AMATEUR RADIO 73

April 1969
75¢

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RF PREAMP

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73 MAGAZINE

April 1969
Vol. LXIX No. 4

Cover Photo: Power Supply for High Power Final Amplifier....K8TSQ.

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...de W2NSD/1

Wayne Green

With Kayla getting married and moving to Florida, I'll be back in the editor's chair after about four years of rest. I hate to see her go. Few hams know the good and the bad guys in ham radio as well as Kayla. We'll miss her perspective. Your letters were at first skeptical that a YL could turn out a good magazine in what is, essentially, a man's hobby. Once she got out from underneath the problems left by her predecessor the letters turned to raves.

In the last four years, 73 has been growing healthily. Our circulation just about doubled during the period while the circulation of the other ham magazines dwindled. Our basic format of concentrating on articles and more articles rather than filling up the magazine with low-cost monthly columns and contest reports seems successful. Our editorial policy of telling just what is really going on and how we feel about it seems popular with just about everyone except our fellow publishers.

From a one-man editorial staff we have grown to a whole team and are now setting all of the type for both the articles and ads in 73 in our typesetting department. Our art department has a number of illustrators preparing our schematics. Our production department is turning out not only 73, but is working on a whole line of new books. The Coax Handbook is the first of these and the Advanced Class Study Course is the second.

Our advertising department, headed by Bill Beatty, is doing quite well, but even so, Bill could use a little help from you. If you prefer to read a magazine that is made up of articles rather than columns and reports, then you should let the manufacturers and distributors who advertise in the ham magazines know where you are looking for their ads. If we had 50 pages of ads we could bring you a 200 page magazine every month with about 150 of them devoted to articles. If you'll look back you'll find that the last 200 page issue of QST had 68 pages of ads and only 34 pages of articles! The rest was activity reports and columns. You can vote for the magazine of your choice by letting the advertisers know where you want to see their new products and specials.

The articles in 73 will start to reflect my own interests again...VHF, DX, RTTY, FAX, contests, and a multitude of construction projects. I have some fabulous goodies in store for you. We'll emphasize antennas in May, VHF in June, mobile in July, transistors in August, transmitters and linears in September, receivers in October and transceivers in November. Our policy of paying the fastest and the mostest for good articles is giving us the pick of the articles and I could easily fill a 200 page magazine every month for you if you could just get the advertisers to back us up.

We are by far the most particular about who our advertisers are and if we get many complaints we bounce 'em until things are straightened out again. Some of the advertisers that are not in 73 are not in there because we will not accept their ads. You can get a good clue to this by checking for some that we have dropped in the last year or so. The readers of another magazine, one which brags about checking their advertisers, lost thousands of dollars to a crooked outfit from which we refused to accept advertising.

73 has grown beyond anything that I expected. Perhaps it is getting too big for me. Sometimes I wonder if we should go public and issue stock. Or perhaps we would do better to join one of the larger publishing houses and let them handle the business end of things. When a business gets this big there isn't enough time left for hamming. I miss that most of all.

It would be nice to be able to get away for a long trip to some relatively remote part of the world and DX a bit. We have all too few amateur DX-peditions. I see that Gus is off again, but Gus is a professional DXer and you have to pay him for working him, one way or another, or else he won't go. This was one of the big difficulties with Don Miller. I don't put much store in the claims that a professional DXer can cage upwards of $50,000 a year in relatively tax-free donations, but there obviously is enough in it to keep one or two fellows on the road year in and year out. If it didn't pay they wouldn't do it.

And, once a fellow is off DXing for a business he is forced to find new places to oper-

(continued on page 67)

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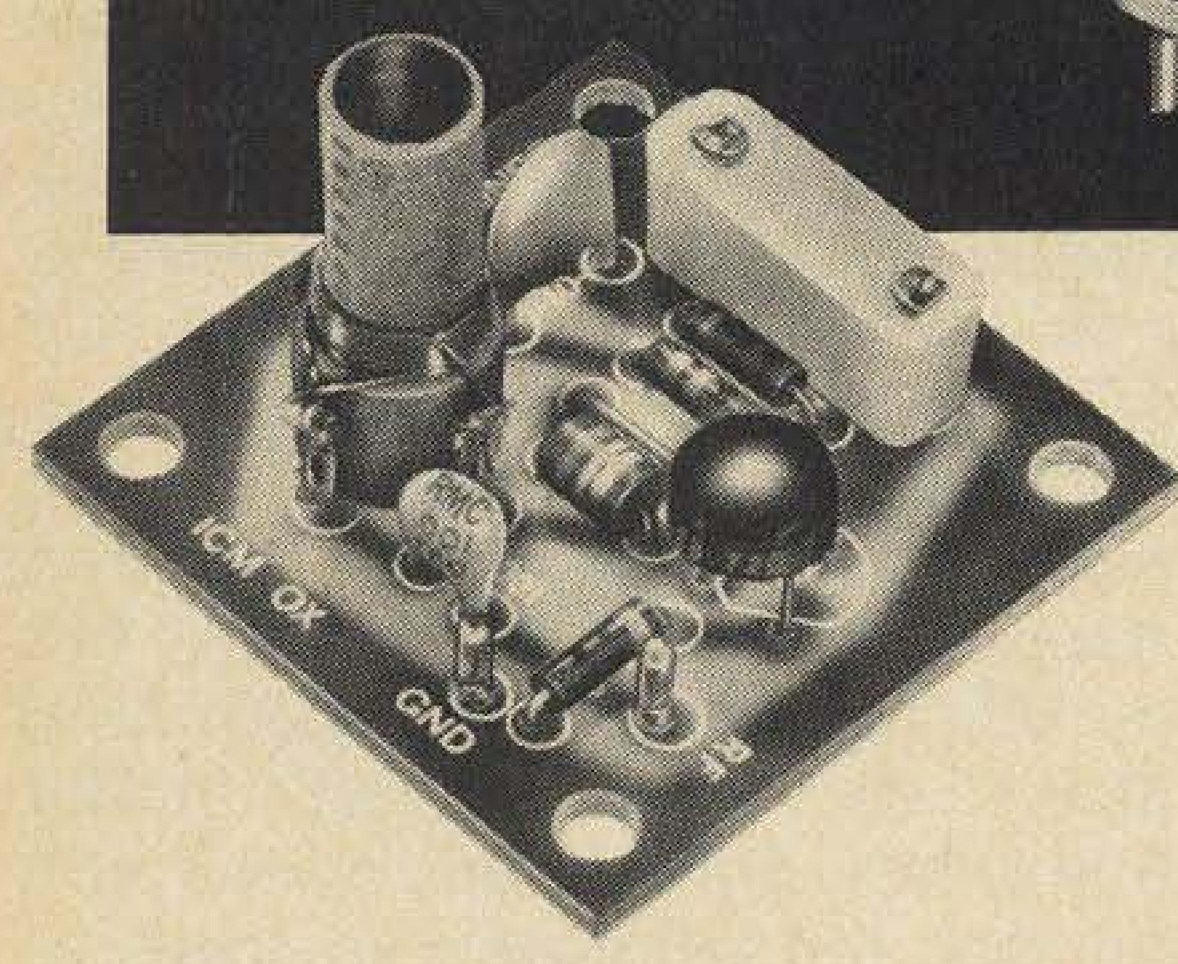

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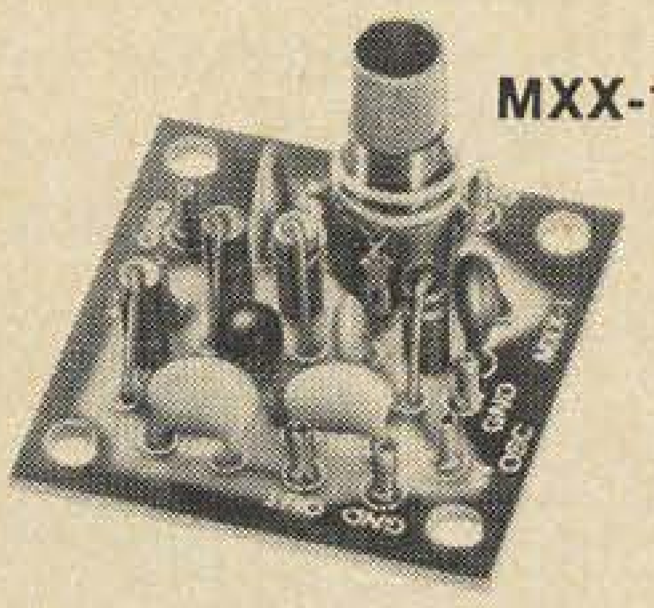
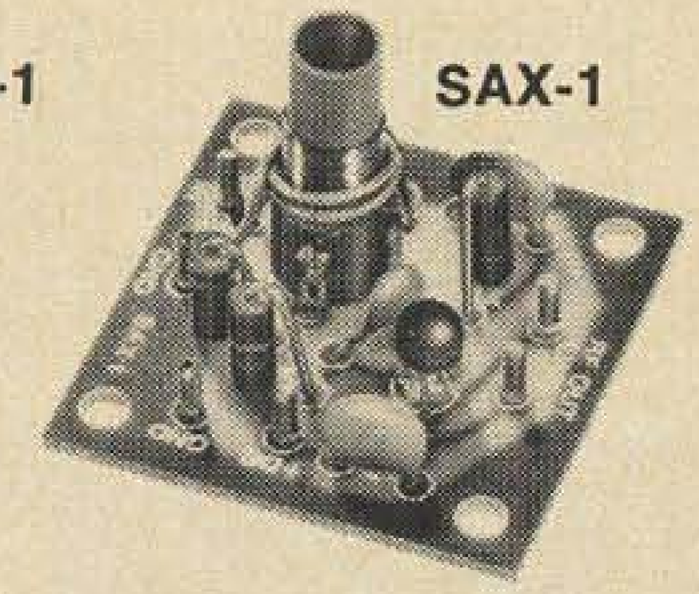
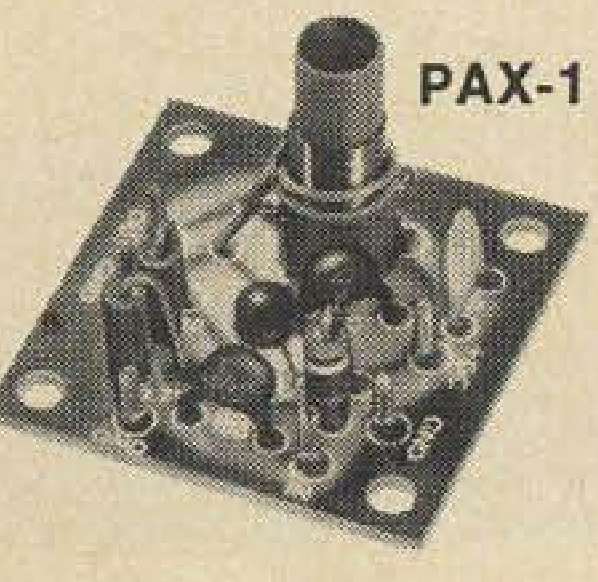


SAX-1



PAX-1



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Editorial Liberties

Apparently I stepped on some toes with my February Editorial Liberties. I dared to suggest that ARRL's OO program might be more effective in the policing of our bands and in recommending that FCC take action against malicious offenders. That segment of the ham population which is opposed to ARRL has been most vociferous in it's opposition.

I'm going to ask two questions, and then try to answer them. The first is: Why ARRL? And, the second: Why has it failed?

The answer to the first is fairly simple. It was obvious many years ago that amateur radio could not stand without an organized body to support it. A look at the Constitution and By-Laws, shows that it is organized along Democratic principles. You elect the person you feel will best represent the interests of your group, and then guide him in those interests. Your Director's job is to take action according to the member's wishes. It works very much like our Federal Government. The voters elect their representative to the Congress, who in turn cast their votes according to the way their constituents tell them to.

The answer to the second question is even more simple. It can be said in one word... "YOU." Back in 1933, a man named Hitler took over Germany. Even long before, a man named Lenin took over Russia. Today, we have our Castro, our DeGaule, our lesser dictators; and why? Because the people really didn't give a darn. They allowed it to happen. ARRL has a fine principle. ARRL has a fine constitution. ARRL could be the democratic voice of amateur radio. Instead it is a closed corporation of people who live for ARRL rather than amateur radio.

Now, I'm going to ask some questions which I am unable to answer. Only you, the reader can answer. Are you a voting member of ARRL? Did you cast a vote in the last election? Do you know the name and address of your Division Director? Did you write to him before the deadline for the coming Board meeting in May? If the answer to any of these questions is "NO," you have no right to criticize. Sitting back and grumbling that things are not going your way won't get you anywhere. The only way to make ARRL work for you is to become involved.

The Ansel Gridley case in Florida is still going on. Grid, W4GJO, is being sued for one million dollars. The plaintiff, who owns a large liquor store in Sarasota, has been advertising in local newspapers with vitriolic anti-ham messages. He has also distributed bumper stickers like the one shown below. Grid has obtained an injunction to prevent further ads or stickers, but if you have ever tried to remove one of those stickers, you know they will be around for a long time. I suggest that large clubs (certainly ARRL won't get involved) should file counter suits against this man for defamation of character in the amount of three million.

With this issue, I sing my "Swan Song." My 22 months with 73 has been rewarding and exciting. However, my forthcoming marriage to K4MWS promises to also be rewarding and exciting and the only deadlines to be met will be mealtimes. We are to be married in May and as soon as I have settled in my new home in Florida and have my feet back on the ground, I will continue as a contributing editor for 73. Thank you all for both your criticisms and your support.

Kayla...W1EMV

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ASK THE HAM . . . WHO OWNS ONE

Dual Channel Oscilloscope Preamp

Robert G. Teeter
16 Poplar Drive
Rochester, N.Y. 14625

Upgrade your present oscilloscope to have dual trace capability. Don't buy a new scope, instead build a preamp that has the features you want and need. Two channels, each with a separate attenuator, can be displayed one at a time or alternately. The scope sync can be triggered from either input.

The heart of the unit described herein, the switcher and driver boards, were originally designed as part of a systems modification. Seventeen Tektronix 360 type indicators (3 inch oscilloscopes) were converted to dual trace operation. Each oscilloscope was modified internally by adding a pedestal switching transistor, pedestal adjust potentiometer, and 10x amplifier. The switcher boards and driver boards were located on a relay transfer panel under the console. The mode switch and individual gain controls were mounted on the operator's control panel.

By building a switcher board and a driver board and adding some switches and accessories, a good alternate trace preamp can be constructed at moderate cost. The required accessories include power of plus and minus 12 volts, a mode switch and knob, and individual channel gain controls. Optional accessories would be frequency compensated attenuators, switched trigger output and an amplifier. A small modification is required within the oscilloscope itself. The block diagram, **Fig. 1**, shows the general relation of the parts.

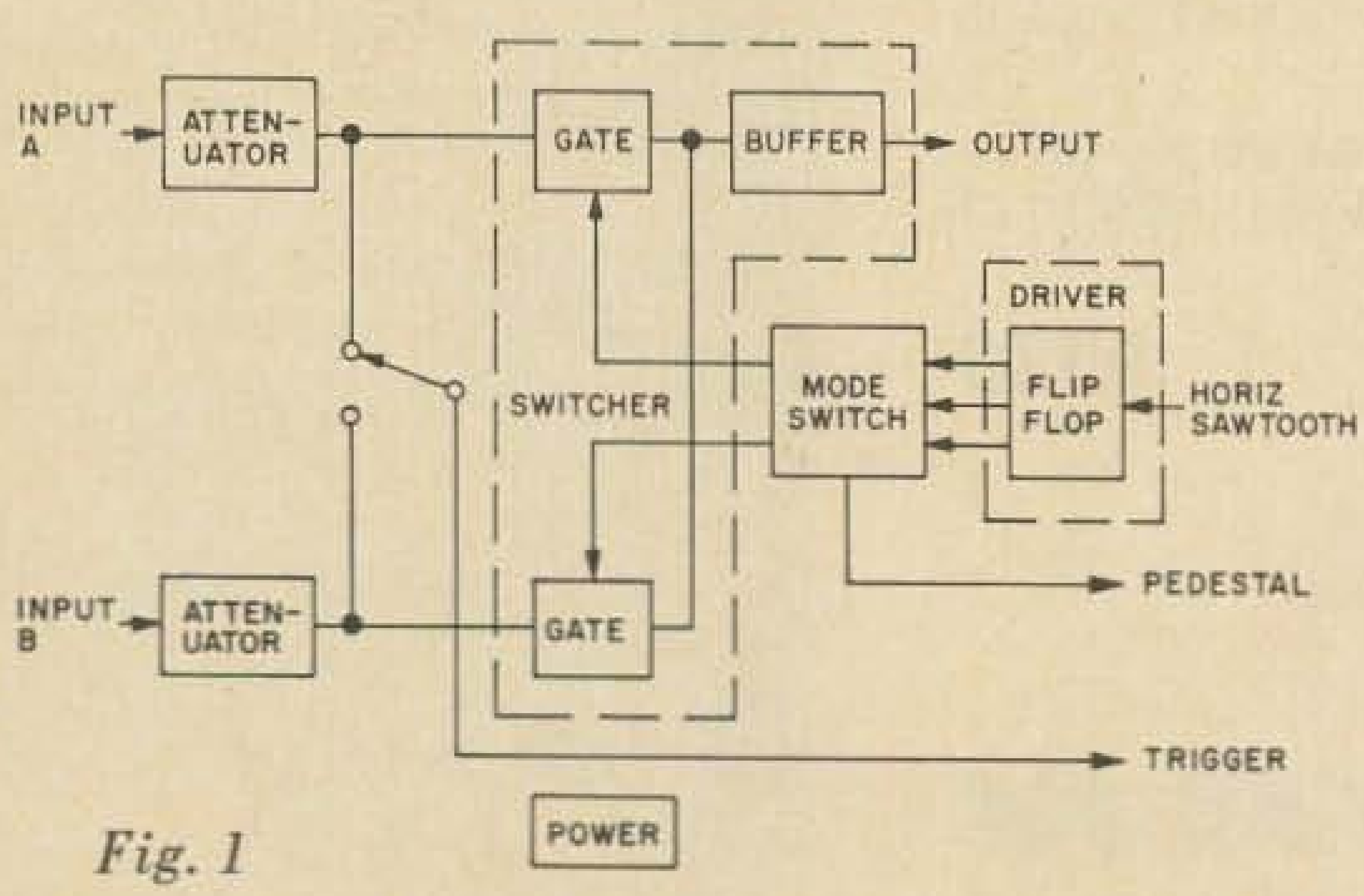

Fig. 1

This is not a step-by-step construction article. Schematics, parts lists, and a description of each circuit will allow anyone who has built from scratch to complete a working unit.

Packaging

Depending on individual desires this unit may be packaged in many ways. First, it could be built entirely within the oscilloscope, if enough front panel space is available for the switches. Secondly, it could be built into a small utility box with one cable, to a suitable connector on the scope. In this case the following functions either go into or come out of the scope (a) 6 Vac for power, (b) horizontal sawtooth, (c) pedestal drive, (d) output and (e) trigger, if the individual trigger is desired. See **Fig. 2**, front panel layout.

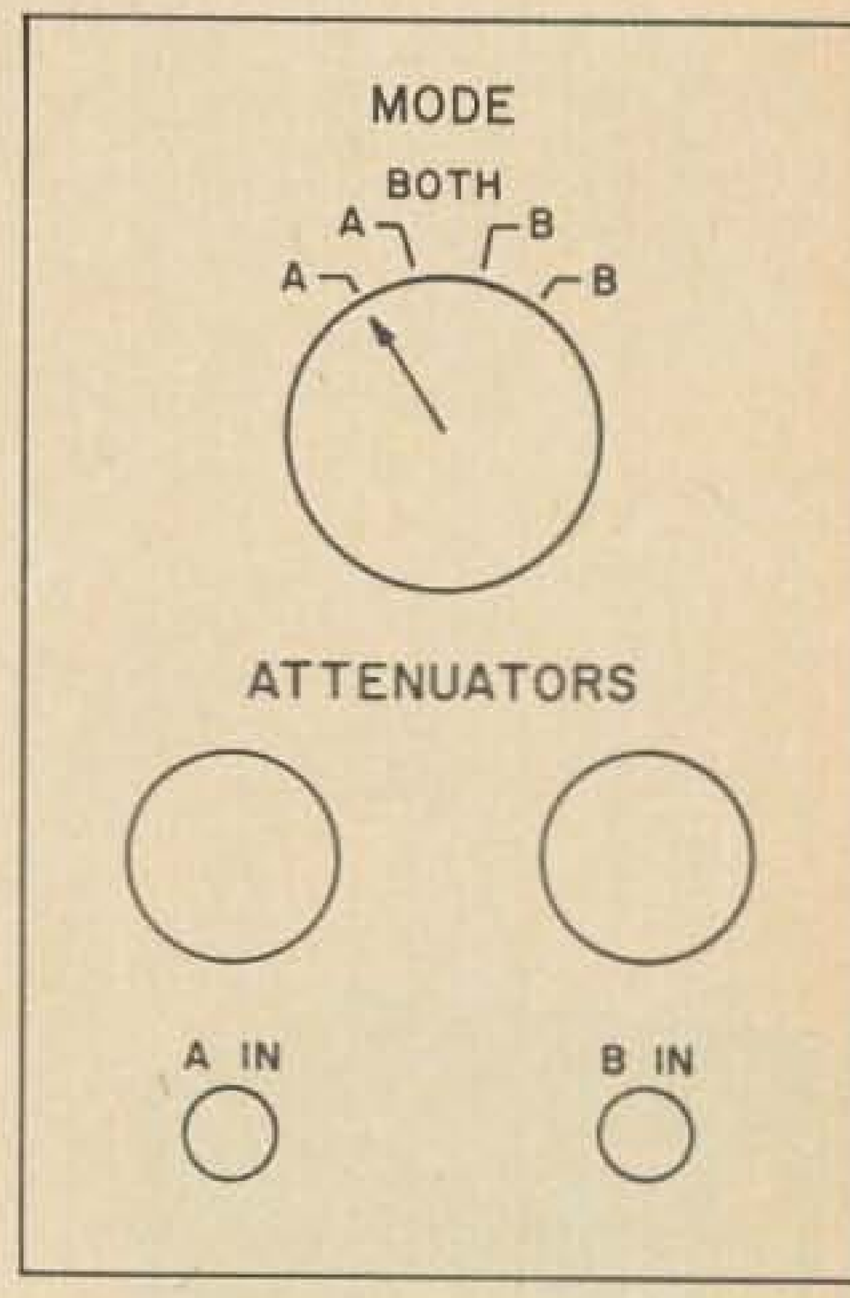

Fig. 2 Panel layout

Power

Power requirements are both plus and minus 12 volts dc at less than 50 mA. Power may be obtained from batteries, a conventional double dc power supply as in **Fig. 3** or from the 6 Vac filaments of the oscilloscope. If the filament supply is used then two voltage triplers and regulating zener are required, as in **Fig. 4.** The voltage triplers eliminate the necessity for a heavy

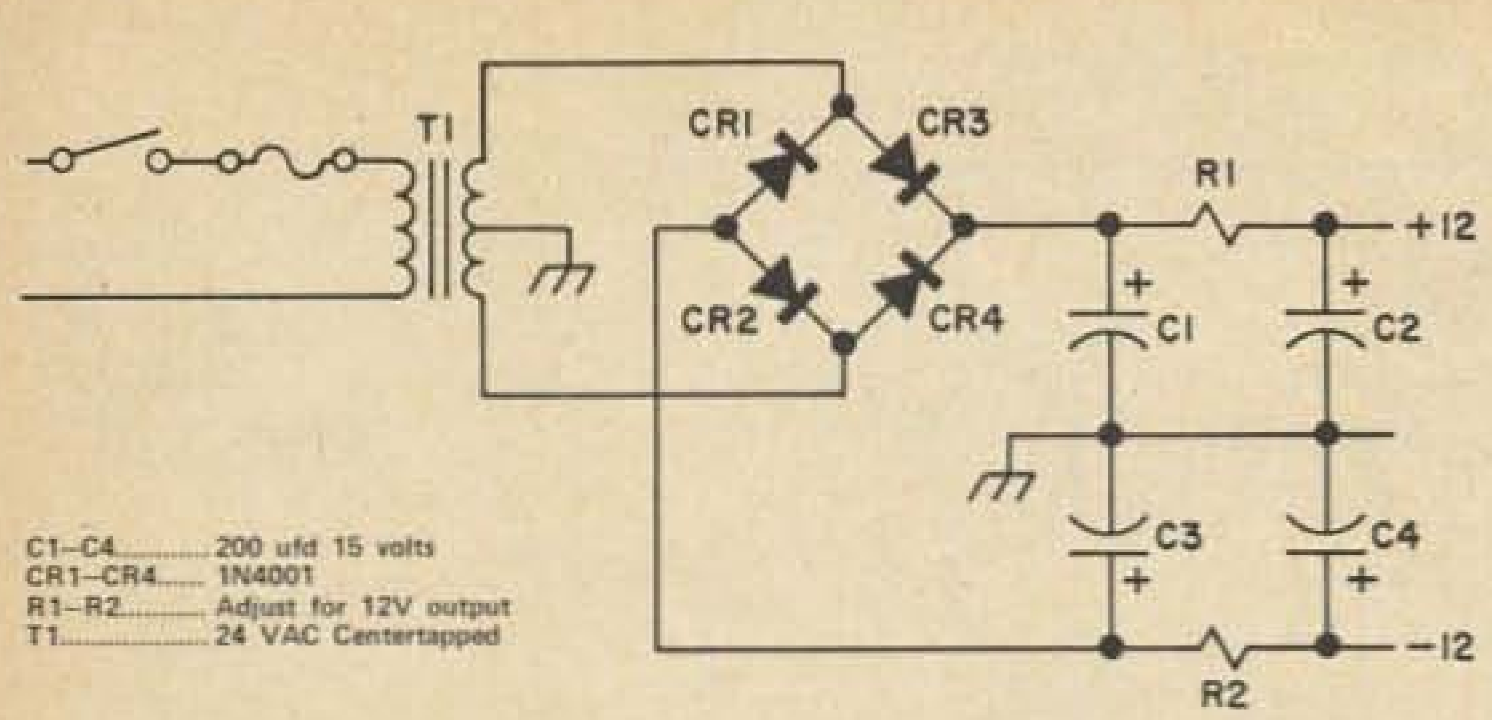

Fig. 3

power transformer, and good regulation is obtained with the zeners. In addition power comes on automatically any time the oscilloscope is turned on.

Switcher board

The switcher board is the heart of the dual trace preamp, Schematic, see **Fig. 5.** Seven Texas Instrument field-effect-transistors are used to alternately pass one signal to the output. For example, if pin F is low and H is high, channel one appears at the output, pin L. If the voltages are reversed, pin F high, pin H low, then channel two appears at the output. Q1, Q4 and Q5 are buffers. Q2 and Q6 are series switches and Q3 and Q7 are shunt switches. The off channel is suppressed more than 70 db.

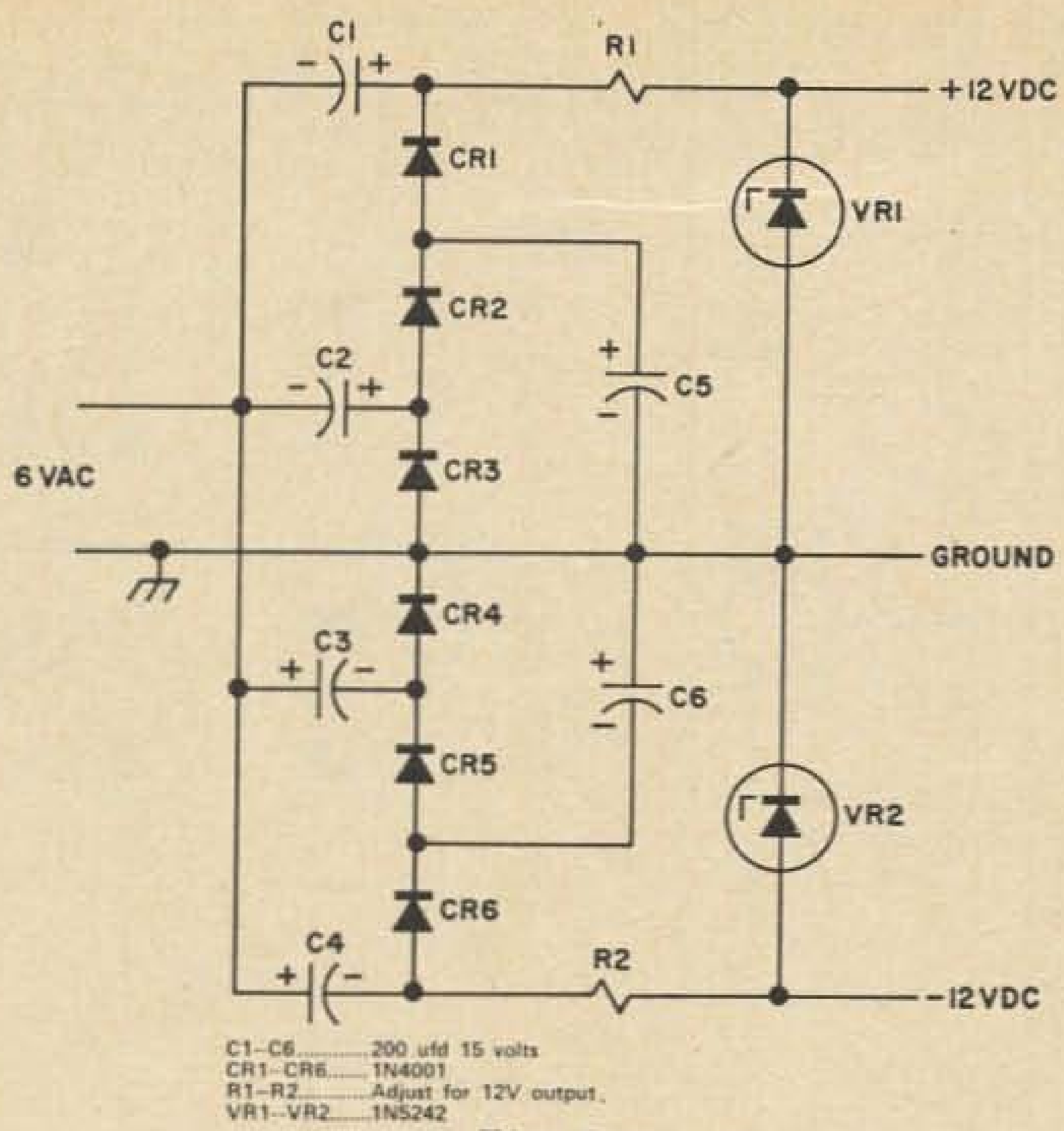

Fig. 4

R14 is used to adjust the output level and R5 adjusts dc balance. If both inputs are connected to ground, then the output, as seen at pin L should be a straight line, not a square wave. Note that to see this another oscilloscope would have to be used, or the pedestal drive to the scope would have to be removed. See discussion under pedestal.

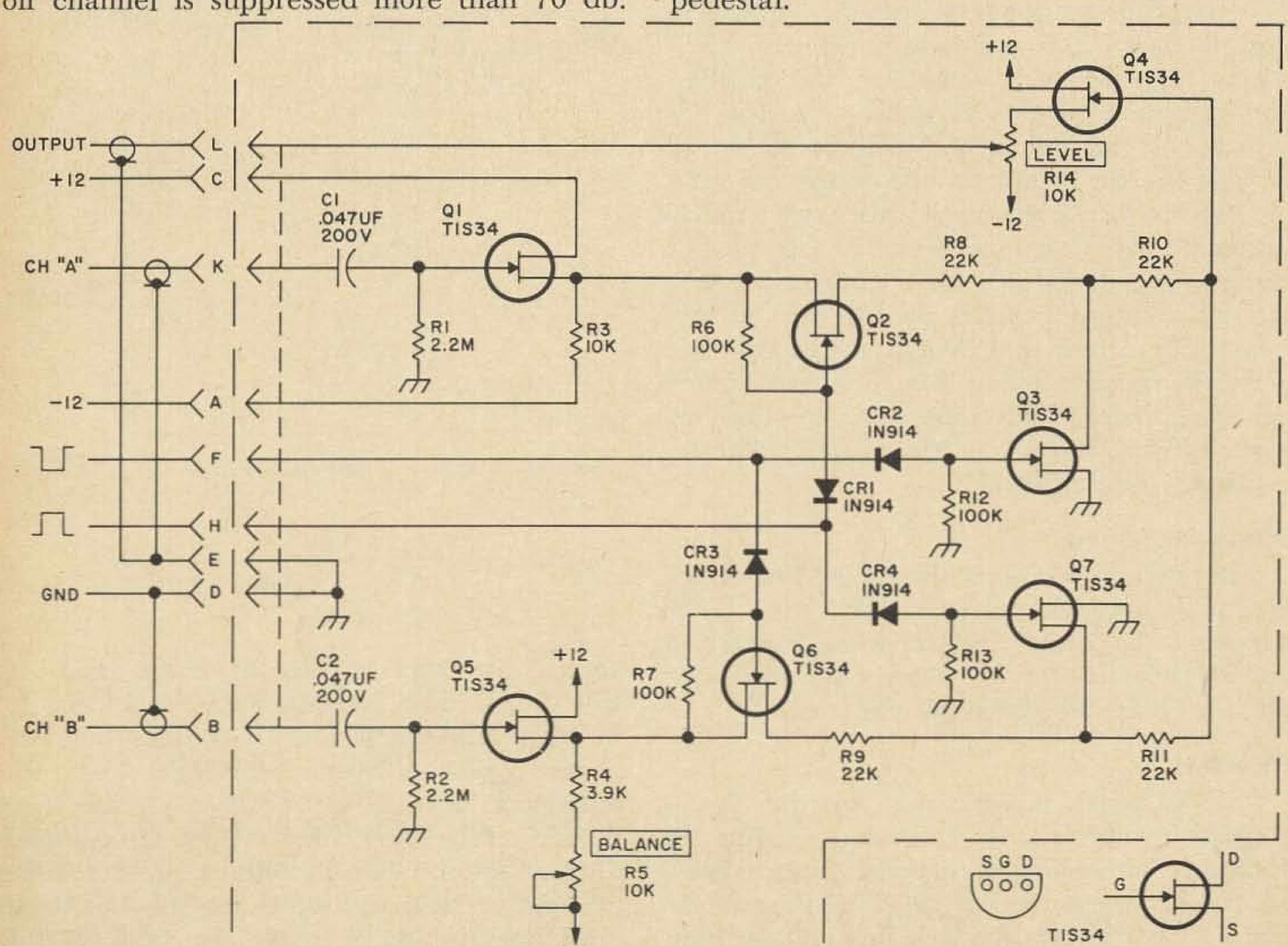

Fig. 5

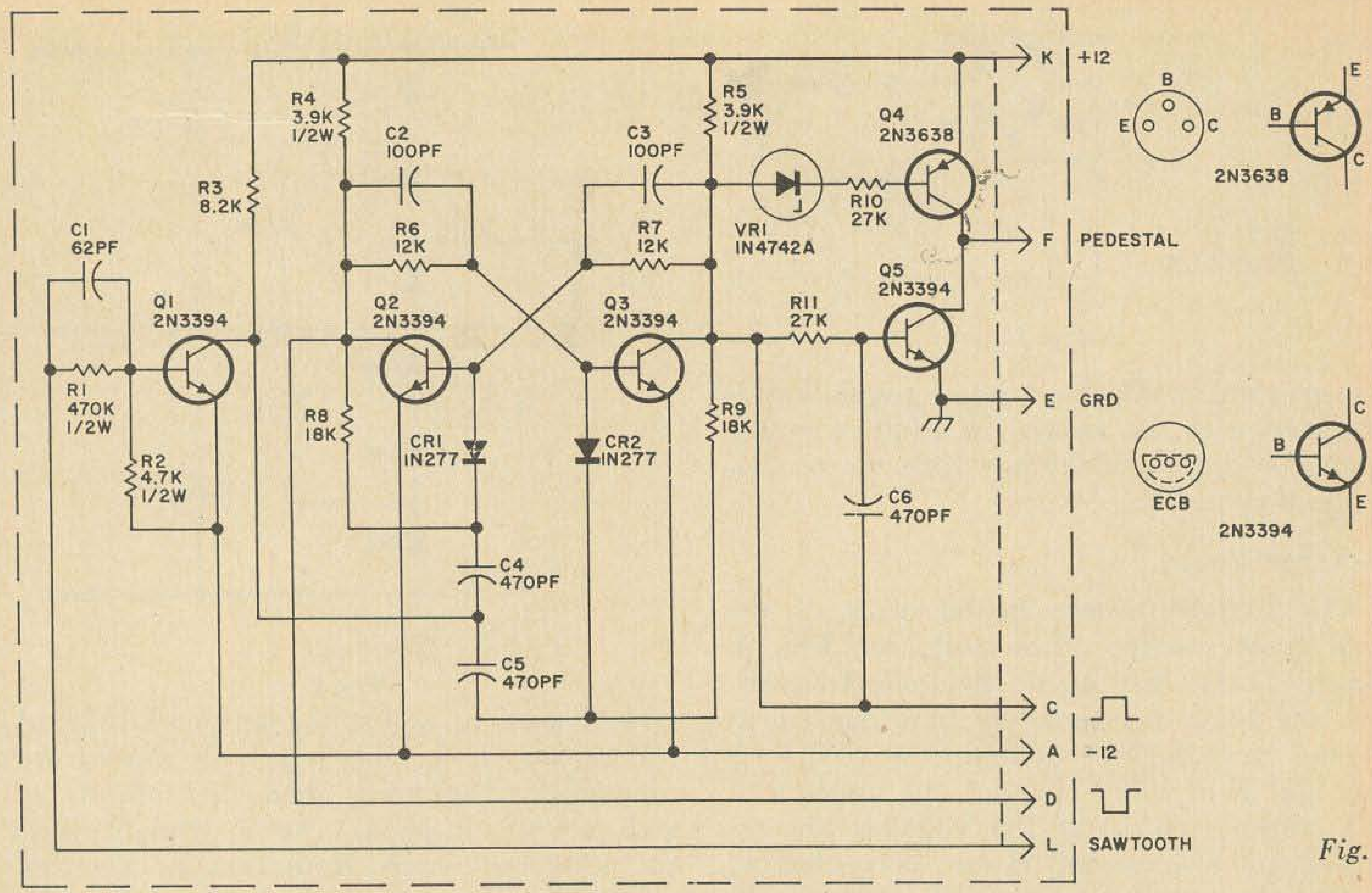

Fig. 6

Driver board

The driver board is basically a flip-flop triggered by the scope horizontal sawtooth. **Fig. 6** shows the schematic. Q1 is a saw shaper. Q2 and Q3 constitute the flip-flop and outputs are taken for gating the switcher board. Q4 and Q5 form the pedestal driver to position the beam on the scope. In conjunction with the circuit discussed under pedestal, the beam is made to go up for channel one and down for channel two, thus the traces are separated on the face of the tube. The driver will switch acceptably for a sweep speed greater than 5 microseconds per centimeter. The inherent rise time of the pedestal, which is the limiting factor, is about 1 microsecond.

Mode switching

The switch positions shown in **Fig. 7** include channel A only, B only, and both, triggered by A or B. It is necessary to switch 4 functions, (a) 2 switcher lines, (b) pedestal line and (c) trigger line.

Pedestal

The internal modification to the scope consists of two parts as shown in **Fig. 8.** First, a connection is needed to the horizontal sawtooth for triggering the driver board. Use caution here as this voltage may be between 100 and 300 volts. This lead should be run in coaxial cable such as RG-174/U. The pedestal lead should also be in coax. The transistor, Q1, causes one side of the push-pull vertical amplifier to be unbalanced, shifting the position of the trace on the screen. Switching occurs pretty much during the sawtooth retrace period. The existing vertical centering control will move both traces equally, while the pedestal adjust control will move only the lower trace.

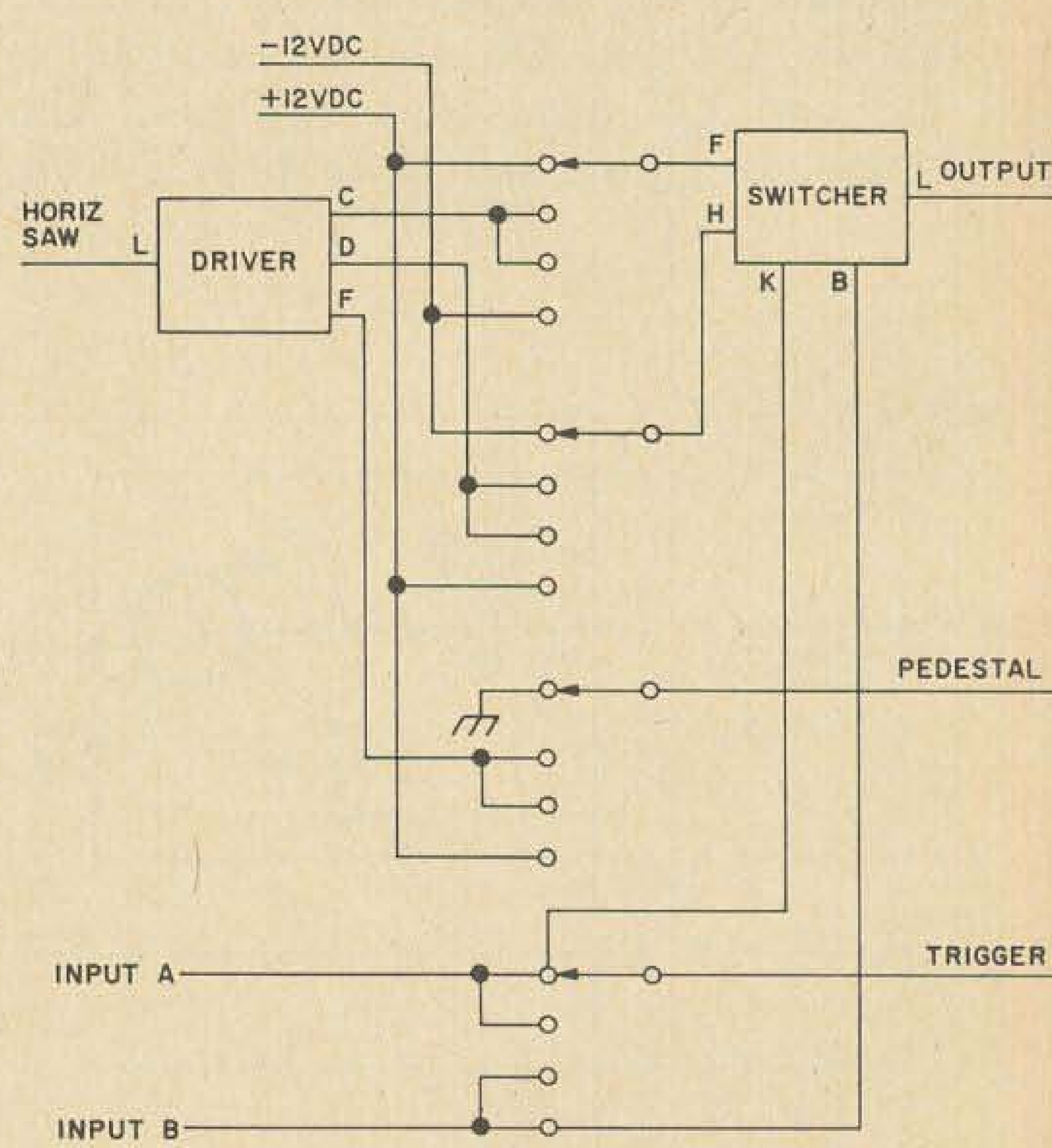

Fig. 7

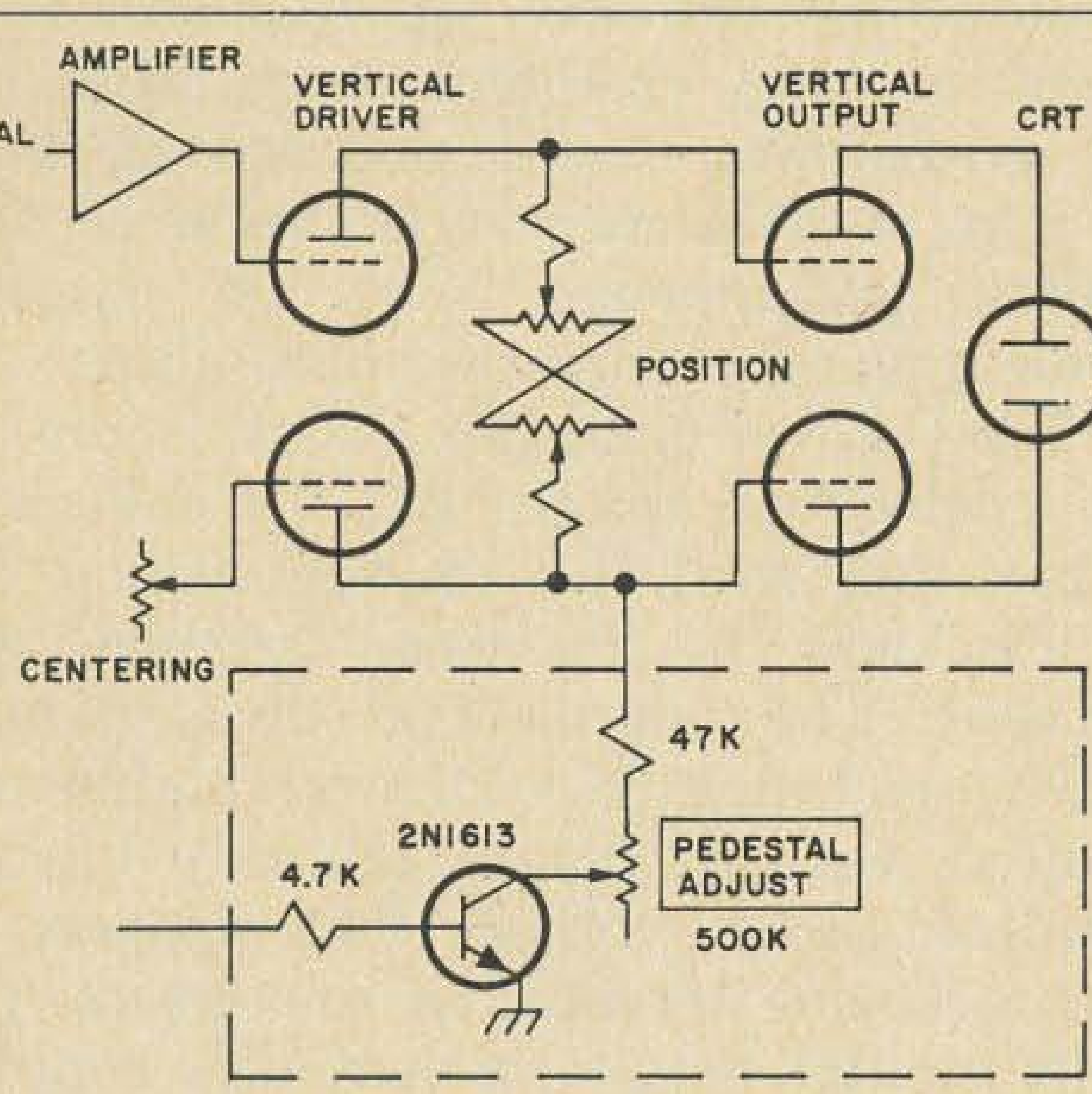

Fig. 8

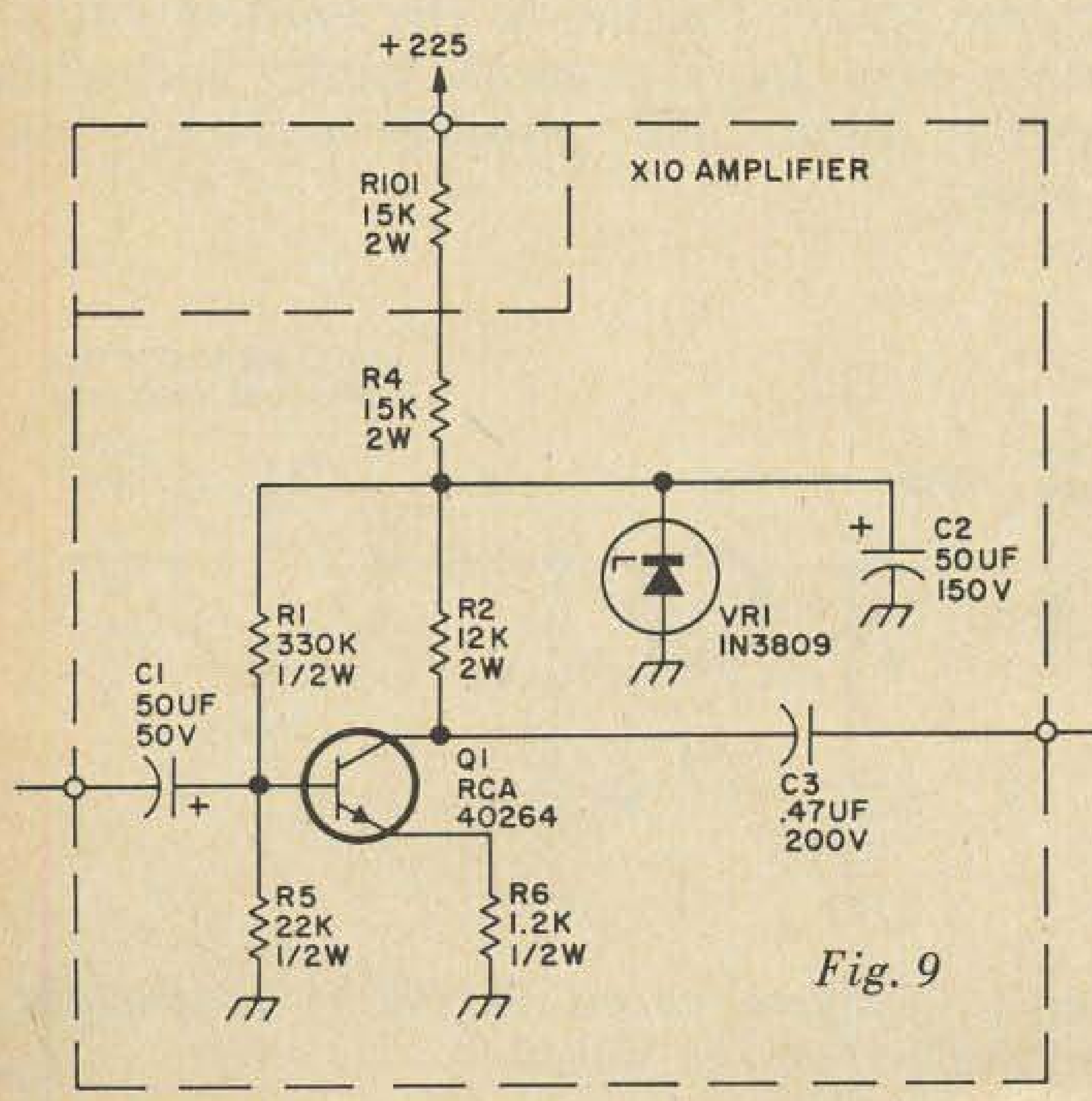

Fig. 9

(Upper trace if you get polarities reversed anywhere.) If it is desired to overlap the traces an easy way to accomplish this is to use a pot that has an on-off switch. Connect the on-off switch between the collector of the transistor and R2.

Attenuator

The attenuator can be a simple potentiometer or a calibrated 10 step attenuator as described in the *Electronics World* article by Donald R. Hicks—"Designing an Oscilloscope Vertical Attenuator." The only requirement is that each input signal to the switcher board be less than about 15 volts peak-to-peak. Otherwise clipping will occur in the FET's.

Amplifier

If desired an amplifier can be added. The amplifier used in the Tektronix modification is shown in **Fig. 8.** This was required in the system modification as the original single attenuator in the 360 indicator was to be used to control both signals. Uncalibrated gain controls were used to vary the levels individually. When the individual gain control was at maximum the original attenuator read correctly.

Printed circuit board availability

Etched and drilled boards are available. Please correspond with author at 16 Poplar Drive, Rochester, New York 14625.

Simplest rf Preamp

Jim Ashe, W1EZT

How simple can a transistor circuit be? Here is a basic *rf* preamplifier, usable from low frequencies to VHF, that must come very near the limit. It looks too simple to work, in fact, but it will do a good job in SWL, VHF, and TV preamplifier applications. Yet it does not compromise in the important bias-stability department as many simple circuits do, and it will accept silicon and germanium transistors interchangeably. The few components can be assembled in almost any convenient style provided the circuit is built on a piece of PC board for good grounding.

The emitter-biased amplifier

We rarely see emitter biasing in experimenter and radio amateur circuits. Perhaps this is because the circuit needs two voltage supply polarities when used in its simplest form. Yet sometimes it is not so hard to use a second battery if the current requirements are low, and a few years ago electronic circuits were expected to need several voltages. Getting by with a single power supply voltage is something of a luxury, which we can exchange for the convenience of a really simple circuit, untroubled by the bias problems often seen in amateur-built gear.

In most of the commonly-used electronic circuits the transistor properties enter into the biasing design. There must be biasing, because the standing bias voltages and currents energize the transistor, and provide power for it to use in amplifying its input signal. But there is one way in which we can bias a transistor which allows the transistor practically no control over its collector current. Using this arrangement eliminates transistor aging, temperature, and replacement effects. We can pull a germanium transistor out of its socket, replace it with a comparable silicon transistor, and discover the circuit works about as well in either case. Very convenient! Specially nice for the hobbyists who must make do with what they have on the bench, or are able to scrounge out of some miscellaneous circuit board.

The complete circuit appears in **Fig. 1.** Although it is a very interesting circuit to industrial designers, unlike many other advanced circuits its basic workings really are simple. Suppose battery B2 is disconnected but B1 remains in the circuit. What happens? A current flows through R1, into the transistor emitter terminal, to the transistor base terminal, and to ground. If the emitter-base diode properties change due to aging or replacement with a different transistor, the current will change only slightly. Using a silicon transistor, there would be only an 8.5% increase in current if we shorted the emitter-base junction. No transistor replacement or type changing, even from silicon to germanium, could produce as large a change as this. Any variations over time in circuit performance must be caused by something other than bias instability.

Now, if we complete the collector circuit by connecting battery B2, the collector terminal will steal the emitter current before it can flow to the base terminal and to ground. The emitter current is practically unchanged, and for ordinary amplifier applications we can ignore the tiny change in emitter-to-base voltage that appears when the collector terminal is energized. This is why emitter biasing is extremely simple and stable. The transistor current is controlled by one single resistor in the emitter circuit rather than by a network jointly including emitter, base, and possibly collector terminals.

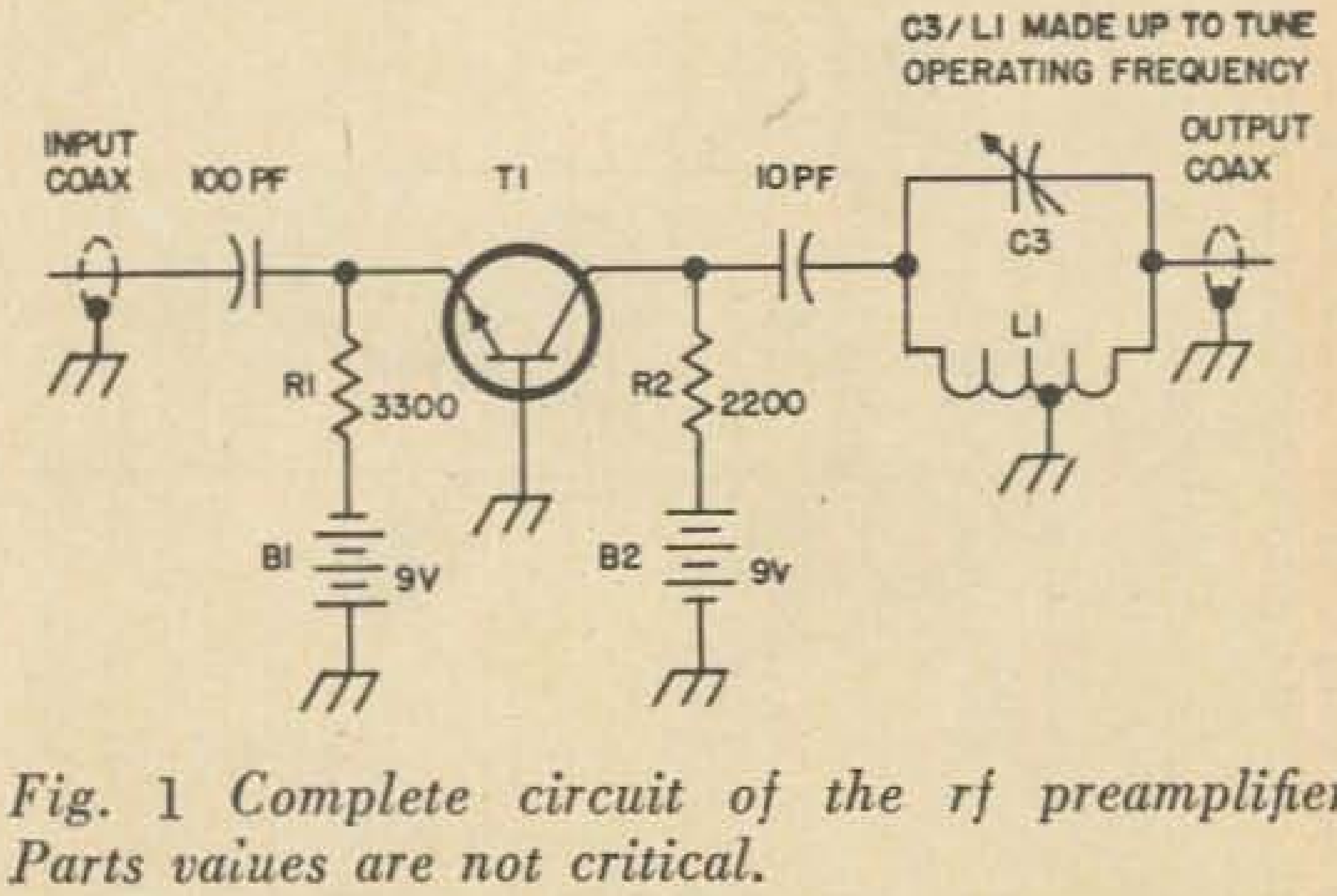

Fig. 1 Complete circuit of the rf preamplifier. Parts values are not critical.

This isn't the best circuit for some applications, and is specially inappropriate for power-amplifier designs. But it works very well indeed for small-signal *rf* preamplifier application because *rf* circuits can easily meet the low input-impedance and high output-impedance requirement set by the transistor characteristics. At audio we would have to use iron-core matching transformers, but at VHF a few self-supporting turns of inexpensive wire will do the job.

A large capacitor, C1, connects the low-impedance input cable to the transistor emitter terminal without upsetting the bias arrangements. Its capacitive reactance should be only a few ohms at the *rf* operating frequency. The values in **Fig. 1** were chosen for operation on the 2-meter amateur band, and the 100 pF capacitor C1 has a reactance of around 10 ohms. A 220 pF capacitor might have been a better choice but those available at construction time were not very small.

The collector circuit is a simple shunt-fed resistor-loaded connection via another blocking capacitor to an inverted pi output coupling network. The reactance of C2 at 2 meters is around 100 ohms, much less than the 2200 ohms resistive load or the load coupled back from the output cable. This capacitor, and C1, serve only to prevent outside connections from upsetting the dc conditions in the circuit, and their values are not critical. You should avoid too-large capacitors since these contribute nothing to circuit performance, cost more, and increase the possibility of unwanted resonances.

If we turn a pi-tuner inside out, what do we have? Instead of one inductor and two capacitors with the connection between the capacitors grounded, we have a single capacitor (C3) across the ends of an inductor (L1) which has a grounded tap. We can look at this arrangement as a resonated autotransformer, in which the unwanted coil reactance is balanced out by the parallel capacitor and the impedance transformation from 2200 ohms input to 52 ohms output is determined by the turns ratio on the two sides of the grounded tap. In this case we have six turns grounded at turn #1 from the cable end, which transforms the 52 ohms to roughly 1260 ohms, approximately. The impedance transformation is the square of the turns ratio.

Construction

The construction style is not printed circuit, although the preamplifier is assembled on a piece of copper-clad PC board. There is no transistor socket simply because we can get by without one. This minimizes lead lengths and inductances, and the base lead is soldered directly to the PC board. An input coax connector is eliminated by soldering the braid of the coax input cable directly to the board. Blocking capacitor C1 is soldered directly from the transistor emitter lead to the center conductor of the cable.

At the output, LH side, a pair of lugs mounted in the board support the inductor of the output matching circuit L1/C3. The lugs could be replaced by a pair of tiny insulated stand-offs, or a small terminal lug strip to avoid the need for removing some copper. In this case it was easy to solder the small mica compression trimmer C3 between the lugs on the opposite side of the board. The output blocking capacitor C2 is mounted between the transistor collector lead and the input end of the matching network, and the output coax cable center conductor is soldered to the lug supporting the output end of the network. With the cable outer braid soldered directly to the copper surfaced board, another *rf* connector is eliminated.

When I originally built the preamp, I connected the coil to ground a little too far to the right hand side of the coil. This didn't work too well and I had to move the tap to the left. This connection can be moved up or down the coil for best gain, and should not be so far along the coil toward the transistor that the tuning capacitor seems to have no effect.

Resistors R1 and R2 extend directly from emitter and collector leads to convenient lugs situated far enough from the transistor to avoid power lead capacitances from affecting the circuit performance. These resistors are half-watt units but quarter-watt units would work as well. Composition resistors are preferred, rather than metal-film or wire-wound variety.

Operation

Complete the circuit assembly (which may require several minutes) without making the connection from collector to output network L1/C3 via C2. This prevents transistor collector-base diode action from killing coil Q when you try to tune it to frequency using a grid dip oscillator, and it may prevent damage to the transistor too. If you do not have a GDO use coil and resonance equations or nomographs, and provide lots of adjustment. When you reasonably believe the output LC circuit resonates near to or a little above the operating frequency, go on to the next step.

Connect a 56 or 68 ohm half-watt or smaller composition resistor across the preamplifier input terminals, and make the collector battery connection through a milliammeter. There should be no current flowing. Upon completing the emitter battery circuit, the collector current should rise to about 2.6 mA and a VTVM or 20,000 ohms per volt multimeter should indicate about 3 to 4 volts at the collector terminal. Base-emitter voltage should be around 0.3 volts for a germanium transistor, or 0.7 volts for a silicon transistor. If you do not find these voltages check first to be certain battery polarity connections are correct. If you've goofed don't replace the transistor, it's probably all right. Switch polarities and try again.

Now complete the collector-to-output connection through C2, and install the preamplifier in your receiver system. Turn it on and listen for birdies. If there are signs of unwanted oscillation replace the input circuit with a 68 ohm composition resistor and if the birdies remain then move the coil tap nearer to the collector terminals. This increases transistor loading and reduces circuit gain. If you find the preamp oscillates with antenna input but does not with a 68 ohm resistor across its input, then you need to improve your antenna system. It's reactive and needs tuning or corrective mechanical work.

Finally, tune C3 for maximum output. In a TV weak-signal area this will appear as a sharper, stronger picture, and in SW and VHF applications you will observe stronger signals and less noise unless your system noise comes from locally generated interference, in which case there may be more of it.

Additional suggestions

We can easily make this simple circuit more complex. For instance, we can replace C1 with a small compression trimmer, adjustable to tune out the small inductance of the cable-to-transistor-and-return loop. This will improve circuit stability by reducing the fedback voltage that collector-to-emitter capacitance can develop from emitter to ground.

We can also improve circuit gain by replacing R2 with an rfc. This choke should have a reactance of several ten-thousands of ohms at signal frequency. 100 MH at 6 meters and maybe 30 at 2 meters looks about right. Then the output matching network can be readjusted for a greater impedance transformation, and signal gain will be increased. Chance of oscillation will increase too, but this arrangement offers an interesting possibility.

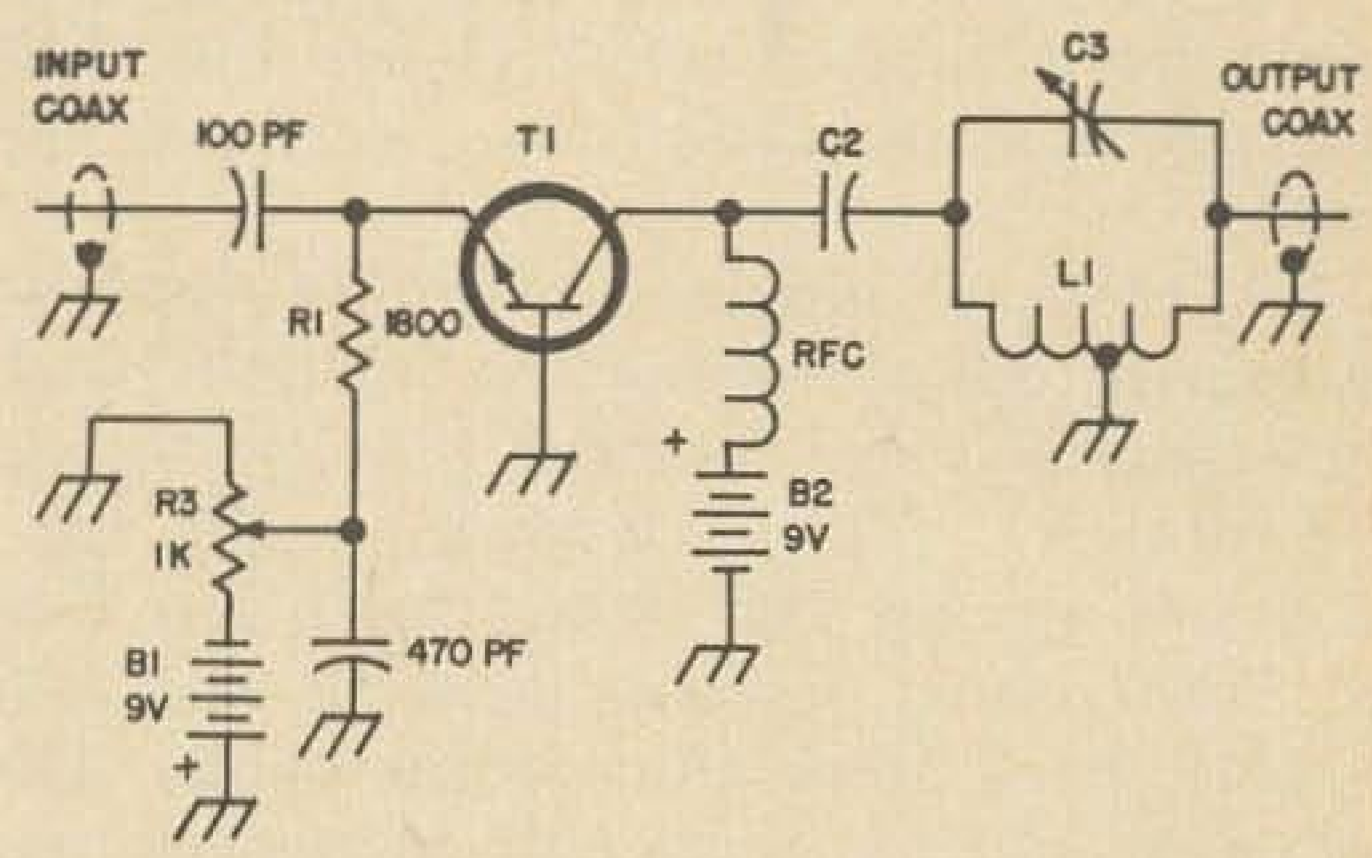

Fig. 2. Suggested variation for improved performance. Operating current may be varied for strong or weak signal work without detuning the output circuit.

With no collector resistor, collector voltage no longer depends upon collector current. We can now adjust collector current by adding a variable resistor in the emitter circuit, which will vary the amplifier operating conditions without detuning the collector circuit. See **Fig. 2.** This circuit is certainly more elaborate than the simple one you may have constructed first, but enables you to choose increased collector current at lower gain to reduce cross-modulation effects, or to adjust the emitter current for maximum gain to hear weak signals.

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George Leonard
Associate Editor
Look Magazine

Education and Ecstacy

The following is reprinted by permission of *Look Magazine* and Mr. Leonard. I think this last chapter of his book describes the "magic" quality of amateur radio.

LIFE HAS ONE ultimate message, "Yes!" repeated in infinite number and variety. Human life, channeled for millennia by civilization, is only just beginning to express the diversity and range of which it is easily capable. To deny is to swim against the current of existence. To affirm, to follow ecstasy in learning—in spite of injustice, suffering, confusion and disappointment—is to move more easily toward an education, a society that would free the enormous potential of man.

When men must serve as predictable, prefabricated components of a rigid social machine, the ecstatic is not particularly useful and may, in fact, erode the compartments so necessary for the machine's functioning. But when a society moves away from the mechanistic, when an individual functions as a free-roving seeker, when what we now term "leisure" occupies most of his hours, ecstasy may usefully accompany almost every act. Technology is preparing a world in which we may be life-long learners. In this world, delight will not be a luxury but a necessity.

I can recall little of what happened in school the winter I was 15. Perhaps that was the year everyone in my English class had to do a chapter-by-chapter synopsis of *Treasure Island*. But the afternoons and nights of that period still are vivid. I was infected with the ham-radio bug. My next-door neighbor, a boy two years older, had got me started, and I lived for months in a state of delicious excitement. I would rush home from school, knowing the day would not be long enough. I would work steadily, practicing codes, devouring ham manuals and magazines, pouring over catalogues of radio parts, building simple shortwave receivers. I loved everything about it. When I read Gerard Manley Hopkins's *Pied Beauty*, the phrase, "all trades, their gear and tackle and trim," immediately summoned up the coils and condensers, the soft-glowing vacuum tubes, and sizzle and smell of hot solder, the shining curls of metal drilled out of a chassis.

One night, my radio experience came to a moment of climax. For weeks, I had been working on my first major effort, a four-tube regenerative shortwave receiver. The design was "my own," derived from circuits in the manuals and approved by my knowledgeable friend. Every part was of the highest quality, all housed in a professional-looking, black-metal cabinet. Every knob and dial was carefully positioned for efficiency and aesthetics, and there was an oversized, freewheeling band-spread tuning knob. That night, I had been working ever since running most of the way home from school. I had skipped dinner, fiercely overriding my parents' protests. Now, at about 11 o'clock, I soldered the last connection.

With trembling hands, I connected the ground and the antenna, plugged in the socket and switched on the set. There was a low, reassuring hum, and, after a suspenseful wait, the four tubes lit up. I increased the volume. Dead silence. Nothing. I checked all the switches and dials. No problem there. Perhaps it was the speaker. I plugged in the earphones. Still nothing.

I couldn't imagine what was the matter. For the next hour or so, I went over every connection, traced the circuit until I was dizzy. Since I had splurged on all-new parts, I didn't even consider that one of them might be defective. The mystery, so powerful and unfathomable, could obviously have been cleared up in a few minutes by any well-equipped radio repairman. But for me, its unraveling was momentous.

The radio's circuit consisted of two stages. The first stage converted radio frequency waves to electrical impulses of an audible frequency; the second stage served as an amplifier for the electrical impulses coming from the first stage. I hit upon the idea of tapping the earphones in at the end of the first stage. Success! Static, code, voices. This seemed to indicate to me that the trouble lay somewhere in the second stage. On an impulse, however, I tied in a microphone at the very beginning of the second stage. Success again. The second stage worked. I could hear my voice coming from the speaker.

In that very instant, the answer was clear: Both stages worked separately. The trouble had to lie in the coupling between them. My eyes went to a little green-and-silver coil (*the broken connection between subconscious and conscious, the hidden flaw between individual and community*). It had to be that impedance coil. With this certainty, I was quite overcome. I would gladly have broken into a radio store to get another one, but my friend, I found, had a spare. I tied it in, not bothering for the moment to solder it. And a universe poured into my room from the star-filled night. I spun the dial: a ham in Louisiana, in California; shortwave broadcasts from England, Germany, Mexico, Brazil. There was no end to it. I had put out new sensors. Where had been nothing, there was *all of this.*

Ectasy is one of the trickier conditions to write about. But if there is such a thing as being transported, I was transported that night. And I was, as with every true learning experience, forever afterward changed.

Every child, every person can delight in learning. Every educator can share in that delight. The methods are available. The needs for reform are clear. The chief obstacles are simply inertia and low expectations. Actually, a new education is already here, thrusting up in spite of every barrier built against it. Why not help it happen, ■

Push to Talk

(The Twoer Way)

Norm Ross VE3ETJ
Box 26, R.R. 1
Dorchester, Ont., Canada

It all started one bad winter day. I was giving road conditions in our area to another local ham when I reached to push down the transmit switch on the twoer. At the same time another car was coming in the opposite direction. The twoer, being out of arm's reach, made me lean over to transmit. This made the car sway towards the oncoming car. If the driver had not headed for the ditch there would have been a real accident. With my heart in my mouth, this brought me to the conclusion that we needed push to talk.

We did it inexpensively without defacing the Twoer in any way. One evening will do the job, and if you have the assembly manual of the Twoer (HW 30), assembly will be much faster when installing the relay.

Step 1.

The relay which we used was a Potter & Brumfield KHP-17All-12 volt (4 P.D.T.) The relay is mounted upside down between coil CC and socket V4. To hold the relay down in place, a bracket was made and attached to the mounting screw of the relay. When the bracket is attached, move the wiring out of the way between the coil CC and socket V4 and place it so that the bottom of the bracket is below coil CC and the relay about ¼ inch away from the coil. Drill a 5/32 hole and fasten to the chassis.

Step 2.

Now the wiring begins:

At any time you find the original wiring is too short, replace it keeping all the wires close to the chassis when transferring from wafer switch Z to relay. Start transferring the wiring at pin 12 of the wafer switch Z to pin 9 of the relay.

From Wafer switch Z	To: Relay
12	9
11	5
10	1
9	10
8	6
7	2
5	7
4	3

Pins 6, 3 and 2 are left connected to wafer switch Z.

Pin 11 on the relay is grounded.

Pin 12 on the relay is connected to pin 3 of wafer switch Z.

Pin 8 on the relay is connected to pin 2 on coil CD.

Connect a .01 disc capacitor from pin 6 to pin 11 on relay.

Step 3.

Now that the relay has been wired in, we need a voltage to operate the relay coil. I wired in a half wave power supply and filtered it just enough to close the relay. (If relay does not close, take the tension of the spring until it does close.)

The power supply was made on a four pin terminal strip (PS) using a 50 mfd. at 50 volts condenser and a diode. Place this strip under the screw that holds V3 in place coming from pin 1 of the terminal strip S which has a RFC to pin 5 of V3 (6BS8) filament supply. At this point the relay voltage was taken. Drill a ¼ in. hole near pin 1 of terminal strip S. Connect a wire from pin 1 of S to pin 2 of PS. Connect a jumper from pin 1 to pin 3 of PS. Connect a 50 mfd. 50 volt condenser from pin 1 (neg.) to pin 4 (pos.) of PS.

Connect a wire from pin 4 of PS to pin 13 of the relay.

Step 4.

All that's left is the microphone connection. Replace the mic. connector 432-3 with any 4 pin female connector. Pins 3-4 of the connector are grounded. Pin 2 goes to RFC coming from pin 1 of V1. Pin 1 goes to pin 14 of relay. Connect jumper from pin 14 of relay to pin 5 of wafer switch Z. For the mic. cord we used an Armaco TFCC and the mic. was a ceramic with push button. The old transmit switch will still work as if nothing had been changed, except we don't have to reach down and fumble with the switch. We have a tener with the same modification, now all THREE of us are doing fine! . . . VE3ETJ

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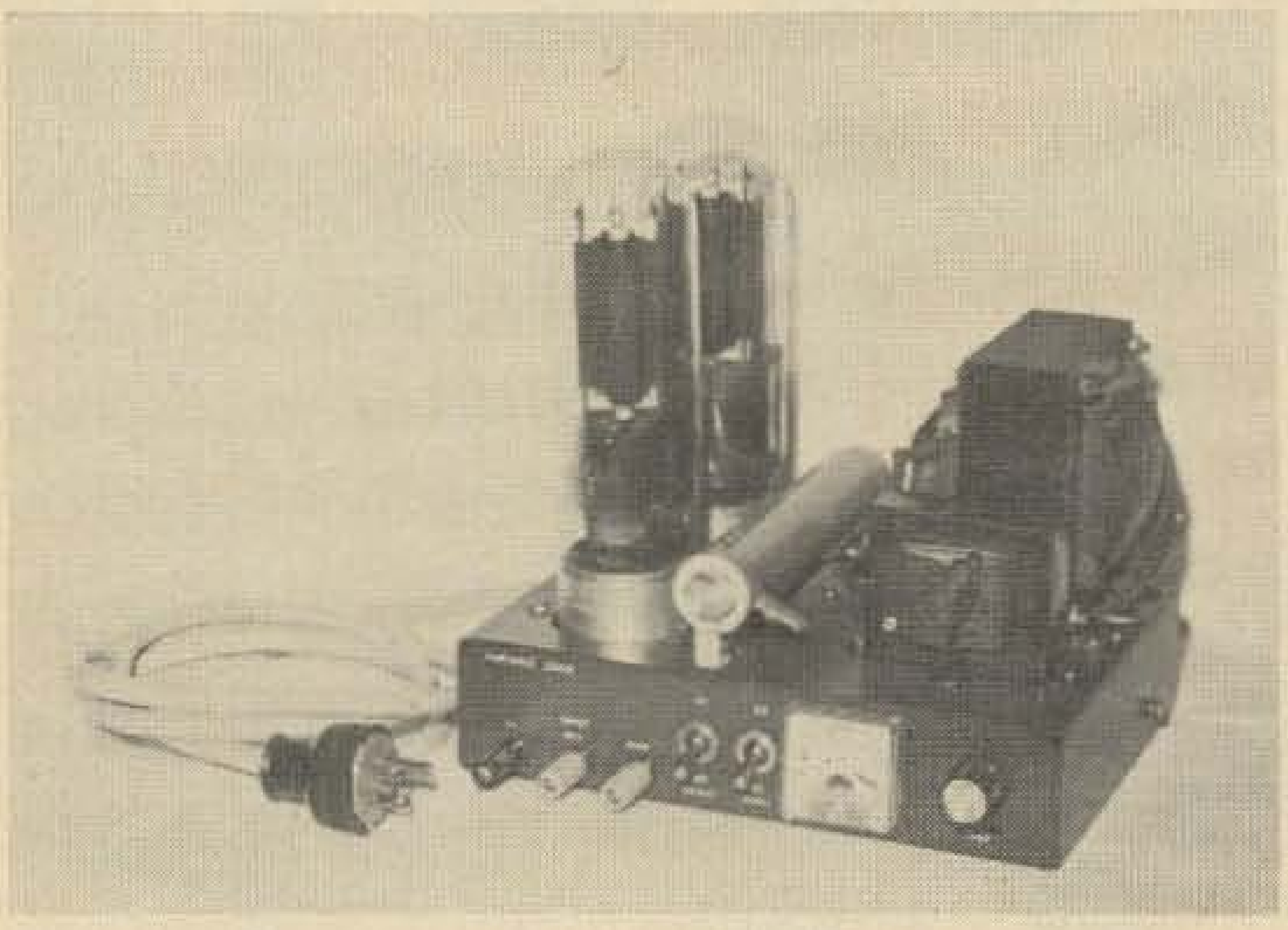

Quite often electronic construction articles go to great lengths to describe the functions of components, their minimum or maximum allowable values and how the circuit works, but end up skimping on explanations about the power supply section. More likely than not they merely state the required voltages and currents and leave the power supply design up to the builder.

Most electronic manuals furnish data and design details for power supplies. If you are the type of builder who can afford to go and buy all new components to build exactly to the handbook design then you won't have any trouble. However, in this world of surplus and used TV set power supply components, most builders turn to the junk box first for the power supply parts.

Since it is rare to find the exact components, even in the best stocked junk box, the builder usually ends up with a power supply constructed with components quite a bit different than those specified. We know it will work but *how well* will it work? Naturally, attaching it to the piece of gear it will power will be the "acid test," but why compound problems? Why try to test and debug a new piece of gear with a power supply that may be bugged because of inadequate regulation or filtering. A power supply defect can really hide itself and show up as a bug on the gear being tested—like distortion in a linear amplifier because of poor power supply regulation.

Why not test the power supply "off-line" before using it?

Here's how.

If you have ten or twenty assorted high wattage resistors or a 200 watt variable resistor in your junk box and don't mind the inconvenience of dropping power to change the resistor or vary the tap then do so as indicated in **Fig. 1A.**

If you have a couple of old transmitting tubes with high plate dissipation, a filament transformer to match, a couple of low wattage variable resistors (one being a potentiometer), a dc milliameter, a small power transformer for bias, and want complete flexibility and ease of control, then do as indicated in **Fig. 1B.**

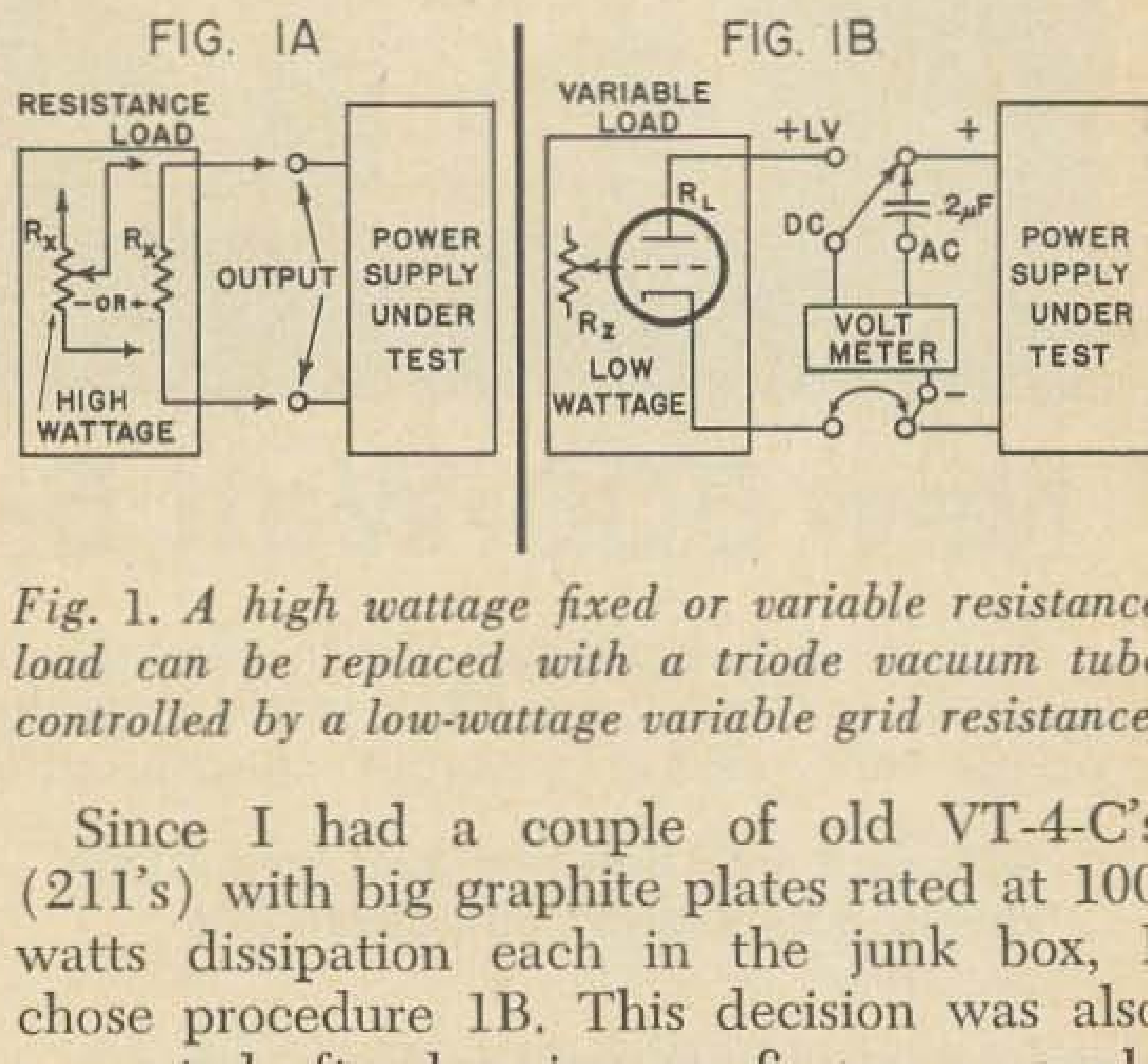

Fig. 1. A high wattage fixed or variable resistance load can be replaced with a triode vacuum tube controlled by a low-wattage variable grid resistance.

Since I had a couple of old VT-4-C's (211's) with big graphite plates rated at 100 watts dissipation each in the junk box, I chose procedure 1B. This decision was also prompted after burning my fingers a couple of times changing hot resistors as in procedure 1A. Actually, any tubes will work. The decision as to type should be made based on plate dissapation rating. Pick the tubes with the highest ratings. The maximum loading and power consumption by the unit will be determined by the plate dissipation of the tubes used.

How it works

Fig. 2 shows the diagram of the variable load. The load consists of tube power dissipators and a bias power supply with a means (R2) of controlling the bias and

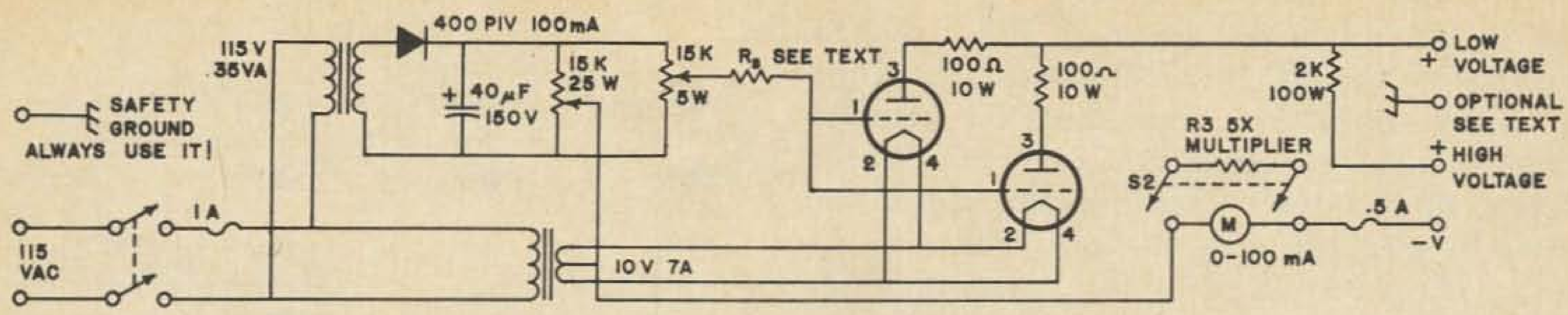

Fig. 2. The practical circuit. Grid and anode re-sistors improve circuit stability.

therefore current drawn by the tubes. A dc milliammeter (M1) is inserted in the cathodes of the tubes to measure the current through the load. The meter has a basic 0-100 dc mA range that is extended to 0-500 mA by switching (S2) a five times shunt (R3) across it to test heavy duty power supplies. A voltmeter is connected between the input terminals (−V) and (+LV or +HV) to simultaneously measure power supply output voltage or ripple and current. The 100 ohm 10 watt resistors in the plate circuits of the tubes are necessary to assure stable tube operation. The resistor in the plate lead from the +HV is necessary if higher than rated voltages will be tested.

As stated earlier the current drawn by the tubes is controlled by R2 which varies the bias on the tubes. Basically, a tube is cutoff (drawing no current), when the grid is more negative than the cathode. A tube is conducting (drawing current), when the grid is more positive or moved closer to the cathode potential. The degree of conduction or current draw depends on the bias setting between these two extremes. Hence the principle of operation of the variable load unit.

Adjustment

The cut-off bias condition of the tubes is set by:

1. Set slider on R1 to mid range.
2. Set potentiometer arm R2 to full minus end. The potentiometer should be wired so this condition exists when the arm is rotated fully counter clock wise.
3. Connect the unit to an external power supply. This supply should be one with a highest output range available which can be used with the type of tubes used in the variable load.
4. Turn on the variable load.
5. Turn on the test power supply.
6. If the milliammeter M1 shows any indication, turn all power off and move the slider on R1 towards the plus end of the resistor. If the meter does not move go to step 7. Turn on power, steps 4 and 5, and again check the milliammeter for a reading. Repeat this step until R1 slider is set at a point that current just stops flowing.
7. If the milliammeter M1 does not show any indication turn all power off and move slider of R1 slightly towards the minus end of the resistor. Turn power on, steps 4 and 5, and again check the milliammeter reading. Repeat this step until R1 slider is set at the point where current starts flowing, then back off R1 slider to the point where current just stops flowing.
8. Steps 6 and 7 will set the bias point of the variable load so that its maximum range of loading can be utilized.
9. Insert a milliammeter between the arm of R2 and the grids of the tubes and measure the current drawn when R2 is set for full conduction. If the value is higher than that allowable for the 5 watt rating of R2 insert a resistor at RS to bring the current back down. The slider of R1 should not be set any closer than 15% of its total value to the minus end of the resistor. This will limit the tube grid current when R2 is set for maximum conduction at the plus end and help prevent R2 burn out.

Grounding

Notice in **Fig. 2** that the only thing grounded to the chassis is the ground conductor of the three wire ac line cord. This will allow testing of minus as well as plus power supplies. The three wire line cord with ground is essential in this application in the event of a short circuit to the chassis. For that matter it is recommended that all electrical equipment be equipped with three conductor power cords. If grounded power cords are not used in your shack then the variable load chassis and the power supply chassis should be bonded together before running any tests.

Operation

In the following two examples the test

set up should be as shown in **Fig. 1B.** The voltmeter should be connected for either ac or dc operation depending on whether measurement of regulation or ripple is the object of the test. Graph paper should be used to plot the progress or results of the test. (It's a lot easier to "see" what a series of numbers represent when they are plotted on a graph.) The graph should be set up with voltage increments on the vertical axis and current on the horizontal axis. The steps or size of the increments will generally depend on the two extremes of the measurement. Try to keep the graph spread out for accuracy.

Once the equipment is set up power is turned on and the load control R2 is turned clockwise until the amount of current representing the first current increment is indicated on the milliammeter. The voltmeter is then read and the indicated voltage is logged as the first spot on the graph. R2 is then advanced to the next current increment and the voltage is again read and logged. This process is continued through the last current increment at which time a line should be drawn connecting each spot on the graph paper completing that part of the test. At this point a component can be changed and the whole sequence runs again to see if an improvement was realized.

These two examples will give you an idea of how it works:

1. Regulation—The graphs in **Fig. 3** were made by testing a power supply using a transformer with an unknown current rating. Two unmarked chokes, L1 and L2, were tied in the power supply to see which offered the best regulation. A dc voltmeter was connected across the power supply output to measure the voltage under the different current settings.

Examination of graphs 3B and 3C shows that the choke used in 3B has 16% better regulation (ac ripple was the same in both cases). The addition of a 10 mfd input filter capacitor and going to a 35 mfd output filter capacitor, **Fig. 3D**, actually made the regulation worse, to 33%, and had little effect on the ripple.

The circuit selected for the power supply was that of **Fig. 3B.**

2. Ripple—The graphs in **Fig. 4** were made to determine the proper value of filter capacitor required to maintain a ripple constant of less than 3%. In this case an ac voltmeter, with a suitable blocking capacitor, is connected across the power supply output to measure the ac component.

FIG. 3

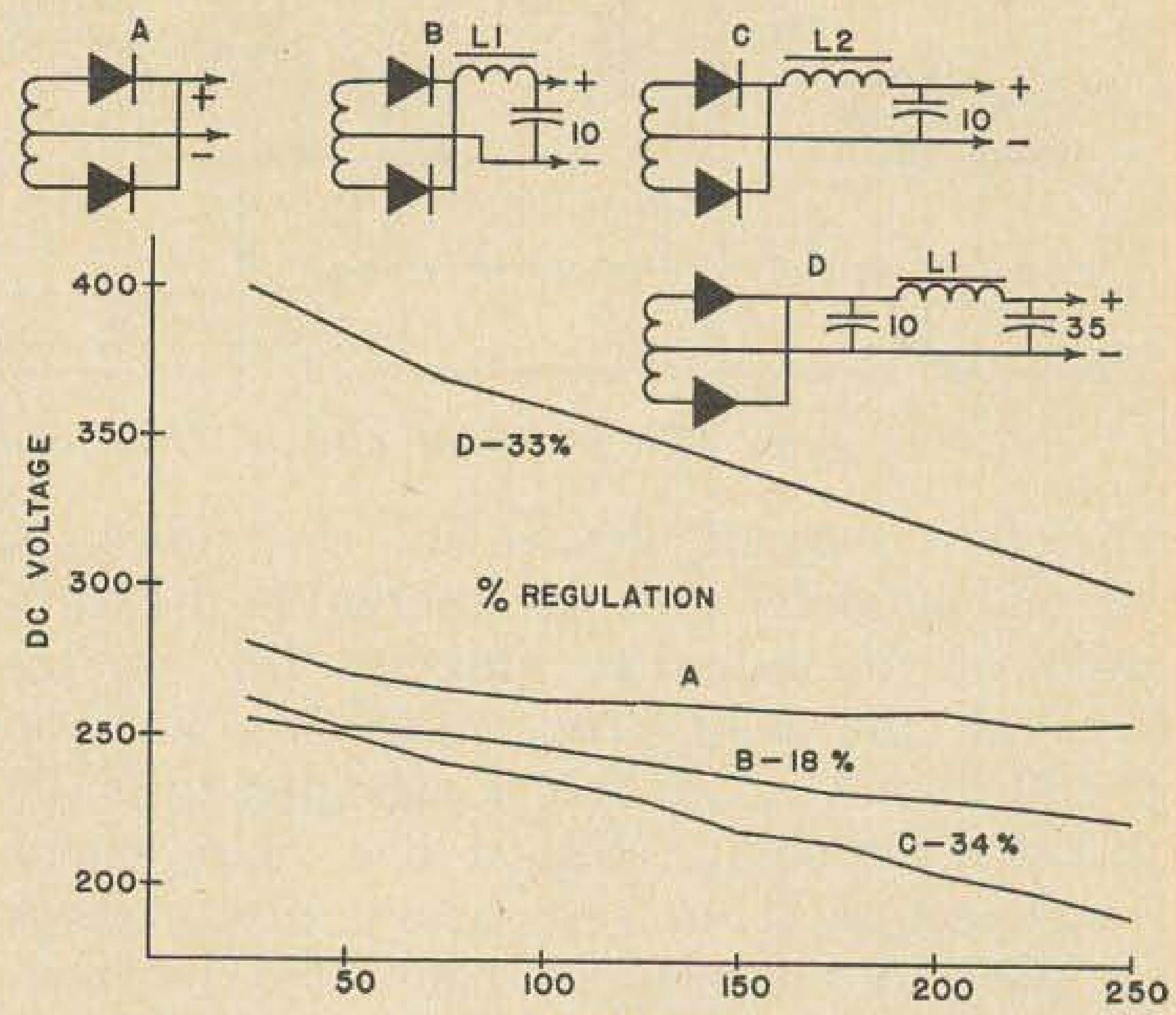

Fig. 3. Test results, obtained quickly and easily, illustrate power supply performance under load.

It can be seen that graph 4B with the 35 mfd filter capacity gives 11% less ripple than the circuit using only 10 mfd of filtering. Circuit 4B also gives slightly better regulation.

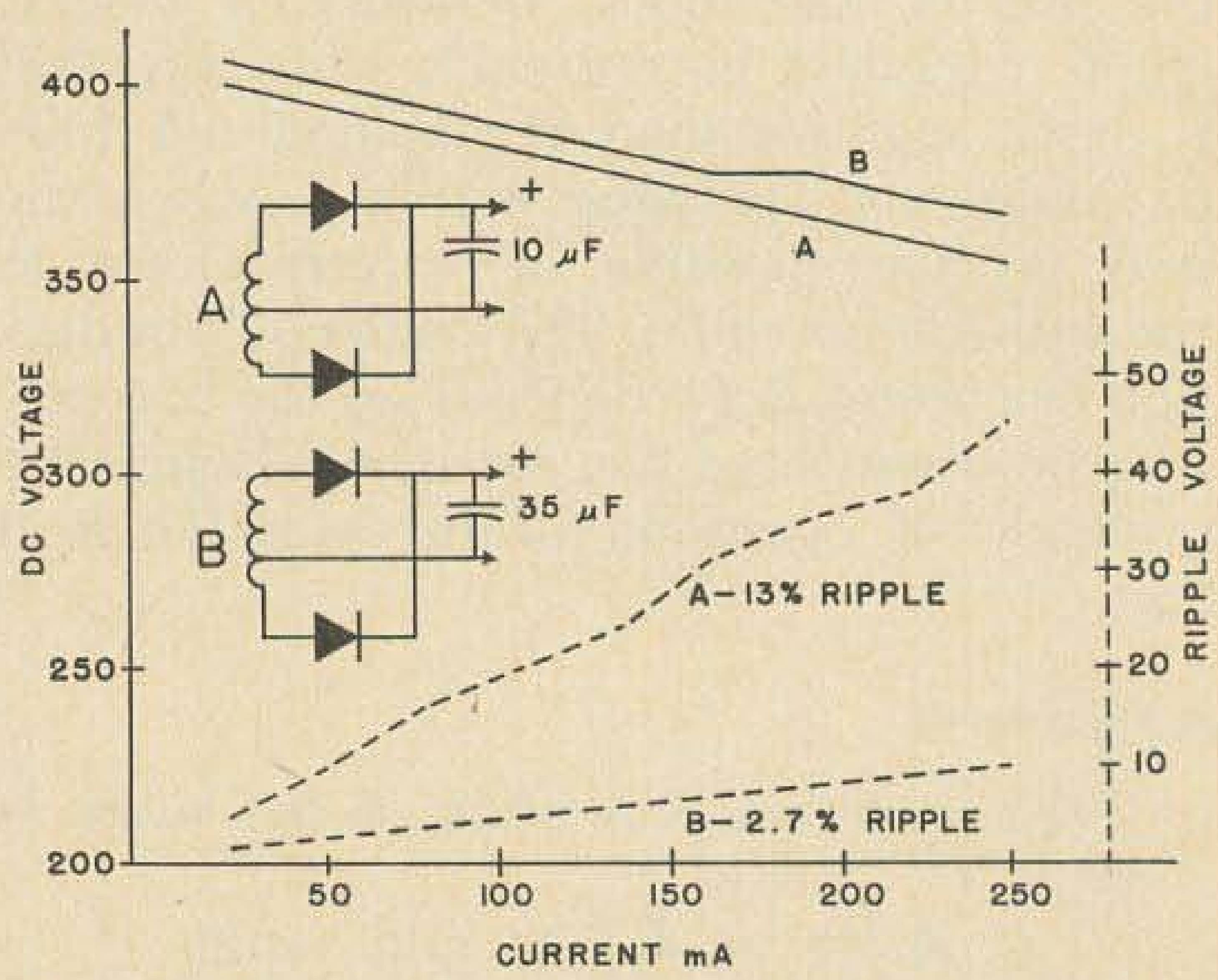

Fig. 4. As power supply load increases, voltage drops together with an increase in ripple.

Variable dc load-Controls left to right: minus voltage, plus low voltage, plus high voltage, ac power/off, meter X5 multiplier switch, meter, load control. The large resistor on the top center of the chassis is in series with the plus high voltage terminal and allows testing of supplies with output capacities greater than the tubes can handle.

These are but two examples of what you can do with a "Variable dc Load." As with anything else, its total effectiveness will be up to the ingenuity and inventiveness of the user.

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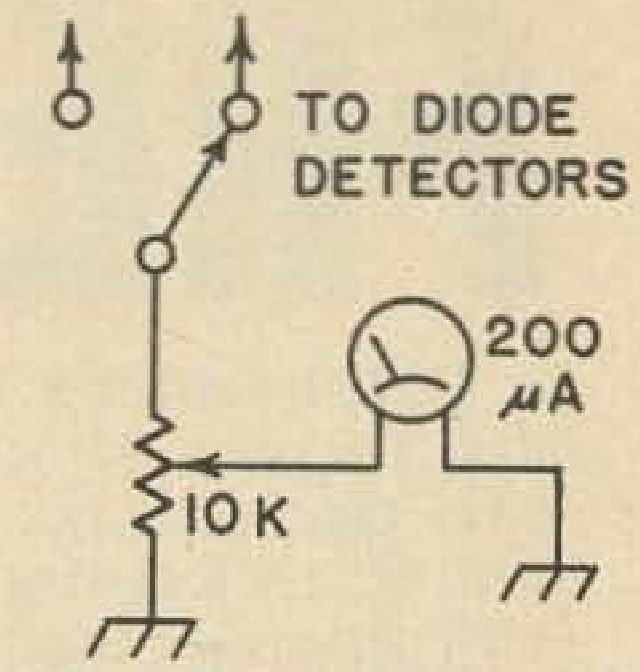
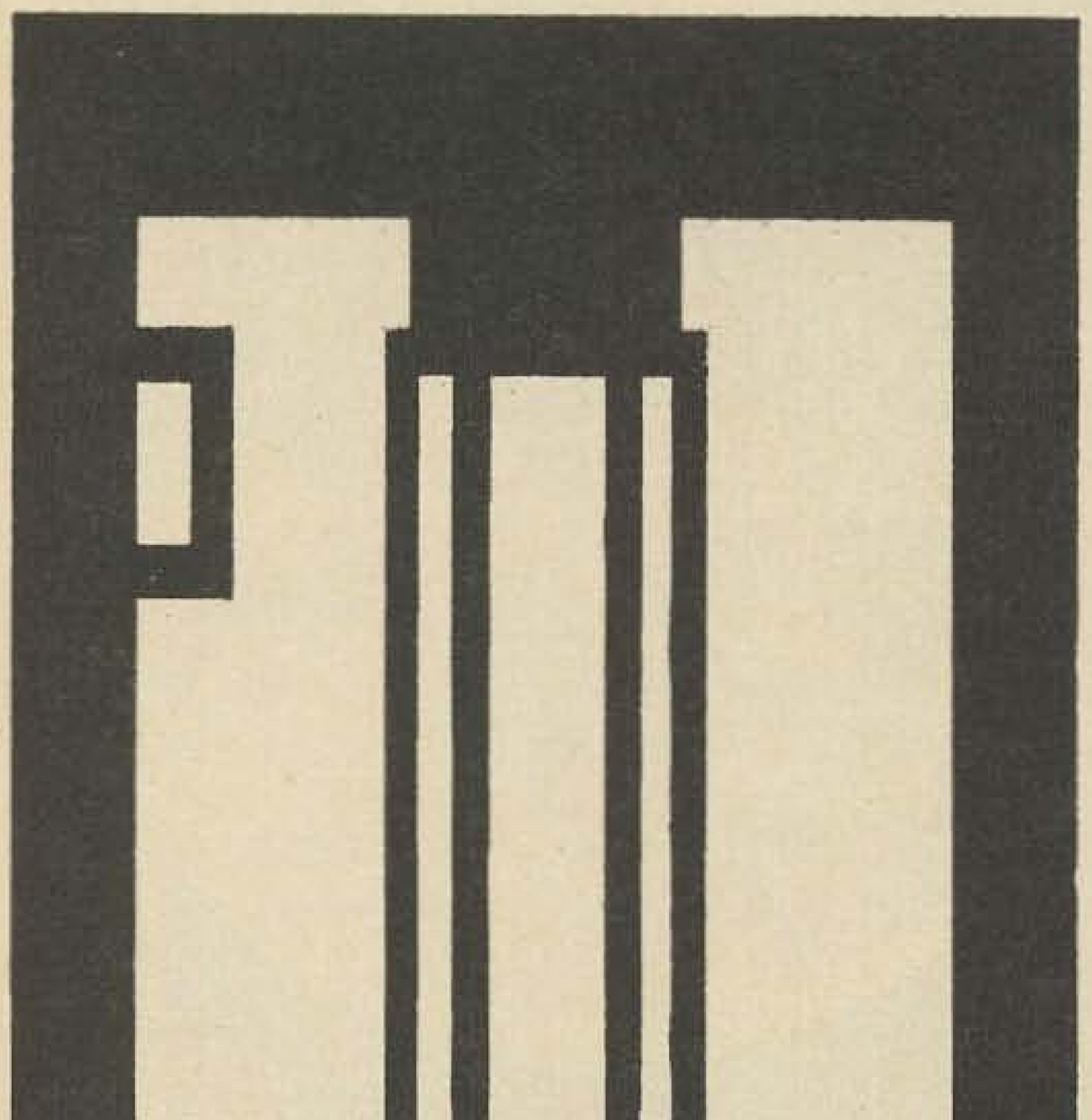


METERING CIRCUIT

Fig. 1. Metering circuit for the Single-sided SWR bridge.

Ed Lawrence WA5SWD
615 *Sherwood*
Richardson, Texas 75080

After reading the articles in 73 on SWR bridges that led up to the double-sided board pick-up,* I decided to try my hand at building one, but on single side board.



Several of these boards have been etched and units assembled, and all have been satisfactory. I have used mine, with a 200 microamp meter, from a kw on the low bands up to a "Twoer," with no problems with sensitivity.

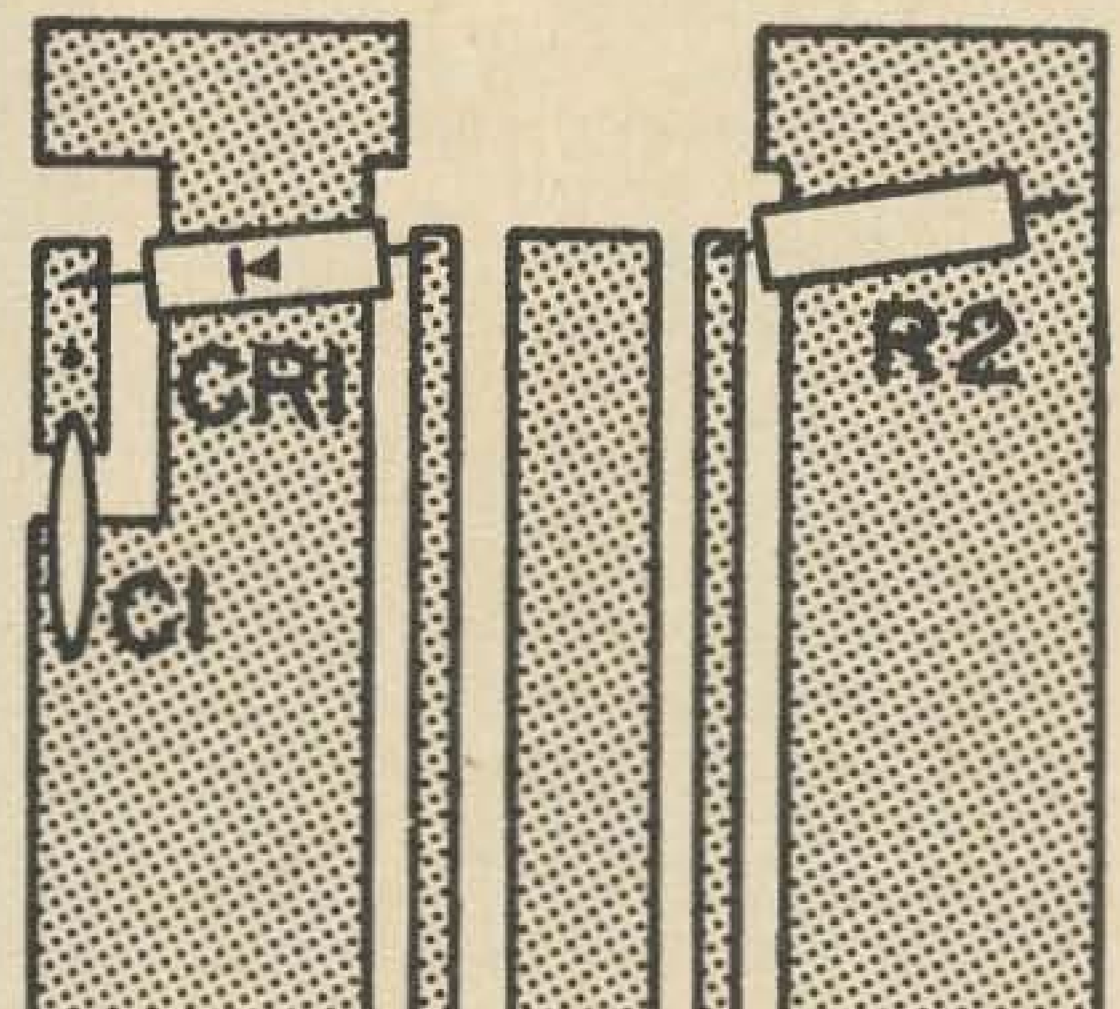
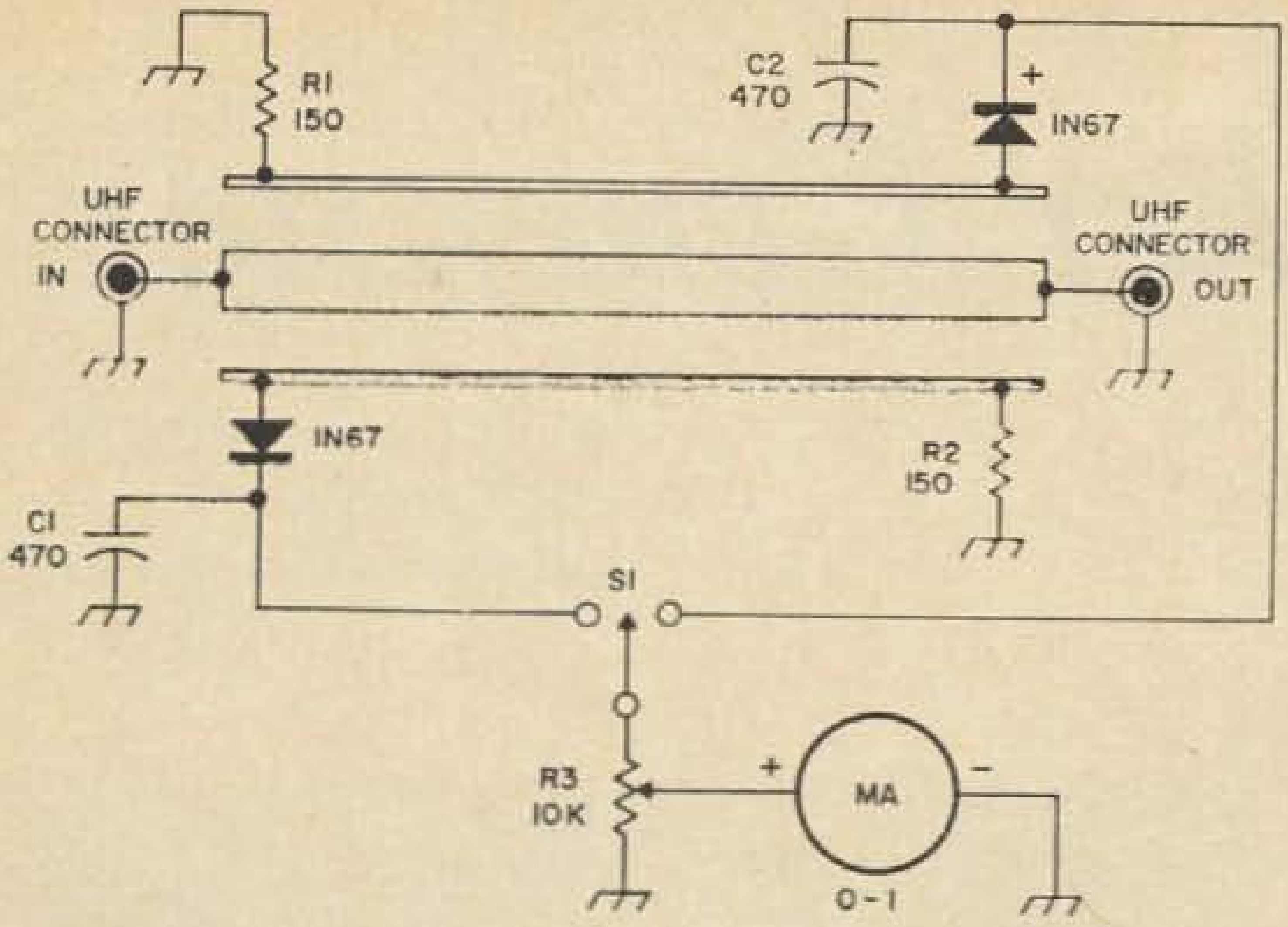
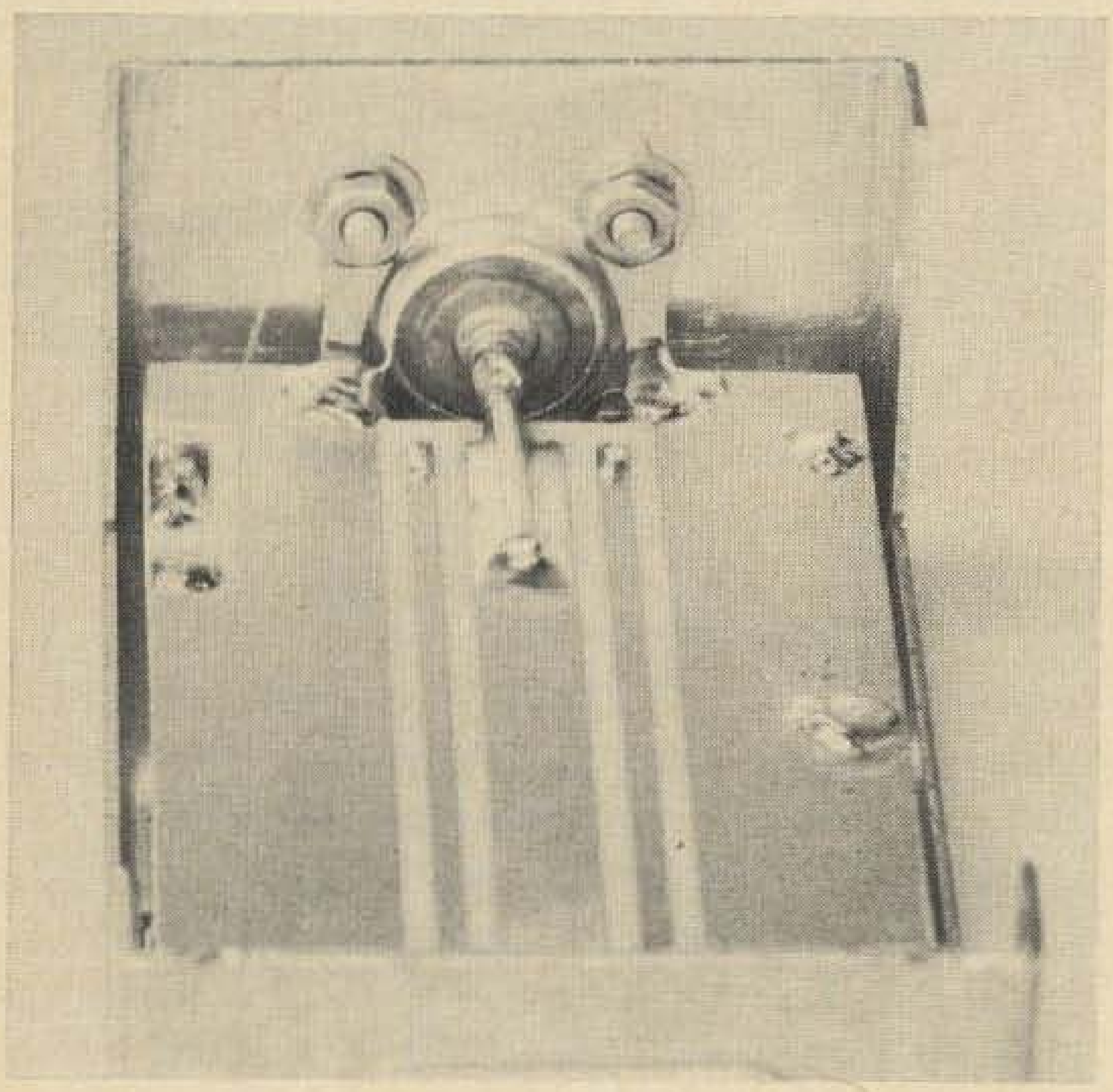


Fig. 2. Layout for the printed circuit board.



Schematic diagram of SWR bridge.

Since Bud Miniboxes are commonly available, I scaled this board to fit into the Bud Minibox CU 2102A or CU 3002A. If you want to include the metering in the same package, the CU 2103A or CU 3003A should be used to give more room.



If you use the CU 2102A, center the coax connectors on the ends. If the CU 2103A, mount the connectors .8 inches from the open end. I used solder lugs bent at right angles to mount the P. C. Board to the chassis. The photograph shows the mounting much better than 10,000 words.

The meter sensitivity control circuit shown has a wider control range than the one shown in the *ARRL Handbook,* since the pot shunts the meter at low settings. This action could be accentuated by putting a fixed resistance in series with the meter movement, at the expense of sensitivity.

. . . WA5SWD

*73, Sept '65

100 KHz Marker Generator

W. W. Davey W7CJB
329 East Kent
Missoula, Montana 59801

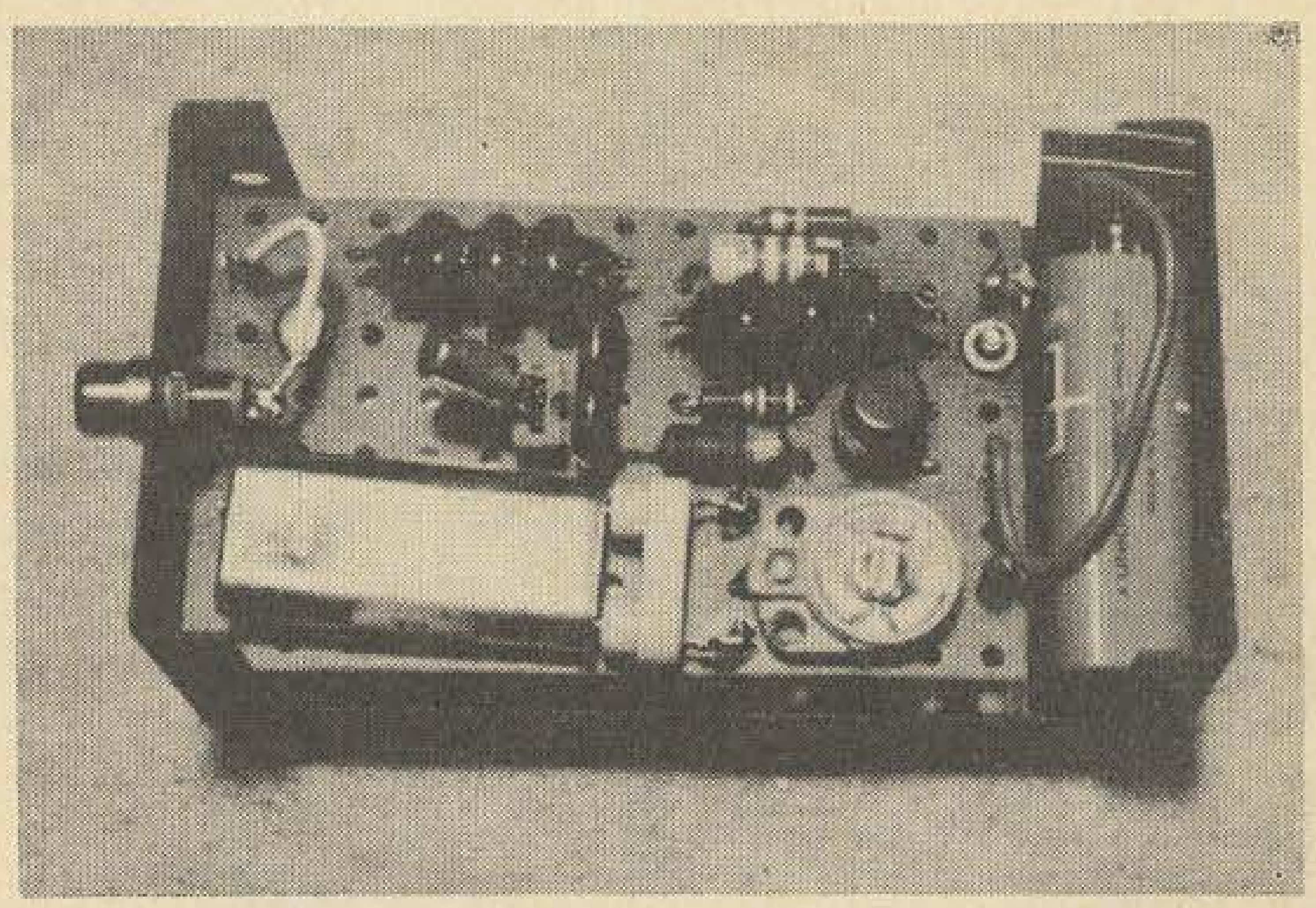
This useful piece of equipment generates usable harmonics from 100 kHz to 225 MHz. It is completely self contained and portable which makes it convenient not only to use in the ham shack, but also in the mobile unit or at a field day location. Its use lies mainly in accurately spotting band edges and 100 kHz calibration points throughout the ham bands.

Most modern day home receivers are equipped with calibrators, but these calibrators are of little use when needed to spot frequencies on VHF and UHF converters or portable equipment.

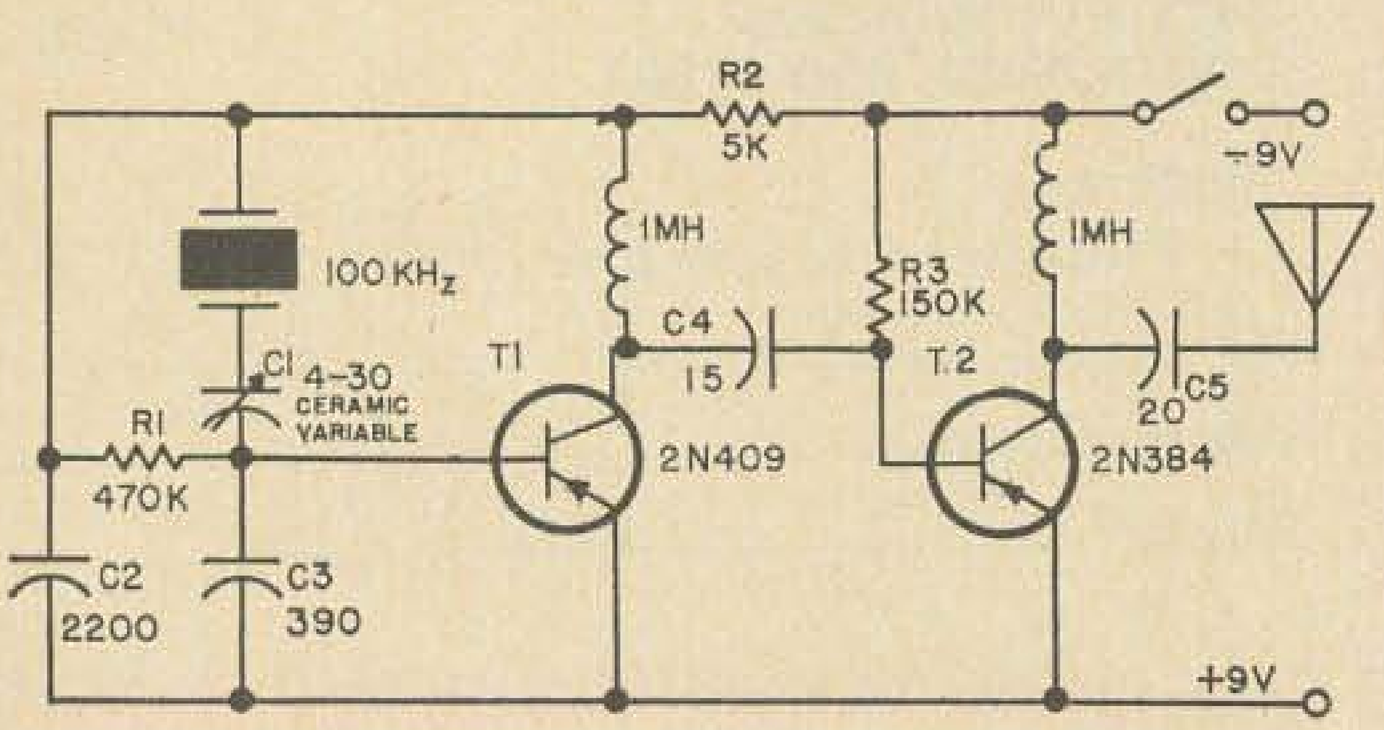
The generator is constructed in a 2¼ x 4¼ x 1½ inch handi-box. The parts are mounted on a vector board, and the entire unit is powered by one #216 nine volt battery or its equivalent.

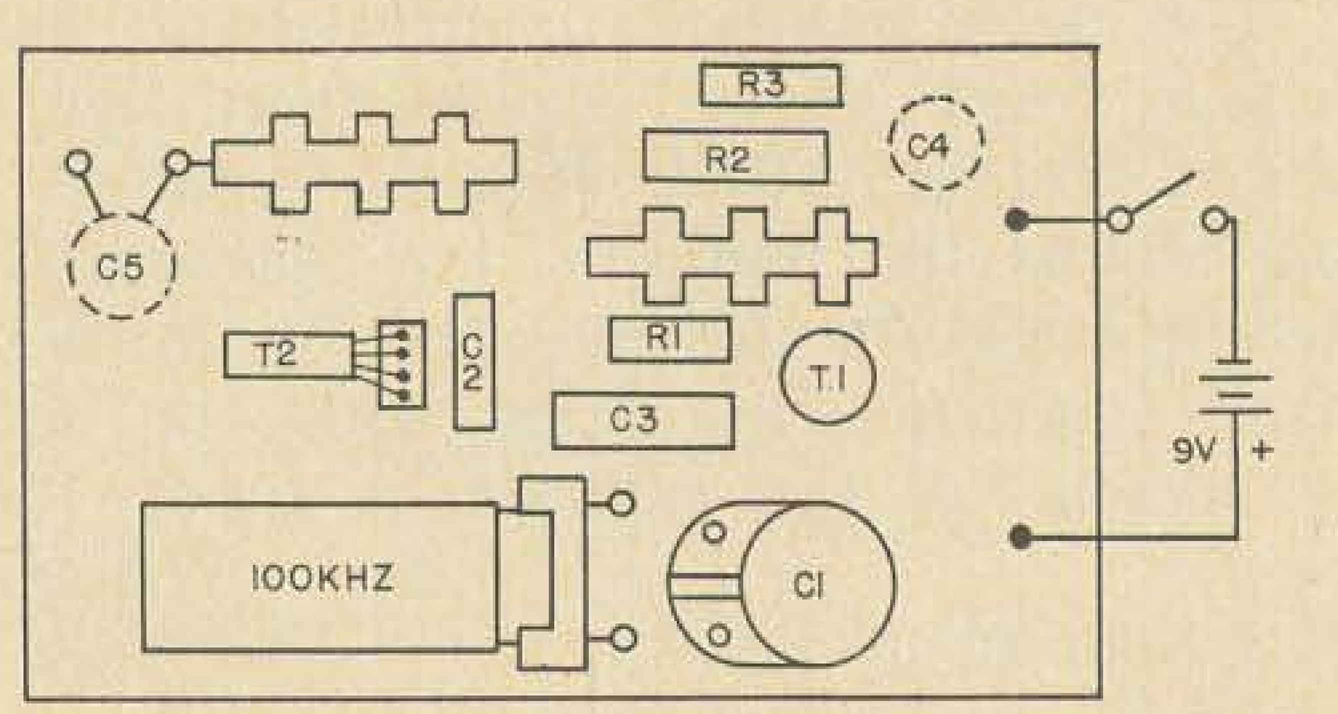
Hints on construction First obtain some vector board. The piece I used was cut from the board supplied in a "GE experimenters aid hobbyist kit." The board must be cut to size before construction and will measure 3½ x 2 inches. This will allow room for the 9 volt battery in the end of the handi-box. Make sure the newly cut vector board will fit inside the handi-box before you start mounting parts. It might save a lot of trimming at a later date.

The parts layout is not critical. Components may be arranged as shown in the photo or in any other arrangement suitable to the components you may be using. I used sockets for the transistors, as I wanted to be able to experiment to see which transistors from my junk box would give the most output in the VHF and UHF bands. I ended up using the 2N404 for the oscillator and a 2N384 in the multiplier stage. I also found that Japanese 2SA83 transistors which had been removed from the *if* stages of a junked transistor radio, would work equally well in both sockets.



All components are mounted on the top of the Vector board with the exception of C4 and C5. For the most part, wiring can be completed with existing leads on components. The push-in terminals furnished with the GE experimenters kit were used for the battery connections, antenna connection and for mounting the crystal socket. The circuit board can be mounted to the handi-box with three ¹¹⁄₁₆ inch bushings. This leaves room for a slide switch to be mounted on the cover of the handi-box. Two of these bushings were purposely placed at the end of the board to form a sort of socket to hold the 9 Volt battery. The antenna output connector which is mounted on the handi-box is a switchcraft #3501FP phono jack. A small hole may be drilled in





the bottom of the handi-box through which a screwdriver may be inserted for adjusting C1. For extreme accuracy C1 is adjusted to zero beat with WWV.

A 36 inch piece of insulated wire soldered into a phono plug may be inserted into the phono jack and used as a test antenna. The intensity of the markers may be varied by moving this test antenna near your receiver antenna lead-in. If you are using a coax lead-in you can couple by drilling a small hole in your coax relay so that the test antenna can be inserted near the relay armature. You will find that most SWR meters provide an easy method of coupling to the center conductor of the coax. As a last resort you can always couple to the receiver or converter antenna coil.

I have made very good use of this gadget to spot frequencies in the 144 and 220 MHz bands. It was well worth the time and effort it took to build it.

...W7CJB

OA2 PECULIARITY

In the process of putting together a small regulated power supply I found myself in need of a convenient stand-off. Unhappily I picked pin 3 of an OA2 gas regulator tube. It seemed like a reasonable choice, but I can assure you that this is not the thing to do.

If you look closely at the tube you will see that the connections from pins 3 and 6 go through the glass envelope and extend about ¼ inch into the tube. They are not connected to any part of the tube. The Handbook shows the pins to be internally connected.

What happens is this: the short pins act like anodes. If you put 500 volts on one of the pins the tube will fire and draw current. In my case there was nothing to limit the current and the tube really went wild!

Conclusion: do not use these pins as stand-offs.

Robert Bailey K3AQH
Philadelphia, Pennsylvania

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One Technique to Avoid that Routine QSO

Maurice Hindin, W6EUV
10471 LeConte Avenue
Los Angeles, California 90024

From time to time amateur radio magazines have all carried editorials and correspondence from their readers directed to the problem of the boring routine QSO ("de W2NSD/1" 73 Jan. 1969; "It Seems to Us" QST Feb. 1969). It has even been suggested that one of the reasons why amateurs often lose interest in their hobby is the uniformity and sameness that most QSO's take. After exchanging a thousand or more reports which simply contain the routine information giving the signal report, QTH, name, power and type of equipment used, followed by the usual "QRU, 73 cul" it is true that the routine QSO can become a dull affair.

Although there has been a great deal written about boring QSO's, very little has been written about what an individual ham can do to improve the situation.

The reason why so many QSO's degenerate into a stereotyped routine exchange of information is in the writer's opinion, the result of several things: First, the operator doesn't know what to talk about and second, he forgets that he is talking to a human being and not just a piece of electronic equipment. Third, the operator is really suffering from mike (or key) fright. As soon as the operator recognizes these facts, something positive can be done to make the average QSO an interesting experience. Many years ago, the writer became aware of his conversational ineptitude at the mike and devised a simple technique which produced excellent results. It may probably have been instrumental in making amateur radio for him a lifetime hobby.

The problem in the first instance is what to talk about after you have completed the routine information. To avoid not knowing what else to say, the writer wrote a series of questions about things that were of interest to him. They were simply things that he would like to ask any new friend that he had just met. Some words of caution are in order, however. *First,* simply asking a lot of questions will not make the QSO necessarily an interesting experience. It is the willingness to share your answers also to the questions you ask with the other fellow that makes for an interesting conversation. *Secondly,* do not ask a question of the other fellow that you would not want to answer yourself if he asks the same question of you. This, however, is really no different than your conduct would be in any social contact with another person. *Thirdly,* the question should not embarrass an ordinary person whose particular beliefs you do not know. One good test is would the information that the question calls for embarrass you if it were asked of you. *Fourthly,* it is not too wise generally to ask questions which you know will invite a controversial answer ("It Seems to Us" QST Feb. 1969). This also is a matter of simple good manners. After all, a QSO should be something that is pleasant for everyone and there are vast areas of subject matter that can be discussed and explored without getting involved with controversial subjects.

The specifics of a program the writer used to eliminate dullness in the QSO require simply listing a series of questions about things of interest to you. Then the moment your mind turns blank as to what to say next or the QSO starts to dry up, simply look at the list and start it up again.

After using the list for a few months, it became almost second nature to engage in friendly informative QSO's, each of which were different from the other and many of which opened the doors for long-term friendships.

As a practical matter, I found that if I volunteered some information first and followed that with an inquiry on the same subject, it would invariably open the door to more discussions and before long a genuine feeling of knowing the other fellow was developed. If you visualize that you are talking to someone sitting next to you as if he were in your own room and not going through a routine testing procedure, the routine stereotype type of QSO which does get tiresome can be avoided. Listed below are the twenty questions which have provided the framework for many pleasant, interesting and diversified QSO's. As you can see, there is nothing unique about the questions. You can easily prepare another list of questions for yourself. The questions are simply guidelines to keep the QSO going so you will never find yourself in the position of not knowing what to say next. If the questions listed below sound interesting to you, simply use them. If other subjects of conversation come to mind that you would prefer to discuss, then of course, use them. The point of the whole idea is that if you make up a list of questions or subjects and have it on the operating table, you can with a minimum of effort change a boring routine QSO into an interesting conversation with a newly made friend.

My list contained the following subject matter:

1. (I am a machinist.) What kind of work do you do? (If he says he is in school, then ask what school grade, and what does he plan to do when finished.) (If he says he is in college, ask him where it is, what he is taking. If you have been to college, tell him about it.)

2. How long have you been doing that work? (I've been a machinist for 17 years.)

3. (I've been on the air since 1935.) How long have you been on the air?

4. What other bands do you operate? (I operate on 15 and 2.)

5. Do you ever operate any other mode? (I operate part time on CW and part on sideband.)

6. Have you ever visited here in Podunk? (Your town.) I've never been in Lower Culicutt (His town). The nearest I've been to Lower Culicutt was in Upper Culicutt (or where is Lower Culicutt?).

7. (I have been a stamp collector for years.) Do you enjoy any other hobbies?

8. (I wish I had more time to operate. I only get on weekends.) How about you?

9. (I've got two children.) Do you have any children?

10. (My kids are 10 and 12 years old. A boy and a girl.) How old are your kids?

11. Are you interested in DX work? (I am. I've got 110 countries confirmed.) How about you?

12. Have you heard or worked any Dx lately? I've just worked UAØYE in Zone 23 after trying for years.

13. What kind of an antenna do you use? (I use a cubical quad.)

14. (I have (or have not) used the type of beam you have.) Have you ever compared it with any other type?

15. (I've been studying for an extra class ticket for a month now.) Have you started working for an extra class ticket?

16. Do you like to build your own equipment? (I do (or do not) like to build my own equipment.)

17. If he says he does build his own equipment, then ask what he has built, and what will be his next project? Tell him what you have built, and what your next project will be.

18. Are you active on any nets? (I check in regularly on the XYZ net.)

19. Are you ever bothered with TVI? (I cleaned mine up or I still have trouble.)

20. If he is bothered with TVI, tell him how you cleaned up yours.

The preparation of a list of questions or subjects has been a practical solution to the problem for the writer. As a matter of fact, once you have tried the Q and A method, you will find there is generally so much to talk about that it is often necessary to terminate a QSO long before all of the subjects are even mentioned.

While the foregoing idea may not be the only or ultimate solution to the problem, it is at least a step forward toward doing something to avoid those dull routine QSO's. It is perhaps an application of the old saying that "It is better to light one candle than to curse the darkness." ...W6EUV

Minimum Cost Semiconductor Silicon Survey

Conrad C. Zaranski
P.O. Box 64
CheekTowaga, New York, 14225

Purpose:

Obtain the cheapest silicon transistors from any major manufacturer. Explore possible applications. Develop useable characterization of devices by actual laboratory measurement.

Background Information:

A manufacturer begins with several basic chips of differing geometry, which are then electrically graded into several broad device families. Some will become hi-reliability mil-spec units, hermetic commercial equivalents, house numbered custom spec units, and recently, consumer grade economy units. The economy transistor did not attain respectability until the advent of silicon Planar* technology control which produced high yield uniform quality devices. The residual product remaining after several grading steps still possessed well-defined characteristics and was registered. This gave the familiar 2N . . . designation to these economy units.

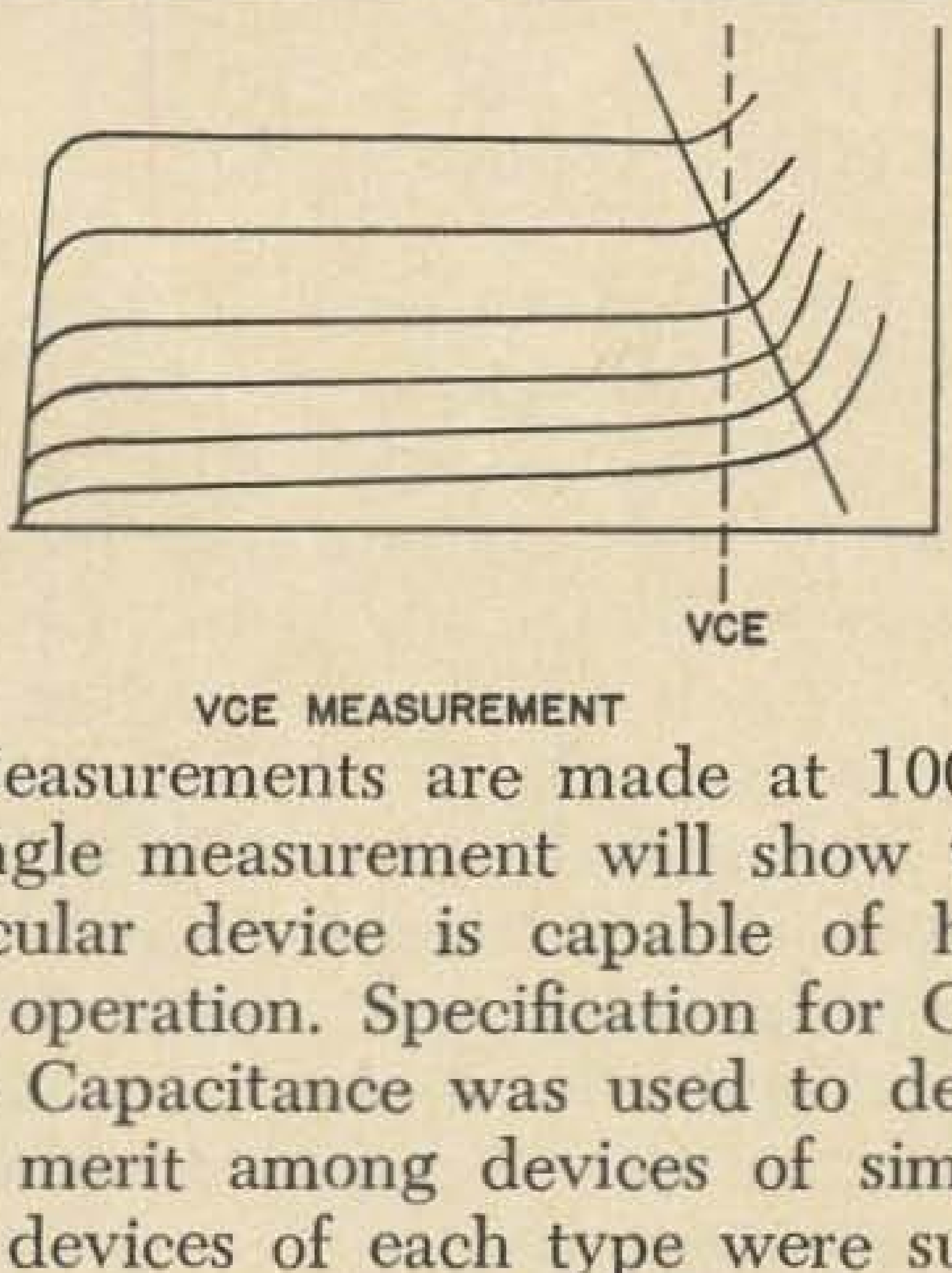
The transistors selected are manufactured by Fairchild and are packaged in either the TO-105 or TO-106 case style (ceramic/epoxy) similar to the TO-5 and TO-18 units. Price shown: 100 pc. lots - 1 November 1968. The study graphically illustrates key parameters which influence cost, and inherent parameters which remain after grading.

To insure reasonable data accuracy, minimum sample (any type) was 100 devices, typical size 300 devices, maximum 100, total 3,300. The devices were procured over an eight-month period (different manufacturing date, codes,) to typify parameter spreads within lot sample sizes most hams would use: Sample distributor sales tend to have more non-uniform parameter distribution than large, bulk O. E. M. sales since most bulk O. E. M. users specify some parameter distribution (not more than 5% of the lot of X thousand shall have parameter Y lower than......or higher than......). This specification is usually derived from the peculiar circuit designs, employed, an uncontrolled family characteristic, or critical limit device requirement. This may produce some unnatural distribution of a key parameter after these sales are completed.

*Fairchild registered trademark.

These abbreviations are used in the article

C_{CB} — Collector to Base Capacitance
V_{CBO} — Collector to Base Voltage
V_{CEO} — Collector to Emitter Voltage
V_{EBO} — Emitter to Base Voltage
N_F — Noise Figure
P_G — Power Gain
F_t — Gain Band width Product measured at 100 MHZ
Example F_t = 600 100 MHZ x 6.0
V_{CE} SAT. = Collector Saturation Voltage
H_{FE} = D C Beta
H_{fe} = AC Beta
T_s = Storage Time
T_d = Delay Time
T_R = Rise Time
T_f = Fall Time
Ton = Turn on Time
Toff = Turn off Time

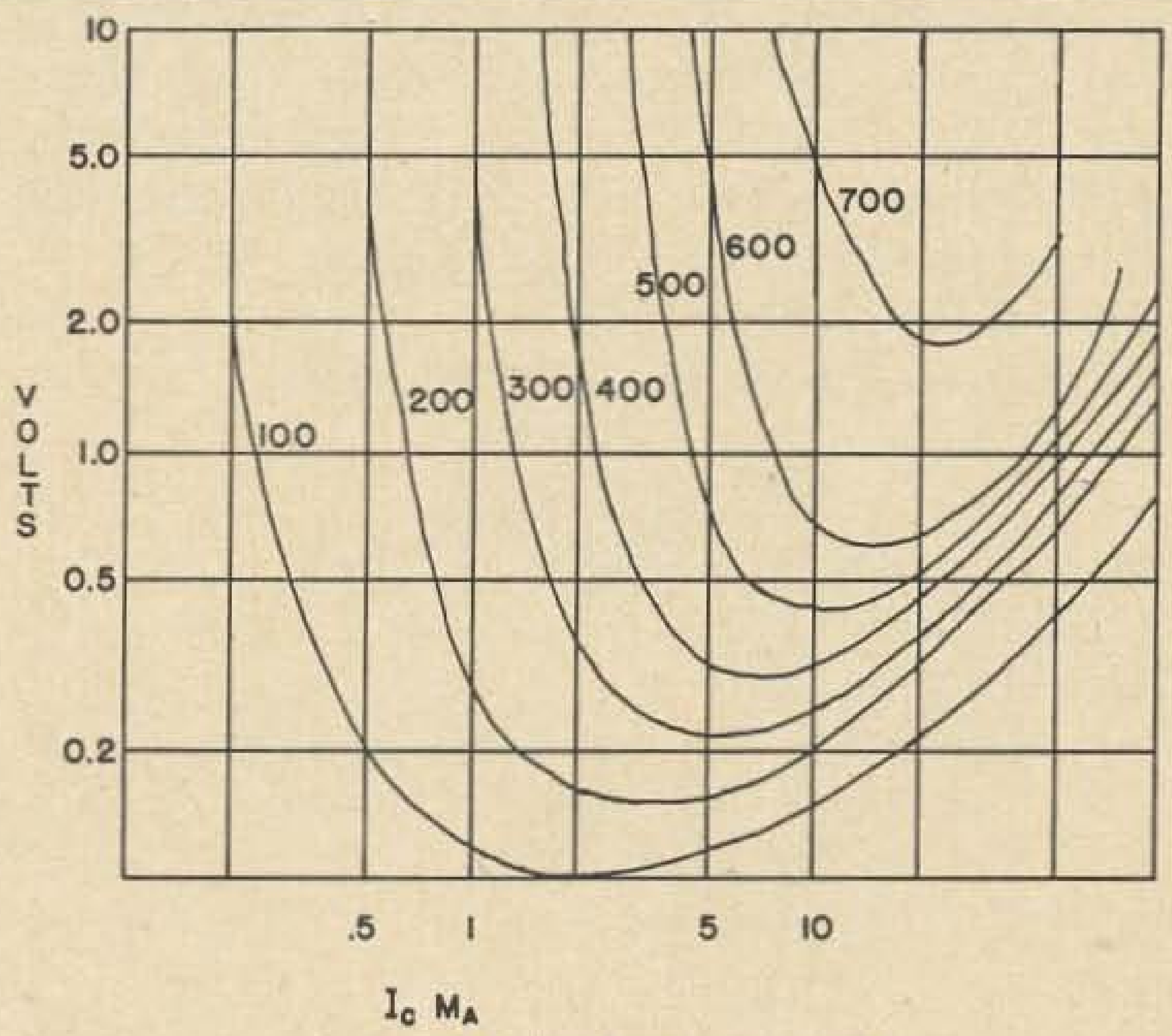


VCE MEASUREMENT

F_t Measurements are made at 100 MHZ. This single measurement will show whether a particular device is capable of high-frequency operation. Specification for Collector to Base Capacitance was used to determine relative merit among devices of similar F_t. Several devices of each type were subjected a 100 MHZ noise test. Devices selected were taken from three F_t groups (low, median, and high F_t). Results were inconclusive. Leakage current was not measured—maximum is 50 Nanoamperes (per spec.) for all types. Beta linearity was measured at several frequencies and collector currents. Condensed data sheet Values are given, a distribution curve is drawn, and then our conclusions. Some devices just do not measure up to the data sheet.

2N5126 – NPNSi RF Amp.

Graded From 2N3688, 2N3689, 2N3690;



FT CHIP CONTOUR 2N5126

Feedback Capacitance C_{CB} = 1.6pf max.

V_{CEO} = 20 Volts MIN

V_{CBO} = 20 Volts MIN

F_t @ 100 MHZ @ 4MA 10 Volts

MIN 300 Typical 600

H_{FE} 20 MIN 70 Typical

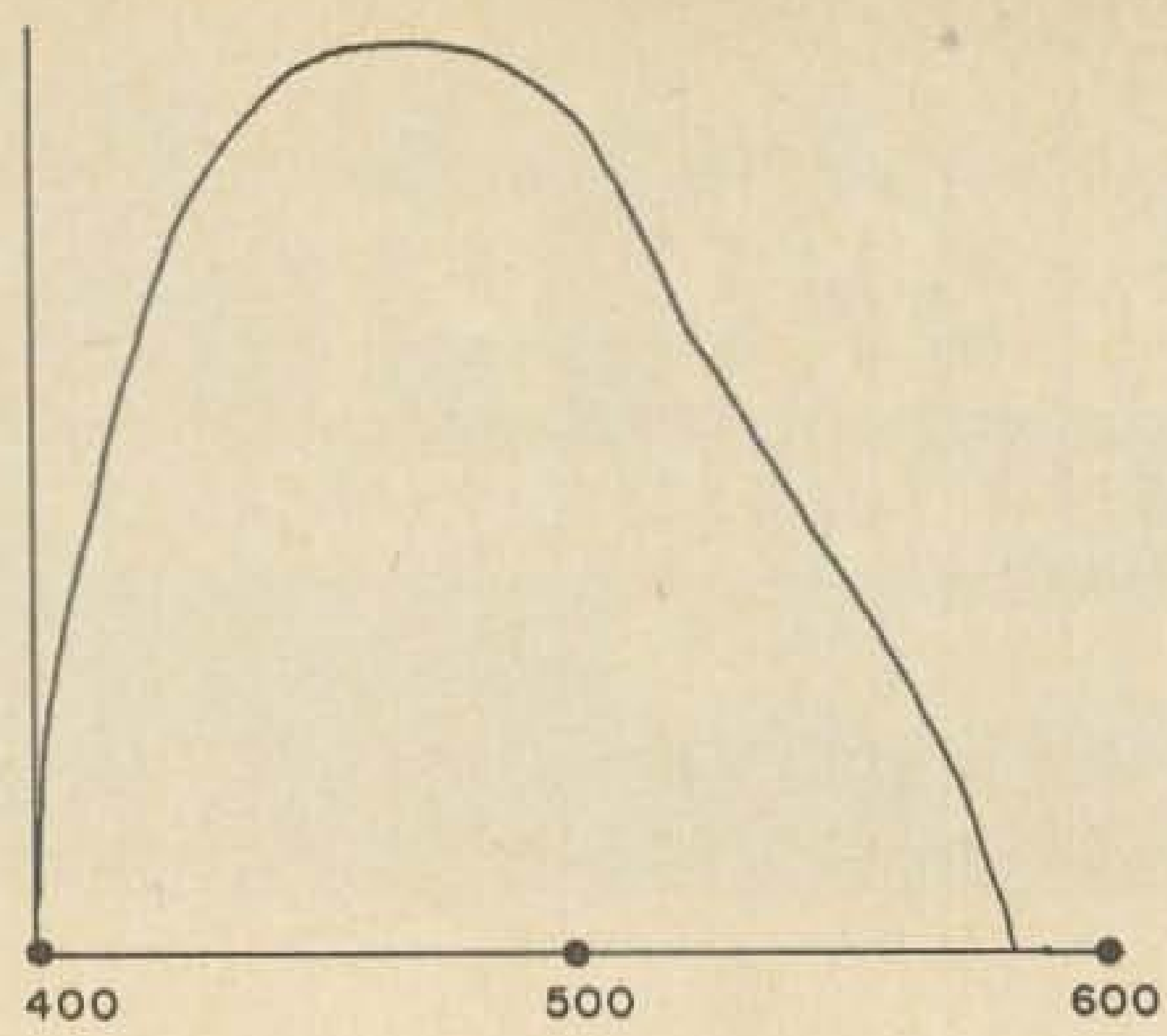
350 MAX @ 4MA. 10 Volts

Forward AGC Characteristic

100 MHZ −30db. @ 9MA Typical

NF = 5.5db. Typical @ 100 MHZ.

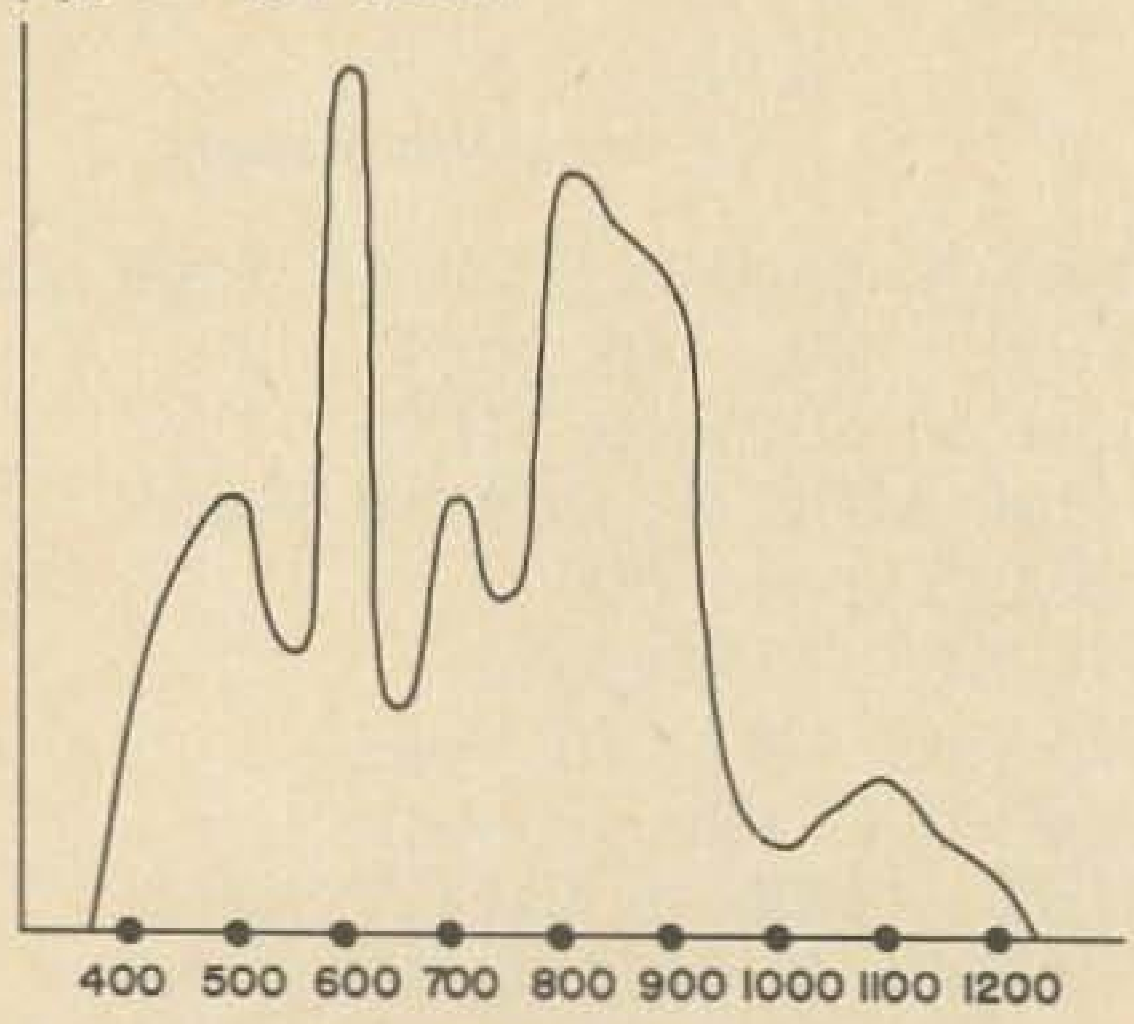
Use: AGC Controlled *if* and *rf* stages of



2N5126 FT DIST

to 100 MHz. AGC Gain reduction vs. current exhibits considerable variation. AGC current and non-AGC'd gain from device to device does *not* track well. This can be helpful to obtain a progressive overload capability to allow wide dynamic range in an *if* amplifier. The 20^{+T}CE is more than adequate. Noise performance ran slightly more than 5.5 db.@100 MHz. F_t was much lower than anticipated, no unit had F_t greater than 600. A rough approximation of AGC Control current can be obtained, by watching β Compression at higher currents on a curve tracer. The device is useful from 1 to 4 mA., ignoring AGC effect, but there are better types available. High-frequency performance above 100 MHz is erratic due to corner noise and F_t distribution

2N5127 – NPN Si RF
Similar to 2N 3564 *and SE* 1010
C_{CB} = 3.5 pF MAX
2.5 pF Typical
H_{fe} 100 MHz (f_t 750 @ 15 mA.
10 Volts Typical
No MAX or MIN
100 MHz F_t 150 MIN 300 Typical @ 2.0 mA 10 Volts
V_{CB} = 20 MIN
V_{CE} = 12 MIN



2N5127 FT DIST

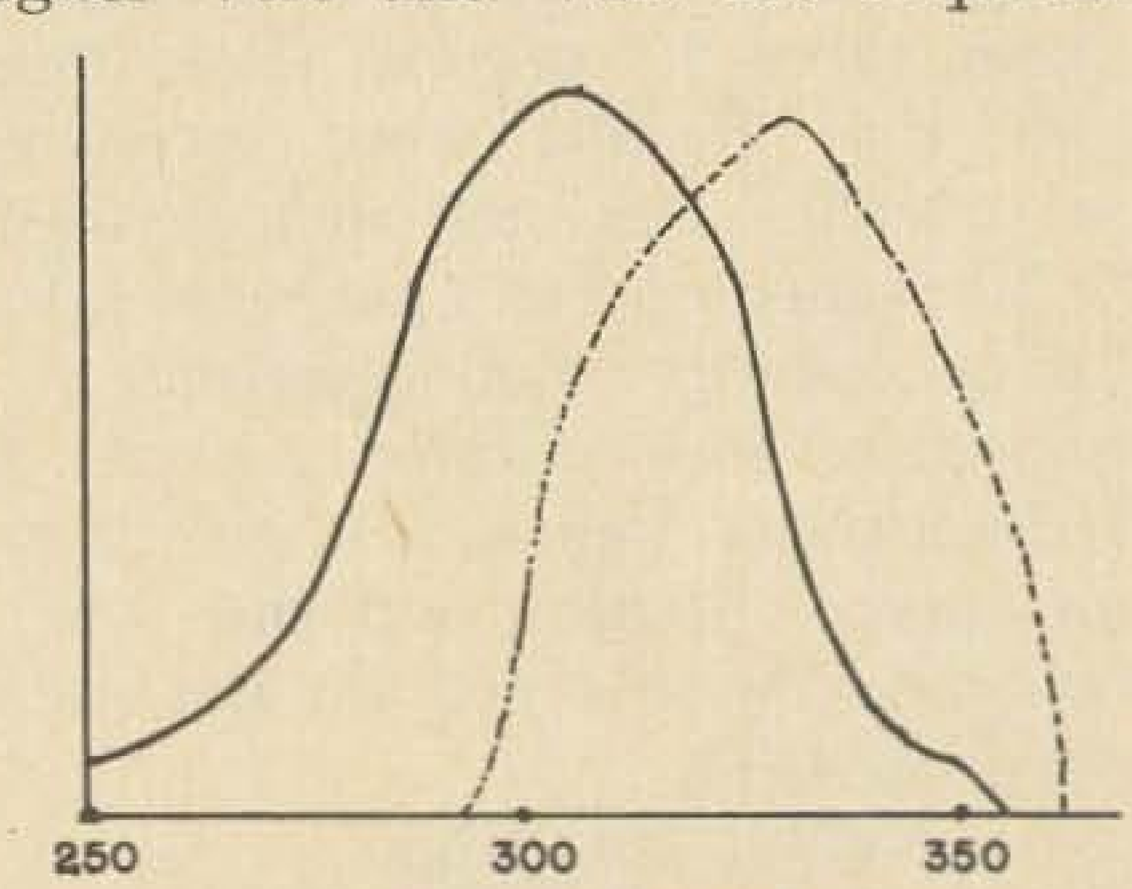
DC Pulsed H_{FE} = 70 Typical
No MAX or MIN
1 kHz H_{fe} = 12 MIN. 80 Typical 400 MAX. @ 2 mA.

Typical characteristic exhibited by actual measurement shows F_t date sheet value is missing from the curve. Units are much lower in β and F_t or are slightly higher– units with F_t 1000 or higher are not β linear. Units of 780 F_t or higher exhibited V_{CE} of about 15 volts. Not as good as anticipated. Units cost 16 cents each. Useable for HF to VHF work if selected. C_{CB} is higher than 2N 5126. Reasonable performance at higher currents (8-18 mA).

2N5128-TO-105 NPN Class – C RF
2N5129-TO-106 High Current Switch
V_{CBO} = 15 Volts
V_{CEO} = 12 Volts
400 Milliwatts Typical @ 30 MHz
G_{pe} F = 30 MHz 12 db Typical
75% efficiency Typical
F_t MIN 200 MAX 800 – 50 mA @ 5 Volts
Pulse H_{FE} MIN 35 Typical 75 MAX 350. 50 mA @ 10 Volts
Pulse H_{FE} Typical 62 @ 500 mA @ 10 Volts
T_{on} 14 ns. Typical I_c 300 mA
T_{off} 80 ns. Typical I_b 30 mA

When swept β measurements were made, units were found to have good Beta at very low currents. Exceptionally good wide range low to high current and linearity. F_t very narrow spread. 2n5123 has higher and F_t curve. It is a nice wide current general Purpose device which reminds me of a 2N2219 but probably not the same chip. I have used it as a current driver/buffer for oscillator amplifiers, tripler drive, large signal *rf* oscillator, audio drivers, and small signal *rf* amps. At 13 cents for either package, this is quite a device.

If higher V_{CBO} and V_{CEO} are required it is

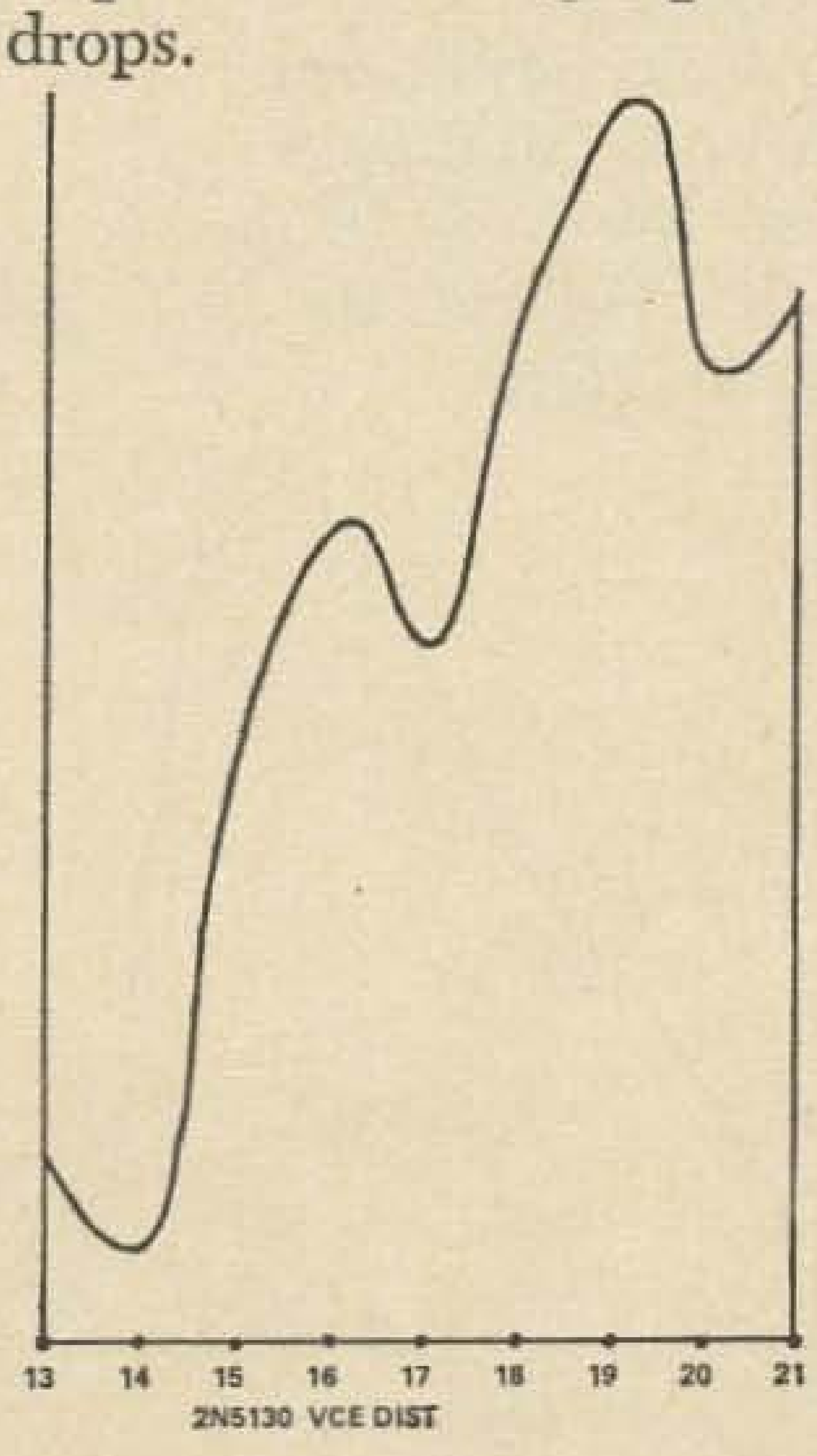


2N5128–2N5129 FT

suggested the following similar devices be utilized.

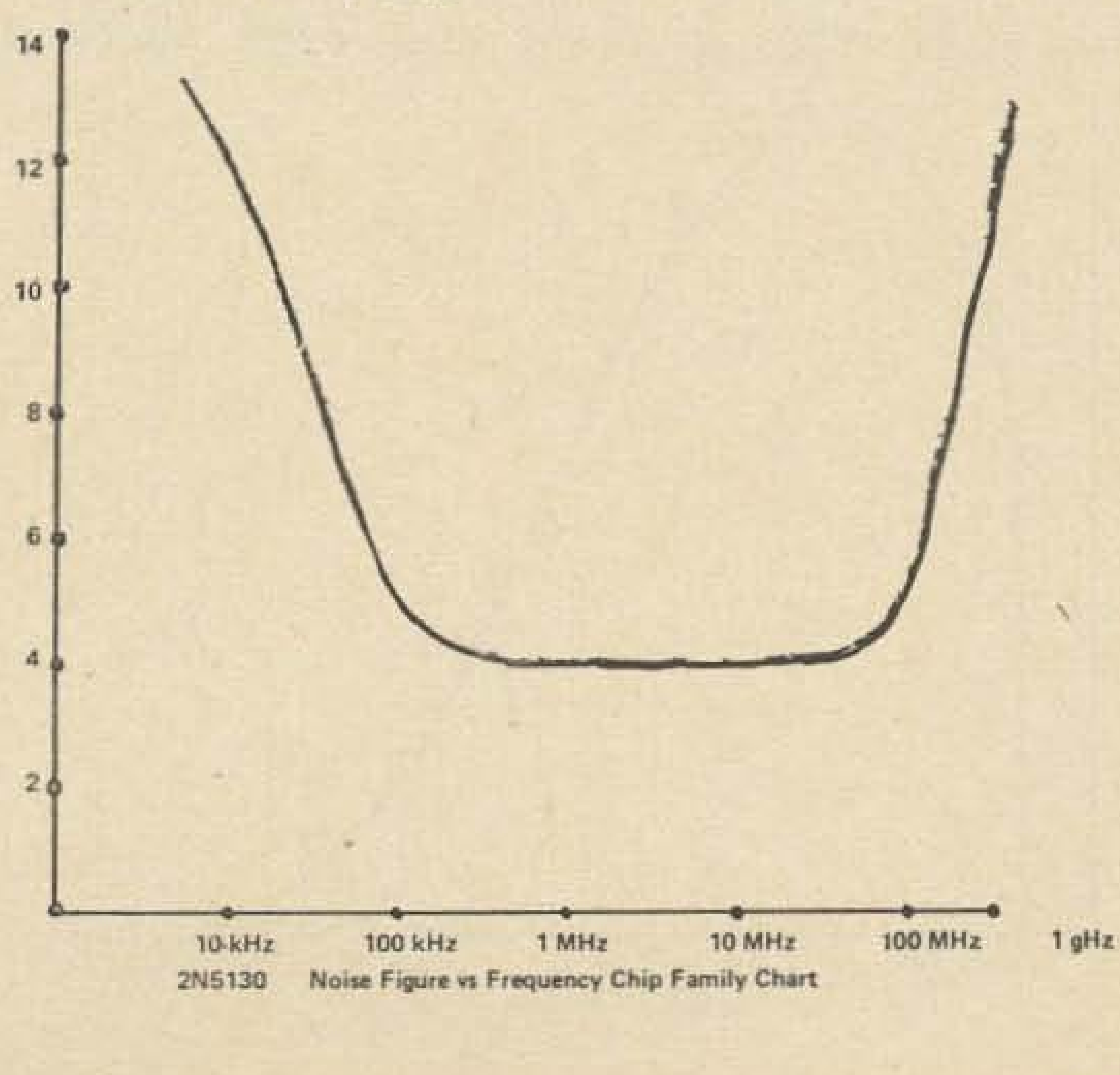
2N3641	V_{CBO} 60 Volts	28 Cents
	V_{CEO} 30 Volts	
2N3642	V_{CBO} 60 Volts	33 Cents
	V_{CEO} 45 Volts	
2N3643	V_{CBO} 60 Volts	38 Cents
	V_{CEO} 30 Volts	

NOTE: These are not devices for operation at VHF frequencies at high power levels—efficiency drops.



2N5130 – NPN Low Level RF AMP
Similar to: 2N3563, 2N918, 2N2616
F_T Contour

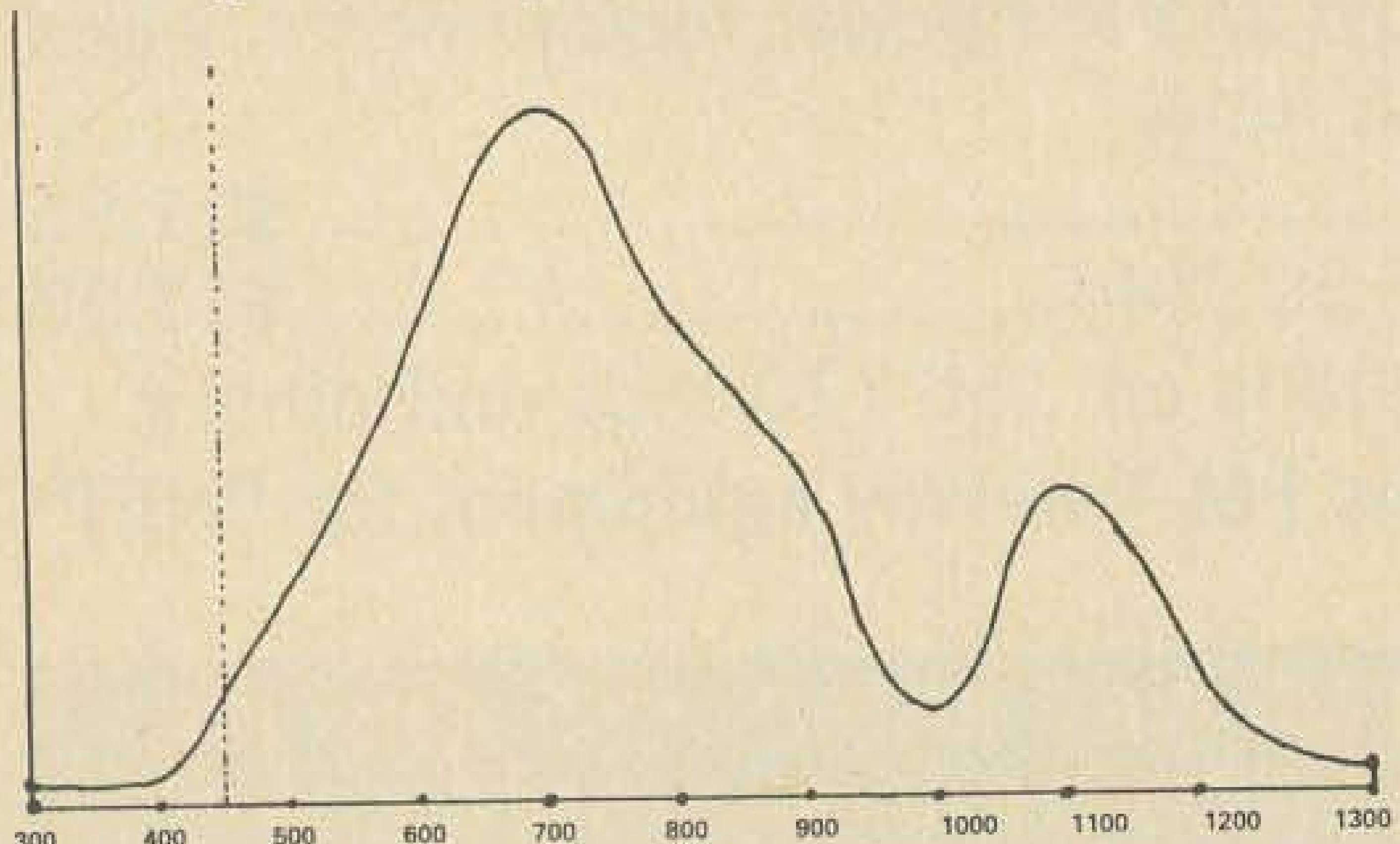
C_{CB} MAX 1.78 pF. @ 10 Volts
G_{pe} = 15 db. Typical @ 200 MHz 8 mA. 10 Volts
P_o = 40 mW. Typical @ 500 MHz. 10 mA. 10 Volts
P_o = 7 mW. Typical @ 930 MHz. 10 mA. 10 Volts
NF = 4 db. Typical @ 60 MHz 1 mA @ 6 Volts



2N5130 Noise Figure vs Frequency Chip Family Chart

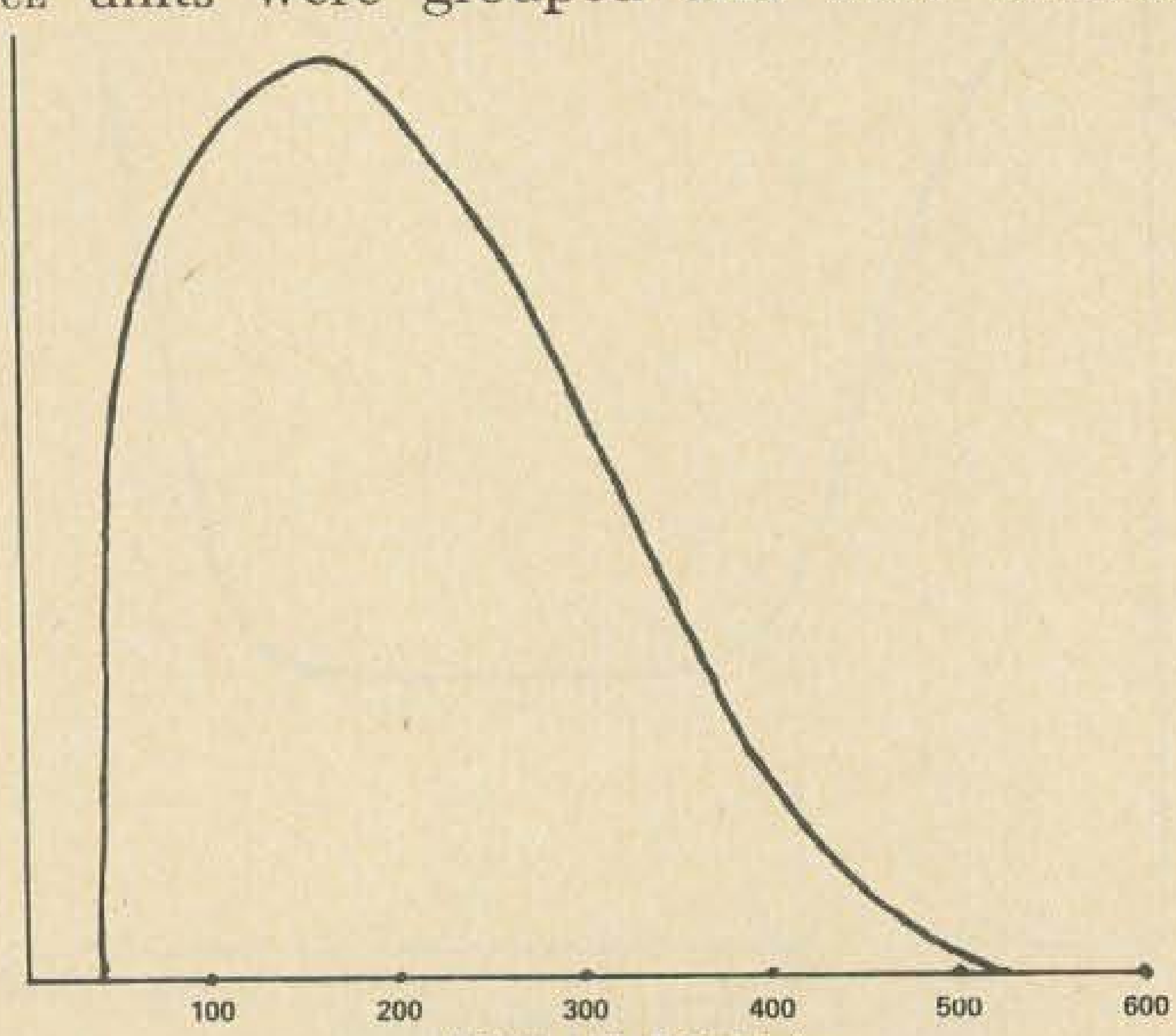
V_{CBO} = 30 MIN.
V_{CE} = 12 MIN.
V_{EBO} = 1 Volt MIN.
F_t = 450 MIN 900 Typical

Most of the transistors were below typical B, typical *rf* Performance, some were out of spec-LO and LO F_t performed like LO 2N918. None of typical specs are met by the majority of devices, though most of the devices perform quite well around 2 meters.



2N5130 FT

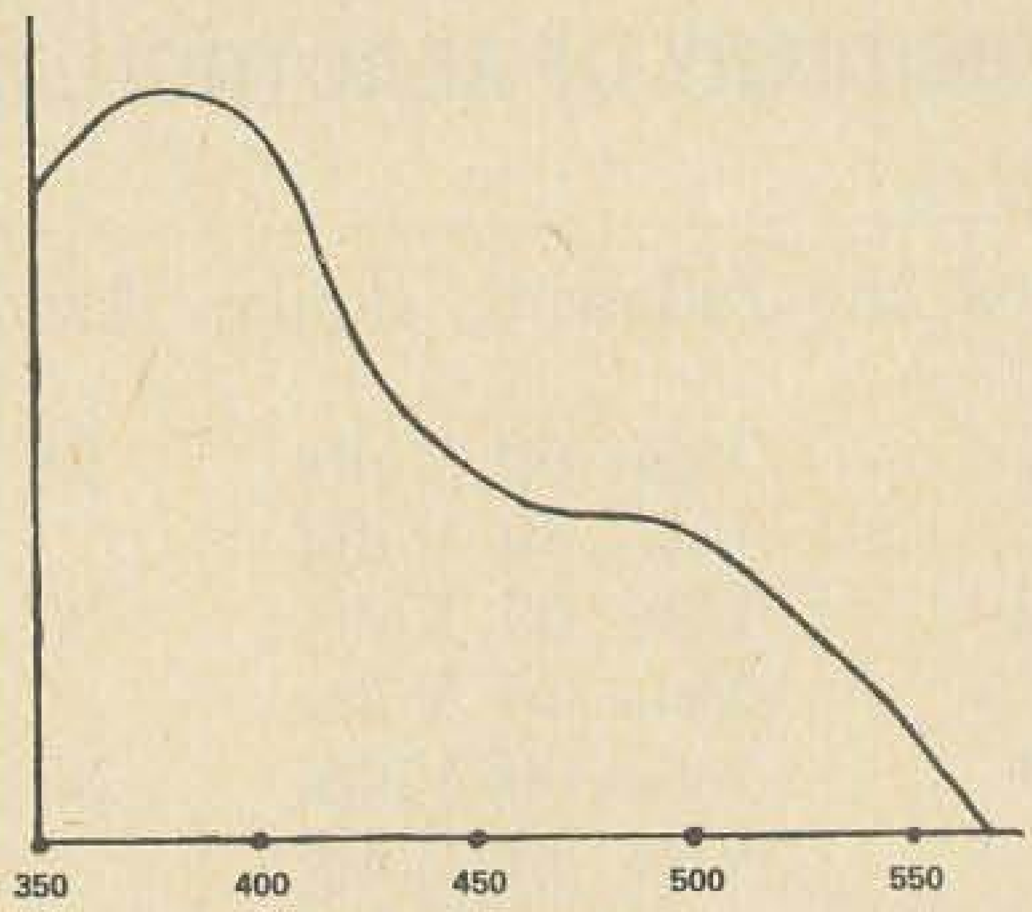
Suggested grading in 144 MHz *rf* AMP Stage Biased At 6 to 8 mA. It only costs 11 cents. Good from 100 kHz to ? High Freq. corner unpredictable without F_T Measurement. The 2N3563 costs 30 cents. It is a little better (F_TMIN 600) noise performance similar, 200 MHZ power gain quaranteed MIN 14 db. Hundreds of 2N5130 transistors have been purchased by local VHF FM'ers. They use them interchangeably with 2N918's for local oscillator/multiplier chains, if strips, trigger circuits and mixers. Everyone has been well-satisfied. Since this device was being used extensively the evaluation of this type was reopened in October, 1968 and several hundred additional devices were measured. New test groups were included, and all transistors were tested for V_{CE} Breakdown. High, low and medium V_{CE} units were grouped and were checked for Band F_T correlation. Low limit V_{CE} units were found to have low limit B and F_T. High and medium V_{CE} units had random distributions. These low limit units were considered "rejects." Upon removal of these items from the sample the lot was acceptable.



2N5131 1 kHz B Distribution

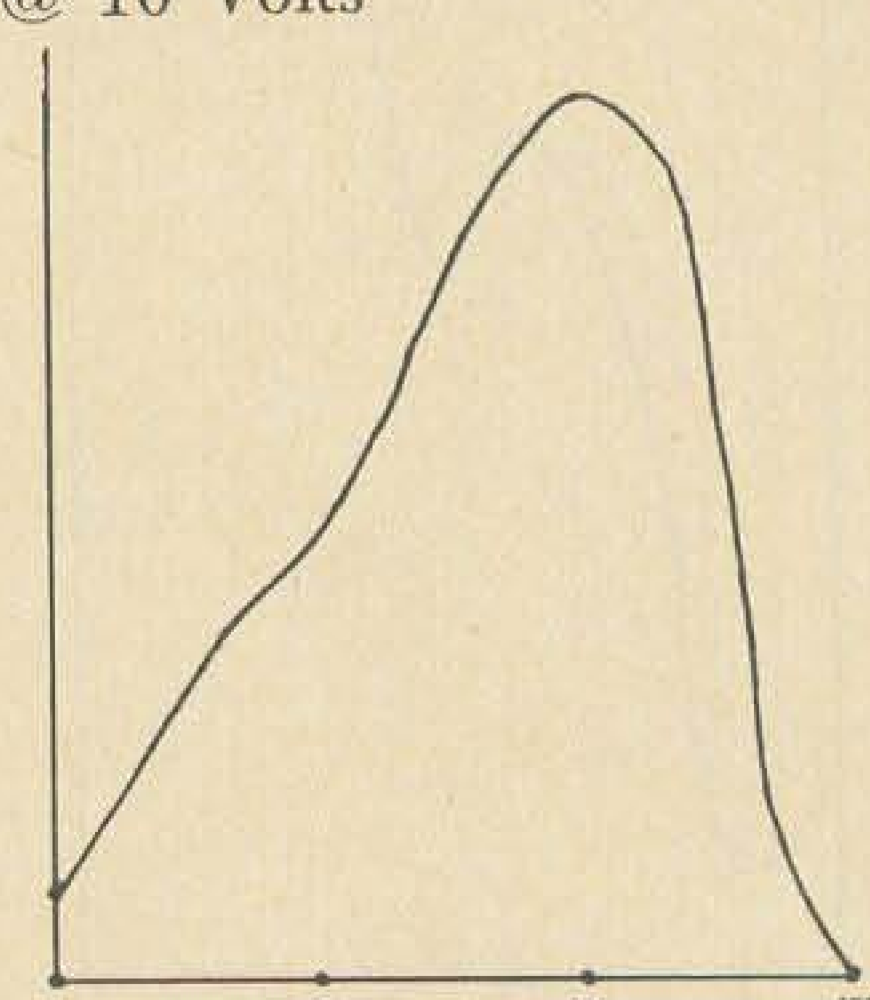
2N5131 – NPN General Purpose
H_{FE} = 30-500 @ 10 mA. 1 Volt
F_t = 100 Minimum I_c = 10 mA. @ 15 Volts
BV_{CBO} = 20 Minimum
V_{CEO} = 15 Minimum
C_{CB} = 6 pF Maximum
V_{CE} Sat = 1 Volt Max
1 kHz hfe = 25 MIN 600 MAX 10 Volts Ic = 10 mA.

A high B unit at 10 mA. Beta falls off at low currents. V_{CE} sat not too good, measurements to high side of spec. One unit considered a "reject" for low F_t. All other units well above minimum F_t Spec. I prefer other devices for specific applications, so have not found any use for this device. Cost: 11 cents.



2N5131 FT Distribution

2N 5132 – NPN AM/FM AMP Graded from 2N3693, 2N3694
VC_{BO} = 20 Volts Minimum
VC_{EO} = 20 Volts Minimum
Pulse H_{FE} 30-400 I_c = 10 mA @ 10 Volts
P_G = 32 db Typical @ 10.7 MHz I_c = 7 mA @ 10 Volts



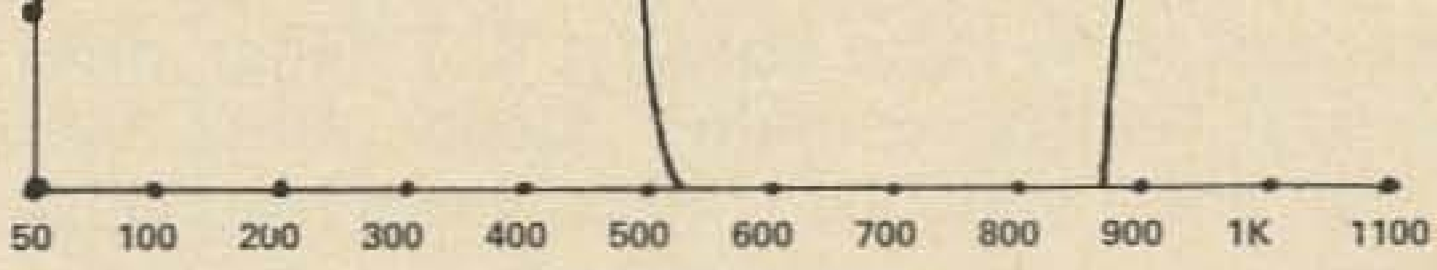
2N5132 FT Distribution

P_G = 55 db Typical @ 455 kHz I_c = 3 mA @ 10 Volts
F_t = MIN 200 Typical 350 I_c = 10 mA @ 15 Volts
V_{CE} sat. = 2.0 Volts
C_{CB} = 3.5 pF max.

This unit tests identically to the 2N3693-94 except 2N3693 and 2N3694 are 45 volt units (minimum). Noise performance was *not* tested. V_{CE} was not very good. The 2N5132 cost 11 cents. 2N3693-4 are 30 cents. Rated better than data sheet limits.

2N5133 NPN Hi-Gain Low Noise
(*Similar to SE*4001, 4002, 4010)
NF = 1.5 db. Typical @ 1 kHz
H_{FE} = 60 Min 220 Typical 1,000 Max @ 1 mA 5 Volts
H_{FE} = 50 Typical @ 50 mA.
V_{CEO} = 18 Volts MIN
V_{CBO} = 20 Volts MIN
V_{CE} Sat = 0.4 Volts Max
h_{fe} = 50 Min 1100 Max @ 1 mA 5 Volts

The curve tells the story. Something is missing. Some current fall off at low currents. Reasonable NF for most work between 1 kHz and 5 MHz in preference to most other NPN Bipolars. It has nice V_{CE} sat compared to other types. It costs 11 cents. It is good from 20 mA to 3 to 4 mA range. Difficulties were encountered with some units used in an audio circuit due to oscillations which occurred at about a 10 MHz rate. Some units are very noisy. Check to insure this is really noise, not spurious oscillation. Several hundred units were checked.

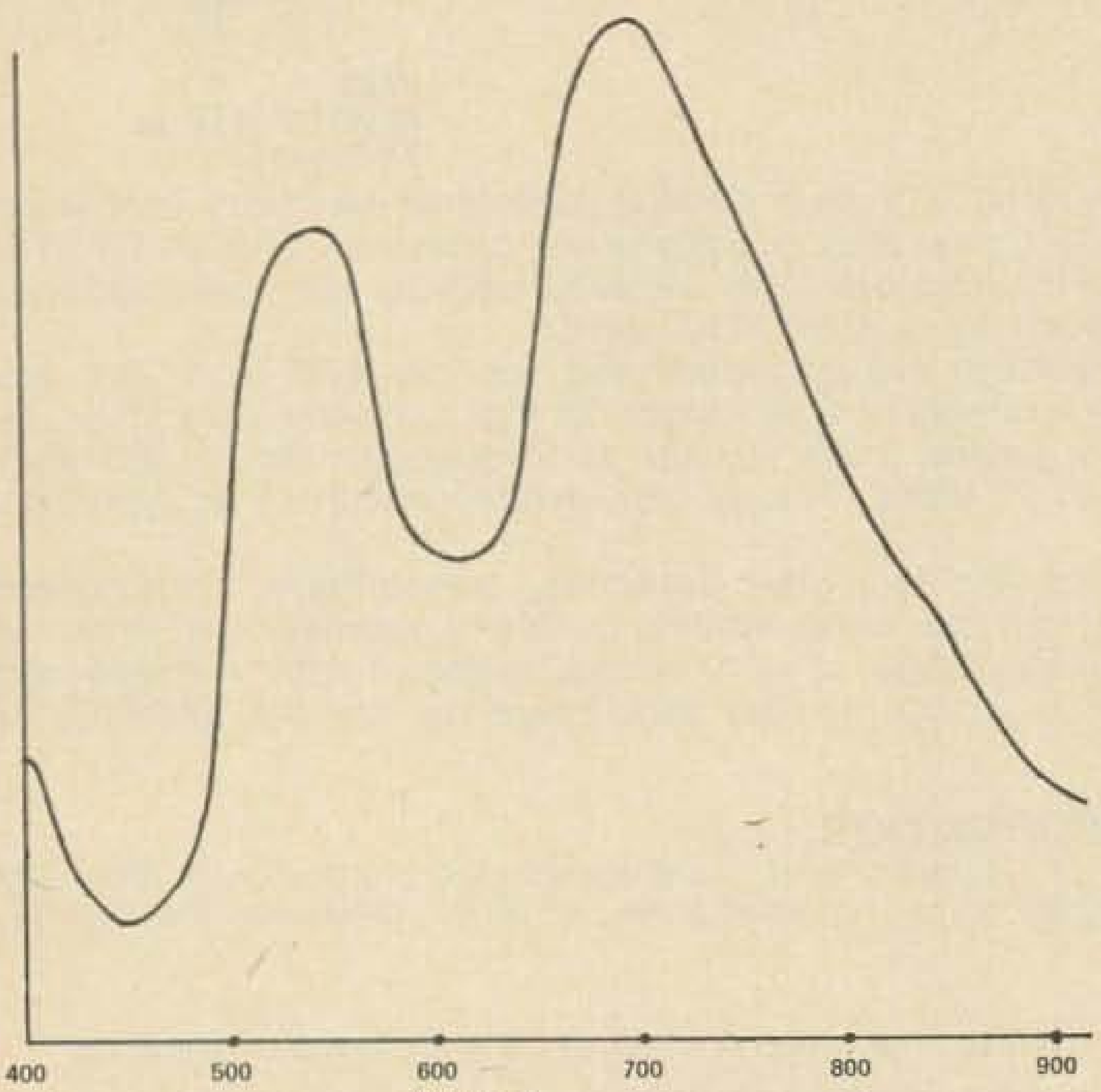


2N5133 B Distribution

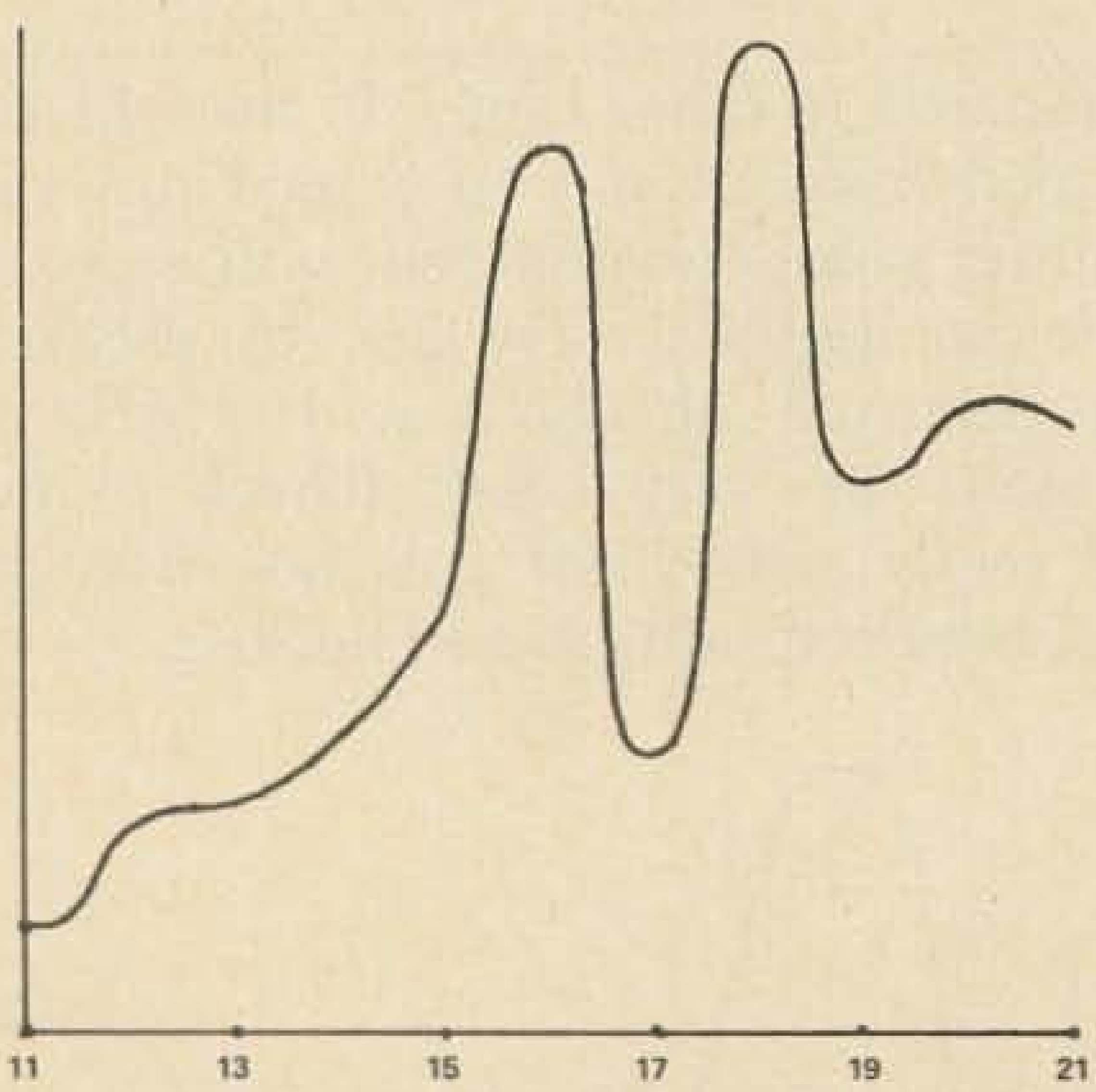
2N5134 NPN Hi Speed Saturated Switch
(*Similar to 2N*4274, *2N*4275, *2N*3011, *2N*2369)
V_{CE} Sat .25 @ 10 mA MAX Ib = 1 mA
.20 @ 10 mA Ib = 3.3 mA
C_{CB} = 4 pF MAX 2.3 pF Typical
V_{CES} = 20 Volts MIN
V_{CBO} = 20 Volts MIN

V_{CEO} = 10 Volts MIN (10 mA Pulse)
Ton – 8 ns Typical 18 MAX
Toff 7 ns Typical 18 MAX
F_t MIN = 250 MHz @ 10 mA
F_t Typical = 575 MHz

Beta correlates with F_t. Good V_{CE} Sat. Useable at currents under 1 mA. Nice *rf* amp at 5-20 mA. Not too bad NF either, to 200 MHz. Beta linear. It costs 13 cents.



2N5134 FT



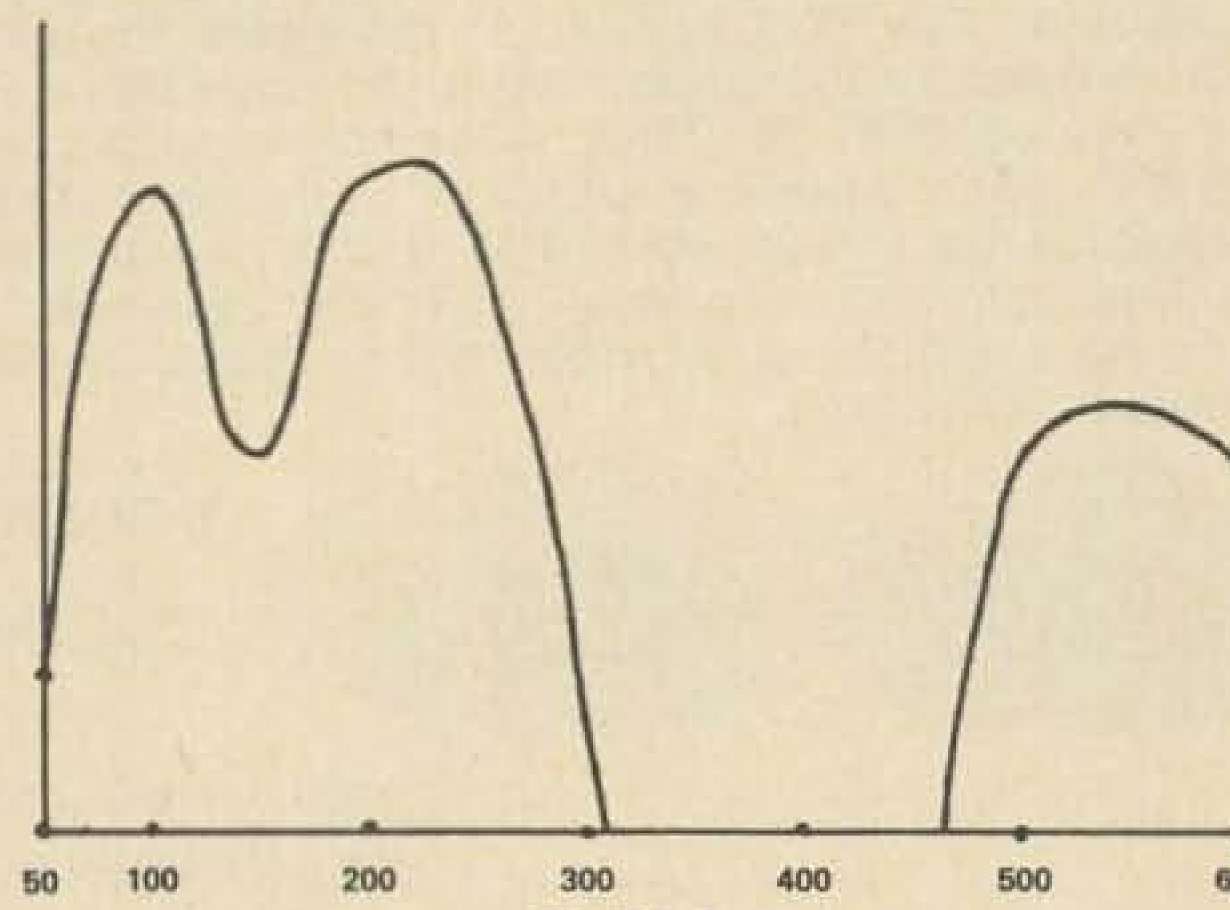
2N5134 VCE Distribution

The 4274 and 4275 Transistors cost 29 and 30 cents. I use it in *rf* Oscillators, pulse inverters, 4 V logic circuits, 6 V lamp drivers, xtal controlled multi's. Good value. May be matched with 2N5140 as complementary pair.

2N5135–NPN High Gain
to –105 Package
Gradeout of 2N3566 *similar to SE*6001, 6002
Pulsed h_{FE} Min 50 Typical 400
Max 600 @ 10 mA 10 Volts
Pulsed h_{FE} Min 15 Typical 325
I_c = 2 mA @ 10 Volts
V_{CEO} = 25 Volt MIN
V_{CES} = 30 Volt MIN
V_{CBO} = 30 Volt MIN
V_{CE} Sat Typical @ 0.9 Volts
MAX 1.0 Volts @ 100 mA
Ib = 10 mA

Summary:

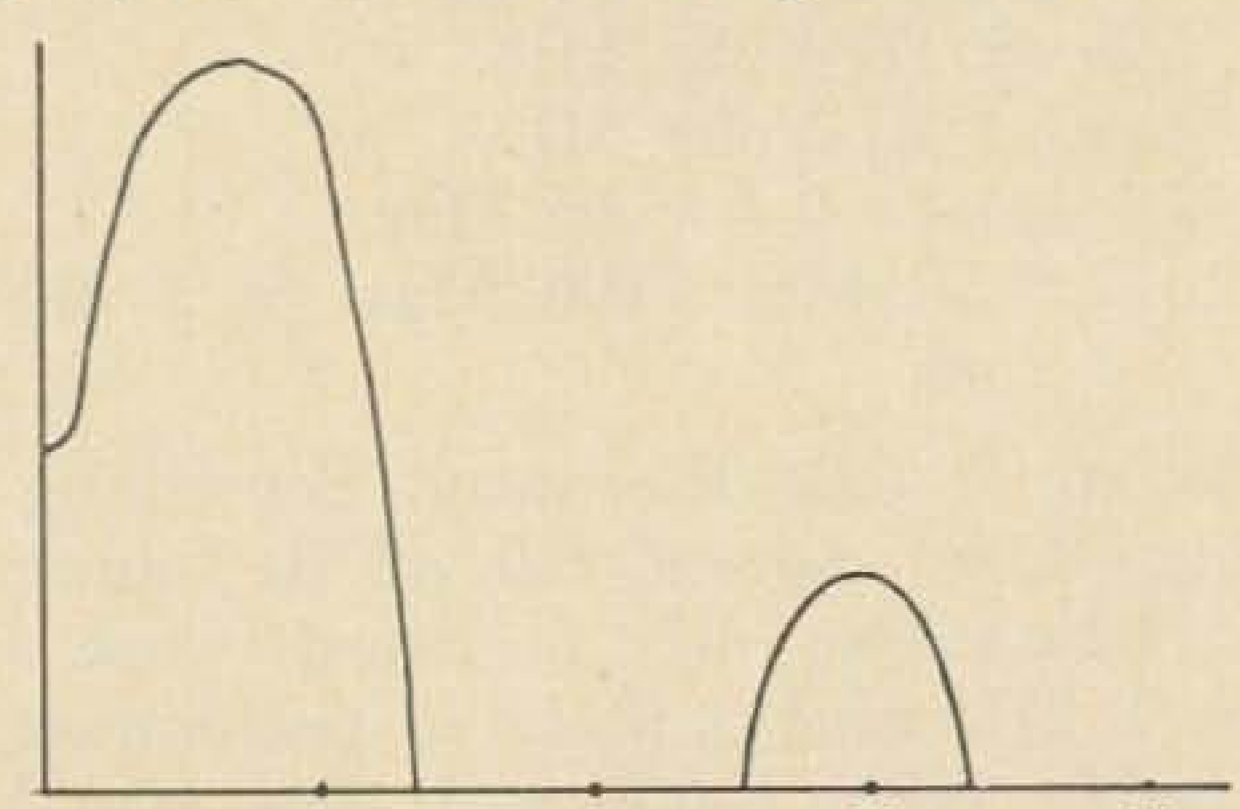
The curve tells the story. Typical value is missing. Transistor is good for audio drivers general purposes to about 10 MHz. Device selection can be made by one measurement. It costs 14 cents. The 2N3566 is 24 cents. V Sat not too good for switching applications. Device noise level in most units was lower than the 2N5133. It has much higher breakdown voltage. Good value; have hundreds measured.



2N5135 B Distribution

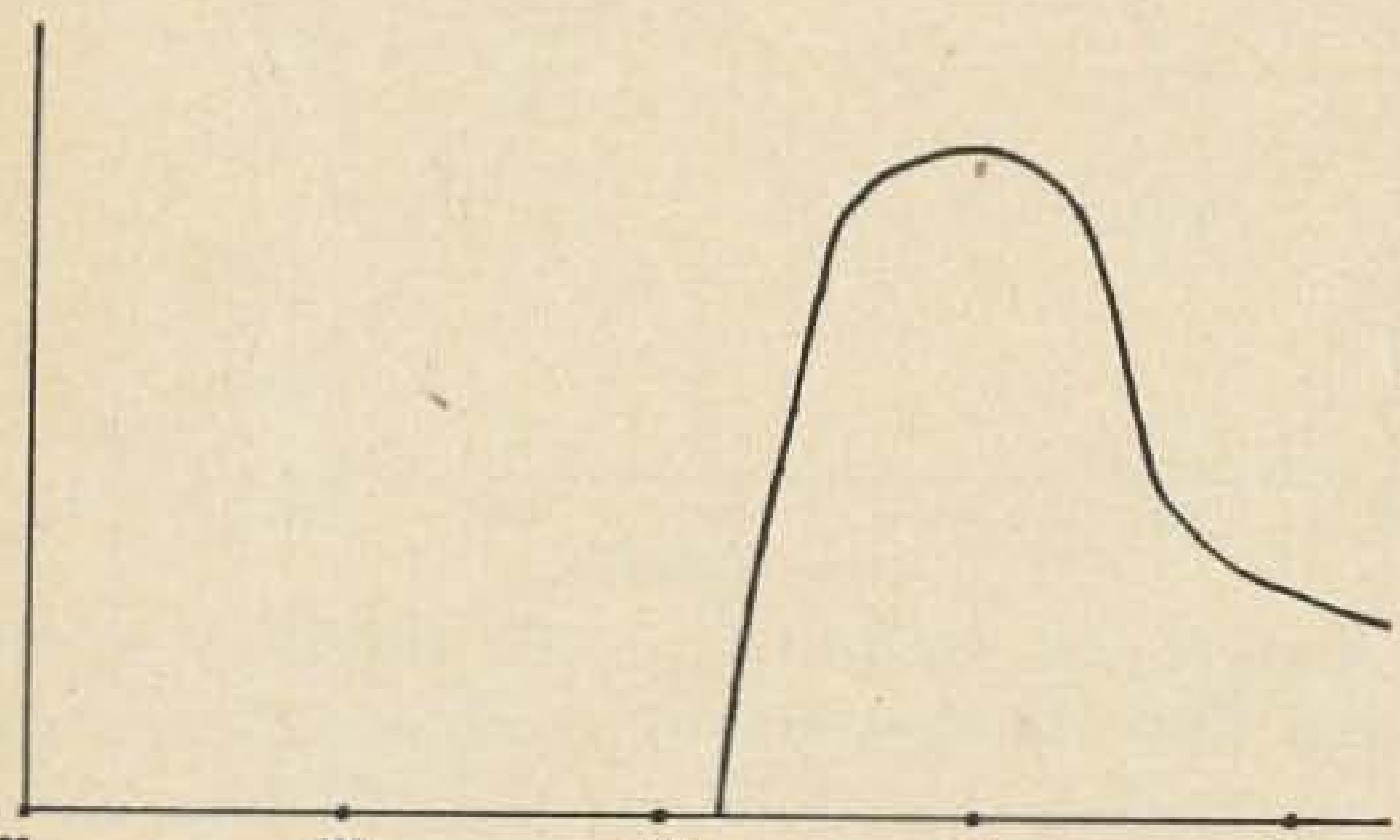
2N5136 – 2N5137 NPN General Purpose Amp.
(*Graded from* 2*N*3567, 2*N*3568, 2*N*3569.)
V_{CBO} = 30 Volts MIN
V_{CEO} = 20 Volts MIN
Pulse H_{FE} Minimum 20 Typical 100 Maximum 400 @ 150 mA 1 Volt
C_{CB} = 16 pf Typical 35 pF Maximum
V_{CE} Sat. = 0.25 Volt Max. @ 150 mA.

The Curve tells part of a story. The swept beta collector family curves showed a pronounced Beta peak at 1 to 3 Volts V_{CE}. Beta was not linear. The curve looked similar to 2N1613 series chips. Pulsed Beta measurements per spec are made at the point where Beta has theo peak. On some units this may be more than three times Beta at normal load line points. Switching



2N5136 B Distribution

characteristics are reasonable. C_{CB} is considered to be very high which makes this device unsuitable for *rf* applications. This is not a very high frequency device. Unit Cost is 11 cents. The 2N5136 is packaged in the TO-105 case, 2N5137 in the TO-106 case. The 2N5137 had higher Beta. Not Recommended.



2N5137 B Distribution

This concludes the NPN Portion of the Survey. Transistors I was most impressed with were the 2N5128, 2N5129 Due to extremely good linearity over a wide current range, and nice switching characteristics. The 2N5134 I use as substitute for 2N706, 2N2369, 2N3011, because the epoxy case is much nicer than a unit with a "hot" case (Collector connected to case) (Case does not radiate switching noise).

The 2N5126 is handy for gain controlled applications in the *if* region; *if* devices are selected for this characteristic.

The 2N5130 is useful for *rf* Amps, although it did not meet expectations.

The 2N5135, and 2N5133 are nice for low frequency work if it is measured, and the 2N5136, 2N5137, 2N5132, 2N5131, 2N-5127 find less application.

Most applications do not need any higher V_{CBO} and V_{CEO} than the above devices in each category provide. For most ham work I prefer discrete components to LIC's due to the poor noise performance, power supply voltage restrictions, and signal handling capability of the integrated circuits.

The preceding data is based on actual measurements, care has been taken to insure reasonable accuracy. It cannot be implied through such data that manufacturing tolerances will allow devices to be shipped to maintain the peculiar distributions measured here; however, the results seem to show exactly what would be expected for the lowest cost devices sold in the U.S.A. since anything much better would be sold at a higher price. Careful study of these measurements (a portion of which are shown) seem to confirm their validity, for the purposes, stated in this study.

Here is the PNP Portion of the minimum cost transistor Survey.

2N5138 – PNP Low Level Amplifier. Graded from 2N4246, 4249, 4250

Typical Unit exhibits Low Noise 0.7db @ 1 kHz I_c = 20 mA @ V_{CE} – 5 Volts

H_{FE} = 100 Typical I_c = 100 @ 10 Volts

V_{CBO} = –30 Volts Minimum

V_{CE} = –30 Volts Minimum

V_{CE} Sat = 0.3 Volts Maximum I_c = 10 mA

I_b = 0.5 mA

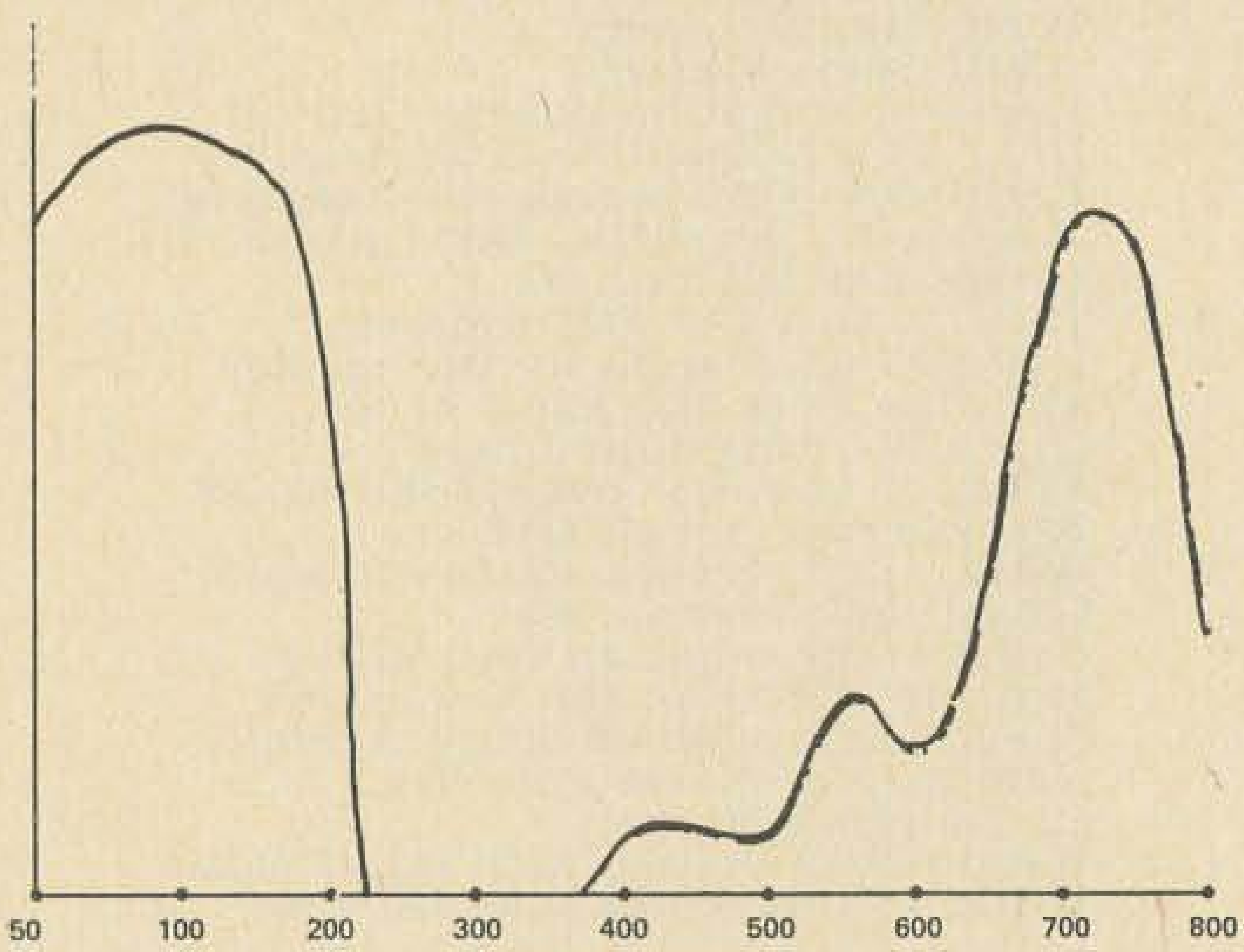
C_{CB} = 7 pF Maximum

A β Linear Transistor with good V. Sat. Useable Current Range 20 Micro Amp. to 50 mA frequency Range 50 Hz to 2 MHz. Low noise performance requires Device Selection. Suitable For Video Amplifier Service to About 4.5 MHz.

F_t up to 300 MHz @ I_c = 3 mA V_{CE} = 10 Volts

Price 11 cents.

Several hundred of these have been used. Device was compared to 2N4248. (Price 16 cents.) Results were similar. 2N4249 is 38 cents. 2N4250 is 40 cents. This series has V_{CE} 40 Volts with 4249 V_{CE} 60 Volts.



2N5138 B Distribution

2N5139 PNP High Speed Switch and *rf* AMP Graded from 2N4916, 2N4917, 2N4121, 2N-4122.

H_{FE} = 150 Typical @ 10 mA

F_t 500 MHz Typical @ 10 mA

C_{CB} = 2.2 pF Typical

V_{CEO} = –20 Volts Minimum

V_{CBO} = –20 Volts Minimum

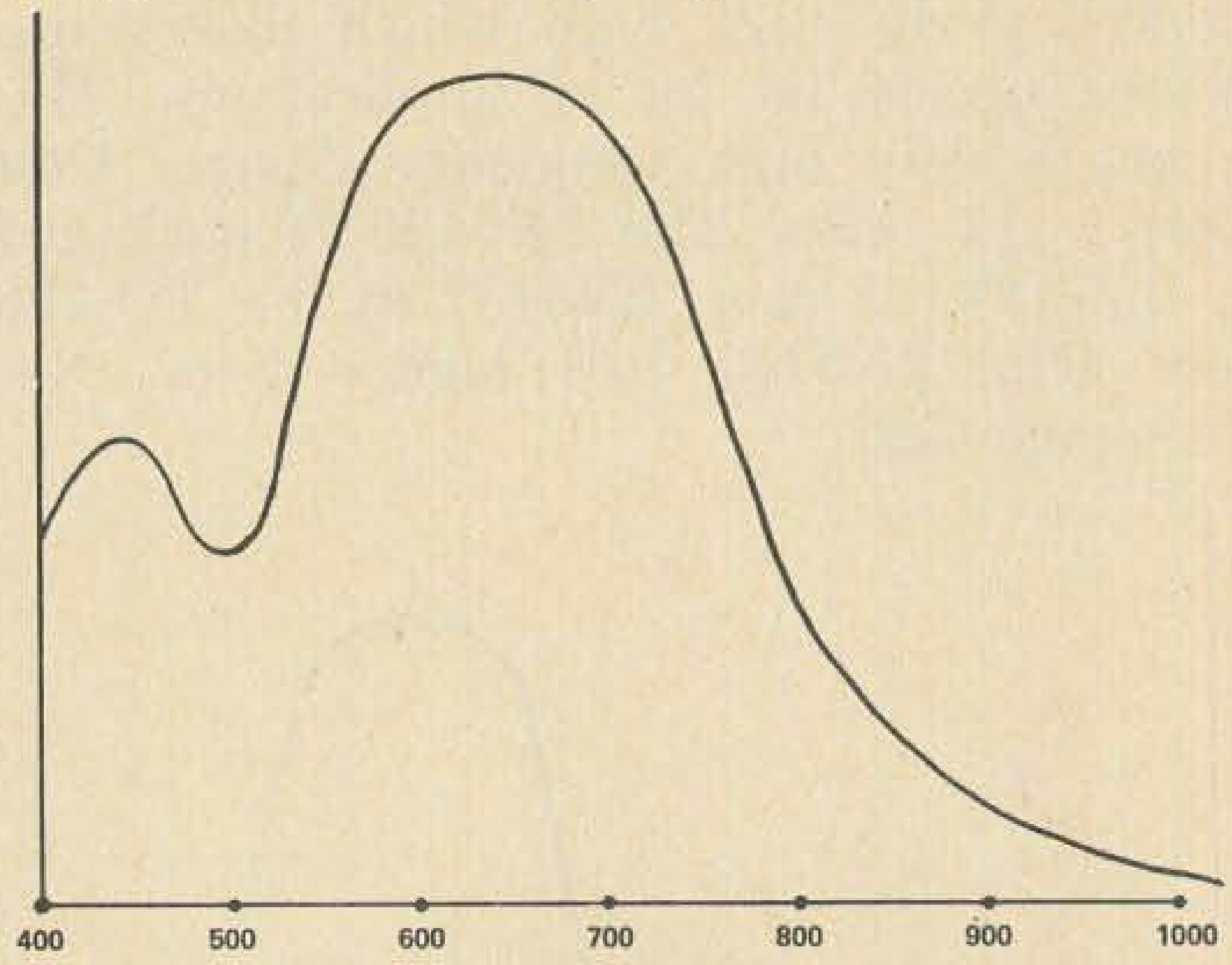
H_{FE} = 30 MIN 70 Typical @ 100 mA –10 Volts

MAX V_{CE} Sat 0.15 Volts @ 1 mA

MAX V_{CE} Sat 0.20 Volts @ 10 mA

MAX V_{CE} Sat 0.50 Volts @ 50 mA

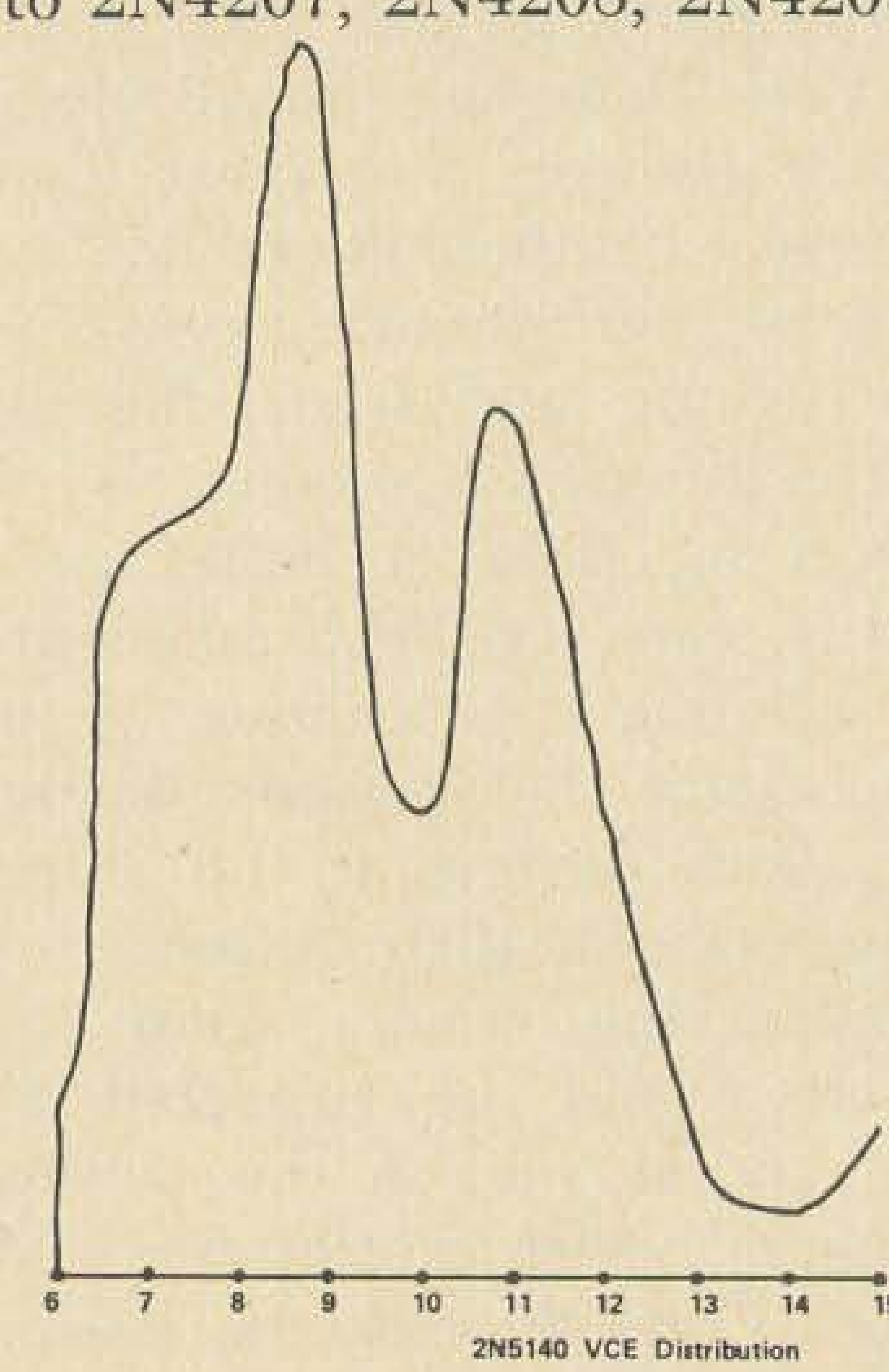
F_t was measured at spec point



2N5139 FT Distribution

A plot was made using 100 devices. Additional 200 devices were purchased. Another curve was drawn. Two more large lots were purchased. The final curve shows F_t distribution for nearly 1000 devices. The smaller lot curves were almost identical. Only one device had F_t = 300 all the remaining devices had F_t Minimum 400 Typical 660 Maximum 1000. Useable frequency range for best noise figure 1 kHz to 100 MHz on selected units. F_t remains high at 1 mA (Typical 300). Switching characteristics good. A very nice device. Price: 11 cents. 2N4916 costs 16 cents was compared. Results similar. 2N4917 is 36 cents. 2N4121 38 cents, 2N4122 41 cents. It appears only parameters comprised are breakdown voltage, and upper corner noise frequency. Used for *rf* amps, Overtone oscillators, a general purpose replacement for PNP Germanium transistors, one was to replace A 2N1142 and performed satisfactorily.

2N5140-Ultra High Speed PNP Switch Similar to 2N4207, 2N4208, 2N4209

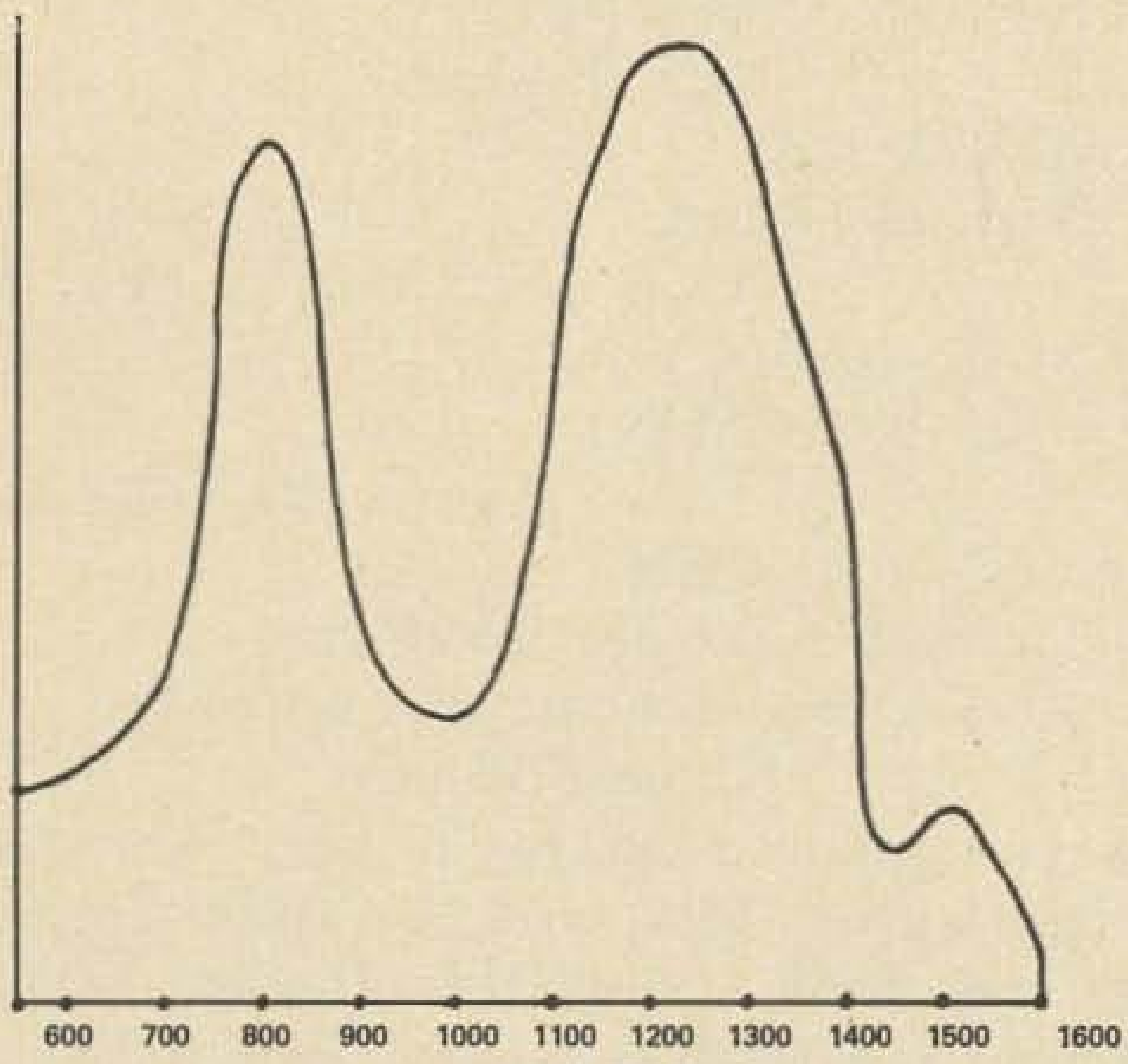


2N5140 VCE Distribution

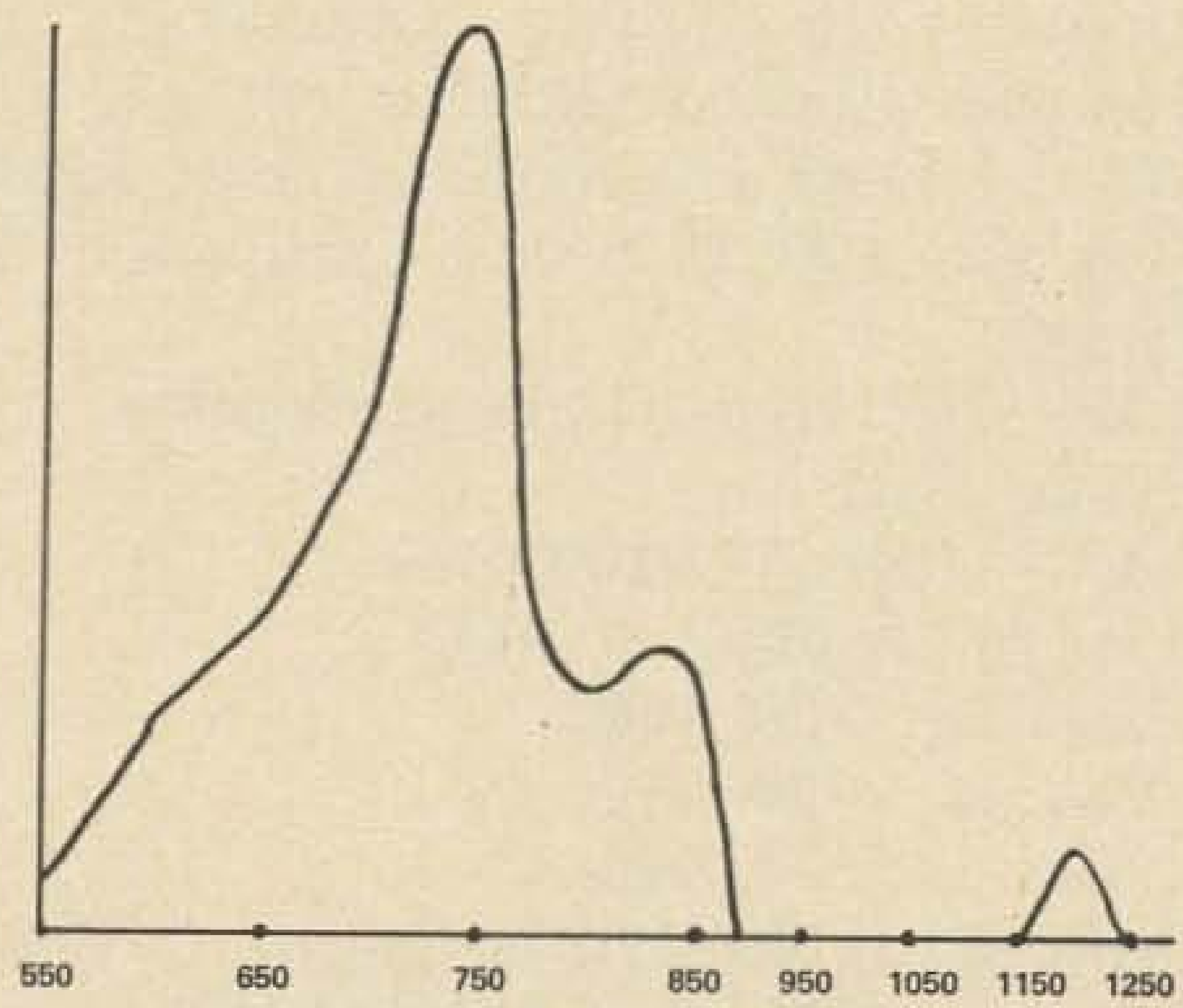
$V_{CBO} = -5.0V$ MIN
$V_{CEO} = -5.0V$ MIN
$V_{EBO} = -4.0V$ MIN
$F_t = 400$ MIN 1000 Typical
$-5V$ @ 10 mA
C_{CB} 2 pF Typical
Ton = 20 NS MAX
Toff = 20 NS MAX
V_{CE} SAT = 0.2 MAX

This device had the highest F_t measured. Superior performance observed in these applications: Logic interface broadband amplifier, pulse shaper, and trigger circuits. Beta falls off at lowered current. Device with $F_t = 1200$ @ 10 mA has $F_t = 900$ @ 5 mA, $F_t = 500$ @ 2 mA $F_t = 150$ @ 1 mA. Voltage breakdown V_{CE} was also measured. Both V_{CE} and F_t were better than anticipated. Price is 13 cents. Nearest equivalent Types 2N4207, 2N4208, 2N4209 are priced \$3.00, \$3.50 and \$5.50 respectively. High performance at low cost.

2N5141 – PNP Hi Speed SW
Ton = 90 NS MAX
Toff = 150 NS MAX
$C_{CB} = 3.3$ pF Typical
7.0 pF MAX
100 NS MAX



2N5140 FT Distribution



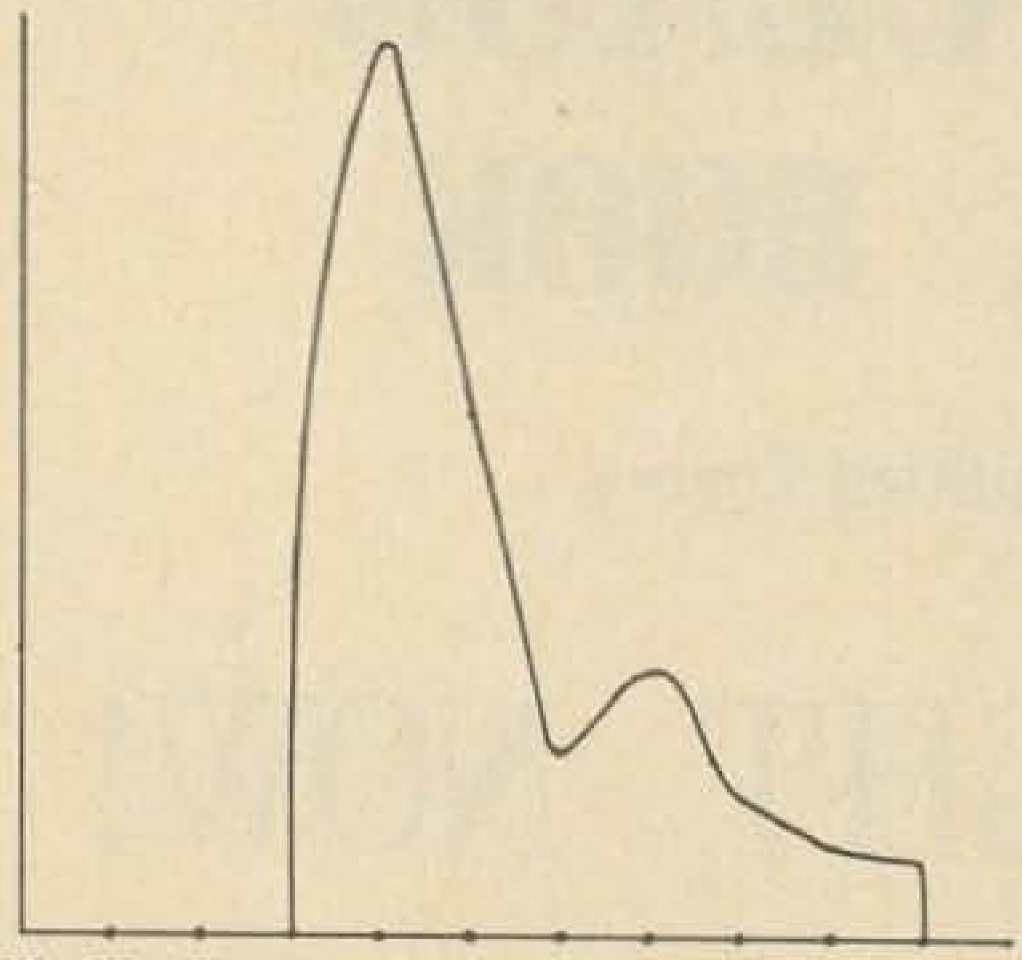
2N5141 FT Distribution

T_D = 4 NS MAX
45 NS MAX
T_R = 6 NS Typical
70 NS MAX
F_t = 300 MHz MIN
1200 MHz Typical
TS = 12 NS Typical
T_F = 3 NS Typical
70 NS MAX
V_{CE} SAT = 0.7 Volts MAX
V_{CBO} = −6 Volt MIN
V_{CEO} = −6 Volt MIN
V_{EBO} = −6 Volt MIN
V_{CES} = −4 Volt MIN

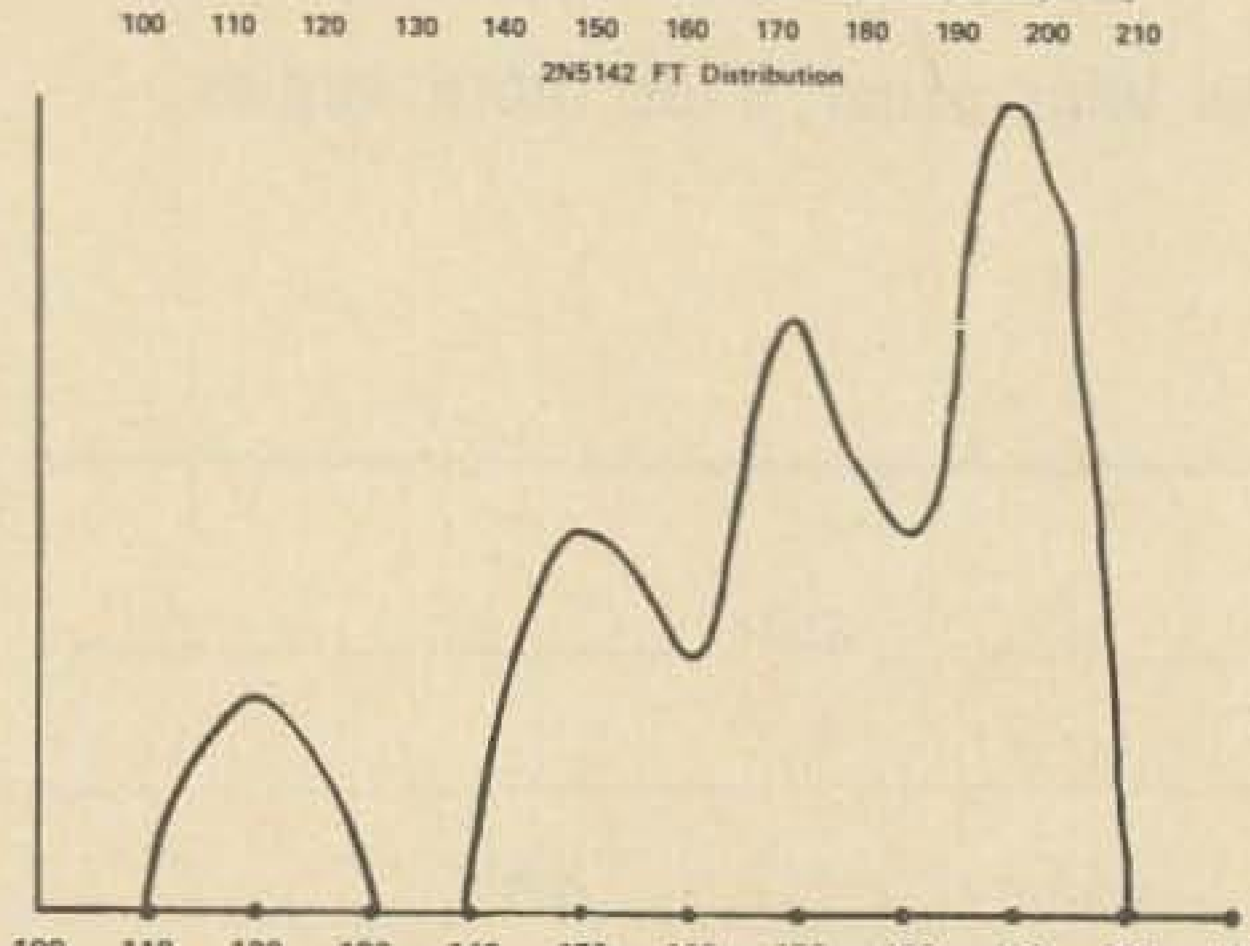
F_t of 1200MHZ Typical not confirmed by measurement. Switching parameters very wide spread. Low breakdown voltage, rather high C_{CB}. I have not found a good application for the 100 PCS I've measured. Cost is 16 cents.

2N5142–PNP High Current Switches
Toios Case
2N5143 – PNP TO-106 Case
(*Similar to* 2N3638, 3638A)
V_{CBO} = −20 Volt
V_{CEO} = −20 Volt
V_{EBO} = −4 Volt
H_{FE} Min 30 Typical 70 @ 50 mA 1 Volt
C_{CB} = 4.5 Typical 10 pF MAX
F_t = 100 MIN 190 Typical 50 mA −3 Volt

F_t falls off Between 5 mA and 1 mA significantly. Suitable for high current line drivers, medium speed switching. Good V_{CE} Sat. over current range. I use it as a voltage regulator current driver. Appears to be a low voltage 2N2905 with low β at lowered currents. It costs 16 cents.



2N5142 FT Distribution



2N5143 FT Distribution

One Other Device is worth mentioning:
2N5163 – N – Channel LO Noise JFET
Very Low Noise
e_n = 12 NV Typical e_n = 50 NV/Hz (MAX) @ 1 kHz
1.0 kHz NF = 0.1 db (Typical) @ 1.0 mA
Rds ON = 500 MAX
125 Typical
I_{dss} MIN 1 mA
Typical 14 mA
V_{ds} = 15 Volt V_{GS} = 0
MAX 40 mA
V_{SG} = 25 Volts MIN
V_{DG} = 25 Volts MIN
V_{DS} = 25 Volts MIN
I_{dss} was typically 22-26 mA
At V_{GS} = 0 Lowest was 14 mA
Highest 36 mA

It is supposed to be a very low noise unit per specs: Most are. An audio amplifier that was built using this device had no difficulty picking up several local radio stations. At 35 cents each in lots of 100, it is reasonable enough to experiment with.

Summary:

PNP transistors I was most impressed with were the 2N5138, for beta linearity, and excellent video amplifier service, the 2N5139 for all general *rf* applications, and the 2N-5140 for high speed switching. Most applications do not require higher voltage breakdown devices than this series of semiconductor devices will provide. It is hoped some individuals will consider this series suitable and incorporate these devices in planned construction projects.

I am reminded Fairchild is *not* the sole vendor source for this semiconductor series. No estimate can be made concerning quality or parameter distribution of an identical type supplied by another vendor.

An estimate can be given concerning the parameter distribution of one typist, not supplied by any vendor, without whose patience this article could not be completed, so at this time I must thank Miss Carole A. Hussar, and add this comment . . . a pretty, blond, young secretary-typist need not supply a data sheet for publication . . . none of the readers of 73 would be interested. ■

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Heathkit SB-610 Monitor Scope Modifications

Ian A. Webb K6SDE
432 Rosario Dr.
Santa Barbara, Calif. 93105

Proper optimum operation of single sideband transmitters is most easily achieved by oscilloscope monitoring. As a result, the Heathkit SB-610 Monitor Scope* is appearing in more and more amateur shacks as a vital piece of equipment. As originally designed, this equipment is a versatile piece of gear. There are a couple of modifications, however, that make this an even more versatile instrument.

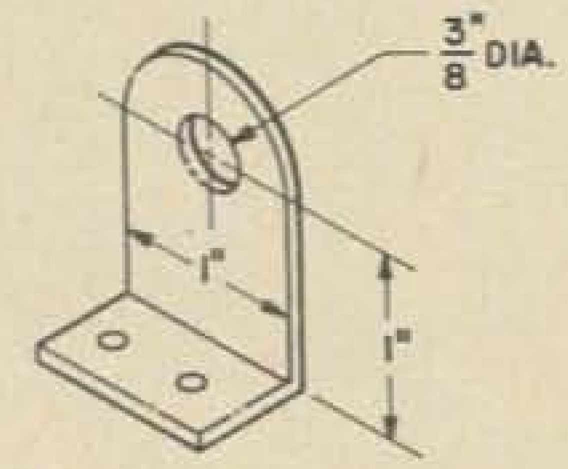
I will describe two modifications that I have made to my SB-610. Neither modification requires new front panel holes or mechanical changes to affect the resale value of the SB-610. Most owners of the SB-610 should consider at least the first modification. Those who have yet to acquire an SB-610 may wish to incorporate the modifications when they construct the kit.

Transmitter attenuation switch

This modification moves the transmitter attenuation switch from its present position in the center of the rear apron of the SB-610 to the front panel. The control becomes concentric with the present vertical gain control. With the transmitter attenuation control on the front panel, it is no longer necessary to reach behind the SB-610 to change the transmitting pattern height when changing power levels or making band changes. This is especially useful when one changes bands frequently or where a linear amplifier is often switched on or off.

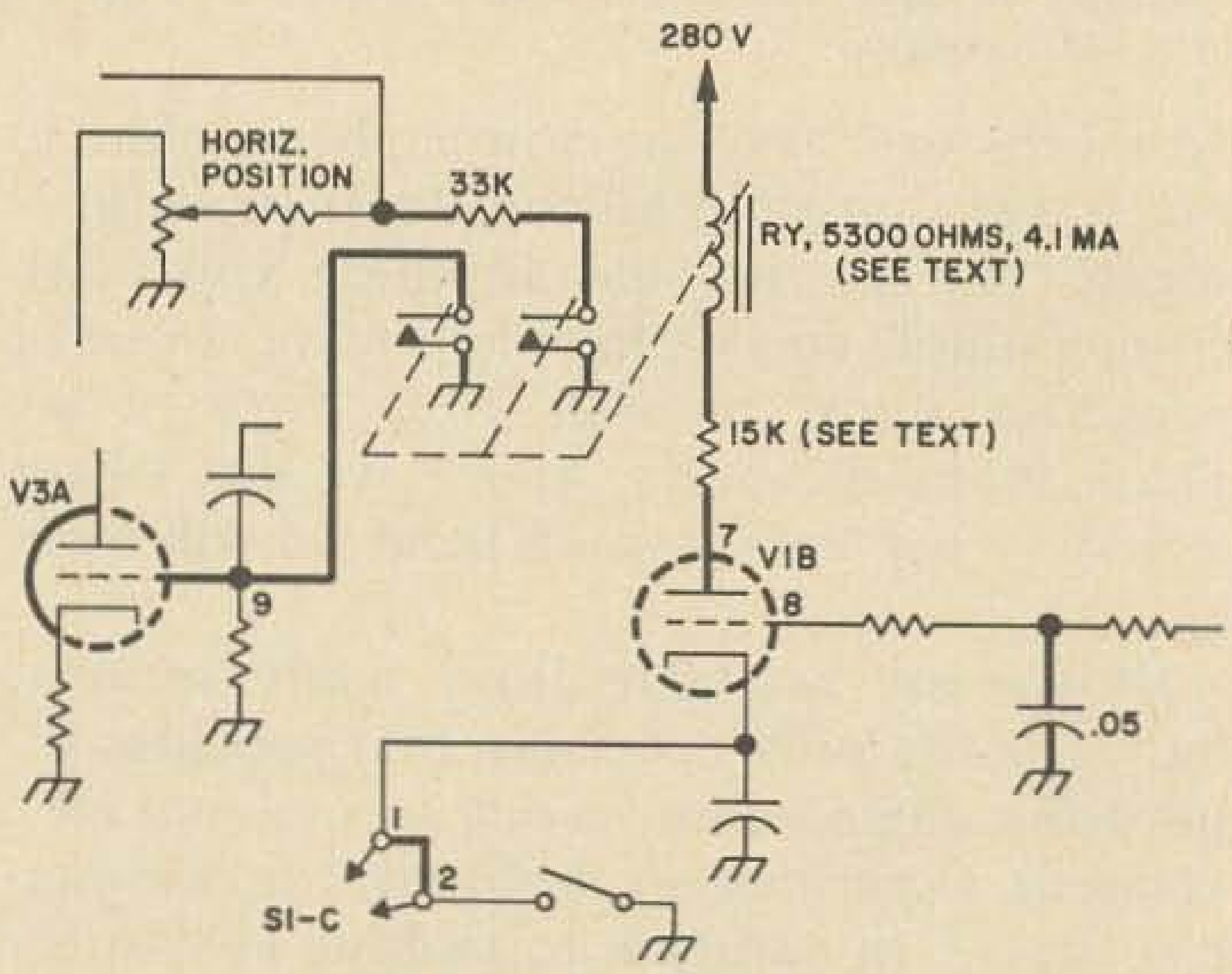
Parts required:

Concentric potentiometer element (outer unit) and shaft assembly, 100 K linear (IRC-CTS CF 13 or equivalent, see text)
Potentiometer mounting bracket (See **Fig. 1**)
Non-conducting shaft (3⁄16 inch diameter by 10 inches approx.)
⅜ inch "butch plug"
Lever knob*
Control knob split bushing*



Mounting Brackett

In this modification, the present 100 K linear vertical gain control, which is in the lower center of the front panel, is replaced with a 100 K linear concentric potentiometer. A Heathkit lever knob, matching the present SB-610 knobs, is put on this new potentiometer. This leaves a hole through the center of the vertical gain control in which to run



Modification Schematic

the insulated shaft which controls the transmitter attenuation switch which is remounted on a new bracket facing forward.

The choice of concentric potentiometer is not critical and by browsing in your local parts house stock of replacement type controls you should find a "make your own pot" selection enabling you to assemble the "outside" portion of a dual potentiometer. (I used an IRC-CTS CF-13 unit with a panel bushing about ⅜ inch long and a shaft about

*"Heathkit SB-610 Monitor Scope," *73 Magazine*, (December 1966), 54.

*Order Heathkit numbers 455-11 Split Bushing $.10 and 462-195 Lever knob $.50 (postpaid) from: Heath Company, Benton Harbor, Michigan 49023.

⅝ inch long which I cut to exactly fit the Heathkit lever knob.)

Remove all three wires to the lugs of the old vertical gain control (AJ in the SB-610 manual) and remove the old control and knobs keeping the wires in order so they may be soldered to the new control. Before mounting the new pot, be sure that the knob shaft will extend just far enough to allow you to mount the new lever knob on it. Do any cutting of the shaft before mounting the potentiometer to prevent damage to the front panel of the SB-610. Mount the new control and resolder the wires to the corresponding lugs of the new control.

Fabricate a bracket as shown in **Fig. 1** and refer to the photos to see mounting details. (If you are lucky as I was, your junk box will yield a suitable bracket.) Unsolder the wire from the coaxial connector to the lug 4 of switch BD, the transmitter attenuation switch, and unsolder the capacitor which runs from terminal strip G, lug 5 to terminal 5 of switch BD. You can now remove the switch from the back apron. If you wish, fill the empty hole in the back apron with a "butch plug."

Mount the new mounting bracket in line with the old hole in which the switch was mounted. Allow enough room for the switch to be remounted between the new bracket and the back apron. Mount the switch and reattach the wire from the coaxial connector to terminal 4 and the capacitor to terminal 5 of the remounted switch. Orient the switch so this can be accomplished with the least difficulty. Be certain that no components stick up far enough to interfere with the case when it is replaced over the Monitor Scope.

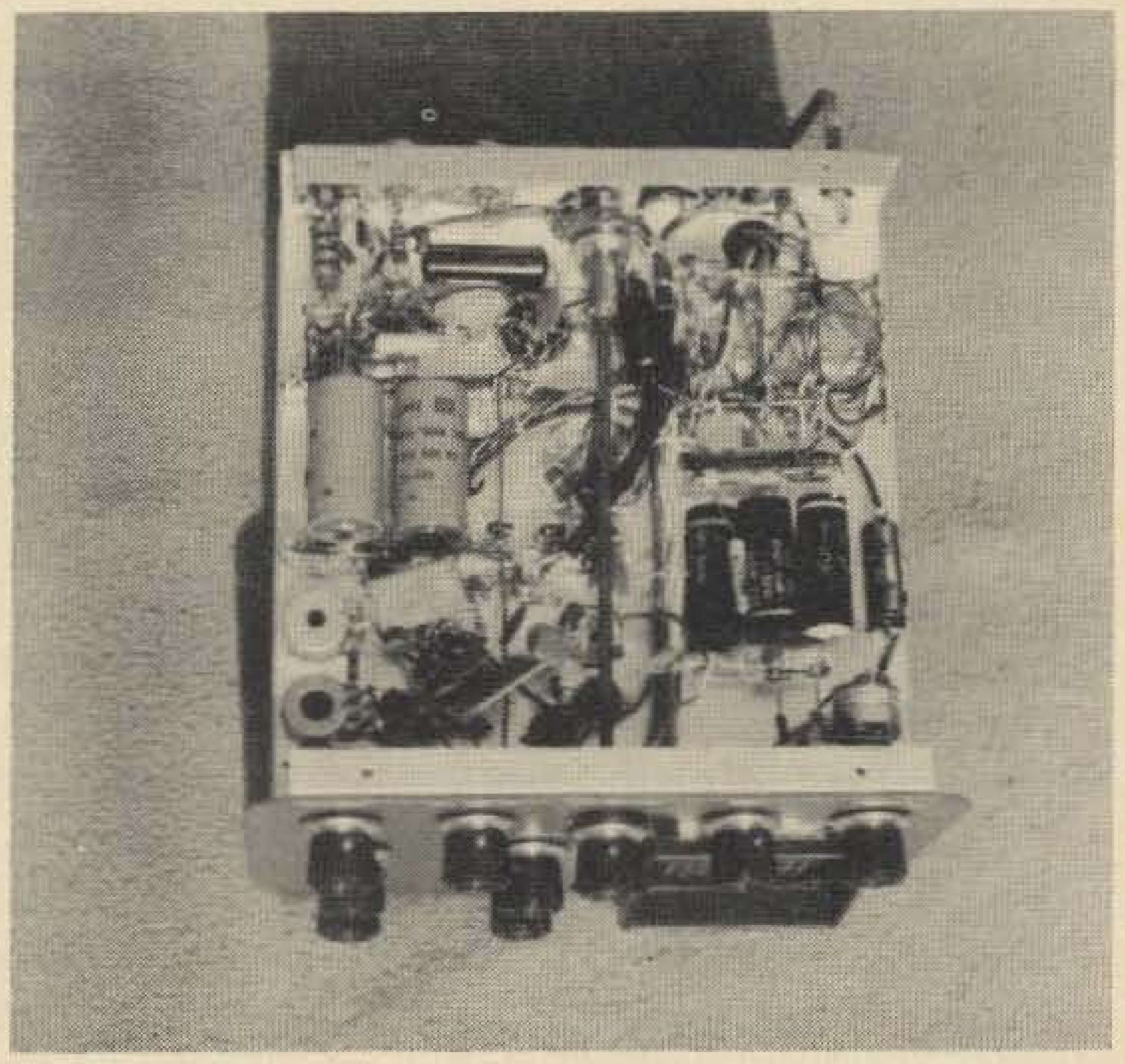
Attach the shaft coupler to the switch shaft and insert the 3/16 inch non-conducting shaft extension from the front panel into the hole through the vertical gain control running it back to the shaft coupler. Carefully move any parts that interfere with the shaft. The large .25 mfd capacitor near the shaft coupler between the tube socket (V3) and the terminal strip G may need to be relocated to provide sufficient clearance. A metallic shaft extension is *not recommended* due to the possibility of accidental contact with parts on the chassis.

When the shaft has been properly mated, make a small shim from a piece of scrap or tin can to reduce the ¼ inch coupler on the switch to accept the $^3/_{16}$ inch shaft extension. With the shaft in place measure ½ inch beyond the lever knob mounted on the vertical gain control and remove and cut the shaft at this point. Mount the shaft firmly, tightening the coupler. Use the new split bushing inside the original knob removed from the vertical gain control to firmly fasten the knob onto the shaft extension flush with the lever knob.

The SB-610 will now operate exactly as it did originally. It is now possible to select the vertical gain when monitoring a received signal using the lever knob and to change the transmitter attenuation using the large original knob. It is no longer necessary to reach behind the SB-610 each time the linear is turned on or off or each time you need attenuation changes when switching bands.

Clamp Modification

This modification should appeal to those people, myself included, who believe that the main virtue of the SB-610 is the monitoring of one's transmitted envelope using the internal sweep. If you use the internal



Top View

sweep *without also monitoring received signals* during standby periods, the trace of the SB-610 will remain a static baseline of high intensity since the clamp circuit is inoperative in this mode. This can cause a burned scope face if the intensity is high enough for good monitoring of peaks in a brightly illuminated room. I decided that I would like to remove the trace from the scope face automatically when the transmitter is turned to standby. This could be done using the relays that switch the rig from transmit to receive, but since my rig is a transceiver that I also use when mobile, this would involve additional connections to attach and remove each time I switched from base station to mobile operation. My modification accomplishes the clamping of the trace with no additional connections to the transmitter or receiver.

Parts required:

Capacitor, .05 mfd, 50 volts

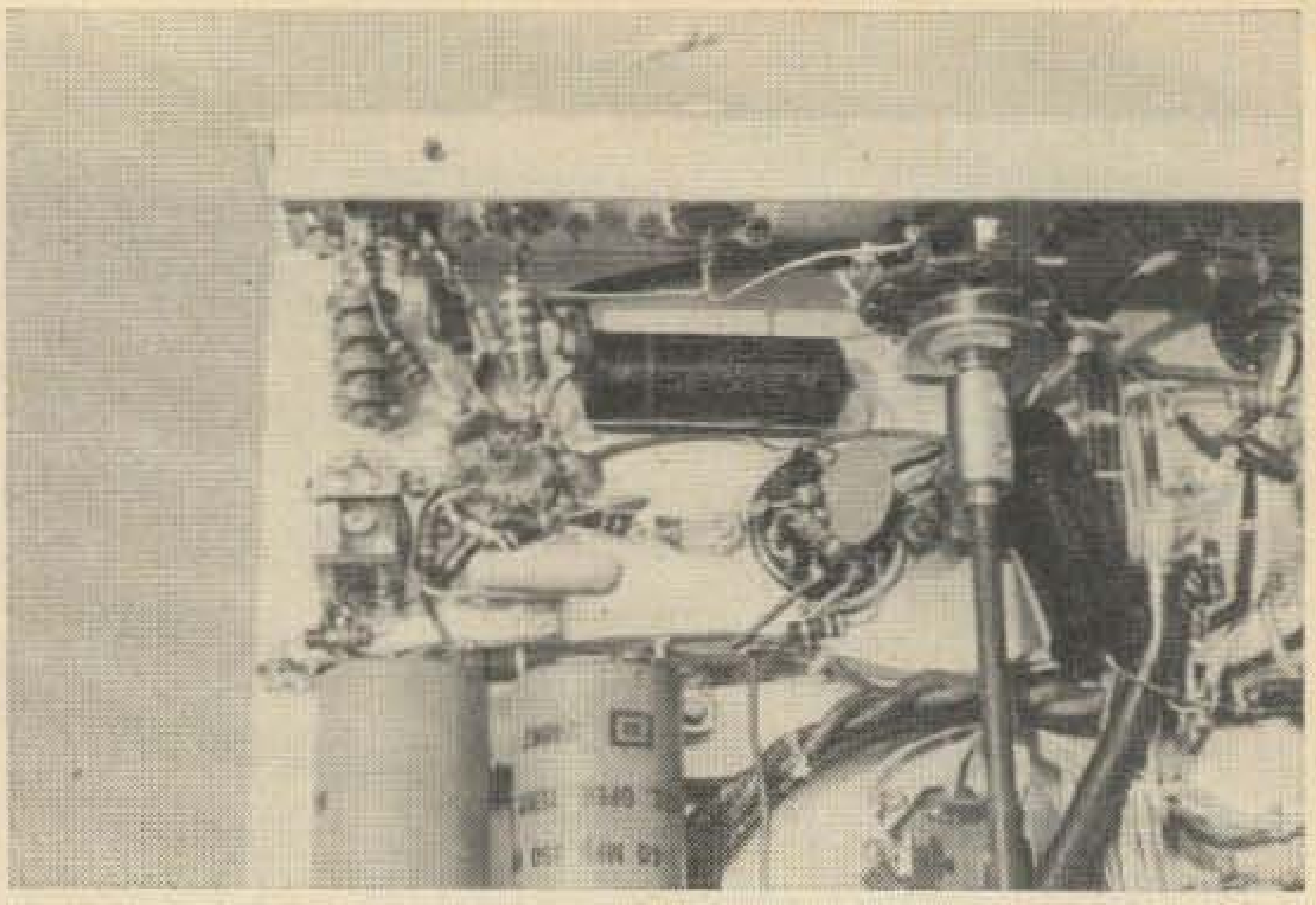
Resistors: 33K, ½ watt and resistor in series with relay coil (see text)

Sensitive plate relay, DPST, N.O., (Lafayette Radio 99H6093, DPDT, 5300 ohm, 4.1 ma., 4 oz., shipping weight, $2.95, Lafayette Radio, 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791) See text for details.

The relay I used, was from my junk box. Lacking a suitable relay, the one listed in the list above is suggested. It may require ingenuity to mount some relays, but a small bit of epoxy will do wonders if properly applied.

Fig. 4 shows the circuit modifications to be made. The dark portions of the circuit are additional components or modifications. The clamp tube, V1B, is turned into a relay amplifier. Relay contacts are used to pull the trace off the screen by shorting the horizontal position control through a 33 K resistor. A second set of contacts grounds the grid of V3A to stop the sweep. If the sweep is not disabled, the left portion of the trace will still be on the screen. Pins 1 and 2 of the front panel sweep control are jumpered so that the "pull for clamp" control will work in the internal sweep position of the sweep control as well as in the other sweep positions. When this modification is made, the SB-610 will operate as originally designed in the RTTY and *rf* Trap positions of the sweep switch. The clamp will also work in the internal (Int.) position of the sweep control when the "pull for clamp" control is pulled out. The clamp switch may be pushed in so that received signals may also be monitored as originally designed.

The .2 microfarad capacitor on terminal strip H adjacent to tube socket V1 is changed to .05 microfarads to allow 1 to 2 seconds before the trace leaves the screen. This capacitor need not be changed, but the time for the trace to leave the screen will be in excess of ten seconds if it is not changed. Remove the capacitor from strip H and replace it with the .05 mfd capacitor if you desire this change.



Bottom View

The left hand lug of terminal strip U, near the chassis edge was originally unused. Remove the blue wire at pin 7 of V1 and solder it to this unused lug of terminal strip U. On the back of the front panel, solder a jumper wire between lugs 1 and 2 of the sweep switch.

Mount the plate relay in the space between the tube socket V1, terminal strip U and the edge of the chassis. If your relay can be mounted with screws as could my junk box relay, that is fine; otherwise you may have to use some ingenuity and perhaps some epoxy to mount the relay.

From one set of relay contacts (closed when the relay is operated) run a wire to a convenient ground point such as the mounting lug of terminal strip U. From the other contact of the set, connect the 33 K resistor to the blue wire which you soldered to the previously unused lug of terminal strip U near the outside of the chassis.

From the second set of contacts (also closed when the relay is operated) run a wire to ground. From the other contact of this set, run a wire to pin 9 of tube socket V3A which is the tube socket near the shaft extension. This set of contacts will now ground the grid of tube V3A when the relay is closed and stop the sweep.

Run a wire from one end of the relay coil to the 280 volt bus. I ran the wire to the junction of the 40 mfd capacitor; 15 K, 1 W resistor; 1 K, 1 W resistor; and 20 mfd capacitor. This is near the center of the chassis on capacitor K, pin 3.

Temporarily, attach the remaining end of the relay coil to pin 7 of V1 through a resistor. (This resistor should be nominally 15 K ohms for the relay in the parts list.) The resistor should be selected so that the relay used just pulls in reliably when the clamp switch is pulled out, the SB-610 turned on, and no *rf* signal is applied. In any event, the plate dissipation of the 6BN8 relay amplifier should not exceed the maximum rating of 1.7 watts. The total resistance of the relay coil plus series resistor should be at least 10 K. (If you use a junk box relay, measure the voltage from cathode to plate, and the current through the tube when the relay is pulled in. The product of the voltage and current—in amperes—should not exceed 1.7.)

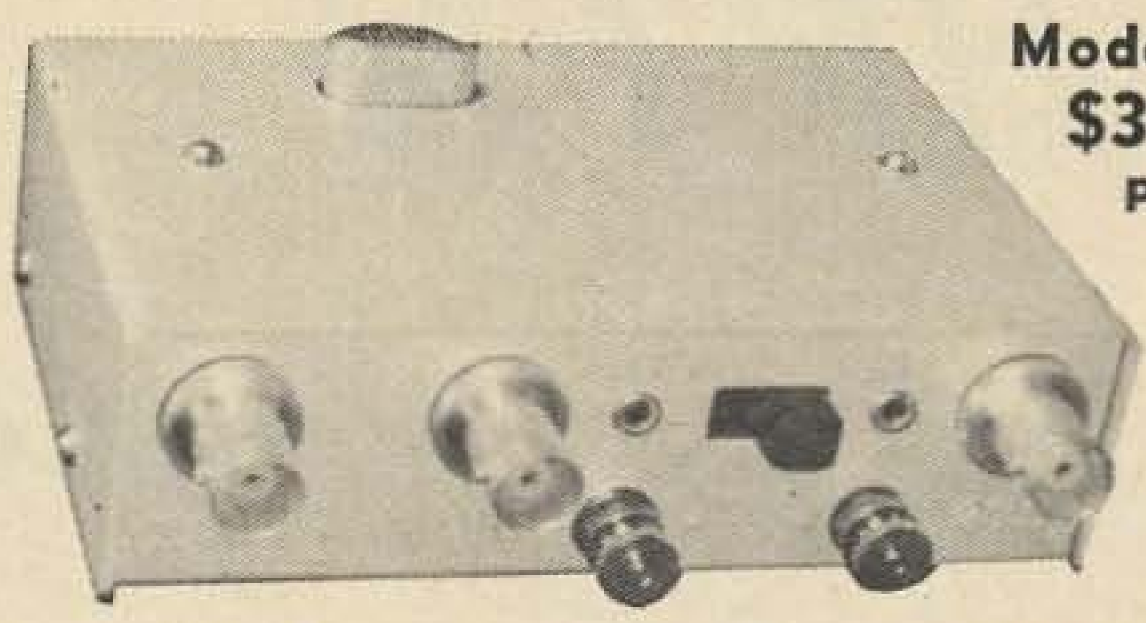
This completes the wiring of the modification. Check the wiring against the schematic in **Fig. 4.** Carefully plug the SB-610 in with it still out of the case and let it warm up. Check to see if the relay operates when the "pull to clamp" switch is pulled out and the sweep switch is in any position. If the relay does not operate, first recheck the wiring to make sure it is correct. If the wiring is correct and the relay will still not pull-in, reduce the value of the resistor from the relay coil to pin 7 of V1 until the relay reliably pulls in. This will assure that minimum plate dissipation occurs in tube V1. When this value is found, solder in the resistor permanently.

When the "pull to clamp" switch is pushed in, the relay should drop out. The trace will then appear on the face of the SB-610 and it should operate normally.

Set the sweep switch to Int. and apply a small amount of transmitter *rf* to the connector at the rear of the SB-610 while the "pull to clamp" switch is out. The relay should release and the trace should appear to allow normal transmitted signal monitoring. If the trace does not appear and the relay drop out, increase the *rf* signal. When the *rf* is removed by turning off the transmitter, the trace should disappear after 1 to 2 seconds. If the trace has not moved completely off the scope face, it may be necessary to decrease the value of the 33 K resistor. If the sweep still continues when the trace is off screen, the grid of tube V3A (pin 9) is not being shorted to ground through the relay.

I have operated my SB-610 24 hours a day for days at a time and experienced no difficulties. You must now remember to turn off the power switch after operating, for you no longer see the green trace on the screen to remind you that the SB-610 is on.

. . . K6SDE



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VHF FM Station Control

Being addicted to the use of FM on the VHF ham bands, I decided to establish a system of communications equipment for two of the most popular bands.

In the area where I have been living 2 and 6 meter FM are the most popular.

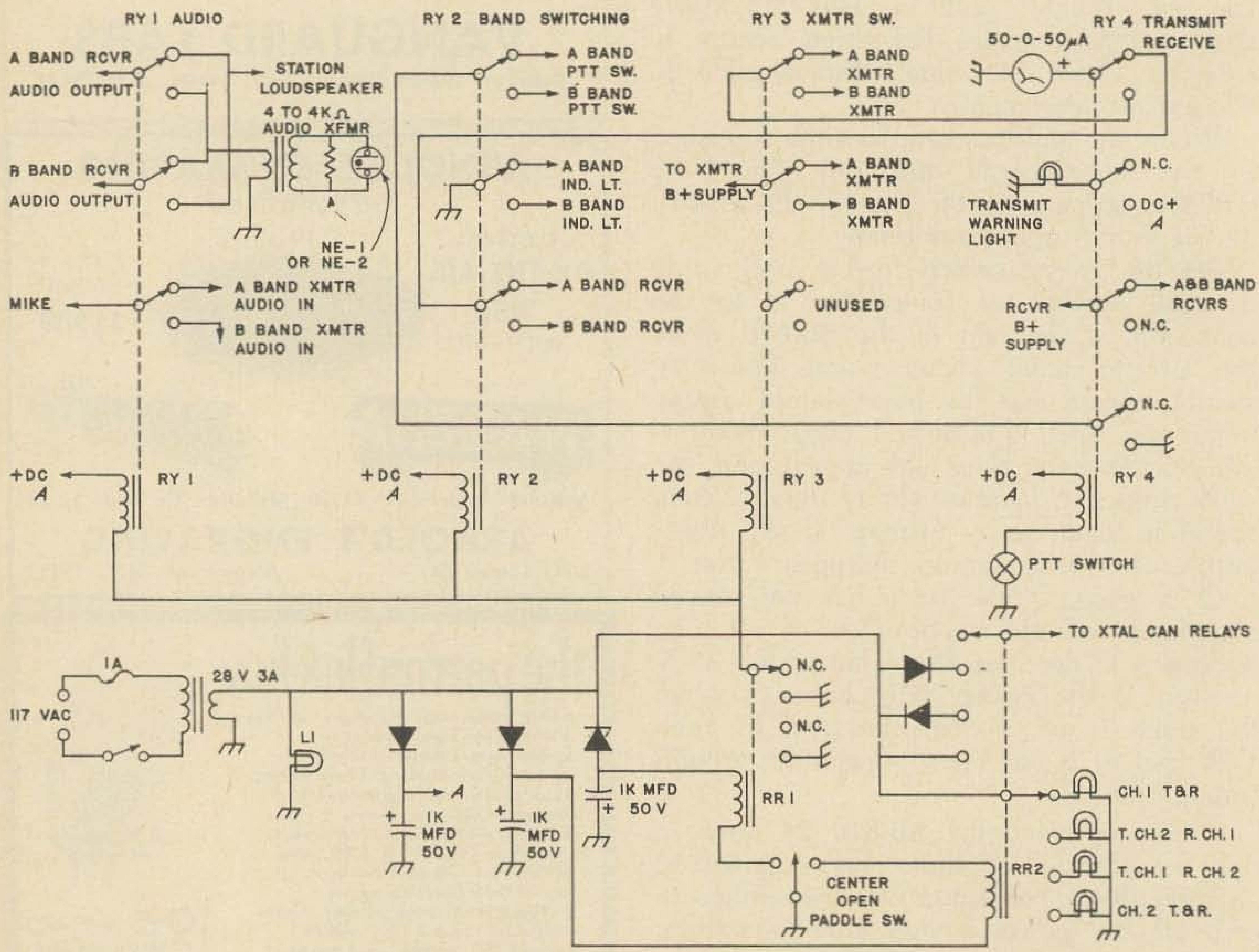

Fig. 1. The station control unit. RR1 changes bands each time the paddle switch is pushed to the left, RR2 changes channel setup in either band when paddle switch is pushed to the right. Lamps in lower LH corner of the schematic indicate which of four channel tuning schedules is in effect.

The unit to be described has provisions for two band operation as well as two separate transmit and receive frequencies on each band.

The unit makes use of surplus parts and is very straightforward in its operation.

There are two rotary-ratchet relays in use, one is set up so that every other terminal is grounded. When this relay is stepped, it alternately energises or deenergises relays ry1 through ry3. These relays take care of the bandswitching function. Provision is also included for automatic switching of metering. The other rotary relay applies a series of pulses to crystal-can relays in the various transmitter and receiver units. The first step applies no voltage to the relays. The second step applies a positive pulse at 28 vdc to the relays triggering one set. The third step applies a negative pulse to the bank of crystal-can relays triggering one set and releasing the other. On the fourth and final step 28 vac is applied to the bank of relays triggering both sets. This works out very well in conjunction with a local repeater, allowing either direct contact or contact through the repeater.

A fourth relay Ry4 has the duty of switching the receiver voltage for muting as well as the metering and keying the PTT. This relay is keyed to ground through the PTT contacts on the microphone. The PTT circuits of both transmitters are keyed every time the PTT is energised, however only the selected transmitter is operational as the power is switched through a set of contacts on the band s selector relay.

This unit has been in use for several months and works out very fine. It saves wear and tear on the operator during band switching operations.

Also included is a second band monitor. Both receivers are running continuously. One is feeding the speaker while the other is feeding an audio output transformer hooked up in reverse. If there is any audio present on the second band it will light 19.

Channel switching is done by means of small dpdt relays. These relays, due to their physical size are called "crystal-can" relays.

One is used in each transmitter and receiver and wired so that the wipers connect the crystal across the the crystal socket. The relay used in t this manner reduces problems, due to the fact that there is only one crystal in the circuit at any one time. One lead is connected in parallel with all other relays and goes to the wiper of Rry2. The other lead of the coil goes to ground through an appropriately polarized diode. It is well to have like relays keyed at the same time. That is both transmitter and both receiver relays keyed together. A provision is included for lamps to indicate which channel is in use at any one time and a chart is easily made to call out just what each lamp indicates.

The purpose of this is not so much for construction of exact duplicates but to open the doorway for thought and design to meet your own personal requirements.

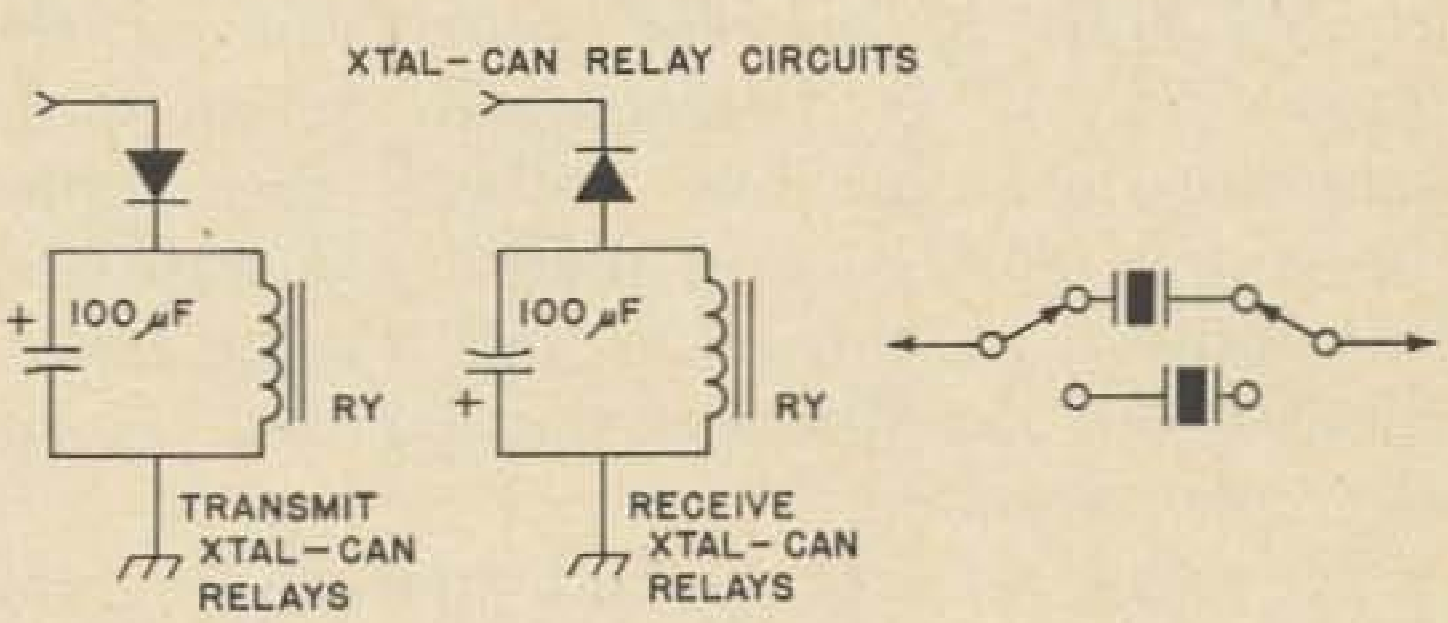

Fig. 2. Series diodes determine applied voltage polarity that will operate the crystal-can relays. With added capacitors, relays will operate reliably on ac, which is applied during some Station Control settings. Note relays switch both sides of the crystal circuit.

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A Simple Portable Rig For Six

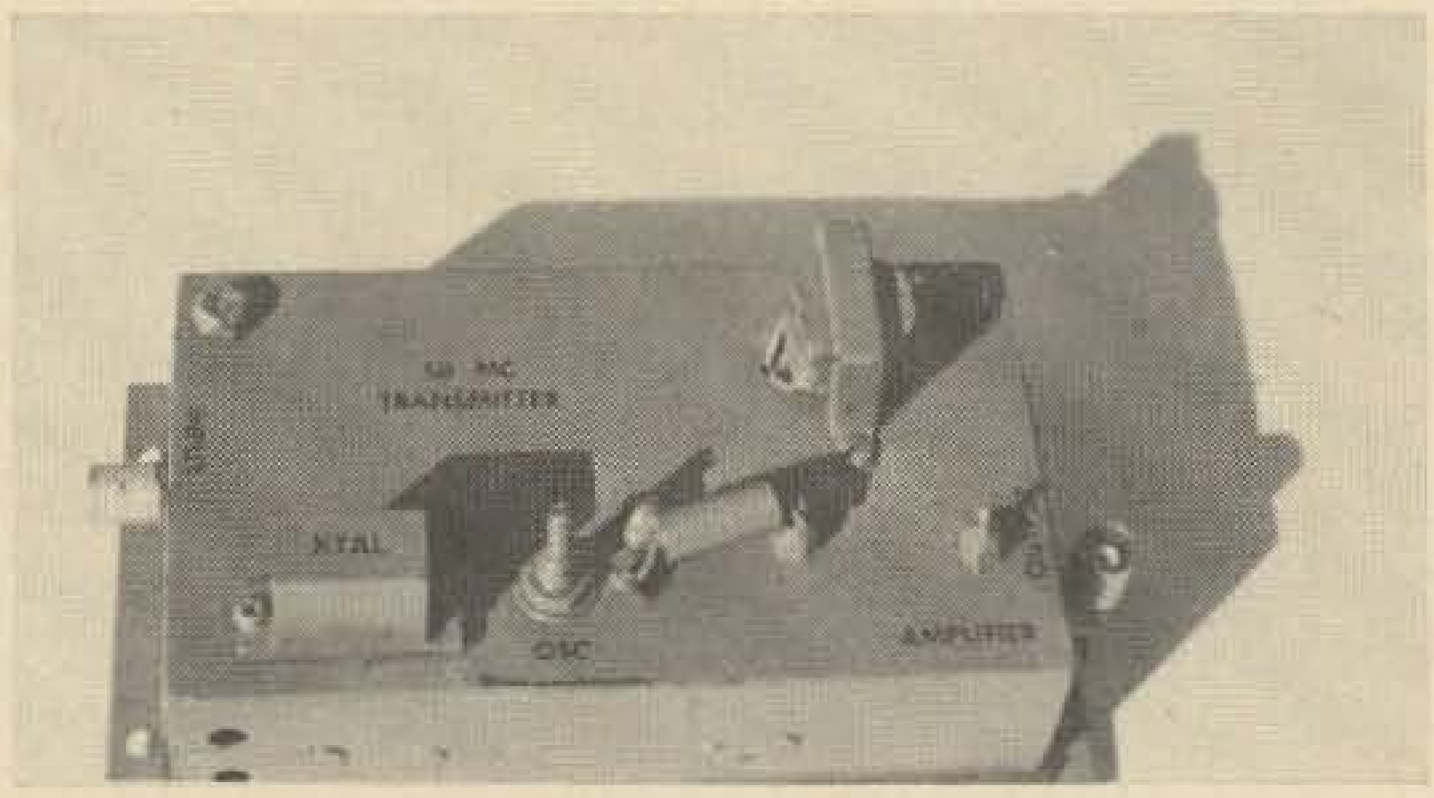
With "mountain topping" becoming a popular sport on the VHF bands, a low power portable transmitter for 50 MHz can be a handy item. This article describes such a transmitter that is not excessively difficult to build and provides a good signal on six meters.

The Circuit

It was finally decided that the one watt power level offered a fair compromise between battery weight and power. Only two stages are needed to generate the desired power, and this simplifies construction. Both the oscillator and amplifier are power modulated for maximum audio "punch." The modulator is a PA-222 one watt integrated circuit amplifier. With the addition of a few external resistors, capacitors, and a transformer, this unit offers one watt of audio at a price comparable to commercially manufactured amplifiers. It is surprising that integrated circuits have not become much more popular with the amateur fraternity.

The RF section was adapted from RCA designs, and is a standard configuration. It was necessary to hold the supply voltage to 22½ volts to prevent destruction of the transistors. It is theoretically possible to generate instantaneous voltage four times the supply voltage in a modulated transistor transmitter. In this case this rating is exceeded, but the theoretical maximum is usually never reached.

In order to obtain full modulation the oscillator must be modulated along with the final. Careful tuning of the oscillator can minimize FM, but for optimum results, it would be best to add a driver stage so that the oscillator would not be modulated. However, in this case, simplicity and power consumption were more important, and careful tuning gave very good results.

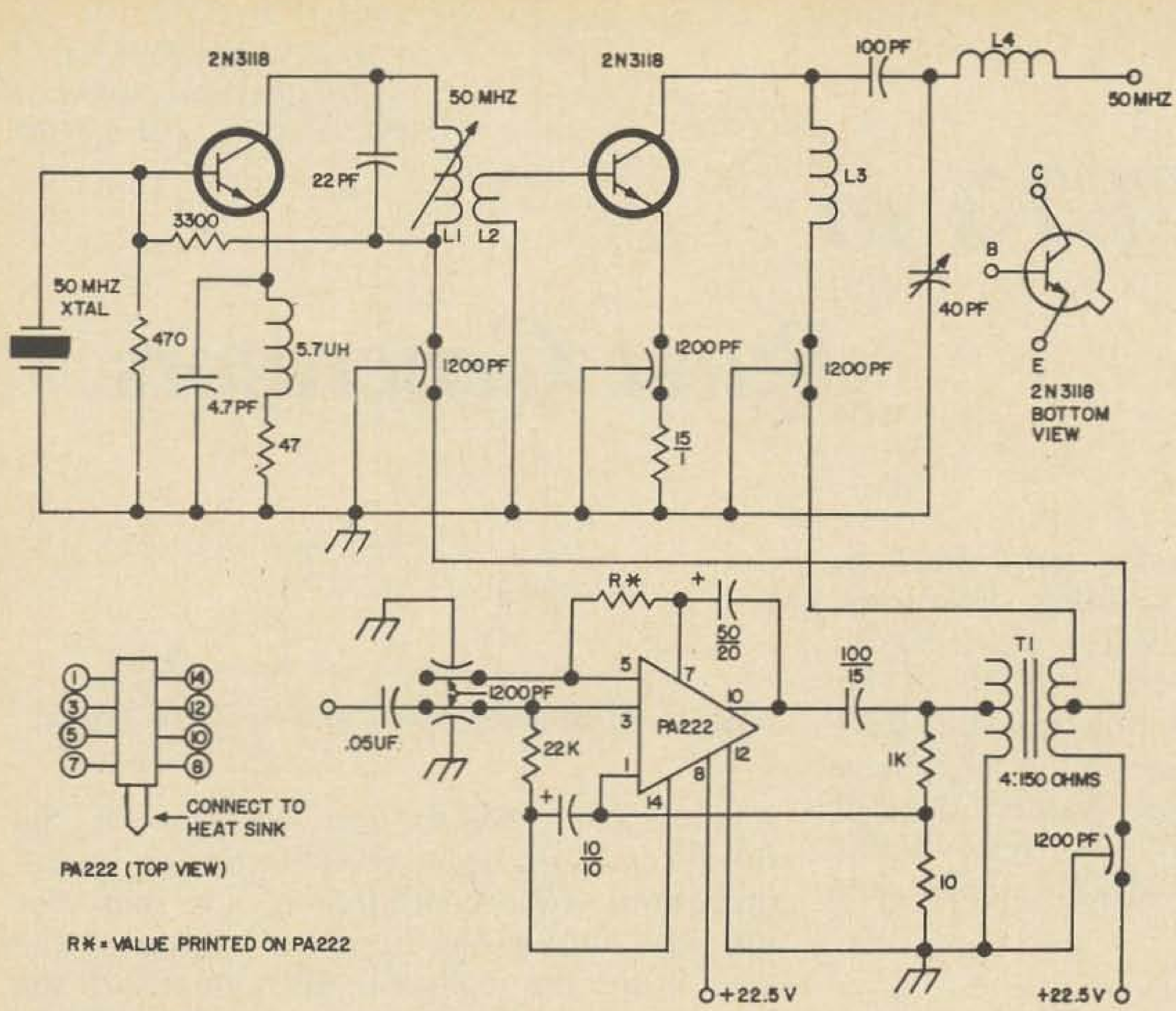


Construction

The transmitter was built in a small four section copper plated box that was obtained from a piece of surplus equipment. This type of construction is very rugged and provided optimum shielding. Standard VHF construction procedures were followed.

An unexpected problem arose in building the modulator. The General Electric PA-222 is just not meant for this type of construction, and one of the leads broke off. However, after some scraping and soldering, a connection was made to the broken lead. It is amazing how much abuse the IC took with no apparent damage. In future projects a printed circuit board should be used.

As a final step, the inside circuitry was painted with anti-fungus varnish made by GC Electronics. This is a reasonable precaution considering the outdoor use that this transmitter will be subject to. For the same reason, lock washers were used wherever necessary to insure mechanical dependability. The cover over the crystal and socket is an unusual feature. It is made of brass, and designed specially for this



Parts List

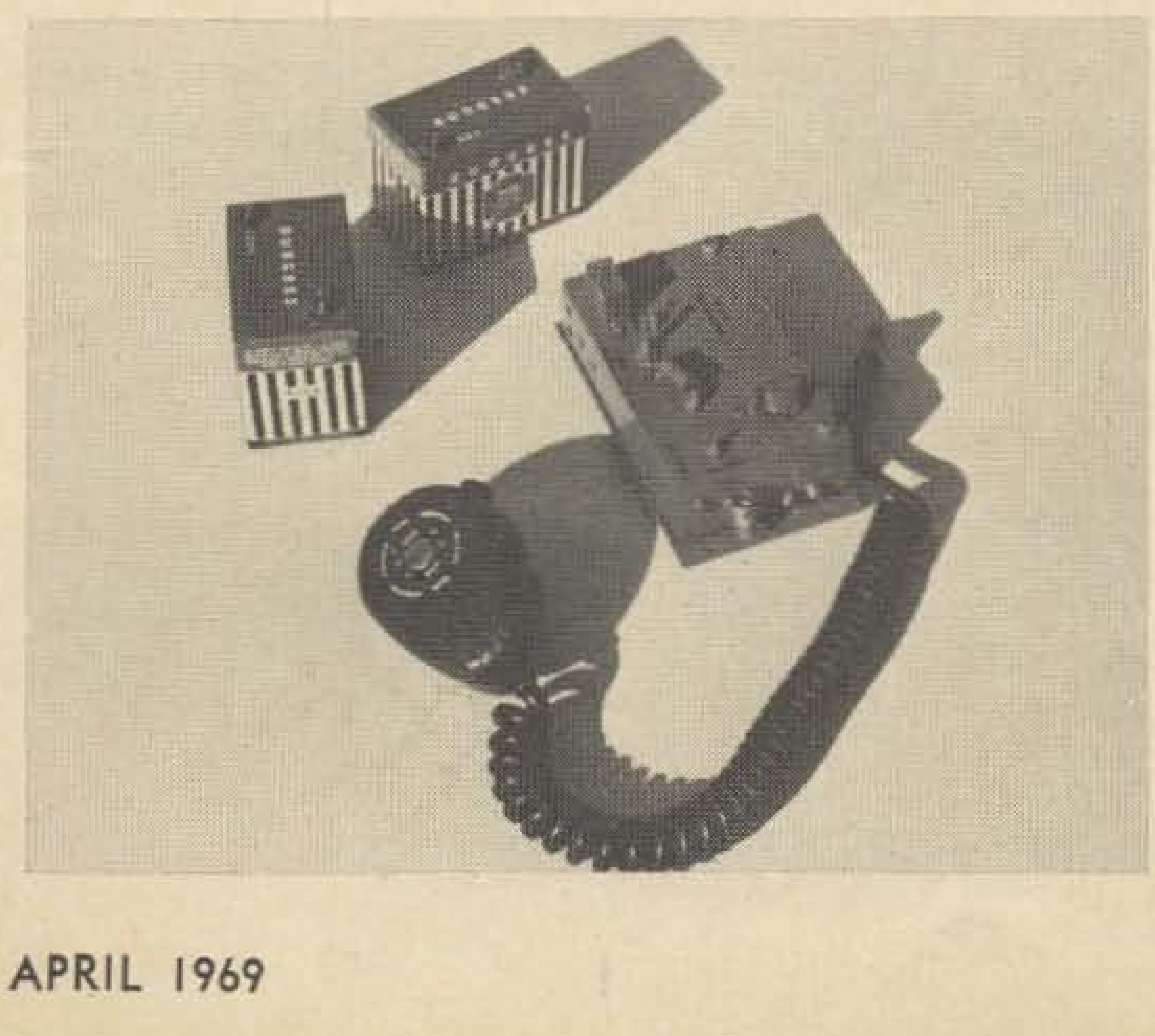
L_1	six turns number 22 on 3/8 inch diameter slug tuned form
L_2	two turns insulated hook-up wire on L_1
L_3, L_4	ten turns number 18 3/8 inch diameter close wound
Xtal	50 MHz overtone type crystal
T_1	Thordarson TR-21

Note:
R* is the value printed on the top of the PA-222. The tab on the PA 222 should be soldered to a suitable heat sink. Resistors are half watt except where noted. Capacitors are disc ceramic except for 1200 pF feedthrough capacitors and output tuning capacitor which is a piston trimmer.

use. Its manufacturer is unknown, but in a situation where one frequency is used, it was reasonable to protect the crystal even if it made frequency changing difficult.

Operation

The first problem that arose was in the oscillator coil. Some experimentation was required to insure easy starting and frequency stability under modulation. The circuit should be tuned to a higher frequency than where maximum output occurs. The final amplifier also had to be detuned slightly to obtain "upward" modulation. The slight reduction in power will not be noticed, but the distortion can seriously impair readability. It was also discovered that the large



current swings in the modulator caused a serious voltage drop during modulation peaks. In order to eliminate this it was necessary to use separate power sources for the RF unit, making two batteries necessary.

Transistor transmitters tend to generate harmonics, and this one is no exception. For sporadic mobile and portable operation, the operator probably will not worry about this, but if operation is centered in a heavily populated permanent location, the operator may wish to check for harmonics. A harmonic does show on the GDO in the middle of the FM broadcast band, but no trouble has been reported. This is probably due to the lack of FM receivers in this locality, and the harmonic signal drops off within a few hundred feet of the transmitter. If problem do arise, standard TVI prevention methods should be employed.

Results

In an unscheduled test a mobile station was contacted. Before being told, he was unaware that the one watt transmitter was being used, and he thought it was the thirty watt base station transmitter.

Even with its relatively low power, this transmitter will provide a reliable high quality signal for the mountain-topper who likes to hike to those "hard-to-get-to" spots.

. . . WB6BIH

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Using FET's in Burst Generators

What's a burst generator good for you say? It's ideal for pulse testing of transistors at high peak power levels, pulse modulating transmitters on UHF or SHF or for other experimental work (or just for fun). **Fig. 1** shows an *rf* burst. V_1 is the sinusoidal "on" voltage and V_2 is the off (leakage) voltage. I call the ratio V_1:V_2, Rv (for voltage ratio). Ideally if the sine

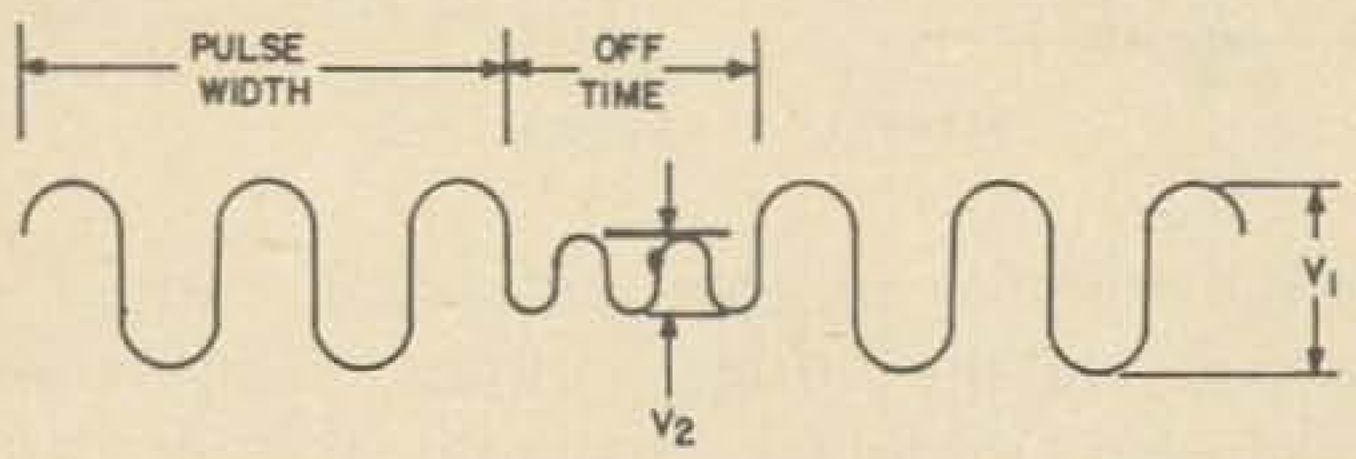


Fig. 1. V1 is the "on" voltage; V2 is the "off" (leakage) voltage.

wave were 100% modulated by the pulse, the leakage voltage (V_2) would be zero. Rv then equals infinity. But since a practical modulator cannot be perfect, there is some modulator output during the off time.

Immediately when I thought about a burst generator, I decided on the circuit of **Fig. 2.**

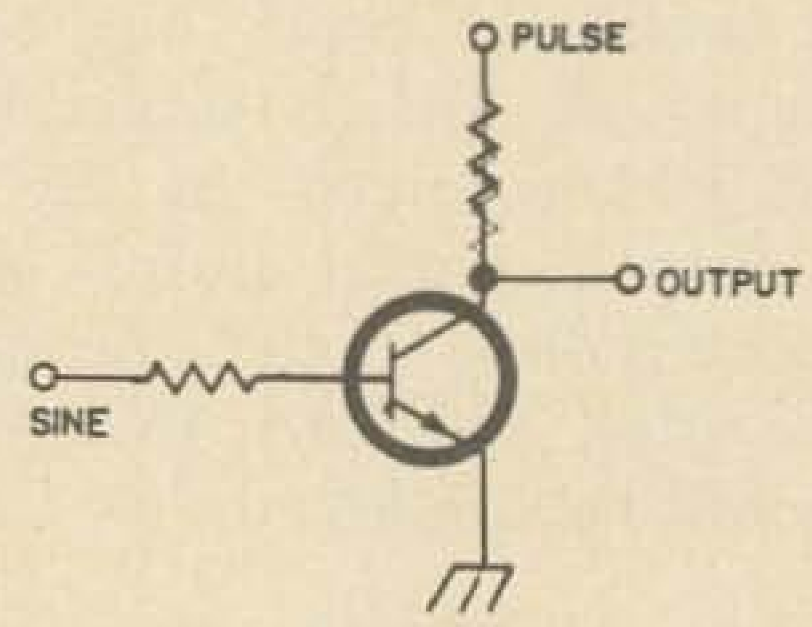


Fig. 2. The simplest and cheapest pulse modulator; however, there is a dc component in the output.

It is simple but has a drawback. It has a dc component in the output. That is, its output is like that of **Fig. 3.** To eliminate that problem let's switch to the circuit of **Fig. 4.** This circuit might seem reasonable at first glance (there would be no dc component in the output), but it fails for this

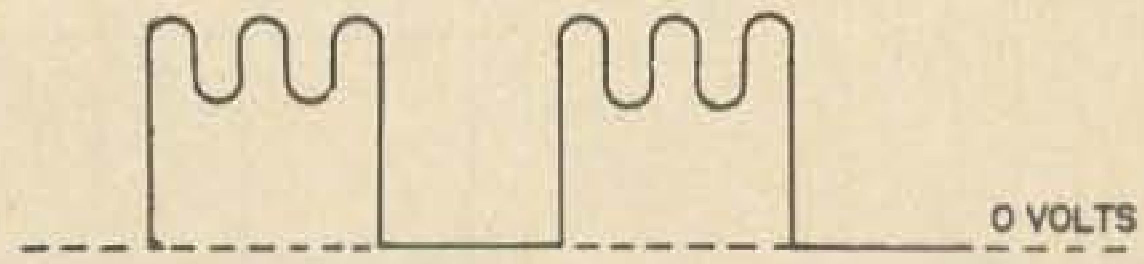


Fig. 3. Idealized output of circuit in Fig. 2.

reason. The collector-base junction of the transistor must be reverse biased for proper operation. This condition is not met (for instance, during the negative portion of the sine wave the collector is minus and the base is plus). Furthermore, because of the saturation voltage of the transistor, this circuit may not act as a very good switch anyway (neglecting the biasing). That is, suppose the sine wave voltage input is perhaps one-half volt, and the transistor saturation voltage is two-tenths of a volt. We loose a large percentage of our voltage across the transistor.

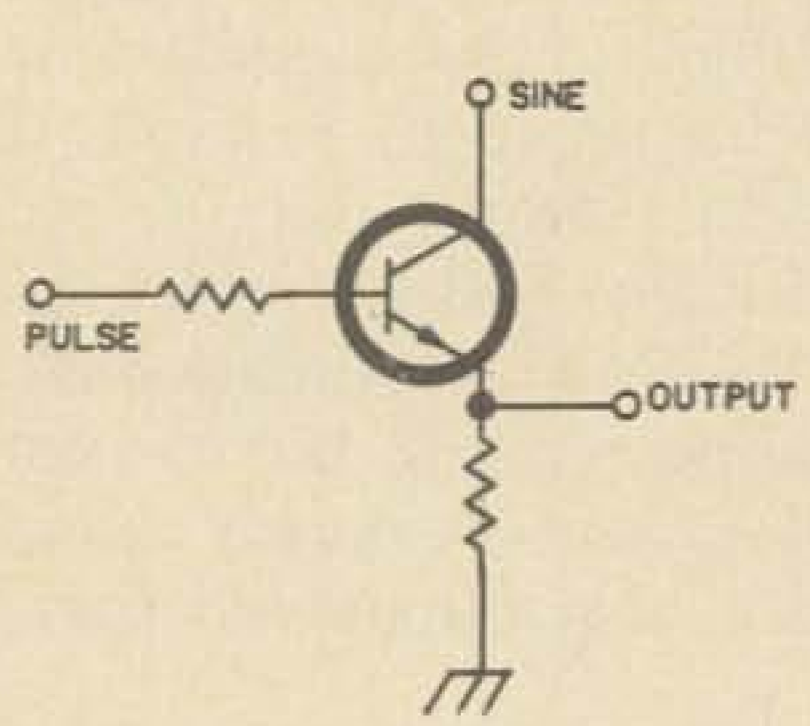


Fig. 4. This circuit is simple, but the transistor will not be biased for proper operation.

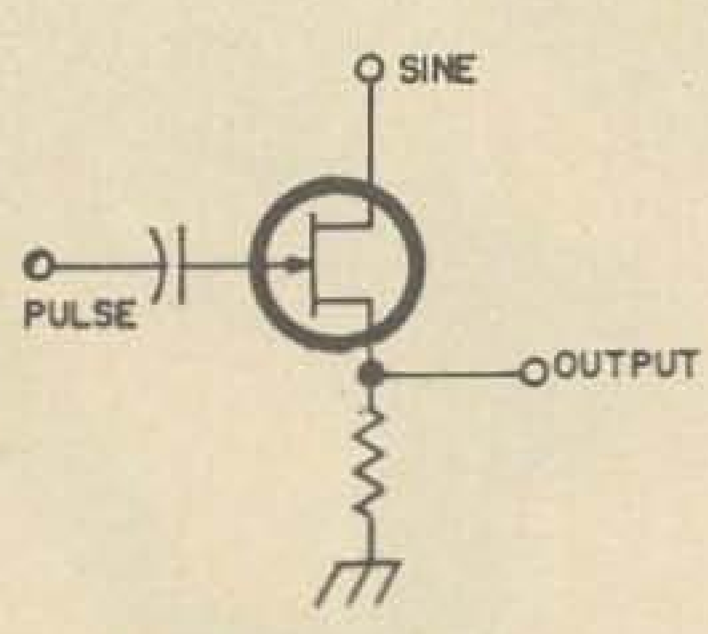


Fig. 5. Basic FET modulator.

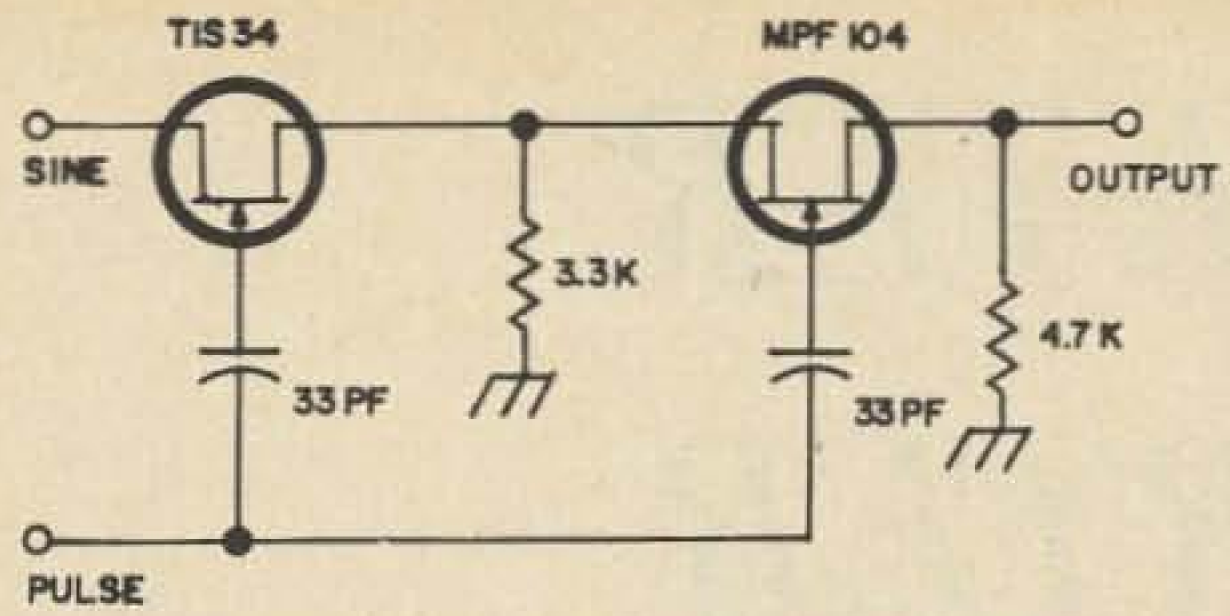
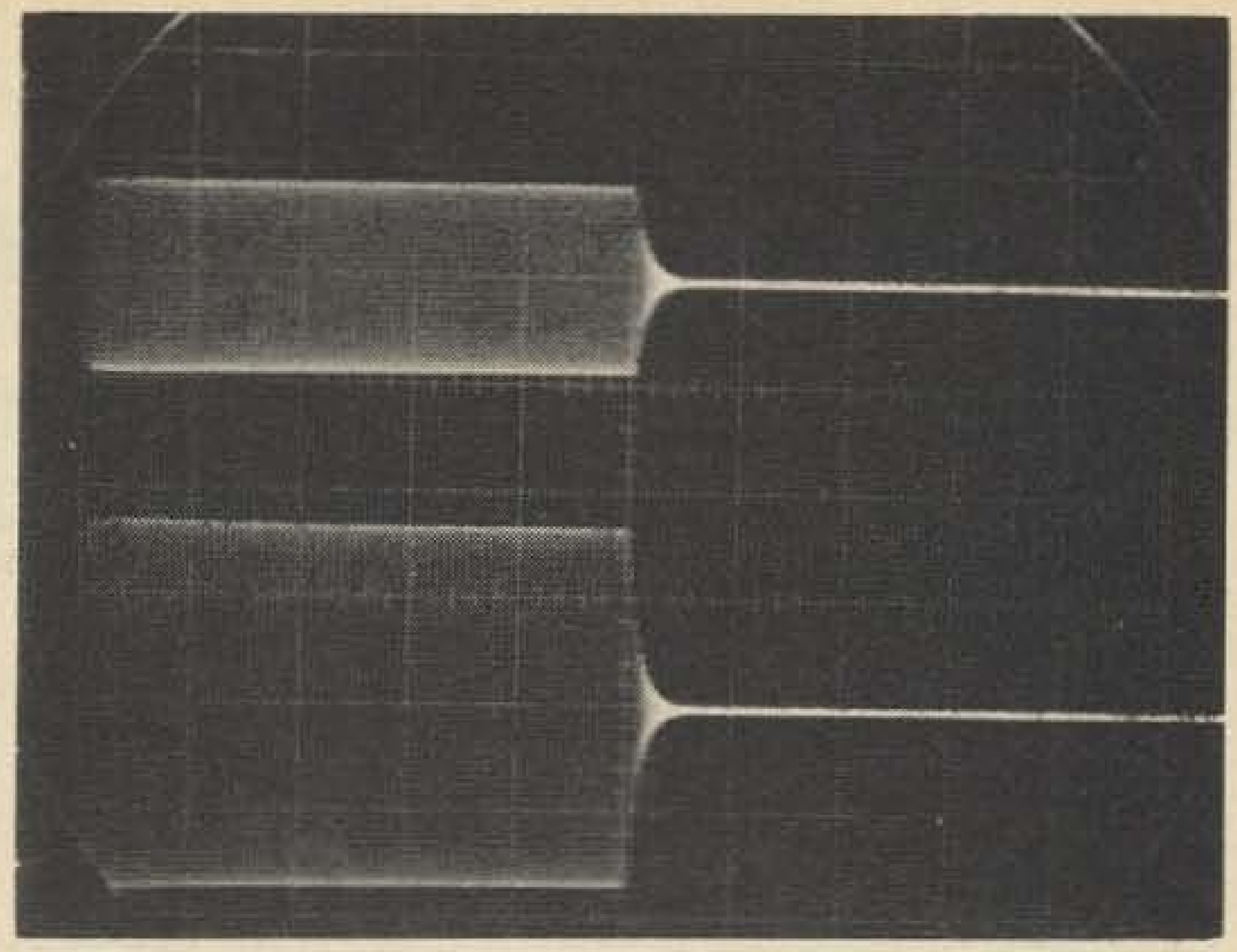


Fig. 6. Final burst generator design.

At any rate, these problems can be completely eliminated by using a junction field effect transistor (JFET). The JFET measures many megohms between source and drain when cut off and the on resistance (channel resistance) on some of the good units runs only a few hundred ohms. The FET is now used as in **Fig. 5.** The Motorola MPF104 is excellent at $1.00, and the Texas Instrument TIS34 is equally good at $1.10. Both are available from Newark Electronics and several of the other large wholesale outfits. By using two burst generators in cascade I was able to get a higher modulation percentage (less leakage). Because of what I had at the time I used one Motorola unit and one TI unit. A pulse of ten to fifteen volts is required (remember to measure pulse height with an oscilloscope). To avoid damage to the transistors do not use excessive pulse voltage.



1 ms rf burst of 200 kHz (top trace) and after amplification (bottom trace).

The circuit values may not be optimum for your application, so some experimentation may be in order. Even so, Rv for this circuit is excellent and typically runs 300 or 400. This setup can easily be used from ultrasonic frequencies up to ten mHz or so. Happy bursting! . . . K3VKC

TWO METER CONVERTER

for the Swan 250 or Anything Else

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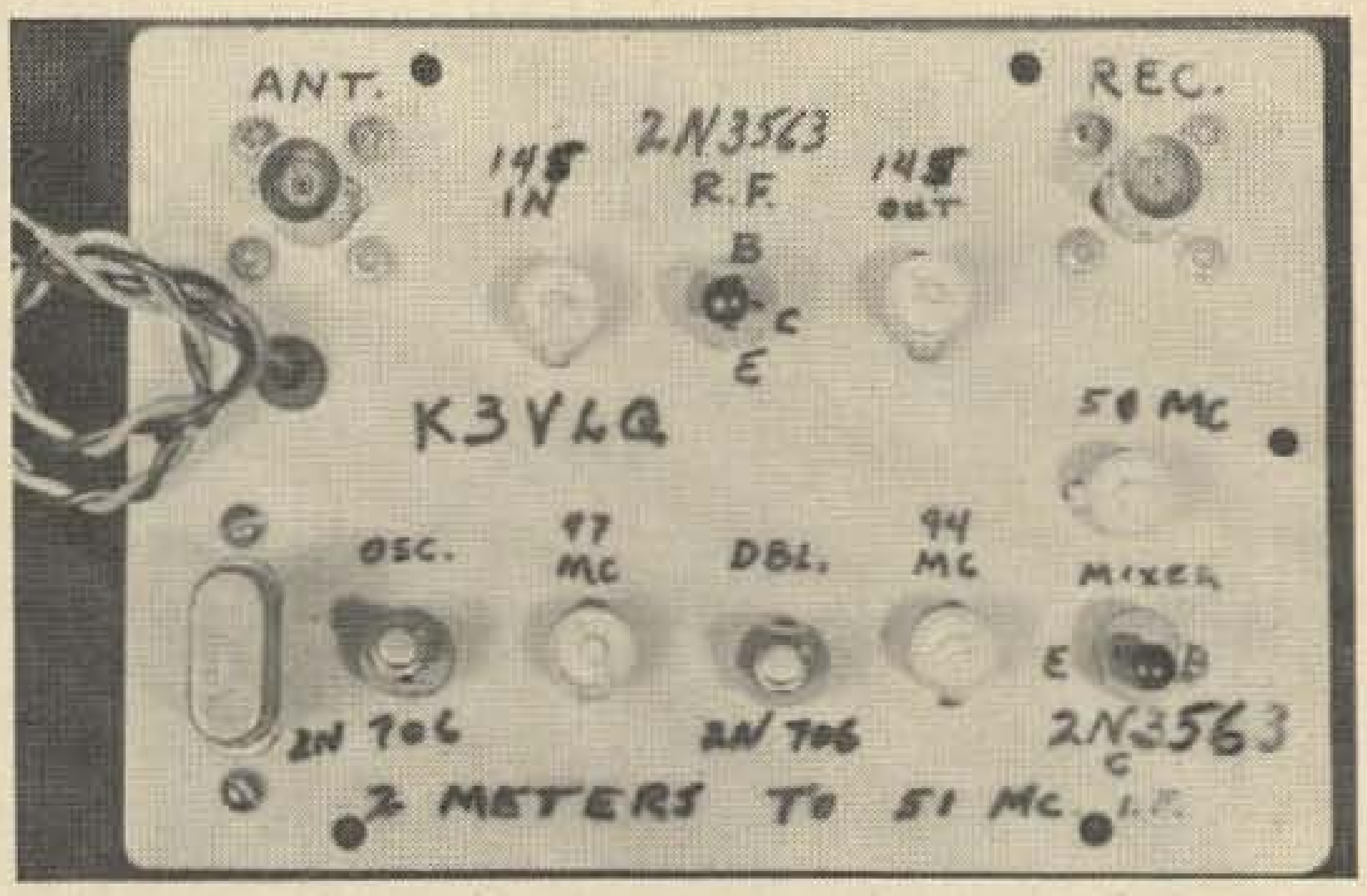
With the number of Swan 250's on the air, there are no doubt quite a few fellows who would like to plug in a converter ahead of theirs to see what's happening on the two meter band. With these fellows in mind, we put together this transistorized job.

For some, it may seem like a rather ambitious undertaking, considering the printed circuit board, but we tried to keep the difficult work to a minimum on the board, and, if it's your first etched board, it's a good project to start on.

A careful study of the underside of the board (foil side) will show that most of the foil remains, and only portions at the trimmer capacitors, the transistor sockets, and one long skinny U-shaped strip for the plus voltage were etched out. This leaves the rest of the foil for ground potential, and leads can be soldered up short, (a necessity at these frequencies).

A little trick we used on this board is worth passing on,—the matter of masking. Most manufacturers of cellophane tape are now making a rough or matte finish tape which can be written on with a pencil. Cover the copper side of the board with this tape, press it down tightly to be sure all the copper is covered, and lay out your work with a pencil. Using a razor blade or sharp knife, cut out the sections of tape *where you want the copper removed,* and lift off these sections of tape. Leave the rest on, because this is your "resist" for the acid.

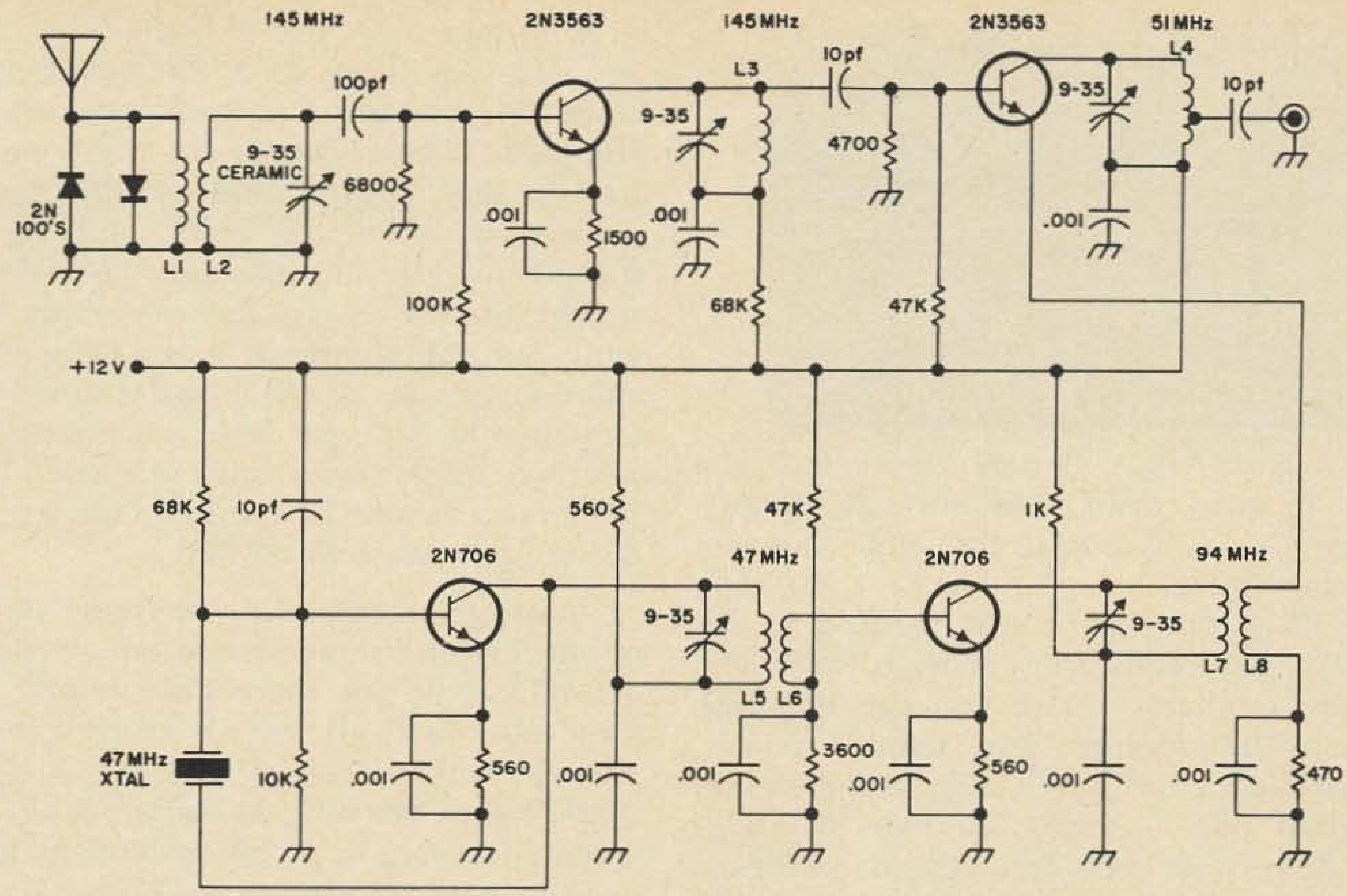
Drop the board in a ferric chloride solution for 45 minutes to an hour at room temperature, and you can watch the progress of the job. Use stainless steel, plastic or hard rubber tongs to handle the part in the acid.



When etching is completed, remove from the acid, flush in running water, and remove the masking tape. Look it over carefully with a magnifying glass, to make sure all the copper is removed where it should be. Any small portions you wish to take off now can be scraped off with a sharp knife or a razor blade.

The ferric chloride is a brown crystal that mixes easily with water. We use 1580 grams of crystals per gallon of water. You won't need much more than a pint in a glass, rubber or plastic tray. Use caution in handling this stuff as it leaves a brown stain that you won't get off a white shirt. The solution keeps well, and can be used over and over again until the etching time becomes too long. By the way, the etching process is accelerated by heating the solution to 160-180 degrees Fahrenheit, if you are in a hurry. If you try a printing shop that does photo-engraving, they may even give you some of the solution already mixed.

Printed circuit board stock is generally advertised in about a half dozen ads in the



back of this magazine. After you've etched a few boards like this, you'll wonder how you ever built anything without them. You can cut it with tin snips, heavy scissors, or a photo paper trimmer. Note the 1" high shield between the R. F. and the oscillator sections on the converter,—cut it, break it, bend it, and tack solder it in place,—cheap, quick and easy.

While we're talking about that shield, look below the "Ant." connector on the photo. Follow the dotted line to the "plus" lead, which is the long skinny U-shaped strip mentioned earlier. You will note that the bottom of the U passes under the shield. This portion of the shield is nibbled out to clear the "plus" lead, so that it won't short out, and doesn't show on the photo. Nibble out clearance with your diagonal cutters. You will also see a coupling capacitor going right through the shield at the bend. A small drill or pocket knife will cut that one for you.

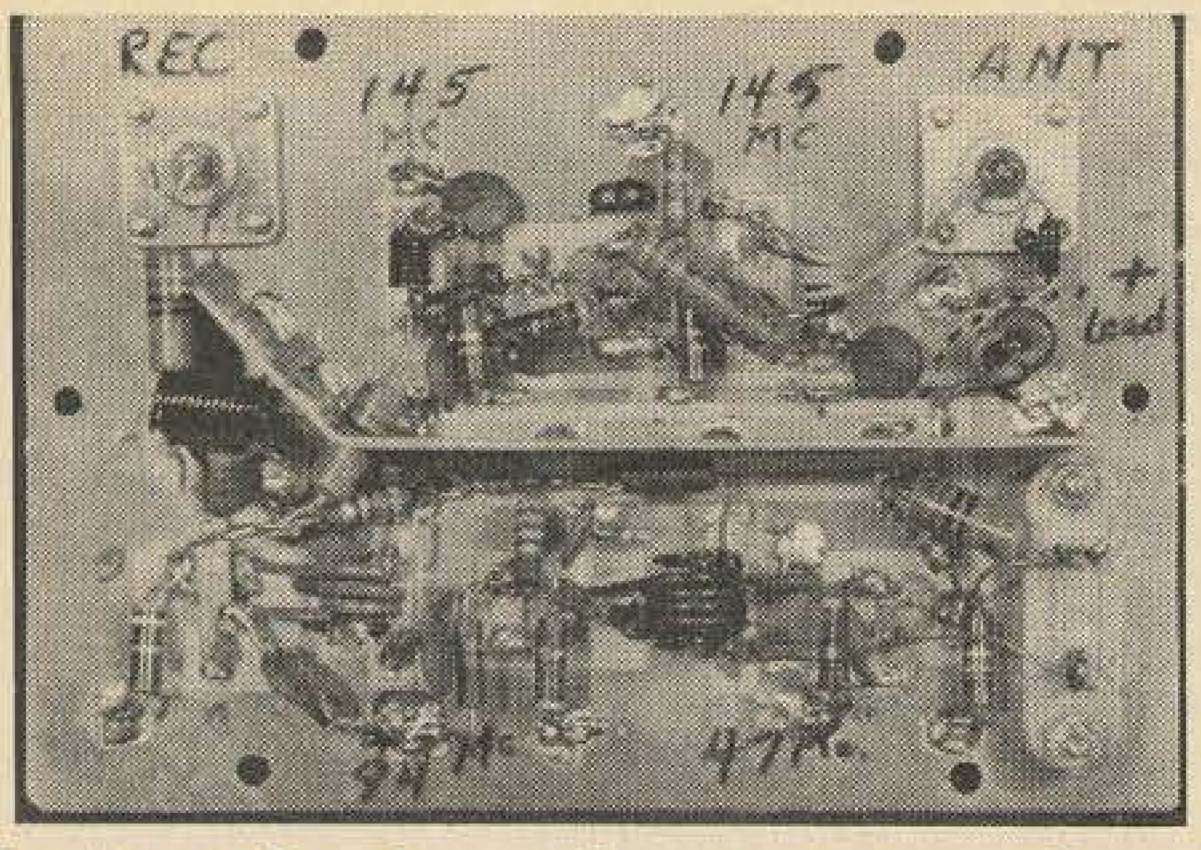
Some experienced builders may question the labelling on the rf and mixer sockets, so an explanation is in order. Considerable experimenting was done on this prototype, with other transistors, including FET's and the leads may seem slightly scrambled. We didn't intend this to be a set of kit-building instructions and hope those who try to duplicate this converter will use a little judgment. The sockets were also used because we intended to do a little experimenting, and you can etch your board to solder your transistors in permanently, if you like, and save the price of the sockets. Since this was an experimental job, we left two of each type transistor in to show that they will work. If you prefer, use 2n3563's all the way through, or 2n706's all the way. Either type, or both are from Poly-Paks at four or five for a dollar. The crystal is also surplus, from JAN Crystals, and picked from their list of available frequencies for about a dollar. This one is for 47.0035 MHz. If you want to throw money around, order one for 47 MHz and it will cost you about \$6.50. Personally, I can't see it. We might also urge you to buy a grid dip meter, if you don't already have one.

While on the subject of grid dippers, you will note that the trimmer capacitors are mounted so that they are accessible from the top of the converter, with the coils soldered directly to them on the other side

Coil Data

L_1— 3 turns	#26 insulated on L_2	
L_2— 6 "	#20 Air wound 3/16" dia. x	1/4" long
L_3— 7 "	" " 3/16" "	x 5/16" long
L_4—13 "	" " 5/16" "	x 1/2" long
L_5— 9 "	" " 5/16" "	x 3/8" long
L_6— 4 "	#26 insulated on L_5	
L_7— 5 "	#20 Air wound 1/4" dia. x	1/4" long
L_8— 3 "	#26 insulated on L_7	

Coils L-2, 3, 4, 5, 7 all tuned to frequencies shown on schematic with 9-35 ceramic trimmer capacitors.



of the board. The coils were wound on the shanks of twist drills, and are self-supporting (see L-1 + L-2 near the "ant." connector in the photo).

The final tune up procedure used in developing this converter started with the 47 MHz oscillator. After you get it going, peak up the doubler, and remove power. Grid dip the rf and mixer coils, and it should take right off. A buddy on two meters is a big help, and once you get an on-the-air signal to peak up on, you've got it made.

We have a 500 kHz crystal calibrator in our Swan 250, and found the 145.06 MHz signal of a nearby Tech right where he was supposed to be the first time up. I guess we had the law of averages with us on that one.

For power, we use a home-brew supply, and can vary the voltage for maximum gain. Once set, voltage and trimmers need little attention. These transistors seem to work well in this configuration on anything from 3 volts to about 18 volts, and there we started to lose it. The 12 volt dc relay supply on the Swan Power supply should work fine, although we haven't tried it and can't guarantee it. A 9 volt transistor battery should let you hear something. Some day we might even stick a meter to this thing, just to see how much current it does draw! Anyhow, it works fine.

From past experience, we found that after publishing an article of this type, we usually get letters. We're more than happy to answer any and all, if we can, if you are having trouble. Just be sure you are having trouble that can't be answered with a little common sense, or a quick look at a reference manual. If you write, please include a stamped self-addressed envelope, and if we don't forget to answer too many, and can get a few evenings away, we plan to whomp out a heterodyne unit, to put the Swan on two-meters, sideband and AM.

. . . K3VLQ

"Q", "Q", Who Got "Q"

This nice article would have been more attractive if some of it had not been inadvertently omitted. If you are thinking about building this little instrument, turn to our October issue, page 82. First error appears in **Fig. 1.**

That can be corrected by drawing a line from the Xtal Osc. directly to the 100:1 Divider. Now the meter can look at the input **or** the output merely by turning the switch to left or right and without disturbing the operation of the circuit. This is the basic test of comparing excitation against response to determine Q.

And here are the parts not described in the schematic of **Fig. 2.** This will answer questions about transistor and diode types, and the values of C1, C2, and C3:

C1—Erie 557-000-39R, 5-25 pf.
C2—Centralab 858S-1000, 1000 pf.
C3—365 pf, see text.
C4—4-10 pf vernier, see text.
D1 & D2—1N97 type diode
R1—25K linear composition, Set Level, with switch.
R2—1K linear, Meter Zero.
L1—20 microH, Miller 41A225CB1
Q1—Fairchild SE2001 (2N3563)
Q2, Q3—Fairchild SE6002 (2N3566)
M—100 microA. meter.

Finally, the table of **Fig. 3** applies to a piece of #816 Airdux, 16 turns per inch, one inch diameter, leads one inch long.

This is cut to 34 turns and used to make up the test inductor shown. And now you can proceed with the test setup of **Fig. 4** for Q calibration but a word of warning is in order.

That is, if you use surplus resistors be certain they are not wirewound construction, or film resistors corrected to value by cutting a spiral groove in the film. Either arrangement will be more inductive than the composition resistors Votipka used in his original work, and will bring you to misleading results. Good luck on this simple test instrument!

Cryptogram

T OUTANYAN ZXZORQYO WYZXS
MZRM IF T ETNAZRYO WYZXS,
TAS T
OUTANYAN ETNAZRYO WYZXS
NZAZQTRZM TA ZXZORQYO
WYZXS.

(*Answer on page* 88)

VSWR-An Outmoded Parameter

As it is not possible to obtain a perfect match between a transmission line and an antenna, all the incident power cannot be transfered to the antenna, and that part which is not transferred is reflected along the line to the transmitter.

The better the match, the smaller the ratio of reflected power to incident power. This ratio can be measured with a reflectometer and is usually expressed in terms of voltage rather than power.

The voltage reflection coefficient is designated Γ (Gamma) and is given by:

$$\Gamma = \frac{\text{E reflected}}{\text{E Incident}} = \frac{[\text{Power Ref.}]}{[\text{Power Inc.}]}\frac{1}{2}$$

from which it is seen that the ratio of reflected power to incident power is given by Γ^2.

As Γ^2 provides an excellent criterion of the 'goodness of match' there is little further to be gained by making other measurements, but more of this later.

When power is reflected from an antenna, standing waves of voltage and current are set up on the transmission line and by measuring the ratio of maximum voltage at any point to the minimum voltage at a point one quarter wavelength away on either side, we get a parameter called the VSWR—voltage standing wave ratio. (The voltage ratio rather than the current ratio is measured because it is easier to measure voltage than current with the test equipment used).

It should be noted at this point that the absolute values of maximum or minimum voltages are in themselves quite meaningless and tell us nothing about the degree of mismatch. Like Γ, VSWR is a function of the degree of mismatch, and is related to Γ by

$$\text{VSWR} = \frac{1 + \Gamma}{1 - \Gamma} \text{ and } \Gamma = \frac{\text{VSWR} - 1}{\text{VSWR} + 1} \text{ so}$$

that each can be derived from the other.

Although VSWR can be measured with a higher degree of accuracy than Γ, it can only be measured directly by using slotted line techniques. Unfortunately this is only possible where the frequency is such that the portion of slotted waveguide used in measurements is at least about ten wavelengths long. This restricts the measurement of VSWR to microwave frequencies, where wavelengths are in the order of centimetres.

The reader, at this point, is no doubt asking the sixty-four-dollar question: How is it then that amateurs measure VSWR on amateur bands well below microwave frequencies?

The answer is—they don't! As mentioned previously, VSWR can be derived from Γ, and that is exactly what is done. VSWR meters used on the ham bands are simply forms of reflectometers with the meter calibrated in terms of VSWR and so we come to the next question: Why, after measuring Γ, do we go to the trouble of converting to VSWR?

Why, indeed?

Once Γ has been measured, we know all there is to know about the line/antenna match; going a step further and converting to VSWR tells us absolutely nothing more than we already know about the 'goodness of match'!

Let us assume that we are making some adjustments at the antenna end of a transmission line. The first adjustment gives a Γ of, say, 0.2. This means that $(0.2)^2 = 4\%$ of the incident power is being reflected. A second adjustment gives a Γ of 0.5 indicating that $(0.5)^2 = 25\%$ of incident power is reflected. In other words, an increase of Γ from 0.2 to 0.5, a factor of 2.5, increases the proportion of power reflected by a factor of $(2.5)^2 = 6.25$ i.e. from 4% to 25%. We can say that the second adjustment is 6.25 times worse than the first.

Now let us consider the foregoing in terms of VSWR.

With a Γ of 0.2, VSWR $= 1+\Gamma/1-\Gamma=1.2/0.8=1.5:1$. A Γ of 0.5 gives a VSWR of $1.5/0.5=3:1$. Although the VSWR has doubled, the actual mismatch is 6.25 times worse.

From many conversations heard over the air, it is evident that most amateurs would assume that with a VSWR of 3:1, the ratio of reflected power to incident power is twice as great as that with a VSWR of 1.5:1, whereas, as we have seen, it is actually 6.25 times greater. In this writer's opinion, the time has come for amateurs to abandon the use of VSWR and to start using the much more informative and realistic Γ. Let us leave VSWR where it belongs—to the microwave bands.

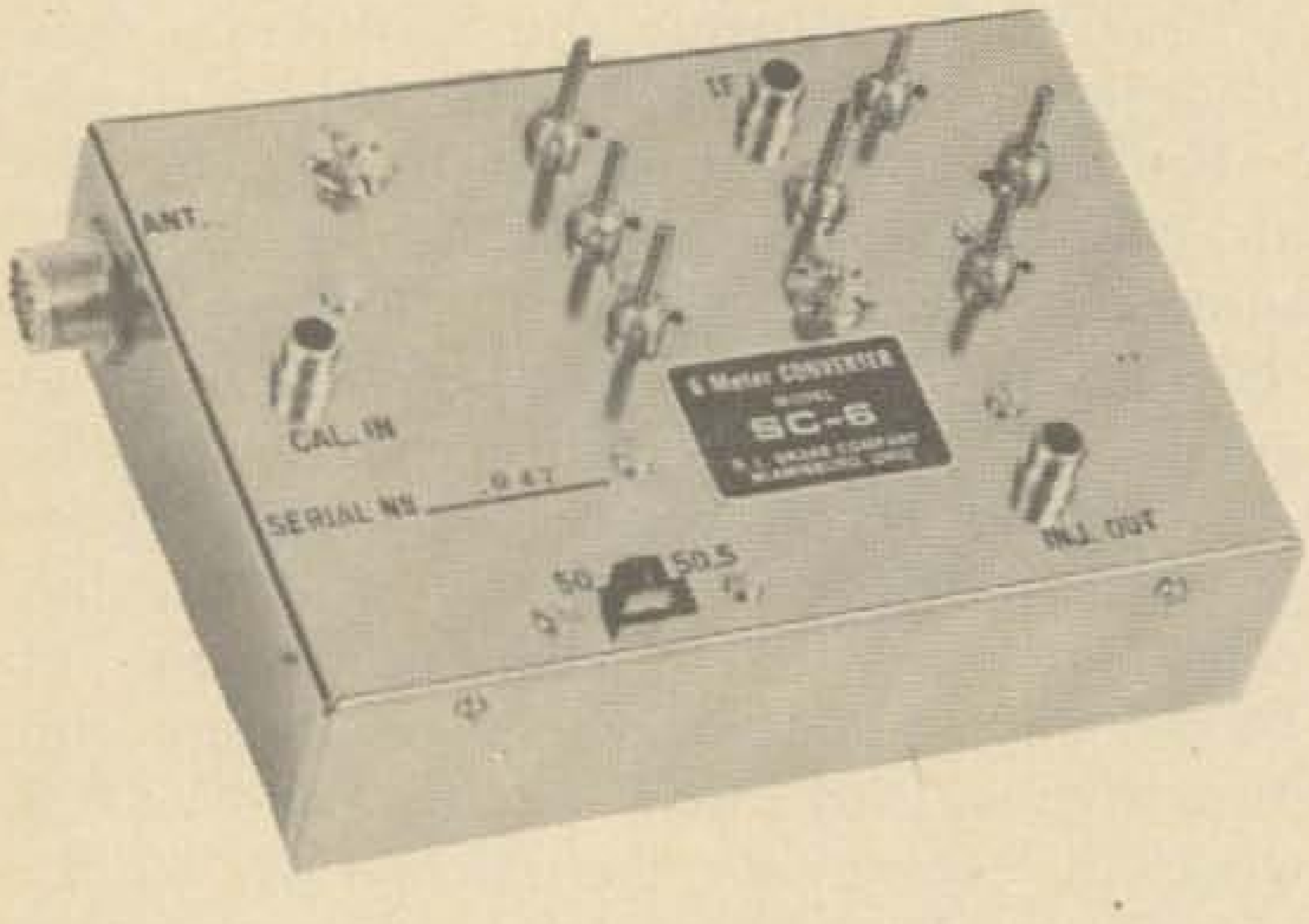
Perhaps when this switch is made, we shall never again hear amateurs talking of VSWR's of 'less than one'! Sid Gould VE2AXQ

Drake VHF Converters

Kayla Bloom W1EMV
Dublin, N.H. 03444

Drake has entered the VHF market with one of the nicest packages I have ever seen. As usual, in recent Drake equipment, the design of the cabinet is beautiful. They have developed a new finish to their panels which makes it virtually impossible to scratch them.

The unit tested consists of the SC-6 and SC-2 converters, the CPS-1 power supply, and the SCC-1 VHF crystal calibrator, all housed in the CC-1 Converter Console. Each of the units may be purchased separately, but when put together in the console they make a complete VHF converter unit.



The console is designed for easy installation of the separate converters and power supply. The units plug in to the console cabinet so as to engage both the power plug and the on-off switch fork. At this time, only the units mentioned are available, but the console has room for a third converter which will be available in the near future.

Getting to the performance angle of the converters, I have been hearing signals which were unreadable in the past. Consistently, not just due to good conditions. Signals are good on 2 meters from New Jersey (350 miles away) and the Boston, Cape Cod area are S9 and better. This is covering a distance of 80 to 110 miles. There is an old saying in ham radio . . . "you can't work them if you can't hear them," but at this point it works the other way. I hear them, but can't work them.

I have to admit to having a better than average VHF location, being 1450′ above sea level, so it is all down hill, but my 2 meter beam is only 20′ above ground.

The two meter converter uses a TIS34 silicon, low noise FET in the front end. The mixer is also a TIS34 and follows a high pass filter to remove the mixer difference frequency.

The six meter model uses TIM12 germanium FETs. The noise level on 6 is higher than on 2, but this is to be expected and is certainly within tolerance for that band.

The *if* of both converters is 14 to 18 MHz and two crystals are provided for each unit giving fairly good coverage of each of the bands. On 6 meters, 14.0-14.5 MHz gives coverage from 50.0-50.5 MHz with one crystal and 50.5-51.0 MHz with the other. On 2, coverage is 144-144.5 with one crystal and 145-145.5 MHz with the other.

For anyone wishing to change the factory alignment, the instruction manual gives fairly good details as well as a list of required equipment, but this can lead to sleepless nights, so unless you are prepared to spend a good deal of time, I would advise against making any changes. In the event you are brave enough to tackle realignment, and

make a bad job of it, Drake will realign it for five dollars plus postage.

The stability of both converters is superb. This is, of course partially dependent upon the stability of the receiver used. In my case, I used the Drake 2B. Interference from strong signals nearby are at a minimum and in some cases the selectivity is almost too sharp, especially on two meters. However, if you are interested in moonbounce or VHF DX work, this is a decided advantage.

The SCC-1 crystal calibrator is a jewel. It provides output for three converters and a separate receiver and gives accurate markings every 50 kHz to above 432 MHz. A trimmer is mounted in such a way that it is easily accessible, even when installed in the console cabinet. The oscillator is zener regulated and the circuit is a printed circuit with all parts easily accessible.

The CPS-1 power supply uses a full wave bridge rectifier mounted on a printed circuit board. The transformer has a fused primary and is mounted inside the case. The whole unit weighs only 17 ounces.

Both in performance, convenience, and good looks, this Drake package is tops.

. . . W1EMV

Reference reading

E. P. TILTON "A Featherweight Portable Station for 50 MHZ" QST NOV. 1964
D. DEMAW "50 MHZ One Watter" QST JUNE 1967
J. FISK "73 Useful Transistor Circuits" 73 MARCH 1967

DX TEST

OK, you DX'ers, let's put it on the line. Let's see just how good you are at beam directions. All you have to do is guess the beam direction for the following countries within five degrees. If you live in Minnesota make that three degrees because you have an advantage over everyone else because we want not just the headings of each of these countries, but the headings that you would use if you were in Minneapolis. That shouldn't be too hard, right?

Credit your self with five points for each right answer.

Israel	......	Bermuda	......
Togo	......	Singapore	......
Burma	......	Iran	......
French Somoliland	......	Nepal	......
		Galapagos	......
Ireland	......	Guam	......
Liechtenstein	......	Canal Zone	......
Egypt	......	Ascension Island	......
Heard Island	......		
Hawaii	......	Virgin Islands	......
Venzuela	......	Ceylon	......

Turn to page 88 and see how well you know your beam headings.

About "Load"ing. . .

Which Loads What - or - What Does It Mean?

Presumably we all know what we mean when we talk about loading a transmitter, or an antenna being a good load–but we often run into some confusion when we attempt to communicate what we mean to each other. Not a small part of the resulting difficulty and confusion is due to the little-known fact that the word "load" has a multiplicity of meanings, some of which contradict each other.

Most of us automatically say, in such a discussion, that we are "loading the antenna," or that "the antenna won't load." Unfortunately a few of us purists feel that an antenna in itself is incapable of "loading" anything–it merely furnishes the "load" for the transmitter.

Discussion between editor, publisher, and a staff member over this point in regard to the License Study Course series led to some research, which in turn led to the discovery (which surprised us all) that for once, everybody was right.

Our authority is Funk & Wagnalls Standard Dictionary of the English Language, International Edition, a two-volume work which is not quite so complete as Webster's Unabridged, but more comprehensive than most for its size.

We found that the word "load" is descended to us from old English, which was the language spoken in England before about 1150 A.D. and includes Anglo-Saxon. Like most four-letter words of Anglo-Saxon origin, it has about as many meanings as it has users.

Specifically, our dictionary lists nine separate meanings for it if used as a noun, and twelve more if it is used as a verb. Of the twelve "verb" meanings, nine are "transitive" and three are "intransitive." This means merely that nine of the verb meanings require an "object" while the other three do not.

None of the twenty-one meanings listed are precisely the usage of ham radio, but several of them are close enough to our usage to draw some conclusions from. The first meaning listed for "load" as a noun is: "That which is laid upon anything for conveyance," and that corresponds pretty closely to our purist feelings that the antenna is the "load" for the transmitter – that is, when we connect the feedline we are "laying the antenna upon the transmitter." The fifth meaning as a noun is also fairly close to this viewpoint: "the resistance overcome by a motor or engine in driving machinery."

Had we stopped right here, the purists would have won a clear-cut victory, and we would have been forced to conclude that those of us who say "the antenna won't load" are wrong. But we didn't stop; we went on to examine the verb definitions too.

The first definition listed for "load" as a verb is a transitive usage, meaning that something must be loaded by something else. The definition reads: "to put something on or into to be carried," and that is a pretty close fit to our usage when we say that a transmitter refuses to load the antenna. It would, however, outlaw the phrase "the antenna refuses to load the transmitter" because the antenna does not put anything into the transmitter to be carried.

We kept reading, and came to the sixth verb definition (also transitive) which says: "to take on (a load, cargo, etc.)." This one fits precisely with those of us who feel that the antenna loads; when we say that an antenna "refuses to load," we are saying that it "refuses to take on" power.

The real clincher to it all, though, was verb definition ten, which reads: "to take on or put on a load or cargo." This one is blatantly two-way, and permits us to say either "the transmitter refuses to load" (meaning "the transmitter refuses to put on the load") or "the antenna refuses to load" (meaning "the antenna refuses to take on the load") while citing the same authority for either usage!

So what does it all mean? Simply this: everybody is right, despite the possibilities for unlimited confusion. When, in a discussion of loading, it appears that everyone is talking at cross-purposes, the thing to do is to bring the discussion to a halting screech and get everybody together with the *same* set of meanings at least for the duration of the discussion. Then you'll be able to make some headway with the real problems of *why* there's a loading problem, without staying hung up in the somewhat artificial problem of what *loading* actually means.

73 Staff

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Ø Cycle Audio Filter For CW

A Short Circuit

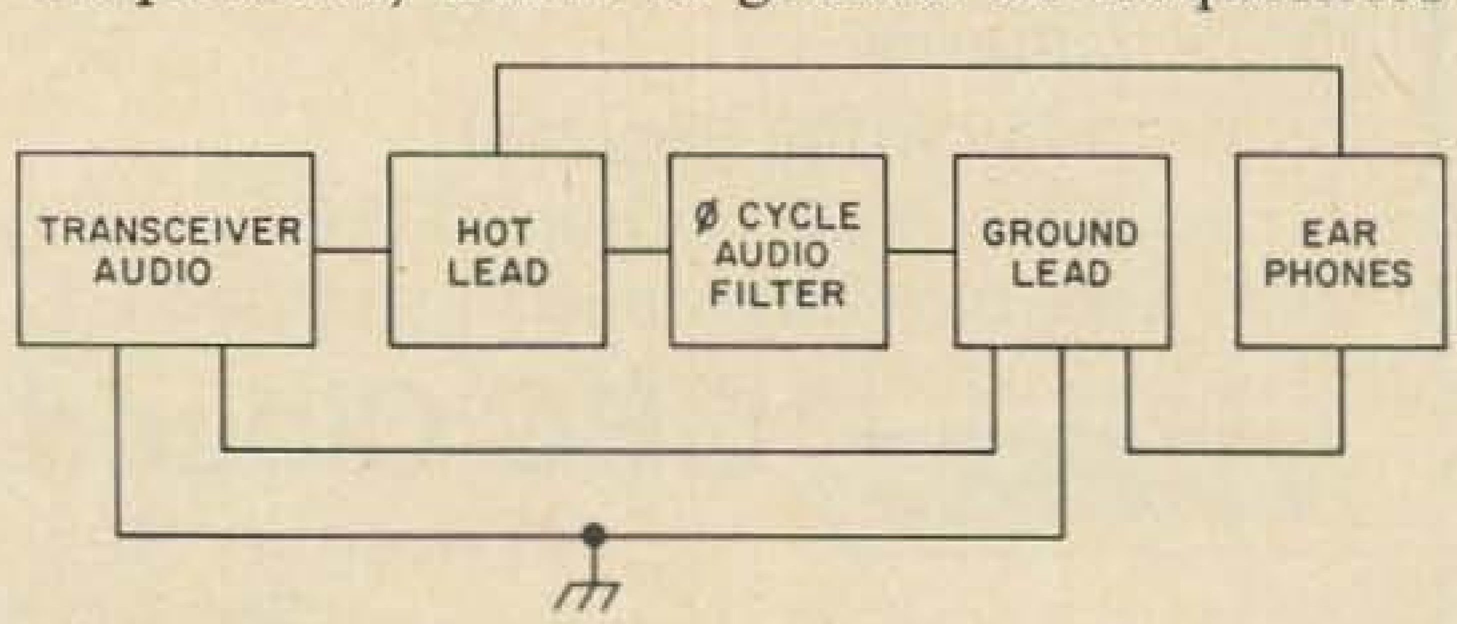
Sam McCluney, LX5SM/W4
910 John Anderson
Daytona Beach, Florida 32074

I am a bit of a CW addict, and at times my Galaxy leaves something to be desired, even with the 300 cycle filter turned on, in the way of selectivity. I felt I was really nitpicking if I was un-satisfied with such performance that I had achieved with no other work but signing the check. But such is striving for state of the art and I hoped to find some way of hearing only one signal and not many. With the BPD expedition in the offing, I felt that I should prepare myself for an even bigger onslaught of stations then I had to cope with when I was looking for WNV.

The narrowest filter I had seen advertised was a selectivity of 120 cycles. I of course had to try to beat this. So my goal was to be zero cycles selectivity, figuring that nothing could get through that in the way or QRM. All the filters I had seen were rather small in appearance. My own 300 cycle one was miniscule enough as was the 120 cycle one and a third that was advertised but I can't find at the moment. So along with outdoing the others in performance I had to outdo the others in size. This last wasn't hard to do for as every day passes there are more and more advances in microcircuitry, and all I had to do was use the advances that the others didn't have available when they were designing what turned out to be my competition. Lastly, if I could build it with parts I had on hand (read junkbox) then I could not only save money but also time in not having to go to the store for parts. Not really a requirement except in the most basic sense was the fact that I would need to be able to build a filter. Or I guess I should say figure out how to wire the parts together so they would achieve the desired resuit. I can use the term "design" now since it works but at the time I started I was "tinkering around with my stuff again." Working with audio, I didn't expect to have the problems I had when I tried to wire a six meter converter, though I am not putting down hi fi a bit. I guess I always will be a hay wire builder as well as I build. Well enough of this circut design parameter stuff and let me try to get into the theory of operation and then we will get down to the actual melting of solder which I call building.

Circuit Theory

After examining how the various audio filters worked I was impressed with the similarity of the circuits, as I am with transceiver circuits. Perhaps I am wrong but I felt if I was to achieve my hoped for performance of zero selectivity, then perhaps a different approach was called for. It seemed to me that maybe the maximum performance those circuts could produce had already been built and trying to achieve further narrowness was impossible. I think also secretly I wanted to do something different, cause I don't like to follow the crowd (except in DX) a prime reason why I was able to go through three years of the Army with a college degree and never rise above the rank of private. My mind settled on how best to eliminate all audio frequencies above zero. I was obsessed with the wonderful performance reports I had seen written up on Times Wire & Cable's new device which they called a "copper conducter." This had the remarkable fact that if it wasn't overloaded it would, at audio frequencies, shunt to ground all frequencies



Block diagram of Ø cycle filter installed in the audio system of receiver.

from zero to infinity, which seemed to meet my needs exactly. It turned out, upon experimenting with several prototypes in a breadboard circuit, that they were just exactly what I needed and my only problem was to choose the one I needed. This was quickly accomplished by choosing the smallest model that matched the audio power output (about 4 watts) of my transceiver.

Construction

I have always been a little bit annoyed with most construction articles, when they reached this point that they then said that if you couldn't follow a schematic then you weren't really a dyed in the wool constructor and they wouldn't tell you step by step how to build their pride and joy. I have been stopped many times from building what looked like a really good deal with just such an attitude of theirs. This is an excellent project for a beginner (my mother built one and her electronics goes only to operating the audio kill switch we have wired into the TV for commercials, and she got perfect performance in her model) as it doesn't take long to build and is very uncritical in wiring. I had the choice of wiring the modification into the receiver but that would mean lowering the resale value on the Galaxy on trade in time so that meant it had to be outboarded. The trouble with that though was that like the Galaxy filter it would be an extra box on the operating table and so at this stage I figured that if it could be wired into some other piece of equipment that wouldn't be traded, all the better. I finally settled upon the earphones themselves, since I had such small components to work with (thanks to microcircuitry) and large ears (thanks to genes). For a while I was going to modify both earpieces but decided against that, because of the extra work involved, so I make the modification in the earphone plug. The following step by step wiring diagram concerns that earphone plug modification, but the principle can be applied to just about any use.

1) Unscrew the plastic shell to the rear of the plug part of the plug.
2) Take a copper conductor and trim the leads to 1 1/8" when stretched straight.
3) Tin sparingly both leads of the copper conductor, use heat sink for protection. S2
4) Bend both leads so that they connect between the hot lead and the ground and make a good mechanical joint. NS
5) Place heat sink on lead extending from the copper conductor to the hot lead of the plug, apply soldering iron and solder. S1
6) Repeat step 5 for the remaining lead to the ground. S1

View of Ø Cycle Audio Filter installed in earphone plug. Note that the hot lead of the plug (top) is coupled to the ground lead of the plug via a Times Wire & Cable copper conductor. The plastic shell of the plug is to the left to show the wiring of the filter in the plug. The copper conductor and its leads are protected with a plastic covering. (VU2HG Photo)

Results

There, in six steps, are the secret to a whole change in CW operation. For me it has meant a whole new world, the complete absence of QRM; though with Gus set for take off in February (this is being typed 5 Dec.) I may still need something with even more selectivity. There is another advantage I think I have achieved with using a new circuit and components. That is, I have eliminated the annoying ring that comes with such narrow filters. The only trouble I have found now, seems to be receiver drift. Before, with 300 cycles, that was no problem but now with a 300% improvement in selectivity I find that I have to leave the transceiver on continuously and variac the line voltage to compensate for even one volt change in the line voltage. With my model 19, I find that I can copy on only one tone when they are on narrow shift and eliminate *all* errors, something that I haven't been able to do before on RTTY. Without a lot of fancy test equipment it is hard to say, but it is far better than anything I have ever read or heard about. The Galaxy filter has an audio amp to compensate for insertion loss. This doesn't need one, so it apparently has no insertion loss. It is very convenient to use, for all I have to do for SSB is to unplug the headphone as usual and I am back at barndoor 2.1 kHz selectivity.

Finally, a note or two on construction hints (where I had trouble). I recommend that, for safety, the earphones be unplugged from the chassis as I attempted to wire the jack up without doing it and had a number of damaged copper conductors to show for the efforts. The other is to be certain of the polarity of the copper conductor so that the hot lead side goes to the hot lead side of the plug and the ground lead goes to the ground lead side of the plug. The two leads look the same, but are marked, so be sure to mark one lead with nail polish before taking it out of the box and risk getting them backwards. If you should get them mixed up, a simple resistance check with an ohm meter will straighten you out. As useful as these new copper conductors are, it won't be long before the price comes down and more people start manufacturing them. I expect to see a whole new series of articles in 73 using the devices that will come from what is now just in the embryo stages. . . . LX5SM/W4

Propagation Chart

APRIL 1969 J. H. Nelson

April 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			

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	7	7	7	7	7	14	14	14	14
ARGENTINA	21	21	21	14	14	7a	21	21a	21a	21a	21a	21a
AUSTRALIA	21a	21	14	14	7b	7b	14	14	14	14	21	21a
CANAL ZONE	21	21	14	14	14	7a	14a	21	21	21a	21a	21a
ENGLAND	14	7	7	7	7	14	14	14	21	21	21	14
HAWAII	21a	21	14	14	7b	7b	14	14	21	21	21	21a
INDIA	14	14b	7b	7b	7b	7b	14	14	14	14	14	14
JAPAN	14a	14	14	7b	7b	7b	7	14	14	14	14	14
MEXICO	21a	14	14	14	7a	7a	14	21	21	21	21a	21a
PHILIPPINES	14	14	14	7b	7b	7b	7b	14	14	14	14	14
PUERTO RICO	14	14	14	7a	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	14	7b	14	14	21	21	21a	28	28	21a	21
U. S. S. R.	7	7	7	7	7b	14	14	14	14	14a	14	14
WEST COAST	21a	21	14	14	7	7	14	14	21	21	21a	21a

CENTRAL UNITED STATES TO:

ALASKA	14	14a	14	14	7	7	7	7	14	14	14	14
ARGENTINA	21	21	14	14	14	7a	14	21	21a	21a	21a	21a
AUSTRALIA	21a	21a	21	14	14	14	14	14	14	14	21a	21a
CANAL ZONE	21a	21	14	14	14	14	14	21	21	21a	28	21a
ENGLAND	14	7	7	7	7	7b	14	14	14	14a	14a	14
HAWAII	21	21	14a	14	14	14	14	14	21	21a	21a	21a
INDIA	14	14	14b	7b	7b	7b	7b	14	14	14	14	14
JAPAN	14a	21	14	14	7b	7b	7	7a	14	14	14	14a
MEXICO	21	14	14	7	7	7	7a	14	14	14	21	21
PHILIPPINES	21	21	14	14	7b	7b	7b	14	14	14	14	14
PUERTO RICO	21a	14	14	14	7a	7a	14	21	21	21	21	21
SOUTH AFRICA	14	14	7b	7b	7b	14	14	21	21	21a	21a	21
U. S. S. R.	7b	7b	7	7	7b	7b	14	14	14	14	14	7b

WESTERN UNITED STATES TO:

ALASKA	14	14a	14	7a	7	7	7	7	14	14	14	14
ARGENTINA	21	21	14	14	14	7a	14	21	21a	21a	21a	21a
AUSTRALIA	28	28	21a	21	21	14	14	14	14	14	21a	28
CANAL ZONE	21a	21	14	14	14	14	14	21	21	21	21a	21a
ENGLAND	14	7b	7b	7	7	7b	7b	14	14	14	14a	14
HAWAII	28	28	21a	21	14	14	14	14	21	21a	21a	28
INDIA	14a	14a	14	14	7b	7b	7b	7b	14	14	14	14
JAPAN	21	21	21	14	14	7b	7	7	14	14	14	14a
MEXICO	21	21	14	14	7a	7a	7a	14	21	21	21a	21a
PHILIPPINES	21	21	21	14	14	7b	7b	7b	14	14	14	14a
PUERTO RICO	21a	21	14	14	14	7a	14	21	21	21	21a	21a
SOUTH AFRICA	14	14	7b	7b	7b	7b	7b	14	14	21	21	21
U. S. S. R.	7b	7b	7	7	7b	7b	7b	14	14	14	14	14b
EAST COAST	21a	21	14	14	7	7	14	14	21	21	21a	21a

Looking Back

Kayla, W1EMV

There seems to be a little Gremlin who plays havoc with articles and manages to build in errors. In some cases the errors originate with the author and the crew at 73, being overworked, lets them slip by. I guess the only way to have a magazine with absolutely no errors is to have more help, prepare each issue six months in advance and have 100 proof readers.

Here are some problems which have been called to our attention in recent issues.

August 1968, Pg. 70. A Review of the Newtronics 4-BTV.

Where reference is made to SWR at resonance, this is incorrectly printed as 1.5:1. It should be 1.05:1. The total height of the antenna is 23', not 33'.

October 1968, Pg. 30. High Performance Receiver for 2 Meters.

There are a couple of errors in the schematic on page 32. The primary center tap of T6 is not grounded. The resistor across L5 was shown with no value. This should be 47k. The oscillator tuning capacitor is shown as C4, but is called C1 in the text. Q5, which is numbered 2N385 on the diagram should be 2N3858.

November 1968, Pg. 20. IC Frequency Counter.

This article was oversimplified to a degree that most hams couldn't build it from the information supplied. We have since received voluminous material containing modifications, clarifications and corrections far too great to print for the limited number who will actually build this counter.

If you are seriously interested in building this counter, a SASE will bring you a copy of the additional material.

December 1968, Pg. 6. First Ham IC

In Fig. 4., page 8, there is no internal connection between the base of Q21 and collector of Q20. Since this article was printed, National Semiconductor Corp. has announced a lower cost version of the LM179/270. The new LM370 is now available through all NSC distributors.

January 1969, Pg. 28. Two Meter Transistor Transmitter.

The coil data was left out. Here it is:

L1- 18t # 24 el. ¼" slug tuned form, 2t sec. on coll. end
L2- 10t # 24 el. same as L1
L3- 6t # 18 bare ¼" dia.
L4- 2t same as L3
L5- same as L4
L6- 3t same as L5
L7- 4t same as L6
L8- 6t # 18 ½" dia. ct with 4t link
L9- Z235 with 6t removed
L10- 5t # 12 ½" dia. ct, 1t link

January 1969, Pg. 48. The Six Net.

Fig. 1. has several errors. In the lower left hand corner there should be a 500 pf capacitor in series with the crystal and the .01 capacitor which shunts the 560 ohm resistor. Without this capacitor, the oscillator will not oscillate. The 56k resistor at the base of TR2 does not go to ground. Rather, it should go to B-. The center tap of the output transformer does not connect to the junction of the two 10 ohm resistors. This creates a direct short. Instead, it goes to B-.

January 1969, Pg. 72. Quick and Easy QRP.

Figs. 1 & 2 were transposed in the text.

You can't win them all, but it would be nice to have a chance to win some of them.

Those Card Inserts

Several supposedly sophisticated readers wrote in to complain about the advertising card insert in the February issue. Perhaps they thought that I had suddenly changed and decided that I liked having cards stuck in 73. No, I hate it. But running a card like that makes it possible for us to print eight more pages of articles and this is hard to ignore.

If we charged you what it costs to put out 73, our subscription rate would be about $12 per year. The advertising in the magazine pays most of the freight and we are able to send you the magazine for three years for $12! Advertising is basic...the more ads the bigger the magazine...the fewer the ads the smaller the magazine. If you enjoy 73 and want to help, let our advertisers know that you appreciate their support of the magazine. And, let the advertisers who are not appearing in 73 know that you will support them if they support your favorite magazine.

— Wayne, W2NSD/1

NEW PRODUCTS

Pinpoint TV Troubles in 10 Minutes

If you are working with electronics gear this book is worth a few minutes of your time just to pick out the key ideas. And if you are in the TV service business it is probably worth much more than that to you. It explains and includes a carefully arranged, logical system for locating TV set faults.

The key point is that, for a given failure, some faults are more likely than others. An analysis of the observed symptoms will indicate certain circuits cannot be at fault, and that certain details might or must be out of line in some other circuits. For instance, if there is audio but no picture, you can scratch the low voltage supply and the front end circuits as sites for the trouble, and the high-voltage supply is worth early attention if a simple test indicates no picture tube voltage.

Pinpoint TV Troubles in 10 *Minutes is* TAB's book #428. It is available at your dealer's, or try TAB Books, Blue Ridge Summit, Pa. 17214.

New AF Generator

If your test gear uses vacuum tubes, it's out of date. Modern instruments using transistors and integrated circuits are more stable and reliable, use less power, and are very much smaller at no reduction in utility or accuracy.

A new audio generator has just appeared on the market. It meets or betters all specs for service type instruments. Imported from Japan by the DGP Company, it is probably going to revolutionize the whole test instrument market, which has not been very progressive lately.

About the size of a VOM, the generator weighs less than 2 lbs, and is about 7½" long, by 4" x 4". It has a calibrated vernier scale, and generates both sine and square waves (0.2 microsecond risetime!) over the range of 10 Hz to 100 kHz, at up to +9 dbm from a 600 ohm load. Amplitude and distortion specs are remarkably good, and the generator is useful anywhere 115-VAC is available.

The time is coming when a lab or service shop will have several little transistor and IC test gear boxes rather than shelf after shelf of big heavy contraptions for measurements applications. The early production runs of this generator are already sold but more are coming in, and are sure to be very popular in radio amateur applications. Price is $59.95.

Two Tips On Cutting Glass

Both of the following suggestions have been around for some time, but they do not seem to be general knowledge. In view of their usefulness, it would seem worthwhile to repeat them for the benefit of those who are not aware of them.

Chimneys for the 4 x 150 family of tubes are easily made by cutting off the tops of baby-food jars. To do the cutting painlessly, tie a heavy string around the jar about a ¼ inch below the point where you would like the break. Saturate the string with lighter fluid and set it afire. After the flame dies out, pick up the jar by the bottom, invert it, and plunge it quickly into cold water. The cut will be straight if the string was properly aligned and the jar vertical when it touched the water.

This works well on larger jars too. There are interesting possibilities in making chimneys for several of the larger types of tubes using peanut butter jars, etc.

Single strength sheet glass, such as is used in meters, dials, etc., is cut quite easily into odd shapes with tin snips or household shears. Fill a container, somewhat larger than the glass to be cut, with water. Immerse the glass and slowly cut out the desired shape. The glass must be entirely under water and the further the better. Be sure to wear gloves to protect your hands.

I know both of these ideas sound slightly unreasonable, but they work beautifully.

William P. Turner, WAØABI

BX Sheath is Handy!

The metal sheath used to enclose wires in BX electrical cable has many uses in the hamshack. The sheath can be used to cover several wires at a time. For example, a single BX sheath will enclose the coax and rotator cable leaving your shack for the tower. This reduces XYL resistance immensely! You can use BX sheath behind the operating bench to untangle the "wire jungle." As a bonus, the sheath looks really "professional."

You can get BX sheath at construction projects or from your electrical contractor. True, the lengths will not be more than a few feet long, but even this is enough to reduce a lot of "jungle" into only several cables. For long lengths of sheath, you will have to buy some BX cable and remove the wires inside.

You will be pleasantly surprised at how much neater your shack is when you use BX sheath!

D. E. Hausman, VE3BUE

BUY 73 BOOKS

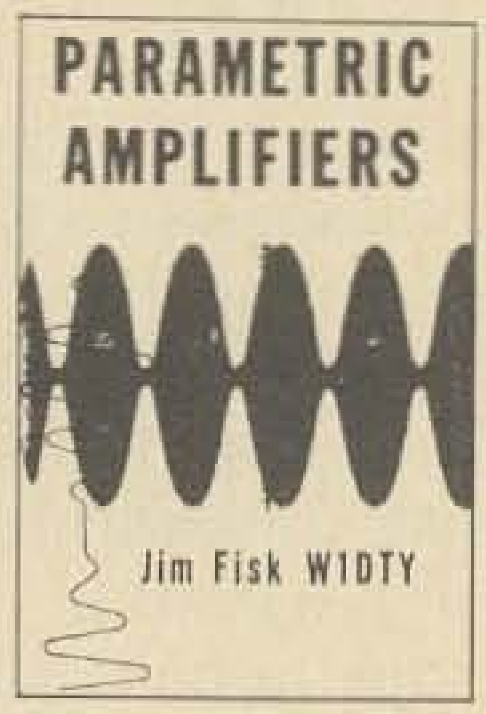
73 USEFUL TRANSISTOR CIRCUITS

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

INDEX TO SURPLUS

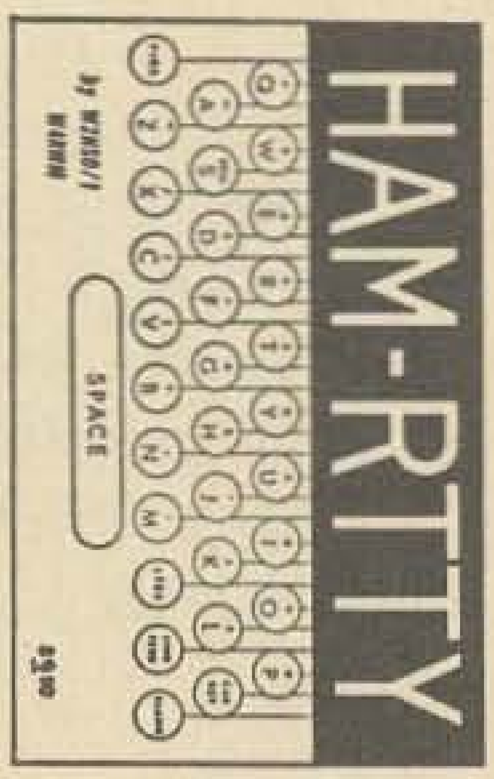
Do you have a piece of surplus equipment that you want to convert but can't find an article? If so, this is the book you need. It lists all of the surplus articles and conversions in popular electronic and amateur magazines from 1945 to 1966. **$1.50**

PARAMETRIC AMPLIFIERS



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

HAM RTTY



More and more hams are joining the RTTY crowd every day. This 112-page book gives you all the basics and tells you what you need to know to get started and get on the air. Written by W2NSD and W4RWM. **$3**

VHF ANTENNAS

This handbook by K5JKX is a complete collection of information about VHF and UHF antennas, with design hints, construction and theory. If you've been wondering what array you need, this book will give you enough background to make the right decision. **$3**

SIMPLIFIED MATH

Does math scare you? It shouldn't in this easy-to-understand book K8LFI explains the simple exponential system of arithmetic, simple formulas, logarithms, and their application to the ham shack. **50c**

HAM TELEVISION

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

DIODE CIRCUIT HANDBOOK by WA1CCH. Will drive you right out of your mind. **only $1.**

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

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

CUMULATIVE INDEX lists all the articles in **73** up throuah December 1966. **25c**

—Transistor Circuits $1.00
—Index to Surplus $1.50
—Parametric Amplifiers $3.00
—Ham RTTY $3.00
—VHF Antennas $3.00
—Simplified Math .... $ .50
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—CW .... $ .50
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73 Magazine

Peterborough, N. H. 03458

(...de W2NSD/1 continued from page 2)
ate from if he is going to keep those dollars rolling in. This is where trouble has arisen in the past...once you are out on a small island somewhere who is to know where you really are? Or if you are sitting in some west African country who is to know for sure which one you are really operating from? It is a lot easier to sit back and drink a beer or coke for a couple of days and then come back on with a new call from a nearby country and save all the wear and tear on yourself.

Perhaps the new restrictions for DXCC will prevent this from happening again. I doubt it. When money is involved people find a way to get around just about anything. We've already seen false statements by ship captains in the recent past. It is possible that the ARRL will continue to accept fake DXpeditions rather than chance the members' anger by discounting them. I believe that they have enough evidence to write off some forty to fifty not too long past DX operations. I guess I don't blame them for choosing to hope that it will all blow over. Did you suspect that there might have been that many crooked operations in the last few years? Well, *you* paid for them. You keep donating money the way you have and you'll probably get more of the same. ... *Wayne*

CLUB SECRETARIES NOTE

Your club can round up some extra funds by imploring, cajoling, convincing, or forcing your members to subscribe to 73 Magazine. Never mind the cries of anguish, just remember that you are doing what is best for them—and the club.

Subscriptions to 73 are normally $6 per year. The special club rate is exactly the same: $6. The only difference is that the club treasury holds 25% of the loot and sends the rest to 73. Send us $4.50 for each one year subscription, in groups of at least five subs. Just think, if your club has 10,000 members you can quickly get $15,000 for the club on this deal!

Send the subscriptions to us on 3"x5" cards, giving the name, call, address, city, state and zip code of each subscriber. If the subscription is a renewal please include the address label from a recent 73 wrapper. Indicate all renewal subscriptions so we won't start a second sub. We have been known to do that.

Send to: Club Finagle, 73 Mag. PETERBOROUGH, N.H. 03458

Camp Albert Butler

Dorothy C. Saunders, W4UF
P. O. Box 295
Englewood, Florida 33533

For the ninth consecutive year, this past August saw men and women, and boys and girls, from all over the country arriving at Camp Albert Butler in the Blue Ridge Mountains of N.C. for its annual radio school. By plane, bus, and car they came, from all backgrounds and businesses, and ranging in age from 12 to 80.

This radio school, the only one of its kind in the country, is under the direction of Carl L. Peters, K4DNJ, General Secretary of the Gilvin Roth Y.M.C.A. in Elkin, N.C. It offers a maximum number of 60 students the chance to take a two-weeks' highly concentrated course leading to either the General, Advanced or Extra class of amateur radio license. On the last day an F.C.C. Examiner gives the students their examinations. Radio theory and code are taught in alternate courses during all of each morning, and again in the evening after dinner. Afternoons are free for study, code practice, swimming in the large outdoor pool, rifle, archery or pingpong. A number of field trips are also arranged during the two weeks to places of interest in the vicinity.

The camp is perched in a flat clearing on the top of one of the Blue Ridge Mountains, just two miles south of the Parkway, at about 3600' in altitude, with a striking view out over the great monadnock called Stone Mt., and miles of the rolling piedmont below. Rustic cottages are scattered among the large trees and rhododendrons, with the dining hall at one end of the swimming pool, and a very large recreation hall at the other. A camp radio station is in active use on several bands, as well as the sets brought by students, for skeds with home and other contacts during the session.

This was my second year as an instructor at the radio school and I had one of the mixed adult-teenager groups in radio theory, and the fastest code speed group, both leading to the general class of license. The general class students are divided into three theory and three code groups. On the first night of camp a code test is given to everyone, and separations into the code classes are made upon their ability to copy at around 5 wpm, or 8-9 wpm, or 12-13 wpm. The advanced and extra classes of students are together for both theory and code, with one instructor.

They worked hard to get their speed up to 13 wpm for their general class ticket, and to understand the intricacies of Ohm's law, and other problems of theory. For the adults, the financial successes of their past lives helped not a bit at the camp, where the only

criterion of success was whether or not one had passed the last theory test, or could as yet copy 65 consecutive letters without a mistake. The M.D.'s, judge, trial lawyer, retired executive vice president of one of the largest national food chains, priest, oil-well driller, oil-well owners, electronic components manufacturer, ex-h.s. principal, nurse, test driver for General Motors, policeman, engineers, and teenage grammar and high school students, among others, all studied and helped each other to understand difficult points, in a wonderful example of *esprit de corps* and friendship. One group of students, who might perhaps more correctly be dubbed "the young at heart" than "the young in years", were put together to live in one of the large cabins, which they promptly named "The Pill Box." They got along so famously that plans have been made to get together on a "Pill Box Net" as soon as they receive their licenses.

Highly motivated and bright as the teenagers are, it is a stimulating experience to teach them. It truly would be a revelation to some of their former teachers, I am sure, to see how hard they work. The teens are definitely the age when it is the easiest to learn code, as many an older student at camp ruefully realized when he struggled to copy 65 letters at around 13 wpm, and found next to him a 14-year-old breezing along with no effort and 100% correct copy. During the last several days of camp, the highest code classes for the General group are at 15 wpm, so that up to two minutes of speed may be lost through tension during the F.C.C. exam. Parents whose teenagers become interested enough in ham radio to want to study and get their general licenses, are indeed fortunate. There will be no delinquency problems in their homes, but instead fascinated youngsters at their little transmitters, learning to communicate with others of like interests elsewhere in the world, and slowly increasing their technical knowledge.

Once again this year on the morning of the last day of school, after a hearty and excellent breakfast, the instructors watched the long line of cars wind down the mountainside on its way to Elkin where the F.C.C. examinations were given.

Now little notes are being received by the instructors from their students, proudly giving their new calls and asking for skeds. And a new group of graduates of Camp Albert Butler is launched upon the amateur bands.

...W4UF

Getting Your Extra Class License

Part III Television and Interference

Staff

One of the most catastrophic factors ever to hit amateur radio was the advent, some 25 years ago, of television.

Old-timers may remember their problems with broadcast interference--but they were virtually insignificant when compared to the problems posed by TVI. Television interference just would not be tolerated by the public--and not a few incidents of violence such as toppling of antenna towers and potshots at the ham shcaks were recorded in the beginning.

Understandably, the FCC has rather strong feelings also about interference between the various services licensed by it, and so all examinations for Amateur licenses include some questions on television interference and its control. As the highest of all ham tickets, the Extra Class requires not only a knowledge of TVI control but also a knowledge of television techniques themselves.

We had originally intended to cover both TV and VHF in this installment of the Extra Class Study course, but it became obvious that if we combined the two we could do justice to neither. This month, then, we'll cover only three of the FCC study questions–those dealing with television. Next time, we'll move on to take our scheduled look at VHF.

This month's questions (the numbers, as always, are from the FCC list in case you're following it) are:

8. How does amateur TVI usually affect television reception?

34. Why are synchronizing pulses transmitted with television signals?

54. How can unwanted VHF resonances in a transmitter amplifier be moved from TV channel frequencies?

Following our usual practice in order to provide more comprehensive background, we'll rephrase these three questions into others.

All three require some knowledge of the actual transmission techniques used in television. Our first question, then, will be most broad–"What is Television?" From this beginning, let's find out "How Is Television Transmitted?" for the answers to the big problem, "How Is TVI Suppressed?"

Even if you're not interested in the Extra Class ticket, you may find this particular installment worth leafing through. While we'll be concentrating on the theory behind the practice, as we always do in this study course we'll also be touching on some most practical "how-to-do-it" points along the way.

Ready? Let's dive in!

What is Television? Some of you may find this question's implications insultingly simple --and others may find it to be far too complex. Lewis Carroll once wrote (if it wasn't he, it should have been): "The place to start anything is at the beginning", though, and that's why we're here.

Television is, of course, the picture on the boob tube; these days, as likely as not it's in glorious color. That's not really the answer we're looking for. What we actually want to know is, "How does it get there?"

Without going into the mechanism of the cameras at all--let's assume for now that they're working as intended--the picture gets on the face of the tube because it's *wiped* there by a speeding electron beam which actually *is* faster than a bullet.

This tiny beam is pulled across the face of the tube from left to right exactly 15,750 times every second, and at the same time it's pulled down the tube face from top to bottom so that it takes 1/60 second to make the vertical trip. During this single pass it covers the complete face of the tube, and draws 262-½ almost-horizontal lines as it goes. The beam then flies to the top of the tube--moving halfway across the tube face as it does so, so that the next pass begins in the middle of the horizontal line and draws another 262-½ lines. The timing is such that the lines almost but not quite overlap each other, so that a total of 525 lines are drawn every 1/30 second.

All the time that this little spot is moving on the tube face, its intensity is being changed

–and these changes in intensity are what put the picture on the screen.

In this entire process, everything happens with extreme speed. The beam must move the width of the screen in 1/15, 750th of a second, which on a "20-inch" tube works out to a horizontal motion of something like 14,000 miles per hour. The intensity must change in much less time than this, to reproduce the fine detail we're used to seeing. In fact, the intensity must be capable of changing in less than 250 *billionths* of a second in order for the signal to meet present federal standards.

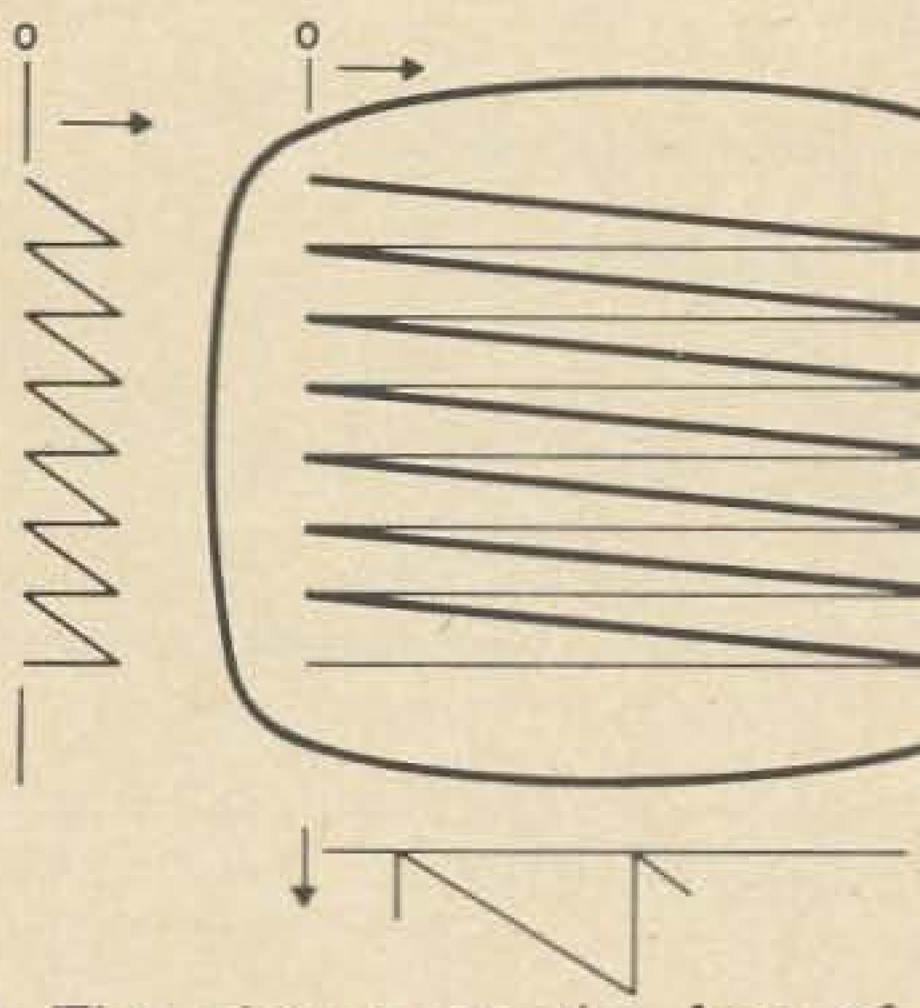


Fig. 1--The picture on the face of a TV tube is produced by the process shown here. A single electron beam is swept horizontally across the screen from left to right 15,750 times per second, and at the same time vertically from top to bottom 60 times per second. As it moves, its intensity is varried to produce the entire screen.

Fig. 1 illustrates the process we've been examining and shows how the electron beam paints the pattern of lines on which the picture appears. One complete pass of 525 lines is called a "frame", and the actual line pattern produced on the screen is known as a "raster".

At this stage, we still don't have a very clear image of how the picture gets on the tube–but we know that in order to get a picture there, we must control three items. These are: (1) the horizontal position of an electron beam, (2) the vertical position of that same beam, and (3) the beam's intensity.

The horizontal and vertical positioning of the beam in any TV receiver is done by "sweep circuits" which produce sawtooth waveforms at the appropriate frequencies. These waveforms are also shown in Fig. 1. The horizontal sweep waveform occurs 15,750 times per second, and the vertical waveform runs at a 60-per-second rate.

Both of these sweep signals are produced by free-running relaxation oscillators in order to generate as even motion as possible for the beam. Relaxation oscillators are notorious for frequency drift but are very easy to stabilize by locking or "synchronizing" them to some reference signal. The necessary reference signals in TV are the "sync pulses" which are transmitted as a part of the composite video signal; they yank the oscillators into step at the beginning of every sweep cycle. We'll get into this more a little later.

Intensity of the electron beam is controlled by varying the bias between grid and cathode of the picture tube; this bias is controlled by a wide-band ac signal known as the "video" signal. When bias is large (cathode positive or grid negative) the electron beam is weak and the screen is dark. When bias is less, the beam is stronger and the screen is brighter.

This action is identical with the amplification action of an ordinary audio amplifier tube, in which the audio signal controls grid bias and so changes the flow of plate current. The major difference is that in the TV picture tube the beam current is directly related to screen brightness and we don't have to have anything like a loudspeaker to convert current to sound or light. The only other significant difference is that the picture tube must handle a signal of much higher frequency than does an audio amplifier, since brightness in the picture may change several million times per second as the beam wipes across the scene.

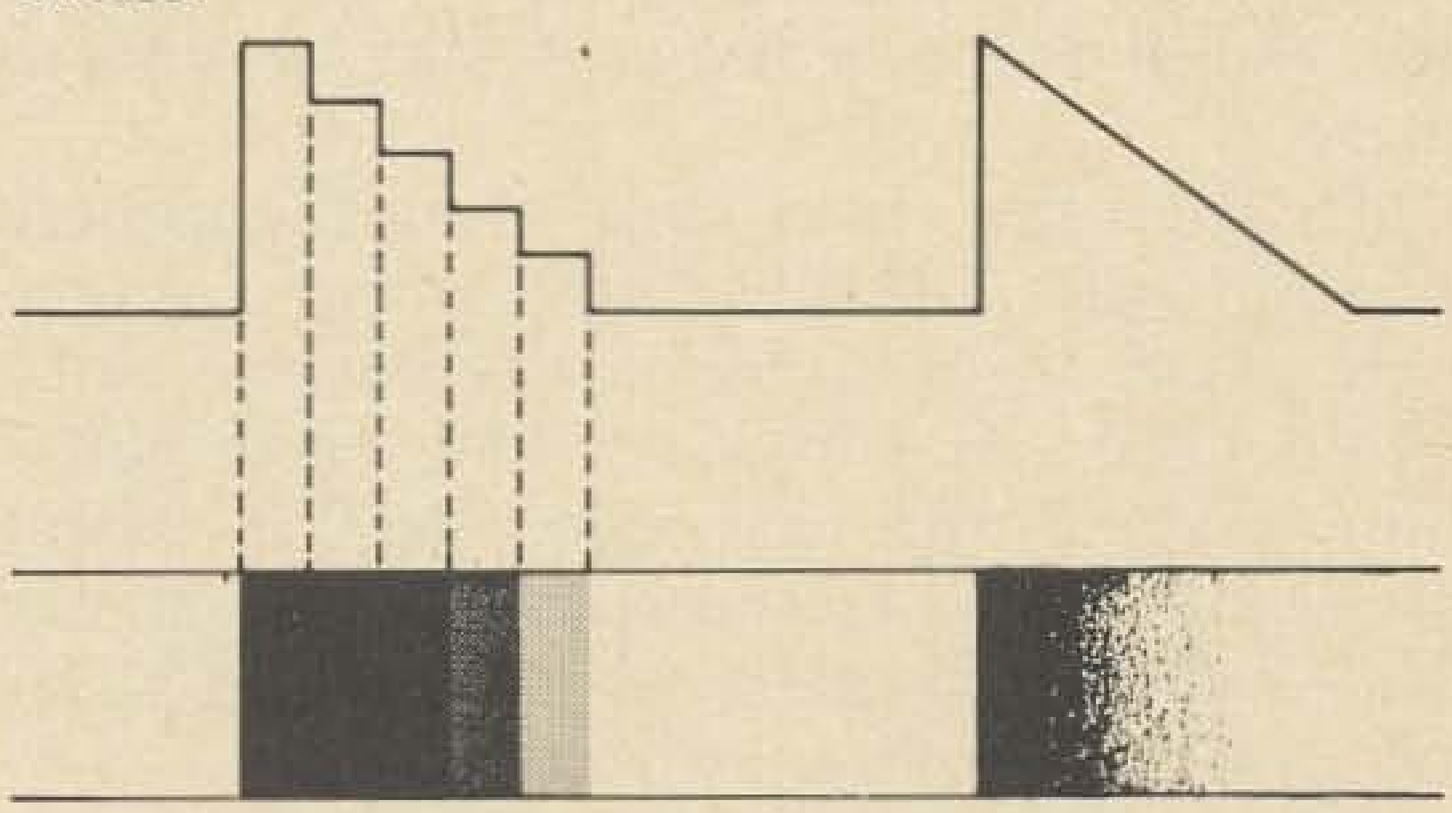


Fig. 2--This illustrates the relationship between the grid-cathode bias in the picture tube (upper waveforms) and the corresponding screen brightness on the tube's face (lower line). The greater the bias, the darker the screen. FCC regulations prescribe that the brightest part of an image must produce the lowest video voltage output, which cannot be less than 1/8 the maximum signal level, and that the darkest part of the image produce the maximum video level, which cannot be more than ¾ the maximum level. The portion of the signal above "black" level is used for blanking and sync pulses.

Fig. 2 shows the relation between picture-tube bias (or signal voltage on grid or cathode) and screen brightness. The upper line represents cathode voltage while the shaded band represents screen brightness. The more positive the cathode, the darker the screen. As you can see, the signal may change either in stair-step fashion (left of figure) or continuously (right). The stair-step changes produce sudden changes of brightness while the continuous changes produce gradual shading effects. A typical picture will have both kinds of changes in it.

The TV camera also operates with a sweeping electron beam, which does the original translation of the picture into a varying electrical signal. For this varying-level signal to reproduce a recognizable image at the receiver, the receiver's sweep circuits must be locked exactly to those of the camera. This is the primary reason why the sync pulses are included in the composite video signal.

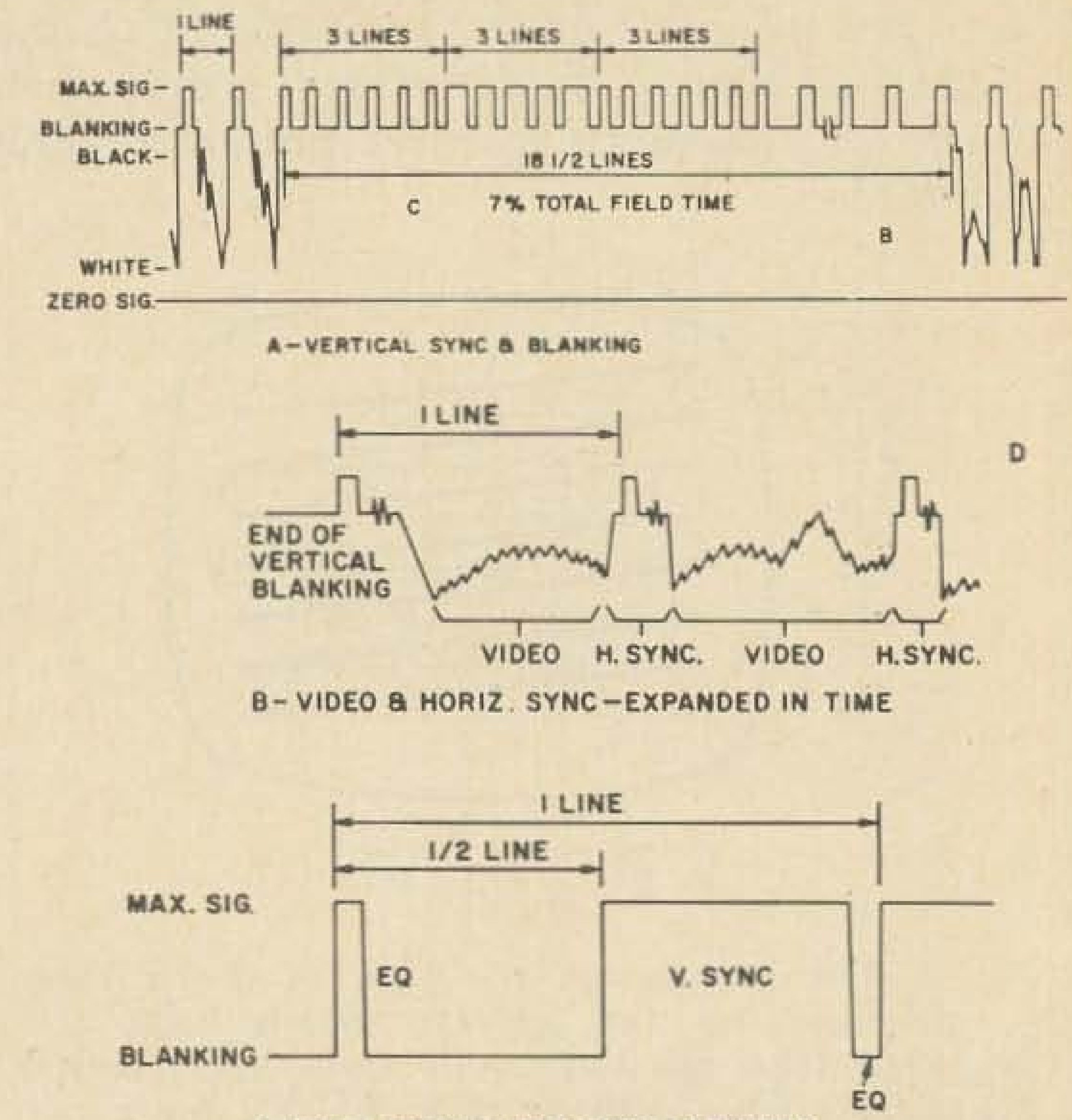
We've talked about the "composite video" signal several times now without explaining it at all. It's not the same as the "video" signal. The "video" signal consists *only* of the voltage changes representing brightness variations. In commercial broadcast TV, bandwidth of the video signal is set at 4.5 MHz; in industrial and closed-circuit TV, bandwidths as high as 6 MHz are frequent. The low-frequency limit on this signal is only a few cycles per second; it must be able to hold the screen dark for several frames at a time. In fact, for highest quality, this signal should extend all the way down to dc at the low end–but for economy's sake, it seldom does.

To keep the video signal from the camera in step with the receiver's sweep circuits. sync pulses in both the horizontal and vertical directions are necessary. When these pulses are combined with the video signal, the result is the composite video signal. Fig. 3 shows the waveforms involved in a black-and white broadcast TV composite video signal.

Before we examine Fig. 3 in any detail, let's move on a little bit and look at color. Color TV is almost exactly like black-and-white so far as the transmitted signals are concerned, although the actual equipment and circuits are far more complex for color.

The big difference with color is that we must control a fourth factor in addition to the two positioning signals and the beam intensity (which is known as the "luminance" signal in color TV). This fourth factor is the signal which determines the exact color mix produced by the beam at any one position, and it's called the "chrominance" signal.

We won't go into much detail about the chrominance signal except to say that it's carried on a phase-modulated subcarrier signal. The only reason for looking at it at all, at this point, is because in a color TV composite video signal we have all the elements of the black-and-white signal–*plus* an 8-cycle "reference burst" to let us work with the chrominance signal. This reference burst is also shown in Fig. 3. It is transmitted *only* in a color signal, and is not present when black-and-white is being transmitted.



Now, let's look at Fig. 3 in detail. You can see that four separate views are necessary to show the complete makeup of the composite video signal. The most general, view A, shows the vertical sync pulse and "vertical blanking interval". This set of waveforms shows up 60 times every second; the rest of the time the signal consists only of straight video over-

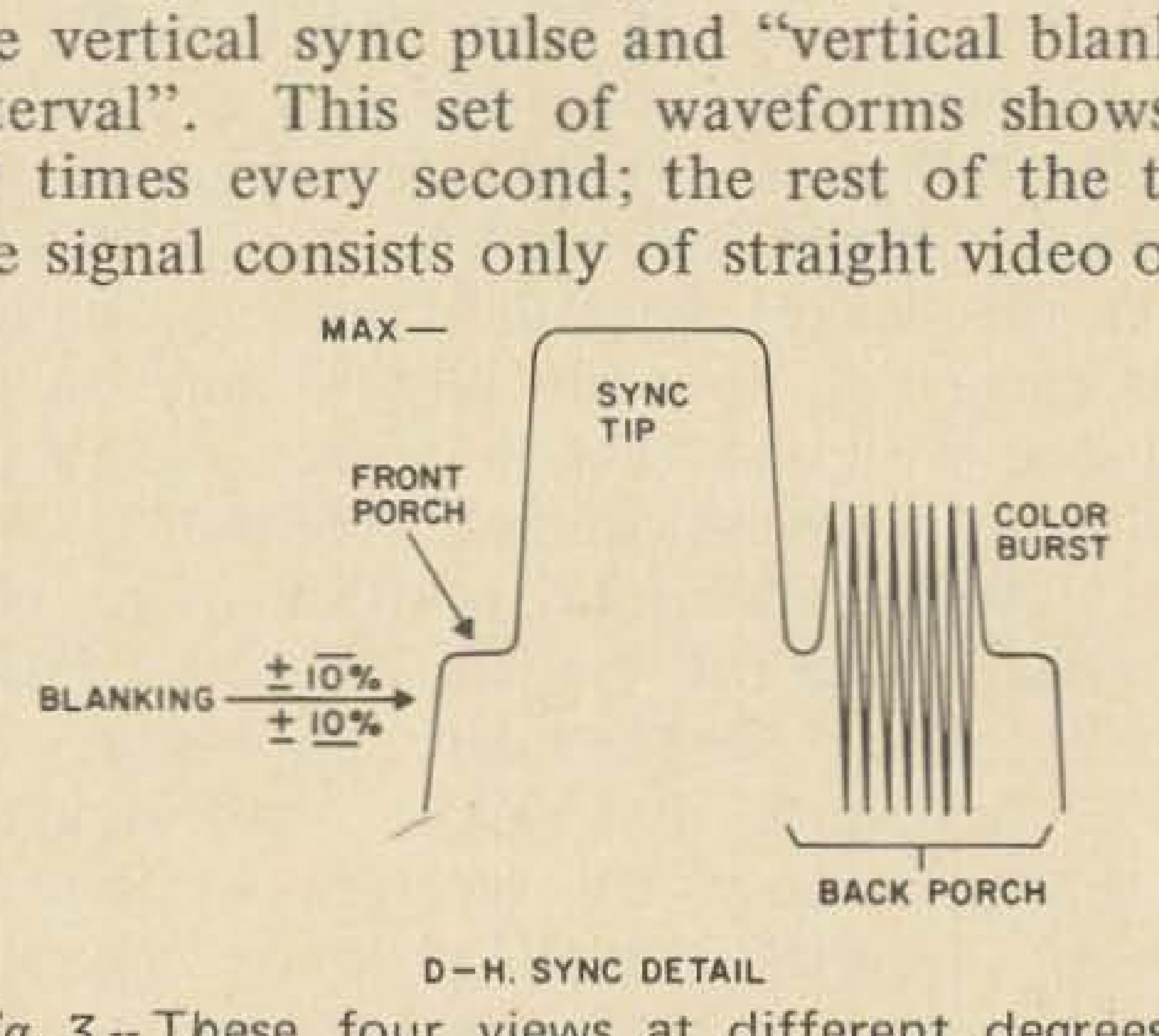


Fig. 3--These four views at different degrees of expansion in both time and signal amplitude show the details of the synchronization pulses, equalizing pulses, and color burst on the FCC standard television signals. View A shows the major portion of the vertical blanking interval while views B and C expand portions of view A. View D details the tops of the horizontal sync pulses to show front and back porches and the color burst. Color burst is omitted from B&W telecasts.

laid with the horizontal sync pulses as shown on either side of the vertical blanking interval in view A.

As view A shows, the vertical blanking interval takes up 7/100 of the time for each complete field (a field is 262-½ lines, or half of a frame) and occupies the same time as 18-½ lines. In TV, incidentally, it turns out to be convenient to refer to time in terms of "lines" since the duration of one line is a key time, to which everything else in the signal must be related.

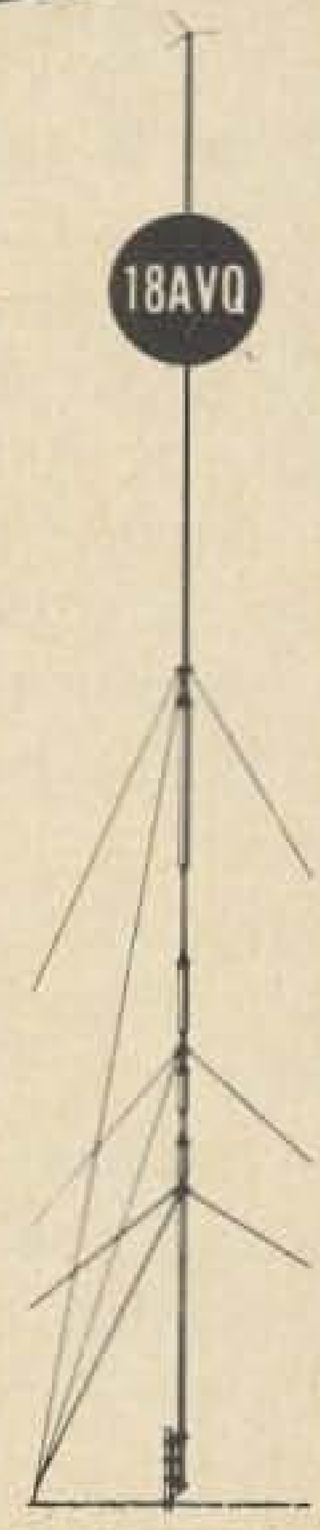
Of the 18-½ lines occupied by the vertical blanking interval, only 3 lines are occupied by sync pulses themselves. Six "equalizing pulses" occur on either side of the vertical sync pulses, and the spaces between vertical sync pulses are also employed as equalizing pulses. During this time, no horizontal sync signals are present and the equalizing pulses are used instead.

The other important point contained in view A is that all of the sync information is transmitted at a level higher than the blackest black in the picture, which in turn is higher than any lighter shades. The technician's term for this is to say that sync is "blacker than black". Maximum and minimum levels for each part of the composite signal, with reference to the maximum radiated level, are set by FCC regulations. The blackest part of the picture cannot produce a level higher than 95 percent of the "blanking level", and the blanking level itself cannot be higher than 85 percent of the maximum signal.

As a result of these restrictions, the transmitted picture is enclosed in a blacker-than-black frame produced at either side by the horizontal blanking and at top and bottom by the vertical blanking interval. More important to the viewer, the sweeping electron beam flies back across the picture during these times. Having its intensity turned all the way off makes circuitry much simpler.

You can see these signals on any TV set, incidentally. All you need do is turn the brightness up and contrast down so that "black" becomes a middle gray, and carefully adjust the vertical hold control until a black bar rolls slowly down the screen. In the center of this dark bar you will be able to see a darker area with a shape in the middle faintly resembling the head of a sledgehammer.

If you are steady enough of hand to adjust the dark bar to a stationary position in mid-screen, you can count the lines in it. You will find that the darker area in the center is composed of the vertical sync pulses, with 3



lines above it and 12-1/2 below. You may count 6 and 25 respectively, if your set is in excellent adjustment, due to the interlacing of successive fields into frames.

View **A** in **Fig. 3.** also indicates the parts of the signal to which views **B** and **C** apply.

View **B** shows two lines of video immediately after the vertical blanking interval, and their two associated horizontal sync pulses.

View **C** shows the relationship between equalizing pulses and vertical sync pulses. The equalizing pulses keep the horizontal sweep in sync during vertical-sync times, and also permit the half and half interlace since they occur twice as often as horizontal sync pulses.

View **D** shows the top of a horizontal sync pulse. The part which protrudes upward is known as a "sync tip" and performs the actual synchronization. The part which is at blanking level immediately preceding the sync tip is called the "front porch" while that immediately after the sync tip is the "back porch".

Also shown in View **D** is the color reference burst, which occurs on the back porch if it is present. This signal, which is absent in black-and-white signals, consists of at least eight full cycles of a 3,579,545 Hz sine wave, accurate in frequency to within 10 Hz. This signal is produced at the transmitter by a continuously-running oscillator and is keyed into the composite video without any change of phase. Its modulation limits are approximately equal to the height of the sync tips.

Now that we know more than we really wanted to about the nature of the composite video signal, we can see how it is used in a TV receiver.

The entire signal is received by the front end just like any other VHF signal, and goes through mixing and the *if* strip. An ordinary diode detector then recovers the composite video from the *if* amplifier output. The composite video is then amplified to a level adequate to swing the picture-tube beam from full on to full off.

The sync signals are applied to the picture tube also, where they blank off any output during retrace times. At the output of the video amplifier, they are also picked off by a sync separator circuit which is essentially a pair of low-pass filters. One filters out everything but the relatively low-frequency vertical pulses while the other takes out the video but lets both horizontal and vertical sync remain.

The signal containing both horizontal and vertical sync is then passed through a clipper which lets *only* the sync tips through, so that nothing comes out from the vertical pulses while one blip emerges for each horizontal pulse that comes in.

The resulting vertical and horizontal sync pulses are then applied to the sweep circuits where they lock the oscillators in step with the transmitted signal. Each sweep circuit contains amplifiers which drive the yoke and deflect the electron beam. The horizontal output circuit also is used to develop the high voltage for the picture tube, since horizontal sweep is always present.

As the sweep circuits wipe the beam across the face of the picture tube, the video signal varies its intensity, and the result is a reproduction in light and darkness of the image being viewed by the camera.

Strictly speaking, this answers our original question "What Is TV?"--at least in an oversimplified version. But all that we have looked at so far is the sending and reception of the video information. When most of us think of TV, we think of the whole thing--both picture and sound and maybe even the color.

We don't go into the mechanics of color very far, because it's full of abstruse mathematics. Commercial TV, though, we can explore in more practical detail. In fact, we must if we are going to use our results in battling TVI!

Even at this state, it's fairly easy to see that any ham signal which gets mixed into the broadcast video signal is going to be displayed on the TV screen as a pattern of light and shadow. The exact pattern displayed will depend upon the ham signal itself, since the unimaginative receiver can't tell the difference between one of our AM voice signals and the also-AM video signal it's designed to receive and display.

But the composite video signal is not the only one present in a TV channel. We've already made in passing the acquaintance of the "chrominance" subcarrier--which just happens to lie in the 75-meter phone band, and *can* get clobbered in some cases by a ham signal. The result is wild to see--the picture is fine except that all the colors are wrong, and they shift with the modulation of the interfering signal. Lovers of the psychedelic should view it sometime; they might find it more entrancing than acid.

Also present in each channel, though, is an audio carrier. Audio in this country is FM, and so hams seldom interfere with it. *Fig. 4* shows the various signals within a TV channel, their frequencies with respect to the low-frequency end of the channel, and the relative strength of their outputs.

In this country, VHF TV is broadcast on 12 channels numbered 2 through 13, and UHF TV occupies the 70 channels from 14 through 83. The VHF group is divided into "low band" and "high band" regions. Low band runs from 54 to 88 Mc, with a 4-MHz hole between 72 and 76 MHz (between channels 4 and 5); high band runs from 174 to 216 MHz continuously. *Fig. 5* lists the 82 channels and their frequency limits. To determine the exact frequency ofaany specific TV signal you can use *Fig. 4* and *5.* together *Fig. 5* provides the channel limits, while *Fig. 4* shows the position of each signal within the channel.

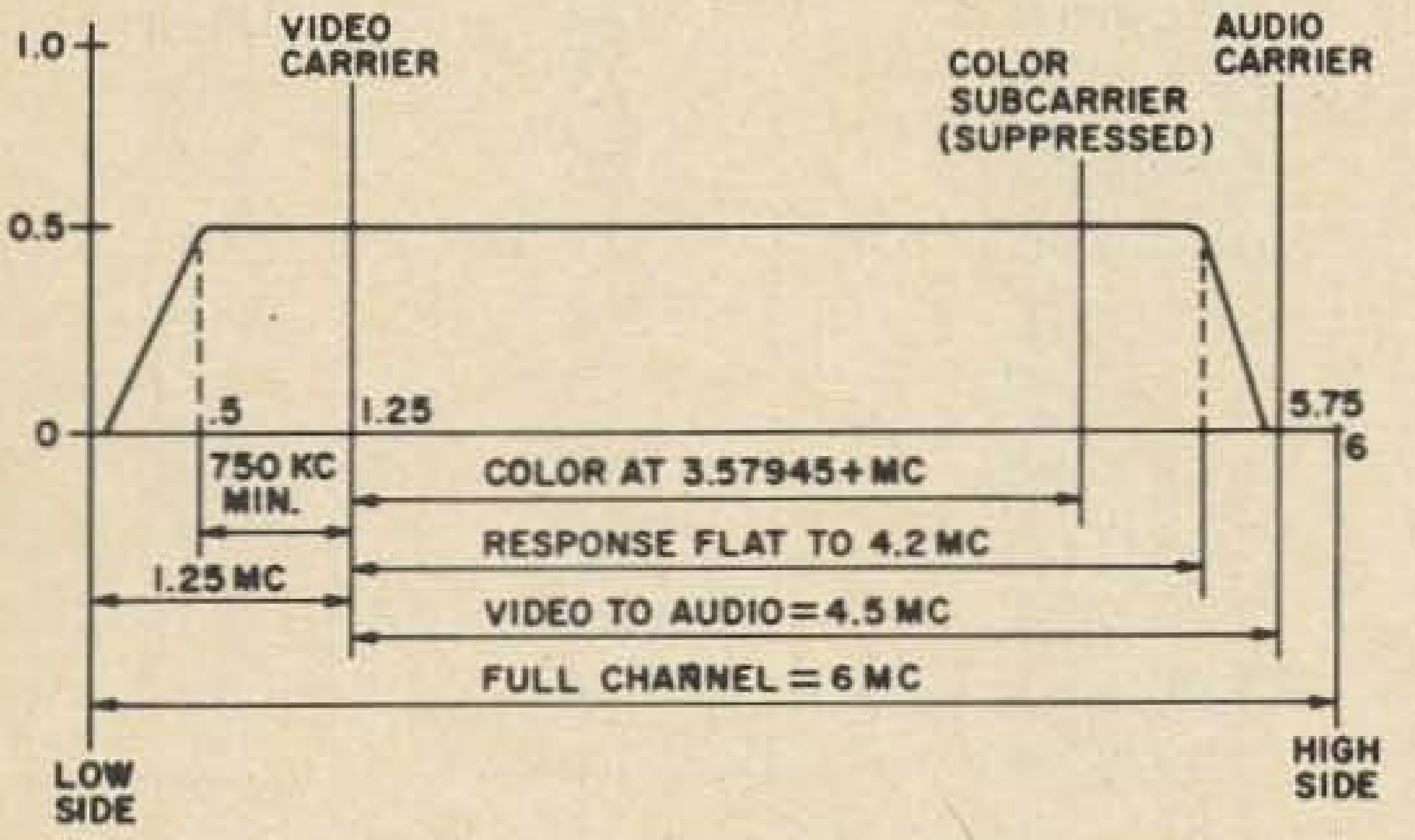


Fig. 4--Arrangement of signals within each of the 82 commercial and educational TV broadcast channels is as shown here. The video carrier, located 1.25 MHz above the low limit of the channel, is the reference for all other signals. The audio carrien is exactly 4.5 MHz higher, and the color subcarrier if present is 3.579545+ MHz above the video. Response must be flat from 750 kHz below the video carrier to 4.2 MHz above, and taper off rapidly beyond these limits to zero at the low channel edge and at the audio carrier. Limiting frequencies for each of the channels are tabulated in Figure 5.

In some cases, signals within a channel may be offset by 10 kHz either side of those shown in *Fig. 4*. If an offset is present for any TV transmitter,it will be the same amount and in the same direction for all signals from that transmitter. The purpose of this offset is to reduce co-channel interference between two stations assigned the same channel; with one of them offset 10 kHz high and the other offset 10 kHz low, their signals will always be 20 kHz apart--and this is enough to reduce interference significantly.

Broadcast TV modulates the video carrier with AM, using a technique called "vestigial sideband". This is partway between ordinary AM and SSB--but the carrier is not suppressed. All of one sideband is transmitted, but only

CHANNEL	BAND	CHANNEL	BAND	CHANNEL	BAND
2	54-60	29	560-566	57	728-734
3	60-66	30	566-572	58	734-740
4	66-72	31	572-578	59	740-746
5	76-82	32	578-584	60	746-752
6	82-88	33	584-590	61	752-758
———	———	34	590-596	62	758-764
7	174-180	35	596-602	63	764-770
8	180-186	36	602-608	64	770-776
9	186-192	37	608-614	65	776-782
10	192-198	38	614-620	66	782-788
11	198-204	39	620-626	67	788-794
12	204-210	40	626-632	68	794-800
13	210-216	41	632-638	69	800-806
———	———	42	638-644	70	806-812
14	470-476	43	644-650	71	812-818
15	476-482	44	650-656	72	818-824
16	482-488	45	656-662	73	824-830
17	488-494	46	662-668	74	830-836
18	494-500	47	668-674	75	836-842
19	500-506	48	674-680	76	842-848
20	506-512	49	680-686	77	848-854
21	512-518	50	686-692	78	854-860
22	518-524	51	692-698	79	860-866
23	524-530	52	698-704	80	866-872
24	530-536	53	704-710	81	872-878
25	536-542	54	710-716	82	878-884
26	542-548	55	716-722	83	884-890
27	548-554	56	722-728	———	———
28	554-560				

Figure 5--Broadcast TV channel limits in MHz. Horizontal lines separate listing into low-band VHF, high-band VHF, and UHF channels. See Figure 4 for exact frequencies of various signals within channel.

a part of the lower sideband is sent. This is the portion closest to the carrier, which is carrying the low-frequency components of the video signal.

Any other signal near the video carrier may beat with it to produce sidebands within the video-sideband range. The effect on the screen ranges from horizontal black bars, if the beat frequency is low, to a grainy cross-hatched appearance if the beat frequency is higher than the horizontal sweep frequency of 15.75 kHz. If the interfering signal is also AM, its modulation will also interfere; this always produces the horizontal-bar effect since the modulating frequencies for speech are below 15 kHz. These bars flicker with the modulation, and are usually called "modulation bars" or "sound bars". They may be produced in the TV receiver even without interference, by mistuning the set so that the FM audio is slope-detected in the video circuits and applied to the picture tube.

If the interfering signal is FM, its modulation will not usually be apparent on the screen. The usual result of FM interference is a shifting cross-hatch pattern, which moves with the modulation. This is much less annoying to viewers than are the big black bars--which is one of the major arguments in favor of FM for VHF operation in metropolitan areas.

But we're getting ahead of our questions Now that we have an admittedly oversimplified idea of the basic principles of TV as used in this country today, let's move on.

How Is Television Transmitted?

We've already met the various components of the transmitted TV signal--the video, the sync components, the color burst if any, and the audio--and we've taken a look at the channel assignments. We've also taken a brief trip through the typical TV receiver. Now let's go through a typical TV transmitter in the same way.

The starting point can be the TV camera itself. Like the picture tube of the receiver, the camera has a screen and sweeps an electron beam across this screen by means of horizontal and vertical sweep signals. However, in the camera the electron beam current is originally steady as it travels from cathode to screen, and is made to vary by the brightness of the image which is focused upon the screen. This is the exact reverse of the process in the receiver, where the beam current varies and these changes of current are transformed into changes of screen brightness.

The mechanics of how image brightness makes the beam current in the camera change vary from one type of camera tube to another; some typical camera tubes are the bidicon, the image orthicon, the iconoscope, and the plumbicon. All, however, produce a video output signal which is determined by the brightness of the single spot on the screen which the beam is resting upon at any instant in the scan.

In a color TV camera, things are more complex; three camera tubes are used; and the image reaching each is filtered so that it contains only one of the three primary colors. The resulting three video output signals show how intense each of the colors is at the particular spot in question. These three signals are then combined into a single "luminance" signal which indicates total brightness of the spot, and also into a complicated "color signal" which indicates the red, blue, and green content at that spot. The luminance signal corresponds to the single "video" signal of a black-and-white transmitter. We'll ignore the "color signal" for a while.

The video carrier of the TV transmitter is generated in the same manner as any VHF or UHF signal; a stable crystal oscillator produces an original signal which is frequency-multiplied until the desired output frequency is obtained. Normal rf-amplifier techniques are used between the oscillator and the modulated amplifier.

The extreme bandwidth involved in the composite video signal makes plate modulation impractical for TV, and the difficulties of getting large amounts of power into a video signal of such bandwidth also tend to rule out high-level modulation of any type.

As a result, general TV practice is to grid-modulate at relatively low power levels so that the minimum of video power is required, and employ linear amplifiers to boost the transmitter power to the desired level. For ham TV, the linears are not necessary, since the modulation is usually applied to a stage producing from 100 to 400 watts output.

The vestigial-sideband response shown in *Fig. 4* is obtained by tuning the linear amplifiers to the center of the channel rather than to the video carrier frequency. Often, additional filtering is added in the antenna transmission line to reduce the out-of-channel energy remaining in the lower sideband.

Between the video output from the camera, and the modulator which adds the video information to the rf carrier, the sync information is added to produce the composite video signal. *Fig. 6* shows in some detail the nature of the transmitter sync-signal generation.

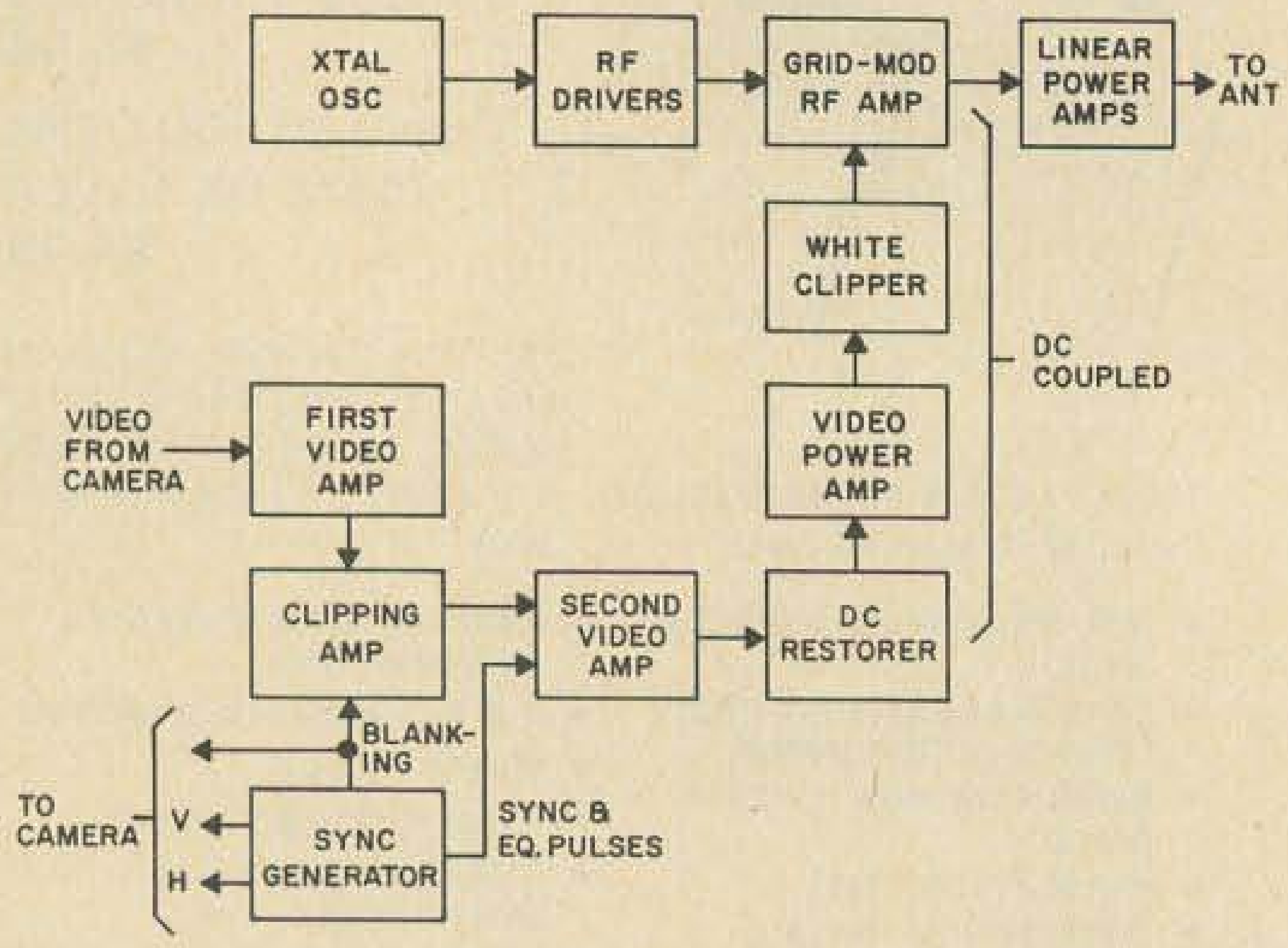


Fig. 6--This simplified block diagram of a black-and-white television transmitter shows how sync and blanking pulses are inserted into the composite video signal ahead of the modulator. Except for these stages, transmitter is functionally identical to any radio transmitter.

The original pulses are produced by a "sync generator", which is usually locked to the ac power-line frequency (both sweep frequencies are integral multiples of 60 hz. In color TV, the sync generator is locked to the color subcarrier oscillator rather than to the power line, and the sweep frequencies are very slightly different.

The sync generator provides pusles to control the sweep circuits in the camera itself, and also produces blanking pulses to the camera and clipper, and sync and equalizing pulses to the second video amplifier.

The blanking pulses kill video output during the vertical and horizontal blanking intervals and thus make space available in the signal for the sync pulses. The clipper cuts off the tops of the blanking pulses at a level just barely "blacker than black". "Black" is a video level which is 75% of the maximum composite-video signal voltage, and the blanking pulses are clipped at approximately 85% of maximum-output level. This assures that the tops of the blanking pulses are free of noise or hum.

The second video amplifier then inserts the sync and equalizing pusles into the signal to produce an almost-complete composite video signal. However, the blanking level of the signal at this stage would vary from a bright picture to a dark one as shown in *Fig. 7*; the restorer between the second video amplifier and the power video stage clamps the composite video signal to maximum output level rather than to the zero output level as shown. From this point on through the modulator itself, the signal is always dc-coupled to preserve the blanking pulses always at the same level as required by FCC regulations. The "white clipper" between the final video stage and the modulator prevents the negative peaks of the composite signal (which represent the white parts of the image) from dropping below 1/8 the maximum-output voltage.

While this completes our examination of the video transmitter, we still have more to see--because there is audio to be considered as well, not to mention the antenna itself and the special considerations of color. The audio signal from a TV station in this country is produced by a completely separate transmitter.

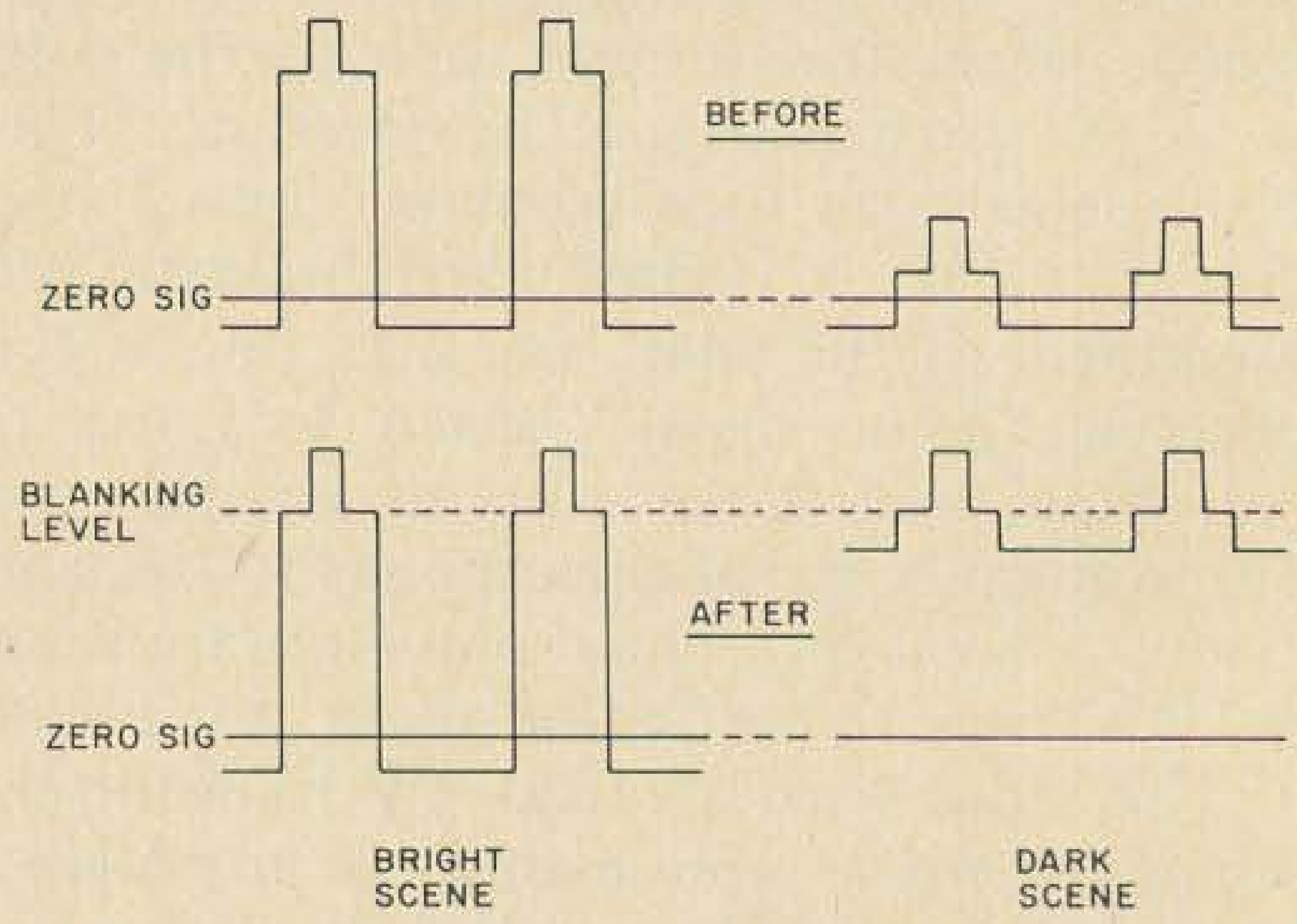


Fig. 7--DC Restorer circuit and subsequent DC coupling of signal is required to hold constant blanking level as shown here. Before DC restoration (top), entire signal shifts in level with brightness of scene. After restoration (bottom) blanking level remains constant and dark scene level is pulled up to correspond to that of bright scene. Many top quality receivers also incorporate DC restoration to preserve proper brightness ratio to final image; lesser-quality sets often omit the circuit and contrast of image varies with scene's brightness. Bright scenes have high contrast but dark scenes become grayish and contrast is dulled.

This transmitter is an ordinary FM unit; the only special points about it are that its frequency is exactly 4.5 MHz higher than that of the video carrier, and its swing is limited to a maximum of 40 kHz either way (25 kHz normal for 100-percent modulation). Also, transmitter output power cannot be greater than 70 percent of video transmitter power.

The audio and video carriers, though generated by totally separate transmitters, are radiated by the same antenna system, and that's where they are combined into a single channel.

TV broadcasting in this country is required by law to use horizontal polarization; turnstile arrays and variants of them are common. Normally the arrays are set up to compress the beamwidth in the vertical plane, and give omnidirectional coverage in the horizontal plane. A turnstile antenna does this by using two sets of radiating elements, one for east-west coverage and the other to cover in the south.

north-south direction. The two are fed 90 degrees out of phase.

The audio and video transmitter outputs are connected to the antenna array by a diplexer arrangement such as that shown in *Fig. 8.* This arrangement does *not* include the

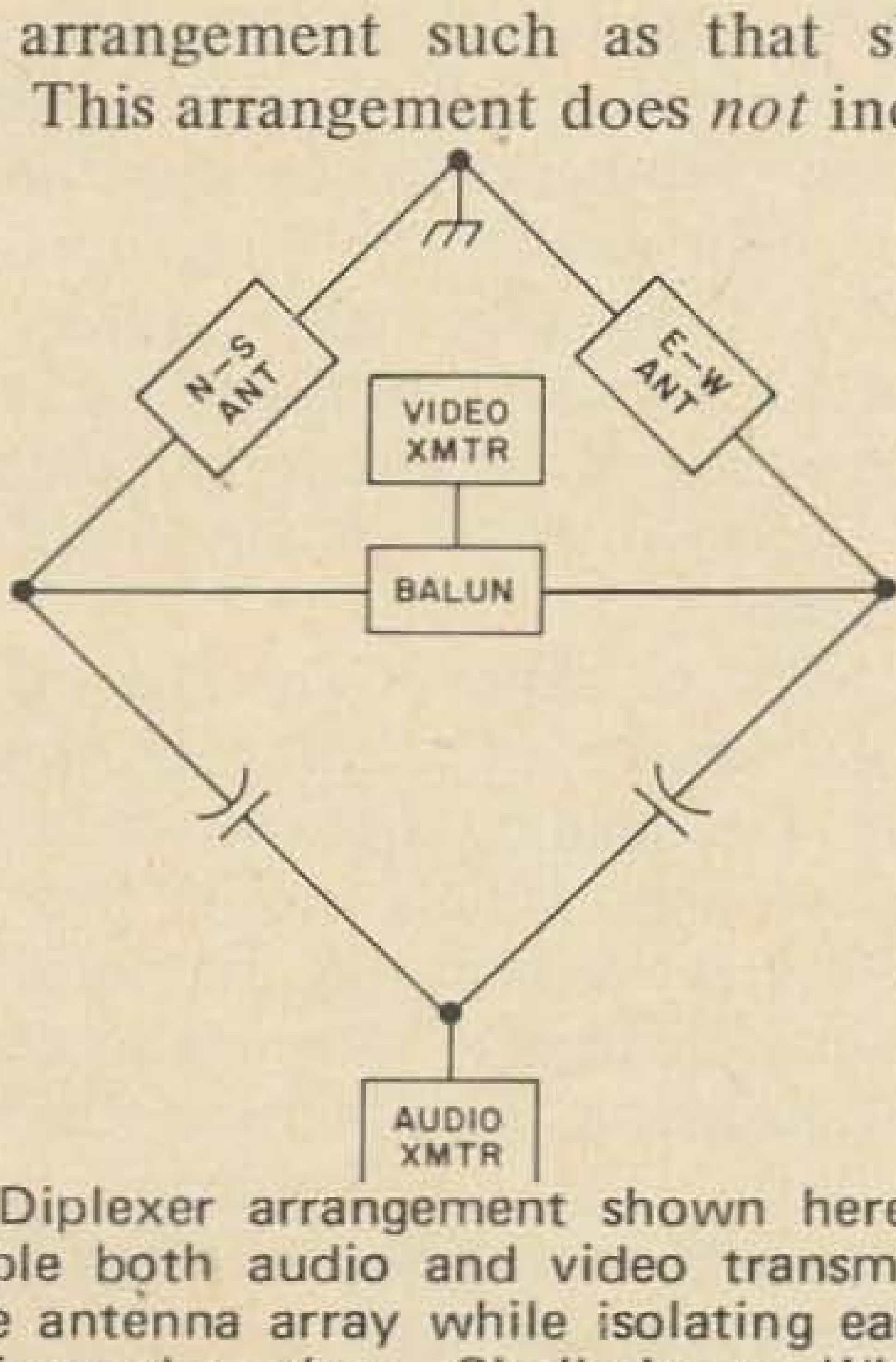


Fig. 8--Diplexer arrangement shown here is used to couple both audio and video transmitters to turnstile antenna array while isolating each transmitter from the other. Similarity to Wheatstone bridge circuit is emphasized in this drawing; isolation is produced by the balanced-bridge principle.

phase shift necessary for operation of the turnstile antennas; its purpose is to permit all the output of each transmitter to flow to the antennas, without any of the output of one transmitter being routed to the output circuit of the other transmitter. The similarity to a Wheatstone bridge circuit is apparent, and it functions in exactly the same manner to isolate the transmitters from each other.

All the way through, this installment, we've been putting off any detailed look at the way color TV works. We can't do so any longer. Now that we have a fairly complete idea how black-and-white TV operates, it's time to throw caution to the winds and look at color.

Before we get into the special requirements, though, we must pause a few moments and look at the whole idea of "color" itself.

"Color" is a characteristic of light, and light is simply electro magnetic energy of fantastically high frequency but otherwise identical to radio waves. The color of light *is* its wavelength (or frequency, of course) and what we know as "white" light is actually a mixture of all the possible colors of light which our eyes can perceive.

Most objects have no light of their own; we see them because they reflect light from other sources. The color of light which is reflected is not necessarily the same as the color of all the light which falls on the object--but (in most cases) the light reflected *is* of the same color as at least a part of the light which falls on the object.

For instance, lips reflect red light during the daytime; the sun's light contains plenty of red to be reflected. But at night under high-intensity "whiteway" lights, which are rich in blue but have almost no red at all, lips appear black. There's no red to reflect, and the blue isn't reflected.

What actually happens to produce color in any object which has no light of its own is that all the light of any *other* color is absorbed from any light which happens to arrive; all that *can* be reflected is whatever happens to be left.

Thus a leaf is green because it absorbs the light of any color *except* green, which leaves only the green light for us to see it by.

If the light falling on anything happens to have only one color in it, then anything which absorbs that color will appear to be black or at least dark gray, and anything which does not absorb that color will be light.

Most of us were taught in primary school art classes that any color we want can be obtained by mixing the three "primary" colors red, blue, and yellow. What most of us were *not* taught at that same time was that the same effect could be obtained by mixing the three "primary" colors of light rather than paint--and that the primaries for light were slightly different than those of paints!

When mixing paints, the primaries are magenta (almost red), cyan (between blue and green), and yellow. Magenta removes the green from any light which falls upon it; cyan removes the red; yellow removes the blue. When we mix light, the primaries are green, red, and blue.

We can prove this with three spotlights and a set of red, blue, and green filters. With one filter on each spotlight we can aim them to produce overlapping circles. Where all three of the light primaries are present, we get white. Where red and green are mixed but blue is absent, we get yellow. Where red and blue mix but green is absent, we get magenta. And where blue and green mix in the absence of red, we have cyan. The effect is similar to

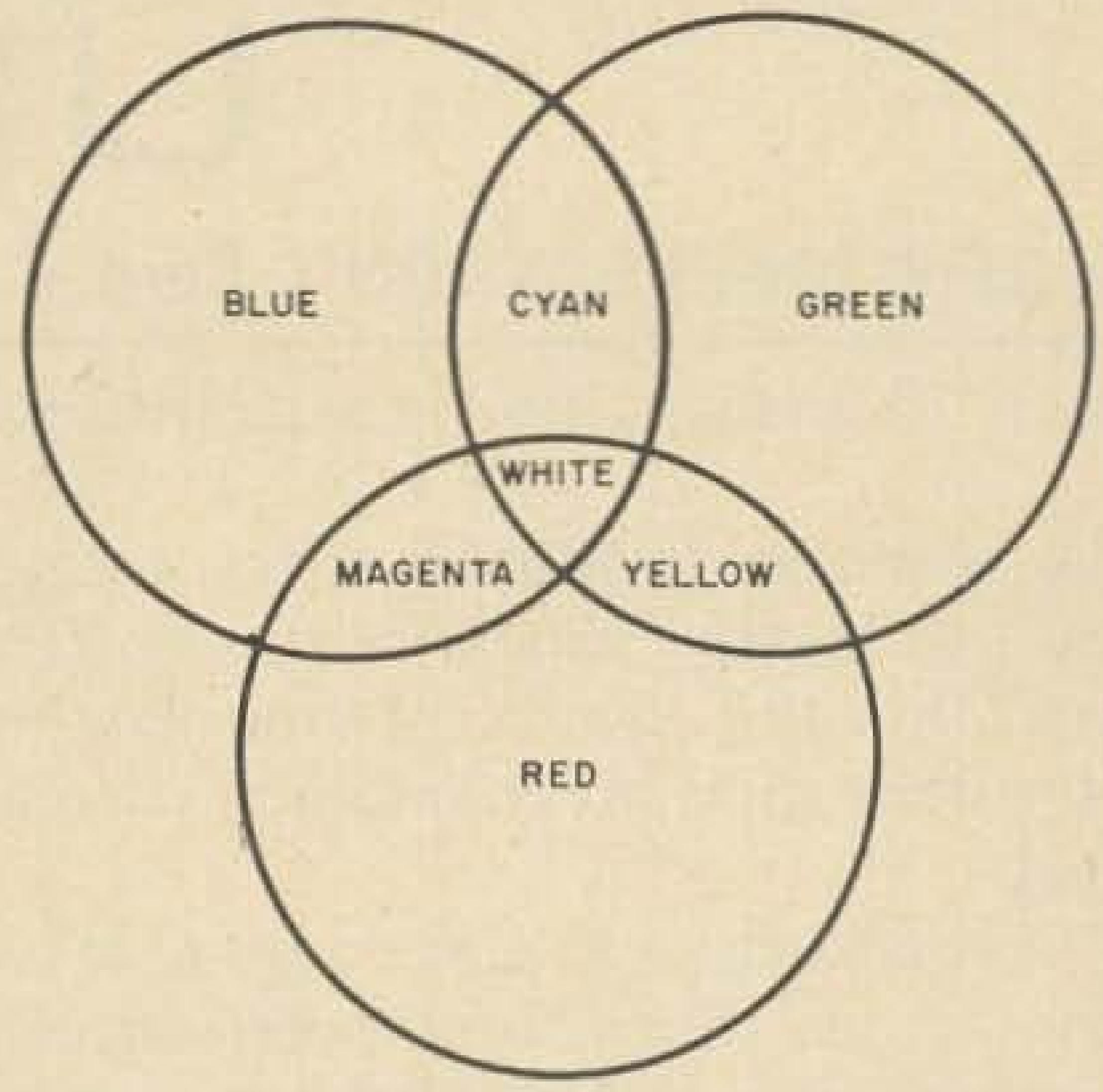


Fig. 9--Generation of color by mixing colored light from three primary sources of blue, green, and red is indicated here. This differs from the traditional production of color because in this case colored light is used rather than colored paints or inks. The color in color TV is generated by mixture of these same three primary colors.

that shown in *Fig. 9.* The color sequence around the ring of white light in the middle runs from blue through cyan through green through yellow through red to magenta.

Exactly the same sequence of colors is produced if we mix cyan, yellow, and magenta paints; where the yellow and magenta are mixed, the yellow removes any blue from incoming light while the magenta removes any green. The only light primary left to be reflected is red. Similarly, where cyan and yellow are mixed the cyan removes any red and yellow removes any blue; what's left is green.

Now back to color TV. The picture we see on the screen of a color TV set is produced by a sweeping spot--which is actually a *source* of light. This means that the primary colors we'll be using in color TV are the light primaries, red-blue-green, rather than the paint primaries you're more likely to be familiar with. In case of confusion, it may help to remember that one is the other turned inside out--and it may not!

We have already noted that in the color TV camera, three video signals are produced, one for each of the primary colors. Each of these signals tells how much of its color is present in a particular part of the image at a given instant.

The three original signals, E_b E_r and E_g, are combined into three new signals. Each of the new signals is a combination of all three of the originals, but the rules by which they are combined differ for each of the new ones.

One of the new signals is combined by a rule which takes into account the relative brightness of each of the original colors. "White" light is 59 percent green, 30 percent red, and 11 percent blue, and so the original green signal contributes 59 percent of this new signal while the original red puts in 30 percent and the blue makes up the remaining 11 percent.

This new signal, sometimes called E_Y but as the luminance signal, carries *all* of the brightness information for the picture. It corresponds exactly to the single video signal of black-and-white and goes through all the same steps.

The two remaining new signals are combined by other rules. If you're really interested in the precise rules for them, and are ready to read several pages of trigonometric equations to learn them, you can find them starting at page 1000 of the fourth edition of *Electronic and Radio Engineering* by F. E. Terman. The important thing, for our purpose, is that the rules produce a pair of signals which tells us how far, and in what direction, the color at that spot in the picture is from a neutral gray tone. These signals are known as the chrominance signals; one is the I signal and the other the Q, for "in phase" and "quadrature".

Both of these signals originally occupy the same bandwidth as does the luminance signal--from 60 hz to above 4.3 MHz--but they are filtered to narrower limits because the eye doesn't sense small changes of color. The I signal is limited to a 1600 kHz band width, and the Q signal is cut down to 600 kHz, without visible loss of detail.

The Q signal is then DSB-modulated on the color subcarrier. The I signal is also DSB-modulated on the same subcarrier after a 90-degree shift in subcarrier phase. The subcarrier is suppressed from both signals, and the I-signal output is filtered to remove that portion of its lower sideband below 600 kHz. Finally, both the I and Q output signals are put together; the resulting single chrominance signal has no carrier, double sidebands for modulating frequencies below 600 kHz, and a single sideband for modulating frequencies

Make Your Own Professional Name Plates

The last word in putting the final 'polish' on a piece of home-brew gear is to provide it with a professional appearing name plate. Applying decals directly to the panel is more often used, but this method makes such lettering appear more like one of the many individual component labels.

To make a name plate which will stand out and serve to identify the unit as a whole, is a simple matter. Apply the small decal letters, preferably of the dry transfer type such as the Ami-Cals, to a small piece of scrap bakelite or a piece of polished metal, if you prefer. Drill two mounting holes and attach the finished plate to the equipment panel with small sheet metal or machine screws.

The accompanying photograph illustrates how the author labelled a recent project using a piece of scrap bakelite 1/16 inch thick, cutting to size and bevelling the edges with a file. Try it on your next project; You'll be surprised what a 'professional' touch it will add to a piece of home-brew gear!

Howard S. Pyle; W7OE
Mercer Island, Wash., 98040

above 600 kHz and below 1600 kHz.

This combined chrominance signal is applied to the transmitter's second video amplifier, just as are the sync and blanking pulses. At the same time, the color burst (taken directly from the subcarrier oscillator) is put onto the back porch of each horizontal blanking pulse. The complete color composit video signal is then transmitted just as is a black-and-white signal.

While both I and Q signals are present throughout the video channel, they have little effect upon the picture itself because the color subcarrier is an *odd* multiple of half the line frequency. This means that any effect of an I or Q sideband upon the electron beam during one sweep of a picture line will be cancelled out by an opposite effect on the next sweep of that same line. The only effect which is not cancelled is a 15 Hz flicker in areas of small, fine detail. You may see this from time to time on your TV screen; it affects both color and B&W sets whenever color is being transmitted and fine detail such as checked fabric appears in the picture.

At the receiver, the I and Q combined chrominance signal is picked off by appropriate filters and applied to a pair of synchronous detectors which are very similar to those used for reception of ham DSB signals. The major difference is that in ham DSB, we must get the carrier back from information contained in the sidebands themselves, and in color TV, the color subcarrier frequency is sent to us in the color bursts which occur at the end of every line.

The outputs of the two synchronous detectors are again filtered to remove the Q signals from the I channel and vice versa. Then the I, Q, and Y signals are applied to three circuits which combine them in an exact reversal of the rules by which they were originally produced at the transmitter. These circuits produce as their outputs replicas of the original red, green, and blue video signals.

Each of these three primary-color signals is amplified separately and applied to the corresponding electron gun of the color picture tube. The result is glowing color on the screen.

For this process to work right, the I and Q signals must bear the same relationship to each other and to the Y signal at the receiver that they did at the transmitter. However, transmission-path differences can disturb this relationship, and additionally the differences from camera to camera at the transmitter can introduce additional disturbance. All these disturbances can be corrected by fine adjustment of the phase relationships in the synchronous detectros; this is the function of the "hue" control on color TV receivers.

How Does Television Interference Occur? Television interference falls into three main classes, each of which occurs for different reasons. The three major classes are (1) TV receiver overloading by the interfering signal, (2) interference, either audio or video, by spurious emissions, and (3) interference by harmonics of the interfering signal. A fourth class consists of interference created by uncontrollable cross-modulation.

Overloading of the receiver normally occurs only if the TV receiver is located within a few hundred feet of the transmitter causing the interference. It is caused by the transmitted signal getting into the TV circuits–either on the antenna line, via the power line, or by direct pickup through the TV cabinet–and overloading some critical circuit. It may easily be recognized by the fact that it is present on all channels in equal degree, and almost invariably disappears if the transmitter is operated into a dummy load rather than into its antenna.

Interference by spurious emissions includes such things as overmodulation splatter, key clicks, and parasitics. At the TV set, this type of interference may resemble that caused by harmonics, but is likely to be much more intermittent.

Harmonic interference is the most common form of TVI and may usually be identified by the fact that it affects different TV channels differently. However, if the harmonic happens to fall at the IF frequency of the TV set, it may affect all channels equally. This rarely occurs since most modern TV's incorporate filtering to prevent signals at the *if* from getting past the first few stages.

Uncontrollable cross-modulation is an interfering signal produced by some non-linear element not under the control of either the amateur or the TV set owner–such as oxidized guy wires on a power pole, or a rusted gutter on the neighbor's roof. When two strong signals reach such a non-linear element, they may mix just as they would in the mixer stage of a receiver to produce sum and difference frequencies. If one of these difference frequencies falls in a TV channel, it will be an interfering signal for that channel.

Interference of this type is called a "phantom" signal; its identifying characteristic is its extreme randomness, since both the strong signals must be present for it to be produced. If either transmitter goes off the air, the phantom disappears. When the phantom is present, however, the modulation of both the original signals may be present on it and capable of being understood--so the TV set owner may be completely convinced that the ham is at fault.

Fortunately, this type of interference is rare enough that you may never experience it--because when you do, only a painstaking search for several miles around can locate the offending non-linear element. Frequently it's easier to merely avoid use of the particular frequency which results in a troublesome phantom!

Most TVI is due to harmonic radiation; good design of the amateur transmitter, coupled with good operating practice, can hold the problem to a minimum--but any transmitter *must* radiate at least some harmonic energy, because of the way in which an amplifier works. The object of harmonic chasing when battling TVI is to reduce these harmonics to such a low level that they will not be troublesome.

We've already looked at the frequencies allotted to television in this country, and the use made of the space within each channel. *Fig. 10* relates the TV channel assignments to the various harmonics of the popular ham bands.

The exact effect of harmonic interference depends upon both the exact frequency of the harmonic, and the type of modulation employed. If the harmonic is within a TV channel, it will form a beat frequency with both the video and the audio carriers. If either beat frequency is below 15,750 hz, horizontal bars will be produced on the screen. If the beat is above the horizontal sweep frequency, vertical bars will result. As the beat frequency moves around 15,750 Hz, the bars rotate from horizontal to vertical, and produce a cross-hatch pattern on the screen.

An unmodulated carrier (or harmonic) normally produces only a steady cross-hatch pattern. A frequency-modulated signal produces a cross-hatch which appears to rotate with the modulation. CW turns the cross-hatch on and off. AM, however, produces modulation bars which we have already met.

An amateur FM signal may, if its harmonic

Fundamental	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
3.5 to 4.0 MHz				NONE					
7.0 – 7.3					TV IF		TV 2	TV 3	TV 4
14.0 – 14.4		TV IF	TV 2	TV 4	TV 6	FM BC			
21.0 – 21.45		TV 3	TV 6	FM BC		TV 9	TV 13		
28.0 – 29.7	TV 2	TV 6			TV 6	TV 10-11-12			
50 – 54	FM BC		TV 11-12-13					UHF TV	UHF TV

Figure 10--Possibilities of harmonic interference from amateur transmitters are listed in this chart. Harmonics higher than 6th are not likely to escape from properly designed and operated transmitters. With reasonable care all harmonics can be controlled.

is very close to that of the TV audio carrier, come through understandably. However, in most cases when a TV viewer reports he is hearing rather than seeing amateur interference, a particular type of overload—rather than harmonic interference—is present.

This type of overload is not confined to TV sets; it may hit hi-fi equipment, hearing aids, AM radios, or almost any device incorporating an audio amplifier. Transistorized amplifiers appear to be particularly sensitive to such interference.

What happens is this: The rf carrier—which must be carrying AM for the signal to be heard—reaches the input stage of the audio amplifier by any of a number of possible routes. There, the amplifier's input stage acts as a grid-leak detector to demodulate the signal into audio; from that point on the amplifier is not able to tell the unwanted audio from the signal it is supposed to be processing, and you have interference.

The sure cure for this problem is to prevent the rf from reaching the amplifier input stage. The normal means of doing this is to add an rf bypass capacitor directly from grid to cathode of the audio stage involved. If an 82 pF capacitor is used virtually all rf will be removed and no audio will be affected.

How Is TVI Suppressed? Regardless of the cause, all TVI is suppressed by the same basic means; the interfering signal is disposed of. Exactly how this is accomplished depends upon the particular type of interference involved.

Interference due to overload requires action at the TV receiver. This action may be such a simple matter as installation of a high-pass filter on the TV-set antenna terminals, and may be such an extreme matter as completely shielding the TV chassis from your signal. As a rule, the less done at the receiver the better. If you can demonstrate that you cause no interference to your own set, you are in a position to wash your hands of the receiver-overload problem. The amateur is not responsible for design deficiencies in TV sets, and the FCC has recognized many times that many of the interference problems are directly due to TV-set design flaws.

Interference due to spurious emissions is suppressed by suppressing the spurious emissions. All spurious emissions are illegal in their own right, and must be absent from your signal in order to be within the rules.

To suppress harmonics, the first steps are to be sure that as few as possible are being generated in the first place. Class C amplifiers should be operated with the minimum grid bias which will produce satisfactory operation. Tuned circuits should be coupled in a manner which will discriminate against harmonics and transfer only the desired frequency from one stage to the next. All power leads should be filtered and bypassed. Any stray resonances in the transmitter which happen to fall inside TV-channel limits should be detuned by adding capacitance, or have their Q killed by inserting resistance if practical. This will help hold the unavoidable harmonics inside the transmitter cabinet.

Tuning of all stages should be accurate, and a tuned antenna coupler should be used. "All-band" antennas are popular, but they offer no rejection of harmonics and should be avoided if TVI is a problem. A low-pass filter between the transmitter and the antenna will help reject high-order harmonics.

VHF operators face a somewhat different problem, as *Fig. 10* shows. The fundamental signal on 50 MHz can be more troublesome to Channel 2 than any harmonic of a HF signal. While sharply-tuned antenna couplers, and tuned-line wavetraps at the TV receivers, can help with this problem, the most reliable cure is simply careful operating practice. Choice of an operating frequency to minimize TVI, and of operating hours to avoid most viewers, does more to eliminate the problems than any amount of technical tinkering can accomplish in this case.

Next Month. VHF characteristics and principles of propagation will be our subjects in the next installment.

Factory Transceiver Installation

The ham crew at the Volkswagenwerk has been working on a ham mobile unit which may be released as optional equipment and be available through all Volkswagen dealers. Detroit, please take notice that the Germans are getting ahead of you again. That is the Drake TR-4 beside the seat. The power supply mounts behind the front seat cushion, out of the way. The whip (a Hustler) is on the back of the bus.

A NEW System For Learning Morse Code!

Robert C. Erwood, K9AAU
2823 W. Lyndale Ave.
Chicago, Illinois 60047

The difficulty of becoming a proficient Morse Code operator is apparent in that at least 25 hours of intensive study is necessary for the average person to learn to copy a modest five wpm. After disappointing experiences in teaching with the present methods, I have set about to scientifically devise a "best way."

When you take a message delivered in code, have you ever caught yourself making up your mind as to what the letter being sent is before the character has been completely received? This is significant in my new system of teaching code to beginners. It is based on the simple code structure.

All communications are made up of bauds. A baud is a length of time of tone or of silence. A baud is the length of time it takes to send a dot. Three bauds is the length of time the tone is sounded to send a dash. One baud is the time the tone is silenced between dots and dashes in building the code characters. Three bauds is the time of silence allowed between characters to distinguish them from one another.

If a beginner knows only two characters, say E (one sounded baud) and T (three sounded bauds) then, when he hears either of these two characters, he makes up his mind which it is after only two bauds. The third baud can be called 'slack time'. He is going to have to 'unlearn' this slack time habit and when a habit must be 'unlearned' progress is slowed. The beginner establishes the habit of determining the character after the second baud but when he learns the new character I (sounded baud, silent baud, sounded baud) he must suppress his habit and wait for the third baud before he can determine what the character is going to be.

An extreme example would be, if the beginner only knew E (one sounded baud) and Zero. He would know which character the teacher was sending after only two bauds because even though zero is composed of nineteen bauds, some sounded and some silent, he knows it is not E when the first tone sounded continues to the second baud.

The science of psychology tells us that learning is a continual process of establishing habits and having to suppress them and add new habits. This applies to learning the code. The characters should be taught in a sequence that will keep the necessity of changing habits to a minimum and not according to the frequency of use or according to surmised patterns of difficulty which are the current methods of presentation.

It is a known fact that tones can be compared which are only 15 milliseconds in duration. There is a strong tendency to decide what a character is as soon as possible and not wait for the end of the last tone. These two premises constitute the foundation of my new system for learning the Morse Code. The idea is to minimize the necessity of changing decisions which takes time.

There must be a scientific order of learning in order to avoid unlearning bad habits which will slow up any study. If a student learns the letters as they are usually taught without scientific order of sequence, bad habits will be formed which then must be unlearned. Receiving code is not the same problem as sending and for speed practice the teacher will send the code symbols the student has learned. Say E and Zero are the known characters and those are the ones the teacher is sending. The student will not wait until all the dashes have been sent before deciding it is a zero and not an E. The student will actually be making up his mind that the character is a zero after one baud when the first tone of the character continues three bauds and becomes a dah. Actually the student has heard T which he has not yet learned and he is deciding the character is a zero when there are yet seventeen bauds to go in that character. Thus the student is establishing a pattern he will have to break in order to learn T and M and O for example. To avoid this difficulty the student must learn the 9 along with the zero so he will withhold his decision as to the identification of the character until the last tone has been sounded.

In my new system the first characters taught are the 9 and the Ø. Nine, dah-dah-dah-dah-dit and zero, dah-dah-dah-dah-dah have the similarity that the decision as to the identification of the character must be held off until the last tone is sounded. The beginner does not yet know that dah all by itself is T, or that dah-dah is M, or that dah-dah-dah is O, and is consequently not changing his mind regarding the identification of the character but is withholding his decision until the last tone.

The following is the progression of the characters as they should be taught. I have divided them into six lessons. Each lesson must be mastered before progressing to the next.

Lesson 1: 908OEI
Lesson 2: Z7QGM
Lesson 3: KCYDZ6B
Lesson 4: NTJPW
Lesson 5: IRA2FU
Lesson 6: 5H43VS

...K9AAU

Letters

Tesla

Dear Kayla,

Thanks for the success story on Nikola Tesla—the best I've yet read on him. A good shot in the arm for the younger set!! I suggest more such stories for the incentive that it may help to create.

Sam J. Main, WØHQW
Brainerd, Minnesota

Dear Kayla,

FB on the life story of Tesla—let's have more of the same. I've been reading it mornings on the Net to the non-73 subscribers, hi. Let's have more of these articles about the *greats* who pioneered the electronic and electrical field.

Howard, KØHPF
Denver, Colorado

Dear Kayla,

Say...you really rang the bell here with that splendid article on Tesla in the February issue. I can't begin to tell you how much I enjoyed it. It was like having a philosopher at a science club. All technique and no history makes a magazine a dull read. Very bright and interesting.

James R. Belt, Jr., WØJIH
Omaha, Nebraska

Ed. note: Space does not allow for all the letters about this one article. There have been at least fifty with the same sentiments expressed above. Below is the one dissenter.

Dear Editor,

Why do you take up so much space with junk like the article on Tesla? This and other non-technical articles make me inclined to cancel my subscribtion.

(Unsigned)

License course

Dear 73,

In reference to your article Getting Your Higher Class License (Part X—Basic rules and units) you have more than adequately described, among other things, impedance in the most common forms of resistance, and capacitive and inductive reactances in an admirable effort to avoid some of the trigonometry and calculus which often tends to snow a good majority of amateurs, not in the engineering field. Your staff should be commended on a fine job, one well worth the effort.

Stuart M. Kravitz, WA3BSC
Middletown, Pennsylvania

Dear Editor,

While I have read the publication for quite a few years, the quality of material lately has impressed me to the extent that I want to be assured of receiving every issue.

You are to be particularly commended on the series of articles on the Advanced Class License. These are truly outstanding. Even though I hold an Advanced License, I have learned a great deal from the material and wish I had had material of this quality to study when I took my exam. My compliments on an increasingly fine publication.

Dr. Lawrence A. Edler
Santa Cruz, California

Dear Wayne,

I want to extend my thanks to both you and your staff for an outstanding job on preparing and presenting articles on "Getting Your Higher Class License." I have read, re-read and outlined every inch of those articles. I'm happy to know there are people who will share their knowledge and understanding of the "State of the Art" in such superlative fashion. Mucho thanks.

Walter Seighman WA3AXQ
Belle Vernon, Pennsylvania

Dear 73,

I would like to add my "thanks" to 73 for offering the advanced Class Study Course. This course, which has been well put together, should make the necessary job of studying easier for those who will take the time to go through it.

Richard Gassman, WB6YIL

Dear Kayla,

This is to agree and disagree with your December editorial. The magic of radio still exists when properly sold by people like yourself. To qualify this, I just passed my Advanced exam, SOLELY due to your last nine articles. Face it, man, you can't find hams with time and ability to simplify and explain a complicated art. The old hack is memorize the answers, pass the exam, and learn later. Hell's Bells, that's why we have so many lids...they will never learn. Each article was well written and aimed at the man, like myself, with no knowledge of electronics.

Dr. Dan A. Farrell
Globe, Arizona

Bouquets and Brickbats

Dear 73,

My sincere congratulations to you and the entire staff of your publication!

The best amateur radio magazine that is for sure, complete and interesting. Please put me in the large list of good friends and fans of your non-plus-ultra publication. Keep up the excellent work for the benefit of the radio amateur family.

Joseph M. Francisco, ex LU6DEM
Whittier, California

Dear 73,

Congratulations on the quality of 73 Magazine. Your magazine is really top at all points of view and very interesting to read.

Gerard Bunge
Tucson, Arizona

Dear Wayne,

The front cover of the January issue sure has impact. It has me broken out in a sweat. I can't sleep. I can't eat. I've stopped looking at the "architecture" of the opposite sex. If I don't make it the first time up, I'm going to take my "Chicago typewriter" out of the violin case and mow the whole damn FCC crew down. Hi . . .

Frank A. Phillips, W5QPH
Houston, Texas

Gentlemen:

Last week when I stopped off at Uncle George's radio store in Wheaton, Md., for some radio parts, one of the clerks told me that 73 Magazine recently ran a series of articles on the questions and answers, and other information, on the new Advanced and Extra Amateur Radio Licenses.

"The best information on this subject that we have ever seen," is the way one of the clerks put it.

DX QUIZ . . . Answers

The quiz is on page xx.

Israel	040	Bermuda	111
Togo	081	Singapore	336
Burma	352	Iran	030
French		Nepal	001
Somoliland	047	Galapagos	178
Ireland	048	Guam	303
Liechtenstein	046	Canal Zone	165
Egypt	047	Ascension	
Heard Island	137	Island	103
Hawaii	269	Virgin Islands	127
Venezuela	138	Ceylon	007

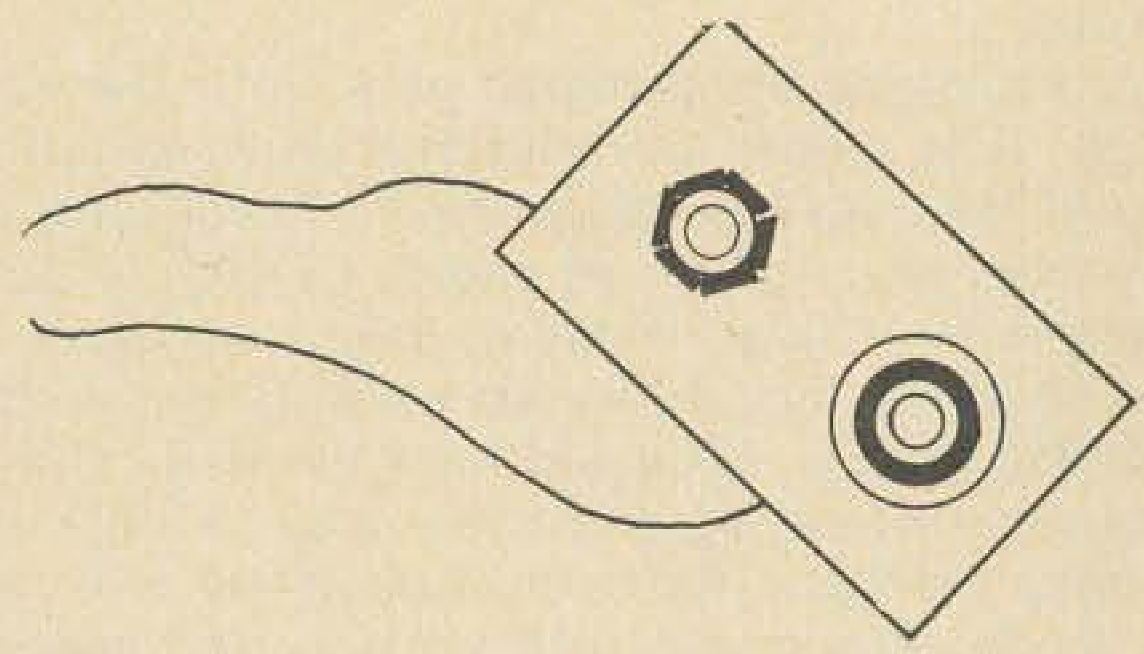
Score five points for each beam heading that you guessed within five degrees (Minnesotans should guess within three degrees). Don't feel discouraged if you didn't do too well. In a test similar to this a group of DXCC'ers averaged about one right. The top man had only three correct.

Solution To Cryptogram

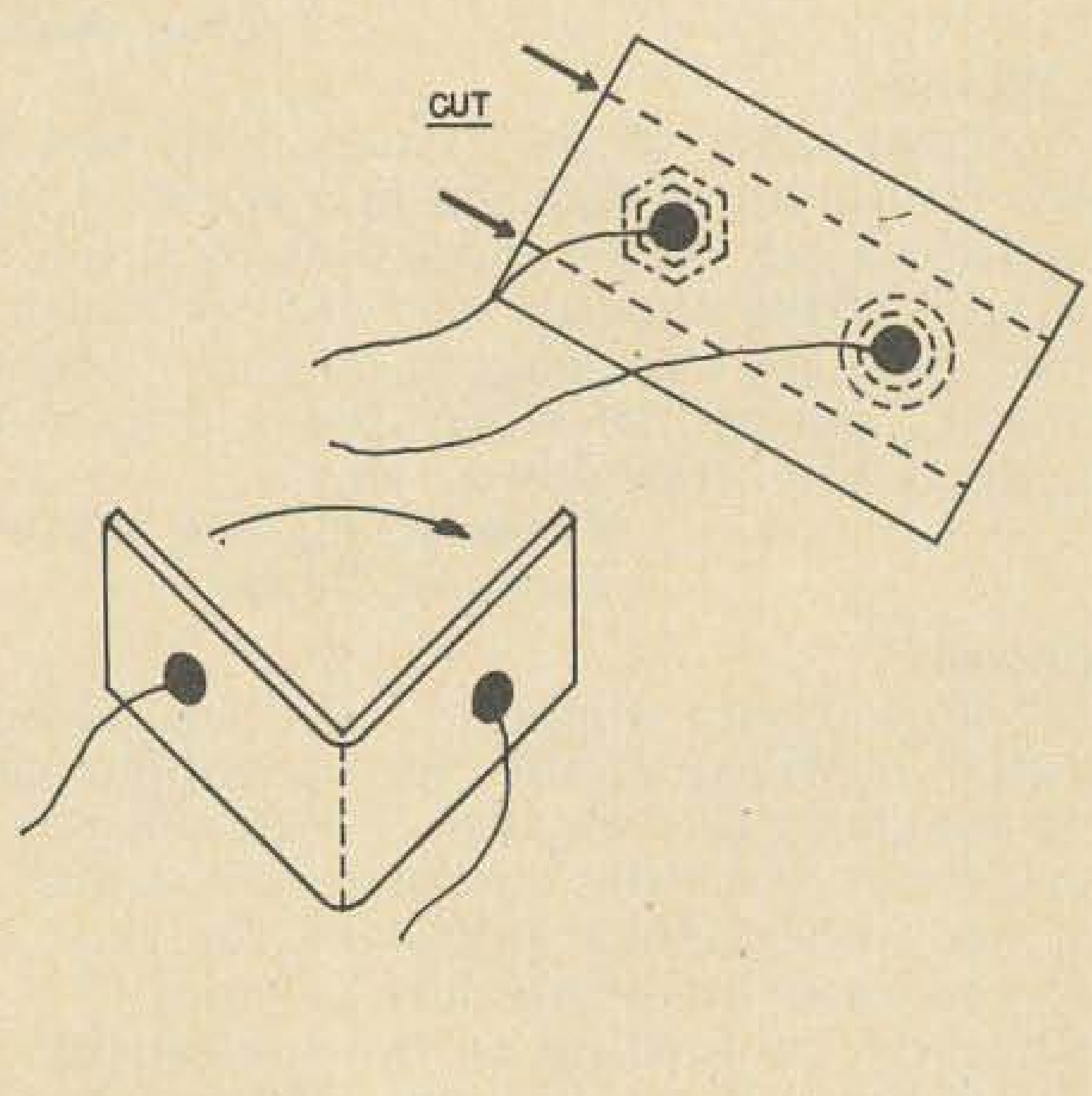
A changing electric field sets up a magnetic field, and a changing magnetic field generates an electric field.

Top Tip

If you use small transistor equipment, you probably have a pile of old dead 9V batteries in the junkbox. If they look too useful to throw away, maybe they are. Just grab one and twist off the metal casing, pull out the plastic top, and you have a 9V connector guaranteed to fit the same size battery from which it was removed. Solder on whatever you need in the way of leads and you're in business. See **Fig. 1.**



Old dead "B" batteries always seem to outnumber good ones, but there is a use for them too. Again, take off the top, which is usually cardboard or a thin fiber material. Now trim the top, as shown in **Fig. 2a**, fold in half, add leads, and (**Fig. 2b**), you have a free SPST switch suitable for haywired circuits or anywhere that you don't want to waste one of your good "store-bought" ones. The 9V tops are usually too stiff for this job, but if you want to go to the trouble of remounting the connectors on different material, they will work just as well. Now all you have to do is figure out something to do with the black junk that's all over your work bench.



David B. Cameron WA4VQR

I wonder if 73 Magazine has reprints of these articles available for purchase, or has considered publishing the series in pamphlet form. If you have reprints, I'd like to get a copy or two.

Jack R. Adams, W4TMJ
Falls Church, Virginia

Dear Sirs,

I would like to take this opportunity to say that the material in your magazine has deteriorated considerably in the past year. Improve, or my subscription will not be renewed.

B.S.Hargrave, K7NWN
Bellevue, Washington

Can't win 'em all, they tell me.

Odds 'n' ends

Dear Kayla,

Four years ago, when my husband, K5DGI, planted his ninety-foot tower in the middle of our rather small back yard, after promising that it would be well over to one side, we came up with the idea of planting climbing roses up the sides to camouflage the steel and wires. The roses have turned out to be quite attractive during the few weeks they are in blossom. However, the most useful side-effect has resulted from the thorns, which provided a highly successful year-round deterrent to the temptations of tower climbing by our own little boy and all the other neighborhood gremlins.

Mrs. Wesley Attaway, K5DGI
Shreveport, Louisiana

Dear Kayla,

A little gadget that is a handy operating aid for DX'ers can be made out of an ordinary desk calendar, though any small calendar would do, of course. The good propagation days on the calendar can be marked with a circle. Fair days left alone and poor days boxed.

My op aid is on a 3x5-inch file card with a little V-shaped cardboard support Scotch-taped to the back. It sits on my receiver next to my GMT clock.

The column width of the magazine will accommodate the art enclosed. It might look good at the top of the propagation column above the three data blocks. The only trouble with this idea, though, is that guys may be tempted to cut it out of the page, thus ruining the magazine. Maybe it should just be shown as an idea.

Alf Wilson, W6NIF
San Diego, California

Dear Wayne,

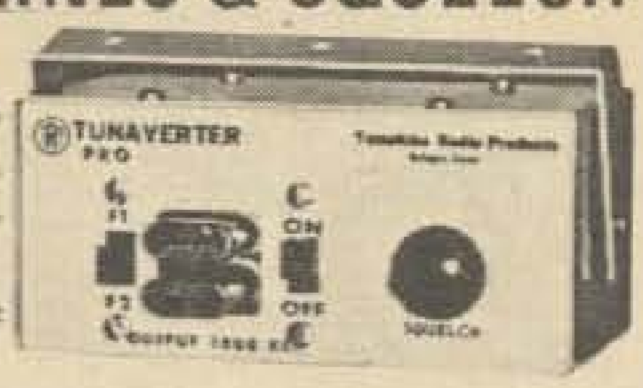
I am sure that your mail this month will include many interesting, and witless suggestions, with respect to your idea for dividing 20 meters into slots for homogeneous groups.

My contribution, however witless, is to suggest that we eliminate your designation of 14298, cultural discussion, as being totally devoid of interest to hams and that we set this frequency aside for the feeble minded; particularly those whose need to communicate is satisfied by the transmission of unidentified jamming signals.

Mike-fright may also account, in this day of thoroughly operational vox control, for the fact that QSO's still consist largely of interminable, alternating, hand-switched transmissions; distinguished both for vacuity and tedium. Vox operation soon discloses the conversational cripple, rendering small talk even smaller.

Frank Melville, W2AQK

4 NEW TUNAVERTER LINES & SQUELCH



Tunable and crystal controlled RF converters for monitoring Police, Fire, Amateur, CB, CD, VHF weather, etc., on your broadcast radio economically.

See listing of models in Mar. issue of 73, page 21.

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HEY THERE! YOU WITH THE GEAR IN YOUR SHACK!

Don't clutter up your home with all that stuff! Better to clutter up our warehouse -- and get paid in the bargain. Don't waste time asking us for prices. **Tell us exactly what you want** *for your Gen Radio, H-P, Tektronix, ARC, GRC, TED, PRC, VRC, ARN, URR, APN and other military/commercial gear.* **Write Today!**

Will pay Hi, unreasonable, fantastic price for Navy 10 W. Audio Amplifier...in cast aluminum cabinet. Urgently need Models AM-215A, -B, -C, -D/U. What have you?

COLUMBIA ELECTRONICS, Dept. 7
4365 W. Pico Blvd., Los Angeles, Calif. 90019
Phone: (213) 938-3731 Cable: COLECTRON

JENNINGS VACUUM VARIABLE CAPACITOR. Type UCS-500. 25-500 pf at 10 kv. Includes panel mounting bracket. BRAND NEW. Factory boxed. (5 lbs.) $39.95
HAMMARLUND AIR VARIABLE CAPACITOR. Type TCD-240-J. Dual section transmitting type. 31-250 pf per section at 4250 volts. 10-3/16" L x 4⅝" W x 2⅝" H. BRAND NEW. (10 lbs.) $9.95
STANCOR POWER SUPPLY CHOKE. Type C-1001. 10.5 Henries at 110 ma. 3000 volt insulation. **BRAND NEW.** Factory boxed. (3 lbs.) $1.00
Quantities are limited. Include sufficient for postage and insurance—any excess will be refunded with your order.

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Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

RAGS (Radio Amateurs of Greater Syracuse) annual hamfest on Saturday March 29, 1969, at Song Mountain. Lee Delasin, WA2DAD, P.O.Box 88, Liverpool, New York 13088.

HALLICRAFTERS SX-100, $130; SX-111, $120; ARC-5 Two-meter 30 wt. xmtr w/pwr supply & 50 wt. modulator, Cush-Craft 7 el beam, $50; Homebrew Converters (not junk) for 50, 144, 220 MHz, $20 each; 6 meter Squalo, $7; Globe HG-303 90 wt CW, $20. WA2PCL, Richmond Hill, N.Y. (212) VI.9-8458.

WANTED OLD CALLBOOKS: 1920 to 1950 State price and condition. Will trade meters, ham parts for same. KEMP, Box 307, South Lake Tahoe, Calif. 95705.

TEST EQUIPMENT WANTED: Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM-( ), USM- ( ), TS- ( ), SG- ( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, Texas 75040.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

NORTHERN CALIFORNIA HAMS. Best deals—new and reconditioned equipment. Write, call or stop for free estimate. The Wireless Shop, 1305 Tennessee, Vallejo, Calif. 707-643-2797.

DO YOU KNOW SOMEONE WHO IS BLIND who would like to receive tape recorded excerpts from 73 without charge? For details write: IEEE, c/o Lester W. Cory, SMTI, North Dartmouth, Mass. 02747.

HQ-145 WITH CALIBRATOR, good condition $130; also Dx-60 with HG-10 VFO $40. WB6LNQ Bob Nottelmann, Rt. 3, Box 60, Chico, Calif. 95926

20TH GRAND RAPIDS Amateur Radio Assoc. (ARRL sanctioned) State Convention May 9-10, 1969. Write GRARA Box 1333, Grand Rapids, Michigan 49501, for tickets and information.

SALE: Hammarlund HQ170, Heathkit DX-100, National HRO-7R, SX-28, cubical quad, Signal Corps Frequency Meter BC221N, assorted instruments. Write WA2TET, 410 Twist Run Road, Endwell, N.Y.

GLASS HOUSE HAMS-Compiling a directory of hams employed in the glass container industry and allied fields. Send information to WB2AHF, 1197 West Woodcrest Drive, Vineland, N.J., 08360

MOULTRIE AMATEUR RADIO KLUB annual Hamfest April 27, 1969, at Legion Pavillion, Sullivan, Illinois. Everyone welcome. Door Prizes. Refreshments on the grounds.

SELL—PMR-7, $42; Heath – Xmitter-MT-1—$39; Mobile supply MP-1—$15; Heath 3" scope OL-1 $23. Good to excellent condition. Include postage. Robert Franck, 12280 Wilfred, Detroit, Michigan 48213.

HW-32 WITH AM-CW, newer knobs, extra meter, etc., $100; microphone, 14 AVQ antenna, all like new; WA7DXQ, Box 7668, Phoenix, Arizona 85011.

COLLINS PTO wanted models 70E15, 70H12, 70E24. State condition, unsealed carton, new or used; need all filters for 75A4 receiver WA4YFI, Bill Smitherman, East Bend, N.C. 27018.

FOR SALE: Precision–ES500A, 5" scope, $85; Sig. Gen. E200, $45; Tube testers: EMC 208 w/case $25; Mercury 201 w/adapter, $4500; Eico 950A, RCL, $25; all FOB. R. Wendel, WB2YYX, 160-20 Grand Central Pkwy., Jamaica, N.Y. 11432.

FOR SALE: Piolet AM-FM tuner Model AF-723; Equipment crafters (Craftsman) amplifier Model 500; Collaro Coronation Model RC440 changer; Oak enclosure w/4 speakers; $225 FOB. R. Wendel, WB2YYX, 160-20 Grand Central Pkwy., Jamaica, N.Y. 11432.

TELETYPE MOD. 14 Reperforator w/automatic tape take up rewinder new, unused, $69.95—4-400's $14.95—transformers: Plate 5KV-1.6ADC $59.95—Modulator 811A's $35 – Filament 12.6VCT-10a $4.95. Ideal for transistor supply, battery charger, catalog 10¢, Fertik's, 5249A "D", Phila., Pa. 19120.

SALE: Heath Apache TX-1; Motorola TU535-Mike, both mint condition $115—FOB, Pr 4x150A $30—Robert Ross, 1436 Lenape Road, West Chester, Pa. 19380.

ATTENTION 160 METER FANS: Change any coax fed 75/80 meter inverted vee/dipole into an efficient 160 meter antenna. Adapts within seconds, right in the hamshack. PL-259 and SO-239 connectors. Perfect for residential areas. TOP BAND SYSTEMS' MODEL 86ADP 160 meter adaptor. $4.75 Ppd. Martin Hartstein, 5349 Abbeyfield, Long Beach, Calif. 90815.

HAMFEST, May 25th at Wabash, Indiana, 4-H fairgrounds, $1 registration, no selling charge, rain or shine. Information? Write K9AYB, 434 Stitt Street, Wabash, Indiana 46992.

WRL'S USED GEAR has trial-terms-guarantee! KWM1, $299.95; TR3, $399.95; SB34, $319.95; Galaxy V, $229.95; Galaxy 300, $139.95; HX20, $149.95; Invader 200, $269.95; T4X, $319.95; SX146, $189.95; HR20, $79.95; SB300, $229.95; Galaxy 2000 & PS linear, $329.95. Hundreds more-free "blue-book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

SELL: HEATHKIT HR-10 receiver, minus crystal calibrator. Excellent condition. $50 FOB. Or will trade for Heathkit IO-21 oscilloscope. WA9UEK, Art Pahr, Box 1, Plymouth, Wisconsin 53073.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1 - or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

RECEIVER BAND CHANGING switch 25¢ postpaid. Send for our surplus electronics parts and equipment flyers. Bob-Frank Electronics, P.O.Box 1327, Harrisburg, Pa. 17105.

INDIANAPOLIS HAM CONVENTION: (Sat.) May 24. (9 to 5) at beautiful Lafayette Square Mall. Indoor manufacturers displays-for sale or auction. Free out-door flea market. 80+ shops, cinema, for XYL and kids, inside airconditioned mall. Airports & Interstate—½ mile. Write: Indianapolis Ham Association, 309 Benton Drive, Indianapolis, Indiana, 46227.

KWM-2 AND PM-2 POWER SUPPLY. Recent complete factory checkout. Like new condition, $695. Dan Hingtgen, WØWIG, 272 Crandall Drive N.E., Cedar Rapids, Iowa 52402.

GONSET-IV-2 meter, very good condition, $200. Companion VFO, $60. (Both $250). WA2OHN 845 Cliffside Avenue, N. Woodmere, N.Y. 11581.

HAMMARLUND HQ110A, Mint Condition, little use, with speaker, $165. DX60 with HG10 VFO, good condition, factory checked, $75. WB2ZIA Box S-1305, Hoboken, N.J. 07030.

FOR SALE TELETYPE Equipment Model 19, 15, and M-14 Reperforator Complete. Carl Calfee, Lanexa, Va. 23089; near Williamsburg, Va. Phone 564-3500.

SELL: NC-300; Johnson Ranger; Astatic Mike, DD104; Low-pass filter; SWR bridge; Bug. First offer over $200 takes. K6SUQ, 5 Rydal Court, Orinda, California.

HAMFEST sponsored by Lancaster & Fairfield County ARC at Derby Downs one mile south of Lancaster, Ohio, on Bis Road, Route 793, June 8th. Gigantic Swap Shop. $1 registration with prizes every half hour. Main prize drawing. Good food at reasonable prices.

DUAL-UNIT MODEL 28 R-T tape set, typing reperforators, TD's, gear shifts for 60, 67, 75, 100, 107 wpm, excellent cabinet—$500. Other FAX, FM gear, list free. White, 5716 N. King's Hwy, Alexandria, Virginia 22303.

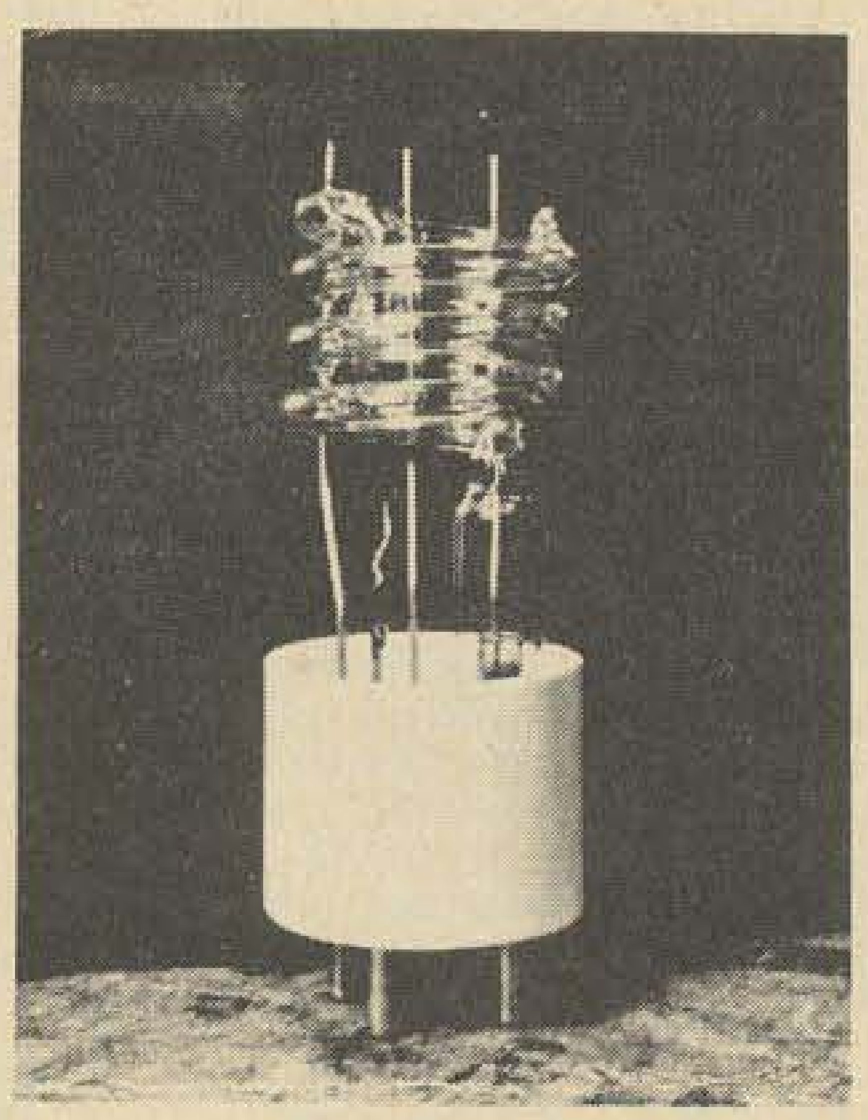
TECHNICAL WRITERS AND EDITORS wanted. Free-lance, part-time. Various electronics topics. Standard rates paid. Send resume. Electronic Publications Company, P.O. Box 504, New Hyde Park, N.Y. 11040.

NEED A VARIABLE CAPACITOR for that home-brew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. Wilson Bridge Road, Worthington, Ohio 43085.

LINEAR BUILDERS: 100 MFD @ 3000 VDC Condensors, $30 each. Basil J. Weaver, 1821-C Ave. M., Lubbock, Texas.

HANDBOOK DESIGNS. Kits for construction projects appearing in Ham Handbooks and Magazines. 144 MHz FM Transmitter $59.50. 100 watt VHF amplifier $34.50. Low noise FET Converters $24.50. Pre-amps, $14.50. FET VFO $34.50. Others, free list. Midwest Communications, 101 E. Healey St., Champaign, Illinois 61820.

CLEAN SWEEP month. The following items, all bargains offered as special "clean 'em out" prices. Some are one or few of a kind, some we just want to make room.



50,000,000 LUMEN FLASHTUBE

Brand new Sylvania flashtube and that's correct, 50,000,000 lumen output. This will make a "fantastic" psychedelic lighting effect. Spec sheet with each. $10.00

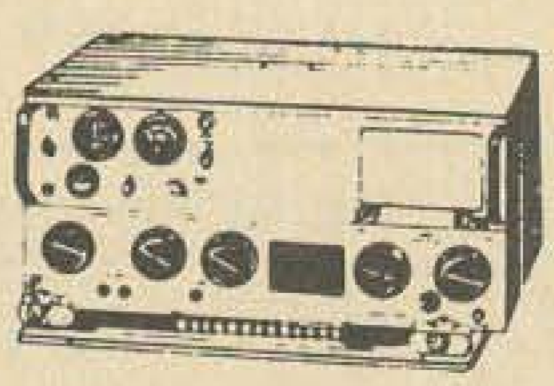
POWER SUPPLY Regatron, programmable model 231, unchecked. 300 volt, 100 ma. $15.00

4CX1000A tube, brand new $50.00

RCA 5819 PHOTOMULTIPLIER, New $10.00

AN/ART-13 100-WATT XMTR
11 CHANNELS
2 to 18.1 Mc **$10**

Poor condition good for parts



Collins Autotune Transmitter, extremely stable and suited for side band. Written up in QST Oct. issue 1953.

PDR-27 GEIGER COUNTER, m/roentgen scale. No batteries, unchecked. As is $15.00

INSTANT CATALOG: Revision, head chopping & new deal in our catalog dept. Send 25¢ for our new earth shaking catalog #69-1. Within 24 hours it's on its way to you. Get your kleenex out and get ready to drool.

All material FOB Lynn, Mass. Which means, send postage.

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PO Box 62 E. Lynn Mass. 01904

BRITISH COLUMBIA: The 1969 Okanagan International Hamfest will be held on July 26 & 27 at the Dollyn Varden Auto Court, Okanagan Falls, B.C. Registration time 11 a.m., Saturday. Further information write: Clarence LaBounty, Secretary treasurer, P.O.Box 551, Oliver, B.C., Canada.

FOR SALE: Eico 753 with VFO conversion, 752 power supply, mike, and Hustler 80-40-20 meter mobile antenna, $225. Don Cook, R.R.#1, Norfolk, Nebraska 68701.

SCOTCH COMPUTER #489 magnetic tape, 1" on metal reel (2) @ $5. Topaz C1OWDG 250 watt mobile p.s., $50. Hygain 12AVQ, $12. FOB. Richard M. Jacobs, 4941 Tracy, K.C.M.O. 64110.

SELL: GLOBE KING 500A, excellent 700 watt SSB linear – $125. Knight R100A plus T-60, both good condition – $100. Offers considered. WA4UNN, Box 221, Toccoa, Georgia.

VIDICONS, RCA 7735A–$20, RCA 7038–$15, Toshiba 7038–$10, Vidicon Yoke & Focus Coil–$35. WB2GKF, Stan Nazimek, 506 Mount Prospect Avenue, Clifton, New Jersey 07012.

TELETYPE–SELL: Gears, paper, cranks, motors, non-overliners, 28 TR's, KSR, ASR. GR syncronometer. Wanted: M.28 typing units (any condition), keyboard perforators-reperforators, bases, all unused parts. Typetronics, Box 8873, Ft. Lauderdale, Fla. 33310.

FANTASTIC-1969 New England ARRL Convention May 24 & 25, Swampscott, Massachusetts. Save money! Early bird registration $10 including Saturday dinner, dance and night club entertainment. Be a winner! Every major manufacturer will exhibit plus top speakers from science & industry. Tickets: W1KCO, John McCormick, Berkeley St., Taunton, Massachusetts.

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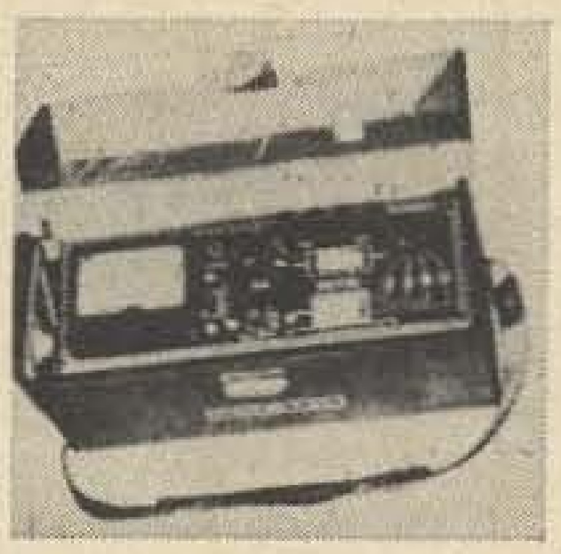
(Model 6T4G)



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1969 April Index

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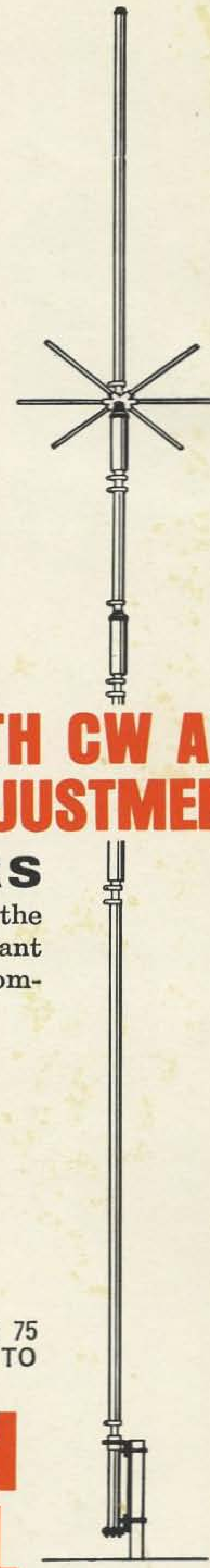

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