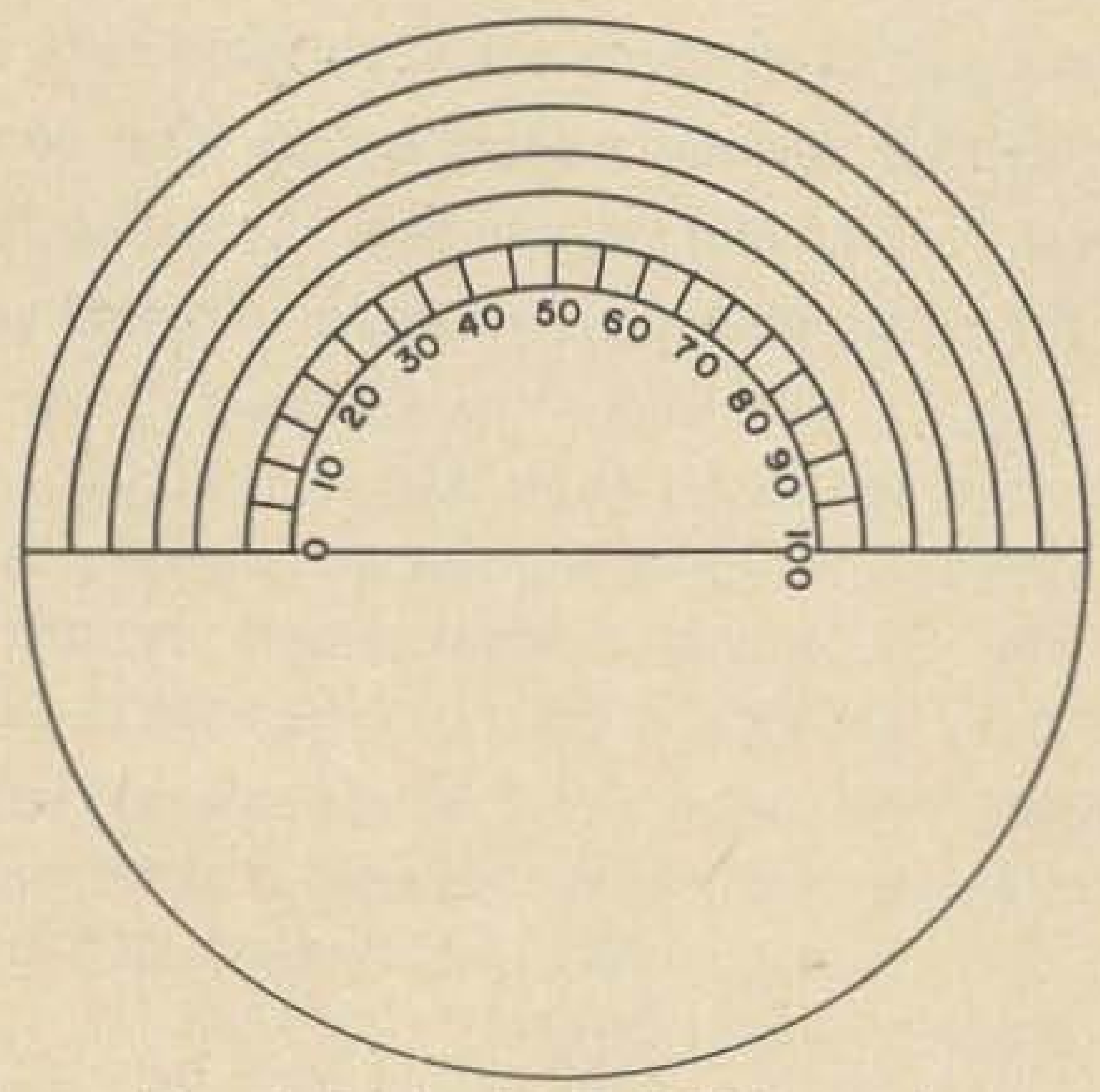


Fig. 1. Dial with 0-100 log scale.

How to do it? First of all construct a dial with some type of linear log scale on it. Such things as protractors may be used. A protractor will give 360 equally spaced log points on a circular dial. Or a 0-100 log scale similar to **Fig. 1** may be used. These types of log scales apply to both circular or semicircular dials. A slide-rule dial is much easier to achieve a log scale on. This is accomplished by use of the simple ruler. Each division on the ruler may be used as a log point on the dial.

The next step consists of locating the position of known frequency points on the log scale. In the case of a receiver various crystals, stations, etc. may be recorded. In the case of a VFO, GDO, Signal Generator, etc., it is necessary to use some type of receiver which will receive the known frequency and the output of the unit being calibrated. All that must be done is to beat the known frequency and the output of the unit until zero-beat. The log position on the dial is recorded and the next frequency checked. Don't forget that harmonics can be used. Their accuracy is usually quite sufficient.

The third step consists of laying out the frequency versus log-scale graph. Any form of quadrilled paper may be used. The graph paper appearing in the back of the log book is fine (now you know what this is for!!!). I prefer the K & E 358-12 8½ inch x 11 inch paper, but any type of paper should be sufficient. First label the bottom of the sheet in equal divisions with the log-scale in use. Next label the vertical axis with the frequency range. Make sure that the frequency divisions are equal, e.g., 100 khz per division, 1 mhz per division, etc.

The fourth step consists of plotting the known points on this set of axis. For example, if 7035 khz were at 79 on the log-scale, it should be placed at the intersection of the lines from 7035 khz and 79 on the respective chart axis. The remaining points should also be plotted.

The fifth step is to connect these points with a smooth curve that fits the points plotted. A draftsman's French Curve is best for this. This instrument is available for less than $1 from many sources. The sixth step is the actual calibration of the final dial. The usual points, e.g., every 10 khz, 100 khz, etc., may be found by following the line from that point of the vertical axis until it crosses the curve. At the point where it crosses the curve, the line coming from the horizontal log-scale axis will give the correct position of this frequency on the log scale of the final dial. This can then be marked and successive points laid out.

In the case of seldom used pieces of gear, especially those using the inexpensive vernier dials, the graph can be retained and the dial not directly calibrated. In fact, this is about the only way with the dials which have the metal circular dial calibrated in a 0-100 log scale. When a certain frequency is desired, it is checked on the graph and set on the log scale on the unit. In fact, this is the way that the good old BC-221, LM, and other surplus units work.

As an example of calibration, the actual points used in the calibration of a home-

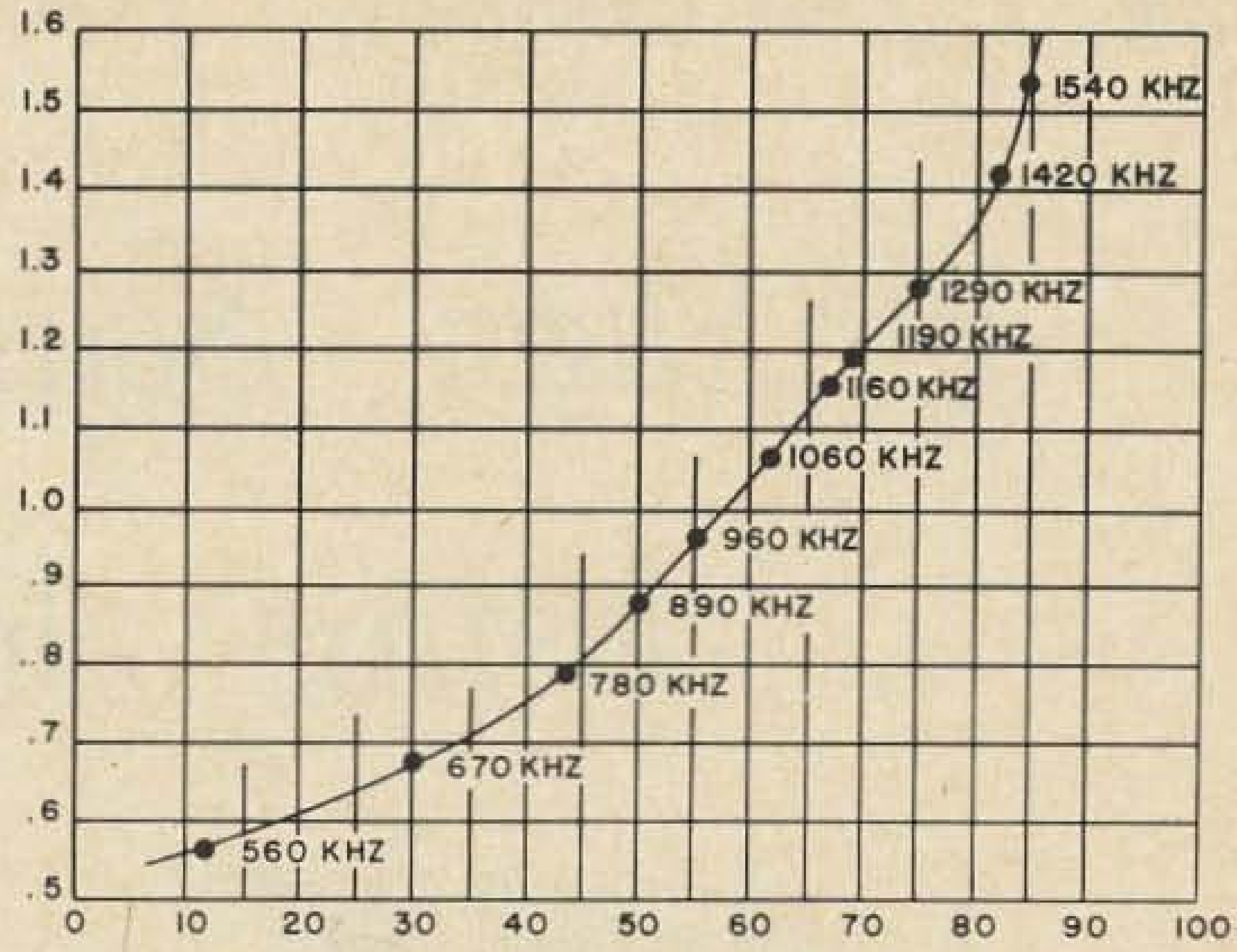


Fig. 2. Graph showing plotted calibration curve.

brew, all-band communications receiver used at K9STH will be listed. For simplicity only one band, the standard broadcast band, will be listed.

First the following stations were logged at the respective log positions on the dial:

Station	Frequency	Log Scale
WIND	560 khz	11.0
WMAQ	670 khz	30.0
WBBM	780 khz	42.0
WLS	890 khz	50.0
WSBT	960 khz	55.0
WHFB	1060 khz	61.0
WJJD	1160 khz	67.0
WOWO	1190 khz	69.0
WNIL	1290 khz	75.0
WIMS	1420 khz	82.0
WLOI	1540 khz	86.5

Next these positions were plotted on the graph paper per **Fig. 2**. The points were then connected with a smooth curve.

It will be noticed that a portion of the graph appears to be a straight line. This is what is referred to as the linear portion of the graph. By using only this portion of the tuning range, it is possible to achieve even marks on a dial such as in the Collins equipment, the new Heathkit equipment, and other pieces of amateur radio gear.

The only thing remaining is the final preparation and lettering of the dial. Some homebrewers type the figures in, others use decals or dry transfers; still others hand-letter. This I leave to the discretion of the individual amateur, for everyone has his own pet method which is just as good as the next. Good luck!

. . . K9STH/5

A Procedure for the Reception of Slow Scan Color Pictures Using Additive Synthesis

Ralph E. Taggart, WA2EMC
1109K University Village
East Lansing, Michigan 48823

The subtractive synthesis approach outlined by Cohen and Tarr (to be published) provides one method for producing slow-scan color pictures. At the same time these authors were experimenting with their process, I was investigating the use of additive synthesis and was fortunate enough to achieve results within a few days of their pioneering effort. Since Cohen and Tarr present an excellent analysis of both subtractive and additive color theory, I am confining this article to a simple description of the methods employed in my own experiments.

The camera used to produce the original color recording is similar to the one described by MacDonald (1965) except that it employs a conventional vidicon instead of the special slow scan type originally specified (Taggart 1968, Hutton 1969). Despite the fact that the 6326 vidicon used has a better spectral response than many other types, it was still found to be rather difficult to get good color separation when direct analysis was used. To bypass this problem, a conventional 35mm camera with Plus-X film was used in conjunction with the red, green and blue primary color filters to produce three color separation prints. One print represented the color pattern as seen through the red filter, another as seen through the green filter, and the last as seen through the blue filter. These black and white photos were then used with the slow scan camera to produce the analysis tape. Approximately ten frames of each print were recorded. The resulting tape now contains all of the information required to synthesize the picture and may be mailed, sent via landline, or transmitted over the air. The actual synthesis of the picture involves several discrete steps:

(1) The tape is played back through the monitor and a photograph is made of a red, a green, and a blue frame. A 35mm camera with Plus-X film is most convenient.

(2) The three negatives of the red, green, and blue frames are then used to make 4" x 5" positive transparencies. If Polaroid positive transparency film is available, these positives may be made directly from the monitor display.

(3) The positive transparencies are carefully superimposed and two pins thrust through the negative stack at points along the upper margin. These are the "key" points which will be used to assure exact registration of the finished image.

(4) The Polaroid camera is loaded with Polacolor film and securely mounted in relation to the negative frame (see Fig. 1). The "red" transparancy is then hung in place on the frame using straight pins in the key holes. The red filter is put in place and a

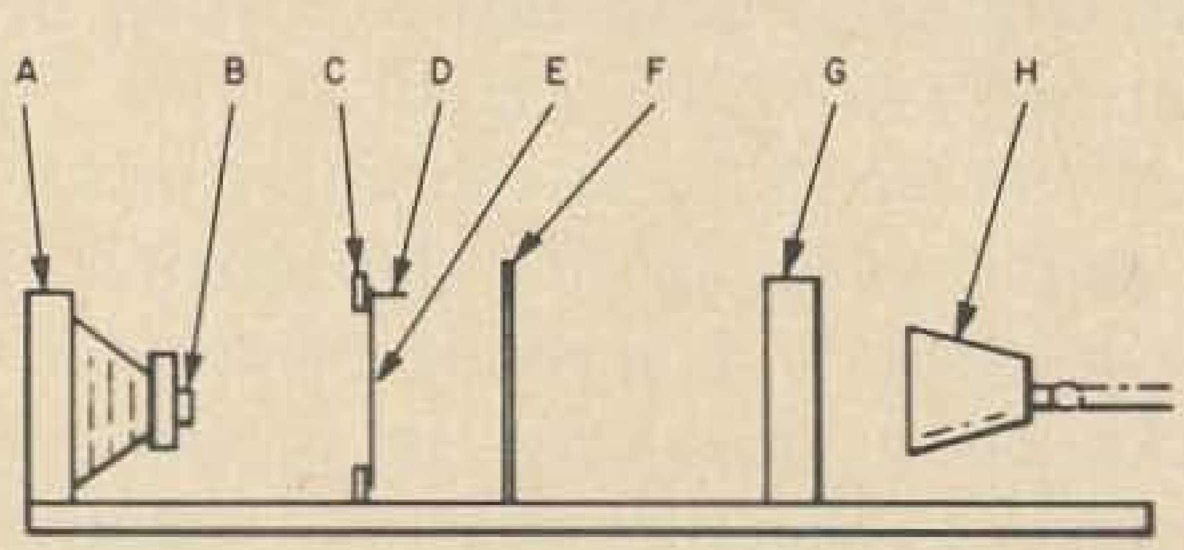


Fig. 1. Apparatus used at WA2EMC for final color picture synthesis. A—Polaroid camera with Polarcolor film. B—close-up lens. C—support frame for positive transparency. D—straight pin. E—positive transparency. F—ground glass screen to diffuse light. G—lucite cell for appropriate filter solution. H—tensor lamp. A and C should be mounted rigidly in relationship to one another so they do not shift between or during the multiple exposures. The distance between them will depend on the focal length of lens B.

single exposure is made on the film. Moving neither camera nor film, the red transparency and filter are removed and the green substituted. If the same pinholes on the frame are used to hang the green transparency, exact superposition is assured. The green exposure is then made and the entire process repeated for the blue transparency and filter.

(5) The Polacolor frame, now containing a three color triple exposure is then processed as directed. Small shifts in color balance may be achieved by varying development time – slightly short development emphasizes reds, while developing slightly longer then directed brings out the blues and greens.

Using the above procedure, no effort need be made to control the exposure time for each of the color exposures since this is done automatically by the camera electric eye. Large shifts in color intensity may be made by changing the density of the appropriate filter. I used the same filters for both analysis and synthesis. The filters consisted of lucite cells containing solutions of ordinary household food colors. The use of dye solutions allows ready manipulation of filter density.

All in all, the additive procedure provides a flexible method of picture synthesis with a minimum of darkroom equipment. The use of Polacolor film in the final stage allows the results to be seen immediately and an acceptable print is usually possible after only a few test exposures. If Polaroid film is used throughout, the total time from picture readout to a finished color print can be as little as a few minutes. This additive procedure and the subtractive synthesis of Cohen and Tarr provide a relatively broad base for further experimentation with this interesting mode.

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A Remote VFO for the HW32A

Mohammed Rafiq Khan AP2MR
Village Pandik
Haripur Hazara, West Pakistan

If you have an HW32A transceiver and wish to make a versatile remote vfo for it with minimum expense, read on!

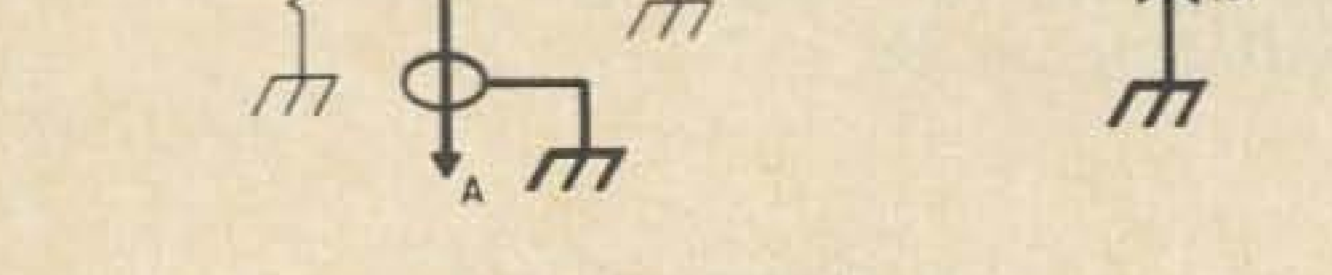
Some time ago I was fortunate enough to acquire an HW32A transceiver. This was my first introduction to SSB. The frequency range of the transceiver was changed so that the transceiver covered 14.10 to 14.25 mhz. After spending a number of enjoyable months on SSB, it was felt that a remote vfo for the transceiver would be very desireable specially for working split-frequency into the American phone band.

My friend, HB9TL, had already made some changes in the HW32A for me, for crystal-control of transmit frequency. But this mode of operation was not very flexible and the receive and transmit frequencies had to be close together. Nevertheless the changes done by HB9TL provided the ground-work.

After some experimentation the transceiver circuit was changed as shown and an external vfo was constructed as shown in **Fig. 2**. The circuit of the external vfo is straight-forward and as a matter of fact, any stable (tube) vfo giving enough output and being tuneable over 1.62 to 1.92 mhz may be used.

A 9-pin socket should be installed on the back apron of the transceiver and wired up as shown in **Fig. 1**. Modifications are shown in bold line. The changes in the transceiver circuit board involve:

1. Interchanging the physical position of R142 with C134.
2. Cutting of the printed circuit at a point between C134 and R142. This can be done with a sharp knife and care must be taken not to damage the circuit board.



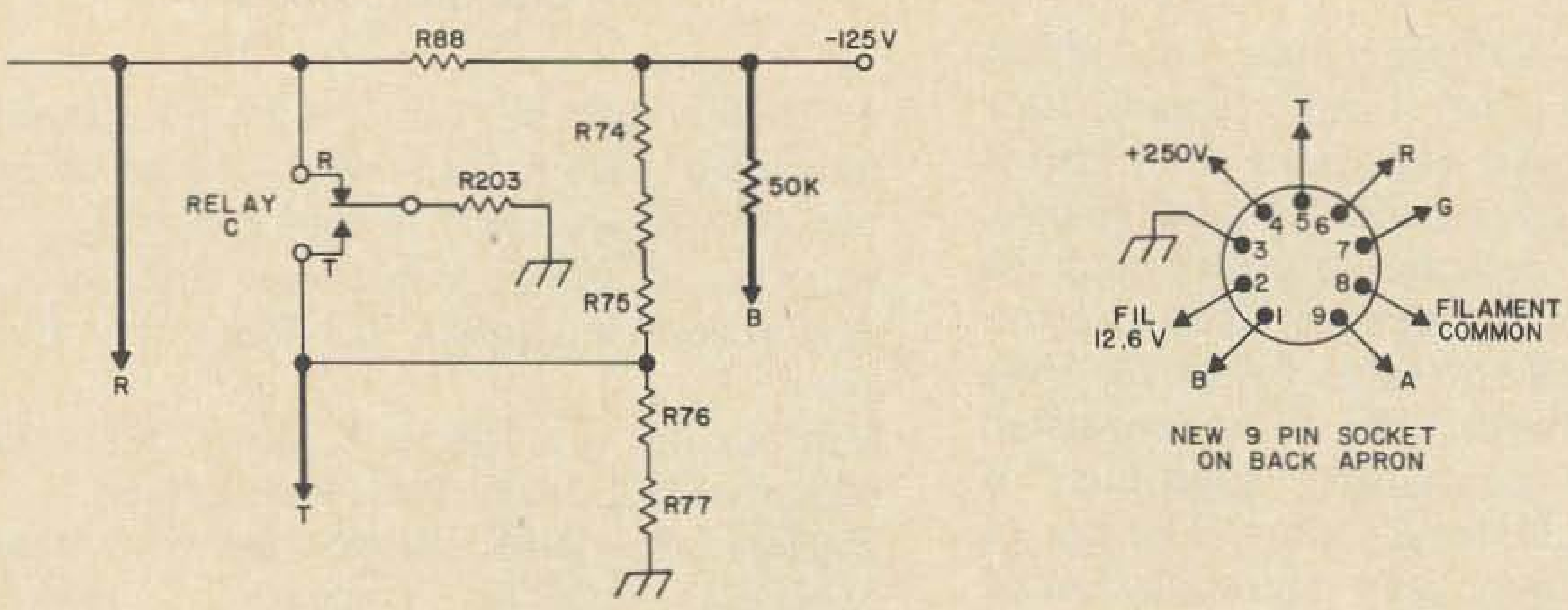


Fig. 1. Modifications to the circuit of the HW32A (shown in bold lines).

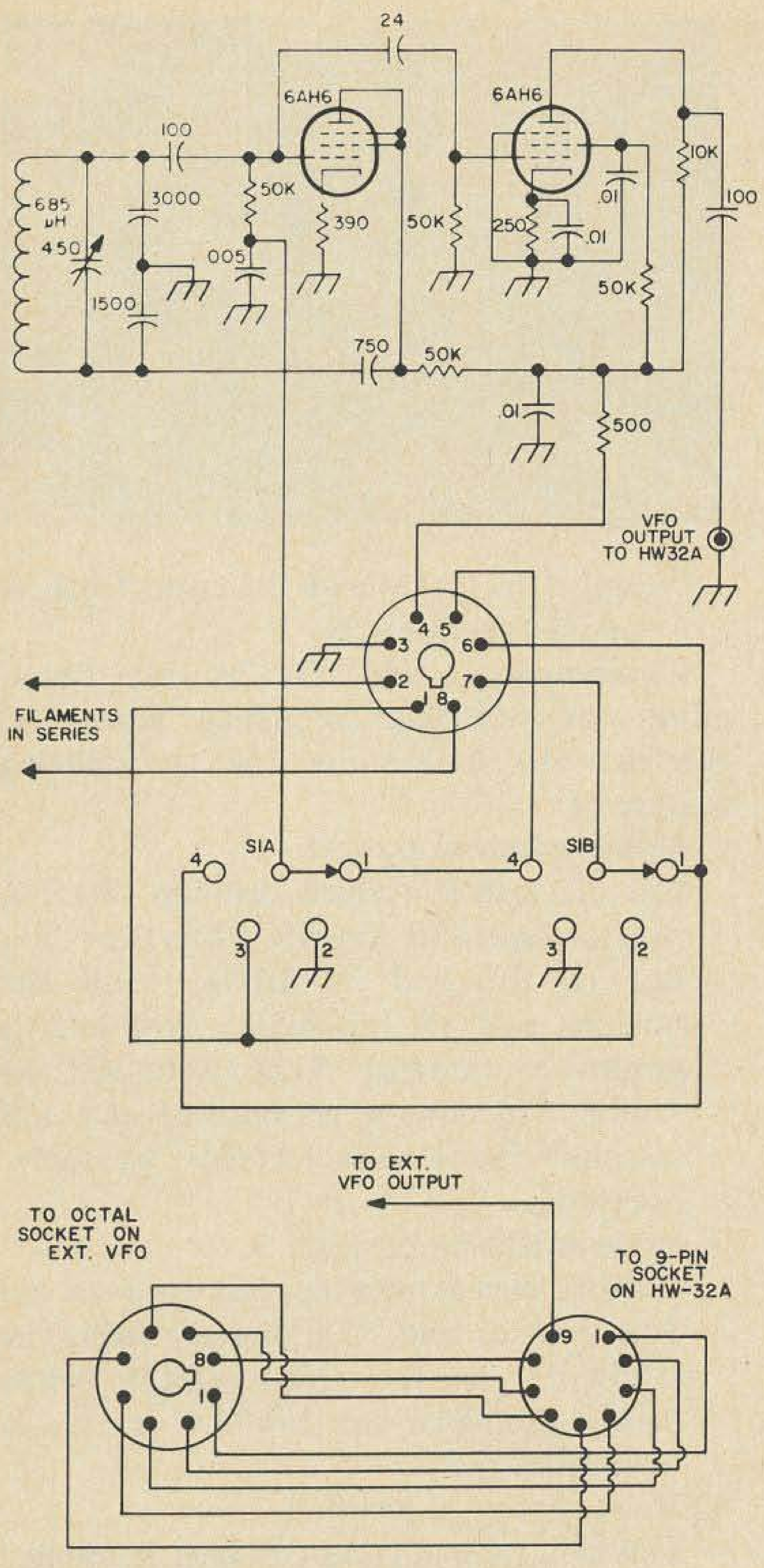


Fig. 2. External vfo and interconnecting cable.

3. Bridging the gap in the circuit board between C134 and R142 with a 100 pf mica condenser.
   These changes are shown in **Fig.3**.

The 4 position switch in the remote vfo provides the following modes of operation:

1. Receive on HW32A vfo and transmit on remote vfo.
2. Transceive on remote vfo.
3. Transceive on HW32A vfo.
4. Receive on remote vfo and transmit on HW32A vfo.

The remote vfo has been tried out with the HW32A with a frequency differential

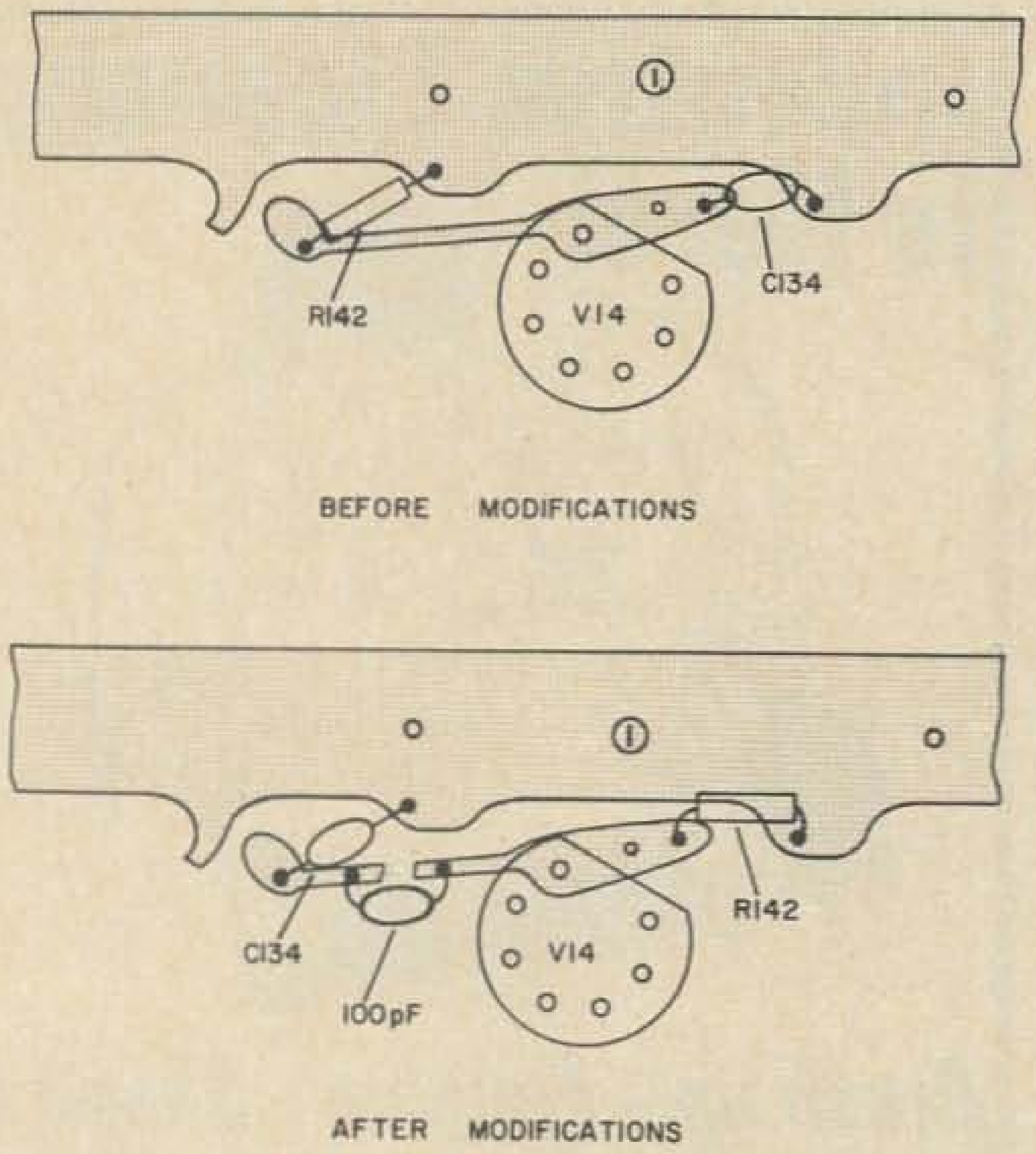


Fig. 3. Circuit board modifications.

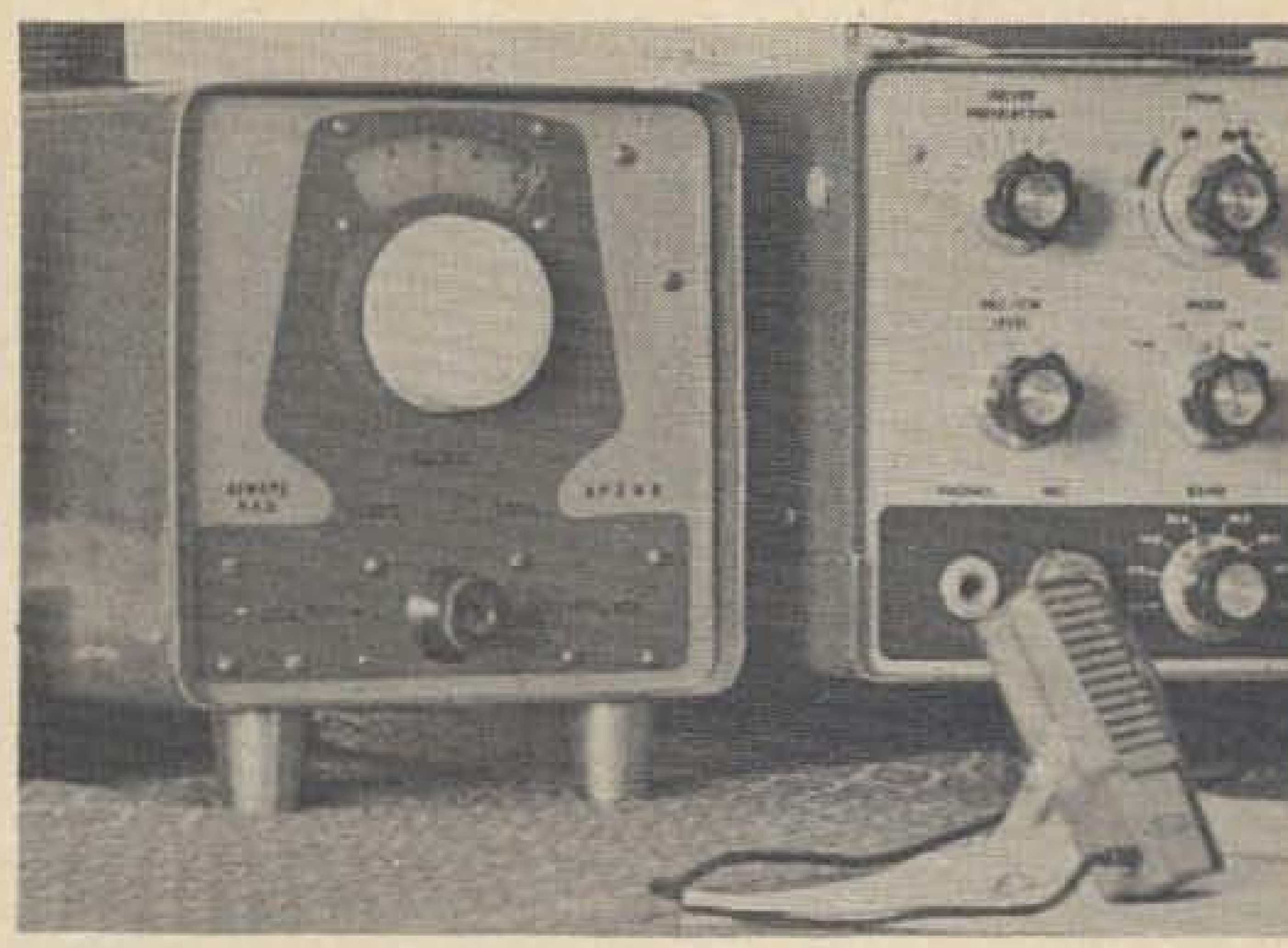
of 150 khz without any noticeable degradation in the signal strength. Apart from the flexibility of being able to work split frequency or transceive, the remote vfo makes it possible to use the whole band from 14.00 to 14.35 mhz as against the 150 khz allowed by the HW32A.

It might be necessary to re-calibrate the HW32A vfo by decreasing the vfo trimmer (C1318) capacitance a little. Even if it is not done, the capacitance introduced by the remote vfo does not change the calibration appreciably.

Unfortunately no photos of the inside of the remote vfo can be given as it has already been dismantled and is being converted into a companion remote vfo for the HW100, the new station rig. A photo of the outside is given showing the home-brew dial and the position of the mode switch.

Operation of the remote vfo is as follows:

1) Mode switch in position 1.
   a) While receiving approx. -50v, cut off bias is applied through relay C and S1A to the grid of the external vfo tube, 6AH6, and at the same time the cut off bias on the HW32A vfo tube, 6AU6, is removed through relay C and S1B.
   b) While transmitting cut-off bias is applied to 6AU6 and the cut-off bias is removed from 6AH6.



Consequently the HW32A vfo determines the receiving frequency while the external vfo determines the transmitting frequency.

2) Mode switch in position 2.
   Cut off bias is applied through the 50K resistor and S1B directly from the -125v line to the grid of 6AU6, while the bottom end of the 6AH6 grid leak is grounded through S1A, and so the remote vfo determines both receive and transmit frequencies (remote transceive operation).
3) Mode switch in position 3.
   Cut off bias is now applied through the 50K resistor and S1A directly from the -125v line to the grid of 6AH6 while 6AU6 oscillates for HW32A transceive operation.
4) Mode switch in position 4.
   a) While receiving cut-off bias is applied through relay C and S1B to 6AU6 grid and the external vfo (6AH6) is operating.
   b) While transmitting the cut-off bias is applied to 6AH6 through relay C and S1A and the HW32A vfo (6AU6) is operating. That way HW32A vfo takes over while transmitting and external vfo while receiving.

From the above description it can be seen that all switching is done by the already existing vox relay of the HW32A. No switching of the circuits carrying rf is involved. The four position switch in the remote vfo merely selects the mode of operation.

. . . AP2MR

Clifford Klinert WB6BIH
520 Division Street
National City, CA 92050

Cheap and Simple for Six

Here is a six-meter converter that has been designed for maximum simplicity and low cost. It uses three vhf bipolar silicon transistors in the common *rf* amplifier-mixer-oscillator arrangement. Surplus switching transistors were used to provide low cost, but if parts are bought new, transistors designed for use in FM broadcast receivers can be used. If the parts are bought new, it should be possible to build this converter for $12 or $13. Since the crystal makes up almost half of this price, a surplus crystal can cut costs considerably.

The Circuit

50 mhz signals from J1 are coupled to the base of Q1 by L1 in **Fig. 1.** D1 and D2 help to prevent burnout of Q1 when the voltage across L1 exceeds about 0.2 volts. Q1 is a neutralized common emitter amplifier. The 10 pf capacitor from L2 to the base of Q1 and the 560 pf bypass on L2 provide neutralization. These values are determined by experimentation. L2 couples the collector of Q1 to the base of Q2, the mixer. Q3 is a Peirce overtone oscillator which is also coupled to the base of Q2 through Cx. The 50 mhz input signal and the 49 mhz oscillator signal are mixed in the mixer to produce the difference frequency of 1 mhz in the output at J2. The *rf* choke in the collector of Q2 is used to avoid using another tuned circuit here. The gain is ample without any effort to match impedances. If a crystal other than 49 mhz is used, only L3 need be changed to provide for the different output frequency.

Construction

Fig. 2 shows the printed circuit board layout and parts placement. If you have done a lot of PC board work, you will

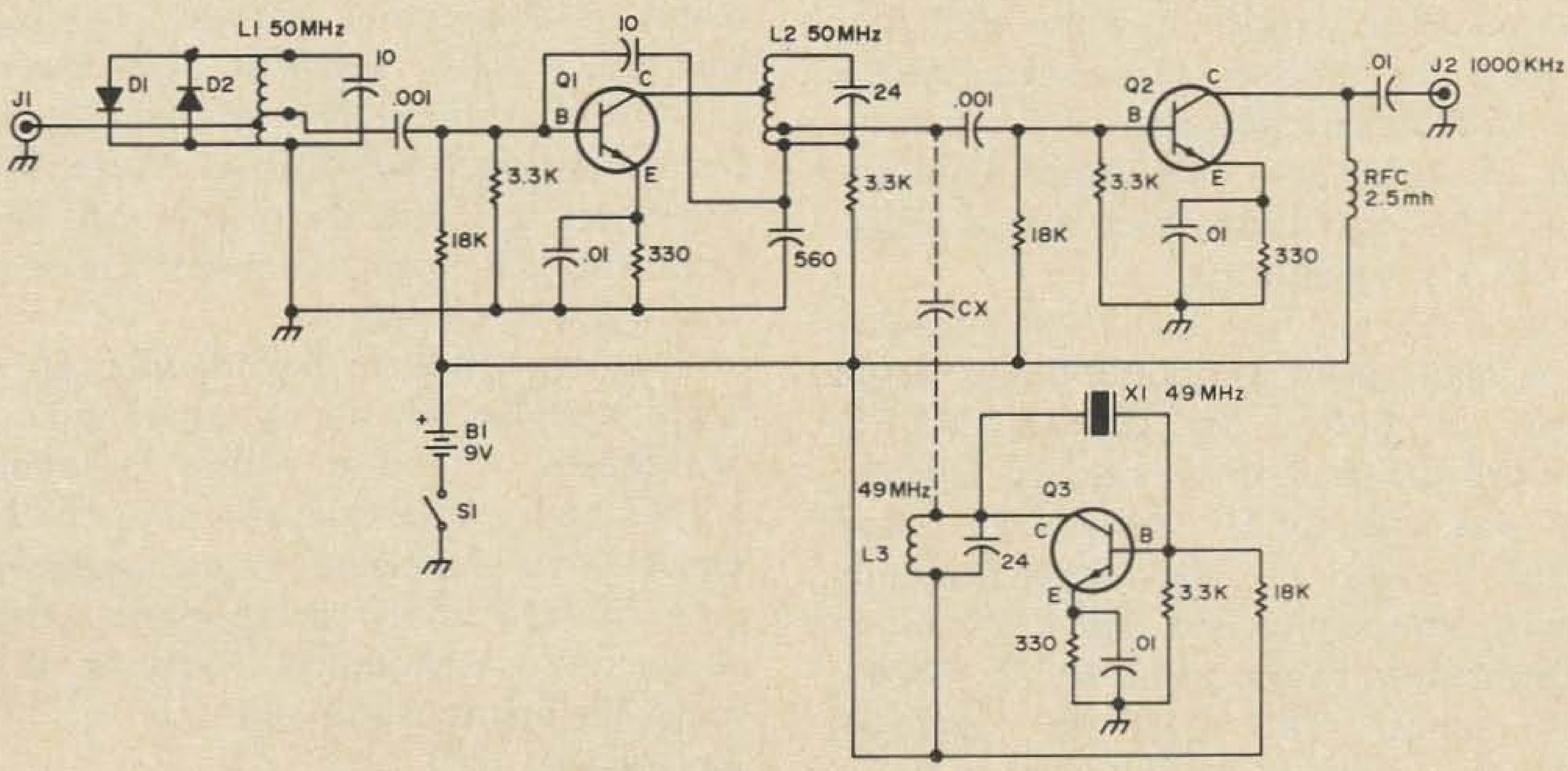


Fig. 1. Six meter converter schematic. Refer to the text for unmarked components.

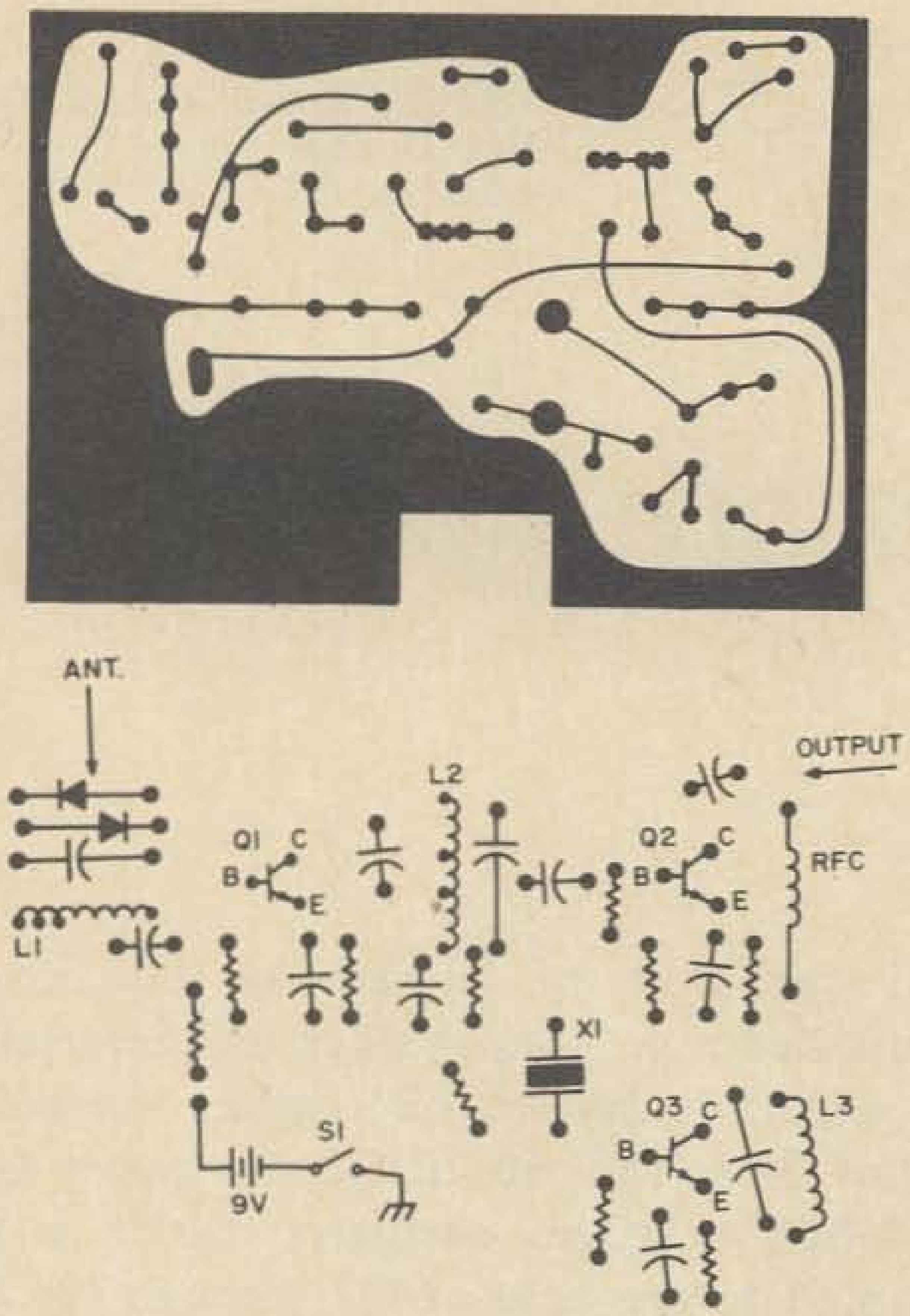


Fig. 2. Printed circuit board and layout. Refer to Fig. 1 and text for parts values.

probably want to use a printed circuit board for your converter. Once the layout is determined, making the board and soldering the components is easy. However, the initial cost of a good printed circuit board kit is high, and would probably not be desired for just one project. Perforated board is available if you decide not to use a printed circuit board.

The next thing to worry about is winding the coils. The wire is enamel covered and about No. 21 in size. The coils are wound on a pencil which is removed after winding. L1 is thirteen turns tapped at three and four turns from the bottom. J1 connects at the third turn from the bottom. L2 is ten turns tapped at three and four turns from the bottom. The fourth turn goes to the collector of Q1. L3 is nine turns.

Diodes D1 and D2 are 1N34A's. Some type of high speed switching diode would probably be better, but the 1N34A was available at the time. In the original version a 2N708 was used for Q1, and 2N917's were used for Q2 and Q3. They were randomly selected from the junk box, but if transistors are bought new, I suggest the 40242, 40243, 40244 series. The 2N3478, 2N4259, 2N706A, or almost any other vhf silicon NPN transistor could also be used. The stable bias circuit will allow for changes in transistor characteristics.

X1 is a 49 mhz overtone crystal. Other crystals in the 40 to 50 mhz range were tried with equal results. If the 49 mhz frequency is used, output from the converter will be in the AM broadcast band, making the converter usable as a mobile receiver with a car radio. Cx is the coupling capacitor from the crystal to the mixer. It consists of two pieces of hookup wire twisted together to form a gimmick capacitor, and it is soldered on under the printed circuit board. The wires can be about one inch long.

The board is mounted in a 4 by 3 by 2 inch aluminum box. A shielded box is recommended to help prevent *if* signals from going through the converter directly to receiver. The board is mounted with solder lugs soldered to the grounded outer foil of the PC board. The other end of the solder lug is bolted to the side of the box. A total of four solder lugs is used for this.

S1 is a d. p. d. t. slide switch. Any small switch will work here so long as it will fit into the box. If the switch were mounted differently, or a different switch were used, the cut out in the circuit board might not have been necessary. The battery mounting problem is the next segment of the construction. There almost wasn't enough room for the battery. The battery is of the standard nine volt transistor radio type, and was mounted with a small dab of glue on the inside of the aluminum box. Battery holders are available, but are expensive and take up space. A connection between the battery and the circuit board is still necessary, however. For about 13 cents you can buy a connector which will fit the battery. Be sure you check the polarity of the leads coming from the plug; the color of the leads is sometimes confusing.

The last things to be mounted after the board is in the box are the input and output connectors. I used a phono jack for the output and a BNC connector for the input. These items happened to be available and they fit well in the small space. After the connectors are mounted it may be difficult to get the board in and out.

Alignment

A grid dip meter is required for tuning

the converter. First check for output from the oscillator coil, L3 at the crystal frequency. If output is not detected, the coils can be tuned by a process called "knifing." The knife is made of a non-metallic tuning wand or other kind of insulated shaft. A small brass slug is attached to one end and an iron ferrite slug is attached to the other end. The brass slug can be obtained from a brass bolt, and the iron slug can be removed from a slug tuned coil form. When the brass end is inserted in a coil the inductance of the coil will decrease and the resonant frequency will be higher. The iron slug will lower the resonant frequency of the tuned circuit. By using this method and watching the output, you can determine whether the coil should be compressed to lower the frequency, or expanded to raise the frequency. Be sure to use a weak signal for final tuning. The tuned circuits should be close enough to the proper frequency for the converter to work before any tuning is done. The tuning should be rather broad and noncritical.

Results

When used with a good receiver the sensitivity of the converter is very good, and the leakage from a Heathkit signal generator with the output at zero almost pins the S meter of the receiver. The main disadvantage of using bipolar transistors is cross modulation. A nearby FM broadcast station can be heard at spots on the dial. There is also some feedthrough into the converter *if* frequency. In this case, however, six meter signals, ignition noise, and power line noise have usually been stronger than the spurious signals. Changing the *if* output frequency by changing the crystal frequency might relieve the problem of BC feedthrough, but it is mainly a problem of shielding the leads from the receiver to the converter. Using an FET for Q2 would improve the cross modulation characteristics of the converter, but would increase the cost.

This converter was built with the idea of saving money. If you have a well stocked junk box and an afternoon or two, it shouldn't cost more than a few dollars to throw it together. Considering the cost and the time spent on this project, I feel that it has given more than adequate results.

. . . WB6BIH

Carl C. Drumeller, W5JJ
5824 N.W. 58th Street
Oklahoma City, Oklahoma 73122

The Mismatched rf Transmission Line

The matter of just how well a transmission line transfers power from a radio transmitter to a load, when that load is not matched to the transmission line, has been debated for many years. Few people feel certain that they know just what occurs. The amazing part of it is that very few radio amateurs have taken the trouble to set up a carefully controlled experiment to determine empirically the facts of the situation.

To settle this question, I built a setup to determine just what happens to radio frequency power sent over an unmatched transmission line. What I wanted to find out from this experiment was what happens to the power that leaves a transmitter and flows along a transmission line to a load that was not matched to that transmission line. How much power actually reached the load? What is the effect of this mismatched line on the tank circuit of the transmitter? And what is its effect upon the vacuum tube in the final amplifier of the transmitter?

To determine just what happened, I first built a source of 25 mhz power, carefully designing it to minimize harmonic output. It started out with an oscillator-tripler driving an amplifier on 25 mhz; this was link-coupled to another amplifier on 25 mhz. The second amplifier had a pi network in its output, which matched it to a 52-ohm transmission line going to a tuned grid tank circuit in the final amplifier. This final amplifier was grid-neutralized so that another pi network could be used in its output circuit. It used a triode tube, an Hk-254. I selected this tube because it is designed to run a shade of red during normal operation. Any overload will cause it to blush up to white-hot in a matter of seconds, yet it can stand this overload for quite some period of time. In other words, it is a very rugged tube that can stand a heavy overload yet still show visual evidence of even a slight overload. To keep harmonic generation at a minimum, only 1000 ohms of grid leak bias was used. The remaining bias was taken from an adjustable supply and was set for operation in the Class AB_2 region. With a harmonic-free source of 25 mhz power available, I was ready to conduct the experiment.

The first portion of this experiment was with a 300-ohm open-wire transmission line. I selected a length that was not a multiple of quarter waves. The purpose of this, of course, was to avoid introducing any repetitive or inverting phenomena. To measure *rf* power at the end of the 300-ohm transmission line, I used a termination consisting of two 150-ohm non-inductive resistors and a 0 to 1 radio frequency ammeter. (See **Fig. 1** for the layout.) These

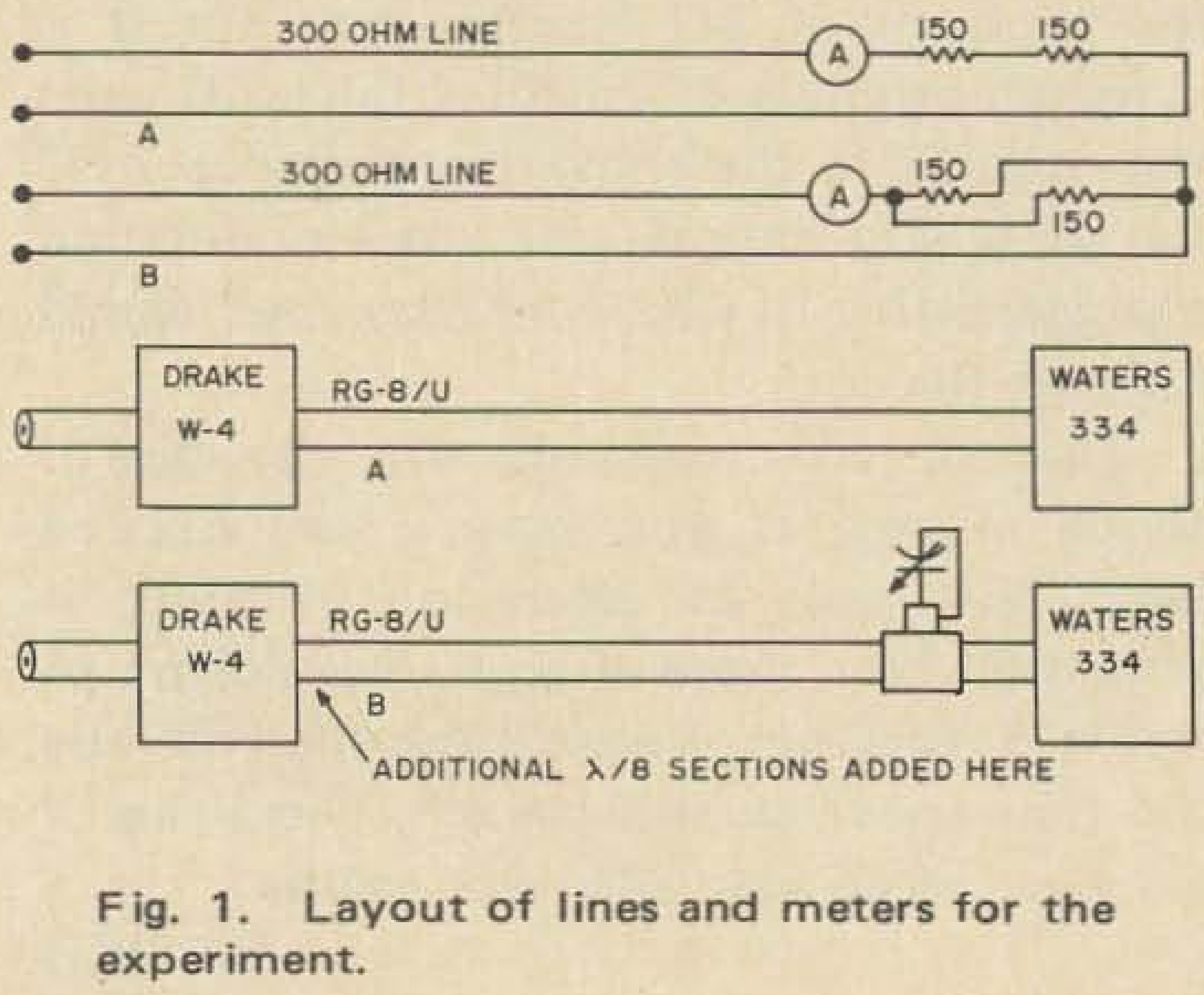


Fig. 1. Layout of lines and meters for the experiment.

two resistors could either be connected in series for a matched 300-ohm termination or could be connected in parallel for a 4 to 1 mismatch (75 ohms). This mismatch, of course, would result in a voltage standing wave ratio of 4 to 1.

With this done, I took a series of readings. First I loaded the transmitter to 165 watts input (125 milliamperes at 1325 volts). With the 300-ohm termination I measured 0.4275 A current which, by I^2R, indicated approximately 68 watts *rf* load. Note this was a matched load. I made note of the color of the plate of the HK-254. Next, I connected the two 150-ohm resistors in parallel, resulting in a 4 to 1 mismatch, and returned and reloaded the transmitter to exactly the same power input. Under this condition, I measured the current as 0.96 a. This also gave 68 watts *rf* power delivered to the load. The HK-254 showed the same color as with the matched load. The results show beyond doubt that the actual radio frequency power delivered to the termination is precisely the same even though there is a mismatch of 4 to 1 (a voltage standing ratio of 4 to 1) on an open-wire transmission line!

After having demonstrated this to my own satisfaction, I repeated the demonstration at a hamfest held at Lake Texoma (between Oklahoma and Texas) in fall of 1968. This demonstration aroused considerable curiosity and also raised the question of what would happen if one were using coaxial transmission line. That suggested the next segment of the experiment, which was presented as a demonstration before the Aeronautical Center Amateur Radio Club early in 1969.

The second portion of the experiment, involving a 52-ohm coaxial line, used a Waters 52-ohm wattmeter as the termination and a Drake *rf* forward and reflected power meter to measure power and VSWR at the transmitter's output. (Fig. 1 shows the set up.) Again I selected a length of transmission line that was not a multiple of quarter waves. In the initial tune up, I adjusted the transmitter to deliver 80 watts to the load, which required 150 ma plate current. This 80 watts was shown both by the Waters wattmeter and by the Drake forward and reflected power meter. (No reflected power, of course.) For the next portion of the experiment, I placed a variable capacitor in parallel with the Waters wattmeter, and adjusted the capacitor until I had a 4 to 1 voltage standing wave ratio on the line. I returned and reloaded the transmitter to 150 ma plate current. The Drake forward and reflected power meter now showed 130 watts forward power and 50 watts reflected power. Note that the increase in forward "power" is exactly equal to the reflected "power." In each instance, this "power" is fictitious, properly measurable in terms of "volt-amperes-reactive" instead of true (or work-producing) watts. The Waters wattmeter now showed 78 watts, a drop of 2 watts from the theoretical 80 watts which would have been present if there had been no losses. At this frequency (25 mhz, which is near the high end of the amateur High Frequency bands), the loss in a transmission line with a VSWR of 4 to 1 was only 2 watts out of 80. To make sure that this was not a freak condition based upon a length of transmission line, I added 1/8 wave length sections of coxial line in two stages, taking complete readings with the addition of each section of line. This did not in any manner change the VSWR shown by the Drake meter or the power delivered to the Waters wattmeter (after returning and reloading to the original power input, of course). In each instance, the HK-254 showed the same color as with the matched load.

What about the effect upon the radio frequency tank of the final stage? There was no effect. The coil did not heat up and.the capacitors did not flash over. When I built this radio frequency power generator, I designed the plate tank circuit of the final amplifier to be quite flexible. This means that I used an input capacitor which would give a quite wide tuning range, and I used an output capacitor for the pi network large enough to cope with a wide range of impedances. These two things are necessary, because with the high voltage standing wave ratio and with a variation of transmission line length, the impedance presented to the output of the pi network may range over very wide limits. This necessitates a wide range of flexibility. In each instance I was able to reresonate the plate tank circuit correctly and to reload it to precisely the same power input it had with a purely resistive (and correctly matched) load at the end of the transmission line.

What about the effect upon the final amplifier tube? As noted before, I used a tube that was very sensitive to any overload. Its plate would flare white-hot with the slightest maladjustment. In each case, when the plate pi network was returned to resonance and loaded to show the same power input, the tube visually indicated precisely the same amount of plate dissipation. This clearly shows that there was no extra load upon the final amplifier tube.

The conclusion from this series of experiments is that the effect upon a transmitter caused by working it into a transmission line having a 4 to 1 VSWR is indeed very small. Such a practice does, however, require that the tuning circuit in the output of the transmitter be quite flexible in order to match the wide range of impedances which may be presented to the transmitter. If this impedance matching capability is adequate, the vacuum tube (or tubes) in the final amplifier always will see a pure resistive load of the proper magnitude for optimum operation. They then will function in every manner just the same as they would if the transmitter were loaded into a proper-sized dummy load.

The findings of these two experiments leave unanswered the vivid questions in the minds of those who have had unpleasant experiences with transmitters connected to transmission lines having high VSWRs. Why will some transmitters load when others won't? Why will changing the transmission line length sometimes enable loading to an otherwise nonresponsive line? Why does the output capacitor of some transmitters flash over when the VSWR is high?

These are all valid questions. Each has a straight-forward answer, one compatible with the findings of the experiments. To answer these questions, it is first necessary to review a modest bit of transmission line theory, just to ensure a common point of understanding.

What happens along a transmission line, reaching from a transmitter to a load (antenna or otherwise), can be described in terms of watts, volts, and amperes . . . or, if you prefer, power, potential, and current. You are interested, primarily, in power; specifically, in power that reaches the load (antenna). All transmission lines have some loss. The transmission lines generally used by radio amateurs, unless inordinately long, have quite low losses when used in the High Frequency spectrum (3 mhz to 30 mhz). These low losses can become somewhat higher when the VSWR on the line becomes high. What is "high"? Most antenna specialists, those engineers who know whereof they speak, will tell you that in the HF band transmission line is constant (neglecting the very minor difference between sending end power and receiving end power that is attributable to actual losses, all dissipated as heat, in the transmission line), the relationship of voltage and current is constant only when the line is terminated in its characteristic resistance. Most transmission lines are not. And this is where we get our interest in VSWRs. Those changing relationships of voltage and current can result in three things that interest us greatly. At a point where the current is high and the voltage is low (the IE product remains constant, remember), some precious *rf* power is lost in the form of heat; the center conductor of the coax line has *some* resistance, and I^2R tells us the amount of power we're losing to heat. At the point where the current is low and the voltage is high, we lose some more power by way of dielectric heating; E^2R tells us how much. As mentioned before, these two losses are so small as to cause us no concern. Matching the impedances, though, that are presented at such points may be difficult. A point on a transmission line where the current is low and the voltage is high represents a high-impedance point. With a pi network, matching this sometimes results in a flashover between the plates of the output capacitor.

The third item, though, can give us much concern. It is the sending end impedance presented by the line. This impedance would be the characteristic impedance of the line if that line were terminated in its characteristic impedance. It seldom is. When it isn't (99.9999% of all instances), the impedance seen at the sending end of the transmission line is dependent upon three variables: The frequency in use, the (electrical) length of the transmission line, and the impedance presented by the antenna at its feedpoint. You see, if you change the frequency of your transmitter one hertz, the impedance it looks into changes. Not much. But some.

You should keep in mind that the *electrical* length of your feedline is changed every time you change the frequency of your transmitter . . even one hertz. That electrical length is important.

Let's consider an example. Just to make things simple, let's say the feedpoint impedance of your antenna remains constant. (It doesn't, unless you're one of the one-in-a-thousand amateurs who uses a frequency-independent antenna.) And to make things even more simple, let's say your antenna presents a purely-resistive impedance to its feedline ... no capacitive reactance, no inductive reactance ... a highly-unlikely situation itself. Let's say too, that this resistance is four times the feedline impedance. Now, under even this hyper-simplified situation, as the effective (electrical) length of the feedline is varied (by changing frequency or by any other means), the sending end impedance will vary. If we were dealing with a 50 ohm line, the sending end impedance could be 200 ohms purely resistive, or it could be 12.5 ohms purely resistive. Or, more likely, it could be any value of resistance between those extremes plus some value of inductive reactance or minus some value of capacitive reactance.

This, then, is the prospective situation that causes the big arguments between the Engineering Design Division and the Marketing Division in manufacturing plants. The engineers would like to turn out a product they'd not be ashamed of, one that could cope with almost any sending-end impedance likely to be found at a transmission line. (No sane engineer hankers to tangle with the design of an output circuit that would match any random-length end-fed antenna ... and still satisfy FCC requirements for attenuation of spurious radiations.) The Marketing Division, however, has dollar signs dancing before its eyes. Versatility costs money. That extra cost gives competition a telling advantage. And amateurs have been conditioned to buy transmitters that'll cope with a 2 to 1 resistive (no nasty reactance) mismatch between feedline and antenna. So why commit financial suicide? All of this is good, sound logic. Look over the specifications of any transmitter on the amateur market, and you'll see who wins the arguments.

Now let's return to the verifications presented by the two experiments demonstrations. Here are the main points:

1. With open-wire feedlines, losses in the HF band resulting from VSWR of 4 to 1 are so low as to be unmeasurable.
2. With 52-ohm coaxial feedlines, losses in the HF band resulting from a VSWR of 4 to 1 are so low as to be wholly negligible.
3. With an output tank circuit capable of being tuned to resonance and loaded to the desired input power, the plate dissipation of the power amplifier tube is not adversely affected by a VSWR of 4 to 1.
4. The length of the transmission line, within any reasonable limits, has no bearing upon the VSWR or upon the power delivered to the load (antenna).
5. The electrical length of the feedline is highly important in determining the sending-end impedance of a feedline not terminated in its characteristic impedance.
6. The most important thing to consider is whether the output tuning circuit of your transmitter will cope with whatever impedance your transmission line presents to it at your operating frequency. If your transmitter will tune to resonance and will load to the desired DC power input, use it. Don't pay any attention to the VSWR. As long as your transmitter is "happy" (tunes as above), you can be happy, too. No harm will come to your transmitter by operating it under these conditions.

My thanks to William O. Todd W5UZX, for his help with the demonstrations.

. . . W5JJ

BKX Bridge

Paul White W6BKX
63 Homestead Boulevard
Mill Valley, CA 94941

Have you ever wanted to know how much reactance your antenna has and in which direction? Here is a radio frequency bridge, modeled after the General Radio 916-A that will do just that. It will tell you not only the resistance but the capacitive or inductive reactance of the circuit. Resistance is read directly in ohms regardless of the frequency of measurement and the reactance reading will be dividied by the frequency of measurement in mhz.

No attempt is made to give every little dimension because most of the parts that you will use will be from the junk box. Old broadcast variables, tin cans, etc., but you will be able to duplicate this bridge so that it will be a useful instrument with good accuracy.

Study the diagram and drawings until you understand how everything is wired and constructed.

The BKX bridge is built in an old Australian signal generator box that is lined with brass. Build the bridge with enough room for the mounting of the transformer. My box is a little too small and the transformer is mounted on a stilt right up against the box shield. Photo No. 2 and **Fig. 6** show the exploded view of the transformer. Some dimensions are given so that you can duplicate it as closely as possible.

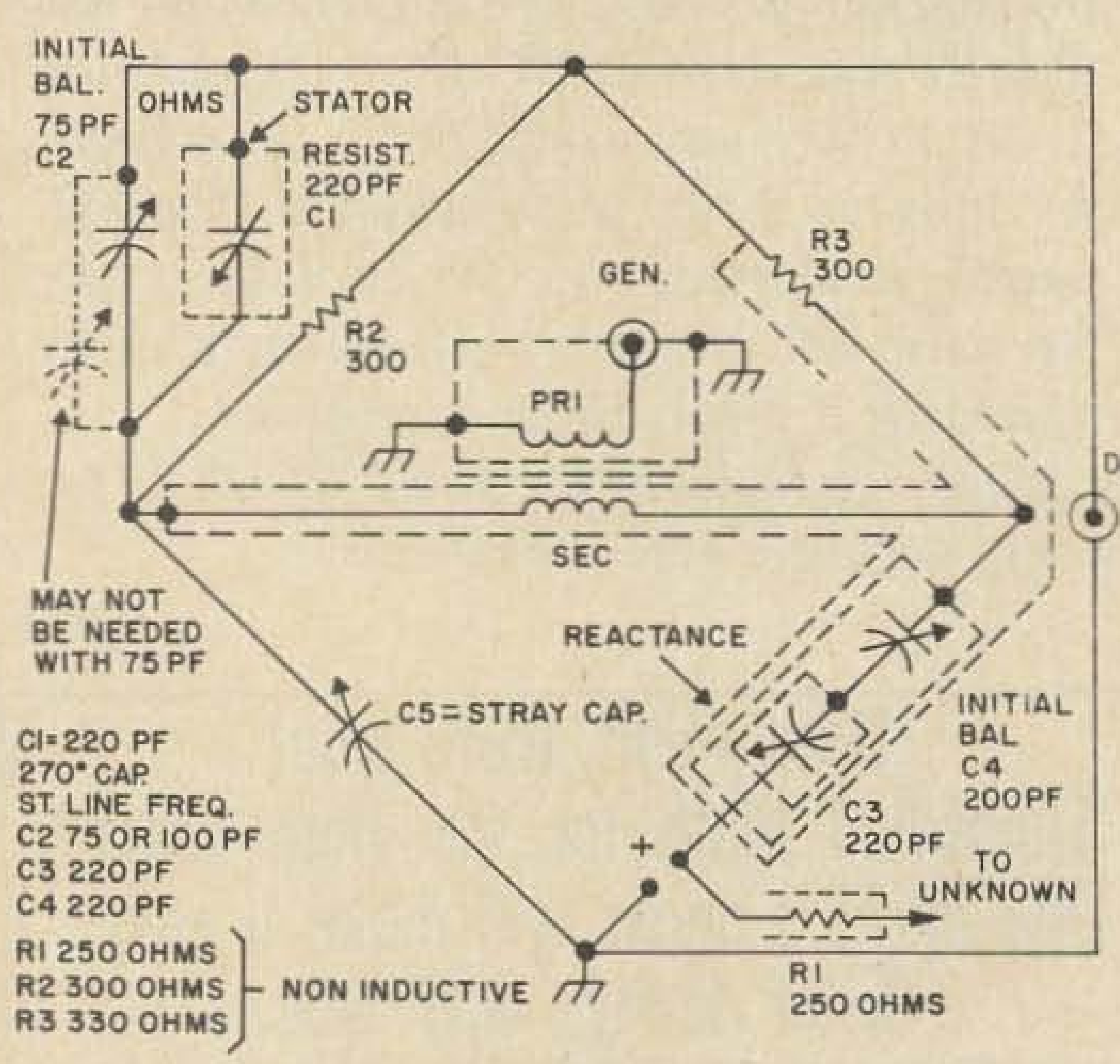
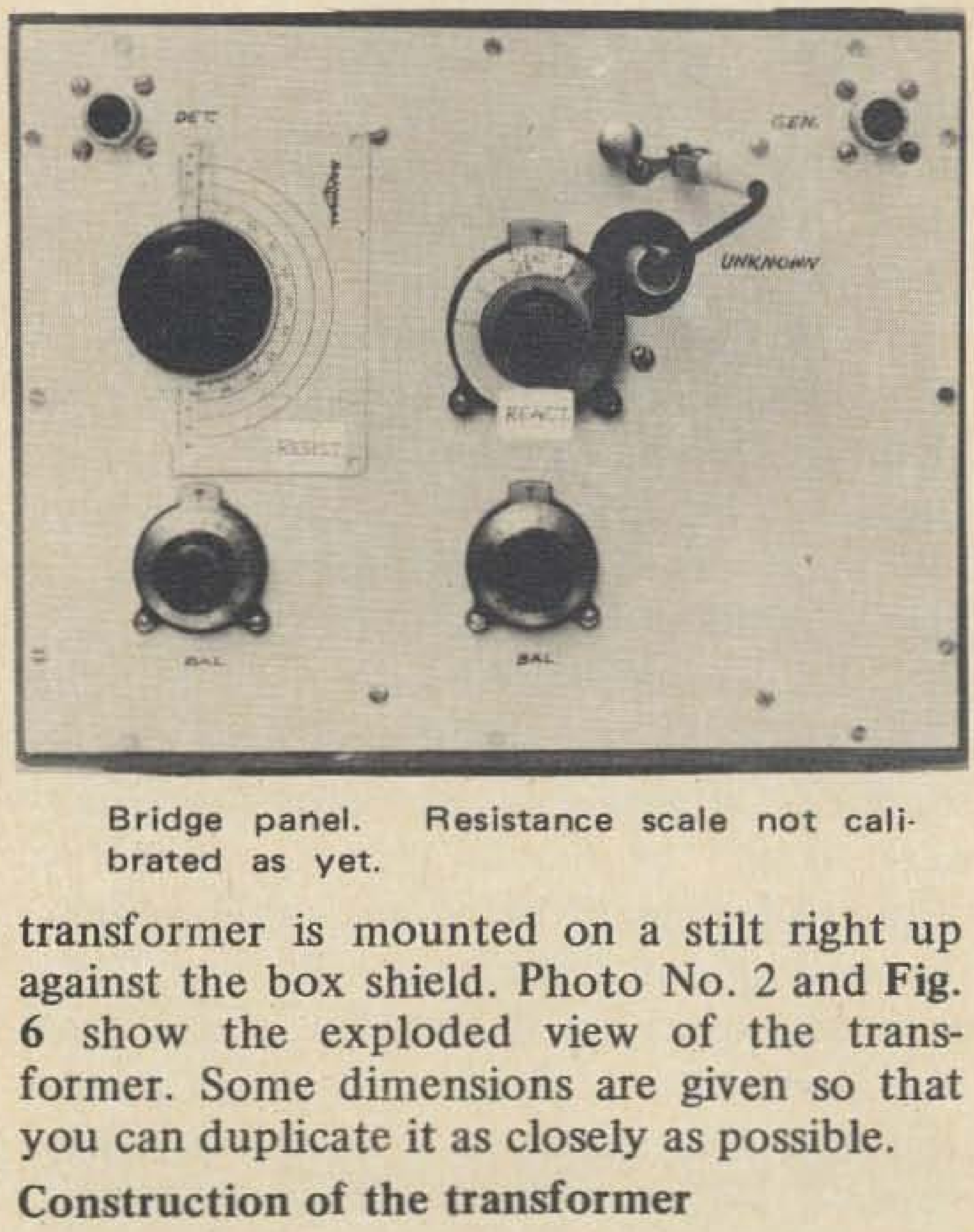


Fig. 1. Diagram and parts list.



Bridge panel. Resistance scale not calibrated as yet.

Construction of the transformer

Start with the inside coil form. Cut the brass foil in the shape indicated in **Fig. 6.** Use masking or plastic tape to insulate the ends about ¼ inch. The length of this piece is cut to go around the form with about 1/8 inch overlap. Fill the space with No. 20 hook-up wire. Solder one end of the winding to the foil, the other to the center conductor of the single conductor shielded wire. Lay in the outside foil with the one insulated end over the other insulated end and bend over the tabs and solder. The lead should be opposite the slit. Slip the 2½" pipe with the slit over and insert spacers so that the two do not touch. Solder the braid of the shield to this pipe. Keep all slits on the same side. Slip on plastic sleeve or spacers. Make reactance coil the same as the other. Insulate the brass tube with a slit using plastic or masking tape. Solder the lead-in, tabs, and slide the assembly over the first coil. The

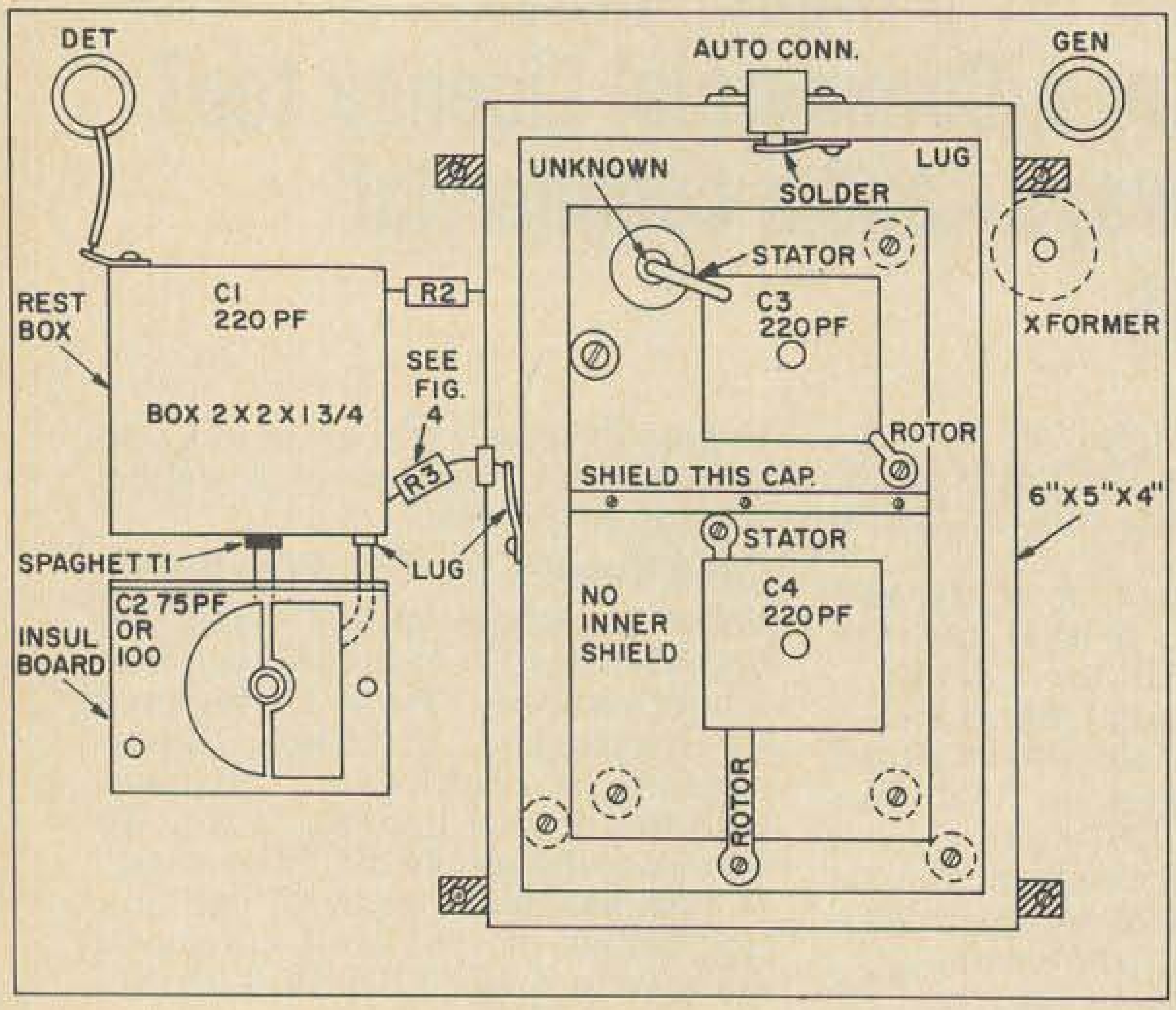
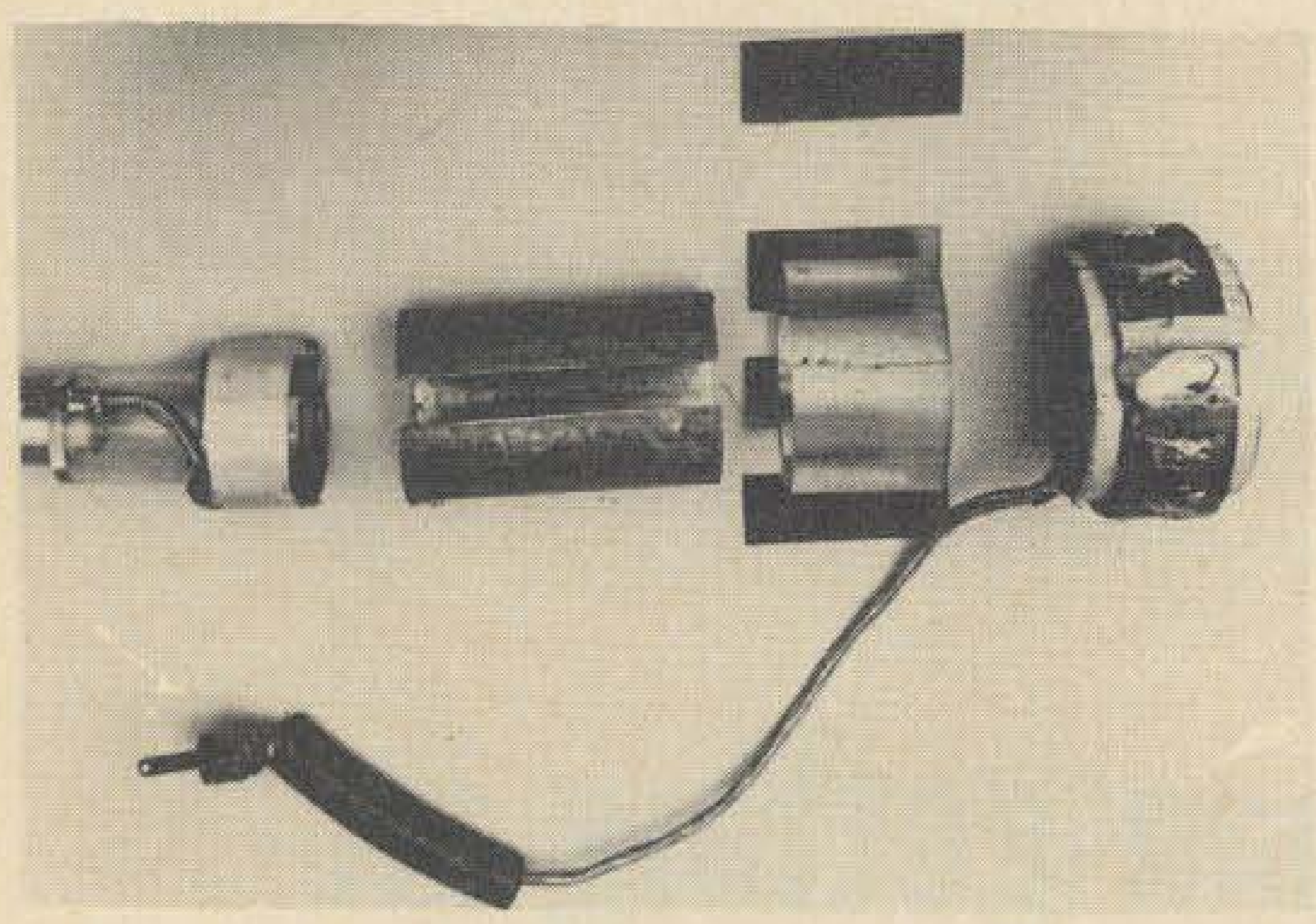


Fig. 2. Physical layout looking through panel.

dimensions don't seem to be too important. The large coil is between 2 and 2½ inches.

Reactance Box

The next item that needs some explaining is the reactance box, **Fig. 2 and 3 B.** This is actually made up of three boxes, one inside the other. Each must be insulated from the other as the diagram shows. The unknown lead from the capacitor C3 must be shielded by each box right up to the unknown terminal at the panel. See **Fig. 3A.** If your boxes are steel or brass, just solder the tubes into them. With aluminum, epoxy would probably work, or you might use 3 or 4 angle brackets to hold the tubes to the boxes, or press fit the tubes with insulated spacers between them. Insulated shafts must be used on all capacitors. The outside box of C3 is also insulated from the panel. Watch the insulation to see that it does not interfere with the tubes surrounding the unknown terminal. Note in **Fig. 3B** that the Motorola receptacle is so spaced that the inside terminal attaches to box No. 2 but the shell of the receptacle is insulated from it by a thin mica washer. Make this *rf* tight. This receptacle may be placed on either side of the box No. 3. The drawings show it in two different positions.



Transformer taken apart to show construction.

Reading from left to right (top of photo marked):

Plastic form with generator coil built upon it.

Pipe with slit.

Spacers to hold small coil away from pipe (under plastic spacer).

Large plastic spacer to hold large coil away from pipe.

Large coil built upon the brass tube and insulated from it by plastic or masking tape.

The lead with RCA plug goes into Motorola auto receptacle on the reactance can.

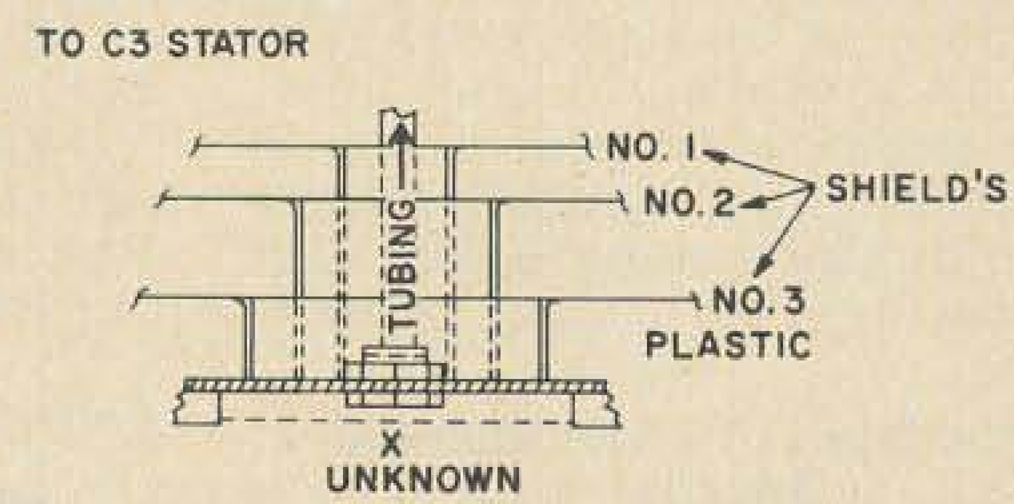


Fig. 3a. Reactance capacitor leadthrough to unknown terminal.

Pick your dials early in construction for you will need enough space between the panel and the capacitor cans to attach them. The small Japanese dials that I used attach to the panel first., then the reactance and resistance can is installed. Jackson Brothers drives would also work well, and you may make the dial larger if you watch the spacing of all the capacitors the reactance capacitor especially, and its shaft proximity to the unknown hole.

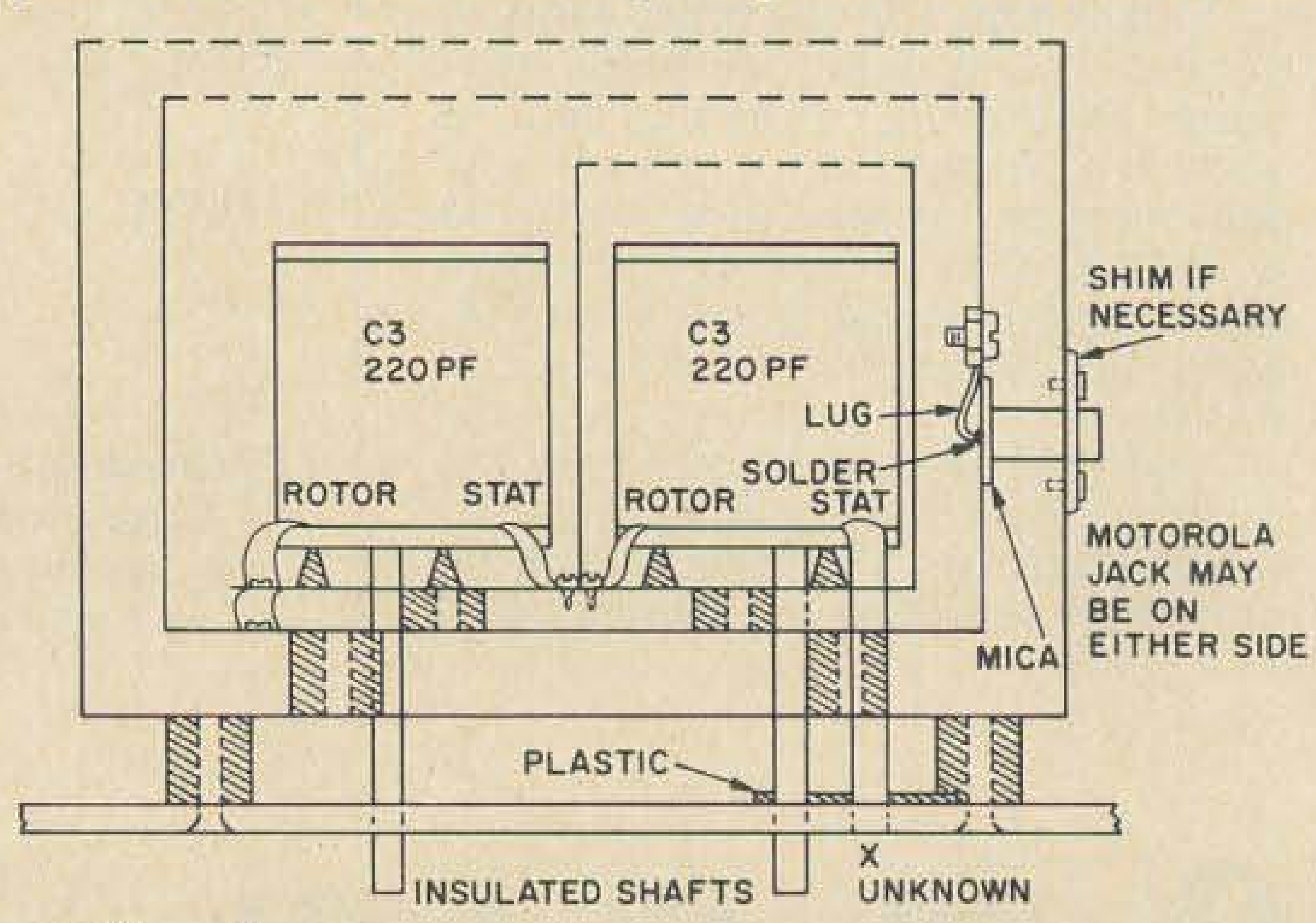


Fig. 3b. Reactance capacitor layout with construction ideas.

The panel is the original one from the signal generator box and has many holes in it so a paper overlay was used and lettered.

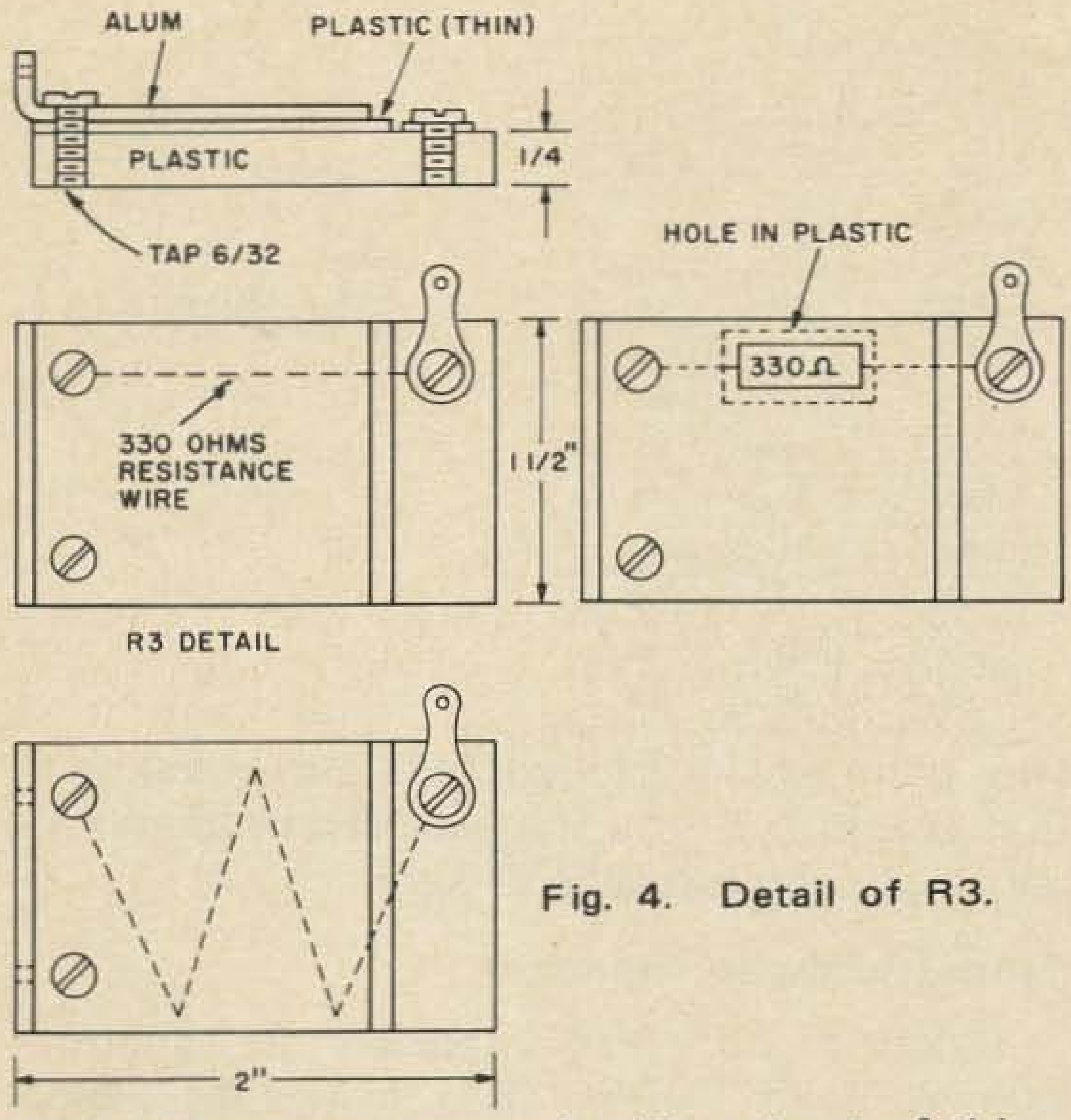


Fig. 4. Detail of R3.

This in turn was covered with a sheet of thin plastic to keep it clean.

Fig. 4 shows several ways to construct the resistor R3. I couldn't find resistance wire that would do the job so a ¼ watt 330 ohm resistor was installed into a tiny depression. This resistor is important. It keeps the bridge accurate over its frequency range, which is approximately 1 to 14 mhz. **Fig. 5** shows how the unknown connector is constructed. Use your imagination throughout. Use what you have. The resistor is soldered to the outside of the plug as shown.

Resistance Calibration

In the following discussion the word balance is used for the initial balancing of the bridge. The word null is used to designate the final balance.

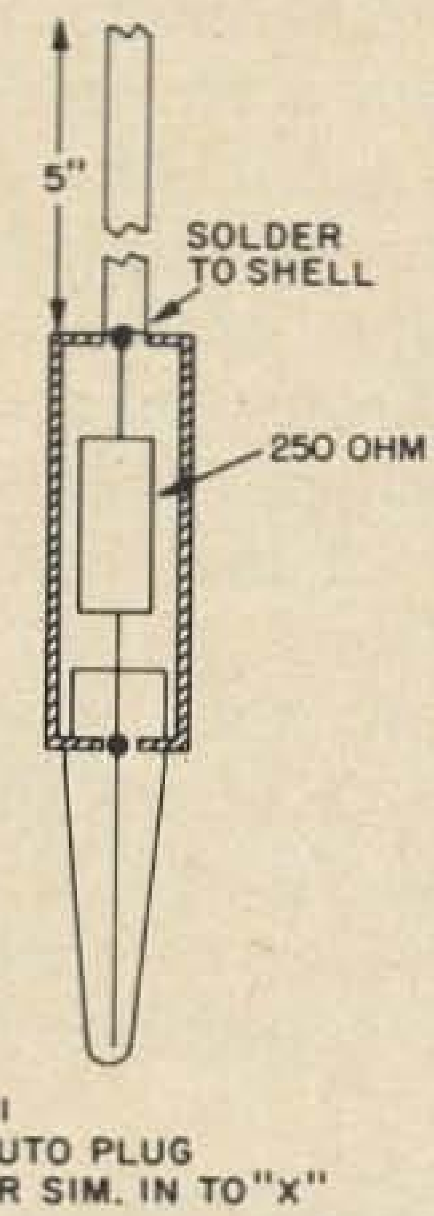


Fig. 5. Detail of R1 in its shield.

Connect a well shielded receiver to the detector terminal of the bridge and a signal generator low in harmonics to the generator terminal. Clip the unknown lead (the one with R1 inside) to ground. Set the signal generator to 1 mhz and tune the signal in on the detector. The signal may be modulated. Set the reactance and resistance dials to zero. Now secure the balance by using the balance capacitors. You should be able to make the signal disappear entirely. If you don't get the balance, check the wiring. Check for shorts in the transformer, the three reactance boxes or try changing the value of R2. Adding capacity to C2 will help balance the resistance dial if you are having trouble with it. Use 75 to 100 pf for

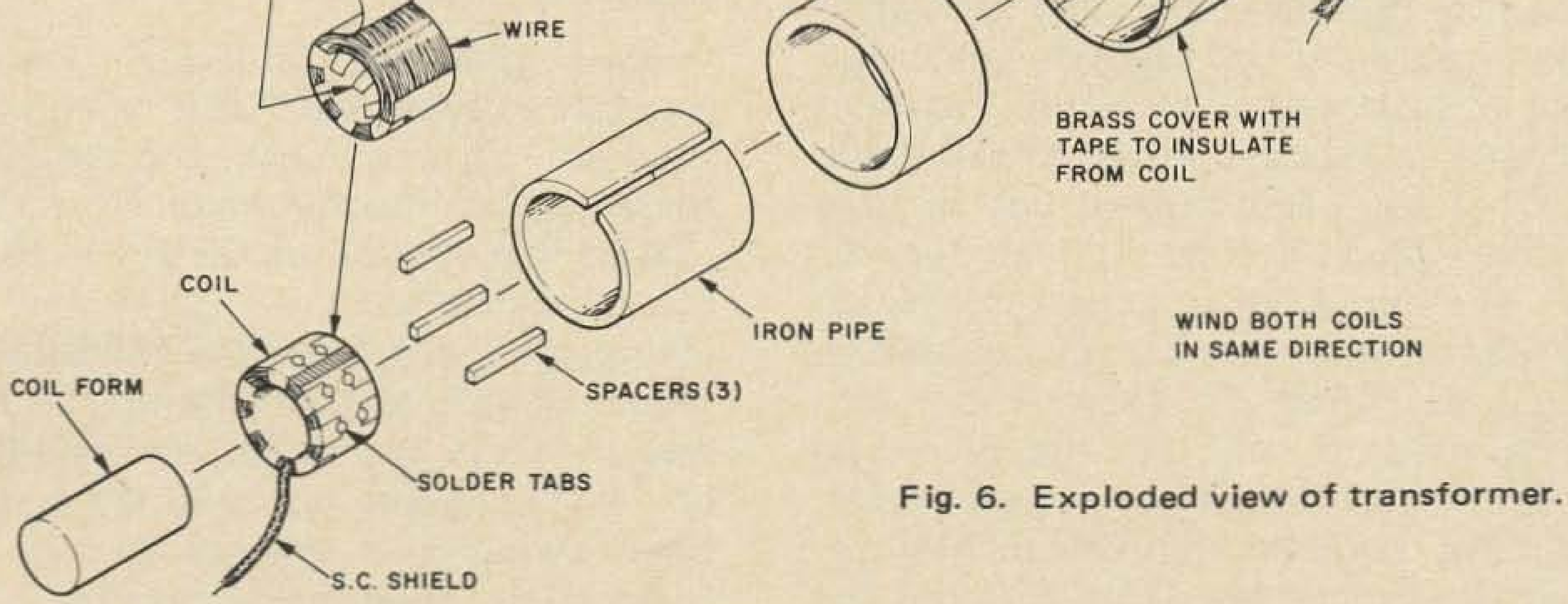
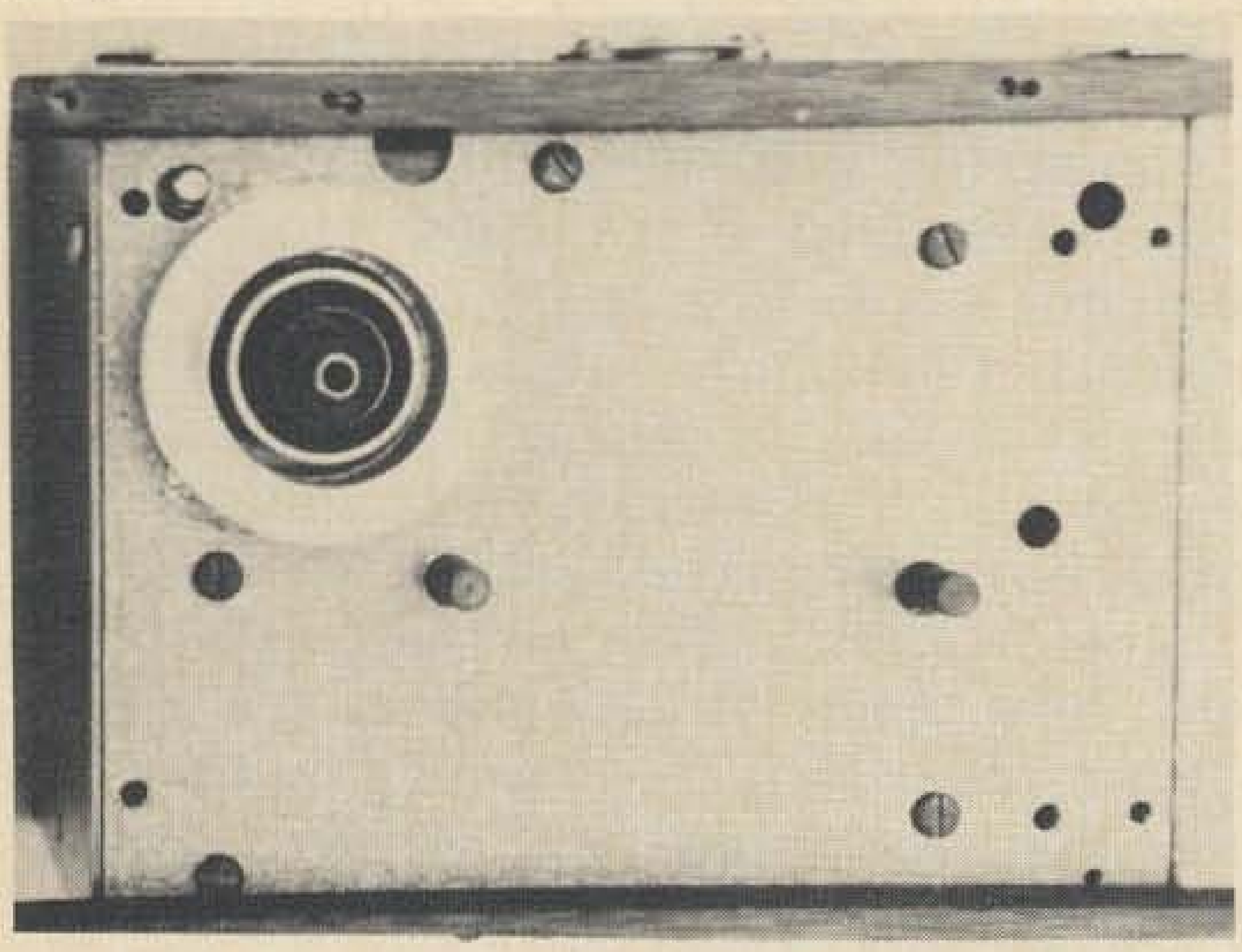


Fig. 6. Exploded view of transformer.

C2 and you won't have to use a trimmer like I did. Zero on the resistance dial C 1 is minimum capacity. Zero on the reactance dial C3 will be at maximum capacity. When a balance has been secured calibration can begin. Substitute a noninductive resistor in the unknown line and move the dial to the null. Mark the value of the resistor on the dial. Use progressively larger resistors until the dial is calibrated to your satisfaction. Some adjustment of the reactance dial may be necessary as you go up in resistance values because of the reactance of the resistors. This won't affect the accuracy of the resistance dial. The BKX bridge reads to 500 ohms. Yours may be slightly differenct according to the capacitors that you have used.



Reactance box looking down into the unknown terminal shielding and showing the insulated capacitor shafts.

Reactance calibration

Most of the calibrating can be done with a 1 μh 5% tolerance choke. J. W. Miller makes one (No. 4602) that sells for about 45 cents. A reactance chart is handy for checking your arithmetic. Most handbooks contain one.

Set the resistance and reactance dials to zero and balance. Insert the 1 uh choke in the unknown line and null. The resistance dial won't move much. The reactance dial will move upscale and at each point write in the reactance values according to the **Table 1**. This table has been worked out to slide rule accuracy and is close enough for our purpose. If you have a general coverage receiver an infinite number of calibration points can be found. In **Table 1** the first column is used to calibrate the dial. The second is the frequency of measurement, and the third is the actual reactance of the choke at each frequency. Note that the last two columns multiplied together equal the first column. If you use a different value of choke use the formula X=2πf1.

DIAL READING	FREQ MHz	REACT
6.3	1	6.3
16	1.6	10
77	3.5	22
100	4.0	25
300	7.0	44
336	7.3	46
1200	14.0	88
1290	14.3	90
2780	21.0	132
2860	21.3	134
4930	28.0	176
5150	28.6	180
5640	30.0	188

TABLE I
CHOKE I uH 5% TOL.
MILLER NO. 4602

Calibration with capacitor

Insert a .005 Mfd capacitor in the unknown lead with the resistance and reactance dials at zero. Balance the bridge. Note that the first balance is with the capacitor. Now remove the capacitor and clip the unknown lead to ground. Null the bridge using the reactance dial. Mark the dial reactance according to **Table 2**. An .005 happens to be about 32 ohms. Calibrating the bridge with capacitors is a backward process; that is, the bridge is initially balanced with the capacitor in the unknown lead and then the unknown is grounded. There comes a time when a balance can no longer be secured. This is around 1000 ohms reactance. To calibrate the remainder of the dial you'll have to switch to an inductor. For capacitors other than those in **Table 2**, use the formula X=1/2πfc.

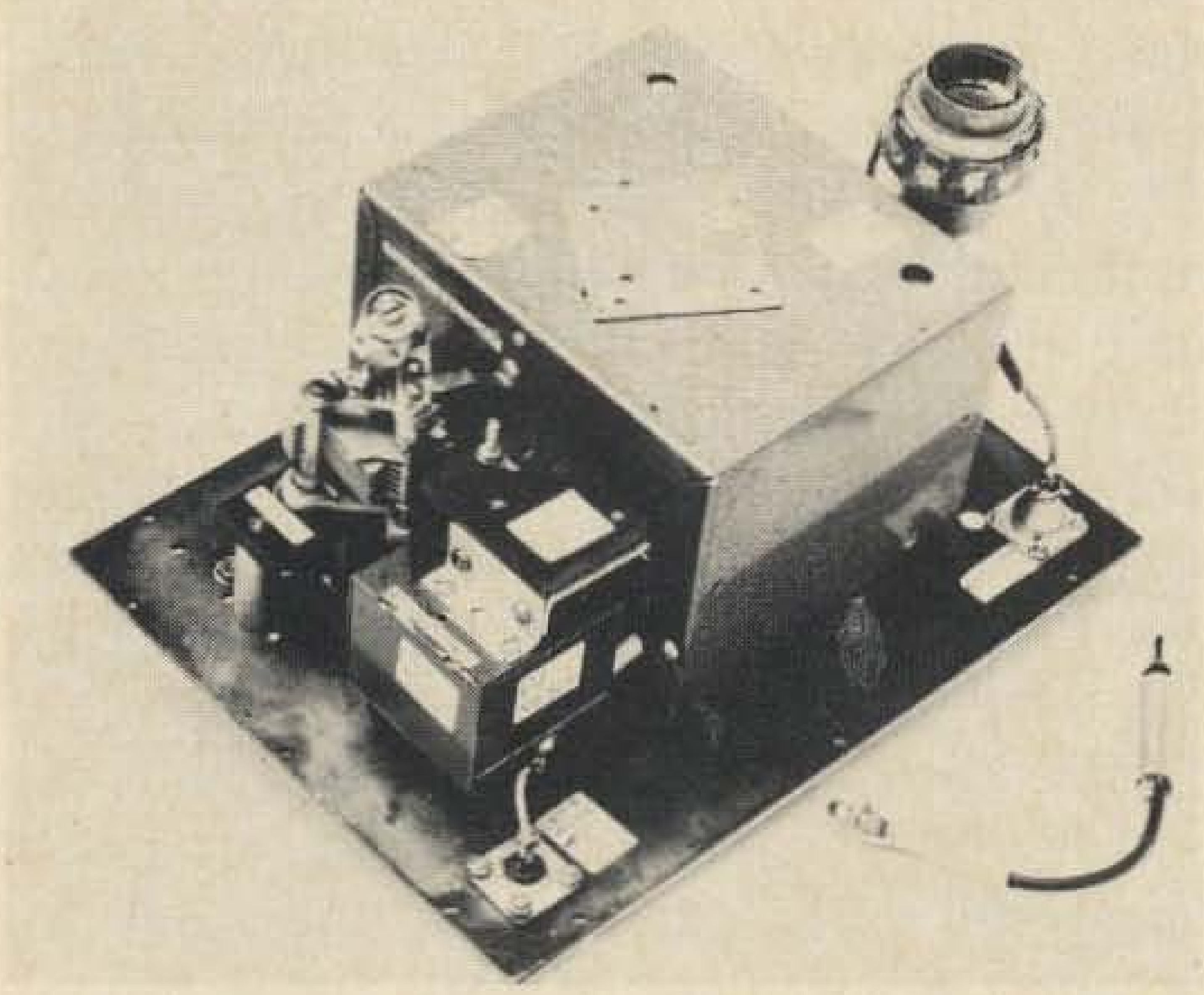
MFD CAP	RESIST OHMS
.005	32
.001	159
.0005	318
.00033	482
.00022	725

TABLE 2
READ AT I MHz

$$X_c = \frac{1}{2\pi FC}$$

Using the bridge

Now that the bridge is working and properly calibrated take a look at an antenna. First balance the bridge at the frequency of measurement. Next clip in the coaxial line, grounding the shield to the case. (The measurement of twin lead is very complicated and laborious and is beyond the scope of this article.) Swing the resistance dial to what you think the reading should be. At this point you will get a slight null. Now swing the reactance dial. If your antenna is inductively reactive, the null



Inside of bridge showing cans and construction.

should be quite sharp when you hit it. Touch up the resistance dial again and go back and forth between the two until you can no longer hear the signal. Don't forget to divide the reactance dial reading by the frequency in mhz that you are using. If you don't get a null with the reactance dial, the antenna is capacitive and the following method must be used.

Set the resistance dial and reactance dial to zero. Connect the antenna to the unknown terminal and balance. Remove the antenna and short the unknown terminal to ground. Null the bridge with the resistance and reactance dials. The new reading is capacitive reactance. Divide by frequency.

Here is another example of measurement of reactance when the sign is unknown. Let us measure a 50 ohm coaxial line at 14 mhz. Ground the shield of the antenna to the ground post on the panel. Plug in R1 and ground clip to panel. Set reactance dial to say 450 and balance the bridge. Set resistance dial to zero. Clip in the antenna and null with resistance and reactance dials. Suppose the new dial reading is 50 ohms resistive and 310 ohms reactive? Subtract the 310 ohms reactance from the 450 ohms reactance that you balanced with and the answer is 140 ohms capacitive. Divide by frequency of measurement. Fourteen mhz into 140 ohms reactance leaves 10 ohms, which is capacitive. Z-50-j10. If the reading of null moved up scale subtract the smaller number from the larger and divide by frequency to get the positive reactance.

The unknown lead with R1 may be made longer than 5". Usually two leads are supplied with a bridge. The shorter is used when practical.

. . . W6BKX

Photographs are by Ralph Parlette, WB6JOY.

James Hartley W1DIS
U.S. Rte 302
Raymond, ME 04071

Religion, Politics or Sex

For the first time in 37 years as a licensed ham I have become incensed enough to write about a trend in operating practice. I want to say that I completely agree with those who feel politics, religion, and sex should not be discussed on the ham bands. Our frequencies are not assigned over to our use as an open forum. I thought it might be well to mention some of the things I discuss over the air, which bring me many QSLs stating that the other fellow has really enjoyed the contact with my station. Perhaps I am an old Fuddy Duddy, but I hope that there are some new comers who would like to become my kind of Fuddy Duddy and enjoy another facet of out art.

I am fortunate I know, in that I have been mobile in 49 of our 50 states. The XYL and I have never been to Hawaii, perhaps because they have never sold a Chevrolet automobile with pontoons. This gives me an edge for a first suggestion. Get yourself an Atlas of the United States. I suggest the Texaco Touring Atlas. The latest issue has a list of towns next to the maps of the various states and provinces. As soon as you get the other station's QTH, look for it in the Atlas, find his location and tell him you know where he is situated, then ask him some questions about his area. If you see a lake near him, ask about boating or fishing, in the case of a mountain, ask him if it is used for field day or other questions that come to mind. If you have been as fortunate as I, to have visited in his area, tell him so and try to recall what interested you when you were there. This map study will bring out something interesting in all but the most hardened introvert.

I think one question many hams ask, is what do you do for a living? Let us go one step further and ask what he does for recreation. It is usually more interesting to you, and certainly most of us feel we have more or less ordinary types of occupation, to be less apt to go into an interesting discussion about our work. If you should have an interesting and ever changing job, such as a traveling salesman working mobile, why not tell your contact about it?

There are other areas that can be used for conversation that will vary with the location of the station. I could make an outline for another operator to follow, but I will cover some of the things I discuss. Perhaps this is a deadly list of subjects to many hams, but from the enthusiastic response I have received, the contacts I have had certainly hide their boredom very well. I live in the state of Maine. Since many stations want Maine QSLs it is possible they will put up with a lot of silly chatter insure getting a card, but I don't like to think this is the case. You follow what I can say about my location, then sit down and write a list of things that you can talk about covering your state or area. It takes a little digging but it is worth it I am sure.

The home QTH is near Portland in southern Maine, which is a big state of almost 400 miles long by 275 miles wide at its widest point. I am actually closer, by a few miles, to New York City than I am to Fort Kent on the northern boundary of our state. Many contacts bring up the subject of cold weather and so are told that over the years I have watched the temperature in New York City and compared it to Portland official temperature which is seldom as much as 15 degrees colder. My guess would be that our average is a 10 to 12 degrees lower reading, but it is enough that in the winter we get snow, and keep it, so most winters' snow is with us all season and does

not disappear as it does even as close to us as Boston, 125 miles toward New York. In winter most contacts are interested in the snow removal operations we have here, and how quickly our driving returns to normal after a storm. The new popularity of snowmobiles for family winter outings, both at night and during weekends make interesting conversation. The other chap may think we are nuts to live in Maine, but he likes to hear about it and sit there in his warm shack shaking his head over such fools as we.

Much of Maine is timberland with little or no population. These wilderness areas make a good topic. Actually, the total population of our state is slightly less than Metropolitan Boston. Is it any wonder so many stations are looking for QSLs? This makes good talk with a W6 station about Sweepstakes Contest. All we have to do is shout "State of Maine" and there usually is a pile up on our frequency, for this reason we have a slight DX edge, over many of the other states. It makes me a little sad because a W6 is just California again! The operator in a rare state like Nevada, Idaho, Delaware, Wyoming, and many others, might be wise to get the habit of calling CQ and stating "here is Idaho calling", etc. These states might do better calling CQ than answering them. When I do call a station after he has made a CQ I always reply "W1DIS State of Maine" and I can often get the nod when my signals are down for they will come back asking for the Maine Station and they don't have my call. Discuss your operating habits and little tricks. Even an old dog can learn new stunts!

Because of location, Maine is a backward state in some ways. Our number one industry is the Pulp and Paper business. Number 2 in dollar income to the state is the vacation money spent here four seasons of the year. Bathing, boating and just vacationing in summer, hunting in the fall, skiing in winter, and fishing all year round is a drawing card for many. I have to be talking to a fairly sad sack if I can't get some response out of a statement on our vacation possibilities. I also live on Sebago Lake which has 47 square miles of water and is one of the largest lakes in New England. It is the home of the "Land Locked Salmon". A fisherman will really bite on this tidbit. Many years ago freight boats traveled through locks being lowered some 260 feet from Sebago Lake to tide water. In those years Atlantic Salmon came up into the lake to spawn, and when the locks were no longer used they could not return to the ocean and so now they go up little streams that feed Sebago Lake to spawn but with the help of the fish hatcheries run by the state, we have good Salmon fishing, as well as exporting Salmon eggs to other states. If I can get a few hams to come this way for vacation I help my state. I always ask them to write to our Maine Publicity Bureau to get information, and ask them to please mention that they got the idea from a radio ham which helps our image.

If the person you are talking to is likely to visit your area, suggest to him the best places to go that would be of interest. Here in Maine, I warn a prospective visitor that he will not see the real "rockbound coast of Maine" from U.S. Route 1, but will have to go down side roads, and mention the best ones to him. In this age of space travel, we have towns with stores that not only refuse to sell beer, but you can't buy cigarettes nor a Sunday paper. These people are not backward, they have their convictions and stick to them, which makes the "yankee" and interesting person. We always recommend that the new visitor eat some lobster while in Maine, and a discussion of the habits of this crustacean, how they are caught and handled live into market, make for an additional topic.

We live 70 miles by road from Mount Washington. This is the highest mountain in the United States east of the Mississippi River and north of the Carolinas. There is a television station, FM and commercial transmitters at the summit. It is said to have the worst weather in the world at the summit, and all power is developed by diesel engines using oil hauled by special trucks during the summer. The crews who man the station up there are changed each Wednesday by the use of a snow cat machine, if it can make the trip up the 6,288 foot high mountain. This road is available to motorists as a toll road in summer, and what a spot for mobile activity, especially on 50 and 144 mhz.

For those hams who might be interested

in history, we go back to the Civil War. I have said Maine is a backward state, and it all goes back to the fact that more men died in battle, in the biggest engagements of the Civil War, based on a population basis, from Maine, than any other state in the Union. The 20th Maine and other Maine groups were at Gettysburg and Chancellersville, as well as many other battles. The old idea of having all the men from one state fight as a unit was the problem. If that unit took heavy casualties, and the 20th Maine certainly did, then the state suffered. Many of the soldiers were farmers of the rocky soil of this state. Some were not casualties of the war but they heard of the wonderful land in the midwest and never returned home, but went west after mustering out of the army. As a result there were many widows in Maine from both situations, and as might be expected a drop in the birthrate, and no men to continue farming the farm land of the state. Maine has never fully recovered for even today stone walls show where fields once were, but are now wooded areas. In recent years the state has become attractive to retired people and younger persons who desire a less accelerated way of life. We have some of the best professional brains in the country living in Maine, because they are willing to take a smaller income, in trade for the assets in the recreation area in Maine.

This does not begin to cover all the subjects I have used during my QSOs. I am sure that almost any part of the country contains as many or more interesting items available for discussion. Just take a few minutes and think of the things that are commonplace to you, but would be of interest to a ham from another part of the country. If we are operators with so little imagination that to remove Politics, Religion, and Sex from our conversation would ruin our hobby, I wonder how we ever managed to master enough technical knowledge to get our ticket? Come on now, let's grow up and be adult!

. . . W1DIS

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Richard Zach WB2AEB
33 Pike Place RFD 4
Mahopac NY 10541

VHF-FM: Part II

Mobile Installations

As stated earlier, 75% of all FM activity is operated from the mobile. Fortunately, mobile equipment is easiest to come by and is less expensive than a base station. Again, when you purchase these units, they come with all accessories–transmitter, receiver, power supply, control head, speaker, mike and cables.

Most two-meter rigs have to be converted from the adjacent 150-174 mhz Business Band down to the high end of 146 mhz. All this involves is maybe padding each of the receiver "front end" rf coils with a capacitor of good quality and possibly making a new final tank coil. As for 6-meters, the units have to be brought up from the 30-50 mhz Business Band to above 52 mhz. Depending upon where the rig was previously tuned, you may have to cut down some coils or perhaps change a few capacitors. The rigs that are to be put on "450" often need no modifications. In every case, however, the rig must be completely re-aligned and new crystals must be installed (more on this subject later). Converting narrow-band gear to wide or wide-band to narrow does get a bit more involved. The rigs are usually slightly scratched up and dusty (depending on age). However, some sandpaper and a can of spray paint can really do wonders. Any way you look at it, the rig itself will be in the trunk and the only things that you can see are the control head, mike, and speaker under the dash.

As for mobile power supplies, they come in three types: dynamotor, vibrator, and T-power* (transistorized). The dynamotor supplies are always found in the rigs from the 1952 to 1957 era, usually running to 60 watts. These dynamotors do waste a ferocious amount of power as compared with a vibrator. The price of the unit is less however. Vibrators provide a good compromise. They do not eat up as much power as a dynamotor and are not as expensive as a T-power rig. Vibrator supplies were most prevalent between 1952 and 1962. If you want to pay for the best, you can get T-power, but quite a few hams who want this feature modify the existing rig. The advantage of T-power is that it is the most efficient method and it lasts the longest. T-power rigs can be found from 1962 to date. The oldest rigs use 6 vdc only, with later rigs using 6 *or* 12 vdc and even later ones using 6 *and* 12 vdc. The newest rigs (still in production) tend to use 12 vdc only.

In receivers, the sensitivity is usually quite good–on the order of 1 μv to 0.5 μv for 20 db quieting without a preamp. If your particular receiver does not match this, a simple FET pre-amp will fix things up in a jiffy. Receivers such as the Motorola Sensicon "A" also have a "cavity front end."

With transmitters, the power rating is in *output* rather than *input*. Thus, you can compare a 60 watt commercial FM rig with a 120 watt amateur transmitter with 50% efficiency when measured for input. The moral is, don't let the 10 watt power rating on some of the cheaper rigs scare you away (i.e. Motorola FMTRU-41V $35 up). By the way, many of these rigs are not really FM, but Phase Modulation. These two methods are received alike in the FM receiver, though.

As for makes of rigs, Motorola and G. E. are the two big names. For the beginner, perhaps these two are the best to start with because schematics and documentation are easy to come by. One more school of

*Reg. trademark of Motorola.

thought is that since these brands are the most popular, if you run into trouble, you can easily consult someone with a similar rig on your problem.

Mounting these rigs is somewhat unique. You have a choice of two methods. First, you can mount the whole rig under the dash. Second, you can mount the rig itself in the trunk with the supplied cables leading to the control head, speaker and mike under the dash. This way, the chance of theft is less, and the XYL gets her leg room. The latter is more popular and the price is usually the same.

If the rig was built before 1952, the chances are that the transmitter and receiver are separate cases. From then on, however, the transmitter and receiver are in the same case, but in modular form. Thus, if a unit went bad, the service technician would simply plug in a new transmitter, receiver, or power supply, "strip" and repair the old one.

Where do we obtain such equipment? Of course, if you want to get the best price, one of the "Hams Only" distributors is ideal. However, if you want a large selection, a commercial distributor is for you. With some companies, some equipment is sold as-is, but most companies have a short guarantee. Before you do anything, however, you had better write for a few catalogs to determine what you would expect to pay and become familiar with some of the rigs.

Here are a few such companies with catalogs:

Gregory Electronics Corp.
249 Rt. 46
Saddle Brook NJ 07662

Mann Communications
18669 Ventura Blvd. Tarzana CA 91356

Spectronics, Inc. (Hams Only)
1009 Garfield Street
Oak Park IL 60304

C & A Electronic Enterprises
2529 Carson Street
Long Beach CA 90810

Although this company does not publish a catalog, Newsome Electronics is a "Hams Only" distributor with competitive prices. See March 1969 ad in 73 Magazine.

When buying antennas for the mobile rig, it may be good to get what is called a "gain antenna." The familiar gutter clamp type antenna which is popular in some temporary installations (which figures out to be about 18.7 inches) let's say has a gain of "X." With the use of a "gain" antenna you have a 3 db gain over the 18.7" whip. Thus you can get 2X gain with the use of the "gain" antenna. Think about that . . . twice the power out (ERP) and twice the receiver gain just by using a different whip. You can get a small 18.7" antenna (commercially built) for about $6. A "gain" antenna will run anywhere from $16 to $27.

Now about one of the most important topics . . . prices. Prices will all vary according to age and condition of unit, transmitter power, type of power supply, manufacturer, and whether the unit is narrow-band or wide-band. Commercial dealers will always want more for narrow-band gear. Just because you paid twice the amount of an older unit for your later model, don't expect the newer one to be twice as good. The older unit may be dirtier and take up more power, but that's about it. . . . WB2AEB

The Umbrella Antenna

By building "out" instead of "up," a very efficient antenna requiring pole heights of only 10 to 20 feet can be built for use on the low frequency bands–40, 80 and 160 meters. No difficult or special construction or materials are required.

John J. Schultz W2EEY/1
40 Rossie St.
Mystic, CT 06355

Short vertical antennas for the low-frequency bands are certainly nothing new. Inductively loaded mobile whips are a common form. They take up very little space and perhaps for the mobile situation are the only practicable antenna form. However, considered for usage in a fixed station situation where even a moderate amount of space is available, it appears foolish to accept the limitations of such a form. The limitations of the loaded mobile whip–poor efficiency, very narrow bandwidth and an awkward value of terminal impedance–arise because of the form of loading used. A small loading coil is required because of space limitations and in order to provide even usable efficiency the coil must be of high "Q" with resultant narrow bandwidth.

If the space limitations did not exist, it would be desirable to make the loading coil as large as possible to increase efficiency. Also, it would be desirable to include some form of capacity or "top-hat" loading since the reactive effects of the inductive and capacitive loading will act to maintain antenna resonance over a greater bandwidth. It is rarely possible to do this in a mobile situation but it is possible in a fixed station situation. This article describes a form of antenna which combines a very efficient method of combined inductive and capacitive loading while still requiring very little space compared to any conventional antenna of full-size dimensions.

Umbrella Loading

The basic form of the umbrella antenna is shown in **Fig. 1 (A)**. The vertical mast is relatively short (10 feet on 40 meters, 20 feet on 80 and 160 meters) and the wire web on top introduces inductive loading by

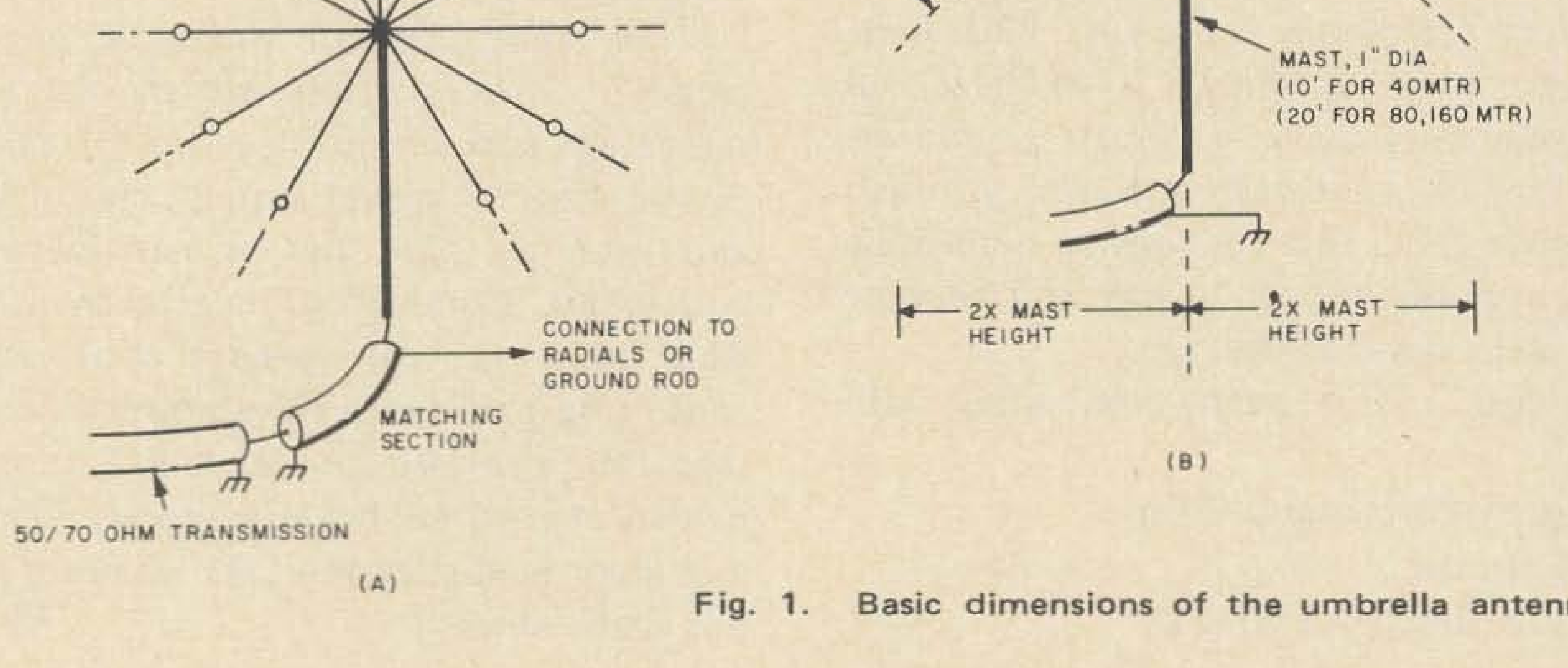
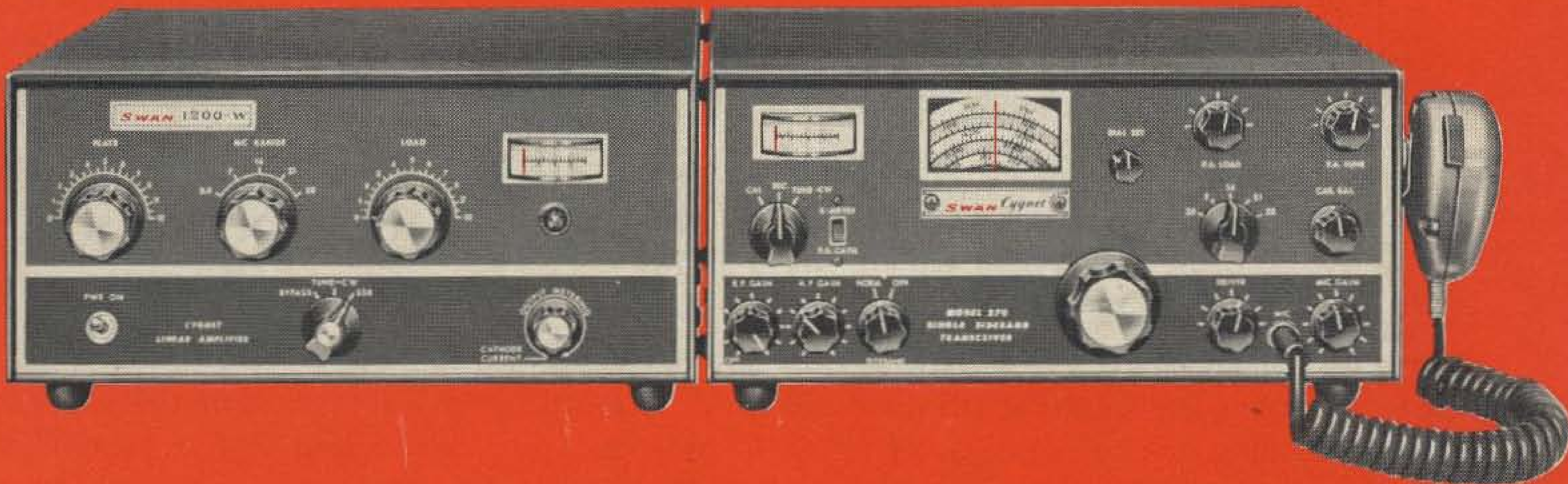


Fig. 1. Basic dimensions of the umbrella antenna.

POWER / PORTABILITY / PERFORMANCE



HIGH POWERED TEAM

Cygnet Linear Amplifier

1200 watt matching amplifier with self-contained AC power supply

For those times when the quarter kilowatt of the model 270 transceiver isn't quite enough to break through, the Cygnet Amplifier illustrated above provides a 5 times increase in power. Utilizing a grounded grid, super-cathode-drive circuit, both efficiency and linearity are exceptionally high. In a matching cabinet which includes the AC power supply, the 1200-W makes a most attractive companion for your Cygnet transceiver. It plugs directly into the Model 270, and may be adapted easily to the 260 as well as other transceivers.

SPECIFICATIONS: Power Rating: 1200 watts P.E.P. input with voice modulation, 800 watts CW input, 300 watts AM input. ● Covers 80,40,20,15, and 10 meters. ● Four 6LQ6 tubes operating as grounded grid triodes. ● Third order distortion down approximately 30 db. ● Pi output tank for 50 or 75 ohm coaxial antenna feed. ● Computer grade electrolytic filter capacitors. ● Silicon diode rectifiers. ● Complete with interconnecting cables, ready to plug into the 270 and operate. ● 117 volts, 50-60 cycles input. Available on special order for 208-220-240 volts. ● **Dimensions:** 5½ in. high, 13 in. wide, 11 in. deep. Weight: 25 pounds. (Carrying handle included.)

Amateur net: **$295**

Deluxe *Cygnet* 270 Transceiver

5 BANDS 260 WATTS for fixed, portable or mobile operation

A complete amateur radio station with built-in AC and DC power supply and loudspeaker. The Cygnet 270 contains all the features required for home station operation, yet it is compact and light enough to make an ideal "traveling companion" on those business or vacation trips.

SPECIFICATIONS: Power Input: 260 watts P.E.P. in SSB voice mode, and 180 watts in CW mode ● **Frequency Range:** 3.5-4.0 mc, 7.0-7.3 mc, 14.0-14.35 mc, 21.0-21.45 mc, 28.0-29.7 mc ● **C.F. Networks:** Crystal Lattice Filter. Same as used in the Swan 500 C. 2.7 kc band width at 6 db down. 4.6 kc wide at 60 db down. Ultimate rejection exceeds 100 db ● **Unwanted** sideband suppressed 50 db. **Carrier** suppressed 60 db. 3rd order distortion down approx. 30 db. ● **Audio Response:** flat within 3 db from 300 to 3000 cycles in both transmit and receive modes ● **Pi Antenna coupler** for 50 to 75 ohm coaxial cable ● **Grid Block CW keying** with off-set transmit frequency ● **Solid state VFO circuit** temperature and voltage stabilized ● **Receiver sensitivity** better than ½ microvolt at 50 ohms for signal-plus-noise to noise ratio of 10 db ● **100 kc Crystal Calibrator** and dial-set control ● **S-meter** for receiver, P.A. Cathode meter for transmitter tuning ● **Improved** AGC and ALC circuit. Separate **R.F.** and **A.F.** gain controls ● **Sideband selector** ● Provision for **plug in of VOX** unit, external VFO, headphones, and Cygnet Linear ● **Tube compliment:** 12BA6 VFO amp., 12BE6 trans. mixer, 6GK6 driver, 6LQ6 pwr. amp., 6BZ6 rec. R.F., 12BE6 rec. mixer, 12BA6 1st I.F. amp., 12BA6 2nd I.F. amp., 12AX7 prod. det. A.F. amp., 6AQ5 A.F. output, 12AX7 mic. amp., 6JH8 bal. mod., 12AV6 AGC-ALC amp. **Dimensions:** 5½ in. high, 13 in. wide, 11 in. deep. Net weight: 24 lbs.

Amateur net: **$525**

PLUG-IN ACCESSORIES: Model 508 External VFO, Model 510X Crystal oscillator, Model VX-2 VOX unit.

OTHER ACCESSORIES: Model FP-1 Phone Patch, Mobile Mounting Kit, Model 45 Manual Switching 5 band Mobile Antenna, Model 55 Remote Switching 5 band Mobile Antenna.

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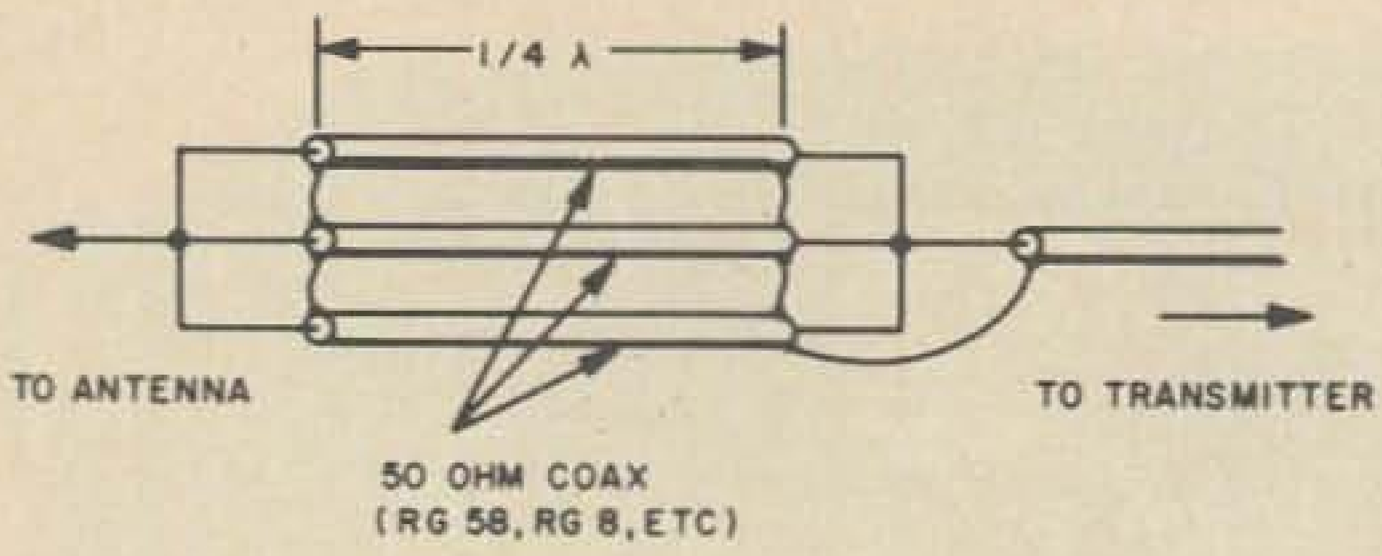


Fig. 2. Transmission line matching transformer for use between base of umbrella antenna and 50/70 ohm coax line.

linearly extending the length of the mast and capacitive loading due to the capacity effect between individual web wire and between the wires and the mast. A side view of the antenna is shown in **Fig. 1 (B)**. The dimensions shown were not randomly chosen as one might at first imagine. They are a compromise between a number of factors. If the web wires are brought closer to the mast, the effect of the loading is reduced. If the web wires are made more horizontal, the ground area required increases (however, the loading effect is increased and if the antenna is mounted on a structure such that a large area is available, this approach may be used.) The vertical projection of the web should be held to within ½ the height of the mast. Making the web wires longer will increase the loading effect but the radiation pattern will change such that high angle radiation results and the antenna does not perform as the equivalent of a full-length quarter wave vertical. If one does not object to the high angle radiation or, in fact, prefers it for short-medium distance work on the lower-frequency bands, the web wires can be made as long as desired.

The number of wires in the web will influence the resonant frequency as well as the feed point impedance of the antenna. Six is the minimum which should be used and probably 10 or 12 is a reasonable number considering loading and constructional complexity. Increased loading effect will take place up to at least 20 wires.

The feed point impedance is not as high as one is used to with a purely inductively loaded antenna. Because of the effect of the capacity loading, the feed point impedance when a good ground connection is used will vary between 5 and 8 ohms. Any one of the conventional methods used to match a low impedance load—such as the driver element on a multi-element parasitic beam—to a coaxial cable may be used and so they will not be shown here. One slightly different method to match the antenna by means of a quarter-wave transmission line transformer is shown in **Fig. 2**. Three lengths of coaxial cable are paralleled. to form the required simulated low impedance transformer section.

Construction

The main vertical section of the antenna was made from a standard 10 foot aluminum TV mast. The mast was mounted to a ground stake by two standoff insulators (Birnbach No. 448 pillars with tube clamps at each end). A home-brew standoff can be easily fabricated from a block of wood or polystyrene and cutting a hole at both ends for insertion of two adjustable hose clamps. Since the base is at a low voltage point, the quality of the insulator used is not critical.

The ten wires comprising the top web were fastened to the mast by means of an ordinary ground lug. Hook-up wire was used to construct the web although it is suggested that stronger wire be used—common TV guy wire would be an excellent choice, for example, for rugged installation.

As with any antenna being worked against ground—be it full-size or a loaded type—the quality of the ground plane has an important effect upon antenna performance. In moist soil a ground rod driven several feet into the ground may suffice but otherwise a cluster of 10 to 12 radials buried several inches and extending at least to the point where the extension of the web wires touches ground is very desirable.

The author's antenna was constructed following the outline dimensions given in **Fig. 1 (B)** to resonate on 40 meters. After installation and testing it was found that resonance was very slightly below 40 meters. The situation was corrected by placing the ground terminal for the web wires slightly closer to the mast. This was done experimentally while checking the transmission line SWR. There are several variables involved in determining the exact resonance of the antenna and either one can vary the angle of the web wires to "fine-tune" the antenna or these wires can be firmly placed on either a small inductor or capacitor used at the base of the antenna for final adjustment.

Summary

Antenna efficiency is at best a difficult thing to measure or estimate even under the most ideal conditions on low-frequency bands. Compared to full-size quarter-wave verticals, the best estimate is that the umbrella antenna is from 60 to 70% as efficient. This is certainly a far cry from the usual loaded mobile whip which has efficiencies of 2-5% (100 watts transmitter output, 2 to 5 watts actually radiated).

The bandwidth depends upon the band for which it is constructed. On 40 meters when resonance is adjusted for 7150 kc, the antenna will satisfactorily cover both the CW and phone band edges with an SWR of from 2:1 to 2.5:1. On 80 meters either the entire phone band can be covered or the CW portion; the bandwidth is about 250 kc overall. No tests were made on 160 meters but the coverage should be in the order of 75 to 90 kc which is certainly adequate for most uses on that band.

If the antenna is constructed for 40 meters, a double resonance will be found to occur on 21 mc—the same as for any monopole or dipole operated on odd multiple harmonic frequencies. The antenna should be quite efficient on 3rd harmonic operation but the problem is one of the resultant radiation pattern. The pattern appears to produce mostly high-angle radiation which, of course, is useless for DX purposes. Nonetheless the antenna may still be useful as an auxiliary antenna on this band.

The umbrella antenna appears at first glance to be a rather simple and elemental type of loaded antenna. Actually, it is not when one considers its advantages in terms of preserving a low radiation angle and achieving quite good efficiency—all within reasonable dimensions. This form of antenna may not allow an apartment dweller to put out a booming signal on 80 meters but it should certainly permit someone with a moderate amount of space to considerably improve his signal on any low-frequency band as compared to using a whip or randomly placed and tuned length of wire.

. . . W2EEY/1

Solid State 432'er Transmitter Part I

Bill Hoisington K1CLL
Far Over Farm
Peterborough NH 03458

Since it is straightforward, why not take advantage of our solid state 432'er? It offers, 1) low cost vhf "plastic" transistors selling for less than $1.60 each, 2) a 12 volt dc power supply for home, mobile and portable use, 3) highly dependable circuitry, 4) small size without sacrifice in operation, 5) will fit inside a small shielded box, and 6) can be used as an exciter for higher power.

If these five points do not satisfy you, you're hard to please. To get to 432 mhz becomes a problem which can be accomplished by both doubling and tripling. You can use a 54 mhz crystal, double to 108, 216, and finally to 432 mhz. Another way uses a 48 mhz rock, triples to 144, then triples again to 432 mhz. If this tripler method causes you to add another stage as an rf amplifier later, you haven't gained much. We'll see how it works out.

Trouble

If my trials and tribulations save you time, that's okay by me, as of course I encountered them right away. Refer to **Fig. 1**, the main schematic for the following, and also **Fig. 2**, layout. As usual when something real bad shows up, it is often caused by more than one thing. This time, out of more than 20 crystals here between 45 and 54 mhz,I picked a poor one. The oscillator coil was no good and also L1 and C1 were too high in frequency. A quick check on all the crystals in the shack showed three "fair" and the rest

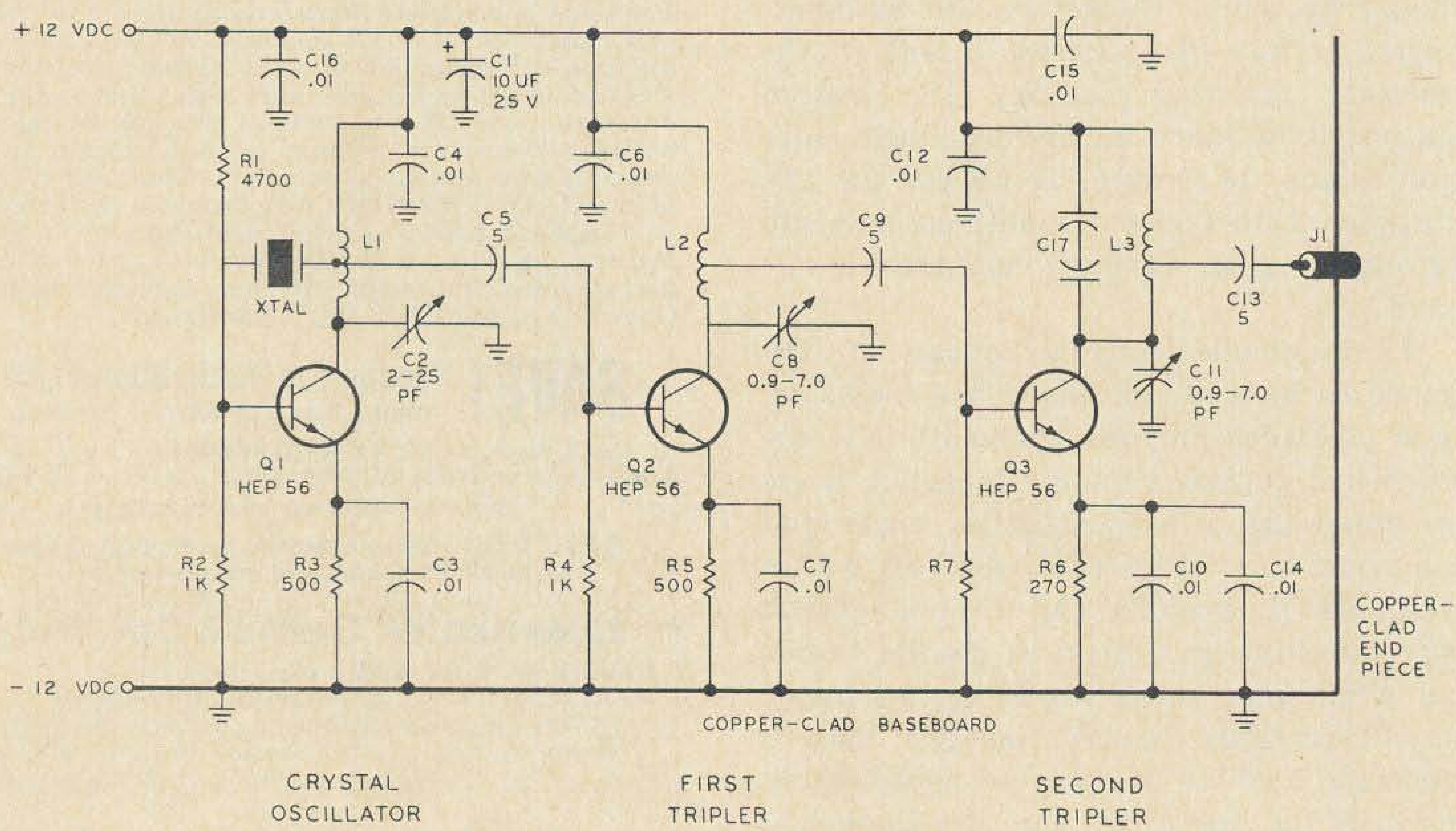


Fig. 1. Main schematic. C1—Arco-421; C8—Arco-400; L1—15 turns no. 26 on 3/16" o.d. form, center tapped; L2—8 turns no. 22, on 3/16" form, center tapped; L3—3 turns no. 20 tinned bus wire, air-wound, 3/6" diameter, 3/8" long, with 1/4" leads on each end. Tapped one turn from ground end.

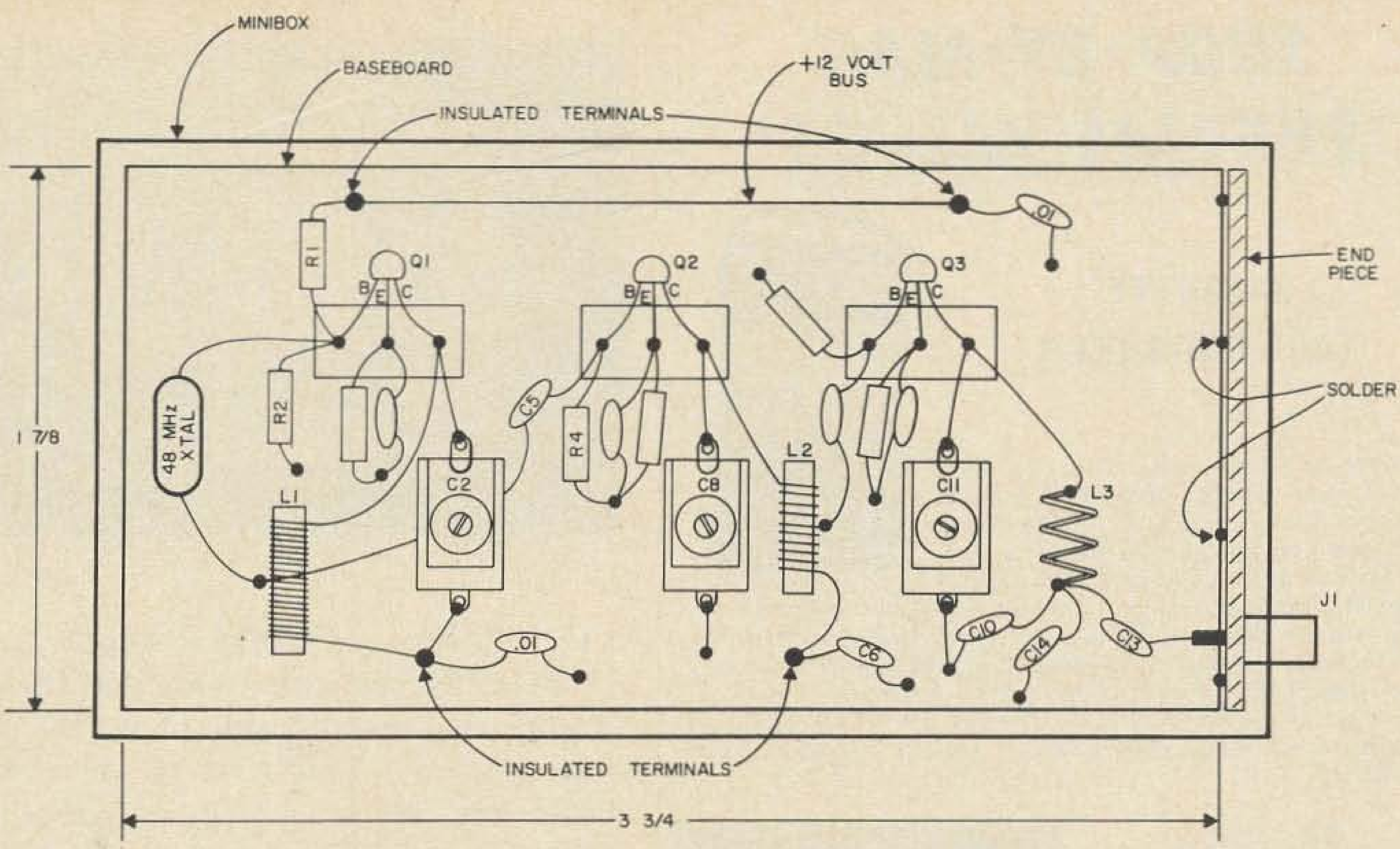


Fig. 2. Layout. This is not a complete schematic. Some wires have been left out for clarity.

good, with the worst being the only 48 mhz one in the lot. So I had to order some more pronto.

Changing L1 to a well-known airwound coil of 16 turns to the inch, ½ inch diameter, and making C1 a good variable 100 pf with an insulated shaft and a knob, I found 48 mhz and everything came back to normal.

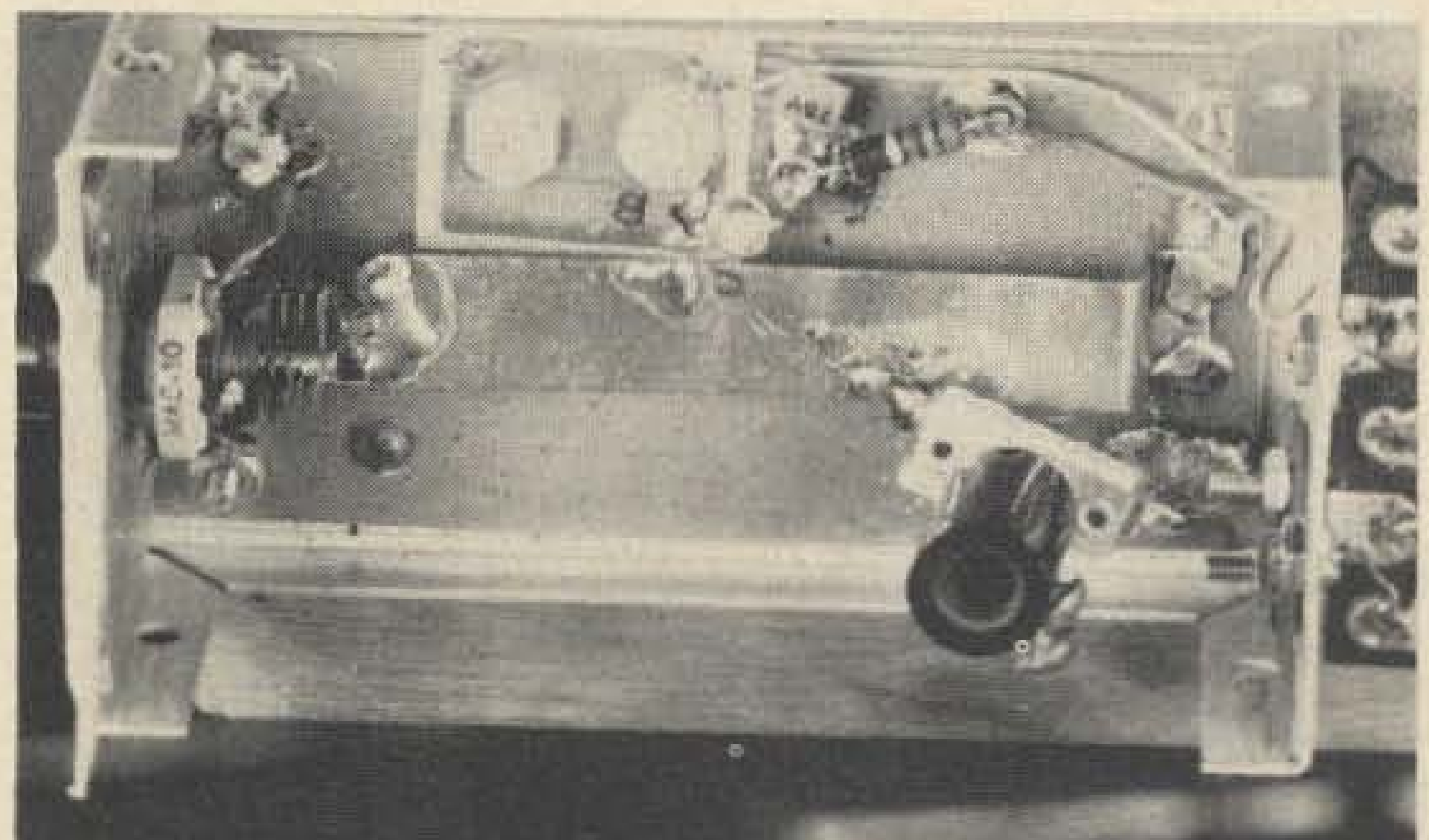
The perfect oscillator

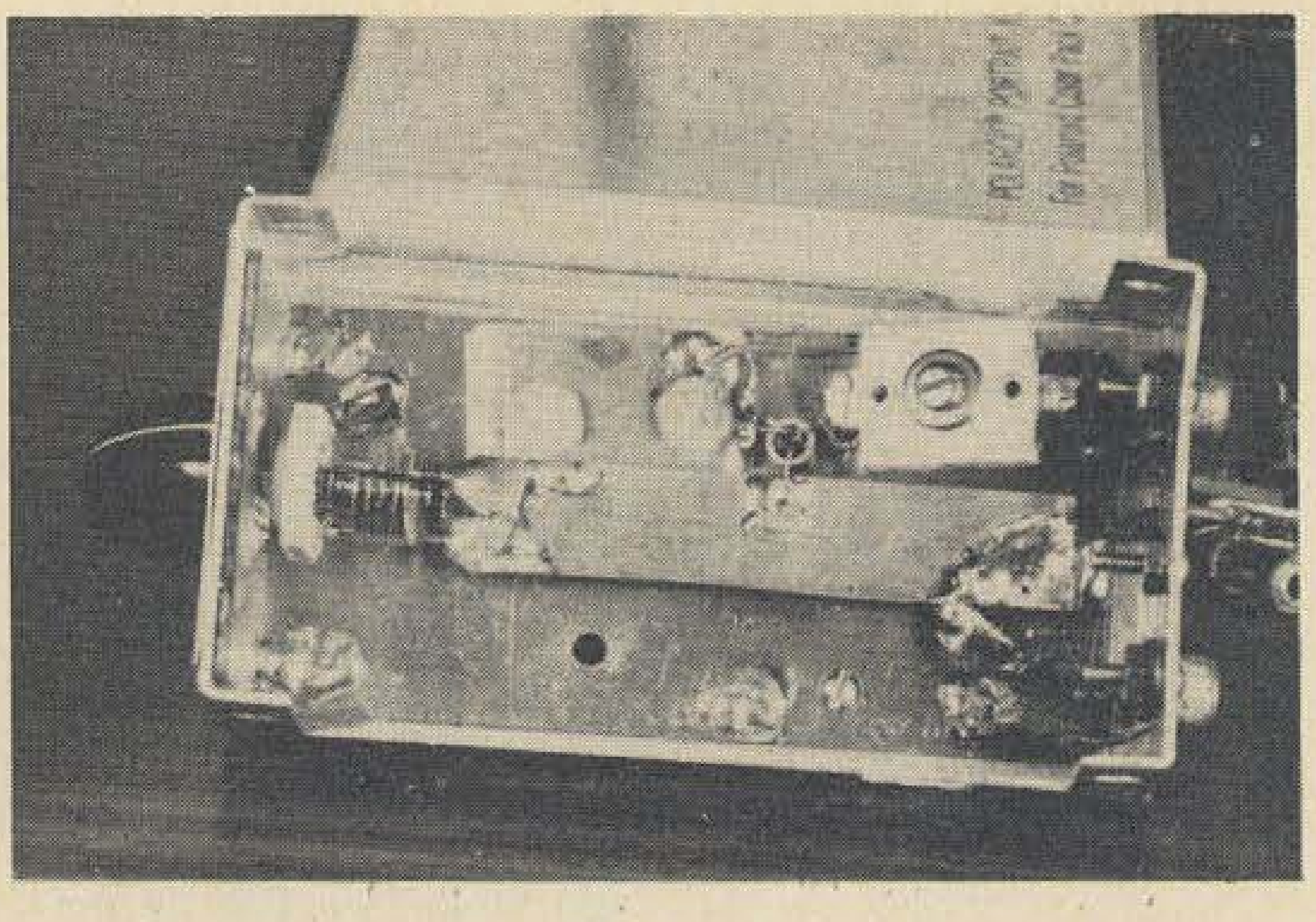
In the proper condition with a good crystal, the perfect oscillator works as follows. With the 100 pf variable capacitor, oscillation will occur when L1 is tuned to 48 mhz, as can be seen on the dc output meter with a tuned circuit for a frequency check. Also, I check with my lab receiver, at present an Ameco R5 .5 to 54 mhz, by listening to the carrier itself *without* the bfo, and with plenty of audio. This way you can hear small spurious rf clicks, etc., as they develop and when they occur. With everything working properly, even tuning C1 does not shift the carrier out of the receiver band pass of some 10 khz.

As you approach maximum power output by reducing C1, a point will be reached where it stops oscillation. Do *not* operate on this point. Back off a ways beyond the maximum power output point, making sure it comes on the air immediately with the battery switch every time. With a little listening as well as watching the output meter you will get the feel of it and have confidence in it. After all, a transmitter (today at least) no matter how big, has to start with an oscillator so it had better be good.

Phase-reversing crystal circuit

Please note that this is my long-time favorite circuit in which the degenerative, or negative feedback connection is used, which only becomes positive at the crystal frequency. The regenerative circuit (not this one) with the base on the other end of L1 from the collector and 180° out of phase, uses positive feedback all the time and is very critical as to just the right amount of feedback, and is liable to take off at a moment's notice on other frequencies under





the influence of slight changes. A crystal operates by changing polarity at its resonant frequency, thus one side of it (one connection) is always 180° out of phase with the other side. When on frequency this puts the base out of phase with the collector, which of course is the proper condition for oscillation.

Coils L1, L2, and L3 are small, so this exciter will fit into a 2 inch by 4 inch minibox (it did, and room for batteries as well).

L1 was wound up on a 5/32 O.D. phenolic form with no. 38 wire just to check on the influence of small wire at 50 mhz in an actual oscillator circuit. It worked just as well as the airwound coil.

Small Components

This 432 mhz exciter in a 2 inch by 4 inch box with batteries is an example of what can be done at low cost by almost any amateur with a good pencil type soldering iron, (I recommend American Beauty. Have one of them running for almost ten years now and it hasn't burnt out yet.) tweezers, and today's small components.

The low cost "plastics"

Motorola has come out with a line of semiconductor products labelled "HEP", for Hobbyist, Experimenter, Professional. Included in this line of low cost goodies is the HEP 56, which so far answers my search for a "universal" transistor for general amateur use up through vhf and uhf. In my work with it, starting with a 48 mhz rock, it triples to 144 and up to 432 mhz like a bird, and puts out a good solid, stable signal.

Small resistors

Tenth watt resistors are listed by mail order houses so you can get those without trouble. The crystal oscillator stage emitter resistor has about a volt at 5 to 10 milliamps across it, which even by my pre-computer age arithmetic, is still only one hundredth of a watt. I used a selection of tenth watt Allen-Bradleys over 12 years ago when building subminiature tube (remember?) transmitters and to look at those little tiny things that they are, you wonder how they hold up, but every one of them still checks out within the rated tolerance of their listed value. And they all work well in other respects also.

Small capacitors

Lafayette still holds the field here, for my money. Granted, they're "imported," but isn't it one of our business creeds to see that "other people" import *our* goods? Anyway, they work. A .001 bypass is 1/8 inch square. And being small as they are they work at 432 mhz, which is more than you say for a lot of others. They must be soldered with TLC though, and the temperature specs read

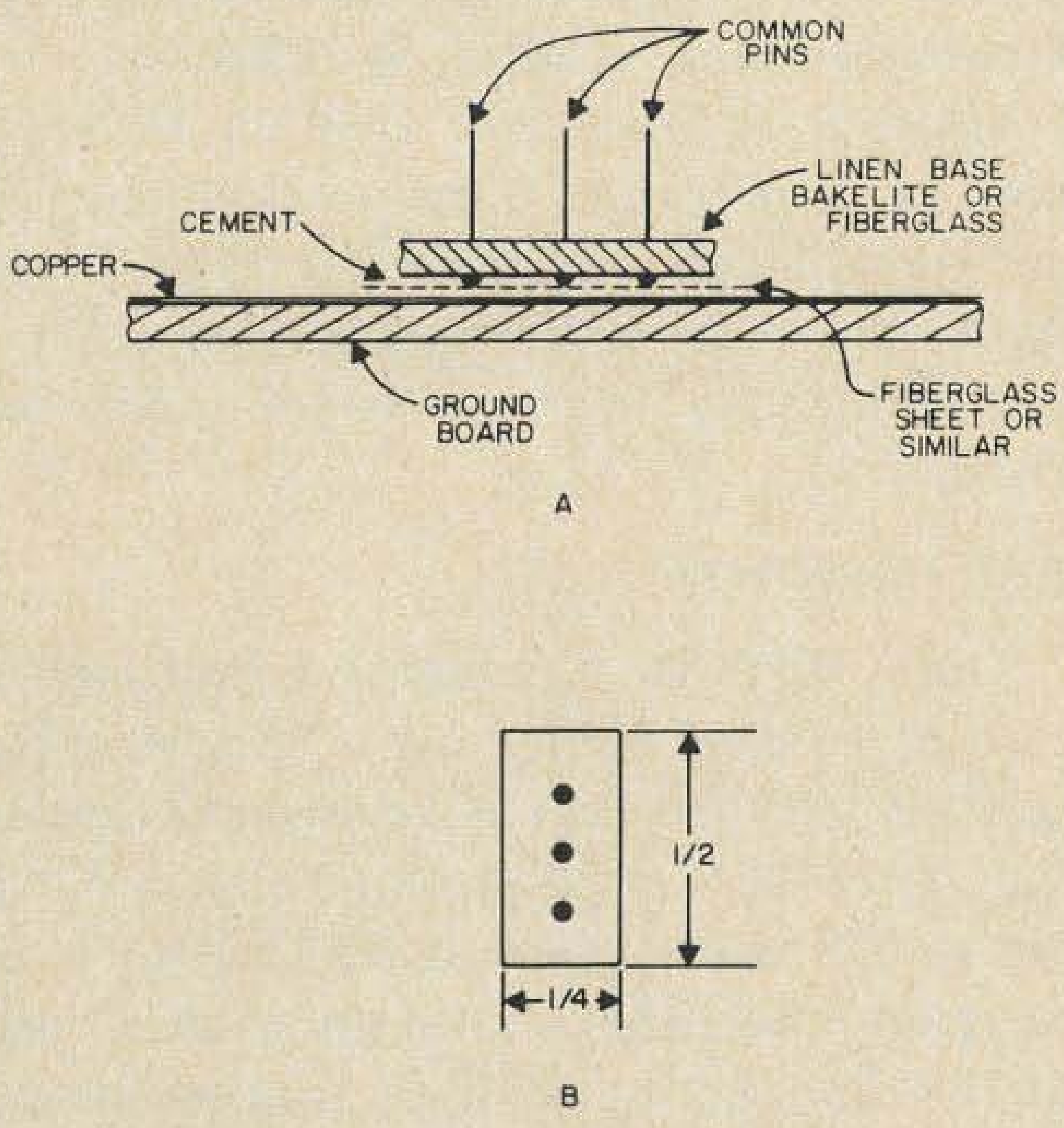
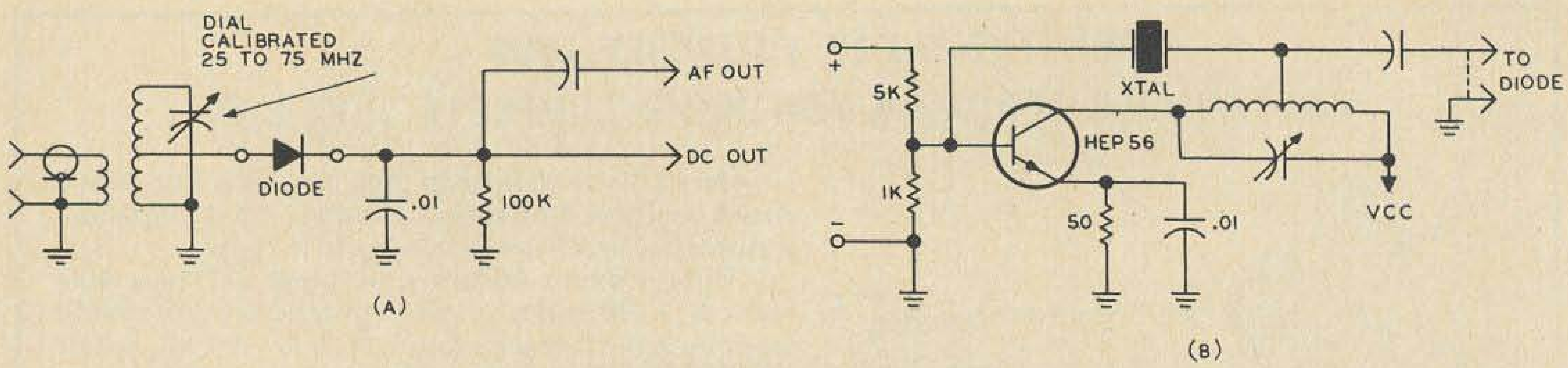


Fig. 3. Homebrew sub-miniature terminals.

"minus zero, plus 100%" which means they may increase capacity like mad on a hot summer's day, but who cares for a bypass? Just so they don't *drop* in capacity. They are made with a magic formula called "High K" whose dielectric constant may be several



Figs. 4A and 4B. Diode checker and oscillator.

thousand that of air (fresh air, that is—no L.A. smog).
stant may be several thousands that of air

For coupling use at rf, the small dipped micas are good, but again not as small as I'd like to see. Mica compression trimmers are not really small enough either but I'm working on that one. I don't like the ceramic rotary ones simply because you can't tell where you are with them. If they would only include a simple printed dial on them, be it ever so small!

Inductors

No trouble here. Nothing over 5/16ths diameter is needed, and they all tune up fine.

Sockets and/or terminals pins

This is a tough one. I make my own out of common pins, (see**Fig. 3**) and small pieces of bakelite or fiberglass. Drill an .020 hole, hammer in a common pin of diameter .021 and you've got one terminal. The layout, **Fig. 2**, shows how this makes things easy for you, especially with a copper-clad baseboard.

Small transistors

The HEP 56 transistors mentioned are small of course, being only .185 inches high, which is still less than three sixteenths of an inch. They have good strong leads, and every one so far works well at 432 mhz. I can't see much else in that little minibox. Crystals can be had about ¼ inch square, at more money of course, but there was room in the box for a "monster" all of 3/4 inch high which I used because I had it.

Diode noise

It is of great importance when you tune up this multiplier or any multiplier for that matter, to be able to listen to the carrier from each stage as you build, or to uncouple the stages and check each, one at a time at its frequency, for noise, spurious radiation, etc. **Figs. 4A and 4B** show the diode checker and oscillator being tested. Use sufficient af amplification to show up "rf jumps," hiss, tendency to squeal, tuning clicks, and other signs of instability or non-smooth tuning. I sometimes use a scope also as then you can look, listen, and measure, all at once. It was while doing just this that I discovered that some diodes are very noisy under rf. I don't mean the noise figure on small signals, I mean that with several volts of rf some diodes at different vhf or uhf frequencies show a lot of noise that you might very well attribute to the stage or oscillator being tested. This is just what I did myself, losing more than half a day on the deal, until finally I tested a dozen or so different diodes here and found only two or three out of ten that do *not* show noise, one of them being my old favorite the 1N295. This one will put out 5 volts of dc, and still be absolutely quiet, either on 144 or 432 mhz. Of course, running lots of af in this fashion, you can hear plenty of action when you touch parts of the rf stages. After all, you're making up the rf carrier for your future rig. Do you want it to be noisy even before you modulate it?

Crystal oscillator

To start with, I see no reason at this time for a vfo on 432 mhz for normal operation. You can order a couple of spare crystals later, a little further up in the band in case of a band opening when the "big lads" would probably swamp you out, and that should be about it. After building this stage as shown, I hooked the diode tester to the output capacitor C5, and tuned it up as detailed in previous paragraphs. The layout,

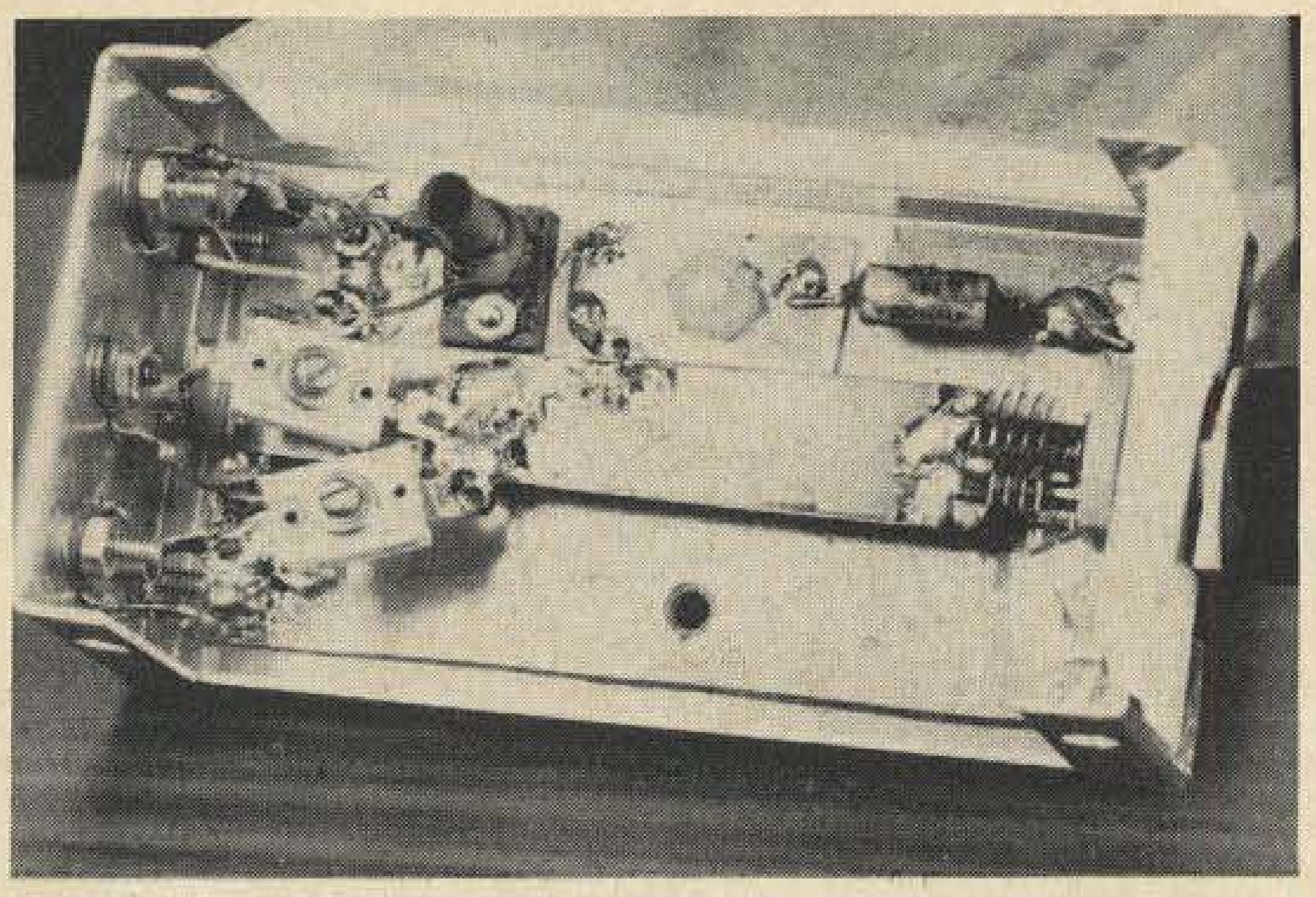


Fig. 2 should help also. I was surprised at what a neat package the whole thing turned into, with plenty of room everywhere.

Coupling circuits

A center tap on L1 and L2, plus the proper values of capacitors for C5 and C9 does the job.

Be sure and listen to the output for noise. I have heard $400 to $600 SSB exciters that sounded like a freight train running before any modulation was applied. The output coupling capacitor needs a little more attention.

First tripler

Another HEP 56 was installed and showed good tripling energy power out on 144 mhz. A little roughness or tendency to jump a bit with tuning was encountered using a choke coil from base to ground, so a resistor of 1K, R4, was put in its place, no loss of power was noticed, and the operation under tuning showed no spurious or jumping of any kind, just a nice clean smooth resonance curve with C2 and plenty of signal power

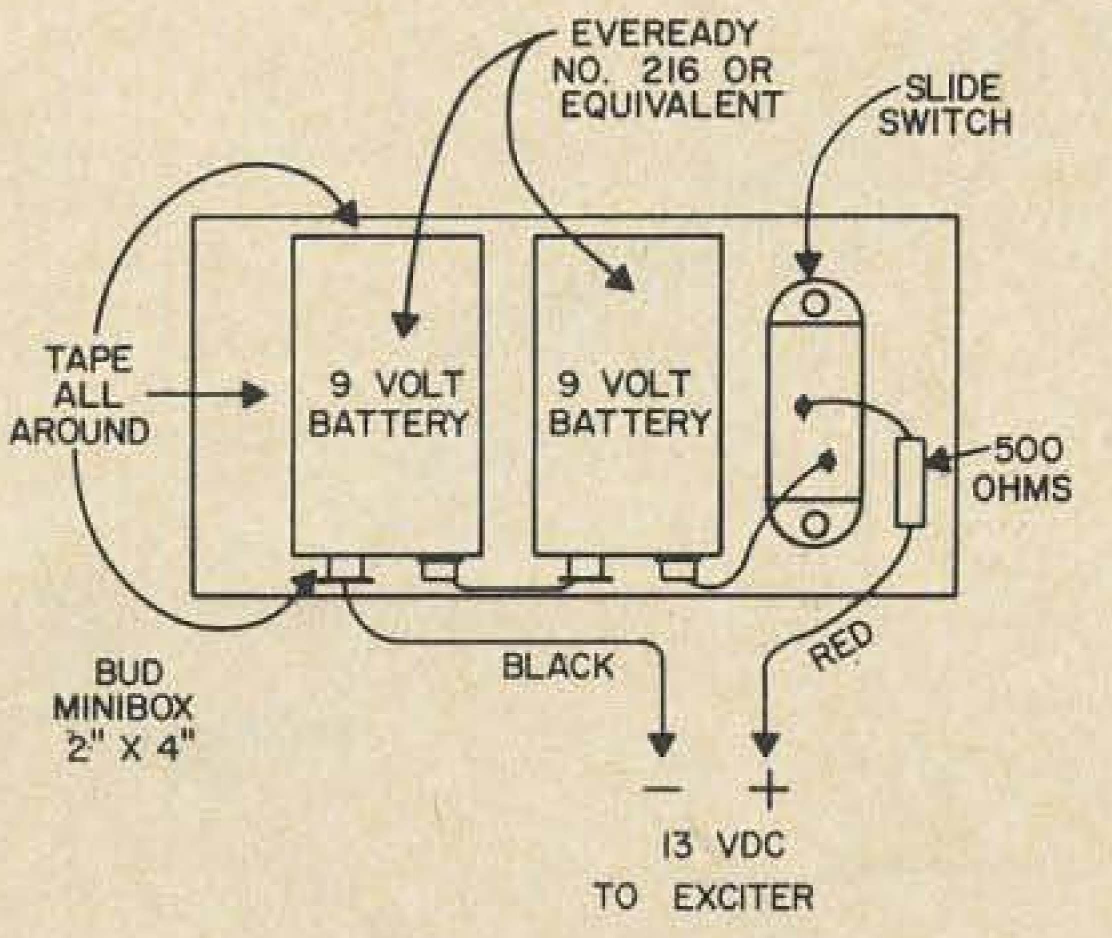


Fig. 5. Batteries and switch in minibox cover.

output. A good three volts on the tuned diode circuit was obtained at 144 mhz.

The emitter resistor was adjusted to its final value for use in this tripler stage. Don't forget that for different harmonics, different bias values will generally be needed.

Milliamps will run between three and five for this stage, depending on the transistor used, and how hard you push it.

Second tripler

The third HEP 56 was wired up and it developed 432 mhz energy almost immediately. I had decided to try a completely conventional coil and capacitor circuit with these small components and it paid off, as you can see in the schematic, **Fig. 1**. Adjust the output tap on L3 and the capacitor value of C13 for the best match to your cable and load. In this unit the tap worked best at about one turn from the ground end.

Between one and two volts of rf at 432 mhz was obtained in the diode test circuit. This has gone 25 miles in the past, but the unit is really just an exciter. Two batteries and a battery switch were wired into the minibox cover just for show. See **Fig. 5**.

Collectors with DC ground

Just in case you were wondering why I didn't use that method here, after much success in receivers, rf stages, etc., I'll have to confess. I did use it here, in fact I built the whole three stage exciter using dc grounded collectors, and ran into uncontrollable noise, spurious radiation, and feedback. The final circuit on **Fig. 1** with collectors off ground operates so smoothly and trouble free that no comparison is possible.

Overall results

Putting the minibox cover on, with batteries and switch installed in it (see **Fig. 5**), no trouble occurred. A cable over to the diode checker tuned to 432 mhz showed good rf voltage, and a dipole plugged in radiated. As mentioned, you can work out with this, but let's put at least one rf amplifier after it before modulating. Of course, all kinds of ideas can be generated here, like putting it in a long minibox with rf amplifier, modulator, plug in a beam antenna, etc.

. . . K1CLL

W. Edmund Hood W2FEZ
223 Pullman Ave.
Rochester NY 14615

Fascinating Fundamentals I: Electrostatics

No one can really say who the discoverer of electricity was. Long before the birth of Christ, the Greeks were aware of the mysterious properties of Amber. Amber is a glass-like clear yellow substance. Once the resin of ancient pines, it has been slowly petrified by the ages. The early peoples noticed that, when briskly rubbed, a piece of amber would draw tiny bits of hair and dust. As if hurled by some unseen force, they would suddenly leap up and cling to the amber. Then, just as suddenly, they would fly away.

For centuries, this phenomenom remained a petty curiosity. Then, as the knowledge of mankind advanced, it was destined to be the key to man's most miraculous achievements. The Greeks called amber ELEKTRON. From this modest beginning comes electricity, electronics, and the name of the real culprit, the electron.

We know today that the electron is that tiny bit of stuff that orbits around the nucleus of an atom, but this was far too advanced for the early pioneers of electrical science. Hampered as they were by fear and superstition, their progress was painfully slow. For example, one of the earliest observers of the properties of amber was Roger Bacon (born 1214). Although he was at first encouraged by an enlightened pope, he was eventually branded as a blasphemer and cast into prison. He came out in 1292, an old man.

Bacon's observations were the first really clear ones. But it was not until 1600 or so that William Gilbert, a private physician to Queen Elizabeth I, began to introduce some light on the matter. Gilbert discovered that many substances showed these properties. He called them "electrics." The force he called "vis electrica." He even made a crude instrument for measuring the electrical attraction—the "versorium." His work was widely published, and drew praise from the great Galileo.

None of these early pioneers, however, could understand or discover the reasons for the phenomena they observed. They had no precedents to refer back to, and even the best of their tools were clumsy by our standards. They had to grope their way along. We are fortunate in that we can back-track on the trails of progress and examine their discoveries in the light of modern knowledge.

The secret lies hidden within the tiniest of particles—the atom. An atom is itself composed of particles—particles of energy. The most readily accessible of these is the electron, the work-horse of electricity.

An atom is made of three kinds of primary particles: protons, neutrons, and electrons. The inner part consists of protons and neutrons, while the electrons revolve around this nucleus like planets around the sun. Of these three particles, only protons and electrons are of electrical importance, electrons primarily.

Let's try a simple experiment. Take a glass rod, and rub it briskly with a piece of silk. Now hold it close to a few splinters. The splinters will leap up to the glass, cling to it for a few moments, then fly away.

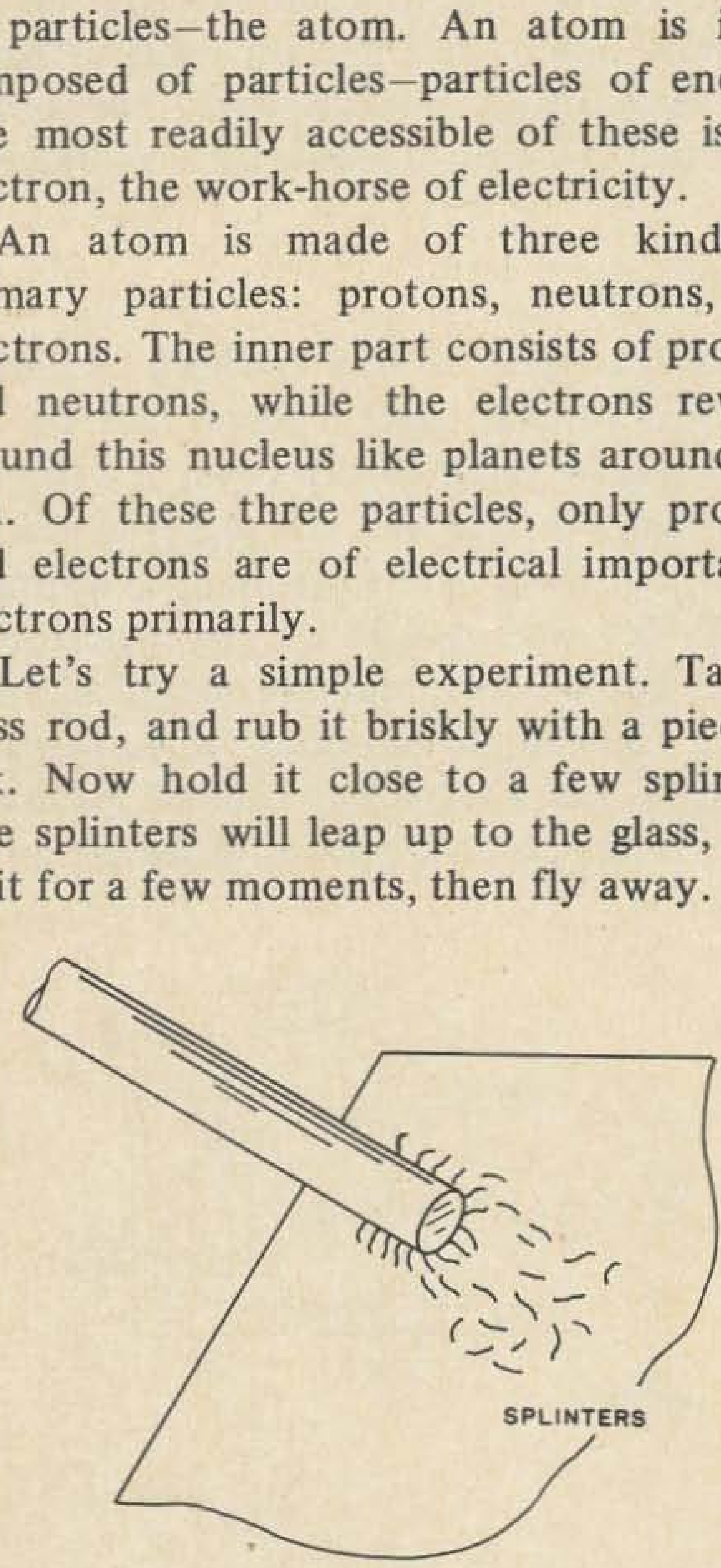


Fig. 1. Glass picks up splinters

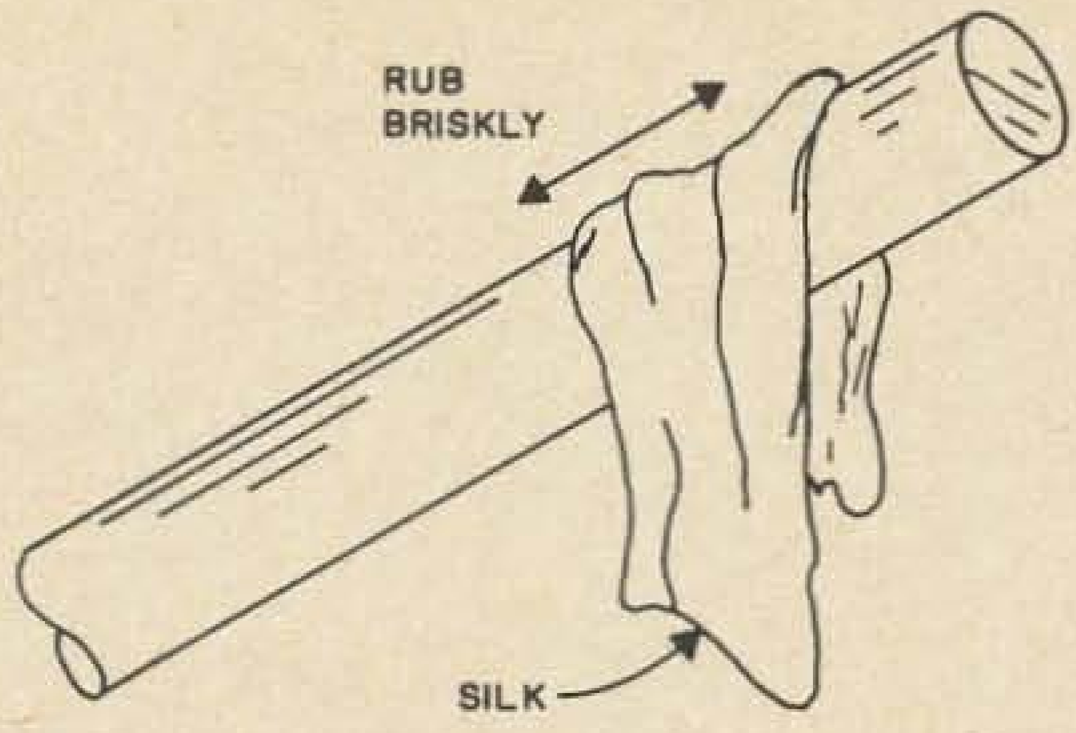


Fig. 2. Electrons are wiped off the glass.

When you rubbed the glass, you actually wiped electrons off the atoms on the surface. (When there is a shortage of electrons, we call it a POSITIVE charge.) Any electrically charged body will attract uncharged particles. As the splinters clung to the glass, it drew electrons away from them. Soon they also had a positive charge. Two objects with the same electrical charge will repel, or push each other away.

Take a piece of hard rubber and rub it briskly with a piece of wool or simply draw a hard rubber comb through your hair. This rubs electrons onto the rubber, making a NEGATIVE charge. A toy balloon rubbed on your shirt sleeve will stick to the wall, because it becomes charged.

There are a great many materials which you can charge by rubbing. A piece of paper will cling to the wall after being rubbed with a wooden stick. Your clothing, rubbing against the seat of a chair, or an auto seat will generate enough electricity to give you a snappy shock!

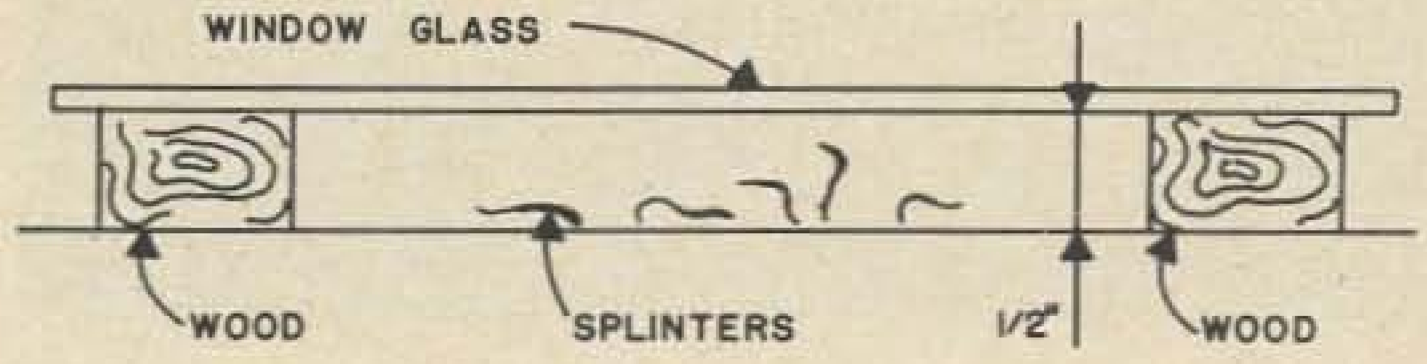


Fig. 3. Wipe the glass and watch the splinters dance.

Here is an easy-to-make demonstration. Sprinkle a few splinters on a table-top. Place a piece of glass about ½inch over them. Wipe the glass briskly with a silk cloth, and watch the splinters dance! This works best on a dry day; the dryer, the better. On a rainy day it may not work at all.

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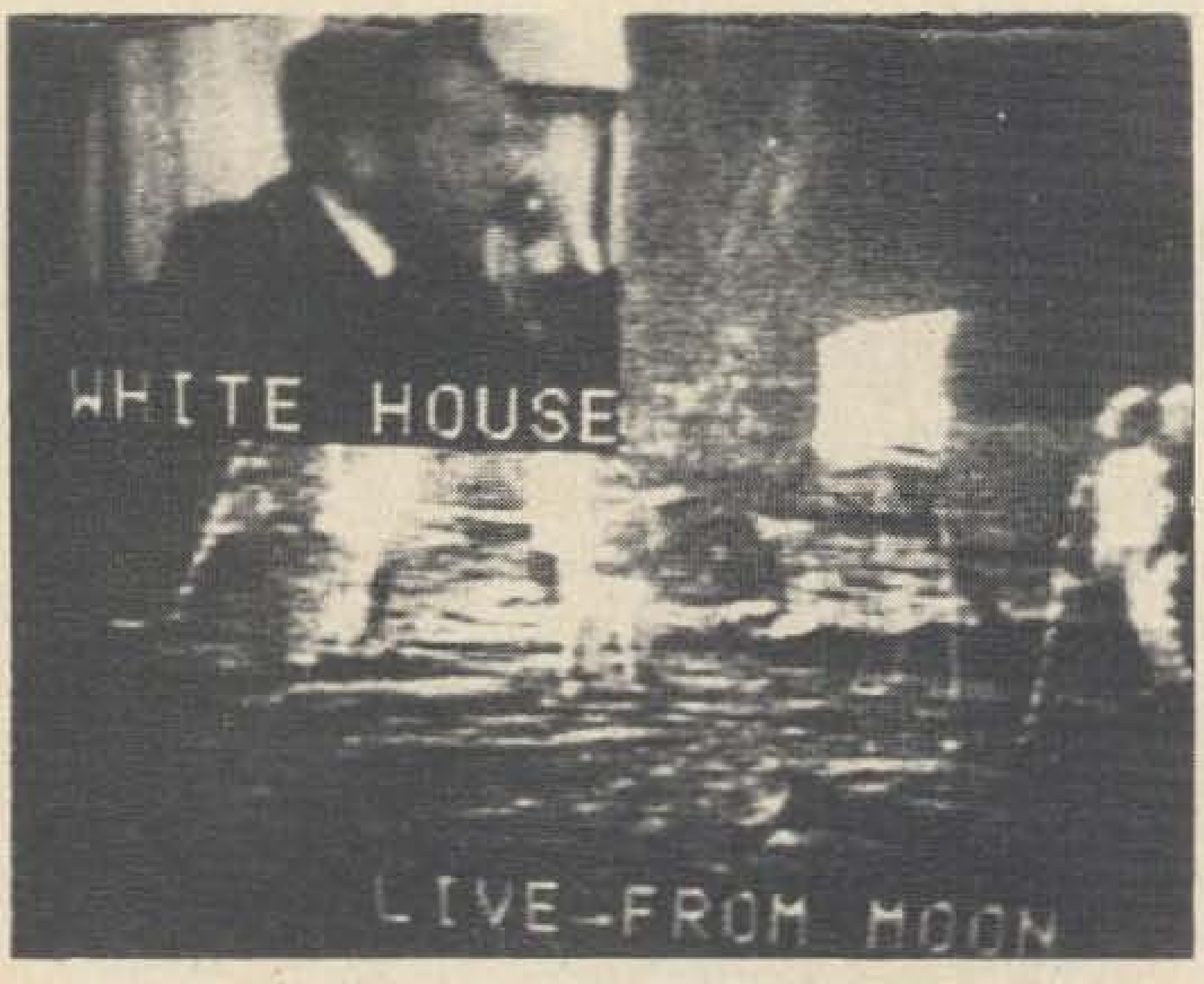


Tom Laffin W1FJE-TV
Hillsboro NH 03244

Apollo TV & Radio

The television camera used on the lunar surface during Apollo 11 and also on the Apollo manned flights prior to Apollo 10, was a black and white (monochrome) RCA slow-scan camera with a 320 line horizontal, 10 frame per second vertical format. The color television camera used in the Command Module of Apollo 11 and Apollo 10 was a three-color wheel Westinghouse camera with a commercial format of 525 lines and 30 frames per second. The three colors are transmitted sequentially, recorded at the site of the deep space antennas, and sent without delay by commercial microwave networks to Houston. At Houston the three colors are converted to commercial mode, or dot-sequential, and released to the commercial broadcasting networks. On Apollo 10 and Apollo 11 the video signal was frequency modulated onto a 2272.5 mhz carrier from the Command Module. During the television transmissions no other signal was multiplexed on this particular carrier. However, the Command Module had another S-band carrier at 2287.5 which was frequency modulated with voice and telemetry, on sub-carriers at 1.25 and 1.024 mhz respectively. In addition, the psuedo-random noise code used for ranging was also multiplexed directly on the 2287.5 mhz carrier. The frequency for the seismometer left by Apollo 11 is 2276.5 mhz. The seismometer frequencies for Apollos 12, 13, and 14 are 2278.5, 2275.5 and 2278.5 respectively. To receive any of these frequencies, you would require a very sensitive receiver, and an antenna with a gain on the order of plus 44 db. There are a few companies which manufacture suitable microwave gear and at prices beginning at a few hundred dollars. The transmitting antenna for the Command Module on Apollos 10 and 11 was located on the Service Module and its forward gain is about plus 27 db. (This antenna was referred to as "the high gain antenna.") The lunar module of Apollo 11 utilized a third S-band frequency with the erectable parabolic reflector placed on the lunar surface. This portable antenna has a forward gain of plus 32 db and was used throughout the exploration. Both the RCA camera left on the moon and the portable antenna, as well as other equipment, are scheduled for further use in future missions to the first lunar landing site.

In addition to the unified S-band system, a VHF system can be used alternatively, and the VHF system of Apollo 11 provided voice communications between Armstrong and Aldrin, and between the lunar module and the command module. The VHF system is redundant to the S-band system, and the lunar TV, audio, and bio-medical data could have been transmitted directly on VHF to earth. Two VHF frequencies were provided at 259.7 mhz and 296.8 mhz. The 296.8 mhz frequency was used for voice communications between Armstrong and Aldrin, and between the lunar module and Mike Collins in the Command Module. In the Command Module of Apollo 10 and Apollo 11 is a second redundant audio-only transceiver, referred to as the "high frequency" system, and the operating frequency was just above WWV, at 10.006 mhz. In the Service Module, a recovery beacon operates during splash-down on a frequency of 243 mhz. (Note: The mixer-diodes used in commercial UHF-TV work well at these VHF-UHF frequencies.) A Sylvania "walkie-talkie" is also included in the service module to aid in recovery and to provide communications between the recovery vessels and the astronauts.

The types of emmission for audio is mostly FM, although communications between the lunar module and the Command Module was AM during Apollos 10 and 11. The types of emmission for telemetry include a variety of PAM/FM/FM, PCM/FM, SS/FM, SF/FM, on twenty-six channels. When television is not on, tele metry is multiplexed on the various S-band frequencies. When the telemetry is used on VHF, the frequencies used fall between 226.2 and 258.5 mhz, with one microwave channel in the Instrument Unit (used during launch only) on 2277.5 mhz. Other specific VHF frequencies used on Apollos 10 and 11 include 230.9 and 237.8 mhz for the Command Module, 247.3, 257.3, and 228.2 mhz for the lunar module. In only the lunar module, an altimeter was provided which operated on the X-band. A backup unified S-band system included frequencies of 2101.8 mhz (to the lunar module), 2282.5 mhz (which was used on Apollo 11) (from the lunar module), and 2282.5 mhz (used from the Command Module), and 2106.4 (to the Command Module). The average speed of the telemetry data is about 1200 bits per second, although the stations at Goldstone, California, Cape Kennedy, Florida, and Houston, Texas, have no upper speed limit. During Apollo 11, the huge dishes at Goldstone, California, were used at all possible times, although a massive global communications network (NASCOM) provides constant communications regardless of the tangent or orientation of the earth. The global network communications myrad is centralized at the Goddard Space Flight Center at Green Belt, Maryland. The relay frequencies include many which can be received on ordinary general coverage receivers with telemetry having frequency precedence. (These frequencies can be obtained by writing the Goddard Space Flight Center.) . . .W1FJE-TV

Peter Bertini, K1ZJH
257 Elm Street
Windsor Locks, Connecticut 06096

The Receiver –

The Overlooked Piece of Test Equipment

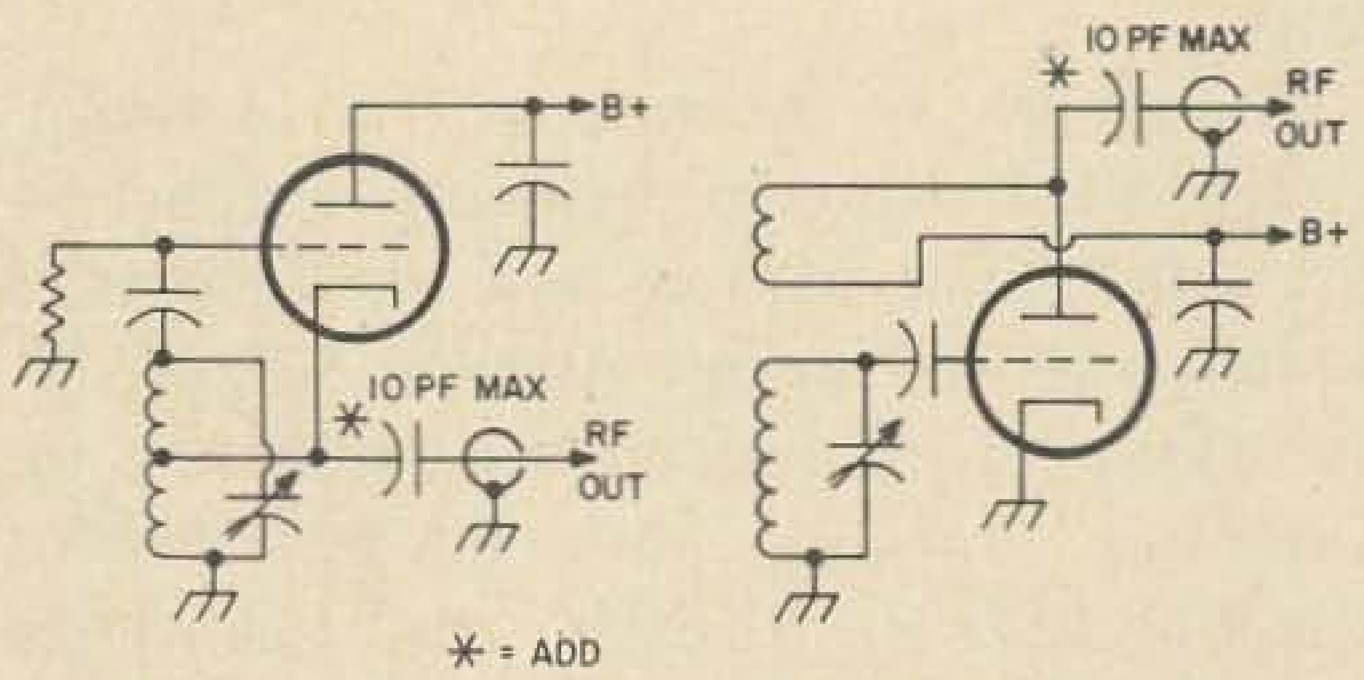
Mention test equipment, and the usual picture of a bench loaded with scopes, meters, tube checkers and various other equipment comes to mind–rarely does one find a receiver used as a standard piece of test gear. For many years the common receiver has been overlooked as a valuable addition to any test bench.

Recently I acquired a RBM-4 surplus Navy receiver after a round of trading. Having a SB-300, a NC-183 and various other special purpose receivers and transceivers, I was hard pressed to find a spot for the old workhorse. It eventually wound up on the test bench and it wasn't long before I realized its worth as a versatile piece of test gear. Besides the usual uses of a receiver-converter alignment, VFO alignment, checking for parasitics and harmonics–there are many other uses it can be put to on your work-bench.

Signal Generator

The receiver can be used as an excellent signal generator. Just couple lightly into the local oscillator and install a BNC connector on the front panel and you are in business. To read the frequency, all you have to do is read the frequency of the band in question and subtract the *if* frequency from it.

Some receivers have the local oscillator operating on the high side of the received frequency; in this case add the *if* to the received frequency to find the frequency of the local oscillator. With a general coverage receiver you will get enough range to cover most of your alignment needs. The receiver should be recalibrated after this modification, since the original calibration may be affected by the added components. Also remember any load placed on the *rf* output will cause a small change in frequency. In any case the signal will be as stable and accurate as many of the medium priced signal generators on the market.



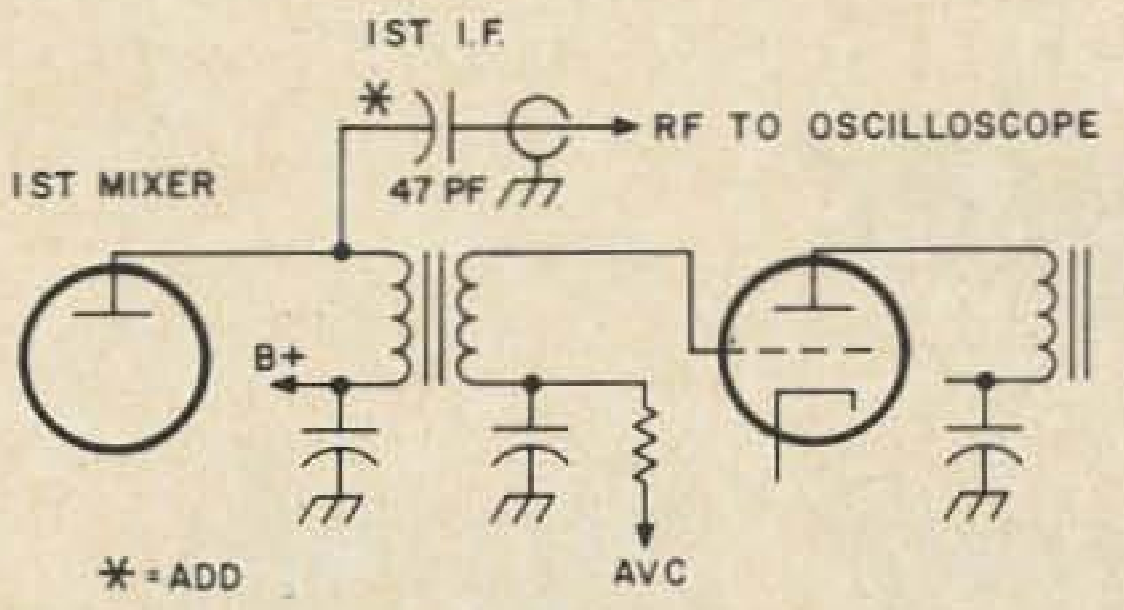
COUPLING FOR USE AS A SIGNAL GENERATOR

General Purpose Audio Amplifier

The audio amplifier may be coupled in to provide your workbench with a general purpose audio amplifier. This is an easy modification. Install a switch on the front panel which will either select the output from the detector or the input of a phono or similar jack installed on the rear apron of the receiver. Many older receivers have provisions for playing a record player through the receiver amplifier. In this case you are already set.

Modulation Monitoring

In addition to being able to listen to a signal being received, it is possible to get a visual presentation of the signal on your oscilloscope. You can monitor your own signal as well as those of others without any direct connection to the transmitter being monitored. This is accomplished by coupling the vertical input of your scope to the first *if* transformer with a 47 pf capacitor.



USING THE RECEIVER FOR MODULATION MONITORING

Use shielded wire between the oscilloscope and the receiver. Realign the *if* stage in question, and you are ready to go. Be sure that your scope's vertical amplifier is effective at the *if* frequency! Another word of caution—while this is a very effective means of monitoring, several things must be remembered. Distortion may be introduced by the *if* itself. Few *if's* are completely linear; the avc will introduce some distortion too. The signal may be strong enough to overload the *if* stage. All of this can cause a false reading, so before you tell someone his signal has imperfections, make sure it is not at your end.

Audio Oscillator

If you need a quick source of audio, the receiver will again come to your rescue. Simply beat the bfo against the harmonic of a crystal calibrator. If one is not built in, use the output of your signal generator. If the receiver dial has 1 khz increments, you can get within a few hundred cycles of the frequency you want. Unfortunately the upper frequency limit is limited by the passband of the *if* and the audio stages. You should be able to get up to several khz with most receivers.

Many hams have old standby receivers that will not quite fill the requirements of today's crowded ham and swl bands. They have been relegated to gather dust on shelves, and now is the time to put them to work for you again. The number of things that can be done with one appears to be limitless. It all depends on what you need and what you have. The old adage "necessity is the mother of invention" certainly holds its own in this case.

. . . K1ZJH

John Bell W5NGX
208 Pat Street
Levelland TX 79336

A Voltage Sextupler Power Supply

(Or, How to Get 900 Volts without a Power Transformer)

In a recent article in 73 Magazine, I described a transformerless ½ wave voltage quadrupler transceiver power supply, operating directly from the 117 volt ac line, delivering 600 volts high voltage, low voltage and bias. Since the article was published considerable comment has been received from readers. I might add that 100% of the comments were in favor of such a supply, due to the many advantages of the transformerless, voltage multiplier type. Typical comments were,"That's a FB power supply, Johnny, and I like the idea of no power transformer, but my brand of transceiver calls for 800 volts, and your quadrupler only supplies 600 volts dc. Isn't there a way to use the same idea and give more high voltage?" The answer to the question is affirmative, and it takes the form of a voltage sextupler, which multiplies the input voltage by six. The circuit is an extension of the modified quadrupler. Actually the resultant output voltage is more than six times the input voltage, about 7.5, because the capacators charge up to the peak of the ac voltage imposed

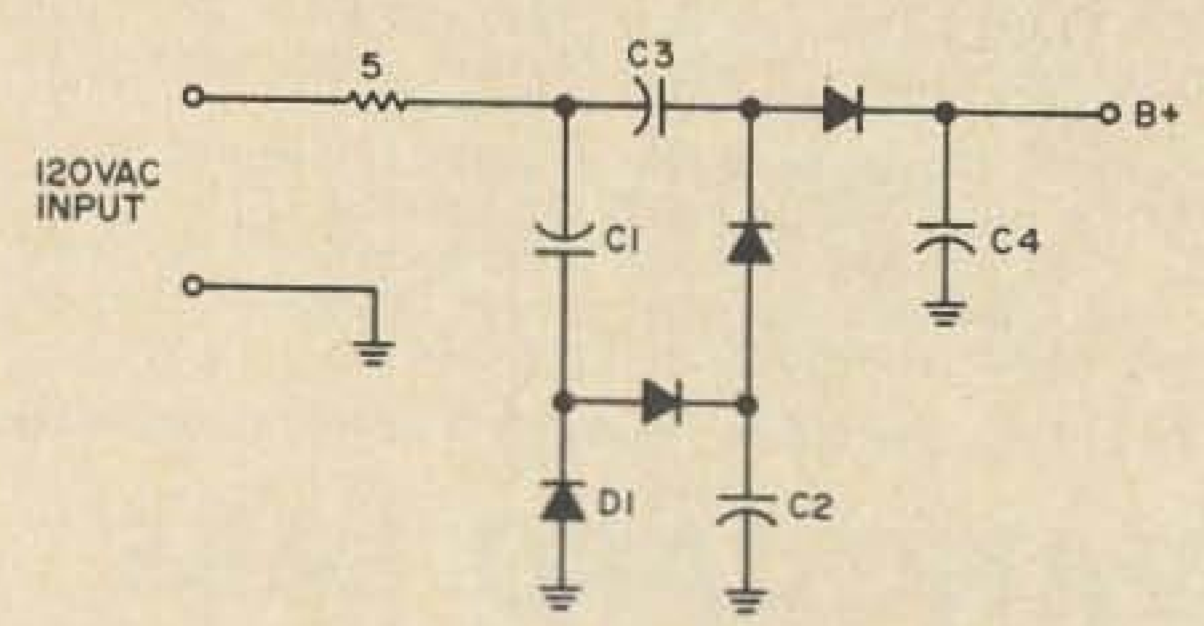
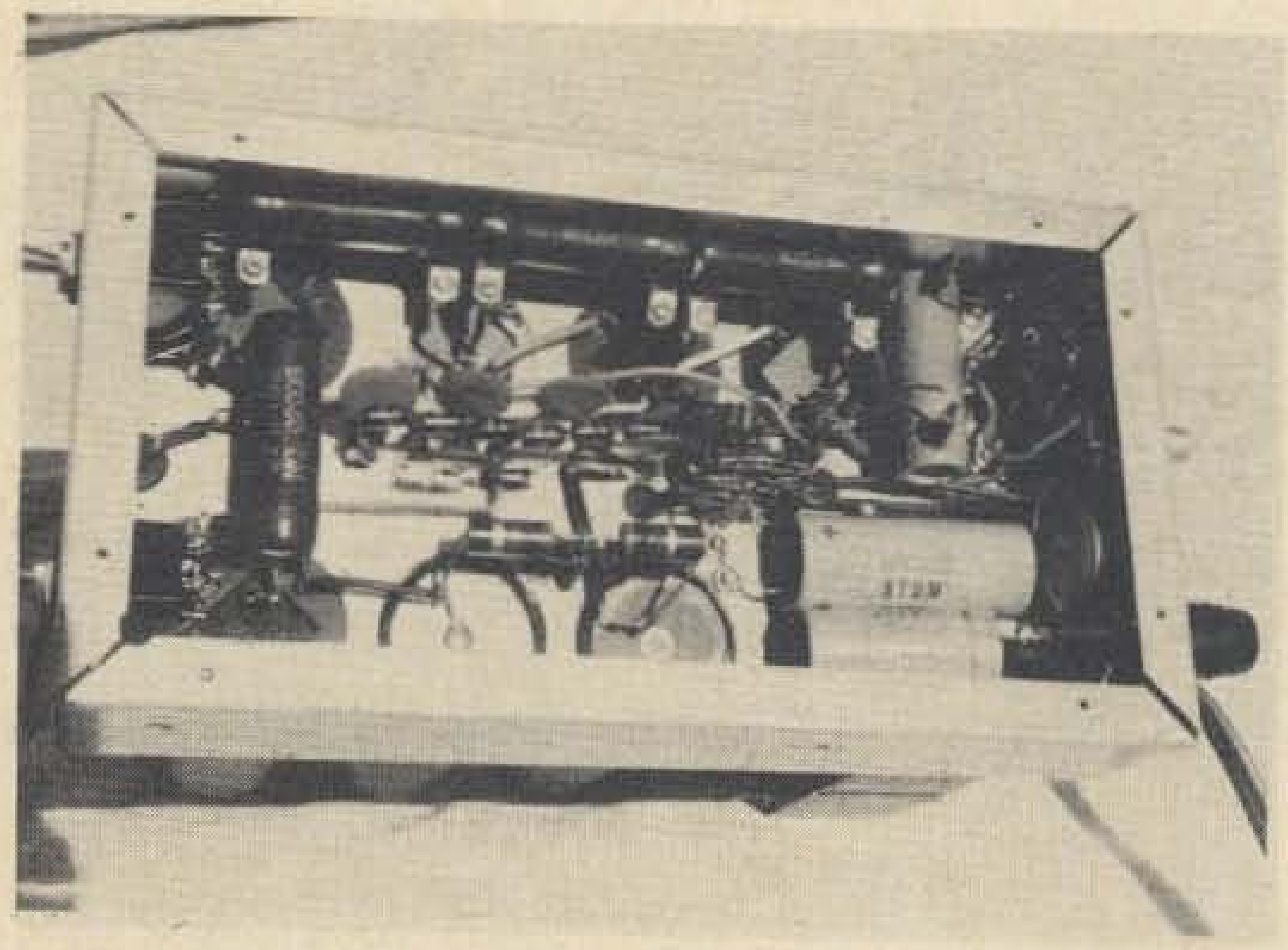


Fig. 1. Conventional half-wave quadrupler. Full output voltage is across C4.



Underchassis view. C5 & C6 are in foreground, are the tubular type, mounted vertically.

on them, and after rectification more dc results than the average value of the ac input. Output dc is 900 volts with low voltage and bias.

This sextupler voltage multiplier circuit was evolved from the modified quadrupler used in the previous article[1]. Figs. 1, 2 & 3 show how the circuit was developed. In fact, this voltage multiplication process could be extended an infinite number of times, but electroletic capacitors have to be used in series, and when they do the effective capacitance is reduced. So there is a practical limit to this multiplication business, as the regulation begins to suffer as the effective capacity is decreased.

I have never seen this circuit in any of the textbooks, but it is a practical circuit, and the results are excellent. Voltage regulation is good, but not as good as with the quadrupler, due to the fact that the output capacitance is made up with C2, C4 & C7, three 300 mfd. capacitors in series, giving an effective 100 mfd. C5 & C6 in series make up the capacitor for the fifth multiplication. Two 200 mfd. at 450 volt units giving an effective 100 mfd. All capacitors are of the twist-lock, can type, except C5 & C6 which are tubular type, since no manufacturer makes a 200 mfd 450 volt type in a can. The photographs show the type brackets used to mount the tubulars in an upright position on the chassis. The 900 volts high voltage drops about 80 volts under 250 ma voice peaks, which is still under 10% regulation. Not bad for this type of power supply, or any other hv supply. The low voltage tap only drops about 5 volts, under voice peaks.

A 5 x 9 x 2 inch aluminum chassis was used to mount the components on and a front panel was used to mount a 4 in speaker. The photographs show the parts layout, although nothing is critical. The lone transformer is for the filaments, and is surrounded by the forest of capacitors. The schematic of the complete supply is shown in Fig. 4.

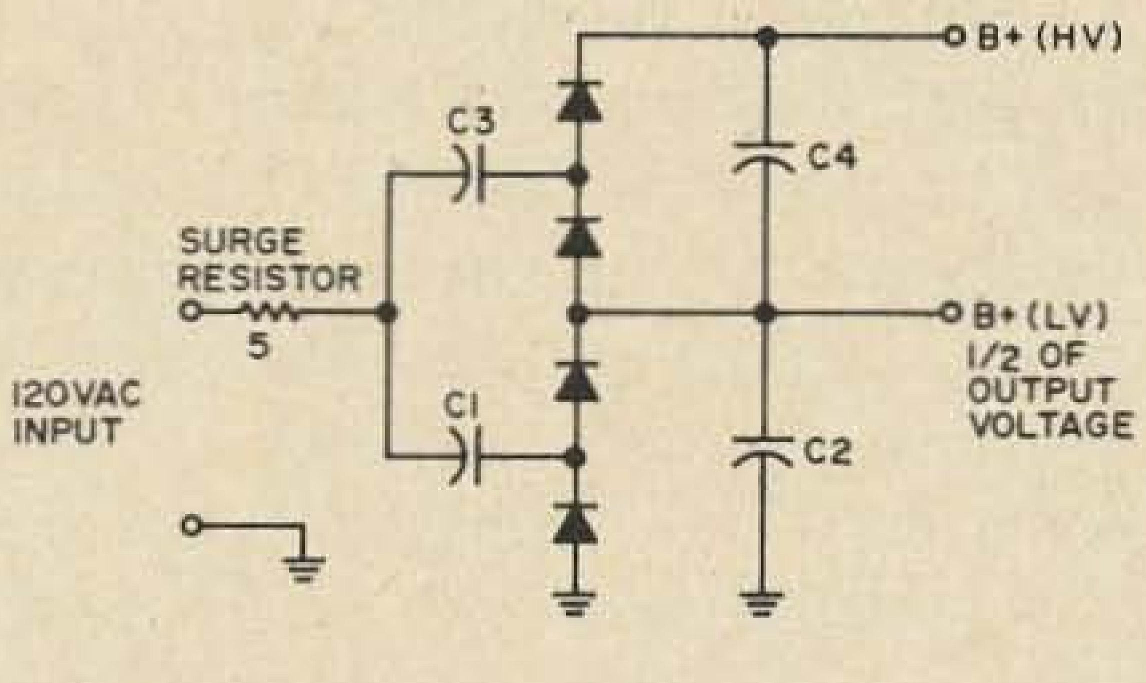


Fig. 2. Modified and redrawn quadrupler. By putting C4 and C2 in series, a lower voltage capacitor can be used for C4.

Mention should be made here of the surge resistor arrangement. It is an absolute necessity to protect the diodes, when the power supply is first turned on and the capacitors look like a dead short; however, after thirty seconds the resistor is shorted out by the time delay relay K1, as the resistor serves no other purpose, and if left in the circuit causes a voltage drop as current is drawn through it. A one volt drop in the input causes approximately a 7½ volt drop in the output voltage at the high voltage tap.

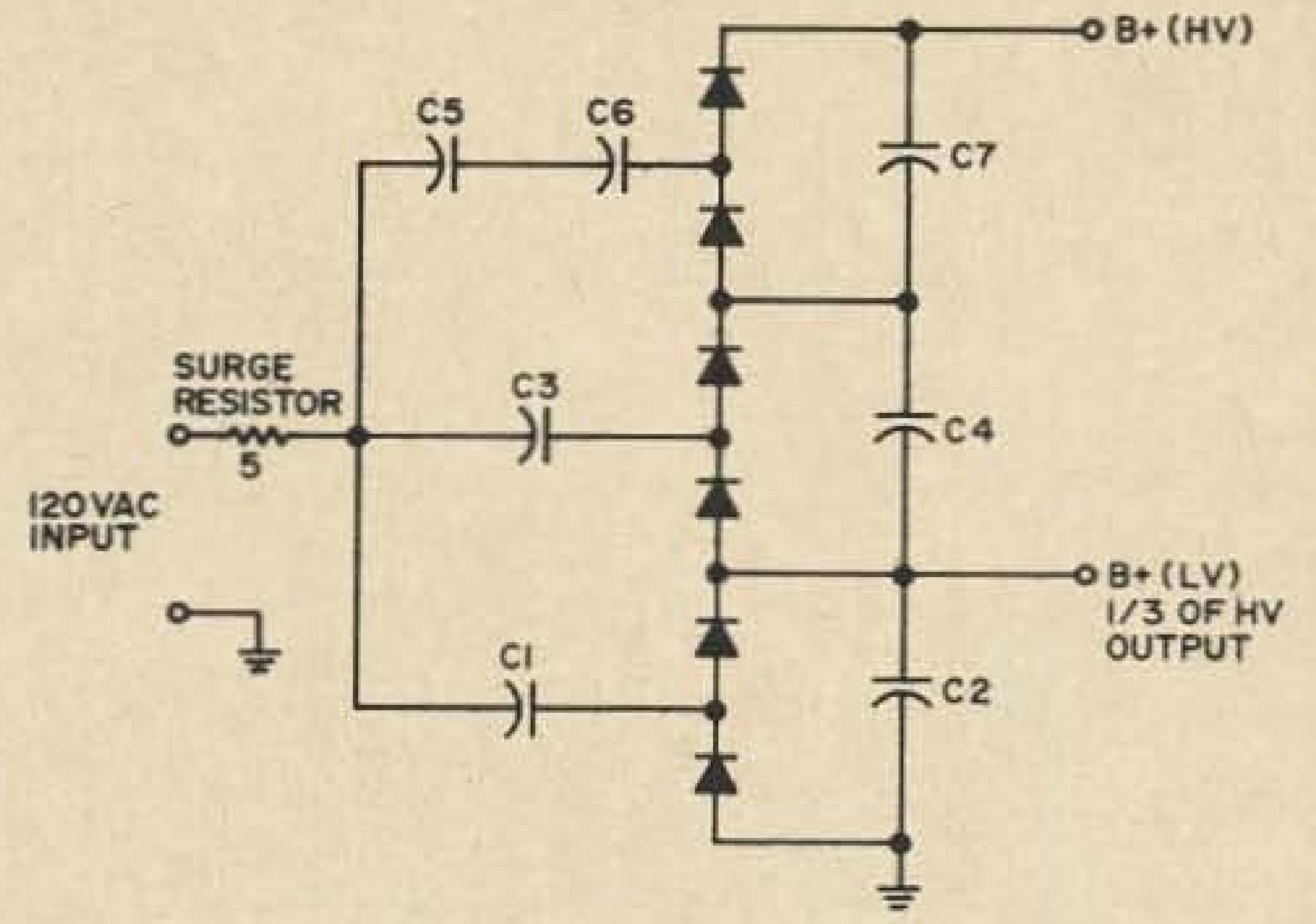


Fig. 3. By extending the circuit of Fig. 2 with two or more diodes and capacitors, we wind up with a voltage sextupler, multiplying the line voltage times six. Two capacitors, C5 and C6, have to be used in series for the fifth multiple because approximately 750 volts appear at this point.

Each diode has an .01 disc ceramic capacitor across it for transient protection.

All of the precautions should be used on this power supply, as were used with the quadrupler, since it operates with one side of the ac line grounded. However, nothing is to be feared if the ac line plug is inserted correctly. This can be determined by two different methods. The first is to run a ground lead from the power supply chassis to a good ground: Cold water pipe, or a driven ground rod. With the switches in the power supply turned off, insert the ac plug into the wall outlet. If the neon bulb ignites, the plug is in correctly. If the neon bulb doesn't light, just turn the plug over, and you are in business.

The other method is to determine which one of the sockets in the ac wall outlet is the neutral or grounded leg of the incoming power. City electrical wiring codes specify that the larger of the two sockets be the grounded or neutral leg, but be sure and play it safe and find out for sure. After you determine which is the hot and neutral, use a polarized ac plug. This is the preferred method, and can be determined with an ac voltmeter, by hooking one lead to a ground and plugging the other lead into either socket which gives you 120 volts. The one that doesn't give a reading is the neutral leg, therefore ground.

This power supply has been used with all of the commercial transceivers on the market requiring an external power supply,

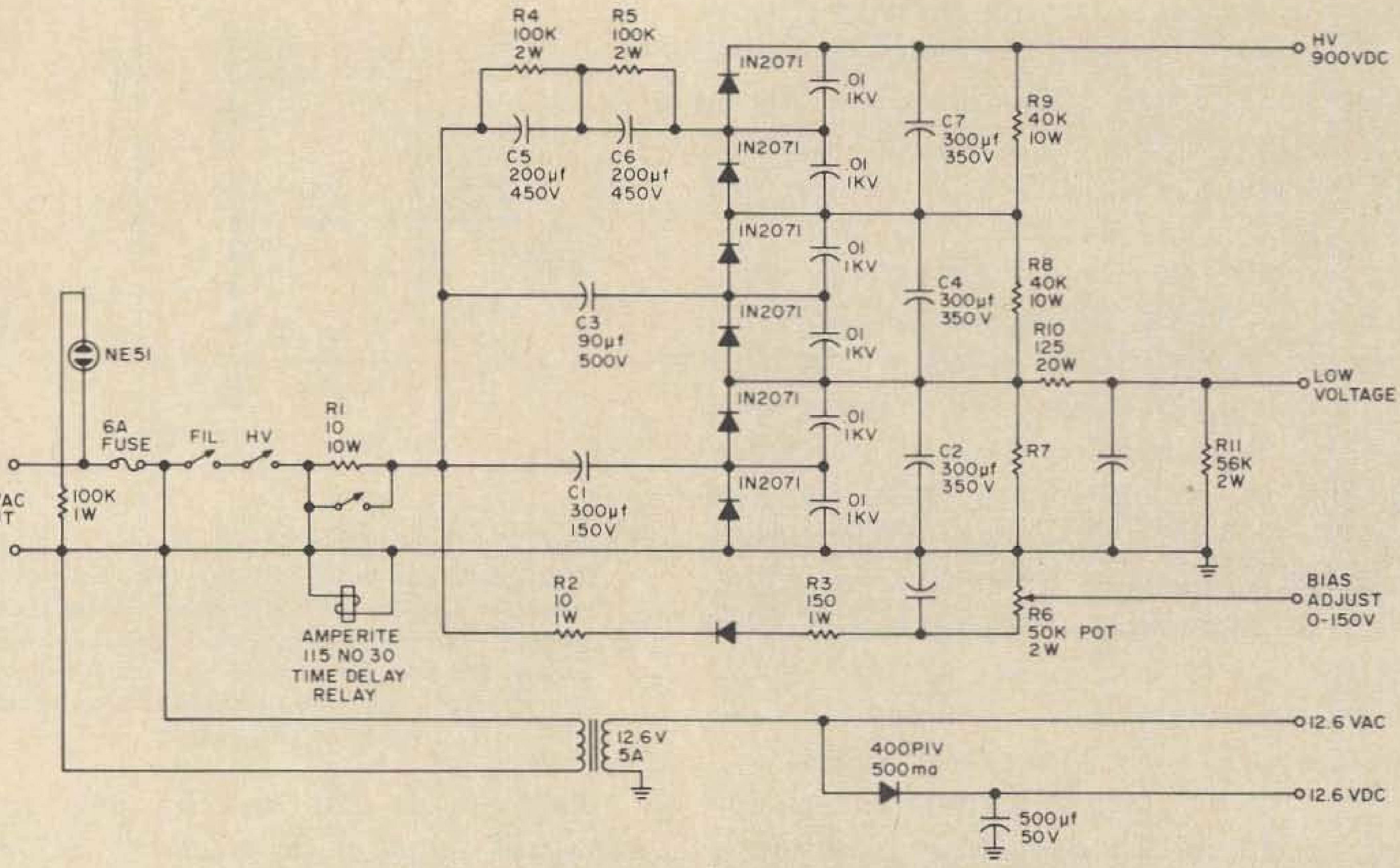


Fig. 4. Complete schematic of sextupler power supply.

with excellent results. The value of R10 may have to be changed to drop the voltage on the low voltage tap to give the correct amount for your particular brand of transceiver. The light weight, 5½ pounds, and good voltage regulation make this type of supply an excellent choice for the modern day, compact SSB transceivers on the ham market today. And the cost isn't too bad. Purchasing all of the parts new, this supply can be duplicated for about $40.00. Quite a savings for the energetic ham who wants to build at least part of his station.

Front panel has been removed to show component arrangement. All capacitors with cans above ground potential have cardboard covers over them for shock protection. C5 & C6 are 2nd & 3rd capacitors from left, front.

One friend of ours who travels quite a good deal by commercial airlines uses this power supply along with a Swan 240 and it makes quite a lightweight and compact station that he carries in a small suitcase aboard the plane without having to pay any excess baggage allowance.

After first building this power supply, it was used to power a linear amplifier using 4 TV horizontal sweep tubes in a grounded grid circuit. The Quadrupler P.S., described in a previous article[1] powered an HW-12 transceiver used as a driver for the linear. With this arrangement we ran 900 watts PEP input, without a power transformer in the whole station. Our next project is to build an Octupler, an eight multiplier, to power the linear.

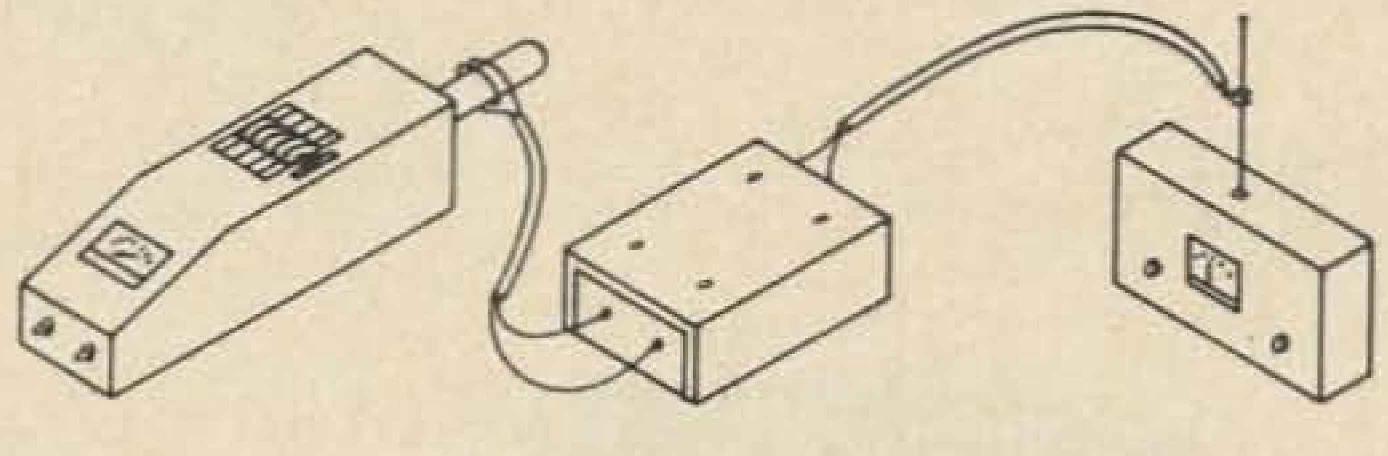
I hope that this article has filled the need for a higher voltage, voltage multiplier type of power supply, for those who wrote and inquired about the possibilities. I answered all letters of request and hope that the information in this article has helped to build a good case for the voltage multiplier and to enlighten the radio amateur on the subject.

. . . W5NGX

1. John R. Bell W5NGX, *A Transformerless Transceiver Power Supply*, 73 Magazine, June 1968, p. 62.

Reliance Check

Have you ever been plagued by the situation of having installed an interference trap or filter, either home built or factory manufactured, only to find out that it does not perform the way you had been led to expect? A sure fire method of pre-testing the interference trap or filter can be found in most ham shacks or can be found at most experimenter's work bench.



GRID-DIP METER — UNIT UNDER TEST — FIELD STRENGTH METER

All the test equipment needed is a grid dipper, or variable frequency calibrated oscillator with low output; and a field strength meter with a means of indicating signal strength. The trap or interference filter undergoing testing is connected in the following manner: the input leads are connected to a pick-up loop to be connected to the frequency source, such as the grid dip meter or the variable oscillator; the output side of the unit is then connected to a test probe that in turn is connected to the field strength meter; the frequency to be trapped is then set up with the source and the amount of energy passed through the filter can be read out on the field strength meter; the trap or interference filter may then be adjusted to pass the minimum amount of energy at the frequency preset at the signal source. By this method you may predetermine the effective band width of the unit before installation.

This method has been in use at my location for quite a while and has been found to be quite accurate in setting up traps by the tvi committee of our radio club, of which I am a member. It is felt that in passing along this method, some time might be saved in other locations.

W. R. Lingenbrink W6HGX

What's par for the course is sauce for the gander.

Joel Eschmann, K9MLD
2036 Erie Street
Racine, Wisconsin 53402

The Unikey

If you are a CW man like I am and have in your possession, as my wife puts it, a rather oversize junk box occupying one bedroom and 50% of the basement, you will appreciate putting these parts to good use.

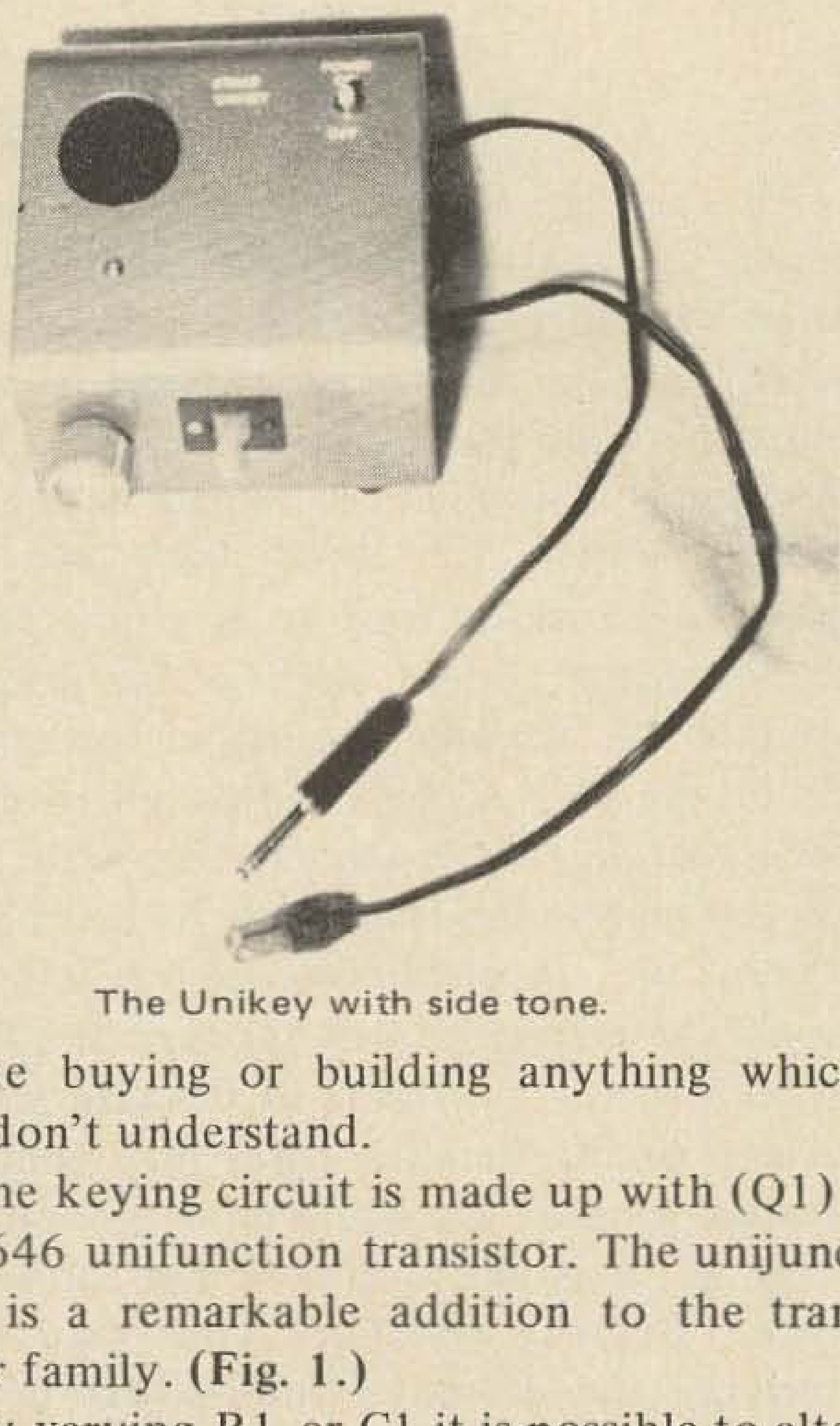
I am an avid 40 meter operator, and while on the air one Saturday morning I couldn't help noticing again the increasing number of automatic keys or keyers. Well, I looked at my wallet and then at my rather large junk box and decided I couldn't buy one right now, but I could build it.

I rummaged for a few minutes and located an old logic module I once used in my many experiments for a clock divider. I pondered with a black board and chalk and arrived at a practical keyer for slow and high speeds – 5 to 30 wpm. I use a sideband transceiver on CW and since I wanted to hear what I was sending, I added a simple sidetone oscillator.

The original unit was constructed in a small sloping-front cabinet with a 110 vac power supply. I approached numerous friends who had a desire for a keyer but wanted it portable for field day activities and, believe it or not, mobile operation. The first unit functioning on a 24 vdc supply, due to the relay used, would of course prove not to be very practical on 12 vdc. Then having to buy a relay, it was felt an important design improvement to use a reed relay which I will explain later.

Circuit Description

This design is very straightforward and easy to understand. It you are like me, you



The Unikey with side tone.

dislike buying or building anything which you don't understand.

The keying circuit is made up with (Q1) a 2N2646 unifunction transistor. The unijunction is a remarkable addition to the transistor family. **(Fig. 1.)**

By varying R1 or C1 it is possible to alter the rate of discharge or to change the frequency of the oscillations. In our case speed is achieved by more conveniently varying R1. Utilizing two diodes for what we'll call steering, we are able to electromechanically change speed and switch on the remaining circuitry. (Fig. 2.)

Key closed for dash operation, current flow is through only resistor R2 plus remaining stages. R2-R3 plus C1 establishes dash frequency, R1 being blocked with the diode D1. Key closed for dot operation, current flow is through D1-D2, R1-R2, plus R3-C1. Now observe R1 is now across, in

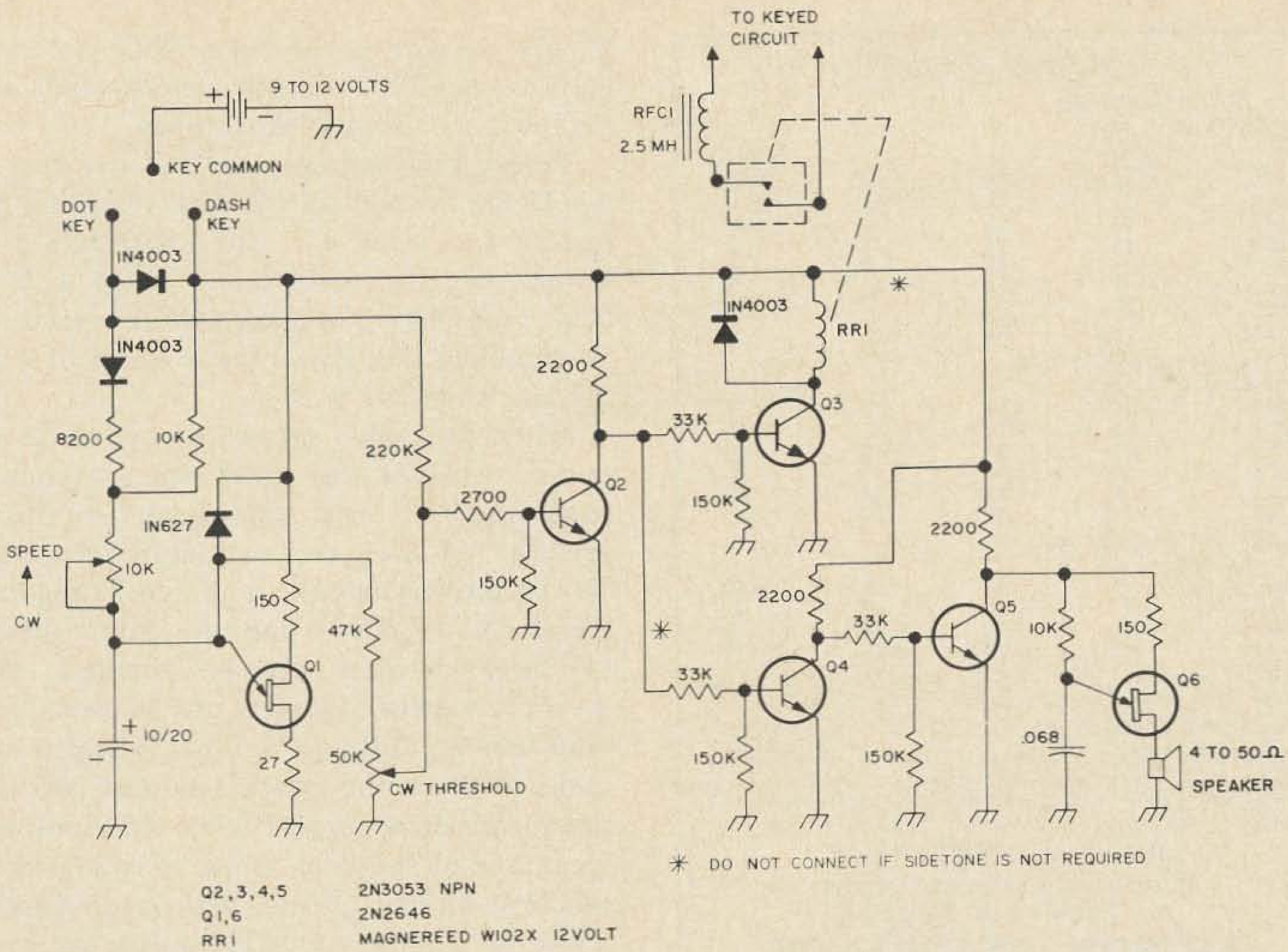


Fig. 1. The unijunction—remarkable addition to the transistor family.

effect, R2 causing a smaller R total which will increase the original dash frequency to establish a dot frequency. The ratio, of course, is fixed in this circuit to minimize adjustment required by the operator.

The desired code speed is adjustable with R3. If the parts described on the schematic are held close to designated values, 5-30 wpm can be achieved. Before proceeding to the remaining stages I would like to explain what might seem like an extra component – a diode from the emitter of Q1 to the supply side of the 150 ohm resistor on Q1's base No. 2. This is an important component which I didn't want to overlook. This diode supplies a discharge path for the capacitor in the emitter circuit of Q1 allowing it to be totally discharged in the event a key open situation would exist in the middle of any character. This way you are guaranteed a uniform character regardless of speed.

Using a sawtooth to switch leaves a little bit to be desired for a proper logic switch, usually a square wave. But, by using some magic, we can cheat a little. We will depend on, for proper logic information, the saturation of Q3 in Fig. 1.

The instant the dash key is closed, RR1 will also close until the proper ramp level is achieved on the base of Q2. This level is adjustable and is set by the operator once. The adjustment is described later. The collector current will rise and the voltage collector Q2 to ground will go to zero approx. causing the base voltage on the base

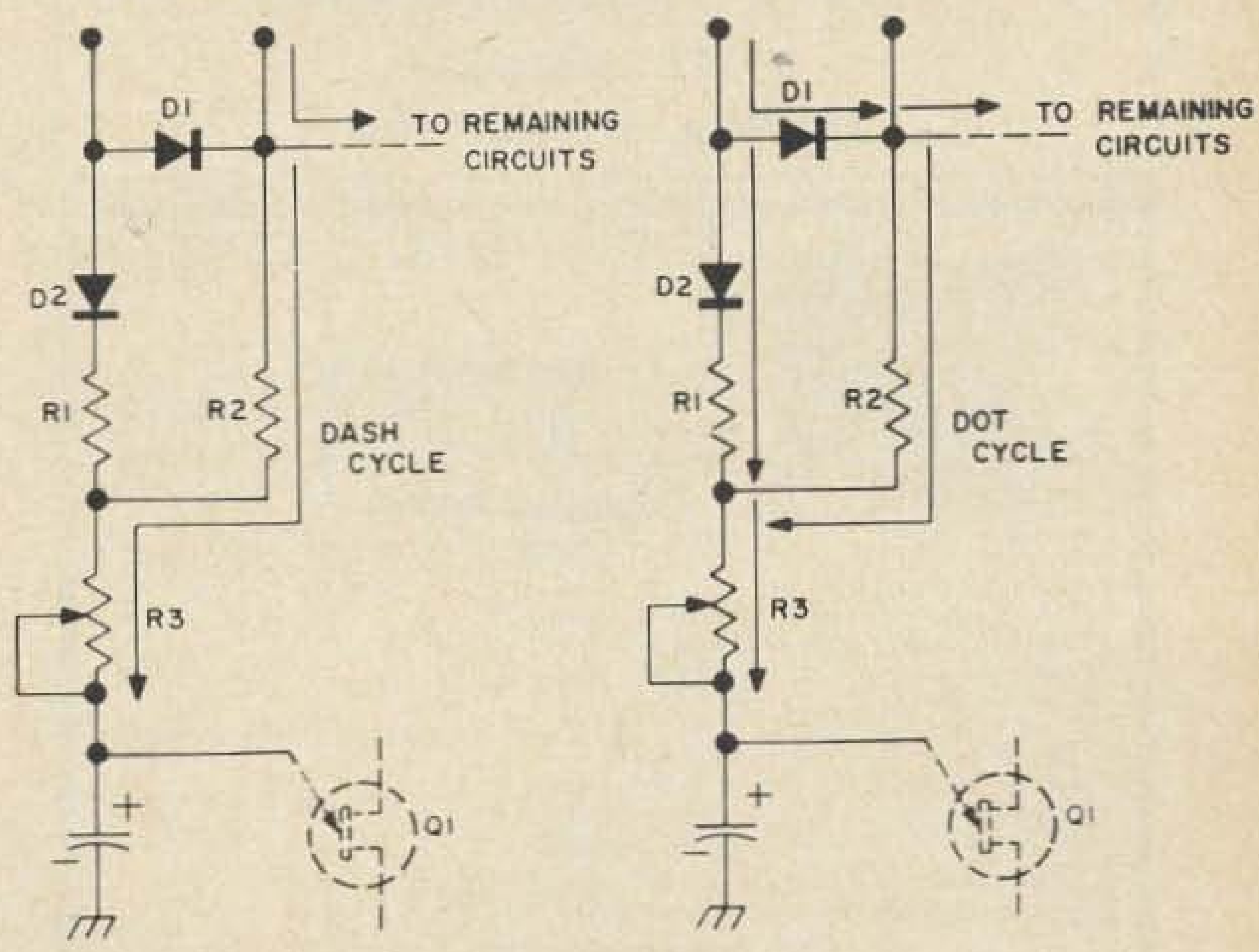


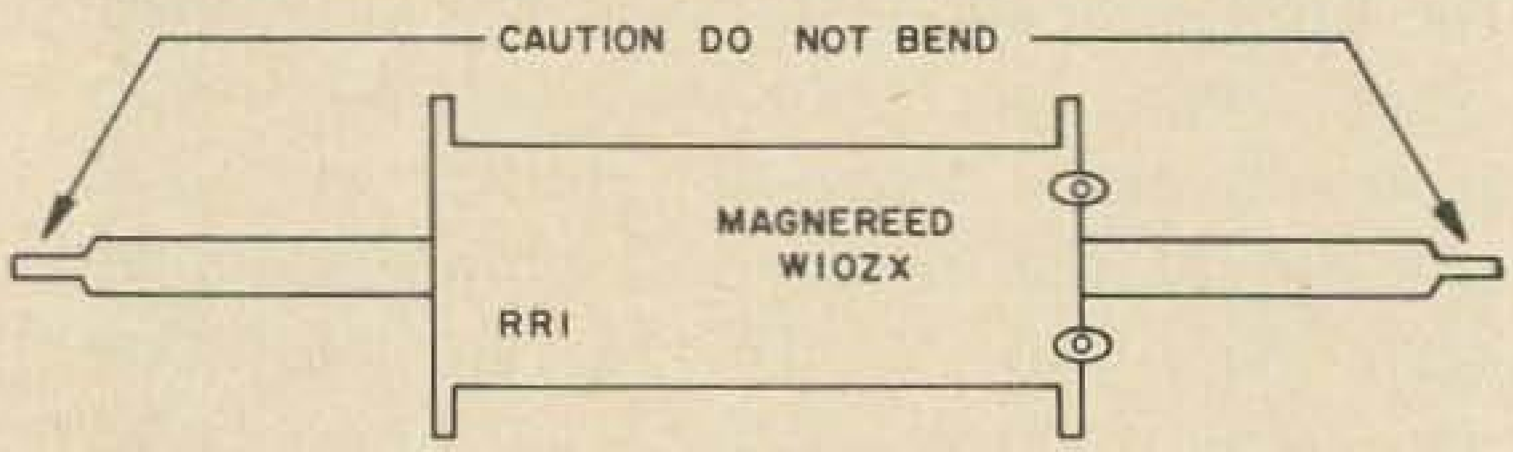
Fig. 2. Circuit during dash cycle.

of Q3 to also go to zero. With the base voltage zero the collector current of Q3 will also be zero causing RR1 to open.

Before proceeding to the dot sequence, I would like to explain the reed relay and my reason for using it. The construction is simple; two iron strips, gold plated, held in close proximity in a glass tube in a vacuum. Surrounding this glass tube is a coil of wire. Simple, isn't it? (Fig. 3.)

When the coil is excited, the contacts act as an armature and close upon becoming magnetized. I used this relay for many reasons: (1) There is no armature mechanics (fewer moving parts). (2) Fixed spring rate (tension). (3) Low current consumption. (4) Large currents can be handled. This means any kind of keying can be used, (e. g. Grid Block, Cathode, etc.). (5) Sealed and quiet. (6) Fast, no contact bounce as compared to a conventional relay. To sum it up: regardless of speed or circuit to be keyed, to practical limits, this unit will out perform a relay. But, not to sound like a salesman, you be the judge.

With the relay theory understood, we can proceed to the dot function. The instant the dot key is closed, RR1 again will close as in the dash description. See Fig. 1. Except for two differences. First, with the steering diodes adding resistor R1 across R2 in Fig. 2 the rate of oscillation of Q1 will increase or speed up. Second, by adding a slight amount of forward bias to Q2 through a 220 k resistor we will in effect change, electromechanically, the point at which Q2 will



REED RELAY

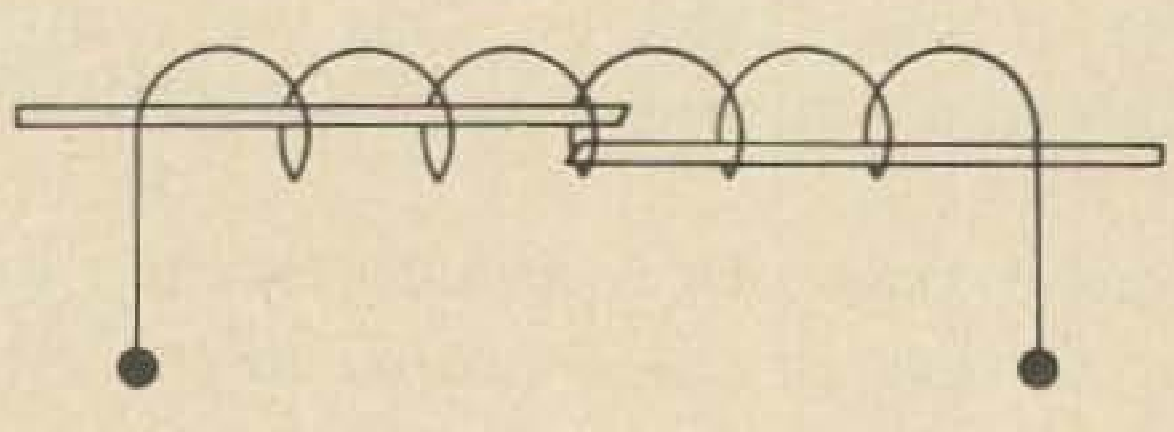


Fig. 3. Construction of reed relay.

conduct giving us the 3 to 1 ratio for a proper dash to dot relationship.

The sidetone circuit, which remains to be explained, can be eliminated if you don't need it. However, its function is desirable, if, like me, you want to hear what you are sending when you use a SSB rig for CW. The sidetone circuit extracts its information, like the relay and keying transistor Q3, from the collector of Q2. Two logic switches, Q4 which shapes the sawtooth to resemble more a square wave and Q5 the sidetone switch, are used. To explain more easily, when Q2 collector is on Q4 is off and Q5 is on. Since Q5's collector has about 10-12 volts on it, this means the unijunction sidetone oscillator has a supply voltage allowing it to run at an audio frequency approximately 1500 hz, which is heard through the speaker in the Base No. 1 lead. The speaker may be 4 to 50 ohms, whatever you have in your junk box.

As for adjustment of the threshold pot, it can be achieved in a number of ways. The best is with a dc scope and applying a supply through the reed switch adjusting for a 3 to 1 ratio on the scope pattern. Next, just listen to the sidetone oscillator and adjust until the proper character is heard. Last, use a VOM to observe a RMS 3 to 1 ratio of collector voltage of Q3. If for any reason the ratio is difficult to achieve, adjust the threshold pot for dash character and change the 220 k bias to set the proper ratio. If the parts described are used, you should have no problems with your keyer adjustment.

Rather than buying different makes and styles of transistors, I thought it well to use only two different ones. The unijunctions 2N2646 and switching transistors 2N3053 NPN both are available at most parts houses. The only unique component is the reed relay. Due to the use of eight small 1.5 volt penlight cells as a source of supply, a low current reed was used. I purchased a 1 amp Magnereed W102X with gold contacts from Allied Radio of Chicago. You will note total current consumption is about 20 25 ma. Excluding resistors, capacitor, speaker and pots, the reed and all semiconductors will cost about $10. Not bad considering what keyers go for these days. See you on forty soon, I hope.

. . . K9MLD

LETTERS

Dear Editor,

First of all I want to tell you how much I support your idea of a magazine that would be for Novices, SWL's and CB'ers. You see, I'm only 12 and haven't quite got my Novice yet (I hope to soon). But I would mainly like to ask you about this: I support Barry Goldwater's Senate Joint Resolution 27 as do many others. As you know, this bill would allow immigrant radio amateurs (permanent residence ones) to apply for a W license.

Steve Antosh
1524 North Oklahoma Avenue
Shawnee, OK 74801

Readers – let your Congressman know you care. Write today.

Dear Wayne,

The article on Broadcast Engineering in the August issue of 73 came somewhat late for me as I had gotten a job with WCWA AM & FM here in Toledo early this summer. This type of work is fun as well as profitable for a ham who is willing to put just a little time to study. As I am only 17 and a Novice, it woufd be no major undertaking for one who is more experienced in electronics. To show how it can be helpful to a younger person, I was employed as a replacement engineer for summer vacations and was able to buy a car just in one summer, and I was kept on as a weekend man when normally just the announcer is on duty. This is going to help keep me in college where before I wasn't sure if I could afford a second year. Keep the good articles going!

Rusty Kinner WN8ZID
736 Holland Sylvania
Toledo OH 43615

Dear Wayne,

Please accept my sincere thanks and appreciation for running the Staff series: *Getting Your Extra Class License*. Although it is not yet complete, I used the published parts to good advantage in taking and passing the Extra Class license when the FCC came to Hartford earlier this month.

It is well written and simplifies difficult theory to the point a non-technical person as myself can properly learn the reason WHY something is so, and not merely memorize by rote, a paraphrased manual.

Ted Melinosky K1GUD
Frederic Road
Vernon CT 06086

Dear Wayne,

The reason you haven't received any manuscripts from me for a while is a long story–an almost unbelievable story–I'll burden you with it.

About three weeks ago, while working on another article for 73, I decided to update my inverted vee. The old clothesline rope kept breaking so I thought I'd go sexy and buy some polypropolene rope. I went to a reputable hardware store and ordered 200 feet of the stuff. The dumb broad that waited on me handed me the spool and told me to stick a finger in each end. Me, a bigger fool, did! She ran down the aisle about twenty feet before I realized that the inserts were metal and that the pencil sharpener action was rapidly putting a good point on my index fingers.

I dropped the spool and bled all over the place. She didn't say she was sorry, but she did toss me a couple of Bandaids.

So for a week I had both index fingers all wrapped up and very, very sore. I couldn't type.

Last Tuesday, with my index fingers about healed, I was installing some plastic water piping and was using my. Swiss Army jack-knife. The blade closed up on me and went right through the nail and over half of the middle finger of my right hand–the tip hung off. I puked, called the ambulance and went to the hospital. They sewed the silly thing back on and put a bandage on it.

It is that finger that, when raised singularly from a closed fist (shades of Jackie Mason), can get you a fat lip, for it has far reaching implications. It throbs like mad and I have come close to getting that fat lip on any number of occasions since Tuesday. Because it does throb, I have to hold the arm up and keep the other fingers away from it. So, as I walk around, it appears as if I were giving everyone the finger.

When the big bandage comes off the digit I'll be back at the typewriter and get more articles to you.

Bob Manning
Box 66
West Rye, NH 03891

Dear Wayne,

Many thanks for the August article "The Genesis of Radio Reception." It was interesting and Bill Hood appears to have done considerable research on the subject. But Mr. Hood didn't research one area well enough. Marconi was NOT "the first to use radio waves over a great distance . . . able to transmit for several miles." Through the arduous efforts of Thomas Appleby W3AX it has been fully documented that the honor belongs to Doctor Mahlon Loomis, a Washington, D. C. dentist. The 89th Congress passed a Joint Resolution to this effect in 1965.

In 1864, Dr. Loomis invented the first wireless telegraph communications system and in 1866 he demonstrated two way wireless communication over a distance of eighteen miles between two Virginia mountain peaks. In 1869, Loomis petitioned the U. S. Congress for a $50,000 grant to develop his system (it was refused). In 1872 (two years before Marconi was even born), Loomis was granted the first patent (#129,971) ever issued by the U. S. Patent Office for a wireless system. Finally, in 1873, the U. S. Congress granted him a charter incorporating the Loomis Telegraph Company.

Dr. Loomis was a far sighted man as well as a unique scientist. He envisioned world-wide communications using his wireless system and even developed a means of electrically fertilizing his garden by sending a current through underground wires. In 1860, before his wireless years, he replaced the battery system of a 400 mile telegraph line with a kite system that tapped the electrical charges of the upper atmosphere. And Loomis didn't neglect his profession. He is acknowledged by the dental profession to be the inventor of artificial teeth and held U. S., British and French patents for the false choppers. Other patents included the electrical thermostat and a cuff or collar fastener.

FLASH!

The FCC announced September 24th that they had decided to abort the further changes in the CW bands set for November 22nd. Ditto the further changes in six meters. The changes in the phone allocations will go through as proposed.

Until recently most of Dr. Loomis' accomplishments were unrecognized. However, Tom Appleby's interesting book "Mahlon Loomis, Inventor of Radio" has given credit to this remarkable man. The book can be obtained directly from W3AX ($3.25) at 5415 Connecticut Ave., N. W., Washington 15, DC.

Wm. B. Shepherd W3ZSR
12,000 Twin Cedar Lane
Bowie MD 20715

Dear Wayne,

Here are my comments on the Diamond letter in September (p.154). First, I wonder if Mr. Diamond is a ham and if so why he doesn't give his call? I also wonder if he is an "Engineer" (registered professional engineer) in the State of California? Any examination is hard, even the first phone, if you don't know the answers. My son (16) passed his General today and did not do it by memorization. He learned the theory! The broadcast industry also has its six-week wonders with first phone tickets gained by memorization. I had my commercial license before I got my ham ticket, but perhaps it was "easy" when I took the exam 18 years ago. I have been on the air for 16 years on AM-FM-SSB-CW-RTTY and have built more equipment than I care to remember. I now use commercial gear and so does WØBL (KATZ), WØBK (KXOK) and WØLWG (KWK), all chief engineers. We have all been around a few years in the broadcast and ham game and when we hire a technical person, a ham license is his best recommendation!

Melvon Hart WØIBZ
WIJ
St. Louis MO 63101

(continued on page 132)

NO-NO Frequencies

Here is a list of frequencies you are no longer able to use, courtesy of Incentive Licensing. This may be a bit easier to follow than the long lists of permitted frequencies.

License	22 Nov., 1968	22 Nov., 1969
Advanced	3,500 - 3,525	3,500 - 3,525
	3,800 - 3,825	3,800 - 3,825
	7,000 - 7,025	7,000 - 7,025
	14,000 - 14,025	14,000 - 14,025
	21,000 - 21,025	21,000 - 21,025
	21,250 - 21,275	21,250 - 21,275
General & Conditional	3,500 - 3,525	3,500 - 3,525
	3,800 - 3,850	3,800 - 3,900
	7,000 - 7,025	7,000 - 7,025
	7,200 - 7,225	7,200 - 7,250
	14,000 - 14,025	14,000 - 14,025
	14,200 - 14,235	14,200 - 14,275
	21,000 - 21,025	21,000 - 21,025
	21,250 - 21,300	21,250 - 21,350
	50,000 - 50,100	50,000 - 50,100
Technician	50,000 - 50,100	50,000 - 50,100

E. H. Conklin, K6KA
Box 1
La Canada, Calif. 91011

Transistor Power Supplies

Although the ideal situation may well be to leave factory-made equipment as is, without modification, it is sometimes necessary to add some function or accessory. When this is done, it is most desirable to leave the equipment unaltered if possible or, at least, so little modified that it can be restored to "mint" condition in a few minutes. Even with such a limitation, there are many things that can be done.

Some equipments provide jacks or sockets from which filament and plate power can be taken for such devices as vhf converters. The additional load, however, will add to the transformer heat and may exceed desirable limits. On the other hand, accessories which use transistors may draw so little current that the savings of the power in one tube heater in the equipment may actually provide more than enough power for all accessories that might be added.

Batteries and added power supplies have some bulk and may involve inconveniences of interconnection. On the other hand, the filament transformer in the original equipment can be used conveniently in almost every case. Let us examine some of the situations and solutions to the transistor power-supply requirement.

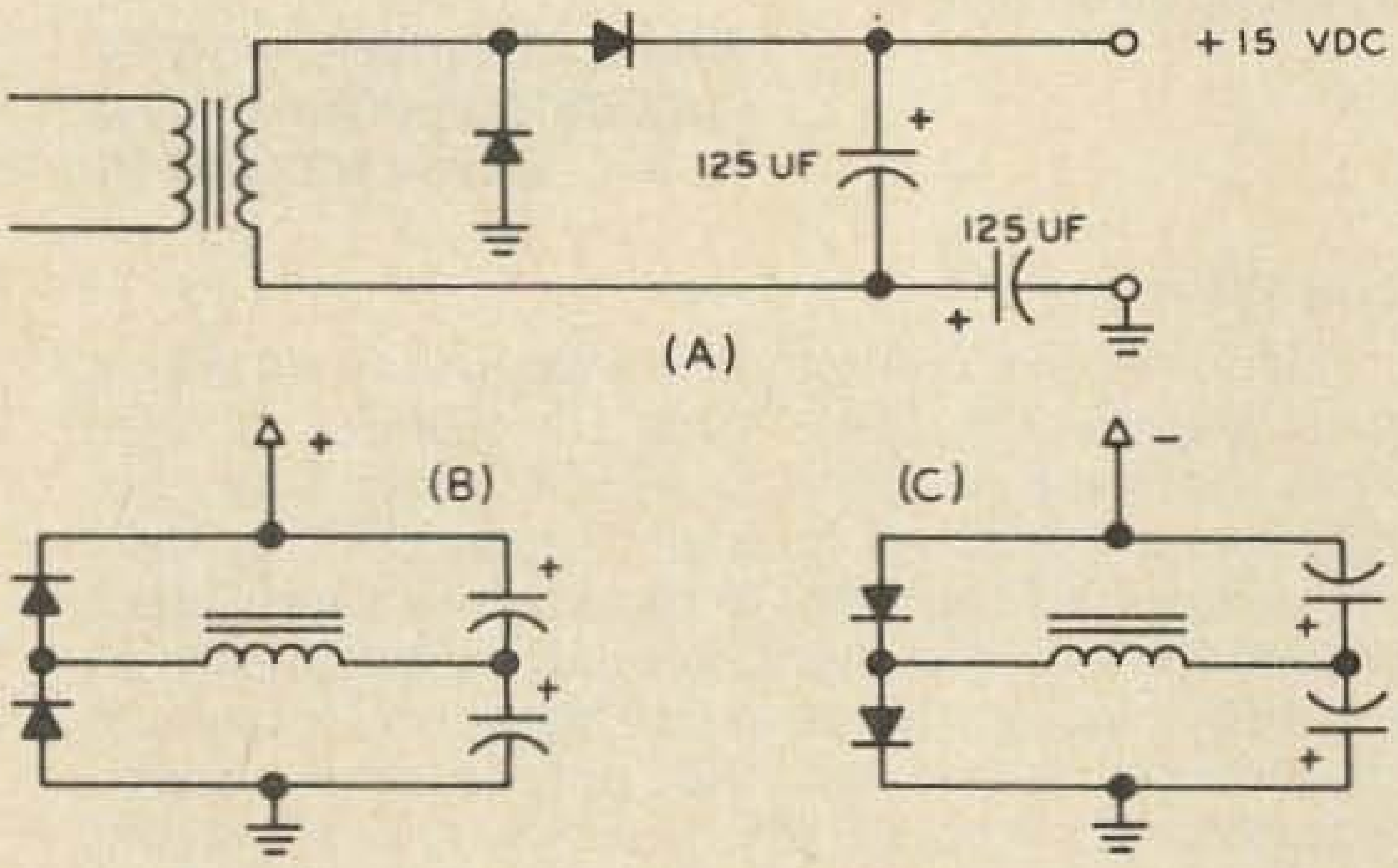


Fig. 2. Voltage doubler circuit. 2B has negative grounded. 2C has positive grounded.

It may be assumed that most existing amateur radio equipment using receiving tubes has a 6.3-volt filament transformer, one side of which is grounded to the chassis. For transistor use, sometimes this voltage is a bit low, and it may have to provide both positive and negative polarity to ground in a dc supply. In a few cases, the accessory may be designed to include transistor circuits which are carefully left ungrounded for dc, with bypass capacitors isolating the circuit from any connections that might reach ground. Coaxial cables, for example, may have to be provided with two blocking condensers—one for the inner conductor, and one for the shield braid.

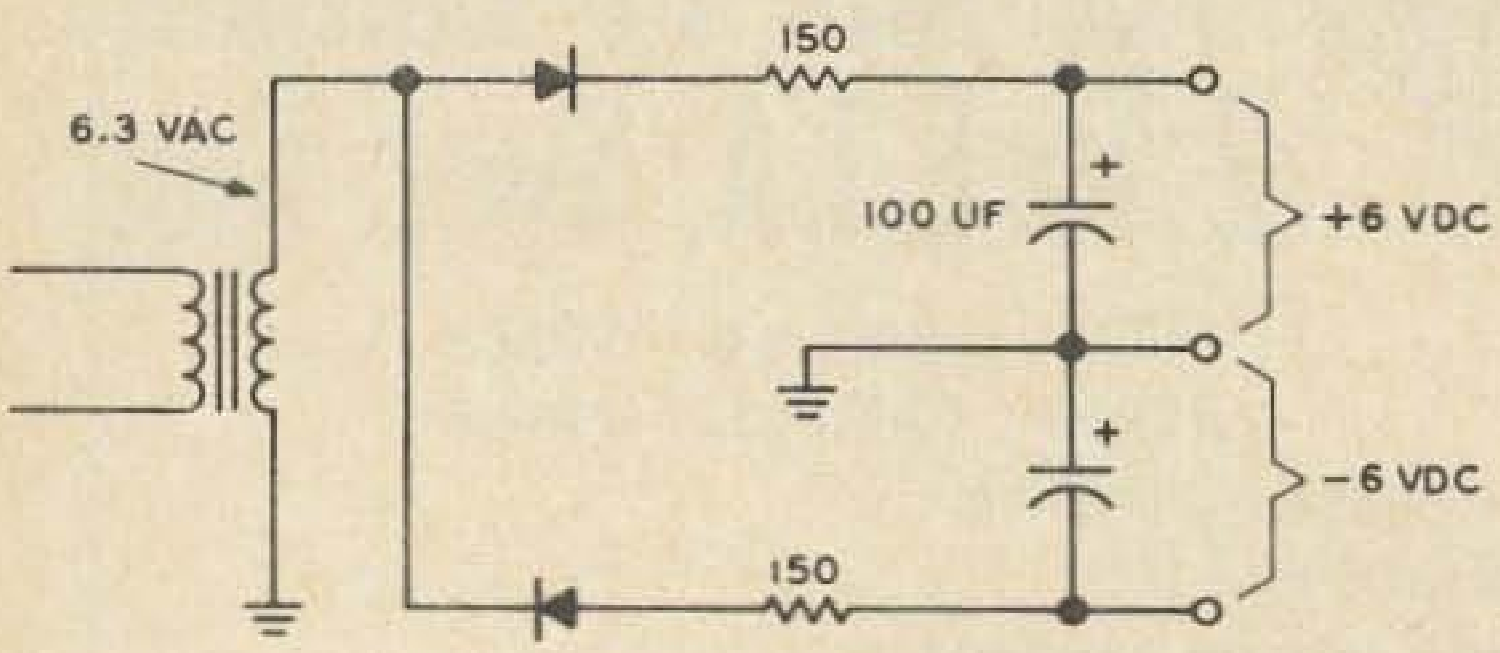


Fig. 1. Circuit for obtaining both plus and minus six volts to ground.

A very simple circuit for obtaining both plus six volts and minus six volts to ground appeared in the "Der Kleiner Keyer" articles in 73 for September, 1965, and May, 1966. This is shown in **Fig. 1**. Actually, the voltage varies considerably depending upon the for-

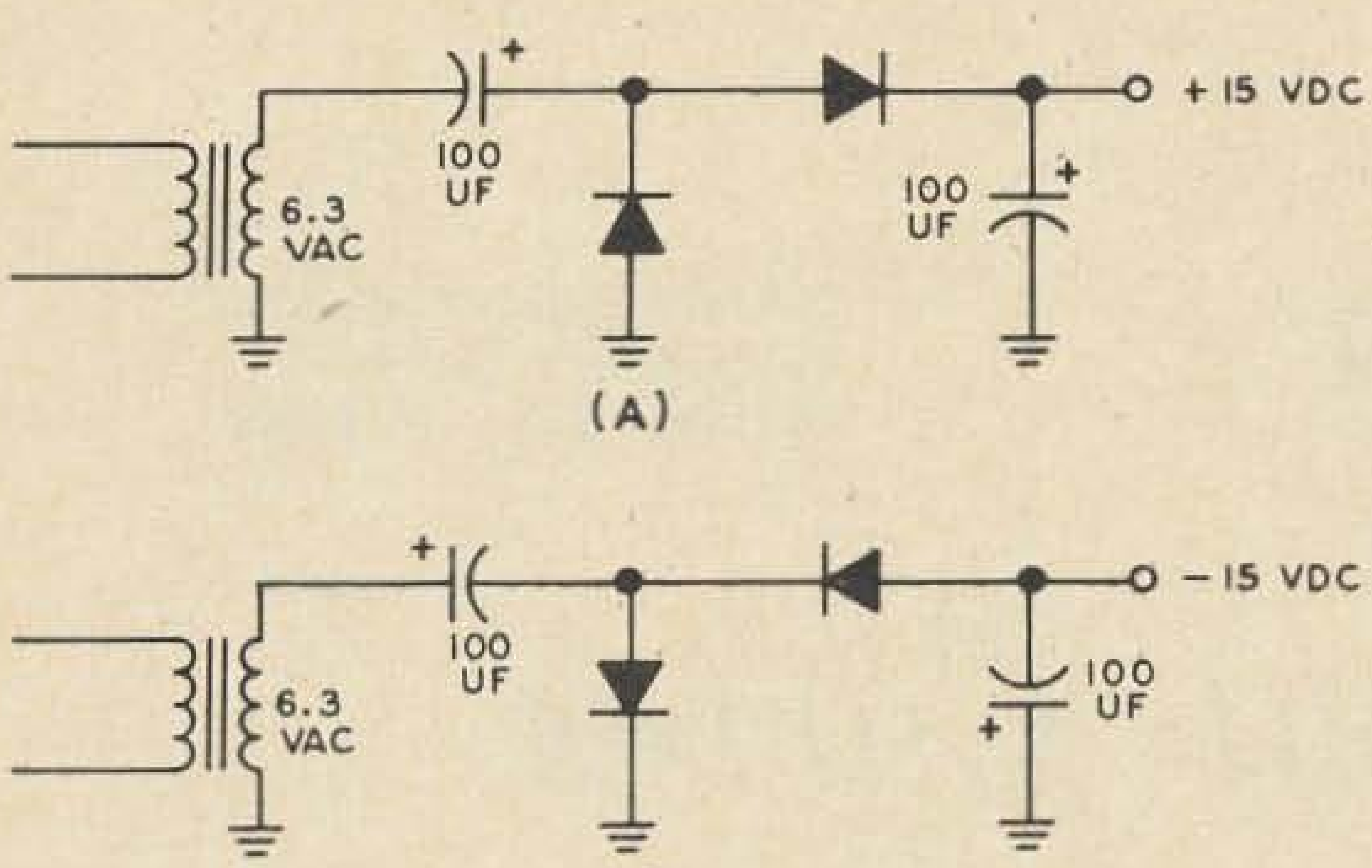


Fig. 3. The filament transformer can be grounded. 3A is negative grounded and 3B has the positive grounded.

ward resistance of the diode, the size of the series resistor (which with other circuit resistance must limit the charging current of the capacitor–practically a short circuit–to a safe surge value for the diode), and the amount of bleeder and useful load.

In addition, there are several voltage-multiplying circuits described by Jim Kyle and Murray Baird in 73 for February, 1966, and December, 1965. A widely-used doubler supply is that shown in **Fig. 2A**. Two diodes in each leg–a total of four–are used in the SB-400 for the 800-volt supply. Eight in each leg on an 800-volt transformer without protective resistors or capacitors across the diodes, but with resistors on the series electrolytic capacitors, furnish roughly 2,000 volts at a kilowatt in the SB-200.

The above circuit may be redrawn as shown in **Fig. 2B** with grounded negative; but it can be arranged as in **Fig. 2C** for grounded positive. The same transformer can be used in two such supplies, provided that all circuits fed by one power supply are isolated for dc from the circuits fed by the other. Also, because both ends of the transformer are above ground at dc, the circuits fed by

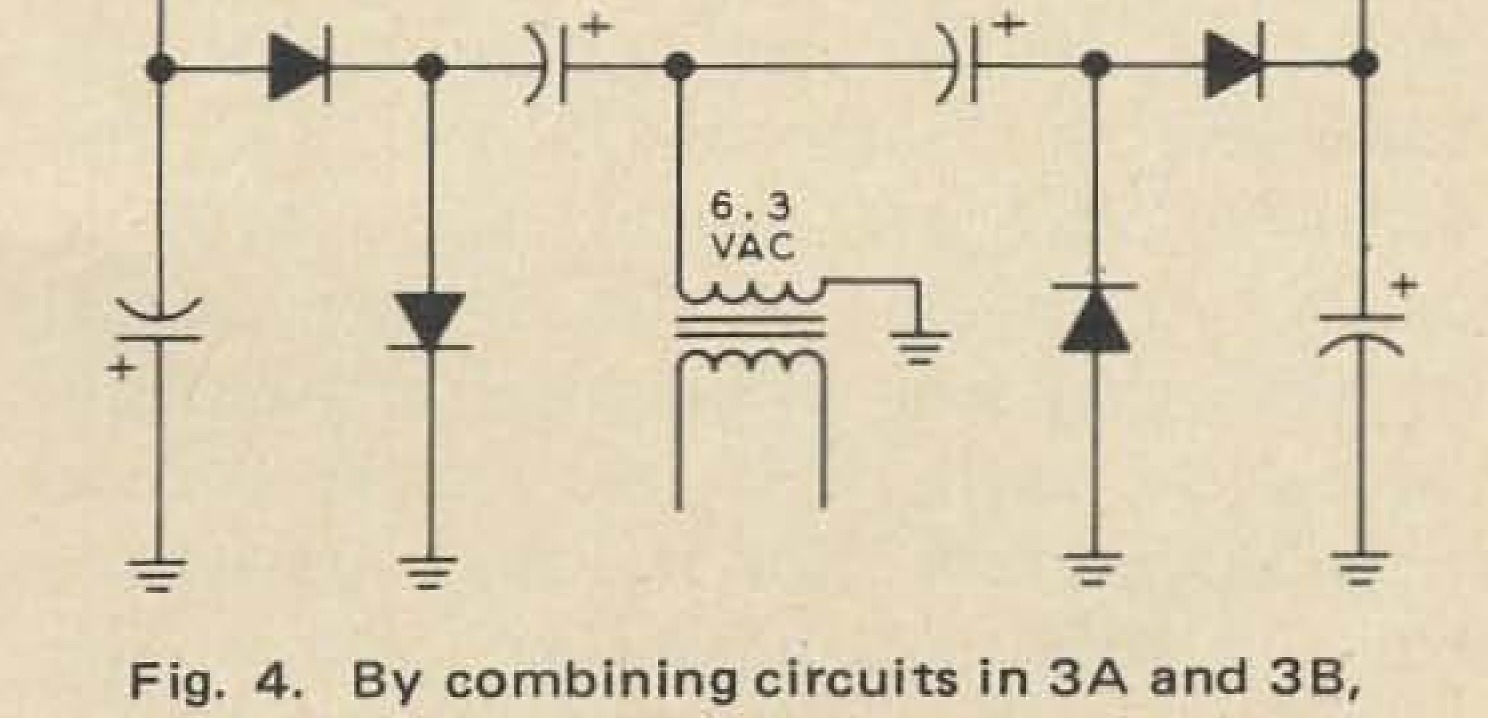


Fig. 4. By combining circuits in 3A and 3B, we can get up to 30 volts out at no load.

such power supplies when using a grounded filament transformer, must be isolated from chassis ground. The usual 6.3 v transformer in radio equipment will produce 15 volts under no-load conditions in this doubler circuit.

By moving one capacitor to the other end of the transformer, a slightly different circuit is obtained which allows one side of the 6.3-volt filament transformer to be grounded to the chassis without isolating the circuits fed by a rectifier and filter connected to the transformer. This is shown normally for positive output as in **Fig. 3A**. It can be reversed to provide negative power as shown in **Fig. 3B**. In each case, it produces 15 volts under no load.

At the expense of isolating circuit grounds, the circuits of **Fig. 3A** and **Fig. 3B** can be combined on the same 6.3 v filament transformer, as shown in **Fig. 4**, to produce a no-load voltage of 30. This may seem a little like lifting oneself by his bootstraps, but it is a great convenience for producing voltages for transistor gadgetry in existing tube-type radio equipment. . . .K6KA

Bias Design Without Curves

Clifford Klinert, WB6BIH
520 Division Street
National City, CA 92050

Many amateurs have the impression that transistor bias design requires complicated calculations, and detailed graphical analysis. Complete gain and frequency response calculations usually do require quite complicated analysis, but the basic caluculations for getting a circuit to work are within the capabilities of almost all experimenters. This article is presented to show that a few simple calculations before assembling a circuit can eliminate a good deal of guesswork and experimentation that can be better spent on other problems.

Class A Bias Circuit

Fig. 1 shows the familiar class A bias circuit. In the discussion for this circuit we will deal only with dc bias values. As a review, **Fig. 1** shows some of the important voltages in the circuit. Vcc is the supply voltage, Vb is the base voltage supplied by the voltage divider R1-R2, and Vre is the voltage drop across the emitter resistor. Vbe is the forward biased base-emitter junction voltage drop. In silicon transistors Vbe is about 0.6 volts, and in germanium transistors this is about 0.2 volt. To simply explain how this circuit operates, we will visualize the effect of changing the R1-R2 ratio. Changing this ratio will either increase or decrease Vb, and thus change the bias on the transistor. As Vb is increased the transistor is increasingly forward biased, and the collector-emitter current increases. Think of the transistor as a switch. The base bias controls the collector current so that the collector and emitter are the two terminals of a switch with the base as the handle. With the transistor turned off the collector emitter voltage, Vce, is equal to Vcc, and no current flows. With Vb high, the transistor is turned on and Vce is zero. This is the maximum current point where the collector current, Ic, is given by Ohm's law as :

$$Ic = \frac{E\ total}{R\ total} = \frac{Vcc}{Rc + Re} \qquad (1)$$

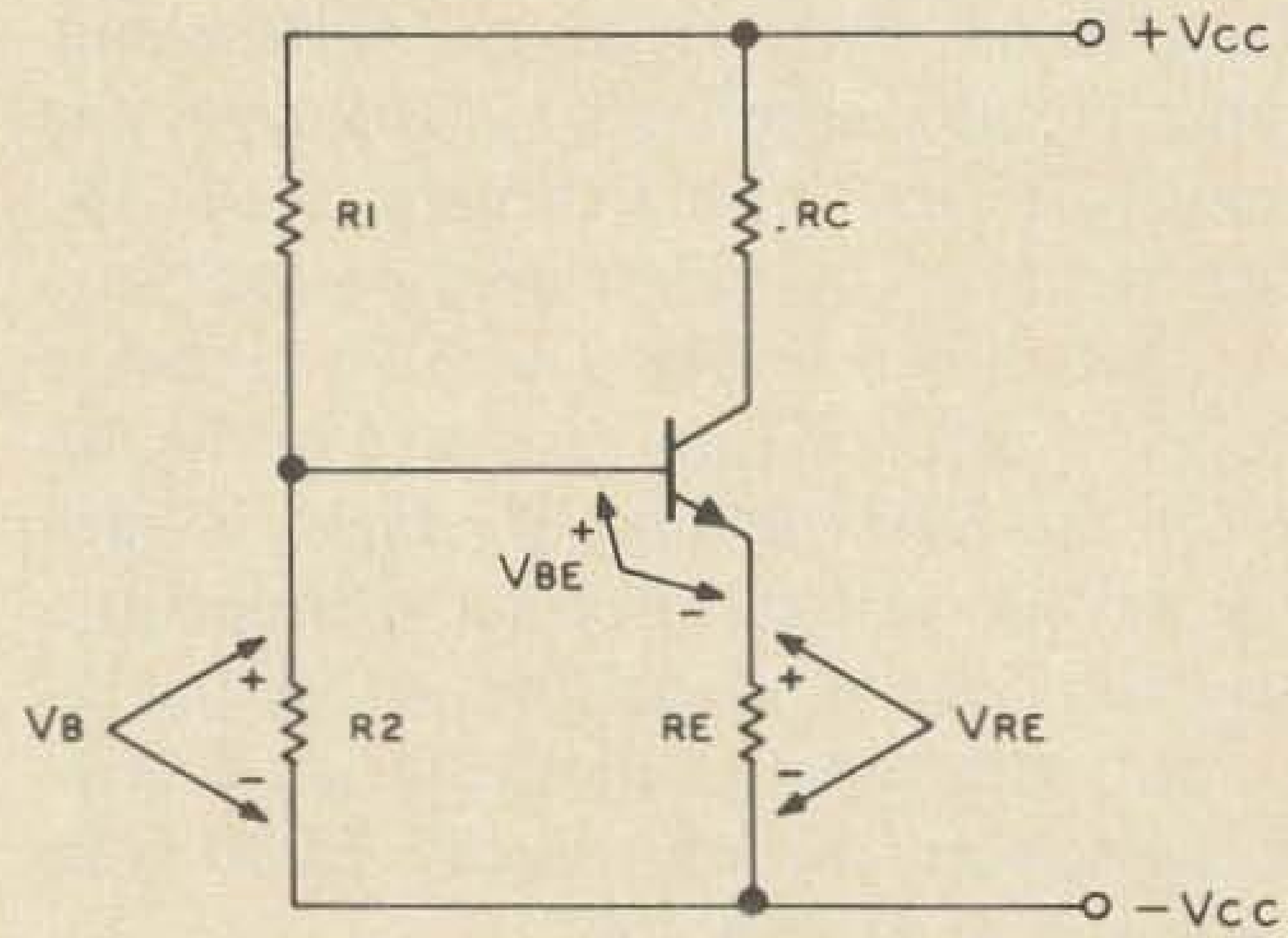


Fig. 1. Transistor bias circuit. This is only for dc values and coupling and bypass capacitors have been omitted.

It is frequently helpful to draw a rough sketch of the circuit action with use of these two current and voltage points. **Fig. 2** shows how we can illustrate the "switch" action of the circuit. The two points are plotted, first where the current is maximum and the voltage is zero, and then where the current is zero and the voltage maximum. Between these points a straight line is drawn to show what the current and voltage in the collector-emitter connection does. The collector voltage (and current) must travel up and down this line to give the varying (ac) output signal. For maximum effectiveness in class A we must adjust the bias to put the collector current (and voltage) somewhere between these two points on the line. This bias point is where the transistor circuit rests

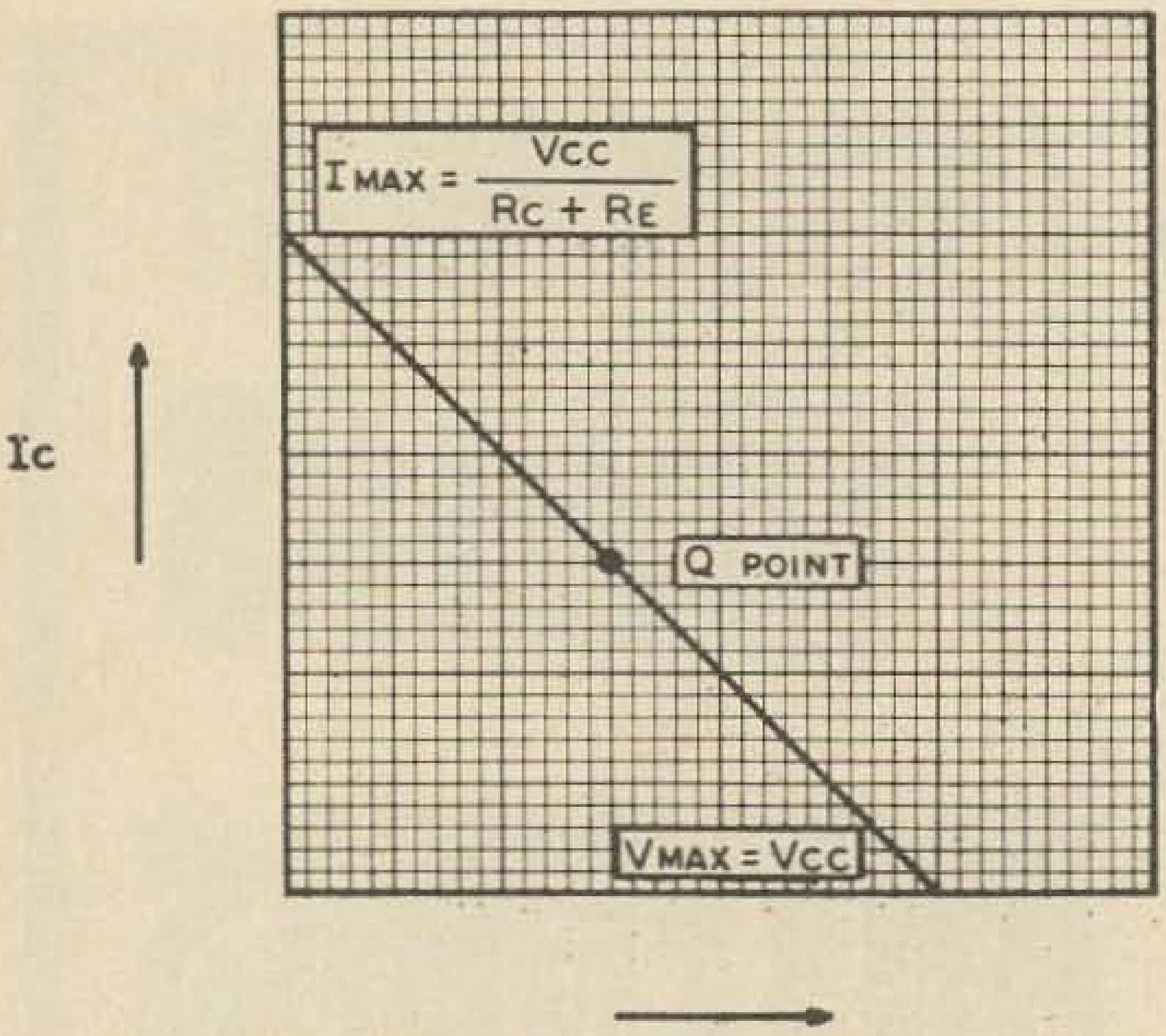


Fig. 2. Collector voltage and current. The Q point is where the current and voltage rest with no signal.

with no signal, and is called the quiescent point or Q point. The location of the Q point will vary with the type of transistor and circuit requirements, but it is usually placed toward the middle of the line. This is shown in **Fig. 2**. The major portion of this article will be devoted to finding bias values to set the bias at a specific Q point.

Simplified Base Circuit

The circuit of **Fig. 1** can be simplified to the circuit of **Fig. 3** by combining R1 and R2 and showing Vb as a separate battery. By making some approximations **Fig. 3** can be further modified to **Fig. 4**. This is possible if we assume that the dc current gain, hFE, is much greater than one, and that the collector rent. Rb is the equivalent resistance of R1 and R2 in parallel:

$$Rb = \frac{R1\ R2}{R1 + R2} \qquad (2)$$

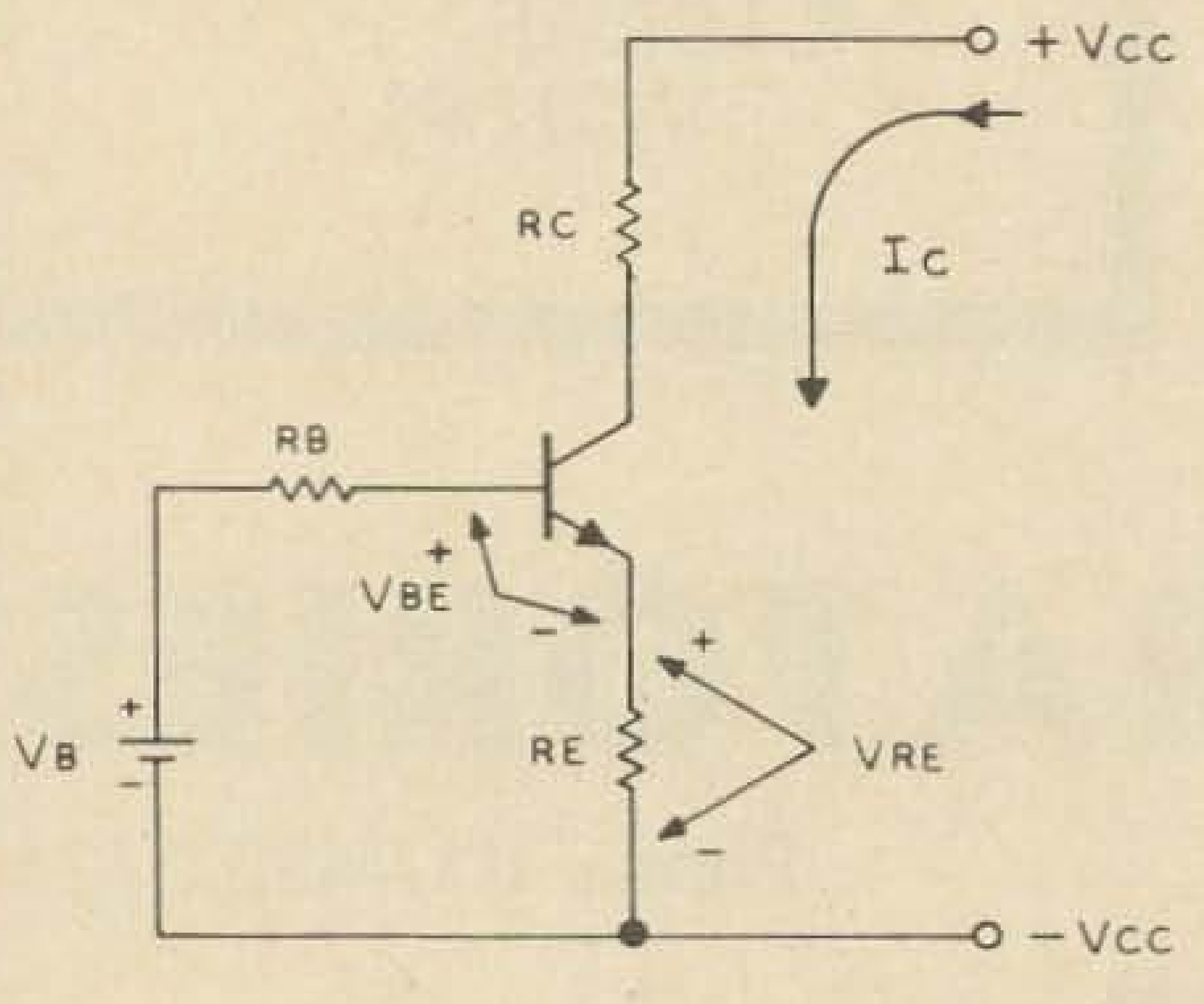


Fig. 3. Equivalent bias circuit. R1 and R2 are combined into Rb, and Vb is represented by a battery.

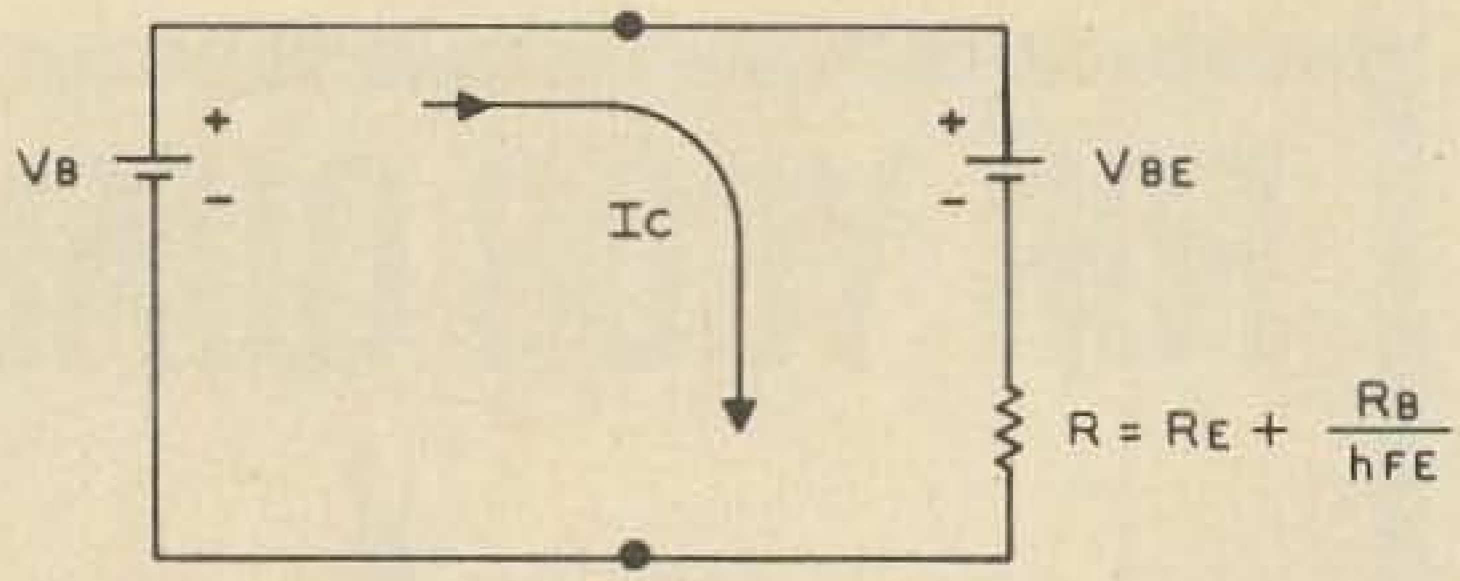


Fig. 4. Base-emitter simplified circuit. Some values are changed to the collector-emitter side to find Ic.

Vb is obtained from the voltage divider formula:

$$Vb = \frac{VccR2}{R1 + R2} \qquad (3)$$

To transfer to the collector-emitter side of the circuit, Rb must be divided by hFE to account for the amplification effect from base to collector. Now in **Fig. 4**, we have the relation between the base voltage and the collector current in one simple circuit. The equivalent resistance in **Fig. 4** is the sum of Re and Rb transfered to the collector circuit. The equivalent resistance, R, is

$$R = Re + \frac{Rb}{h_{FE}} \qquad (4)$$

Vbe is shown as a battery.

To mathematically show this relation between Vb and Ic, we use Kirchoff's and Ohm's law around the loop of **Fig. 4**. Taking the sum of the voltage drops:

$$Vbe + IcR - Vb = 0 \quad \text{or}$$
$$Vbe + IcR = Vb \qquad (5)$$

Take a look at what we have now. If we know Vcc, R1, and R2, we can use equation 3 to find Vb. Equation 2 will get Rb. Vbe is either 0.6 or 0.2, depending upon whether the transistor is silicon or germanium. R can be found from equation 4 with hFE and Re specified. We can now use equation 5 to find Ic. With a little algebra,

$$Ic = \frac{Vb - Vbe}{R} \qquad (6)$$

The previous discussion has shown the relations between voltages, resistances, and currents in the bias circuit. In the next section we must make a few decisions and reverse the process to find the circuit parameters.

Determining Circuit Parameters

The most important thing to first consider is the stability factor, S. A simple formula for S is

$$S = 1 + \frac{Rb}{Re} \quad (7)$$

Like some of the previous equations, this is a simplified approximation that will make calculations easier. Actually S might be better called the *instability factor* because the larger S is, the less stable the circuit is. Stability will be discussed in greater detail later, but if a circuit is said to be stable it simply means that it keeps its Q point at the same spot. A look at a few commercial designs shows that a factor of ten is a common value for S. For high reliability designs, S may be as low as three or four. For amateur circuits where temperature variations are not severe, values of twenty or more may be used.

Looking at equation 7, we see that the main determining factor for S is the ratio of Rb to Re. Since this is only a ratio, we must turn to other information for absolute values. This further information is supplied by the voltage drop across the emitter resistor. Many commercial and military designs use a voltage drop of two to four volts for Vre. Vre is obtained from Ohm's law by

$$Vre = Re\ Ic \quad (8)$$

Now we have all the information necessary to design a working bias circuit. We first decide on the Q point which determines Ic. Next a value for Vre is selected. Using equation 8, Re is found. Using equation 1 with the maximum Ic, Rc is determined. By picking an S factor Rb is obtained from equation 7. With equations 4 and 5, Vb is determined. Since we know Vb, Vcc, and Rb, we can use equations 2 and 3 to find R1 and R2. This gives two equations with two unknowns, making an algebraic solution possible. The solution to this problem results in the following:

$$R1 = Rb\frac{Vcc}{Vb} \quad \text{and} \quad R2 = \frac{R1\ Vb}{Vcc - Vb} \quad (9)$$

Thus the complete path that we must take has been outlined. In the next section we will pull a transistor out of the junk box and see how this procedure works.

Designing a Bias Circuit

In a project with a vfo, I found an old 2N910 to use for a class A buffer between the vfo and a following class C stage. A check of the manufacturer's specs revealed the following numbers:

h_{FE} = 80 min. to 200 max. (at 5 ma)
BV_{CBO} = 100 volts
Pt = 1.8 watts (with heat sink at 25°C)

After brief consideration, the decisions about the Q point were made. Since the hFE ratings were given at 5 ma, this was selected as the Q point. Vcc was chosen as 22.5 volts because this was the voltage available, and is within the manufacturer's ratings. With the Q point at the center of the line as in Fig. 2, the maximum Ic is twice the Q point Ic, or 10 ma. To determine the actual value of hFE of the transistor, it was inserted into a bias circuit with variable resistors and the hFE was measured. Most experimenters probably have some method of testing transistors to determine this parameter. In this case the hFE was found to be 133. This is only good for the conditions of the test, and is only an approximate value. Since this circuit might be used along with tube amplifiers, a low S factor of 3 was chosen for Vre. More details on the selection of these parameters will be discussed later, but now we just want some values to work with to test our equations.

The total resistance in the collector–emitter circuit is determined from the maximum Ic and Vcc:

$$Rtotal = \frac{Vcc}{Ic\ maximum}, \quad (10)$$

where R total is the sum of Rc plus Re as in equation 1. From this we obtain:

$$Rtotal = \frac{22.5\ volts}{10\ ma} = 2.25\ K\ ohms.$$

For a voltage drop of two volts across Re, with Ic equal to 5 ma (at the Q point) we use Ohm's law:

$$Re = \frac{Vre}{Ic} = \frac{2\ volts}{5\ ma} = 400\ ohms.$$

Now that Re is known, Rc can be found by subtraction:

$$Rc = Rtotal\text{-}Re = 2.25K\text{-}.4K = 1.85K\ ohms.$$

With Re known, Rb can be found from equation 7 with S factor as three. Equation 7 becomes

$$Rb = Re(S\text{-}1) = .4K(3\text{-}1) = .8K = 800\ ohms$$

To find Vb R must be found. From equation 4 we have

$$R = Re + \frac{Rb}{h_{FE}} = .4K + \frac{.8K}{133} = .406\ K$$

Using equation 5, Vb is determined.

$$Vb = Vbe + IcR$$
$$= 0.6 + 5 \text{ ma} \times .406 \text{ K} = 2.63 \text{ volts}$$

The 0.6 volts came from the fact that the transistor is silicon, and Vbe is 0.6. Now that we have Vb, R1 can be found in equation 9.

$$R1 = Rb \frac{Vcc}{Vb} = .8 \text{ K} \frac{22.5 \text{ volts}}{2.63 \text{ volts}} = 6.85 \text{ K}$$

Also R2 can now be calculated.

$$R2 = \frac{R1\ Vb}{Vcc - Vb} = \frac{(6.85K)(2.63 \text{ volts})}{22.5 - 2.63 \text{ volts}} = .91K$$

Well, there you are. The values can now be applied to **Fig. 1** and we have an amplifier. However, you may have some trouble finding all the precise resistor values at your neighborhood electronics store. I picked the closest values I could find, and went through the calculations again. I obtained a calculated Q point of 4.95 ma which is quite close to the desired value. By breadboarding the circuit, the current was quickly measured. The current was 4.8 ma. This result is quite good considering the approximations used. Even if exact formulas were used, the values of the resistors could not be specified exactly, and even if we measure the hFE of the transistor, it will change considerably at other temperatures. Thus, there is little point in using calculations that are any more precise than is necessary.

Bias Stability

As was stated previously, one of the most important considerations before designing a bias circuit is circuit stability. By using regulated voltages and fixed resistances in the circuit only one thing is left to cause bias changes—the transistor. There are three factors that can change in the transistor, either with different environments or with different transistors of the same type. Professor W. L. Brown of the San Diego State College School of Engineering has presented simplified equations to show the effects of these three factors.

The first factor is I_{CBO}, the leakage current. The change in Ic can be approximated by

$$\frac{\Delta Ic}{Ic} = \frac{\Delta I_{CBO}}{Ic}\left(1 + \frac{Rb}{Re}\right) \qquad (11)$$

The change in collector current from equation 11 is in percent of the Q point current. The change in I_{CBO} will usually have to be determined from manufacturer's specs or by experiment. However by the use of one simple measure, this effect can be completely eliminated from our calculations. If we use silicon transistors instead of germanium, this consideration can usually be neglected. As a matter of fact, silicon transistors are much more widely used than germanium.

The second effect to be considered is the change in h_{FE}. The h_{FE} of transistors of the same type may vary over a two-to-one spread or more. There is a manufacturer who makes transistors that are each marked with its own h_{FE} by attaching an IBM card to each transistor. When a large order comes in the transistors are simply sorted for the desired specifications and the number of the ordered transistor is marked on each transistor. There is very little point in making the h_{FE} very precise because it may change by a factor of two to one with temperature. However, with the knowledge of how the change in h_{FE} affects the change in Q point current, we can design the circuit to minimize this effect. The simplified formula for this is:

$$\frac{\Delta Ic}{Ic} = \frac{\Delta h_{FE}}{h_{FE1}\ h_{FE2}}\left(1 + \frac{Rb}{Re}\right), \qquad (12)$$

where h_{FE1} and h_{FE2} are the minimum and maximum values of h_{FE}. We again see that the old familiar Rb over Re factor (or the S factor minus one) must be small for the change in Ic to be small. However, there is another factor that is interesting. Suppose h_{FE} changes from twenty to thirty, giving a change of ten. With S equal to five:

$$\frac{\Delta Ic}{Ic} = \frac{10 \times (5)}{20 \times 30} = .0835 = 8.35\%$$

This is a small change, but suppose we use a transistor with a h_{FE} of two hundred to two hundred and twenty. This is still a change of ten in h_{FE} but

$$\frac{\Delta Ic}{Ic} = \frac{10 \times (5)}{200 \times 220} = .00113 = 0.113\%$$

which is a much smaller change. So by using a low S factor and high h_{FE}, high stability can be secured.

The last important factor in bias stability is the effects of change in Vbe. The change in Vbe is rather predictable and is usually about -2.5 millivolts per degree centigrade.

$$\frac{\Delta Ic}{Ic} = \frac{\Delta Vbe}{Vre} \qquad (13)$$

is the simple equation for the effects of change in Vbe. This brings us to the fact previously pointed out about Vre. High values of Vre will minimize the effects of Vbe because Vbe and Vre are both in the base circuit. The large value of Vre will tend to overshadow the small changes in Vbe. As previously stated, the voltage for Vre is usually about two to four volts in commercial and military designs. Note that it is the voltage that is important, and just having a large Re will not help if the collector current is small.

Don't go too far in trying to make a circuit more stable. If a value of Rb over Re is one or less a point of diminishing returns results. The gain of the circuit will suffer because of the low resistances that tend to load down the signal. Also, a small value of Rb in the R1-R2 voltage divider will pull considerable current from the power supply. This current drain is essentially wasted because it does not contribute to amplification. If the unit is to be used portable or mobile, this will become an important consideration because of shortened battery life and low efficiency.

Conclusions

The first part of the discussion may have seemed a bit detailed, but the actual design of a bias circuit actually only takes a few minutes with pencil and paper. A little practice and experimentation will result in a good deal of satisfaction. It really gives quite a feeling of "power" to be able to make some marks on a piece of paper, and then built a circuit that works exactly as you predicted. Even though most of these calculations are not exact, the results will be very close. In small signal class A audio amplifiers, a shift or error of as high as thirty percent is usually acceptable anyway. Even though calculations are not made, the simplified formulas present an indication of how the circuit works, which is also helpful. So, the next time you design an amplifier, check a few of these equations first to be sure that your endeavor will be a success.

. . . WB6BIH

Malcolm Oakes K6UAW
4834 Carmelynn Street
Torrance, CA

FM Receiver Tweeker

I've found that the singlemost piece of needed test equipment by the amateur on FM is a receiver alignment generator. Most of us, however, do not have access to a signal generator. (Come on now, you wouldn't really call that *TV thing* a signal generator would you?)

The unit to be described is a very functional device that will allow you to scrape every ounce of sensitivity from your receiver. The generator can be built so small you can carry it around in your shirt pocket. Compactness, combined with its battery-powered portability make it ideal for servicing mobile receivers. Stability? It's crystal controlled and is as good as the rock you plug in (you obtain the rock from your transmitter). Output reactance? Nearly zero degrees, allows proper tuning of rf stage. The attenuator shown does not have a great deal of dynamic range due to distributed capacity of the potentiometer. However, I said before, the unit was "functional" and it is just that. The signal can be attenuated into the noise and brought up to approximately a 30 uv level; overly sufficient for a normal alignment.

Construction

The circuit layout is not particularly critical, and if laid out in a manner similar to the schematic, no problems should be encountered. The attenuator section should be completely shielded away from the oscillator and multiplier stages, so rf leakage will not be a problem. A crystal socket should be provided so the unit is versatile for any frequency. However, if you plan on using it on only one channel and can spare a crystal, build it with the crystal inside. Two glass piston screwdriver adjusted trimmers must be provided (to "rubber the crystal" and tune the output to resonance) as front panel controls.

Circuit

Transistor Q1 in the first stage is a crystal oscillator which is very loosely coupled to Q2 the multiplier. This stage is biased into "class C" so as to multiply the 6 mhz crystal 24 times, up to the two-meter band. (3 mhz crystals will also work at a multiplication of 48.) Another important function of this stage is to attenuate the oscillator output (about 6-7 volts peak-to-peak) to a level usable at the two-meter frequency for align-

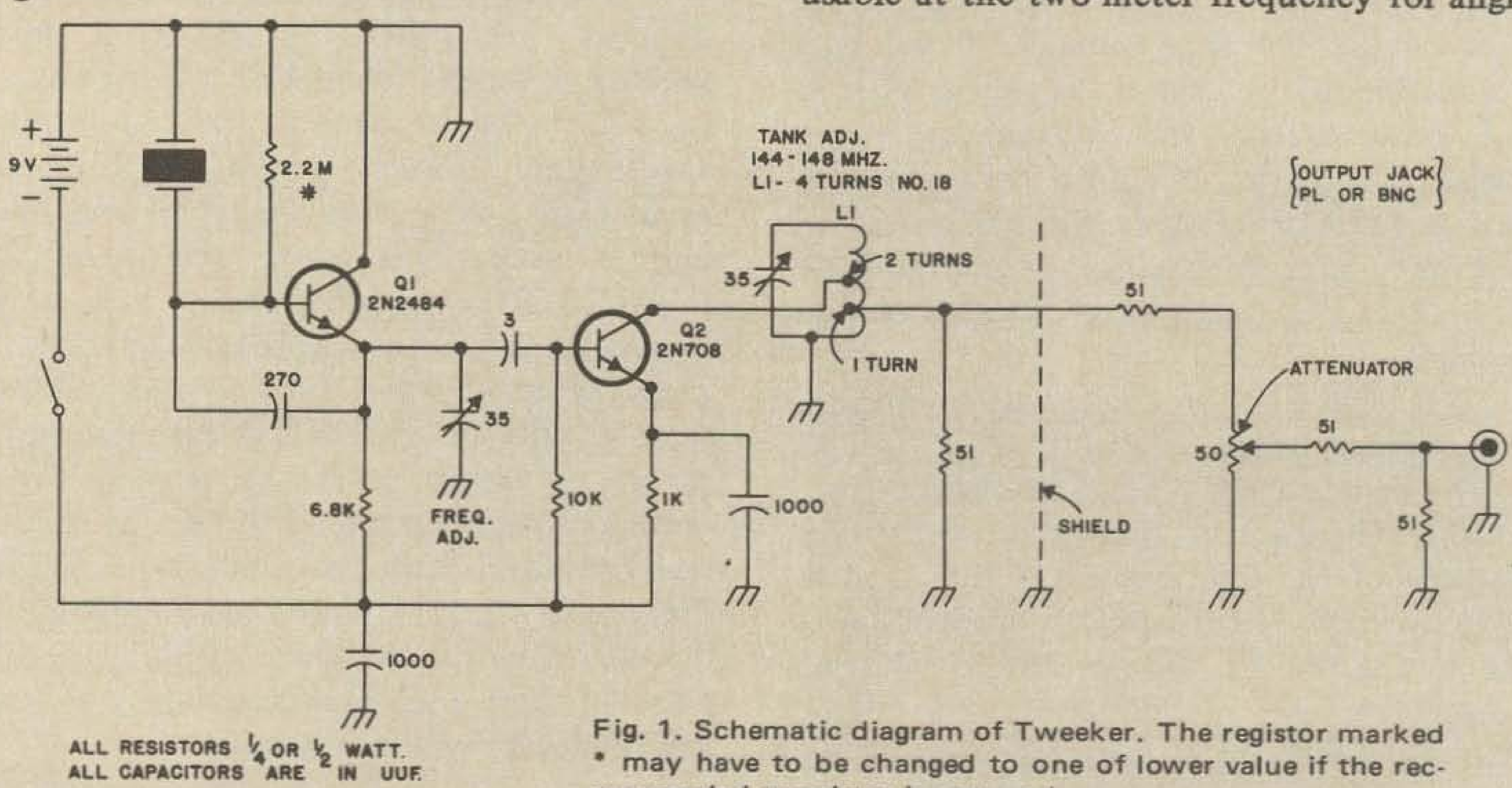
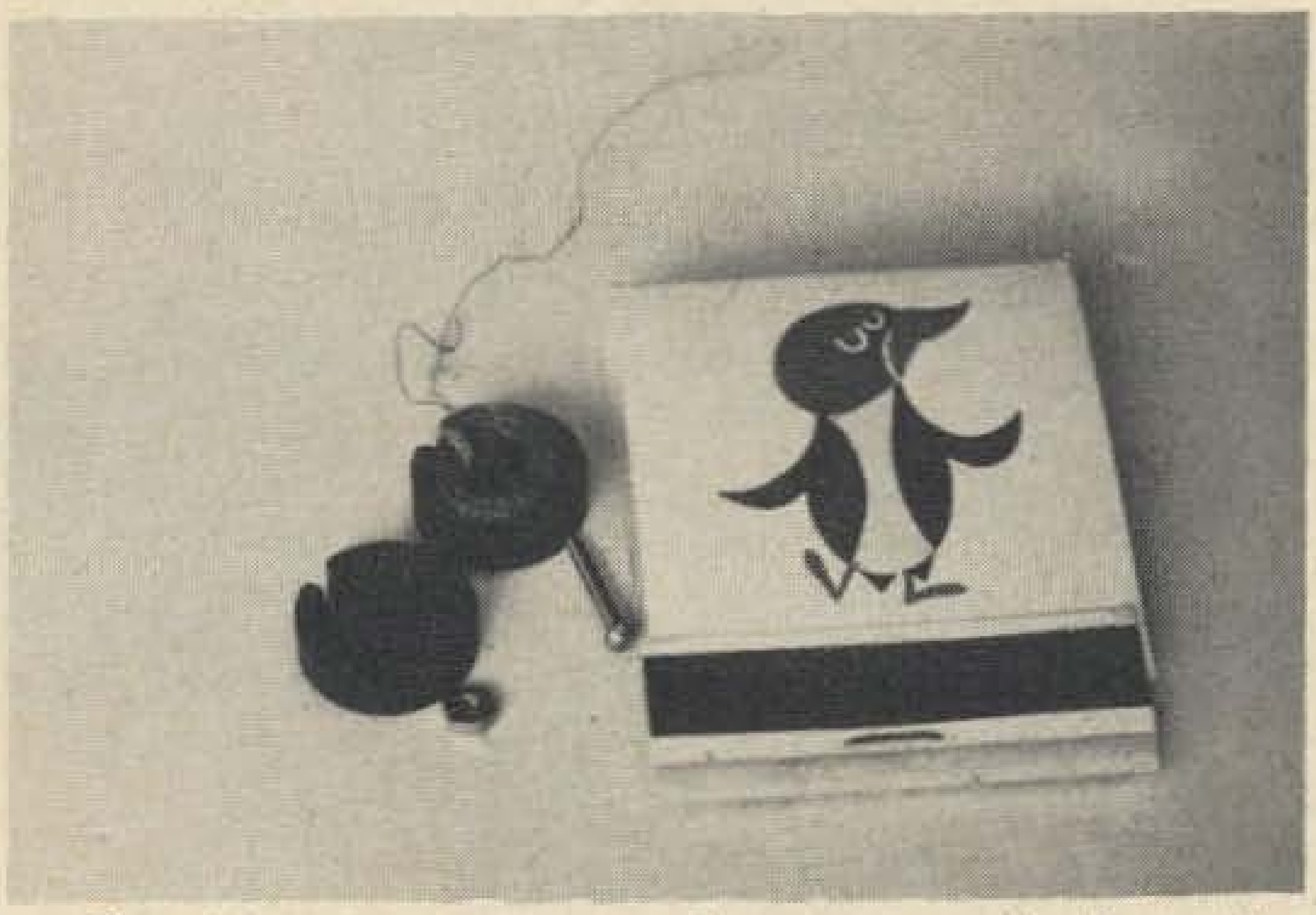


Fig. 1. Schematic diagram of Tweeker. The registor marked * may have to be changed to one of lower value if the recommended transistor is not used.

Shielded rf Chokes or Coils?

The tighter we pack radio frequency circuits, the tougher become the problems of shielding. To be efficient, a shield has to either reject or absorb the *rf* energy. Of course we can use toroids, and, not to belittle them, they are now being used in commercial hf equipment to good advantage. Toroids have one disadvantage, either they have one turn or a multiple of that, or they don't. And, winding them for high inductance takes time or a machine.



Pot cores are nearly as good for the self-contained shielding effect. They are very much cheaper. Plastic bobbins are quite inexpensive and very easy to wind by hand or with an electric drill at slow speed. For moderate values of inductance, no winding is necessaary. Simply take a pi-wound *rf* choke, remove one of the pies (sections), and slip it into the pot core. No mechanical tightening or potting is necessary. Q is much higher than the equivalant air wound coil or slug tuned coil. If the inductance is too high, and it usually is, simply unwind turns.

Roy A. McCarthy, K6EAW

ment – 30 to 40 uv. The potentiometer adjusted attenuator takes the signal down to a level as desired by the operator.

I developed this unit for use on two meters. Several have been built and all work fine. But, for those of you who need a six-meter generator, this same circuit should work fine with the only modification needed being the final tank frequency. (A few more turns on the coil and a slightly larger trimmer capacitor.)

Adjustment and operation

Connect the output of the generator to your rig. Plug in a crystal and tune for zero (with frequency adjustment) on the discriminator (center frequency). Now, looking at the first limiter voltage, peak the final tank. Attenuate the generator as necessary to avoid saturation of the limiter. Repeat as necessary until a definite peak is reached.

If the generator will not go down into the noise with the attenuator control, the final tank may be detuned as necessary to provide the desired range on the attenuator.

. . . K6UAW

A Mate for the Swan 350

Anthony Sperduti WB2MPZ
4740 Newton Road
Hamburg NY 14075

I have been operating the Swan 350 Transceiver for a year and a half and outside of a few bugs and minor breakdowns, think that it is a very versatile and dependable rig. But I missed having Vox, a crystal calibrator and selective sidebands.

Swan did make the TCU (Transmitter Central Unit) for the Swan 240 Tri Band (80-40-20-) Transceiver. The TCU includes these goodies plus a built-in speaker, but unfortunately does not have a side-band selector. The TCU is available inexpensively, so I bought one and adapted it for use with the 350.

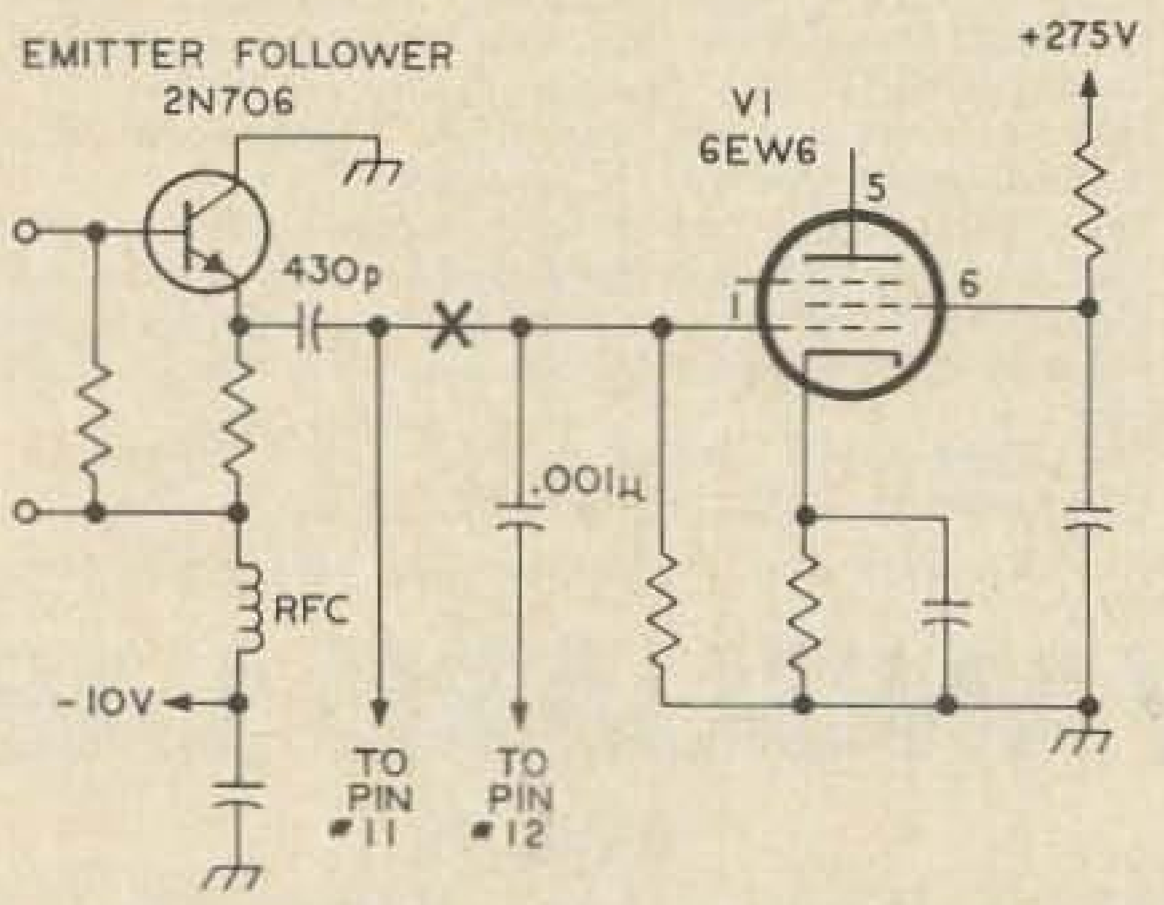
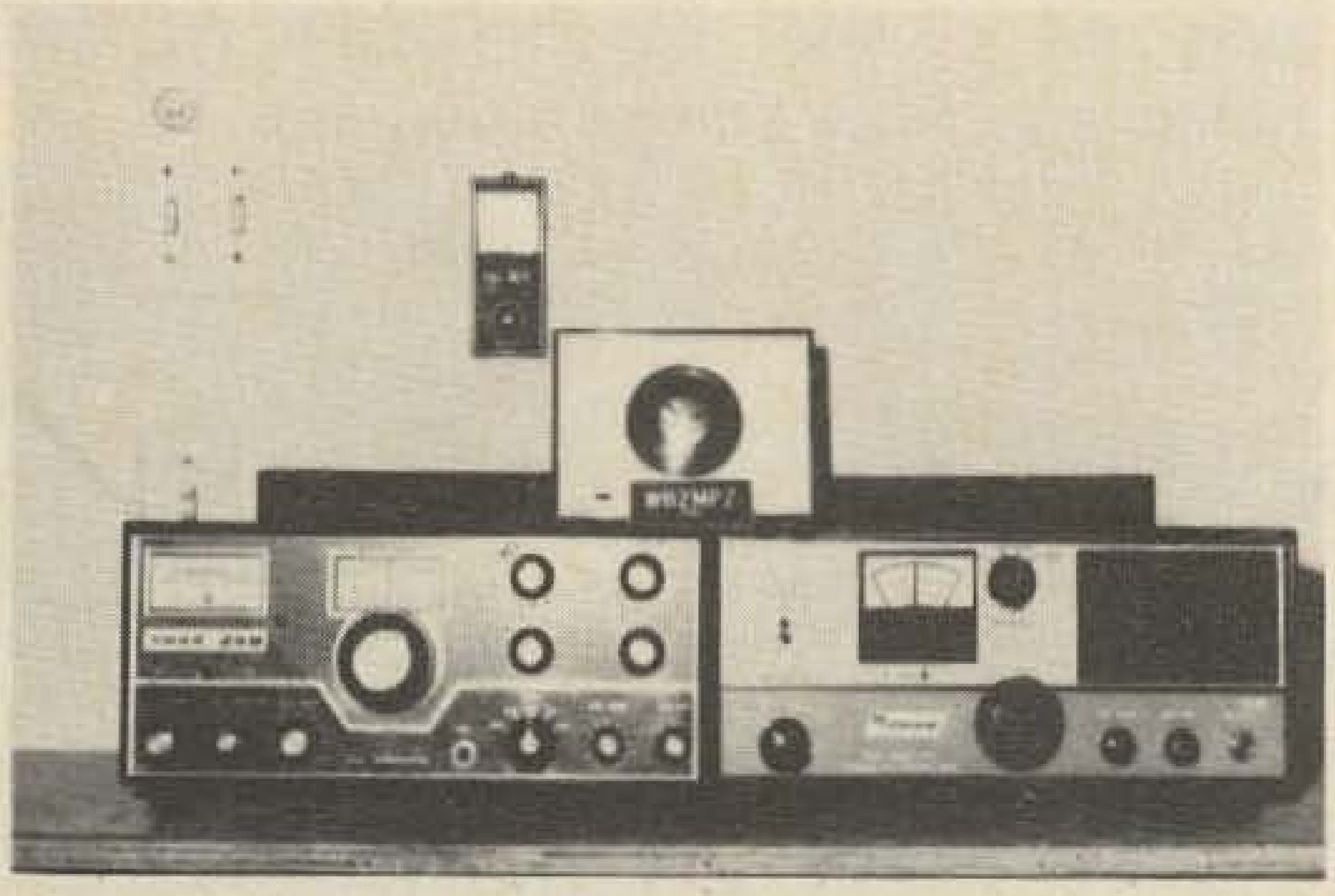


Fig. 1. Partial circuit of Swan 350 VFO. Cut wire at X and run one lead down to pin No. 11 and another lead through a .001mf cap. to pin No. 12 of the twelve pin accessory socket.

Remove the tube socket, .01 capacitor, 1000 ohm resistor cut off a small brown wire from the harness which is attached to the 12 pin receptacle supplied with the TCU. Discard these items as they will not be needed.

Install the receptacle in the accessory hole in back of your Swan 350 and connect according to Fig. 1 & 2.

The only necessary changes on the TCU are the rewiring of the VFO selector and the addition of a 12V. SPDT RC Relay. Fig. 3.



Swan 350 along side the Swan TCU. They are the same height, length, depth, and make a nice-looking pair.

There are a number of different ways to control this relay. The relay must be in the de-energized position to receive on VFO A,

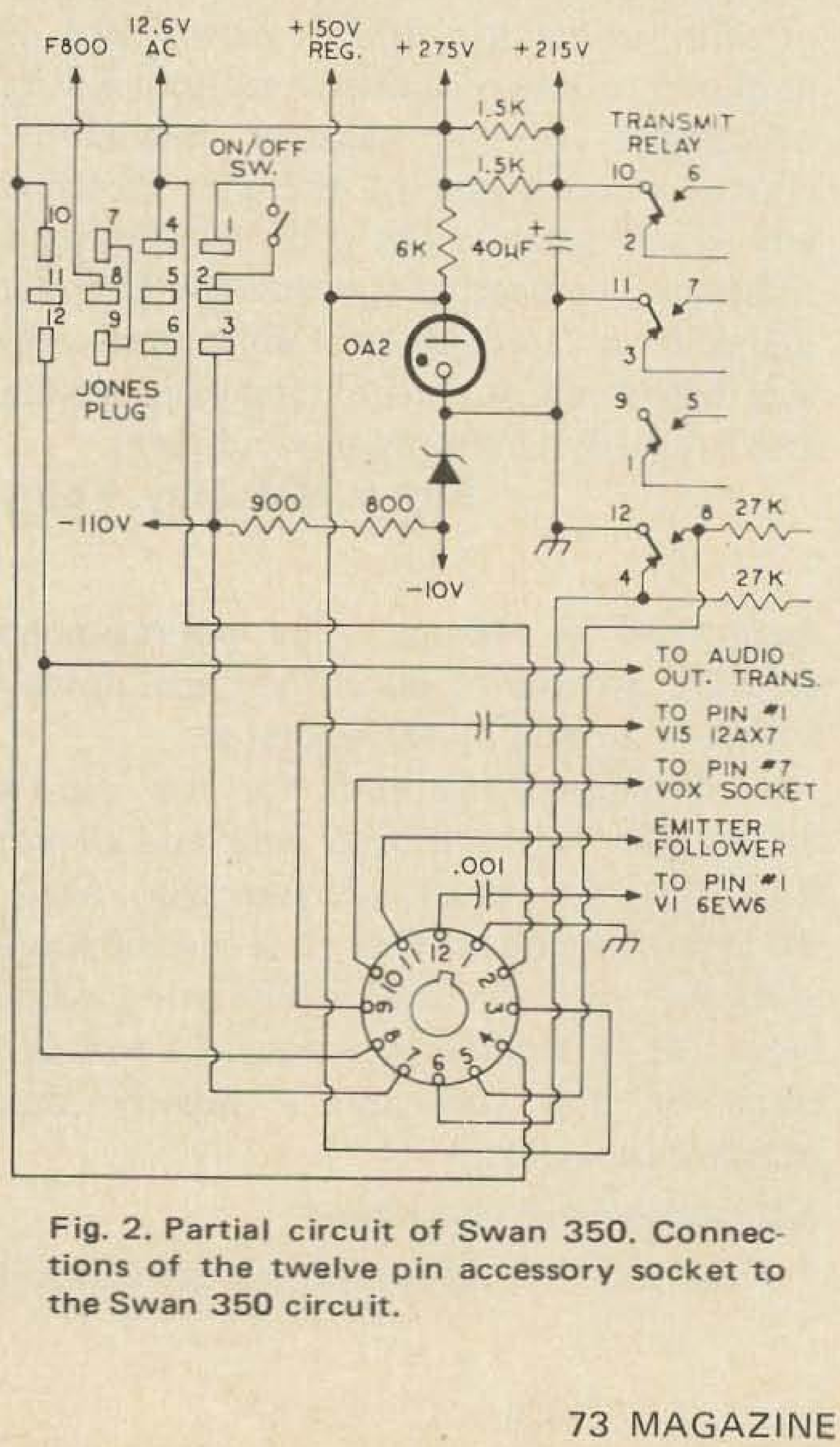
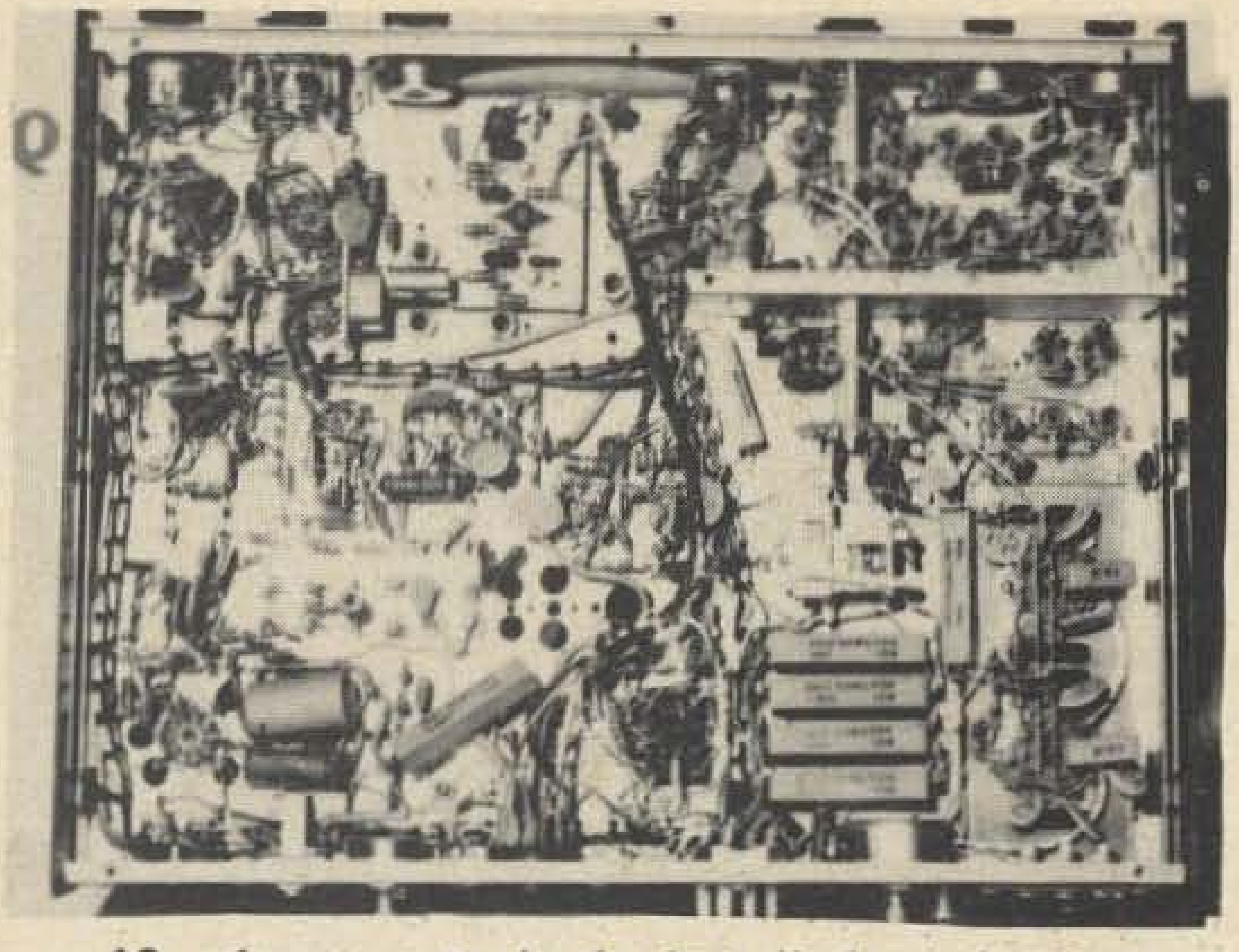


Fig. 2. Partial circuit of Swan 350. Connections of the twelve pin accessory socket to the Swan 350 circuit.



12 pin receptacle is installed at bottom center of photo. Note harness running to printed circuit VFO and where 2 lug terminal strip is placed.

which is the VFO in the Swan 350 and in the energized position to transmit VFO A. The only fault I have found with the way I have done it is that the vox relay must operate in order to energize the RC relay. This can be overcome by running another lead from the TCU to the 350 microphone jack for relay control. Also by running one wire, you could eliminate the need of taking 12 volts ac from the filaments of the TCU and rectifying it to operate the relay.

When you operate the Swan 350 mobile or without the TCV, a jumper must be installed from pins 11 to 12 instead of from 11 to 1. The Crystal Calibrator on the TCU did not give me much volume in the trans-

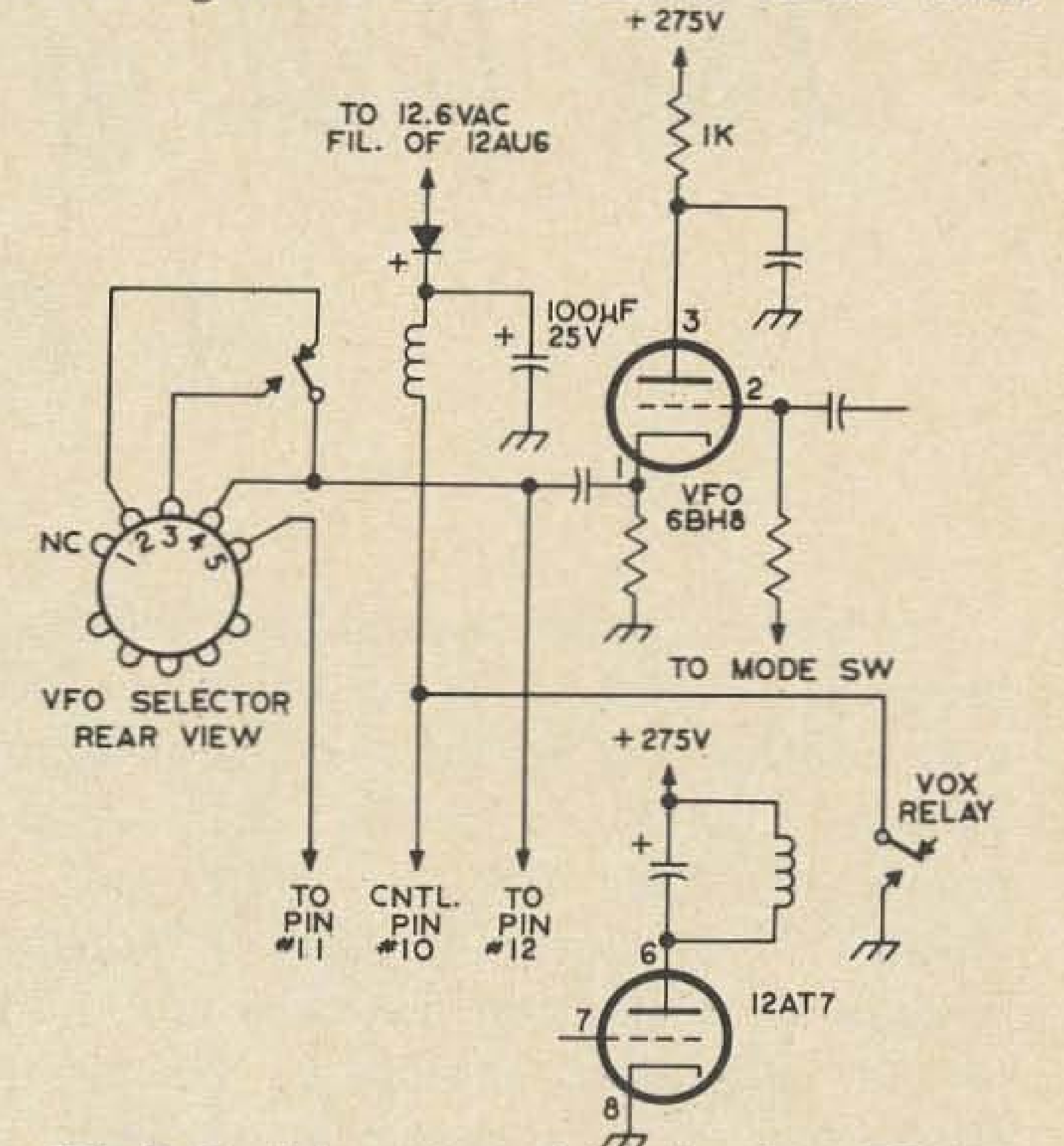


Fig. 3. Partial schematic of the TCU. Changes on the TCU VFO selector switch and addition of 12 vdc relay.

ceiver, so I changed the 10 pf coupling capacitor to a 100 pf capacitor, and now I have good volume on the calibrator.

Since I have been operating with the TCU it is amazing, how much more enjoyable it is to operate and how much easier it is to find a clear frequency without losing my original contact.

. . . WB2MPZ

Ham Hospitality

The idea for a Ham Hospitality list in 73 has brought many enthusiastic replies. We will list, each month, every new offer for hospitality. Please send in your name, call, address, phone number, what hospitality you are offering, and your interests. Specify if you are interested in stateside amateurs as well as DX visitors.

Buffalo, N.Y. DX OM/XYL/children, overnight/dinner, local sightseeing, rag chewing, State University. Interests: travel, photography, computers, skiing, camping, politics. Dick Eckhouse WA2CVL/W9EGY, Amherst, N.Y. 14226. 716-839-3627.

Hobart, Tasmania, Australia, OM/XYL/kids, two days. Guidance for tourism, some local sights, lots of talk. Try to come first Wednesday of month, to meet members of W.I.A. Interests: amateur electronics design, human destiny, fishing, magazine publishing. R. Leo Gunther VK7RG (ex-W6THN), 32 Waterworks Road, Dynnyrne, Tasmania 7005. Phone: 23-7670.

Dear Wayne,

My wife and I would like to appeal to 73 Magazine and its readers for some help and hospitality. We will both graduate from Iowa State University next spring and are hoping to visit Europe for three months before beginning work. Our hope is to meet with and better understand our friends' thoughts and lives in Europe.

Our method of travel will be with Eurail Pass and we plan to travel north to Norway and Sweden and south to Spain and Italy. We wish to correspond with and become friends with Europeans before we travel in the 13 countries serviced by Eurail Pass trains.

Below you will find our listing for Ham Hospitality. Thank you and may we soon have new DX friends visit us in Ames, Iowa.

Jim and Nancy Larsen WAØLPK

Washington, D.C. – Annapolis, MD Area. DX OM/XYL, overnight/dinner, local sightseeing and rag chewing. Bill Shepherd W3ZSR, 12,000 Twin Cedar Lane, Bowie, Maryland 20715. Telephone 301-262-0155.

Ames, Iowa, DX OM/XYL overnight/meals, tour Iowa State University. Interests: OM–talking, flying, music, occult. XYL–speaks French, art, sewing, computers. Jim & Nancy Larsen WAØLPK, 587 Pammel Court, Ames, Iowa 50010 (515-233-2591).

The Ball of Wax – A Calibrator

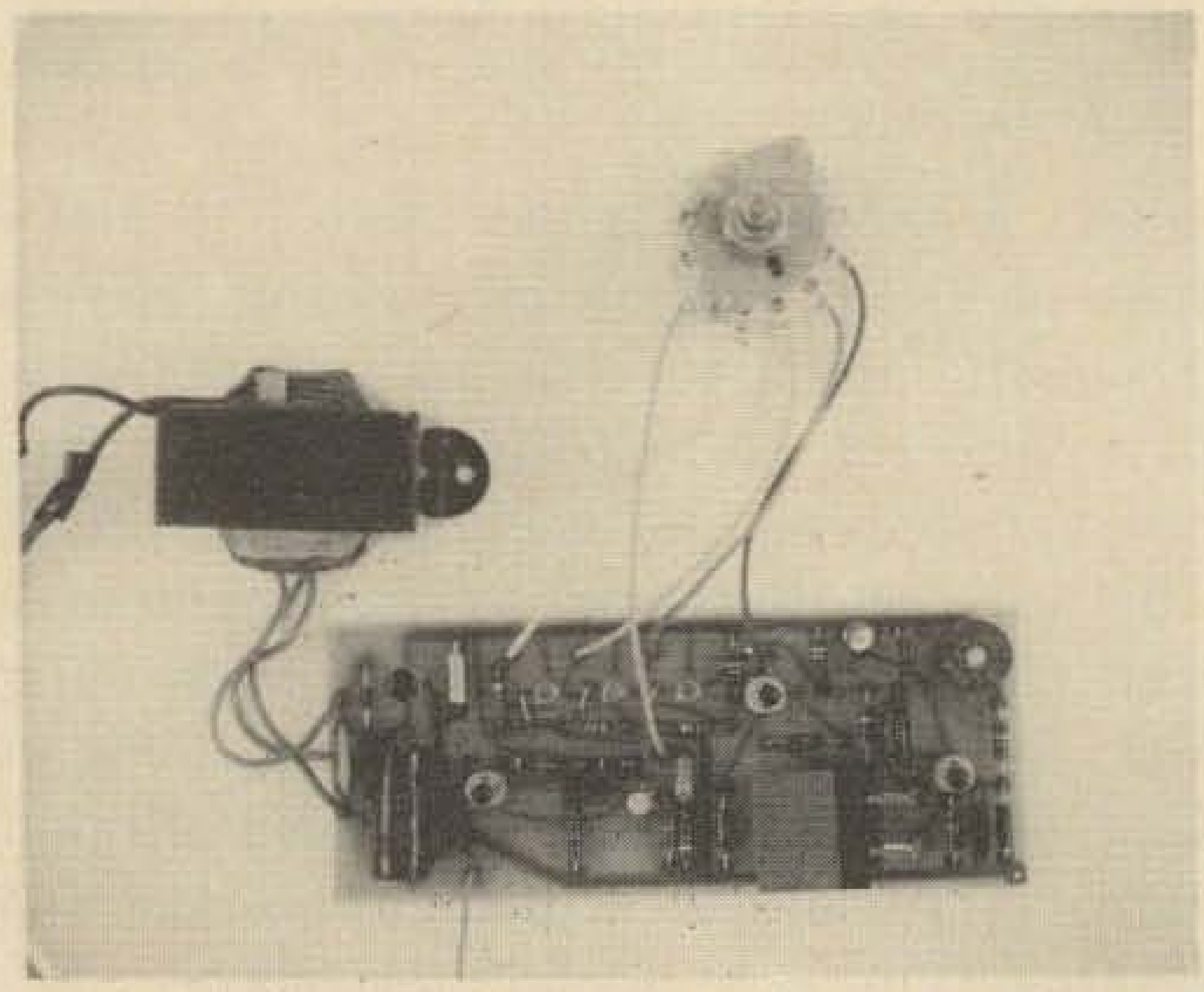
Hank Olson W6GXN
Box 339
Menlo Park CA 94025

In several receiver calibrator articles in the past, the author has used bipolar transistors, emitter-coupled logic (ECL), integrated circuits, junction FET's, and resistor-transistor-logic (RTL) integrated circuits.[1,2,3] By now, the idea of integrated circuits as dividers in 100 khz and 1 mhz crystal calibrators should be pretty well established. The acceptance of ECL and RTL integrated circuits by hams and experimenters is underlined by the fact that both of these logic families are now available in Motorola's HEP line, at most any radio parts store.

The calibrator to be described here is one that uses an admixture of bipolar transistors, a junction FET, MOS-Digital IC's, an MOS-FET, and a linear IC. Such a unit could only be called a "ball of wax," because of the variety of components. We will find, however, that in spite of the differences between the various components, they compliment each other very well.

The finished calibrator provides the operator with a quite useful choice of frequency calibration marks: 200 khz, 100 khz, 50 khz, and 25 khz spaced spectrum lines. This set of calibration markers is a convenient one for use with the general-coverage type of hf receiver.

The design philosophy of this calibrator is somewhat different than most others published in recent years. Usually, the crystal oscillator is followed by a squaring circuit, and *then* by dividers, as in **Fig. 1**. This is the method used in references 1 and 2. However, in "The Ball of Wax," since MOS - IC's were used as dividers (whose uppermost counting speed is only 500 khz), the dividers were followed by a Schmitt-Trigger. This system is shown in **Fig. 2**. The Schmitt-Trigger circuit "speeds up" the waveform, assuring that the rise-time is fast enough to produce good, useable harmonics throughout the hf bands.



Finished circuit board.

The complete rf circuit of the calibrator is shown in **Fig. 3**. Although the circuit of the **Fig. 3** looks complicated, it contains less than $7.00 worth of semiconductors.

The crystal oscillator (Q1) is a Colpitts-type which operates the surplus FT241 crystal in the series-mode. Most hams are accustomed to operating FT241 crystals (of the 400 to 500 khz variety) in a parallel-mode oscillator. Apparently the 200 khz FT241 crystal is the one exception in this holder style; so operate it series-mode! The 200 khz crystal was obtained from Jan Crystals (2400 Crystal Drive, Ft. Meyers, Fla. 33901) for $1.75 plus 10¢ postage.

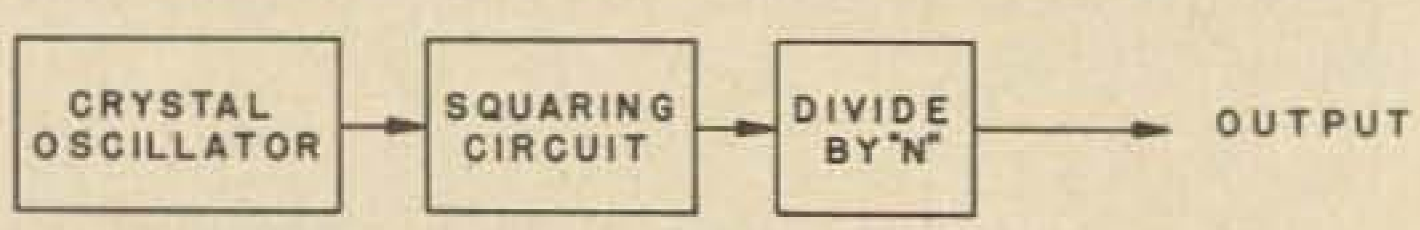


Fig. 1. Usual design circuit.

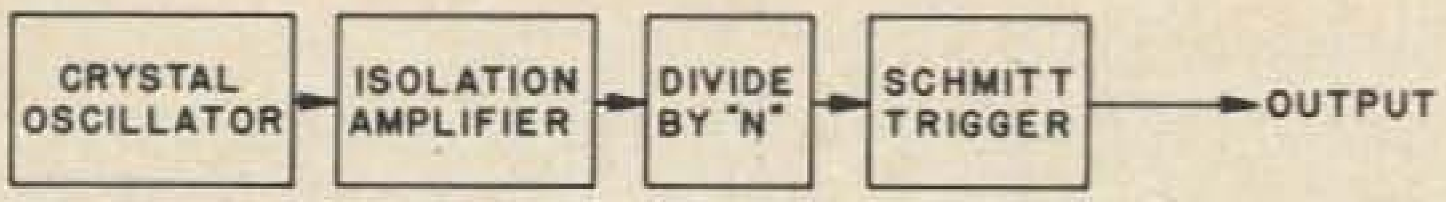


Fig. 2. Drawing of the Schmitt-Trigger system which is used to produce useable harmonics in the hf band.

Following the crystal oscillator are two isolation amplifiers, Q2 and Q3. Q2 drives the MOS-IC divider chain, and Q3 drives the Schmitt-Trigger when 200 khz output is desired. Less elaborate isolation gave small variations in crystal oscillator frequency when one switched between 200 khz and 100·khz outputs.

The "heart" of the calibrator is, of course, in the three binary dividers: Hughes HRM-F/2 MOS integrated circuits. Unlike other IC's, these are packaged in TO-18 transistor cans with four leads. With one lead for power and one for common, that leaves the other two leads for input and output. If we'd look inside the F/2, we'd probably find a complete J-K Flip-flop, as offered in more complex members of Hughes' HRM family. However, in this simplified binary, only the "T" (toggle) and "Q" (output) are brought out of the can. The HRM-F/2 will operate up to 500 khz and costs *less* than any RTL binary, (even less than half of an MC790P dual-ff). Three HRM-F/2 IC's divide the 200 khz output from Q2 down to 100 khz, 50 khz, and 25 khz.

The Schmitt-trigger is unusual in that it has an MOS-FET in its input stage. This feature is used to prevent loading the output of any of the dividers of Q3. An ordinary Schmitt-trigger, using two bipolar transistors, so heavily loads its input, that it is almost invariably driven via an emitter-follower. The use of a fast N-channel MOS-FET gets around the input loading, without sacrificing rise time.

If it is desired to operate the calibrator from its own line-operated power supply, a simple regulated supply is shown in **Fig. 4**. An integrated regulator made by Continental Devices Co. is used because of its low price and simplicity. The CMC 513-4 looks like any epoxy TO-5 transistor, having only 3 leads. Inside this wondrous $3.00 package are all the components to make up a regulator: transistors, resistors, voltage reference, and even a thermistor to shut down the regulator when the temperature gets too high. With a finned clip-on dissipator, the author has run these little regulators up to 100 ma. The rf circuit of the calibrator only requires 15 ma, so the CMC 513-4 is more than adequate for this job. The Philbrick/Nexus 2105 IC-regulator is apparently a

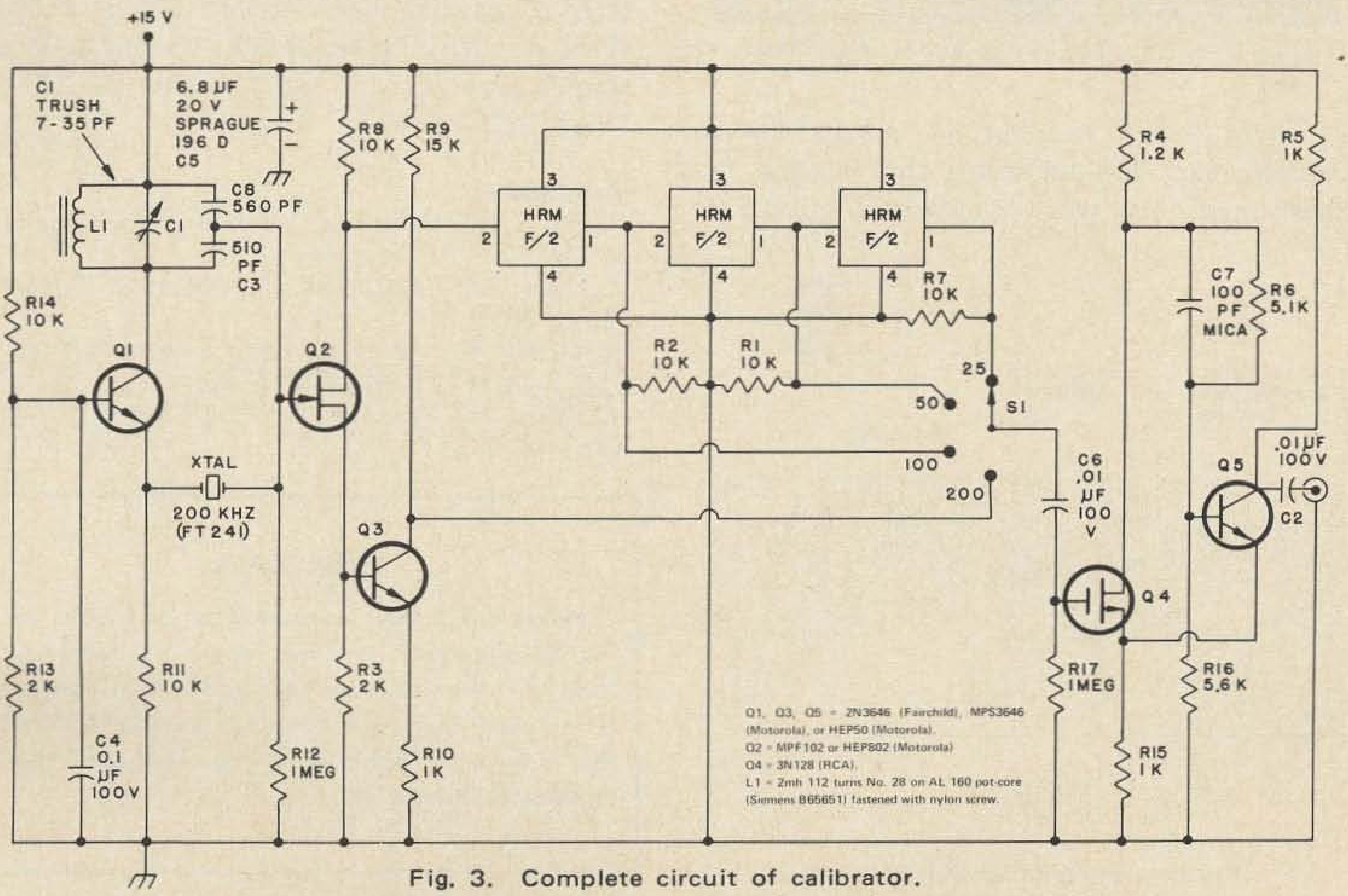


Fig. 3. Complete circuit of calibrator.

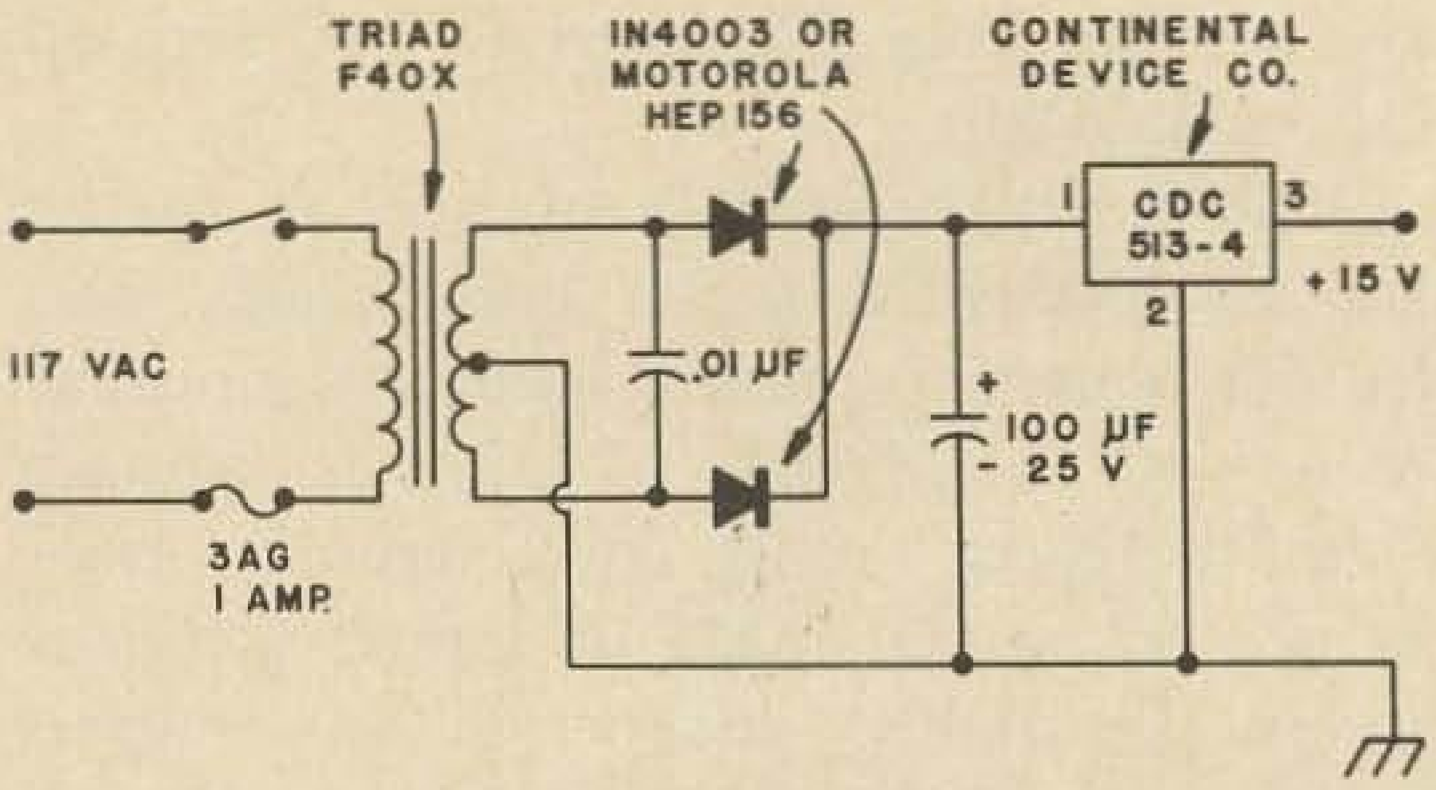


Fig. 4. A simple regulated power supply for the calibrator.

similar device (at approximately the same price), and may also work here. A Triad F40x was used for the power transformer; it is capable of considerably more output current than needed, but smaller transformers are more expensive.

It was decided to put the rf circuitry and the power supply circuitry all on one etched circuit board. Since the power supply has so few components, little space is wasted if one decides not to build that portion. The board layout is shown in Fig. 5 and the parts layout in Fig. 6.

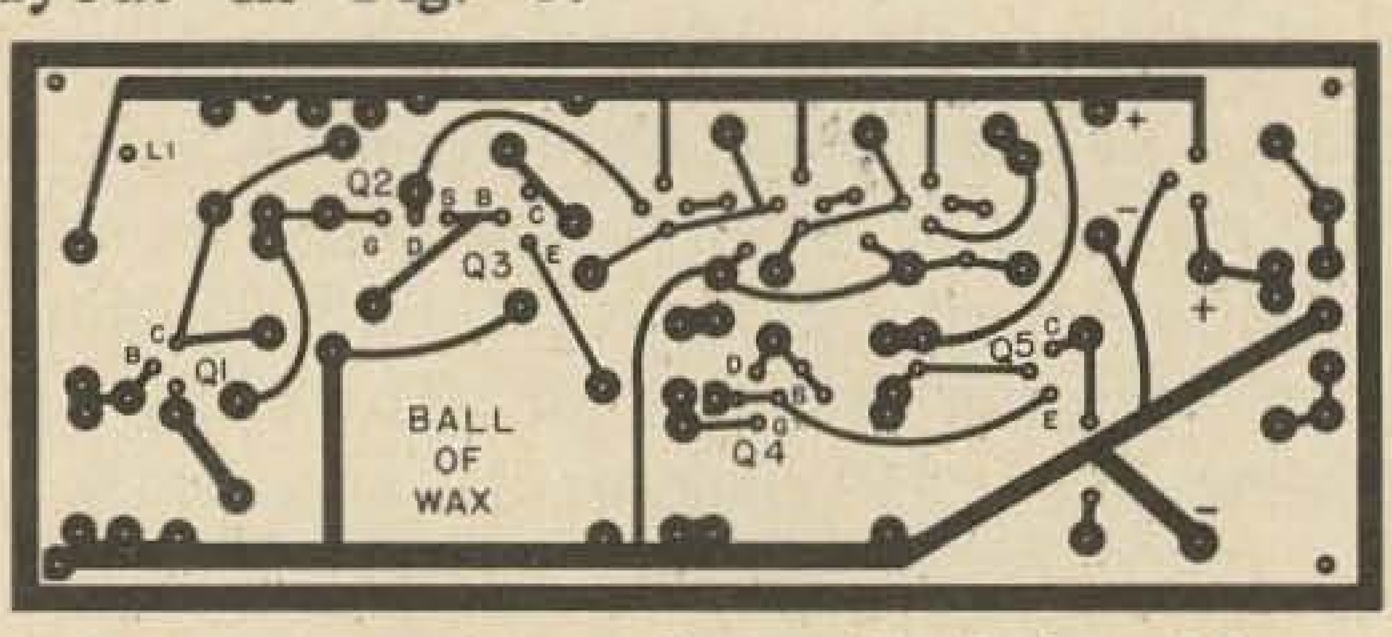


Fig. 5. Illustration of the circuit board layout.

There are a number of points about construction and materials that should be mentioned. L, was handwound using a Siemens B65651 pot core; the cost of two core-halves and bobbin are less than $1.60. The core was clamped together and held down on the etched circuit board with a nylon 4-40 screw. This core has an air gap in it, *thru which the screw passes*; so don't use metal screws. The AL160 printed on the core would indicate that we'd need 112 turns for 2 mh, but 112 turns is nominal. (The AL number on a core is the number of nano-henries per turn-squared we wind on that core.) The tuning capacitor, C1, is a Trush miniature ceramic type. Other types will work, but the board is laid out to fit this Trush model. The crystal socket is made from two pin-grips removed from an old octal socket. They are soldered through the board and bent 90° to accept the FT241 pins.

The procurement of parts, especially ferrites and semiconductors, may prove to be a bit more difficult than usual. The advantages offered by the modern components used in the "Ball of Wax" however, seemed to outweigh this increase in procurement difficulty. Parts procurement for the unit should certainly not be beyond anyone working in the electronic indstry. However, if one does have trouble getting parts, Stafford Electronics (427 South Benbow Rd., Greensboro, NC) is offering both etched circuit boards (Part no. ST-11-69E at $2.50) and a kit of semiconductors and i.c.'s board ($15) for "The Ball of Wax."

. . . W6GXN

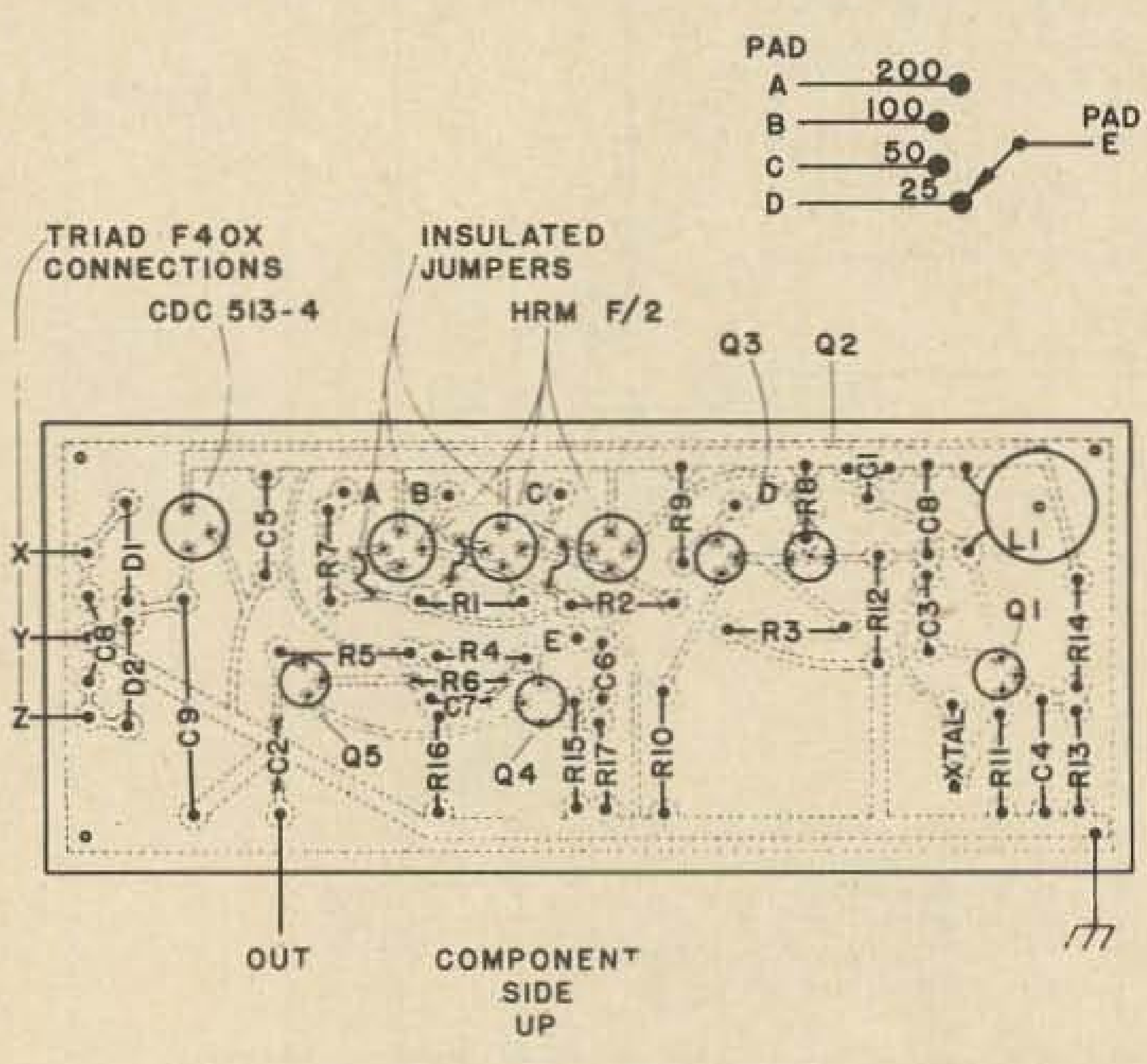


Fig. 6. Illustration of the parts layout.

References

1. Olson, H., "A 50 khz Calibrator," 73, Aug. '66, p. 42.
2. Olson, H., "The Mark 11 Calibrator," 73, Dec. '66, p. 58.
3. Olson, H., "A Frequency Calibrator for the V.H.F. Man," 73, Aug. '67, p. 12.
4. Olson, H., "Ferrites, or What's Mu with You," CQ, Apr. '66.

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

James Riff K9JSC
2101 North Neva
Chicago, IL 60635

Electronic Variac

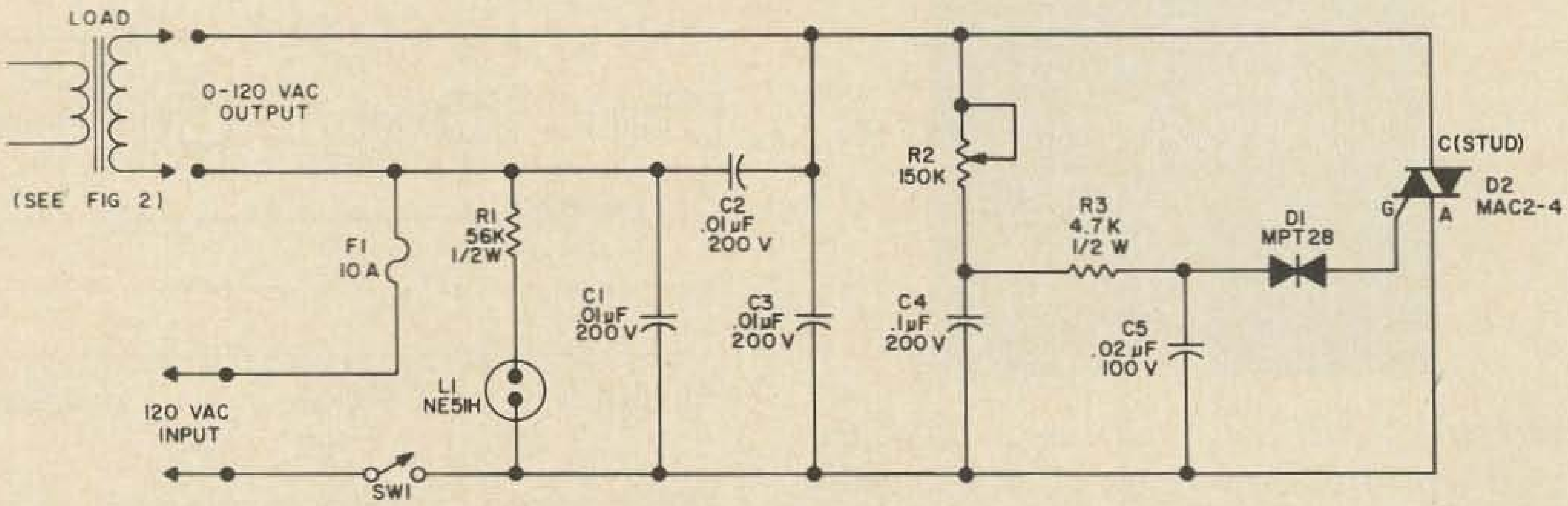


Fig. 1. Electronic Variac schematic. C1 to 3—.01uf 200V Capacitor; C4—.1uf 200V Capacitor; C5—.02uf 100V Capacitor; D1—MPT28, 3 Layer Diode (Motorola); D2—MAC2-4, 200V Triac (Motorola); F1—10 Amp Fuse; L1—NE51H Neon Lamp and Socket; R1—56K, 1/2 Watt ±10% Resistor; R2—150K Pot, Lin. Taper, 1/2 Watt; R3—4.7K, 1/2 Watt ±10%; SW1—SPST Switch, 10A; Misc.—Line Cord, Terminal Strip and Chassis.

In the realm of electronic experimentation, it becomes necessary to use a variable voltage source as a means of precision voltage control.

The Electronic Variac circuit outlined in **Fig. 1** will provide a full range of voltage control for the primary of any 120 vac 60hz transformer requiring less than 10 amperes of primary current.

The Electronic Variac may be constructed in a small 3"x5" utility box, or mounted in the front panel of the controlled source. The only modification to the equipment in which the Variac is added is a single 3/8" mounting hole for the 150K pot. If an outboard system is more versatile, then a line cord and socket will be needed for ease of connection.

Construction:

Choose either of the two above mentioned mounting arrangements and begin by mounting the MAC2-4 triac to a good heat sink surface. Since this is a stud mounted device, a single ¼" hole will be needed. Apply silicon grease or IRC heat sink compound to both insulating washers and the base of the device before mounting. Check for electrical shorts between the stud and chassis after mounting the triac, for the stud carries full line potential. When connecting the MPT-28 trigger diode, be certain to heat sink the leads before soldering. The leads should be left their full length for heat dissipation. Both leads of the MPT-28 are identical and no polarity need be observed. Although the anode and cathode of the MAC2-4 are identical, the gate is the shorter of the two terminals protruding from the top of the device and it must be connected to the trigger diode MPT-28.

Addition of the on and off switch, fuse, neon lamp and capacitors C1, C2, C3 are all optional. The capacitors are installed to eliminate the rf or noise generated by the system. Experimentation with the requirements for these capacitors are left up to the individual.

Applications:

The control of many types of ac loads is within the capabilities of this simple circuit. One example is the addition of the Electronic Variac to the circuit shown in **Fig. 2.**

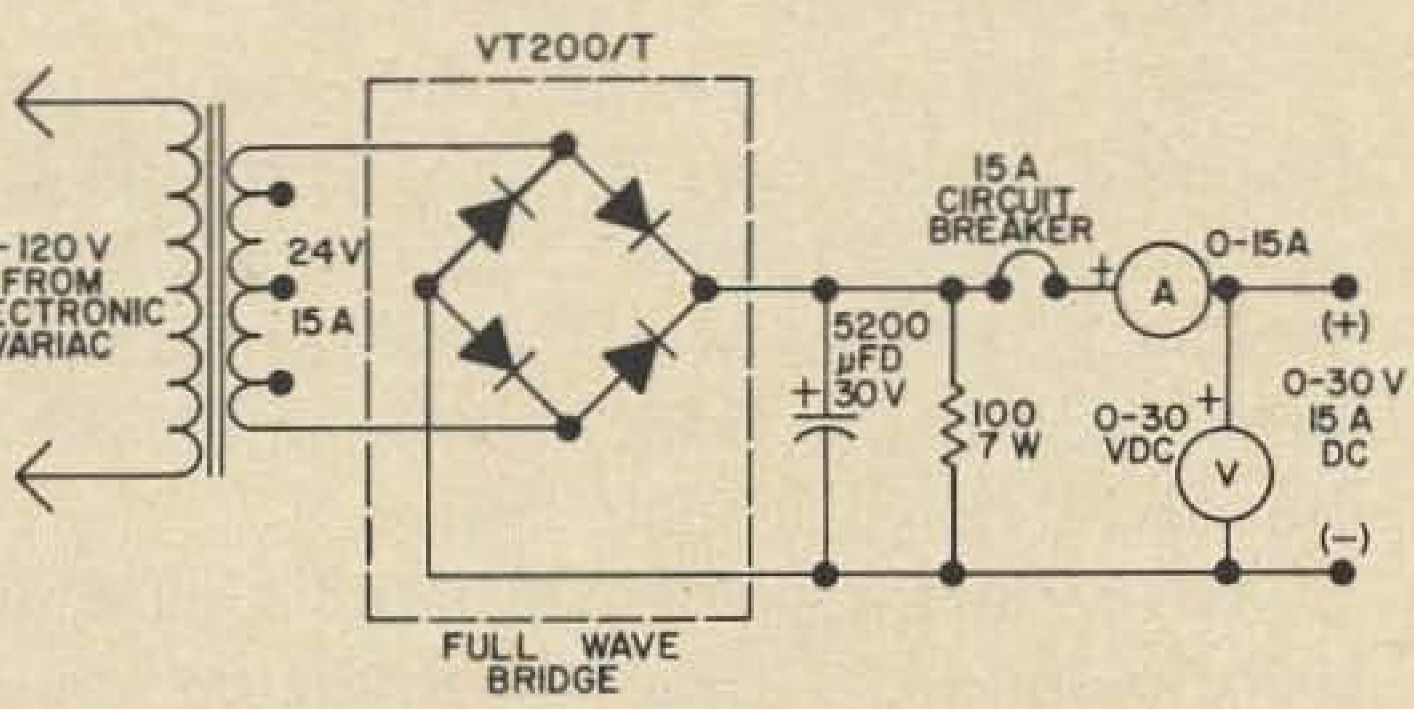


Fig. 2. DC battery eliminator/charger/power supply. C1—52000UFD, 30WV, (GE, 86F147M; CB1—15A Circuit Breaker (375-215-101 Wood Electric); D1—Full Wave Bridge, (VARO VT200/T), (or: 2-MR1120, and 2-MR1120R, Motorola); M1—0-15 Amp Ammeter (EMICO); M2—0-30 Volts dc, Voltmeter (EMICO); T1—24V 15A Filament Transformer (Knight 54F2335) or Equivalent; Misc.—Chassis, Terminal Strip, Binding Posts; R1—100Ω, 7W Wire Wound Resistor.

A battery charger or high current bench supply that is variable from 0-30 vdc is very useful in checking the mobile rig on the bench or powering bread board circuits. **Fig. 2** shows a straight forward power supply using a full wave bridge if needed. A well stocked junk box should yield most of the parts required for the supply.

Other applications include a variable supply for hobby use such as electric trains or slot cars, plating of metals and light control. The Variac can be used to replace that worn out hunk of Variac in the plate supply of your high power rig. The Electronic Variac is small, produces little heat and for less than $8.00 worth of parts, does the job of a large variable transformer costing more than three times as much.

. . . K9JSC

Ham Hospitality

If your home is open to visiting hams, please send a note to 73, Peterborough, NH 03458, giving your name, call, address, phone, hospitality offered and whether to DX or U. S. hams. You are missing one of the finest aspects of amateur radio if you are not being visited now and then by DX operators.

SB-33 Modification

D.J. Lynch W4MNW
113 Robinhood Avenue
Titusville, FL 32780

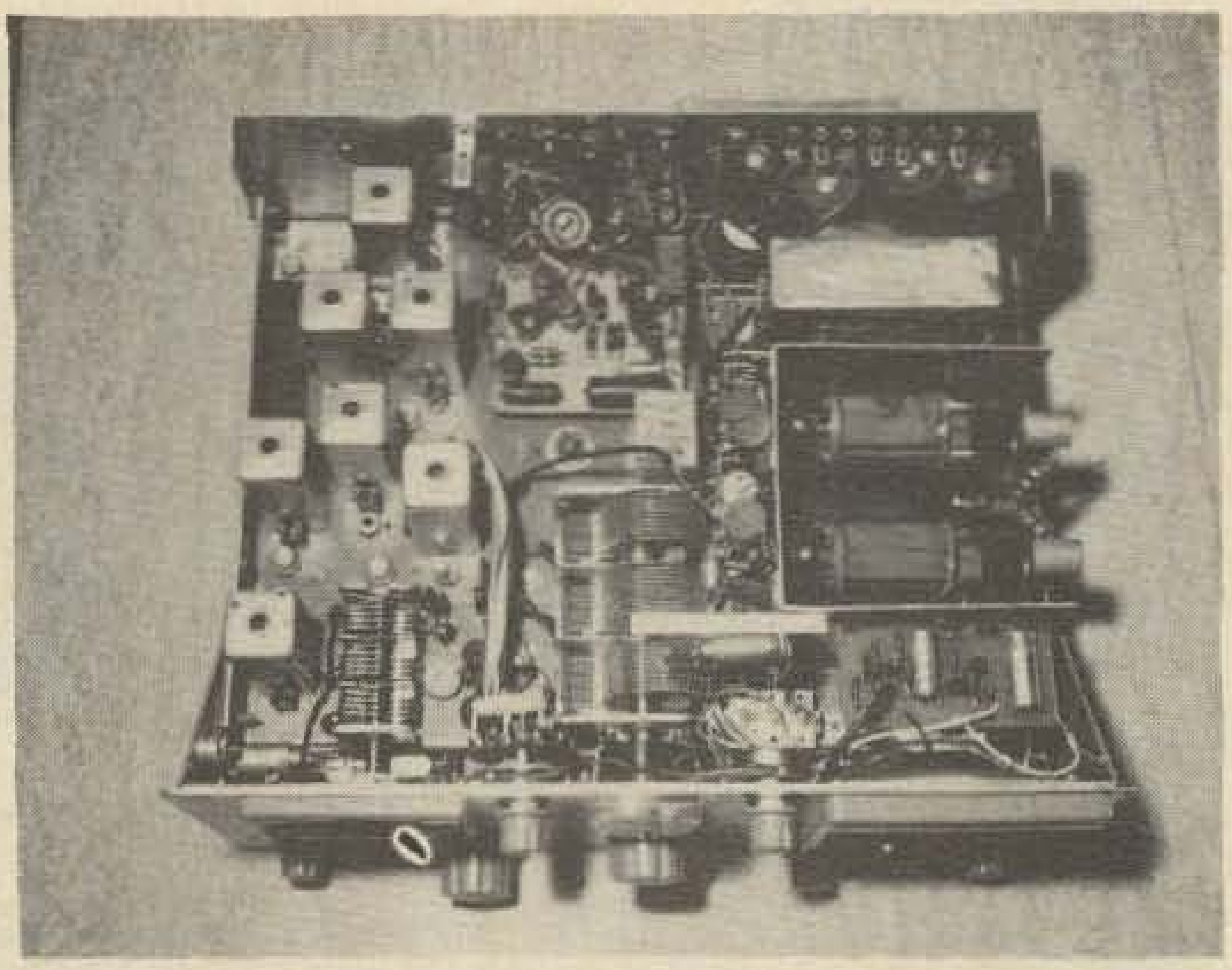
When the time came to purchase a SSB transceiver, the SB-33 was chosen. It is compact, solid state and the price had just been reduced when the new SB-34 was released.

After several months of operating it was decided to try to improve the performance and increase the flexibility of the transceiver.

The first item added was a 100 khz calibrator, shown in **Fig. 1**. The crystal oscillator was taken from an earlier GE transistor manual, but the harmonics did not have sufficient amplitude, so the amplifier stage was added. This provided more than enough harmonic output and even produced outputs in excess of 100 mhz when checked on a Nems-Clarke receiver. By using an amplifier transistor with a higher ft than the 2N2189 I am sure output would be sufficient for 100 khz markers on two meters.

The calibrator was assembled on an epoxy board and put in a 3¼ x 2 x 1 inch Minibox which was attached to the back of the transceiver. A switch was installed on the side of the Minibox to control calibrator operation and the 10 volts needed to operate was obtained from the transceiver.

As far as the receiver was concerned, the next items the author felt needed improvement were the sensitivity, especially on 15 and 20 meters, the overload characteristics and a quicker acting agc at normal volume settings was desirable. The rf amplifier transistor Q12 was replaced with the mixer transistor a 2N2495. According to the data sheet, the 2N2495 noise figure is 2 db up to approximately 25 mhz which is probably lower than really needed for hf. The transistor used for the mixer Q11 was a 2N2672 which was taken out of the original rf stage. Other hf transistors checked in the mixer stage include a 2N502, TIXM10 and a 2N1742, but they had too much gain and



Top view of modified transceiver. The two added crystals Y7 & Y8 are visible in the lower left on either side of the vfo capacitor shaft, lower right of photo shows the compressor/preamp on top of speaker. The two front panel mounted toggle switches are seen on either side of the bandswitch knob. In the upper right of the photo are seen the added 300uf capacitor and part of the minibox containing the 100 khz calibrator.

the receiver would overload at lower signal levels than with the 2N2672. No bias changes were made in either stage.

With the volume at comfortable room listening levels it was felt the agc should start at lower signal inputs so the 10K ohm agc feedback resistor was changed to a value of 4.7K. SBE used a 6.8K resistor in the SB-34, but the 4.7K performed better.

If the audio gain is operated higher such as in mobile use it may be desirable to use a somewhat larger value than the 4.7K ohms. The receiver is now more pleasant to tune with the agc holding the audio output at a more constant level.

To further minimize cross modulation or overload, a 12 db pad was inserted between the receiver and the antenna relay as shown in **Fig. 2** and a switch to insert it or remove it from the line was mounted on the back panel next to the antenna connector. Adding in the pad sometimes helps the copy of signals when strong signals are adjacent in frequency, especially on 40 meters at night.

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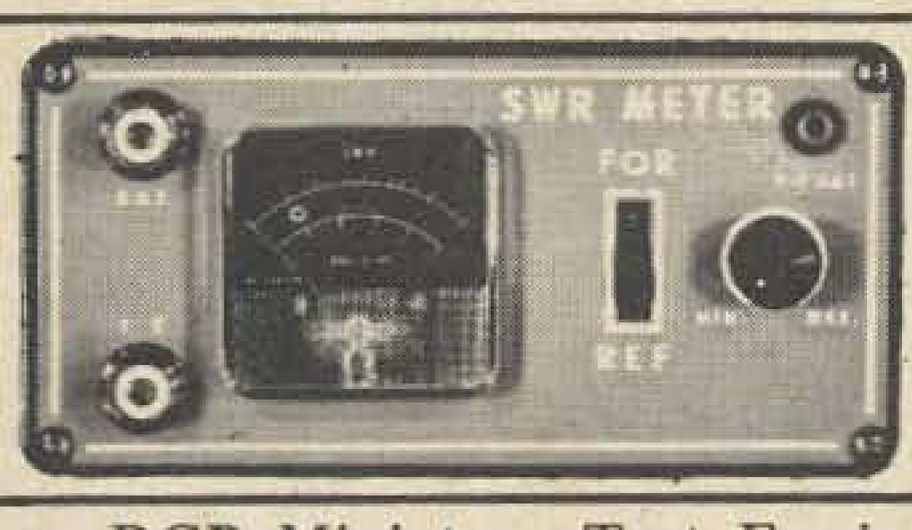

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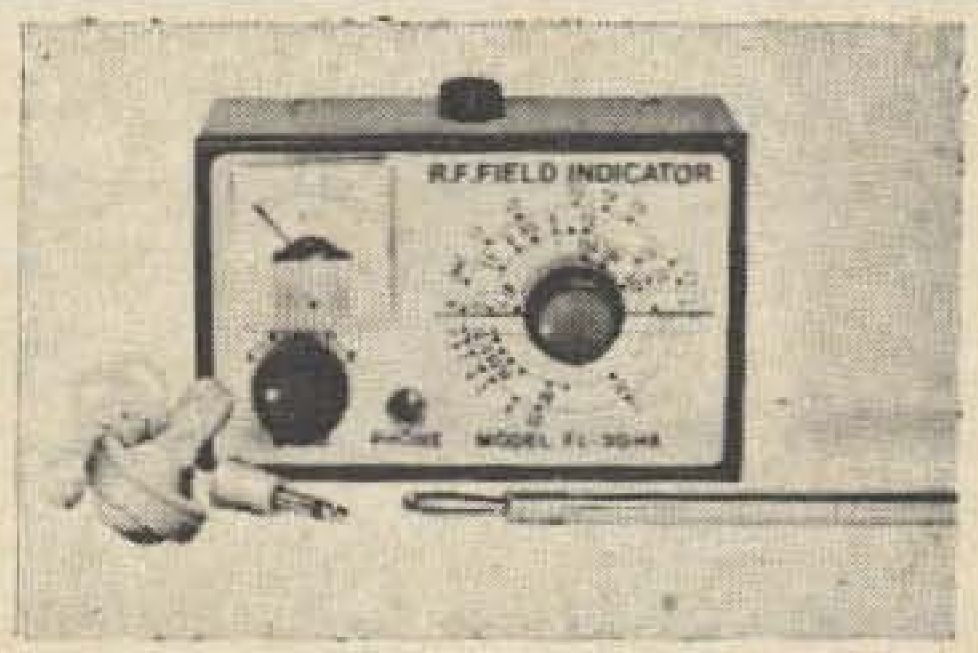

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In an effort to increase the gain of the receiver so that the volume control could be operated at a lower level, it was desired to have more *if* gain and audio gain. The collector load resistor of Q5 was changed from 1K ohm to 3.3K ohm, which SBE does in the SB-34. Q7, the receiver *if* amplifier transistor, was replaced with a 2N1224 which provided more gain at the same volume setting than the 2N2672 used originally. Now with the greater amplification in *if* and audio stages the volume control does not have to be advanced as far for a specified audio output. By operating the volume control at a lower setting the amplification of the hf mixer, Q11 is held to as low a value as possible which helps to prevent overload of the vfo mixer and *if* amplifier.

The proof of the pudding is in the testing so the receiver was subjected to the following tests in both the modified and unmodified condition: in the original configuration it took a cw signal level of .7 microvolt to produce an audio output at the speaker terminals 10 db above noise. After modification a .35 microvolt signal produced an output 10 db above noise. This test was performed on 15 meters and the rf stage was repeaked for each configuration.

To test overload characteristics, a cw signal of 5 microvolts was fed into the receiver at 21.3 mhz, another generator was set at 21.35 mhz and the output increased until the audio output from the 5 microvolt signal decreased by 6 db. In the unmodified state a signal level of 9.5 millivolts at 21.35 mhz was required to reduce the desired 21.3 mhz signal output by 6 db. After modification a 13 millivolt signal was required at 21.35 mhz to reduce the 21.3 mhz signal by 6 db. The better overload rejection can be attributed to the increased gain in the *if* and audio sections, which allow lower gain control settings.

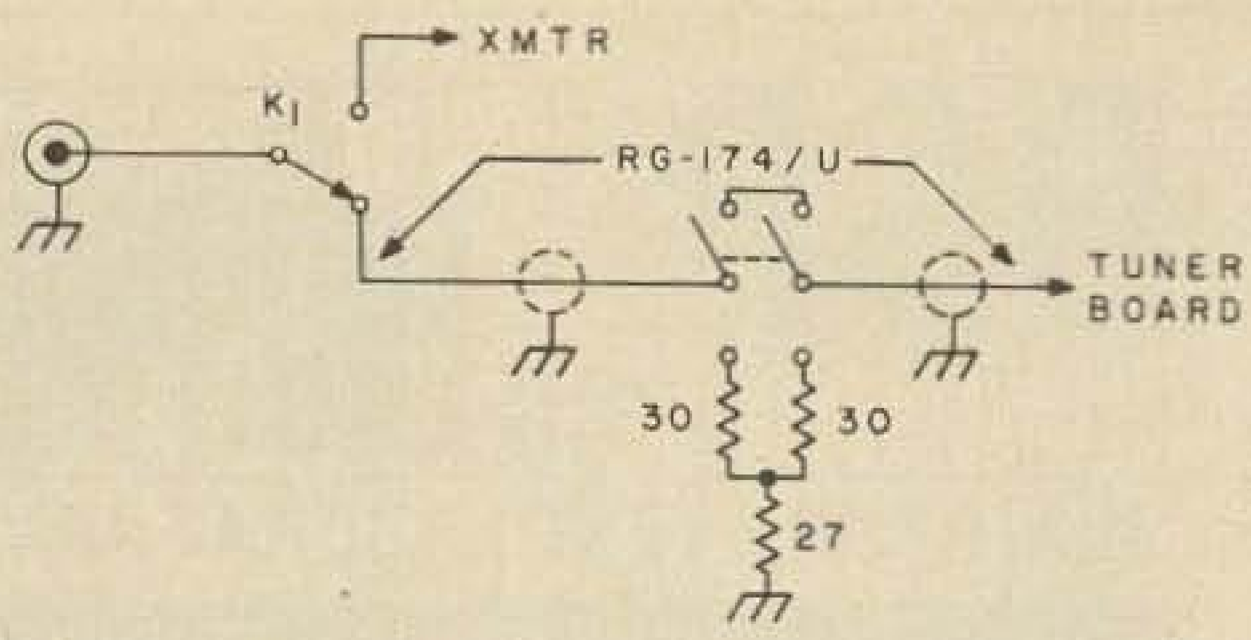

Fig. 2. Schematic of 12 db attenuator added to receiver. Small RG 174/u coax was also added between relay K1 and the tuner board as shown.

The above tests were conducted using HP-608 generators and a HP-3400 rms voltmeter. Output level at the speaker was maintained at .1 volt rms with signal and the agc transistor, Q19, was removed to disable the agc.

The first change in the transmitter was the high voltage supply. It was noticed that under 250 milliampere load the B+ voltage dropped to 385 volts from about 470 at 80 ma. To remedy this a 300 mf 150 volt capacitor was used to replace the 100 mf 150 volt unit in the voltage tripler supply. Even though the 300 mf capacitor is larger than the 100 mf unit, it fits quite well in the allotted space. Be sure to use small heat sinks on the diode leads when soldering the capacitors. After the modification, the high voltage at a current of 250 ma was 445 volts. Although this change yields a minimal power gain it is felt that the better regulation provided is worth the change.

In an effort to use a high impedance microphone with the transceiver (the author did not have a low impedance microphone), a preamp was needed. Since a preamp had to be constructed, it was decided to combine it into a speech compressor. The preamp/compressor was built on a 1 3/8 x 2 5/8 inch epoxy board and mounted on top of the speaker coil. A switch was added on the front panel to change the amount of compression.

To be able to operate in the cw portion of the bands additional crystals were added

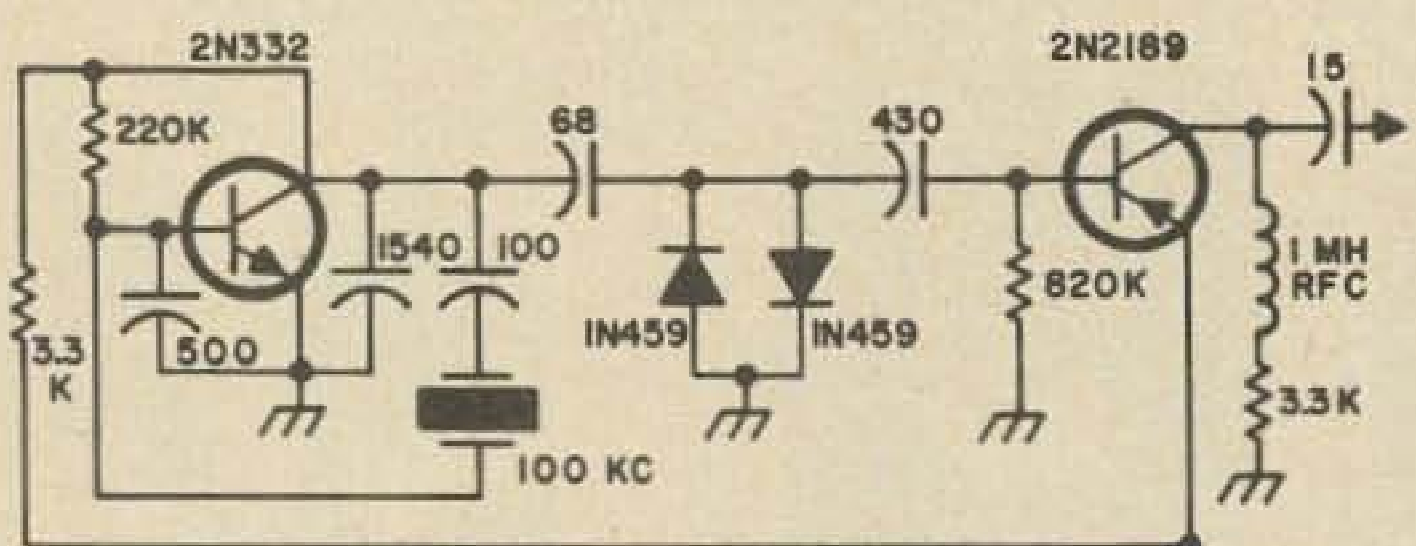

Fig. 1. Schematic of 100 khz calibrator. Parts values are not critical and the transistors do not have to be the ones listed. It is suggested that a late version of the GE transistor manual be consulted for a slightly revised oscillator circuit.

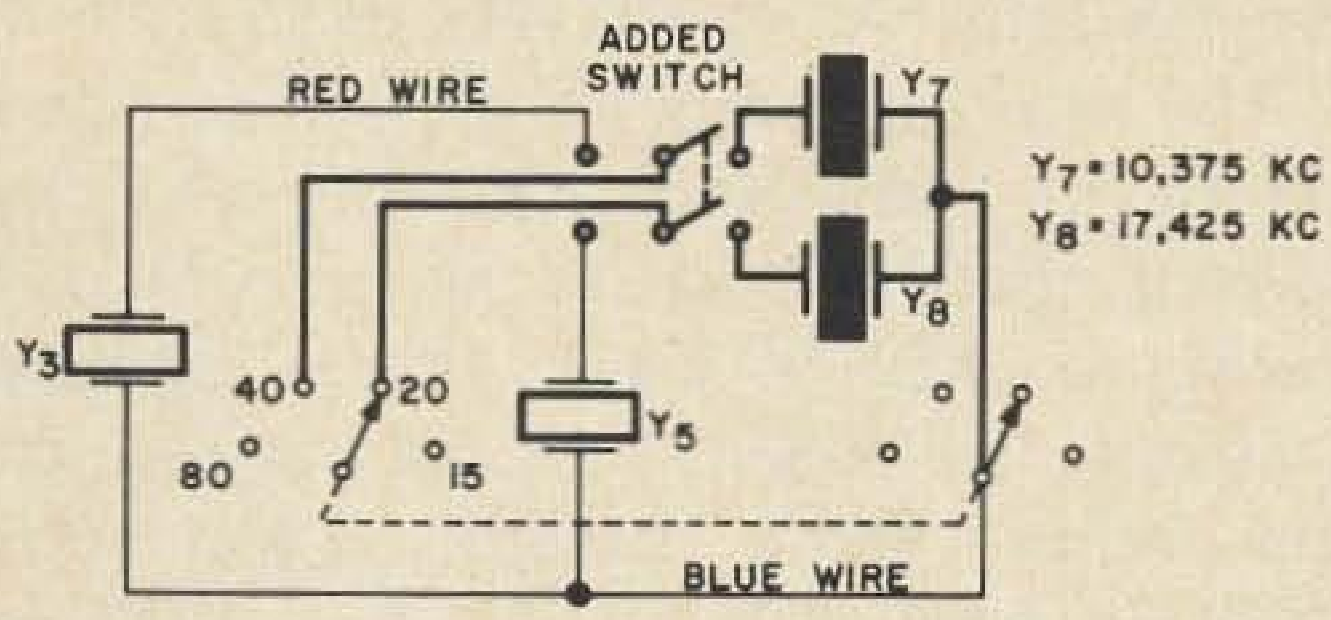

Fig. 3. Circuit showing the additions of crystals Y7 and Y8 for CW coverage on 20 and 40 meters. The added components are shown by heavy lines.

in the hf oscillator. For 20 meters a 17,425 khz crystal and for 40 meters a 10,375 khz crystal were used to cover the cw portions. They are type HC-17/U crystals installed in two crystal holders mounted to the chassis lip behind the lower portion of the tuning dial. The crystals are switched by a simple DPDT miniature toggle switch mounted to the left of the mike jack on the front panel. A schematic of the changed circuit is shown in **Fig. 3.** If one wishes to cover all four bands on cw, a miniature four-pole double–throw rotary switch could be used with the additional crystals. To keep front panel appearance the switches might be mounted on the rear panel. To key the transceiver, a circuit as shown in the February, 1966, 73 could be fabricated on a board and installed on the back of the 33 near the *if* section. This has not been accomplished by the author, but will be forth-coming in the near future.

Additional changes in the original transceiver were to add a single hole SO-239 uhf connector in place of the original antenna connector and another change was to move the tuning dial pilot light further forward away from the vfo circuitry. When the transceiver is buttoned up tight, the pilot light does give off some heat. An alternate method might be to dim the pilot lights by using a dropping resistor. A three-amp fuse was also added; although the schematic showed a fuse, there was none in the unit.

Well, there it is, a good transceiver made a bit better. Most of the changes can be made without altering the physical appearance of the transceiver and the rest require only minimal changes, most of which could be removed later if desired.

. . . W4MNW

Philip Moshcovitz
65 Bellingham Road
Chestnut Hill, Mass. 02167

Call Letter Lunacy

When Hubert H. Humphrey lost the election, gloom clouded the airwaves of radio station WHHH in Warren, Ohio. They didn't support this staunch democrat, but the president's initials in their call sign would have given the station prestige. Richard M. Nixon won, and WRMN in Elgin, Illinois, celebrated. KFDR in Grand Coulee, Washington, also gained some fleeting recognition when Franklin D. Roosevelt was in office.

These are only a few examples of the 4,224 standard (AM) radio stations in the United States that have distinguishing and sometimes, meaningful, call signs. Referred to as "license plates" of the air, they identify the nationality of the station, the type of station, and the individual station. Since 1927, under international agreement, the alphabet has been used by the countries of the world for radio identification. The United States is assigned the letters K, W, and N. The Navy and Coast Guard employ the letter N. K is used for those stations west of the Missippi River, while those beginning with W are east of the river. A few stations such as KDKA in Pittsburgh received their call letters before this plan was adopted.

The Federal Communications Commission, through the Communications Act, is responsible for allocating call letters to all radio stations in this country, with a few military exceptions. Stations have the privilege of requesting particular call signs other than the first letter. If a new broadcasting station makes no specific request, it is assigned appropriate letters. Amateur call signs are also assigned from unused letters.

Most radio stations prefer call letters consisting of letter combinations which specify the station's location or some aspect of the broadcasting area. The best and simplest call letters include• the name of the broadcasting city or town. There is immediate identification with KADA in Ada, Oklahoma; KELY in Ely, Nevada; WACQ in Waco, Texas; and WARE in Ware, Mass. KAYS in Hays, Kansas, and KODI in Cody, Wyoming, are allowed some literary leeway. Cities with long names must use abbreviations in their call letters. This is exemplified by KANA in Anaconda, Montana; KAST in Astoria, Oregon; and KIND in Independence, Missouri. The latter also indicates a very friendly city.

The weather plays an important role in selecting a radio station's letters. Citizens of cold climates such as Aspen, Colorado, shiver to KSNO while those in Barre, Vermont, hail WSNO. The winter resort of Sun Valley, Idaho, supports KSKI, while WSKI is located in Montpelier, Vermont. Warm weather is wonderful to KSUN in Bisbee, Arizona; KTAN in Tucson, Arizona; KHOT in Madera, California; WSOL in Tampa, Florida; WSUN in St. Petersburg, Florida; and WTAN in Clearwater, Florida. In Ocean City, Maryland, everybody gets WETT, while the breezy city of Chicago has WIND. Ironically, it's KOLD in Tuscon, Arizona; KOOL in Phoenix, Arizona; and WARM in Scranton, Pennsylvania. It could be said that these radio stations are very "unsound."

The agricultural products of a region are represented by its call letters. Cattle country caters to KALF in Mesa, Arizona; and KCOW in Alliance, Nebraska; while Mitchell, South Dakota residents hear KORN. Visitors to Farmville, North Carolina, curiously contemplate WFAG. However, a fag is a British term for cigarette and North Carolina is the leading producer of tobacco. Idaho, known as the gem state, naturally has KGEM in Boise. KAVE echoes in Carlsbad, New Mexico, which is noted for its mammouth caverns. Hawaii is famous for the hula and poi, a native food prepared from the taro root and allowed to ferment. Honolulu is proud of KPOI and KULA.

Las Vegas, Nevada, is the city of chance, with gambling a prominent pastime. The glamorous atmosphere permeates into radio with KLAS, KLUC, and KENO. Keno is also a form of lotto used in gambling. Another Las Vegas in New Mexico wants part of the action and promotes KFUN.

There must be considerable confusion in Easton, Pennsylvania, with WEST. How do they stay awake at WZZZ in Boynton Beach, Florida? Are things really green in Greenville, Missipi, with WDDT?

Some radio stations are quite hip. They WSOK it to you in Savannah, Georgia, and WSOC it to you in Charlotte, North Carolina. One of the "highest" rated stations in the country is WLSD at Big Stone Gap, Vermont. Do they also have a generation gap there?

The FCC frowns on pornography and tries to keep the airwaves clean. They overlooked KIZZ in El Paso, Texas; KKIS is Pittsburg, California; and KXXX in Colby, Kansas. In staid, stoic, Salt Lake City, Utah, founded by the Mormons, one can listen to KSXX, but only if you're twenty-one.

. . . Philip Moshcovitz

"Old soldiers never die —
young ones do."

Assistant Editor Opening

Somehow, working doesn't seem that much like work when it is in your hobby. We have a fun bunch of people here at 73, for the most part, and we need someone to help with the technical editing, testing of new equipment, and about 8000 (plus or minus a half dozen or so) jobs. New Hampshire is one of the most wonderful places in the world to live, with an incredibly varied climate and beauty. Requirements? A good solid knowledge of radio, and English, and a convivial personality. Here is an opportunity to help make 70,000 plus readers of 73 get a little more enjoyment every month. What can you find to do that will be better than that? Salary? That depends on your background and ability. I think we are paying the highest salaries in the ham publishing field even though we live in a low rent district.

Antenna Interaction – What to Do About It

F. J. Bauer W6FPO
P. O. Box 870
Felton, CA 95018

If you have an antenna farm (and who doesn't nowadays?) you may have wondered what effect your unused antennas may have on antenna performance. I too had thoughts about those unused radiators, when one day I noticed that a quarter wave grounded vertical produced a half ampere of antenna current while the transmitter was on the inverted V! Receiving tests showed very noticeable changes in S-meter readings as various antennas were grounded and ungrounded at random. Other tests also revealed that transmitter loading varied as other antennas were grounded and ungrounded. The more I experimented, the more confused I became, so I concluded that these haphazard tests had gone far enough.

Since the interaction seemed to be most severe at the fundamental frequencies, the question was basically whether to ground or not to ground the offending antenna. With the assistance of the trusty grid dipper, all antenna systems were checked for resonant frequencies, both in the grounded and ungrounded state, as shown in the illustration. The beam was also checked with the end of the feed line shorted out. Very often a ten or twenty meter beam with its feed line will resonate on forty or eighty meters as a half wave or quarter antenna.

After tabulating the grid dipper findings, it should be easy to check on potential absorbing frequencies. The procedure is simple. Carefully load the transmitter at the frequency of interest and alternately ground and unground all unused antenna systems one at a time. If this affects transmitter loading appreciable (more than five or ten percent change in final plate current) check the unused antenna further by touching a neon bulb to the end of the shorted feed line in the shack. If the bulb lights, it is an indication that the antenna system is absorbing power as a half wave antenna and should be grounded to move the resonant frequency out of the band. On the other hand, if transmitter loading is excessive with the antenna grounded, it is an indication that the antenna system is absorbing energy as a quarter wave antenna, and should accordingly be left ungrounded to move the resonant frequency out of the band.

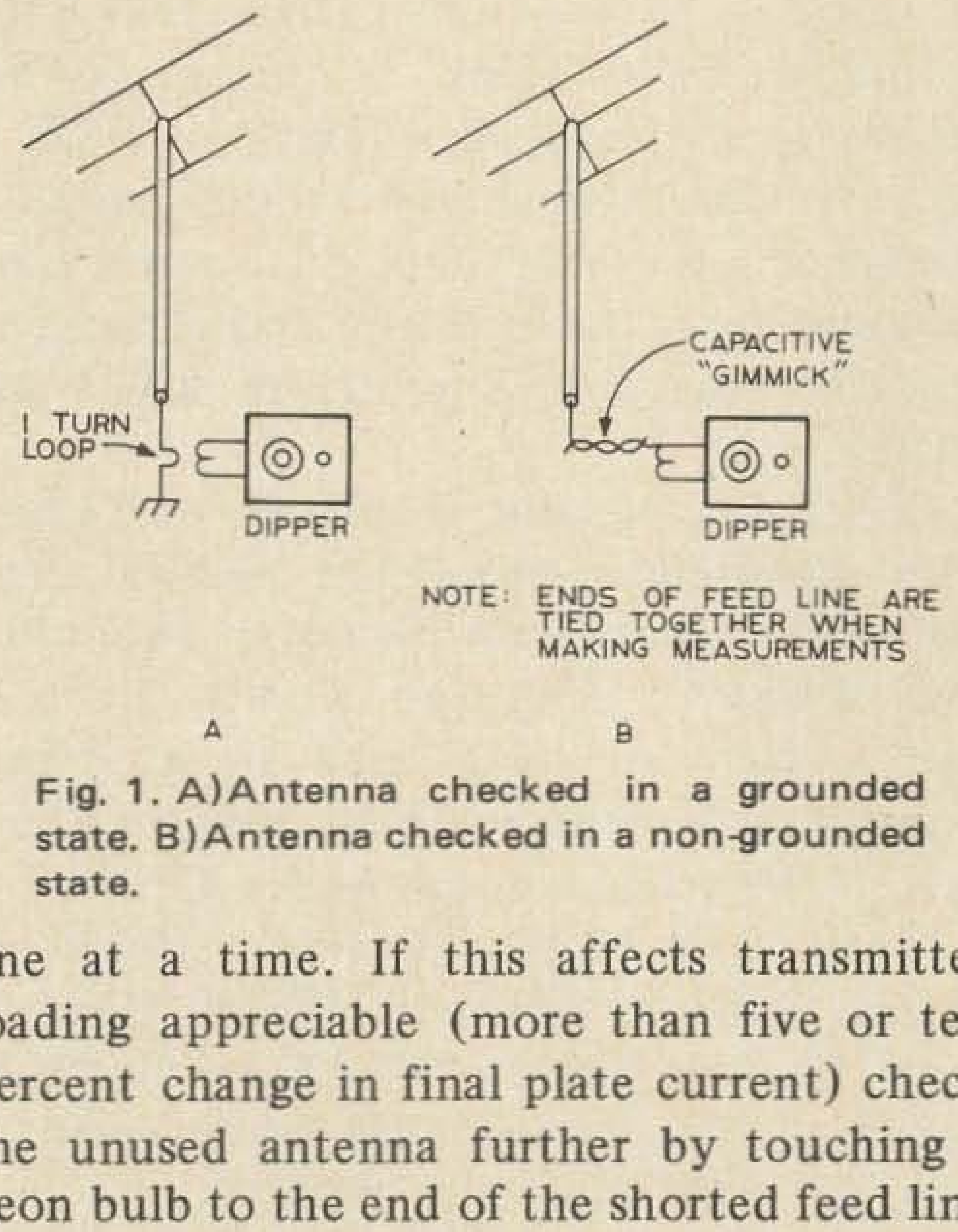

Fig. 1. A) Antenna checked in a grounded state. B) Antenna checked in a non-grounded state.

In other words, all unused antenna systems will act either as half wave or quarter wave absorbers, depending upon whether or not they are grounded. The trick is to set up the antenna system so that its resonant frequency is always outside the band you are working.

Occasionally you may run into a situation where an unused antenna absorbs power whether it is grounded or ungrounded. This can happen particularly on the higher frequency bands such as 10 or 15 meters, the offending antenna usually being a 160 or 75 meter antenna. However, in cases where this has happened, the effect on transmitter plate loading has been negligible.

It has been generally found that antenna interaction is at its worst on the lower frequencies from 160 meters through 40 meters. In one instance the interaction was so severe that final loading was always excessive and could not be reduced by the usual turning procedures. In another case, full loading could not be attained with any adjustment of the final. Both of these, of course, were extreme cases. However, if you have two or more antennas, interaction can be a problem which a little thought and experimentation will reduce to negligible proportions in almost every situation.

. . . W6FPO

Keyboards for Keyers

The amateur press has carried several articles on building keyers that work from a keyboard, like a typewriter or a Teletype, instead of a paddle or knob. Such devices can be bought, but few amateurs would want to pay the cost. Besides, it's much more fun to build something.

Building a keyboard type keyer has one time-consuming, as well as non-interesting (from the electronic viewpoint), portion. That's the keyboard itself. Fortunately, the ambitious builder has at least three sources from which he can buy such an item.

A simple make-and-break preassembled keyboard can be bought from Nutronics, Box 72, Paramus, NJ 07652. It's only one inch deep, has a throw of 0.1 inch, and needs only three to five ounces pressure to make a firm contact. Also, they're designed to be compatible with printed circuit building techniques.

Going to a bit more exotic practices, there's one that uses magnetically controlled solid-state "contacts"; these should never wear out! If you're interested, you can get more information from NPC Electronics, 3133 East 12th Street, Los Angeles, CA 90023.

For the top in sophistication, you'll want a keyboard that actuates by proximity. This is an infinite-life device, guaranteed for 100% reliability. The whole structure is 15-7/8 inches wide, 8 inches deep, and 3½ inches high; it weighs 12 pounds. This one is marketed by Transducer Systems, Inc., Easton and Wyandotte Roads, Willow Grove, PA 19090.

Carl Drumeller W5JJ

"He who knows but little presently outs with it."

Getting Your Extra Class License

STAFF

Part X-Sidebands

In our last session of this study course, we examined the commonly-used types of modulation—with a couple of very major exceptions. We completely passed by SSB and DSB techniques, for the reason that they are sufficiently detailed to deserve a complete installment in themselves.

So this time, let's continue with modulation, and concentrate on sidebands.

In so doing, we will cover only four questions from the official FCC study list—but those four questions are most comprehensive ones indeed:

9. Describe briefly the basic sections of a single sideband transmitter. In what section of a properly operating SSB transmitting system is distortion most likely to originate? In what section is non-linearity most likely to originate?

14. How can the two-tone test output of a linear amplifier be used to tell if a transmitter is working properly? Show scope patterns for optimum, overdriven, and underdriven amplifier conditions.

20. How would the reception of a single sideband signal be affected if the carrier is not completely suppressed? How can spurious signals in the output of the mixer stage of an SSB transmitter be suppressed?

21. How does the beat frequency oscillator affect the tuning of a single sideband signal?

Following our usual practice, we won't attempt to answer these questions directly and specifically. Instead, we shall substitute four other questions of broader scope—and our exploration of the answers to these broader questions will, we hope, include the answers to the FCC questions as well as to similar questions not on the study list.

In order to have single sideband communications, we must generate a SSB signal, and we must receive it. If it has any faults, we must be able to meausre them—but before we can measure them, we must have some notion of what we're looking for.

This list provides us our four broad questions: "How can we generate SSB?", "What faults mar SSB signals?", "How is SSB quality measured?", and finally "How does the receiver affect SSB?"

At this stage it would be well to note that any attempt to provide exhaustive discussion of even one of these questions would—and has—filled large books. In this study course, we can only try to provide a way of looking at the answers together with enough meat to enable you to start studying for yourself. We may, at times, oversimplify in our efforts to meet this goal. For complete authority, check the references listed in the bibliography at the end of this installment.

Having made our disclaimer, let's get on with the business at hand:

How Can We Generate SSB? We saw in our previous installment that a conventional AM signal involves the mixing of the audio frequency voice signal and the rf carrier signal to produce not only the original pair of frequencies, but new sum and difference frequencies known as sidebands. One, the upper sideband, is made up of the *sum* of the audio frequency signal components and the carrier; one way to think of it is as an rf signal made up of as many frequencies as there were in the af signal, in which each rf-signal component's frequency is equal to the carrier frequency *plus* the audio component's frequency.

The other, or lower, sideband is identical except that its frequencies are determined by *subtracting* the audio-component's frequency from the carrier frequency.

Because the carrier frequency is constant, this means that each sideband is an audio signal which has been converted to a radio frequency. The lower-sideband signal is inverted; that is, the low tones of the audio become higher radio frequencies than do the high tones of the audio. The upper-sideband signal, on the other hand, is not inverted; its low and high tones bear the same absolute relationship to each other at rf that they do in the af original.

If we generate a conventional AM signal, and then by some magical means strip away from it the carrier and one of the two sidebands, what we have remaining is only a single sideband. Such a signal is known as a single sideband signal, abbreviated SSB, and the first SSB was generated in just that fashion—at very low radio frequencies (approximately 27 khz to be specific). Today's SSB is generated a little differently—and that's what our question deals with. First, though, let's look at SSB characteristics.

The characteristics of SSB are, on the surface at least, quite different from those of conventional AM. It takes less power to produce a signal of equivalent strength using SSB, and despite the lack of the second sideband, SSB appears to be more effective under crowded band conditions.

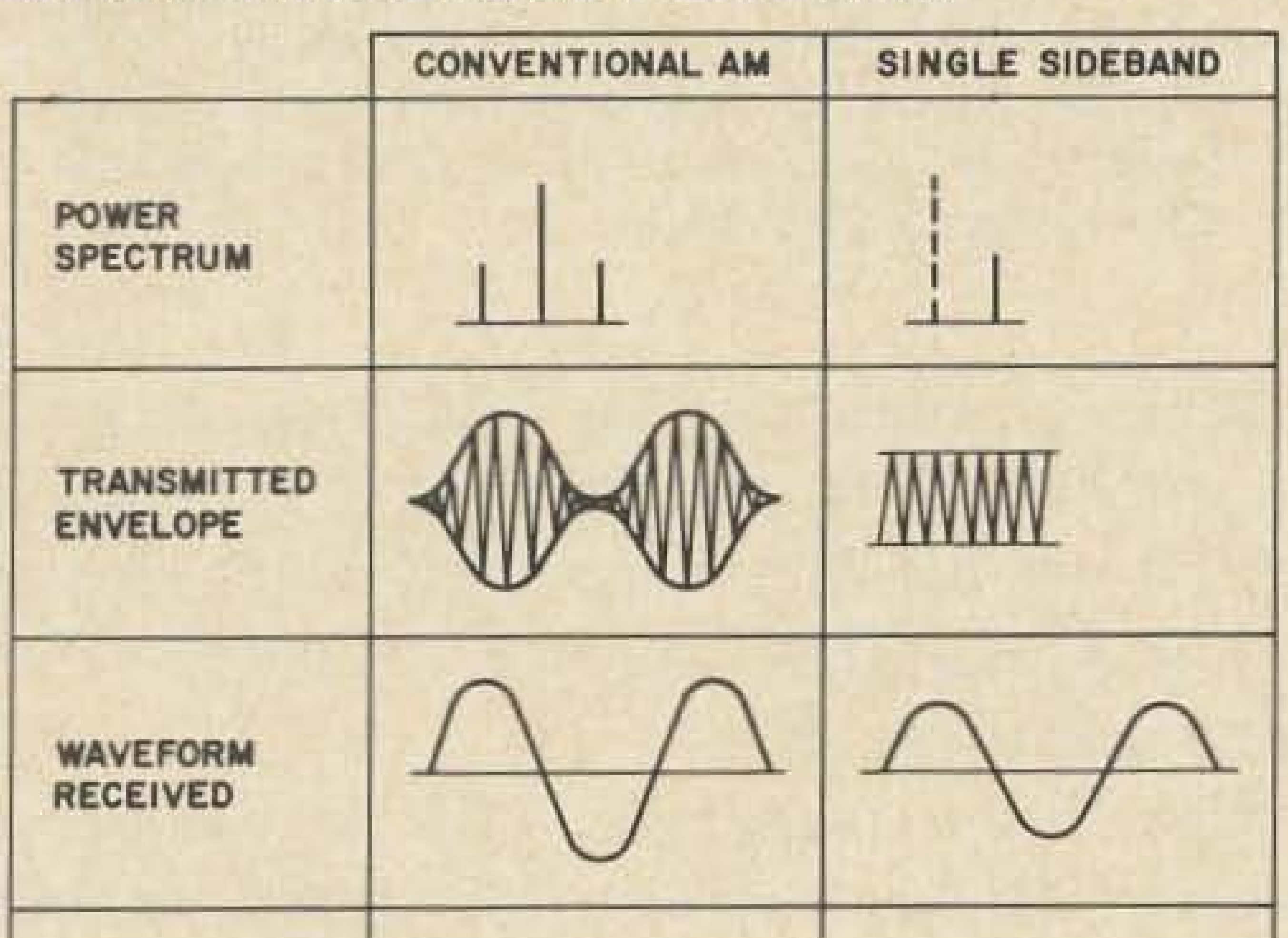

Fig. 1 Comparison of conventional AM and SSB for equal carrier strength, showing power spectrum of transmitted signal, signal envelope as transmitted, waveform recovered at receiver, and noise accompanying received signal.

A comparison of the power distribution in the signals produced at the transmitter, recovered at the receiver, and the final signal-to-noise ratio appears in **Fig. 1**.

The top pair of illustrations in **Fig. 1** shows the power spectrum for AM, at left, and SSB, at right, drawn for the case of equivalent carrier power (the suppressed carrier of the SSB signal is shown as a dotted line). You can see that using SSB means that *all* the power is concentrated in the sideband, while AM splits the information power between two sidebands and puts most of the power into the carrier, which carries no information.

The envelope waveforms of the two signals appear on the second line. The single-frequency rf signal produced by the SSB transmitter appears much weaker than does the AM signal.

However, the third line indicates the audio voltage developed in the receiver. The carrier power in the AM case contributes nothing to this waveform; AM is stronger because the contributions of the two sidebands reinforce each other at the detector, but the actual difference is only 3 db.

And the final line, showing noise voltage, gets that 3 db back. The SSB signal needs only half the bandwidth and so permits only half the noise power to enter.

The net result is that in these two comparison cases, SSB and AM produce the same signal-to-noise ratio at the receiver but the SSB signal started with only half the power (only a third as much power, if the total sideband-plus-carrier power of the AM signal is compared to the single sideband power level). For equivalent power at the start, then, the SSB system would produce a stronger signal at the receiver.

The signal is not only stronger, it's clearer too (with proper receiver design and operation). **Fig. 2** shows why; this illustration shows what happens to conventional AM signals when they encounter selective fading—a normal event during any skip contacts. If the sidebands fade and the carrier does not, the audio power goes down as shown in the left column. If the carrier's phase is shifted relative to the sidebands, again audio power goes down as shown in the right column. Worst of all, though, is when the carrier fades and the sidebands (or at least one sideband) remain steady. The resulting distortion, shown in the center column, resembles overmodulation but is

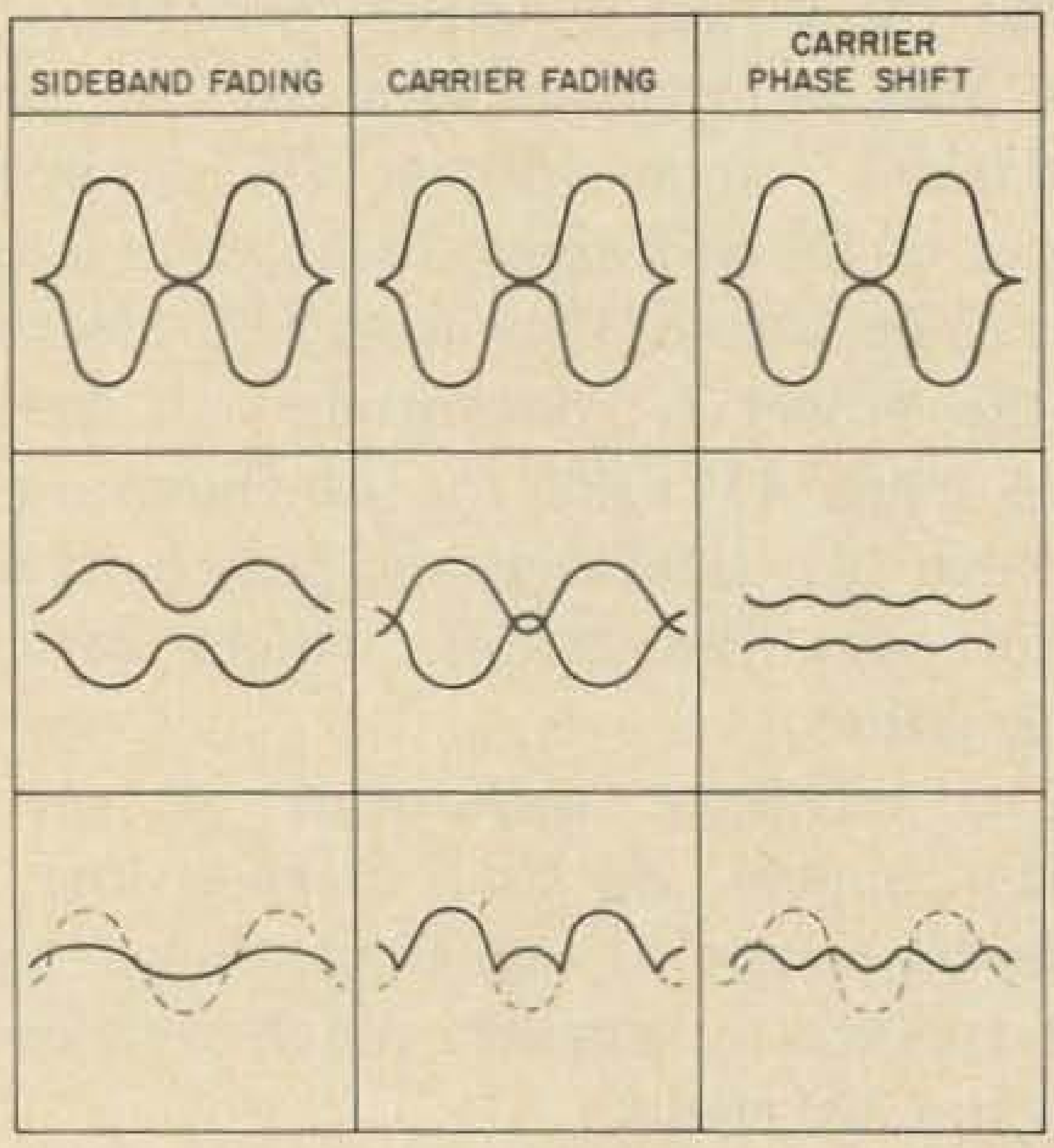

Fig. 2 Effects of selective fading on conventional AM signal. Upper row of waveforms shows envelope as transmitted; it is identical in all three cases. Middle row shows envelope as received under different types of selective-fade conditions. Bottom row shows waveforms recovered from received envelopes; dotted waveforms show what *should* be recovered. Note especially effect of carrier fading when sidebands are unaffected (center column).

much harder to understand.

A SSB signal, consisting of only the one sideband, is much less affected by selective fading. While one component can fade with respect to others, the effect is almost unnoticeable.

Now that we're convinced that SSB is a good thing, let's see how we can generate some. **Fig. 3** is a block diagram at the most basic level of a SSB transmitter. As you can see, it is composed of three major sections–the SSB generator, the frequency selection circuits, and the power amplifiers.

We'll go into all three in more detail a bit later; right now we just want to get the big picture in view. The purpose of the SSB generator is to produce a single sideband signal; it may be at final output frequency or not, depending upon our particular transmitter's design. The SSB signal may be produced in any of several ways, although two methods are by far the most popular. Once originated by the SSB generator part of the transmitter, the signal must be brought to final output frequency by the frequency selection circuits. This part of the rig includes any VFO, frequency synthesizer, and mixers which may be present. It takes in a SSB signal of some freuqency, and turns out an equivalent SSB signal at the desired operating frequency.

The operating-frequency SSB signal is then brought up to the desired power level by the power amplifiers, which may be anything from a micro-powered transistor amplifier up to a 2-KW PEP cannon, depending upon your tastes and your pocketbook.

The power amplifier's only job is to bring the signal up to the level you want for application to the antenna; they are not supposed to add anything new to the signal. Unfortunately, many amplifiers *do* add their own contributions; eliminating these distortion products is one of the major causes of premature graying among SSB operators!

With some idea of where the various parts fit into the overall transmitter functioning, let's turn our attention to the block labelled "SSB generator" in **Fig. 3** and find out what can go in that space.

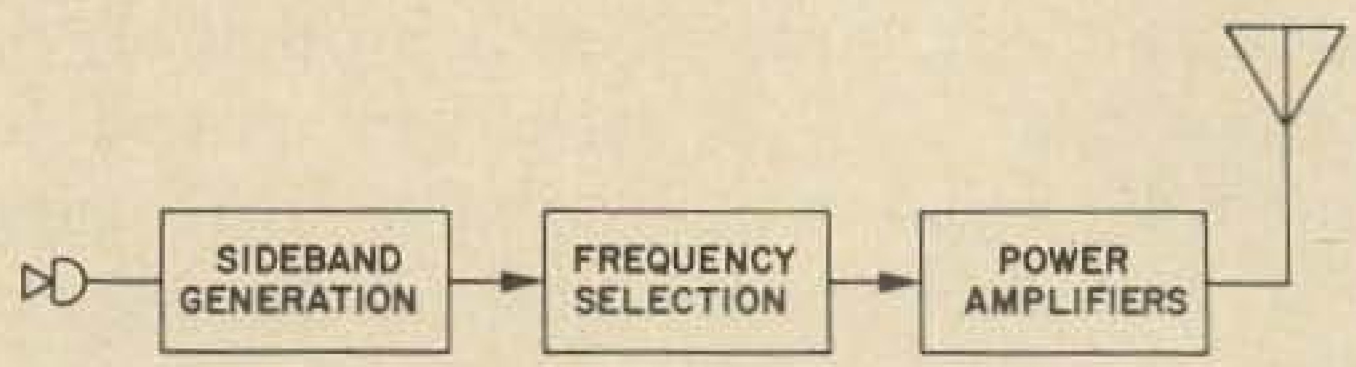

Fig. 3. Most basic block diagram of SSB transmitter; no matter what type of SSB circuitry is being used any SSB rig includes these three major sections. All are subject to wide variation, however.

While a number of methods may be used to generate SSB, the two basic systems in general use are the "filter" technique shown in **Fig. 4** and the "phasing" approach diagrammed in **Fig. 5**.

The filter technique uses a band-pass filter which has extreme selectivity to slice off one sideband, and pass the other. Such filters were originally constructed only for very low frequencies. The first generally used by amateurs, operated at a suppressed-carrier frequency of 17 khz. With development of the filter art, sideband filters are now available for frequencies as high as 9 mhz.

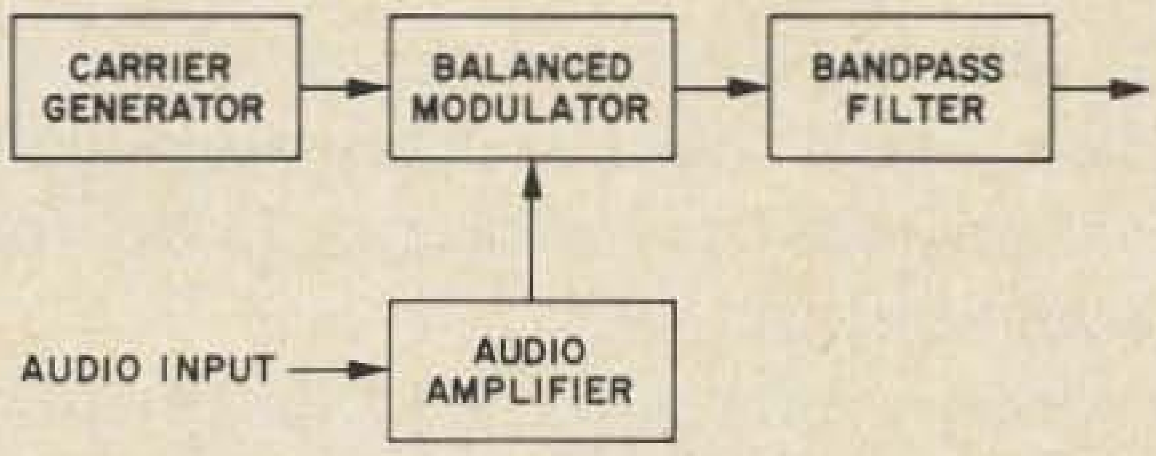

Fig. 4. Filter technique for generation of single sideband signal. Carrier generator produces rf at single, fixed frequency. Balanced modulator produces both sidebands but suppresses carrier. Narrow bandpass filter then shaves off undesired sideband, producing output signal which contains only one sideband and no carrier.

Regardless of the filter frequency, a major characteristic of the filter technique is that the SSB signal is originally generated at a single, fixed frequency, because the frequency of the filter cannot be readily varied. Subsequent stages of the transmitter then convert this fixed-frequency SSB signal to the desired operating frequency.

Starting point for the filter technique, then, is a fixed-frequency carrier generator. This rf carrier is applied, together with the audio signal, to a balanced modulator. The balanced modulator, unlike a conventional AM modulator, produces *only* the sum and

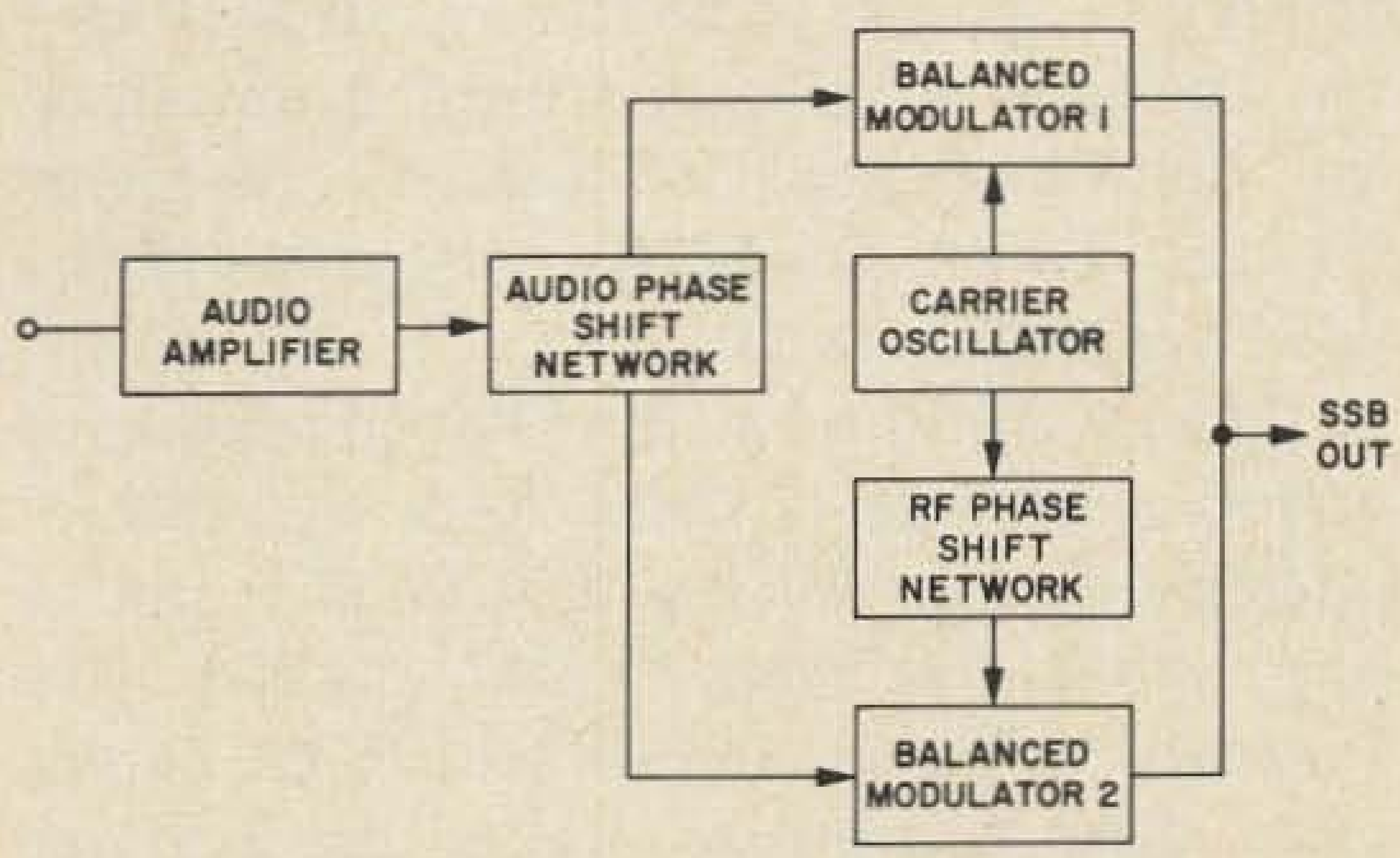

Fig. 5. Phasing approach to generation of SSB signal. Audio is frequency-limited and then split into two channels which are 90° apart in phase. A carrier frequency is generated and similarly split into two channels each 90° away from the other. Audio and rf are combined separately by a pair of balanced modulators. Resulting phase relationships between DSB outputs of balanced modulators are that one sideband is in same phase in both outputs, while other sideband is 180° away (in one output) from same sideband in other output. Summing the outputs causes the in-phase sideband to reinforce itself while the out-of-phase sideband cancels itself out.

some otherwise pretty odd-looking frequencies as those on which fixed-frequency SSB signals are generated.

The thing to be avoided, if at all possible, is what is known as an "integral relationship" between signal and mixing frequencies; this is a ratio of whole numbers, such as 3/2 or 7/3 between the two frequencies at any point in the desired operating range. If such a relationship cannot be avoided, the next best thing is to pick one involving as large numbers as possible, which means that the harmonics which might cause trouble would have to be much higher than mere second or third order.

Then, to hold down the possibility of spurious signals being generated, the mixers should be operated in such a manner as to create as few harmonics as possible. In general, this means a mixing circuit similar to the product detector, which minimizes intermodulation distortion. Finally, the output tuned circuits should be as selective as is practical, to reduce harmonics.

Experience has shown that the fewest spurious signals are generated when the sideband signal's amplitude is kept to a minimum, compared with the injection-frequency signal. In general, the SSB signal should be kept small until it is completely generated, on the final output frequency. Then it can be built up as desired by linear amplifiers. Any attempts to economize by running the early stages of a transmitter near their operating limits may backfire by introducing spurious signals, distortion, and non-linearity.

Besides the mixer or mixers, the frequency selection circuits of the transmitter contain the injection-frequency oscillator, which produces the signal which mixes with the SSB signal to produce the output-frequency signal. This oscillator has at least one special requirement—stability.

An SSB signal's frequency must remain constant in order for it to be received; experiments have shown that a frequency shift of as little as 20 hz is detectable, 50 hz is enough to make a voice difficult to recognize, and a 100 hz shift in frequency will turn a bass into a soprano (or vice versa).

The fixed carrier frequency used in the SSB generator is usually crystal-controlled, and care is taken to keep its frequency stable. Equal care is necessary with the injection-frequency oscillator in the frequency-selection circuits.

Normal technique is to make the single variable oscillator in the frequency selection circuits operate at relatively low frequency, and use one of several exceptionally stable designs for this circuit. Any other frequency changing necessary is accomplished by multiple mixer stages, as in double-conversion receivers.

With the signal brought to the desired operating frequency, all that's left to do is to bring its power level up to however much we may desire. That's the job of the power amplifiers.

The only essential difference between SSB linear power amplifiers and hi-fi audio amplifiers is that the SSB amplifiers use tuned resonant circuits for coupling while the audio amplifiers use high-quality transformers. Operating conditions for the tubes, power driving requirements, and power output capabilities are essentially the same in both classes of service. Hi-fi audio amplifiers have been around for many years, and it might seem a bit surprising that SSB linear amplifiers should present any difficulties—but the fact remains that most if not all of the distortion and non-linearity problems associated with bad SSB signals arises in the power amplifier stages.

One of the most major problems, perhaps not so surprisingly, stems form the all-too-human desire to get just a little bit more for one's money. In using a linear amplifier, this amounts to driving it just a little bit harder in an effort to squeeze another db or so out at the antenna.

This is a particularly insiduous problem, because if the operator is in the habit of judging his output power from the flickering of the final amp's plate meter, he will see the meter rise higher when he increases the drive.

What he won't see on the meter is the fact that the added power he gets is almost all in the form of distortion products!

We'll go into this in a little more detail a little later, when we look at some ways of judging signal quality and power output which are more revealing than merely using the plate meter.

Back in the second installment of this Extra Class study course we examined the theory of amplifiers in some detail. In the process of doing so we looked at the way in which the "class" (A, B, or C) of amplifier operation was determined, and saw how an input signal could be distorted whenever it swung past the established operating limits of the particular circuit.

SSB power amplifiers come in many different types, but one of the most popular variety these days is that known as "class AB1". Such an amplifier is set up with operating conditions partway between pure class A (in which average plate current is steady regardless of signal) and pure class B (in which the tube permits current to flow during only half of the signal cycle), and the suffix "1" indicates that grid current is never permitted to flow.

A Class AB1 circuit requires virtually no driving power; only a voltage swing at its grid is necessary. Many tubes have been designed specifically to operate at rf in this class of service, and to have low distortion when doing so.

The fact that grid current never flows in a properly operating and properly driven Class AB1 linear amplifier has been used by several circuit designers to include an automatic servomechanism known as ALC or "automatic load control", which prevents

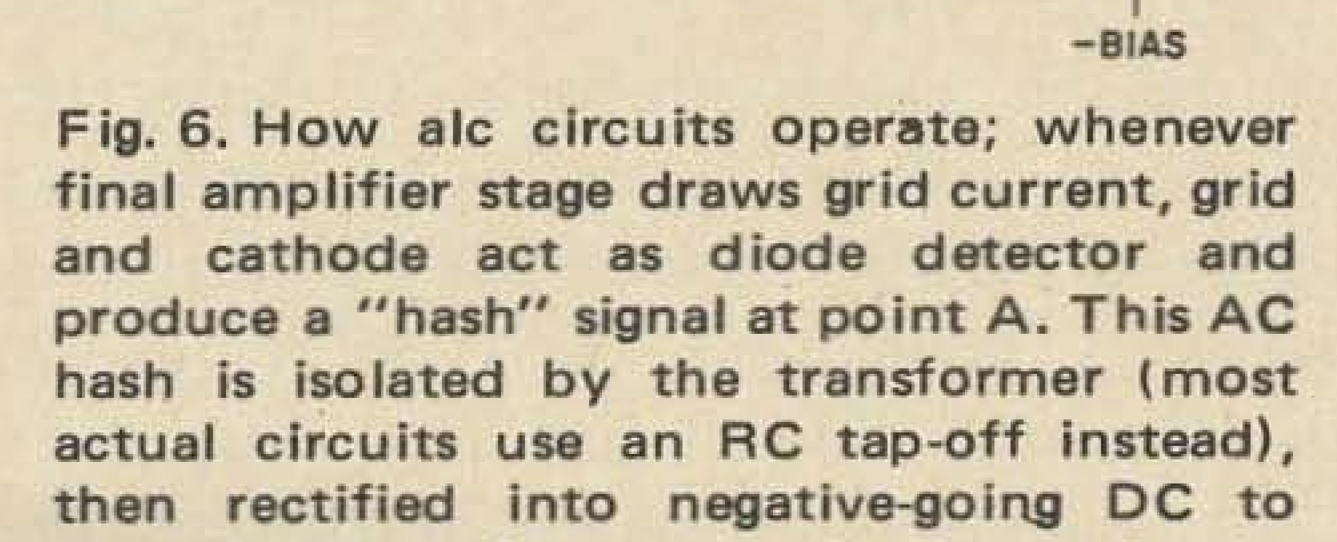

Fig. 6. How alc circuits operate; whenever final amplifier stage draws grid current, grid and cathode act as diode detector and produce a "hash" signal at point A. This AC hash is isolated by the transformer (most actual circuits use an RC tap-off instead), then rectified into negative-going DC to control gain of some earlier stage in the transmitter. Reduced gain removes excessive drive to final, which causes hash to disappear. This servo action maintains final drive at the maximum *usuable* level while preventing overload.

difference frequencies in its output. The two original input frequencies (the carrier and the audio) balance themselves out within the modulator circuit, so that carrier suppression occurs within the modulator.

Output of the balanced modulator, then, consists only of the two sidebands. The filter passes one of them and rejects the other. The resulting single-sideband signal is then ready to be applied to the frequency selection circuits.

Somewhat more sophisticated in its theory of operation is the phasing approach; this technique involves the introduction of differential phase shifts into otherwise-identical signals so that one sideband cancels itself out while the other is reinforced.

For the phasing approach, the audio must first be frequency-limited (this step is not necessary in the filter technique, because the sharp filter will itself trim the signal's bandwidth to the 3 khz voice-quality minimum). After its bandwidth is limited, the audio signal goes through a phase-shift network which produces a pair of output audio signals which are 90° apart in phase at all times.

Each of these signals is applied to its own balanced modulator. The rf for the balanced modulators comes from a carrier generator, which may operate on any frequency. One balanced modulator gets its rf direct from the carrier generator, while the rf applied to the other is shifted 90° in phase on the way.

The result is that we obtain at the outputs of the two balanced modulators, two sets of double-sideband signals, but because of the separate phase shifts applied to the audio and the rf signals the phase relationships between sidebands are rather unusual. Depending upon the direction of the phase shifts, either the upper or the lower sideband outputs of both balanced modulators will be in phase. If the upper sideband outputs are *in* phase, the lower sideband outputs will be exactly 180° *out* of phase, and vice versa. This means that we can cancel out either sideband just by combining the outputs of the two balanced modulators.

While in theory, at least, the carrier can be at any frequency, in practice phasing exciters are usually designed to operate at a fixed frequency and the resulting SSB output is converted to the desired output frequency by mixers, just as when using the filter technique. The most popular such fixed frequency is 9 mhz—chosen because it permits a single mixing oscillator in the 5 mhz range to produce either a sum frequency output around 14 mhz or a difference frequency output in the 75-meter band.

Both the filter and the phasing techniques have their own peculiar advantages and disadvantages. Through the years popular opinion has tended to elevate the filter technique, and it's certain that a filter rig requires less adjustment to keep it going if a high-quality filter is employed. Phasing, on the other hand, simply because it does offer more possible adjustments, may make it easier to compensate for component aging. Sideband selection may be simpler with phasing and a complete phasing exciter also has built into it provision for the generation of narrow-band phase modulation, should you desire that feature.

Whichever technique is used to generate the single sideband signal at this point, the signal must still be brought to the desired output frequency and boosted to the desired power level.

Frequency selection is normally done by means of one or more mixer circuits, identical in principle to those used in receivers. In fact, the close correspondence between the portions of a SSB transmitter and a superhet receiver is what gave rise to the idea of the SSB transceiver which hit ham radio like a storm several years ago!

Two points, not generally considered of main importance in mixers for receiver use, are important in mixers intended for SSB signal frequency selection. The first is the simple point that an upper-sideband signal is changed to lower-sideband by difference-frequency mixing, while sum-frequency mixing preserves the sideband-to-carrier relationship unchanged. This point, in conjunction with the choice of 9 mhz as the signal-generation frequency in early phasing-type exciters, led to a convention which virtually ruled for a number of years that communication on frequencies above 9 mhz would be by upper sideband, and that on frequencies below 9 mhz would use lower sideband. The reason was simply that the early users adjusted their exciters to produce USB signals at 9 mhz; sum-frequency mixing to reach the 20-meter band maintained the USB sense, while difference-frequency mixing to reach 75 meters inverted the signals to LSB.

The other point, of considerably more practical importance, is that any mixing process can cause generation of spurious signals. These spurious mixer products can result in out-of-band and out-of-channel signals, and can also introduce in-channel distortion. The point is sufficiently important to cause one authority to state, "It is these spurious products which exert the most influence on the design of the frequency translation system."

To minimize the production of spurious mixer products a designer has two major variables he can juggle. One is the specific type of mixer device and/or circuit he uses, since some circuits and some devices are more free of spurious outputs than are others. More important, in many cases, is the second major variable—the ratio of the two frequencies to be mixed.

For instance, if an output frequency of 7 mhz were desired and the starting frequency were 3.5 mhz, the designer would have only two choices available for his mixing-frequency signal: he could use 3.5 mhz and sum mixing (3.5 + 3.5 = 7), or he could take 10.5 mhz and use difference mixing (10.5 - 3.5 = 7).

In this case, there's really very little choice at all, because one of the first rules is to never introduce two signals of exactly the same frequency for mixing. The output is too likely to contain harmonics of one or both input signals, not to mention literally dozens of spurious products caused by the *n*th harmonic of one input mixing with the *n+2*nd harmonic of the other.

But the alternate choice wouldn't be very much better, because he would still be faced with all the harmonics of his original 3.5 mhz signal mixing with either the fundamental or harmonics of the 10.5 mhz injection frequency.

It's almost a case of "you can't get there from here"—and this particular problem has been one of the major reasons for choice of the final stage from ever being seriously overdriven and yet permits the operator to crank up the gain just about as high as he may desire.

Fig. 6 shows how it works. The grid of the final stage is used, in addition to its normal role, as the plate of a diode detector. Whenever overdrive occurs and grid current begins to flow, this diode detector rectifies the overdriving portion of the signal and produces a "hash" voltage at point "A".

This hash voltage is rectified and filtered to remove the "hash", and is then applied to some variable-gain amplifier stage earlier in the amplifier chain. There, it reduces the gain, which in turn reduces the drive to the final stage.

With reduced drive to the final, the hash and in turn the DC ALC voltage are reduced, which permits gain to come back up. Thus we have a closed feedback loop; the greater the drive, the less gain is available, and the less the drive, the greater the gain. The net result is that the final stage will always operate with a very few microamperes of grid current; this is not enough to cause appreciable distortion, but is enough to keep the servo loop operational.

ALC has several advantages. The obvious one is that drive adjustment is not so critical, since it provides an automatic safety against moderate overdriving. Not so obvious is the fact that the operating conditions of the final stage as well as all other stages within the loop are more tightly defined, and so can be designed and adjusted more precisely.

What Faults Mar SSB Signals? In our examination of the means by which SSB signals are generated, we touched in passing on a few of the possible faults. Now let's turn our full attention to the possible problems.

To the operator, most SSB faults appear to be in one of three categories. The first and by far the most populous is that known as "buckshot"; this includes most distortion and non-linearity, and some forms of other problems as well. It gets its name from an audible resemblance to buckshot rattling in a can.

The second broad category is that of "insufficient suppression", either of the carrier or of the undesired sideband. In many cases this problem produces results very similar to buckshot; in others it presents difficulties in receiving the signal.

The final problem is that of frequency stability. We've already seen how stringent are the requirements on frequency stability for SSB communication. Any failure to meet these requirements poses a problem.

Now that we've categorized the faults, let's examine them a bit more closely.

"Buckshot", or to be a bit more precise about it, spurious distortion products, is the normal result of distortion in the power amplifier stages. This distortion may be in the form of harmonic distortion, intermodulation, or both. Such distortion and non-linearity go hand in hand; one is, in fact, both the cause and the partial effect of the other. A distorting amplifier cannot be linear, nor can a non-linear amplifier fail to produce at least some distortion.

The causes of such distortion were wrapped up succinctly by Don Norgaard W2KUJ, one of the first hams to fo on SSB some 20 years back, as "amplification which increases with increased signal level", and "amplification which decreases with increased signal level". The second of these is the more common; it's what you hear, for instance, if you disable the AVC of a receiver and tune in too strong a signal.

While the causes of distortion fall into these two broad classes (and the cures are different for each class), the results insofar as a SSB signal is concerned are the same for both; in both types of distortion, the result is a *change* in stage gain with signal strength, and as we saw a couple of installments back in this course when we first examined the way a mixer works, any change in stage gain caused by signal strength provides mixing action. In other words, the change itself is a non-linearity.

What happens next is simple; the distorting amplifier puts signals back on, where we have spent so much effort taking them off. If you like, you can try it with figures. Assume that we start with an audio signal containing just two tones, one at 500 hz and the other at 750 hz. Let's generate an upper-sideband signal around a suppressed carrier of 3.9 mhz with these two tones; the result is that we have just two rf signals, one at 3900.500 khz and the other at 3900.750 khz, if we suppress the carrier and the lower sideband properly.

Now let's put those two rf signals through an amplifier which has a little distortion in it. We'll get out not only the two signals we started with, but their sum and difference; we will also get the sum and difference of each with at least the second harmonic of the other. That is, we can expect to find:

3900.500 - one original input signal

3900.750 - the other original signal

3900.750 - 3900.500 = 0.250 - the difference signal

3900.750 + 3900.500 = 7801.250 - the sum signal

2x3900.500 = 7801 - 3900.750 = 3900.250 - buckshot 2x3900.750 = 7801.500 - 3900.500 = 3901.000 - buckshot

And this is just a partial listing, incomplete at that. In practice, the signal will have more than just two components, and unless we're awfully lucky, we'll have more than mere second-order distortion products to contend with.

We will find that some combinations of frequencies, at some critical orders of harmonics, produce products in the supposedly suppressed sideband. In fact, as it happens it takes a pretty bad signal to produce buckshot within its own bandwidth. A signal which is only moderately lousy will frequently appear to its user, and to its listener, as an acceptable signal; the only people who know it's sick are the fellows trying to use all the rest of the band!

While the major cause of such problems is overdrive, there are other causes as well. Operating conditions for the amplifiers must be properly chosen to minimize distortion, because no amplifier is perfect. Even the best amplifiers have some traces of distortion remaining in them, and good design plays off one factor against another in a hopefully successful effort to cancel out as much of this as possible. The variables to be considered include such things as plate supply voltage, tuned circuit impedances, grid bias, screen voltage, and tube types (some tube types are designed to be more free of distortion than others).

All of these factors are, to some extent, under the control of the operator. At least, he has enough of them under control to permit him to make any linear amplifier behave. We'll get into the ways and means in our next section when we examine the means of measuring signal quality, because any control must include a means of measurement. Right now, let's turn our attention to the question of suppression.

We have labeled insufficient suppression of either the carrier or the undesired sideband as a fault in a SSB signal, but the reasons why it's a fault are not that obvious.

In fact, in the early days of SSB many operators felt that a reduced-level or "pilot" carrier *should* be transmitted, in order to simplify frequency-locking the bfo at the receiving end. Ancient issues of QST carry some interesting debates on this subject—which would indicate that at the minimum, incomplete carrier suppression is not automatically a "fault" for any technical reasons, but is called a fault only because current operating practice calls for complete suppression!

So far as the undesired sideband is concerned, there are some pretty practical reasons for its suppression. If both sidebands are transmitted and received at full strength, then the locally supplied signal which replaces the carrier in the receiver must be in *phase* synchronization with the original. This is a degree of precision virtually impossible to attain without rather exotic techniques; the only way to do it known to most hams involves more special circuits in the receiver than you normally meet in a phasing-type SSB exciter. It's called "synchronous detection", and we've mentioned it before in this study course.

For any simpler method of reception to work, one of the two sidebands must be shaved away. This can be done either at the transmitter, which gives us SSB, or in the receiver, if DSB is used, but only one of the sidebands may be permitted to reach the detector circuits. If a part of the unwanted sideband gets through, the effect is a "burbling" superimposed on the audio. Experiments have shown that the burble is only barely noticeable when the undesired sideband's level is 30 db below the desired; this is the origin of "30 db" as the "magic figure" for rejection.

The effect of incomplete carrier suppression would depend upon the precision of tuning of the receiver. If tuning were inexact, the local carrier and the incoming carrier would beat with each other to produce a difference frequency which could either cause a low-pitched tone, sub-sonic overload of audio circuits with resulting distortion, or possible an effect similar to the burble of insufficient sideband suppression. If, however, the receiver were especially designed to permit a "pilot" carrier to be selectivity amplified to a much higher level than its accompanying sidebands and then used for local injection, no ill effects at all would occur.

It's a matter of pride among today's operators, though, to obtain as complete suppression of both carrier and unwanted sideband as they can achieve. It's not unusual to find carrier suppression as great as 60 db, and sideband suppression greater than 40 db, in the signal of a really careful operator.

How Is SSB Quality Measured? We've seen that a number of faults can mar an SSB signal, and that the generation of such a signal is a process complex enough to require many adjustments. How can we be sure that all the adjustments are correct, and that our signals are free of the faults which make signals lousy?

Surprisingly enough, an SSB signal is even simpler to measure (in most cases) than is a conventional AM signal, and is much easier to tame than is an FM or PM signal. Measuring its quality, though, does require one instrument—the oscilloscope.

Many operators attempt to measure quality of their SSB signals without a scope, using only a receiver. This fact is one of the major reasons why so many poor SSB signals are found on the air; a large part of the things that can go wrong with an SSB signal are of such characteristics as to show up quickly on a scope view of the signal, yet escape detection completely when the signal is inspected by tuning a receiver across it.

The scope can be used to measure SSB signal quality in any of four different hookups. These hookups are called the two-tone test, the bow-tie test, the envelope test, and linearity tracing. The first three present essentially the same information, and which you use depends almost completely upon personal preference.

Except for linearity tracing, all the test hookups require that the vertical deflection plates of the scope be driven by the actual SSB signal being tested. The signal is usually picked off from the final amplifier tuned circuits by means of a pickup loop as shown in **Fig. 7**, and coupled directly to the deflection plates (bypassing the scope's internal vertical amplifiers). Pattern height can be adjusted by changing the location of the pickup loop; the larger the pattern, the easier it is to detect slight flaws.

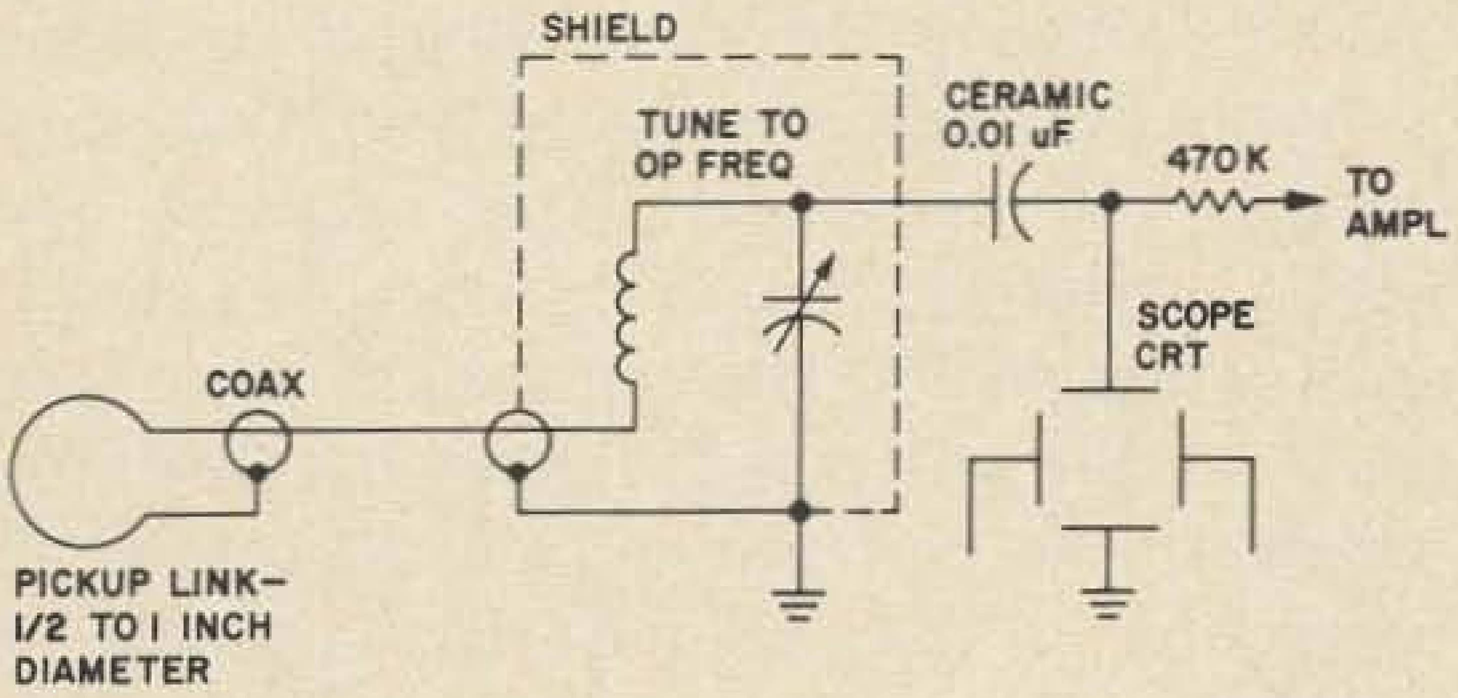

Fig. 7. For two-tone, bow-tie, and envelope tests of SSB signals, this hookup is used to sample rf and apply to vertical deflection plates of oscilloscope. Tuned circuit may not be necessary in all cases, but makes it easier to get adequate pattern size for good display. Pickup link may be coupled to final amplifier, dummy load, antenna tuner, or any point in the transmitter after all adjustments which are to be checked. Pattern size may be varied by adjusting tuning of resonant circuit or by adjusting coupling of pickup link, or both.

These tests depend upon the fact that any distortion or non-linearity will cause mixing and the generation of spurious outputs when two or more signals are applied to the system; that's where the two-tone test gets its name. For the two-tone test, two sine-wave audio signals are fed into the mike input of the exciter. The two should be of equal amplitude but about 1000 hz apart in frequency. Alternatively, a single tone can be fed in and carrier inserted to supply the other tone, but if this is done, then only amplifier linearity can be tested. To test for proper carrier and sideband suppression, the input must be a pair of audio tones.

The horizontal plates of the scope, in the two-tone test, are driven by the scope's

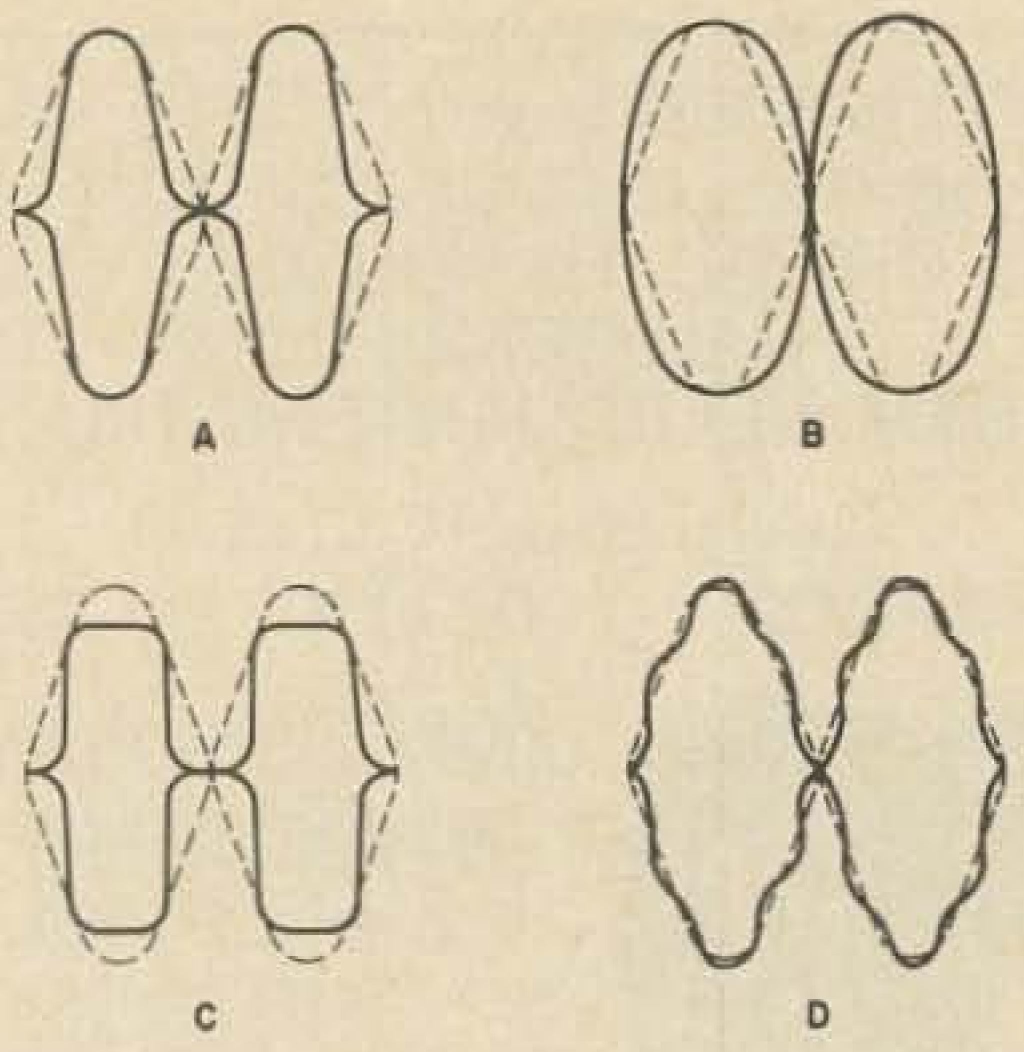

Fig. 8. These are typical displays produced by two-tone tests. Dotted lines indicate normal display in every case. Pattern A results from too much bias on amplifier stage. Pattern B is one of many which can be caused by overdriving a stage; characteristic common of all is that sides of pattern are fatter than normal and top is rounded or squared off rather than coming to smooth peak like a sine wave. Pattern C is combination of A and B, and pattern D indicates inadequate carrier suppression.

internal sweep circuits. It may prove necessary to adjust the sweep carefully, since it normally is synchronized to the vertical-deflection signal inside the scope, and the direct connection used in this test set-up bypasses that part of the circuit.

The pattern which should be displayed by a perfectly operating transmitter on a two-tone test resembles a pair of sine waves mirror-imaged over each other; it appears as the dotted line in **Fig. 8**. Any of the patterns shown by solid lines in **Fig. 8** represent improper operation. Pattern A is an exaggerated view of what is shown when an amplifier is overbiassed; the "crossover" is pinched and the sides of the pattern become concave. Pattern B is an indication of overdrive; the pattern "fattens out" and in extreme cases may even begin to look like a square wave. Pattern C indicates a combination of too much bias (Pattern A) and too much drive (Pattern B).

Pattern D indicates insufficient carrier suppression; the more carrier is present, the more pronounced will be the ripple along the edges of the pattern.

The envelope test is identical to the two-test insofar as the scope hookup is concerned, but the audio input for this test is normal speech. Horizontal sweep for the scope is furnished by the internal scope circuits, set for approximately 30 sweeps per second. The envelope test, in itself, tells very little, but is useful as a means of monitoring the signal once all adjustments have been set up properly using either the two-tone or the bow-tie tests, to be certain that overdriving is not permitted to occur.

The bow-tie test differs from the two-tone test in two major respects; the horizontal sweep for the scope is taken from the exciter's audio section, and the pattern produced is somewhat different.

In this test, the scope is used to compare the *audio* signal generating the SSB output with the actual *SSB* signal produced at the system output. If everything is working properly, the relationship between these two signals will be linear. The result is the stylized bow-tie pattern on the scope shown at A in **Fig. 9**. The perfect straightness of the sides of the pattern, extending through the crossover at the center, indicates that all operation is normal and signal quality is good.

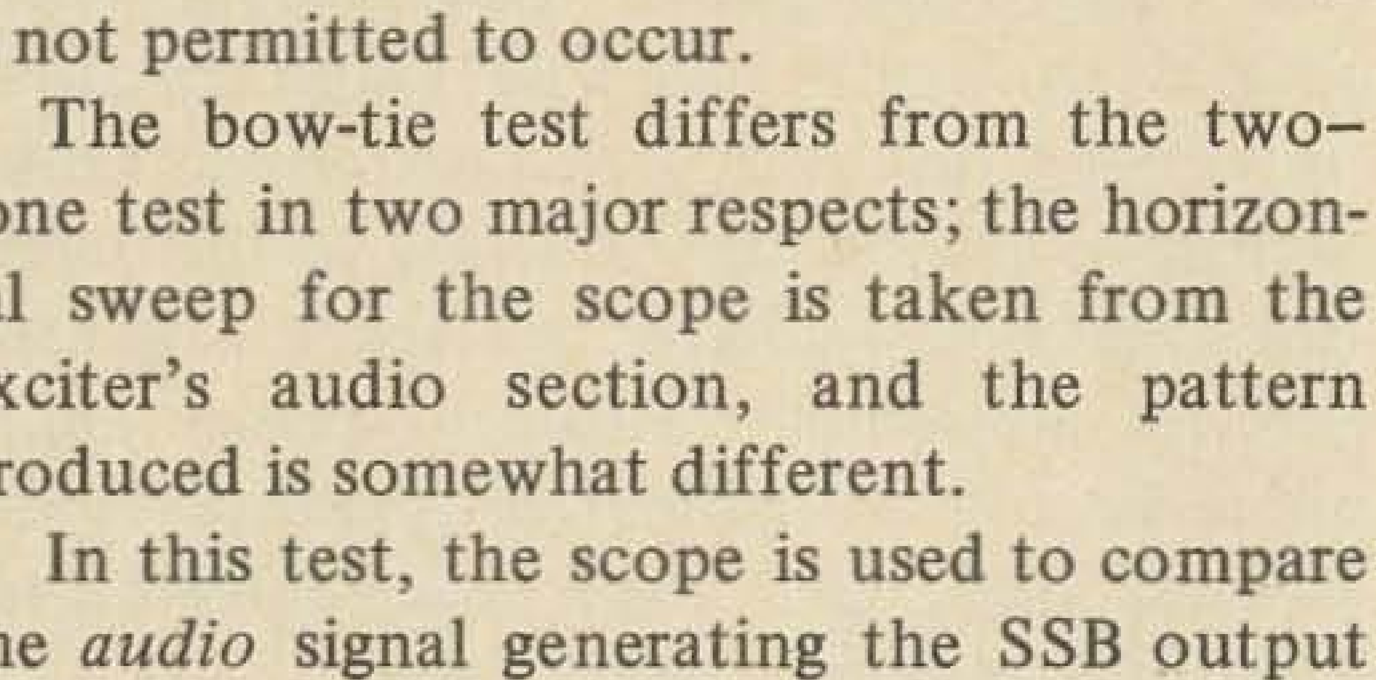

Fig. 9. Typical bow-tie test patterns. Pattern A is normal indication; all lines are perfectly straight. Too much bias produces concave-sided pattern such as B. Overload produces pattern C, with chopped-off peaks rather than points. Combination of overdrive and too much bias produces Pattern D. Inadequate carrier suppression puts ripples on sides of pattern as at E.

Too much bias (which produced Pattern A, **Fig. 8**, with the two-tone test) will cause the sloping sides of the bow-tie to become concave as shown at B, **Fig. 9**.

Overdrive, which causes the peaks of the output signal to be clipped, shows up as Pattern C. The combination of too much bias and too much drive, which produced Pattern C in **Fig. 8**, appears as shown at D in **Fig. 9**.

Lack of carrier suppression will show up as at E, with ripples on the edges of the pattern, and as in the two-tone test, the depth of the ripples indicates the amount of carrier.

Either the two-tone or the bow-tie test can be used to adjust amplifier loading. An amplifier which is too lightly loaded will display the pattern of "overdriven" conditions, but the pattern will clear up into the "normal" pattern as loading is increased. As loading is increased still more, the pattern will remain "normal" but its height will decrease, indicating that less actual power is being produced (regardless of what the final meters may indicate—all that they show is dc input power, and the display is showing you actual rf output voltage across a fixed load impedance).

The point of optimum loading, for any given amount of drive, is that point at which the largest "normal" pattern is produced. Once this point is found for a single drive level, it's usually worth while to increase the drive a bit and see if a better "optimum" can be found. This boils down to a pair of rules: If the final stage is not being driven to its design limit, its loading should be reduced until it will accept limiting drive, and if the power level obtained by doing this is less than anticipated, provide additional drive.

While we've been going into some detail on three of the four test setups, we have passed by the technique known as "linearity tracing". Unlike the other three setups, linearity tracing does not involve feeding rf to the scope. Instead, samples of the rf input to, and output from, the amplifier being tested are detected by identical linear detectors. The resulting signals are then compared to each other in the scope, by applying one ot the vertical amplifier and the other to the horizontal.

Fig. 10 shows the schematic of a typical

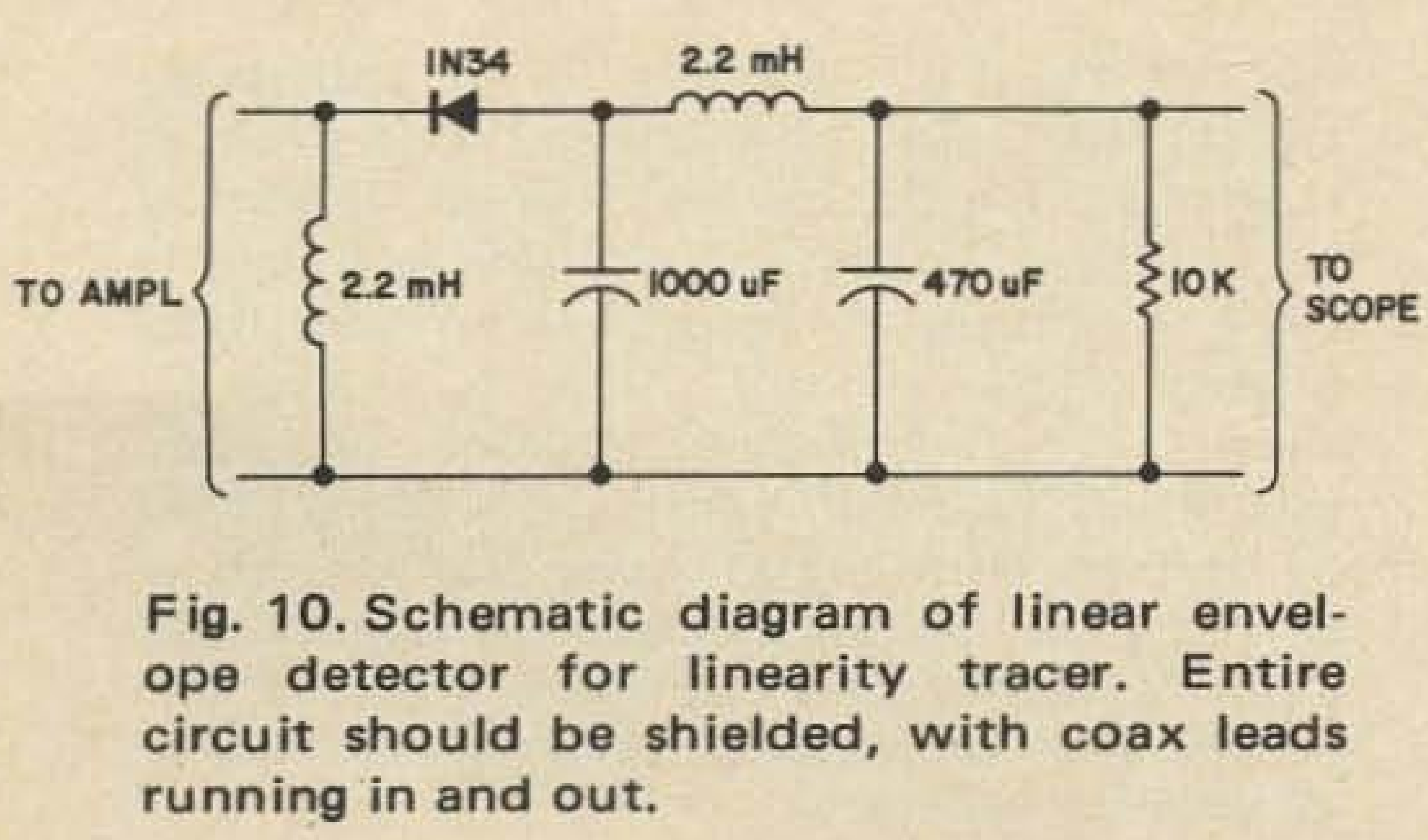

Fig. 10. Schematic diagram of linear envelope detector for linearity tracer. Entire circuit should be shielded, with coax leads running in and out.

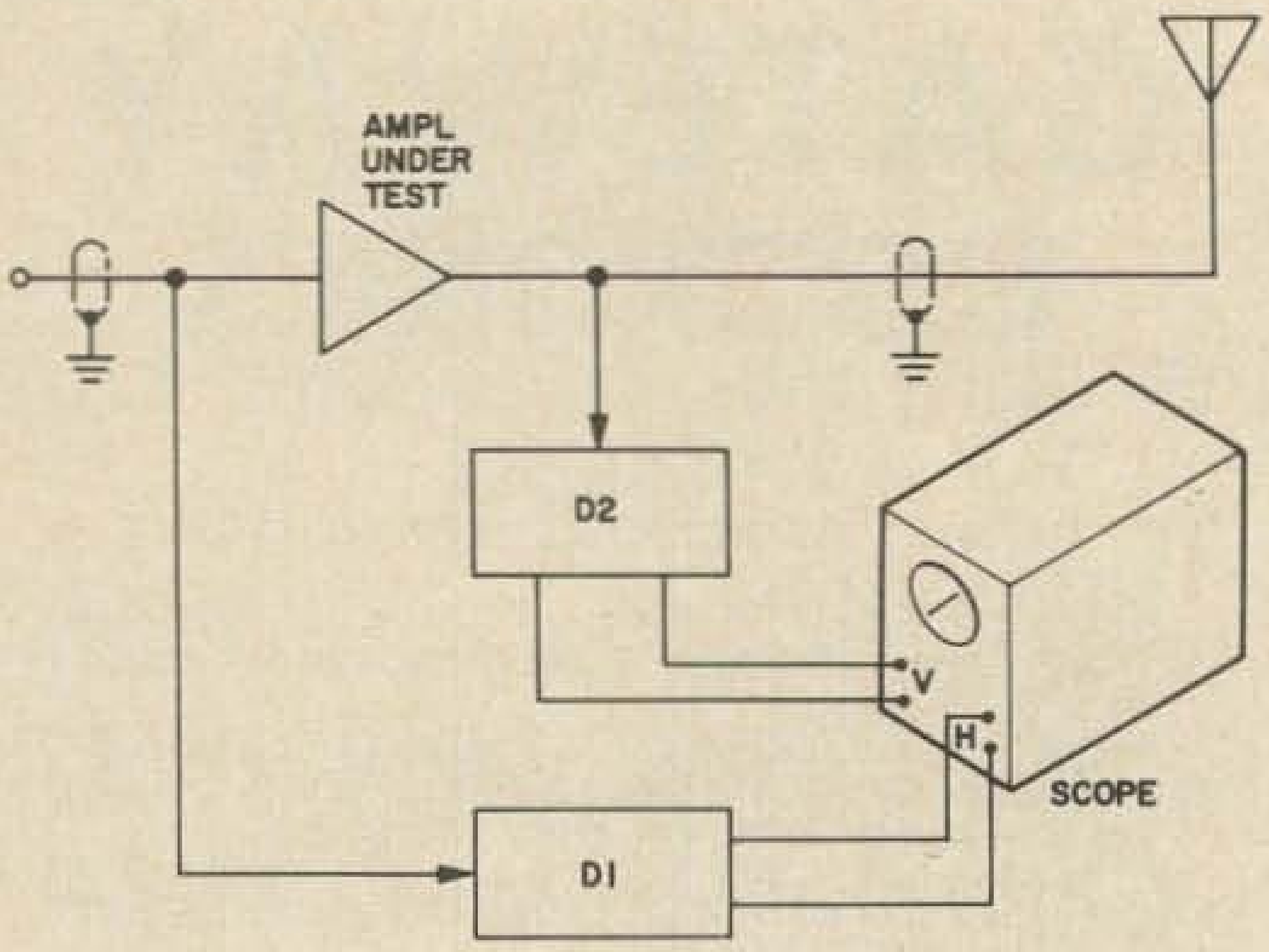

Fig. 11. Test setup for linearity tracing. Detector coupled to amplifier input should feed horizontal input of scope, and second detector coupled to amplifier output should feed vertical input. Scope gain adjustments should be set for 45° tilt on displayed line or curve. This requires more horizontal gain than vertical.

linear detector for such use, and **Fig. 11** shows the test setup in block diagram form.

Any type of audio input can be used for this test, since it merely compares the output of the amplifier to the input. If the amplifier is linear, the display will be a straight line as shown at A in **Fig. 12.** A curved line such as that at B indicates too much bias or insufficient screen voltage; the specific problem indicated by this is "crossover distortion" caused by too little static plate current. An oppositely curved line such as that at C indicates poor grid-circuit regulation or plate-circuit difficulties, with improper loading as one of the prime suspects. The "S" curve at D is simply a combination of curves B and C, and indicates that several problems are present simultaneously. Overdrive of the amplifier is shown by a sharp break in the line as at E.

The linearity tracer, because of the simplicity of interpreting its display, is probably the best measurement technique for everyday measurement of signal quality. The bow-tie test provides similar results. Most commonly used is the envelope test–which is the least indicative of all.

How Does The Receiver Affect SSB? Having generated our SSB signal and measured its freedom from faults, we can pour it forth into the spectrum without shame. To use it for communication, though, we still must receive it.

We have examined some of the details of SSB reception elsewhere in this study course; what we'll concentrate on right now are three important ways in which receiver features affect the usefulness and intelligibility of the SSB signal.

Since the SSB signal has no carrier to permit recovery of the audio, the receiver must provide a substitute for the carrier. This "local carrier" is normally provided by the bfo, and it must meet two requirements–it must be strong enough so that the received sideband cannot "overmodulate" it, and it must be at proper frequency to demodulate the sideband into its proper audio components.

The problem of strength of the bfo signal can always be overcome by attenuating the received sideband, and this is the idea behind the way in which SSB is received on a pre-SSB receiver: Audio gain is turned full on, rf gain way down, and the receiver tuned carefully until the SSB signal becomes intelligible. Keeping the rf gain down low makes certain that the sideband is at low level when it mixed with the bfo signal in the detector circuits; the audio is kept high to make the best of a bad situation.

Tuning of the bfo is comparatively critical; it must be on the right side of the sideband to replace the suppressed carrier, and must be within a very few cycles of the

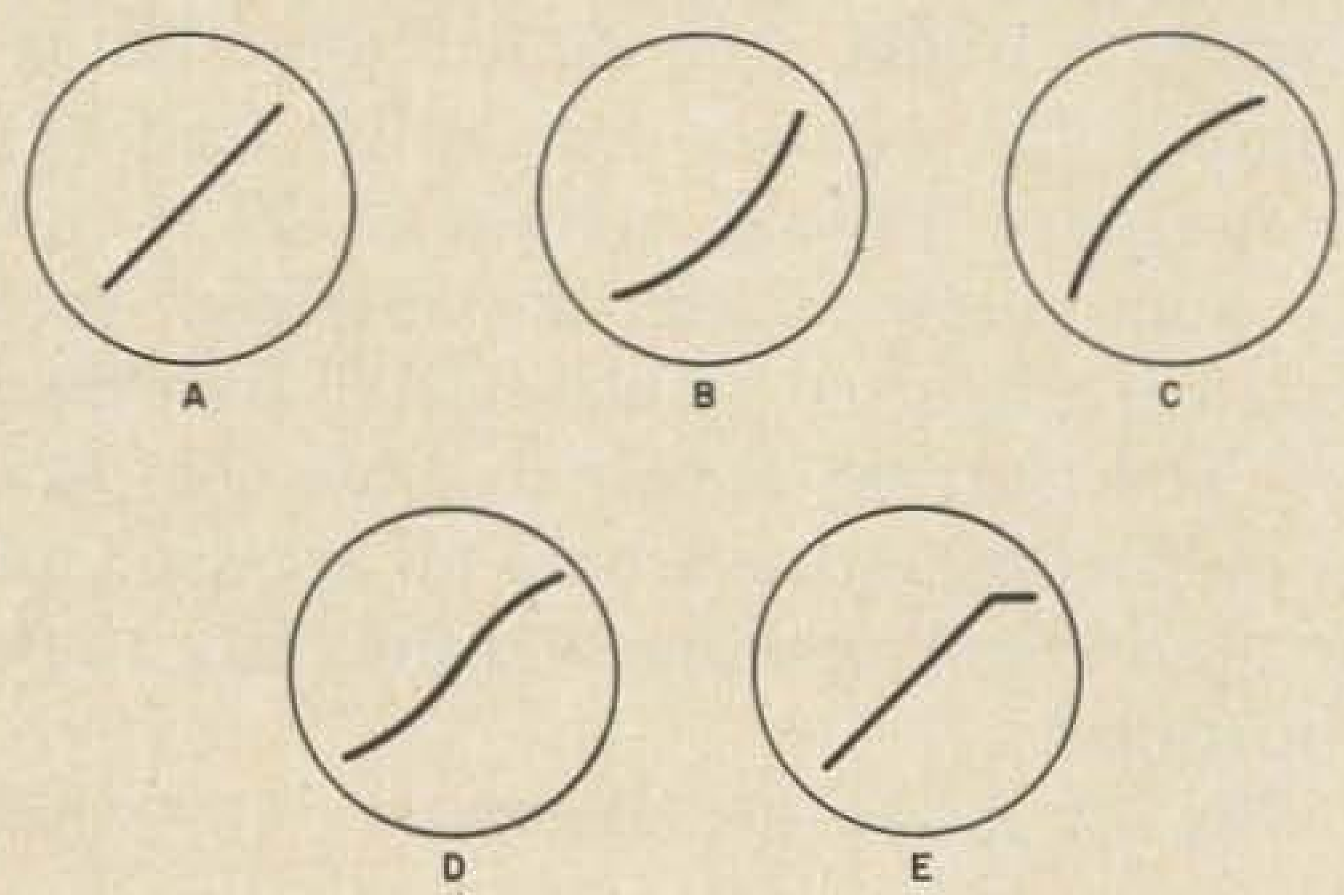

Fig. 12. Typical displays from linearity tracer tests. Perfectly straight line such as that at A indicates perfectly linear operation of amplifier. Concave curve such as B results from overbias of amplifier or too little resting plate current. Convex curve, C, results from improper loading or poor grid-circuit voltage regulation causing drive to change with signal level. S-curve, D, is combination of faults B and C. Overdrive of amplifier is indicated by sharp break at top of line, E. It may also be combined with any of the other patterns.

suppressed carrier's frequency to reproduce the audio accurately enough to permit voice recognition.

If DSB signals are to be received, the receiver must have sufficient selectivity to slice off one sideband and accept the other, or the signals cannot be comfortably received. This selectivity may be achieved by a sharp filter in the *if* strip, or by a phasing technique similar in principle to the phasing type of SSB generator. Such a phasing device is often called a ' signal slicer"; in the early days they were popular accessories, but the sharp-filter technique appears to be predominant now.

Frequency stability is also a necessity in the receiver, both in the front end and the bfo oscillator circuits. Because of the need for extreme absolute stability (tuning should stay put within 50 hz, regardless of operating frequency), multiple conversion techniques have become almost standard for SSB receivers. These employ crystal-controlled converters to bring all incoming signals into the same frequency range, where a single variable oscillator which is built for extreme stability is used for tuning. Often, the bfo is crystal-controlled, with choice of upper or lower sideband being made by switching to one of two crystals, either above or below the *if* passband by the correct amount.

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"Single Sideband Techniques," Jack N. Brown W3SHY (edited by Oliver P. Ferrell), Cowan Publishing Corp., 1954 (now out of print but of historical interest as one of first books published on amateur SSB).

(continued from page 4)
or hobby. In other words; make the public believe that our activity is a vitally important part of civilized societal welfare, contributing essentially to the common good. It was intimated that those nations would then be unable to commandeer our frequencies, and that we would be secure from those who persisted in casting covetous eyes in our direction. Hogwash!!!!! The bare truth is; if every ham in the USA were to achieve the technical competence of an electronic wizard, the prowess of a genius, those nations would still seek expansion of their frequency allotments at our expense. If we handled traffic from now till Doomsday . . . if we all became active in AREC, RACES and MARS . . . if we eschewed the hobby aspects completely . . . if we designed and built our own stations to the total exclusion of commercially built gear . . . these nations would still be attempting to acquire our precious bands. They only know that they have a propaganda story to tell the rest of the world. So far as ham radio is concerned, they couldn't care less!

The tragic thing is that ARRL could not possibly have failed to know all about this at the very time we were being regaled with this pleasant little fairy-tale version of the real facts. Why were we not told the real reasons for the League's championing of Incentive Licensing? Many have speculated about this. One account holds that the League found it necessary to create a fake issue around which to rally some controversy, in order to inspire vitality where merely bored indifference and ennui existed. That they succeeded in provoking the exact opposite was patently obvious in short order.

Even when it became painfully clear through the correspondence to the League, to QST, and to individual Directors, that those in favor of the proposal were but a negligible minority, consisting predominantly of engineers, older members who had been around long enough to "grandfather" into the Extra Class, and a number of gullible, impressionable persons who believe anything they see in print, still the League held fast to its committed course, like a juggernaut plunging downhill. Like certain politicians of recent vintage, they found it unbearable to own up to having made a mistake. They refused to retreat, simply because it was regarded unseemly for ARRL to show any sign of human fallibility. Talk about a credibility gap! Talk about false pride! Oh, brother!

The letters of objection, in the main, were characterized by the loyalists in precisely the way you might expect. They accused the writers of being unprogressive, indolent, short-sighted, stagnant, or downright seditious. You doubtless know that there have been instances when any adverse criticism of the League, no matter how mild, has been interpreted as high treason, as though the critic were a bomb-carrying anarchist. . . . . or at the very least, certainly no gentleman. "Foul," cry the Old Guard. ("Off with her head," cried the Queen.)

Now the bands are decimated. An FCC evaluation of the sub-bands is certain to disclose that which we already know . . . there's hardly anyone using them. They are sterile monuments to cocksureness and obstinacy. Why? Because, despite the percentages quoted, comparatively few amateurs have taken the trouble to upgrade. Those who have, were not impelled by any desire merely to demonstrate their technical ability for its own sake. They were motivated rather by their operating needs; they wanted to hang on to DX frequencies, for example. Nobody felt particularly noble about it, like winning a Phi Beta Kappa key, or the Congressional Medal. If a golfer wants to swat a three hundred yard tee shot instead of his customary two hundred, he goes out and buys a special high compression ball for three bucks, and gets a driver with a longer shaft and weighted clubhead. If a ham wants to work the restricted sub-bands, he studies some theory, brushes up on his CW, and goes down and takes the exam. The guy doesn't do it in order to fulfill his birthright as a red-blooded patriot, nor in order to uphold the honored traditions of our pioneers, nor yet in an effort to protect our "sacred" frequencies from the depredations of unfriendly foreign powers. He does it for the same reason he pours high octane fuel into his gas tank; in order to gain an advantage. By improving his performance he increases his own enjoyment. This is the way of the world . . . we do what we do for personal reasons . . . it's the nature of the beast! And though poets and philosophers may rhapsodize about the inherent nobility of man's spirit, the sad truth is that man's fundamental and predominant instincts are based upon self-interest. We are not a race of idealists, nor altruists, we humans. Ask any clergyman or psychiatrist. They deal with human frailty every day, and they know.

I'm no misanthrope, really. I truly love my fellow man. I'm just getting a bit fed up with those who constantly judge others and exhort them to be exemplars of saintly behavior, while pridefully refusing to heed the ancient dictum, "Physician, heal thyself." A great philosophical figure once said, "Love the people for what they are; not for what you would like them to be." I think there are far too many who try to remake others into more acceptable molds. What a travesty for mere man to regard himself so high and mighty that he can judge someone else! Of all human sins, I think sanctimonious pride is the worst. Self appointed hypocrites are all over the place, criticizing the government, college administrators, parents, clergy, the military, the rich, the poor, the old, the young . . . you name it. I'm not qualified to preach the Gospel, but I wish fervently that more people would read the 7th Chapter of St. Matthew, with special emphasis on the first five Verses.

Well, anyway, to get back to the subject; despite those few endorsements of the League's position, hardly anybody was actually in favor of it. There was never a mandate from the membership, signifying wide-spread enthusiasm. Quite the reverse! And the wholesale resignations which coincided with the adoption of this scandously unpopular change, are not attributable to other factors. The deepening diminution of our numbers may not be laid at the doorstep of the USSR, the fuzzy-headed liberals, the unwashed, the bearded, college youth, black militants, 73 Magazine, or any other of dozens of favorite scapegoats. The ARRL, and only the ARRL is responsible.

It must be stressed that not all the Directors were in accord with the change. Some received mail, which must have been most distressing. But there is incredible pressure on these men. Perhaps many of them would deny this, but such a denial would only tend to confirm the existence of pressure.

To repeat; if the second phase goes through as scheduled, there will most likely be an unprecedented exodus from our ranks. But, at least, we now know from QST that there are second thoughts about it all. Some chickens have assuredly come home to roost. Unless I am very much mistaken, our Directors are now more aware of the thinking of their constituents than they were before. I am glad we have been asked to write to our Directors. I hope that the response will dwarf all expectations. I hope there will be a deluge of mail . . . a protest so loud and insistent that it cannot be overlooked or swept under the rug.

I wish ARRL well. It is my organization, just as it is that of the functionaries who run it. I, too, am concerned about it. I, too, am dedicated to its welfare and growth. I, too, want to contribute all I can toward making it better and stronger. That is why I believe so fervently that our best hope lies in the direction of far less centralism, and far more democracy.

By all means, let's preserve our precious traditions and heritage. Let's not ever fail to continue to honor our esteemed founders and pioneers. Let's keep our memorable past evergreen and fresh in our minds. But, let's not forget that our League exists to function in the best interests of all of Amateur Radio . . . not just a group here, and a group there, no matter how we respect them nor no matter how prestigious they are.

I'm just waiting for the day when a man who is not in complete favor with the leading circles in Newington is elected to be Director of his division. After all, we can afford to have a two party system in our Federal Government; why must there be complete unanimity of viewpoint in the American ham population's organization? I'm just waiting for the day when the League stops resting on its laurels; the great achievements of those who lived in a far less complicated time . . . a time when it was much less difficult to cope with adversity. I do not seek to denigrate these men. They were brilliant and resourceful, and beyond a doubt they were surely dedicated to the cause of ham radio. But the present circumstances are not going to be dealt with by looking over our shoulder. Prayerfully, if ever the ARRL commences to realize that yesterday's answers will not suffice for today's questions, then there might be a gleam of hope for tomorrow.

There is a group of people who think that because I have criticized the League from time to time, I have severed my connection with it. I have been a member and active supporter of ARRL for practically all the time I have held a ticket, and have seen no reason to change my posture with respect to this. That is...until recently. Lately, I have been wondering about it all.

The constant message of ARRL has been that it is a democratically run organization, beholden to its members through their duly elected representatives, and accountable to the rank and file through the instrument of the election process. But, just how democratic is an organization in which the sole participation of the membership is merely the casting of a single ballot once every couple of years? And are these representatives truly answerable to the membership? Or are they answerable to those in control of the machinery of the League?

Is it possible to effect changes in ARRL through its Directors? All of us have mixed feelings about the League's programs and activities. Some of us disagree on incentive licensing. Some find fault with the failure of ARRL to implement reforms in the iron-handed approach to DX accredition. Still others feel badly about the Legal Department's reticence to become involved, except in an advisory sense, in lawsuits where fundamental rights of amateurs are imperiled. And so forth. While all these disagreements are going on, we are told...-"You can only improve the League from the inside." This is the word from Headquarters, echoed by the Directors, SCM's, EC's, and on and on, down the line. The message is, join....join.... join....no matter how strongly you may disagree with the direction and policies of leadership.

Isn't it time to mull over this state of affairs, in order to determine the wisdom.... or folly...of following blindly? Have there been any meaningful changes, suggested by the rank and file, not the officials, carried out by these "responsive" representatives?

Many have pleaded for the necessity of a new look in policy, with respect to our total lack of an affirmative public image. I challenge you to name one other national organization that does so little for its members. We desperately need a voice in Washington. But the League is so all-fired concerned with maintaining their tax-free status, that it is neglecting the fact that so far as the public is concerned, we are nothing but a bunch of idiots, who deliberately interfere with television; a group of arrested old crackpots, playing with toys and childish gimmicks. Literally a handful of people are aware of the role of Amateur Radio in our society. Hardly anyone knows that there is a difference between hams and CB'ers. All right...agreed that if we established a voice in the Nation's Capital, we would no longer be tax-free. So what! Other groups are paying their way without too much strain. What does it profit us to be tax-free, if we suffer million dollar damage suits when some crackpot sees a ghost on his TV screen? If we enjoyed good public relations, no attorney in his right mind would dare to institute such action to begin with. Supposing it does cost us some money? Heaven knows, we have it. And why should we operate by government handout? Many hams who make no bones about their opposition to huge government deficit spending...relief...Social Security...foreign aid, don't even think twice about the fortune it costs out Nation every year in the form of uncollectable taxes from outfits like ARRL. Any other similarly successful publishing firm would be carrying its own weight; paying its own freight; not freeloading on a technicality.

And it is just that. If you take an educated squint at the ARRL annual report you will discover that about 10% of our money is spent in behalf of hams. DXCC, Communications Department, W1AW, Clubs, etc., are all run as inexpensive window dressing in order to maintain the tax-free status. The remainder, a whopping 90%, less salaries and expenses, is reserved for the publishing activities. This is a million-and-a-half dollar publishing firm we're talking about. What happens with all that money? I think we have a right not only to know, but to determine how and where it is spent, or invested, or what have you.

The point is, if the League really started working for its members, instead of just for its bank account, it would probably have no trouble doubling the membership dues, for the members would feel they were getting something for their money. In terms of new members, forget it...we could increase our membership by leaps and bounds.

It is not enough to publish QST and blow our own horn. No one but hams read it! We are in dire need of national coverage on the wire services, press and periodicals, radio and TV. We need promotional ideas; not just a single little film to show at ham clubs, either. And we can certainly do without the tired old blurb that appears every so often in the magazine, about getting the local news editor to give us a couple of lines, or arranging for a spot on the Wednesday luncheon program of Lions, Kiwanis or Rotary. For a sample of this impotent pap, just take a gander at QST for May, 1969. Then compare it with QST for May, 1967. They're the same, word for word, except for changes to accommodate the calendar. You see, public relations is so unimportant, the editorialist doesn't even take the time to write a fresh piece about it! After all, it might take as much as an hour of his valuable time. So, he conveniently exhumes the old one. Nobody read the darned thing anyway, so why bother with a new one!

We hear moans and groans about our dwindling numbers, and many proposals that we ought to seek the means of remedying the situation. But thumbs down on the one thing that would really accomplish the task; a public relations office in the City of Washington, D.C. Outside of a few dozen dedicated individual hams, nobody's doing anything about recruitment. There's not much in the way of a program for junior and senior high schools, other than the radio clubs in these institutions, themselves, and the handful of teachers there who happen to be amateur operators. Of course, in all honesty, the League does print some material on this project, but how many people send for it and use it? Not many!

We spend a lot of valuable time and effort in the glorification of the past... Wouff Hong, 50th anniversary, museums, T.O.M., etc., but we do not devote much of our energy to the proselytization of our young citizens. I'll guarantee you that at least a few young acid heads might not be in their present loathsome predicament if some hams had attracted their attention to Amateur Radio in time to make an impression. And perhaps there are some guys sitting around in pool-halls, letting their minds stagnate, who might have been involved meaningfully in our hobby, if only someone had taken the trouble to stimulate and nurture their interest. Think about it!

Now; can anything be changed from inside the League? Perhaps it can. But not unless a struggle takes place. Up to now, most such efforts have met with failure. Those candidates who have proposed the most sweeping changes, which might have changed the League for the better, have never succeeded in being elected. I do not accuse anyone of rigging elections. But there are many similar organizations which have found it advantageous to permit their elections to be supervised by outside, impartial personnel. In this way, at least, there can not be any question of skulduggery, and this is one positive advantage. Many unions and guilds run their elections under the aegis of the Honest Ballot Association, which has a long history in this field. Since we are assured that our elections are scrupulously honest, we have nothing to lose by permitting such outside supervision. That is, we have nothing to lose, unless the elections are being rigged. The writer is a member of ASCAP, the performing rights society of the publishers and songwriters. The Government made us sign a consent decree, permitting them to oversee our activities. This was not done because of any dishonesty. It merely made it easier for persons in sensitive positions to avoid temptation. ASCAP collects and distributes over $40,000,000 per year to its members, and all of us are happy and secure in the knowledge that not one penny is sticking to anyone's fingers. But we were sure of this before the consent decree. The decree has merely made it possible for us to be doubly confident that our organization is being administered with integrity. I find absolutely nothing objectionable in putting an extra lock on my front door, or installing a burglar alarm in my automobile! Why then, should anyone object to reasonable precautions being taken, so as to guarantee the integrity of the elections in the American Radio Relay League?

Another thing; the only time your membership really counts for anything at all is when you write your check. Take the large business firms....take Detroit, for instance. Tens of thousands of car buyers told the manufacturers they wanted economical compacts. They were ignored. So, they began buying VW's, Volvos and Renaults. The moment the dough started to diminish, and not before, Detroit started to make economy cars. People bought them by the thousands. Detroit then raised the prices, typically. The public went back to Volkswagons! Finally the light dawned on Detroit! But their short-sighted stupidity cost them billions of dollars. And that is why you see so many VW's and Toyotas today.

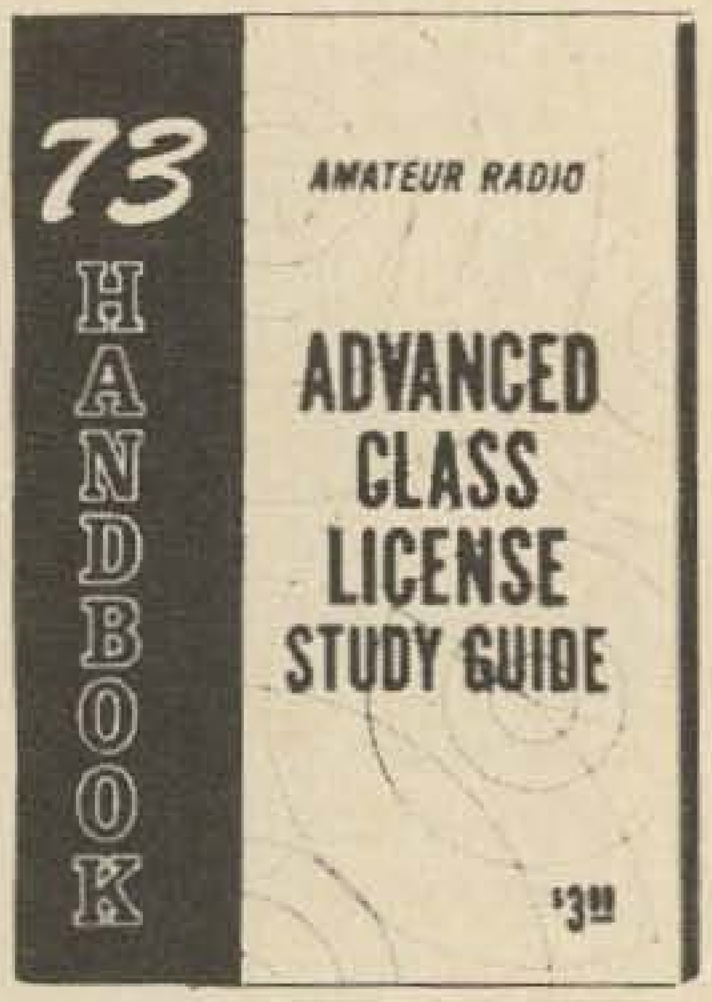
Well, what can be done? I suppose the staunch and dependable old guard will begin calling me an ingrate, a renegade, a blackguard, or worse. There has already been a snide reference to Wayne Green in the August editorial of QST, on the basis that he was not exactly bowled over by a new film which was screened recently. You have been warned that you will see adverse criticism of the film in this magazine. So far as I know, the film is a nice, innocuous, little thing, neither good nor bad, but certainly nothing new or startling. And it is not going to be premiered at the Radio City Music Hall or Graumann's Chinese! It will be shown at ham clubs, and if that is the League's idea of public relations or publicity, I regard it a total waste of time. So, I'm anticipating outraged yells of "foul" from Headquarters. Remember, though, what General Motors tried to do to Ralph Nadar when he got into their hair? They tried to frame a phoney moral turpitude charge against him. They had to admit it in open court when he fought back, confronting them with irrefutable evidence. They had to eat crow...but good, when they were exposed for the filthy conspiracy they tried to engineer. I trust that no one in Newington comes up with any such bright idea. For the Nader vs. General Motors case establishes the illegality of this type of reckless adventurism.

Until the League demonstrates a willingness to act in accordance with the expressed will and interest of a large segment of the amateur fraternity, including vast numbers of its own membership, rather than the special interest of the Headquarters group alone, I am very much afraid that it cannot count on the strong rank and file support it persistently claims to enjoy. This is a time when we all need to recognize that democracy is one thing....oligarchy is quite another. The type of paternalism which we get constantly in QST insults the intelligence of every rank and file member. We have recently seen an example of arrogant contempt which sank to a hitherto unplumbed depth. If there were any doubt at all, it was surely dispelled by the disgraceful editorial of last February! We were not even credited with the ability to determine the content and substance of our conversation; that's how much faith they have in our intellectual capacity.

We are no different than any other fraternal or political entity. Either we have a voice (I mean a real voice) in our organization's policies, or we haven't. If the latter be true, then it is high time for some sweeping changes. And these can be accomplished in only one positive way. Remember Detroit!

Dave Mann K2AGZ

73 Books for Hams



ADVANCED CLASS STUDY GUIDE

128 pages of up-to-the-minute simplified theory, written with the beginning radio amateur in mind. This unique book covers all aspects of the theory exam for the Advanced Class license and has helped hundreds of hams to sail through the exam. . .nothing else like it in print. **$3**

DX HANDBOOK

Includes giant world country-zone wall map. Articles on QSL design secrets, winning DX contests, DXCC rules, DXpeditions, reciprocal licensing and many more. World postage rates, WAZ record lists, time charts, propagation, etc. Special ham maps and bearing charts. A must for the DXer. **$3**

COAX HANDBOOK

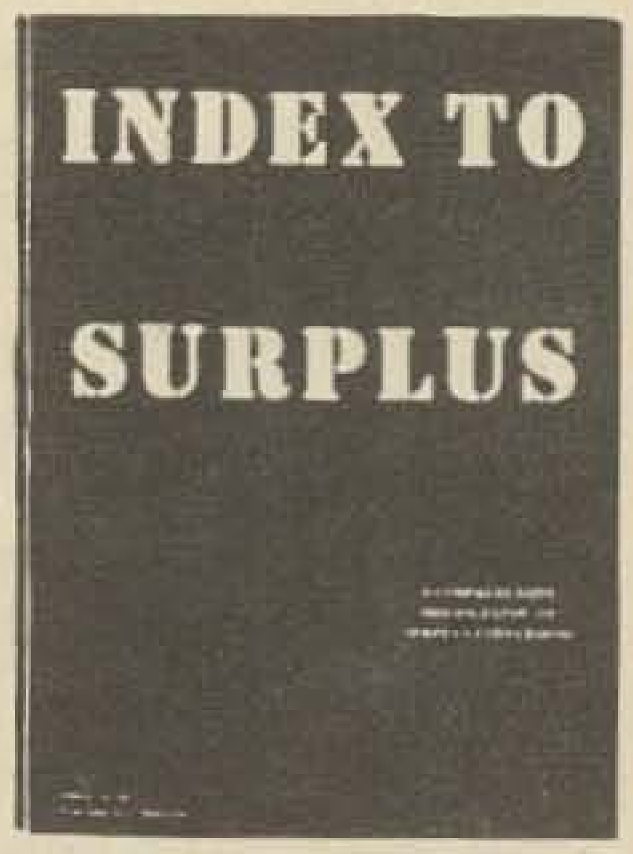
Invaluable book for the ham or the lab and for everyone else who doesn't want to have to keep a whole library on hand for reference. . .or even worse, have to write to the manufacturer for coax spec. **$3**

PARAMETRIC AMPLIFIERS

For the ham who wants to work DX on the bands about 432 MHz, there is nothing that can beat the gain and noise figure of a paramp. This book shows you how they work and how to build and use them. Lavishly illustrated with photographs and drawings. **$3**

VHF ANTENNAS

This handbook is a complete collection of up-to-date information about VHF and UHF antennas, with design hints, construction and theory. If you've been wondering what array you need, this book will give you enough background to make the right decision. **$3**



INDEX TO SURPLUS

Do you have a piece of surplus equipment that you want to convert but can't find an article? If so, this is the book you need. It lists all of the surplus articles and conversions in popular electronic and amateur magazines from 1945 to 1966. **$1.50**

DIODE CIRCUITS HANDBOOK

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

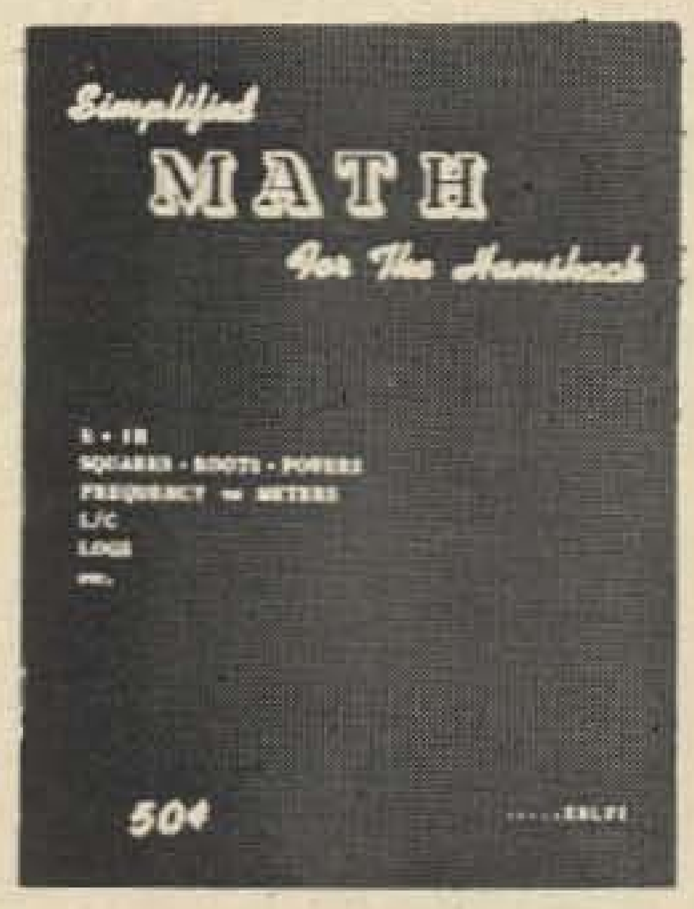
73 USEFUL TRANSISTOR CIRCUITS

If you've been looking for a transistor circuit to do a special job, chances are there is a circuit in this book that will give you a head start. It covers circuits for audio, receivers, transmitters and test equipment. **$1**

HAM TELEVISION

The Amateur Television Anthology is a collection of the technical and construction articles from the **ATV Experimenter,** edited by WØKYQ. If you're interested in ATV, this is the book for you. It covers the gamut from the simple to the complex in amateur television equipment. **$3**

MILITARY SURPLUS TV EQUIPMENT by W4WKM is a necessity to the surplus-scrounging ATV addict. **$1**



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CW by W6SFM explains code and how to learn it. **50¢**

CUMULATIVE INDEX lists all the articles in 73 up through December 1966. **25¢**

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- _Ham RTTY. $3.00
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73 Magazine

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Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen K1FWF, high school student, 51 Pine Plain Road, Wellesley, **MA** 02181. HF and vhf antennas, vhf transmitters and converters, AM, SSB, product data, and surplus.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, **NY** 11360. Novice help.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, **VA** 22042 General.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, **IL** 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Glen H. Chapin W6GBL, 3701 Trieste Drive, Carlsbad, **CA** 92008. HF and vhf antennas, novice transmitters and receivers, vhf converters, semiconductors, receivers AM, SSB, general, surplus.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, **VA** 22307. Amateur TV, both conventional and slow scan.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans **LA** 70118. Novice help and general questions.

George T. Daughters WB6AIG, BS, MS, 1560 Klamath Drive, Sunnyvale, **CA** 94807. Semiconductors, vhf converters, test equipment, general.

Gary De Palma WA2GCV/9, P.O. Box 1205, Evanston, **IL** 60204. Help with AM, Novice transmitters and receivers, vhf converters, semiconductors, test equipment, digital techniques and all general ham questions.

Steve Diamond WB6UOV, college student, P.O. Box 1684, Oakland, **CA** 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, vhf antennas and converters, receivers, semiconductors, and product data.

Frank M. Dick WA9JWL, 921 Isabelle Dr., Anderson, **IN** 46013. Will answer queries on RTTY, hf antennas, vhf antennas, vhf converters, semiconductors, mobile, general, and microwave.

David D. Felt WB6ALF, 79 East Highland Ave., Sierra Madre, **CA** 91024. Semiconductors, IC's, television, test equipment, product data.

Louis E. Frenzel, Jr., BAS, 11287 Columbia Pike, Silver Spring, **MD** 20901. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

Paul Gorrell, high school student, P.O. Box 228, Mashpee, **MA** 02649. Novice transmitters and receivers, hf equipments, CB to ham gear conversion. Marine to ham gear conversion, Civil Air Patrol Communications, all aspects.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, **CA** 95240. TV, hf antennas, SSB, vhf antennas and converters receivers, semiconductors, and general questions.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, **NY** 14619. Specializes in vhf/uhf solid-state power amplifiers, but will be glad to make comments on any subject.

D. E. Hausman VE3BUE, 54 Walter Street, Kitchener, Ontario, **Canada**. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO **NY** 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 SW Salmon St., Portland, **OR** 97205. This group of radio amateurs will answer any technical questions in the field of electronics.

Douglas Jensen W5OG/K4DAD, BA, BS, 2505 Broadway, #1704, Houston, **TX** 77012. Digital techniques, digital and linear IC's and their applications.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, **WI** 53402. Novice transmitters and receivers, general.

Ira Kavaler WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, **NY** 11236. SSB transmitting, color TV, computer programming and systems, digital radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Ronald King K8OEY, Box 227, APO **NY**09240. AM, SSB, novice transmitters and receivers, hf receivers, RTTY, TV, test equipment, general.

G. H. Krauss WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, **NY** 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitters and receivers, vhf antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Bert Littlehale WA1FXS, 47 Cranston Drive, Groton, **CT** 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

J. J. Marold WB2TZK, 279 Farmers Ave., Lindenhurst, **NY** 11757. General.

Wayne Malone W4SRR, BSEE, 8624 Sylvan Drive, Melbourne, **FL** 32901. General.

Charles Marvin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, **OH** 44084. Will help with any general amateur problems.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, **CA** 94952. Double sideband.

Fred Moore W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, **PA** 19047. Novice transmitters and receivers, hf and vhf antennas, vhf converters, receivers AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Eduardo Noguera M. HK1NL, EE. RE, P.O. Box Aereo 774, Barranquilla, Columbia, **South America**, antennas, transmission lines, past experience in tropical radio communications and maintenance, hf antennas, AM, transmitters and receivers, vhf antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, **CA** 91780. ATV, vhf converters, semiconductors, general questions.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, **MN** 55060. AM, SSB, novice transmitters and receivers, hf receivers, vhf converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, **PA** 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

Howard Pyle W7OE, 3434 7th Avenue, S.E., Mercer Island, **WA** 98040. Novice help.

Robert Scott, 3147 East Road, Grand Junction, **CO** 81501. Basic electronics, measurements.

Pfc Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO **NY** 09742. Help with current military gear, information from government Technical Manuals.

Walter Simciak W4HXP, BSEE, 1307 Baltimore Drive, Orlando, **FL** 32810. AM, SSB, Novice transmitters and receivers, vhf converters, receivers, semiconductors, mobile, test-equipment, general.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, **NY** 11357. General.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, **IL** 61820. Antennas, transistors, general.

Jon Teich WB2JAE, 22 Olden Road, Ediron, **NJ** 08817. General assistance and problems with rigs.

James Venable K4YZE, MS, LLB, LLM, 119 Yancey Drive, Marietta, **GA** AM, SSB, novice gear, vhf, semiconductors, and test equipment.

Hugh Wells W6WTU, BA, MA, 1411 18th Street, Manhattan Beach, **CA** 90266. AM-FM receivers, mobile test equipment, surplus, amateur repeaters, general.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, **CA** 91504. Club licensing classes and Novice problems.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, **OH** 45342. HF antennas, AM, SSB, novice gear, semiconductors.

Modifying A Kitchen Clock for the Shack

In this shack a kitchen type clock is used for logging. And, being just a bit fussy about the time, I made two small but useful modifications. I'm not so sure that it's all that important or necessary to be that accurate, but we all have our small idiosyncrasies of one sort or another.

In this case, I took the old clock from the kitchen after convincing the wife that she should buy a new one. The second step, or maybe it should have been the first, was to determine that the hands of the clock did not have any flop to them. Flopping hands would not make a very accurate clock. You may have to "set-a-while" and watch the clock, but you can do this while you talk to some interesting station.

The first step was to add an extra hand to the clock so whenever I had to convert from local EST time to GMT time (for the local MARS net), I was able to do this with just a glance at the clock.

Next, I took the clock apart and cleaned it in a good detergent (except for the motor), to get off the years of grease. The small hand was removed from the clock, the paint removed, and the third (GMT) hand, fabricated from sheet metal, was soldered onto the small hand. Both were repainted (different colors), and put back on the clock. *Be sure to get the proper angle to the third hand before you solder it!* Before you put the clock together, put a small switch in the bottom of the clock and wire it to open the line to the clock.

Reassemble the clock and plug it in to see if it still works. If so, fine! You are now ready to set the clock to the proper time. Get a convenient time signal: WWV; Bell Telephone; or my particular favorite is the Canadian time signal from CHU. They give the time announcements every minute and give you 1 pulse every second, with a blank pulse at the 30 second period. I look for CHU on 3330 kHz and 7335 kHz and find them quite well on both. Stop the clock with the second hand on the 12 and the other hands of the clock set to what ever the approximate time happens to be, *plus* one minute. When the proper time is announced which corresponds to your clock setting, switch it on. Unless your line frequency changes, you should hold the time quite well for a long time.

The need for the switch was necessitated by the fact that my clock is accessable, but the plug is quite out of the way and out of reach. If your wall plug is handy, you can omit the switch.

I have found that this small extra hand and switch adds just one more small convenience to the operation of my ham shack.

R. Bailey, K3AQH

SBE Improvements Made Easy

R.E. Barrington W6JDD
1087 Hewitt Drive
San Carlos, CA

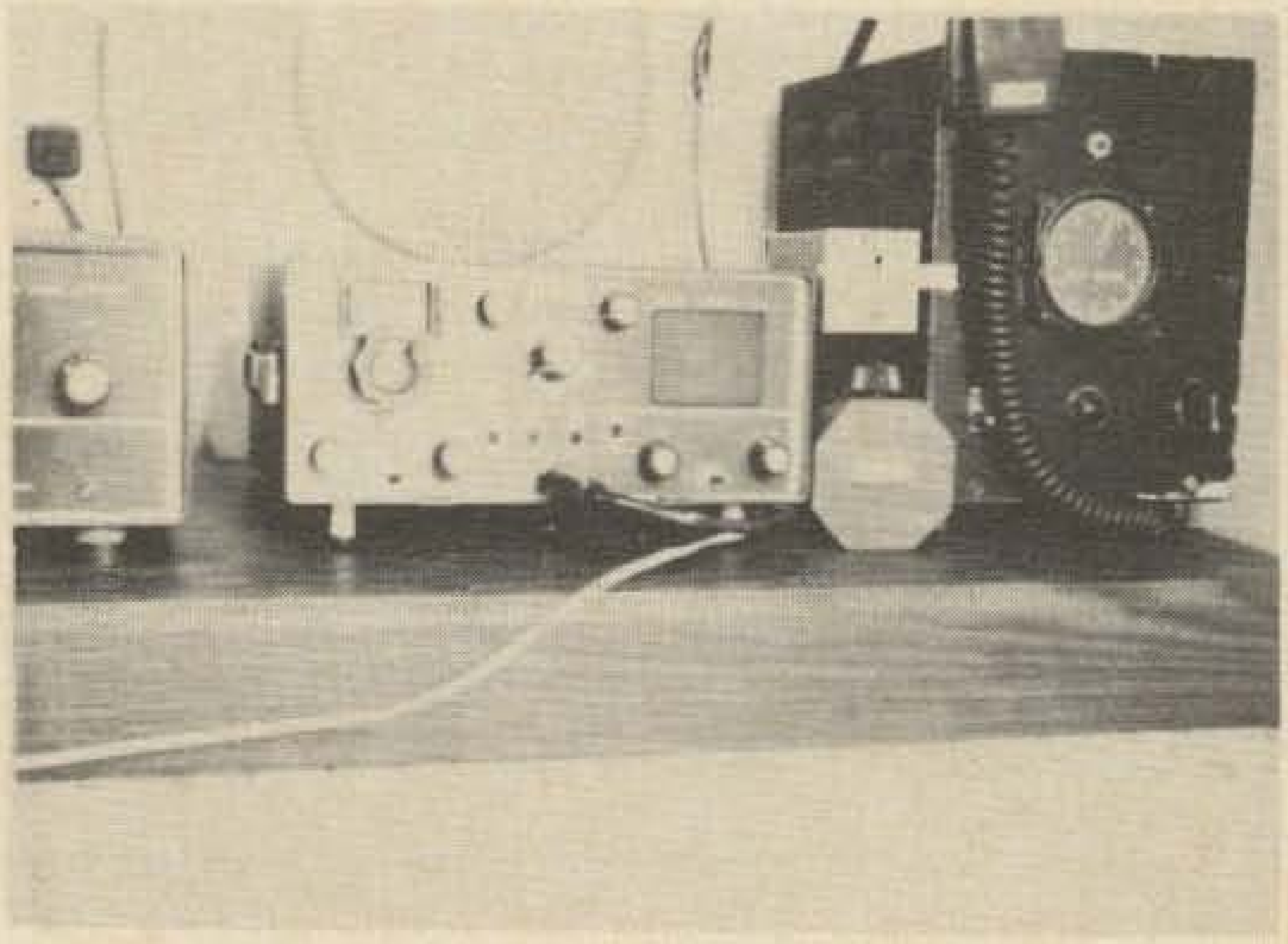
If you are the owner of an SB-34 transceiver or the exciter-SB2 linear combination, have you ever wished:

1. The stuff didn't get so hot!
2. The exciter stayed on slow-speed vernier tuning all the time?
3. You had an "S" meter.
4. You could use any one of several mikes . . . and still completely modulate the rig?
5. The gear didn't thump from the receiver's speaker when switched from receive to transmit and back again?

Let me hasten to say that the foregoing is not meant as a slur against SBE equipment. Certainly the SB-34 is a pretty advanced design as transceivers go. And by the hundreds they're bringing a lot of pleasure and operating satisfaction to many sidebanders today.

Let's consider one point at a time. First, heat. Both the SB-34 and the SB2-LA *do* generate a tremendous amount of heat. Unfortunately, the cause results from the features that make these rigs so desirable—extremely compact size, but with built-in power supplies, both ac and dc, in the case of the transceiver.

There is no room at all for any kind of a satisfactory fan for mounting inside of a 34; virtually impossible in the linear, too. But both pieces of gear do have grillwork openings, top and bottom. Therein lies a simple and most effective solution to the problem, with a modification to the operating work space (instead of the equipment), and the addition of a pair of Muffin or Whisper fans.



Modifying the work space rather than the equipment may even improve the appearance of the shack.

If your operating table or desk is a bit fancy to cut holes in directly, a section of elevated plywood as a false top will serve nicely. Use whatever's handiest, then cover with wood grain contact paper. The result will probably look better than your operating surface did in the first place!

This arrangement makes a dramatic difference in the operating temperature of both the transceiver and the linear. Never again will any of the crystals or transistors quit... at least not from heat.

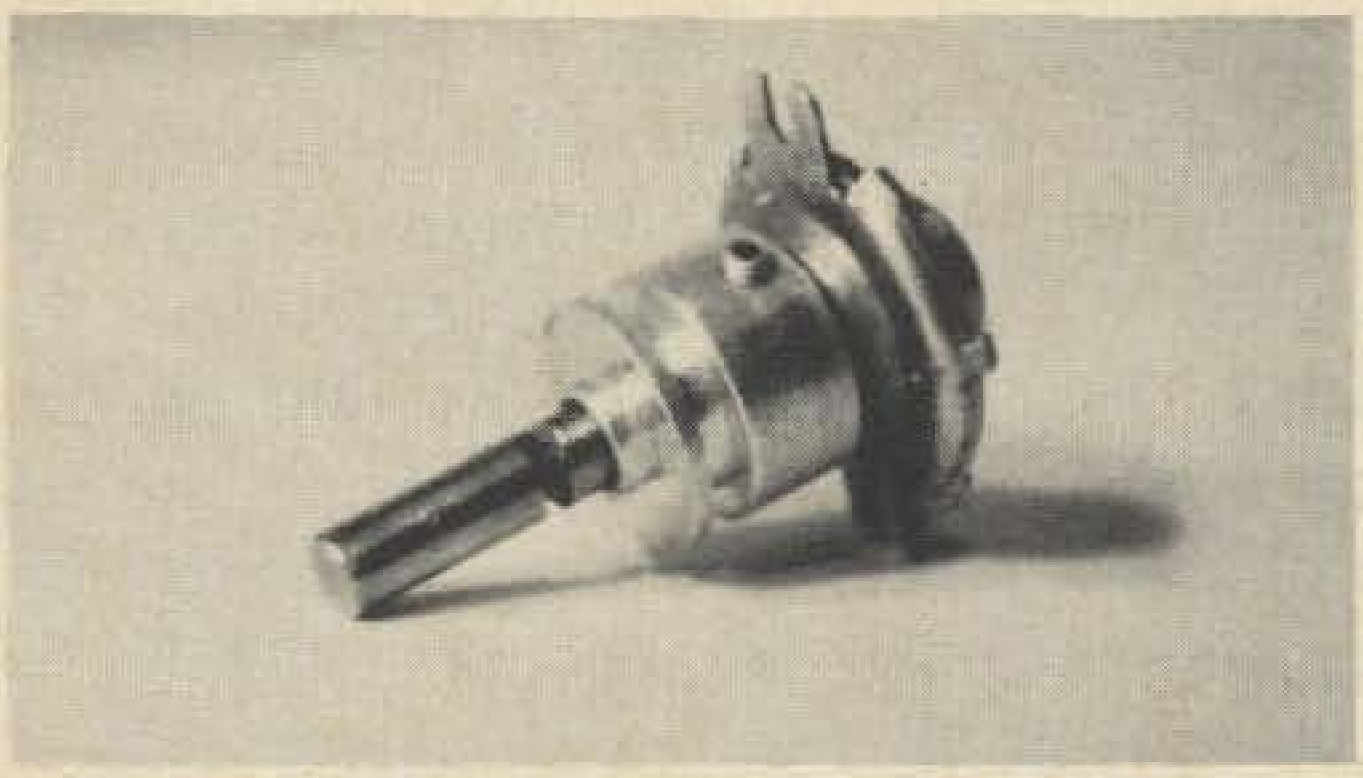
The two-speed vernier dial drive on the SB-34 has been a source of annoyance to many owners. If you prefer a slow tuning rate, don't hesitate to remove this unit.

The dial drive shaft is segmented into two sections. Actually, where the slot appears between the two shaft sections, the soft brass of the factory units has an eccentric notch. The opposing steps or notches are placed in such a way that the outboard shaft turns several degrees of a circle before engaging the opposite notch. It is this engagement that forces the clutch arrangement of the mechanism into a fast speed mode.

A quick cut with a hacksaw blade removes the notch on one shaft or the other. Presto! No eccentric engagement. . .smooth, constant slow speed tuning!

The SBE people will tell you that the 34 is on the shy side for audio gain. Many owners have had to give up using their favorite mike because it simply wouldn't drive the rig. A highly satisfactory solution to this problem is transistorized pre-amplification—or better yet, compression. For the owner who really wants improvement in audio punch and mike flexibility at very low cost, the best solution I've seen yet is a $4.95 modification to the 34 available nationally through the Radio Shack stores. The simple outboard modification is designed around an Archer solid state module, known as the CB Compression Amplifier.

The Archer unit is encapsulated in plastic with screw terminals for 3 volts of battery and audio in and out. Knob twisters can't louse it up! A fixed threshold of compression is built in with no adjustments.



The vernier tuning drive shaft for the SB-34.

With the suggested compressor in the circuit between your mike and the exciter, you'll get much higher average output than ever before (without flat-topping) at a mike gain setting backed off as far as 8 o'clock.

The diagram (**Fig. 1**) illustrates some simple precautions to be taken in assembling the SB-34 adaptation. With the switch in the battery-off position your mike feeds straight through, so you can quickly test in and out of the circuit. If you use a linear, the rf chokes are a must to avoid feedback at the higher frequencies. It's also a good idea to ground the minibox to your transceiver chassis electrical ground.

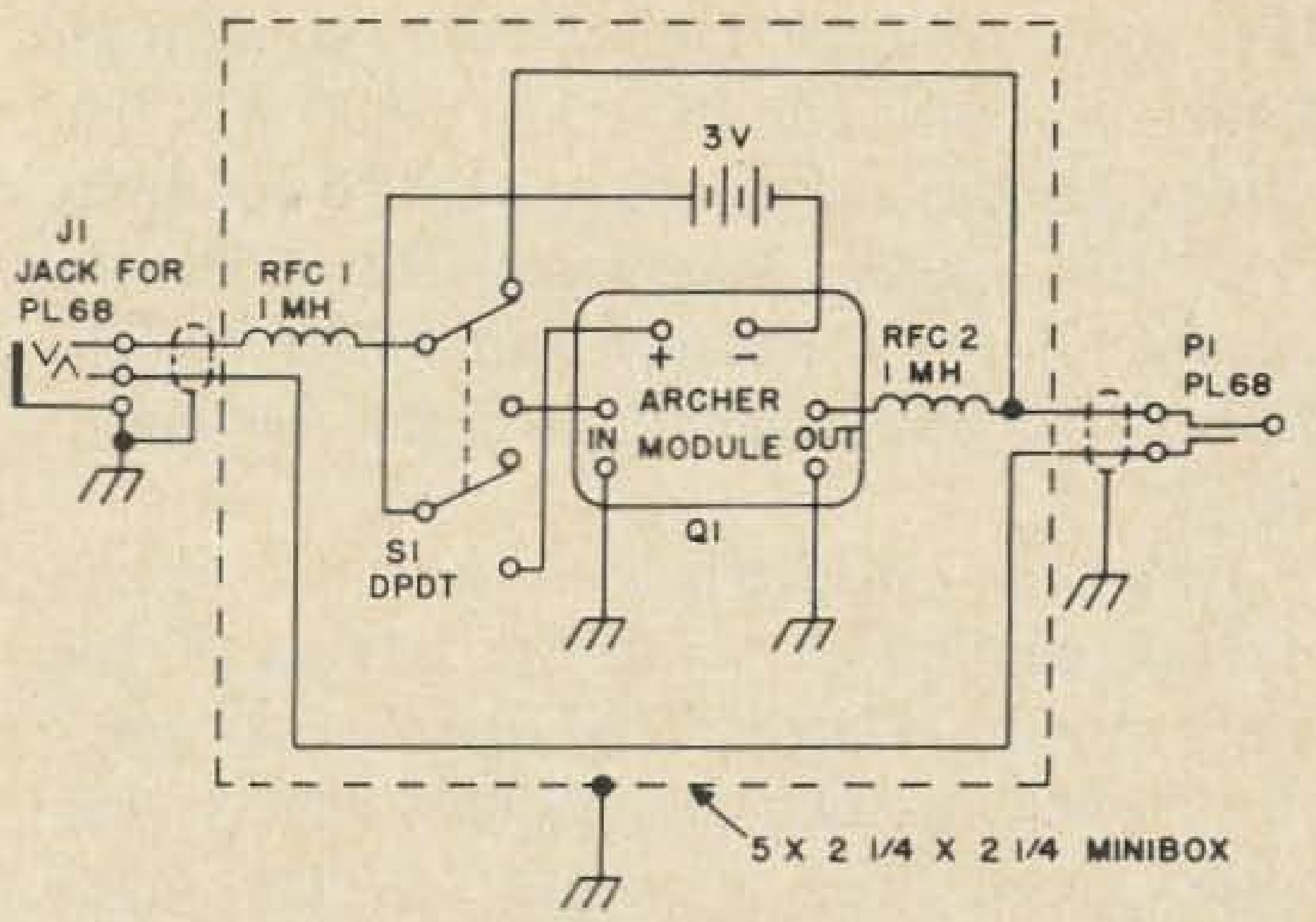


Fig. 1. Some simple precautions to be taken in the SB-34 adaptation assembly. J1—jack to fit PL68 mike plug; RFC1—1 mh rf choke; S1—DPDT toggle switch; B—two 1½ volt penlight cells in series; Q1—archer solid state module; P1—PL68; M—minibox, 5 x 2¼ x 2¼.

You can add a transistorized "S" meter circuit as an external outboard device, without modification to the SBE equipment. The only connection to the receiver is via the speaker output terminals (**Fig. 2**). The rf choke is not absolutely necessary. It was incorporated in this particular installation because of fairly long leads to an external remote wall speaker, known to gather some rf during transmit mode.

The simple PNP transistor Q1 is biased to cut off by the adjustment of the 10K pot, R2. This should be done with the circuit connected to the speaker output terminals of the SBE-34, but with no signal present.

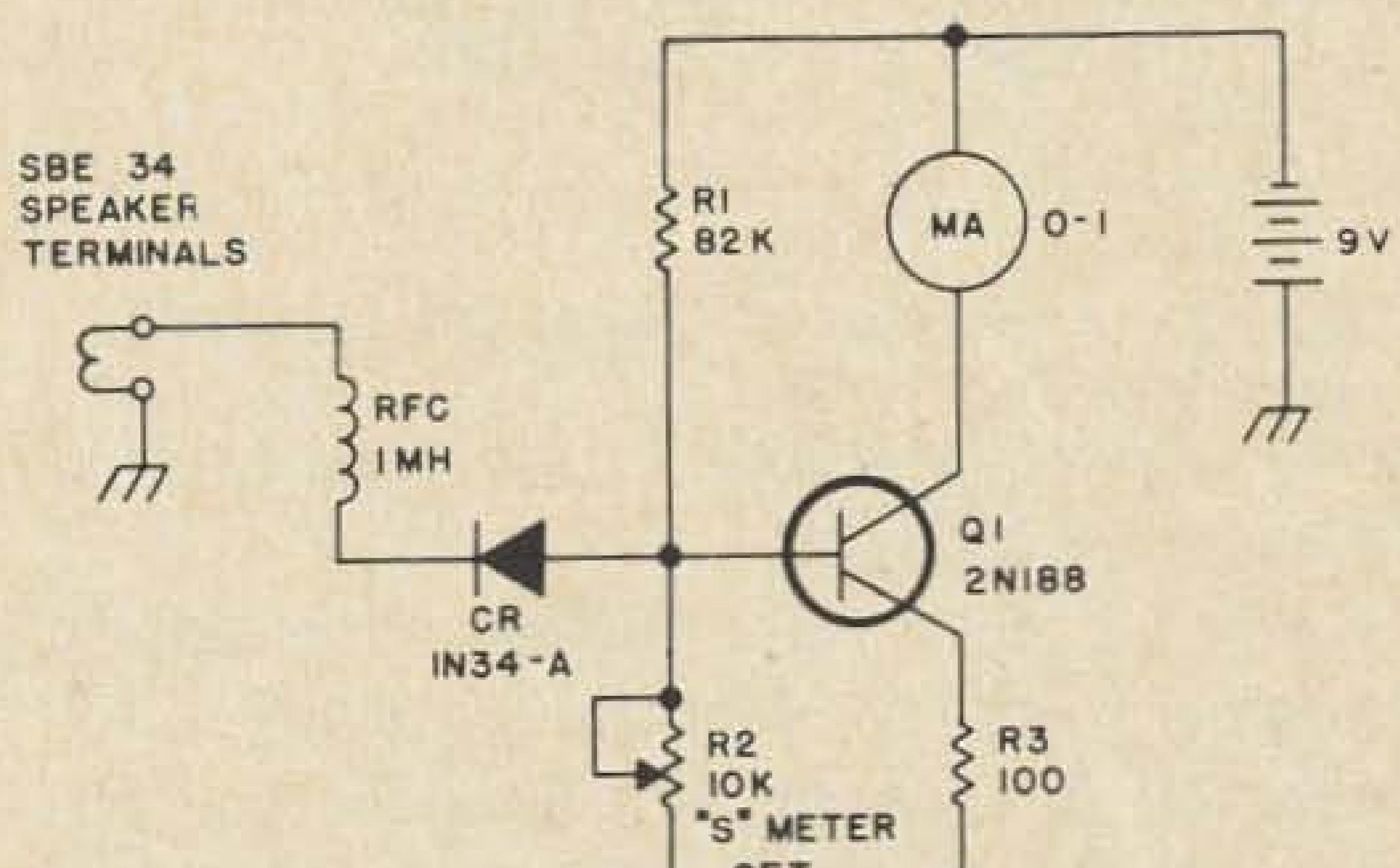


Fig. 2. Adding a transistorized S meter circuit as an outboard device. The only connection to the receiver is via the speaker output terminals. RFC—1 mh rf choke; CR—IN34-A germanium diode; R1—82K; R2—10K (S-meter set); R3—100Ω; Q1—PNP 6-9 volt audio type transistor Radio Shack Archer type 276-403 or type 2N188, SK 3004 (RCA); M—Radio Shack Micronta 0-1 mil "S" meter model 22-020 or 22-004.

The audio output fed to the germanium diode is rectified by the 1N34-A. The resultant pulsating dc causes Q1 to conduct. The "S" meter measuring the collector current of the transistor will swing in proportion to the relative strength of audio signals.

Isn't the strength of the "S" meter reading dependent upon the setting of the receiver gain control? The answer is "yes," but it's not as much of a disadvantage as you might think. For example, at any given setting a group of signals on a round table will fall into their proper perspective as related one to the other. At normal comfortable room volume, the readings on strong signals compare favorably with any other "S" meter.

Resounding audio thumps from switching transients are heard in the loud speaker when changing the SBE equipment from receive to transmit mode, and back again. You can substantially reduce, or eliminate this completely depending upon which of the following two methods you choose to employ. If you operate VOX or use your 34 barefoot, try Method 1. If you prefer push to talk, and especially if you also use a

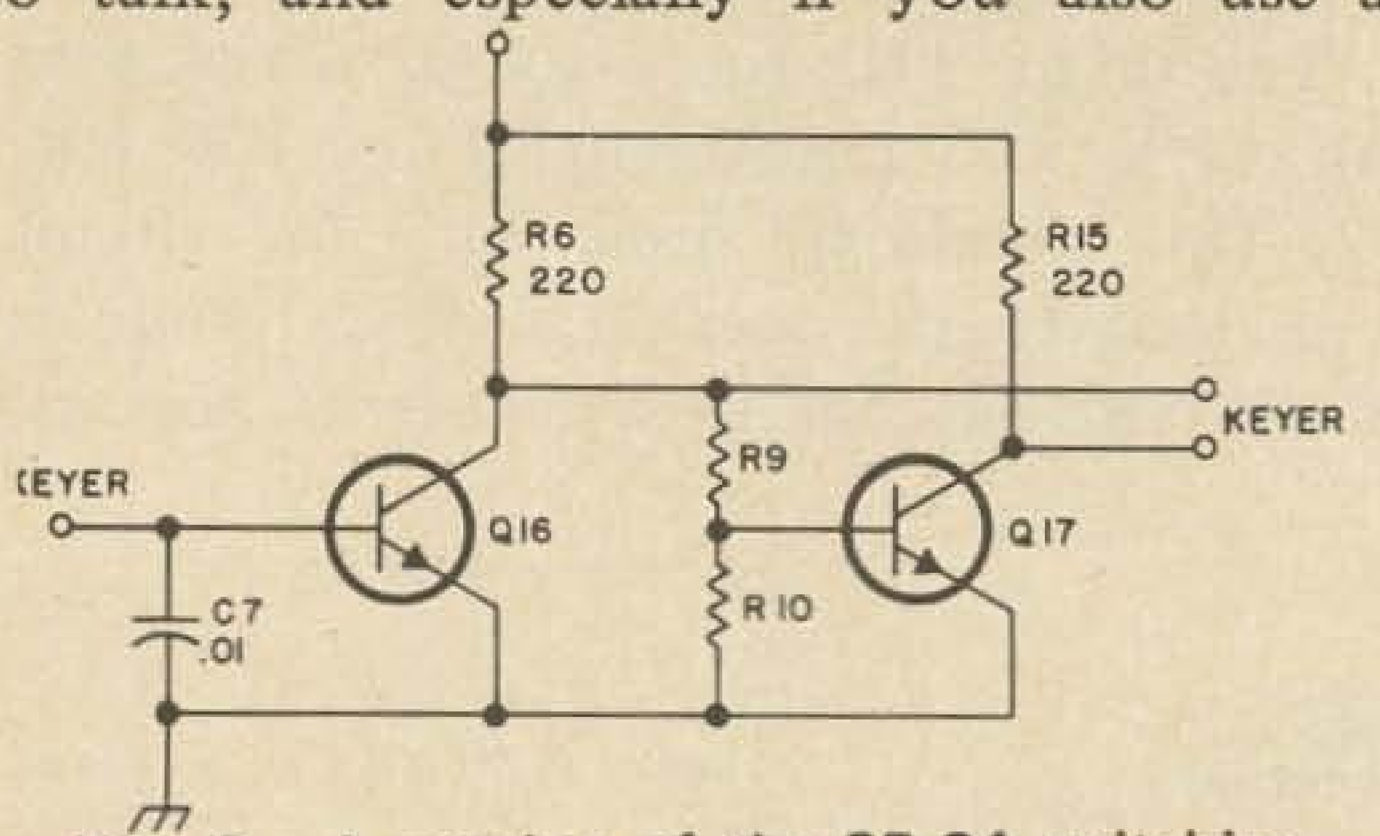


Fig. 3. A portion of the SB-34 switching circuitry.

linear, choose Method 2, for reasons that will become apparent.

Refer to **Fig. 3** for a portion of the SB-34 switching circuitry. Method 1 involves experimental by-passing of the collector circuits of both switching transistors, Q16 and Q17, using large values of capacitance. The values required may vary within fairly wide limits, depending upon the preference of the operator, variations from one SB-34 to another, and the inclusion or exclusion of a larger speaker in the individual shack. The results are more noticeable when only the internal built-in speaker is involved.

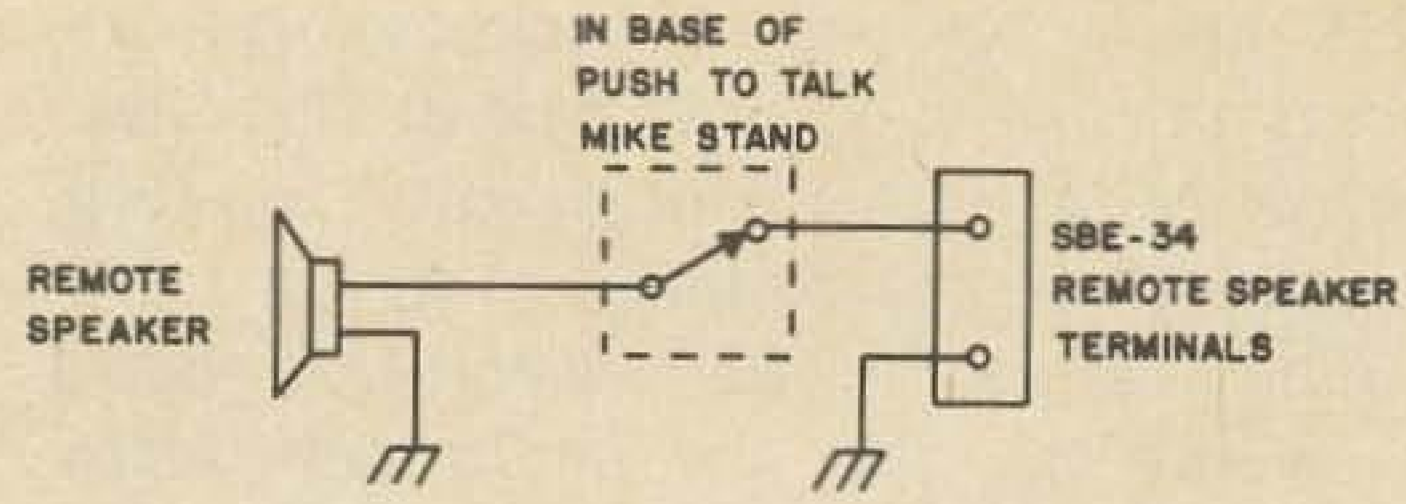


Fig. 4. How the additional circuitry is applied to the remote speaker.

Small transistor type electrolytics are used—15 to 25 volts ratings. Values from 50 to as high as 250 μf will each provide a slightly different shaping to the audio result of the keying transient.

The capacitors may be applied from either above or below the circuit board. Care should be taken to see that in each case the positive terminal of the electrolytic is connected to the transistor side of the circuit; the negative terminal goes to ground since this is required by the circuit polarity of Q16 and Q17, both NPN type transistors.

Method 2 involves a combination electronic and electro-mechanical remedy that is most effective. Many push-to-talk microphones employ a leaf spring system of switching contacts, similar to a relay. In the Shure 444, for example, there is plenty of room in the base for additional switching contacts. New ones can be fabricated by pulling them off a relay discarded in the junk box. A rubber chassis grommet on the tip of the new leaf spring allows contact by the plastic push to talk bar slightly in advance of normal switching contact. **Fig. 4** shows how this additional circuitry is applied to the SB-34's remote speaker.

In method 2, a 25 volt, 50 μf transistor electrolytic is also applied from collector to ground on keyer Q17. It was included in the push to talk application to soften any remaining switching transient audible on those occasions when the operator's hand too roughly contacts the mike base switching bar. When even pressure is applied, the new switching contacts do their job of silencing the speaker before the transient takes place, returning the speaker to life, post transient. Result: barefoot SB-34, completely silent switching. Add the linear and all you'll hear is the soft reassuring click of the antenna relay.

. . . **W6JDD**

Antenna Fishing

Most hams of my acquaintance would like to have a 100 foot self-supporting tilt-over tower for their antennas. However many of us are not numbered among those that do. Therefore we must make do with what our finances, premises, landlords, and ultimately our XYL's will allow.

At my former QTH I was blessed (or cursed) with several tall oak trees which were pressed into service. These trees went some 30 feet to the first limb and at the 80 foot level one of them had a large limb that overhung an open place in the backyard. This limb was used as the support for my 80 meter inverted V and 40 meter ground-plane antennas.

Whenever a friend came over to visit for the first time the question was invariably asked, "How did you ever get that antenna way up there?" To which I always answered, "With my fishing pole." This often resulted in a look of disbelief. Actually it is very simple and quite effective and works as follows:

I take my open faced spinning outfit and put a small sinker on it. An experienced angler will be able to tell what size. A sinker too small will result in it falling short because of lack of weight. A sinker too large will not work because the rod cannot provide enough whip action to propel it high enough. I would stand approximately 20 feet from directly underneath the limb and cast the sinker over the limb. Usually several tries were necessary as you are casting almost vertically. After the sinker and line were over the limb and returned to the ground I removed the sinker and replaced it with the end of a spool of nylon fishing line of the type used for trotlines. Cotton line such as used for plumb lines may be used but is not as strong.

The monofilament line is then reeled back on the spinning reel, pulling the nylon line back over the limb. When the heavier line is over the limb and back down to ground level it is tied to a rope, polypropylene is best. Remember that both the nylon line and the rope must be at least twice as long as the limb is high. The nylon line is then pulled back over the limb, pulling the rope over after it. This rope is used to pull up and lower the antenna or antennas.

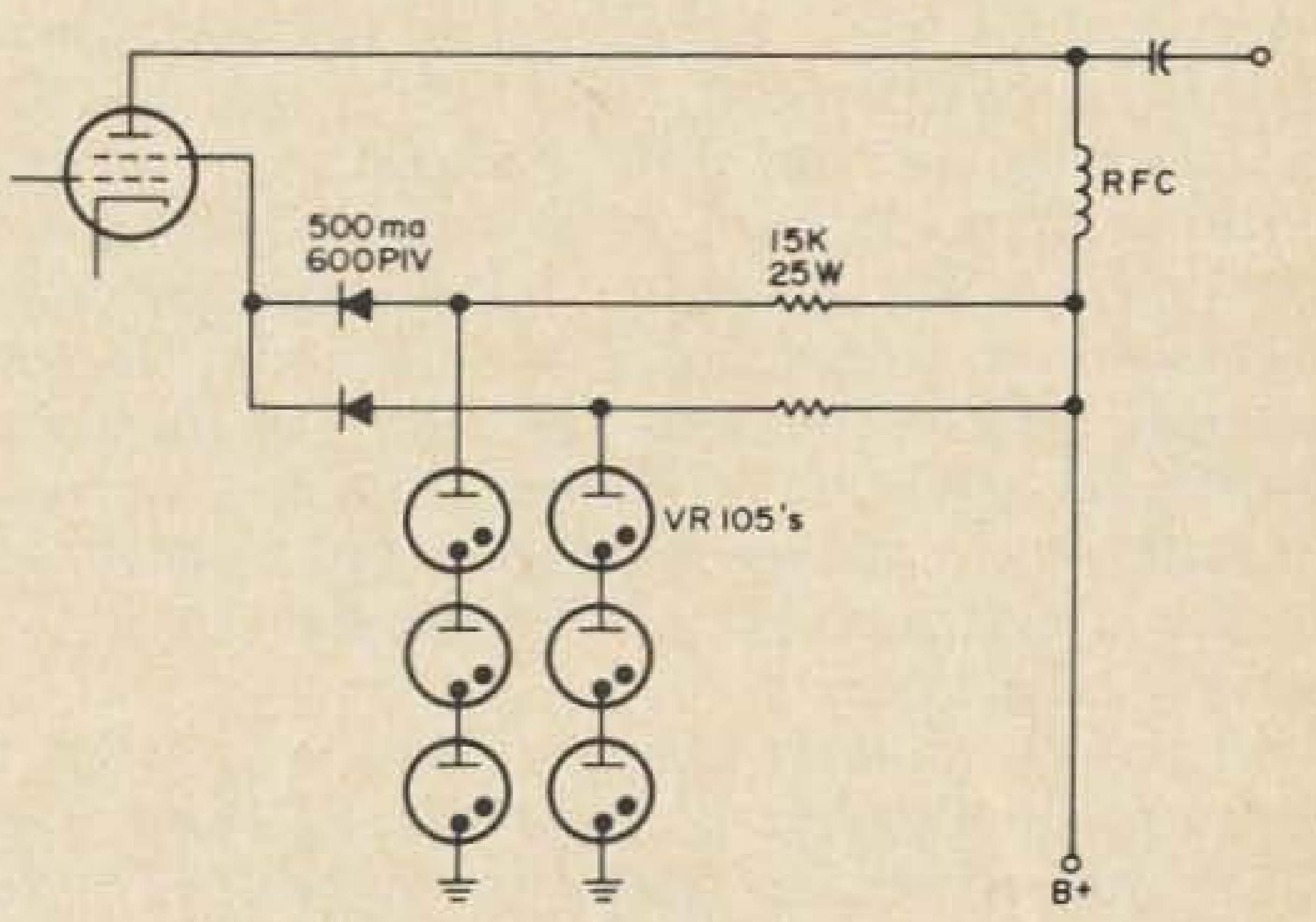
I found this system to be very satisfactory and more effective than other methods I tried to get the line over the limb, such as weight and line and bow and arrow to name a couple. A couple of pointers, however, to those interested in trying it. When tying the nylon line to the rope tie the knot in such a way to lessen the chances for the knot to hang up on the limb. Wrapping the knot with plastic tape helps. Secondly, the polypropylene rope is strongly recommended because of its strength and resistance to weather and rot. It can be purchased at most any sporting goods store.

As I said before, we all might prefer a 100 foot self-supporting tilt-over tower, but as the saying goes, "Beggars can't be choosers."

Norman Ralph W4AYI/5

More Current from VR Tubes

You can always operate VR-tubes in series to get higher regulated voltages, but what can you do when you need more current? If you put the VR's in parallel, when one branch ignites, the voltage is too low to ignite the other. A neat solution was found



while designing a 4X150 linear: 2 diodes solve the problem by acting as switches. We used 500 ma, 600 PIV diodes as they were on hand.

Curtis Goodson, W4QBU

continued from page 2
changes, he has not written to me. For that matter I can recall darned few ever in favor of the first stage. My mail is 100% opposed to further changes. The letters I get complain that the fragmentation of our CW bands has essentially emptied them and that the commercials are moving in. There are far too many of these letters for them to be taken lightly.

The FCC figures on new Extra Class licenses issued are not in any way encouraging. Outside of the few thousand Extras that were originally "grandfathered" in, few operators have shown much interest in taking the test. To be specific, in June 139 Extra Class licenses were issued, in May 133, in April 190, in March 136, in February 145, etc. When you figure that the latest FCC list shows 262,052 licenses amateurs, with about 9000 of these being Extras and only 130 or so being added per month, you can appreciate the total rejection that this demonstrated. It is completely insignificant.

While a large number of amateurs agree with the principle of Incentive Licensing. few appreciate its actuality. They resent having to go back to school and learn a lot of theory that will be of little actual value to them in order to take the new license exam and thus retain the frequencies they feel that they had already earned. They resent having to pay the additional examination fee and having to make the trip to the FCC examining point and suffering the nervousness and tension of the test. They even more resent having to go down a second and third time . . . as a great many do . . . when they fail it the first time. What an embarassment that is!

All this has had an effect on QST, which engineered and drove through the rules changes. Subscriptions have been dropping of at an alarming rate and dissatisfaction with the power elite running the show is getting out of hand. Something must be done, obviously. My guess is that QST has already decided to ask the FCC to put off the second stage of the rules changes and that the board meeting has been called to rubber-stamp this decision. I doubt (wistfully) that the directors have the ability or the influence to bring about the real changes that are needed. Too many of them are deathfully afraid of offending HQ and we will probably see as much rocking of the boat as has been in evidence in the last several years . . . namely, very little.

There is no harm whatever in your dropping a letter to the director of your area (see page 8 of QST) and expressing your own convictions as to the changes that should be made. Should we continue to be split up as we are now or go back as we were to one relatively happy family with equal QRM for everyone? Since the director has no way of knowing for sure whether you are a QST subscriber or not is no reason why you should let this deter you.

There seems to be little opposition to the opening of new bands for the higher licenses. This is consistent with the concept of giving something in return for effort rather than taking it away if the effort is not made. The reward system as opposed to the punishment system. 14150-14200 could easily be opened for phone. How about 7050-7150? 28100-28500? Etc. The gradual change from predominantly CW to predominantly phone operation has not been followed by band allocations and CW is presently allocated frequencies all out of proportion to the occupancy on several bands.

Write the FCC

If you like the present allocations then now is the time to write to the FCC and tell them so. If you believe that the proposed changes for November 22nd will be beneficial, tell them about it. If you feel that the system is all wrong, write to them about that. Make yourself heard.

And just in case QST does have the inside track, they think they have to write to your area director and tell him the same thing.

Public Relations

A survey of the method of introduction of newcomers to amateur radio has shown that most of them have come to us through fellow amateurs rather than through interest sparked by magazine or newspaper articles. This is rather obvious when you consider the vacuum we have had in public relations. You can't tell me that advertising doesn't work. It does work and it works well . . . when it is used.

We need publicity. Publicity is advertising that is free. We have hundreds of fascinating stories to tell and, with a good PR man organizing it, we could have articles in every major magazine and interest thousands of dollars upon thousands of people in our wonderful hobby. QST has hundreds of thousands of dollars just lying around doing no one any good. Some of this money could easily be invested in a reasonable stock or mutual fund and the earnings used to buy PR for amateur radio so we could be sure that our hobby would grow.

QST Investments

A fascinating part of the yearly report from QST is the information on their investments. If I had an investment councilor that turned in the rotten performance they have experienced I would start looking for a sticky finger in the till. They had about $575,000 in cash and securities at the beginning of 1968 and ended up with only $618,000. Since about $35,000 of the "profit" went for inflation, they ended up with peanuts. This was a whole lot better than the year before when they came up with about 1½% profit *before* considering inflation.

At the same time as the QST financial situation was staying put, the stock market was going to new highs. The ISEC model fund rose about 80% during the period and few prudent investors made less than 50% on their investments.

Perhaps, while you are writing or calling your director, you might ask him to account for this situation. This might just goad him into bringing up the matter at the November meeting and getting something done about it. While some investors are making millions out of nest eggs a lot smaller than the $500,000 or so QST has in its pocket, amateur radio is hurting and hurting badly for money to invest in its future.

With money we could have public relations and get amateur radio growing. We could put the pressure on internationally and help to keep our bands at the next ITU conference. We could organize mass shipments of old gear to poverty countries to get thousands of new amateurs on the air around the world. We could even open an office in Washington and thus invest in our survival here at home.

Are your directors representing you or are they merely glorified QST Subscription Agents? Make them do some work! Make them represent you and give you answers to your questions. If they won't work or answer questions, throw them out and get in some that will.

QST Quote on the FCC

September QST says, "...the amateur division of FCC consists of one man who is about to retire and wants no trouble." This is in print! It is in an editorial! This is certainly a strange follow up on the article by W4GF (FCC Amateur Division) in the August QST and requires some explanation. What was their motive in printing this scurrilous item? It is billed as something someone said that someone else said, however since they made no effort to check in any way, we can only assume that in their usual round about way they are trying to tell us something.

My own feeling on the matter is that QST is guilty of exaggeration. Since they do not have an office in Washington and are not representing amateur radio there, dealing with that agency only through a part time attorney, it is obvious that they are dangerously out of touch with reality. The FCC, like any other government agency, will give amateur radio as much attention as it demands of them. When we are almost completely silent we are going to be forgotten and are going to be ignored. This can lead to rules changes which are poorly thought out, like the incentive licensing rules. When, many of us want to know, will ARRL stop spending the members money almost entirely on publishing and start providing some representation? Let's stop taking digs at the FCC in QST and open an office in Washington for the good of amateur radio!

ARRL National Convention Report

Chuck Boegel WØCVU (a very active and well known ham) has been sending us copies of his correspondence with ARRL HQ on the subject of the 1969 ARRL National Convention in Des Moines. He seems to have some very legitimate gripes about the way he and several other well known amateurs were treated at the convention (including the past president of the ARRL). He has gone on to ask for an accounting of the funds of the convention and has so far found his letters ignored by the organizers of the convention and ARRL HQ. The major organizer was, he says, the president of the ARRL, Robert Denniston. I am sure that this must all be a mistake and that ARRL president Denniston will publish the full facts of the financial accounting of the convention. I was disappointed to find out from Chuck that the Eye-Bank net boys were charged $150 for the little room they had to show the work they are doing. If this is true it is shameful. Chuck mentioned having a copy of a letter from Huntoon saying that ARRL does not expect to get an accounting of the funds from the National Convention. Little was given away in prizes, so there should be a handsome profit for the Des Moines Radio Club....or someone. Let's hear more about this one ARRL.

ARRL Articles of Association Waived

Though Article 12 of the ARRL Articles of Association says, "No person shall be eligible for the office of Director, Vice-Director, President or Vice-President who is...commercially engaged in the publication of radio literature intended in whole or in part for consumption by radio amateurs," I see that Ralph Anderson KØNL has made it as a Vice-Director. Since Ralph is publishing two magazines for radio amateurs, both on a commercial basis, complete with ads and subscription fees, perhaps I can run for Director now? Ralph has been accepting paid commercial ads in his magazines for years and, as far as I know, he is presently devoting just about full time to their publication. Full or part time, the magazines are obviously commercial and everyone at ARRL knows it and has, in flagrant violation of the Articles of Association, overlooked the rules. Please ask your Director about this one.

Disaster Communications

In the early days of amateur radio we enjoyed a virtual monopoly as two-way radio operators. In times of emergency there just was no place else to turn for radio communication.

While we still have long range communications pretty well to ourselves, we should recognize that local communications systems are well developed these days and perfectly capable of handling many of the emergencies that used to fall automatically to amateurs.

We can take advantage of this situation, once we recognize it and adjust to it. If, instead of competing or fighting with the other services to provide local communications, we worked to organize them and tie them in with the longer range communications that only amateur radio can provide, the result would be a better total service and a commanding position for amateur radio.

Communications during most disasters requires local coverage to help officials direct the efforts and know what the results are of their directions. Officials from outside the local area also need to know what is happening so they can coordinate their efforts to bring in help and supplies.

While amateur radio might be able to handle the whole situation in larger areas where we have plenty of mobile units to use, in most emergencies we can well use the help of other mobile two-way operators such as CB, taxi, police, fire, doctors, and others. We can provide a very valuable service in coordinating communications between the various two-way users. This might take the form of our placing a mobile or small portable station near the base station of each of the other services so we could use amateur radio as the master communicator.

Perhaps we should recognize that in the event of any serious emergency we cannot depend upon either telephone or commercial power. In many cases it will be up to us to provide power and use our system in place of the telephone.

As a first step toward setting up a workable disaster communications system it would seem to me that an inventory of the equipment, operators and power sources would be in order. Once you know the workings of the other two-way radio systems in your area you will be in a position to coordinate the ham portable and mobile stations for a truly efficient emergency service.

Under normal circumstances an operation like this would be set up under the auspices of Civil Defense. Unfortunately, in most of the reports I have received, CD is in no position whatever to undertake any real coordination. The CD has been operating for too many years with little purpose or organization, with the result that there are few outfits of any real value. No, I think that we would do a lot better if we decided to take the bull by the horns and set up our own emergency system, using our own initiative. If there is enough interest in radio clubs in getting a service like this going I will be glad to have some window decals made for the cars in order to lend an air of officialness to the effort. I suggest that we call those working this end Disaster Communications Coordinators (DCC's) and have a nice red-white and blue DCC car sticker. Comments?

Radio amateurs are the natural leaders for emergency communications because we are the only service that is everywhere and can communicate over any range. Rather than fight or ignore the other services, we should enlist their aid and get them to cooperate with us.

What do you think?

Ham Hospitality

Jock White ZL2GX, 152 Lytton Road, Gisborne, NZ and XYL are glad to meet visitors. Drop them a line if you are getting to the South Island. Jock has a desperate need for a 4D32 in case you have a good spare around. Send it as used and of no commercial value.

FCC Petition

Lowell White W2CNQ has asked that the amateur rules be amended to add some additional frequencies for SSB international contacts and for a carry-over of commercial licenses toward amateur. RM-1477.

Reade Apgar asked the Commission to amend the rules to permit AFSK RTTY 40F2 to be used in the 145.17–145.71, 146.79–147.33, and 220–225 mhz bands. RM-1478.

Paul Lee requested 3775-3800, 7175-7200, 14175-14200, 21200-21259 khz for Amateur Extra. RM-1479.

Sour DXpedition

DX'ers who are nice enough to send in donations for DX'peditions may soon fade away. I'm not speaking of Gus and his fizzled expedition, but of what appears to be a scheme by an American living in Australia to gather some loose donations by promising a trip to rare spots. It seems that Jerry VK2BFI may have taken another whack at the neck of the goose that laid the golden donation eggs with promises in Gus' DX Bulletin to visit VS5, CR8 and 2P1 (?). Now, say the bulletins, no DXpedition and no refunds. Can the goose, already badly maimed by Miller, survive much more of this?

Gus is reported to have finally given up and returned home after a number of attempts to get a repeat of his earlier DXpedition running again. Equipment failures and transportation problems seem to have scuttled him. DX'ers, depressed by the incentive licensing disaster, changes in the DXCC rules, and fake or fizzled DXpeditions, could use some good news about now.

Pay TV

On June 12th the FCC authorized a fifth TV channel for pay-TV in the 80 largest American cities which have four or more free-TV stations. I think that those of you readers who have worked in television or have read much about the inside workings of the business will agree with me that while pay-TV has a lot to offer the broadcaster, it has little to offer the customer in the long run.

Television is in the execrable state it is in today because larger audiences bring in more money. Pay-TV can't be any different. What pay-TV station is going to show an art film of interest to 5% of the viewers when he can show a sex film that will get him 65%? All that will happen is that we will accelerate the demise of our movie theaters. I somehow doubt that we will see many good movies made for television. So far every one I have seen has been dreadful. And how long will it be before we start seeing commercials on the pay-TV stations? We pay $2 to go to the movies and find that we have commercials there now! No, I believe that we will find ourselves very shortly back where we started, but having to put quarters or dollars in the television set to watch the Beverly Hillbillies.

It is possible that the members might want to know a little more about the recent $1500 donated by ARRL to a local radio club. It may well be money carefully investigated, but again, why the secrecy? The club has been run, for many years, I understand, by League officials. I know that I would like to know more about the VHF accomplishments of the club, what sort of equipment has been set up in the past for the club station, where it came from, who operates it, and what success it has had on what bands. Let's hear what the $1500 will be used for and see occasional status reports in QST on the effort.

Writer Beware!

One of our more prolific authors complains that he submitted a manuscript for a booklet to one of the other ham magazine publishers in early 1967. A contract was signed and he was promised that the book would be published by the Fall of 1967. It was not published in 1967. During 1968 he received many letters from the editor promising publication in 1968. It still has not been published and he has been unable to get them to either publish the book or return the manuscript. What can he do?

While we too have been a little slow in publishing some of the book manuscripts that we have on hand, we have paid the authors for them on acceptance. We have been getting a new printing plant ready to produce books right here at 73 headquarters and the final piece of machinery has just been purchased and installed. We now have a Chief 22 printing press, a Rossback collator, a Baumfolder, a Boston stitcher and an Oswego paper cutter. In all we have invested about $15,000 in the new printing facility. Now all we have to do is get it working smoothly and we will have a stream of interesting books coming out for you. Authors, please take note.

RM-1346

Werner Esseluhn K3MGO has petitioned the FCC to establish a new class of license for senior citizens (60 and over) which would permit the use of crystal controlled type-accepted (no homebrew) equipment on the top end of two meters. The requirements would be five wpm code plus asimple theory and rules test. The major purpose of the new license would be to provide an activity and relief from boredom for the senior citizens.

RM-1493

Emery Mitton W6ARM has petitioned the FCC to amend the rules to change six meters so that 50.0-50.05 are for Extra and Advanced, 50.0-53.5 for telephony, and 53.5-54.0 for telegraphy. This would move the virtually unused CW band to the top end of six meters. Why not do away with it if it is not going to be used?

Five Band WAS Award

QST has announced the availability of a five band Worked All States award. This seems like a fine idea to me; I think I've plugged for just that in my past editorials.

The starting date for the award has been set for 1 January, 1970, thus giving everyone an equal fresh start at getting the award. I sure wish that the QST board had not decided to do that. I can see a lot of good reasons for setting the date at 1 January 1969 and a lot of reasons why the 1970 start is bad news.

Most important for all of us interested in DX is the impact that this decision will have on the DX operators. This is a catastrophe for many of them. The five band DXCC started in January 1969 and our DX operators have been working through all of the countries on every band as fast as they can, aiming at that award. The DX ops must cooperate with them in sending QSL's. This means that thousands of DX operators will be well on their way toward WAS by the end of this year on all five bands. They will have invested a stupendous amount of money in those QSL cards. So what happens? None of those cards are any good for the new WAS . . . they will have to start all over again! This will be an unnecessary expense. Why couldn't the date have been made retroactive to coincide with the five band DXCC date?

Those operators in the rarer states will find themselves facing a contest-type existence come January. Most of the fellows contacted in the past will now want QSL cards all over again... duplication...expense...time...and a lot of work.

Would someone like to make a rough calculation of how many cards each operator would have to send out if, say, 10,000 amateurs decide to go for the new WAS award? It will take 250 cards for the award, but each op will have to send out around 25,000 cards or so! Ops in Nevada, Delaware. Vermont, Montana, Wyoming, New Hampshire, etc., had better just buy a small printing press and get ready for the onslaught. Imagine 10,000 stations trying to work you on five different bands!

It wouldn't hurt for you to call your QST director and see whether you can get him to move that date back one year. Or ten.

Typesetting Style in 73

One of the authors got all uptight over a recent change in our style of setting type. We had gone along with the convention of setting electronic notation based upon people's names with capital letters–mA, pF, mV, kHz, etc. Recently I changed to all lower case letters and, sure enough, the angry voice of protest was heard.

Ampere, Hertz, Volta, Ohm, Faraday and the other fathers of electricity and radio have been well honored and I hope that by now very few 73 readers don't at least recognize their names. By keeping their initials in capital letters it seems to me that we are putting off the honor of letting their names go into our language. Lower case "ohm" is generic and is like taking the quotation marks off his name.

Then there is the matter of the readibility of 73 magazine. The texts on type tell us that the frequent use of capital letters slows down the speed of reading and the comprehension of the material. Just look at a page of radio text that is full of capital letters and see how cluttered it looks compared to all lower case type. Italics also slow up reading and we are working on keeping them to a minimum in 73.

It comes down to this, basically. The only thing that is unchanging about our world is change. Change is always with us. Some people fight change every inch of the way, others grudgingly go along with it. For me, I like to initiate change.

When I see something that looks like a good change, I go ahead, even in the face of traditions and convention. Isn't this really the best thing to do?

For the time being we will continue to set our mhz, pf, ma, and such. If you find that this makes the articles harder to read rather than easier, then please let me know. That, obviously, is the final test.

My books on type tell me that the Press Roman type we are using now is by far one of the easiest to read. We can change to a sans-serif type such as Univers (this is a sample of Univers type) such as is being used by Ham Radio, but it would be a lot harder to read. I admit that it looks nice. Please advise.

In the last couple of issues we have started setting our feature articles in a nine point type spaced as if we were using eleven point type. This makes the type a little more spread out than previously and a little easier to read. Editorial articles such as this, Leaky Lines, etc., will be set in smaller type, eight point on a nine point spacing, so that they will take up less space in the magazine than feature articles.

. . . Wayne

NEW BOOKS

Radio Amateur Q & A License Guide

Ameco adds yet another book to its family of publications, this time a question and answer license guide for the prospective novice, technician, conditional or general licensee. Forty-eight pages in length, this informative manual prepares readers for the theory requirements of the above classes of amateur licenses, includes sample FCC-type tests with answers in the back of the book, and contains a wealth of schematics, illustrations and tables. Written by Martin Schwartz, the book is available for 50 cents from Ameco.

Meter Handbook

Prentice-Hall Publishers have spawned another book in their series in electronic technology. The new book is titled *Handbook of Electronic Meters Theory and Application*," written by John D. Lenk.

A worthwhile addition to the technical library of any engineer, technician or amateur, this book in one single volume explains the how's and why's of electronic meters for virtually every known practical application. Solid state and integrated circuit data, practical theory on laboratory and shop meters, testing and calibrating meters, meter principles, servicing components and circuits with meters, in addition to a host of other topics, are well treated in this highly enlightening book. There is a wealth of graphs, schematics, charts and diagrams all carefully selected to provide the reader with the ultimate in simplicity and yet being more than adequate in illustrating each point.

Mr. Lenk who has authored twenty-one other books and hundreds of articles, has put together a well researched, prepared, written and authoritative book on meters which we suggest to every user of meters.

180 pages in length, the book is sold by Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

New Heath Catalog

The 1970 edition of the Heath catalog lists over 300 kits on 116 pages. In addition to their fine line of ham gear they have CB, hi-fi, radio control, color TV, test equipment, and many other kits of interest to the amateur. Write Heath, Benton Harbor, MI 49022 and tell 'em 73 sent you.

LETTERS

Dear Wayne

I just opened the September issue of 73 and read several letters of complaint about the quality level of present-day amateurs compared with the good old days. Well, Wayne, I returned last night with the others of Twin City Hams from four 18-hour-plus days operating our club station WA5WKP/5 at the Gulfport, Miss., Red Cross HQ after Hurricane Camille. You can sleep well with the knowledge that there are plenty of hams all over the country with the true amateur spirit of cooperation and with skills which can stand comparison with those of any professional service. If the critics monitored the traffic and emergency frequencies they would have been impressed with the way the hams almost fought to take traffic and consistently demonstrated their "by the book" procedures. Our group, including several newcomers to ham radio, received the utmost consideration from everyone (with some help from FCC, of course).

No doubt you will have many stories on the disaster from those more deeply involved than me, but one impression which may be of help to those planning for future emergencies is that much more VHF gear was needed than was available for use on other than the rag-chew channels. All available frequencies were jammed on all bands, and everyone had top priority traffic.

For a long time, amateur radio was the only means of communication in the stricken area. Ham radio did an excellent job and all who participated, even by just standing by, are to be commended. Their efforts were truly appreciated by the people who needed their help. Ham radio's reputation is high in Camille Country.

Frank M. Boyd WA5QVN
713 Hinke Drive
Monroe LA 71201

Dear Sirs,

In reference to "Leaky Lines" and "What Are We Here For' in the August 73, I would like to put in my thoughts. These articles are quite true, but have you ever listened to the Novice bands lately? On 80 it is QRM, QSB, RTTY and blank carriers being tuned up. Ditto 40. Forget 15. The Novice is so neatly boxed in and hampered and harried no wonder many would-be hams drop from the bands as their licenses expire.

My call letters tell what I know about ham radio (No Blinking Knowledge) and I make no denials that my copy is probably still 5 wpm. It is just that when a higher class operator zero beats my signal, calls me, and then goes into a 20 wpm frenzy, I want to give up. To my request to please QRS comes back, "Get the hell off the air, lid." It comes back slow and precise. I keep trying and appreciate the consideration and understanding of those who take the time to contact me and the thousands of others like me. I am almost always QSK and, for those who don't know what QSK is, you are not up to my level. Those who are anti-ARRL, CW, SSB, AM, FM, RTTY, hear me! I don't particularly agree with the ARRL policies, but those two articles should mean something to some of you so-called amateurs. The goings-on on the air should make you sick. Techs going to get onto your precious ten meter band? Maybe, but at the moment CB and business radio are after it ALL. Why? They have the most people and need to expand. You wonder what happened to 160M and 11M? You so-called amateur! Your ticket means so much. ARRL has its faults, but the real responsibility lies with you and only you. That's right, sit back and gripe, you've paid your dues and the ARRL will set everything right. I hope that ten will go CB, maybe then even the rankest of amateurs will get up and shout—will become active in the amateur affairs. We have played footsie too long with our precious amateur allocations as well as our civic responsibilities. You'd better get with it, Mr. Amateur or your hobby will go QRT.

Robert Addy WN4NBK
Sav. Terrace Apartments 27D
North Augusta SC 29841

Dear Wayne,

While reading the article on WWV in the September issue, I noticed that the coding system given is the old system which has been replaced by a newwer one. Readers desiring more information can get a 14 page booklet entitled "NBS Frequency and Time Broadcast Services" for 15 cents. Write to the Superintendent of Documents, Government Printing Office, Washington DC 20402 and ask for Sepcial Publication 236.

Lee Blanton WA8YBT
10495 Deerfield Road
Cincinnati OH 45242

Dear Wayne,

Good Grief! You wasted five good pages on amplitude modulation in September. Come now—who would use Taylor Modulation on VHF? FM is the way to go, and it does not have to be rock bound either. Even CB'ers wish they had something else instead of AM to work DX with—as they do, day in and day out.

WB6LNS/4
326 Brady Drive
Warner Robins GA 31903

Dear Wayne,

First, I must congratulate you and your staff for publishing the most exciting, interesting, and informative ham magazine available. All others are cheap imitations.

About a month ago, I sent in subscription blanks to 73, and CQ. With both, I said, "Please bill me later." From CQ I received my letter and its envelope, and a notice saying they (CQ) don't have a billing policy. 73 sent me the August edition, making me thankful for the existence of a superior magazine (73).

Your articles on gaining your Advanced, and Extra Class licenses are second to none. They are the most informative articles ever written. I think they will greatly influence incentive licensing. Your articles are so easy to understand, I am eager to sit down and learn from them. Understanding the material gives me a sense of accomplishment. This is the boost which will get me my Extra, not band shrinking by the FCC, or the stupid actions of the %!$&!! ARRL.

Dave Eischens WA2CAF
46 Round Hill Road
Poughkeepsie NY 12603

Dear Wayne,

I subscribed to your 73 magazine recently and am quite impressed. There are three projects that I would like to see in 73. These are super-regenerative receivers for the citizen's band, for six meters and for two meters, all to be operated on 12 volts mobile. This type of receiver has many advantages and I am looking for schematics.

Vern Swedberg K9GZI
10943 South Albany
Chicago IL 60655

Sounds great for CB, but I'm not all that sure that we need more super-regens on two and six. They might be okay with pre-amps. Any readers have this worked out for Vern? Send 'em in and we can pass the circuits on to all.. ed.

Dear Wayne,

As per your request in September 1969, 73, may I submit the following information.

"Code and Theory instruction are offered by The El Cajon Amateur Radio Club, 1113 East Madison Ave., El Cajon, CA 92020."

We invite anyone from the greater San Diego Southern California area to visit with us. Regular meetings are held on the 2nd Thursday of every month where class times and schedules will be available.

Last year was our first attempt at this project and we netted 10 new Novice, one of which was my own XYL.

Thank you and 73 for your interest in developing new amateurs.

Robert Smith WB6ODR
Vice-President
El Cajon ARC

Dear Wayne,

Wow! 35 stories in one issue. Wowee. The other magazines will have to improve because of you.

George Bonadio W2WLR

Dear Sir,

Your August 69 issue was a damn good one; It finally convinced me I should subscribe. Bet you can't keep up the pace.

Joe Buswell WA5TRS
Box 10674
Midwest City, OK 73110

If the articles keep coming in we will make the magazine even bigger...ed.

Testimonial:

This letter is addressed to all non-writers. I am a non-writer.

Just a very short time ago acceptance for an article came in the mail. The number of dollars per man-hour of research, write and rewrite time was low, but it looks like the fringe benefits are the payoff. When the notification of acceptance comes home the impact on you is great, but the impact on others is out of this world. Where once they "laughed when you sat down to type," the typewriter is left in a convenient place with cleared chair and blank paper. You sit down to tiddle with the keys a little and the house becomes quiet where you are. In a little while someone brings you coffee (or tea) and asks if everything is okay.

The guys at the club and on the job look at the acceptance verification form and change their minds a little about you. At least they say so–which becomes the most beautiful music you ever heard. Suddenly people begin to wonder what they have said or done that you might write about next. People are nice if they think the whole world will find out if they are not.

When your paper is published, then come the invitations to speak, to lecture, to give interviews to a greater or lesser degree. This gives you a little taste of celebrity action.

So, if this sounds good to you and you want to "become a prophet in your own country,' write! Every ham has to have some brains and probably is involved in something that would be of interest to other hams. Write about it and send it to 73. This Green guy is just smart enough to print it–and I want to read it. If he keeps printing this stuff the magazine will become one of the Must Magazines for every High School and College library in the nation. And for the future of ham radio that can't hurt....and that is an understatement.

Bill Hounsell W5OUK
220 Fannin
Refugio, TX 78377

Not a few authors have written to say that their articles in 73 went a long way toward getting them a better job... ed.

Dear Wayne,

I am interested in being on the T.A.G. for your new Novice magazine. I can handle General Help, and "Problems with Rigs."

Readers with questions *must* send a SASE! I use up enough money for QSL stamps!

The Advanced Class book was great! I finished my Advanced in half the time I used on the General (and passed)!

Jon Teich WB2JAE
22 Olden Road
Edison, NJ 08817

Dear Wayne,

I have some suggestions for the authors in 73. What do hams use? By an overwhelming majority they use "appliances." So why not make your magazine different from the 1920 type QST by featuring articles on manufactured gear? How about articles on how to keep from burning up your horizontal oscillator finals in less than seven seconds–the best way to get a store-boughten receiver, transmitter or transceiver–ham transmitters and receivers from around the world–shipping: REA, PP, bus, UPS or the various air deliveries–contents of an appliance operator's tool kit–antennas–how I established a good ground system–the 34NB noise blanker–souping up the Swan 250–how to get a 100 foot mast up when you're on the road from Friday until Monday or vice versa–test equipment–broadband receivers–-how to tell if your finals are soft–how to align your transceiver–what to do if your new equipment arrives all beat up and not insured–fixing up that old KWS-1–what each company will do under the terms of its warranty–window ledge antennas for 10-15-20– let's upset the ARRL by getting them to take a poll via QST on important issues such as incentive licensing–the scent is obnoxious, you know–how do ham radio stores decide the trade-in figure they give you–how to make a cheap VHF or UHF receiver–where to locate the ham shack (from the XYL's point of view–what country is KC4USV/KC4 in?–why I can copy much faster in my head than I can write or do on the mill–tri-band yagi vs a good 40M quad–can 75M ever be retrieved from the over-redundant nets?–-the increasing presence of retired hams on the bands and why didn't they choose something else?–hamming with a pickup camper–with a trailer–mobile home–TVI cases and litigation–-census of hams who also use CB–operating a rig from your office–how to work out TVI with a neighbor.

There are many more subjects, but it is now Saturday afternoon and I have to go down to the office and open it up to see a child who has had diarrhea for two weeks....should adults be allowed to have children?

Arthur Woods W4GJW
201 Second Avenue SE
Cullman AL 35055

With 40 articles or so a month we can certainly use info on all of those items you suggested Art. I hope this will get some prospective authors busy at their typewriters.. ed.

Dear Wayne,

Why did you print the letter (Sept. '69 issue) from Mr. Diamond, "Radio KALX?" The man quite patently doesn't know what he's talking about. Please be advised that the Amateur Extra Exam is on a par in every way with the Commercial First Phone Exam; in fact, most of the exam material is the same.

Furthermore, the average amateur ticket holder got his Extra (or other license) on his own, via the school of Hard Knocks–not through formal education, or a correspondence course that guaranteed "a first class license or your money back." I know many First Phone men who are first class dunderheads, including many low-paid, so-called "Chief Engineers." The First Phone license just doesn't hold that much prestige!

I do agree with Mr. Diamond on one point, however: Ham radio seems to have lost its charm and its pride, now that it's relegated to the manipulation of dials on a transceiver–but to say that the amateur exam is "hardly a test at all" compared to the First 'Phone exam, is pure drivel.

O. R. Heinz III K7KHA
2530 Tybo Avenue
Reno, NV 89502

Dear Mr. Green:

The article "What Are We Here For?" by Mr. Grenell, ex-W8RHR, in the August issue was quite interesting. Many articles have been printed relative to amateur radio's continued existence; however, this gets closer to the bone than any I have seen thus far.

I have been a "paid communicator" since 1955 and obtained my amateur call during the summer of 1968. Presently, I am involved in emergency communications planning for the state of Texas and, as such, have also inherited the position of State RACES Radio Officer.

The many magazines and periodicals crossing my desk continually plead for relief of the crowded rf spectrum. Professional communications journals tell of the efforts made by the broadcast industry to prevent the take-over of their part of the bands. High-powered, high-paid individuals are arguing in defense of the TV spectrum loss which seems inevitable. It isn't just loss of spectrum which concerns them; it is bread-and-butter. Money seems to be of less concern than ever before to these individuals and corporations fighting in a last ditch effort.

With all this resistance (not in ohms) being met, will the FCC look elsewhere to provide frequencies which are sorely needed?

J. R. Messenger WA5VTO
Technical Operations Officer
Texas Department of Public Safety

Dear Wayne,

Last night I browsed through the September issue and was REALLY impressed. Especially by the "Light Naturally Runs Down" article. I would rather see material like that in 73 than in the Scientific American where one might naturally expect to find it. This is the kind of article that will impress my generation simply because it stimulates the imagination (not trying to sound trite).

Bill Kellogg
10000 Rushing Road
El Paso, TX 79924

Grounds

Dear Wayne,

I have been reading 73 Magazine since you started and can say without reservation that it has the highest caliber technical articles of the "big three." This is the first time I have felt compelled to comment critically on anything you have published. I work as a consulting engineer, specializing in the area of electro-magnetic interference, and you would be surprised how many engineers and multi-degreed scientists do not understand grounding and shielding, how it works, or the techniques involved in interference suppression. Even in today's sophisticated missile and space programs, some of the worst problems occur because of where, what, and how to ground. If the "pros" can get fouled up with their grounds, it is not surprising that a lot of mis-impressions exist among amateurs.

W2EEY/1's article in the September issue describes a very practical method of checking shield effectiveness. The communications receiver is probably the best test instrument the ham has and I would like to see other articles on its uses–such as in locating parasitics in transmitters, locating leaks in rf shields, etc. However, he does create the impression that all currents induced in a shield are bad, and that single point grounding is the greatest thing since canned beer. Unfortunately, it's not that simple–and that's what keeps me in business.

Single point grounding is most effective in low-level, direct-current servo mechanisms and instrumentation systems where "ground loops" cause unbalance, bias, or off-set errors. It is important to remember that the culprit here is not magnetically induced current in the shield, but minute voltage differences between the ground tie points which result in a current flow along the shield, which in turn induces a voltage into the signal conductor. (The shield is seldom used for the return circuit.)

Single point grounding is also effective in audio frequency and power circuits, but as frequencies go up, the effectiveness of the single point ground goes down untill we reach radio frequencies where it is often worse than no shield at all!

In using single point grounds (such as in phone amplifiers or audio stages of a transmitter) it is pretty much cut and try as to which end of the shield to ground, but usually it works best to ground shields at the source end for low-level signals and at the load end for high-level signals.

Since many audio circuits are susceptible to rf pickup, it may be necessary to provide protection from both types of interference. One method is to ground one end of the shield (audio) and by-pass the other end with a .01 μf capacitor (rf). Definitely *don't* use an rf choke (per W2EEY) unless you plan to use the shield, adding the rf shield over the audio shielded cable (with insulation between, of course).

In rf work the effectiveness of a shield is directly related to how "close" it is to "ground." This is why so much emphasis is place on long ground rods, heavy copper or aluminum busses for bringing ground into the shack, and making solid, short, low-resistance connections to it. In rf grounding, the closest and shortest is the best.

To illustrate why multiple point grounding is used in rf work, visualize a shielded wire, carrying a signal, but with the shield *not* connected in any manner whatsoever. An interfering magnetic field can pass through the shield as though it were not there, and induce an interfering current directly into the center conductor. Now ground both ends of the shield and we have a completed path where the interfering signal can induce a current flow in the shield. This current is accompanied by its own magnetic field which is such as to cancel or neutralize the interfering field *inside* the shielded cable. The result then, is that the current due to the interfering field flows harmlessly to ground instead of in the center conductor. What does this do to the signal current in the shield? Nothing. If you want to talk "skin effect," the signal current is on the inside surface of the shield and the interfering current is on the outside surface. But it is easier to just parody Gertrude Stein and say, "A ground is a ground is a ground . . . ," rf ground that is. So endeth the reading of the lesson.

Earl Burdick WA6BDN
1620 Benedict Canyon
Beverly Hills, CA 90210

Dear Wayne,

I believe I might have accomplished a "first" for amateur radio. You be the judge of that

While operating in the South China Sea I held a 30 minute QSO on July 29, 1969 using my call K7WPC/mm and worked WB4KST/mm on the USS Merideth. On July 27th (first QSO!) I worked WA2YQB/mm aboard the USS Biddle. Our frequency: TEN khz. Our distance–about one mile. The rig was a pair of 810's to a transducer (Navy name is the AN/UQC-1, called the "Gertrude!" The mode was both CW/LSB, about 1200 watts. The medium, of course, was water instead of air. How about that for a QSO? Whether or not it is a first for us, somebody may get a laugh out of it.

Scott Gray K7WPC
AS Div. c/o FPO
San Francisco, CA 96601

Dear Sir:

I would like to thank you for the terrific work you have done on the Advanced Class Study Course and now the Extra. Because of you I got my Advanced license.

John C. Koning WB6VQE
4680 Crestview Drive
Norco, CA 91760

Gentlemen!

The members of The Mid Island Radio Club are shown here . . . top row–WB2MBU, WA2LJS, WB2CZL, K2LCK, W2MFI, W2PLQ. Middle row–WA2CSE, W2OIE, W2SEU. Front row–W2SMQ, W2VL.

The Mid Island Radio Club, formed in 1946, is active in Teletype, HF, and VHF, and meet on Sunday mornings, at 1000 around 3940, and at 1030 on 146.52 with RTTY and AM modes. Members meet twice monthly at members homes. The Club has been active in supplying Teletype equipment to NY hams through an arrangement with several major common carrier communications companies. When available, such equipment is distributed for a nominal fee for transportation costs. Information on equipment availability is disseminated thru the Club nets. Contact any member for information on membership or equipment.

Bill McNally WB2MBU
Secretary, Mid Island Radio Club
35 Laurel Street
Floral Park, NY 11001

Anyone else Novicing people?

Later Findings

Gentlemen:

Since the "Super Gain Antenna for 40 Meters" (October 73) was written, more sophistication has been applied to the evaluation of the antenna. In the article, I had only S-meter signal strength measuring capability in the HF bands, and although I tried to keep the receiver calibrated, it varied considerably. Out of necessity, I developed rather sophisticated antenna gain measuring instrumentation which measures true antenna gain, including ground effects, losses in the installation site, and reflection gain. This instrument is a synchronous comparator, which compares the antenna under test, to a reference antenna, 60 times a second, and measures the long term integrated signal difference from the two antennas. The instrument is capable of 1/4 db accuracy, provided each antenna is exactly adjusted to precisely the same impedance at the comparator, so there are no reflection losses. An rf bridge is used to adjust the antenna impedances accurately.

Using this instrument I found that the description of the antenna in my article is a reasonable representation of performance when compared to antennas that are relatively high above ground, as is usual for DX antennas. Further data using a conventional high radiation angle antenna for reference is given later.

Effect of Reflectors

Accurate gain measurements revealed that the 3 wire reflector version is not perfect, since the ground reflection is enough different from perfect to decrease gain by about 1 db. A perfect reflector is 2" mesh screen covering the ground. A five wire reflector system comes within about 1/2 db of perfection, however. The biggest effect of inadequate perfection in the reflector is in shifting the electrical length of the driven element. With a 3 wire reflector the driven element is appreciably shorter than usual, and the length for resonance gradually lenghtens as more perfect reflection is attained, until about 13 wires, spaced a foot apart are laid down. With the 13 wire reflector, or with a chicken wire screen, 12 feet wide, under the antenna, the length is very close to that normal for a high dipole.

Gain is "all there" with a five wire reflector, but the resonant length of the driven element is still shortened, and the degree of shortening is easiest found experimentally. Therefore, more than five wires spaced about three feet apart is not really necessary.

Incidentally, according to wave theory, reflecting wires spaced 1/10 wave apart are seen as a solid reflector by a wave, and a reflector made of wires of .05 wavelength separation is not normally discernable from a solid metal reflector. However, my measurements with the antennas here, show that if a lossy or reactive material is immediately behind the reflecting wires, then the wires must be about .01 wavelength apart to completely shield the lossy material. With an inadequate reflector, there appears to be a strong image from the reflector wires sufficient to obtain almost all the gain possible, but a weaker image from the unshielded ground is still capable of shifting the electrical length of the dipole.

In summary, it all boils down to this: A 3 wire reflector works pretty well provided you use the correct dipole length specified in the article. Five wires give all the gain you'll get, and requires a slightly longer dipole, and 13 wires, or a chicken wire screen is the ultimate, and requires a regular length dipole.

Performance vs. an Optimum Height Dipole

While the gain of this antenna is considerable when compared to a high antenna, I decided to test it against a reference dipole antenna with height optimized for vertical radiation. A half wave dipole a quarter wave above ground is the best antenna for vertical radiation that is described in the literature. The pattern maxima is straight up, which is just what is required.

Regular antenna theory shows that such an antenna 1/4 wave about a perfect reflecting surface has a gain of 5 db above a dipole in free space. (This gain is attained only straight up into the sky, however.) So, I constructed a folded network, and compared many, many signals received from all over, via the two antennas, using the synchronous comparator. The super gain antenna consistently had about 2 db gain over this optimum height dipole, and rejected long distance QRM about 3 db better than did the reference dipole. Incidentally, hidden away in all these data is proof of the fact that a high antenna has large effective gain for long distance signals, ranging up to about 20 db when the ionosphere is weak and won't bounce high angle signals, and the converse fact, that a low antenna has large gain over a high one for short to moderate distance work.

For those hams with a venturesome soul, an inexpensive 40 meter super gain kit will be made up in small quantity to speed you on the way to trying this efficient new antenna concept. Features of the antenna are nice gain, and no need to rotate it. Since your signal bounces almost vertically off the sky, it's practically omnidirectional. Stations on the ground are looking at the image of your antenna in the ionosphere some 200 miles up and due to the high angle involved, they see the broadside of the image regardless of compass direction relative to the dipole on the ground. In addition, and antenna this close to the ground with such high efficiency and gain has some obvious advantages to hams, not the least of which is easy concealment.

E. Dusina W4NVK
571 Orange Avenue West
Melbourne, FL 32901

Dear Wayne,

If the ARRL provided its members with any of the services that most national societies provide, I would pay $10 gladly, but the ARRL's main job seems to be to put out a magazine and kill off competition. Renew my membership? When Hell freezes over!

Mike Czuhajewski WA8MCQ
Route 3
Paw Paw, MI 49079

Wash your typewriter out with soap . . . ed.

Dear Wayne,

It took incentive licensing to get me into ham radio and I expect to go for Extra Class when I pass the two year limit next August. I'm loyal to ARRL, CW, traffic handling, the low frequency end of 80M and my American Morse heritage. But I like your unpompous, irreverent style, your fighting spirit and your magazine. I don't expect to find you at the Antique Wireless Association conference October 3-5, but I think it would be very interesting if I could.

Dick Loveland WA3LAK
6808 Henry Avenue
Philadelphia PA 19128

I'll be on a hunting trip in Canada, sorry!

(continued on page 70)

NEW PRODUCTS

Gonset GSB-201 Mark IV

The GONSET division of Aerotron, Inc., of Raleigh, North Carolina announces the new GSB-201 Mark IV, Grounded Grid Linear Amplifier for the Amateur Radio Service.

The GSB-201 Mark IV is capable of the maximum legal input of 2000 Watts of peak-envelope power in the 10, 15, 20, 40, and 80-meter bands. Four husky carbon anode type 572B tubes are employed, together with long life silicon diodes in a full wave bridge power supply (not voltage doubler). A built-in bias & high voltage supply is featured, together with a universal antenna changeover relay, with unique circuitry that permits it to be used either for transceiver use, or independent receiver and transmitter-equipped stations. In addition, the built-in power supply may be used either on 110 or 220 Volts 50/60 hz. A built-in cooling fan operates only while transmitting.

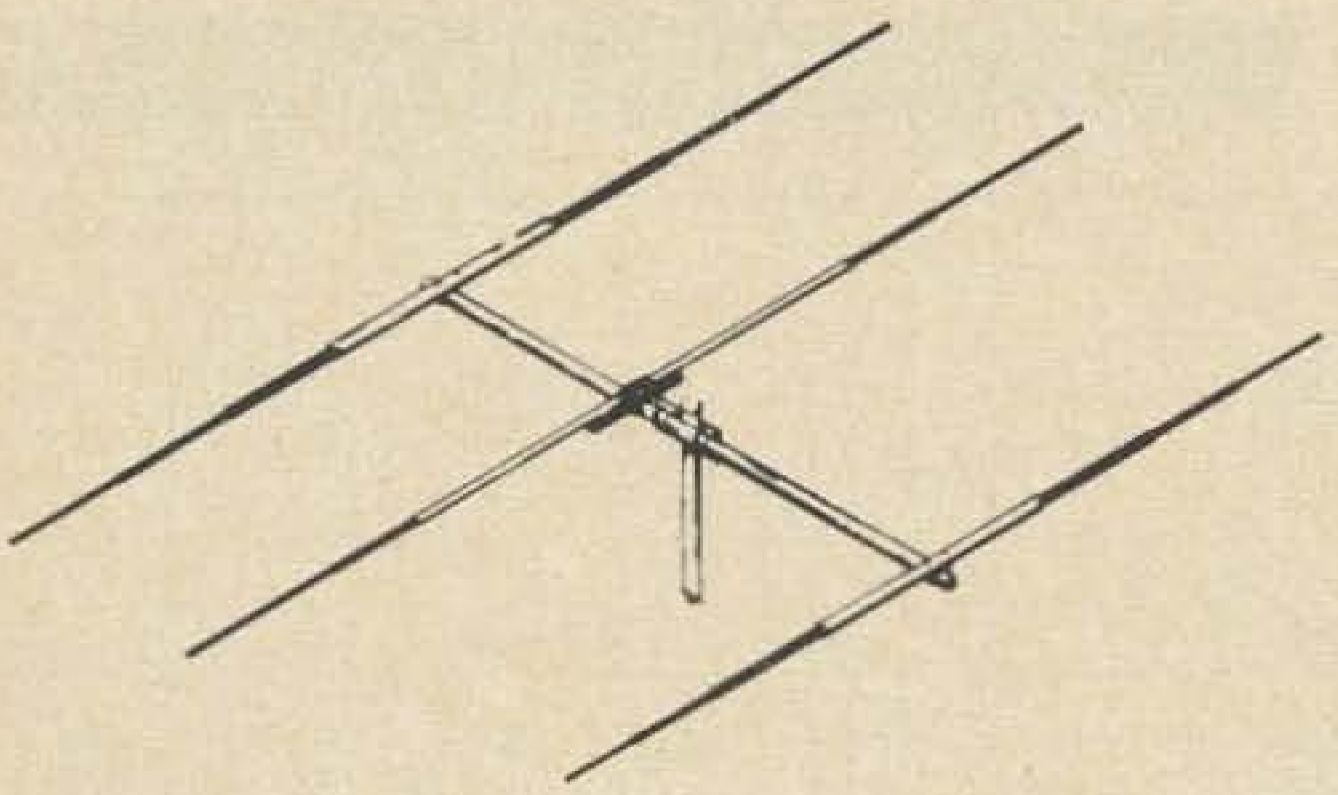
No additional or external relays or power supplies are required when the unit is used either with transceiver or separate receiver-transmitter-equipped stations. The GSB-201 Mark IV is 8½ inches High.....12 5/8 inches Wide.....17 inches Deep...and weighs 73 lbs.

Descriptive literature for the GONSET GSB-201 Mark IV Linear Amplifier is available from Aerotron's "Award-Winning" plant in Raleigh, North Carolina.

Galaxy FM-210

Galaxy Electronics has announced their new two meter FM transceiver which will net at just under $200. This unit should help spark even more interest in FM. This transceiver is fully solid-state, with an FET front end. It operates from 12 volts. It runs five watts input and has three crystal controlled channels. It will run either narrow or wide-band FM. An accessory power booster (10 watts input) is available for $40 extra. Watch for the ads or write to Galaxy, Council Bluffs IA 51501 for info. What can it hurt if you give 73 a little mention?

Mosley Single Band Beams



Mosley Electronics has announced two new single band beams, the Classic 10 and the Classic 15. These both use the new Mosley patented balanced capacitive matching system, the Classic Feed. They have a forward gain of about 8 db and a front-to-back ratio of about 20 to 25 db. 52 ohm feed and a kw rating. Weight is about 21 lbs. and 30 lbs. Priced at $57.64 and $66.50. Both beams are broadly resonant and can be used over the entire bands without difficulty. Write Mosley for full details. 4610 N. Lindbergh, Bridgeton, MO 63042.

Printed Circuit Boards Available

Dirck Spicer, 11 Ridgeland Road, Wallingford, CT 06492, has printed circuit boards available for the WB6BIH Stable HF VFO, July 73, page 128. The three boards are available from Spicer for $4.50 and are for use with a Heath DX-40 or any other crystal controlled transmitter. Ask for number 10221.

Spicer also has 10231 available at $2 postpaid, the Novice FET converter from the December 73 (1968). The Super Simple VFO in the July 73 (page 71) is only $.35 pp.

PROPAGATION CHART

J. H. Nelson

November 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
						1
2	3	4	5	6	7	8
9	$\boxed{10}$	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	3A	7	14	14	21	21
ARGENTINA	21	14	14	14	7	7A	21	21A	21A	21A	21A	21
AUSTRALIA	21	14	14	7B	7B	7B	7B	14A	14A	14	21	21A
CANAL ZONE	21	14	7	7	7	7	14A	21A	21A	21A	21A	21
ENGLAND	7	7	7	7	7	7A	14A	21A	21A	21	21	14
HAWAII	21A	14	7B	7B	7	7	7	7B	14	21A	28	21A
INDIA	7	7B	7B	7B	7B	7B	14	21	14	14	14B	7B
JAPAN	14	14	7B	7B	7B	7	7	7	7B	7B	14	21
MEXICO	14A	14	7	7	7	7	14	21	21A	21A	21A	21
PHILIPPINES	14	14	7B	7B	7B	7B	7B	7B	14	14	14B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	14B	7	7B	7B	14	21A	28	28	28	21A	21
U. S. S. R.	7	7	7	7	7B	14B	14A	21	21	14	14	14B
WEST COAST	21	14	7A	7	7	7	7	14	21	21A	21A	21

CENTRAL UNITED STATES TO:

ALASKA	21	14	7A	7	7	7	3A	7	14	21	21	21
ARGENTINA	21	14	14	14	7	7	14	21A	21A	21A	21A	21
AUSTRALIA	28	21	14	14	7B	7B	7B	14	14A	14	21	21A
CANAL ZONE	21	14	7A	7	7	7	14	21A	21A	28	28	21A
ENGLAND	7B	7	7	7	7	7B	7B	14A	21	21	14	14B
HAWAII	21A	21	14	7B	7	7	7	7	14	21A	28	28
INDIA	14	14	7B	7B	7B	7B	7B	14	14	14	14B	7B
JAPAN	21	14	7B	7B	7B	7	7	7	7	7B	14	21
MEXICO	14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	14B	7B	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	7	7	7	7	14	21	21A	21A	21A	21
SOUTH AFRICA	14	14B	7	7B	7B	7B	14	21A	28	21A	21A	21
U. S. S. R.	7B	7	7	7	7B	7B	14B	14	14A	14	14	14B

WESTERN UNITED STATES TO:

ALASKA	21	14	7A	7	7	7	7	7	14	14	21	21
ARGENTINA	21	21	14	14	14	7	7B	14A	21A	21A	21A	21
AUSTRALIA	28	28	21	14	14	7A	7B	7B	14	14	21	21A
CANAL ZONE	21A	21	14	14	7	7	7	14A	21A	28	28	21A
ENGLAND	7B	7B	7	7	7	7B	7B	14	14	21	14	14B
HAWAII	28	28	21	14	7A	7	7	7	14	21A	28	28
INDIA	14	14A	14	7B	7B	7B	7B	7B	14	14	14	7B
JAPAN	21	21	14	7B	7B	7	7	7	7	7B	14	21
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21A
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7B	14	14	14	21
PUERTO RICO	21	14	14	7	7	7	7	14A	21	21A	21A	21A
SOUTH AFRICA	14	14	7	7B	7B	7B	7B	14	21	21	21A	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	7B	14	14	14	14B
EAST COAST	21	14	7A	7	7	7	7	14	21	21A	21A	21

A—Next higher frequency may be useful this period
B—Difficult current this period

Caveat Emptor?

- ★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.
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- ★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.
- ★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.
- ★ For $1 extra we can maintain a reply box for you.
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GET YOUR "FIRST!" Memorize, study—Command's "Tests-Answers" for FCC First Class License. Plus—"Self-Study Ability Test." Proven. $5.00. Command, Box 26348-S, San Francisco CA 94126.

NOVICE THREE-BAND DOUBLE INVERTED-VEE: Tuned assembled SWR. Under 1.5-1 15-40-80 Novice bands. W3FQJ Design, $15.75. Antenna Products, Box 276, Warrington, PA 18976.

NC-121 RECEIVER with manual, like new, $40.00. Ameco PCL-P preamp, $19.00. Clobe Chief Xmitter, $20.00. M. Severson WØHE, 301 W 17th, Hutchinson, KS 67501.

SCR (GE C50F) 110 Amp. 500 PIV mounted in insulated sub-assembly with 1 N250B, $12. Jon Lusk, 2871 Birch Hollow Dr., Ann Arbor, MI 48104.

RBL-3 VLF RECEIVER 15 to 600 khz, $20; 10B SSB transmitter and VFO, $55; unused Beachmaster 250 watt pa amplifier, $60; Gonset 88-108 mhz car FM receiver, $25; RCA antique AC receiver, $10; TS-155C/UP signal generator, approximately 3 kmc, $8; Finco 6&2 meter beam, $10; $5 each: unused BC-604DM; BC-620A; T39-APQ9, 10 watts on 420; 12 to 1000 volt dynamotors; Central Electronics "A" receiver SSB convertor; Wilcox 308B VHF aircraft receiver; Dynamotors, $2.50 each: 12-250; 6/12-500 volts. Cannot ship all items. SASE for details. Jim Hill W6IVW, 26107 Basswood, Palos Verdes Peninsula, CA 90274.213-378-4411 not evenings.

HIGHLY CORROSION RESISTANT Stainless, Brass, Bronzes, threaded, washer, Hardware for Antennas-Towers, Equipment building. Many Antenna, Guying, Accessories. Lists—Dime! W8BLR, 29716 Briarbank, Southfield, MI 48075.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $2.50 postpaid. Elliot Buchanan & Associates, Inc., 1067 Mandana Blvd. Oakland, CA 94610.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1.00—or 10 holders $3.00. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, TN 37066.

FOR SALE—SWAN 250 & 117 Power Supply, $350 or best offer. Henry Darrell KØLXU, 2506 64th, Kansas, KS.

WRL's USED GEAR has trial-terms-guarantee! 75S1—$299.95; G50—$159.95; SR150—$299.95; HW-12—$89.95; Swan 250—$279.95; DuoBander 84—$119.95; NC200—$249.95; SB34—$299.95; Valiant—$149.95; Ranger—$99.95; Galaxy 300—$139.95; Galaxy Vmk2—$299.95; many more. Free "blue-book" list from WRL, Box 919, Council Bluffs, IA 51501.

NEMS-CLARKE RECEIVERS WANTED. 1400 Series crystal controlled telemetry models covering 215-245/260 MHz preferred but all models in 1300, 1400, 1500, 1600 and higher numbered series also of interest. Please send accurate description of what you have to TUCKER ELECTRONICS CO., POB 1050, Garland, TX 75040.

TWOer, UNMODIFIED, CLEAN, Mike Rocks, Accessories, $35.00. BC-639-A, RA-42-A, Excellent, $50.00. Send for list Surplus, Commercial Material. W6KEC, 320-A S. 2nd Ave., Arcadia, CA 91006.

IBM COMPONENT BOARDS, 3 x 5 in., 6 for $1.00. Cash or M.O. only, include 50¢ postage. Terry Kepner, Box 17038, Tucson, AZ 85710.

CHEYENNE, COMANCHE, AC SUPPLY, $100.00; Vancouver Radio Lab. General Coverage Receiver, $50.00; J. Custy, 4011 Royal Ave., Montreal 261, Canada.

SAROC NEW QTH Stardust Hotel new QTR February 4-8, 1970. Cocktail parties hosted by Ham Radio Magazine, SWAN and GALAXY. Additional information and Stardust Hotel special SAROC room rate card QSP SASE SAROC, Box 73, Boulder City, NV 89005.

WANTED: MINT 80-10 linear, HW32, Heath 3" scope, Ameco pt preamp. Sell: 90 ft. heavy duty tower. Give full particulars, K3WI4, Waymart, PA 18472.

"TOWER HEADQUARTERS!" 11 brands! Heights aluminum 35% off! Strato crank-ups, low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog—$.20 postage. Brownville Sales Co., Stanley, WI 54768.

OPPORTUNITY for Linear Integrated Circuit Design Engineer, San Francisco Peninsula. BSEE, recent monolithic design experience required. Send resume to: Box 921, Cupertino, CA 95014.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for largest event in northeast, May 16, 1970. Write WNY Hamfest, Box 1388, Rochester, NY 14603.

TEST EQUIPMENT: HP 524 D counter, $495; HP 400 DR VTVM, $45; Dumont 401 BR, $150; Tektronix RM 15, $400. All equipment in excellent condition. D. G. Wilson W6GOT, 2036 Briarwood, Santa Maria, CA 93454. Phone 805-925-0754.

TECHNICIAN: Fast growing cable television company needs electronic technicians in several areas. If you are young, outdoors type, and have experience in trouble shooting and repair of transistorized amplifiers, send complete resume or call Aurovideo Inc., 1380 Main Street, Waltham, MA 02154 (617-891-6748).

73 IS AVAILABLE to the blind and physically handicapped on magnetic tape from: SCIENCE FOR THE BLIND, 221 Rock Hill Road, Bala Cynwyd, PA 19004.

DIAL PLATES: all types. Give your home brew and other gear an attractive appearance. Send for catalogue. Radio Dials, 1397 Washington Circle, Forestville, OH 45230.

COLOR ORGAN KIT: 3 Channel, 600 Watt, $7.50. Cabinet, $8.50. Power Supplies, $2.75 to $8.50. Ceramic Capacitors, $.10. Dual Flasher 1000 Watt, $3.98. Catalog. Murphy, 204 Roslyn Ave., Carle Place, NY 11514.

QSL CARDS–FCC LABELS, eyeball cards–call sign decals, free samples, florescent and glossy. Latest designs. April Products, 56290 Van Dyke, Washington, MI.

WIRELESS SHOP–new and reconditioned equipment. Write, call or stop for free estimate. 1305 Tennessee St., Vallejo, CA 94590 (707-643-2797).

AEROMATIC TOWER, 85', four legs; 35' masting; gin pole; prop pitch rotor. Antennas: Mosley S402 and TA36; Telrex 11 el. 6M; Ranger II; HX30; T/R switch. Will ship. Joe Engressia, 9050 SW 117 Avenue, Miami FL 33156.

TR-108, factory aligned, warranty, $100. Viking 500 transmitter, $200. DX-60, $39. Matching HG-10 VFO, $18. Knight V-44 VFO, $15. SX-101 mkIII, just had factory $45 overhaul (Aug. '69), immaculate condition, works like new! $120. Jim McClure WA9BYR, 627 Dundee Ave., Barrington, IL 60010.

GREENE . . center dipole insulator with . . or . . without balun . . see September 73, page 41.

TELETYPE PICTURES FOR SALE. 50 pics for $1.00. Perforated and audio tapes available. Write for prices specifying speed and tracks. Pictures to be included in second volume solicited. W9DGV, 2210 30th St., Rock Island, IL 61201.

FOR SALE: Drake TR-6, all accessories complete package $750.00 plus shipping. Consider SB-110-A and Swan 250C. J. Gysan W1VYB, 53 Lothrop St., Beverly, MA 01915.

MANUALS–TS-323/UR TS-173/UR, R-274/FRR, TS-186D/UP, BC-638A, LM-18, $5.00 each; OS-8C/U, USM-26, $6.50 each. Hundreds more. List 20¢. S. Consalvo, 4905 Roanne Drive, Washington, DC 20021.

HW-22 $70, Mobile supply, $30, Nixie readout digital volt-ohm meter, $60, Solid state 80 and 40 meter CW xmtr with vfo 30 watts input attractive cabinet, $70, Heathkit VTVM, $25, Hallicrafters TO-9 keyer, $40, Heathkit lab rf generator, $30, Roberts 6000s stereo portable tape recorder, mic, ac supply, $250. K7AZB, Box 252, Mountain View, CA 94040.

FOR SALE: H-P 524B counter HP416A. Wanted—one model SBE side-band exciter for technical material corporation transmitter model 6PT 750. I am interested in swapping test equipment (Tektronix H-P, etc.) for it. Eugene H. LeGer, 63 Jewett Lane, Hollis, NH. 603-465-7791 or in MA, 617-433-2721.

COMPLETE STATION—SWAN 400, 80-10 VFO, power supply and mike. All mint condition. All for $325.00. E. Parks, 6486 Nancy St., Los Angeles, CA 90045.

SELL NCX-3 good condition without power supply, $165. Call 215-692-7547 or write 518 Nottingham Drive, West Chester, PA 19380. W3CAW.

Printed Circuit Resist the Easy Way

When caught one Saturday evening with an all important pc board to make and no resist in the house, I started looking for a readily available substitute. Within minutes I located two things around the house which worked so well I have given up the commercial types.

My system involves laying out the desired circuit to scale on plain paper. After double and triple checking, I tape it to the pc board and mark all the holes with a center punch. The paper is then removed and the lines drawn in with a pencil, using the punch marks as a guide. The next step is to draw the lines again, this time using fingernail polish. When large areas are to be covered, rubber cement works somewhat better because it flows more evenly, but it is often difficult to see what portions have been done. After the polish is completley dry, the lines are "manicured" with a sharp scribe to make them look better and to remove any possible shorts due to the various adjacent areas having flowed together.

The etching process is the same as usual in every way. After the etchant has been flushed from the board, remove the nailpolish with nailpolish remover or Acetone, and the rubber cement by rubbing. The board is then cleaned with household cleanser to remove the residual resist and oxides. Drill the holes, plug in parts, solder the leads, turn on the power and your project is complete. I find this system faster and cheaper than any others I have tried.

William P. Turner, WAØABI

Transmitter Spotting Switch

There are no doubt many ways of keying the oscillator of a transmitter for spotting your own frequency when tuning up to another station or net. Shown here

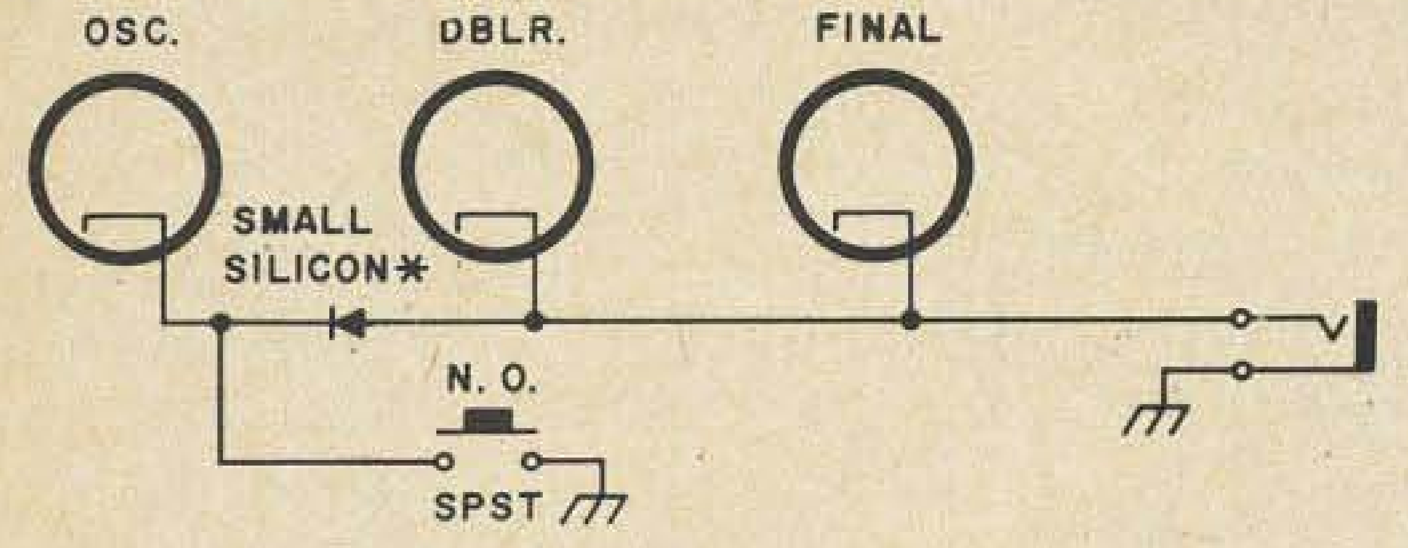

Fig. 1.

are two ways we have gone about it here at this Qth; we are currently using the one with the diode between the cathode of the oscillator and the cathodes of the following stages as in **Fig. 1**.

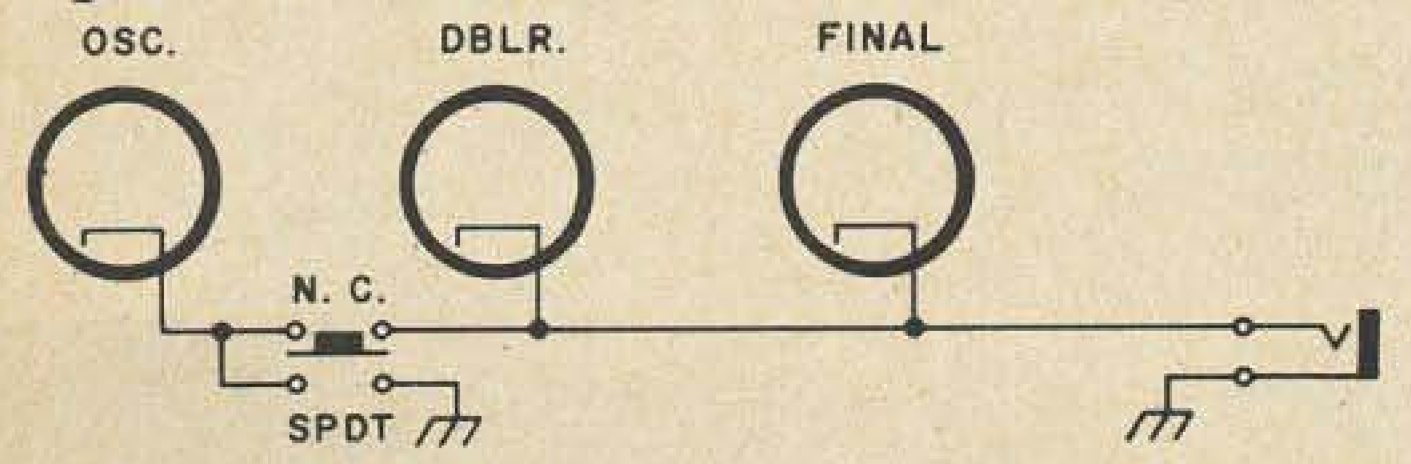

Fig. 2.

The other method is to use a SPDT push button switch in the same place, as in **Fig. 2**.

Irvin Kanode WA9CKP

CLUB SECRETARIES NOTE

Your club can round up some extra funds by imploring, cajoling, convincing or forcing your members to subscribe to 73 Magazine. Never mind the cries of anguish, just remember that you are doing what is best for them—and the club.

Subscriptions to 73 are normally $6 per year. The special club rate is exactly the same: $6. The only difference is that the club treasury holds 25% of the loot and sends the rest to 73. Send us $4.50 for each one year subscription, in groups of at least five subs. Just think, if your club has 10,000 members you can quickly get $15,000 for the club on this deal!

Send the subscriptions to us on 3" x 5" cards, giving the name, call, address, city, state and zip code of each subscriber. If the subscription is a renewal please include the address label from a recent 73 wrapper. Indicate all renewal subscriptions so we won't start a second sub. We have been known to do that.

Send to Club Finagle, 73 Magazine
Peterborough, N. H. 03458

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R-4B Receiver

• Permeability-tuned VFO reads to 1 kHz • Crystals cover all of 80, 40, 20, 15 mtrs. and part of 10 • Ten 500 kHz accessory ranges (1.5-30 MHZ) • Four bandwidths • Passband tuning • Noise Blanker on CW-SSB-AM, Notch Filter, Xtal Cal

Amateur Net $430.00

T-4XB Transmitter

Frequency coverage and VFO similar to R-4B • USB/LSB • Semi break-in CW • Controlled Carrier AM • VOX or PTT • Adjustable Pi-Net • Xmit AGC, no flat topping • 200 watts • 8 pole SB Filters

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DRAKE 4 LINE ACCESSORIES

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Matching Networks

Integral Wattmeter: fwd pwr in watts and VSWR direct • Can read refl pwr • Matches xmtr to ant VSWR 5:1

MN-4 200 watts **$ 90.00**
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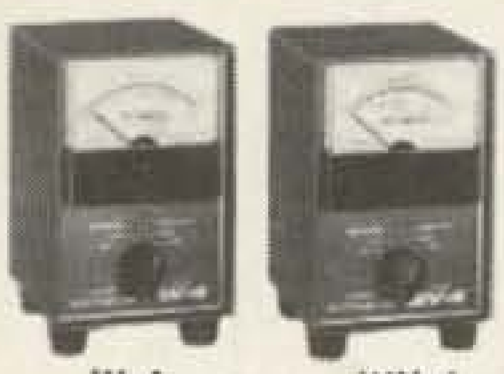

W-4 WV-4

Fwd and refl pwr directly in watts • Two scales each direction • Calib Acc: ±(5% of reading + 1% of full scale)

Model	Range	Full Scale	Price
W-4	1.8-54 MHz	200/2000W	$49.50
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5"x7" speaker, space for power supply **$19.95**

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60-8000 Hz, ceramic, Hi-Z, highly directional, plug . . .
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Standard Crystals, ea **$ 5.00**
Power Supply **AC-4** **$99.95**

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TV-100-LP	Low Pass Filter	**5.95**
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LP LN

T-4B Transmitter • Like T-4XB except use with R-4B in Xcv mode or from 10 accessory crystals • Built-in speaker for R-4B **$395.00**

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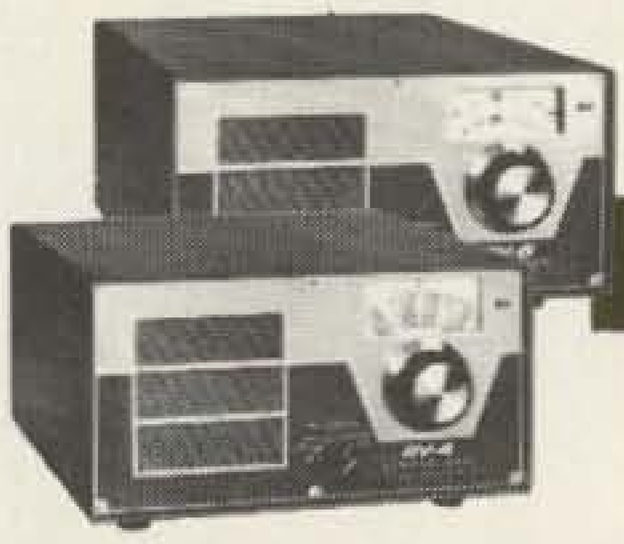
BOTH have Linear VFO, 1 kHz acc, 300W PEP-SSB, Semi Break-in CW with Sidetone, VOX or PTT, Adjustable Pi-net, Plate and AGC Mtrs.

TR-4 covers 10-80 meters; USB/LSB, CW, AM; **TR-6** tunes 6M plus MARS with 9 xtals (2 furn), USB-CW-AM.

TR-4 OR TR-6 $599.95

RECEIVERS: Sensitivity for 10 dB S/N: **TR-4** .5 μV, **TR-6** .1 μV (FET front end) **Selectivity: Both** 2.1 kHz @ 6 dB, **TR-4** 3.6 kHz @ 60 dB. **BOTH** have diode & prod detectors, S-meter.

RV-4 & RV-6 REMOTE VFO's



Permit rcvg, xmtg or xcvg on separate freq in same range as transceiver. **RV-4 OR RV-6 $99.95**

TRANSCEIVER ACCESSORIES

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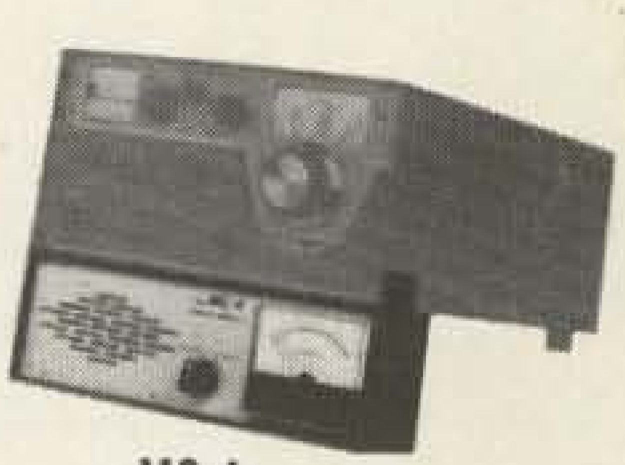
Power Supplies: **AC-4**	**$ 99.95**
DC-4	**$125.00**
DC-24	**$210.00**
MS-4 Matching Speaker	**$ 19.95**
FF-1 Fixed Freq. Adapter	**$ 24.50**
MC-4 Mobile Spkr/Wattmeter	**$ 69.00**
34-NB Noise Blanker Kit for TR-4	**$129.00**



MC-4

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• Xtal control 1st converter • 500 kHz Ranges: 80, 40, 20, 15, 10 meters • Accessory Ranges 3-30 MHz • SSB-AM-CW • Accessories: Spkr, Q-Mult, Calib, Noise Blanker, Xtals.

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• 100 (or 75) watts • Break-in CW with 2-C • 80, 40, 20, 15, 10 mtrs xtal controlled • Ant. Relay • Sidetone • LP Filter • Pwr. Sup. incl.

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FET, Lo Noise, Uniform Gain, Low Spurious Response
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VHF Xtal Cal **SCC-1 $24.50**
Console **CC-1 $24.50**

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TC-2 • Entire 2-meter band • 180 watt input
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