APRIL, 1964

40c

73 AMATEUR RADIO

measure the performance...

Stack up the features!

VOX & Push-To-Talk Circuitry.

Output Power — Two-tone SSB and CW — 50 watts at 10 meters to 65 watts at 80 meters for conservatively rated input of 90 watts DC, 130 watts P.E.P. AM is 25% of SSB/CW values.

3 element Pi network variable output circuit (40 to 80 ohms).

5 position switch for internal or external VFO plus three crystal control frequencies suitable for Novice, MARS, C.A.P., etc.

Built-in antenna changeover, VOX and break-in keying.

Amateur Bands Covered — 80, 40, 20, 15 and 10 meters. 160 meter band position provided for use with optional kit.

Complete passband coupler design used throughout low-level stages provides minimum 1 MC bandwidth at the following frequency ranges: 3.2 to 4.2 MC; 6.9 to 7.9 MC; 13.8 to 14.8 MC; 20.8 to 21.8 MC; 27.0 to 31.0 MC.

HAMMARLUND'S HX-50

ONLY $449.50 AMATEUR NET

...and we are sure that you will agree that despite the new price tag we have had to put on the FABULOUS HX-50, it still gives you more dollar-for-dollar value than any other transmitter in the market today! The '50 is crammed full of outstanding features to deliver the performance you have always wanted — but have never been able to get in this price range.

Now Available! 160 Meter Band Kit for only $11.00. Or, if you prefer, this plus feature can be wired right into the unit on special order for an additional charge. NOTE: The Hammarlund HX-50 is the only commercially manufactured Amateur transmitter that presently provides 160 meter band capability.

Don't wait. See the FABULOUS '50 at your authorized Hammarlund Distributor — or send for complete technical data on the transmitter that is still "THE BEST BUY IN ITS CLASS."

Established 1910

HAMMARLUND Manufacturing Company

A Giannini Scientific Company   53 West 23rd Street, N. Y. 10, N. Y.

AMATEUR RADIO EQUIPMENT • COMMERCIAL COMMUNICATIONS EQUIPMENT • THE OUTERCOM 2-WAY RADIO
VARIABLE AIR CAPACITORS • SUPERVISORY REMOTE CONTROL SYSTEMS

73

Magazine

Wayne Green W2NSD/1
Editor, etcetera

April, 1964

Vol. XVIII, No. 1

73 Magazine is published monthly by 73, Inc., Peterborough, N. H. The phone number is 603-924-3873. Subscription rates have just been hiked (after considerable warning) to $4.00 per year, $7.00 for two years, $10 for three years world wide. Second class postage is paid at Peterborough, New Hampshire and at additional mailing offices. Printed in the U.S.A.

Postmaster: please send form 3579 to 73 Magazine, Peterborough, New Hampshire.

de W2NSD/1

never say die

My editorial last month nudged enough skeletons so that I knew we'd have to have an answer of some sort from the ARRL. Sure enough. Affiliated clubs received a letter from Huntoon claiming that the Geneva administrative conference positively will not be held in 1965. Though this is contrary to the reports I've had on a confidential note from State alerting other agencies to be prepared for the possibility that an administrative conference might be added to the plenipotentiary conference in 1965 since all of the delegates will be on hand anyway. The later the administrative conference the better for us . . . I hope they turn out to be right. I, frankly, feel that we should expect the worst and work hard to be as ready as possible. If we have more time then we are just that much ahead.

Hunty reassured us all that Hoover will remain president of the League. I think I can speak for all ARRL members in commending Herb for sticking to the ship in time of storm. We were all dismayed to read in the March issue of QST that membership in the ARRL dropped off last year . . . possibly for the first time in history except for war time. We'll all be watching very carefully to see if things are straightened out enough this year so the thousands who have threatened to drop out of the ARRL change their minds.

The letter also claimed that it would be months before the FCC would give any answer on RM-499. Well, one way to handle a hot potato is to let it cool off first. I hope that we will see something soon, before ham radio is further pulled apart by this ill-considered action. I think that the League should exert their influence to help speed up this action, not slow it down.

The revolution brought on by the incentive licensing hassle was felt in some areas of the country during the last ARRL elections when Tom Moss W4HYW and Phil Spencer W5LDH won the elections in the Southwestern and Delta Divisions. I'd like to see some more fellows on the ARRL Board of Directors with some gumption . . . it is just possible that some dynamic leadership could get the League going again and eventually have it resume representation of the amateurs.
This fall the League will hold elections in the Central, Hudson, New England, Northwestern, Roanoke, Rocky Mountain, Southwestern and West Gulf Divisions. If you meet the qualifications to run for Director and you are willing to put up a fight to get ham radio back in shape why not seriously consider running. I hope that this year we will be able to devote considerable space in 73 to the qualifications of the aspirants to Directorship so members won't have to make their decision on the basis of a short and perhaps hopelessly biased biography which comes with the ballot.

To qualify under the present rules you must have been a League member continuously for at least four years (with not even a one day lapse in membership) and you must not be in the radio industry. All you have to do to run is get the signatures of ten League members on your petition and then visit as many clubs in your division as you can to round up votes.

I have a few other hints which some of the past directors claim are sure fire for election. As far as I know none of them that knew the formula ever lost an election.

The petitions for nomination don't have to be in until September, so you have lots of time to talk this over on the air and at club meetings and get some fellows interested who can get in there and straighten things out. I'm interested in hearing from anyone who wants to give this a try.

Catalogs Are Free

Though I haven't mentioned it recently, advertising is still the life-blood of magazines.

This means that whenever you write to an advertiser and mention that his ad in 73 brought you to him that we will be able to run just that many more pages in future issues of 73.

Though advertiser after advertiser tells me that 73 is the best pulling magazine of all for direct sales and for the sale of new equipment, we seem to lose out every now and then on catalog distribution. Fellows, how can you get along without some of the basic catalogs? I have several that I keep right at hand all the time . . . I wouldn't be without 'em. If you'll just send for a few catalogs and perhaps get a few fellows you talk to on the air to send in too, we will be in good shape.

How can you be without the Allied catalog? It's the largest in the business. Write Allied Radio, Department 73, 100 N. Western, Chicago 80, Illinois. Just a QSL card will do it fellows.

Next you'll want to get the Lafayette catalog. Lafayette not only has a whole line of ham gear, but they import terrific little gadgets from Japan that you can't get elsewhere. I order stuff from them every day. Lafayette Radio, Department 73C1, Syossett, L. I. N. Y.

While you're cataloging drop a card to Heath, Dept. 11-1-1, Benton Harbor, Michigan. Heath has so much new stuff that it is hard to keep up. I'm still kicking mystelf for letting some of their past equipment be discontinued before I latched onto it.

Another dandy catalog is the one from International Crystal, Dept. 73, 18 North Lee, Oklahoma City. Oklahoma.

Leo, out there in Iowa, has a fine ham catalog. Write World Radio Labs, 3415 West Broadway, Council Bluffs, Iowa. Tell Leo that 73 sent you.

Texas Crystals will be upset if you don't get one of their new catalogs . . . you will be too, when you find what you've missed. Well worth the effort. Texas Crystals, Dept. 73-4, 1000 Crystal Drive, Fort Myer, Florida.

Not only will this make all these companies happy, but you will get just that much more mail.

More Help

Between the extra work brought on by the Institute of Amateur Radio and the loss of four staffers due to draft board handiwork we are still looking for fellows to come up here and work with us. We don't need experience as much as intelligence and versatility. Fel-

(Turn to page 88)

The Los Angeles Six Meter Repeater

The author and the repeater. Panels, top to bottom: 1) Preselective LC tuned filter 2) Six meter receiver 3) Audio panel 4) Tape deck 5) Modulator 6) 220 mc control receiver 7) Control panel 8) Six meter Transmitter

Douglas Sherman K6VWM
5438 4th Avenue
Los Angeles 43, California

In December of 1959, within the confining walls of Los Angeles City College, a momentous decision was reached, a decision that was destined to shake the very foundations of amateur radio. A brilliant young physicist (me) and an aspiring young engineer (the other guy) decided to provide a service for the amateurs in Southern California that was heretofore unheard of, and indeed unthought of, throughout the history of mankind! And all this with no ulterior motive, (much)!!

Actually, upon closer examination, it wasn't really unheard of, or even unthought of, and it didn't shake the foundations of amateur radio, but it is a service, and it is offered (toll free) to all amateurs on the six-meter band in Southern California. It's called "The Los Angeles Six-Meter Repeater."

One of the fundamental differences between radio waves of high frequency (HF) and those of very high frequency (VHF) is that the very high frequency waves are not sufficiently affected by the earth's atmosphere to cause them to display the property known as "skip." Both HF and VHF radio waves emanate from the antenna in straight lines, but where the HF waves are returned from the ionosphere, the VHF waves continue on out into the blue. Therefore, the only VHF waves that are useful for communication are the ones that travel along the ground.

Unfortunately, we now run into a very bad design error: The earth is round! To a VHF man, this is very sad news indeed, but nevertheless it is true. Now, the earth being round wouldn't be so bad if VHF radio waves either

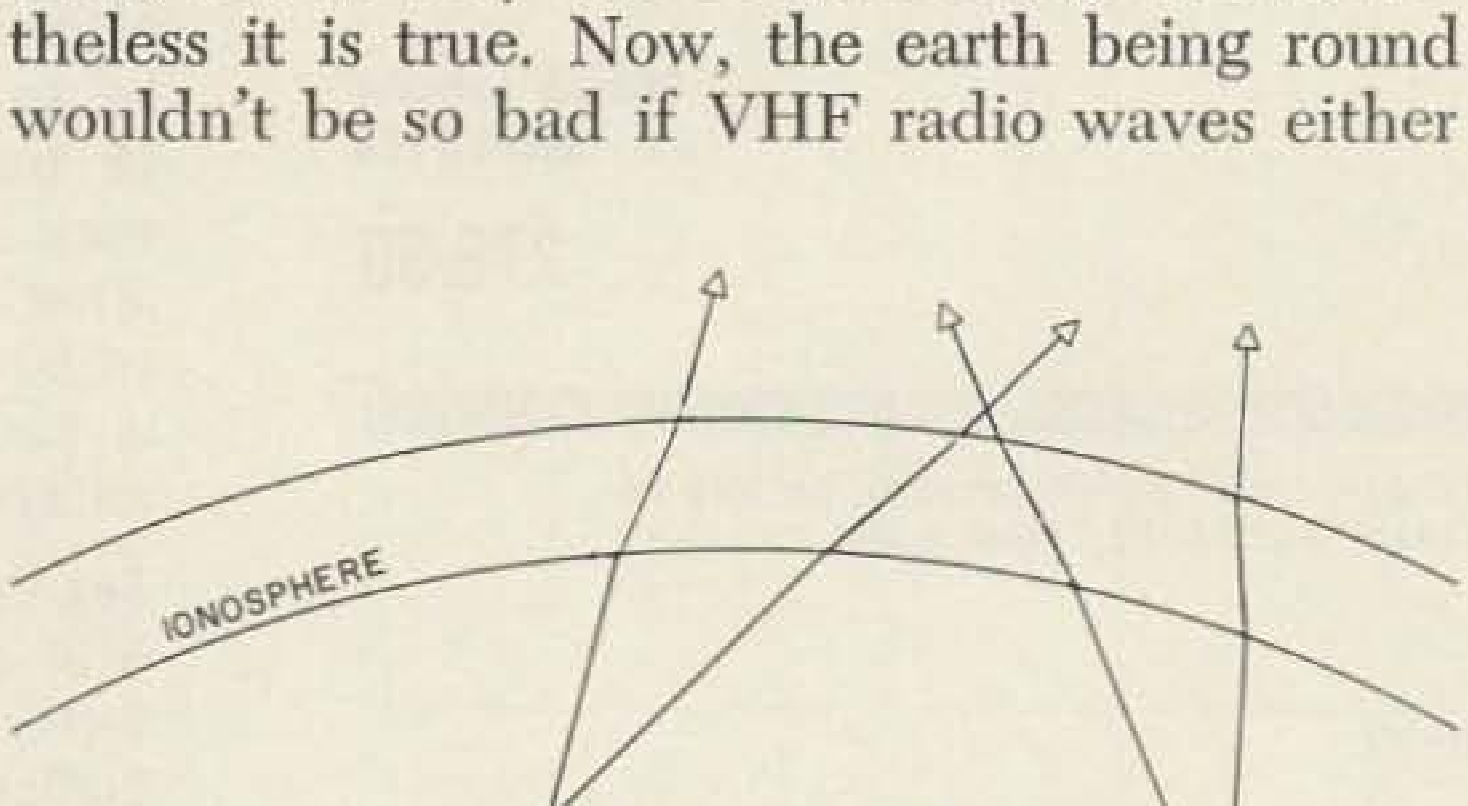


FIGURE I

R = Radius of communciation = 300 to 500 miles

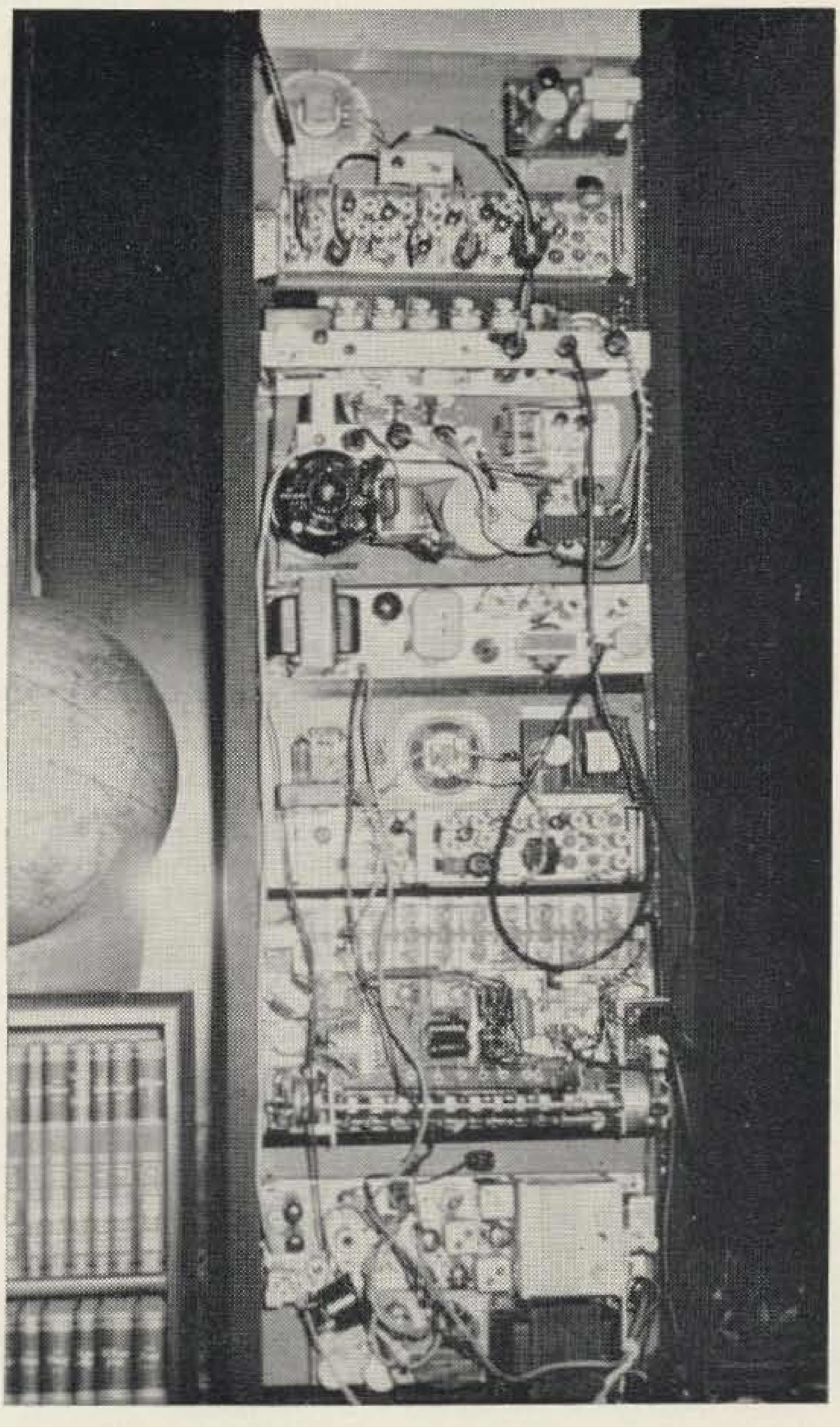
r = Radius of communication = 30 to 50 miles traveled in circles or would always come back from the ionosphere, but alas, they don't. As a result of the straight VHF waves and the round, round world, one can talk, under normal conditions, only a distance of 30 to 50 miles. A nasty trick of nature indeed, and one that had to be reckoned with.

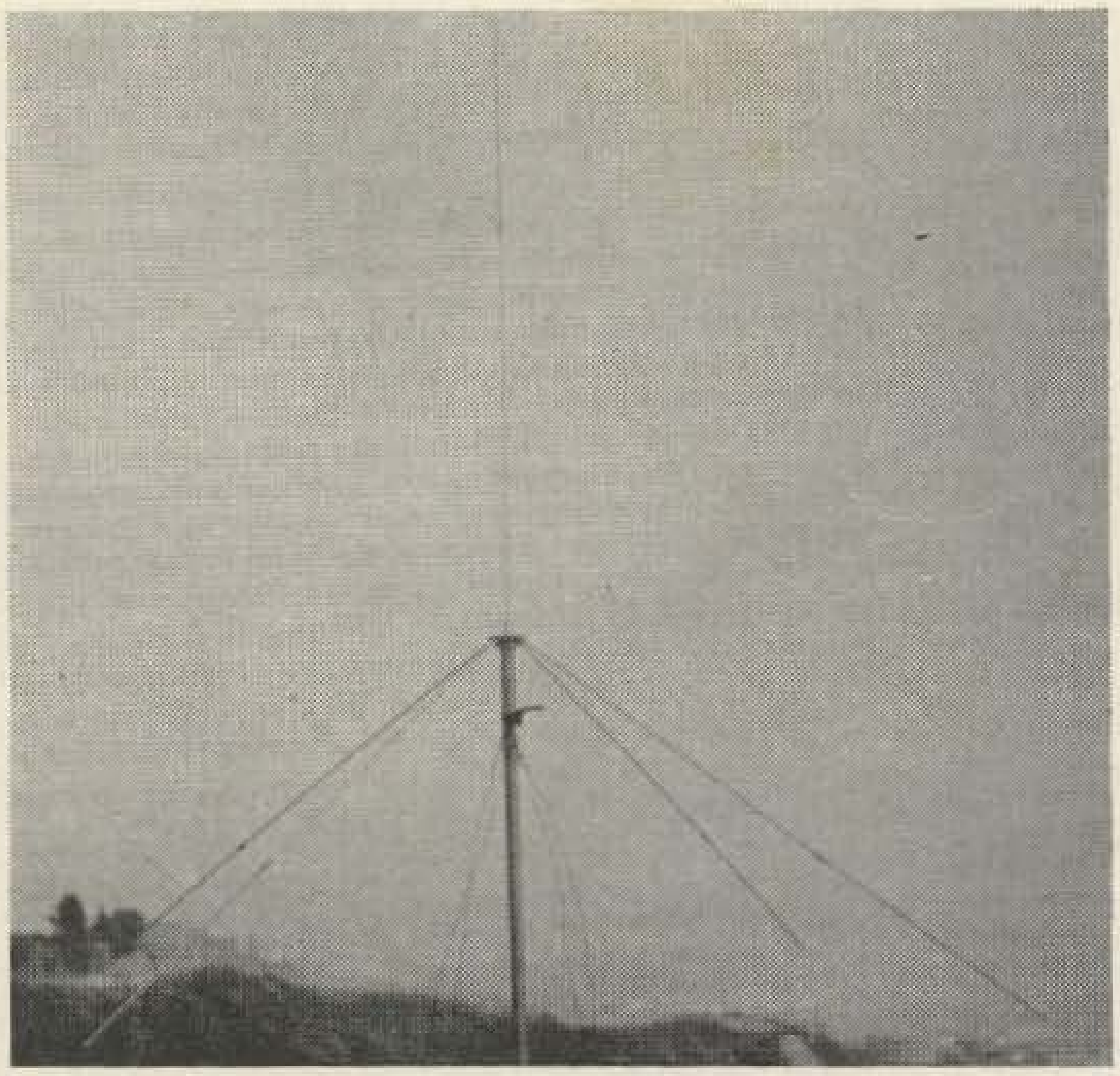
Now it is common knowledge that VHF amateurs are a minority group and as such are discriminated against because hilltop housing is not available to them. However, consider the possibility of a VHF amateur on the top of a tall mountain. Not only he, but his transmitter can see much farther than any of his ground-bound counterparts. See Fig. 1. Unfortunately, not all amateurs can live on the tops of mountains. Therefore they must be satisfied with the meager range that they can cover from their locations.

Being firm believers in the equality of man, and that ground-bound amateurs are just a little more equal than the rest and deserve something extra, we placed a six-meter receiver, a six-meter transmitter, a tape deck for identification, and other circuits that are peculiar to repeater operation, on the top of a mountain. And presto, we had a repeater! Actually that "presto" is quite misleading. Well over 4000 combined man-hours of concentrated work during the months of June, July, August, and September of 1960 were spent designing, building, redesigning, and rebuilding until "it" worked.

A repeater is essentially an instrument that sits on the top of a mountain, listens on some frequency in an amateur band and simultaneously transmits, on a different frequency, everything that it hears. It effectively puts every amateur using it on top of the mountain. The Los Angeles Six-Meter Repeater receives on a frequency of 50.55 megacycles, transmits a 25 watt signal on a frequency of 51.10 megacycles and is controlled on the 220 megacycle band. The repeater has excellent coverage over most of Southern California. It has been copied by an aeronautical mobile over Phoenix, Arizona. The signal there was S9 at heights over 100 feet and eventually dropped into the noise at about 50 feet above the ground. The signal has been reported as S9+ along the beach in San Diego, California, and it is easily copyable mobile in downtown San Diego. The repeater provides excellent coverage of the San Fernando Valley but unfortunately it does not provide coverage north of the range of mountains separating the San Joaquin Valley from Southern California. We also have trouble getting into the resort town of Palm Springs, California. The repeater is copyable there, but it is only about S1. Apparently some of the signal is bounced off the side of Mt. San Gorgonio and down into Palm Springs behind Mt. San Jacinto. We have never been able to successfully copy the only six-meter station in Palm Springs. All in all though, the repeater solidly covers an area in excess of 250,000 square miles.

The repeater is built around a modified Motorola 80D receiver and transmitter. This Motorola mobile unit was once part of the Montana Highway Patrol and was purchased indirectly from the Motorola Warehouse in Burlingame, California. The 220 megacycle control receiver is a modified Motorola 5V, which used to be mounted on a police motorcycle. The 220 megacycle transmitter is homebrew and can be found in the ARRL *Radio Amateur's Handbook*. The tape deck is homebrew, but utilizes Concertone hardware and 8 IBM recording heads. The tape deck accommodates one inch wide tape, upon which there are 8 possible recording tracks matching the 8 IBM recording heads. On one of the tracks one finds voice identification; MCW identification is on another track. There are 6 tracks left





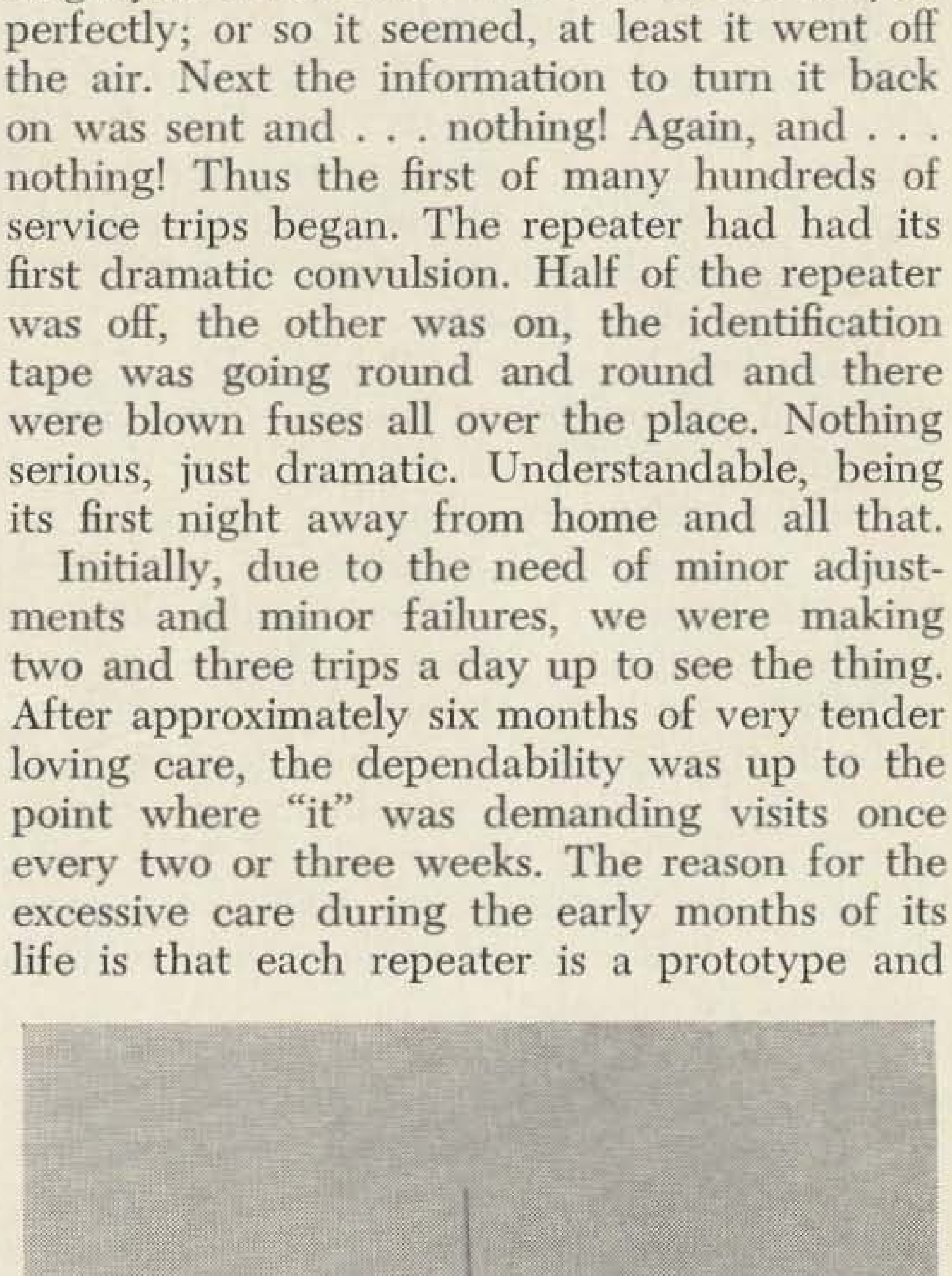
Six meter communicator

for experimentation, special seasonal messages, etc. The tape is in the form of a loop and is automatically cycled once every five minutes when the repeater is in operation. It has been found that MCW identification is far superior to the voice method. With MCW identification, the weakest stations can be copied but the voice identification blanks out even the strongest stations. The identification was made very strong because it was found that the FCC is very sensitive about weak identification in repeater applications.

In repeater operation, the transmitter remains on the air whether or not anyone is on the input channel. (There is one exception to this that will be discussed later.) It is sometimes difficult to tell when an amateur removes his carrier from the input channel because the noise level at the repeater is always very low. To facilitate the realization of this and provide a guarantee of break-in capability, a 2 second delayed beep tone circuit was built and installed. This circuit waits for two seconds after a carrier has been removed from the input channel, and then puts a 600 cycle sawtooth wave on the output of the repeater transmitter. This serves as a signal that a carrier has just left the input channel and that the repeater is clear for another transmission. The two seconds of silence enables any break-in stations to identify and make their desires known. All stations using the repeater are requested to wait for the beep tone before each of their transmissions. The break-in stations do not wait for the beep tone but come in before it comes on. Because of this break-in capability, many emergencies have been given immediate attention and several lives have undoubtedly been saved.

The repeater was first put into service at about 8:00 pm on December 25, 1960. That was a night that will long be remembered. For two weeks previous to that date, the repeater sat in a garage and ran 24 hours a day loaded into a lightbulb without any failures. Then it was installed in the Baldwin Hills and manually put into operation. It was functioning perfectly. We came back down the hill to the control point and decided to put it through the acid test of remote control. The necessary 220 megacycle information was sent and it obeyed perfectly; or so it seemed, at least it went off the air. Next the information to turn it back on was sent and . . . nothing! Again, and . . . nothing! Thus the first of many hundreds of service trips began. The repeater had had its first dramatic convulsion. Half of the repeater was off, the other was on, the identification tape was going round and round and there were blown fuses all over the place. Nothing serious, just dramatic. Understandable, being its first night away from home and all that.

Initially, due to the need of minor adjustments and minor failures, we were making two and three trips a day up to see the thing. After approximately six months of very tender loving care, the dependability was up to the point where "it" was demanding visits once every two or three weeks. The reason for the excessive care during the early months of its life is that each repeater is a prototype and



220mc antenna

Clegg VENUS - SSB Transceiver For 6 Meters

The Clegg Venus is a high quality, compact, attractively styled SSB receiver and transmitter that puts you on 50 mc single sideband without all the fuss, bother and expense associated with adapting low frequency SSB exciters, crystal controlled converters, relays, linear amplifiers, etc.

Employing all the latest circuit techniques, the Venus, in one small package, provides a combination of advanced operating features and conveniences heretofore unavailable in rigs at any price. Some of the outstanding features of the VENUS include a nuvistorized high sensitivity, low-noise front end; crystal lattice filter in both receive and transmit positions; ± 1.5kc receiver offset tuning; broad band circuits throughout providing maximum simplicity and ease of tune-up; and a separate front panel control for smooth injection of carrier for excellent quality AM and adjustable CW output.

ELECTRICAL SPECIFICATIONS

TRANSMIT: Frequency Range: **49,975 to 50,475 KC, standard (other ranges available on special order).** Power Ratings: **85 watts PEP input—all modes (AM, SSB, and CW).** SSB Performance: **(9 MC lattice filter). Unwanted sideband down more than 50 db at 1000 cycles. Carrier suppression greater than 56 db. Distortion products down more than 30 db at full ratings.** Frequency Stability: **Less than 500 cycle warmup drift after first five minutes. Less than 100 cycles/hour drift after warmup.**

RECEIVE: Frequency Range: **Same as TRANSMIT.** Frequency Stability; **Same as TRANSMIT.** Sensitivity: **.25 μV for 6 db S/N on AM. .1 μV for 6 db S/N on SSB.** Selectivity: **2.7 KC at 6 db, less than 6 KC at 50 db.** Spurious Responses: **Images and IF leak through down more than 60 db.** Overload Characteristics: **Less than 5% cross modulation results from any two signals separated by more than 20 KC if stronger signal is less than 2 MV across 50 ohm input.** AVC Characteristics: **Less than 10 db change in AF output for input change from 1 μV to 400 μV (52 db). Fast attack, panel selectable release times of .15 or 1.2 seconds.** AF Power Output to Speaker: **More than 2 watts at 3.2 ohms.** Physical: **15" wide x 7" high x 10½" deep. Weight approximately 22 lbs.**

Interested in HF? See the Squires-Sanders SS-1R at your nearest distributor.

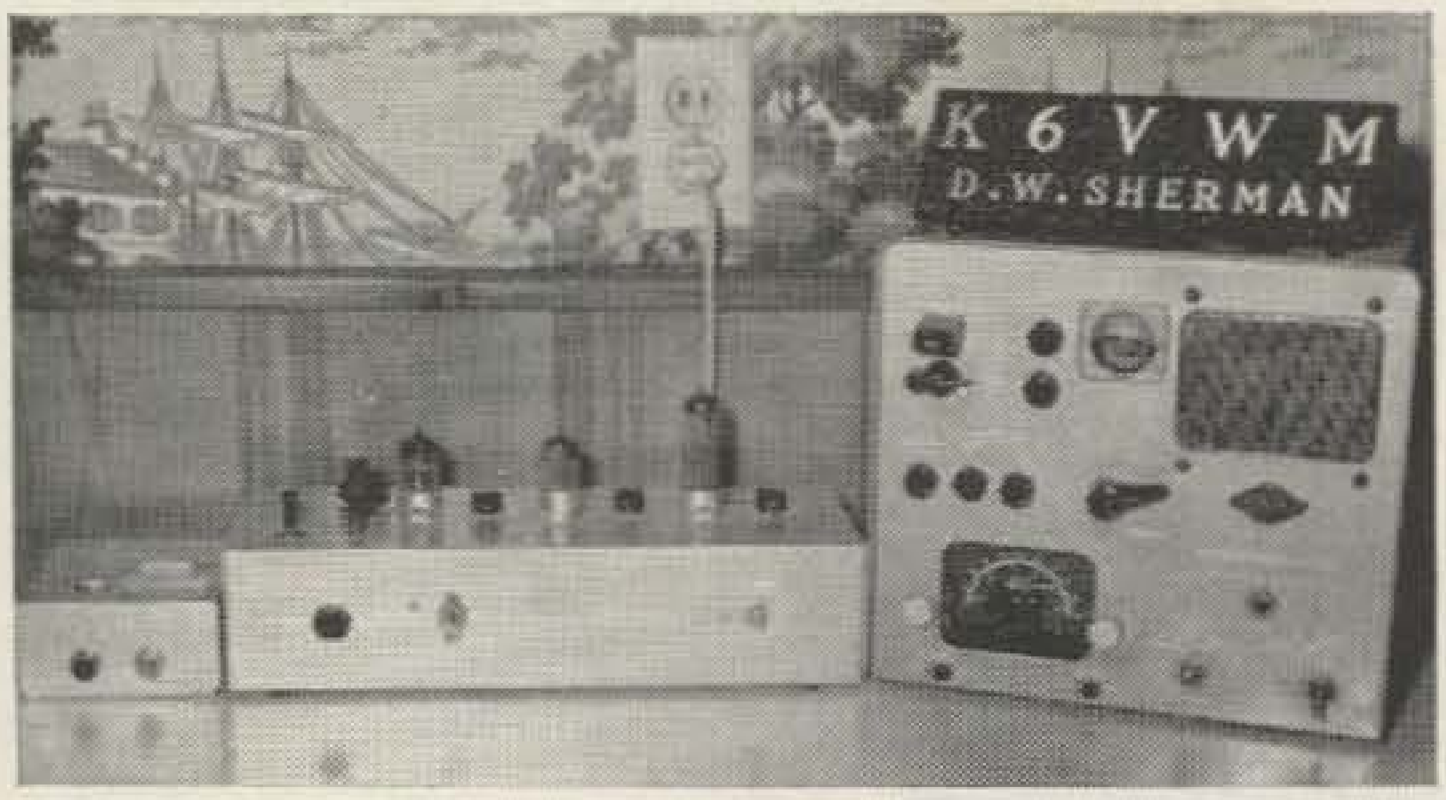
VENUS 6 TRANSCEIVER—Amateur Net Price $495.00

115 V. A.C 60 CPS Power Supply—Amateur Net Price $110.00

See your Distributor or write for information.

Clegg LABORATORIES
Division of Squires-Sanders, Inc.

222 RT. 53, MT. TABOR, N. J.
TELEPHONE 627-6800



Author's home and control station, l to r: 1) Automatic Combination and Periodic Information Unit 2) 220mc transmitter 3) Six meter transmitting antenna

the one important thing that cannot be designed into it is reliability. This was the reason for the Baldwin Hills location, all of 400 tremendous feet above sea level. As a repeater location it was worthless but as a service location it was excellent, being only a couple of miles away from home.

Initially, there was a lot of trouble with the six-meter receiver. It was badly desensitized when operated in the presence of the transmitter. When the transmitter was modulated over 30% the receiver would literally go out of its mind. Such noises you have never heard; it was unnerving. To solve the problem, selectivity was needed before the signal ever got to the front end of the receiver. For selectivity, a tuned cavity, or tuned LC filter was needed. The commercial Motorola tuned cavity for the 80D receiver costs approximately $500.00. Consequently, an LC tuned filter was designed and built. It didn't completely solve the problem, but things are must better. At least the hideous howls that proceeded from the mouth of the repeater are now forever squelched. We are currently modulating 120% with negative peak clipping.

The repeater, in operation, functions in the following manner: When there is a carrier on 50.55 megacycles, the repeater will simultaneously transmit on 51.10 megacycles any and all information that it hears. When the carrier leaves the input channel, there is approximately a two second period of silence followed by a beep tone. This silence enables break-in stations to be heard easily and also acts as insurance that, in the event of an emergency, the station in distress will be heard and will not be covered up by the next transmission. Also, if the repeater is not used for a period of two minutes, the transmitter is put in a standby position. It can be put back on the air by merely placing a signal on the input frequency, 50.55 megacycles.

The repeater will soon be performing an additional service. A unit is now being designed which I am calling a "D. C. Digital Voltmeter with Audio Readout." A more revealing name might be a "Signal Report Generator." When completed, this unit will enable any amateur on the input frequency to ask the repeater what his signal strength is, his presence on the repeater constituting the asking of the question, and when he goes off the air, he will get a series of audio frequency beeps different in frequency from the beep which follows the two second delay after every transmission. Each beep will indicate 3 db of signal above the noise level at the repeater location. Every two beeps then will indicate 1 S unit. The repeater is most useful in mobile work because it is strong enough to blank out all ignition noise and make mobile armchair copy possible over previously unheard of distances.

The outward operation of all repeaters is, in general, quite similar. It is the method of control that varies from one repeater to another. It is felt that the control described below is not only unique, but absolutely unbreakable! As you will see, it is a totally new and unique method of remotely controlling a transmitter.

Before we could decide on what was wanted in terms of control, we had to find out how other repeaters were being controlled. The only other repeater in Southern California providing a similar service at that time was the two-meter repeater, K6MYK. It is remotely controlled by a series of tones, kept on the air by means of continuous carrier on the 420 megacycle band, and there are beams at both ends of the link. Although there is nothing really wrong with this type of control, it embodied everything that we wanted to get away from. We wanted to see if we couldn't arrive at something that was completely breakproof and

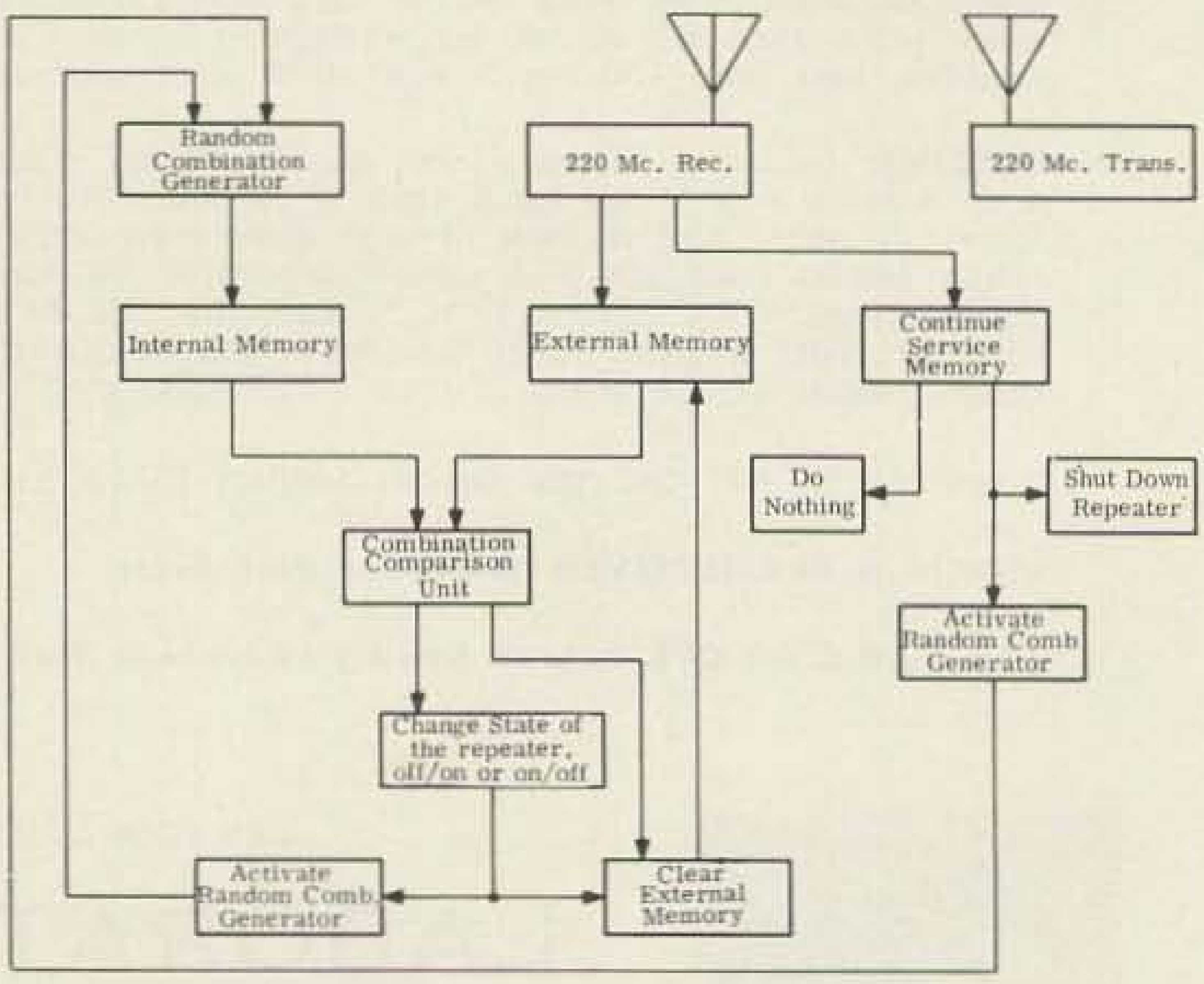


FIGURE 2

yet uncomplicated.

What was wanted was a method that would meet the following requirements: (1) omnidirectional antenna systems at both ends of the link, (2) no tones or modulation of any kind on the control carrier, (3) control information constantly changing in an observationally unpredictable manner, (4) no identification of control carrier, (5) absolute frequency secrecy, (6) no continuous carrier control (identification would be necessary). Fulfilling all the above requirements would constitute an absolute, unbreakable control that is in fact quite versatile. Impossible to do? Almost! To help solve the problem, we called upon one of our good friends and former instructors, Mr. Fred Gruenberger, a computer expert at the RAND Corp. in Santa Monica, California. With his help, the system of control that is in use today was developed and found to meet every requirement!

In order to keep the control breakproof, the actual specifics of the control operation will be very lightly covered, but the general principle of operation will be covered in detail. A brief description of each block on the diagram in Fig. 2 will be followed by a more comprehensive description of the control operation.

(1) 220 Megacycle Receiver: Frequency—crystal controlled and ultra top secret, approximately 2 Kc bandwidth, 24 hour operation. (2) Random Combination Generator: Every time the repeater is turned on or off, this unit generates a new set of information needed to turn it off or on the next time, and stores this information in Internal Memory.

(3) Internal Memory: A memory unit for the purpose of storing the information given it by the Random Combination Generator. This memory cannot be affected in any way by the control information that comes over the 220 megacycle channel. The sole determinate of its contents is the Random Combination Generator.

(4) External Memory: A memory unit for the purpose of storing the information given it by the 220 megacycle receiver. This memory can be partially filled, fully filled, or cleared by pulses of 220 megacycle carrier of varying duration.

(5) Continue Service Memory: This is a small memory unit that serves as a control channel failure indicator. If there is a control channel failure either at the repeater or at the 220 megacycle transmitter, this memory unit causes the repeater to be shut down, and also activates the Random Combination Generator unit so that a new "set" of information will be required to turn the repeater back on after the

trouble has been corrected.

(6) Combination Comparison Unit: This unit maintains a constant 24 hour comparison of Internal and External Memories. When they contain different information, this unit clears External Memory and does nothing else. However, when they contain the same information, the repeater is turned *on* if it has been *off* or *off* if it has been *on*. Then this unit activates the Random combination Generator so that it will generate another "combination," and it clears External Memory.

A slightly more detailed discussion of the total control circuit follows.

The overall picture of the control is not much different from that of an electronic combination lock that changes its combination every time it is used. Each combination consists of not just 3 numbers but is actually made up of many digits. Every new combination is, to the observer, unpredictable. This affords sufficient protection against anyone's tape recording our signals and gaining control, because once a combination is used, it is no longer valuable.

As far as outside observations are concerned, the changes are random in nature but, in reality, they are not random changes and the new combinations can be predicted, provided one has inside information on how the Random Combination Generator is constructed and the principle upon which it operates. A program was run on the IBM 7090 computer which gave us over 5000 years of combinations in their proper order, and I intend to use every one of them!! It may seem unbelievable but the Random Combination Generator can generate over five hundred trillion (539, 682, 289, 432,-600) combinations that are seemingly unrelated to each other before the sequence of combinations begins to repeat as a whole. It is evident that by using two combinations per day, one to turn it on and one to turn it off, that it would take in excess of 51 billion years to exhaust all the possible combinations. A little overdesigned perhaps, but it does the job. (We had an immortal repeater in mind at the time.)

Perhaps the randomness of the combinations alone would have assured an unbreakable control, but more is yet to come; read on. Anyone could listen to the control transmissions only if they found the frequency on which we operate. Our next move was to transmit the control information in such a manner as to maintain absolute frequency secrecy. This was done by designing the control panel to accept the needed information in terms of nothing but pulsed 220 megacycle carrier. To comply with FCC regulations concerning the operation of a transmitter on the 220 megacycle band, for the purpose of remote control, without identification, the length of any one pulse transmission was kept less than that which would require identification. Pulsed CW transmissions on the 220 megacycle band for the purpose of remote control need not identify if the transmission length is less than 10 seconds.

The combination of short transmissions, pure carrier, no identification, and extreme selectivity in the control receiver assures a virtually undetectable control and therefore an unbreakable control.

The method of shutting down the repeater appearing on the logic block diagram, that is, sending the new combination, is not the only way it can be done, but it is the fastest way of ceasing the service. Of course, in the event of an emergency this is the method that would be used. Now for another method. Once the repeater has been activated, it must receive periodic information in order to continue the service. This information is fed to the Continue Service Memory unit through the 220 megacycle receiver. Again this information is pure pulsed carrier. If the Continue Service Memory unit does not receive this pulse information in any one of the time intervals in which it is expected, the unit will assume that there has been a control channel failure, promptly shut the repeater off, and cause the Random Combination Generator to change the control information to a brand new combination. With this method, when one desires to turn the repeater off, he just stops sending the periodic information to the Continue Service Memory unit. This method of control can be, and is, often used to let the repeater slip out of service.

With the method of control outlined above, the FCC gave their unprecedented approval of the remote control of a transmitter with omnidirectional antenna systems, and without contínous carrier control. The biggest advantage is obvious, the control can be taken mobile. A 30 watt 220 megacycle transmitter could solidly control the repeater from as far away as San Diego. The first such mobile control will be running shortly.

Although there is nothing really complicated about the control, a great deal of attention was initially demanded of the controlling operator. The combinations and the periodic information had to be sent manually. Being intrinsically lazy and a lover of the push button, I designed a small unit that would do all the work at the mere touch of a finger. It can be seen immediately to the left of the 220 megacycle

KWM-3

?

Well, almost . . . the Waters Channelator™ is one of the biggest improvements you can make in a KWM-2/2A. The Channelator has six crystal positions which can be used for transmitting, receiving, or both, or the PTO can be used for one and a crystal for the other. Instant bilateral transceiver.

Since most of us have two or three channels where we usually talk, the Channelator is ideal. With a flick of the switch we can check the net frequency and call in or just listen. In the car we don't have to carefully tune from one channel to another and don't have to retune the dial every time a leg hits the PTO knob.

Or perhaps you like to work DX. You can flip in a crystal for the transmitter, knowing that you are in the band, and go hunting with the PTO for the receiver. You can check your transmitter frequency with a switch flick at any time for QRM.

MARS members can put in two or three MARS channel crystals and flip from one channel to another with the one switch . . . mobile or at home.

The Channelator is designed to fasten to the side of the KWM in a few moments without the slightest marring of the cabinet. It takes its power from the accessory socket in the KWM (thus will operate with any KWM power supply). There is one simple solder connection to make (which you can reach from the top) and a plug to put in . . . and you're in business. The crystals for the Model 349 Channelator are available from Waters for $6 each. There is a pad on each crystal which will vary it over ½ kc either way so you can zero in exactly on a net channel. Specify whether crystal is for USB or LSB.

The Channelator is now in stock at most ham distributors around the country. The price is only $79.95 (less crystals).

The Channelator and all the other Waters ham products are given the full treatment in the new Waters catalog. Send for one.

Waters Manufacturing, **Wayland 73, Massachusetts**

control transmitter in the photograph of the author's home and control station.

At first, the logging of all the stations using the repeater was quite a chore, but that too was overcome. Now, not only the calls of the stations using the repeater, the time that they used it, and the operating time of the repeater itself is logged, but every word passing through the repeater is logged. This is done by means of continuous tape logging. The logging machine uses 5000 foot rolls of one inch wide tape passing by the dual stereo heads at a speed of seven eights of an inch per second. By choosing the appropriate portion of the two stereo tape heads and indexing them four times across the one inch wide tape, a total of sixteen recording tracks are used. At seven eights of an inch per second you wouldn't want to record the London Philharmonic Orchestra, but for logging the repeater it works fine.

In summary, the Los Angeles Six-Meter Repeater was placed in service at approximately 8:00 pm on December 25, 1960. Its first home was in the Baldwin Hills between West Los Angeles and Inglewood, California. The altitude was only 400 feet or so above sea level but it was an excellent location to provide the tender loving care that it needed so badly during the early months of its life. After about 6 months the reliability had improved sufficiently so that we felt it was ready for a higher home.

It was moved to its present location in a private home in the Santa Monica Mountains in Beverly Hills, California on June 6, 1961. The location is roughly one mile east of Laurel Canyon and about one mile north of the of the Beverly Hills business district, at an altitude of about 1700 feet above sea level. It has been in its present location for approximately 20 months and requires service on the average of once a month. We are quite fortunate that the gentleman in whose home the repeater is located is dedicated to the repeater cause because for the past 20 months the repeater, a seven foot, four hundred pound monster, has been sitting in his kitchen!!

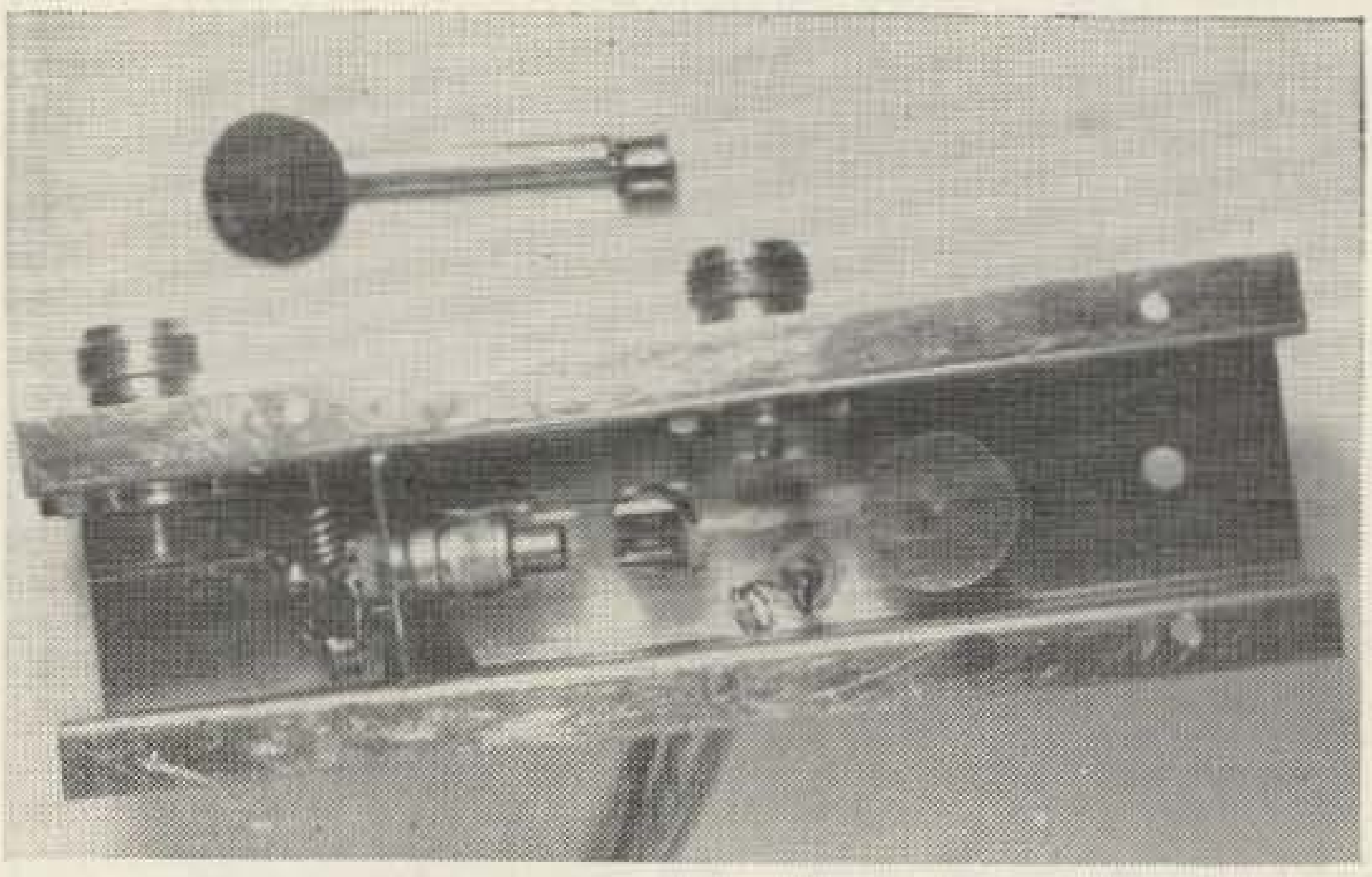
Our deepest gratitude to Mr. Gruenberger and all those who have helped us in this endeavor and without whose help the Los Angeles Six-Meter Repeater might never have become a reality. The service of the repeater will continue to grow and it is hoped that it will become a valued tradition among the amateurs on six-meters. This is evidently becoming a reality also because, from the results of a recent survey, it was found that approximately 75% of all the QSO's that take place in Southern California on six-meters take place on the repeater!!

1296 mc RF Receiving Amplifier

Augusto Lovisolo I1LOV
Malnate, Varese, Italy

Description

Not long ago a receiving radio frequency amplifier at this frequency would have been out of question for the average amateur, since suitable tubes were unavailable or too expensive. This amplifier is built around the new 8058 nuvistor triode and, so far, has given very satisfactory results. Theoretically, an rf amplifier like this ahead of a *really working* crystal mixer should not noticeably improve the noise figure. It is very difficult to make a crystal mixer work as well as it should because of too many factors involved: antenna coupling, varying characteristics in crystals, injection current and so forth. This amplifier was tried and is actually working ahead of a 1N21B mixer and the improvement it makes is quite noticeable.



1296 mc rf amplifier. Plate line removed to show simplicity of construction.

The circuit is simple: the antenna is capacitively coupled to the cathode which is untuned, while the plate circuit is a half wave line fed at the low rf point and tuned at the end. The amplified signal is capacitively coupled out of

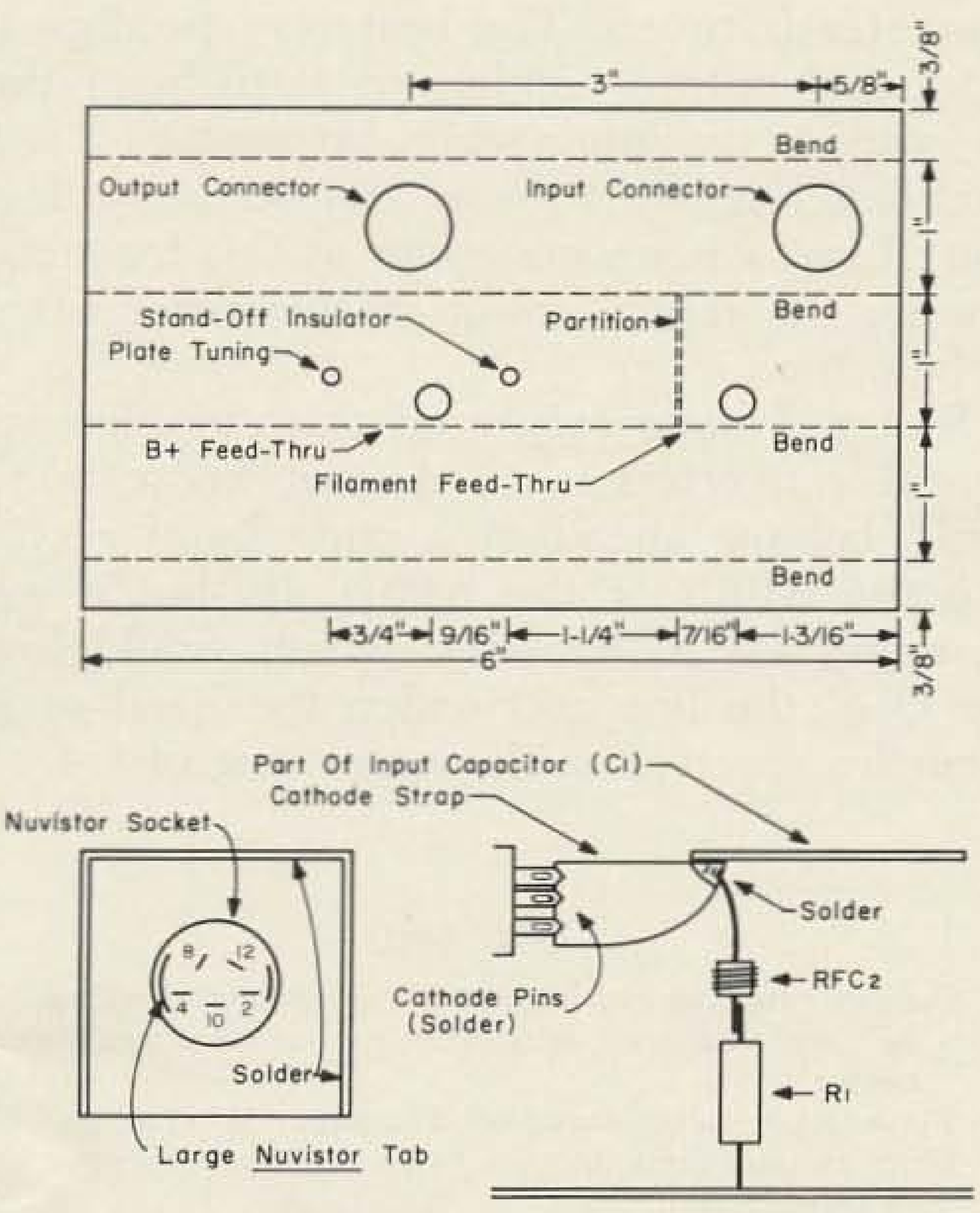


Fig. 1

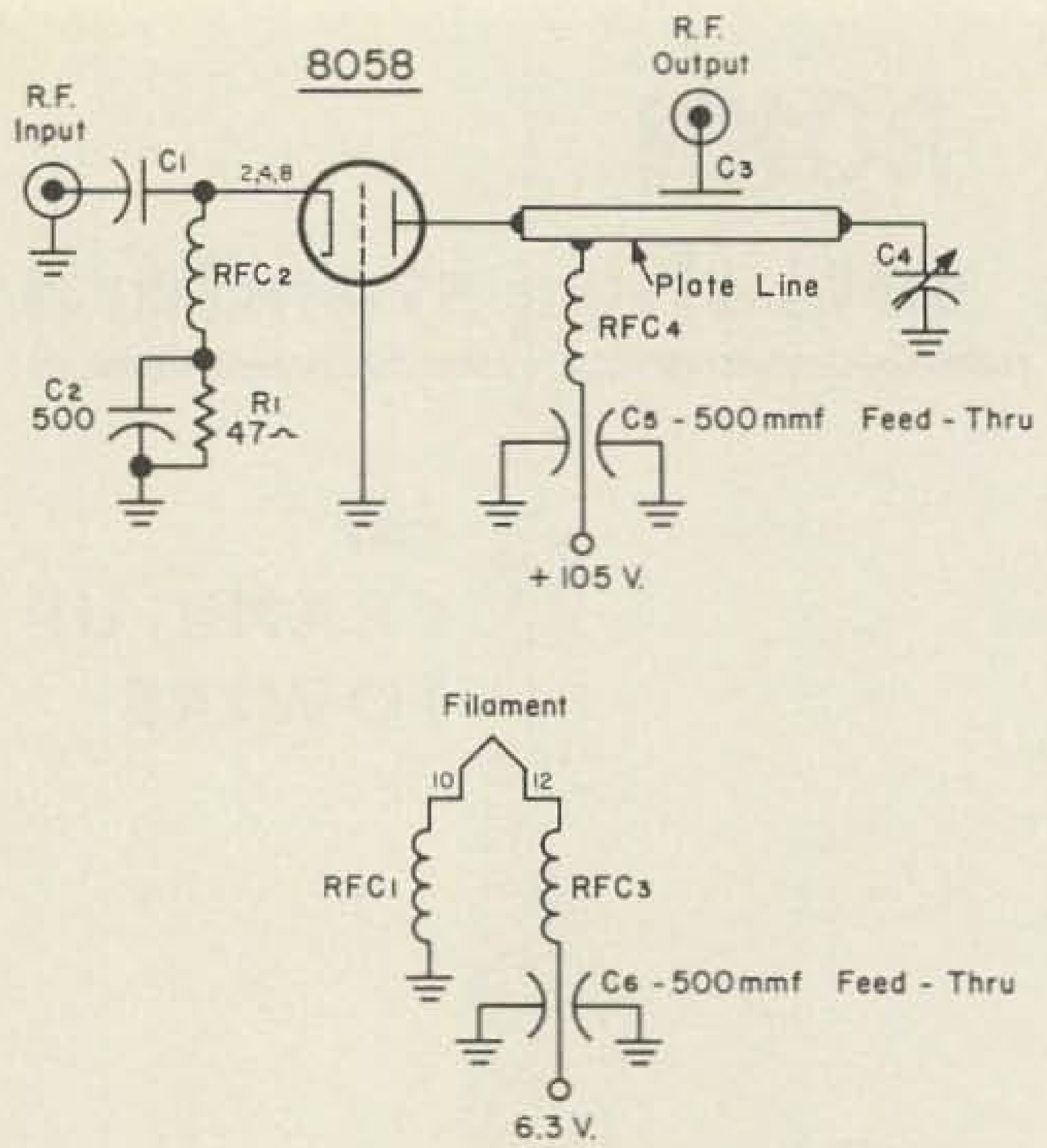
the line in order to minimize loading effects which would lower the Q of the plate circuit.

Construction

The amplifier is built into a brass or copper trough, the dimensions of which are given (Fig. 1). The easiest way is to cut the brass plate, drill it and then bend it as shown. The cathode input capacitor is made of tabs, one of which is directly connected to the cathode pins of the tube socket through a cathode strap which is soldered to one tab at right angles (see Fig. 1 and picture). At the point where tab and strap are soldered together, there is the connection of RFC2. The partition is cut out of sheet copper or brass: drill it in the center for the nuvistor socket, solder the socket as shown in Fig. 1 and then solder the partition in place. The plate line is held in place by a clip soldered to it which connects to the 8058 plate cap and by another fuse clip which is mounted on a ceramic standoff insulator. Plate B plus goes to this clip through RFC4. This mounting of the plate line allows for quick and easy removal of line and nuvistor. The plate tuning condenser is made of two disks cut out of sheet copper: one is soldered to the plate line, the other on a screw which runs on a nut soldered on the outside of the trough. RFC1 is wound over R1.

Operation

Plate voltage should be 105 volts, filaments 6, 3 volts. Experimenting with lower plate



voltages could lead to a better noise figure. The amplifier is very stable, since the 8058, with the grid connection coming out on the entire socket, lends itself to grounded grid circuits. Before working properly, the tube must warm up for at least ten minutes. This time is needed for the transconductance to go up. Connect the amplifier to the converter and and to the antenna and tune the plate condenser. At one point you should notice a small but definite increase in noise; the amplifier is now working on the frequency to which the converter is tuned. The best way to align the input and output condensers is to bend them one way or the other while listening to a weak modulated signal. I mean, the best way if you don't have a noise generator at this frequency. Tuning the input circuit of the mixer can be of help too.

So far, I have only used this amplifier with crystal converters, so I do not know how it could behave ahead of a wide band receiver like the APR5 or the APX6. It should work changing C3 with a link which would lower the Q of the line and widen the band of frequencies received with one setting of C4.

. . . I1LOV

Parts List

a) Output coupling capacitor tab C3, copper sheeting ½" x ⅜" and soldered in center to output coupling connector.
b) Plate line ceramic stand-off insulator, ⅜" dia., ⅝" high.
c) Plate tuning capacitor C4 (two required), copper sheet ⅞" dia. round.
d) Plate line. ¼" copper tubing 2" long. Plate feed point is ⅜" from tube end of line.
e) Input coupling capacitor tab, ⅜" x ⅜" solder to input connector. Part of C1. Copper.
f) Input coupling capacitor tab, ⅜" x 1". Other part of C1. Solder one end to cathode strap. Copper.
g) Cathode strap. Cut a small piece of copper sheeting 5/16" x ⅝", trimming away one side until it looks like a small knife blade. This is used to connect pins 2-4-8 together and solders at right angles to (f).

R1 47 ohms
C2 500 mmfd
C5-C6 500 mmfd feedthrus
RFC1-4 4 turns #30 copper wire ¼" dia.

Letter

Dear Wayne,

In December "73" you had the interesting article by K6CTV/4, for which I have been waiting and lots of other interesting stuff, but I am protesting the VE3AZX article. Actually, W6WYD disposed of the "negative cycle loading" myth in Viney's reference (p. 48 May 1962 QST) and furnished some good reasons (non-linear B H curve for the modulation transformer core, or improper modulated amplifier operation) for modulator unbalance. VE3AZX, in dividing O by O and coming up with infinity is committing an arithmetic sin. His particular care of O/O occurs immediately after and immediately before conditions of 5000 ohm load, and by the usual rules, he could assume that his O/O might be evaluated as 5000—certainly there is no reason to call it infinite. Part of the confusion comes from the fact that the modulated amplifier's plate supply is the audio and DC sources in combination. Since these two supplies in series will act the way they do if, instead of the final amplifier's D-C plate circuit they feed a constant plain old resistor of 5000 ohms, it is apparent that for the behaviour charted, they do see 5000 ohms—ALL OF THE TIME!

The exception occurs during overmodulation when the instantaneous supply polarity is reversed and the load does become infinite. With proper operation, we never actually reach a full 100% (it's too hard to keep from splashing over and 80% is undistinguishable from 100% to the human ear—or our clipper prevents it), so conditions for overmodulation are not of significance.

On page 78, he hits the nail on the head: ". . . how come none of the commercial transmitters use it?" Because, to reply in the words of W6WYD, it corrects for a condition that does not exist.

It is significant that the circuits which Viney claims will be benefitted by his hook ups are in transmitters using small transformers. In any case, two wrongs, as the old cliche goes, don't make a right, so the diode is not necessarily the correct approach.

If the assymmetry is in the audio system, no carrier shift exists and the modulating function is, while not the same as that coming from the microphone, not severely distorted. If carrier shift exists, causing this assymmetric modulation no amount of working on the primary side of the transformer will correct it. Remember, also that we have somewhat lopsided voices, so that proper audio polarity may alleviate matters.

To borrow W6WYD's words, the systems proposed by Viney serve only to waste power and increase complexity, both of which we can do without!

73,

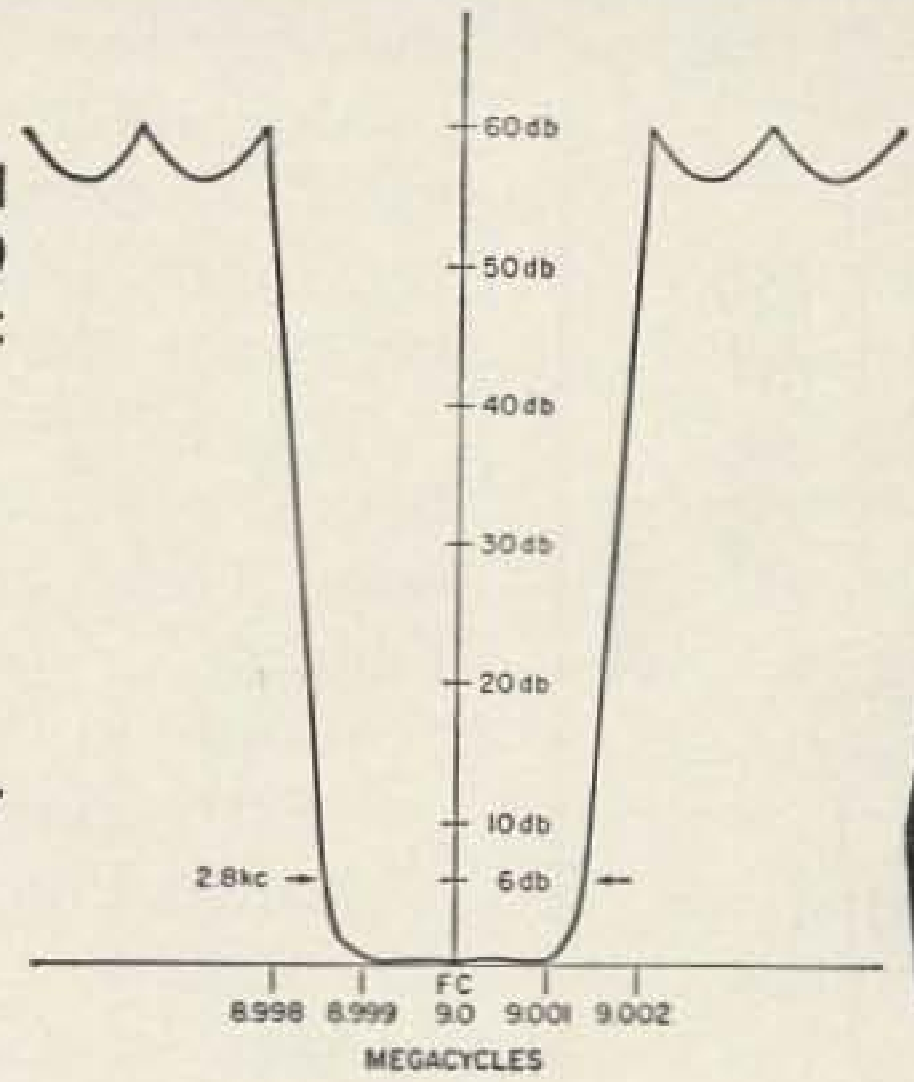
Bob Schoening WØTKX

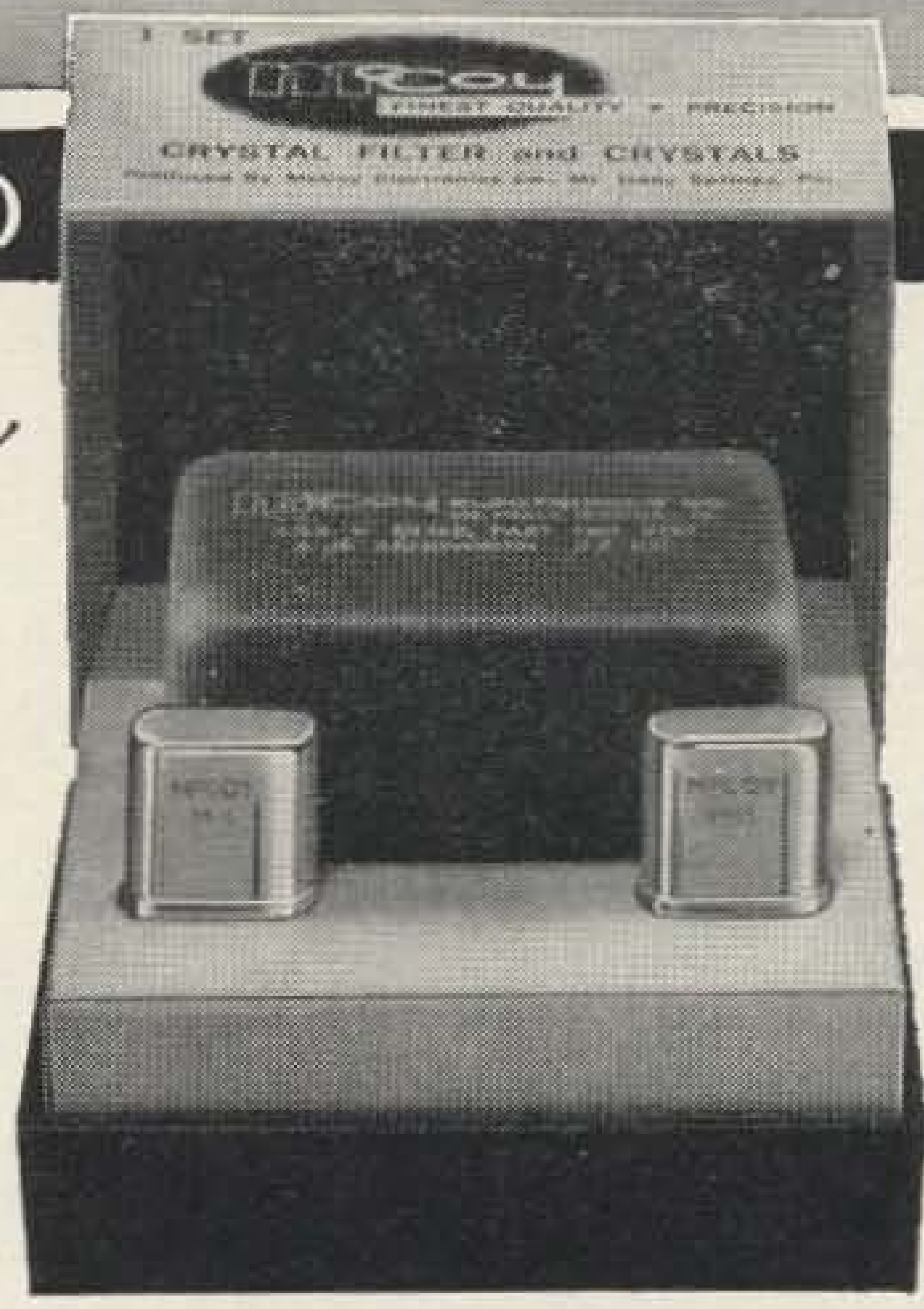
Now! for discriminating amateurs who are satisfied with nothing less than *THE VERY BEST*

McCoy SINGLE SIDE BAND FILTERS

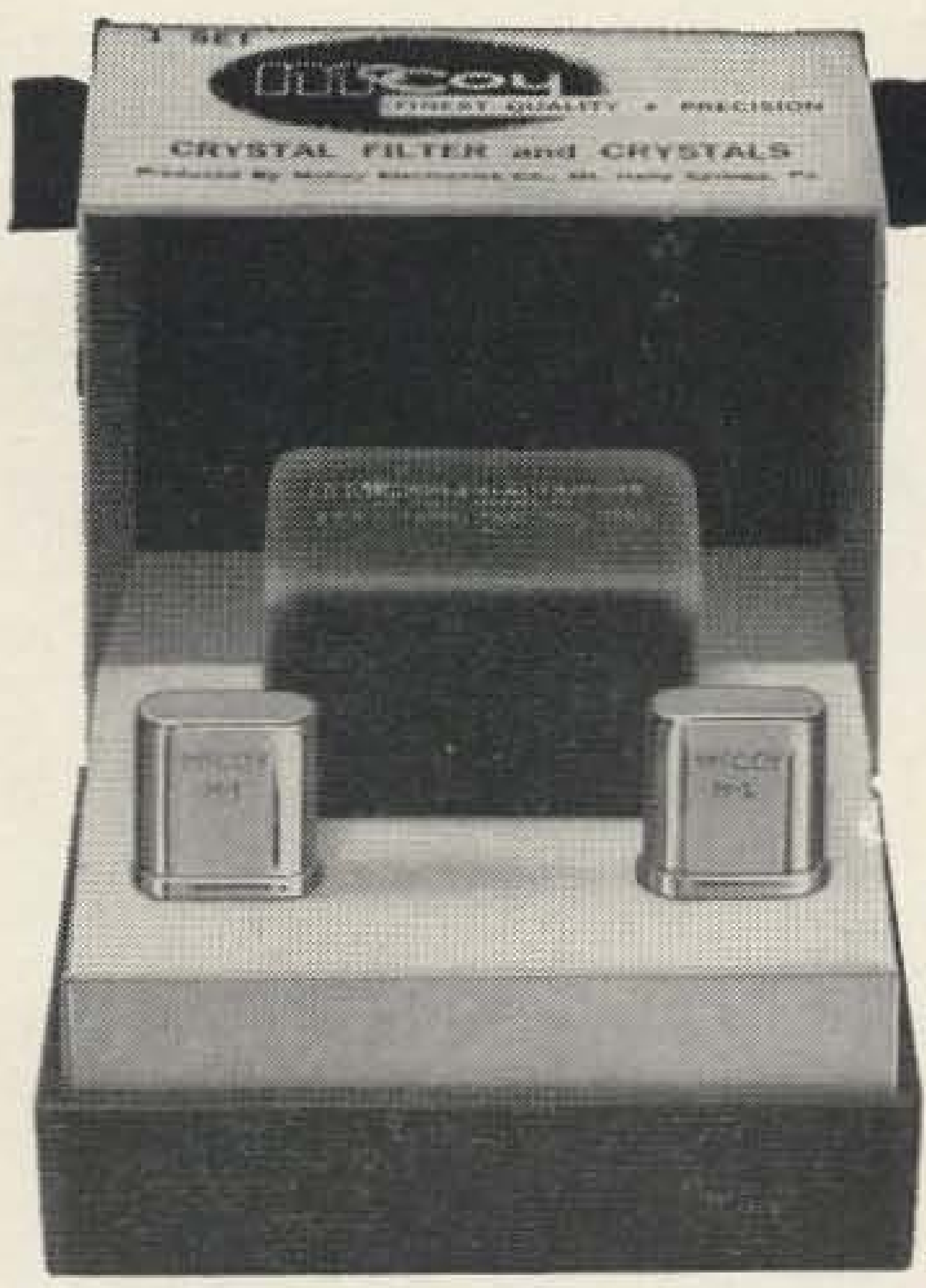
The GOLDEN GUARDIAN (48B1)

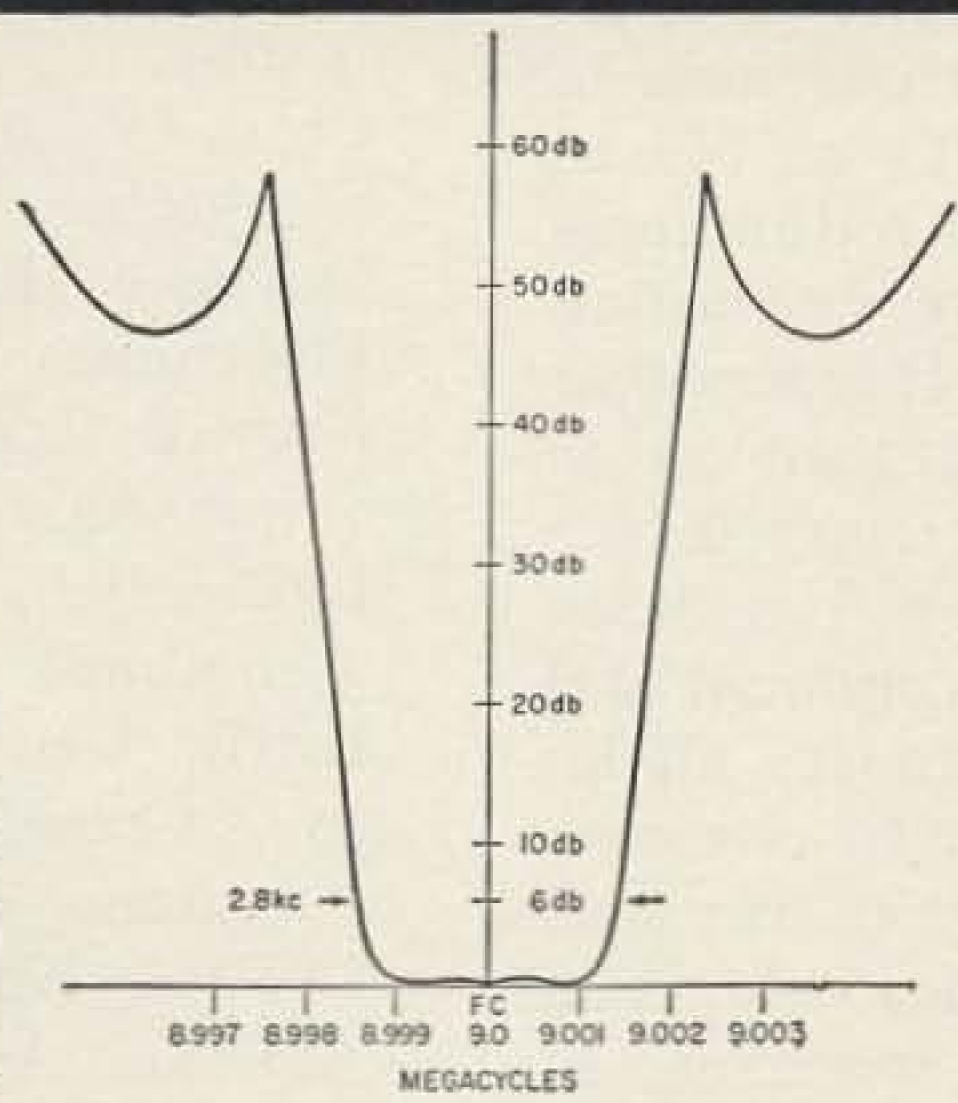
TECHNICAL DATA
Impedance: 640 Ohms in and out (unbalanced to ground)
Unwanted Side Band Rejection: Greater than 55db
Passband Ripple: ± .5db
Shape factor: 6 to 20db 1.15 to 1
Shape factor: 6 to 50db 1.44 to 1
Package Size: 2 7/16" x 1 19/32" x 1"
Price: $42.95 Each





The SILVER SENTINEL (32B1)





TECHNICAL DATA
Impedance: 560 Ohms in and out
Unwanted Side Band Rejection: Greater than 40db
Passband Ripple: ± .5db
Shape factor: 6 to 20db 1.21 to 1
Shape factor: 6 to 50db 1.56 to 1
Package Size: 1 3/4" x 1 1/4" x 1"
Price: $32.95 Each

Both the Golden Guardian and the Silver Sentinel contain a precision McCoy filter and two of the famous M-1 McCoy Oscillator crystals. By switching crystals either upper or lower side band operation may be selected. Balanced modulator circuit will be supplied upon request.

Both sets are available through leading distributors. To obtain the name of the distributor nearest you or for additional specific information, write:

McCoy **ELECTRONICS CO.**
Dept. 73-4
MT. HOLLY SPRINGS, PA.
Phone: HUnter 6-3411

SUBSIDIARY OF OAK MANUFACTURING CO

THAT RARE COMBINATION

Our Man in Washington

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

To be or not to be, that is the question. Or where do we go from here. This subject of an Amateur Radio headquarters and our man in Washington is not a new one. It's as old as Amateur Radio. Old issues of QST and minutes of AARL Director meetings make interesting reading on this important subject. It seems that displacement of people and sentiment as to where we started have been key issues in the past. The importance of location has been secondary to us, yet most of the prominent and important users of the rf spectrum are all located in Washington. In addition to our own political life focused in Washington, we find the embassies of all the countries who also are looking for their slices of the spectrum. In addition to the lobbies that are directly protecting their spectrum allocation, you have many others that indirectly use the spectrum such as the Aircraft Owners and Pilots Association, Trucker's Assoc. and still hundreds of others such as American Rifle Association, etc., etc.

Let's ask ourselves, is a man necessary? A good yardstick to measure by is what are other services doing that use this valuable spectrum we are part of. Who has Washington representatives? Do they just have an attorney or do they have offices and a man or men or women to represent them? Do they have public relations people in Washington? etc., etc. Examining a few of the groups to see who have Washington Assoc. Headquarters, we find that the very fine Bible of the Broadcasting Industry for 1963 is a valuable source. This is an excellent document, as believe me, this industry knows how to keep what they have and get what they want.

The following groups are listed in alphabetical order. These cover spectrum allocation only. There are a great number of additional lobbies for other purposes. Ninety-nine per cent are in Washington.

ARRL, Hartford, Conn.

Armed Forces Communication Assn., Washington;

Assn. of Communication Consulting Eng., Washington;

Assn. of Maximum service Telecasters, Washington;

Canadian Assoc. of Broadcasters, Washington;

Clear Channel Broadcasters Service, Washington;

Daytime Broadcasters Assoc., Washington;

Electronic Industries Assoc., Washington;

Federal Communication Bar Assoc., Washington;

International Assoc. Broadcasters; Washington;

IFRB, Geneva;

Joint Council on Educational Service, Washington;

JATAC, New York;

National Assoc. of Broadcasters, Washington;

National Assoc. FM Broadcasters, Washington;

National Community TV Assoc., Washington;

Television Study Alloc. Organization, Washington.

Let's discuss several of these associations. All have some axe to grind for their service. These people use parts of the whole spectrum and all are sandwiched in or vice versa with our amateur service.

For instance, a classic example of what a good association can be is the Clear Channel Broadcasters Service. This Washington group has successfully defended the clear channel broadcast station's position for over 25 years.

Another good example of a very fine organization is the Association of Maximum Service Telecasters. This group is doing a very fine job of seeing that we TV viewers get good TV reception. It is interesting to note that this group was formed after channel one was deleted from your TV set and mine.

The Electronic Industries Association is a most important group. It consists of the major manufacturers and others. They provide a very valuable impartial service to the electronics industry and in general are a real factor in what the pattern of electronics follows. It is interesting to note that most of your major amateur equipment manufacturers belong to this group who must consider all services. Thus, it is easy to see that on the one hand, an amateur equipment manufacturer loves and sells to amateurs while on the other side of the coin, their livelihood depends upon the needs of the military and commercial interests. You find many amateurs among the regular employees of this very useful, important, and fine group. The names associated with this group are the tops in industry.

The Federal Comm. Bar Association is a group of attorneys whose sole work in most instances is to obtain a place in the spectrum for their services. This is the group that most practicing FCC attorneys belong to. These FCC attorneys in some instances represent other associations (and there are many associations) in frequency allocation problems for their total industry such as truckers, taxis, and the oil industry. These attorneys are in turn hired by all the other associations mentioned in this article. This is indeed a very important group whose interests are very diversified. Among this group you find some very competent famous names. They are all very sharp men who know this allocation problem. Many are avid amateurs.

The Consulting Engineers and attorneys who do FCC work are pretty generally located in Washington. All the other lobbies who have Washington offices, such as the transportation industry group, generally have in their hire on a retainer basis, very competent law and consulting enginnering firms who are also in Washington. Typical for instance is all forms of mobile communication for police, fire, taxicabs, truckers, etc., etc. There is not a single portion of the spectrum that has not one or more services looking at it or operating in it.

It's rather obvious that we amateurs are mavericks—all those outfits that really want to hold onto what they have are where the action is. Further, it would seem to me, that Amateur radio, with its world wide implications and its importance as one of the tools of peace and good will, would have its headquarters in the place the world knows is our Capitol.

OK—so we should have a man in Washington—this would appear to take a pretty good man—we want our best foot forward. So what are the important attributes this man must have?

1. He preferably must be an amateur-active and well known man—a non-controversial type.
2. He must have the standard attributes of of personal acceptance of appearance, likes people, sales type, a joiner and above all a diplomat.
3. He must be an avid amateur and be very familiar with our past.
4. He must be a planner (to protect our future).
5. A good businessman.
6. Understand promotion and public relations work.
7. Be politically astute and acquainted.
8. Speak French and German. Naturally, English HI.
9. An engineer with a good spectrum allocation background, both FCC and world-wide.
10. Acceptable to the ARRL-CQ-73. Member of ARRL and IOAR.
11. Willing to travel.
12. An avid reader.
13. This man must be acceptable to all amateurs.

By now you are convinced that the above description just fits you. Hi. It will take quite a man to fill this Washington post. So why not dive in and describe what you think the man should be like—maybe even as basic as to voice your opinion as to how you feel about Washington representation. I'm sure Wayne Green will pass on your letters to me to start a series of "letters re our Washington Man." This type of thing should make interesting and important reading for the 73 readers.

. . . W2DUD

Under the Noise

W2NSD/1

Bill Ashby K2TKN has been working hard at digging down deeper and deeper into the noise after weak signals. His article on synchronous Detection in the September 1962 issue of 73 started a lot of fellows thinking about the subject. Now Bill has come up with a breakthrough in the field which permits the best laboratory receivers to dig down another 30 db and come up with copy.

Below is an extract of the information contained in the patent application, which should give you a good idea of the theory involved. A fuller explanation, written in ham-style and avoiding the math that normally would be a part of an engineering paper, will be found in the April issue of 6up along with a complete schematic diagram of a practical operating unit. We plan to run this in the May issue of 73 as well, but Bill wanted to make more of the VHF men aware of 6up and asked that it be published there first.

The input of the working unit is designed to take the 50 kc *if* output of your receiver and change this into a dc signal for operating a relay or a code oscillator. In operation Bill reports that when he tunes what sounds like an absolutely dead twenty meter band his Flying Noise-Lock unit finds all sorts of CW signals down under the noise (as well as many receiver birdies never suspected before) and brings them out. Ditto on two meters. This should be fantastic for moonbounce and extended scatter work.

Flying Noise-Lock

A system of reliable detection of coherent continuous wave energy heretofore impossible due to random electron shot noise, commonly termed "Johnson noise." By use of the proper combination of a number of commonly used electronic circuits, either passive, tube or solid-state, each performing it's normal electronic

12 NEW AMATEUR BEAMS

from

FINCO®

ALL GOLD CORODIZED

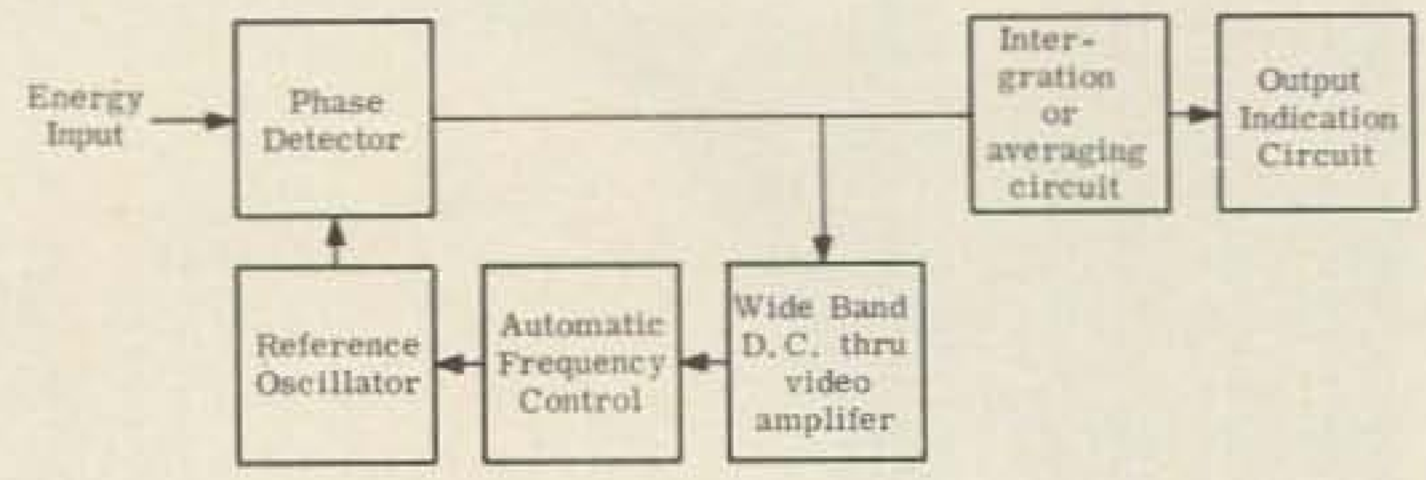
ALL GAMMA MATCHED

3 New combination 6 & 2 meter beams
5 New 6 meter beams
3 New 2 meter beams
1 New 1¼ meter beam

SEND FOR NEW TECHNICAL INFORMATION CATALOG #20-226

THE FINNEY COMPANY

34 West Interstate • Bedford, Ohio



function, the overall system readily can be made to have a minimum reliable detectable signal sensitivity, in the presence of the inevitable noise caused by electron motion in all high gain electronic systems, heretofore unobtainable.

This Flying Noise-Lock system is unique in that the overall shape of signal plus noise is not used as a prime function, nor is stable phase relationship between that of a standard and the wanted energy necessary for successful operation. A prime function of this system is that certain components of the unwanted noise are utilized to locate and indicate the presence of the desired energy.

The fact that electron motion noise in linear circuits is totally non-coherent in phase and amplitude, yet continuous wave energy has at least partial coherence in phase or amplitude variation allows a system such as this to successfully treat each in a selective manner so that "signal" can be detected in the presence of many magnitudes more of this noise.

Operation of the Flying Noise-Lock system is so radically different that ready application of currently accepted theory of Boltzmans' Constant, pre or post detection bandwidth, integration factors or self and cross correlation detection systems become very difficult to apply or cross-reference.

The entire spectrum of frequencies to be investigated for the presence of desired signal is introduced into the phase detector circuit. If amplified in any manner prior to this point, it must be accomplished in a linear manner with low phase or amplitude distortion. Random energy peaks of noise will occasionally be of the proper phase to result in a pulse of voltage or current output from the phase detector of either positive or negative polarity, depending on its instantaneous relation to that of the reference oscillator. This random output of either polarity is amplified in a linear manner and applied as automatic frequency control to the reference oscillator. A random noise pulse out of the phase detector locks the reference oscillator in phase relationship to it as long as this particular pulse is in the system passband or until it fades out in amplitude. The natural resonant frequency of the reference oscillator, without AFC influence, is centered in the system passband, so without AFC information it returns to normal.

Due to the entirely random nature of noise, along with the closed loop relationship between phase detector output and the reference oscillator, output of the phase detector, during conditions of no coherent energy in the system passband, is entirely random in amplitude and polarity.

If, on the other hand, even a very low level of coherent, continuous wave energy is present in the passband of the system, the output of the phase detector becomes a direct current or voltage, so amplified and interconnected through the AFC system as to shift the reference oscillator into a desired phase relationship to increase this direct current output. Random peaks of noise have swept the reference oscillator into close phase proximity and pull it away when they contain more energy than the coherent signal, but due to their transient nature their resultant output from the phase detector tend to cancel out in a simple averaging circuit that readily passes the direct current result from the desired continuous wave energy to an output indicator of any sort.

This unique interconnection of commonly used electronic circuits results in a system that uses the undesired system noise to locate and implement indication of low intensities of desired signal with only vague and odd-order relationships to presently known and recognized techniques, and accompanying theories.

Tracer

Cheap and handy adjuncts to preliminary signal tracing are the two-transistor-one-diode reflex broadcast receivers available for as low as $3.95.

The reflex circuit responds to both audio and radio frequencies, and to convert to signal tracing all you need do is remove the antenna loopstick and substitute for its secondary an r.f. choke with sufficient inductance to be effective at the intermediate frequency of your receiver. Connect a shielded probe in series with a blocking capacitor to the transistor base end of the r.f. choke. These receivers have surprising gain and in measuring at substantial levels, tracing audio, or to avoid loading a circuit it would be advisable to add a series resistor to the probe. I expected the front transistor to perish from careless exposure to voltage peaks, but a year later it's still able and willing.

. . . W7IDF

A Reader Looks at the Hallicrafter's SR-160

Larry Hess W8GTT/KIENX
45 Chandler Avenue
Walpole, Mass.

The introduction of the compact SSB transceiver has created great interest in the amateur ranks and, notwithstanding, in my own station where a 1955 vintage receiver was not the ultimate for SSB operation.

My interest increased when Hallicrafters announced the SR-150 transceiver with Receiver Incremental Tuning. This eliminated the one problem in transciever operation, namely having the transmitter frequency shift whenever slight corrections were made in the receiver frequency, such as often occurs in round tables.

When the Hallicrafters SR-160 transceiver was recently introduced, at a price considerably under the SR-150 and included Receiver Incremental Tuning, the decision was made.

The SR-160 provides complete coverage of the 20, 40, and 80 meters bands with 150 watts PEP and 125 watts CW. The Receiver Incremental Tuning (RIT) (pat. pend.) provides a plus or minus 3 kc deviation from the receiver frequency without changing the transmit frequency. Full Automatic Audio Level Control (AALC) provides maximum talk power. No AM provisions are included but satisfactory exalted carrier AM detection results are easily obtained. Push-to-talk (PTT) is standard with VOX as an optional accessory. One meter is used as a combination S-meter and relative output indicator. A 100 kc calibrator circuit is included selected by the Operation switch, but a 12AU6 tube and a 100 kc crystal are not supplied. A matching ac solid state power supply/speaker combination is available as well as a mobile dc power supply.

Functionally, the receiver is a single conversion design with a 5200 kc *if*. The RF amplifier and mixer circuits are tuned by the Driver Tune control on the front panel. Selectivity is provided by a crystal lattice filter and two *if* stages. A product detector and amplified AVC are also employed.

The Receiver Incremental Tuning (RIT) is quite novel in design. A pot applies a variable voltage to a voltage controlled variable capacitance (Varicap) in the frequency determining circuit of the transmit/receive VFO, thereby shifting frequency a small amount. In transmit, this circuit is disconnected by the T/R relay so as to not change the transmitter's frequency. Dial calibration is corrected in a similar manner with a second pot continually in the circuit.

The AALC (Automatic Audio Level Control) provides approximately 15 db of compression when the flat topping point of the two 12DQ6B final amplifiers is reached. When flat topping occurs, a ripple apears on the final amplifier grid bias. This ripple is amplified and rectified by a diode. The resulting dc voltage, which is proportional to the amount of flat topping, is applied to the first *if* amplifier grid as a control bias, thereby reducing its gain and driver output .

Initial installation is quite simple. Power supply, mike, and antenna are conneceted and then inserting a voltmeter into two tip jacks on the power supply, the bias voltage is checked and its pot adjusted for the correct value.

Tuneup consists of injecting some carrier through the Carrier control and then peaking the Driver Tune and Final Tune controls for maximum S-meter reading. No loading control is provided as the output network is designed for a 50 ohm load. The Carrier control is then momentarily advanced to obtain a maximum S-meter reading. No carrier balancing is needed.

In push-to-talk operation, the Mike Gain control is adjusted for an S-meter swing equal to one half of the maximum S-meter tuneup value. This adjustment is not critical because of AALC action.

Several notable points were observed in operating the transceiver. The tuning control is very smooth and precise with a good weighted feeling. The receiver sensitivity of 1 microvolt for a 20 db signal-to-noise ratio produces a very low background level with signals almost leaping out of the noise. Tuning is not critical and stability is excellent. The advertised stability is "within 300 cps after warm-up" and operation confirmed this. Banging and dropping the cabinet produced no reaction. Receiver audio is communication quality but not excessively peaked and with plenty of reserve.

On the air tests produced excellent audio reports with no trace of any flat topping, even driving hard, but with plenty of punch. The carrier suppression is -50db down. Mike gain is more than adequate.

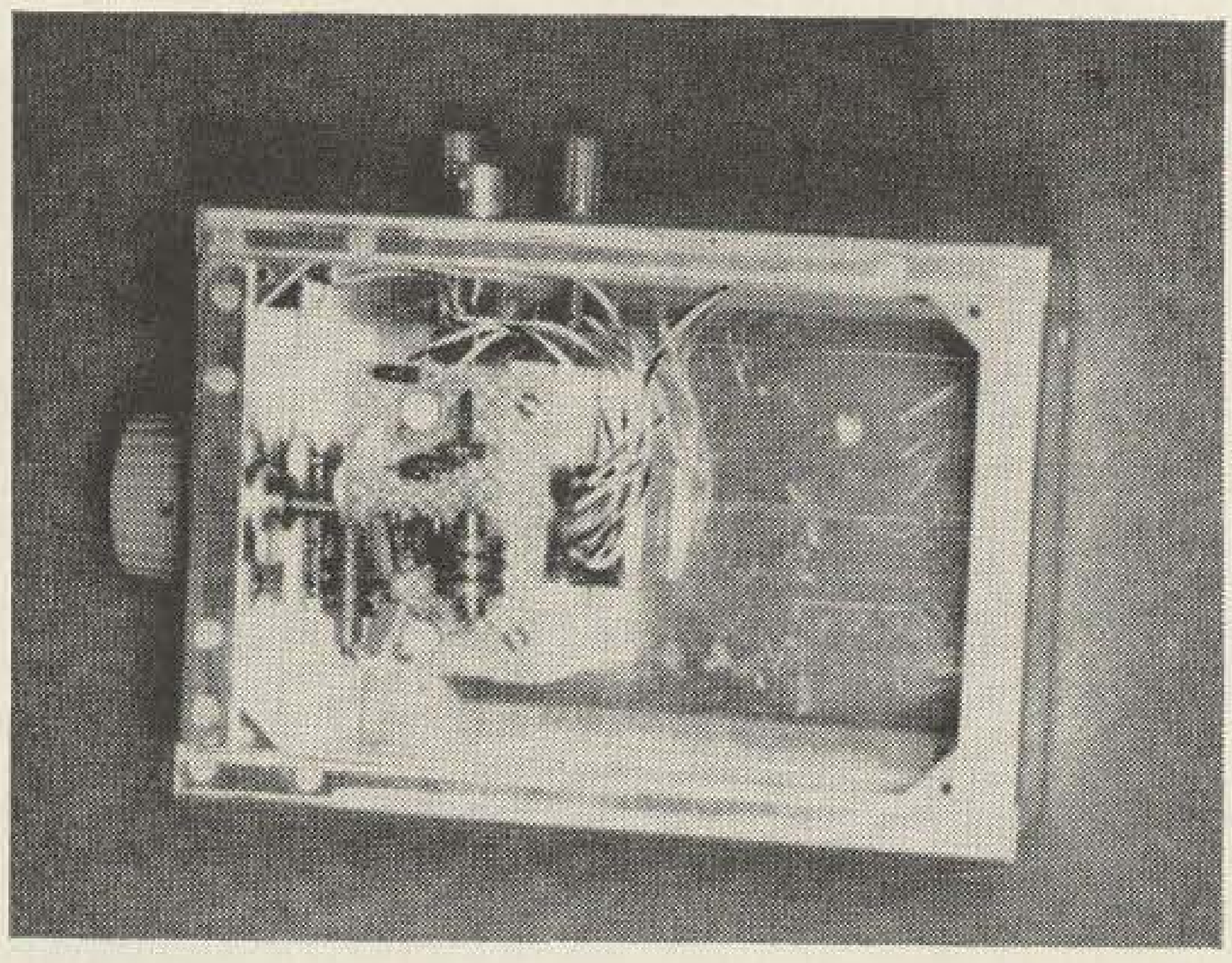
Provisions are provided on the read apron for driving a linear amplifier.

No objections of any kind were found in operating the transceiver. Extra features might be desired but would raise the present $349.95 price.

Hallicrafters has entered the medium price transceiver market effectively with a very pleasing piece of equipment, and demand should soon confirm this.

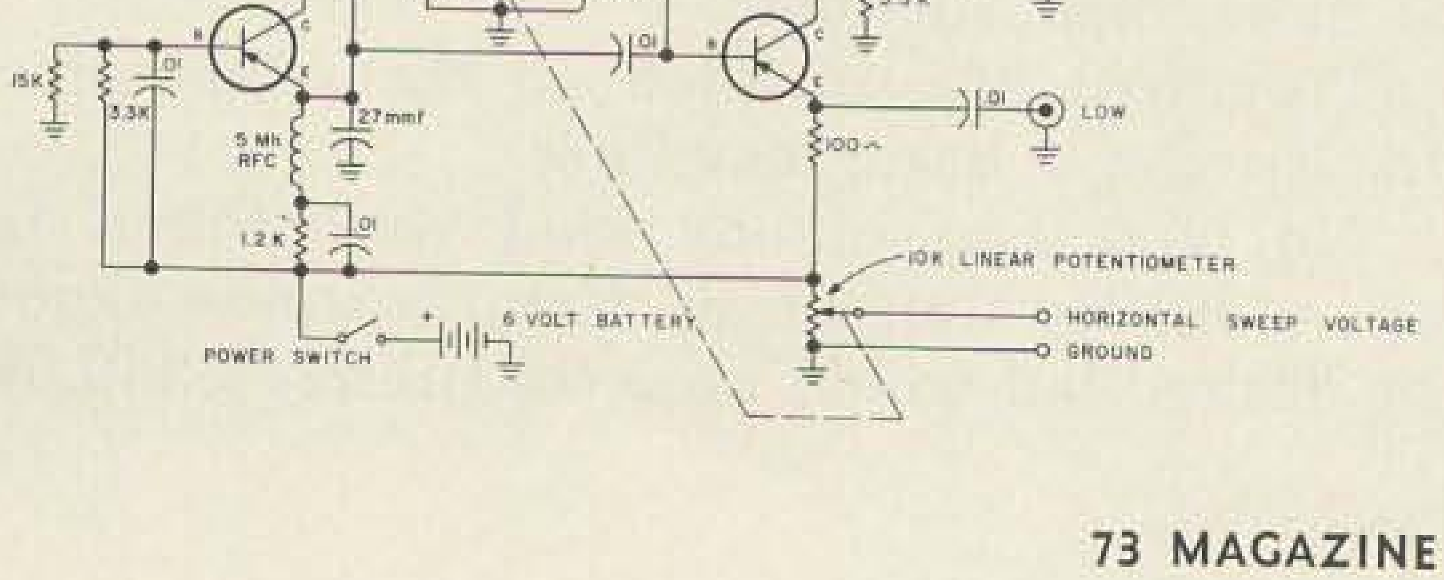
. . . W8GTT

An Armstrong Sweeper



Sometime ago while experimenting with SSB crystal filters at 480 kc, it occurred to me that a manually swept Armstrong oscillator with a pot coupled to the tuning capacitor for 'scope sweep voltage would save point by point frequency measurements with a BC221 while adjusting the filter for minimum in-band ripple. A circuit was hurriedly developed, and the results were even better than expected. Simple though it may be, I'm sure anyone who is working with crystal filters will appreciate its usefulness. The effects of tuning and "diddling" were immediately visible in the in-band ripple and the skirts down to about 20 db could be observed with a few twists of the knob.

With this encouraging experience, a sturdier



model was constructed. The circuit was assembled on a small piece of Vector-board, with the tuning capacitor and batteries mounted in a $5 \times 7 \times 3''$ aluminum chassis. An aluminum bracket was bent to hold the "sweep" pot and mounted behind the tuning capacitor, spaced to accomodate the mechanical shaft coupling. The Vectorboard was also mounted on the bracket.

The oscillator circuit is simple, using a 1 mh rfc for the tank inductor. The range of the circuit as shown is about 400 kc to 500 kc, at center frequency. The tuning capacitor is a Hammerlund MC-50-M with two of the rotor plates removed, resulting in a range of approximately 7-25 mmfd. An untuned amplifier provides isolation of the oscillator from the reactance of the load. I used 2N404 transistors but most PNP *if* transistors will work.

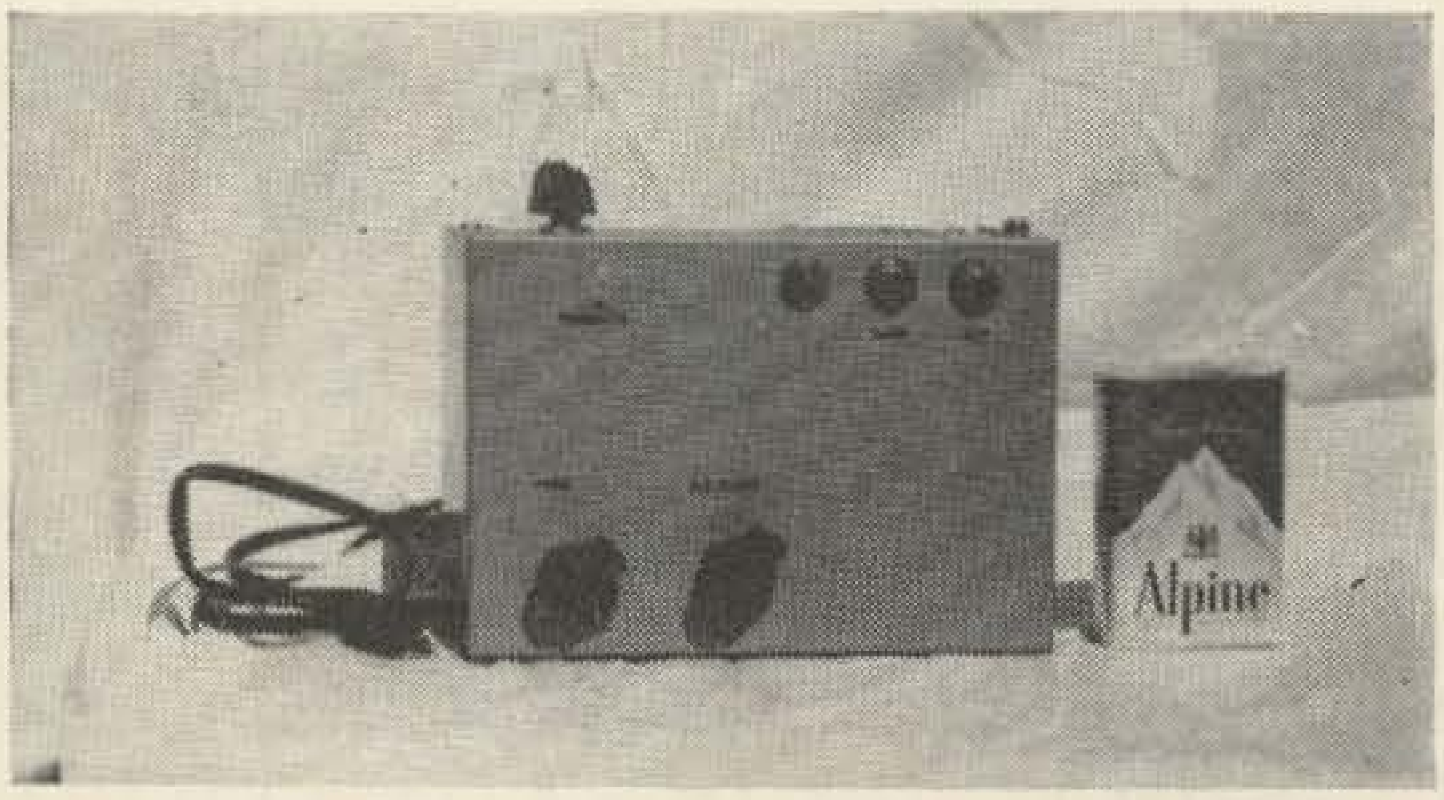
In addition to sweeping crystal filters, I have found this little box handy as a general purpose low frequency oscillator and sweeper for receiver *if*'s. The persistency of most oscilloscopes produces a much better display than might be expected, and it certainly beats the point by point method of plotting filter responses. Now I only wish I had a logarithmic amplifier for my scope, so I could look 40 or 50 db down those filter curves. (If the filters were that good!)

. . . W2EMF

Parts Kit Available

This sweep generator solves most of your if and crystal frequency problems. Operates on center frequency 455 kc.

Complete kit W2EMF-1 . . . . $11.95



Pete Crystal WA6OHD
691 Serenade Way
San Jose 11, Calif.

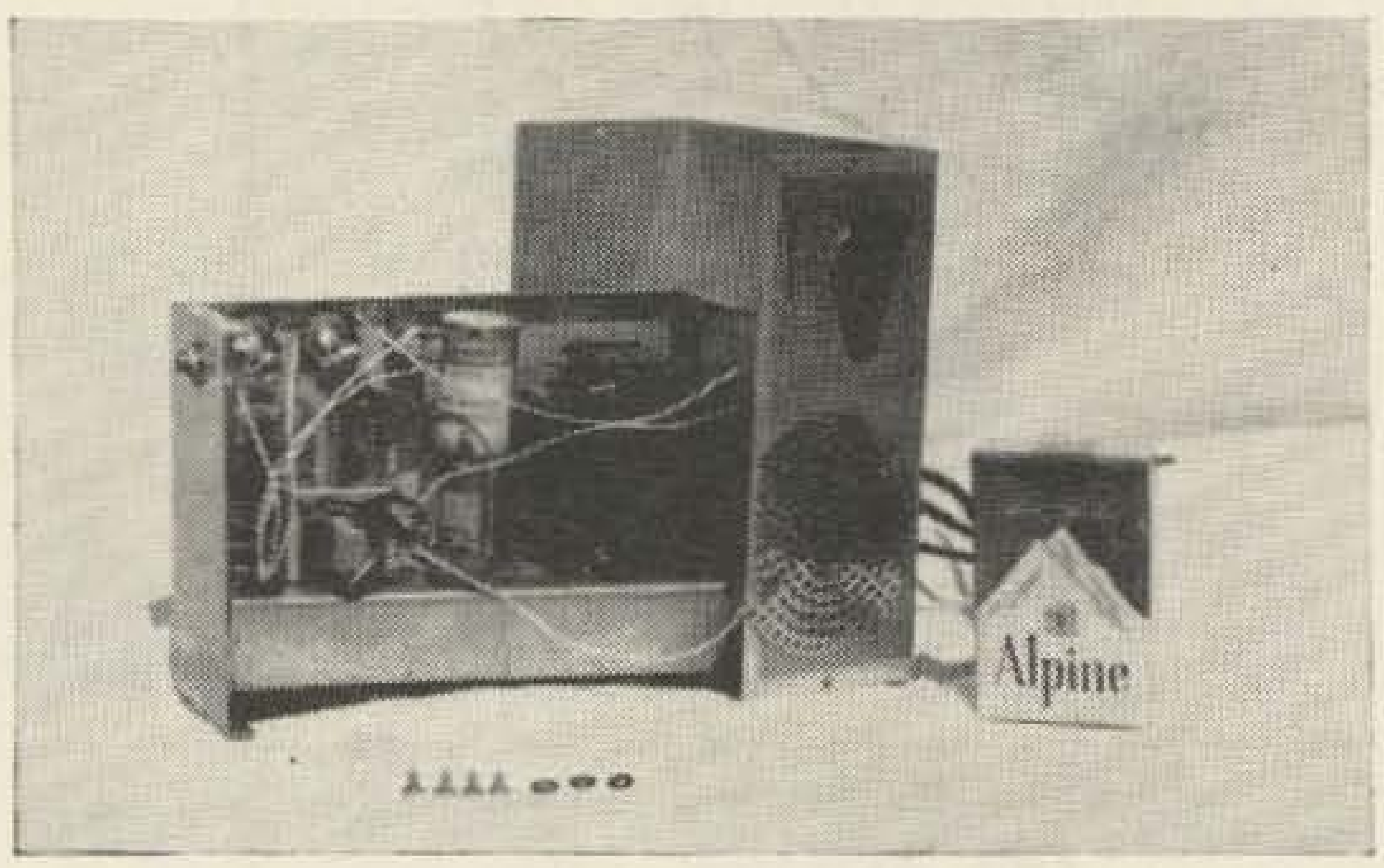
Photos by WA6JWJ

The Mon-Key

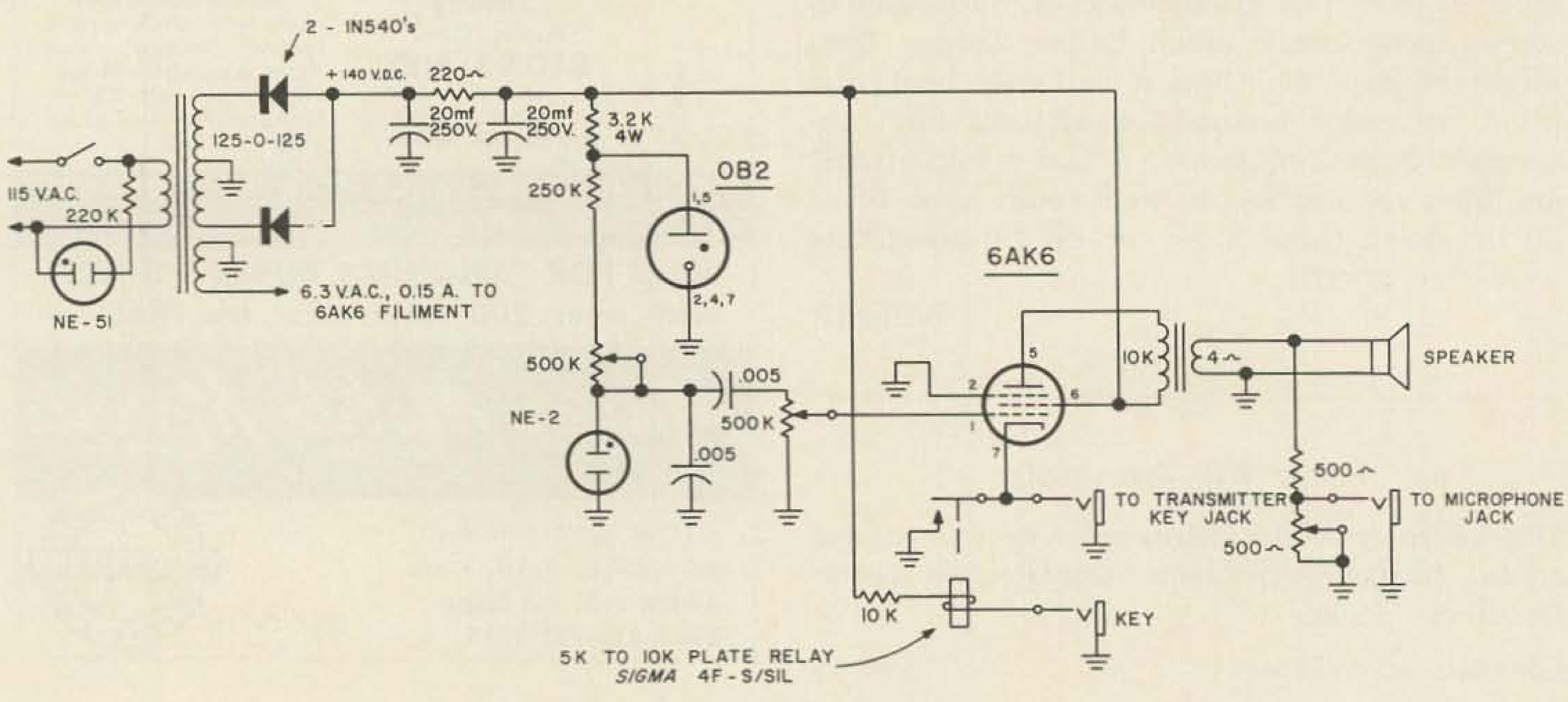
Parts kit available

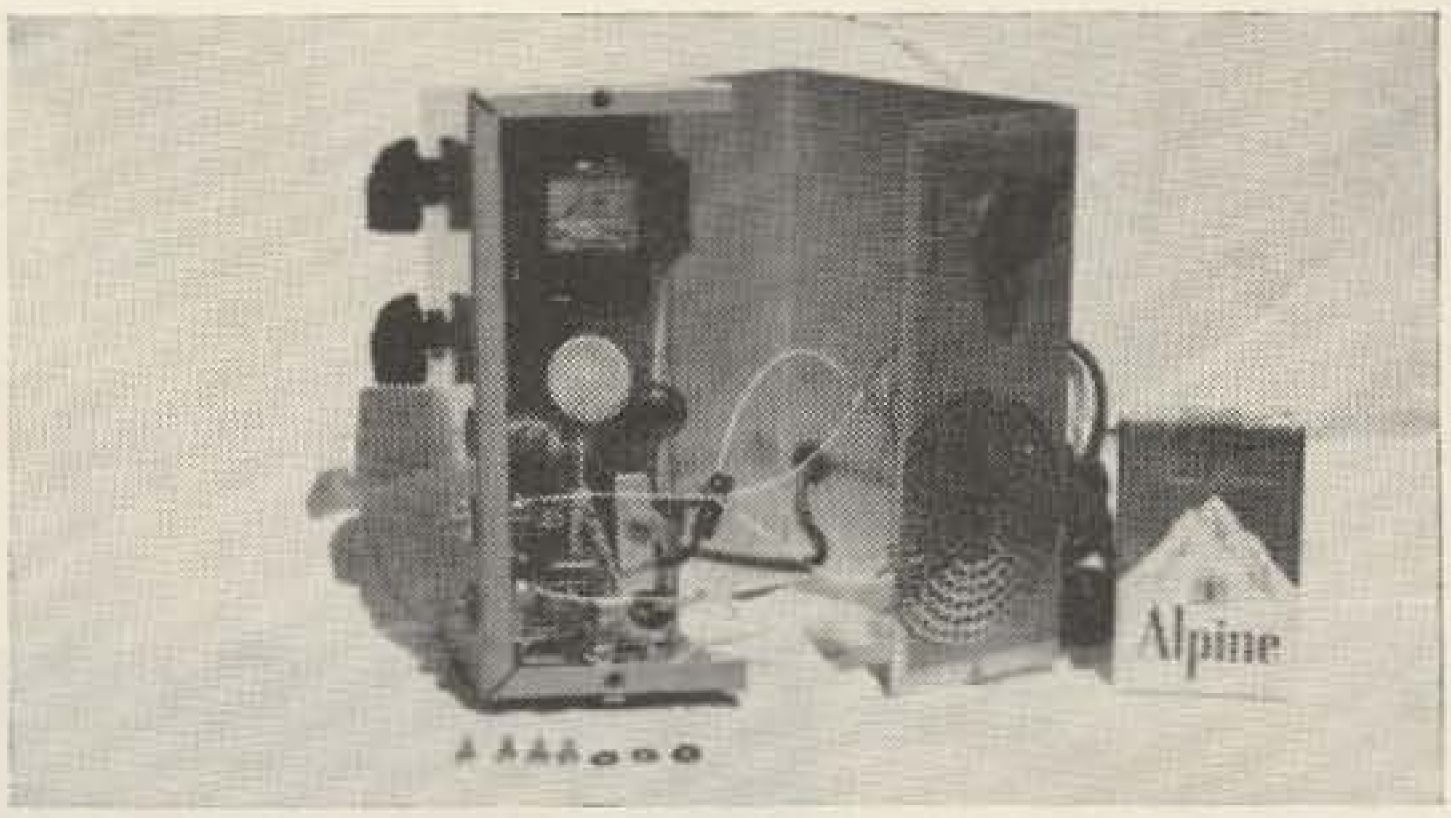
With the mounting interest of MCW on the VHF bands, my Dad, WA6CNL, has built the mon-key. The mon-key is an audio oscillator for monitoring, an audio source for the modulator and a relay for keying the transmitter.

One of the problems of MCW is having a microphone right in front of a CPO which is always a temptation for the operator to talk into. It's also distracting for the receiving end to hear coughs, chairs dragging, or dogs barking in the background. We eliminated this problem by feeding the output of the mon-key into the input of the modulator. Another advantage of the mon-keg is that you can key the audio and the carrier. This method has been used for many years by the military as a QRN puncher and it does just that. If you're not interested in A2, this oscillator makes a great CW monitor. It'll work on any type of keyingand speeds, depending on the relay used.

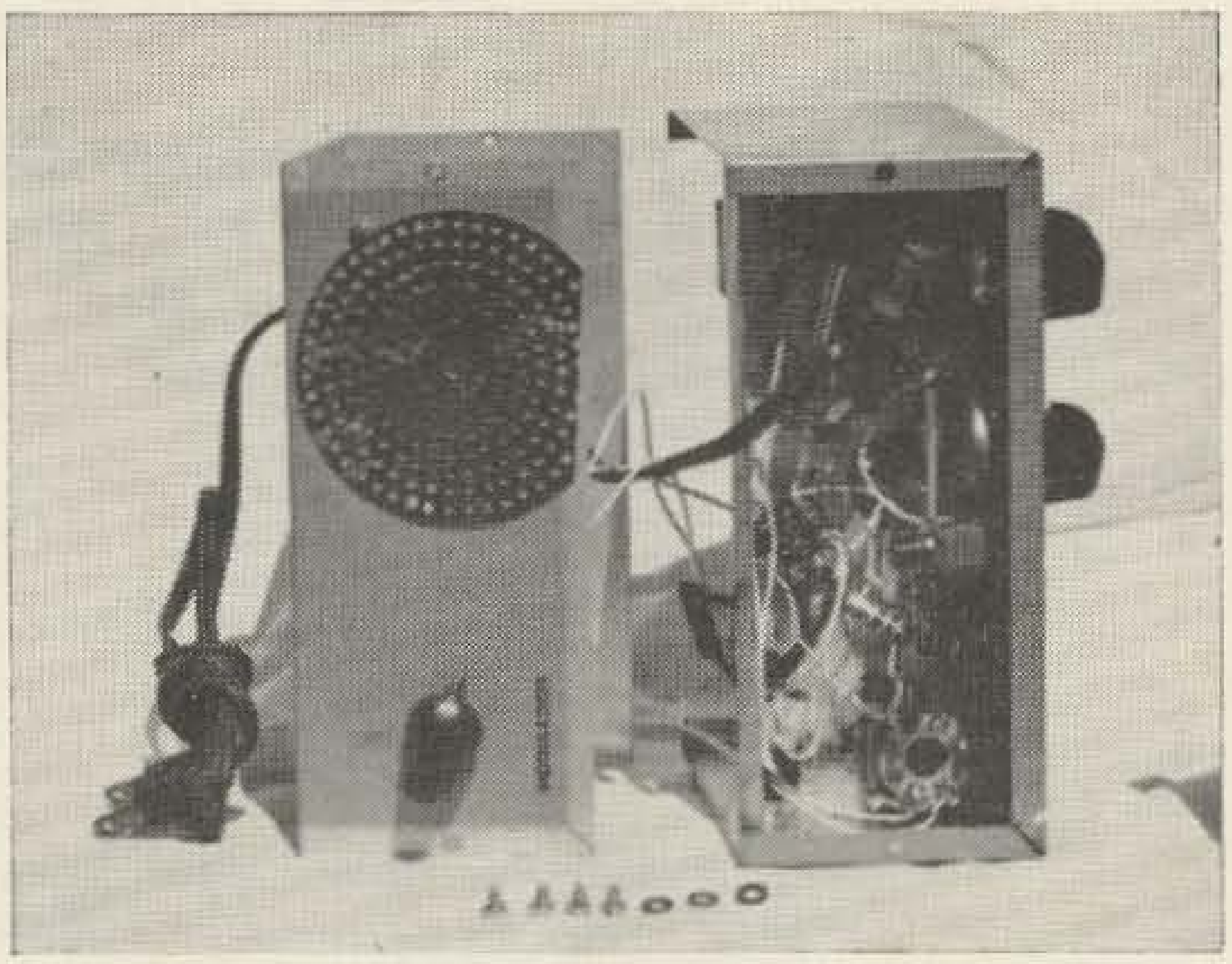


This whole unit was built in a 5″ × 7″ × 3″ box. A two inch speaker scrounged out of a transistor radio was mounted at the top of the box. The relay we used was a Potter Bromfield KCP11, but virtually any relay will work depending on the speed desired. The circuit used is a relaxation oscillator. The voltage for it should be regulated or the oscillator will





shift. The tone from the speaker will not sound real crisp due to the absence of harmonics. Although the audio doesn't sound too crisp through the speaker, it will sound real clear on the air. After everything is wired in, adjust R5 and R6 for the proper tone and audio level. Then with the mon-key connected to the modulator, adjust R8 until you get 100 or near 100 per cent modulation. Do not adjust R6 after you adjust R8 or you will have to readjust R8 all over again.



We have had great success with the mon-key. We have been able to poke a hole through severe QRM and still maintain intelligent communications. The mon-key gives a more CW type of effect and would be beneficial for the tech or novice that can't go on CW, due to the lack of receiving provisions, but wants to go on CW to get more practice.

. . . WA6OHD

Parts Kit Available

Complete kit with power supply and speaker. WA60HD-1 . . . . $19.95

New Products

Halo Xformer

Hi-Par now has a new matching transformer for the Saturn 6 antenna. It improves the band-width, simplifies the feeding system, lowers the SWR and costs $4.95.

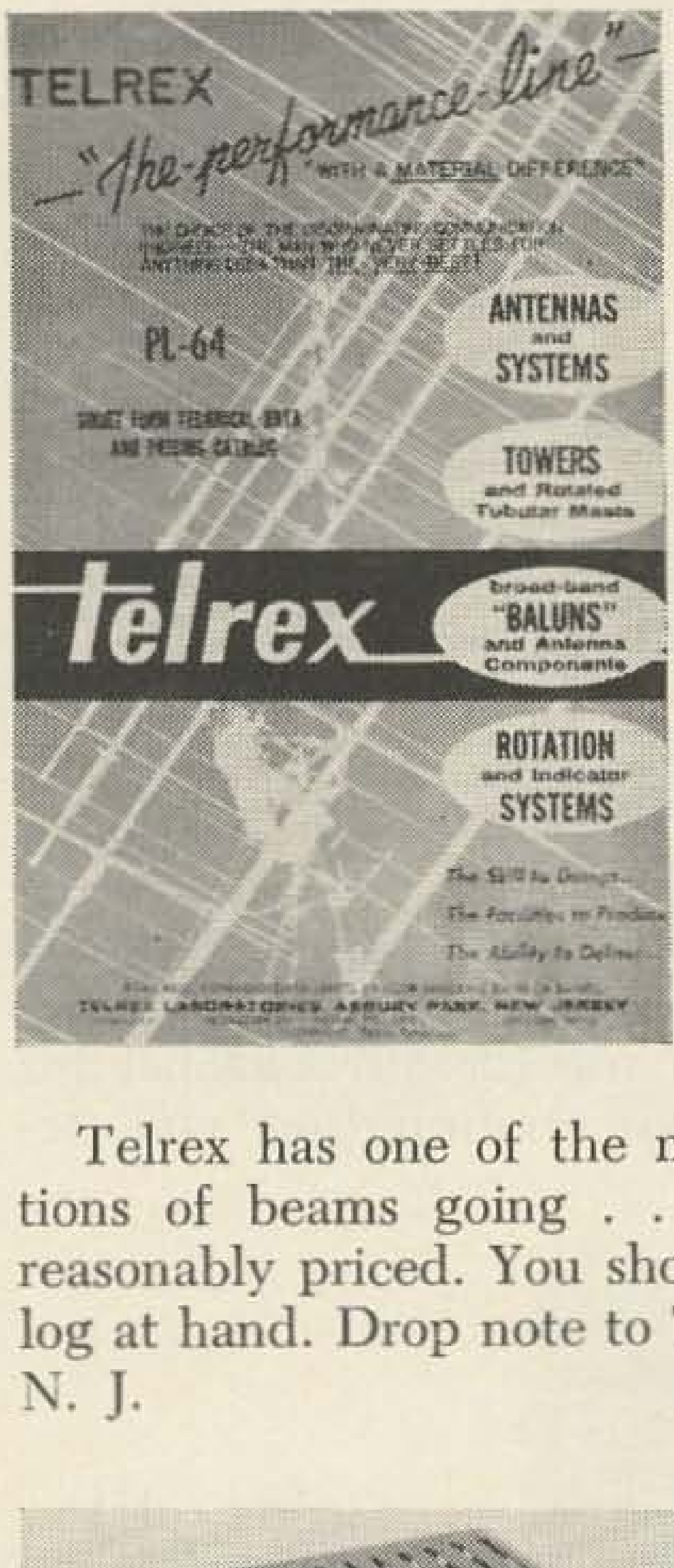
Crystal Catalog

Texas Crystals, 1000 Crystal Drive, Fort Myers, Florida have a new 12 page crystal directory for Citizens Band crystals. You can find what crystal to use for any channel for any make equipment, transmitting and receiving.

Galaxy III

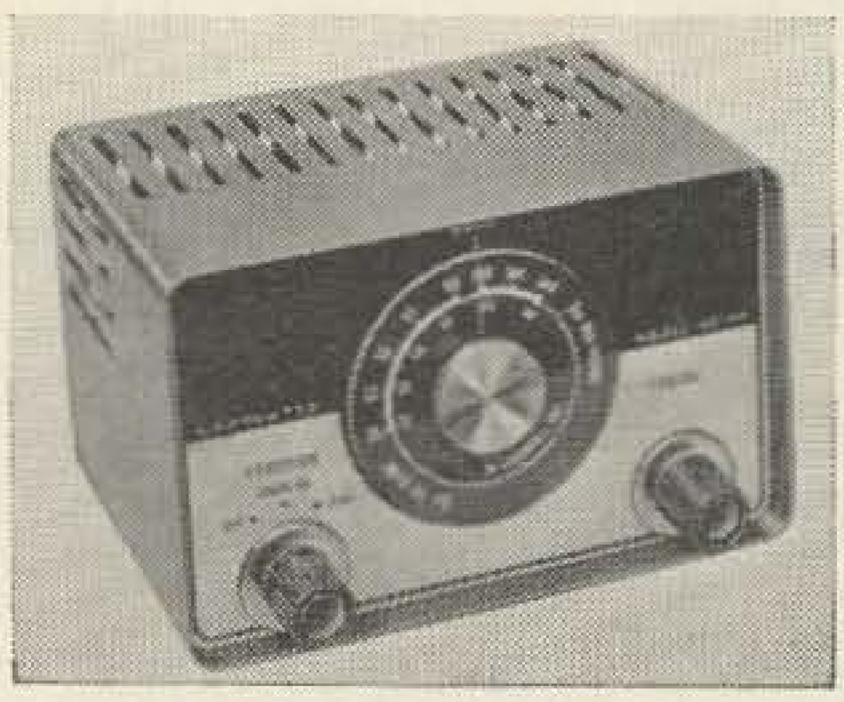
WRL has changed their name to Galaxy Electronics and their newest product is the Galaxy III, successor to the Galaxy 300, a 300 watt (PEP)/SSB/CW transceiver for 80, 40 and 20 meters. The hybrid transistorized circuit permits the small size of 6 v 10¾ x 11¼ which is fine for both home and mobile use and a weight of only 14 pounds. It has a full 500 kc coverage on all three bands, upper or lower sideband. Price is only $349.95. Available accessories are ac and dc supplies, remote VFO, speaker console and a DeLuxe Accessory Console complete with 24 hour clock, speaker, SWR bridge and hybrid phone patch. Write Galaxy Electronics, 10 South 34th Street, Council Bluffs, Iowa for more info.

New Products



Telrex's New Catalog

Telrex has one of the most complete selections of beams going . . . well constructed, reasonably priced. You should have their catalog at hand. Drop note to Telrex, Asbury Park, N. J.



6 and 2 Meter VFO

Lafayette Radio Electronics Corporation, 111 Jericho Turnpike, Syosset, L. I., N. Y. announces a new self-powered Variable Frequency Oscillator for the 6 and 2 Meter Amateur Bands. Model HE-89. Price 29.95

A high quality variable Frequency oscillator designed to operate with modern transmitters using crystal ocsillators in the 8-9 MC region. High electrical stability is achieved by a series-regulator tube protects unit from line voltage variations. Illuminated plexiglass dial is calibrated from 50-54 MC (6M) and 144-148 MC (2M). Output voltage is 10-20 V rms. Tubes 6BA6, OB2 plus low heart half-wave silicon rectifier. Complete 24" low loss coaxial cable. Operates on 117 volts 50/60 cycles AC. Dimensions, 6¼W x 4½H x 4" deep.

Miniature Antennas

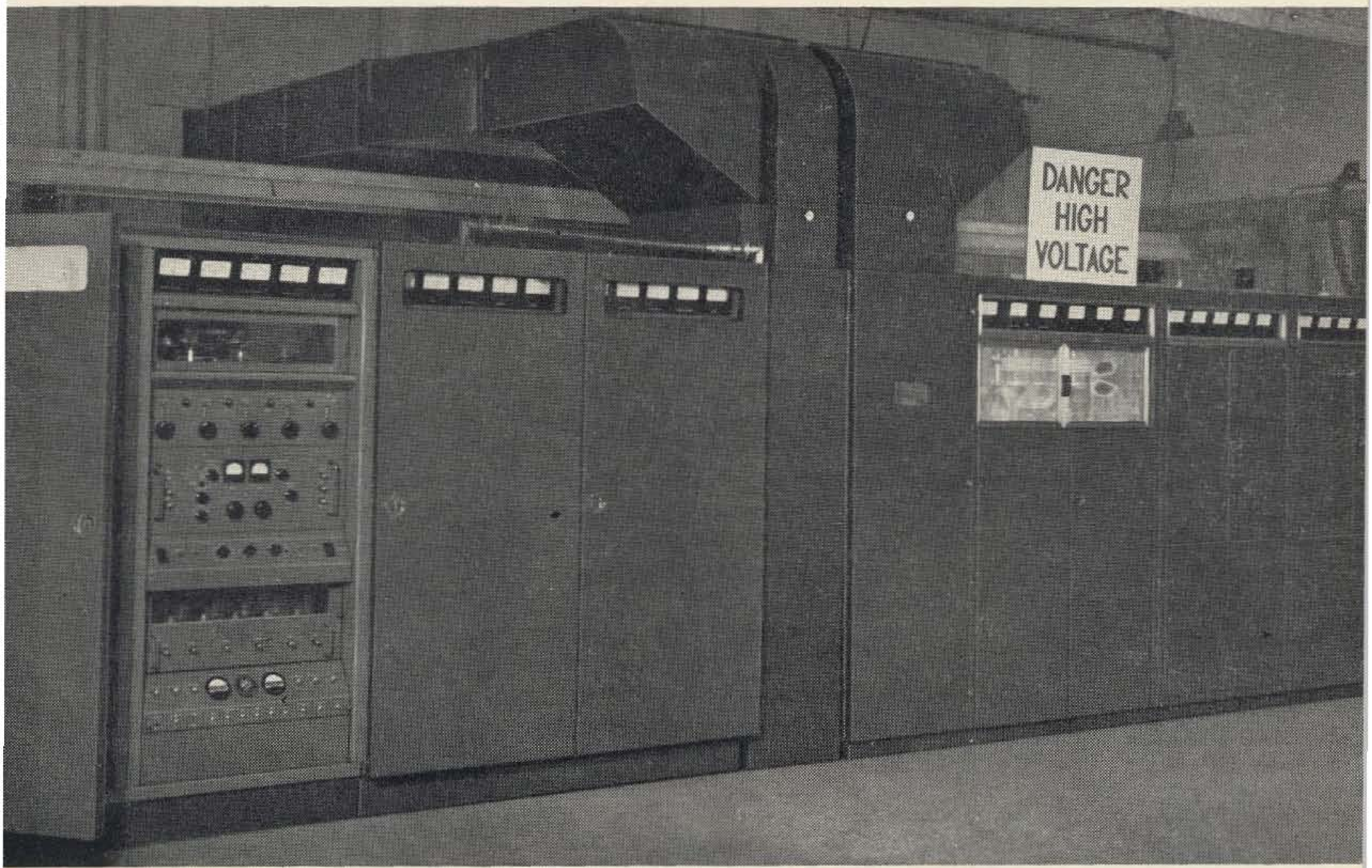
Mini-Products has a new catalog available which gives data on 13 different miniature antennas. These are designed for restricted area and mobile applications. Mobile antennas are available for 6 & 10, 6 & 15, 6 & 20, etc. The most ambitious model is a two element beam with elements only 11 feet long that will work on 6-10-15-20 meters. The catalog includes an engineering report on the principle used and gives full info on all models. Mini-Products, 1001 West 18th Street, Erie, Pennsylvania.

EZ-Etch

One of the best ideas we've seen yet for printed circuits. Frankly you have lost your spirit of adventure if you don't send for one of these kits. EZ has taken the misery out of circuit boards by coming up with a scheme which eliminates the drawing and photography. Write Ami-Tron Associates, 12033 Otsego Street, North Hollywood, California. Kit is only $5.95!

GPT-200K

200 KILOWATTS



(AN/FRT-62)

This is a complete general purpose transmitter providing SSB, ISB, AM, compatible AM, CW, FSK and FAX modes of operation. Accuracy and resetability is 1 part in 10^8 per day with tuning in 100 cps steps from 2-28 mcs.

Conservative ratings provide reserve power for maintaining peak power under conditions of complex waveform transmission, such as 64 tone voice frequency modulation, while adhering to signal to distortion ratio of at least 35 db. The final amplifier in the GPT-200K is air cooled. This transmitter is capable of 20 kc bandpass at the 3 db points.

WORLD WIDE SUPPLIERS • OF ELECTRONIC COMMUNICATIONS EQUIPMENT •

For complete detailed specifications, request TB 1014A.

THE TECHNICAL MATERIEL CORPORATION
MAMARONECK, NEW YORK

and Subsidiaries
OTTAWA, CANADA • ALEXANDRIA, VIRGINIA • GARLAND, TEXAS • LA MESA, CALIFORNIA
SAN LUIS OBISPO, CALIFORNIA • LUZERN, SWITZERLAND • POMPANO BEACH, FLORIDA

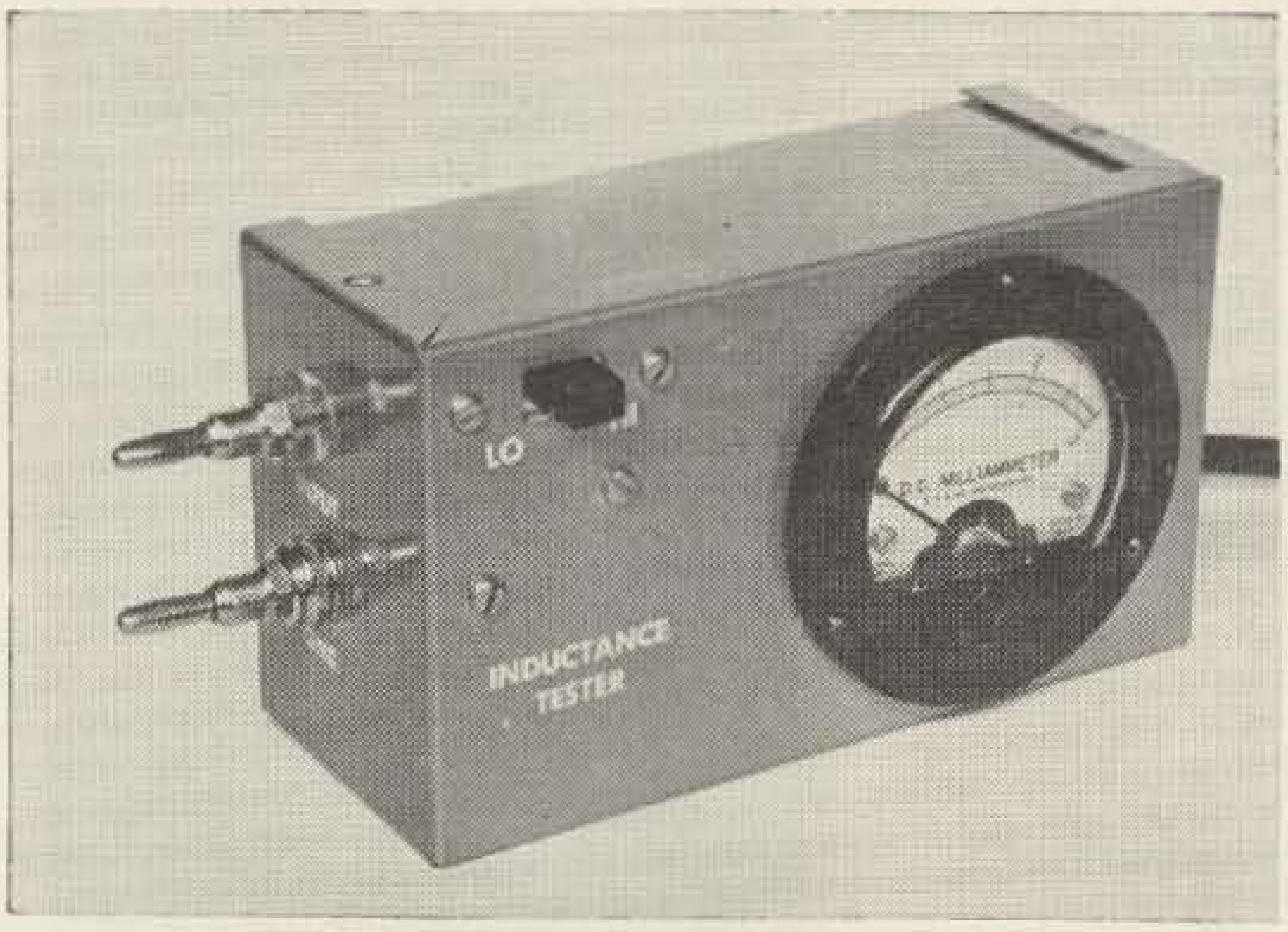
An IF Spotter

Howard Burgess W5WGF
1801 Dorothy St. N.E.
Albuquerque, N. M.

If you have ever tried to find the *if* frequencies of unfamiliar and inoperative pieces of surplus gear with no schematic, it is a waste of time to tell you how rough it can be. Even a single *if* transformer from the junk box can be a problem if it has no part number or identification.

Of course in some cases a grid dip meter can be used to find the operating frequency. However, few grid dippers cover the important *if* frequencies below 2 mc. To complicate things, if a dipper is used on a shielded transformer above 2 mc, the resonant frequency of the transformer may be shifted if the shield is removed.

If these problems sound familiar to you, we would like to suggest a little gadget that can help solve them. With just two resistors, two capacitors, and a tube, don't expect it to give a digital read-out to all your questions, but it can put you in the ball park.



The if spotter. The switch for changing the coupling capacitor is at the upper left marked "HI" and "LO." The posts on the end are X1 and X2.

The principle of operation is as simple as the construction. The tuned circuit in question is merely made to oscillate at its resonate frequency. The frequency can then be determined by tuning in its radiated signal on the ham receiver. To set the unknown coil into oscillation requires the use of a simple "two terminal" oscillator. Such an oscillator is shown in the schematic of Fig. 1. When any tuned circuit is connected to the two points marked X, the circuit will oscillate at its resonant frequency.

In this oscillator the twin triode is a tube such as the 12AT7. The section V2 furnishes the necessary feedback and eliminates the need for extra coils or feedback connections.

The construction is simple. The unit could have been built in a larger case with its own power supply and would have become a nice piece of bench equipment. However, due to the few parts required and the small amount of plate power used (3 mils at 90 volts) it was built as an overgrown probe. The power is robbed from another piece of test equipment or the receiver.

As a probe it can be used on the work bench to test individual coils and transformers or it can be held in contact with the various transformers in a receiver.

There is only one point of caution that should be observed in construction. The lead from the grid contact of VI to the XI post should be kept as short and direct as possible with the least capacity to ground. This lead becames part of the oscillating tuned circuit and limits the upper frequency to which the unit will operate.

The coupling capacitor from the grid of V1 to the plate of V2 furnishes the feedback required to maintain oscillation. To reduce the loading on the tuned circuit, this capacitor should be held to the smallest value that will sustain oscillation. Because of the wide range over which this instrument operates, a switch is provided to change values. With the capacitors shown, operation is possible from about 60 mc down to well below 50 kc. The larger value is used at the lower frequencies and is switched in only when required. With coils of medium Q the switching point is around 3 to 5 mc.

The connectors X1 and X2 can be almost any kind of posts. The ones shown on the unit here are banana plugs. These can be used as test points, or alligator clips can be slid over them for use in clipping to coil leads.

The meter shown is a three mil meter and is used to read the total plate current of both halves of the tube. This will indicate when the circuit is oscillating. When the tester is not oscillating the meter will indicate a current of about 1 mil (with 90 plate volts). Under oscillating conditions the meter will rise to as much as 3 mils with a high Q coil. The actual amount of current is not so important as the fact that the upward shift indicates that the coil is not open and is oscillating. A 5 or 10 mil meter will serve the purpose just as well.

As the pictures show, this unit was built in

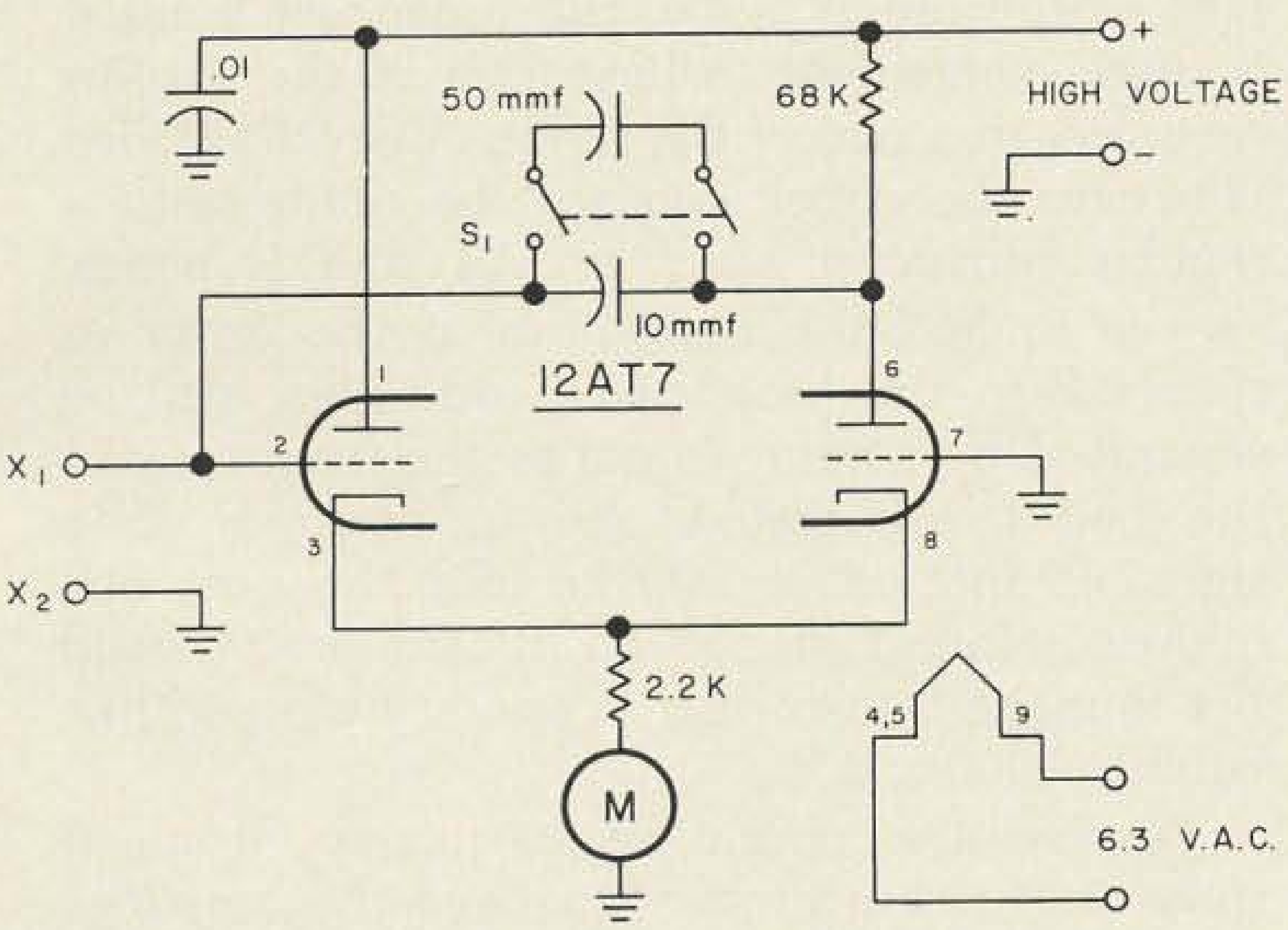
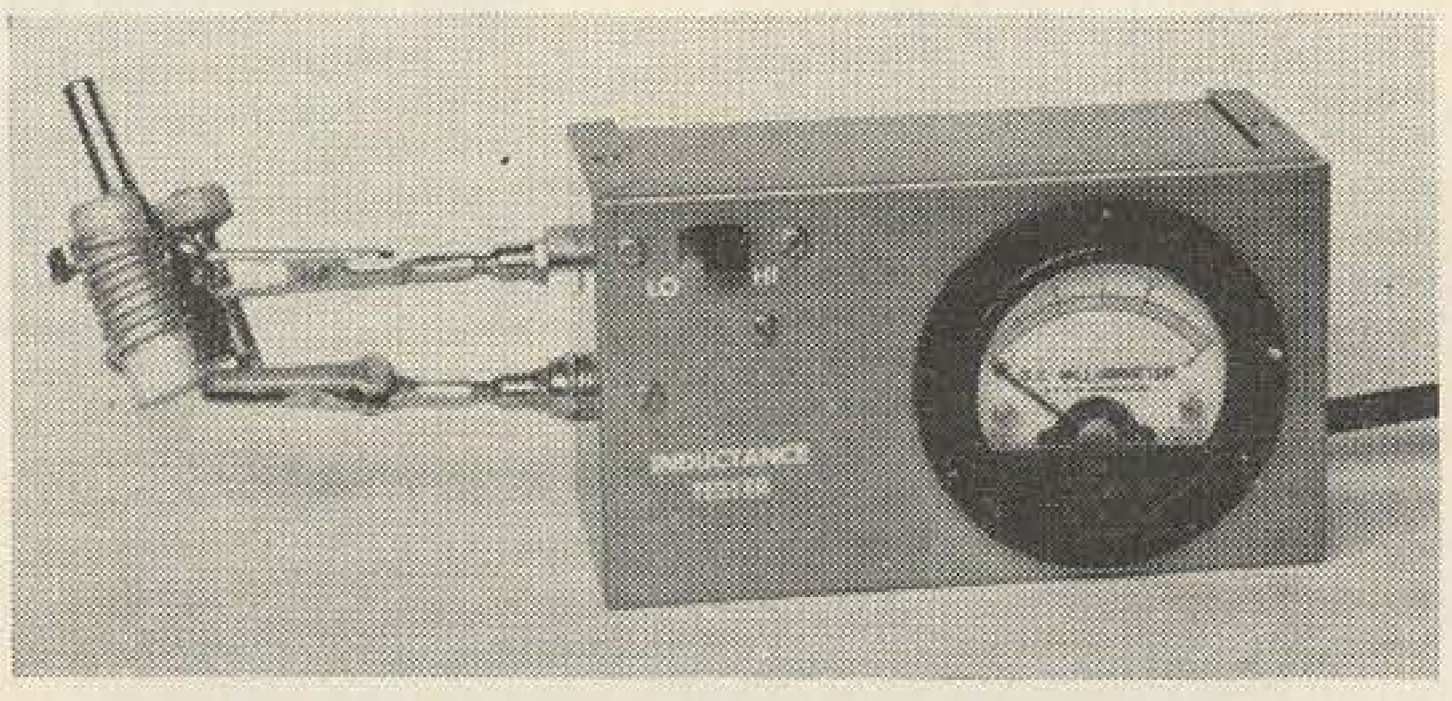


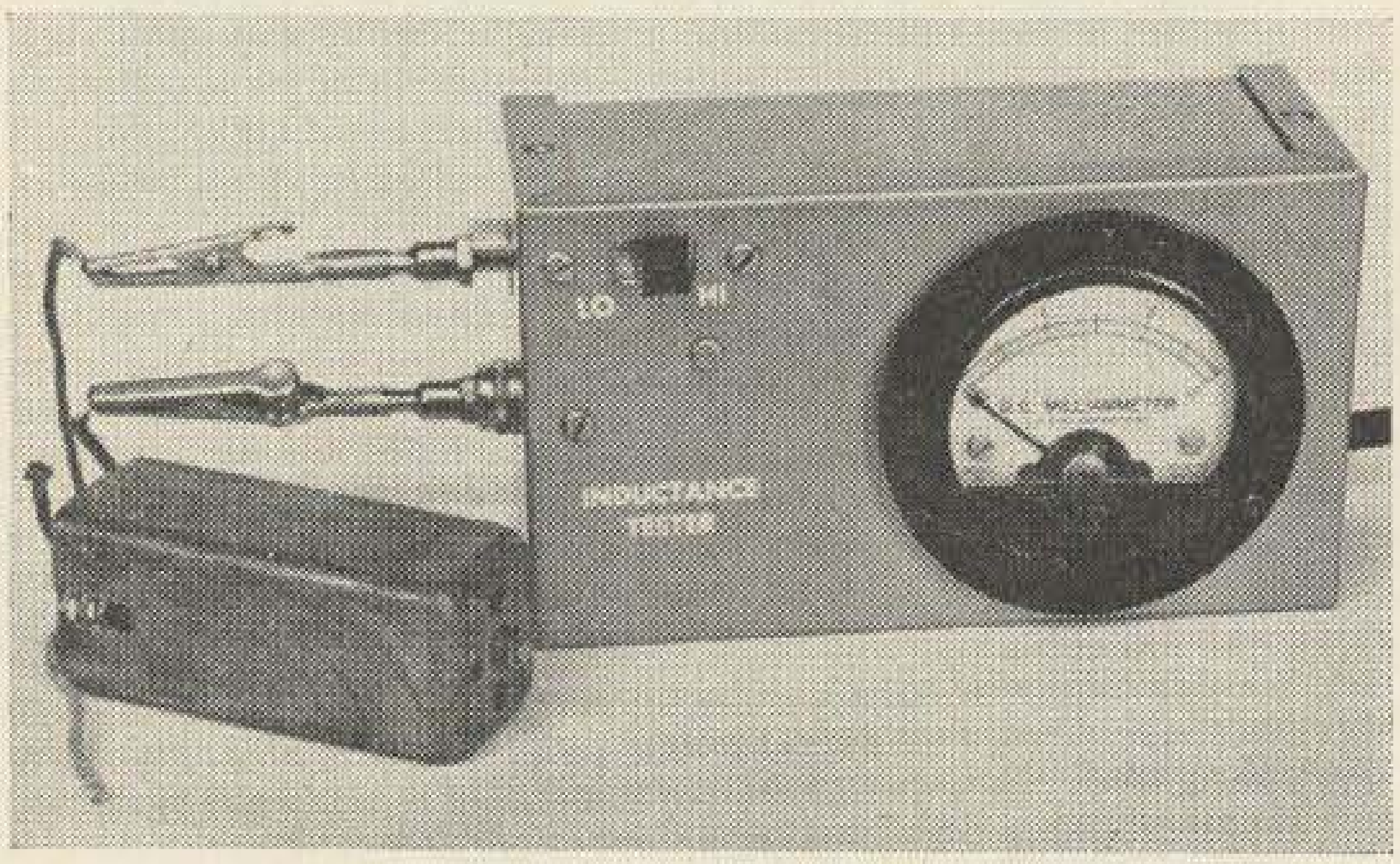
FIGURE I

Circuit diagram of the if spotter

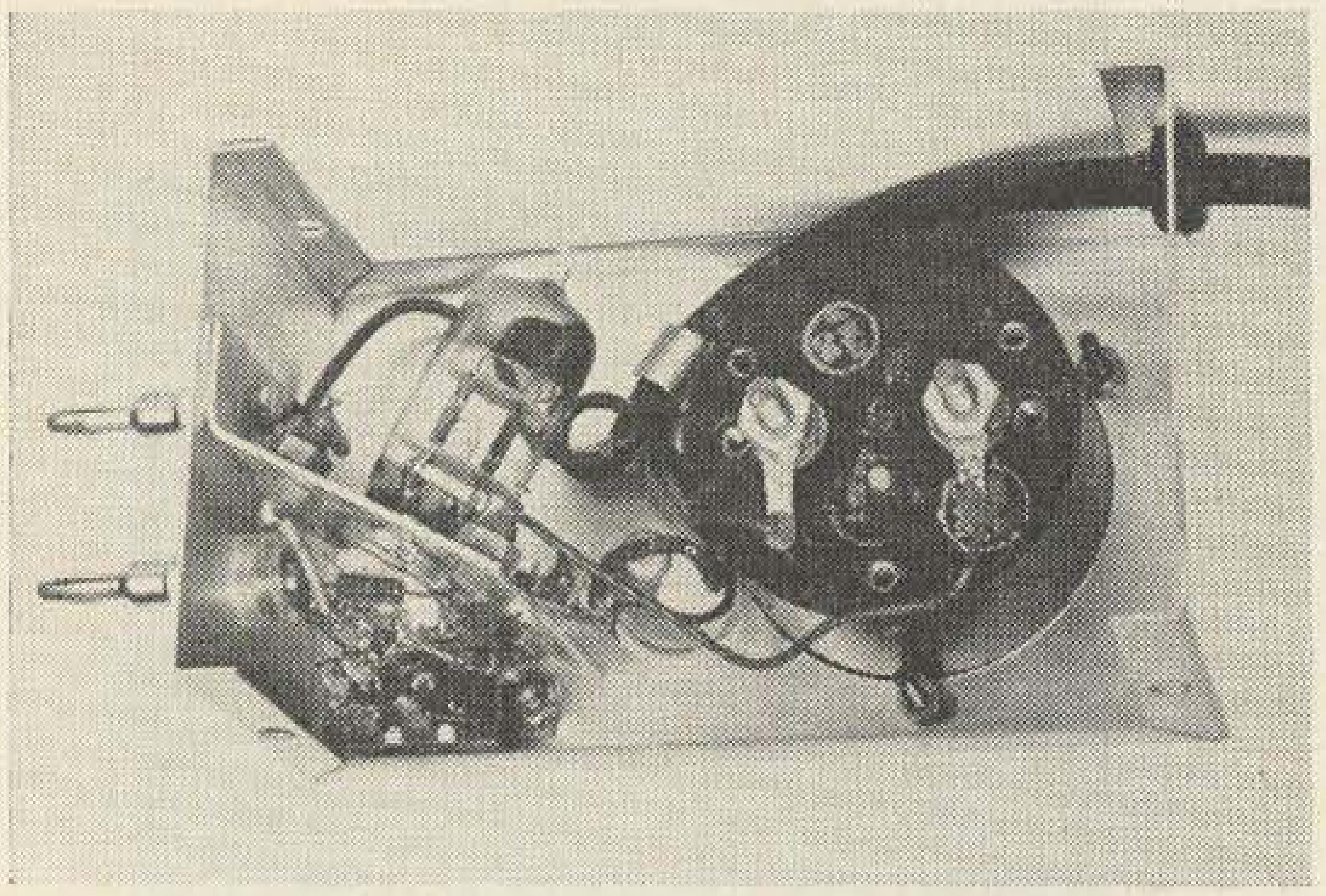
.01 Ceramic capacitor
50 pf Mica capacitor
10 pf Ceramic
68 K ½ watt carbon resistor
22 K ½ watt carbon resistor
Milliammeter in range of 3 to 10 ma
Slide action Double Pole-Single Throw switch (S1)
2 Banana plugs (x1 and x2)
12AT7 tube
Minibox (size depends on type of meter used)
9 pin miniature tube socket



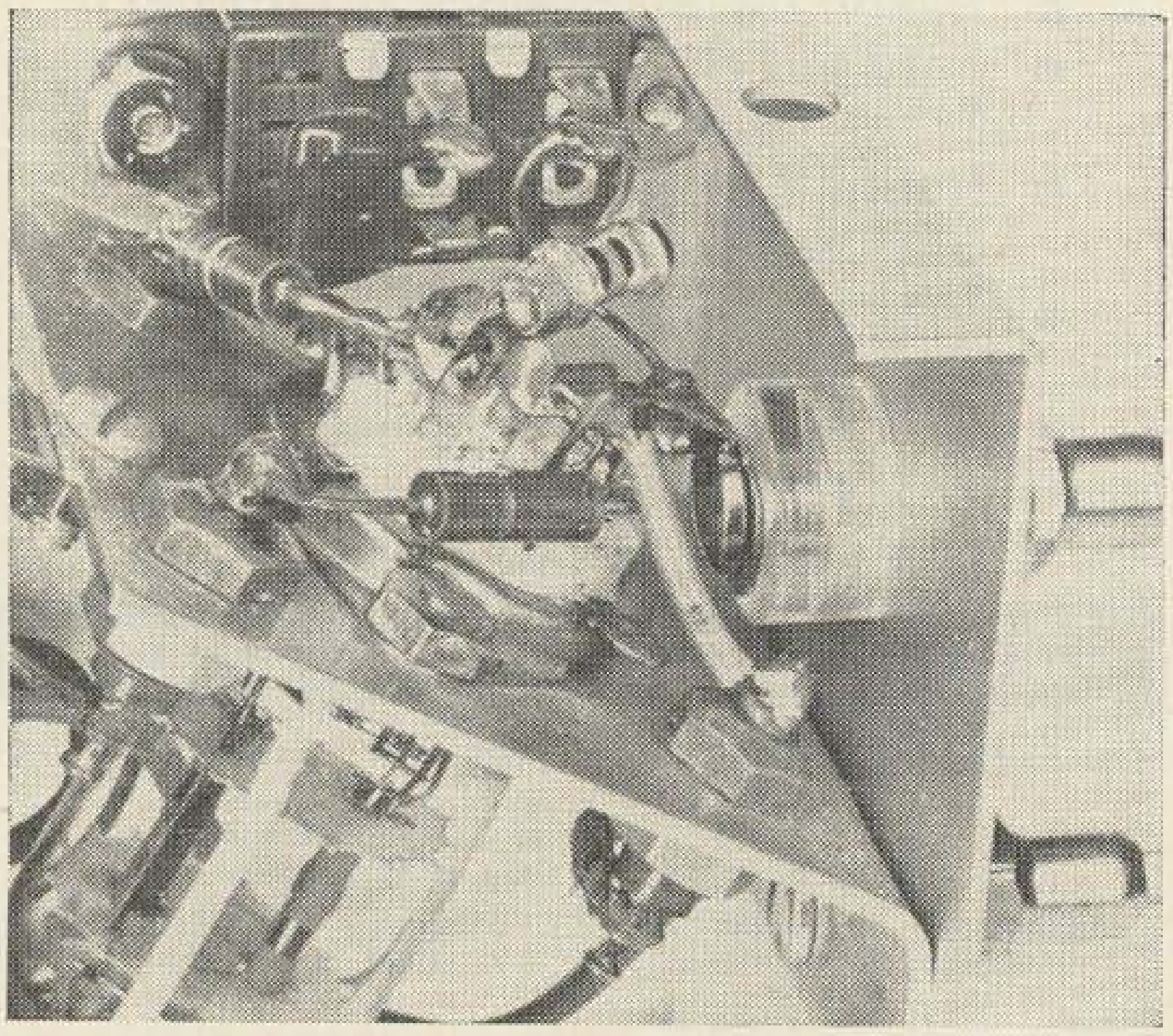
Checking a ten meter tank circuit



Checking an if transformer



Inside view showing extreme simplicity of the "Spotter." The tube is mounted at an angle to keep the grid lead to the "unknown" as short as possible.



Close up of tube socket showing parts placement.

a small 5" x 3" x 2" box. The unit will work just as well if it is built on a small piece of peg board with a couple of leads run out to the multimeter. This is for the man in a hurry.

When the unit is finished, apply power with the "X" points open (no coil across them). Because of the open grid of V1, the meter will drift about. After the tube has had time to warm up, short the X posts with a heavy piece of bus or copper. The meter will now come to rest somewhere around 1 mil. This is the "no oscillation" current and should be kept in mind as a reference point for future use. Now remove the short and connect almost any kind of an LC circuit across the posts. The meter reading will now rise from the "no oscillation" value indicating that the coil is oscillating. Do not use the large coupling capacitor unless the circuit refuses to oscillate with the smaller value.

To check a single *if* transformer, all that is necessary is to hook one of the *tuned* coils to the input terminals of the tester. Be sure that the coil used is not tuned. Some transformers have a number of terminals which may not go directly to the tuned circuit inside. To obtain oscillation there must be both a dc and an rf path between the two posts.

If the transformer is one whose frequency falls in the range below the broadcast band it is quite convenient to have one of the surplus receivers that covers the range down to 200 kc. However the check can still be made with a regular broadcast receiver. All that is necessary is to find the harmonics of the tester as they fall in the broadcast band. They will be separated by a value equal to the frequency of the coil being tested. As an example, if a signal is spotted at 900 kc and the next one higher is found at 135 kc, it is a pretty good bet that the transformer is operating on 450 kc $(1350 - 900 = 450)$.

To find the operating frequency of an *if* stage it is not necessary to have the amplifier in operating condition or the tubes hot. Just connect the two contacts across the primary or secondary of the transformer in question and watch for signs of oscillation on the meter. Some transformers have a portion of the bias system inside of the can. This can usually be overcome by connecting the tester from grid to ground of the tube in the stage being tested.

In addition to checking transformers it can also be useful in testing the range over which a transmitter tank will tune. Just make sure that the high voltage is turned off and connect the probe across the tank to be tested. Now you can tune the tank and follow its entire

usable range with the receiver. If the tank being checked happens to be the final, the meter on the probe will indicate when the antenna is brought into resonance.

This little tester was built to do just one thing—sort out some old *ifs* in the junk box. After we tried it we found that it would do a lot of useful chores around the ham shack. With proper care and feeding, it can probably learn to do tricks that we haven't even thought of.

. . . W5WGF

Jim Kyle K5JKX
1236 N.E. 44th St.
Oklahoma City, Okla.

The Case of the Naughty Pi-Net

(*Why it misbehaves*)

One of the most popular final-amplifier tank circuits around these days, at all power levels, is the "pi-net"; in the nearly 30 years since it was first introduced to hamdom, it has put almost all other circuits out of the running. One of the main reasons for this is its reputed ability to "match anything," and within limits it fulfills this promise to an amazing degree.

But from time to time one turns naughty, and refuses to behave as billed. Instead of following the book, which says that with the output capacitor (C2 in Fig. 1) set for maximum the loading should be lightest, increasing as the capacitance of C2 decreases, the naughty pi-net either refuses to dip at all, or does so at much too high a plate-current level.

In his excellent roundup of pi-net design data (February, 1962, 73—and required reading for this course) W6JAT had this to say about such a naughty pi-net: "The trouble is probably that the Q is too low. It may be corrected by taking off a turn or two of coil and increasing the input condenser."

But this isn't *always* the trouble; as often as not—particularly in the case of commercially-built rigs which misbehave—the trouble isn't in the pi-net at all. It's in the antenna! With a brief bypass into some supposedly exotic areas of antenna measurement, let's see how it works:

Before getting to the antenna itself, let's take a fast glance at the pi-net and how it works. The handy little circuit is actually an impedance-transforming device, which makes the (hopefully) 50 ohm impedance of your coax look like a high impedance to the final-amplifier tube. When the impedance transformation is what you want it to be, the plate current is automatically what you want also. This is why most of us never meet up with the impedance idea at all—the plate current or "loading level" takes care of it for us.

But for the impedance transformation to take place properly, the pi-net must be terminated by pure resistance on each end. No reactance at all is permissible. In practice, any reactance which *does* show up is tuned out by adjustment of C1 and C2. For instance, if your feedline happens to look like 50 ohms resistance together with a capacative component equal to 10 mmfd at operating frequency, you just set the loading capacitor (C2) to 10 mmfd *less* than you normally would. The 10 mmfd contributed by the line makes up the difference. Again, it happens automatically when you adjust controls for proper dip and plate current.

That last paragraph is important, because it contains the full key to why some pi-nets turn naughty. When you have the idea down pat, proceed into the mud of antenna measurements.

Most of us have made the acquaintance of SWR before, but maybe not all of us have seen "Smith charts." These charts are rather complicated-looking graphs used by antenna engineers to simplify some of their measurement techniques, and Fig. 2 is a part of a

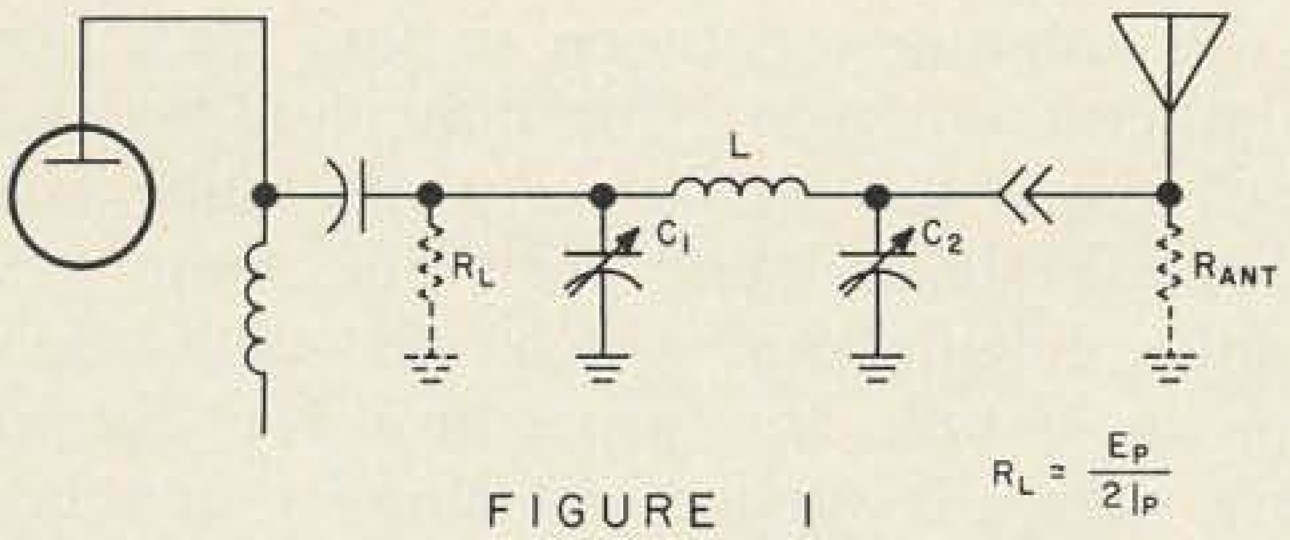


FIGURE 1

Basic pi-net circuit, identifying parts designations used in examples throughout text. For data on pi-net design, see W6JAT article, February, 1962, issue of 73, or standard radio handbooks.

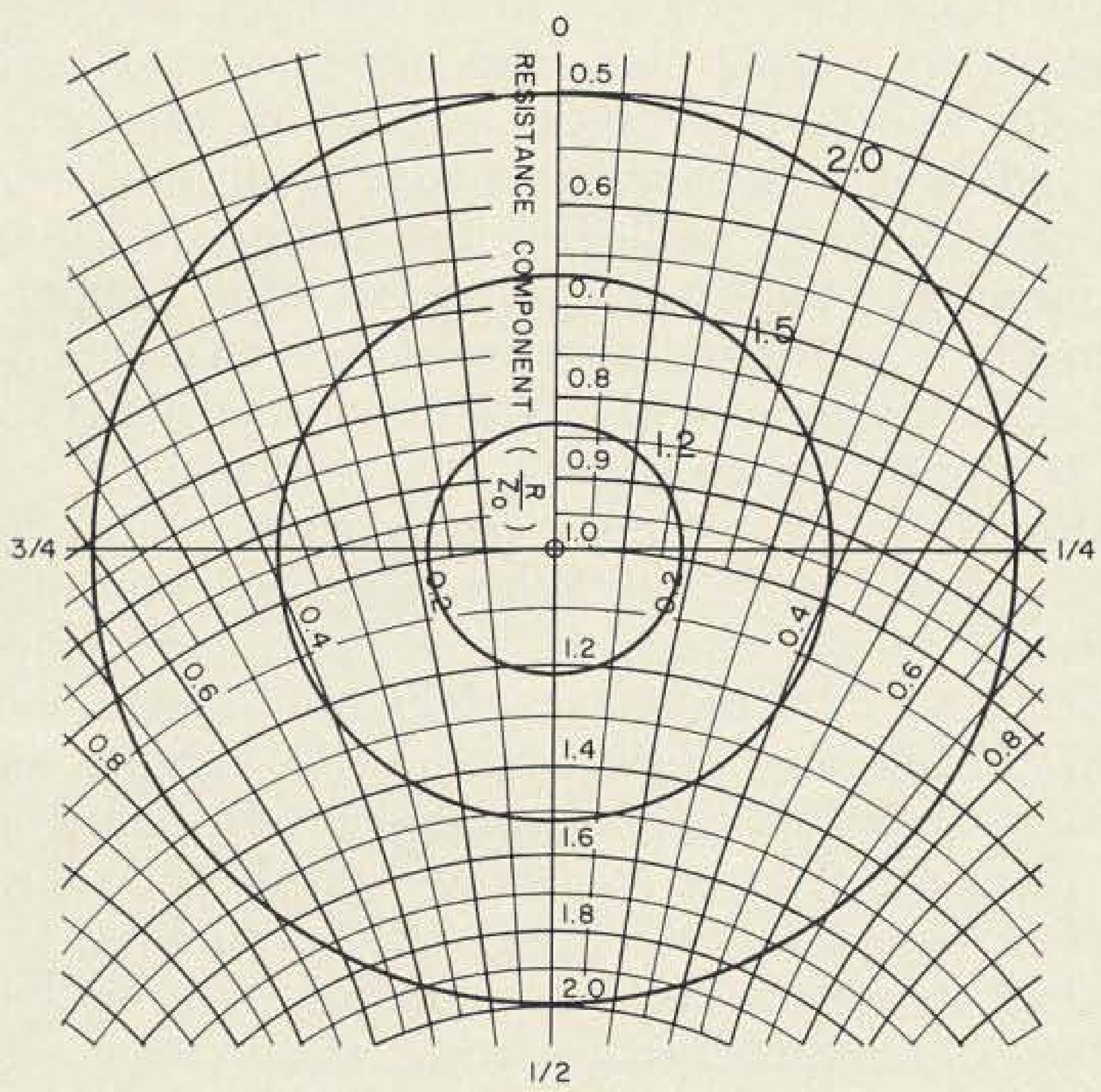
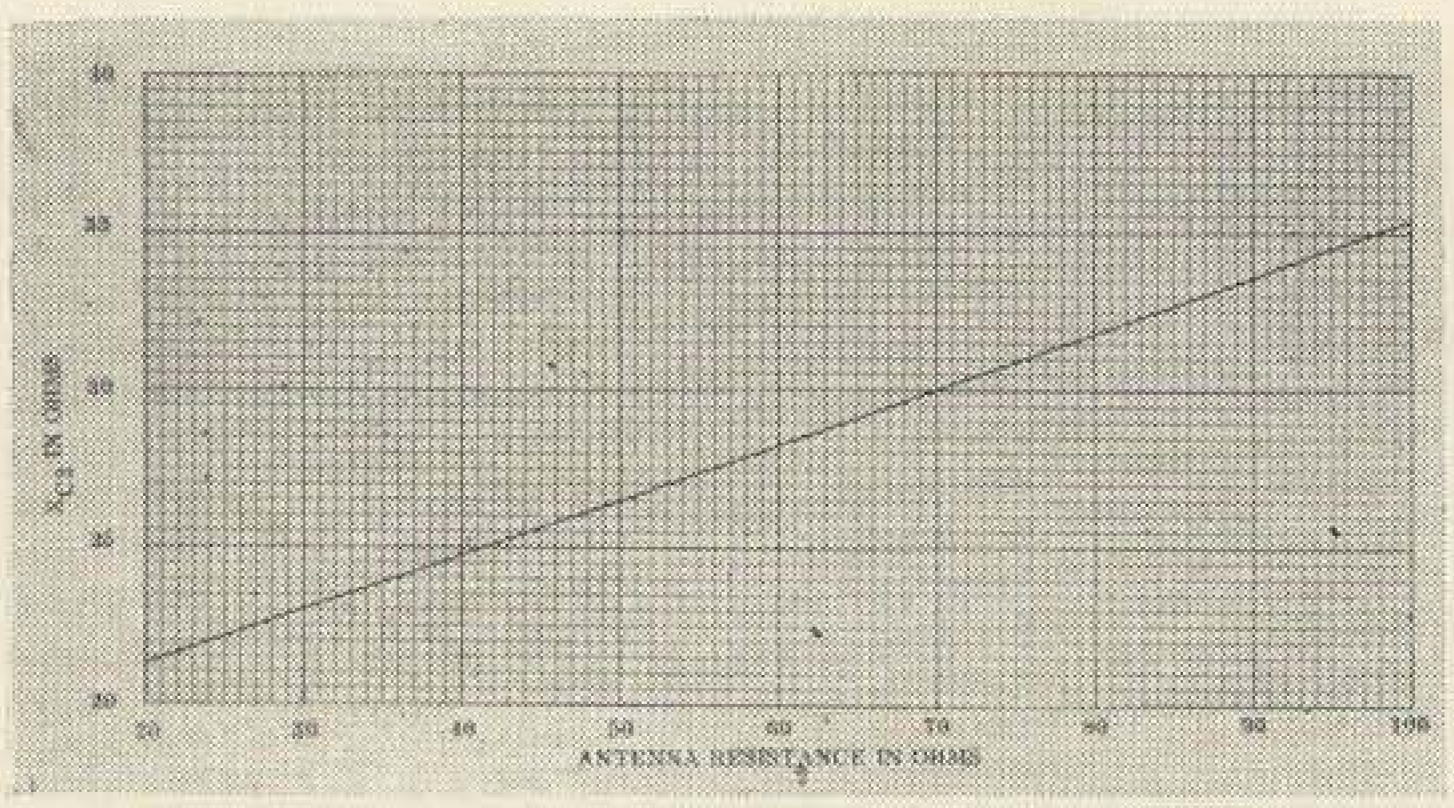


FIGURE 2

Portion of Smith Chart showing resistive and reactive components of coax impedance at transmitter end of line, for all possible line lengths. Figures at edges of graph represent wavelengths of line; all even wavelengths may be ignored since impedance repeats itself every full wavelength and thus only fractions of the last wavelength are important. See text for details of remainder of chart and how to read it.

Smith chart drawn for SWR values of 1.2, 1.5, and 2.0. All these SWR readings are within the limits usually considered acceptable for ham work.

Here's what this Smith chart shows: The concentric circles represent all the possible values of impedance which the coax can present to the transmitter regardless of its length. The scale labelled "resistance component" shows the resistance presented by the coax (after you multiply by 50, which is the resistance for an SWR of 1.0). The other scales composed of arcs coming in from the sides shows the reactive components of the coax input impedance; those to the right of the resistance scale are capacative reactance while those to the left are inductive; again, the



Reactance of C2 in ohms required to match various antenna resistance values between 20 and 100 ohms; antenna is assumed to be pure resistance.

values on the chart must be multiplied by 50 to come up with the true applicable values in this case.

To make it simpler, here's an example. If the SWR is 2, the coax can look like 25 ohms (0.5 times 50) pure resistance at a voltage null, or like 100 ohms (2.0 times 50) at a voltage peak. In between, it can be 40 ohms resistance plus 30 ohms capacative reactance (read at the intersection of the horizontal line and the 2.0 SWR circle) or 40 ohms resistance plus 30 ohms inductive reactance. It can also be 30 ohms resistive plus 15 ohms capacative (at the point marked X), or anything else on the 2.0 SWR circle.

One complete trip around the circle represents one full wavelength of coax between transmitter and antenna. If the antenna is taken to be the starting point, and we start at the top (the 25 ohm point on the 2.0 SWR circle) then the intersection of the circle and the right-hand horizontal line will mark ¼ wavelength, the intersection with the lower vertical line will mark ½ wavelength, and that with the left-hand horizontal line will mark ¾ wavelength. As we keep on going, we find that the values are the same at ¼ and 1¼ wavelength, etc.

All of which may seem as clear as the inside of a strawberry pie but not very relevant to the case of the naughty pi-net. However, things are about to begin falling into place.

Let's go back to the pi-net itself and find out what happens to the adjustments of C2 as the antenna resistance varies: we'll ignore all other adjustments for now, and we won't think about tuning out any reactance either.

Fig. 3 shows the results of some rather lengthy calculations which we won't go into here in detail; the procedure for obtaining these values is spelled out step-by-step in the 1957 ARRL handbook but has been omitted in later editions; W6JAT's article also gives the equation for this calculation.

The values shown in Fig. 3 were calculated for a single 6146 operating with 600 volts on the plate and 120 ma plate current, which is equal to a 2500 ohm load impedance. They'll hold true for any tube and set of operating conditions which amounts to a 2500 ohm load impedance, as well—but the important thing here is not the exact figures, but what happens to them as the antenna resistance changes.

For instance, with an antenna resistance of 50 ohms (design value) the reactance of C2 should be 26.5 ohms. This comes out to be 860 mmfd at 7 mc. When antenna resistance drops to 25 ohms, C2's required reactance drops to 22.2 ohms, or 1040 mmfd at 7 mc. With antenna resistance of 100 ohms, C2 must show 35.3 ohms, which is 642 mmfd at 7 mc. All of these values are within the range of a 3-section 365 mmfd BC capacitor, the kind so widely used for loading control, but the 1040 mmfd requirement means that the loading will be nearly at zero when proper loading is actually achieved!

Now let's go back to the Smith chart in Fig. 2 and see what the coax looks like when there's some SWR on the line. If we tried to make a table showing every possible length of coax we would run out of space in a hurry, so we'll show only the quarter-wavelength-aparts points. And since all the even wavelengths can be subtracted without changing things, this means we need only show the 0, ¼, ½, and ¾ wavelength positions along the line. The table appears in Fig. 4.

In Fig. 4, the first figure in each of the impedance entries is pure resistance, while the second is reactance (which must be tuned out by our pi-net). Following the normal convention, capacative reactance is shown as nega-

LINE LENGTH SWR Value	0	1/4	1/2	3/4
1.0	50± 0	50± 0	50± 0	50± 0
1.2	60± 0	49+ 9	41± 0	48− 9
1.5	75± 0	42+19	33± 0	42−19
2.0	100± 0	40+30	25± 0	40−30

FIGURE 4. Input impedance of coax as function of line length and SWR on feedline. See text for details.

LINE LENGTH SWR Value	0	1/4	1/2	3/4
1.0	-26.5	-26.5	-26.5	-26.5
1.2	-28.4	-35.2	-24.8	-17.2
1.5	-31.1	-44.0	-23.7	- 6.0
2.0	-35.3	-54.7	-22.2	+ 5.3

FIGURE 5. Reactance in ohms of C2 for example cited in text with variations in SWR and in length of feedline; reactive component of coax input impedance is ignored.

tive while inductive becomes positive.

You can see that with an SWR of 1.0, the impedance looking into the coax is 50 ± 0 regardless of line length. You knew this anyway.

But with an SWR of just 1.2, the impedance varies from 60 ± 0 at the 0-wavelength position through 48 − 9 at ¼ wavelength back to 41½ ± 0 at ½ wevelength, then through 48 + 9 at the ¾-wavelength point before returning to 60 ± 0.

This, of course, means that now our pi-net has to cancel out the reactance as well as matching the resistances. To find out where C2 should be set to accomplish this, let's subtract the reactance values in Fig. 4 from those given in Fig. 3 for the corresponding resistance values. Reactance values in Fig. 3 are all negative numbers, by the way. The result of all this arithmetic appears in Fig. 5, which gives the capacative reactance required in C2 to match the line at the various line lengths and SWR values we've been talking about.

All looks pretty cozy in Fig. 5, with one exception. Remember that negative reactance values are capacative, while positive values are inductive. Now look again at the reactance of C2 for a ¾-wavelength line with 2.0 SWR. How are we ever going to make C2 look like 5.3 ohms of inductance???

LINE LENGTH SWR Value	0	1/4	1/2	3/4
1.0	860	860	860	860
1.2	800	645	915	1320
1.5	730	516	958	3790
2.0	642	415	1040	***

FIGURE 6. Value of C2 in micromicrofarads at 7 megacycles for example in text; *** notes that no value of capacitance will satisfy the requirements—0.1225 microhenries of inductance are necessary in this case.

The answer, of course, is that we can't. The pi-net is being naughty. But as you have seen it's not the pi-net's fault at all.

And we're not through yet. Let's move on to Fig. 6, which presents the same thing as Fig. 5 except that now instead of ohms of reactance we're talking in terms of mmfd of capacitance, figured at 7 mc.

With a 1-to-1 SWR, all is well, and the pi-net will behave as billed. Ignoring the ¾-wavelength point, the pi-net w'll still load more or less with higher values of SWR, but the loading controls will be far from the book-stated positions. At ½ wavelength with 2.0 SWR, particularly, proper loading will happen at nearly full capacitance of C2.

LINE SWR	0	1/4	1/2	3/4
1.0	79	79	79	79
1.2	73	59	84	(1)
1.5	67	47	88	(2)
2.0	59	38	95	(3)

Notes: (1) Maximum C not enough
(2) Max C not near enough
(3) Impossible with Cap.

FIGURE 7. Setting of loading control in percentage of rotation, for example discussed in text. Note wide deviations.

To drive it home still more, move on to Fig. 7 (the last of our little charts). This shows approximate percentage of rotation of the loading capacitor, with 100 percent equal to maximum capacitance. It's figured for our 2500 ohm pi-net, the same as everything else we've talked about, and for 7 mc operation using a 3-gang BC variable for C2.

Now we find that if the coax happens to be ¾ wavelength long, the pi-net won't behave with any appreciable SWR at all. Even a "tiny" 1.2 SWR value will put the setting of C2 out of range of the variable.

And as we've said all the way through, it's not the fault of the pi-net. The trouble is in the antenna and the SWR.

So what can we do? At lower frequencies particularly it's almost impossible to keep SWR down to 1-to-1 over an entire band. In addition, the SWR may not be causing any other troubles at all.

One of the quickest ways to do something about it is to prune the line. This sounds horribly old-fashioned in view of all that's been published in the past few years to the effect that line pruning will not change SWR. It won't change the SWR, true, but it *will* change what the SWR does, most drastically.

Look back at Fig. 7 to see just how much difference a half-wave of line length can make. With SWR of 2.0, it's impossible to load the pi-net at a line length of ¾ wave; the same antenna loads more easily than with a 1.0 SWR at a line length of ¼ wave!

If your coax is too short to prune, get an extra half-wavelength and add it in; this will have the same effect.

If you want to be more scientific about it all you can add an antenna tuner between the transmitter and the feedline to make the SWR seen by your pi-net exactly 1.0. This will not only bring the loading control back to instruction-book settings but will guarantee you additional reduction of harmonics, always a good thing.

But either way, don't always blame the pi-net. Even if it appears at first glance to be naughty, frenquently it's not the culprit.

Case dismissed. . . . K5JKX

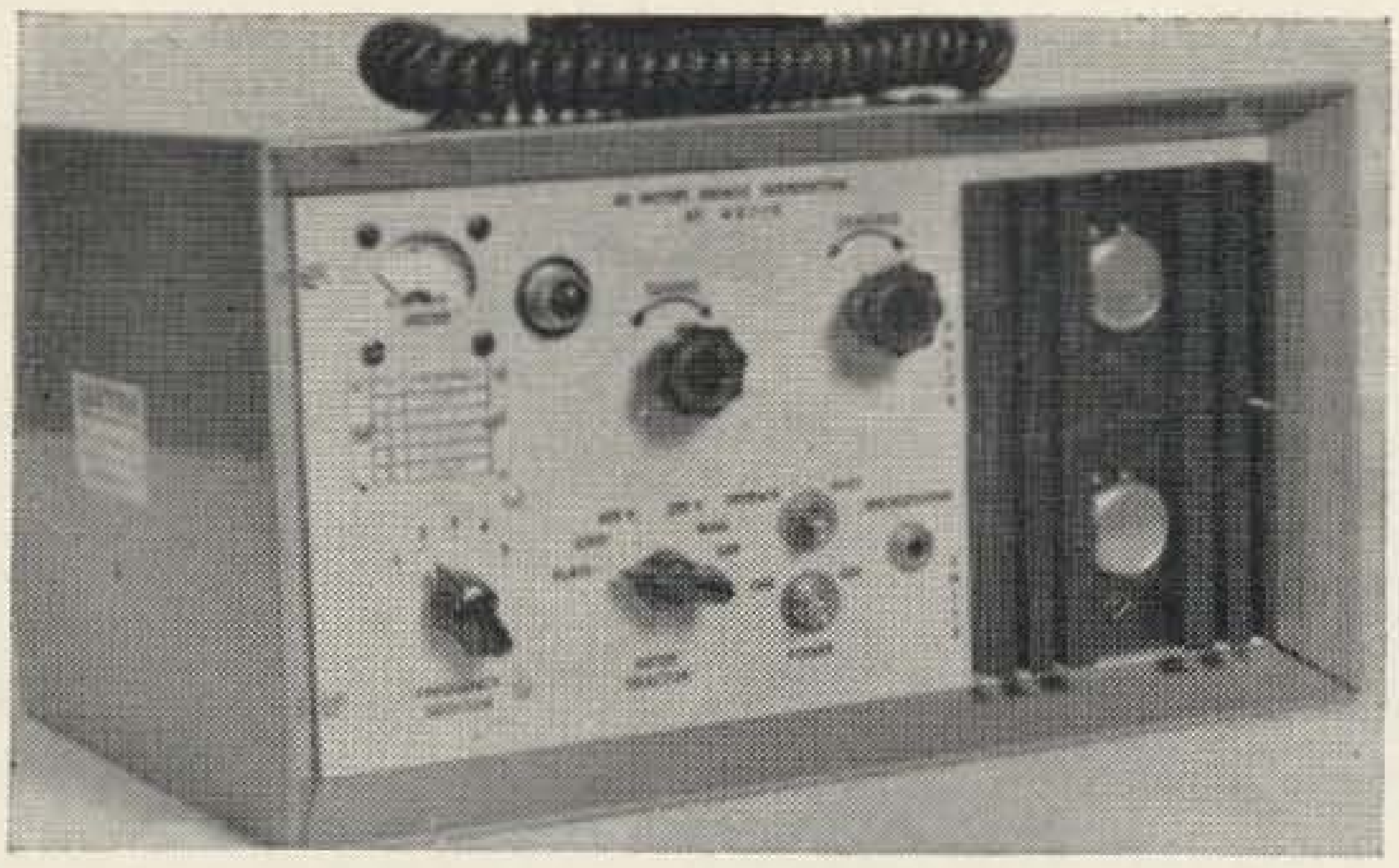
60 Watts on 75

Don Mathon VE1IC
Box 516
Middleton, N. S., Canada

For a long time I had planned building a transmitter which would include as many modern features as possible and which would have an appearance comparable to that of commerical equipment.

The first step in obtaining a commercial appearance was to choose a modern streamlined cabinet for the finished product. Searching through my catalogues, I discovered the Bud "Shadow Cabinet" line which seemed to fill the bill very nicely, so, number SB214D was ordered along with a chassis number AC424 to match.

Now that the cabinet and chassis had been decided upon, the circuit and accompanying features had to be designed. The idea of commercial quality was kept in mind throughthis design phase and for the sake of compactness and modern functional features, the modulator and power supply, both transistorized, were built-in. The schematic diagram seen in figure two is the result of much head scratching, slide rule heating and paper wasting.



Circuit Description

A few words of wisdom, explaining the theoretical operation of the transmitter, is a must in any article, so, here goes.

The rf section, consisting of an oscillator, a buffer/driver, an output tube and a PI network antenna coupling, will be discussed first.

The oscillator is a crystal controlled, modified Pierce type. This particular circuit was chosen and voltage regulation introduced with a view that, if it ever became desirable to operate this stage as a VFO, the changeover would be fairly simple and would not necessitate major changes in wiring. The crystal selector switch allows any one of five channels to be selected (more crystals may be used by having more contacts on the switch). The plate of the 6BA6 is broadly tuned to the center of the most used portion of the 75 meter band. The oscillator is capacitively coupled to the buffer/driver stage.

The rf choke in the grid circuit of the 5763 provides for a more efficient operation. The screen of this stage is connected to the B plus through a 50K 5W potentiometer which allows its voltage to be varied, thus allowing control on the grid current of the 6146. Again the plate of this stage is broadly tuned; the broad tuning in this and the last stage, eliminates two controls which would otherwise be on the front panel. Capacitive coupling is used again between this stage and the 6146.

An rf choke is also found in the grid circuit of the output stage and its purpose is the same as explained above. Extensive by-passing is used around the 6146 socket by connecting capacitors from pins 1, 2, 4, 6, and 7 to ground. This heavy by-passing prevents parasitic oscillation and the radiation of high frequency harmonics which would interfere with television. A certain amount of fixed bias is used on the grid in addition to the excitation bias as a safety measure to protect the 6146 in case of drive failure. This fixed bias also assures better linearity of modulation. The modulation is applied to both the plate and

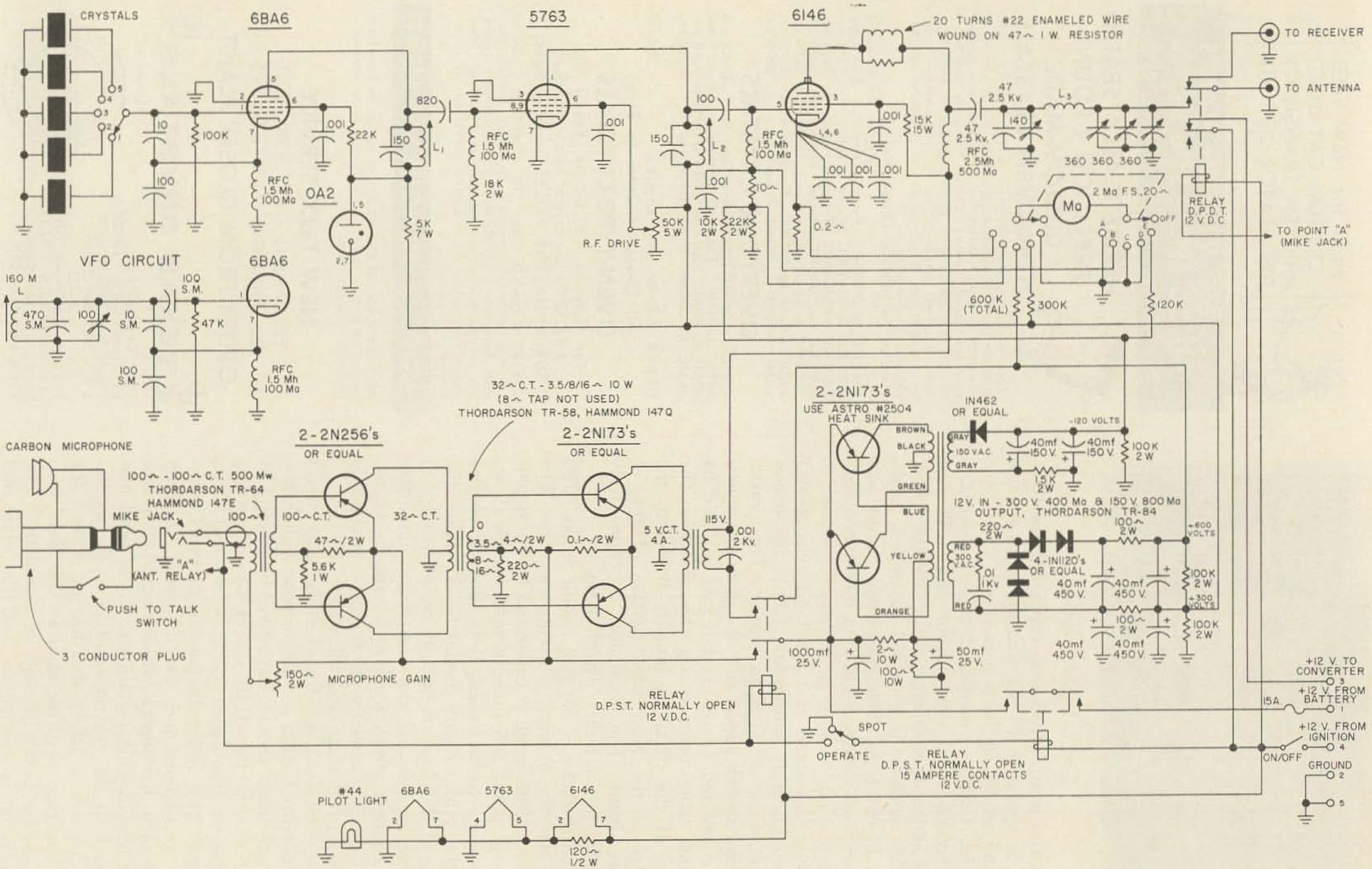

CRYSTALS
6BA6
5763
6146
20 TURNS #22 ENAMELED WIRE WOUND ON 47∼ 1 W. RESISTOR
TO RECEIVER
TO ANTENNA
100K
RFC 1.5 Mh 100 Ma
OA2
22 K
5K 7 W
820
150
RFC 1.5 Mh 100 Ma
18 K 2 W
.001
R.F. DRIVE
50K 5 W
10K 2W
22K 2 W
10∼
0.2∼
15K 15W
47 2.5 Kv.
140
RFC 2.5Mh 500 Ma
360 360 360
2 Ma F.S. 20∼
OFF
RELAY D.P.D.T. 12 V. D.C.
TO POINT "A" (MIKE JACK)
VFO CIRCUIT
6BA6
160 M
470 S.M.
100
10 S.M.
100 S.M.
47 K
RFC 1.5 Mh 100 Ma
600 K (TOTAL)
300K
120K
32∼ C.T. - 3.5/8/16∼ 10 W (8∼ TAP NOT USED) THORDARSON TR-58, HAMMOND 147Q
2-2N256's OR EQUAL
2-2N173's OR EQUAL
2-2N173's USE ASTRO #2504 HEAT SINK
1N462 OR EQUAL
-120 VOLTS
40mf 150 V.
100K 2 W
1.5K 2 W
CARBON MICROPHONE
100∼ - 100∼ C.T. 500 Mw THORDARSON TR-64 HAMMOND 147E
MIKE JACK
"A" (ANT. RELAY)
PUSH TO TALK SWITCH
3 CONDUCTOR PLUG
100∼ C.T.
32∼ C.T.
47∼/2 W
5.6 K 1 W
4∼/2 W
0.1∼/2 W
220∼ 2 W
5 V.C.T. 4 A.
115 V.
.001 2 Kv.
150∼ 2 W
MICROPHONE GAIN
BROWN
BLACK
GRAY
150 V.A.C.
GREEN
BLUE
YELLOW
ORANGE
RED
300 V.A.C.
12 V. IN - 300 V. 400 Ma & 150 V. 800 Ma OUTPUT, THORDARSON TR-84
220∼ 2 W
100∼ 2 W
+600 VOLTS
+300 VOLTS
4-1N1120's OR EQUAL
.01 1 Kv
40 mf 450 V.
100K 2 W
100∼ 2 W
1000 mf 25 V.
2∼ 10 W
100∼ 10 W
50 mf 25 V.
RELAY D.P.S.T. NORMALLY OPEN 12 V.D.C.
SPOT
OPERATE
RELAY D.P.S.T. NORMALLY OPEN 15 AMPERE CONTACTS 12 V.D.C.
+12 V. TO CONVERTER
+12 V. FROM BATTERY
15A
+12 V. FROM IGNITION
ON/OFF
GROUND
#44 PILOT LIGHT
120∼ 1/2 W

FIGURE 1

screen of the 6146 also to obtain better quality of audio. The plate of the output stage is coupled to the PI network. This type of output network is used to provide better efficiency and eliminate TVI problems.

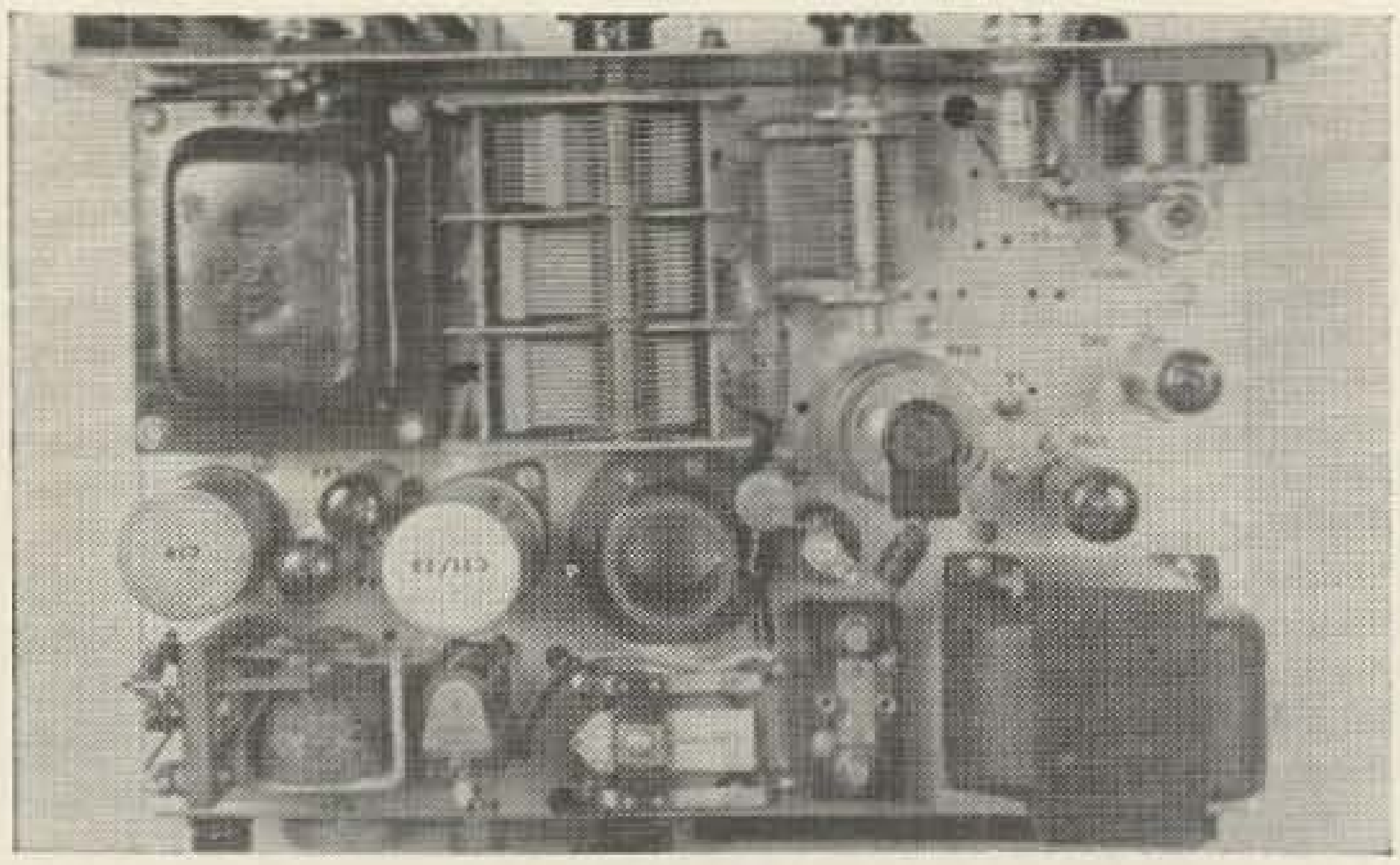
The front panel meter serves a twofold purpose; it is used first as an ammeter to measure the plate and grid current of the 6146 and, second, as a voltmeter to measure the output of the power supply (600V., 300V. and −120V). The shunt and multiplier values were chosen so that, when all voltages and currents are correct, the pointer will rest within a red portion painted at mid-scale on the face of the meter.

The mike gain potentiometer controls the voltage applied on the carbon microphone, thus effectively controlling the amount of audio applied to the bases of the 2N256s. Their collectors drive the bases of the 2N173 modulators and, in turn, the modulators apply the audio to the 6146. Both stages of the modulator use transistors in push-pull biased by resistor networks in such a way that only a very slight amount of current will flow through the transistors when no audio is being applied. This small bias will prevent cross-over distortion from being produced in the audio system. The .1 ohm resistor prevents current run-away of the modulators while the .001 condenser effectively limits the high frequency response of the audio system as well as absorbing any high voltage transients which might be harmful to the modulator transistors.

The power supply is the ordinary run-of-the-mill multivibrator type with feedback being provided by a winding on the transformer. The high voltage secondary makes use of a voltage doubler rectifier circuit so that a 300 volt winding may provide both 600 and 300 volt dc. The −120 volt bias is provided by a separate 150 volt winding which is rectified by a 1N462 silicon diode and filtered. Resistors provide a bias on the base of the power supply transistors which assures instant start when power is applied.

The control circuits are a little unorthodox in their designs; they will prevent operation of any part of the transmitter when the ignition switch of the car is off and they will

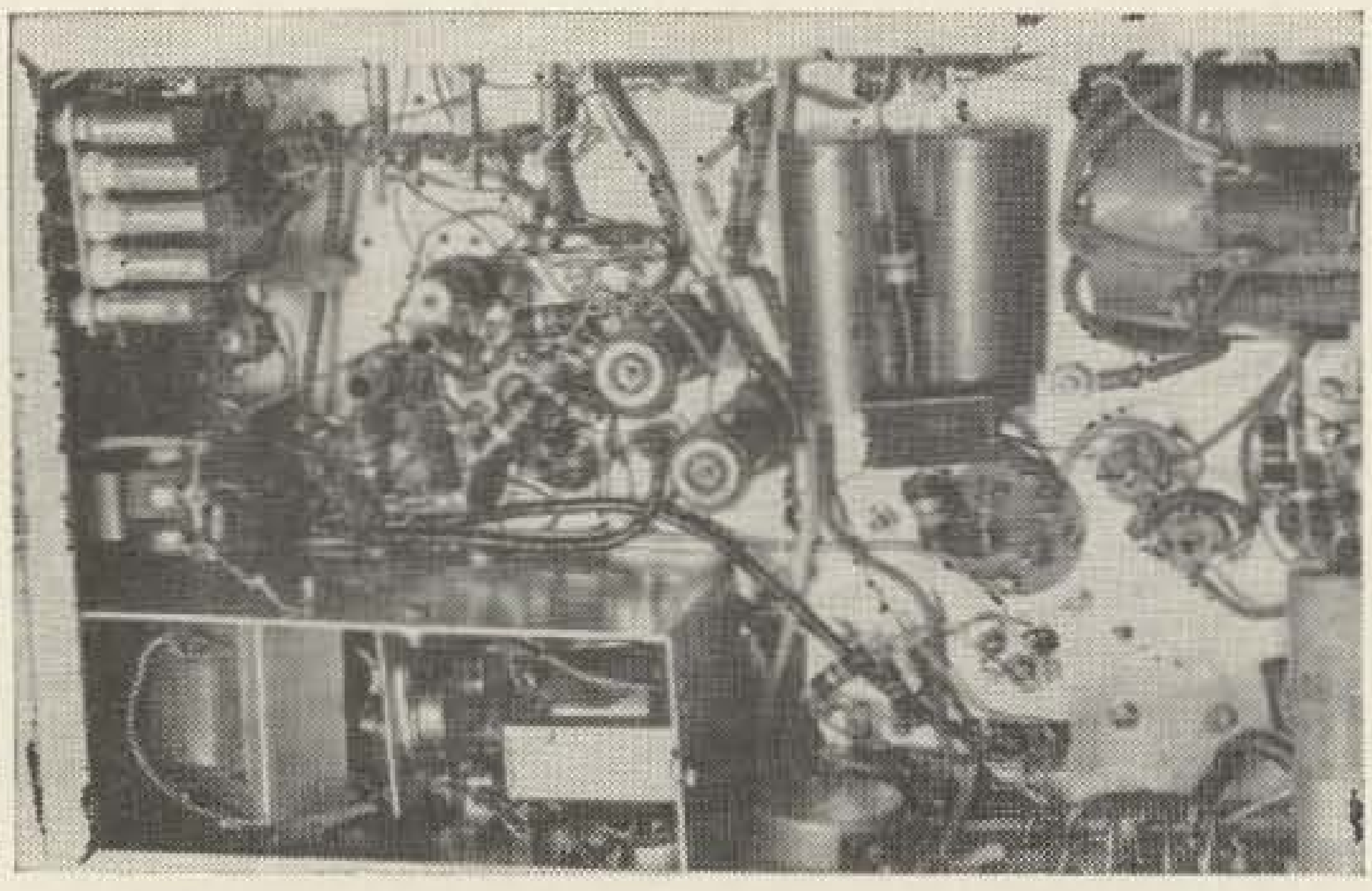
Coil Data, Fig. 1
L, L1, L2: 46 turns #27 enam wire on 1/4" dia. slug tuned coil form. Two layers of 23 turns closewound.
L3: 35 turns #18 enam on bakelite 1 3/8" form, 1 1/2" long close wound.



Top view. Power transformer lower right, transistors on front panel. Modulation transformer upper left. The two 6X4 rectifiers have been replacd with silicons. Modulator transistors are mounted on rear apron.

allow spotting to be carried out without putting a signal on the air. Plus 12 volts is brought in from the accessory terminal on the ignition switch to pin 4 of the power plug, from there, through the on/off switch, it is used to feed the filaments, the power relay and, through the relay, the transistorized convertor used here in conjunction with the transmitter. Another 12 volt line is brought directly from the car battery to pin 1 of the power connector and from there goes to the contacts of the power relay through a fuse. It can be seen from the diagram that when this relay is energized, it provides power to the other two relays, to the modulator and to the power supply. If the spot/operate switch is in the spot position only the power supply receives 12 volts from the power relay, the modulator is off, the 600V does not reach the 6146 and the antenna and 12 volts dc is still connected to the converter. The oscillator and buffer/driver stages are both on at the same time as the converter, thus allowing spotting.

For those who may want to build the oscillator stage as a VFO rather than crystal controlled, a diagram is included giving all the necessary information and parts values.



Bottom view. Gain control at mid-top, modulator at top right, drive control mid-right.

Construction

When all holes have been punched on the chassis and all components have been mounted in position, the actual wiring is started.

The first part to be wired is the modulator sub-assembly. All components are mounted on the shield/bracket and all connections soldered. When all wiring is done and rechecked on the shield/bracket, it should be mounted in position and the final connections made to the modulator transistors and to the audio gain control.

The filaments and control circuits are wired next. This wiring should be routed along the edges of the chassis and around the modulator shield or, directly in the center of the chassis from front to back.

The power supply section wiring comes next. Care should be taken when connecting the feedback winding of the transformer and the color code of the leads should be observed as per the instructions which come with the transformer. If the feedback winding is reversed the power supply will not operate and it may damage the transistors.

The rf section is the last to be wired. All wires in this section should be kept as short and as direct as possible and, to this effect, extensive use is made of terminal strips and ground lugs. The bracket holding the crystal sockets is the last component to be mounted and for easier access, all wires from the crystal switch to the crystal sockets are soldered before the bracket is mounted to the chassis.

The heat sink for the two modulator transistors is made from a small piece of 16 gauge copper. The base of the sink is bent in a U shape. The fins, which are also bent in a U shape, are soldered in position and then the holes for mounting the transistors are drilled. The heat sinks for the power supply transistors are purchased commercially because they have to dissipate considerably more heat and also look better on the front panel. The shield/bracket for the modulator is made from 16 gauge aluminum bent in J shape with ⅜" lips bent outwardly from the shield at the bottom and at both ends. This shield measures 5⅝" long by 2½" wide by 2¾" high. Transistors Q1 and Q2 are mounted on a small piece of 16 gauge aluminum fastened to the center of the shield/bracket.

Testing and Alignment

Connect rig to 12 volts and check filaments. With the spot/operate switch in the spot position when the microphone push-to-talk switch is depressed the power supply should start operating immediately and a high pitch hum should be heard.

Make a voltage check with a VTVM or VOM at the output of the power supply (600V, 300V and −120V). The voltages should also check on the front panel meter.

Adjust the slug of coil L1 for maximum grid bias on the 5763. The slug of coil L2 is then adjusted also for maximum bias on the 6146 and the drive control is advanced slowly until the grid current of the 6146 reaches 3 ma as indicated on the front panel meter. A VTVM is necessary for the measurements of grid bias to provide an accurate adjustment of L1 and L2.

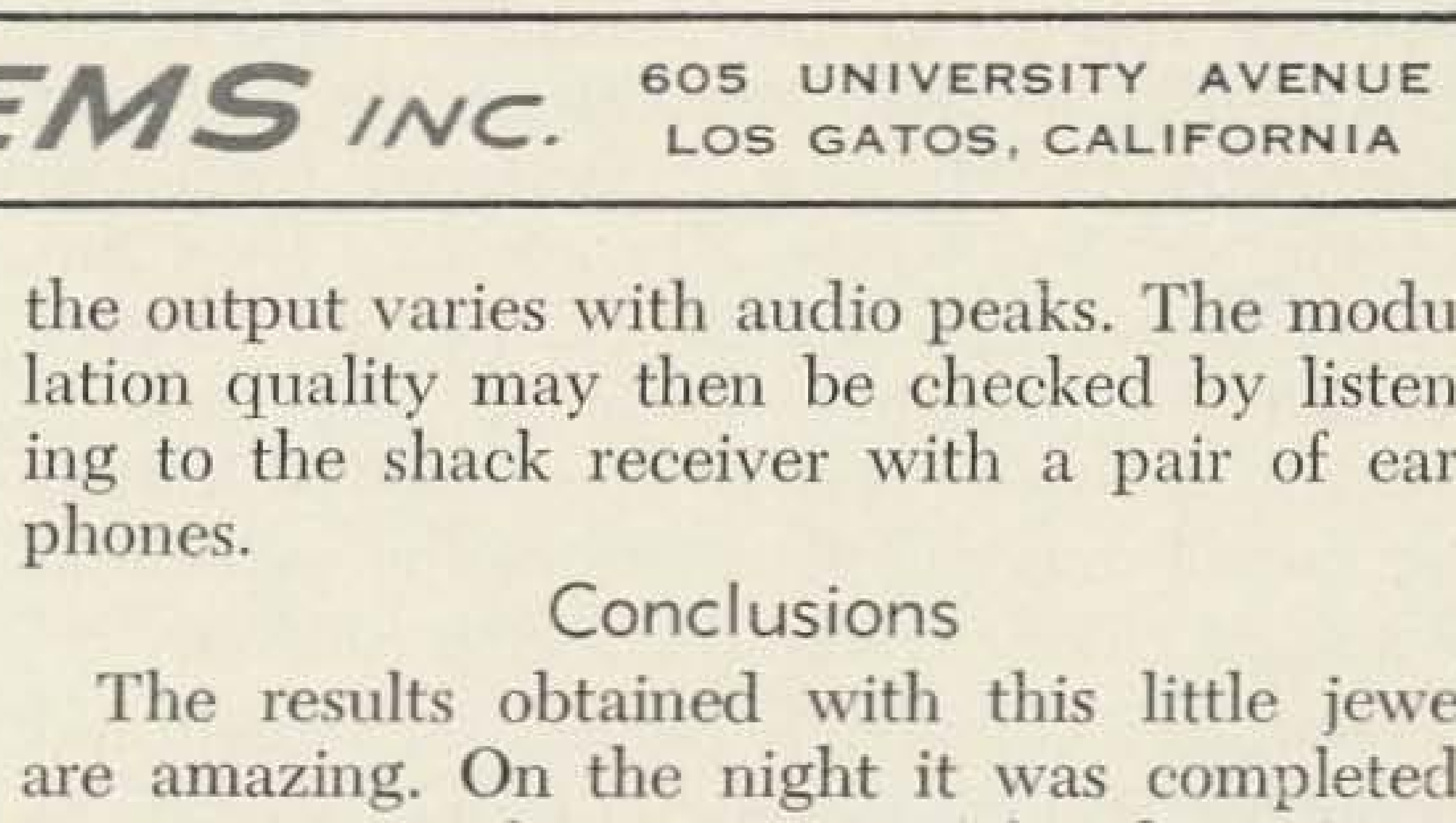
Place the spot/operate switch to the operate position, connect a dummy load (60 watts light bulb) to the antenna jack. Depress the PTT switch and proceed loading the 6146 in the usual manner. The light bulb should glow near normal brilliance when the plate current reaches approximately 100 ma on the front panel meter. The drive control is then readjusted for a reading of 3 ma.

Press the PTT switch and, while speaking into the microphone, advance the gain control slowly until the brilliance of the light bulb in the output varies with audio peaks. The modulation quality may then be checked by listening to the shack receiver with a pair of earphones.

Conclusions

The results obtained with this little jewel are amazing. On the night it was completed, using a piece of wire some 15 feet long (most of it was lying on the basement floor) as an antenna, I got a 5 by 7 report from a station 150 miles away when all I was looking for was a report from a local station on my audio. When connected in the car to the whip antenna, the results were also excellent and lived up to my most exacting expectations.

. . . VE1IC



Push Button Control

Dale Cockle K5JIC/1
50 Barrett Street
Needham 92, Mass.

How would you like your transmitter control circuitry to be controlled by a single pushbutton? Push the button and, presto, B plus, plus it again, and back to standby. How would you like your transmitter control circuitry to automatically prevent reapplication of B plus through those cold mercury vapor rectifier tubes upon resumption of power after a power failure or blown fuse? How would you like this same circuitry to mute the receiver and switch the antenna relay automatically just before the B plus is applied to the transmitter, and to reactivate the receiver and release the antenna relay after the B plus is removed from the transmitter? I reiterate, all controlled by a single pushbutton; push it once to go from receive condition to transmit condition, and push it again to return to receive condition. All this is just one of many applications of the sequential switching circuit whose discussion follows.

First, let's completely discuss the circuit and its output options in general terms in order to give the experimenters the whole story to enable them to dream up their own applications, and for general edification.

Fig. 1a. is a functional diagram of the circuit. The capacitor looking double parallel lines indicate normally open contacts, and the single lines are normally closed contacts. The identifying letters indicate on which switch or relay the contacts are "built" (the prime notation on an identifying letter also indicates normally closed contacts). In this circuit the S and S' indicate contacts on the pushbutton, the R_1 and R_1' indicate contacts on Ry1, and R_2 indicates contacts on Ry 2. Fig. 1b. is the schematic representation of the same circuit. Fig. 1 indicates no contacts associated with controlling the load's power loop. These contacts merit special mention which is made further along in the article.

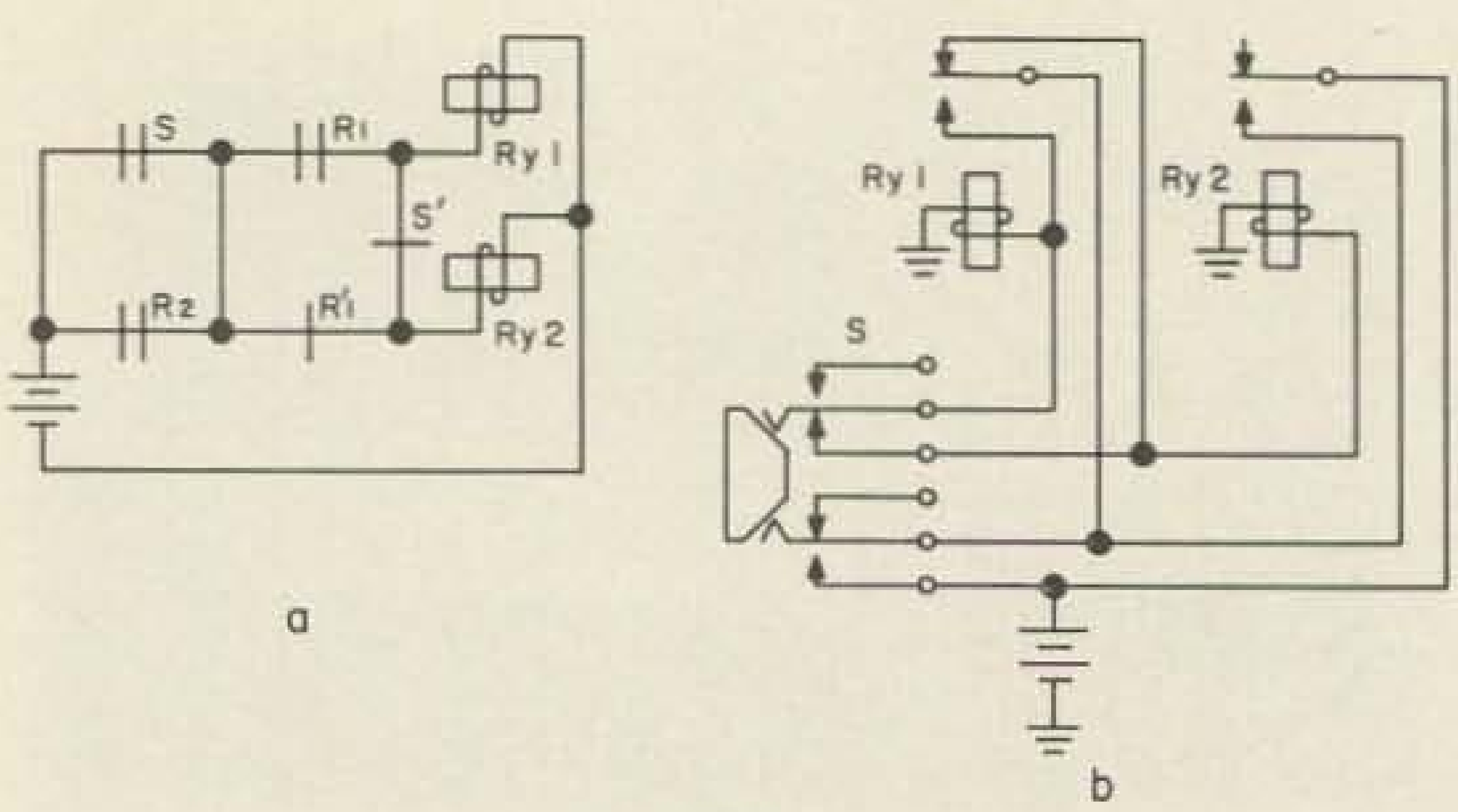


FIGURE 1

A study of chart 1 tells us what happens in Fig. 1 as we operate and release S. Each condition has been assigned a step number to which future references will be made.

CHART 1

Step #	S Operated	S Released	Ry 1 Operated	Ry 1 Released	Ry 2 Operated	Ry 2 Released
1		X		X		X
2	X			X	X	
3		X	X		X	
4	X		X			X
5		X		X		X

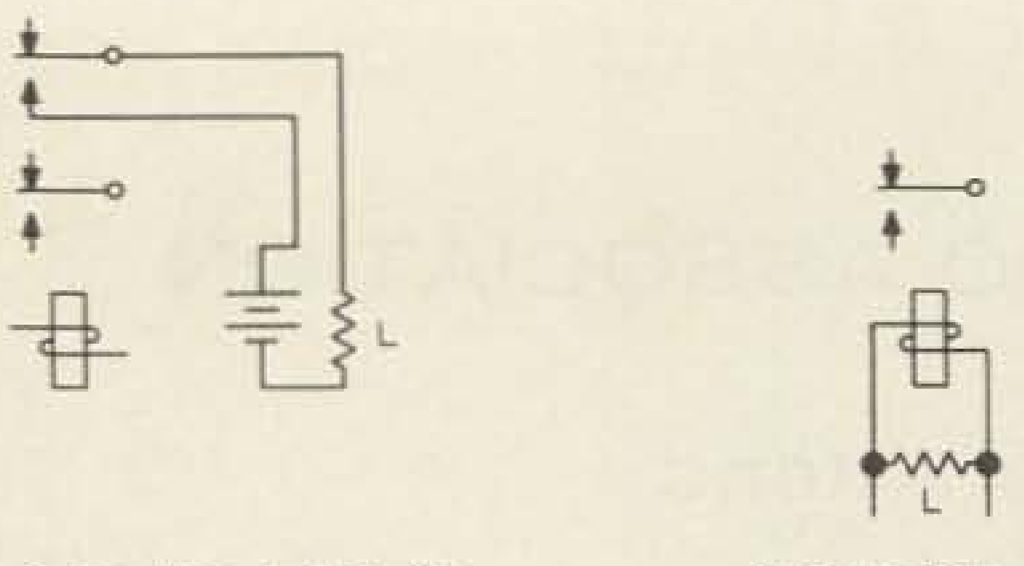
Step 1 is the off condition (and the initial condition taken upon availability of power to operate the circuit).

Step 2 occurs when S is depressed during a step 1 period. Ry 2 becomes activated during step 2.

Step 3 occurs when S is released during a step 2 period. Ry 1 operates during step 3.

Step 4 occurs when S is depressed during a step 3 period. Ry 2 releases during step 4.

Step 5 occurs when S is released during a step 4 period. Ry 1 releases during step 5. Actually steps 1 and 5 are identical if we say that step one is the condition achieved upon availability of power to operate the circuit or condition achieved upon release of S during a step 4 period.



Ry 2 For Step 2 & 3 ON
Ry 1 For Step 3 & 4 ON
a

Ry 2 For Step 2 & 3 ON
Ry 1 For Step 3 & 4 ON
b

FIGURE 2

Now we can talk about controlling power to a load. There are seven possibilities with respect to ON periods assuming that steps 1 and 5 are OFF periods. The seven possibilities are:

1) Steps 2 and 3
2) Steps 3 and 4
3) Steps 2, 3 and 4
4) Step 3
5) Step 2
6) Step 4
7) Steps 2 and 4

Below is discussed each of the seven possibilities in order of simplicity. Although some of the possibilities may not seem important to most of us, they merit mention at least to mention the versatility of such circuits and to furnish more food for thought to the homebrewers and tinkerers who follow this publication for new ideas.

The simplest outputs to achieve occur during steps 2 and 3 and during steps 3 and 4. Chart 1 tells us that Ry 2 is operated during steps 2 and 3, and Ry 1 is operated during steps 3 and 4. Simply by using a set of normally open contacts on Ry 2 or Ry 1 in series with the load's power loop, the load can be turned on during steps 2 and 3 or during steps 3 and 4 respectively (see Fig. 2a). As an alternative, if the switching circuit's switch, relay contacts, and associated wiring can handle the load's power requirements, power for the load may be taken from across the relay winding (s) (see Fig. 2b.).

To attain outputs during steps 2, 3 and 4 we must, as the logic circuit engineers would say, "OR" Ry 1 and Ry 2. This means that we attain an output if Ry 1 and/or Ry 2 is operated. To accomplish this we need a set of normally open contacts on Ry 1 and Ry 2 connected in parallel. This contact arrangement, in series with the load's power loop, will turn the load ON during steps 2, 3 and 4 (see Fig. 3).

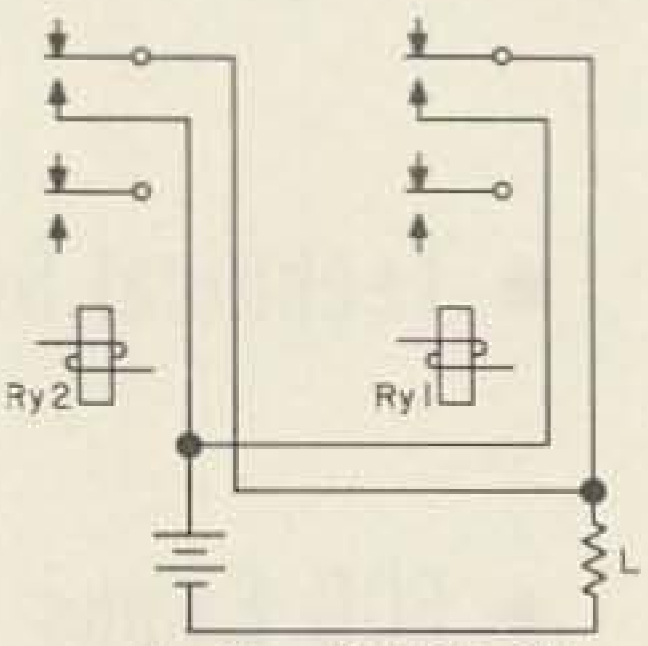
If we desire an output only during step 3 we must, as the logic term "AND" implies, place a set of normally open contacts on Ry 1 *and* Ry 2 in series. This combination of contacts, in series with the load's power loop will result in the load being ON only during step 3 (see Fig. 4).

For output only during step 2, or only during step 4, requires a normally closed set of contacts on one relay in series with a normally open set of contacts on the other relay, this combination in series with the load's power loop. To attain output only during step 2, the normally open contacts are on Ry 2 and the normally closed contacts are on Ry 1. The converse holds for output only during step 4 (see Fig. 5).

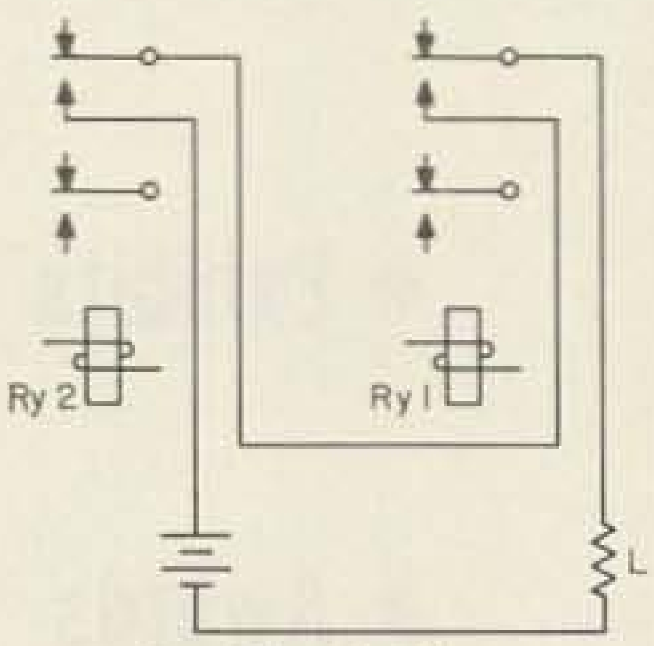
To attain output only during steps 2 and 4 is the most complex of the seven possibilities. A transfer set, commonly called double throw contacts, is required on each relay. The normally OFF sides of each are connected to the normally ON sides of the other. The common contacts of each are the two terminals used in putting this contact combination in series with the load's power loop (see Fig. 6).

Naturally, more than one of the seven possibilities can be "built up" on the two relays. The transmitter control example at the beginning of this article is a case where we want the B plus ON during step 3, and the antenna relay operated and receiver muted during steps 2, 3 and 4.

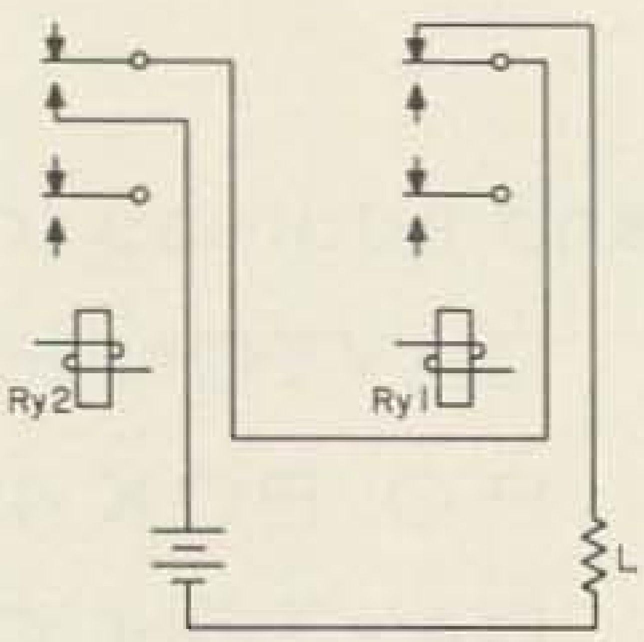
If you cannot come up with a pushbutton from your junkbox with the necessary contact arrangement, you may use a relay with the necessary contacts in lieu of the pushbutton (S) and use a simple doorbell type pushbutton to operate the relay. This configuration also permits control from more than one location by putting additional pushbuttons in parallel



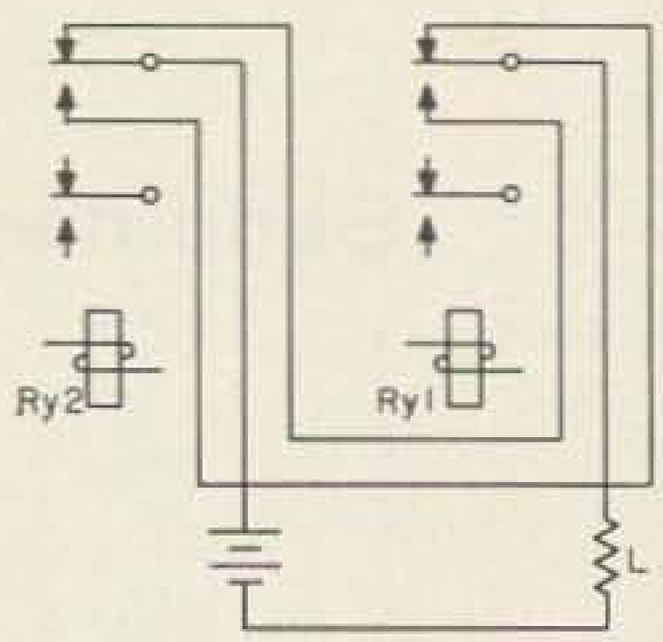
For Steps 2,3 & 4 ON
FIGURE 3



For Step 3 ON
FIGURE 4



For Step 2 ON
(Reverse Ry 2 And Ry 1 Contacts In Load Loop For Step 4 ON.)
FIGURE 5



For Steps 2 & 4 ON
FIGURE 6

with the first (or the push-to-talk control on the transmitter mike that wouldn't have to be held down during the transmission).

At this point you may be asking yourself, "Why doesn't that guy go out and buy a multi-position relay?" Well, I do the most with what's in my junkbox before spending a cent.

A word of caution: make sure that the contacts on the switch and relay contacts can carry the current and have necessary insulation from adjacent contacts in your application of any sequential switching circuit.

There it is fellows, a sequential switching circuit that has many uses around the shack. Have fun with it and let our honorable editor or me know if you want some more info on more complex (and more versatile) sequential switching circuits. One I'd like to do for this publication is "Dial-A-Tenna"; using a telephone dial mechanism to select an antenna. How about it?

Armed Forces Day: May 16

Here's your once a year opportunity to get a QSL from a non-ham station and to get a certificate for copying a message at 25 wpm. An RTTY message will be sent too for the RTTY gang. General contacts will be made from WAR/NSS/AIR in D. C. from 161400 to 170245 GMT. NPG in San Francisco from 161800 to 170800 GMT. WAR: 4001.5 CW, 4020 AM, 6992.5 CW, 7325 CW to phone, 14405 SSB. NSS: 3365 CW (working 3.5-3.65 mc), 4015 CW (working 3.65-3.8 mc), 6970 CW (working 7.0-7.1 mc), 7301 CW (working 7.1-7.2 mc), 4040 AM (working 75 & 40M), 14385 SSB, 4012.5 RTTY, 7380 RTTY, 14480 RTTY. NPG: 3357 CW (working 3.5-3.65 mc), 4005 CW (working 3.65-3.8 mc), 6835 CW (working 7.0-7.1 mc), 7301.5 CW (working 7.1-7.2 mc), 13920 CW, 4045 AM, 13975.5 SSB, 4001.5 RTTY, 7375 RTTY, AIR: 3397.5 CW, 6997.5 CW, 13995 CW, 20994 CW, 7305 SSB, 14397 SSB, 7332 RTTY.

The CW receiving contest is at 170300 GMT. WAR/NSS/AIR on 3347, 3385, 4015, 5200, 6970, 6992.5, 7301, 7680, 13995, 14405. A6USA San Francisco on 6997.5. NPG San Francisco on 4005, 7301.5, 13920. AG6AA California on 7832.5.

The RTTY receiving contest is at 170335 GMT. WAR/NSS/AIR on 14480, 3347, 4012.5, 6992.5, 7305, 7380, 14405. A5USA in Texas on 4025. AG4AA in Texas on 4455. A6USA in Calif. on 6997.5. A6GAA in Calif. on 7832.5 NPG in Calif. on 4001.5, 7455, 13895.

Send all logs as received to: Room 5B960, Pentagon, Wash., D. C. Include time, frequency, call sign of station copied, your name, call, and address on page containing text.

Waveguide Simplified

Jim Kyle K5JKX
1236 N.E. 44th St.
Oklahoma City, Okla.

With the present emphasis on UHF, the region of the future, many of us are scratching our heads in wonder at the strange types of circuit components we'll have to deal with. Not the least perplexing by any means is waveguide, the UHF man's answer to cable losses. How the dickens can a hollow pipe carry rf anywhere?

Few of the available reference books prove to be of any help, either, unless you happen to be an electrical engineer well versed in the solution of partial differential equations and highly familiar with Maxwell's equations—and in that case, you wouldn't have been asking anyway. Which leaves the rest of us in the dark.

At the risk of insulting the engineers among us, and quite possibly of oversimplifying things a bit here and there (although we'll try not to), we're taking this stab at explaining accurately just how waveguide works. Along the way, we'll examine the posibilities of making our own.

To start, though, we must point out a couple of ideas which are pretty well entrenched but are *not* how waveguide works. One of them starts out with the idea that rf reflects from a smooth conducting surface, and builds this up to the picture of myriads of reflections as the UHF wave bounces its way down the guide, reeling from side to side like a Saturday night celebrant. It's a credible enough visualization, with only one major flaw. It's false.

On the other hand, you may have imagined the evolution of waveguide as a sort of ultimate extension of the shorted quarter-wave line. You know of course that a shorted line reflects an open circuit at the unshorted end if happens to be a quarter wave long; it's a simple step from that to stacking millions of these shorted lines one on top of the other to form a U-shaped channel, then inverting an identical channel over the top to come up with a waveguide.

This one is closer to the truth but is still oversimplified to the point that it makes actual comprehension of waveguide mechanics difficult. Let's wipe both of these pictures out and start with a different tack. Let's go back to ordinary 80-meter antennas.

If you've read up any on the way an antenna works you may remember that any electromagnetic energy going anywhere, whether in a coax cable or in free space, is made up of two interlocked fields which are always at right angles to each other. One of these is called the electric or E field, while the other is the magnetic or M field. Like love and marriage (in the song at least) "you can't have one without the other."

The E field corresponds to a voltage potential, while the M field is the result of current flow. Now let's take a detailed look at the way these fields show up in ordinary ac, keeping in mind that while we'll talk about only one at a time, both are always present.

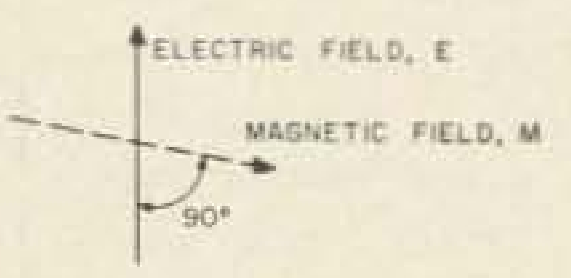


FIGURE 1

Relationships of E and M fields

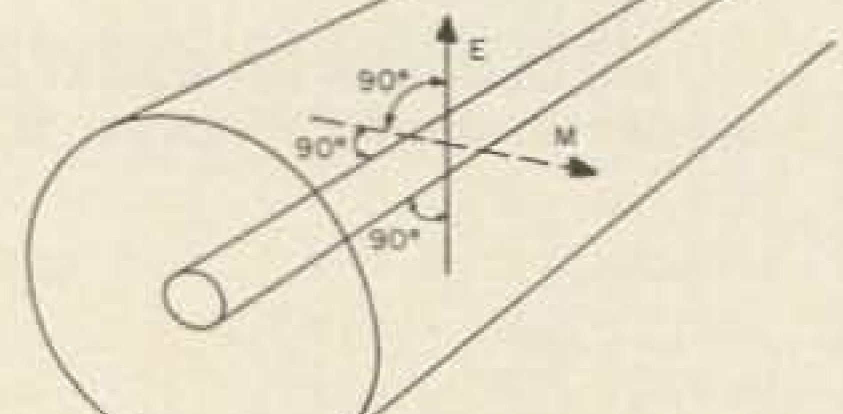


FIGURE 2

X-ray view inside coax showing field relationships

SERVICE TESTED EQUIPMENT from

HERE IS A PARTIAL LIST OF OUR QUALITY RECONDITIONED HAM GEAR, FULLY GUARANTEED, AND SHIPPED PREPAID WITHIN THE CONTINENTAL U. S. WITH CASH ORDERS.

Ameco Nuvistor 6Mtr Conv. 7-11Mc IF	$ 29.00
B & W 5100 W/51SB SSB Generator	279.00
CDR Ham-M Rotor	75.00
Central Electronics 20A SSB exciter & QT-1	119.00
Central Electronics GC-1 compression ampl.	38.00
Collins 32V1 Transmitter	129.00
Collins 32V2 Transmitter	159.00
Collins 310C VFO	79.00
Collins 75S1 Receiver	359.00
Collins 75S3 Receiver	579.00
Collins 32S1 Transmitter	459.00
Collins KWM2 Transceiver (near new)	849.50
Collins 62S1 6 & 2 Converter	695.00
Collins 312B4 Spkr. Console	149.00
Drake 2-A Receiver	199.00
Drake 2-B Receiver	219.00
Drake 2-BQ Q-Mult-Spkr	29.00
Elmac AF-67 Transmitter	59.00
Elmac AF-68 Transmitter	139.00
Elmac PMR-6A Receiver & DC Supply	39.50
Elmac PMR-7 Receiver	69.00
Elmac M-1070 Power supply	49.00
Gonset G66 Receiver W/3-way supply	79.00
Gonset G-66B Receiver W/3-way supply	89.00
Gonset G-77A Transmitter W/P.S./Mod.	99.50
Gonset Communicator II 6 Meters	109.00
Gonset Communicator III 6 Meters	159.00
Gonset Communicator IV 6 Meters	199.00
Gonset Communicator IV 2 Meters	239.00
Gonset G-76 DC Power Supply	69.00
Gonset G-76 Transceiver	219.00
Gonset GSB-100 Transmitter	239.00
Hallicrafters HA-4 Electronic Keyer	39.00
Hallicrafters HT-32A SSB Transmitter	399.00
Hallicrafters HT-32B (near new)	529.00
Hallicrafters HT-33 Linear Amplifier	325.00
Hallicrafters HT-37 SSB Transmitter	329.00
Hallicrafters HT-40K Transmitter (Brand new)	79.00
Hallicrafters SX-71 Receiver	89.00

Hallicrafters S-85 Receiver	59.00
Hallicrafters SX-99 Receiver	79.00
Hallicrafters SX-101A Receiver	229.00
Hallicrafters SX-111 Receiver	159.00
Hallicrafters SX-117 Receiver	295.00
Hammarlund HQ-100C Receiver	119.00
Hammarlund HQ-110C Receiver	139.00
Hammarlund HQ-170C Receiver	219.00
Hammarlund HQ-180C Receiver	319.00
Hammarlund HX-50 SSB Transmitter (Demo)	299.00
Heath VF-1 FVO	12.00
Heath DX-20 Transmitter	24.00
Heath DX-35 Transmitter	34.00
Heath DX-40 Transmitter	39.00
Heath DX-100 Transmitter	99.00
Heath Marauder SSB Transmitter	319.00
Heath Warrior 1 KW Linear (like new)	209.00
Johnson Adventurer Transmitter	29.00
Johnson Challenger Transmitter	59.00
Johnson 275W Matchbox	32.00
Johnson Ranger	119.00
Johnson Invader "2000" (near new)	795.00
Johnson Valiant Transmitter	219.00
Johnson Viking II Transmitter	99.00
Johnson Viking 500 Transmitter	375.00
Johnson Mobile	39.00
Johnson 6 N 2 Thunderbolt (near new)	475.00
Johnson 6 N 2 Transmitter	99.00
Johnson Pacemaker SSB Transmitter	199.00
National HRO-60 W/5 Coils. (Xlnt. Cond.)	279.00
National NC-173 Receiver	89.00
National NC-98 Receiver	79.00
National NC-270 Receiver (Brand new)	179.00
RME 6900 Receiver	219.00
RME DB-23 Preselector	27.00
Swan SW-140 40-Mtr Transceiver	159.00
Swan SW-175 75-Mtr Transceiver	169.00
Topaz DC supply	49.00
Swan Heath AC supply	39.00

"THE STORE OPERATED BY HAMS FOR HAMS"
K6LOS, K6GCD, K6DXD, K6EF, K1SFQ, K6HAA

MISSION HAM SUPPLIES

3316 Main Street
Riverside 3, California 92501
Phone 683-0523 (area code 714)

ORDER TODAY

Mission Ham Supplies
3316 Main Street, Riverside 3, Calif. 92501

Attn: Bill Hullquist, K6LOS Ship me the following:

____

____

$ .... enclosed. Cash orders prepaid within continental United States.

Name________________ Call________
PLEASE PRINT

Address________________________

City__________ Zone_____ State______

☐ Put me on your mailing list.

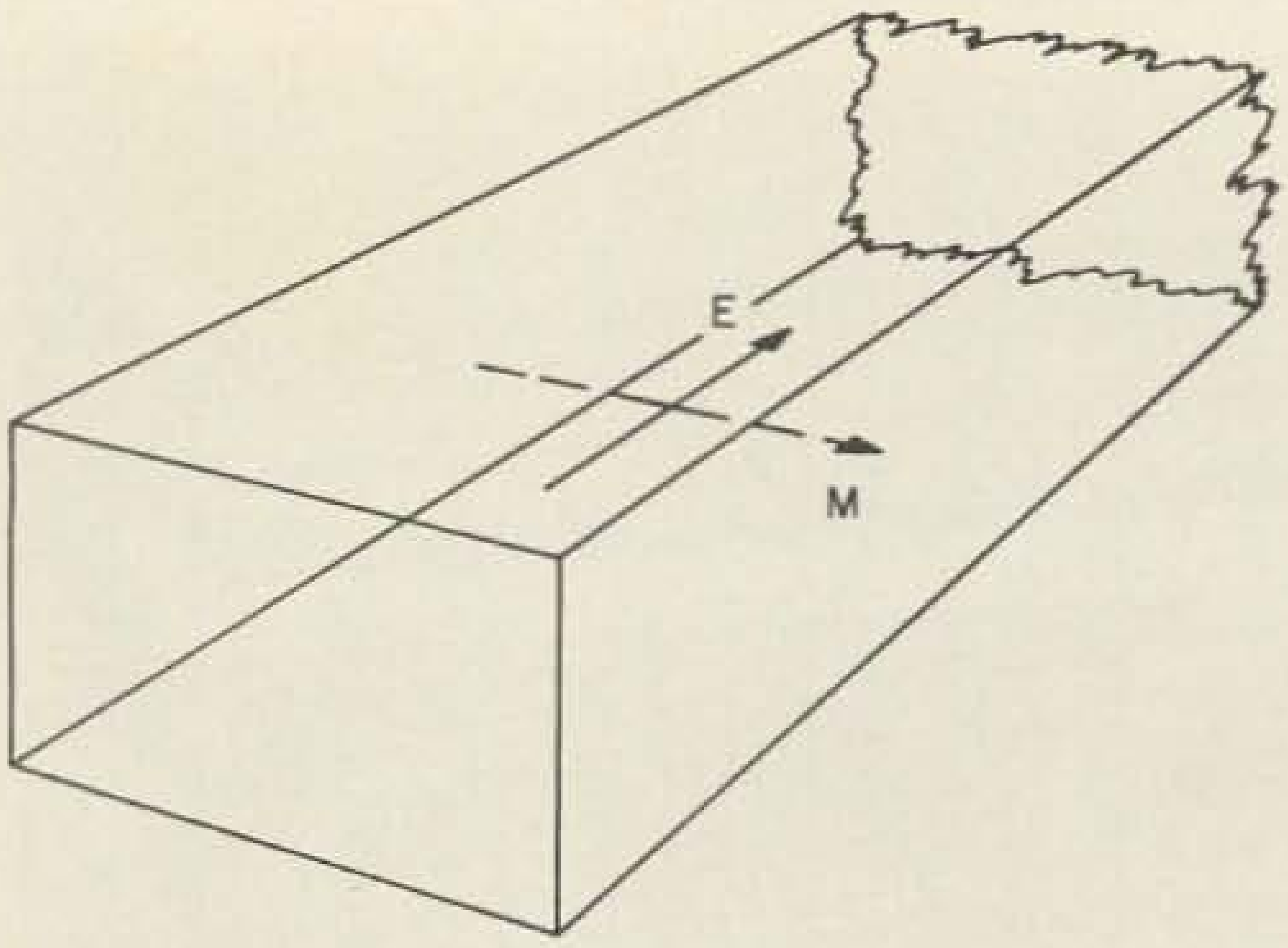


FIGURE 3
TM Wave in waveguide

By the definition of the animal, an alternating current is one which flows in one direction for a while, then reverses itself and flows back the other way. Quite naturally, the *voltage* connected with this current rises to a peak, drops back through zero, and reaches an opposite-polarity peak, following the same cycle.

And it's almost insulting to remind you that this doesn't happen simultaneously at every point along a wire—when the voltage, for example, is at a positive peak at point A, then a half-wavelength down the wire it's at a negative peak, and halfway between (or a quarter-wave away) it's at a value of zero.

All this, of course, is the basis of most of our present-day antenna theory. If we make a wire exactly half a wave long, we force the current to be nearly zero at each end. This in turn makes the voltage low and the current high near the center, and so we can feed the wire.

Let's refer to the zero points as nulls; then we can say accurately that in an ordinary wire carrying an alternating current we find a succession of peaks and nulls of both voltage and current, and that these nulls in particular are separated by a definite amount of space at any given instant.

Now let's go back and pick up the statement that an E field corresponds to a voltage potential while an M field results from current flow (it would be every bit as accurate to reverse cause and effect in this statement and say that an E field *causes* a voltage potential while an M field causes a current flow —isn't this precisely what happens in a receiving antenna?).

In an ordinary wire-line or two-wire system such as we're familiar with at lower frequencies, both the E and M fields associated with our electromagnetic energy are at right angles to the conductor at all times. If we represent the E field's direction of action by a solid arrow and the M field's direction by a dotted arrow, then Fig. 1 is a pictorial representation of the situation in free space while Fig. 2 shows us what goes on inside a coaxial cable, for instance.

And any time that both the fields are at right angles to the conductor while they're at right angles to each other as well (like the corner of a cube), the conventional concepts of voltage and current apply nicely.

However, let's assume that we launch our pair of fields into some space which is not quite free. To be specific, let's launch them into a confined space which extends indefinitely in one direction but which is surrounded in all other directions by a conducting surface. The inside of an infinitely long pipe would be one such example; to make things easier, though, let's visualize it as a rectangular pipe.

Now if the frequency of our wave happens to be such that any two nulls in *either* of the two fields can touch the conducting wall at the same instant, the wave will "lay over" so that the nulls involved do just that and will remain in that position. Fig. 3 shows what happens if a pair of the M-field nulls happen to coincide with the walls of the tube. The E-field now points down the direction of the axis of the tube, while the M-field is transverse (engineeringese for cross-wise), and the resulting configuration is known as a Transverse-M or simply TM wave.

A bit of simple arithmetic will show that the *lowest* frequency at which this can happen in a pipe of given size will be the one at which the two widest-spaced sides are just a half-wave apart, since nulls occur only once every half wavelength. However, there will be no upper limit! The second, third, fourth, fifth, etc., all the way to infinitieth harmonics of this frequency will also find the same happy circumstance that two of their nulls coincide with the walls of the guide. *This is what the books mean when they say that a waveguide has an infinite number of modes.* They do *not* mean that it will always support all of these modes at once.

We have just examined the TM wave; in exactly similar fashion, the nulls in the E-field can coincide with the walls, giving us a TE wave with the magnetic field projecting down the axis of the guide. This is diagrammed in Fig. 4.

The choice of whether you have a TE wave or a TM wave in a guide depends primarily upon how you feed the energy into the guide

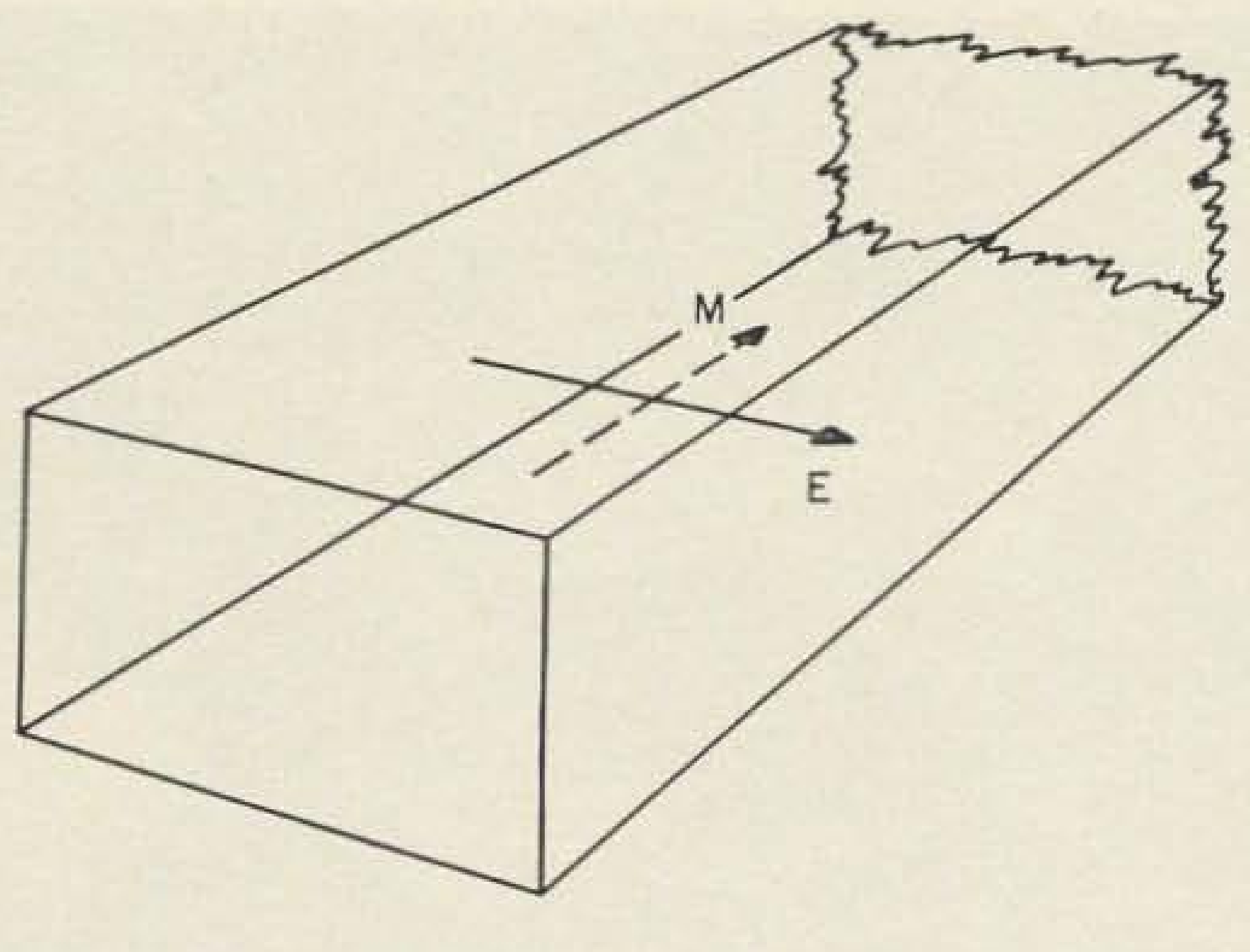


FIGURE 4
TE Wave in waveguide

in the first place, since it is obvious by the nature of the beast that any guide capable of supporting a TM mode will also support the corresponding TE mode.

If you couple in inductively, with a loop, after the fashion of a low-frequency coupling link, you will probably get TE waves. On the other hand, capacitive coupling with a probe is more likely to give you TM modes in the guide. Cavity coupling can give you either, depending on the position in both the cavity and guide where the coupling is made—but that's something a bit deep to get into right at this point.

One more point before we get into the question of do-it-yourself waveguide—and that's the effect of "discontinuities" in the guide.

Since the effective propagation of energy down a waveguide depends critically on the distance between two parallel walls of a rectangular guide (we'll get into circular guide later), it should be obvious that *any* variation in this distance will have some effect. Carried to extremes, this would indicate that variations in spacing of 0.000001 inch might be harmful —and if the frequency is high enough, they certainly would, since that distance might represent a quarter-wavelength!

For professional use, the dimensions are usually controlled to 0.001 inch. Larger variations will certainly introduce some reflections and subsequent losses, but it's difficult to say just where the line should be drawn for amateur use.

An important thing to remember, though, is that a *gradual* change of dimension is not nearly so harmful as an abrupt change. The abrupt change usually sets up a local standing-wave pattern (in microwave terminology, it "excites a number of higher-order modes") which results in bad SWR and excessive power loss throughout the system. Any dent, for instance, which you can see is probably too big!

Now to some practical material on our subject. As you have seen, a waveguide has no upper-frequency limit. However, by careful choice of guide dimensions, you make it easy to excite in only one mode and difficult to feed in any other—and this is the normal way the problem is handled.

If a rectangular guide is made wider than a half-wave, but less than a full wave in width, then only the dominant mode (the case where only two nulls exist in the transverse field, and both coincide with the guide wall) can be carried.

To avoid simultaneous excitation of another mode involving the top and bottom of the guide, the inside height of the guide is usually made approximately one half the width. This prevents any vertical mode from being supported.

The restrictions on width automatically mean that a guide of given size is normally used within only a 2-to-1 frequency range even though it can carry energy up to much higher frequencies. Additional considerations of attenuation and the possibility of accidental excitation of unwanted modes, with resulting undesired coupling out of the guide, make the actual restriction even narrower: maximum operating wavelength is usually taken as 1.65 times the inside width of the guide, while minimum wavelength is about 1.05 times inside width.

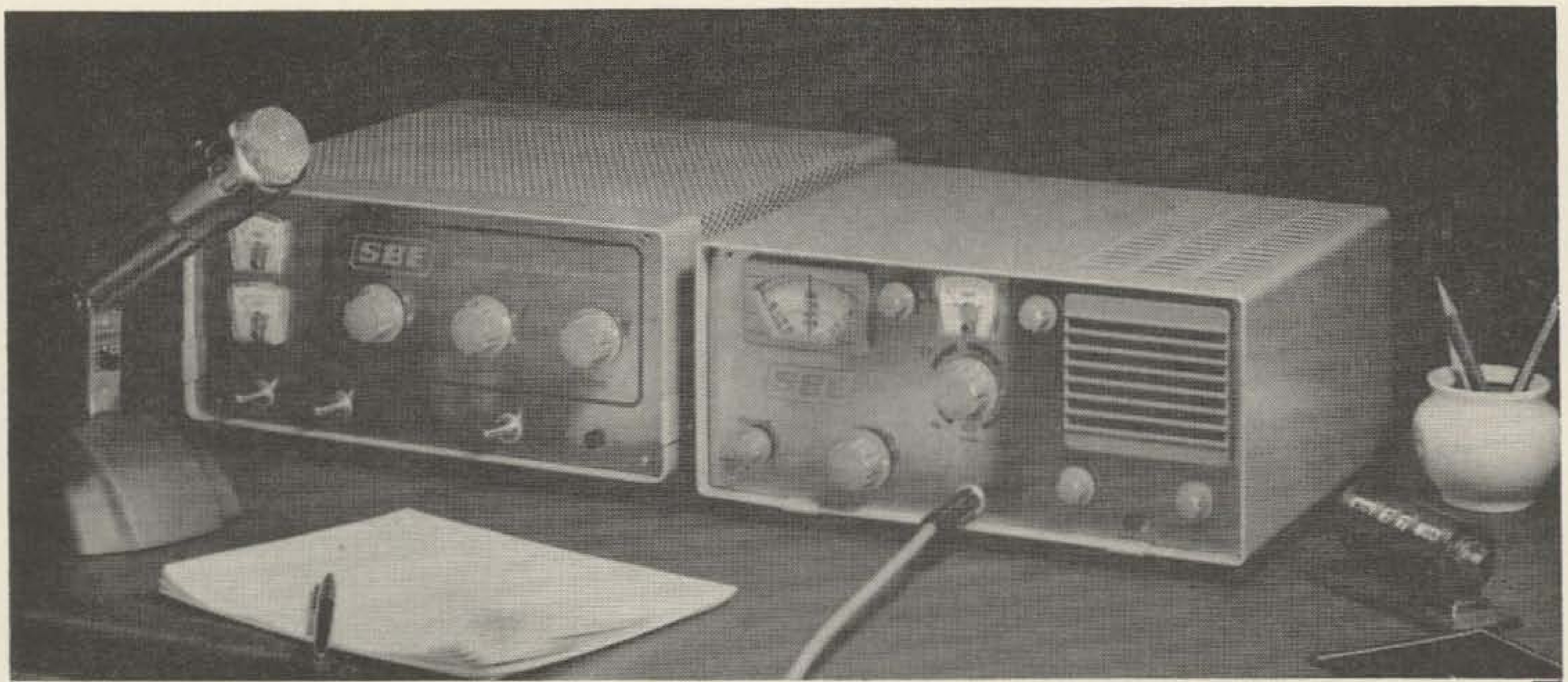
To put it into megacycles, a 1.338 inch high by 2.833 inch wide (inside dimensions of 1½x3 guide with 0.081 inch thick walls) is recommended for the frequency range 2,540 to 3,950 mc. For the next skip, from 2,540 to 6,000 mc, dimensions are 0.838 high by 1.838 wide (1x2 o.d.). The sometimes-obtainable ¾x1½ inch guide is used from 5,250 to 8,150 mc, while ½x1 inch guide covers 8,100 to 12,500 mc.

The RG-numbers for the guides described in the preceding paragraphs are, respectively, RG 48/U or 75/U; RG 49/U; RG 50/U; and RG 52/U or 67/U. RG 48 and 52 are brass, while 75 and 67 are aluminum.

So how about circular waveguide, as promised?

The exact description of how it works requires pages of complicated mathematics and so it will be skipped; in essence it amounts to the same thing.

In practice, rectangular guide is easier to work with. However, copper and brass pipe and tubing are somewhat more available to



Yes, OM: Don't you agree that "IT'S AMAZING" the way we at Burghardt's turn up one good deal after another—month in and month out. Our Ham Business was never better. We are far from being the biggest but we are sure mighty proud to be the best all around ham supplier in the business today. This month we've really put the prices through the meat grinder again. Just look for yourself and you'll see what we mean. If you haven't already done so, why not give us a try today?

73

Stan Burghardt WØBJV

THESE PRICES ARE CASH — NO TRADE

B&W 5100B/51SB AM/CW/SSB transmitter	$219
Collins KWS/1 KW transmitter, SSB 80-10 meters	595
Collins 351D2 KWM-2 mobile mount	49
Drake 1A receiver	139
Drake 2A receiver	169
Drake 2AC Crystal calibrator	10
Eico 760W factory wired CB transceiver, 117 vac, NEW	49
Elmac AF67 transmitter	69
Globe 755 VFO	29
Gonset G-66 receiver & 12v supply	59
Gonset G-66B receiver & 3 way supply	69
Gonset G-77 AM/CW transceiver & 3350 dc supply	229
Gonset GSB-100 SSB exciter	225
Gonset GSB-101 KW linear	179
Hallicrafters HA-2 2 meter transverter w/P-26 p.s.	275
Hallicrafters HA-8 splatter guard	15
Hallicrafters HT-32A SSB transmitter	329
Hallicrafters HT-37 transmitter	299
Hallicrafters S-76 receiver	69
Hallicrafters S-102 2 meter receiver	22
Hallicrafters S-119 receiver, NEW	29
Hallicrafters SR-150 transceiver w/P-150 ac, P-150 dc supplies and mobile mount	599
Hallicrafters SX-25 receiver w/speaker	49
Hallicrafters SX-101 Mark 3A receiver	189
Hallicrafters SX-111 receiver	149
Hallicrafters SX-140-K receiver kit, NEW	69
Heath HP-10 dc power supply	25
Johnson Valiant transmitter	189
Johnson Valiant II, transmitter, factory wired, exc unit	350
Johnson Ranger I transmitter	135
Johnson Viking I transmitter	59
Johnson Viking II transmitter	99
Johnson Viking Invader 2000	695
Johnson 250-38/250-39 SWR equipment	19
Johnson 250-39 TR switch	19
National NC-300 receiver w/speaker	179
National NC-300 converter cabinet w/6 & 2 meter converters	59
P & H LA-400-C linear amplifier	119
Swan SW-120 transceiver	139
Swan SW-175 transceiver	159

PACKAGE I

Gonset Mobile/Fixed Station
Gonset G-66B receiver
Gonset G-77A transmitter
Gonset 3 way supply

$179 cash

PACKAGE II

Elmac Mobile/Fixed Station
Elmac PMR-8 receiver
Elmac AF-68 transmitter
Elmac M-1070 3 way supply

$199 cash

PACKAGE III

National SSB Station
NCX-3 transceiver
NCX-A ac supply and speaker
NCX-D 12v dc and mounting rack
Originally $598.50

$449.00 cash

Prices are cash. All subject to price sale.

LOOKING FOR NEW GEAR? We feature all the really good ones. For instance CLEGG, COLLINS, DRAKE, HALLICRAFTERS, HAMMARLUND, HYGAIN, NATIONAL, SBE and SWAN. TRADES and TIME PAYMENTS? SURE BOTH! ASK for brochures, prices quotes on any of them. Also request our latest bulletin of top quality, fully reconditioned and guaranteed used gear.

AMERICA'S MOST RELIABLE DEALER

Burghardt RADIO SUPPLY Inc.

BOX 37A, WATERTOWN, SOUTH DAKOTA

PHONE
Area Code 605
886-5749

eager UHF experimenters than is surplus rectangular waveguide.

One major difference between circular and rectangular waveguide is that circular guide is recommended only for a narrow frequency range as compared to the rectangular version. The following chart lists the diameters of circular guide recommended for various frequencies:

Outside Diameter	Wall	Frequency Range (MC)
3 in.	0.065 in.	2750-3130
2⅝	.065	3130-3610
2¼	.065	3710-4230
2	.065	4170-4840
1¾	.065	4840-5500
1½	.042	5550-6380
1⅜	.065	6250-7230
1⅛	.032	7230-8330
1	.032	8330-9680
⅞	.035	9680-11,100

. . . K5JKX

New Ones from Old Ones

William English W5FUP
114 Little John Rd.
El Paso 24, Texas

In this age of the 22 tube super-sniffer receiver offering the near-ultimate in selectivity and sensitivity, many of our cohorts are overlooking the possibilities of some of the least expensive and most satisfactory communications receivers available today. These units are the older receivers currently available on the used equipment market for a nominal price. After all, it hasn't been too many years since the SX-25 was considered a prime piece of used gear and the HQ-129X and S-40 were the latest things out. Do you remember the Howard receivers? Many of these old ones still have much to offer.

Don't expect to be able to pick up an oldie but goodie, plug it in and be in competition with a new Brand X. It just ain't so. BUT, with a reasonable amount of effort and common sense, coupled with a few small parts, most of these old inhalers can be made to turn in a very creditable performance on 160 thru 10 as well as the general coverage bands. They also make excellent tuneable *if's* for converters.

The best procedure for utilizing these receivers is to put them in the best possible condition and then modify them to obtain the desired performance. There are advantages to this approach other than saving money. One of the most painless ways to learn the inner secrets of receivers is to work with them. This also provides a good outlet for those of us who like to build but don't have the time (or ambition) to start from scratch.

Also, don't overlook some of the choice surplus items still available. The same basic rules will apply except that most of the surplus units will require the construction of a power supply and a bit more work.

Now that you are properly inspired, choose your weapon. Remember, you can modify as little or as much as you wish. The newer the receiver, the less the work. Select a used receiver according to your pocketbook and how much work you are willing to do. You can usually purchase just about any post war model by mail. You must visit the store for older models. You may be able to get a bargain from an individual or from Joe's Junk Shop. Equipment advertised as reconditioned will usually be working reasonably well, but never is in the very best of condition. The stores are honest but they just can't afford to invest $30.00 worth of time in reconditioning an old receiver in order to sell it for $69.50. By visiting the store, you can frequently have your choice of several similar units on display. If possible, make sure the one you buy is working on all bands. How well it works is unimportant. Also do your best to obtain a schematic or instruction manual. If this is not available, the manufacturer can frequently supply one for a nominal fee.

Now the fun begins. First, clean up the beast. Blow out the dust with the XYL's vacuum clear and clean the chassis. Careful! Don't bend the tuning capacitor plates or cause any shorts. Make any repairs necessary to get things working so that you at least know where you are starting. Check all of the bypass and paper coupling capacitors and replace any leaky ones. It is a good idea to replace all of the paper capacitors in any receiver over about 10 years old. As little as 10 megohms leakage can cause a reduction in receiver performance. This job is easier than it sounds. The newer disc ceramics are much smaller than the old paper units, and quite inexpensive.

Clean and lubricate the gain controls, bandswitch and other moving parts with one of the special solvents sold for this purpose. Check the bearing tension and the rotor wiping contacts on the tuning capacitors and replace any resistors which show signs of heating. Now check all of the tubes and replace any weak ones.

This is the time to replace some of the older type rf and *if* tubes with more modern equivalents. For example, a 6SG7 makes a good direct replacement for a 6SK7, giving more gain with a better noise figure. Other substitutions may be determined from magazine articles, handbooks etc. Remember that it is frequently necessary to change cathode and screen resistors when making tube substitutions. Also keep in mind that the rf amplifier noise figure is as important as gain at frequencies above about 14 mc.

Now you are ready to completely align the receiver. If you have the instruction manual, go by it. Otherwise refer to one of the good amateur handbooks for general procedures.

Don't worry if you don't know the exact *if* frequency. If the receiver has a crystal filter, you will have to measure the crystal frequency with a signal generator anyway. Be as precise as possible when aligning the filter. Crystal filters will usually work beautifully when carefully aligned, but are next to useless otherwise. If the receiver does not have a crystal filter, it really doesn't matter if you are off a couple of kilocycles as long as everything is aligned at the same frequency.

When aligning the rf stages of a general coverage receiver, the bandspread capacitor should be fully meshed if the bandset marks on the main tuning dial appear at the low frequency end of the amateur bands. The capacitor should be fully open if the marks appear at the high frequency end of the bands.

After the alignment, if you have had any luck at all, the old inhaler should be working somewhat better than when it was new. Connect it to a good antenna and listen. Use the receiver for several days and become thoroughly familiar with its operation. Find the good points as well as the bad. Determine what you think is needed and carefully plan the desired modifications. The handbooks, old magazines and other literature will be very useful at this point. The early issues of 73 are an excellent source of modification information. When planning changes, sketch out the original circuit in a notebook for future reference.

You need not be too worried about retaining the original receiver appearance. After all, it was a klunker when you first got it. Is the thermal stability poor? More ventilation usually helps. You can add a small light bulb near the oscillator to keep things warm while the receiver is turned off. (The bulb should be off when the receiver is on.) Add a product detector for SSD. Vernier mechanisms are readily available which can be easly attached to the tuning shaft for finer tuning. Make a new bandspread dial scale for 15 meters. Add a Q multiplier or even a mechanical filter for the desired selectivity. How about an S-meter or crystal calibrator? If the front panel is too beat up, it can be repainted with a spray can and labeled with decals.

Work carefully but use your imagination and don't be afraid to try new tricks. You will be pleasantly surprised.

. . . W5FUP

Voltage Regulation

Staff

For proper operation, many electronic circuits require excellent regulation of their supply voltages. Oscillators, linear amplifiers, and may other devices must have regulated voltages for best results. And as a result, there's a lot of talk about voltage regulation. But what is it, and how can it be done? Put these questions to any number of hams picked at random, and the replies will undoubtedly amaze you.

Let's find out a little more about this regulation bit, so that if anyone asks us those questions we can give them accurate answers. And along the way, we may find a few ways to regulate voltages that turn out to be new to most of us.

As a starting point, let's find out just what "voltage regulation" means. We all know it's a measure of the change of voltage from a power source as more and more current is drawn from it, or as its input power varies—but just what are we measuring?

Surprisingly enough, the definition differs depending upon where we happen to live. By one definition, a high regulation figure indicates a "rock solid" supply, but by another equally accepted version the reverse is true: the "solid" supply has a regulation figure of zero, and the figure increases as the voltage variation gets larger!

Both definitions call regulation "the percentage change of output voltage with change in load or input," but one takes the percentage with respect to the no-load voltage while the other takes it with respect to the full-load figure. Let's plug in some figures and see what happens.

Assume we have a supply which delivers 150 volts at no load (not even a bleeder) and drops to 100 volts at 100 ma drain. The change in voltage is 50; regulation by the first definition is 50/150 or 33.3%, while by the second it is 50/100 or 50%. Let's increase current drain on the same supply to 150 ma and assume that this drops the output voltage to 75. Now regulation by the first definition is 50%, while by the second it is 100 percent. You can see how confusing all this can get.

There's a simple way to avoid all the confusion, but few hams use it. Circuit design engineers are used to drawing "equivalent circuits" for analyzing what goes on in a complex network. In these circuits, power supplies are assumed to have perfect regulation, and the actual physical loss of regulation with load is represented by a resistor in series with the supply.

This resistor, which doesn't physically exist in the circuit, is called the "source resistance" of the supply. Since $R = E/I$, it is a direct measure of the relationship between voltage at the output and current being drawn. And though it may surprise you, most power supplies behave exactly as if this situation actually existed.

For instance, in our example above the voltage dropped 50 volts with 100 ma of current being drawn. Using Ohm's Law, and dividing 50 volts by 0.1 amp, we get a "source resistance" of 500 ohms for it.

When current increased to 150 ma, the drop across the "source resistance" increased to 0.15 times 500, or 75 volts, leaving 75 volts at the output.

In addition to eliminating all the confusion brought about by the various definitions of "regulation," the source resistance concept lets us estimate quite closely what the output voltage of a supply will be if we know the amount of current it is furnishing.

For instance, in a capacitor-input power supply—or in a choke-input either, for that matter—with not even a bleeder load the voltage at the output will be very nearly equal to the peak value of the ac applied to the rectifiers. All we need do is measure the ac rms voltage, multiply by 1.414 to get peak, and this is our zero-load voltage. Now any kind of load can be applied to draw exactly 100 ma of current from the supply, and the output voltage under this load measured. Subtracting this voltage from the zero-load value gives us the amount of voltage change for 100 ma load, and multiplying this voltage change by 10 (equal to dividing by 1/10) gives us the source resistance of the supply.

With the source resistance known, all we have to do is multiply the source resistance in ohms by the current in amperes to find out how much the voltage will drop from the no-load value; subtracting this drop from the no-load value gives us the actual output.

In using this method to determine source resistance of a choke-input supply, it's better to measure output voltage at two values of load current differing by 100 ma than to use the no-load voltage, since the source resistance of this type of supply has a sharp break near zero load. This sharp break is the reason for the bleeder-current requirement, to keep the break out of the working range.

As we said before, this approach to regulation is uncommon in ham usage, and can't even be termed common practice in engineering laboratories! Therefore data on typical source resistance figures for common power supplies isn't readily available.

To get an idea of typical figures, the capacitor-input power-supply designs on page 228 of the 1962 ARRL handbook were evaluated for source resistance. All of these, incidentally, are typical good designs, so the figures should be representative of most supplies.

Source resistance of the supply was found to be determined largely by the rectifier used, and also by the transformer and choke resistances. The small supplies rated at less than 50 ma output ranged from 1500 to 2500 ohms in source resistance, due to high-resistance choke windings. Larger supplies ranged from 735 to 1350 ohms. Those supplies using type

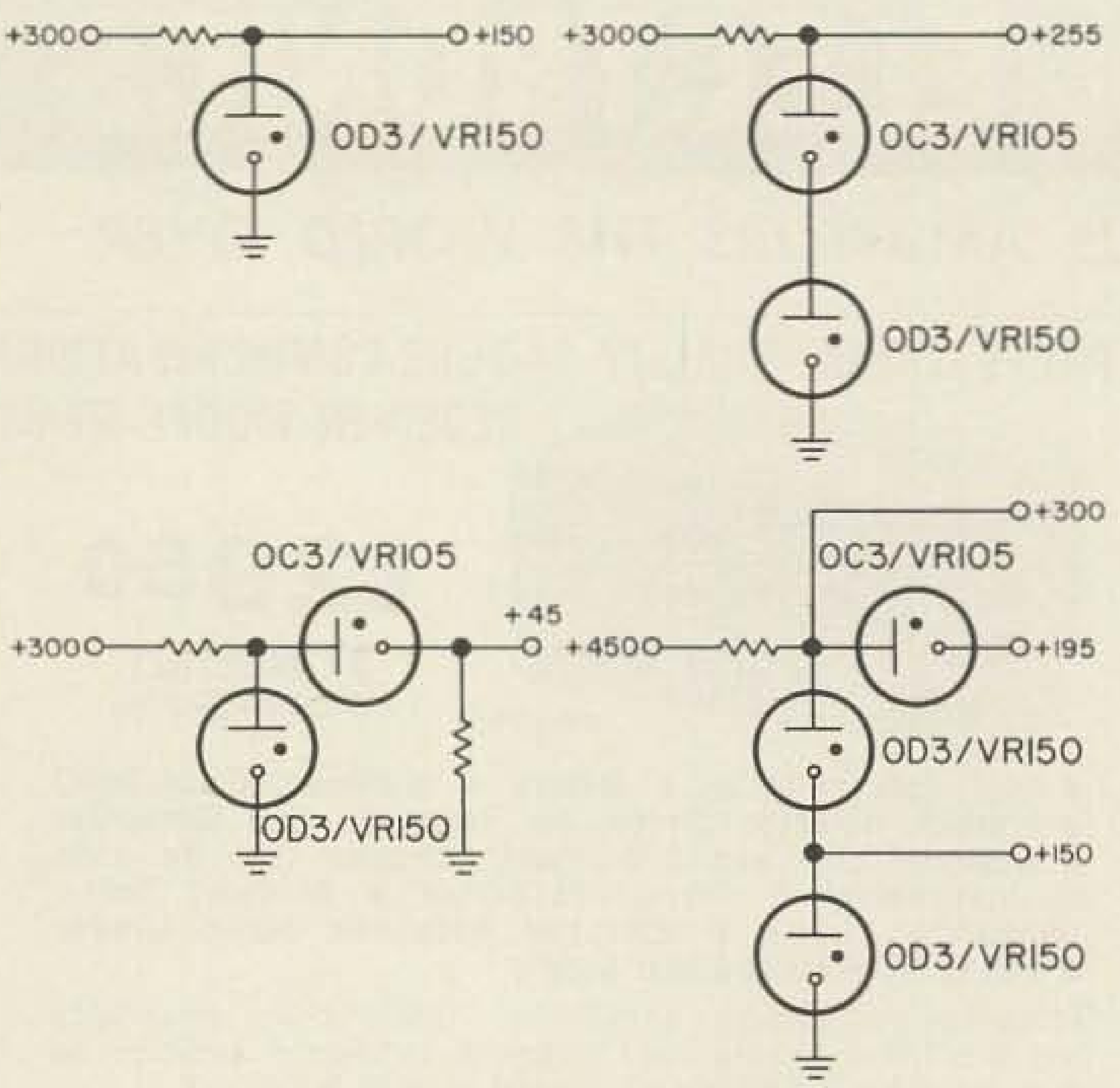


FIGURE 1
VR tube hookups

5Y3 rectifiers averaged 1200 ohms; 5U4GB rectifiers averaged about 1000 ohms; and the 5V4 cathode-type rectifier circuits averaged 800 ohms. No data was taken for silicon-diode rectifiers but source impedance should be lower, probably about 80 percent of the 5V4 figure.

None of these source resistances, of course, are low enough to satisfy "regulated-voltage" requirements for oscillators, etc. Even a 500-ohm source resistance drops output voltages by 5 volts for every 10 ma increase of load current. In a SSB linear, screen current can swing as much as 50 to 60 ma, so a 500-ohm supply would allow screen voltage to vary by 30 volts or so. This would not be acceptable.

Because of this, additional means must be taken to lower source resistance of a power supply. If the source resistance could be reduced to zero, the output voltage would remain constant regardless of load. At even 1 ohm, it would take a full amp of drain to change the voltage by a single volt. For many purposes, a 100-ohm source resistance is adequate; this lets voltage change by 0.1 volt per milliampere. In the linear example of the preceding paragraph, screen voltage would remain within 6 volts of design figure, which would be acceptable.

Three basic means exist to reduce the source resistance; all involve adding some circuit element. A gas-discharge tube maintains a constant voltage across itself, varying its own resistance to accomodate changes in current. Adding a tube of this sort holds the voltage more constant, which as we have seen is the same thing as lowering source resistance.

A battery, by chemical action, holds voltage constant also. If voltage becomes lower than that of the battery, the battery makes up the difference, while if it is higher the battery simply charges up to hold the excess energy.

Finally, certain semiconductor junctions have the same constant-voltage effect as the gas-discharge tube, and can be used in the same manner.

Five types of devices are available for putting into use these basic means of regulation: They are the VR tube, the neon bulb, the battery, the Zener diode, and (for small voltages) the silicon power diode, Let's look at them in order.

The familiar VR tube is the commercial version of the gas discharge tube. It's designed to hold voltage constant at its design through a range of load current variations which depend upon tube type. The larger "VR" series handle current swings between 5 and 40 ma, and come in 75, 90, 105, and 150-volt models. The smaller "OA" series had a current range of 5 to 30 ma, in 105 and 150 volt ratings.

If the voltage you need comes out to anything which can be made up of these various values, and the current swing is within ratings, the VR tube is the simple answer. To get a 255-volt regulated source, for instance, you would use a 105-volt and a 150-volt tube in series.

You can also get some unusual values by subtracting one VR tube from another; to have 45 volts regulated, use a 150-volt tube, then place a 105-volt tube in series with the load. Output will be 150 minus 105, or 45 volts.

All VR tubes require a source voltage considerably higher than the operating voltage, since they take some extra voltage before they will "fire" and begin operation. This, in turn, requires a current-limiting resistor. Fig. 1 shows the various hookups using VR tubes.

To calculate the value of resistor needed, subtract the operating voltage from that of the supply and divide by maximum load current plus 5 ma for the tube. The results will be the resistance; power rating of the resistor should be voltage drop times current flow, times two for a safety factor.

The conventional VR regulator is widely used, and many of us tend to believe it holds "perfect" regulation. Actually, however, voltage across the tube depends to some degree on the current through it. The source resistance of a single VR tube works out to be approximately 80 ohms; using two or more tubes in series won't appreciably change this figure, but the "subtraction" hookup may increase the resistance to 150 ohms or so.

Often we have need for a regulated voltage where little space is available for a VR tube, and the current swing is relatively small. A handy substitute for the VR tube, still in the gas-discharging family, is the ever-ready NE-2 neon bulb.

Like the VR tube, the NE-2 maintains reasonably constant voltage across its terminals. It is rated to handle only 2 ma, however, and therefore shouldn't be used where current swing will be high. One handy spot for a NE-2 or two is in regulating the screen voltage of an oscillator; current variations here are usually tiny and the object is to keep changes in input voltage from affecting the tube.

The exact value at which any given neon tube regulates can be determined only by experiment, which may be a drawback. The range will usually be between 50 and 130 volts; most of them tested here seem to average about 70 volts but this reading is in conflict with most published data, which claims an average regulating voltage of 55. To be sure, measure it!

The NE-2 hookup is identical with that of a VR tube, and all the same tricks can be used so long as we remember that the current rating is extremely small. But don't let that small current rating knock the neon completely out of the picture; a bit later we'll see how to increase it.

About the only place that a battery is useful as a voltage regulator is in grid-bias supplies, where the battery is still sometimes employed to prevent having to build a separate supply. Another use for the battery as a regulator is as the reference element in an active regulator, but that's getting ahead of ourselves.

Which brings us around to the world of semiconductors, and the Zener diode as a start.

The exact happenings inside the Zener diode which make it work as it does are rather complicated, and anyone interested is hereby referred to a paper by Dr. C. A. Escoffery of International Rectifier Corporation, which forms the first chapter of IRC's "Zener Diode Handbook." But this knowledge isn't necessary to make good use of the Zener.

All we really need to know about the Zener diode to use it is that, when connected in the "forward" direction it's a conventional rectifier. When connected in "reverse," however, it (like a conventional rectifier) is the equivalent of an open circuit *until* a particular voltage is reached. At that point, it "avalanches" and prevents any additional rise in voltage. So long as the current through it is held to a safe

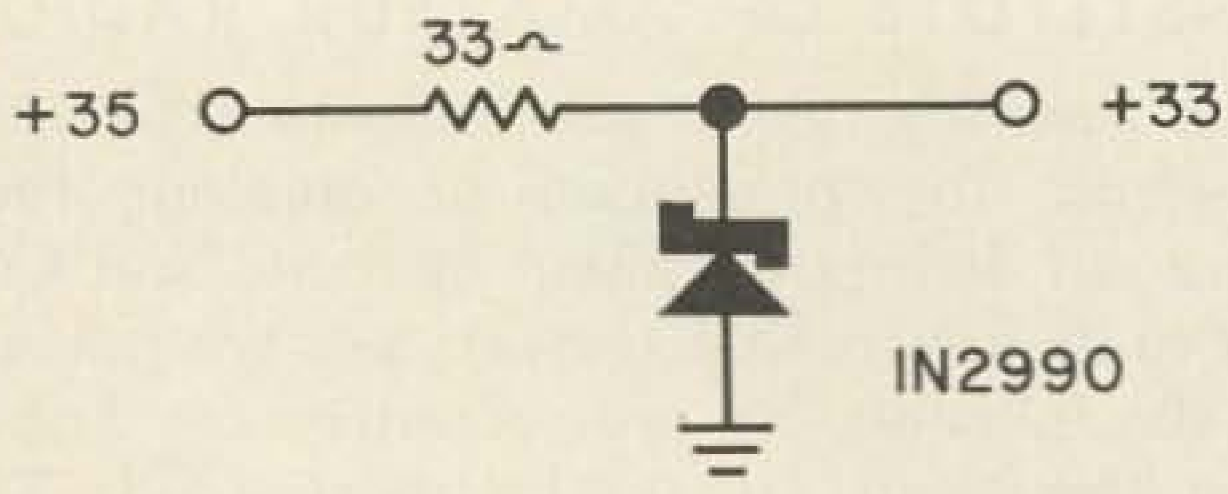


FIGURE 2
Basic zener diode circuit

value, no damage is done.

Thus a Zener diode must be connected so that it is always in "reverse" to prevent shorting out the power supply, and it must also be used with a current-limiting resistor to prevent self-destruction.

This leads to a hookup (Fig. 2) which appears identical to that of a VR tube, and the two devices are indeed very much alike. However there are a couple of important differences!

First of these differences is that instead of being limited to four basic voltages and the combinations you can make from them, as with VR tubes, you have almost no limit to the voltage range available. Zener diodes are available from less than 4 volts up to 150 and higher.

The other differences is that the Zener diode requires no "striking"voltage. Where the VR tube must be supplied from a voltage source considerably larger than the VR rating, because the firing or striking voltage is approximately 25 percent above operating voltage, the Zener diode has no such over-voltage requirement. It can operate from a supply only a volt or two greater than the Zener rating.

A less important difference is in the frequency response. While a VR tube has only a short "reaction time," enabling it to regulate out audio-frequency ripple, the Zener diode's reaction time is even shorter. The Zener is as useful at 100 kc as it is at dc.

Source resistance of a Zener-regulated power supply is typically less than 3 ohms, and frequently comes out to be less than one ohm. For all practical purposes, this is near-perfect regulation.

For extremely small regulated voltages, two Zener diodes can be arranged in a difference circuit as shown in Fig. 3. The output voltage will be the *difference* between the diode voltages, and can be only a small fraction of a volt.

A similar circuit providing an adjustable regulated voltage appears in Fig. 4. Source resistance of this circuit will be approximately equal to ½ of the resistance of the potentiometer, since at midpoint the two halves of the pot are in parallel between the load and the regulators.

When working with very small regulated voltages, below 2 volts, a useful trick is to use ordinary silicon power diodes as regulators. Thse diodes have a "voltage offset" of between ⅜ and ¾ volt in the forward direction; that is, approximately half a volt must be applied to them before any current will flow. Then, with current flowing the half-volt still drops through the diode.

Thus if a diode and resistor are placed in series across a voltage supply, the drop across the diode will be about ½ volt.

While the regulation is nowhere near as precise as that obtained with a Zener diode, and like the neon tube the voltage can be determined only by experiment for a specific diode, the idea is still useful.

For instance, fixed bias of 1.8 volts can be obtained on an audio amplifier by using three silicon diodes in series in the cathode lead of the tube. Each diode will drop about 0.6 volt, so the three total 1.8 volts. No bypass capacitor is required as the ac variations pass on to ground. This use is shown in Fig. 5.

To sum up basic regulating devices, we have a number of such devices available. None, however, is completely adjustable, and all suffer from restricted range of current swing. Adding means of adjustment reduces the regulation by increasing sources resistance. Thus basic devices are not always adequate to handle our needs.

Fortunately, another class of regulators is available which fills in the gaps. For want of a better generic term, let's call them "active regulators."

An active regulator uses an amplifying element such as a tube or a transistor to lower the source resistance of a power supply. Basic regulators may be included, or may be omitted. With proper design of an active regulator,

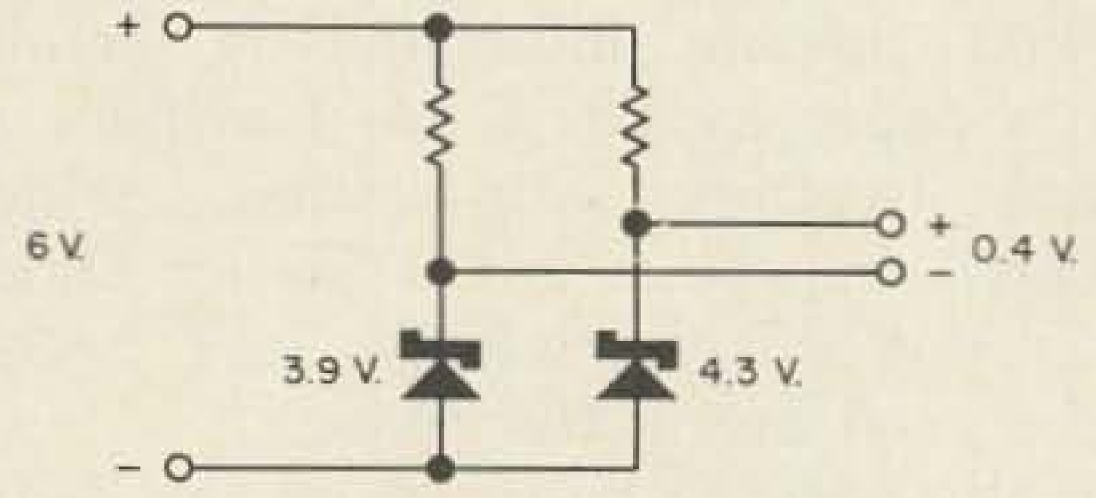


FIGURE 3

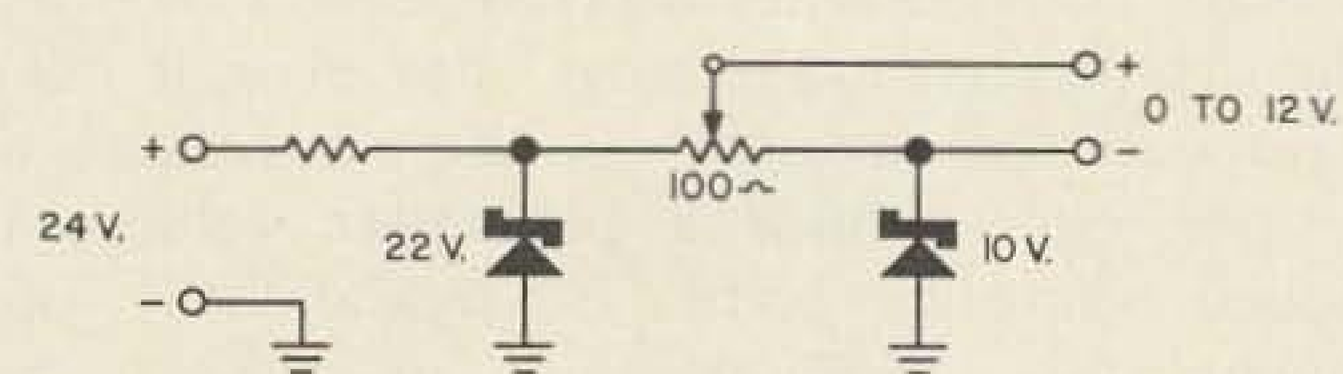


FIGURE 4

including cascaded basic regulators, the ultimate of zero source resistance can be obtained —or source resistance can even be made negative, so that the output voltage of the supply rises with increasing current. This, however, is usually undesirable.

Before getting into such complex arrangements, though, let's examine a couple of elementary active regulators which do not include basic regulators in their designs. Neither of these will reach the low source resistances of a basic regulator, but both are adjustable and their source resistances are low enough to meet many practical needs.

The first of these regulators, shown in Fig. 6, is a dc cathode follower. It acts as an impedance transformer, just as the more conventional cathode-follower amplifier, to transform a high source resistance down to a lower figure; the result is improved regulation.

Operation of this circuit (not a generally known one, by the way) can be made a bit more clear with an example. Let's asume that the tube is half of a 12AU7, supplied from a 150-volt source and delivering 100 volts at a maximum current of 10 ma.

The 12AU7 will then have a plate-to-cathode voltage of 50, and a current of 10 ma. Consulting the tube curves shows that these conditions require a grid bias of +2 volts with respect to cathode, so that grid voltage must be +102 from ground.

The voltage divider in the grid circuit is proportioned to deliver this voltage; at design values, the circuit delivers its 100 volts at 10 ma. If current drain drops to 5 ma, the required grid bias drops to 0 volts; since grid voltage is fixed, the cathode voltage rises to this value, or 102 volts. Since output voltage varies 2 volts for a 5-ma change in current, the

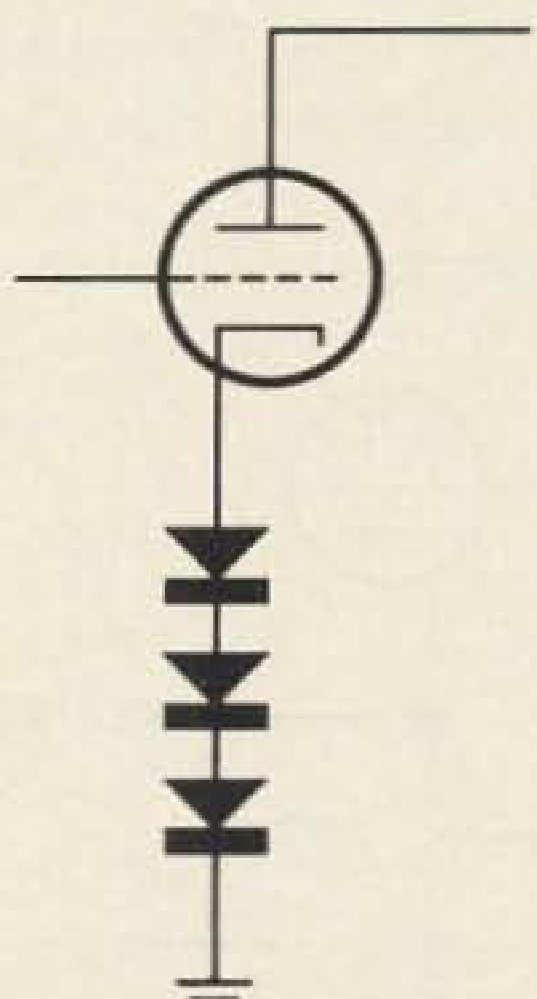


FIGURE 5

Power diode regulators

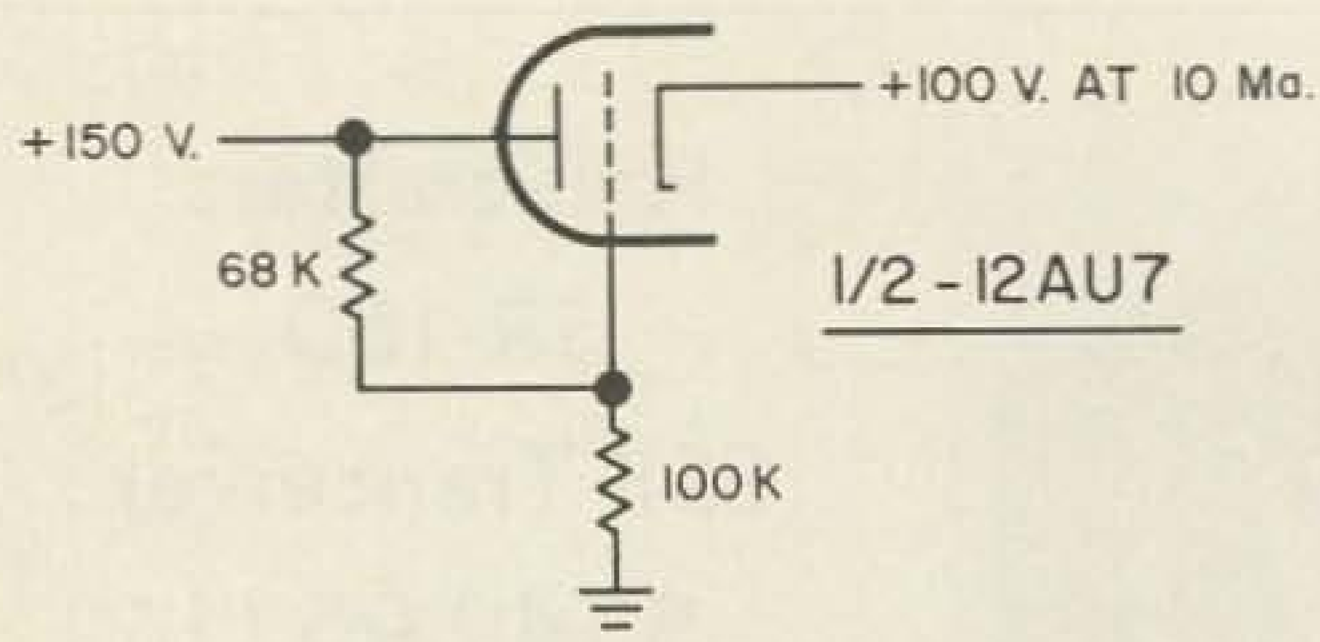


FIGURE 6

Elementary series regulator

source resistance of this regulator is 400 ohms.

If input voltage goes up to 200, the grid bias will rise to 134. Assuming that the load remains constant, the cathode voltage will again rise until the bias is just right to allow proper current flow. This happens with a output voltage of 134 and a load current of 13.4 ma.

Which doesn't sound too good until we stop to notice that a 50-volt rise in input voltage, from 150 to 200, resulted in only a 34-volt rise in output voltage. This is a reduction of 32 percent in input voltage variation.

The other of the elementary active regulator circuits is shown in Fig. 7, and is known as a degenerative regulator. It is similar to the circuit of Fig. 6 except that the grid bias is now taken from a divider across the output rather than from across the input. This allows better regulation against changes in input voltage.

However, this circuit cannot be used when the regulator tube requires positive bias as in the previous example. Let's see what happens when we use the Fig. 7 circuit to drop a 250-volt input down to 150 volts at 6 ma, with half of a 12AU7.

To find out what happens, let's just design the circuit. The first step we must take is to determine the resistance of the potentiometer. It carries almost no current, since its only load is the grid of the 12AU7 which is always negative, so its resistance can be high. Let's

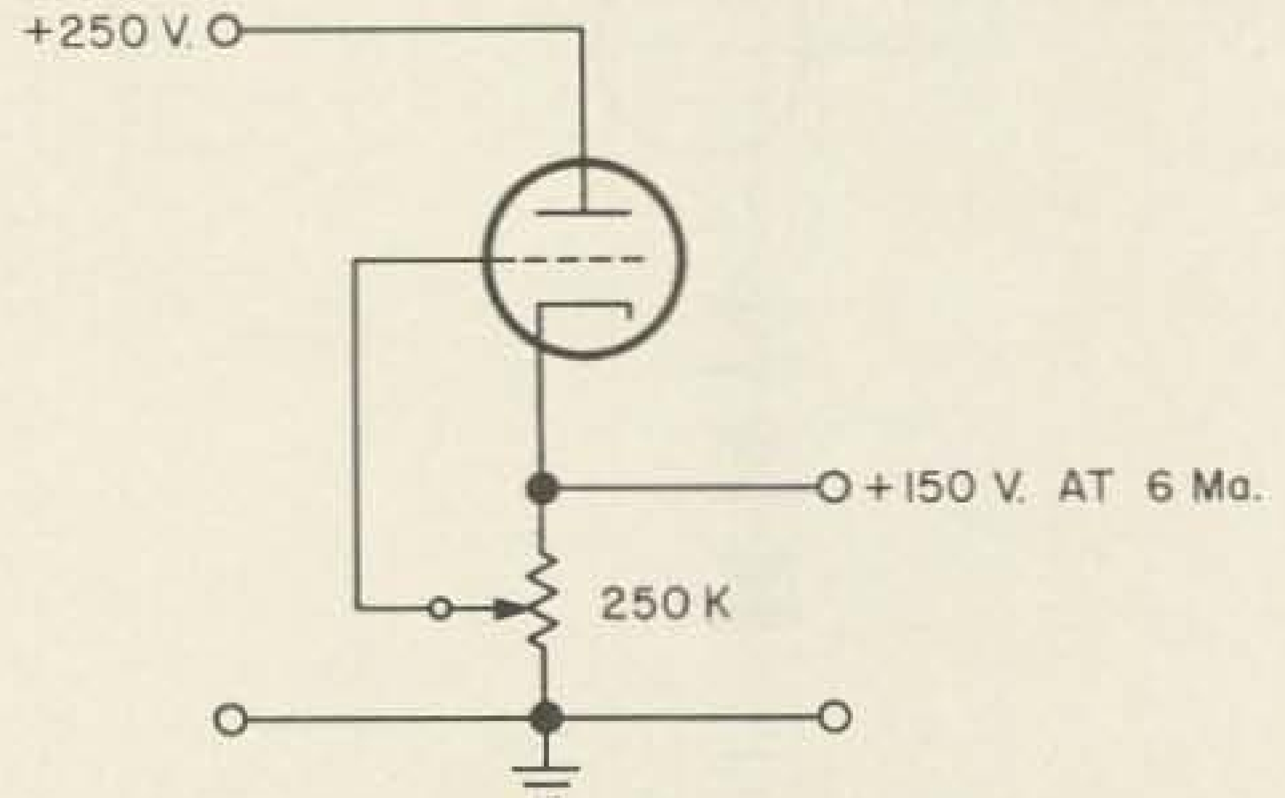


FIGURE 7

Degenerative regulator

arbitrarily pick a resistance which allows 1/10 of the load current to pass through the pot. With a specified load current of 6 ma, this means 6/10 ma through the pot; output voltage is specified as 150 volts, so the pot's resistance must be 150 divided by 0.6, or 250K ohms.

Since we're dropping 250 volts to 150, 100 volts must appear across the tube. The tube must also pass load current of 6 ma and bleeder current of 0.6 ma, for a total of 6.6 ma. Checking the tube charts for the 12AU7 we find that with a plate to cathode voltage of 100, 6.6 ma will flow through if grid voltage is −2.

This grid voltage is with respect to cathode rather than to ground, and since the cathode is at +150 then the grid must be at +148. The potentiometer arm is set for this voltage, and we get 150 volts out.

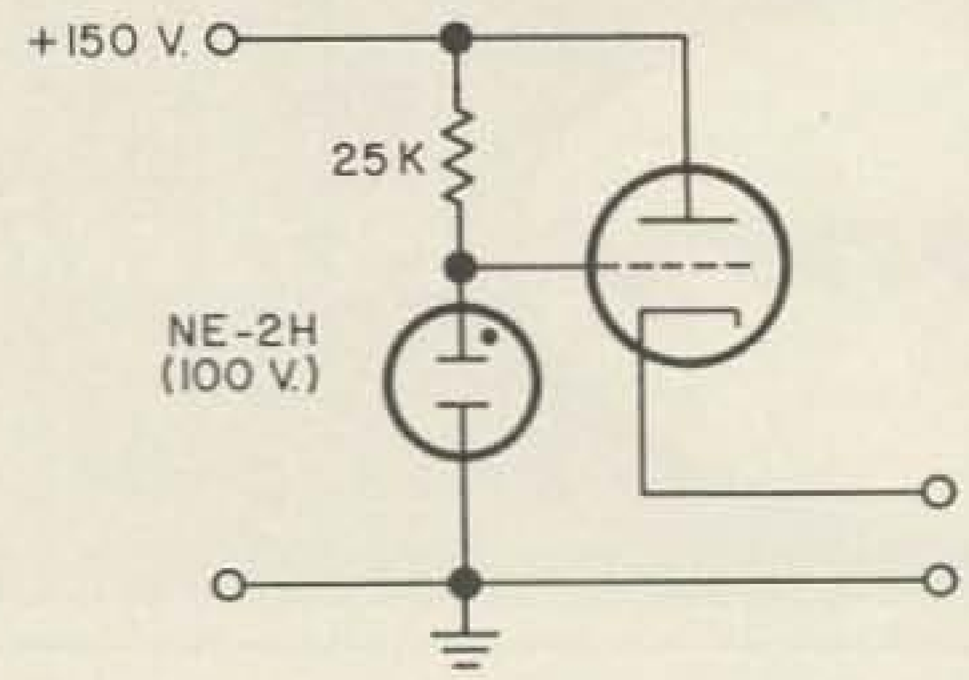


FIGURE 8

Regulated supply

Now let's see what happens if input voltage rises from 250 to 400. Since feedback is involved, we can't do a step-by-step analysis, but we can say that as the output voltage rises, the grid-to-cathode negative bias also increases, reducing current flow and thus holding output voltage down. For the exact values given in our example, the output voltage rise would be 87.6 volts (compared to an input voltage rise of 150 volts). Only about half the increase would be passed on to the output. When it comes to changes in load, the circuit of Fig. 7 is to be avoided. The source resistance of the example is higher than 7600 ohms; the supply is virtually unregulated for changes in load.

Either of the two elementary circuits, however, can be vastly improved by adding one of the basic regulators to them. To start the simplest way, let's convert the circuit of Fig. 6 into a truly regulated circuit, as drawn in Fig. 8.

Taking the left-hand half of the circuit first, we have a simple VR regulator except that we're using a NE-2H selected for 100-volt regulating point. The 25K resistor allows 2 ma to flow through the bulb.

The right-hand part of the circuit is the cathode-follower regulator of Fig. 6. If as in our previous examples we use half a 12AU7 here, let's see what happens with various loads and input voltages.

With no load at all taken from the supply, the grid bias from grid to cathode will be about —3 volts. Since grid voltage is clamped by the NE-2H at 100, this means cathode voltage will be about 103.

With 5 ma being taken by the load, a plate-to-cathode voltage of 50 and a grid bias of 0 volts will allow the current flow. This means cathode voltage will drop to 100 volts.

Taking 10 ma in the load, plate-to-cathode voltage must still remain in the neighborhood of 50 volts; for 10 ma to flow at this plate voltage, the grid must be about 2 volts positive to cathode. This, in turn, means cathode voltage must fall to 98 volts.

Our 5-volt change in output was brought about by a 10-ma change in load current, so the source resistance of the circuit is approximately the same as that of the Fig. 6 circuit. But let's see what happens when input voltage changes.

If the input voltage goes up to 200. the grid voltage of the tube will remain the same because of the regulating action of the NE-2H. If load current is zero when this happens, the output will climb to approximately 107 volts. Seven volts is cut-off bias for a 12AU7 with 100 volts between plate and cathode, and with 100 volts on the grid the cathode must be seven volts more positive in order to cut

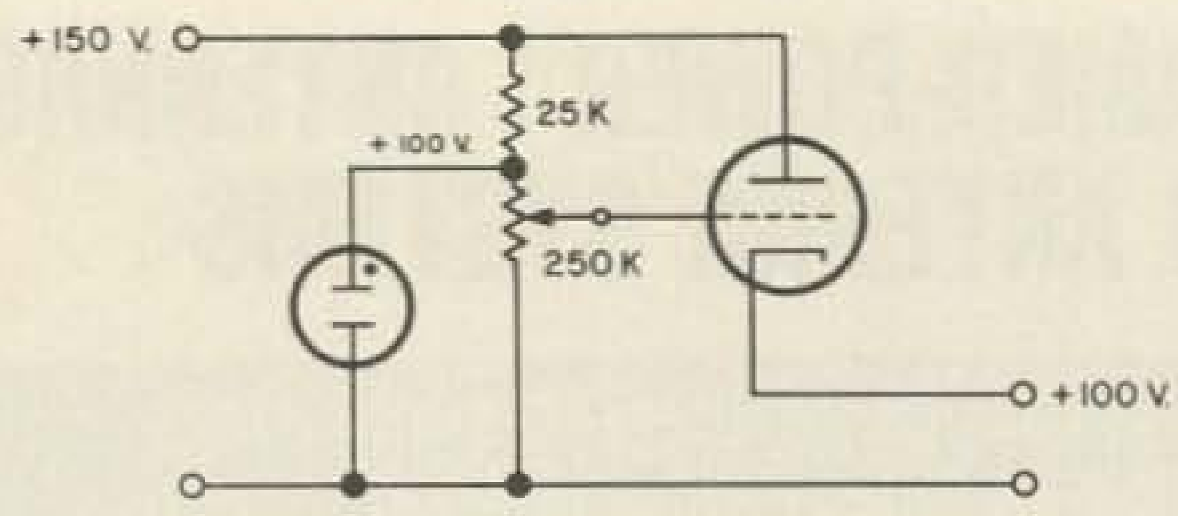


FIGURE 9

Electronic regulator

the tube off and satisfy the zero-load-current condition.

With 10 ma being drawn, the output voltage will be only 101. Again, with 100 volts between plate and cathode, a grid bias of −1 volt allows 10 ma to flow, and with the grid held at 100 volts the cathode must be one volt more positive to satisfy the requirements.

So at 10 ma load, varying input voltage from 150 to 200 causes a change of only 3 volts in output. This is a vast improvement over the 34-volt change of the Fig. 6 circuit, so that the circuit of Fig. 8 represents a marked improvement even though the regulation for changes in load current is about the same.

So far, we've been using half a 12AU7 as our control tube, and this tube has only limited current-handling capacity. Let's see what happens if we replace it with a triode-connected 6DQ5, in the circuit of Fig. 8.

Now, at no load, the grid voltage is still 100. Cut-off voltage is approximately −16, so that the cathode voltage would be 116. Now let's increase the load to 160 ma. With both plate and screen at 50 volts (since the tube is triode-connected) it takes 0 volts between grid and cathode to let this current flow. Resulting output voltage will be the same as that on the grid, or 100 volts. Thus the source resistance of this regulator becomes 16/0.16 or 100 ohms, and the current capacity is more than 4 times as great as that of the largest VR tube. Now, the neon tube is capable of competing.

For an even more useful version of this circuit, it can be modified as shown in Fig. 9. The potentiometer resistance must be much higher than that of the dropping resistor, so that the voltage at the top of the pot is high enough to fire the regulator tube. Now, output voltage can be varied by adjustment of the potentiometer, from a minimum near zero to a maximum determined by the voltage of the regulating tubes.

The circuit of Fig. 9 provides the stepping stone to the more complex but much more "solid" full electronic regulators. These circuits use the same basic principle as that of the Fig. 9 circuit, except that the difference between output voltage and the desired level is amplified by a "control amplifier" rather than being dictated by design of the series tube.

Fig. 10 is a block diagram of a generalized full electronic regulator; all these functions are present in all electronic regulators, but they are frequently somewhat disguised.

The "reference element" is usually a VR tube, often of somewhat special design for maximum voltage stability, but in transistorized regulators may be a Zener diode. The "sampling" circuit is usually a voltage divider across the regulated output, with bypass capacitors to shunt any ac on the line around the divider. The "differencing circuit" may be any type of circuit which produces as its output the *difference* between two input voltages, while the "amplifier" is a high-gain dc amplifier. The "gate" is the cathode-follower stage we've been talking about since Fig. 6.

The "reference element" supplies a known voltage, which is subtracted from the output voltage through the sampling and differencing blocks. Usually, the sampling circuit picks off a portion of the output voltage which is nominally equal to the voltage of the reference element, so that the difference is zero if the output voltage is precisely at design value. If output voltage is a trifle high, the difference output is a small positive voltage, while if output is low, the difference is a small negative potential.

The difference output then goes to the amplifier, where the small changes become large. The amplifier output controls bias on the gate tube, so that if the output voltage of the supply tends to be a bit high the grid voltage of the gate tube falls slightly, increasing the plate resistance of the tube and reducing the output. Thus any change in output voltage is made to cancel itself out.

If amplifier gain is sufficiently high, source resistance of a supply of this nature can be made as close to zero as we like. If an amplifier with voltage gain of 1000 is available, the source resistance can be made as low as 0.01

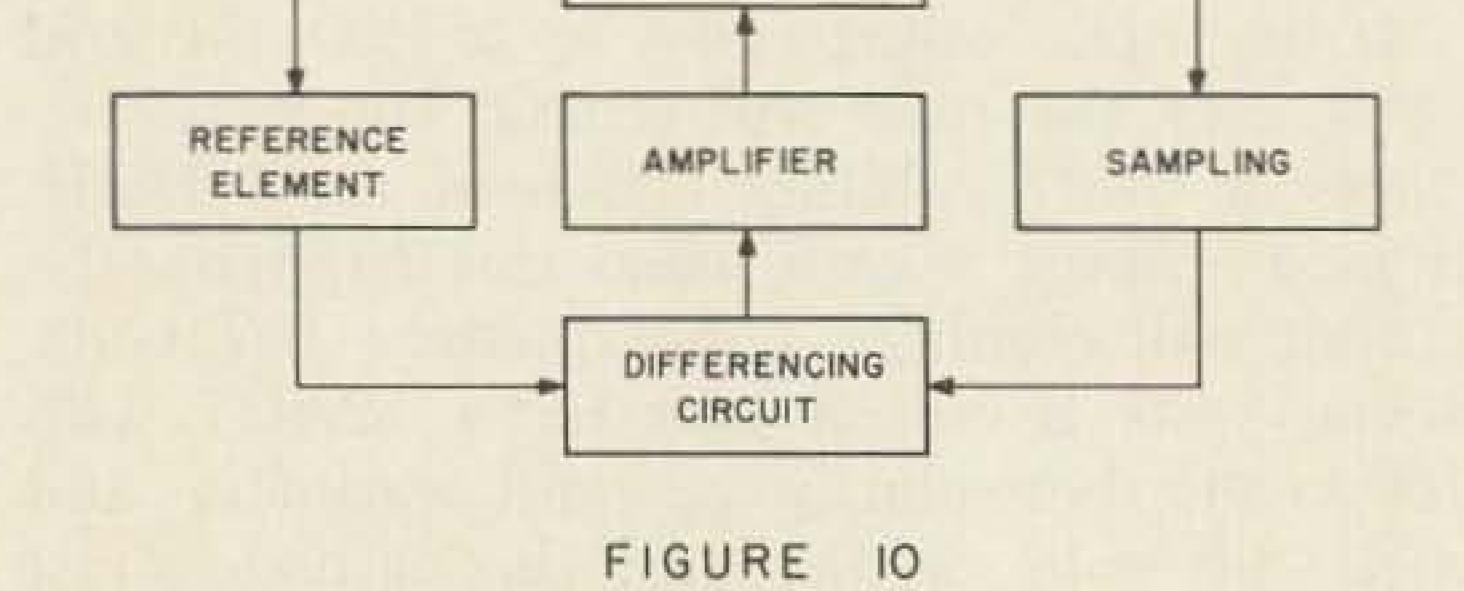


FIGURE 10

Adjustable regulator

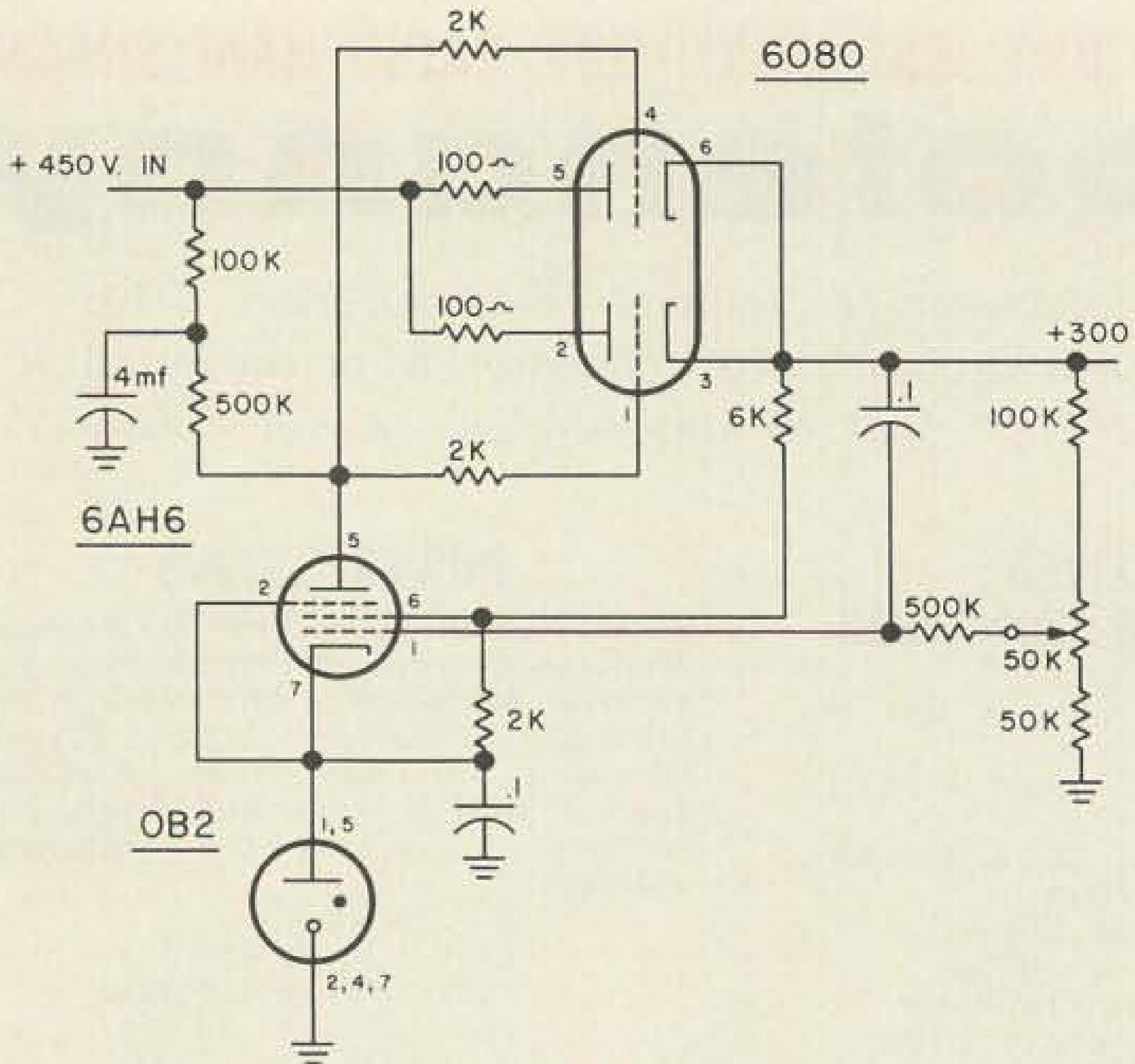


FIGURE 11
Typical electronic regulator

ohm—near enough to zero for almost any purpose.

A typical regulator of this type is shown in Fig. 11. This regulator delivers 300 volts at load currents from zero to 100 ma, from a 450-volt dc source. Its source resistance is only 6.1 ohms. The only critical parts values in this circuit are the resistors in the string from the 6080 cathode to the OB2 anode, which are chosen to provide a 25-ma bleeder load for the swinging choke in the 450-volt source. All other values are typical for this type of circuit.

This circuit, incidently, is one in which some of the functions shown in Fig. 10 are disguised.

The OB2, for instance, is the reference element although it takes its voltage from the output rather than from the input side of the gate. The 6AH6 combines the differencing circuit with the amplifier; since the reference element is in its cathode while the sampling-circuit output goes to its grid, the output is an amplified version of the difference between them rather than of either voltage alone. The 6080 is the gate tube (the 6080, incidentally, is a rugged version of the 6AS7, which can be used instead), and the sampling circuit consists of the voltage divider across the output. The 50K pot is used for minor adjustment of output voltage, to allow for parts tolerances elsewhere in the circuit, and will require checking whenever any of the tubes is replaced.

Many variations of the circuit are possible. If output voltage is to be considerably higher than that of the reference element, the upper resistor in the sampling-circuit string can be replaced with VR tubes. These simply subtract volts from the output, rather than dividing the total, so that a change from 300 to 310 volts shows up at the sampling tap as a move from 150 to 160 volts. With the divider, the same change would show up as a shift from 150 to 155 volts.

If very high output voltage is desired, the entire regulator circuit can be "floated" above ground and the ground returns shown in Fig. 11 would then be made to the top of a VR string. In this way, as shown in Fig. 12, regulation can be provided in the 1000-volt range.

The full current swing of the regulator is retained in the hookup of Fig. 12, since the VR string merely establishes a 705-volt "ground" potential for the regulator circuit itself and no load current passes through it. Thus this type of circuit finds wide use for regulating screen-voltage supplies for SSB linears which require 750 to 1000 volts screen voltage, with current swings exceeding the values readily achieved with VR tubes.

Transistorized regulators may be designed using the same principles illustrated in Fig. 10, but with semiconductors instead of tubes for all elements. Since extensive design articles have appeared in the recent past in other ham publications, and most comprehensive design data is included in IRC's "Zener Diode Handbook," we won't go into them further here.

Suppose, for instance, that we have a transthe way, though, lend themselves to various uses.

Suppose, fo instance, that we have a transmitter which requires regulated voltage for its oscillator, for the final screens, for the modulator screens, and for the speech preamp. Think we can do it with two VR tubes?

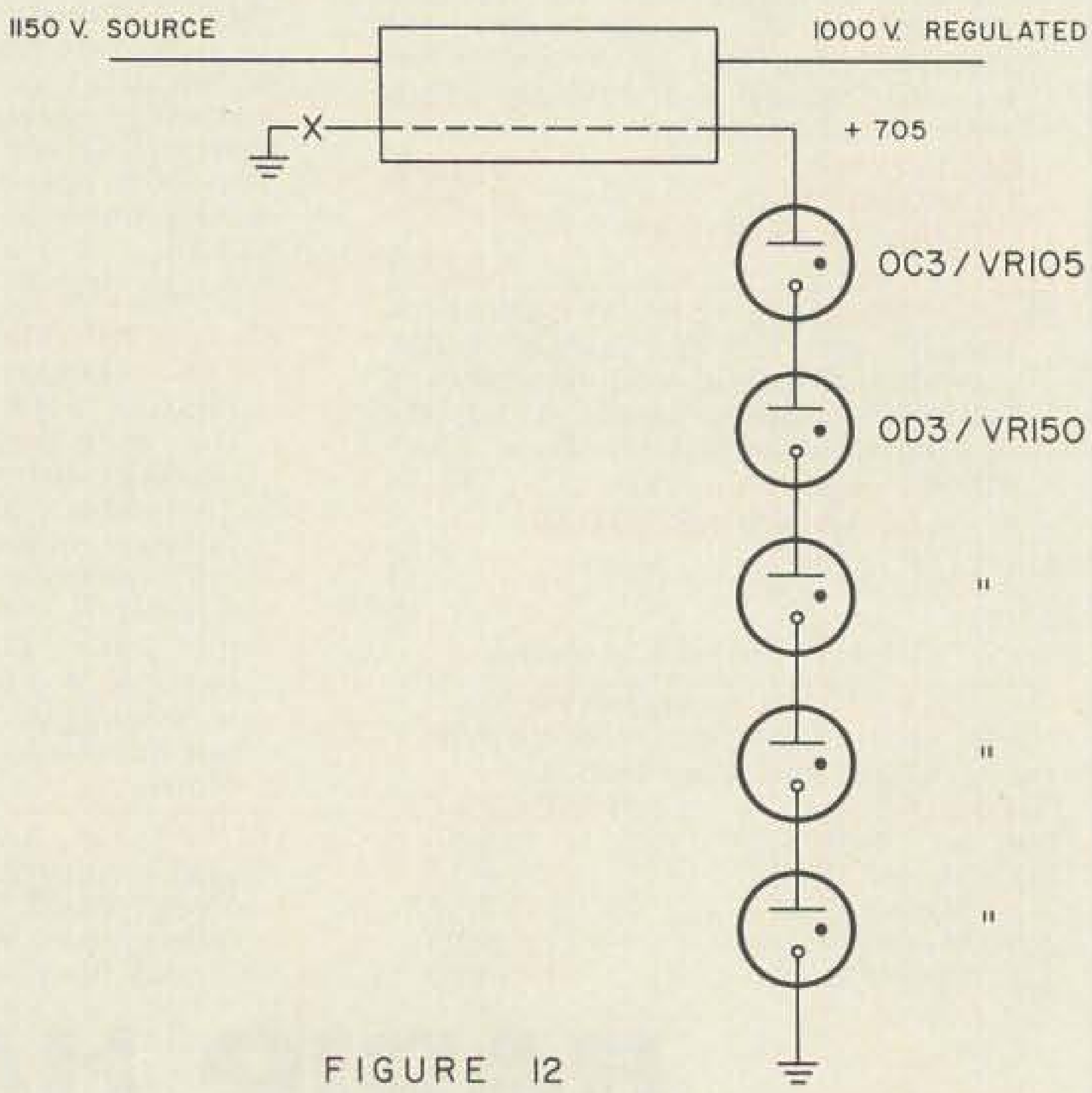


FIGURE 12
Floating regulator

By using the circuit of Fig. 9, and hanging several pots and control tubes onto a single VR string, it's easy.

Just set the VR string for 300 volts at maximum tube current with maximum expected supply voltage, and hang on the pots. Select control tubes to fit the requirements of the circuit being regulated; a 12AU7 might do for the oscillator but the modulator screens would probably like a 6V6 better. Adjust each pot individually for proper voltage in its regulated circuit, and we're in business.

Only one thing must be kept in mind when doing all this; that's heater-to-cathode voltage breakdown possibility. Most modern tubes are rated to withstand a potential of 200 volts between heater and cathode, with cathode positive, but a few are not. And if the regulated voltage exceeds 200, breakdown is possible anyway.

Best way to handle this is to supply the regulator tubes from a separate filament line, and tie one side of the filament line supplying them to a DC voltage which is equal to the average of all regulated voltages (if no more than 250 to 300 volts separates the highest and lowest regulated voltage). Then heater-cathode voltage ratings won't be exceeded.

REFERENCES

ARRL, **The Radio Amateur's Handbook**, 1962 edition, pp. 228-236.

Anon., **Zener Diode Handbook**, International Rectifier Corporation, published 1960.

Anon., "Regulated Power Supply," **Radio-Electronics**, April, 1959, page 125.

Bramham, Kenneth, "Voltage Regulation for Transistors," **Electronics World**, July, 1960, page 62.

Chipman, L. D., W4PRM, "Combination Regulated Power Supply," **QST**, October, 1957, page 16.

Christman, C. J., WA8AFF, "Power-Supply Control and Regulation by Means of Thyratrons," **QST**, November, 1962, page 26.

Clark, Richard L., W1SUN/1, "Electronic High-Voltage Regulator," **QST**, May, 1958, page 30.

D'Airo, Leonard J., "Regulated Low-Voltage Supply for Service Bench or Lab," **Radio-Electronics**, February, 1962, page 30.

Gouge, J. R., W3RXI, "The Design of Regulated Low-Voltage Power Supplies," **QST**, October, 1961, page 23.

Jones, George W., W1PLJ, "Improved Control Circuit for Regulated Power Supplies," **QST**, November, 1957, page 30.

Landee, Robert W., Davis, Donovan C., and Albrecht, Albert P., **Electronic Designers' Handbook**, McGraw-Hill Book Company, New York, 1957, pages 15-23 to 15-48.

Lowry, Hugh R., "Regulated Supply for Transistor Amplifiers," **Radio & TV News**, October, 1957, page 55.

Murphy, Lawrence J., "Regulated low-voltage Power Supply," **Radio-Electronics**, August, 1960, page 53.

Schauers, Charles J., W4VZO, "Voltage Regulator," **CQ**, July, 1962, page 81.

Snyder, Tom, K6PGB, "1200 volts, regulated," **CQ**, November, 1957, page 58.

Stratman, Hardin C., "Regulated Heater Supply," **Radio-Electronics**, November, 1959, page 51.

Vogelgesang, Peter J., "Transistor-Regulated Power Supply," **Electronics World**, June, 1959, page 60.

Witte, W. E., WØDYW, "Novel Regulator," **QST**, May, 1959, page 48.

What Every Amateur Should Know

ITU—IRAC—FRC—FCC—IFRB

Wells Chapin W2DUD
118 Woodmancy Lane
Fayetteville, N. Y.
Pictures by Eli Hobaica K2YFP

We are avid users of one of the worlds most important resources, spectrum allocation. There is just so much of this resource so until someone invents negative frequency we will just have to resign ourselves to using techniques to conserve it. In addition we must use it wisely and fight for it desperately. This limited spectrum is the direct cause of the extreme pressures of diverse groups to obtain space for their groups. The fight for frequency allocation (and we amateurs are part of it) is really a blue chip poker game that is extremely complicated by the demands and needs of the Military-Government-Commercial and private services. There is a great feeling by all groups that their interest is more important than any other group and each is out to prove it. Millions of dollars are spent every year by these groups with permanent lobbys in Washington whose sole job is keeping what they have and looking for a slice of the other fellows spectrum for their own group. They all are looking at our ham bands covetously. All of this grows more complicated daily by the rapid growth of the worlds population and its inherent dire need for communications. Then toss in the enemies of the free world impRications and those who are interested in only spectrum for themselves. Then add the interests of friendly foreign nations you have the makings for a real donniebrook at the ITU in 1965. The pressures over the years to relieve us of frequencies has been extreme. There is no question that the pressures will become greater. In the past the ARRL has done a good job in representing our interests, however, I think the time has come to reappraise our situation in Amateur Radio. Unfortunately some of us take this valuable resource, use it and take it for granted. Perhaps its time for all of us to make a contribution to perpetuate amateur radio. You ask—what can I do? Well the first thing you can do—is to learn a little about this wonderful hobby of ours.

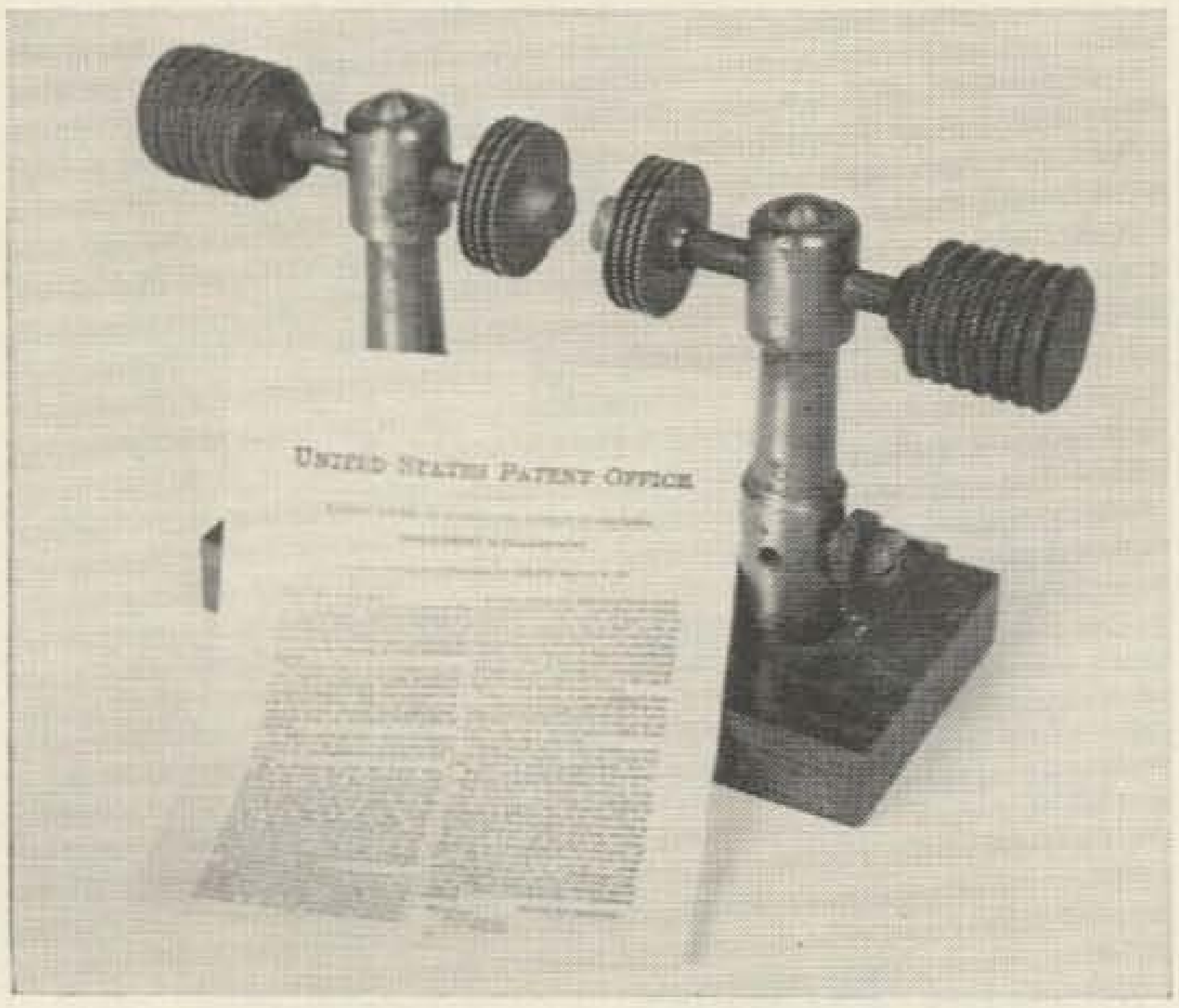


Fig. 1

You should know how we came into existance. If you are interested in history try Two Hundred Meters and Down by Clinton Desoto and then pickup some history books in the library to get the commercial side of the picture.

This whole radio business started way back in the 1800's when the names of Michael Faraday (perhaps this is where we got mike farad) Henry, Ohm, Kirchoff, Ampere, Hertz, Morse and then the more recent names of Marconi, Fleming, Tesla, DeForest, Armstrong and others appeared. Maxwell really started the whole thing with his famous theory ie. he reduced all known electrical and magnetic phenomenon to motions in the form of waves in a substance which due to the etheral like nature of this phenomenon he called ether. Like he said, was a wave in space, heat another and electrical another. The difference between them was in the rapidity of their oscillation. Light waves were short and heat waves long and between them was an enormous space about which nothing was known. This unknown space trigged off a rash of scientific experiments leading eventually to radio.

While researching for material for this article I was surprised to learn that Marconi was really not the first to use ether for transmission as Dr. Mahlon Loomis the brother of the famous radio author Mary Texana Loomis, patented telegraphy through the atmosphere in 1872 as shown in Figure #1. For those who do not recognize it the background gadget is a spark gap—a key item in the transmitters of those days. Those early days must have been exiting—imagine yourself in 1872 when even wire telegraphy was new— then along comes ether transmission.

It took a sharp persistant intelligent youth named Marconi who realized the commercial significance of radio and took advantage of all the past and started commercial radio. Marconi did not invent radio as so many think—he took advantage of and understood and promoted this new communication tool. Marconis lot was not easy—he encountered superstition, untold opposition and harrasement but he finally succeeded in transmitting a mile via the ether and by early 1896 had increased this distance to four miles. In this same year, twenty-six years after Loomis, Marconi received his famous British Patent #7777.

It was obvious from the start that some form of international agreement was necessary, because this new medium was used aboard ships who sailed the seas. In the early days things were quite loose in Amateur Radio one merely used his initials for call letters. The events in the international regulation of telephony and telegraphy over wires and then radio was really the history of what is now known today as the ITU International Telecommunication Union.

These events were:

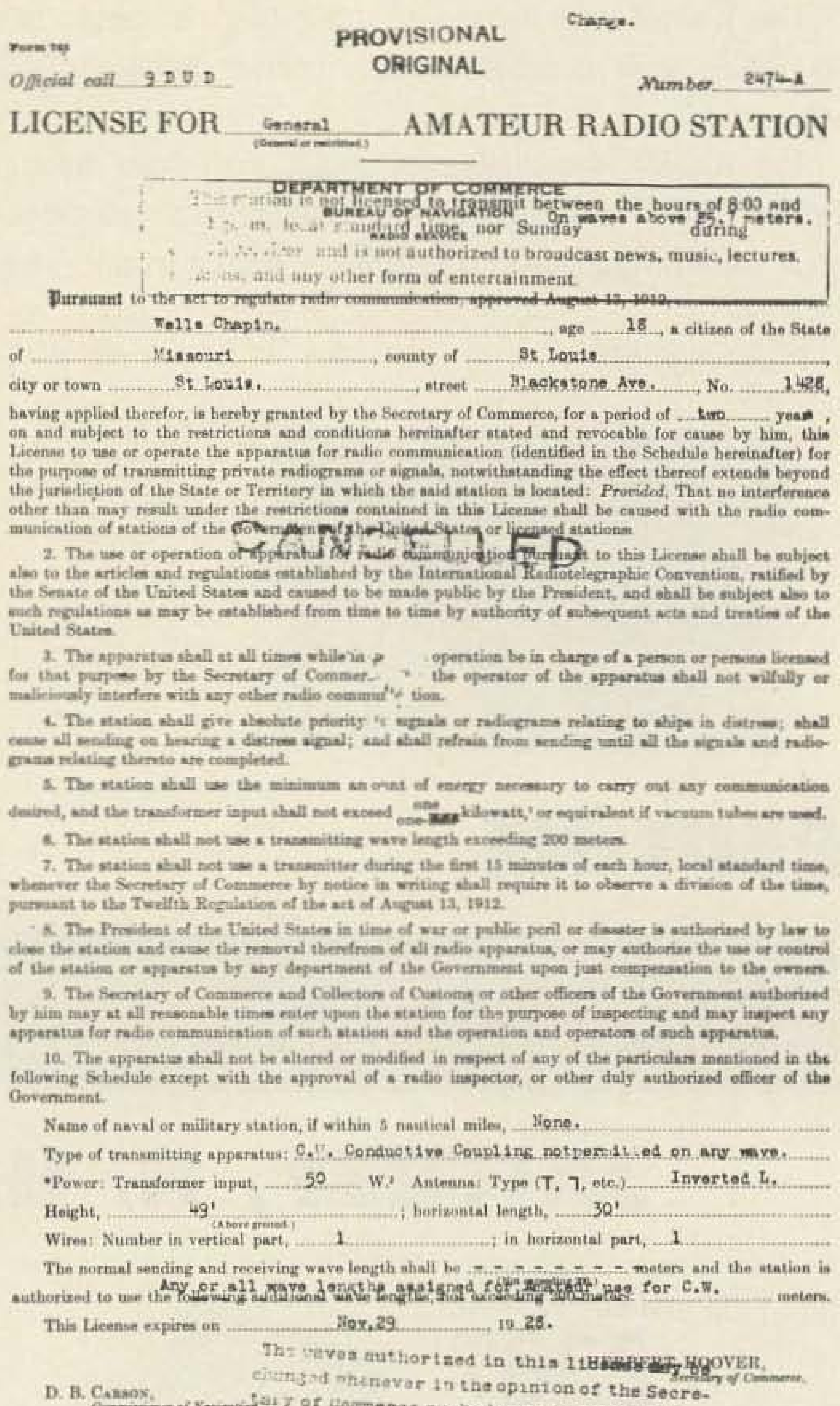
1849—The telegraph first used internationally.

1865—Foundation of the International Telegraph Union by twenty States with the adoption of the first Convention. First Telegraph Regulations.

1868—Vienna Conference. Bureau of the Union set up in Berne.

1871-2—Rome Conference.

- 1885–Berlin Administrative Conference. First ITU provisions for international telephony.
- 1903–Berlin. Preliminary Radio Conference of nine States.
- 1906–Berlin, First International Radio Conference with 29 States. Convention and Radio Regulations drawn up. Adoption of SOS Signal.
- 1912–London Radio Conference. Improved Radio Regulations.
- 1924–Paris. Creation of CCIF (International Telephone Consultative Committee).
- 1925–Creation of CCIT (International Telegraph Consultative Committee).
- 1927–Washington Radio Conference with eighty States. Establishment of CCIR (International Radio Consultative Committee). First allocation of radio frequencies to the various radio services.



Form 762 PROVISIONAL Change.
ORIGINAL
Official call 9 D U D Number 2474-A

LICENSE FOR General AMATEUR RADIO STATION
(General or restricted)

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
This station is not licensed to transmit between the hours of 8:00 and ... p. m. local standard time, nor Sunday during ... On waves above ... meters. ... and is not authorized to broadcast news, music, lectures, ... and any other form of entertainment.

Pursuant to the act to regulate radio communication, approved August 13, 1912, Wells Chapin, age 18, a citizen of the State of Missouri, county of St. Louis, city or town St. Louis, street Blackstone Ave., No. 1428, having applied therefor, is hereby granted by the Secretary of Commerce, for a period of two years, on and subject to the restrictions and conditions hereinafter stated and revocable for cause by him, this License to use or operate the apparatus for radio communication (identified in the Schedule hereinafter) for the purpose of transmitting private radiograms or signals, notwithstanding the effect thereof extends beyond the jurisdiction of the State or Territory in which the said station is located: *Provided*, That no interference other than may result under the restrictions contained in this License shall be caused with the radio communication of stations of the Government of the United States or licensed stations.

2. The use or operation of apparatus for radio communication pursuant to this License shall be subject also to the articles and regulations established by the International Radiotelegraphic Convention, ratified by the Senate of the United States and caused to be made public by the President, and shall be subject also to such regulations as may be established from time to time by authority of subsequent acts and treaties of the United States.

3. The apparatus shall at all times while in operation be in charge of a person or persons licensed for that purpose by the Secretary of Commerce, and the operator of the apparatus shall not wilfully or maliciously interfere with any other radio communication.

4. The station shall give absolute priority to signals or radiograms relating to ships in distress; shall cease all sending on hearing a distress signal; and shall refrain from sending until all the signals and radiograms relating thereto are completed.

5. The station shall use the minimum amount of energy necessary to carry out any communication desired, and the transformer input shall not exceed one kilowatt,[1] or equivalent if vacuum tubes are used.

6. The station shall not use a transmitting wave length exceeding 200 meters.

7. The station shall not use a transmitter during the first 15 minutes of each hour, local standard time, whenever the Secretary of Commerce by notice in writing shall require it to observe a division of the time, pursuant to the Twelfth Regulation of the act of August 13, 1912.

8. The President of the United States in time of war or public peril or disaster is authorized by law to close the station and cause the removal therefrom of all radio apparatus, or may authorize the use or control of the station or apparatus by any department of the Government upon just compensation to the owners.

9. The Secretary of Commerce and Collectors of Customs or other officers of the Government authorized by him may at all reasonable times enter upon the station for the purpose of inspecting and may inspect any apparatus for radio communication of such station and the operation and operators of such apparatus.

10. The apparatus shall not be altered or modified in respect of any of the particulars mentioned in the following Schedule except with the approval of a radio inspector, or other duly authorized officer of the Government.

Name of naval or military station, if within 5 nautical miles, None.

Type of transmitting apparatus: C.W. Conductive Coupling notpermitted on any wave.

*Power: Transformer input, 50 W.[2] Antenna: Type (T, ˥, etc.) Inverted L.

Height, 49' (Above ground.); horizontal length, 30'

Wires: Number in vertical part, 1; in horizontal part, 1

The normal sending and receiving wave length shall be - - - - - - - - - meters and the station is authorized to use the following additional wave lengths, not exceeding 200 meters: Any or all wave lengths assigned for amateur use for C.W. meters.

This License expires on Nov.29 1928.

The waves authorized in this license may be changed whenever in the opinion of the Secretary of Commerce such change is necessary

HERBERT HOOVER,
Secretary of Commerce.

D. B. CARSON,
Commissioner of Navigation.

Delivered by [signature] 9PS. (Supervisor of Radio.)

Place CHICAGO, ILL. Date Nov.30, 1926.

[1] Strike out "one" if the station be within 5 nautical miles of a naval or military station; otherwise strike out "one-half."
[2] Not to exceed 1,000; or if the station be within 5 nautical miles of a naval or military station, not to exceed 500.
If vacuum tubes are used, power should be actual watts in antenna circuit, as indicated by rating of tubes.

Fig. 2

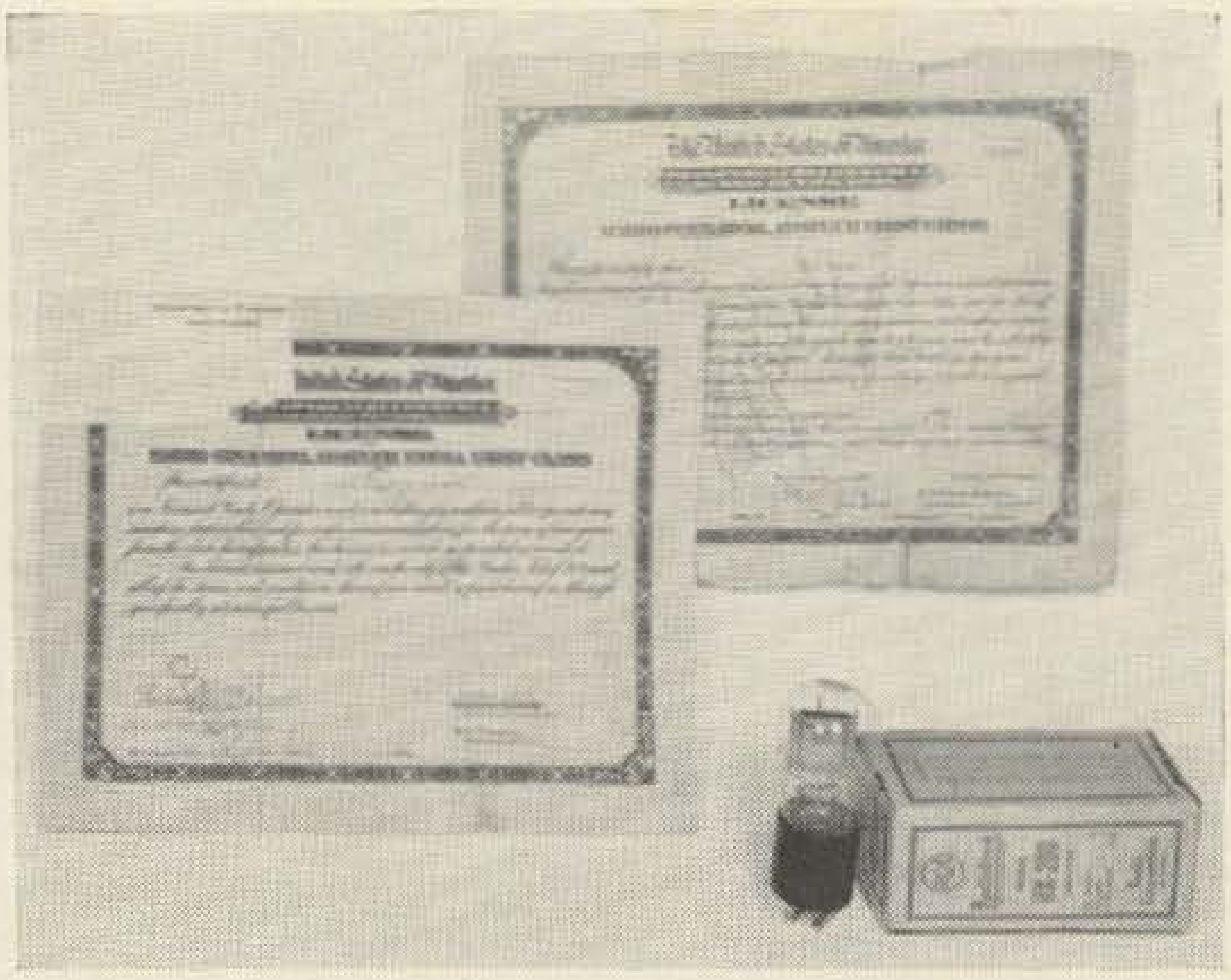


Fig. 3

- 1932–Madrid Conferences. Organization's title change to International Telecommunication Convention. New Radio, Telegraph and Telephone Regulations.
- 1938–Cairo Administrative Radio and Telegraph and Telephone Conferences.
- 1947–Atlantic City Plenipotentiary and Radio Conferences. Creation of International Frequency Registration Board (IFRB). New International Frequency List. Creation of the Administrative Council. Agreement with the United Nations approved.
- 1948–Seat of the Union transferred to Geneva.
- 1952–Buenos Aires Plenipotentiary Conference.
- 1956–Geneva. CCIF and CCIT merged into new CCITT (International Telegraph and Telephone Consultative Committee).
- 1958–Geneva Telegraph and Telephone Conference.
- 1959–Geneva Plenipotentiary and Radio Conferences.

Radio in the United States was not officially regulated in the early days and it was not until 1910 that the U.S. approved and required certain ships to carry radio. July 1, 1911 saw a Radio Division formed under the Department of Commerce to enforce the act of 1910. It was not until 1912 that an Act was passed licensing radio wireless operators. On February 23, 1826 President Coolidge signed the Dill-Whitebill that created the Federal Radio Commission (FRC) and brought order to a chaotic radio situation.. Vacuum tubes had just taken hold and had a good foothold. One of the early licenses of this period is shown in Figure 2. The extra First Class license for hams apeared in this period and

Figure 3 shows a license of this category along with a Radio Operator First Grade. Also note—the UV200 tube shown was used in this time period. The Extra First Class license had its incentive in that it let the holder use additional phone space. The FRC quickly developed rules and regulations and operated until July 11, 1934 at which time the Radio Act of 1934 was signed creating the Federal Communications commission (FCC) which we are operating under today. Figure #4 shows the books that contain the information that means life or death to ham radio.

Figure 5 shows todays rules and regulations with the Amateur Section Volume 6 Part 12 held in the hand. Figure 6 lists the complete set. You will note the FCC regulates a good deal more than Amateur Radio. These regulations are available from the government printing office and a post card will bring you the price list.

The international aspect of radio has developed to such an extent that almost no major frequency allocation can be made without considering world-wide usage. In consequence, the primary allocation of frequency bands is now determined by international treaty and other agreement ,and assignment of individual channels within those bands is made by the member nations accordingly. This now in cludes frequencies for space communication.

Therefore, it behoves us as users of this spectrum and having a real interest to retain our position—that we understand all the aspects. The (ITU) International Telecommunication Union is a most important part of our life or death story—though we amateurs have a dual job of selling our own government and people of our worth to them. So—lets take a look at the whole aspect. See Figure 7 chart. This chart is specifically shown to indicate that this spectrum allocation problem is a

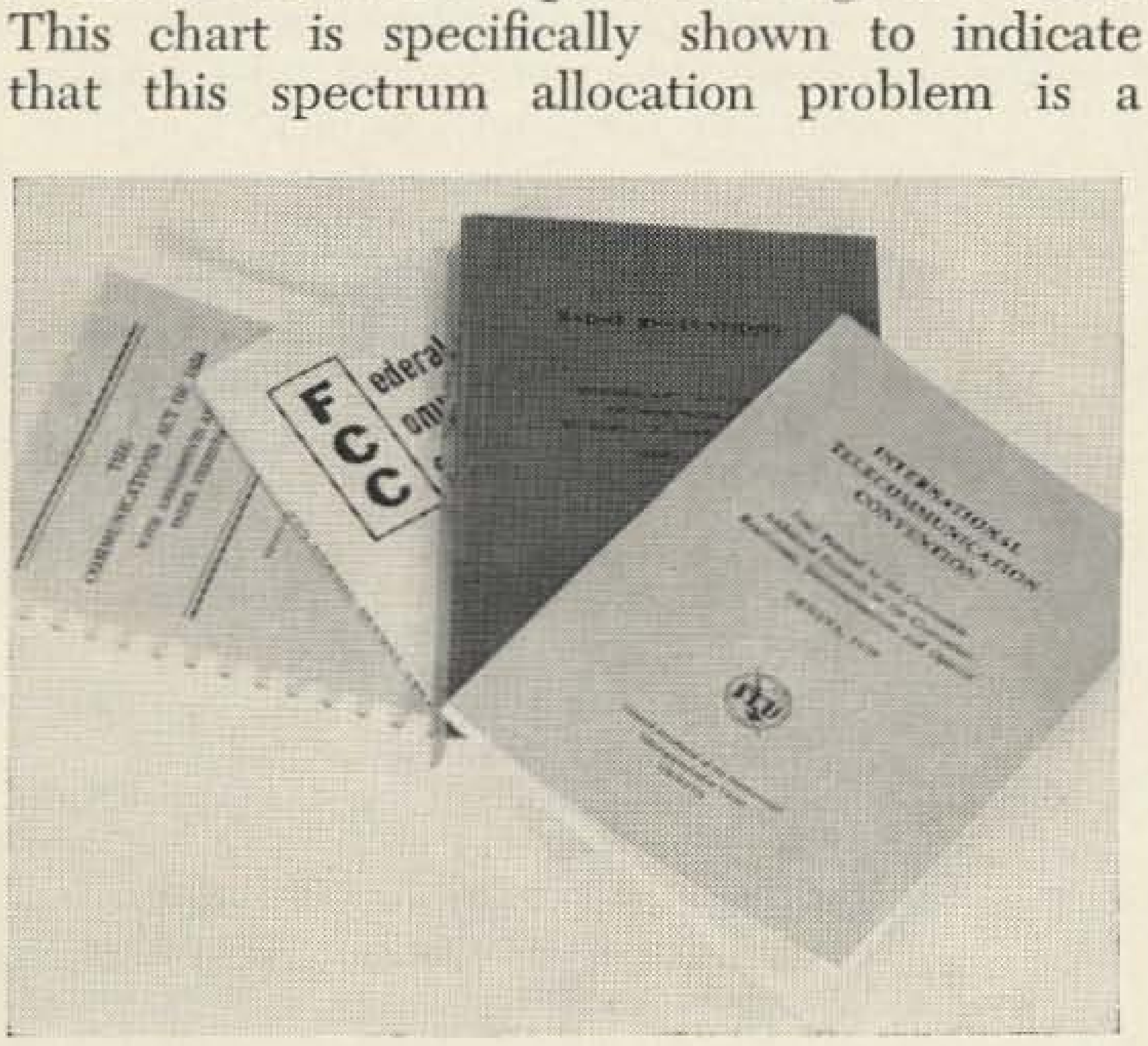


Fig. 4

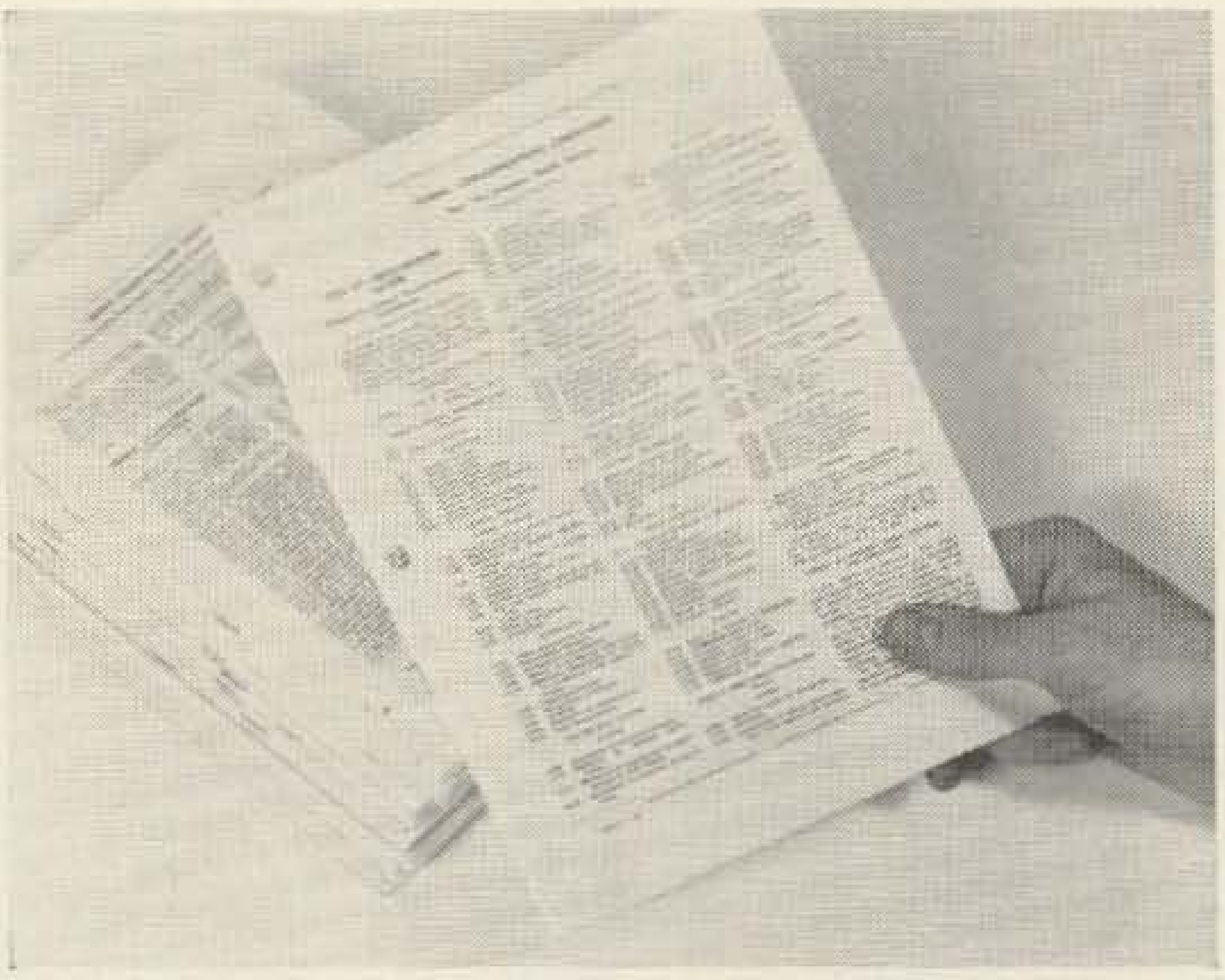


Fig. 5

game for knowledgeable experts. One finally grasps the fact that there are a great many groups interested in spectrum. This is a simplified chart-for instance: under the various committees the interdepartment advisory committee has 13+ member groups, the telecommunication planning 20+ and the telecommunication advisory board 13. There are many intricate tie-ins and delicate interrelations to consider. Our own national problem as shown is complex but when you add the international as shown on the right you complicate the problem to a considerable degree. The practical problems are real and you can put your finger on them but the intangible political and psycological problems are extremely complex. The small box indicating lobbyist is indeed a very important box.

Now lets take a look at the ITU—what is it and what does it do? Quoting from a Department of state document serial No. 384—4th revision:

International Telecommunication Union (ITU)

The Convention referred to herein is the International Telecommunication convention, Geneva 1959, which on January 1, 1961 replaced the Buenos Aires Convention, 1952. The instrument of ratification by the United States of the Geneva Convention was deposited with the Secretary General of the ITU on October 23, 1961.

Volumes of FCC Rules and Regulations by Categories

Volume I — (Aug. 1962)
- Part 0, Commission Organization
- Part 1, Practice and Procedure
- Part 13, Commercial Radio Operators
- Part 17, Construction, Marking and Lighting of Antenna Structures

Volume II — (Dec. 1961)
- Part 2, Frequency Allocations and Radio Treaty Matters: General Rules and Regulations
- Part 5, Experimental Radio Services (other than Broadcast)
- Part 15, Radio Frequency Devices
- Part 18, Industrial, Scientific, and Medical Services

Volume III — (Sept. 1961)
- Part 3, Radio Broadcast Services
- Part 4, Experimental, Auxiliary and Special Broadcast Services

Volume IV — Feb. 1962)
- Part 7, Stations on Land in Maritime Services
- Part 8, Stations on Shipboard in Maritime Services
- Part 14, Public Fixed Stations & Stations of the Maritime Services in Alaska

Volume V — (Feb. 1961)
- Part 9, Aviation Services
- Part 10, Public Safety Radio Services
- Part 11, Industrial Radio Services
- Part 16, Land Transportation Radio Services

Volume VI — (Feb. 1962)
- Part 12, Amateur Radio Service
- Part 19, Citizens Radio Service
- Part 20, Disaster Communications Service

Volume VII — (Jan. 1963)
- Part 6, International Fixed Public Radio Communication Services
- Part 21, Domestic Public Radio Services (Other than Maritime Mobile)
- Part 25, Satellite Communications

Volume VIII — (Jan. 1961)
- Part 31, Uniform System of Accounts for Class A and B Telephone Companies
- Part 33, Uniform System of Accounts for Class C Telephone Companies

Volume IX *
- Part 34, Uniform System of Accounts for Radiotelegraph Carriers
- Part 35, Uniform System of accounts for Wire-Telegraph and Ocean Cable Carriers

Volume 10 — (Jan. 1961)
- Part 41, Telegraph and Telephone Franks
- Part 42, Preservation of Records of Communications Common Carriers
- Part 43, Reports of Communication Common Carriers and Certain Affiliates
- Part 51, Occupational Classification and Compensation of Employees of Class A and Class B Telephone Companies
- Part 52, Classification of Wire Telegraph Employees
- Part 61, Tariffs
- Part 62, Applications to Hold Interlocking Directorates
- Part 63, Extension of Lines and Discontinuance of Service by Carriers
- Part 64, Miscellaneous Rules Relating to Common Carriers
- Part 66, Applications Relating to Consolidation, Acquisition, or Control of Telephone Companies

Fig. 6

The International Telecommunication Union (ITU) is an international organization established for the purpose of coordinating international telecommunications of all kinds. It operates principally through conferences, meetings, an Administrative Council and a secretariat and by correspondence. Its seat is located in Geneva, Switzerland. It is the specialized agency of the United Nations concerned with telecommunications. As of this date, it has 122 members and 2 Associate members. The membership is increasing steadily and rapidly as the new countries of Africa join the Union.

The Plenipotentiary Conference is the supreme organ of the Union. It deals with the basic principles underlying telecommunications, and with administrative, budgetary and personnel questions, as outlined in Article 6 of the Convention. Its decisions are embodied in a convention or treaty. It can amend, revise, set aside or change the decisions of the Administrative Council, other organs of the ITU and any of the other conferences or meetings, or of the Secretary General. It meets normally at a place and date decided on by the previous Plenipotentiary Conference and the delegates have full powers to sign a treaty or convention, which, in the case of the United States, must be approved by the Senate and ratified by the President.

The 1962 report published in 1963 lists 328 persons employed—excluding staff engaged on short term contracts. Of the above 16 were elected officials, 242 permanent office holders with contracts and 70 holders of fixed term contracts.

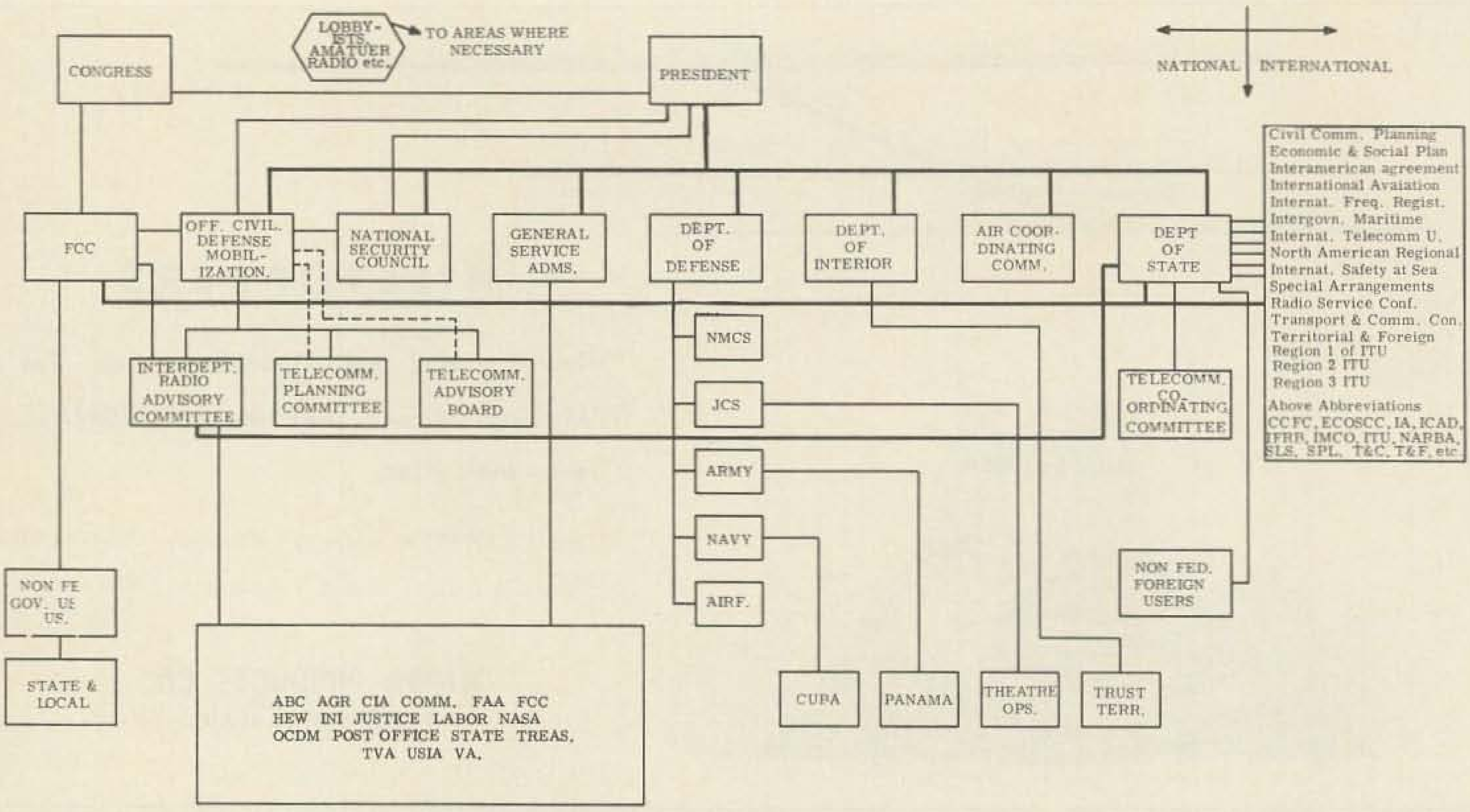


FIGURE 7

The chart Figure 8 shows the 1965 plenipotentiary conference that will affect ham radio.

There are several types of conferences convened by the ITU. Articles 6 and 7 of the Convention describe them and set forth the procedures for calling them. Briefly, depending on the type of conference, they may be convened by the preceding conference of the same type, or when at least twenty Members and Associate Members of the ITU have addressed individual requests to the Secretary General, or on a proposal of the Administrative Council of the ITU.

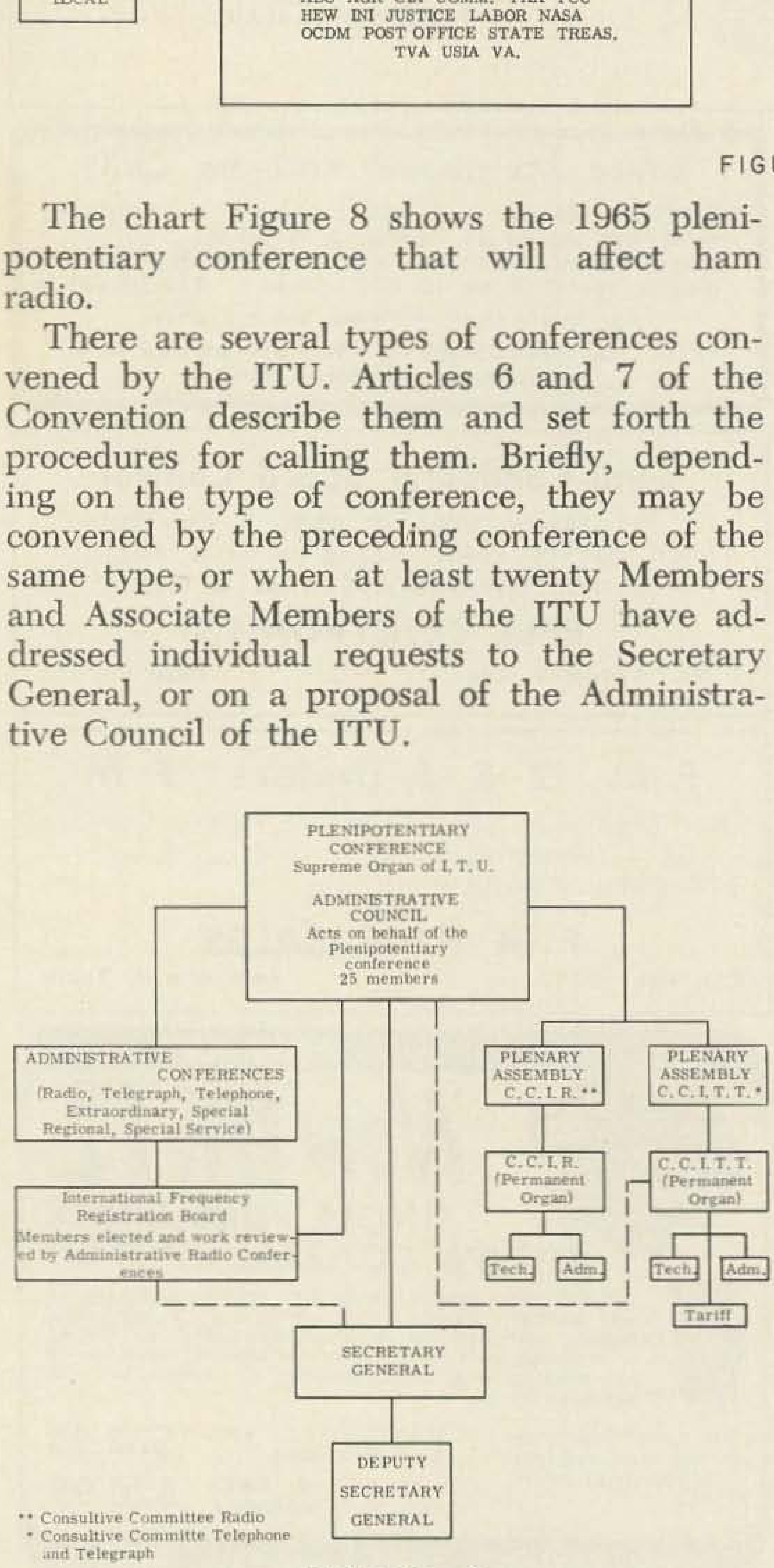


FIGURE 8

A United States Delegation for a conference is made up prior to the holding of the conference and, in general, is composed of persons from Government and industry who are familiar with the subject matter of the conference and have participated in the preparatory work.

We now have three excellent Amateur Radio Magazines to express our views. Through these mediums we can express our views and have some amount of control over the problems. They, in turn, realizing the power of the printed word will use only those things that benefit ham radio. We have too many pesudo experts who rant and rave on the ham bands (with the world listening) about a subject that is unbelievaeably complex while our competition for spectrum allocation has a group of Washington attorneys carefully studying every move and this in turn is coldly calculated and released for publicity. Other groups have taken to poison pen writing and promiscuous mailing. Still other groups, especially clubs have some very fine magazines.

We need lobbying help but there is a way to do it. We have many hams in important places —Senators, Congressmen, sons of ex presidents, high military officers and many others. By proper action the group who is presenting our case can use help—so— know your ARRL Director and see that he represents you read CQ and keep in tune with the times. So let's cooperate and preserve our bands—it is time for everyone to accept what the best minds in radio can do for us. The die is cast for 1965 ITU—let's be sure we don't lose bands—let's gain some—with your letters and ideas to the magazines—we will have the strength of 250,000 minds welded into a single master plan to see that our wonderful, useful necessary amateur radio grows and prospers.

This is the time for QST, CQ, and 73 to do a yeoman job in presenting the best side of amateur radio.

. . . W2DUD

Club Announcements

Win A Trip to Bermuda!

Tired of contests where the only award is a fancy piece of wallpaper? The Bermuda Amateur Radio Contest offers first prize of an airline round trip to Bermuda for two plus a week at Carlton Beach, Bermuda's newest hotel. In addition, high scorer in each U. S. and Canadian call district will receive a handsome certificate signed by the Governor of Bermuda. The contest will be held the weekends of May 2, and May 16, and is for single operator phone or CW stations on 80 through 10 meters. Log sheets and complete rules can be obtained from the Contest Committee, Radio Society of Bermuda, P.O. Box 275, Hamilton, Bermuda.

Birmingham Hamfest

The 11th consecutive session of the Birmingham Amateur Radio Club will hold forth in Birmingham on the week end of May 2-3, 1964. The location is the State Fair Grounds.

The Southern Tier Radio Clubs of Broome County are holding their Fifth Annual Dinner on April 4, 1964, at St. John's Ukranian Hall, Virginia Avenue, Johnson City, New York. Doors open at 5:00 p.m.; dinner will be served promptly at 7:00 p.m. Tickets are $3.50 per adult and $1.75 per child under 12 years of age; reservations must be made by April 1. For tickets write **Harry Spencer, 1165 Vestal Avenue, Binghamton, New York.**

Letters

Dear Wayne:

Please excuse the league stationery but I want to use it up as fast as possible—I may be ashamed to use it at all one of these days if the little people of Newington keep having their way.

I have been a loyal ARRL member ever since I started in ham radio in 1958 at age 47 to satisfy a need for an absorbing hobby following a coronary the year before. Upon getting my general license I immediately dedicated a substantial portion of my available time to serve my community with the new privilege which I had earned the hard way with no technical background. I joined the Wayne County RACES organization serving as assistant zone officer, zone officer and now assistant county officer. I have served in many other ways, such as handling traffic for our service men overseas, relaying emergency messages, etc. I have sent important news messages via radio teletype, for example, my own TV-eye witness account of the shooting of Oswald sent to the S. S. Hope minutes after event, etc. On the technical side, my son, K8JND, and I designed and built a RTTY TU with image inversion and flip-flop section that performs as well as any that I have seen yet. I have some store equipment and I have built about fifteen kits but I have many other things that I and my son have built and developed on a strictly home brew basis with due regard to our gradual self acquired technical knowledge. I believe that, although still not fast at cw, I am a good operator.

With that background, plus a substantial professional education in other fields, I feel that I have the capacity to reach fair conclusions concerning the relative value of organizational endeavors on the part of others who purport to represent the amateurs of the United States. Up to a certain time last year, I continued to support the ARRL in every respect. I sought new members and contributed to the building fund. When the question of incentive licensing came up I considered the matter seriously, not necessarily from my own personal point of view, but from the angle of every ham I knew. I talked with others, young and old, technically inefficient and proficient, and I came to the conclusion that perhaps some form of incentive licensing might be good for the long pull by increasing the requirements of the present examinations but realizing, of course, that technical upgrading alone will never solve the purely operating problems. Some of the most insolvent and provocative hams I know or encountered are so-called old-timers obviously possessing some degree of technical skill but lacking in decency and let's call it amateur "civil rights."

Well, to shorten the story, when I discovered that the ivory tower boys were trying to make a case for license degradation under the guise of the absolute need for mass education I began to think of the injustice to even a minority who deserve and paid for the protection of the ARRL—I began to think about my retired friends who have invested in equipment but through perhaps illness or age itself would be hard pressed to aspire to higher technical demonstration—for what—just to keep their present status. On the other hand if the examinations were only multiple choice questions easily mastered by memorization without the need for sound basic education, what good would the upgrading do in the long run?

Naive as I was I believed that the ARRL would not even consider the question any further if even a substantial minority felt the unfairness of a degradation proposal. When I saw that the wind was blowing in the wrong direction through **QST** editorials and numerous articles and speeches by a handful of professional technicians posing as true amateurs, most of whom, you can bet, got their education and technical backgrounds at the taxpayers' expense either in the service, by G.I. bill or with some government contractor, I finally decided to write a personal letter to each ARRL director and vice-director and our honorable league president to alert them to the pressure that was going on. I made it clear that what I was opposed to was simply the downright degradation and not to incentive itself. Furthermore, I proposed a simple and reasonable solution which has been the basis of upgrading every license privilege since Kingdom Come. A copy of my letter is attached. As you will note it was mailed a few weeks before the fateful "unanimous" decision. For all my trouble, I received a reply from one West Coast director who said it was a fine idea. My own director or vice director did not show the courtesy of even a post card reply, nor did I get a peep out of the president or the little people at headquarters, nor was my letter published or mentioned anywhere. As far as I could see the only negative letters published were bitter and uncompromising in nature, presumably to make sure that most of the membership would feel that these objectors were rabid reactionaries who probably didn't deserve a general ticket in the first place.

I have to admit, Wayne, I used to think you were a screw-ball for taking perhaps somewhat violent stands on various controversial subjects. Maybe you still are, but I have been following you closely on this licensing question and you are right in their pitching for everyone of us and you are right in there pitching for everyone of us whether we like it or not—and I like it.

So, before the little men at Newington decide to disclose any of their other nine points of progress, here is my ten dollars for the Institute of Amateur Radio and let's get with it and a sound and sane representation of all of us who want to protect our beloved avocation from without and within.

Good luck, Wayne, and may the organization rise to the occasion under your leadership.

73

Sincerely Yours,
Everett M. Hawley, Jr.
K8JTT

Dear Mr. Green:

I wish to take this time to compliment both you and your devoted staff for your excellent contributions to the field of amateur radio. During this time of divided feelings something is needed to stand fast and defend the true radio amateur. This is what you are doing. Please continue to hold your ground. There are many of your fellow hams standing behind you.

I have one suggestion in regard to the Institute of Amateur Radio. There are many college students like myself who find it very difficult to find the ten dollars to invest in the very worth while organization. May I suggest a fund for donations where hams like myself can donate whatever amount of money we can spare to support the IoAR?

73,
K8LPD/9
c/o Rose Polytechnic Institute
Terre Haute, Indiana

Dear Wayne:

Being a newspaperman as well as an "old-timer" (first ticket 1916) I am not too avid in this "Letters To The Editor" bit. But as I had occasion to write your Circulation Department anyway, thought I'd toss a bouquet at the same time.

You ARE doing a very fine job now, and have always done so, even when hamstrung by the Cowan group. Being more or less inactive (ham-wise) the past couple of years, I wondered what ever happened to "Never Say Die," and it was only within the past year I noticed "73" on the newsstands and have consequently been taking the publication since. For your over-all information: I am (and have been for years) a member of the ARRL; I disapprove of the methods being used by the Board of Directors and/or the "Executive Committee"; and I am opposed to proposal as set forth by the ARRL. I am of the opinion that there should be and will be some changes made in the license structure, but the "Proposal" isn't it!

As a newspaperman, I like your approach to the entire question, by not going off half-cocked, but rather reviewing the pros and cons of all the facts that can be associated, or affect the proposition in judgment.

R. A. Pedersen, W7FBL
Fallon, Nevada
(formerly: 9NX 9CDN
W9FBL K6ZFW
W7FBL.)

Dear O.M.:

I am enclosing a copy of a letter to the ARRL, which you will see by the date was sent to them at the beginning of their Guerilla Warfare. Today, February 29, marks the end of my membership in the ARRL, I do not intend to renew, for I feel that they do not represent the wishes of the Ham fraternity. And, I know of many more Hams that are going to take the same action, many have already done so.

It is my opinion that the whole mess is without reason. Why?, at this late date must the Hams suddenly be upgraded? All the past years should have been used to upgrade the dignity and consideration for the Hams around the world, this has not been done. All through history and in all endeavors, some bright boys have always moved in with schemes to divide and conquer, always with the theme that they are doing it for the good of the people, who are being deprived of their rights. Could it be that some bright boys have moved in to headquarters and are stirring up this mess so that in the melee, the Hams will be so badly disorganized, that some special interests can pirate some of our bands? Anyone with an ounce of grey matter can see that the whole mess is outrageous.

I was a Ham back in 1908, I have a grandfather's right to an Extra License ,but haven't felt that I should go to the trouble to get it at my age.

Thank the Lord that all through history when a crisis develops someone stands out above all to carry on the fight, it looks like you are the one this time.

I was a charter member of tht old National Amateur Wireless Association. This group and Hugo Gernsback, Major Armstrong, DeForest and many others saved amateur radio when we were supposedly sent down to below 200 Meters, in the rat hole. The amateurs dug their way out with startling results.

Later, Mr. Maxim came up with the idea of Hams relaying messages from point to point, this caught on like wildfire and was the birth of the League. Naturally Mr. Maxim wanted to control his child, and he did a good job, but before he passed over the torch, he should have reorganized, which is the thing he would have done to a personal fortune.

The members are the stock holders, they should elect the Pres'., V. P., and the board of directors. A financial statement should be published yearly, the same as a corporation has to do. A summary of salaries paid and traveling expenses should also be available to any member who asks for it. A complete reorganization is definitely in order, but how can it be done?

I predict that the FCC will turn down this proposal with a Bang! They have done a good job in the past, and I can not bring myself to believe that they will go back on the great Wisdom that they used in 1952.

I would think that the equipment manufacturers would rally behind you in a big way, after all they will be the big losers if this is put over. The league is not "Sacrosanct."

I hope that I have not bored you wtih my Personal Opinions, I am just an old timer, who wanted to get it off his chest.

Paul J. Rasmussen K7EML

Correction

Through a typographical error RG8/U was priced at 85 feet for 69c (a fantastic bargain if true!). The correct price is **69c, 4 for $2.50** for **6** feet with UG-59A/U at each end (still a bargain, but this way we don't go broke).

B C Electronics

2333 S. Michigan Ave., Chicago 16, Illinois

The Vertical J

a simple, inexpensive six meter antenna

Jim Kyle K5JKX
1236 N.E. 44th St.
Oklahoma City, Okla.

Having trouble working 6-meter mobiles who're using whips, with your home-station beam?

Or maybe you're interested in an omnidirectional antenna for CD net use which you can put up or take down in a heck of a hurry?

Or maybe you just want a simple and inexpensive skywire for Six, which you can put together in a very few minutes and which will perform excellently (although admittedly, it's *not* in the same league with a 4-element or bigger beam).

If any of these situations fit you, you might consider using a vertical J. That's what we call it in the Midwest, although the fellows out in 6-land know the same antenna as "the grounded J." This is a simple, fast-to-build antenna which meets all the needs outlined above.

This is *not* a radical new antenna. Its basic principle has been included in the VHF antenna portion of every ARRL handbook I have ever seen, all the way back to the 1943 edition. But this is a case of something being so old it's new again!

Around Oklahoma City, the first vertical J went up something like four years ago (naturally, I mean the "first" of the new generation). It took quite a while to catch on—but today more stations are equipped with Js than are not.

Which isn't saying that Okla. City is a vertical area, for it's not. Many if not most of the J-equipped stations are also equipped with beams. The J is used for local net work and ragchewing with mobiles; the beams come into play when DX is available or when extended groundwave is the object.

So what is this device? Fig. 1 shows what it looks like; the long element is ¾ wave long while the shorter one is ¼ wave. In essence, this is an end-fed half-wave, using a shorted quarter-wave section of parallel transmission line (the lower sections) as an impedance transformer. While it's possible to feed it directly with 50 ohm coax by connecting the shield to the grounded strap across the bottom and tapping the inner conductor several inches up either element, the preferred feed method is shown in Fig. 2—a half-wave "trombone" balun to provide 208 ohm balanced feed, which is then tapped up both elements at the proper point.

Where is this "proper point?" It will depend to a large degree on just how you put the antenna together; best practice is to determine it with the aid of an SWR bridge as will be explained later, but it's usually within 6 inches of the bottom.

Before we look at some more-or-less detailed construction data, let's examine the advantages and disadvantages of this antenna. On the advantage side you have omnidirectional pattern resulting from the vertical polarization; lack of cross-polarization loss when working to whip-equipped mobiles; ease of construction; and positive grounding if recommended construction practice is followed. On the disadvantage part of the ledger you find the introduction of cross-polarization when working horizontal stations, and lack of any antenna gain (although this antenna is usually credited with 3 db gain over a ground plane, for no tenable theoretical reason that I have been able to locate).

If you want one of these, at this writing, you'll *have* to build it yourself since no one I know of makes a commercial model. This, however, is not hard to do. Start out with a long

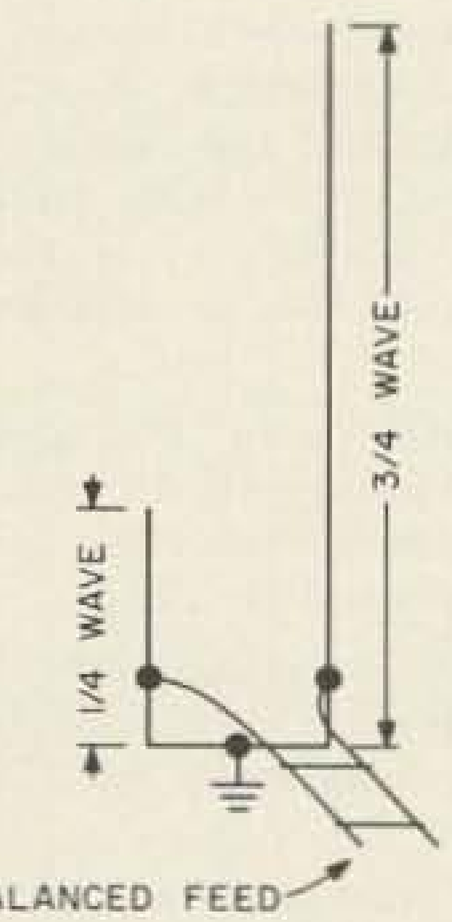


FIGURE 1

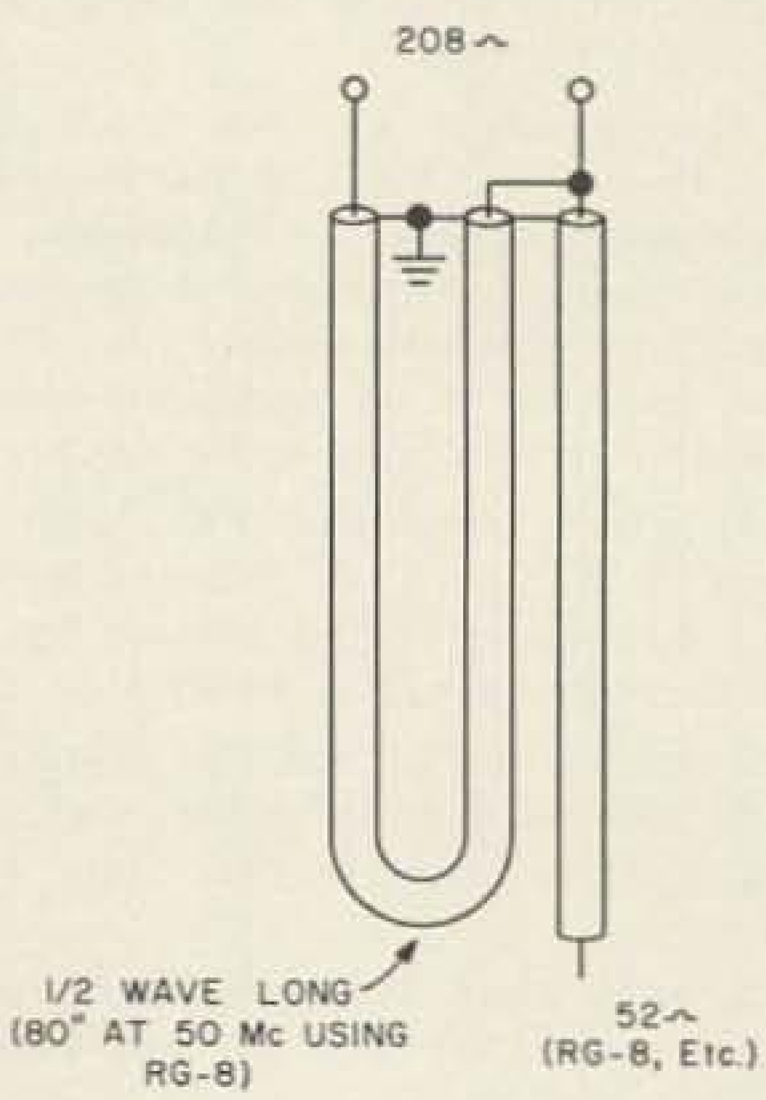


FIGURE 2

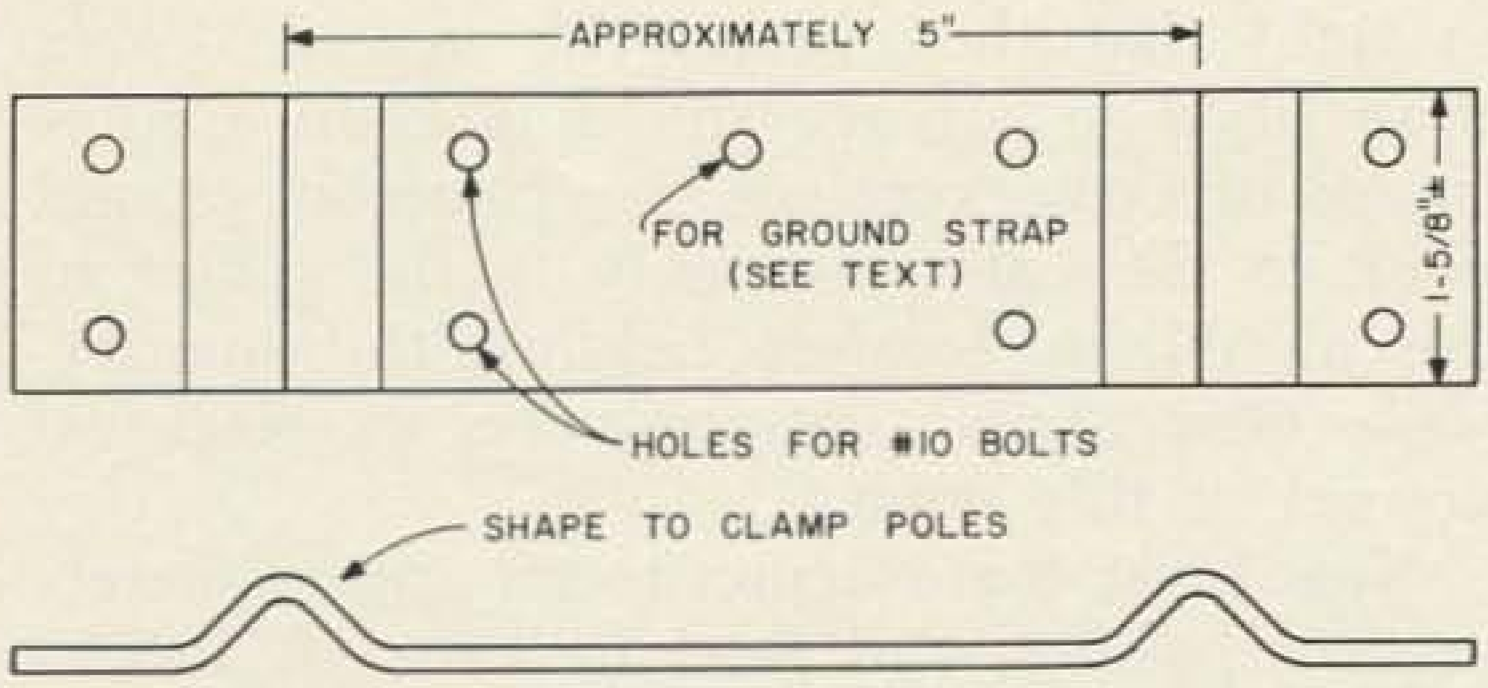


FIGURE 3

supporting mast. Telescoping TV poles will do. Extend the top end of the mast the required ¾ wave distance above the upper guying point. This will be approximately 15 feet, requiring a 5-foot extension if you use a telescoping stick.

Shape two straps similar to Fig. 3 from ⅛ inch aluminum (a 1⅝ inch relay rack panel comes in handy as a source of raw material at this stage) and bracket the quarter-wave element to the pole just above the guy point as shown in Fig. 4. Scrape all metal surfaces clean and tighten screws fully, since this is a high-current point and any resistance will cause power loss.

Form a similar set of straps from ⅛ inch Plexiglass or Lucite. Most cities of any size at all now have plastic-sign shops which provide a source of this material from their scrap piles. To bend the plastic, soak it in boiling water until it softens and then bend rapidly, holding in place until cool. Attach this insulating bracket near the top of the quarter-

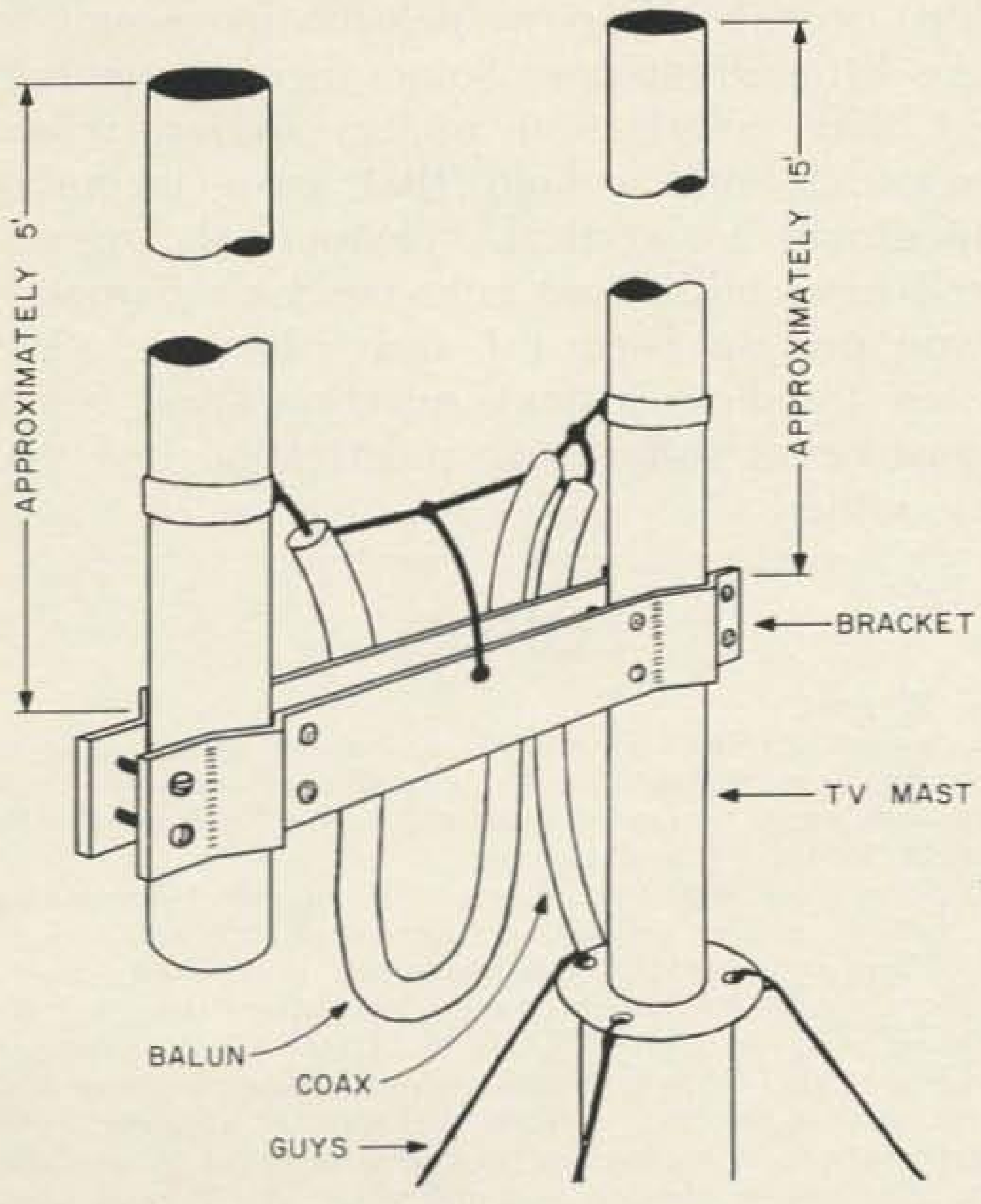


FIGURE 4

wave element to maintain spacing and to support the element.

Now prepare your balun as shown in Fig. 2, and solder each center conductor (the 208 ohm connection points) to a radiator-hose clamp of proper size to slip over the antenna elements. Slip the clamps over the elements (this may require partial disassembly of the antenna or may not, depending on your clamps. If you use the "universal" variety, no disassembly should be necessary) and tighten them just enough to hold in position but not so tight that they cannot be moved. Using strap braid or salvage shielding from a short chunk of coax, connect the common ground point of the balun assembly to the center of the aluminum bracket holding the quarter-wave element on. This provides an electrical ground at this point.

Now hoist the antenna to an approximately vertical position and feed in some rf. If you have a source of about 5 watts or less you can make adjustments with power in the line; If you use higher power it's best to turn the rig off unless you have a special fondness for rf burns. With an SWR bridge in the coax, preferably as closely as possible to the balun, slide the clamps up and down on the antenna until you get a reading of 1.0 (or as close to this as you can) at your favorite operating frequency.

The only remaining step is to tighten the clamps down firmly so they won't slide, and waterproof all connections by spraying with Krylon or similar plastic. Tape the coax to the side of the mast as you raise the antenna into position, and prepare to work the world!

If you have never experimented with cross-polarization, be prepared for a surprise. Losses due to this factor alone *can* be as great as 20 db. This means that you may find 20 db improvement on whip-equipped mobiles compared to your past results with a beam—but it also means you may find 20 db loss on halo-equipped mobiles or beam-equipped fixed stations. Strangely enough, on Sporadic-E (skip) signals the cross polarization seems to make little difference. Some theories tend to hold that polarization rotates during reflection, while others hold that most incoming skip signals are vertical. Whatever the reason, you'll have additional enjoyment on 6 meters if you put up *both* a J and a beam, with a switch to allow instant selection. And you'll almost never suffer cross-polarization loss that way, either!

Letters

Dear Wayne:

Lying on my back in a hospital bed for pretty close to a month gave me a chance to really go over the still rather numerous pieces of mail which the XYL graciously brought to me each afternoon.

With a break like this, I was able to sort from among the various pieces (including the usual "riff-raff" which we all get and resent) the items which really had "meat" in them. I kept coming back time after time to the INSTITUTE of AMATEUR RADIO which you initiated in 1962. Weighing this against what we have had in the past some 50 years in the way of amateur radio representation, it became increasingly apparent to me that very definitely a change was indicated. As I read more and more, through your editorials in "73" and the occasional IoAR bulletins, the more thoroughly I became convinced that you had a new and fresh grasp on the requirements, legal and otherwise, which would serve to keep ham radio alive and active. It has becom increasingly obvious that present representation through what has become a more or less "smug" organization (ARRL) has fallen by the wayside and continues to do so. Rather than being representative of the amateur body as a whole, it has degenerated into "amateur radio for the few elite" who sit in the top spots. Perhaps a few in the upper brackets were beginning to see the hand-writing on the wall. As the saying goes, "Hell was paved with good intentions." While I have never had any particular admiration for Budlong, he did do a better job than Huntoon has been able to compete with. Being of the "old school," I still deplore the lack of leaders like Hiram Percy Maxim Jr., and Clarence Tusko. I joined the League which they established, along about 1914 and found it run honestly and with sincerity; I wish I could say so now! On the contrary, I have found it essential to send the ARRL a letter terminating my membership therein (copy enclosed for your information). I think that a very great number of their membership, has done the same.

At some instigation from the Pacific Northwest area of radio amateurs, I ran successfully for Vice-Director of this section, and served in this capacity for the full two-year term (Jan. 1, 1957 to Jan. 1, 1959). What with financial reports as well as administrative order copies, I really became appalled. When elections for Director came up, I was urged to put in my oar; (this may sound like "ego" but I don't mean it that way). I frankly refused although (maybe "ego" again) I feel that I could have probably overcome the incumbent. I wanted no part of it; I had seen enough of that kind of politics during my period of service (?) as Vice-Director! This division has gone along for way too many years with the same director who has actually accomplished nothing for the amateurs of his division. Granted that perhaps a very great deal of the fault lies with the hams themselves, as they very evidently did **not** tell the director what they thought; what they wanted, yet it does not excuse the director from putting his finger on the pulse of his division, which he did not and does not do, other than attending local, regional and divisional "conventions" where a lot of vocal "blow-hard" supposedly takes the place of sincere action.

Frankly, I don't like to write this kind of a letter and seldom do. It seems to be in order in this instance however, as I think that all of us, at least the majority who are dyed-in-the-wool hams, are mainly interested in preserving and fostering the grand and glorious "hobby" of ham radio. In present administrative hands (yes, I mean ARRL), it is becoming less and less of a "hobby" and more and more of a "political" issue; there is your chance to bring it back where it belongs, thru IoAR.

Sure, I know, as does every ham with a few years background, that commercial and military interests, continuing their fight of many years, are constantly trying to "grab" our frequencies. It is going to take intelligent (not political) representation for the hams as a whole, to hold together what we have; again, there is your opportunity.

I could go on and on, Wayne, and actually say little more. I think the above paragraphs express my individual feelings. I am going to add only a few words of "caution" if you want to call it that. The ARRL as we all know, after soliciting funds from any member who would stand still for it, built themselves a most impressive new headquarters building. To a more modest extent (37 room house, plus a recently acquired ten room domicile to which can be added a 5 room mountain-top VHF spot), you are dangerously approaching a parallel. Maybe you and Virginia haven't considered, and maybe frown on, a mid-continent location, but you might keep it in mind in the event of future expansion! An awful lot of hams with whom I have talked (and they've been many over the past half-century), seem to resent the idea of a ham headquartrs being way up in the northeastern part of the United States. Maybe this is a hint which will let your growth go by leaps and bounds . . . certainly the Mississippi valley for example, doesn't have much more snow, ice and unfavorable weather than your part of the country! We don't even know what snow, snow-shovels etc. are in our little ol' Pacific Northwest, but actually, you'd be better off in mid-US, administratively!

Name withheld as requested. Re our location: if anyone can come up with a place where we can get by as inexpensively as we are I'll listen. I doubt it. There are other factors too: our mountain VHF shack is virtually unique in that we can shoot a signal on any VHF band right on down to Washington; this is one of the most beautiful areas in the country; big cities and publication printers are all nearby.

ex ARRL Member

Dear Wayne:

With all the fuss and bother of moving into a new apartment I haven't been paying much attention to the licensing controversy lately, but I am enclosing $20 for your efforts in behalf of amateur radio throughout the world—with pleasure. I feel it's only a small fraction of what it's worth to me personally to keep ham radio intact as far as frequencies are concerned. I approve of your stated principles and hope they will bring our aims at the Conference to fruition.

You will notice that I have also enclosed my vote in your poll, but it's not on one of your blanks, but on some that Bill Orr printed up for the occasion, as you undoubtedly have heard by now. More power to him; hope he helps you get greater results than anticipated.

The last couple issues of *QST*, in small ways, appear to indicate that ARRL realizes other methods besides incentive licensing will have to be resorted to in order to insure our well-being at Geneva. I would certainly support anything they come up with, but it's a shame that there's not more of an open attempt to scrap all the old saws and get with the 20th century.

I see by *Time* magazine that you're running for Vice-President! Good luck!

Alexandria, Virginia 22311
Fred Laun, W9SZR/4

Dear Wayne,

Just reviewed Feb. CQ. Can this Trossman be for real? His editorial comment . . . "it is rumored that the ARRL is seriously considering placing a working office at Geneva" . . . is that a QST leak? A bellwether for Huntoon in payment for the long "Me Too" attitude of CQ?

As to your "up-dating program for the ARRL" . . . off hand I could write you a jillion words on the subject. One thing, long ago forgotten, is that as positions in the League open up there should be competitive bidding for such jobs from licensed members of the ARRL and a selection made by the Exec Committee, not by salaried ARRL officials only. Further, an immediate increase in ARRL membership dues to a minimum of $10 a year. QST should drop the monthly SMC reports under the title of "station activities" using the space for Director reports . . . when and as needed; and if not used, cut the size of QST down and thereby realize savings which should go into our Geneva defense funds. In fact, all ARRL-QST functions should be evaluated to the end of saving money and in turn building up a defense fund. Many and more items for League improvement are evident and I am sure you have adequately covered them; the above, less obvious, are sent along from recollections of motions and petitions I made when a Director.

Len Collett KZ5LC

(W2NSD/1 from page 4)

lows who haven't been following my editorials would do well to be cautious for our group is quite dedicated.

Some of the jobs to be done are: preparing copy for offset printing, making negatives and stripping them in, sorting out material for the Institute bulletin from press clippings and stories sent in by readers, keeping our Washington mailing list up to date, plus we need more help with circulation, advertising, and the preparation of articles for 73.

Salaries aren't great here yet, though they are improving. We do have one of two apartments available for families and plenty of space for single fellows or gals to room and board in. We have a lot to do and we're growing fast . . . perhaps you'd like to grow with us. Send full information on your background: schooling, all the jobs you've held draft status, when you will be available, photo, other hobbies, etc., to Ron Lyon W5WNF/1, our personnel director.

We'll have room for a few fellows this summer, but after our try last year the 73 Summer Camp will have to be on the basis of room-board and $5 a week unless Virginia puts her foot down.

Dayton April 25-26

Virginia and I are going to blast loose from Peterborough a little more this year, venturing out to a few conventions. Naturally one that we certainly don't want to miss is the Dayton Hamvention . . . I've been going there for a long number of years. This year they've finally moved their show into bigger quarters and we may just be able to move around from exhibit to exhibit. The Hamvention has been, to my mind, one of the most perfect conventions going. It has always been well organized, they've specialized in giving a multitude of smaller prizes so that hardly anyone goes home empty handed. I'm still using the Turner mike I won there eight years ago.

The new spot, Wampler's Arena, 1001 Shiloh Springs Road, will be serviced by a bus which runs every twenty minutes from downtown Dayton. They've got ten acres for cars to park . . . it probably won't get too crowded.

In addition to selling subscriptions to 73 and vending a few Radio Bookshop books, I'm on the program to answer any questions you all may have about the Institute of Amateur Radio.

If you want to pre-register drop a note to Dayton Hamvention, Box 426, Dayton 1, Ohio.

6-up

The ninth issue of 6-up is going to press now. The big feature in this issue is a construction article by Bill Ashby on his Flying Noise Lock unit which is described in theory in this issue of 73. Bill wanted us to run the circuit in 6-up exclusively in order to bludgeon more fellows into subscribing to 6-up. Laudable. I hated to see such an important breakthrough get only six thousand circulation when it should be out for everyone to read. We'll run the article in 73 next month . . . this month you'll have to get 6-up if you want the details.

More Mischief

Among the flood of publications that pour in here each month is a little satire magazine, The Outsider's Newsletter. One of the editors, Marvin Kitman, decided to enter the New Hampshire primary as a presidential candidate in the interests of a good yarn. In reading over the steps necessary I noticed that the official petition form had a place on it to run for vice president. Hmmm. There is always some crack-pot running for the presidency, but I couldn't recall any crack-pots running for vice president.

The Secretary of State of New Hampshire couldn't remember any crack-pot ever running for vice president either. Obviously a volunteer was needed for a new first.

We had quite a time getting the 100 signaturs for the petition, but we got 'em. Kitman didn't. Our primary will be March 9th and I will win, since I am unopposed. Fortunately this means absolutely nothing since the only purpose of the New Hampshire primary is to indicate the *preference* of the New Hampshire people.

When people ask me why I was running for vice president I usually explain to them that it's every red blooded American boy's dream to be president, but that it seemed to me that there was just too much politics involved in getting that job the usual way and that I thought I'd go for vice president, a job no one else wants, and then sit back and wait. After all, I point out, the pay is excellent, you get lots of free travel and you aren't too pressed unless the president gets a bad break. I tell 'em all this with a straight face and they seem to believe me . . . trusting folks up here.

I have, for those of you who do not take life too seriously and whose tongue is still flexible enough to fit in your cheek, some nice bumper stickers saying GREEN FOR VICE PRESIDENT. A stamped self-addressed envelope and I'll send you along a couple for your car. They're special ones that will peel off without difficulty in case you change your mind. A couple thousand of these around the country will drive the professional politicians out of their minds. It's a worthwhile cause, isn't it?

Swampscott May 9-10

This is the largest hamfest going. There are so many fellows here that you can go for two days talking to friends and still miss seeing people. They'll have plenty of exhibits, contests, talks, demonstrations, and entertainment. Tickets are $3 before April 19th, banquet $5.50. Send $$ to John McCormick W1KCO, RFD #1, Berkeley St., Tauton 1, Mass. Virginia and I and the whole staff of 73 will be down for this one . . . look for us. I'm one of the speakers so have your wits sharpened and ready to ask questions on anything.

Value

One reader wrote in saying: A ham is a fellow who has an $800 transmitter, a $400 receiver, a $300 tower, a $150 beam, a $100 rotator, a $600 transceiver in his $3000 car, and won't spend $10 on the Institute of Amateur Radio as insurance that he will be able to use all this.

. . . Wayne

73 parts kits

In the interests of making home construction simpler for those readers with anemic junk boxes 73 has gathered together the parts required for building our less complicated projects. These kits are as complete as we can make them, containing good quality parts. Except where the chassis or case is integral to a unit we do not supply it. We will mention when we do supply a case or chassis. We do supply tubes, sockets, condensers, resistors, transformers, connectors, etc. The kits are kept in stock to the best of our ability, though sometimes the distributors who supply us delay us a bit.

TWO METER PREAMPLIFIER. Uses two 6CW4 nuvistors in a grounded grid input circuit (March '63 p8) and one 6CW4 nuvistor grounded grid output. Complete with power supply. Uses 50 volts on the plates for extraordinary noise figure. Full scale drilling template supplied.
W9DUT-1 .... $18.50

TRANSISTOR TRANSCEIVER. One of the most popular kits we've ever assembled is this six meter miniscule transistorized transceiver. Really works. Hundreds built. See page 8 in the May '63 issue. Five transistors.
K3NHI $25.00

CW MONITOR. Connects right across your key and gives you a tone for monitoring your bug. Page 44, June '63.
WA2WFW $4.25

TWOER MODIFICATION. Increase your selectivity considerably by installing a new triode 7587 nuvistor stage. This is our best selling kit to date. Everything you need for the modification is included. See June '63 page 56
K6JCN $6.50

SIX METER CONVERTER, DELUXE. 6EW6 low noise front end, 6U8 oscillator and mixer. Output is 10.7 mc (easy to change to suit your needs). This is a tunable converter with fixed frequency output, not the usual converter that requires you to tune the receiver. This helps considerably on eliminating interference from nearby high power stations. See page 8, July '63.
W9DUT-2 .... $20.00

NOISE GENERATOR. Invaluable test instrument for tuning up rf stages, converters, etc., voltage regulated by a Zener diode. Kit includes even the battery and mini-box. See page 15, Aug. '63.
K9ONT $5.00

QRP TRANSMITTER. Have fun with this little one half watt CW rig on 40 meters. Uses any 40M surplus crystal. Kit supplies 1S4 tube and socket, condensers, resistors, coil, rf choke, terminal trip, etc. Runs from flashlight battery for filament and portable radio 67½ volt B-battery. See March '63 p22
W1MEL $6.00

CAST IRON BALUN. Eentsy balun using ferite core, covers 6-40 meters, will handle up to 20 watts, complete with cabinet, connectors, etc. See September 1963 page 8.
W4WKM-1 .... $3.00

TONE MODULATED CRYSTAL STANDARD. Uses one tube and one mc crystal to generate 1 mc markers all the way up through 225 mc. The built in tone generator makes it possible to easily identify the markers. Including Minibox, tube, vrystal, etc. See Oct. '62 p 26.
W9DUT-3 .... $12.95

TRANSISTORIZED MODULATOR. 40 watt modulator, excellent for plate modulating mobile rigs, four transistors, uses 12 volts dc, only draws 250 ma while resting with peaks of 4-5 amperes. Kit includes transistors, transformers, resistors, condensers, etc. See Sept. 62 p 24.
VE7QL $27.50

SHORT WAVE CONVERTER FOR HAMBAND RECEIVERS. One tube short wave converter so you can tune SW broadcast stations. Power supply included. See Aug. 62 p 38.
W2LLZ $13.00

RECEIVER-DECEIVER. Substitute local oscillator for your receiver for sideband reception, complete with power supply, tubes, voltage regulator, etc. See Jan 64 pg 30.
W2RWj $19.95

HAM BAND AUTOMOBILE CONVERTER. Listen to the hambands instead of that rocky-roll junk. Transistor converter, complete with battery, etc., mini-box, coax cables, crystal for either 20M or 75M. Crystal controlled. See Jan. 64 pg 36.
VE2AUB $7.95

WRETCHED K2PMM

BADGES $1.00 each.

Individually engraved badges: $1.00 Room for first name and call, 3" x ¾", with pin and safety lock. Specify whether you prefer red with white letters or black with white letters.

BADGES FOR CLUB MEETINGS & HAMFESTS

Club badges 3" x 1" with name or initials of club on one line and first name and call on second, in groups of five or more: $1.50 each.

Order from

73 Peterborough, N. H.

OTHER 73 BULLETINS AND BOOKS

6UP Magazine. Now in its fifth month with back issues getting rarer and rarer. This VHF monthly magazine is edited by Jim Kyle K5JKX and presents up to the minute reports on activities on all VHF and UHF bands, technical articles of interest to VHF'ers, and other general information not to be found elsewhere. This is the only strictly VHF magazine being published now. If you are a VHF'er you won't want to miss a single issue of 6up . . . you should support it. Subscriptions are only $2 per year, back issues are available at present for those who would like a retroactive subscription.

ATV Bulletin. In direct refutation to the ARRL claim that amateurs are lagging technically are the 2000 readers of the semi-monthly Amateur Television Experimenter Bulletin, edited by W0KYQ. If you are at all interested in amateur television you should subscribe to ATV, the only source of operating and technical info on this amazing branch of our hobby. Back issues are virtually all sold out, so don't put off subscribing. $1 a year for six issues.

Ham-RTTY. This is the most complete book on the subject. Written for the beginning TT'er as well as the expert. More complete and authoriative than books at twice the price. Pictures and descriptions of all popular machines, where to get them, how much, etc. $2.00

Bound Volumes 1, 2, 3. Complete library volume containing the 1962 issues of 73. $15.00

Binders. Bright red leather binding. Specify which year you want stamped on them: 60-1, 62, 63, 64. Darbs. $3.00 each

Care and Feeding of Ham Clubs—K9AMD. Carole did a thorough research job on over a hundred ham clubs to find out what aspects went to make them successful and what seemed to lead to their demise. This book tells all and will be invaluable to all club officers or anyone interested in forming a successful ham club. Hundreds of grateful letters have been received from clubs who have applied the ideas in this book. $1.00

Simplified Math for the Hamshack—K8LFI. This is the simplest and easiest to fathem explanation of Ohm's Law, squares, roots, powers, frequency/meters, logs, slide rules, etc. If our schools ever got wind of this amazing method of understanding basic math our kids would have a lot less trouble. 50¢

Index to Surplus—W4WKM. This is a complete list of every article ever published on the conversion of surplus equipment. Gives a brief rundown on the article and source. $1.50

Ham-TV—WØKYQ. Covers the basics of ham-TV, complete with how to get on the air for under $50. Not the usual theory manual, but a how-to-do-it book. $3.00

Surplus TV Schematics. You can save a lot of building time in TV if you take advantage of the real bargains available in surplus. This book gives the circuit diagrams and info on the popularly available surplus TV gear. $1.00

AN/ARC-2 Conversion. This transceiver sells in the surplus market for from $40 to $50 and is easily converted into a fine little ham transceiver. Covers 29 mc (160-80-75-40 meters). This booklet gives you the complete schematic and detailed conversion instructions. $1.00

AN/VRC-2 Conversion. Completely different from the ARC-2. This book gives you complete instructions on converting the inexpensive VRC surplus gear into a six meter wide band FM transceiver. There are probably over a thousand stations now operating on 52.525 mc around the country. Join the crowd. Fun. $1.00

Coils—K8BYN. Basic book which covers the theory and practical aspects of the many different types of coils found in ham work. Well illustrated. 50¢

CW—W6SFM. Anyone can learn the code. This book, by an expert, lays in a good foundation for later high speed CW ability. 50¢

3D Map of World. Maybe you've been eating your heart out for one of these beautiful relief maps after seeing one at a friend's shack. Comes complete with one year subscription or extension to 73. $9.95

3D Map of U. S. Complete with one year sub to 73. $9.95

Mickey Miker—WØOPA. Complete instructions for building a simple precision capacity tester. Illustrated. 50¢

Frequency Measuring—WØHKF. Ever want to set yourself up to measure frequency right down to the gnat's eyebrow? An expert lets you in on all of the secrets. Join Bob high up on the list of Frequency Measuring Test winners. $1.00

Impedance Bridge. Full scale construction prints for the bridge described in the August 1961 issue of 73. Comes complete with a reprint of the article. Watch out General Radio! $1.00

SSB Transceiver Schematic—W6BUV. Giant size schematic of the transceiver that appeared in the November 1961 issue of 73. Complete with extra November issue. $1.00

Radio Bookshop

11—16TH EDITION RADIO HANDBOOK—by Bill Orr W6SAI. This fantastic book is loaded with the most understandable theory course now available in our hobby plus dozens of great construction projects. This is the best ham handbook in print by a wide margin. Easily worth twice the price. **$9.50**

13—REFERENCE DATA FOR RADIO ENGINEERS. Tables, formulas, graphs. You will find this reference book on the desk of almost every electronic engineer in the country. Published by International Telephone and Telegraph. **$6.00**

21—VHF HANDBOOK—Johnson (W6-QKI). Types of VHF propagation, VHF circuitry component limitations, antenna design and construction, test equipment. Very thorough book and one that should be in every VHF shack. **$2.95**

22—BEAM ANTENNA HANDBOOK—Orr (W6SAI). Basics, theory and construction of beams, transmission lines, matching devices, and test equipment. Almost all ham stations need a beam of some sort . . . here is the only source of basic info to help you decide what beam to build or buy, to install it, how to tune it. **$2.70**

23—NOVICE & TECHNICIAN HANDBOOK—Stoner (W6TNS). Sugar coated theory: receivers, transmitters, power supplies, antennas; simple construction of a complete station, converting surplus equipment. How to get a ham license and built a station. **$2.85**

24—BETTER SHORT WAVE RECEPTION—Orr (W6SAI). How to buy a receiver, how to tune it, align it; building accessories; better antennas; QSL's, maps, aurora zones, CW reception, SSB reception, etc. Handbook for short wave listeners and radio amateurs. **$2.85**

Car Plates

Sixteen states have only one plate this year . . . this is a good time to put a call letter license plate on the front of the car. Specify color of background, color of call, and wording for the bottom line. **$3.00**

37—101 WAYS TO USE YOUR HAM TEST EQUIPMENT—Middleton. Grid-dip meters, antenna impedance meters, oscilloscopes, bridges, simple noise generators, and reflected power meters are covered. Tells how to chase trouble out of ham gear. 168 pages **$2.50**

26—59 SIGNALS—Orr (W6SAI). A manual of practical detailed data covering design and construction of highly efficient, inexpensive antennas for the amateur bands that you can build yourself. **$1.00**

27—QUAD ANTENNAS—Orr (W6SAI). Theory, design, construction, and operation of cubical quads. Build-it yourself info. Feed systems, tuning. **$2.85**

28—TELEVISION INTERFERENCE—Rand (W1DBM). This is the authoritative book on the subject of getting TVI out of your rigs and the neighbors sets. **$1.75**

32—RCA RADIOTRON DESIGNERS HANDBOOK—1500 pages of design notes on every possible type of circuit. Fabulous. Every design engineer needs this one. **$7.50**

63—GE TRANSISTOR MANUAL—6th edition. This is one of the best buys around: 22 chapters, 440 pages, diagrams by the grass, data, facts, charts, etc. If you don't have this one you just aren't up to date. only **$2.00**

SPECIAL SPECIAL SPECIAL

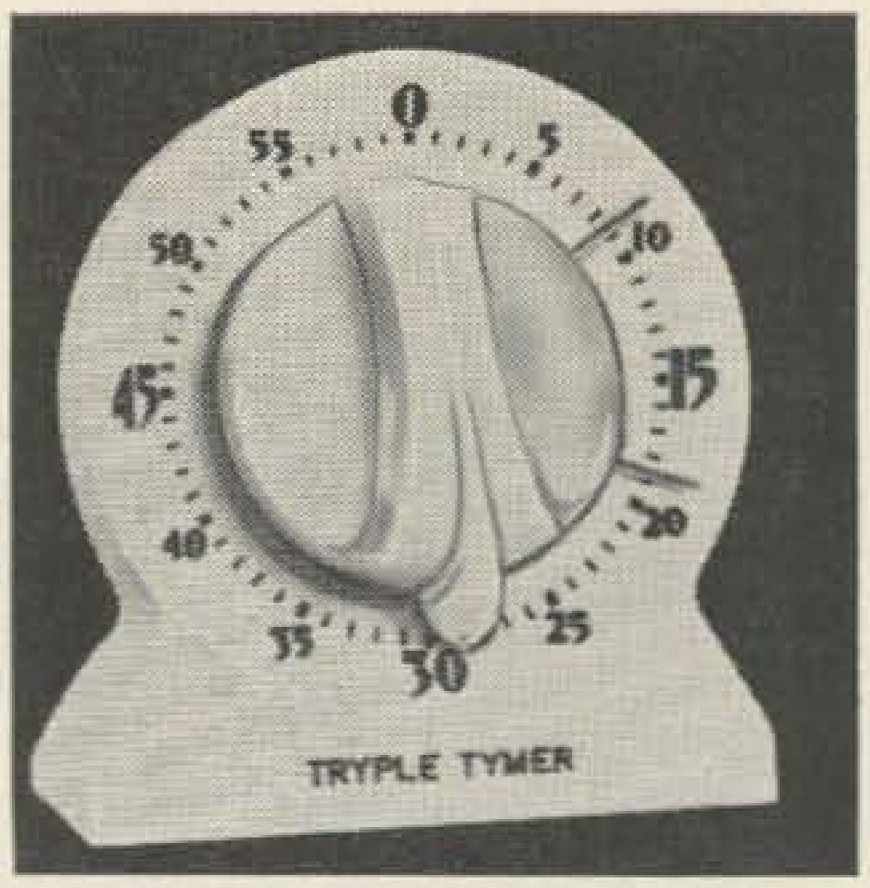
Radio Handbook, 15th Edition, written by Bill Orr W6SAI, over 800 pages. Covers every phase of amateur radio from the very basics right up through the construction of just about everything you could want in ham gear. Originally published at $8.50. Superceded by the new 16th edition which is the same except for new construction projects and selling for $9.50 (see number **11**). Special, until the last few copies are gone, only **$5.95!**

100—ELECTRONIC CONSTRUCTION HANDBOOK by W8MQU. Covers all sorts of info on how to build. **$2.95**

104—SCIENCE HOBBIES—Eleven American made semiconductors with instructions for making an automotive tachometer, a photocell light meter, a transistor preamplifier, an audio oscillator, a transistor regulated power supply, speech clipping, cathode biasing and screen biasing circuits. A $29.95 value **$2.98**

107—THE AMATEUR RADIO HANDBOOK—Published by RSGB. This is a thorough and complete 540 pages handbook which covers every aspect of amateur radio: tubes, transistors, receivers, transmitters, VHF gear, sideband, FM, antennas, mobile gear, noise, power supplies, and much, much more. You'll find this one suite interesting and informative. **$5.50**

108—RADIO DATA REFERENCE BOOK—Published by RSGB. This contains all of the formulas that you have to hunt around for when you want them, all in one place and indexed. There are such items as feedline charts, coax tables, yagi measurements, pi-net charts, wire tables, conversion factors, logs, thread sizes, reactance charts, filter design charts, etc. **$2.25**



116—TRIPLE TIMER. Works like regular kitchen timer except dings at three separate times. Fine for 10 minute reminders. Set once and it will ding every ten minutes for 30 minutes. Many other uses. Can be set to ring at any time intervals up to full hour. **$4.95**

109—AMATEUR RADIO TOWER INSTALLATION INFORMATION—published by Rohn. Nearly 100 pages of info on selecting, buying and setting up towers for amateur radio. While this book is one of the most complete catalogs of Rohn towers ever published, it also has all the instructions you could possibly want on installing your tower. Lots of good color pictures. Well worthwhile. **$1.25**

112—COMMUNICATIONS RECEIVERS—Design considerations and a practical design for radio amateurs. Nicely written 32 page book discusses various stages and presents a fine receiver design for home building using regular commercially available parts. **75c**

113—TRANSISTOR RADIO HANDBOOK—Simplified theory and many ham construction projects, including SSB exciters, SSB transceiver, VHF xmtrs and rcvrs, etc. **$5.00**

114—RSGB BULLETIN—One year subscription to the most popular amateur radio magazine in England. Top notch. **$5.00**

ARC—PRACTICAL HAM RADIO PROJECTS—W6NJV. Complete construction details on 12 projects, including a 500 watt all band linear, all band antenna tuner, electronic keyer, 6 M mobile xmtr, 2M superhet, transistor dipper, etc. **$2.50**

HTF—ELECTRONIC TABLES AND FORMULAS. New revised edition. 192 pages of info. Hard bound book. **$3.95**

SSH5—TRANSISTOR SUBSTITUTION HANDBOOK, 5th EDITION. With over 5000 different type numbers of transistors what do you do when one g west? You look up the nearest replacement you have on hand in this book. It lists foreign transistors too. Very thorough. **$1.95**

RSG2—NORTH AMERICAN RADIO-TV STATION GUIDE, 1964 EDITION. All stations listed by call, frequency, and location. Over 5000 AM, 1500 FM and 1000 TV stations. **$1.95**

CBH2—CITIZENS BAND RADIO HANDBOOK, 2nd EDITION. All the latest equipment, operating techniques and requirements, antennas, maintenance, adjustments, etc. Complete rules, call area map. **$2.95**

Send check or M.O. to:
Radio Bookshop
Peterborough
New Ham Shire

Subscriptions

If you like 73 we'd appreciate your help in getting more fellows to subscribe. The big difficulty is to overcome inertia and actually get them to sit down to get it done. We try to make it as simple as possible on our end. The price is a simple (and low) $4. Our address is simple: 73, Peterborough, N. H.

MASTER ORDER BLANK

73 Subscriptions — Name________ Call________

1 yr $ 4.00________ Address________

2 yr $ 7.00________ City________ Zone________ State________ Zip________

3 yr $10.00________ Parts Kits (page 90) Bookshop (page 92) One year subscriptions

LIFE $50.00________ $6up $2________ ATV $2________

New sub.________

Renewal sub.________ IoAR Membership 1 yr $10________

Start with________ 73 Products: (page 89)________

Back issues (50c each)________

Badge. Red____, Black____. (page 90) First name:________ Call ________ $1.

INDEX TO ADVERTISERS

To aid you in finding ads which are not running in this issue we have listed the last ad run by each company in 73.

SELL TRADE BUY

HEWLETT PACKARD

205AG Audio Generator $325.00 • 130B 'Scope $350.00 • 540B Transfer Oscillator . $600.00 • 212A Pulse Generator $350.00 • 302A Wave Analyzer $1200.00 • 683C 2 to 4 KMC Sweep Oscillator like new $1800.00 • 650 Test Oscillator $300.00 • 410B VTVM $150.00 • 202A Function Generator $250.00 • Ad-Yu Precision Phase Angle Voltmeter #405L $450.00 • Boonton 202B, AM-FM Signal Generator 54-216 MC $375.00

SIGNAL GENERATORS

Ballentine 300 VTVM ... $[illegible]9.00 • Hewlett Packard 430B Power Mtr $120.00 • TS-382D/U Audio Gen. 20cps to 200kc $295.00 • TS-268D/U Extal Rectifier Test Set $17.50 • TS-375A/U VTVM $65.00

METERS

Dumont 304AR Scopes ... $195.00 • Dumont 256D Scopes ... $90.00 • Dumont 324 Scopes .... $245.00 • Boonton 212A Glide Scope Tester L/N ... $375.00

SPACE ELECTRONICS

4178 PARK AVE. BX, N.Y., 10456
TELEPHONE CY 9-0300

SCOPES

PL-259, SO239, M-359-UG 100A/U New Any 3 $1.00 • Collins 51J3 Receiver $555.00 • AN/URM-26 Sig Gen 4mc to 408mc ... $295.00 • Hewlett Packard 200CD Audio Generator . $130.00 • Hewlett Packard 400DR VTVM $140.00

RECEIVERS

SP-600 JX—540kc-54mc/s ... $450.00 • R-390 Digital Job 500-32mc/s $790.00 • URR-13 225 to 400mc/s ... $320.00 • CR-10 RCA Fixed Freq. .. $75.00 • Wilcox F-3 Fixed Freq. .. $65.00

FREQUENCY METERS

TS-174/U Freq. Mtr 20mc to 250mc/s $150.00 • TS-175A/U Freq. Mtr 85mc to 1000mc/s .. $135.00

BUYING! BUYING!

What have you got? We'll give fast, high quote. Particularly need AN/APR-9, 13; AN/GRC-3 thru 8; AN/ARC-27, 34

GOT QUESTIONS? ORDERS? CALL COLLECT. EVERYTHING MONEY BACK GUARANTEED. THIS IS ALL WE COULD LIST IN THE SPACE. WE HAVE LOTS MORE. TELL US WHAT YOU NEED.

RIPPLE FILTER KIT Smooth out your 6 or 12 volt supply for transistor work 1 32 Mh Choke 1 25,000 Mfd. Cap. with mount. **Only $3.95**

STUD MOUNTED DIODE RECTIFIER 2 Amps @ 200 p.i.v. 2 with reversed polarity **4 for $2.00**

100 Mfd. @ 450 volts Paper Electrolytic **$1.00 each**

100 Assorted Disc. Capacitors (Good Assortment) **100 for .90c**

Surplus Specialties

P.O. Box 118 **Pittsfield, Massachusetts**
No C O D Orders please

COMMAND RECEIVER

R23/ARC5—(BC453)— Low Freq. 190 to 550 KC	$14.95
Slide-in-Mounting Rack for Receiver	2.75
Shock Mount for Rack	1.00
Dynamotor Base-Plate to Fit Rear of Receiver	.75
12 Volt Dynamotor Adaptable to Base Plate (220v.)	1.95
24 Volt Dynamotor with base plate	1.95

COMMAND TRANSMITTER

BC458 (T21/ARC5)—5.3 to 7 mc. 4.95 used **7.95 New**

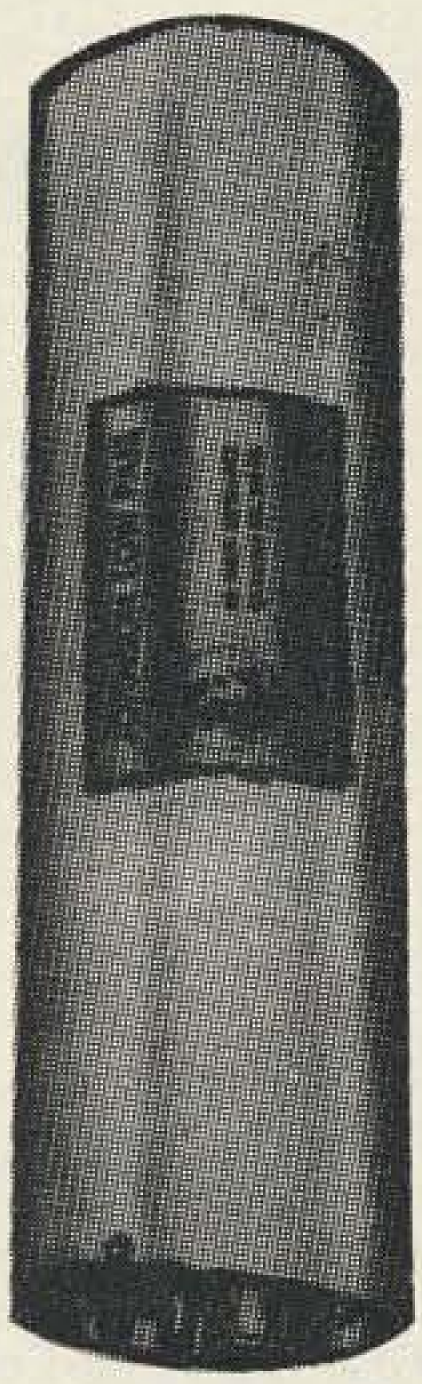
VIBRATOR POWER SUPPLY

6VDC to 300v @ .90 MA Complete—New **$2.95**
Send Addressed Envelope for Listing.

ARROW SALES-CHICAGO, INC.
2534 S. MICHIGAN AVENUE
CHICAGO 16, ILLINOIS

ELIMINATE T.V.I. FAST

"Get em at a LOW PRICE—ONE TME OFFER" SEZ Sy Denby "W2BNW"



E. F. Johnson **Low Pass FILTER** For use with RG8U Etc—52 ohm—75DB Attenuation or more above 54mc Insertion loss less than .25DB 4 section filter, END Sections "M" Derived will handle up to ONE Gallon of R.F. Terminates in two SO239 connectors in & out.

CAT. 250-20 (users net) 14.95.

Your Cost 7.95 Postpaid in U.S.A.
Brand New!

Full Description Back of ARRL HANDBOOK

METRO ELECTRONICS
172 Wash St N Y 7, N Y

Propagation Chart

April 1964

EASTERN UNITED STATES TO:

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

CENTRAL UNITED STATES TO:

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

WESTERN UNITED STATES TO:

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

Good: 8-9, 15-16, 19-20, 25, 26-28

Fair: 1-2, 10, 13-14, 17-18, 29-30

Poor: 3-7, 11-12, 21-24

J. H. Nelson

*** Means next higher frequency may be useful.**

East coast to West coast, same as to Mexico.

West coast to East coast, same as to Puerto Rico.

...need we say more?

Have been in amateur (and commercial) radio since the '20's, and the NCX-3 is the most enjoyable and interesting rig I ever owned. W7M--, Seattle, Washington

In comparison with a higher priced unit ur NCX-3 walked away with the honors. I am more than pleased with my NCX-3.
K9U--, Rockford, Illinois

Amazed at the ease of operation and tuning. Fine quality signal reports.
K6O--, Palo Alto, California

I have used SB gear commercial and amateur. NCX-3 tops even commercial.
K5G--, Midkiff, Texas

I have always believed National to be the best; now I am sure. NCX-3 is best in the field. WN5F--, Vicksburg, Mississippi

Best I have used in 32 years. Excellent.
W1G--, Framingham, Mass.

This is without doubt the best buy ever made.
K6B--, Fresno, California

The advertising on the NCX-3 is completely misleading. The equipment looks considerably better than the pictures in the advertising. The performance and styling is much better than advertised.
W4Y--, Grovetown, Georgia

Far better performance than anyone has a right to expect.
W9K--, Park Ridge, Illinois

Best transceiver design in its price class. DJ5--, West Germany

Finest piece of communications gear of this type I have seen and used.
W9W--, Taylorville, Illinois

Having a ball with it! Excellent reports audio wise and signal strength.
W1H--, Merrimac, Massachusetts

I've had the NCX-3 just over a month now, and I must say that it does everything your advertisements say and then some.
W1--, Portland, Maine

I get amazing signal reports on mobile op. Most fun I've had since I got on the air! Very excellent piece of electronic equipment.
W6L--, Mission San Jose, California

NCX-3 is untouchable in its class.
WN5F--, Vicksburg, Mississippi

How you did it I don't know. The rig is absolutely unbelievable, fabulous.
WA2J--, Freeport, New York

This is one of the nicest pieces of equipment I have ever had the privilege to own.
KØI--, Cedar Falls, Iowa

I have been in ham radio for about 9 years and I am sure that this is the best piece of radio equipment ever to enter my room. Keep up the good work.
W9R--, Belleville, Illinois

Best VOX I've ever used!
K5R--, Dallas, Texas

Words cannot express my ultimate satisfaction with the NCX-3. Thanks to National for putting such a rig on the market.
K9M--, Peoria, Illinois

Am quite surprised and pleased with my investment in the NCX-3. SSB reception quality is best I've heard. Good job National! K9A--, Cicero, Illinois

This rig is the best rig I have run for general performance. The SSB audio is terrific.
WAØA--, Delta, Colorado

Best investment in amateur equipment I ever made! WA4A--, Colonial Heights, Virginia

Couldn't be happier. Wouldn't trade this NCX-3 for the world!
K7V--, Williams AFB, Arizona

Best piece of amateur radio gear on the market for performance and price.
W9R--, Indianapolis, Indiana

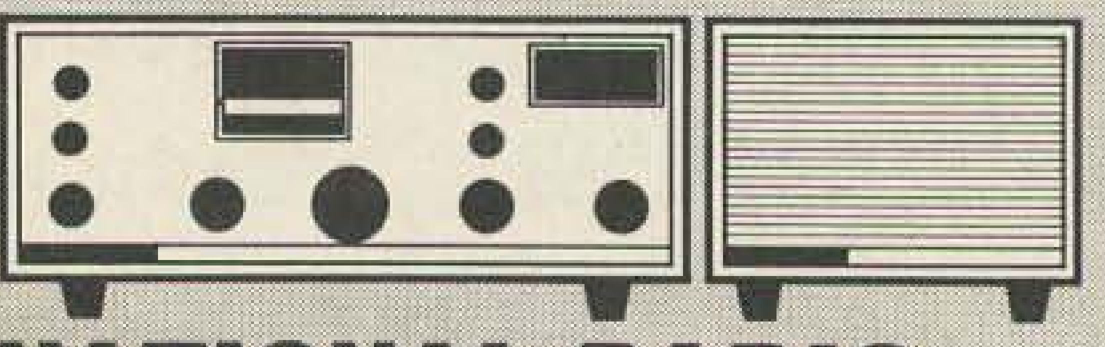
I wish to state the performance is beyond my expectations — the performance of the unit is excellent. Merriam, Kansas

Outperforms any other transceiver I have heard. National has done it again.
K9L--, LaPorte, Indiana

You have a wonderful rig in the NCX-3! I wouldn't sell it for double the purchase price! Sure works fb on SSB and CW. Couldn't be more happy with the finest rig I've ever owned!
WØP--, Independence, Kansas

The nicest piece of equipment I've had in many a year. W8L--, Lansing, Michigan

50 YEARS OF LEADERSHIP
50
1914-1964
NATIONAL RADIO COMPANY, INC.



NATIONAL RADIO COMPANY, INC.

37 WASHINGTON STREET, MELROSE 76, MASSACHUSETTS 02176
Export: Ad Auriema Inc., 85 Broad Street, N.Y.C.; Canada: Tri-Tel Associates, 81 Sheppard Avenue, W. Willowdale, Ontario