73

October 1968

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AMATEUR RADIO

RECEIVERS

Thoughts on Receiver Design

3 Tube Super Het Receiver

Midnight Oil Receiver

High Performance Receiver for 2

Mobile Noise Suppression

AVC Circuits

Regen Detector

And Many More in this Issue

73 MAGAZINE

October 1968
Vol. XLVII No. 10

Cover Photo: A collection of current receivers available. Top to Bottom and Left to Right: Radio Shack Realistic DX-150, Hallicrafters SX-130, Davco DR-50, Hammarlund HQ-215, Galaxy R-530, Heath SB-301, R.L. Drake R-4B, with the Amphenol 830 Transistor Analyzer, McCoy Silver Sentinel Crystal Filter and associated oscillator crystals. Photo by Fred Meyer Studio.

Next Month: Look for an article by Fred Clepper, W3RET on the application and selection of crystal filters.

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Departments

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Miller & CQ

In view of the confession of Miller about his hoax expedition I was wondering how CQ would handle this disaster to their Miller series and their Miller DX Handbook. They did beautifully. After reading the CQ editorial I was left with the distinct impression that Don Miller had been most kind and gracious to the ARRL in letting them off the hook on his libel suit. No mention was made whatever of the hoax or the confession. Nothing was said at all about his evasions on questions about many other trips of his. I think CQ should certainly win the Baron Munchausen award for Forthright Reporting for 1968.

Silver Futures

As I find myself wearing out from these foolish 16 hour work days it is not too unnatural for my mind to turn to alternate means for survival in this world. More and more I've been getting interested in the stock market. Lot of money there.

In talking with one of our advertisers I mentioned my interest and he poo-poohed the market. The real money is in comodities, he explained. Take silver, for instance . . . it is in short supply and going to get in nothing but shorter supply . . . right? So how do you make money from that simple bit of information? He explained about how simple it was to buy a "silver future" . . . that you only had to put up 10% of the cost and the rest was on margin. You could make thousands of dollars. That sounded pretty good. I did like the ring of that.

My local broker quickly bought one silver future for March 1969 for me. A bargain at only $27,000! I had to put up only $2700. My friend was right . . . two days later my future was up to $27,500 . . . I'd made $500 in two days! Well, if I'd sold out right then I would have made $500 in two days. But that future was headed towards $30,000 by the end of the year, at the very least, my friend had explained. In the next five days it dropped daily, arriving at the $25,000 mark. Oi! My friend said not to worry, just a little fluctuation. Silver is in short supply and the price has to go up. I nervously held tight. Sure enough, for five days it went up, reaching $27,000 again. Whew! Four days later it was down to $25,000 and I was a nervous wretch. A few days more and it was back to $26,000. I called my broker to see what he had to say . . . "I'm a bear on silver," said he. Hmmm. "Sell," said I. I got out at $26,000 and watched the March futures skid down to under $22,000. Perhaps I should have bought a future down there, but somehow every time I started to pick up the phone my arm went numb and I put it off.

Publishing may require long hours, but it isn't so bad.

Post Office

It seems to me that our mail service may well be headed for extinction. As the rates go up and the deliveries go down, something else is bound to take its place. Of course I feel that the post office could easily automate if they had the inclination. By standardizing on an envelope size and authorizing a simple addressing machine which could be read by a computer they could get most of the mail in shape so it could be sorted and handled entirely by machine. A special low postage rate would force all commerical users and prudent private persons to use the new service.

The addressing machines could vary from a $5 Dymo type contraption to regular typewriters. I'll bet they could turn them out to sell for $2.

I've wondered why AT&T hasn't taken advantage of their extensive wire facilities which go into virtually every home and business in the country and put in small Teletype-type of printers which would permit you to type up a letter and then feed it into a tape for instant transmission to any other similar machine. The printers would cost a little more than a phone, but would permit almost instant mail. I'll bet they could turn out a small printer, complete with built in tape recorder, for under $200. That's $20 a year for 10 years. You'd type your letter and it would record on tape. You could play it back on your own printer if you wanted or else just push the button and it would be sent to your local

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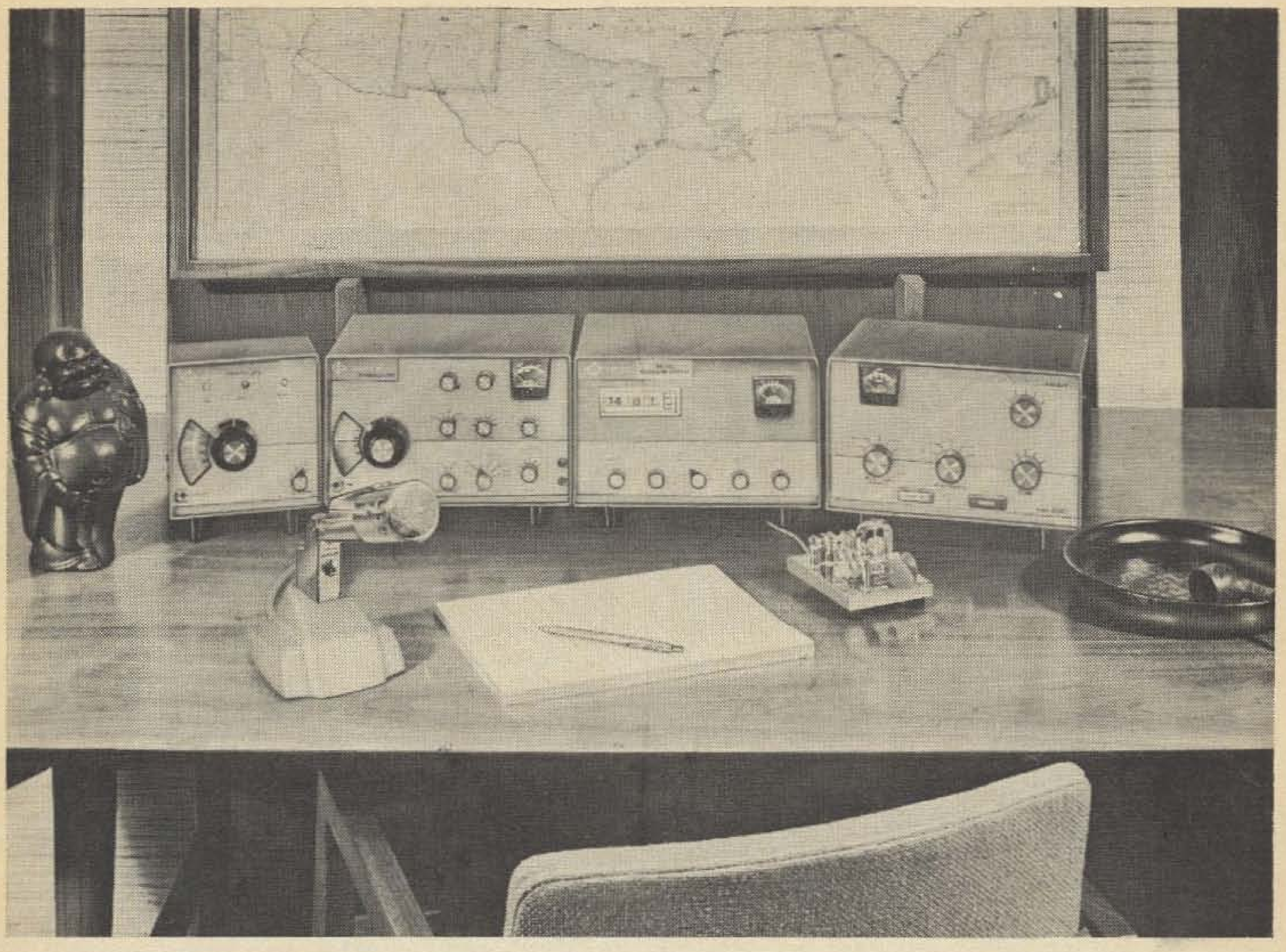

UFO

Late in July headlines were made all over the U.S. when Dr. McDonald, senior physicist at the University of Arizona's Institute of Atmospheric Physics, indicated a probable connection between UFO's and the power blackouts. This theory is strongly substantiated in Fuller's book, "Incident at Exeter." available in paperback.

Just about everyone involved in studying the UFO reports is in agreement that now is the time for a step up in the investigation of these objects. Russia, despite some conflicting reports, is going all out to investigate and photograph UFO's. Amateur radio has it in its power to do more to help bring light to this mystery than any other group in the world. Only amateur radio reaches into every community in our country and makes it possible to provide the fast communications that will be needed to alert investigation teams along the line of UFO travel.

If we get to work on this we can set up the most comprehensive alerting network the world has ever seen. We can tie in every other communications system to our amateur net . . . we can include all users of mobile radio, marine radio and aircraft radio . . . all fixed stations . . . military . . . government services . . . UFO watching groups . . . fire tower watchers . . radio and television stations . . . everything. If each of us sets up a liason in his own area to all other services and interested parties to receive and forward any UFO reports we can achieve this vast system.

Between NICAP and APRO I suspect that we will all be able to find at least one person in any area who is interested in helping to solve the UFO mystery. If we ask him to set up the liason by phone to receive reports of any sightings in the area from any source and pass them on to you and, in turn, to pass along any alerts you get via amateur radio to those interested. The net can be set up with a minimum of responsibility on your shoulders. Of course if your wife is interested in acting as the liason then she could handle that aspect of the net. The liason man should be available most of the time and have two phones . . . one for incoming calls and the other to pass along messages to you or others who should get the word.

If you can fire up on 14.3 MHz and can devote a bit of time to helping to solve this UFO problem as well as enormously aiding the radio amateur image in your community then get started by checking in at 0200 GMT (10 pm EDT) on any night and reporting your interest. Next drop a line with SASE to NICAP, 1536 Connecticut Ave. NW, Washington 20036 and ask them for the name of a person interested in UFO's in your area that might be able to work with you on this. If you want to handle it all yourself then just get to work contacting the local papers and giving them the story of the net and your service with the net. Same for radio and television stations. Promise all of them full cooperation on incoming reports if you get immediate reports from them of anything hot.

After you've contacted your local CB group, police, fire, CAP, road department, public service, telephone company and doctors with mobile radio then start looking for other mobile radio users and groups or individuals that might either be able to report sightings or benefit by knowing of probable sightings. You will certainly get to know a lot of people in your community.

You don't have to profess any belief or disbelief in UFO's. That is one of the purposes of the net . . . to pin this whole matter down as quickly as we can and either make it possible for positive identification of these things or else to expose them for what they really are.

The nice part of it is that we can provide an enormous public service, complete with great benefit to amateur radio. When we get this going well we should be getting a good deal of national promotion . . . and we may see more fellows getting interested in amateur radio and find Congress more interested in helping us. Even the FCC may begin to realize that we exist.

One other point that you might not have considered . . . when you are the hub of this

(*turn to page* 121)

A Collection of Thoughts on Receiver Design

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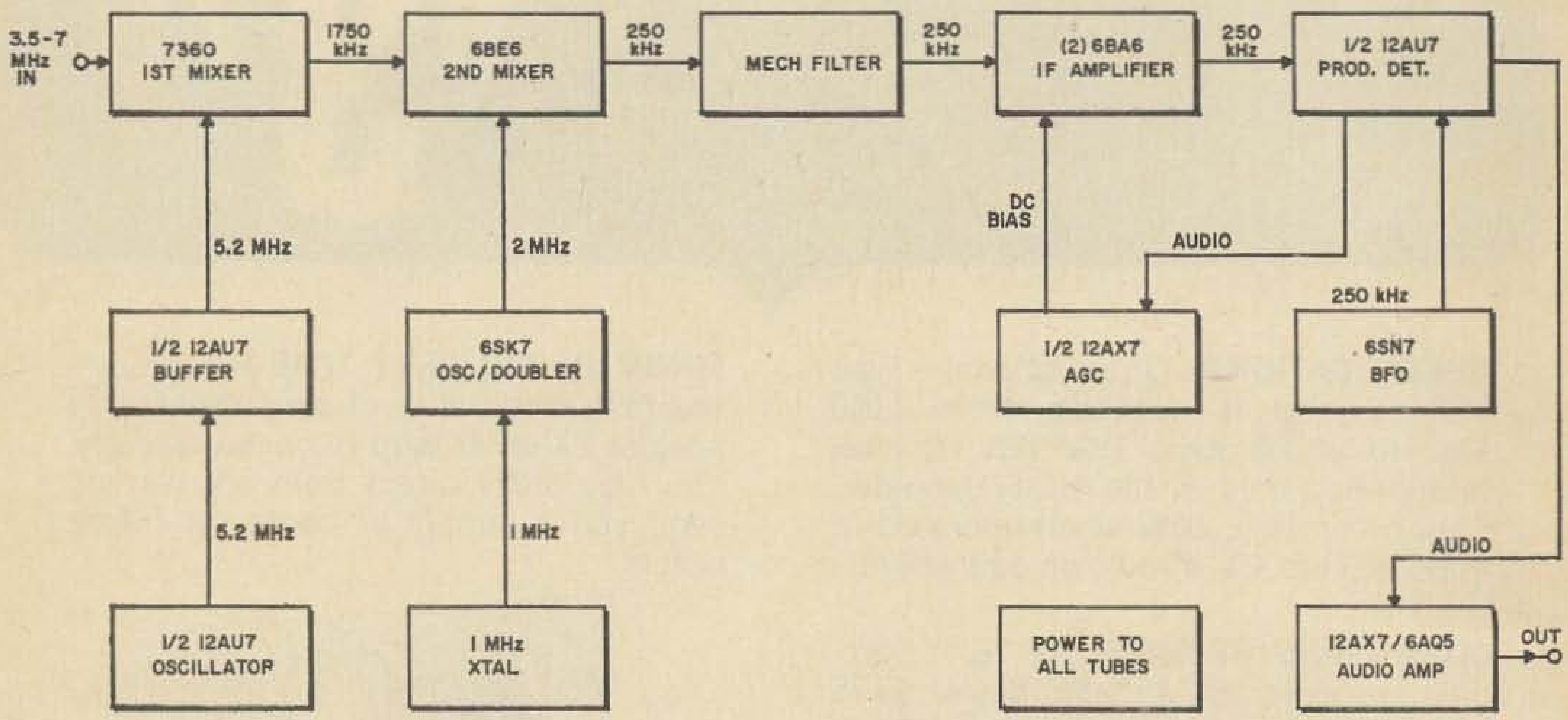

Fig. 1. Block diagram of the receiver.

The purpose of this article is to outline some of the difficulties which can be encountered in home construction of amateur band receivers. This is not intended to be a construction project and no parts values will be given, but will deal with the general problems encountered in a year long receiver design and construction project. Although the field of receiver design and homebrewing may seem beyond the grasp of most of the casual weekend builders, if a real desire or need exists for an individual to achieve a goal, a little effort and organization, and a lot of patience can lead to a great deal of satisfaction. It is with this spirit and determination that this article is written.

Prerequisites

There are a few basic preliminary requirements to fulfill in order to complete a receiver project, or any project. The ones that have been found to be important are listed below.

1. *Experience*: This is the most important factor, and is usually dependent on considerable homebrewing and project construction in the past. However, even with a limited background of mechanical skills, it is still possible to do an acceptable job. It is most important to do a great deal of reading. Read every magazine article or book that is available, and search for more. Look for things that are interesting and have a place in your project.
2. *Organization*: Start a folder or note book of schematics, articles, gadgets, and hints and kinks that pertain to receiver design. This folder can be constantly in use, being revised, added to and reviewed, in order to keep it current and alive in your mind.
3. *Design*: This is where you do the sorting. Here all the ideas, schematics, and methods that are obtained are integrated into a block diagram of the future receiver. The objectives here should be a compromise between your desires, and what is available or prac-

tical. Singlemindedness should be avoided. It can happen in engineering projects that a designer will use certain methods just for the sake of using them. An example is the conflict between integrated circuits and individual component circuits. Don't feel that you have to design a project with all integrated circuits when a circuit with ordinary transistors will be acceptable at a lower cost. 4. *Test Equipment and Tools*: In many cases frustration can result from simply a lack of the proper tools. A simple volt-ohm meter is a must, and a vacuum tube voltmeter is handy for measuring voltages without loading the circuit down, but is not an absolute requirement. Perhaps the most important piece of equipment for working with radio frequencies is the grid dip oscillator. The availability of this instrument made this project possible. One of the most difficult problems is detecting *rf* and telling what frequency it is. Also along this line, a signal generator is useful for tuning up and rough calibration. All the various tools for wiring and metal working have been mentioned many times in other articles, but the most used ones deserve mention. In chassis working, an electric drill with a good set of bits up to about ⅜ inch diameter, a nibbler, and a few handy sizes of chassis punches are necessary. For wiring, wire strippers and needle nosed pliers are constantly in use.

The design

Fig. 1 shows the final block diagram of the receiver. Starting from the antenna input, a 7360 beam deflection mixer is used to convert to the 1750 kHz intermediate frequency. There is only one tuned circuit in the input, but the Q of the air wound inductor is high enough to prevent most troublesome images without a Q multiplier. The most significant feature is the low cross modulation distortion, and the disadvantage is the high cost compared to other tube types. This is a very common circuit and can be found in many publications.[1]

The oscillator circuit is taken from the Highflyer[2], and consists of the popular high C colpitts circuit with the other section of the 12AU7 used as a buffer. A little extra care here really makes the difference with respect to stability. The oscillator operates on 5250 kHz to provide an *if* output on 1750 kHz with an input on either 3500 or 7000 kHz. **Fig. 2** shows this circuit.

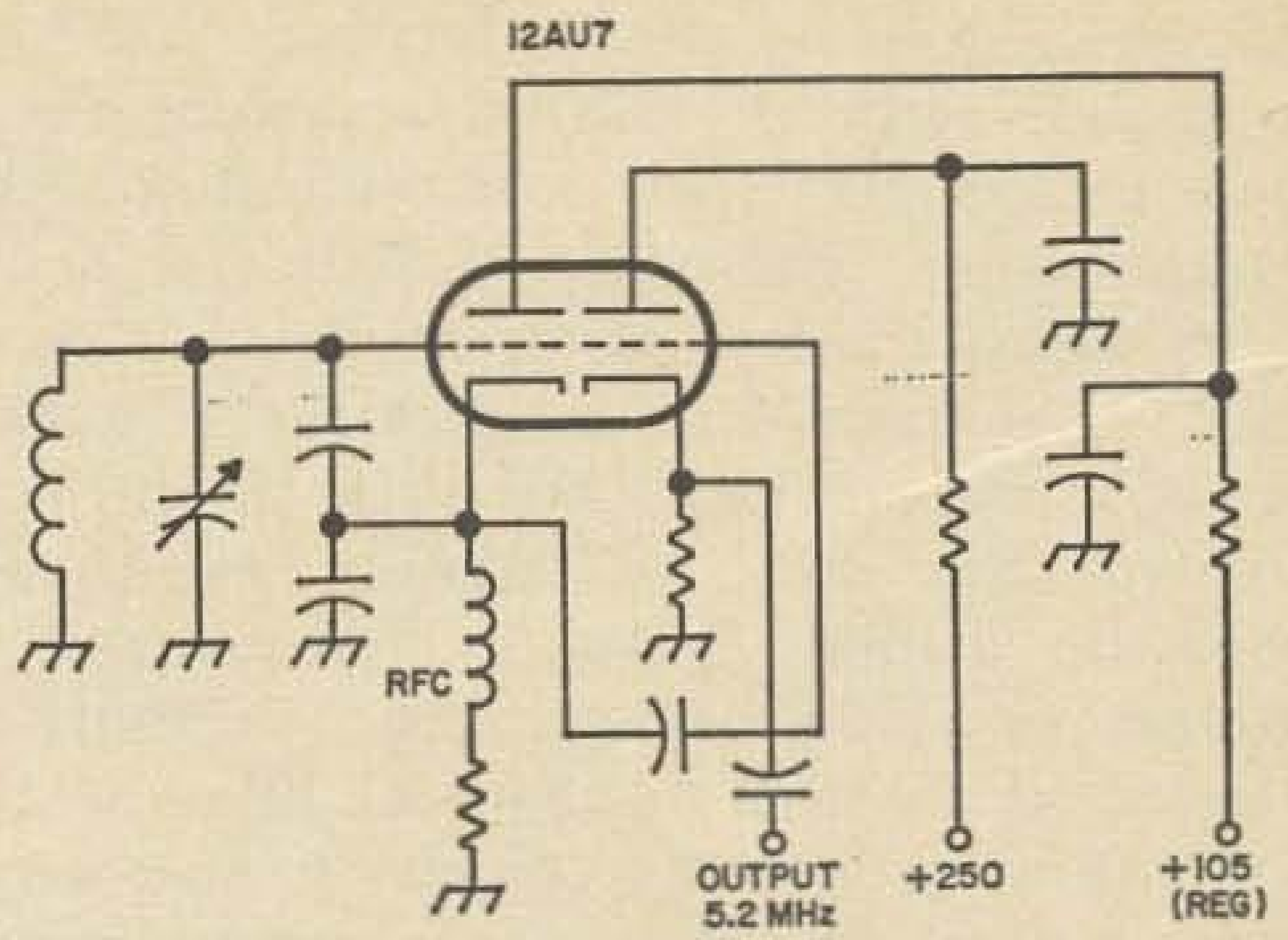

Fig. 2. Schematic of the oscillator circuit.

The second mixer is a necessary evil when a low second *if* is used. It was decided that a pentagrid mixer circuit would be tried in this case, and it was found to be adequate. This was a classical circuit taken from the handbook.[3] It was found that double tuned circuits were necessary in the coupling between the two mixers to reduce image response.

The second conversion oscillator was modified from a circuit in an old handbook,[4] and is a very useful device. A 1000 kHz crystal provides calibration markers, while the plate of the oscillator is tuned to 2000 kHz to provide injection to the second mixer. On the seven MHz frequency the signal from this oscillator is close to the same level as most incoming signals, and provides a handy calibration checkpoint. The schematic is indicated in **Fig. 3.**

Following the mixer is the real reason for the low *if* frequency; the Collins mechanical filter. It was obtained from a friend, and is really the backbone of the receiver. After much experience with crystal filters, it was feared that too high an input level to the filter would harm its frequency response, but even with one volt across the input the response curve is unchanged. The two *if* amplifiers were taken from the handbook[5],

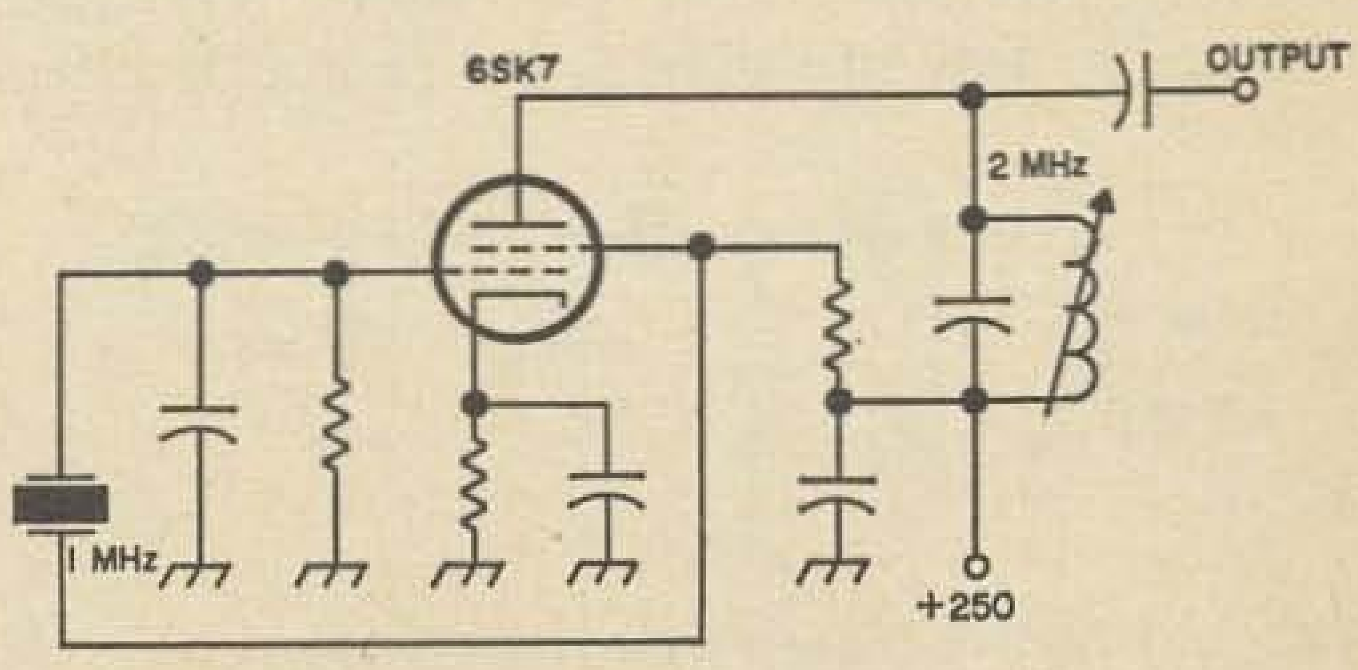

Fig. 3. Second conversion oscillator.

and are completely straightforward. 262 kHz automobile radio *if* transformers were tuned down to 250 kHz with no modification. The *if* transformers were loaded with 10 K resistors across their windings to prevent oscillation when necessary. Expect the *if* amplifiers to oscillate, and take steps to prevent it when they do. The circuits can be detuned or loaded down to reduce the Q without worrying because the selectivity is determined by the mechanical filter at the input. Don't reduce the voltages to stop oscillation, but run the tubes at the recommended voltages for best results.

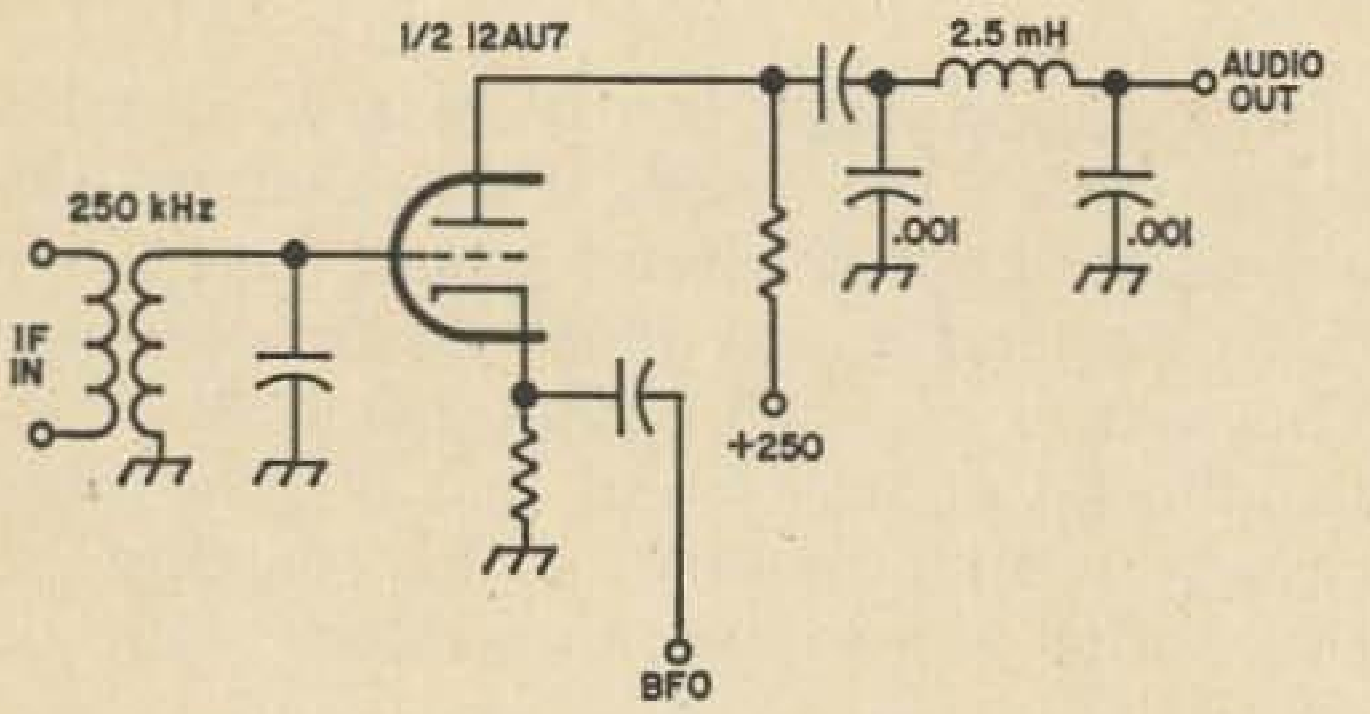

Fig. 4. Simple product detector circuit.

There are many types of product detector circuits which can be used, and **Fig. 4** shows the simplest. The dual diode configuration was tried with less than the best of results. The reverse resistance of the diodes is critical, and it will not work well with just any type diode. The distortion that resulted may have been caused by too low an injection voltage from the BFO, but finally the circuit shown in **Fig. 5** was used. This is similar to a circuit that has been used by Heathkit, and is not much more complicated than the diode circuit. The signal from the BFO is injected into the cathode, the *if* signal goes in at the grid, and audio comes out at the plate. This will handle the strongest of signals without distortion. It is unfortunate that the BFO had to be on the same frequency as the major *if* amplification. If the BFO signal gets around to the input of the *if* amplifier it can ride on through and reduce the effectiveness of the amplifiers. The ideal solution to this problem is using another con-

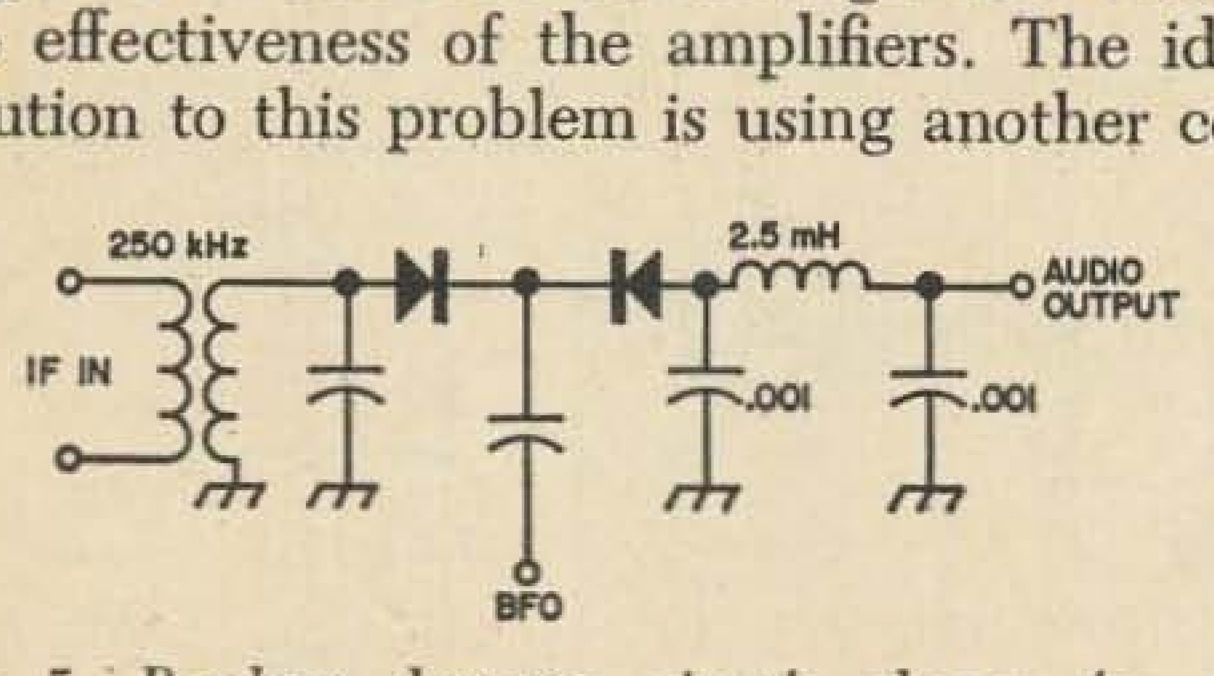

Fig. 5. Product detector circuit chosen for this receiver.

version and putting the BFO and product detector on another frequency. In this case, another conversion would not have been desirable, and careful isolation of the BFO from the first *if* stage is the only recourse. The BFO is a typical circuit$_6$, and a schematic is shown in **Fig. 6.** The only major requirements that this circuit must meet are frequency stability and high output voltage. The output obtained from the 6SN7 was adequate, but the frequency tends to "pull", or change frequency when a strong signal comes through the *if*. This is a major problem in all mixer-oscillator circuits, and the solution is to isolate the mixer, or in this case the product detector from the oscillator. This pulling only results from very strong signals, and has not been a problem except when deliberately driven by a signal generator. This has not been a problem, but if it were, the other section of the 6SN7 is available to use as a cathode follower to isolate the BFO from the product detector as was done in the first mixer.

An automatic gain control (AGC) is usually included in modern receivers to allow the receiver to run at maximum gain without being overloaded by a sudden strong signal. The AGC circuit used in this project is a popular one$_7$ that sees a great deal of use in home constructed receivers because of its simplicity and reliability. The audio voltage from the product detector is amplified, rectified, and applied to the grids of the *if* amplifier tubes with a negative polarity. R and C in the circuit determine the duration of the hold-in time between the instant that a signal is removed and the instant that the AGC voltage returns to its no-signal value. The higher the product of R times C, the longer the delay will be. Longer time delays are usually provided for SSB operation, while shorter delays are usually desired for CW operation. Typical values for R and C are 5.6 megohms and 0.1 microfarads. A schematic of this circuit is shown in **Fig. 7.** There are more complicated circuits that are available, but this one will usually prove very successful for a beginner.

One unusual problem that occurred in the AGC area was finally found to be caused by inadequate filtering in the output of the product detector. The strong BFO signal was going through the product detector just like an amplifier and was appearing at the AGC amplifier to produce a high AGC voltage that refused to change value.

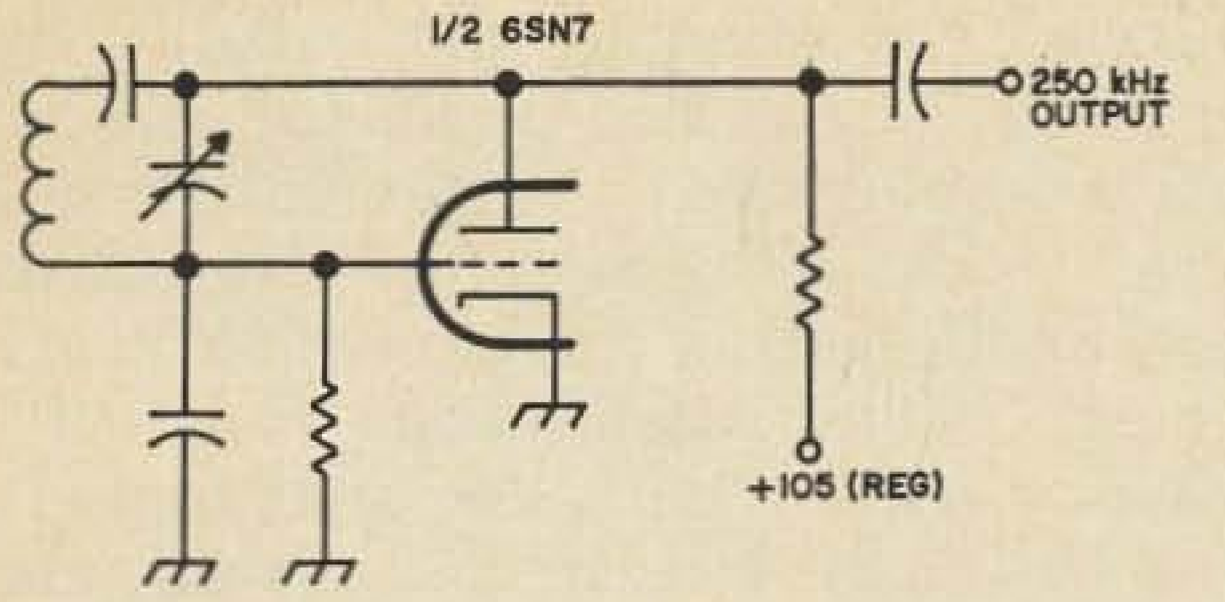

Fig. 6. BFO circuit.

Note the filtering circuit that is used in the plate of the product detector with the *rf* choke and the two .001 microfarad bypass capacitors. Increased filtering is necessary at lower frequencies.

The audio amplifier consists of a 12AX7 driving a 6AQ5 output tube. This is a simple circuit and can be found in many different versions in many publications. Unfortunately, the simplicity can be deceptive, because in this case the audio amplifier caused a great deal of trouble that was attributed to other circuits, thus increasing the problem. The low level voltage amplification stages (12AX7) should be isolated from each other, and from the 6AQ5 to prevent feedback. This can be simply done by adding a resistor (47K is typical) in series between the 12AX7 plate circuit and the power supply, and bypassing it at the plate resistor end with a ten or twenty microfarad electrolytic capacitor. This is almost always included in modulator circuits, but is seldom used in receivers. This precaution was found to be quite necessary in this case. Also, all the ordinary precautions should be observed of shielding the low level audio leads that go to the volume control and the grids of the voltage amplifiers. Power leads should be placed so that they are away from these sensitive leads.

Last and usually least discussed, is the power supply. The power supplies today are usually built with solid state rectifiers, and this receiver is no exception. The problem encountered here was the assumption that a small transformer could be used if some of the tube filaments were on the 5.0 volt winding of the power transformer. In this case, this resulted in a degradation of the overall sensitivity of the receiver, and caused months of frustrated *if* amplifier building and modification where none was needed. This is a case where a good VOM applied to the right place can help a great deal. In a last effort, the tubes were checked in a tube tester, and, by chance, one was replaced in the receiver while the filament was still hot. What a difference! The transformer found its way to the trash can in the same evening.

Mechanical layout and construction

In starting a project of this magnitude it is usually a good idea to invest a considerable amount of money to provide a proper foundation for the receiver. A one-eighth inch thick aluminum rack panel was purchased as was a chassis and side braces. These components along with the dial make up the major cost of the receiver. The chassis was selected as large as possible, and was still too small after several additions were made. Also, a collection of smaller chassis would provide better shielding between circuits and better mechanical rigidity but it is very difficult to work down inside the small spaces. The best Eddystone dial was selected to provide a smooth and mechanically stable frequency control. The price is reasonable when the results are considered, and can be justified by noting the feelings that can be involved when working with a project of this magnitude. There is also a great incentive involved when a considerable amount of money has been spent, and using cheaper components can result in discouragement.

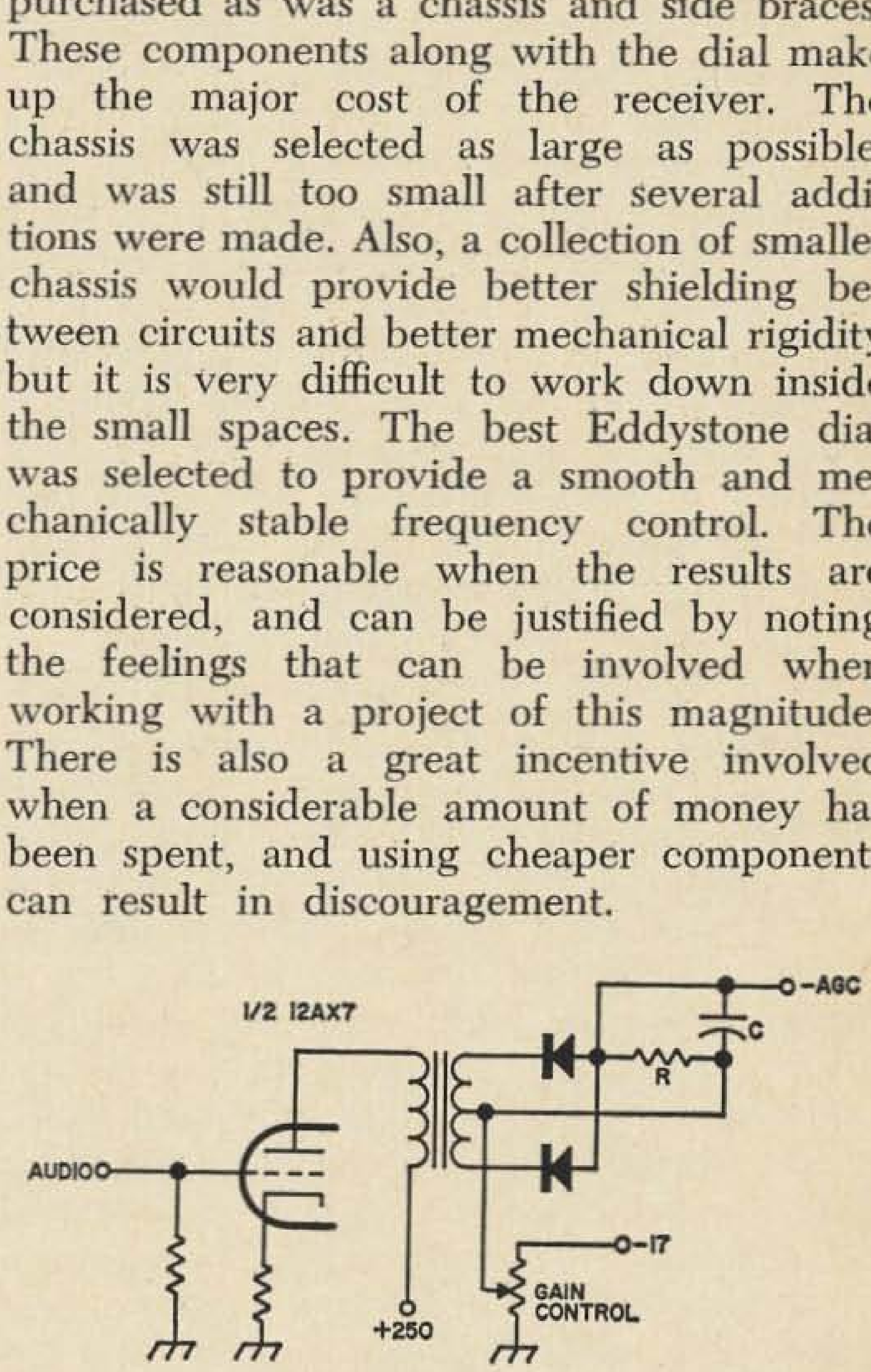

Fig. 7. The AGC circuit.

The objective here is to arrange the components so that they physically resemble the block diagram. This is to provide isolation between circuits that when coupled may cause annoying feedback, and to provide close coupling between circuits that are connected to each other. Also, the mounting of the first oscillator circuit is considered, and all possible methods should be employed to provide a solid mechanical mounting of this unit. The oscillator is usually constructed in a separate box to provide thermal insulation with the ambient temperature to prevent temperature changes from affecting the frequency. This was considered in this case, and it is also important that the tube is mounted outside of the box. The oscillator compartment was mounted on a three-eighth inch thick aluminum slab and mounted with one quarter inch diameter brass bolts through spacers to align the oscillator variable capacitor with the dial shaft. A semi-flexible coupling taken from an old surplus tuning unit was used to prevent binding in the case of any misalignment. The large metal base was used only in the hopes that increasing the mass of the unit would make it more resistant to mechanical shocks. The chassis is depended upon to provide most of the coupling between the box and the dial. An improvement here with the addition of more bracing between the oscillator box and the dial would be a needed improvement if the unit were to be subjected to a great deal of vibration in operation. At this point, as a reminder, it is always good to use lock washers in all construction. The bolts that hold the panel to the chassis have a habit of working out if the unit is moved around.

The only comment about wiring is: be patient. Wiring can get quite messy in experimental work during the excitement of the chase, and should be gone over after final decisions have been made. Also, when wiring it is always a good idea to start from the output and work forward. This is done to prevent frustration that can result when a large device is built with the inevitable errors which are always present, only to find a massive trouble shooting project when it was thought the project was completed. Each circuit was constructed so it could be checked in operation before going on to another circuit. Building a huge receiver seems like quite a large project, but no one will balk at building just a power supply, or just an audio amplifier, or some other individual circuit. The success of each step will add encouragement, and success is not difficult in any given unit.

A few words concerning parts substitution are in order here. A well stocked junk box can be a great asset, but it can cause a good deal of grief if used excessively or unwisely. It must be established without any doubt that a component to be employed is usable for the intended application. A component that is faulty and is assumed to be good can cause one to suspect some component that is not the cause of the problem. For example, the variable capacitor used in the first oscillator was taken from a surplus ARC-5 command transmitter. Here was the ideal capacitor with ball bearings at both ends of the rotor shaft, and very rugged, stable construction. However, the contact between the rotor and ground was corroded, and caused an uneven change in frequency as the dial was turned. A great deal of effort and worry was involved in trying to cure the "backlash in the dial." The main point is just to avoid using components which are not new or in new condition, and it doesn't make much sense to build a new receiver with components which are not new. It is also a good idea to buy small components such as resistors and capacitors new, rather than using old ones. The old leads which have been bent can break, and sometimes a distributor will give a discount when large quantities are purchased as would be true when building a receiver.

Results

The sensitivity was measured with a TS 413 A/U signal generator. The *rf* voltage was applied to a fifty ohm carbon resistor across the input at 7200 kHz. With the output on the ten microvolt scale, the receiver could still give Q5 copy on the generator output with the output level control at zero. This was probably less than one half microvolt, which was the least scale count on the output level meter of the signal generator.

The stability was good. In a test where the first oscillator was zero beat with WWV (on 5 MHz) the power had been on only long enough for the filaments to come up to operating temperature. During this one half hour test period, the signal stayed zero beat as far as could be detected, and the drift must have been less than 100 Hz. In actual operation, warm up drift is never noticed. In a condition like amateur operation, short term stability is the prime consideration rather that how much drift there has been after two days. Since transmissions and QSO's are usually short, it is the stability during a short period of time that is most important. Dropping the receiver can cause a frequency change of a few hundred Hertz, depending on the height from which it is dropped. This is mostly due to the dial changing, and not being rigidly referenced to the tuning capacitor. However, in normal operation, the receiver is seldom dropped, and is of no great consequence.

Just indicating that a mechanical filter is used is sufficient to determine the degree of selectivity. The selectivity is adequate in all respects, indicating that care had been taken to isolate the input of *if* amplifier to signals that might have sneaked around the filter. Image response is not so commendable, and a few weak images from strong navy teletype stations near this location can be heard. This is a result of the multiple conversions also multiplying the chances for images. This has not caused any problems when the receiver is used with a well tuned antenna, but for weak signal reception with a poor antenna close to a strong transmitter, problems could result. There are plans for increasing the selectivity for CW by the addition of toroid coil audio filters. Also the bandpass can be widened by adding capacitors across the mechanical filter if the receiver is to be used for AM.

Afterthoughts

Since this receiver covers only eighty and forty meters, crystal controlled converters are planned for the higher frequency bands. The good cross modulation characteristics of field effect transistors with their low cost (less than one dollar), their simplicity (only three leads; no filament or screen), and compact size make them ideal to meet the requirements of this receiver. The now widely available information on them will make this an easy addition, and mechanical layout will be the only chore.

In conclusion, considering the money and effort that went into this project, it has given a very good return, not just considering the performance of the receiver, but the experience which has been gained from the errors and corrections leading to the final success.

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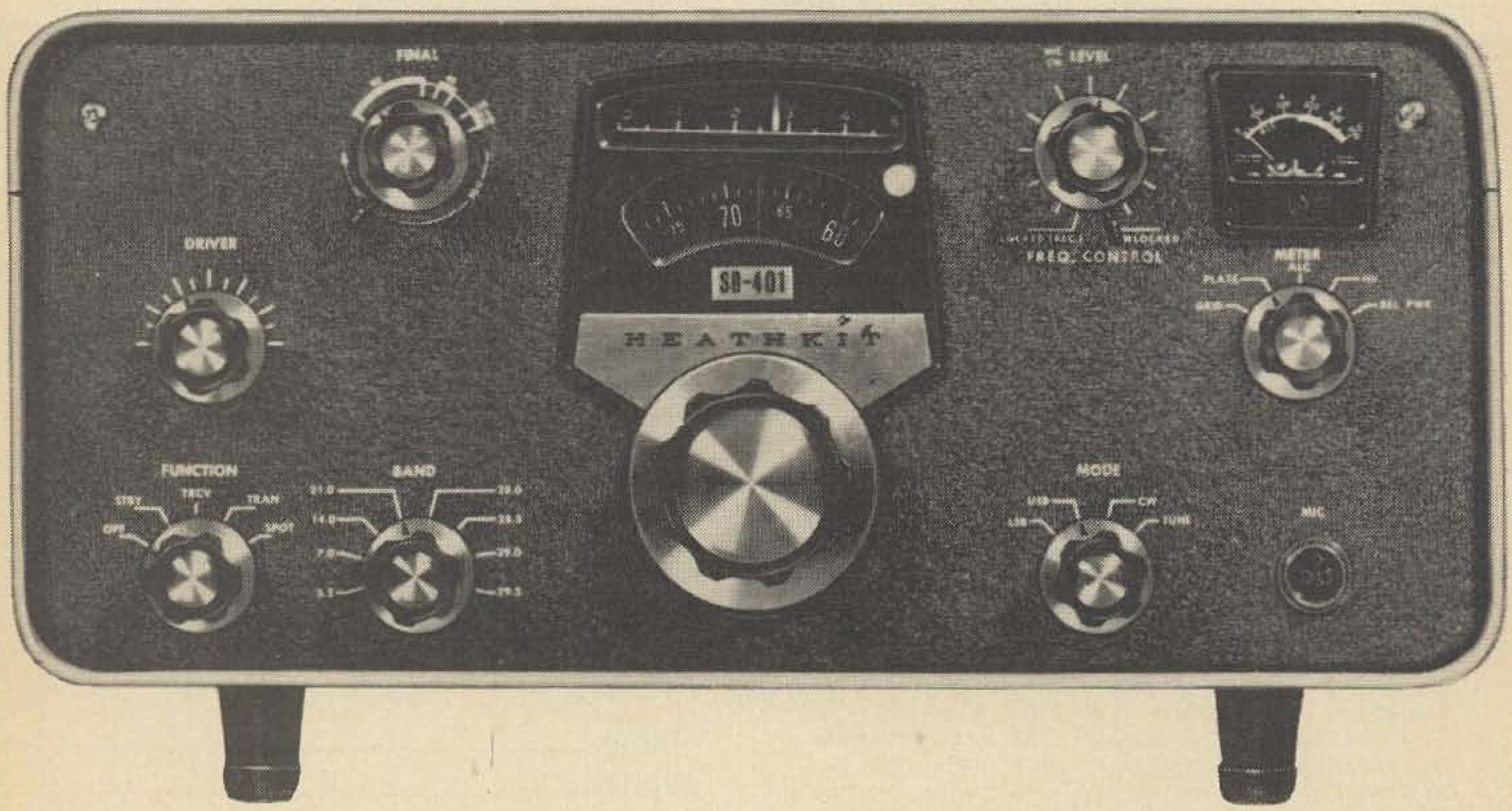
Some Hams Still Prefer A Separate Receiver

And Transmitter...



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Kit SB-600, Communications Speaker, 5 lbs. **$18.95**

Look over the specs and find out why thousands of hams have chosen the SB-301 for their shack!

SB-301 PARTIAL SPECIFICATIONS — Frequency range (megahertz): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 15.0 to 15.3, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. **Intermediate frequency:** 3.395 megahertz. **Frequency stability:** Less than 100 Hz per hour after 20 min. warmup under normal ambient conditions. Less than 100 Hz for ±10% line voltage variation. **Visual dial accuracy:** Within 200 Hz on all bands. **Electric dial accuracy:** Within 400 Hz on all bands after calibration at nearest 100 kHz point. **Backlash:** No more than 50 Hz. **Sensitivity:** Less than 0.3 microvolt for 10 db signal-plus-noise to noise ratio for SSB operation. **Modes of operation:** Switch selected; LSB, USB, CW, AM, RTTY. **Selectivity:** RTTY; 2.1 kHz at 6 db down, 5.0 kHz at 60 db down (crystal filter supplied). SSB; 2.1 kHz at 6 db down, 5.0 kHz at 60 db down (crystal filter supplied). AM; 3.75 kHz at 6 db down, 10 kHz at 60 db down (crystal filter available as accessory). CW; 400 Hz at 6 db down, 2.0 kHz at 60 db down (crystal filter available as accessory). **Spurious response:** Image and IF rejection better than 50 db. Internal spurious signals below equivalent antenna input of 1 microvolt. **Audio response:** SSB; 350 to 2450 Hz nominal at 6 db. AM; 200 to 3500 Hz nominal at 6 db. CW; 800 to 1200 Hz nominal at 6 db. **Audio output impedance:** Unbalanced nominal 8 ohm speaker and high impedance headphone. **Audio output power:** ½ watt with less than 8% distortion. **Antenna input impedance:** 50 ohms nominal. **Muting:** Open external ground at Mute socket. **Crystal calibrator:** 100 kHz crystal. **Power supply:** Transformer operated with silicon diode rectifiers. **Power requirements:** 120/240 V AC, 50/60 Hz, 50 watts. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

The HEATHKIT® SB-401 5-Band SSB Transmitter

Imaginative Engineering and Rugged, Reliable Performance Capabilities Have Made The SB-401 The World's Largest Selling Transmitter

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Kit SB-401, 34 lbs. **$285.00**
SBA-401-1, Crystal Pack, 1 lb. **$29.95**

Check the specs and see the many reasons why you hear the SB-401 on the air more often than any other transmitter!

SB-401 SPECIFICATIONS — Emission: SSB (upper or lower sideband) and CW. **Power input:** 170 watts CW, 180 watts P.E.P. SSB. **Power output:** 100 watts (80-15 meters), 80 watts (10 meters). **Output impedance:** 50 to 75 ohm — less than 2:1 SWR. **Frequency range:** (MHz) 3.5 — 4.0; 7.0 — 7.5; 14.0 — 14.5; 21.0 — 21.5; 28.0 — 28.5; 28.5 — 29.0; 29.0 — 29.5; 29.5 — 30.0. **Frequency stability:** Less than 100 Hz per hr. after 20 min. warmup. **Carrier suppression:** 55 db below peak output. **Unwanted sideband suppression:** 55 db @ 1 kHz. **Intermodulation distortion:** 30 db below peak output (two-tone test). **Keying characteristics:** Break-in CW provided by operating VOX from a keyed tone (Grid block keying). **CW sidetone:** 1000 Hz. **ALC characteristics:** 10 db or greater @ 0.2 ma final grid current. **Noise level:** 40 db below rated carrier. **Visual dial accuracy:** Within 200 Hz (all bands). **Electrical dial accuracy:** Within 400 Hz after calibration at nearest 100 kHz point (all bands). **Backlash:** Less than 50 Hz. **Oscillator feedthrough or mixer products:** 55 db below rated output (except 3910 kHz crossover which is 45 db). **Harmonic radiation:** 35 db below rated output. **Audio input:** High impedance microphone or phone patch. **Audio frequency response:** 350-2450 Hz ±3 db. **Power requirements:** 80 watts STBY, 260 watts key down @ 120/240 V AC, 50/60 Hz. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

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3-Tube Superhet Short-Wave Receiver

Jess W. Speer W6ELJ
3059 *Austin Avenue*
Santa Susana, Calif. 93063

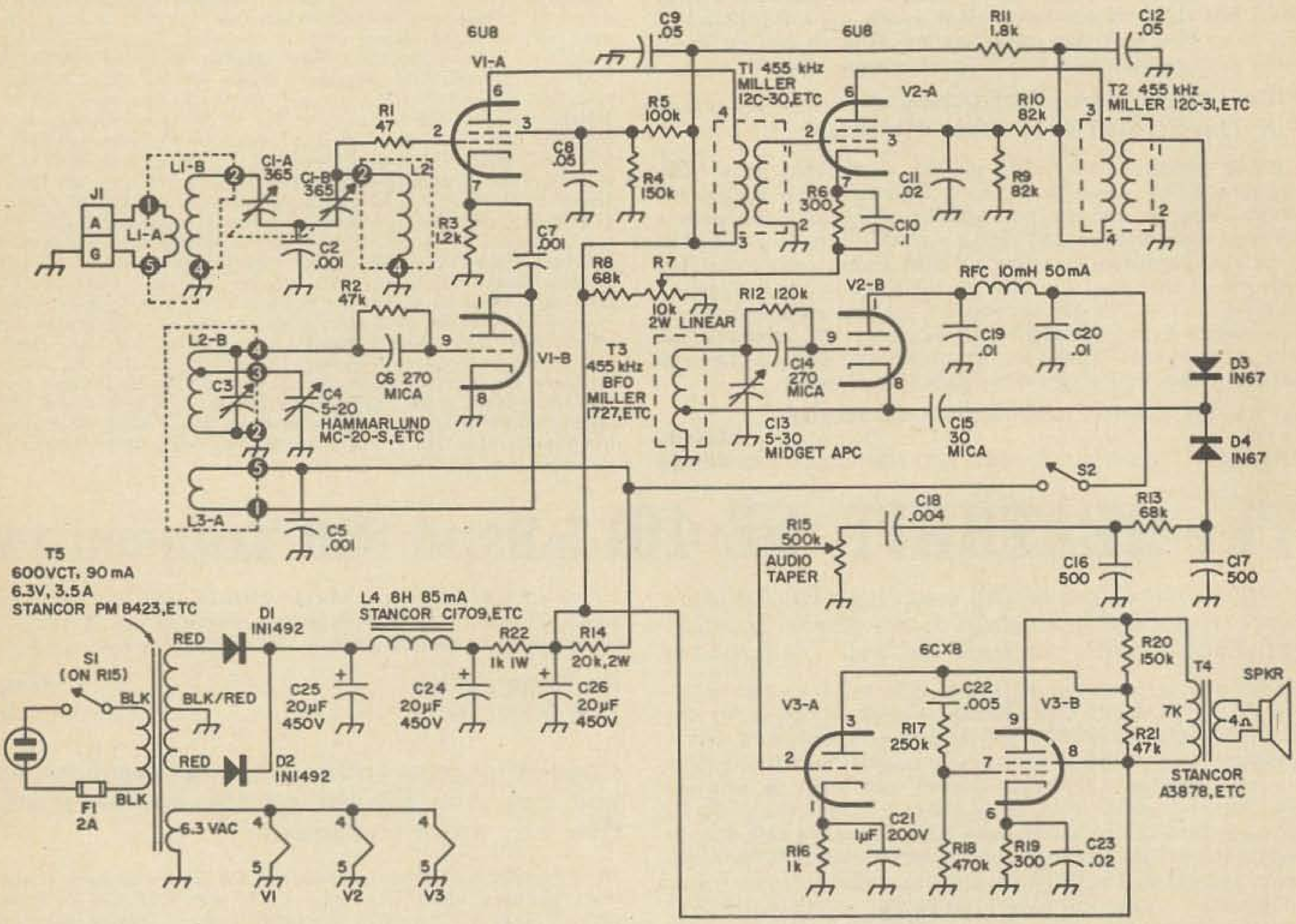


Fig. 1. Complete schematic for the 3 tube superhet receiver.

Here's a 3-tube package of electronic dynamite that carries as big a wallop as many short-wave receivers costing three times as much. It is simple enough for a beginner to construct, performs well enough to please an old timer, uses readily available parts throughout, and cost less than fifty dollars to build—and even this amount can be reduced by half if you cannibalize an old broadcast set for some of the parts!

True this receiver doesn't have all the fancy bandswitching found in larger, more expensive sets, but it *does* have all necessary circuitry for code and single sideband reception—plus plenty of gain, and loudspeaker output. Its very simplicity is one of its salient features. For here is a receiver which can be modified, added to on the front end, its coils and tuned circuits changed and experimented with; all resulting in a lot of fun and self-satisfaction, while at the same time giving its builder valuable experience and confidence without pressing too hard on his pocketbook.

Experience gained from building this receiver will allow the ham to work on his own communications receiver without "fear of messing up a piece of expensive equipment," as is so often heard. You may want to make an improved or modified version, but a note here: The receiver, exactly as shown, will give a good account of itself, and is a project well worth undertaking.

The "dynamiter" employs plug-in coils and one-dial tuning to cover the 80 and 40-meter amateur radio bands. And with a little experimenting (and some sacrifice in performance), coils for the 20-meter, 15-meter, and 10-meter bands can conceivably be wound.

About the circuit

Essentially, the "dynamiter" is a 2-stage superhet using three dual-purpose tubes to deliver 6-tube performance. (See **Fig. 1.**) It employs a converter, an *if* amplifier, a product detector, a beat frequency oscillator, and two stages of audio amplification.

Signals from the antenna are fed to the mixer, the pentode section of VI (6U8), through coil L1 and coil L2, which are tuned by the dual-section broadcast capacitor C1. This adds selectivity and the capacitor is large enough to all two-band coverage without changing coils L1 or L2, simply by retuning.

The triode section of VI serves as the local oscillator. The oscillator coil L3 is tuned 455 kHz below the incoming signal with padding capacitor C4, mounted inside the coilform. Main tuning (of the local oscillator) is by the large vernier dial centered on the front panel, and which is attached to the small bandspread variable capacitor C3.

After the signal is hetrodyned to 455 kHz in the mixer, it is fed to the pentode section of V2 (6U8), which functions as an *if* amplifier. The amplified signal is then applied to the product detector formed of the two IN67 diodes D3 and D4. The triode section of V2 serves as a Beat Frequency Oscillator, and a signal from this oscillator is capacity coupled through C15 to the product detector for carrier re-insertion of sideband signal or to produce a beat note with CW signals. AM signals may be received by tuning them in and zero-beating the bfo. The detected signal is amplified by V3 (6CX8) to a level sufficient to drive the loudspeaker, the triode section of V3 serving as the first audio amplifier and the pentode section as the second.

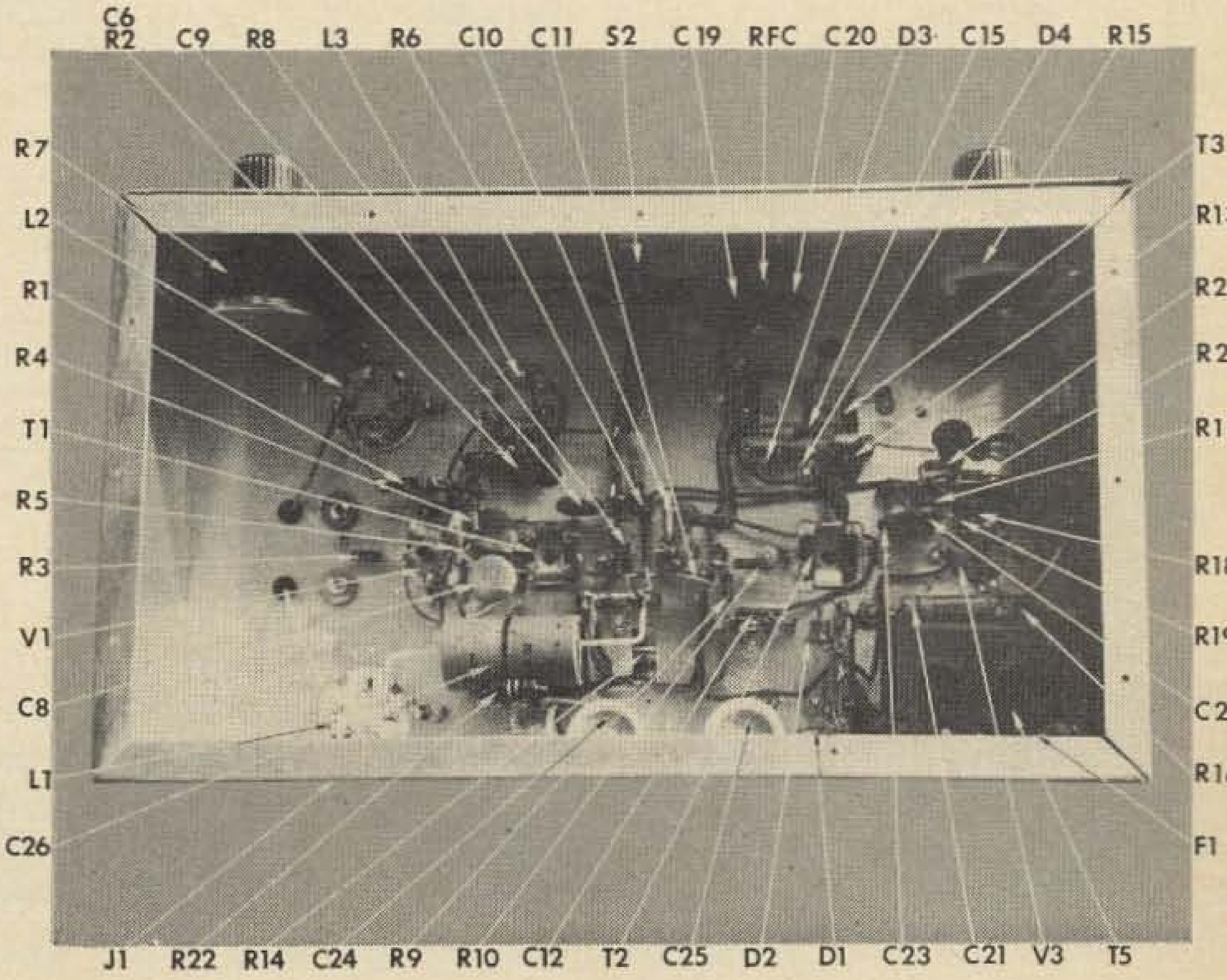
Full-wave rectified B+ is furnished by the power supply, comprised of power transformer T5, two (IN1492) silicone diodes D1 and D2, the smoothing choke L4, and filter capacitors C24 and C25.

Construction

The receiver is assembled on a 7 x 12 x 3 inch aluminum chassis. **(Fig. 2.)** The speaker and operating controls are mounted on a front panel 7¼ inches high and 12 inches wide, cut from scrap aluminum sheetmetal. The case is also fashioned from scrap aluminum sheetmetal.

Mounting dimensions, coil and tube hole sizes are shown in **Fig. 2.** And while these will vary with individual construction (depending upon the size of the speaker, output transformer, and power transformer used), adhering to the general layout shown will result in over-all symmetry, making for a neat job. Drill sizes are not given, as these also will vary. All screws that protrude the front panel are countersunk.

The bandspread tuning capacitor C4 and



Parts layout for the Dynamiter receiver.

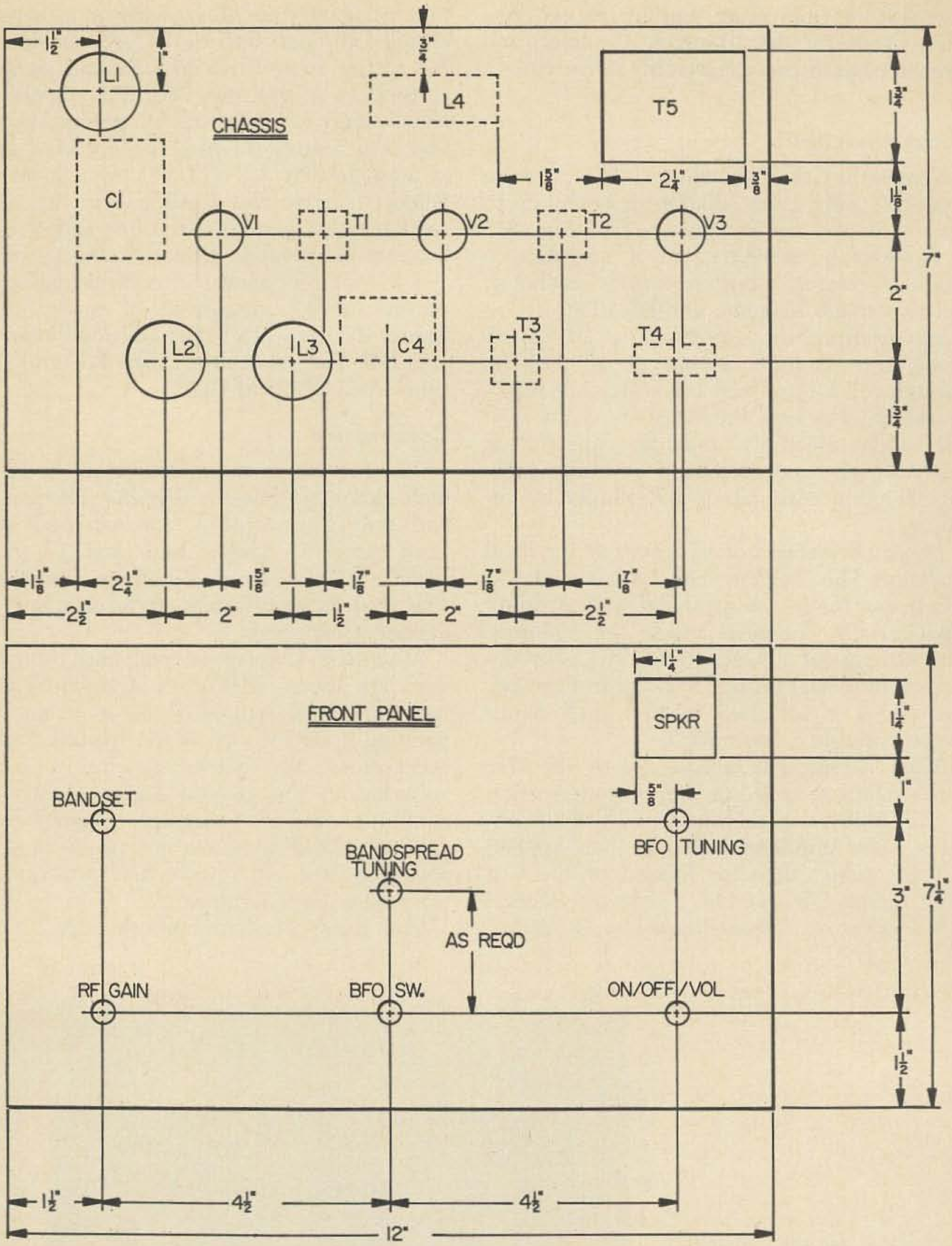


Fig. 2. Mounting dimensions, hole sizes and general chassis layout.

the dial assembly should be mounted first. The capacitor is centered on the chassis, and the dial aligned on the front panel to match the capacitor shaft. (The front panel may be attached temporarily to the chassis with four #6 countersunk screws placed ½ inch from each chassis corner.) After the main tuning capacitor and dial are mounted, mount power transformer T5. Order of mounting is important because the rest of the layout hinges around these components.

This accomplished, mount the speaker, the output transformer, and bfo coil next, as the size of the speaker and output transformer may vary. You may then juggle the remaining components to be mounted on the topside of the chassis as desired; maintaining as closely as possible the symmetrical layout shown.

Coil Data

Coilforms are 1¼-inch diameter polystyrene 5-pin plug-in (Amphenol 24-5P). Coils L1A, L1B, and L2 are cut from B&W 3016 Miniductor and fitted down inside coilforms. Coil L1A is 8 turns and coil L1B and L2 are 19 turns. Count off 30½ turns, clip at 9 turns, and use ½ turn for leads, leaving L1A and L1B on same piece of stock and separated by 1 turn. Coil L3 is wound with #26 enamel wire. All coil windings are in the same direction. For 80-meter reception, coil L3A is 12 turns close wound. Coil L3B (separated from L3A by ⅜ inch) is 30 turns close wound, then 4 turns space wound over ¼ inch, then 5 turns close wound, tapped at 32½ turns. C3 is 75 pF. For 40-meter reception, coil L3A is 10 turns close wound. Coil L3B (separated from L3A by ¼ inch) is 7 turns close wound, then 17 turns spaced over 1 inch, tapped at 10 turns. C3 is 50 pF.

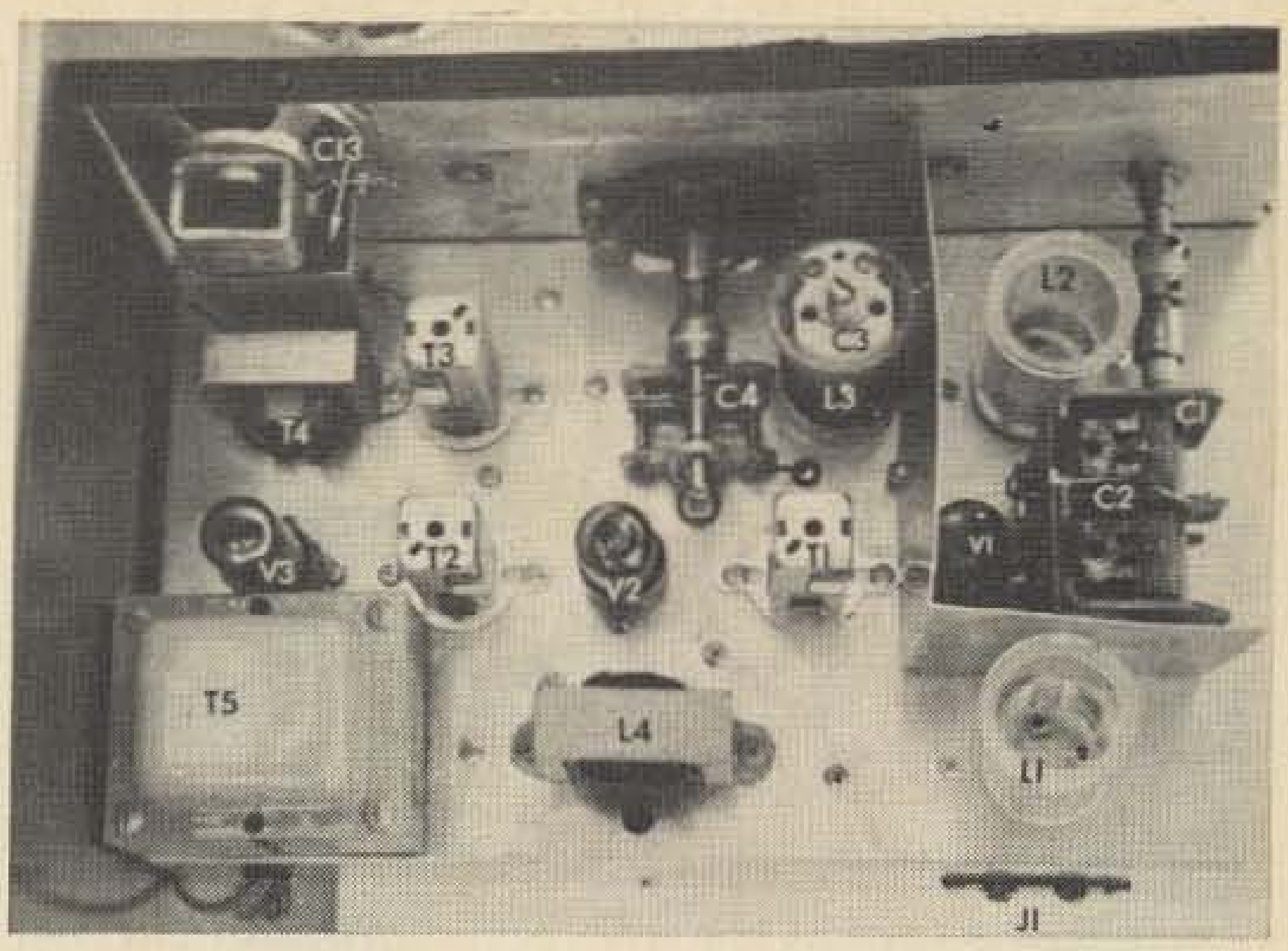
The shield separating the coils, and the shield around the bfo tuning capacitor (also cut from 1/16 inch thick aluminum scrap and mounted with spade lugs) are a must. They permit required electrical separation of the circuits.

The remaining construction is not too critical. However, liberal use of terminal strips for mounting of the components underneath the chassis is recommended. So is the use of fairly stiff (#20) hook-up wire. These help prevent the receiver from becoming mircophonic. All wiring except power supply wiring should, as much as possible, be point-to-point, and leads kept short.

After the receiver is completed and playing, the front panel may be masked off, spray painted, and dressed up with decals or transfer lettering. The enclosure (if one is used) may be removed and painted. And the dial, once calibrated, also may be marked with transfer numbers.

Adjustment

Although it is possible to align the receiver without the use of an rf signal generator, it is a job for an experienced serviceman or an oldtimer, and takes some time and doing. So if you don't own such an instrument, beg,



Top view showing parts layout

badger, or blackmail a friend into the loan of one. The job without it is almost a hopeless chore.

Start adjustment by setting the generator to deliver an audio signal. Connect the "hot" lead of the generator to the end of R13 (68K) that feeds the audio. Advancing the volume control should produce a loud signal through the speaker.

Next, place the bfo switch to OFF, feed a 455 kHz modulated signal to the grid (pin 2) of V2. Tune *If* transformer T2 slugs for the loudest signal. *If* transformer T1 is tuned by removing oscillator coil L3, and coupling generator lead (thru a blocking capacitor) to the plate (pin 6) of V1. (**Caution:** B+ voltage is present at pin 6 of V1.) It will be necessary to adjust rf gain pot R7 for optimum results.

To adjust the BFO coil T3, leave the generator connected to pin 6 of V1. Set generator to an unmodulated output and the bfo tuning capacitor C13 half meshed. Adjust bfo coil slug for zero beat. (Zero beat is determined by finding the "valley" of two loud whistles just each side of 455 kHz.)

To tune the front end, set the generator for 3.8 MHz modulated output. Connect generator leads to antenna terminals J1 and plug in the 80-meter coil L3. Set bandset capacitor C1 to about three-fourths (approximately number 8 on the knob). Set bandspread capacitor C4 to full mesh and advance volume to full gain. Turn up the rf gain to about three-fourths maximum and tune capacitor C3 (inside coil L3) for maximum signal output. It may be necessary to re-touch the slugs at transformers T1 and T2). The oscillator coil for 40-meter operation may be tuned in the same manner. Once an oscillator coil has been set, it may

PARTS LIST

C1A, C1B—365 pF, dual variable capacitor
C2, C5, C7—0.001 μF, 600-volt ceramic disc capacitor
C4—5-20 pF variable capacitor (Hammarlund MC-20-S or equivalent
C3—Midget "APC" variable capacitor (See Fig. 4)
C6, C14—270 pF, 400-volt mica capacitor
C8, C9, C12—0.05 μF, 600-volt ceramic capacitor
C10,—0.1, 200-volt ceramic disc capacitor
C11, C23—0.02 μF, 400-volt ceramic disc capacitor
C13—35 pF midget "APC" variable capacitor
C15—30 pF, 400-volt mica capacitor
C16, C17—500 pF, 150-volt ceramic disc capacitor
C18—0.004μF, 200-volt ceramic disc capacitor
C19, C20—0.01μF 400-volt ceramic disc capacitor
C21—1.0μF, 200-volt paper capacitor
C22—0.005μF, 400-volt ceramic disc capacitor
C24, C25, C26—20μFD, 450-volt electrolytic capacitor
D1, D2—1N1492 diode
D3, D4—1N67 diode
F1—2-ampere fuse (and fuse holder)
J1—Antenna terminal
L1—Antenna Coil, B & W 3016 Miniductor coil
L2—B & W 3016 Miniductor coil
L3—Oscillator coil (See Fig. 4)
R1—47-ohm, ½-watt resistor
R2, R21—47,000-ohm, ½-watt resistor
R3—1.2K ohm, ½-watt resistor
R4, R20—150,000-ohm, ½-watt resistor
R5—100,000-ohm, ½-watt resistor
R6, R19—300-ohm, ½-watt resistor
R7—10,000-ohm, 2-watt potentiometer, linear taper
R8, R13—68,000-ohm, ½-watt resistor
R9, R10—82,000-ohm, ½-watt resistor
R11—1800-ohm, ½-watt resistor
R12—120,000-ohm, ½-watt resistor
R14—20,000-ohm, 2-watt resistor
R15—500,000-ohm potentiometer audio taper
R16—1000-ohm, ½-watt resistor
R17—250,000-ohm, ½-watt resistor
R18—470,000-ohm, ½-watt resistor
R22—1K 1W resistor
RFC—10 millihenry, 50 mA, radio frequency choke
S1—S.p.s.t switch (on R15)
S2—S.p.d.t. miniature toggle switch
T1—455 kHz intermediate frequency transformer (J. W. Miller 12C-30 or equivalent)
L4*—8-Henry, 50 mA filter choke (Stancor C1709 or equivalent)
T2—455 kHz intermediate frequency transformer (J. W. Miller 12C-31 or equivalent)
T3—455 kHz beat frequency oscillator transformer (J. W. Miller 1727 or equivalent)
T4—Output transformer: primary 7000 ohms; secondary, 4 ohms (Stancor A3878 or equivalent)
T5—Power transformer, 600 VCT @ 90 mA and 6.3 volts @ 3.5 amperes (Stancor PM 8423 or equivalent)
V1, V2—6U8 tube
V3—6CX8 tube
Spkr—3", 3.2-ohm speaker
Chassis—7" x 12" x 3" aluminum
Coil Form—1¼", 5-pin (Amphenol 24-5P; available from Allied Radio, Chicago, Ill.
Misc.—Knobs, a.c. line cord, 9-pin tube socket, 5-pin coil socket, terminal strips, hook-up wire, hardware, 1/16" thick aluminum scrap, etc.

be plugged in and out of the circuit without re-setting.

Operation

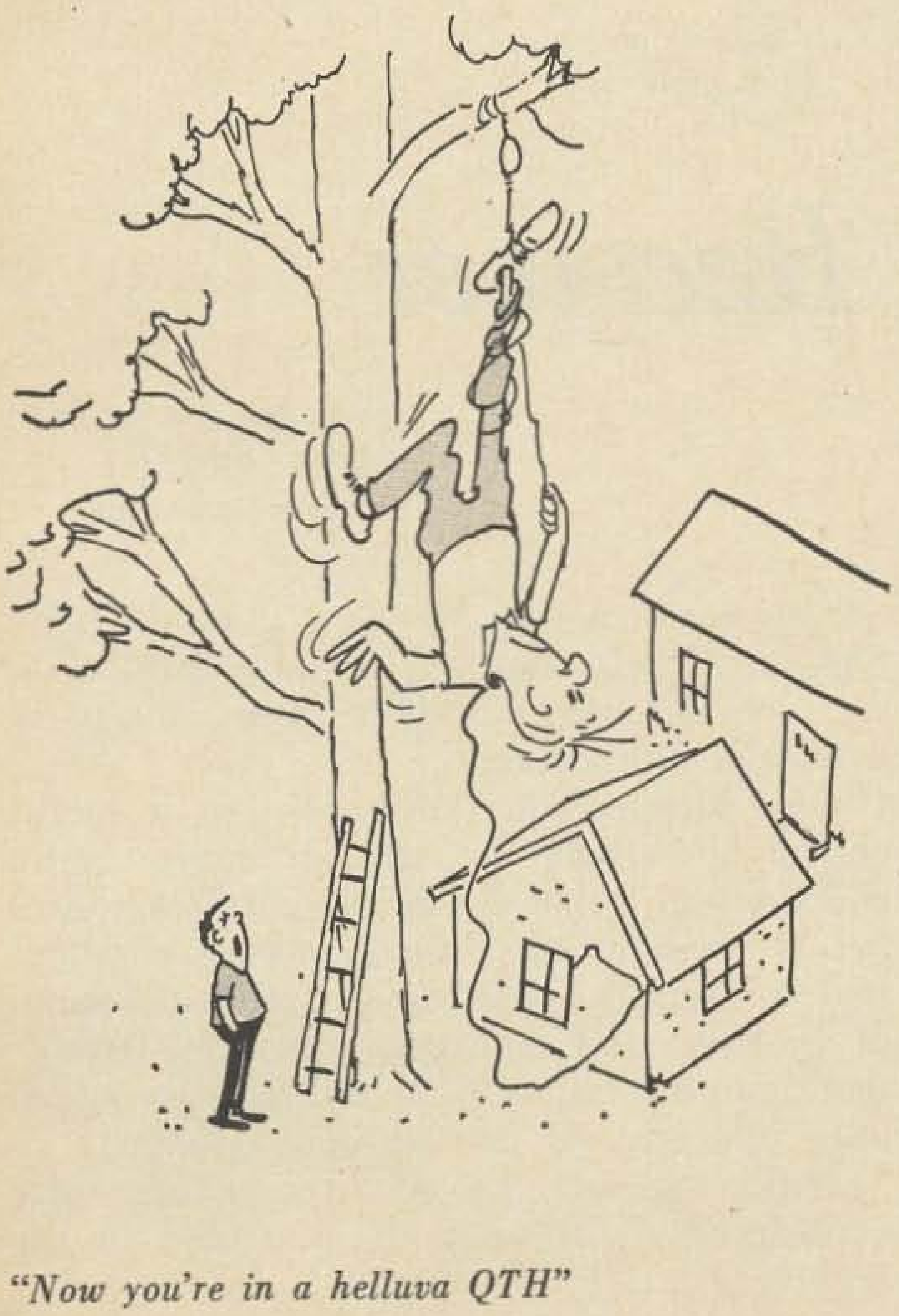
Connect a good antenna system (aerial and ground both) to antenna terminal J1, and turn the receiver on. Set the rf gain control all the way up. Advance volume control until a loud oscillation or noise is heard.

Then back off on the rf gain to just below the point of oscillation. Manipulate the bandspread tuning dial. The stations should come booming in! If the station being received is a CW or an SSB station, adjust bfo tuning knob for best results.

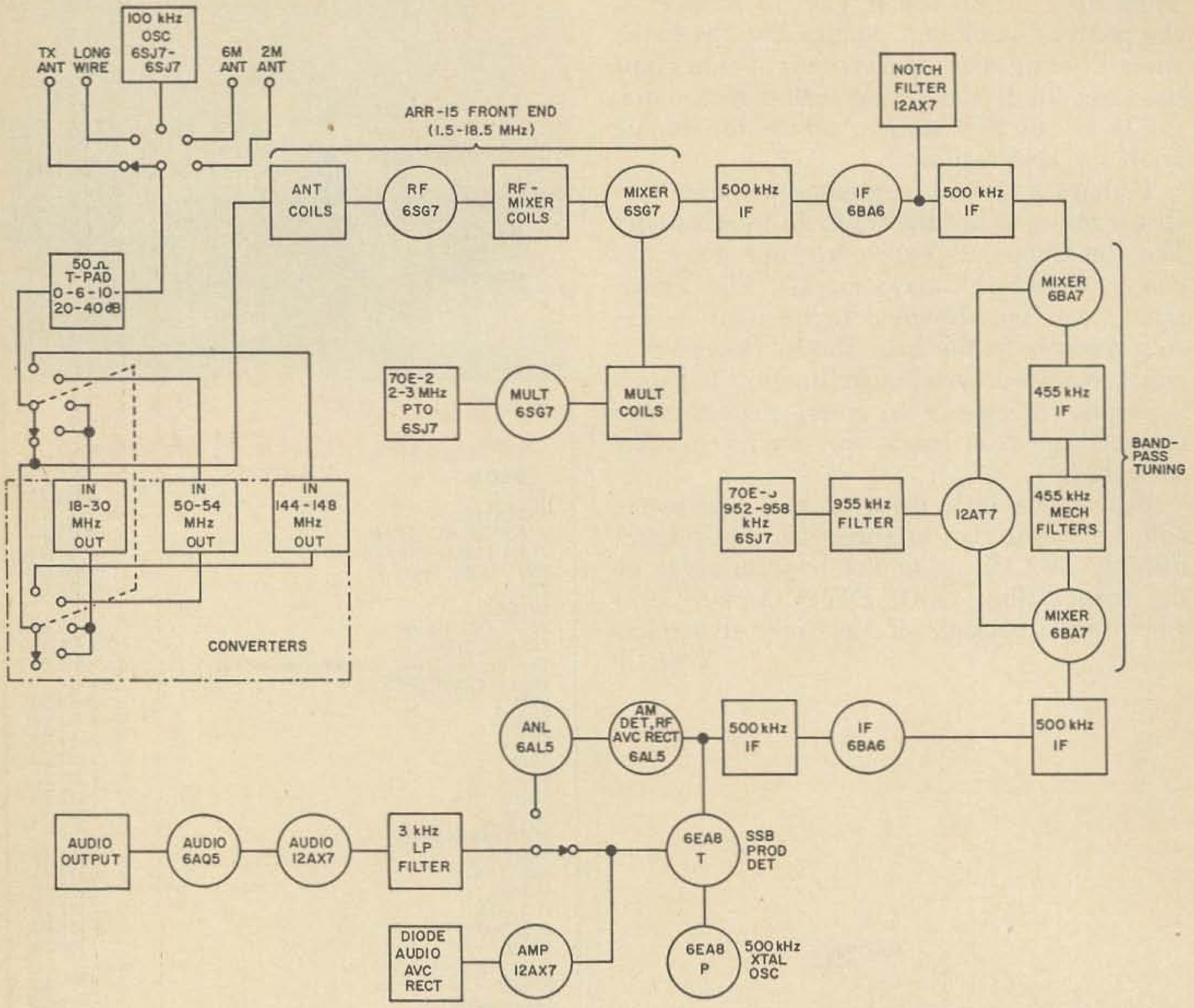
Perhaps it should be pointed out here that this receiver is not the ultimate in selectivity like the numerous expensive, but good, receivers found on today's market. The "dynamiter" was not designed to be used as the sole receiver in the ham shack. However, it *can* and *will* do creditable standby for such a purpose in case of an emergency. Also remember the ham bands are overly crowded these days.

But with a little practice and experience, you will soon be listening to the ringing *dit-dahs* of CW, or to the hopeful voice of the ham calling, "CQ, DX! CQ, DX!," on your 3-tube package of electronic dynamite.

. . . W6ELJ



"Now you're in a helluva QTH"



The MO Receiver*

Walt Cleland K5WYG
1202 *Holly Drive*
Richardson, Texas

Introduction

Through the years since becoming interested in radio, the author has built and modified many communications receivers; all the way from crystal sets to multi-tubers-(no transistors). The purpose of each new receiver project was, of course, to incorporate new techniques and ideas in an effort to improve reception. Many articles and discussions have been presented in the amateur journals covering a multitude of improvements to old receivers, construction of new receivers and some suggested ideas requiring further development. This article describes a receiver design based on the employment of a portion of a surplus airborne communications receiver.

* Midnight Oil

This is not a step by step "nut and bolt" type article; but rather, a description of a receiver that was constructed from junk parts from old equipments.

It was prepared in the hope that it might encourage others to attempt more home construction projects. It obviously requires access to some machinery, test equipment and not just a little time. The satisfaction of building and enjoying homebrew equipment far outweighs that of being an appliance operator (in the authors opinion).

Following are the features which were considered desirable to be included in the receiver:

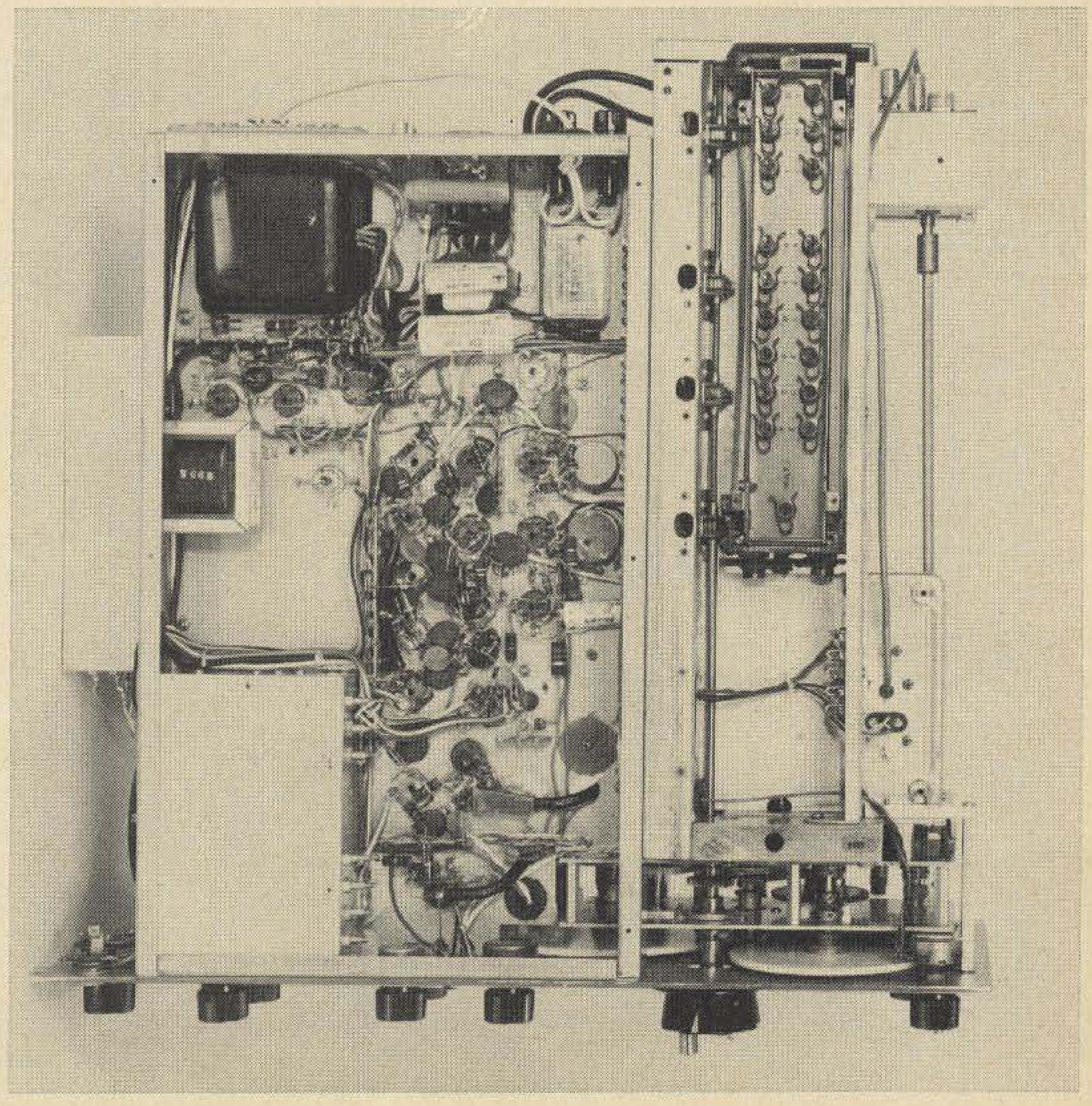
1. Continuous coverage from 2 MHz to 30 MHz with crystal controlled converters for 6 and 2 meters.
2. One kHz calibration accuracy throughout the 2-30 MHz range of the receiver (when calibrated at closest 100 kHz point)
3. Stability-for good SSB reception.
4. Several degrees of *if* selectivity.
5. Band pass tuning.
6. RF or Audio operated avc.
7. Tunable (across *if*) notch filter.
8. Antenna input T pads (0-40db).
9. Good front end design to minimize cross modulation and result in reasonable sensitivity.
10. Separate *rf, if,* and audio gain controls.
11. Other routine features such as S meter, ANL, Audio low pass filter, AM and SSB detectors, 4 and 600Ω audio output, etc.

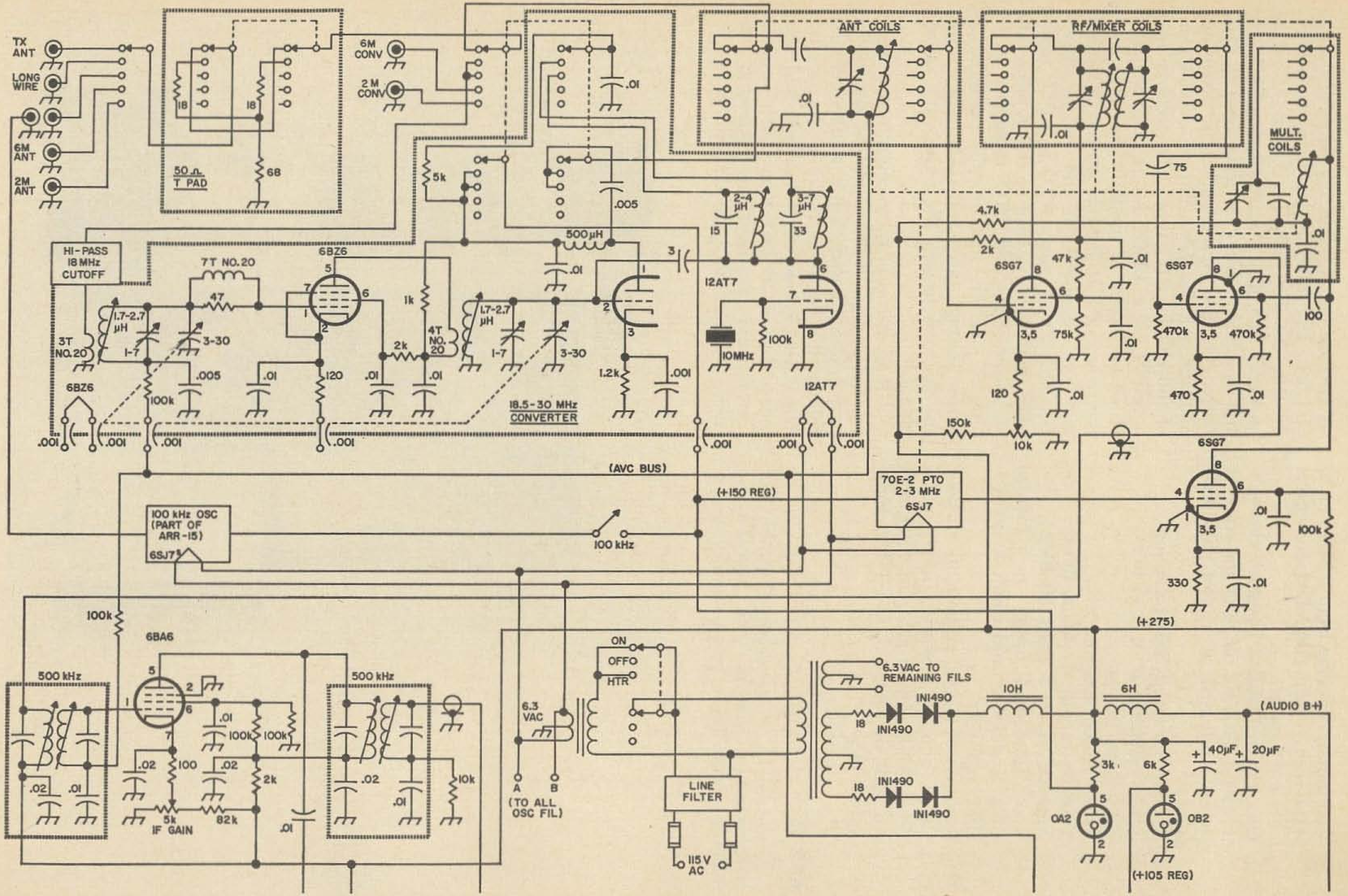
AAR-15

The AAR-15 is an airborne tunable HF communication receiver with provision for remotely controlling a given number of preset frequencies. It covers the frequency range of 1.5 to 18.5 MHz in six bands as follows: 1.5-2.5, 2.5-3.5, 3.5-5.5, 5.5-8.5, 8.5-12.5 and 12.5-18.5. The *if* is centered on 500 kHz and is tunable from 40 kHz to 550 kHz. Both, the first mixer injection frequency oscillator and the *if* tunable bfo oscillator are of the Collins PTO type. The receiver uses a 12SG7 rf, a 12SG7 mixer, and a 12SG7 tuned multiplier to multiply the PTO basic frequency of 2 to 3 MHz up to the desired injection frequency for the various bands. It is only the rf, mixer, PTO and PTO multiplier that are of interest to this project. The rf, mixer, PTO and PTO multiplier tuned circuits are all mechanically ganged together through gears and shafts which drive the slug rack to tune the coils of the various circuits.

The front end of the receiver was checked for tracking, calibration and sensitivity before it was decided that it would merit becoming the basis for building the receiver. The AAR-15 used on this project had been junked out as it had seen much "maintenance" and modifications—fortunately the front end was in fairly good condition.

Bottom View




TX ANT
LONG WIRE
6M ANT
2M ANT
50 Ω T PAD
6M CONV
2 M CONV
ANT COILS
RF/MIXER COILS
MULT. COILS
HI-PASS 18 MHz CUTOFF
6BZ6
7T NO.20
3T NO.20
4T NO. 20
500 μH
12AT7
10MHz
18.5-30 MHz CONVERTER
(AVC BUS)
(+150 REG)
70E-2 PTO 2-3 MHz 6SJ7
6SG7
100 kHz OSC (PART OF ARR-15) 6SJ7
100 kHz
6BA6
500 kHz
IF GAIN
6.3 VAC
(TO ALL OSC FIL)
ON
OFF
HTR
LINE FILTER
115V AC
6.3VAC TO REMAINING FILS
1N1490
10H
6H
(+275)
(AUDIO B+)
OA2
OB2
(+105 REG)

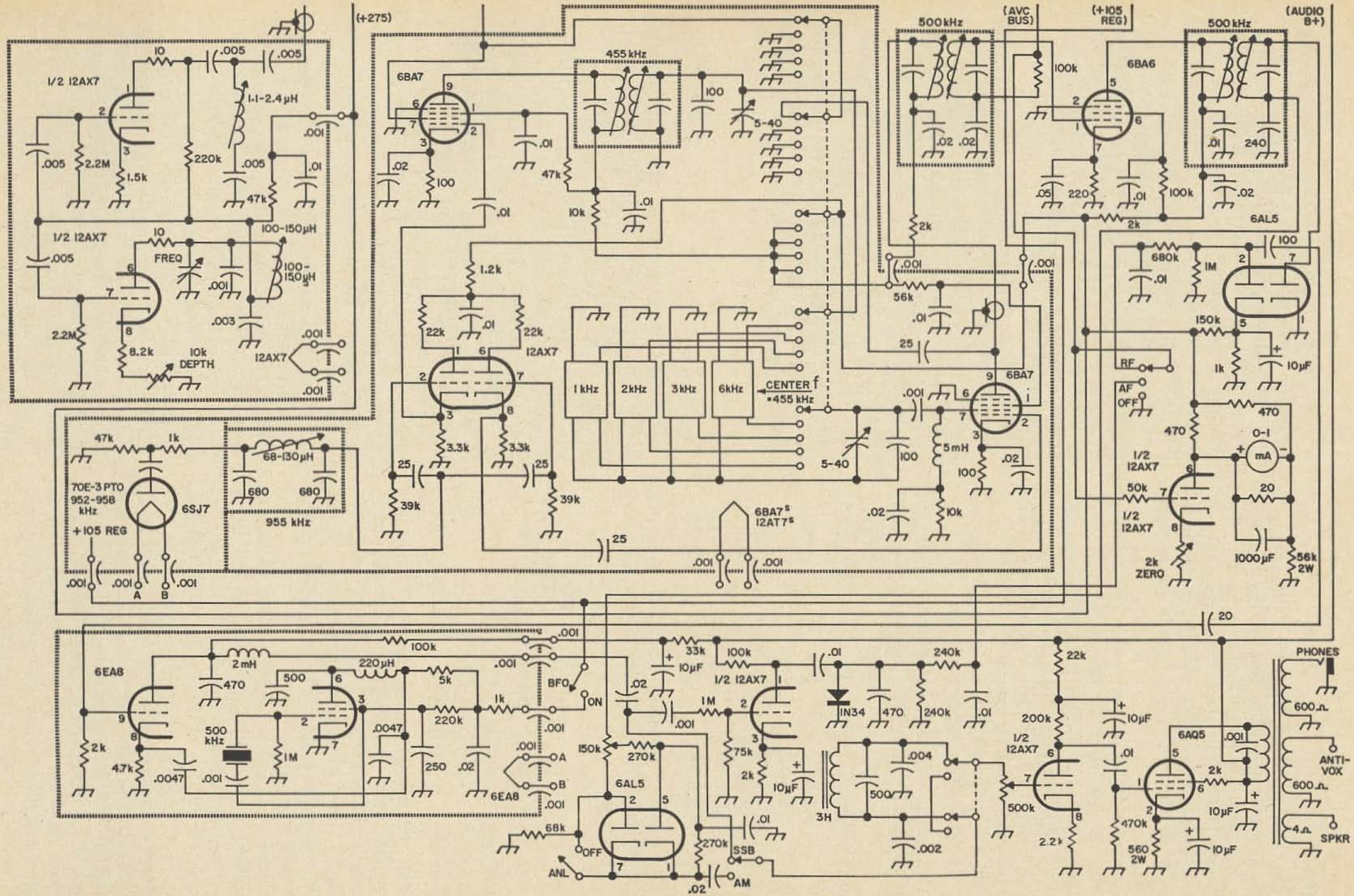


Fig. 2. The complete schematic diagram.

Circuits

Fig. 1 is the block diagram of the receiver. **Fig. 2** shows the complete schematic with the rf, mixer and multiplier circuits. The only uncommon circuit is the band pass tuning arrangement. This idea was described in one of the amateur journals some years ago.

Antenna input is selected by a wafer switch. A 0-6-10-20-40 db 50 ohm T pad, is in the antenna circuit to provide attenuation to help reduce cross modulation when strong local signals are encountered. The ganged wafer switch selects the desired converter or connects the antenna directly to the 1.5-18.5 MHz basic receiver.

The basic 1.5-18.5 MHz receiver covers the frequencies in the following manner:

Band	Recvd Freq.	PTO Freq.	Mixer Inj. Freq.
A	1.5- 2.5	2-3	2-3
B	2.5- 3.5	2-3	2-3
C	3.5- 5.5	2-3(x2)	4-6
D	5.5- 8.5	2-3(x3)	6-9
E	8.5-12.5	2-3(x4-	8-12
F	12.5-18.5	2-3(x6-	12.18

The basic frequency range is extended to 30 MHz by a converter in the following manner:

Recvd Freq.	Recvr Band	Conv OSC Freq.	Inj. Freq.
18.5-22.5	E(8.5-12.5)	10	10
22.5-28.5	F(12.5-18.5)	10	10
28.5-30.0	E(8.5-10.0)	10(x2)	20

This arrangement provides for having the dial indicating the correct frequency after mentally adding the 10 or 20 MHz as required. The converter preselector tunes rather sharply and must be peaked at the selected frequency.

Output from the 1.5-18.5 MHz section is amplified at 500 kHz and fed to the band pass tuning section. The 500 kHz signal is converted to 455 kHz by a PTO tunable 952 to 958 kHz; with the same PTO frequency converting the 455 kHz signal back to the original 500 kHz frequency-*after* the *if* signal has been processed through the mechanical filters. Any one of several bandwidths may be selected or the band pass tuning and filters may be by-passed entirely for broadband AM type reception.

The signal from the band pass tuning circuit is then amplified again at 500 kHz and fed to a conventional AM diode detector and a SSB product defector. A crystal oscillator is employed for the bfo injection frequency to the product detector. AM and SSB Audio may be processed through a 3 kHz low pass filter if desired. Audio from the product detector is amplified and rectified by a diode and then filtered to provide the audio operated avc voltage. 4 and 600 ohm audio outputs are provided by the output transformer.

A separate *rf* gain control was provided for the converters. The *if* stages were also provided with a separate gain control.

The AVC voltage is applied to the *rf* stage (both basic and in the converters) and to the 500 kHz *if*'s.

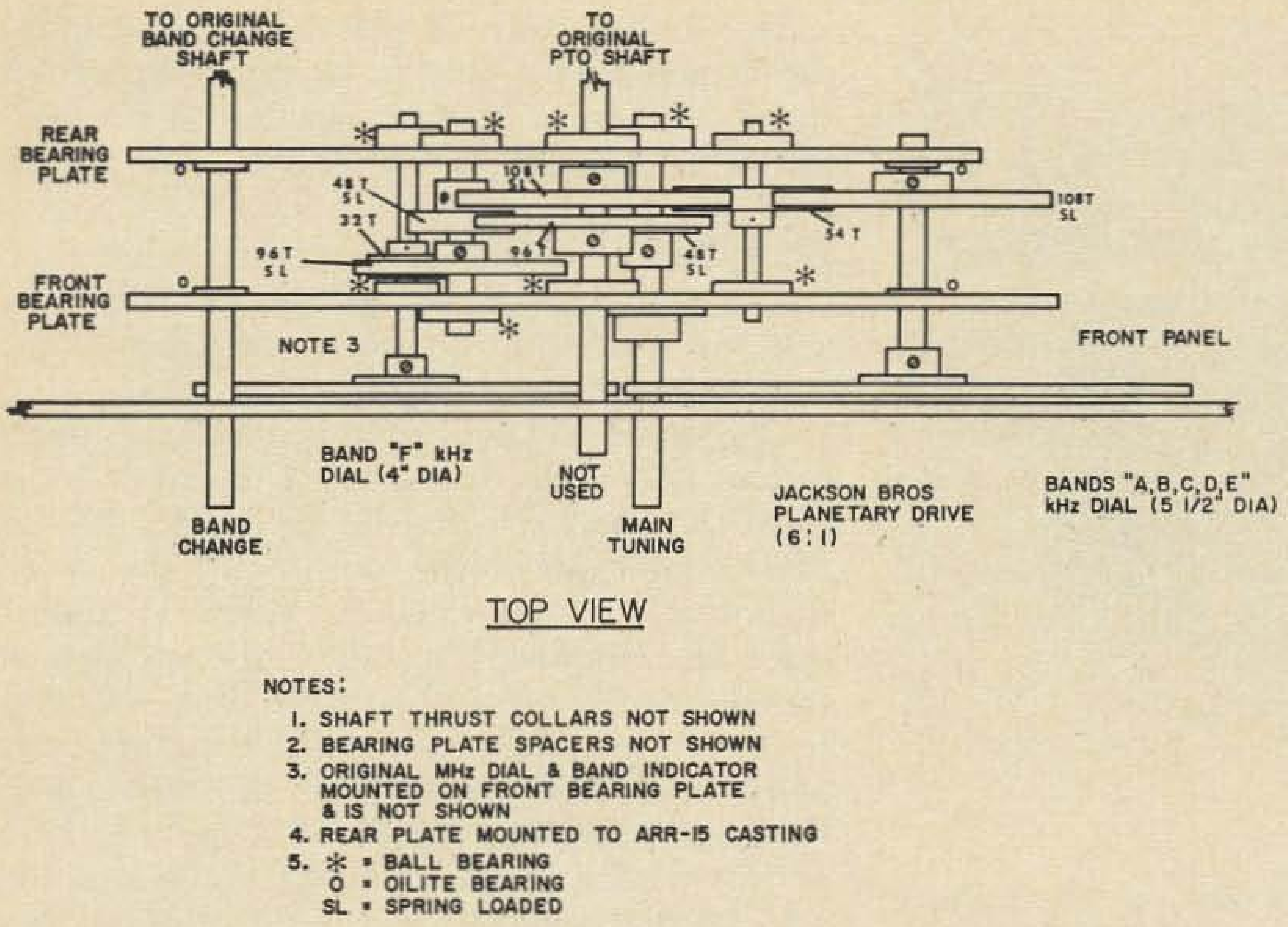
The power supply is conventional with solid state rectifiers and plenty of filter. Provision was made for being able to keep the oscillator filaments on separate from the other filaments if desired.

Construction

The first major step in the construction of the receiver was to amputate the desired section of the ARR-15 from the rest of the machine. All of the autotune drive mechanism, dials, front panel tubes, etc. were first removed. A hack saw was then used to saw the cast aluminum base in two; leaving the *rf*, mixer, multiplier and PTO intact with their slug rack tuning mechanism still coupled to the PTO tuning shaft.

A new aluminum chassis was selected on which to mount the new *if*, audio, and power supply. The front panel is a nominal 8¾ inches high by 19 inches wide standard rack size panel.

The second major step was the design and construction of two new dials and a new gear train mechanism to drive the new dials. See **Fig. 3** for a sketch of the new gear train. The original MHz dial coupled to the PTO shaft was retained and provides the MHz indication. The two new dials provide 1 kHz readout on all bands with the second dial (F) being added in order to provide larger calibration divisions on Band F where the PTO frequency is multiplied six times. Thus, one dial is read on Bands A, B, C, D, and E: and the other dial on Band F only.



Gear train and drive dial assembly.

The gear train was built up using two ⅛ inch aluminum plates between which all of the gears and couplings were mounted. Spring loaded gears were used where needed which resulted in no backlash. Practically all gearing shafts run in ball bearings. A Jackson Bros. planetary drive was employed between the gear train and the main tuning knob for additional gearing reduction and smoothness of tuning. The gear train and dial assembly attaches to the front of the ARR-15 aluminum casting at four places and is in no way attached to the front panel. Fiducial markers are installed on each of the two new dials to permit accurate frequency calibration on any band.

The band pass circuitry, except for the 70E-3 PTO, is all mounted in a separate shielded compartment beneath the new chassis with all leads entering the compartment through feedthru capacitors with the exception of the *rf* leads which are of coax. The 70E-3 PTO frequency range was raised from the original nominal of 500 kHz to a nominal 955 kHz by replacing the 1700 pF (N50) capacitor with a 360 pF silver mica. The 955 kHz single pi section tank is mounted in a small aluminum box on top of the PTO with coax carrying the PTO signal to the bandpass tuning mixers. A Jackson Bros. planetary drive is employed between the PTO shaft and the bandpass tuning knob.

The product detector and the crystal oscillator bfo are mounted in an aluminum *if* can with all leads entering thru feedthru capacitors except the *rf* lead from the last *if* transformer.

The 18.5-30, 50-54 and 144-148 MHz converters are mounted on a single enclosed chassis which mounts upright to the right hand side of the main chassis. All leads enter thru feedthru capacitors. Only the 18.5-30 MHz converter has been completed. All of the 50-54 and 144-148 MHz components have been mounted. These two converters will employ 6CW4 tubes in circuits borrowed from the *ARRL Handbook* and will be crystal controlled.

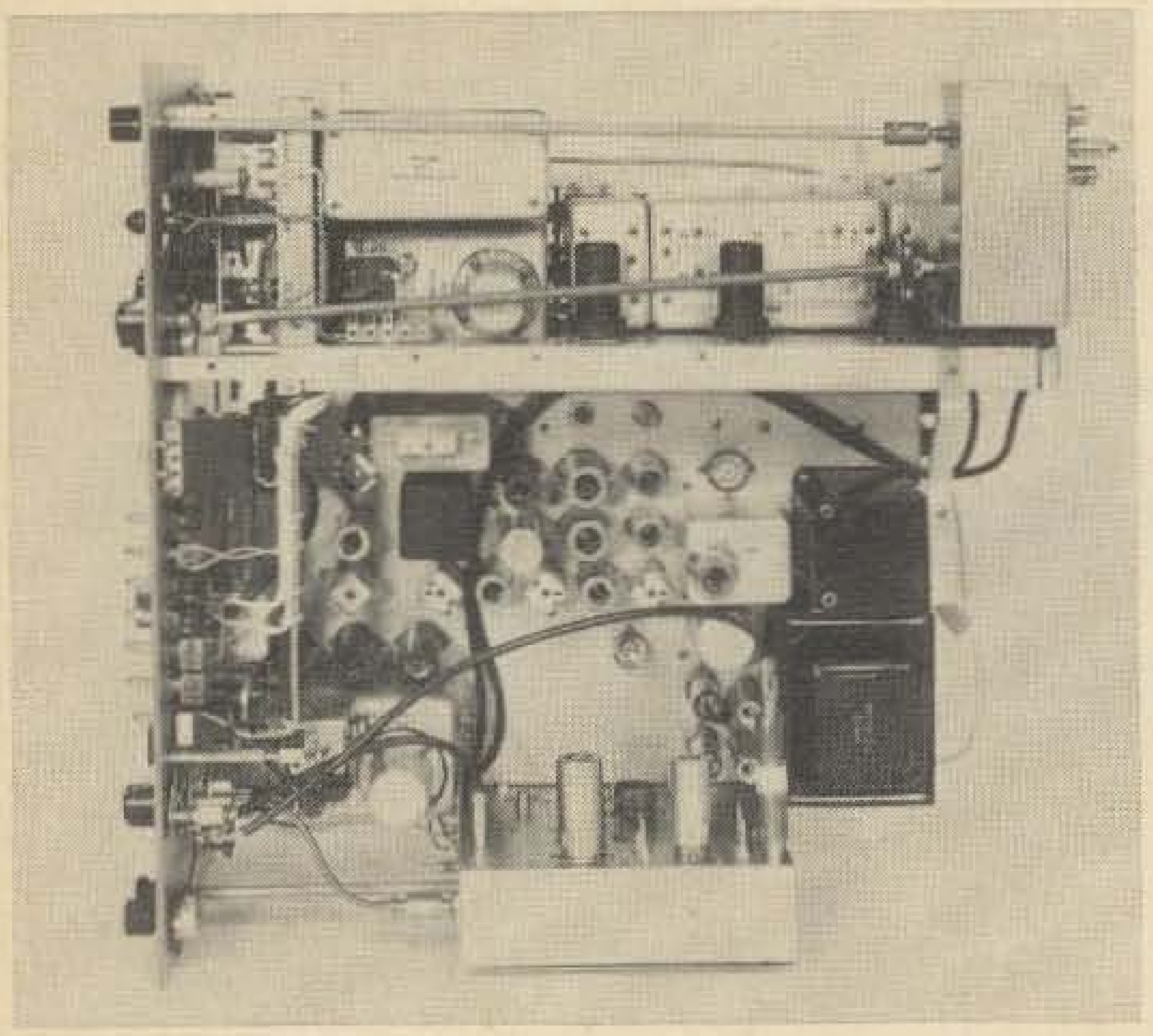
The *rf* mixer and multiplier stages were completely rewired (external of the coil boxes) with disc ceramics being used for the bypass capacitors. The original 12SG7s and 12SJ7s were replaced with the six volt equivalents.

The 500 kHz *if* transformers are nominal 455 kHz transformers that were capable of being tuned to 500 kHz.

The original "cut and try" kHz dials are hand lettered on bond paper and cemented to ⅛ inch thick pressed wood discs. Final dials will be made by photographing an ink lettered vellum and then cementing the negative to an opaque Plexiglas disc; thus permitting back lighting.

Operation

Operation of the receiver has been most satisfactory. Stability is very good after a moderate warm up period. Frequency calibration is well within one kHz when the



Top View

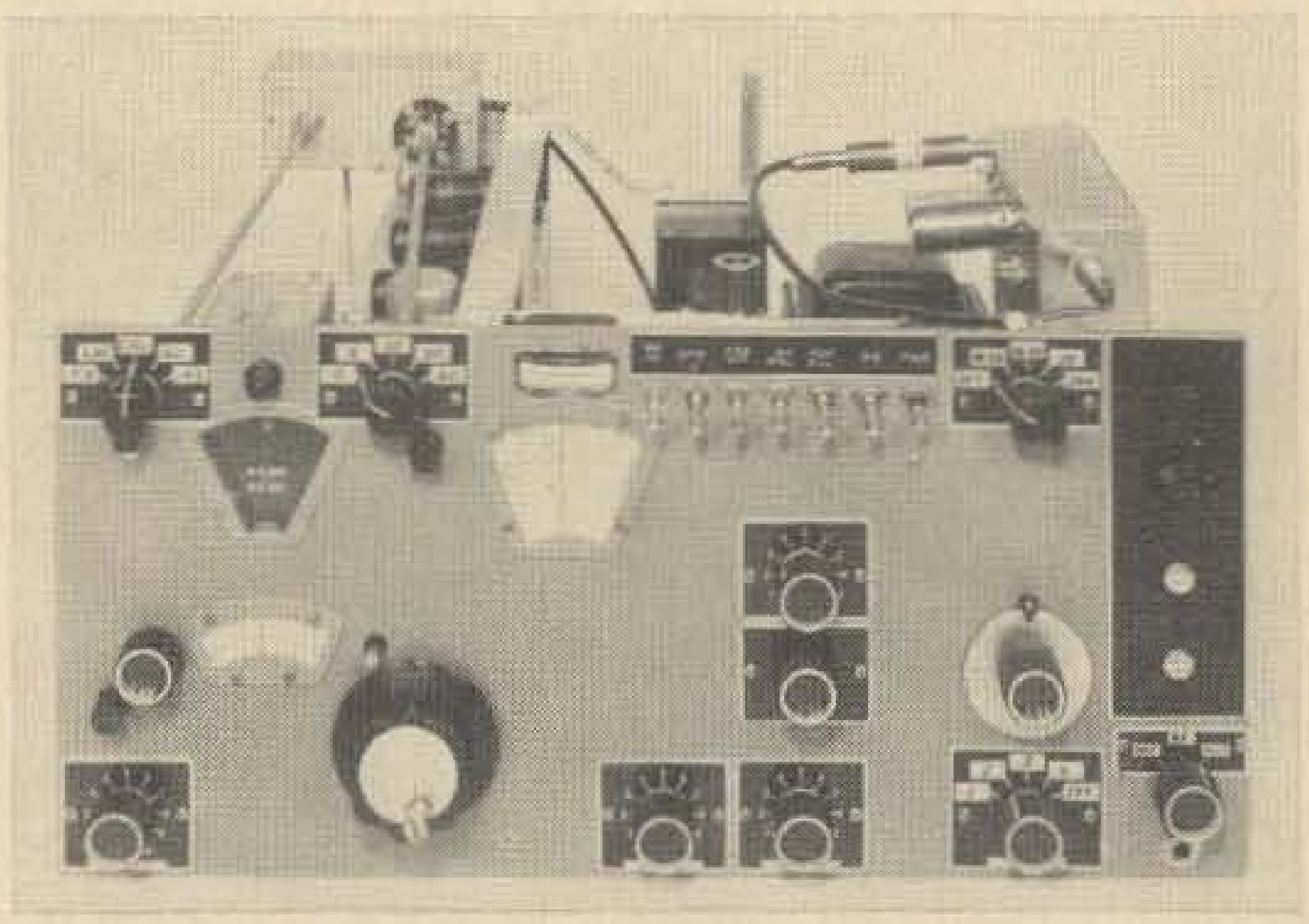
fiducial marker is set to zero at the nearest 100 kHz point. The selectable *if* bandwidth/ band pass tuning feature is most rewarding when tuning SSB on the crowded amateur bands. Antenna sensitivity in the SSB mode (for 10 db S/N) is better than - μv from 1.5 to 30 MHz with the average being in order of .5 μv when measured with a GR No. 1000-P2 series pad and a 3 db pad at the receiver input terminal). Both the rf and audio operated avc circuits permit an audio output increase of 6-7 db when the input signal is increased from 5 μv to 100 K μv. The audio operated avc appears to be more desirable when receiving in the SSB mode. Although the Q multiplier notch filter is effective in reducing carrier interference, some other type of tunable notch filter would probably produce better results.

Since considerable effort was spent in parts layout, shielding, by-passing and filtering, few "birdies" have been found. The only one encountered of any consequence is the second harmonic of the 18.5-30.0 MHz converter crystal at 20 MHz. The three section, 50 ohm, 18 MHz cutoff high pass filter at the input to the converter practically eliminates the frequencies below 18.5 MHz from "riding through" the converter. When a 10 M antenna is connected to the converter, no low frequency signals have been heard in the 10 M band. Installing the single pi section right at the output of the band pass tuning 70E-3 PTO eliminated several spurious signals in the lower frequency bands. Care must be taken to prevent the 500 kHz bfo signal from getting into the front end of the *if*.

The tuning meter is plainly a tuning indication and useful only in giving comparative signal reports. It is not calibrated in db over too, if you would like a receiver with all of with an input of 100 K μv at 14 MHz. With the avc characteristics being what they are, a signal level of several μv will give a useful indication on the meter; depending of course, on the ambient noise level.

The band change control rotates a mask in the MHz dial window. This mask indicates the band selected ie, BAND C, 3.5-5.5 MHz and exposes the portion of the MHz dial which is calibrated in MHz. To determine the frequency to which the receiver is tuned, merely read the MHz dial and add to it the indication presented by the appropiately calibrated portion of the kHz dial; thus providing the tens and hundreds kHz of the whole frequency number. When the 18.5-30 MHz converter is in use, the number 10 or 20 is added to the kHz and MHz dial indications.

Since the rf, mixer, PTO and PTO multiplier are all ganged together, only the single tuing control is required in the 1.5-18.5 MHz range. When the converter is in use, the converter rf tuning control (preselector) must be peaked to the selected frequency.



Front View

Conclusion

Although the construction of a receiver such as described herein, does require some cash, a large junk box and a considerable amount of time, it is most rewarding. And too, if you would like a receiver with all of the characteristics and features in the receiver described—where would you obtain it? If you could find one, you would most likely have to re-mortgage the homestead and car and leave two of the kids as security to finance the purchase. . . . K5WYG

Project Facsimile Antarctic

Ralph Steinberg K6GKX
110 *Argonne Ave.*
Long Beach, Calif. 90803

BULLETIN . . . Successful transmission of the first facsimile picture by the Project Facsimile Group was made to KC4USV, Mc Murdo Station in the Antarctic on June 18th. The operations, a morale booster for the Navy personnel, have completed transmission of sixty more pictures since then. Project Facsimile Antarctic will continue to transmit more pictures each week through to October 15th, on 20 meters.

Project Facsimile Antarctic results may sound easy but there was lots of work, many hours and days in the preparation of the project before the first successful transmission of a picture was received at McMurdo Station.

It all began when your author was writing the article "Operations Deep Freeze . . . 1957-1967" (March issue of 73). With the successful facsimile operations that Paul Blum, W2KCR carried on with Little America in 1957, the idea came to repeat the operations in 1968. Contact was made with KC4USV, and inquiry was made, "would the personnel like facsimile pictures of their loved ones transmitted to them. The answer was "Yes."

This all started in November 1967 and from then on there was a lot of planning to do. Project Facsimile Antarctic was organized with WB6EGH, Ellis Wampler, Sr., WA6URW, Earl Darnell and your author forming the group to work on the project. The next order of business was to locate the facsimile equipment and get the permission of the Federal Communications Commission to transmit facsimile on the 20 meter band.

With new facsimile equipment not available, the word was put out on the ham bands that certain Times Corp. facsimile equipment was needed. The result was a surprise, to see the cooperation from amateurs and non-amateurs who loaned the necessary equipment for our project. In a short time the equipment was installed and local tests were made on the UHF band (420 MHz) to be sure of fault free operation. The results were good pictures at short distances but the big test was to come later when the pictures were to travel many thousands of miles to the Antarctic.

While waiting for special permit from the Federal Communications Commission, checks were made by WA6URW with KC4USV to get information as to signal quality needed to transmit the pictures. Under favorable band conditions WA6URW had no problems reaching KC4USV with sufficient signal strength for facsimile operations. The equipment at WA6URW is a Drake T4X Transmitter, Drake R4B Receiver, Drake L4 Linear and a Drake MN-2000 Matching Network. The antenna is a Mosley TA-36 erected on a tower 54 feet above ground.

It was now April 1968 and more work had to be done. Pictures of the families of the men at McMurdo had to be received before facsimile operations started. At this point, the Navy Relief Society at the Long Beach Naval Station offered aid in writing letters to the Navymen's families to sent pictures to their office for later transmission by the Project Facsimile Antarctic group. Pictures arrived from all parts of the United States and one from Rota, Cadiz, Spain. Some were pictures of new born babies and others of complete families. The new born baby pictures were some the Navy fathers at McMurdo had not seen before. In the early part of May, Project Facsimile Antarctic received special authorization from the Federal Communications Commission for WA6URW to transmit facsimile pictures for morale purposes on 20 Meters. Everything was ready to go on the operations but we found magnetic storms in the Antarctic. With these conditions we had to delay our first facsimile transmission for a later date. These magnetic storms last from three days to two weeks and some frequently last a month. When band conditions did improve, tests were made with KC4USV on facsimile but the first picture transmitted was not perfect, due to fading. However, this first test proved we could get pictures to McMurdo when conditions were favorable.

Band conditions again in the early part of June were still plagued with magnetic storms but on the evening of June 19th, the first successful picture was transmitted and received at Mc Murdo Station. With the first taste of success, six more pictures were transmitted during the week June 22nd to 26th. Fortunately all of these were received satisfactory, and all of the Project Facsimile Antarctic group were thrilled about the results of the operation thus far.

Further plans are being made for a weekly newspaper (one page) giving sports news, sports pictures or anything which would be interesting to the men at Mc Murdo. A local paper is working on the details and the Antarctic edition should be ready shortly. The newspaper is to be called "The Mc Murdo News."

For those who are not acquainted with amateur radio operations at McMurdo Station, KC4USV it might be well to explain that the greater part of the operations is phone patching. As phone patch calls are a priority for the personnel, each evening, there is a limited amount of time for both facsimile and phone patch operations. Schedules are arranged with McMurdo Station for transmissions of facsimile each week to fit their routine. Although the phone patching is done on the Navy MARS frequency, facsimile operations can be going on at the same time on the 20 meter band. The facsimile signals are received at the communication center at McMurdo Station and the amateur radio activities are all from KC4USV.

Project Facsimile Antarctic has accomplished part of what it set out to do, and through the next few months the project will have completed many happy hours of boosting the morale of the Navy personnel stationed at Mc Murdo Station. . . . K6GKX

Donald Lawshe W2HUX
216 *Pulis Ave.*
Franklin Lakes, N.J. 07417

A High Performance Receiver for Two Meters

Transistor circuitry has much to offer in the construction of VHF equipment, especially when trying to cram the highest possible performance level into the smallest possible space. The receiver described on the following pages was built as an attempt to make a compact package to be used on vacations and portable outings such as Field Day. As the construction and testing proceeded, it became apparent that the level of performance of the receiver was going to be at least on a par with regular station equipment, and perhaps above it. The finished unit shows a noise figure of 3.5 db measured on a Kay noise meter, selectivity sufficient to separate a strong local station from a weak one only 6 kHz apart, and absolute freedom from drift and instability.

The circuit uses Motorola MPF-102 field effect transistors in the *rf*, mixer and oscillator stages for low noise figure and excellent overload characteristics. The oscillator was first designed using conventional VHF transistors such as 2N706A and ZN3663, but was found hard to stabilize, especially with respect to warm-up drift. Using the field effect transistor completely eliminated these problems, and proved so stable that stand-by could have been accomplished by cutting the supply voltage to the local oscillator, a technique that would make old die-hard tube addicts shudder!

One problem encountered with an otherwise exceptionally stable oscillator was an extreme sensitivity to voltage changes. Many attempts were made to regulate the supply voltage, but the class B audio amplifier still caused enough change to affect the received signal. The final solution may not appeal to the purist, but it does work with a minimum of trouble. A pair of D flashlight batteries were mounted inside the case and turned

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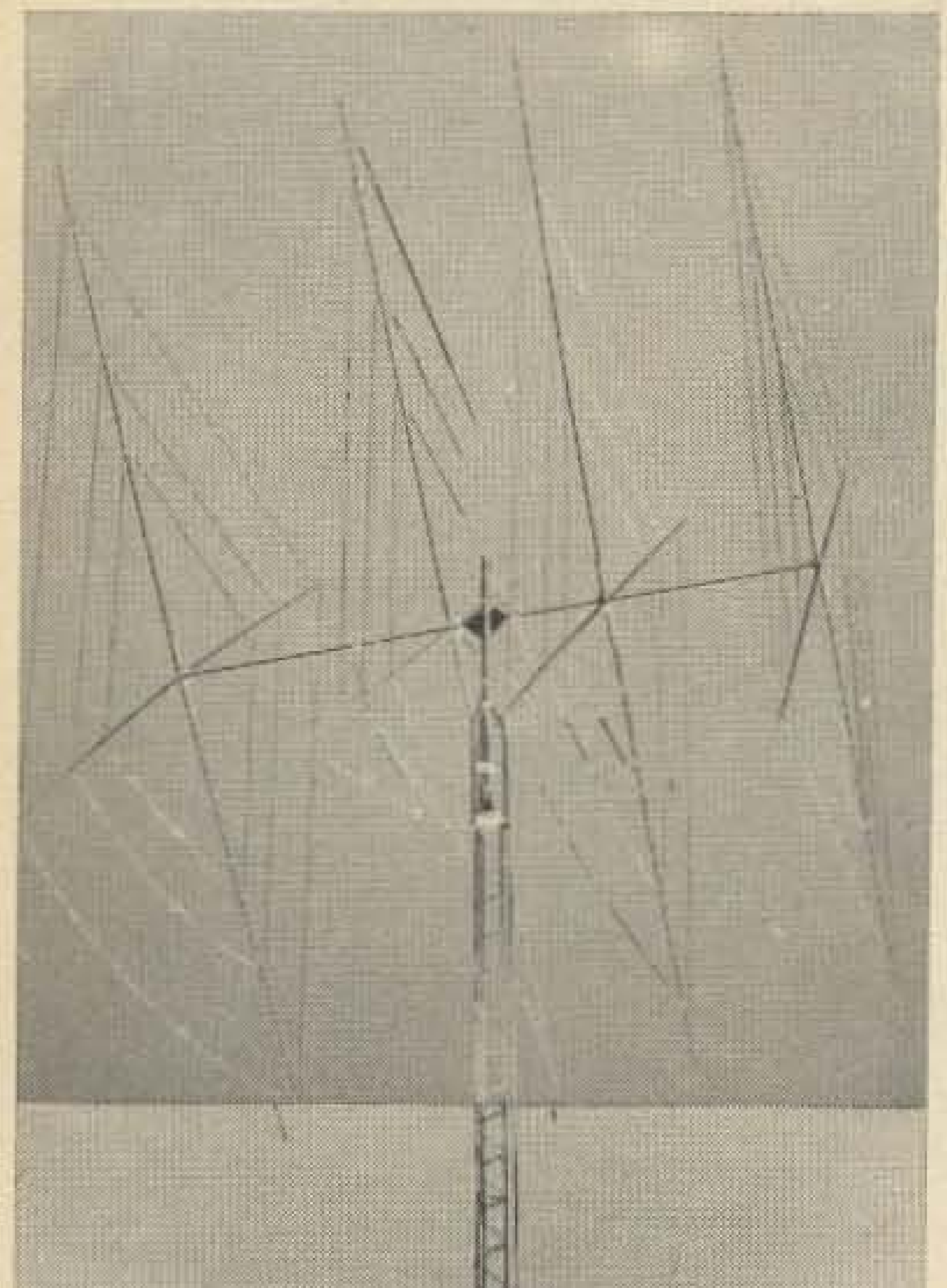

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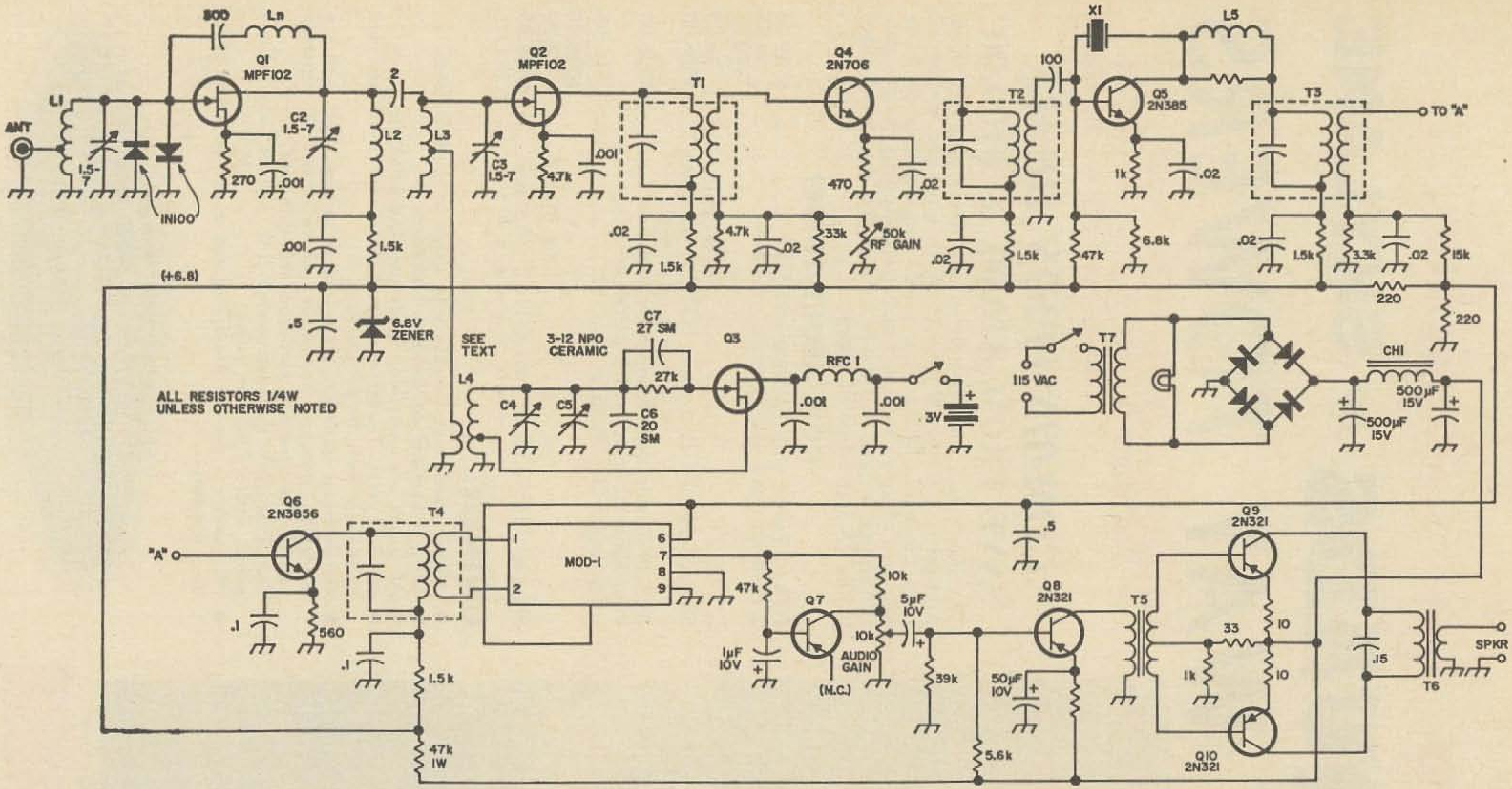


Fig. 1. Schematic Diagram

T1	*10.7 mc. FM input IF transformer, J. W. Miller* 2070
T2	*10.7 mc. FM interstage transformer, J. W. Miller* 2071
T3	455*khz input transformer, J. W. Miller* 2031
T4	455*khz transformer, supplied with IF module*
T5	*driver transformer,* 10K *to* 2K *c.t. Midland* 250633, *Calrad CR*75
T6	*output transformer,* 500 *ohms c.t. to* 3.2 *ohms, Midland* 25-631
T7	6.3*V*, .6 *amp or smaller filament transformer, Triad F*-13*X*
CH1	2 *hy,* 15 *ma. low resistance choke, Stancor C*2707
L1	4*t.* #20 *bare copper* 5/16" *ID* 1/2" *long*
L2	5*t.* #20 *bare copper* 5/16" *ID* 7/8" *long*
L3	3*t* #18 *bare copper* 5/16" *ID* 1/2" *long tap* 1*t. from ground end*
L4	13/4*t.* #14 *bare copper* 5/16" *ID tap* 3/4 *turn from ground end link* 1*t.* #20 *bare copper* 1/4" *away from ground end*
L5	200 *microhenry RF choke, J. W. Miller* 9210-90
Ln	8*t.* #26 *enamel closewound at one end of* 1/4" *dia slug form*
RFC-1	*Ohmite Z*-144 *or* 18 *turns* #24 *wound on* 1 *meg* 1 *watt resistor*
X1	*crystal,* 11.155 *mc.*

"Drake 4-Line is the most satisfying...totally efficient..."

says WØYDB, Minneapolis . . .

To quote in part from a letter received from W. C. Higgins, WØYDB, Minneapolis, Minn., dated May 10, 1968 . . .

". . . Enclosed are several snapshots of my hamshack and equipment. Since the Drake 4-Line is so predominant, I thought that you might like to add to your photo collection of Drake-equipped stations. Granted, the gear is not the new B series but it is still the most satisfying and totally efficient that this old-timer has used in 32 years of amateur, military and commercial electronic experience. I earn my living as a Production Manager of (aerospace) electronic instrumentation production . . . and I think I can recognize excellence in electronic engineering design and performance when I see it.

"Again, congratulations for developing the 4-Line. 73 . . ."

(Signed) Bill, W. C. Higgins

Ask any ham who owns a Drake 4-Line Rcvr, Xmtr or Linear...

or write for detailed specifications:

Dept. 388 **R. L. DRAKE COMPANY** 540 Richard St., Miamisburg, Ohio 45342 on and off with the power switch. Absolute stability now exists, and at 2.5 mA battery current I expect it will be a long time before replacement is needed.

The oscillator tuning capacitor, C1, is made from a Hammarlund HF-15 with all but 1 fixed and 1 movable plate removed. This is easily accomplished by holding the plates with long-nose pliers and bending back and forth. Doubtless many other similar capacitors could be used with minor changes in coil dimensions.

The oscillator tuning capacitor is mounted on a piece of copper-coated phenolic board, 2" by 1½" soldered along its entire length to the chassis board. A similar copper-phenolic board is mounted in front of the capacitor to support the dial assembly, leaving enough room for the front panel to clear the dial, and a flexible, insulated coupling to drive the oscillator capacitor. An insulated coupling is needed to eliminate a variable-length ground path for the oscillator capacitor rotor. The remaining oscillator parts are mounted as solidly as possible with the transistor socket resting on short, solid leads. Leaving the socket out would provide even better mechanical stability at the expense of easy transistor substitution. Not knowing much about field effect transistor stability at the beginning of this project, the socket was used.

The dial assembly is a Jackson model 4511/DRF, giving two speeds for accurate tuning: 36 to 1, 6 to 1. The dial drive mechanism is mounted on a piece of phenolic board soldered to the main chassis, and coupled to the oscillator board with a piece of metal tubing. This coupling reduces the backlash in the unit to an unnoticeable level, and allows very smooth tuning over the band. The dial itself was made from a piece of cardboard cut to 4 inches in diameter and mounted on the Jackson assembly.

The *rf* amplifier stage has protection diodes connected across the input coil to provide a path to ground for excessive *rf* voltages, as might be encountered when operating a transmitter near the receiver. Following the mixer is a single stage of *if* amplification at 10.7 MHz to help control the undesired images which might otherwise occur if the only *if* was 455 kHz. The completed unit shows 42 db supression of the primary image, which occurs 21.4 MHz below the desired 2 meter signal. A secondary

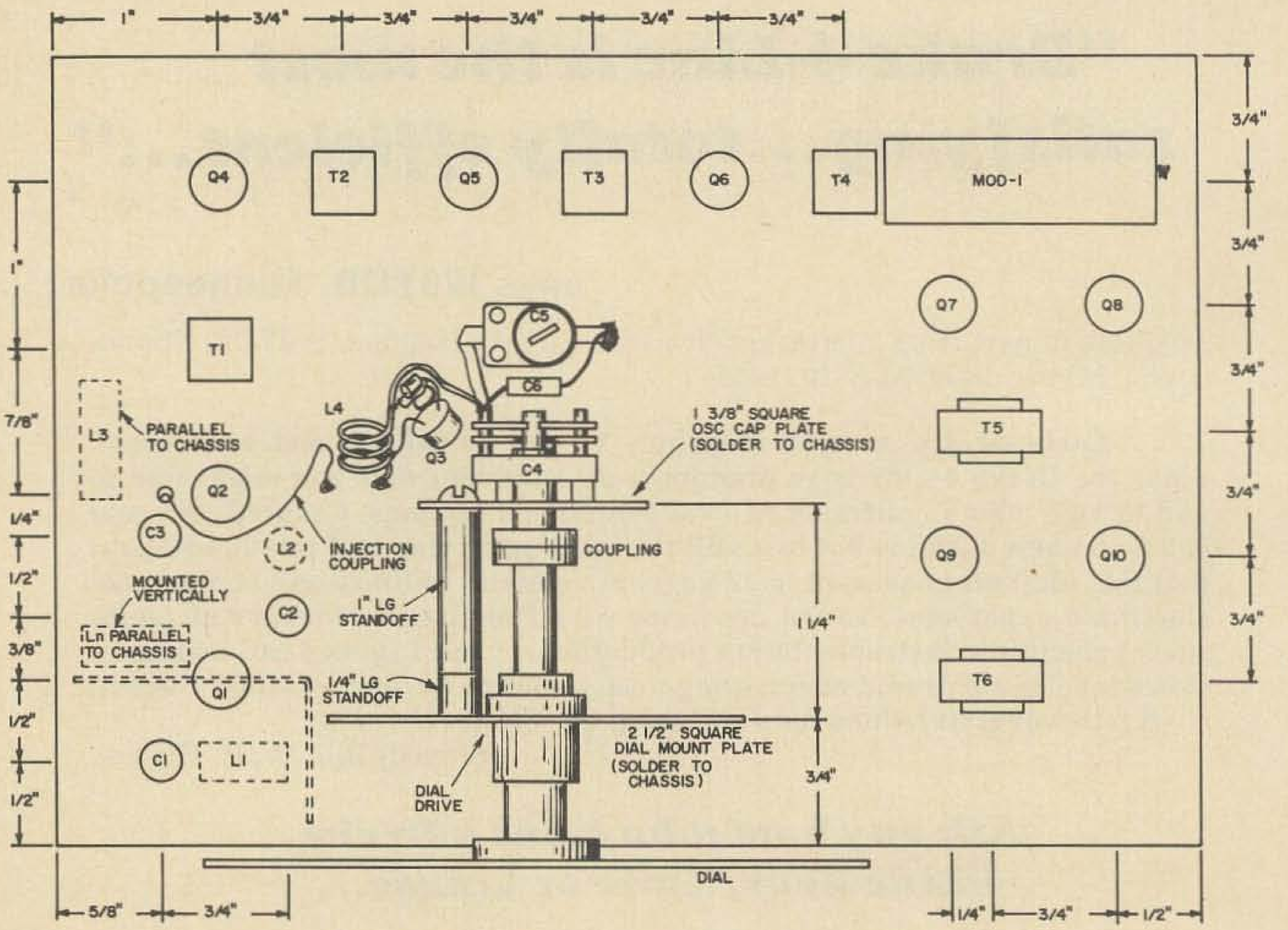


Fig. 2. Chassis Layout with dial drive assembly.
MOD-1 IF amplifier and detector module, J. W. Miller 8903B or Lafayette 99H6254

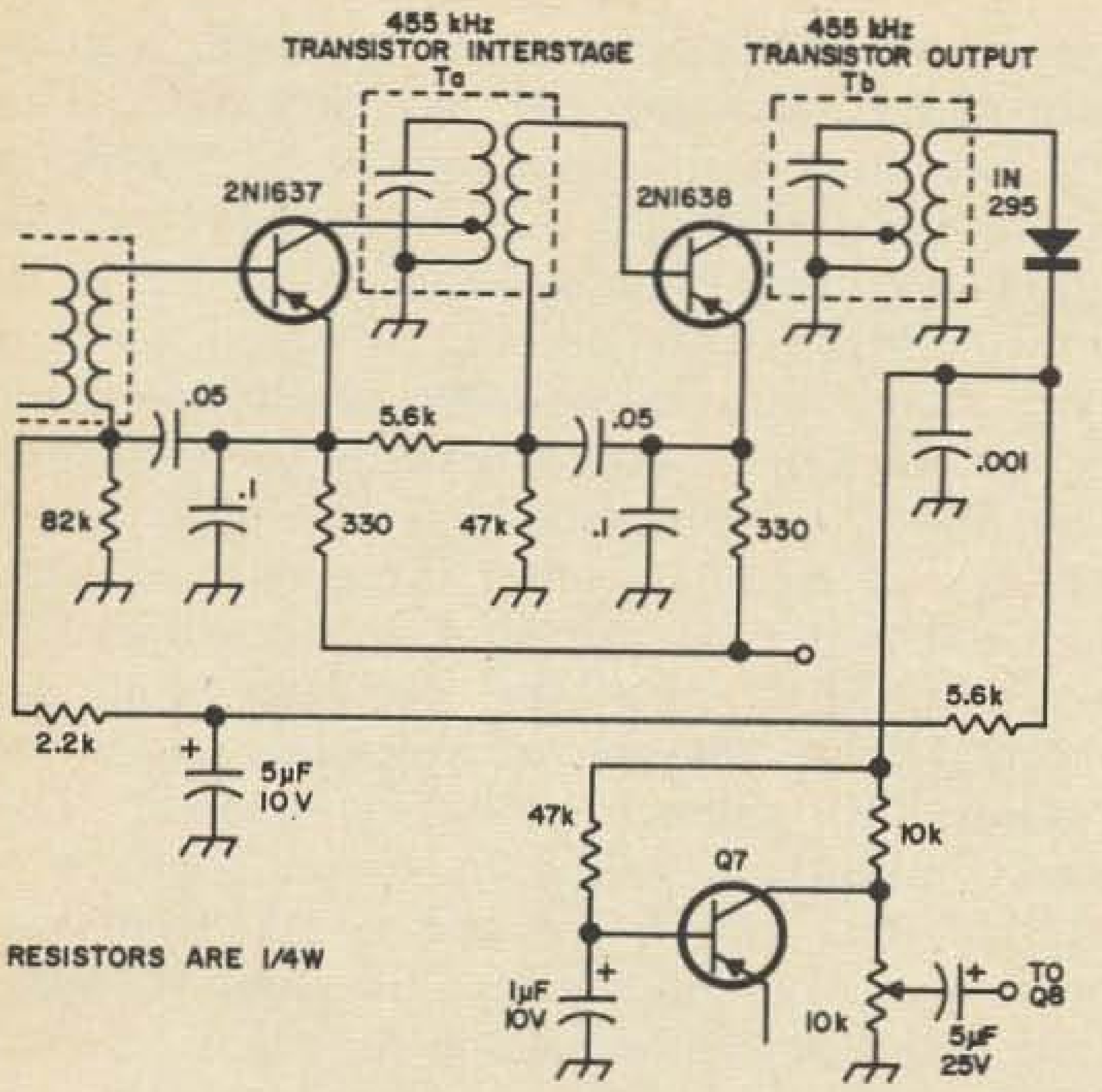


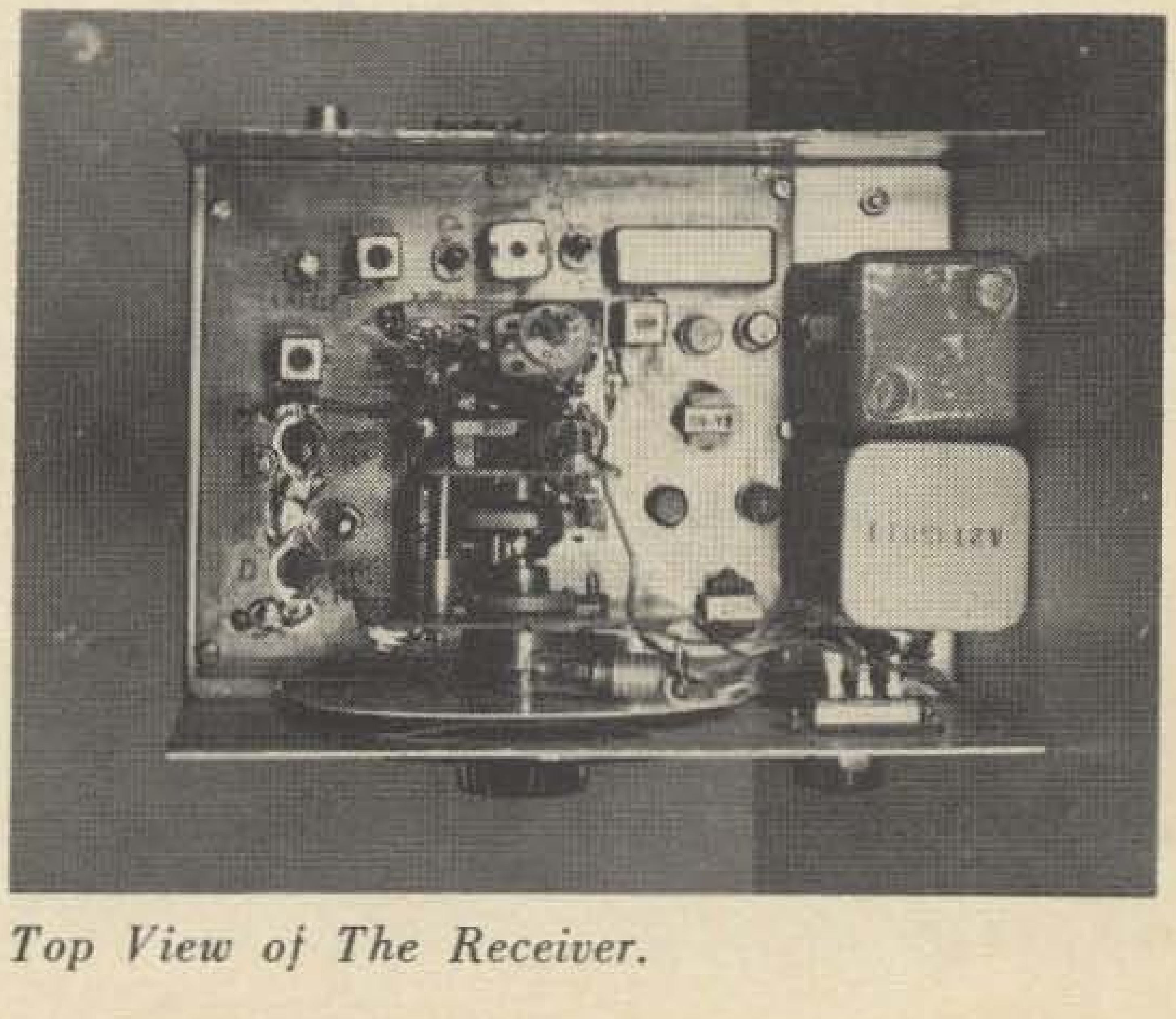
Fig. 3. Optional 455 kHz If Strip to replace module.

image is also noted, however, due to the low selectivity of the 10.7 MHz *if* transformers used, occurring at 910 kHz above the desired signal. This image response is down 36 db, and usually causes no trouble except when a strong local station is operating near the bottom edge of the band, the image then falling in the beginning of the technician band. An additional stage of *if* amplification at 10.7 MHz, or use of an additional *if* transformer loosely coupled to the 10.7 MHz output transformer would reduce the image to a negligible level. In actual use no images have been heard from outside the amateur band, and the in-band image only served to provide an additional spot to listen to strong locals. *if* gain control is accomplished by varying the base voltage on the 10.7 MHz *if* stage.

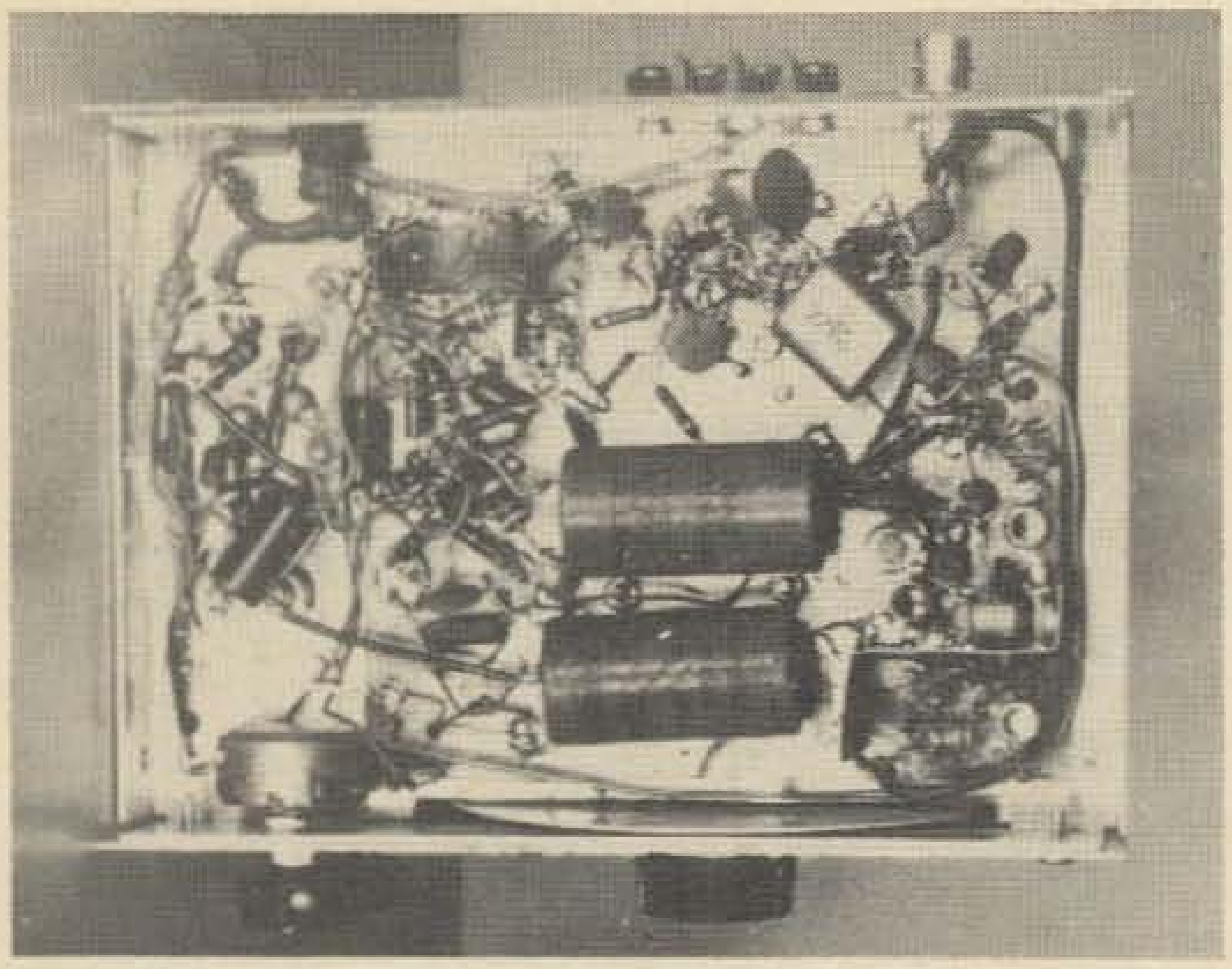
Following the 10.7 MHz *if* stage is a combined mixer-oscillator stage, using a crystal to beat the frequency. This circuit is an adaptation of one used in many pieces of commercial equipment, and provides excellent conversion characteristics without any tuning adjustment other than the input and output transformers. In the original model of this receiver, the 455 kHz *if* amplifiers were built on the circuit board. However, in the final version, a J. W. Miller pre-packaged *if* module was used as part of the circuit. Both schematics are provided so the builder can incorporate whichever design he prefers. The difference in operation of the two *if* amplifier designs are small, but the pre-packaged *if* unit provides better avc action than was obtainable with the separate design. The choice of transistors in the *if* amplifiers and converters is not critical. Both 2N706 and 2N3856 can be used interchangeably.

A very low voltage diode is required in the noise limiter circuit, and the most satisfactory unit seems to be the collector-base junction of a 2N107 transistor. Perhaps there are some separate diodes which have the required characteristics, but in trying over twenty types, none worked as well as the transistor specified. The audio stages need no special comment other than to note the power output is sufficient for any normal use. If higher audio output is needed, the supply voltage may be raised to 15 volts with a corresponding increase in output. The voltages on the remainder of the set should be held to the specified ones to avoid upsetting the conditions needed for maximum gain. This will automatically be accomplished by the 6.8 volt zener diode, but the supply resistor of 47 ohms may have to be increased to keep the zener dissipation within operating limits.

Power for the receiver is supplied by a 6 volt filament transformer and bridge rectifier assembly feeding a capacitive input filter to yield an output voltage of 7.5 volts under load. The transformer and choke shown are not those specified in the parts list, but some "junk box" specials. Those recommended have the same ratings. Receiver muting is accomplished by breaking the supply voltage to the entire receiver with the exception of the local oscillator. As mentioned earlier, stand-by can be accomplished by breaking power to the oscillator. This leaves the *rf* amplifier and mixer operating, and even with the protection diodes,



Top View of The Receiver.


Bottom View

the mixer gets a pretty good shot of *rf* when a transmitter is operating, if the *rf* amplifier is left running. Since breaking both the *rf* circuits and the oscillator would require two contacts on the mute switch, it was decided to let the oscillator run. The power transformer and choke used were surplus items picked up at a local "junk store," and somewhat smaller than those specified in the parts list. If the specified ones are used, the next size larger cabinet may be needed. One possible solution might be to use the smaller cabinet with the power transformer mounted on the back; another to mount all power components in a small mini-box and connect with a short cable.

In constructing the unit, it is strongly recommended that some two-sided copper-phenolic board be purchased and used instead of conventional chassis techniques. The necessity for soldering to ground many times, along with the high frequency and low impedences of the transister circuitry precludes the usual ground lugs and resulting long leads. The actutal copper board size is 4⅝ by 7⅛". A cut-out, 4 by 6½" was made in the aluminum chassis to receive the copper sub-chassis.

All transistors were mounted in sockets for initial testing, and probably could be lead mounted in the final model, but care should be taken to prevent excessive heat from damaging the plastic encased units. Assembly and testing of the unit can be done in stages beginning with the *rf* amp, mixer, oscillator and 10.7 MHz amplifier. Connection of the output of this combination to a communications receiver will enable the set-up to be accomplished without wondering about all stages at once. After the front end portion of the receiver is wired, a grid-dip meter is a big help in alignment. The *rf* gate and drain coils can be tuned, along with the mixer gate coil to 145 MHz. The oscillator coil should tune from 133.3 to 137.3 MHz with perhaps a small overlap for band-edge monitoring. Adjustment of the coil length and the trimmer capacitor on the oscillator should enable this range to be covered. Injection from the oscillator to the mixer is adjusted by bending the coupling link near the oscillator coil, although the amount of injection seems to make little difference in performance. The best procedure seems to be to tune in a signal and adjust the link away from the coil until the signal drops off, then increase the coupling somewhat beyond that required for maximum signal. Too much coupling will cause no problems, other than excessive interaction between the mixer gate coil and oscillator frequency.

Neutralization of the *rf* amplifier is mos easily accomplished by disconnecting the drain voltage and tuning in a rather strong local signal. The coil should be adjusted for minimum feed–through. It should be possible to drop all but the very strongest signals into the noise level by careful adjustment. If no strong local stations are on the air, neutralization may be done by leaving the drain voltage connected, and adjusting the coil through its range until oscillation is noted by strange whistles and ploops on the receiver. There should be two settings where oscillation will occur: the correct setting and midway between. While building various models of the front end, it was noticed that the neutralizing coil dimensions had to be varied somewhat for each model. Do not be afraid to add (or subtract) turn to Ln if it seems necessary. The 10.7 MHz *rf* amplifier stage can be peaked for maximum output with the communications receiver connected to the secondary to T_2. The second converter stage, Q5, needs no adjustment other than repeaking of T2 and peaking of T3; the crystal oscillator portion has no tuning adjustments.

After the front end is set up and working, the 455 kHz amplifiers can be connected and checked out. A separate audio amplifier connected to pin 7 on the *if* module will assure that if the signal sounds fishy, at least it isn't the receiver amplifier doing it! Peaking the *if* transformers is a simple job, but be sure to use the fibre tools recommended for the purpose. The use of a metal screwdriver results in very short transformer life—usually about one turn of the slug is all you get. The writer originally tried inexpensive 455 kHz *if* transformers, the imported types sold as replacements for use in transistor radios, but settled on the slightly larger J. W. Miller ones. The selectivity is definitely better on the larger units, and the space saved by the ultraminiature units is not really that valuable in this receiver. Once the complete *rf* system of the receiver is working, the audio amplifier can be connected and checked out. The only comment about it is that the use of voltages higher than 9 volts for supply may require the changing of the bias resistors in the audio driver and out put stages. At 15 volts the 39 k driver resistor should be raised to 56 k ohms.

Calibration of the dial is done by using several known frequencies from a nearby transmitter and interpolating to find the points at 144. 145 MHz etc. Dial markings and panel labels were done using a fine-line felt-tipped pen, after which a couple of coats of clear lacquer spray were added for protection. The completed receiver was housed in a cabinet made by the LMB Company-Type W-1A, measuring 7" long by 5" deep by 4½" high. A Bud cowl-type minibox, 10" long, 7" deep by 6" high would easily enclose the receiver and poyer components sepcified. The entire unit was completed and checked out on the copper board first, then a hole to receive it was cut in the chassis and small sheet metal screws used to hold it down. The power supply was built on the metal chassis itself for better mechanical stability. One problem encountered in the final checking-out of the finished unit was in the mounting of the loudspeaker in the top of the cabinet. It seems that the FET oscillators are very stable unless shaken at an audio frequency! The resulting feedback sounds nothing like the microphonics found in most 2 meter tube oscillators—it makes everyone appear to have audio feedback in their transmitter! The frequency of oscillation is high due to the mechanical stability of the oscillator, with the end result of accusing stations being received of having problems. The solution can be reached by two approaches: One, place the speaker outside the cabinet. This works every time, but takes up extra space. Two, anchor the FET and socket extra epoxy glue to the edge of the tuning capacitors, and make the remaining parts so mechanically stable that they are totally unaffected by vibration. This method of attack removes 99% of the problem, but there is still a bit on very strong stations at very high audio levels. If desired, the receiver may be run from batteries, either a 9 volt source or higher with appropriate dropping resistors. If resistors are used to lower the voltage, it is recommended that the input power be fed through the filter system to act as a decoupling network in the absence of a low impedence normally furnished by the battery.

The completed receiver should truly be a testimonial to the statement, "a good things come in small packages."

. . . W2HUX

The Ham Workshop

Bill Hayward WØPEM
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St. Joseph, Missouri 64507

The ham workshop can be almost anything from a VOM and screwdriver to one with a complete set of test instruments and complete metal working equipment.

Oh! You say you don't have a workshop, well fellow hams you maybe missing out on a lot of fun in ham radio.

You hams who don't have even a VOM, what happens when your ham gear quits working properly? Pack it up and send it back to the factory. Well, I guess this is ok if you have lots of money, anyway it makes a lot of jobs for technicians at the factories.

Maybe you are the kind of ham who likes to fix his own gear or build something new. But, you say test gear cost lots of money? True the better test instruments cost more, but a Cadillac cost more than a Ford too. Good test instruments don't have to cost a lot, look around at some of the kits on the market today. Such as the new Heathkit IM-17 solid state VOM, with 4½" meter, one FET, four other transistors, test leads, carrying case all for $19.95, this would be a nice VOM for you if you are just starting out.

If you have a lot of test gear around the workshop, do you know how to use them? Using test gear is a subject in itself and I wouldn't go into it.

A workshop is also tools to help repair the trouble after your test instruments told you what was wrong. Every ham should have screwdrivers of different sizes, pliers (both long nose and side cutters). a soldering iron or gun, and rosin core solder.

A good place to start, for hams who don't have a workshop would be the above tools, plus a VOM or VTVM. As you work on more of your own equipment, you find you need more items, such as a signal generator, oscilloscope, VTVM (if you don't already have one), grid dip meter, *rf* probe, dummy load (you should have this already), an assortment of test leads, wire strippers, and a nut driver set. These are but a few of the items you can add on, not necessary in the order listed above.

If you go in for building your own ham equipment, you might need in addition to the above, such items as an electric drill (a must), drill bits, reamer, chassis punches (for tube sockets if you use them anymore), a set of files, a variable voltage power supply, BC-221 frequency meter, and a big box for miscellaneous parts carried home from a bargain sale for that future project.

Where do you put your workshop? Anywhere that you might have room. An extra room (if you are lucky), a corner of the basement, or in a corner somewhere else in the house.

When you build, where do you get your ideas? You need to take as many of the ham magazines and books as you can. Then, when you see a circuit, you can go to the workshop and build it up, add your own ideas to it, see what it will do and maybe even write an article about it. A bookshelf is then needed to hold all the books and magazines you have.

It doesn't matter which you have the big well equiped workshop or the one meter workshop, you should at least try to repair or build some of your ham equipment. Who knows, you might find out what's behind that panel and help yourself learn something at the same time. . . . WØPEM

The following Cryptogram was submitted by Fr. Robert O. Gardiner K1OXK

Defi-Gram

P SPOONLO UPQL UZNSZ NA YALE IM KMEYTPIL PXMIZLO SPOONLO MO PX NXILOKLENPIL AYDSPOONLO.–AYD-SPOONLO.

(Solution on pg. 57)

New Life for an Old Circuit

Darrell Thorpe
3110 *N.* 83 *St.*
Scottsdale, Arizona

Simple inexpensive VFO circuit can supply stable fundamental drive sources to 50 MHz and beyond.

The Clapp oscillator circuit has eclipsed all other circuit configurations when it comes to buildng a VFO with inherent stability. However, it is not generally known that the Clapp circuit (first described by J. K. Clapp in 1954) is based upon a design conceived by Jiri Vackar in 1949. Most naturally, it is called the Vacker circuit. The Vackar circuit for some unkown reason has not received much attention in ham radio publications, so it is hoped that this reintroduction of the Vackar configuration to the ham ranks will breath new life into an old circuit that has much to offer.

What it offers

The Vackar provides inherent stability that is superior even to the Clapp circuit or any of the other common circuit configurations that are often described in VFO articles. Moreover, the output of the Vackar oscillator can be made constant over a wide frequency range. For purpose of comparisons, the basic Vackar, Clapp and Colpitts circuits are shown in **Fig. 1**. Note the similarity of the Clapp and Vacker circuits which is as should be because the Clapp was derived from the Vackar. Also, note that Vackar is not a Colpitts.

The Vackar circuit is series tuned by CV and the tank is shunted by a large capacitor C2. In addition, the tuning capacitor, CV, can be large in respect to the other capacitors if a wide tuning range is desired, and a 2.5: 1 frequency range is practical. Or, the tuning capacitor can be small to cover a narrow band.

80-Meter VFO

A practical Vackar circuit suitable for operation in the 3.5 to 4 MHz range is shown in **Fig. 2**. However, as will be described, values can be changed to cover any other frequency range that is desired. The high Q toroid inductor together with CV, and C1 thru C5 form a resonant circuit at the VFO frequency. But, for all practical purposes, the value of CV, trimmer C3 and C4 together with L1 are the primary components that determine the frequency range. Note that C4 is not needed at higher frequencies. Capacitors C1 and C2 should be as large as practical, that is, the shunt reactance across L1 and the transistor should be small for best stability. To determine C1 and C2, which are the same value, at other frequencies use the following equation

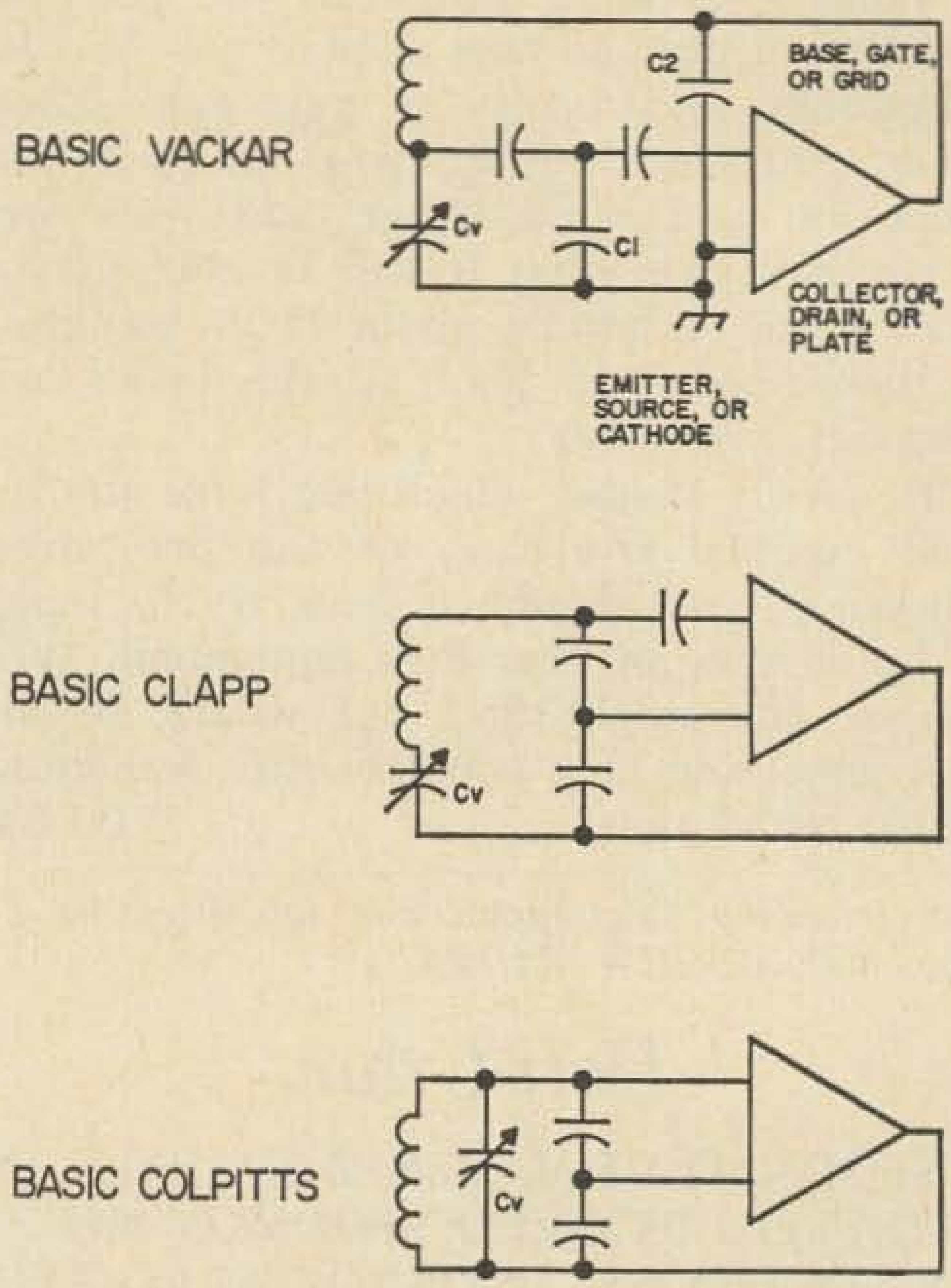


Fig. 1. Basic Colpitts and Clapp circuits are shown with The Vackar for comparison.

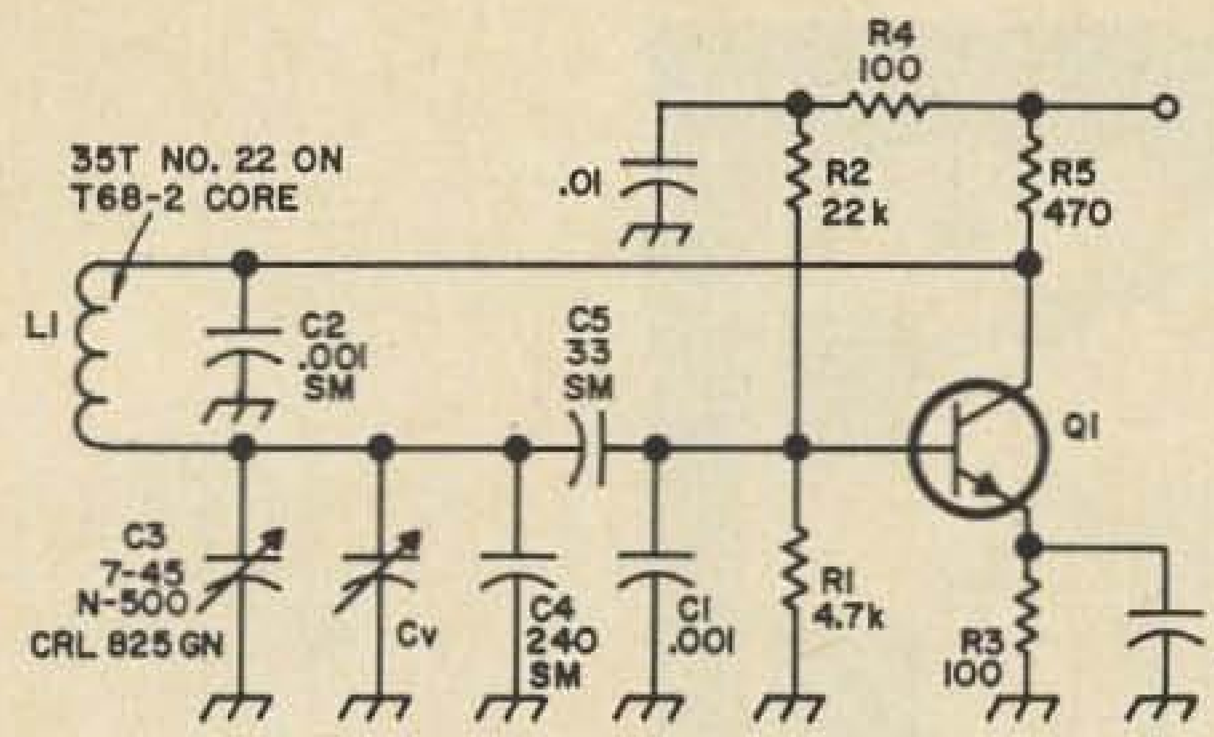


Fig. 2. Vackar oscillator circuit

$$C\ (pF) = \frac{3000}{f(MHz)}$$

Values determined from this equation will provide optimum stability and still remain consistent with other oscillator requirements. C5 should be small enough to prevent the transistor from being driven into saturation or into cutoff.

So, to get to another frequency, calculate C1 and C2, select suitable values for CV and C3 and padder C4 at lower frequencies, and then determine the inductance needed for L1 to resonate with this amount of capacitance from charts in the radio handbooks. One other point of consideration is the decoupling provided by R4 and C6. This decoupling prevents spurious oscillations at audio frequencies and R4 must not be replaced by a choke because the choke which gives good rf decoupling would not give the necessary suppression of these potential audio oscillations.

VFO/Driver

Fig. 3 shows the basic Vackar VFO with an emitter follower isolation stage and low power driver stage. If the VFO is to be used in a stable temperature environment and not in conjunction with vacuum tube furnaces it will probably be stable enough without compensation. However, compensation can be provided by using an N500 trimmer capacitor for C-3.

For low drive power, the MPS 706 does a fine job in all three sockets, providing an output of about ¾ of a watt. But, if several watts of output are needed or if it is desired to use this unit as a QRP transmitter an RCA 2N2270 or 2N3053 (a real bargain at 75c) can be used in the final stage and the collector voltage upped to about 20 volts. If two of these devices are paralleled, you can put out a pretty healthy signal. Don't put more than 10 volts or so on the MPS 706 or you will lose it. The collector emitter breakdown voltage of the 706 is only 20 volts, and collector voltage should not exceed ½ of the collector-emitter breakdown voltage. The 2N2270 has a BV_{ceo} rating of 45 volts and the 2N3053 is rated at 60 volts.

The same printed circuit layout can be used to build this VFO/driver at any other frequency that may suit your fancy. The circuit board wiring is included for those who want to make their own board. However, if you don't want to fiddle with making your own circuit board, an etched and drilled board (type VFO-A) ready to mount the components to build a stable VFO at any frequency from 160 thru 6 meters is available from Circuit Specialists Co., P.O. Box 3047, Scottsdale, Arizona 85251. The price is $2.00 post paid. Also, toroid coil kits VFO-80 meter and VFO-6 meter including the two toroid cores and the specified wire are available at $1.00 per kit from the same source. Once you've gathered the few parts needed to go with your circuit board you can have a unit working in an hour or less. I've built several units at different frequencies and all worked immediately upon application of power.

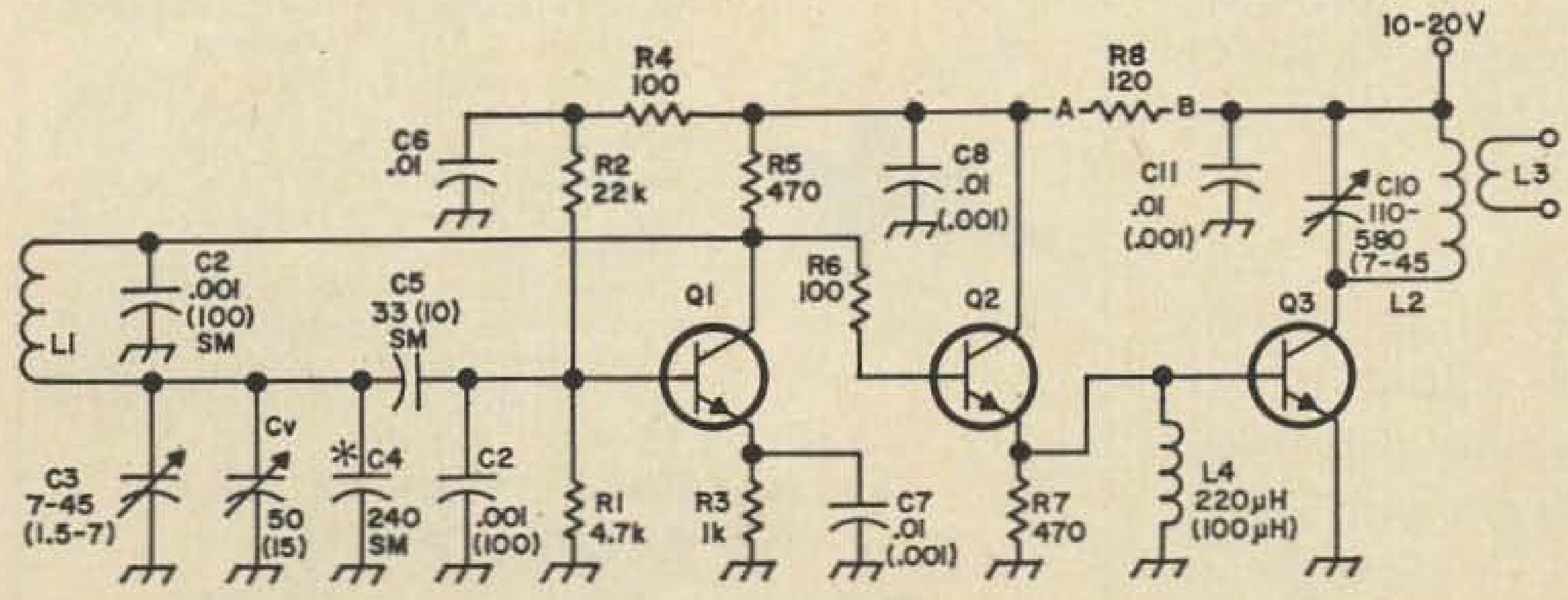
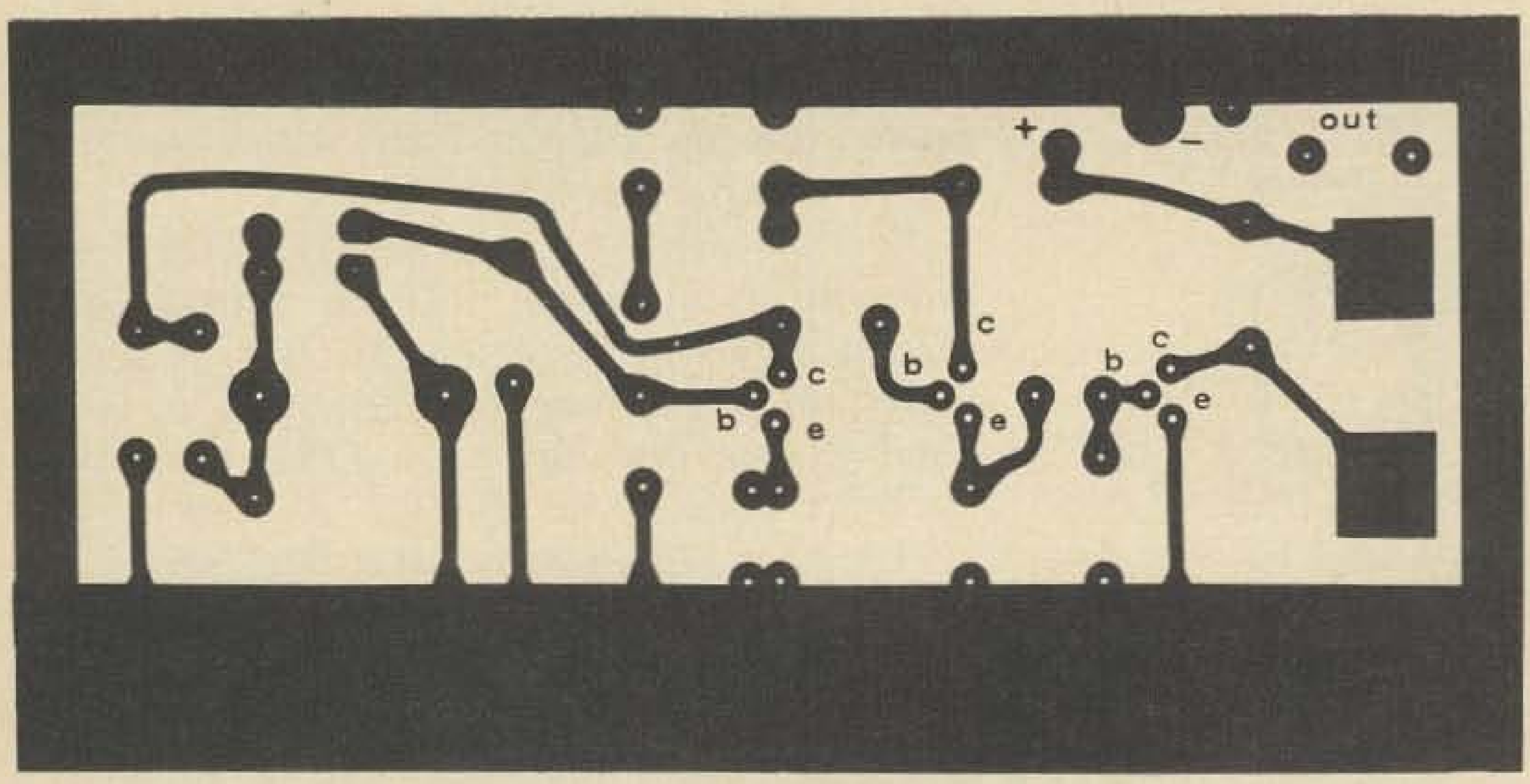


Fig. 3. Basic Vackar VFO

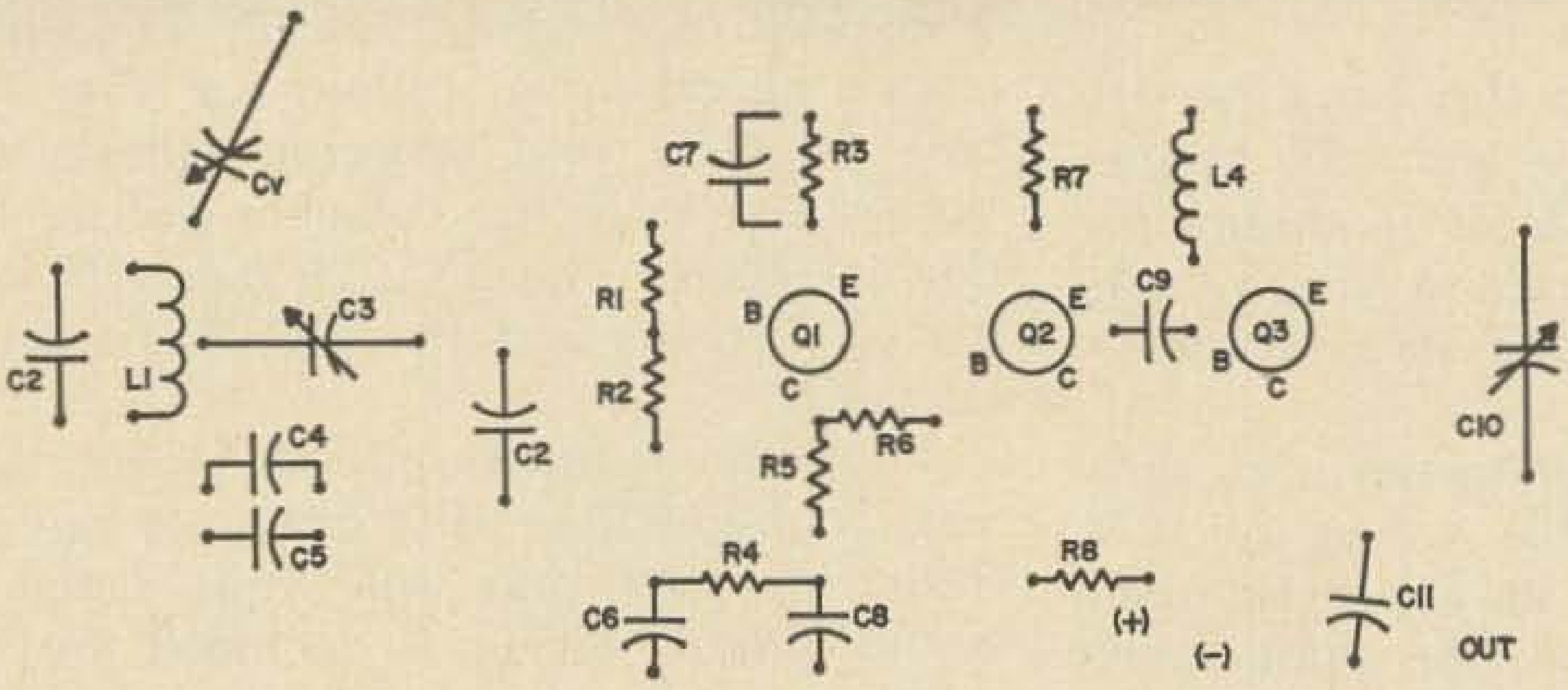
TO COLLECTOR-MODULATE FINAL:
OMIT R8
APPLY MODULATED VOLTAGE AT B
APPLY 9 TO 10V AT A

*C4 NOT USED IN 6M VERSION

COIL DATA		
COIL	80M	6M
L1	35T NO. 22 ON T68-2 CORE	9T NO. 22 ON T50-10 CORE
L2	SAME AS L1	SAME AS L1
L3	3 TO 4T NO.22 ON COLD END OF L2	SAME AS 80 M



Printed Circuit Board foil side



Parts Layout for P.C. Board

6-Meter VFO/Transmitter

By simply changing a few of the values determining the resonant circuits the previously described circuit can be converted to a VFO controlled low-power 50 MHz transmitter or a driver for a higher powered final.

For stability over a wide temperature range, N-750 capacitors should be used for C1 and C2. Wth the toroid inductor and N-750 capacitors the drift due to temperature is negligible except at extreme temperatures. This unit was built as a test for several purposes, therefore an HF-50 variable capacitor was used and the tuning range is from about 40 MHz to 60 MHz. For 50 MHz only an HF15 would be more desirable. The turns on the toroid can be compressed or spread slightly and this together with the trimmer will set your bandspread. Note that C4 is not used in this version.

At 50 MHz, transistors became a little more of a problem. MPS-706's in all sockets seem to work, but the power output is low and VCC is restricted to about 10 volts. The 2N3053, which in the beginning I had high hopes for, proved to be a disappointment at 50 MHz. It worked pretty good at 40 MHz, and it probably would do a fine job on 10 meters. The RCA 2N5180 (available at 48c but not yet listed in the catalogs) does a fine job. Although it is a low power type, it is a VHF device (900 MHz) and therefore has good efficiency. Two or more 5180's can be paralleled for a pretty healthy signal. They are economical enough to be used in all sockets. The Motorola 2N2219 also does a fine job. In fact, almost any silicon NPN that has an f_t of 200 MHz or more would probably work. At higher voltage a small clip-on heat sink should be used.

. . . Thorpe

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- Crystal lattice filter for high sideband suppression on transmit, and rejection of adjacent-channel QRM on receive . . . plus solid-state balanced modulator for "set-and-forget" carrier suppression.
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Alton E. Glazier, K6ZFV
3154 *Jordan Road*
Oakland, California 94602

VHF rf Noise Suppression

Probably one of the least understood problems with VHF mobile is *rf* noise suppression. After participating in, and listening to many conversations, it becomes apparent that a basic knowledge of the problem is lacking.

One of the most common complaints is that the converter or receiver is at fault because it picks up noise, or the antenna is at fault for the same reason. If the receiver and antenna are at all satisfactory, you *will* hear noise, for neither has intelligence to differentiate between the radio station to which you wish to listen and that being transmitted by the electrical system. True, most VHF receivers have some type of noise clipping which takes place either in the *if* section or second detector, or a blanker between the converter and receiver. It is also true that a narrow pass band in the *if* section will help; however, as most amateurs today are using commercial equipment, little can be done about this. Sometimes the location of the antenna will help, but these things in themselves will not cure all evils.

RF noise in mobile operation falls into two main categories. The first is conducted *rf* noise, and the second, radiated *rf* noise. Both types are quite broad banded. Conducted *rf* noise is that which is conducted along the electrical system of the car, and may originate from the alternator or generator, the voltage regulator, the points at the distributor, the windshield wiper motor, turn indicator flashers, etc.

The first step in conducted *rf* noise suppression is to remove the antenna from the receiver and short out the antenna jack. Turn the gain up and note the amount of inherent noise in the receiver (nothing can be done about this unless you want to rework the receiver). Start up the engine with the antenna jack still shorted. Rev the engine up and down. In most cases, you will hear alternator whine and distributor noise. Shut off the engine and start the windshield wiper. Increase and decrease speed. Shut off the wiper motor and start the turn indicator. Follow this through for any electrical device.

Now, for the conducted noise suppression: In some cars most of the electrical equipment conducted noise cannot be tolerated. In others, perhaps only two or three areas will require suppression. A great deal depends on the individual operator. In all conducted noise suppression, mount the suppressor as close to the offending equipment as possible. The reason for this is that as noise is being conducted along the electrical system, it can start radiating, and become an additional problem.

For alternator or generator suppression, there are two main types of suppressors. One is the tuned parallel trap, consisting of a coil and variable capacitor. This is connected in series with the lead from the alternator (as closely as possible). Of course this trap must be able to resonate at the desired listening frequency.

Now, with the antenna jack still shorted, and the audio gain well advanced, tune the trap for minimum noise. The second method, and my choice, is to install a feedthrough capacitor as close as possible to the alternator.

Perhaps a word at this time about feedthrough capacitors would not be amiss. A feedthrough, as its name implies, is one where the conductor, or lead, goes through the capacitor. The foil making up the capacitance is wound around this lead. The other lead of the capacitor is usually the metal case. From this it can be seen that inductive reactance is held at a minimum, and that any noise present on the line is forced to take this path. Be sure to scrape the metal clean in mounting capacitors. Do not use a wire ground lead, as the inductive reactance in the lead may defeat the purpose of the capacitor. As to the value of the capacitor necessary, this will depend on the amount of suppression needed.

There are several companies who publish charts showing current capacity, frequency and suppression in db, and the necessary capacitance value together with the types of mechanical mounts. The current spoken about here refers to the amount of current the lead can pass. For example, if your alternator can produce 30 amperes, a 30-ampere type capacitor is needed. If the alternator can produce 60 amperes, a 60-ampere capacitor is needed. I was unable to acquire this information from the local wholesalers, but had to go directly to the manufacturer.

For those who do not have the time, inclination or ambition to follow this course, there are noise suppression kits available, consisting primarily of feedthrough capacitors. Instead of the capacitors being selected for any particular frequency, these kits are more of a brute force, general coverage type, and in most cases are satisfactory; however, for those electrical devices not covered by the kits, use feedthroughs.

Radiated *rf* noise. After the conducted noise is suppressed to your satisfaction, connect the antenna. Tune between stations, shut off the noise limiter and listen to the atmospheric and man-made noise. No type of suppression will affect this noise. The only thing affective here is previously mentioned blanker, clipper, etc. Start the engine and see how the noise increases. This radiated *rf* noise is that emanating from your autoelectrical system, and here is where radiated suppression counts. If your receiver and antenna are performing their functions well, the noise should increase considerably.

Now for the radiated noise suppression: First, be sure the receiver or transceiver is properly grounded. Do not rely on the Gimble mount for this purpose. Use broad straps. Two are better than one, and they should be as short as possible. Be sure the bolts used are large enough, and the surfaces clean. Now we look at the engine compartment. First, check the ground strap from the engine block to the frame. Clean and retighten. Install at least one more strap from the engine to the frame at some other point, and perhaps one from the block to the fire wall.

Remember, what is a satisfactory ground for your six or twelve volt system is not good enough for VHF operation. In some difficult cases, it is also necessary to ground the muffler and tail pipe with broad straps, and sometimes it is even necessary to use wheel static suppressors. This wheel static can be detected best if you can find a road to yourself on a warm, dry day. At a speed of about sixty miles per hour, shut off the ignition switch and listen closely to the noise. As the car loses speed, the static noise will decrease and disappear as the car stops.

In some cases, you may have to ground the hood of the car. If so, use broad straps on each side, near the hinges. Make sure the ground connection at the base of the antenna is tight. Remember that a bumper or bumper mount is a very poor mount for VHF. If you must use the bumper, use broad metal straps from the base of the antenna to the body of the car, making them as short as possible.

As you have gathered by now, any part of the car that is radiating *rf* noise must be grounded. One simple way of detecting this is to use your receiver with a random length of coax connected to the antenna jack. At the opposite end of the coax, wind two or three turns of hookup wire, making a coil one inch in diameter. Tape the coax with the coil at the end to a yardstick. You now have an *rf* sniffer. By moving the coil around the car, you can detect areas of radiation.

The high voltage portion of the ignition system is something else again. The most common approach is to use resistor cable from the distributor to the spark plugs. This may be all right for the high frequency bands, but for VHF it leaves something to be desired. I prefer the resistive type of spark plug. The resistor is built right into the plug. Here we hear cries about poor gas mileage, etc., etc., etc. Remember, the purpose of the resistor is to minimize the jagged peaks found in the electrical wave form. If your high voltage is so marginal it must rely on these broad spikes, you have electrical problems. If you are going all out for suppression, there are kits available which will give maximum radiation suppression. Primarily, they consist of shields for the coil, distributor, high tension cables and spark plugs. (If you can stand the tariff).

In mobile noise suppression, how far to

go is entirely an individual matter. Also remember, two cars of the same model may require different measures. Antenna location plays some part in the amount of radiated noise pickup. For example, if there is radiated noise leaking around the hood, and the antenna is near this area, you will have noise. However, hiding the antenna behind the car is not the answer. Suppression at the hood is.

For those of us who must use city streets and freeways, how much suppression to strive for is a question, for nothing can be done about those cars in front, behind, to the right and left of us, except a very good noise clipper, blanker, etc. For those rare times when we get away from it all, and for those living in less crowded areas, use the greatest suppression possible.

. . . K6ZFV

Hallicrafters SR-400

The Hallicrafters SR-400 arrived the other day for an evaluation test. This is the first piece of gear that has turned up with my name on it, even temporarily, in about three years, so I got right at the rig to see what Hallicrafters had come up with and what improvements had come about since my last new transceiver.

Once you have become used to a one kHz per division dial I don't think you ever are comfortable until you get back to one. (I may write kHz, but until I pass into the great DX'pedition in the sky I shall think kilocycles.) The 400 has just such a dial and it is light as a feather. It also resets with absolutely no backlash. With a little practice I found I could set my dial to within 100 Hz (cycles) as easily as I can set some other transceivers to a kHz.

One knob on the front panel that I viewed with great relief was for the noise blanker. I don't know about you, but when I put my tower up I managed to find the worst possible place for it. My twenty meter beam virtually hangs over route 101, the major truck route east-west for this whole area. I'm right at the top of a medium sized hill so I get a good long shot over a quarter mile of road where the trucks are struggling to get up some speed after stopping at the one and only traffic light in Peterborough. The ignition noise often is staggering. So I just pulled the blanker knob and removed all those trucks from my speaker. Halleluja!

They have another little contraption built into this transceiver that is very handy. This is the RIT, the receiver incremental tuning control. On phone this means that you don't have to follow someone down the band if his transceiver doesn't really transceive. And you don't have to move your transmitting frequency every time someone calls you a little off the channel. You just move your receiver off a kHz or two and leave the rig where it was. This is great for nets on 80 meters where half of the fellows never seem to be able to hit the net frequency exactly.

The RIT can certainly be useful when you are working phone DX and you want to move off the channel just a little to work around a pileup. This is absolutely basic for CW DXing.

The 400 would seem to be ideally suited to the CW operator. Not only does it have the RIT arrangement for small QSY, but it has a 200 Hz filter position with an adjustable notch. That isn't enough for you? It has automatic break-in for CW and you can adjust the delay so you can have almost instantaneous break-in. What about monitoring your own signal? It has sidetone built in. Frankly, if Hallicrafters forgot anything in this package, I can't think what it is.

The 100 kHz calibration oscillator is built in and not, as on other transceivers, an accessory.

I found the rig simple to tune. It did take me a little time to get it on the air because I wanted to test it through my Henry 2K linear and this required a couple of soldered connections to the power plug on the 400. I finally found a soldering gun out in the back of the barn storage area. Every last inch of solder had been lifted so I had to go downtown for that. And the mike used an Amphenol connector which I couldn't find around. Evans sent one down the next day and I was in voice.

My first contact was with Bert, ZL4IA, who said that not only was I by far the loudest signal on the band, but that the audio sounded excellent, every bit as good as AM. KR6JK was next, and Dave said that my signal was by far the loudest on the band and the audio teriffic. I worked about thirty other countries during the evening and in no case was I able to get anything but excellent reports. I tried turning up the mike gain to the top and giving the Amplified Automatic Level Control a workout. In the midwest, where my signals were booming in about 50 over nine, the reports were that my signal was about 3 kHz wide on the lower side and about 10 kHz on the higher side. That seemed to me to be remarkably good considering that I had everything wide open and the meters were going almost off scale.

In all, Hallicrafters has turned out a beauty of a transceiver. It is one which will do everything the hardened phone man could ask. It doesn't go all to pieces when a whalloping signal is just off frequency. It is nice and stable. When you calibrate it you know that you can depend on the dial telling you exactly where you really are in the band.

If you like your CW, as many of us do, you may have been frustrated at the short shrift that many of the present day transceivers give this half of amateur radio. The SR-400 obviously has been designed by a CW man for CW men. With all those frequencies opening up to the Extra Class licensees this coming fall I'll bet that a lot of you will be wishing your transceiver had some of the abilities of the 400.

Phone men will want the associated HA-20 remote VFO unit. This permits split frequency operation over a wider range than the RIT function, letting you work DX stations down around 14,100 while transmitting above 14,200. Most of the time I don't personally feel that this type of operation is in the best interests of the other fellows trying to use the band, but I recognize that it happens and when it does you don't want to have to swing your transceiver down to copy the DX station and then back up to the U.S. band to talk back to him. You'll do this about once before you call your distributor and get the HA-20.

. . . W2NSD/1

Technical Specifications

Tuning Ranges:
Full frequency coverage of the amateur bands in eight ranges from 3.5-30 MHz.

Types of Emission:
SSB—selectable USB/LSB with suppressed carrier either manual, or voice control.
CW—Keyed RF carrier either manual or break-in.

Dial Calibration:
One kHz increments, 500 kHz tuning range.

Frequency Stability:
Less than 250 Hz drift in first hour, after a fifteen minute warm-up, and less than 100 Hz per hour thereafter.

Power Supply Requirements:
Model PS-500-AC for 105-125V 50/60 cycle AC base station operation, or PS-500A-AC for 117-234V 50/60 cycle AC base station operation.
Model PS-500-DC for 12 VDC mobile operation.

Transmitter

Power Output:
SSB—200 watts PEP
CW—200 watts.

Distortion Products:
30 db signal to distortion ratio.

Unwanted Sideband Rejection:
50 db below desired output.

Carrier Suppression.
60 db below PEP output.

Receiver

Crystal Lattice Filter:
Six pole, symmetrical passband. Center frequency = 1651.4 kHz. B/W = 2.1 kHz (3db) B/W = 4.2 kHz (50 db).
Sharp CW filter, 200 Hz @ 6 db.
Notch rejection, up to 30 db.

Antenna Input:
50 ohms nominal.

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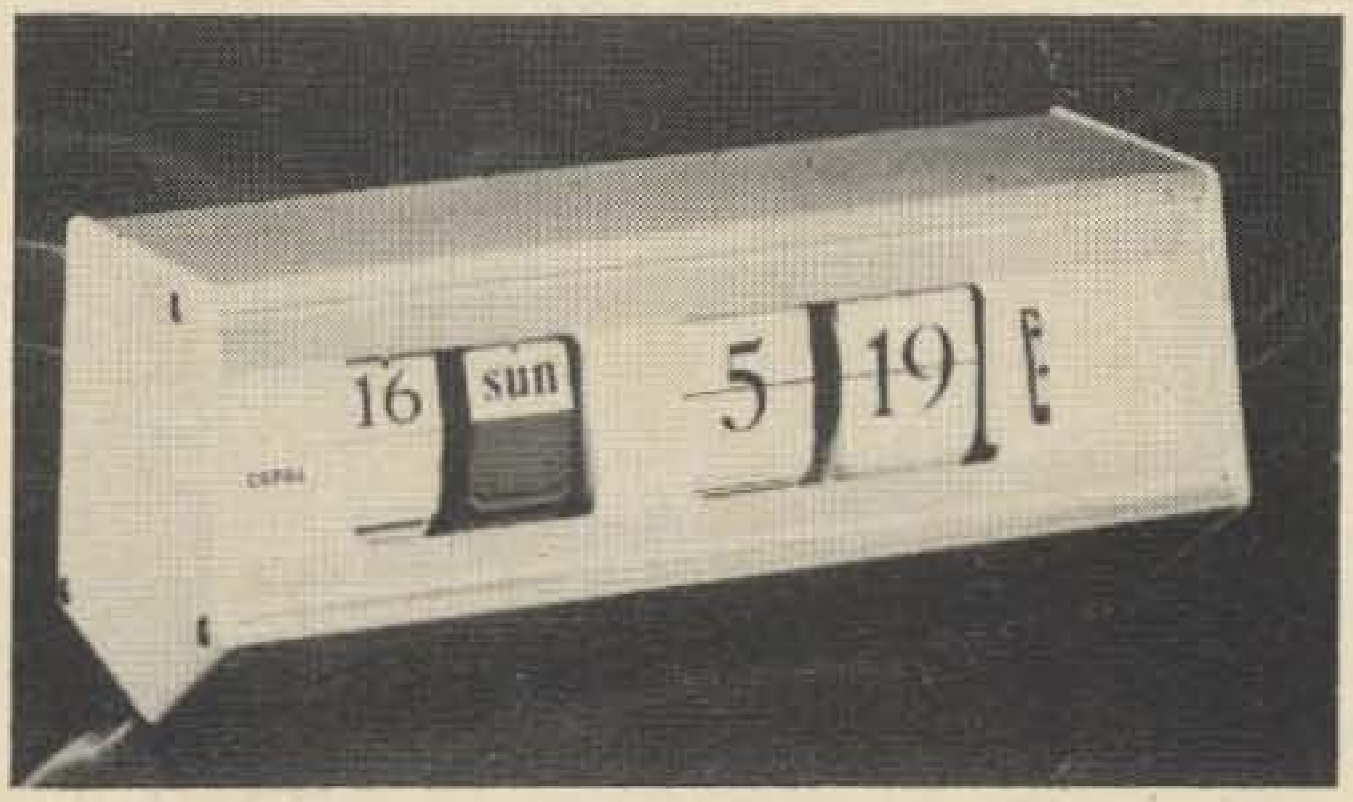

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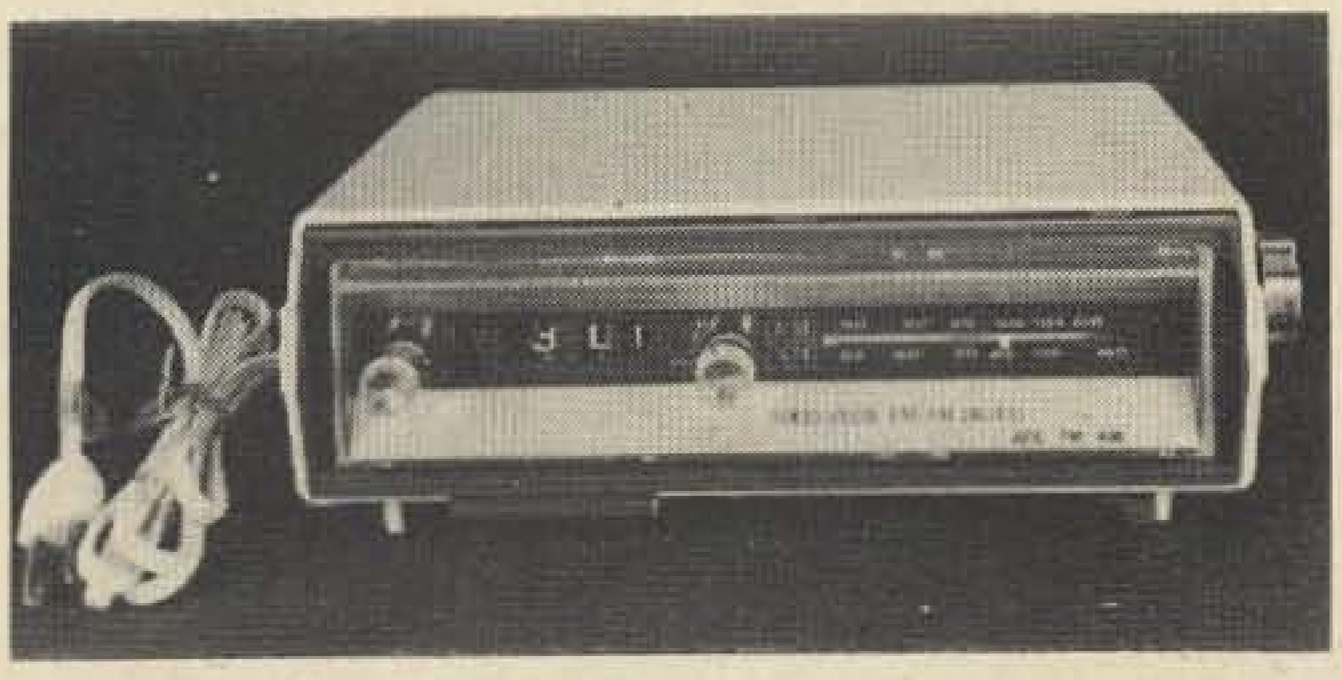

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☐ travel clock radio
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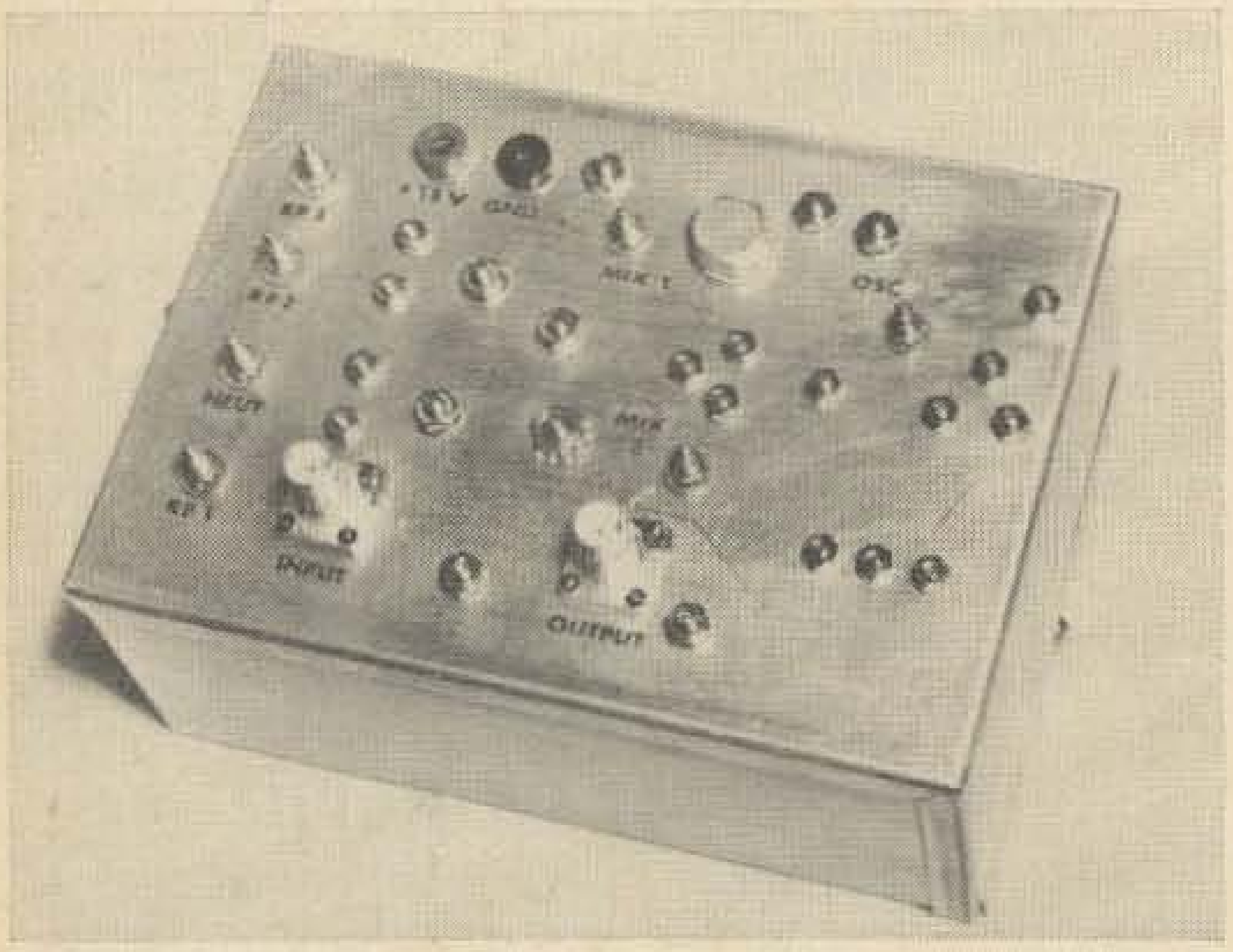
Livermore, Calif. 94550



Here is a FET converter which offers the extremely low noise figure of the new TIS 88 transistor, as well as good cross-modulation performance. This exceptionally low noise converter should be valuable to anyone interested in weak-signal 6-meter reception. The TIS 88 has a noise figure of 0.8 db at 50 MHZ and sells for $1.75 in single quantities. The ability to get below the atmospheric and man-made noise at 50 MHz to dig out the weak ones will be especially attractive for receiving skip signals during the approaching sunspot maximum. In this converter, the stability of a cascode *rf* stage, plus a TIS 34 mixer stage biased near cutoff insures high *rf* and mixer gains plus good overload control. The author also offers an optional bias circuit for the *rf* stage for those confronted with unusual antenna overload problems. The FET local oscillator should also be of interest to the ham builder, since there have been few FET receiver oscillators in the current ham literature. In summary, the clean, crisp reception qualities of this FET converter should be pleasing to everyone interested in 6-meter signals. The builder should be quite happy with the excellent performance of this unit.

Circuit description

The *rf* stage is a typical cascode circuit using a TIS 88 input and a TIS 34 output. The TIS 88 is a plastic version of the remarkable 2N4416, while the TIS 34 is a plastic version of the popular 2N3823. The cascode does not have a better noise figure than a single neutralized stage but was selected primarily for its better inherent stability.

The TIS 34 mixer stage is biased near cutoff for high local oscillator injection and conversion gain. This type of bias also provides good overload control and allows high *rf* stage gain. The cross-modulation distortion of the FET remains low even near cutoff. A TIS 34 is used in a series-mode local oscillator circuit. This type of circuit is recommended for overtone crystals. The oscillator tank output voltage at a 2K load is about 10 volts peak-to-peak. The crystal frequency of 43.000 MHz produces a converter *if* output of 7 to 11 MHz. This particular *if* frequency range was selected for the following two reasons. First, the converter should work well in this frequency range with low price receivers which usually have limited gain and frequency stability from 14 to 18 MHz. Secondly, the 58 MHz carrier of a local channel 2 TV station can produce an apparent 50.0 MHz image if a 14-18 MHz *if* frequency is used. In this case a 58 MHz antenna trap is required at the converter input. This reduces the sensitivity of the converter. However a 7-11 MHz *if* frequency eliminates the need for such a trap.

Construction

Two plain aluminum chassis boxes were used. A 4" x 2¼" x 2¼" (LMB No. 107) box was bolted to the bottom of a 7"x 5"x3" (LMB No. EL 753) box to form three partitioned compartments. The center mixer compartment physically separates the local oscillator and rf stages. This configuration reduces local oscillator pickup and

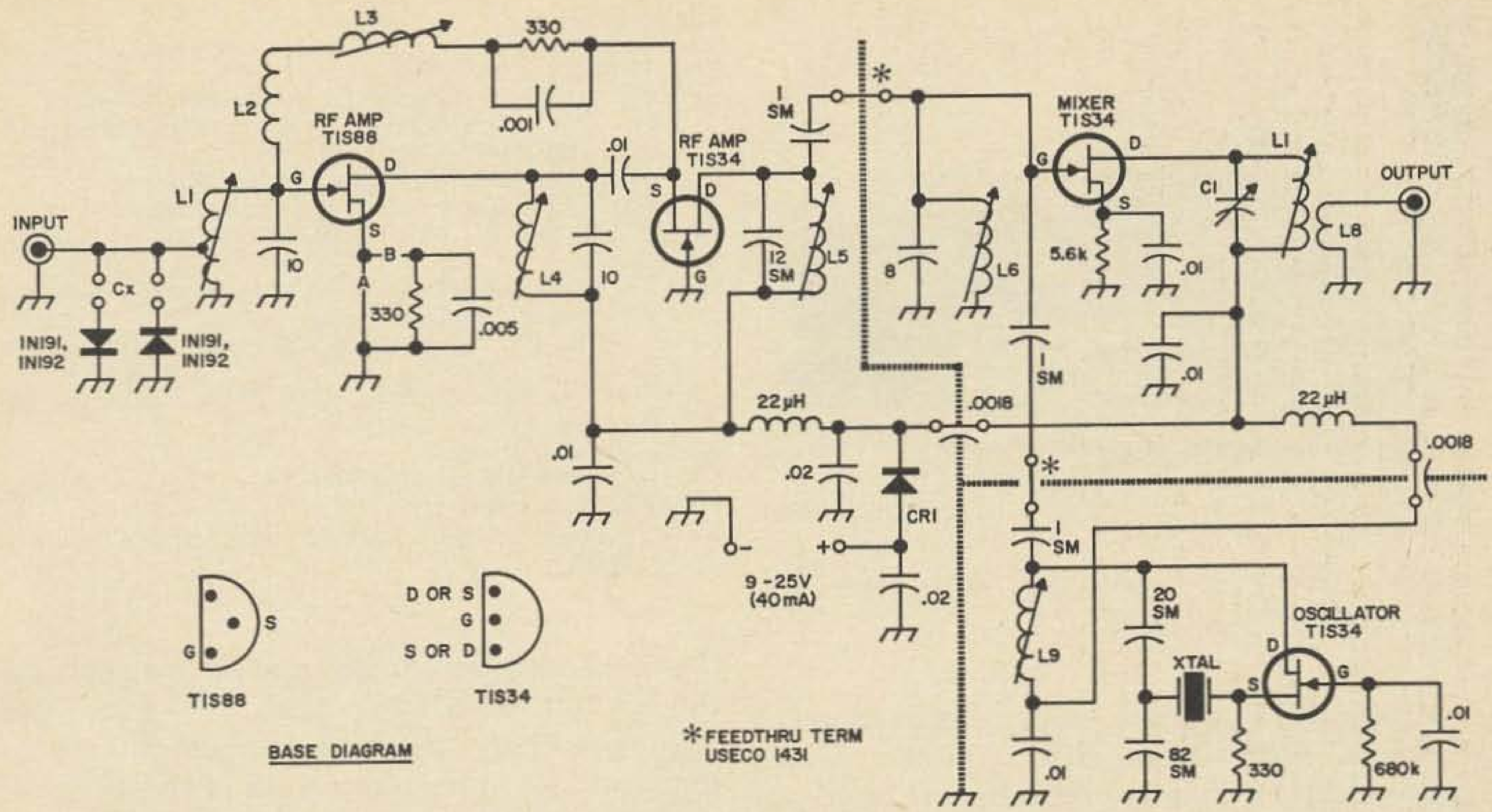


Fig. 1. Schematic diagram of the converter. All resistors are ½-watt carbon. All bypass capacitors are disk ceramic. Dipped silver mica capacitors are preferred for capacitance values below 100 *pf., but disk ceramics are acceptable unless otherwise specified. The* 1 *pf. dipped silver mica capacitors are made by Cornell-Dubilier. For best sensitivity, connect the TIS*88 *source directly to a ground lug as at A. For better overload control, connect the* 1*N*191 *(or* 1*N*192*) diodes across* J_1 *as at CX, and then connect the TIS*88 *source to the* 330 *ohm* (.005 *mf.) bias network as at B.*

amplification through the *rf* stage.

An electrically continuous circuit ground from input BNC receptacle to output BNC receptacle has been provided by size 18 bus wire. All mechanical connections of wire, lugs, screws, and even BNC receptacle base are soldered over to provide this electrically continuous ground circuit. This technique may seem redundant but, in low noise circuitry, it is not particularly wise to depend upon mechanical connections for electrical continuity. Ground currents from one circuit, in general, should not enter the ground circuits of another circuit. This ground current isolation is most easily achieved by using only one grounding point for each circuit.

Transistor sockets are not used. The transistor leads are soldered directly to ceramic base standoff insulators (Useco 1460B). The transistors, barring electrical accidents, should never require replacing. Since the converter input is at dc ground, the TIS 88 should be well protected from dc overvoltages. The builder who is concerned with *rf* overvoltages or an unusually strong signal can protect the input with the optional diode and bias circuit described in the schematic diagram. These optional circuits will produce a very slight decrease in converter sensitivity.

Ceramic slug tuned coil forms are used throughout. Coil losses are most important in the input stage. A slight improvement in noise figure might be obtained by replacing the input coil and fixed capacitor with an air core coil and ceramic base air capacitor. The air core coil should be of large size wire and can be enameled, silver-coated, or bare. Tinned wire is not recommended. The coils should be at least one diameter distant from other objects. However, air core coils are not actually necessary since the converter already has a lower noise figure (2 db or less) than can ever be used at the fairly low frequency of 50 MHz with its high atmospheric noise level.

The ⅜" nut and bolt in the mixer selection is used only to fill a hole in the chassis. This hole has been used to hold an *rf* gain control. A 100 K or 1 Meg (audio) taper pot had been installed from mixer gate to ground and it provided several decades of good gain control. However, the mixer stage is now biased near cutoff, and this should provide enough overload control for all but the most unusual situations. No.

Inside the converter. rf stage on right; mixer in center; oscillator on left.

18 wire has been used in many places merely to obtain high mechanical rigidity. This rigidity adds frequency stability to critical regions such as the oscillator and neutralization circuits.

Finally, the outside of the aluminum chassis can be rubbed with sandpaper or steel wool to give it a pleasing white satin appearance.

Alignment

First of all, it is important that the power supply or battery have the right polarity when plugged into the converter. A medium current diode, with a P.I.V. of 50 volts or more has been set in series with the power input to prevent damaging the transistors. The converter will operate well for voltages in the range of 10-25 volts.

Connect the converter output to the receiver with a shielded cable. Without a shielded cable, 7-11 MHz atmospheric noise may mask the converter signals. Next connect a signal generator to the converter input. Set the generator at 52 MHz. Set all tuning slugs at mid-range. Adjust the oscillator coil slug until the signal generator signal "kicks" in. Then peak the mixer output, mixer input, *rf* output, and *rf* input, in that order. The oscillator coil may need additional peaking as the other coils are adjusted. Since the cascode rf stage is designed for high gain, it may be in oscillation at this point. Careful adjustment of the neutralization coil L_3 should stop the oscillation and bring the desired signal in loud and clear. Neutralization of triode type receiver circuits can be difficult especially for the inexperienced builder. However, once

Parts Data

SM—Dipped silver mica.
L_1—8¼ turns No. 24 enam. wire closewound on ¼ in. diam. slug tuned form. Tap 1⅝ turns from gnd. end. (Miller 4500-3).
L_2—10 uh. molded r.f. choke (Miller 9230-44).
L_3—Slug-tuned, 9.9 to 15.0 uh. (Miller 4506).
L_4, L_5, L_6, L_7, L_9—Slug-tuned, .44 to .76 uh. (Miller 4501).
L_8—2½ turns No. 22 insulated wire wound around L_9. Winding direction same as L_9.
RFC_1, RFC_2—22 uh. molded r.f. choke (Miller 9230-52).
CR_1—Silicon diode (optional), 50 P.I.V. minimum, 200 ma. min.
J_3, J_4—Banana jack.
C_7—15 to 130 pf. mica padder (Arco-Elmenco 302).
J_1, J_2—BNC receptacles.
XTAL—43.000 MHz, third-overtone, series resonant crystal.

the neutralization technique is learned and the circuit stabilized, the low noise performance of the triode stage more than compensates for the tedium of neutralization. Tapping of the bare finger on the *rf* stage output coil should produce a loud clunk in the receiver speaker and a jump in the S-meter. While so tapping the finger, the neutralization coil should be adjusted for smallest clunk in the speaker and smallest jump in the S-meter. This will be the approximate neutralization point, and the stage should be stable. Remove the signal generator and replace it with an antenna. The atmospheric noise can be used for the fine adjustments of all previously peaked circuits. A 50 ohm noise generator can be used to obtain the very lowest noise figure.

At VHF frequencies, tuned circuits are quite sensitive to component geometries. The geometry of the builder's circuit may differ somewhat from that of the author's so, to properly cover the 50 to 54 MHz range, it may be necessary to slightly change some of the values of the capacitors in the various tank circuits. It may also be necessary to change the value of the RFC L_2 used in the neutralization circuit.

If a TIS 34 with an extremely small gate-to-source cutoff voltage is used for the mixer, the local oscillator injection level may be too high. This will cause cross-modulation distortion and a profusion of clunks and bleeps across the band. This could be remedied by changing the values of the coupling capacitors C_{11} and C_{12}. However, for most cases, it should be enough to merely try other TIS 34's until the distortion ceases.

The converter is designed for 50 ohm and output impedances. If the receiver used does not have a 50 ohm input, the number of turns of L_8 should be adjusted for maximum gain

The measured converter noise figure is about 2 db or less. The measured converter gain is about 30 db. Further reductions in noise figure could be obtained by the selection of an especially quiet TIS 88, and by the use of a very high Q coil-capacitor combination at the converter input. However, a 2 db noise figure is more than adequate for six-meter work.

Since the converter gain is high, an unusually strong signal may cause the converter to overload the communications receiver used as the *if amplifier*. This overload problem can be avoided by placing an attenuator between the converter output and receiver input.

I would like to thank Texas Instruments, Inc. for the sample TIS 88 transistors used in the development of this converter.

. . . WB6YVT

Hy-Gain Announces New 6-Element Tribander

Hy-Gain Electronics Corporation, Lincoln, Nebraska 68501 has announced a new 6-element tribander beam, The Super Thunderbird TH6DXX, for 10, 15, and 20 meters.

A new feature is a cast aluminum, universal tilt-head boom to mast bracket that accommodate masts from 1¼" to 2½" and allows easy tilting for installation, maintenance and tuning. It also provides mast feed-thru for beam stacking.

Another exclusive Hy-Gain feature is taper-swaged, slotted seamless aluminum tubing on all elements which allows easy adjustment and re-adjustment. Taper-swaging permits larger diameter tubing where strength is important and less wind loading at the tips. Full circumference compression clamps are mechanically and electrically superior to self-tapping sheet metal screws.

All Hy-Gain Thunderbird beams incorporate the Hy-Gain invented Beta Match system for balanced input, optimum matching on all 3 bands and dc ground to eliminate precipitation static. And, new, improved separate HY-Q Traps on each band.

The Super Thunderbird specs include up to 9.5db forward gain, 25db front-to-back ratio, SWR less than 1.5:1 on all bands, and a 24 foot boom (none longer in the industry).

Hams interested in further information should write to Hy-Gain.

Neutralization!

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"Neutralize: to make of no effect by some opposite force; counterbalance.[1]" Obviously, this is of concern in amateur radio transmitters, to prevent self-oscillation in amplifier stages. The receivers, using superheterodyne circuits and pentode or tetrode tubes, have not generally required neutralization on the individual stages. Well, not until the advent of the triode transistor. In fact, not since the early 30's.

To obtain oscillation, and substain it, requires a gain of at least one, and feedback in phase with the input. Let us consider then, a typical grounded cathode amplifier, as has been simplified in **Fig. 1.** Assuming the grid and plate tank circuits are tuned to resonance at the operating frequency, where is the feedback path? Since the tube reverses the phase by 180°, any feedback through the grid-to-plate capacitance would approach 180° if this capacity is large, or 90° if it is small. As it works out, tubes with the larger grid-to-plate capacity seem to be the greatest offenders. That is why tetrode and pentode tubes were developed- to cut down the interelectrode capacity. But, this fedback is 180° out, negative feedback, is it not? So, we go to the bottom of the tank circuit, either grid or plate, and send back a *positive* feedback signal to counterbalance it. Or, do we? *If* the circuits in grid and plate are tuned to resonance, they are resistive, hence no phase shift. The tube reverses the phase 180°, so the feedback through the grid-plate capacity can't possibly be zero. Take a grounded grid configuration, however, and with the same conditions, the feedback does approach zero phase shift. Although the grid acts as a shield between the two tuned circuits in this case, stray capacitance (or other un-

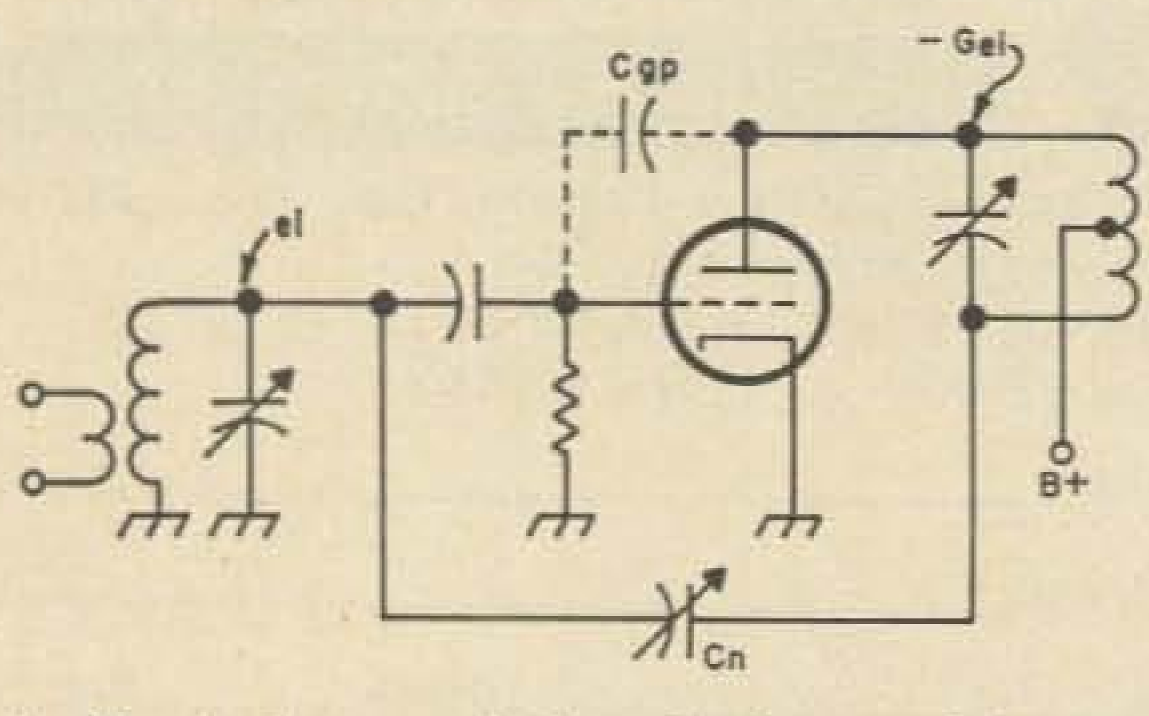


Fig. 1. Typical grounded cathode amplifier circuit.

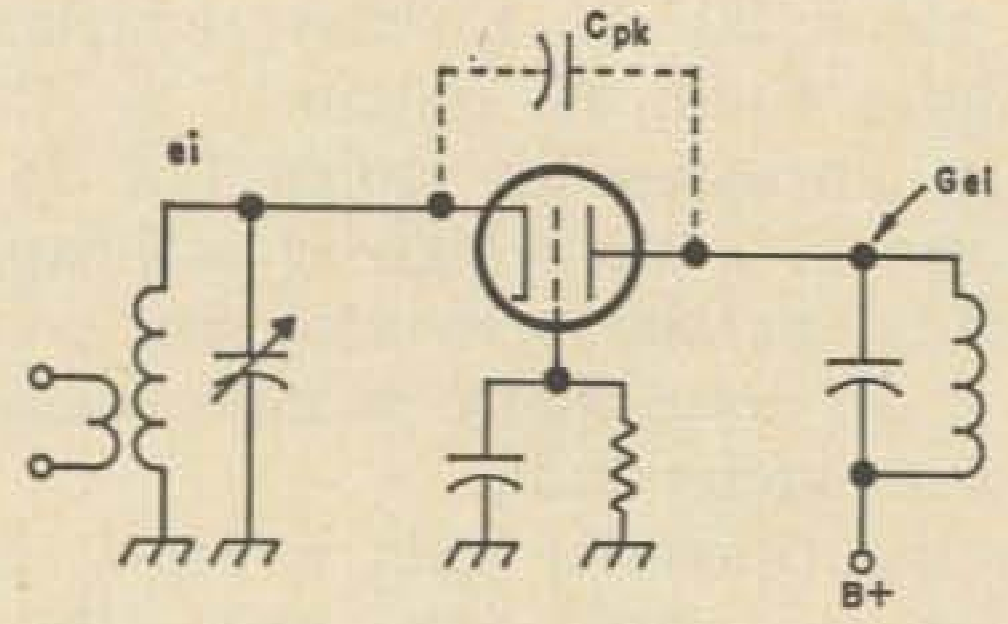


Fig. 2. Grounded grid circuit.

expected impedances) may create oscillations.

We certainly do tune the circuits to resonance, so there must be another explanation. There is! The circuits tend to oscillate at *another* frequency where the gain and phase shifts add up to the required specifications, 1 & 0, respectively. This is why, on the CW bands in particular, you may hear harsh broad key clicks, yet no carrier is present. Tune 50 or 100 kHz away and you may find the carrier that is being keyed, with only a trace of clicks. As the tube is keyed, its gain, and the effective grid-plate capacity (which are interrelated at *rf* frequencies) also vary. At some points they hit a happy medium and random oscillations occur. The effective C_{gp} is the product of the gain and the static C_{gp}. The effective gain is determined in part by the negative feedback through C_{gp}. Except for the unfortunate circumstance where the circuit is not so heavily loaded that it's reactance is negligible over a broad band. Then phase shift sets in and oscillations occur. And people promptly tell you to add a capacitor from the other end of the plate tank back to the grid. (C_n).

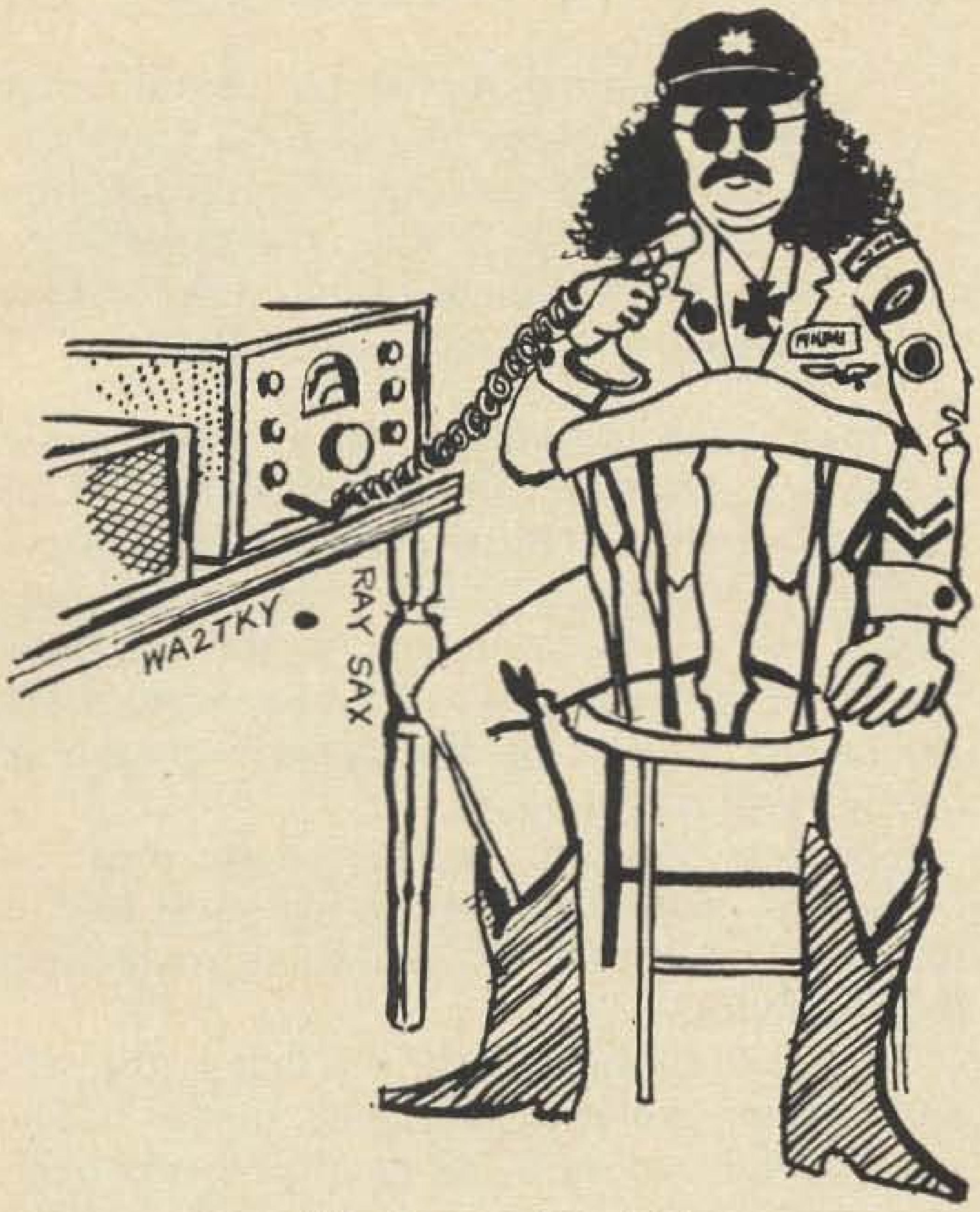
This *is* positive feedback, at the operating frequency, but it is compensated for by the negative feedback through the tubes interelectrode capacity. That is, at *your* operating frequency. At other frequencies, it is negative feedback (hopefully). Any filter has phase shift, and the grid and plate tank circuits are definitely no exception. The higher the Q, the greater the phase shift *near* the operating frequency. And naturally the gain is higher closer to the operating frequency, since the circuit is designed to match the amplifier, be it tube or transistor.

With all the possible stray impedances present in an amplifier using a high G_m tube at the higher frequencies, proper neutralization is extremely difficult, and may require a combination of two or more methods. But *few* of them use negative feedback at the intended operating frequency.

By referring to the grounded-grid schematic, it will be noted that this configuration does not reduce the problem of grid-to-plate capacity, it eliminates it. The remaining problem is cathode-to-plate capacity, and, of course, grid lead inductance. In one recent article[2] the author claimed "any plate-grid capacitance now feeds the signal back in wrong phase to regenerate." I couldn't agree more. It feeds it straight to ground.

. . . K6EAW

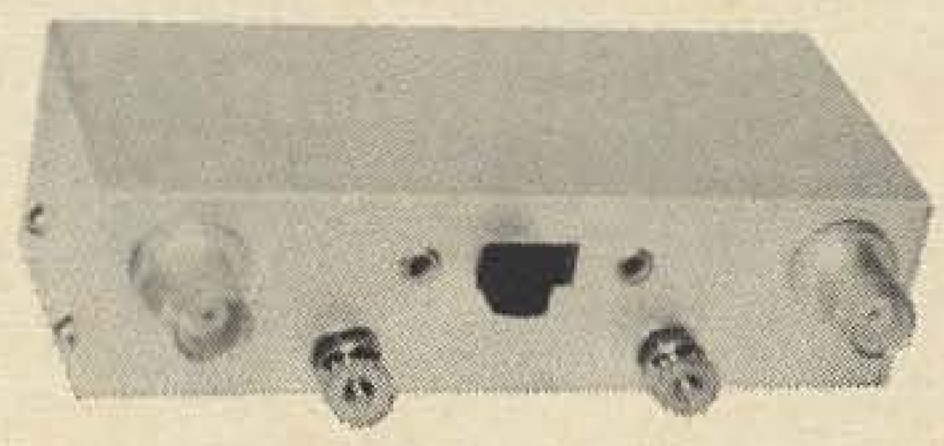
References: 1. World Book Dictionary.
2. ham radio, April '68, page 18.



"Yeah, man, like 73"

Defi-Gram Answer

A carrier wave which is used to modulate another carrier or an intermediate subcarrier.—subcarrier . . . K10XK



Getting Your Higher Class License

Part VII — Measurements

In the preceding six installments of this study course for the Advanced Class license exams, we've leaned heavily on theory—because the point of the whole series is to provide the additional theory you'll need to pass the exam!

But all this theory must be tempered somewhat with its practical applications. Any practical application of any part of the theory is going to involve some type of measurement — even though we may not realize that we're making it.

For example, simply tuning a receiver is making a measurement of the receiver local oscillator's frequency; when a station is tuned in "on the nose," the receiver oscillator is operating at a "measured" frequency. Just what the measurement may mean is a different question.

Most measurements we make are more deliberate than that; we may measure time in order to make our log entries, frequency in order to stay within the band limits, current in order to tune our transmitters, and voltage (via the S-meter) to check received signal strength.

The Commission recognizes the importance of measurements in practical applications of theory, and several questions dealing directly with measurement are included on the FCC study guide. Among them are (numbers are from the FCC list):

10. How close to the edges of a certain amateur band can you safely operate a VFO-equipped CW transmitter if you are using a frequency meter which has a maximum possible error of 0.01 percent?
16. What do oscilloscope patterns showing 25% modulated signals (with no distortion) look like? 50% 75%?
22. What are Lissajous figures in oscilloscope operation? What patterns would be produced on the oscilloscope if the signal applied to the horizontal input has a frequency equal to 2 times the frequency of the signal applied to the vertical input? 3 times? 4 times?
37. Should a voltmeter have high, or low, internal circuit resistance? Explain.

These four questions, with their many parts, actually span almost the entire art of making electrical measurements. As usual, we'll re-phrase them to make the basic points a little more obvious, and move the emphasis from that of specific answers to specific problems over to that of the general reasoning behind typical problems.

The first question, in this phase, must be "What is 'measurement'?", for most of us probably think of it as something more than it actually is.

Directly following from the first is the second, "How are measurements made?". The third, "How accurate can measurements be?", naturally accompanies the second. One of the remaining key factors is the question, "Can a measurement affect itself?", and of vital practical point is the final question of our paraphrased group: "What are measurement 'standards'?"

Ready? Let's go.

What Is "Measurement"? The word "measurement" means many things to many persons, but most of us tend to think of it as a process including more than it actually does.

A measurement cannot be anything more than a *comparison* of two like quantities, to determine whether they are equal, and if not, which is greater. The mythical scales of Justice are a typical example of measurement at its most rudimentary level.

One of the two quantities—the one which we are "measuring"—is unknown. The other, hopefully, is known, and we call it "standard" against which we are measuring the unknown.

When our comparison device is able only

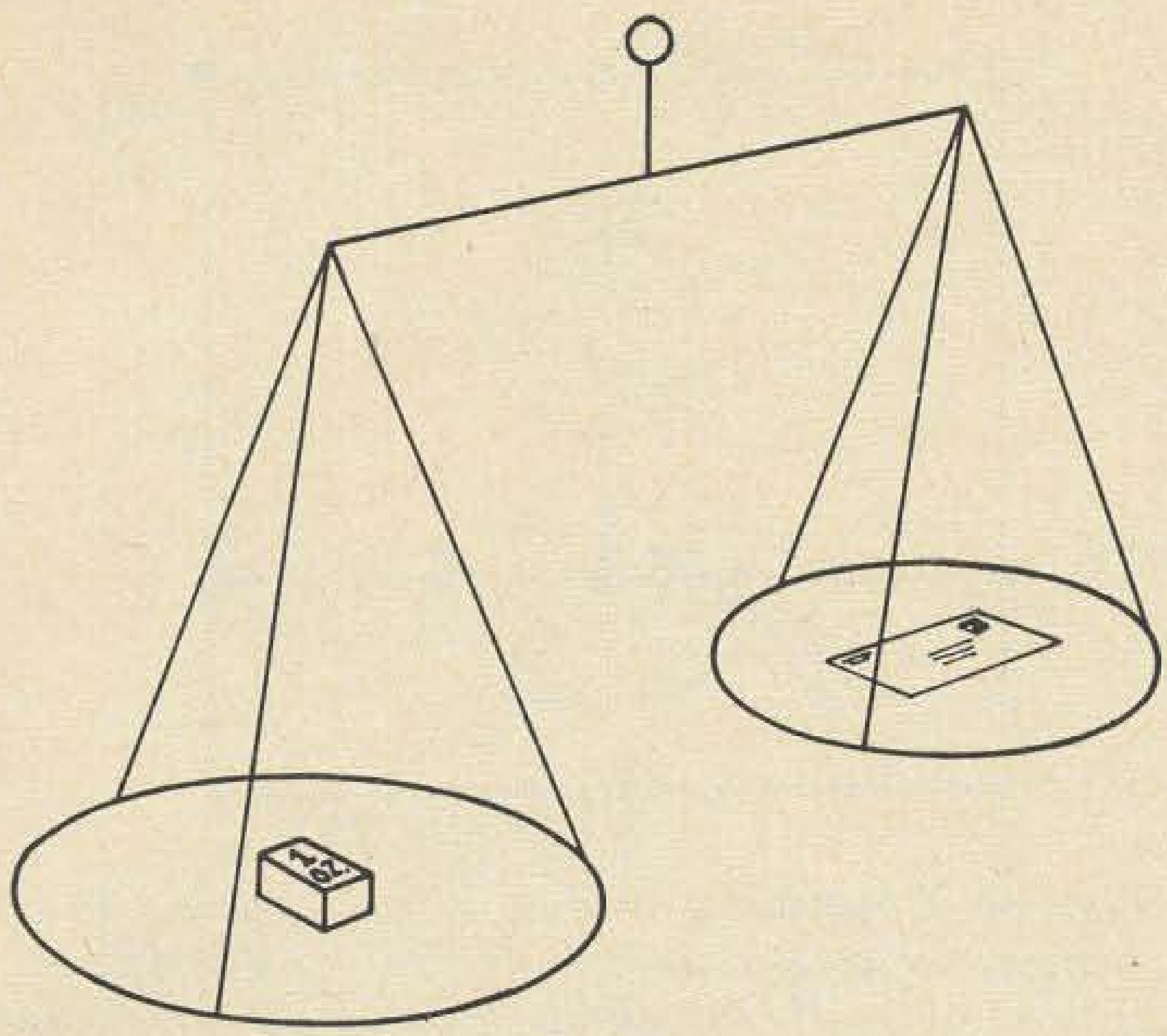


Fig. 1—Comparison of the unknown quantity (such as the weight of the letter) and a known standard (the 1-ounce weight) forms the basis of all measurements. Any measuring instrument which does not have the comparison standard within itself is merely acting as an indirect comparison device. In this case, the initial comparison to a standard is known as "calibration" of the instrument.

to indicate exact correspondence and relative unbalance, we must have not just one but many "standards", each of which bears some relation to the others. Staying with weight and scales for our example, we would need not only 1-pound standards but also 1-ounce, 2-ounce, 4-ounce, 8-ounce, 2-pound, 4-pound, and 8-pound standards in order to be able to "measure" unknown weights from 1 ounce to 16 pounds within 1-ounce accuracy.

Some comparison devices are able to indicate the amount of unbalance more precisely; we'll get to them a bit later. The point we're looking at now is the fact that *all* measurements are forms of comparison against standards. Sometimes the measurement includes a counting action (as in measurement of time by a clock) but the comparison to a defined standard is always involved.

In ancient history, the standards were considerably less precise than those we use today. The biblical standard of length, for instance, was the cubit—which was the length of a man's forearm. Just how many cubits long a wall happened to be depended upon whose arm was used to establish the standard. As recently as the middle ages, the english-standard "foot" (which today is defined as 12 inches) was defined as the length of the right pedal extremity of the reigning monarch —and varied all over the kingdom when a new King took the throne.

Our electrical standards are much more precise, even if they do happen to be phrased in the language of physics. A volt is defined as the potential produced by a specified type of primary-standard cell. An ohm is defined as the resistance of a particular and highly-specified conductor. An ampere is defined as the current required to electroplate a given quantity of silver out of a solution of specified strength. Additionally, each of these standard "units of measurement" is defined in terms of each of the others by means of Ohm's law, and the whole system of physical units is geared together so that all the equations of physics hold true.

When we measure a voltage in a circuit, though, we aren't performing any such direct comparison—and what we actually measure is *not* voltage, but length! How this can tell us the voltage in the circuit is what the next question is all about.

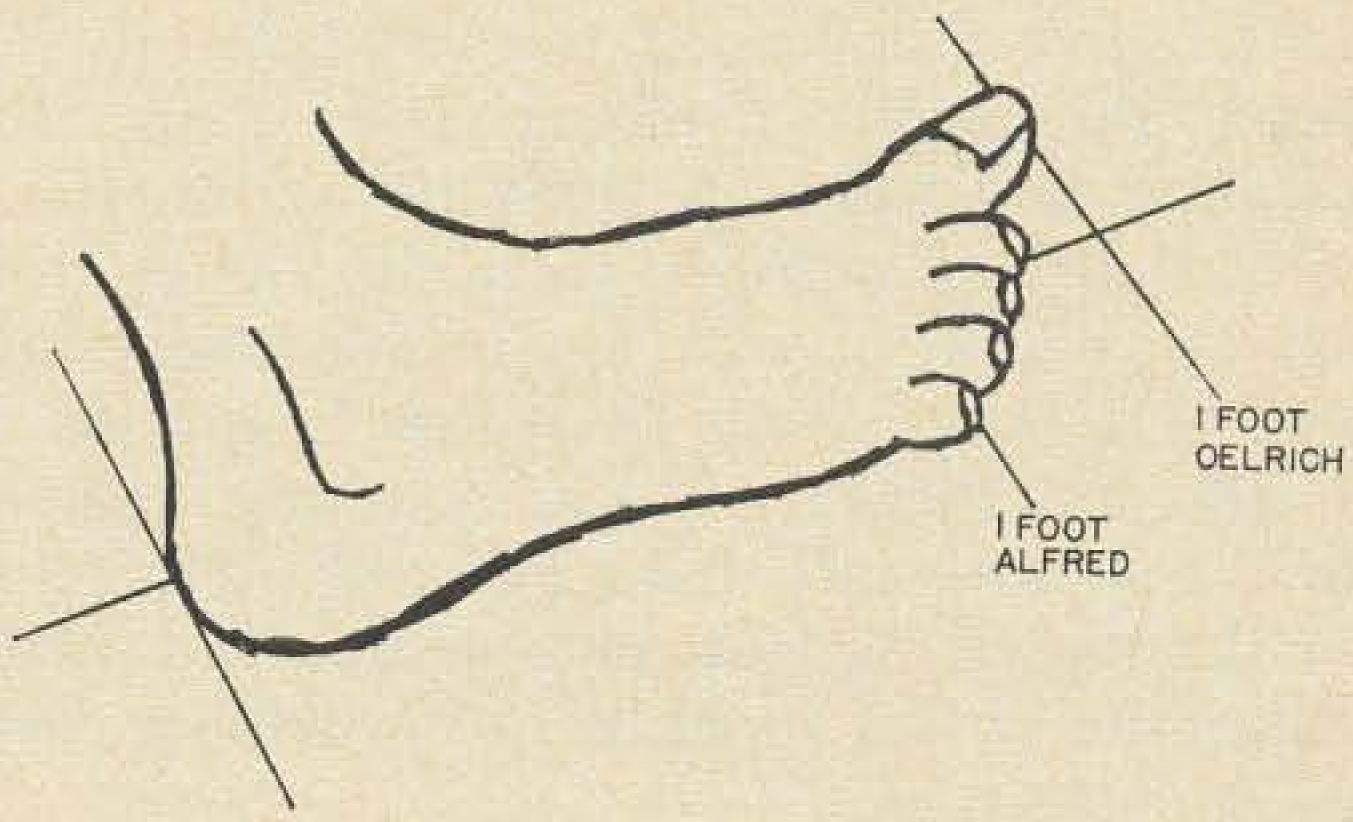


Fig. 2—In olden days, standards were a bit less precise than those we use today. The standard of length in England through the Middle Ages, for instance, was the King's right foot—whence comes the name of the unit. This was some slight hardship to surveyors when the reign changed, but most people could live with it and those who couldn't, didn't, courtesy of the royal executioner.

How Are Measurements Made? If measurement means only a comparison of an unknown quantity against a standard, how can it be possible for us to measure the voltage in a circuit by using a voltmeter which does not contain any standard voltage source against which the unknown can be compared?

The answer, surprising though it may be, is that it's not. We speak of measuring voltage, but we don't. What we actually measure is *length*—the distance across the meter face travelled by the needle—and the comparison standard is the printed scale under the needle.

How can length indicate voltage? Again, it doesn't; what it does indicate is power. In the ordinary moving-coil meter movement, the electrical quantity which is measured is power. This power forces the meter needle against a spring in some cases, but in more sensitive meters the power is only capable of pushing the needle partway across its scale. The deflection of the needle is proportional to the applied power, and since the meter is of fixed construction, the distance travelled across the scale by the needle can be used to indicate the power.

We normally calibrate meters to indicate either voltage or current, rather than power; in a circuit of fixed resistance, though, either voltage or current may control the amount of power available. If the circuit resistance is low, then current is usually the controlling factor. If circuit resistance is high, voltage indications are obtained. One rather unusual result of this is the fact that a milliammeter, calibrated for current, can be used without any modifications for measurement of extremely low voltages. If the resistance of the meter movement itself is 100 ohms, for instance, and full-scale deflection is obtained with 1 mA of current, then the meter may also be used as a voltmeter in the range from 0 to 1/10 volt. When 1/10 volt is applied to a 100-ohm resistance, the resulting current flow is 1 mA—and that's full-scale deflection for the meter. At least one commercial VOM makes use of this capability to provide a very-low-voltage range.

Don't become confused by this approach—the power used by the meter is *not* related to the power consumed by the circuit being tested. To measure power consumption of the circuit, two meters are normally required; one measures the current flowing through the circuit and the other measures the voltage. Certain special meter movements have been built (mostly for ac uses) to combine both these measurements in a single meter, and indicate power directly on the scale, but you are not likely to run into any of these meters in practice.

The type of measurement we've been examining thus far in this section can be called "indirect", since we are not making a direct comparison and so are not, in the strictest sense of the word, measuring what we think we're measuring. Indirect measurement can be summarized in the idea that we actually measure something which is *related to* the quantity we want to know. The process of establishing that relation so that we can trust our instruments is known as "calibration",

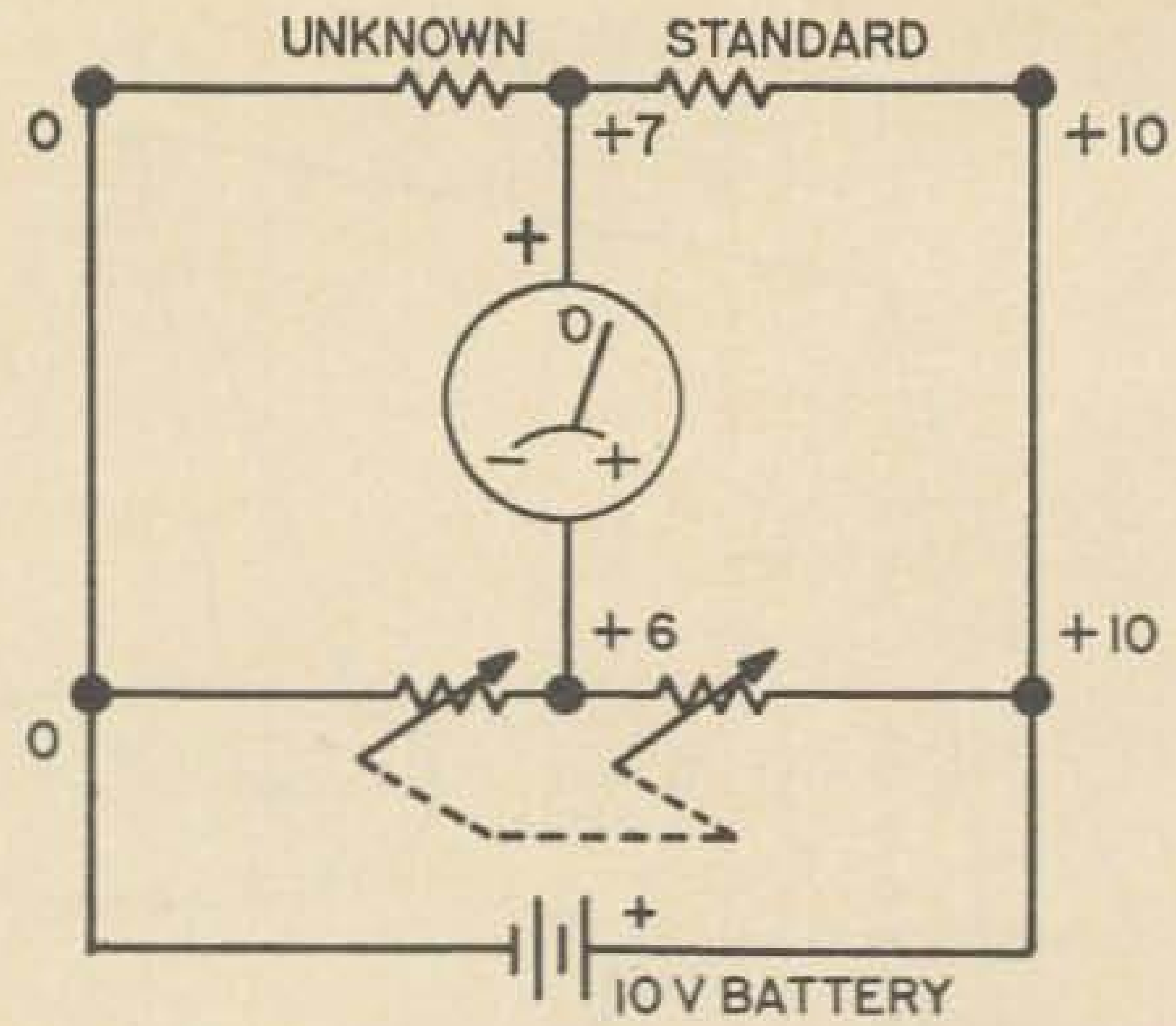


Fig. 3—Wheatstone bridge circuit shows direct comparison measurements. Figures in drawing are typical only. If adjustable ratio arms of bridge divide the 10-volt source into 6 and 4 volts respectively (3 to 2 resistance ratio) while unknown and standard together divide it into 7 and 3, the 1-volt difference appears across the meter and causes the needle to deflect. When the ratio arms are adjusted to also provide 7-3 voltage division, no voltage exists across meter and deflection is zero. At this time, unknown bears same relation to standard as left-hand ratio arm does to right-hand ratio arm. This performs direct comparison of unknown and standard.

and could be the subject of an article in itself. Most often, calibration is accomplished by making a "direct" measurement and an "indirect" measurement at the same time, and adjusting the "indirect" instrument as required to make its reading correspond with that obtained directly.

"Direct" measurements involve direct comparisons between the unknown and the standard. One of the most widely known examples of this type of measurement is the Wheatstone bridge, used to measure resistances. Other examples include the Kelvin-Varley potentiometer (not to be confused with the variable resistor of similar name) for measurement of voltages, capacitance bridges, impedance bridges, and some types of frequency-measuring devices.

The action of the typical bridge circuit is shown in **Fig. 3.** The bridge contains four "arms", one of which is the unknown resistance and one of which is the standard. The other two arms are also standards, but are variable so that their ratio to each other can be changed. A "null indicator" which may be a sensitive dc meter or some other current-indicating device is used to detect the "balance" condition. Current is provided to the bridge circuit, and the ratio of resistances in the adjustable-standard arms is varied until the indicator shows an *absence* of current flow through the center leg of the circuit. When this condition occurs, the ratio of the unknown resistance to the fixed standard is the same as that of the corresponding adjustable standard to its mate; a simple calculation then produces the value of the unknown resistance.

This works because current will flow between any two points which are at different voltages, but cannot flow between two points at the same voltage. Current flowing through the two adjustable standards produces a voltage drop across each; similar voltage drops are produced across the unknown and the fixed standard.

The bridge leg, which contains the null indicator, connects these two path midpoints. If the voltage drop across the left-hand adjustable standard is not the same as that across the unknown resistance, the two ends of the null-indicator are at different voltages and current can flow. When both voltage drops have the same value, both ends of the indicator circuit are at the same voltage and current flow ceases.

The absence value of the unknown resistor need not be the same as that of the left-hand adjustable standard, though, because the total current flow in each of the series-resistance legs is also affected by the resistance of the fixed or the right-hand adjustable standard, as

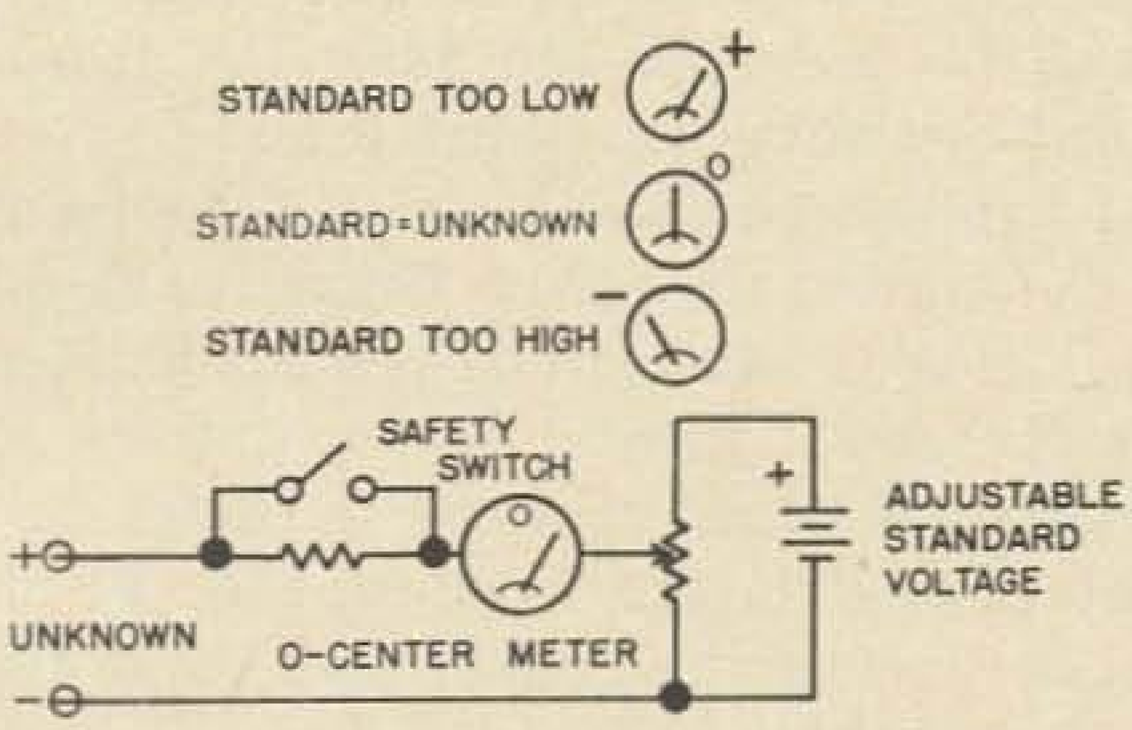


Fig. 4—This slide-back voltmeter circuit, while too simplified for practical use, illustrates another application of the direct comparison technique. The resistor to left of meter simply protects meter against overvoltage; switch is left open until reading approaches zero, then closed to make instrument more sensitive. When the standard is of lower voltage than the unknown, current flow through meter is from left to right and needle deflects to right. When standard is greater than unknown, current flow reverses and needle goes to left. When standard and unknown are exactly equal, no voltage exists across meter and deflection is zero. Accuracy depends upon precision with which standard can be adjusted.

applicable. The factor which establishes the voltage drops developed is the *ratio* of left-hand to right-hand resistance in each leg; an identical voltage drop means an identical ratio, and since three of the four resistances are known, the fourth can be easily found.

Voltage measurement can be done in a similar manner, and the "slide-back" voltmeter shown in **Fig. 4.** does just this. The voltage to be measured is applied to the circuit, and it deflects the null-indicating meter. An adjustable standard voltage is applied to the other side of the meter to cancel out the effect of the voltage being measured. When the two voltages are equal, the meter indicates no current flow. Such a meter takes no power from the circuit under test—the "no power" indication is used to signal that the adjustable standard is equal to the unknown voltage.

One of the most essential instruments for measurement of modulation quality and performance of linear amplifiers operates in a direct-measurement mode. This is the oscilloscope, which is essentially a gadget designed for the purpose of making direct comparisons between two signals and displaying the resuts upon its CRT screen.

Fig. 5. shows how a scope operates; the electron gun produces a sharply focused beam of electrons which strike the phosphor coating of the screen. Wherever the electron beam hits, the phosphor glows. Two sets of deflection plates control the positioning of the beam. One set, the V plates, move the beam in the vertical direction, up and down. The other set, the H plates, move it horizontally back and forth.

In a general-purpose scope, both the V and H plates are driven by separate amplifiers so that small signals may be built up to the several dozens of volts strength necessary to produce easily-visible deflections. In some types of modulation-monitoring hookups, though, the plates are driven directly by rf signals.

If two different signals are applied to the two different sets of plates, the beam traces a path which is determined by the comparison of the two signals. For instance, one of the main uses of a scope in general service work is to examine a waveform. To do this, a sawtooth signal which increases linearly with time is applied to the horizontal plates. This moves the beam across the CRT at a constant speed from left to right, and causes the beam to fly back to the left when it reaches

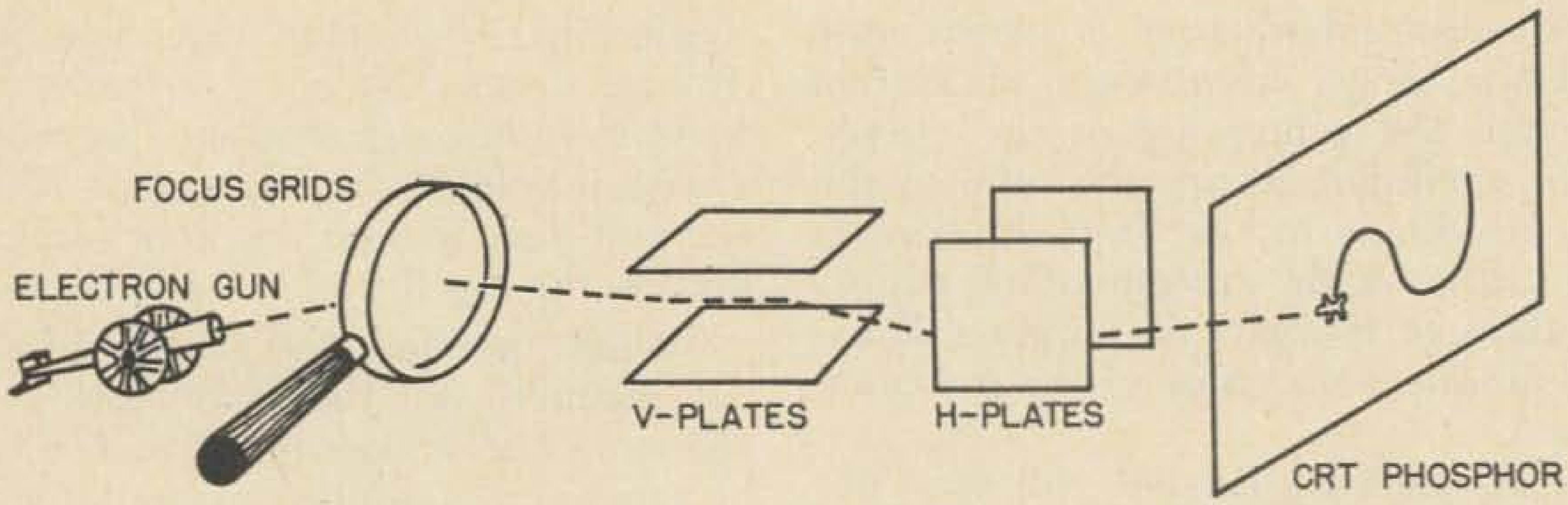


Fig. 5—Oscilloscope uses electrostatic (voltage-operated) deflection of focused electron beam to perform comparison. Beam is moved vertically by voltages on V plates, and horizontally by voltages on H plates. Phosphor makes beam visible when it strikes screen, and path traced by moving beam provides comparison of voltages on the two sets of plates.

the right edge. The signal to be examined is applied to the vertical plates. The beam then moves up and down in response to the signal being examined, and from left to right at a constant speed—and the result is, as shown in **Fig. 6.** a picture of the signal being examined.

If the sawtooth signal's frequency is exactly the same as that of the signal being examined, then one complete cycle of the test signal will occupy the full screen. If the frequency of the sawtooth is cut in half so that the beam moves just half as fast, two cycles of the test signal will be shown. This is illustrated in **Fig. 7.**

Since this is one of the major applications of a scope, almost all general-purpose scopes

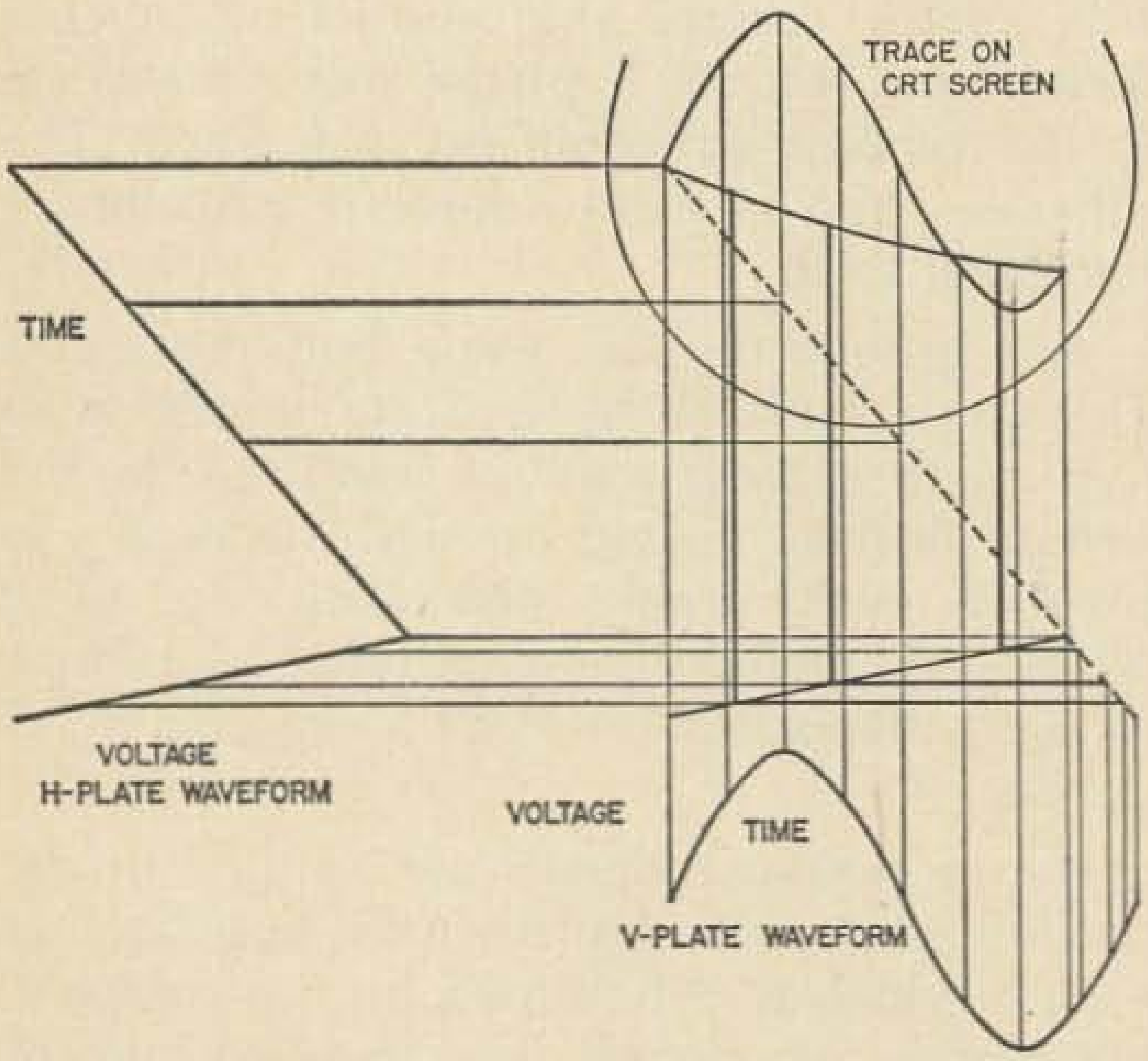


Fig. 6—Application of voltage with sawtooth waveform to H plates makes beam move across from left to right at constant speed (except for 'flyback' time, shown exaggerated here). Sine wave applied to V plates then moves beam up and down, reproducing waveform visibly on screen. H-plate waveform is turned on end in all these illustrations to show how it moves beam.

include a built-in sawtooth generator to provide the "internal sweep" signal for the horizontal plates.

However, there's no requirement that only a sawtooth be used. If you want to compare two frequencies of sine waves, you can apply one to the V plates and the other to the H pair. The resulting display is called a "Lissajous figure" and can be used to measure frequency if one of the two input signals is a standard of known frequency.

Fig. 8. shows how the pattern is developed if both signals are of the same frequency. In this case the pattern may be anything from a straight line to a circle, depending upon the phase relationships between the two signals. If one of the signals is only a fraction of a cycle displaced in frequency from the other, the pattern will undergo a slow rolling, and this can be used to tell how far from the standard the unknown actually is.

If the unknown signal is twice the frequency of the known version, a **Fig. 8.** pattern will appear; this is illustrated in **Fig. 9. Fig. 10** shows the development of the pattern when the unknown signal is at three times the frequency of the standard, while **Fig. 11** shows only the pattern for the 4-to-1 ratio of unknown to standard.

If the unknown is half, one-third, or one-fourth the frequency of the standard, the same patterns will be displayed but they will be turned by 90 degrees.

Because of the way in which the pattern is developed, this technique produces a stationary pattern for *any* frequency ratio x/y if both x and y are whole numbers. That is, a ratio such as 8/9 in which the unknown is at 8/9 the frequency of the standard will produce a stationary pattern. Whenever the pattern is stationary, you can determine what ratio is represented by counting the loops which appear along a vertical edge of the pattern and those which appear along a horizontal edge. The ratio of vertical loop count to horizontal loop count *is* the ratio of the frequencies.

When a scope is used to monitor modulation the technique is similar in many ways to the Lissajous-figure approach, but not identical. The modulated rf signal is applied to the V plates, and the modulating audio is applied to the H plates.

Whenever there is no audio, the carrier is constant. This produces vertical deflection, but without audio there is no horizontal movement of the beam and so the pattern is a vertical line in the center of the screen.

When audio is applied, the rf output swings to a maximum at one peak of the audio cycle, and to a minimum at the other peak. At the maximum peak, the vertical deflection is greater, and at the same time the horizontal deflection is maximum in the corresponding direction. This moves the beam to a corner of the display—and since the rf frequency is so much greater than the audio at this stage, the effect is a taller line at one side of the screen.

At the minimum peak, the horizontal deflection is maximum in the other direction and the vertical deflection is less because there is

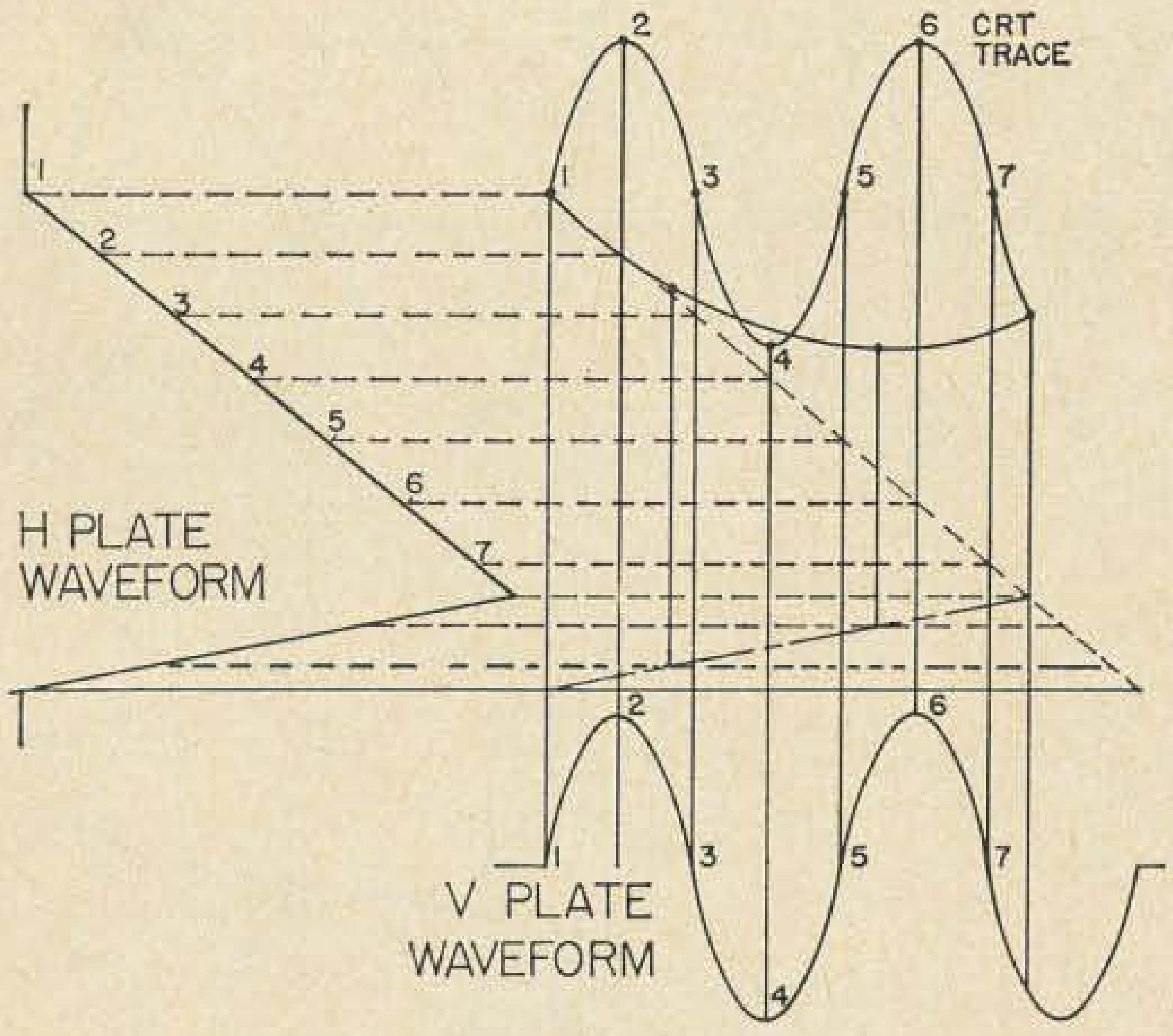


Fig. 7—If H-plate sawtooth frequency is just half that of the V-plate sine-wave, two complete cycles of the sine wave will be traced on screen rather than one. In practice, it's best to adjust H-plate signal frequency to ⅓ that of V-plate signal so as to display 3 complete cycles, since first and last cycles are usually slightly distorted by flyback effects as can be seen here in last part of second cycle. If 3 cycles are displayed, center cycle will be undistorted and complete waveform can be examined.

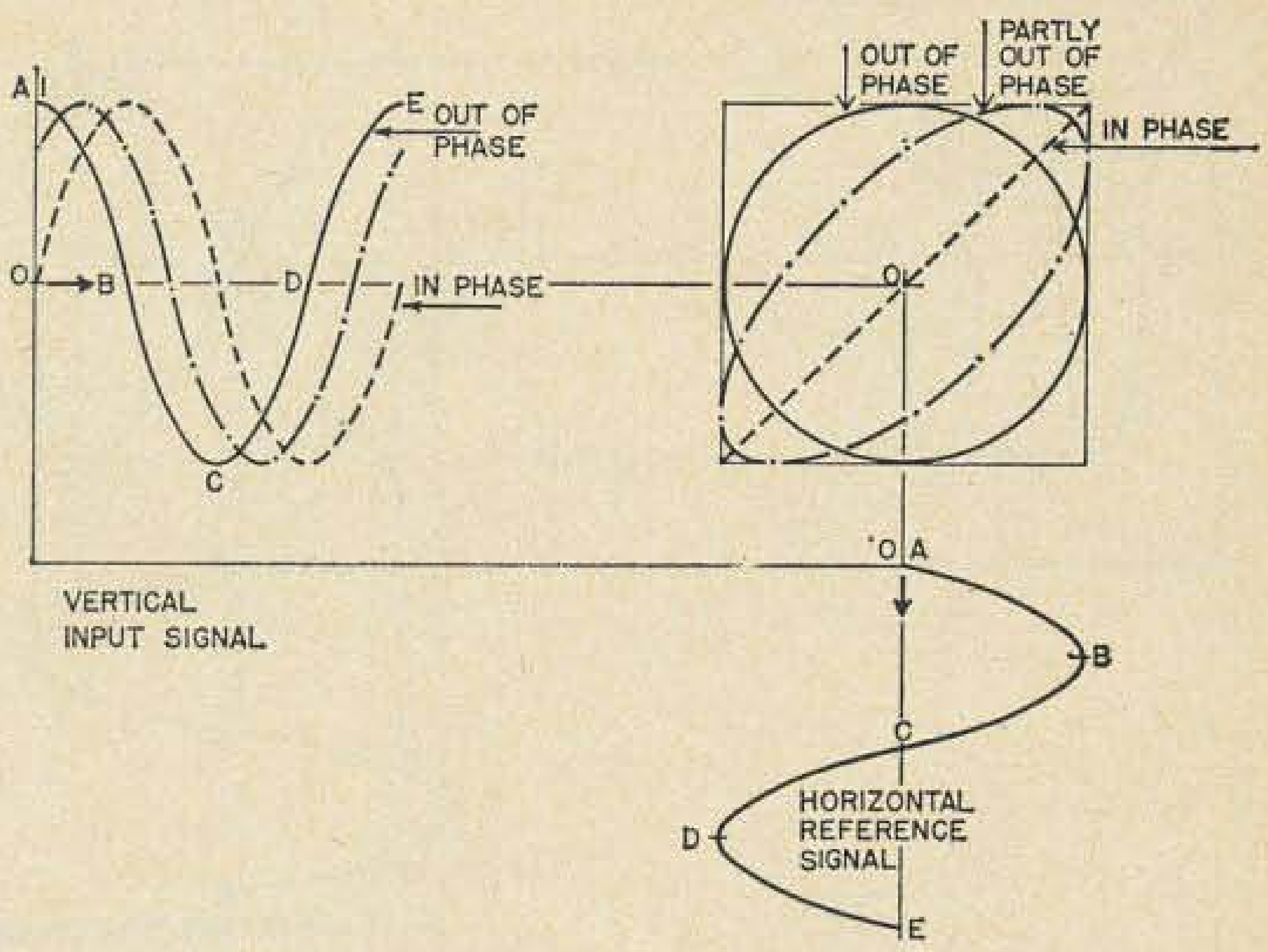


Fig. 8—When sine waves are applied to both V and H plates, patterns called "Lissajous figures" result. If both sine waves are at same frequency as shown here, pattern may be anything from straight line to perfect circle depending upon phase relationships of the two. In-phase signals produce diagonal line (1) *while* 90-*degree phase difference produces circle* (3), *phase differences between* 0 *and* 90 *degrees produce ellipse* (2).

minmum rf. The effect is a shorter line at the other side of the screen.

Since the audio signal is continuous between these two peaks, the beam also occupies all positions between these two extremes, and thus paints a "trapezoid" upon the screen.

If you haxe exactly 100 percent modulation, without distortion, the minimum peak will cut off before the audio signal reaches its a triangle coming down to a perfect point at the minimum-peak position.

If you have overmodulation, the rf output will cut off before the audio signal reaches its negative peak; the display then will be just like the 100-percent picture except that the left-over audio will produce a line sticking out from the point.

If modulation is less than 100 percent, the tip of the triangle will never be reached.

Fig. 12 shows how these patterns are produced, and **Fig. 13** illustrates the patterns developed by 25%, 50%, 75%, 100%, and more-than-100% modulation.

Note that all these patterns assume that the modulator is operating without distortion, so that the modulated signal is a faithful reproduction of the original audio. If distortion is present, the sides of the triangle won't be straight; instead, they will be curved. What this display actually amounts to is a picture of your modulator at work—and that's why it's so helpful.

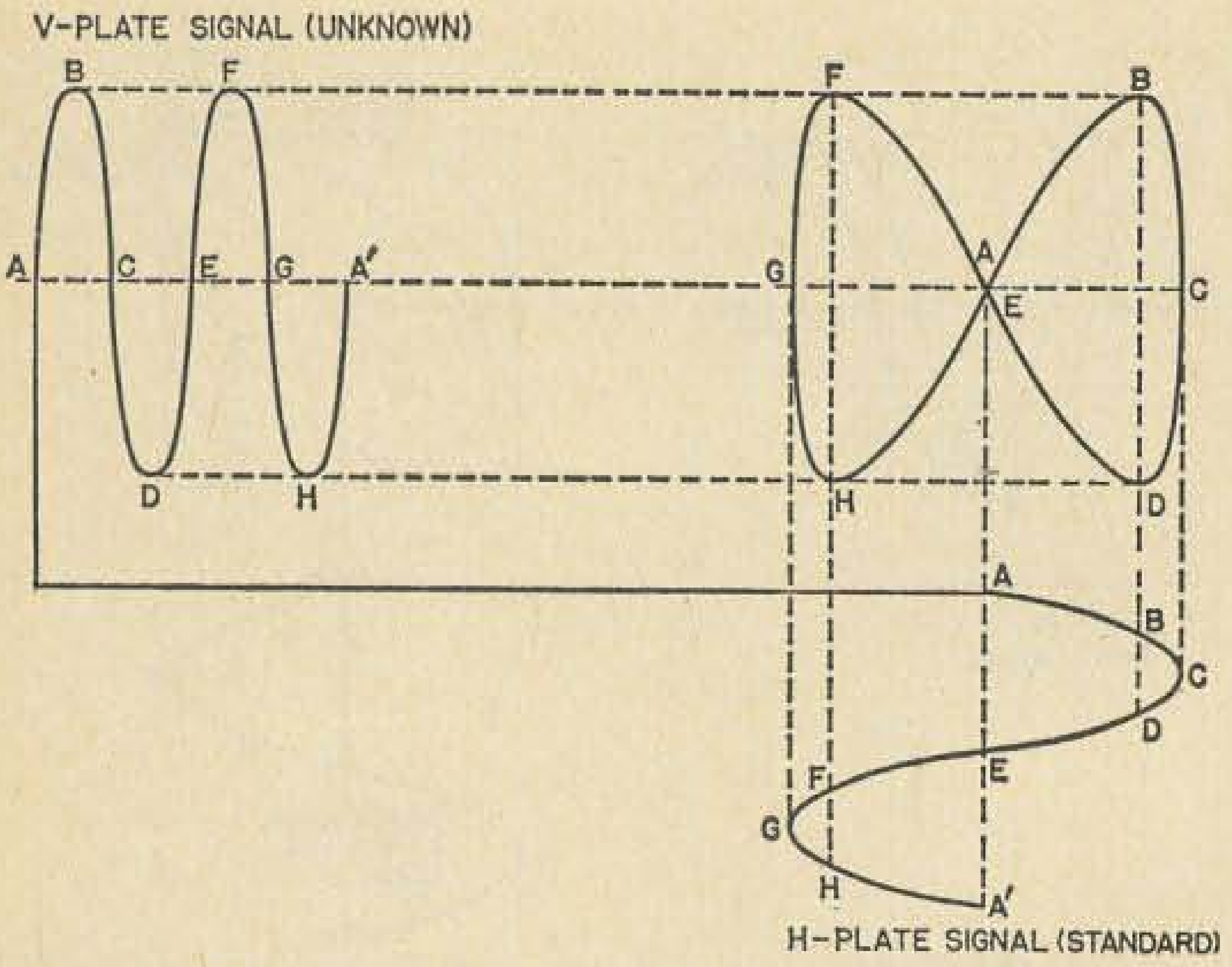


Fig. 9—When sine-wave signal of twice frequency of H-plate signal is applied to V-plates, figure-8 pattern is traced as shown here. Phase differences will rotate pattern; as pattern is moved, it gives illusion of being a cylinder with the pattern traced on the surface of the cylinder. Pattern for 2-1 ratio may resemble a U, if phasing is such that points D and H coincide on trace while A and C match. This happens when H-plate signal is 90 degrees out of phase with signal shown here.

The "bowtie" or two-tone-test measurement of SSB linear amplifier adjustment amounts to exactly the same thing as the trapezoid test for AM modulation. The only difference is that you get two patterns tip-to-tip on the bow-tie test; it's interpreted in just the same way.

The oscilloscope can also be used as a voltmeter, and is one of the best such instruments available for measuring ac since the comparison is direct and visual. The technique for using the scope as a voltmeter is simply to determine how much deflection is produced by a "standard" voltage, and then compare this to the deflection produced by an unknown voltage. The comparison can be made by measuring the length of the line produced by the deflection. A voltage which produces a line twice as long as the standard is a voltage twice as great as the standard. If the line is 74/100 as long, the voltage is 74/100 of standard. By proper choice of standard and line length, you can get greater accuracy by this method than by any moving-coil meter movement. Thus the scope can be used as either a direct or an indirect measuring instrument.

Most measuring instruments, though, are limited to one or the other of the modes. How can you tell which is which?

Any measuring instrument which includes the word "bridge" in its name is likely to be a direct-measurement device, while those which include the word "meter" in their names are more likely to be indirect devices.

A notable exception to this general rule is the "SWR Bridge; the instrument which originally bore this name actually was a bridge, and thus a direct-measurement instrument, but the original circuitry has long since been replaced in popularity by a directional-coupler- based hookup which is more accurately termed an SWR meter. The measurement is indirect.

How Accurate Can Measurements Be? The two points we've established so far about this business of measurement are (1) that any measurement is a comparison of an unknown quantity against a known standard, and (2) that most measurements we make are made indirectly rather than directly.

The next natural question is, "How accurate can a measurement be?"

It may not appear obvious that *no* measurement can be perfectly accurate, and that *all* measurements must include at least some margin for error—but it's true.

For a measurement to be *perfectly* accurate, the quantity being measured would have to be identical to the standard in every possible respect. If we were measuring

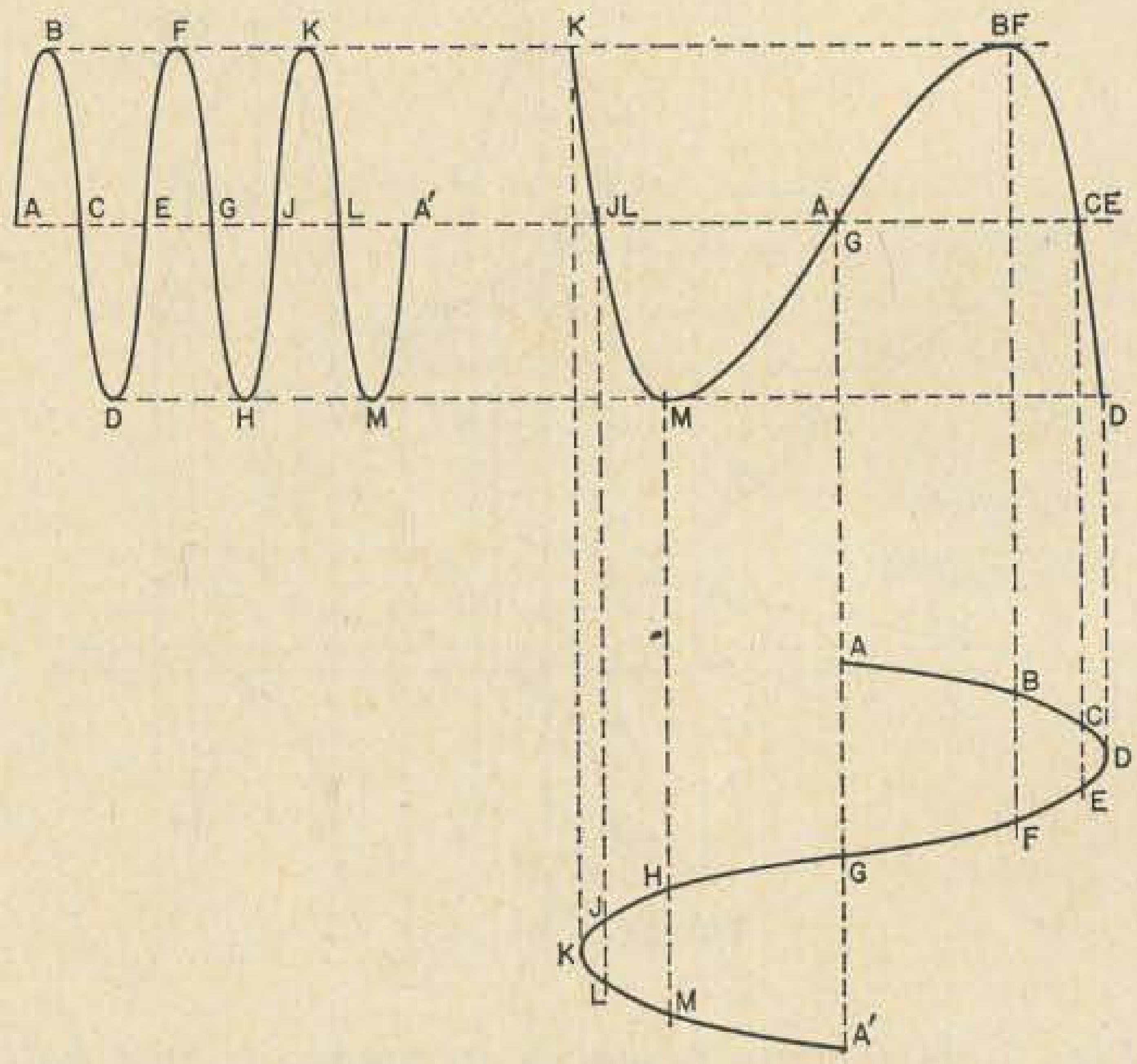


Fig. 10—At 3-1 ratio pattern is developed in this manner. Again, many patterns are possible at this ratio due to possible phase relationships; if either signal is offset in time from that shown here pattern will change as discussed in caption of Fig. 9. If pattern is made to rotate by slight adjustment of frequency to produce tiny difference from 3-1 ratio, number of cycles can be counted to determine which standard pattern is being displayed.

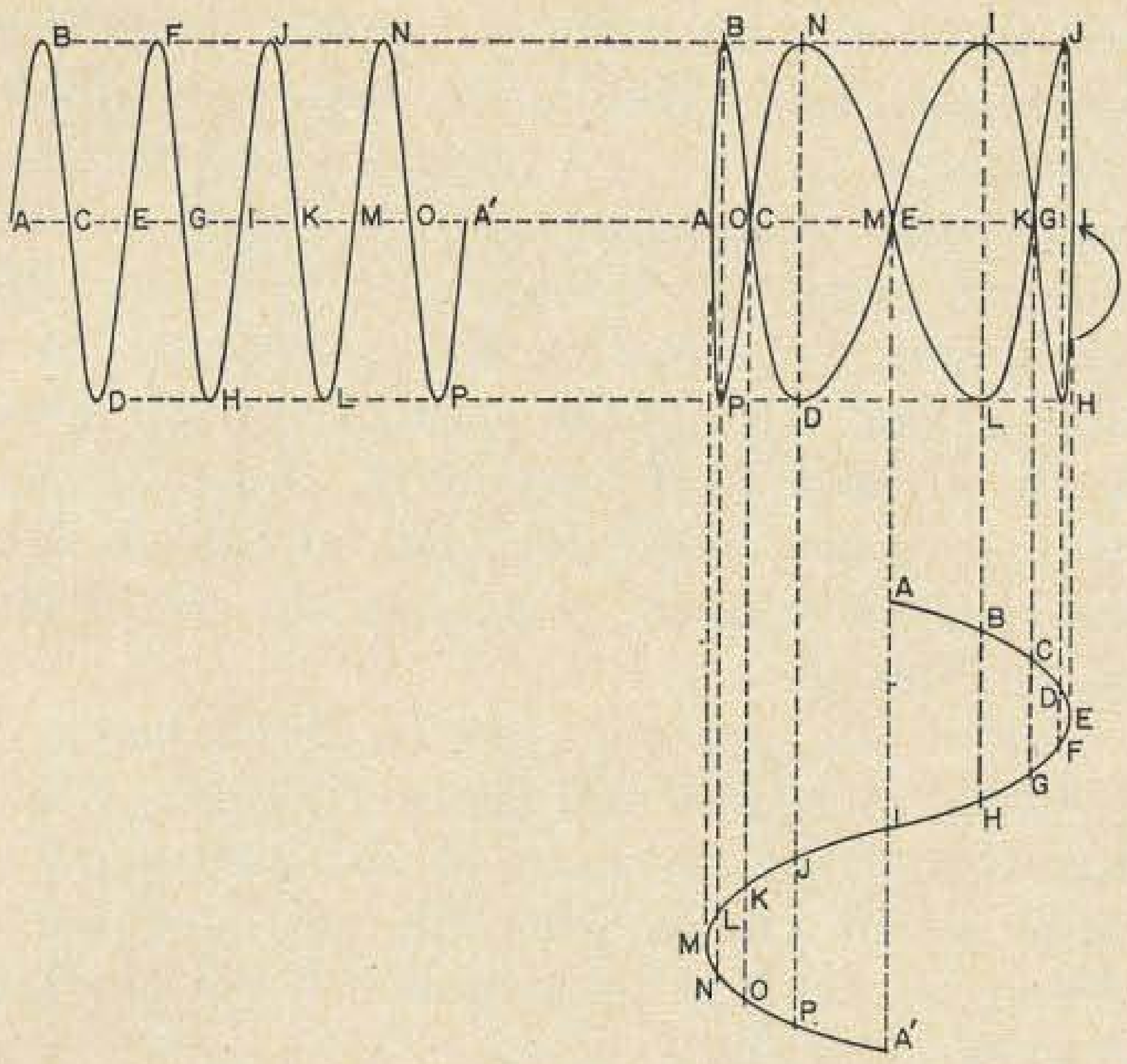


Fig. 11—This is one of the many possible 4-1 Lissajous figures. Any offset of either signal from time relationship shown here will change the pattern, but in all cases it will be stationary and will have four points at the top edge and four at the bottom, as does this one. Frequency ratio of vertical signal to horizon signal is same as ratio of number of top-or-bottom points to number of "side" points; all patterns shown here have only one "side" point.

weight, for instance, not only would the two have to match perfectly in the number of pounds and ounces represented, but *also* in the number of atoms represented, and even in the number of neutrons in the nucleus of each atom on either side of the comparison. What's more, if so much as a single cosmic ray were to hit one of the two items in comparison and not the other, then at least some part of the mass of the one hit would be changed to energy and the exact match would no longer be exact.

When you consider the number of elementary atomic particles involved in even the smallest practical standard of weight, and then hang on the requirement for exact matching of each and every one of these, you may not be outside the realms of theoretical "possibility"—but the probability of ever achieving such a match is vanishingly small. It's much more likely, for instance, that a monkey typing at random would produce the complete works of Shakespeare—and *that* is an event which has been calculated as likely to happen not more often than once in ten times the total history of the universe to date!

To continue this line of "unreason" a bit longer, just consider the practical question: How would you know you had such a match if you achieved it?

All the objections we've raised here to bring out the impossibility of a "perfect" or "zero-error" measurement of weight apply equally to any other measurement by comparison. The main point is that "zero" error means just that—no error at all—and an error by as little as one-fiftieth the diameter of a single electron is *still* an error.

While "perfect" measurements are not possible, it's not only possible but relatively easy to make "practical" measurements to any degree of accuracy you're willing to afford.

Our ordinary milliammeters and voltmeters, such as we use in most of our ham-radio measurements, are usually rated at "5 percent of full scale" accuracy. Many are rated at "2%" instead of "5".

If we want more accurate measurements than this though we can go to lab-quality instruments guaranteed to be within ½ of 1% of full scale.

And if that's not enough and we have several thousand dollars to lay on the line, we can use 5-place digital voltmeters and read voltages to a guaranteed accuracy of five significant figures. In terms of length, that's more accurate than one inch in one mile.

The major problem with the use of high-accuracy instruments such as these, incidentally, is being sure that their original calibration is accurate. After all, no measurement can be more accurate than the standard against which it is compared. To use five-

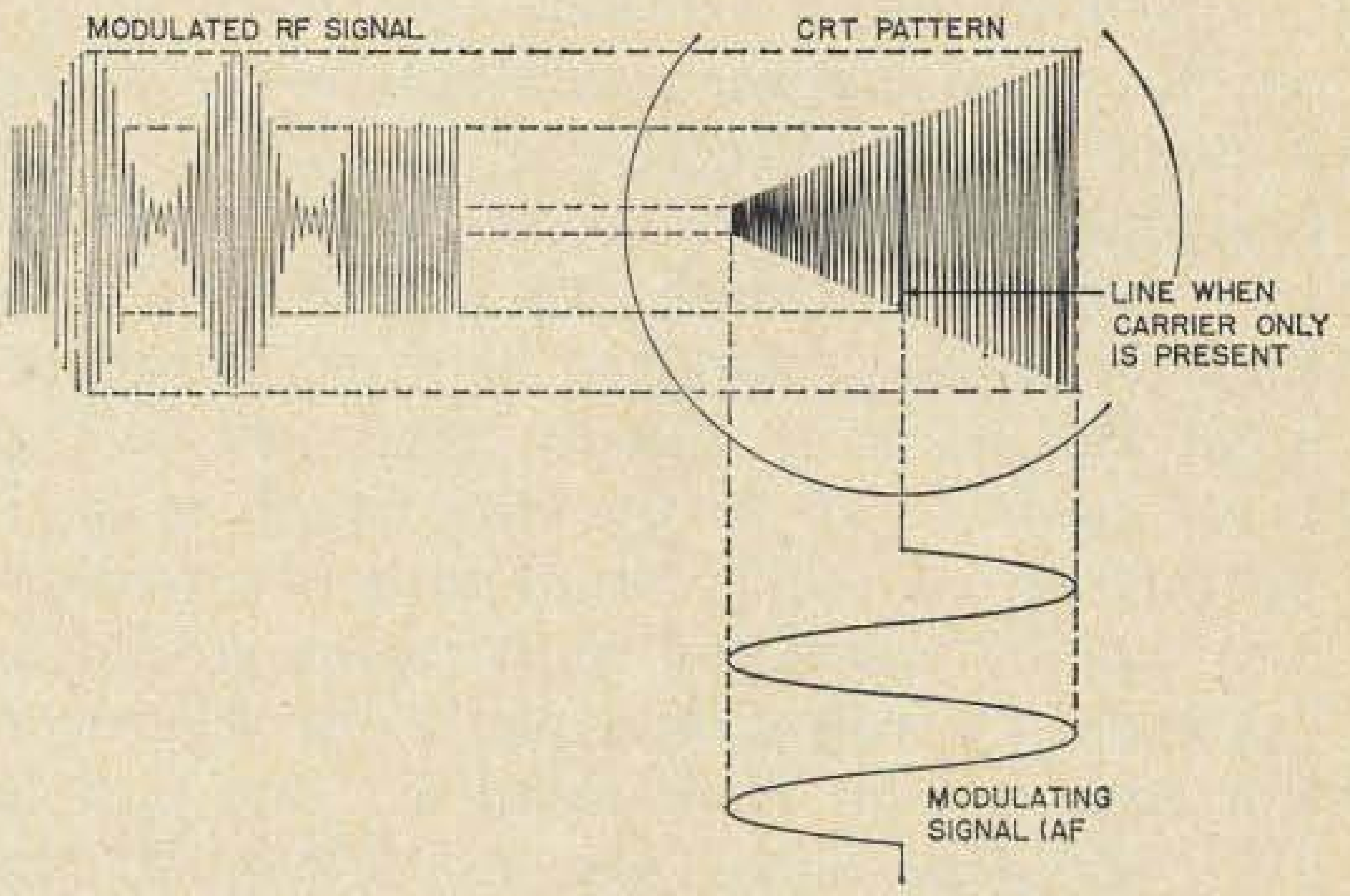


Fig. 12—Modulation-monitor pattern for checking quality of AM signal is developed in manner very similar to Lisajous figures as shown here. Pattern shown represents about 98% modulation (100% was not used in order to show how the negative-peak trace is developed). Audio signal should be taken from the modulator output, and RF signal sampled from the antenna feedline or antenna tuner, to get proper phase relationship and produce straight-sided patterns.

place accuracy, you must have a standard which is *more* accurate than five places.

While we're talking about accuracy of voltmeters and the like, it's a good time to establish just what that "5% of full scale" rating really means. Most of us tend to unconsciously assume that it means 5% of the indicated reading. If we read "100 volts" from the scale, we assume that the actual voltage is somewhere between 95 and 105 volts.

Actually, the 5% is "of full scale," and translates to an absolute error. On a 300-volt scale, the possible error would be 0.05 x 300, or 15 volts either way. On a 150-volt scale, it would be just half as much. On a 1000-volt scale, however, it would be 50 volts either way.

If we're using a general-purpose multimeter to make this measurement, most likely we are able to choose any of these ranges by simply switching to a new range. In this case, the *same* meter will have an absolute error of from 7.5 to 50 volts, depending upon the range which we select.

This is the reason for the general rule in making measurements: always make the measurement using a scale which brings the measurement as near to full-scale as possible without going off-scale with the reading. The purpose of the rule is to minimize error.

Voltages and currents are not the only things which we measure, however. Frequency is another item which we must, by law, measure rather accurately.

When we use a 100-kHz frequency standard to make our measurement, we're doing it more or less directly. If we use a beat-frequency frequency meter, we're indirect. In either case, though, we will always have some error. In a standard or direct measurement this error is usually discussed as "so many parts in 10 to the–th" which is engineeringese for mighty small parts of a percent and can be translated most meaningfully as "so many cycles per megahertz" or whatever. For instance, an error rated as "one part in 10^9" would be one Hz in 1,000,000,000 Hz, or one Hz in 1,000 megahertz. The standard frequency station WWV (about which we'll say more later) maintains considerably greater accuracy (less error) than this.

When our measurement is indirect, it's more usually specified as to error by a percentage rating such as 0.01 percent. This, too, can be converted rather readily to "x" Hz per megahertz or some similar approach. For instance, the military surplus BC-229 or LM heterodyne frequency meter is usually considered to have an accuracy of 0.01 percent when calibrated and operated in the manner originally intended. If you use this instrument to measure the frequency of a signal near the bottom end of the 20-meter band, around 14.0 megahertz, the 0.01 percent accuracy won't let you be certain that the reading you get is exactly the frequency of the signal.

But 0.01 percent of 10 megahertz is 1/10000 of 10,000,000 Hz or 1000 Hz, which means that the accuracy of our instrument is 1000 at 10 Hz or 100 Hz per megahertz. When we use it at 14 megahertz, our possible error is 1400 Hz.

The practical meaning of this uncertainty in our measurement is that we should assume that the band limit (in this case) is 1400 Hz *higher* than it really is at the low end, and 1450 Hz *lower* at the high end. Then if we measure a signal as being at our pseudolimit of 14.0014 MHz, it *must* be inside the band—because our maximum error would put it only at the actual bottom edge, not outside!

With the same instrument but in the 28-MHz band, we could measure band limits only to within 2800 Hz at the low end and 2970 Hz at the high end.

The important thing here is to remember that absolute accuracy in Hertz becomes less as the operating frequency goes up, since the percentage of error remains constant.

Can Measurement Affect Itself? Closely allied to the question of accuracy and error is the question whether the mere act of making a measurement can have an effect upon the measurement made.

Let's look first at the everyday variety of voltmeter. We've already discovered that it actually measures length instead of volts, and the length is related to the voltage by way of *power* which moves the needle across the scale.

Where does this power come from?

In the ordinary voltmeter, which has no internal power source of its own, there's only one possible place—from the circuit being measured!

But if we're drawing power from the circuit while we make the measurement, and not doing so when the meter is removed, then the mere act of hooking up the meter must involve a change in the circuit—and there's a

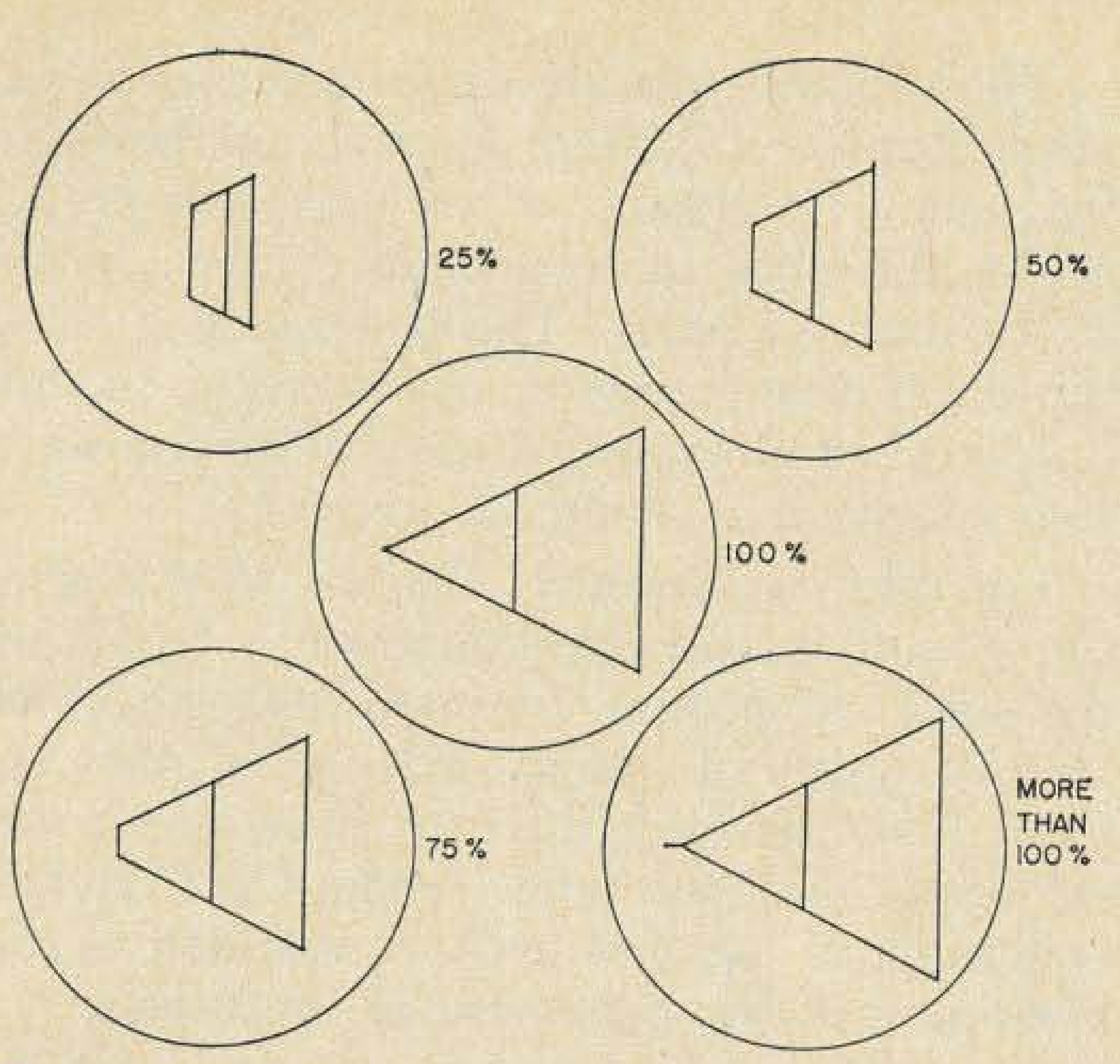


Fig. 13 Modulation percentage can be measured by these patterns, but it's easier to estimate it using these five examples. Overmodulation causes a 'tail' at point of pattern as shown; undermodulation prevents point from being developed. Controlled-carrier transmission will prevent line in center from being developed; it's the carrier-only line traced whenever modulation is absent from signal.

chance that conditions while we measure are *not* the same as those when our meter is taken away.

If you want to see how much change this may be, try measuring the AVC voltage of a receiver, using a 1000-ohm-per-volt voltmeter. No matter how strong the signal coming in, you will be hard-pressed to find more than a very small fraction of a volt in most such circuits.

The reason is that the 1000-ohm-per-volt meter has a total resistance of only 100,000 ohms if set to a 100-volt scale—but the series resistor in most AVC circuits is on the order of 5 megohms. The 100-volt meter acts as a 100 K resistor to form a voltage divider and reduce AVC voltage to 1/50 its normal value—or about ½ volt in most cases.

Using a 20,000-ohm-per-volt meter instead will help matters somewhat, but the effect is still rather large. Total resistance of this meter on a 100-volt scale would be 2 megohms, which is series with a 5-megohm resistor would reduce the voltage to 2/7 its normal value. This is still less than half the voltage present when the meter is removed.

Vacuum-tube voltmeters normally have extremely high input impedance, at least 11 megohms, regardless of the scale to which they are set. Using one of these on the same example AVC line, the voltage-divider effect would be only 11/11+5 or 11/16—but even with this meter the AVC voltage would be some 31% less with the meter hooked up than when the meter is absent.

Apparently, then, connection of any measuring instrument to a circuit will upset that circuit to some degree. This would mean, if taken to extremes, that even if *perfect* instruments were available and even if that impossible *perfect* measurement could be made, we would *still* have inaccuracy whenever we attempted to make an in-circuit measurement due to the effects of the instruments upon the circuit.

That's true. It's one of the basic principles of physics, known as the 'uncertainty' principle. No measurement can be exact, because the act of measurement in itself disturbs the quantity being measured and thus introduces error.

It works both ways, too. While the instruments upset the circuit, the circuit also can affect the instruments. A standard voltage source may be extremely accurate so long as no current is taken from it—but any load may ruin its accuracy.

The effect is particularly noticeable when making measurements of frequency. A frequency meter is not likely to have much influence upon the crystal or VFO in a good transmitter—but the transmitter's output signal may easily "pull" the frequency meter by a few cycles, and thus destroy accuracy.

If the instrument and the circuit are not connected to each other in any way, then neither can affect the other—but neither are you able to perform any measurements. If they are connected too well, each will affect the other in so great a manner that any measurements you make are inaccurate.

The answer to this seeming paradox is to connect them, in order to make measurements, but no more closely than is necessary to permit the measurement to be made. A frequency meter is normally coupled to the circuit under test only by incidental radiation in the room—this is enough, and any wire connection would be too much. Voltmeters, on the other hand, require wire connections.

When close connections must be made, as with voltmeters, the loading effects can be minimized by making the meter's internal resistance as high as possible so that it looks as much as possible like an open circuit to the device being measured. VTVMs, for example, are designed specifically to provide extra-high resistance—and as we have seen even this is not always good enough.

But high internal resistance is not always a good idea for meters. Current meters should have as little resistance as possible, for example, since they should look as much as possible like a straight piece of wire to the external circuit.

What Are Measurement Standards? Throughout this discussion we've been talking about "standard" quantities and units, but we haven't yet seen where the "standard" comes from.

Actually, for any one type of measurement such as length, voltage, resistance, etc., the "standard" is entirely arbitrary. The important thing about any *one* standard is simply that everyone who uses it must agree that it *is* the standard, so that measurements made by one individual can be meaningful to anyone else. An example of the confusion which can arise when this factor is ignored is the "gallon"; in the United States, a gallon is four quarts, which is equal to 231 cubic inches of water. In Great Britain, however, a "gallon" is not the same. There, the "Imperial gallon" is the standard, and it is equal to 1.2009 U.S. gallons!

Another example of similar confusion is the "mile" which we use on land, and the "nautical mile" used at sea. The "pound" in Russia is only 0.90282 of our "pound"—and the "Troy pound" used by silversmiths contain only 12 ounces.

Many similar examples can be found in any good encyclopedia. A standard is "standard" only to those who accept it.

In radio and electronics, fortunately, the standard units are almost universally accepted by everyone. We work with quantities which are very closely related to the basic standards of nature, and when we agree upon standards for measuring those basics—time, and electric charge—the rest of our standards are completely fixed by the interdependence of all our quantities.

For instance, if the "volt" and the "ohm" are defined, then the "ampere" is also defined by Ohm's Law and no additional standard for it is necessary.

The most basic of all our standards is that of time. In this country, the time standard is maintained by the National Bureau of Standards and is made available to all through the broadcasts of station WWV.

These broadcasts are on frequencies at exact multiples of 5 MHz throughout the high-frequency spectrum, as well as one at 2.5 MHz; the ones most generally used are on 5, 10, and 15 MHz. The frequency itself *is* the basic time standard; by counting 10 million individual cycles of the 10-Mc transmission you have a "standard" second.

For user convenience, though, WWV does the counting and superimposes a "tick" on the signal at precise 1-second intervals. This "tick" consists of exactly 5 Hz of a 1000 Hz tone (also derived directly from the main standard), and the time standard is from the beginning of the first cycle of one tick to the beginning of the first cycle of the next.

For our purposes this is accurate enough, but for many more scientific uses the error introduced into the standard by the radio transmission path from WWV's transmitters at Boulder, Colo., to the receiving station is excessive. For these users, low-frequency transmissions at 60 kHz are made; at this very low frequency, transmission-path errors are minimized and frequency accuracy of one part in 1,000,000,000,000 are possible. This amount of error is approximately the amount represented by the thickness of a cigarette paper compared to the distance from earth to the moon. That's very close—but it's *not* exact!

Since frequency of a signal is simply the count of the number of cycles within a stated period of time, the standard for time is simultaneously the standard for frequency. Thus WWV provides a frequency standard against which we can all compare any signal we desire.

Other time standards are maintained by the Dominion Observatory at Ottawa Canada, through station CHU at 3.330, 7.335, and 14.670 MHz; by station MSF at Rugby, England, operating on 2.5, 5, and 10 MHz; by ZUO at Olifantsfontein, South Africa, 5 MHz; by JJV, Tokyo, Japan, 2.5, 5, 10, and 15 MHz, and a number of other governments. In addition to WWV, the NBS operates WWVH in Honolulu (which is slaved to WWV in such a manner that it's possible for you to receive both at the same time without interference).

In this country, our standards of voltage and resistance are also maintained by the NBS. Only one "primary" standard of each exists. From these, "secondary" standards are developed and all actual use involves the

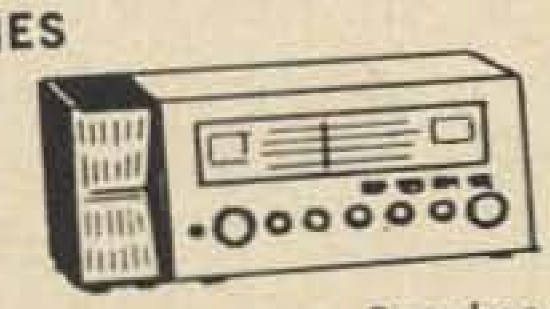
No, we're not lazy! It's just that "Popular Electronics" (Dec. 1967) tells the DX-150 story so well.

Reprinted Without Editing

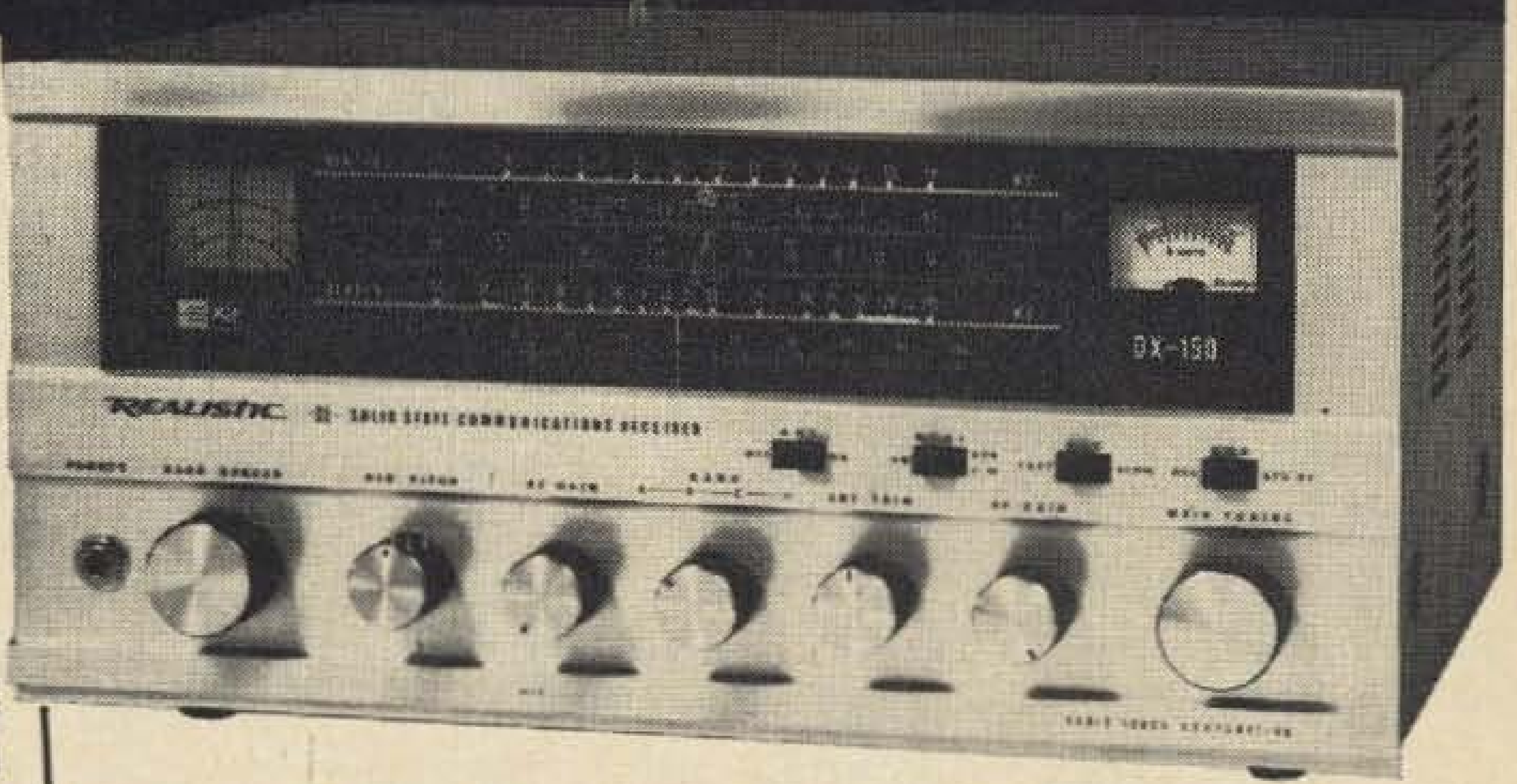
"What may be the first really noteworthy advancement in communications receivers is wrapped up in the new Radio Shack imported DX-150. Featuring continuous coverage from the top of the AM broadcast band (535 kHz) to the bottom of the 10-meter band (30 MHz), the DX-150 is a single-conversion superhet with a tuned r.f. stage, two i.f. stages, full-wave product detector for SSB/CW reception — and it's 100% solid state. Selling at $119.95, the DX-150 has the flexibility of a communications receiver that a ham or SWL is used to buying for $175-plus. To rattle off a few more "features": there is a front panel antenna trimmer, fast or slow a.v.c. attack, a cleverly concealed built-in monitor speaker, plenty of calibrated bandspread, and noise limiting in both the i.f. and audio stages. Because of the solid state circuitry, the usual warm-up drift expected with a tube-type receiver is virtually absent here. And, although the DX-150 is primarily a base station receiver with a 117-volt a.c. power connection, it can be operated from an outboard d.c. power supply consisting of only 8 D-cells. Radio Shack claims that the receiver will operate for 100 hours — continuously — using only the d.c. supply. Ideal for Field Day and emergency work! The proof of the pudding so far as any communications receiver is concerned is how well it works "on the air". At POPULAR ELECTRONICS, the DX-150 was hooked up to a 125-foot long-wire antenna and tuned across the AM broadcast band. Needless to say, the S-meter was pinned on just about every single channel, and the audio quality with Radio Shack's voice-selective speaker (extra, $7.95) was crystal-clear. Tuning the band between 1.55 and 4.5 MHz, your reviewer got a chance to appreciate the comfortable handling on SSB reception. Going a little higher (4.5-13.0 MHz), the 25- and 31-meter bands were "alive" and signals appeared to leap out of the air — possibly due to the very quiet background of the DX-150. While quietness is usually regarded as a lack of sensitivity, that wasn't the case with the DX-150. On the top band (13-30 MHz), the sensitivity still seemed high; and on the CB frequencies, the DX-150 could hold its own against a dual-conversion receiver built just for CB work. **Summary:** Radio Shack has the Model DX-150 in most of its 160 retail outlets. Take a look at it, and get the "feel" of this unusual receiver."

CUSTOM ACCESSORIES

12 VDC Power Set



Matching Speaker



And only Radio Shack has this 119.95 receiver!

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secondary (or even more remote copies) versions.

The NBS primary standards agree with the definitions adopted by the International Committee on Weights and Measures. These definitions establish the "ampere" as an electric current which would produce between two conductors of infinite length and negligible cross-section separated by one meter distance in a vacuum, a force of 0.0000002 newton per meter. The "volt" is then defined as the potential which causes a dissipation of one watt when a current of one ampere flows, and the "ohm" as the resistance which permits one ampere to flow when one volt potential appears across it. The coulomb (unit of electrical charge) is similarly defined as the amount of charge transported in one second by a current of one ampere, while the farad and the henry are also defined in terms of coulombs, volts, and amperes.

These "standard" definitions may sound as if they go in a circle—to measure any one of them you must already know all the others. In practice, that's just about the case.

It *is* possible to measure the forces involved in the definition of an ampere and so determine a standard ampere directly—but since the ampere exists only while current is flowing, the standard ampere cannot be preserved to use as a comparison standard!

The procedure actually followed to establish a primary standard, as a result, is to build coils in such a manner that their inductance can be calculated very accurately and then to use these coils together with a standard one-ampere current to measure out standard resistances. The resistance standard, together with the current-measuring devices, permits establishment of a voltage standard.

The primary standard which result provide permanent references for measurement of both voltage and resistance; the current standard—which is the only one which can be established directly in the first place—is then derived from the voltage and resistance standards whenever it is needed.

If you want some exact figures for standards, the coulomb (which is the unit of electrical charge) is supposed to be the charge of 6,280,000,000,000,000,000 electrons, give or take a few million billion. The ampere is derived from this as the number of coulombs which pass a given point in one second. The ohm is defined by some as the resistance of a column of mercury at 0° C, having a length of 106.300 cm, a mass of 14.4521 grams, and constant cross-sectional area; the volt is then defined as the potential which permits one ampere to pass through one ohm.

For everyday purposes these official standards don't give us much help. Simply determining the basic standards accurately enough for any use is a most delicate and costly operation. Fortunately, there are many "standards" readily available which are accurate enough for almost all our uses.

For instance, you can buy resistors which are guaranteed to be 1% accurate for less than a dollar. If you need accuracy of 0.01% you can get this too, but it will cost a little more. For most ham applications, since our meters themselves are only 2% accurate at best, the 1% standards are plenty good.

A mercury cell is a pretty good voltage standard, since it produces 1.34 volts for essentially its entire life. In a pinch you can even get by with a *fresh* size D flashlight cell, which should produce 1.561 volts, but the voltage of these carbon-zinc dry cells varies with age and so they are not so trustworthy.

A zener diode offers another standard-voltage reference. While most such diodes are rated to only 5% accuracy, any one diode will have a constant voltage drop throughout its life if it is not abused, and so it can be used as a secondary standard once you have calibrated it against some more accurate primary standard.

The best frequency standard is a quartz-crystal oscillator which has been calibrated against the transmissions of WWV. However, commercial AM broadcast stations are required by law to remain within a 20 Hz of their assigned frequency, and you can use a VFO which has been zero-beat against a broadcast station to provide a reasonably accurate standard in an emergency.

The one item you should *not* use as a standard is a meter, no matter how costly or how accurate its rating. Meters are sufficiently delicate that any small shock can throw them off; their accuracy should never be trusted except immediately after they have been compared to some known standard. This process is called "calibration" and should be carried out at regular intervals for all meters, although almost none of us do so.

Next month. As our series draws toward its close, we'll move closer to the state of today's art and take a look at semiconductors. ■

More on Receiver Blocking

Strong-Signal Receiver Modifications

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La Canada, Calif. 91011

The problem of the blocking of a receiver *if* by a strong, nearby signal, has been discussed.[1,2] Further experience indicates that a more-standard approach that applies equally well to transceivers, has some advantages.

In several types of equipment, there has been a spurious oscillation when a separate exciter uses the heterodyne crystal oscillator of the receiver, as must be done in the transceive mode. This oscillation may not be identifiable by others because it usually is not modulated. The only identification seems to be the coincidence of VOX action, which can be matched between the spurious and the true signal using two receivers. In one case, the oscillation was strong enough to prevent normal modulation.

With Collins S-Line in OPR (unmuted receiver) condition, the 6146 and linear amplifier plate current were noted to be above the normal static levels. Subsequent investigation disclosed an 8-tube oscillation, as follows:

The antenna relay K2 in "transmit" feeds a small amount of power to the receiver contact leaf. This is fed through the coaxial cable to the receiver antenna input. Then it goes through the rf stage, and to the first mixer. The cathode of the latter leads to T2, one side of which is tuned by the preselector knob. T2 also passes from the receiver through a coaxial cable, in transceive patching, to the "RCVR xtal osc input" of the exciter. This leads to the second mixer tube, the 6AH6, the 6CL6, and a pair of 8146's to the antenna relay, K2, completing the circuit.

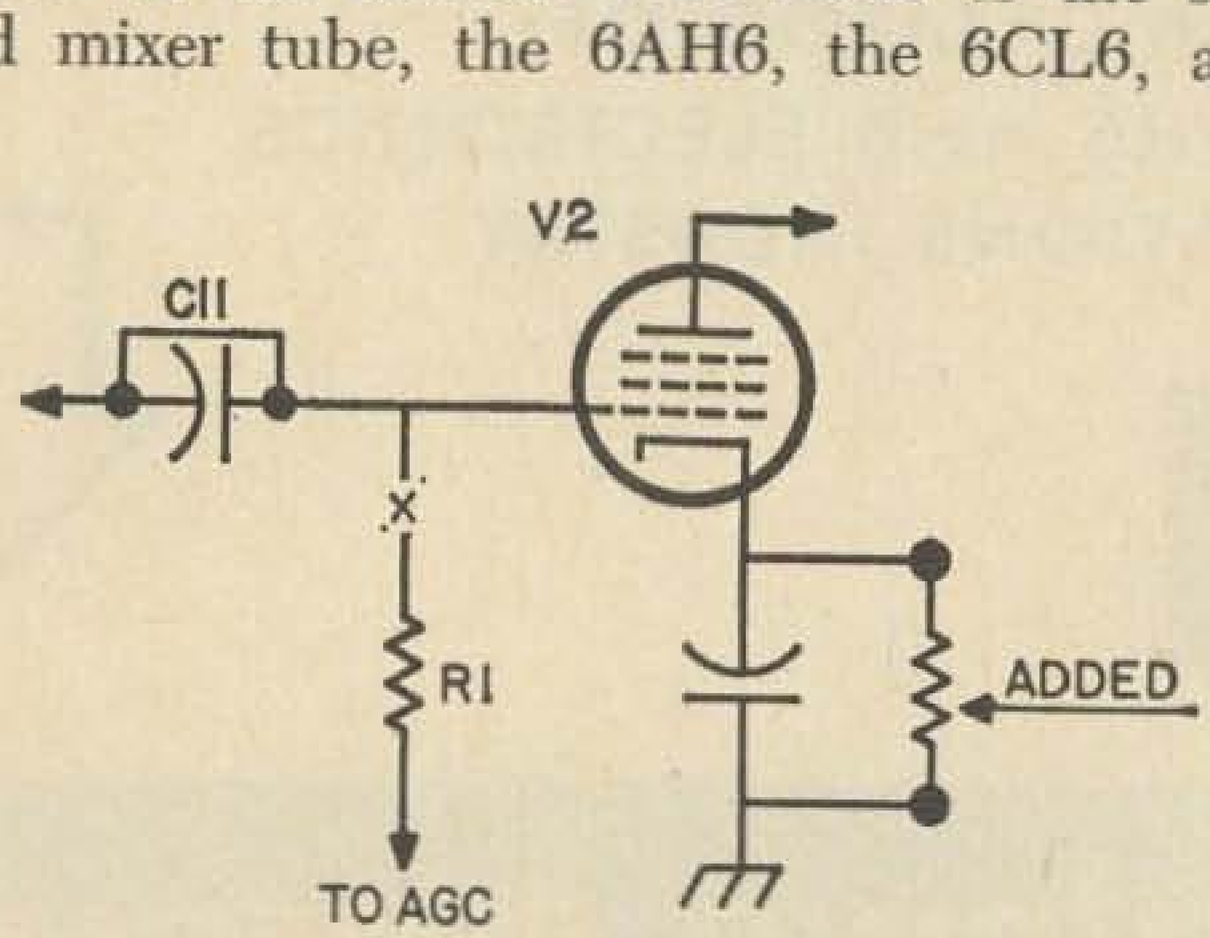

Fig. 1. Removal of AGC connection to prevent blocking of receiver.

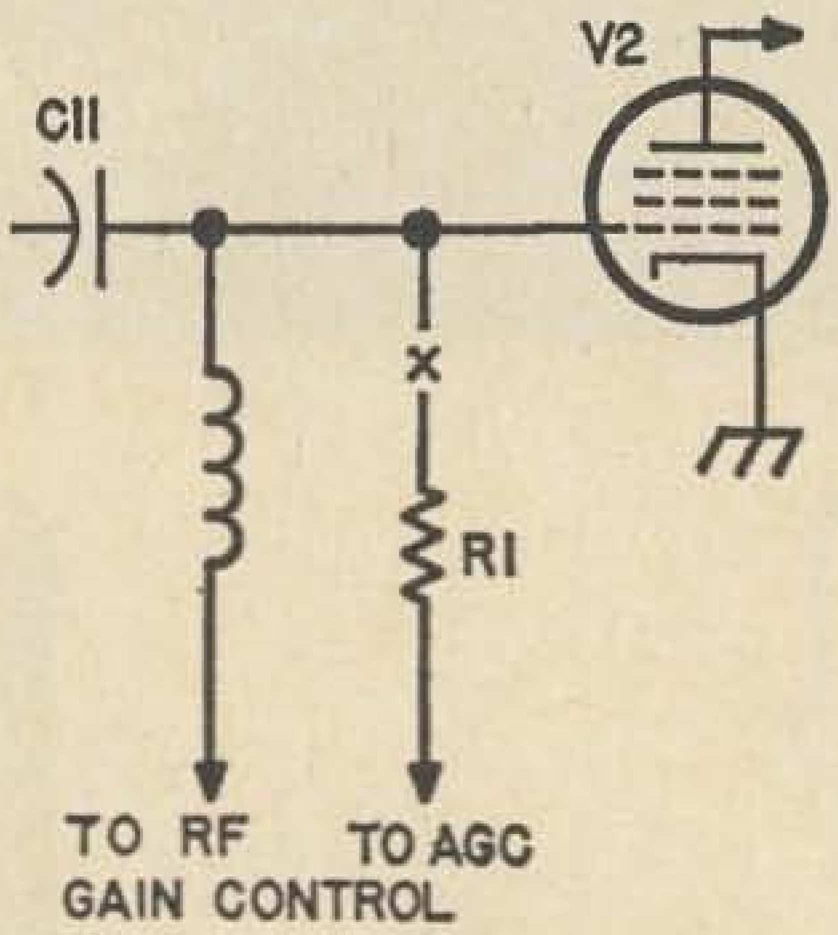

Fig. 2. AGC resistor detached from the grid and rf choke connected.

In my equipment, the oscillation has been found only on the 21 and 28 MHz bands, when using a short 16-inch *rf* patchcord. This short cord is necessary to prevent the exciter from sucking out heterodyne crystal oscillator power, and making the receiver insensitive. The longer cable allows the oscillation only on one band.

If the receiving antenna lead is removed, or the rf tube pulled, or any other break made in this long circuit, the oscillation stops. In fact, the lower tube voltages used on CW also sometime confine the problem to the SSB mode.

Normally, the S-Line does not have this trouble when the receiver is muted in the STBY (muted) switch position. However, in order to prevent blocking of the agc by local stations, the shortening of the rf tube's grid capacitor, provision of cathode bias, and removal of the agc connection as shown in **Fig. 1**, meant that one less tube is muted. This allows a small amount of oscillation to continue in STBY position.

A good way to stop this was found to be possible, as shown in **Fig. 2**. The grid condenser of the *rf* stage is left in (or reduced

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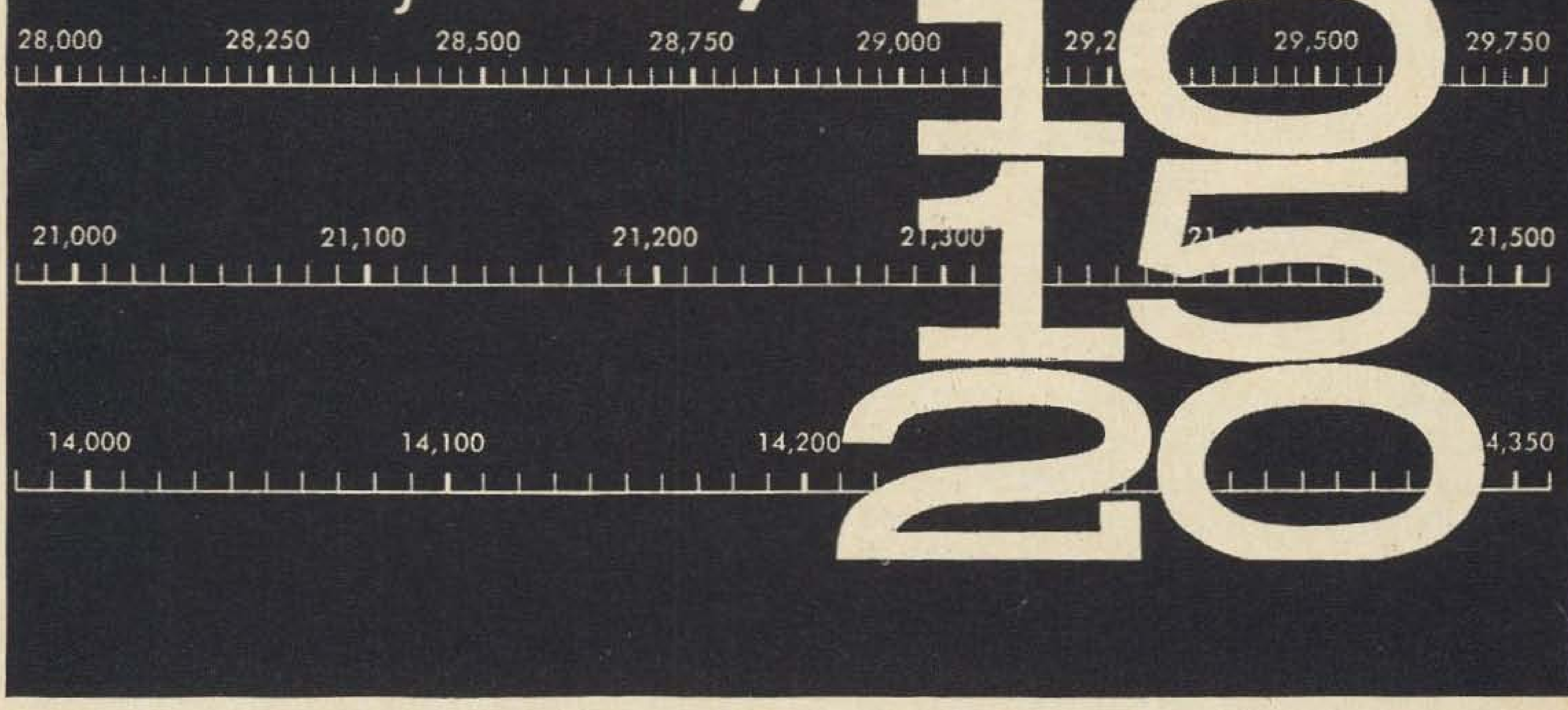

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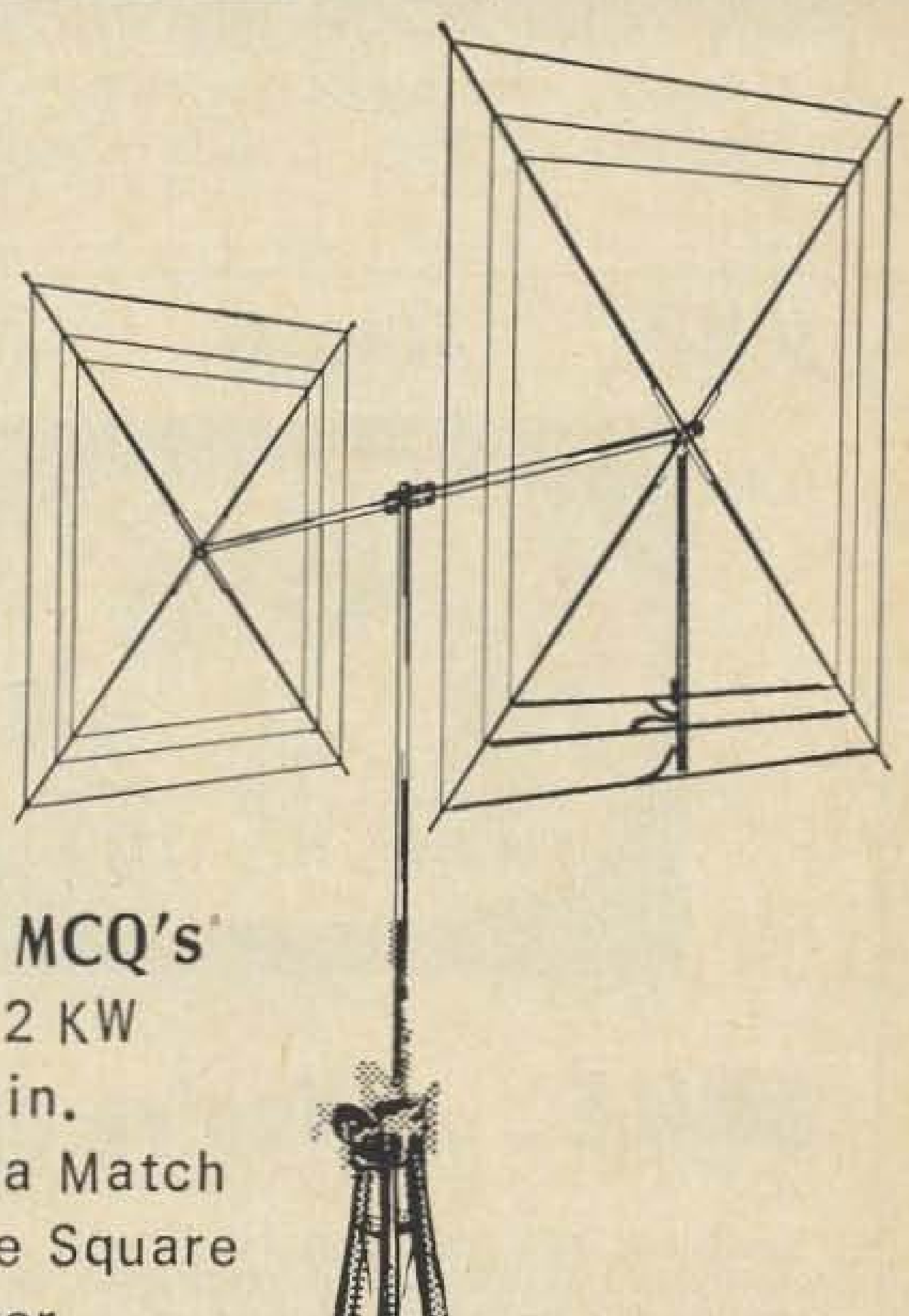

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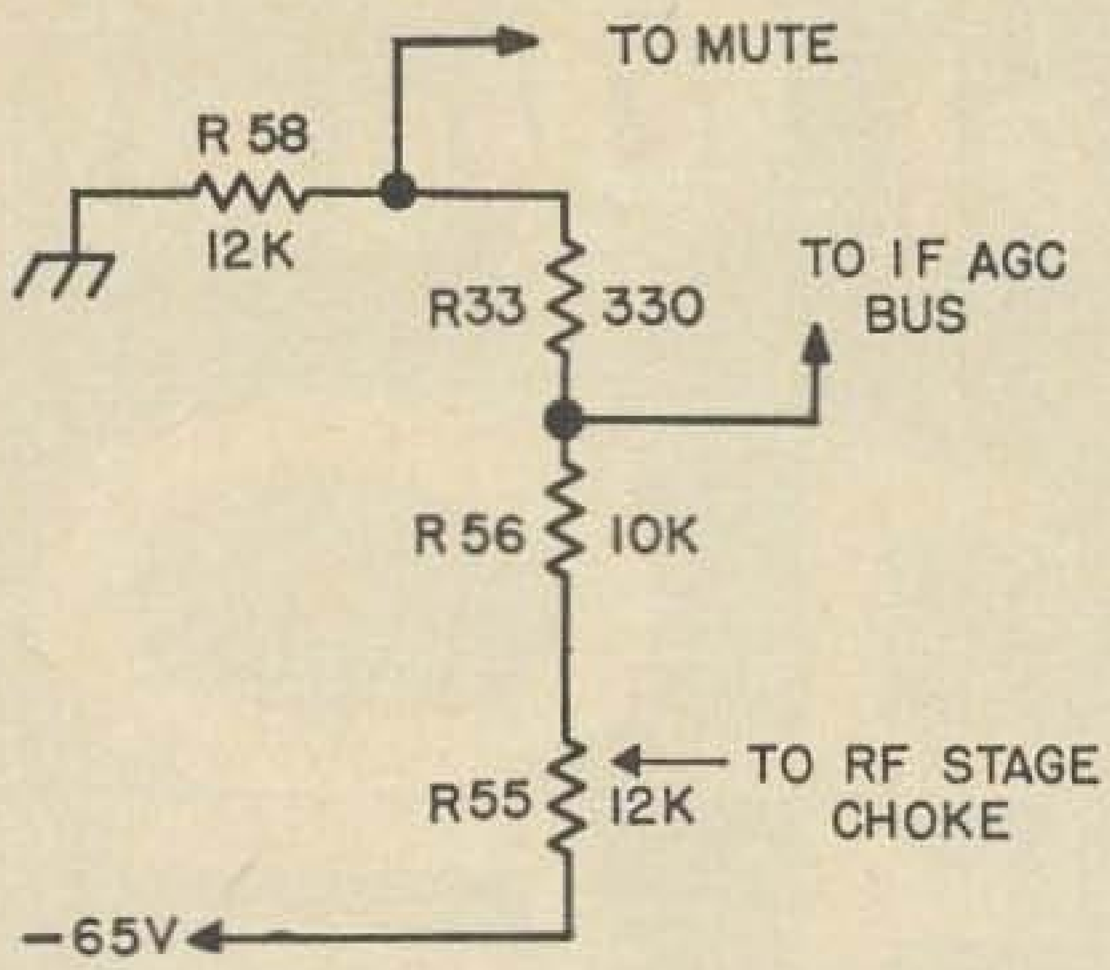

Fig. 3. Removing if stages from the rf gain control.

to 100 pF), the agc resistor is detached from the grid, and an 0.1 mH *rf* choke is connected to the grid. The bottom of this choke is connected to the arm of the *rf* gain control, R56. Now, muting is normal, and S-meter operation is normal–if you don't mind the rise in meter reading when the *rf* gain control is retarded.

There is a considerable loss in sensitivity (SN/N) when the *rf* gain control affects the *rf* stage. This had been stopped with the modification of **Fig. 1**, but is still present with the modification of **Fig. 2**, if the *if* agc bus is left connected to the arm of the *rf* gain control. I do not find any reason to use the *rf* gain control in the presence of fast-attack, slow decay agc, or without agc, on SSB, AM or CW. Therefore, it is attractive to leave the *if* stages off the *rf* gain control, and to use this control only for the *rf* tube. See **Fig. 3**.

This is easily done by lifting the correct black-red-orange (in my receiver) lead from the agc bus to the terminal strip forward of the coil cans, and to connect it to the negative end of the 330-ohm bias resistor, R33, on the next terminal. The *rf* choke lead from the *rf* stage then can be connected to the terminal leading to the arm of the *rf* gain control, R56.

Now, there is no longer any *if* blocking by nearby strong signals, the *rf* tube is muted normally, effectively preventing the round-about spurious oscillation in "Transceive" mode. The S-meter (which still needs a 100-ohm resistor across it whenever agc is removed from the *rf* stage) reads normally at all settings of the *rf* gain control.

There is no need for by-passed cathode bias in the *rf* tube, which had been added in the modification of **Fig. 1**. The 6DC6, 6FV6, 6BZ6, 6AK5, 6GM6, and other tubes can be used, whichever way the cathode and suppressor are connected to pins 7 and 2 of their bases. The most remote cut-off tube has some theoretical advantages, but *some* 75S-line receivers are more sensitive with the 6FV6, when properly realigned for the tube used.

It is well to keep in mind that maximum results may occur when the *rf* stage alignment is touched up with the normal antenna on the receiver; that the best sensitivity (SN/N) may not occur when the alignment is trimmed for maximum signal; and that the best sensitivity is not necessarily indicated by the tube giving the highest total gain. Those liking a "hot" S-meter and good sensitivity, will like the 6FV6.

. . . K6KA

1. 73 Magazine, December, 1967.
2. "Front-End Receiving Filters," by E. H. Conklin, K6KA. p. 14, *QST*, August, 1967.

Build Yourself a Relegator

Right! Build yourself a relegator. Relegate that danged buzz and/or hum out of your antenna relay to the limbo of unpleasant memories. Cure those jitters the maddening things are prone to become afflicted with without warning or reason, which turn you into a switch flipping, red eared, jitter nut yourself in trying to stop it while the QSO or message is hung up.

It is so simple that a pre-Novice could probably build it from the accompanying circuit diagram. Your junk box won't even miss what it takes to build this gadget. Furthermore your relay will love you for feeding it pure dc even though it is only half wave. In fact it won't even miss the other half; I'll guarantee you that.

Components for the conversion are: 1-200 PIV, 400-750 mil. Silicon diode (either the popular top-hat or epoxy); 1-25 mfd 150 volt tubular capacitor; 1-miniature 115 volt 6 watt lamp; and 1-500 ohm 10 watt resistor.

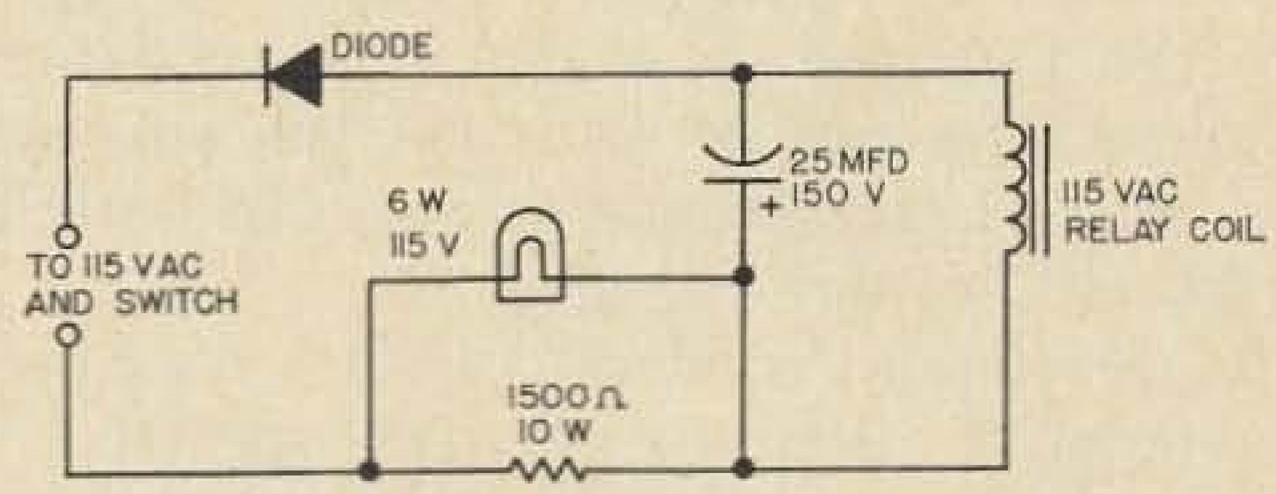

Fig. 1. Diagram for converting a 115 Vac relay to dc operation at about 40-45 Vdc.

Simply disconect the 115 volt ac source from your relay temporarily, and when you have the conversion completed and mounted right on the relay, that's generally the handiest place, again connect up the 115 volt ac supply through your regular activating switch to your new solid-state converter and you're in business; with an indicator light to boot, and 40 to 45 volts dc on your relay. What a relief!

. . . K6GRP

Transistor Regenerative Detector

Jim Ashe W1EZT
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Peterborough, N.H. 03458

I've thought many times about some of the odd transistor regenerative detector circuits I see in the magazines. Very often they seem to have a certain unreal quality, and I've wondered if they really worked. Don't transistors make good regenerative detectors? They ought to, because their characteristics are far sharper than those of vacuum tubes. Yet the 1968 Radio Amateur's Handbook has no transistor regenerative detector circuits, and only one project. And that circuit, too, looks weird to me.

How about regenerative detectors?

Why are there so few regenerative detectors in transistor construction projects? Nobody wants them any more? No, I think there are more regenerative detectors in this country right now than at any time in the history of electronics. Good regenerative detectors offer better performance per parts dollar than any other circuit going, and I reckon those of us who must or want to build still outnumber the appliance operators. So I started some regenerative detector studies. First results were not too encouraging but as I continued thinking and building, consistent results emerged.

I developed a clear picture of how a regenerative detector should operate. We need to choose an operating point that is quite different from usual practice. Because the incoming signal is not strong enough to carry the base-emitter diode into cutoff part of the time, the detector cannot detect by straightforward rectification. We must have approximate square law detection, which reduces one side of the incoming signal and emphasizes the other side to bring out the audio. See **Fig. 1.**

Looking at this figure, we see transistor operating conditions are very important. The usual biasing standards emphasize linearity, which we do not want. The collector current must be very small so that downward collector current swings are limited but upward swings are not. If we have a large collector current the changes due to incoming *rf* will be so small compared to average current that negative half-cycles will not be appreciably different from positive half-cycles. It looks as though collector currents in the microampere range are appropriate.

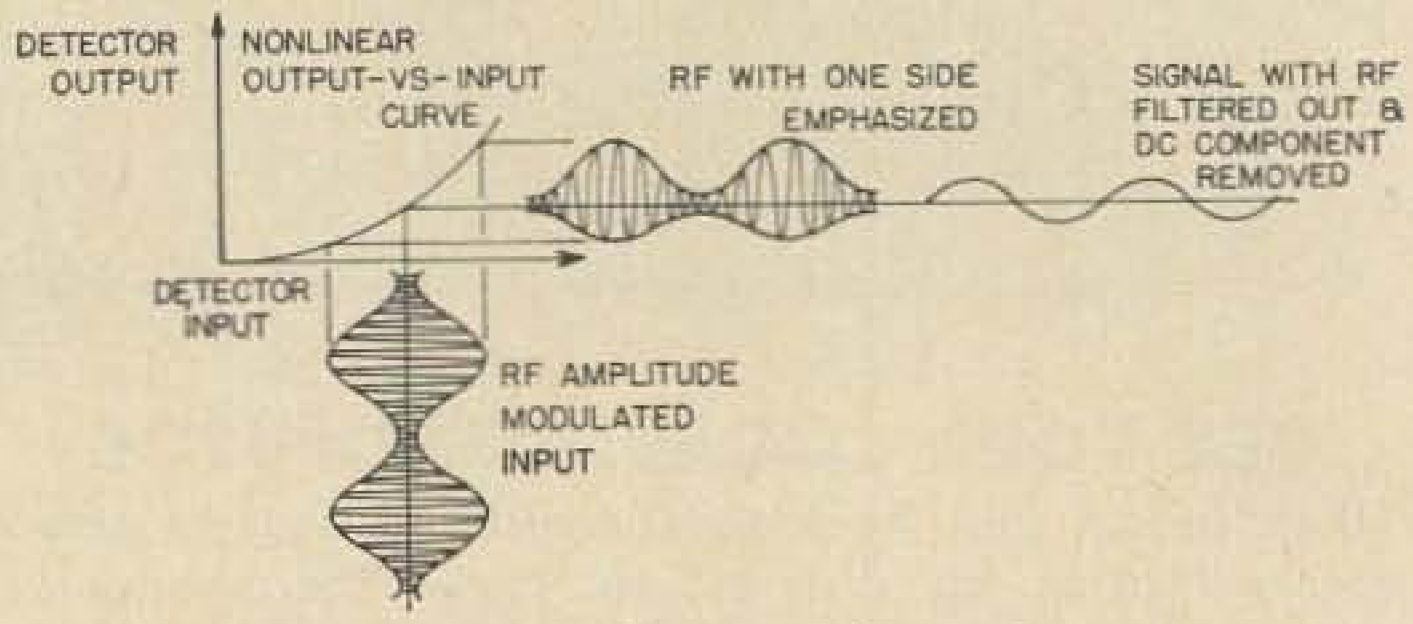

Fig. 1. If we operate the transistor detector at very low base and collector currents, its input-output characteristics are not linear. One side of the RF signal is emphasized more strongly than the other, producing a DC component that becomes our audio after passing through a coupling capacitor.

With this point secured, we think about the transistor's gain. Evidently it cannot be very good. At this point I almost convinced myself the reason there seemed to be no good transistor regenerative detectors was simply that transistors were inherently unsuited for the application. Yet I felt my picture was not clear enough. If the transistor offers enough gain for oscillation at *rf* is any more gain needed? Probably not, and I recalled again that transistor characteristics are maybe a hundred times sharper than the 01A I used in my first regenerative receiver. It seemed reasonable to suppose gain could be far less important than I thought.

At this point I built a regenerative detector circuit in breadboard style. It summed up my thinking about biasing and feedback control, and I felt quite confident until I turned it on. The result was an awful howl. Way off to one side of the regeneration control range there was a region where the detector worked, more or less,, but its sensitivity was notably poor.

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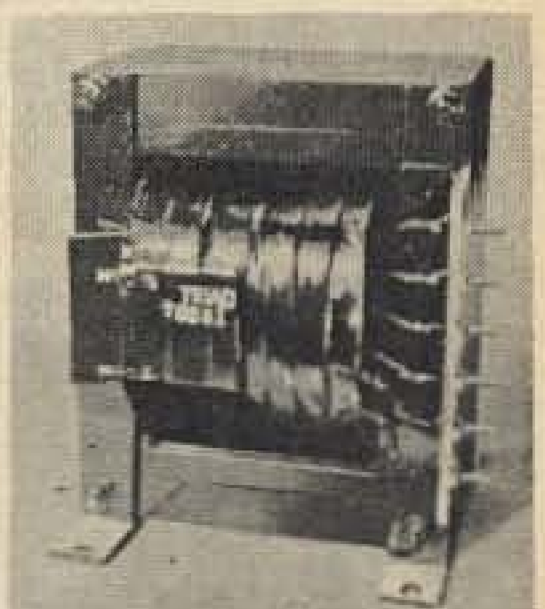
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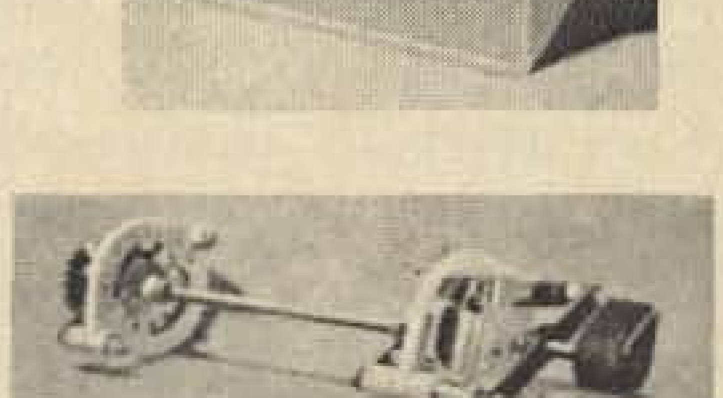
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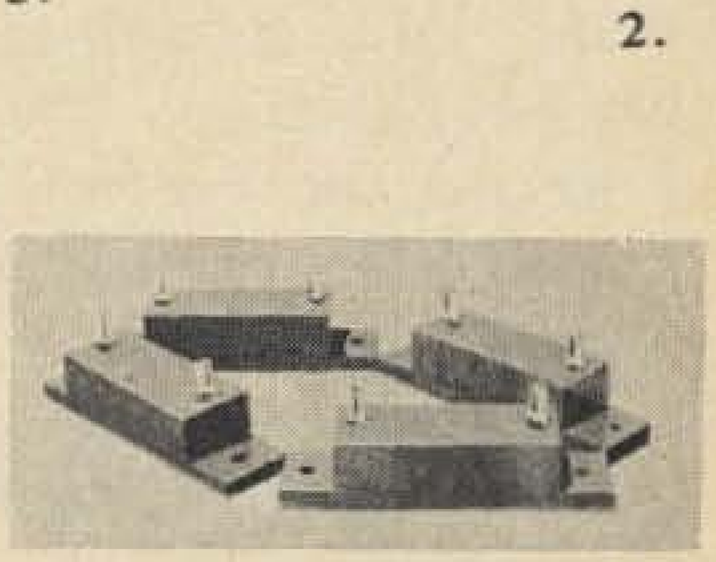
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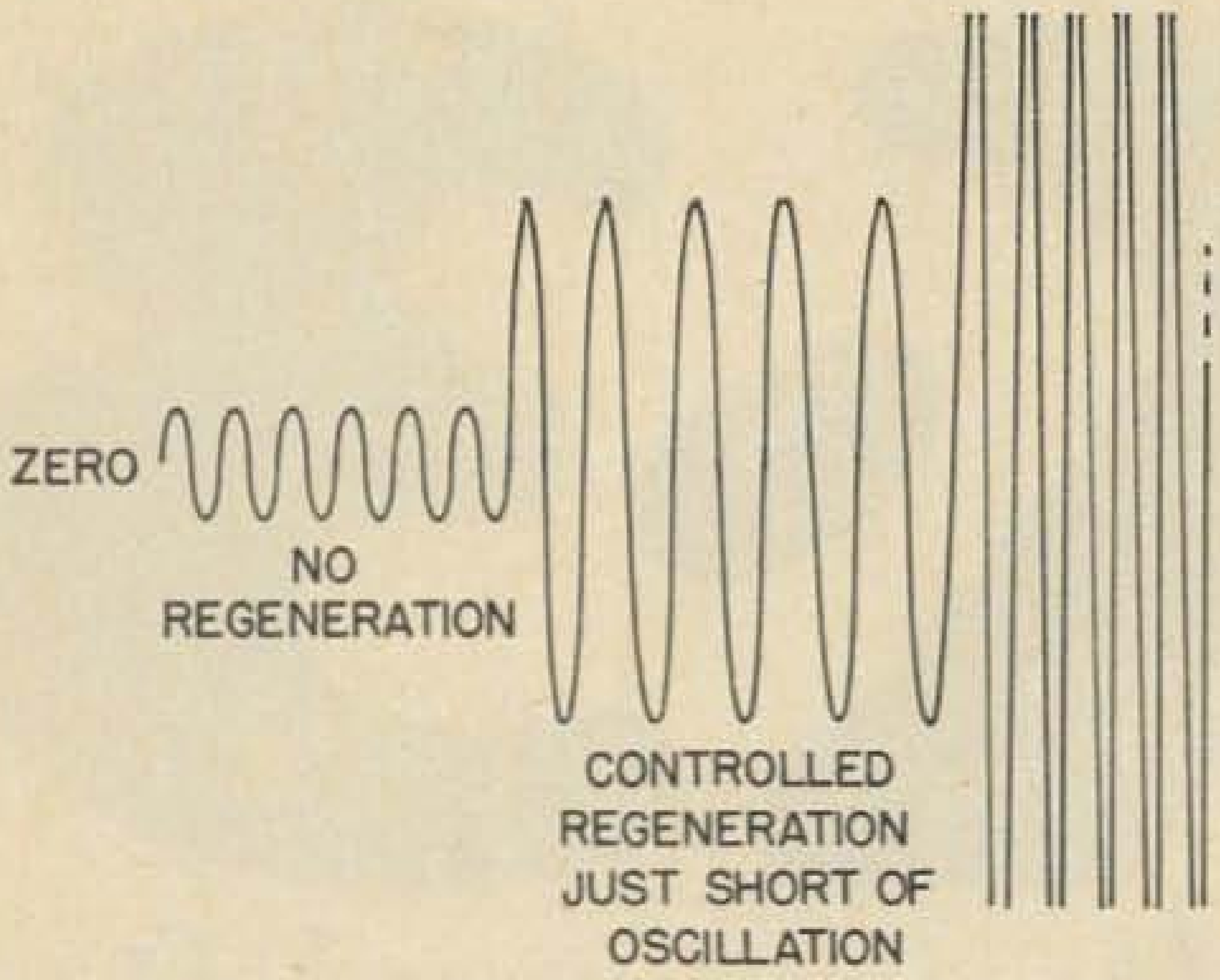

Fig. 2. RF feedback increases the RF voltage swing in the detector input circuit. Suppose we have a constant, very small RF input. As we increase feedback the voltage swing increases, even though the input voltage has not been changed. Too much feedback results in the uncontrolled-amplitude swings of oscillation, and detector sensitivity is reduced.

Thinking about the sensitivity control's sensitivity, I soon came to some conclusions. It appeared the control itself was in good shape, and the circuit design was reasonable on the basis of the factors I had taken into account. I realized I had missed a key point.

At the tiny collector current I had chosen, the transistor's *dc* beta was well below its normal value. This is a well-known property of transistors, which need a certain amount of current to become actively energized. My regeneration control acted to increase collector current and was also increasing the transistor's *dc* beta. At the critical point of starting to oscillate, the extra base current from the fedback *rf* would carry the transistor into a well-energized state, and it would stick there. It would keep oscillating til I turned the control way down, and at last the collector current would fall to a low non-oscillating value.

This kind of instability can be controlled by turning the transistor's current current gain against itself. We can ask the transistor to regulate its own base current, and if anything makes the transistor more lively, the regulation becomes more efficient. This is called feedback biasing and is very easy to arrange.

While thinking this through, I realized it is important to use a suitable transistor in the regenerative detector circuit. We cannot use just any old transistor that happens to be available. The best transistor will have a physically tiny structure for best operation at the tiny currents required, and for minimum circuit reaction. These properties are indicated by manufacturer's specs showing good beta at tiny collector currents, or perhaps by a collector dissipation rating of 50 milliwatts. I see General Electric's 2N3394, priced at 42¢ has a beta of about 50% of its best value at a collector current of 100 microamps. After looking at some other specs and making comparative tests on my Heathkit transistor tester, I concluded the 2N3394 is almost certainly one of the best inexpensive transistors for regenerative detector service.

I realized one other important point. The operating conditions appropriate for a transistor regenerative detector guarantee a very high output resistance. That is, the detector cannot develop a good signal voltage across the load typically presented by a transistor audio amplifier. The solution is to add one more transistor and a resistor, in addition to the components we would use anyway, as an emitter follower circuit.

Putting these considerations to work, I developed and breadboarded a new circuit. The results seemed to be very good.

Practical regenerative detector circuit

Here is the circuit I breadboarded. See **Fig. 3.** Operating into a handy Lafayette audio amplifier, it brought WWV in very strongly on 10 MHz. Several feet of test lead, draped over the top of the workbench, served as antenna.

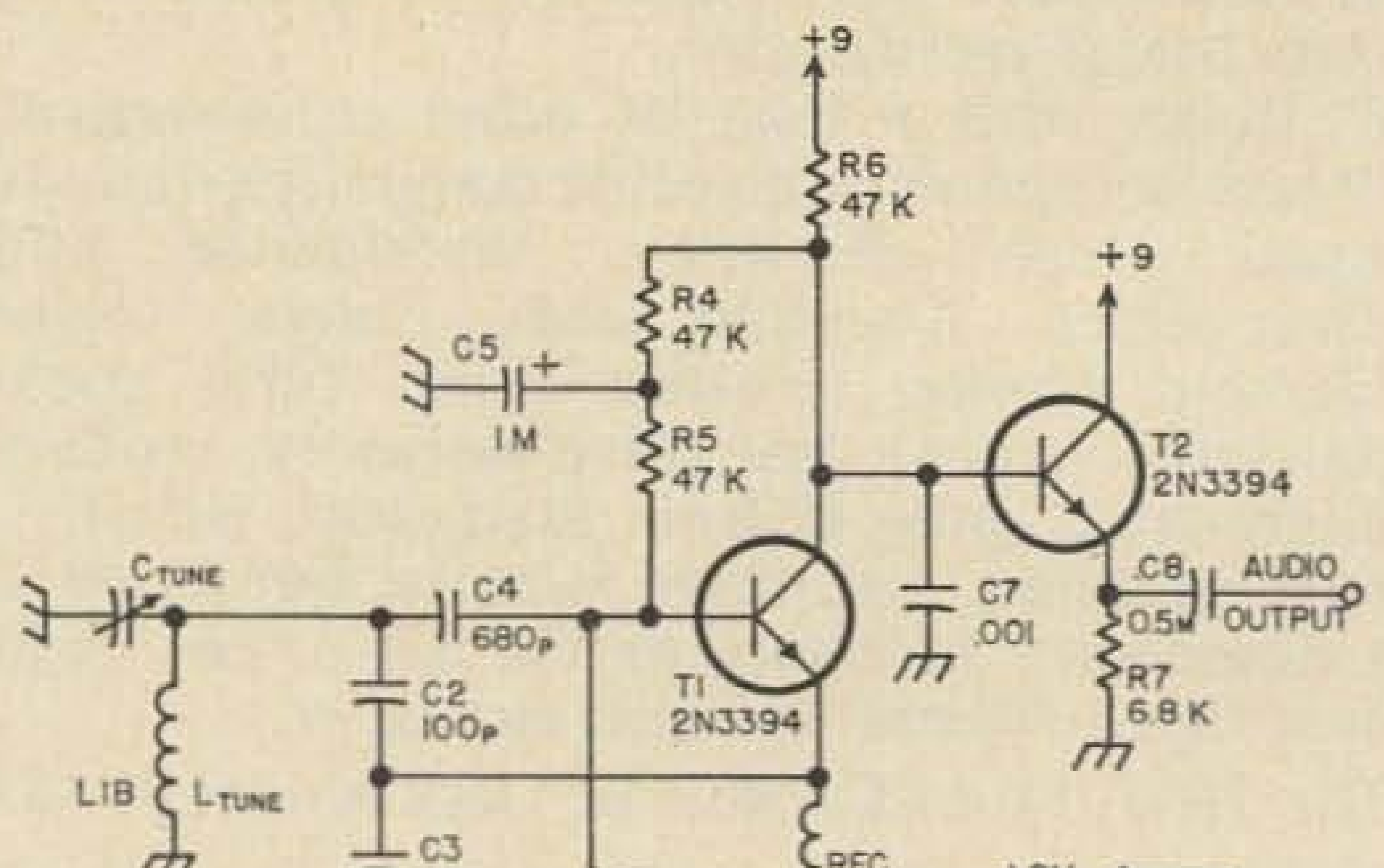

Fig. 3. Complete schematic of a good working regenerative detector. Transistor T1 is the actual detector, which operates at very low power levels. T2 is an emitter follower, which copies out the signal with minimum loss.

Jim Romeljanger K9PKQ
117½ 4th Street
Baraboo, Wisconsin 53913

Test Aid for Motorola FM Transmitters

Here's a simple gadget the FM addict using retired Motorola gear will find useful. Used in conjunction with a test set, the equipment can be used in its normal location, i.e., in the trunk, at its remote location, etc. If you've ever spent a cold night wrestling a rig out of your trunk to put it on frequency or service it, you'll appreciate being able to use the rig where it sits and get the procedure over with.

Materials are: 1 11-pin Amphenol male plug and 1 4-pin Amphenol mike connector. The hole in the cover of the 11-pin plug is enlarged to fit the mike connector. The wiring is done, and the mike connector is mounted in the cover, the cover snapped into place, and it's ready to make FM life a little easier for you.

Integrated Circuits Fundamentals and Projects

Rufus P. Turner's straightforward approach to integrated circuits opens with a discussion of what IC's are, and finishes with several simple projects easily assembled from available parts.

Chapters 1 and 2 introduce integrated circuits to the reader, who will be pleasantly surprised if he has been trying to work from some of the deep technical literature. There are several kinds of integrated circuits, and they are very versatile, but Turner's bread-and-butter approach gets the basic ideas over very well.

Each of the following six chapters discusses the construction and operation of a real IC circuit, easily assembled from parts available almost anywhere. None of the circuits require unusual voltages, and each is provided with photos, schematics and wiring diagrams. The well-chosen assortment includes a frequency-standard oscillator and an electronic voltmeter (using an easily-available 1 mA meter) as well as several audio circuits.

Available from Allied Radio. 75¢.

Now, here is the key idea. The base terminal of T1 regenerative detector is involved in a tug-of-war between two opposing voltages. Through R3, there is a constant dc voltage that is trying to turn off the transistor. Through R5, there is a variable dc voltage that is trying to turn it on. If we imagine the turnon voltage momentarily loses, collector current drops. T1 collector goes very positive and there is a strong return turnon signal through R5. And if we imagine the turnon voltage has momentarily won, the collector draws greatly increased current, collector voltage drops, and the available turnon voltage is reduced. This arrangement is known in scientific and industrial work as feedback biasing.

We adjust the interplay between these two opposing influences by varying the regeneration control R1, until we have just the amount of circuit liveliness we want. This will usually be just under or over the point at which the circuit goes into oscillation. And then the tug-of-war takes over, holding the transistor firmly at the critical operating point.

Two capacitors in this circuit deserve special attention. We want the regeneration control to have a good feel, and if it produces some contact noise we don't want to hear the noise. The large capacitor C6, tends to this. When the regeneration control is varied, the voltage across C6 follows it slowly. Noise is lost, and your ear has a better opportunity to hear what happened when you turned the control. This gives a clearer impression of effective control. And C5 prevents collector-to-base negative feedback at frequencies above a few tens of Hz. Without it, there would be signal as well as dc feedback, and this would kill the operation of the circuit. Since both are acting as bypass capacitors their values are not critical but values over ten times larger than shown won't do anything for the circuit operation.

At *rf* frequencies, the detector circuit is simply a common-collector oscillator. Feedback is from emitter to base, and looking at C2 and C3 we see that emitter and base are at nearly the same *rf* potential, as they would need to be in a low-impedance transistor circuit. You could try eliminating three components by tapping the emitter up on L1B, which would take out C2, C3, and the rfc. Next time I build the circuit I think I'll try this. And I noticed some influence of the

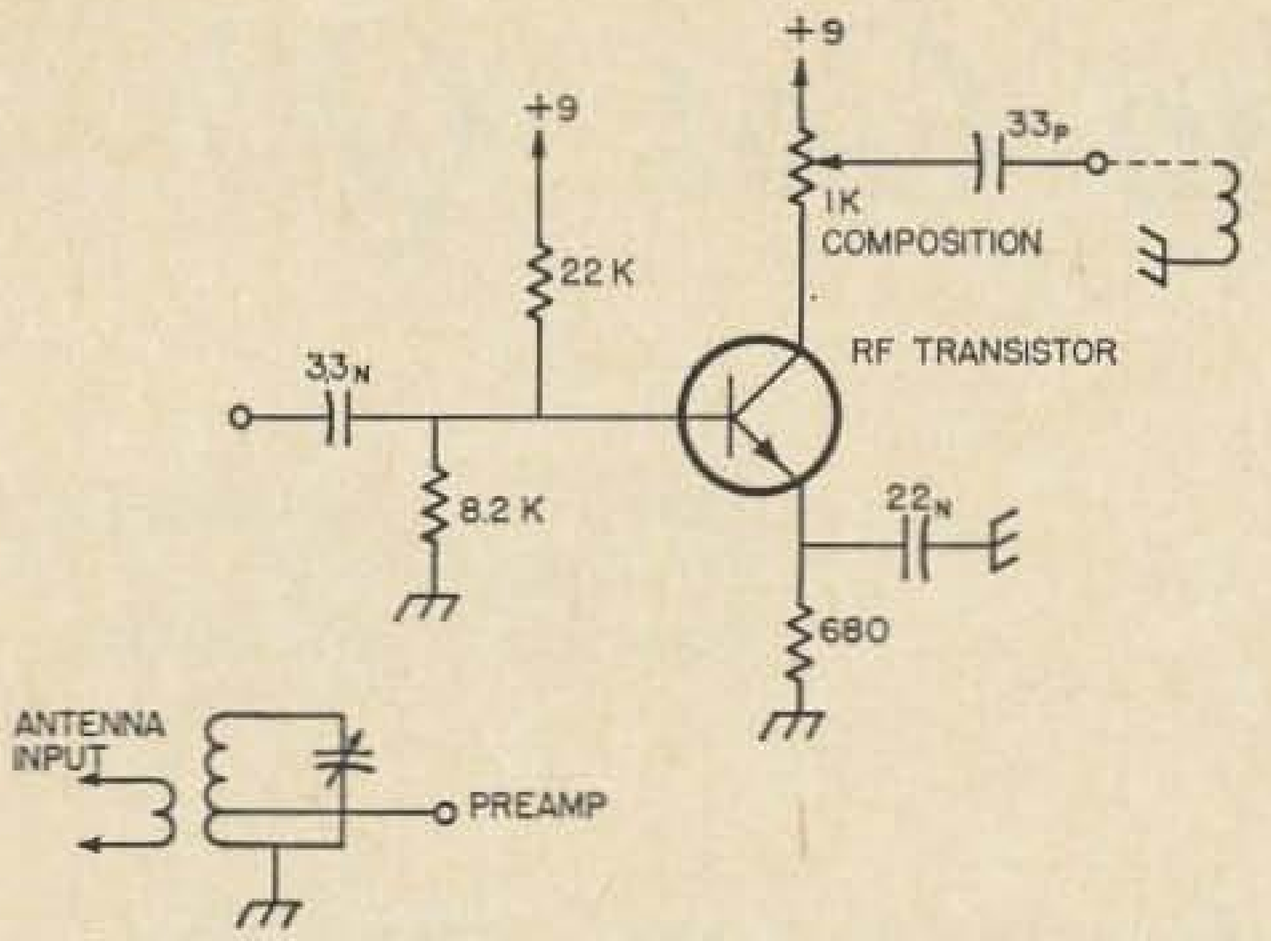

Fig. 4. The regenerative detector circuit can be coupled directly to an antenna, but this should give better results. The gain control reduces signal strength, for strong signals which try to take control of the detector. Its performance will fall off above 10 MHz even with very good transistors, but I think it will get by up to 30 or 40 MHz.

tuning control upon regeneration control setting, but this was not troublesome. A tapped coil circuit might reduce this.

Transistor T2 is the emitter follower output. Since the base terminal does not have to be at any particular potential so long as other components and voltages are appropriate, we can hook the base directly onto T1's collector. I provided C7 to keep T1's collector at *rf* ground, which is required for good *rf* performance. And it avoids transferring *rf* into the following audio stages.

Why bipolar voltages? That is, plus and minus supply voltages? Well, that is because it is the easiest way to make this circuit. It goes back to that tug-of-war effect which stablizes the regeneration at a naturally unstable point. The transistor emitter needs to be held at a fixed dc voltage, and ground voltage is most convenient. Then, if we are to have workably sized resistors in the base circuit, which is at about ground potential, we have to have a far-negative voltage to work from. You could try putting the emitter voltage up a few volts on a zener (suitably bypassed for *rf* and audio) along with a higher positive supply voltage, and if properly done it would work as well as what I have here. I merely chose the simplest easy way to make the circuit.

Application

My regenerative detector circuit seems to give as good performance as you could want, operating directly from an antenna. But like all regenerative detectors, it will respond to changes in loading and input signal strength. Here's a simple circuit you can try as an *rf* front end. See **Fig. 4.**

It's not designed to be efficient. If you want something better there are lots of ideas around in the amateur electronics books and magazines. I designed this to get by without any critical parts or transistors. Use any transistor you can find (but be sure to use correct polarity supply,) and see what happens.

The gain control in the transistor collector circuit is for use when signals overload the regenerative detector. Turn the control away from the transistor collector connection, and the signals will become weaker. If there is cross-modulation, or you want to try for better sensitivity, add a tuned circuit at the input as illustrated. Good luck with my new circuit! . . . W1EZT

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

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How good are your coils? "Q" a figure of coil "merit" can be easily measured with a simple instrument. If we know our "Q's" (no "P's") maybe we can have less phone calls about TVI, BCI and HFI with a bonus of better efficiency in the rig, hence a better signal.

Until now very little has been mentioned in amateur articles regarding the "Q" meter and its application and construction. The "Q-Q" can be built for approximately twenty bucks (American money) or for five dollars if your buddy has lots of parts.

The "Q-Q" operates on the principle of resonance. To obtain this resonance, two conditions must be met: (1) there must be a circuit capable of resonance, (2) there must be a signal to which the circuit can resonate.

The block diagram (**Fig. 1**) shows the basic parts of the "Q-Q". The oscillator provides the signal and calibration voltage. This calibration voltage is applied to the tuned circuit through a 100:1 voltage divider. This voltage (let's call it drive voltage) is amplified by the tuned circuit at resonance; detected and measured on a voltmeter.

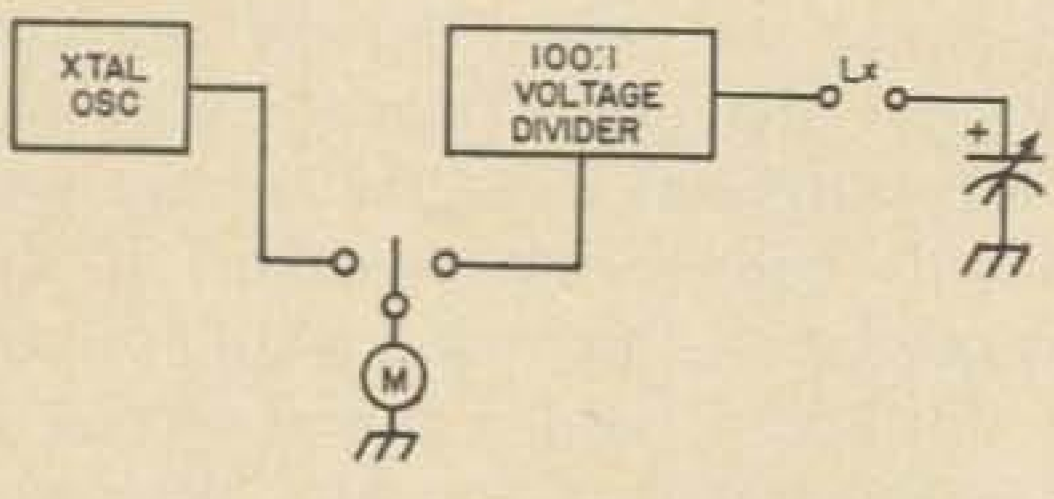


Fig. 1. Block diagram of "Q-Q"

In operation, a small voltage (E_1) is introduced in series with a tuned circuit, the unknown coil and C_3. The circuit is then tuned to resonance and the voltage (E_2) developed across the tuned circuit is measured on the voltmeter. The measured voltage E_2, is then compared to the driving voltage E_1. The Q of the circuit is then the measured voltage divided by the drive voltage.

$Q = E_2/E_1$

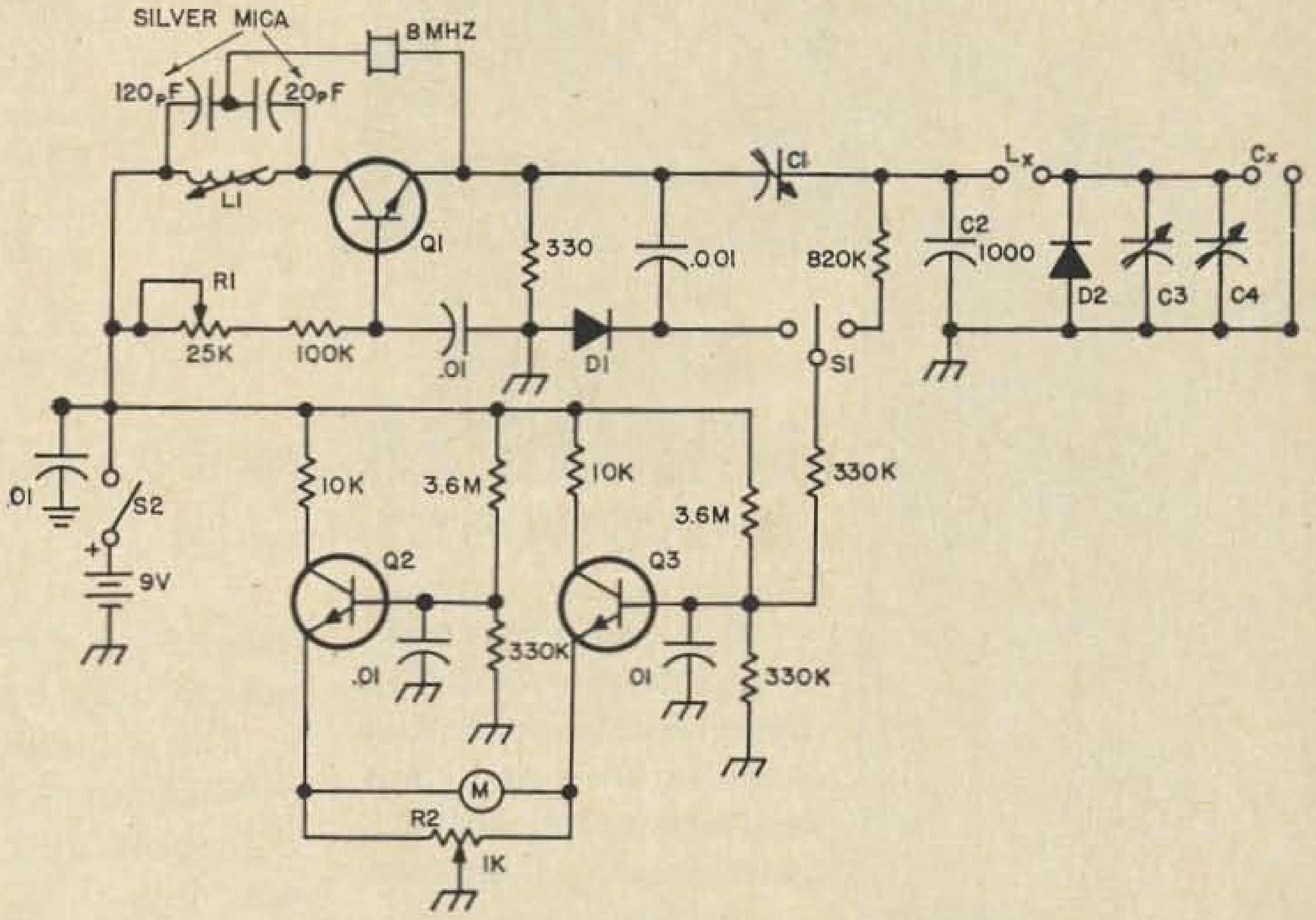
Thus a driving voltage of 1 v using a 100 to 1 divider for E_2 at resonance of 1 v gives a Q of 100. Any losses in the resonant circuit will result in a lower Q reading. In general, the losses in the coil are much greater than the losses in the other circuit elements. Thus the Q of the circuit is the Q of the coil for all practical purposes.

The battery powered "Q-Q" Meter (shown in **Fig. 2**) uses only three transistors, one as crystal oscillator and calibration source, the other two as a high-impedance voltmeter, Use of a crystal-type oscillator provides a more stable and less complicated circuitry than a variable oscillator, although a tuneable oscillator is used in the lab type Q Meter. Later in the article we will show you how to adapt to a tuneable oscillator which allows us to measure Q at the operating frequency. Crystal switching can be used if necessary. The stability of the crystal oscillator also allows the calibrating voltage and the drive voltage to be used directly without the use of emitter followers to isolate the load from the oscillator. The current drain is only 1.5 mA so battery life should be no problem.

Building the "Q-Q" is simple, although good rf construction should be followed, i.e., short signal leads and common rf ground.

The tuning capacitors must have very low loss insulating material used in its construction. Ceramic, Rexlite, or Teflon insulation is preferred. The fiber board used in the ordinary broadcaster capacitor, while usable in

Fig. 2. Schematic diagram of the battery powered "Q-Q Meter."



a Pi network (where the in circuit Q is around 10-20), definitely has too much loss for this application. Many surplus capacitors with low loss ceramic insulators are available and one with a vernier drive is to be preferred. The one used here is a J. W. Miller #2111 with the fiber insulators removed and 4 small ceramic standoffs (similar to cambion #3848-2) added to support the stator. Capacitor C_4 is a surplus type CT15 modified to two stator and one rotor plate. The meter is mounted by a tight fitting hole in the front panel and a dab of rubber cement between a corner of the meter and the chassis. The terminal binding post should be mounted on a good insulator such as Lucite and mounted under a cutout at least ¼ inch larger than the post dimensions, to reduce stray capacity. Also use heavy bus wire (#14) or brass strap to keep the inductance down in leads connecting the binding post and tank capacitor together. Diode D_2 is mounted directly in the L_x binding post to ground. Capacitor C_1 is mounted on a small terminal strip near L_x binding post. The crystal oscillator and voltmeter circuitry are built on a piece of vector board using flea clips and point-to-point wiring.

Now that we have the "Q-Q" Meter built, let's calibrate it. Rotate Cal-Q switch to Cal. Turn R_1 to turn meter on, adjust R_2 to Zero meter. If meter cannot be zeroed, check wiring for errors. There should be no problem as this is a very straight forward dc amplifier. After zeroing meter, rotate Cal-Q to Cal position, adjust oscllator coil slug (L_1) for maximum on meter, then turn slug slightly into coil so oscillator starts in application of power every time. Adjust R_1 (set level) control for 50 μA on meter. This reading of 50 μA is used as the reference set Call level on the meter for all future use of the instrument and may be marked on meter face.

Now for calibration of L-C scales and Q Meter face. With a coil (tapped per **Fig. 3**) connected across the unknown L_x terminals switch to "Q", zero meter, rotate C dial knob (C_3) for peak on meter with vernier tuning (C_4) set at mid capacity. Record μA reading on meter VRS Q of standard coil also mark values for L and C on L-C dial plate. Using the A to D taps on the standard coil, connect resistors in parallel across the unknown (L_x) binding post, to complete calibration of meter face using Q values versus resistance in **Fig. 4.** After calibration appropriate marking may be made by transfer

TURNS	TAP	Q	$C\mu\mu f$	$L\mu h$
7	A-B	135	256	1.57
13	A-C	210	106	3.8
18	A-D	235	69	7
23	A-E	260	50	8
6	B-C	120	310	1.28
11	B-D	180	134	3
16	B-E	215	69	7
10	C-E	170	151	2.62
11	F-E	195	120	3.35
16	F-D	230	77	5.2
21	F-C	280	55	7.4
27	F-B	275	39	10
34	A-F			

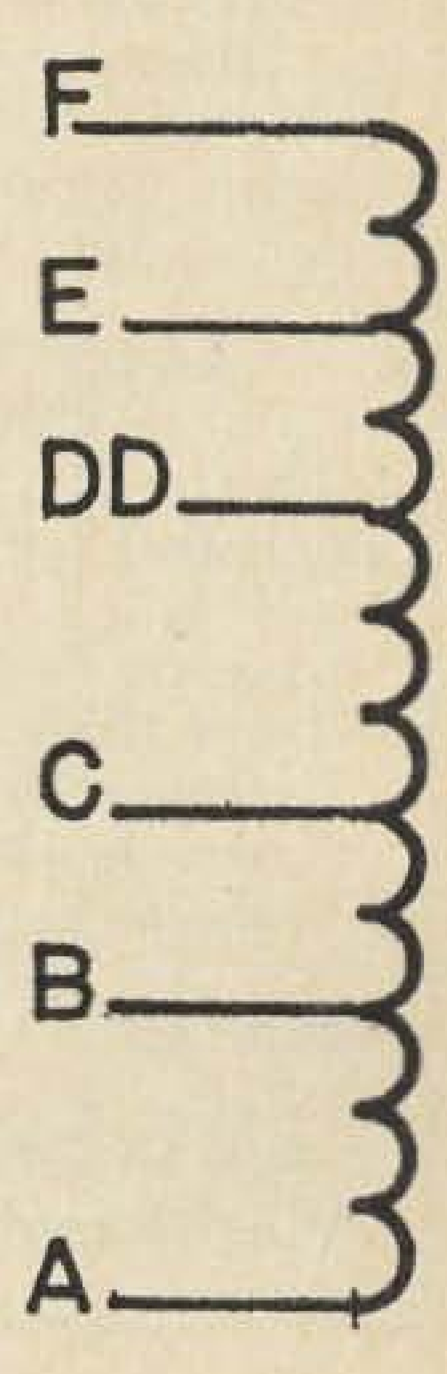


Fig. 3. See text.

A-D	Q = 235	R = 0
	= 165	= 220k
	= 145	= 150k
	= 140	= 100k
	= 110	= 68k
	= 104	= 56k
	= 90	= 47k
	= 85	= 33k
	= 57	= 22k
	= 39	= 15k
	= 25	= 10k

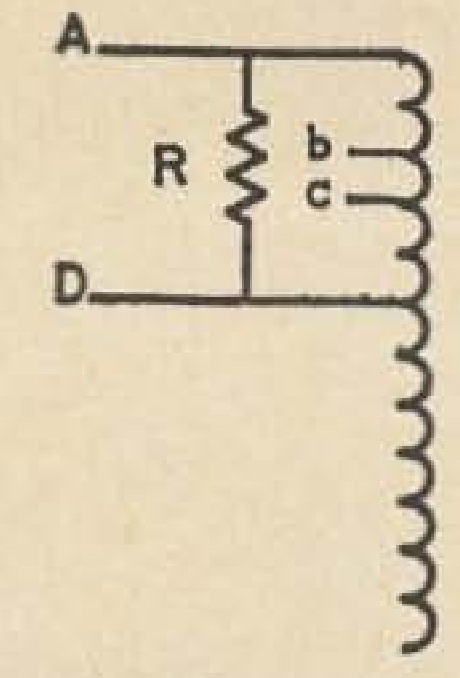


Fig. 4. Q values vs. resistance

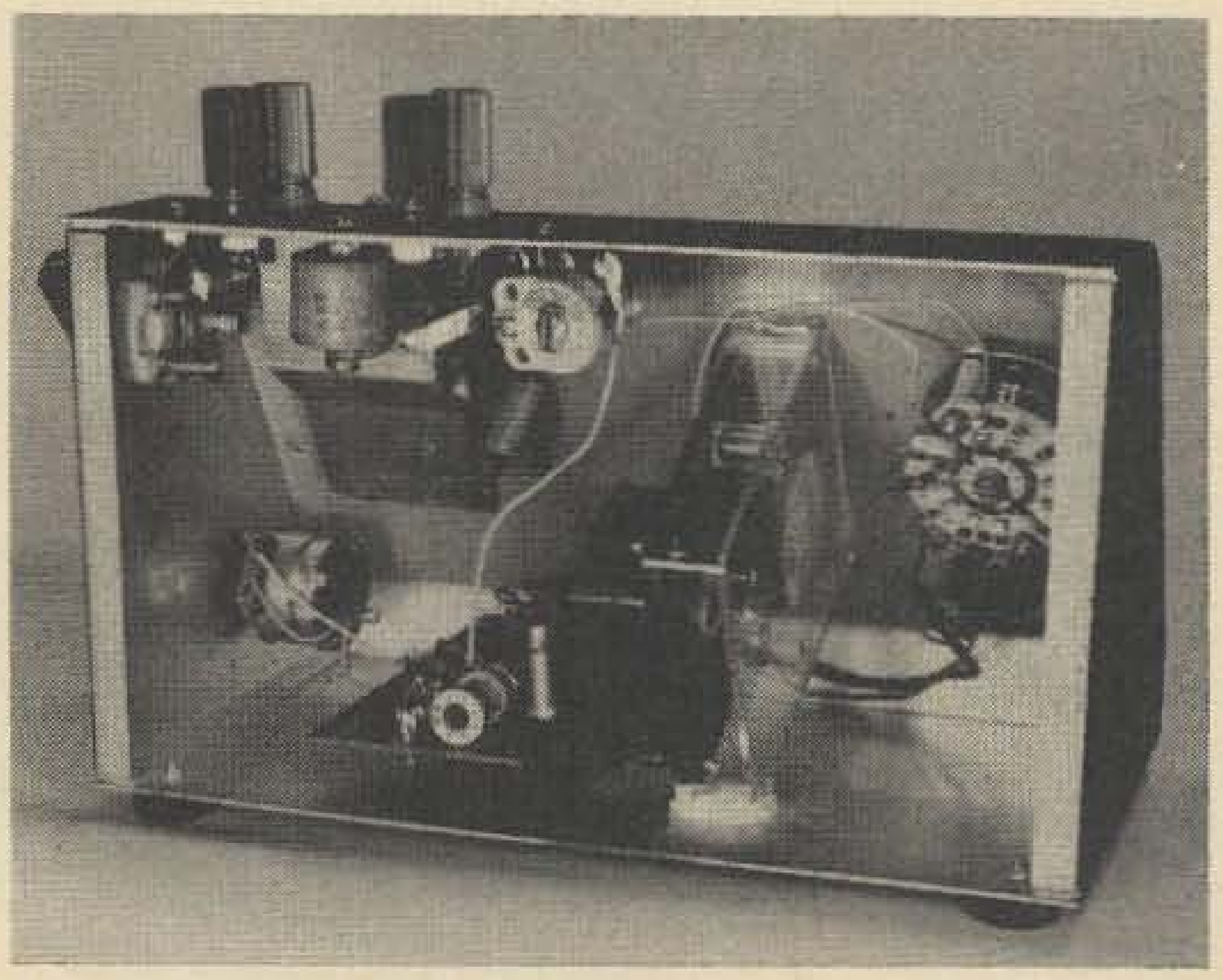
letters or pen and ink. The intermediate points may be marked by interpolation.

The standard coil has been measured on a Marconi #1245 Lab "Q" Meter and of 5 coils built and measured, the tolerance spread was less than 3 per cent maximum between coils. With reasonable care in tapping the coil and calibration one can have an instrument with 5 per cent of lab equipment.

The true experimenter may not be satisfied with the fixed frequency used in this unit, so if you have a good rf signal generator, it can be pressed into service as a VFO for this unit by changing Q_1 to a common emitter amplifier as in **Fig. 5.**

When using the external signal source (VFO) this unit will work very satisfactorily up to 25.2 MHz, with a degrading of 15-20 per cent for "Q" above 200, in the range of 15-50 there is no error measurable at this frequency. Standard frequency for measuring "Q" are 25.25 MHz, 7.95 MHz, and 795 KHz and for inductance values of .1-1 μh, 1-10 μh, and 10-100 μh, respectively.

The following procedures may be used as a guide in operation of the "Q-Q" Meter:



Interior of the Q-Q meter.

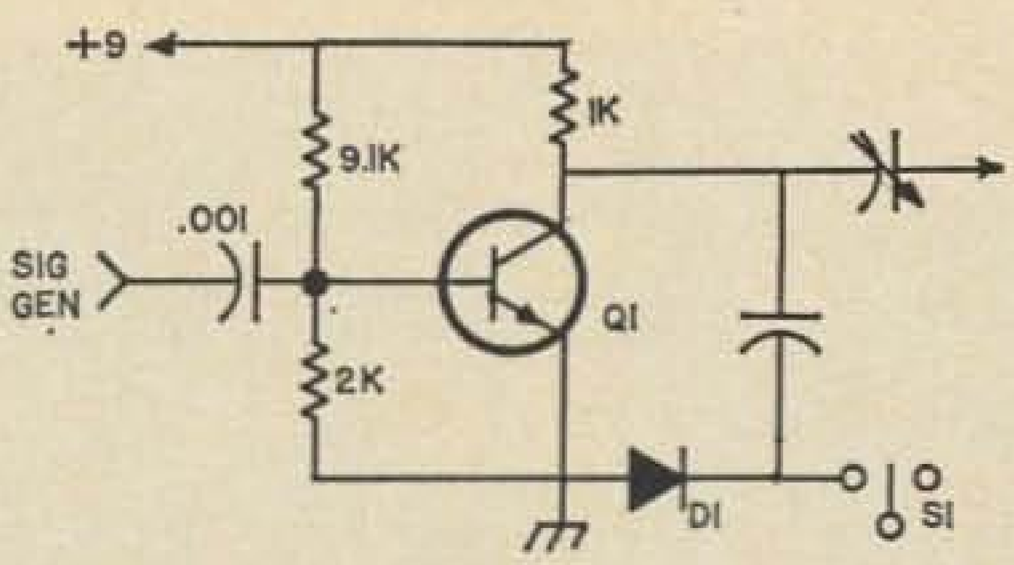
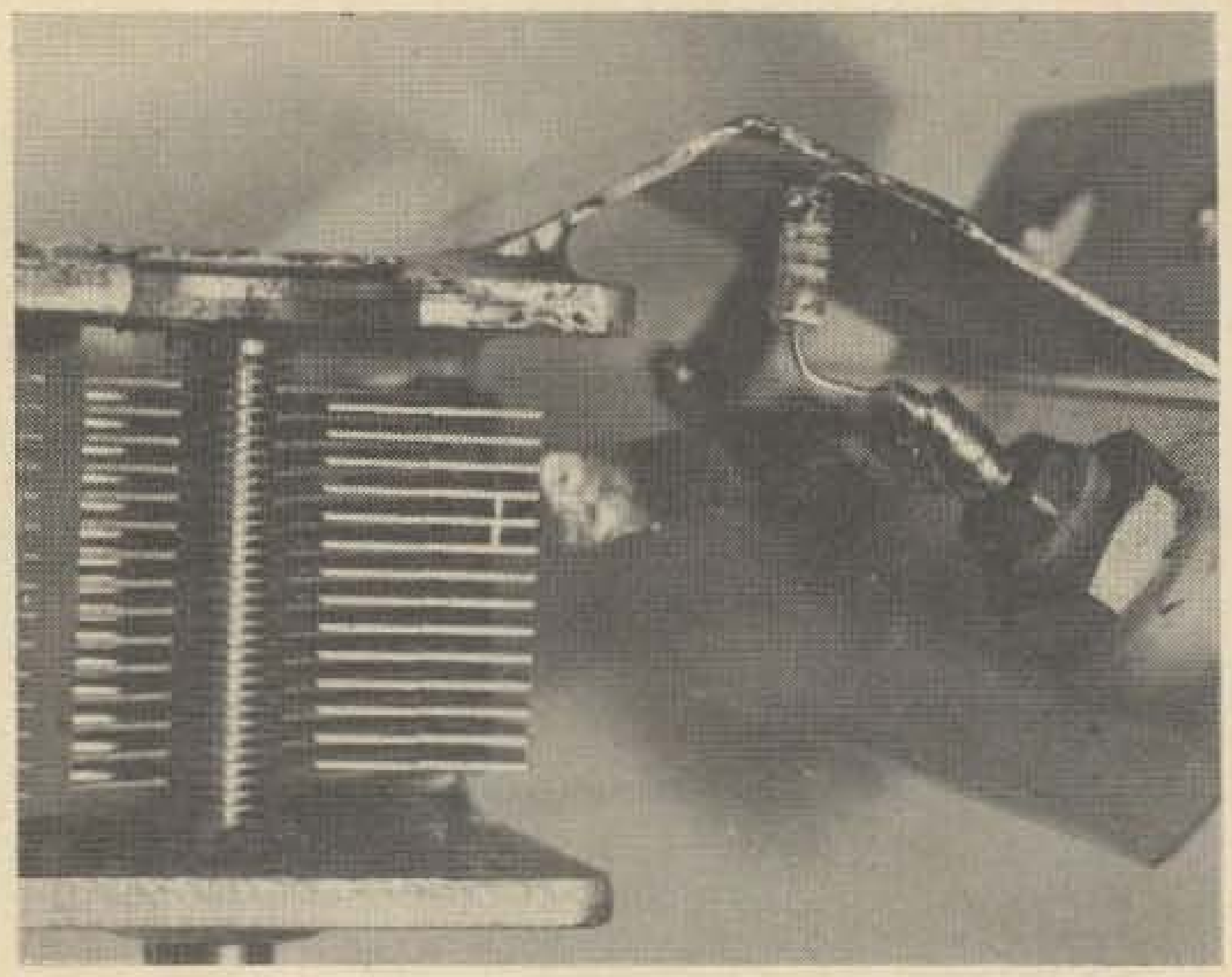


Fig. 5. Common emitter amplifier.

To measure the inductance of a coil:
- Set the Cal-Q switch to Cal.
- Connect the coil to the L_x terminals.
- Adjust R_1 to Cal (50 μA).
- Set the Cal-Q switch to Q.
- Set tuning (C_3) to max counter clockwise.
- Adjust R_2 for Zero on meter.
- Adjust tuning (C_3) for max indication on meter.
- Read the inductance on the L scale.

To measure the Q of the coil:
- Set the Cal-Q switch to Cal.
- Connect the coil to the L_x terminals.
- Adjust R_1 to Cal (50 μA).
- Set the Cal-Q switch to Q.
- Set tuning (C_3) to maximum counter clockwise.
- Adjust R_2 for Zero on meter.
- Adjust tuning (C_3) for maximum indication on meter.
- Read the Q of the coil on the meter.

To measure capacity by substitution:
- Set the Cal-Q switch to Cal.
- Connect a test coil across the L_x terminals.
- Adjust R_1 to Cal (50 μA).
- Set the Cal Q switch to Q.
- Set tuning (C_3) to maximum counter clockwise.
- Adjust R_2 for zero on meter.
- Adjust tuning (C_3) for maximum indition on meter.
- Note the value on the C scale as C_a.
- Connect the unknown condenser across the C_x terminal.
- Switch to Cal and check Cal level.
- Switch to Q.
- Adjust tuning (C_3) for maximum indication on meter.
- Note the value on C scale as C_b.
- The unknown capacity added across the C_x terminals is found by subtracting the C_b value from the C_a value. $C_x = C_a - C_b$.



Inside view of mounting of diode and straps connecting the binding posts to the capacitor.

Now that you have the L, C, and Q of a coil, you may wonder what is its parallel resistance? Without going deep in theory, we may use the relationship:

Parallel Resistance, $R_p = 2\pi fLQ$
or $R_p = w_oLQ$
where L = measured value
Q = measured value
$w_o = 2\pi f$

Therefore @ 8 MHz,

$$w_o = 2 \times 3.1414 \times 8 \times 10^6 = 50.04 \times 10^6$$

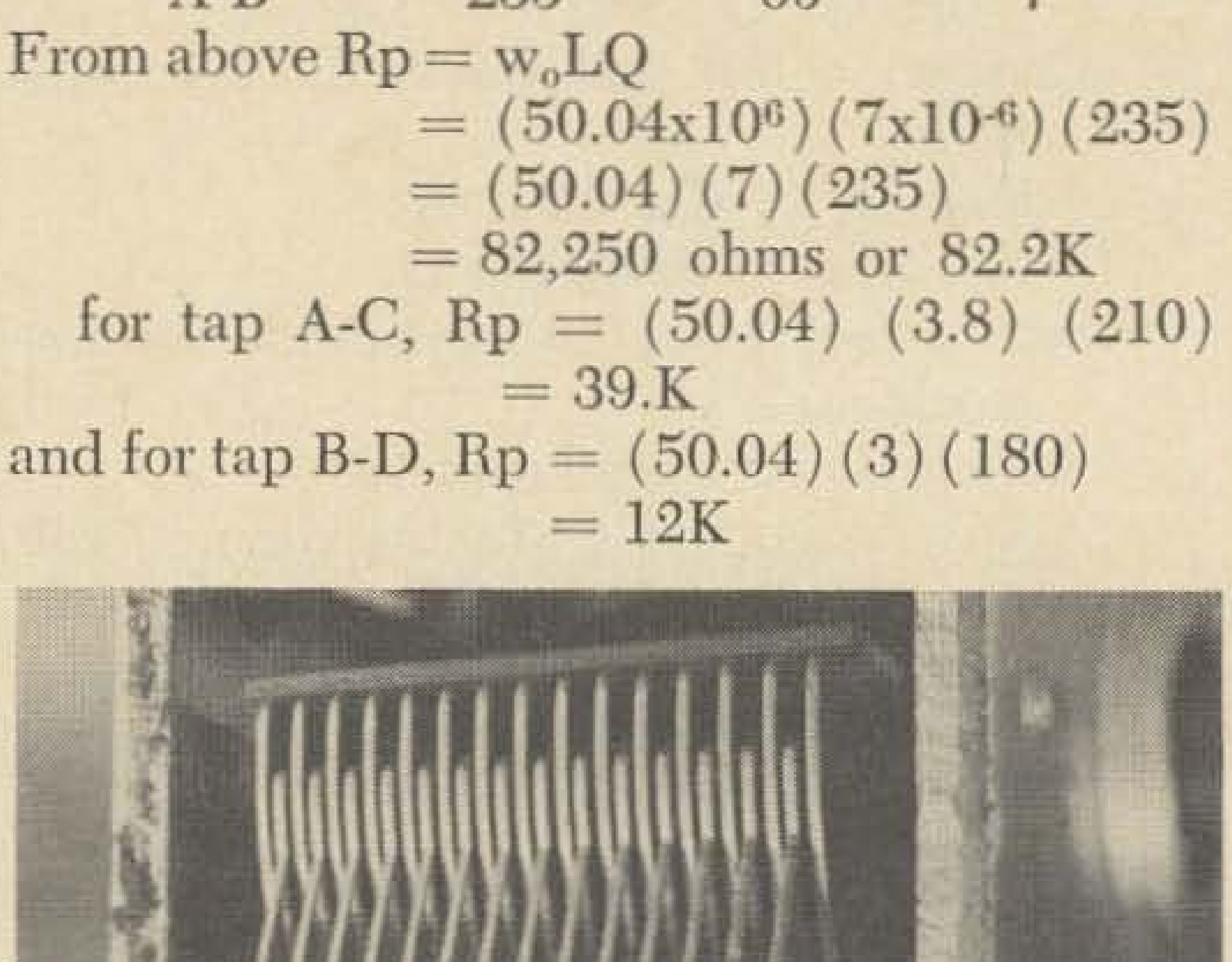
Let's keep this value of $w_o = 50.04 \times 10^6$ as a constant factor for further use. As an example, let's find the R_p at tap A-B in **Fig. 3.**

Tap	Q	Cμμf	Lμh
A-B	235	69	7

From above $Rp = w_oLQ$
$= (50.04 \times 10^6)(7 \times 10^{-6})(235)$
$= (50.04)(7)(235)$
$= 82{,}250$ ohms or 82.2K

for tap A-C, $Rp = (50.04)(3.8)(210) = 39.K$

and for tap B-D, $Rp = (50.04)(3)(180) = 12K$



Inside view of variable capacitor (C3) showing the two ceramic standoffs for support of the stator.

The above examples stress the need for high quality components used in the "Q-Q" meter, as all losses are charged to the coil and would give much lower readings than expected. These examples are by no means all the "Q-Q" meter can do. This meter, (with pencil, paper, and a little work) can be used in the initial design of Transmitters, Receivers and Converters or just about any thing using rf, coils, and condensers.

It is hoped this article will stimulate the building of the "Q-Q" meter and in future articles we read, instead of saying 17 turns of wire removed from a surplus choke, wound on a ¼" slug tuned form, will call for 17 turns of #30 Enameled wire close wound on a ¼" slug tuned form with an unloaded Q of 30. Come on fellows let's get with it!

. . . WB6IBS

"Good grief, Betty! Can't we come back later for your ham equipment?"

Save That Cordless!

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The age of the cordless electric appliance is upon us. Anything from a $5.00 flashlight to a $60.00 drill can be obtained with a built-in battery and charger, and the list includes such "essentials" of modern life as electric slicing knives and electric toothbrushes. Sooner or later some of these gadgets quit working and wind up in the trash can. The purpose of this article is to point out to hams that they can be a source of useful and unusual parts.

The diagram of a typical cordless appliance is shown in **Fig. 1.** In this diagram B is a nickel-cadmium cell, or a battery of such cells, which is the heart of the device. The useful load (flashlight bulb, or whatever) is represented by R, and the switch is used to turn it on and off. The charging circuit consists of the Capacitor C and the bridge rectifier assembly CR1 through CR4.

The total voltage of the battery B is usually just a few volts, considerably less than the 115 V 60 Hz power used for charging. As a consequence the rectifier operates under current-limited conditions, that is the charging current through the battery is practically the same as the rectifier short-circuit current. This current is determined by the electrical size (capacitance) of the capacitor C.

A capacitor of 1 μF has an impedance at 60 Hz of 2650 ohms, and if connected across the line would draw a current of 43 mA. Allowing a little leeway for the various tolerances a 1 μF capacitor will produce a charging current between 40 and 45 mA. Smaller capacitors will produce lower charge rates, and vice-versa. Of course the charge rate is directly affected by the line voltage and frequency. Another way to look at it is to assume that the capacitor charge reverses with each reversal of polarity of the line, whereupon the capacitor "dumps" a quantity of electricity equal to twice its charge through the rectifier and into the battery.

Most of the smaller cordless appliances are not made to be repaired and are sealed tightly in plastic housings. The housing protects the user from shock hazard and reduces any danger which might exist from exploding cells, but does nothing to facilitate our access to the contents. While the bolder readers may wish to attack the housing with hammer or vise, a more cautious approach using a hacksaw is suggested. Usually it is possible to make a series of shallow cuts completely encircling one end so as to get at the insides without damage. At this point I would like to say that in my opinion it is not worth the trouble of opening the device carefully with the idea that it can be repaired. If you are cutting into an expensive appliance you may think otherwise.

The first cordless device I opened was a flashlight. This had been received as a Christmas gift and had quit before Valentine's Day. Since return would have embarrassed the donor, the thing lay in the workbench drawer for two years before I faced up to the problem. Since I make it a policy to break open all defunct capacitors, transistors, etc., to see what gives, I had to cut into the flashlight before consigning it to File 13. The circuit was as shown in **Fig. 1.**

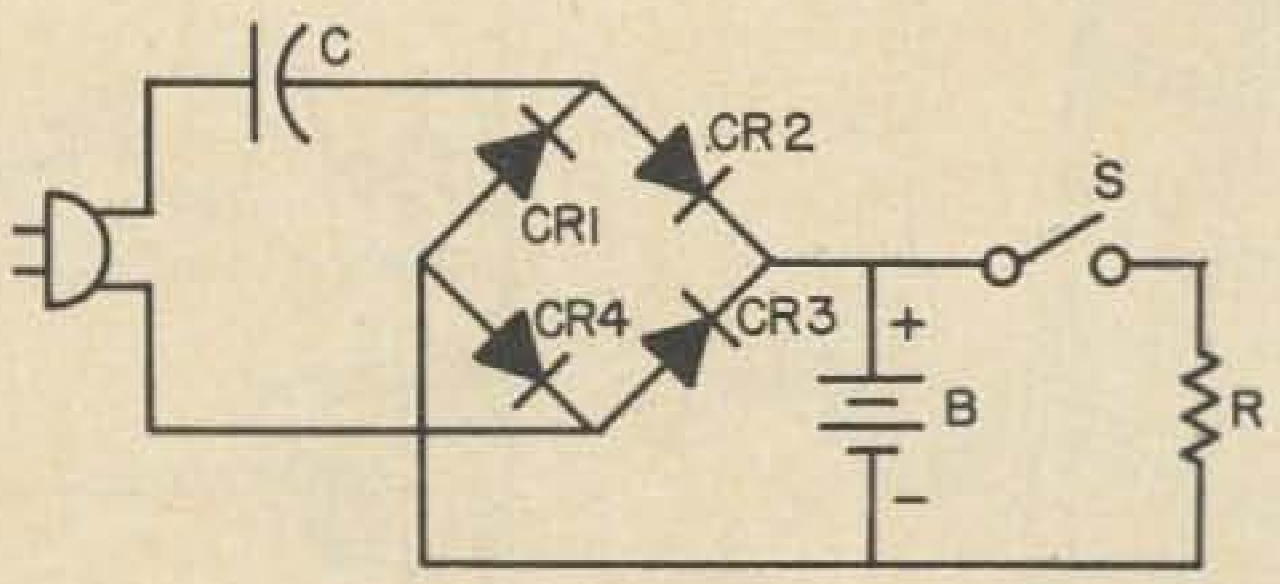

Fig. 1. Typical circuit for a small cordless appliance.

The battery consisted of two cells in series, each marked "250", which seems to be the capacity in milliampere-hours. The charging capacitor was 0.325 μF. The rectifier was a pellet about the size of a pea. One Ni-Cd cell was defective and all other parts were good. The charger charges the single good cell at 16 mA when connected across my power line (which reads a little over 120 v). After discarding the lens and housing I wound up with the following usuable parts:

1 Slide switch
1 Lamp bulb
(The parts mounted on an ac plug and suitable for re-use as is)
1 Capacitor, 0.325 μF, 200 v dc
1 Bridge rectifier
1 Ni-Cd cell, 250 mA

The next victim on my list was an electric toothbrush. The original had been purchased from one of the big chain stores. In a few weeks the brushes began sticking in the chuck and finally the shank of one broke off inside. The dealer exchanged the entire machine for a new one. This one ran for a couple of months before it got tired and wouldn't brush any more. Back to the store and we acquired unit #3, free of extra cost, of course. When it failed after a few months the wife tossed it in the wastebasket and forgot the whole idea of brushing teeth electrically.

When the toothbrush was opened the rectifier was found to be defunct. This rectifier also was a small pellet. It was cracked open and found to contain four rectifier plates, possibly selenium, each about 3/16" in diameter. Otherwise the toothbrush yielded the following parts in good condition:

1 Capacitor, 1.0 μF 250 v dc
1 Motor, Pm dc, 1.4 v at about 1 ampere
1 Ni-Cd cell, capacity estimated at 700 mA

To an experimented the potential utiliy of parts such as these should be obvious. The batteries do not supply a lot of voltage, but the voltage requirements of transistor and IC apparatus are decreasing. Many modern circuits are designed to operate around 3 volts and will operate satisfactorily from a single cell if the highest performance is not needed.

More discussion of the charging circuits may be in order. Note that in a circuit like **Fig. 1**, neither side of the battery is conconnected to either side of the power line. This means that neither side of the battery can be grounded while under charge. If a circuit like this is used in home-built apparatus care should be taken to disconnect the battery from any exposed loads before charging, and to make certain that you do not contact any part of the circuit while it is turned on.

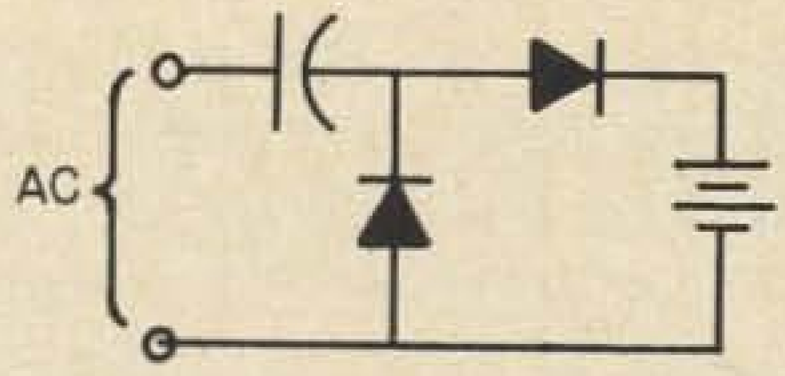

Fig. 2. Simplest charger.

Fig. 2 shows an alternate charging circuit which permits one side of the battery to be grounded. In this circuit half of the current bled from the ac source is shunted to ground through one of the diodes. For this reason the circuit charges the battery just half as fast as the circuit of **Fig. 1** would for the same size capacitor.

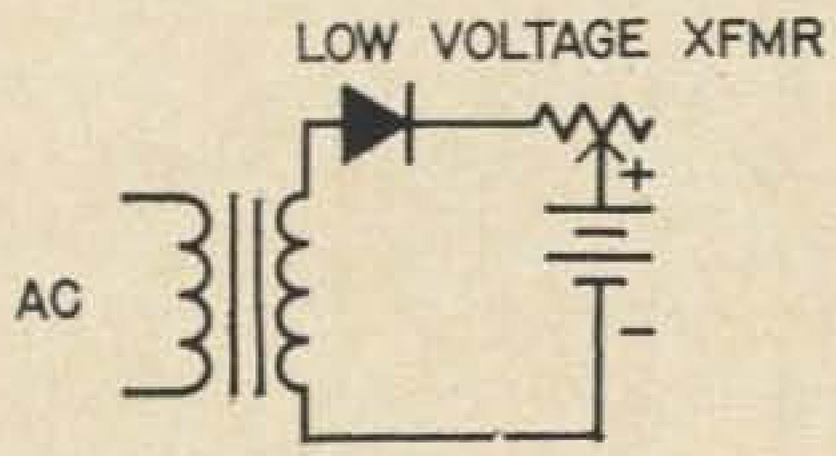

Fig. 3. Safest charger.

The simplest and safest circuit is shown in **Fig. 3**. This requires a transformer for isolation and protection, and may require some experimentation with the resistor to get the desired charge rate.

If the protection afforded by an isolating transformer is desired but no suitable low-voltage transformer is available, the circuit of **Fig. 4** may be of interest. This is a combination of the **Fig. 2** circuit and a high-

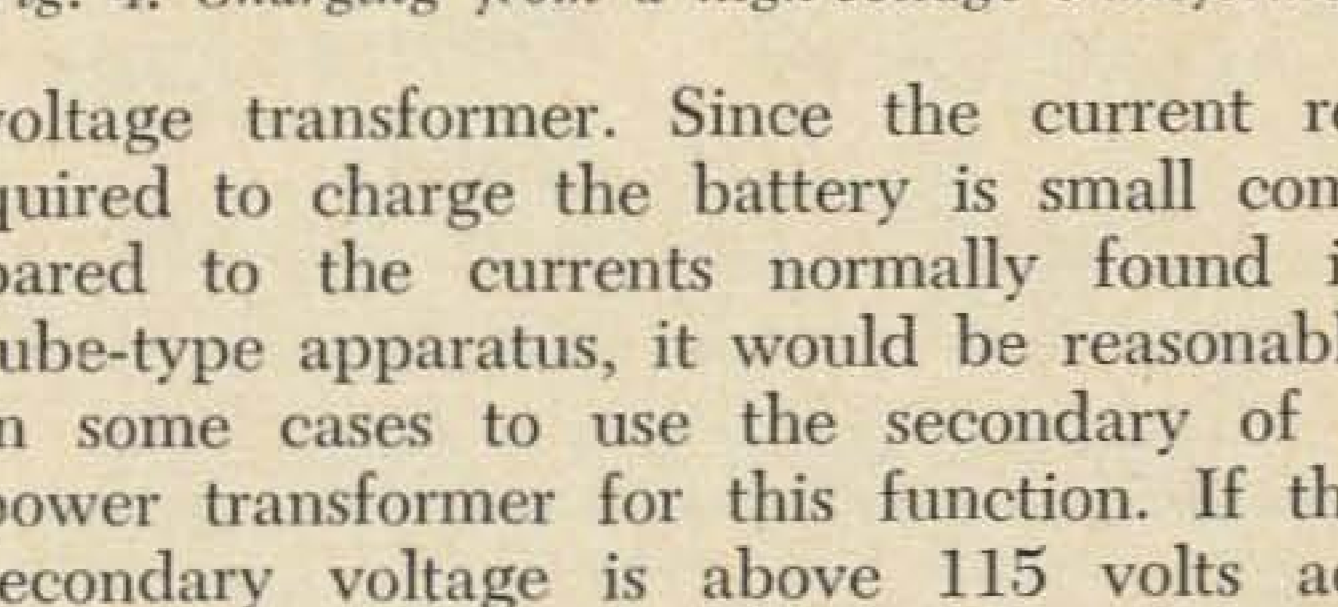

Fig. 4. Charging from a high-voltage transformer.

voltage transformer. Since the current required to charge the battery is small compared to the currents normally found in tube-type apparatus, it would be reasonable in some cases to use the secondary of a power transformer for this function. If the secondary voltage is above 115 volts ac, it will be necessary to reduce the capacitor size to get the desired charge rate.

An interesting point arises in connection with the voltage ratings of the components used in the circuits of **Figs. 1, 2** and **4.** Of course the capacitors should be rated for continuous service at the peak voltage encountered. Just to play it safe use a capacitor rated for at least 200 v dc on a 115 v ac circuit. The rectifier PIV rating is a bit more involved: so long as a battery is connected and drawing current the rectifier diodes are subjected only to potentials not much greater than the battery voltage. In other words, the battery and the conducting diode (s) hold down the voltage across the non-conducting diode(s). The situation is drastically different if the charger is operated without load. Under this condition there is no current drawn, and the reverse voltage applied to the diode(s) may approach the peak of the ac line voltage. So we have a situation rather the reverse of that usually encountered: these circuits are not harmed by normal loads, and are not harmed by operating into a dead short-circuit, but if low-voltage rectifiers are used they can be ruined by being operated with no load. The solution is obvious: either use high-voltage diodes or don't operate the charger without a load.

The writer does not qualify as an expert on the care and use of Ni-Cd cells, and cannot give complete instructions on the subject. The following abbreviated instructions may warrant consideration by those with no experience at all along this line:

1. The voltage of a single cell ranges from about 1.1 volts when discharged to about 1.4 volts when fully charged.

2. Leaving cells discharged in storage, especially with a load connected, does not extend their life. Despite this no cell should be discarded just because the output is below 1.1 volts before charging.

3. The capacity in milliampere-hours is sometimes marked on the cell. Unmarked cells frequently can be identified by looking up the physical dimensions in a catalog. Some of the radio mail order companies list enough information in their catalogs to make identification possible.

4. Most of the chargers charge the cell at somewhere between the ten-hour rate and the twenty-hour rate, that is, the charging current in milliamperes is between $1/10$ and $1/20$ of the capacity in milliamperes-hours. This information can be used to design a charger for a cell of known capacity, or conversely, to estimate the cell capacity from the size of the charging capacitor.

5. Cells contain a caustic electrolyte. Leaky or broken cells should be discarded in a place where children and pets cannot get at them. Wash the hands after handling and make certain none of the electrolyte gets in the eyes.

6. Cells can explode, but it seems to happen rarely. I have had just one go up on me and it was a defective cell of high resistance which I was trying to force charge with a charger bigger than the one included in the original device. It made a sharp crack like a firecracker but did not spew its contents about. If the cell capacity and the charging rate are known, overcharging can be avoided by discharging the cell fully before commencing charging, then charging just long enough to put in the rated capacity plus 20% or so. Probably it is safest to remove the cell from any delicate equipment in which it is used before charging.

7. The potential shock hazard of any transformerless charging circuit should be recognized. Note that the manufacturers who use these circuits nearly always seal the apparatus so the user cannot contact any part of the circuit while it is plugged into the ac line. . . . W3GKP

Building a Two Meter Ground Plane

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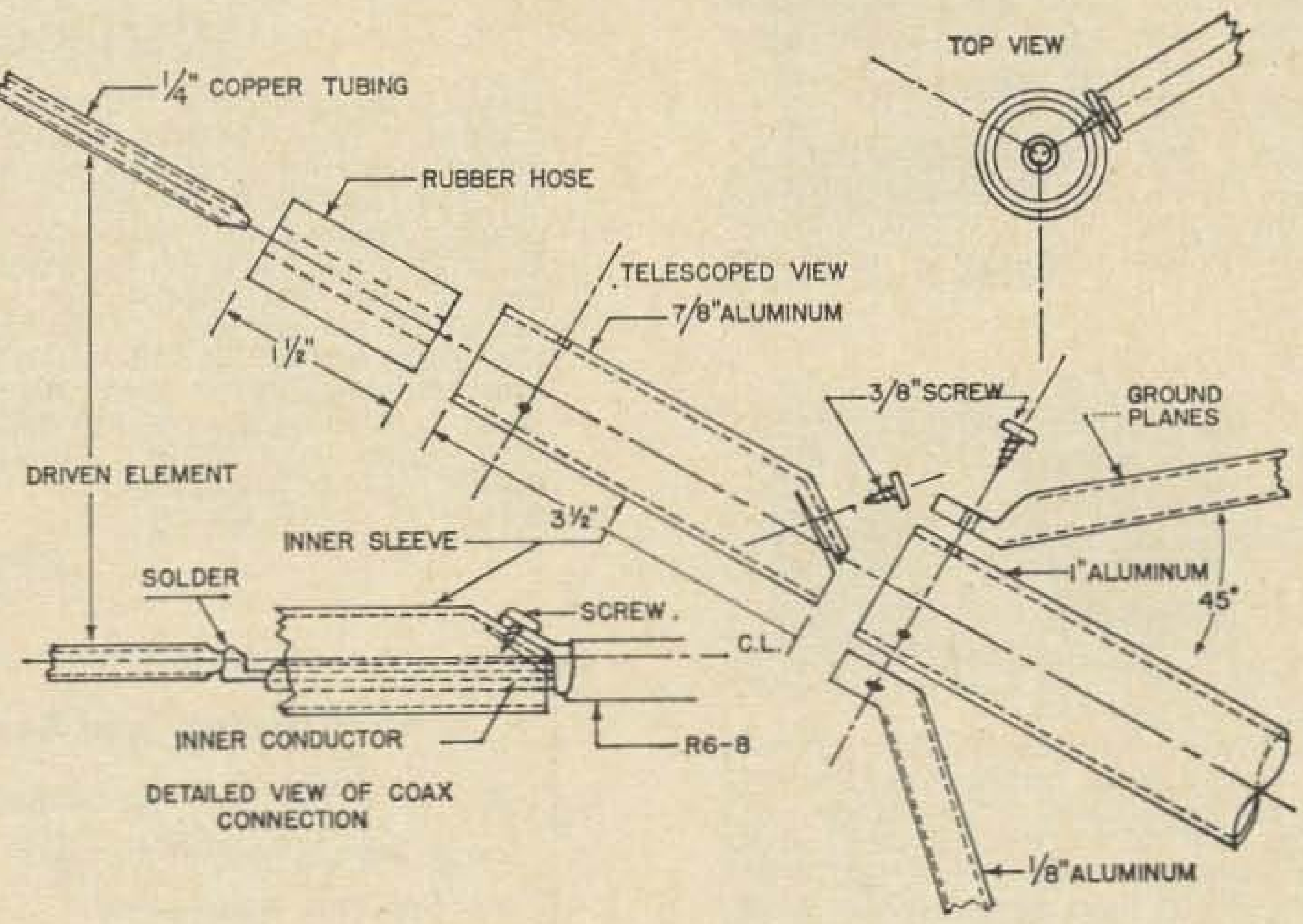

The simple ground plane antenna has long been a standard for simplicity, low cost, and dependability on the two meter band. If you are just getting started or are contemplating setting up a two meter station, the ground plane should be your first consideration for an antenna—especially if you are planning on participation in a net where a nondirectional antenna is desired. Granted, the ground plane offers no gain as you would expect from a beam or yagi antenna, but the ground plane need cost you very little, and will work effectively until you get a more exotic installation. This article will cover none of the theory involved; most hams will be eager to get on the air now and ask questions later. So, if you want an effective two meter antenna that will cost you very little, read on.

This whole idea resulted from the following three conditions:

1. A burning desire to get a two meter antenna installed quickly with no cost.
2. Holding a short piece of ⅞ inch diameter aluminum tubing in my right hand.
3. Holding a piece of one inch tubing in my left hand.

It soon became evident that the ⅞ inch tubing would fit inside the 1 inch diameter tubing, and very shortly after this, the idea of making the antenna completely coaxial evolved. A quick glance at **Fig. 1** from time to time during this discussion will aid you in constructing this antenna in your mind as you read. Perhaps later you can construct it in your garage or shack.

Construction

The telescoped view of **Fig. 1** shows the antenna pulled apart to show how it is assembled. The bottom piece of one inch aluminum tubing may be any length you desire, just cut the top off squarely and clean the rough edges to allow the ⅞ inch inner sleeve to fit inside it. This piece can be about three or four inches long, and is probably the most important part of the antenna. This is where the shield of the coaxial cable is connected. The detailed view of the coax connection shows that one end of this inner sleeve is cut and flattened to provide a way of connecting the coax shield. Since it is difficult to solder to aluminum, the coax braid is removed from the inner conductor by the conventional method of bending the cable, with the plastic outer shield removed, into an inverted U-shape, separating the wire braid of the shield and pulling the inner conductor out through the hole. This is more difficult with the larger cable, such as RG-8, but it can be, and is best done this way. Of course, the smaller RG-58 can be used as well, to lower costs. The shield is now flattened, tinned with solder, and can be fastened to the inner sleeve with a self-tapping metal screw. All holes were made with an ice pick to simplify construction. The coax shield may be permanently mounted after the next step which is construction of the driven element. All elements can be made about 19½ inches long for 144 MHz operation. Allow a little more length for the driven element to go down inside the inner sleeve. The driven element is made from ¼ inch diameter copper tubing to allow for soldering it to the coax inner conductor. The only problem that some of you may find is locating something to hold the driven element in place. In my case this was solved quite easily by a thick-walled piece of rubber hose that tightly fit onto both pieces to provide mounting and insulation. If you can't find a piece of hose try wrapping the driven element with plastic electrical tape to provide the same effect as the hose. After you have done this the coax may now be connected. After the inner conductor is soldered on, slide on the inner sleeve and attach the coax shield. If this makes too large a lump to fit into the bottom piece of aluminum tubing, file or grind it until it does.

Now that this part has been assembled, the ground planes can be attached. These elements were cut from an old TV antenna and are 19½ inches long. Flatten the ends with a hammer and make holes in them for the metal screws. Make three holes for the screws in the one inch tubing, all the way through to the insulator. Obviously, the screws can not be so long that they will short out the driven element. In this case ⅜ inch long screws worked well. All three elements are tightly screwed into the antenna body to provide a secure mechanical and electrical connection.

The final step is to carefully bend the ground planes up to an angle of 45 degrees. The antenna can be mounted to the bottom piece of aluminum tubing by any way you wish, but in my case, I made a vertical cut in the bottom of the tubing to split the bottom, allowing it to telescope over the top of a TV mast. A clamp was then applied around the split part to tighten the two pieces of tubing together. The coaxial cable then comes down inside the mast. The TV mast was then clamped to the top of my main antenna mast with U-bolts.

Results

The only proper way to adjust an antenna is with the aid of an SWR bridge to determine how well the antenna is matched to the feed line. This also provides a way to check our results. In this case I was very pleasantly surprised to find that the SWR for this antenna is about 1.1:1, a very good reading, considering that no adjustment was made to the antenna before putting it up. The important point to make here is that anyone can construct this antenna without elaborate measurements or adjustments and be confident that it will work, if no drastic errors are made. The SWR stayed very constant over the whole two meter band, showing that it can be used over a wide range of frequencies without degradation of its performance.

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

Since the top of the antenna is sealed, very little moisture can get in to corrode the coax connection. The coaxial construction, while being physically attractive is also electrically desirable. This antenna has been in use for over a month now and shows no wear in some of the strongest winds that we have here. In the same storm, it even survived the heaviest snow fall that the South Bay Area has seen in eighteen years.

Conclusion

If you have been considering two meter operation perhaps these ideas will provide the incentive that you've needed. This antenna has provided me with an effective "temporary" installation that may last for several years.

. . . WB6BIH

(1) If a ground plane is mounted at the side of a mast rather than at the top, it will give a small amount of gain for covering an area other than a symmetrical circle around the antenna. Be sure to read 'The Two-Meter Groundplane as a Gain Antenna", by K6MVH in the January, 1968 issue of *73*.

Improving Frequency Stability in Older Receivers

Alfred Wilson W6NIF
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San Diego, Calif. 92103

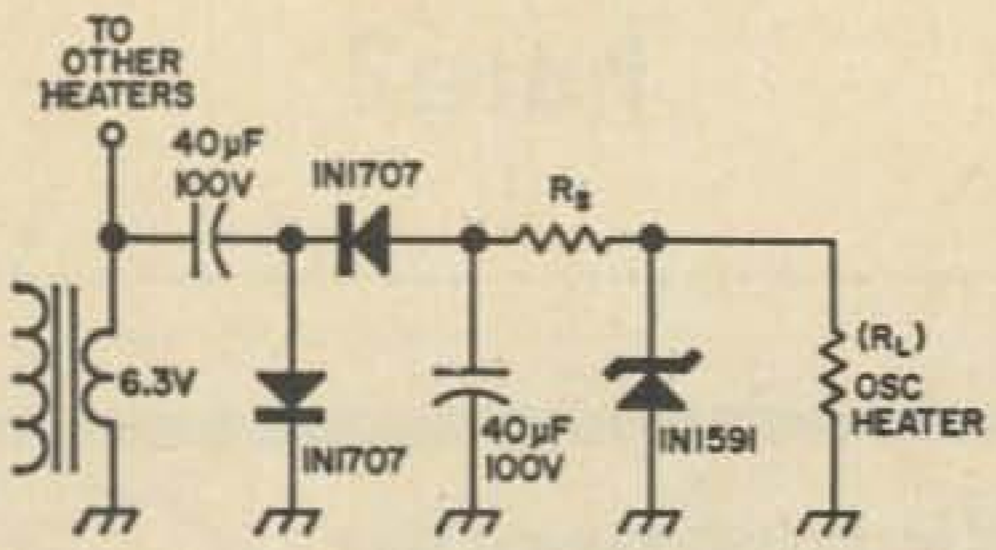


Fig. 1. *Modification Schematic*

Today's modern receivers and transceivers are marvels of engineering advancement and a joy to look at and operate. Frequency stability and selectivity are just about as good as anyone could ask for. But what about the old clunkers of, say, 1950 and earlier vintage that many of us are stuck with? Components deteriorate with time, temperature, and humidity to the point where many of these older sets are virtually useless for communications purposes, especially on single sideband and cw.

The following article offers an easy and inexpensive way of reducing local oscillator frequency drift to a degree that is competitive with contemporary designs. The writer's receiver is a case in point. Local oscillator drift became so bad over the years that the 25-year-old receiver was impossible in DX or contest work.

The *if* circuits had been reworked in the past for increased selectivity, and the local oscillator drift problem was aggravated because the narrower bandwidth reduced the size of the "window" in which the oscillator frequency had to stay put. Receiver drift became so bad during periods when the transmitter was on the air that it was futile to even call a station in QRM. He just wasn't there when the receiver was reactivated. After losing several DX contacts because of this nuisance, it was decided that something had to be done.

The receiver local oscillator is typical of those in most older sets: a triode in a grounded cathode Hartley circuit, with negative temperature coefficient coupling and padding capacitors. Oscillator plate and mixer screen voltages are stablized with a VR tube. This particular receiver even had a temperature compensating device on the frame of the local oscillator tuning capacitor. This little gadget was a bi-metal strip that operated on the thermostat principle. As the internal temperature of the receiver rises, the bi-metal strip, which is positioned close to the end of the oscillator tuning capacitor rotor shaft, moves in a direction to reduce the oscillator tuning capacity. This, theoretically, is supposed to compensate for the frequency drift.

All the usual remedies to cure drift were tried without much success. Replacing the oscillator, mixer, and VR tubes did not help. The temperature compensating capacitors (coupling and padding) were replaced with units having a higher negative temperature coefficient. This helped to stabilize the long-period drift, but did not solve the problem for short-term variations such as occurred during standby (receiver B voltage off; transmitter on).

A hot soldering iron placed near the bi-metal compensator strip had absolutely no effect. The thing wouldn't budge, even with the iron almost touching it. The only answer to this seemed to be that, over the years, the coefficient of expansion differential of the two metals had somehow changed, so that it was probably near unity; hence no movement with temperature variation. Out with the "bi-metal compensating strip"!

In a final attempt to stabilize the receiver local oscillator, some quick measurements revealed that the oscillator heater voltage decreased from a nominal 6.3 volts to anywhere from 5.6 to 5.8 volts when the transmitter was turned on, depending on what other transient loads were on the 115-volt ac line. One remedy would have been to run a pair of No. 6 ac feeders into the shack, but this would have cost about $100 including materials, electrician's license, and inspection fees.

The circuit of **Fig. 1** solved the problem nicely, with a total outlay of about $2.00 for the 1N1591 zener diode. (The other parts were obtained from the junk box.)

The 1N1707 silicon diodes are in a half-wave voltage doubling circuit. The current through resistor R_S depends on the load, R_L; i.e., the current required by the oscillator heater. The only precautions to observe are that the diode polarities are as shown and to make certain that the value of R_S is such that the zener does not exceed its maximum power dissipation if R_L is removed. An added refinement is to include the mixer heater in the regulator circuit, again observing the requirement for maintaining the zener power dissipation within ratings by appropriate choice of R_S.

What actually happens in the oscillator, when heater voltage varies, is that the thermal differential changes the heater-cathode capacitance. The cathode is part of the Hartley tuned circuit, so obviously the LC ratio is no longer constant under these conditions. Another effect is that oscillator grid current also varies, further complicating the stability problem.

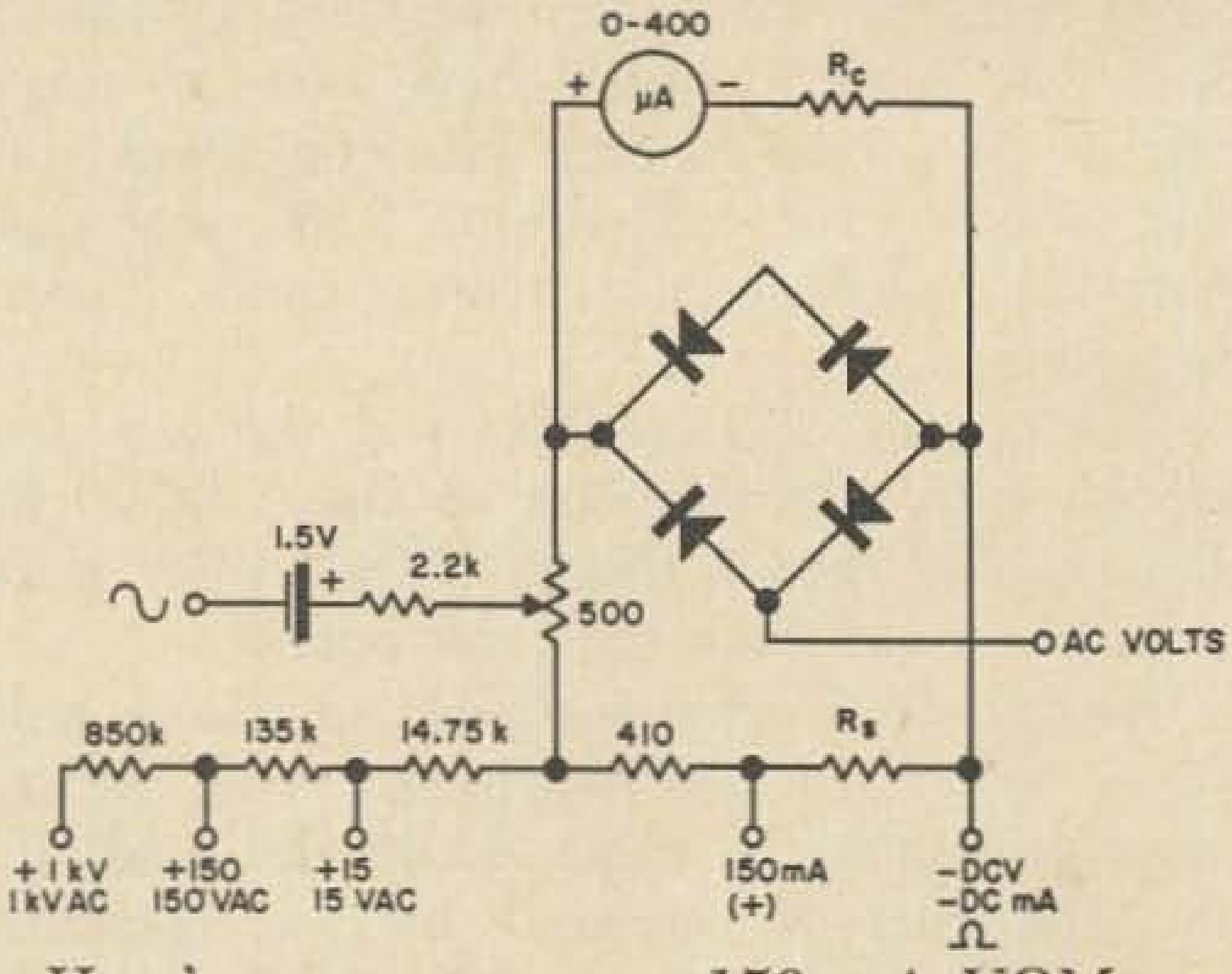
With the receiver cooled down in this manner, the oscillator drift was reduced by an order or magnitude; i.e., from 2000 to 200 parts per million. An added benefit was that dc is used on the heaters, with a corresponding reduction in hum on the 10 and 15 meter bands.

. . . W6NIF

Swedish CB

A note from SM5ZS tells us that there are now about 15,000 Private Radio licenses in Sweden. This is the same as our CB with licenses being issued for $4 to anyone over 18 years old. They may not contact stations which are not on the same license. They are permitted ⅛ watt on the lower PR band and 5 watts on the higher band. Many potential amateurs are getting interested in radio through the PR license.

VOM SENSITIZER



Here's a way to use a 150 mA VOM as a 0-450 micrammeter—an increase in sensitivity of 333-fold. It takes no transistors, batteries, diodes, or, for that matter, wire or solder. The whole job can be done in five seconds.

The meter used is Radio Shack's small 1,000 ohms per volt VOM #22-4027, which sells for $5.95. Other radio supply houses sell identical or similar ones, possibly made by the same Japanese manufacturer. It's the one that measures 3⅛" x 2⅜" x 1".

To make the 0-450 microammeter out of it, simply put the positive test lead in the "AC Volts" socket, and the negative lead in the usual one (labeled DC-ohms in Radio Shack's version), and you're in business.

To see how it works, take a look at the circuit.

The meter movement has a sensitivity of about 400 microamps; R_c, inside the meter, calibrates it to that figure. Used to measure current, the VOM shunts the test leads with R_s, about 2.7 ohms. Remaining current flows through the meter, with 910 ohms in series with the meter's internal resistance of about 100 ohms. Result: 150 mA sensitivity.

But if you feed the unkown current in by way of the "AC Volts" socket (positive) and the "DC mA" socket (negative), the current will flow through part of the diode bridge direct to the meter. This leaves a shunt of 2.7 ohms or so (R_s), but of nearly 913 ohms. This is of course large compared with the meter's internal resistance.

This shunt and the small forward resistance of the diode in series, give a range of 0-450 microamps.

It's a convenient figure, for the calibration on the meter face is 0-150. Simply multiply by 3 to get a true reading. . . .WN6ZRB

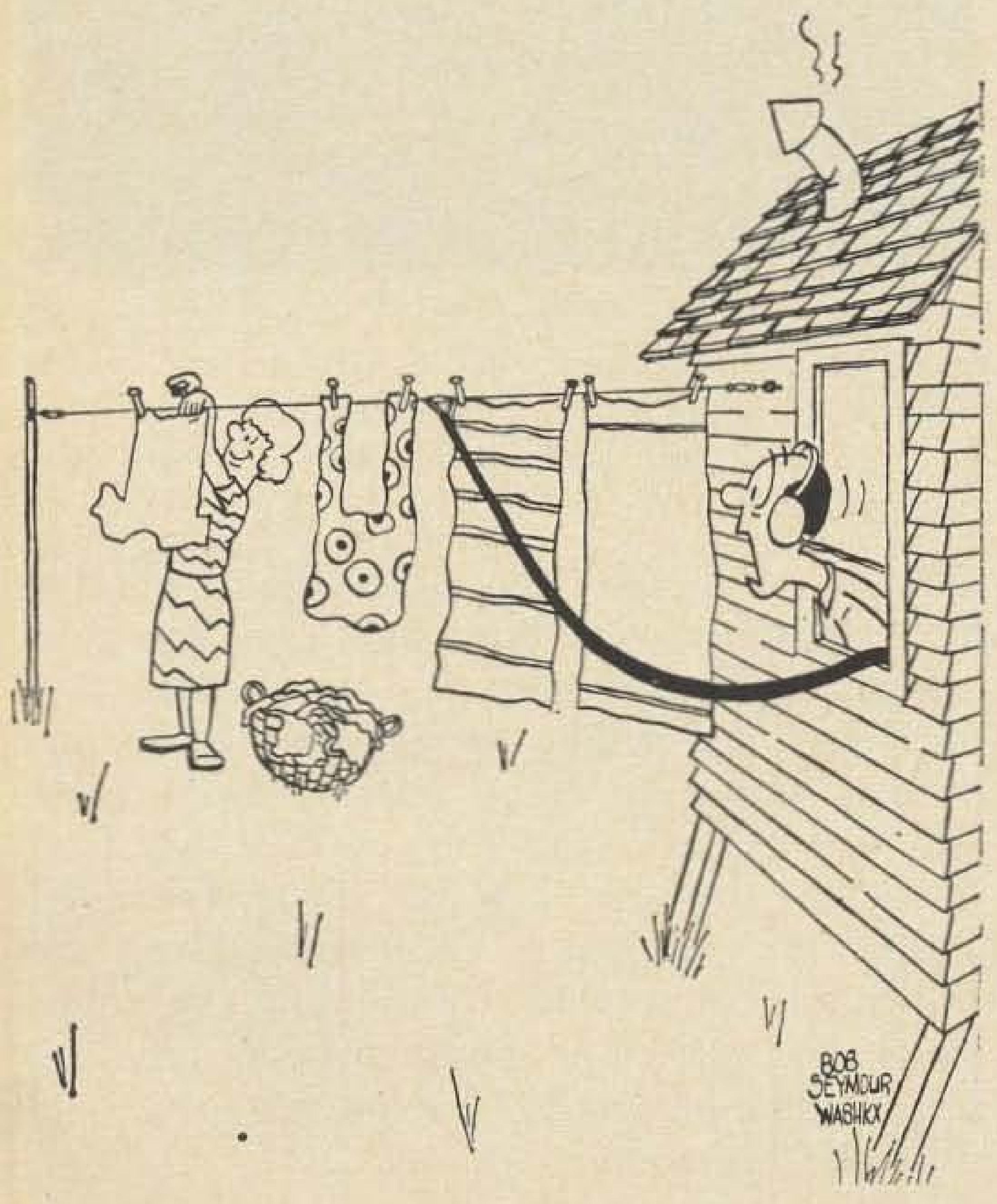
Missed Opportunities

While a lot of hams seem to be looking around for some way to get a toe in the ham business end of things, I notice that one nice little enterprise has been left rather open for several years.

Kits. A few years ago we had a chap down in Texas that used to put together kits for most of the interesting construction projects that were published in the ham magazines . . . particularly those using printed circuit boards. He did a nice brisk business in these kits. Then along came a heart attack and he had to take it easy.

There probably isn't enough profit in the thing to attract a regular parts supplier, one who would have to pay salaries . . . but it should be a good home business for a fellow with some time on his hands and enough money or credit to work up a deal with a parts supplier.

After my own experience in the kit business a couple years ago I would suggest some agreement with the parts supplier whereby he will take back unused parts for credit. The margin on kits has to be rather small in order to attract buyers so you can't really afford to have a lot of stuff sitting around when a kit runs out of steam. I found that kits sold quite well . . . some sold hundreds upon hundreds. My only problem was that I ran out of spare time to do the work needed. This might make a nice little family business.



The Care and Feeding of a Ham Club

Carole Allen W5NQQ
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Part IV Hams VS the Public

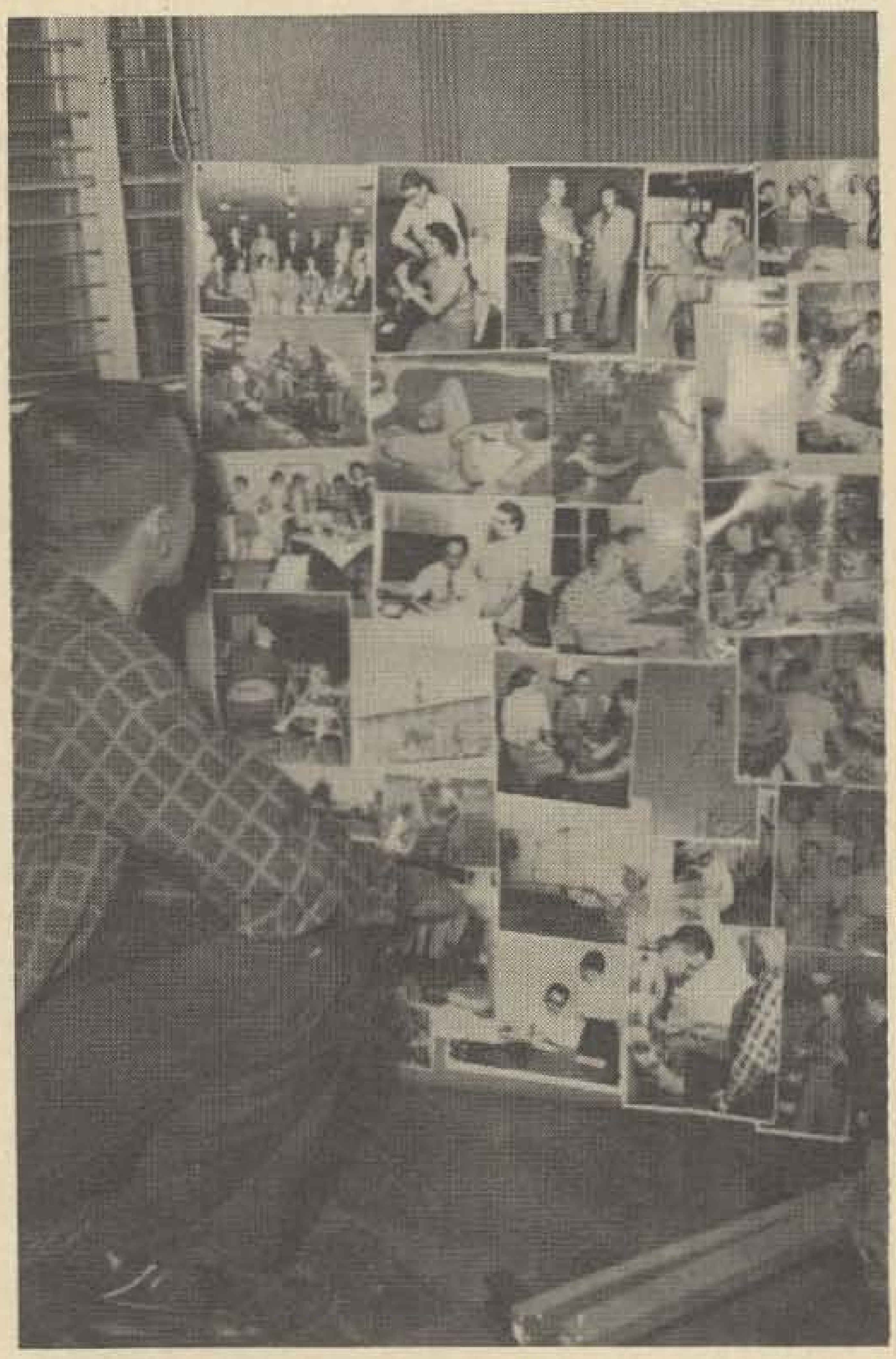
Hams get a lot of publicity, but it isn't always the right kind. One bad case of ham-type television interference can stir up a whole neighborhood, and it takes a lot of good publicity to calm it down. In fact, the more time, money, and energy the publicity chairman has to devote to his job, the better it is for every member of the club.

Sending notices of meetings and social events to members is among the routine duties of the chairman, but there are lots more. Folks who don't know much about amateur radio get the idea that all hams can do is call "CQ", talk about the weather. and broadcast on television sets when the best programs are on. Sooner or later, some of these people ask "why" and want answers.

The "ounce of prevention is worth a pound of cure" policy is always best because folks who realize they may need a high-pass filter on their own TV set will try to sweep their own doorstep before lynching the neighborhood ham. It's safe to assume that the general public doesn't know what knowledge a ham has to have to get a license, the regulations he observes, etc., so this is a good place to start. Every newspaper and radio station clamors for interesting features about local personalities, and the publicity chairman should take advantage of this chance to get the "ham story" across. By introducing an operator and his family to the community and then sneaking in vital facts about filters, FCC regulations, and the ham's role in emergencies anl disasters, the publicity chairman can sugar-coat the public's pill and get alot of information to them.

An informal interview on the local broadcast station reaches hundreds of owners of small filter-less radios who pick up amateur transmissions as handily as some television sets.

The interview or article should begin with a brief explanation of "How to be a Ham" moving on to the "fun side" about what its like talking to every type, age, size, and color human being all over the world, and then finishing on a public service theme. It's just human nature to enjoy hearing what someone else can do for you, so mention Civil Defense programs, RACES plans, the availability of emergency communications, and the nation's network of willing volunteer hams. If a person is going to know anything about amateur radio, he ought to get all sides of the story.



A sharp Publicity Chairman will always be on the look-out to publicize the activities and public services of local hams. Photographs of each member available for publication add interest to a publicity release.

The publicity chairman should try to strike while the iron is hot when big news breaks. If your club flies into action during a crippling ice storm, hurricane, or forest fire to order medical supplies, provide communications, dispatch trains, or call fire fighters, let the public know. Before the ashes cool or the ice melts, type up news releases for all newspapers in the area. Do the same before and after practice alerts and mobile drills; let the people hear that hams spend hours and days at the job of being ready to work for the public.

Field Day offers another golden opportunity to advance the cause of amateur radio. News releases with photographs of local hams get more attention than a nameless review of what the club is going to do and where. Emphasize and re-emphasize the fact that the purpose of Field Day is to test equipment and train operators who will be needed to serve if real trouble comes along.

The truth is, of course, that bad publicity travels as fast as lightning to ground and people learn all too quickly about TVI, BCI, and HI-FI-I. A Publicity Chairman has to work hard to show John Q. Public that hams are important and valuable members of every community.

How About a Job?

Election of new club officers is sure to start members buzzing, and whether you vote in the spring, fall, or in between, make the most of it. Attendance should be great on election night, for when everyone gets the word that its time to switch jobs around, they'll show up in self-defense to make sure nobody else "volunteers" their services.

One tried-and-true election procedure begins with a list of candidates drawn up by a nominating committee appointed by the president. This group of thinking people can take their time picking prospects who seem qualified for certain jobs. They've got to remember that everybody isn't able to lead a meeting, take down notes, or keep the bank account balanced. Sam's voice may flow like honey when he's holding a mike, but he might spew and sputter with a president's gavel in his hand. In addition to selecting candidates who will work out well, the committee can check to make sure the by-laws of the club are observed. For instance, the Stuyvesant High School Radio Club of New York with 150 members stipulates that their president must hold at least a Technician or General Class license while Novices can be secretary or treasurer if they have spare time after copying code.

In order for a club to be ready to function smoothly during a disaster or emergency, drills have to be planned on a regular basis. Here, a mobile operator (left) relays traffic from the scene of a near-drowning.

To avoid embarrassment and confusion at the election itself, the committee should check with the candidates to make sure they'll accept if voted in. If the "O.K." is given, the list can be presented to the membership for their revisions and approval. The president will ask for nominations from the floor before the final vote in order to give everyone an equal chance.

It's generally agreed that the "secret ballot" is the best way to elect officers to avoid hard feelings among friends. Why risk a rhubarb if it isn't necessary?

Here and there, a club chooses to pass the buck and elect a Board of Directors who function annually to pick a new president, vice-president, secretary, and treasurer.

Sometimes members say "no" to the nominating committee because they're not sure what's expected of them. For this reason, a clear-cut definition of the duties of the officers will be a big help. The Johns Hopkins ARC of Baltimore, Maryland, submitted a good example of a Constitution which leaves no questions unanswered. Consisting of 10 Articles with numerous points of explanation, it covers everything from Purpose and Policies to Voting and Attendance. Under Duties of Officers, the following comments are listed which can be applied to all clubs:

1. The President shall preside at all meetings and shall assume all duties usually associated with this Office. He shall, further, be a member ex-officio, of all standing committees and shall execute

all duties as are assigned him in several places in this Constitution and its By-Laws.

2. The Vice-President shall assume the duties of President in the absence of that Officer. He shall, further, assist the President in all functions of that Office and shall be a member ex-officio of all committees.
3. The Secretary shall keep an accurate record of all Official meetings of the Club which may be ready upon request. He shall also carry out all such correspondence as is necessary in the normal operation of the Club.
4. The Treasurer shall handle the finances of the Club. He shall, further, be responsible for filing the necessary forms with the Student Activities Commission of the Johns Hopkins University for the purpose of obtaining funds from the Club's Account with the Commission. These forms shall be counter-signed by the President.

If the Nominating Committee can cajole, convince, and wheedle members to take over the top spots, their job is almost done; that is, if the club has a constitution similar to the Hopkins ARC specifying that the President shall make various appointments. Among the important chairmanships to be filled are: Publicity, Program, Field Day, Refreshments, Newspaper, Special Projects, Training, Civil Defense and Alerts, Attendance, Fixed Station and Traffic Handling, and dozens of others.

Should the nominating committee or the new president find that nobody's willing to take a job, there's only one course of action left . . . Just fall back on the system used by the Bedford Radio Club of Massachusetts—they call it "lassooing" and it means just what it says.

Do It With Dues!

The best things in life may be free, all right, but it still takes money to run a radio club. Whether your group is big or little, it's easy to list a lot of items that cost; some small, but all essential.

For example, postage for publicity releases, meeting notices, and bulletins requires a substantial amount. If the club mails certificates to those who work a certain number of members, this takes more postage and printing expense, too. Most clubs have bulletins and that means buying paper, stencils, Ditto-masters, and still more stamps. A large group may have to rent a hall, maintain a special building, and pay utility bills. Log books and QSL cards are needed for the club chairman, and don't forget the program chairman who needs a few shekels to rent a film and cross a speaker's palm with silver.

Although there are several ways to keep a treasury in good shape, collecting dues is probably the most dependable one. And almost everyone is used to paying dues in other organizations, so announcing that they're payable won't be a rude shock to anyone.

Many radio club members pay their dues either annually or monthly, and the amounts vary from \$2 to \$5 per year from 25¢ to 50¢ per month. Of course, the method of payment directly affects the amount of club income, so the Monthly vs. Annually payment plan is discussed enthusiastically at a lot of meetings.

The Lump-Sum people contend that forking over the entire amount at one time has several advantages including getting rid of the obligation for a whole year and also in knowing that a member's support of the club continues even if he can't make it to every meeting. Should \$5 dues seem steep for a family of two, three, or more hams, a scale can be used requiring full dues from the "boss" and \$1 for his XYL and each licensed harmonic.

The Pay-as-You-Go folks argue that it's easier on the pocket-book to pay by the month or the meeting. High school and college students who have to pinch pennies appreciate the installment plan more than adults. For this reason, too, a student-rate is used by many clubs to encourage younger members to join. And although a busy ham attends only three or four meetings during a year contributing one or two dollars in dues, he may have a 100 per cent record the following year and more than pay his way.

It would be misleading to leave the impression that everyone pays dues without a second thought, for it isn't the case at all. Most hams meet their obligations as faithfully as they renew their licenses, but now and then someone forgets to pay off. And occasionally a floater shows up who comes to meetings, uses the club station, dirties the ashtrays, and drinks free coffee without adding a cent to the till. This guy can be a problem if too many faithful dues-payers hear about him. Since the treasurer is the one with the purse strings, he or she knows who pays and who doesn't. Perhaps he can remind everyone at once during the business meeting with a statement like "Say, gang, the treasury's down a little; how about you late ones kicking in your dues?" If this doesn't get results, a notice in the club bulletin along the same lines will serve to remind the delinquent member.

Many folks prefer a regular billing procedure, and if this can be set up, payments are apt to be made on a more business-like level. Of course, in the event these efforts aren't successful, you can try passing the hat to him at the meeting, and if you still don't get a donation, just be thankful he didn't take any out!

. . . W5NQQ

To all ARRL Members

B. R. Council, KØATZ, is a candidate in the upcoming election for Rocky Mountain Division ARRL Director.

"Slats" Council is well acquainted with the legislative and administrative side of Amateur Radio and the ARRL.

Council pledges his strongest action for a better and more representative ARRL, and will do all possible to secure Board action to strengthen ARRL and Amateur Radio in the following:

(a) More DIRECTOR action to secure compliance by ARRL HQ with Board directives.
(b) ARRL support, by QST articles, of FM, and FM repeaters. ARRL to publish an FM manual.
(c) Stronger ARRL action *against* the malicious QRM, obscenity and other illegal operation so prevalent on the bands.
(d) Sale of ARRL publications at lower cost to MEMBERS than to non-members.
(e) An ARRL-operated outgoing DX QSL bureau, without delay.
(f) QST-published factual test results of manufactured equipment.
(g) ARRL support of the EIA Standards project and program.
(h) ARRL Communication Department to better serve the ARRL Members thru handling of routine Comm. Dept. matters.
(i) ARRL to establish DX committee consisting of representatives of leading DX clubs, representatives of all magazines in USA carrying DX matters, plus an ARRL staffer—this committee to arrange for DX contests, awards, and to settle country lists and other similar disputes.
(j) ARRL to take a more active part in the Amateur Radio SPACE program by supporting OSCAR-type projects, and NASTAR, the project to put a ham station on the Moon. ARRL to equip and maintain an ARRL Earth-Moon- Earth station on a 24-hour basis for EME work with other stations.
(k) ARRL to add Field Representatives to better SERVE the ARRL members and the Amateur body as a whole.
(l) Mr. Council pledges to keep the membership fully informed as to the results of legislative and administrative measures brought up to the Board for action, and to take cognizance of members ideas, desires and suggestions, with "feed-back to the members" thru the Director's letter to the Members. ARRL Members will shortly receive literature setting forth the above, in detail. Your careful study and consideration of this material will be worthwhile.

Your vote for Council, KØATZ will help bring about a BETTER ARRL and a more representative type of Directorship in this Division.

Committee to Elect Council and Banks.
A. David Middleton, W7ZC/W5CA, Chairman
Past Director—West Gulf Division
Director—WCARS
Member—Utah Ham Boosters

Using Candles

One of the many cheap but useful accessories in the workshop is an ordinary wax candle. Besides being handy to have around when the lights go out after you "Blow The Fuse", a candle is also:

a . . . the recommended lubricant to use when drilling or sawing aluminum.

b . . . an effective emergency soldering flux.

c . . . good for easing sticking drawers, doors, etc.

. . . R. B. Kuehn WØHKF

Glenn R. Brown W8JZI
689 Drummond Court
Columbus, Ohio 43214

Practical 6 Meter Ground Plane Construction

Many fine articles have been written about the ground plane antenna. These articles go into great detail about polarization, angles of radiation, methods of matching, etc., etc.

This article is intended to show how to *construct* a ground plane antenna for six meters. The method of construction can be duplicated with very little expense, and a minimum of tools. You don't have to be part owner in a machine shop, foundry, or plumbing supply house to get through this project.

Popularity of the ground plane antenna is due to several characteristics. Since the ground plane receives (and radiates) equally in all directions, the ground plane is ideal for local nets. With the increasing availability of good surplus FM equipment, the ground plane should become even more popular.

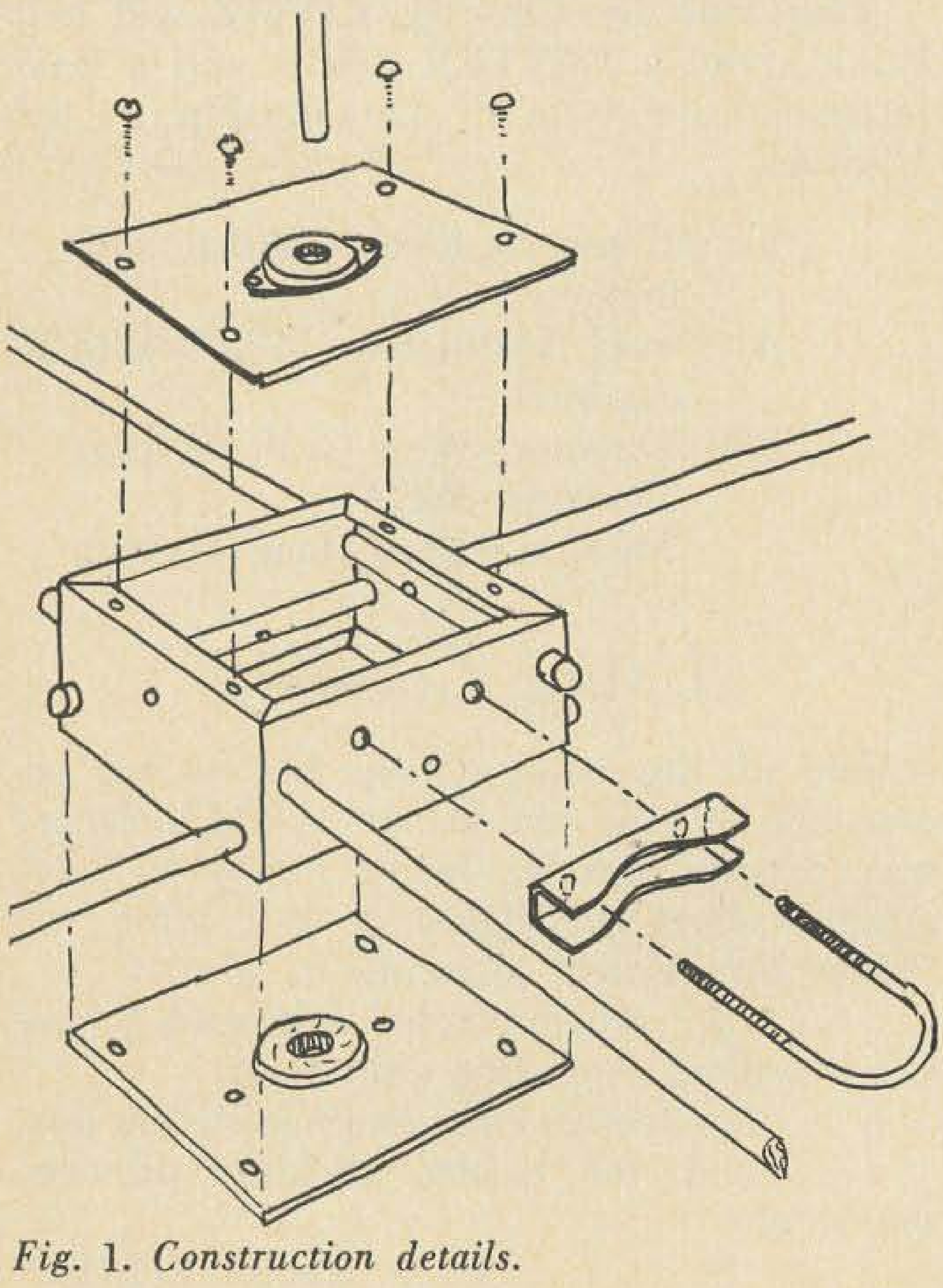


Fig. 1. Construction details.

Since the ground plane is vertically polarized, good reliable communications can be maintained between mobile and fixed stations.

Even the most serious 6 meter amateur should supplement the beam antenna with a ground plane to assure all-around good coverage under all conditions.

Construction. The elements used here were ⅜" diameter solid aluminum tapered shafts, cut down from a Citizens Band Antenna. (This commercial ground plane antenna had failed at the center where elements were joined!) Similar Citizens Band ground plane antennas abound in all parts of the country, and it should not be too difficult to find a damaged or used antenna available at reasonable cost.

The elements can, of course, be aluminum tubing. TV antennas should not be overlooked as a possible source of suitable elements.

Referring to **Fig. 1**, the heart of this ground plane is a *steel* box. The box used here was a *Bud* CU-883-HG Metal Utility Cabinet. (About $1.30 Net). This box comes with 2 removable covers, and necessary screws to attach the covers.

The elements are cut to the proper length for the frequency desired as described in the various Handbooks.

Holes are drilled in the 2" sides of the box for the four horizontal elements. Note, in **Fig. 1**, that two elements are set high, and two are set low, so that adjacent elements will not interfere with each other when inserted into the box.

Measure and drill all holes carefully so that all elements will parallel the top of the box when assembled. Select a drill size that

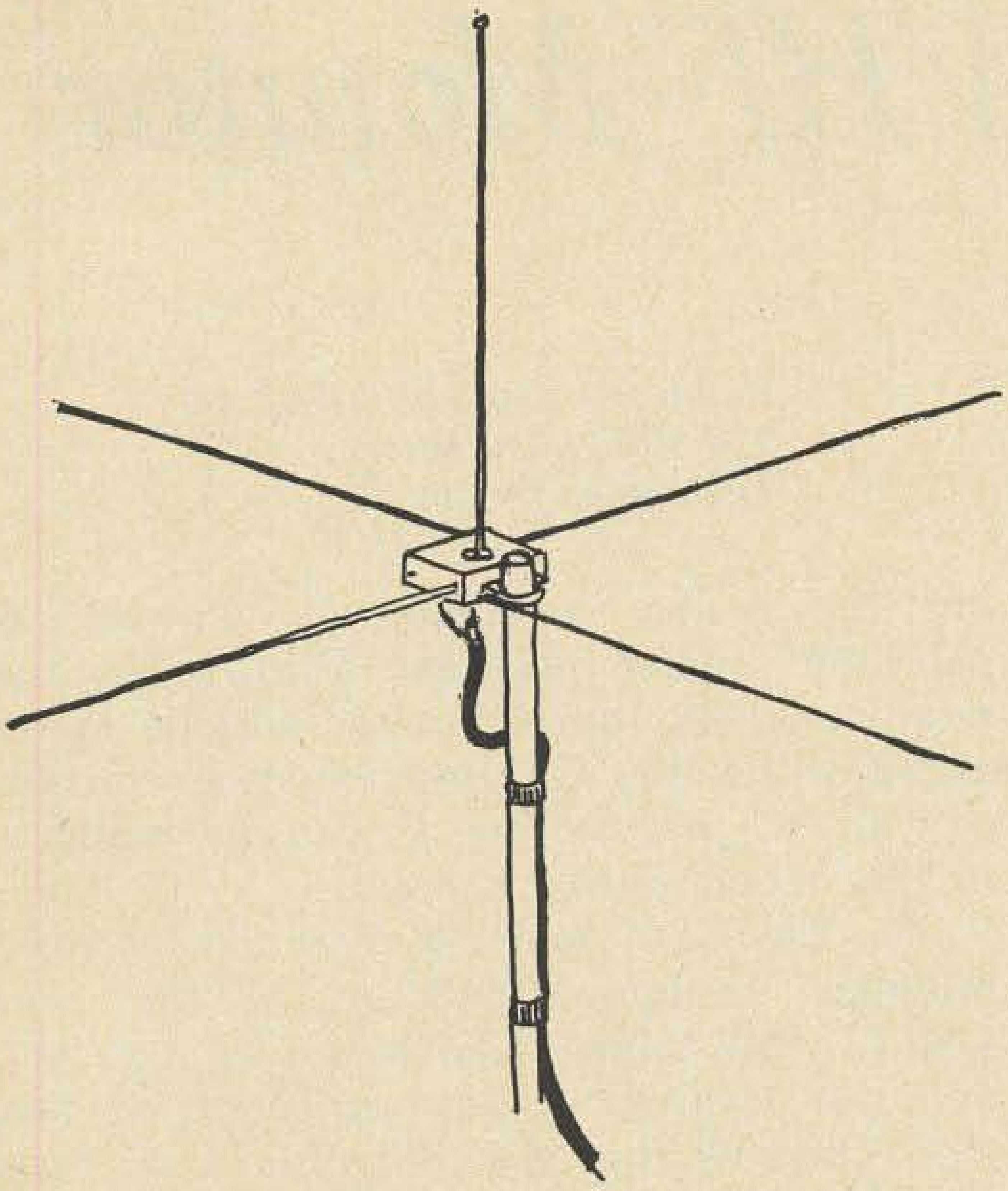


Fig. 2. The completed ground plane.

will give a snug fit when elements are inserted.

Once the horizontal elements are in place, they are secured by drilling a small hole through the box and through the element. A small bolt is then fastened through each element to a nut and lock washer.

The vertical element is insulated from the box by two octal sockets, located in the center of the top and bottom box covers. All pins in the *bakelite* sockets are carefully removed. The center hole in each socket can be filed out slightly to provide a snug fit for the vertical element. A small hole is drilled in the vertical element just above and below the point at which the element protrudes from the assembled box. Small screws are inserted into these holes. The bottom hole provides a point for connecting the inner conductor of the coax feed line.

The ground connection (outer shield) is connected to a lug secured to one screw of the bottom octal socket base.

After all parts have been assembled and checked, the top cover and vertical element are temporarily removed. Holes are then located and drilled for the U-bolt clamp. A convenient length of mast is then placed through the U-bolt and the U-bolt is secured.

The antenna can be re-assembled and the coax attached as shown in **Fig. 2.**

Many schemes of weather-proofing this assembly are available. One unusual and very easy method is to apply undercoating material from an aerosol can. This material is available at very reasonable cost in spray cans from most auto supply houses.

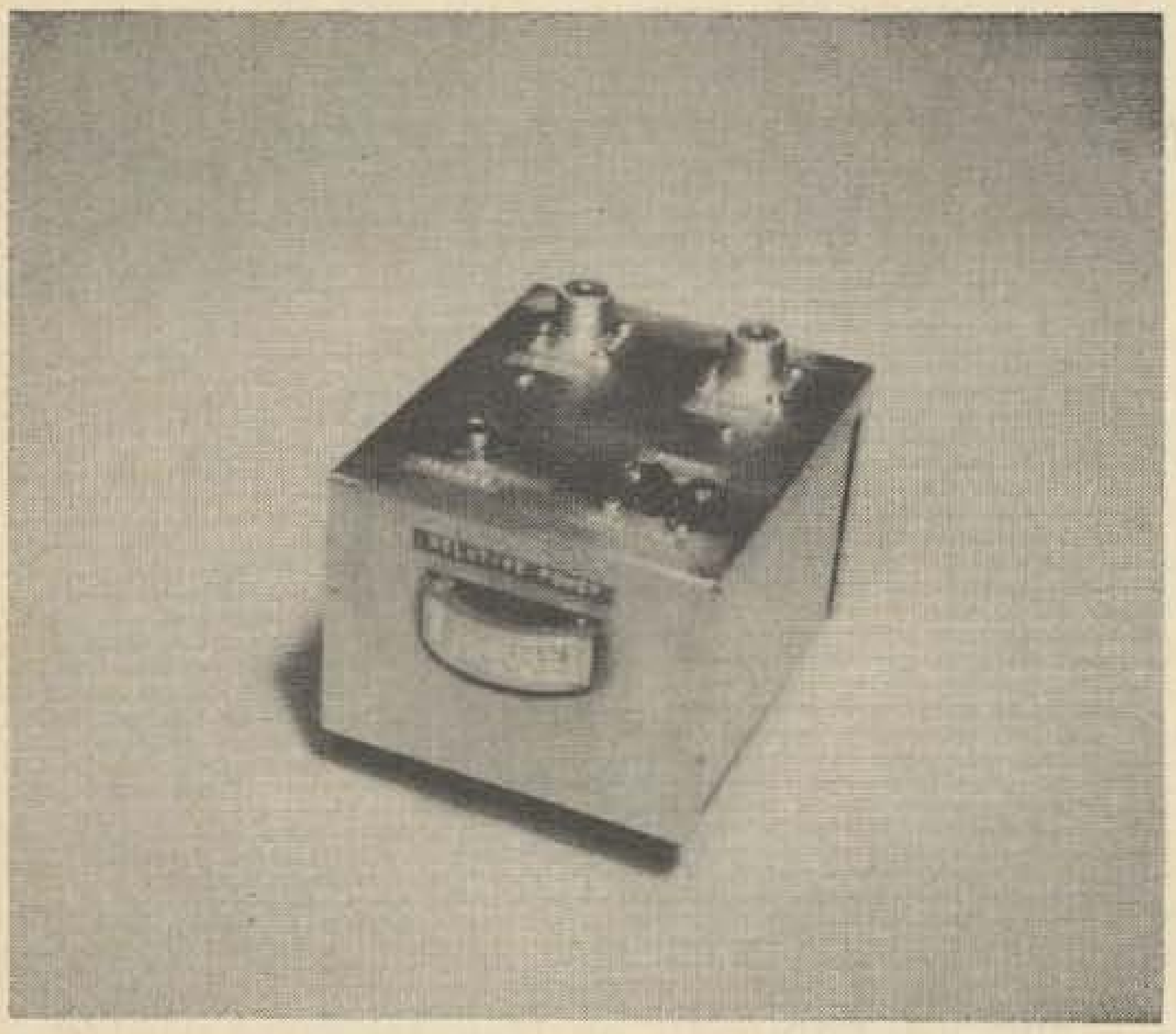
The resulting antenna should provide communications with a minimum of up-keep for several years to come.

. . . W8JZI

CLUB SECRETARIES NOTE

Club members would do well to get their club secretaries to drop a line to 73 and ask for the special club subscription scheme that we have evolved. This plan not only saves each club member money, it also brings badly needed loot into the club treasury, if desired. Write: Club Finagle, 73 Magazine, Peter Boro Ugh, New Ham Shire 03458.

Darn-Handy VHF Monitor



Ralph W. Campbell W4KAE
316 Mariemont Drive
Lexington, Ky. 40505

Introduction

The need for a good quality AM monitor for VHF became apparent to myself when delving into high power 2 meter linear adjustments. Using a TX-62 to drive two PL-177WA's in Class B AM linear required a device which could be installed in the output line of the linear so that bias and screen voltages could be properly set. Minimum distortion of the modulated driver was the goal. And, like any transmitter monitor at close range: " 'You can't believe that what you hear is an accurate sample,' my friends said" of the actual signal at a distance! Well, this is not always true. Careful experimentation yielded an improved circuit which is presented here. Incidently, most oscilloscopes are ineffective for use on VHF, unless you go directly to the vertical plates: and who wants to botch-up a commercial unit?

Equipment Description & Schematic

The completed VHF monitor is enclosed in a 3 x 4 x 5 inch Bud Minibox. At the rear are the two SO-239 IN/OUT chassis connectors. Either one can be used for input or output to coaxial line. Next, to the left, is an audio jack of the kind that mates with PL-55 type mike plug; but in this case, is used for listening with HI-Z headphones. To the right is an SPDT slide switch: giving the reader a choice of "Power," or "Monitor" switch positions. With a flat line, relative power measurements can be made; and if you follow the instructions given later on: an "engineered-guess" can be made as to the actual power present.

The EMICO[tm] meter is mounted by a rectangular retaining speednut in the front wall. To the upper right is the 2.7 μH RFC and the 1N4149 diodes are wired in near this. Observe that the 560 ohm/2 w. resistors are wired to the SO-231 jumper with both resistors in series—first—and then over to the rf coupling capacitor (1pF). They must be connected this way, otherwise enough energy could be coupled in to destroy the diodes.

Fig. 1 is the schematic. The half-wave doubler/detector is straight-forward. It is interesting to note that the coupling value of 1pF works best on the "monitor" position of the unit (listening) for 2 meters, with 100 pF as the output to the audio filter. The same ratio of 1 to 100 holds for the "linearizing resistor" as compared to the output dc load of 220k. The 2.7 μH RFC are chosen to have an impedance maximum just above 2 meters (149MHz) & 39pF discoidal capacitors are series-resonant near the two meter band with usual lead-length. The 0.001 bypass is a ceramic disk, chosen for a low value of reactance as compared

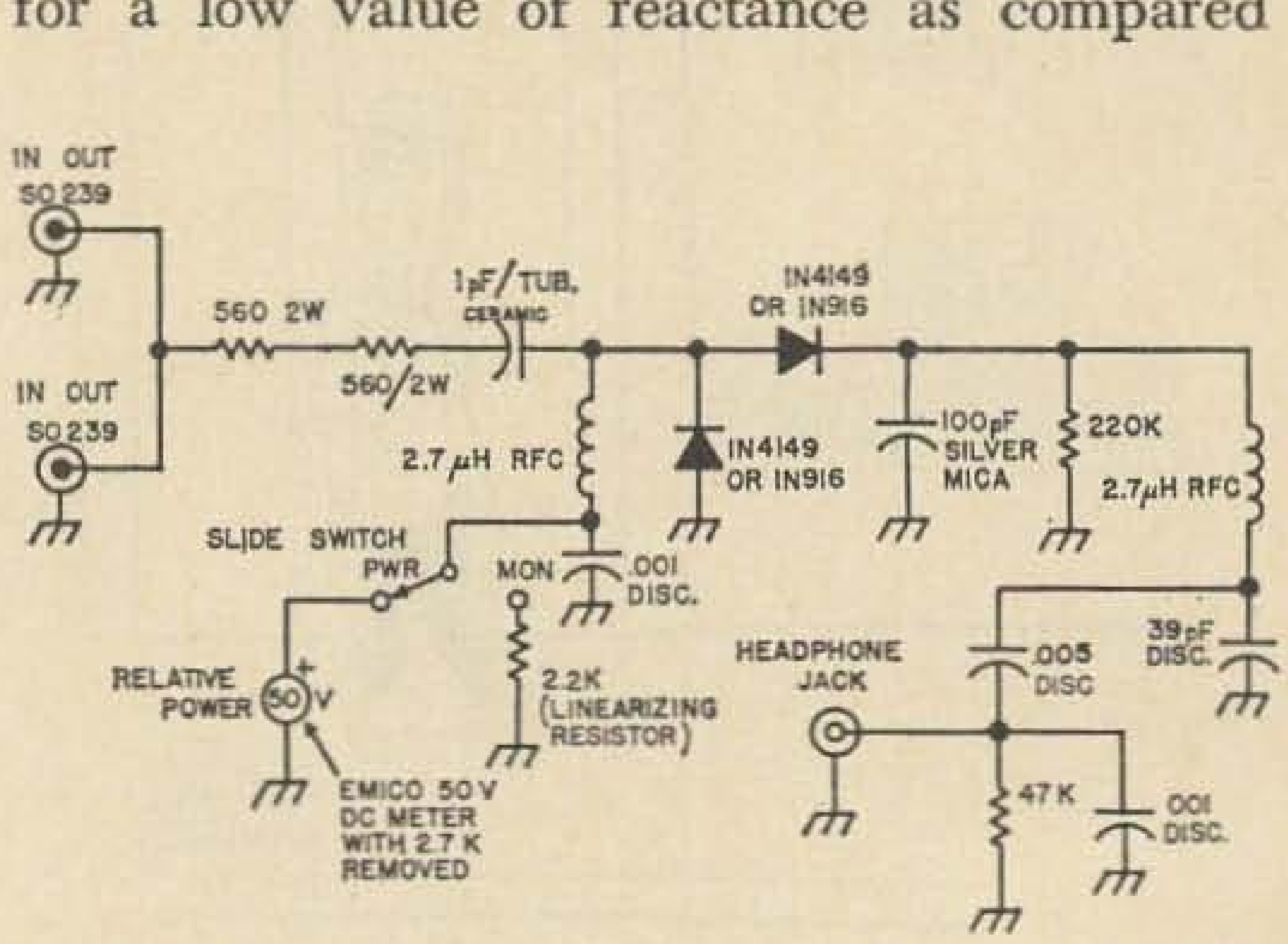


Fig. 1. Schematic for the Monitor.

to the internal meter resistance. The remaining components comprise the audio filtering and coupling.

Using The VHF Monitor

Any power level up to a kilowatt dc input, on two meters, will drive the voltmeter to some position on the scale. 432 would be an upper nominal frequency limit with this unit; however, the "relative power" meter would have little meaning, but it would be useful for tuning-up. If you wish to modify the design for 432, use Z-460 chokes and 13 pF discoidal ceramics. The other capacitors should be left as is. Of course, even with a flat-line you can expect considerably higher meter readings on this band.

On 2 meters, an Ameco TX-62 will give a reading on the meter of about 7.5 volts; for an AB_1 *rf* linear we registerd 15 volts. For the big half-kilowatt Class B linear, we observed 30 volts! A nominal 15 volt reading is equivalent to 75 watts into the monitor in the "power" position; but remember, you must have a flat-line or this doesn't mean anything. And these indications were made from notes in our set-up using a Bird™ Model 34 Directional Wattmeter, in series with the VHF monitor.

Just above we said that "any transmitter" could be used. Don't expect a TWO'er to do more than jar the meter; You will get enough audio through the detector to listen to the signal, though. The main use for the 'Darn-Handy' is to set up 75 watt transmitters & the big amplifiers we use at W4KAE. When adjusting a stage, plug in the headphones, after peaking the output: and listen for maximum *background audio pickup*. Bias and screen voltage controls are to be varied for this purpose. Make sure the slide switch is in proper position. Background pickup is like an increase in gain; without changing the audio level! Preset audio before this step; and you will find bias adjustments related to detected audio. Once you hear the increase in gain, NOW advance the audio gain until the signal is raspy or tinny. Set the audio gain back about ¼ and you're linear. If you can't get enough power output . . . with linearity . . . try increasing the amplifier screen voltage, and repeat the process. . . . W4KAE

Wells Chapin W2DUD
118 Woodmoney Lane
Fayetteville, N. Y.

Simplified Decibel Leveling

Late some night you're listening to the quiet ones. Then you tune into a real whopper and wake up the family. An awful feeling, isn't it? Other awful feelings come up when you over-modulate and get poor reports, or one of those friendly QSL's from the FCC. A lesser annoyance which we could do without, is the variations in round-table signal strength as nearer or more distant stations come in. Can we do something about these irksome unpleasantries?

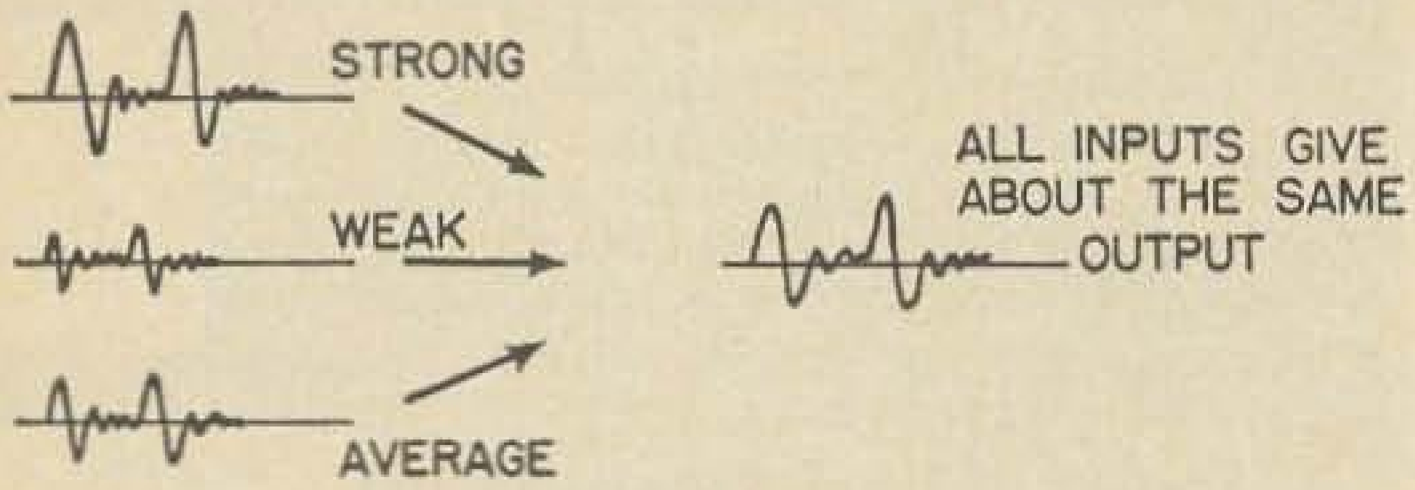


Fig. 1. AVC system adjusts system gain for a roughly fixed output voltage, independent of changes of input amplitude.

Automatic volume control key ideas

What is it we really want to do? See **Fig. 1.** We want a variety of signal strengths to come out all practically the same size. Typically, the circuits that perform this magic do not respond to average levels. They respond to peaks, and hold the peak signal strength to a certain level. The rest of the signal follows along.

But how about very weak signals? Our leveling circuitry reduces circuit gain to pare down the big signals, but when does it start? The simpler control circuits start with the very smallest signal that comes through the circuitry. We avoid this sensitivity loss by adding an extra circuit, which refuses to generate any controlling action until the signal amplitude exceeds a specific, often adjustable value. This is "delayed" control, but with a voltage delay rather than some time-dependent effect. See **Fig. 2.**

This problem of loudness control has received much engineering attention. Searching through the maze of technical literature we find a lengthy list of automatic level control methods, along with a confusing set of names.

An AGC system controls the gain of amplifier circuit, following some predetermined schedule according to changes in the input signal amplitude. If we have an avc system it maintains a constant *output* by adjusting the gain as required, and this is a very different thing. Most "agc" systems might better be called avc systems. Finally, we come across the alc system, which holds transmitted carrier amplitude or sideband power to a constant average value.

For effective use of a volume or level control system, we need to know something about normal speech characteristics. Amplitudes vary widely, from the shouting man's output of five or six milliwatts through the normal conversational range of about 40 microwatts to those soft dulcet tones of perhaps 10 microwatts.

Also, we must know something about speech frequencies. Those frequencies carrying maximum energy are between 300 and 600 Hz, and if we wipe out all frequencies outside the range of 250 to 2500 Hz or so we lose nothing of intelligibility. And, in

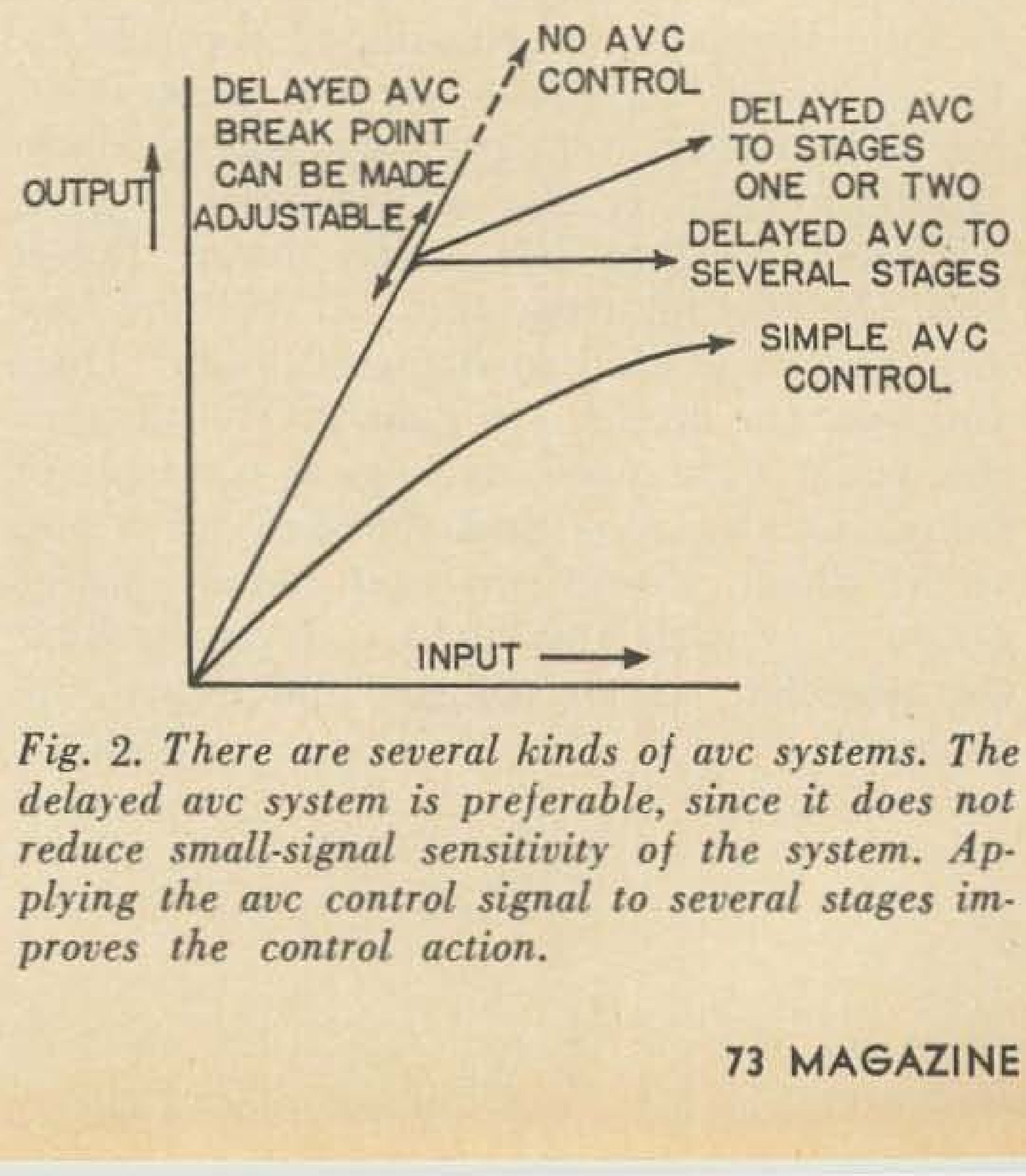


Fig. 2. There are several kinds of avc systems. The delayed avc system is preferable, since it does not reduce small-signal sensitivity of the system. Applying the avc control signal to several stages improves the control action.

transmitter applications this frequency paring saves valuable spectrum space.

Receiver control circuits

Receiving level control circuits feed back a gain controlling signal to the *rf* and *if* stages before the detector. The manufacturer chooses the circuits to use, and their application, and it often appears he could have done a more complete job of it. But he likes to sell simpler designs to stay within price boundaries. Receiving level control systems can often be improved upon, for better general action or to optimize the receiver's performance for a particular type of reception. The requirements for best reception of CW or sideband are quite different from those for AM.

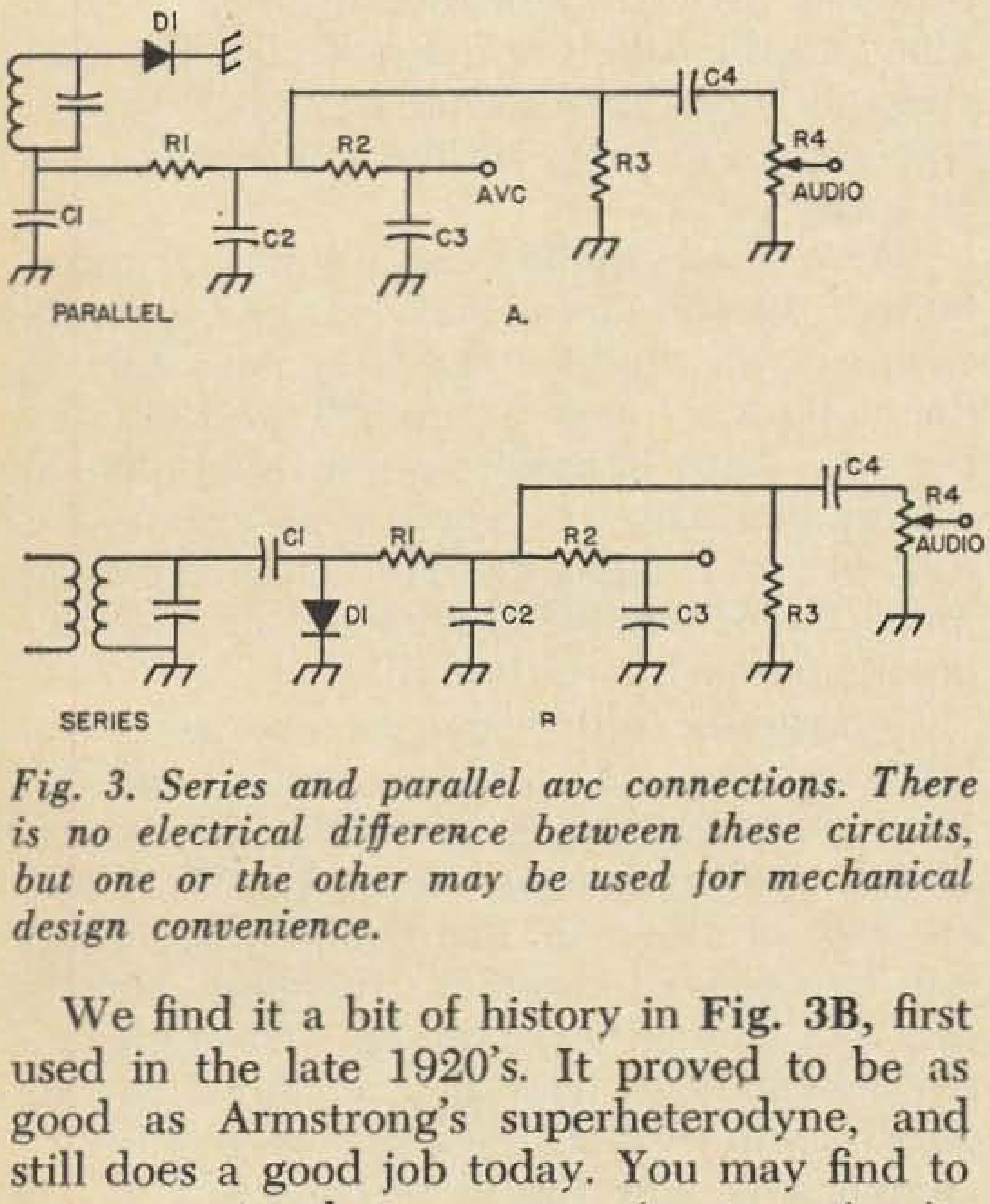


Fig. 3. Series and parallel avc connections. There is no electrical difference between these circuits, but one or the other may be used for mechanical design convenience.

We find it a bit of history in **Fig. 3B**, first used in the late 1920's. It proved to be as good as Armstrong's superheterodyne, and still does a good job today. You may find to your surprise that you are using two circuits invented by Armstrong in WWI in your bright and shiny new receiver. Here, we automatically vary the total receiver gain according to received carrier strength. In this circuit we usually employ variable mu tubes, with the fed back dc control signal adjusting their effective gain.

Fig. 3A shows another version of the same circuit, offering a little leeway in physical construction. Both versions operate in the same way, which we see by looking at C1.

Rectified *rf* produces a varying dc voltage across C1. Going through R1 and R2, past C1 and C2, we come to the avc control volt-

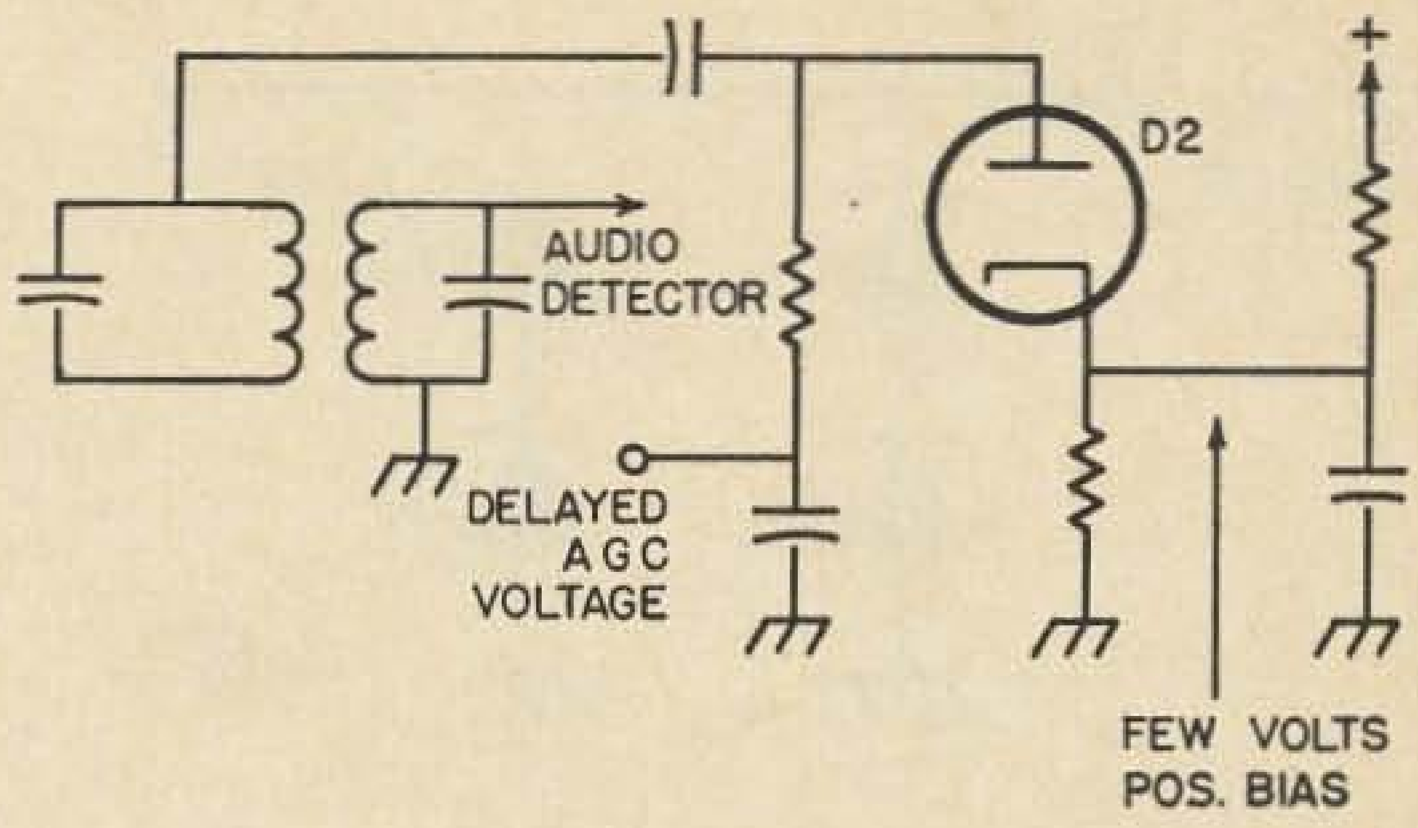


Fig. 4. A reverse-biased diode, separate from the audio detector system, does not rectify any input signal until the signal amplitude exceeds the positive bias applied to D2's cathode. AVC control appears only for large signals.

age terminal, which carries practically pure dc after the passage of the rectifier signal through the two low-pass rc filters. And taking the other route we come to the bleeder capacitor R3, which completes the dc path for D1, to blocking capacitor C4, and finally a gain control for adjusting the audio output.

This arrangement develops a gain-reducing control voltage as soon as there is any signal at all, and if it is preceded by a high-gain *if* circuit it may generate AVC on noise alone. We can avoid this conflict of interests by adding another diode to take off the avc voltage, as in **Fig. 4.** Since diode D2 is reverse biased, it develops no avc voltage until the signal strength exceeds the previously adjusted bias voltage. This is "delayed" avc.

In all receiver avc circuits, the near-dc control voltage is fed back to several earlier stages in the receiver. Generally, the more stages it controls, the better, although there may be little or no control voltage applied to the *if* stage feeding the detector because the signal there is a large percentage of the bias voltages. The usual avc control techniques work best on stages handling a *small* signal voltage, up to maybe 10% maximum of the applied bias voltage. See **Fig. 5.**

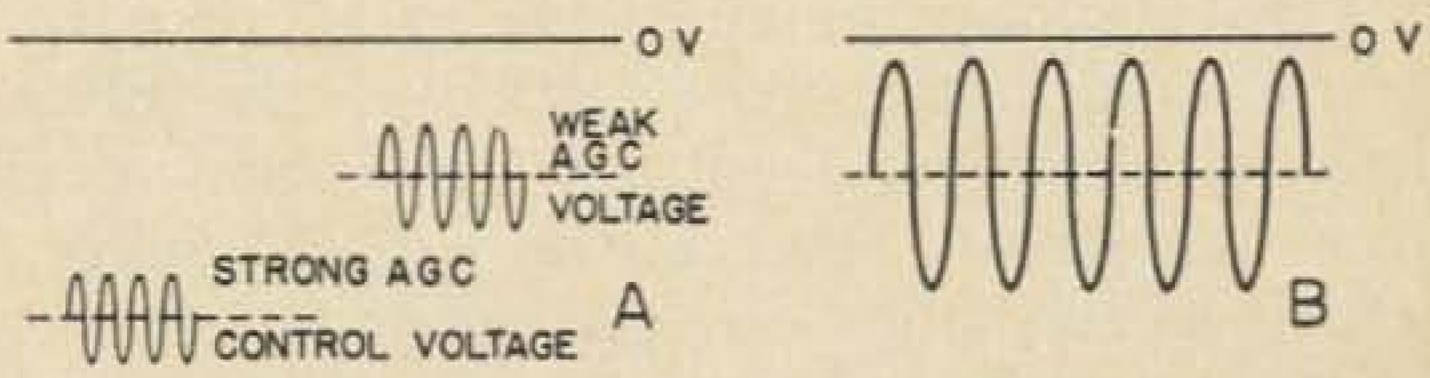
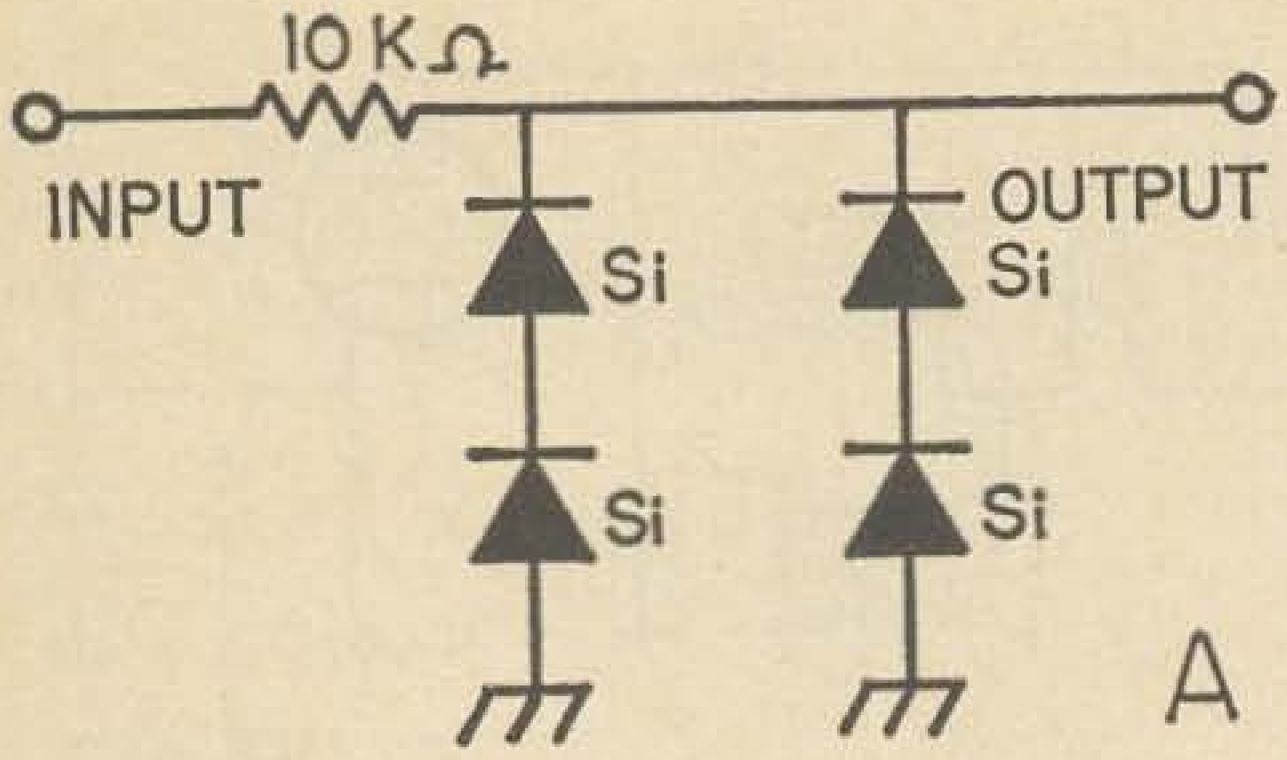


Fig. 5. AVC control voltage usually is not applied to large-signal if or audio stages because the output would be distorted under small-signal conditions. The signal is only small at the input end of the amplifier.



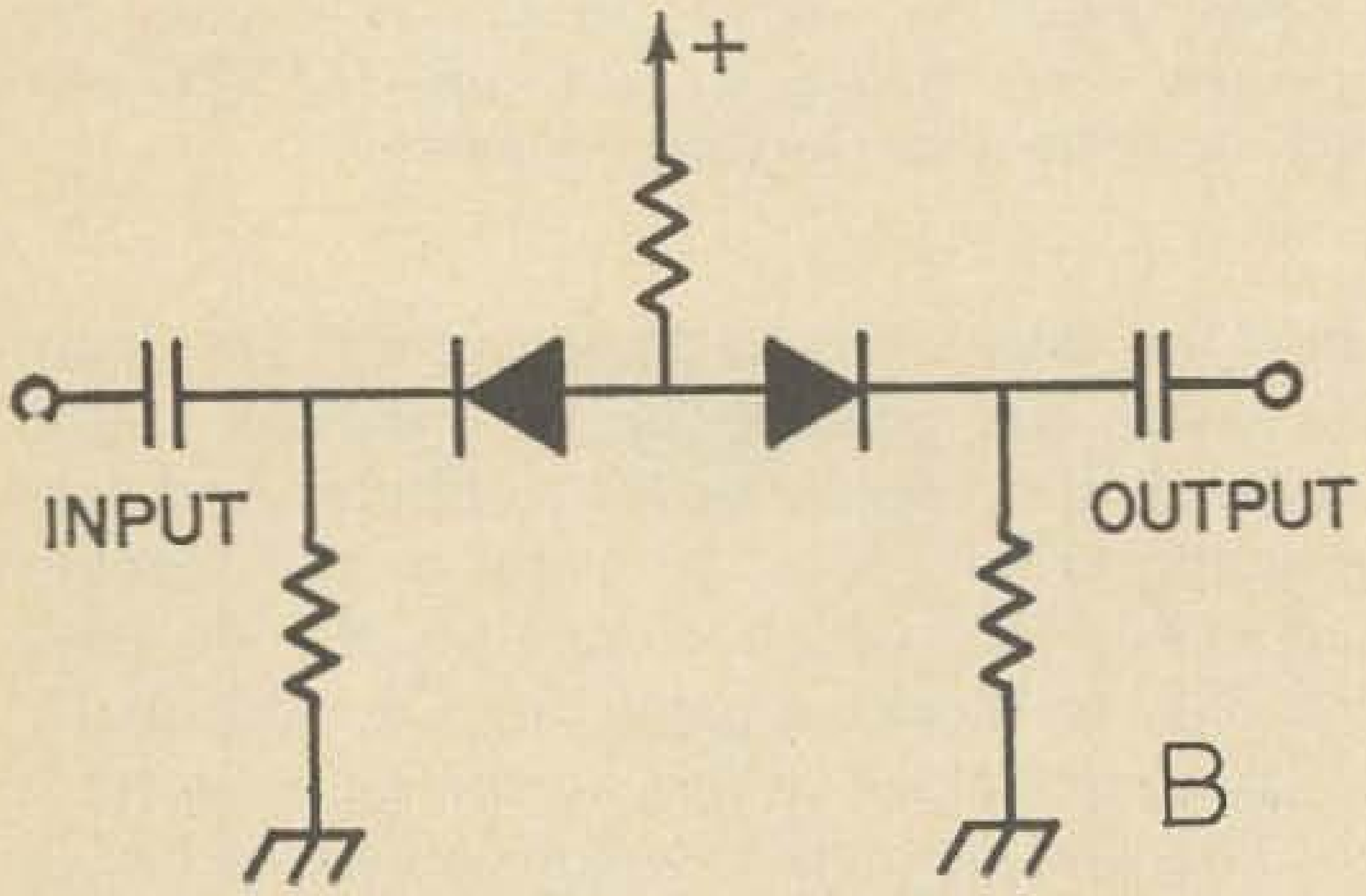


Fig. 6. Parallel and series type limiters. The parallel limiter uses the semiconductor diode property of requiring a rather large input voltage before it conducts at all. The series limiter is permanently biased, with one diode going out of conduction is signal current exceeds bias current.

AVC system design for transistors differs in one significant respect from that for vacuum tubes. A zero-biased vacuum tube is very much alive, but a zero-biased transistor is dead since its base-emitter diode is not energized. So all transistor avc circuits must be provided with sources of base current to energize the transistors when there is no signal, and the increasing signal opposes the fixed bias to reduce base current and transistor circuit gain. In both tube and transistor cases excellent bypassing is required, since the avc lead is common to serveral high-gain stages.

One familiar circuit seems to act like an avc circuit, but it does not have the filter networks and the feedback application of a true avc circuit. This is the simple limiter, which merely clips off any signal amplitude above a certain value. It is a sort of an electrical low bridge. See **Fig. 6A** and **B.**

The shunt limiter is a slightly reverse-biased diode, and when the signal level exceeds a certain value, the diode goes into conduction. It appears as a heavy load across the circuit until the signal returns to more familiar levels. And a complementary circuit, the series limiter, becomes a large series resistance when presented with too-large signals.

Transmitter control circuits

When we begin to think about getting the most effective use from a transmitter, we come to the remarkable variation in loudness of various speech tones. Most of us speak at varying amplitudes and ranges from the mike, closer at one time and perhaps quite distant if we reach for something while talking. It turns out we can achieve a substantial improvement in effectiveness if we apply some or all three of the following electrical treatments to the incoming speech. They are, limiting the frequency range, clipping off large peaks, and applying an avc type system to bring up the low-power parts of speech.

There is no simpler way to limit our transmitted speech frequency range than to choose a microphone that responds only to the important range from 250 to 2500 Hz. But the best limited-response microphones are as expensive as good hi-fi mikes. For example, one 200-4000 Hz communications mike (the Shure 488T) is priced at $34. Another approach is indicated.

Comparable results can be obtained from less expensive mikes, using simple audio filters to attenuate signals outside the important frequency ranges, as in **Fig. 7.** There are lots of these in the handbooks, falling into two general varieties. RC filters, and filters that contain inductive as well as capacitive components. The more complex circuits yield a faster rolloff for a certain number of components, but the rc circuits will do as well if there are a few more sections.

Once we have limited circuit response to

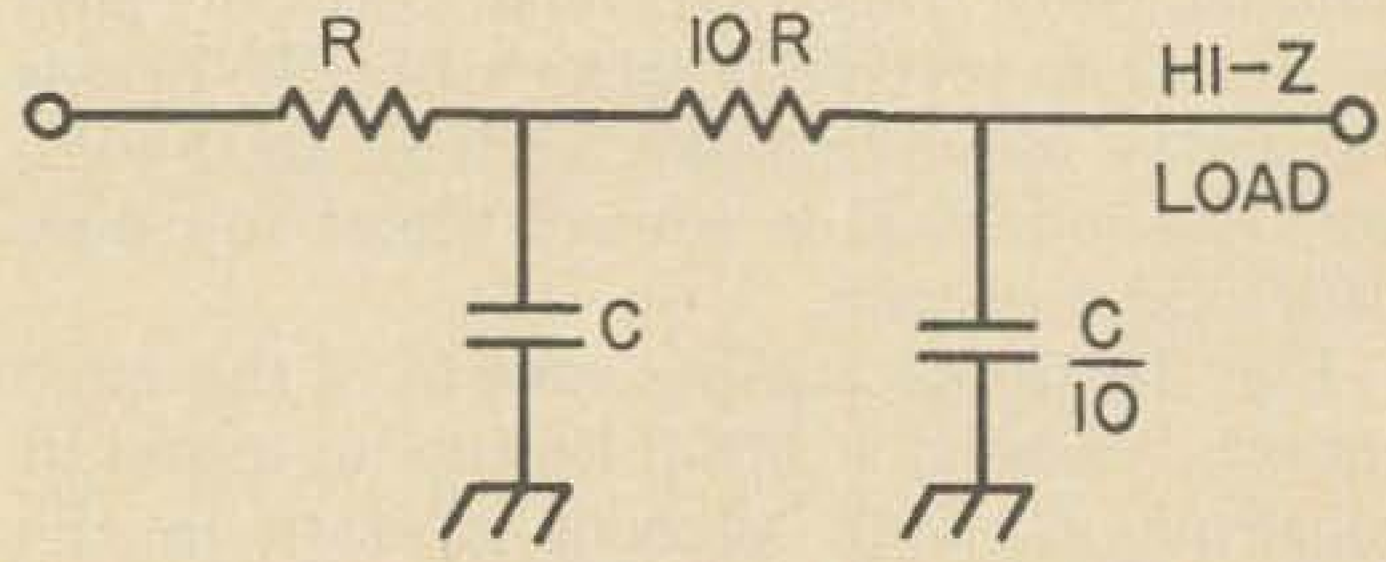


Fig. 7. Simple rc low-pass filter. Second section has same time constant as the first, but larger resistance and smaller capacitance reduced reaction on the first section.

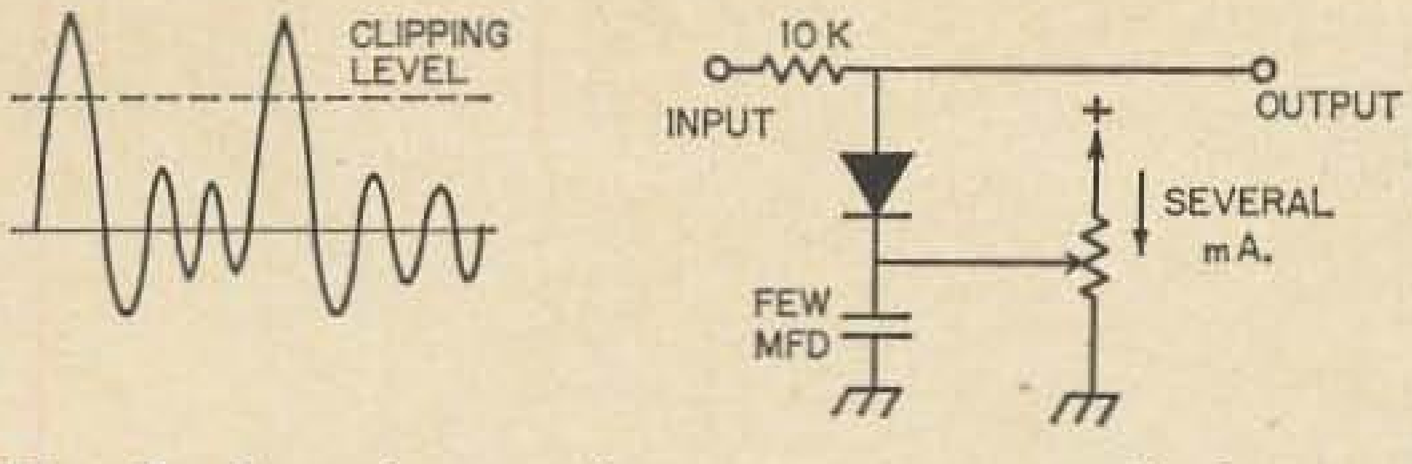


Fig. 8. Speech waveforms are unsymetrical, so a one-sided clipper can pare off peaks. Adjustable bias to control peak amplitude, with audio by-passed through a small electrolytic capacitor.

the most efficient frequencies we are concerned with level control. The simplest level control arrangement is simply to clip off peaks, and not get too close to the mike. See **Fig. 8.** This can be very effective if we use it properly, and follow the clipping circuits with a bandpass filter to remove the high frequencies associated with sharp corners generated by the clipping circuit.

Inside the transmitter we use methods closely resembling the receiver automatic volume control methods described in the last section. The goals are the same, and so are the methods.

The major difference is that we typically take the control voltage from a high power level part of the transmitter, and use a sharp delay action. A small voltage divider as in **Fig. 9** can steal a bit of *rf*, which is rectified by the back-biased rectifier for delay, and fed back to a small-signal audio or low-frequency *rf* stage.

This system is simply another version of the volume compressors used in AM transmitters, except that the return control voltage is derived from the sideband output, rather than from a high-level audio stage.

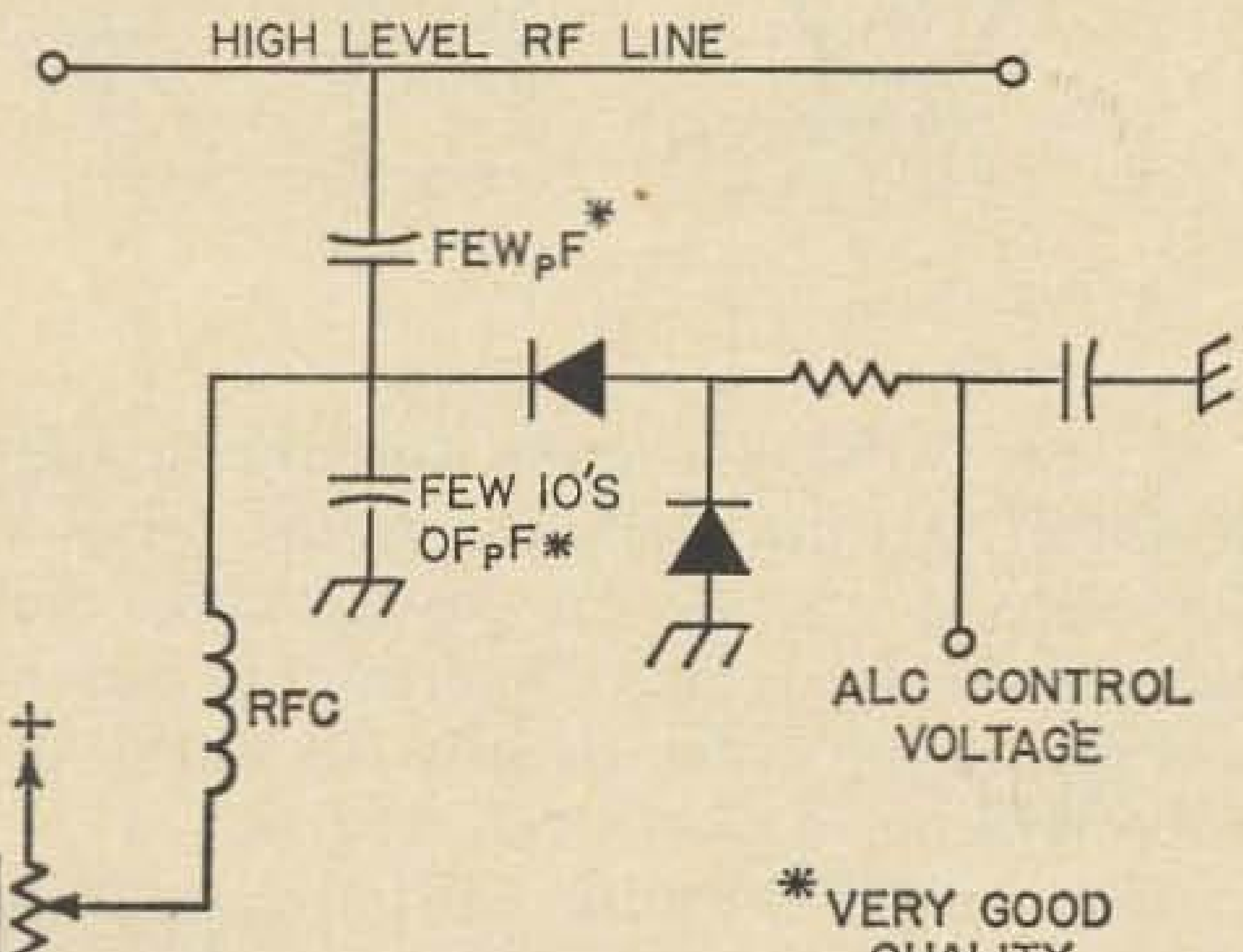


Fig. 9. Stealing a bit of rf voltage for automatic level control. Good bypassing required to avoid unwanted rf feed-back to earlier stages of transmitter.

Breadboarding AVC circuits

AVC circuits are easy to breadboard, and they can be tested using normal audio or *rf* generators. The *rf* has to be controlled carefully so that it does not find unwanted routes past the attenuator into the circuit, giving false results. Alternatively, a breadboarded avc circuit can be tested in two steps.

After breaking the avc feedback line, the circuit response is observed for various signal strengths, measuring the avc voltage. And then, with a fixed input signal, the circuit gain is checked against variations in avc voltage, which can be fed into the broken avc line from a simple battery and pot arrangement. . . . W2DUD

FM'ing a VFO

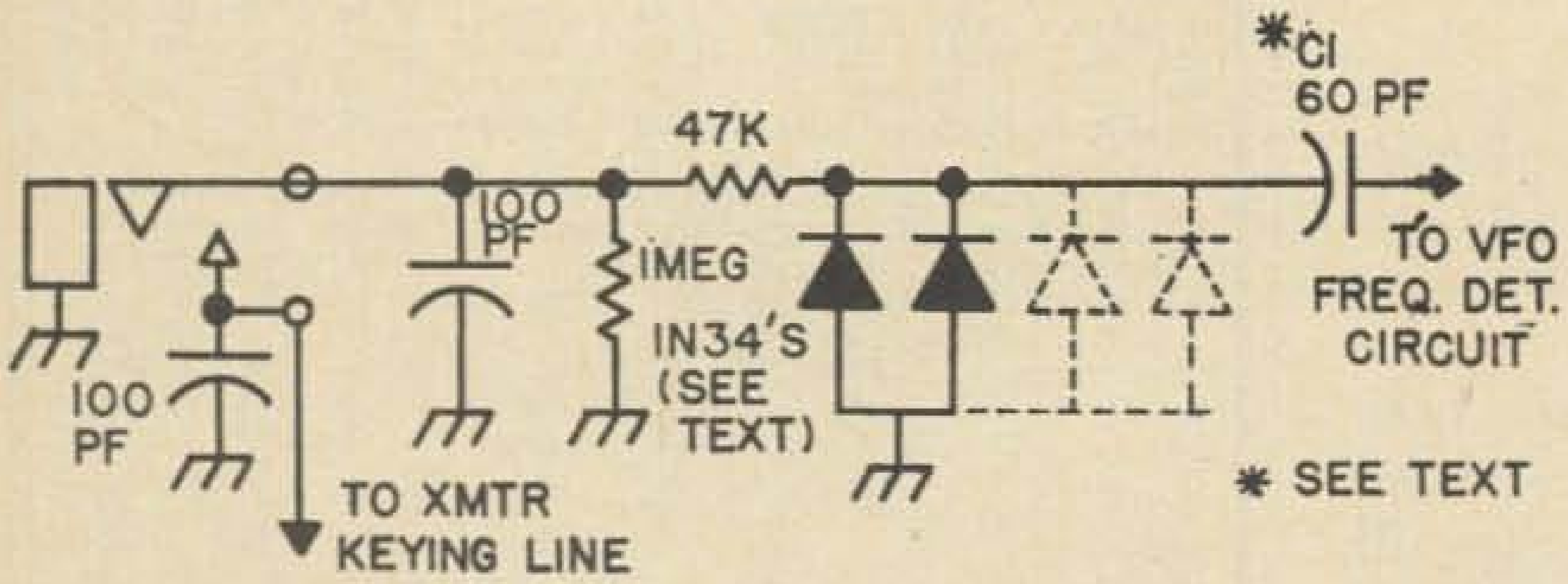


Fig. 1. See text.

Donald L. Schliesser WA6UFW
3160 *Fairmede Drive*
Richmond, California 94806

With the interest in 2 meter FM Repeaters these days, and with many of the hams being active on 2 meter AM, there have been many conversions for FM'ing 2 meter rigs.

Recently I acquired an Ameco VFO-621 to add to my 2 meter AM rig. Being a member of two FM Repeater groups, I immediately started researching to find a suitable way to FM the vfo. All of the circuits I found were too complex. By this, I mean they involved a lot of time and expense. Being lazy and wanting to use my junk box, the circuit in **Fig. 1** evolved. This circuit is not new—Gonset uses a similar circuit in their VFO. The difference comes in that they use a Varicap (voltage variable capacitor) costing about $4.00, and not in the average ham's junkbox! The same effect can be had with any germanium diode—it just takes more of them.

I wanted to achieve plus or minus 15 kHz deviation and the values shown will give that much deviation with the Ameco VFO-621.

This circuit can be adapted to any VFO, either commercially made or home-brew by changing the value of C1 and varying the number of diodes.

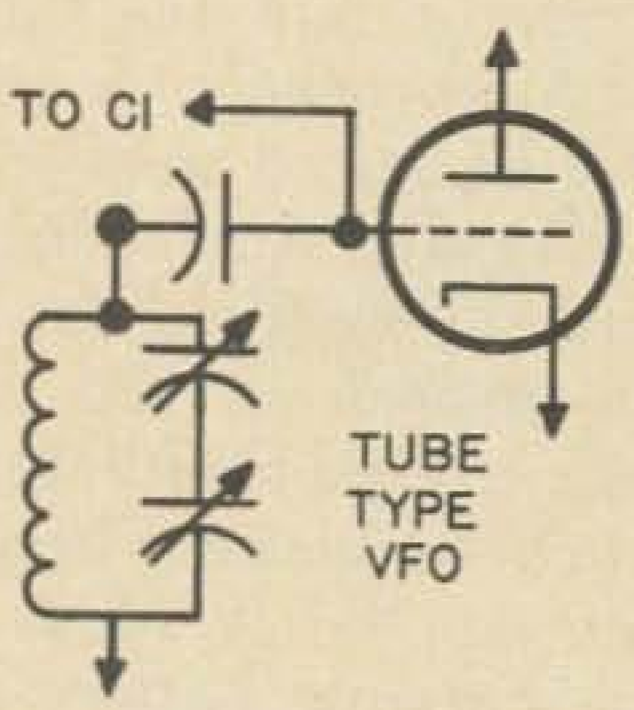


Fig. 2.

A good place to start is with 2 diodes and about 5 pF for C1. If that does not give enough deviation, increase C1 to about 10-20 pF and add another diode. By varying C1 and the number of diodes you can come up with any amount of deviation you want.

The input to the circuit should be a high impedance ceramic, crystal, or dynamic mike. I use a Collins MM-1 dynamic but a cheap crystal or ceramic high output mike will work fine.

The capacitors across the mike input and the keying line are to keep *rf* off the leads to prevent the VFO signal from leaking out except when the spot switch on the rig is turned on. In the VFO-621, the oscillator runs all the time and the buffer stage is keyed.

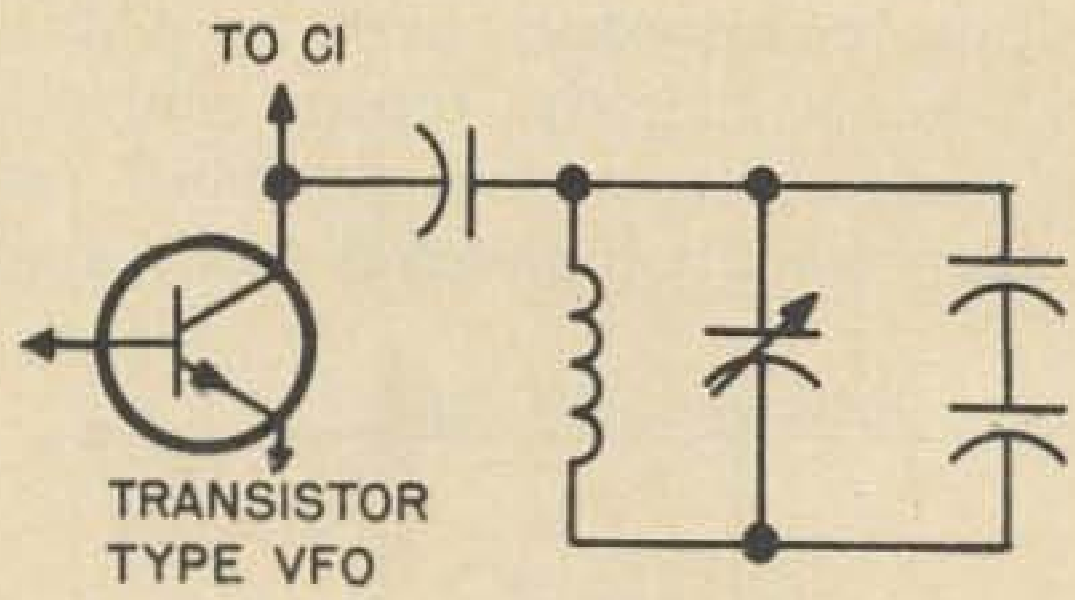


Fig. 3.

In my VFO, C1 goes directly to the collector of Q1, the oscillator. In the other VFO, the circuit should go in parallel, that is, across, the frequency determining circuit. In a tube type VFO, usually the grid of the tube will be in place. See **Fig. 2.**

If your VFO quits with the addition of this circuit, try a smaller capacitor at C1. Make C1 as big as you need to get the deviation you want and if the VFO oscillator quits before you get C1 large enough, use more diodes to make C1 just small enough so the VFO still takes off OK.

I mounted a mike jack right on the VFO chassis near the oscillator. When on FM, I plug the mike into the VFO; for AM the mike goes into the normal mike jack on the 2 meter rig.

After installing the circuit and finding the proper combination of C1 and the number of diodes to get the deviation you want, you must recalibrate the VFO using standard procedures.

The comments from listeners on the air has been that the quality is excellent and has a "hi-fi" sound.

. . . WA6UFW

FCC Announcement

This is to advise that the previous announcement concerning the exchange of third party communications with amateur stations in West Berlin has been rescinded. It has been determined that the regulations of the Federal Republic in Germany, which in effect prohibit third party communications, also apply to amateur stations in West Berlin including stations operated by United States Forces personnel.

FET Preamplifiers

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40 Rossie Street
Mystic, Conn. 06355

Two extremely simple, but effective as well as inexpensive, FET rf amplifier circuits are presented which can be used to boost the performance of an existing receiver or transceiver.

Field effect transistors are semiconductor devices that have properties similar to a triode vacuum tube—high input impedance and large dynamic range. These properties make them especially suitable for use as *rf* amplifiers or preamplifiers. The FET in this application has also one extra advantage over a triode in that the feedback capacitance is lower than the grid-plate capacitance in a triode used as a *rf* amplifier and so operation on higher frequencies without neutralization is possible.

The two *rf* amplifiers described in this article are built around a newly developed plastic-packaged economy FET from Motorola—the MPF 157. Although other FETs can be used, the MPF157 is highly recommended since it is available for less than $1 and is specifically designed for *rf* amplifier use. The MPF157 will operate at frequencies up to 400 megacycles/second, although neutralization will be required. The low feedback capacitance of less than 0.2 pF eliminates the need for neutralization for most 80-10 meter circuits. The unit will provide at least 16 db gain and the noise figure should be 4-5 db.

The *rf* amplifier circuits shown may be used in whatever manner the reader wishes —as a mast-mounted preamplifier for a single band to improve a receiving system, as a bandswitched preamplifier at the receiver, or even as the *rf* amplifier stage in a receiver.

Single state amplifier

Fig. 1 shows the schematic of the simple single stage amplifier. It will operate properly with a drain supply of 12 to 15 volts (20 volts absolute maximum), thus making it useful in mobile situations also. The coil

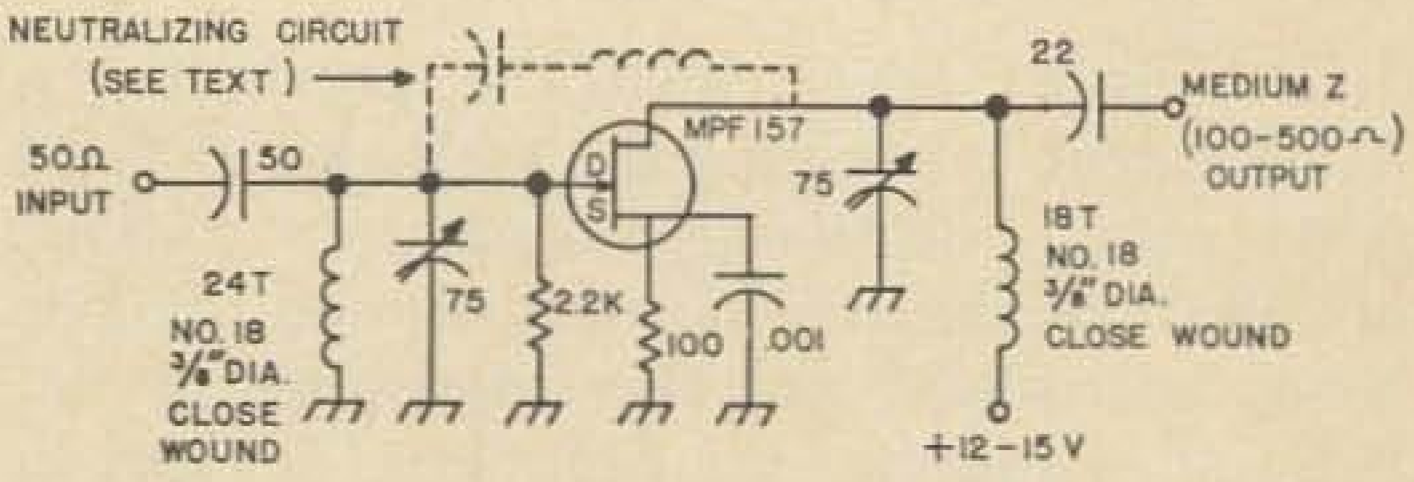


Fig. 1. Single stage FET preamplifier. Coil dimensions are for 20 meters. For untuned or broadband operation, input and output circuits are peaked at opposite ends of the band.

dimensions shown are for operation on 20 meters but with the aid of of a grid-dipper, coils can be developed to cover any desired band. If the circuit is used on frequencies higher than about 30 MHz, a neutralizing circuit between the drain and gate terminals of the FET will be necessary. The series capacitor is usually made fairly large (.001 μF on 6 or 2 meters) and the coil made broadly self-resonant. Although the dimensions of the neutralizing coil are almost impossible to specify exactly because of the dependence upon individual circuit layout, a good starting point is to make it with about 6 times as many turns as the coil in the drain output circuit. If avc or manual gain control of the stage is desired, the grounded end of the 2.2 K ohm gate resistor is lifted and connected to a negative control voltage.

Cascode amplifier

Fig. 2 shows the schematic of a two-stage FET amplifier. It uses direct coupling and is a modification of the so-called Wallman configuration. The vacuum tube equivalent is the direct-coupled driven grounded grid circuit and the FET circuit has most of the same characteristics. The amplifier is quite

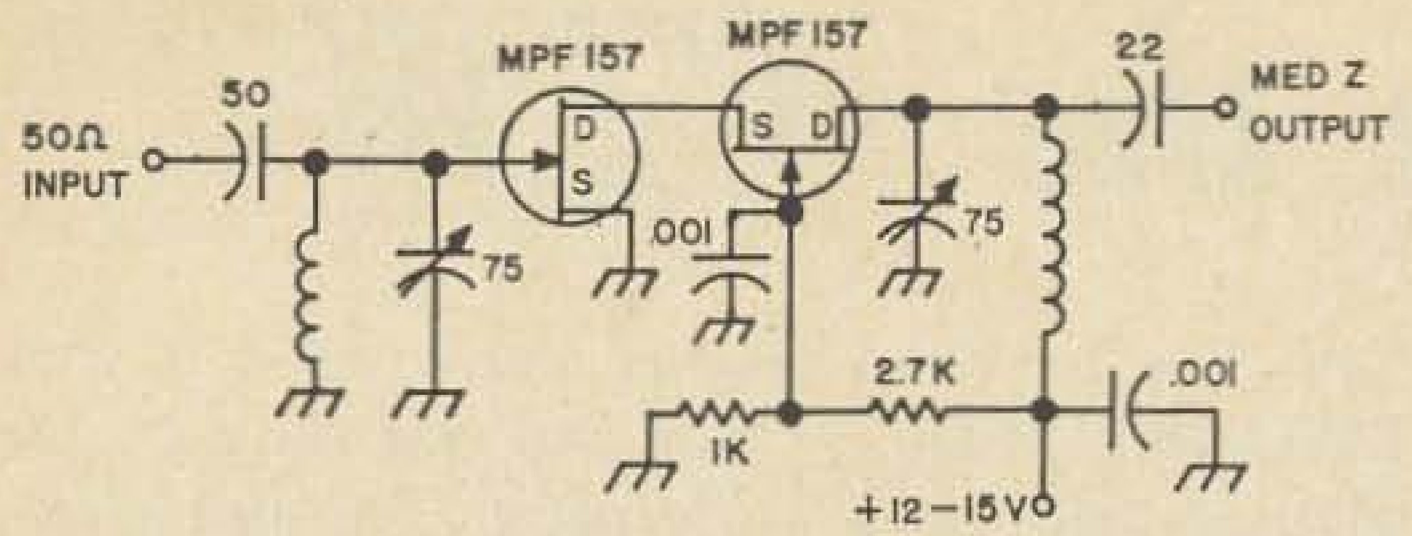


Fig. 2. Cascode amplifier circuit. Input and output circuit values are the same as Fig. 1 *for* 20 *meters.*

stable because of the low drain load on the first stage. Neutralization is often not required although at VHF frequencies the noise figure of the overall amplifier may be improved by neutralization. The voltage gain of the first FET is negligible and the main gain is provided by the second FET. On the other hand, the noise figure of the overall amplifier is determined almost entirely by that of the first FET. Thus, if it is possible in any way to evaluate the noise figure of individual FETs, the best one should be used as the input stage. Another approach is to use sockets for the FETs rather than hard-wire them and switch the FETs to determine which way they perform best.

Construction and Adjustment

The construction used somewhat depends upon the application for which the amplifier is intended. For instance, for use as a single-band preamplifier, the variable capacitors shown in the diagrams can be replaced by fixed values once the proper values have been determined with variable capacitors. Final peaking can be done by pinching the coils. The coils themselves can be wound on any convenient form—1 watt 1 megohm resistors, for instance. The photograph shows the cascode circuit assembled on a piece of vectorboard using fixed value capacitors (silver mica types should be used except for bypassing where disc types can be used). No particular circuit layout is required except that the input and output coils should be as far apart as possible and oriented at right angles to each other. On VHF a shield, in addition, may be required between the coils. The entire assembly should be enclosed in a shielded container when used as a separate preamplifier outside of a piece of equipment.

One note of caution is necessary when handling the FETs. They come with their leads shorted together because static charges may damage them because of their extremely high input impedance. Handle them by their case and leave the leads shorted until the FET is placed or soldered in a circuit.

Summary

The MPF157 allows the construction of a relatively inexpensive but high performance amplifier. It's low current requirement (5 to 6 mA) for either circuit allows it to be operated from a battery source for extended periods of time or allows power to be furnished for operation from the internal power source in any receiver or transceiver.

. . . W2EEY/1

A Report on the WTW

I have been asked by quite a few fellows where should they send their cards to be checked for the WTW. This time I will make a complete list of all check points we now have. If your area is not covered you should send your cards to me at:

> Gus M. Browning, W4BPD,
> Route 1, Box 161-A,
> Cordova, S.C.

along with the $1.00 to cover costs of the certificates, handling, etc. PLUS enough EXTRA to pay for the return of your cards —otherwise I will return them to you via THE CHEAPEST WAY I CAN—and don't blame me if they go astray! We are still looking for check points—so if you are a member of a well established club or society—how about discussing the handling of our cards by them, provided they are in some area which doesn't now have a check point.

The following stations have qualified for these WTW awards since last issue:

WB2RLK-WTW-100, 14 MHz phone
W2VBJ-WTW-100, 21 MHz phone
K5HYB-WTW-100, 21 MHz phone

Still QRX for anyone who qualifies: Certificate Nr. 1-WTW-100, 28 MHz CW. Certificate Nr. 1-WFTW-100, 7 MHz phone, and both CW and phone Nr. 1 for 80 meters. Some good low numbers are still available in most other certificates. And I am glad to report I am now checking ALL CARDS SENT ME within 7 days, and I am sure all check points are doing the same— I suggest sending cards via Certified mail, it's much cheaper than Registered and I think just as safe. Of course with a return receipt requested for proof of delivery.

I would like to call to everyones attention that a PHONE QSO is a phone QSO as far as we are concerned—It can be either SSB, AM, NFBM or any other way you can have a VOICE CONTACT. We only go by whats shown on the cards you submit to us. If you can get a CW station to listen for your phone signals and his card says ur SSB or AM or NBFM is Q-3, S-2 with no mention of CW on the card—thats OK as far as I am concerned. The same goes with CW. We have no way of knowing if it was TWO-way phone or not, we can only go by whats on the card you send us. We don't encourage this practise of course—sometimes this is doing it the hard way.

Beginning with this issue we will list STANDINGS in our Honor Roll. Send us your CLAIMED SCORE—BUT when you hit the next WTW level WE WANT TO SEE THE CARDS. Would like to have your score as soon as possible so the standings will be of more interest to everyone.

WTW HONOR ROLL (claimed scores)

#1—W4NJF —261—14 MHz phone
#2—XE2YP —209—14 MHz phone
#3—WB2WOU—204—14 MHz phone
#4—WB2NYM—204—14 MHz phone
#5—WA5LOB —202—14 MHz phone

Others with much lower scores, will QRX for a late score from them for next month.

#1—W4OPM —220—21 MHz phone
#2—WA8WRP—106—21 MHz phone

#1—W5DAJ —103—28 MHz phone

The complete list of ALL WTW CHECK POINTS:

W1/K1—NONE (send cards to me)

W2/K2—NONE (send cards to me)

W3/3—Western Pennsylvania DX Society,
John F.Wojtkiewicz—W3CJY
1400 Chaplin St.,
Conway, Penna. 15027

W4/K4—The Virginia Century Club,
P.O. Box 5565,
Virginia Beach, Va. 23455

W5/K5—Garland Amateur Radio Club,
2905 Sheridan Drive,
Garland, Texas 75040

W6/K6—Orange County DX Club,
James N. Chavarria
3311 Stearns Drive,
Orange, Calif. 92666

W7/K7—Western Washington DX Club,
William H. Bennitt, W7PHO
18549 Normandy,
Seattle 66, Wash. 98166

W8/K8–Straits Area Amateur Radio Club,
William Moss–WA8AXF,
307 Grove St.
Petoskey, Mich. 49770

W9/K9–The Montgomery County Amateur Radio Club,
Scott Millick–K9PPX
Litchfield, Ill. 62056

WØ/KØ–NONE (send cards to me)

ALL CANADIAN DISTRICTS SEND CARDS TO:
The Edmonton DX Club,
(VE6GX) 12907–136th. Ave.
Edmonton, Alverta, Canada

OCEANIA–ALL EXCEPT HAWAII (Hawaii to W6/K6 check point)
The New Zealand Association of Radio Transmitters (NZART)
Jock White (ZL2GX) Contest & Awards Manager
152 Lytton Road,
Gisborne, New Zealand

ALL SOUTH AMERICA–Venezuela Amateur Radio Club,
P.O. Box 2285–ATTENTION OF: YV5CHO DX Committee
Caracus, Venezuela, South America

ATTENTION ANY CLUBS ON Southern part of South America, we need a check point for this part of South America.

EUROPE: NONE (send cards to me)

AFRICA: NONE (send cards to me)

ASIA: NONE (send cards to me)

AGAIN I REPEAT: We are in need of other clubs for WTW check points. Especially in Asia, Africa and Europe as well as the few we still don't have covered in the USA. How about a club in Mexico too?

Thats it for this month, thanks fellows–LETS HAVE YOUR CLAIMED SCORES, etc.

. . . W4BPO

SUBSCRIPTION PREMIUMS!

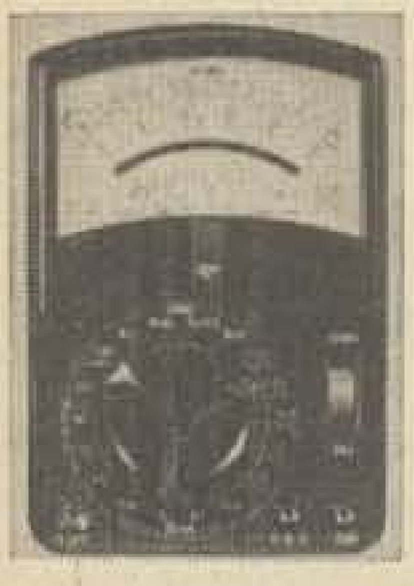
You can do good and do well at the same time. Do good by selling or giving gift subscriptions to 73 to friends. Do well by getting rather nice premiums for your effort or thoughtfulness. Some amateurs are working their way right through our whole list. All subs, other than one for yourself, must be new and will start with the November issue. You can renew yours if you send your address label from the wrapper and it will count towards the prizes. To make some of the bigger items easier to get you have a choice of substituting cash for some subscriptions.

$3 THREE SHELF ROTATING PARTS BIN

Free with 2 subs or $3 with 1 sub. Great around the shack or workshop. 11 compartments in each shelf.

$13 RAND-MCNALLY IMPERIAL WORLD ATLAS

Free with 3 subs or $6 with 1 sub. 300 pages of maps and info. Fine for DXing, school, arguments.



20,000 O/V V-O-M, 5000 VDC

Free with 3 subs or $7 with 1 sub. Keep one in the car, one in the workshop and one in the shack. Plus maybe a loaner?

HAMMOND WORLD GLOBE 18" DIAMETER

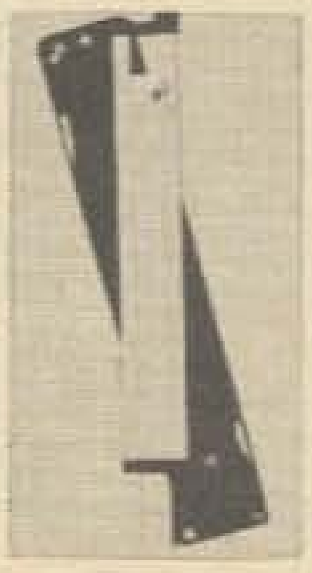
Costs $17. Free with 5 subs or $12 with 1 sub. Wonderful globe for DXing as long as you don't use any pins.

$25 MINI-TEST LAB

Free with 7 subs or $15 with 2 subs. VOM, rf-af generators r & c substitution, etc. Incredibly handy.

$12 WARM CAR BLANKET

Free with 2 subs or $4 with 1 sub. Handy around house, football, etc. Comes with zipper case & handle.



K & E SLIDE RULE

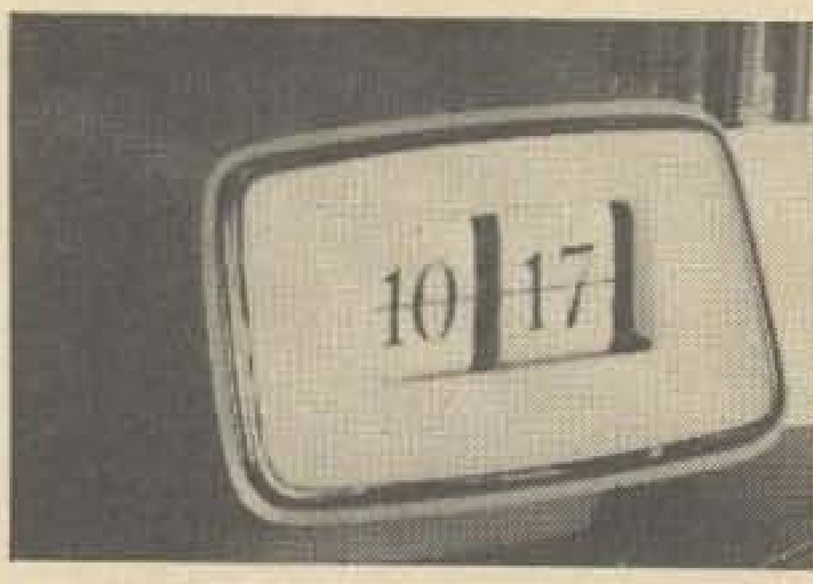
Free with 2 subs or $2 with 1 sub. You need a good slide rule every now and then.

Polaroid Big Swinger

Free with 10 subs or $20 with 2 subs. Uses regular pack Polaroid film, gives big size pictures. Foolproof?

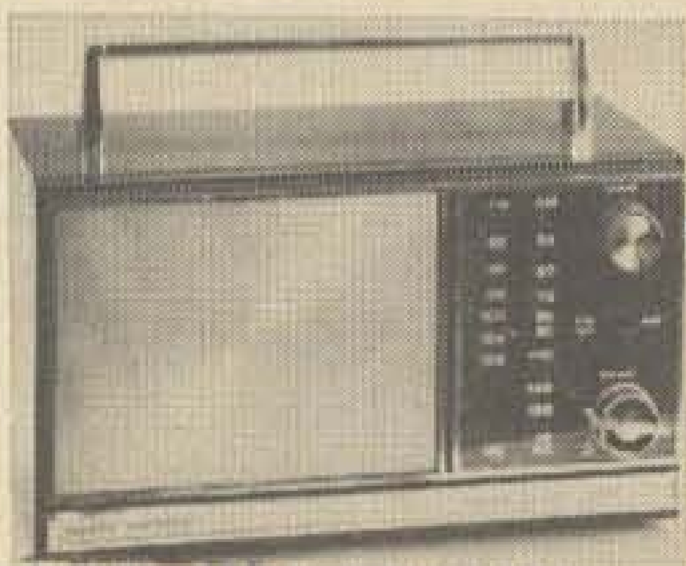
AM-FM 15 TRANSISTOR RADIO

Free with 8 subs or $18 with 2 subs. This radio sells for $30 normally. AC or battery.



24 HOUR DIGITAL DESK CLOCK

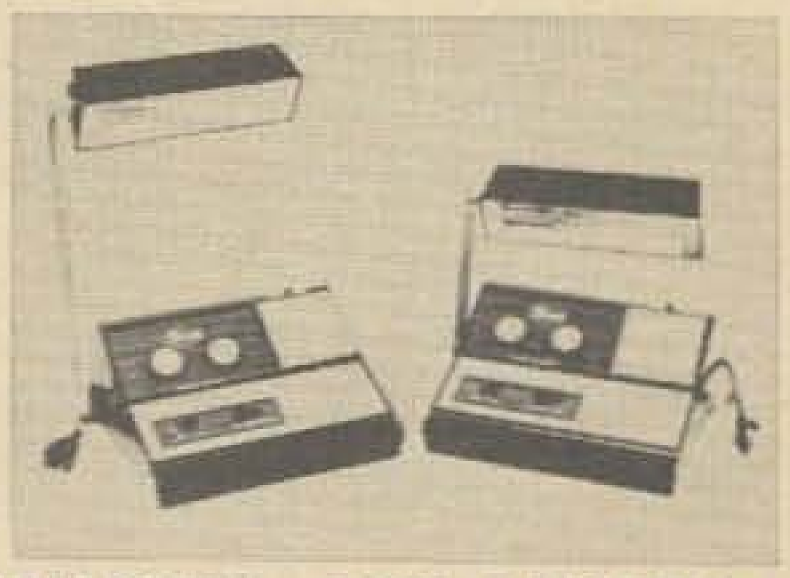
Free with 7 subs or $15 with 2 subs. Large numbers, prize-winning design. Makes ham shack look like $million. Sells for $25.



AM-FM 10 TRANSISTOR AC-BATTERY RADIO

Free with 8 subs or $18 with 2 subs. Works like crazy. Fabulous gift too. Be loved.

$35 HI-INTENSITY LAMP-RADIO AND CLOCK!



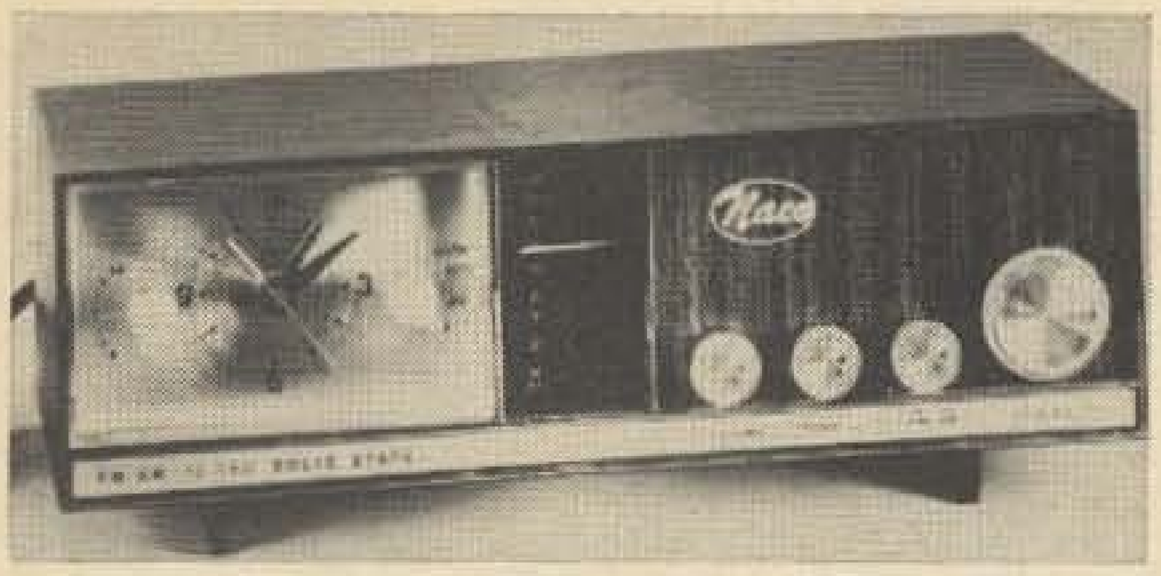
Free with 8 subs or $18 with 2 subs. Clock operates radio, etc. Fine for desk.

HAMMOND 18" LIGHTED $25 WORLD GLOBE

Free with 6 subs or $12 with 2 subs. Get two, one for jr op. No pins.

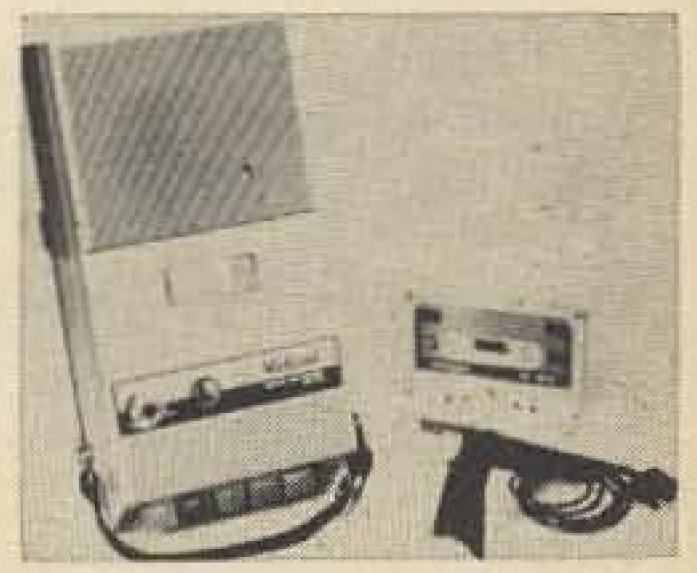
NAME & CALL PLATE

Free with 1 sub. Up to 20 letters and spaces on 10" desk plate. Walnut with white letters.



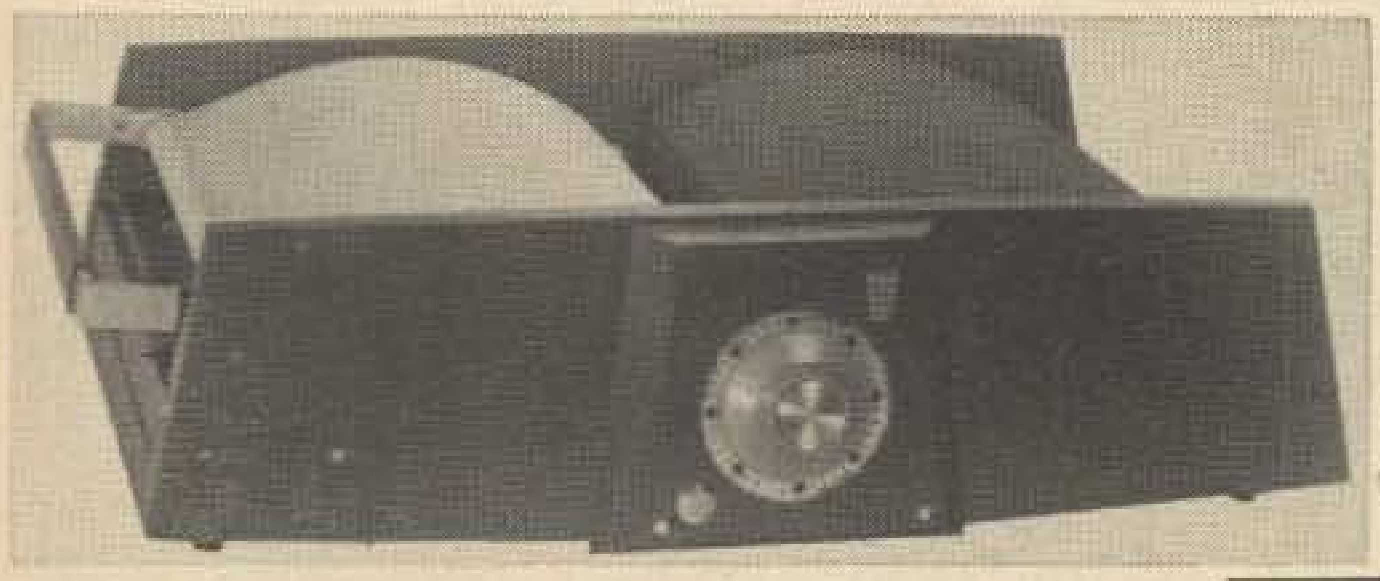
AM-FM TELECHRONE CLOCK RADIO

Free with 12 subs or $30 with 2 subs. This really beautiful clock-radio usually sells for $65. Has buzzer, radio alarm, slumber button, and delayed snooze turn off. Give yourself one . . . or the XYL.



$50 CASSETTE TAPE RECORDER

Free with 12 subs or $30 with 2 subs. We tested a dozen recorders before we found this darb. Really works. Record birds, rare DX, family squabbles, jokes, singing. Sneekily small.



COPYMATE PHOTO COPIER MACHINE

Free with 10 subs or $24 with 2 subs. This does every bit as good a copy job as a well known $400 copier and uses same inexpensive paper. Comes with paper all set to go.

DIGITAL CLOCK AM-FM RADIO

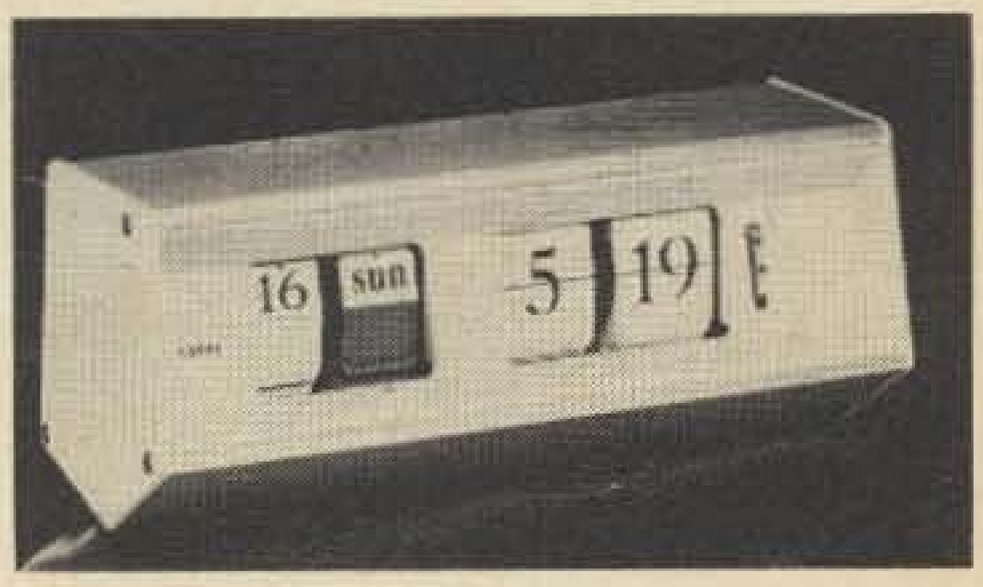
Free with 9 subs or $20 with 2 subs. This is the only digital clock radio we've ever seen. Fine FM radio built in with sleep alarm, buzzer, whole schmear. Like the unusual and new?

OPERATING DESK

Free with 9 subs or $23 with 2 subs. $35 desk just right size for modern transceiver ham station. Shipped FOB factory in Michigan.

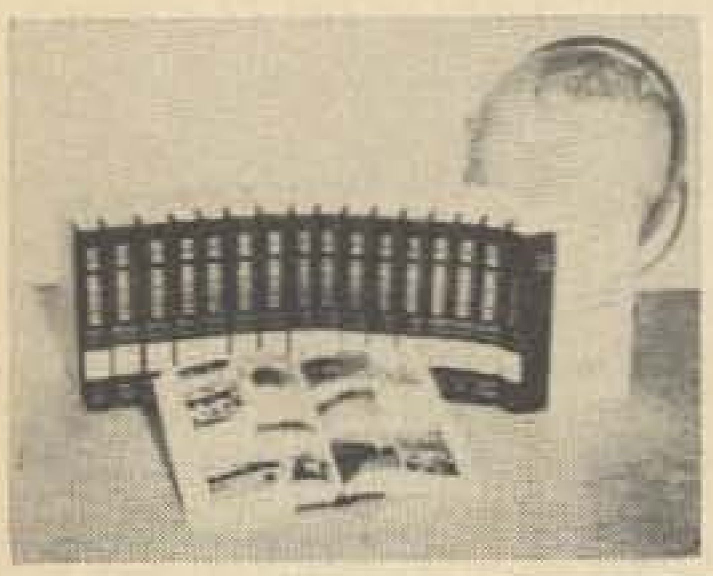
RAND-MCNALLY MAGELLAN WORLD GLOBE

$15 globe free with 3 subs or $8 with 1 sub. You can't beat a deal like that.



CASLON 601 DIGITAL DATE-DAY CLOCK

This $50 Ferrari of desk clocks is free with 12 subs or $32 with 3 subs. Brushed aluminum. The last word in operating aids. 24 hour clock, naturally.



$160 ENCYCLOPEDIA SET

Free with only 20 subs or $52 with 8 subs. This is a first rate encyclopedia. This one is FOB the publisher. Tap your fellow club members for 73 subs and win this mass of books.

Send each gift subscription on a separate 3 x 5 card with name, call, address and zip. All must be new one year $6 subscriptions to start with the November issue. You want to renew your own subscription? OK, if you include the label from your wrapper. On another card write your name and addess and indicate which prize you wish. Allow up to eight weeks for delivery in case we are back ordered from the factory. Prizes will be sent postpaid unless otherwise stated. This offer is good for the USA and APO only and expires December 31, 1968.

73 MAGAZINE, PETERBOROUGH NH 03458

W2NSD/1 from page 2

phone office and routed from there. If the phone on the other end is busy the office there would hold the recording until the phone was available and then send in the message.

Future Magazines

Several technological developments are closing in on the old fashioned magazine. The one that looks like a comer to me is color television with video tape. If you leave a tape on an individual frame you can read that frame just like a page in a magazine. A magazine the size of 73 would take very little tape. Perhaps we will be able to have a small tape cassette for each magazine.

Subscribing and billing would all be done in an instant. It doesn't look like it will be many years before all our banking will be instantaneous, eliminating the need even for small change. You will probably be doing almost all of your shopping via color television . . . mail order . . . just punch the button on your set when you flip to the ad you like and it will be delivered that same day. Why go to the supermarket when you can flip through their catalog on TV and have whatever you want delivered almost immediately?

It is unfortunate that our television standards were frozen as early in time as they were, back when the picture was relatively crude compared to those possible today if our standards could be changed. Some of the European television has considerably better definition than ours because they standardized a few years later. Perhaps when we make the change to satellite broadcasting direct to homes we can use a new set of standards.

The magazine via television could come in a few pages every day rather than waiting for one big lump a month. I suspect that the costs of "publishing" and distribution may be enough lower so you will be able to have a lot more material and advertising costs will be but a fraction of those today. The costs may go back up if magazines integrate moving sequences with the single frame readout. The Life magazine of the future may be more of a half hour program that you can subscribe to . . pay TV . . . rather than a magazine. Like the old March of Time.

A magazine today has to pay the authors for the articles . . . and pay well and rapidly. Then, in our field, we have to have the schematics drafted by professional draftsmen. Type has to be set, engraving plates have to be made of the drawings and the photographs. Everything has to be read carefully for mistakes. The articles are then put together on the pages and made ready for printing. More proofs . . . more proofreading. When everything is all set one copy of each page is printed and an offset negative is made of the page. The negatives are pasted together in 32 page groups and a large printing plate is made of that.

Meanwhile, off in Canada, a swatch of trees has been felled and crushed into paper, coated for a nice looking page, and shipped to the printer. We use up to 40-000 pounds of paper for an issue . . . that is about 20 tons! This whizzes through the press in a couple of days. The pages are then folded, collated, glued together and trimmed. Subscriber copies are wrapped and the address label from our computer in Massachusetts stuck on. Bulk copies for radio parts stores and newsstand distributors are bundled and shipped by truck or mail around the country.

Every one of the hundreds of people involved in this whole operation have to be paid. Plus our bookkeeper, advertising department, and other staff. A lot of money could be saved if we could eliminate the printing.

The day is approaching when type will mostly be set by an advanced type of typewriter. The IBM chaps arrived here the other day with just such a machine hoping to sell it to me. I am not ready to buy a $4000 typewriter yet, even if it does do a fine job of setting type. I suspect the day of the old Linotype machine are numbered now. It can't be long before most printers change to something like this IBM job. Just a few years ago offset printing couldn't compete with letterpress for our type of magazine . . . now we are offset and it is working out quite well. The obvious next step is in typesetting.

Subscription Premiums

The idea of giving prizes for selling subscriptions to a magazine is not new. Older readers certainly will remember the glowing ads for free bicycles and things that used to appear in the comic pages, just for selling subscriptions . . . or Christmas cards . . . or soap.

The idea still seems to work. We have quite a number of 73 fans who are working their way through our list of prizes. The slide rule, being one of the easiest to get, is by far the most popular. The parts bins, digital clocks and operating desks have been keeping us hopping too.

We have had a little trouble getting across the concept that these prizes were for *selling* subscriptions to 73 and not for *buying* them. There is a basic difference there. This month we capitulate and allow the addition of a renewal to accompany the new subscriptions. This means we have to offer a little less for each new subscription. After all, the money for the prizes comes from our savings on soliciting *new* subscriptions. We still have to send out renewal notices.

The result of all this has been one of the most rapid periods of growth in the history of 73. We've had to double our staff here to handle things. The early miseries of our computer for subscriptions are past and we are now able to handle a growth like this without falling to pieces.

Advertisers will have to face another rise in our rates. The economics of publishing dictate that the advertising revenue must pay for the printing bill. And as the circulation increases so does that bill. The post office grabs a good percentage of the subscription money and promises to take even more as they decrease service.

Wayne

"This'll give you a laugh! Some wise guy is giving me the call letters UFO."

UFO from page 4

UFO activity for your area you will be the one that is called when something is doing . . . and that is fun. Just the other day I got a call from a farmer in Francistown. Seems that he had been haying down in this field and saw some mighty peculiar burnt spots that he knew had not been there before. He asked around and someone remembered ny name and he called me.

Lin and I drove right up to take a look. Sure enough, we found two circular almost bare spots along the edge of the field. It looked as if something about three feet thick and 21′ in diameter had set down there for a while. None of us could imagine what on earth could have made two identical marks like that about 50 feet apart, plus several smaller bare spots about ten feet in diameter. The farmer swore they hadn't been there before this summer.

Almost identical marks have been found in other fields near here in the past and no one has an explanation. It was interesting to me that just about a half mile up the hill from the bare spots was a microwave repeating tower. Hmmm.

I reported the whole matter to the local NICAP investigator and Dean Coles at Franklin Pierce College. Dean is going to make some radioactivity tests on the spots.

Like I say, when you get involved in this you can have a lot of fun.

UFO NET SCHEDULE

Wednesdays 0200 GMT 14,300
Thursdays 0200 GMT 3950

. . . W2NSD/1

SUBSCRIBERS

We want to make absolutely sure that no one is using our 73 mailing list. We do not rent this list out as do other magazines. If your address label from 73 is distinctive and you find that you are getting any mail addressed in the same distinctive way please let us know immediately and send us the envelope or wrapper that you received so we can take appropriate action. Your help in this will be very much appreciated.

International Notes

The DARC recently reported that there are now 11,997 DJ, DK, and DL licensed amateurs in Germany, 497 DL4-5, and 1491 DM's. The annual membership fee for the DARC is, by the way, $10. 87% of the licensed amateurs in Germany are members of DARC. When you consider that $10 in Germany is about equal to $25 here in terms of comparable prices and wages, it is obvious that the DARC must in some way have won the confidence of the German amateur. Perhaps our ARRL, with about 27% U.S. amateur support, could get some pointers from DARC?

160M buffs may be interested to know that the German bands are 1825-1835 kHz and 1985-1992 kHz.

Interested in a short term DL license? Write to DARC International Affairs Office, Muehlenstrasse 27, D-5601, Doenberg, Germany. Complete regulations for amateur radio in DL can be obtained from Secretary DARC, Beseleralle 10, D-23, Kiel, Germany.

The SRJ (Yugoslavia) now has 400 radio clubs, 30,000 members (including school children), 5000 radio operators and 1800 amateur transmitting stations (1200 private, 600 club). During the 7th National Convention in June there were competitions for the fastest construction of radio equipment by children, a QRQ contest for adults (code speed, if you don't know your Q-signals), an amateur radio cartoon contest, a contest for the best jokes in an amateur's life, an exhibition of home-made gear and foxhunting for children and adults on 3.5 and 144 MHz. Program chairmen for our conventions please take note.

Region III (Asia) of the IARU has had difficulty in getting together for meetings up until this year due to the distances involved. Australia, New Zealand, Japan and the Philippines were able to send representatives for the first meeting this year. The Wireless Institute of Australia will provide the secretariat and the funds will come from member societies.

Visiting Finland? Reciprocal licenses can be had for $11.33. Send for application to SRAL, Box 10306, Helsinki 10, Finland.

Licenses for Italy? Send for application to ARI, via Vittoria Veneto 12, Milan.

Propagation Chart

OCTOBER 1968

ISSUED AUGUST 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7A	7	7	7	7	7	14	21	21A	21A
ARGENTINA	14A	14	14	7A	7	7A	14A	21A	21A	21A	21A	21A
AUSTRALIA	21A	21	14	7A	7A	7B	7B	14B	21	21	28	28
CANAL ZONE	14A	14	7A	7	7	7	14	21A	21A	21A	21A	21
ENGLAND	7	7	7	7	7	14	21	21A	21A	21A	14	7A
HAWAII	21A	14	14	7A	7	7	7	7B	14A	21A	28	28
INDIA	14B	7B	7B	7B	7B	14B	14A	21A	14	14	14	14B
JAPAN	14A	14	7A	7B	7B	7	7A	7B	7B	7B	14	21A
MEXICO	21A	14	7A	7A	7A	7	14	21A	28	28	28	28
PHILIPPINES	14	14	14B	7B	7B	7B	7B	14	14	14	7B	14A
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	14A
SOUTH AFRICA	14	14	14	14	7B	14A	21A	28	28	28	21A	21
U. S. S. R.	7	7	7	7	7B	14B	21	21A	21A	14A	14	7A
WEST COAST	21A	14	14	7A	7A	7	7A	14A	21A	21A	28	28

CENTRAL UNITED STATES TO:

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

WESTERN UNITED STATES TO:

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

A - next higher frequency may be useful this period
B - difficult circuit this period

Good: 1, 2, 4-6, 9-12, 14, 16-18, 23-25, 27-30

Fair: 3, 8, 13, 15, 21, 22, 26

Poor: 7, 19, 20

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.

★ 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 . . .

FOR SALE—perfect condition Clegg 22er $175.00. Central Electronics 10A with coils, $65.00. Will ship. F. Myers, 1403 Main St., Honesdale, Pa. 18431.

SELL! HRO50T1, ABCDEF coils, speaker, manual, $165.00. Will ship prepaid. Cashier check or postal money order. Clyde Lee, K4OOW, 925 Blue Springs Dr., Pensacola, Fla. 32505.

GROUNDED GRID FILAMENT CHOKES, 30 amps, ferrite core, ¾" x 5", $4.00. Plate chokes 2500 VDC 800Ma, $2.00. PPUSA48. Calif. add tax. William Deane, 831 Sovereign Rd., San Diego, Cal. 92123.

HAM—TV, Close Circuit TV Camera—$125.00, Hitachi 7735A Vidicon—$15.00, Toshiba 7038 Vidicon—$10.00, Reverb—$15.00, Simpson 260-5 VOM—$35.00. Stan Nazimek WB2GKF, 506 Mt. Prospect Ave., Clifton, N.J. 07012.

THE OAK RIDGE RADIO OPERATOR'S CLUB will sponsor the 18th Annual Crossville Picnic at Cumberland Mountain State Park July 20-21. For information write The Oak Ridge Radio Operator's Club, Inc., PO Box 291, Oak Ridge, Tenn. 37830.

ART-28 TELEVISION transmitter. Excellent condition with plugs, manual, and power supply. 400 watts peak power. $125. Warren Dunning, 2828 S. Simpson St., Philadelphia, Pa. 19142.

COLLINS 75-A3, .8 and 3.1KC. Mechanical filters, 100KC calibrator. Product detector and hang A.V.C. added. Realigned, recalibrated, excellent. Price $225.00. W5NHB, 4615 Laurel, Bellaire, Texas 77401.

WANTED. January 1961 issue of 73. Please state condition and price. W2DYY, Russ Schroeder, 469 Salt Rd., Webster, N.Y. 14580.

HILLSBOROUGH AMATEUR Radio Society, Inc. (HARS) Annual Tampa, Florida Hamfest will be held Sunday, October 13, 1968 at Lowry Park (Sligh Ave. and N. Blvd.). Free parking—many prizes.

SWAP 514 AD 410B each Harrison Power Supplies. Goodies for linear 4-1000A 4 spare tubes. Want TR4 or similar size. Write Swift, W1CZM.

SELL: Immaculate SB-34 transceiver with mike, $300. Eico electronic keyer, new, $45. Hallicrafters SX-42 and R42 speaker, aligned and reconditioned, $150 or make offer. KWS-1 serial, #1465, $800. Knight RF 'Z' bridge impedance device, $10. Turner 80X microphone, $5. Eldico SSB-100F aligned and reconditioned, $275. Spare 5894/AX9903, good, $4. Lee Richmond, 166 Floral Ave., Plainview, N.Y. 11803, GE 3-8663.

"SAROC" FOURTH ANNUAL National Fun convention hosted by Southern Nevada ARC, January, 8-12, 1969, Hotel Sahara's new Space Convention Center. $12.00 Advance Registration accepted until January 1, 1969, regular registration at door. Ladies program in Don the Beachcomber. Technical seminars; ATV FM, MARS, RTTY, QCWA, WCARS-7255, WSSBA meetings. Golf and bridge tournaments. "SAROC" registered participants entitled to special room rate $10.00 plus room tax per night single or double occupancy, admittance to cocktail parties, technical seminars, exhibit area, Hotel Sahara's late show, Sunday Safari Hunt breakfast (equal to any banquet—ask any "SAROC" veteran). "SAROC" brochure planned for November mailing QSP QSL card for details. Please send separate checks for accomodations and registration now if you like to W7PBV c/o "SAROC" Hotel Sahara, Las Vegas, Nevada 89109.

MICRO-MICRO-TO KEYER: Perfect code from one cubic inch, microcircuit digital electronic keyer module designed for mounting inside any transmitter. Speed range 4-40 WPM. Grid block keying only allows price of $19.95. Includes mounting hardware. Unconditionally guaranteed. Micro-Tech Labs, PO Box 884 (I.A.B.), Miami, Fla. 33148.

NATIONAL 200, A/C 200; A/C power supply, NCXD-DC power supply. Very good condition, almost new. Extra rig, and must sell to best offer. WA2OHN, 845 Cliffside Ave., North Woodmere, New York 11581.

WANTED: Teletype equipment & parts. Also R-390A/U-R, R-220, etc. Cash or trade for new amateur equipment. Alltronics-Howard Co., Box 19, Boston, Mass 02101 (Tel: 617-742-0058).

STARTING A HAM STATION? Tell us requirements and cash available. Will advise on best possibilities. $3.00. WB6VFG, WB6YPF, 1035 N. Ave. 63, Los Angeles, Calif. 90042.

DO YOU HAVE A PROBLEM with your equipment? Let the communications specialists handle it for you. Complete amateur service—kits wired, tested. J-J Electronics, Canterbury, Ct. 06331.

VARIACS: Panel mount, in new condition—20A—$32.50, 6A—$12.95, 1¼A—$6.25. Condenser, computer grade, 74,000 Mfd. @ 10 V DC—$1.89. Send for catalogue listing other condenser bargains; Nicads; Solid State material; test equipment and other "hot" items. Advance Electronics, 54-M West 45th St., New York, N.Y. 10036.

WANTED: April 1964 and 1965 issues of QST. Write box 691, Savannah, Georgia 31402.

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