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July 1969

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...de W2NSD/1

Wayne Green

Silent Keys

It seems passing strange to me that I have yet to hear of any sort of ham ghost story. Do hams who pass beyond suddenly give up the passion of a lifetime and find something better to do? It may be that there is something to this tale Dante passed along about hell and perhaps most of the DX'ers are there, hacking away with bent keys and crystals that won't oscillate. Their dial cables probably have a lot of slack too.

In all semi-seriousness, I wonder if any readers have had any hints from the next world about DX conditions there? Any ouija board communications? Automatic writing? Or even via a medium? I gather, after a lot of reading, that communications with the departed is rather well substantiated to all but the most closed of minds. The problem with getting through seems to be one of converting frequencies. . .time and again they try and explain to us that their "vibrations" are on a different wavelength than ours. Since this obviously is not electro-magnetic waves that are involved, we may just have a clue that there are other types of waves than electromagnetic.

Mediums seem to be people that are sensitive to the other frequencies. Converters. They usually are connected in, not without QRM and other noise, to a medium in the next world who acts as a second converter. The result can be a rather good circuit, but is frequently about like trying to work a YK long path on a weekend.

Merely being aware that there is a possibility of a spectrum other than our electromagnetic should be enough to get some experimenters working on the problem. I am not sure what we might do if we found out how to use a new spectrum. I suspect that it would tie in with telepathy, might well be instantaneous (which make wavelength hard to define) and spaceless (which is an obvious function of instantaneous). What do you think? Or would you rather not think about it?

Conversions of Commercial Equipment

In the past I have been somewhat reluctant to devote much space in 73 to detailed conversions of commercial equipments. The concept being that, no matter how fascinating the conversion, it would be of specific value to only a very small percentage of our readers. In cases where a conversion or modification would work with a number of different pieces of equipment we have gone right ahead and published the articles.

While this policy was good for the majority of our readers, it still had the drawback of withholding valuable information from others. Now I have a little scheme that may solve this problem. I propose to publish modification articles separately and make them available to those interested at a nominal price. The author would still be paid the regular price for his article. . .the readers who need information on their particular piece of equipment could get it. . .and we wouldn't have to fill up the pages of 73 with mods on commercial gear owned by 2% of our readers.

So, if you have worked out any interesting improvements on your gear, perhaps this is the time to sit down and write an article on it. Send in the complete schematic diagram with the article. While it is virtually impossible to print these in 73 because they take up too much room, we can easily include them in a modification booklet.

Proofing 73

Now and then an incautious reader has, in the past, offered to help us beat back the growing tide of small errors and typos in 73. Unfortunately we have never been far enough ahead to do anything as simple as that. Now that we are setting our own type right here in our own headquarters there is a glimmer of hope that we may someday have a few articles ready for publication more than one week before the presses start running.

If you would like to have a chance to look at some of our incredibly fabulous articles before publication and promise to read them, watching for obvious typos and unobvious author errors. . .and even downright mistakes. . .and return them at the next high tide, all done with the welfare of amateur radio in your heart (no pay, this means), then keep not your intentions a secret.

(continued on page 98)

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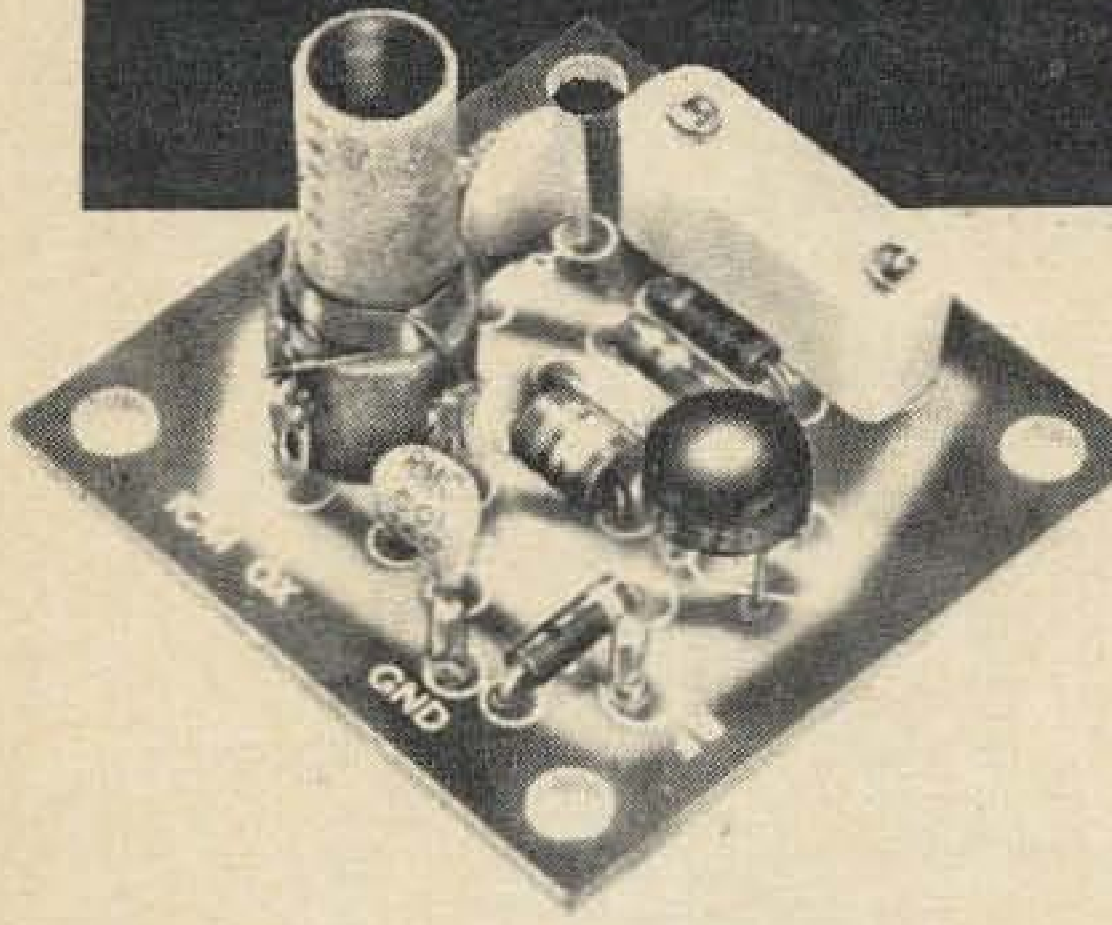

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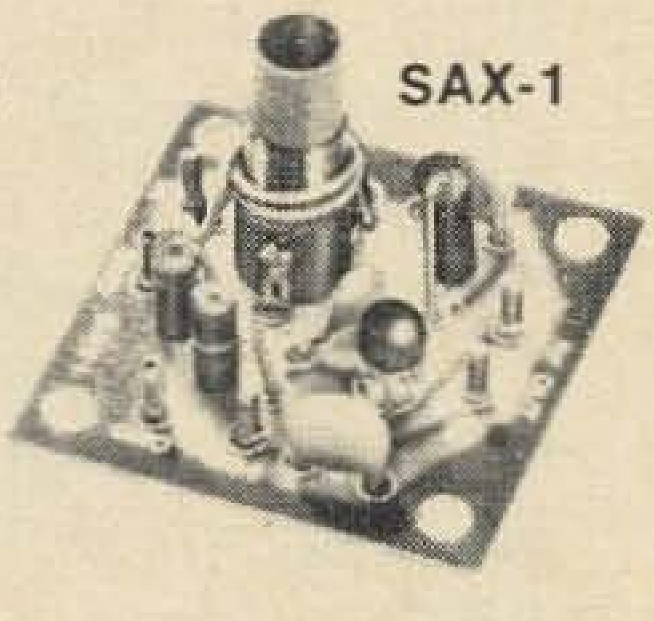

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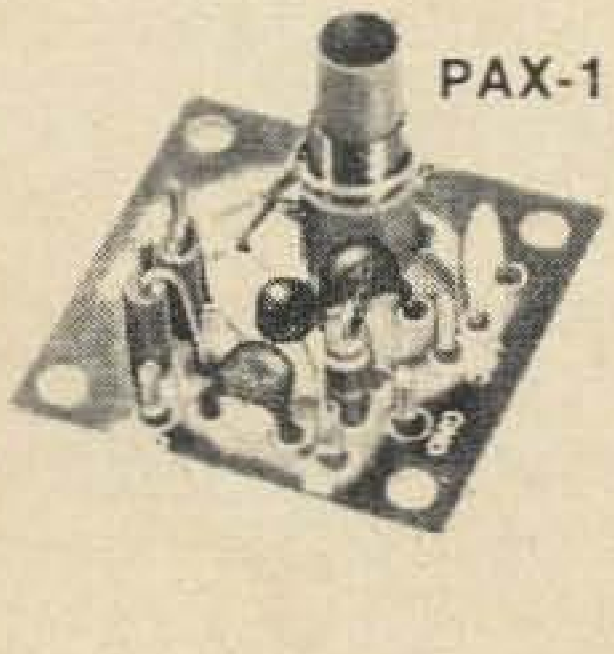

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Confessions of an Appliance Operator

Thundering across the airways and reverberating from speaker cones throughout the length and breadth of "hamdom" has come, like the piercing wail of a cow with a stepped-on udder, yet another epithet with which to flail and degrade an ethnic group within the amateur radio fraternity, i.e., You! You! You! Unspeakable appliance operator, you!!!

By over-simplification, an appliance operator is one who does not build his own equipment. He allegedly has the intelligence of a mentally retarded and recently pole-axed ox, the energy of a three-toed tree sloth, thinks manual labor is a Spanish War hero, is as socially acceptable as a skunk-farming roto rooter man with an aversion to soap, deodorant and mouth wash (in fact, he supposedly possesses all the mandatory prerequisites for becoming one of Katy Winter's closest friends); and his family tree–always suspect–is believed to be something he's living *in* rather than descended *from!*

At this point, it is necessary to clarify what is and what is not an appliance operator. Those who build at least 60% of their equipment can be classified as "homebrew specialists" or "artisans", those who build 10% or less are "appliance operators." The in-betweeners, for the purpose of this article, don't count.

There is, however, one nebulous Tinker Toy group that assumes the aura of, and is tolerated by, the artisan. They, in turn, look down their noses at the pure appliance operator. These ersatz artisans, called Gahzinters or Gahzonters do, in fact, build their own equipment...Uh Huh! In KIT form! (Hell, I know a 75 year old li'l ole lady with arthritis, palsy, 60/60 vision who didn't know the difference between a soldering iron and the south end of a north-bound mule who assembled a 23" television kit–this hardly qualifies her as this year's nominee for the second lead in David Susskind's off-Broadway production of "Tom Swift and His Electronic Grandmother.")

The Gahzinter is theoretically superior to the appliance operator 'cause he really knows what goes on behind the front panel of his equipment. For instance, T1–the big

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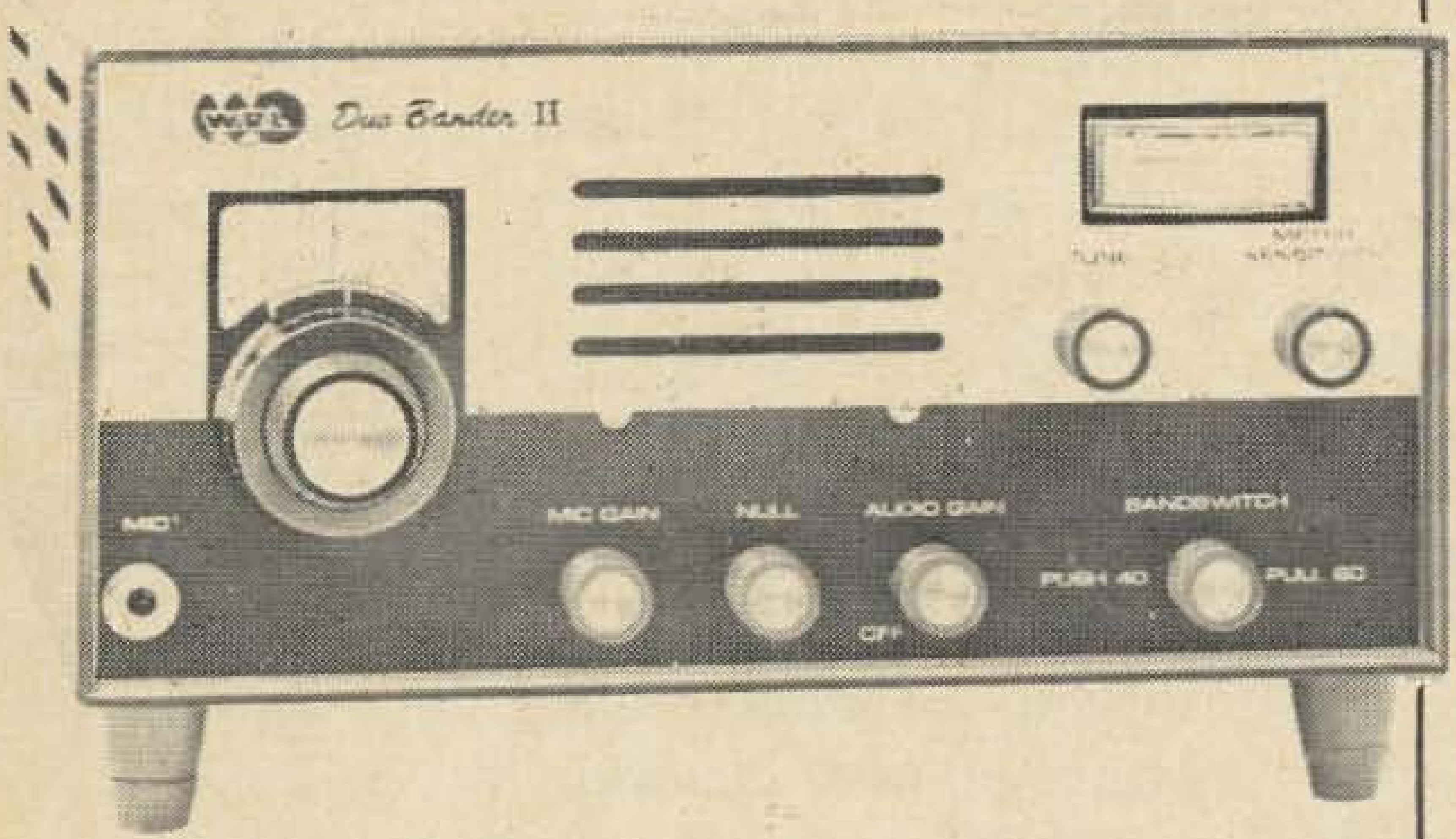

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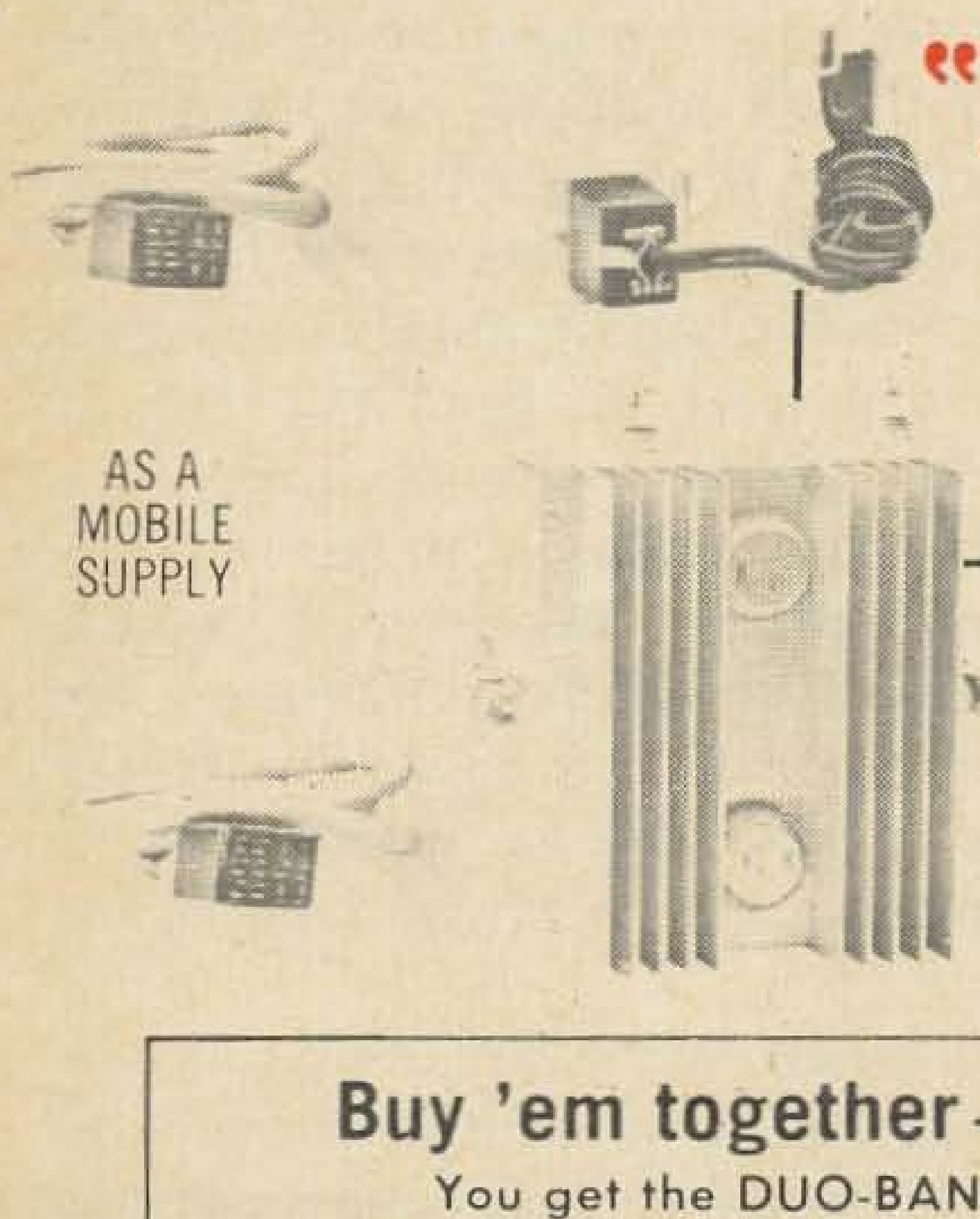

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black whatsis–gahzonter the chassis, the little glass things gahzinter the little holes, then the chassis gahzinter the cabinet, the cabinet gahzonter the table and the plug gahzinter the wall socket! (Whoopee! electronic "silly putty.")

It must be obvious–even to the Gahzinter–from the title and tenor of this article that I am that most loathesome of all creatures, an appliance operator!

There are many reasons that a person follows the path of the appliance operator–lack of time–lack of interest–inaccessability of parts–ad infinitum–ad nauseum. My reasons are two-fold; I was born under an unlucky sign and am afflicted with the domino syndrome!

Astrologers tell us that there are only 12 signs of the Zodiac–a gross untruth: there is a 13th sign (Heinie, The Municorn). The name Heinie was selected as a tribute to two of the unluckiest Municorns of them all, Buster and Lotta Heinie(named by parents with a perverse sense of humor). Uncoordinated "Three Thumbed" Buster Heinie, so uncoordinated, he couldn't walk and whistle at the same time, and his twin sister, Lotta, a cross-eyed seamstress who couldn't mend straight; both came to untimely ends. Buster traveled to India to take up snake charming and, on his first solo mission, was assigned a "deaf" cobra. Lotta, out of remorse, became a street walker in Venice.

The symbol for the thirteenth sign, The Municorn (a cross between a large mule and a pygmy unicorn) was selected because it epitomizes a continuous exercise in futility.

The male Municorn (the Gaffer) retains its pygmy size and horn, while the female (the Frail) remains large and mule-like.

The Municorn, understandably, proved to be unprolific and soon became extinct. For each time the Gaffer approached the taller Frail, it was necessary to get a running start and launch himself into the air. (Now, the Gaffer, like the Koala bear, feeds exclusively on eucalyptus leaves and is in a constant state of inebriation–accompanied by the blind staggers which tended to limit the height and often times the direction of his hunger). Keeping in mind that the Gaffer retained the one single horn directly in the center of his forehead and his inability to gain the required altitude, it was not an uncommon sight to see a Frail–with a startled, open-mouthed, buldging eyeball pained-look on her face–vaulting high into the air or dangling uncertainly from the uppermost limb of an apple tree.

You can usually recognize a "Municorn" by the soldering iron burns on his fingers, the crazy-quilt outer skin of band-aids, the battery acid holes in his clothes, singed eyebrows from overfilling his Zippo, and the cauliflower ear he got when, trying to put a "gleem" in his xyl's eye (he goosed her while she was brushing her teeth and she damned near decapitated him with the bathroom dixiecup dispenser.

My second drawback, the domino syndrome, is a series of cataclysmic and destructive events set in motion by one single action which blossoms out in mathematical sequence inversely proportional to their desirability.

It can best be explained by an example. Let's say it snows: you haul out your snow blower and attack the mountains of snow, accidentally gulping up the aluminum driveway reflector which feeds through the chute with unbelievable force and, like some vindictive NIKE missile, imbeds itself in your newest $65 snow tire.

The tire, suddenly devoid of air, goes wham! The rear end goes plop! And the shock absorber goes snap! pffsst! clunk! Now, while you're watching these mechanical hi-jinx, you absent mindedly run the snow blower into your son's brand new Flexible Flyer, which he'd brought out just before the snow fell, transforming it immediately into basket weaving material, bend hell out of your impeller blades and send slivers into everything within a radius of 50 feet–including the omni-present goggle-eyed poodle.

Thence, in a fit of pique, you become, for the moment, an olympic hammer thrower and hurl your snow blower high into a fir tree, ripping down your phone lines in the process.

This, essentially, is the domino syndrome.

The hardest part, of course, is trying to explain–coherently–to the phone repairman (who, when coming up the drive has wonderingly observed the harpooned snow tire, the pile of sawdust, the twisted sled runners and your wall-eyed hedgehog-like poodle and is now peering at you with a jaundiced eye, ready to burst into frenzied flight at your first suspicious move) exactly what snapped your phone line and precisely what your snow blower is doing, roaring away, in a fir tree 30 feet above the ground.

Not long ago, I was involved in a domino repair project that began, as they all do, innocently enough. I had discovered that with two TV's coupled together on the same antenna, the broadcast receivers in the upstairs bedrooms buzzed loudly. Investigation showed that a simple two-set coupler eliminated the problem. I screwed the coupler into a shingle and, as usual, ended up needing about two inches of extra twin line. I gave a slight tug—just enough to not only pull down the twin line, but the antenna and a cleverly secreted hornets nest, complete with its irate inhabitants!

Later, after disengaging myself from the aluminum monstrosity, hiking back from the tar pit where I'd gone to escape the now homeless hornets and applying unguentine to the now-swelling stings, I climbed the roof and successfully re-installed the antenna. Unfortunately, on the way down, I slipped and clutched at the rain gutter for support. One end let go and I swung, pendulum fashion, back and forth past the kitchen window where my xyl was conducting a suburbian covin—a koffee klotch—with a local Gossiporter (Gossip/Reporter). (A Gossiporter—there's one in every neighborhood—is the end product of careful selective breeding during which the brain is completely disconnected from any thought processes and left to control only the dynamics for muscular activity. Since the brain no longer functions, the eyes and ears are left to absorb bits and pieces of information seen through curtained windows, heard over the back fence, or just imagined. These bits and pieces are assembled at a central point which I sincerely suspect is located slightly below the bottom-most verterbrae in that portion of the female Gossiporter's anatomy which looks the most ridiculous in slacks or shorts. There, it is embellished, distorted and transmitted to the tongue—a perpetual motion muscle—which oscillates at a fantastic rate of speed and in a screech that will peel paint, break glass and give every dog in the county an earache!

As I swung back and forth loudly scream-

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ing for aid and assistance, I heard the scorched tongue visitor exclaim, "Good Lord! there's a huge bumpy faced 'ape' swinging outside your window!" To this, my xyl replied, "Don't pay any attention. That's my husband, the Dingbat! Yesterday he was playing Lloyd Bridges in the septic tank and today, apparently, he's Tarzan!"

The other end of the rain gutter finally let go and I sailed in a beautiful arc and was unceremoniously deposited into our utility trailer which, predictably, was filled to overflowing with a week's greasy garbage, a number of dust-filled vacuum cleaner bags and several shovelfulls of rabbit droppings from our pet rabbit (my children, little sadists that they are, they take after their mother, call the rabbit droppings, "fat raisins)."

Now, I've heard of being tarred and feathered for some heinous crime, but to be unguentined, garbage-greased, dusted and rabbit raisined should be reserved as a Rettysnitch for failing to prostrate oneself in the direction of Newington, Connecticut, during the 2100 broadcast, omitting a genuflection at the mere mention of the Newington deity–the spark gap–or for using Wouff Hong's name in vain. (Incidently, I understand that the National Simian Society is also located at Newington, Connecticut–there must be some moral significance in that fact somewhere!)

Naturally, I had an audience that burst into immediate and uncontrollable, hysterical laughter, claiming that, as I climbed out of the utility trailer, I looked not unlike a giant animated, slightly fuzzy and extremely malodorous toll house cookie.

To make a long story short, after de-raisining myself, I finally managed to remove the buzz from the broadcast receivers, but not before I'd discovered that the holes I'd drilled in the shingle were letting rainwater into the cellar and managed to drop the largest of the AM receivers on my foot.

Sitting, ankle-deep in rainwater, repairing the AM receiver was the project I was involved in when I first heard the phrase, "appliance operator!"

I'd just finished one of my better solder joints–slightly under an ounce of solder on the terminal board. Hearing the phrase appliance operator caused me to pop a diode and solder both my wedding ring and Timex watch to the B plus.

In an attempt to loosen the ring and watch, I overheated the connection, spoiling my solder joint, and accidentally slid my right thumb down the soldering iron, burning the thumb, my ring finger, left wrist and splattered boiling solder into the most inappropriate spot in my lap - yeah! in fact, it went right through the button holes–talk about lead in your pencil...wheee!!!

I screamed and leaped to my feet–the AM receiver still attached to my left wrist. I was sucking on my burned right thumb, trying to extinguish the fire and shake loose that damned AM chassis when I noticed my father-in-law poke his head into the shack. He looked at me sadly and shook his head and, turning to my xyl, said, "Daughter, please don't look in there–puulleease!!!–the damn fool is hopping around like a 230-pound sea numph, doing what appears to be a semi-lunar fertility rites dance, waving a radio over his head with his left hand and alternately sucking on his right thumb like a middle-aged male counterpart of Lolita and whomping himself on the lower abdomen–or crotch–which, believe it or not, appears to be on fire! If that clot-headed wahoo ever starts fanning with the other hand, he's gonna start riding side-saddle, need a transplant, sound like Wayne Newton and you'll be able to hear the 'top forty records' booming out of his navel. It wouldn't surprise me if the jerk yelled, 'Shazzam!' and leaped out the window!"

All this happened one evening at–for the ham: 2130 local–for the swl: 9:30 p.m. and for any Citizen Bander who may be having this read to him, that's when the little hand is on the 9 and the big hand is on the 6 and it's dark outside.

For what they're worth, these are my reasons for being an appliance operator.

In order to co-exist in the Artisan/Gahzinter world of amateur radio it has become necessary to devise a two-phase system to make it appear that I am a non-appliance operator. I've listed them here in the hope that they may help others in the same predicament.

Phase 1 (Making your shack look non-appliance operator). Assemble the following:

a. 1 ea. ½" wire brush to remove all the factory paint and lettering and give your equipment that "Spirit of St. Louis" look.

b. 1 ea. Dymo labeller to relabel all the lettering you just wire brushed off. (A magic marker is optional for the purist). Be sure to over-label everything—a light switch should read, "Switch," "Lights," "On-Off," "Up and Down."

c. 1 ea. pop rivet gun (remove all factory permanent screws, nuts and bolts and replace with pop rivets).

d. 1 ea. pkg of slightly rusted machine screws for replacing non-permanent fasteners.

e. 1 ea. package of assorted knobs, no two alike in size, shape or color.

f. 1 ea. can of spray crinkle paint complete with "paste on" paint runs.

Points to remember for Phase 1:

a. Always have a chassis or two laid out on the bench with a Sams photo-fax laying beside it.

b. Maintain a number of suspicious looking wires dangling from various and sundry places—give the impression that one false move by the visitor will instantaneously turn him into an unrecognizable cinder or arc weld him to the thunder jug in the corner.

Phase 2 (Second, but by far the most important, in co-existance is sounding like a non-appliance operator.

1. Break in on a net or round table at the most inopportune time to ask how your signal sounds since you substituted 8298A's for 6DQ6's in your final. If someone should fall into the trap and ask what an 8298A is, you can assume a pompous self-righteous air and inform him that to a dummy, that's a 6146B.

2. Be sure to be always looking for some obscure item—perhaps a transformer with one secondary of 5,000 volts, one at 7.3 volts and one at 1.9 volts—all at 2 amps or possibly a .007894 mfd electrolytic rated at 52 kvdc. One disadvantage to this is that you're liable to get some of this junk.

3. Be critical of all other signals. Make it sound as if you were carefully scrutinizing them on a scope (homebrew, of course). He's always drifting, flat-topping or pushing it a little too hard. (I had one fella give me a complete analytical observation of my signal. I later found out he was running mobile at 70 mph—half in the bag—and a hitch-hiker was tuning the rig.

4. During qso's, nets or roundtables, always miss a turn; then boom in explaining that you were just putting the finishing touches on your final stage.

5. If the other station is using a transceiver, keep coming up a little higher in frequency until you've reached the extremity of the band.

6. Become a specialist in some practically unknown subject, like the comparative value of aluminum waveguides as opposed to galvanized waveguides.

7. Become expert on one tube and its exact replacement. Be able to argue the non-existant merits of each.

8. During qso's, slowly insert carrier into your SSB signal, or slowly reduce your output until someone brings it to your attention. Then correct it.

9. Install a toggle switch in your mike cord. By flicking it a few times during transmissions, you'll give the appearance of "breaking up."

10. When asked about your equipment, tell 'em it's home-made—home modified, altered and destandardized equipment.

11. Assemble a glossary of epithets concerning those "durned appliance operators."

12. So that you won't sound like a young whippersnapper, keep a memorobilia folder containing a list of old time operators, info on old radio shows, a sheet of "I remember when..." items.

Incidently, if you need any good unused ideas, let me know. I'm running a "going out of mind' sale...

Treat your fellow radio amateur as if he were someone special...he is!!

...K1YSD

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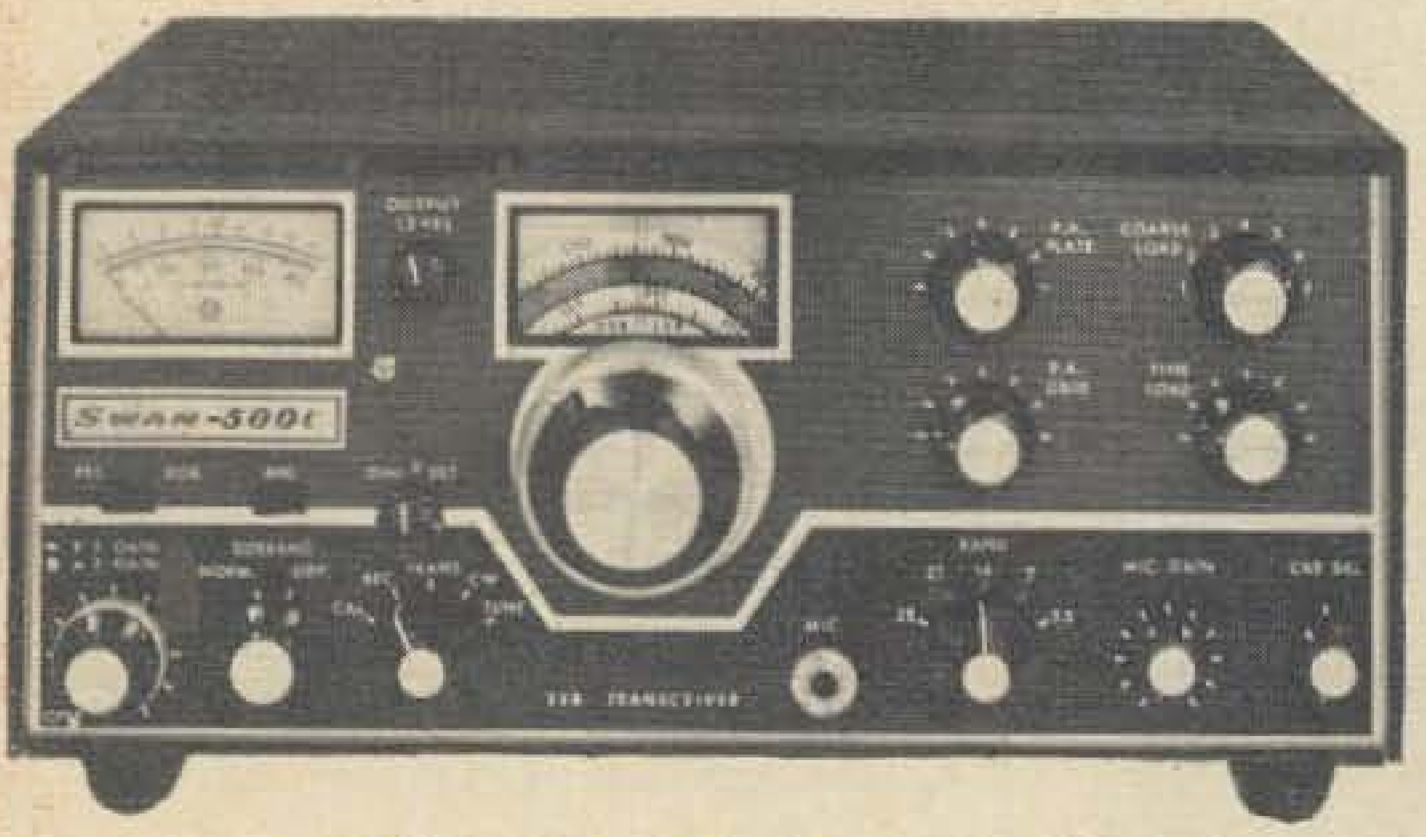

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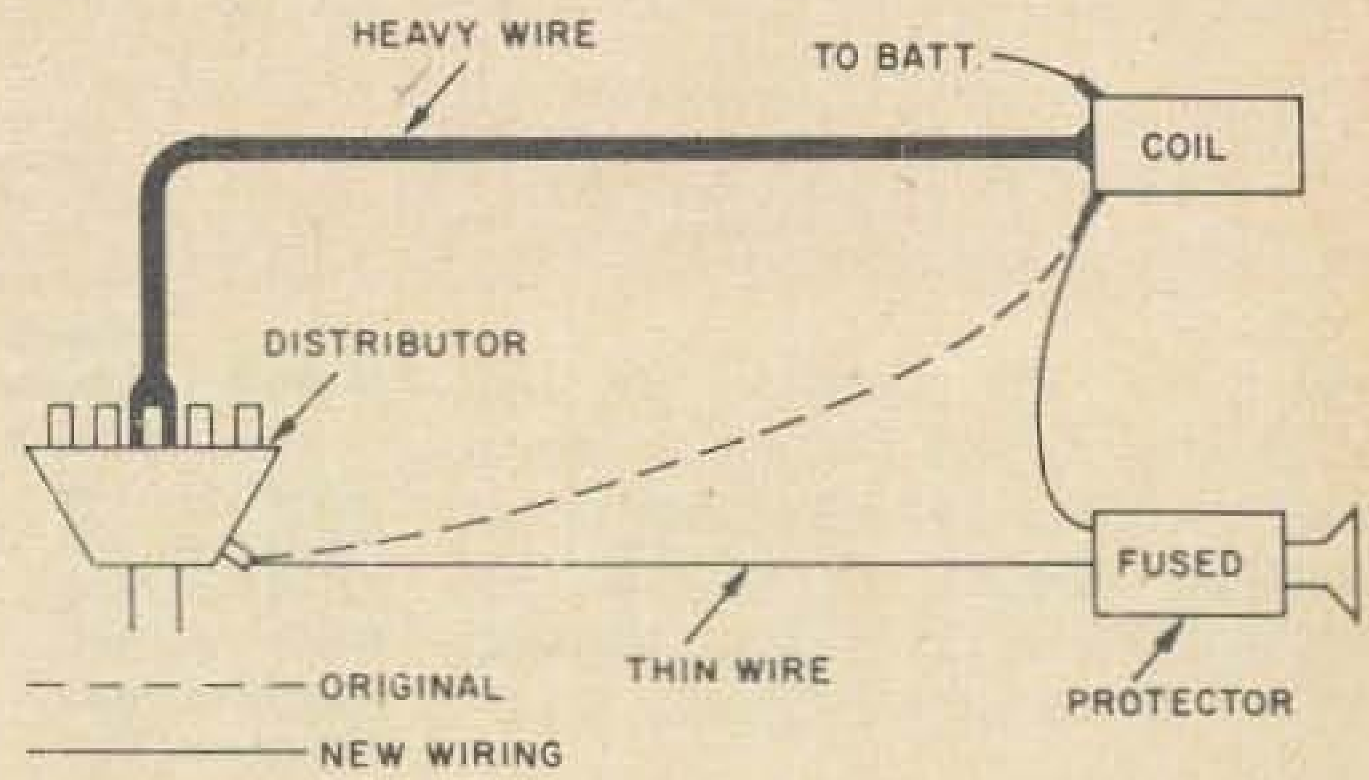

Fig. 1. Hookup of protector is very simple.

Anyone who tries to start the engine with the protector in the on position will find the engine quitting within one minute or less. When this happens, a thief is not going to take the time to look under the hood for problems, he's going to abandon the car. Remember, most thieves would rather drive your car to a safe spot before they strip it or try to take out your radio equipment.

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Robert N. Taylor, WA2SQZ

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The Ancient Modulator

With the opening of new 160 meter frequencies and the tenacity of AM operators on VHF, a low power modulator can be quite handy in the shack of either a beginner or old timer. when a power supply and switching are included, it can provide power and control to any *rf* unit that is plugged into it. Let's take a look at this handy unit, and see how it was built.

Design

The first step toward bringing any project to life is to decide what is desired with respect to performance, and compare this with what is available. However, in this case, the parts in the junk box made the decision. Power transformers that would deliver 400 volts were there, and since 807's and 1625's were present in large numbers, the input of the rf amplifier would be limited to 40 watts, the plate current limitation of the tube at 100 milliamperes. This is still a very reasonable power level for vhf, and with the tubes and transformers operating at so conservative a level, long and dependable service could be expected.

Even with the low power required from the modulator, a pair of 1625's were used in push-pull as shown in **Fig. 1** T2, the modulation transformer, was a junk box item that does not exactly match the requirements. The required impedance is given by

$$Z = E/I = 400 \text{ volts}/0.1 \text{ amp} = 4{,}000 \text{ ohms}$$

So, it would be wise to consider this in the initial design. The unit used, however, had an impedance of 6,000 ohms, but no problems were encountered. The screen voltage was held at 300 volts by two voltage regulator tubes and the bias was provided by three nine volt transistor radio batteries in an attempt to run the modulators in class AB2. Again, these voltages are not exactly correct, but they are easily obtained and seem to work perfectly. A meter to measure the modulator plate current can be included, but it should not be considered as an accurate indication of the percentage of modulation.

The 6J5 was chosen to drive the 1625's because it was in the junk box. T1, the driver transformer, can be almost any single-plate to push-pull grids interstage audio transformer. The exact specifications of the one used are unknown. The one megohm gain control was placed in the grid of this stage as is customary to provide a good signal to noise ratio.

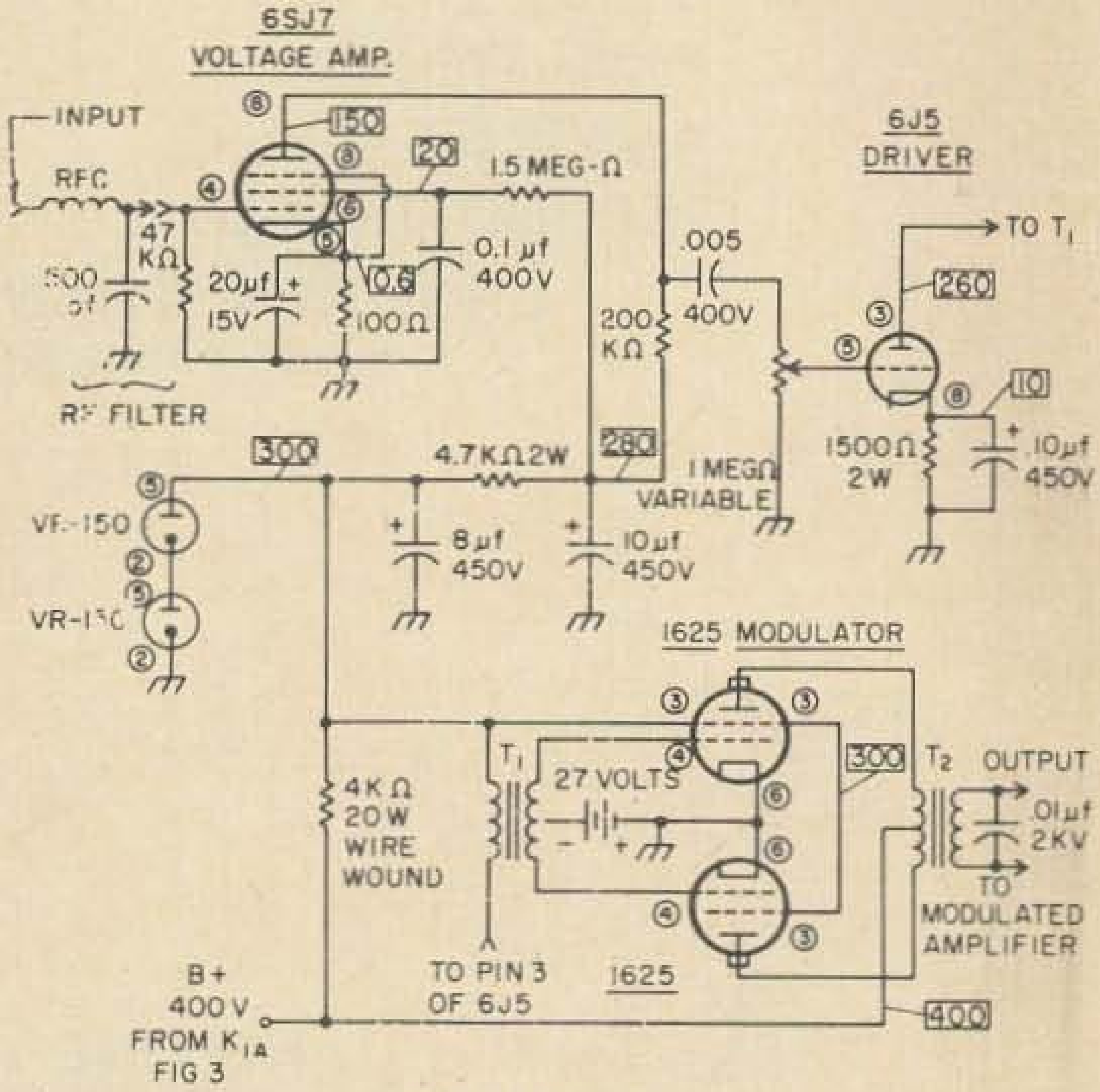


Fig.1. Modulator.

After a great deal of experimentation with twin triodes the 6SJ7 was finally chosen for the voltage amplifier first stage. It provides better than adequate gain from a single stage. The 47 K ohm resistor in the grid return of this stage was used to reduce rf feedback. It also reduces the gain of the stage considerably, but this was not a problem. A better solution would be a small rf choke in series with the grid lead, with a 500 pf capacitor from the grid to ground. RF feedback may not be a problem on the lower bands, but it is sure to show up on the vhf bands as the howl that is so familiar.

Fig. 2 shows the power supplies, which require very little explanation. Again, components were selected for their reliability and availability. Two separate supplies were used to prevent the current variation of the modulators from causing a simultaneous drop in the voltage on the rf amplifier that would cause downward modulation. Two filament transformers were used to provide the twelve volts required for the 1625's and the six volts for the other tubes.

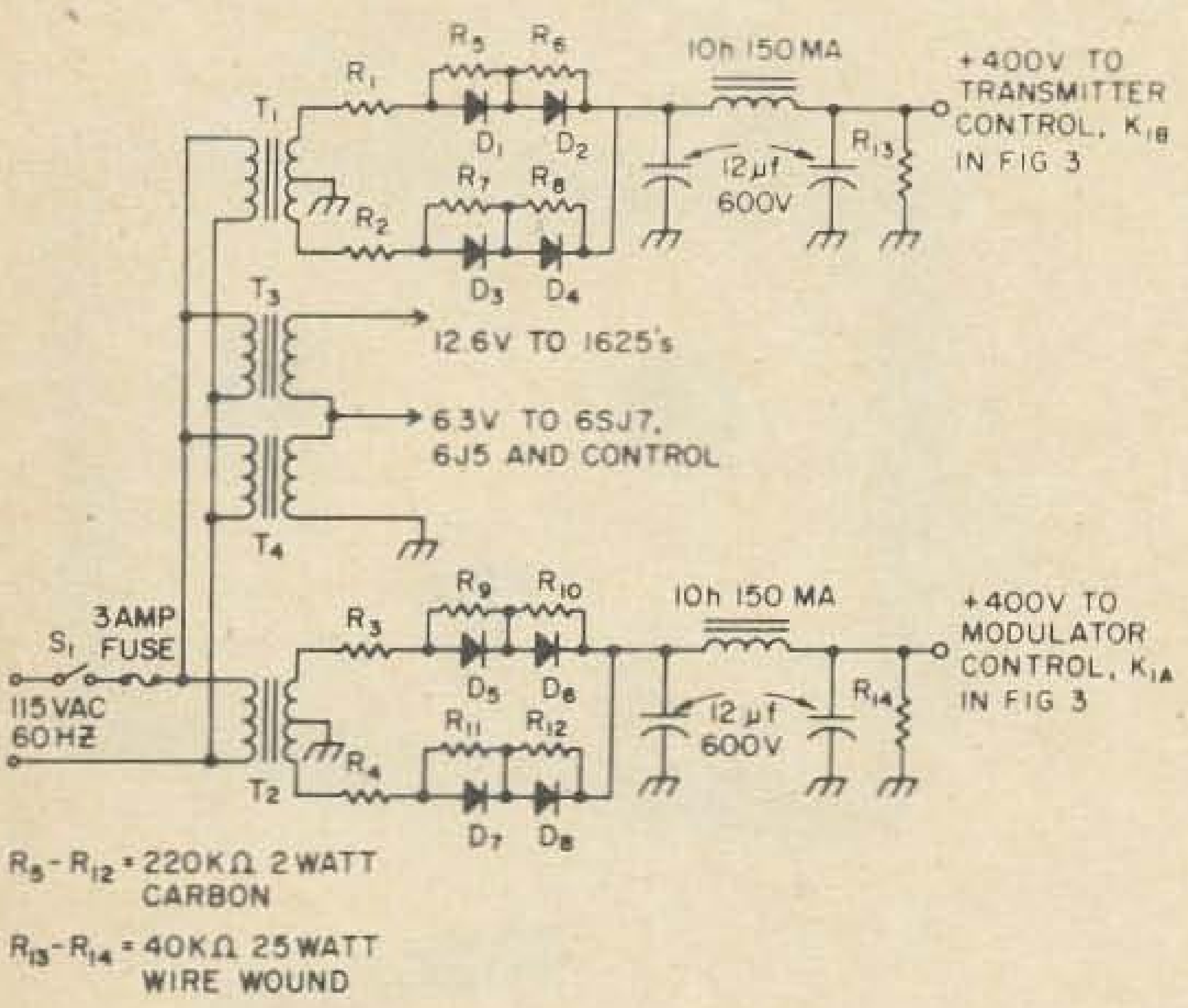


Fig.2. Power Supply.

The control circuit consists mainly of the relay and transformer shown in Fig. 3 . T5 was used to provide isolation from the 115 vac line, and to provide six volts for indicator lamps. The isolation is necessary if one side of the microphone push-to-talk switch is to be grounded. The relay was used for rf switching as well as power and control switching. At vhf a coaxial switch would probably be desired for this application to provide low loss and shielding against feedback. The method used, however, was considered adequate considering cost and simplicity.

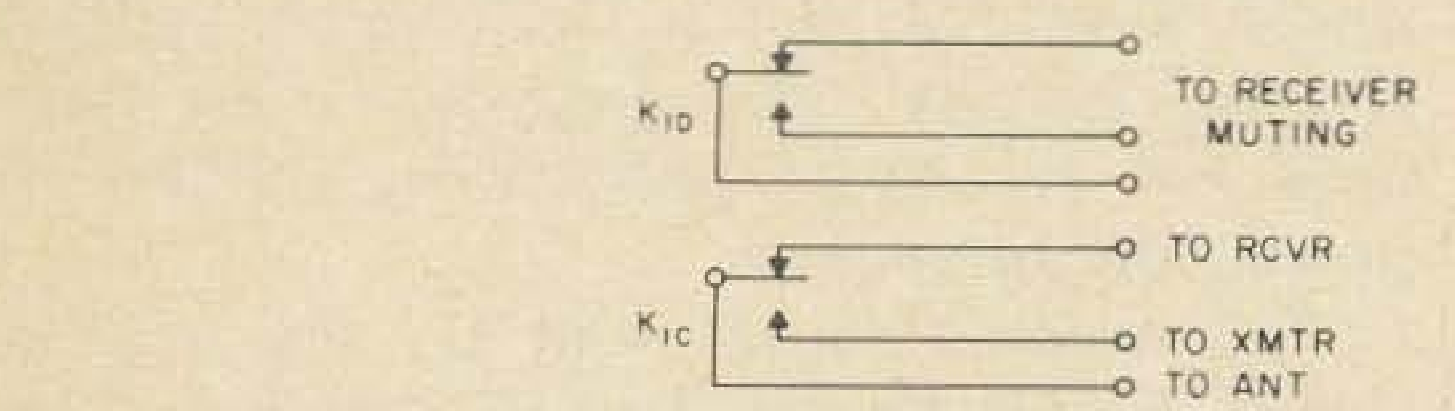


Fig.3. Control.

This is how it all started, now let's take a look at how it was built.

Construction

A standard 14 by 17 by 2 inch chassis was chosen along with the 19 by 8-3/4 inch rack panel and the side braces. They are all made by California Chassis. Handles were used on the panel because the unit is quite heavy. The layout and wiring are not critical except for the input audio stage, which should be carefully shielded to prevent hum and feedback.

If the relay is to be used for rf switching, the leads should be coaxial cables. In my case RG-58 was used.

Operation

The assembly can be tested one part at a time, first starting with the power supplies by measuring voltages, and proceeding through the amplifiers checking for output. Some typical voltages are shown in Fig. 1 . These voltages were measured with a 20,000 ohm per volt vom, with all power applied and no load or audio signal. The final checks can be made with a suitable resistor or an output transformer connected to a speaker used for a load. Under no circumstances should the modulator be operated with no load. Even a small signal at the input can cause high voltages in the modulation transformer that can break down the insulation. Once the unit has been checked and is found to be operating satisfactorily, the output can be connected to the screen and plate of a suitable rf amplifier final stage.

This unit has given excellent service and has been very dependable over a period of six months since the final version was put into service. The only failure was the result of a cold solder joint that had worked loose.

This modulator and power supply can become the basic starting point for a system made up of any number of low power *rf* units. Switching from one band to another can be accomplished by simply switching the filament power to each transmitter. The modulator could also be used in a more modest installation, as a part of a single transmitter. If this unit is used properly, it will give reliable and high quality performance in any system that its owner desires.

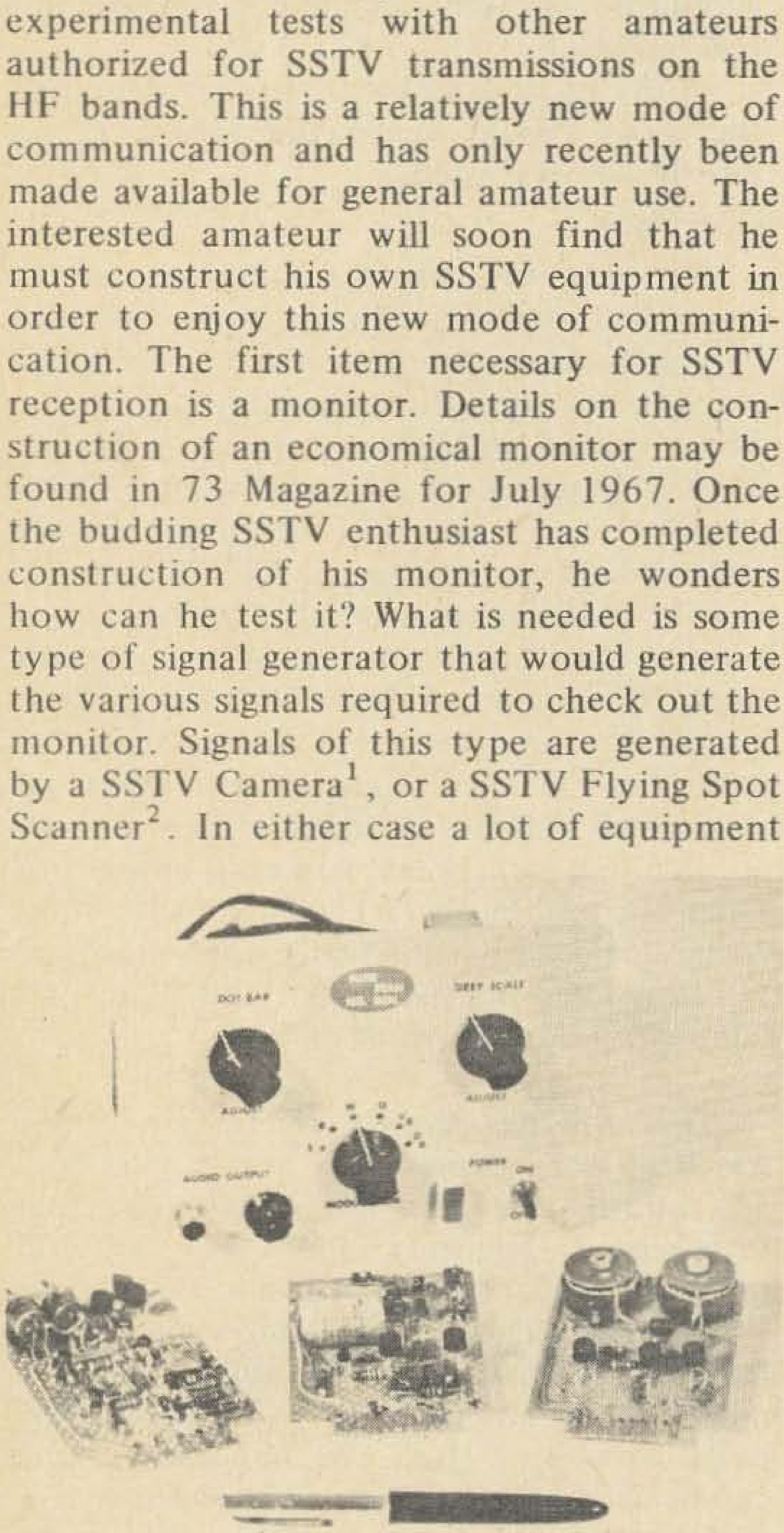
. . . WB6BIH

A Slow Scan Television Signal Generator

Louis I Hutton, K7YZZ
2235 SE 62ND St
Bellevue Washington 98004

For a two year period (1967-1968) I was granted permission by the FCC to conduct experimental tests with other amateurs authorized for SSTV transmissions on the HF bands. This is a relatively new mode of communication and has only recently been made available for general amateur use. The interested amateur will soon find that he must construct his own SSTV equipment in order to enjoy this new mode of communication. The first item necessary for SSTV reception is a monitor. Details on the construction of an economical monitor may be found in 73 Magazine for July 1967. Once the budding SSTV enthusiast has completed construction of his monitor, he wonders how can he test it? What is needed is some type of signal generator that would generate the various signals required to check out the monitor. Signals of this type are generated by a SSTV Camera[1], or a SSTV Flying Spot Scanner[2]. In either case a lot of equipment is involved in generating a test signal. The unit described in this article has been developed to provide SSTV test signals.

Generator with Panadaptor.



Three circuit boards that comprise the generator.

1 "A Fast-Scan Vidicon In The Slow-Scan TV Camera," 73 Magazine.

2. "A Slow-Scan Television Picture Generator," 73 Magazine, Oct., 67.

Circuit Description

The SSTV Signal Generator provides selectable test signals of the Sync, Black and White Frequencies, a variable Grey Scale signal, a vertical Bar pattern and a variable Dot-Bar pattern. The sync signals are stabilized by synchronization with the 60 Hz power line frequency.

The transistors Q1 and Q2 are used to shape the 60 Hz power line frequency sine wave into a square wave so that it will stabilize the horizontal frequency miltivibrator (Q3 and Q4) at 15 Hz. The 8 second per cycle vertical oscillator (Q5 and Q6) is frequency stabilized by inter-connecting the horizontal oscillator through the IN-648 diode and the .047 coupling capacitor. Sync pulses are taken from the collectors of Q4 and Q6, combined and fed to the sync amplifier Q10 and modulator Q11. The vertical sync pulse is 30 ms long and the

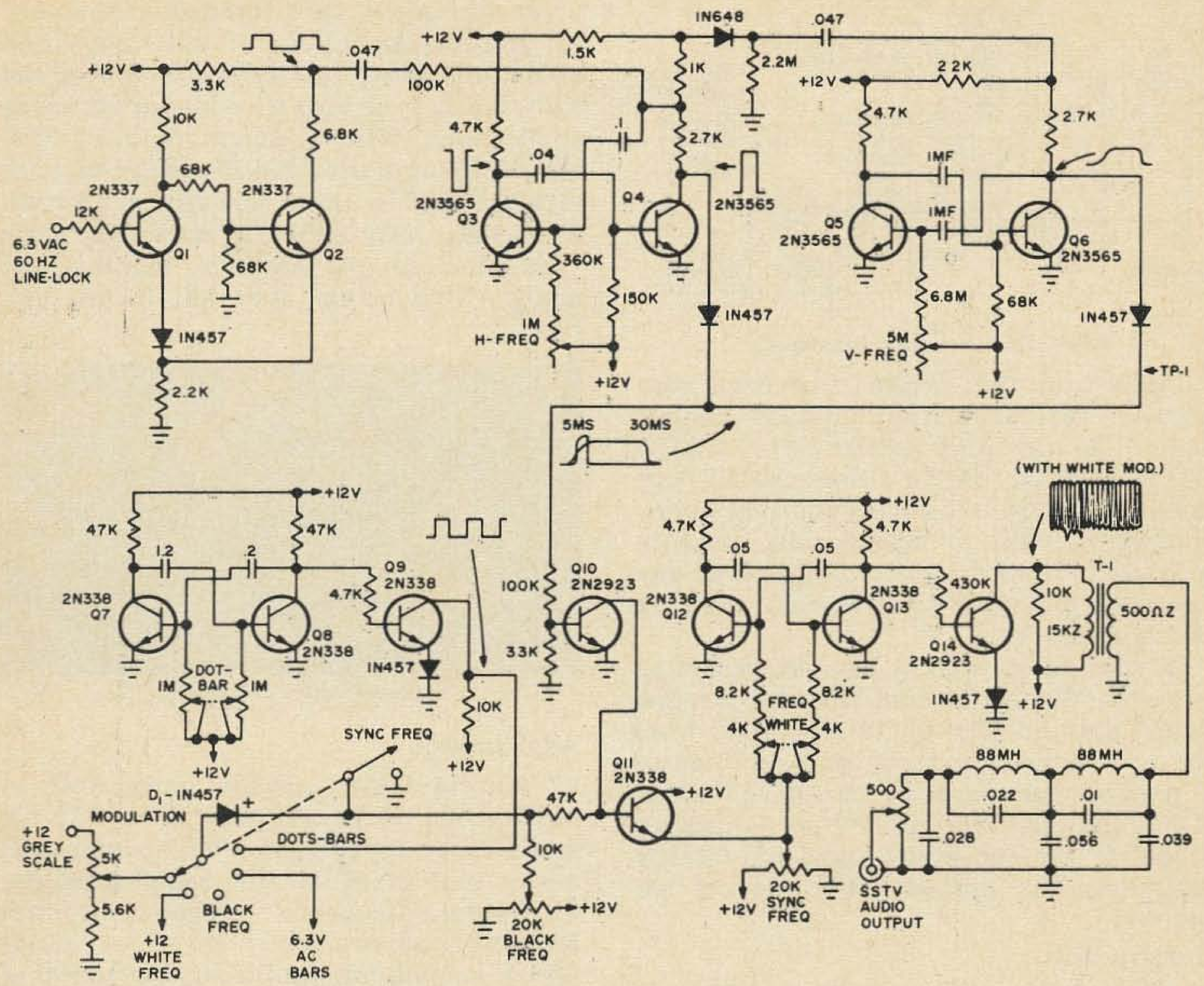


Fig. 1. Schematic of SSTV signal generator.

horizontal sync pulse is 5 ms long. The Dot-Bar oscillator (Q7 and Q8) output frequency is manually adjustable from approximately 7 Hz to 80 Hz. This signal is amplified by Q9 and is connected to the Modulation Switch Dot-Bar position.

The 1500 Hz SSTV sub-carrier oscillator (Q12 and Q13) output is amplified by Q14 and is connected to the low pass filter through the step down transformer T1. The low pass filter rounds off the square wave output from the sub-carrier oscillator and attenuates any spurious frequencies generated above 3000 Hz. Positive going voltages appearing at the base of Q11 will shift the sub-carrier oscillator up in frequency and negative going voltages will shift it down in frequency.

The sync pulses from the sync oscillators are of the proper polarity when they appear at the base of Q11 to cause the 1500 Hz sub-carrier oscillator to shift to 1200 Hz for the duration of the sync pulse. The positive

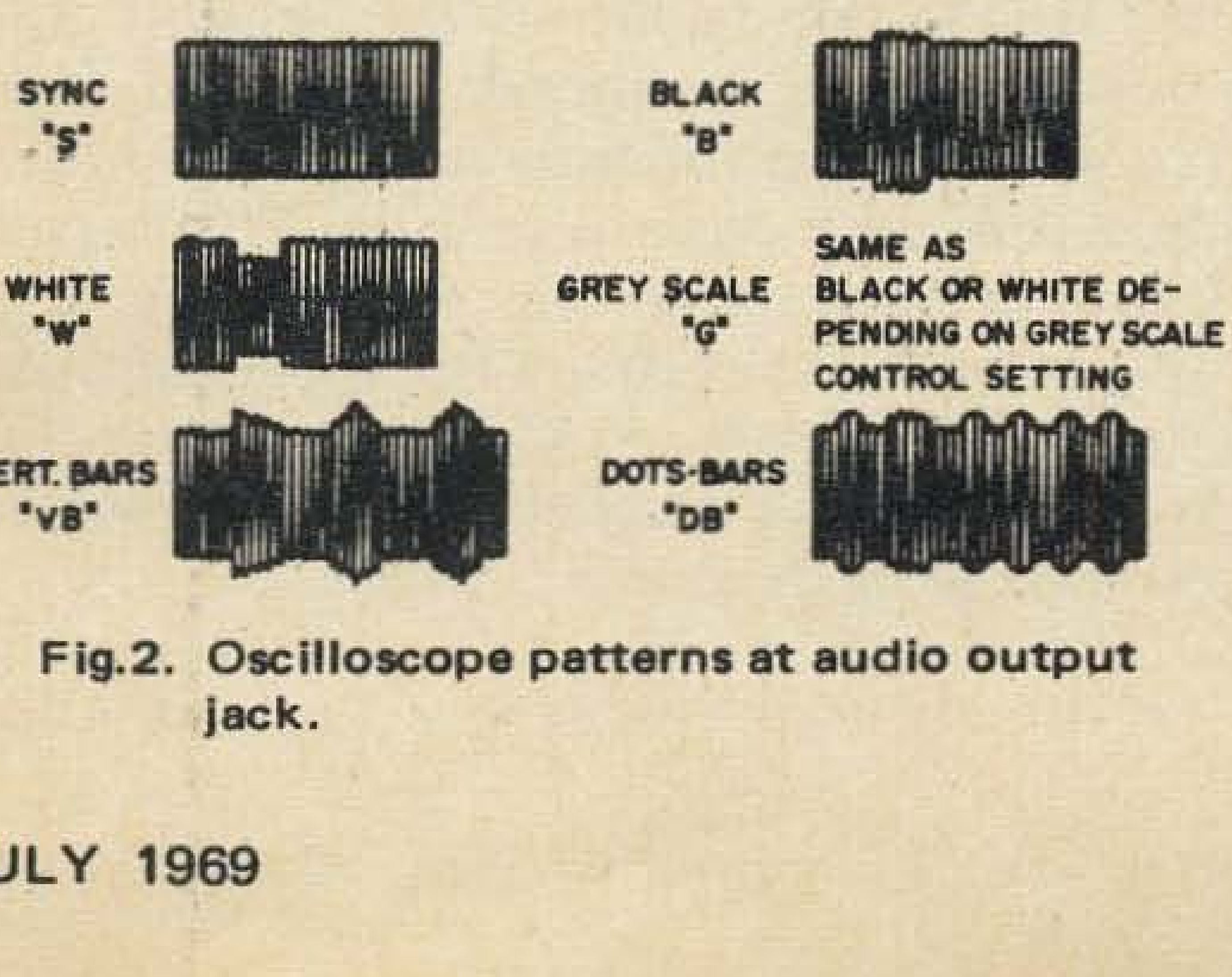
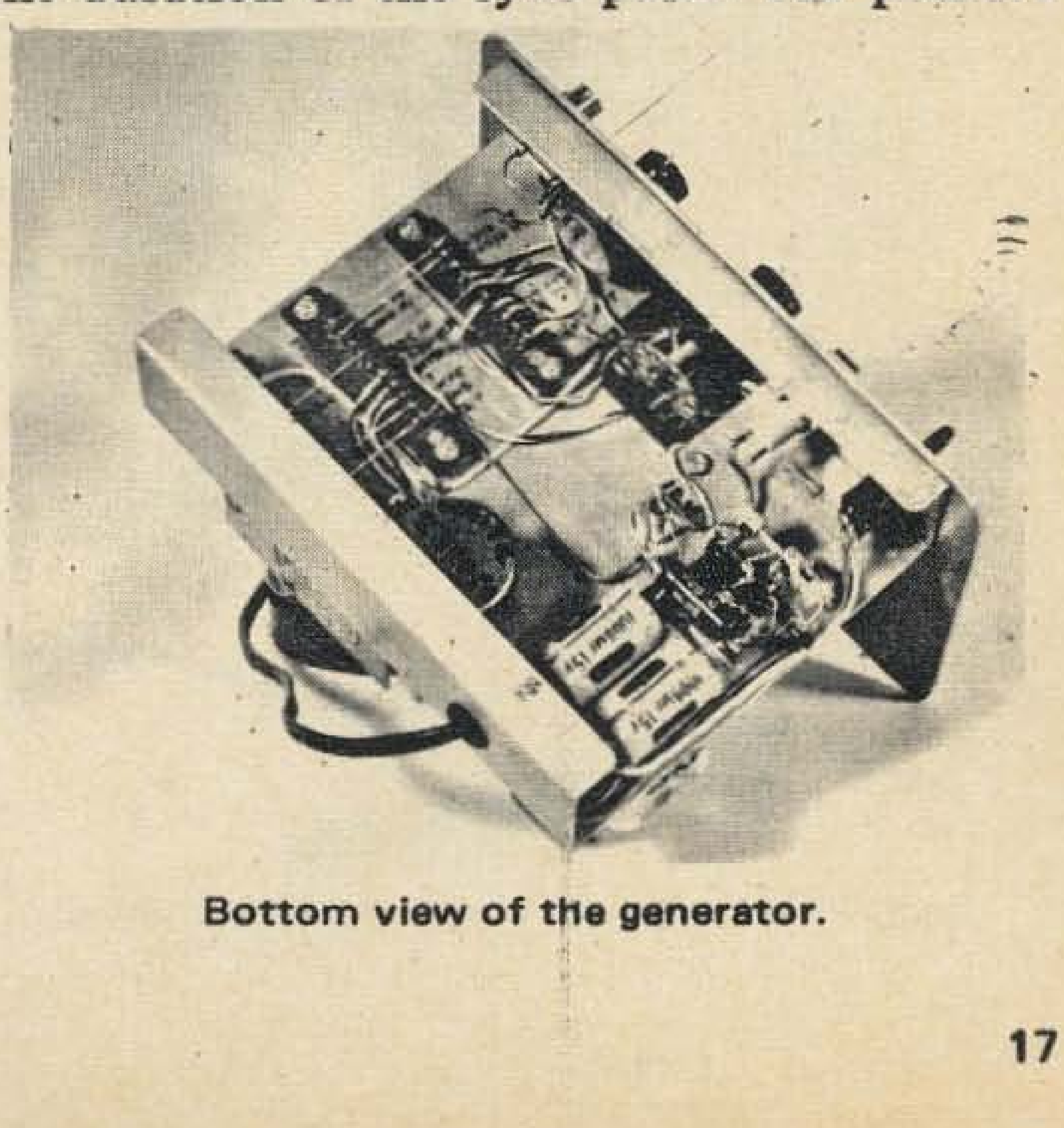


Fig. 2. Oscilloscope patterns at audio output jack.



Bottom view of the generator.

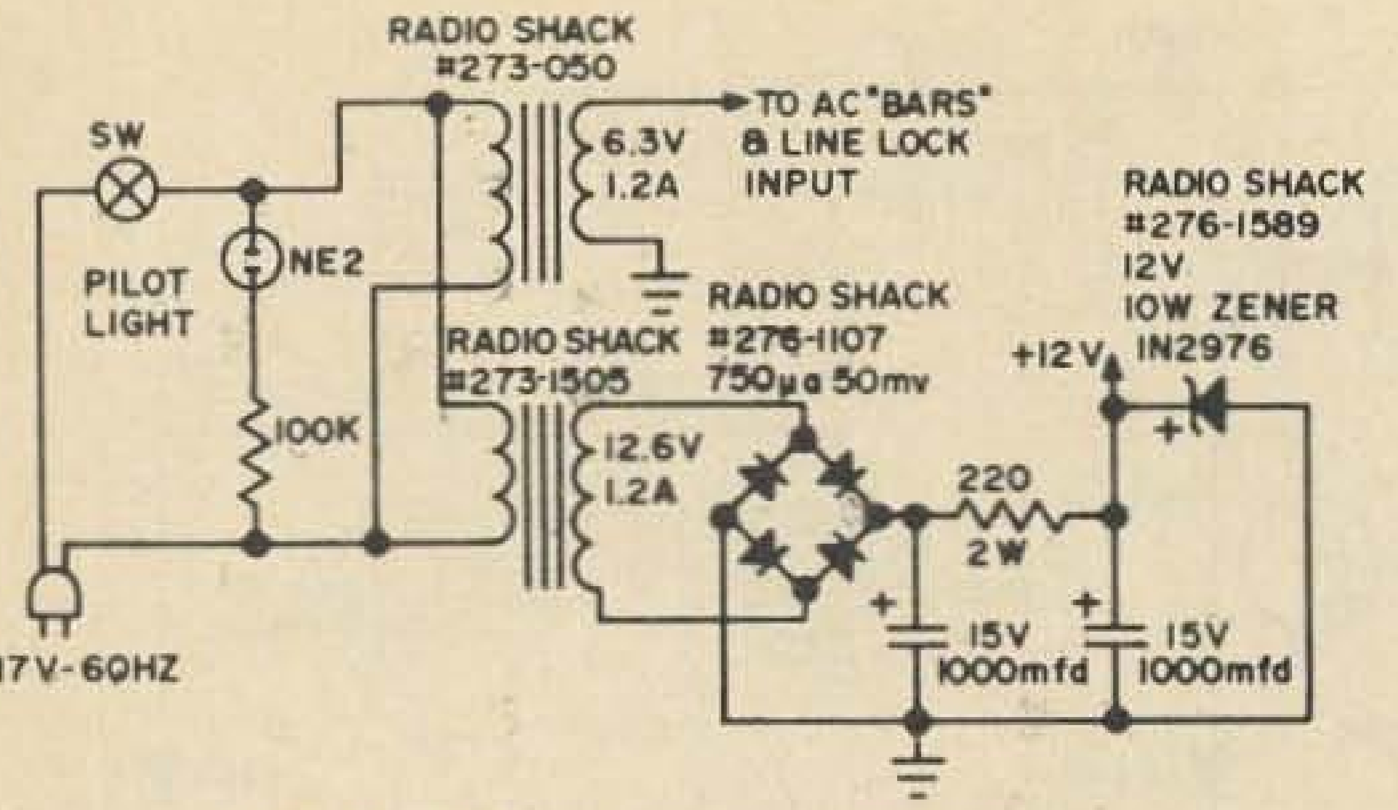


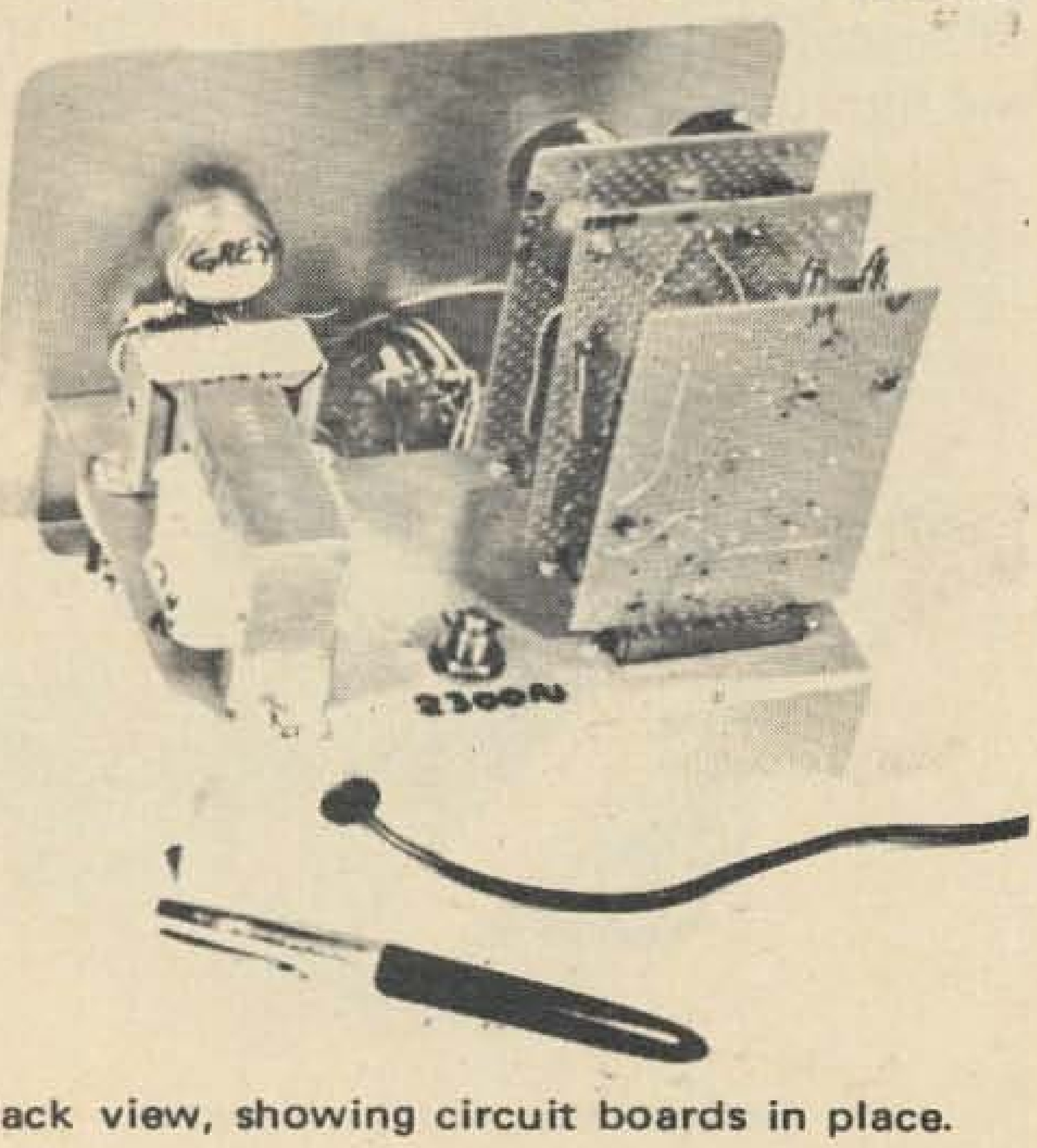
Fig.3. Power supply schematic.

12 volts from the "White" frequency position on the Modulation function control drives the sub-carrier oscillator from 1500 Hz to 2300 Hz. In the "Grey Scale" position, the voltage is manually adjusted from a positive 12 volts to near 0 volts which in turn shifts the sub-carrier oscillator to any frequency between 2300 Hz and 1500 Hz (White to Black).

Several fixed vertical bars are generated when the Modulation control switch is in the "Bar" position. The 60 Hz sine wave from the 6.3v filament transformer is rectified to a positive half wave by the IN457 diode (D1). This half wave dc voltage is used to modulate the sub-carrier oscillator thereby generating the desired stable vertical bar pattern.

Construction

The major portion of the electronic circuitry is assembled on three plug-in perf-boards. One board contains the circuits for Q1 through Q6. The second contains the circuits for Q10 through Q14. The third board is used for the low pass filter and Q7 through Q9. The chassis is of hand-formed aluminum and is 5" D x 6½" W x 1½" H. The cabinet is 6" D x 8" W x 6" H. Point to point wiring was used throughout the unit. All resistors are of the ½ watt size unless noted otherwise. All transistors are of the NPN silicon type used for audio or switching applications. Many different types of NPN transistors were tried and all seemed to work satisfactorily in these non-critical circuits. The reader may probably note that some types used are old numbers, but that just happened to be the type left in my junk box.



Back view, showing circuit boards in place.

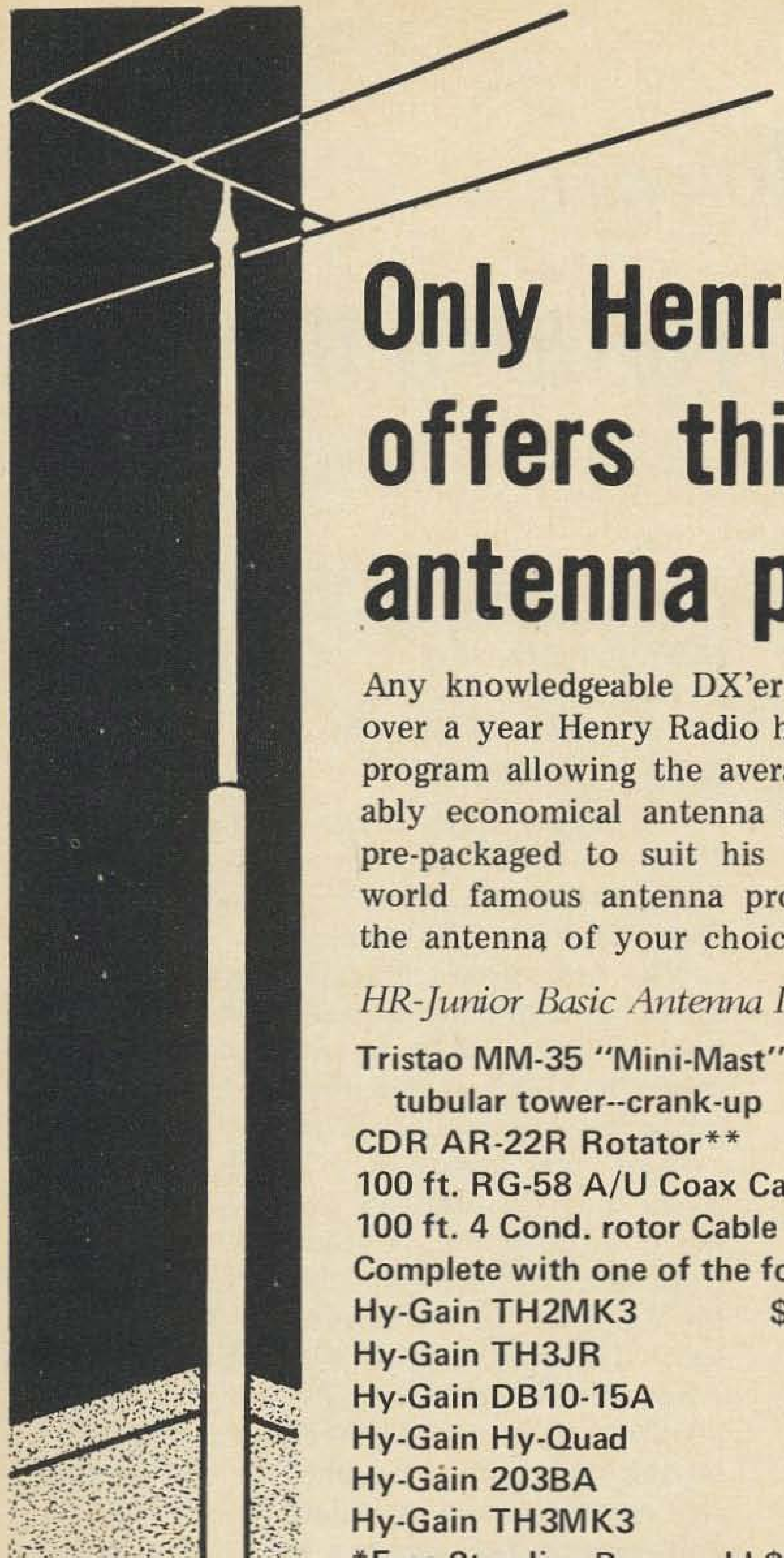
Generator with Panadaptor

Adjustment

Connect a low capacity probe from an oscilloscope to the test point TP-1. With the scope sweep set to 15 Hz and the horizontal sweep sync at 60 Hz the signal generator horizontal frequency oscillator control should be adjusted for 15 Hz. There will be one 5 ms pulse appearing on the screen of the scope. The adjustment of the vertical sync pulse is more time consuming because of the long time lapse between pulses (8 seconds). Slowly adjust the vertical frequency control until the start of the vertical sync pulse coincides with the start of the horizontal sync pulse at each 8 second interval.

An audio frequency meter or audio digital frequency counter of the type described in 73 Magazine for November 1967 is connected to the SSTV Audio Output Jack. Preset the Black, White and Sync frequency controls to mid-rotation. Select "White" on the Modulation control and adjust the white frequency control to 2300 Hz. Then turn the Modulation control to "Black" and adjust the black frequency control to 1500 Hz. With the modulation control at "Sync" adjust the sync control to 1200 Hz. Repeat these adjustments several times as there is some interaction between the three controls. Typical oscilloscope patterns as observed at the SSTV Audio Output Jack are shown in accompanying diagrams.

. . .K7YZZ



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Illustrated: Tristao MM-35 "Mini-Mast"

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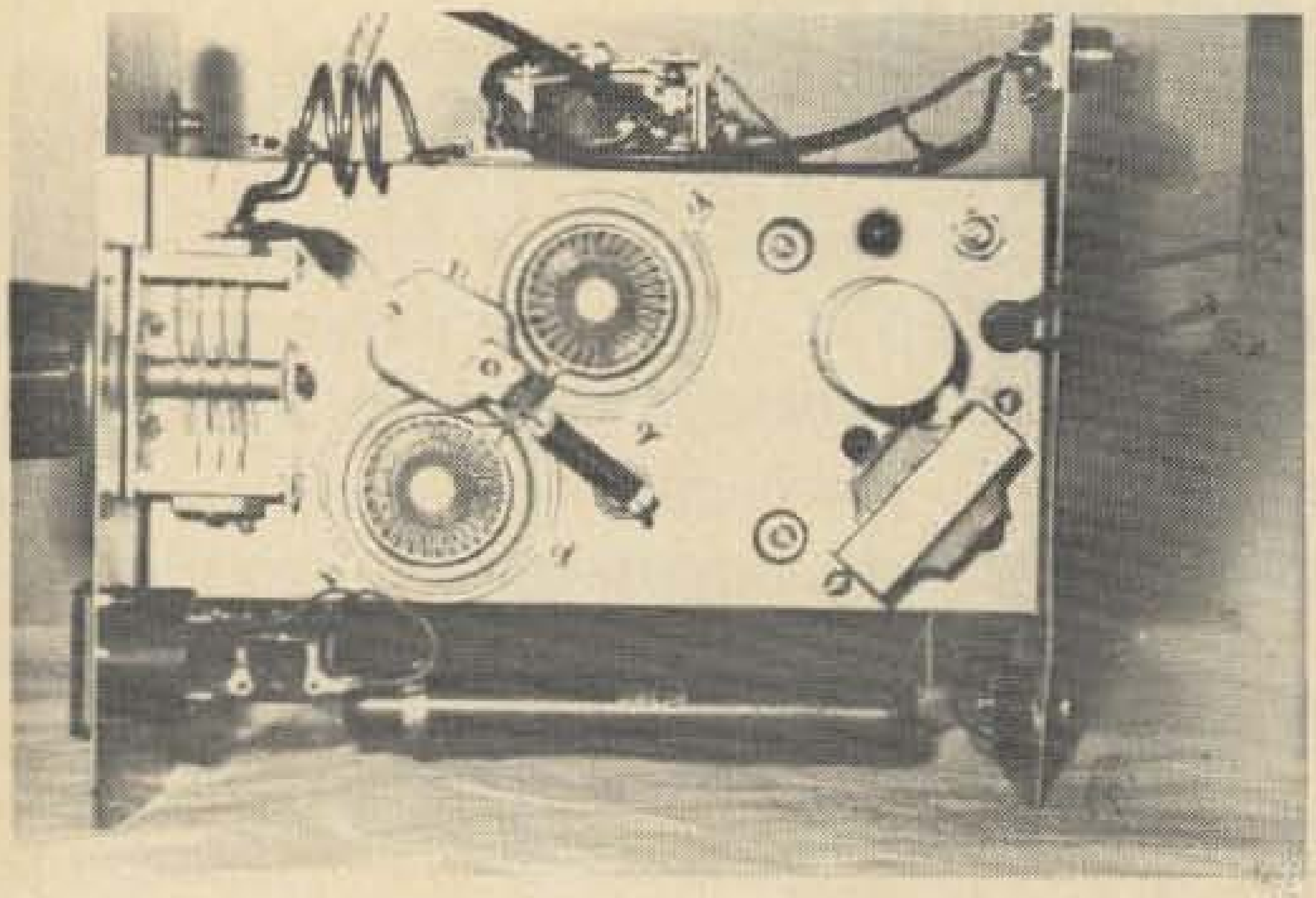


Top view of the amplifier. The resistor at the bottom of the picture is in series with the 100 CFM blower used to reduce air flow noise.

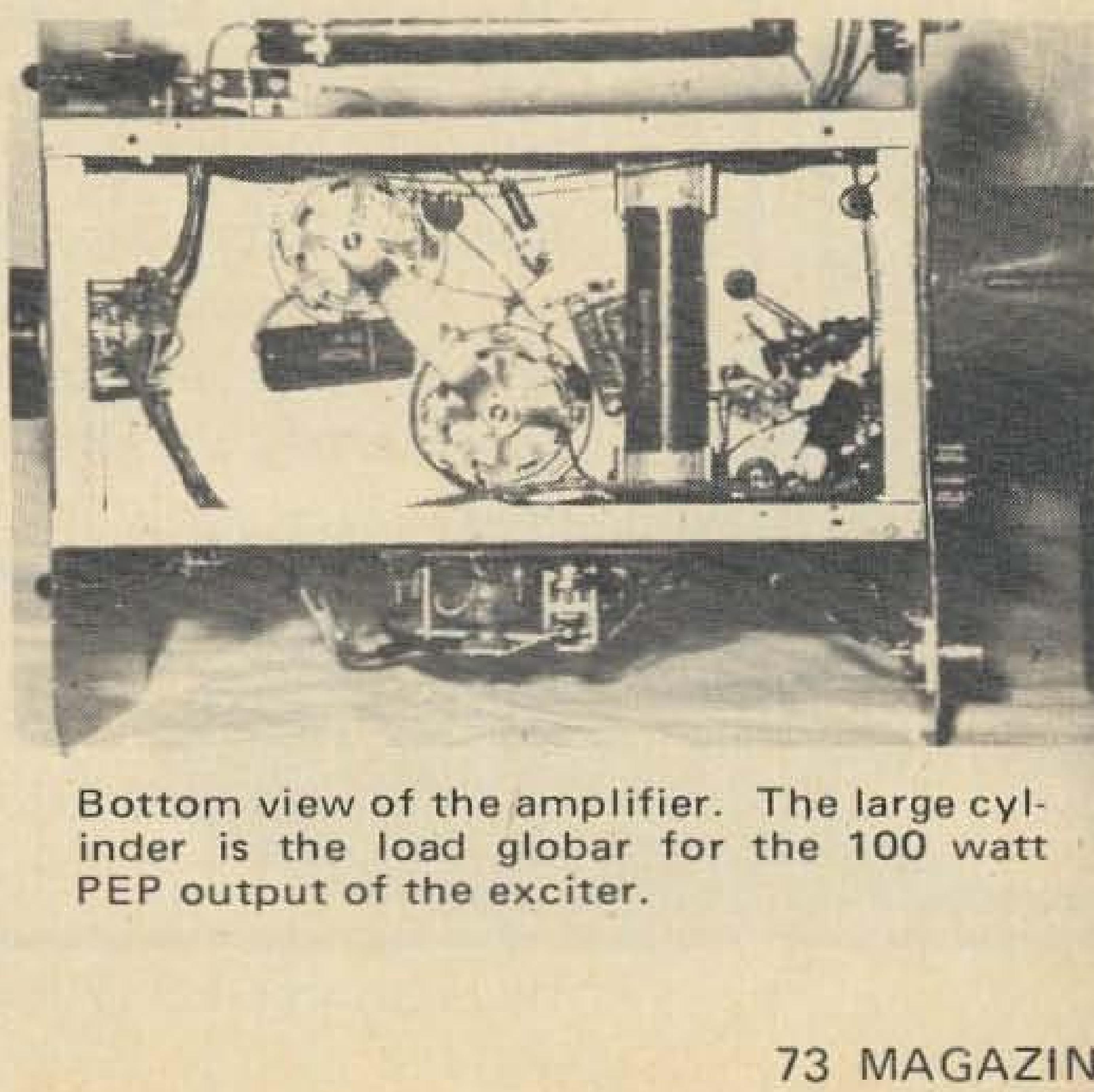
With the increasing sales of 6 meter SSB gear in kit and wired form and the sunspot cycle on the upswing, many hams are showing interest in running greater power in hopes of working long distance ground wave and international DX. This article will outline a simple, inexpensive kilowatt PEP linear and power supply. Quite frankly, the original amplifier was based on one described by K6QQN and W6QMN in the November 1961 issue of "73." The original has been rebuilt and modified several times during the past year. Three additional amplifiers of this type have been built, two more are under construction and several are in the talking stage. Performance has been outstanding, all have shown a signal increase on the order of 10 db and have been free of bugs. This power level was decided upon for several reasons. The tubes and transformers are readily available at reasonable prices, and the size and weight are in keeping with the state of the art.

Experience has shown that with careful shopping the complete unit can be built for less than $100, even if all parts are purchased. The average junkbox will make a dent in this figure. In fact, many parts may be salvaged from a TV if desired. All of the capacitors in the linear, the bias network resistors and potentiometer, low voltage·transformer and rectifiers, etc., may be obtained from this source at little or no cost.

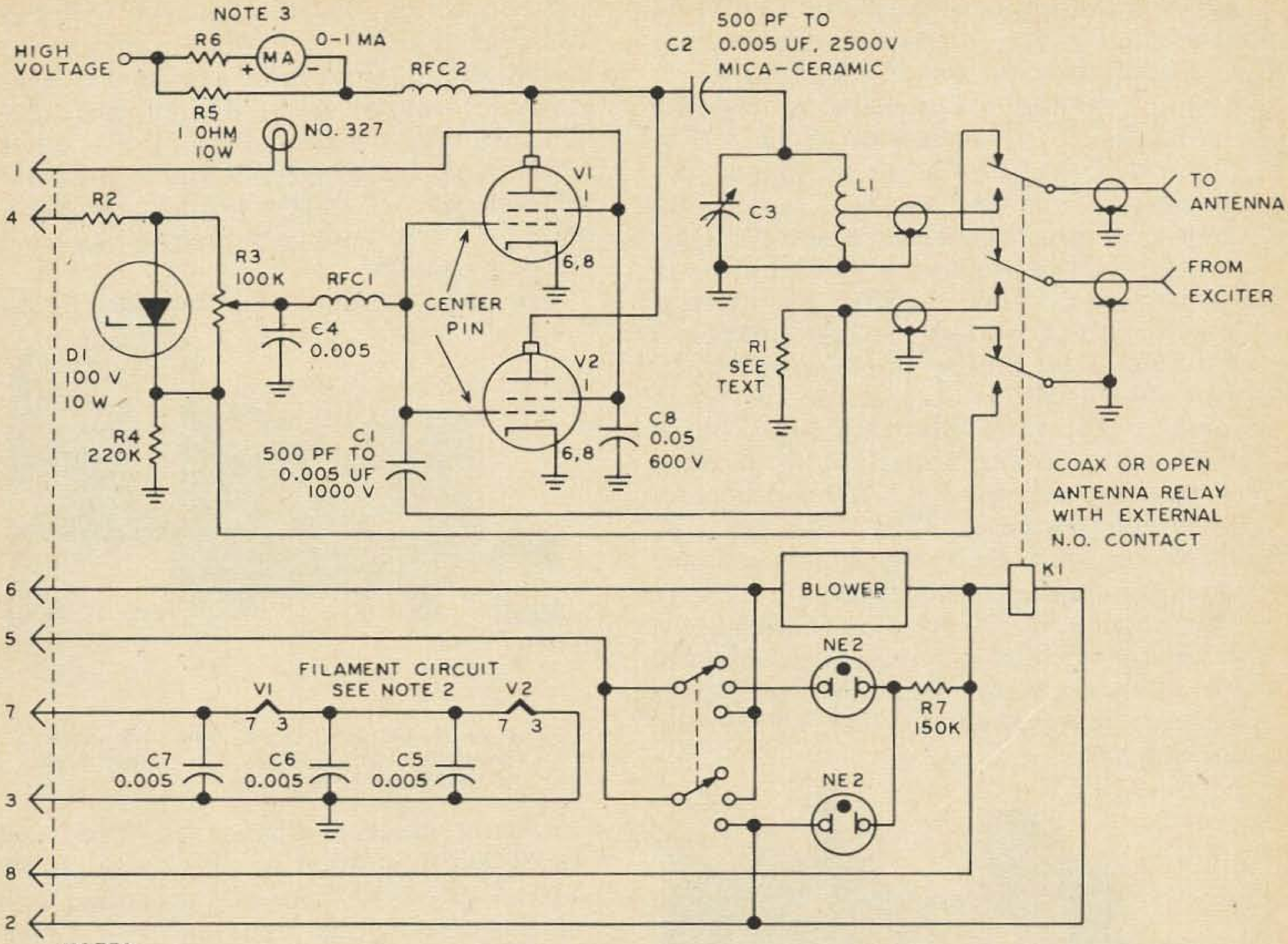
General Description

The linear consists of a pair of 4x150A/7034 or 4CX25OB tubes in parallel in a passive grid circuit. The plate voltage is 2000V, plate current is 500 ma peak.

The grid circuit load is dependent upon the amount of drive available. A 50 ohm, 50 watt Globar may be mounted internally for rigs in the 100 watt PEP output class or a Cantenna may be connected to the input through a coax "tee" connector. Much lower drive levels may be used by increasing the resistance at this point. A noninductive (carbon) resistor of sufficient wattage rating will allow the amplifier to be driven by five watts or less. The plate circuit is shunt fed through a home-brew or Ohmite Z-50 choke. Matching the load is accomplished by tapping down on the tank coil with a clip. Screen overcurrent protection is afforded by a #327 light bulb which acts both as an indicator of screen current and as a fuse.



Bottom view of the amplifier. The large cylinder is the load globar for the 100 watt PEP output of the exciter.



NOTES:
1. C3 = 25 TO 40 PF MAX, 3000 V.
2. C4–C7 = 600V CERAMIC. CONNECT C5–C7 DIRECTLY TO GROUND USING AS SHORT AS POSSIBLE LEADS.
3. R6 + RM = 1000 OHMS.
4. RFC1, RFC2 = 1-3/4" #28E ON 3/8" TEFLON, OR OHMITE Z-50
5. V1, V2 = 4X150A, 7034, ETC.

Fig. 1. The schematic for the six meter linear amplifier.

Purists may frown on some of the preceding, however there are good reasons for it. The passive grid circuit will accommodate any reasonable drive level and while wasteful at high levels it should be remembered that linears are for use only when required to maintain communication. It also eliminates neutralization as well as several parts. The shunt fed tank also makes for simpler, less expensive, and easier to adjust equipment. The bulb in the screen circuit functions as a protection relay and meter as well, but costs only a small fraction as much.

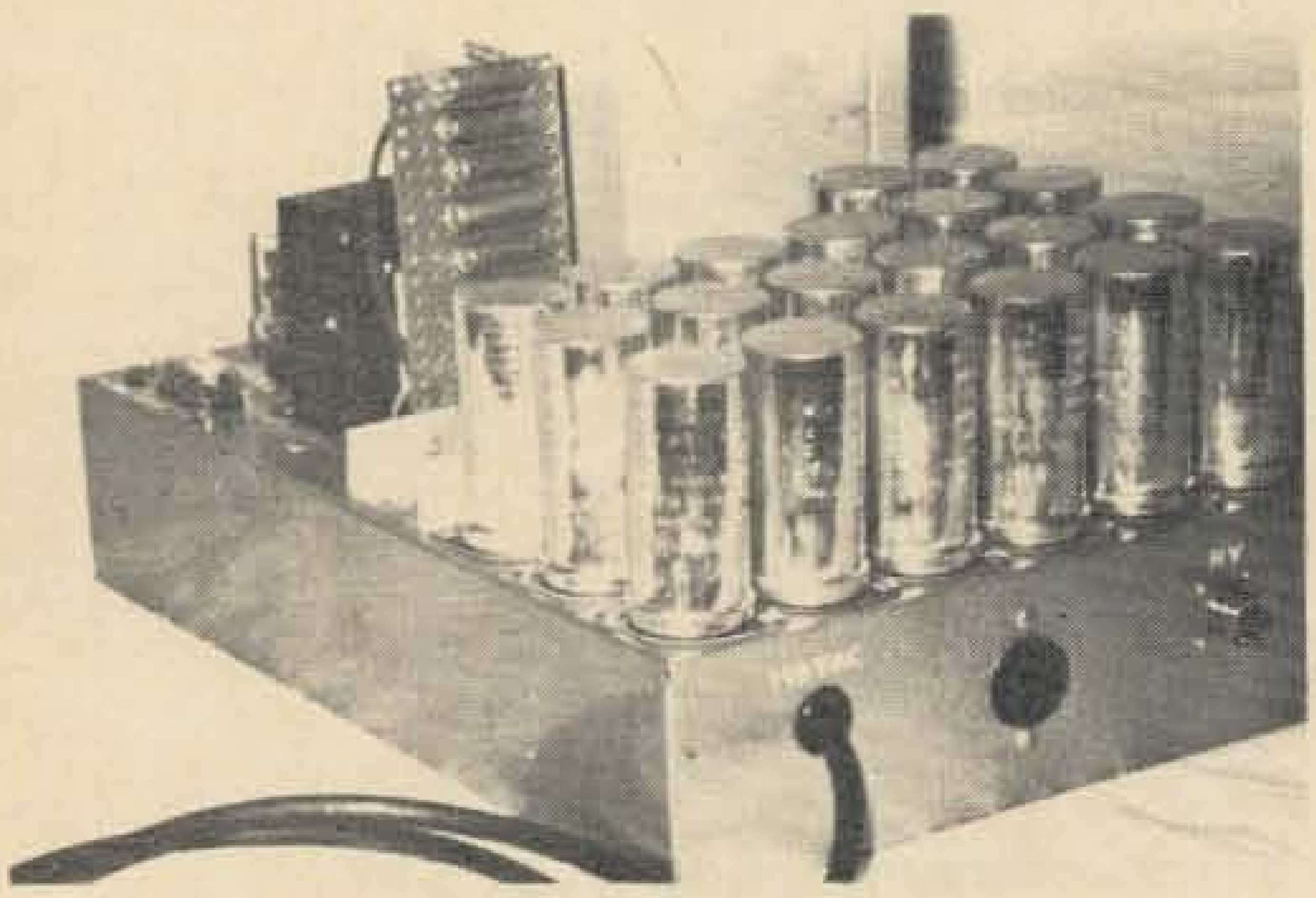
The screen power supply consists of a light to medium duty replacement or TV transformer, with full-wave rectifier and capacitor input filter. This supply is zener regulated at 300 to 350 volts. One half of the same winding is half-wave rectified and regulated (in the linear) at 100 volts negative for operating bias. The same supply furnishes cutoff bias in the receive condition. Filament voltage is obtained by phasing the 6.3 and 5 volt transformer windings in series. Slightly over 11.3 volts is available to the filaments which are also wired in series. This arrangement runs the finals at approximately 5% below their nominal 6.0 volts, which is within tolerance.*

The DC Supply

The high voltage transformer is rated at 850 to 1000 volts center tapped at 350 to 500 ma. Several power supplies have been built with a commercial surplus transformer available locally at $5.95. This transformer is rated at 1000 volts CT at 400 ma and provides 2200 volts at 450 ma in SSB service. Several nationally known supply houses list

*Ed. note: This voltage should be measured during normal operation to ensure that it stays inside tolerances.

usable transformers at $2.00 to $5.00. In some cases it may be necessary to series or parallel two transformers in order to arrive at the proper voltage or current rating. I would recommend a transformer of about 850 to 900 volts CT, otherwise the maximum voltage rating of the tube will be exceeded (this has been done without harm, however). Only the high voltage winding is used in order to increase the available current. Rectification is by eight 700 volt PIV silicon diodes in a voltage doubler and the filter consists of sixteen 40-40/450 volt capacitors in series-parallel. The total filter rating is 20 mf at 3600 volts. Twenty capacitors of the same type were purchased for $7.80 and used for all filtering purposes. The 10" x 14" x 3" chassis on which the power supply is mounted is not crowded. All bleeders are 13 K, 10 watt obtained at 20 for 59¢. Each bleeder section in the high voltage supply consists of two of these resistors in series. The remaining resistors are used in the bias and low voltage supplies.

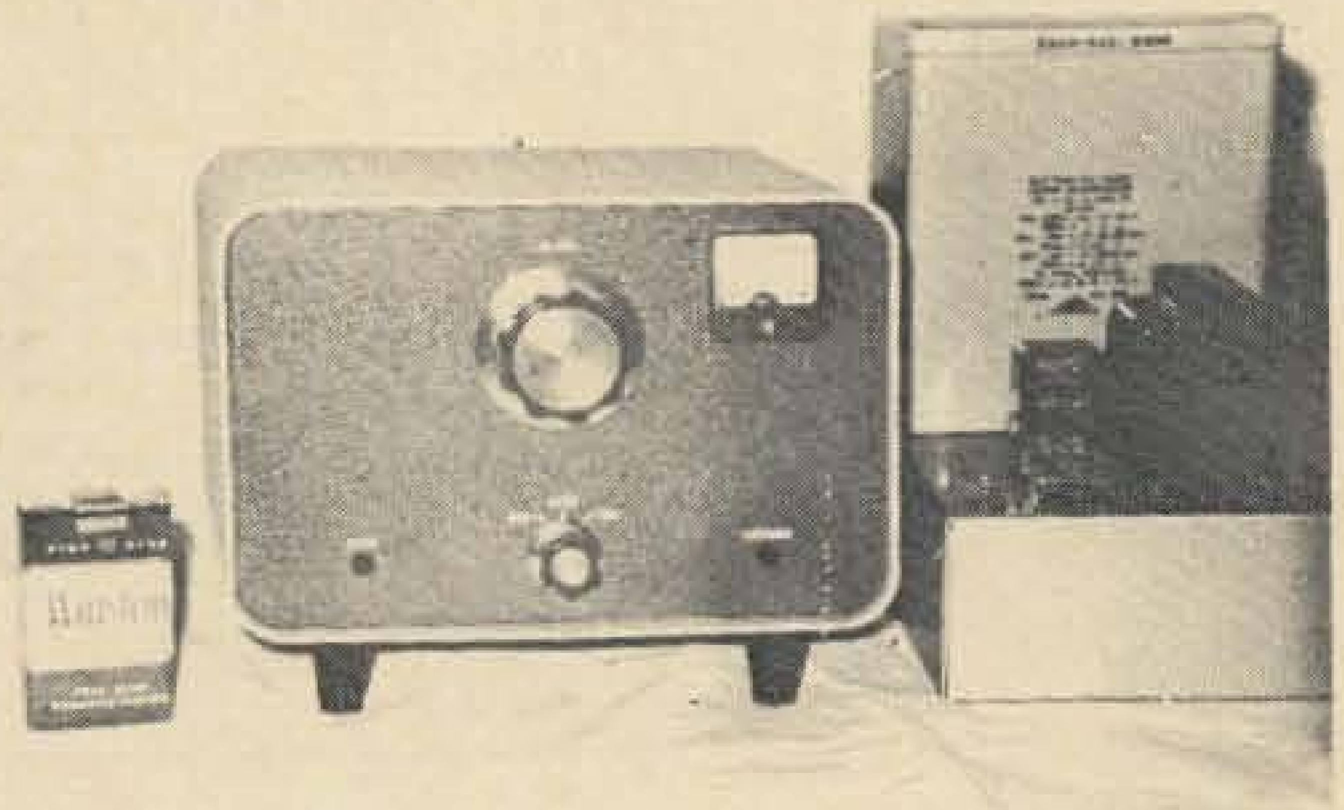


Power supply

Finishing Up

The controls are all on the amplifier and consist of a two pole, three position switch which turns on the 60 CFM blower and the filament, bias, and screen supplies in the "standby" position and also keys the high voltage primary relay in the "operate" position. This primary voltage is also fed to the antenna relay coil through the normally open contacts (spare) on the exciter PTT relay so that in "standby" it is possible to operate the exciter alone and in "operate" the linear is automatically switched into service. The only other panel control is the plate tuning capacitor. Neon lights indicate the position of the function switch. Inside controls adjust the bias in "operate" position and control the antenna loading. All of the control and low voltage wiring is contained within an 8 conductor cable: the high voltage lead is separate and consists of a length of RG-8U with PL-259 connectors which have been painted *red* to indicate their unusual function. Other connectors may be used if desired. Plate current metering consists of a 0-1 ma meter which with the proper multiplier indicates full scale when 1 ampere is drawn through a one ohm resistor which is in series with the high voltage lead.

The amplifier shown was built in a Heath



The amplifier matches the Heath SB series. It should be possible to use it on other bands by changing the tank circuit.

SB series speaker cabinet and fitted with Heath knobs in order to compliment an SB-110. A 10"x5"x3" chassis is supported within the case by the front and rear panels.

The panel was sprayed with Illbronze, "forest green" wrinkle paint, which is good for the Heath green. For Swan owners, I suggest the possibility of using a power supply cabinet. The above mentioned paint also comes in black.

Adjustment is simplicity itself. The exciter is tuned up per usual with the linear function switch in the "off" or "standby" position. The linear is then switched to "operate" and keyed momentarily while the bias control is adjusted to a static current reading of 200 ma. At this point a small amount of drive is applied and the plate tuning is peaked for maximum output as indicated by an SWR bridge in the forward mode or by using a monitor scope. Modulation is now applied until the plate current *peaks* at 500 ma. Some slight adjustment of the tank coil tap may be required at this time in order to load the amplifier properly.

The possibility of using commercial pull-out tubes should not be overlooked. These tubes are common in FM broadcast and aircraft ground station transmitters and as such are often changed on a time basis rather than on condition. They are available at hamfests and at surplus stores at nominal prices.

Amplifiers have been built with coax and

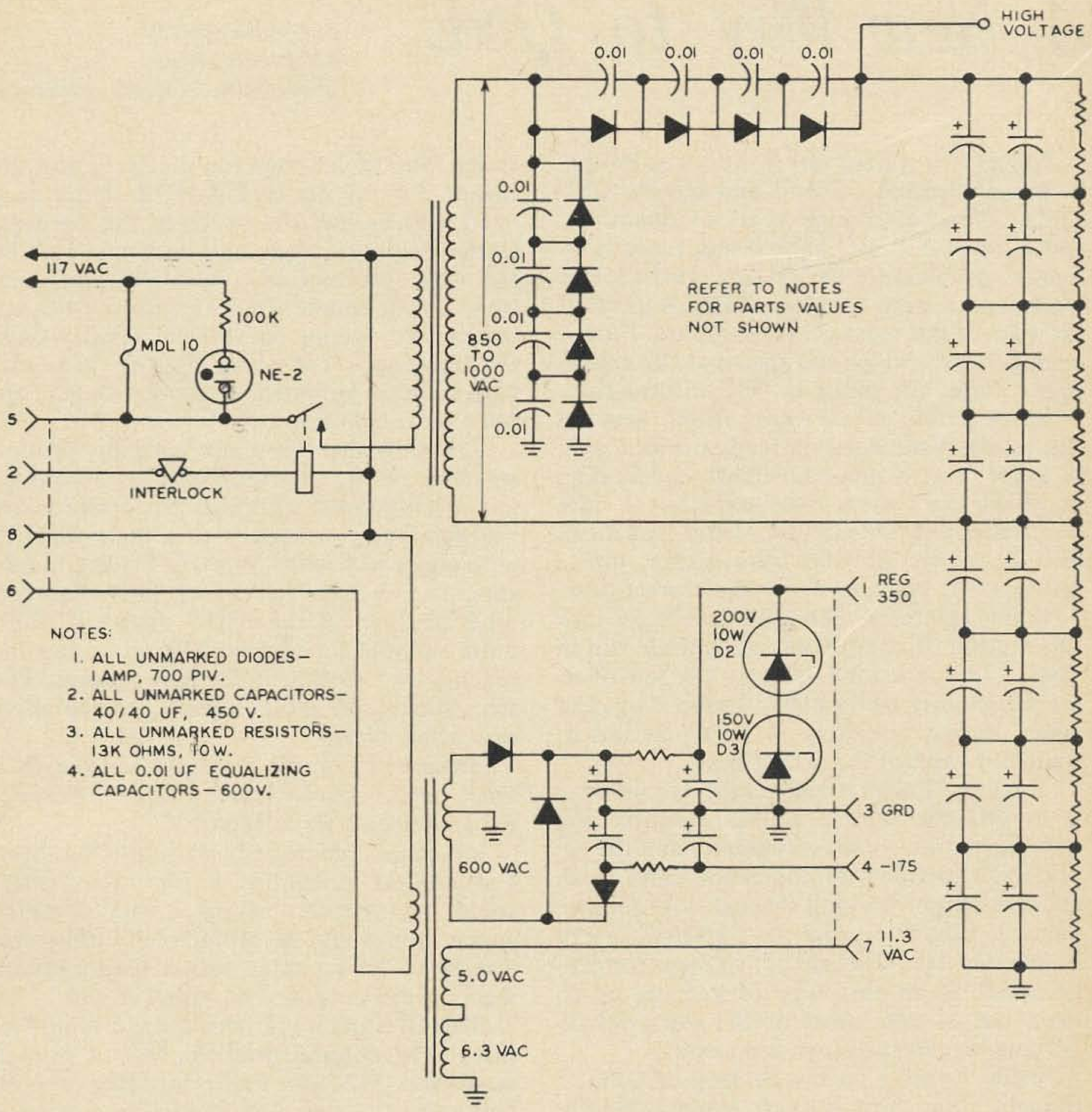


Fig. 2. Power supply diagram. See caution note at the end of the article.

open type antenna relays. The coax type have been found to be preferable; however, the open type will work quite well and will save the builder much cash.

For the sake of economy the blown fuse indicator and power supply cover interlock may be omitted. It is suggested that in the interest of safety the interlock be included.*

Most of the parts are of a highly non-critical nature. The input and output coupling capacitors have been varied from 500 pf to .005 without degrading performance. Various tuning capacitors have been used and all have worked well. The plate coil in each case was adjusted to resonate at 50 mhz with the capacitor fully meshed. Blowers from 30 to 100 CFM have been tried, the only undesirable effect noted was increased air flow noise above about 60 CFM.

The most critical item is the tube socket. *Do not use sockets without the built-in bypass* and do not leave out the external screen bypass.

...WAØABI

***Ed. note: I would suggest safe plastic covers for the large electrolytic capacitors at the top of the chassis. The interlock should *not* be eliminated under any circumstances, and do *not* depend on the bleeder resistor to drain the capacitor bank. Short *each one* before working on this rig. The amplifier is a good design, but could become a death trap for the uninitiated. If you haven't been burned yet, believe me, it isn't fun.**

A New Way to QSL

Ken Millar, ZE7JV
8 Plympton Road
Chadcombe, Salisbury, Rhodesia

When I first started out in Amateur Radio, it was a pleasure to send and receive QSL cards. Now, after nine years of operating, and a lot of contests behind me, there is no longer any pleasure in QSLing. Just a lot of work, and a large backlog of QSL's to catch up with. Like most other amateurs, I use a personal card, which has spaces at the appropriate places for filling in QSO information.

Some amateurs use cards which have all the necessary information ready printed, and, in order to save time and effort, check, ring, or strike out where necessary, but I have never adopted this method. I feel that it can lead to errors in vital information, unless great care is taken to check the correct item.

Some amateurs who QSL 100%, get into the routine of completing cards while still in QSO. This is a good system, but few of us are sufficiently methodical to keep it up, and when contest operating, it isn't practical to write out cards at the same time.

It seems, though, that present day practice is to QSL on receipt, unless, of course, the worked station's card is required, and the economy is justified—although the extra work and time spent looking through logs for previous months and years for a station's entry is considerable. What the active operator really needs, is an easy way of keeping up to date, but to take most of the work out of QSLing, a radical change is necessary.

While working on my backlog of QSLs, I thought about how the task could be simplified. I recalled that while operating in contests, log-keeping had been simplified by taking carbon copies, sending the original to the contest organizers, and keeping the carbon copy for my station records. I remembered, also, those "GE" cards which were so popular a few years ago, that used a small extract of an ARRL log book for the QSO information. It seemed to me that the way to simplify QSLing would be to use a method which would transfer the log information onto the QSL, with a minimum of effort.

If the logbook were made so that a strip of paper with the QSO information on it, it could be torn out and gummed to the QSL card, this would greatly reduce the amount of work required. The pages of the log book would be in duplicate, with a carbon in between—the upper page for the QSL, and the carbon for the actual log. The upper page need only be half the width of the log page, as the only writing on this portion would be the QSL information. Additional information, power input, time of ending QSO, remarks, etc. would be written directly onto the log page. The paper used for the QSL page could be gummed, or plain with gum applied by an applicator.

The QSL sheet does not need any printed wording on it, just the columns necessary, and perforations, although perforations are not absolutely necessary as a little practice with a pair of scissors, or razor blade and rule should soon make light work of it. The column headings in the ARRL logbook aren't quite suitable for this application, as the line spacing isn't sufficient for easy tearing. The strip should be about ½ inch deep to allow ease of handling.

Suggested column headings for the QSL sheet are: Date; Time; Station Worked; Freq.; Mode, 2-Way; Report.

All other columns appear on the log sheet. For contest operating, a second log sheet could be inserted, making a total of three copies, and it may be preferable to use looseleaf pages, or a binder, rather than a bound logbook which cannot be varied at will.

The QSL card will need a slight modification. The column headings will be printed across the QSL, with sufficient space allowed below for the strip to be positioned without covering up other information. If the strip is made slightly narrower than the length of the card, it will be easier to place the strip in the correct alignment. A check should be made to insure that the card used for the QSL is suitable for a firm adhesion by the gum used.

The one disadvantage to this method of log-keeping and QSLing is the fact that more log pages will be used. An entry in the log will use about twice the space used in a current log, but the advantage gained more than outweighs this. A 100% QSLer using this, will just tear out the strips, gum them to his QSLs, and send them off. The "QSL on receipt" amateur can tear these strips out of his log as each page is completed, file or pigeonhole them in call-sign order; and as incoming cards are received, can quickly locate the correct strip without referring to his log at all. The contest operator has most to gain, as while actually operating, he can, at one fell swoop, complete his station record, contest logs, and QSL cards.

As I had a printing of QSL cards recently, I am unable to change over immediately, but I certainly will as soon as possible.

...ZE7JV

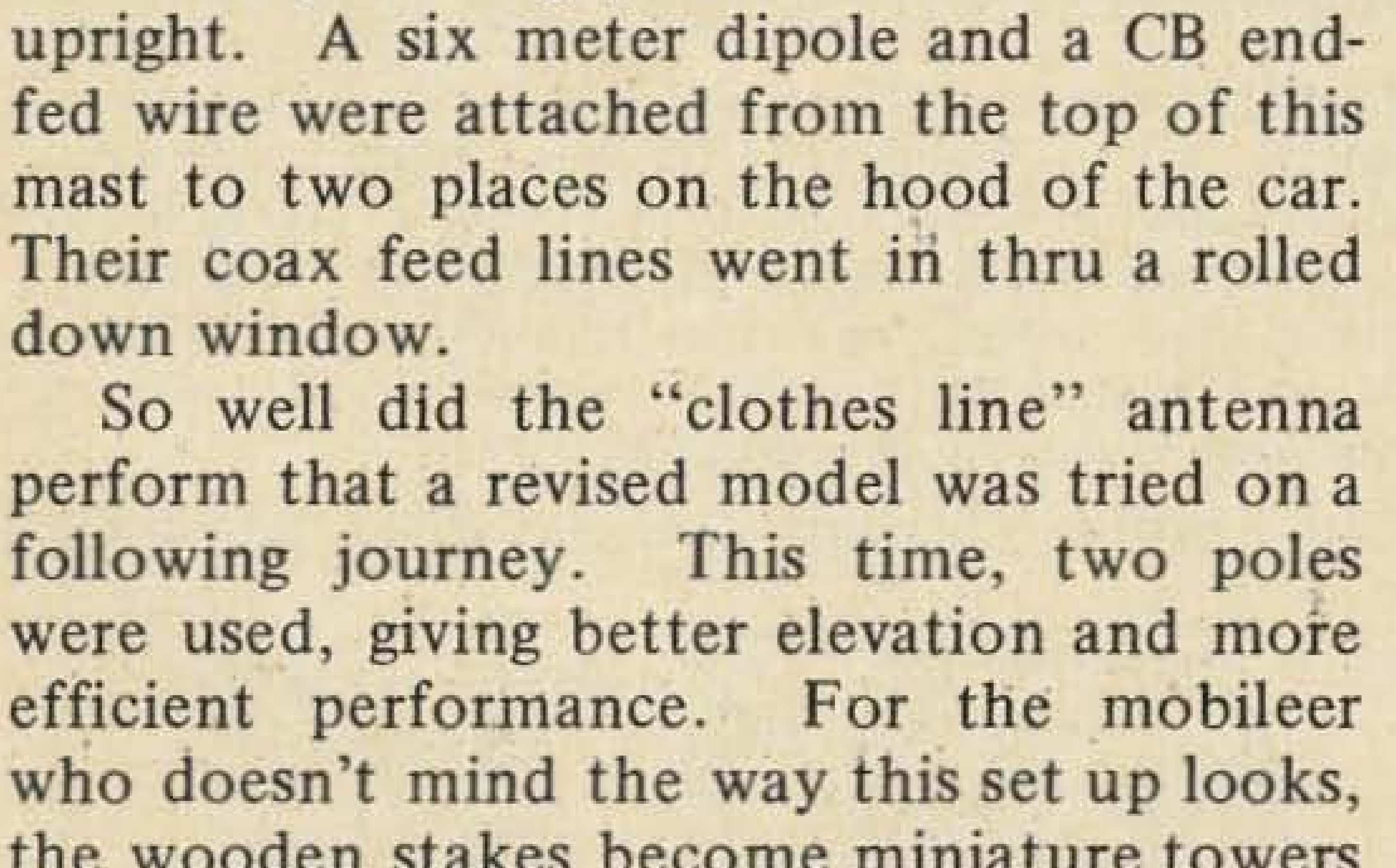
The Clothes Line

How often have you wanted a mobile antenna that could be assembled in minutes, costs pennies, adaptable to almost any band—then removable without a trace?

We needed such an antenna last winter. A friend and I had planned a trip to North Carolina for several weeks, but hadn't decided to take our rigs along until the last moment. Needing some sort of antenna, I stuck a large suction cup on the end of a five foot tomato stake and planted it on the roof of his station wagon. Four nylon lines were run from the corners of the front and rear bumpers as guy lines to hold the stake upright. A six meter dipole and a CB end-fed wire were attached from the top of this mast to two places on the hood of the car. Their coax feed lines went in thru a rolled down window.

So well did the "clothes line" antenna perform that a revised model was tried on a following journey. This time, two poles were used, giving better elevation and more efficient performance. For the mobileer who doesn't mind the way this set up looks, the wooden stakes become miniature towers that can hold any number of arrays. Ground planes, halo and whip types, even dipoles (which work surprisingly well on a moving car) are just a few of the antennas that can be suspended from the masts.

The next time you see a car with a clothes line on top, look again, it's someone operating mobile.



Larry Jack, WA3AQS

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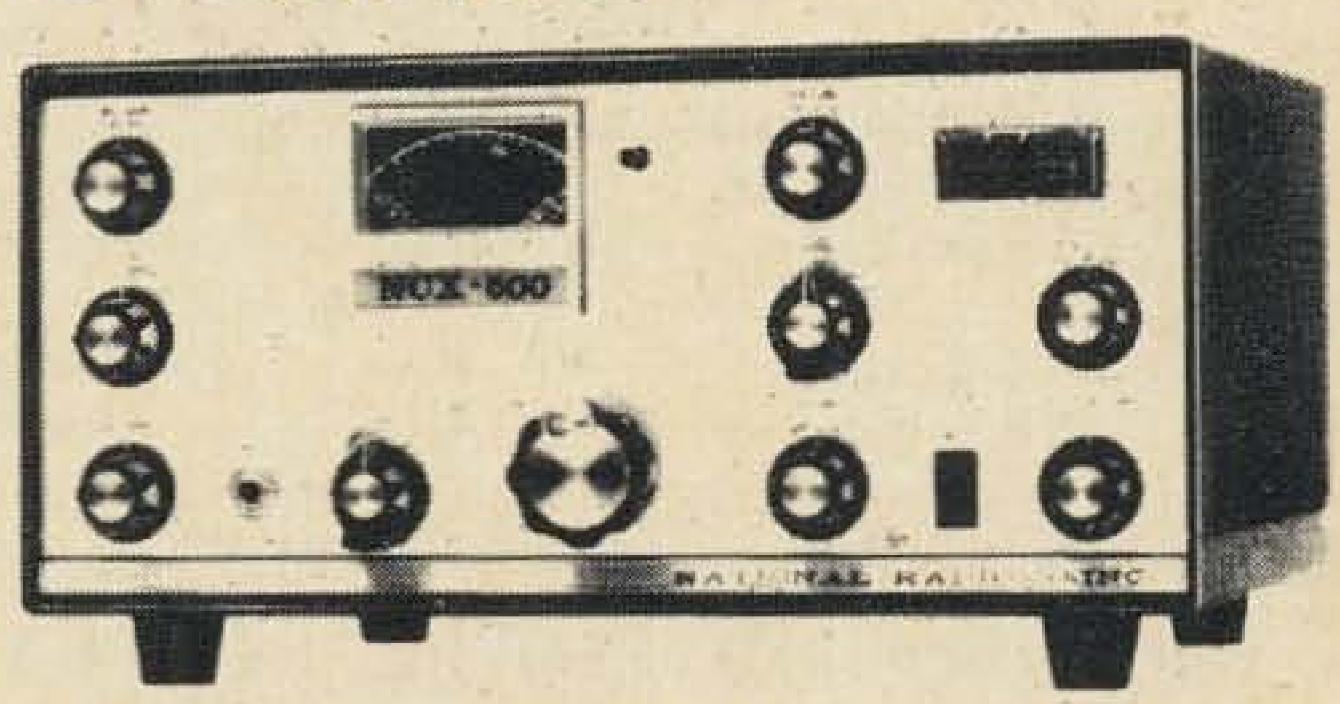

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Power Perk

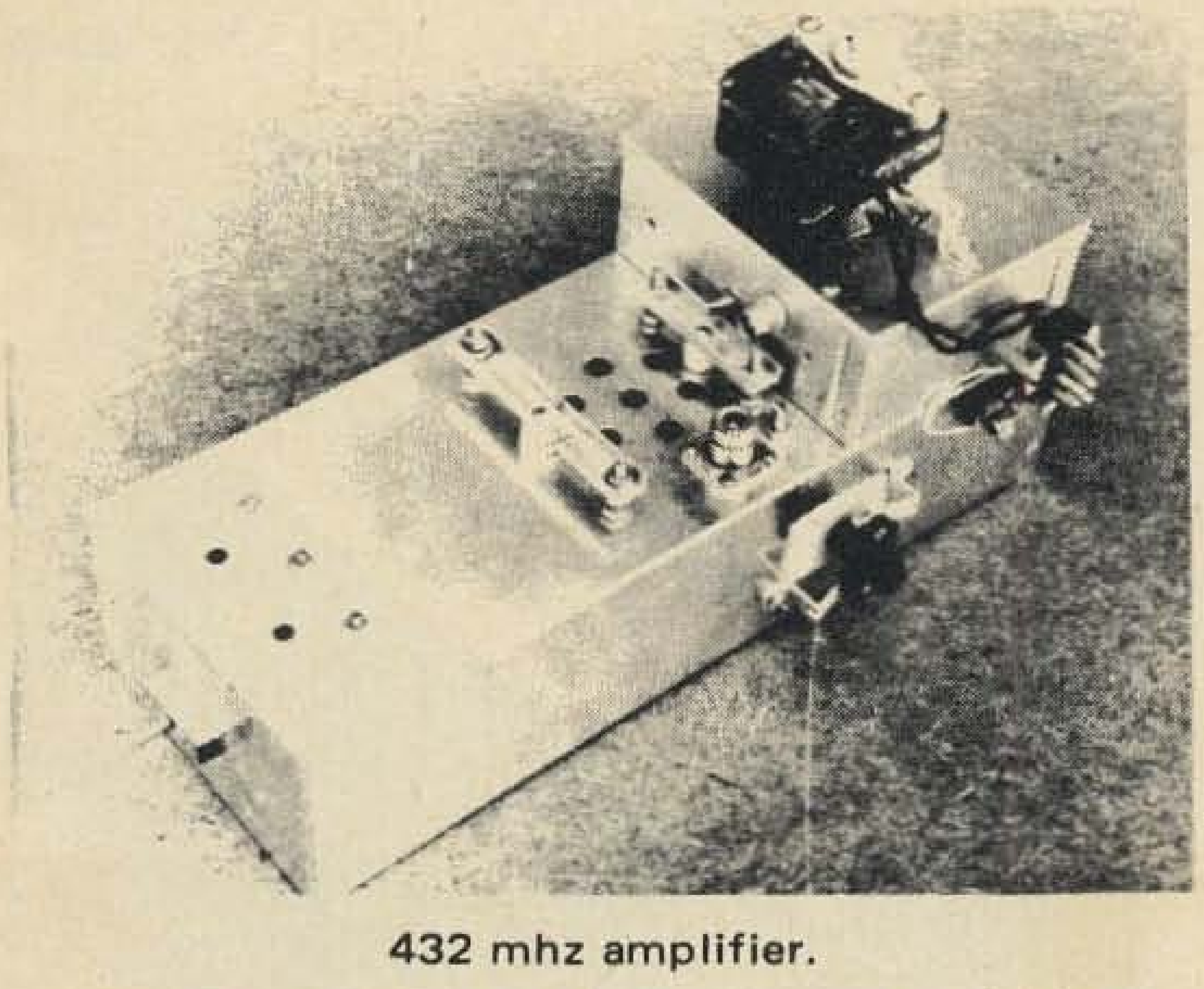
432 MHZ Power Amplifier

Here's an amplifier capable of running a full kilowatt on 432 mhz, without straining either the budget or the final tubes. The big difference between this amplifier and others that have been described, is the use of vapor phase cooling. This allows a relatively small tube to dissipate a lot of power.

Other features of this amplifier are:

1. Simple construction requiring no machine tools.
2. Single ended operation with no balancing problems.
3. Large overload capacity.
4. No noisy blowers.

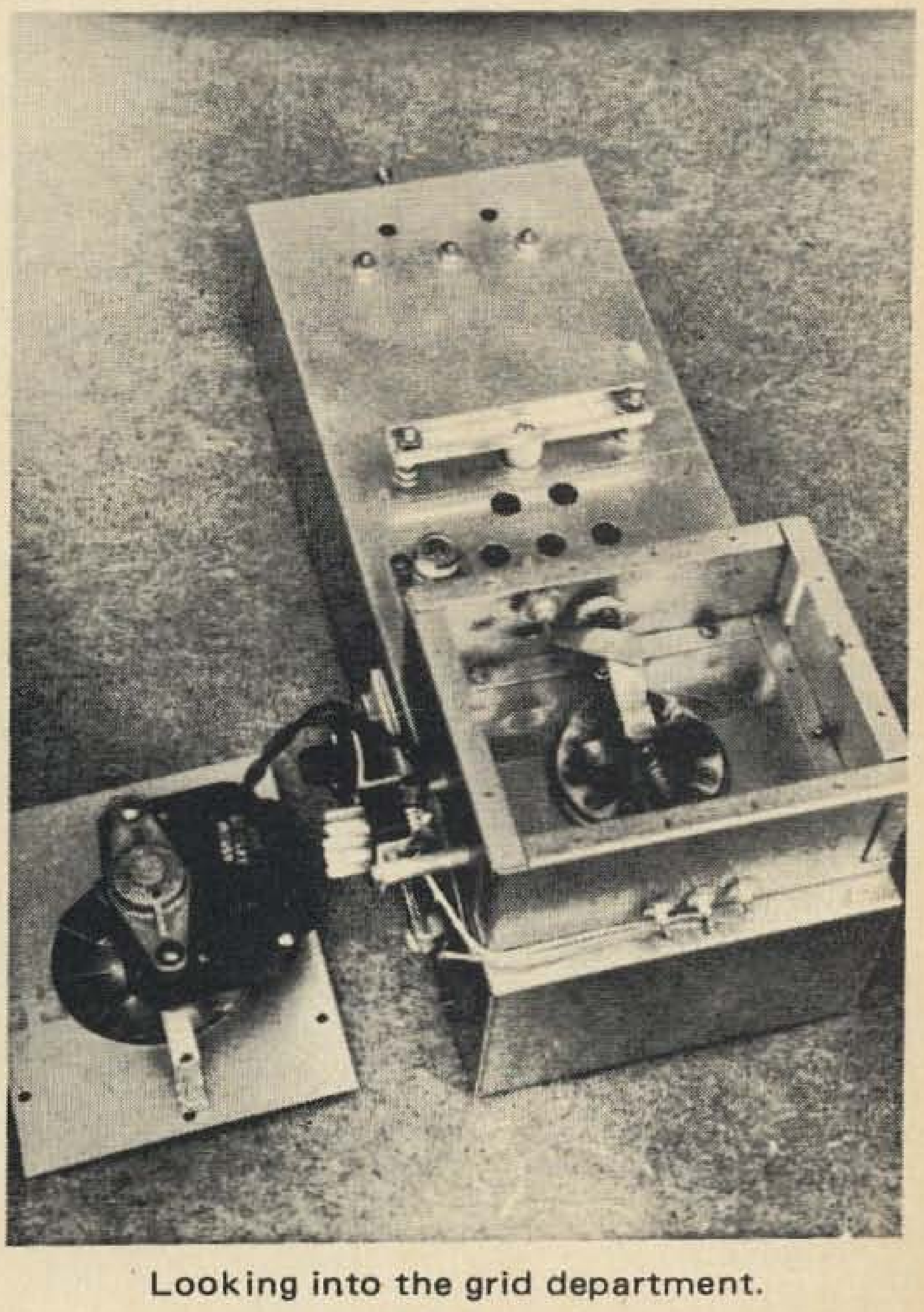
The tube used is a 4CN15A. Electrically, it is the same as the 4CX300A, but mechanically different in not having any air cooling fins. Fins are not required when vapor phase cooling is used.



432 mhz amplifier.

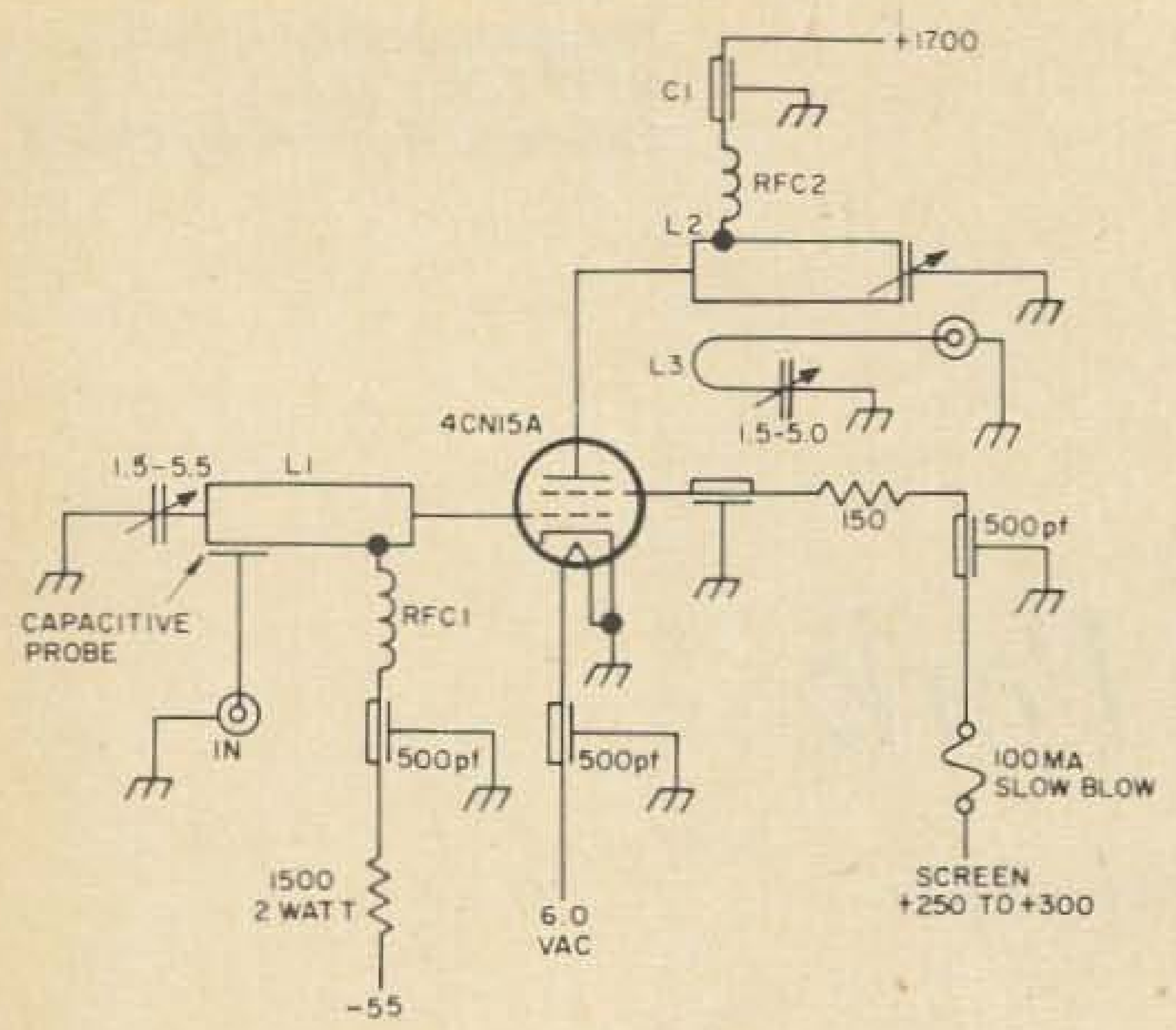
The fan over the grid compartment cools the tube pins and keeps steam away from the socket. Braces are used to support the plate trough to allow more room for the standoff insulators.

Dissipation of plate power is accomplished by boiling water inside the plate trough. This holds the plate temperature at about boiling



Looking into the grid department.

Inside the grid compartment the tab capacitor can be seen attached to the BNC input connector. Filament, grid and screen voltages come through the capacitors in the end of the compartment.



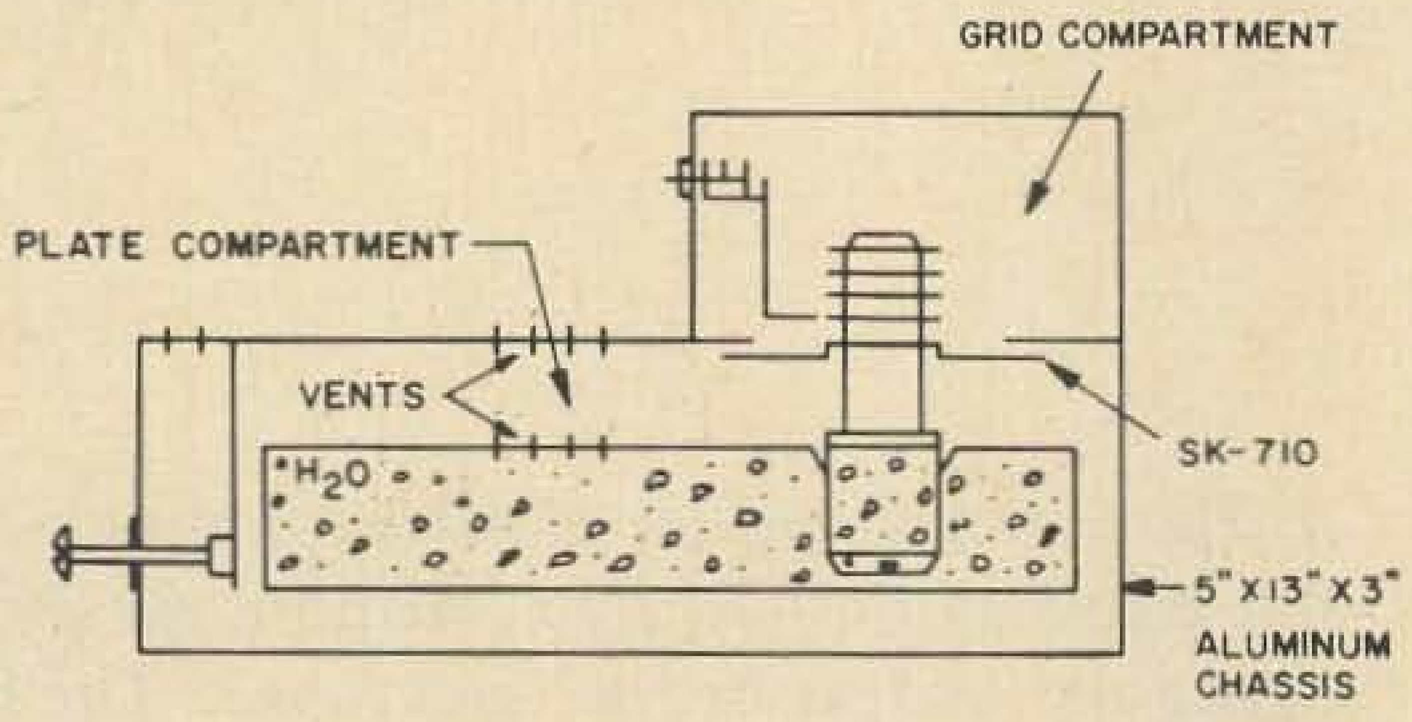
Schematic of the 432 amplifier.

temperature (100° C). As more power is dissipated the water boils harder but never gets any hotter. The tube anode is actually somewhat hotter than the water because it is not entirely immersed. Being inside the plate trough, the water is separated from *rf* and dc fields, and therefore causes no electrical problems.

W6MJG built a vapor phase cooled hf amplifier (May 1966 QST) that used many special pieces of hardware. He had a closed cycle operation using reservoirs and condensers to save the water. But why? Water is cheap! Here we let it boil away into the air. The rate of usage for intermittent amateur operation is modest; one filling normally lasts several evenings.

Construction

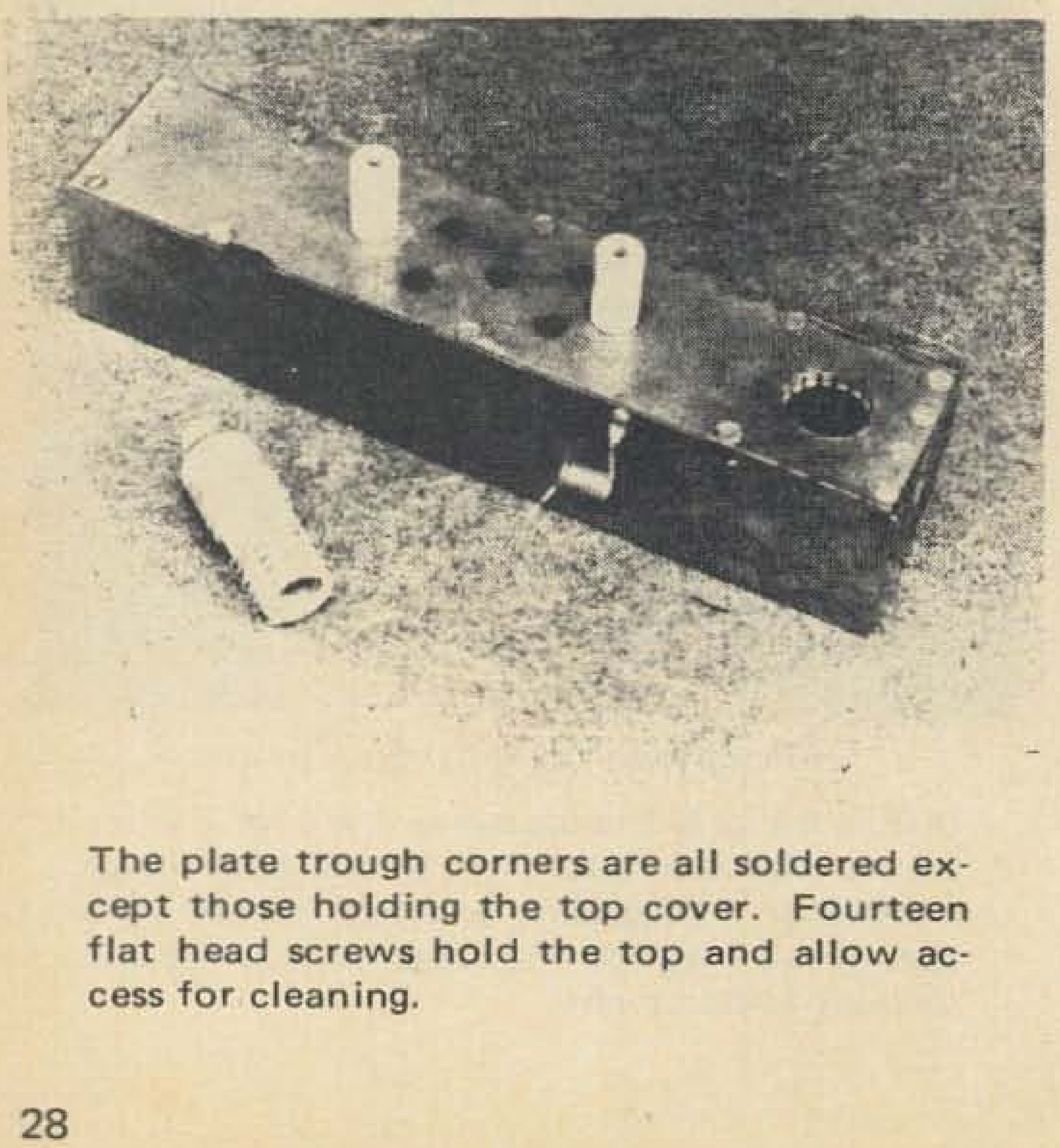
The construction of the amplifier is clear from the drawings and pictures. Half wave, capacitively loaded lines are used in the grid and plate circuits. The grid line is made from flashing copper and tuned by a 5 pf variable capacitor. Coupling into the grid circuit is by a capacitive probe also built from flashing copper. This is adjusted by bending to maximize the drive. A small fan is mounted over the grid circuit to cool the tube pins and prevent steam from coming up through the tube socket. A slight modulation can be heard locally from the fan blades passing near the grid circuit. A wire mesh shield could be used to prevent this effect.



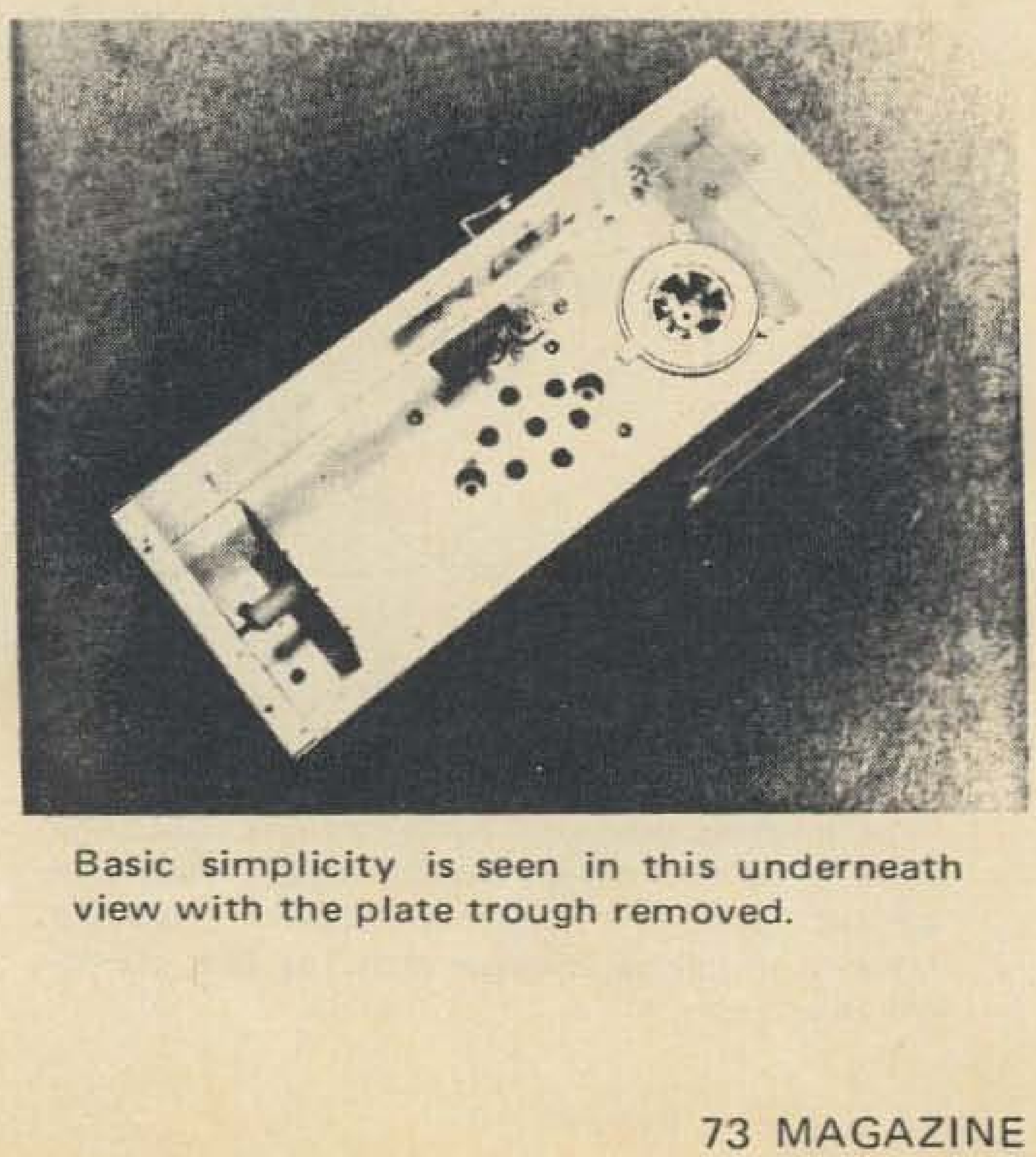
Water inside plate trough boils to keep the tube plate temperature from rising above 100 °C. Steam escapes from ventillation holes in the plate trough and plate compartment.

Brass stock 2"x1/16" is used to make all sides of the plate line. Since, mechanically, the line is a water trough it is made leak-proof by careful soldering of all joints. Acid flux is used and, after soldering, thoroughly scrubbed out. The top of the trough is made removable for cleaning.

Electrical contact to the 4CN15A is made



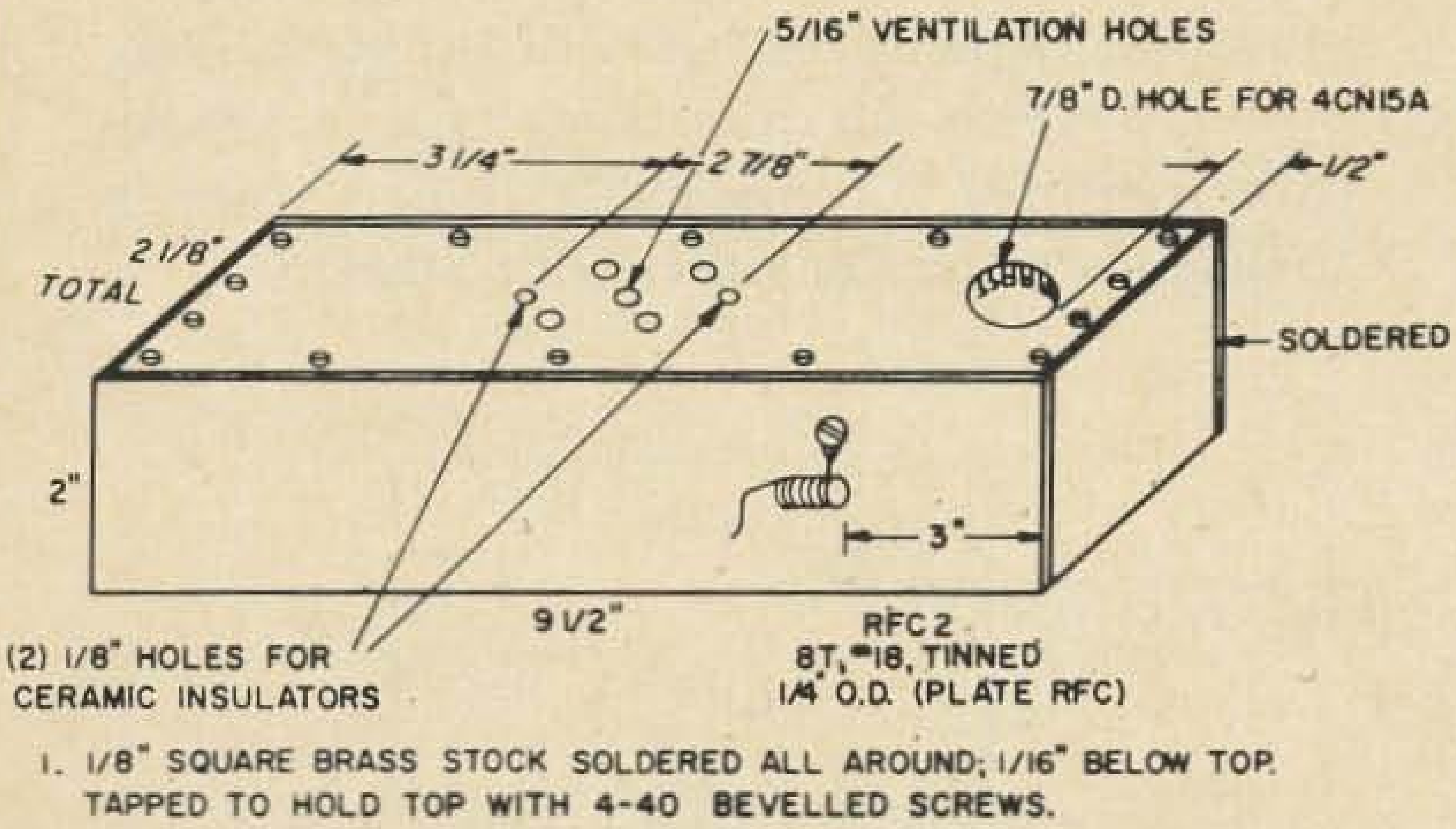
The plate trough corners are all soldered except those holding the top cover. Fourteen flat head screws hold the top and allow access for cleaning.



Basic simplicity is seen in this underneath view with the plate trough removed.

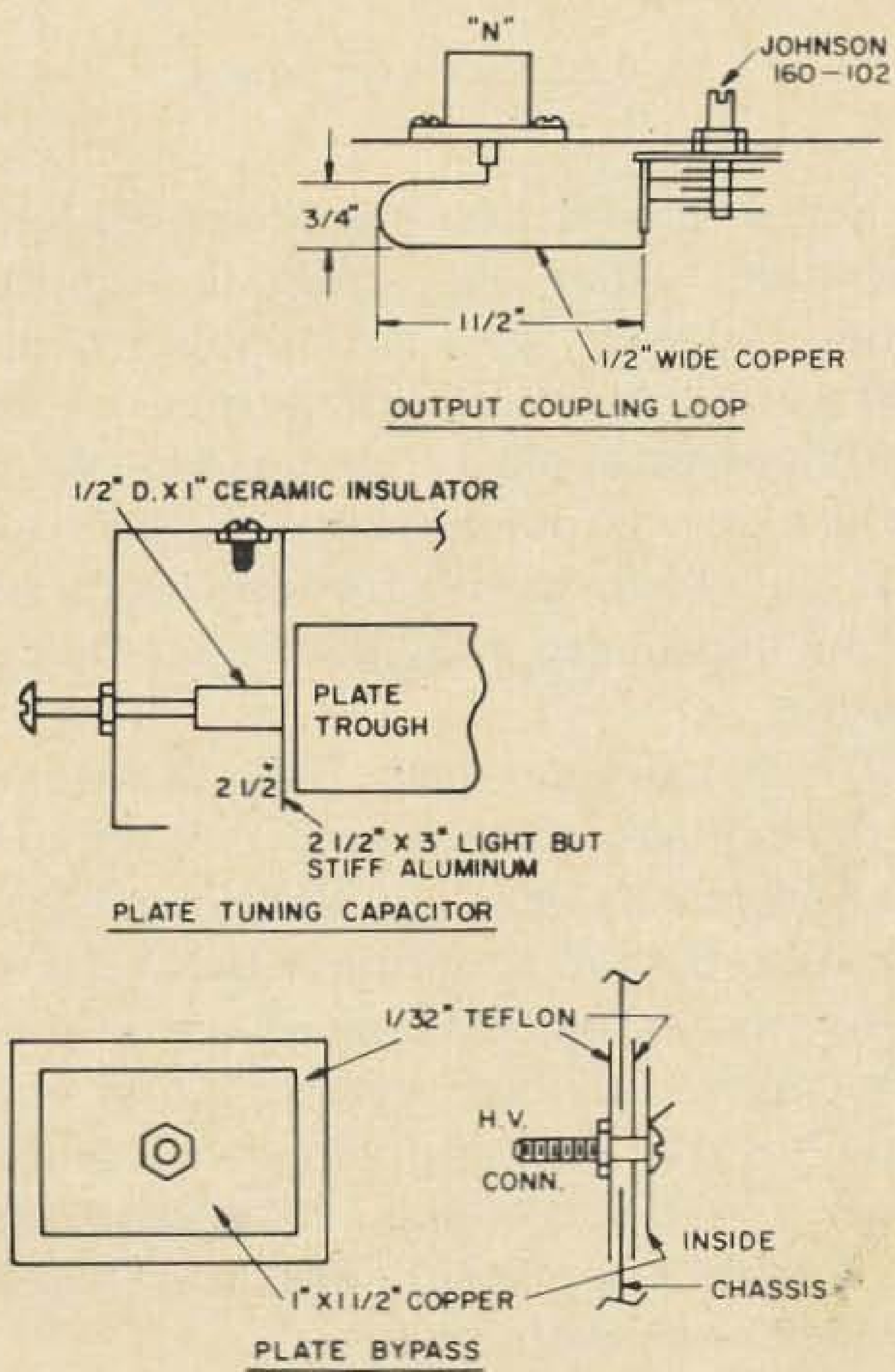
from cut down Eimac CF100 finger stock.

The outside of the plate compartment is a 5x13x3 inch chassis. Ceramic standoff insulators are used to support the plate trough. In order for the tube anode to protrude as



Dimensions of the plate line box.

far as possible inside the plate trough, the clearance left is insufficient for standoffs inside the plate compartment. For this reason braces are mounted over the main chassis as can be seen in the photos. The height of the



Details of construction.

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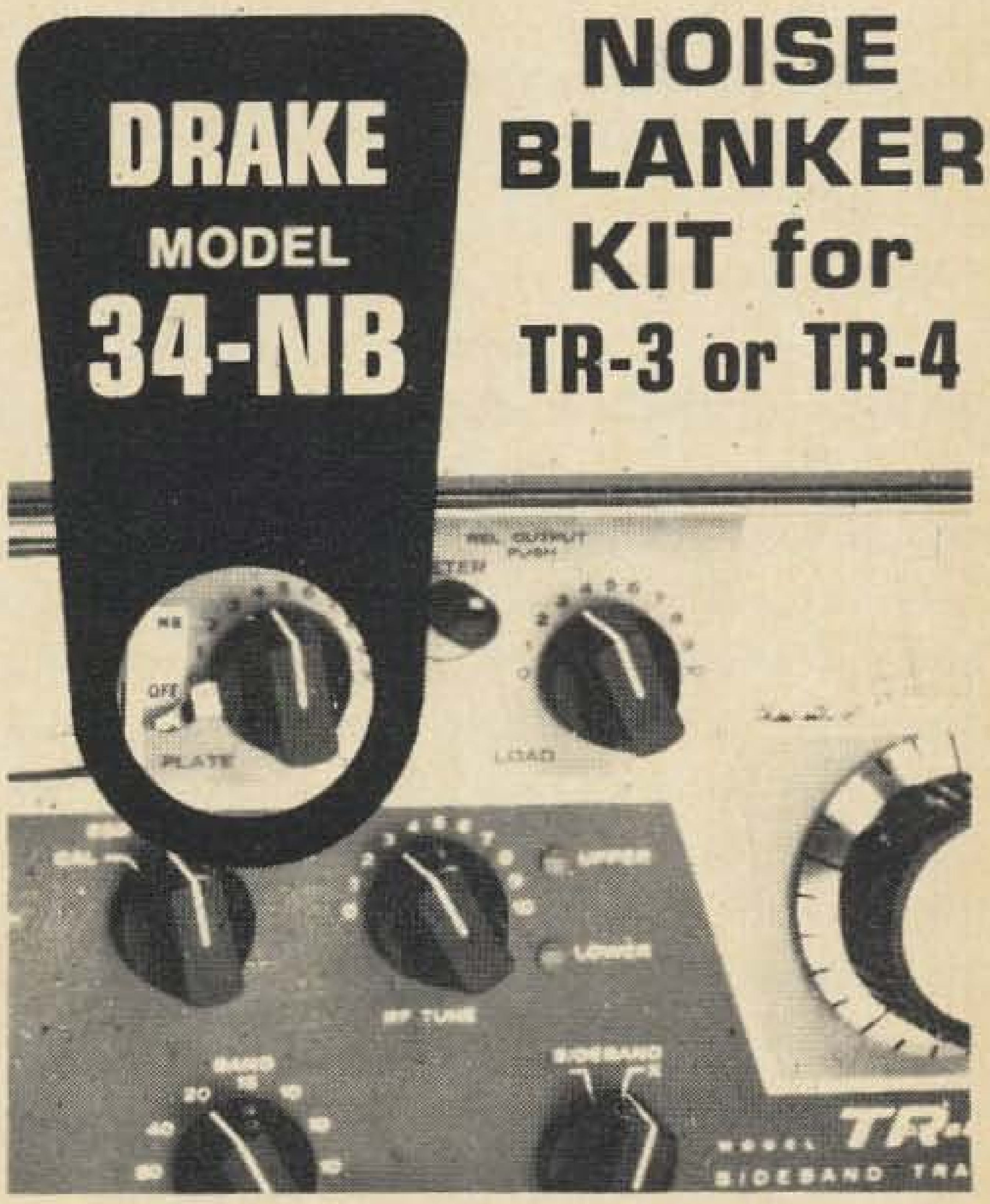


Unlike the usual noise clippers or limiters, the 34-NB is an advanced noise blanker which actually mutes the receiver for the duration of the noise pulse. Between noise pulses, full receiver gain is restored. (The receiver AGC is affected only by the desired signal strength, not by the noise at the antenna.) Low level signals masked by noise impulses without the noise blanker can be copied when the blanker is used. The 34-NB is a must for the mobile operator.

HOW IT WORKS . . .

A noiseless electronic series switch is inserted at the output of the receiver mixer. This switch is operated by the output of a special receiving circuit which is tuned to the 9 MHz IF with bandwidth of 10 kHz. The switch opens for noise impulses but closes to allow the signal to pass.

The kit consists of these main parts: 9-NB board (composed of 17 transistors, 4 diodes and circuitry), NBK board, capacitor assembly, switch assembly, lever knob, and miscellaneous hardware.

Installation of the kit is about a two hour job for the competent technician only, requiring the usual hand tools, plus soldering iron and electric drill. Factory installation, $15 plus shipping.

Model 34-NB $129.00 Amateur Net

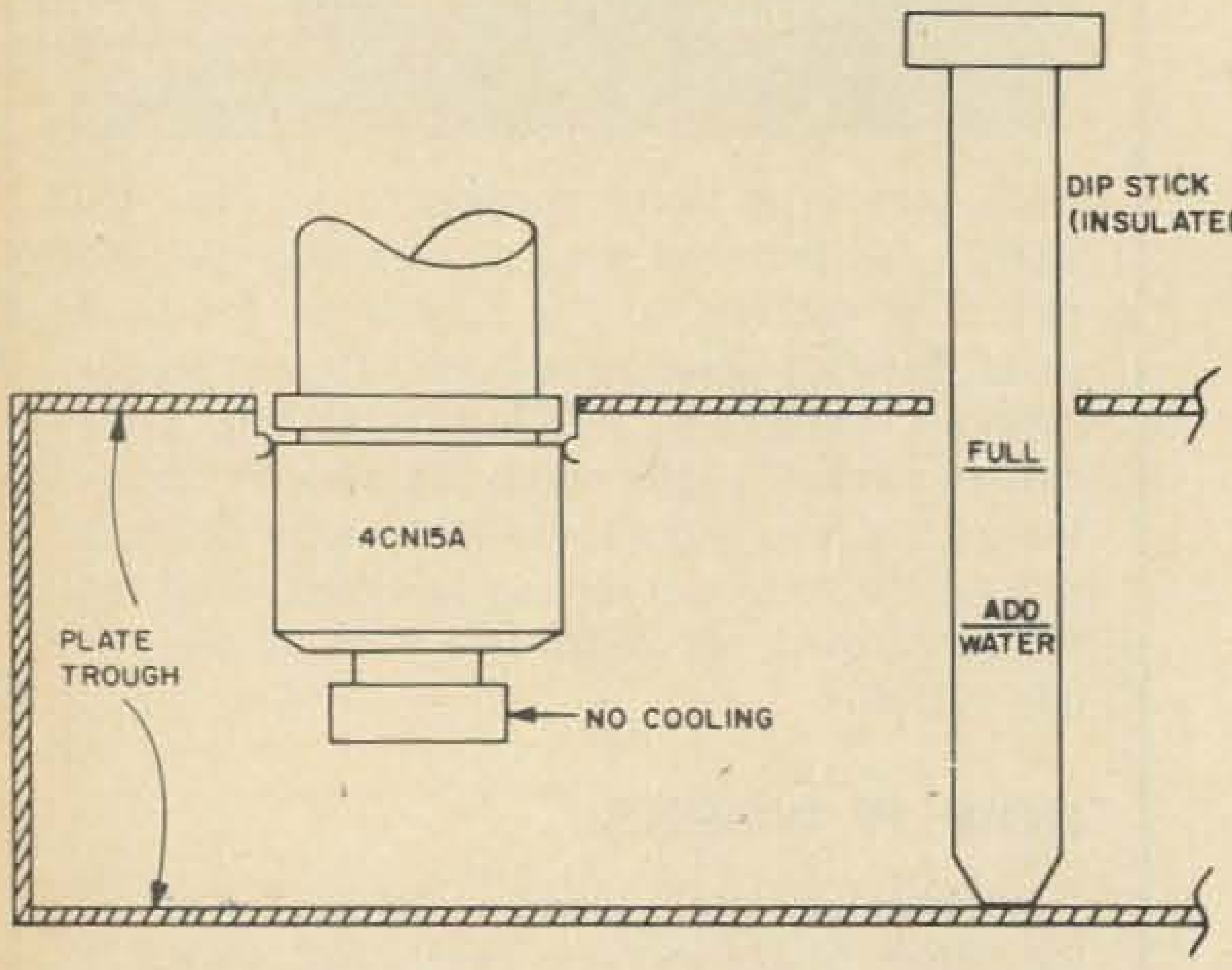
At your distributor or write to

R. L. DRAKE COMPANY

Dept. 379, 540 Richard St., Miamisburg, Ohio 45342 plate trough is adjusted so the anode seal is flush with the top of the trough. The plate tuning capacitor is a sheet of "springy" aluminum, operated by a 10-32 screw with a ceramic insulator between the screw and the aluminum. When the amplifier was first assembled, the insulator was not used and considerable arcing took place at the metal-to-metal contact.

Operation

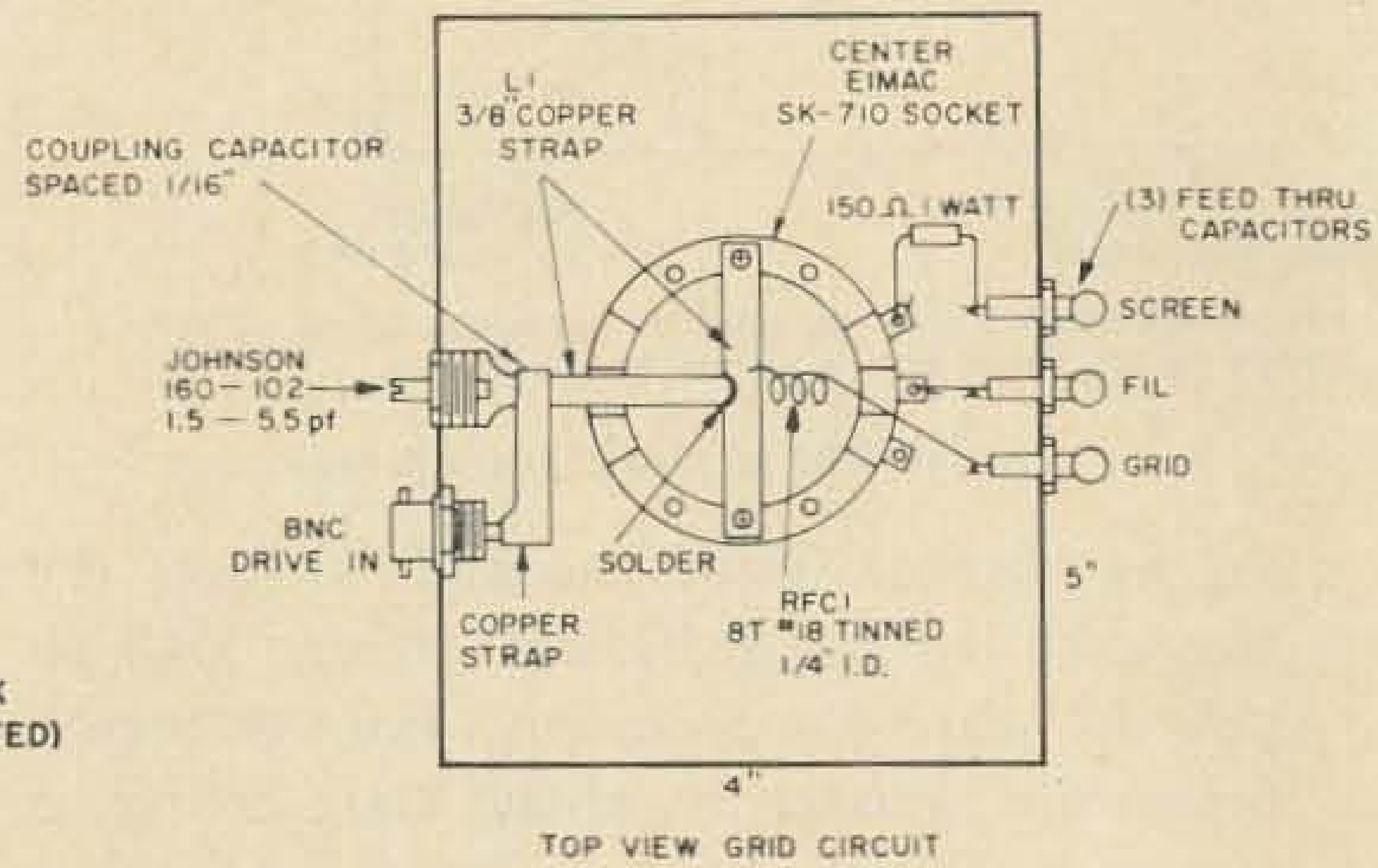
The maximum power capacity of the amplifier is difficult to determine. The maximum allowable temperature for the ceramic-to-metal seal is 250° C. Measurements of the seal temperature were made using Tempilac indicator with no *rf* applied. It was found that the tube can dissipate well over a kilowatt in a good rolling boil (see graph). About 200 watts is dissipated with no boiling occurring. Thus, in general, dissipation of heat is not a limiting factor for amateur power levels.



View of water levels inside plate trough. Water must cover part of main body of the tube. Small portion on end of tube is a seal cover and cannot conduct any quantity of heat.

Manufacturers specifications for CW operation limit the plate voltage to 2000 volts and the current to 250 ma. This gives an input of only 500 watts. However, this amplifier has been operated for many hours at a kilowatt (2500 volts, 400 ma) with no sign of tube deterioration. At W2CLL, the amplifier has been operated at 500 watts for general operation and a kilowatt for schedules and band openings for the past three years using the same tube with no drop in output.

About 25 watts of grid drive are required for full output. This gives 25 ma of grid current at about 90 volts bias. The screen voltage is adjusted to give the desired input. This requires about 250 volts for 500 watts input and 300 volts for a kilowatt. Screen current is usually not more than 10 to 15 ma and, under some conditions, will be 5 or 10 ma negative. The plate current dips at resonance but the best tuning device is a power output indicator. Another method of tuning at high power levels is for minimum boiling sound (this requires a reasonably quiet room!) Efficiency generally runs about 50%.

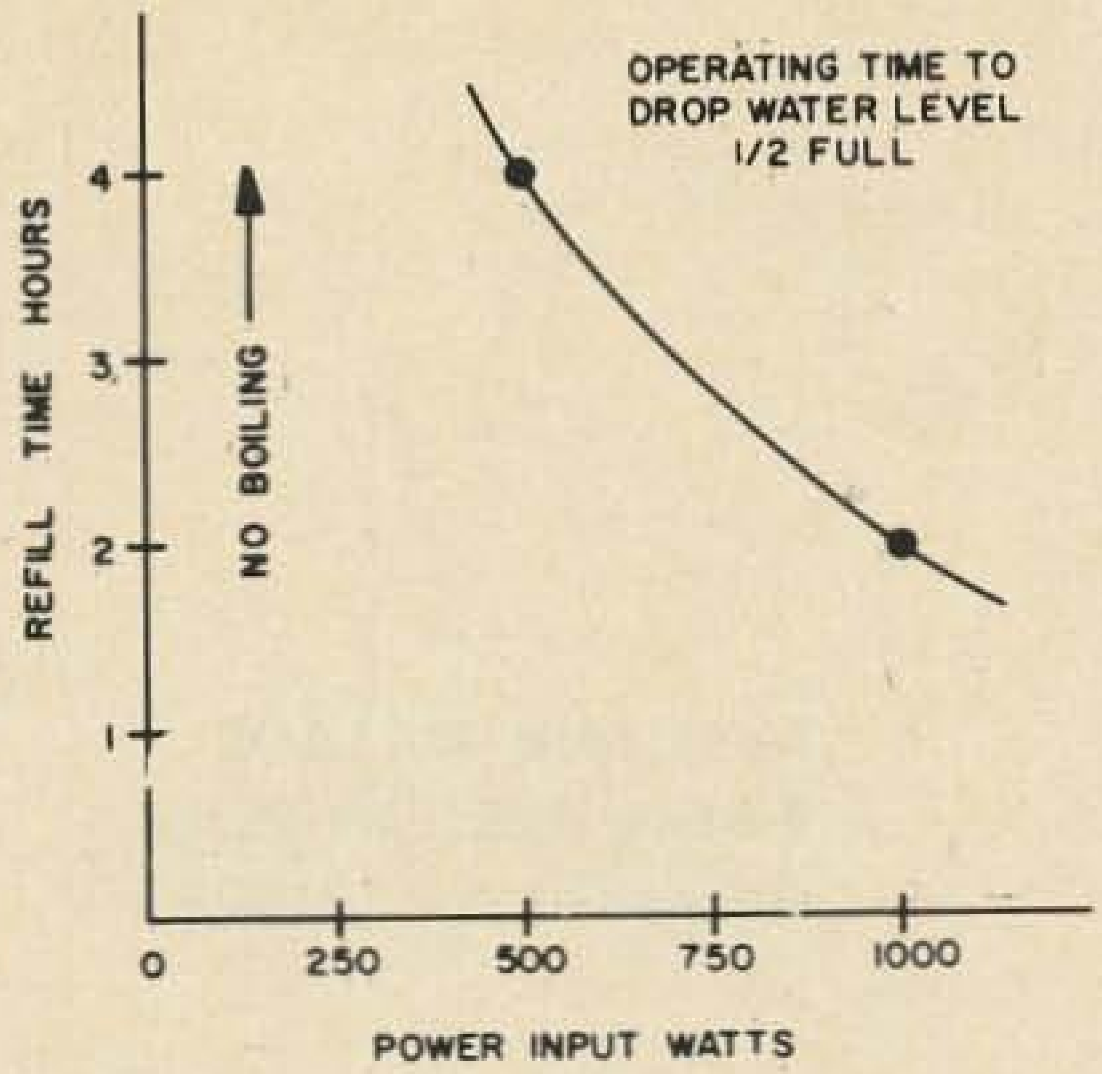


Grid compartment details.

Screen modulation has been used for AM operation. Here the screen is dropped to about 100 volts for a carrier power of about 100 watts. About 300 peak-to-peak volts of modulation is applied from a modulator with 4000 ohms output impedance. This was a push-pull 6146 modulator with 8000 ohms output impedance, swamped by an 8000 ohm resistor.

The trough is normally filled to within ¼" of the top and allowed to boil down to half the tube length before refilling. An *insulated* dip stick is used to measure the water level with *power off* and the high voltage grounded. Remember, full high voltage exists on the plate trough. Filling is done by siphoning water from a bottle with a length of ¼" plastic aquarium air hose. The hose is placed through a ventilation hole.

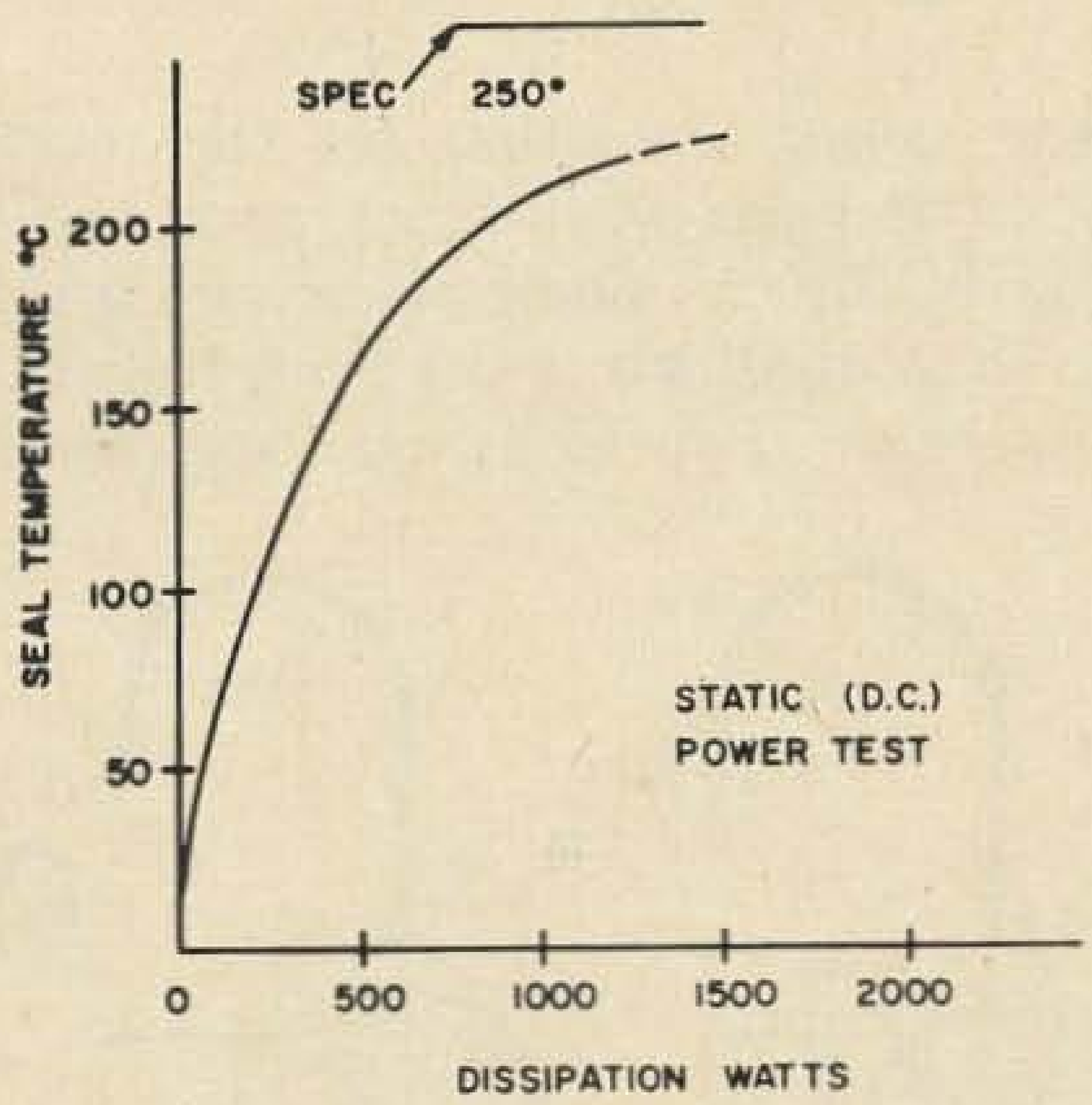
Distilled water is not required, since no voltages are impressed across the water. However, if tap water is used, deposits will build



up inside the trough necessitating frequent cleaning and making distilled water a worthwhile convenience.

Modifications

Although finless tubes such as the 4CN15A are mechanically ideal for amplifiers with "poor man's" vapor phase cooling, almost any external anode tube with ceramic insulation can be used. Check the temperature rating on the seals—if they are 250° C or higher there should be no problems. Glass-to-metal



seals are generally rated at 150° C which is not far enough above the 100° C boiling point to be safe.

A version of the 2C39 series, the 3CPN-10A5, has no cooling fins and can be easily used in this type of amplifier. Additionally, many of the 2C39A's have their fins held on by a set screw and can be easily removed.

Some additional ideas may be obtained from the 220 mhz amplifier described by K2UYH (July 1968 CQ). This amplifier used the 4CX250.

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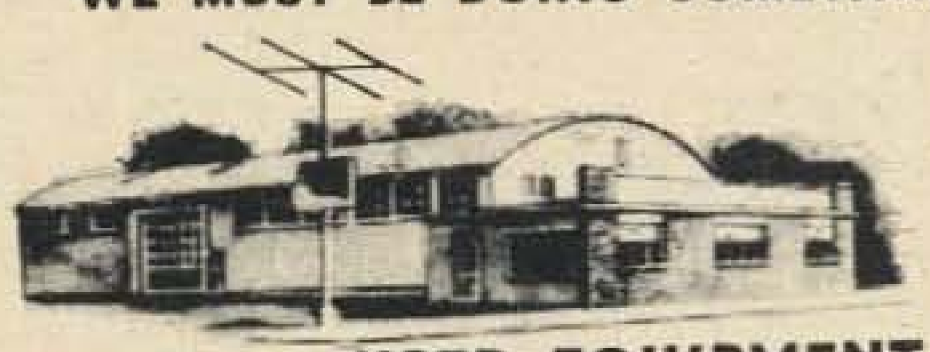

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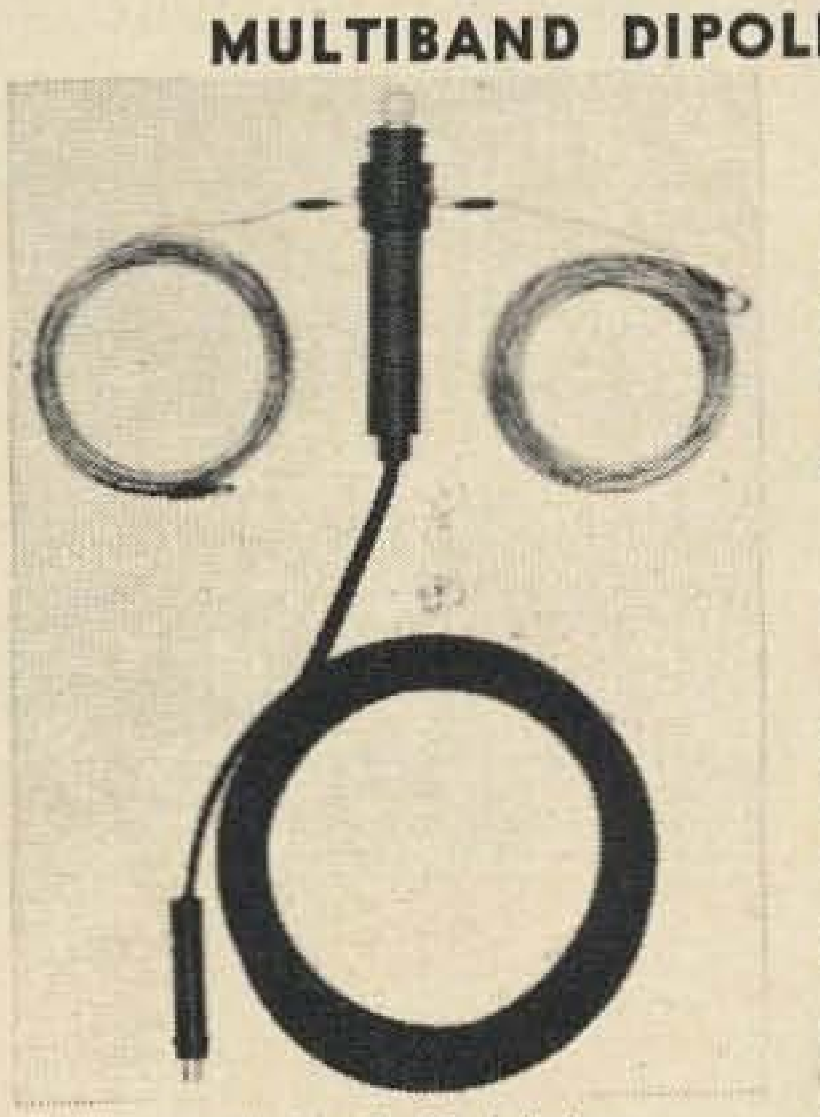

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4 Thirty Two'er

Larry Jack, WA3AQS
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432: a band just itching for new operators. Sooner or later, most VHF'ers want to try this frequency. But here they run into a problem; little, if any commercial equipment is available for 432. The operator must either convert surplus or build the entire system himself. Of course, the gear can be as simple or complex as the builder's funds allow, although most will agree, it's better to start out with a simple station and work up.

Here are two simple, easily constructed adapters for the Heathkit Two'er which will allow the budding 432'er a glimpse at the band. Granted, no DX records are going to be set by these little units, but solid contacts 5 to 10 miles are possible with good antenna systems. An added feature is that they still remain useful around the shack as *rf* monitor, signal source, converter and so on, when more elaborate equipment is later added.

Transmitting Converter

From the dark recesses of a basement, an old, well-punched mini-box was recovered. Measuring 5x3x2½ inches, it was decided one-half was to be used for the transmitting

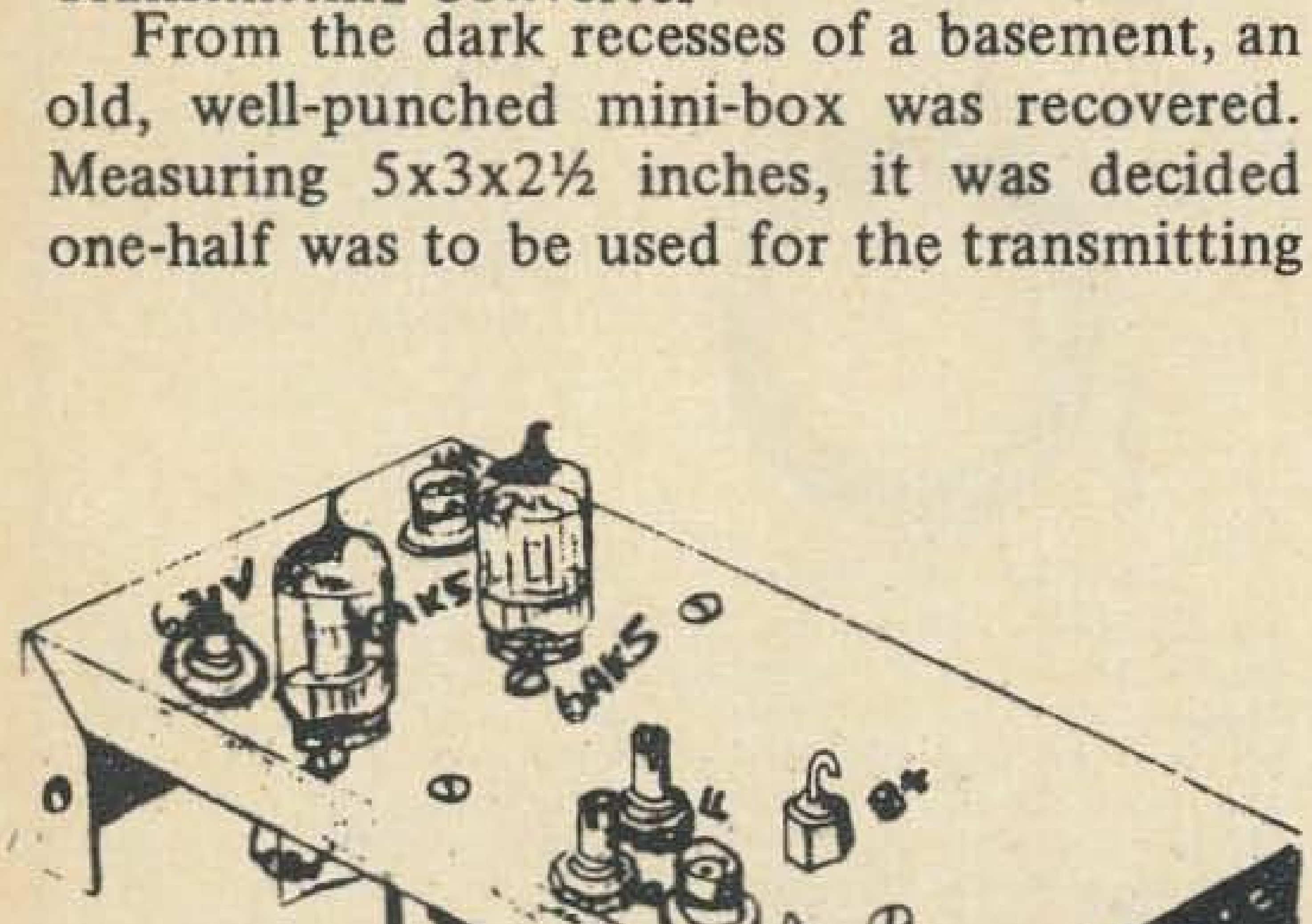

Fig. 1. Transmitting converter built in Mini-box.

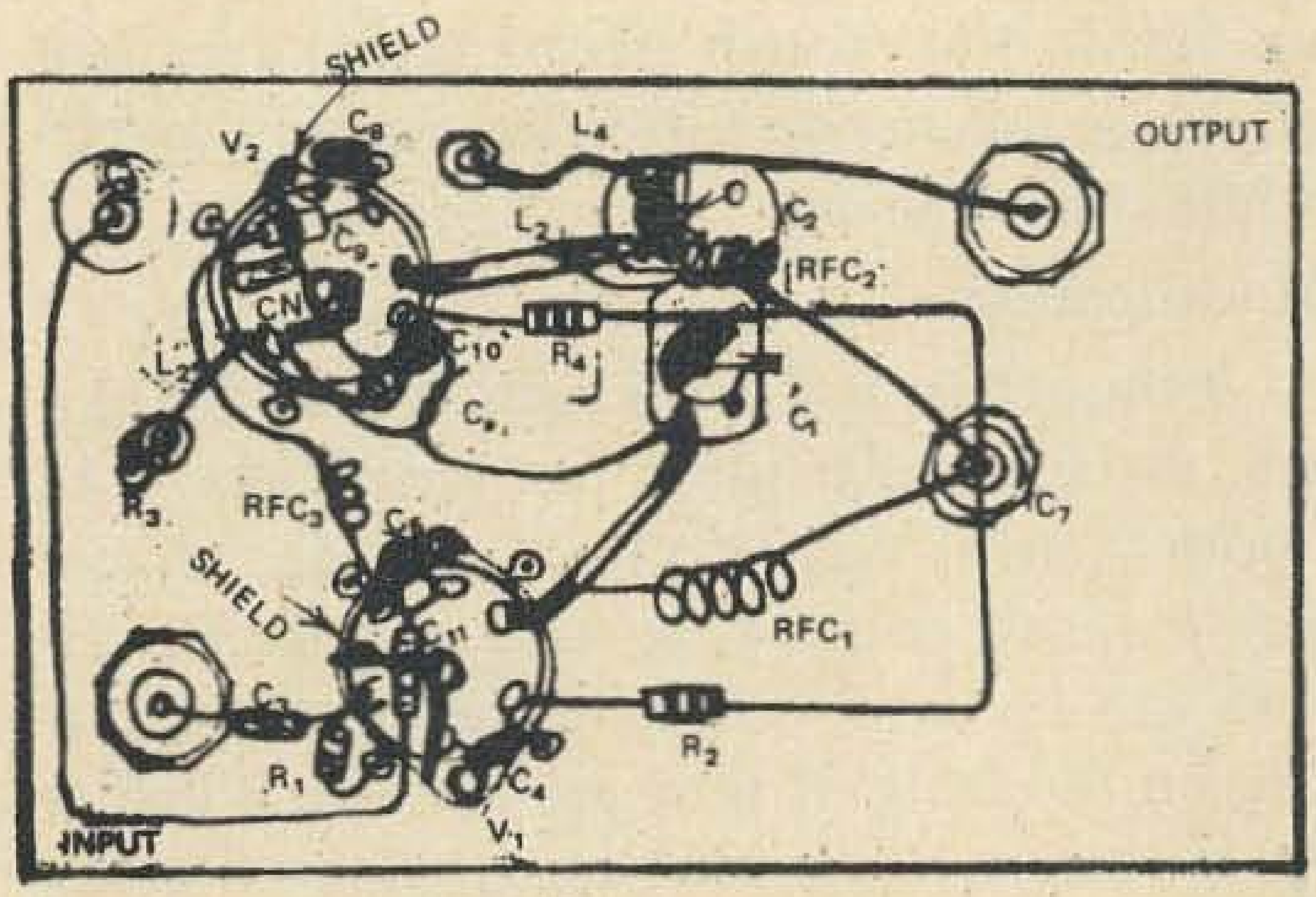

Fig. 2. Parts layout for converter.

converter, saving the other for the receiver section. The parts were arranged about the chassis as in *Fig. 2.* Their placement is quite critical, so in duplicating the unit, follow the layout closely. Especially pay attention to

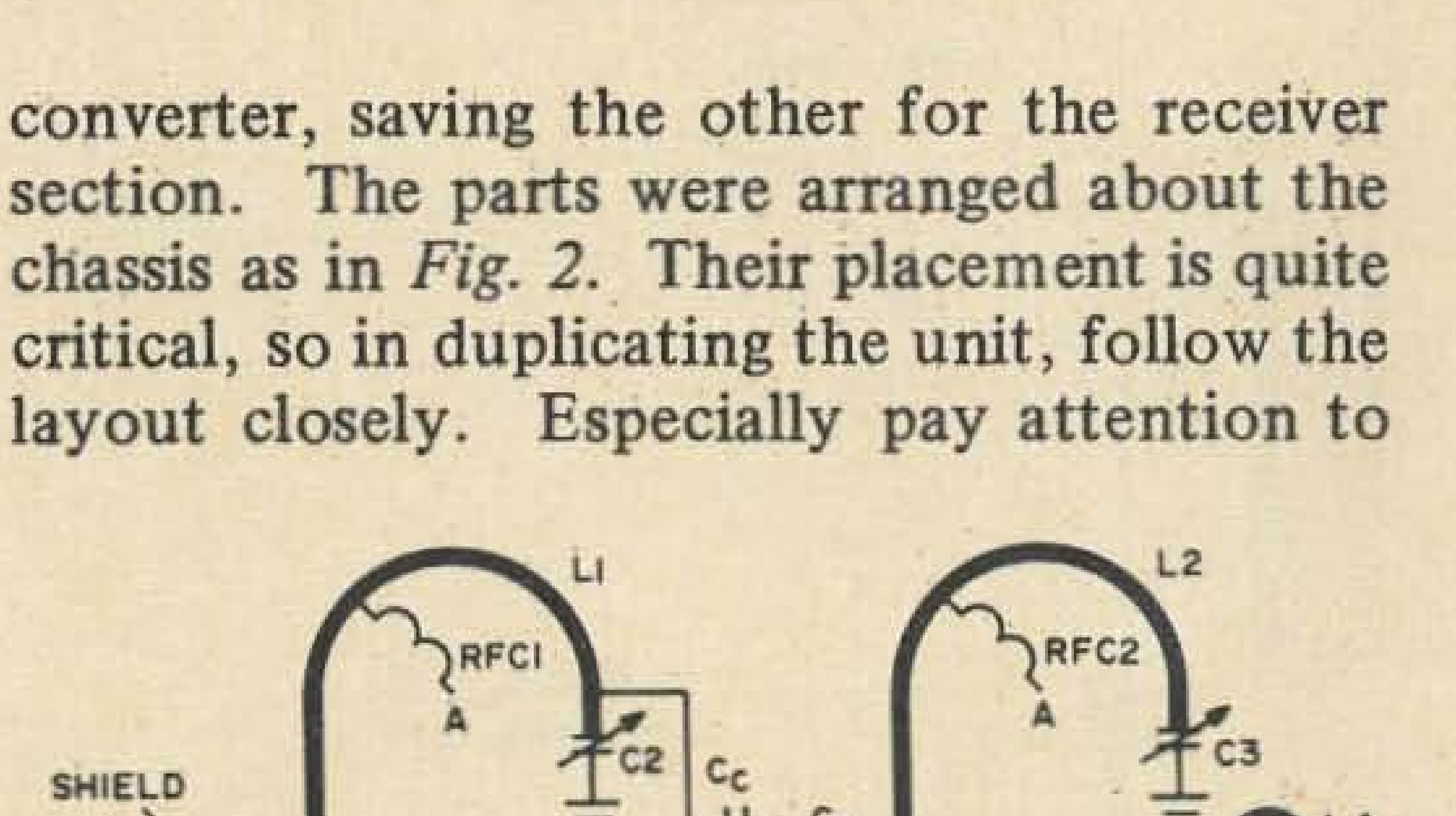

Fig. 3. Schematic of converter.

the way the keys on the tube sockets face.

For those who are just wetting their feet in UHF, (for whom the article is really intended) at these frequencies, please remember that lead lengths just *aren't*. Any stray inductance or capacitance at the UHF's will cause unstable operation. That is, if the rig will function at all!

Small isolation shields are soldered from the tube socket center pins to ground, in such a manner as to separate the plates from their grids. These shields are about one inch long by half an inch high. If your sockets have grounding rings, puddle lots of solder about its and the shield's junction. Good, short connections are paramount. Lacking grounding rings, make the chassis connections thru large lugs, fastened to the same screws that hold the sockets secure.

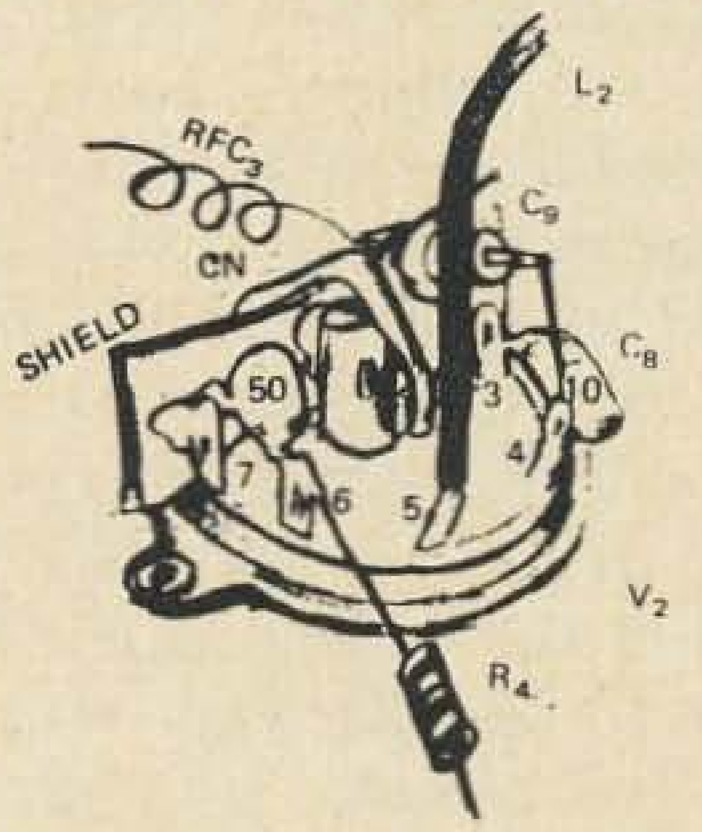

Fig. 4. Detail of V2 socket.

When scrounging tube sockets for these units, use only ceramic types. Bakelite and plastic ones just don't work at these frequencies.

The plate "coils" are hairpin loops of soft copper wire with small chokes connected at

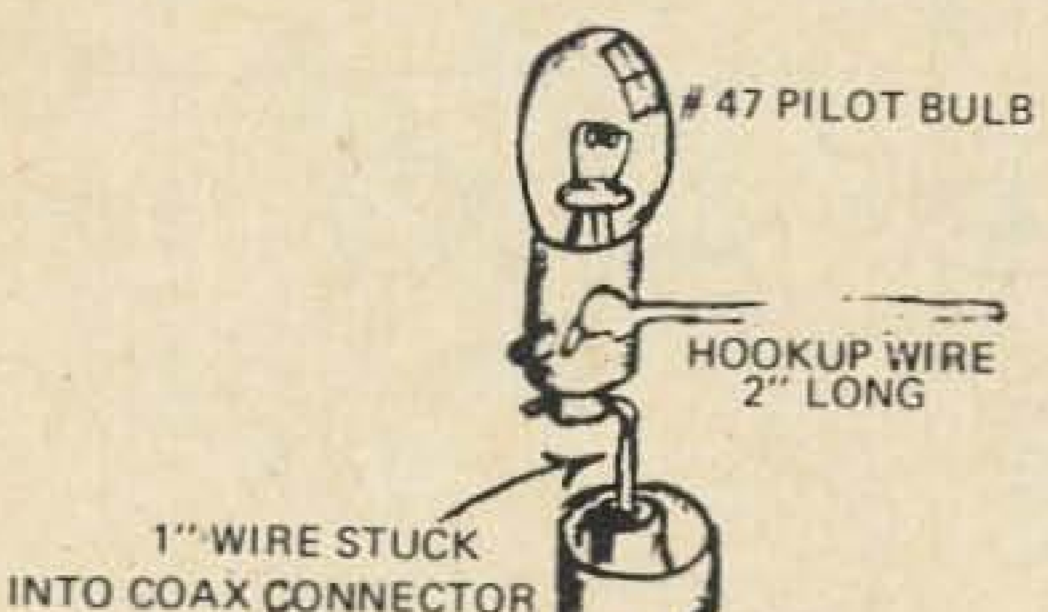

Fig. 5. Output load for tuning transmitting converter.

points (a) for Vl and (b) for V2, *Fig. 7.* The positioning of these chokes isn't too critical, nor are their values. The chokes are made by winding five turns of bare hookup wire closely spaced, a quarter inch in diameter.

Capacitor Cc is two lengths of insulated wire, each one inch long. The first runs from the junction of Cl and Ll, twisting two turns with the second wire, which comes from pin 1 of V2. This forms the coupling capacitor from the tripler stage to the final amplifier

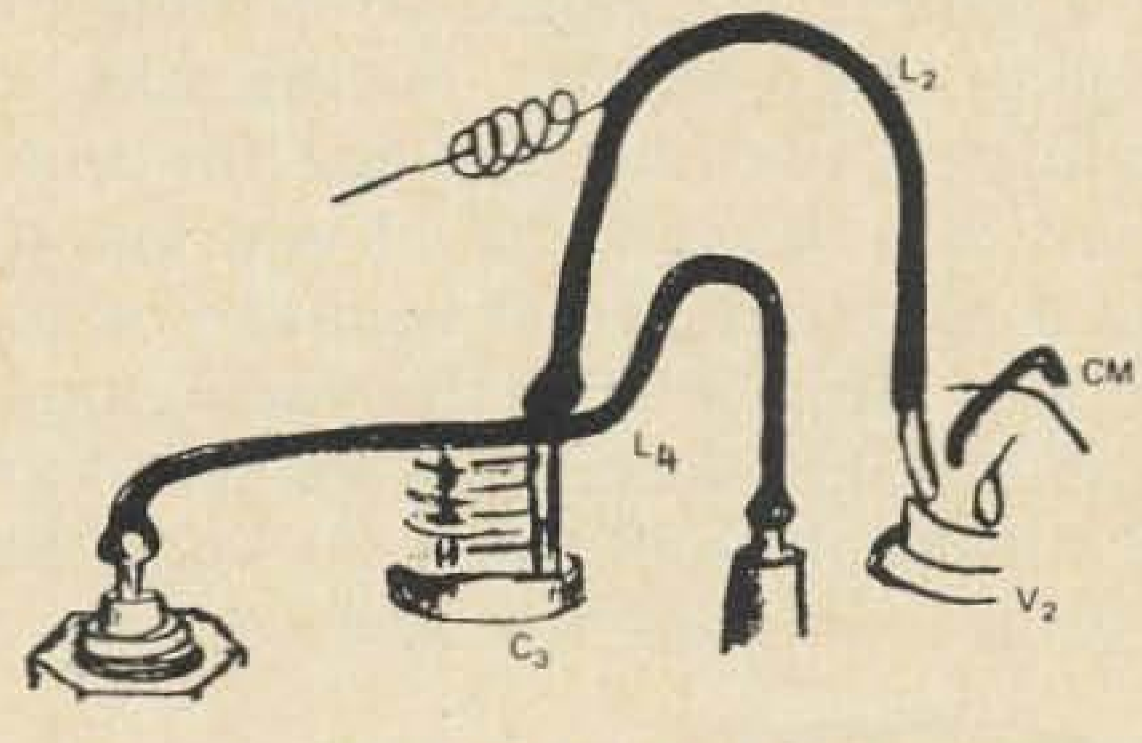

Fig. 6. Detail of L2 and L4.

Cn is also insulated hookup wire. Running ¾ inches from pin l of V2, over the isolation shield and close to pin 5, it becomes the neutralizing capacitor for the final. Its adjustment will be described later.

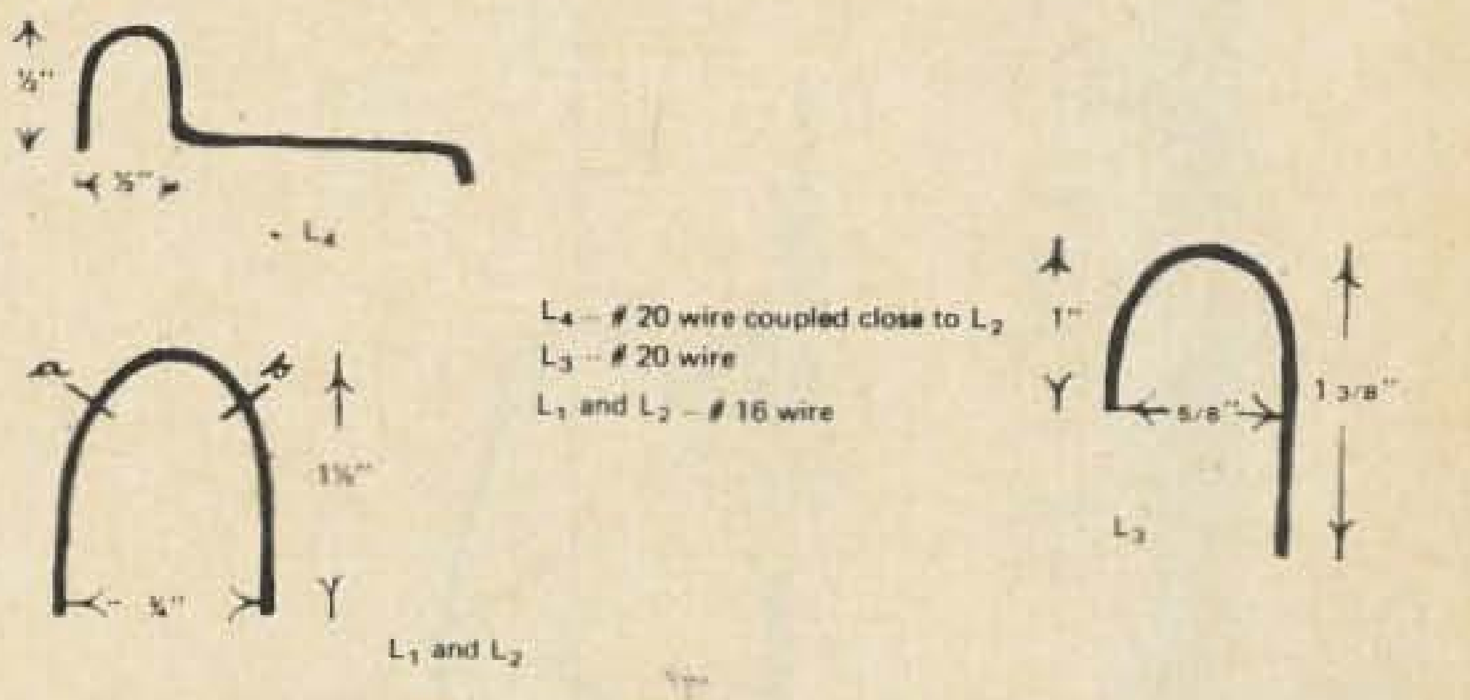

Fig. 7. Details of coils.

L4, which couples the final to the antenna, is positioned within 1/8 of an inch from the cold end of L2, *Fig. 6.*

Tuning Adjustments

A source of 250vdc and 6.3 v needed for the unit, may be taken directly from the Two'er. By tapping the high voltage off the transmit side of the Two'ers TR switch, the transmit/receive function may be controlled from this switch. After checking solder joints for poor connections and shortening that last bit of extra lead, already very short, you're set to try the rig out.

While it is warming up, preset Cl to 25% mesh and C2 to 75% mesh. Insert a dummy load made from a #47 pilot bulb into the output connector *(Fig. 5).* Keying the Two'er should cause the dummy load to light brightly. Peak Cl and C2 for maximum brilliance. Moving L4 nearer or farther from L3 may further increase power output. Check for neutralization by momentarily removing the crystal from the Two'er. The output should drop completely. If the dummy load continues to glow, move Cn to another position near the plate lead until no output is obtained when the two meter drive is removed. At full power, there should be .2 MA of grid current between R3 and ground.

The transmitting unit is now complete and will deliver better than a watt of output power. I haven't attempted to modulate either stage of this converter, relying solely on the modulated two meter signal for audio. The result is a weird form of AM (mostly downward modulating) but seems to be copiable on any receiver. For the purist, modulation can be taken from the Two'er but you have to modify the unit to get it. Something I don't want to do; not now anyway.

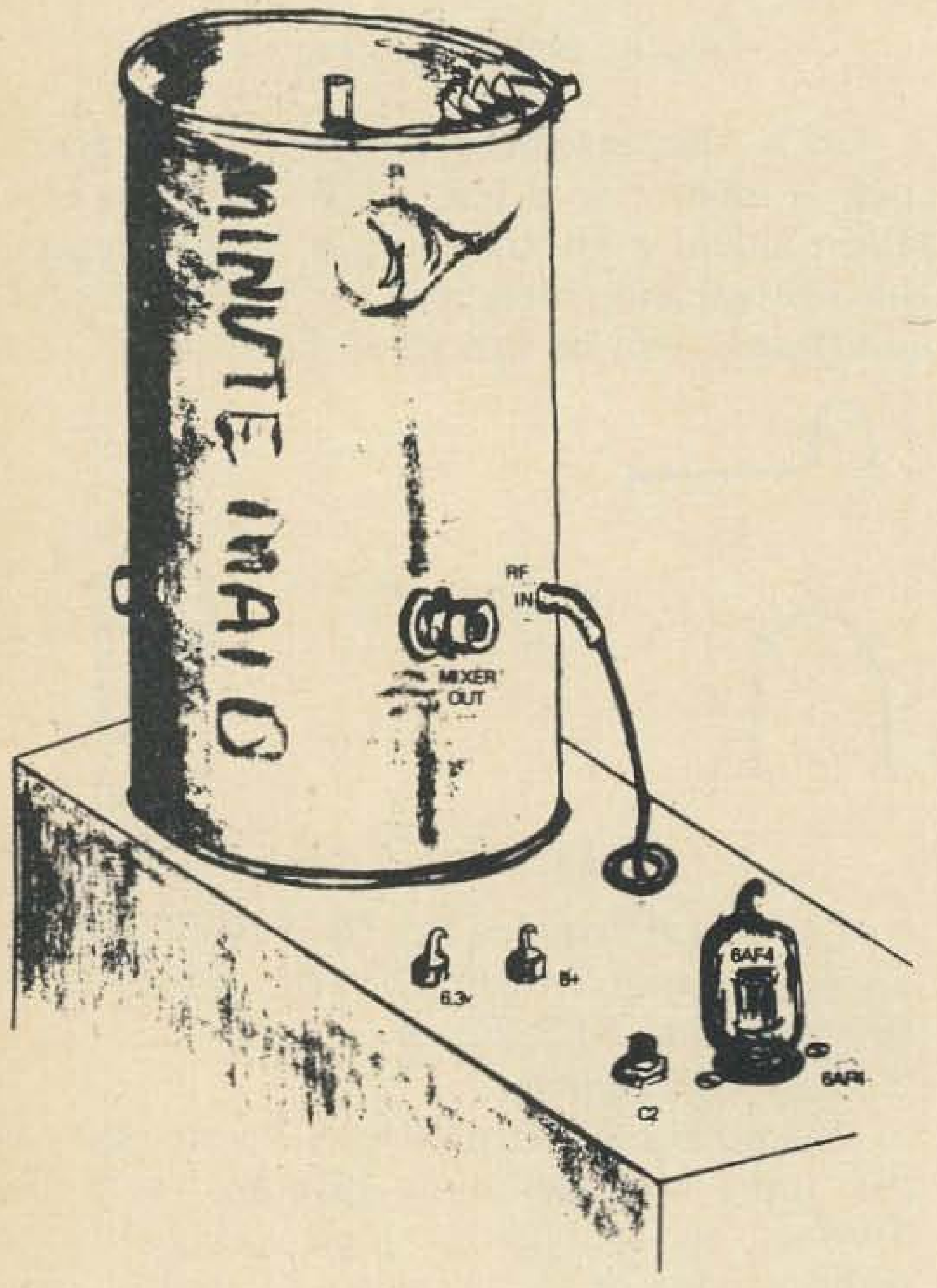

Fig. 8. Receiving converter layout.

Receiving Converter

The receiver end is probably the simplest project you're likely to build. A single mixer diode when coupled with the sensitive Two'er makes a good UHF receiver. And, after all, that is all there is involved in the modern UHF television tuners, which seem to do a fair job. If later you wish to add a transistor preamp, the combination makes a very hot little rig.

The second half of the mini-box is used for this converter's chassis. A fruit juice can (Minute Maid, 6 oz. variety) is mounted in a convenient corner. This will be the mixer cavity. Three holes are punched 1¼ inches

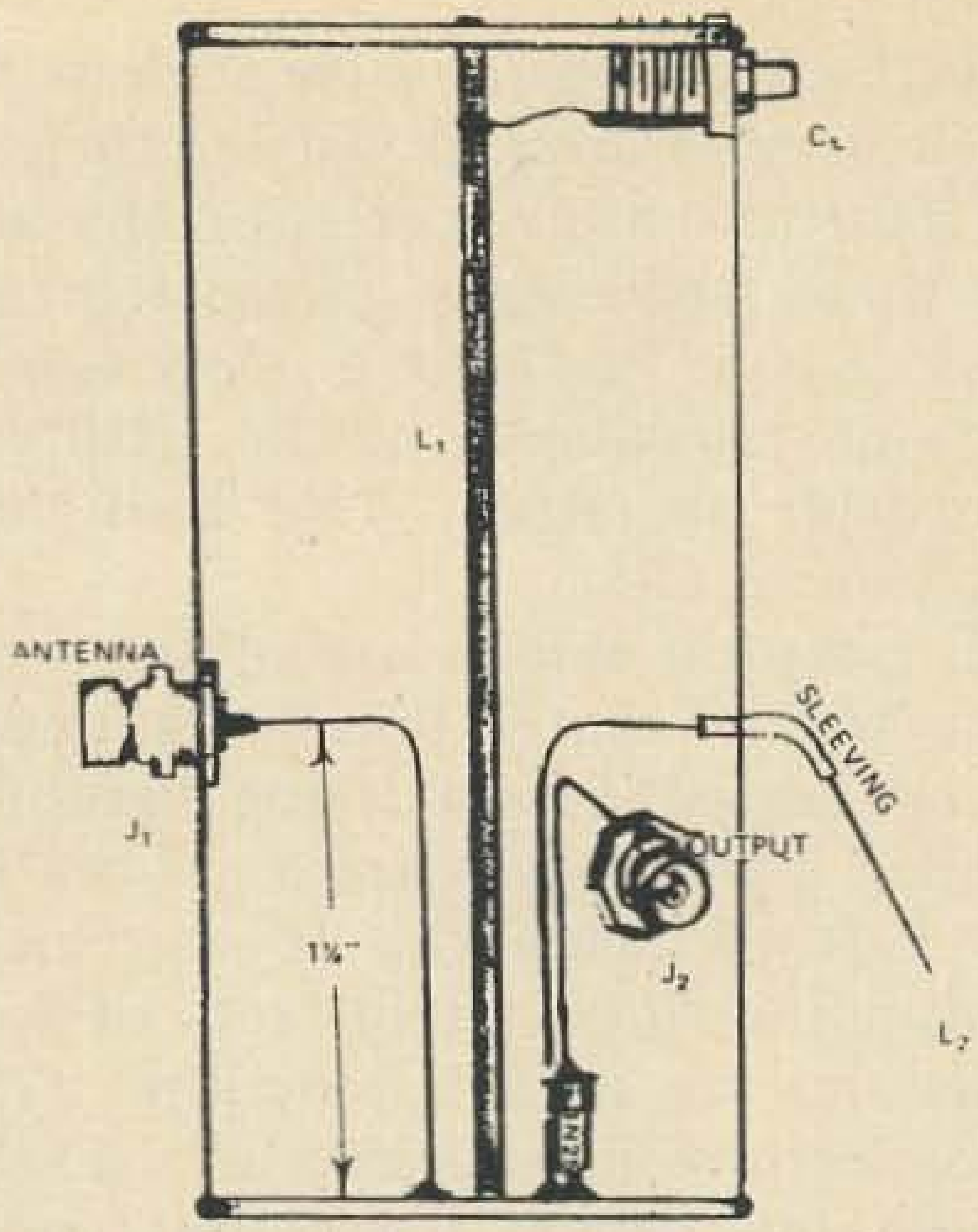

Fig. 9. Detail of mixer cavity of receiving converter.

from the bottom of the can *(Fig. 7)* and into two of these are mounted coax connectors for the antenna input and mixer output.

A miniature variable capacitor is mounted on the upper lip of the can and soldered to L1. L1 runs thru the center of the cavity. This capacitor will tune the mixer to resonance. The tip of a UHF diode (1N21, 1N25) is soldered (watch the heat!) to the bottom of the can, close to L1. An easy way to attach this diode is first punch a hole thru the metal, stick the tip thru the hole, then solder it from the outside. Another wire runs from the remaining side of the diode to the output connector (again watch the heat while soldering).

If you feel lazy, a grid dip meter will do for the oscillator section of this converter.

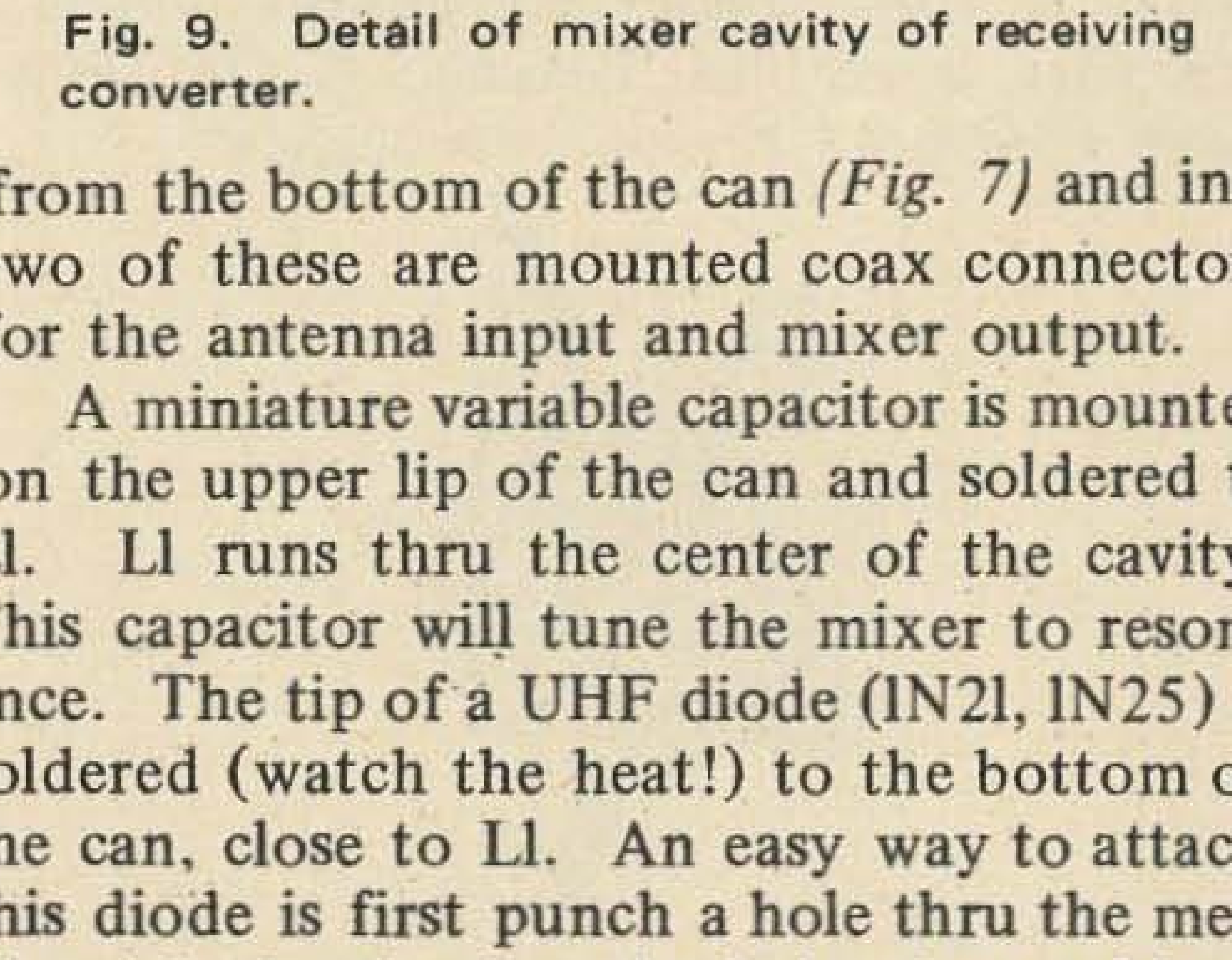

Fig. 10. Schematic of receiving converter.

Parts List

V1 - 6AF4.
L1 - #12 wire running thru center of can.
L2 - ½" loop closely coupled to L3, hookup wire.
L3 - ½" loop, copper strap.
C1 - 1-14 uuf.
C2 - 1-10 uuf per section.

However, for those who want a more permanent set up, I've included an oscillator in the schematic. By adjusting C2, the receiver will cover a very wide range of frequencies. Aircraft, CB, television and radar all make the listening more interesting if you can't find anyone on 432.

Tuning

But we're primarily concerned with 432 MHz, so to start off, first move the Twoer's receive frequency down to about 130 MHz. This is because the regeneration from the Two'er at 144 sort of messes things up at 432 (144x3–hmmm).

A piece of wire three or four inches long stuck into J1 will serve as an antenna during tune up. Like the transmitter converter, power for this unit can be drawn from the Two'er. Set the converter's oscillator near 300 MHz. Now radiate some signal at 432; it can be from another two meter rig's harmonic, a grid dip meter (if not already using it for your local oscillator), a signal generator, etc. A signal should then be heard at the Two'er. Now peak C1 for maximum signal and that's it. Finished, simple, huh?!

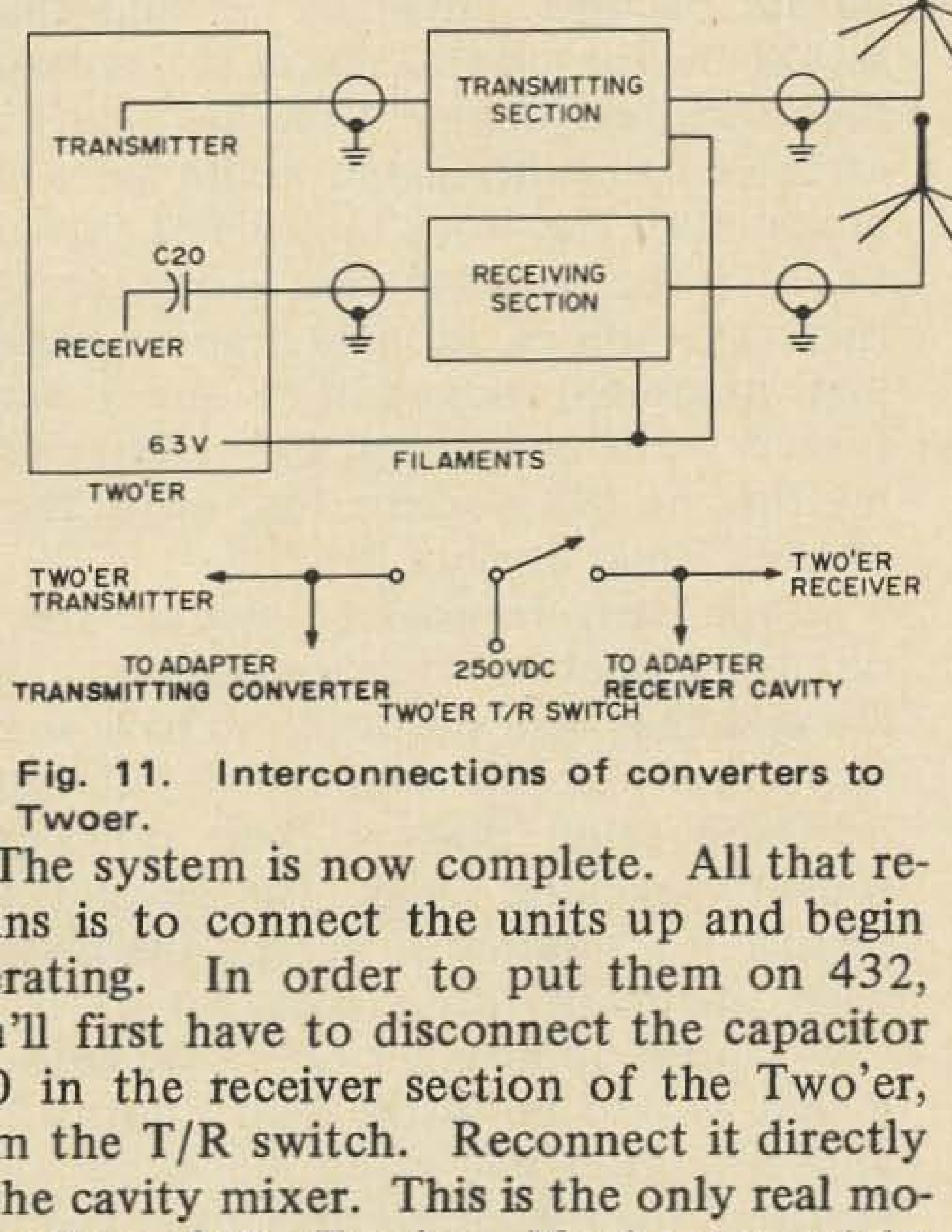

Fig. 11. Interconnections of converters to Twoer.

The system is now complete. All that remains is to connect the units up and begin operating. In order to put them on 432, you'll first have to disconnect the capacitor C20 in the receiver section of the Two'er, from the T/R switch. Reconnect it directly to the cavity mixer. This is the only real modification of the Two'er. Maybe you might want to by-pass this altogether by using a small relay to switch the Two'er from the transmitting converter to the receiving cavity.

Separate antennas are utilized for transmitting and receiving. Here again, a suitable *rf* relay can be used if you want to simplify things.

That's all the installation. You're now on 4 Thirty Two. ...WA3AQS

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CW Can Get Your Goat

Dear avid and sometimes rabid readers of 73. I am sure you recall my initial contact with Rotaciraverp which was so graphically described in a recent issue and how the goat ate the converter which made this contact possible. Also the dit dahs which began to emanate from the goat, possible due in part to having swallowed an 807. And, that I thought my friend Rota (for short) was trying to contact me through the goat, using dit dahs. Well, early one evening when the moon was low, I later refilled the jug, don't drink myself but the goat sure got hooked after one 807, it seemed that the dit dahs were beginning to form strange sounding words. Suddenly I realized why he sounded like off-resonance SSB when he was talking to me. These people pronounce their words backwards so, naturally, talk backwards. I have the ability to reverse my mental facilities and did it without thinking. We have a name for people who do this but I don't remember what it is. Other people talk in circles and they are called politicians.

I began to copy the letters which spelled Moolb Alyak and suddenly I realized the score. Personally, I use that new product called Tint Scalp. Now I want to clarify something once and for all and that is that the following has no reference, insinuated or otherwise, to our dear sweet editor who has shown such a compassion for the trials and tribulations of the Little People. It is pure coincidence and nothing more that when this small bundle of femininity burst upon this earthly scene for the first time, kicking and squirming and squalling loudly, her parents named her Kayla and I doubt that they could have known she was to become a Ham. Nor do I make any inference to her having what is commonly called a big mouth. But it is odd that the reversal of the letters of her first name spells Alyak, pronounced All Yak which seems to be a by product of this means of communication whereby everyone becomes a faceless personality who looks like a loud speaker. On the other hand, it does seem strange that she should become editor of 73 and that she would be the one to reveal Rotaciraverp to the electronic denizens of this planet called earth and that her name would be so closely linked with the stock in trade of this hobby. Could it be possible that Rota foresaw all this? The use of thought transmission gives him unlimited possibilities and I am glad that he is the benevolent type and he assured me that he had nothing to do with the birth of the "Great Society."

Rota flatly refused to give me the name of their planet or its spaceographic location. He said they had no desire to have someone with more of the taxpayers' billions than common sense making their outerspace a rocket wrecking yard. He doesn't blame people for wanting to escape the mess they have made on this planet but as he said, "Why mess up another one?" He did tell me which way to point the goat's horns for the best reception but made me swear an oath stronger than a politician's promises before election that I wouldn't reveal it.

The atmosphere on their planet is made up of a blend of electrons from conductors and non-conductors with a dash from semiconductors thrown in. Thus, when they breathe, they get a mild tingle rather than a severe shock and in comparison to our polluted atmosphere is pleasant indeed. At one time they all got on an electronic drunk due to a malfunction of the blending machine which fortunately righted itself; but if you have never had an electronic hangover, you don't know what a hangover is. The liquid they drink is beyond description in that it is akin to voltage as we know it. After the planetary binge, some of the residents with a tendency toward alcoholism started deep breathing exercises and drinking heavily of their liquid in an effort to recapture the feeling of intoxication but it didn't work so they said, "Watts the use," and gave the idea up. Speaking of watts, they have no need to eat anything because by breathing and drinking they have all the PEP they need.

Before marriage, the males and females are, atomically, in an ionic condition. The males have an excess of electrons, the females are short a few and I didn't say marbles. When an ioness sees an ion with a magnetic personality who attracts her, she exerts a great deal of perveance and tries to bypass his capacity to resistor. However, as usually is the case, his dielectric breaks down which, in turn, short circuits the impedance he has generated and he cannot choke his reactance towards being resonant through mutual inductance. The marriage ceremony is simple in that they step into a converter, a heterodyning process takes place and they become atomically balanced. Being in a balanced condition, their toroid hysterisis for each other collapses and they phase life with a minimum of harmonic distortion.

The men enjoy fission and sometimes catch a gamma ray if they beta hook properly. Fish or no fish, they love to watch the oscillations on the newclear pool. Or they will go down to the village square and try to talk the squares into cutting off their beards and long hair and taking a bath. If they desire children, they have a computerized propagation machine which delivers children according to the frequency allocation. Once and only once, the computer delivered an atomically balanced baby and later they named it "Millie Henry." If the men get mad at their wives they call them meghertz and if you have been married as long as I have, you know how painful that can be at times. On other occasions they tell them to shut their ion traps and neutralize the feedback but, being females, this doesn't seem to phase them because they are determined to have the final output probably due to their natural excitation.

The barbers are called trimmers and some people think their clippers should be applied to their modulators. Although they seem crude, they have counterpoise and broadcast audio which contains some bias and needs filtering. Some people wear pigtails and this shunts business away from their station. A barber named Pico Farad got over charged about this and degenerated to the point where he couldn't sine his log.

Molly Cule married Mike Rofone who was quite an emitter. Mike was a collector of germaniums which bothered Molly's sineus because of the field effect and she had to give him the gate. He tried to tell her that it was caused by negative bias but she was positive and told him to take his silly con somewhere else because he no longer got to first base with her. Mike did a flip flop and started practicing Yagi and was right in his element until he choked on a balun while trying to make a match with Sue Perhet. They tried artificial reactivation but got no reactance so poor Mike went to ground.

Just as things were getting interesting, trouble developed: the moon got low and the goat was high and started to hiccup. Now I have copied CW signals which sounded like a chipmunk burping under water and others which sounded like someone keying the power line. Or the catch-me-if-you-can boys who drift up and down like a yo yo. And then we have the high speed boys who send part of a word about 17 mistake symbols of their own choosing and finally get the other two letters for a grand finale. All this is bad enough but you try copying a goat with the hiccups. Here a dit, there a hic. There a dah, here a hic. I gave up on the copy and as I was leaving, the goat was weaving and heaving and the moral of this story is, "If you are a goat on the receiving end of Ham radio, don't get moon struck with CW (Corn Whiskey) and make a pig of yourself."

. . . K7TTA

Ed. Note: My secret is out! K7TTA has revealed to the readers that I am "out of this World." Actually, I was born at the age of 7, and for anyone to call me a "small bundle of femininity" is ridiculous, as anyone who has met me will attest. I am a large bundle of femininity. My Father, who's name is Llib, is 6' 4" tall, and my Mother, Neelhtak, is 4' 11". The probability of these two people ever having children is remote, so it was fortunate that I arrived by mail. I followed a brother by 3 years. They were pleased with him, so put in another order. They have never quite recovered from the shock, and now live in retirement in a small town in Ohio, where they are trying to forget the whole unpleasant incident. . .Kayla

Bob Eshleman, W4QCW
3716 Drakeshire Rd.
Richmond, Va. 23234

Rio de Oro the Easy Way

In the past ten years, peaceful Rio de Oro has become the rarest African country on the dxcc countries list. This is ironic since most of the rest of the continent has been politically disturbed during this same period. From 1956 until late 1966, there was a complete absence of amateur activity from Rio de Oro.

In September of 1966 the long silence was broken by Justo Perez, EA9EJ. It is strange that not a single dx publication carried news of this dxciting event. About eight weeks later, Justo was discovered by Eva, PY2PE, and the dx grapevines began to hum. Unfortunately, Justo spoke no English, could not copy SSB signals, and worked only on 15 meter AM. DX'ers are a plucky lot, though, and 15-meter beams began to sprout all across the country. With Eva's encouragement, Justo agreed to attempt to work some of the W/K gang. In mid-December, W3DJZ and a few others broke the ice with AM qso's, but the odds of making a qso for an East Coast station were formidable and for a West Coast station impossible. The biggest single problem confronting the North American dx'ers was that Justo's signal was always extremely weak.

Most of the Richmond dx gang needed Rio de Oro, and our six meter net was buzzing with ideas on how to improve our chances of making a qso. Frank, WA4HTR, offered to donate a used TA33 Jr. beam if we could raise enough money to air freight it to Justo. In the meantime, PY2PE and EA8CI made all the necessary arrangements with Justo. Since a twelve-foot package will not go aboard a DC-3, it was necessary for Manuel, EA8CI, to pick up the beam in Las Palmas and sea freight it the last 300 miles. When the beam arrived in March, I had no idea that this event would have such a bearing on my already planned European vacation. Shortly after the beam reached its destination, I learned that Jack, HB9TL, was sending one of his famous 20-meter transceivers to Justo. Jack's little rigs are similar to a Swan 120 except that they cover 14,000 to 14,320 and the transmitter portion can be crystal controlled for split frequency operation.

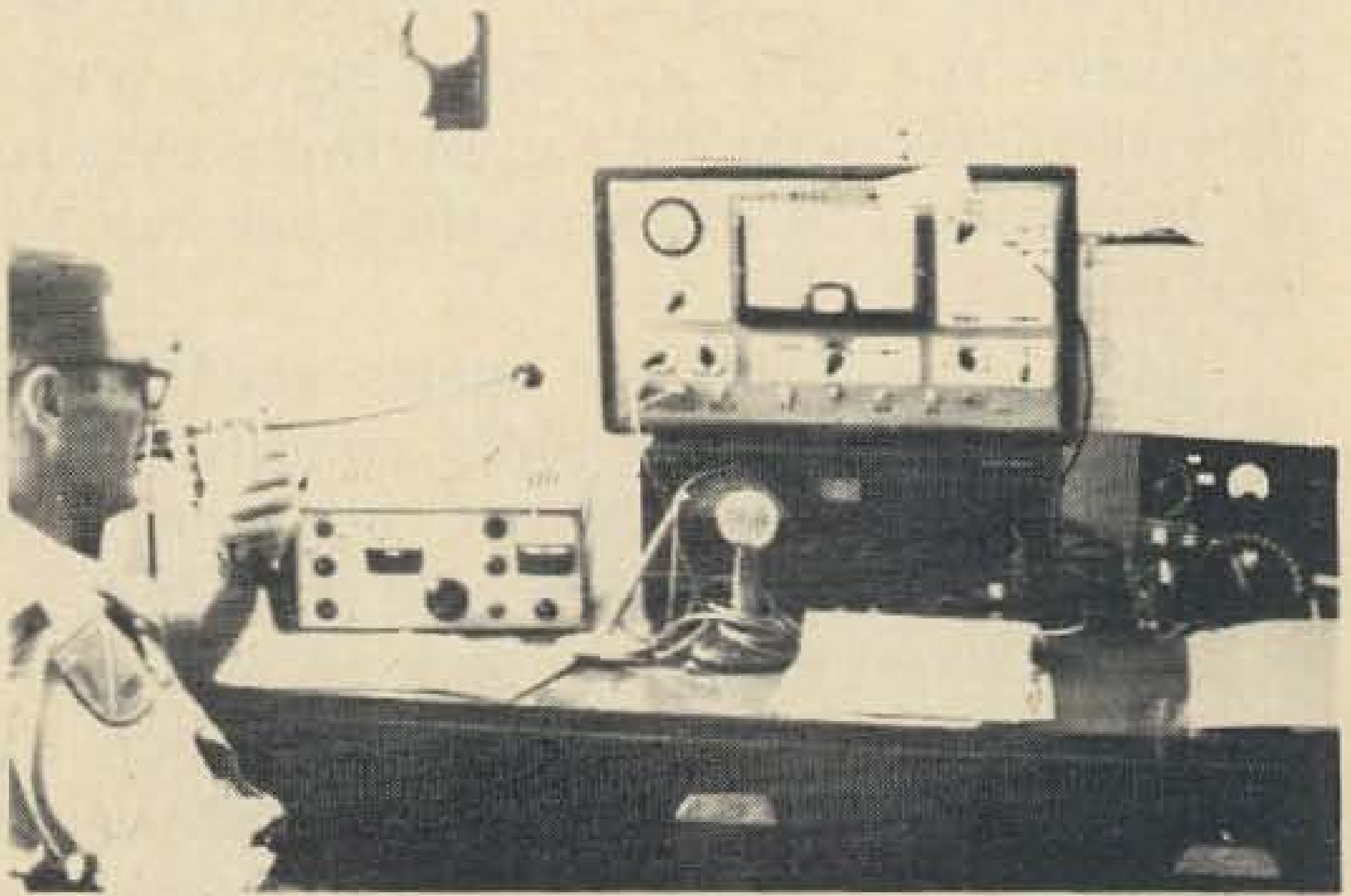

Fig. 1. Justo in his shack. Gear L. to R. is: HB9TL transceiver, Geloso transmitter, S-40 receiver and voltage regulator.

In early April the first two way SSB qso's with Rio de Oro took place. Unfortunately, the large number of expected qso's did not materialize. With Justo making an average of two or three contacts per day with the USA it was obvious that in the remaining year of operation only a small percentage of the stations needing EA9EJ would make a qso. Later I learned why most amateurs in Justo's circumstances would probably have made far fewer contacts, especially with English speaking stations.

As a result of qso's between Justo, Eva, and myself, we worked out a plan to break my European vacation for several days and fly down to visit Justo. The success or failure of the plan depended on whether I could obtain a visa to visit Villa Cisneros. Gus Browning, the Colvins, and others told me that it was impossible, but I had one thing going for me which they didn't–inside help. With six weeks left before our departure date for Europe, I applied for a visa. I was told that my application would either be granted or denied within three weeks. Five weeks later, when there was no word from Madrid, the whole idea was scrapped. Just five days before our scheduled departure for London, a WA3 called me on the telephone and told me to come on 15 meters immediately as Eva had urgent traffic for me. Eva had just spoken with Justo and he had informed her that an authorization for me to visit Rio de Oro was waiting for me in Las Palmas! Justo had interceded on my behalf with the governor of the Sahara, and the governor had telegraphed the permission to Las Palmas. I immediately wrote to Justo and asked him to send a confirming letter to Amsterdam before July 29 if everything was still go. This seemed safer than flying from France to the Canary Islands merely on the strength of one relayed radio message.

On July 19, my xyl, Rosie, and I flew from New York to London. Space does not permit me to relate what a wonderful group the G gang and their ladies are, but I must mention just one example. George, G3LNS, and his fiancee, Sylvia, took us for an all-day excursion through the English countryside, where we visited such interesting places as Salisbury cathedral, Stonehenge, Stratford-on-Avon, and many others. When we arrived in Amsterdam on July 25th, the confirming letter from Justo was waiting for me. Justo told me to give up the idea of bringing a generator along. I interpreted this to mean that the long-promised 24-hour electric power service for Villa Cisneros was now in effect. Eleven days later I would have given my OK7HZ/ZA qsl for the little generator George offered me while we were in Birmingham, but that's getting ahead of my story.

To carry out the dx'pedition successfully and still not foul up the rest of our trip, I needed bookings on five different flights. A single miss would leave things in a terrible mess. My travel agent in Amsterdam put all five flights "on request" but was unable to confirm a single one before we had to leave for Paris. Our plans called for me to leave Rosie on August 4th and fly from Bordeaux to Las Palmas. On Saturday, the 5th, I would pick up my visa and catch one of the tri-weekly flights to Villa Cisneros. Flying by way of Las Palmas and Madrid, I was to meet Rosie in Barcelona on the 9th. Meanwhile, Rosie and two friends would drive from Bordeaux via Andorra to Barcelona. When we reached Paris on July 31st, I was able to confirm the Bordeaux-Las Palmas flight with Air France. As for the four remaining flights with Iberia I would just have to hope for the best.

Early Saturday morning I went by the Sahara Administration Office in Las Palmas to pick up the promised visa. With a little luck, I should have the visa and airline tickets within an hour which would leave me the rest

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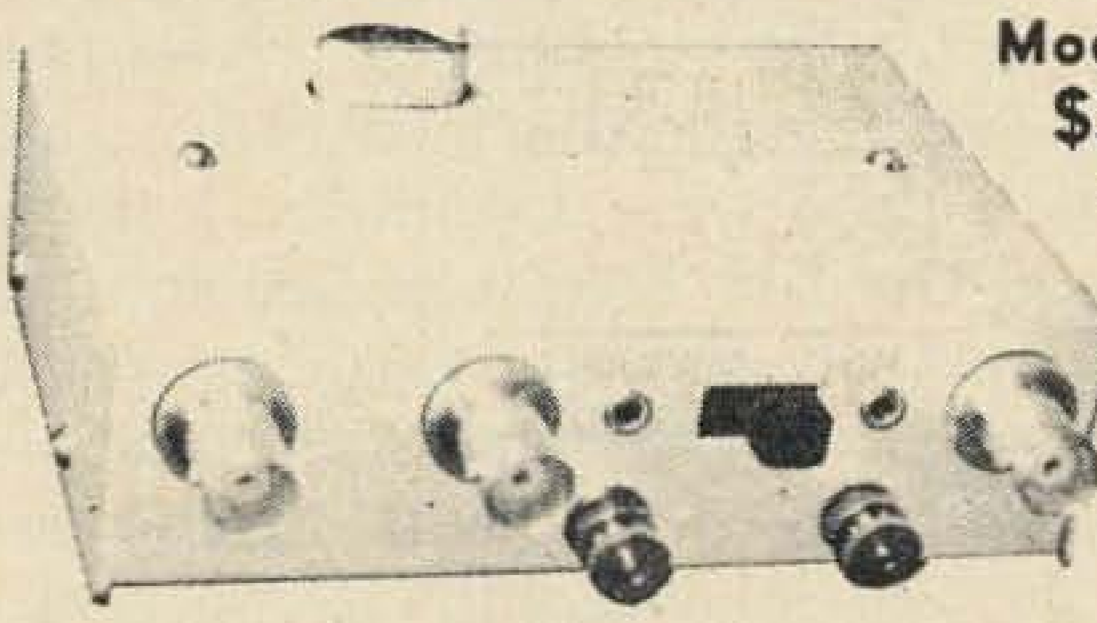

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of the day to see the island. The visa was issued within twenty minutes, but then my luck began to run out. I was told to go to the post office and buy a 3 pesata stamp for the visa. Then I was to take the visa to the Las Palmas police for their validation. I wasted 30 minutes looking for the post office and finally wound up buying a stamp at a news stand. Since the Las Palmas police station was on the opposite side of town, I caught a taxi to save time. Ten minutes and six *pesatas* later the visa was duly validated by the police. Rio de Oro seemed a lot nearer now.

With just such pleasant thoughts in mind, I took the first long hard look at this magic carpet which had eluded so many dx'peditioners before me. To my horror, my eyes fell on the phrase, *"Y con una duracion de 48 horas."* The return flight from Villa Cisneros to Las Palmas was not until Tuesday evening, 72 hours later. I walked back into the police station and attempted to explain this to them. The officer just shrugged his shoulders and said it wasn't of any concern to him. The Sahara Administration officials didn't seem inclined to issue a new visa although they did find a second telegram in their files authorizing a 72-hour stay.

I taxied back across town for the third time to the Iberian Airlines office. Unfortunately, the Iberian representative refused to sell me tickets on the basis that I could not possibly return before the visa expired. I explained to her that I had already made a second trip to both offices about this and everyone said that the present visa was satisfactory. "Oh, yes, but when you get out to the airport (20 miles from town) this evening the airport police won't let you board the plane." At this point, I practically got down on my knees and begged the little girl to phone the airport police, explain the situation to them, and find out if they would let me board the plane. An hour later, she came back smiling. Yes, I could go, but she couldn't promise what would happen to me when I was ready to return. Since I was going as a guest of Teniente Coronel Perez, second highest ranking officer in the Sahara, I decided to take that risk. By this time, it was too late for a tour of the island, but at least I could relax for a change.

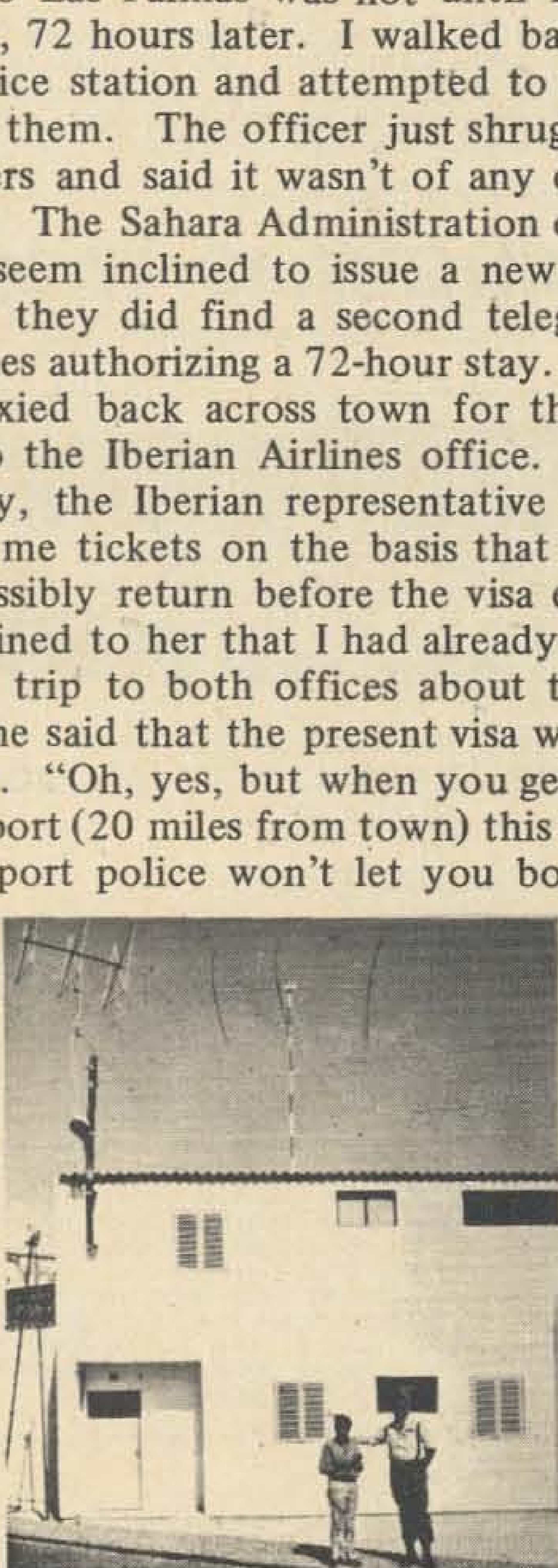

Fig. 2. Justo and son in front of his house. Quad is for TV reception from Las Palmas. TVI was a problem! Note how the wind blows the TA33 Jr. elements.

The little T-47 took off promptly at 7:00 p.m., and 90 minutes later I could see dim lights of a small village. The runway was outlined with a row of smudge pots, but this seemed to be adequate for a safe landing. Just as I reached the fence a tall man stepped forward and said, "Bob!" It was Justo, accompanied by an English-speaking military chaplin, Father Eusebio Espinosa. Justo said a few words to the police, and I was informed that I could stay in Villa Cisneros as long as I liked.

At 21:39 GMT, I logged W2FXA for the first qso. I had expected to work 100 stations per hour easily, but when the first twenty minutes produced only four qso's, I began to realize that something was wrong with my signal. The transceiver seemed to be working satisfactorily so the trouble had to be in the antenna. To make matters worse, Justo informed me that the power was off daily from about 00:50 GMT until 07:00 GMT and that from 07:00 until 19:00 the regulation was so poor that operation was impossible. As the evening wore on, conditions gradually improved and by 00:45, when I went qrt for the night, my qso rate was up to one per minute. I made a dash for the officers' barricks, and, just as I finished undressing, the lights went out abruptly. From my second story window, I could see most of the village, and to my surprise there were a few electric

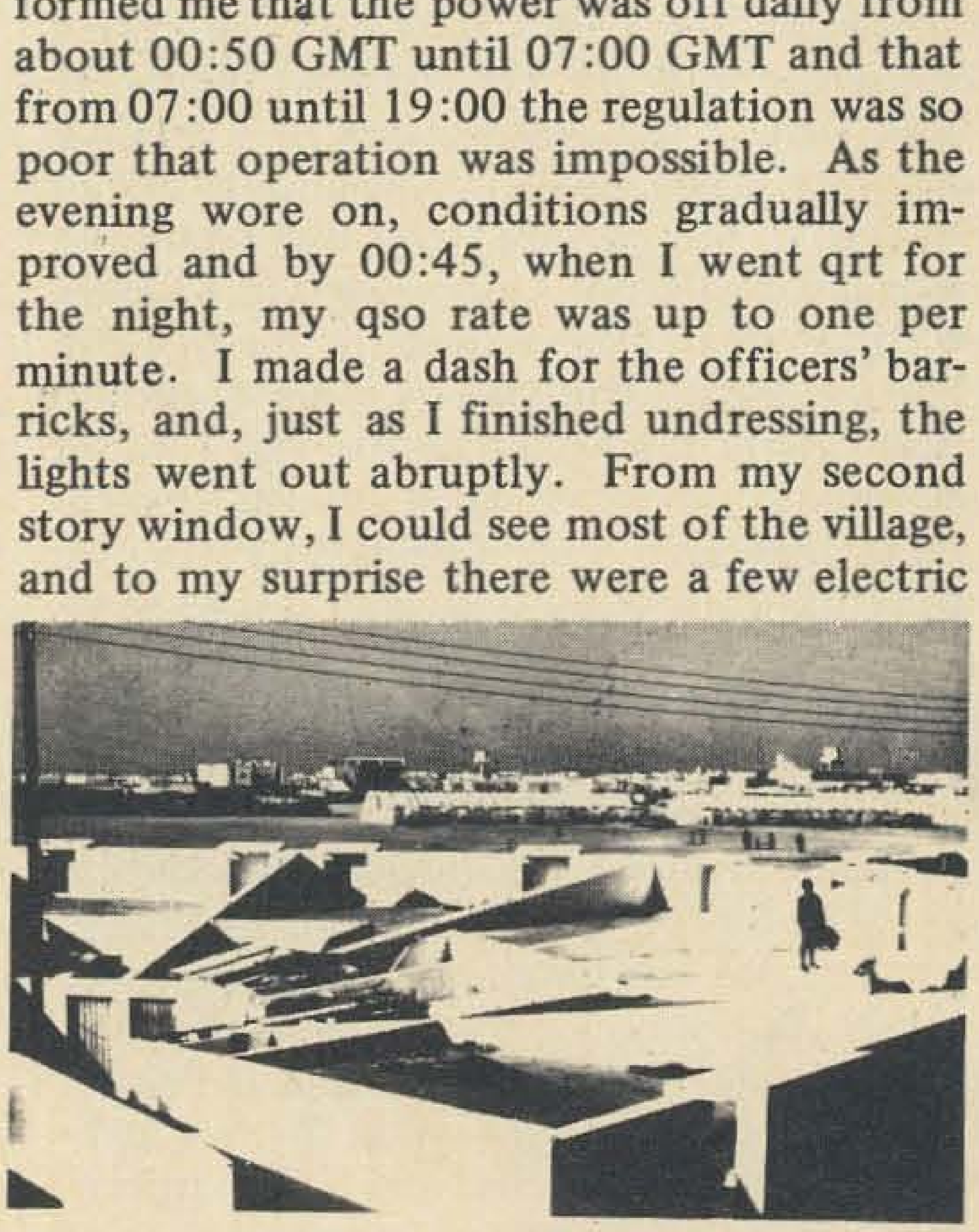

Fig. 3. The Villa Cisneros skyline.

Fig. 4. Justo's legionaires drilling on a Sunday morning.

lights still burning. If I could just figure out a way to get some of that power!

In the morning, Father Eusebio and Pvt. Allen Marcos, an English speaking legionnaire, whom Justo provided as a valet, took me sightseeing through the village. I was pleasantly surprised to learn that I could take pictures of anything I wished. Roughly, half of the population is Arab with a few of their darker-skinned former slaves and the other half mainly Spanish military personnel with their dependents. After lunch, Justo decided we should try 20 meters as the power regulation seemed better than usual.

The first thing I heard was friend George, G3LNS, calling CQ AFRICA right on our crystal frequency. It was a pleasure to repay some of George's kindness by giving him a new country the easy way. The next hour's operation produced only a dozen contacts, so I decided to see what could be done about the antenna. An ohm meter revealed that there was 10,000 ohms resistance across the feedline when it was disconnected from the transceiver. Since the TA33 Jr. has a split driven element, this had to mean trouble in the line or its connectors. I traced the line to a DPDT ac-type knife switch. From the switch it ran up to the wall where it was spliced to the main cable from the beam with two wood screws. With Justo's permission, I decided to run the line directly to the transceiver. As I disassembled the line, I discovered that the braid of the RG8U wasn't soldered to the PL-259. The center conductor was soldered, however, and Justo's soldering iron was still cold. A soldier was dispatched to find another iron. An hour later, he returned with a mighty fifty watt job. In the meantime, I had prepared the end of the coax to receive the salvaged PL-259. Unfortunately, the braid was so corroded that I couldn't clean it adequately to make a good solder joint, especially with a fifty watt iron. With the job completed, the line still read 10,000

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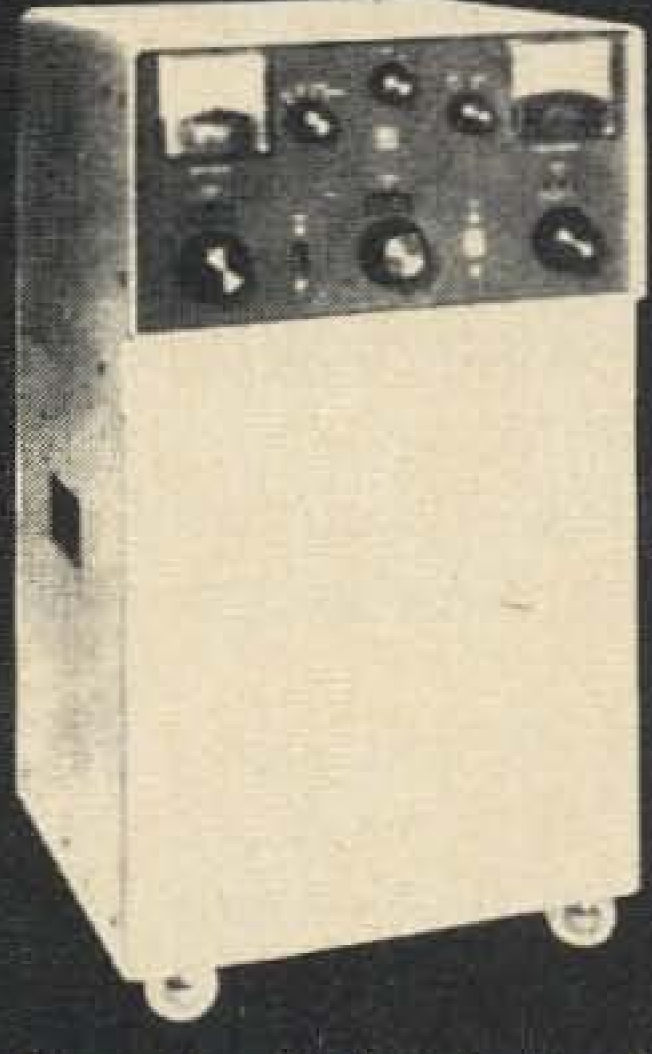

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ohms across the end so apparently the trouble was in the line itself. I asked Justo through my interpreter if I could replace the feedline with the new coax which we sent with the beam. No, it was impossible to reach the beam without taking it down and with the high winds he didn't think it should be taken down.

Since there was no possibility of improving the antenna, I began to explore the idea of some source of power from 01 to 07 GMT. Every lead drew a blank. There just simply wasn't any way that I could get the transceiver, an antenna, and a power source all together for those hours of optimum propagation to the States.

Since 1956, no W6 or W7 stations had qso'd Rio de Oro and at this point, it was beginning to look as though there might not be any qso's in the next eleven years either. Then at 00:39 GMT, with a scant eleven minutes of power left, Allen, K6YRA, broke through for the first west coast qso. With numerous repeats, I managed to get five Californians in the log before the shack was plunged into darkness. The next morning, as I was having coffee in the mess hall, Justo came bursting through the door and excitedly announced that he had worked two W6's. Obviously, my planned trip into the desert with the Spanish army would have to be given up. In the next hour, I logged 74 stations of which 61 were sixes. The 07-09 opening was a bonus I hadn't expected, and luckily the power regulation held out just long enough.

A second unexpected bonus materialized from what was supposed to have been a joke. Since Justo does not work CW, Eva had suggested I take him a gift of a hand key as a gag. With my SSB results not up to expectations, I decided to try CW. In order to work CW, I had to hold the mike in my left hand since the PTT button was the only transmit switch the little transceiver had. With a mike in one hand and a straight key in the other, I managed around 250 CW qso's in five hours operating time. With a little advance notice, the number would have been much higher.

On the last afternoon of my visit to Rio de Oro all of the native musicians and dancers were assembled to put on a show for me. The stars of the show turned out to be two eleven year old female dancers. It was difficult for me to believe that these two little girls were already married. As the show progressed, we all sat around with our legs crossed drinking syrupy Arab tea and eating spiced camel meat off of metal skewers.

Fig. 5. The eleven year old dancing girls at farewell party.

This was a grand climax to a wonderful three days in Villa Cisneros and it made me wonder why any dx'peditioners would want to spend their time on some barren uninhabited rocks in the middle of the ocean which have absolutely no cultural value. After the show, I went back to the shack for one final operating session. At 20:28 GMT on August 8th, I pulled the switch after a final qso with I2LAG. Twenty hours later, I was getting a big welcome back kiss from Rosie at Barcelona.

A check of the logs showed that in twenty-two hours operation a total of 801 qso's were made with all US call areas and all continents. Although 11 percent of the contacts were with the sixes only two sevens, K7GCM and K7ABV, were worked. VK4YP was the only Oceania station worked, although others were heard and called. Contrary to the claims of one of the better known dx'peditioners that most of the "big gun" W/K dx'ers are lids, I found the exact opposite to be the case. Both the big guns and small fry behaved extremely well. When I asked for particular call areas, everyone who copied my request cooperated, and I rarely had difficulty copying reports being given to me.

For those who still haven't worked Justo or myself, I suggest learning a little Spanish. If you will just learn your call letters and his call letters in Spanish, your chances of making a qso will improve 100 percent. If you could not speak Spanish, as Justo cannot speak English, can you imagine how difficult it would be to identify a single station out of twenty South Americans calling you in Spanish on the same frequency? My advice is—do your homework, monitor 14,115 and 14,125 and hope for the best.

...W4QCW

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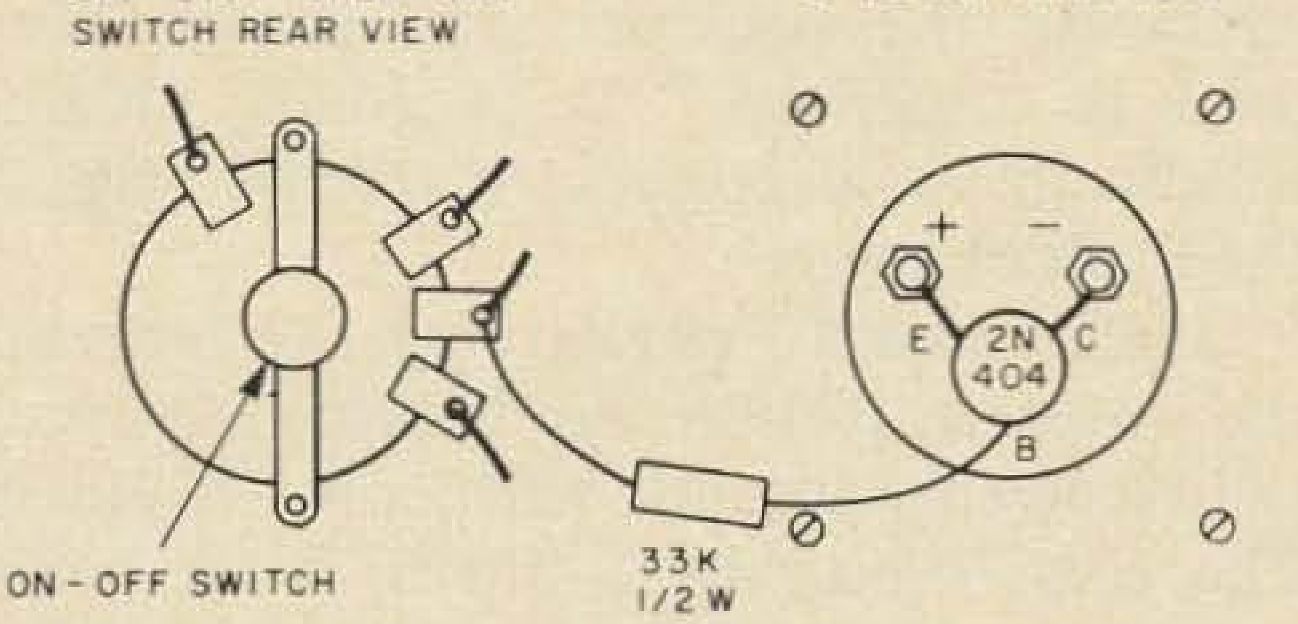
Does your S-meter peg when you switch from operate to standby? We had that problem with our Heath SB-301 (a really fine receiver, by the way) and it was annoying enough to be worth fixing.

All it takes is a 2N404 transistor and a 33 to 100K resistor. Install the transistor across the S-meter with the emitter to the + side and the collector to the – side of the transistor, saturating it and thus just about shorting it out.



Let the receiver warm up on STBY until the filaments are warm and the mute voltage is available for the meter protection.

This should be helpful for any piece of equipment that has this problem.

Michael Tenore, WB2LCW

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Trouble Shoot Your Antenna from Indoors

Neil Johnson, W2OLU
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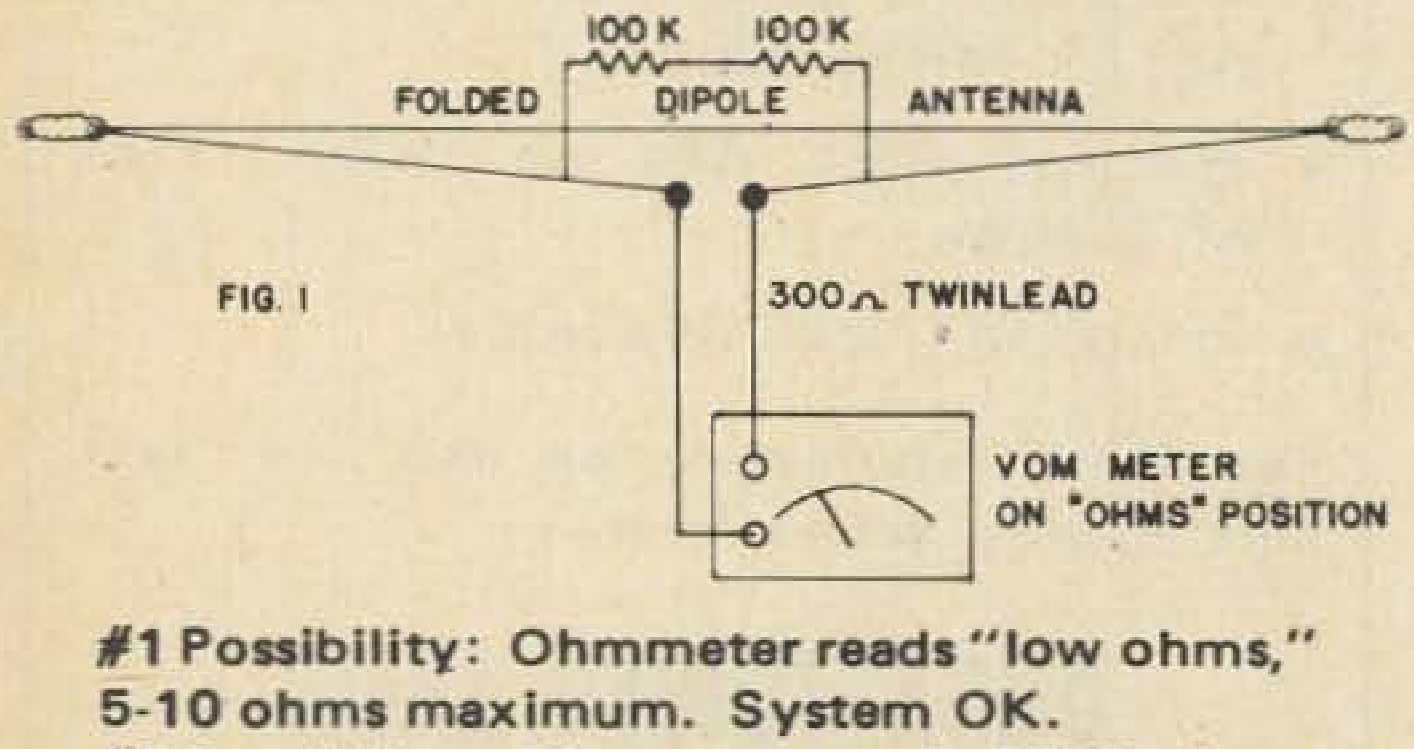
Would you like to shoot trouble on your TV or short-wave antenna without going outdoors? It can be done, without the need for any complex instruments. The cost? Just a few cents. Here's how it's done. Assuming your antenna feeds into a transmission line of the 300-ohm type—this applies to most installations—the trouble shooting setup becomes simplicity itself: two carbon resistors, plus an ordinary ohmmeter (**Fig. 1**).

Two composition resistors, of values approximating 100K ohms each, are connected in series. This combination is then connected to the "top" end of the twin lead, where it joins to the antenna proper. Now...the twin lead is disconnected from the equipment which it feeds, such as TV receiver or short-wave apparatus. The normal reading for a "folded-dipole" type antenna installation will be in the order of a few ohms, possibly as high as 5 or 10 ohms at most. Should a break occur in the antenna or "flat-top" portion, the ohmmeter will read in the neighborhood of 200,000 ohms. On the other hand, if the meter readings should be extremely high, it is safe to assume that the twin lead coming down from the antenna has a break in it somewhere. Through this simple process of elimination, the experimenter quickly pinpoints the area of trouble. This reduces the total time needed for diagnosis and repair. It will also eliminate, or reduce, the need to climb over hazardous rooftops, thus cutting down on a few bruises, or possibly broken bones.

This scheme, using resistors, is not confined to antennas of the folded-dipole type. Many short-wave and TV antennas have a single conductor for the flat-top, such as a copper wire or an aluminum rod or tube. Breakage in the antenna proper is thus easily spotted. But twin-lead breakage, concealed inside a plastic overlay, cannot be detected without a minute and close-up inspection. Rather than needlessly risk a broken arm or leg, why not put two ten cent resistors to work? (**Fig. 2**).

In the case of "intermittents," one of the hardest of all radio troubles to spot, sometimes the fault may be determined by placing the ohmmeter terminals across the lower end of the down-lead, while at the same time keeping a sharp eye on the ohmmeter and simultaneously shaking the twin lead. The few check-points in this elementary "system" are not a 100% cure-all, but each only takes a few minutes' time; and in the majority of cases, diagnosis can be completed while the experimenter stands on "terra firma." Half watt resistors will suffice for all receiving set-ups, and 1 watt resistors will work out fine for all low-power amateur applications, both receiving and transmitting. Two watt resistors should be used for high-powered "ham" applications. In any case, very little power loss takes place through the resistors, since their total of 200,000 ohms is approximately 3,000 times the nominal impedance of a resonant dipole, or 70 ohms. The reason for using two resistors in series is mechanical, rather than electrical. Located as they are shown in the diagram, there is no physical strain on the resistors, and no chance for them to "open up." To avoid any chance of trouble, clean all connections thoroughly, and then solder them.

In addition to connecting the resistors to the antenna, trouble can be avoided by using twin-lead that is made with copperweld steel. The cost is no more, and it is far stronger than ordinary twin-lead, which is made with copper. Several manufacturers produce this "long life" variety of twin-lead. Belden offers these under several designations, such as type 8285 Permohm, type 8275 Celluline, and type 8230 Weldohm. Of these three, the last mentioned is least expensive. Amphenol makes



#1 Possibility: Ohmmeter reads "low ohms," 5-10 ohms maximum. System OK.
#2 Possibility: Ohmmeter reads 200K ohms, folded dipole section of system disconnected from feedline; or, folded dipole "open."
#3 Possibility: Ohmmeter reads much higher than 200K ohms, the feedline has an "open circuit" before it joins the antenna section.

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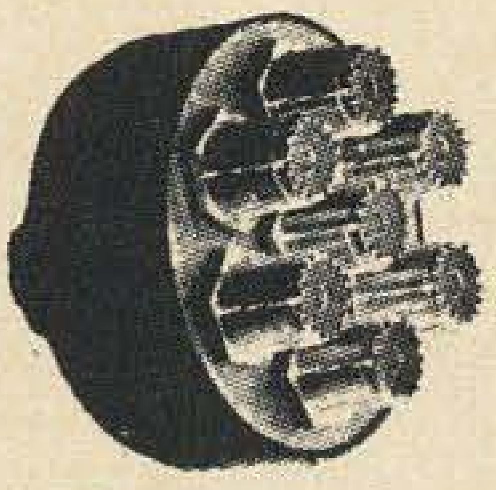

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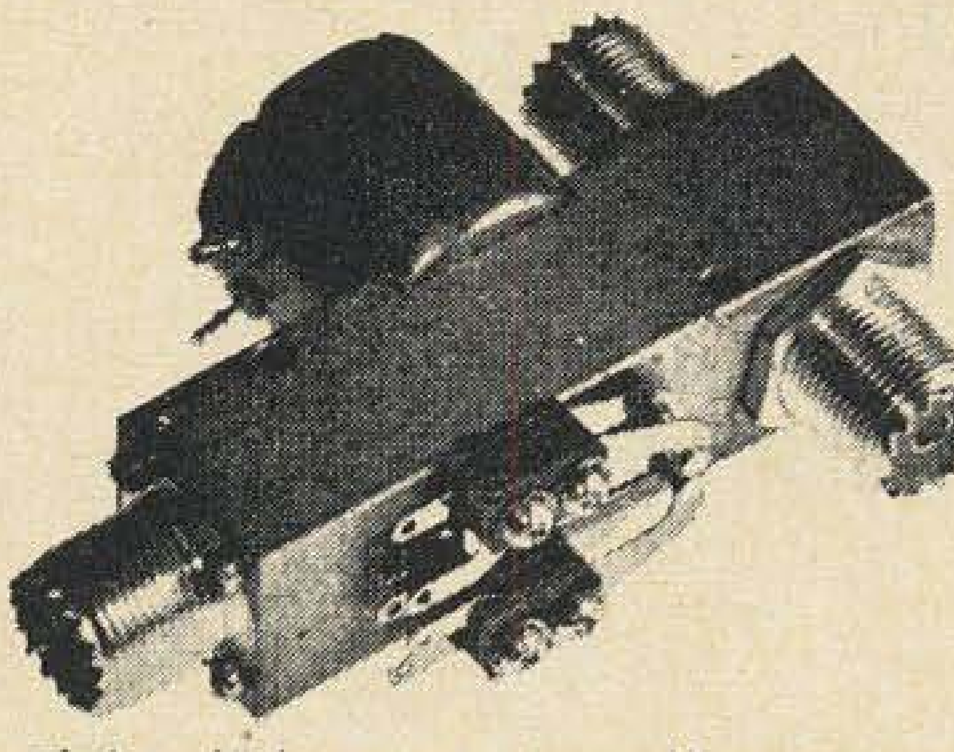

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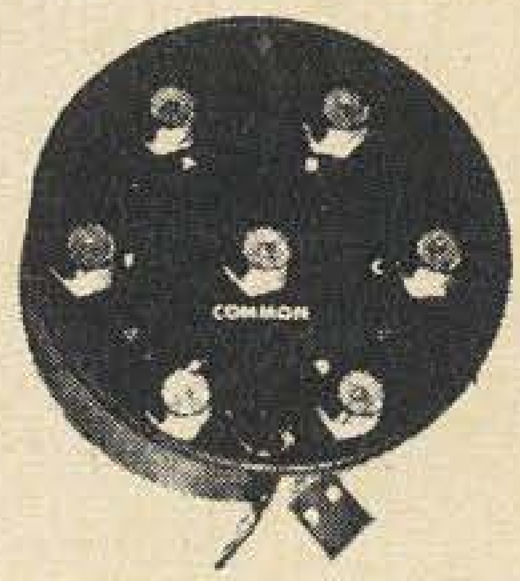

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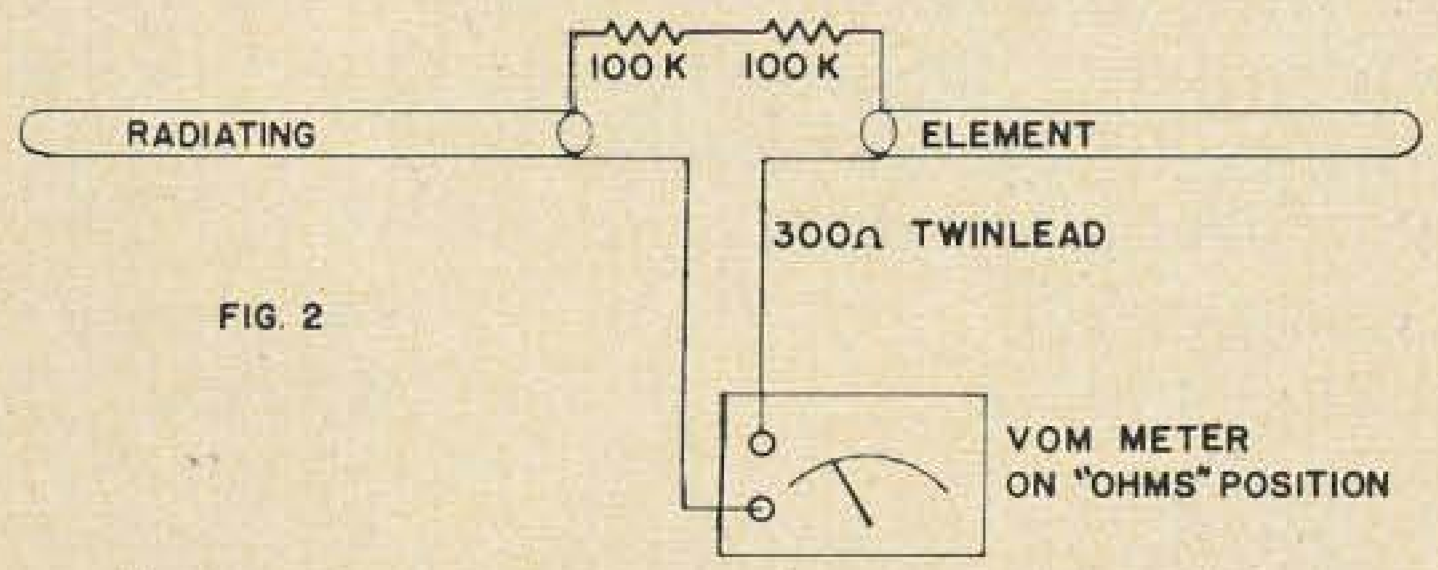
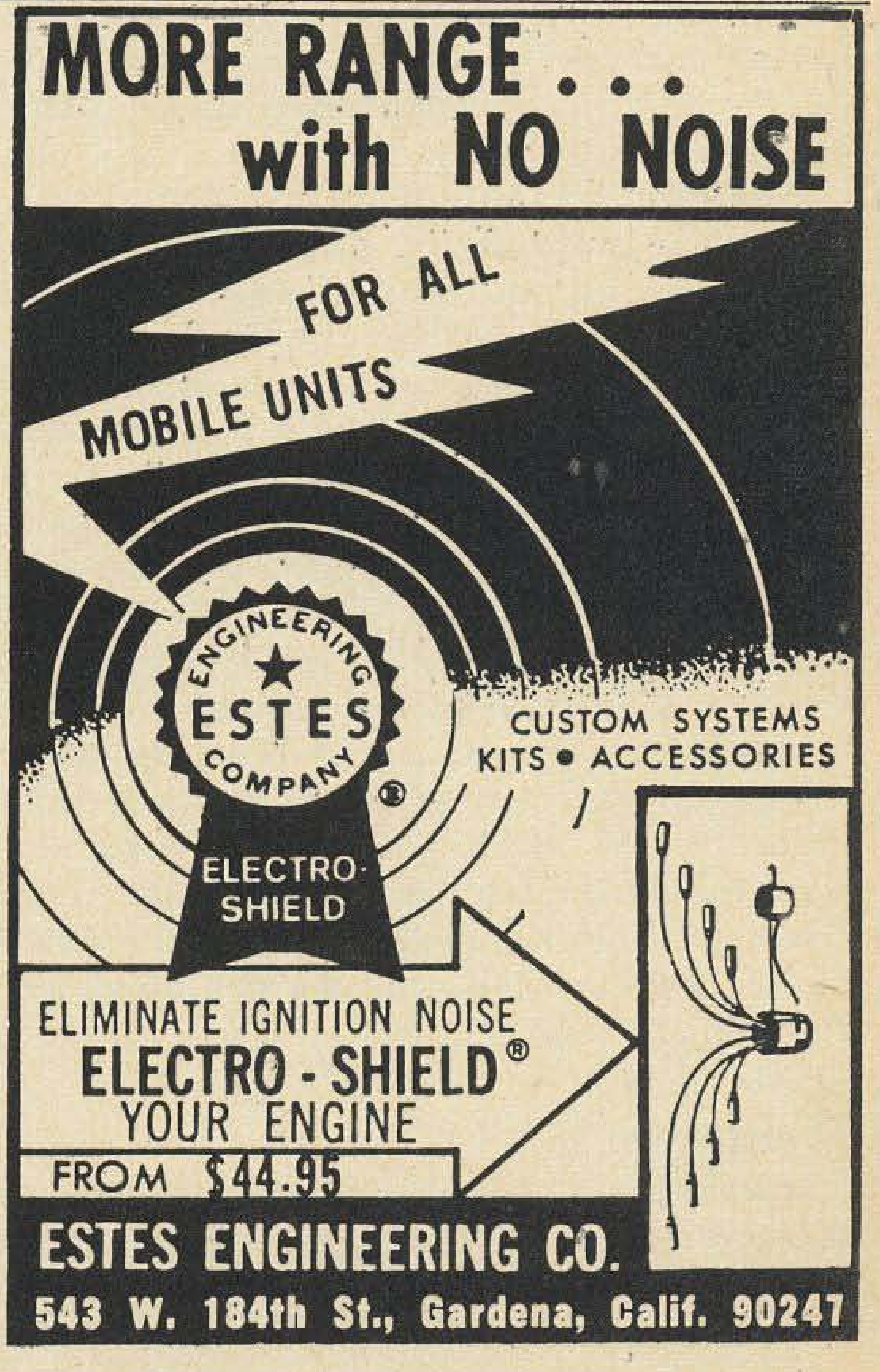


FIG. 2

#1 Possibility: Ohmmeter reads approximately 200K ohms. System is OK.
#2 Possibility: Ohmmeter reads very high, in megohms. Twin lead is "open."

a similar flat line, "Steelcore," number 214-559. A somewhat more expensive line by Amphenol is their number 214-022, which has two number 16 conductors and is suitable for transmitting amateurs. Other makers offer copperweld twin-lead under such names as "lifeline." If doubt should exist as to the wire's having a steel center or core, a small magnet will give an indication of the wire's being copperweld. If you have been having trouble with ordinary twin-lead breaking frequently, why not give one of these copperweld lines a trial? You will be impressed by their relatively greater durability. Through the utilization of long-life twin-lead, plus the resistor scheme, it should not be necessary to make that dangerous trip to the roof so often.

...W2OLU



G. William Reynolds, K2ZEL
32 Perry Avenue
Latham, New York 12110

A Six-Meter IC Converter

This converter is one module of a solid state mobile receiver and transmitter designed, constructed and tested by the author. The advent of solid state devices make it possible to design highly stable receivers and transmitters which will operate directly from the car battery. The modular system was selected to insure adequate shielding between sections of the receiver and the transmitter and to facilitate changes in the system at a future date if desired.

The converter is constructed of two "ICs" and associated components. The one is an *rf* amplifier of 30 db gain and the second is a crystal oscillator, mixer, amplifier stage of 40 db gain. Evaluating insertion losses, the overall gain of the converter is 55 db. The factors considered when selecting the particular "IC" used were cost, availability and suitability. The Fairchild 703 operates as a differential amplifier of 20 to 30 db gain at frequencies up to 200 mhz and is inexpensive and readily available. The RCA CA-3028 is more expensive and can be used as an *rf* differential amplifier with nearly the same gain figure, but its advantage in this converter is that it can be used as a mixer, local (crystal or tuned circuit controlled) oscillator and amplifier of 40 db gain. The circuit employs a third overtone crystal in the series resonant feed back position of the oscillator circuit.

The shield placed across IC is necessary to prevent inductive feedback and self-oscillation of this "IC." The tuned circuit L1C1 is provided to match the antenna input to the converter and link coupled through a shield to reduce cross-talk and birdies being fed through the converter to the tunable *if* module (or receiver).

Construction

Construction was made on a vector board using vector board clips as mounting terminals. This form of construction permits substitution of electrically similar components without detriment to the circuit configuration. The vector board was cut to fit the standard 5"x2¼"x2¼" minibox and mounted with 5/8" nylon (plastic) standoff insulators. The metallic shields were made of sheet copper and soldered to supporting vector board clips. All resistors used are ¼ watt dissipation and the capacitors are either disc ceramic or mylar printed circuit type. The jacks for coupling the converter to the antenna and to the tunable *if* module (or receiver) are standard BNC jacks. Coil forms are ¼" nylon rod. Component layout is shown in Fig. 1.

Alignment Procedure

After completing construction use a grid dip meter or tunnel dipper to adjust the frequency of the LC combinations to the appropriate frequencies per chart.

Tuned Circuit	Frequency
L1C1	50 mhz
L4C2	50 mhz
L5C3	50 mhz
L6C4	Xtal Frequency
L7C5	IF out.

The *if* output will be the difference between the crystal frequency and the 50 mhz.

Connect the converter to a receiver set and apply power to the converter. Using the grid dip oscillator in the wavemeter condition adjust C4 for maximum *rf* signal when the dipper is near L6.

Next apply a 50 mhz modulated signal

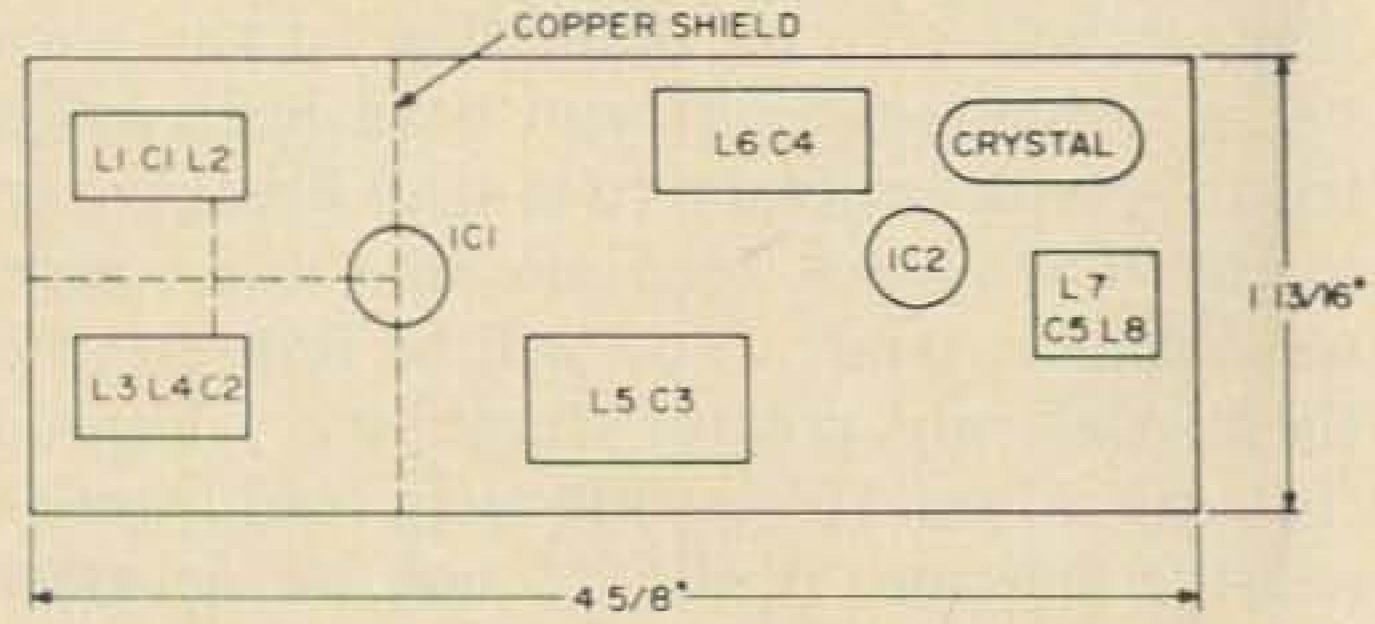
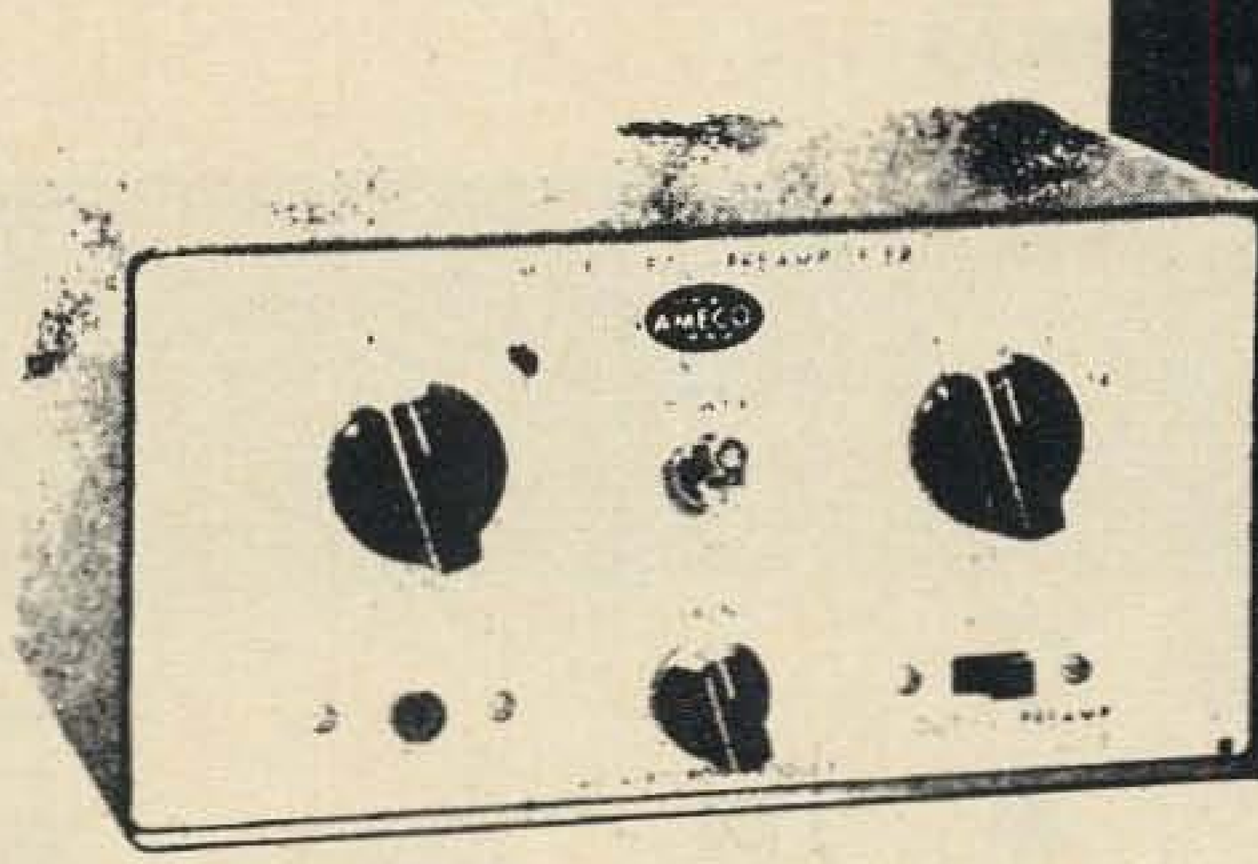


Fig. 1. Component layout.



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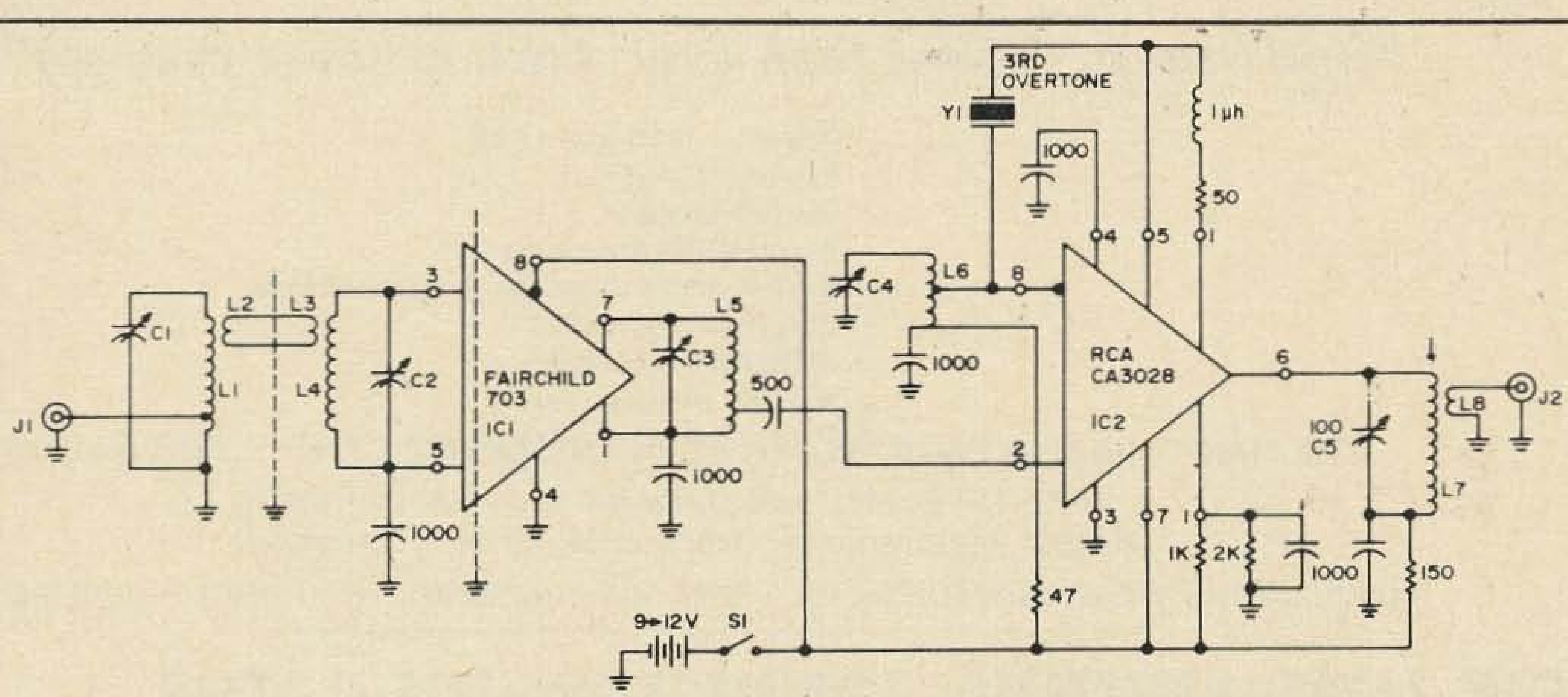

Fig. 2.

L_1 6T ¼" dia. closewound
L_2 2T ¼" dia. "
L_3 2T ¼" dia. "
L_4 6T ¼" dia. "
L_5 6T ¼" dia. " Tap 2T
L_6 6T ¼" dia. " Tap 2T
L_7 30T ¼" dia. "
L_8 3T ¼" dia. "

C_1 50 pf
C_2 50 pf
C_3 50 pf
C_4 50 pf
C_5 100 pf

Y_1 = Xtal 43.5 mhz for 6.5 ic.5 mhz *if*

R = ¼ watts
C = 50 vdc
C1-4 = 7-45 pf trimmers

from a signal generator to pin 2 of IC2 and adjust the receiver for the signal at the *if* output. Adjust C5 for maximum output. Disconnect the signal generator and apply signal to J1 and adjust first C3, then C2, and then C1 for maximum signal output. Repeat adjustments C5, C3, C2, C1 with the generator at antenna input (J1) because of slight interaction between adjustments. Remove the signal generator and connect the antenna. Happy listening to six meters.

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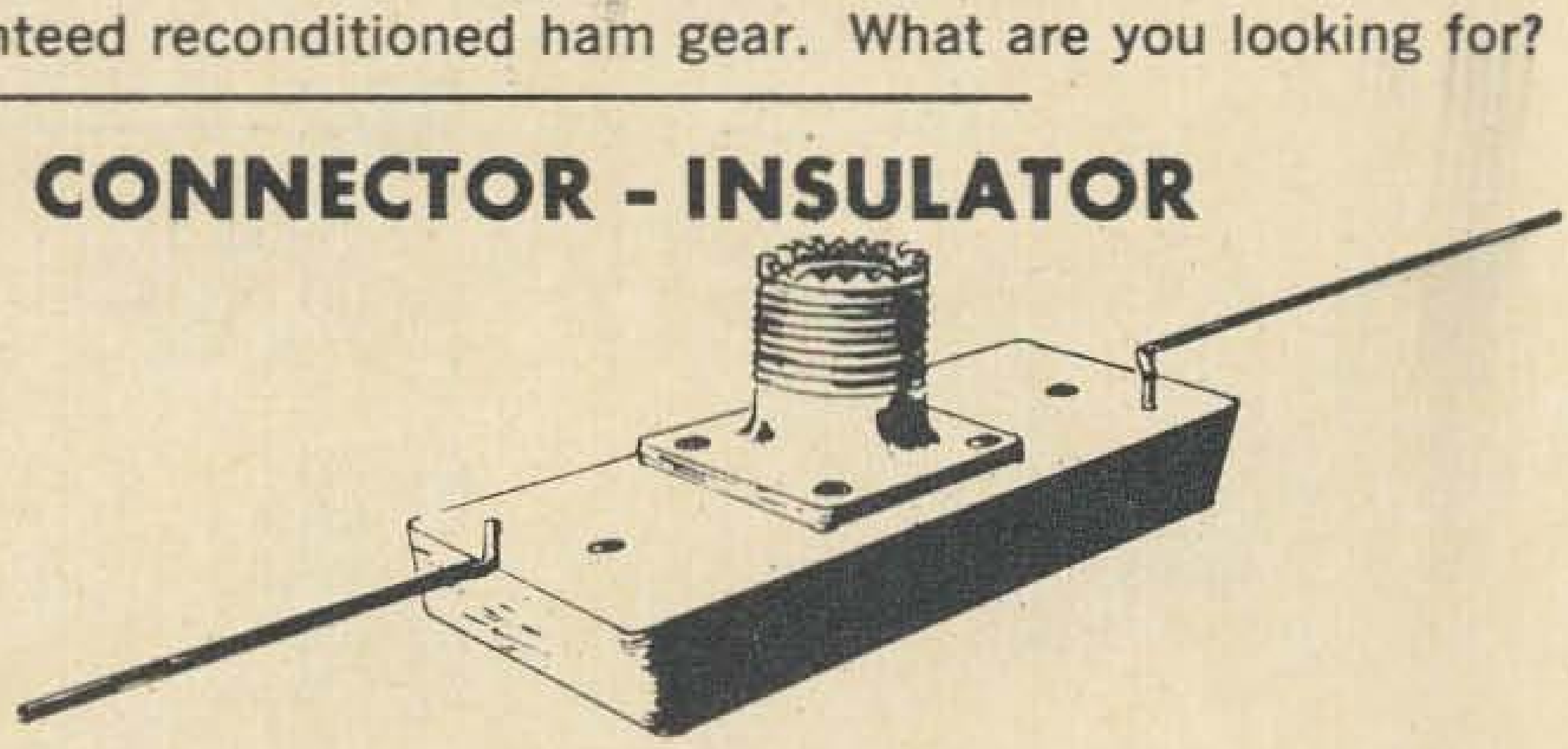

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Walpole, Massachusetts

Radio Control Revisited

With no apology to Aldous Huxley,[1] the title of this article describes my intention and purpose quite adequately.. This article will up-date an article published in the September, 1963, issue of *QST* and, as in the case of "Brave New World Revisited," we must report changes that have materialized seemingly before their time.

The previous article covered the basics of radio control (rc) and defined a number of terms which have been specially applied in the literature on rc. It is suggested that the reader review the previous article if he is not familiar with the subject. Although many amateurs have contributed in large measure to the development of the rc hobby, the main body of enthusiasts has sprung from the ranks of the model aircraft builders. With this background it is easy to understand why the terminology tends toward the aeronautical vernacular. "Glitches" in the electronics are recognized as the cause of crashes but the "Red Baron" is a more likely cause of any spectacular "clobber."

High Lights of Recent Developments

The changes that have occurred are most noticeable in the electronics and the basic controlling elements, i.e., the control systems and the devices that drive the control surfaces. Radio control airplanes have not changed greatly except to become more functional. Typically, strip ailerons attached to the trailing edges of the wings which have almost entirely replaced the scale-like ailerons previously used. A number of new building techniques such as "foam wings" are prevalent. The particular technique involves the use of polystyrene (or similar) foam as a core and covering this core with sheet balsa wood. The result is an extremely crash resistant, warp-proof, light-weight wing.

W1QON, Eleanor Wilson, poses with W1-OLP's latest RC model called the "Seapprentice." This model is capable of water take-offs and landings. Seaplanes are a rapidly growing part of the R.C. hobby.

Two phases of activity have had recent surges of interest. The first is that of radio controlled seaplanes and the second is radio controlled sailboats. The interest in seaplanes stems at least in part from the increasing difficulty in finding adequate flying sites for land planes. Lakes provide a large, flat landing area which is considerably softer than the usual landing area. Water take-offs and landings can be easily made into the wind since no "landing strip" limitations exist. Airplanes can be water-proofed without much difficulty and, in general, the life of a seaplane appears to be longer than its land equivalent.

Sailboat interest has been prompted by the availability of kits and hardware for relatively large racing type models. The hardware in-

1. In the 1920's Aldous Huxley wrote a science fiction novel entitled *Brave New World*. It dealt with a situation in the year 2,000, some 80 years in the future. In 1963, less than 40 years later, Huxley wrote a sequel, *Brave New World Revisited*, which pointed out how many of the things he described as existing in 2,000 actually existed in 1960.

cludes special servos which operate winches for trimming the sails as well as for setting the rudder. These models stand six to seven feet tall from topmast to keel and tend to be expensive if one goes the route of buying a fiberglass hull and a ready-made suit of dacron sails.

Transistorization

The use of vacuum tubes has all but disappeared. Transmitters, receivers and control circuitry are all transistorized. This approach has increased reliability, reduced battery drain and reduced the over-all weight of control equipment. In fact, without the use of transistors much of the new proportional control equipment, which will be described later, would be completely impractical. Silicon transistors have been used extensively because of their ability to operate over wide temperature variations. Integrated circuits are beginning to find application in the newest commercial equipment. Since rc equipment must work outdoors, it has this handicap to overcome as well as the other more obvious environmental hazards such as vibration and shock.

Fig. 1 is the circuit for a single channel transmitter developed by Dick Jansson. A commercial version of this unit is available

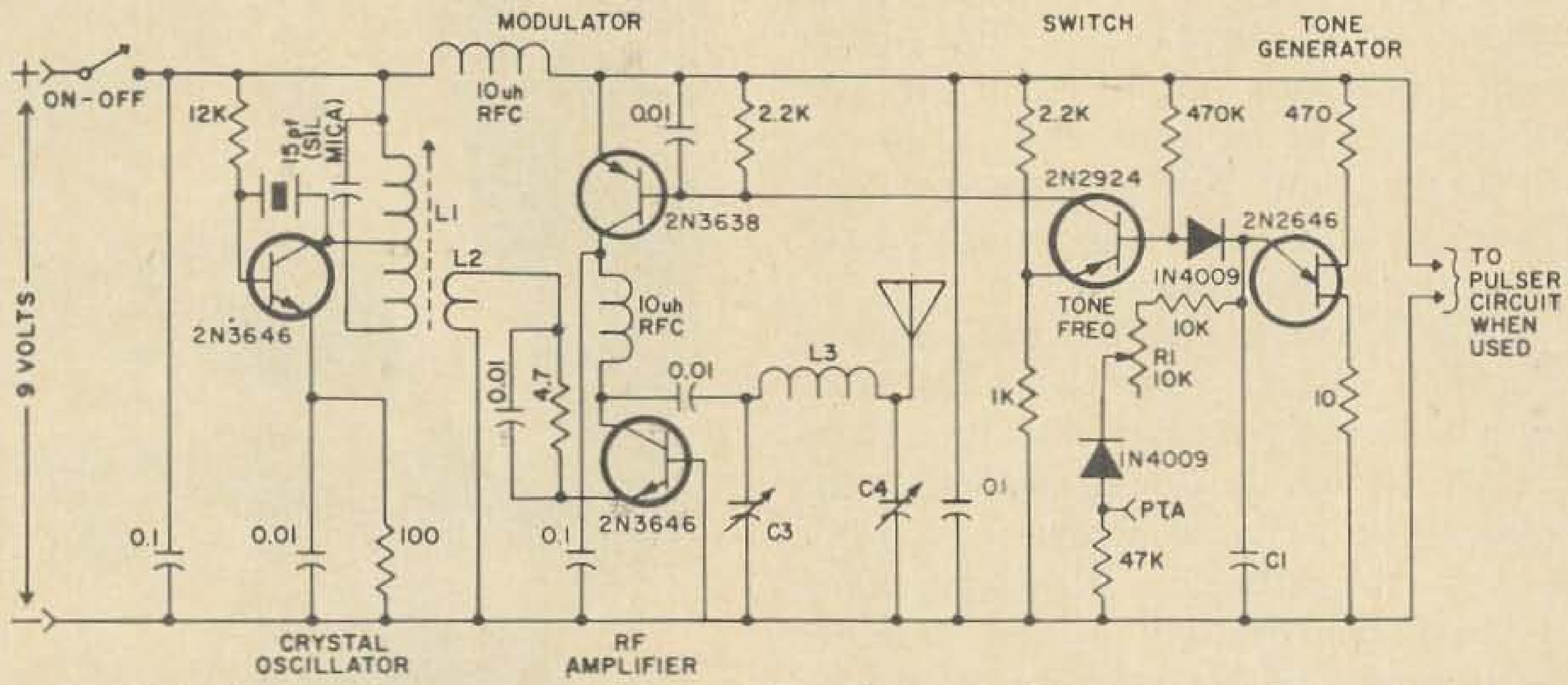

Fig. 1A. Basic transmitter with tone modulator. All resistors are ½ watt; capacitors are disc ceramic in uf unless marked.

L1—8¼t, #26, tapped 4 1/8 from +9V CTC form #2173-3.
L2—2¼t, #26 over center of L1.
L3—4t, #20, ½ dia. self-supporting.
Crystal—50 mhz, 3rd overtone.

C3—ARCO 423 (100-7 pf)
C4—ARCO 422 (40-4 pf)
Antenna—50 inch whip (approx. length)

C1	Tone Freq. Range
0.082	450-900 cps
0.047	800-1600
0.027	1400-2600
0.015	2500-4400

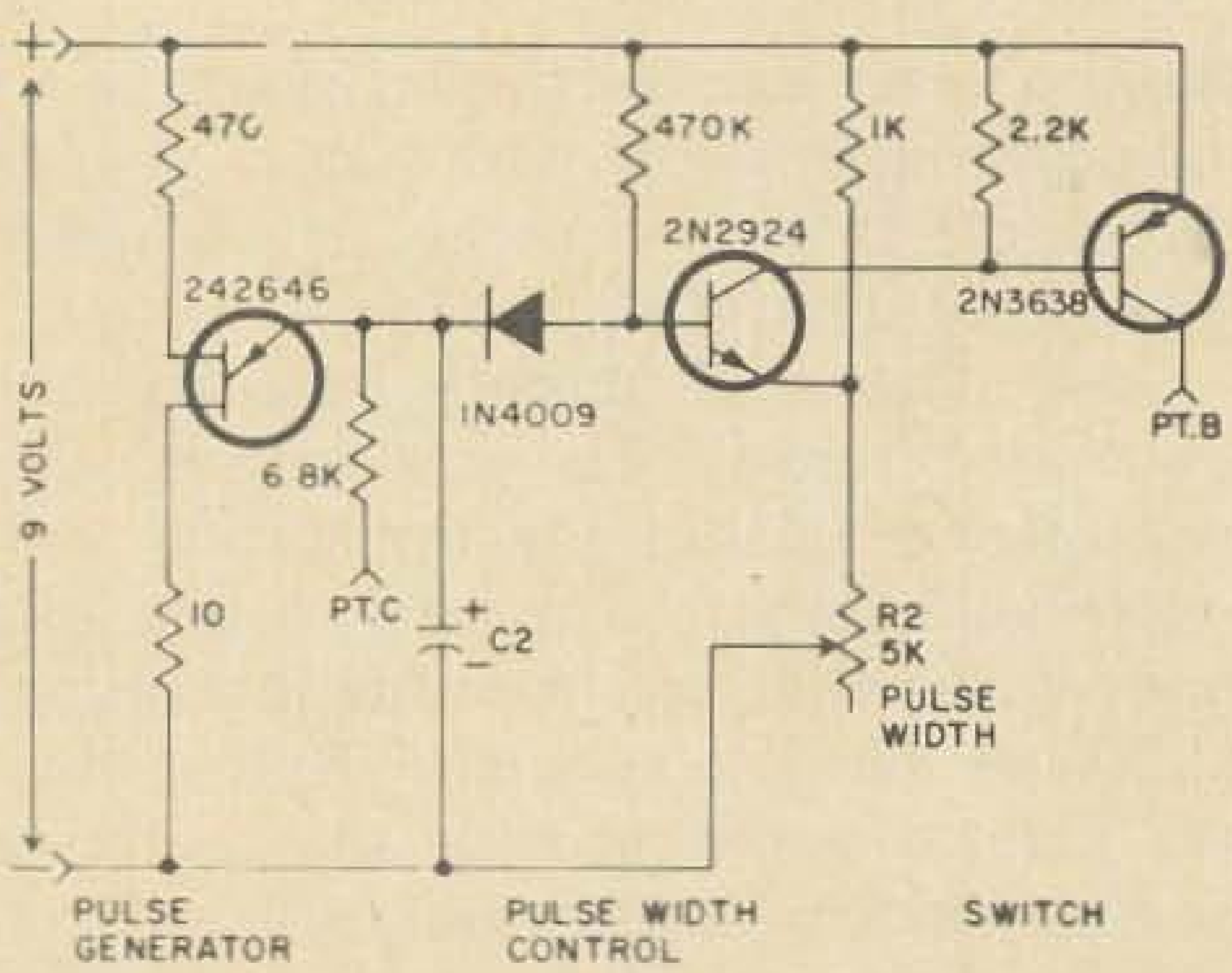

Fig. 1B. Pulser circuit.

C2	Pulse Freq. Range
8 µf	7.5 - 20 pps
6	10 - 27
4	15 - 40

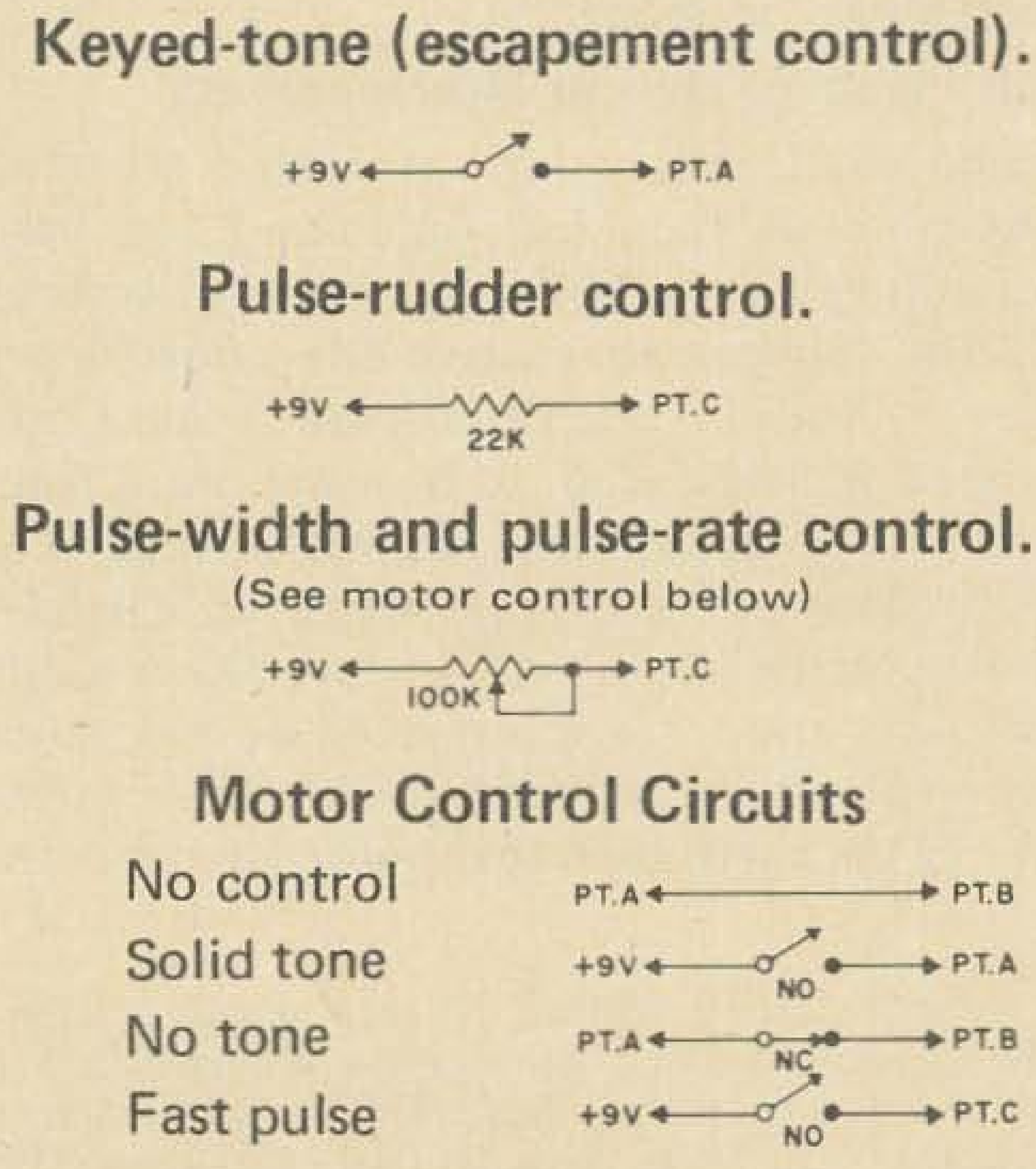

Fig. 1C. Control circuits.

Fig. 1. Six meter single channel R.C. transmitter.

from Ace Radio. This circuit provides for two basic modes of control: Escapement control and pulse-proportional control. The *rf* section and its modulator are all that are necessary for escapement control. The pulse control circuits may be added to provide control of modulation pulse-rate and pulse-width. In the latter case, the absence of pulsing, extra fast pulsing, or continuous tone modulation may be used for additional control(s). The following system has been used many times:

Control Function	Control Signal
Rudder	Pulse width (20 to 80%)
Elevator	Pulse Rate (5 to 30 cps)
Motor Speed	Continuous tone or absence of tone.

Scale R.C. model of Cessna Skylane built by Roger Carignan, W1NRO. A simple pulse-proportional control system is used in this model with a switching circuit designed by Roger and shown schematically in Fig. 2.

Developments in Simple Pulse Proportional Control

Since the previous article was written there has been a rebirth of interest in simple pulse proportional equipment. The merits of this system from a cost standpoint are immediately obvious when compared with multichannel proportional equipment cost. Its major disadvantages are: 1) The relatively high (and continuous) current required by the actuator (servo) in the airplane and 2) the fact that the rudder and elevator surfaces continuously vibrate back and forth. The vibrations may cause the airplane to noticeably

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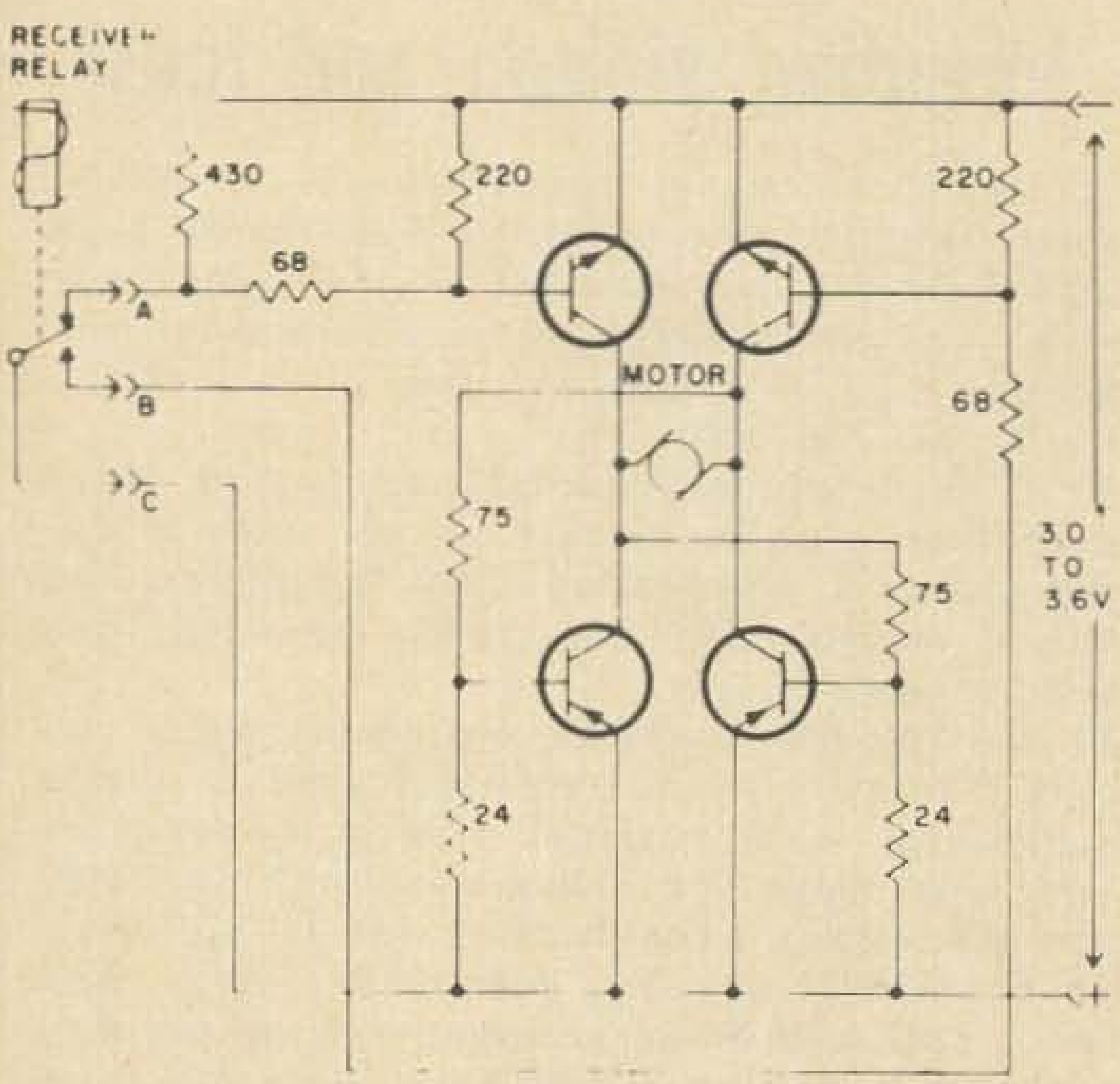
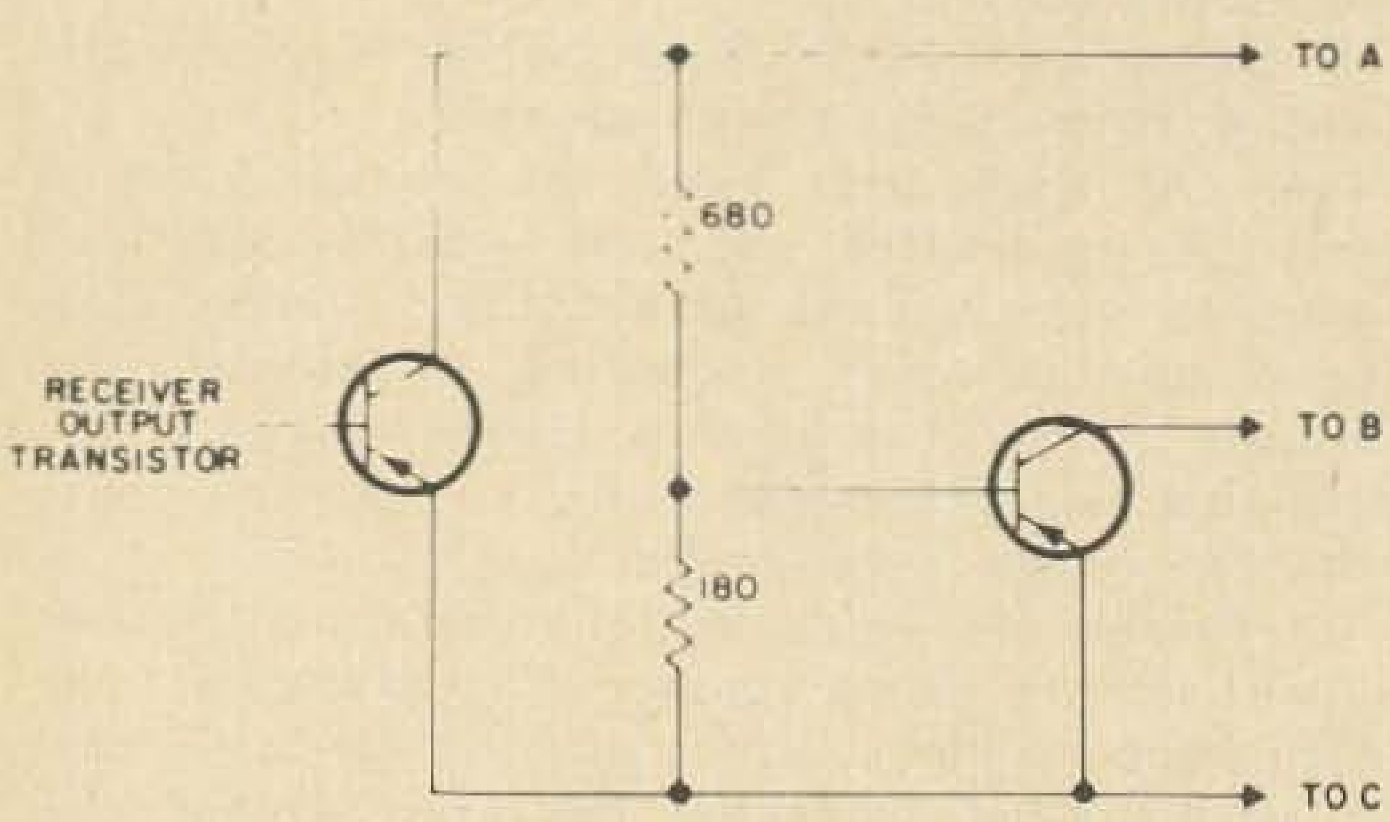
weave up and down or left and right. This has given rise to this type of control being known as the "Galloping Ghost" system.

Several "Galloping Ghost" or pulse-proportional actuators are now available that allow push rod connections to the control surfaces. Previously, these connections were made using an oscillating torque rod from a simple actuator to a motion-sorting linkage that was exposed at the tail end of the airplane. The exposed linkage was very vulnerable to damage and gave the appearance of a mousetrap (bat trap?) hanging onto the rear of the model. The use of low impedance nickel-cadmium batteries is essential in this system. Transistorized switchers are becoming more prevalent. These allow the use of one set of batteries in place of the balanced negative and positive supplies previously used. This approach saves battery weight[2] and assures that balanced control occurs in both directions (left/right and up/down) as the battery discharges. Transistors can also be used to replace relay contacts for added reliability. Fig. 2 is the circuit for a pulse proportional switcher developed by Roger Carignan, W1NRO. This switcher is used in Roger's Cessna Skylane model shown in one of the pictures accompanying this article.



Switcher circuit for pulse actuators that eliminates the need for both positive and negative batteries.



Relay eliminating switcher for use with switcher circuit shown above.

Fig. 2. Pulse control switcher circuits. All resistors are ½ watt. NPN transistors are type 4JX11C1847 (GE). PNP transistors are type 4JX1C1132 (GE). Motor is permanent magnet type with armature resistance greater than 6 ohms.


Seen one lately? This flying saucer is real. It is radio controlled and performs very well with a galloping-ghost proportional control system. This off-beat project was undertaken by W1OLP, writer of this article.

Improvements in Single Channel Servos

In the area of escapement control there have also been notable changes. In fact, the term escapement control is no longer generally correct since most single channel "escapement control" is now performed using electrically driven "servos" rather than rubber band driven escapements. Several excellent single channel servos are now available and have eliminated the hazard of forgetting to wind the escapement rubber before a flight is begun. Single channel servos work in a manner similar to their predecessors; an electric motor and a battery have replaced the rubberband. A continuous signal causes the actuator arm to move 90 degrees. When the signal is stopped the arm moves in its initial direction until it stops at the 0 degrees position. A signal like an "A" in CW with the dash held, will move the arm through the 90 degrees position and cause it to stop at 270 degrees. Interruption of the dash part of the "A" will cause the arm to return to 0 degrees.

2. For equal battery life the basic weight of the battery is the same except for mounting hardware and wiring which is equalized by the switcher's weight.

A third position is attained by sending a "U" with the dash held. This stop occurs at about 350 degrees. The 90 degrees position is used for right rudder; the 270 degrees position gives left rudder and the 350 degrees position gives negligible rudder movement but actuates a switch in the servo which can be connected to an auxilliary servo that controls the throttle. Note that the third position (350 degrees) switch is fed from the back contact of the control relay in the receiver. In this way the auxilliary servo is actuated only when the third position is called for and not when the arm passes through this position on its way back to neutral (0 degrees). A number of systems exist for getting more control functions from single and "cascaded" compound escapements.

Single channel servos are more expensive and are heavier than an equivalent rubberband escapement system. However, they tend to be more reliable and to perform their appointed task over long periods of time without adjustments. Rubber driven escapements have shorter life and take some tinkering to keep them in top-notch condition.

Multi-Proportional Advancements

In 1963, essentially all multi-channel control systems used a series of tones selected by the pilot at the transmitter to actuate tuned reeds in the airplane. The reeds, in turn, actuated on-off servos that worked the control surfaces or other functions in the airplane. At that time "multi-proportional systems" existed, but only a few people gave them a chance for survival. Only the most enthusiastic supporter of proportional control would have predicted in 1963 that in five years it would replace the reed system which

Cliff Piper, WA1IEC, Academy of Model Aeronautics, District I, Vice President poses with his six channel reed system R.C. model. Cliff is a long time modeler and recent amateur radio enthusiast. He's active on 75 meters from his Atkinson, N.H. QTH.

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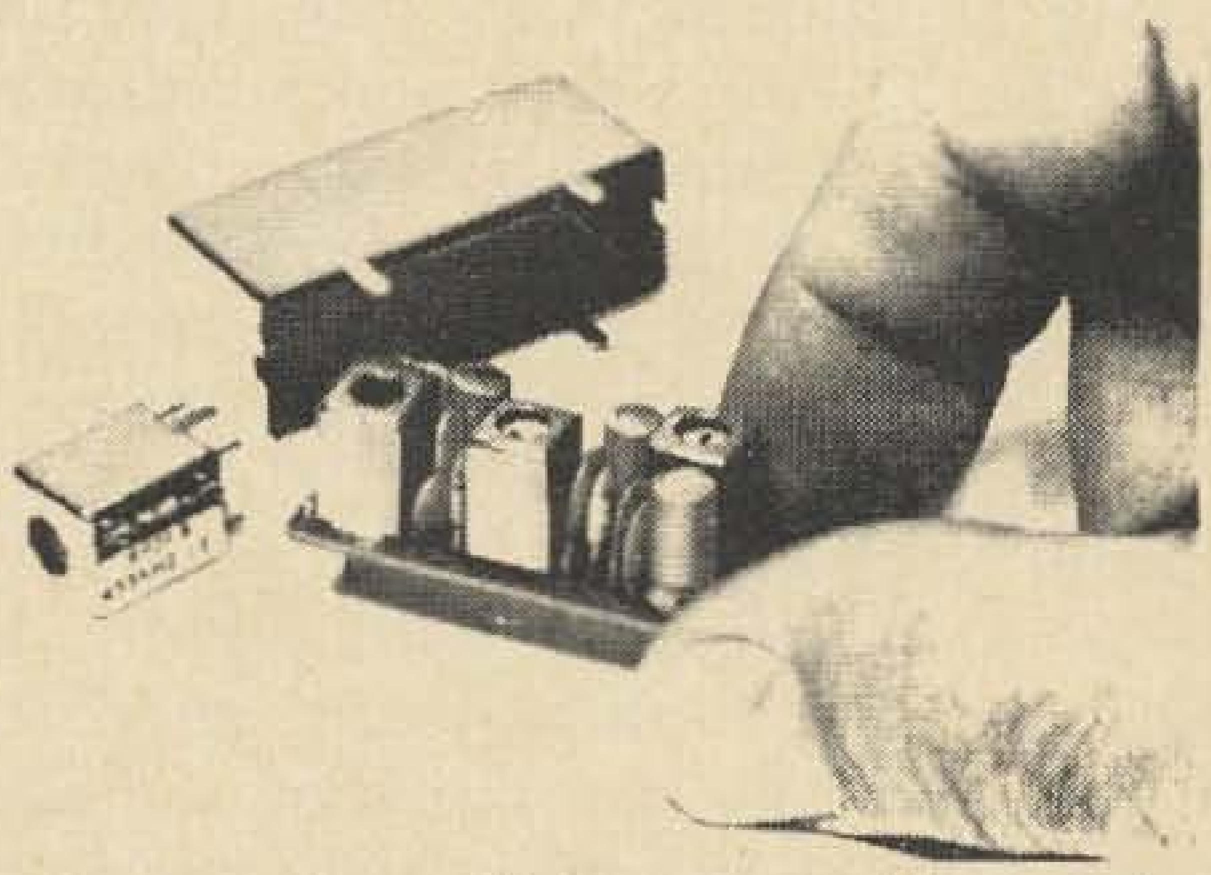

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had been the standard for many years.

Proportional control allows the pilot to position the control devices in the airplane to any position in proportion to the setting of joy-sticks, knobs or levers on the transmitter. Unlike escapement and reed systems which give full control (e.g., full-right or full-left) when control is called for, the proportional control system allows the pilot to give any partial amount of control action he desires. Additionally, this type of control inherently allows each control function to be "trimmed" as well as actuated. Rudder, elevator and aileron trim can be provided with no additions in the airplane and very simple additions in the transmitter. In a reed system trim for one function (e.g., elevator trim) requires an added servo in the airplane and two additional channels in the transmitter and receiver.

Unlike reed systems, proportional systems use joy-sticks in place of switches to initiate control action. There is considerable variation between systems in the number of sticks used and in what functions the motion of these sticks control. One of the most used systems employs a single stick. Back and forth motion controls the elevator; left and right motion controls the ailerons; and a knob on the top of the stick controls the rudder. Trim for the foregoing controls is provided by thumb-adjustments located on three sides of the stick. Motor speed and auxilliary controls such as flap position (when flaps are installed on the airplane) are controlled by other thumb-adjustments, levers or knobs located on the face or side(s) of the transmitter. Control of brakes on the left, right and nose wheels is obtained by tying them into the rudder and elevator or flap controls. Use of three separate brakes greatly improves the ground handling capability of a model airplane. Both mechanical and electric brakes are being used successfully.

Two basic control philosophies exist for proportional model control. Originally, proportional systems were of the "analog" variety. Later a so-called "digital" control approach was introduced and, today, is the most popular by far. The rudiments of both approaches are alike: A signal proportional to the desired control position is generated in the transmitter; this is used to modulate the transmitter's *rf* output; the receiver demodulates the signal and converts it to a voltage; and this voltage is used as the input to a closed-loop servo which actuates the control surface. Fig. 3 is a block diagram of the typical closed-loop servo. Those who have worked with servo-mechanisms will immediately recognize that this is a true "servo-mechanism" and can rightfully be termed a "servo." Previous usage of the term in the r.c. vocabulary has referred to a device which performs a similar function but in an open-loop manner.

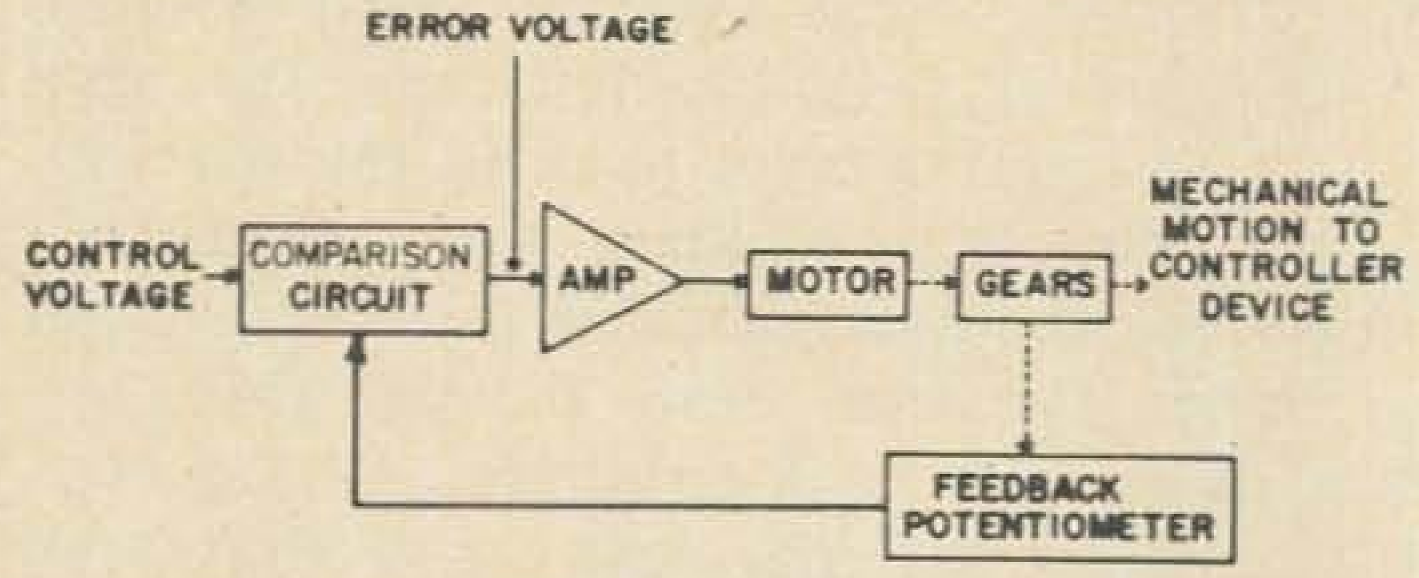

Fig. 3. The closed-loop servo shown in block diagram style in this figure is a major element in a fully proportional control system.

The motor in the closed-loop servo will run until the error-voltage is reduced to a low value. The error-voltage is generated by comparing the input-signal-voltage with a feedback-voltage. The latter voltage is obtained from a potentiometer or variable capacitor which is driven by the servo's output gear-train. It is a measure of what position the servo is actually in. If the input-voltage and the feedback-voltage are alike, the servo is in the correct position. If there is a difference, an error exists and the resulting error-voltage is amplified and fed to the motor which, in turn, goes in the direction necessary to correct the error. **Fig. 4** illustrates the error voltage as a function of the mechanical (angular) error at the output of the servo. Note that a closed-loop servo will respond to changes in the input signal; i.e., it will make corrections until the output position agrees with the position called for by the input signal *and*, unlike open-loop systems, it will also correct for "load errors." A typical load error in model control system results from wind pressure on a control surface as it is moved into the airstream. If this pressure is large enough it will tend to neutralize the control position and the control becomes less effective. In a

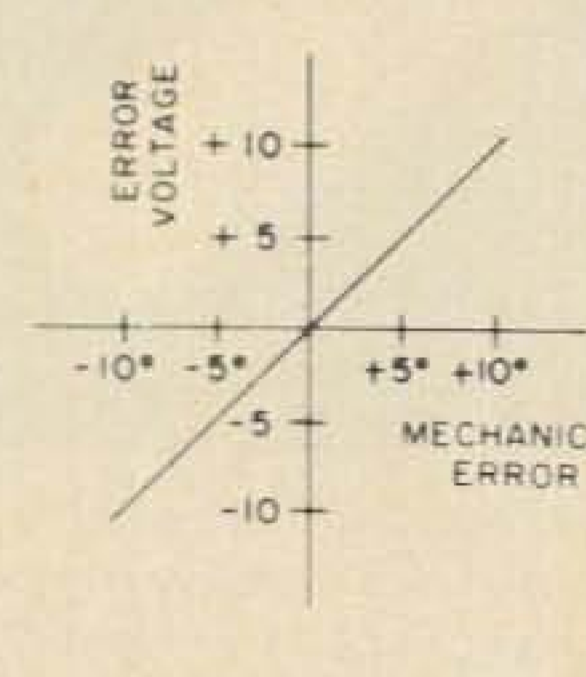

Fig. 4. Error voltage in a closed-loop analog servo.

close-loop servo the error caused by "blowback" of a control surface is recognized by the error detector and the servo motor operates to correct the error. Notice that this occurs without the need for the pilot to recognize the error and make changes in his command to the airplane.

A servo is needed for each basic function to be controlled in the airplane. They weigh between 1 and 2 ounces; they are roughly 1"x1½"x1½" in size; and they have seven to nine transistors in their amplifiers. Control action is relatively fast; no lag is perceptable between the pilots command, and the control response in the airplane.

Analog control signals are most often transmitted in the form of frequency variations. Discriminator circuits are used in the receiver to convert these variations into voltage variations. This method of transmission is independent of signal strength and is fairly immune to interference. "Digital" control systems use various forms of pulse-code-modulation and de-modulation to transfer commands from the transmitter to the servos. A discussion of the various systems used (or possible) and their relative merits is far beyond the scope of this article and, perhaps, is beyond the present state-of-the-art. Most digital systems use pulse-position modulation. Combinations of pulse-rate, pulse-width, and pulse-spacing are used in other systems to convey the needed information. When listened to on a communications receiver, the signals from a digital transmitter sound like a 19th-century music box programmed to play notes in a relatively unmusical order.

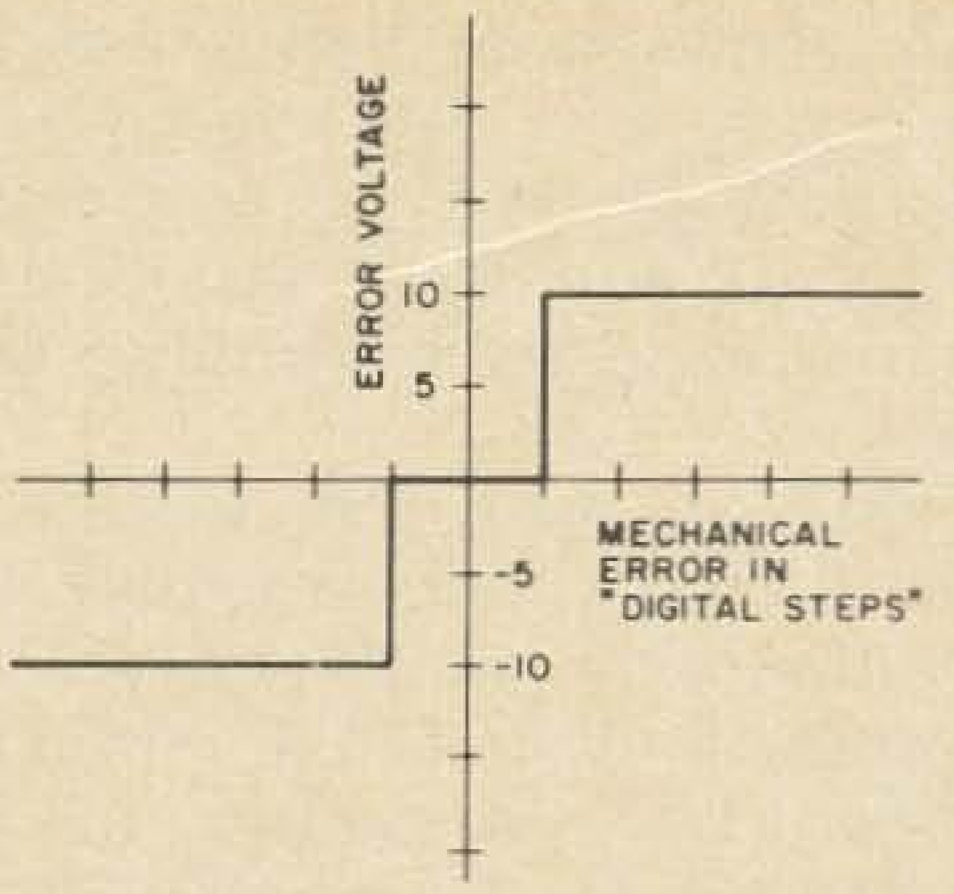

Fig. 5. Error voltage in a closed-loop "Digital" servo system. This curve is idealized.

Digital systems have error-voltage characteristics like that shown in Fig. 5. This type of error characteristic causes relatively stiff control action for small errors and yet does not cause oscillation in the servo system. The analog system (see Fig. 4) generates an error signal that is proportional to the error and,

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HOW TO ORDER: The **VANGUARD FMR-150** is available only direct from our factory. Include remittance in full plus sales tax if you reside in N.Y. Be sure to state the 6 MHz segment you will want to cover and the exact push button frequencies to be included. **VANGUARD LABS** Dept. H, 196-23 Jamaica Ave., Hollis, N.Y. 11423 hence, has relatively soft control action when the error is near zero. When more gain is added to an analog servo to make it more stiff, it tends to oscillate (or "hunt") unless precision gearing or special control functions are included.

Many proportional systems include a "fail-safe" feature which prevents serious fly-away situations. In most cases, these features work on the basis of remembering when the last control signal was received from the ground. If no signal has been received for a preset length of time (generally set between 15 and 30 seconds) the motor speed is reduced to minimum and all controls are set to their neutral positions. These settings will normally cause a gentle descent and a landing within reasonable walking distance.

Proportional systems have two disadvantages: first, high cost; and second, less immunity to interference than reed control systems. Interference problems are related largely to the "equivalent bandwidth" of the receiving system. In proportional systems "equivalent bandwidths" are wide because of the pulse type modulation used. In reed systems the bandwidths for each channel is about 30 cps: the reeds themselves being the limiting devices.

The cost of proportional systems run from $200 to $600 for the electronics including the transmitter, receiver, servos, and batteries. The $200 system is in kit form. The most preferred proportional systems are selling in the $300 to $500 range. Needless to say, it is important to investigate carefully before you decide "to go proportional."

Performance Records

Model airplane competition has been on an international scale almost from the inception of the hobby. The United States sponsors free flight, control-line and radio control teams that compete yearly for international honors. The United States radio control team has placed high in both an individual and a team basis for the past several years. Competitions are held every other year in Europe, which has made it necessary to subsidize the travel expenses of the competitors. The Academy of Model Aeronautics (AMA) has played a major role in this area as well as governing the competitions within the U.S.A. Chart 1 summarizes our performance in the 1967 International rc Championships. Phil Kraft, K6SQF, who took first place, is an amateur.

In addition to the world championships, a continuous world wide competition exists

COUNTRY	INDIVIDUAL PLACES
Austria	21, 30, 39
Belgium	15, 25, 27
Czechoslovakia	29, 36
Denmark	33
France	2, 12, 26
Germany	3, 5, 24
Great Britain	9, 23, 32
Greece	35
Holland	13
Italy	16, 20, 28
Liechtenstein	6
Luxembourg	37, 38, 40
Norway	19, 41, 42
South Africa	7, 11, 22
Sweden	14, 18, 31
Switzerland	8, 17, 34
United States	1, 4, 10

Chart 1. 1967 International r.c. Championship score summary. United States placed first both on a team and individual basis. Phil Kraft, K6SQF, is world champion.

to extend certain specific records. These records are summarized in **Chart 2.** The Federation Aeronautique International (FAI) governs all record attempts and establishes the rules for each event. The FAI is the same organization that performs this function for full size aircraft records. This competition is a deliberate process that requires much from the competitor, himself, and a great deal from others who must act as witnesses and who must provide the precise measuring equipment required by FAI rules. The armed services, governmental agencies, educational institutions and private industry have been very cooperative in assisting individuals to establish new records.

Radio Control Frequency Considerations

Amateurs have a great advantage over those who are limited to Citizen's Band frequencies for r.c. activity. **Chart 3** lists the CB and amateur radio control frequencies presently in use. The CB frequencies are shown here to indicate the type of competition amateurs may expect from CB rc enthusiasts. Note that very few 27 mhz CB rc transmitters and no 72-75 mhz CB r.c. transmitters exceed 1 watt input to the final stage. Even in the face of interference where high power transmitters and low sensitivity receivers are in order, no trend toward higher power has occurred. The use of selective superheterodyne receivers has solved most of the CB rc interference problems. With 1 watt input there

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100	.32
200	.46
400	.62
600	.86
800	1.18
1000	1.54

8. Stud mounted 7/16" hex base rectifiers available in steel or epoxy case. 10/32 thread 12 A types. (240)

PIV	
50	.22
100	.28
200	.42
400	.58
600	.78
800	.98
1000	1.38

9. 30A units 11/16" hex base ¼" x 28 threads steel or plastic case. (300)

PIV	
50	.48
100	.56
200	.62
400	.74
600	.94
800	1.08
1000	1.38

10. 40A stud units steel case (1000), plastic case (500), 11/16" hex base, ¼" x 28 threads, diffused junction.

PIV	
50	.64
100	.78
200	.88
400	1.28
600	1.68
800	1.98
1000	2.48

11 100A stud units with 5" flex lead, 11/16" hex base 3/8" x 24 threads, alloyed diffused or avalanche types (1500)

PIV	
50	2.88
100	3.48
200	3.68
400	4.88
600	7.68
800	9.48

12. 160A stud rectifiers flex leads (2200)

PIV	
50	3.68
100	3.98
200	4.38
300	5.88
400	6.48
600	8.68
800	10.88
1000	12.78

13. 240A stud units flex leads, (3000)

PIV	
50	3.78
100	4.68
200	5.98
300	6.78
400	8.88
500	9.68
600	10.98
800	14.48

14. 275A stud with flex leads, (5000)

PIV	
50	4.48
100	4.98
200	5.98
300	7.28
400	9.98
500	10.78
600	12.88
700	13.98
800	16.88
1000	23.88

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FWCT Configuration (good for 2 times the diode current rating with proper cooling. On 2" x 2" heatsinks.

Diodes mounted, wired & tested @ full power.

12 Amp Diodes

50V PIV	$1.88
100V PIV	$2.18
400V PIV	$3.28

40 Amp Diodes (FWCT 3" x 3" plates

50 PIV	$3.88
100 PIV	$4.18
200V PIV	$4.68
400V PIV	$5.28
600V PIV	$5.98

FWCT Single Phase Full Wave on heat sink plates.

12 Amp. Rect. on 2" x 2" plates.

50V PIV	$1.88
100V PIV	$2.18
200V PIV	$2.68
300V PIV	$2.88
400V PIV	$3.28
500V PIV	$3.68

12 Amp. Rect. on 3" x 3" Plates same as 2" x 2" Plus $1.00 each.

All ass'y fully tested & guaranteed same as above. 40 Amp units on 3" x 3" plates add $2.00 ea. ass'y. 40 Amp units on 5" x 5" plates add $3.00 ea. ass'y.

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600V PIV $4.28	12A Devices
50V PIV $3.88	40A Devices
200 PIV $4.48	40A Devices
400 PIV $4.88	40A Devices
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On 3" x 3" plates add .75¢ each

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Powered	16,610 ft.	Northrop, USA
Glider	3,660 ft.	Hill, USA
ENDURANCE		
Powered	8h, 52m, 25s	Hill, USA
Glider	11h, 33m, 28s	Smith, So. Africa
SPEED		
Powered	140.28 mph	Hill, USA
Glider	29.5 mph	Hahn, USA
DISTANCE (Straight Line)		
Powered	184.146 m	Hill, USA
Glider	10.39 m	Malikov, USSR
DISTANCE (Closed Course)		
Powered	173.89 m	Piston, USA
Glider	43.55 m	Colver, USA

Chart 2. The records listed in the chart are those recognized by the Federation Aeronautique International (FAI). The FAI is the organization which governs and records all international aircraft records. It has headquarters in Paris, France. Since this chart was compiled, many of the records shown have been broken. Typically, the altitude record is now in excess of 19,000 feet.

is no practical limit to the range that may be obtained. Recent high altitude flights have gone to over 19,000 feet with no loss in reliability. At distances over 1,000 feet in the normal rc case, the model becomes difficult to see: spirals (or spins) to the right cannot be distinguished from their left-hand equivalents. It is generally agreed that long, reliable battery performance is much more advantageous than extra range which is never used.

Amateurs will no doubt choose frequencies in the line-of-sight bands to preclude regular interference from dx stations. Choice of the uhf's has other advantages, the most important being freedom from local interference. Even the uhf bands that are most used are quiet during the daytime when most r.c. activity takes place.

Maiden flight tension shows as Bob Fish starts the take-off run of Charlie French's "Duster" biplane. Bob and Charlie are typical radio controllers who operate on CB licenses.

All amateur frequencies above 51 mhz, with the exception of 147.9 to 148.0, are legal for AØ and A2 emission. AØ is defined as the "absence of modulation" and A2 is tone modulation. A2 is legal as low as 50.1 mhz, but the question of call signing becomes an interesting one. In any case, for interference reasons, operation below 51 mhz is not desirable the bulk of all amateur communications on six meters is at the low frequency end of the band. The high end of the six meter band is most attractive. The author has operated for years at 53.4 mhz with superregenerative receivers. No interference has been experienced from a channel 2 (54-58 mhz) television station located within 5 miles. No amateur interference has been experienced. Some difficulty has been experienced with harmonics of a 5 watt CB transmitter when using a highly sensitive transistorized superregenerative receiver. CB channels between 26.965 mhz and 27.005 mhz have second harmonics in the range of 53.930 mhz and 54.010 mhz. This range includes the popular 26.995 mhz r.c. channel. Because of potential harmonic problems from local CB stations, and possible overload from television channel 2, the extreme top of the six meter should be avoided.

Citizen's Band R.C. Frequencies

27 MEGAHERTZ BAND

26.995 mhz
27.045
27.095
27.145
27.195
27.255*

1. Class "C" CB license required**
2. 5 watts input maximum
3. .005% frequency tolerance
4. Shared with other r.c. users

* 30 watts input maximum; shared with CB voice (Class D).

** Less than 100 mw; transmitters do not require licenses.

72-75 MEGAHERTZ BAND

72.08 mhz
72.24
72.40
72.96
75.62

1. Class "C" CB license required
2. 1 watt input maximum
3. .005% frequency tolerance
4. Exclusive for model rc users

Amateur Band R.C. Frequencies

Band (meters)	Frequency Range (mhz)
6	51 to 54 mh
2	144 to 147.9
1.4	220 to 250
0.7	420 to 450

Chart 3. This chart summarizes the frequencies available for r.c. model use.

As the bands get more crowded and good equipment for the higher uhf bands becomes more available, the two and 1.4 meter bands may become more popular for rc. Several years ago, CB rc equipment was available on the 450 mhz band. The receivers in this equipment used crystal detectors followed by high gain audio amplifiers. The transmitters used conventional uhf self-excited modulated oscillators. This equipment, though crude in many respects, enjoyed a fine reputation for reliability.

Tuning difficulties may limit the practical use of the superheterodyne to frequencies below 100 mhz. The frequency of rc superhets is most conveniently controlled through use of a crystal controlled oscillator. Matching the transmitter's frequency with that of the receiver is a subject that bears special consideration. This problem is presently being faced by those designing equipment for the new 72-75 mhz CB frequencies. In diagram form, the problem is shown in **Fig. 6.**

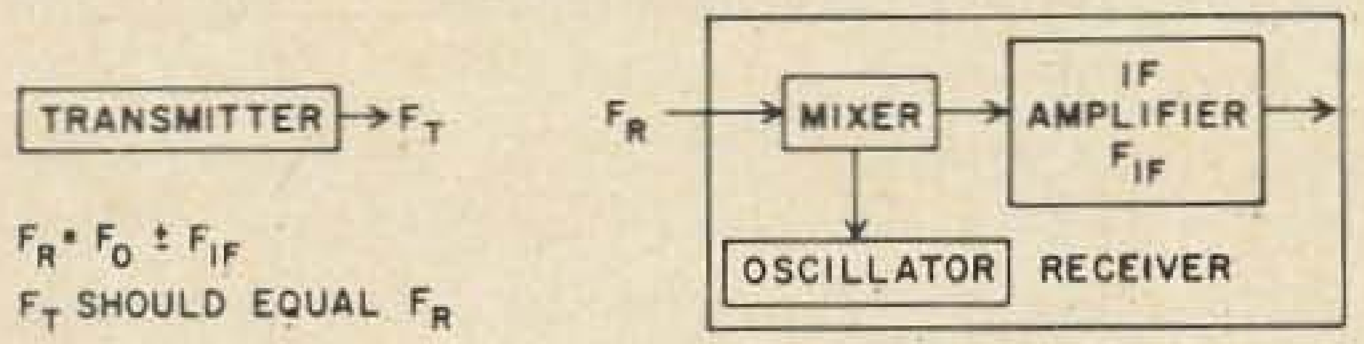

Fig. 6.

Ideally, the transmitter frequency (F_T) must be exactly equal to receiver frequency (F_R). With 5 khz receiver bandwidth and transmitter modulation frequencies of about 1 khz, the practical case allows about 2 khz variation between F_T and F_R (see **Fig. 7**). This permissible variation is very little when we consider temperature, vibration, aging, and the other factors which tend to detune the system.

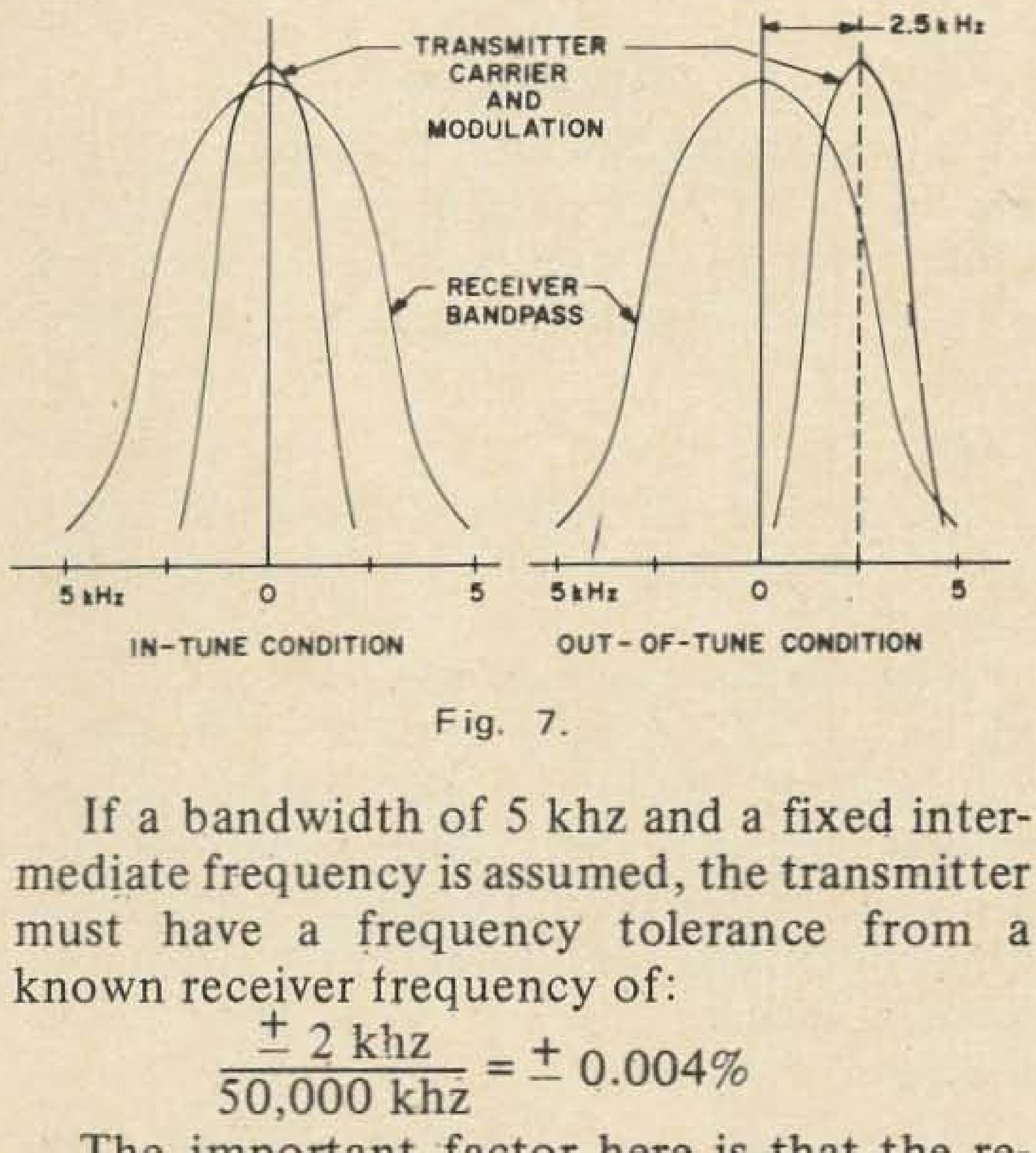

Fig. 7.

If a bandwidth of 5 khz and a fixed intermediate frequency is assumed, the transmitter must have a frequency tolerance from a known receiver frequency of:

$$\frac{\pm 2 \text{ khz}}{50{,}000 \text{ khz}} = \pm 0.004\%$$

The important factor here is that the receiver frequency must be known accurately. If the receiver crystal has a marked tolerance of 0.005%, in any circuit other than the one it was designed for, it may have twice the marked tolerance. A typical 50 mhz crystal may then be:

$2 \times \pm 0.005\% \times 50{,}000 \text{ khz} = \pm 0.0001 \times 50{,}000 \text{ khz} = \pm 5$ khz away from its marked value of frequency. If the *if* frequency is off $\pm$ 3 khz and is not tunable, the receiver may be tuned as much as $\pm$ 8 khz from the chosen spot. With this sort of frequency separation between the transmitter and receiver range

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Silicon Rectifier Choice of Package Bullet - Glass - Min - Metal
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1.5 AMP
18- 50V 5- 800V
15-100V 4-1000V
10-200V 2-1200V

3 AMP
15- 50V 4- 600V
10-100V 3- 800V
8-200V 2-1000V
5-400V 1-1200V

5 AMP
10- 50V 4- 400V
8-100V 3- 800V
6-200V 2-1000V
5-300V 1-1200V

8 AMP STUD
6-100V 3- 400V
4-200V 2- 800V

12 AMP STUD
5-100V 2- 800V
3-500V 1-1000V

20 AMP STUD
4- 50V 2- 500V
3-100V 1-1000V

40 AMP STUD
3- 50V 1- 300V
2-100V

60 AMP STUD
2- 50V 1-1000V

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1 WATT
1 EA 4V - 6V - 8V - 10V
2 WATT
12 to 60V
CHOICE OF THREE
10 WATT
1 EA 6V - 8V - 10V
10 WATT
12 to 60V THREE

Silicon Controlled Rectifier
To - 5 Package
5- 50V 3- 250V
4-100V 2- 400V

7 AMP
4- 50V 2- 200V
3-100V 1-1000V

20 AMP
2- 50V 1- 300V

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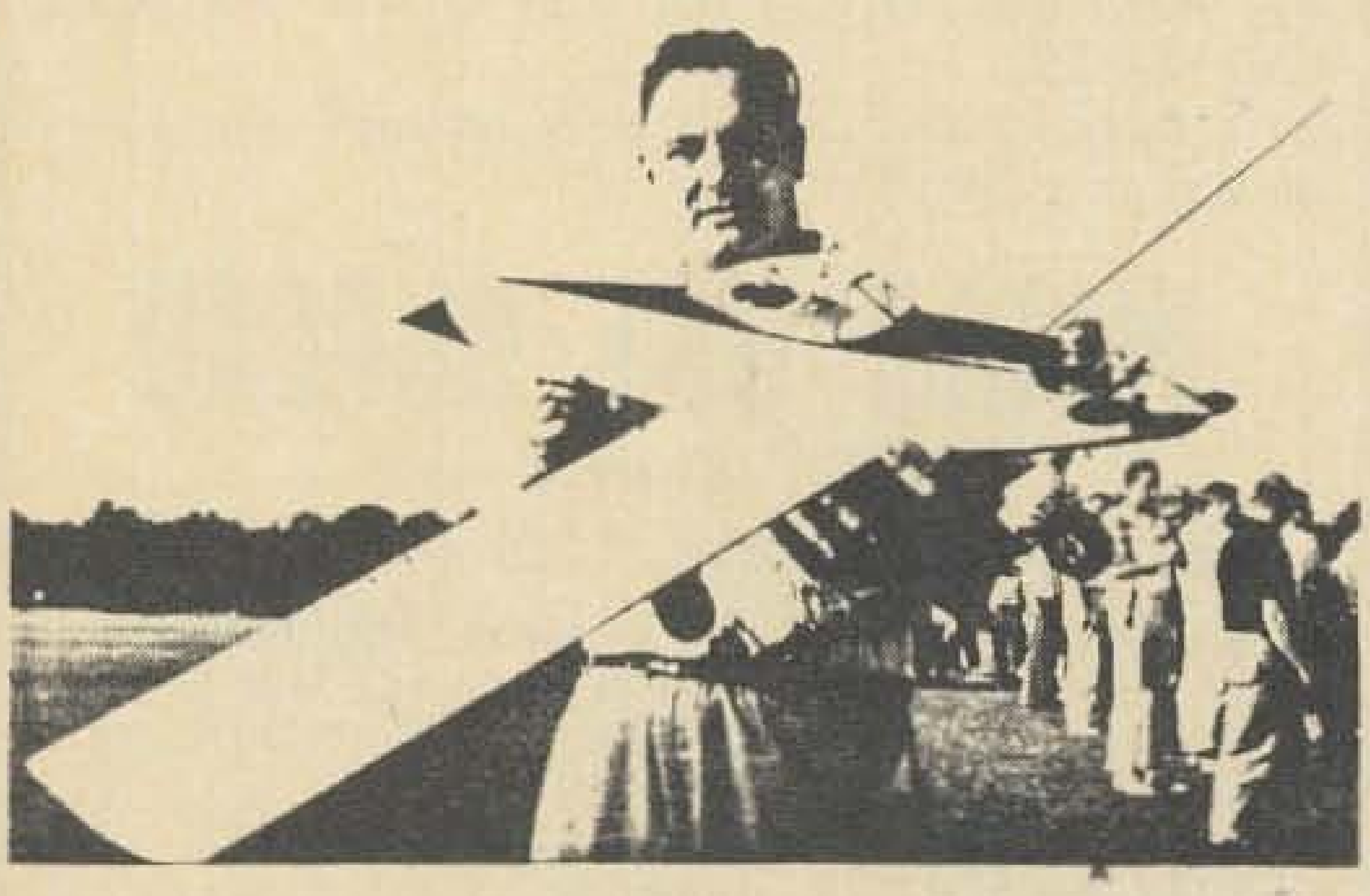
can be reduced greatly

If the *if* frequency is tunable, it can be adjusted to compensate for the misalignment between the transmitter and receiver frequencies. If the *if* is not tunable, you have a real problem since the two crystals reciever and transmitter are the only practical variables. Generally you can "pad" crystals by adding capacity across them (or inductance in series) to get a maximum of about 2 khz change in frequency at 50 mhz before crystal activity is seriously affected. The addition of parts to the receiver is not a practical solution because of space problems. The transmitter crystal can be padded, reground, or "weighted" by someone experienced in the business of shifting crystal frequencies. Another approach which may not be too "far-out" is the use of a variable frequency oscillator (vfo) in the transmitter. A vfo might have to be adjusted regularly, but certainly should hold its adjustment through one flying session if the transmitter were handled carefully and the vfo were well designed.

The most practical solution for the amateur is to use superregenerative receivers. Under present band conditions they provide enough selectivity, high sensitivity and excellent reliability.

Conclusion

Estimates of the number of people involved in the radio control hobby vary widely since there are no good ways of counting heads. It is safe to say that interest is increasing rather than decreasing. The increase is evident from the observation of the rc equipment that is being successfully marketed, from the fact that a new slick paper magazine devoted entirely to rc has been successfully published for over three years and from general interest in clubs, rc competitions and "Sunday flying" sessions. The increased interest should spark ever more interest.



John Ross, WA1BGP, was founder of the New England Radio Control Modellers. This group represents all the New England states, runs regional contests and helps formulate contest rules for the whole country. Many similar groups exist throughout the United States and in other countries.

From the correspondence we have had, we are convinced that many of those who have decided to take an interest in radio control have followed our advice; 1) to start with something simple, and 2) to find someone experienced in the hobby and listen carefully to his advice. Even the experts have their bad days when the Red Baron prevails and the wreckage is dismaying, to say the least. The experts add this sort of thing up to experience and are back in the air quickly. On the other hand, many novices end their interest after a disappointing first visit to the flying site. Most of these failures could be avoided if the novice enlisted the help of an experienced rc fan before he attempts his first flight. Again, happy landings!

...W1OLP

Appendix

This appendix includes material for those who wish to find out more about the rc hobby. Clubs, books and periodicals that provide more detailed information are covered.

Clubs

Local clubs can be located by contacting a hobby shop that caters to model-airplane hobbyists.

Nationwide, the Academy of Model Aeronautics, 1239 Vermont Avenue, N.W. Washington, D.C. 20005, is the ARRL of the model-airplane hobby. Membership in this organization includes insurance coverage for damage that may be caused by the member's model airplane.

Books

DCRC Technical Symposium Papers, published yearly and available from AMA Supply and Service (see address under clubs). The serious rc fan will find these papers most useful. They are on a generally higher technical level than other available literature. Cost is about $2 per year; back issues are available.

How to Build R/C Models, by William Winter, Kalmbach Publishing Co. Milwaukee, Wisconsin, 2nd printing, 1962.

Radio Control Handbook (revised edition) by Howard McEntee, Gernsback Library No. 93 ($4.95).

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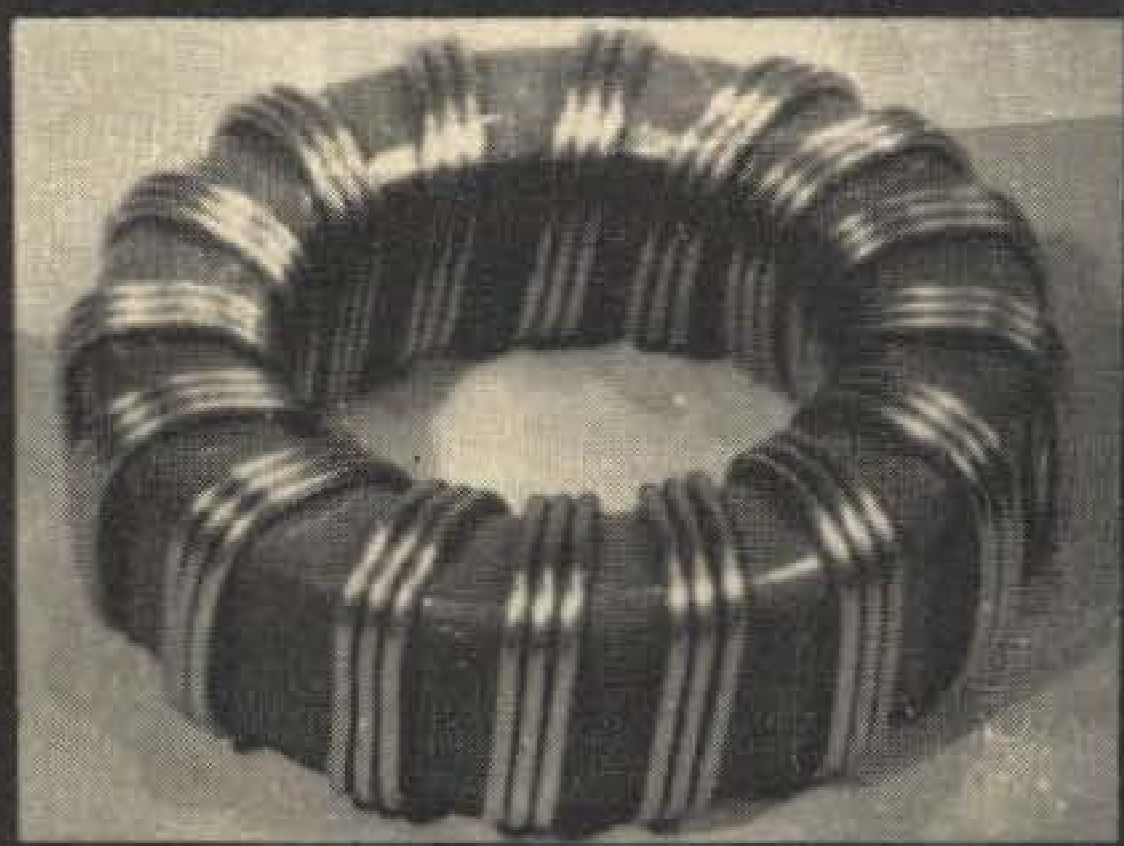

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R/C Primer (2nd Edition) by Howard McEntee, Kalmbach Publishing Co., Milwaukee, Wisconsin, copyrighted 1964.

Model Airplane News R/C Digest published by Air Age, Inc., 551 Fifth Ave., New York, N.Y. 10017 ($2).

Periodicals

American Modeler, published monthly by Potomac Aviation Publications, Inc., 1012 Fourteenth Street, N. W., Washington, D. C. 20005. Howard McEntee, Radio Control Editor. This publication includes the official publications of the AMA.

Flying Models, published monthly by Rajo Publications, Inc., 85 Canisteo St., Hornell, N.Y. 14843. Maynard Hill, Radio Control Editor.

Model Airplane News, published monthly by Air Age, Inc., 551 Fifth Ave., New York, N.Y. 10017. William Northrop, Radio Control Editor.

Radio Control Modeler, published monthly by R/C Modeler Corp., P.O. Box 487, Sierra Madre, California 91024. Don Dewey Editor. Devoted entirely to radio control modeling.

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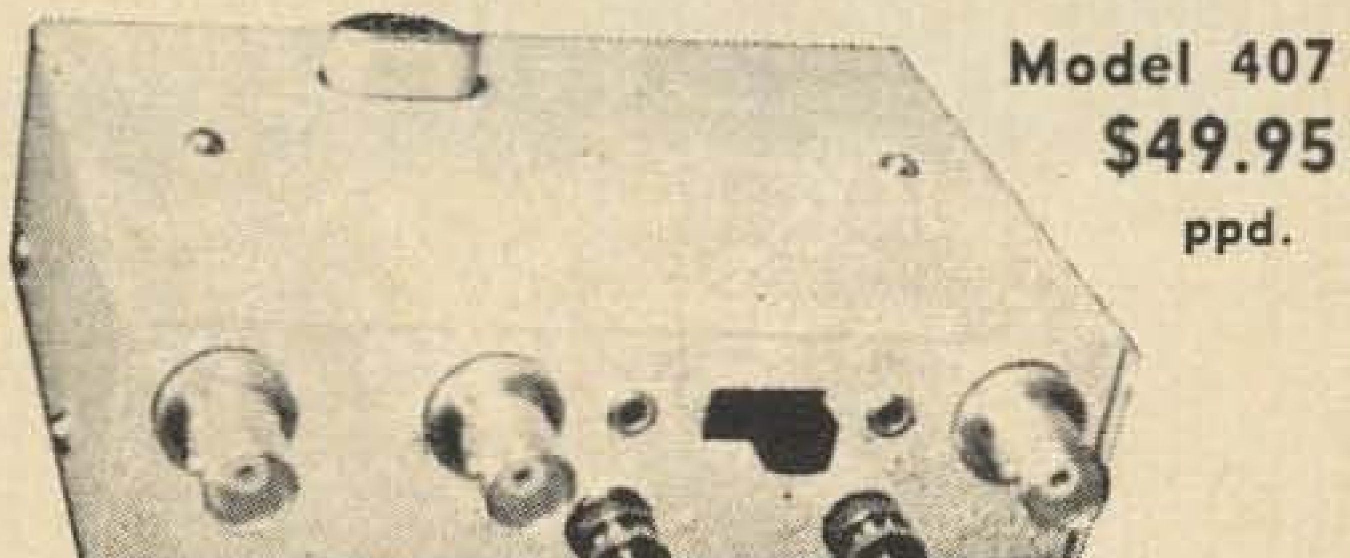

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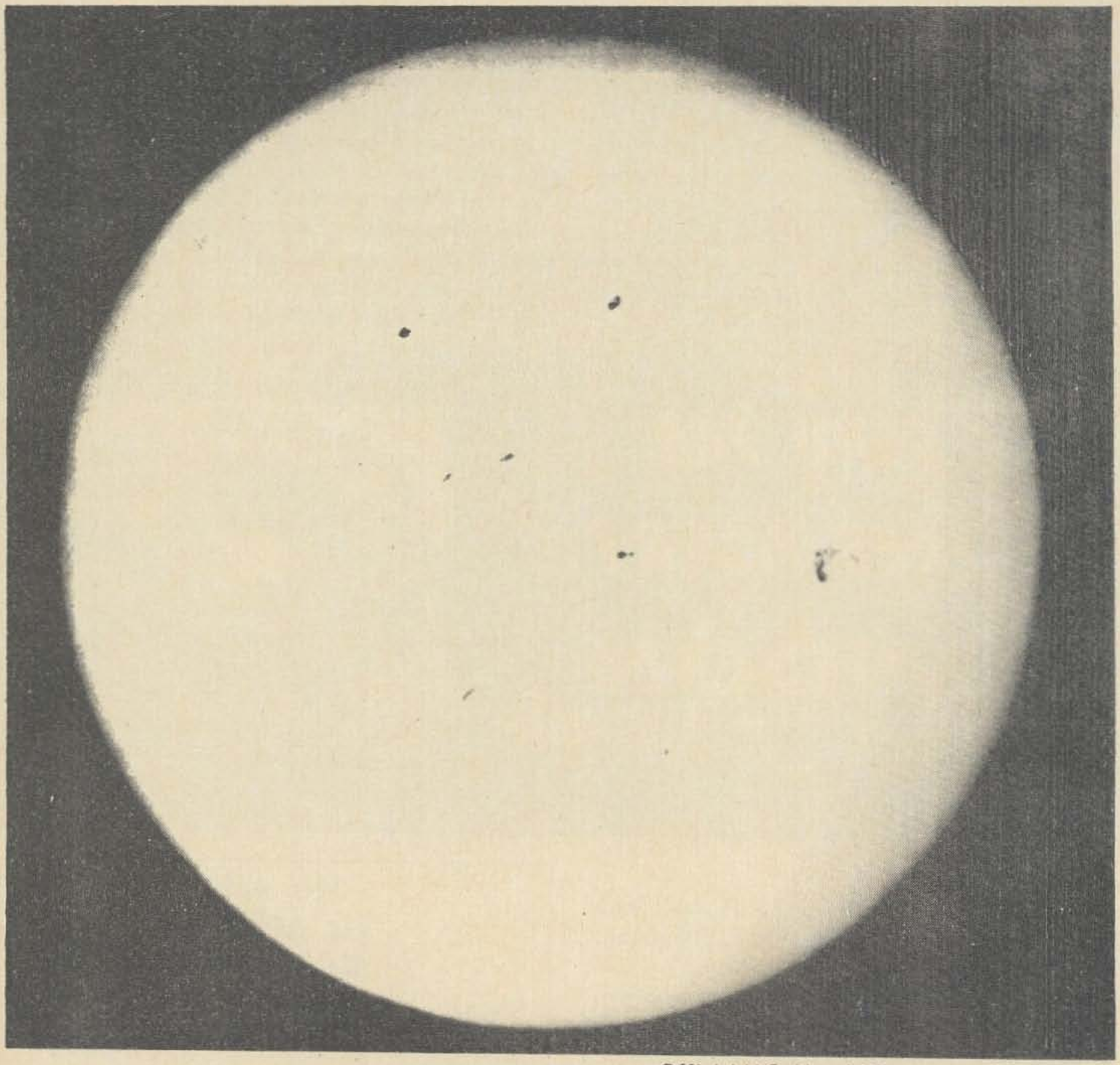

Official U.S. Naval Observatory Photograph

Long-Range Propagation Forecasting

J. H. Nelson
157 Fernwood Terrace
Garden City, New York 11530

It is necessary that my propagation forecasts to the editor of 73 Magazine arrive two months ahead of publications. The forecast is for a full month and therefore must cover a period beginning 60 days away and ending 90 days away. Several amateurs have asked me how it is possible to make forecasts of something so whimsical as a radio disturbance so far in advance. I do this by using the angles that separate the sun's planets as they circle it on a day-to-day basis.

It is not common knowledge, but some daring astronomers of over a hundred years ago suspected that the planets were in some unknown manner related to the formation of sunspots and also to the well-known 11-year sunspot cycle. They researched the subject and produced statistical evidence that strongly indicated there was a connection between sunspots and planets. Unfortunately, in spite of the evidence supporting this theory, the leading astronomers of the world took the stand that the planets were too small and too far away from the sun to affect it. For that reason, this theory really never got off the ground and is, to this day, not accepted by leading astronomers. The astronomers themselves are still trying to develop a more acceptable theory that would explain both the sunspots themselves and their cyclic behavior. Incidentally, there are several cycles in sunspot numbers but the 11-year cycle is the most well known.

My career in radio began in 1923 with RCA in New York as a long wave radio operator. In 1930 I was changed from operating to supervising duties in the then new field of short wave radio. I continued supervisory work until 1946 when I was assigned to sunspot research. In an attempt to develop a short wave radio disturbance forecasting technique based on the study of sunspots, I used a six inch telescope mounted on the roof of the Central Radio Office in downtown New York. Astronomy books stated that sunspots caused poor shortwave radio signals.

After three years of intensive study comparing daily sunspot behavior to daily short wave signal behavior, it became apparent that sunspots per se were not the full answer to the problem. There were many cases in which the sun would be covered with spots from the eastern edge to the western edge in a belt 15 degrees to 20 degrees each side of the equator and accompanied by good radio signals. There were other cases in which the sun would be completely devoid of spots and accompanied by poor signals night after night. Such a situation was intolerable to a forecaster.

This was strong evidence that some other forces were also at work here. I decided to follow in the footsteps of the early astronomers and see what could be produced from a search for possible planetary effects upon sunspots and our ionosphere.

Back tracking through five years of radio signal quality records and comparing each day with the angular separation of the planets each day showed a very strong correlation between certain angles and disturbed conditions.

The analysis comparing short wave signal qualities and planetary angles made between Mercury, Venus, Earth, and Mars (the inner planets) to other planets farther away from the sun than they were showed that disturbed conditions began close to the time (usually plus or minus one day) when there was a 0 degrees, 90 degrees, or 180 degrees separation angle existing between one of the inner planets and more distant planet. Therefore, these angles were selected for special research attention and referred to as significant angles.

The analysis showed that there were more of these significant angles than there were disturbances, however, and this would cause a forecaster to call for too many disturbances. Further analysis showed that the best correlation existed between disturbances and planetary configurations of a multiple type and the closer a configuration came to being a multiple, the greater chance of a disturbance.

In a multiple configuration one fast inner planet will make a significant angle with two outer planets while the two outer planets are themselves at a significant angle. An example would be Mercury 180 degrees from Venus while Mercury and Venus are both 90 degrees from Saturn. There are three other forms of multiples, such as two planets at 0 degrees while a third is 90 degrees from each, two planets at 0 degrees while another is 180 degrees from each, and three planets all 0 degrees at the same time.

These special multiples do not occur very often and their use reduced the tendency to call for too many disturbances.

Single contacts of 0 degrees, 90 degrees, and 180 degrees are also accompanied by disturbed conditions at times. Solving this problem was somewhat more difficult but when smaller angles were studied it was found that

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sub-harmonics of 90 degrees were also important.

The sixth sub-harmonic of 90 degrees is 15 degrees and the fifth is 18 degrees. Study of the disturbance producing single contacts of 0 degrees, 90 degrees, and 180 degrees showed that there would also be present at the same time several angles to other planets that were some multiple of 15 degrees or 18 degrees from the fastest planet during the same day. The planets all have different velocities as they circle the sun, Mercury of course having the greatest.

One example of this type of configuration would be Mercury to Jupiter 90 degrees, Mercury to Venus 45 degrees, Mercury to Uranus 18 degrees, Mercury to Mars 72 degrees. There are, of course, several other arrangements of planets that would fall into this category. The main consideration is that the arrangement satisfy the single 0 degrees, 90 degrees, or 180 degrees set-up along with several simultaneous harmonics.

On the evening of March 23rd this year, there was a spectacular aurora accompanied by poor radio signals and a major magnetic storm. The forecast for this event was mailed to 73 late in December.

The arrangement of the planets in this case was a multiple configuration involving the Earth, Jupiter, and Uranus all at 0 degrees, that is, in a straight line to the sun. Also, there was a second arrangement of Venus and Pluto being at 0 degrees while 135 degrees from Mercury. Bear in mind that the Sun is always at the center of this circle. The position of the planets is given in what is referred to as Heliocentric Longitude in The American Ephermeris and Nautical Almanac published by the U.S. Naval Observatory.

The research conducted at RCA Observatory since 1946 confirms beyond any reasonable doubt that the planets do influence the tenuous electrified gases in the solar atmosphere.

. . .J.H. Nelson

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C.W. Andreasen, WA6JMM
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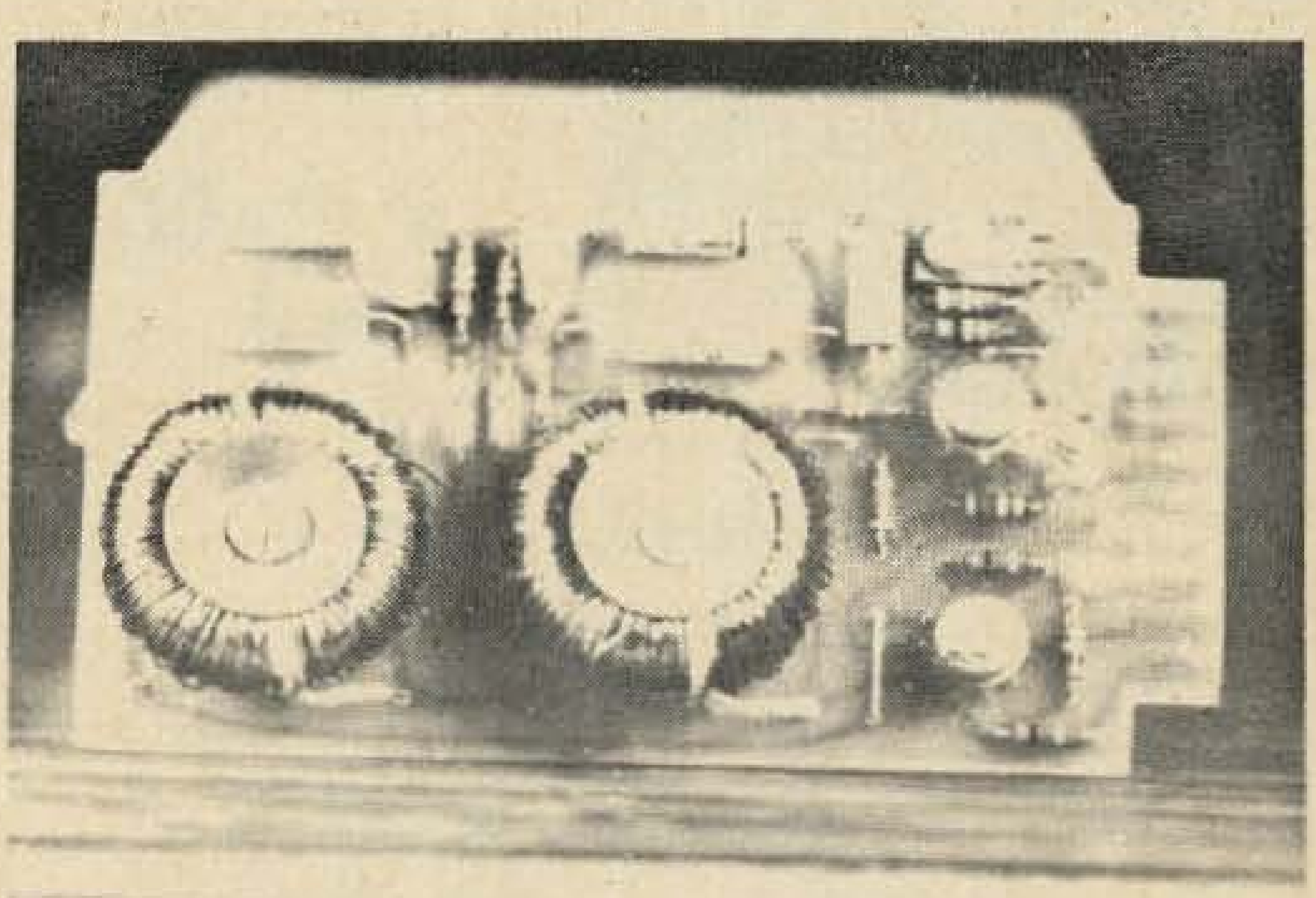

I have been experimenting with amateur radio Teletype for several years and during that time have come to the conclusion that a new design is needed to update the terminal unit. The two most popular units used are the military surplus converters, which are hard to come by at best, and the "Twin City" type TU, which is shown in the ARRL's handbook. Working in electronics, and doing a lot of transistor work, I thought I would try my hand at coming up with a better way. Over a period of several months, I built up units of different designs which worked with varying degrees of success.

In my testing, I would work my good friend WA6CFA, John Cullings on the two meter band. Laguna Beach is about 90 miles north of San Diego, my location. This made a pretty good test, since signals were not the very strong, noiseless, local type. I got John interested in the subject and he started working in the same direction, only he felt that an analog approach would prove superior to the digital line I was following. To make a long story short, he won and came up with the basic design for this unit which I am presenting. We have both put much time in on this unit and have found it, even in its most basic form, to out-perform just about any unit short of very sophisticated gear.

The basic unit consists of four functional blocks: the isolation amplifier, ratio detector, the voltage comparator, and the high voltage switch. The isolation amplifier and the voltage comparator are both low cost integrated circuits, whose use keep the cost of this unit to a minimum.

The secret of this terminal unit is in the UA-710 integrated circuit. The "710" is a high gain, high speed voltage comparator. Its operation can be summed up by stating

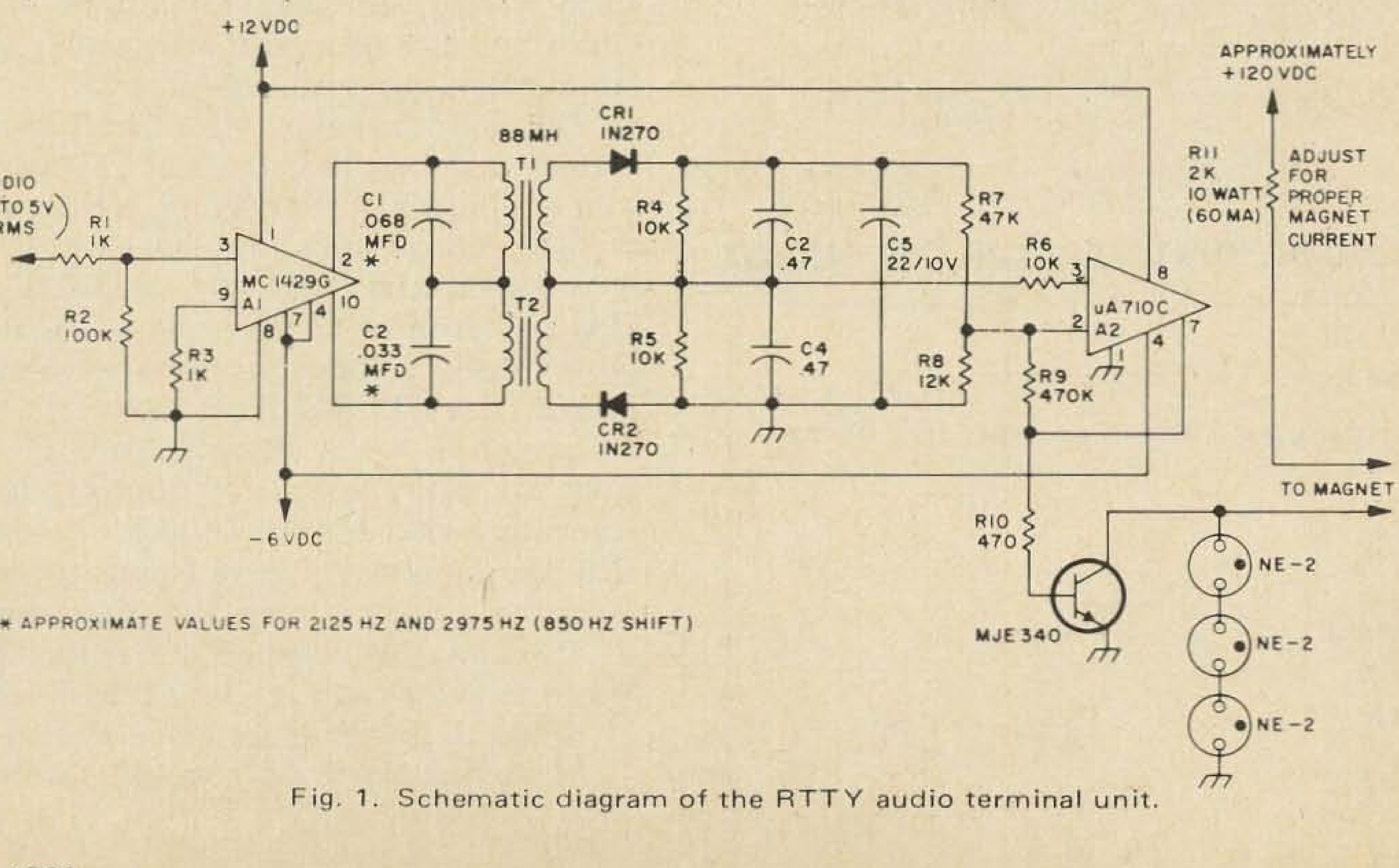

Fig. 1. Schematic diagram of the RTTY audio terminal unit.

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that a reference voltage is applied on one input and the signal in question is applied to the other. Any time the incoming signal is greater than the reference, the output is in one state, and when the signal drops below the reference point, the output will switch to the other state. There is a very narrow threshold which gives this unit its extreme sensitivity.

The detector portion of this TU is a ratio detector, such as is used in an FM receiver. This type of detector is very insensitive to amplitude modulation which allows the FM (FSK) to be detected when it is down in the noise.

The incoming detected signal is integrated across C5 which is divided by R7 and R8 to form the reference voltage for the comparator. Since this voltage is proportional to the detected signal, it automatically tracks and eliminates the need for a variable reference control.

T1 and T2 consist of the standard 88 mH toroid telephone chokes which are available surplus or as advertised in the back of this magazine. They have been modified into transformers by the addition of 50 to 100 turns for a secondary. The number of turns used is not at all critical, as long as the same number of turns are on each transformer. My unit has 100 turns, while the one built by WA6CFA has only 50; both units work equally well.

A-1 is used as an isolation amplifier to drive T1 and T2 differentially, and is no more than a Darlingtor differential amplifier. Two different units were tried with good results. I used the Westinghouse "WC115" since it cost less than the MC1429G, but either unit can be used if attention is paid to the different pin connections.

The output keying transistor is a high voltage type, so the standard 150 volt loop supply could be used. Again, most any type of high voltage transistor can be used, but I recommend the MJE-340 which Motorola sells for around $1.00 and can handle the power easily. The neon bulbs are a must to protect the MJE-340 from kick-back spikes.

Layout is not at all critical and modifications are easily added for tuning indicators, reversing switches and the like. I might add that the best way I have found to put in a reversing switch is to switch the "hot" end of C1 and C2 between respective places. Wired as shown in Fig. 1, the mark frequency is 2125Hz, with space being 2975Hz.

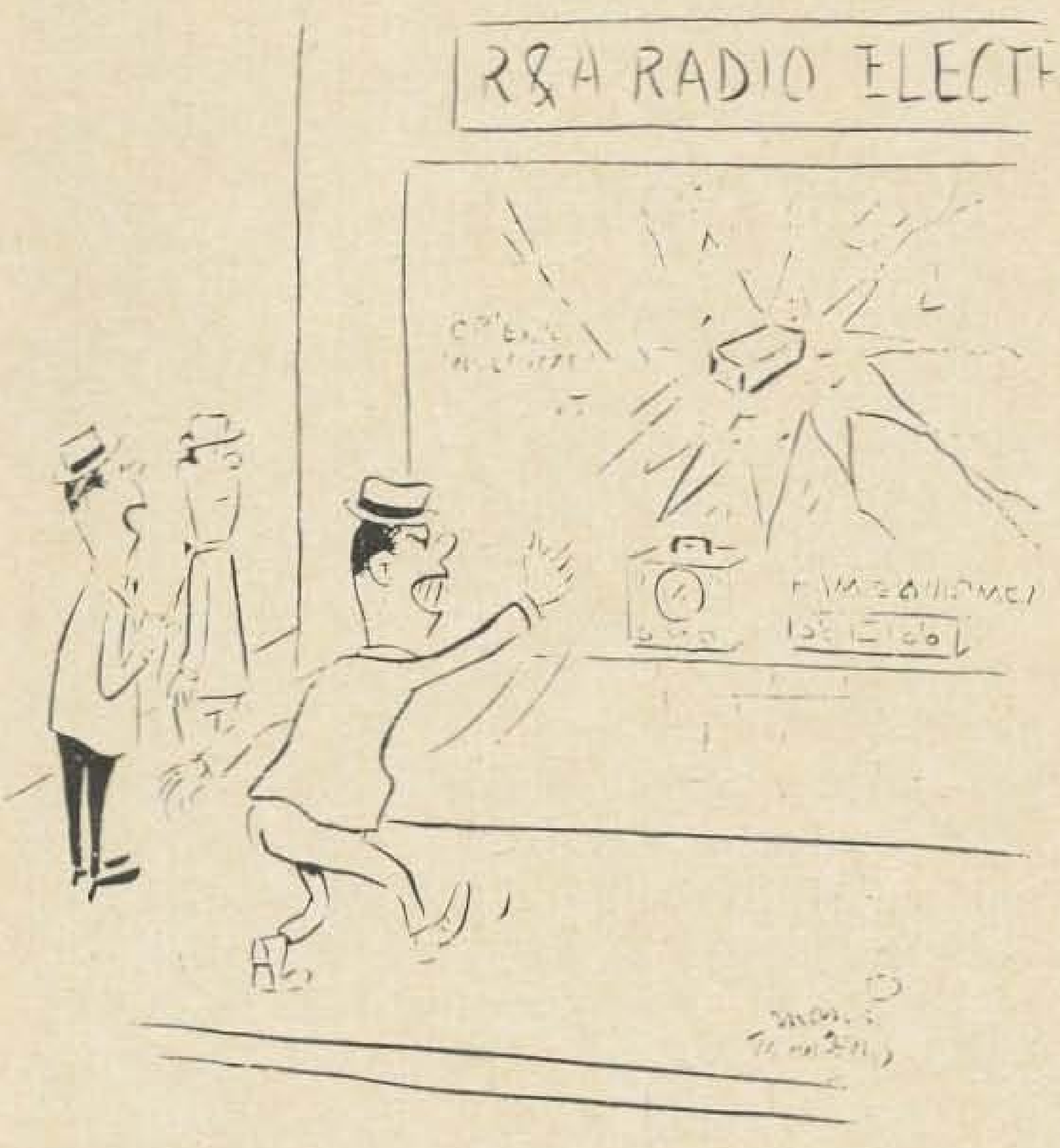
In buying the IC's, I would recommend

that the Fairchild 710 be purchased since it can be obtained for approximately $3.00, which is less than the other makes.

With this unit, very narrow shifts are possible. I am able to copy a 200 cycle audio shift when it is below the noise level and voice communication is impossible. Narrower shifts should present no problem. I have not tried a shift of less than 200 Hz, but with the proper selection of values for C1 and C2 there is no reason it would not work somewhat narrower.

Exact shift frequencies are not manditory for copy since the ratio detector is an FM type of detector. If the received station's tones are a bit off frequency, you probably will not notice any increase in error rate unless the received signal is very weak or the tones are considerably off frequency. The operation of this unit can be vastly improved when utilizing narrow shift, by the addition of a good audio bandpass filter, designed for the shift in use, between the receiver audio output and the terminal unit input. If the signal being copied fades below copy level, or there is no signal at all, the Teletype machine will not run open; it will sit quietly until a proper signal is tuned in.

...WA6JMM



"It just now occured to Frank that he met his wife through the ham equipment they sold him!"

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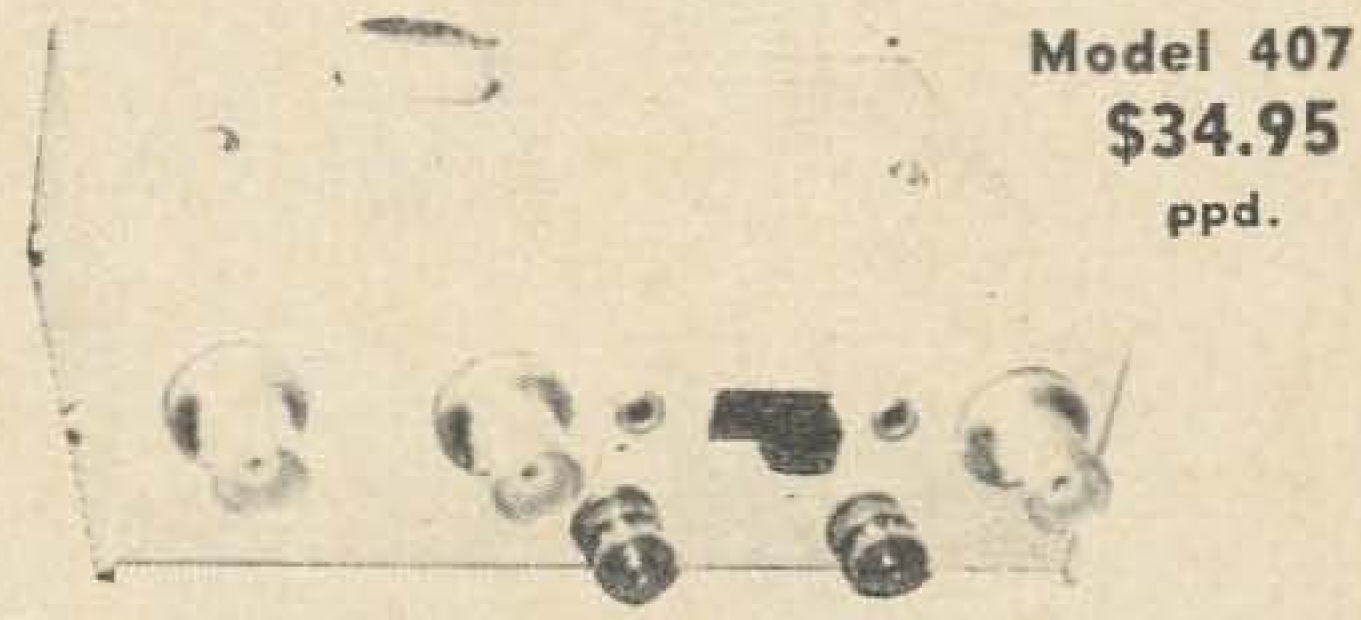

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Facts and Fads

I once heard our illustrious hobby defined as "that class of individuals who, by demonstrating a certain degree of achievement in radio techniques and principles, have earned the privilege of playing with the air waves," and while I know a few guys will get a bit huffy over such a definition, I frankly like it. True it may be that our hobby has contributed much in the way of the development of the arts, but it always has been with the idea of pleasure, foremost, and when it becomes otherwise, we will no longer be amateurs. The very word, "amateur," comes from the French amator meaning one who loves. If you find pleasure in the art, that is, if you love the art, you are an amateur in its truest sense. (Just in case you're interested, the word "ham" was first applied to amateur actors. They couldn't afford to buy professional make-up, so they made their own out of hamfat.)

Strange as it may seem, most sciences were first explored by pleasure-seekers, or amateurs. For example, gunpowder was first invented for fireworks displays. The Chinese had little interest in its destructive power. Optics developed from the enjoyment of the light-scattering effects of irregularly shaped pieces of glass. Last of all, for many centuries, electricity was valueless except as a plaything. The early experimenters, in their course of discovery, some for pleasure and some for constructive purposes, stumbled through a comedy of errors as funny as anything that ever graced a ham actor's stage.

As far back as 700 BC electricity was known by the early Greeks. A scientist named Thales of Miletus commented on the peculiar property of amber. Amber is a glass-like, yellow stuff which, so they say, is petrified pine-sap. When briskly rubbed, amber would mysteriously draw other substances toward it, where they would remain for a while and then fly away. As men will do when they can find no other explanation, Thales credited the supernatural. These materials had a soul—they were alive. The soul of the amber drew them as if with a sucked-in breath. They flew away as the spirit exhaled! The Greek word for amber was "Elektron." Anyway, it was a beginning.

Throughout the dark ages little happened with this plaything. Experimenters were either jailed or burned as witches. But by the 17th century, hams were at it again. Once Gilbert had listed the various "electrics," or materials showing electrical characteristics, and Von Guericke had built a static generator, the clowns took it from there. In 1743, a Frenchman named Dufay suspended a small boy from the ceiling and charged him up with a static machine in order to watch bits of dust and splinters, etc., fly up to him. Dufay and his partner Nollet delighted the French court with this trick, and by charging each other up and drawing sparks from each other's nose. It wasn't long before kids were being charged up all over the place.

Another popular fad was to load a pretty girl with a nice hot static charge and then let her sweetheart kiss her! In 1745, Professor van Musschenbroek and a pupil were conducting an experiment in Leyden, Holland. They were seeking a way to store electricity, which by that time was thought to be a fluid (origin of the expression, "juice"). The good professor had his student hold a jar of water in one hand while an electrical charge was fed into the water through a metal conductor. After a while, the student touched the conductor with his free hand and nearly got knocked on his can. He didn't know that he had formed a capacitor with the water as one plate, his hand as the other plate, and the jar as the dielectric. He holds rather doubtful honor of being the first person to be socked by a loaded capacitor. Van Musschenbroek offered the theory that his "Leyden Jar" condensed the electric fluid, hence the use of the word "condenser."

Van Musschenbroek called his experiment terrible and frightening, and advised his friends not to try it, so they tried it. The jar was soon improved by using foil conductors inside and out, and shocks were "the thing." Dufay's partner, Nollet was quick to pick up the idea. People swarmed into Paris to experience his shocks. It was a real fun idea. Nollet made a whole company of the king's guards jump simultaneously. He visited a monastery and zapped a line of monks three kilometers long. The idea soon came out that no matter how long the line of people was, they still jumped all at the same time. This electric stuff traveled awful fast.

So, Leyden jars were the "in thing." They were built into canes as a handy weapon, or practical joke, whichever was preferred. It was noticed that the shocks could kill small animals, or start fires in ether and alcohol. It was sensational. A hundred years later the Leyden jar was still the object of much speculation. In *20,000 Leagues Under the Sea*, Jules Verne had captain Nemo killing sharks with miniature Leyden jars. (Under water, no less!)

I'm getting a bit ahead of myself. It had been noticed that small animals, killed by a Leyden jar, would, upon dissection, show the same symptoms as if they had died during a lightning storm. Could there have been a connection? Then came Ben Franklin.

It's generally agreed that Franklin took a tremendous chance of being knocked tail over teakettle when he performed his famous kite experiment. Of course, Ben didn't know that. How often ignorance of danger can look like courage. Giving credit where it's due however, Franklin did not fly his kite with a wire for a string, as some people think. In the first place, there wasn't any wire around in his time strong and light enough to do the job. A wire thick enough not to snap would have been so heavy the kite would never have gotten off the ground. He used a piece of wet hemp string as his conductor, while he held it by means of an insulating silk cord. He still took a heck of a chance.

While we're on the subject of Franklin, I might mention in passing that he gets credit for naming positive and negative polarity, and defining them just the opposite as they actually are. (Positive should imply an excess not a shortage.) His odds there were 50:50, but he just didn't luck out. I guess he used up all his luck with the kite where he needed it.

Out of this came the lightning rod. I have a picture before me that I wish was not copyrighted, so the editor could only re-

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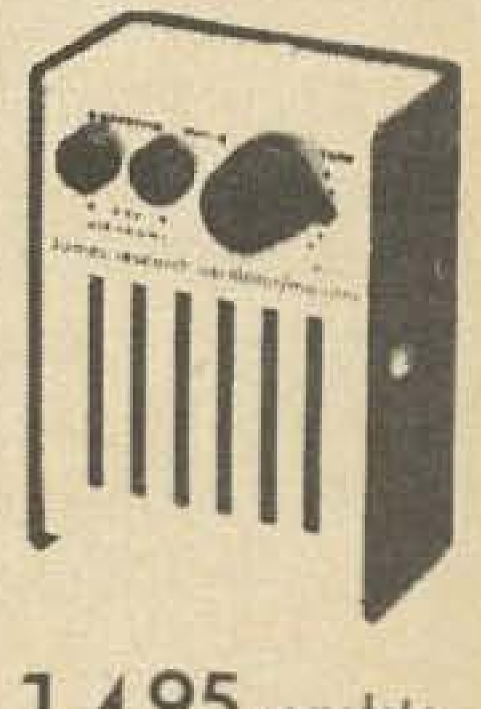

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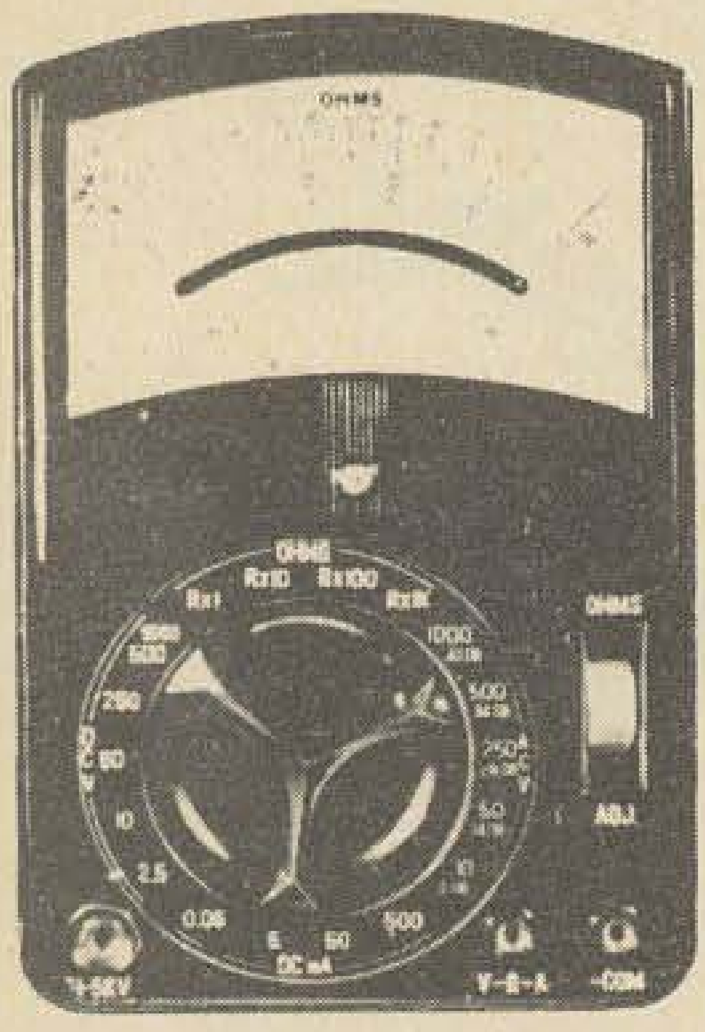

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produce it. It shows a man holding an umbrella with a lightning rod on top, and a long wire trailing off along the ground. I'd like to see the next scene.

In St. Petersburg, a Professor Richmann connected a lightning rod to a metal sphere in his lab, ungrounded. He got too close during a storm and was instantly killed, science's first electrical fatality.

When Galvani's wife had the tar scared out of her by a pair of frog legs that jumped without having the rest of the frog attached, (around 1786) there began a great deal of speculation that electricity might be the secret of life itself. Scientists began to toy with the idea of electrical cures for crippling diseases. Many an unfortunate cripple was wired up to various wierd and wonderful machines, and watched hopefully as limbs hitherto immobile kicked convulsively. In 1818, a condemned murderer sold his body to some English scientists who sent powerful surges of current through it. This was perhaps the most gruesome experiment in the history of man. The corpse jumped, wiggled, gasped, moaned, squirmed, and even pointed a finger. Life, however, never returned. In 1886, New York State decided to try out the first electric chair. They fouled the job very thoroughly, and the victim was ghoulishly cooked. Ever since, the chair has been called the "hot seat."

Morse's invention of the telegraph in 1844 did not begin, as many think, with the words, "What hath God wrought?" That message was the first *official* message, and Morse had promised in advance to a lady friend that he would use it. Actually, the news of Henry Clay's nomination for president had been reported from Baltimore to Washington several days earlier.

Bell had his share of sport with his telephone. It has been said that when he demonstrated it from Boston to Salem, his audience at the Salem end were treated to hearing Bell's landlady bawl him out for being late with the rent. The emperor of Brazil, upon hearing a telephone for the first time jumped back and cried, "My God it talks!"

Edison made many an invention for his own convenience. He had made a profound impression when, as a rookie telegrapher, he was "initiated" by the old timers. For two hours the fastest boy on the line whooped it up, and Edison copied solid. Finally he opened his key and signalled, "Send with other foot." In spite of first impressions he did finally get himself canned. He was on the night shift, and required to send out a recognition signal (to prove he was awake) every hour. He doctored up a clock and connected it to the line, and his signal went out automatically. The boss got suspicious, however, when he failed to get an answer just after the hourly check. He went out to the station and caught Tom sleeping like a baby as his machine faithfully ticked out its hourly check. To frost the cake, Edison when he was awake, carried on his own independent research in the station. One night he tried to get a little battery acid out of a large carbouy in the back room. The carbouy spilled over and the acid seeped through the floor where it made short work of the rug downstairs.

I could go on and on, but eventually it would get boring. In closing, let me just relate one more tale. The late Ernie Kovacs was famous for technical sculduggery on his TV shows. Nothing he did there could quite match his joke on a certain hospital staff when they examined his chest xray plate and saw the words, "out to lunch" in big black letters. Ernie had cut the letters out of aluminum foil and pasted them on his belly.

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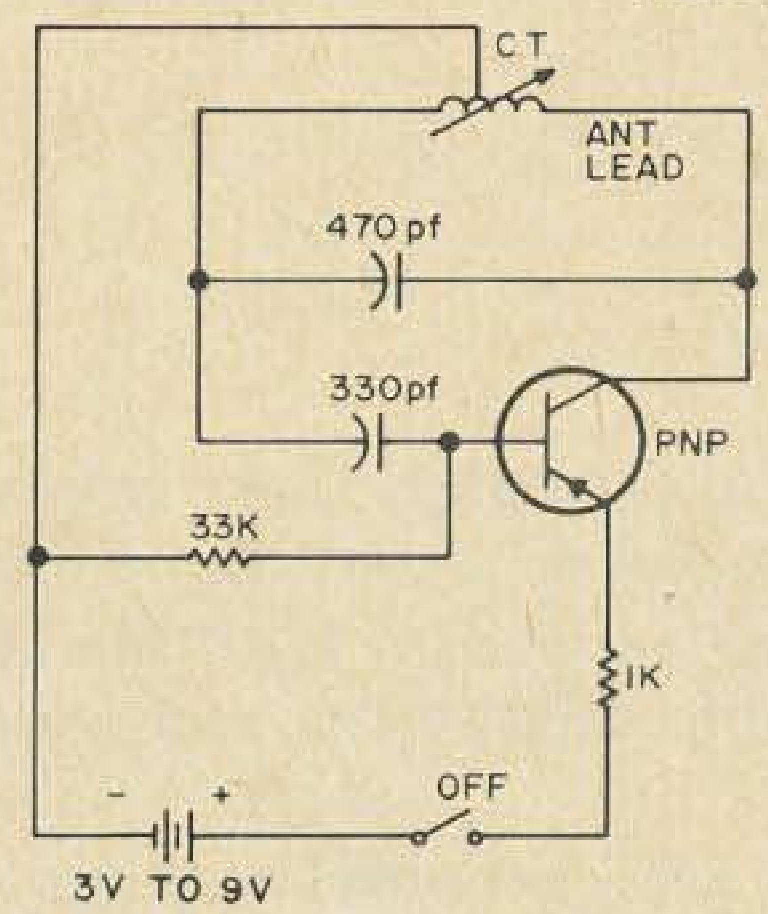
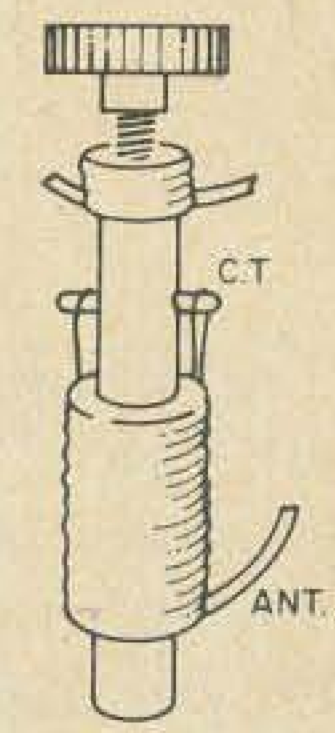
Have you ever wanted a small bfo to receive CW or SSB on one of the many multiband transistor portables which are available on the market today?

Many articles are available which state "Simply modify an old *if* transformer as follows, etc., etc." Attempts to remove the built-in capacitor or simply cut the unused and unnecessary winding from a miniature transformer is enough to drive a good man to drink. By the way, that drink doesn't help a large unsteady hand cut that elusive #42 wire from a small transformer with any less effort. Should you be fortunate enough to remove the lead without damage to the remainder of the transformer you usually find the tuning rate to be too fast to be practical if not just impossible.





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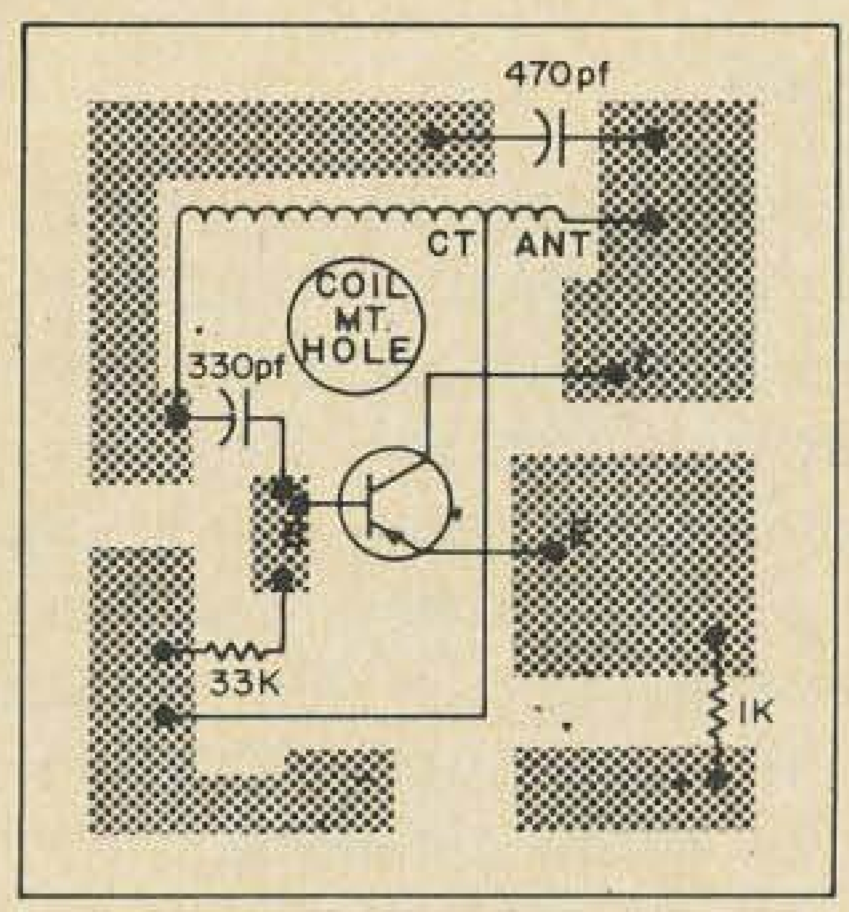
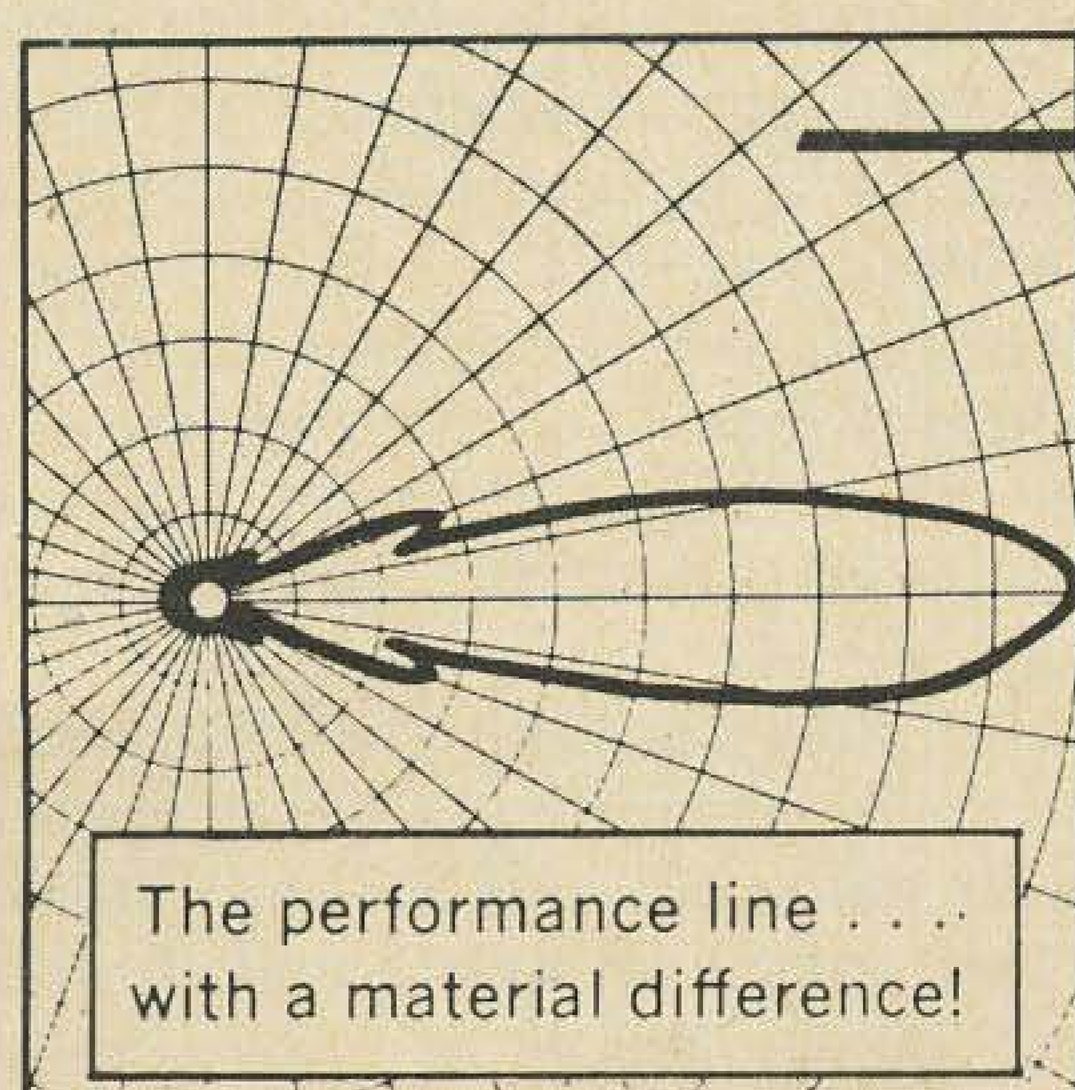


Actual Size P.C. Board

The circuit described herein utilizes an inexpensive (39¢) Vari-loopstick. There are four additional Components and any pnp transistor gives sufficient signal that no direct coupling to the receiver is needed. Most replacement loopsticks are supplied with a small chrome knob and in this circuit two revolutions are needed to go through zero beat at 455 kHz. Therefore, adjustment of SSB or CW signals by changing the oscillator frequency is not at all critical in the event the tuning rate of your receiver is too fast.

Wiring is not at all critical; however, short rigid leads are desirable and should you elect to use the circuit board or a metal mounting plate the effects of hand capacitance when tuning will be eliminated. As a final precaution against instability due to the construction of the loopstick, I suggest coating the coil with paint or epoxy glue for rigidity. The PC board may be mounted to the bottom of the loopstick and the coil then inserted through a hole in the receiver case. Outboard operation is also possible by merely placing the bfo close to the receiver being used.

. . .WA8BHK/WB4MYL



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An IC Audio Notch Filter

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

A bridged-T audio notch filter combined with an IC amplifier produces a highly versatile, wide-range audio rejection filter with both variable frequency and variable "Q" controls.

Audio filters are certainly nothing new. They have long been used to improve the selectivity of a receiver or transceiver when it was not desired to "dig" into the *if* circuitry and improve the selectivity at the *rf* level. The disadvantage of such a method of selectivity improvement is that the selectivity takes place late in the receiver processing chain. Therefore, when one is listening to a weak station, a strong station near in frequency can control the avc or overload the receiver stages.

Nonetheless, audio selectivity is easy to apply and can take the form of either an audio frequency peaking or notching type function. Audio peaking can easily be provided by a number of fixed frequency filter designs and numerous inexpensive units are available from surplus outlets. The disadvantage of the peaking approach is that most filters which are of any real use produce a "ringing" effect. The sound is unnatural and definitely very tiring if the filter is constantly left in the circuit without any provision for disabling it. Stations can also be lost when scanning a band unless tuning is done very slowly when using the filter on CW.

The notching type filter, on the other hand, is usable on both CW and phone. It does not cause any ringing effect and does not mask any signals when quickly scanning a band. A single notch filter can only eliminate the one frequency to which it is set, but when a receiver already has a good phone filter – such as the multiple crystal or mechanical types found in SSB transceivers – one notch frequency possibility seems to suffice in most qrm situations. Audio notch filters built around passive components only are fairly old, but their use has disappointed many operators because to achieve reasonable narrowness and high attenuation at the notch frequency, expensive capacitors were necessary and the filter could only be used in very high impedance circuits. The use of an integrated circuit amplifier with a notch filter in a feedback arrangement, however, produces a notch filter of very high Q using inexpensive components. It is neither critical as to circuit impedance nor does it introduce any overall circuit insertion loss.

Basic Circuit

The circuit of the IC notch filter is shown in **Fig. 1**. The actual notch filter consists of the bridged-T network – the ganged 50 K potentiometer and the two .05 mf capacitors. The circuit presents a very high attenuation at one frequency which is related to the time constants of the circuit. The frequency of maximum attenuation can be changed by either changing the value of the resistive or capacitive legs. As was mentioned, however, unless special precautions are taken, the bridged-T network alone will tend to produce a very broad rejection notch which is particularly unsuited to CW work. The integrated circuit, however, corrects this situation in the following manner: the input signal passes through the bridged-T network to one input of a differential operational amplifier (a Motorola MC1533 in this case). Feedback through R4 is coupled from the amplifier output back to the signal input point. The other amplifier input (-) then receives a combination of the original input and feedback signals. Since the nature of a differential amplifier is such that when the (+) and (-) inputs receive equal level signals, the output is zero, R2 and R3 are chosen such that this condition exists and infinite attenuation takes place at the notch frequency.

There may be situations where a somewhat broader rejection notch is desired with correspondingly less maximum attenuation at the notch frequency. This adjustment is provided by making R1 variable, as shown in Fig. 1. As the wiper arm on R1 moves from right to left, the feedback voltage around the operational amplifier decreases and the effective Q of the bridged-T network is reduced. Thus, if desired, R1 can be made variable and functions as a "Q" control. Otherwise, R1 can be a fixed value resistor and R2 is connected to the junction of R1 and R4 to produce a single frequency, deep notch audio filter. In this case, the only variable control would be the dual 50K ohm potentiometers which vary the time constant of the bridged-T network and hence the notch frequency. The dual potentiometer is capable of varying the notch frequency over about a 10:1 frequency range – 300 to 3,000 cycles approximately. This range should certainly suffice for most applications but, if desired, the range can be changed by using different (but equal) values of capacitance for C1 and C2.

The differential operational amplifier used may seem an unusual component to

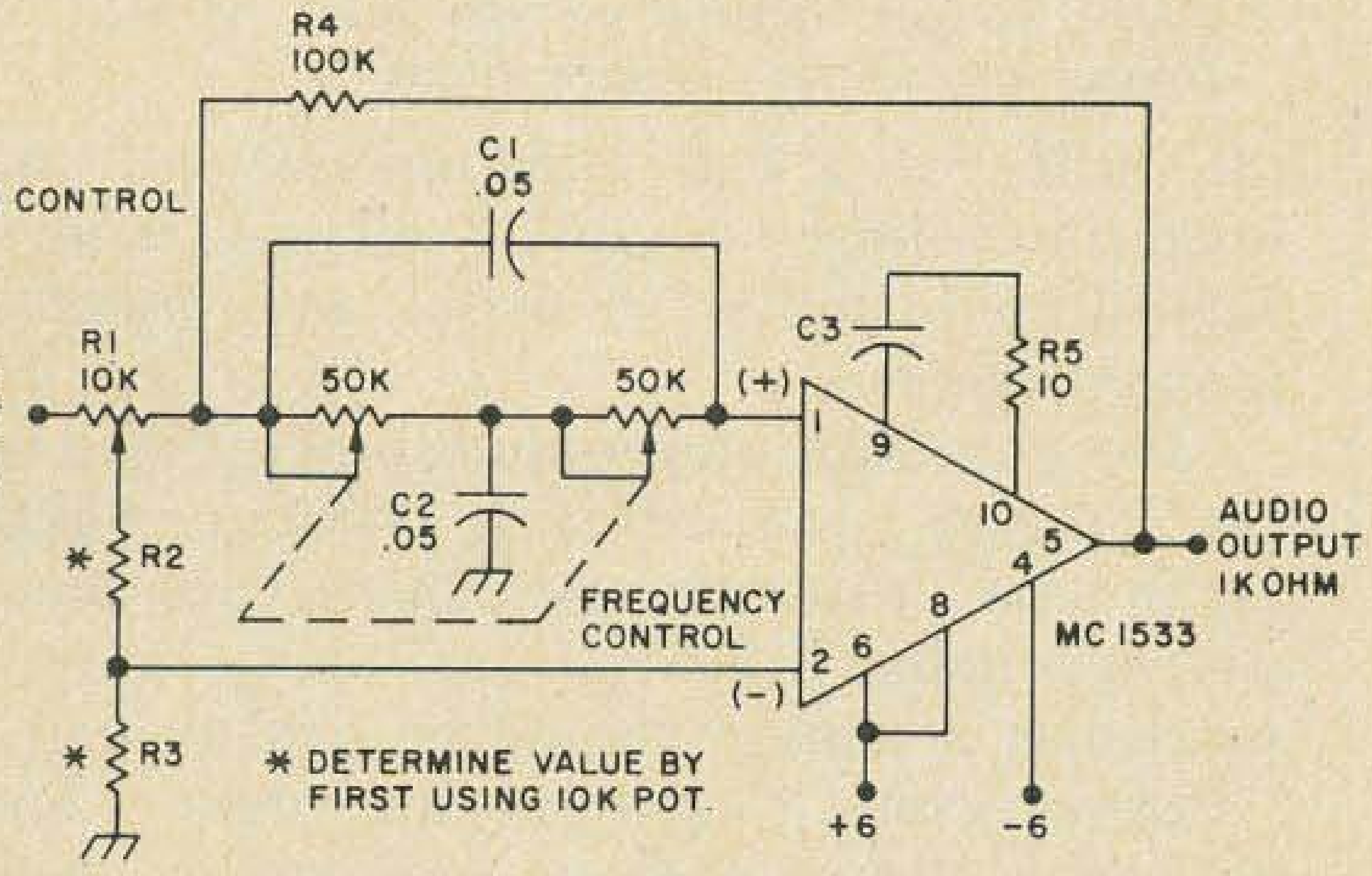
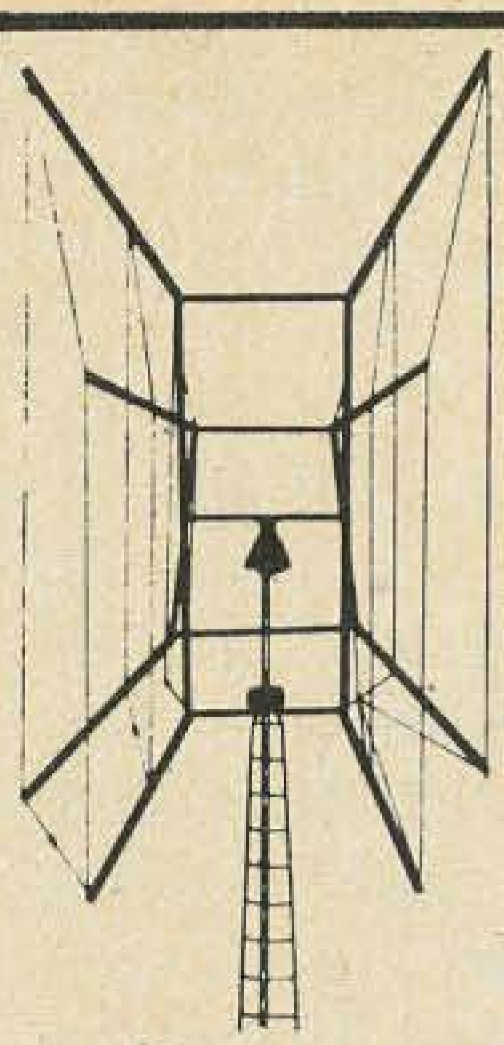


Fig. 1. Schematic diagram of the variable frequency and variable bridge-T notch filter. Various other IC units may be used besides the unit shown.

many readers. Although the basics of integrated circuits cannot be explored in this article, it should be realized that the integrated circuit used is only a multi-stage transistor amplifier packaged into a housing the size of the usual single transistor. The main feature that separates the differential amplifier from a conventional amplifier is its input circuitry. The "differential" input has a non-inverting (+) and inverting (-) input. A positive-going voltage applied to the non-inverting input produces a positive-going output voltage. The same voltage applied to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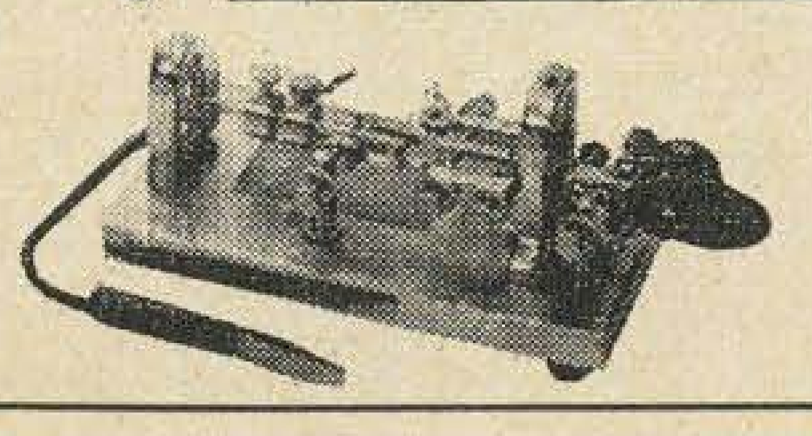
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the inverting output produces a negative-going output. Thus, the same value and polarity voltage applied to both inputs will produce no output.

Fig. 1 shows the use of a Motorola MC1533 operational amplifier, but almost any similar unit will suffice. A number of inexpensive "surplus" IC operational amplifiers are available from such suppliers as Poly Paks, Lynnfield, Massachusetts 01940. Other units may differ in their voltage requirements and roll-off compensation needs (the RC network between pins 9 and 10 on the MC1533), but this information is usually supplied with the unit. It should be noted that a simple integrated circuit audio amplifier cannot be used; such units do not have differential input circuits.

Construction

There are very few precautions to be observed in constructing the unit because of the nature of its operation. One possible method of construction which the author explored is shown in Fig. 2. All of the circuit components are mounted on a piece of vectorboard which in turn is mounted on the rear potentiometer of the dual 50K ohm potentiometer. A piece of foam plastic material is glued between the underside of the vectorboard and the rear potentiometer to achieve the mounting.

The parts layout shown for the vectorboard in Fig. 2 need not be followed exactly, although it was the simplest which the author could devise. If an integrated circuit packaged in a dual-inline container is used (rectangular with 5-7 connections on each long side), the IC can be mounted on the left side of the vectorboard and R5 and C3 both placed under C1. No "Q" control is provided for in the parts layout shown, and R1 is a fixed value resistor. R1 need only be made variable, as shown in Fig. 1, if this feature is desired. The values of R2 and R3 can only be properly chosen by first using a 10K ohm potentiometer in their place (with the wiper arm going to terminal 2 on the IC) due to component value variation. The procedure is fairly simple. The wiper arm on R1 (if a variable unit is used) is first set towards the junction of R1 and R4. Then, using an input signal containing a frequency which the notch filter can reject, the dual 50K ohm potentiometer is adjusted for maximum rejection. Leaving this control set, the temporary potentiometer used in place of R2 and R3 is adjusted for complete signal rejection. At this point, the arms of the 10K ohm potentiometer are measured and replaced by equivalent value fixed resistors.

The resistors used in the notch filter can either be ¼ of ½ watt sizes. The capacitors need be rated no higher than the maximum value of the supply voltage used for a particular IC. The capacitors used in the bridged-T network should be of good quality to achieve the sharpest notch selectivity. Disc ceramic types are acceptable, although, if possible, low-loss types such as the Aerovox P123ZN series are preferred. The current demand from the power supply is in the order of a few milliamperes, but the operating voltages should be obtained from a well-filtered source to avoid any possible hum problems.

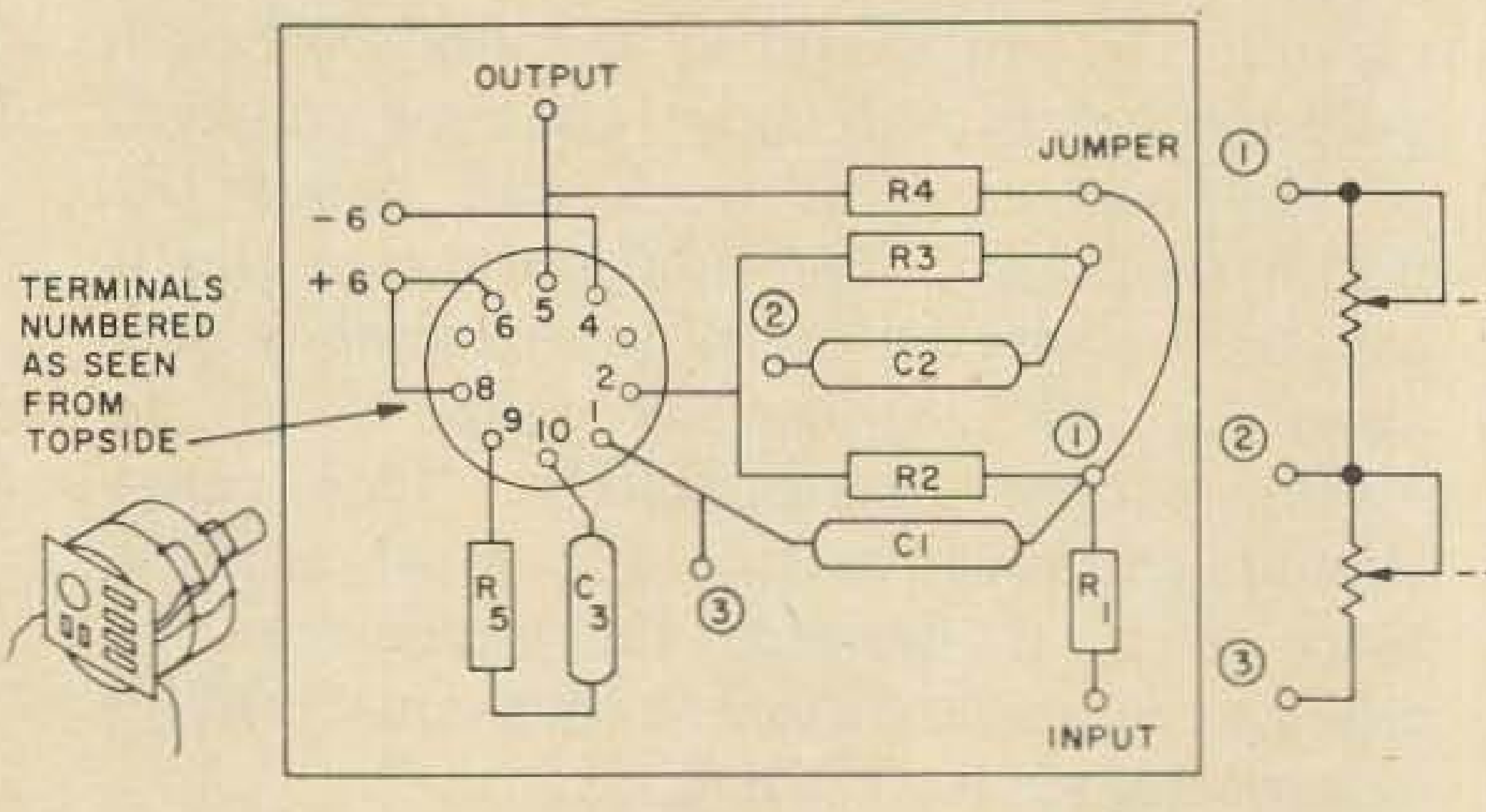

Fig. 2. No particular circuit layout is necessary but the components can so compactly be grouped on vectorboard that the entire circuit mounts on the back of the frequency control potentiometer.

The dual 50K ohm potentiometer used in the bridged-T circuit is a standard linear taper type. Although one can purchase such potentiometers from various supply houses, particular attention should be paid to being "cost-conscious" about this item. The author has found such potentiometers available for as low as 35¢ as compared to prices of $3 for similar units at regular catalog prices.

Mounting and Operation

The mounting or placement of the notch filter in a receiver or transceiver is fairly flexible. The unit can be inserted between almost any two audio stages. DC blocking capacitors must, of course, be used to prevent other than audio frequencies passing through the filter. Alternatively, the unit can be used completely external to a receiver or transceiver. The audio output from the receiver or transceiver can be taken from a headphone jack or from the loudspeaker terminals through a transformer (4-10 ohms to 1K ohm or more). The gain of the operational amplifier, in the latter installation, is more than sufficient to drive any pair of medium to high-impedance headphones.

Operation of the notch filter is extremely simple. When not in use, the filter is adjusted for maximum low-frequency attenuation. As qrm develops, the filter is used (in conjunction with tuning of the receiver bandpass) to eliminate the most severe interfering beat (on SSB or CW). The result is an almost complete attenuation of the interfering signal while still retaining the full fidelity of the desired signal. The difference between this method of qrm elimination and that which depends upon a severe reduction in bandpass to accomodate only the desired signal is quite startling in terms of fidelity and ease of tuning.

Summary

Many thanks are due to Herman Gelback, W7JPU, of the Boeing Company, who completely developed the original circuitry of the IC notch filter and who allowed the author to present this description of its operation. Herman has also suggested that besides the MC1533 IC, another suitable off-the-shelf IC would be the General Electric PA-230, which sells for just over $3.

. . . W2EEY/1

PC Board Improvement

Before starting to wire your next printed circuit board, kit, or homebrew, take time to save yourself trouble later. Drill out all holes where wires connect to the proper size and install Vector terminals. This eliminates future problems involved in trying to reconnect wires to holes which are out of sight beneath a pool of solder. The possibility of lifting the foil during repairs is also minimized.

Another place where this technique bears fruit is in a situation where a component must be removed in order to make circuit adjustments. Some transceiver front ends are a prime example. In order to neutralize the RF stage it is necessary to remove plate voltage. This is done by removing a resistor from the pc board at a point which is at best impossible to reach. Reinstallation is even worse, calling for at least three hands, long nose pliers, and a truck driver vocabulary. After the Vector terminals are installed on the *bottom* of the board, removal and installation is a distinct pleasure. SB-110A owners please note.

William P. Turner, WAØABI

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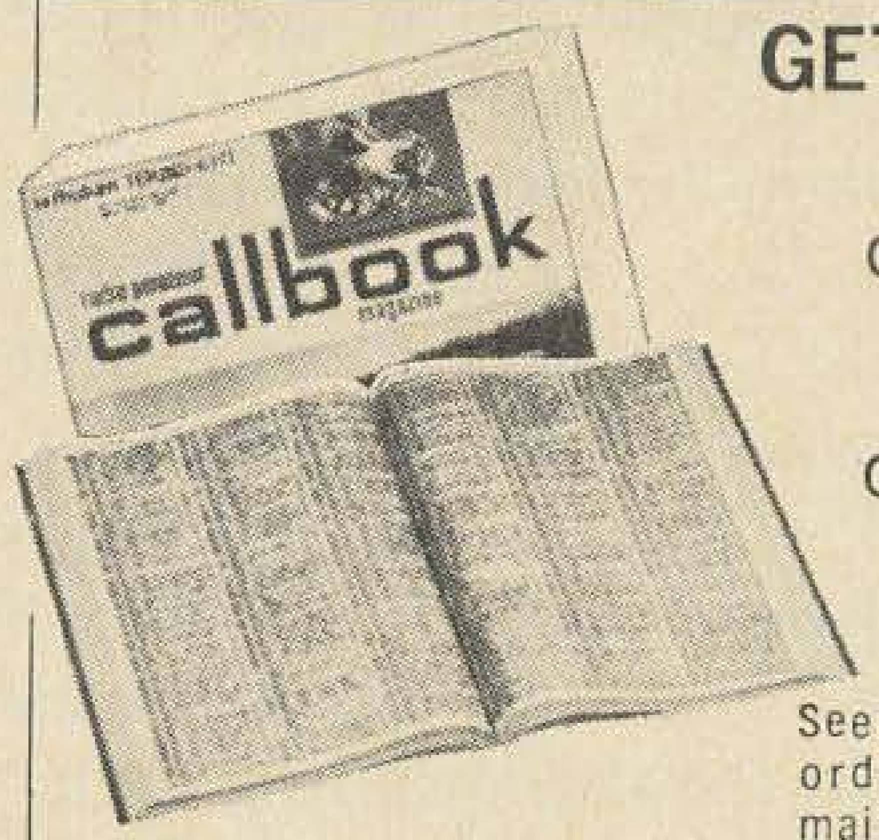

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Converting the AN/VRC-19 Transceiver

S. T. Kelly, W6JTT
12811 Owen Street
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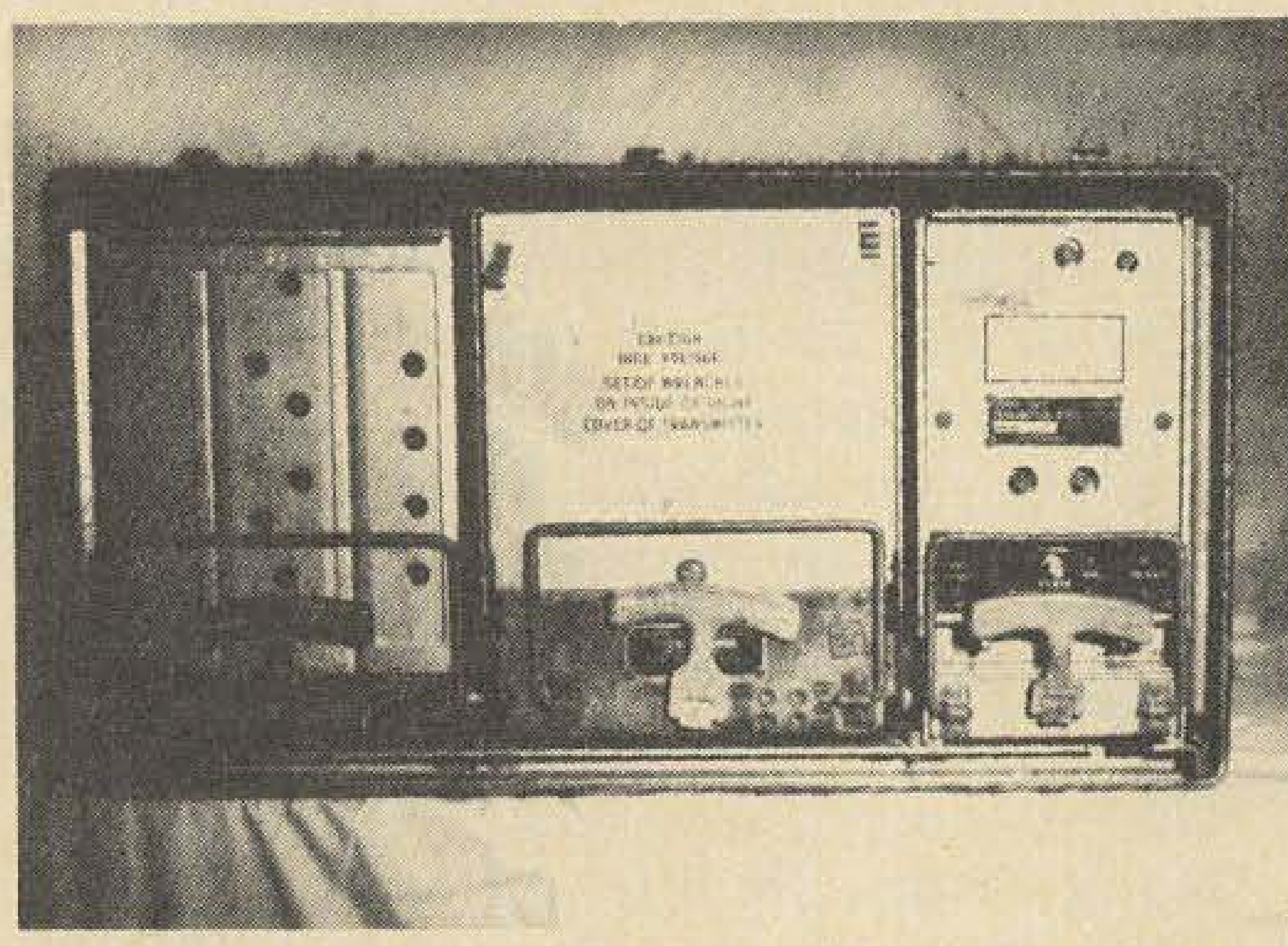
Recently there has appeared on the surplus market, and through MARS channels large quantities of a unique vhf FM transceiver called the AN/VRC-19. The three versions of this set all cover the same frequency range (152-174 mhz), but they differ in their input power requirements. The most commonly encountered version is the AN/VRC-19 X which is the 12 volt model. The set consists of a single case containing a transmitter (T-278/U), receiver (R-394) and a dynamoter power supply. It was originally designed for use in military police vehicles and other non tactical applications. It is of 1950 vintage having numerous sub miniature tubes. Typically, the sets are found without the control head or manual.

Basically, the set is a wide band (15 khz deviation) single channel crystal controlled transceiver with a 30 watt output. The transmitter has provision for operation on two channels providing that they don't differ by more than 500 khz. However, this feature was seldom used and most of the transmitters will be found with the channel 2 1AD4 oscillator tube missing. Also, don't worry if you see a hole for a missing module in the receiver. This is for the re-transmission relay which is normally not supplied.

Getting the set on the air consists of solving two problems–wiring in the controls, and obtaining power. This article will assume that you will use the set mobile from a 12 volt battery.

The fastest way to get on the air is to get a C-847/U control head and apply 12 vdc (at 24 amps on transmit) to terminals 1 and 2 of J-806. The control head has two terminal boards inside. TB-1501 and TB-1502. The terminals on these boards are numbered 1 through 20. Connect these to terminals 1 through 20 of TB-804 and TB-805 in the case (see **Fig. 1**). The C-847 head is rare, so the circuit shown in **Fig. 2** was built to replace it. The controls including a 3" speaker were mounted on a 5¼ EIA panel.



The AN/VRC-19 with the front cover removed. The receiver is the unit on the left.

After assembling and wiring the control panel, you will have to obtain the proper crystals. These should be CR-27's for the transmitter, calibrated for a 32 pf circuit. The receiver uses CR-32 third overtone crystals. The transmitter crystal frequency is obtained by dividing the desired output frequency by 32. The receiver crystal frequency is calculated by:

Crystal freq.=desired frequency(mhz)-7.8/6.

The receiver crystal oven assembly is located in the local oscillator module.

Receiver alignment

After installing the receiver crystal in the oven, turn the power on and allow the receiver to warm up for 15 minutes. Connect vtvm between the LO and GND test points. Adjust the four slugs on the local oscillator module (Z-31, Z-32, Z-33, and Z-34) for maximum negative voltage.

Next, move the vtvm probe to the 2nd *if* test point. Connect a signal generator to the antenna connector and tune it to the desired operating frequency. Adjust the five slugs on the *rf* amplifier module for maximum negative reading on the vtvm while keeping the

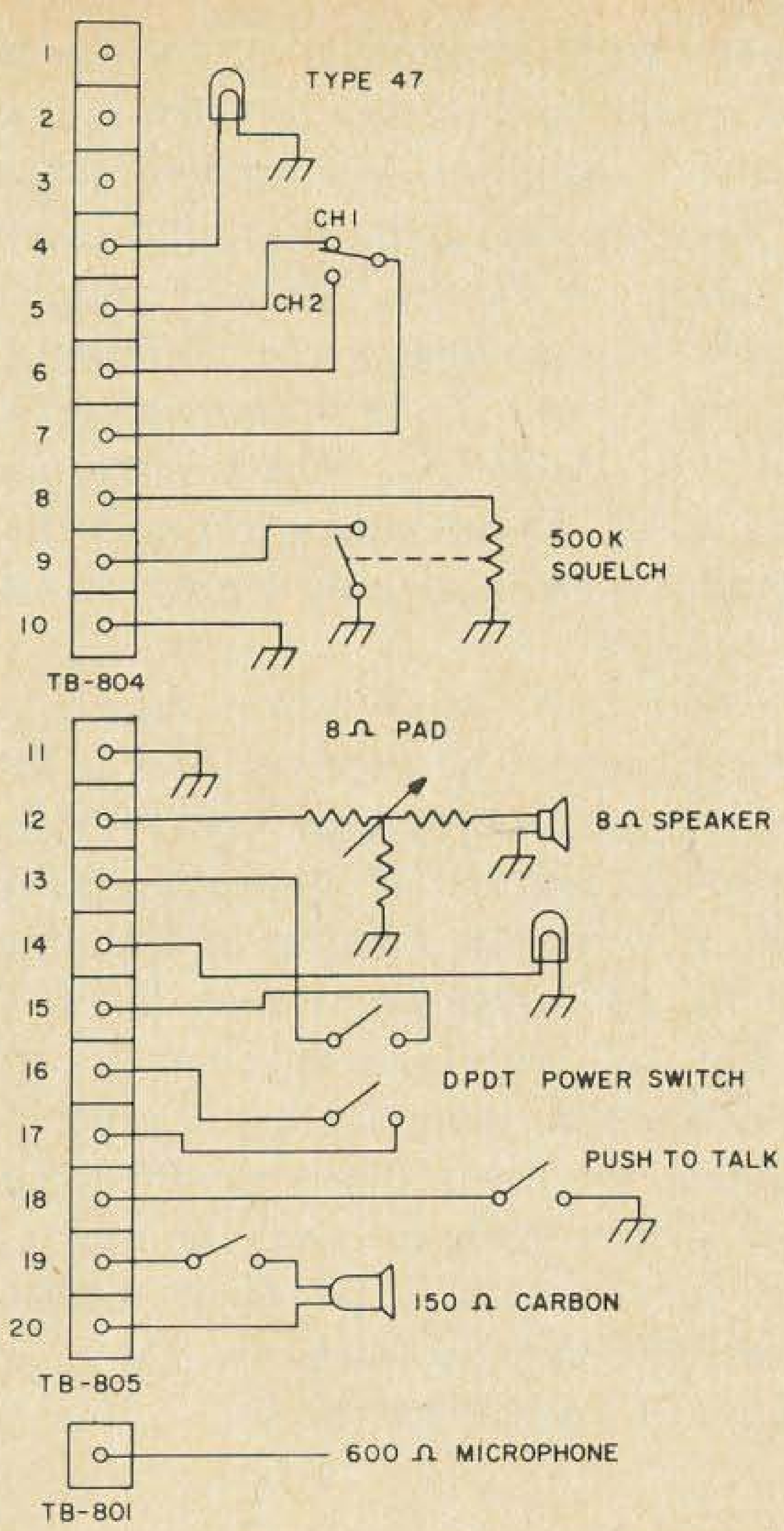


Fig. 1. Control Schematic For AN/VRC-19 Transceiver.

signal generator output as low as possible.

Precise adjustment of the receiver frequency can be obtained, after the above alignment, by connecting the vtvm between DISC and GND test points and adjusting Z-31 (top slug in the local oscillator module) for zero reading on the vtvm when receiving the desired frequency.

Transmitter tune up

First get your hands on cable assembly CX-2371, or build a jumper cable 30" long so that you can work on the transmitter out of the case. Without this it is impossible to align the transmitter.

Remove the dust covers from the transmitter and turn the set on, allowing it to warm up for at least 15 minutes. Set the channel selector switch to channel 1. Turn the coupling control to minimum and place the Tune/Operate switch in the tune position. Set capacitors C-403 and C-404 to their mid point positions. The test/off switch is used to control the transmitter during the alignment procedure. Do not operate the transmitter for more than a few minutes at a time or the dy-

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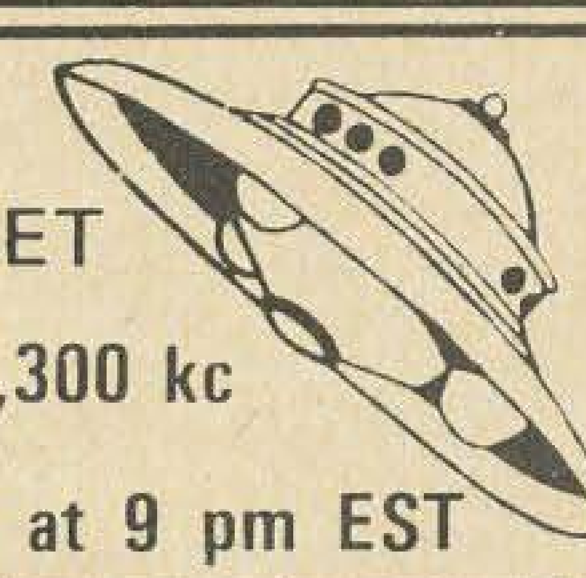
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namotor will overheat.

Place the vtvm probe in J-401 and adjust Z-401 for maximum deflection. Then back it off until it is reduced to 2/3 of its maximum value. The reading should be approximately - 3.5 volts. Next, place the probe in J-402, 403 and 404, adjusting Z-402, Z-403 and Z-404 sequencially for maximum deflection. Place the probe in J-405. Set Z-405 to approximately the same physical setting as Z-404. Adjust C-429 for a maximum reading, then peak using Z-405. Repeat as these controls interact. Replace the dust covers and reinstall the transmitter in the cabinet.

Place the vtvm probe in the driver grid jack and adjust the final grid tuning capacitors C-437 and C-439, and the driver plate tuning capacitor C-436 for maximum.

Set the tune operate switch to the operate position. Place the vtvm across the PL CUR jacks and connect the antenna or dummy load. 2.5 volts is equivalent to 100 ma. Dip the final tank using the plate tuning control, and adjust the antenna tuning capacitor for

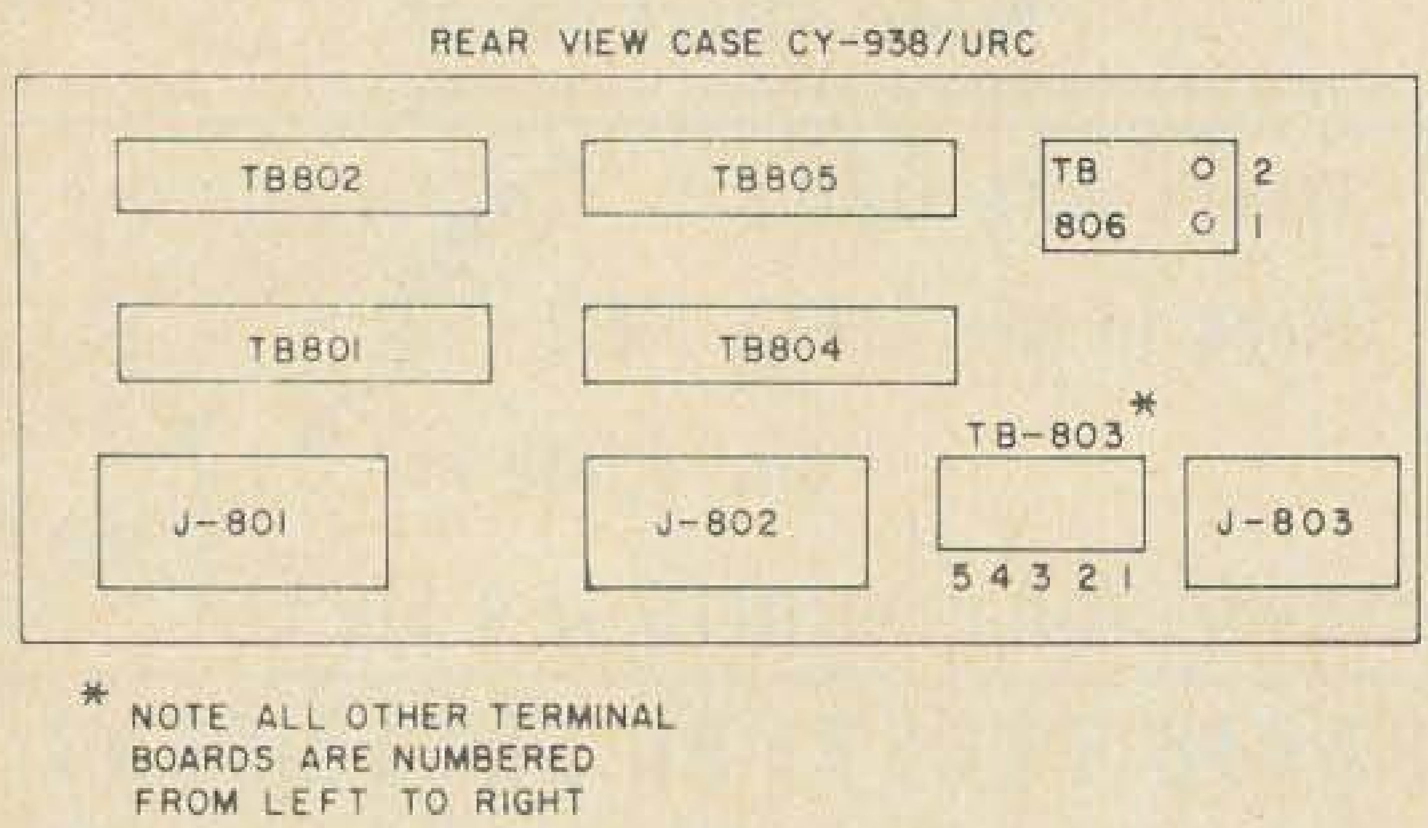

Fig. 2. Terminal Board Locations.

maximum plate current. Increase the antenna coupling while repeating the adjustments of the plate tuning and antenna tuning controls until the plate current reaches 140 ma. Connect the vtvm across the BAL test points. The reading should be 0. If there is a deflection, adjust the final grid controls until a zero reading is obtained.

Precise adjustment of transmitter frequency can be accomplished using C-403 for channel 1 and C-404 for channel 2.

The set is now ready for operation. This set has a unique re-transmission feature enabling it to operate as a repeater. This requires installation of relay assembly K-271, to be plugged into the empty cell in the receiver, and terminals 1 and 10 and 2 and 9 of TB-801 to be jumpered. If you use the set in this mode be sure the squelch is operating, or the transmitter will transmit constantly.

As a matter of interest, the receiver can be used on 60 hz, without modification, simply by unplugging the vibrator and fuse and applying 6.3 vac 4 amps to terminals 4 and 5 of PP-867/U. The transformer is designed for 95 hz operation and the 6.3 V winding is rated at only 1 amp, but it is husky enough.

There is a 110 V power supply available for this set. The receiver uses a PP-846/U and the dynamotor assembly is replaced by a PP-804/U supply. If these supplies are available, it is simply a matter of applying 115 V 60 hz to terminals 4 and 5 of TB-803.

The unit on hand was tuned to operate on 148.01 mhz without any circuit changes. Judging by the settings on the controls, it should be possible to cover the upper portion of 2 meters without padding. Additional information can be found in TM-11-297, the technical manual for the set.

...W6JTT

Rhyme with Reason

"Thirty days hath September, April, June and November..." What would we do without this handy little rhyme to tell us the number of days in the months?

Why wouldn't a rollicking rhyme help us to memorize the many confusing terms and definitions we meet in beginning radio? Does a volt or amp light up the lamp? Watt keeps hot the coffee pot?

In assisting some 75 Novices over the last fifteen years, I discovered these terms or "tools of the trade" to be the hardest thing the student had to learn—and to tell one from the other! And the student must know them well before he can even begin to discuss the fascinating topic of ham radio.

Nobody would think of starting to assemble a transmitter or vacuum tube voltmeter without being able to recognize a screw driver, pliers and soldering iron—plus the ability to use them.

Let's see what we can do with the subject in rhyme right now!

An ampere is a rate of flow
Like gallons in a minute,
A coulomb is how much the pail
Eventually has in it.

A volt, like water pressure
Expressed in PSI (Pounds per square inch)
Is pushing force and is of course
What sends the amperes by.

The ohm, resistance, tries to stop
The ampere as it flows,
Remember how the water slows
In long, long lengths of garden hose?

A kilo is a thousand of, (1000)
Let's learn it right away,
So when you see the FCC
You'll grin and bless the day.

MEG means a million of, (1,000,000)
As everybody knows,
Try writing down the figure 1
And follow with six o's.

A micro means a millionth of, (.000 001)
Be sure you get the point,
Pico one millionth micro,
Both eyes jump out of joint.

For frequency it's cycles, (per sec)
Or hertz these modern times,
It doesn't make much difference
For neither one will rhyme. (Kilocycle now Kilohertz) (Megacycle now Megahertz)

Inductance comes by henrys,
It's like a stretching spring, (Current lags in coils)
Delays the current for a while
But gives back everything. (No power loss)

Capacitance is farad,
It's like that spring let go,
CAPS store up "juice" then turn it loose
To leap ahead and flow. (Current leads voltage wave)

The watt is rate of power used,
Volts multiplied by amps,
It's on appliance name-plates,
Like toasters, irons and lamps.

The joule is simply energy,
One watt per second's time,
Hold on, have patience, this is all,
We'll quickly end this rhyme.

KW meters multiply
Volts push X amps X hours,
And you must pay each thirty days
For energy from power.

Now get to work and memorize
This swinging little rhyme
And you will "best" that Novice test
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The Greatest DX of All!

Old-timers like to tell of the "good old days" when they proved the worth of those useless short waves below 200 meters- -and a newer generation of pioneers can rightfully claim their honors for the first low-power earth-moon-earth contacts on uhf.

It's true, too, that the first working parametric amplifier was built by a ham in his home shop. Even Hertz and Marconi were "amateurs" in the strictest sense of the word, at first anyway, so amateur radio can truthfully claim to have pioneered the art of radio communications.

Unfortunately, as the state of the art has expanded in ever-widening spheres, the cost of experimentation and the depth of knowledge required in order to be aware of just where today's frontiers may be located has made it exceedingly difficult for hams, 1968 model, to maintain the pioneering tradition.

If this bothers you, cheer up! There's at least one major frontier still left open to ham exploration, and it won't cost you the price of a new rig to enter it. Any results you come up with may be as far-reaching in their effects as were those of the earlier generations, and the study may (if you happen to have that turn of mind) be even more interesting than were their efforts.

Interested? Read on.

This one remaining new frontier was first broached in the winter of 1931-32, with publication of an article in the Proceedings of the I.R.E. titled "Atmospherics at High Frequencies." VHF addicts may be interested to know that the original article is followed, in bound copies of the proceedings, by another pioneering study titled "The Ionizing Effect of Meteors in Relation to Radio Propagation"- -but that's outside our subject right now.

The paper on atmospherics reported upon tests made on behalf of RCA at Holmdel, New Jersey, by an engineer named Karl Jansky. RCA's communications network, like all others then and now, had been plagued by atmospheric interference, and Jansky had been assigned to use a sensitive receiver and directional antenna to attempt to locate the sources of this interference.

He located three types of interference and charted all three over a period of several months. One of the three types gave birth to a new branch of science.

In his original report, on page 1930 of the 1932 volume of Proceedings of the I.R.E., Jansky described it: "The static of the third group is also very weak. It is, however, very steady, causing a hiss in the phones that can hardly be distinguished from the hiss caused by set noise. It is readily distinguished from ordinary static and probably does not originate in thunderstorm areas."

Jansky's report went on to describe the arrival direction of the signal and its changing relation to the sun's position in the sky. As the sun's rays became more and more perpendicular at the receiving station, the signal source appeared to move more and more toward the west.

"It would appear," wrote Jansky, "that the change in the latitude of the sun is connected with the changing position of the curves. However, the data as yet only covers observations taken over a few months and more observations are necessary before any

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hard and fast deductions can be drawn."

In this first report, Jansky speculated that the static might come either "directly from the sun, or, more likely, it may come from the subsolar point on the earth."

A second report several months later corrected this conclusion. As the spring of 1932 advances, the source of the unknown signal failed to keep step with the sun's position. It became increasingly evident that the source of this signal was not on earth, or even in the solar system, but somewhere farther out.

Surprisingly enough, the discovery made little stir at the time in scientific circles, although newspapers and network radio made much of the signals from outer space. When Jansky completed his original assignment, his discovery was almost forgotten.

With one exception. A young ham in Wheaton, Illinois, just out of college, found his imagination fired by Jansky's discovery. At the age of 22, Grote Reber, W9GFZ, became the first ham radio astronomer—and for a dozen years, until 1945, he was the only radio astronomer in the world!

By the time Reber was ready to start collecting his gear, several years had passed. The time was late 1936. Considering the state of the radio art at that time, his plans appear almost impossible—yet he designed and built a 31-foot parabolic reflecting antenna, almost entirely from wood except for the galvanized-iron reflector surface itself.

"All the wooden pieces, including the lattice parapet, were cut, drilled, and painted by me personally," Reber wrote in an article prepared for the special Radio Astronomy issue of the I.R.E. Proceedings published in January, 1958. "Part time assistance. . .was secured on the foundations, metal parts, and erecting the structure, with the exception of the skin which I personally put together piece by piece."

Erection of the antenna took him four months, from June to September of 1937. The antenna is still in existence; in 1947 when Reber joined the National Bureau of Standards it was disassembled and re-installed on a turntable near Sterling, Virginia. Some 5 years later it was disassembled and the parts sent to Boulder, Colorado. Since then, it has been made available to the National Radio Astronomy Observatory for exhibition purposes.

Anyone who hopes to be a pioneer by ordering the latest equipment fresh out of a catalog should read Reber's own account; there's room here to cite only the highlights. When the two-ton antenna was completed, the work had barely begun. Some type of receiver, also, was necessary- -and in the mid-30's, uhf had hardly been explored at all. All Reber's first attempts at reception were on a frequency near 3300 mc.

The entire spring and summer of 1938 was spent working at 3300 mc with a variety of receivers, but no repeatable results were obtainable. ' All this was rather dampening to the enthusiasm," Reber reported.

Reluctantly, he decided to come lower in frequency. A new receiver for 910 mc was built, using type 953 and 955 acorn tubes. The cavity resonator for this receiver was a steel drum which originally held 100 pounds of white lead, and the dimensions of this drum determined the exact operating frequency.

The autumn of 1938 and the following winter were spent in a duplication of the earlier year's work, but at lower frequency. Again, W9GFZ found no positive results. "In a measure, it was disappointing," was his reflection 20 years later. "However, since I am a rather stubborn Dutchman, this had the effect of whetting my appetite for more."

"It was perfectly clear," he continued, "that a further great increase in sensitivity

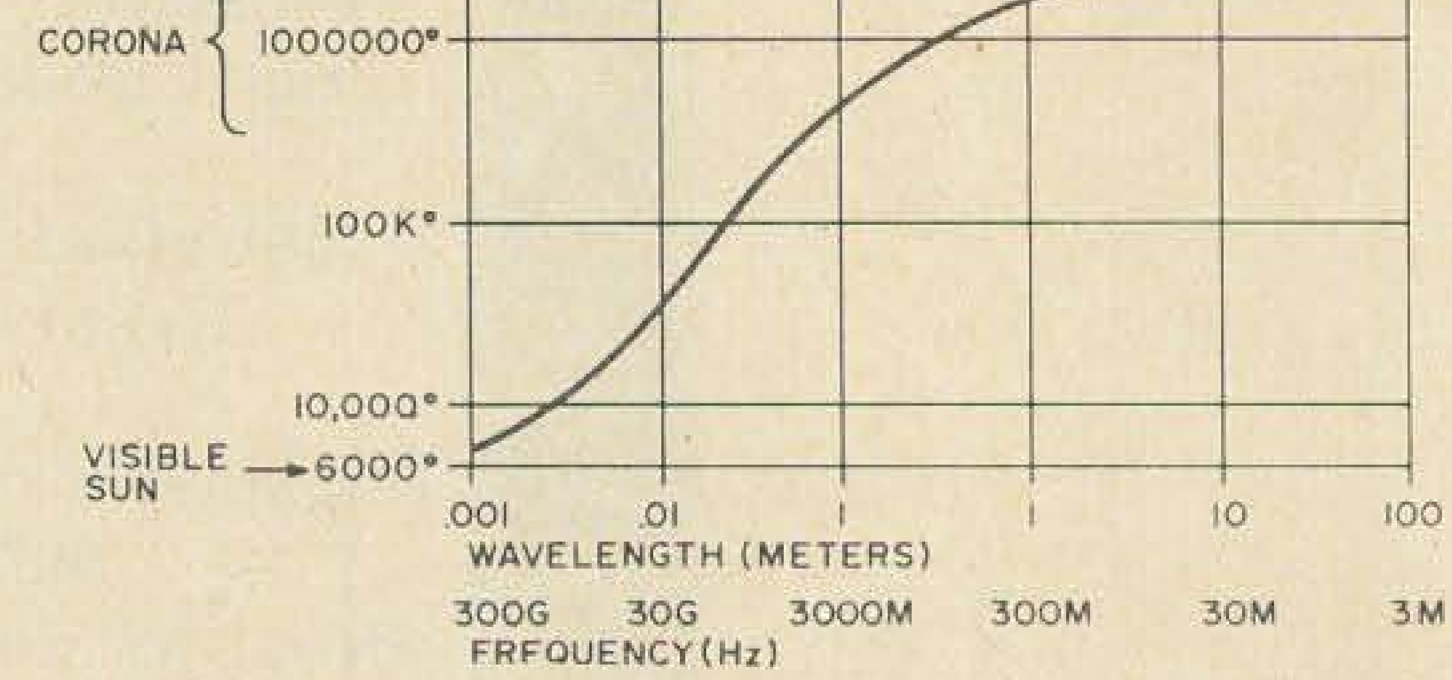


Fig. 1. Comparison of sun's radio-frequency output across hf, vhf, uhf, and ehf frequency spectra. Most hf energy comes from high-energy corona while visible light and heat come from cooler photosphere. Radio astronomers tend to talk in terms of wavelength rather than frequency, thus both are shown here.

was necessary." The only answer to that was to come still lower in frequency. A frequency near 150 mc was selected and a state-of-the-art receiver using type 954 tubes and coaxial line resonators was constructed. It was completed in the early spring of 1939, and on the first Saturday when help could be obtained, was installed at the focal point of the huge dish in the Reber yard.

This time it worked. In early April 1939, good reproducible plots were being secured every night that observations were made. At this stage, the plots were made manually recording signal strength once every minute- -a practice which limited the observations to those hours which Reber could spare from his fulltime employment in the Chicago radio-manufacturing industry.

The only signals which could be located with this setup were those from the Milky Way. In addition, the signals were much weaker than any then-existing theory predicted. Equipment difficulties continued, since the entire project was a one-ham operation with no subsidies from any outside source. Nevertheless, Reber published his first reports in the February, 1940, issue of I.R.E. Proceedings and the June, 1940, Astrophysical Journal.

The success, limited through it was, whetted Reber's appetite, and he immediately turned his efforts toward the making of a complete radio survey of the sky.

With this in mind, he purchased automatic recording equipment early in 1940, and constructed an array of test equipment with which to keep the receiver properly maintained. The survey, at a frequency of 150 mc, was begun in 1941 and results were published in August, 1942.

A world at war had little time for such far-out pursuits as radio reception from space, but Reber stuck with it. Better vhf tubes became available and a completely new wideband receiver was designed and installed. A re-survey was begun in 1943 and published in late 1944.

"When it became apparent, toward the end of 1943, that the situation was fairly well in hand at 160 mc," Reber's recollections continue, "I cast about to see what could be done at higher frequencies to improve the resolution." He obtained some 446B lighthouse tubes in the summer of 1945, and built a 6-stage 480-mc receiver. Observations at the higher frequency began in the summer of 1946, and this series was the last work done from the urban Wheaton location. The following year, Reber joined the NBS as a radio physicist. This final series accomplished two major points: it provided the expected increase of detail in the sky map, and it revealed a completely unexpected phenomonen in the sun's production of radio signals. Both were highly significant.

Meanwhile, in 1942, J.S. Hey in England and G.C. Southworth in New Jersey independently recognized radio signals from the sun during the course of radar experiments. Their reports were delayed for military reasons and Reber's 1944 report was the first published.

When the war came to an end, many scientists in England, Australia, and Europe followed in Reber's pioneering footsteps. Hey himself, is credited with three major discoveries, which is a significant percentage of all the major discoveries so far in this field. The list of those in the field is much too long for this space; progress was paced by Hey, a group in Sydney, Australia, under J.L. Pawset, and another group in Cambridge, England, led by M. Ryle.

By this time, the major emphasis was on high-resolution sky surveys with huge antennas. John Kraus, W8JK, at Ohio State University, made major contributions with a 96-element array of helix antennas operating near 300 mc, and a double reflector array 360 feet long by 70 feet high. The first half of this second array cost $48,000 to build. Installations of this nature, obviously, are out of reach for the individual ham.

Other such installations include several "Mills Cross" antennas in Australia, the 260-foot Jodrell Bank radiotelescope in England, and of course the 1000-foot Arecibo dish scooped out of a mountain in Puerto Rico (which is occasionally used for ham work)!

An Alternate Approach

The year 1958 was designated as the International Geophysical Year, and scientists all over the globe banded together to obtain and exchange data. That year was picked because it was expected to be a sunspot maximum- -and the choice was fortuitous indeed, because 1958 set all-time record for solar activity. Many operators made WAC on 50 mc with the aid of sunspot-induced abnormal F2 skip frequencies.

While the major emphasis of radio astronomers from 1945 onward has been upon deep-space exploration- -the latest significant discovery in this direction is that of the quasars, which may be the most distant objects ever detected- -solar physicists have continued to show high interest in the questions raised by Reber's discovery of "impulse noise" from the sun, and some discrepancies between theory's predictions and the observations of Hey and Southworth.

As any photographer who works with color film knows, the "color temperature" of sunlight is about 5900 degrees Kelvin. That means that the sun radiates light of the same nature as would be expected from a theoretical "black body" heated to 5900 degrees above absolute zero- -and that's the temperature which had been accepted as the reading for the sun's surface.

The interior of the sun is thought to be much hotter, in the tens of millions of degrees, but the surface (as measured by its color) must be about 5900 degrees K.

Southworth's observations of the sun's radio signals agreed with this temperature; he reported 6000 degrees K as the temperature of his signal source.

But a little later the result was corrected to 18,000 degrees, much hotter. Spectroscopic analysis of light from the sun's corona indicated a temperature there, far above the surface, of about one million degrees- -and the radio signals failed to match this.

At the time it occasioned little surprise, since the high temperature of the corona was not widely accepted. But evidence in favor of the million-degrees temperature continued to accumulate.

It was finally discovered that the corona acts as a sort of "leaky shield" for the solar mass beneath it. At high frequencies, the super-hot corona puts out little radio energy while the cooler "photosphere" (the visible portion) produces all the energy which we detect. As the frequency goes down, the photosphere's output drops while the corona's output climbs–and so does the apparent temperature. **Fig. 1** is a graph showing this effect.

And this effect–the usefulness of low-frequency signals in study of the sun- -is the pioneering field still open to today's hams who want to break new ground.

Not all the signals from the sun, of course, are at low frequencies. As shown in **Fig. 1**, they span the entire spectrum of electromagnetic radiation- -including, of course, infrared (heat) and visible light!

Most of the direct-reception methods for high frequencies, however, require precise antenna tracking over small areas of the solar disc. This puts them out of the "reasonable" realm for individual ham effort because of the size of antenna farm required.

The one exceptionally promising area open to the would-be ham pioneer is an indirect method of detecting solar flares by means of "sudden enhancement of atmospherics" (SEA) and "sudden enhancement of signals" (SES).

For more than a decade such studies have been conducted by the American Association of Variable Star Observers, Solar Division. The AAVSO is one of the few amateur (not ham- -rather "non-professional") organizations fully recognized by scientific authorities, and their reports are included in official publications of the Environmental Science Services Administration.

Despite its recognition, the group is relatively small. It has fewer than 100 members. Spark-plug of the project is David

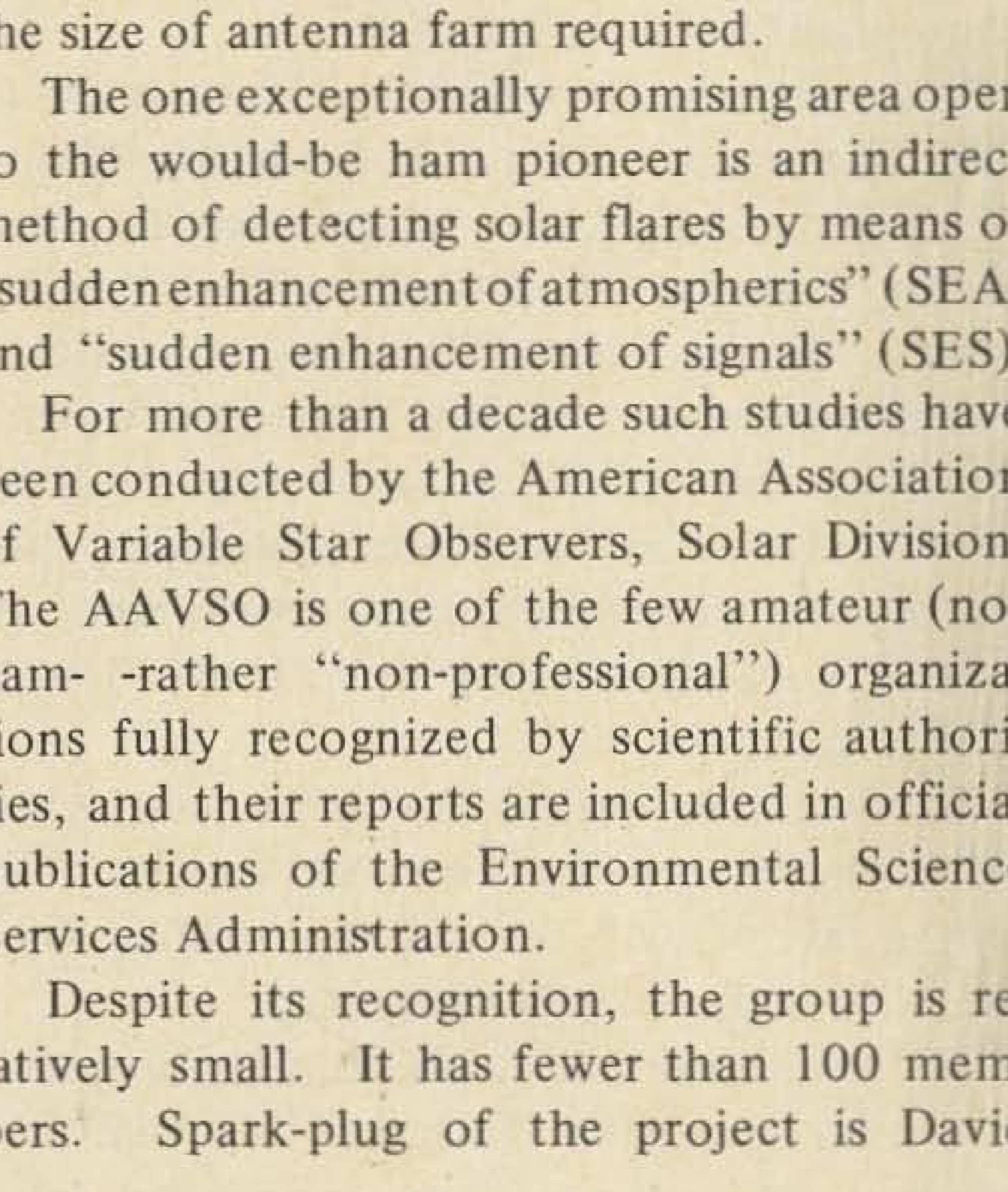


Fig. 2. Schematic diagram of Warshaw solar-flare indicating receiver. Coil L1 is adjustable from 60-130 millihenries while all others are fixed 50-mh units. L4 is a toroid for reduced magnetic field and higher output. Gain is controlled by 15K pot in input circuit; test point is for oscilloscope monitoring if desired. Circuit is relatively straightforward and not particularly critical.

Warshaw, a technical supervisor with ITT World Communications, Inc., whose address is 544 State Street, Brooklyn, N.Y., 11217. If you're interested, he can provide details on how to join.

The major effort carried on by the AAVSO group is a continual recording of SEA and SES effects, as a part of the international Solar Flare Patrol efforts originated during the IGY in 1958. They use, for the most part, a simple transistorized receiver operation at about 27 kc which was designed by Warshaw.

The receiver is merely two stages of tuned rf amplification followed by a detector and a dc amplifier which drives an indicating meter. Most of the observers use an automatic chart-drive recording meter, which is far and away the most costly part of the installation. Fig. 2 shows the schematic of one version of the receiver; several versions are in use.

The VLF method of solar flare detection depends upon the effects of solar disturbances upon the earth's own ionosphere. These effects are believed to be due to x-rays emitted by the flare, which reach the earth at the same time as light. Auroras and magnetic storms, also affected by flare activity, are affected by particle streams which take several hours to reach the earth after the flare. The VLF detection method thus offers some warning of possible magnetic storms.

In the absence of a flare, the ionosphere on the sunlit side of our planet contains the D layer, from 30 to 54 miles above the surface of the earth, which absorbs most low-frequency energy. This is why 80 meters is a short-range band during daylight.

When a flare occurs, the x-rays produce an extra layer of ionization which extends down to about 12 miles below the D layer, and which reflects radio energy instead of absorbing it.

At night, the D layer disappears and the remaining E and F layers reflect. No flares can be detected under these circumstances. Fig. 3 shows the day-to-night variation of signal levels observed in the 27-khz region.

Source of these signals, incidentally, is thunderstorms in the tropics. Enough such storms are in progress at all times to provide a steady source of random vlf energy.

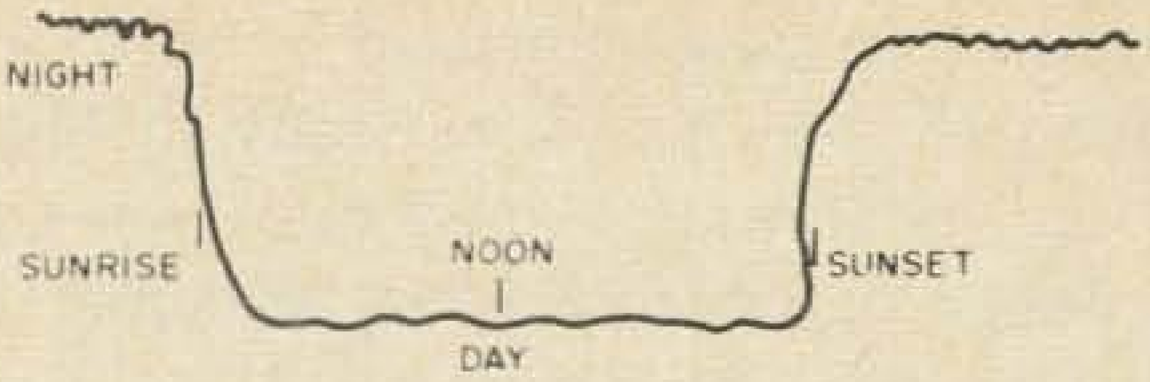


Fig. 3. Day-to-night variation of vlf energy is shown here. During night, signal levels are high with much fluctuation. In day, signal level is very low by comparison. Only the daytime levels are of use for astronomical purposes. Curved appearance of these and following traces is due to type of recorder from which originals were taken. Recordings have been reversed to maintain conventional left-to-right time flow as well; the recorder produces right-to-left tracings with the most recent events at the left.

These are the "atmospherics" of the SEA observations. For SES observations, the receiver is tuned to a vlf transmitter such as NSS, and the changes of its signal level are noted.

Observations of both SEA and SES effects require little effort if an automatic recorder is used. As in all types of radio reception, interference may prove to be a problem. The trace left by an SEA or SES is, however, very different in its appearance from that produced by interference, as shown in Fig. 4 which illustrates several types of SEA's together with interference.

One discovery has already been attributed to the AAVSO observations- -that of a ring of ionization circling the earth at the twilight-sunset junction. This was first observed by Harry L. Bondy, chairman of the AAVSO Solar Division, as a slight dip in the traces 35 minutes before sunrise followed by a hump about 15 minutes later. Bondy's observations were made in 1958. They have been confirmed by all observers in the following years, but as recently as 1965 the University of Natal, Durban, South Africa, reported that "no satisfactory explanation of this phenomenon has been possible." Warshaw on the other hand believes that it is a ring of ionization due to solar energy passing through the upper layers of the atmosphere and illuminating the D region from beneath. causing another and more intense region at the division between the sunlit portion and the earth's shadow. Fig. 5 shows typical tracings of this effect.

Practical Receiver Details.

Although as mentioned earlier a number

of vlf receivers have been used by the AAVSO group, that shown schematically in Fig. 2 is the one most widely used and time-tested. The design dates from 1958, so some of the parts may have been superceded by more recent ones and the transistors specified in the schematic may not be on hand in all parts stores. These should be only minor problems for a true pioneer.

Coils L1 and L2 which form the input circuit for the receiver are pre-wound J.W. Miller items. L1 is an adjustable 60-130 millihenry unit, while L2 is a 50-millihenry rf choke (as is L3). The slug of L1 should be opened two turns from the fully-in position to tune to 27 khz, while L1 and L2 should be mounted about 1/2 inch apart for proper coupling.

Inductance of L4 is also 50 millihenries, but a toroidal inductor is used here to provide best output and reduce stray magnetic coupling which could lead to instability problems. Tuning capacitance for the various tank circuits is provided by the 0.001-mfd series capacitors, so that the base-emitter junctions of the transistors are in series in the tank circuit rather than shunting it as is more often the case.

Lack of base bias may alarm some; the 3K emitter resistors make the emitters more negative than ground, and since the bases return directly to ground through R2 and R4 they are actually forward biased. C2 and C4 provide bypassing of the emitter resistors for desired rf. The final stage is used only as a dc amplifier, while the scope test jack is a handy convenience during tuneup and adjustment. The 0-200 microameter shown is also primarily a convenience, since it is in series with the recorder.

Recommended recorder for use with this receiver is the Rustrak miniature chart re–

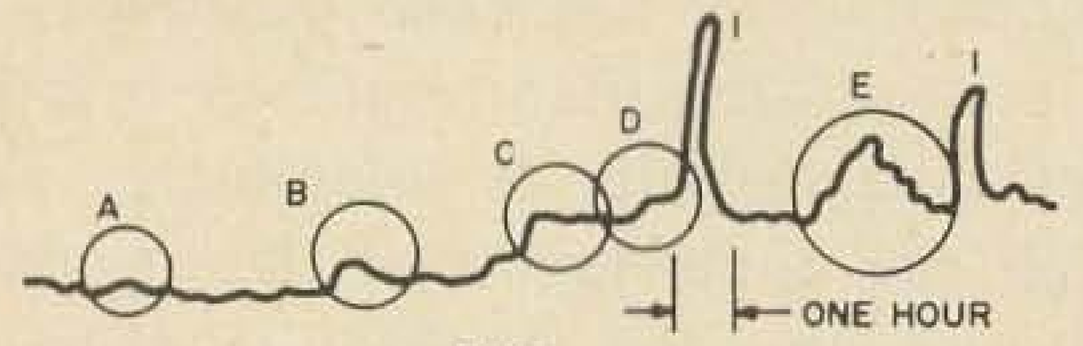


Fig. 4. Differences between traces of SEA's and interference are shown here. Circled records at A through E are SEA's of varying types ranging from almost undectable effect at A through violent symetrical peak at E. Interference traces are identified by I. Note that interference rises and falls much more rapidly than do SEA's; most SEA's last from 1 to 3 hours from start to finish.

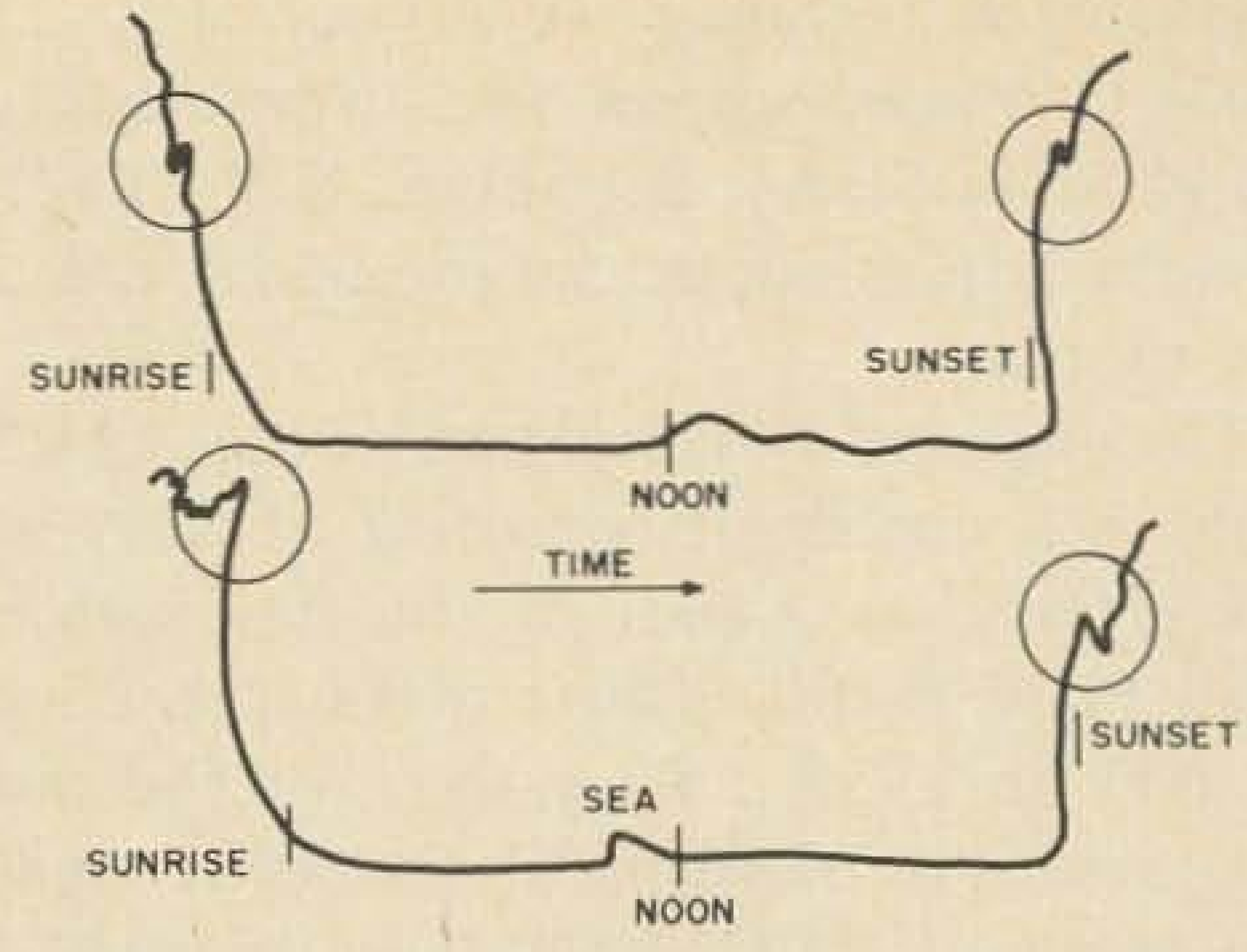


Fig. 5. These two tracings, dating from 1959, illustrate the twice-daily hump-and-dip effect which has not yet been fully explained. It has been observed by all members of the AAVSO team but is not always present. When it occurs, the dip happens about 36 minutes before local sunrise and lasts for some 8 minutes, then signal begins to peak and reaches its highest level about 20 minutes before fading. Similar timing is present at the sunset phenomenen. Some correlation with weather patterns has been noticed; the effect fails to appear on extremely cloudy days.

corder which comes in 0-50, 0-100, and 0-200 microamp sensitivity ratings as well as in more rugged sizes. The 0-100 microamp unit is the one most observers use; gain can always be cut down to stay within this range.

The recorder is sold by Allied Radio, but is listed only in their industrial-electronics catalog. Cost of this unit is about $95, making it far and away the most costly part of the entire setup- -but it does permit continuous recording of up to 31 days of observations, 24 hours a day, without the need for any human intervention.

Cost of the rest of the receiver should not exceed $20 even if all items are purchased new; most junkboxes can furnish at least half the required parts and many can supply all, since almost any transistor will amplify at 27 khz.

It wouldn't be fair to omit mention of problems you are likely to encounter if you try this. One of the greatest is that of electrical interference. Sparking electrical appliances put out sharp gobs of energy in this region, and the receiver is broad enough in its tuning to also be subject to trouble from the 31.5-khz second harmonic of TV horizontal sweep circuits. Both these problems can usually be cured by moving the antenna, sometimes as little as 50 feet making the difference.

The antenna itself should normally be as long as possible, but no one expects to be able to put up a 27-khz rhombic in most locations. Fortunately it isn't especially critical.

Other Facets.

While vlf observations of SEA and SES effects is one area of radio astronomy in which activity is heartily welcomed, it is by no means the only possible area which might prove interesting.

Jansky's original observations were made at a wavelength of 14.6 meters- -or about 20.5 mhz, very close to the present 15-meter band. Much other observation in the ensuing years has been done in this same region.

The sun is not the only member of our planetary system which transmits radio energy. In 1955, B. Burke and K. L. Franklin unexpectedly discovered that the planet Jupiter was a strong, sporadic radio source at 22 mhz. The signals from Jupiter appear to peak in strength around the 15-meter band, and are extremely weak when the frequency gets up to 38 mhz. These signals are rather sporadic; in the first four years during which they were observed they were found up to 22 percent of the time at 18 mhz, down to as little as 1.5 percent of the time at the same freq - uency but a different period. They may be connected with the sunspot cycle in some unknown manner.

Radiation has also been detected from Saturn, but it is too weak to be picked up without the huge professional antenna systems. Again, it appears to peak around 15 meters.

W8JK at the Ohio State University radio observatory has reported reception of signals from Venus in the 11-meter region, but they were even weaker than the Saturn signals and other professionals were unable to locate them immediately.

Of all these signals, none is stronger than the general "galactic noise" static discovered by Jansky, and only those from Jupiter reach that intensity- -which is in the neighborhood of 1/10 micro-micro-microwatt per square meter per cycle-per-second bandwidth! That is, 1 x 10-19 watt/meter -2/(cps)-1.

The sun's signals, on the other hand, are some 10,000 times stronger than this, or one milli-micro-microwatt per square meter per cycle.

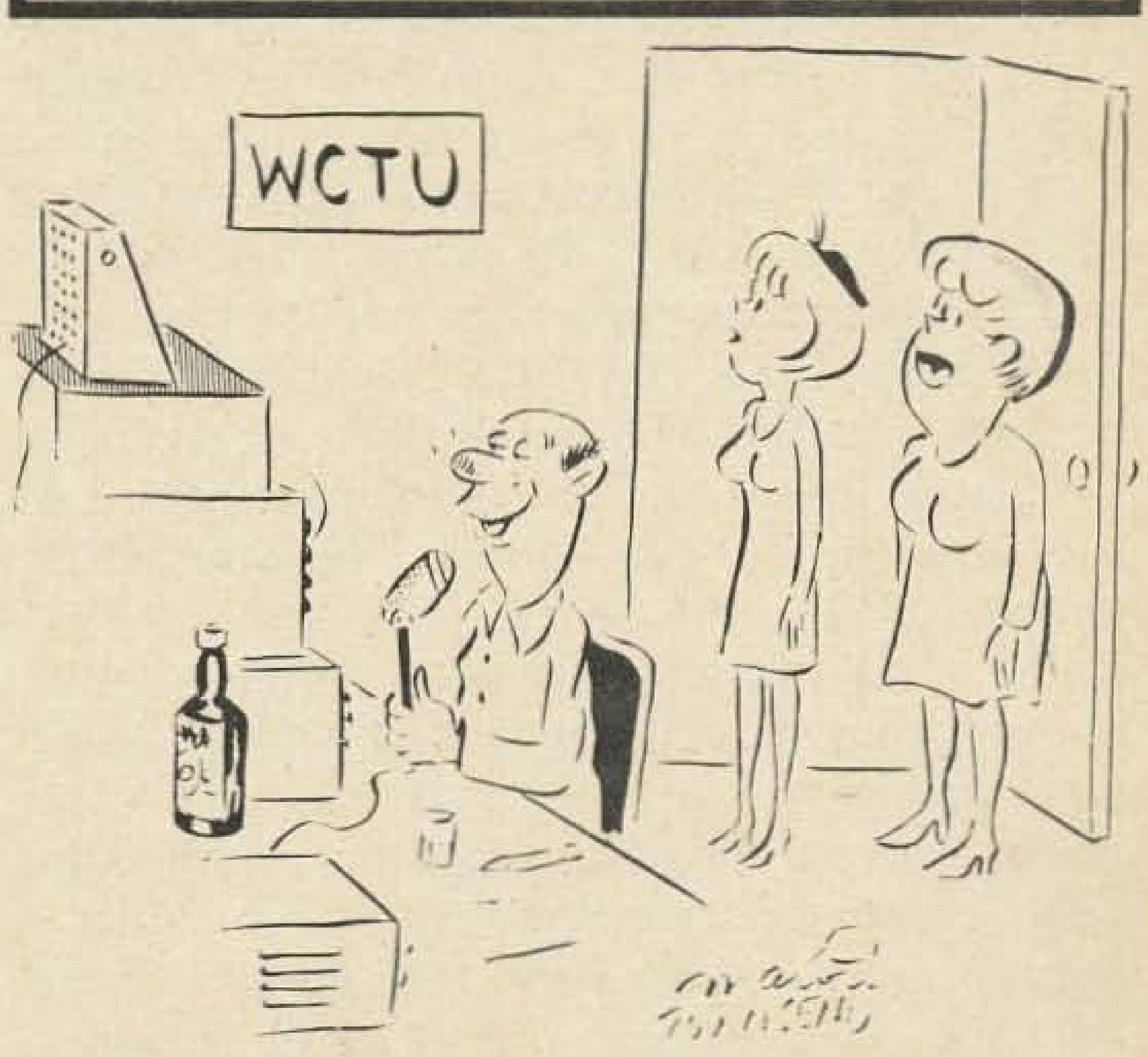
In both these sets of figures, the "square meters" refer to effective antenna aperture while the cycles per second refer to receiver bandwidth. For the sun's signals, this means that a receiver connected to an antenna one meter square with a bandwidth of 1 cps would receive one milli-micro-microwatt of energy (to an oversimplified approximation). Increasing bandwidth to 1000 cps would reduce the energy a thousandfold, while increasing antenna size to 100 square meters (10 by 10 yards, for example) would increase signal by a factor of 100. No matter how you slice it, these signals are pretty weak.

However, if you're tired of the DX rat-race or just looking for something new, you might give it a whirl. The DX available in this field is the most distant of all- -and Reber himself explained his initial interest in it as being because "after contacting over sixty countries and making WAC, there did not appear to by any more worlds to conquer."

. . .K5JKX

Errata

In VE3CEA's article on the Antennascope, May, 1969, issue, page 36, in the example quoted, change the 66' figure to 33'. Overall length was 66', not the legs. *(Do a better checking job, Ross - Ed).*



"Of all people to get those call letters!"

T. W. Banks, K3LNZ
426 Orange Street, S.E.
Washington, D.C. 20032

Intelligent Tube Substitution

Sooner or later, any ham finds himself in a situation where a vacant tube socket must be filled, and not with the same type tube. Examples would be (1) during a contest when Murphy's Law dictates that the only tube to burn out will be the one for which there is no spare, (2) a desire to "soup up" a piece of gear, or (3) it's so old it's hard to find a replacement. I have been all three routes, so present herewith my advice on selecting suitable substitutes.

Basic Principles

Probably the first consideration is that the replacement tube should fit the socket which awaits it. This is easy when one considers that standard codes have been provided for the various base connections. For example, reference to almost any tube manual will show that base 9A is used for the 12AT7, 12AU7, 12AX7, and quite a few others, all of which will prove to be twin triodes of varying amplification factors and other things. The next consideration is that one should stick to the same general class of tube such as "remote cutoff", "sharp cutoff", etc., otherwise there will be troubles with blocking, poor avc action, and so forth. Last is the knowledge that there is "nothing new under the sun". Example, a triode with a 2.5 volt heater known as a 56 evolved into a 6.3 volt type 76, thence (getting a little hotter) into the 6C5 octal-based variety, and still later into the 7-pin miniature 6C4. At the same time, "two in one" varieties 6SN7 and 12AU7 came along. Similarly, 6AU6, 6SK7, and most sections of modern multiple-section tubes can be traced back to familiar varieties of a few years ago. In other words, some browsing around comparing tube characteristics will supply you with a gold-mine of information for emergency use. All that follows are a few hints to aid in your search.

RF and IF amplifiers

Here is where the object is most often to get more gain and/or better noise figure out of an existing receiver. Explore carefully the range of cascode dual-triodes and *rf* amplifier pentodes (don't forget cutoff) and you'll find that the 6BQ7, 6BK7 and 6BZ7 are all one family – but nowadays a 6BS8, 6ES8 or 6DJ8 will be used, and justifiably so anywhere above 20 meters or so. Pentodes will run in families, but will almost always have one of two base connections, 7CM or 7BK. A look in the book will show these two are identical except for pins 2 and 7 to which the cathode and suppressor grids are connected. To make a switch from a 6AU6 to a 6CB6, which is a good (and useful) example, simply reverse the connections to pins 2 and 7. Yet a third family, 7BD, has both these pins tied together, so offers even more choices as long as the cathode and suppressor are (or can be) tied together. In any of the above cases, whether triodes or pentodes, the object would be to find a substitute with equal, or nearly equal, voltages on G1 (and G2, if a pentode) and equal, or higher, transconductance depending on whether you want equal or hotter performance. In the older tube types, 6SK7, 6SJ7, 6BA7 and 6AC7 all use the same base, and again offer varying degrees of "hotness".

Frequent Burn-outs

Now and then a tube is run too close to it's maximum ratings in a particular piece of gear and therefore quits with appalling regularity. Here is a situation where the book will often disclose a substitute which will do the same job, but not work so hard in the process. A good example (although you have to change sockets) is the 6BQ5 for an over-worked 6AQ5. Some direct replacements are the 12BH7 for the 12AU7 and the 6EA8 for a 6U8, the latter giving better results either as an oscillator/mixer or in Class C *rf* amplifier/multiplier service.

Rectifiers

The modern trend is to use solid-state diodes, which give more B+ due to lower voltage drop and don't require 10-20 watts of filament power. But what do you do when one goes west? The best way is to install sockets, provide the necessary filament voltage, then use one of the plug-in replacement units available. In a pinch, a tube may be pressed into service. If you build this way, or are already using tubes, you will find that the 5Y3, 5R4, 5T4, 5U4 and a host of less common varieties all use the 5T base. By wiring for this base, but then also tying pin 3 to 4, 5 to 6 and 7 to 2, even more types such as 5W4 and 5X4 can be used. Note that at any rectifier socket of the octal variety, the B+ should always be taken from pin 8, since that is where the cathode is connected on such types as the 5V4. At higher power levels, the 3B28 turns out to be a vacuum, and therefore less noisy, replacement for the mercury-vapor type 866. The replacement can therefore be made in the other direction when necessity demands something be done to stay on the air.

RF Power Amplifiers

There is frequently an urge to get some more signal out of an existing transmitter, usually at a lower power level, which is just as well since replacement of larger tubes usually involves complete rebuilding. If you have sufficient B+ available, a 6146 will replace a 2E26, or the newer type 6146B will handle still more power, and such a substitution will make a pretty big difference. On the other hand, you can go the opposite direction in an emergency, which certainly isn't any improvement, but beats going off the air entirely. The twin-tetrode family offers a fertile field for tube-swapping if you operate VHF, since the 6252 replaces the 832 and the 5894 replaces the 829 directly, and will operate much more efficiently to boot. There is also an in-between model, the 6524, which is bigger than the old 832 but smaller than the 829 or 5894. If you operate the lower bands, you might be interested in knowing that the old 815 is a pair of 2E26's in one bulb.

Making the Job Easy

The correct way to replace an obsolete, or otherwise un-wanted, tube is to install a new socket and re-wire for the substitute. I don't know how many conversion or modernization articles I have seen which say, "remove the old octal socket and mount the new 9-pin socket on a metal plate....." Don't you believe it! *Amphenol* makes nifty 7 and 9-pin miniature sockets that mount directly in the hole vacated by a ring-mounted octal, or even older, socket. However, there are times when you have to make a replacement in a hurry and/or don't care to dig into a bunch of old wiring. The solution in this case is an adaptor. Break the old tube and clean the glass out of the base, then heat the pins and shake out the old solder and wires. Make the necessary connections to whatever socket the new tube requires, bring the wires to the correct pins on the old base (using plenty of "spaghetti" sleeving where wires must cross) and plug the finished adaptor into the original socket, then the new tube into the adaptor. This is also a good way of trying out certain modifications, such as a cascode replacement for a pentode *rf* stage. If it doesn't work, or if you're afraid of lowering the re-sale value, just remove the adaptor and everything is the same as when you started.

Adding a Stage

There are many times when an additional tube would come in handy for a Q-multiplier, S-meter amplifier, bfo, more audio, noise-limiter, or a zillion other things. Here again, the solution is to dig around the tube characteristic charts until you find a near or exact replacement for one of the tubes presently in use, plus another section that will do the extra job you want done. A much-used trick is to substitute a 6S8 (octal) or 6T8 (miniature) for a 6SQ7, 6SR7, 6AU6, 6AV6, etc. diode detector and 1st audio. This gives you two more diodes for use as a noise limiter, avc, or what have you. An even better trick is to replace the diode detector with a 1N34 solid-state diode, then install a dual tube to replace the 1st audio stage and give you another tube for some additional function. The usual conversion information on the ARC-5 receivers tells you to rip out the bfo and convert it to an additional audio stage. Why not install a 1N34 for the diode that was in the original 12SR7, then rewire the socket for a 12SL7 and have your bfo and audio too?

In conclusion, there isn't a tube built yet that doesn't have an equivalent in another package, or a near-equivalent in the same package. Read the specifications, and you'll find that the sky's the limit on substitutions.

...K3LNZ

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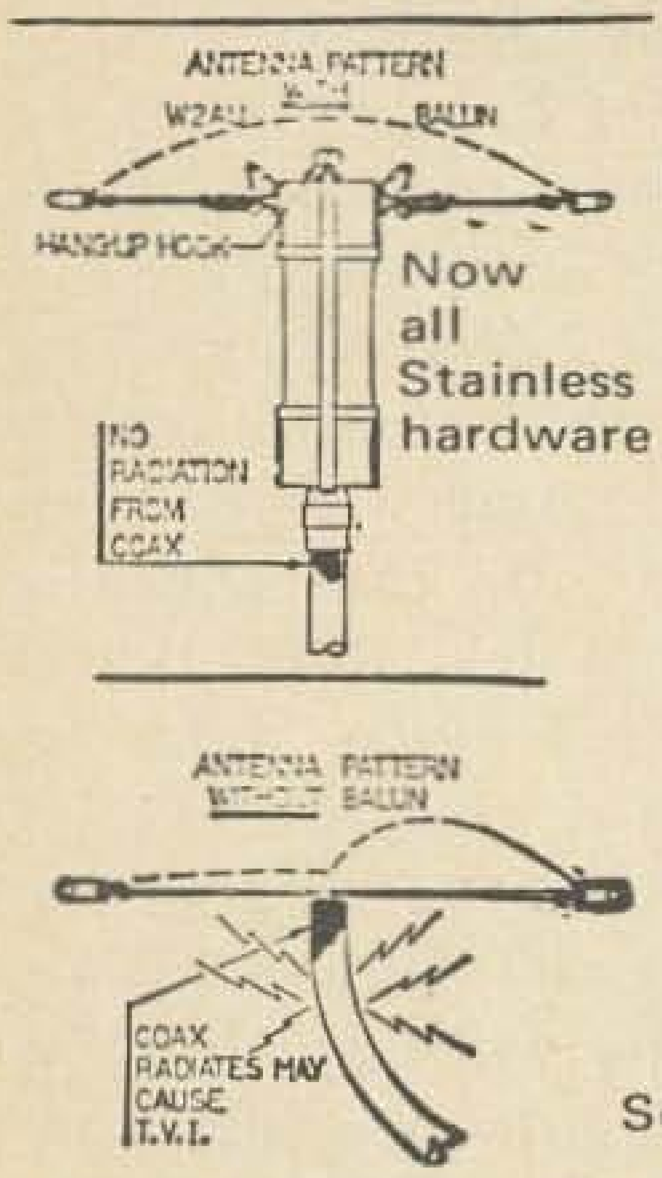

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Each section of your decade need contain only 4 resistors, the values are 1, 2, 3, and 4 times the section multiplier. If you need seven ohms, open the switches across the 4 and 3 ohm resistors (or 4, 1, and 2).

In each succeeding section the values are increased by a factor of ten, for example, the hundreds section is made up of 100, 200, 300, and 400 ohm resistors. A total of twenty resistors are required along with 20 good quality switches. With this complement, it is possible to select any resistance from 0 to 111,110 ohms in one ohm steps.

By now you have calculated the cost of 20 resistors and switches. To be sure, they are not cheap, but by buying in this quantity it is possible to get good switches for about 20 cents each. The resistors are another problem, the normal catalog price being 35 to 40 cents each. By careful shopping in the bargain houses, it is possible to reduce this by at least 50% if not more. McGee Radio Co., 1901 McGee Street, Kansas City, Missouri, advertises a kit of 10 watt resistors in 100, 200, 300, 400, and 500 ohm values for only 59 cents. The same company also sells the same deal in values of 1K to 5K at the same price. These resistors alone will allow a decade covering 100 to 10K ohms in 100 ohm steps and would require only 8 switches.

The switches are wired in series with the resistors across the normally closed switch contacts. The desired value is selected by removing the short from the desired resistor by means of opening the switch.

The entire assembly is mounted in a chassis or other case, the size of which is dictated by the physical size of the components selected. Connections are made through your choice of terminals, binding posts, clips, or what have you.

In use, the leads from the decade are attached to the circuit under development and the switches adjusted for the desired result. It is best to start at the high resistance condition and work down in order to prevent damage due to over voltage or current. The value may then be read off the decade and a fixed resistor of the proper value installed.

You will also gain an extra advantage in that your resistor supply won't look as if they had been used over and over again.

William P. Turner, WAØABI

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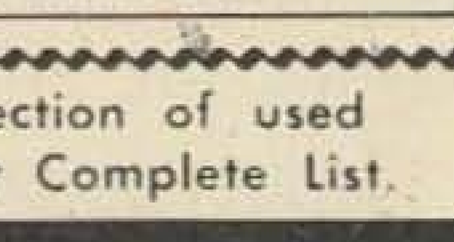

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Passive Reflectors for Amateurs

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A state-of-the-art technique to increase your effective radiated power at microwave frequencies without receiver or transmitter circuit modification.

An often overlooked method in amateur circles, and even in the professional engineering society, of increasing the effective system gains at microwave frequencies is through the use of the antenna/reflector system. This system uses a parabolic antenna colocated with the transmitter-receiver and a remotely located plane faced reflector. **Fig. 1** diagramatically illustrates the arrangement.

Depending on various factors, such as operating frequency, antenna/reflector spacing, antenna diameter and reflector size, gains upward of 4 db to 5 db are easy to achieve in a practical arrangement. This is gain over and above the antenna gain available using just the parabola.

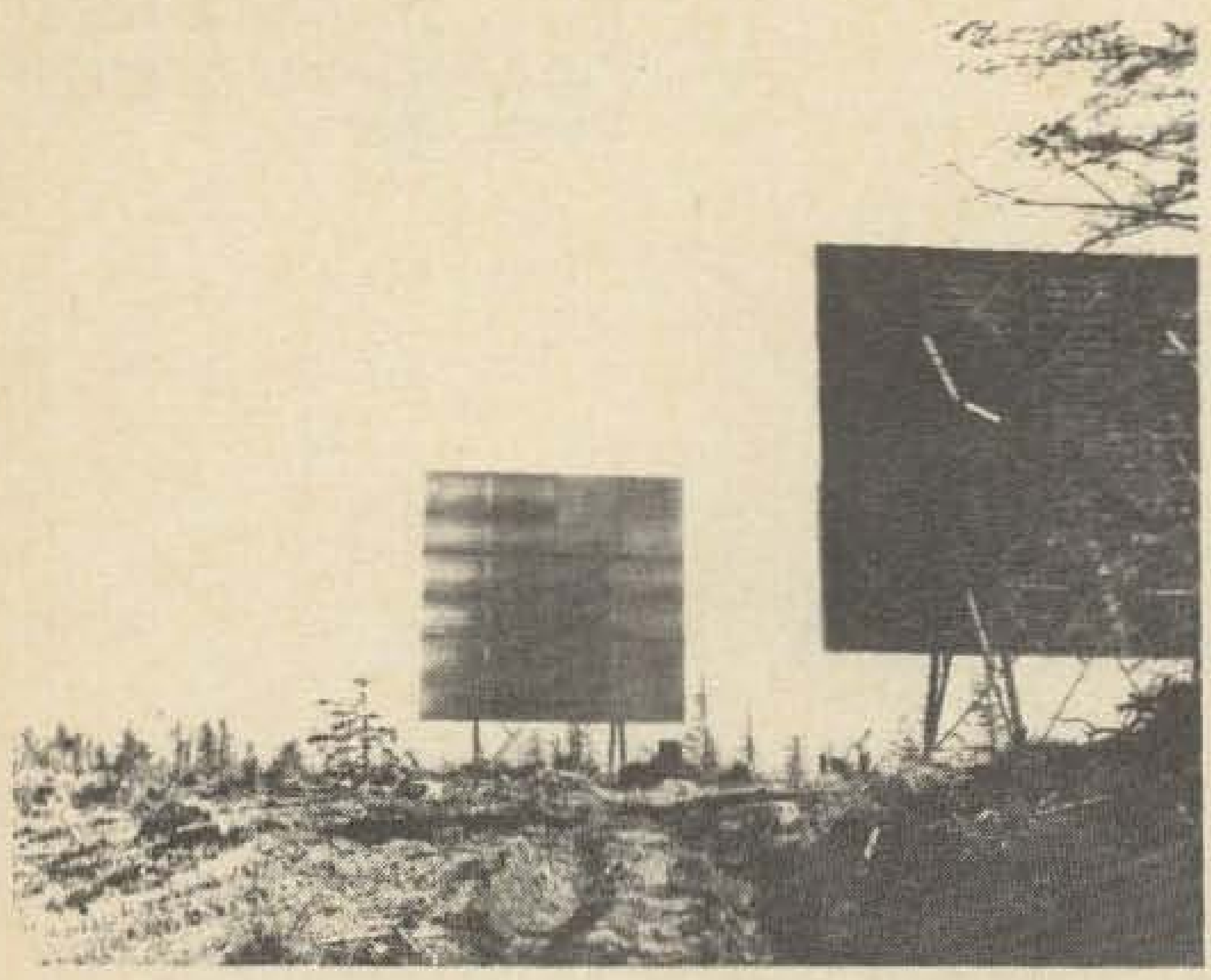
Commercial microwave systems, carrying as many as 960 simultaneous voice conversations or one video program or thousands of channels, use giant radio mirrors such as the one above. (Photo courtesy Microflect Co., Inc., Salem, Oregon.)

Before going into the techniques of calculating antenna/reflector combinations, there are some other advantages available through their use, that bear a little discussion.

Suppose your microwave equipment is all peaked for performance. A hill, mountain or other high projection has been found that provides proper microwave path clearance* to a location with which you wish to communicate. However, power may not be available at the exact spot you want to use. And, perhaps an access road doesn't exist, so you can't get portable power up to the site. One solution would be to locate the microwave gear down low and run a long transmission line (usually high loss coax! What ham can afford an expensive and sensitive waveguide?) up the hill and mount the parabola at the top of the tower or on the roof of the building on the hill.

This very thing is often done in the common carrier, public safety, and industrial radio services except waveguide of one type or another is generally used. Even so, the ingenious microwave engineer often uses the reflector technique because it offers lower losses, and is generally less expensive. The reflector technique also allows the active equipment to be located at just about any point within a wide area. Of course, the reflector must be optimized for performance each time the active terminal is moved.

*Amateur Microwave Propagation, Ray D. Thrower, 73, November, 1966.



This double radio mirror redirects a microwave beam carrying 600 simultaneous telephone conversations from an active terminal 25 miles away to another active terminal 6.4 miles further on. It provides a 39.5 db fade margin in the 6 ghz common carrier band. (Photo courtesy Microflect Co., Inc., Salem, Oregon.)

One additional advantage that receives much consideration in the western states, where high mountains and deep winter snows are not compatible with mountain top microwave repeater stations, is the fact that the reflector may be placed up high while the active equipment may be placed at a low elevation where it enjoys year around accessibility. This way, one can enjoy the availability of amateur microwave propagation testing or communication on a year-round basis.

Transmission line is part of antenna system

The main drawback to direct mounting a parabolic antenna a long distance from the active equipment is the transmission line. The transmission line must be considered a part of the antenna system since the length of the line will affect the overall efficiency of the antenna. In **Fig. 1**, the overall length of the transmission line is 205 feet for the remotely located 10-foot parabola. The gain of the 10-foot parabola at 2.3 ghz is 34.5 db. However, commonly available 7/8" coaxial transmission line has a loss of 3.3 db per 100 feet. 205 feet of this line will have a loss of 6.8 db. This loss must be subtracted from the antenna gain (34.5 db) to obtain the antenna system gain which is 27.7 db.

Using the antenna-reflector

Converting the direct mounted parabola with its long transmission line to an antenna-reflector arrangement will provide a more efficient system as can readily be seen by looking at **Fig. 1**. It is necessary to use only a 6-foot parabola to achieve equal or greater gains than with the 10-foot parabola.

A 6-foot parabola has 29.9 db gain at 2.3 ghz. With only 20 feet of transmission line there will be only 0.7 db transmission line loss. Then, if a 10x15 reflector, elliptically shaped, is used and if the slant distance between the parabola and reflector is 121.7 feet, there will be 1.9 db Near Field coupling gain. So, adding all the gains and losses, we find an antenna system gain of 31.1 db which is 3.4 db greater than with the direct mounted 10-foot parabola. This is better than double the effective power and well worth the effort.

Calculations

The above comments and statements are just that. It now becomes necessary to provide curves and charts and the method of their use to prove the numbers just mentioned.

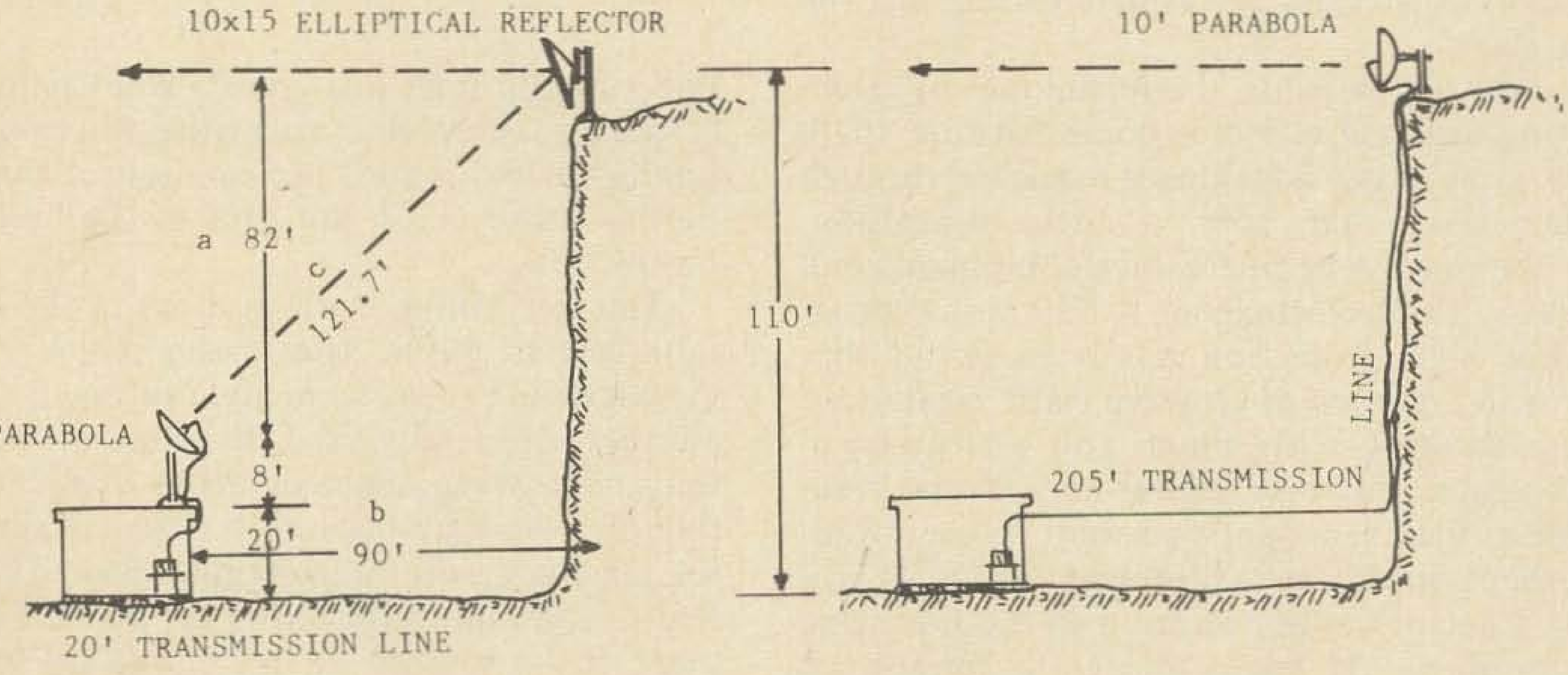


Fig. 1. Two methods of radiating a 2.3 ghz signal. "Periscope" system at left has effective antenna system gain of 31.1 db and is less expensive than its direct mounted counterpart which requires a 10' parabola and provides only 27.7 db gain. The example at left is often called a "Skewed" periscope shot.

Figs. 2, 3 and 4 take most of the work out of calculating the requirements of antenna-reflector combinations. Fig. 2 will be used in two basic ways. One way, using standardized size elliptically shaped reflectors and with the reflector mounted directly above the parabola (or any arrangement where the angle formed by the two beam paths is 90° ± 5°, (as shown in Fig. 5) will use the complete chart of Fig. 2. Assuming a 12x17 reflector, spaced 190 feet from a 6-foot parabola, and an operating frequency of 2.3 ghz, we would proceed as follows: Refer to Fig. 3. Determine the value of φ. With a 6-foot parabola and 12x17 elliptical reflector we will have a value of 0.5. Note this number and retain it for a moment. Going to Fig. 2, enter the graph on the bottom right hand side at 190 feet (the distance between reflector and parabola). Read up to the reflector size (12x17). At this point, read left horizontally until you intersect the curve corresponding to the frequency of interest, 2.3 ghz (curves for other frequencies may be computed using the formulas shown). Now, read vertically up until you intersect the φ curve corresponding to the number noted earlier (0.5). Again, reading horizontally to the left, read the gain or loss in db. Here, we will have about 0.1 db gain.

Adding up the gains and losses (remember, a 6-foot parabola has 29.9 db gain), we find the antenna system, with 20 feet of transmission line of the type previously mentioned, will give us a gain of 29.3 db. (29.9 db antenna gain + 0.1 db Near Field Gain − 20 feet coax at 2.3 ghz; 0.7 db).

As mentioned before, the above is to be used when the so-called "periscope" antenna arrangement is used. In offset arrangements, as in Fig. 1, it is necessary to perform a few calculations.

"Skewed" shot calculations

Using the parameters of Fig. 1 at 2.3 ghz there are three things we must determine before we can perform the necessary calculations. First, the slant distance from parabola to reflector. The old ($c^2=b^2+a^2$) method works very well here with the right triangle, and you will find that for Fig. 1 the distance is 121.7 feet.

With this distance determined we are ready to calculate the angle formed by the two paths (parabola to reflector and reflector to

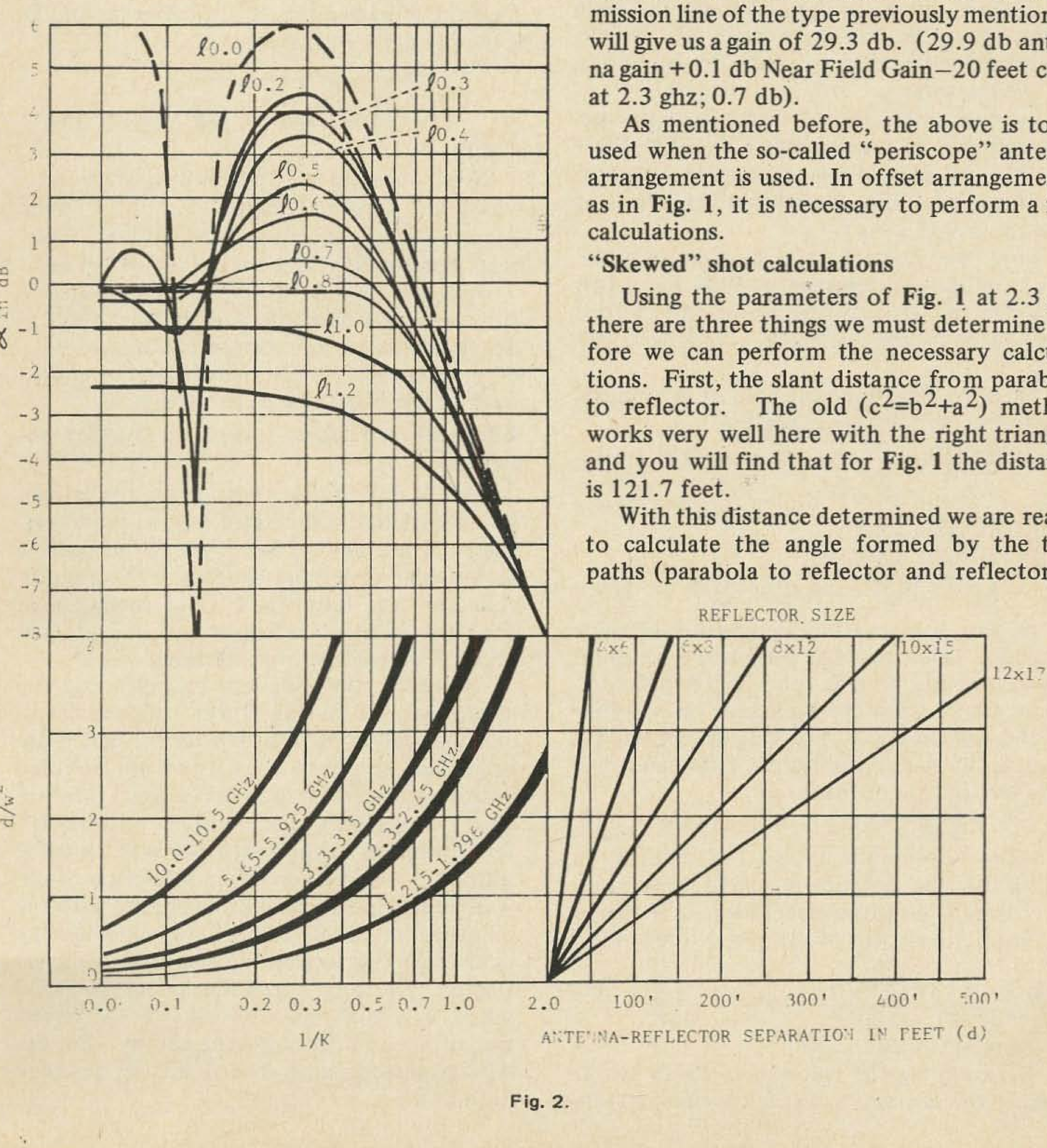


Fig. 2.

far terminal). Using the base line of 90 feet and the slant distance of 121.7 and working with the cosine function, we have cos Θ $\frac{b}{c} = \frac{90}{121.7} = .740$. Referring to a book of Trigonometric tables we find .740 is represented by an angle of 42° 44'. We refer to this as the vertical included angle.

With this angle determined, we can now calculate the final item required before getting into the real calculation of the antenna-reflector system.

The effective area of the reflector must now be determined. The effective area will be something less than the actual area depending on the angle at which the reflector is viewed by both terminal parabolas. Since the angle of reflection is equal to the incident angle, the angles for both paths will be the same and the effective areas in both directions will be the same.

To determine the effective area we use one-half the included angle. So, $\frac{42° 44'}{2}$ = 21° 22'. Then, referring again to the book of Trig tables, it will be found that the cosine of 21° 22' is .9313.

Now, we multiply the long axis of the 10x15 elliptical reflector by .9313 and this will give the effective length of the 15-foot dimension of the reflector. This is 13.97 feet.

Then, to determine the area of the ellipse, the following formula is applied:

$A_e = \frac{(a)\ (b)\ (\pi)}{4}$, where a is the 10' dimension, b is the 13.97' dimension and π is a constant value 3.14.

In this case we have:

$$A_e = \frac{(10)\ (13.97)\ (3.14)}{4} = \frac{438}{4} = 109.9$$

At this point, we will determine the value of 1/K. Once this has been done we enter Fig. 2 directly at 1/K, ignoring both the frequency curve and the Reflector Size-Reflector Separation curve. Entering at 1/K we will read up to the appropriate φ curve and then read left to gain or loss in db.

$1/K = \frac{\pi \lambda d}{4\ A_e}$, where π is the constant 3.14, λ is the wavelength in feet (985)/(Freq. in mhz), d is the distance from parabola to reflector and, Ae is the effective area of the reflector at the angle of interest. In our case:

$$1/K = \frac{(3.14)\ \frac{(985)}{(2300)}\ (121.7)}{(4)\ \ (109.9)} = \frac{163}{438} = .381$$

Note this value, .381.

Determining the value of φ, so we can intersect the correct curve, is easy and is done

VALUES FOR $\ell = \frac{D}{W}$							
REFLECTOR (W)	ANTENNA SIZE (D)						
	2'	4'	5'	6'	8'	10'	12'
4x6	0.5	1	1.25	1.5	2	2.5	3
6x8	0.33	0.67	0.83	1	1.33	1.67	2
8x12	0.25	0.5	0.62	0.75	1	1.25	1.5
10x15	0.2	0.4	0.5	0.6	0.8	1	1.2
12x17	0.16	0.33	0.41	0.5	0.67	0.83	1

Fig. 3.

as follows:

$\varphi = D\ \sqrt{4\frac{\pi}{Ae}}$, where π is the constant 3.14, Ae is the effective area of the reflector and D is the diameter of the parabola.

Therefore:

$$=6\ \sqrt{(4)\ \frac{(3.14)}{(109.9)}} = 6\ \sqrt{.00717} = (6)(.0845) = .508.$$

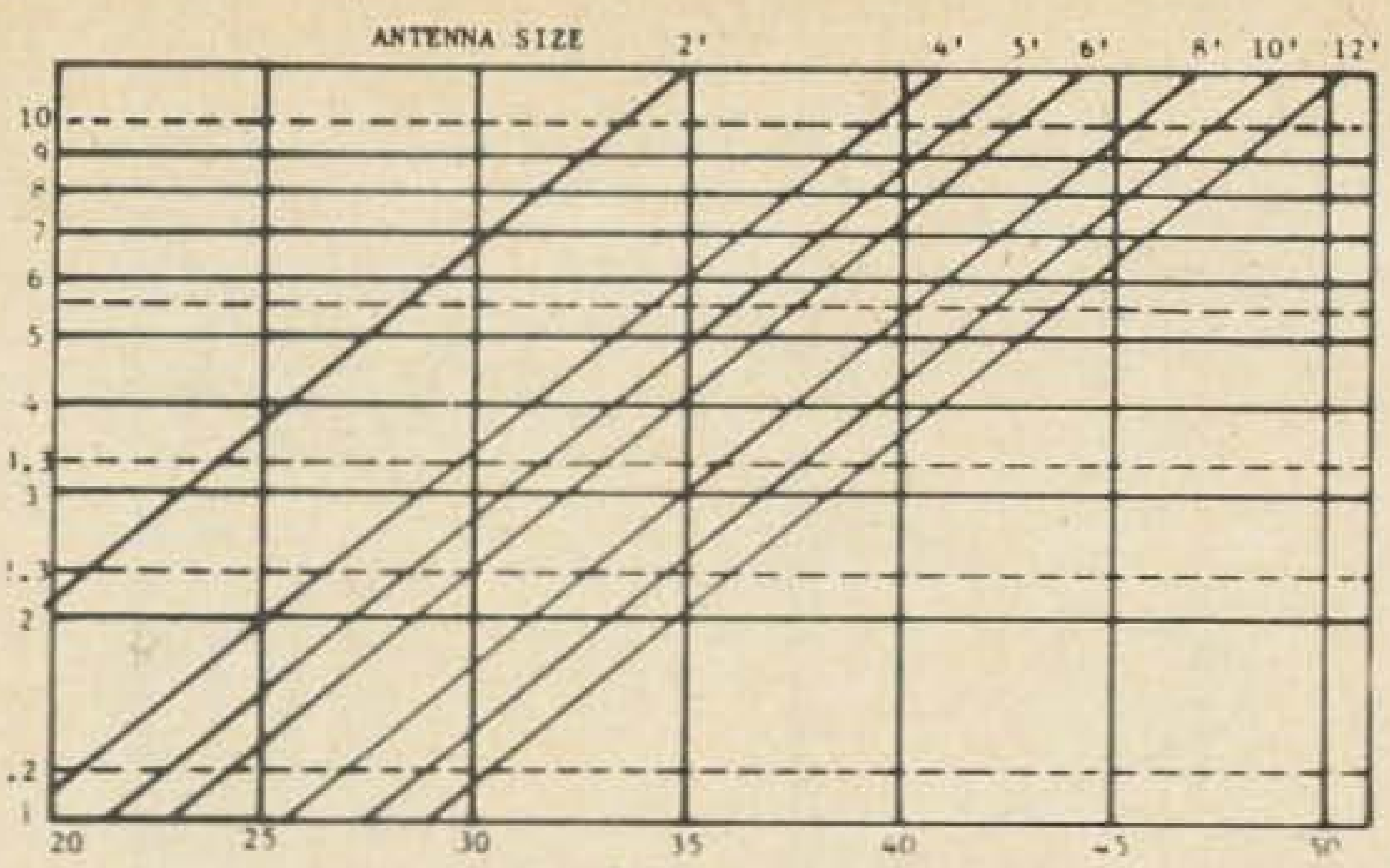
Now, entering the 1/K at .381, read up to where the φ curve is equal to .508. (You'll have to visually interpolate here a bit). Then read horizontally left and read 1.9 db gain.

Add 1.9 db gain to 29.9 db gain available from a 6-foot parabola and subtract the 0.7 db transmission line loss and you have 31.1 db antenna system gain which puts us almost back at the beginning of the article.

Elliptical reflectors versus rectangular reflectors

You'll notice that throughout the article, I've mentioned elliptically shaped reflectors. There is nothing to keep you from using a rectangular reflector. In fact, a rectangular reflector has about 20% more surface area than the elliptical reflector and will provide about 2 db more gain accordingly.

However, the elliptical reflector has the advantages of having lower sidelobe levels and sharper nulls between lobes, which are important considerations if you are troubled with co-channel or adjacent channel interference. In addition, the elliptical reflector offers 20% less surface area for wind loading purposes. Also, there is no reflection of unwanted Second Fresnel Zone energy with the elliptical reflector as might occur with the over-projecting corners of the rectangular reflector. The keep notch that occurs in Fig. 2 where 1/K is about .13 is due to the reflection of Second Fresnel Zone energy. For optimum performance, 1/K should be designed around 0.3.



$= 20 \log_{10} (f) + 20 \log_{10} (D) - 52.6$

(f) is frequency in Megahertz

(D) is paratola diameter in feet.

Fig. 4.

Reflector face flatness

The reflector face should be essentially flat at microwave frequencies. The face must be flat to within 1/8 of the wavelength over the face of the reflector. If there should be deviations from flat (not to exceed 1/8 of a wavelength), the deviations must be concave rather than convex.

Deviations of about 3/4" over the entire face of the reflector can be accommodated at 2.3 ghz without appreciably degrading the signal. Various construction techniques may be used with the most successful being a cross ribbing technique.

Flat reflectors and gain

There is often some confusion, even in engineering circles, concerning how a flat surface can have "gain." Gain is usually defined as an increase (or decrease) over a predetermined level. The predetermined level serves as a reference point. In microwave antenna work the most common reference point has been established as the isotropic radiator (a point source). Sometimes a dipole will be the reference source, though. The dipole has a gain of 2.15 db referred to the isotropic source, so if conversions are necessary, that value should be used.

Any increase in aperture over the isotropic point source will result in more energy being radiated or redirected. Thus, the more energy, the more "gain."

Quite probably, the difficulty in realizing how a flat surface can have gain relates back to another popular misconception concerning parabolic antennas. This misconception is that it is the focussing effect of the parabolic antenna that provides "gain." Therefore, goes the faulty conclusion, since there is no focussing with a reflector that is flat how can there be gain?

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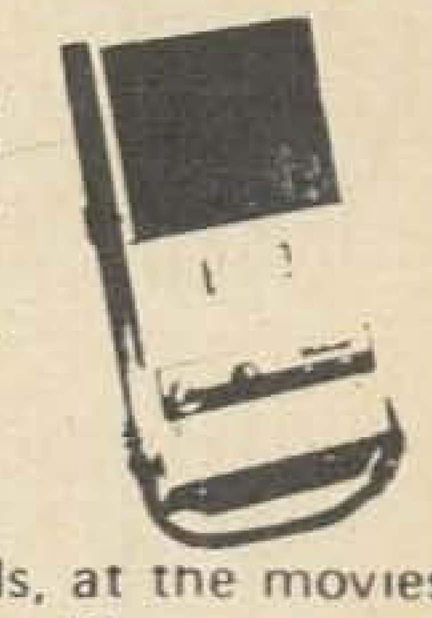

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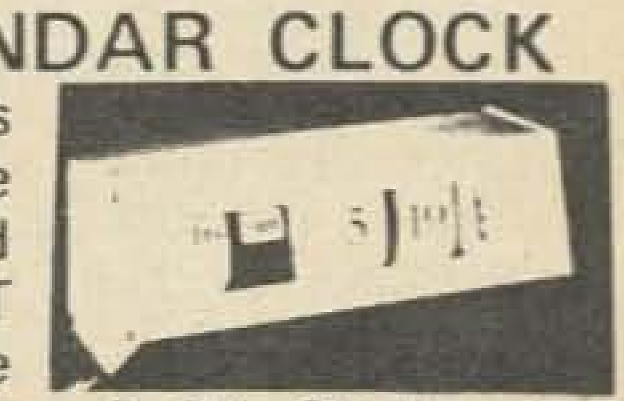

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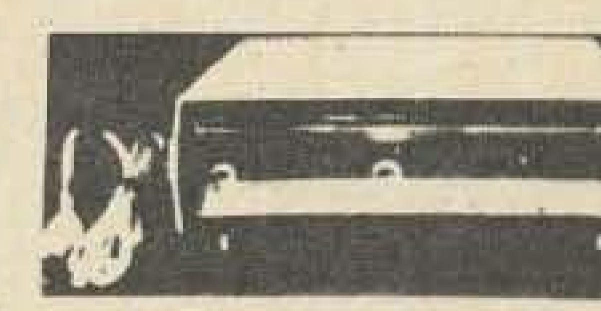

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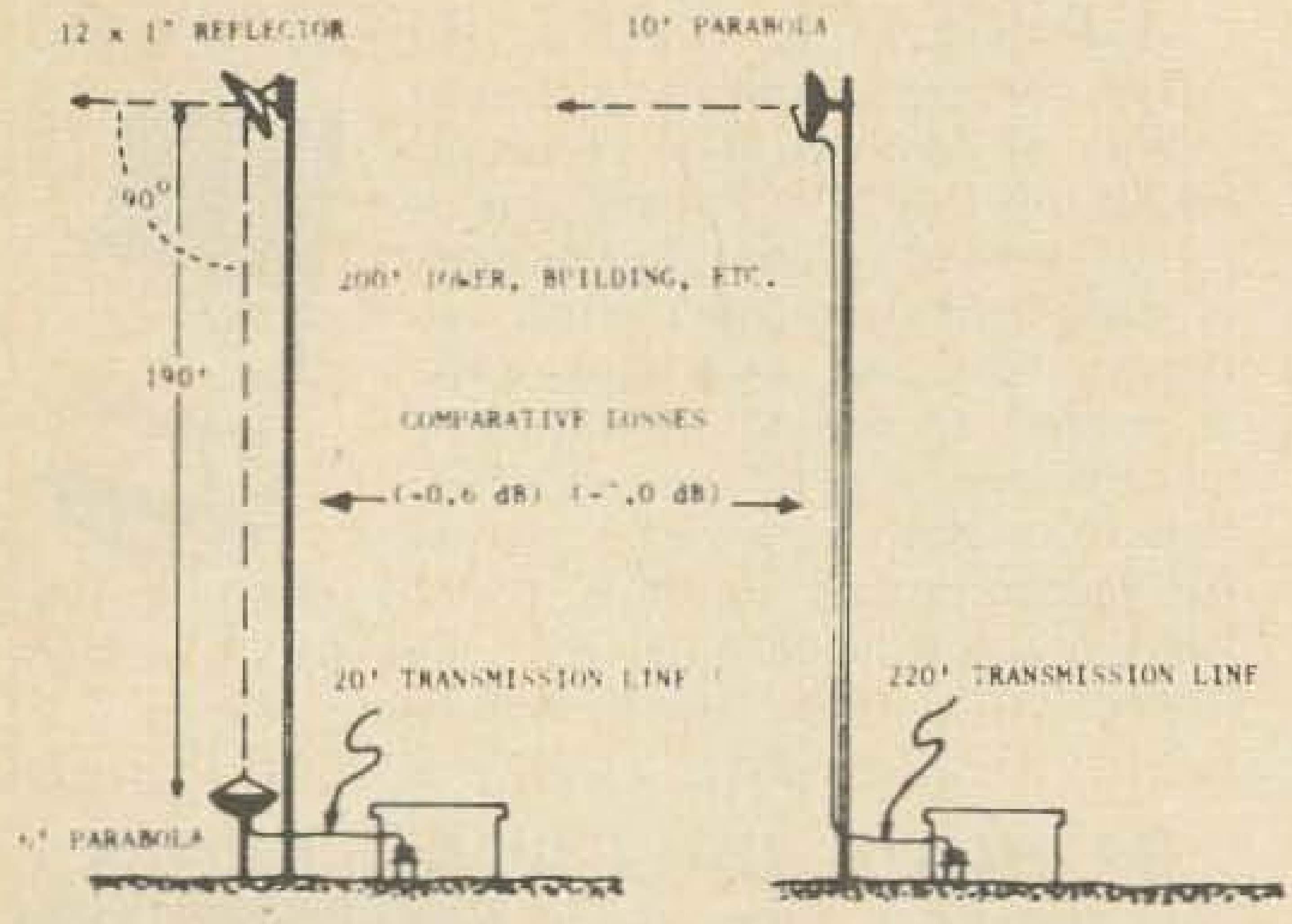

Fig. 5. Another example of the "Periscope" antenna system. A question often asked with regard to using small transmission lines (such as 7/8" diameter) is, "Why not go to a larger size coax to cut down on the losses?" There is nothing to prevent this except the economic consideration. As the transmission line gets larger in diameter and its loss goes down the cost goes up drastically.

The simple answer is that it is not focussing, as a characteristic of the parabolic antenna, that provides the gain. The focussing is merely a convenient means of transition from a large aperture (the dish) to a closely spaced small aperture (the feed device). It is projected aperture of the dish that provides the gain, not the focussing. Since it is the projected aperture that provides gain, the flat reflector, with its projected aperture, will provide gain which can be reliably calculated and measured.

Plane reflectors rather than back to back parabolas

Plane reflectors are extremely efficient devices. Commercial production line models have an efficiency of 99% as compared with the 55% efficiency of parabolas. So, if a passive repeater were to be made from a pair of back to back parabolas, the passive could be made from a plane reflector that would be about 6 db smaller.

As an example, a single 7x8 rectangular reflector will provide as much gain (with a horizontal included angle of 90° or less) as two 10' parabolas back to back.

A single reflector may be used where the angle to be turned is about 135° - 140° or less. With angles greater than that, the effective area is greatly reduced and efficiency of aperture drops off. Then, the common practice is to use a pair of reflectors closely spaced to get the "in-line" microwave beam over a hill or other in line obstruction. Depending on the aperture of the reflectors, the operating frequency and the spacing between them, the coupling loss with the double reflector will be less than 1 db.

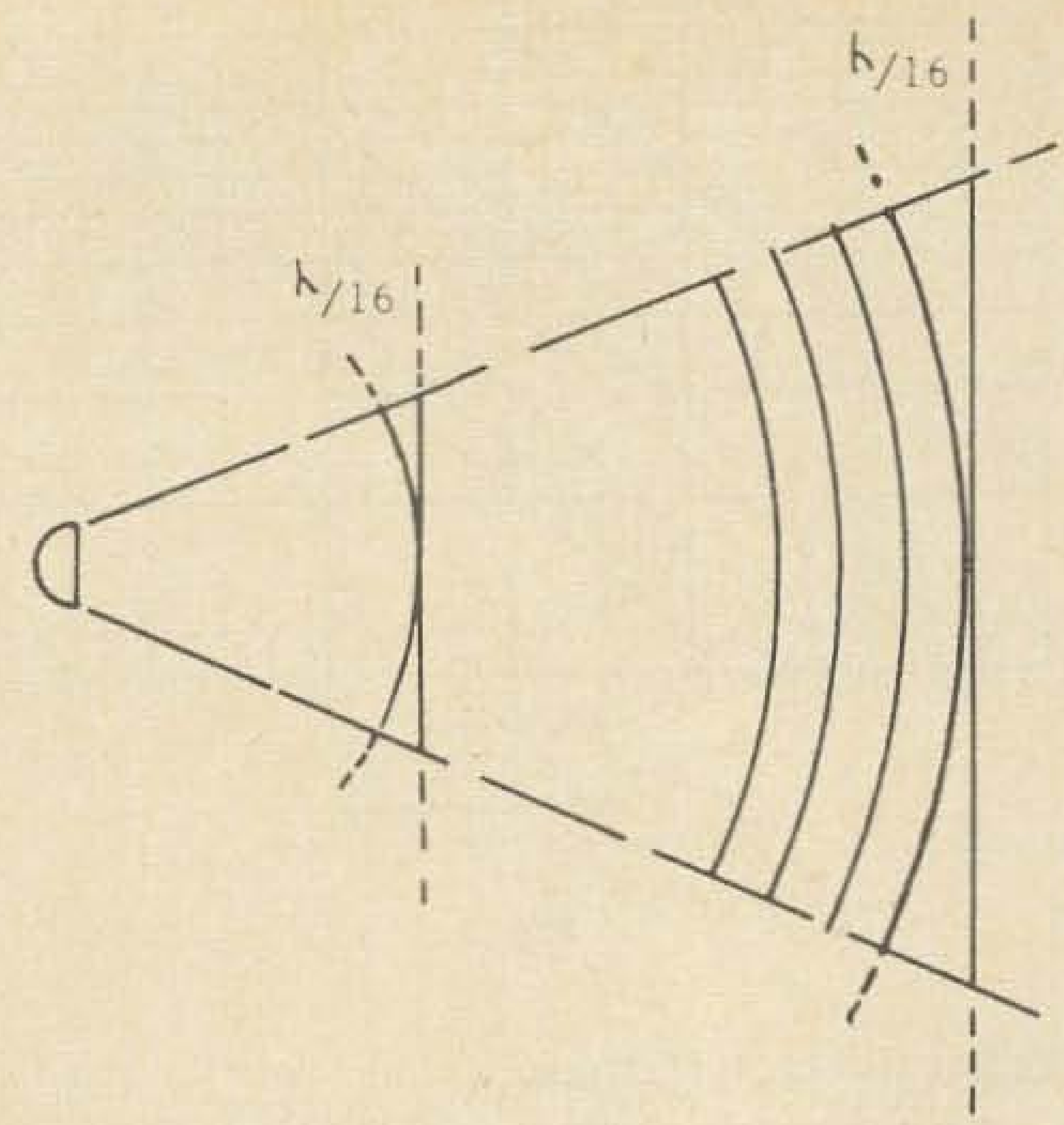

Fig. 6. What are near field and far field? The classical definition of the occurrence of near field is the point when a radiated wave (The microwave beam) intercepts a plane surface (the passive reflector) and the difference between any point along the radiated wave and the plane surface is 1/16 wavelength or greater. Note that either moving the passive reflector closer to the source or making the passive reflector larger can result in greating a near field situation. It will also be found that near field occurs when the computed value of 1/K is equal to 2.5 or less, i.e., 2.3, 2.3, 0.3, etc.

Conclusion

Reflector technology has been overlooked in amateur microwave work. Little emphasis has been given to it. With the development of microwave nets it would be a simple matter to interconnect many stations in an area where they normally would not enjoy line of sight and proper Fresnel Zone clearance. Use of reflector technology would eliminate the need for tall towers to provide proper path clearance.

Reflectors may be used at frequencies as low as 420-450 mhz. They may be used even at lower frequencies but unless the spacing is close and the reflector rather large, the aperture gains are somewhat low with the reduced frequency.

However, each situation should be mathematically calculated to determine whether or not it will perform. Use of any rule of thumb is to be avoided since no rule of thumb

can possibly include all the system design parameters and therefore no rule of thumb can possibly be accurate except by accident.
...W7EEX

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4. *Electronic and Radio Engineering*, Frederick E. Terman, McGraw-Hill.

NEW BOOKS

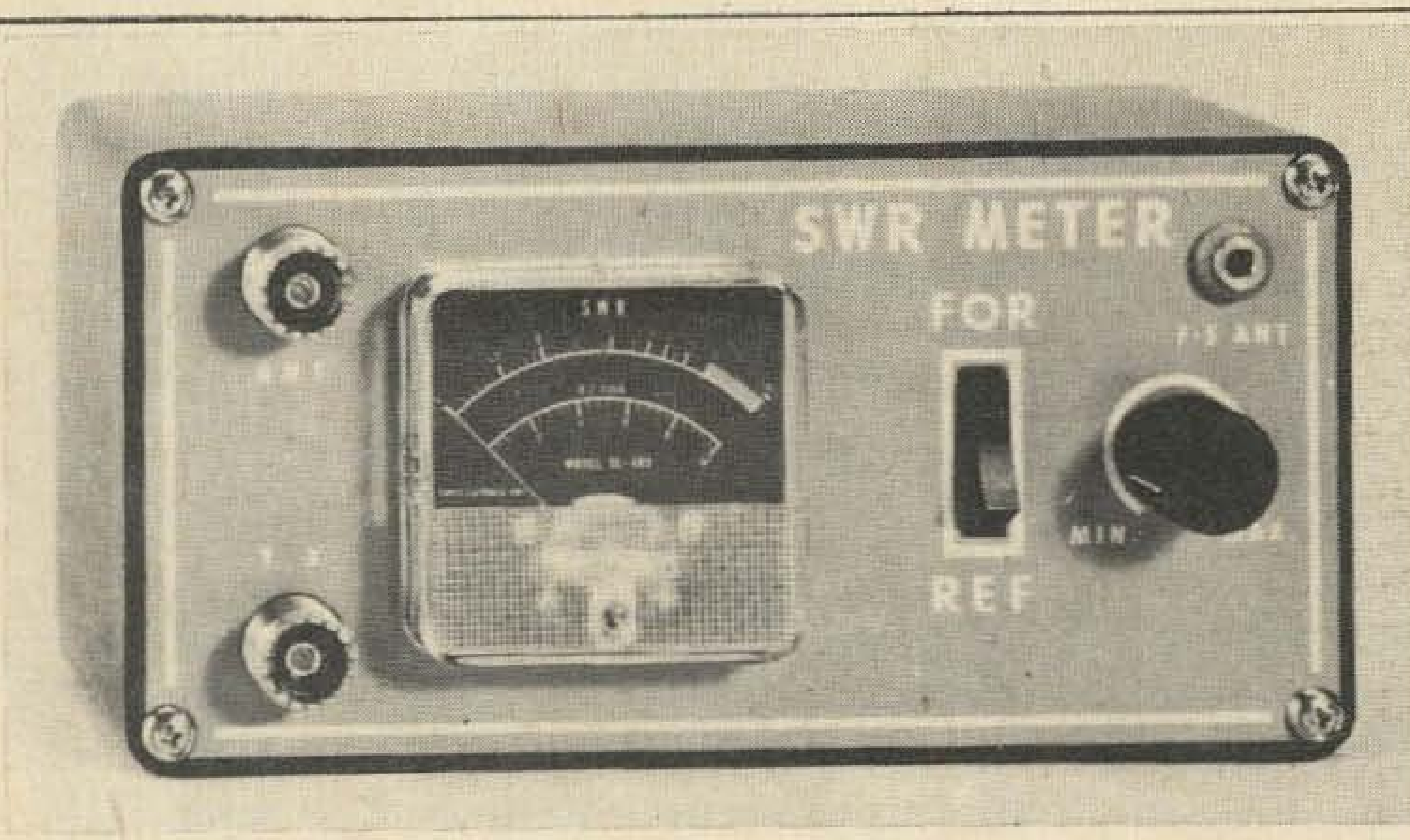
How to Use Grid Dip Oscillators

Complete operating data on the uses of the grid-dip oscillator is contained in the revised second edition of this book by Rufus P. Turner. It tells in clearly written text with easy to follow diagrams and illustrations how to check LC circuits, linear and coaxial tanks, how to convert a signal generator or *rf* test oscillator into a GDO and vice-versa. It gives step-by-step instructions on measuring inductance, test and align TV, radio and FM receivers and how to find the resonant frequency of an antenna.

Another in the Rider series, it is available from Hayden Book Co., Inc., New York, or from your distributor. Price: $2.95 paperback.

How to Select and Install Antennas

While this book deals primarily with the selection and installation of TV and FM antennas, much of the information can be applied to ham vhf antennas. Construction and installation details are well covered. The various feedlines are discussed in detail. Lon Cantor, the author, has compiled years of experience in design and installation of vhf/uhf/FM antennas. He has written numerous articles on the subject for the leading electronics publications. One of the Rider series, How to Select and Install Antennas, is available from Hayden Book Company, Inc., New York, or from your local distributor. Price: $3.95 paperbound.



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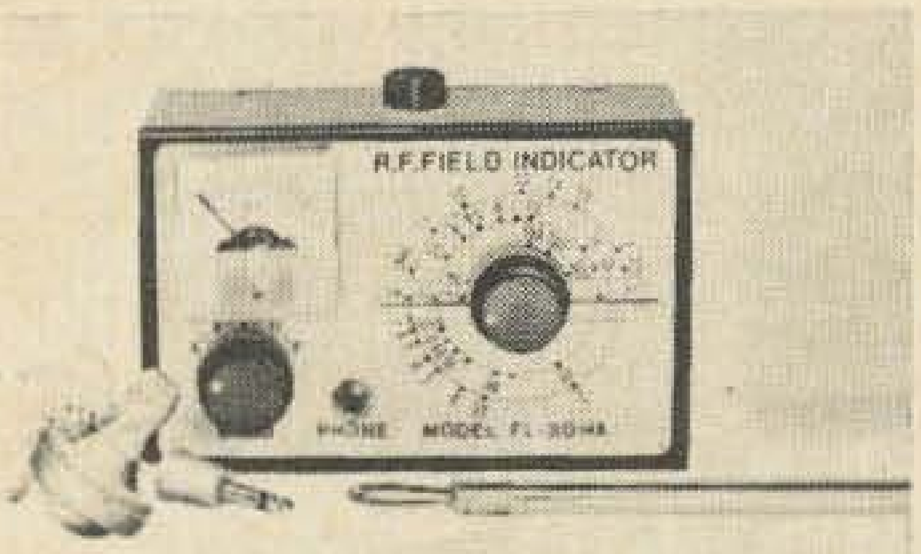

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(. . .de W2NSD/1 continued from page 2)

New Magazine Planned

There has been rather continuous pressure for us to expand the coverage of 73 to include short wave listening and citizens band material. These are allied hobbies, I grant, and few amateurs have come into hamming other than through one or both of those avenues, yet I have felt that I would prefer to keep 73 a ham magazine pure and simple and leave CB and SWL coverage to others.

Those of you who are interested in SWL know that there has been all too little information published in this field. And, frankly, I am not impressed with the activities of some of the CB magazines. They seem to pander more to the base elements of the "hobby" than to try and provide leadership.

In all, I feel that there is a need for a magazine aimed at the beginning radio hobbyist. 73 is far too technical for the beginner and we need a magazine which can help the rank novice into the many interesting facets of radio and electronics hobbies. Accordingly, we are starting to work here at 73 to lay out the first few issues of a new magazine and I am hoping that the readers of 73 will support the idea since the basic scheme is to bring more people into amateur radio as an end result.

We will need articles. . .and plenty of them. This has made 73 successful and it just might work again. In the CB field we will look for articles on tests of commercial equipment. . .on simple accessories that can be bought or built. . .on antennas. . .mobile installations. . .articles of discussion of rules and proposed rule changes. . .the most basic of theory articles. . .reviews of books. . .discussions of good and bad operating practices . . .or anything else that you think would be of value to the CB operator. SWL's will be interested to read about new equipment, how to SWL with RTTY, with FAX, on TV . . .unusual SW stations. . .what to hear on different bands. . .police. . .ship-to-shore. . . aircraft. . .weather. . .news. . .etc.

Novice amateurs also need a lot of help toward their General Class license and they have been just about forgotten by everyone. We need articles on tests of Novice equipment. . .simple rigs for the Novice to build. . . accessories. . .discussions of operating on the various Novice bands. . .Novice contests. . . Novice DX.

Short wave listening can be a lot more than just sitting back and listening to Radio Moscow tell us what rotters we are. Although it is fascinating at times to listen to a country that has just sent their army into another country to subjugate it trying to tell us over the air that we are imperialist warmongers. Short wave listening today can include, it seems to me, tuning in directly on the satellites, the moon capsules, getting weather maps from satellites or from the weather services by facsimile, getting news, stock quotations, or whatever by Teletype, tuning for long distance stations down on 20 khz. Short wave listening can be more fun today than it ever was in the past, if only the information can be brought out on what is going on and how to get in on it.

CB, a dirty word to many amateurs, has a lot of possibilities too. I don't think it is really necessary to encourage illegal CB operations. A growing number of amateurs are using CB because it permits them to do some things that are not possible with amateur radio. If the abuses of CB could be discouraged the service would be of tremendous value. Many of us need a simple and relatively inexpensive communications medium for business and this means CB. Perhaps we would like to be able to keep in touch with the wife or family while working or driving not far from home. . .CB again.

If I were a newcomer into radio these days there is no question whatever that I would immediately get started on CB. This is a logical first step. Without encouragement I might get hung-up there and never get further. Thousands. . .or even tens of thousands are getting hung-up. Amateur radio has a lot to offer these fellows. . .and they have a lot to offer amateur radio. We need to urge them along. . .get them into our radio clubs. . .get them into theory and code classes.

As publication nears I'll let you know about subscription prices and when the first issue should be out. We're sort of aiming at this fall and I expect that the cover price will be 50¢ and the subscription rate about $5 for one year and $10 for three years.

The pay for articles will be a little less than for 73. . .this reflects the smaller circulation, probably starting at about 25,000, and the simpler type articles involved. So, authors and prospective authors, make your hobby pay. . .write some articles.

Free Trip To Bermuda

The tenth annual Bermuda Amateur Radio Contest is upon us. Two free trips to Bermuda for both the CW and phone winners plus a week at the Carlton Beach Hotel add spice to this contest. Phone 0001 GMT June 22 to 0200 June 23, and CW 0001 July 20 to 0200 July 21. 80-40-20-15-10 meters. Three points per contact, multiplier one for each band, one for each Parish contacted. Logs to BARC, Box 275, Hamilton, Bermuda.

Visiting Switzerland?

Visitors to Switzerland may now obtain a three month temporary license by sending an application to Posts & Telegraphs Department, Berne, Switzerland together with a photo copy of your home station license.

Reciprocal Licensing

During the last year agreements were signed between the U.S. and Indonesia, Monaco, Ghana, Badbados, and Ireland. Denmark is still pending. The total is now 37 countries plus Canada.

73 vs Contests?

One of our readers wrote recently suggesting that 73 start running some contests. We have, so far, avoided this sort of misbehavior. I could be sanctimonious about it and point to the unending number of contests filling our bands with fruitless QRM. However, looking at the other side of the coin (a nasty practice of mine), the reason our bands are so filled with contest activity is that so many operators have fun that way.

Wouldn't it be fun, methinks, if some reader could come up with a corking good new DX contest? It would be even more fun if a serious DX'er (whatever that is) or a DX club would volunteer to run a DX contest. You know, score the logs, send out the certificates, and all the hard work. I suspect that I could put in a good word and get 73 to publicize the contest, provide the certificates, some postage money, and run the top winning score. Perhaps there is really nothing new in DX contests possible? I wonder if there really is any way to set up the scoring so that ops in different countries have a relatively equal chance of winning? Probably not.

Or might there, perchance, be a club or even one fellow with one hell of a lot of time and energy who would like to run a neverending set of state QSO parties? Not likely. Just imagine, without boggling your mind, starting with Alabama in January and having a contest every lousy weekend until Christmas, ending with Wyoming. Maybe a snappy twelve hour panic, starting at noon and ending with the Cinderella chimes each Saturday. And how about a giant all-state QSO party during Christmas week? Boggled on that, eh?

Now that the good old CQ VHF contests have dried up and blown away all we have are those three time dishonored QST VHF contests. Are they enough? Are they too much? Or should we put on our little old thinking cap and work up a fascinating new set of rules for a contest along in July? And maybe one during Christmas week for those not interested in working all states? Only if you think up the rules, the scoring, take care of the logs, fill out the certificates, and write up the results for 73. Otherwise send the idea over to one of the other ham magazines and let them botch it up.

. . .Wayne

FCC RM--1311

The present regulations permit an Extra Class licensee who has been licensed at least 25 years to apply for a two letter call. The FCC now proposes to accept licenses issued by foreign governments at least 25 years ago in addition to FCC issued licenses.

One must have had a license better than a Novice or Technician grade for two years before he can apply for an Extra Class license. The FCC now proposes to accept foreign issued licenses equivalent to the General Class or better as well as FCC issued licenses.

Comments, pro and con, should be sent to the FCC before July 25th and replies to those comments are due by August 11th. Original and 14 copies, as usual.

Ralph Hanna, W8QUR
3023 Emmick
Toledo, Ohio 43606

A VFO for the Heath HW 18-3

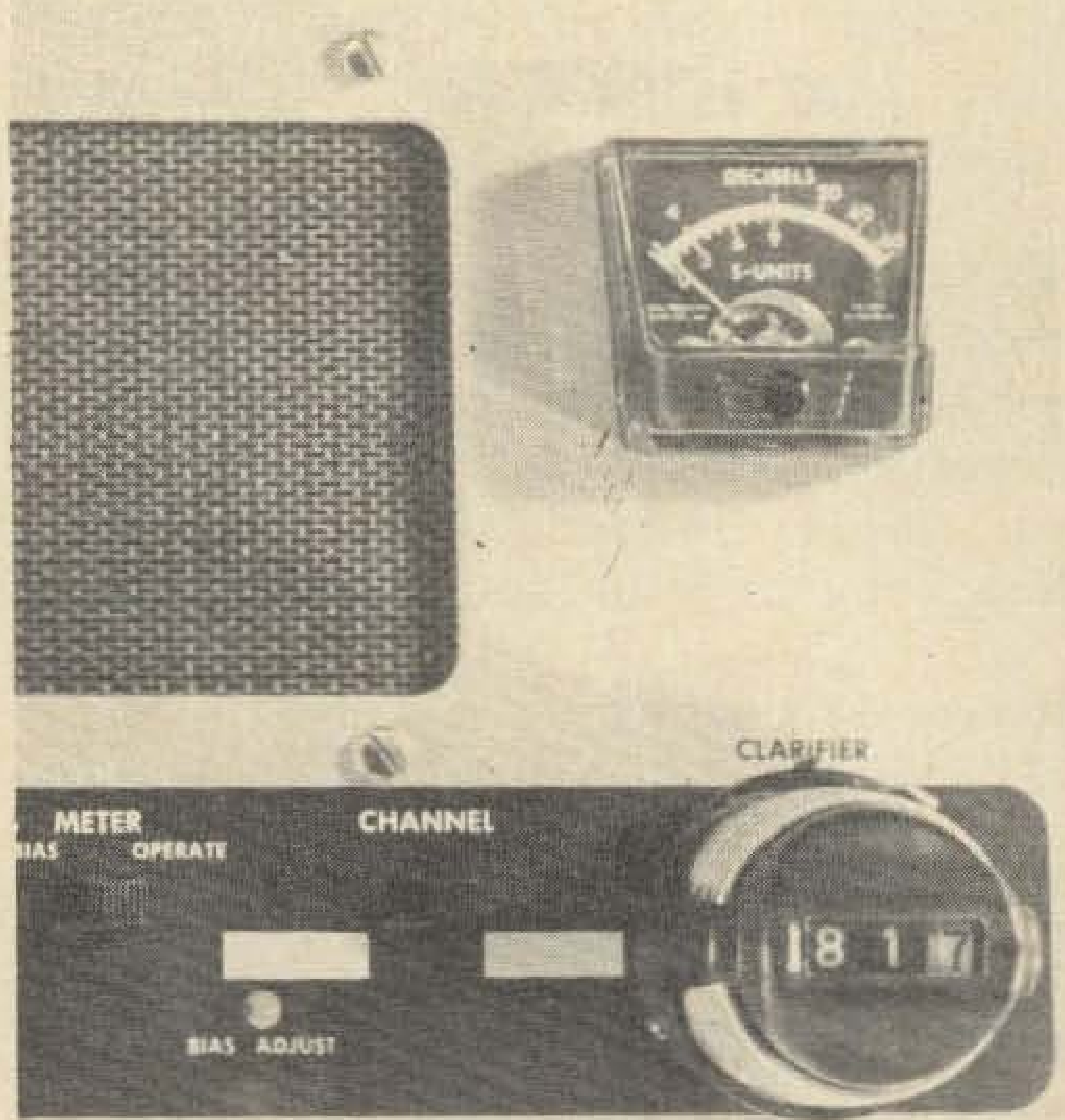
Even more fun on 160M

In my recent article on the Heathkit HW 18-3, it was pointed out that a VFO would be a very nice addition to this excellent 160 meter SSB transceiver. I used the LMO in the SB 100 with such good results that I decided it would be real nice to build a VFO of some sort right into the HW 18-3.

The pictures show the results. The one with the digital dial is real nice if you insist on direct reading of the frequency. This is not easy and the dial is not cheap. The other dial makes a very neat looking installation with a minimum of cost. Everything that is needed for $3.00. The only drawback is that this method uses the clarifier capacitor and linear readout is impossible. A tuning table or graph can be made that will be accurate to a half khz. To get a good band spread, a 22 picofarad capacitor is used in series with the clarifier capacitor as shown in the wiring diagram. This allows the rig to be tuned over any 100 khz segment. Since the whole set must be retuned for anything else, this was considered the best way.

The added capacitors were all mica. I used what I had but 500 volt would be suitable. The original capacitors were not removed and the new ones were soldered directly to the foil side of the board. 100 picofarad capacitor is (or was) c 211 that was in series with clarifier capacitor.

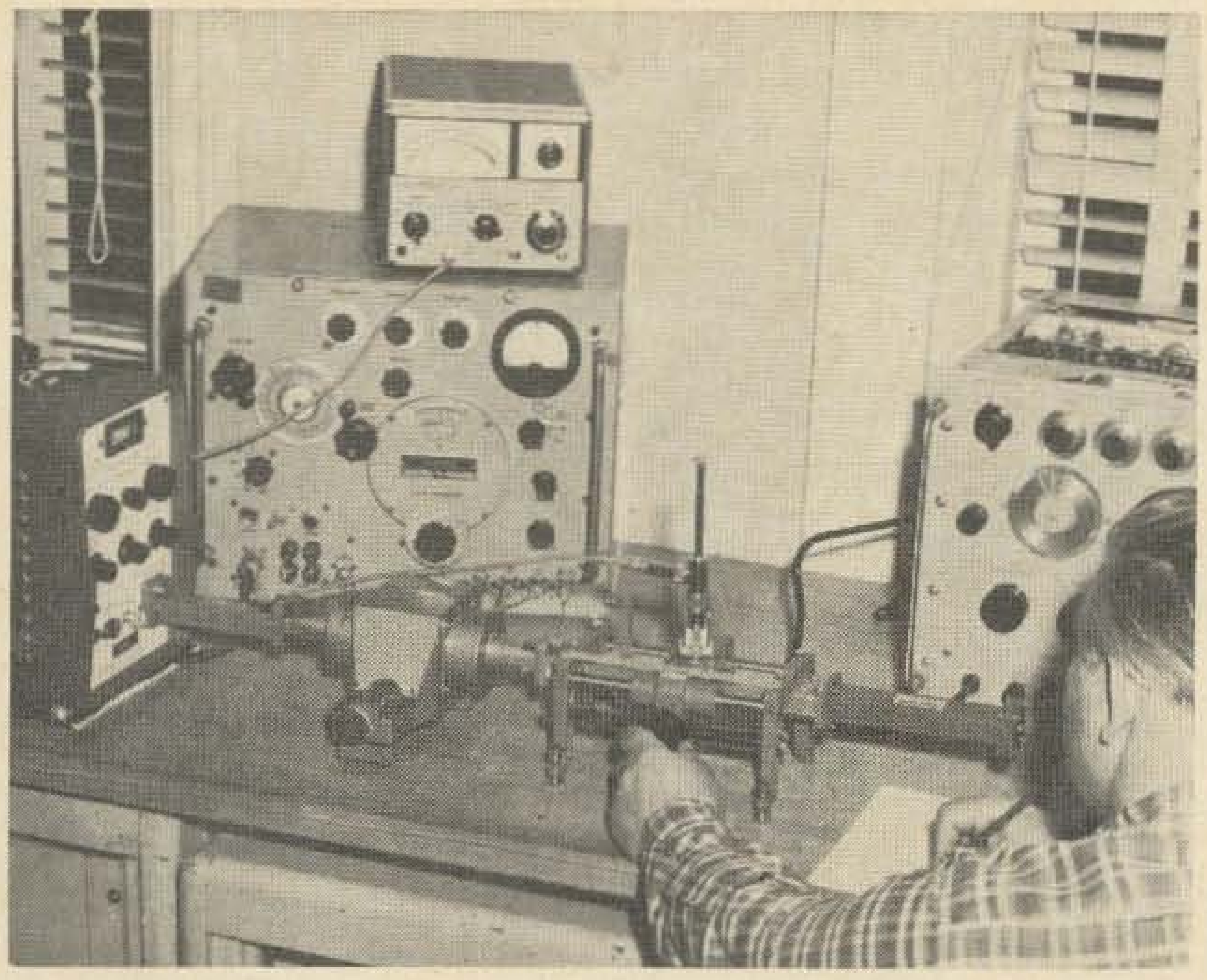
The coil is 15 turns of No. 28 wire on a Miller nylon slug tuned coil form. Any material is OK for the coil. I do not recommend nylon for anyone doing much experimental



This inexpensive digital dial readout is nice.

work as they melt very easily. The slug is used to bring the VFO into the operating range and this makes it easy to adjust. I reamed one of the holes in the subpanel you put the screwdriver through to tighten the slide switches in place.

Once all the parts are installed, it is a simple matter to adjust the slug to receive (and transmit) on the lowest frequency to be used. If you have a frequency meter such as a BC 211 or a Navy LM, then you have no problem. You can either feed in a signal from 1800 khz to 2000 khz or, better yet, listen for the oscillator in the freq meter. I say this because at 1800 khz range you are working with the 5th harmonic and may pick the wrong one. There is no question in the 5 mhz range as this is the second harmonic



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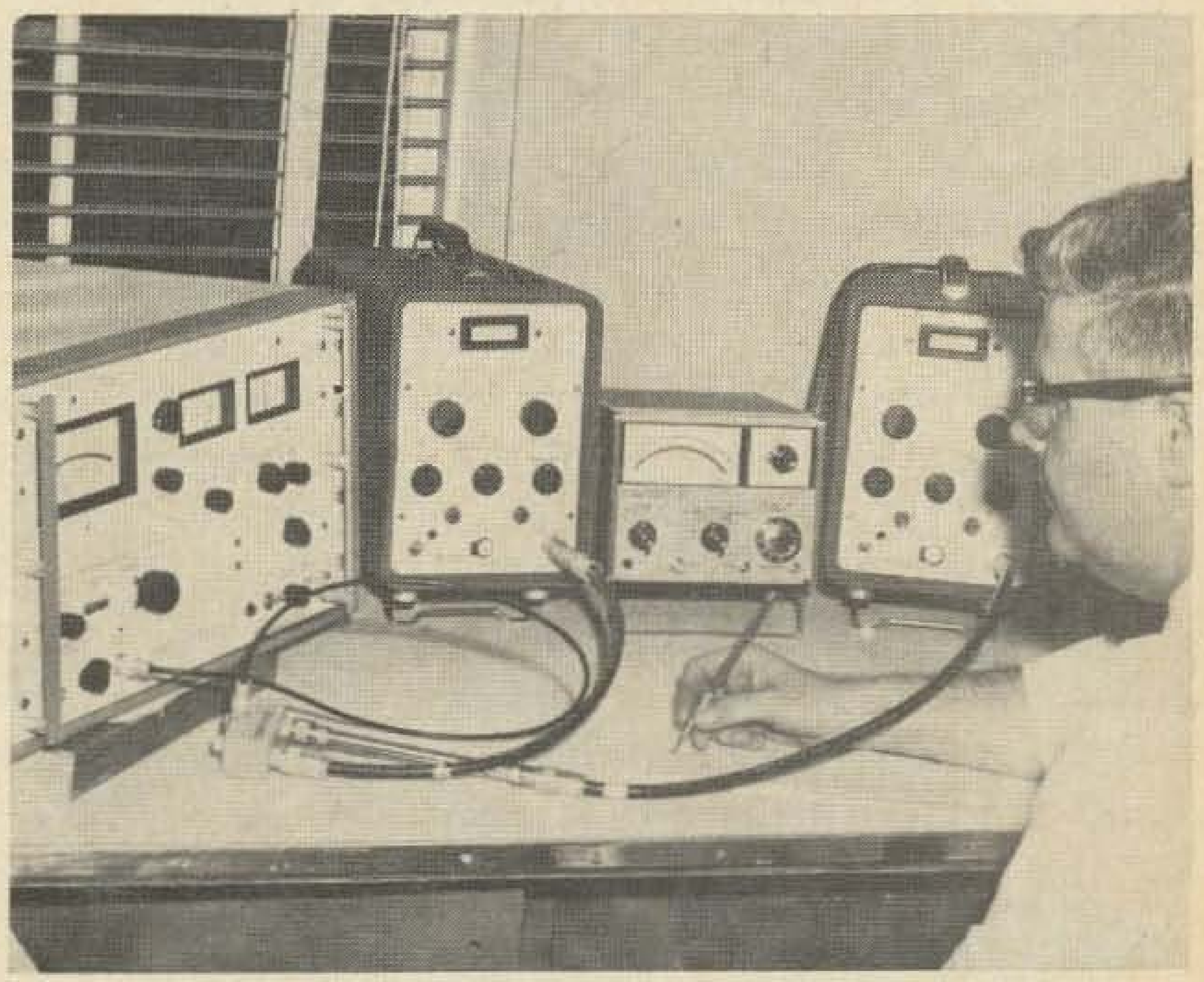

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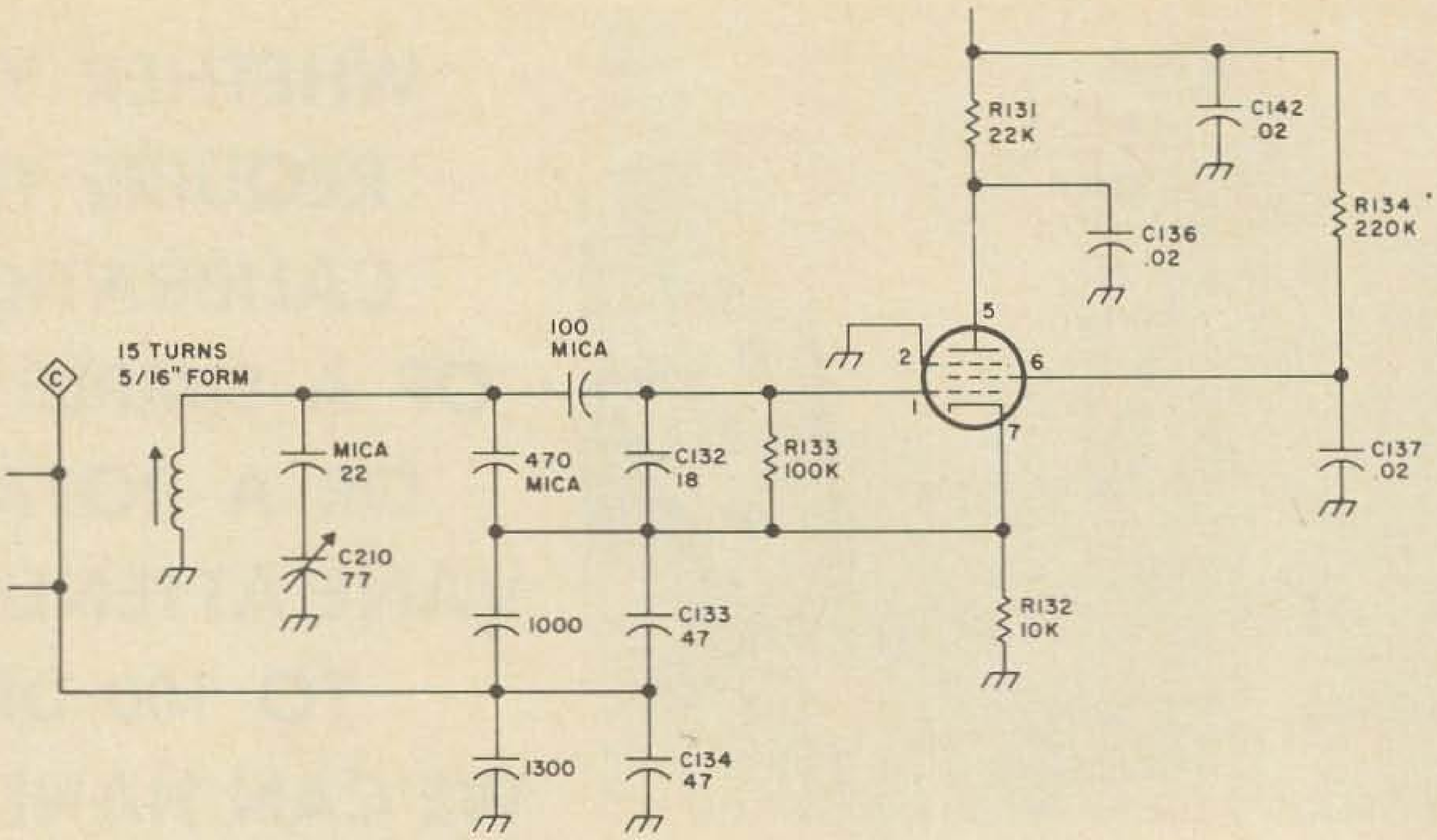
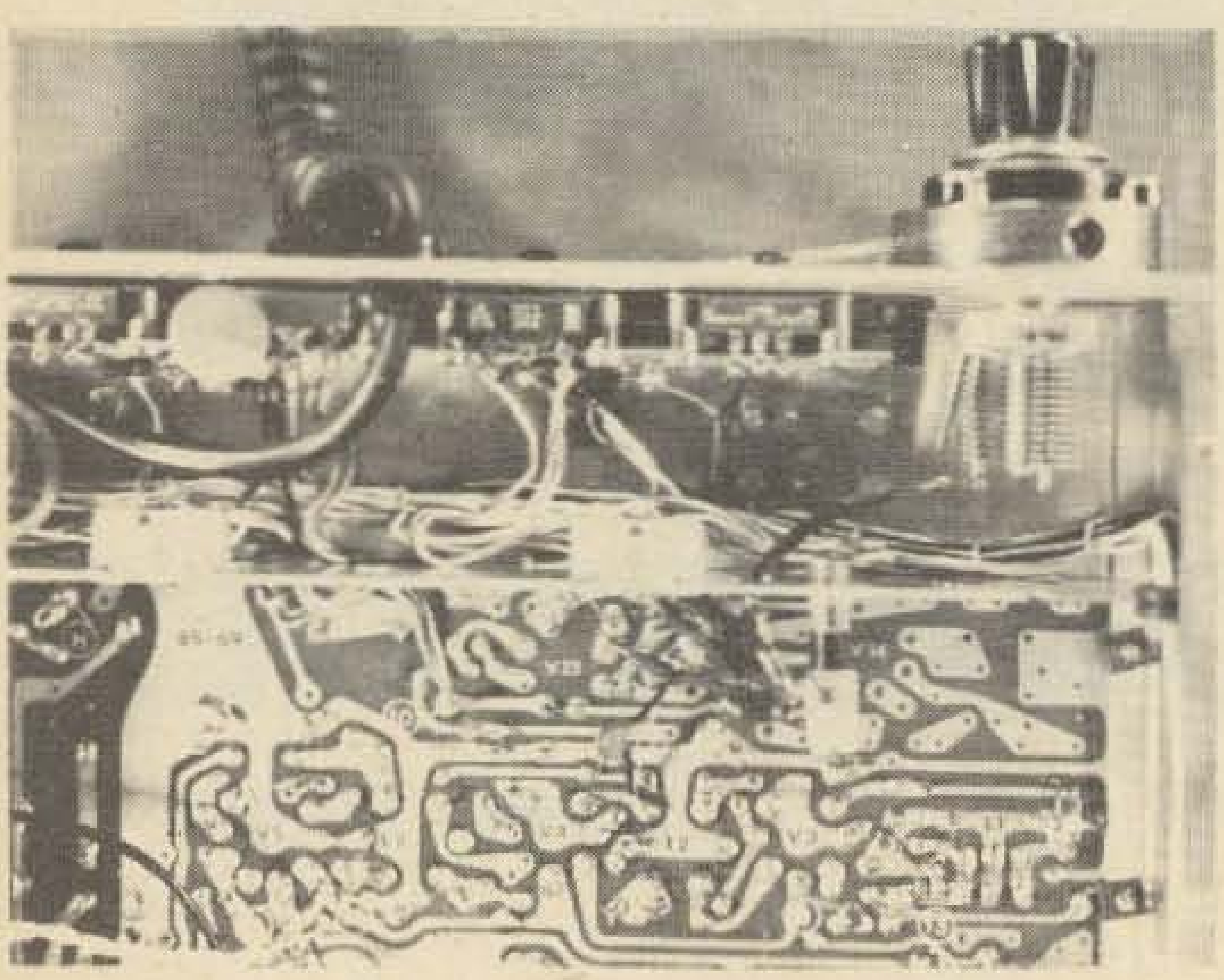


Fig. 1. VFO circuit for HW18-3. Simple. Works.

of the high range of the freq meter. If you use the high range then for 1800 khz the oscillator will be at 5.1935 mhz. At 1900 khz it would be 5.2935. With this information you can easily figure the other settings for the freq meter.

If you do not have a freq meter then you can do fairly well with a broadcast receiver that you can assume is aligned fairly accurately at an IF of 455 khz. Place the receiver close to the antenna of the HW 18-3 and tune in a station as close to 1345 khz as you can. The BC receiver oscillator will be very close to 1800 khz. 1445 khz on the BC receiver gives 1900 khz. In between points can be selected by adding 455 khz to the BC frequency. Of course, if you have a receiver with a 100 khz calibrator then you can use this. Connect the HW 18-3 antenna connect-



VFO installed in HW18-3.

or directly to the receiver antenna post.

The direct read-out dial takes a lot of work to get the values of the capacitors right. The capacitor I used was one from an HW 12 that had a 4 1/2 to 1 planatary drive. Since the capacitor only turns 180 degrees, the dial read-out about 225 digits so that by putting a figure 1 on the case read-out was direct in khz. The big problem is adjusting the capacitors to cover the range exactly. The capacitor used was 47 picofarad with an 8-30 picofarad for final tuning. You've got to juggle back and forth between this and the coil slug to get perfect tracking but it can be done.

The little planatary drive (Lafayette 99 H 6031) works real well and so as not to drill any holes in the panel, a spacer was made 2 inches in diameter with a 1 inch hole about 1/2 inch thick. A thin metal plate was attached to the back with countersink screws. The dial is attached using only the two bottom screws. The spacer and plate are held on by the nut holding the capacitor. A 5/16 inch hole was bored in the bottom of the spacer to get in to tighten the set screw on the shaft.

I am sure that once you have made this addition to the HW 18-3 you will find a whole new world of fun on the "top band."

. . .**W8QUR**

Tell Our Advertisers You Saw It in 73

IC Breadboards

While working with Integrated Circuits, I soon found that some means of mounting the IC's had to be devised because: (1) the leads on an IC are much too small to work with conveniently; and (2) if I soldered directly to the IC, I would probably have destroyed it after a small amount of experimenting, because of the heat. I was fortunate because my first contact with IC's was through Kaye Engineering's integrated circuit kit which contains two Fairchild uL914 and two printed circuit mounting boards. The PC mounting boards are my

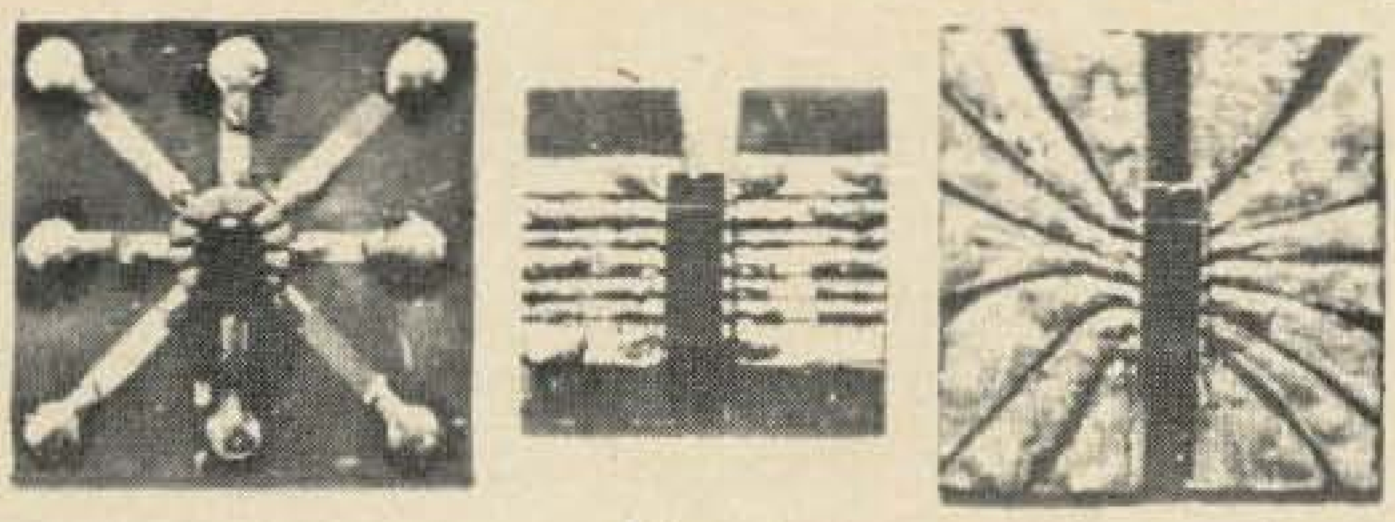


Fig. 1.

concern here. Fig. 1 left shows one of the boards (and its IC) contained in this kit. Fig. 1 center shows a homemade PC mounting board with a 14 pin IC on it. This board is hard to work with because of the small width of the copper strips to the middle pins. The board shown in Fig. 1 right is a solution: by curving the copper strips there are large soldering pads for each pin.

The boards are easy to duplicate. The left board can be made from a 2" by 2" piece of copper clad board, a few inches of 1/8" wide resist tape, and eight resist circles. Set it up as in the picture and etch. The center board was made by scoring through the copper on a piece of PC board and pulling off the unwanted copper foil. This is the least messy method of making these boards and can be used, if instead of soldering parts directly to the PC board, wires are used to connect from the PC board to the external circuitry. The left board was made using Scotch tape to cover the areas of foil that are wanted. Set it up as in the picture and etch.

I have shown boards for only two types of IC cases; but by using the same techniques, boards can be made for any size and shape IC. You will find these IC PC breadboards will make experiments and projects using IC much easier.

Richard Roth, WB2UMH

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A Whip Antenna Add-On

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

Various simple "add-on" attachments for vhf mobile whip antennas are described which can be used to modify the directive pattern or even the radiation polarization of the basic antenna. Most of them provide a significant gain factor.

Often one wishes to mount only a simple whip antenna on an automobile for use on vhf bands. Such an antenna suffices in many cases for local contacts while "in motion," especially in large city areas. However, when outside the local area and especially when the automobile is stationary, one often requires or can utilize a more effective antenna if any contacts are going to be made with reasonable signal levels.

One can take two approaches towards this type of antenna problem. The one approach used by many vhf mobile enthusiasts for stationary hill-top operating is to pack along a full-size beam and mast. Unpacking, assembling, connecting, etc. of such an antenna can be quite a chore. Of course, the results are often worth the effort as far as vhf dx is concerned. The other approach is to utilize some form of auxiliary antenna structure which can simply and quickly be attached to the mounted whip antenna whenever the automobile is stationary. A number of problems arise when one tries to devise such an auxiliary antenna structure. It must provide a significant improvement in antenna performance, not upset the matching conditions to any great degree to the whip antenna, be relatively simple in construction and yet attach to the mounted whip in much the same fashion as a cap is put on a bottle – a rather tall order.

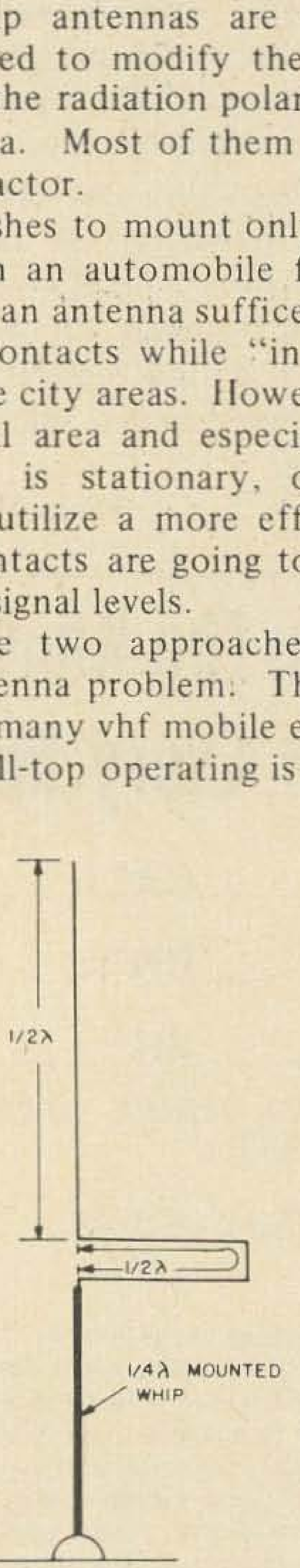

Fig. 1. Addition of phasing stub and ½λ radiator to basic ¼λ whip retains vertically polarized radiation, omnidirectional in the horizontal plane but with about 3 db gain in the vertical plane.

This article discusses some of the problems that are involved in devising such an auxiliary antenna "add-on" structure. Several designs are presented, but none of the designs will instantly transform a simple mobile whip into the equivalent of a 10 element beam. The determined vhf hill-top dx enthusiast will still have to take along his beam for best results. However, the "add-ons" described will significantly improve antenna performance under specific conditions, and they really are as easy to use as putting a cap on a bottle.

Basic Considerations

Adding an auxiliary structure to a ¼λ whip mounted in the middle of the roof of an automobile has certainly been done before. **Fig. 1**, for instance, shows the addition of a ½ λ element to the basic ¼ λ whip. The phasing stub is necessary to insure the same direction of current flow in the ¼ λ and ½ λ radiating elements and, therefore, prevent the vertical radiation pattern from splitting and sending most of the radiation out at useless high angles. Otherwise, the

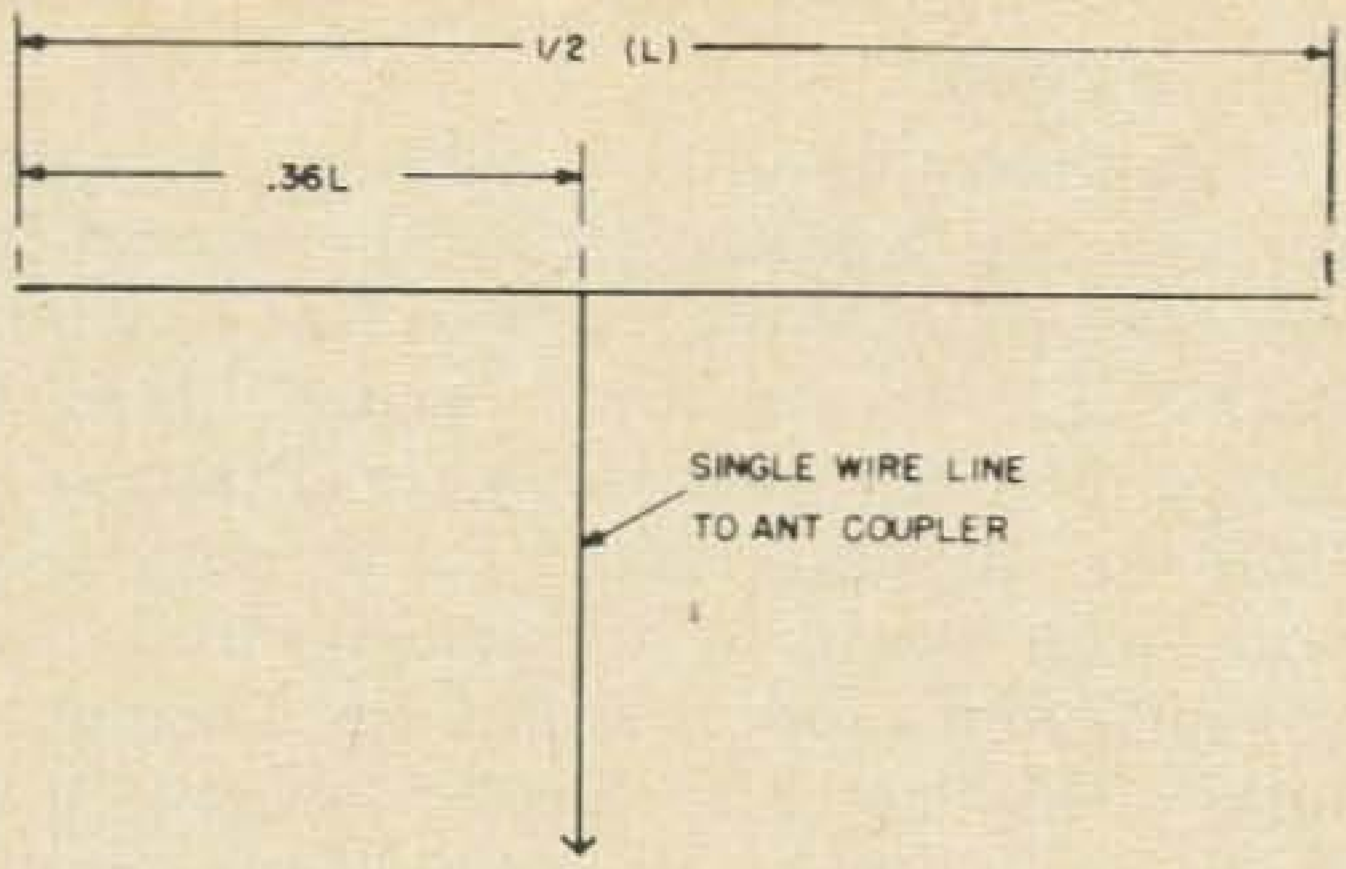

Fig. 2. Old style window antenna. Its single wire feed system idea is used as the basis for other antenna types shown.

phasing stub need not be used as far as impedance matching the added ½ λ element to the basic whip is concerned. The phasing stub itself can be formed of stiff wire rod wound in a circle around the vertical elements. A gain of about 3 db will result but the radiation will still be vertically polarized and omnidirectional in the horizontal plane. One can extend this design to as many elements as desired but the basic radiation characteristics will not change, except for gain in the horizontal plane.

Another concept is necessary to modify the performance of the basic whip antenna. The concept which the author developed is based upon the old Windom antenna idea (Fig. 2). Old-Timers will remember this form of off center fed dipole very well. It used a single wire feed line which represented about a 600 ohm feed system using an earth return path for the "missing" half of the usual 2 wire feed line. Due to the earth return path, it performed best over earth of high conductivity.

The usual mobile mounting of a vhf antenna provides an excellent high conductivity ground path via the automobile body. So, ground conductivity is not a problem in adopting the "Windom" feed system concept to a mobile whip. What is different, however, is the impedance relationships. The "Windom" feed line was connected to the dipole flat-top at a point off center which provided about a 600 ohm impedance. The transmitter end of the feed line was connected to an antenna coupler set to match the feed line impedance. If the ¼ λ mobile whip is visualized as the "Windom" feed line, it does not match the impedance of the coaxial feed line to which one end is attached. The only way the impedances will match is if the ¼ λ whip-turned "Windom" feed line also acts as a ¼ λ transmission line impedance transformer between the coaxial transmission line and the antenna structure which it feeds. This requires that the antenna structure (the whip "add-on") present a very high impedance at the point of connection.

Typical "Add-On" Designs

If one understands the feed system concept explained in the preceding paragraphs, it is possible to study antenna manuals and find many designs that could be used as whip "add-ons." The few that are presented here are relatively simple and seem to work well.

Fig. 3 shows two configurations. The Spider-Leg (A) provides mainly horizontally polarized radiation with a bidirectional radiation pattern centered on the intersection of the legs. The horizontally polarized radiation could be further emphasized by keeping the entire length of the legs mount-

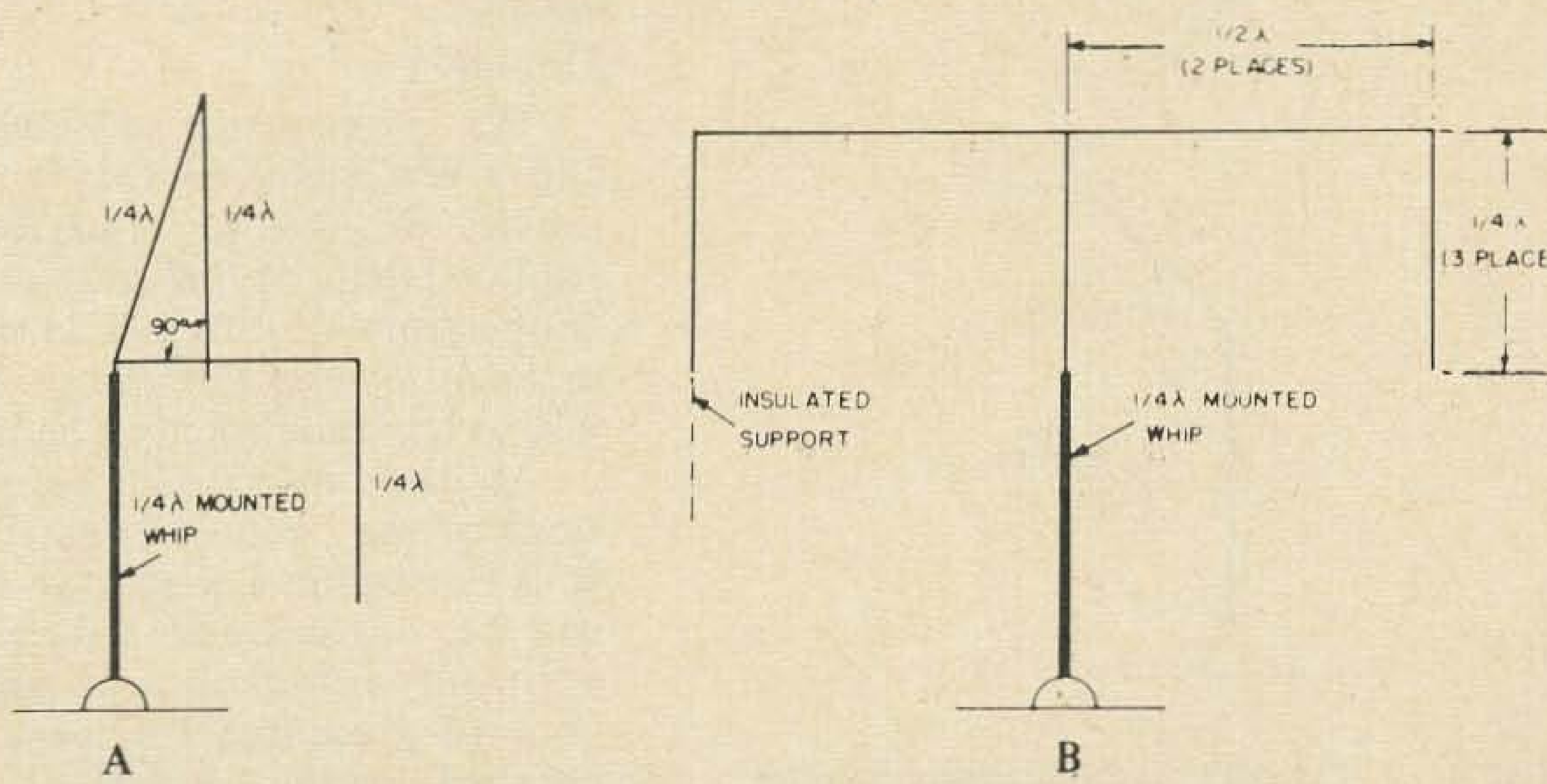

Fig. 3. "Spider-leg" configuration (A) provides combination horizontally and vertically polarized radiation. Modified "bobtail" configuration (B) produces quite directional vertically polarized signal.

ed horizontally. Although it was not tried, some gain in the horizontal plane could possibly be achieved by making the legs longer in multiples of ½ λ.

The modified "Bobtail" antenna of **Fig. 3** (B) produces a vertically polarized signal but one with a fairly good amount of gain (about 7 db). The radiation is bidirectional and broadside to the array (in and out of the page as the antenna is shown).

Fig. 4 shows a more elaborate "Zig-Zag" "add-on". In spite of its appearance, the radiation produced is mainly horizontally polarized with several db of gain and a bidirectional radiation pattern. Due to the current reversal that takes place every ½ λ, the vertical components cancel while those in the horizontal plane enforce each other. If found more convenient structurally, the antenna can be mounted with the first element horizontal to form a staircase outline, but this would result in the production of some vertically polarized radiation.

Although not tried, it would seem to be feasible to form beam antennas by placement of parasitic elements either in front of or in back of the main antenna. The spacing would have to be kept fairly wide (¼ λ or more) in order not to appreciably lower the feed point impedance of the main antenna since there is no way to adjust the "match" to the main antenna.

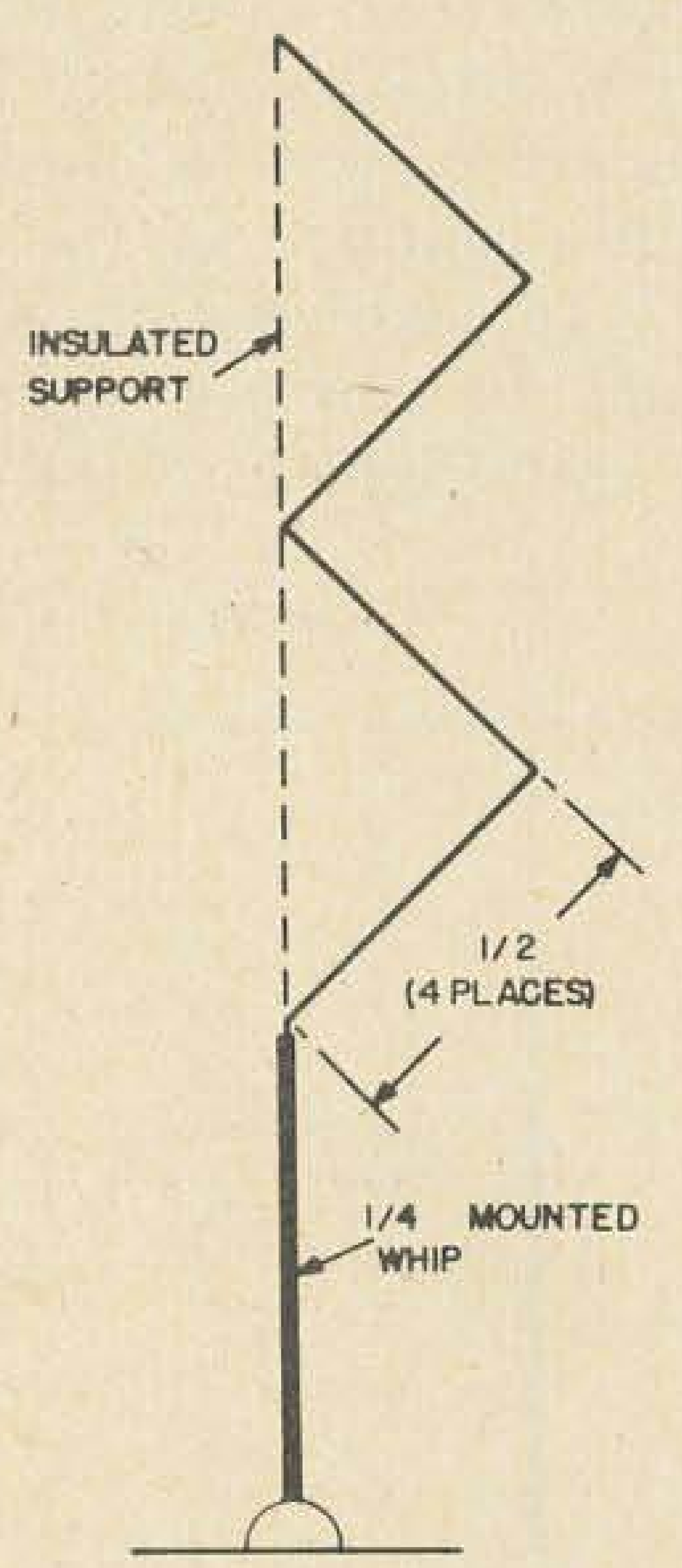

Fig. 4. "Zig-zag" configuration provides directive horizontally polarized radiation. Two sections are shown but only one may be used, if desired. The gain will be reduced but the polarization will remain horizontal.

Construction

Depending upon how durable one wishes to make an "add-on," it can be constructed from anything from No. 8 to No. 10 wire to 3/16" or 1/4" duraluminum rod. It is suggested that for initial experimentation, the "add-on" be constructed from heavy guage wire with wooden or plexiglas rods used for insulated support structures when necessary. The "add-on" can be secured to the whip by a variety of means from clips to clamps. One of the handiest found by the author was the use of electricians' small U-shaped cable clamps, available in most large hardware stores. The "add-on" structure made of wire can be soldered to the flat side of the U-clamp surface.

An swr meter should be inserted in the coaxial transmission line to the whip to determine the effect upon swr when the "add-on" is used. Generally, the swr should not change to any great degree. It may, in fact, even improve slightly in some cases, depending upon how good the original match was, by canceling some reactive components.

The improvement in performance can be checked with another station by simple comparison checks. When making such checks, however, due consideration should be given to the fact that some "add-ons" will change the polarization characteristics of the radiated signal. Therefore, the station with which checks are made should have available an antenna that will match the polarization of the radiated signal. If this is not observed, very confusing results will occur as in short distance line-of-sight contacts, an antenna polarization difference between stations can easily produce a 20 db loss in the received signal.

Summary

The convenience of being able to simply add a few elements to a whip antenna and modify or improve its performance without readjustments or disturbing transmission line connections is difficult to describe. One is inclined to stop the automobile for contacts just so the "add-on" can be used.

As was mentioned before, many variations of the "add-on" described are possible. It is not claimed that they are the best that can be devised and the reader should experiment with various designs - following the concept presented for using the basic whip antenna as the equivalent of a singlewire feed line.

. . .W2EEY/1

PROPAGATION CHART

J.H. Nelson

July 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Legend: 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	14	7A	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14	14A	21	21	21A	21
AUSTRALIA	14	14	14	14	7B	7B	7	7	7B	7B	14	14
CANAL ZONE	21	14	14	14	7A	7	14	14	21	21	21	21
ENGLAND	14	14	7A	7A	7	14	14	14	14	14	14	14A
HAWAII	14	14	14	14	7B	7B	7	14	14	14	14	14
INDIA	14	14	7A	7A	7B	7B	14	14	14	14	14	14
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PUERTO RICO	14	14	14	7A	7	7	14	14	14	14	14	14
SOUTH AFRICA	7B	7B	7B	14	14	14	14	21	21	21	14	14
U. S. S. R.	14	7A	7A	7	7	14	14	14	14	14	14	14
WEST COAST	21	21	14	14	7	7	7	14	14	14	14	14

CENTRAL UNITED STATES TO:

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AUSTRALIA	14	14	14	14	14	7A	7A	7A	7B	7B	14	14
CANAL ZONE	21	14A	14	14	14	7	14	14	14	21	21	21
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HAWAII	14	14	14	14	14	7A	7	14	14	14	14	14
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PHILIPPINES	14	14	14	14	7B	7B	7B	14	14	14	14	14
PUERTO RICO	14A	14	14	14	7	7	14	14	14	14	14A	14A
SOUTH AFRICA	7B	7B	7B	7B	7B	14	14	14	14	14	14	14
U. S. S. R.	7A	7A	7A	7	7	7	14	14	14	14	14	14

WESTERN UNITED STATES TO:

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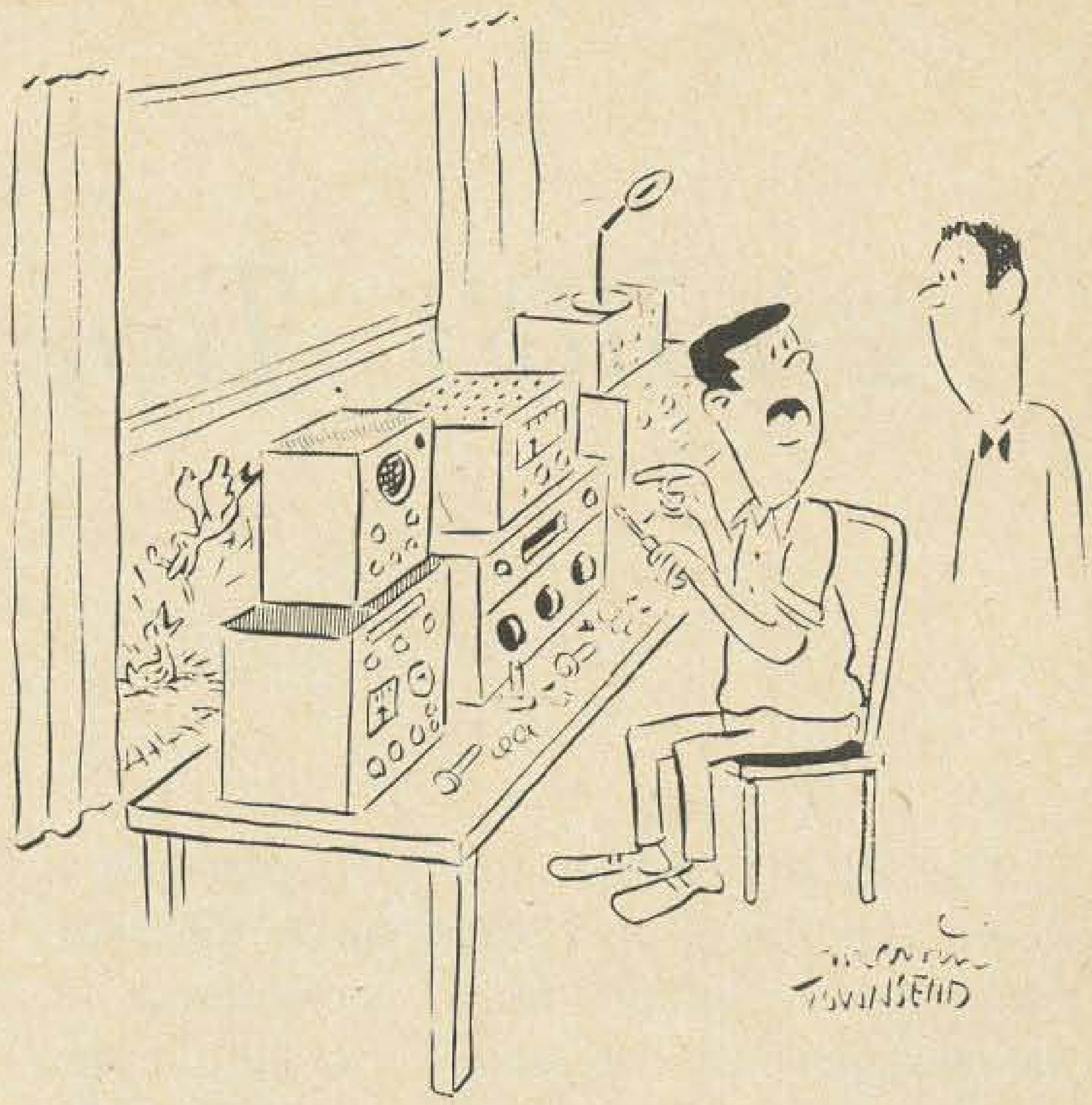
ARGENTINA	21	21	14	14	14	7	14	14	14A	21	21	21
AUSTRALIA	21	21	21A	21	14	14	14	14	7	7	14	21
CANAL ZONE	21	14A	14	14	14	7	14	14	14	14	21	21
ENGLAND	14	14	7A	7A	7	7B	7B	14	14	14	14	14
HAWAII	21	21	21A	21	14	14	14	14	14	14	14	21
INDIA	14	14	14	14	7A	7B	7B	7A	14	14	14	14
JAPAN	14	14	14	14	14	14	7	7A	14	14	14	14
MEXICO	14	14	14	14	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	14	14	7B	7B	14	14	14	14
PUERTO RICO	14A	14	14	14	7	7	7A	14	14	14	14A	14A
SOUTH AFRICA	7B	7B	7B	7B	7B	7B	7A	14	14	14	14	14
U. S. S. R.	7A	7A	7A	7	7	7	7	14	14	14	14	14
EAST COAST	21	21	14	14	7	7	7	14	14	14	14	14

A - Next higher frequency may be useful this period
B - Difficult circuit this period



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2N5188 Two-Meter Exciter

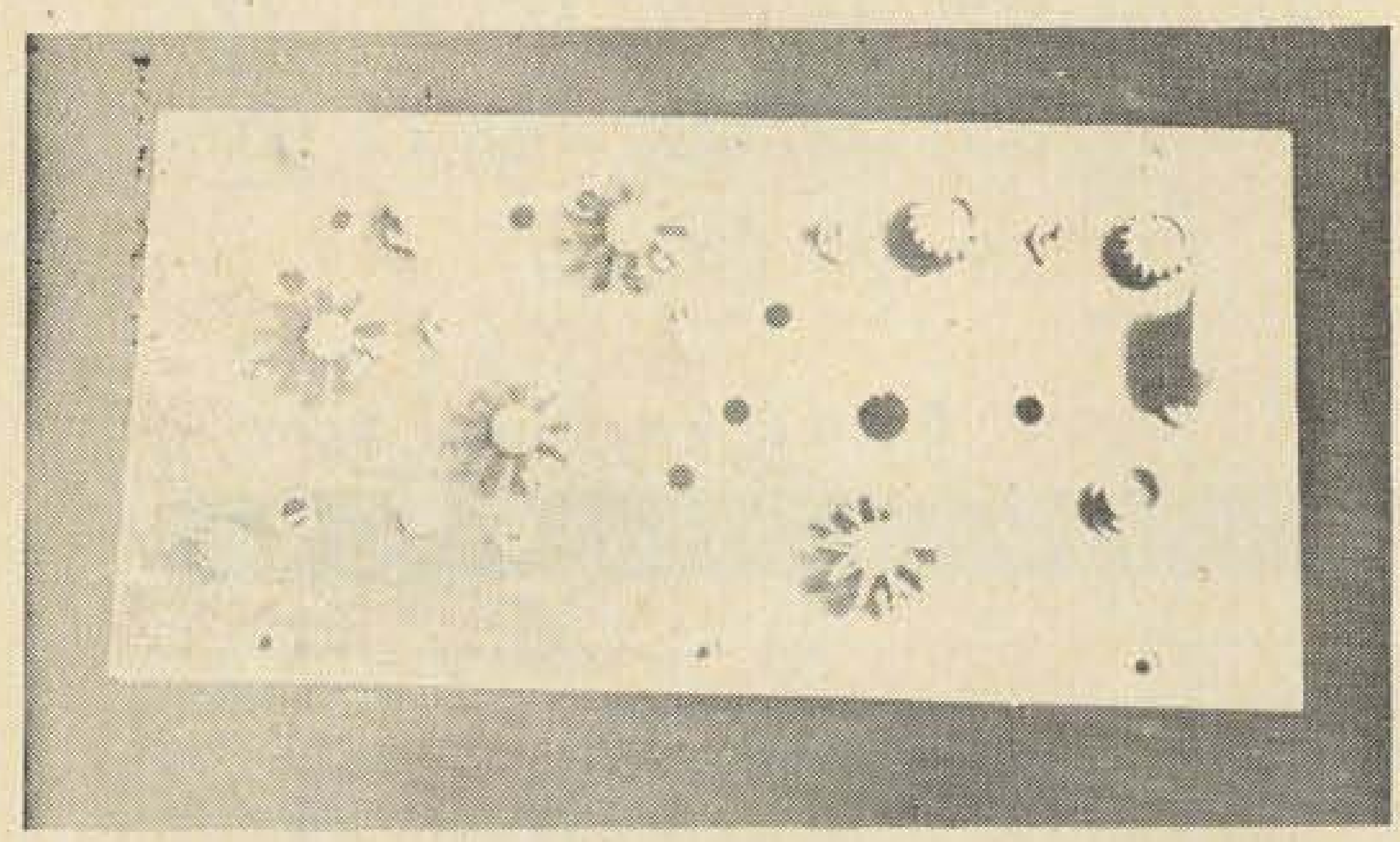
Frank C. Jones, W6AJF
850 Donner Avenue
Sonoma, California 95746

The RCA 2N5188 power transistor is a recent type rated at 4 watts maximum dissipation and is available for 55 cents apiece. It was designed for core-driver and line driver as well as class C *rf* service. Its f_t of 325 mhz means it will operate well up thru 50 mhz in class C operation, and fairly well up thru the 144 mhz or two meter band. Some 2N5188 transistors are better at 144 mhz than others, so the "hotter" ones should be used in the last two stages of the exciter illustrated here. These transistors were used throughout the exciter.

The 2N5188 has a maximum rating of 25 volts from collector to emitter, and 5 volts from base to emitter. The maximum power rating of 4 watts is for a case temperature of 25° C. Allowing for some temperature rise (at a derating of 23 mw per °C) and the use of small heat radiators, still means that about 1 to 2 watts input can be run into these transistors. In this exciter, the output amplifier runs about 1 to 1¼ watt input with from .4 to .5 watt output on CW, with a 12 volt battery power supply. An 18 volt supply and large heat radiator should result in more than one watt output. CW keying probably could be done in the base bias resistor return connection to ground of any stage or two stages.

The 2N5188 output amplifier was compared with 2N3512 and 2N3553 transistors. The latter was about 20% better in output at 148 mhz but cost about nine times as much as the 2N5188. The 2N3553 isn't too effective with a 12 volt supply, being designed for 28 volt operation, so these tests at 12 volts weren't really fair to the 2N3553 costing nearly $5 each.

The *rf* exciter shown in the photographs



Top view of 2N5188 exciter. Crystal oscillator, buffer and tripler along the top of the 8x4" copper plated board. The doubler, buffer and final amplifier are toward the lower edge.

and in the circuit diagram, was built on a piece of copper plated bakelite or epoxy board 4x8 inches in size. This fits into a 4x8x2 inch chassis as a bottom cover and shield can. The copper plating makes a good ground surface for mounting small variable condensers and can be soldered to with a 25 or 50 watt soldering iron. By-pass condenser and emitter leads should be very short to help maintain stability.

Two types of heat radiators were used on the transistors. Both types are snug fitting on the TO-39 transistor case. The "fin" type is less expensive unless one happens to find the smaller "ribbed" type in the surplus market. The two ribbed units shown in the top view are surplus radiators or coolers and were used on the oscillator and buffer stage. The first two transistors do not require a cooler since their collector current runs between 15 and 30 ma, at 12 volts, but the following tripler, doubler and amplifiers do warm up and need one type or the other. The collectors are connected to the TO-39 case, so a large cooler or radiator does increase the 8 pf output capacitance somewhat. This effect can be taken care of in the circuit design.

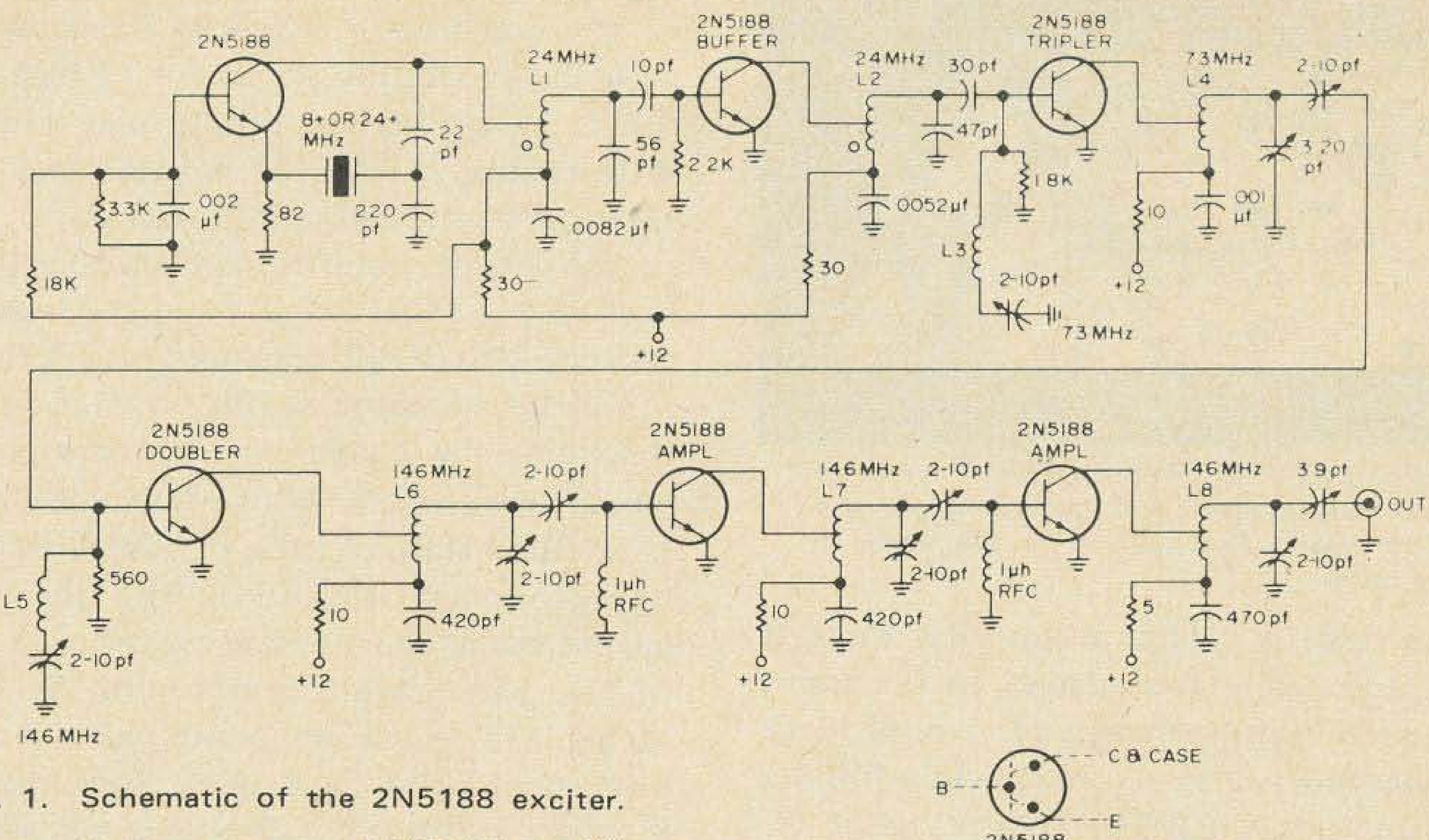


Fig. 1. Schematic of the 2N5188 exciter.

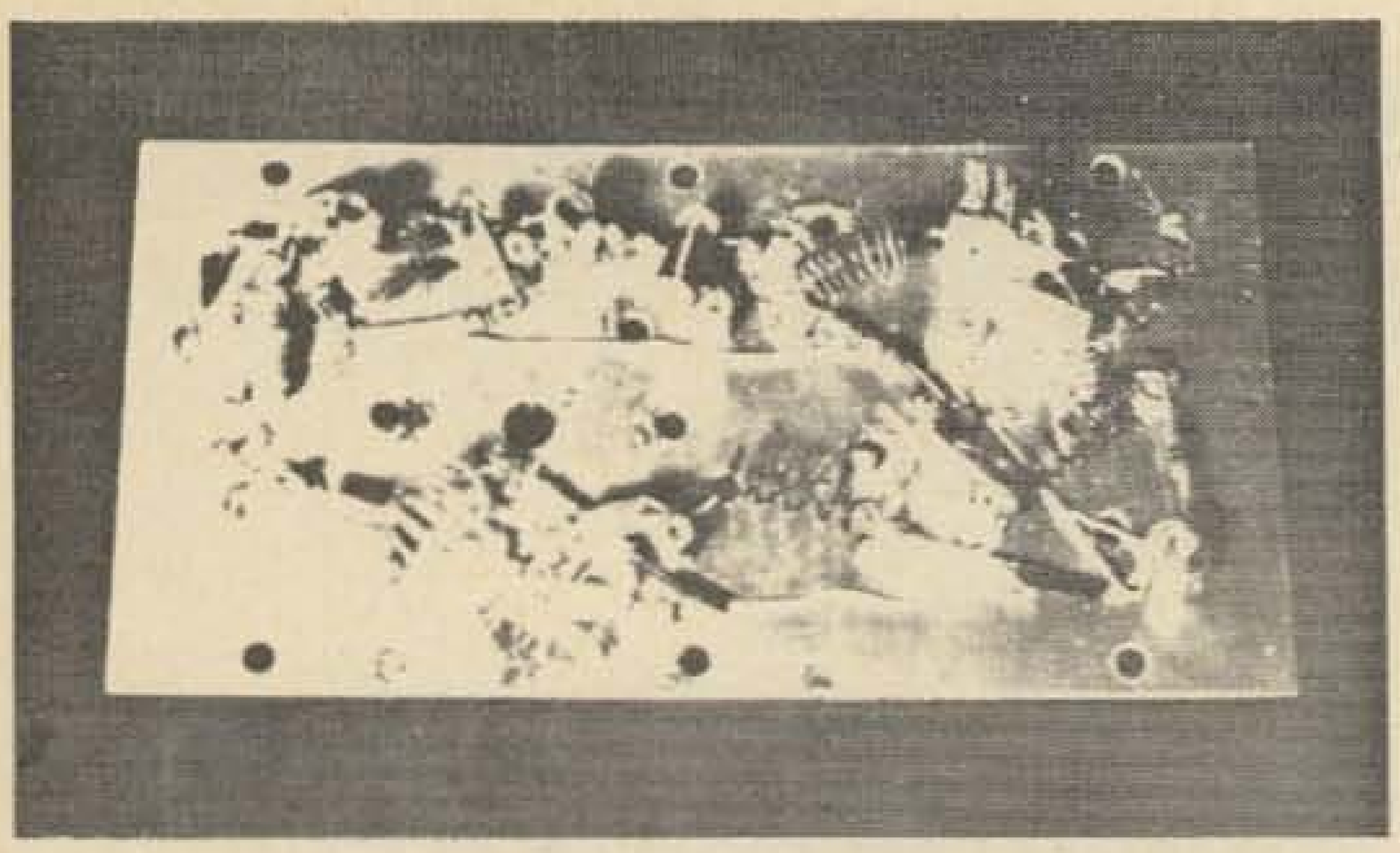
L1-L2 10 turns 22 enamel 5/16" long, ¼" diameter. Fr. slug coil form.
L3 20 T 24C, ½" long by ¼" diameter poly rod form.
L4 10 T #18, 3/4" long ¼" diameter tap 3 turns up.
L5 10 T #24C, ¼" long by ¼" diameter poly rod form.
L6 6 T #18, 3/4" long, ¼" diameter tap 2½ turns up.
L7 6T #18, 1" long, ¼" diameter tap 2 turns up.
L8 5T #14, 5/8" long, 5/16" diameter tap 1 turn up.

The 2N5188 transistors were found to be quite stable at two meters in grounded emitter circuits, without any form of neutralization. Tapping the collector leads into the lower end of each coil can be used for impedance mismatching to eliminate the need for neutralization, and also to provide a fairly high Q tuned circuit. The output load resistance of the 2N5188 varies over a range of from about 600 ohms down to about 100 ohms in this exciter, depending upon the dc collector current. The base to emitter impedance is lower, ranging from about 50 ohms down to 25 ohms. These low values can be matched to the tuned circuit values of 1000 to 2000 ohms by either using adjustable link coupling or by small coupling capacitors. The latter method was used in this exciter. The total C and L values in each circuit were chosen to have a Z of from 15 to 25 in order to reduce unwanted harmonics with only a single tuned circuit between each stage. Many circuits shown in transistor handbooks and in some magazine articles, are so heavily loaded by the transistors that the operating Q may be closer to 3 than to the 15 or 20 needed for harmonic suppression. A tripler should be used as a tripler not a combined doubler, tripler and quadrupler, since only the tripled frequency is useful. The same reasoning holds true for doubler and amplifier stages.

The crystal oscillator is a type that will function with either 8 or 24 mhz crystals for output at 24 mhz. The slug tuning adjustment is more critical with 8 mhz crystals than with 24 mhz overtone crystals. The buffer stage was lightly coupled to the oscillator to insure good oscillation starting ability with 8 mhz crystals. Both types of crystal were tested in the exciter with good results in either case.

A buffer stage at 24 mhz was needed in order to drive the tripler stage to 72 mhz, or higher. The tripler stage requires a higher value of base bias resistance than for a doubler. The rule used here was to try different values in each stage so as to produce enough *rf* drive to the next stage, but not run into the problem of too high a peak voltage across each base to emitter. Remember, the absolute maximum base voltage on these transistors is 5 volts, so often low values of resistors, or none, (only a *rf* choke) is required in each stage.

The doubler and tripler stages function by waveform distortion across the base to emit-



Bottom view of 2N5188 Exciter. Crystal oscillator at upper left and 2 meter stages near bottom side. See text for explanation of extra holes.

ter bias resistor. This means that there is double and triple frequencies in the input side of these transistors and a low impedance path is needed, just as in a parametric doubler using varactors. Small high Q series tuned LC circuits were connected from base to ground in each frequency multiplier stage. The output power increases greatly as these circuits are series tuned to resonance with the transistor output circuit also tuned to resonance. This effect is particularly noticeable with low power supply voltage and low driving *rf* power in each stage. The 2N5188 is a double diffused epitaxial planar transistor of the silicon NPN type, not too far different from a varactor diode. Probably some parametric frequency doubling action takes place since a straight doubler or tripler generally has very low *rf* output at low supply voltages.

Small German-made ceramic (low cost) trimmer condensers were used for these series tuned circuits as well as for coupling and parallel tuned two meter collector circuits. These condensers have high enough Q and mount easily, or they can be suspended by heavy leads but do not tune smoothly when there is much *rf* current flowing through them. Small Erie or CRL adjustable flat circular types might be used. Other piston type trimmer condensers are available, but are more expensive. The German mass-produced units may not be available in radio stores, so substitution may be required in constructing this type of exciter.

Standard sized red coded ferrite slug coil forms were used in the oscillator and buffer stages. Number 18, 16, or 14 wire was wound over a ¼" and a 5/16" diameter steel drill as a temporary winding form for the higher frequency circuits.

The coil data is listed in a separate part with the proper tap points for 12 volt operation. 15 or 18 volt supply may require a little change in coil tap position and in the values of bias resistors throughout.

The output circuit is matched to a 50 ohm load with a small 3.9 pf fixed condenser but another 2 to 10 pf trimmer (or 2.5 to 7 pf) would be advisable in this position in order to couple the output into an antenna coax line or into 75 or 93 ohm coax lines to a larger amplifier stage. A tube, or a larger *rf* power transistor might be driven with the ½ watt output available from this exciter.

The parts layout starts with the crystal socket and progresses along one side of the 8x4" board and back again along the other 8" side, leaving ½" clearance on all sides. This permits the unit to be fastened to the lips of an 8x4x2 inch chassis. The extra holes in the copper plated board were not for ventilation, but resulted from numerous circuit changes and ideas tested along the way. Some people might suggest these were design errors but that is too close to the truth to be admissible by a true experimenter.

Tune up is not difficult if a 0 to 300 or 500 ma meter is connected into either the - or + leads to the battery. All stages will draw very little current, except for a few ma in the oscillator stage since it has some + bias on the base to make the stage start oscillating easily. As soon as the crystal oscillator coil is tuned correctly the dc meter reading will increase from about 12 or 15 ma to 30 or 40 ma even if all other stages are detuned from resonance. Then as each stage in turn is tuned to resonance, the dc meter reading will increase. The total dc reading will be over 200 ma when all circuits are correctly aligned for maximum output reading into a one or two watt *rf* wattmeter. A 50 ohm 1 watt resistor termination across the output jack and a diode *rf* voltmeter (5 volt range) across the resistor may be also used for reading *rf* output. Even a nearby two meter receiver S meter may be used to tune up the exciter into some form of dummy load. Nearly all circuits have to be adjusted carefully and the variable stage coupling condensers readjusted for getting maximum output. Too much capacity in these coupling condensers will lower the Q of

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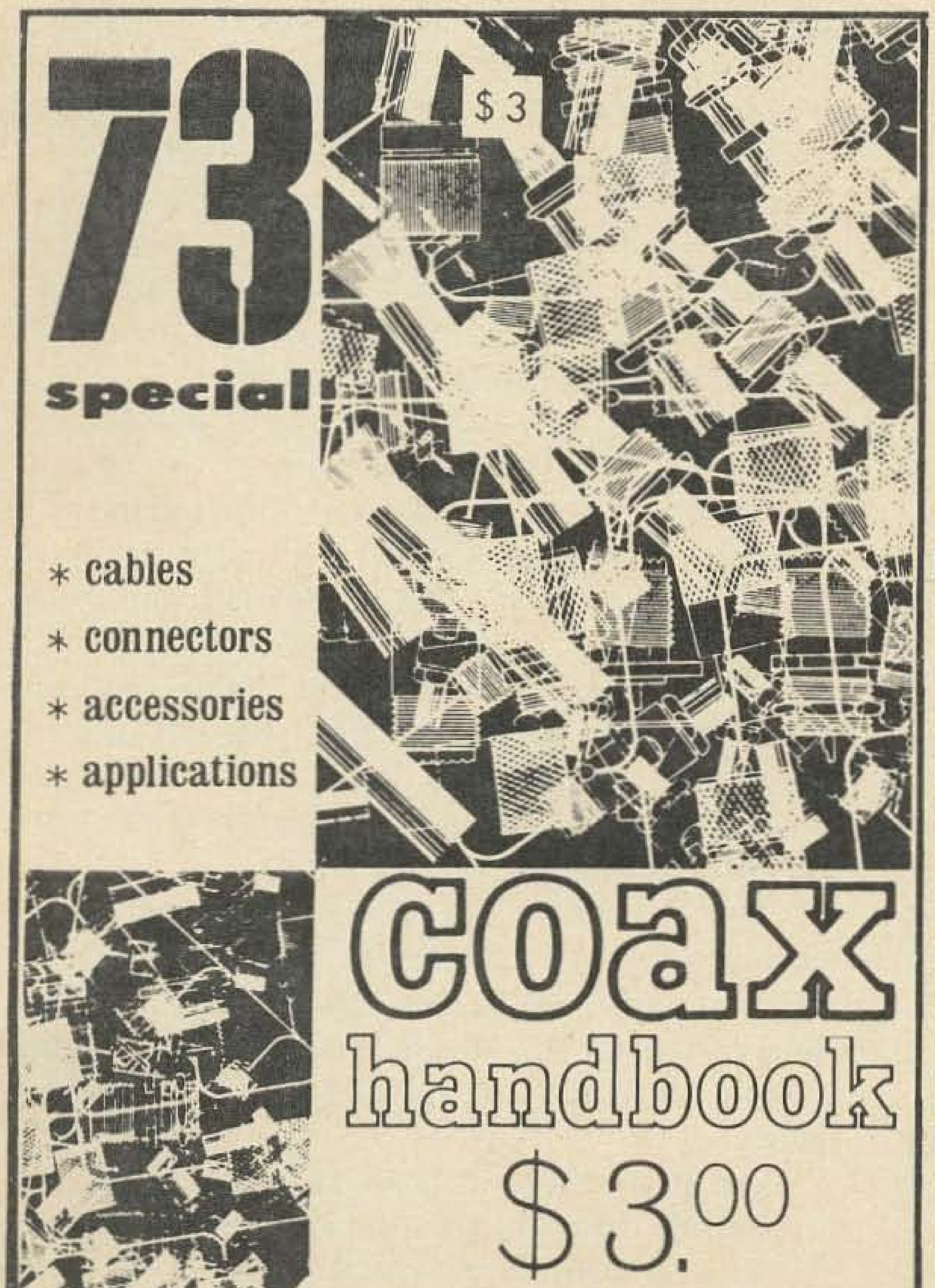
the tuned circuits too much for good spurious signal suppression. Too little will mean less output. An *rf* meter in the output of the exciter will measure spurious as well as desired frequencies. The two meter receiver S meter is a selective device reading only the desired frequency. If the various adjustments do not result in agreement on the two *rf* metering systems, one can suspect spurious oscillation or excessive harmonic power in the output system. The adjustments for maximum radio receiver and *rf* wattmeter or diode voltmeter readings should be the same. If not, start reducing coupling capacity values and retune each circuit for resonance and maximum output.

Some 2N5188 transistors have better gain at two meters so these can be used in the two meter amplifier stages. The lower frequency stages are much less critical so the weaker transistors can be plugged into these parts of the circuit. It probably has to do with the cut-off frequency of each transistor, since 148 mhz is getting pretty close to the average ft of 325 mhz. At a cost of 55 cents each, an amateur shouldn't expect perfection in each transistor. The writer has seen nearly similar variations in the' $5 types of transistors.

...W6AJF



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Part VI - Noise

Staff

One of the most annoying problems in radio communications is that of noise; many volumes have been written on various aspects of this problem. As a result, a good understanding of the noise problem is a pretty fair indication that the person having it also has a good understanding of radio communications—and so the Extra Class examination study list includes a number of questions dealing with this problem.

Now that we have fairly well digested the subject of antennas, in our previous two installments, let's move on to the noise questions, and devote this installment to them. In addition, let's examine receiver detectors—which are, in practice, closely connected with the noise problem.

The specific questions from the FCC list which we will examine are:

3. How may a limiter be employed in an FM receiver?

23. How can you distinguish between a product and an envelope detector?

24. How can a receiver be adjusted for single sideband reception when the receiver does not have a product detector?

27. Where in a receiver circuit should a limiter/blanker stage be placed to provide maximum utility?

43. What are some different types or sources of noise voltages in reception? How is each type generated?

57. Of what importance is the signal-to-noise ratio of a receiver? At what radio frequencies is this ratio most important?

As usual, let's substitute for the specific FCC questions other questions of somewhat broader scope, so that we won't be limited in our studies to specifics but instead will be able to take a more general point of view.

Since our major subject this time is "noise," a good starting point would be to ask, "What is noise?" Then we will be in position to determine, "What does signal-to-noise ratio mean?" as well as "How is noise reduced?"

We can then turn to our secondary subject for this installment and inquire "How are signals detected?" Here we will see how product and envelope detectors differ, among other things, and how to use both. Finally, we'll try to find out, "How does FM reception differ from AM?"

Ready? We're off!

What is Noise? In radio—or, for that matter, throughout science—the word "noise" has almost as many meanings as it has users. One of the first paradoxes to result directly from this multiple meaning which most of us meet is the fact that a noise limiter will do almost nothing to limit thunderstorm noise. A similar paradox is the fact that installation of a low-noise front end in a receiver usually increases the amount of ignition noise received.

So the question "What is noise?" is actually much more than a rhetoric query; before we can begin to examine "noise" we must decide just which "noise" we're talking about.

When we want to know the meaning of a word, most of us consult a dictionary. That doesn't help us much this time. An ordinary dictionary provides the following:

"**Noise.** 1. A sound that is not musical or pleasant. 2. A sound. 3. Din of voices and movements; loud shouting; outcry; clamor."

None of these seem to fit any kind of "noise" we meet in radio. Let's try a physics textbook:

"**Noise.** An electrical signal having random distribution of frequency components and of amplitude, distributed throughout the electromagnetic spectrum from zero frequency to infinite frequency."

That's closer. Translated from the engineeringese, this is a precise definition of the kind of noise developed in a high-gain amplifier. That is, it's the hissing or frying sound which provides an absolute limit to useful gain.

But it doesn't even mention the effect of a passing dune-buggy on a 10-meter signal. To find a definition which will include that kind of "noise," we must go to Information Theory:

"Noise. Any portion of a received signal which was not present in the transmitted signal."

That one, at first, seems to wrap it up with a definition which includes not only the sputtering ignition of passing autos, but atmospheric crashes and the physicist's kind of noise as well. This one, in fact, includes all interference of any sort as "noise."

But hold on there! This information-theory definition would even include qrm as "noise"—and while it would be nice, nobody expects any kind of noise limiter to get rid of interferring signals from other transmitters (though it would be worth while working out one which would do so, were it possible.)

So the common definition has little to do with radio, the physicists' definition is too narrow, and the information-theory definition is too broad. Can we ever answer our question, "What is noise?"

As it happens, we can. If we couldn't we wouldn't have asked it in the first place, naturally. What we must do is to break the broad term "noise" down into several more-limited categories, which we'll call "hiss," "sputter," and "crash" for our examination. Keep in mind, though, that these are only *our* names for them; the FCC will want other names which we'll dig out as we go.

Hiss is the physicists' kind of noise—random voltages which come out of a speaker as a hiss or frying sound. If you've ever turned a good amplifier all the way up with no input signal applied, you've probably heard hiss.

Sputter is ignition noise, electric-motor interference, and the like. Strictly speaking, these are "signals" rather than "noise," but they are so completely unlike the signals we expect to receive that the information-theory meaning of "noise" has come to apply. A graphic example of this is provided by radar pulse interference to uhf operators; the radar pulses are most definitely signals—but to the ham trying to dig through them, they're just so much noise and he has developed circuits to blank them out.

The final category, crash, is like sputter in many ways. The most common crash is the atmospheric static resulting from lightning strokes which wreaks havoc on 40 and 75 meters during the summer thunderstorm season.

The differences between hiss, sputter, and crash are easy to hear but difficult to describe. An oscilloscope display of the waveforms shows many of these differences. Figs. 1 through 3 are approximations of typical hiss, sputter, and crash waveforms respectively.

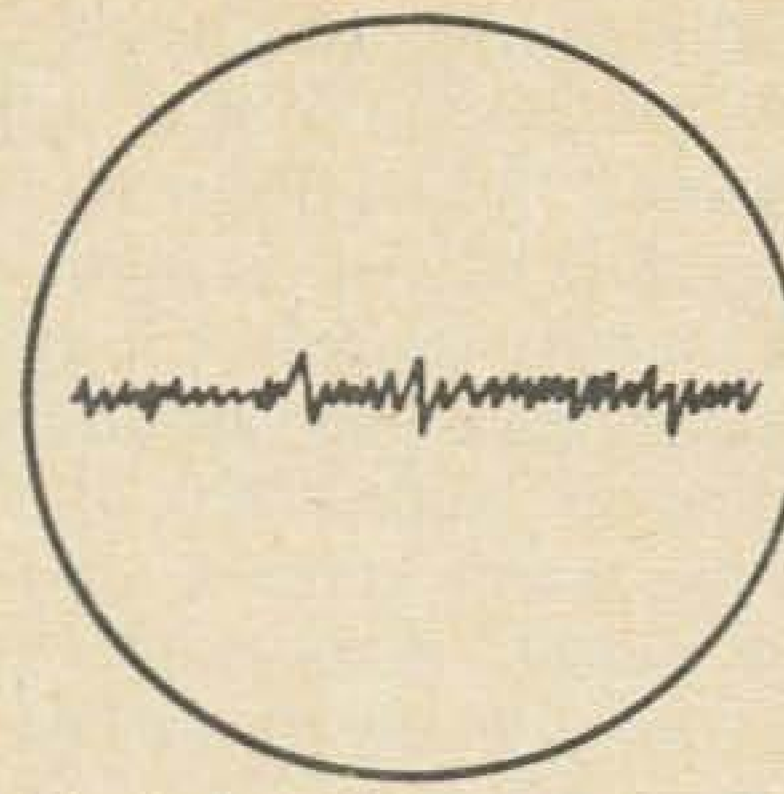

Fig. 1. Typical oscilloscope trace of "hiss," or random electrical noise due to thermal agitation. Origin of British term "grass" is obvious from waveform.

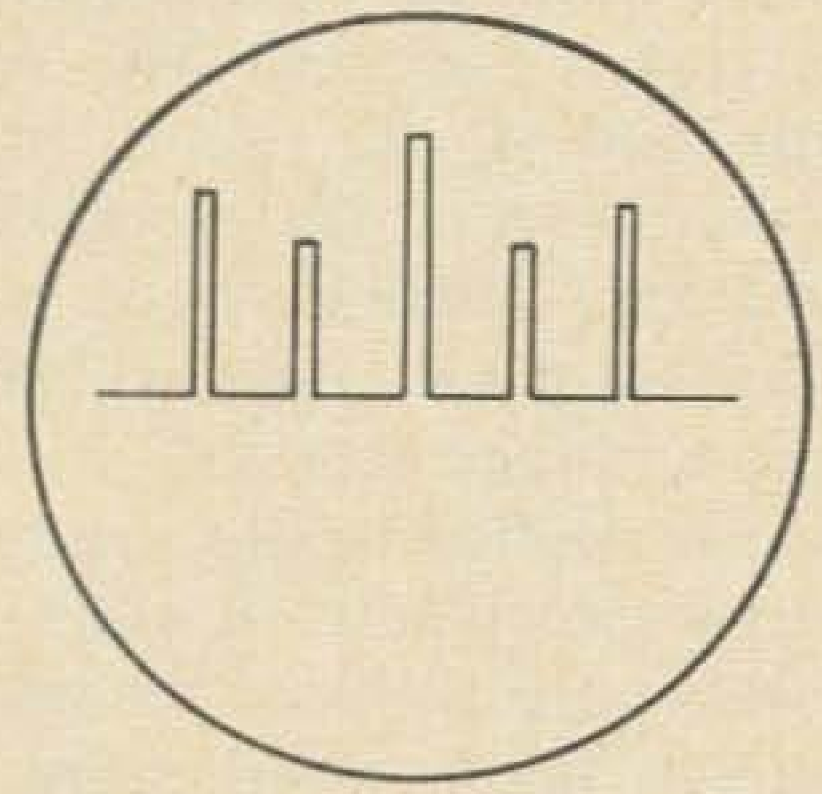

Fig. 2. Typical scope trace of "sputter," or impulse noise. This type of noise is distinguished by brevity of its pulses and usually regular recurrence rate. Most common source of sputter is by radiation from spark plugs in automobile ignition circuits, but it may originate elsewhere as well.

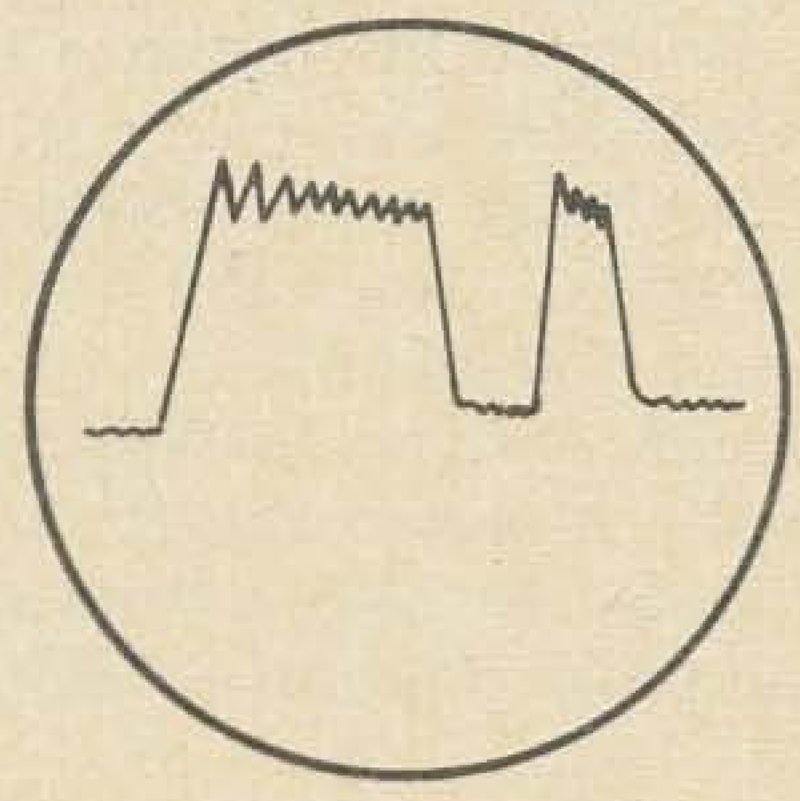

Fig. 3. "Crash," or atmospheric noise, presents waveforms such as this. Origin is spark discharge of lightning bolts; duration and magnitude of pulses are both larger than for sputter, and periodic repetition rate is absent.

While hiss is a relatively low-energy type of noise which is almost always present, sputter and crash are brief high-energy pulses. Sputter consists of shorter pulses which recur at a regular repitition rate, and crash is made up of longer pulses which occur only sporadically.

Some of the sources of hiss are "Johnson noise," "galactic noise," "shot noise," and "partition noise." In addition to these "official" names, hiss is also known as "grass" in industrial electronics where it plays a vital part. This unofficial name was adopted from British radar usage, and a look at **Fig. 1** will show where the name came from originally.

"Johnson noise" is possibly the major source of hiss in any electronic circuit. This noise actually consists of the net effective movement of the electrons in any conductor or resistor. At any temperature greater than zero—which has never yet been attained—electrons are always in motion. This motion is unpredictable and so we call it "random." The random motion of the electrons in the circuit produces a small current, and if any resistance is present (as it always is) the current develops a voltage across it.

If any heat is applied to the conductor, its energy must go somewhere. It ends up for at least a time in the electrons of the conductor, where it makes them move more rapidly. This increase in motion increases the current flow, and so increases the Johnson noise.

Since the motion is completely unpredictable, it will contain frequency components all the way from the lowest frequencies imaginable to the highest, and with strengths (which depend upon the distance moved by each electron) over an equally wide range. The average strength is low, though, because the noise is spread over such a wide band.

The greater the bandwidth of a circuit, the more Johnson noise the circuit will amplify. This is one reason that the noise of an amplifier is affected by its bandwidth, and wideband amplifiers appear to be inherently more noisy.

Johnson noise is present in all conducting or resistive materials, and this includes the very thin plasma of ions which apparently pervades outer space. The resulting radiated noise which comes from outside our planet is usually called "galactic noise," however, to distinguish it from more mundane noise sources.

While Johnson noise is inherent in the nature of matter, and galactic noise is simply a form of Johnson noise originating outside our planet, shot noise and partition noise are connected with the way in which we amplify electrical signals. Although the terms originated in the days before transistors, similar effects are present in solid-state circuits and are often called by the same names.

Shot noise originates at the cathode of a tube and makes itself felt at the plate. You may recall that a tube operates by boiling electrons off the surface of the cathode and then controlling their flow to the plate circuit. Think back to the last pot you watched boil, and you'll remember that boiling is a rather violent and unpredictable action. At one instant many pockets of vapor may bubble up, and at the next instant none.

Electrons boil off the cathode surface in the same manner. While we know that in any easily measurable period of time a constant number of electrons will leave the cathode, we do *not* know just how many are going to leave in the next instant. They may wait a moment longer and then leave, or they may leave just a trifle sooner.

These random or unpredictable fluctuations in cathode emission effectively modulate the assumed steady flow, with variations which are electrically indistinguishable from Johnson noise.

We feel the effects only at the plate circuit, when the varying stream of electrons arrives. And, strangely enough, we usually attribute this noise to an imaginary resistance in series with the tube's grid, inside the tube, which we call the "equivalent noise resistance" of the tube, so that we can calculate the noise by the same equations used for Johnson noise.

Partition noise is similar in its origin to shot noise, and identical in its effects, but only afflicts multi-element tubes. Triodes are free of partition noise, and this is the major reason why triodes are preferred when extremely low noise must be attained in a circuit.

Partition noise comes about because any individual electron in the electron beam from cathode to plate *may* be captured by some other tube element such as the screen grid. We know that the screen will capture a certain proportion of the total number of the electrons flowing, to produce the screen current, but we cannot determine which or when.

This capture of random electrons amounts to a "partitioning" of the total cathode current between plate, screen, and any other positive elements inside the tube. Each electron partitioned out of the plate current never reaches the plate—and its absence produces a variation in the plate current which is called partition noise.

While shot noise is determined primarily by the design of any specific tube type, partition noise is determined by the operating voltages chosen by the circuit designer. The greater the current flowing through the screen and similar elements, the greater the partition noise which will result.

Unlike these forms of hiss, the "noise" we are calling sputter is not inherent in the nature of our components and our circuits. It's really a form of undesired signal, radiated from its source and picked up by our receivers. Most noise-limiter circuits are intended to operate only on sputter.

The two most marked characteristics of sputter are the shortness of its pulses and the magnitude of its peak voltage. Most sputter, but not all, originates in the ignition circuits of internal-combustion engines, where it's radiated by the spark-plug wiring and spark gaps themselves.

The width of most sputter pulses ranges from one to 10 microseconds, which corresponds to a single cycle of a 2 mhz to 200 khz signal, respectively. This, as you can imagine, isn't very long. The repitition rate is determined by the speed at which the engine causing the sputter is running, but is usually relatively slow.

The only major difference between crash and sputter is that sputter, being caused by man-made sources, has less energy and lasts a shorter time. Additionally, while sputter recurs at a more or less regular rate, crash occurs only sporadically.

Since crash lasts longer, it's not as easy to get out of the signal. For this reason, most ANL circuits appear to be ineffective against crash although they usually perform at least acceptably against sputter. Actually, the circuits are performing the same function against either type of noise, but the crash remains objectionable after being limited while the briefer sputter is reduced to a livable level.

What does signal-to-noise ratio mean? We meet the phrase "signal-to-noise ratio," often abbreviated simply as "S/N," almost everywhere in electronics.

Information theory experts apply it to their studies, computer engineers study it in their digital communications networks—and radio operators curse it when the dx fades down into the mud.

In radio, we usually endow "signal-to-noise ratio" with a special restricted meaning, which is similar to but not identical with its meanings in other areas of electronics. When we use the phrase, we most usually mean specifically the ratio between the residual noise level of a receiver and the weakest signal that receiver can detect. It has nothing to do with sputter or crash, even though they may render a signal uncopiable. When used in this sense, signal-to-noise ratio is most often expressed in decibels, and we say for instance that the S/N ratio of a receiver in a given situation is +3 db.

In commercial broadcasting, a S/N ratio of +60 db is not uncommon, but most amateur signals (except for "armchair copy" situations) run in the range from +3 to +20 db. Any signal whose S/N ratio is less than +3 db is excessively difficult to copy although some experts can dig them out of the mud down to 0 db. Signals which are below the noise level, with a resulting S/N ratio less than 0 db, are literally buried and only sophisticated reception techniques can bring them out.

We saw earlier that hiss is equally distributed over the entire frequency spectrum. Among other things, this means that the wider the receiver's bandwidth the more hiss can be received; any single signal, on the other hand, has a limited bandwidth. If the receiver's bandwidth is wider than necessary to let the signal through, the signal level will not be affected but the level of hiss will be higher. The best S/N ratio for a given signal is obtained when the bandwidth is just wide enough to admit the signal. Then the least possible amount of hiss gets through to compete with the complete signal. For really weak signals, it often helps to cut bandwidth still more and lose some of the signal. This relationship between bandwidth and S/N ratio is one of the major advantages CW transmission enjoys in weak-signal work; the CW signal requires only a few cycles of bandwidth while any voice transmission requires much more, and the wider bandwidth lets more noise come through.

To specify the S/N ratio of a receiver, the signal itself must also be specified. A conventional method of measuring S/N ratio is to start with no signal input and measure the noise output, then introduce a slowly increasing signal level until the output power level doubles. This is the +3 db point, and the signal level which produced that condition is the minimum signal for which the receiver can produce a +3 db S/N ratio.

Another method of measuring is to introduce an arbitrary level of input signal—for instance, 1 microvolt—and determine the ratio of power output with signal to that without signal. In this case the result would be a specified S/N ratio for 1 microvolt input, while with the more conventional method the result would be a specified number of microvolts input for +3 db S/N ratio.

Measurements such as these are always

made under more or less ideal test conditions, but receivers in use are usually connected to an antenna in order to receive radio signals. Atmospheric and galactic noise offer additional sources of hiss to a receiver in use, which are not present under test conditions, and these additional hiss sources modify the usefulness of S/N ratio readings as comparisons of receiver quality.

If a receiver is capable of producing a +3 db S/N ratio with 1/10 microvolt input, and a second unit can produce the same S/N ratio with 1/100 microvolt while a third requires 10 microvolts to do as well, then it would seem obvious that the second receiver was 10 times as sensitive as the first while the third was 100 times less sensitive.

But if, in use, the antenna always furnished 20 microvolts of atmospheric and galactic noise, you wouldn't be able to tell the differences between the three receivers in your shack! Any one of the three would be better than necessary under such conditions.

On the other hand, if the noise level from the antenna never exceeded 1/1000 microvolt, the difference in sensitivity would be easy to tell in use since none of the units would reach the antenna noise.

The amount of "antenna noise," which includes all types of hiss and other noise coming in on the antenna lead-in, will naturally vary from location to location. It also varies from band to band. Man-made noise tends to predominate on the lower-frequency bands. Atmospheric and galactic noise provide the major part of antenna noise in the uhf regions and above.

When man-made noise provides a "floor," a receiver need not be excessively sensitive in order to reach that floor. For this reason the 5-tube ac-dc "All-American Five" works well on broadcast bands, and some near relatives of this simple receiver serve credibly on 40 and 75 meters. As frequency goes up, though, the sensitivity of the receiver must be progressively greater in order to be certain that you can detect any signal that's above the antenna noise, because the amount of antenna noise is going down as frequency increases.

By the time you get to the 10-meter band, S/N ratio of the receiver is important, and as you move into vhf operation it becomes ever more so. Low-noise receiver designs (which are actually low-hiss designs, to improve receiver sensitivity) predominate at vhf.

Fig. 4 is a graph of antenna noise versus frequency for two extremes of location; most situations will fall between these extremes. As you can see, for the lower bands S/N ratio of a receiver isn't something to worry about—but if your interest is in uhf, it's one of the most important items to be concerned with. Like most aspects of this fascinating activity of electronics, it all depends upon your viewpoint.

How is noise reduced? Noise reduction, as you must have surmised by now, offers not just one but several problems. The first is that of just which noise you're trying to reduce. Any measures to reduce hiss and consequently increase receiver sensitivity are most likely to increase sputter by making it more readily detectable.

Most noise limiters (including "blankers" and "silencers") are intended to reduce sputter, while most "low noise" circuitry is intended to reduce hiss. To cover our subject properly, we must examine both problems.

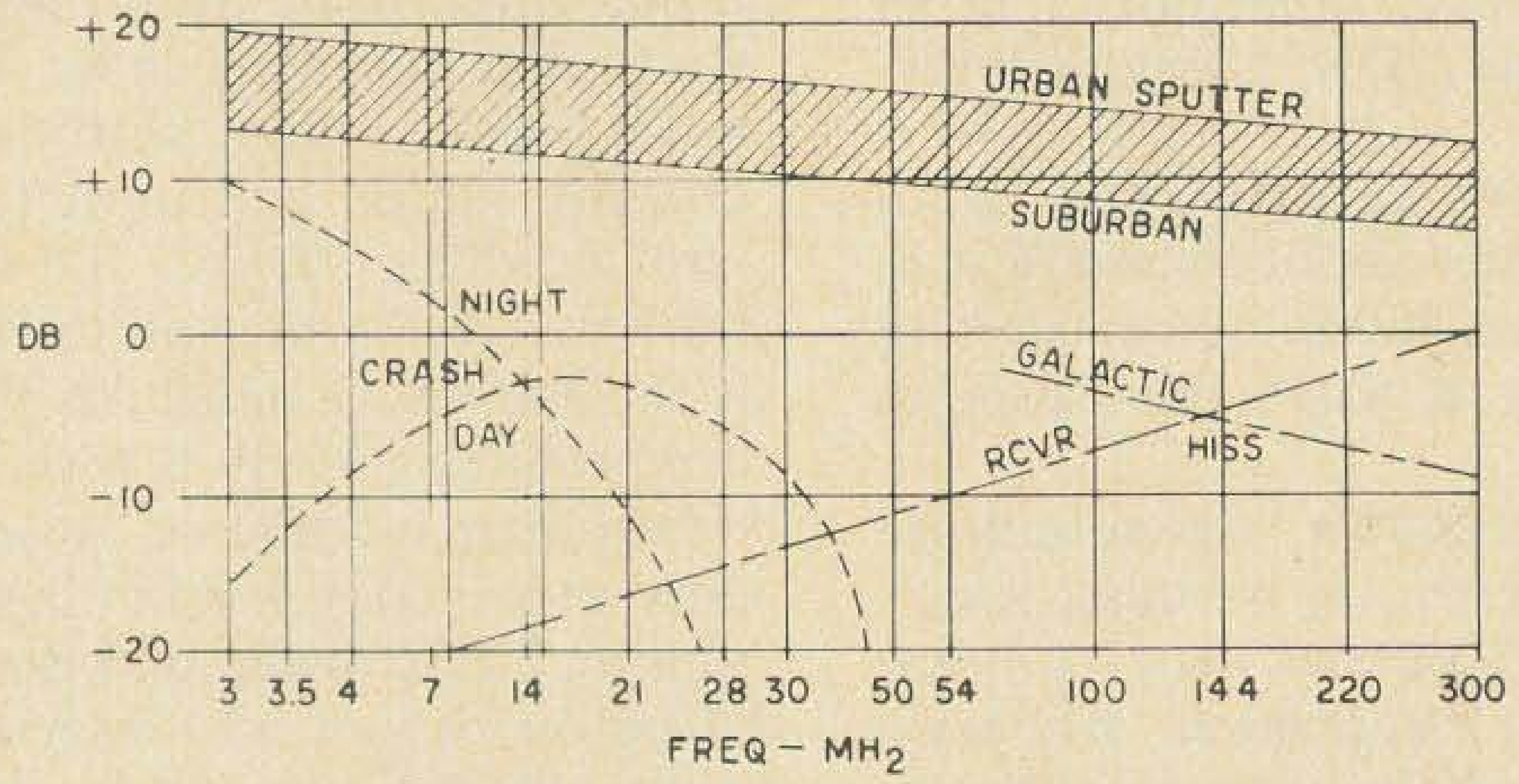

Fig. 4. Various sources of antenna noise and their average strength with respect to frequency are shown here. The 0-db point represents a field strength of 1 microvolt per meter; ham bands from 3 to 300 mhz are indicated on frequency scale. All curves are "median values," which mean that they will be exceeded as often as they will not be met. Receiver-noise curve, shown for comparison, is that of a typical tube-type receiver; exotic low-noise techniques are not considered.

Much of the material we'll explore in this section is presented in more detail in the *73* handbook, "Receivers" (plug), if you're interested in doing more with it than just learning the principles upon which it operates.

Let's look first at the circuitry intended to reduce hiss. This "low noise" area almost always involves the *rf* amplifier and/or mixer stages of a receiver, because any hiss that gets in in the early stages can't be taken out later.

Much has been written on the subject of noise (meaning hiss) in *rf* amplifiers, and you may be convinced already that for low hiss only triode tubes should be used. Don't believe it. A good transistor has lower noise than any tube, and a good pentode tube will out-perform a fair triode. In fact, a few pentodes are available which will out-perform almost all triodes—but they're expensive.

In general, though, when tubes are involved, triodes tend to have less noise because they're free of partition noise. They do, however, have less gain than pentodes, together with a tendency to oscillate unless neutralized.

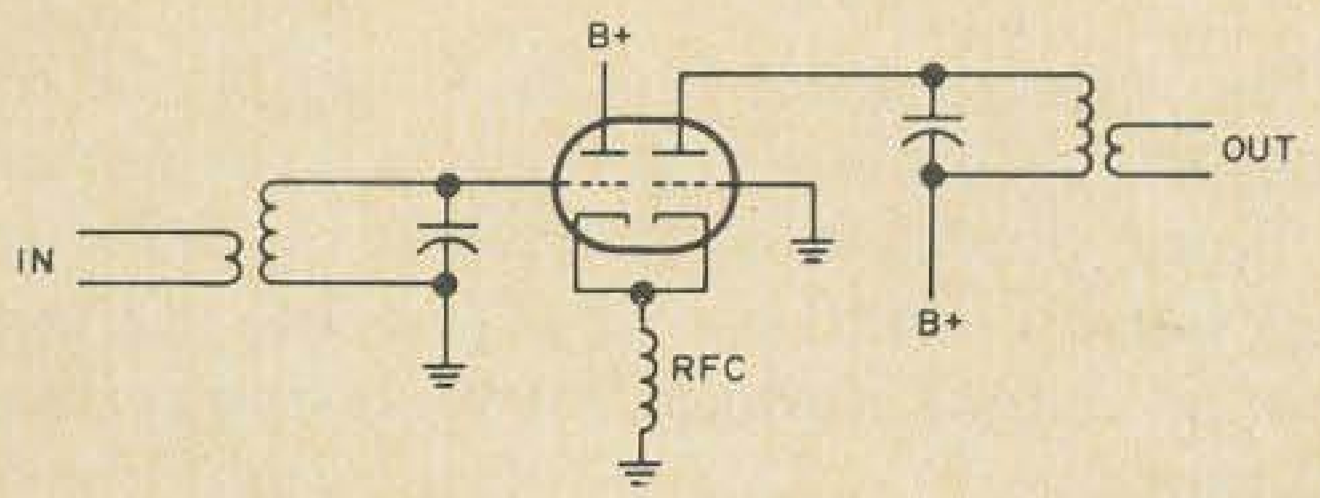

Fig. 5. Cathode-coupled amplifier schematic diagram.

A number of special low-noise circuits have been developed to overcome these disadvantages of triodes. Among them are the cathode-coupled amplifier (**Fig. 5**) and the cascode circuit (**Fig. 6**). Both use two triode stages to provide the gain obtained by a single pentode, but twin-triode tubes were developed in the early years of TV to make such circuits competitive with pentode amplifiers.

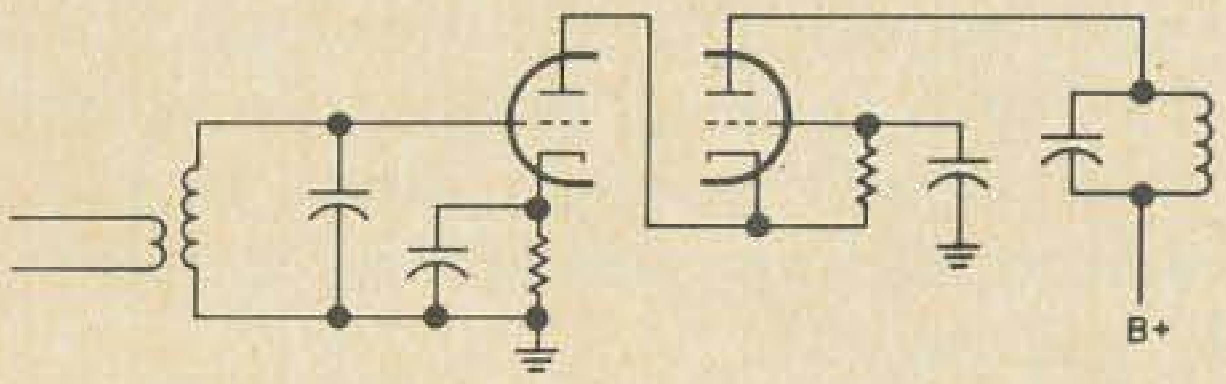

Fig. 6. Cascode amplifier schematic. This is series cascode circuit; the two tubes can also be shunt-connected but circuit is much more complex and performance is no better.

The cathode-coupled amplifier is essentially a grounded-grid amplifier, preceded by a cathode follower to match its low input impedance. The cathode follower has no voltage gain, and the grounded-grid has little

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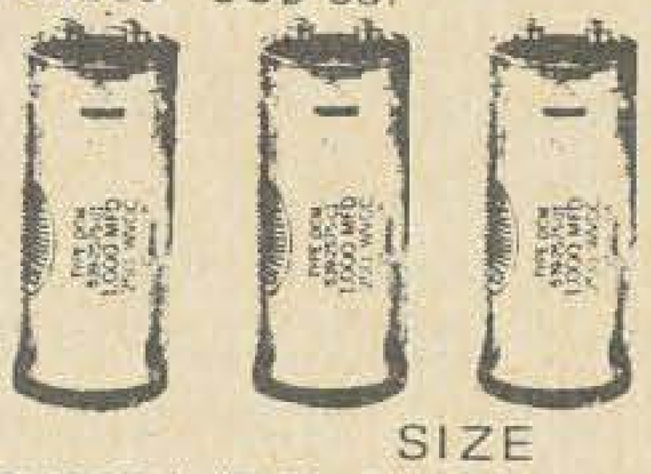

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35,000 MFD- 12 VDC	2" x 6"
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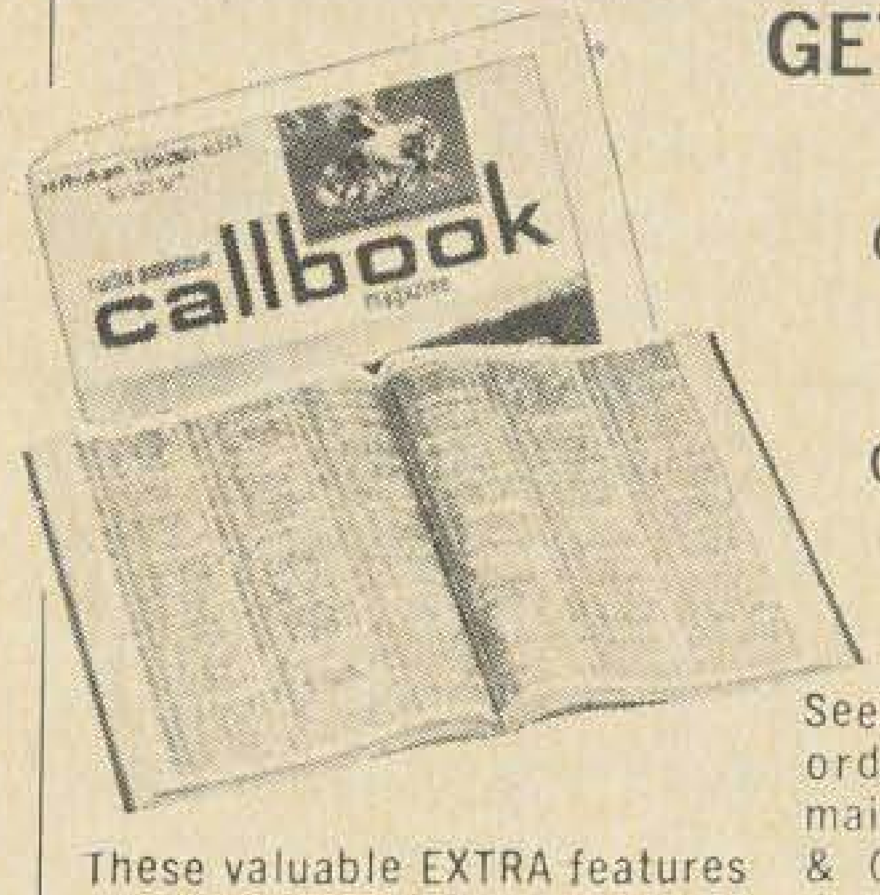

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output-to-input feedback, so this circuit won't oscillate any more readily than would a pentode stage.

The cascode circuit is similar, with its grounded-grid output stage, but the input half is a conventional grounded-cathode stage rather than a cathode follower. The first stage is so loaded down by the grounded-grid's low input impedance that it cannot oscillate, even though it does have some voltage gain. The result is higher gain for the cascode than for the cathode-coupled, and equally low noise. Since its declassification in 1945, up until transistors came into wide use, the cascode was virtually the standard circuit for TV-receiver front ends, and became deservedly popular among vhf hams also.

Neutralized triode stages are also in wide use, as are plain grounded-grid circuits. The purpose of all of these approaches is to amplify weak signals to a level much greater than the Johnson noise of the rest of the receiver, while adding as little hiss of their own as possible. When receiver noise is an important factor, the first *rf* stage is the critical one; its noise level controls the noise level of the entire receiver.

The second receiver stage, though, is next most critical, and in many receiver designs this second stage is a mixer circuit. Mixers are inherently more noisy than are amplifiers for a number of reasons. One is that a mixer must combine two signals, and each of these signals has at least some noise in it. The output contains all the noise of both inputs.

In addition, the new signal created by the mixer is the difference between the two input signals, and at, at least one point in the mixing process, its strength is much less than that of either input signal. Thus the noise (which spreads across the entire spectrum) becomes a larger portion of the output signal.

Finally, in order to obtain mixing action of the type desired in a receiver the circuit must operate in a non-linear manner. The conditions which produce the desired non-linear operation also, in general, produce more noise.

Fortunately, it's possible to reduce noise in a mixer stage in several ways. One of the simplest—and it's so effective that it's still the standard technique in much uhf work—is to use a passive mixer rather than an active one; most often, a silicon diode is used as the mixer. This type of mixer does its work with the smallest noise contribution, but the output signal still contains noise from both the original input signals.

If gain is desired in the mixer stage, and it most usually is, then a low-noise mixer circuit can be used. Fig. 7 shows one twin-triode mixer which has as little mixer noise as any vacuum-tube circuit available; the resemblance to a cathode-coupled amplifier is obvious and the only major difference is that the second input is applied to the grid which is grounded in the amplifier circuit. Since the output circuit is not tuned to the same frequency as either input there is little tendency to oscillate and screening action is not so necessary.

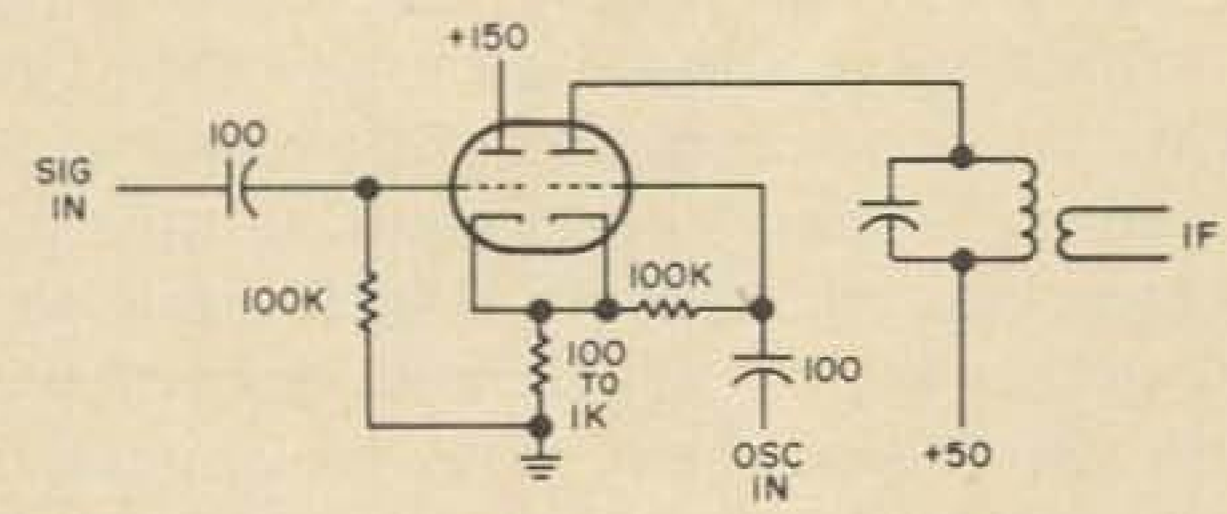

Fig. 7. Low-noise twin-triode mixer circuit first popularized through article in October, 1961, issue of 73. Circuit was taken from design by K. A. Pullen. Noise is as low as that of cathode-coupled amplifier which this circuit resembles.

The ultimate limit to which hiss can be reduced in a receiver is reached when the antenna noise produces a noticeable increase in total noise output, but it *is* possible in some cases to reduce noise of the receiving system still more.

If antenna noise is setting the floor for signal reception, and an omnidirectional antenna is in use, there's a chance that some of the antenna noise is coming from a different direction than is the signal. Use of a directional antenna will then cut down on the noise picked up by the antenna, and may thus reduce antenna noise.

If the reduced level of antenna noise is still setting the limit for weak-signal reception nothing will be changed. However, it's possible—and frequently turns out—that the reduced antenna noise is once again lower in level than internal receiver noise; in such a case, additional improvement in receiver sensitivity will pay off.

How about reducing sputter? A look back at Fig. 2 will show that sputter is characterized by high-intensity, sharply rising pulses of energy. Most of the time they're absent, but when one hits a receiver's circuits the result is chaos for the duration of the sputter pulse.

The high-energy pulse causes *if* transformers to "ring," overloads amplifier circuits, charges up the avc circuits to reduce receiver sensitivity, and after doing all this comes out as an ear-shattering smash of sound.

If each of the pulses could be limited in strength to a level no greater than that of the strongest component in the received signal, things would be much better. You would still hear the sputter, but it wouldn't blanket the signal out completely because the signal is there most of the time and the sputter is present only a small part of the time.

As their name implies, most noise limiter circuits have exactly this purpose: to *limit* the incoming signal level. An automatic noise limiter adjusts its limiting level automatically to that of the signal; any sputter pulse which exceeds this level is trimmed off or limited at its top.

If, though, instead of merely limiting the pulses, we could make the receiver completely dead until the pulse disappears, then we would blank out everything for the duration of the sputter pulse. We would have "holes" in our signal, but they would be quite short, and would be holes of silence rather than of noise.

That's the way a noise blanker works. It doesn't kill the entire receiver, but it blanks the output at some early stage whenever a sputter pulse is present, and lets through only the signal.

While the noise in the audio output is bothersome, it's only a small part of the damage sputter does to the receiving process. The ringing of circuits all through the receiver makes the pulse appear to last much longer than it actually does, and the reduction of sensitivity can make it impossible to detect signals of quite respectable strength. A noise limiter removes only a part of the problem, since it usually operates only upon the recovered audio. A blanker, on the other hand, is usually placed at the earliest stage in the receiver at which adequate signal level is available, and thus takes out most of the problem.

Most often, the blanker is placed between the mixer stage and the *if* amplifier. Noise may get as far as through the mixer, but no farther.

Many different types of limiter and blanker circuits exist; they are far too numerous to examine in detail here. The *73* "Receivers" handbook includes diagrams of many.

Crash has much the same waveform as sputter, but the pulses are longer and frequently are more powerful as well. This difference in duration and strength is just enough to make a limiter or blanker circuit which works well against sputter appear to be inef-

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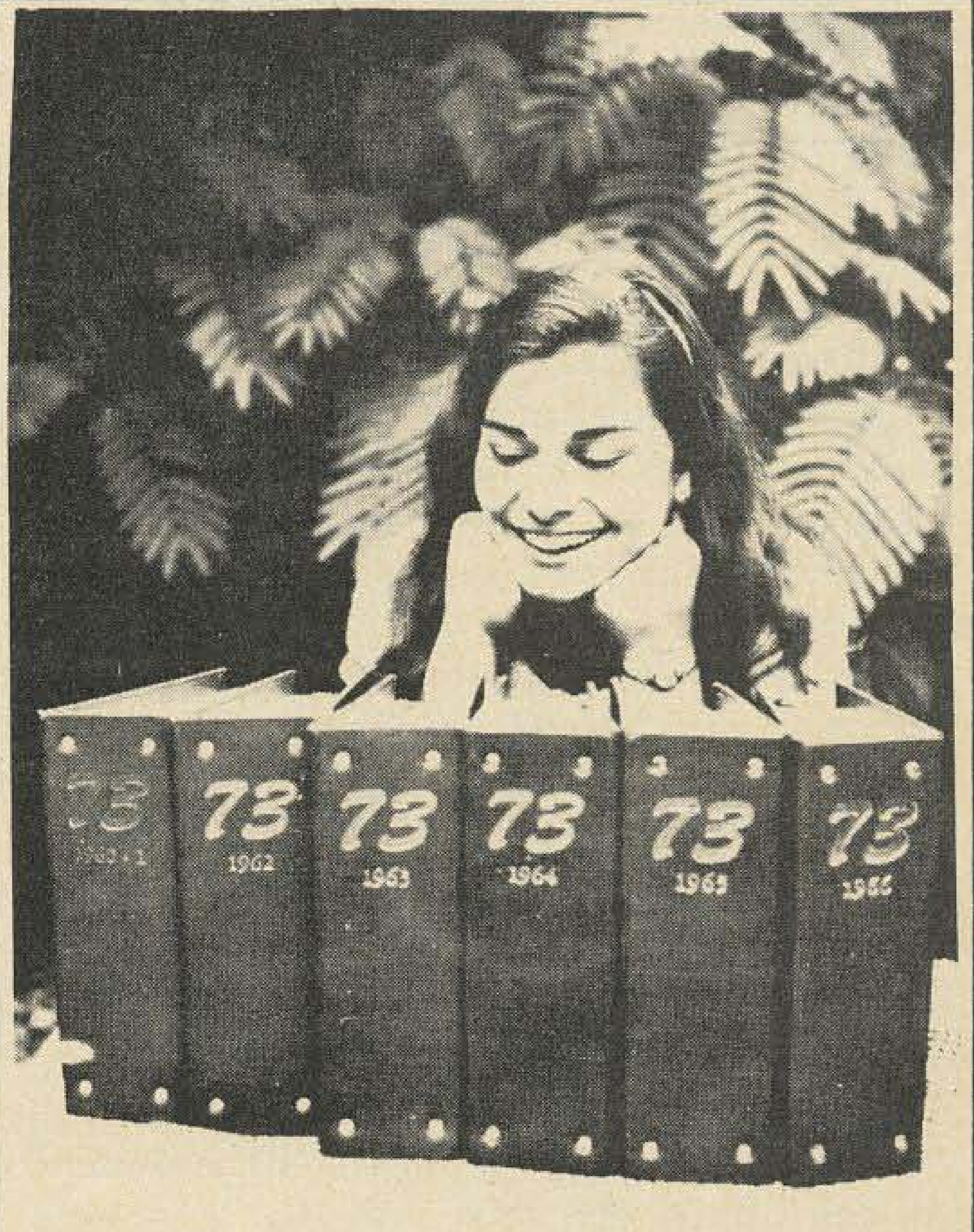

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fective against crash.

The problem is that while limited sputter can be tolerated by most ears, a crash pulse limited to the same level will appear to be much louder because it lasts so much longer. Meanwhile, its greater strength ahead of the limiter has overloaded circuits and caused improper operation of most of the rest of the receiver.

Similarly, our ears tend to fill in the brief periods of silence which result when a blanker takes out sputter pulses, but the pulses of crash last long enough to be bothersome.

In general, blanker circuits tend to outperform limiters against both sputter and crash–and offer almost the only usable defense against severe crash problems. Fortunately, crash is the smallest of the three noise problems since it is objectionable only when thunderstorms are within radio range of the receiver.

How are signals detected? While three major types of modulations systems are in commercial use, only two of these are used to any appreciable extent by amateurs. The two we use are known to engineers as amplitude modulation (which includes CW and SSB) and angle modulation (which is composed of FM and phase modulation both); the third, pulse modulation, is illegal except at uhf.

Each of the major types of modulation systems produces signals of differing types, and each type of signal must be detected differently.

However, the obvious differences between the different types of detectors tends to mask some less-obvious similarities of the two modulation systems we use, so before we begin to look at the detection schemes themselves let's take a second look at the modulation systems.

All ham modulation systems carry the information in sidebands which accompany the carrier. Even CW has its sidebands, which provide the "keying characteristic" of the signal. The only real difference between the amplitude modulation system and the angle modulation system lies in the relative phasing between sidebands and carrier.

In any amplitude modulation system, the phase relationships between the sidebands and the carrier are such that the "envelope" of the total signal–that is, the total amount of energy present at any instant within the signal's bandwidth–appears to vary at a rate determined by the modulating signal. In this system, the carrier level actually remains constant; the fluctuations in the sideband levels cause the apparent variations in the envelope.

In any angle modulation system, the phase relationships between the sidebands and the carrier are such that the envelope appears to remain constant, but the apparent frequency of the carrier signal varies at the modulating rate. Actually, the frequencies remain the same but the carrier level fluctuates at the same rate as the sidebands. This, together with the phase-aiding or cancellation effects, gives the appearance of constant level and varying frequency.

If you consider the sidebands as the reference, the difference between amplitude and angle modulation amounts to a 90 degree difference in carrier phase; that's all it takes to change one system to the other. At least one detector circuit has been designed on just this principle.

Now that we've seen the similarities between the two general systems, and the small but critical difference between them, let's turn our attention to the amplitude modulation family and look a little closer at its various members. After all, they make up most ham applications.

Within the amplitude modulation family, we can take our choice of CW, double sideband full carrier (what we usually call AM), double sideband suppressed carrier (DSB), or single sideband suppressed carrier (SSB). There are other possibilities also, but these four are the ones most commonly met.

Since all four are members of the amplitude modulation family, they have the characteristic of apparently constant carrier frequency and varying signal envelope level. The CW envelope varies between the two extremes of zero and full-signal while the other three vary at an audio rate with many in-between levels.

We can see the varying envelope if we examine an AM signal with a good oscilloscope; if we rectify this signal the resulting dc output of the rectifier will still vary just as the signal envelope did, provided only that we do not filter out the variations. This is a valid technique for detection of conventional AM, and detector circuits based on this principle are known as "envelope detectors." Fig. 8 shows a popular envelope detector circuit in comparison with a half-wave rectifier power supply circuit.

However, the envelope variations follow the original modulation only because of the phase relationship between sidebands and the original carrier. If the original carrier is re-

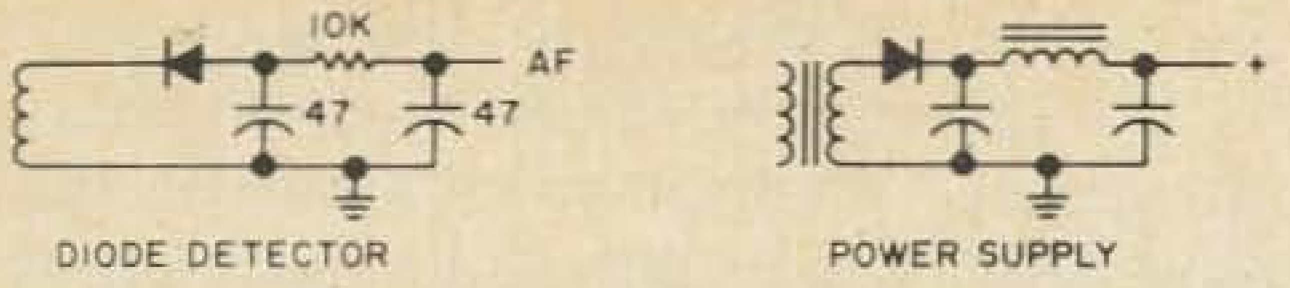

Fig. 8. Diode envelope detector compared to half-wave power supply circuit. Major difference is that power supply uses choke for more complete filtering—but detector is intended to preserve audio and filter out only *rf* half-cycles.

moved before transmission, as in SSB or DSB, the envelope variations cannot reflect the original audio and the result is a meaningless signal when envelope detection is used.

And, a CW signal, if envelope detected, will produce only a pulsating dc output which our ears cannot hear. It's possible to use the dc output of an envelope detector to key an audio oscillator, or to drive a pen recorder—but we cannot feed it directly to phones or a speaker.

The envelope detector of Fig. 8, then, is fine for conventional AM but by itself is of little value in detecting CW, DSB, or SSB signals.

Pioneers in the art of radio early realized that one way to make the CW signal and the envelope detector get along with each other was to introduce a new signal from a beat-frequency oscillator; the envelope detector would then *mix* the incoming CW signal and the locally-supplied BFO signal to produce an audio output.

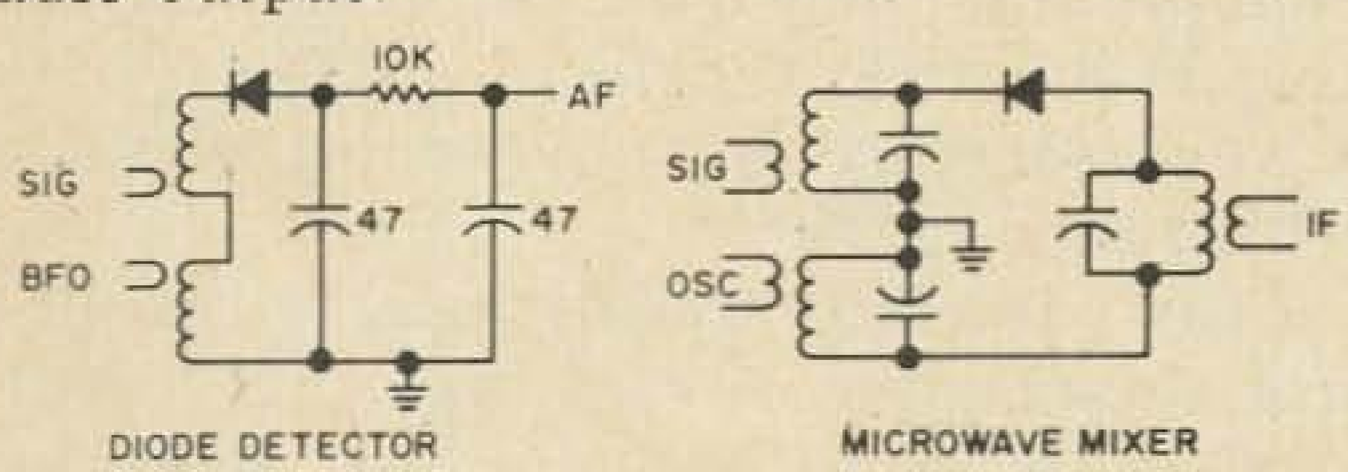

Fig. 9. Diode envelope detector compared to microwave crystal mixer circuit. In practice, diode uses only one transformer at input but signal and BFO frequencies are both fed into it. Major difference here, as in Fig. 8, is in output circuit. Diode action is similar.

It wasn't until much later, though, that they realized that the envelope detector, which looks so much like a half-wave rectifier, actually is acting as a mixer all the time! When it's receiving AM, it's mixing the carrier of the signal with the sidebands and producing as a difference-frequency output the modulating audio signal. When receiving CW with a BFO, it's mixing the CW and BFO signals to produce an on-or-off audio tone.

Fig. 9 compares the same envelope detector shown in Fig. 8 to a microwave-style crystal mixer circuit. Again the similarities are obvious.

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In a mixer, the ratio between the two input signals is rather critical for best results—and receiving CW using an envelope detector also calls for critical adjustments of signal level to BFO level.

Until the rise of SSB, the envelope detector was the standard detector circuit in communications receivers. But when SSB came into use, the critical adjustments quickly became unpopular.

It's possible to receive SSB using an envelope detector, just the same way as CW is received. The signal level must be carefully adjusted by using the receiver's *rf* gain control, and the BFO must be tuned to one edge of the *if* passband. Then the signal is carefully tuned to a point where the BFO signal precisely fits into the place left by the suppressed original carrier. At this point, the BFO is supplying a local carrier and the sidebands are at the proper level with respect to it; the result is instant audio, and in many cases you cannot tell the sound from AM.

But if the signal level changes because of fading—and particularly if it increases—distortion may get into the act. In addition, you will hear annoying chatter from other signals which are not at the same frequency but are near enough to produce some sound output.

And the procedure takes a considerable amount of care. When this technique is used to receive SSB, you usually keep both hands on the receiver controls most of the time.

So other detector circuits were devised, based upon the same principles as the mixer circuits used in the front end of the receiver. These circuits are known collectively as "product detectors;" a couple of them are shown in **Fig. 10**.

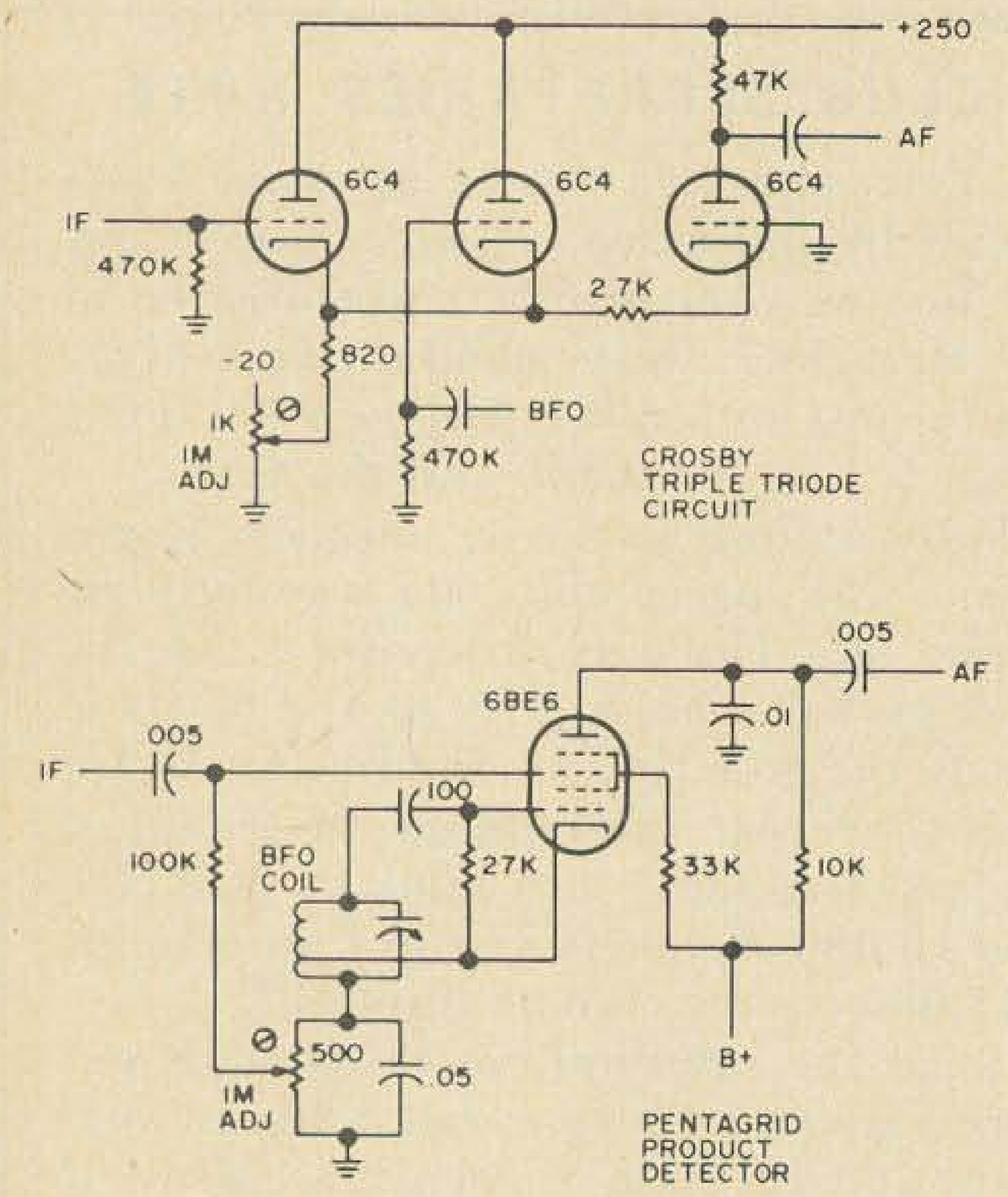

Fig. 10. Two product-detector circuits. Similarity of these to conventional *rf* mixer circuits can be seen; major difference is inclusion of "IM ADJ" control for each, to adjust operating conditions for minimum intermodulation in detected signal.

In any product detector, the circuit is set up so that signals coming in at the same input port cannot mix with each other. Mixing only occurs between the signals coming in at the two different input ports. One of these ports gets its signal from the BFO and the other gets the signals from the *if* strip. The result is lower distortion since *if* signals cannot mix with each other as they do in an envelope detector. Additionally, the circuit is usually designed to permit a much wider range of signal levels, so that fewer operating adjustments are required.

Because a product detector is designed to prohibit mixing between any two signals coming in at the same input port, it cannot produce output unless signals are present at both inputs. This is the major point which can be used to distinguish between product and envelope detectors; a product detector produces output only when the BFO is turned on, while an envelope detector produces output whenever it has any input signal whether the BFO is on or off.

Today's receivers usually include two detector circuits, one of each type, and switch from one to the other depending upon the type of signal to be received. Since CW reception also requires mixing to produce audio output, the product detector is used for it as well as for SSB and the envelope detector is used for AM.

Reception of DSB is a bit more of a problem, since it has both sidebands present. In this case, the local carrier must be not only exactly on frequency with the original carrier, but must also be locked to it in phase; it only takes a 90 degree phase difference to turn the signal from DSB into FM or PM!

One solution to the problem is the use of a "synchronous detector," but a more common way out is to use the receiver's inherent selectivity to shave off one of the sidebands and then treat the signal the same way as an SSB signal. The only advantage DSB has, when this is done, is that the receiving operator has the choice of which sideband to use.

If one is clobbered by interference, he can use the other.

How does FM reception differ from AM? Now that we've examined the two major ways of receiving amplitude modulated signals, let's turn our attention to the other modulation system—angle modulation. This system is composed of frequency (FM) and phase (PM) modulation; both are detected in the same way and the only effective difference between them is in their audio response curves. By suitable tailoring of audio frequency-response curves, either can be converted into the other.

We have seen that the traditional techniques for detection of AM operate upon the apparent variation of signal envelope level; similarly, the normal techniques for detection of FM operate upon the apparent variation of signal frequency.

One of the oldest such detector circuits is the Foster-Seeley discriminator, sometimes called a phase discriminator or merely a discriminator. It's shown in **Fig. 11**. As you can see, this circuit consists of two AM envelope detectors tied back-to-back, fed by a rather unusual transformer. This transformer is the secret of the circuit.

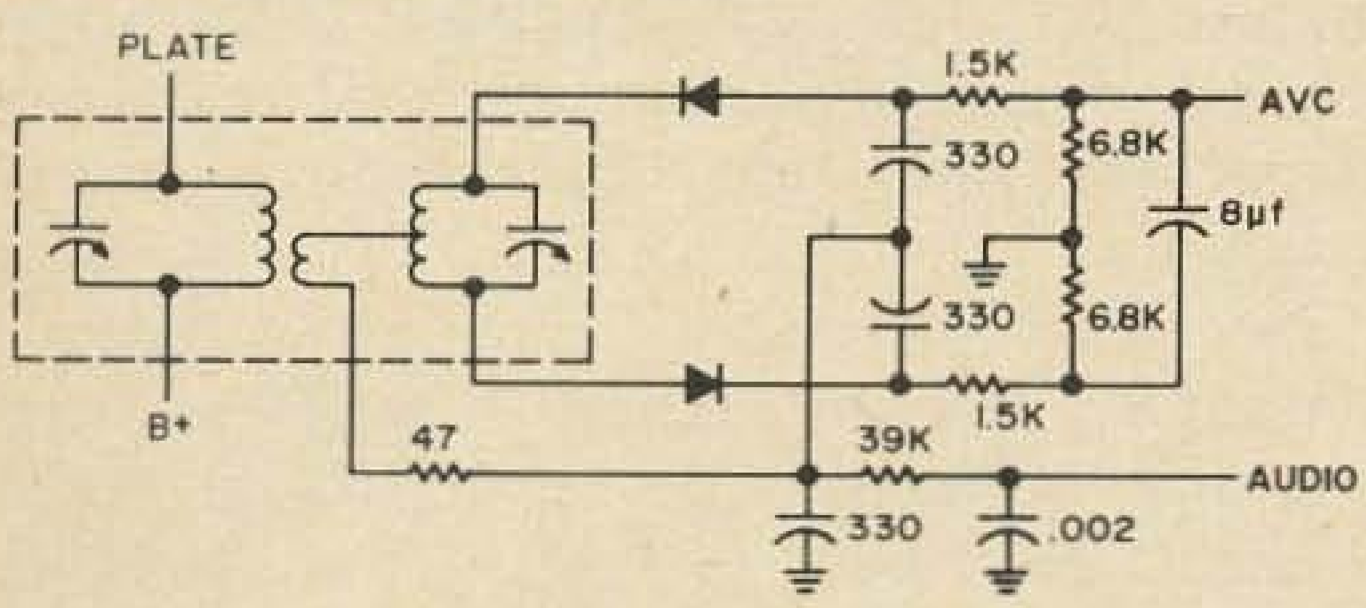

Fig. 11. FM discriminator schematic. Action depends upon design and adjustment of special transformer, shown in dotted box.

In any transformer tuned to resonance, there's a 90 degree phase shift between the primary and secondary voltages. In the discriminator, a part of the primary voltage is coupled into the secondary at the tap, and also into the detector output at the junction of the resistors.

Each of the two diodes produces its own output voltage across its own load resistor—but the phase relationships are such that the *total* voltage developed across the two resistors in series is actually the *difference* in output between the two diodes.

If both are producing the same output voltage, as they will when the incoming signal is at the exact resonance frequency of the transformer, the difference will be zero.

If the frequency of the incoming signal is slightly higher than that at which the trans-

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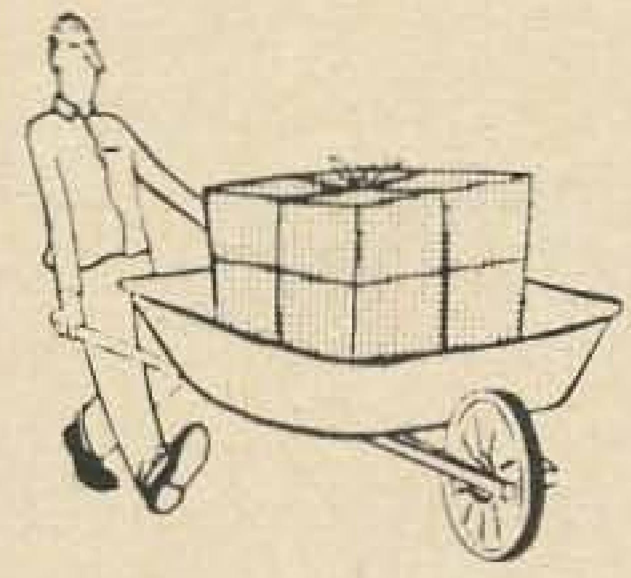

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former is resonant, the output of the upper diode will be greater than that of the lower, and the output will be a positive voltage.

If, on the other hand, the incoming signal is at a lower frequency than the center-frequency at which the transformer is resonant, the output of the lower diode will be greater and the total output will be a negative voltage.

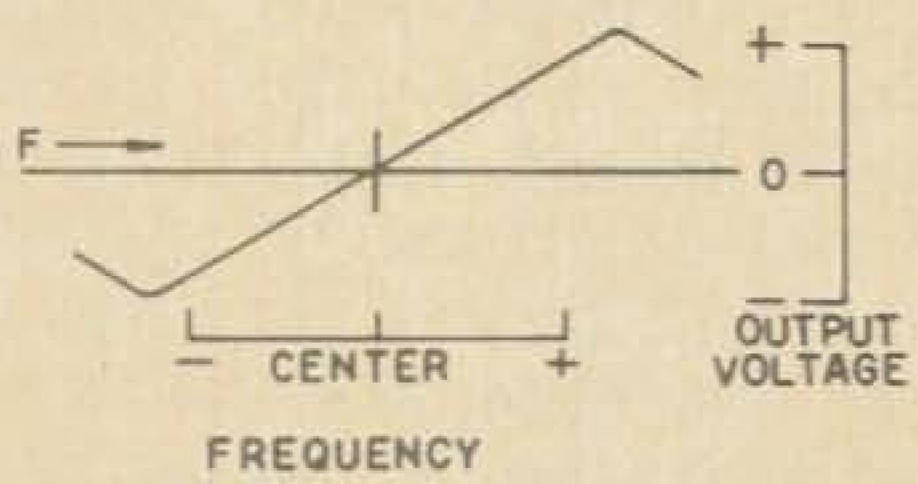

Fig. 12. Response of discriminator as frequency is varied above and below "center frequency" for which circuit is adjusted. Output swings either positive or negative depending upon direction of frequency swing.

As the frequency of the incoming signal is varied around the center frequency for the circuit, output voltage will follow the S-shaped curve shown in Fig. 12. So long as the frequency variations are limited to the straight part of this curve, they will be translated linearly to output voltage variations.

This circuit, while most effective at converting frequency variations into voltage variations, is also sensitive to voltage variations at its input. A stronger signal at the input will produce stronger signal at the output; in other words, it will receive AM as well as FM.

And one of the major advantages of FM over AM is that most sputter and crash is AM; it's possible to make an FM receiver that won't receive AM, and thus get rid of much troublesome noise.

To do this with a discriminator, it's necessary to put one or more "limiter" stages in the *if* strip ahead of the discriminator. These limiter stages serve to strip off all amplitude variations from the incoming signal, leaving only the frequency variations. The discriminator then detects the frequency variations.

The circuit most often used for limiting is simply an overdriven amplifier stage, sometimes with a grid resistor to increase its effectiveness as a limiter. Enough gain is provided ahead of the limiter to assure that it is overdriven at all times, even by the hiss normally coming in from the antenna.

To get away from the need for a limiter, several other FM detector circuits have been developed. One of the most popular is known as the ratio detector. It resembles the discriminator to some degree, as you can see from Fig. 13.

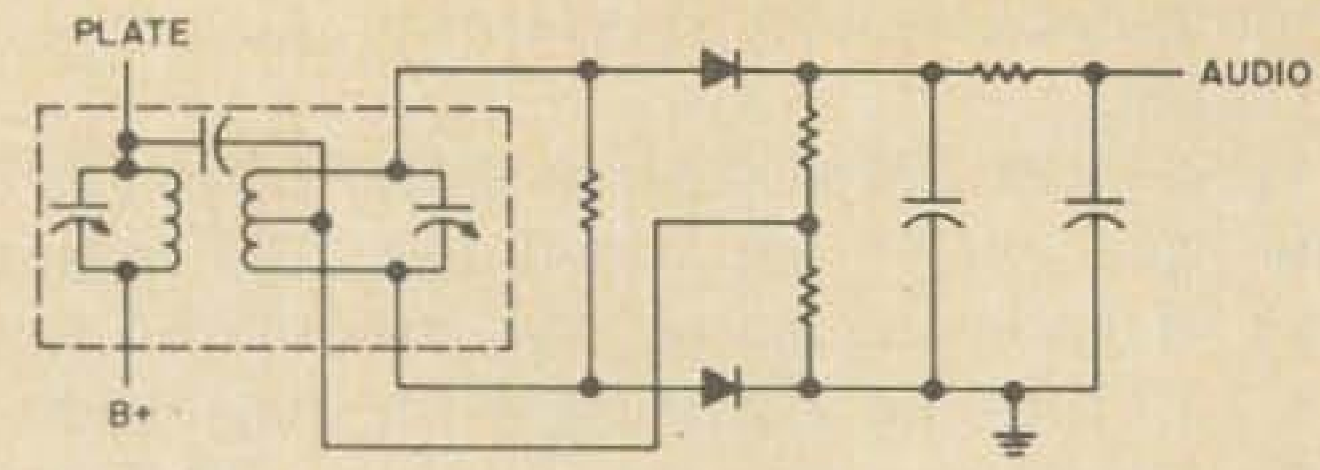

Fig. 13. FM ratio detector schematic. Like the discriminator, this requires a special transformer (shown dotted) but of a different type than the discriminator. Audio output of this circuit also swings either positive or negative, but an additional always-negative voltage dependent upon signal strength, which may be used for avc, is also available.

The major differences between the ratio detector and the discriminator are that one diode is reversed, in the ratio detector, and that a large capacitor is placed across the series-connected load resistors to filter off any amplitude variations. The audio output is then taken from the center-tap rather than across the resistors.

Reversing the diode changes the effective phase relationships so that the output voltage is now determined by the ratio between individual diode outputs, rather than by the difference. If an AM signal is received, the ratio remains relatively constant; only a signal with a varying frequency component can change the ratio and thus produce output audio.

Not all FM detectors use the two-diode techniques. One of the first to get away from such principles entirely was the Bradley locked-oscillator circuit. In this circuit, a rather unstable local oscillator, designed to produce an output vbltage which varied with the frequency at which the oscillator was running, was synchronized or "locked" to the incoming signal. The output of the oscillator then varied with the frequency of the incoming signal.

A similar principle more recently used is the gated-beam discriminator, which required a special type of tube design. This tube was capable of oscillating with one set of elements, while being turned on or off by a second set. The input signal was used to turn the tube on and off in step with the incoming signal frequency while the free-running oscillator also caused an on-off action. The result was that the tube's plate current consisted of a series of pulses, the width of which was determined by the ratio between incoming signal frequency and the "quadrature circuit" frequency associated with the tube. These pulses, filtered, produced the audio output.

This circuit, using the 6BN6 or similar tubes, was almost standard for TV audio reception for many years. It is not, however, convenient for use with transistors, and the ratio detector and discriminator are still holding their own as a result.

The final technique for detection of FM is one which also can be used for AM; in fact, it's almost a "universal detector." The circuit has been around since 1957, but is still virtually unknown because of its complexity. It's known as "synchronous detection."

We don't have space here to go into it in detail; essentially it makes use of the fact that the sidebands themselves contain all necessary phase information, and also of the fact that a 90 degree phase shift between carrier and sidebands converts AM to FM/PM. Any incoming signal is split into two parts and applied to a pair of balanced mixers. The other input to these mixers is the local oscillator signal; it's shifted 90 degrees before application to one and applied directly to the other. Outputs of the two mixers, then, result from AM on one side and PM on the other, regardless of the original signal type. These two output signals are fed to a phase detector, which produces a dc control voltage. The control voltage then varies the frequency of the local oscillator. The idea is to keep the local oscillator locked to a frequency which will produce maximum output from one of the balanced mixers and zero output from the other.

If the incoming signal is FM or PM, the 90 degree phase shift in the synchronous detector converts it back to AM. If it's AM, the local oscillator is locked into phase synchronization with the carrier and there's no bothersome beat note. If it's DSB, the same conditions hold, and perfect reception results. For SSB, no locking action occurs but the balanced mixers act as product detectors. And as an additional bonus, any interference which is present in only one sideband of any received signal cancels itself out in the output of the circuit.

Circuits of this sort are now standard in aerospace communications, but for amateur use the complexity is still frightening to most of us. For instance, the first such circuit published for ham construction required 11 extra tubes, plus phase-shift networks and power supply.

Next Month. We'll continue our examination of receiver techniques.

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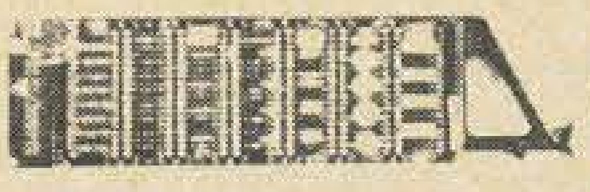

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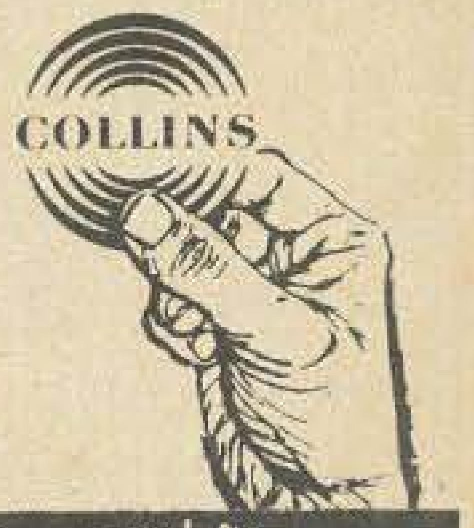

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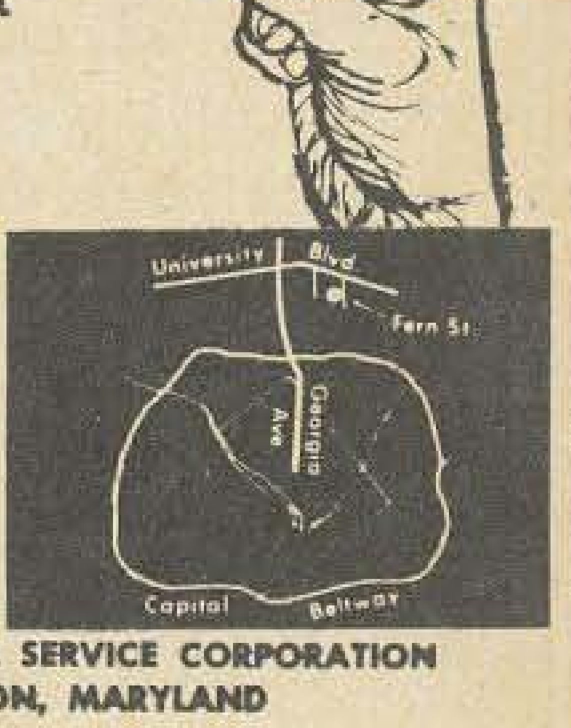

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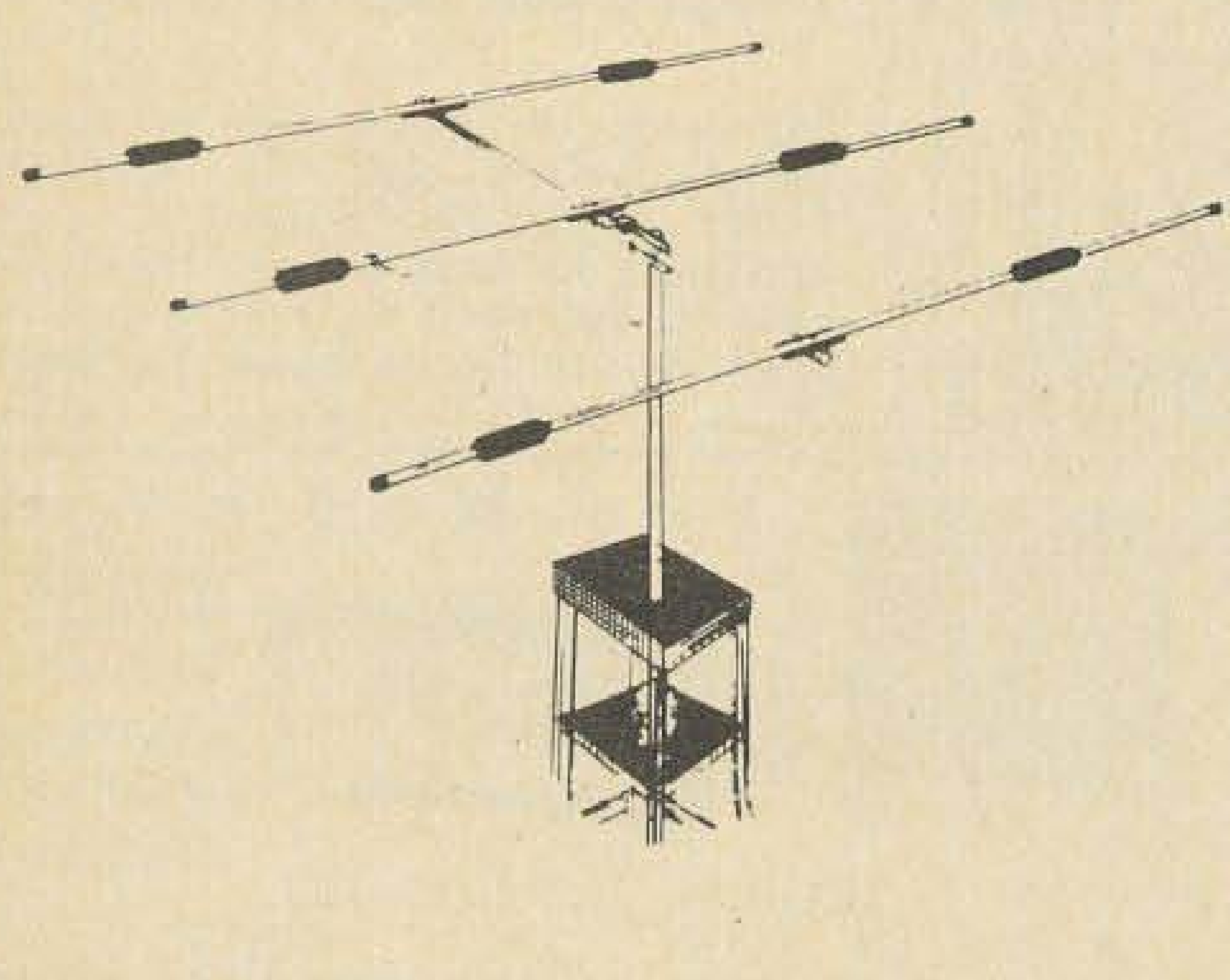
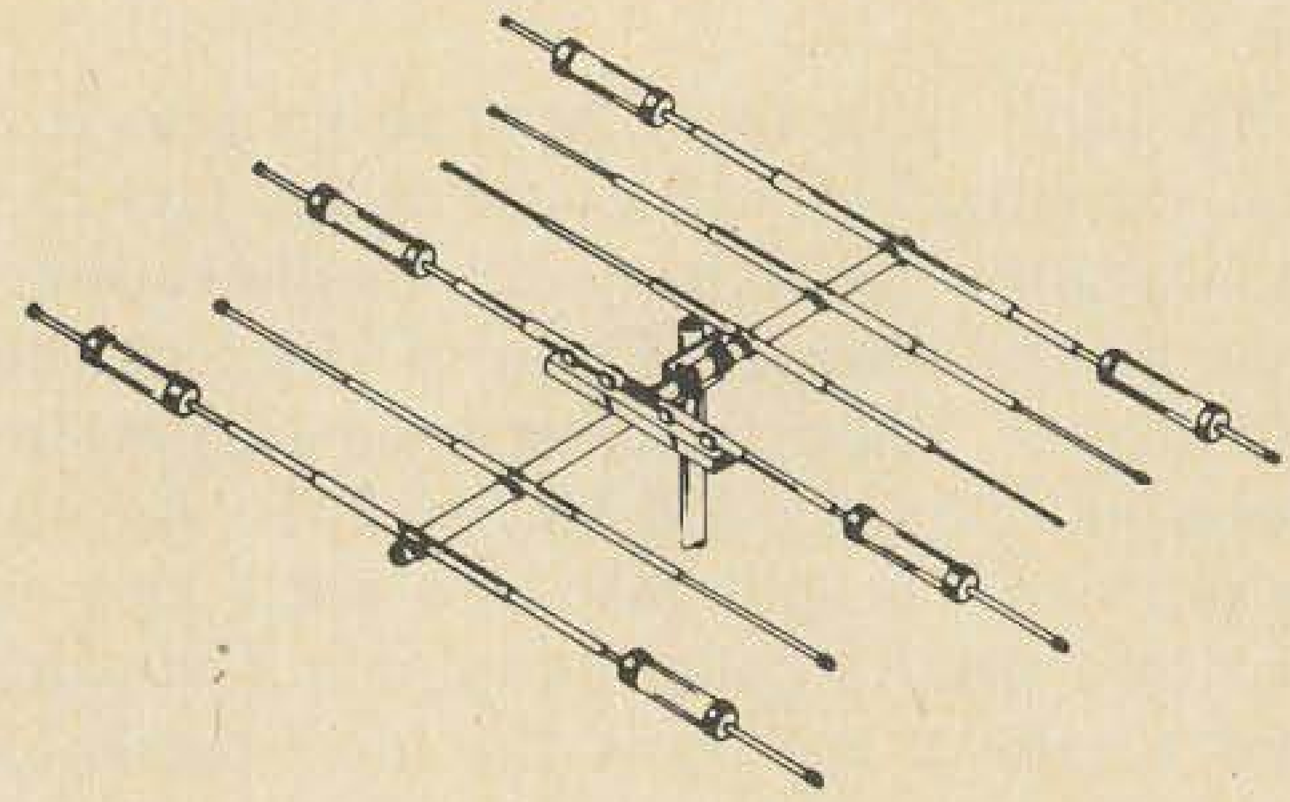


Mosley Tri-Bander

The Mosley CL-36 is a three band (10-15-20) six element beam. The gain on this monster is rated at 9db on 10M, and 8db on 15 and 20M. That's good! This is the famous old Mosley TA-36 beam with their new balanced capacitive feed system, which resists corrosion much better than the older types. Weighs 69 pounds and costs under $175. It will handle maximum power on all three bands.



Reviewing the DAH-DITTER Model EK-1 Electronic Keyer

The M&M Electronics EK-1 Keyer is a real joy for the CW operator. It is self completing, so that neither dots nor dashes can be cut short, and it provides exact three to one dah to dit ratio with correct spacing between characters.

It can be used with any key providing SPDT action with center off. I used it both with the James Permaflex Key and with my antique Vibroplex bug. When used with the "bug" type key, it is necessary to disable the spring mechanism on the dit side. This is easily accomplished by using a rubber band to tie the end of the vibrating arm to the right side of the damper at the rear of the base, and adjusting the contact settings for correct contact spacing.

A built-in side tone monitor provides a constant tone without using the station receiver. Reed relay output makes it possible to use either grid block keying or cathode keying by following simple instructions.

The Dah-Ditter is adjustable from about 5-40 wpm with a single control, and allows an operator to send perfect CW with a minimum of practice. However, even though the keyer will space automatically between dits and dahs in a single letter, it is still up to the operator to provide correct spacing between letters and words. A few hours of practice should be sufficient for anyone who has used a keyer in the past.

This keyer uses modern digital computer techniques utilizing digital flip flops and gates which are arranged to give correct spacing independent of speed setting. It is not necessary to make adjustments for each speed setting.

The instructions supplied with the Dah-Ditter are complete and explicit. Complete circuitry is provided in the event trouble-shooting is needed. The unit is fully guaranteed for ninety days under standard warranty terms, but if trouble develops outside the warranty terms, it may be returned for factory service for a nominal charge of $7.50. This charge does not cover cockpit troubles where the equipment has been abused, however. Under normal use and installation, the IC's used should give thousands of hours of reliable service.

Considering the modest price of $34.95, this keyer is a good deal. Further information is available from M&M Electronics, 6835 Sunnybrook, N.E., Atlanta, Georgia 30328.

. . .W1EMV

Make Your Soldering Gun Tip Last Longer

My soldering gun tip always seemed to part company near the end of a project when I least wanted to stop everything to change it. The natural result was an attempt to finish the job with the two ends bent together or by completing the circuit through the joint to be soldered. Neither of these methods has been found conducive to good workmanship.

While not eliminating the problem entirely, the following will increase tip life considerably and make these frustrating moments fewer and further between.

Obtain (your refrigeration repairman is the best bet) a short piece of silver solder and a small quantity of flux. Sand the tip until it is bright and completely free of oxides. A stiff wire brush will do as well. Dip the tip in flux and apply the heat of a household-type propane torch to a point slightly below the tip proper. When the flux starts to look glassy, gently touch the silver solder to the tip until it starts to melt. The solder will shortly flow over the tip forming a protective coating. You may need to add a little more solder to insure that the whole tip is covered. When cool, brush the tip and tin as usual. The silver solder prevents the oxidation which causes the tip to erode and makes it last several times longer.

William P. Turner, WA0ABI

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Clifford Klinert, WB6BIH
520 Division Street
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A Stable HF VFO

This article will describe a transistorized vfo to cover the amateur high frequency bands from 3.5 to 30 mhz. It is designed to drive small transmitters such as the DX-40, which have provisions for vfo input and 115 vac output for a *tr* switch. Construction details and sources for obtaining parts are given to aid the home-brewers.

Circuit Details

Fig. 1 shows the oscillator circuit. This is a Seiler oscillator using the popular MPF-102. This transistor has a minimum effect on the frequency of the tuned circuit. The tuned circuit, however, will change frequency with temperature. In breadboarding experiments with this circuit, soldering really caused frustration. If the temperature of the shack in the morning was about 50 degrees, after turning on the heater and the oscillator, the frequency would gradually drift as the room changed temperature. In a later test, when the temperature was constant, the stability was much better. In this test, the vfo was zero-beated with a crystal oscillator. A rather unusual behavior resulted. The beat note would rise to about three or four Hertz over a five minute period, and then go back thru zero beat. The drift was never more than a few Hertz, and went back and forth in this manner over a one hour test period. Of course, this could have been caused by several things, but it illustrated the stability of the oscillator.

The only possible cause of trouble in the oscillator is in the small capacitor in series between the gate of the MPF-102 and the tuned circuit. If this capacitor is too small the oscillator will not oscillate. For best performance the capacitor should be just large

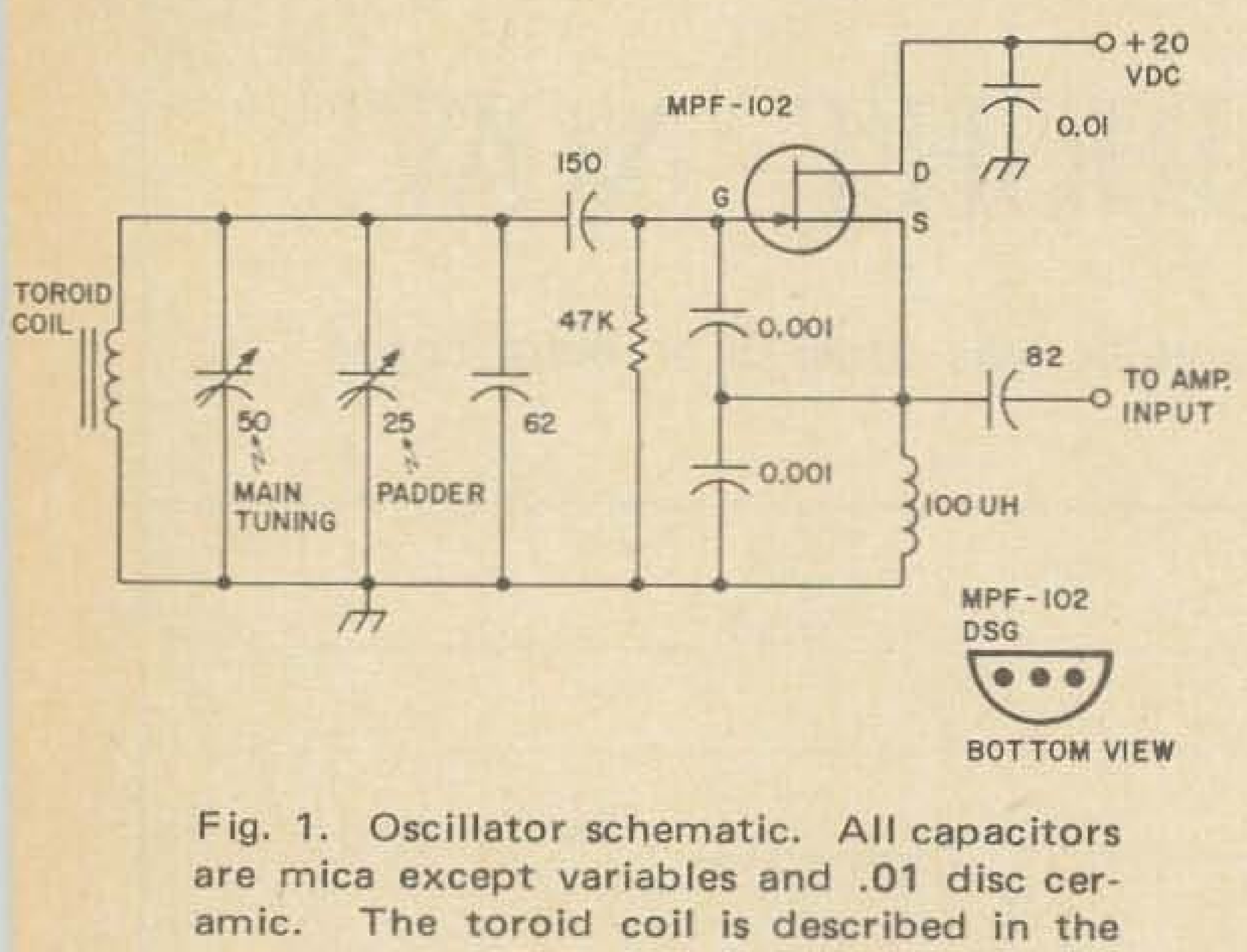


Fig. 1. Oscillator schematic. All capacitors are mica except variables and .01 disc ceramic. The toroid coil is described in the text.

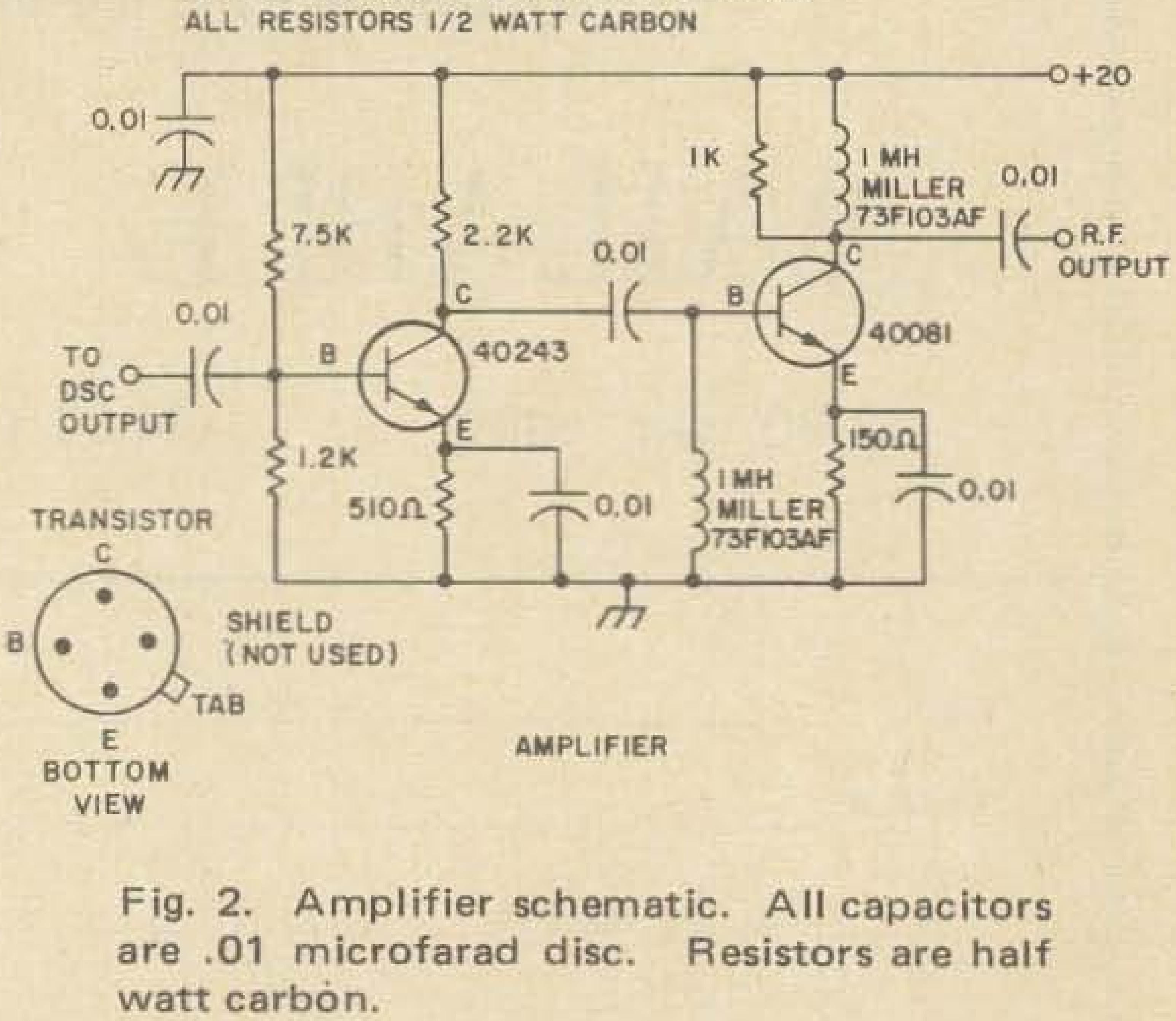


Fig. 2. Amplifier schematic. All capacitors are .01 microfarad disc. Resistors are half watt carbon.

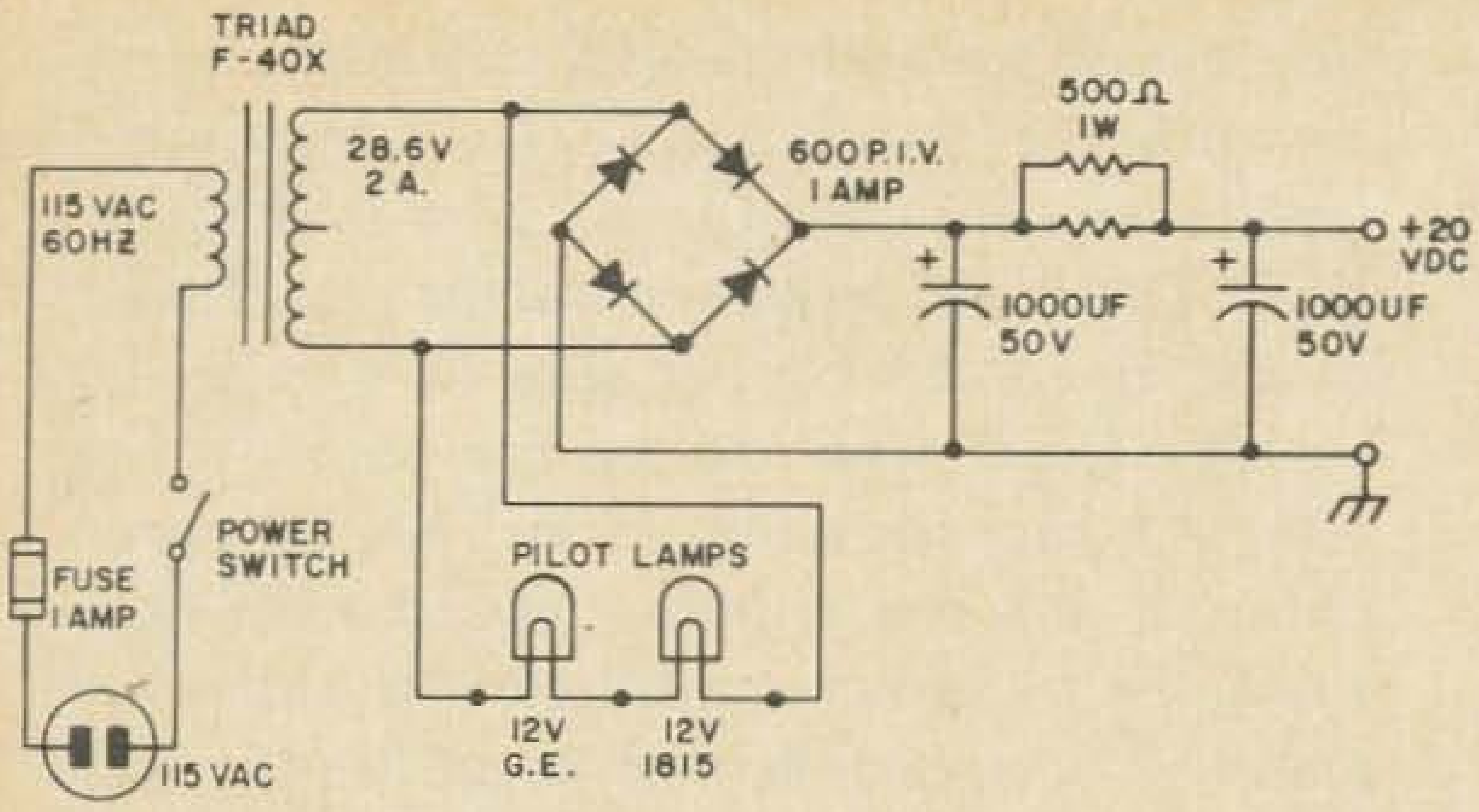


Fig. 3. Power supply.

enough to maintain stable oscillation. The 150 pf value has been found to be adequate for most circuits.

The amplifier circuit is shown in **Fig. 2.** This is a simple two stage common-emitter amplifier. The 40243 is biased into class A to act as a buffer. The quiescent collector current is about four or five milliamperes. This rather high value of current was chosen to allow a high output signal voltage. This high collector current also reduces the input impedance to as low as five hundred ohms. Performance was adequate, however, and the circuit was left as it was. The main advantage of this design is bias stability. Almost any vhf or hf silicon NPN transistor can be plugged into this circuit in place of the 40243. The low value of the base resistors allows for variations in h_{fe} of the transistor. The emitter resistor voltage drop of about two volts helps to compensate for changes in the base-emitter voltage drop of the transistor. The 40243 is a small signal transistor used for FM receiver applications and was selected because of its low cost and availability.

The 40081 output stage is pushed into class C by the 150 ohm emitter resistor. *RF* chokes are used instead of tuned circuits to

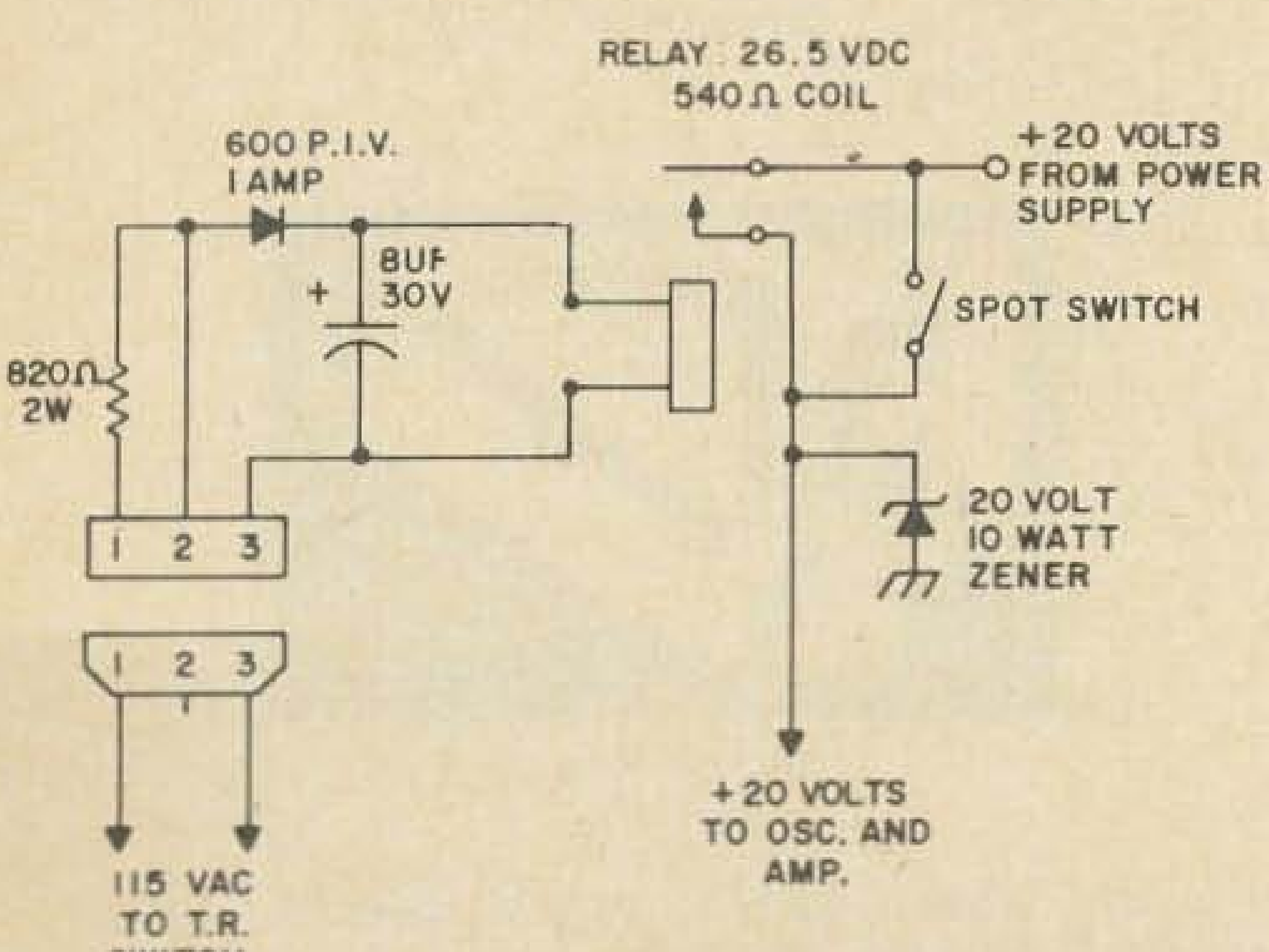


Fig. 4. Control switching.

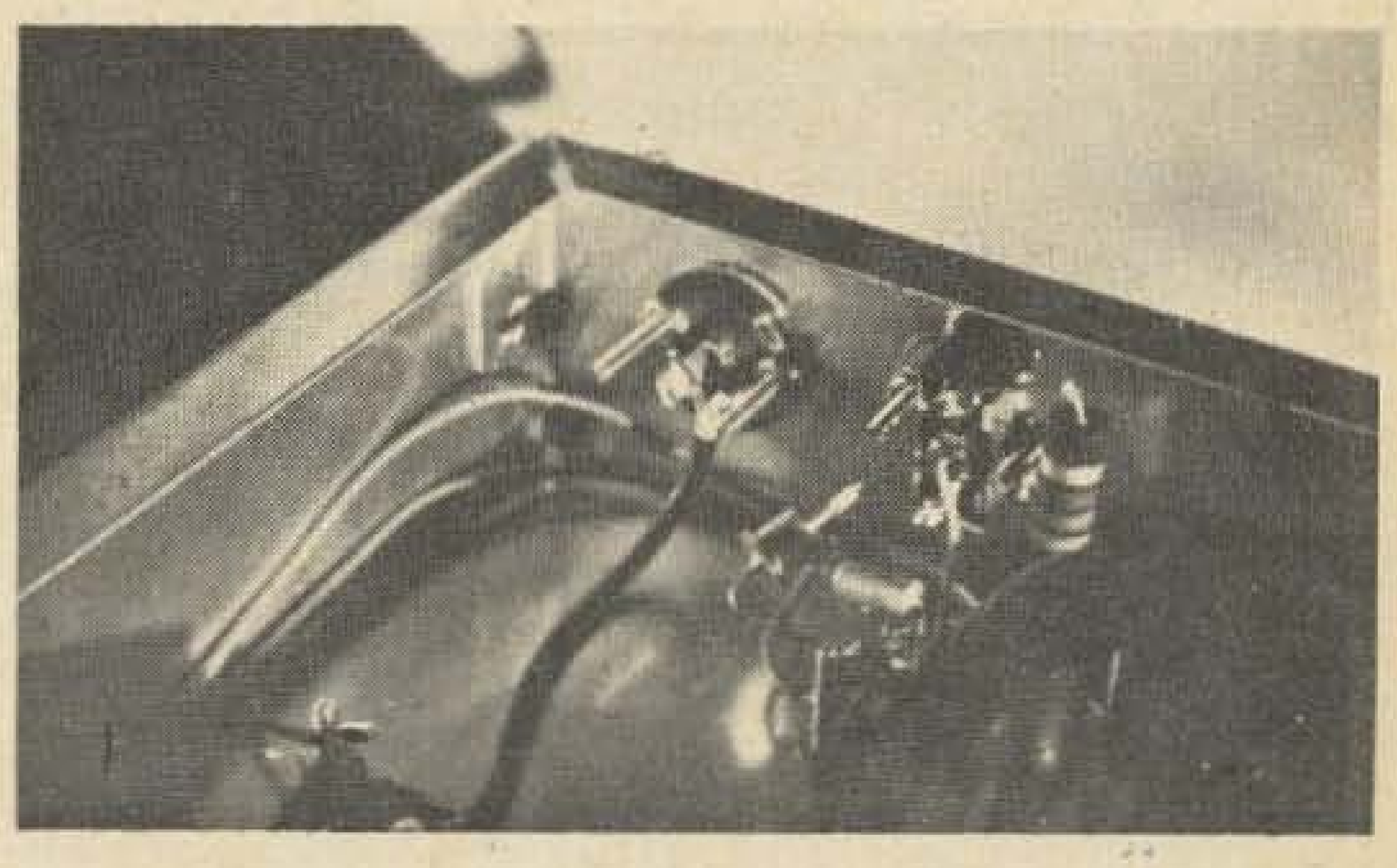
Fig. 5. A list of parts obtained from Allied catalog.

Part	Stock Number
Dial	47F3241
Cabinet	42-7200
Chassis	42F7851
Chassis	42F7904
P.C. Board	47F0592
Tuning Capacitor	43F3663
Transformer	54F4974

P.C. boards can be had from Spicer, 11 Ridgeland Road, Wallingford, CT 06492.

provide a broad banded output. The 1 K resistor in the collector of the 40081 reduces the Q to prevent parasitic oscillations. The output voltage is about ten volts peak-to-peak, and provides adequate drive on all bands when used with a DX-40 transmitter.

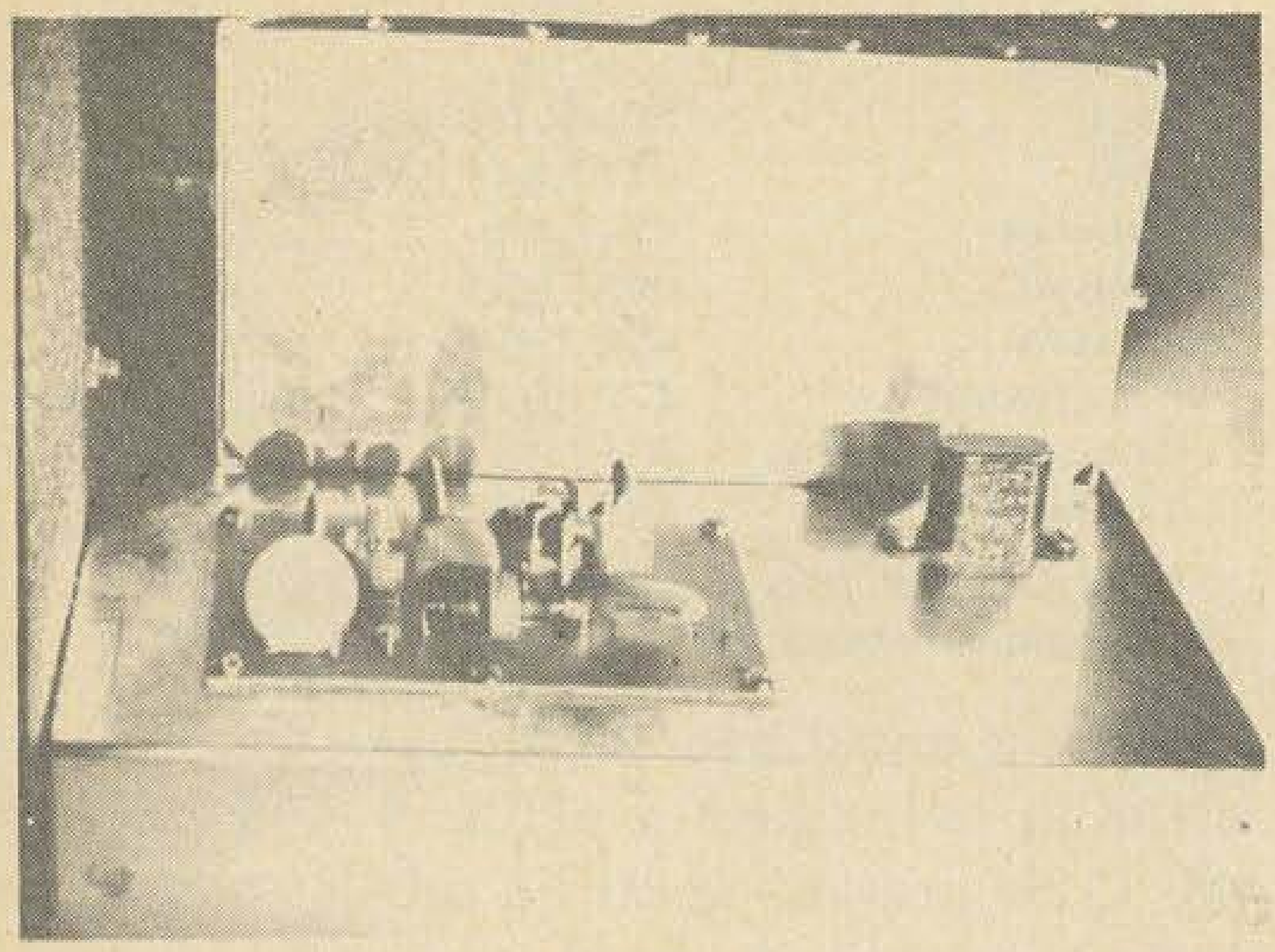
The power supply in **Fig. 3** is very conventional in design. The resistance between the two filter capacitors drops the almost 40 volt peak output from the bridge rectifier to 20 volts across the Zener voltage regulator diode. The total resistance could be increased to almost 1 K before the voltage would drop, but high current is maintained for stability.



Control circuit and output jack.

The control circuit of **Fig. 4** is used to turn the vfo on when 115 vac is applied from the transmitter TR relay. A "spot" switch is also provided to manually activate the vfo. Almost any relay that can be activated by 115 vac could be used. The one I used was surplus. If a dc relay is used, first calculate the coil current from its voltage and resistance. The rectified dc voltage is about 70 volts. 70 volts minus the coil voltage is the voltage drop required of the resistors of **Fig. 4.** Its value is found by dividing the voltage drop by the coil current.

The Zener diode is also shown in **Fig. 4.** It is only in use when the vfo is activated. This is done to reduce heating from the diode and dropping resistors.



Amplifier board mounted on chassis. Relay is at right.

Construction

As a convenience, some of the major parts were obtained from Allied Radio. **Fig. 5** lists them with their stock numbers. Other parts will be described as completely as possible. The pictures will also aid in describing the mechanical layout.

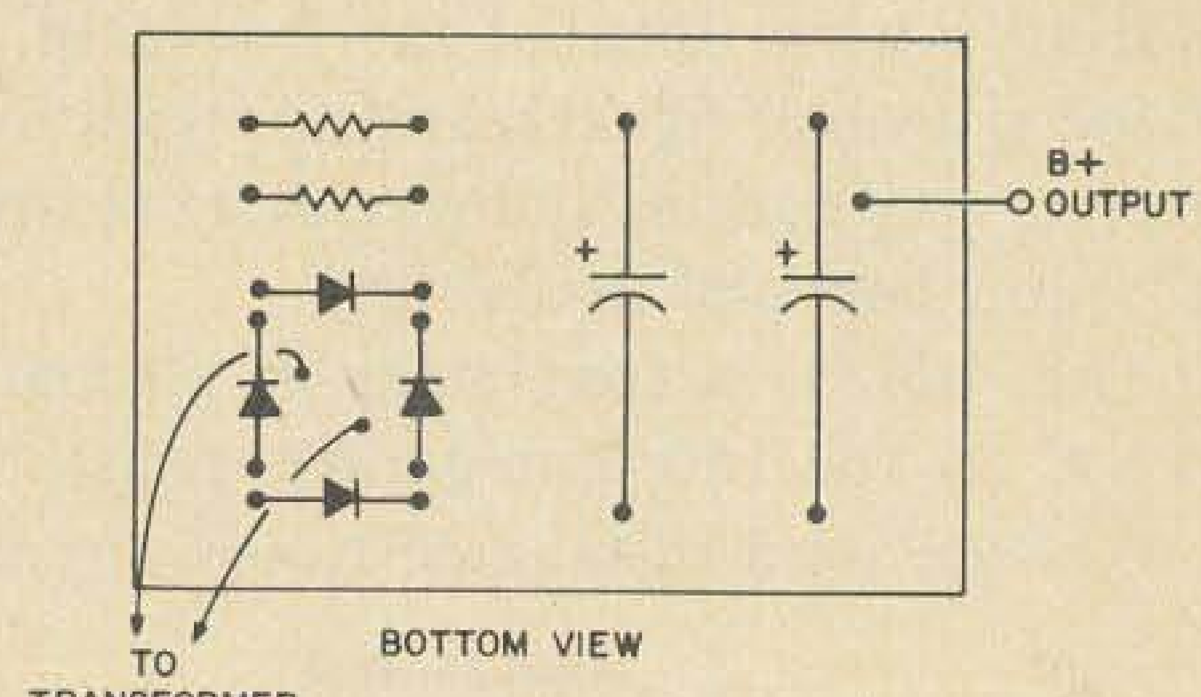
The first step is to mount the dial with the instructions and template supplied by the manufacturer. The dial is centered on the front panel. The chassis is mounted, being careful to allow for the flange on the front of the cabinet. The smaller chassis is mounted in the center of the larger one after the hole for the tuning capacitor is measured and drilled. No special attempts were made to make the structure more rigid. The method used is simple and the structure is remarkably stiff.

The fabrication of the printed circuit boards will be discussed in one step because of their similarity, but a definite order should be observed to simplify construction. The power supply should be attempted first because it is the easiest and will be needed to test the other circuits.

Fig. 6 shows the general layout of the printed circuit board for the power supply. As with the other boards, the actual parts to be used should be checked for fit before laying out the board. The method used in making these boards is a result of personal preference, and other builders may have their own methods.

The first step was laying out all the parts on a piece of paper corresponding to the layout of the schematic. The mounting holes were measured and marked, carefully checking with the actual parts. Then lines were used to connect components as in the schematic. The paper was then cut out and taped to the unetched copper side of the circuit board. Holes were drilled for components using the paper as a template. With the paper removed and the copper cleaned with steel wool, the holes are connected with the resist material. A type of acid-resistant lacquer was used for the resist in this case. However, almost any kind of good enamel paint could be used. Dry-transfer kits are available which will make a much neater job, but with the paint you have lower cost (free in this case) and more "freedom of expression" in making wider conductors. As much of the copper was covered as was possible. This was done to provide a handier low impedance ground around the edge of the board. This also makes it possible to use less etchant which is much more expensive than the resist. The etchant used was a commercially available brand packaged in small amounts. A one-gallon bottle of Ferric Chloride ($FeCl_2$) solution was also obtained from a chemical supply house for about three dollars. Either etchant gave good results, but it is important to keep the etchant solution warm while etching.

After the board has etched sufficiently, wash it with water to remove the acid, and in



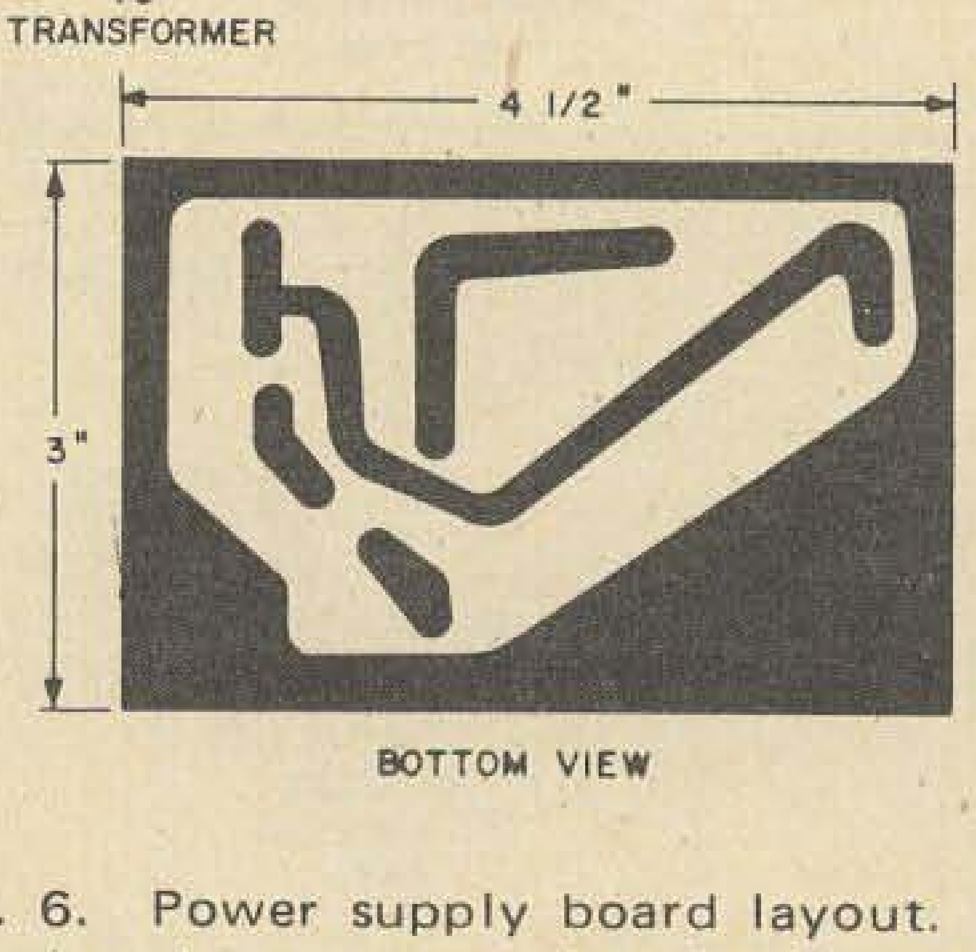


Fig. 6. Power supply board layout. Both board and component location illustrations are full size and bottom views.

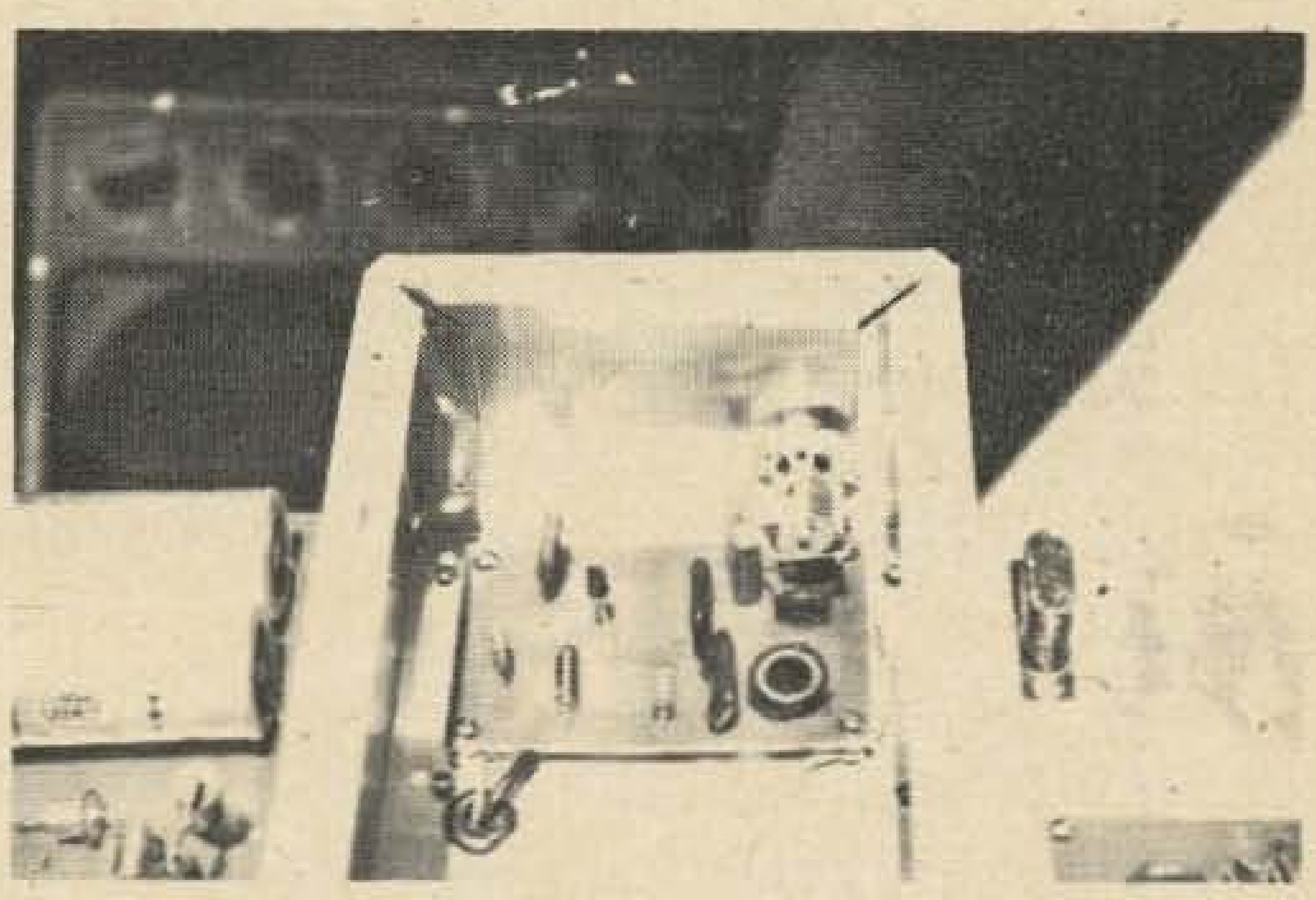
paint thinner to remove the resist. You might wish to use steel wool once again to clean the copper before soldering. It will take only a few minutes to place the components, solder them in, and clip excess leads.

Since there was no need for miniaturization, the boards were made large to make assembly easier. Some builders may prefer to avoid using printed circuit boards, but they present a very neat appearance and reduce errors. If the board layout is copied properly, it serves as a check against errors in the schematic that can be made by either the author, draftsman, or reader.

With the power supply board completed, temporarily connect the transformer. The voltage without the Zener diode should be about thirty-five to forty volts. The Zener diode is stud-mounted to the chassis to provide heat dissipation. After the diode is added, the output voltage should drop to about twenty volts or slightly higher. The diodes in this case were "surplus" diodes obtained from Solid State Sales at a reasonable price. Delivery will usually take less than a week after mailing the order, even to the west coast.

Power transformer and tuning capacitor mounting.

After the power supply has been checked out and is working properly it can be mounted on the chassis. A hole is cut in the chassis with a nibbler, and the board is bolted in place. This is a good time to complete wiring connected with the ac switch, line cord, fuse and pilot lamps. Put some electrical tape on the inside of the metal dial front cover. With the pilot lamps wired in series, the metal cover will short them out. Tie points are used liberally under the chassis to make the wiring neater.



A look inside the oscillator box.

Fig. 7 shows the board layout for the oscillator. The method is the same as that for the power supply except for mounting. Since the oscillator is shielded (for temperature, not *rf*) it must be completely inside its box. Spacers are used to lift the board from the chassis to prevent shorting. The toroid coil is mounted on the board with glue. The form is available from Amidon Associates, 12033 Otsego Street, North Hollywood, California 91607. Thirty-eight turns of number 30 wire

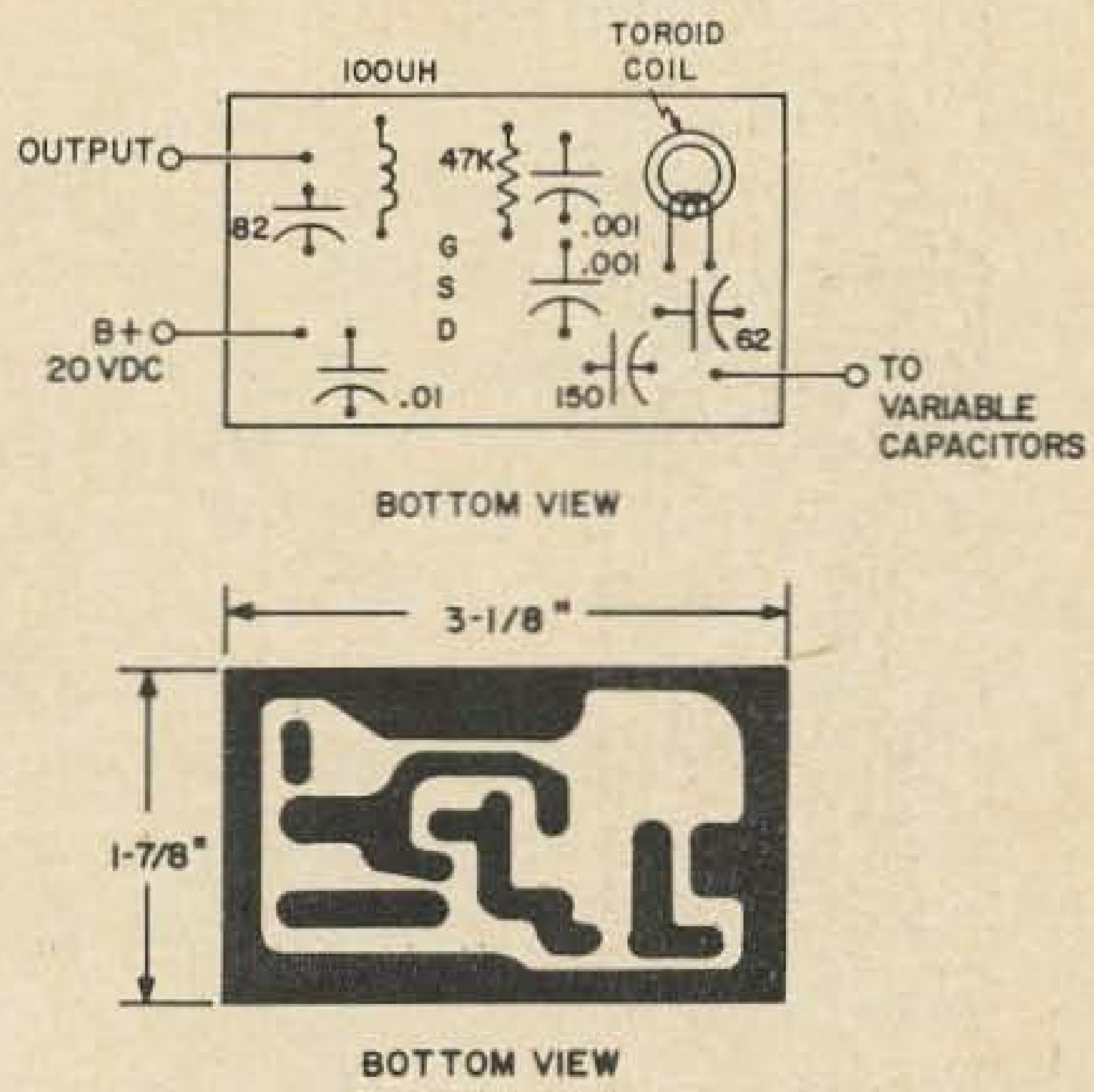
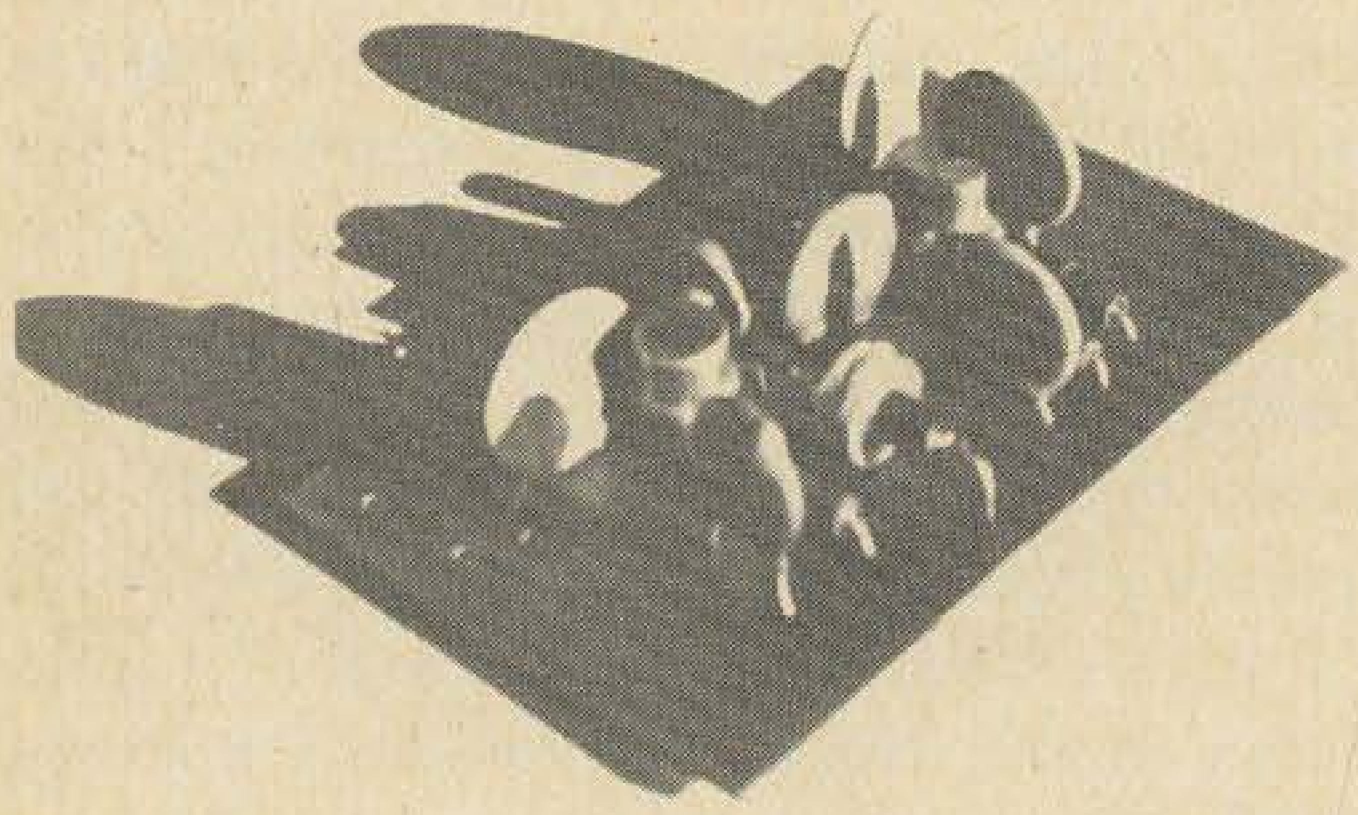


Fig. 7. Oscillator board. The toroid coil form is ½" ferrite (Amidon T-50-2). D, S, and G indicate drain, source, and gate of the MPF-102. See Fig. 1.

used to cover 3.5 to 3.8 mhz. Adding more turns will widen the frequency range, but CW operation is the only mode used, and 'phone band coverage is not needed. There is absolutely nothing critical about the oscillator circuit, and it should cause no trouble if connected properly. If a toroid coil is not used, a slightly larger (200 to 300 pf) capacitor should be used between the tuned circuit and the gate of the MPF-102. A lower Q coil will require more feedback to sustain stable oscillation. If you experiment with this circuit, you may find that there is a condition between oscillation and non-oscillation. This condition is to be avoided because the oscillator may appear to be working, but is not. Always try the next larger value gate capacitor that will give the stronger, more stable output.

After the oscillator board is mounted, the output is brought out through the bottom of the chassis with a short piece of RG-174 coaxial cable. The power wiring will be taken care of last.



Amplifier board.

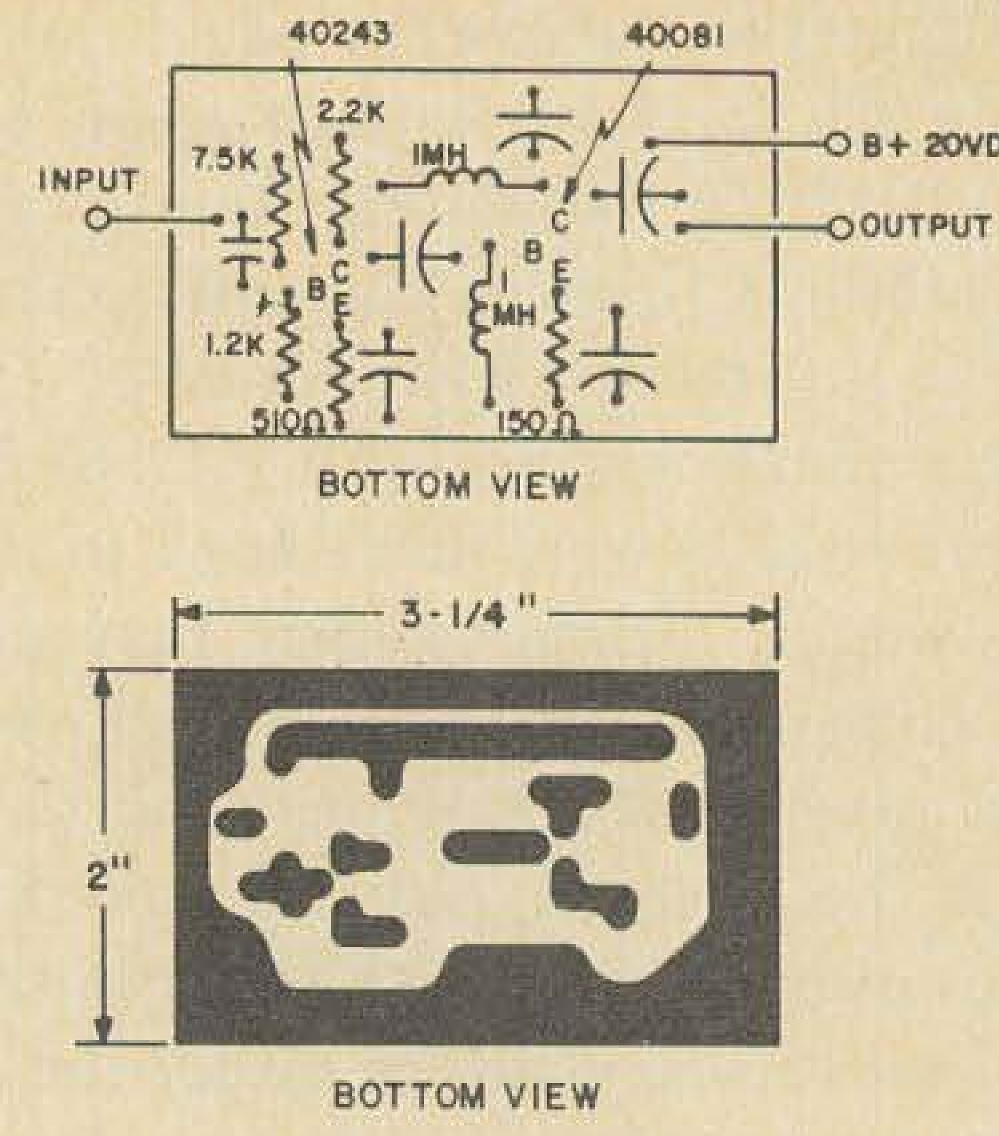


Fig. 8. Amplifier board. All capacitors are .01 disc. C, B, and E indicate collector, base and emitter of transistors. See Fig. 2.

The amplifier layout is shown in **Fig. 8.** The only new feature here is that sockets are used for the transistors. This is done to allow trying different transistors in the circuit. Almost any high frequency NPN silicon transistor will work, but the output transistor should be capable of handling at least a half watt of power. In this case, a heat sink was used on the 40081 to increase its dissipation. The circuit board is bolted into a rectangular cut out in the chassis as was done with the power supply.

The control circuitry and power wiring are completed last. No printed circuit board is needed here. The circuit may vary depending upon the type of transmitter the vfo is to be used with, and the type of relay used. The builder may even wish to reverse the process and have the vfo switch operate the transmitter.

Final Alignment and Adjustment

Other than calibrating the oscillator, there isn't any. These circuits have withstood many weeks of breadboarding, experimenting, and redesigning. When assembled properly they will be stable and reliable. When the final version shown in the pictures was assembled all circuits worked the first time as was planned.

The builder may wish to modify the tuning range of the oscillator. On higher frequencies the band is quite crowded into a small portion of the dial. If bandspread is not considered adequate a small capacitor (50 to 100 pf) could be placed in series with the tuning capacitor. This, of course, will reduce coverage on the lower frequency bands. Perhaps a bandswitch could be used in the circuit to change the tuning range, but a mechanical linkage would be a complicating problem.

If large temperature changes are a problem, you might try temperature compensating the oscillator. Drift, however, is not serious. In one experiment this vfo circuit was built in to the same chassis with a pair of 6146's. A fan was used to blow the hot air from the tubes away from the oscillator. This simple solution was all that was needed to stabilize the oscillator.

Conclusion

This vfo has the best performance of any circuit I have built of this simple a nature. Better performance could be obtained using the same oscillator circuit in a heterodyne vfo, but this would be much more complicated. Considering the required effort and performance, this vfo would be an excellent project for the amateur who has had some construction experience and wishes to add vfo capability to his rockbound CW transmitter.

...WB6BIH

LETTERS

The article VSWR-An Outmoded Parameter by VE2AXQ in the April 1969 73 Magazine may offer a new cause for you and 73 Magazine.

In the article the author proposes to do away with VSWR on the ham bands where he says it doesn't belong and relegate it to the microwave bands where it does belong, according to VE2AXQ.

One can hardly argue with VE2AXQ's contention that there is no room for VSWR on the ham bands and I'm with him and in favor of banishing trouble with that dern VSWR and even plain old SWR and what with all the other troubles about we sure don't need any more of those VSWR's.

It doesn't really matter that we get rid of VSWR by substituting for it the reflection coefficient, a very close relative, and it doesn't really matter that VSWR is one means of expressing the reflection coefficient just so long as we banish VSWR and SWR from the ham bands. It makes no difference that both VSWR and SWR and the reflection coefficient issue from and are functions of the same condition because over the years just having SWR's has become a hateful and distasteful thing on the ham bands.

It is to be noted that of all the different designations for reflection coefficient that have appeared in articles and reference works on transmission lines that VE2AXQ has wisely chosen Gamma. Gamma has a pleasing sound with a nice ring to it. Some writers designate reflection coefficient by p (Rho), others by a small K, and still others by a capital K. I don't think that the small k really stands for or is short for anything but it is believed that the capital K is short for Krutchley (K for Krutchley) who I am not familiar with but who probably had something to do with the discovery of reflection coefficients. But anyway, note the far better sound of Gamma as opposed to Krutchley. We can all be thankful that VE2AXQ selected Gamma. Can you imagine how distressing it would sound for some guy in QSO on the ham bands to remark "I gotta QRT now because I got some dern high Krutchleys." It wouldn't do much for the image of ham radio.

In this budding campaign to banish VSWR's and SWR's from the ham bands there is bound to be considerable squawking from a great many hams who own SWR meters and who may therefore be opposed to progress. Noting the 73 Magazine Editor's comment on page 2 that he pays the fastest and mostest for good articles immediately leads me to the conclusion that I can be of great assistance here in easing the grief of those many hams who own SWR meters and who would otherwise tend to stand in the way of this noble cause save for my services.

What I propose is a lengthly and well-paid for article as a follow-up to VE2AXQ's piece which will explain in great detail to the present owners of SWR meters how they can convert them at practically no cost and no effort to read Gamma rather than SWR. I would, of course, have furnished the information free as a public service except that I don't want to interfere in any way with your announced policy of paying the fastest and mostest.

Please advise the fastest the mostest that you will pay for my proposed article.

E.A. Wingfield, W5FD
26 Belmont Drive
Little Rock, AK 72204

I would like to take this opportunity to thank you, Kayla and the staff for the Swan 260 you gave away at the Dayton Hamvention. I had it on the air the day it arrived, and have a whole slew of contacts from 20 sideband and cw. The dipole I strung between the balconies is outperforming my beam with depressing success--but at least rotation is a little easier under the tri-bander.

My sixth contact was Kayla, and at the time, she was mobile in Texas. I had to run off to class though and only got to talk with her for a few minutes.

Being a college student, and especially a poor college student, the transceiver sure was a welcome addition to the shack. Since I'm in the co-op program here at school (EE) I spend half my time at home, where I drive 70 miles a day to work and back. My HT-32 was never designed for much mobile work and the Swan seems to be the answer to a long standing prayer.

I hope to be meeting you at a future hamfest, or perhaps on 20 one of these days. (say about 14250, fifth layer?) Once again, pass my thanks to all concerned and keep up the good work.

Bill Chidester, WA4ZCL/8
Box 500, Sawyer Hall
University of Cincinnati
Cincinnati, OH 45219

In your May issue by W8GI, Who's Who in Amateur Radio, you left out the best Guitar Picker in the Whole Wide World. . .Mr. Chet Atkins is a Ham and right now can't remember his call but I think he is as great as anyone that was listed, so let's get on the ball and quit leaving out us Hillbillies down here in Tennessee.

Ernest Tucker, W4MQV
Box 251
Fayetteville, Tenn.

I found K9AAU's short article ("A New System for Learning Morse Code," April, 1969) very interesting. When I learned the code a few years ago, it was by being exposed to the alphabet in groups unlike those suggested in the article; and it was necessary to suppress or unlearn some letters while being introduced to others. I am a nearly total cw operator and am always interested in improving my ear so after reading this article I realized that I am one of those with the habit of deciding what the letter is before the character is finished. Consequently, it is often necessary to change my mind after the character is complete. and this takes up time so it is a definite impediment. With this in mind, I took some practice with the intention of losing this habit. It took me very little time to realize that if I actively tried to stay a letter or two behind the sender, I could hear the complete character before I had to decide what it was. This immediately gave me at least a three word per minute increase in speed with a very accurate copy. Copying behind the sender is not a new idea by any means, but when this method is understood in light of Mr. Erwood's article, it can provide a springboard for someone like me who is stuck at a good, but not yet 20 wpm speed to gain the extra few words to upgrade.

Frank E. Wargocki, WA3AYW
2602 Orthodox Street
Philadelphia, PA 19137

As I sit here listening on the ham bands, it makes me wonder if the amateurs in the states know what kind of signals and how many signals are getting through to Vietnam. Apparently not, because I listen to stations over in this area, approximately, call them and receive nothing but a snub in return. It's a pitiful thing.

But, that isn't the reason I'm writing this letter to you. The first reason is to congratulate you on your forthcoming marriage to K4MWS and to congratulate you the fine job you've done in editing 73 for the past 22 months. Believe me when I say that I've really enjoyed your work.

While reading the April copy, though, I came across your editorial and it really stirred me up, to put it lightly. You mean to say that our Fraternity is going to let someone cut us to nothing and libel the best hobby in the world, without standing up and speaking their feelings on the matter? Ma'am it is a very good thing that one soldier is over in Vietnam, because I'd be doing some tall talking if I were capable of it. I can't feature just how weak people have become in helping out their fellow man and not ask for something in trade.

Of course, I'm speaking of the case being brought against Ansel Gridley, W4GJO. I'll say this, that anything I can do and anything that I can say to help will be said. If the man that is bringing this action against Ansel would concentrate his efforts on something that would help people instead of trying to hurt someone that was BETTERING himself, I don't think I would be writing you from my present location! The money he has spent on bumper stickers and advertising could have been used to write letters to Congressmen and to prominent citizens to help cure situations like Vietnam. That would be money well spent if he has enough to throw away!

About the magazine now. It is great, but how about some construction articles with analog circuitry in transceivers to make them automatically tune themselves?

One more thing before I close this almost editorial, here at AB8AS we average only about 1200 phone patches monthly. And guess what is the cause? No contact stations! With over 250,000 hams in the United States and many of these fellows belonging to the different MARS programs, this is a pity. All of the services over here have a MARS program and they all suffer this same question.

If any fellows interested in patching for RVN stations really feel that they could spend some time helping these stations out, we suggest that they contact their area MARS director and request authorization to work with RVN stations. Believe me, all help would be gratefully appreciated and we could better serve these fellows fighting over here. They deserve it don't you all think?

Thanks a lot, Kayla, and tell them to keep up the great work after you've gone.

Sgt. Ronald L. Berry, WA5BUG/XV

Congratulations to Kayla on her marriage and becoming a Floridian. She showed plenty of sense as your Editor and even more by coming to the Sunshine State. 73's loss is our gain. Hope to hear W1EMV/4 on 75 or 40 meters soon.

Ken Stewart, W4SMK

Quite a rational editorial of yours in 73 Magazine for May, 1969. Can't find anything to dispute your reports in it, and maybe it is about time that we amateurs realize, that with the coming of solid state, transistorized gear, intregated circuits, etc., that service on these rigs will no doubt be done by the manufacturers or service centers. The day of the present amateur having the proper service equipment to do an A-1 job of testing this new type gear is about extinct, Wayne, so lets just face it.

We take our cars to the garages; call the plumbers to fix our leaky pipes; call the piano tuner in to tune the piano; call the TV service man to fix our TV sets, and especially those in color; call the electrician in to put in some new wiring, and NOW—this sophisicated ham gear is right in the same vein.

The ARRL talked about "appliance operators" within the amateur ranks a few years ago, well, "They ain't seen nothin' yet!" Just give this new breed of ham gear using transistors, intregated circuits, solid state, etc., a few years on the market, and we all better have some good packing cases to ship the stuff back and forth to the manufacturer for needed repairs.

Charles Boegel, WØCVU
1500 Center Point Road NE
Cedar Rapids, IA 52402

My article on Learning the Morse Code in April has kept me busy answering letter. Purists may want to correct lesson three to read KCYDX6B, lesson 4 to read NTJPW1 and lesson 5 to read LRA2FU. Readers may be interested to know that reversable errors (A mistaken for N and N mistaken for A) plots a nice tree or chain with no exceptions! The non-reversable condition (you put down B when you hear J, but do not put down J when you hear B) is also plottable and a real brain twister. I've a bottle of aspirin reward for anyone solving this simple yet complicated problem.

Robert Erwood, K9AAU
2823 W. Lyndale Street
Chicago, IL 60647

Just a suggestion you may be able to use in your campaign to re-vitalize amateur radio.

Under current income tax laws donations of property to non-profit schools may be classed as deductions to income, thus reducing the donors tax liability. It is possible that many amateurs have obsolete, but operable equipment which could be donated to a nearby public school to stimulate interest on radio. The fair value of tax equipment or parts thus donated may be reported as a contribution under current tax regulations. If tax dollar amount is large it is recommended that tax prospective donor get more detail from the nearest Internal Revenue Service office.

George P. Firmin, WA4FSK
2193 Bollingbrook SW
Atlanta, GA 30311

Just returned from a stay in the hospital and am rushing my check for $6.00 to renew my subscription to 73 for another year as I do not want to miss an issue.

Must tell you I went in with loads of reading material as I have already passed the code portion for my Conditional General and have been waiting for the theory exam. I never opened any of the books and turned down friends offers of books etc. So when 73 came in, my O.M. told me he didn't bring it in - as I didn't seem to care to read - well, spurious radiation flew from WA2PGR to O.M.'s receiver (ears) and I must tell you upon reading it, all the medicine in the world couldn't have cheered my up more than Bob Mannings' article for May "In the beginning."

Marian, WA2PGR

Dave Middleton's letter to you in the May issue in which he asks "why are so many licensees who are now permitted to utilize the 'restricted' segments, still holding forth in the cluttered-up sections?" prompt this reply. . .namely, in spite of the fact that I have now held my Extra Class since Sept. 29th, so many of my very good friends are still restricted to either the General or Advanced portions and transceiver operation being what it is, it would just leave me with practically nobody to talk to if I stuck exclusively to those portions of the bands permitted by my Extra status.

I like my freinds better than my privileges. 'Nuf said?

Clayton Gordon, W1HRC
Box 85,
West Millbury, MA 01586

I'd like to know how many write in about the technical errors of the May cover, W7NVY: (A) You raise the antenna outside the guy wires; thus, the director goes up first with the boon vertical to the ground, and the reflector is the last to leave the ground and is held out by ropes till it slides on the guys. As drawn, the section of the tower hidden from view would have to have two guys on it, but I assume the artist lost his prospective here and couldn't figure how to get himself out of the deal. (B) A good man on the tower would have another foot of belt out and would not have his arm around the mast, nor would he have the wrench in his hand with people directly below him. (C) You don't raise the beam with a sling. Where is the leverage to get it higher than the guy on the mast? Either use a mast mounted jin pole or hook down on the boom to give height when up. Strain insulators aren't the right kind either, or else are wired wrong.

The colors are nice.

As for K1YSD- -more, more, more.

Arthur W. Brothers, W7NVY
Salt Lake City, UT 84313

George Taylor, W4PZS, whose letter appeared in the May issue of 73 is so right in his views on incentive licensing. I say three cheers for his ability of putting into writing what I've been thinking for a long time.

During the controversy, in a letter to the ARRL, I pointed out that this is equivalent to allowing the better auto mechanics to use the class A highways and relegating other persons, who may be excellent drivers, to back roads.

I have been an amateur operator since 1931 and have subscribed to QST whenever I had the money but like many other hams I dropped out of the ARRL membership with the incentive licensing issue.

So you see, George Taylor is not alone in urging you to pressure the rescinding of this ridiculous rule.

Yours for better operating procedures.

Theodore DeCrescenzo, W2DAD
244 Columbia Ave.,
Jersey City, NJ 07307

I agree with most of what Wayne (March de-W2NSD/1 has to say. The whole ARRL should be in Washington. I lived and worked there for 30 years. I worked with all the associations (and there is one for everything). It's not only advisable, it is totally necessary. I agree also with the need for publicity. . .we must be heard and felt, but we'll never do it the way things are going now.

Hank Bray
1324 West Knox
Tucson, AZ 85705

We wish to thank you whole heartedly for the article (May, page 46) on QRP operation by Arthur Child, W6TYP. This article is very interesting, informative, and will give our Club a very big boost. Thru no fault of yours, the office of Corres. Sec. was changed from K7LNS to K3YNN (me). Am a steady reader of 73 and do sincerely hope that you keep up such a marvelous job for 73 magazine.

Elmer J. Worth, K3YNN
946 Franklin St.
Reading, PA 19602

The article "Education and Ecstacy" (April, page 14) was beautiful. It takes me back 35 years. Mr. George Leonard has hit upon the difference between the Old Timers and the modern amateurs. The old timers had a feeling of ecstacy gained from the thrills of the sound and flash of the crashing spark, or us youngsters by watching the 852 glow a cherry red while listening to the hum of the pole peg and watchin the house lights blink. Those days it was easy to build a rig and receiver.

What have we today? Cold, hard, unhuman, solid state. No color, no hum, no beauty! I pity the poor educator who has to overcome the barrier today.

Ed. Marriner, W6BLZ
528 Colima St.
La Jolla, CA 92037

The biggest mistake the average ham makes when he finds himself being intentionally jammed by someone with a serious mental problem is to answer the idiot. Almost all receivers are equipped with a little knob for tuning which can change the game to hide and seek. It also helps to change over to CW as few of the morons can copy over 13 per.

Charles Larson, W9JWH
RR4, Connersville, IN

Out here in the western Pacific I work for IT&T/Federal Electric Corporation as an electronics tech. A chap who left for the U.S.A. left behind a Heath HW-16 that he had built for 21 megs only, leaving out the band switch complications and so forth. He left behind only one crystal that is for the low end of 21 megs CW. I know how you feel about incentive licensing and it has its pros and cons. One thing it has done for us is to keep clear the low end of 21 megs so DX can work DX without US interference (QRM). With the low power of the HW-16 I have worked DX I never dreamed of back home without having to QSO any W's. This sounds selfish, but when you're not here and work those real rare ones when no one else is on the bands, it's sensational. I know sigs are coming through from the USA 'cause I can tune up the band and hear the Generals and Novices. Unfortunately I can't qso them due to a lack of crystals. I won't be here long enough to import any since I did have hopes of giving some of the Novices their first KX6. I thought I would add one bit of sentiment about the incentive licensing that from the DX man's standpoint, it's great because it's keeping the USA gang off the DX frequencies.

Jim Jaeger, KX6KR
Marshal Islands

In the February, '69 issue of 73, page 10, Mr. Matthews' schematic does not include an important safety component. . .and rf choke across the output to ground. The rf choke is normally included in this place on a linear to put the high voltage to ground in case the blocking capacitor (c-11) should break down.

Keep up the great work with 73. Thank you.

Wayne L. Jinske, WA9SSH
Route 1, Box 157A
Cluster, WI 54423

As you can see from the address I am living in Brooklyn again. My company decided that they needed someone in the New York City area, so I deported from sunny California. I found the article by W2ZRX/4 on "The VHF Vacation Special," very interesting and useful. The antenna works quite well. I found that if two sheets of "Oaktag" (heavy paperfinished cardboard) were taped together the antenna can be mounted on the "Oaktag" with an office type stapler. Staples are also used to mount the coax feed to the antenna instead of taping the coax to the antenna (better electrical contact). The antenna can be mounted either vertical or horizontal and relocated easily. By building the Antenna on the "Oaktag" all I have to do is take down the Antenna, fold it up and store it.

Dave Abramowitz, WB6JEV/2
2520 Batchelder Street
Brooklyn, NY 11235

Compliments to Mr. Sam McCluney and to 73 for presenting the revolutionary audio filter as described on page 60 of the April 1969 issue of 73. The selectivity available with this device has enabled us to make QSOs easier and to communicate the desired information in shorter time than was previously possible.

However, it was found during attempts to con- Mr. Gus Browning, W4BPD, on his travels that even this filter was insufficient to cope with the maximum useable interference level (MUIL) on filters' performance and a solution was found which may prove helpful to toher hams.

The copper conductor specified in the article was removed and replaced with a low resistance silver conductor cut to a length of exactly 0.73051." The length is extremely critical to the performance of the new filter and was determined after lengthy experimentation.

The performance of the new filter is even more amazing than the original. Lab test so far have indicated a filter selectivity of -0.3 cycles. The negative term applied to the filters bandwidth indicates the filters ability not only to eliminate all QRM but also its capability of internally amplifying the desired signal. The numeral following the decimal point indicates the amplification in decibels.

The obvious advantages of a filter of this selectivity are that much less on-the-air time is required than previously to communicate the same amount of information. The amateur will now find much more time available to spend in keeping up with current states of the art, with his family, and with other activities he previously was unable to find time for.

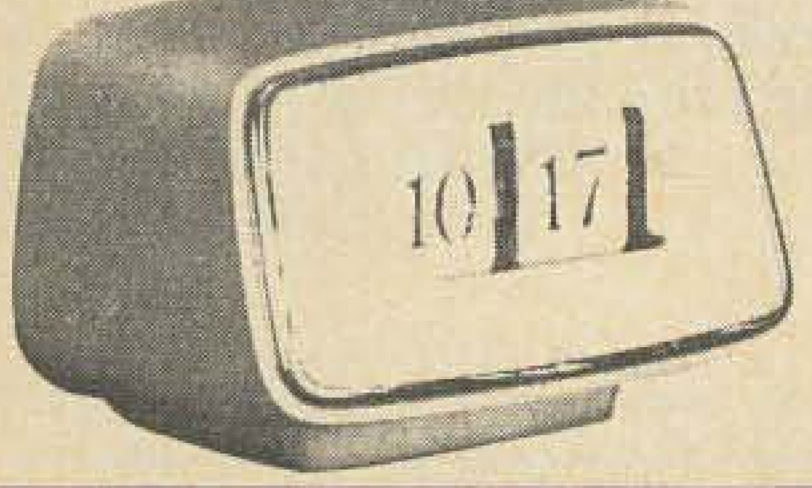
Again, congratulations on this article which is in tune with most of the other revolutionary article which 73 published as a service to the amateur.

Jon P. Zaimes, WA3BGN
6117 Smithfield Street
Harrisburg, PA 17112

For a long time it has seemed to me that the Technicians are the forgotten people of ham radio in the band frequency shuffle. I believe that a large percentage of "Techs" are home brew builders and tinkerers, and that they should be encouraged to maintain their interest and curiosity in ham radio for the good of all radio. One way to do this would be to allow them to use a small portion of the upper end of the large 10 meter band so that they could participate in more reliable DX conditions.

By the end of this year when more of the lower end of 6 meters is allocated to Advanced and Extra Class license holders, everyone else using this band will be forced closer to TV channel 2. That will cause more TVI complaints and I don't believe anyone needs more of that!

The Technicians have to pass a theory test



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which is similar to a General test and they are competent and able to handle their equipment properly.

It would be nice to hear some discussion and see some action on this suggestion. I know that ARRL petitioned the FCC to keep the entire 6 meter band open for all classes, but was turned down. However, the idea of "Techs" using a portion of 10 meters was not laid before them.

Thank you for any consideration you may give this idea.

R.L. Gardner, WB6VON
3695 Strong St.
Riverside, CA 92501

I want to thank you very much for the Advanced Class License articles, and make a few comments on the FCC exam. I studied each article carefully, month by month. At the end of the series, I read through each one again, at about one per day. I guess I was very well prepared for the exam was no problem and I feel much more knowledgeable and competant. I am very grateful to you; just hope I can do as well with the Extra Class!

My exam was in San Francisco, Friday at 8:30 a.m. If you missed 8:30, as some hams did, you had to wait until 9:30 or ten to be "run through" again - or come back next week. This all seems unfair to working people. Couldn't they schedule more times? And what about lunch hours, or late afternoons, or evenings?

The exam room was so crowded with desks that it was not possible to get between them. The noise of people clanging through the desks, plus the room's being used for all applications, verbal questions, eyeball QSO, made a nearly impossible examination atmosphere.

The exam, itself, contained a variety of poor questions. I mean poorly composed questions as well as poor questions. One question asked about the best frequency for communication over a "long distance." The term "long distance" was too general for the variety of answers that were possible. Is two hundred miles a "long distance?" If so, what is two thousand? The subject matter could be quite relevant in an emergency.

Second, I remember at least two questions which were not really amateur radio questions, but were "tricky english" questions: Unusual word orders, synonyms of what universally appears, with the result that more than one answer was actually possible. If it uses "plain english" on the code test, why can't the F.C.C. use "plain english" on the written? After all, our job is to be tested for our radio knowledge and competance, not to be alertly playing examination word games.

Third, the rules and reg.s question on my exam was one which I would never rely on my memory for. Knowing band edges is one thing, but amateur-to-F.C.C. communications regarding portable operation are complex enough to call for careful & thorough study of the rules and reg.s as you communicate with them, and hardly a simple "memory" questions.

Nowadays, they don't grade your exam on the spot; they claim they are too busy. I wonder about this: the exams are only one morning per week. There were less than two dozen people taking exams over the two hour period I was there. Grading is simple and fast on their answer sheets. and it used to be no problem to do it, several years

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ago - just a courtesy to let you know before they sent it away. And then the absurdity of hoping not to get any mail for ten days, because if you don't get any mail it will mean that you passed! Like a sort of undercover organization: if you don't hear from us, everything's O.K.

We amateurs are being asked to upgrade ourselves. I think the F.C.C. ought to upgrade itself, too, in respect to the radio amateur. We should expect and demand that the F.C.C. shape up. In the area of exams, there should be a better calender. a better exam room atmosphere, a more to-the-point examination, and better grading feedback.

Steven Saslow, KFBDK
1300 Grove St. #4
Berkeley, CA 94709

In the latest issue of 73 (April, 1969), you stated that since Kayla is leaving your staff, you will be featuring lots of articles on your favorite subjects, VHF, RTTY, Fax, etc. That's why I'm writing this letter.

As an avid believer in experimenting with new modes of amateur activity, I have bounced around from one project to another with the enthusiasm of a young puppy.

I have found though, that many hams like to use such phrases as "Somebody should write a letter to the F.C.C. on this or that matter." But by and large that's all they do. They keep repeating the phrase over and over but never seem to practice what they preach. Well this is where I come in, Wayne, I don't like to work any harder than the next guy, but I do get sick and tired of everyone talking but nobody doing anything about any given ideas. So I generally proceed to write letters and, in general, stick my neck out for any cause which I have a personal interest in. So, now finally, I am getting to the real purpose of this letter.

You say you're interested in Fax and VHF. Well, Wayne this pet project concerns both. Let's take the history first. A few months ago, Western Union released a large lot of desk-top facsimile units (trade name "Telefax") which is manufactured by the Seeburg Co. These units reproduce printed material onto specially treated 4½ x 6½ blanks. The machines are self contained and operate on the principle of a steady 2500 hz tone which is amplitude modulated directly by the change in intensity of reflected light from the original. The original is fastened to a drum which revolves and traverses laterally at the same time. The light source is directed onto the original and reflected back through a series of lenses, through a rotating "chopper wheel" and finally striking a photo sensitive tube. The "chopper wheel" produces high speed light pulses on the photo tube. The output of this photo tube generates the audio tone of 2500 hz. The amount of light reflected from either lines or shading on the original varies the amplitude of the light striking the photo tube. This amplitude modulated, steady tone is fed directly into a low impedance microphone circuit in the transmitter. The station receiver feeds the incoming audio signal directly from a speaker connection on the receiver to the input of the Fax machine for the receive mode. A sensitized paper is attached to the same drum as uded for transmitting. Now, however, when the unit is actuated on the incoming mode, the drum begins to rotate and traverse. At the start of motion, a small stylus swings over and rubs on the paper. A high voltage spark passes through the sensitive paper to the drum itself. This spark varies directly with the amplitude of the incoming audio signal. The traces to appear in relation to the intensity of the spark. This, basically, is the principle upon which the machines operate.

These machines were sold in Cleveland, Ohio and are being sold by other surplus outlets throughout the United States at a selling price of from $10 to $20 apiece. Many of us in northern Ohio purchased these units.

Now the VHF part. There has been a very high level of activity on 2 meter FM in northern Ohio recently. We operate converted commercial gear using 146.940 mhz/s as an operating frequency. Other frequencies spaced at 60 khz intervals are also used. We operate only FM and most of us have both base and mobile station capabilities. Effective communications of 50 miles are commonplace. There are 2 repeater stations within our effective operating range which can be utilized to increase our coverage. I am also a participant in a small local autostart RTTY net on 146.700 mhz/s using AFSK. (RTTY, by the way is a phase of ham radio very close to my heart. See 73 for January, 1969, for my feelings).

To continue, when these Fax units were purchased, many of them were immediately placed into service through the FM units. Utilizing this mode, the fax pictures are extremely clear and sharp. However, someone discovered that the type of emission that was being used (type F4) was not authorized in the 144 to 147.9 mhz/s band. The only type that is authorized on 2 meters is type A4 (AM Facsimile) emission. The few units which had already begun operations were immediately removed from the air. Then everyone started asking, "What can we do now?" A suggestion was made that everyone owning one of these fax machines should write to the F.C.C. and request special permission to operate them using type F4 emission. After hearing much talking but seeing no action, I decided that I would write the F.C.C. a request letter myself. As it turned out, mine and one other request were the only ones received by the F.C.C. as far as I can determine. In due course of time, I received an answer which, about as I had expected, denied my request on the basis that they did not believe it advisable to issue temporary authorization such as the one requested. They did state, though, that I was free to file a petition as per the procedures they outlined to have the Commission's rules ammended. I again brought this out over the air and agian I heard the same old cry, "Somebody should file a petition with the F.C.C." Again after hearing a lot of talk but seeing no action, I took up pen in hand and drafted a petition asking to have part 97.61(a) of the Cbmmission's rules amended to include F4 emission. I then sent this petition to Washington. Again after due course of time, I received a copy of a schedule of hearings and found that my petition had been accepted for hearings and was listed as file number RM-1429. No mention was made of when the petition would come up for hearing before the Commission. I let the fact that there was now a petition at the F'C.C. be known and most of the fellows were quite pleased. A few of the interested hams in the area then sent comments to the Commission regarding the petition (all favorable, I hope).

Now to the heart of the matter, Wayne, I can campaign over the air to the hams in the Akron, Canton, Youngstwon, Ohio areas myself but I am in no position to carry the message throughout the country. I have seen ads from surplus centers in St. Louis, Mo., New York City, and other places which are selling these fax units, so it stands to reason that many hundreds of hams could possibly benefit from the acceptance and subsequent adoption of my petition by the F.C.C.

Wayne, since you have been a crusader for the little fellow and you are highly respected in ham circles, I felt that a little boost or some promotion by you of the RM-1429 petition through 73 magazine would help tremendously.

So in summary, Wayne, I am asking for some help from you in spreading the word that there is a petition on file with the F.C.C. and anyone interested in operating Facsimile on 2 meters using FM equipment should please send their comments and support to the F.C.C. in Washington, D.C.

The comments must be typed, double-spaced, using 1½ inch left margin and be filed with (1) original and 14 copies. All correspondence and comments must refer to the file number RM-1429. (These are all Commission's rules and any correspondence not conforming to these specs can be ruled unacceptable and not valid.

Remember, A4 is allowed on 2 meters so let's have F4 allowed too. Keep the file number in mind: RM-1429.

Thanks, Wayne, for your time and we here on 2 meter FM all appreciate whatever help you can give us.

James L. Turrin, WA8DCE
Box 245
New Philadelphia, OH 44663

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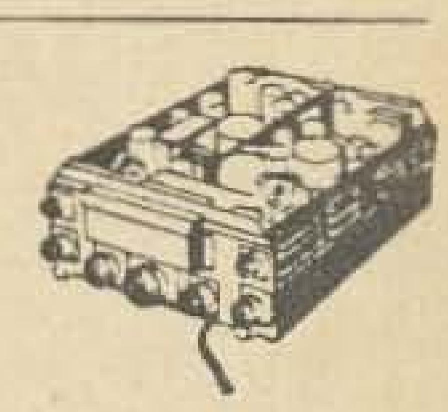

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Linear Systems Century Power Supply 12v DCN, 2200v DC 450 MA Out For 1 KW Mobile	$ 75.00
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NLS 450 DVM, for voltage ratio measurements. Appears good, not checked.	$ 95.00
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THE ANNUAL HAMFEST for the Washington, D.C., metropolitan area, sponsored by the Foundation For Amateur Radio, will be held at the Gaithersburg Fairgrounds in nearby Gaithersburg, Maryland, on Sunday the 21st of September from 1000 until 1700 hours.

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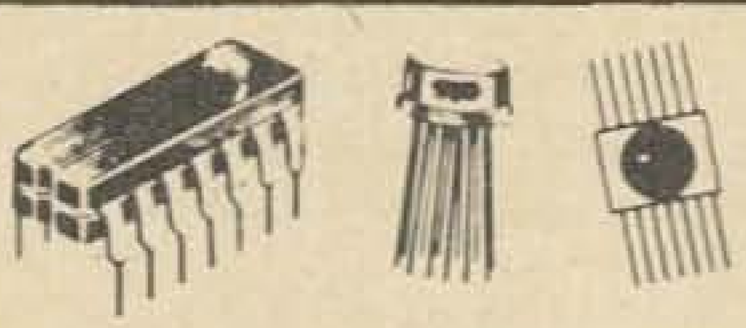

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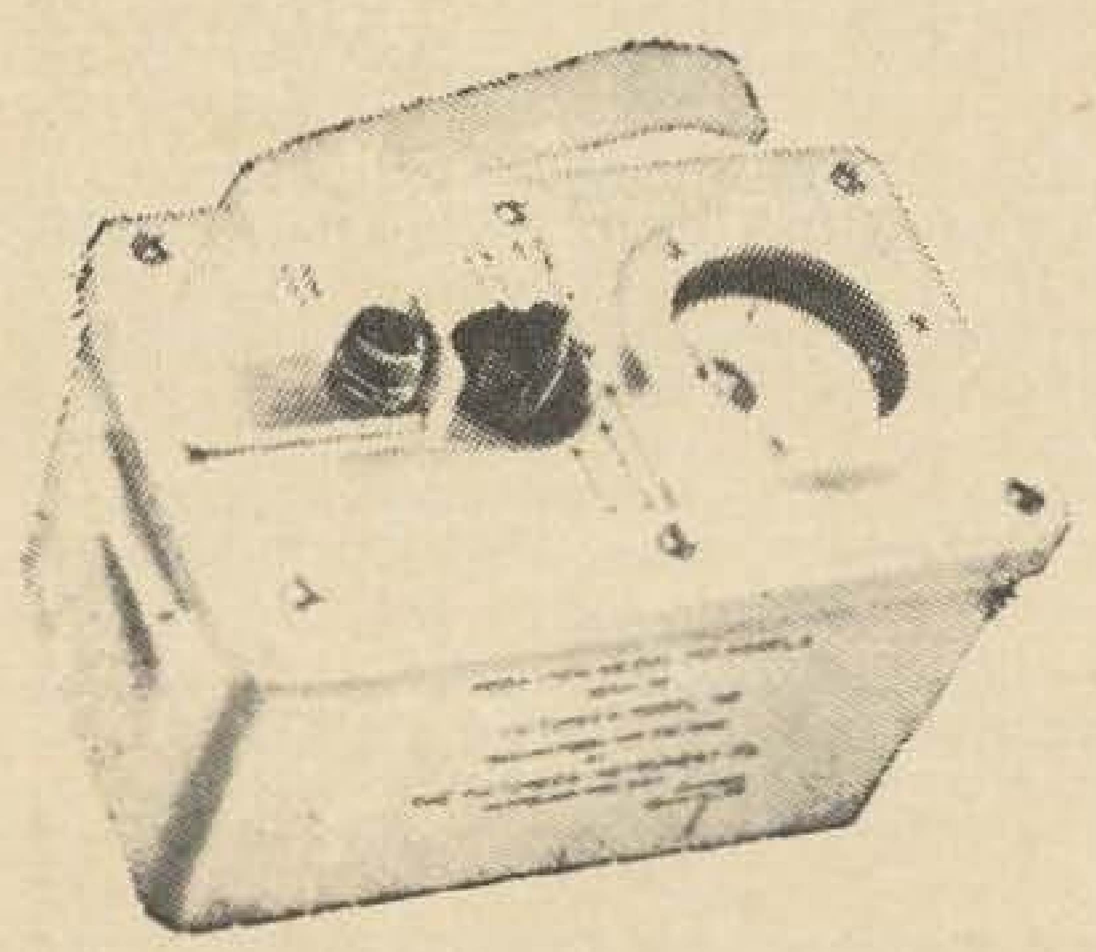

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W.A.R.A. 12th annual Hamfest Sunday August 24, 1969, Newton Falls, Ohio. Take Ohio Turnpike to exit 14 and ask for map to Hamfest. Prizes, XYL activities, Swap & Shop. For further information write: W8VTD Box 809 Warren, Ohio 44481.

FOR SALE: Sencore FE-14 FET-VM $35, Data Instruments 536A oscilloscope $70, Mini-AF generator 6803 $30, Kay RF attenuator 432D $30. All like new. Herbst, 39 Lucille, Dumont, N.J. 07628

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CRYSTALS for amateurs. All meters: 1 K C at 20pf. HC6/U holders, -093 pins, 10¢ extra. Crystal frequencies 3501 to 3999; 7000 to 7300; 8001 to 8221; 8334 to 8900. K C. $2.95 each prepaid. Add 12¢ for postage. Listed dealers inquires solicited. American Crystal Co. Box 2366, Kansas City, Mo.

THE TOTAH AMATEUR Radio Club will hold it's Annual July 4th family picnic at Lake Vallecito, Colorado, July 4th, 5th & 6th. All interested per- are welcome. Please bring own camping equipment. General location is east end of lake. Watch for road marker. Thank you.

THE OAK RIDGE Radio Operator's Club will sponsor the 20th Annual Crossville Hamfest at the Cumberland Mountain State Park July 26-27. For information write The Oak Ridge, Radio Operators Club, Inc. P.O. Box 291, Oak Ridge, Tenn. 37830.

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"HAM-A-RAMA. The 5th Annual Wood County Ham-a-rama will be held Sunday July 6th at the Fairgrounds in Bowling Green, Ohio. Contact WB8AYY, Bradner, Ohio

THE SHAWNEE AMATEUR Radio Association better known as SARA will be holding their SARA Hamfest on the first Sunday in August, August 3, 1969, at the Herrin City Park in Herrin, Illinois. There will be a trading line and prizes. Tickets can be gotten from W9ERI Bill Johnson 502 Kennicott in Carbondale, Illinois 62901.

39TH–ARRL WEST GULF Division Convention August 15, 16 & 17, Amarillo, Texas. For an ideal summertime weekend of ideas, fellowship, entertainment, fun (and maybe good luck) you can't miss at $10.50 for registration. W5WX Panhandle Amateur Radio Club, Box 5453, Amarillo, Texas 79107.

FOURTH ANNUAL Mini-Hamfest, sponsored by the Rockford Amateur Radio Assn., August 17, 1969 at the Boone County Fairgrounds in Belvidere, Illinois. Lunch and refreshments.

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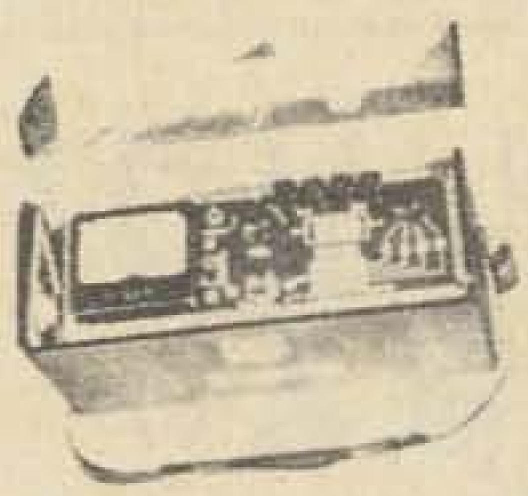

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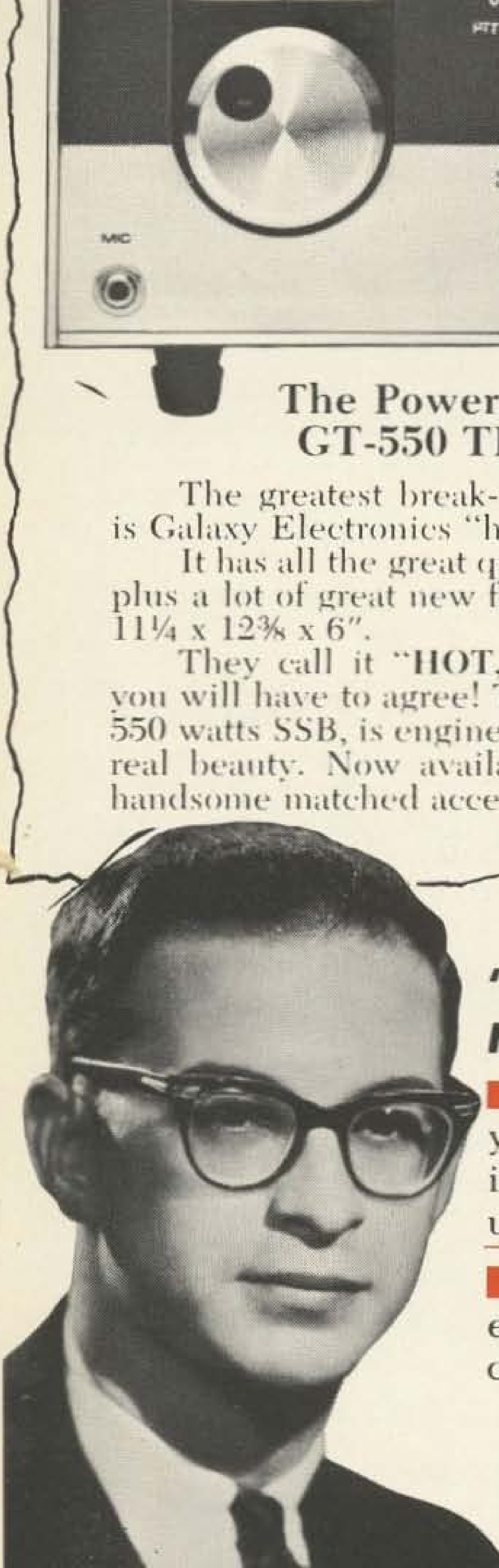

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Please send me the following: (F.O.B. Council Bluffs, Iowa)

- ☐ Information on GT-550 2-Week Trial
- ☐ Free Galaxy GT-550 Brochure
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- ☐ Quote me a trade
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Some comments from warranty cards by owners of

DRAKE TR-4
SIDEBAND TRANSCEIVERS

"The TR-4 is the best rig I have ever known to be made. Glad to own one."

Dan Tangorra, WA7FWH
Tacoma, Wash.

"Finally got what I wanted!"

Ronald E. Lyons, WB2BQX
Oakhurst, N. J.

"A superb piece of equipment, no comments necessary.

C. G. Noakes, G3UHR/VO2
Labrador City, Newfoundland

"Great rig—First contact was an ON5 in Belgium."

Bill Busse, WA9TUM
Mt. Prospect, Ill.

"Best gear I have had the pleasure of working with. Receiver is exceptionally sharp and stable."

Albert V. Mitchell, WA9BUP
Jeffersonville, Ind.

"Nothing to comment, except that my TR-4 is a real jewel, and I am very satisfied with it. I would like to receive the catalogue of your products."

Joe Braz Ribeiro, PY4UK
Monte Carmelo (MG) Brazil

"A very F.B. piece of equipment. Audio very nice, especially on SSB, which is rare."

Thomas F. Totten, Jr. WB2GZR
Saratoga Springs, N. Y.

"Running it with a Mosley "Classic" beam and proves a most fine and nice transceiver. Really proud of it."

Orlando Escudero O., CE-3-OE
Santiago, Chile

"Looks good—sounds good—very well pleased with performance."

Wayne M. Sorenson, WAØETL
St. Paul, Minn.

"Have had Drake 2-B for three years. Knew that TR-4 was same Good Stuff."

Charles E. Bishop, WA8FTT
Columbus, Ohio

"Just what I always wanted."

Daniel N. Hamilton, WA4WXQ
Ashland, Va.

"Why not build a good 6 Meter SSB & AM Transceiver . . . hurry up, I'm waiting."

Harold A. Zick, WA9IPZ
Creve Coeur, Ill.

"Excellent equipment."

W. T. Newell, WB6UZU
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"O.K. 100 x 100. RV-4: O.K./W-4: O.K./ L-4: O.K. Very Good!"

Franscisco Fau Campmany, TI-2-FAU
San Jose de Costa Rica

"A beautiful piece of equipment. My second piece of Drake. The first was a 2-B and this sold one friend an R-4 receiver and another a TR-4. We are Drake-minded here in town. Many thanks."

Charles E. Boschen Jr., WA4WXR
Ashland, Va.

"I'm sure this, like the other Drake equipment I have, is the finest money can buy. YOU MAY QUOTE ME ON THAT."

C. E. (Ed) Duncan, WA4BRU
Greenville, S. C.

"I'm a real happy man with it. Does a real good job of getting thru."

Jerome D. Lasher, W2RHL
Hamburg, N. Y.

"Replaces my TR-3."

D. G. Reekie, VE 6 AFS
Calgary Alberta Canada

"Finest performing gear I have ever had the pleasure of operating."

Milton C. Carter, W2TRF
Lakewood, N. J.

"PS Several months have passed . . . I now employ TR-4 as mobile unit and base station. I have logged more than 1000 contacts, many being rare DX. I am looking forward to owning a second unit to be used strictly for mobile. To date TR-4 has been trouble-free."

Milton C. Carter, W2TRF
Lakewood, N. J.

"Well pleased."

Rev. James Mohn, W3CKD
Lititz, Pa.

"I am delighted with Drake gear. This is the second of your transceivers for me. I have used a TR-3 in my car for about 2½ years—only trouble: replacing a fuse!"

Guy N. Woods, WA4KCN
Memphis, Tenn.

"Ask the ham who owns a Drake TR-4"

. . . or write for details . . .

Dept. 379 **R. L. DRAKE COMPANY** 540 Richard St., Miamisburg, Ohio 45342