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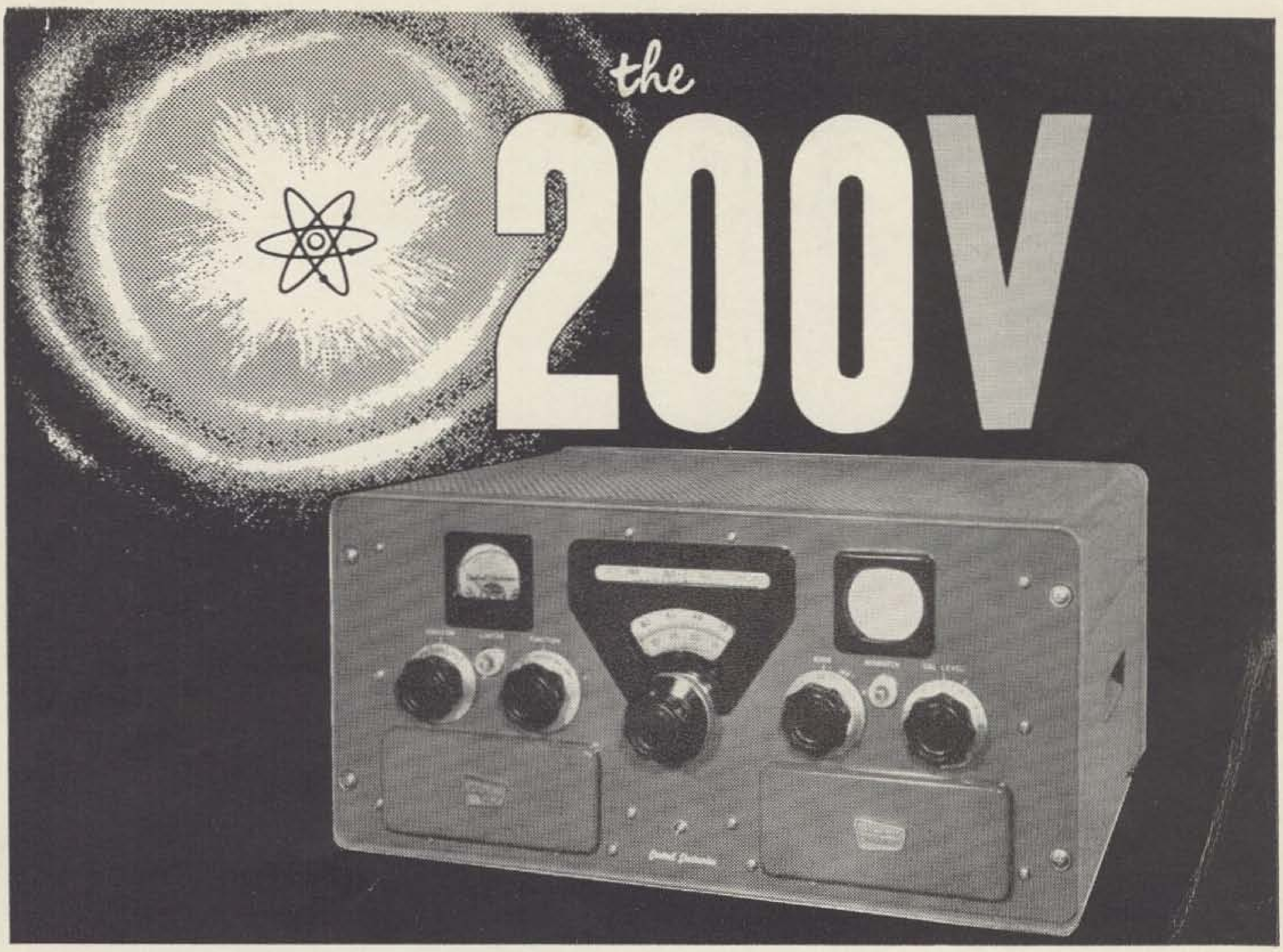

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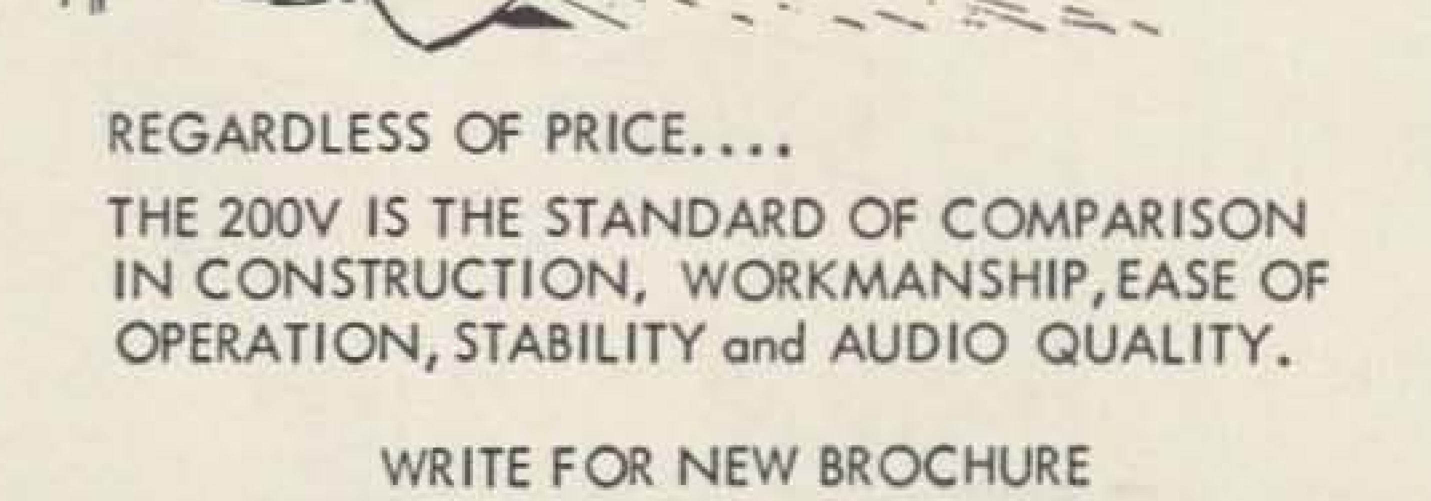

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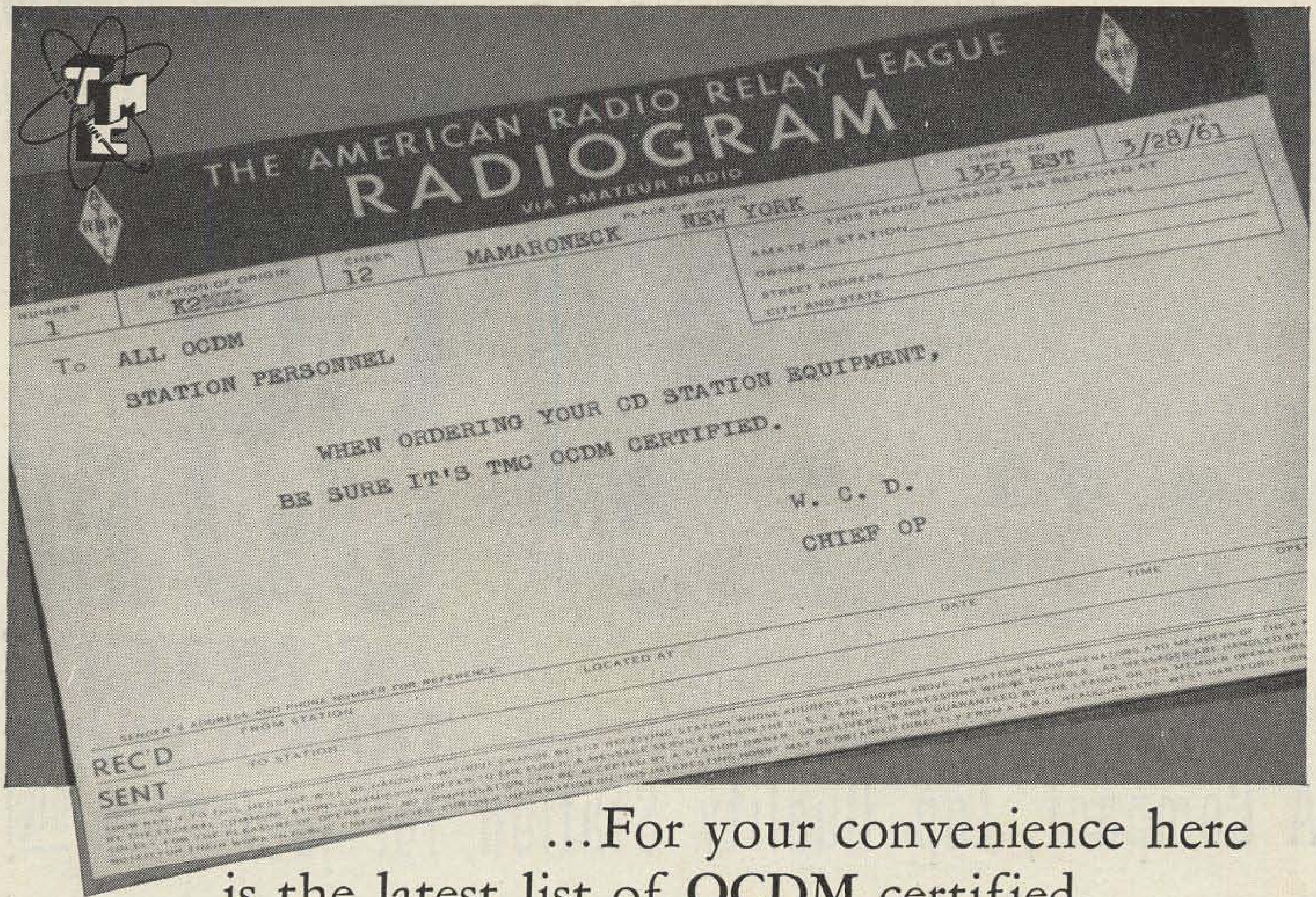

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	GPR-90RX	SSB 205
	GPR-90RXD	SSB 205
OCDM T-32	GPT-750	SSB 227
	SBT-1K	SSB 237
OCDM T-32 CW	SBT-1K	SSB 237
OCDM T-32 SSB	GPT-750	SSB 227
	SBT-1K	SSB 237
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	MSR-5	SSB 196
	MSR-6	SSB 196
	GSB	SSB 194
	GSB-2	SSB 194
	PAL-350	SSB 215
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July 1961
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. . . de W2NSD

(never say die)

May Votes

Angel W2NQS took an early lead in the May voting and kept increasing it to a total (so far) of 1782 votes! The Big Technical Article (Staff) placed second with 1435 votes. I'm real proud that our technical articles are so well received. This bodes well for the whole basic concept of 73. G4 Zed Smith was third with 1119 votes. A few mild grumbles about this issue being a little light may be the result of our having nothing much for VHF this time.

The June votes are piling up for Bill Ashby K2TKN and his Abe Lincoln two meter antenna. If you haven't voted for June yet please send in the card quickly.

Breaking Even

One of the first in-person questions I get at conventions, as I mentioned a few months ago, is how're we doing? That break-even point that we were aiming for turned out to be very flexible and has been following us very closely. Sometimes I think it is preceeding us, but a tote of the accounts receivable put it back in place . . . if we ever get some of the receivables.

Our biggest problem is the prodigious amount of work to be done. Two of us are doing the same work that is full time employment for from 15 to 20 people on other magazines, plus all the extra work involved in getting to every major convention and many smaller hamfests, keeping up a steady stream of promotion to possible advertisers and parts distributors who should be selling the magazine on their counter, and little additional chores like our monthly postcard which has to be octsected and sorted.

I'm not pushing for sympathy so much as maybe a little help. I have to admit that so far we have been working just for the fun of it, with all of the proceeds going to authors and our printer. If you're within commuting distance of our office (?) and have time on your hands we can keep you just as busy as you care to be. Some of the available chores: cutting and sorting those readers request cards; counting article votes; bookkeeping; filling back issue orders; addressing stencil changes; keeping the HQ station on the air; emergency trips to New York City; processing subscriptions; typing subscription stencils; sending out promotion letters; invoicing; statementing . . . plus lots more. Any takers? I thought not.

Looking Ahead

The topic for today is the Geneva Conferences. Before I plunge into the matter at hand I would like to just make a word of explanation: please forgive me for being rather terse. It is against my nature to carry on at length about things. I get a bit worried when I find that I have written about some event, taking perhaps a page to cover it, and then I read about the same thing in another magazine where they have made a six page article on the subject. I suspect that the six pager carries more weight even though it may say the same things that I did. So, on to Geneva.

We went into the 1959 Geneva Conference with much forboding. Many countries had announced plans for cutting back the ham bands and there was much gloom prevalent in official Washington circles. While the Government was behind us, in a manner of speaking, their support left a vast amount to be desired. What it amounted to was this: everyone was 100% for ham radio, right down the line . . . unless frequencies happened to be chopped from any other service, in which case the chopping would be reflected to the nearest ham band, just as it had when we lost 14,350-14,400 kc.

With so many strikes against us, plus the fact that we (the amateurs) went into Conference without a single request for extra frequencies, if for no other purpose than to provide us with a minimum bargaining position, how come we came out in such good shape? The U. S. position with regard to most frequency assignments, particularly in the shortwaves, was for a status quo agreement which would put off any major changes until the next Conference, probably in 1964 or 1965.

The present assignments had been made many years ago, back when few countries had much in the way of radio communications. In the interim the need for radio in these countries has mushroomed and they are still stuck

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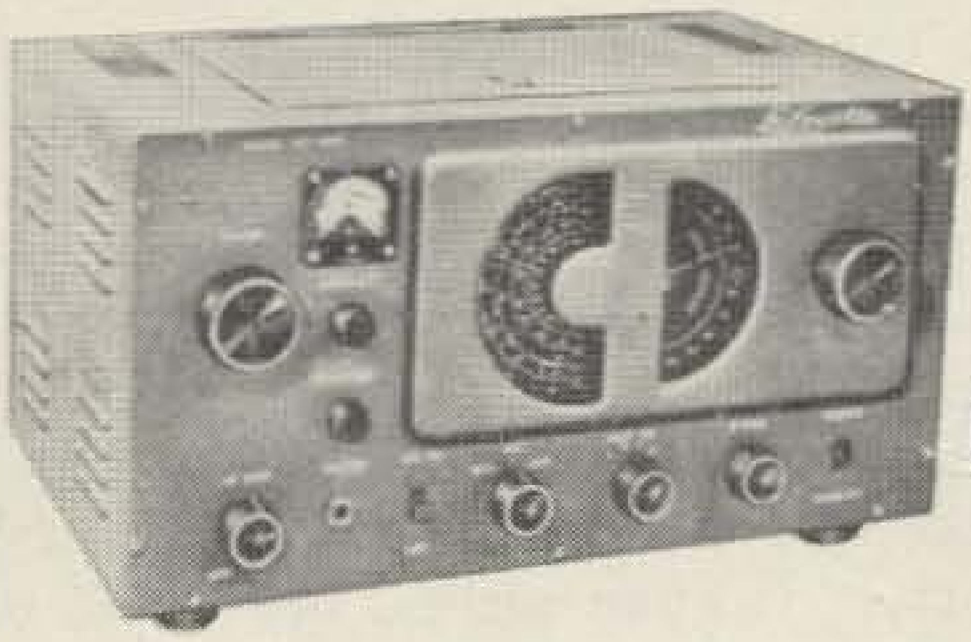

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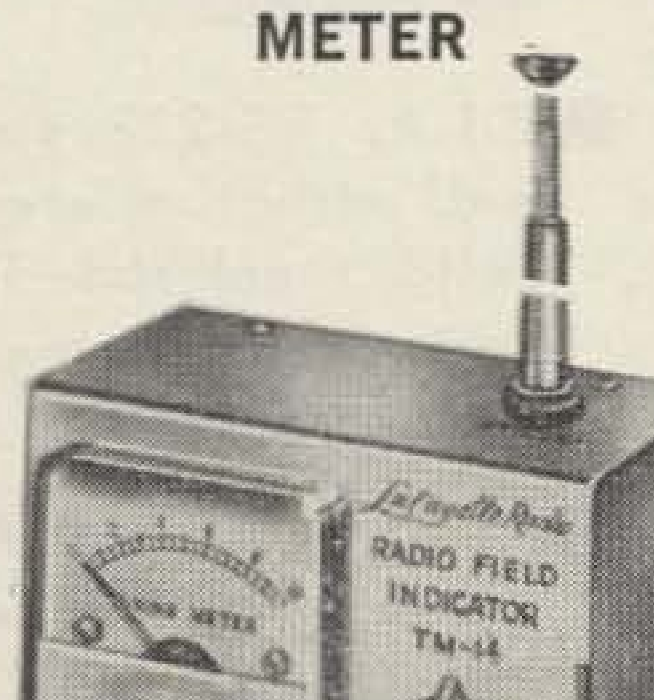

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with a mere handful of frequency allocations. Thus, at the Geneva Conference, where every little country had the same weight vote as the U. S., and re-apportionment of frequencies would in all probability wreck severe hardship on the U. S., you can understand why the U. S. was all for putting everything off for a few more years: anything else would have cost dearly in allocations.

The U. S. was in a pickle when the Conference started because our delegates knew that they were in for trouble from the smaller countries. The one unknown was the U.S.S.R. and all of the votes that they swing. Russia, as ever, had not tipped its hand before the show.

This was the one imponderable of the whole conference, so they got to the point quickly. The U. S. got a friendly country to propose the doctrin of status quo for the short wave bands almost as soon as the opening session of the conference began. There were loud sighs of relief when the Russian Delegate got up and expressed complete agreement with the proposition. That was it, we were safe until the next conference. From then on it was just a question of a few thousand committee meetings to thrash out administrative problems of international communications and some VHF allocations.

We don't know whether the Russians had planned this move for their own benefit, or whether the agreement was a result of the sweetness and light movement then afoot in the wake of the Krushchev-Ike visit. Whatever the motive, it sure pulled our hash out of the fire.

What Next?

Will the U. S. go into the next Geneva Conference as unprepared to hold onto amateur frequencies as we did last time? Well, I know of nothing as yet afoot which would be of advantage to us. Let us hope that we develop some aggressiveness about this . . . you can bet that the other competing services are going to be as aggressive as they can. But *what* can we do?

Well, I've a suggestion. I'll probably be blasted all over the place for it, but then I've been lambasted before. We amateurs have one big advantage over all other services: ubiquity. I think we can take advantage of this.

The services claim that their frequencies are all in use. Perhaps we could organize some sort of world-wide all-band listening program which would for the first time actually establish the real use of frequencies by all services. To the best of my knowledge nothing like this has been done before . . . and I've asked about this among the delegates from many countries and just about all of the various branches of the U. S. government.

(Continued on page 62)

William E. Smith K8LFI
5030 Janet Avenue
Sylvania, Ohio

Tinker Toys for Two

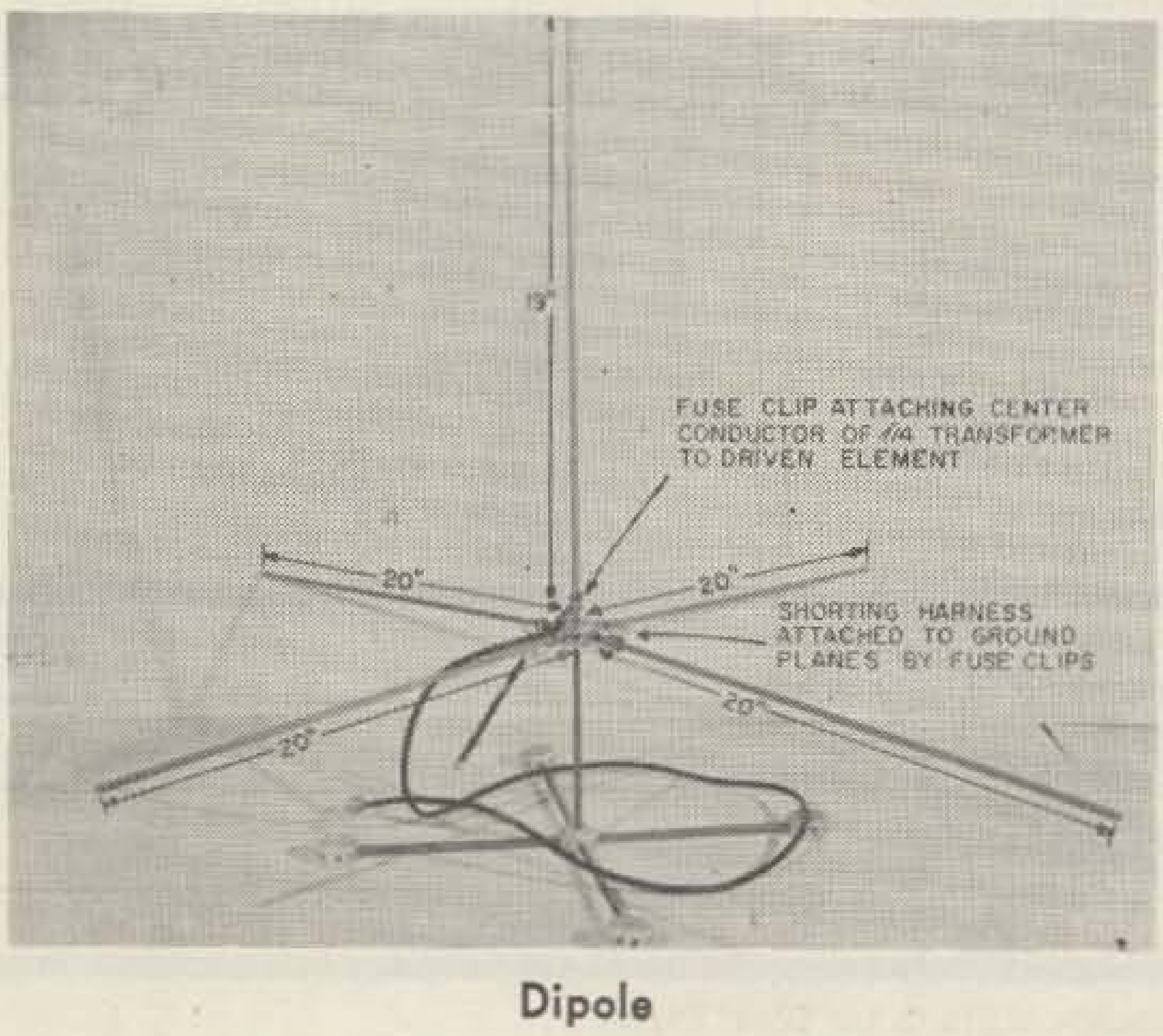
Photos by Bill Kunz

Do you travel a lot (or a little)? Are you frequently (or infrequently) stuck in a hotel or motel room in a strange city at night? If so are you bored with watching television, reading newspapers and magazines, frequenting the nearby bars or movie houses, alone? Those of you who recognize these symptoms know that there is no lonelier feeling than being away from friends and family under such circumstances. Such isn't the lot of a ham, however, if he has his equipment along. He looks forward to each new city eagerly for the new contacts he will make; the new friends he'll accumulate and maybe even the invitations for personal visits he'll wangle.

The increased occupancy of the VHF bands and the advent of the Gonset Communicators, which would load a coat hanger or a hotel window frame, did much to alleviate the aforementioned loneliness for those who could afford a "Gooney Box" or could squeeze the added weight into their airline allotment. The introduction of the Heath series of transceivers has removed both the cost and weight problems for most travelers with the result that many hams carry these little rigs with them wherever they go.

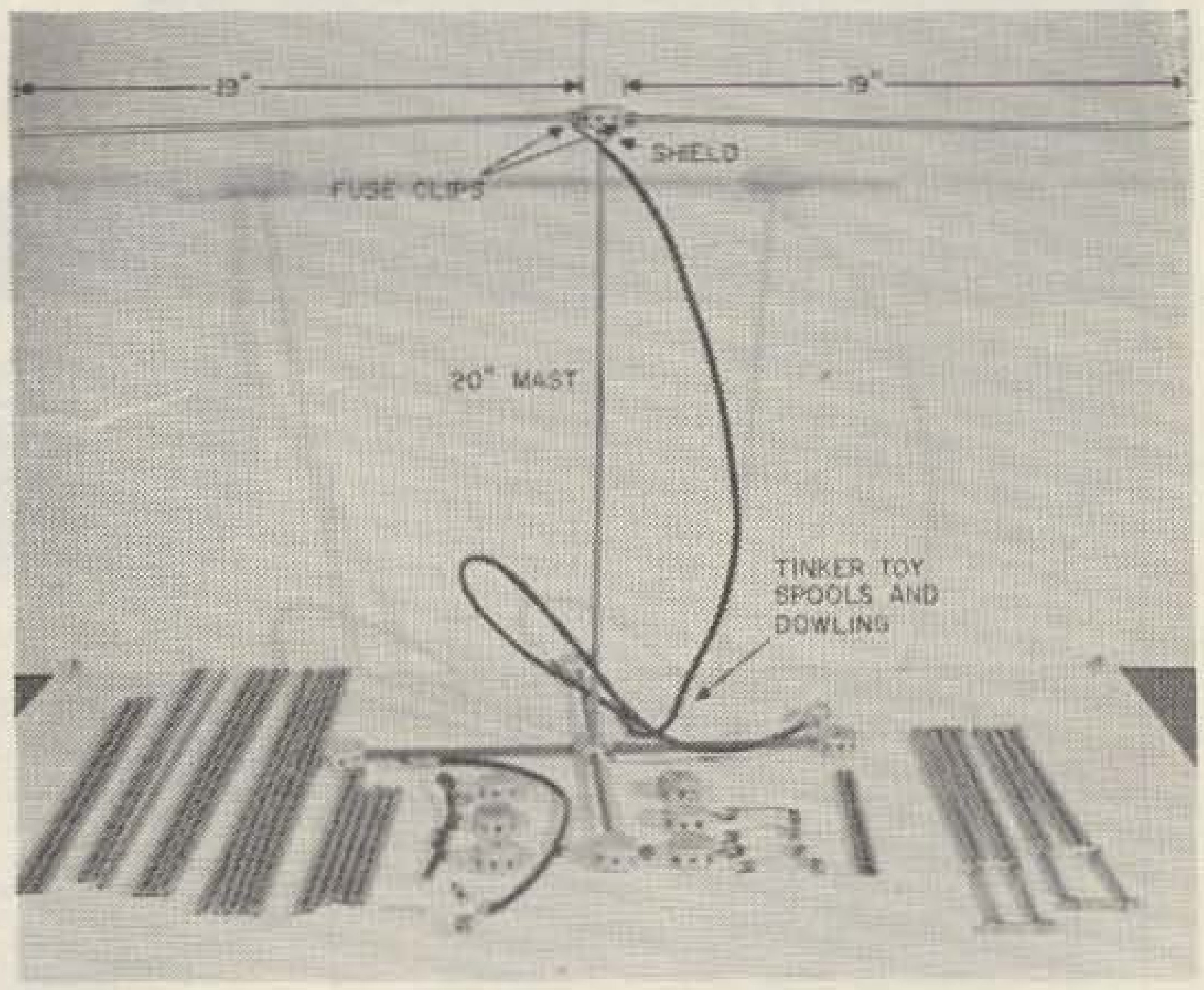
Up until now, however, antennas have been a problem with most operators using either a simple vertical or a dipole set up in a hotel window.

Because of the size of ten and six meter antennas and because of the rapid growth of the two meter band for short range work, particularly in the larger cities, it was decided that efforts would be concentrated on the development of a series of highly efficient, easily assembled, light weight two meter antennas for portable use with low powered rigs such as the Heath Twoer. Thus evolved the Tinker Toy idea of antenna construction and assembly.



Dipole

The heart of the system, of course, is a ninety-eight cent set of Tinker Toys available at any Dime Store. This set provides the base for the antennas plus all the insulating connections required. The wood in the Tinker Toy kits is well seasoned and dry thereby offering excellent insulation even at Two Meters for the type of use described in this article (indoors with low power). If higher power or outdoor use during field day is contemplated two of the Tinker Toy wheels can be replaced by similar



Vertical Ground Plane

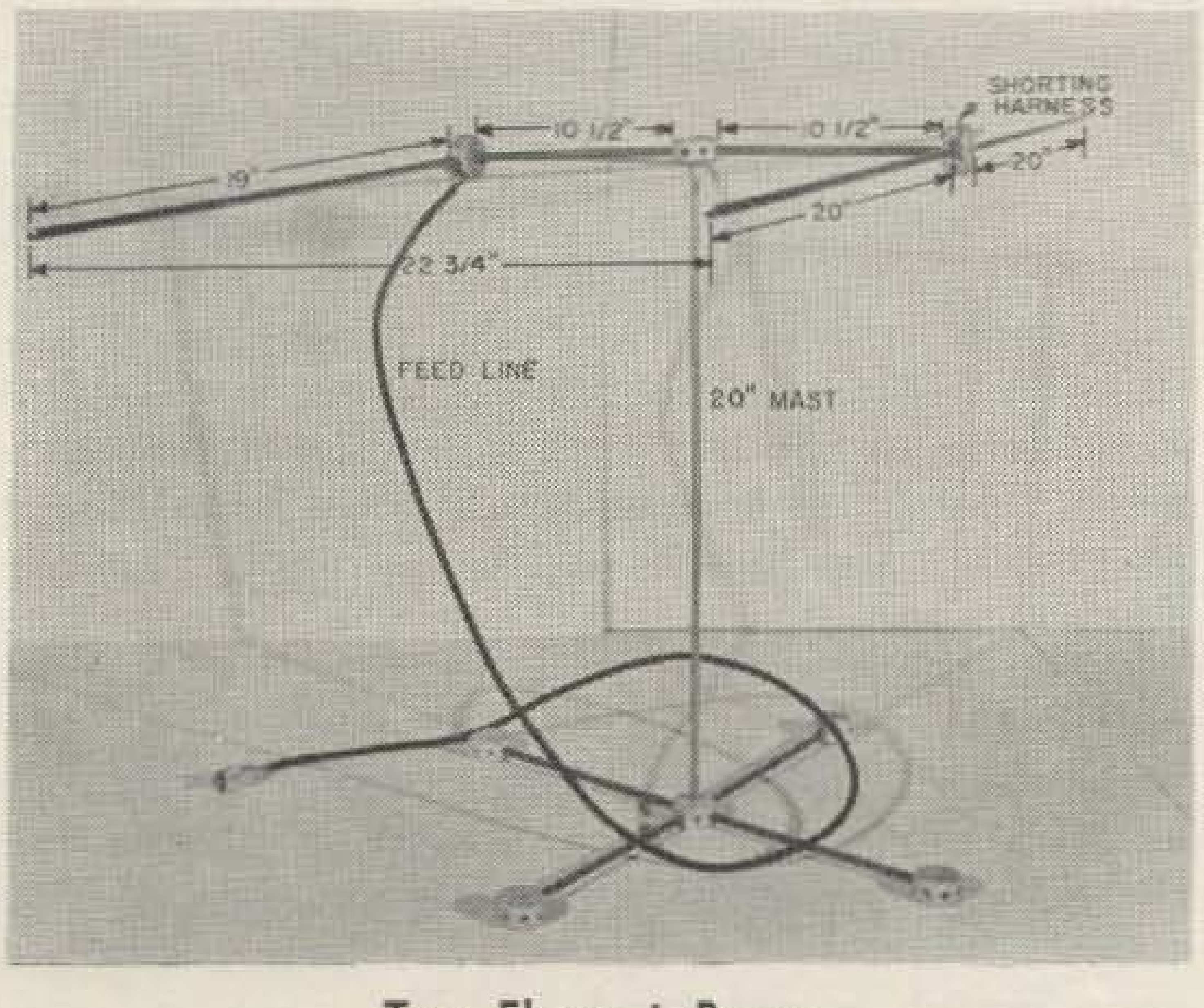
wheels cut and drilled from 1½ inch diameter polyethylene or polystyrene rod available at most radio supply houses. Insulation is needed only for the driven elements.

The holes in the Tinker Toy wheels are a little small and too shallow so they should be drilled out further with a ¼ inch drill to give a snug fit with the tubing used.

All the elements and the mast for the various antennas are carefully pre-cut to exact length with a tubing cutter from ¼ inch OD by .035 wall hard drawn aluminum tubing. This tubing may be anodized in which case it should be scraped at points where electrical connections are to be made. This material is available at your hardware store for about twenty cents a foot or about $1.75 a pound if you have a wholesale connection. A twelve foot section of the material weighs 0.34 pounds, need I say more? About 36 feet of this tubing is required to make the elements described in the parts list with a total weight of about 1 pound and costs under $2.00 (at the wholesale price). As a matter of fact, less than $5.00 worth of total parts and three pounds of weight are involved in the entire project. The parts list below includes enough materials to build more than five different antennas for two meters ranging from a simple dipole to a cubical quad and giving the experimenter a number of configurations to try under various conditions in order to obtain the desired communciation results.

All the antennas are designed from standard hand book dimensions and are calculated to present feed point impedances of approximately 72 ohms so that they may be fed directly with RG-59-U coax. The feed line is cut to an exact full electrical wave length at 145.25 MC to fulfill two requirements. This length assures that the transmitter will be a minimum of a half wave away from the transmitter and also assists in reducing SWR resulting from the feeding of balanced loads with an unbalanced line at this frequency. If not satisfied with this arrangement, and some critical amateurs will not be, any random length of RG-59-U can be balanced at the antenna by the simple attachment of a quarter wave balun (13.5" long) of RG-59-U coax so that the shield only of the balun connects to the center conductor of the feed line at the antenna and to the shield of the feed line a quarter wave away. The drawing of the dipole shows such a balun attached. It can be used with all the antennas except the ground plane which is an unbalanced antenna requiring an impedance matching device.

Electrical and mechanical connections are made between quarter wave sections with short lengths of heavy stranded copper wire with brass fuse clips soldered to each end. Feed line connections to the driven elements are also made with fuse clips. Tuning stubs, spacers and half-elements for the cubical quad are made from ¼ inch tubing which has been tapped with a 10-24 thread. Fuse clips are



Two Element Beam

attached to the ends by means of ⅜ inch 10-24 brass machine screws.

For the average user, all of the antennas will be found to operate quite satisfactorily without adjustment over the most used portion of the band (144.5-145.5 mc). The more discriminating amateur, however, will find that the versatility of the system is such that the antennas can be tuned to resonance at his favorite frequency by lengthening or shortening the quarter wave sections while closer impedance matches can be made by varying the distance of the parasitic elements from the driven elements on the beams or the quad. Now, on to the construction.

The Tinker Toy Two Meter Dipole

assembly time 1 min.

The dipole is the simplest antenna presented here and while usually assigned the relative gain figure of 1 has resulted in many fine QSO's over fairly long paths. It is assembled simply as shown in the picture and is ready to transceive in about a minute of elapsed time (while your filaments are warming up). Parts used are six of the Tinker Toy wheels, four pieces of ¼ inch dowling (for base), one 20 inch section of tubing (mast) and two 19 inch sections of tubing 180° apart in the top wheel. Clip on the feed line as near the wheel as possible and start communicating.

The Tinker Toy Two Meter Vertical Ground Plane

assembly time 2½ min.

Don't sell the ground plane short, particularly in locations where signals are predominantly vertically polarized or where a good earth or water pipe ground is not available. It establishes its own ground. The ground plane is the only antenna in the group which does not match RG-59-U directly at the base. In the parts list will be found a quarter wave matching transformer of RG-58-U coax and a shorted matching stub of RG-59-U coax. Either of these devices may be used effectively to raise the feed point impedance of the ground plane from about 30 ohms to 72 ohms.

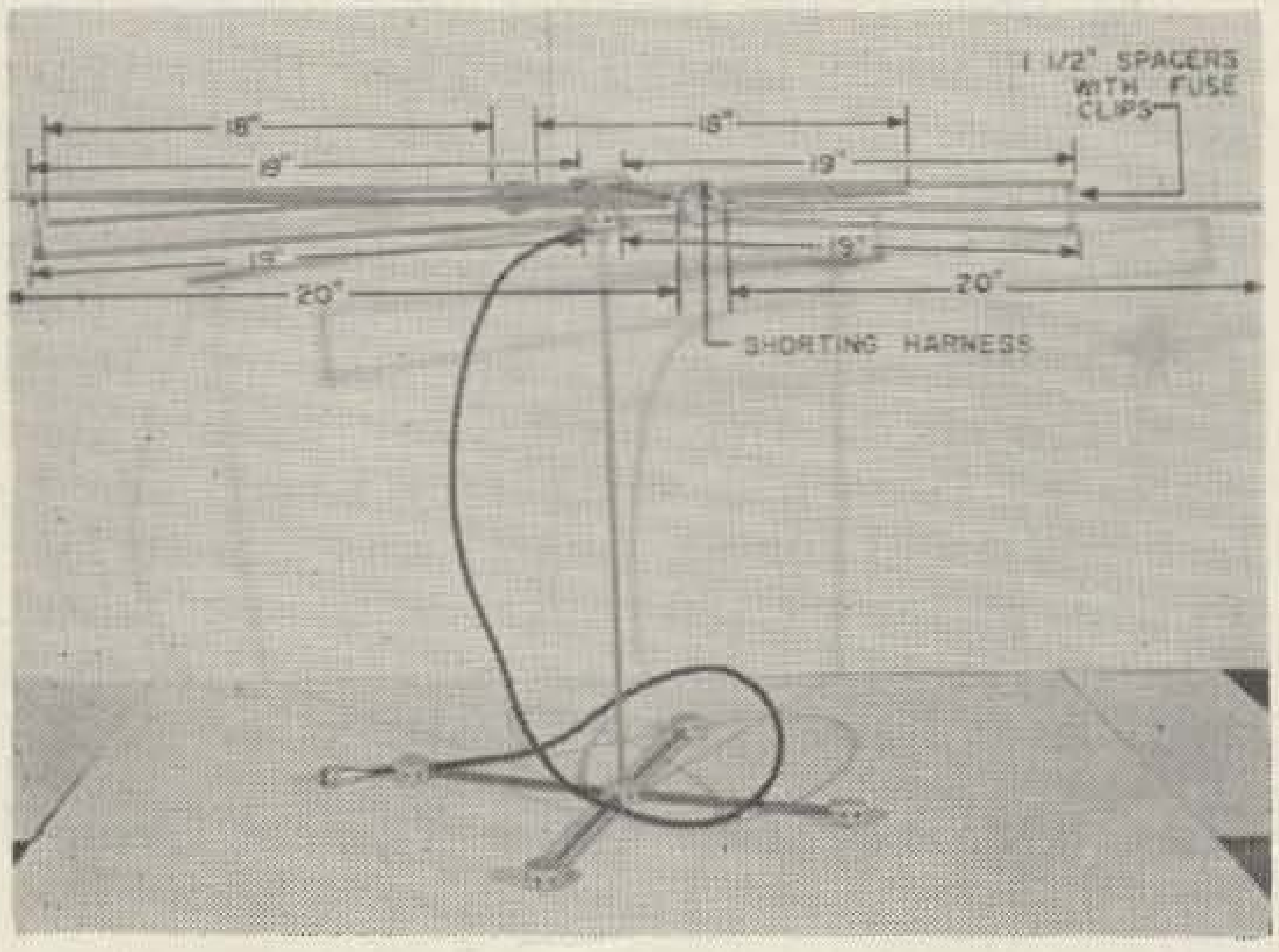
The quarter wave transformer is installed in series with the feed line while the shorted stub (in picture) is attached to the driven element, and the shield is connected to the ground planes which in turn are connected together with the shorting harnesses. The same base and mast described for the dipole are used for the ground plane. The vertical or driven element is 19 inches long while the four radials are 20 inches long and fanned out 90° from the vertical element. Many of you readers can think of a number of other methods for obtaining an impedance match with this antenna such as varying the number of radials or drooping the radials from their 90° angle. It should be evident by now how readily the

Tinker Toy system lends itself to experimentation.

The Tinker Toy Two Element Two Meter Beam

assembly time 2 min.

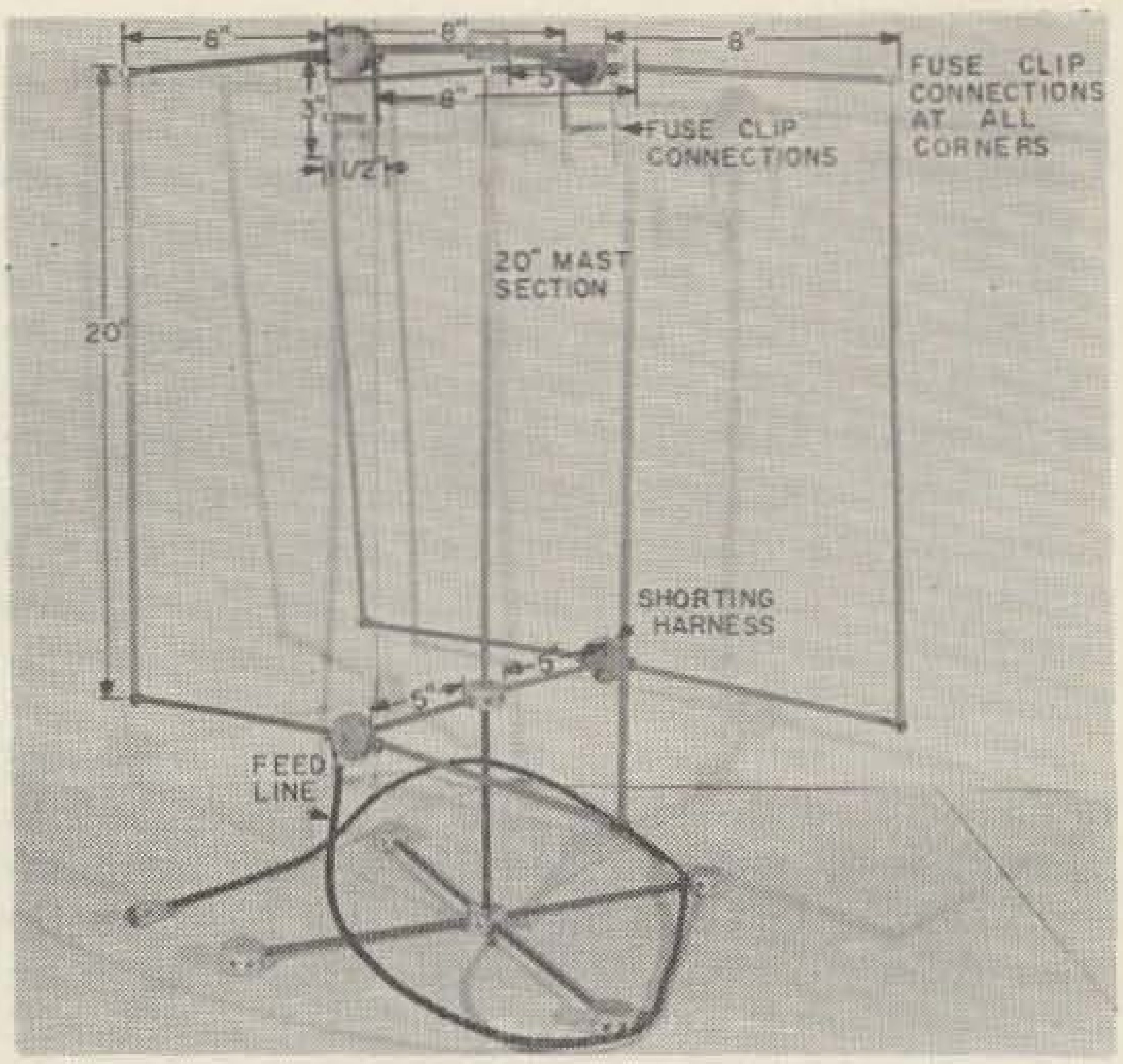
The addition of a 40" reflector (2-20 inch sections connected with a shorting harness) spaced .28 wave lengths away from the dipole antenna described earlier results in a two element beam maintaining the 72 ohm input impedance but giving a theoretical 4 DB gain over the simple dipole. Proper spacing is obtained by using the two 10½ inch segments of tubing along with part of the diameter of the center "wheel" and half the thickness of the end wheels. The front to back ratio of this antenna is only about 6 db, however so the desire for a little sharper antenna with higher gain led to:



The Tinker Toy Three Element Two Meter Beam

assembly time 4 min.

This antenna, slightly more complicated than those described previously utilizes a folded dipole to step up impedance, then two relatively close spaced parasitic elements to bring the impedance back down to approximately 75 ohms. The driven element is made by electrically and mechanically connecting four of the 18 inch elements and two of the 19 inch elements in a continuous loop configuration spaced 1½ inches apart and joined at the ends with the two 1½ inch clips described in the parts list. The over all element length should be 78 inches while the half wave configuration is 38 inches. The antenna is fed at the open ends of the two 19 inch segments as shown in the picture. Two 18 inch sections joined together and spaced 16 inches from the driven element give a parastic director while two 20 inch sections joined together and spaced 16 inches on the other side of the driven element as a reflector completes the antenna. The three elements should give a theoretical forward gain of 7.5 db which is believed to be just about the ultimate that can be achieved with the simple materials in the kit. (Want to bet someone makes a liar of me?)



The Tinker Toy Two Meter Quad

assembly time 8 min.

My own experience with Quad antennas on ten meters and on six meters led to the inclusion of this antenna on the list. It is a little more complicated to assemble and adjust but its low angle of radiation, 6 db forward gain and variable front to back ratio make it the ideal antenna for experimentation particularly when working with a table sized model where changes can be made quickly and conveniently. Its large signal capture area also makes it an ideal receiving antenna for weak signals. The quad has still further advantage in that it can be either horizontally or vertically polarized depending on choice of the feed point. The quad driven element is made by joining four 8 inch sections with fuse clips on the ends to each of two 20 inch sections (sides). The 8 inch sections are then joined together with a Tinker Toy wheel as shown in drawing. Three inch tuning stubs are then hung from the top by means of fuse clips and the element tuned to resonance at your frequency by sliding one of the shorting harnesses up and down the stub. The feed line is attached at the bottom wheel on either side of the insulation. The reflector is made in the same manner except that a shorting harness is clipped on across the lower Tinker Toy wheel. Three inch tuning stubs are attached with fuse clips across the top wheel as shown and the tuning stub adjusted so that this element is about two inches greater in over all length than the driven element. The front to back ratio may be adjusted by varying the length of this element. The two elements are joined together with two booms (top and bottom for extra rigidity) and spaced about 12 inches apart to give an input impedance of 72 ohms. Here again, impedance can be varied by lengthening or shortening the booms or merely by sliding the Tinker Toy wheels back and forth on the booms until a good match is obtained.

So there you have it, a kit which weighs less than three pounds and cost less than $5.00 and which can be fit readily into a briefcase or a corner of a suit case to go along with your Heath Twoer on these out of town business or pleasure trips.

It should be obvious by now that any number of arrays can be designed and built around the parts provided in this kit. At least two are included here which are not even described in the body of the text. The folded dipole incorporated in the three element beam can be used as a separate antenna fed with 72 ohm coax if a half wave (27 inch) impedance transforming balun of RG-59-U as described in the ARRL Hand Book is used. The driven element of the Quad is nothing more than a stretched out folded dipole, however, about 1 db gain is obtained from this configuration taken by itself. The input impedance is about 130 ohms, however, so a quarter wave Q section (two of the 19 inch elements) spaced 0.28 inches apart (center to center, .030" between walls) can be used as a matching device.

I would be disappointed if in experimenting with this system someone did not come up with a brand new antenna design superior to anything presented here, in fact I hope to have some new configurations myself to try out on my next trip.

Think of some of the fantastic arrays we can come up with for 220 or 432! Anyone game to try? . . . K8LFI

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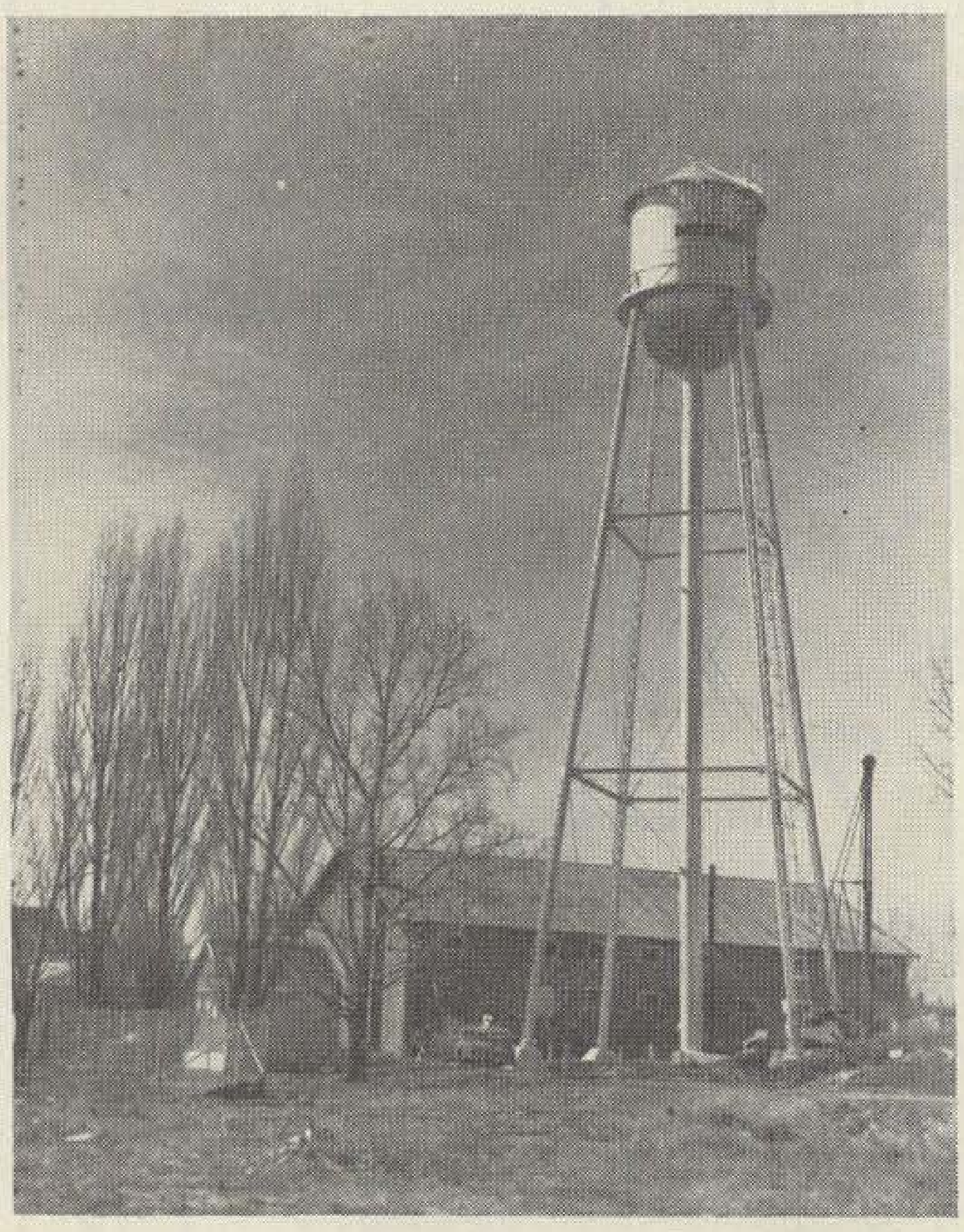
Editors and Engineers **Radio Handbook**—(Editors and Engineers, Summerland, California).

Quad Antennas—William T. Orr (W6SAI).

Parts List

1—Set of Tinker Toys (98-cent size).
33 feet 1/4 inch diameter by .035 wall hard drawn aluminum tubing cut as follows:
7—20-inch lengths.
4—19-inch lengths.
4—18-inch lengths.
2—16-inch lengths.
2—10½-inch lengths.
4—8-inch lengths tapped at one end with 10-24 thread and fuse clip attached with 3/8" 10-24 brass machine screw.
4—3-inch lengths tapped as above.
2—1¼-inch lengths tapped both ends with 10-24 threads and fuse clips attached as above.
1—1½-inch piece driven element spool spacer for 3 element beam.
2—½-inch lengths for connecting lead line to quarter wave transformer (if used).
1—quarter wave transformer—13.5 inches of RG-58-U ohm coax. Fuse clips soldered to center conductor and shield at both ends, or:
1—matching stub 5.7 inches of RG-59-U, fuse clips attached one end, other end shorted shield to center conductor.
1—quarter wave balun (optional) 13.5 inch piece of RG-59-U, fuse clip attached to shield only at one end, small alligator clip at other.
4—shorting harnesses. #12 or heavy stranded copper wire 2 inches long with fuse clips soldered to both ends.
1—feedline 54 inches long RG-59-U coax. Fuse clips attached to one end, coax connector or RCA type phone plug attached to other (for Heath Twoer).



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Klamath Falls, Oregon

IN the ranks of hamdom the shunt fed vertical antenna is seldom mentioned. Some reference has been made to this oddity used for six meters and once in a while back in the days when we had a five meter band but to this writer's knowledge practically nothing has been done on the lower frequencies. When have you worked anyone on 75 meters using a shunt fed tower? Many hams would tell you that it is impossible. Yet the boys up in the broadcast band have been doing it for years. Much has been written about the virtues of the vertical ground plane antenna. A 75 meter quater wave series fed ground plane has been used quite widely by hams who could figure out how to get 60 feet of mast mounted on an insulator.

How about the shunt fed? A shunt fed vertical is any grounded vertical antenna, preferably a quarter wave length or higher, which is fed some distance off the ground. The base of the antenna is grounded to the earth. The more elaborate the ground system the better. Broadcast stations use 120 radials or more, usually at least a quarter wave length long. As is the case with the popular ground plane at least four radials would be a good idea although water systems many times have a pretty good contact with the ground. The method of feeding this type of antenna is shown in Fig. 1a. A simplified equivalent diagram is shown in Fig. 1b. Consider the tower (or vertical wire) to be an LC circuit which is not quite resonated. For most applications; that is, under a half wave high the circuit is inductive. By adding a capacitor between the tap point and the ground end the tower may be resonated. In the physical system the sloping lead and the capacitor form this part of the tapped circuit.

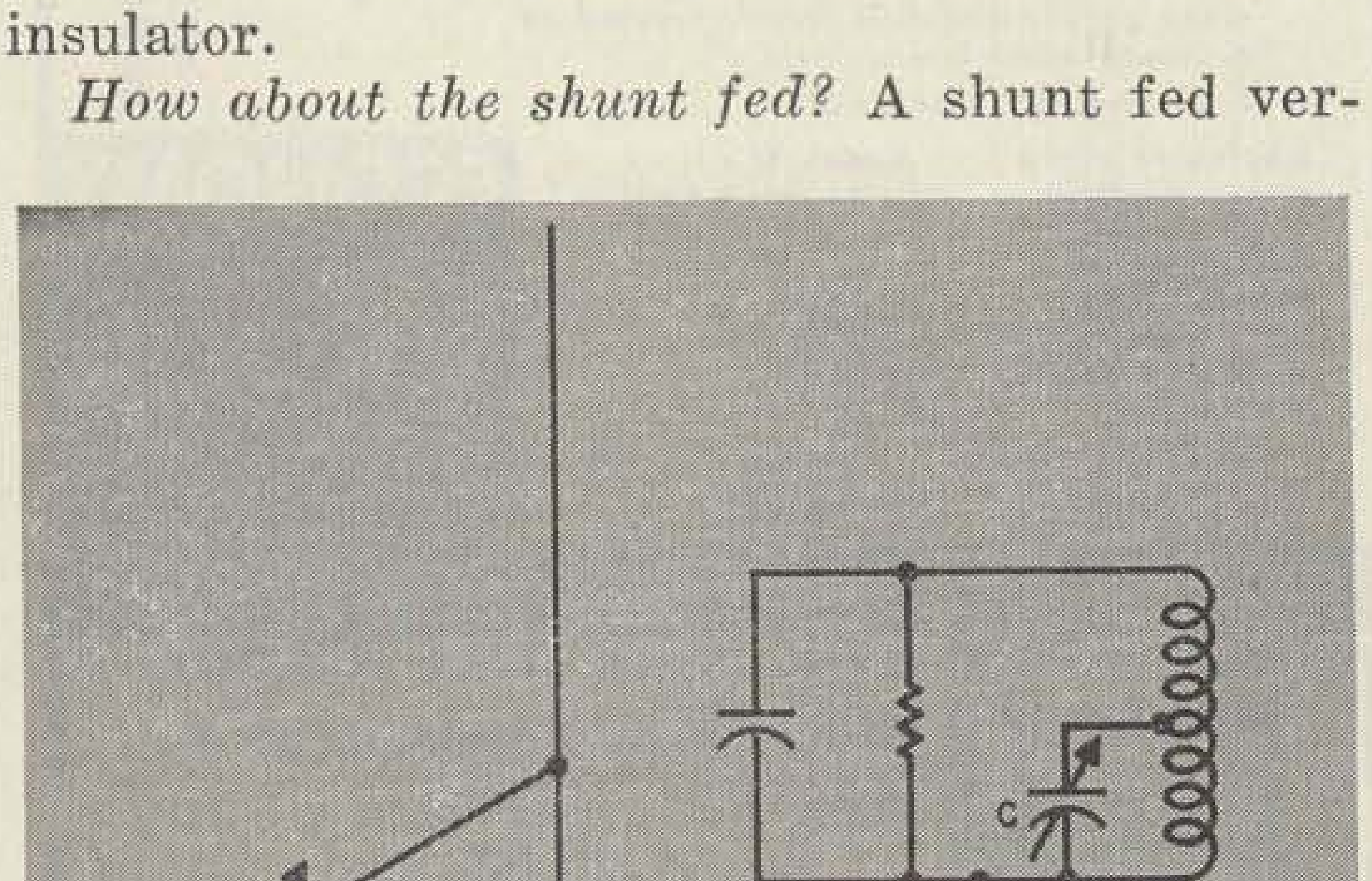


Fig. 1a and b

The impedance presented at point "x" is a function of the slope of the lead and the height of the tap point. It is possible by trial and error to find the exact impedance of any size co-ax line simply by moving the tap up and down the tower. A broadcast station with a 72 ohm line will tap the tower at the 72 ohm resistance point and resonate with the capacitor, thus eliminating impedance matching networks. The ham who has a high tower in the back yard (even with a hat full of beams on top) could do the same thing. An impedance bridge would be a must. *However*, if you feed the shunt fed tower *directly* from a transmitter that has a pi network in the final, with the help of a series capacitor the network will work into most any reasonable sloping lead set up. The old style tank with a coupling coil will work equally well with a little adjustment of the pickup coil size and resonating with the series capacitor. Just as a random guess use a lead at approximately a 45° angle connected about one third of the way up the tower. A little trial and error on the series capacitor and the pi network will load the transmitter to the optimum value.*

The above gives a little background on how this thing works and if you have a grounded tower in the back yard, give it a try. Most

folks don't have a high tower and its for sure a ham mobiling 200 or 300 miles from home doesn't have one. So where do you find a ready grown quarter wave or higher tower? If you are traveling in flat country its a cinch that any town you might drive through will have a steel water tower. It will be 60 feet high or higher, maybe 100. The ground system will be the whole city. So wheel up about 30 or 40 feet from the tower. Take a wire from transmitter ground to the base of the stand pipe and clip on with a large battery clip. Then take a lead in series with a 100 mmf variable capacitor and the hot side of the pi network, about 50 feet long, and climb up the ladder until you run out of wire and clip on to the ladder. Tune up the rig to the proper loading and you are in business.

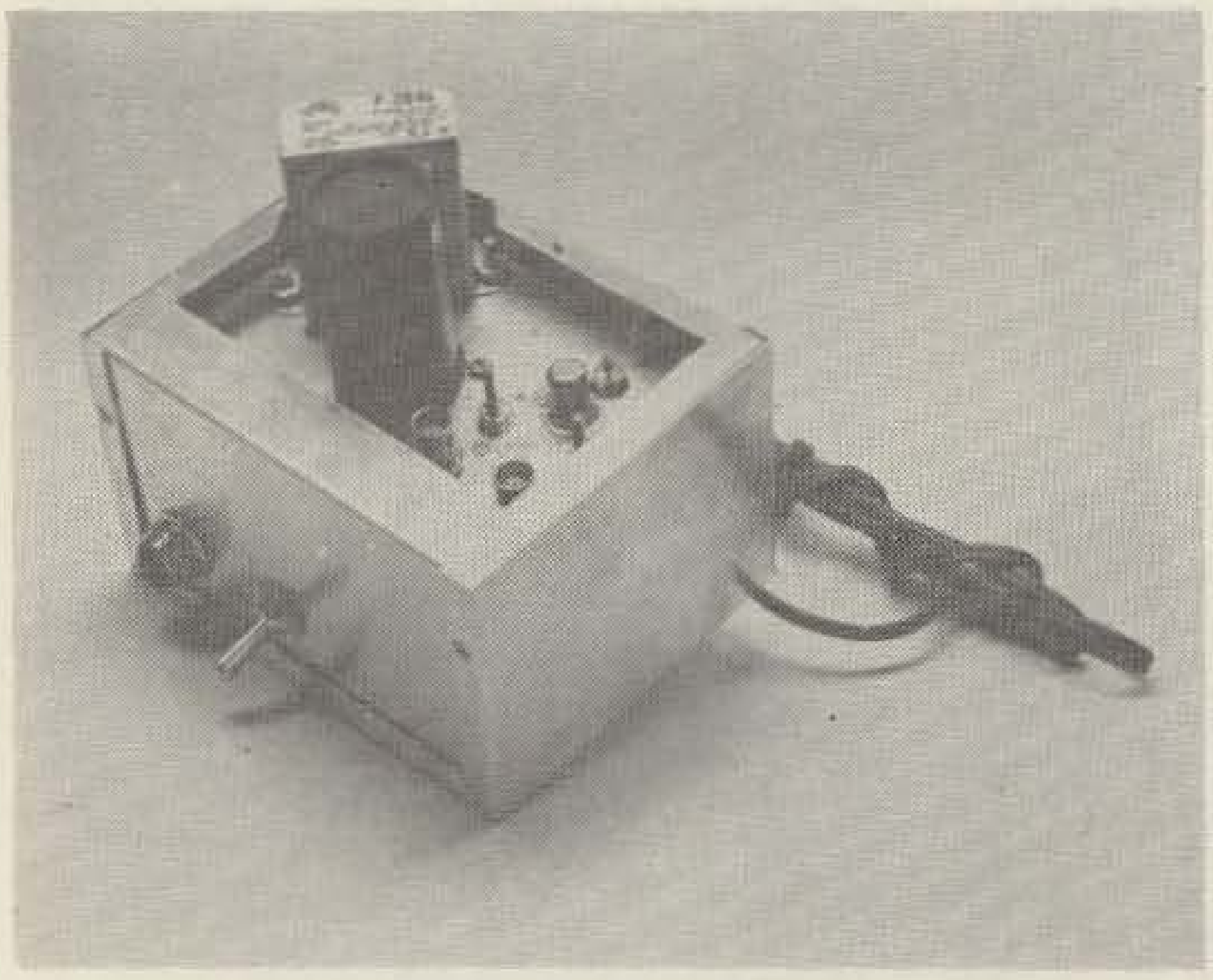
Proof of the pudding

We took K7DDI's mobile to a high water tower in Merrill, Oregon to actually check out a shunt tower in the field. An Elmac 77 was used for the transmitter. This normally worked into a 9 foot center loaded whip. Measurements were made comparing the tower to the whip. In general the height of the tap was not critical. We first tried to load the Elmac without the use of the series capacitor. Loading was alright but when modulation was

applied things started arcing over. So we put in the capacitor to cancel out the inductive reactance of the tower and things worked fine after that. In our actual case the tower was about 100 feet high and we tapped in about 30 feet off the ground with the car 30 feet out from the tower, as can be seen in the accompanying photographs. *In all cases* the water tower was at least 3 "S" points better than the whip. Receivers, of course, differ but in Ft. Lewis, Washington 500 miles away we received a 10 db over 9 armchair copy with the water tower against an "S" 5 down in the mud report with the whip. From Eugene, Oregon, over 200 miles away the report was similar. From Klamath Falls, 15 miles away there was still 3 to 4 "S" points difference. Now if an "S" point is 6 db, as has been alleged by many manufacturers, this means our minimum report indicated an 18 db gain over the mobile whip antenna. To anyone who has ever designed a beam this is a fantastic amount of gain. We are a little skeptical, but one thing is for sure, a shunt fed water tower compared to a mobile whip antenna can make the difference between good intelligible copy and no copy at all.

We hope some ambitious mobiliers will experiment further with the shunt fed tower. A water tower has a ready made ground but presumably a grain elevator or any other metal structure with some height to it could be made to work. In case of a disaster area this would be a sure fire antenna to get some rf into the ether and start handling traffic in jig time. And the ham a few hundred miles from home can avail himself of a good antenna to get into home base for the cost of a hundred feet of connecting wire. . . . W7CSD

* It is quite likely that some mobile as well as larger transmitters will load without the use of the series capacitor and not experience any fireworks.



Frank Bullock
191 Puritan Avenue
Forest Hills 75, New York

Two Meter Nuvistor Line Amplifier

AFTER playing with two meters for a while, and chewing the fat with all of the locals, the thought of a little DX may whet the appetite. Even with the addition of a good antenna or beam, the limiting factor is often the noise figure of the receiver. A good preamplifier will improve even the best commercially available receiver. The *Line Amplifier* is just that; a good low noise Nuvistor preamplifier.

With the advent of the Nuvistor, a new opening exists in the realm of low noise equipment in VHF and UHF. The Line Amplifier is capable of a 46 db overall gain, but in the interest of making the entire band flat, with a given noise figure over the band, we settled on an overall gain of twenty six db. This produced an overall noise figure of 2½ db, which is pretty good for a low cost preselector.

The major trouble with most pre-amplifiers is that the sheet metal parts are difficult to fabricate. We had a choice of several types of packages, but finally decided upon the Minibox type of construction with a sub-chassis. The sub-chassis must be of cadmium plated steel (such as a steel chassis plate), tin plate, copper or zinc plate, so that it can be soldered. Notice that no shielding is used. Because of the neutralization of the amplifier none was necessary, and no problems were encountered.

The line amplifier has its own ac power sup-

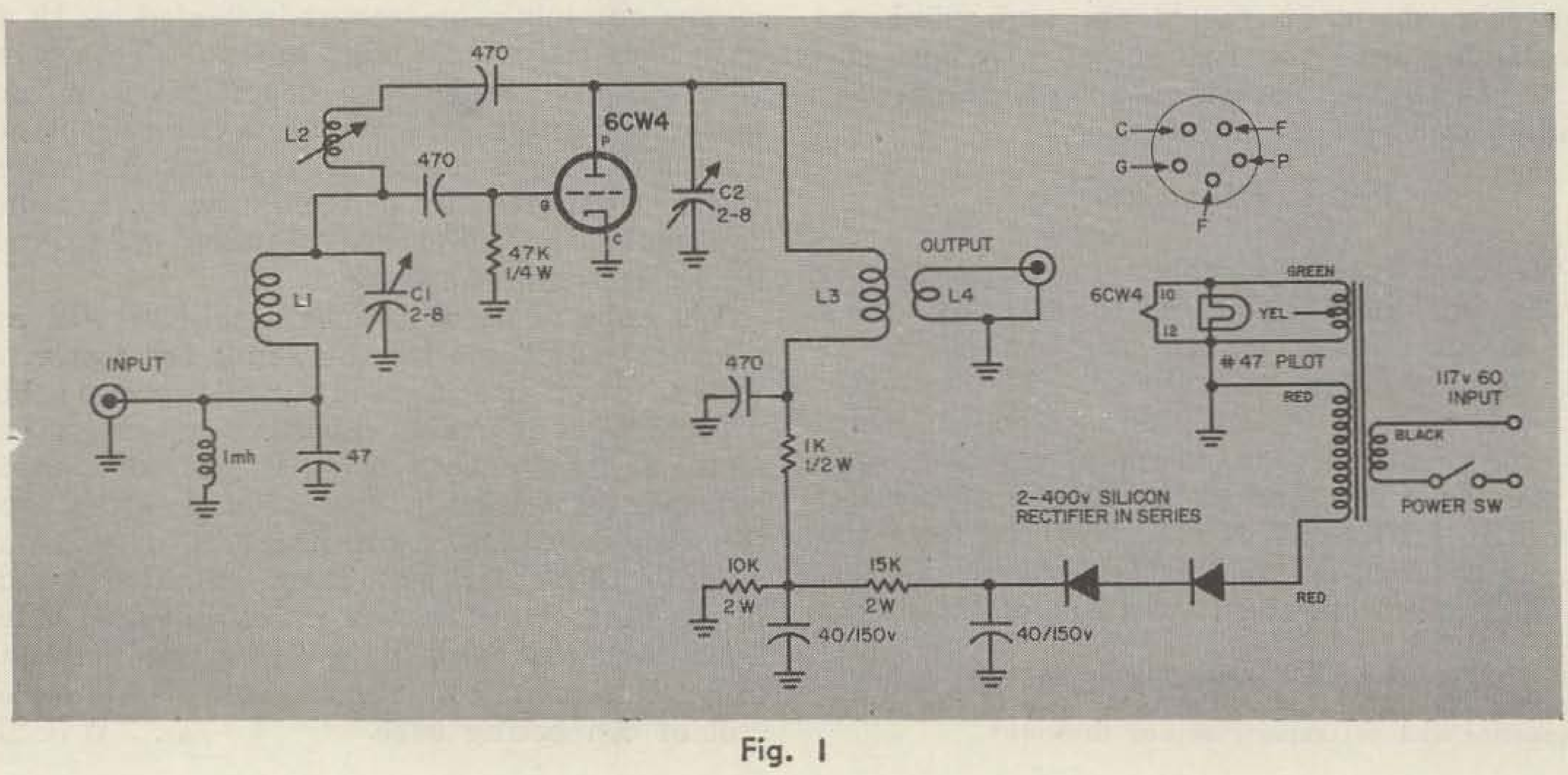


Fig. 1

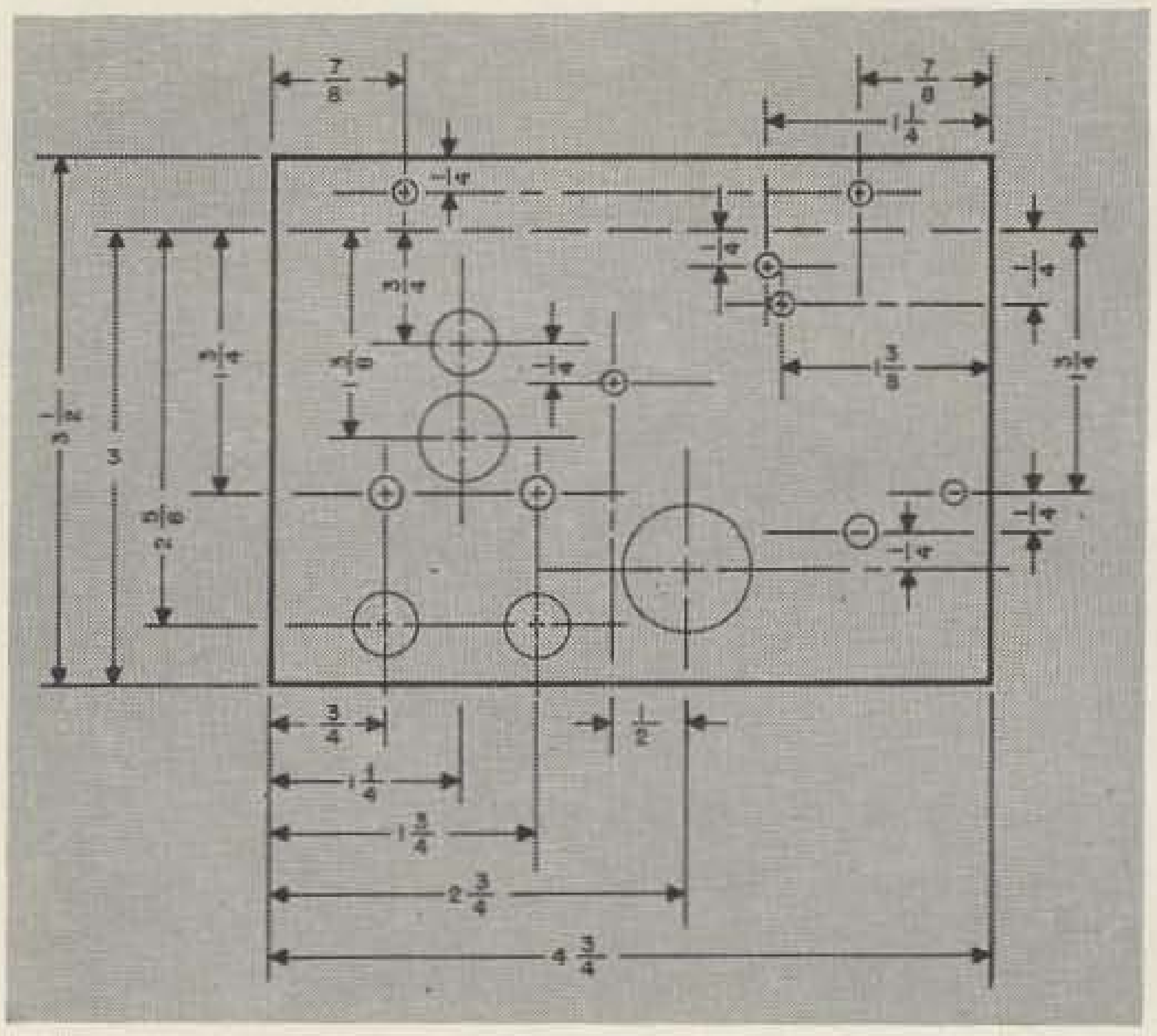


Fig. 2

ply built in and can therefore be connected to any receiver without having to get into the receiver circuitry. BNC type connectors were employed so that a small quick disconnect 50 ohm connector could be used. The total cost should be about fifteen dollars, using the best available commercial parts.

Construction

Construction of the line amplifier dictates that all leads be short and soldered with a hot clean iron. Whether it is a ground connection or to a tube socket, a clean solder connection is a must, since a cold solder joint can generate noise. Start by following the sub-chassis layout and drilling all holes with care. Locate all ground connections and pre-tin for easy soldering later. Mount all parts after mounting the Nuvistor socket, which is soldered into place. A word about the socket is important here. The socket should be mica-filled and not the standard black bakelite type socket. Since solder will flow very easily around the shell of the socket, which also acts as a shield, buy two just in case, and if solder should get into the inner shell part, discard the socket. You'll find your time is worth a lot more than the twenty five cents the socket cost. All wiring is point-to-point, especially in the vicinity of the socket.

The self-supported coils (L1 and L3) are mounted last. L4 is constructed by placing two turns of number thirty wire over the B-plus end of L3. The loose ends of L4 are secured through a ¾ inch long piece of spaghetti tubing slid up against the coil body

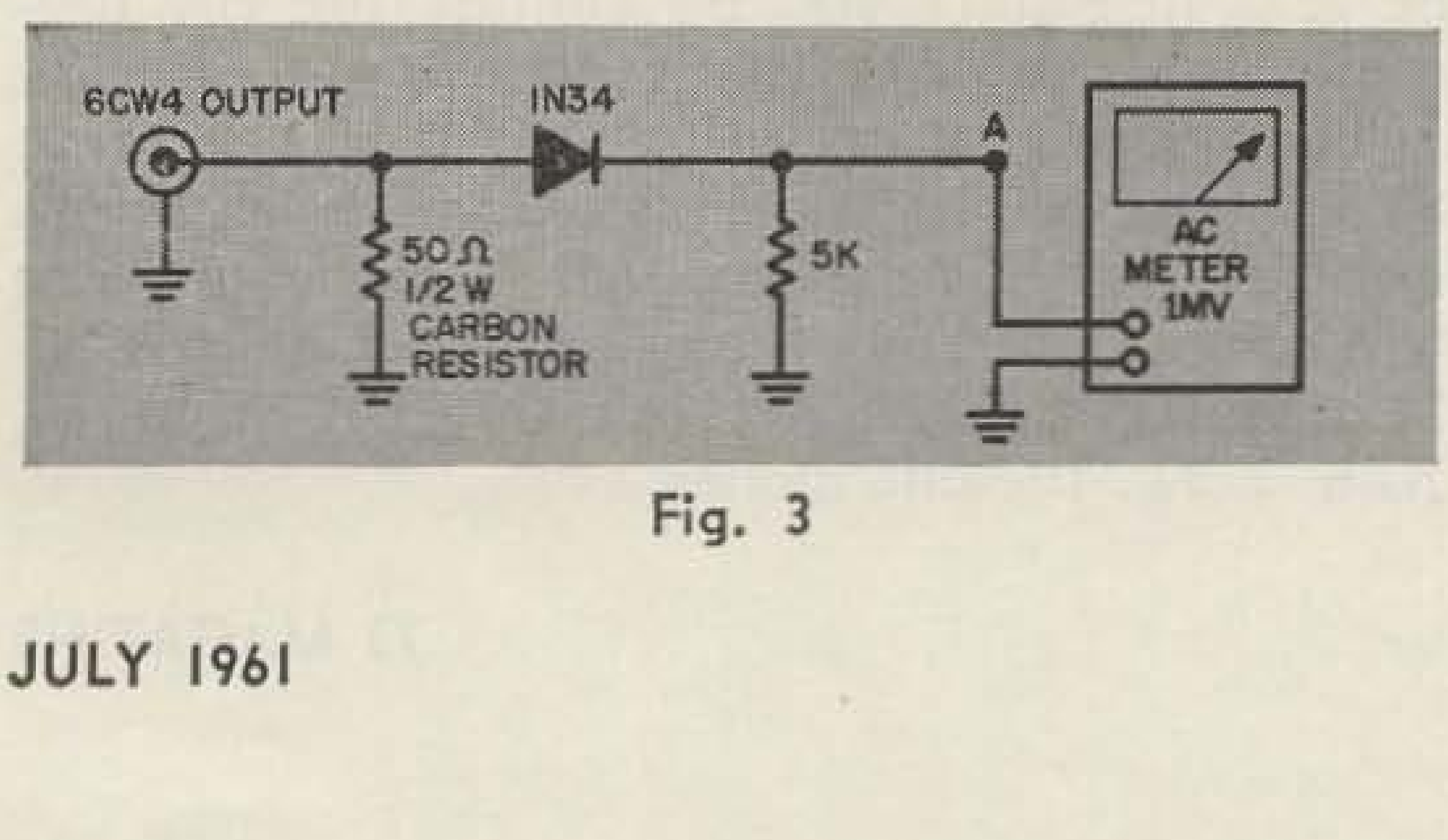


Fig. 3

Letter

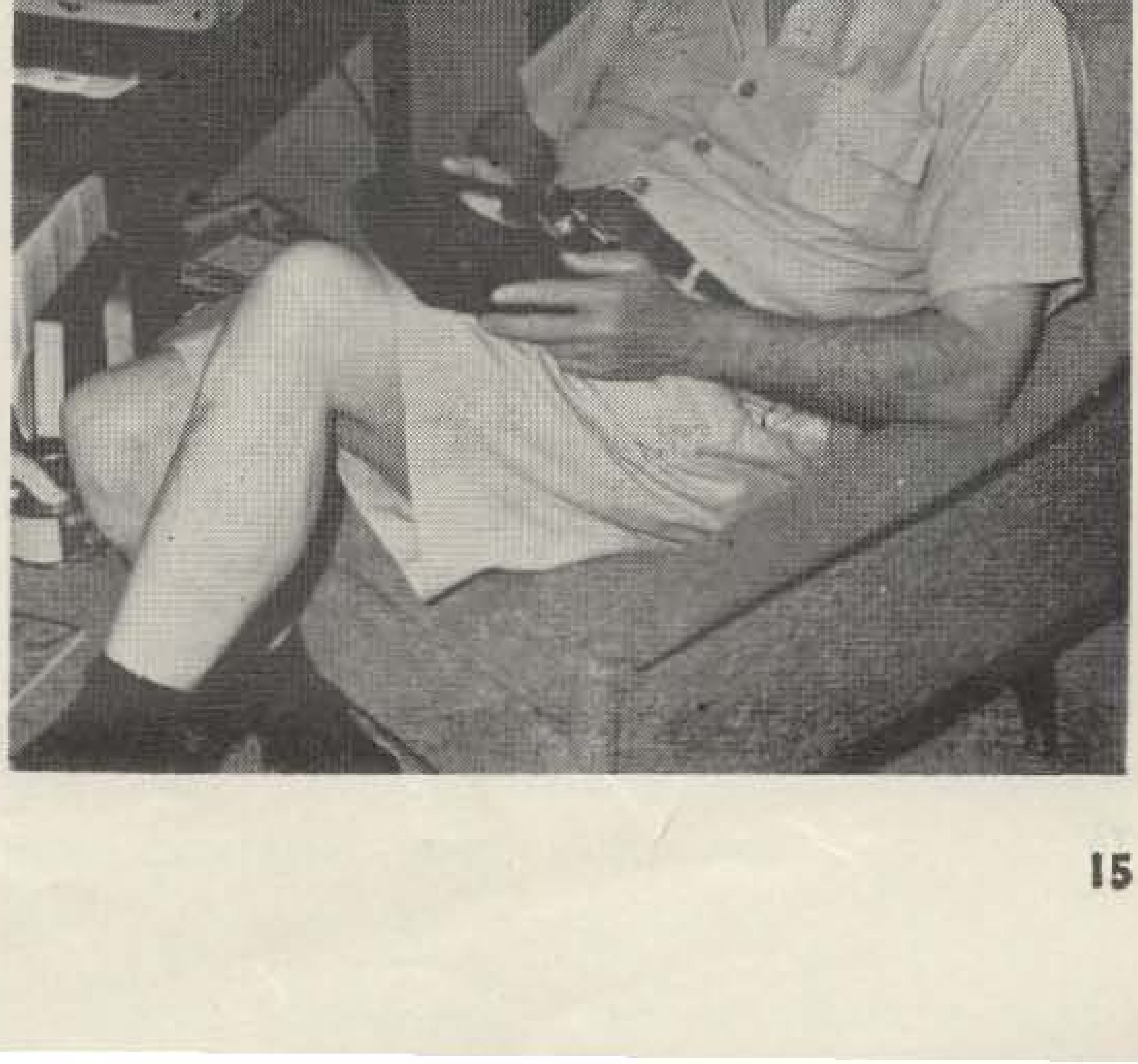
John K6BJ and XYL

Ed:

I dropped in on John Reinartz, K6BJ, and Mrs. Reinartz at their super-nifty double-width modern trailer type retirement home near Santa Cruz. I caught them just as they were starting out for the beach and an afternoon of clam hunting.

John was just on the verge of sending us an article of a little frequency deviation meter he developed which measures very accurately plus or minus 500 cycles of desired carrier frequency, and operates directly from the headphone output of the receiver. Very handy for net operation or at any time you want an immediate visual check on deviation of a received signal from "target" frequency. Parts cost less than $10, easily built. The one shown in the photo with John is built in a surplus meter case with a few acres of space to spare. **Jim WA6EXU**

The article is in Jim and being prepared for publication. It sure is good to see John getting back into print again!



and cemented in place with either "Q-Dope" or Duco cement. Wait until the entire assembly is dry before mounting and keep the iron away from the coil body. Solder the ends of L4 right at the BNC, keeping leads of L4 as short as possible.

Initial Testing

Once assembly is completed the Line Amplifier should be plugged in and turned on. Measure the voltage at "A," where the filter resistors, bleeder and B-plus points meet. The exact voltage is not critical, but should not exceed fifty volts. A lower voltage may actually give a better noise figure. The alignment procedure requires a good signal generator and a grid dipper. The signal generator is important, since the noise figure is dependent upon good alignment. Unfortunately, we have been unable to find a different procedure using just a grid dipper that will do the job.

Alignment Procedure

Start the alignment by turning off all power and with the aid of a grid dipper, set L1 and L3 to 146 mc, using C1 and C2. Connect the signal generator (which should have a 50 ohm output) to the input of the line amplifier.

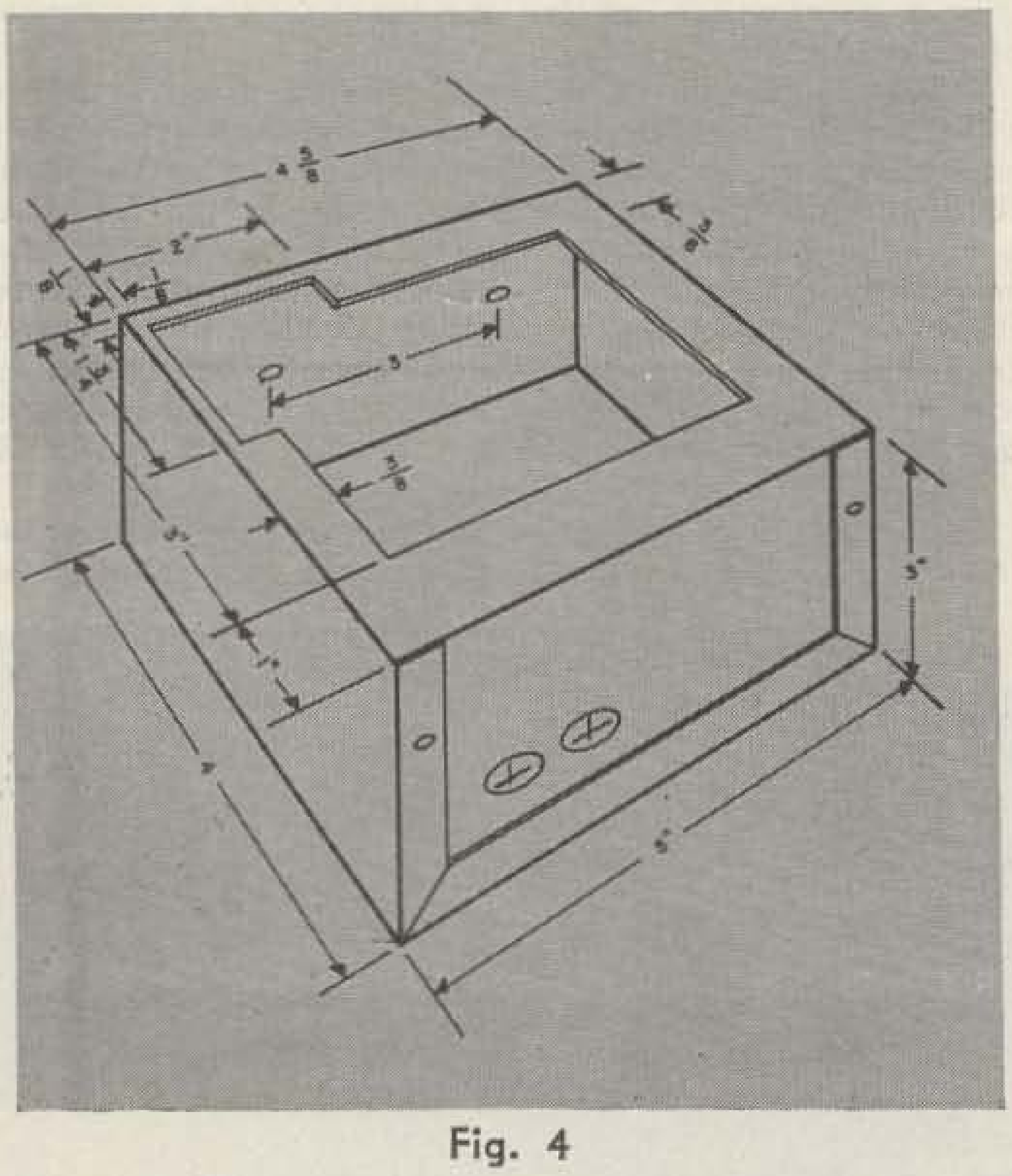


Fig. 4

Connect the output meter circuit shown in Fig. 3 to the line amplifier output.

With the signal generator power off, but connected so as to terminate the input, adjust L2 until *no* dc appears at the output point "A," making use of any 1 volt, 1000 ohm (or better) per volt meter. It may be necessary to add or subtract turns from L2 if this point cannot be found with the iron core adjustment. The layout determines the exact size of L2.

Turn the signal generator power on and set

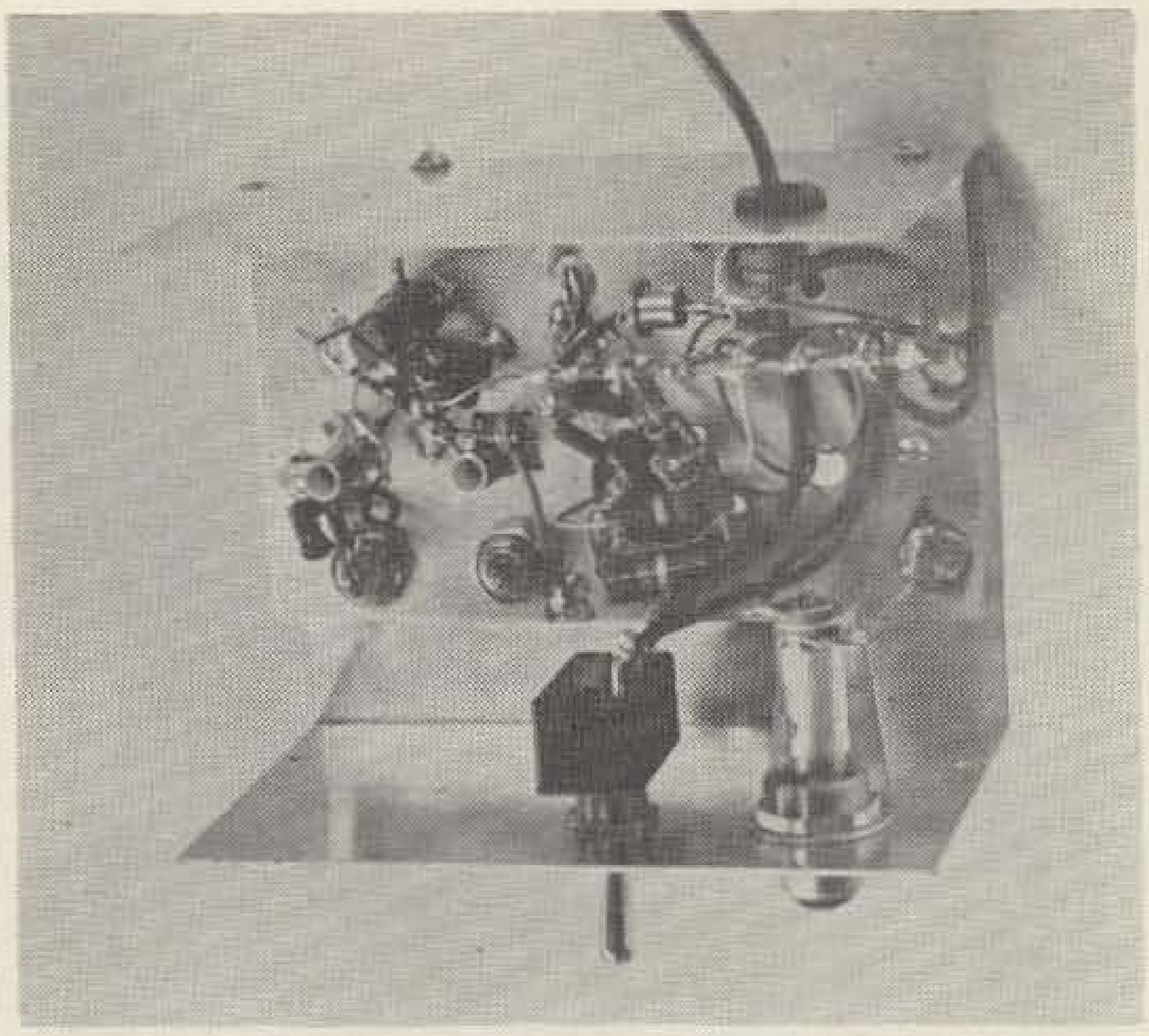


Fig. 5

it for about 30% modulation and 146 mc. Adjust C1 and C2 for maximum output on the 1 millivolt ac meter. Don't feed more signal in than is necessary to provide ½ millivolt of recovered audio. If your signal generator has a good well calibrated attenuator, check to see if the gain is constant over the band. It should be within 1½ db at either end (144 to 148 mc). With the signal generator removed there should be no tendency to oscillate, as would be indicated by any dc at point A, Fig. 3. Should dc be present, it would be necessary to readjust L2 as before and realign at 146 mc.

The line amplifier is designed to work into fifty ohm antenna systems and into a fifty ohm receiver. Any deviation from this would necessarily require minor changes.

Coil Data

L1—5 Turns #18 close wound on 3/16" dia. form. Use enam. wire. Remove form.
L2—14 Turns #22 close wound on ¼" iron core tuned coil form. Use enam. wire. (CTC-LS-6 with white slug).
L3—6½ Turns #18 close wound on 3/16" dia. form. Use enam. wire and remove form.
L4—2 Turns #30 wire. Wind over B+ end of L3. Use enam. wire and fasten with Duco.
C1, C2—Tubular type trimmers (Erie).

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As announced a few months ago, clubs may send in group subscriptions at the rate of $2.50 per one year subscription in groups of five or more subscriptions. These subs must start with the next published issue and be for just one year. Orders for back issues should be sent in separately. By simplifying the procedure we can offer this reduced rate.

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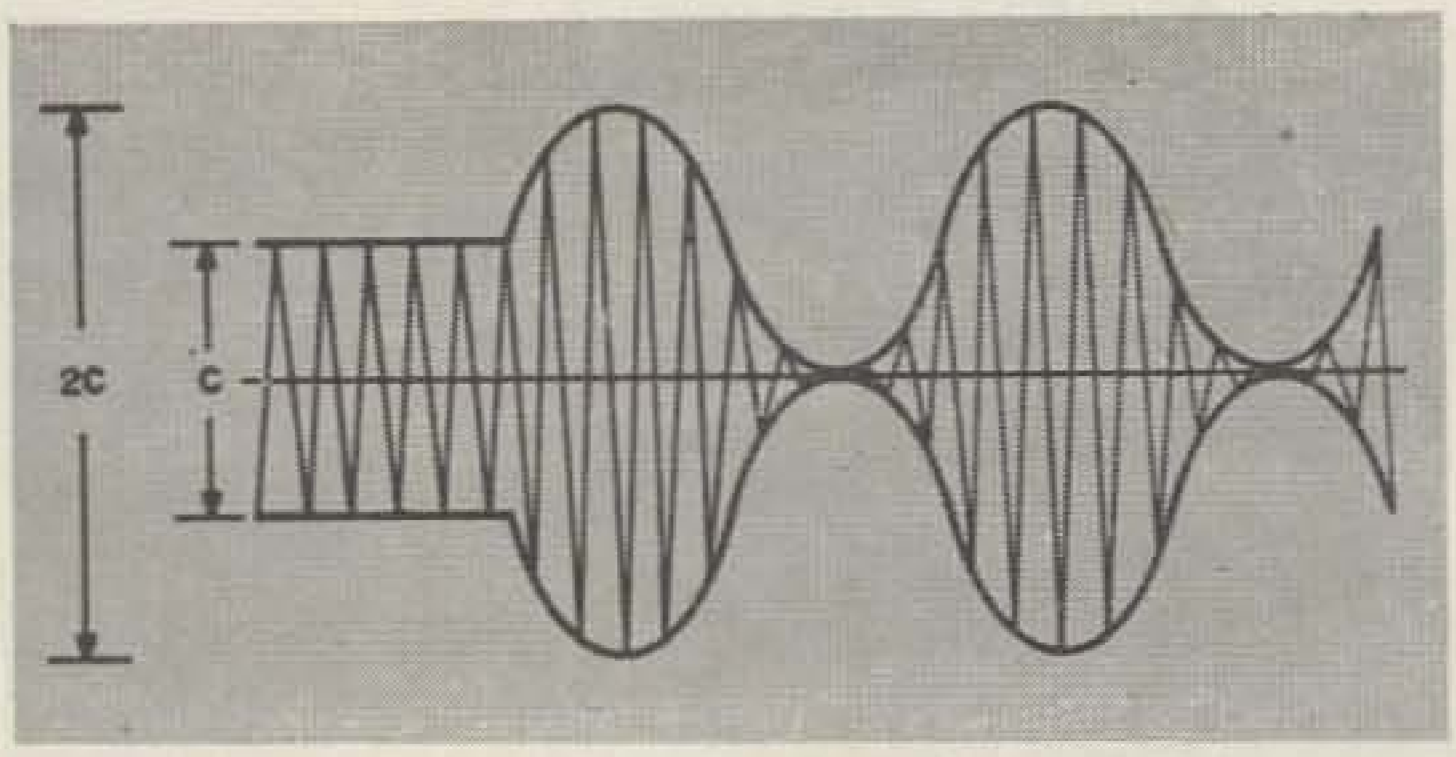

A Review of

AM Modulation Systems

With Special Reference to an Oldie

R. E. Baird W7CSD
3740 Summers Lane
Klamath Falls, Oregon

MOST people are acquainted with the standard diagram for the linear wave form pattern of 100% modulate AM. To refresh your memory observe Fig. 1. If the amplitude of the carrier is C the amplitude of the positive peak at 100% modulation must be 2C. The negative peak must be zero. Let us consider Fig. 1 to be the pattern formed on an oscilloscope connected with the vertical deflection plates tied to the output of the modulated amplifier; thus, it would be a voltage wave form. Since an antenna (or dummy load) is a fixed impedance, if the voltage doubles on the positive modulation peak the current must also double. This means that the modulated amplifier must deliver four times the carrier power on the 100% positive modulation peaks. Regardless of the method of modulation this is an *absolute* requirement of an amplitude modulation system.

The purpose of this article is to show how this requirement is satisfied by several methods of modulation and to show the advantage of one of the easier methods.

Plate Modulation

Plate modulation (or plate and screen modulation if the modulated stage happens to be a tetrode or pentode) is probably more used than any other system of amplitude modulation. There may be some economic arguments for plate modulation but ease of operation would perhaps be the leading argument. It is comparatively easy to get good modulation under just about any set of bad conditions you can think of. Within limits the excitation to the modulated stage may be varied widely. The loading can vary from light to very heavy with or without reactive components and the proper wave shape will still be maintained. A wide range of plate voltage will only affect the carrier power and the efficiency can be maintained at a rather high percentage.

The common system used at the present is some form of audio amplifier, usually class B push pull, transformer coupled to the modulated amplifier as in Fig. 2.

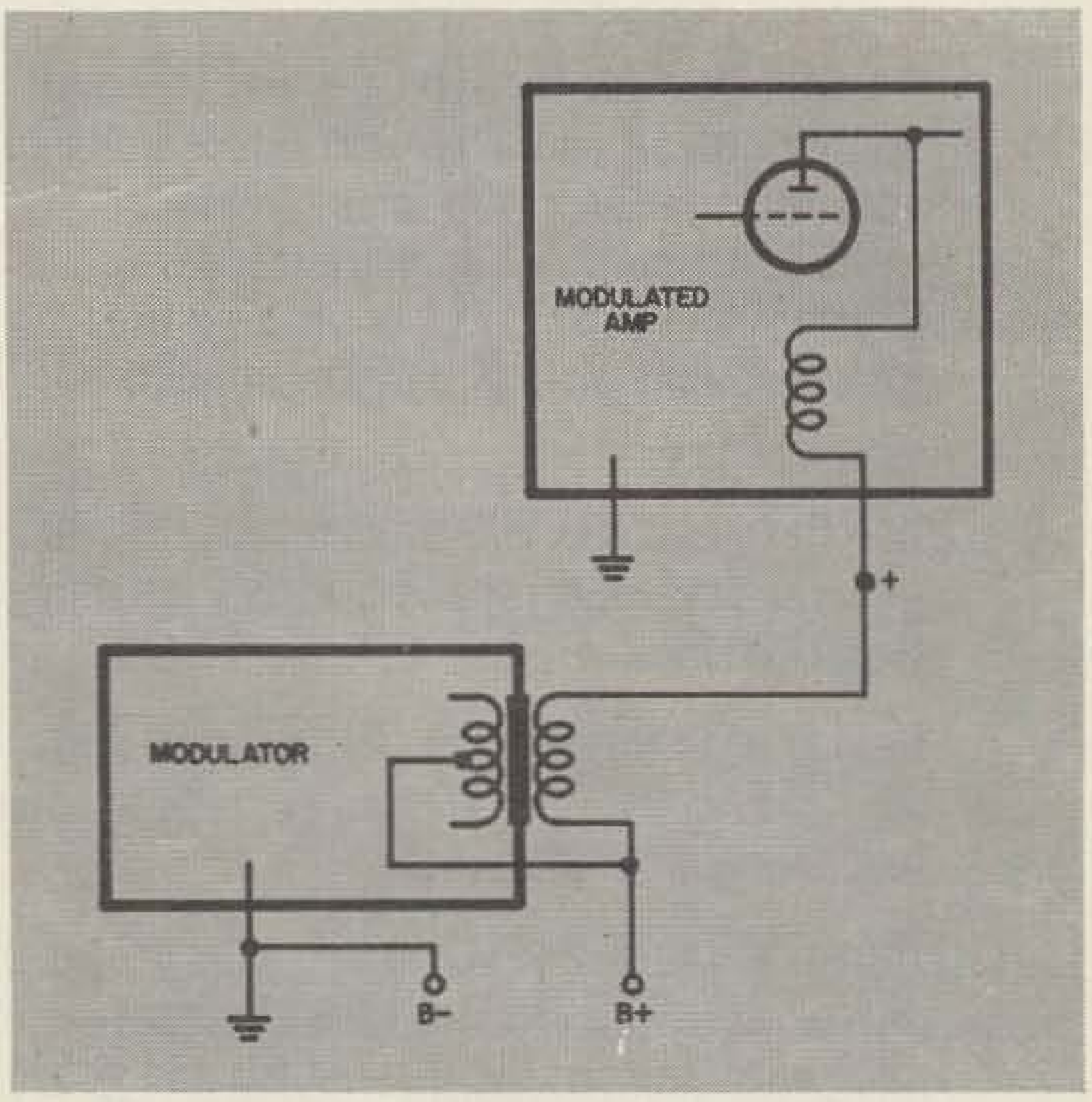

Fig. 2

A mathematical example will serve as an easy explanation of plate modulation. Assume the modulated amplifier in Fig. 2 has an unmodulated input of 500 volts and 100 ma and is adjusted for normal high efficiency output. From the power input standpoint this looks like a fixed resistance load of 500 volts divided by .1 amps, or 5000 ohms. On the 100% negative peak of modulation the voltage in the secondary of the modulation transformer is exactly equal to 500 volts peak and is in series opposition to the 500 volt dc supply; thus, voltage on the modulated stage is zero and

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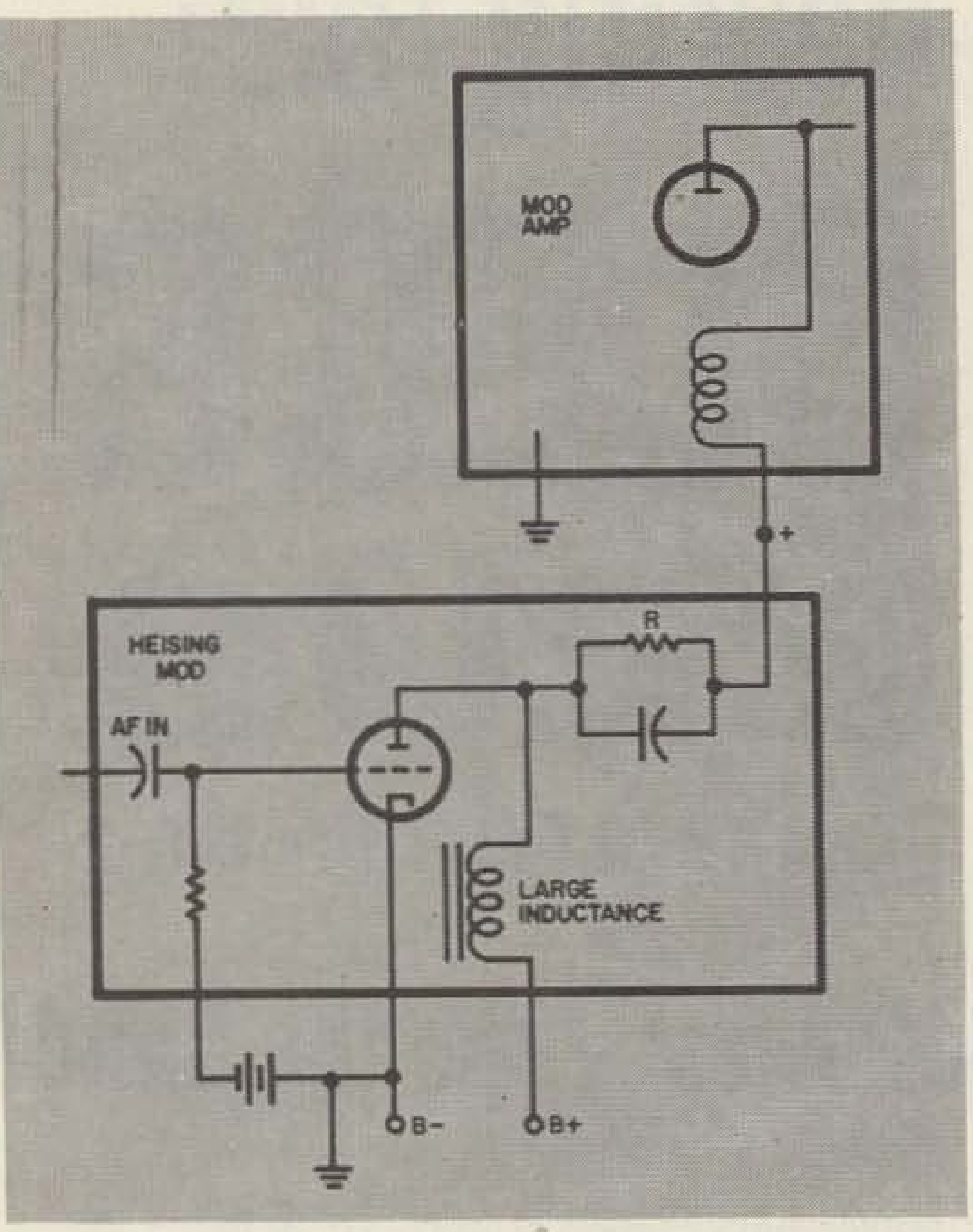


Fig. 3

power is zero. On the 100% positive modulation peak the voltage in the secondary of the modulation transformer is exactly equal to 500 volts peak and is in the series aiding direction with respect to the 500 volt dc supply; thus, the voltage on the modulated stage is 1000 volts. Since the modulated stage still looks like 5000 ohms the current will be 1000 divided by 5000 or .2 amps. The voltage has been doubled and the current has been doubled; therefore, the power input is four times the unmodulated value. Nothing has been done to change the efficiency; so by the same token, the power output is four times the unmodulated value.

The foregoing is easy to follow and will readily be understood by anyone with an elementary knowledge of Ohm's law.

In order to complete the plate modulation picture Heising modulation should also be mentioned. The effect on the final amplifier is identical to the above. Heising uses a single tube (or parallel tubes) in class A and is connected as per Fig. 3. In order to get a full the rf tube and usually a dropping resistor R with a large by-pass capacitor across it (to allow the ac modulation to get through) is incorporated. This circuit is practical only in low power applications.

Series modulation also does the same thing. In this case the modulator acts as a series variable resistor which varies at audio frequency. It reaches plate current cut off on the negative peaks of modulation and allows the voltage applied to the modulated stage to double on the positive peaks. Because of inherent losses in the tube the power supply must have more than twice the rated voltage of the modulated stage. For example, using the foregoing mathematical problem, the power supply would probably need to have 1200 volts. 500 volts would be across the modulated stage and 700 across the series modulator in the unmodulated condition. This method is not too practical for reasons of the high voltage necessary and the fact that the modulator tube must have high dissipation properties, in the case noted 70 watts.

The three different systems noted are all systems of getting plate modulation. To get plate and screen modulation in the case of a tetrode or pentode all that is needed is a series dropping resistor from the screen to the B+ lead of the modulated amplifier. The theory is still the same.

Efficiency Modulation Systems in General

Nearly all systems of AM modulation other than plate modulation involve variable efficiency. Grid, screen grid, suppressor grid, and the use of a class B linear all involve applying modulation to some other element than

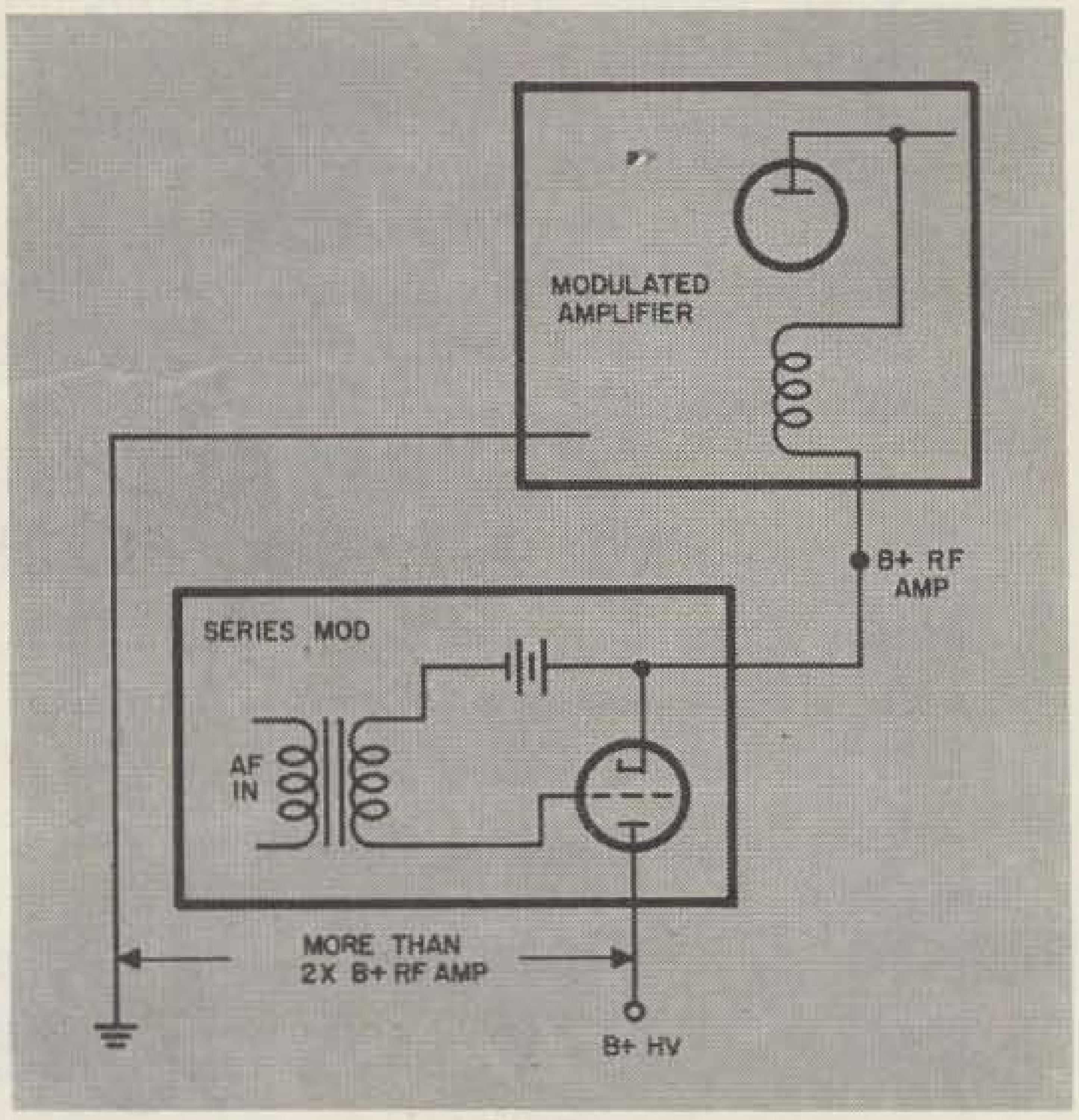


Fig. 4

the plate in such a manner that on negative modulation peaks the plate current is cut off; hence, the power will be zero. On the positive peak the plate current is driven to double the unmodulated value. This alone will supply twice the unmodulated power. Something else must double in order to get four times the power. The only other variable is the efficiency. If the unmodulated efficiency is 30% it is comparatively easy to double the efficiency in a nearly linear manner to get the necessary 100% peak. If the unmodulated efficiency is 35% it is still very possible. If the unmodulated efficiency is 40% or over, the positive peaks will probably start flattering unless all adjustments are right on the nose. For ex-

ample, suppose we are all tuned up to 80% efficiency with no modulation. It becomes obvious that this will be a little hard to double. They don't hardly make 'em that way any more, 160% efficient that is. Soooo what do we do? There is only one way out. We deliberately louse up our efficiency. This really hurts and is probably the outstanding objection to methods other than plate modulation. The redeeming feature of course is that only a small amount of audio power is required.

A Simplified Version of What Actually Happens

For purposes of illustration let us consider the battery shown in Fig. 5a. This battery has an internal resistance of 10 ohms. The fixed external load is 5 ohms. A quick Ohm's law calculation reveals a current of 1 amp, a total power delivered of 15 watts and only 5 watts delivered to the load.

In Fig. 5b the battery has been replaced with a battery having only 2.5 ohms internal resistance. Now we have 2 amps, a total of 30 watts, and 20 watts delivered to the load. *Note,* this is four times the power delivered to the load in 5a. The efficiency has doubled, going from 33% in 5a to 66% in case 5b. The voltage generated remained the same.

The vacuum tube modulated amplifier is not unlike the battery. As far as the load is concerned, the vacuum tube is a voltage generator with an internal resistance. As the modulating voltage is applied the internal resistance of the generator changes. Actually this is an over simplification as the generated voltage changes some too and in the right direction. But essentially it is necessary to lower the efficiency to something on the order of 33% unmodulated in order to get the linear modulation we want. The internal resistance of the generator is increased by changing the dc bias on the element to which modulating voltage is to be applied or coupling back an overload, that is to say a low value of ^{R}load, to the plate of the tube may give the right ratio of ^{R}load to ^{R}internal, or a combination of both will bring the efficiency down. In certain cases, the

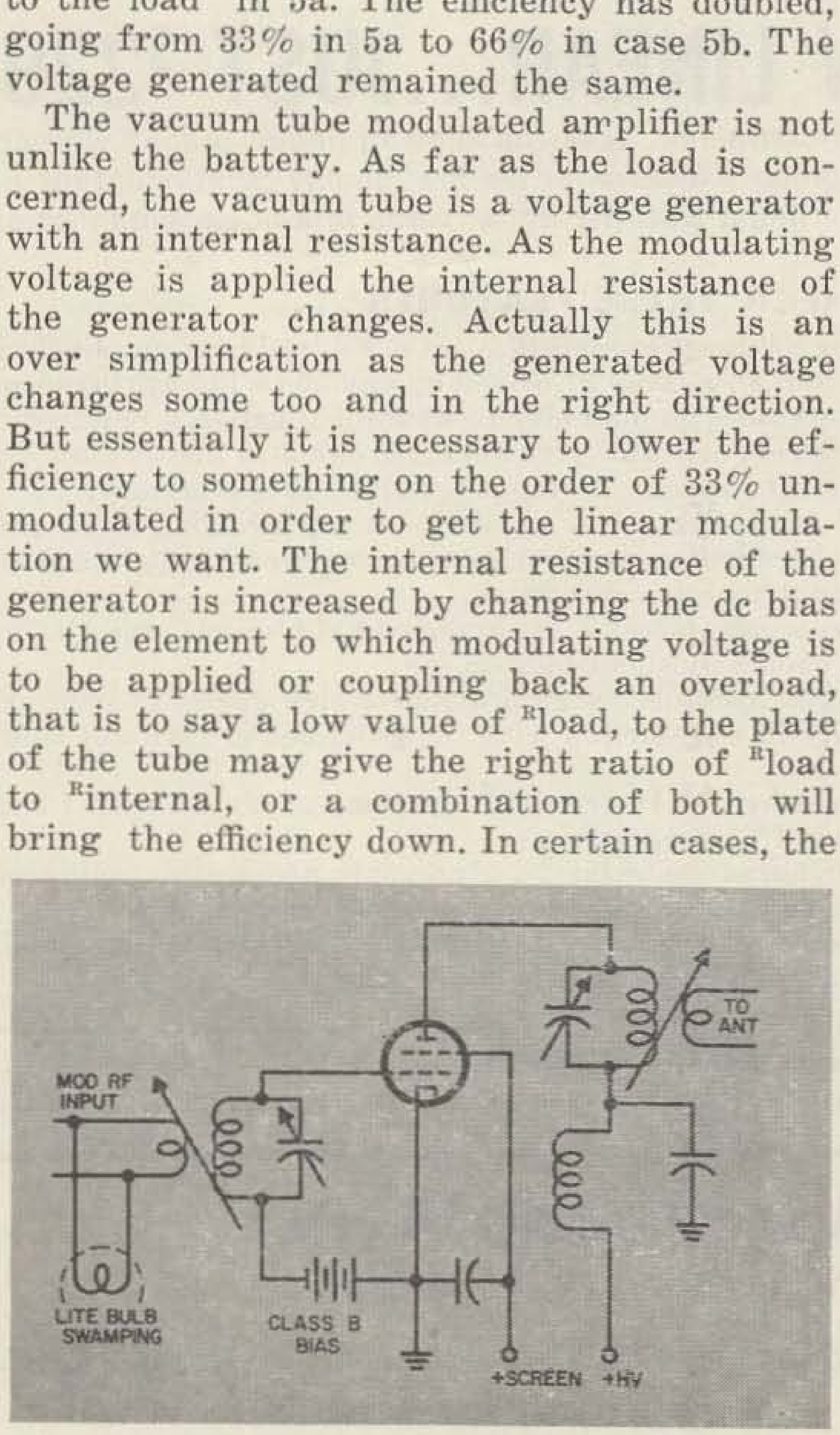


Fig. 6

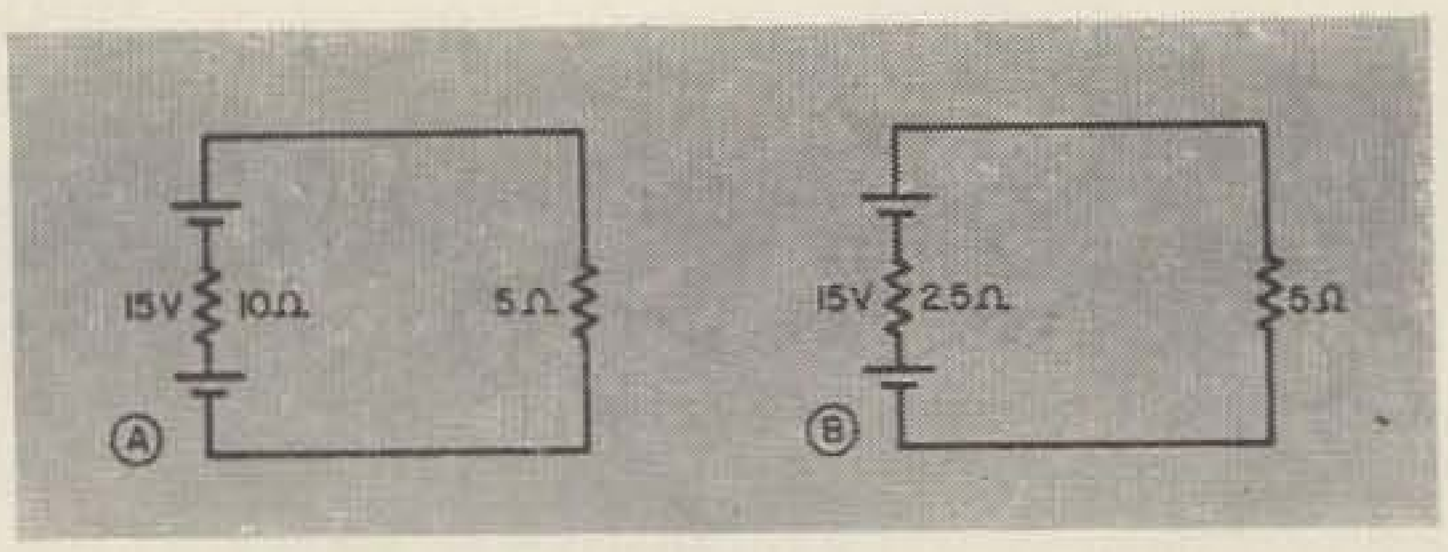


Fig. 5

class B linear for example, the excitation must be greatly reduced.

Some Variable Efficiency Modulation Systems

Class B linear: This is not really a system of modulation, but has many of the attributes of efficiency modulation. The rf input to the class B linear is already fully modulated. However the input impedance of the Class B linear is anything *but* linear. During the negative peak the grid draws no curernt at all; whereas, on the positive peak the grid draws considerable current. So the load to the preceding stage varies from practically nothing to fairly heavy in different parts of the modulation cycle. In order to minimize this non-linear load it is necessary to put an artificial load in parallel to "swamp" the modulated signal. This can be a non-inductive resistance or even a light bulb hung across the link coupling. Having hung the swamping load, voltage regulation from the modulated exciter will be good. By reducing the excitation to a low value and by carefully adjusting the coupling of the antenna system, definitely on the too close coupling side, (or too wide open a loading capacitor in a pi network) very linear output may be achieved. A variable dc bias is highly desirable. Grid leak bias is out!!

In order to not exceed plate dissipation ratings of the tube, power input cannot exceed 150% of rating because efficiency will be on the order of 35%. Higher efficiency will result in flat positive peaks. A conventional circuit is shown in Fig. 6.

Control Grid Modulation

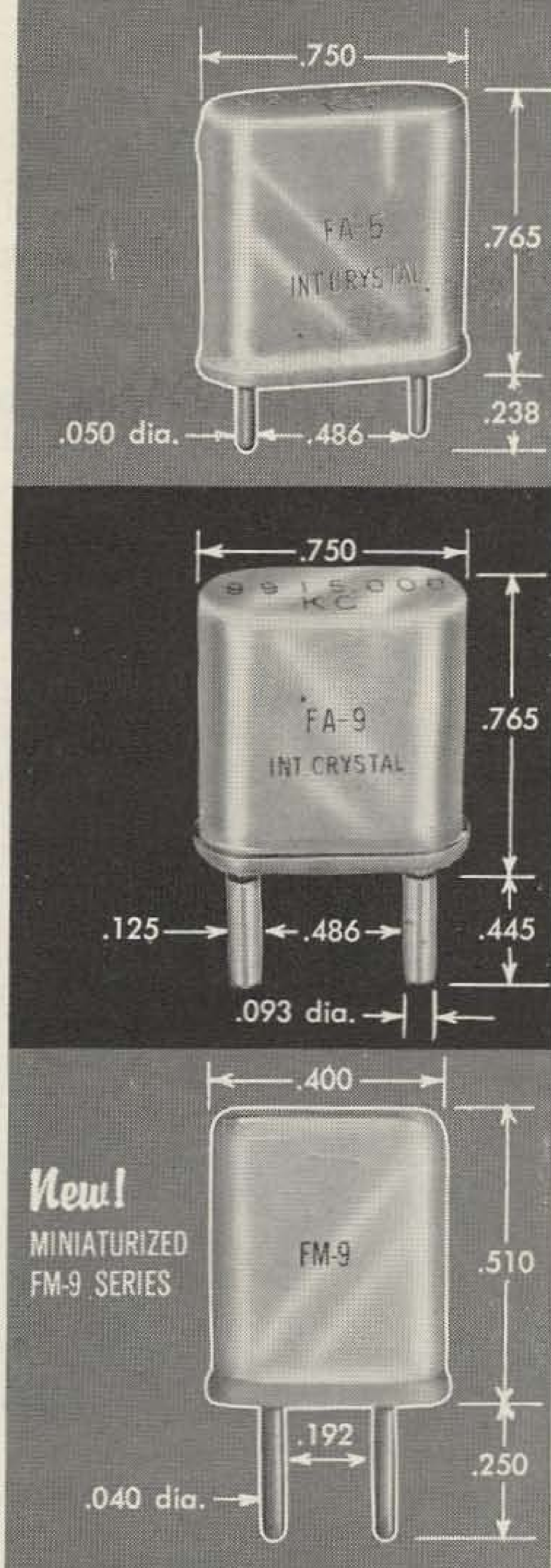
All of the requirements for control grid modulation are same as for the Class B linear except that the bias may be for class C. The modulating voltage is applied in series with the grid bias. Again a combination of overloading and excitation adjustment to get the efficiency down so that it will vary linearly must be followed. A close study will reveal that grid modulation and class B linears are very much the same. A conventional circuit is shown in Fig. 7.

Cathode Modulation

Cathode modulation, as shown in Fig. 8, is merely a combination of grid modulation and

Amateur Crystals

1000 KC to 137 MC - .01% TOLERANCE



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Fundamental	1000 - 1499 kc	$ 5.75	Not available	
	1500 - 1799 kc	$ 4.95	Not available	
	1800 - 1999 kc	$ 4.40	Not available	
	2000 - 9999 kc	$ 3.30	8000 - 9999.999 kc	$ 5.00
	10000 - 14999 kc	$ 4.40	10000 - 15000 kc	$ 5.50
	15000 - 20000 kc	$ 5.50	15001 - 19999.999 kc	$ 6.50
Overtone (3rd)	10 - 14.99 mc	$ 4.40	Not available	
	15 - 29.99 mc	$ 3.30	20 - 39.99 mc	$ 5.00
	30 - 59.99 mc	$ 4.40	40 - 59.99 mc	$ 5.50
Overtone (5th)	60 - 75.99 mc	$ 4.95	60 - 89.99 mc	$ 6.50
	76 - 99.99 mc	$ 7.15	90 - 100 mc	$ 8.50
	Not available		101 - 110 mc	$10.00
Overtone (7th)	100 - 137 mc	$ 9.35	Not available	

Overtone crystals are calibrated on their overtone frequency. They are valuable for receiver-converter applications and are NORMALLY NOT UTILIZED IN TRANSMITTERS, since only a small amount of power is available under stable operating conditions.

- **CALIBRATION TOLERANCE:** ± .01% of nominal at 30° C.
- **TEMPERATURE RANGE:** −40° to +70° C. ± .01% of frequency at 30° C.
- **DRIVE LEVEL:** Recommended, maximum 3 milliwatts for overtones; up to 80 milliwatts for fundamentals, depending on frequency.

ONE DAY PROCESSING . . .

Orders for less than five crystals will be processed and shipped in one day. Orders received on Monday through Thursdays will be shipped on the day following. Orders received on Friday will be shipped the following Monday.

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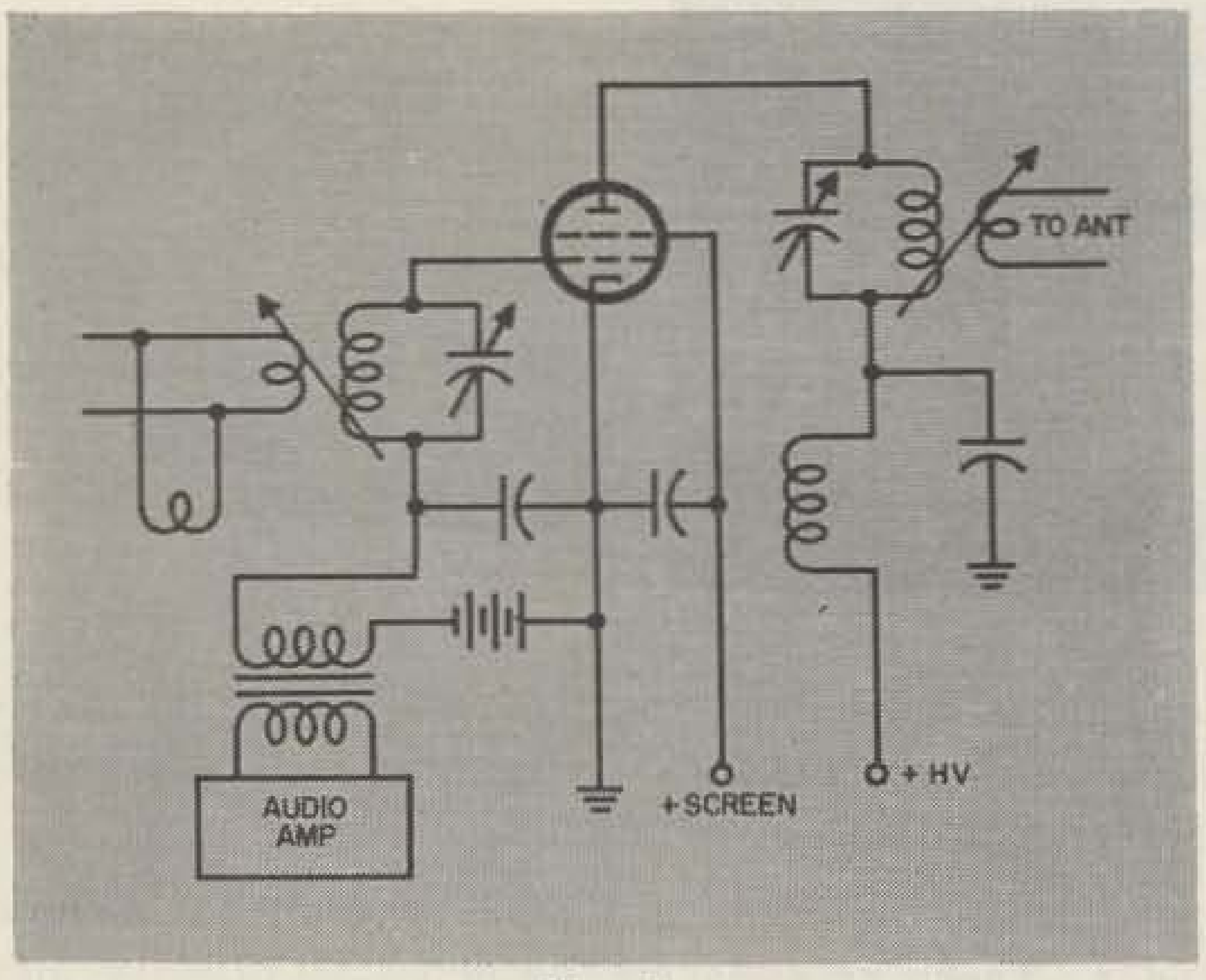


Fig. 7

plate modulation. Consider for a moment the effect of having the grid connected above the modulation transformer. In this case we have ordinary plate modulation except the transformer is connected on the cathode side of the amplifier. Since it is a series circuit it would make no difference on which side the transformer is connected. Suppose for an instant that we have sufficient audio to plate modulate 20%. If we now advance the grid down the adjustable resistor tied across the modulation transformer we get additional grid modulation. If adjustments are carried out as outlined in grid modulation we can get the additional 80%, making a total of 100%. In this case, due to the presence of some plate modulation we will not have to double the efficiency. So we can run at a higher unmodulated efficiency. Depending on the amount of audio power available, the efficiency may run up to

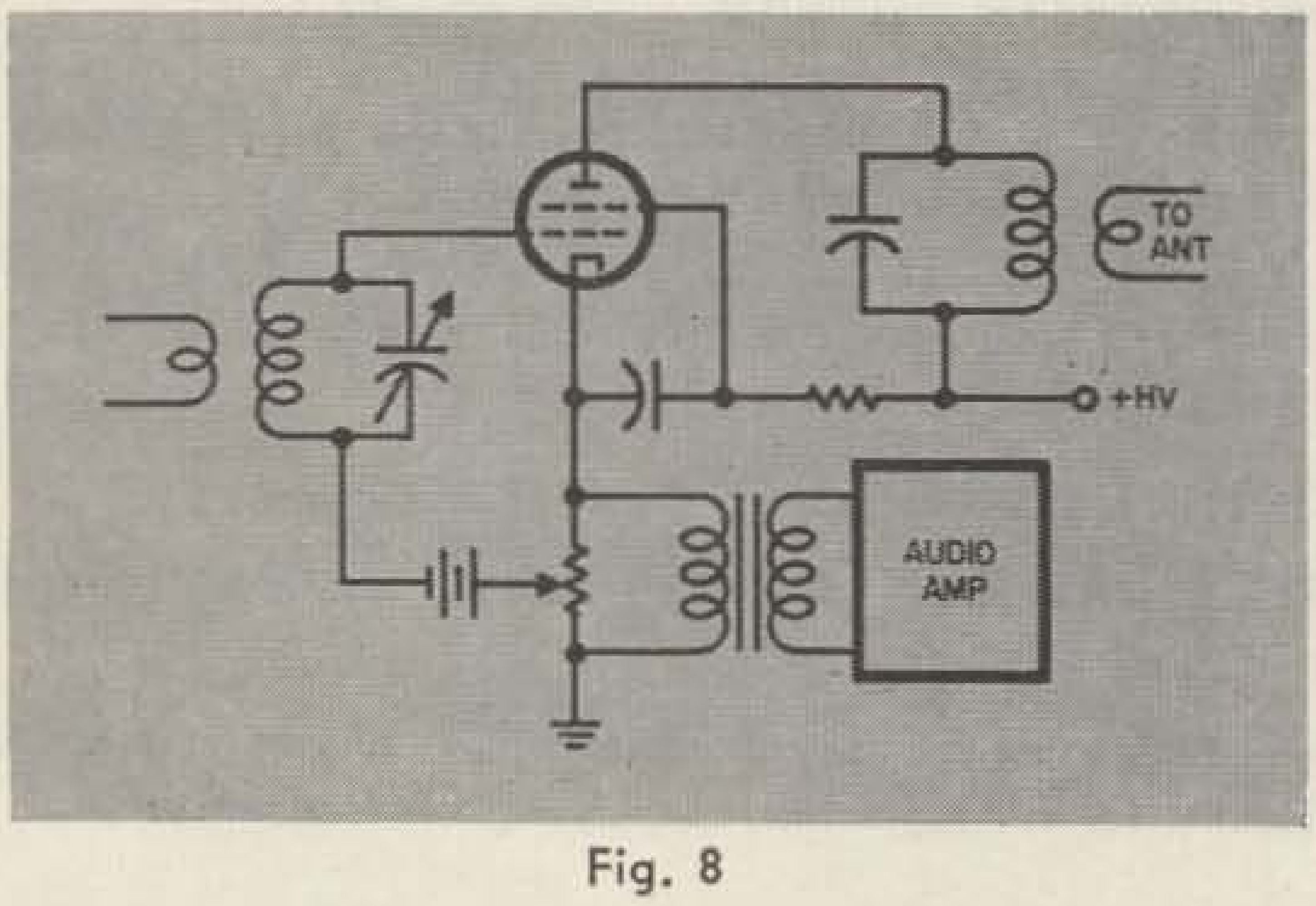


Fig. 8

50% or so. This is an expedient that may be used when one has a public address system, or similar piece of gear, having insufficient power to plate modulate the final amplifier.

Screen Grid Modulation

There are assorted forms of screen modulation but they all hinge on lowering screen voltage, in some cases into the negative region, and adjusting for the proper coupling to get linear performance. Many screen grid type tubes are not capable of 100% screen modulation. Some specially built tubes do a very good job, particularly on speech. In general it is difficult to get a distortion free scope pattern on a pure tone; however speech may be quite acceptable. In many cases, judging from what this observer hears on the air, the positive and negative peaks are badly unbalanced and considerable flattering occurs on the positive peaks. This is probably the result of adjustment without the use of a scope. This particular form of modulation has become popular in controlled carrier systems of which there are too many for the scope of this article. They all trade on running with very little output and plate dissipation with no modulation. When modulation is applied input, output, and plate dissipation go up. With a sustained sine wave of modulation many of these circuits would have plate dissipation far exceeding manufacturers ratings. But with speech, ratings are only exceed momentarily. Fig. 9 is a conventional circuit. Quite an article could be written on variations of screen modulation.

Suppressor Grid Modulation

This form of efficiency modulation was very popular back in the 30's, but is almost unknown today. Yet it is perhaps the easiest of all the systems of this kind to adjust for linear operation. Its chief claim to fame is the

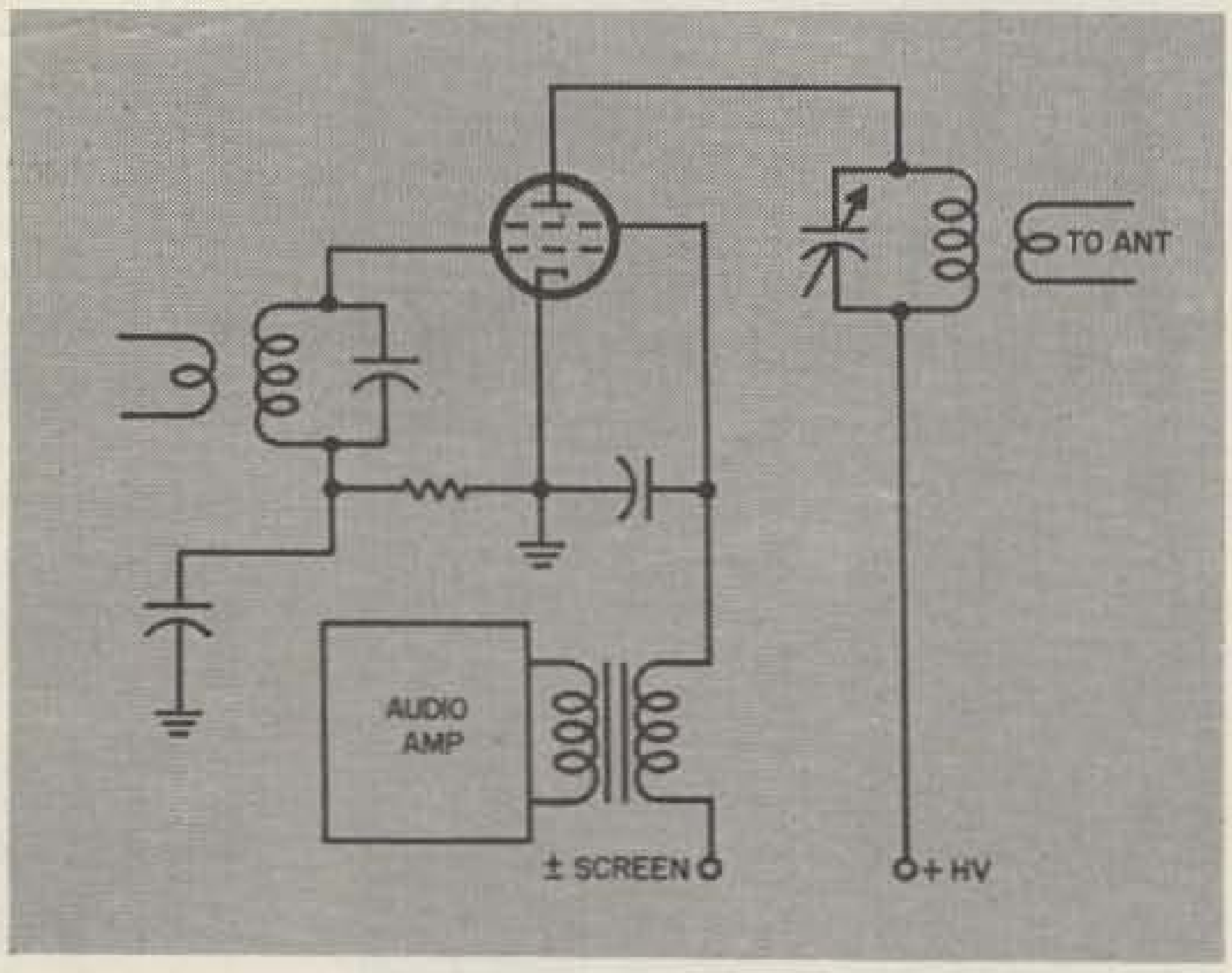


Fig. 9

relative unimportance of the loading. Almost all of the variable efficiency is derived from adjustment of the suppressor grid voltage. If you are not concerned with efficiency it is possible to get linear modulation at any value of load whatever just by reducing (making more negative) the dc potential on the suppressor grid to the necessary level. In practice the optimum loading for an unmodulated signal will not have to be changed. Just bias the suppressor grid sufficiently negative to get a linear pattern by observation. This usually requires a modulating voltage that never drives the suppressor into the positive region; hence, little or no audio power is required. As is the

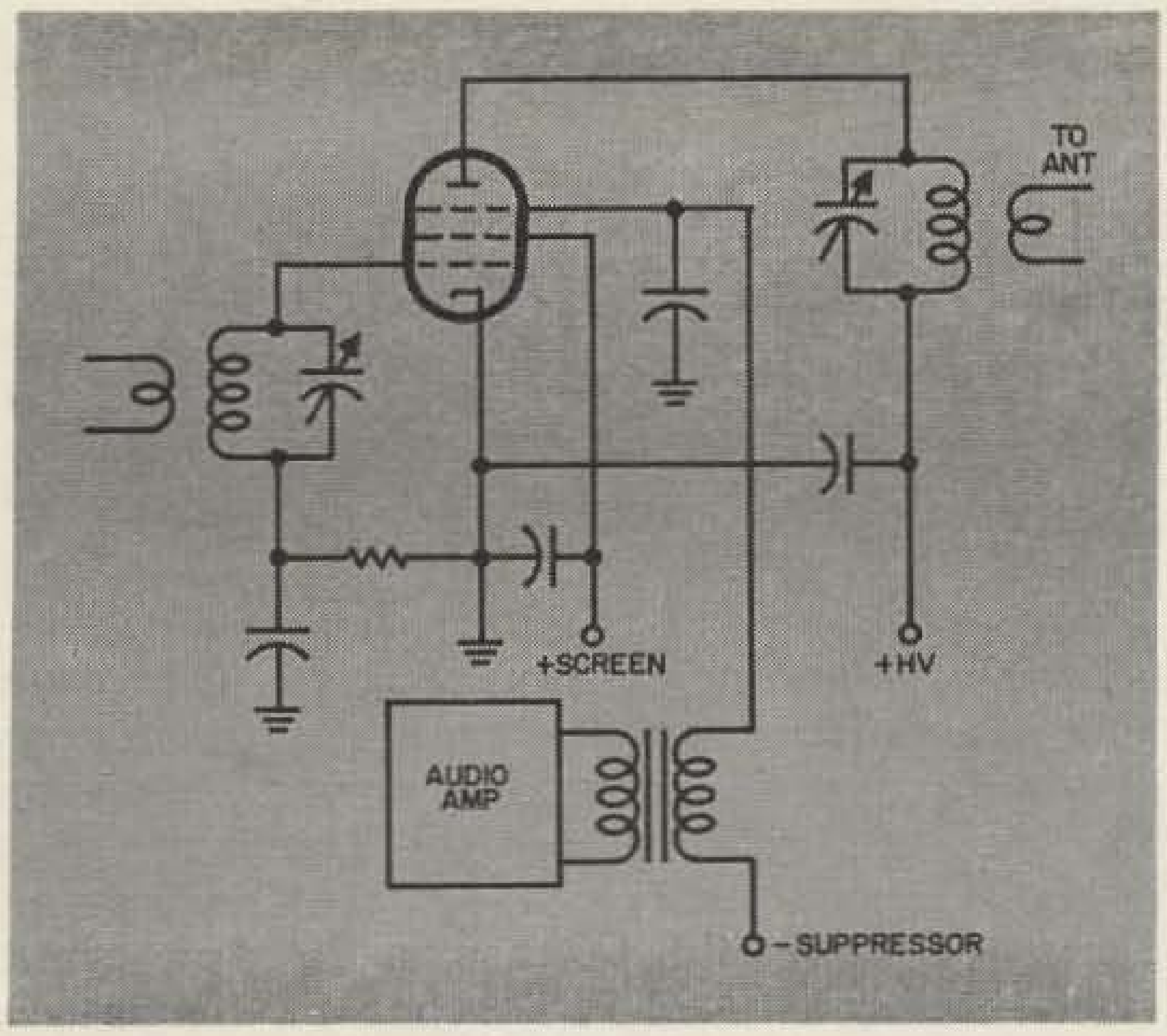


Fig. 10

case with most efficiency modulated systems, more power out, well modulated, can be obtained with high plate voltage. A conventional circuit is shown in Fig. 10.

Transmitting type pentodes are a scarce article on the modern market. The 4E27 and 4E27A are a good example in the 100 watt plate dissipation region. The 803, although a little on the obsolete side, is excellent and readily available on the surplus market. The WE-312A (also with Navy number CW-38412) in the 50 watt size is one of the best pentodes for suppressor modulation ever built. And of course in the low power bracket we have the 837 and the 802. The GF-11 GI transmitter, which is familiar to many, uses 837's. The BC-1306 uses a 2E22 suppressor modulated. The BC-325B uses a pair of 803's with about 2500 volts on the plates. There were several other military transmitters using suppressor grid modulation.

It is hoped that this review of AM modulation systems will bring the old timers up to date and show the younger ones what they are getting into. If you have access to a high voltage supply and do not have any high power audio available buy a couple surplus 803's and give supressor grid modulation a whirl.

Letters

Dear Wayne:

You seem to know all about everything, perhaps you can explain something that has been bothering me for a long time. How come the WΦ calls have a zero with a line through it instead of a plain zero?

Wretched Coward K2PMM

Good Heavens, I thought everyone knew the answer to that! Originally the country was divided into nine call areas. Unfortunately the Ninth Zone was much too large and it filled up quickly. The obvious answer was to add a Tenth Zone. This was done. International regulations did not permit the FCC to issue W10 call letters, so they had to put the one on top of the zero, making one single number out of it. This number is a ten, not a zero, and should be read as a ten. Any knowing ham gets a laugh out of the lids who go on the air and call themselves W-zero instead of W-ten, as they should.

Globular Calculations

G. T. Martin, Jr. K5RPB
3296 Sandefer Street
Abilene, Texas

An amateur radio operator interested in exact alignment of a high gain antenna to better than one degree of arc will also find a use for the mathematical method of calculating exact true bearing and distance to a remote location from his own position. Although the solutions appear formidable, ten minutes of effort will eliminate guessing the right direction to point your beam for that elusive rare DX.

If you own a large globe, the use of thread and a protractor will give you reasonably accurate bearings. By typing one end of the thread to a pin placed at your position on the globe, and stretching the thread across the point on the globe you wish to contact, you can determine a true bearing by measuring the angle between the lay of the thread and a meridian at the midpoint of the thread. The distance may be roughly measured by laying the length of thread along any meridian and multiplying by 60 the degrees of latitude subtended. One minuts of arc is equal to one nautical mile. The degree of accuracy is dependent upon the size of the globe, the accuracy of the plotted information, and for distance, how you stretch the thread. Unfortunately, not all of us have globes, and must resort to other methods.

Another way to find true bearings to distant points is by using great circle charts, which are available from several sources. Most of these assume all of us live in New York City, San Francisco, or Kansas, and are subject to error if used from some other location. For short distance, aeronautical charts (polyconic projection) are reasonably accurate. Mercator charts, those which portray the earth as flat, with latitude and longitude at right angles, are unreliable for determining bearings.

The most accurate method of finding azimuth and distance of a point from your location is to solve for the great circle path between these two points by using spherical trigonometry. A great circle path is the shortest distance between two points on a sphere. It is not necessary to understand how the formulae are derived in order to obtain the required information. The proper answer is dependent only upon correct computation. You must know the geographic coordinates of both your transmitter and the receiver you wish to contact, and have access to tables of trigonometric functions. Usable angles of latitude and longitude may be obtained from any available charts, gazetteers, or publications. The necessary tables can be found in most engineering handbooks, professional references, or your old textbooks. In any event, everything you need is at your public library if you don't have the information in your shack.

For example, assume you are at Dyess Air Force Base, Texas 32°26'N-99°51'W, and desire a base azimuth for a rhombic pointed toward March Air Force Base, California 33°53'N-117°15'W. By substitution of values in the given formulae, you will find the correct true bearing is 280°. The distance is approximately 880 nautical miles.

Where Lx is transmitter latitude
Lr is receiver latitude
$\triangle Lo$ is difference in longitude
D is distance between sites (expressed as an arc)
Zn is true bearing East or West of North
then $(\text{Sin } Lx)(\text{Sin } Lr) + (\text{Cos } Lx)(\text{Cos } Lr)(\text{Cos } \triangle Lo) = \text{Cos } D$
and $(\text{Cos } Lr)(\text{Csc } D)(\text{Sin } \triangle Lo) = \text{Sin } Zn$

In illustrating this solution, logarithms are used for convenience in computation because tables were available. Simple tables of functions to the nearest 10' of arc, or a slide rule, will give an acceptable degree of accuracy. Multiplication of functions will take a little longer without the use of logarithms.

$\text{Sin } 32°26' \cdot \text{Sin } 33°53' + \text{Cos } 32°26' \cdot \text{Cos } 33°53' \cdot \text{Cos } 17°24' = \text{Cos } D$

log Sin 32°26' = 9.72942
log Sin 33°53' = 9.74625
9.47567 = .29900
log Cos 32°26' = 9.92635
log Cos 33°53' = 9.91917
log Cos 17°24' = 9.97966
9.82518 = .66861
.96761 = Cos 14°37'20"

$D = 60 \cdot 14 + 37\frac{1}{3} = 877\frac{1}{3}$ nautical miles

$\text{Cos } 33°53' \cdot \text{Csc } 14°37' \cdot \text{Sin } 17°24' = \text{Sin } Zn$

log Cos 35°53' = 9.91917
log Csc 14°37' = 10.59800
log Sin 17°24' = 9.47573
9.99290 = .98379 = Sin 79°40'

359°60'
79°40'
280°20' True Azimuth

Since March AFB is obviously west of north from Dyess FB, subtract 79°40' from 360° to determine true bearing, 280°. Measuring

true bearing and distance on a Lambert Conformal Conic projection of the United States (USAF GNC Series) gave Zn 275°, distance 890 nautical miles.

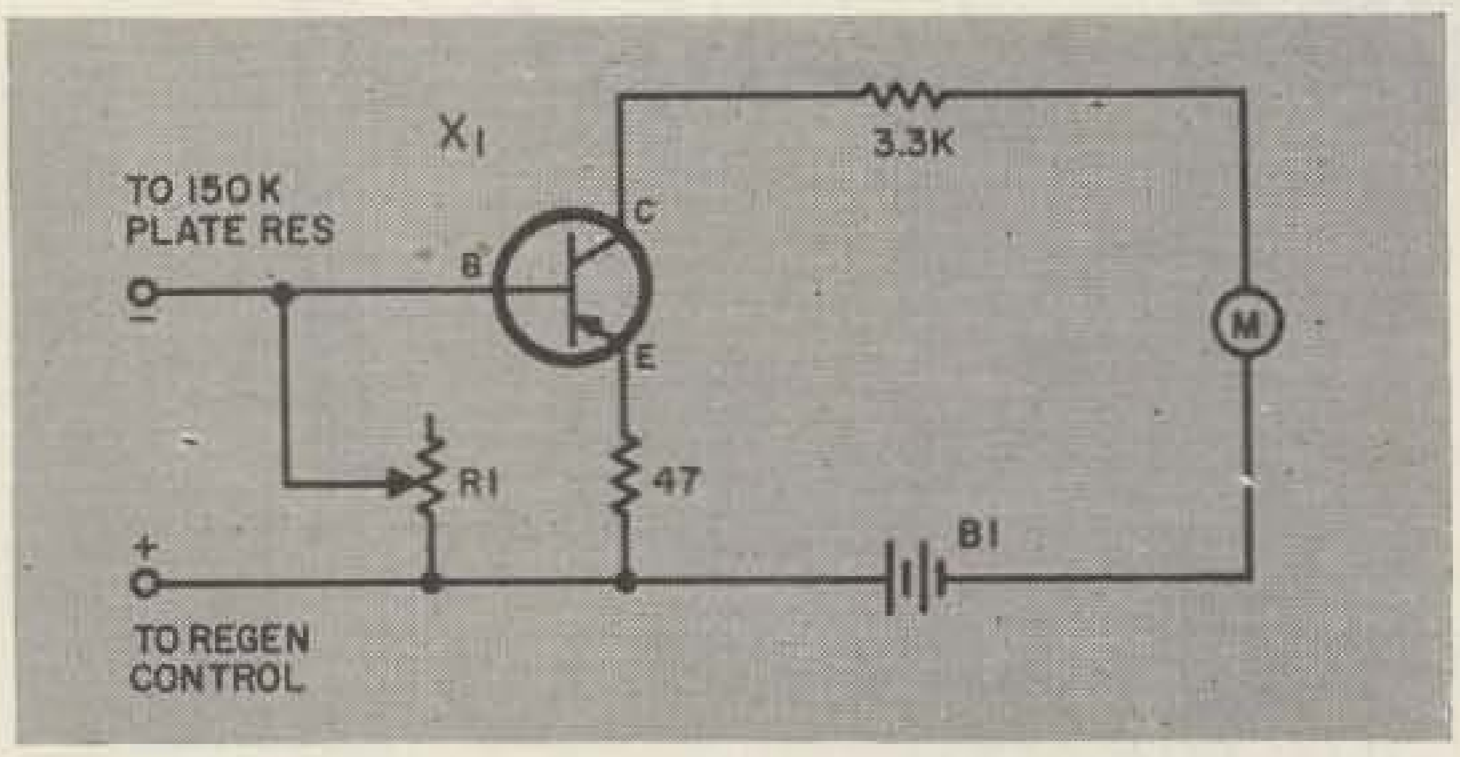
For those interested in the origin of this solution; it is common to the practice of celestial navigation. The astronomical triangle determined by the observer's assumed zenith, the observed body, and the north celestial pole is assumed to be on the surface of the earth. With the introduction of an auxiliary right angle, the unknown true position of the observer is determined from the known true azimuth and altitude of the body. Range and bearing from one point to another on the earth's surface is simply a different solution of the astronomical triangle. Now, point your beam in the right direction, and good luck.

73

Refer to: American Practical Navigator, H.O. No. 9.
Antenna Systems, AF Manual 52-19.
Handbook of Electronic Tables and Formulas, Howard Sams.

A S Meter For Your Sixer

Alan Bierbaum, K5VMC
332 Atkins Avenue
Shreveport, Louisiana



Due to the increased activity of six meter hidden transmitter hunts and the influx of the popular Heathkit "Sixer," an "S" meter circuit was developed at K5VMC/M to allow the use of a "Sixer" on local hunts. The circuit is applicable to the "Tenner" and "Twoer" as well.

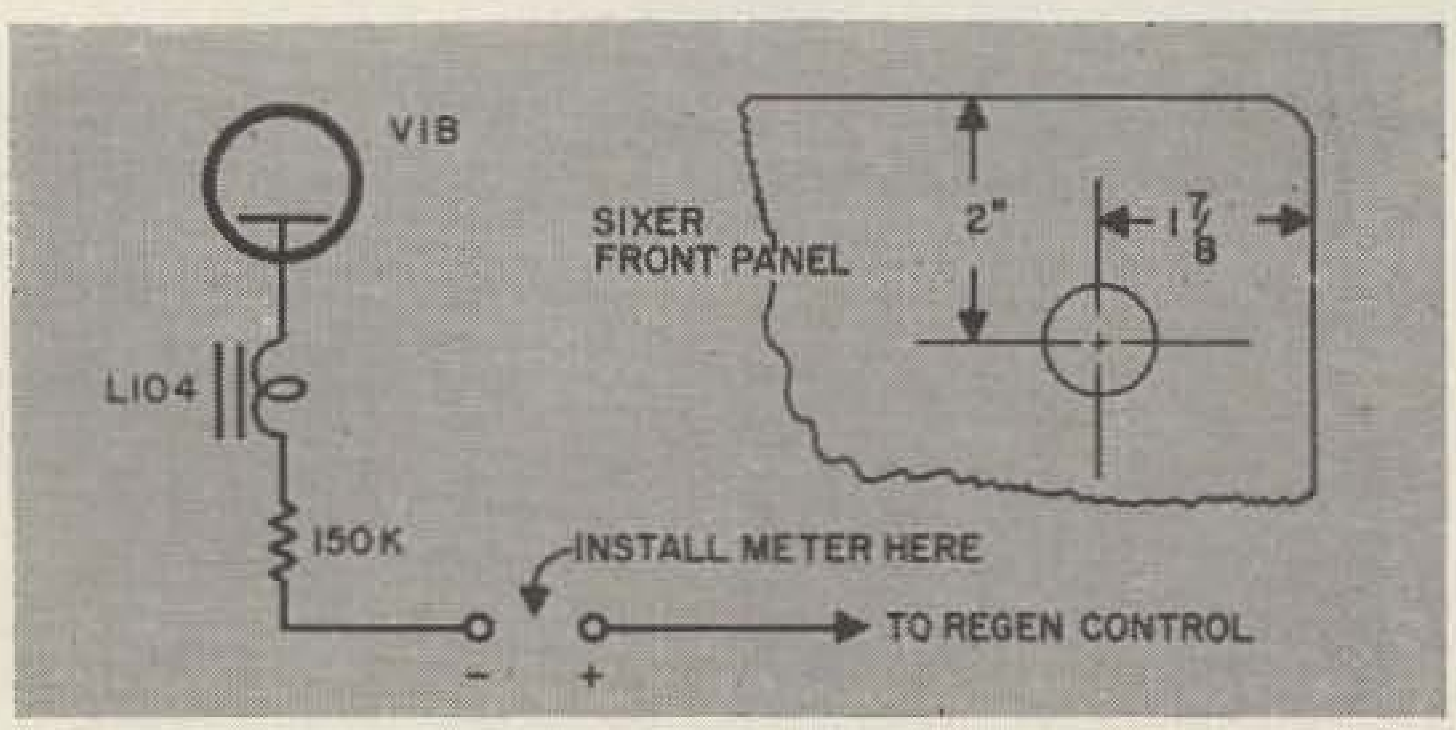
The unit consists of an inexpensive 0-1 ma. meter and a single transistor meter amplifier. Half scale deflection is obtained on a signal strong enough to quiet the background hiss as compared to approximately one fourth to one third scale on a 20,000 ohms per volt meter or a VTVM reading the voltage drop across the plate dropping resistor.

When the detector is operating under no signal conditions, it draws less than one mil. A strong signal causes the detector to draw just slightly more. Measurement of the voltage drop across the 150K plate dropping resistor produced approximately a seven volt drop which was not enough to give an accurate indication. A transistorized meter amplifier was built that would give 100 microamp sensitivity to a 0-1 ma. meter. The input was shunted to give approximately full scale reading with no signal. Application of a weak signal produced about half scale deflection which proved to be ample for hunts as well as relative indications in a fixed station use.

In operation, the meter functions as a transistor volt meter which measures the voltage drop across the input shunt. The shunt is adjusted so that the meter pointer just begins to deflect downscale with no signal input. This is the most sensitive setting and will give the best results.

The meter circuit here was built into a minibox just large enough to accommodate the meter on one end. A socket was used for the transistor but the leads can be soldered if extreme care is used to keep any heat from reaching the transistor. No special layout is necessary and lead lengths are not critical. The only precaution will be that the leads from the "Sixer" to the "S" meter should be hooked exactly as shown and that battery polarity is exactly as shown; otherwise the transistor will be damaged. To dress up the appearance a miniature imported "S" meter was used but any 0-1 ma. meter will work just as well.

In the HW-29 and the new HW-29A, the unit may be mounted permanently as shown in Fig. 2. The old HW-29 with the 8 mc modification kit can incorporate the "S" meter circuitry by installing two banana jacks on the rear apron and using an insulated shorting bar when the "S" meter is not in use. The meter in no way affects operation of the unit.



Using a conventional electrostatically shielded loop, a deflection of one tenth mil was obtained fifty feet from a sixty watt transmitter and a three tenth mil deflection at six miles from a twenty watt transmitter.

One meter, one transistor, three resistors, a battery, and you have an "S" meter which will give better fluctuation indication than the meter on the Gonset Communicator III.

Happy hunting! . . . K5VMC

Bruce Boyd W3QA
415 Wickham Road
Baltimore 29, Maryland

VLF 1961

VLF—very low frequency—is identified[1] by the FCC as that part of the radio frequency spectrum between 10 and 30 kilocycles per second. In the early 1920's these frequencies were crawling with transoceanic commercial circuits which have long since been abandoned in favor of more profitable channels in the HF region. Nevertheless, this band is far from dead.

The U. S. Navy has found VLF signals ideal for reaching submerged submarines and now operates a number of powerful stations in this frequency range including the "megawatters" NPG at Jim Creek, Washington and NAA[2] at Cutler, Maine. These two stations, along with NSS at Annapolis, Maryland and NPM at Pearl Harbor, transmit weather, press and traffic at good code-practice speeds. When things get dull, they while away the time sending "v's" in the time-honored manner of long wave stations.

The National Bureau of Standards has determined[3] that the transmission error in standard frequency broadcasts is much less at VLF than at higher frequencies because multiple reflections from the ionosphere do not take place. As a part of a program[4] to establish a uniform system of time and frequency broadcasts of high accuracy, station NBA in the Canal Zone sends one second dashes on a nominal frequency of 18 kc (offset −150 parts in 10^{10}) with the frequency maintained to an accuracy approaching one part in 10^{10}.

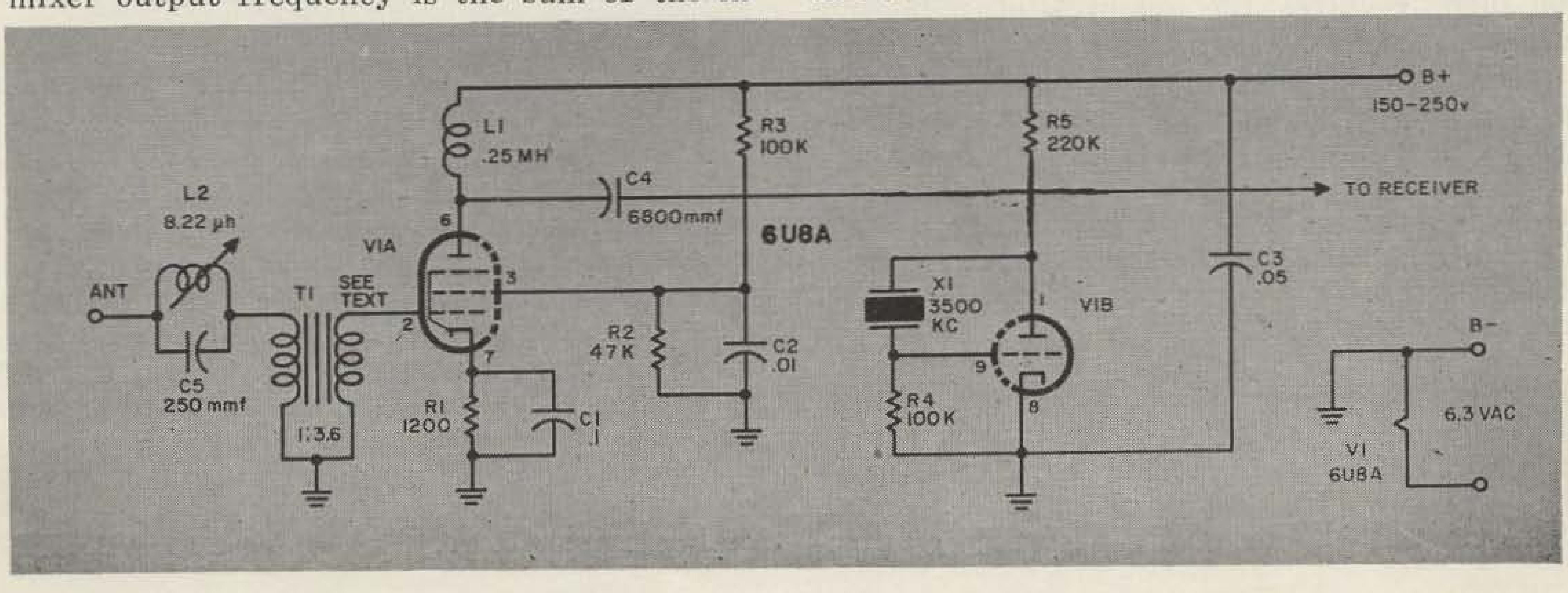
Converter for VLF

You can build a very simple converter that will bring VLF signals into your regular amateur-band receiver. No additional tuning controls are used. This device is similar in principle to the more familiar crystal-controlled VHF converter except that the selected mixer output frequency is the sum of the input and local oscillator frequencies instead of the difference of these frequencies.

The schematic diagram shows a converter which consists of an input filter, a fixed local oscillator and a mixer. A 6U8-A is used for the mixer and local oscillator. The oscillator is crystal controlled for convenience and simplicity. It is important to keep the oscillator level as low as possible so as not to block the receiver, which must tune to within 15 kc of the oscillator frequency. If a 3500 kc crystal is used, the combination will be automatically self-calibrating. For instance, a 20 kc signal will appear at 3520 kc on the receiver dial. Of course, any old crystal in the receiver's range can be used at no sacrifice in performance except the loss of calibration.

Component values are shown on the schematic diagram. T1 is a ⅓.6 vertical blocking oscillator transformer from a discarded Emerson TV set. The transformer is marked "B 12 M 18241 606" and peaks nicely in the 10 to 30 kc range. The 3500 kc crystal came from a BC-696 command transmitter. The trap, L2 C5, may be omitted, but it helps a lot if you have strong amateur signals or harmonics from TV set oscillators in the receiver band. L2 has 27 turns on a ½″ diameter slug-tuned form using No. 30 enamelled wire.

The arrangement of components is not at all critical. A coffee can cover will make a good "breadboard" if you want to give the circuit a quick try. The unit shown in the photograph was constructed on a 4″ x 2¼″ x 2¼″ Minibox and is provided with a cable and octal plug which connects with the accessory socket of an NC-300 receiver. The output jack is a BNC fitting. Use a short piece of coaxial cable between the converter and the receiver input terminals. Minimize pick-up of *if* signals by keeping this connection well shielded.



Receiver

The performance of this converter depends to a large extent on the receiver use with it. For best results the receiver should be as selective as possible and have good bandspread. Remember, the VLF stations are only separated by a kilocycle or so. Use a peaked audio stage or a Q-multiplier, if you have either, to make tuning easier.

When you are ready to try the converter for the first time, connect it to a source of filament and plate power and connect the output cable to the antenna and ground terminals of your receiver. Tune the receiver to the crystal frequency of 3500 kc and make sure the local oscillator is working. There should be a strong CW signal at 3500 kc which stops when you pull out the crystal. Connect the largest antenna you have to the converter input and tune carefully between 3510 and 3550 kcs for CW signals from the VLF station nearest you.

Some 80 meter CW signals may get through the converter too. Pick out one of these and adjust the trap inductance, L2, for a minimum signal. Adjustment of the trap should have no effect on VLF signals. After you have identified one or two of the loud VLF signals and adjusted the trap, tune carefully between 3510 and 3530 kc for some of the weaker stations. The converter has reasonable sensitivity in the LF band also. If your input transformer does not cut off too sharply and you are not too far from NSS, their transmitters on 64, 88, 122 and 150 kc may also be heard. The following table lists the VLF stations heard on this converter in Baltimore in 1961, together with their approximate frequencies.

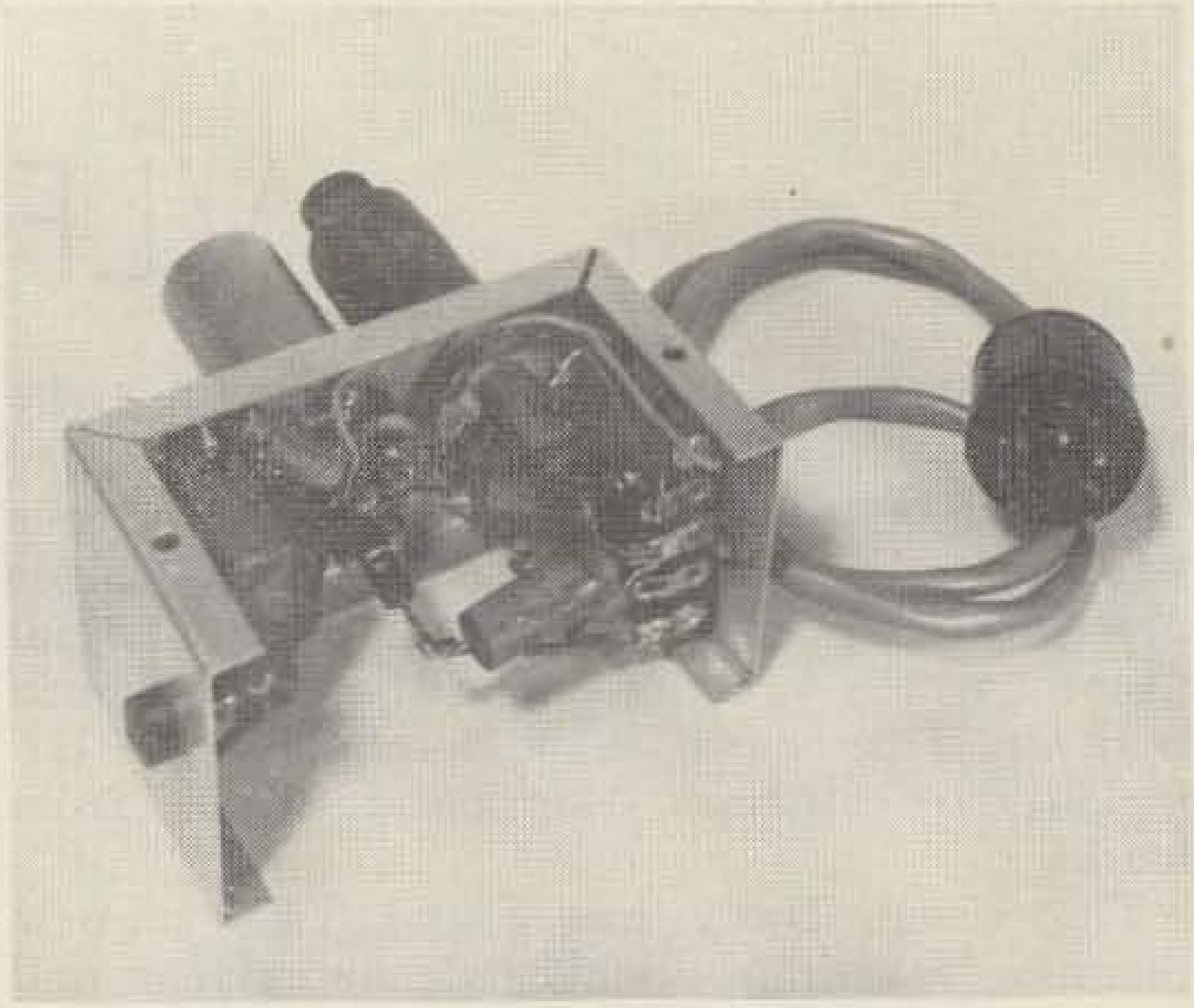


Table I

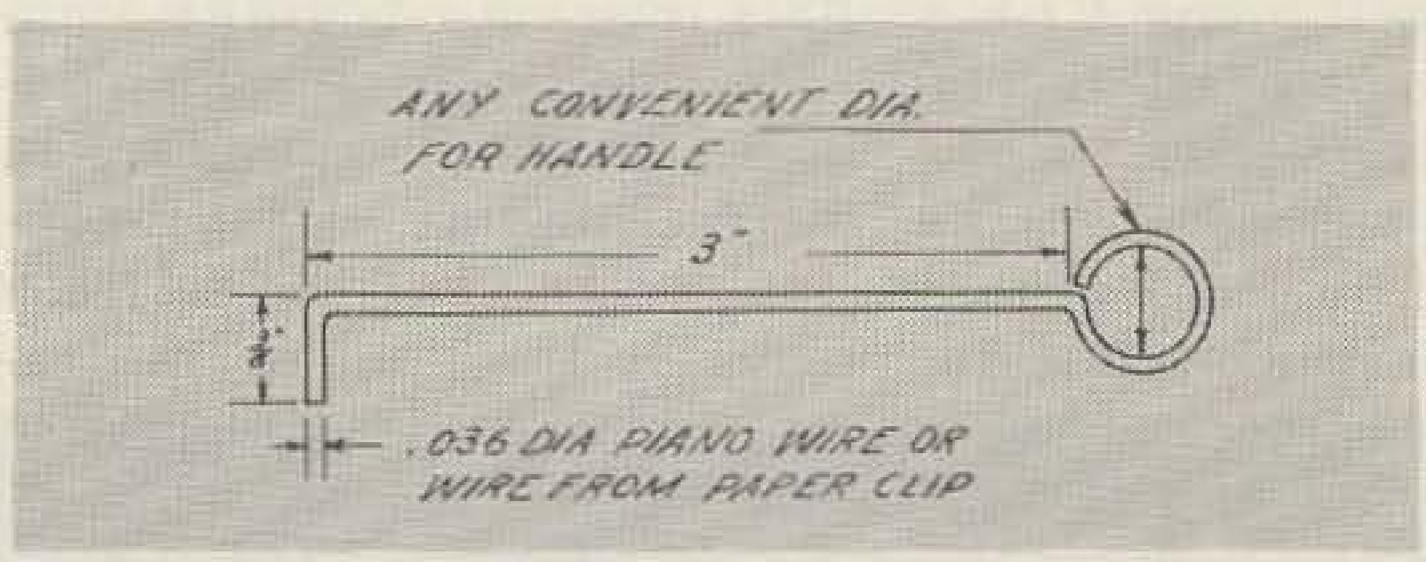
Call	Frequency kcs
NAA	15
GBR	16
FUB	17
NBA	18
NPG	19
NPM	20
NSS	22
NSS	64
NSS	88
NSS	122

Footnotes:

1. Editorial, **Electronics**, April 1943.
2. "VLF Maine," **Bureau of Ships Journal**, February 1960.
3. "New NBS Standard Frequency of 20 Kc Reported Furnishing Accuracies of 10^{10}''", **Electronic Design**, May 11, 1960.
4. "Changes in WWV/WWVH Standard Broadcast", **CQ**, February 1961.

Viking Transmitter Adjusting Tools

Occasionally the owners of Viking Valient transmitters find it necessary to touch up the VFO calibration and adjust the modulator static current. To do this, it has been necessary to pull the rig out of its cabinet. This, in turn, requires the removal of numerous screws, connectors, etc. This lengthy operation can be completely eliminated through the use of a couple of paperclips or lengths of .036 dia. piano wire. Here's how it is done.

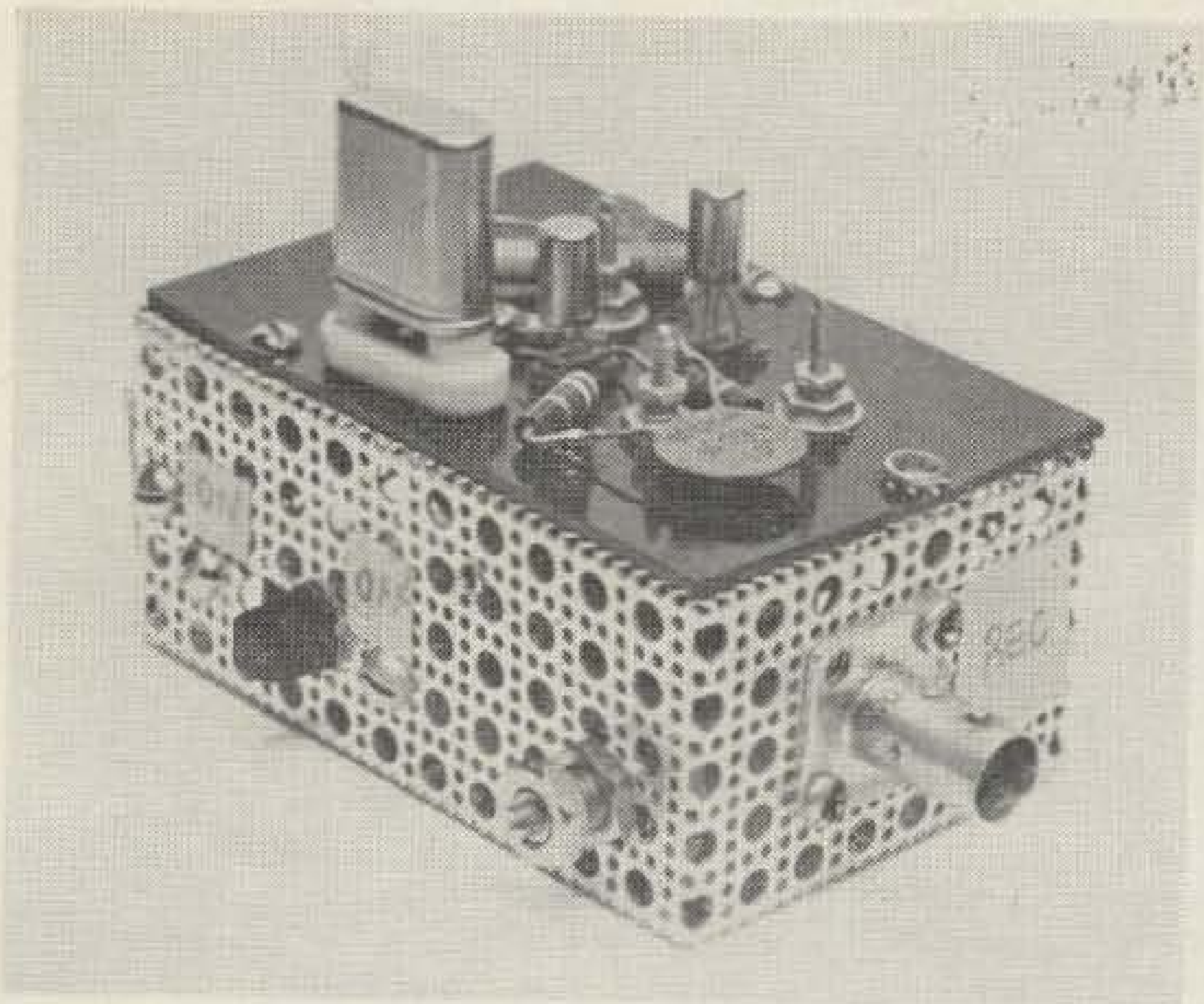


After selecting your material, bend it into the shape and size shown in the illustration. The adjustments can be made with one tool; however, two will make the VFO calibration adjustments easier.

To adjust the modulator static current, insert the "L" shaped end of the wire tool through one of the vent holes in the side of the cabinet. Then engage it with the slot in the shaft of the appropriate potentiometer. The current can be easily adjusted by turning the ring end of the tool.

To calibrate the VFO, use two of the wire tools. Insert them through the vent holes in the cabinet in a location so as to engage the slots in the high and low frequency adjustments for the range to be calibrated. The normal calibration procedure can then be followed and adjustments made by turning the ring ends of the tools as necessary.

These same tools may also be useful in making similar adjustments on other models of Viking transmitters. . . . W6NKE



"Little NIC"

6 Meter Transistor Converter

Capt. John J. Sury K8NIC/5
39 Nebraska Road
Dyess A.F.B., Texas

THE popularity of transistors among the hams is increasing by leaps and bounds. The prices are reducing within reach of our building hams (which are getting fewer by the day). With the advent of VHF transistors hams, designers and manufacturers have been experimenting to make the transistor practical for receivers, converters and transmitters. Because of their size and low power requirements they become the ideal device for miniaturization for mobility. The author attempted to design and build a simple miniature converter with the least amount of components and folding stuff and still maintain performance. The results of such endeaver is the "Little NIC" 6 meter converter designed for portability with the Heath Kit Mohican transistor receiver. Any receiver can be used that tunes from 7 to 9 mc without not too much of a modification. This little gem lays nicely in the palm of your hand.

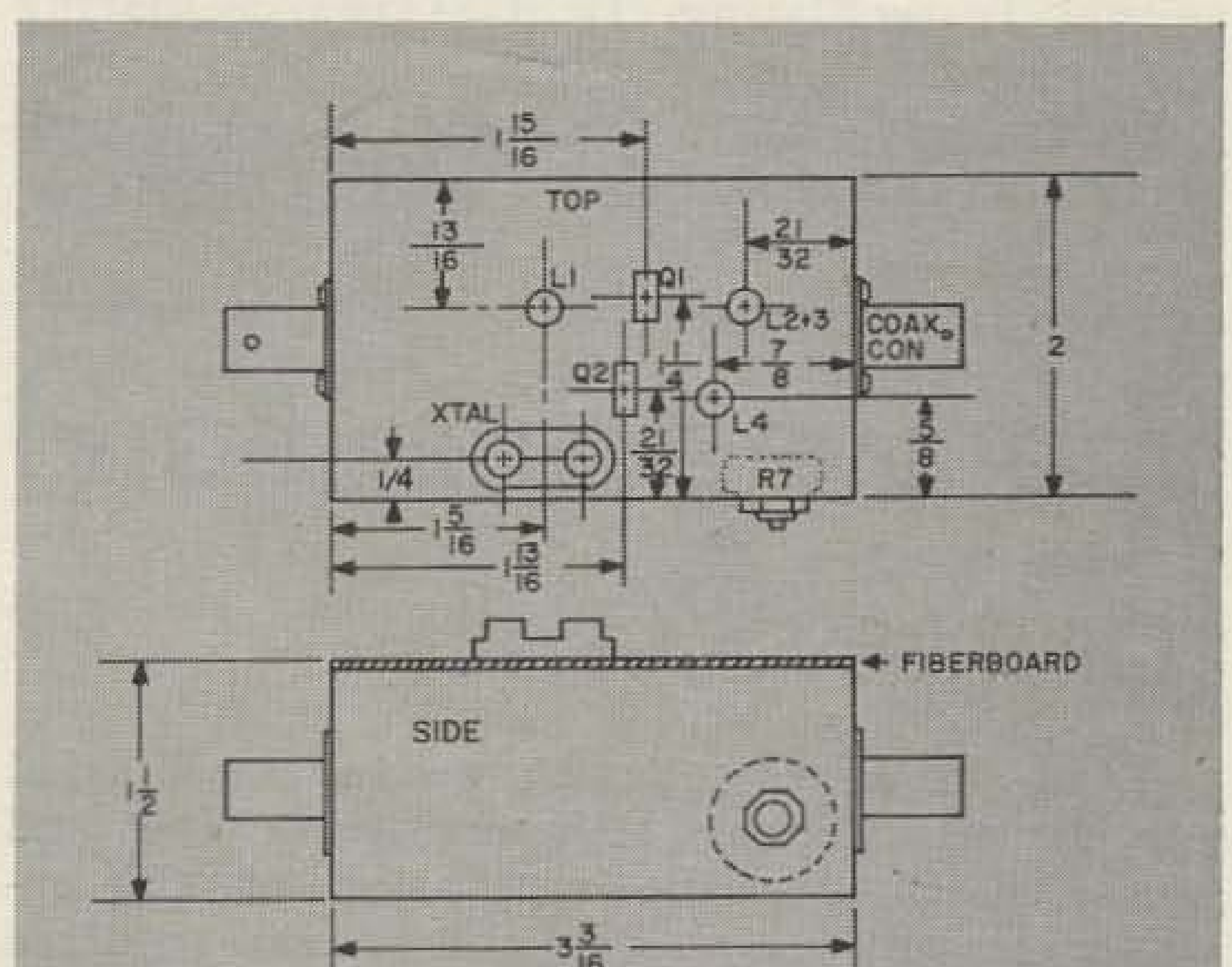
The chief items consist of 2 transistors and an overtone crystal. The remainder of the parts are normally found in a builders spare parts box. It may be tuned to either 7 mc *if* or 8 mc *if* without changing anything except the crystal. A 42 mc overtone crystal was used in the authors model. A 43 mc crystal was tried with equal success. All that has to be done is retune L2 and L4 for max. L1 need not be retuned because it is broad.

It should be noted on the schematic several transistors are mentioned for Q1 and Q2. The RCA 2N1177 rf and the 2N1178 oscillator transistors do a terrific job. These are two new transistors by RCA for FM receiver application. By experimenting it was found that these transistors made the converter more sensitive than the others tried. The 2N384 will also do a fine job. The 2N247 may be used in the oscillator section with less sensitivity because of its lower frequency cut off.

The 5K pot (miniature) R7 is used to set the correct voltage from the 9 volt battery. The converter requires approximately 7½ volts at 2.5 ma. By using a pot in series with the miniature 9 volt battery for storage ease in the converter as the battery voltage drops the pot resistance is decreased. The battery should last a long time for continuous service. With the advent of 9 volt transistor radios these batteries may be purchased almost anywhere.

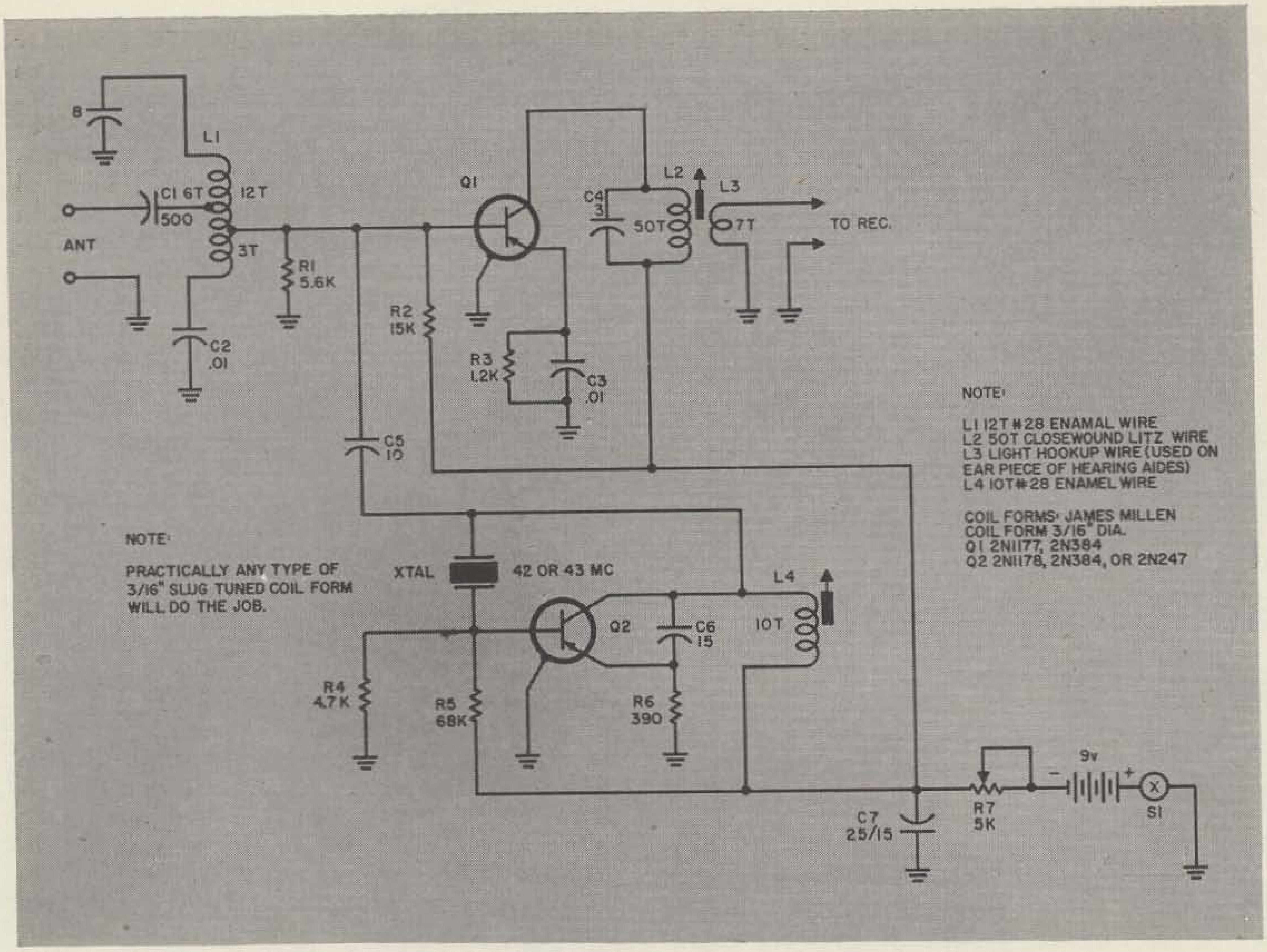
The construction will not be covered in detail because of the simplicity. The wiring is not critical so no difficulty should be encountered, just follow the schematic.

The chassis is a 2 x 3-3/16 x 1/16 inch fiber board. Refer to the chassis layout to get the approximate location of the components. A piece of "do it yourself aluminum" (the author used perforated) which may be obtained at any hardware store is formed into a box and the chassis is mounted on it (see layout). The box serves as a switch mount, pot mount, internal battery mounting and RG-58 coax fittings. Wire converter as indicated on the schematic.



In winding your coils a grid dipper will keep you on the right track. On L1 the coil tap to the base of Q1 should be one fourth of the turns from C2 and the antenna tap one half of the turns.

To align the converter hook it up to your receiver. Tune the receiver to the desired *if*. Turn the converter on. Using a 50 mc signal generator or grid dipper adjust the slugs and R7 for max. sensitivity. Putting a multi-meter in series with the battery to measure current will give an indication of whether the crystal



is oscillating or not. By touching the oscillator coil L4 the current will change slightly if the crystal is oscillating. If it is not oscillating the current will not change.

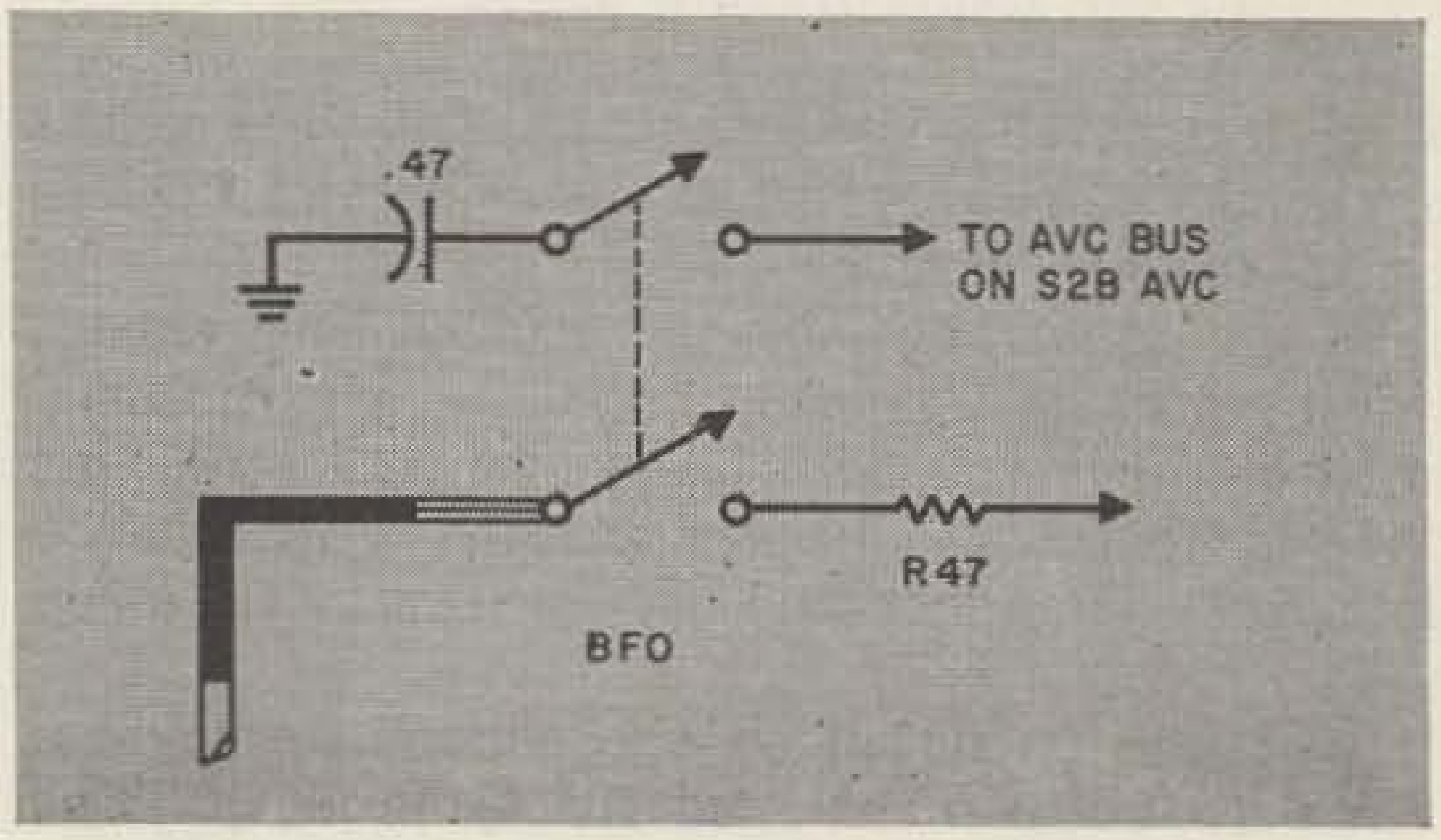
By changing L2 to the standard AM broadcast band and changing L4 and the crystal to resonate at 49.3 mc, it should work fine with an auto radio. A filter in front of the converter may be required to filter out the strong AM signals. Get 'er built for the coming 6 meter DX season. Good hunting.

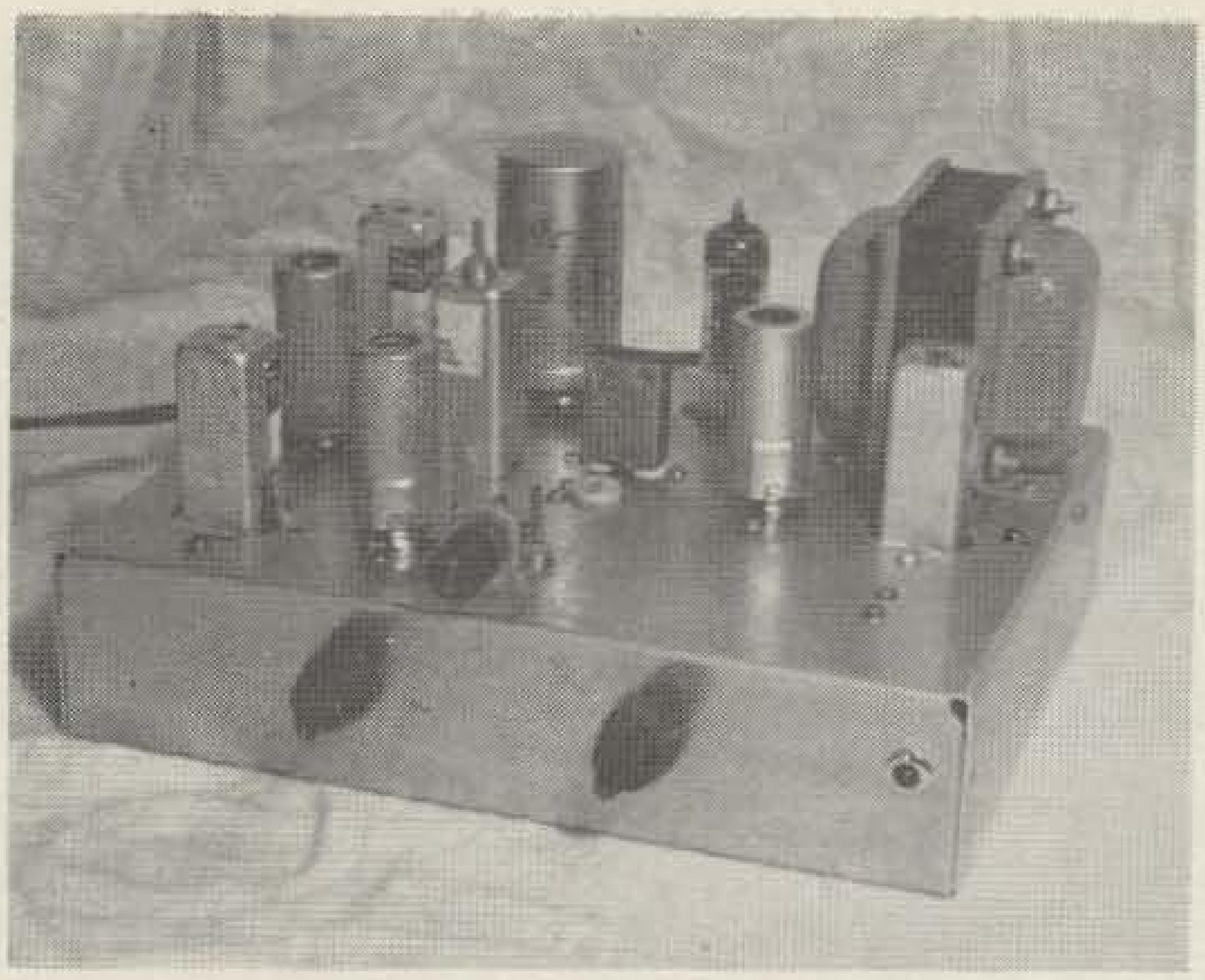
. . . K8NIC/5

Improved Side Band and Reception for the SX-111

This simple circuit change to the SX-111 receiver will improve its operation on SSB and does not involve the mutilation of the receiver in any way. The only parts required are a double pole single throw bat handle toggle switch and a .47 mfd-100 WVDC tubular capacitor. The change consists of replacing the BFO switch (S6) with the DPST switch. Re-connect the BFO wiring to one side of the switch. From one contact on the other side of the switch connect the .47 mfd condenser to ground. Connect the remaining contact of the switch to the AVC line at the AVC switch (S2b). The circuit is now wired so that when the BFO is on a .47 mfd capacitor is connected from the AVC line to ground. This will provide for a fast attack-slow decay action of the AVC circuit. The S meter will now work on CW or SSB with the AVC on, and the RF Gain control may be run wide open with the audio turned down to a comfortable level.

. . . WøRQF





Part II

A New Panadapter Unit

J. H. Ellison, W6AOI and R. L. Hopton, W6LQK

LAST month we described a panadapter unit to be used in conjunction with any oscilloscope and went into some detail describing the advantages of panoramic reception. We pointed out the types of information that could be gleaned and indicated the uses for it, and stressed the fact that a comparatively simple and inexpensive adapter unit would make it possible to use your station oscilloscope for this purpose. This is accomplished with only a minor modification to the scope, which rather than detracting from its utility actually adds to it because there are other uses for the scope which require this modification. We also described the theory behind the frequency sweep system and the method of synchronization selected for it. Since these two are the most important parts of the panadapter it is essential that they be clearly understood in order that you won't be tempted to make substitution of components or values that can get you in trouble in trying to get proper performance from the unit. We don't mean to imply that changes can't be made but please, —again we say,—please read the first part of this article so you will know why certain things were done as they were. (Frankly, we are just trying to eliminate the letters that describe multiple changes in a unit "constructed exactly in accordance with your description which doesn't work, and who are you trying to fool?")

Assembling the Unit

The circuit is reproduced here as Fig. 1 and was described last month. The chassis layout, Fig. 2, is made on a 7″ x 9″ x 2″ aluminum chassis such as the *Bud* type AC-406. As you can see from Fig. 2, and the photographs, this size chassis accommodates all the parts comfortably, if you are reasonably handy with the "tools of the trade." Lay out the chassis and use socket punches for the *if* transformers and tube sockets, but be reasonably careful and accurate so you will not encounter interference problems when mounting and wiring. The *if* transformers known as "K-Tran" by *Miller* are recommended because of the ease of mounting. Unfortunately, there is no K-Tran available for T-3 so you will have to drill the seven holes to mount the type available. T-3 must be modified before mounting to provide the center tap. Remove the secondary condenser and replace by two condensers of twice the value connected in series and with a center tap lead brought out through the bottom of the can. The orientation of each transformer and tube socket should be checked from the photos and the wiring diagram to get short, direct interconnecting leads. Check the loop-stick for length before mounting. You may have to trim the end of the paper from about one-eighth of an inch with a razor blade so that it doesn't project below the bottom of the chassis. Then wind a 8-9-turn tickler winding at the mounting end of the loop-stick about one eighth of an inch from the main winding. Leave the leads long enough to be able to reverse them if the oscillator doesn't "take off." This may seem to be a very small tickler winding but that is what we ended up

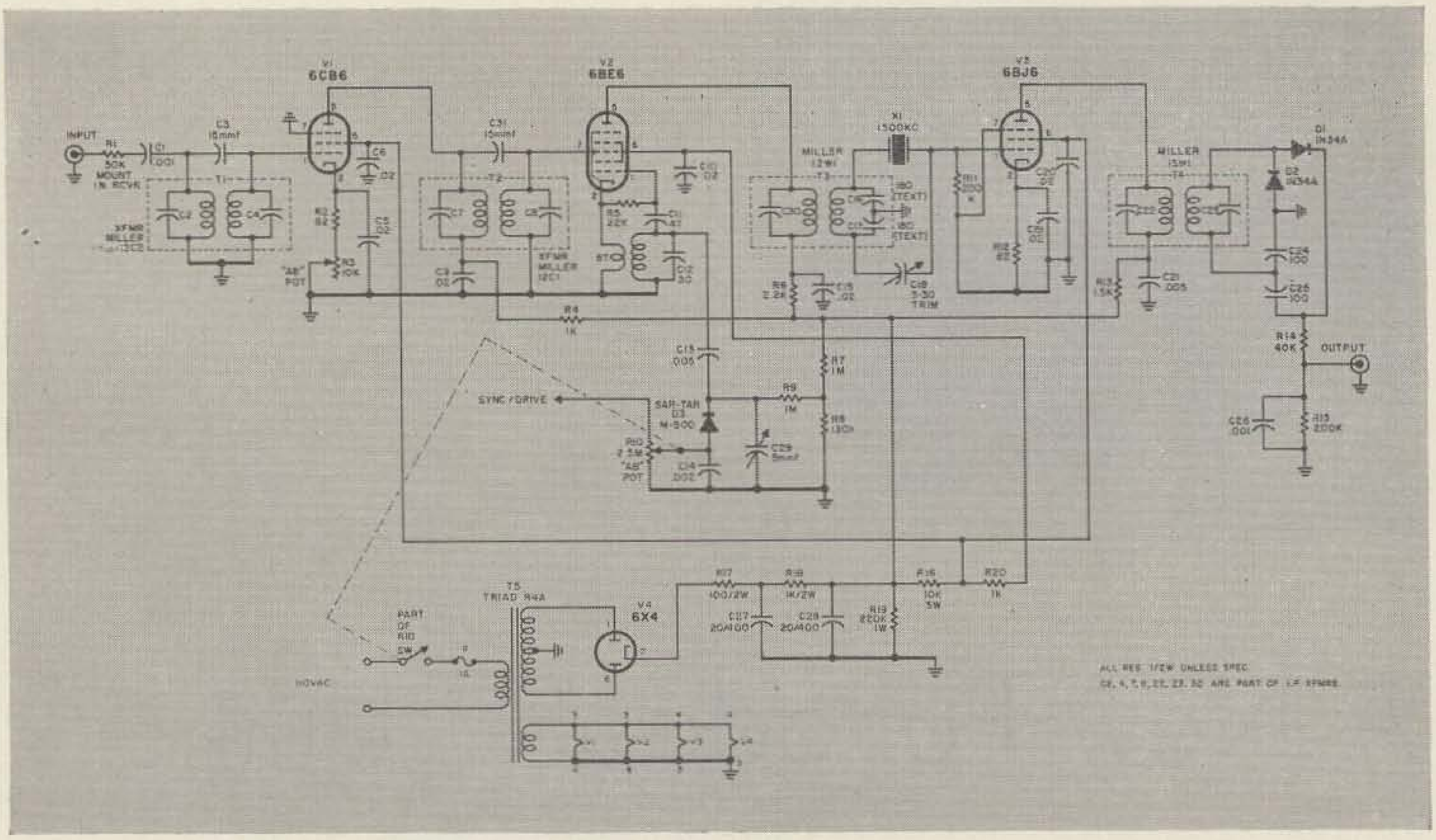


Fig. 1—T6 is a standard ferrite-cored loop stick. This was discussed in last month's text.

with. There are two sub-assemblies that should be made before mounting. One is the detector circuitry seen in the upper right corner of the bottom photo, and the other is the decoupling resistors seen at the lower middle. The detector circuitry is wired as in Fig. 3 on a small plaque or terminal board 1¼" x 1½". Watch the diode polarity or you may end up an upside down picture. The decoupling resistors can be assembled on a terminal board as we did or hung out in the wiring if you prefer. Those on the board from left to right are R4, R6, R13 and R16. There seems to be no difficulty with wiring dress; we used the most direct approach in most cases, only keeping clear the area around the crystal and trimmer. Unwanted capacities there might cause ringing in the crystal due to feed-back or degrade the selectivity and picture due to signal feed-through.

A few words now about certain components are in order. The connectors on the rear apron are the threaded type jacks that fit the conventional *RCA* phono pin plugs. The fuse mount is desirable, but not essential. Similarly desirable, but not essential, is the small pilot light on the front apron. It is a neon assembly running off the 115 ac line through a 100,000 ohm resistor. It won't light up the shack like a Scotchman's reading lamp as some pilot lights do, but will remind you that the power is on. As stated previously, the crystal doesn't have to be 1500 kc exactly. It need be only within the tuning range of the associated *if* transformers. Plus or minus 20 kc would still be satisfactory. We used a plug-in type filter condenser because it was convenient and available,—other types will do as well. Any power transformer delivering the same voltages and currents will do if it fits the space. Note the location of the soldering lugs before you assemble and mount the components and you will save time and have short ground returns. There are two on T1, two on V1, one on T2, two on V2, two on the crystal socket and one on V3. The two *if* tube types were chosen for high transconductance, but there are other types that match the same socket connections. In fact, if the suppressor connection is returned to cathode instead of ground many tube types are suitable, but check the Tube Manual first. In general, we might say that the components specified fit easily in the space, but if you substitute indiscriminately, you're on your own. If a cabinet is desired for the unit, the *Bud* CU-879B will take the chassis with the cabinet covers on top and bottom instead of front and rear. This is a real convenience for access. No special sequence is necessary in wiring except for the sub-assemblies previously mentioned. The decoupling resistors are used in the plate and screen supply leads as normal precautions against interaction and instability. They were put in at the start, not as corrective measures. All other components can be identified from the photos.

There are two items to be taken care of in the associated equipment, the receiver and scope, and they might as well be gotten out of the way first. If we don't, we reach a point in alignment where we have to stop and do them before we go on. So first to the receiver; —as mentioned last month, connect a 50K resistor to the plate of the mixer tube and bring the other end of the resistor out via a shielded cable to the input of the adapter unit. Try to keep the length less than 30 inches so that the cable capacity doesn't shunt off the signal appreciably. If you make up the permanent cable instead of the temporary rig you won't have to peak up the front end after tune up and alignment. Next refer to your scope schematic or Instruction Book and find the lead from the horizontal amplifier plate to the scope deflection plate. This is the lead that is going to furnish us with the horizontal sweep voltage for the adapter. Connect a .05 mfd ceramic condenser to this lead and bring the other side of the ceramic condenser to an

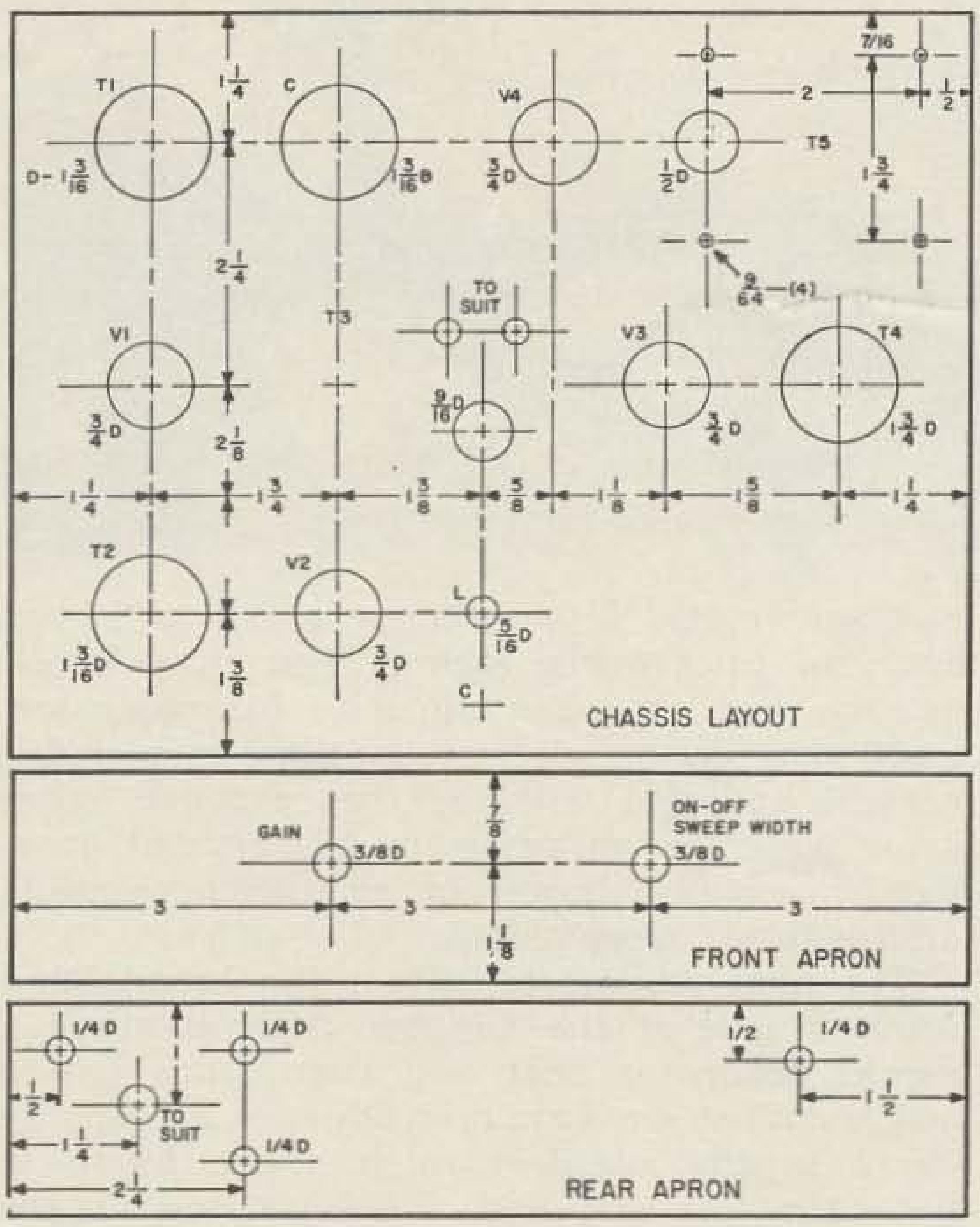


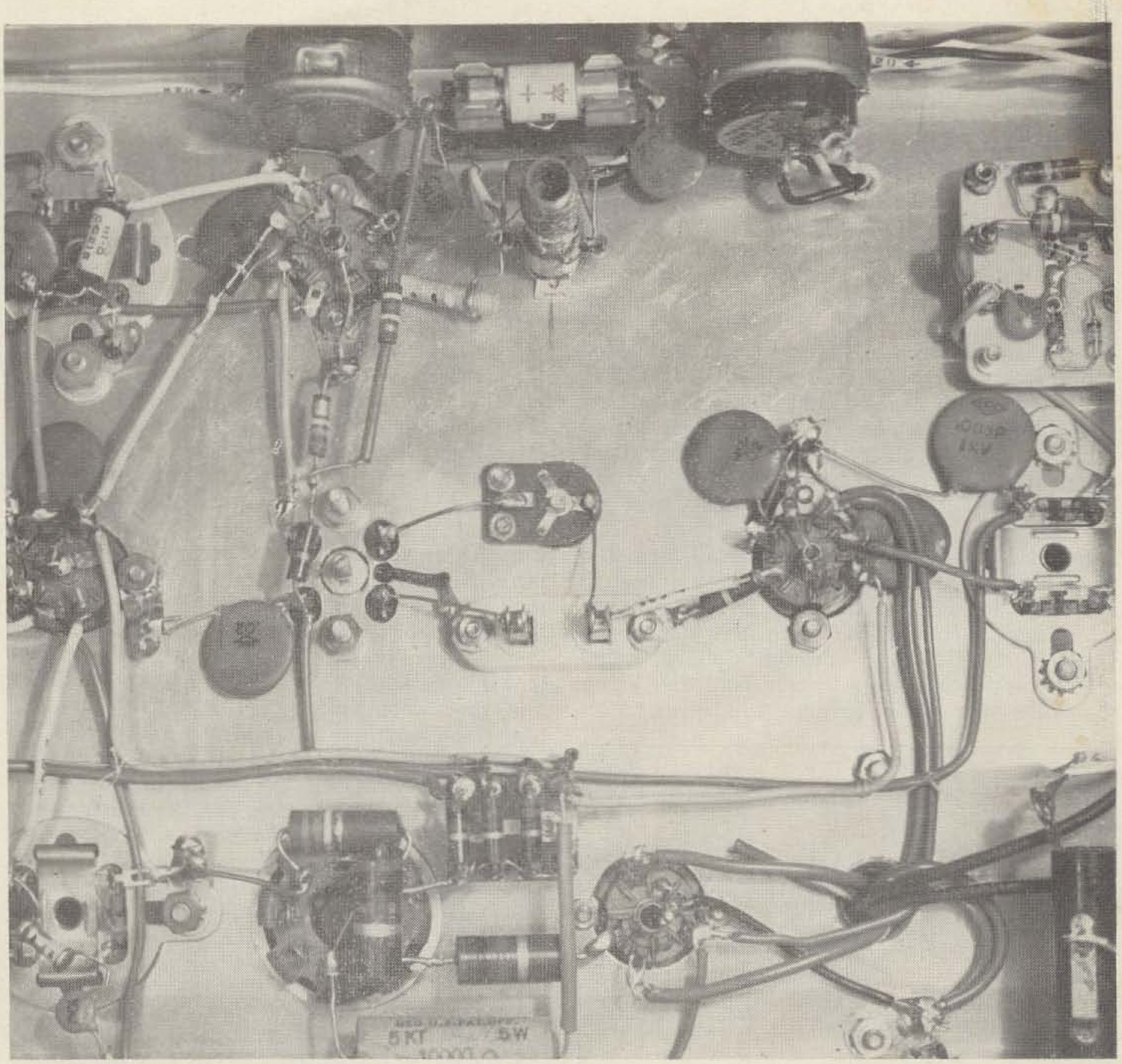
Fig. 2

insulated pin jack on the outside of the scope case. Don't worry about the voltage magnitude available, it will be more than enough.

The first step in aligning the unit is to get the 1500 kc *if*'s on frequency, which will be the actual frequency of the crystal. This alignment is not critical because the pass band of transformers at this frequency is at least 20 times that of the crystal. Set the crystal trimmer at about half capacity and remove the crystal. Couple a VTVM to the detector output and feed a frequency corresponding to the crystal into the 6BE6 mixer plate and align the two *if* stages in the usual manner. Just be sure that the mixer oscillator sweep is at zero and that its frequency is well above 1500 kc by backing the slug all the way out. Once the *if* transformers are aligned, no further touching up is necessary because of their broad selectivity relative to that of the crystal. Their sole function is gain.

The next step is to get the mixer oscillator strength set and on frequency, assuming it is oscillating. Screw the slug well in and find the oscillator signal in the upper part of the Broadcast band. Use a short wire from a broadcast receiver antenna connection hooked over the loop-stick to get a quick check of where you are. If no signal appears, reverse the tickler leads. Once the oscillator is running, measure the dc voltage on the oscillator grid with a VTVM. Between —5 and —8 volts is satisfactory, but it *must not* be higher or you will be in trouble. As explained in last month's article, the rf swing of the oscillator and the sweep voltage swing must not overlap. Hook up the output of the adapter to the scope vertical amplifier input and hook up the sweep take-off from the scope to the sweep input jack on the adapter. Set the scope sweep at about 30 cycles and sync it to the ac line in whatever manner your scope does this (internal switch or external jumper). Increase the scope horizontal gain to draw a base line and position the base line somewhat below center. Now we will check the adapter oscillator performance. Measure the dc voltage on the diode cathode with the sweep control at zero. (Use a VTVM because any other type will give a false reading if the meter requires current.) It should read 18.5 to 19.0 volts. If it doesn't, the resistors R7 or R8 in the voltage divider must be adjusted to give that reading. Now, leave the VTVM connected and advance the sweep control to about half scale. If there is *any change* in the voltage reading on the diode cathode it shows that the diode is conducting and either the mixer oscillator bias is too high or the sweep is too great. Assuming that we have adjusted this properly, the oscillator should be set by the slug to a frequency which is the sum of the main receiver *if* (455 kc or thereabouts) and the crystal frequency (nominally 1500 kc). Don't bother with the band center control at this time, it can be set later.

Now we can get the crystal filter circuit lined up properly. Put the crystal back in the adapter and feed a signal to the adapter mixer grid at the *if* frequency of your receiver. Now advance the sweep width control about one quarter open and the crystal response curve will appear on the scope. You have three adjustments to play with, namely, the crystal trimmer or balancing condenser



and the crystal input transformer primary and secondary. Get the maximum height response with the primary first. it won't need any further peaking. Now peak the response with the secondary and start adjusting the crystal balancing condenser. You will see the crystal rejection notch appear on one side of the curve as you adjust, then the curve will become symmetrical, and then as you continue adjusting you will see the notch appear on the other slope of the response curve. Work the secondary tuning and the trimmer tuning together until you are satisfied that you have the best compromise of the three factors, response shape symmetry, least response curve width and maximum response height. Notice the shape of the curve when the notch is present. The skirt at the notch is practically vertical but the other skirt slopes off at quite an angle, and the response curve is rather broad at the base line. The symmetrical curve with no notches will be rather less than half as wide at the base line, indicating better selectivity and better resolution. This is a vivid representation of what happens with your receiver crystal filter when you try to "notch out" an interfering signal. You may knock out one but you open the gate for other low level interference. Now vary the sweep width control and you will see the response curve grow wider or narrower as the crystal passband becomes a larger or smaller percentage of the total sweep width.

The next step is to adjust the broad band input stages of the adapter. This requires a signal generator that will tune from 400 to 500 kc. What we want to achieve is a response curve in the adapter which has a hump at both the low end and the high end of the pass band. The companion receiver will produce a hump response in the middle of the pass band and if the three humps are appropriately spaced the result will be an over-all response that will be fairly flat. This flat response will result in all signals on the scope showing up with their true relative strengths. The most satisfactory approach to reach this condition is to make a preliminary adjustment of the adapter by itself, followed by a further adjustment in conjunction with the receiver.

The reason for this is that no two receivers and antenna systems have the same response curve, so that the desired flat response can only be obtained with your own receiver and antenna. Although it is seldom mentioned, note that the receiver antenna trimmer adjustment can have a considerable effect on the shape of the response curve. Also, in a multiband receiver any lack of tracking in the oscillator, mixer and rf stages will distort the response curve shape. You can check your receiver internal alignment on various bands by this observation.

1. Put a 455 kc signal on V1 plate and tune T2 secondary (top) for maximum response on scope.
2. Put a 435 kc signal on V1 grid and tune T2 primary (bottom) for maximum response.
3. Put a 475 kc signal on V1 grid and retune T2 secondary for max. response.
4. Put a 455 kc signal on regular adapter input and tune T1 secondary (top) for max. response.
5. Put a 435 kc signal on adapter input and tune T1 primary (bottom) for max. response.
6. Put a 475 kc signal on adapter input and retune T1 secondary for max. response.
7. Repeat steps 2, 3, 5 and 6 to peak responses.

Now hook up to the regular receiver and find a steady non-fading signal (or feed in one on a fundamental signal) on some convenient band. Tune it in carefully, peak the antenna trimmer and then tune from about 40 kc below to 40 kc above the signal while watching the scope. It should remain fairly constant in height (plus or minus 20%) if your adjustments are correct. If there are very low or very high response points anywhere but the very edges of the picture, touch up T1 and T2, but go easy. At this point all touch-up adjustments interact and some compromise must be accepted. On the other hand, if you have access to a multi-vibrator for rf you can use it now as a signal source and see the entire response curve like a picket fence and very quickly get the best over-all adjustment.

Band Center Adjustment

The band center adjustment is pretty obvious. With the receiver and adapter warmed up and stabilized, pick a signal, tune it in exactly by ear, put the band center control at mid-position and center the signal on the scope by trimming with the oscillator coil slug. You should calibrate the sweep width control by means of either a signal generator on a high frequency band or by a receiver with a calibrated dial. Tune the generator to move the signal from the middle of the scope to the edges, both directions. Don't try to get too much sweep, 5 kc, 20 kc, and 40 kc are suggested points, each of course, giving plus and minus the amount from band center. Remember that the sweep width setting in kc is a true setting on any band because it is a percentage of the *if* frequency, which is fixed. This completes the alignment of the unit. To many it may appear we have gone into too much detail, but we have tried to give a detailed description in proper sequence and cover questions that might arise from those who are not familiar with panoramic receivers. We hope they can get a clearer picture of its operation while building and aligning it. Of course, no amount of words takes the place of actually going through the steps by oneself either in an original approach or following someone's description. Fortunately, there is very little in the entire job that can go out of alignment so you can be assured of long time satisfactory performance when the adapter is finished.

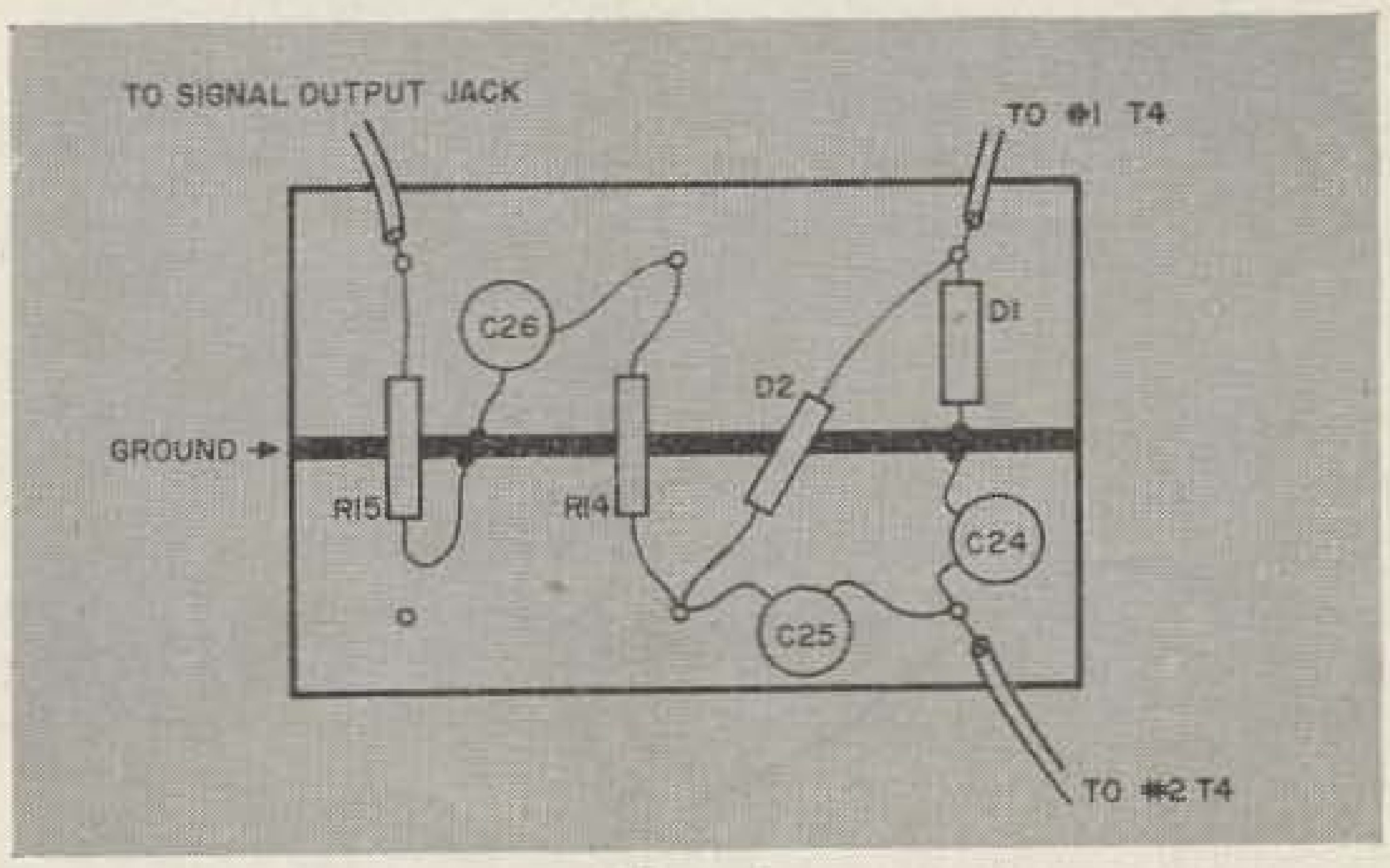


Fig. 3

Interpretation of Patterns

In the text of both parts of this article we have described in more or less detail, the types of information produced by the panadapter. Now let's consider some of the patterns, first those appearing at normal sweep, say a sweep of 20 kc where a signal is fairly narrow. Fig. 4a is a typical CW signal (or an unmodulated carrier) which appears and disappears with keying. A frequency shift keyed teletype signal will look the same as an unmodulated carrier except that it seems to jitter erratically with the keying characters. A carrier with FM applied will "fuzz up" with modulation as in Fig. 4b and clear up with no modulation. Note the similarity of all these signals. They are all characterized by a constant amplitude signal, neglecting fading, of course. All appear as signals originating at the base line and reading up from it, rather than signals reading above and below a middle axis. This is because we are viewing a *response* curve and not actual rf or af voltages. Pulse noise such as ignition noise will appear as in Fig. 4c. Either spikes or triangles or both may occur. They usually appear at several points, equally spaced, and do not move with tuning although they may run slowly across the scope either way. This is typical of ignition type noise. They are also

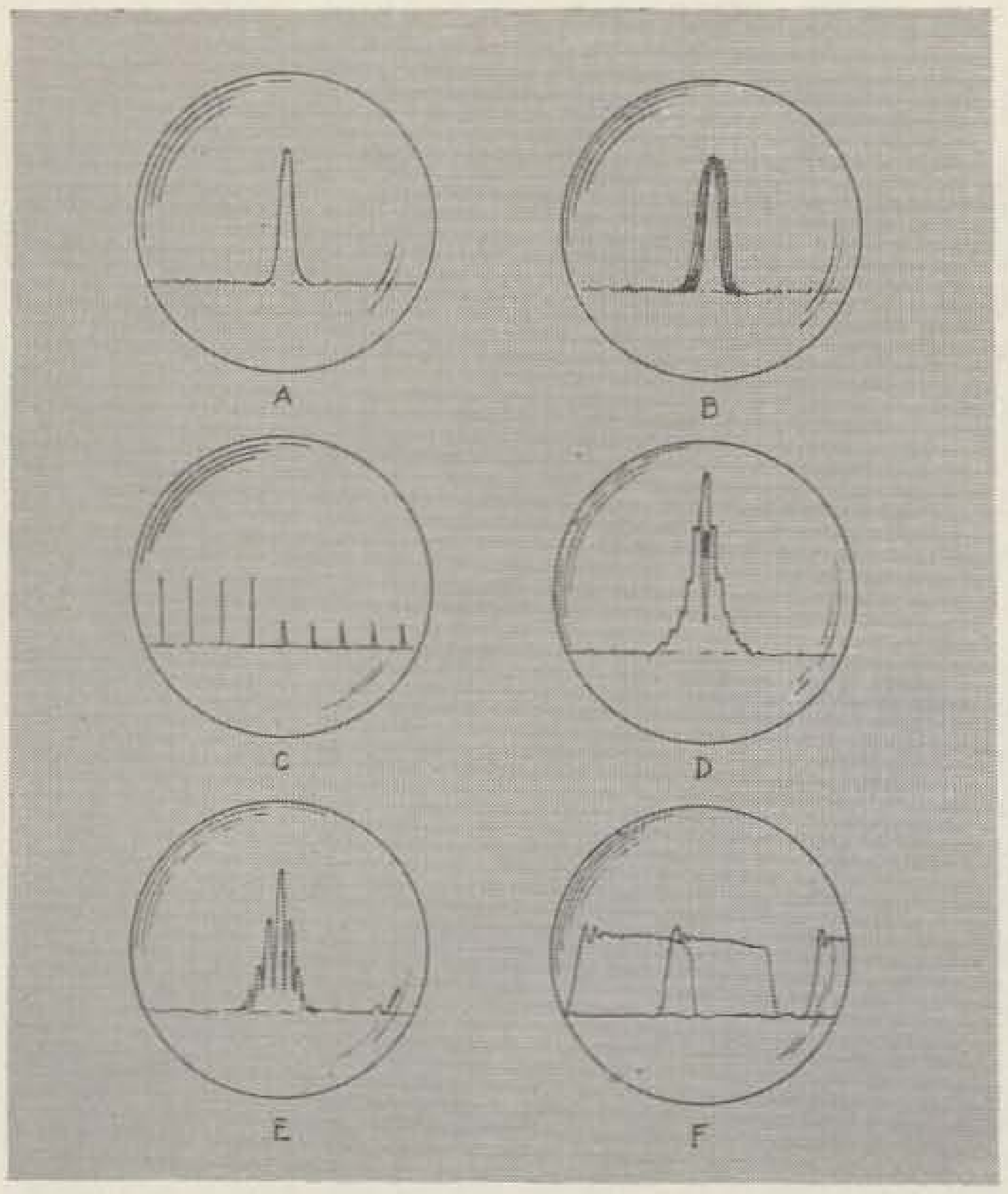


Fig. 4

constant amplitude signals because the offending source is usually close by and no fading exists. This persistent regular pattern is typical of man-made interference as contrasted with static or random noises which appear in short irregular bursts.

Now consider an AM signal which will look like Fig. 4d with modulation. You will note that this signal while still having the response curve shape, varies in amplitude about a middle level which is the unmodulated carrier, and swings with 100% modulation to twice amplitude and to zero amplitude in the audio cycle. Unsymmetrical modulation can be determined by comparing the amount of swing above and below the mean when a steady modulation tone is used. Over modulation will be manifested by an excess of the upward swing over the downward swing combined with the appearance of bright spots on the downward peaks at the base line. When this occurs you will frequently find splatter pulses spaced each side of the main curve and synchronized with modulation. Don't be misled into thinking these low amplitude peaks are unimportant. The reason these are small on the panadapter is because they are at the edges of the response curve, but to the listener tuned to those frequencies they are anything but small.

SSB signals appear in bursts at a fixed point on the scope. They resemble Fig. 4e instantaneously, but emanate from the base line like a keyed signal. In fact, they are keyed signals of many frequencies, the sideband frequencies generated by the voice in the suppressed carrier system and transmitted simultaneously. We don't see them as separate spikes because they run together, shift and overlap. If we could trace the outline of all these frequencies at any one instant we would get a curve just like that produced by an AM signal. Again, this is because we are viewing a response curve so we will not see an unsymmetrical group right or left representing upper or lower side band, but we will see extensive amplitude variations.

All the foregoing discussed wide sweep patterns. If the sweep is narrowed to say 3 or 4 kc each type of pattern will broaden to fill the scope face. A teletype signal under this condition reveals some interesting information about fading and multiple path propagation. You will see the two response curves representing mark and space separated by the frequency shift, and you can see each fading relative to the other, even though the time interval between them is measured in milliseconds. Since fading is a measure of multiple path lengths, absorption and many other things this gives us a mental image of ionospheric propagation which is rather different from the popular conception of a reflecting surface. This and other pictures indicating drastic fading shows us how our receivers and the human ear average out signals over time and intensity to produce copyable signals.

At zero sweep and with the receiver and adapter centered on a signal, we can see the modulation frequencies on an AM signal just as the audio would appear on a scope, swinging equally above and below a horizontal axis. The same picture could be obtained with a SSB signal if a strong local signal to supply the carrier is injected at the antenna. Normally, keyed signals fluctuate so radically that the signal biases itself off the scope. The level of a CW signal, however, can be set to show keying characteristics even though a stationary pattern can not be had. You will get a picture like Fig. 4f at any instant. The leading and trailing edges of keyed characters can be caught "on the fly" and transients that produces clicks and key thumps can be plainly seen.

The last few paragraphs on patterns will give you a starting point for making use of the panadapter other than as a signal seeker. You will find many more than we could tell you about. Perhaps you will be interested enough to pass on such information to the rest of us, either on patterns or on other uses for the panadapter. We haven't exhausted its potentialities by any means in this article. One nice feature which wasn't planned is the control obtained at narrow sweep. One of the major difficulties in an original design is resisting the temptation to "improve it" long enough to use it and write it up for others. (The Editor sometimes gets difficult, too!) Well, we resisted the temptation (so far) and wrote it and we will leave it to you to improve it. . . . W6LQK . . . W6AOI

Plate Modulate Your DX-40

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THE advantages of plate modulation over screen or cathode modulation are considered to be worth the extra cost of the relatively higher powered modulator required. This article describes a simple modification of the DX-40 to allow its use with an external plate modulator, yet allows the operator to return the DX-40 to its original circuitry at the flick of a panel switch for built-in controlled carrier modulation, or for CW operation. The only parts required are a simple DPDT switch, a resistor, a small terminal strip, two banana jacks, a double banana plug, a couple of feet of hook-up wire—and the modulator.

The UM-1 Universal Modulator (Globe Electronics, $34.95 in kit form) is ideal for plate modulating the DX-40. It furnishes 25 watts of audio, so running the DX-40 at slightly over 50 watts input results in almost 100% modulation. Signal reports verify the improvement with plate modulation, especially under poor band conditions or QRM.

The schematic showing the changes (Fig. 1)

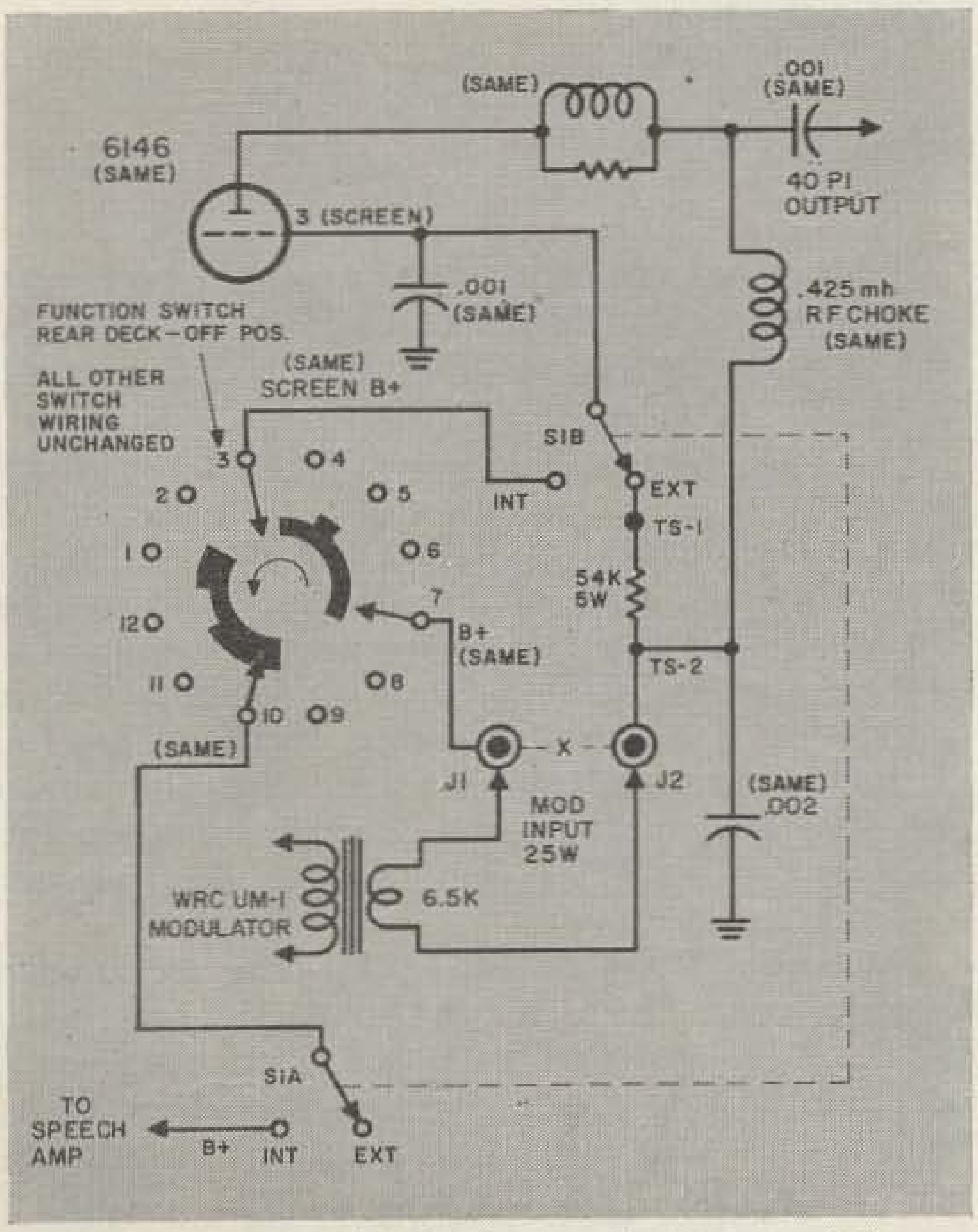


Figure 1. DX-40 circuit changes for plate modulation.

is almost self explanatory, especially when compared to the DX-40 schematic in the Heath manual. However, for those that prefer to make the changes step-by-step, here are the details:

(Refer to Fig. 1 and Photo 1)

(1) Install a DPDT switch, toggle or slide type, between the key jack and the function switch on the front panel of the DX-40. This switch will be called S1A and S1B.

(2) Install two *insulated* banana jacks (J1 and J2) on the rear apron between the mike input and the antenna output connectors. Space these banana jacks so that the centers are three-quarters of an inch apart, to allow mating with a double banana plug from the modulator.

(3) Remove the wire from function switch lug #3 and solder this wire to S1B center lug.

(4) Solder a jumper wire between S1B "internal" lug and function switch lug #3.

(5) Install a two-lug terminal strip (TS1 and TS2) to the underside of the chassis in a convenient spot (see Photo).

(6) Connect (do not solder yet) a 54K 5 watt resistor (or one 10K 2 W and two 22K 2W in series) between the two terminal strip lugs TS1 and TS2.

(7) Solder a wire from S1B "external" lug to lug TS1 of the new terminal strip. (Note: Either lug may be considered TS1. The other lug will then be TS2.)

(8) Remove the wire from function switch lug #7 and connect (but do not solder yet) to terminal strip lug TS2.

(9) Twist two 14-inch long insulated wires together to make a twisted pair. Strip ¼-inch of insulation from each end of both wires.

(10) At one end of the twisted pair of wires, solder one wire to banana jack J1 and the other wire to banana jack J2. Route the twisted pair along the existing cabling on the underside of the chassis to the front panel.

(11) Solder one of the twisted pair wires to function switch lug #7.

(12) Solder the other twisted pair wire to terminal lug TS2.

(13) Remove the wire from function switch lug #10 and solder it to S1A "internal" lug.

(14) Solder a jumper wire between center lug of S1A and function switch lug #10.

This completes the wiring. Now here's the way to use the DX-40 now that it's modified:

Plate Modulation Operation

(1) Put the new switch S1 in the "external" position.
(2) Plug the modulator output (pins 1 and 8 of the UM-1 accessory socket) into J1-J2 banana jacks just installed on the back of the DX-40. A double banana plug is very convenient for this connection. The modulator output tap should be about 6000 ohms. If you are using the UM-1 the 6500 ohm output tap will match the DX-40 very nicely.
(3) Connect your microphone to the modulator input.
(4) Put the DX-40 function switch in the "Tune" position and adjust the grid drive to about 2-3 ma.
(5) Put the function switch in the "Phone" position, dip the final and load to 100 ma. plate current. Operation above 100 ma. is not recommended in this mode.
(6) Advance the gain control on the modulator as you speak into the mike. You will probably hear the modulator talking back to you a little and the plate current needle on the DX-40 may flicker. Adjust the grid drive control to stop the flickering during modulation. With the UM-1 and a crystal mike the modulator gain control may be run "wide open". Don't eat up the mike, however. Adjust your voice power and mike distance from on-the-air checks or with an oscilloscope.
(7) When using the UM-1 Modulator, it may be switched on and off with the DX-40 automatically. Just connect the coil of a 115 volt 60 cycle relay to pins 5 and 6 of the DX-40 accessory socket and connect the contacts of the relay (the normally open contacts) to pins 4 and 5 of the UM-1 accessory socket. (If there is a jumper between pins 4 and 5 of the UM-1 socket, remove it, of course).

Controlled Carrier (Internal) Modulation

(1) Remove modulator input plug at J1-J2.
(2) Put a jumper across J1-J2. (A double banana plug with a wire jumper makes a quick change even quicker).
(3) Put the new switch S1 in the "internal" position.
(4) Connect your microphone to the DX-40 mike input connector.
(5) Since all internal wiring is now electrically identical with the original wiring, the DX-40 should now be operated just as if you never saw this article in the first place.

CW Operation

Follow steps (1), (2), and (3) described above for Controlled Carrier Operation. Then follow step (5).

That's all there is to it. Whew!

. . . K6UGT

Note 1: Use 10K 2W and two 22K 2W (or similar) in series. Screen current is approximately 8 ma. **Note 2:** When controlled carrier operation is desired short out J1-J2 and switch S1 to "Internal." Don't forget to change the mike from the modulator to the DX-40. **Note 3:** Switch S1 mounts nicely on the front panel. J1-J2 are banana jacks which mount on rear apron of the DX-40, near the mike input. **Note 4:** When using the external modulator load to 100 ma plate and 2-3 ma grid with the function switch on "Phone." Adjust the grid drive for a steady meter when modulating.

Minimizing Test-Lead Requirements

When you're using several types of test gear in the shack, the number of different types of test leads required rapidly reaches the point of total confusion.

The usual snarl of test leads can be reduced to only two or three sets simply by standardizing the connectors used on the various items of equipment. One of the best connectors to use for this purpose is the ordinary mike fitting (Amphenol Series 75 or equivalent). This connector is a modified coax termination for rf gear, a completely shielded joint for audio and low-level meters, and it isn't so expensive that conversion of all your gear will drive you to bankruptcy court.

Typically, three 3-foot leads—one made with flexible coax such as RG-58A/U, one with mike cable, and one with test-lead wire—will be enough. Use gator clips on the other ends, or a set of universal test prods. A 3-foot extension of RG-58A/U with a type 75-MC1F connector at each end adds to the versatility.

. . . K5JKX/6

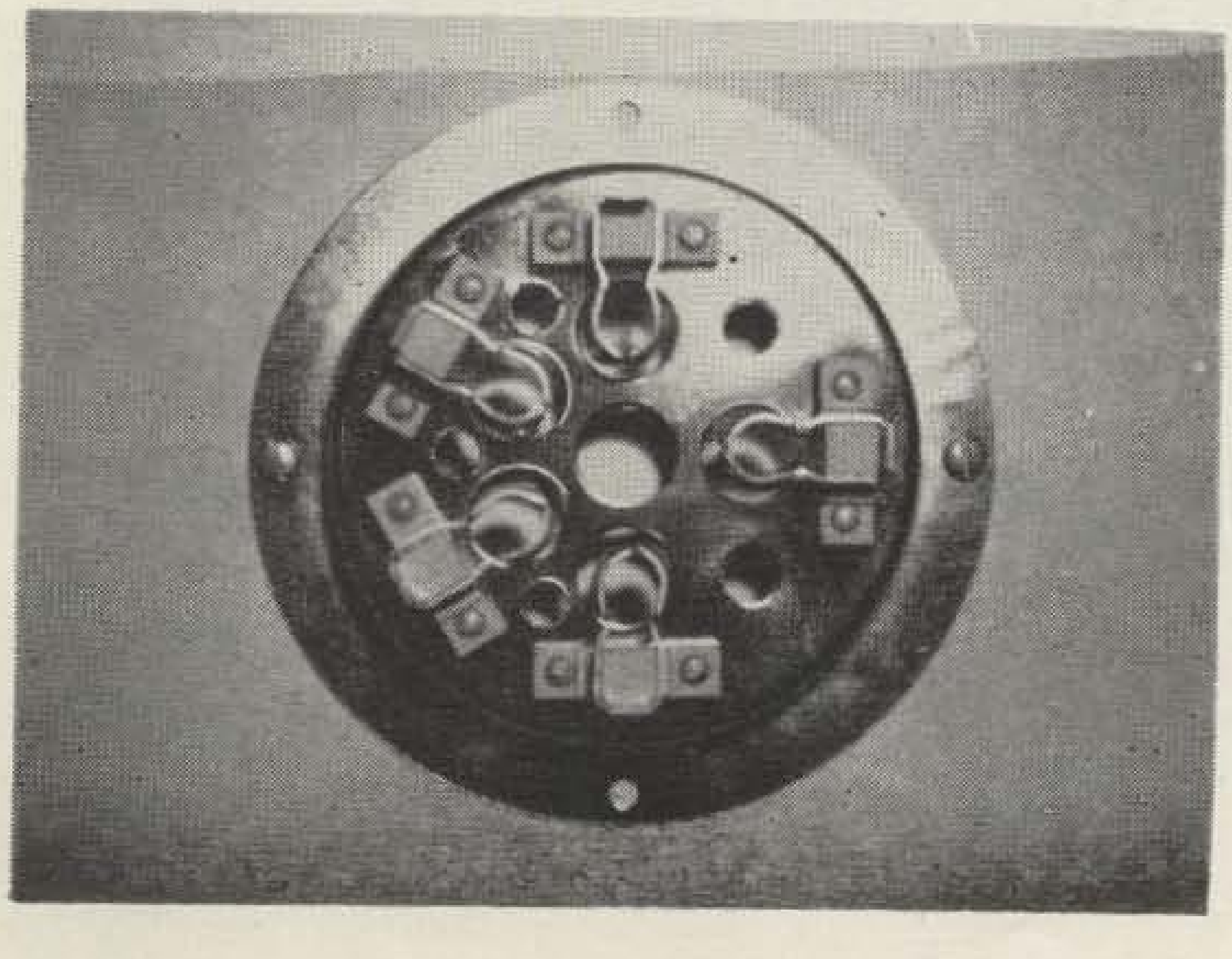
An Economical Socket for the 4-1000A

ONE of the juicyest items to appear on the surplus market, at a now modest cost, is the 4-1000A. Of the many virtues this tube has is it's excellent application to grounded grid linears, by now well covered in popular literature to date, therefore not requiring repetition here. Even the 7½ volt filament transformers necessary have appeared at reasonable prices as surplus. So far, so good—but not the sockets!

A search through the latest stock market reports and the usual local stores, as well as inquiries over the air, failed to reveal any source of supply. It seemed downright discouraging to pay more for a socket than for the tube!

The tube manufacturer's specifications recommend forced-air cooling be provided in order to maintain base seal temperatures below 150° centigrade, and the plate seal below 200°. The air-flow rate recommended is 30 cubic feet per minute below 30 megacycles, rising to 45 cfm at 110 megacycles. However this sturdy jug has the capability of more than 3 kilowatts average plate input, which is considerably more than the law allows amateurs. This fact would lead one to the idea that a lesser input could get by with less stringent specifications due to the lesser temperatures encountered when operating at less than one-third of the maximum ratings.

The specifications go on to say that in the event an air-system socket and air chimney are not used, air must be circulated through the base of the tube and over the envelope surface and plate seal in sufficient quantities to maintain the temperatures below the maximum ratings. Also, that seal-temperature ratings may require cooling air to be supplied to the tube if the filament is maintained at operating temperature during standby periods.



Further socket research revealed that among the tubes with the same *pinning* are the Amperex type 6079/AX-9908 which has been used in both commercial and amateur class C and linear amplifiers. The same pinning is used for the industrial triode type 5868/AX-9902 and a new SSB developmental tube type QB 5/2000. The ratings for the latter looks mighty interesting for amateur use both in grounded grid and grounded cathode, and the author feels that it is worthy of an article describing its characteristics. None of these tubes require forced air cooling, and the socket used is the Amperex S-37C3, available through distributors at $4.50 net.

While the socket assembly is not recommended for the 4-1000A due to the forced air requirements, it is easily modified. It is metal with ceramic pin supports, rather than all ceramic. There is enough clearance between the pin supports to drill holes matching the base holes of the 4-1000A, thus providing a means for the air flow to the base seals, and, should a chimney be used, to the plate seal.

As may be seen in the photo, the distance between pins 2 and 3, and 3 and 4 is greater than between the other pins. These two holes were drilled with a 5/16" bit. The other three were drilled with a 17/64" as the maximum size permitted by the available space. Of course these sizes are not critical, but should be as large as possible as long as care is exercised to insure the holes are not so large as to damage the ceramic pin standoffs while drilling. It will be a much easier operation if you use a center punch marking the center of the widest space between each pin, as may be seen in the photograph. Drill a small pilot hole first. This hole will automatically be aligned to the 4-1000A base holes if care is used in centering, a not too difficult process. The entire operation can be done faster than it takes to tell about it.

A word about chimneys. You may be wondering where to get a suitable glass chimney. You can use a metallic fruit juice can, which would be satisfactory. In case this seems startling, I have some 4-250A sockets taken from surplus equipment which use metal chimneys. Admittedly you will miss the beautiful glow outlining that pretty rosy-hued plate. My good friend Ike, W9RUK has been running his 4-1000A for about two years without a chimney and without adverse results. He just uses a fan aimed at the tube, using this socket. As a matter of fact, he hasn't even drilled holes in it. He just mounts it *above* the chassis and allows the general flow of air from the fan to do the trick. Drilling the holes, however, will give you additional safety by improving the air flow distribution and will not interfere with later use of the 6079 or QB 5/2000. 73

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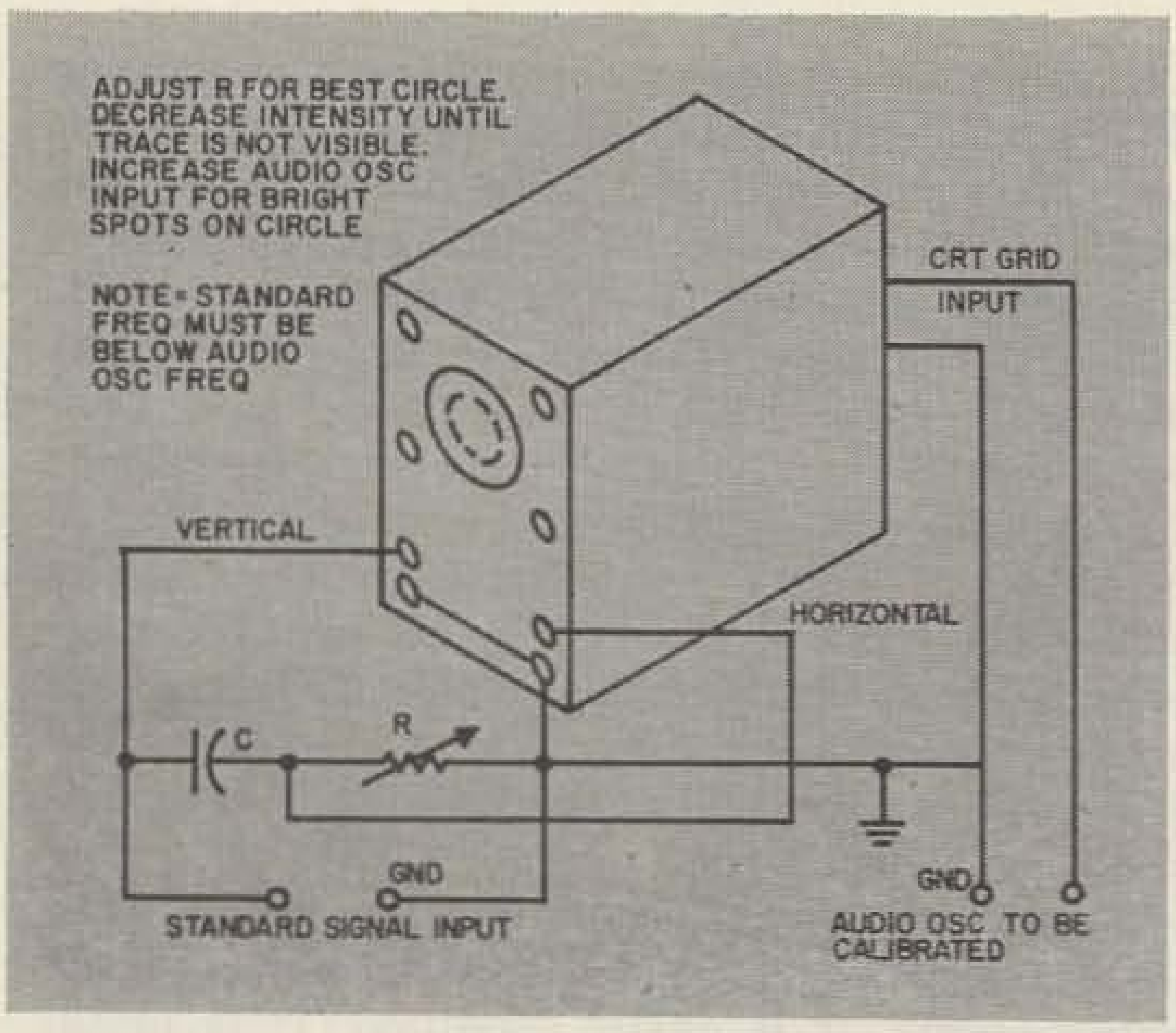

Fig. 3

Measuring Frequency with Simple Equipment

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In amateur radio, a knowledge of your operating frequency is essential for many reasons. First of all the FCC requires it. Remember the old saying, "don't fight city hall." Then too, would you tell a friend "shift frequency OM to 3.5 mc or so?" Or maybe, "our net operates at 29.2 mc, I think?"

No, we all have a very definite interest in determining frequency, sometimes even to the exact cycle.

Frequency measurement is possible in many ways, and each has it's own distinctive disadvantage. Possibly the simplest, and least accurate, is the absorption wavemeter, which is merely a parallel resonant circuit. Although simple to construct and operate, it is insensitive, and interacts with the circuit under test. If you had a coil with infinite Q, and coupling so loose there was no interaction, accurate measurements might be possible this way. The absorption wavemeter is useful in another way however, which I shall explain shortly.

The other type of frequency measurement equipment commonly in use by the amateur is the xtal calibrator. Usually either a 100 kc or 1000 kc xtal is used, mainly to determine the band edges. The disadvantage of this is that you may, unless very cautious, use the wrong harmonic and be 100 or 1000 kc off. A further question when using this type of measuring equipment is interpolation. By this I mean, how do you check your frequency if it is not an exact multiple of 100 kc? Elaborate calibrators use multivibrator chains to cut the signal interval to 10 or 1 kc. Some even have built in interpolation oscillators which can be calibrated internally and will cover a 100 kc interval. However, it is possible to measure

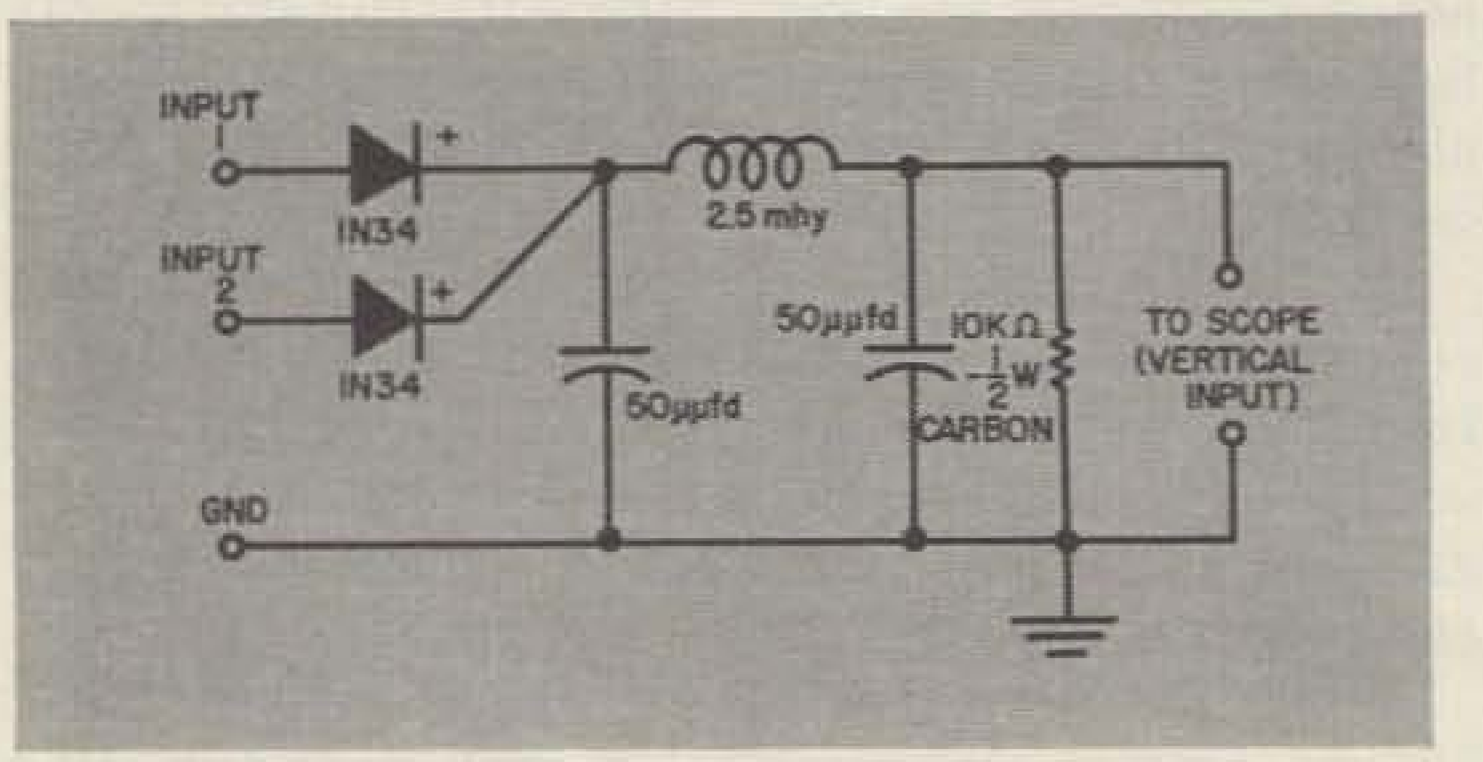


Fig. 1

any frequency exactly using only a minimum of equipment. A communications receiver is desirable, although not necessary. The absorption wavemeter mentioned previously can replace it. An oscilloscope, audio oscillator, and xtal calibrator are essential.

Added to the above equipment you must have a mixer, which can be built easily with two germanium diodes. See Fig. 1.

First though, before checking an unknown frequency, you must check and calibrate your equipment. The xtal calibrator can be adjusted against WWV, preferably at as high a frequency as possible. This should be done just before the unknown frequency is measured. Wait until the WWV tone stops, and adjust the calibrator to zero beat. When the tone returns, adjust the calibrator further until the chopping of the tone is as slow as possible. You may have to do this several times, to be sure of the correct setting. An error of one

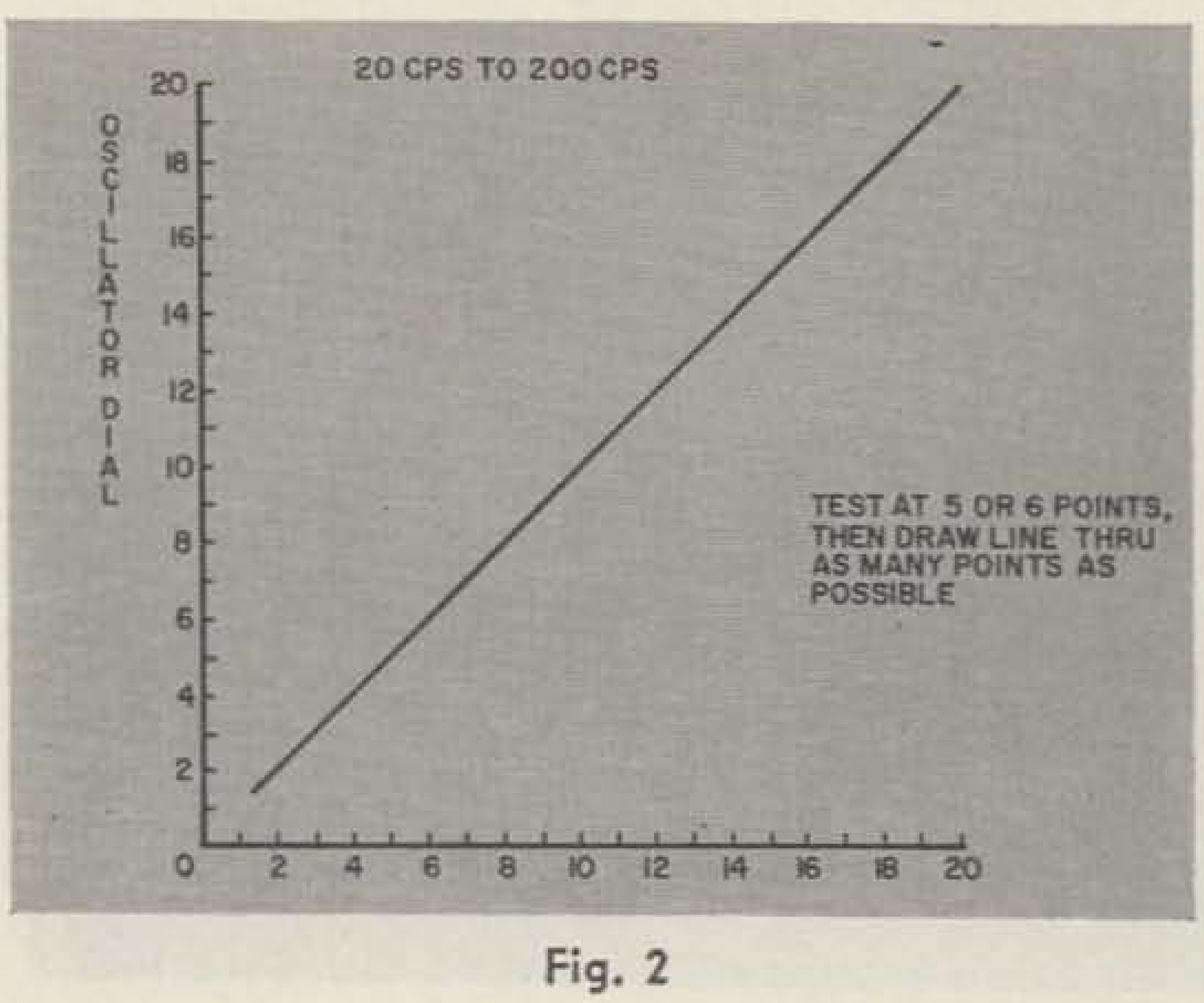
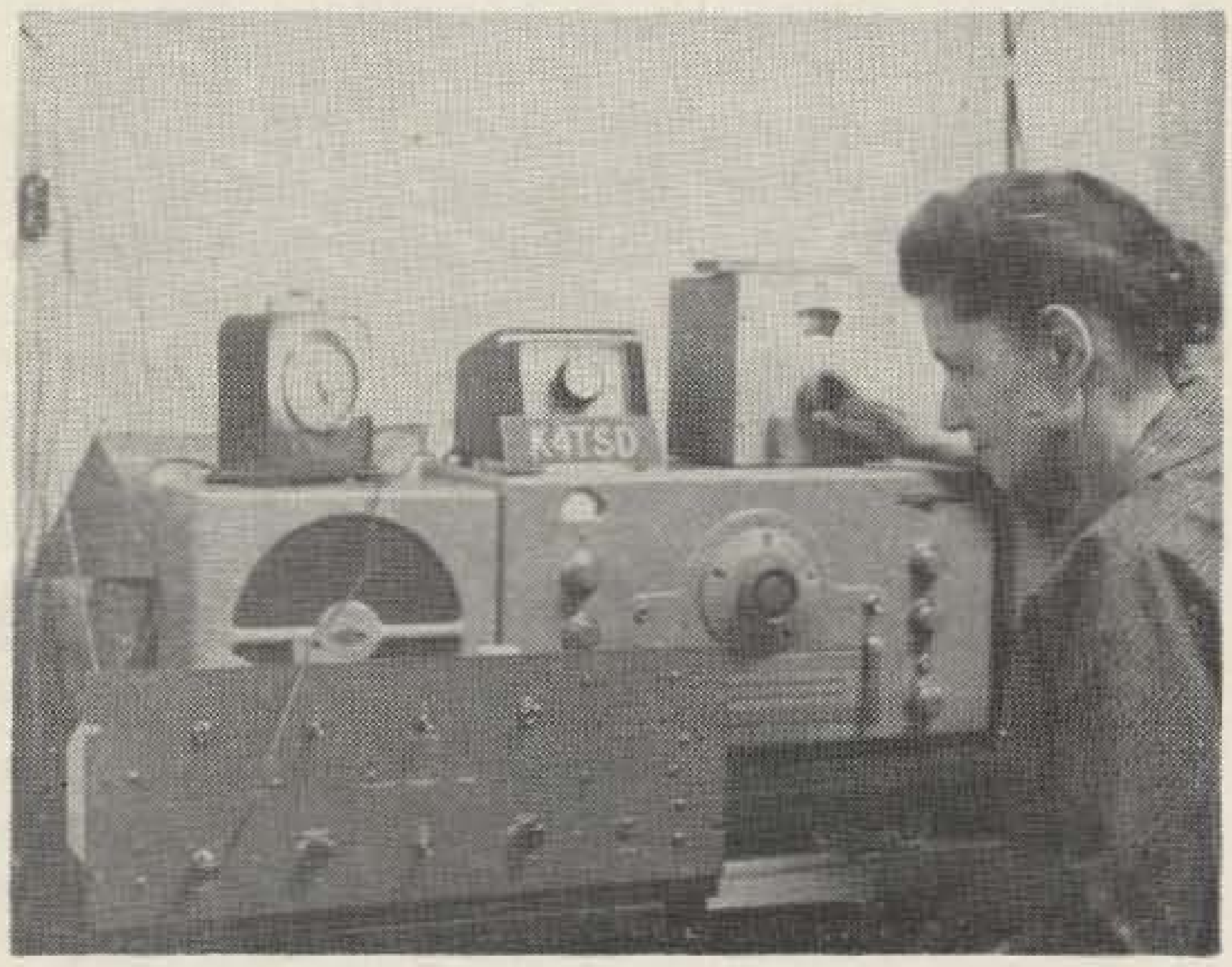


Fig. 2

cycle at 20 mc is an error of 0.000005%, which is close, *real* close!

Next you must calibrate your audio oscillator. In most cases it is easier to run a graph or chart on the dial error rather than try to rework the oscillator. The dial can be checked at several points, and a line drawn through these prints on a graph. A straight line should result. See Fig. 2. This chart can then be checked occasionally, and corrected. Let the audio oscillator warm up for several hours. Then, using the scope, check the lower fre-



A custom built calibrator gives greater accuracy. The calibrator contains a 50 and 10 kc multivibrator chain, together with a 200 kc xtal standard.

quencies against the power line frequency, using Lissajous figures. From 20 to 600 cps this should be possible. From 600 to 6000 cps you can use the 600 cps tone from WWV (connect the af output of your receiver to the vertical input of the scope), since ratios up to 10:1 can be read easily with Lissajous figures. Above 6000 cps use the 100 kc xtal calibrator. All the checks are made by applying the audio oscillator to the horizontal input of scope. The vertical input is connected to the unknown frequency.

An alternate method which can be used on some scopes is shown in Fig. 3. With this method of using intensity modulation of a standard circle, ratios of 100:1 can be read.

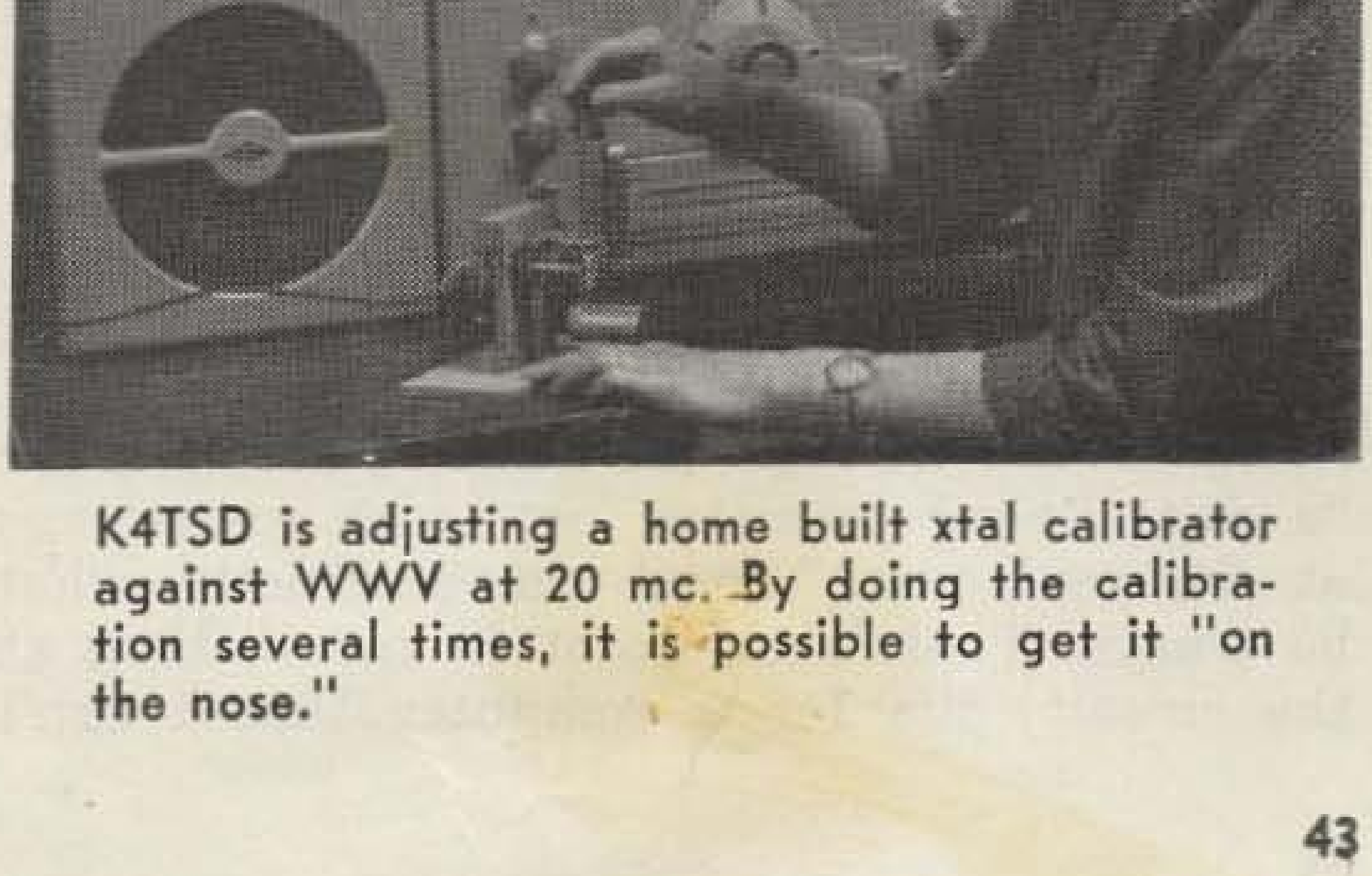
With your equipment calibrated, you now have the equivalent of a $1000 frequency meter. Now let's put it to work. The first thing you will want to measure is your transmitter frequency. Assuming you operate xtal controlled, use the following procedure (if you use a VFO, you will want to check the dial at several points on each range and run another graph).

You must determine the approximate frequency of the unknown signal first. Do this with your receiver and xtal calibrator or with an absorption wavemeter. In making this check, remove the antenna from your receiver and use only the oscillator or VFO stage of your transmitter. This will prevent an erroneous reading from an overloaded receiver.

Using the calibrated audio oscillator and oscilloscope to interpolate the beat between the xtal calibrator and the unknown signal. Do this several times to be sure of the result.

Now suppose your unknown frequency seems to be 3550 kc. Beat this signal with the xtal calibrator by using a mixer, such as the simple diode type described previously. The output of this mixer will be the difference between the 100 kc harmonic and the unknown signal, having a maximum of course of 50 kc. Apply this signal to the vertical input of your oscilloscope. The calibrated audio oscillator is connected to the horizontal input. Lissajous patterns can then be used to determine closely the beat difference, as in photo. If a three to one ratio is obtained at 16 kc on the audio oscillator, the beat difference is three times this or 48 kc. Our unknown frequency is found to be 3548 kc, with an error depending on the accuracy of the audio oscillator. If the oscillator is within 0.5%, and this is easily possible, our final measurement will be 240 cps or less, which figures out to be approximately 0.007% at 3548 kc. If a one to one ratio is possible, the error will be less. For instance, if a one

(Continued on page 65)



K4TSD is adjusting a home built xtal calibrator against WWV at 20 mc. By doing the calibration several times, it is possible to get it "on the nose."

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From My Side of the Counter

At least once every day, a customer—who may be a fireman or a successful lawyer,—will say to me, "I envy you, Sy . . . making money at your hobby. Nothing but radio gear all around. What a way to make a living!" Most of the time I don't answer; there *is* no answer to that one. But it's time, I think, to put down on paper one ham's reactions to living all day with his hobby.

I've been a ham since my teens—and let's not discuss when *that* was. Just for the record, I run a radio parts store on New York's Radio Row. We deal mainly in surplus, which means that I generally get a special kind of customer. I'd like you to come behind the counter with me for a while to see what it's like. In common with any businessman, I have to show a profit at the end of the month, and some of my reactions are colored by this fact. But, as a ham, I have more in common with my customers than most salesmen, and this makes things interesting.

On a Saturday, for example, the shop, which has little floor space at best, resembles the meeting-room of the local Key Klix Klub. There are hams and experimenters all over the place. Some come in just to look around and talk, and that's OK with us. Once in a while they buy something, and that's even better. Many of them are providing me with a liberal education, as well.

Take teenagers. There was a time when I could take a circuit out of a youngster's hand, fix him up with the components he wanted, and send him away happy. Nowadays it's not so easy. A kid will march up to the counter, squint at me through his glasses, and ask for "a dual linear precision pot, with extra lugs at the midpoints." And that's exactly what he wants. There's no point in my looking at the circuit; it's for a computer that I can't figure out, and anyway it's three pages long. I feel especially sorry for the fathers who come along to pay for the stuff. The kids are so darned superior that while Dad is still asking, "Do you think that this will do?" Sonny is already on the next item, a dozen diodes, "but all matched, please."

I still do get a kick when I can dig out a lot of parts for a boy, watch him count out the dimes and pennies, and see him come back next week, with the report that "I've already worked six states, Sy." Sometimes the pennies add up 20¢ short or so, but rather than take back a couple of resistors, I tell the kid to forget it. The big grin and the handful of QSLs he shows me the next time he comes in is worth it.

Not all of them are kids. Plenty of fathers have latched onto the game of ham radio to get some relaxation after a hard day at work. With luck, I catch them while they're Novices and watch them progress, learning as they go, through the thrills of DXing with a single 807 and on to bigger and better things. Radio is completely new to them, and an hour in a place like mine is likely to be confusing to a fellow who pushes a pencil all week, so I help them out just as I do the kids.

The older and wiser hams come in to swap lies, look around at the "new surplus" and very often pick up a gadget that I bought but can't make heads or tails of—there's a part in it that may be useful some day. That's how junk boxes are born. One item was an amplifier of some sort. It contained two sensitive relays and umpteen re-useable resistors, condensers and what-have-you. We had hundreds of them, and they are now sitting in ham shacks as small transmitters, converters, power supplies and whatever else the amateur imagination saw in them.

Apart from hams, we have many experimenters who come in for odd-ball parts to go into odd-ball devices. Many of these fellows are working on "secret" projects . . . they for because they're afraid that someone will swipe their idea. I do the best I can. We get our share of real cloak-and-dagger stuff, though. Any number of experts from the FBI, CIA and other agencies come in for components to build specialized devices. They know what they want their rigs to do, and they know what they need, but they can't tell us much about it. They get the VIP treatment, as opposed to the guy who comes in for "an oscillator or something to mess up my neighbor's TV set—it's so darned loud I can't sleep." The latter just gets a reading from the section of the FCC Regulations dealing with willful interference, and the penalties attached.

I try to be especially patient, and it takes a lot of patience, with the women who come in with a parts list from a son or brother or husband who's away in the Armed Forces, or in college, or on a job where there are no parts stores. These gals think that they're shopping in Macy's where the customer is always right. We try to make things easy for them, and when they come back asking for an exchange or a refund, we act like the uptown department stores. The only time that we get really tough about refunds is when someone has obviously given a component a few whacks with a hammer to make it work.

I do have some gripes in this business. The Number One Louse is, of course, the know-it-all. He wrote the book, has a cellar full of gear and has all the answers. He comes into the shop just to browse around, make loud, disparaging comments on the merchandise, and bargain for a 10¢ pilot lamp. He frequently imposes his ignorance on an innocent bystander with, "Don't buy *that!* It's not what you want. And anyway, I know where you can get it cheaper."

Closely related is the customer who picks up an item and then tells me that he saw the same thing at Discarded Parts, Inc., for $3.00 less. Of course, that was three weeks ago, and now Discarded, our favorite competitor, is out of stock on that particular gadget. Speaking of competitors, it may be my imagination, but do my competitors make a special effort to send me *all* of their problems? And are these problem customers *always* in a tearing hurry because they're double-parked? Or does it just seem that way?

I get a little unhappy with the fellow who asks to see the Gold-Plated Gammatron which is in the most inaccessible part of the show window. After I've knocked over a box of 100 loose transistors, and stepped on a 4D32 in an effort to get it for him, he looks at it lovingly, says, "Gosh, I haven't seen one of these since I was in the Royal Navy in 1942," and walks out. At this moment the phone rings, and just as I'm saying, "Hello, Metro Radio . . ." a fellow barges in on my conversation to ask if I have any way of checking the 4X1000 from the final of his Super Cyclone Single Sideband Signal Shocker.

It may be a personal prejudice, but I haven't much patience with the self-styled ham who puts several thousand dollars into a completely commercially-assembled station, has it installed by a technically-minded buddy, and goes on the air to call CQ for 18 minutes before signing. Perhaps it springs from my own approach to ham radio, but I feel that such fellows are not really amateurs; they are just using their licenses to engage in some kind of high-powered Citizens Band operation.

I've given a lot of thought to this radio business, and I've often wondered whether the grass is greener on the other side of Radio Row. Television repair parts sell very well, and stereo hi-fi is going big. But, from my side of the counter, the kicks I get from the surplus business far outweigh the gripes. I think that I'd rather stay in a shop where a good number of the customers know more about radio than I do . . . where I can teach a little and learn a lot. One meets such interesting gadgets, and such interesting customers.

Transistor Biasing Simplified

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APPLYING the proper bias to a transistor circuit is admittedly slightly more complicated than biasing a similar vacuum tube circuit. As a matter of fact, the problems involved have no doubt caused many an amateur to become quite biased against transistors. It is hoped that this short conversion to amateur techniques of a few of the major problems involved will assist those who are really interested in using these little jewels.

A transistor is considered to be a current operated device. The obvious thing to do then would be to bias the "control electrode" with a source of fixed current, rather than fixed voltage. As usual, the obvious method proved to be wrong. In practice a little bug-a-boo called IcO changes the picture entirely, so that attempts to use a simple fixed bias current circuit, as shown in Fig. 1, resulted all too often in developing thermometers rather than useful amplifiers.

This IcO is the collector-to-base current, with the emitter circuit open. It consists of two major components, a thermally sensitive one which is mainly dependent upon the junction temperature, and a leakage current which is proportional to the applied junction voltage. In good quality small transistors the second component is usually insignificant, but in power transistors it may become the larger component of IcO at room temperatures. These two components of IcO can be broken down into more specific paths, but for practical work the methods of combatting the effects of IcO are more valuable than the detailed physics involved.

The simple bias circuit of Fig. 1 should not be rejected without at least giving it a try-

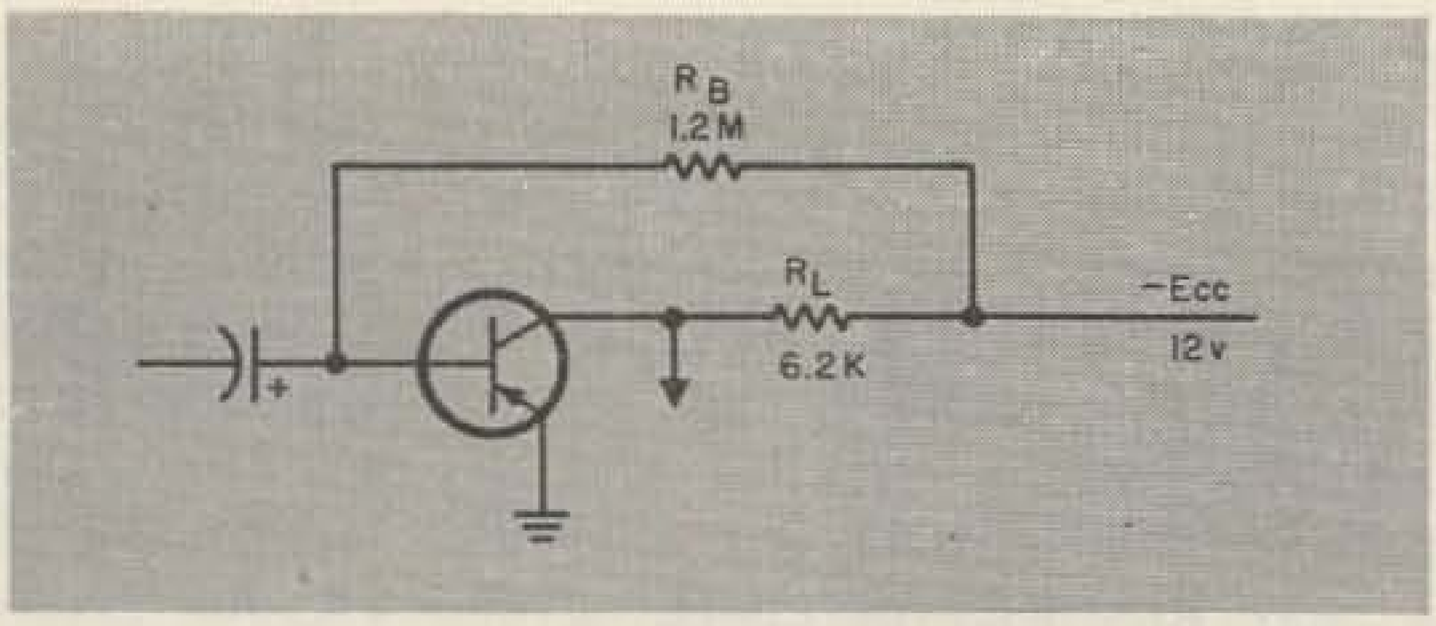

Fig. 1

out, if only to gain a better understanding of these little beasts. It is quite useful to the ham as a simple meter amplifier for wavemeters, or audio amplifiers where the bias resistor can be selected for the individual transistor in the circuit. The PNP transistor in Fig. 1 may have a typical IcO of 10 μA and Beta (ac current gain) of 50. As a starting point, most transistor amplifiers are designed for around 1 ma emitter current. The collector current will then also be nearly 1 ma, so that with a 12 volt supply, —Ecc, and a 6.2K ohm load resistor the collector voltage has plenty of room to swing with large signal voltages without clipping or bottoming.

To get this 1 ma of collector current we need a base current of 1 ÷ 50 ma, or 20 μa of base current. We already have 10 μa of base current supplied by IcO, so RB needs to supply only 10 μa additional, from the 12 volt supply. As indicated by the typical input characteristics of Fig. 2, the emitter to base voltage is negligible, so RB = 12 ÷ 10 x 10—6 = 1.2 megohms. Now what happens if the operating temperature of the circuit is

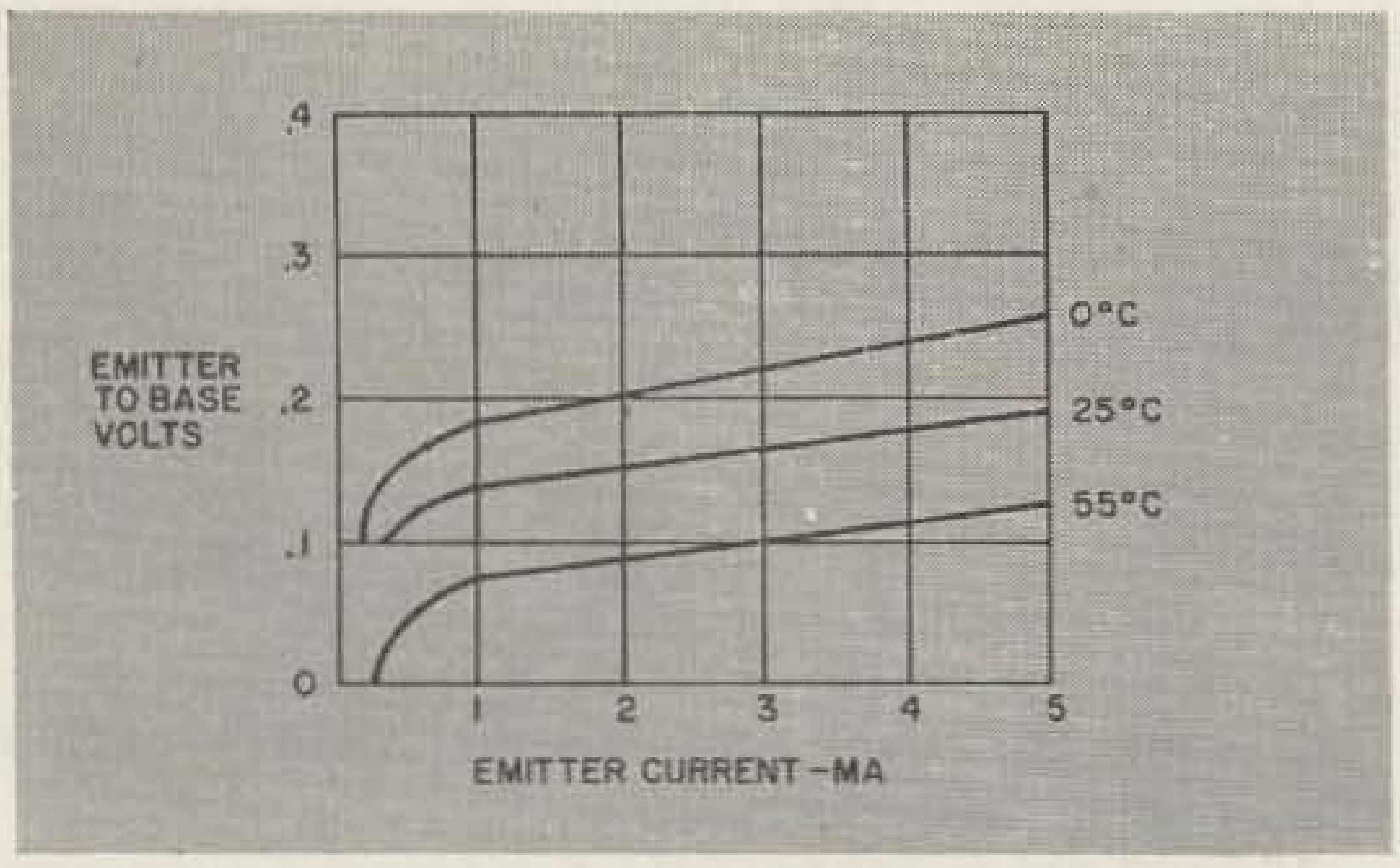

Fig. 2

increased about 10° C., or 18° F.? IcO doubles to 20 μa, RB still supplies 10 μa, so the base current is now 30 μa. The collector current now becomes 50 x 30 μa, or 1.5 ma, and the collector voltage drops to 2.7 volts. The circuit still works as an amplifier, and for small signals the effect so far may not be noticed, but a further increase in temperature, or changing to a transistor of higher gain, may cause saturation of the transistor and its refusal to function as an amplifier.

A slight improvement in the dc stability may be found in the circuit of Fig. 3a. By connecting RB to the collector instead of to —Ecc a bit of dc feedback is obtained which helps out by compensating for the increase of IcO with temperature. As the collector voltage tends to drop the base current supplied by RB also decreases. Unless the collector is capacitively coupled to a low impedance ac load, this circuit may also result in ac feedback which reduces the available ac gain. One method of preventing this is to split RB in two equal parts, as in Fig. 3b, and bypass the ac feedback signal with a capacitor. For radio frequencies this may not be necessary, since the input capacity of the transistor may be sufficient to cause the input impedance to be very low compared to RB.

In Fig. 4 is shown the usual method of biasing individual low power amplifier stages. Although it is only slightly more complicated than those previously discussed, it offers tremendous advantages in improved dc stability and ease of predicting its performance with normal variations in temperature or transistor characteristics and circuit components. Calculation of the exact value of each resistor for a given Stability Factor can of course be quite involved, and the same goes for working out the optimum values for best performance. However, as amateurs who work in engineering labs may have noticed, optimum final design is normally based upon experimental verification, more commonly known as "cut and try." Simply picking the values of the components from any commercial circuit may result in a usable amplifier, but one which is over-designed for amateur work. So, it might prove profitable to see what factors influence the selection of components.

The emitter bias resistor, RE in Fig. 4, provides a considerable amount of negative current feedback. Hence, any tendency for the emitter current to change is compensated for to a large degree. In addition, RE is generally large compared to the resistance of the emitter to base junction, and so prevents changes of the base to emitter voltage from affecting operation. Selection of the value of RE is more generally an intelligent guess, rather than a mathematical calculation. Too high a resistance would cut down the available collector to emitter voltage, which would limit the ac signal voltage swing. Too low a resistance would make it necessary to use a low value of RA for good dc stability, and this would shunt too much of the signal, reducing the gain. Typical values for RE are 1K ohm for general purpose amplifiers, 2.4K for low noise preamps where the normal emitter current may be ½ ma and 470 ohms for low level driver stages.

The base resistor RA is usually made 3 to 10 times the value of RE. A smaller value will provide better dc stability, but a higher value results in less signal loss due to shunting the input. In Fig. 4, we chose to make RE 1K ohm, and RA 3.6K ohm with an emitter current of 1 ma. These values should give good stability even out in the desert in midsummer. The 1 ma through 1K puts the emitter 1 volt above ground, and the base a little more than 1.1 volts above ground; picking the emitter to base voltage from Fig. 2. RB then can be readily calculated. The current through RA, and also RB, is 1.1 V ÷ 3.6K = .31 ma (neglecting IcO). RB is then 12 V − 1.1 V ÷ .31 ma = 35K ohms. A 36K resistor will do as well.

Since we had 1 ma of emitter current, and nearly 1 ma of collector current, a 6.2K ohm collector load resistor will set the collector voltage at slightly below the half way point. We lost one volt in the emitter resistor so the supply voltage is now 11 volts, rather than 12. A more optimum bias level would call for a lower load resistor, but this would lower the amount of signal available to a following stage, since the collector load and the input circuit of the following stage are effectively in parallel as far as the signal is concerned.

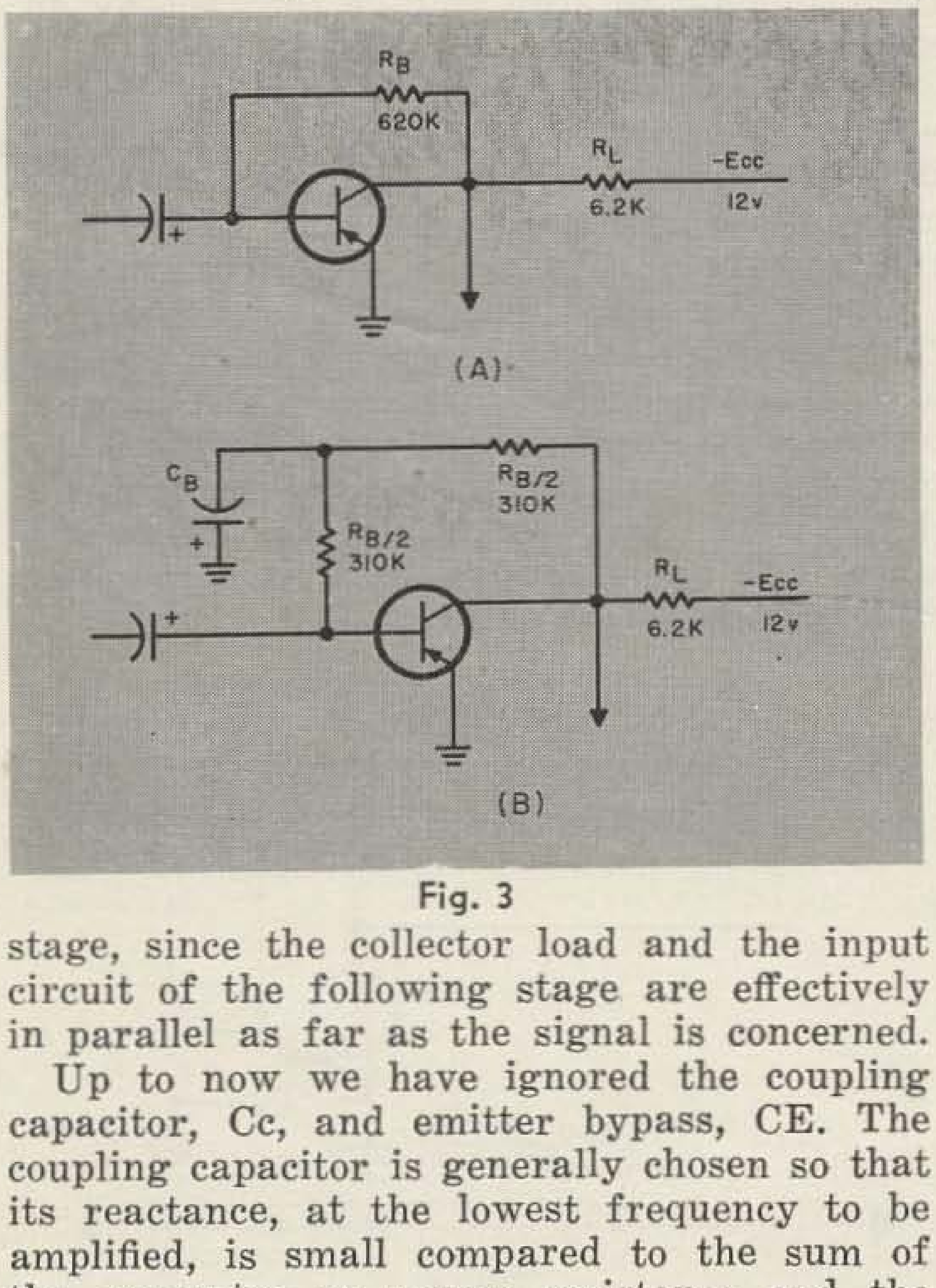

Fig. 3

Up to now we have ignored the coupling capacitor, Cc, and emitter bypass, CE. The coupling capacitor is generally chosen so that its reactance, at the lowest frequency to be amplified, is small compared to the sum of the generator or source resistance and the input impedance of the amplifier. In a multistaged amplifier Rg is of course the collector load resistance of the previous stage, since it is usually very low compared to the transistor's output impedance. Typical values for Cc in the audio range are 1 to 10 mfd. Since these are usually low voltage electrolytics, the polarity must be carefully observed.

As with vacuum tube circuits, CE should have a very low reactance compared to the value of RE over the range of frequencies it is desired to amplify. But, unlike vacuum tube circuits, the low frequency cut-off point, at which the response is 3 db down, is where the reactance of CE times Beta is equal to the source resistance. In this case the source resistance is Rg in parallel with RA and RB. Typical values for CE are 25 to 100 mfd for audio.

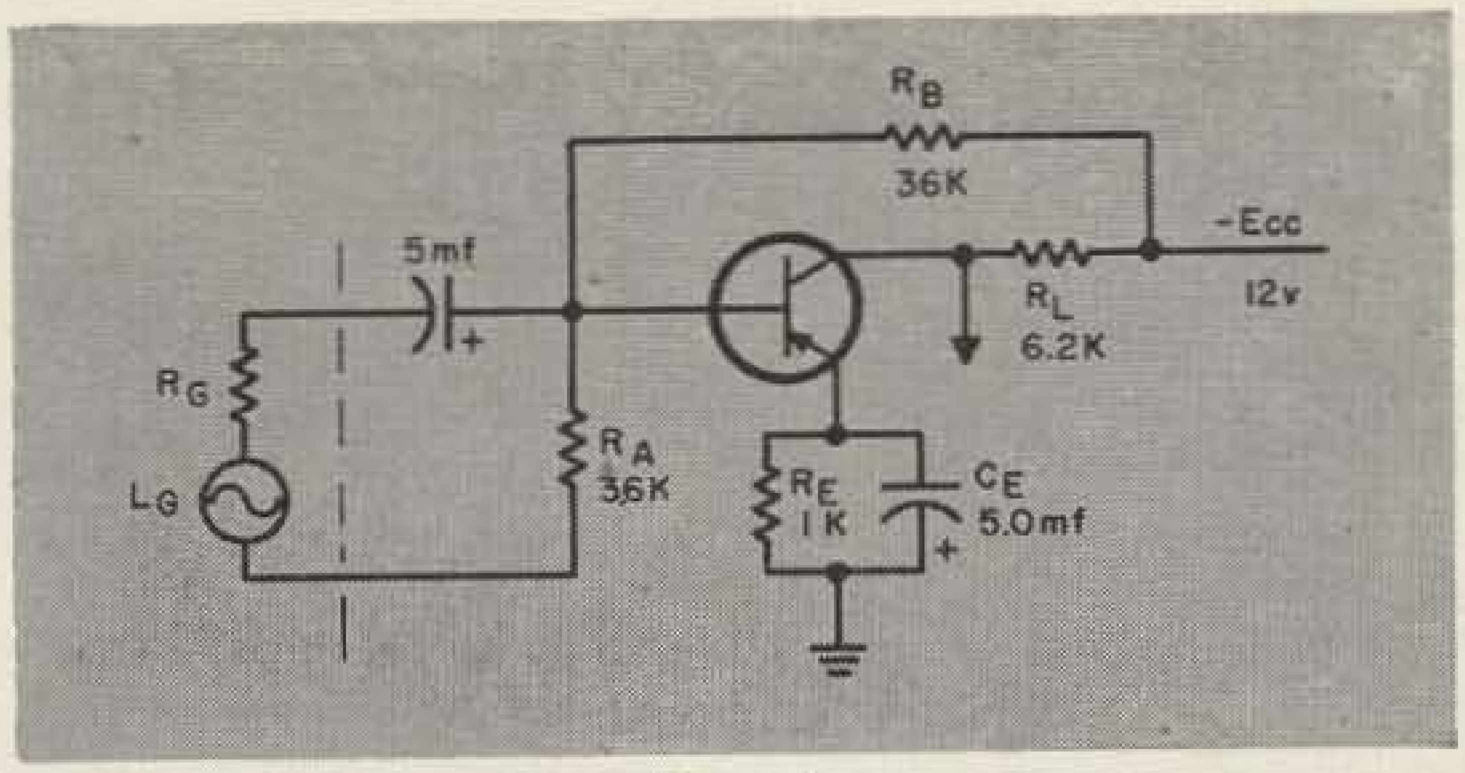

Fig. 4

Now that we have worked out an amplifier, as in Fig. 4, even though it might not be quite as well designed as could be done by a more rigorous mathematical treatment, it might be interesting to see if we could estimate its useful gain. We started with a typical transistor with IcO of 10 μa and Beta or hfe of 50. An additional parameter of interest would be the common base input impedance, hib, which is approximately 30 for typical audio units. If it isn't given, it can be readily calculated from the formula: hib = hie ÷ (1 + hfe), where hie is the common emitter input Z.

The voltage gain is then readily approximated by the formula: Av = R1 ÷ hib, and therefore in this case it is 6,200 ÷ 30, or around 206. If the amplifier is loaded down by a following stage the R1 used in the formula would be the sum of the collector load resistance in parallel with the input impedance of the next stage as well as any biasing resistors connected to that stage. The same applies to the current gain, which in an unloaded stage is equal to Beta. However, the lower the input impedance of the next stage, the more the available current gain is used, whereas the voltage gain is reduced. Since transistors are current amplifying devices, reduction in voltage gain is not much of a loss.

The dc gain was cut down so much by this amplifier configuration that it really isn't worth wasting time calculating the stability factors, except perhaps for practice. For those who are game to carry on a couple of excellent references are listed below. Naturally, this short an article couldn't begin to cover all the intricate aspects of transistor biasing. In addition, considerable liberties were taken in using approximations with the calculations. Nevertheless, the procedure outlined will result in perfectly usable amplifiers, and assist in gaining further insight into the workings of these mysterious little trinkets.

. . . K6EAW

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Transistor Circuit Engineering, R. F. Shea, John Wiley & Sons.
General Electric Transistor Manual, 5th Edition, G. E. Co.

Power-house Pros

Last month, in Part One of this article, we discussed basic power supply circuits, filters, and voltage multipliers. While they're important, they're only the starting point toward a power supply which is designed rather than tossed together out of the junk box. Let's see what's on down the road. . . .

Staff

A basic power supply, consisting of an input power source, a rectifier circuit, and a filter, is capable of operating any electronic device. However, its operation can be improved tremendously for many purposes by incorporating additional circuits and by using the more-familiar circuits in different ways. While these additional circuits are admittedly the frosting on the cake, some kinds of cake are completely flat-tasting without any frosting at all.

The most familiar of these extra circuits is the voltage regulator. Like the term "power supply" itself, this name actually describes a number of different circuits. All have the same purpose: to hold output voltage constant under varying load. This can be accomplished

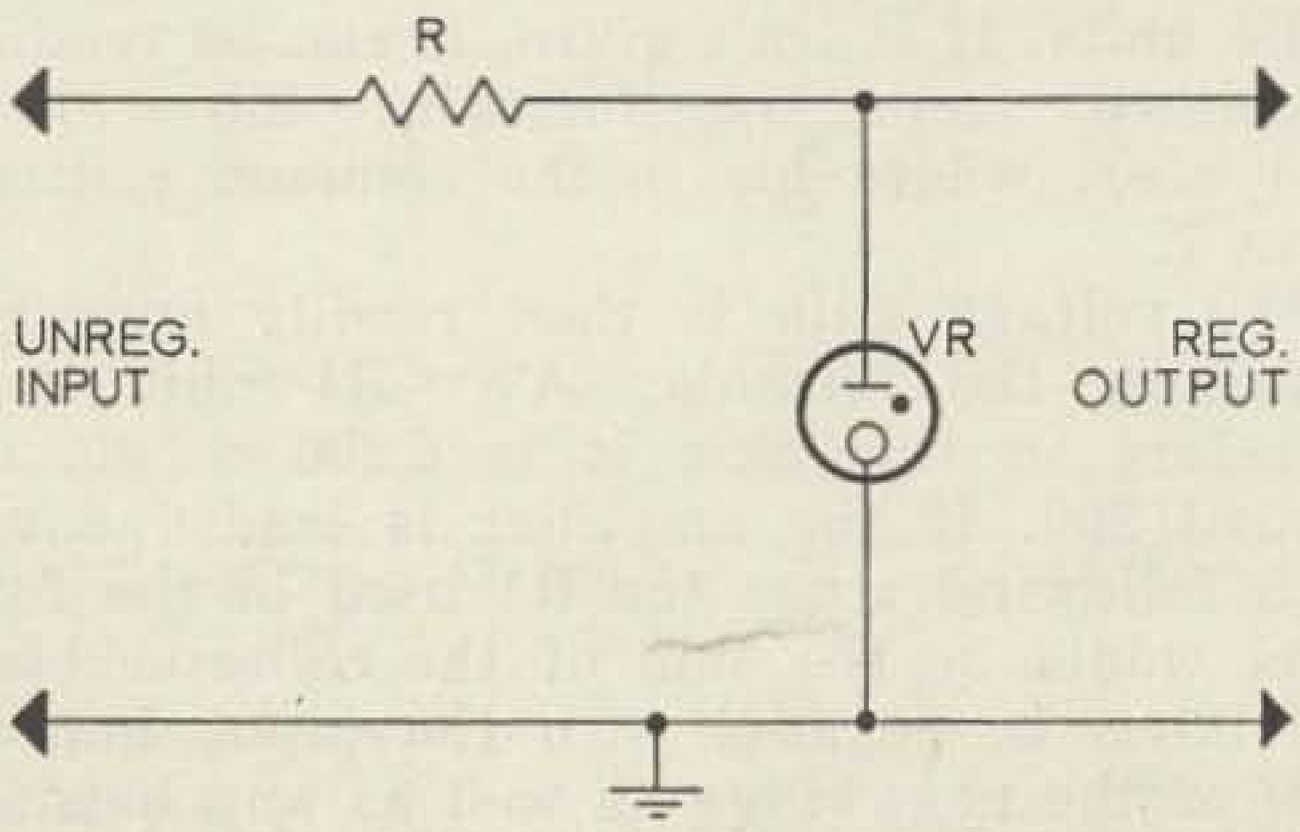


Fig. 1

with active or with passive elements (or, more frequently, with a combination of both.)

Most of us are familiar with the simplest voltage-regulator circuit, which employs a special type of cold-cathode gas discharge tube called (oddly enough) a voltage regulator tube. This tube makes use of the fact that voltage drop across a normal-glow gas discharge tube is almost constant within rather wide limits, and that value of this voltage drop is established in design of the specific tube.

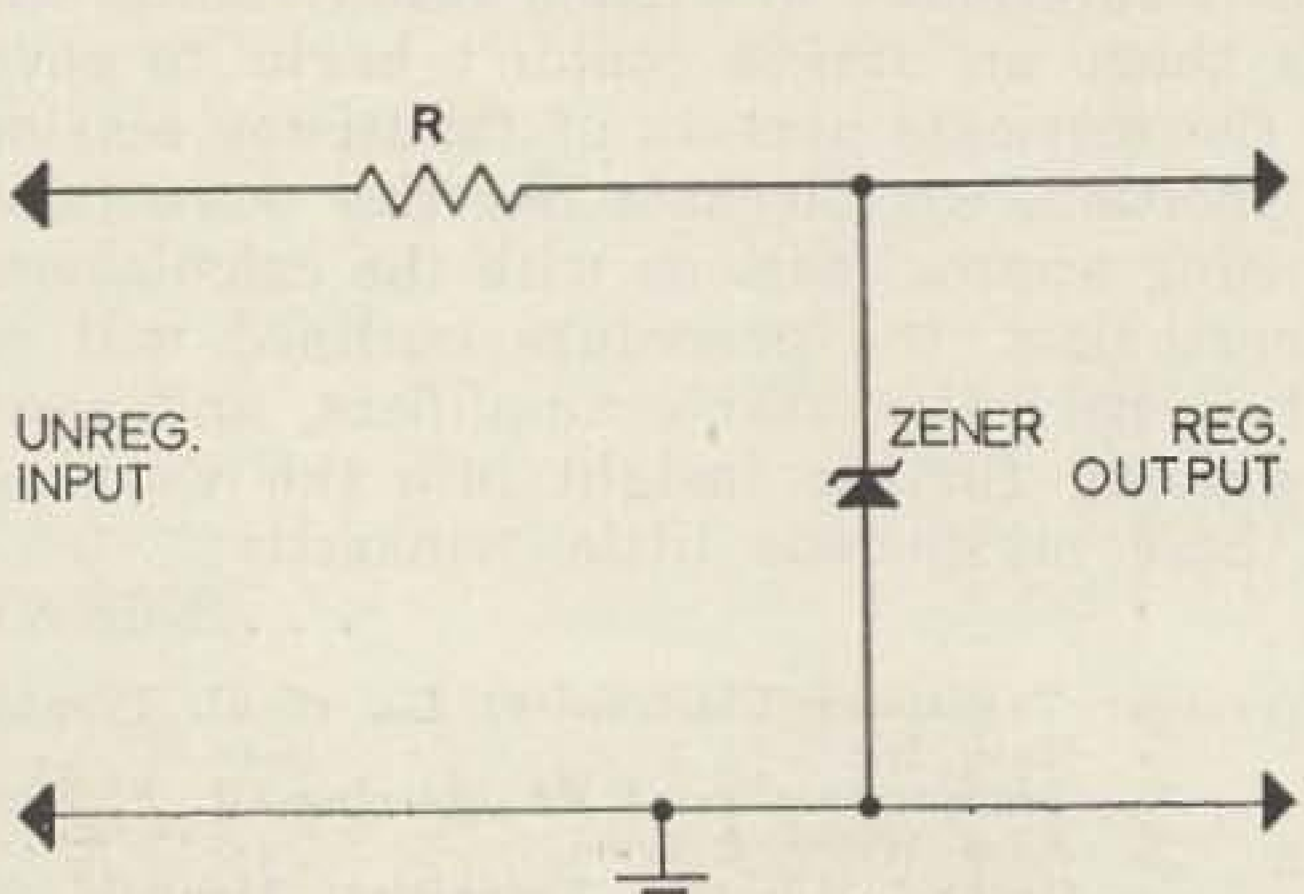


Fig. 2

In use, the tube is connected in series with a current-limiting resistor as shown in Fig. 1, and output is taken in parallel with the tube. VR tubes are normally available in 90-, 105-, and 150-volt ratings; other values are obtained by series connections.

To understand circuit operation, imagine that the tube is actually a variable resistor whose resistance is controlled by the voltage across it. As voltage drops, the resistance rises, tending to keep voltage constant by divider action.

VR tubes are not the only circuit elements which behave this way. An ordinary neon glow tube exhibits exactly the same effect, although at a different voltage level (which varies from tube to tube) and at much lower currents.

One of the main disadvantages of the gas-tube regulator is that output voltage is fixed at one of the design values or a combination of the few available voltages. Another element which acts in an identical manner for different reasons overcomes this difficulty, since it is manufactured in a wide range of voltages: the Zener diode.

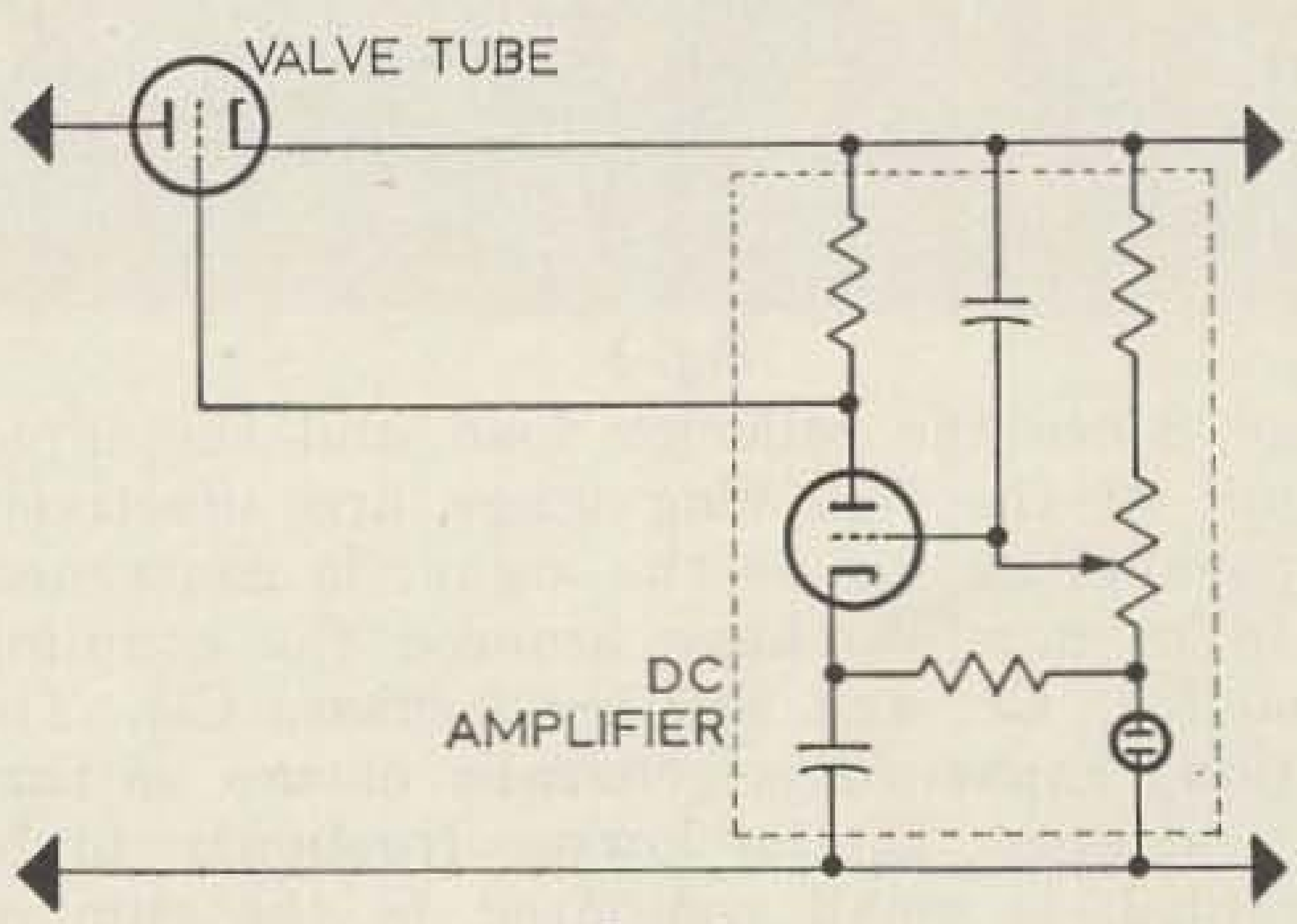


Fig. 3

The Zener diode is a specially-processed type of silicon diode which also exhibits constant voltage drop under certain conditions. As can be seen from Fig. 2, the circuit is identical to that of a gas-tube regulator with the diode replacing the gas tube.

However, Zener diodes are available in voltages from 3.9 volts up to 150, at prices ranging from 44 cents (for an economy line put out by Hoffman) to many dollars (for high-wattage industrial-type units). Since they don't burn out with use as tubes do, the approximately doubled cost is actually less expensive in the long run.

Both the Zener and the gas-tube circuits can regulate output voltage to within 1 percent

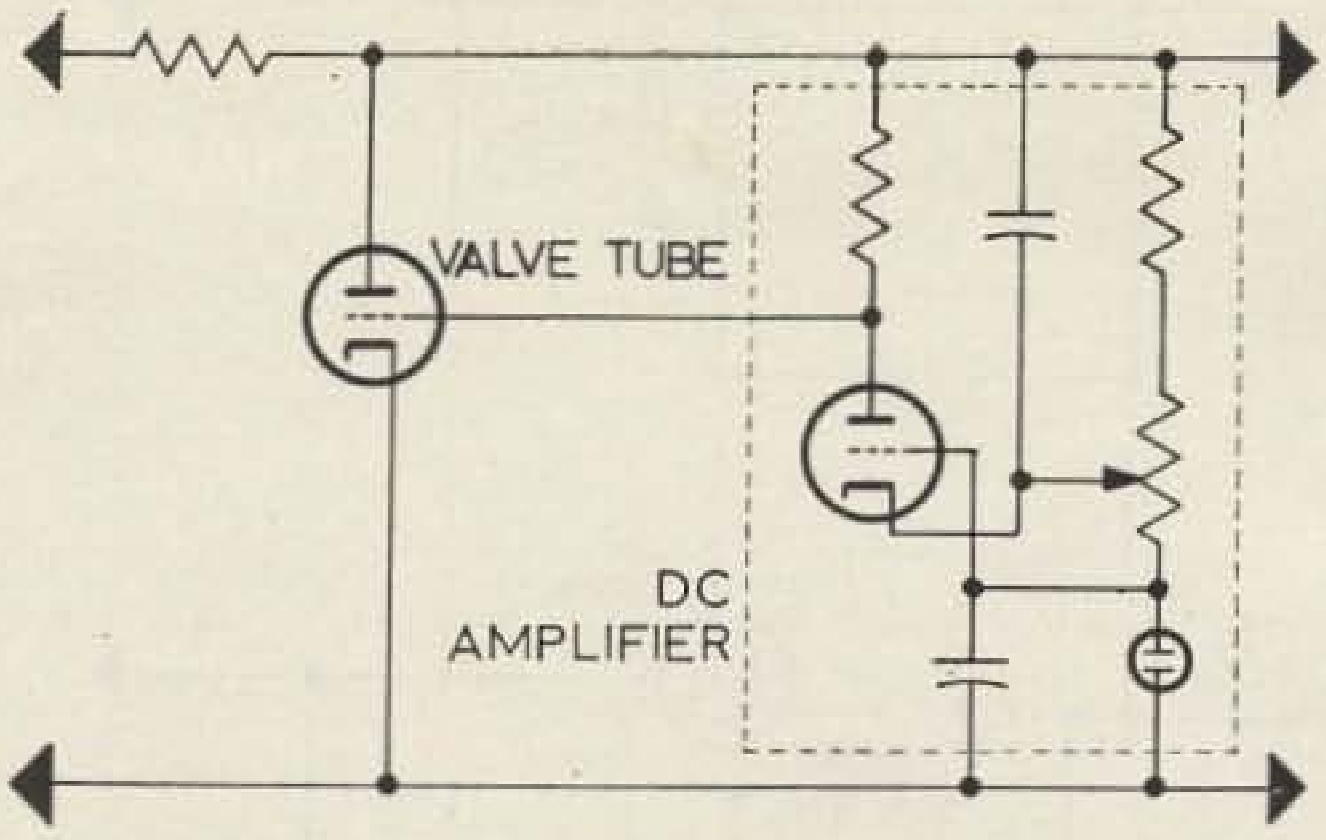


Fig. 4

for varying loads or for input voltage changes, but frequently regulation must be even closer than that. An example is the oscillator voltage supply for an FM rig, or for a high-selectivity SSB receiver. Voltages here should be regulated to much closer than 1 percent stability.

Regulation of this type demands an active regulator, rather than the passive types described so far. Such a regulator is shown in Fig. 3.

This circuit uses a high-current, low-voltage vacuum tube as a series valve. Resistance of the tube is determined by its grid-cathode voltage, which in turn is controlled by the dc

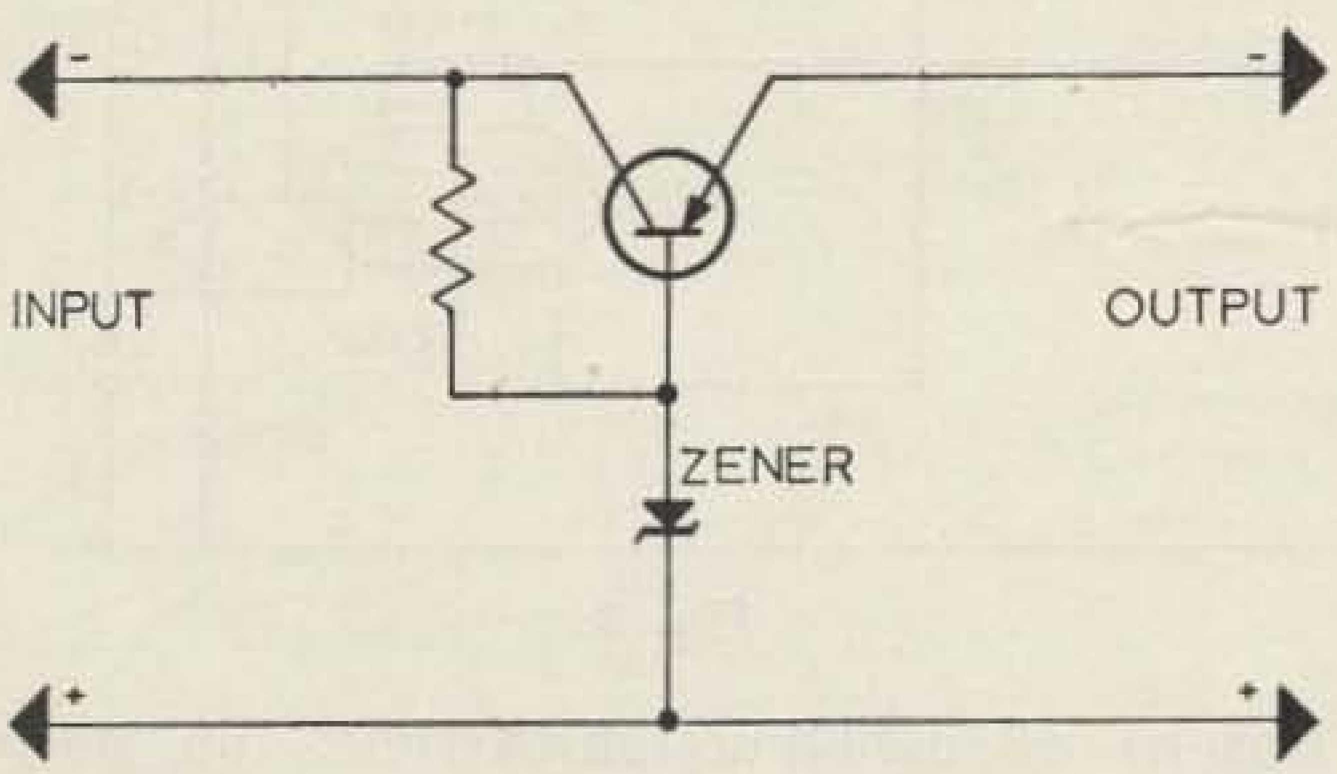


Fig. 5

amplifier circuit shown enclosed in dotted lines. The dc amplifier compares a selected portion of the output voltage to the voltage of a passive standard, and adjusts the valve tube's bias accordingly. With a high-gain dc amplifier, this circuit can maintain output voltage constant within 0.01 volt for 10 percent variations in input voltage, from no-load to maximum-load conditions. It also provides instant adjustment of output voltage value by means of the potentiometer, which determines what portion of output voltage is fed to the dc amplifier.

Another circuit providing close regulation and adaptable to higher current is that of Fig. 4, which uses the vacuum tube as a shunt element (replacing the VR tube in the circuit of Fig. 1). In operation, resistance of the control tube is varied by the dc amplifier in the same manner as for the circuit of Fig. 3 (but with opposite polarity), and the control tube

(Turn to page 50)

then varies output voltage to keep the output value constant.

Similar series- and shunt-type regulators can be built using transistors (Fig. 5 and 6) and operate in the same manner. Engineers at Motorola have built such a supply to deliver more than a kilowatt at up to 30 volts, for test purposes, and report regulation within a quarter-volt from no-load to full-load conditions.

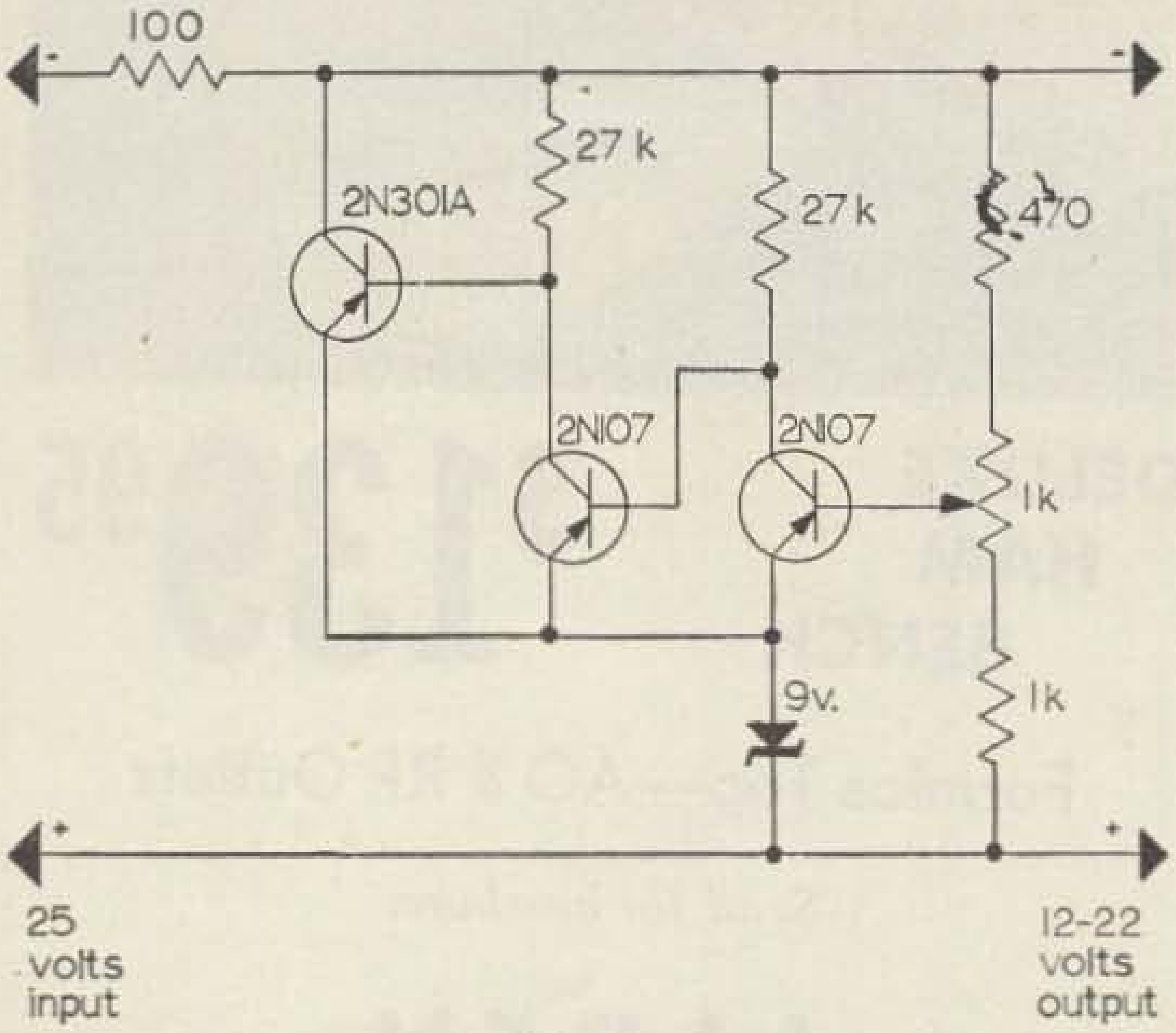


Fig. 6

All these active circuits employ feedback to reduce "error" voltage to something approximating zero; feedback can also be used to eliminate heavy filter chokes from a power supply without loss of performance. The circuit is shown in Fig. 7.

In operation, the input voltage has a strong ac component which is coupled directly to the grid through a capacitor and to the cathode through a resistor. Screen voltage is filtered through an RC filter. The variable resistor is adjusted so that the tube's series resistance is low except when the grid receives a negative pulse at the top of the input waveform. At this time, tube resistance rises. The property of

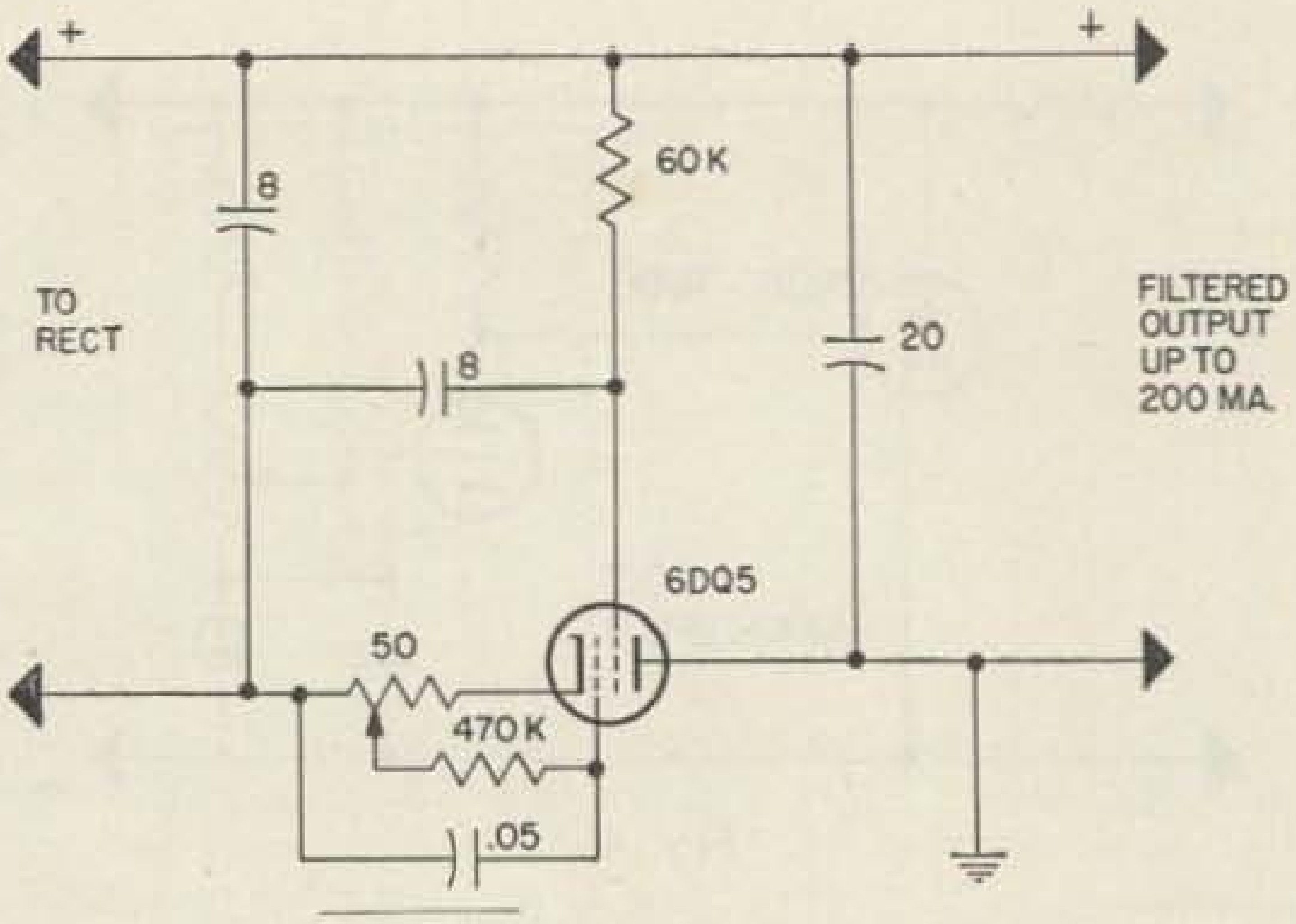


Fig. 7

rising impedance with increasing current characterizes inductance, making this circuit interchangeable with a choke in any power-supply application. In practice, less voltage is lost across the tube than across a choke for the same load current value.

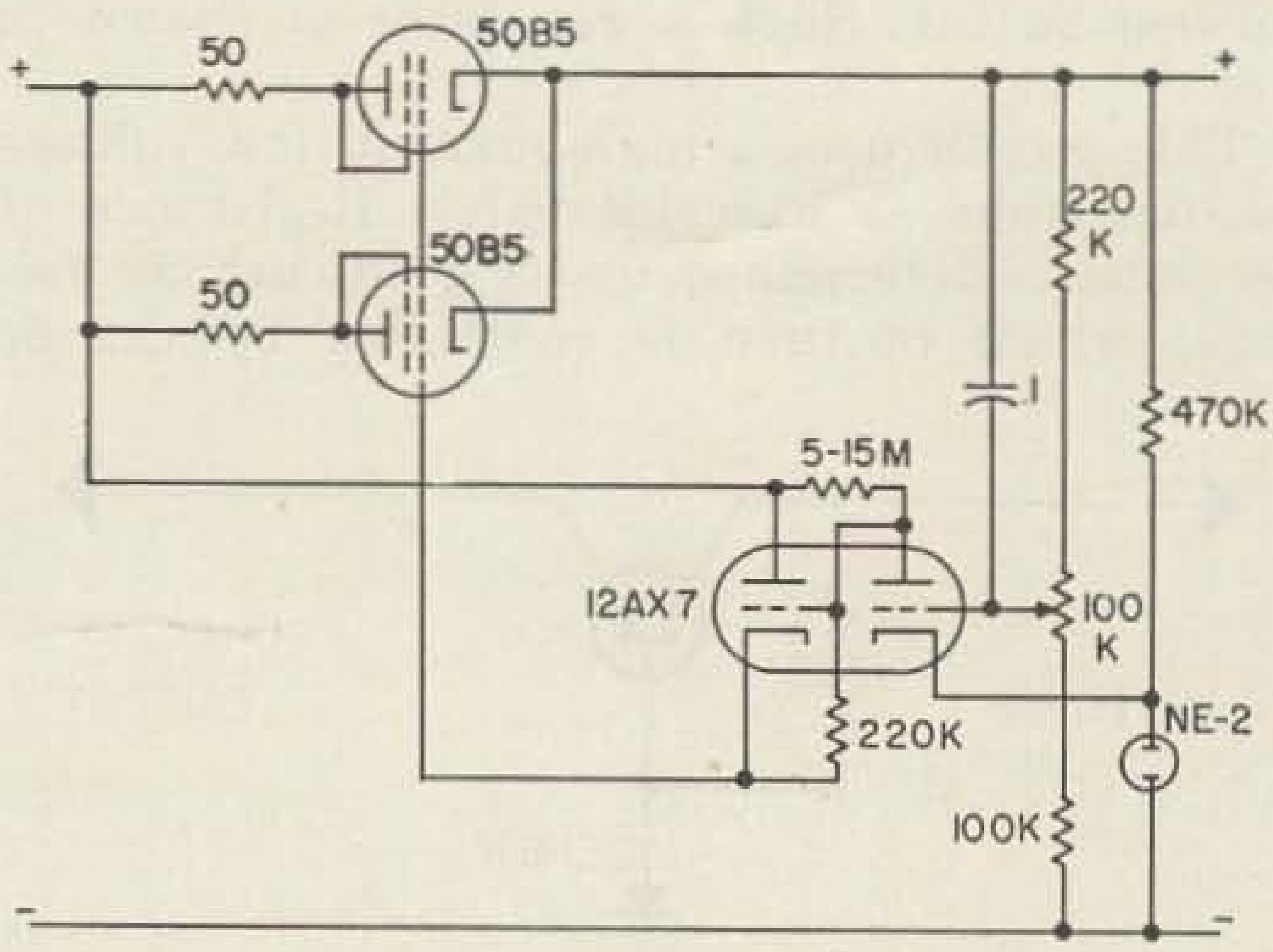


Fig. 8

Dozens of construction articles on power supplies for various purposes have been published; they include variable-voltage units for

(Turn to page 52)

Letters

Dear Wayne,

Another fine issue of 73! You sure have it "at both ends," both fine articles and interesting ads.

If you're interested in more subscribers (hi) you might try sending one copy of 73 to the president of some of the many radio clubs around the country and including a circular on the magazine giving more information including individual and club rates. If you don't have a list of some of the clubs across the nation you always could include a blank along with your next reader's poll.

I thought that I'd pass along some handy information for the VHFers who "roll their own." Discarded televisions are easily available in most sections of the country, either from neighbors or from television dealers who cart them off while installing new models. Besides having a great number of good tubes, a useful power supply, and other goodies, the tuner invariably contains coils for the various channels which can easily be converted to use on the VHF bands. First check the capacitor in parallel with the coil and determine the inductance of the coil using the **Handbook** formula and the **Handbook** table for television channel frequencies, then calculate the capacitance required to resonate the assembly in the desired band, add the capacitance, and presto, you're in business.

Channel Two and Three coils work best on six meters, while those for channels six and seven perform best on two meters. Because of the six mc bandwidth of the tv channels, the coils perform admirably in broadband converter circuits.

Would you by any chance be interested in publishing an article on a control unit that I am working on that incorporates an ultrasimple, but effective conelrad monitor, a selective audio filter for code, complete power fusing and control, a T-R switch, and a code monitor? This unit is entirely non-critical and can be adapted to ayone's junk box.

. . . Kenneth Hirsch K9TMB

Well Kenneth, I sure would like to send a copy of 73 to club presidents, but the problem is one of time. This magazine is snow-balling so fast I don't even have time to answer much of my mail, much less start more going out. I know everything would go faster, but it still isn't possible. Of course if I could round up a few more fellows to lend a hand with the work we might get things speeded up, but I find that enthusiasm wanes when I answer the salary question by offering them the same pay that all of us on the staff are getting. Your control unit might be of more interest for the parts: your audio filter, if it is different, would be of great interest and would be an article in itself. Ditto the T-R switch and code monitors. Conelrad monitor? Bah! . . . Wayne.

Dear Wayne,

You remember that fabulous little KW mobile linear built **in-the-antenna**, with midget water-cooled Eimac final, Jennings vacuum capacitor, and midget inverter supply in the car? W6TMG, the fellow who was producing it at Yuba Dalmotor Division, has moved over to the Electro Mechanics Division of Cabral Motors, with all the goodies hamwise, and is in addition taking over production of the D. Moore SSB Transceiver and putting it out wired and tested for under $100. The rig is now called the Mark 2B, and a matching 100-watt linear is now on the planning boards. Thought you might like to know, since W6MHP was swamped with orders for this rig even without overt advertising of any kind. However the full dope will probably now appear in an ad somewhere around this end of the magazine.

Jim WA6EXU

(Power from page 50)

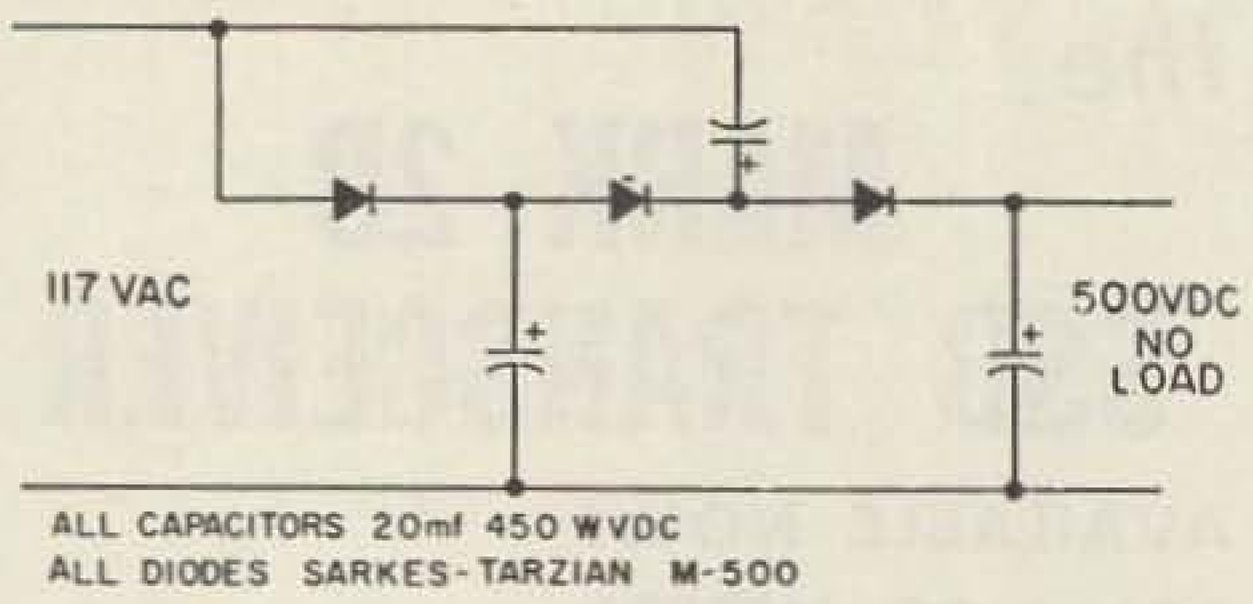


Fig. 9

bench use, high-power units to supply several items of equipment at the same time, low-ripple units for powering transistor equipment, and a host of other special-application circuits. Some of the more-interesting ones from a general-application viewpoint are described in the following paragraphs; many others are included in the bibliography at the end of this article.

Among the most-interesting circuits described in the past 5 years are the Minipacks developed by Rob Wagner, W6WGD. Delivering approximately 150 volts at up to 50 ma., they're ideal for powering a VFO or other small station accessories.

The basic circuit of the two versions of Minipack is a voltage regulator of the series-valve type using two 50B5's in parallel. The dc amplifier is a 12AX7. Filaments of these tubes are connected in a series string across the ac input. Using a neon tube as the voltage reference, output is held within 1 percent over the range from 75 to 175 volts.

One version uses a conventional center-tapped full-wave rectifier, the other a voltage doubler. Since the regulator is the heart of the circuit, it alone is shown in Fig. 8. Due to small sizes of the components, it can be built on a 2x2x5 chassis box.

Another tiny supply with a wallop is that shown in Fig. 9, adapted from a similar but larger circuit in the Handbook (1959 edition). This complete unit develops 500 volts without load and more than 300 volts at 200 ma output, yet occupies a space only 3x5x1½ inches complete. Basically, it's a half-wave tripler using medium-large capacitors. Filtering action of the three capacitors shown is adequate for normal receiver use, but for powering low-level audio stages a simple RC filter (shown in dotted lines) should be added to minimize hum.

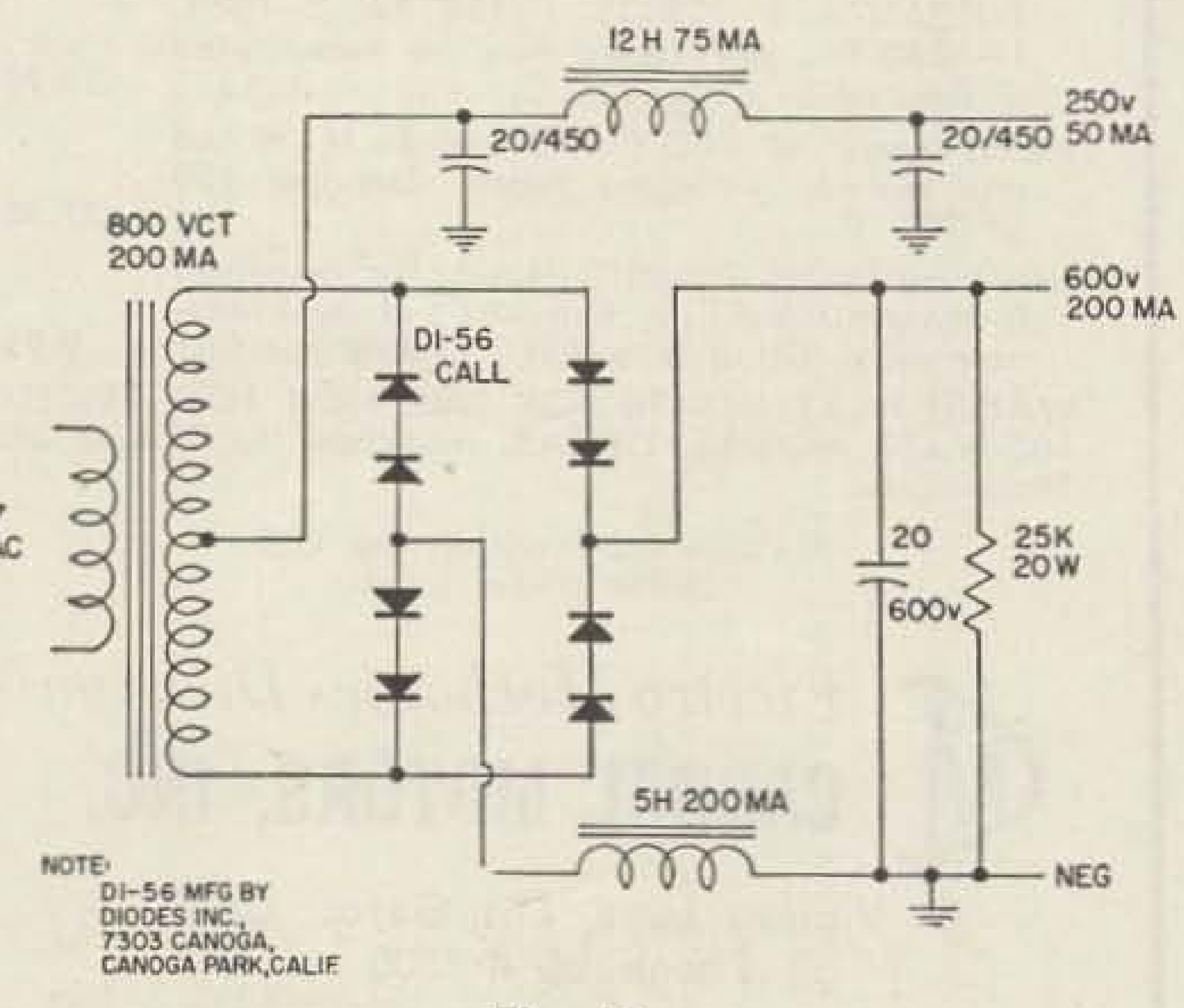


Fig. 10

With present-day silicon diodes, we can go even smaller in size. The circuit of Fig. 10 was originally described in GE Ham News, and adaptations of it have appeared in several publications since. It's basically a normal bridge-type rectifier using miniature silicon units (less than ⅛ inch in diameter and ¼ inch long) instead of vacuum diodes or more-conventional selenium rectifiers.

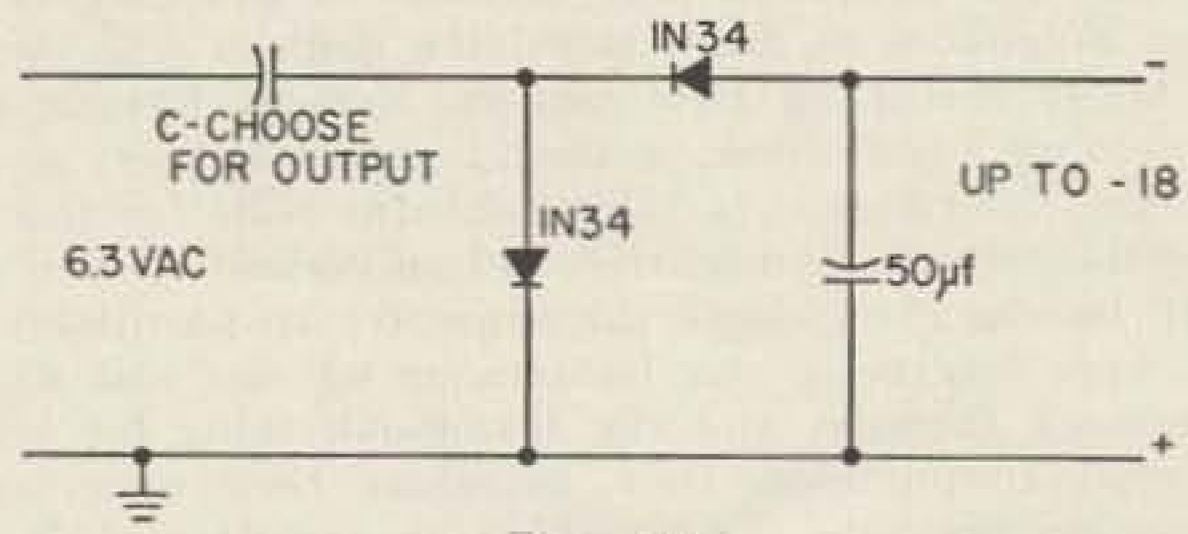


Fig. 11

Many of the newer receiver circuits require a bias voltage, which is seldom provided by an existing set's power supply circuits. Since this bias voltage is usually supplied at low current, hefty savings can be made by using inexpensive 1N34-type diodes in voltage-multiplier arrangements off the 6.3-volt filament line, a la Fig. 11.

If bias requirements are less than —9 volts, the shunt diode bias supply shown in Fig. 12 may be added easily to any receiver. It was originally described in the Radiotron Designer's Handbook for use with a vacuum diode, and has been converted here to use a semiconductor instead. Any semiconductor diode is satisfactory.

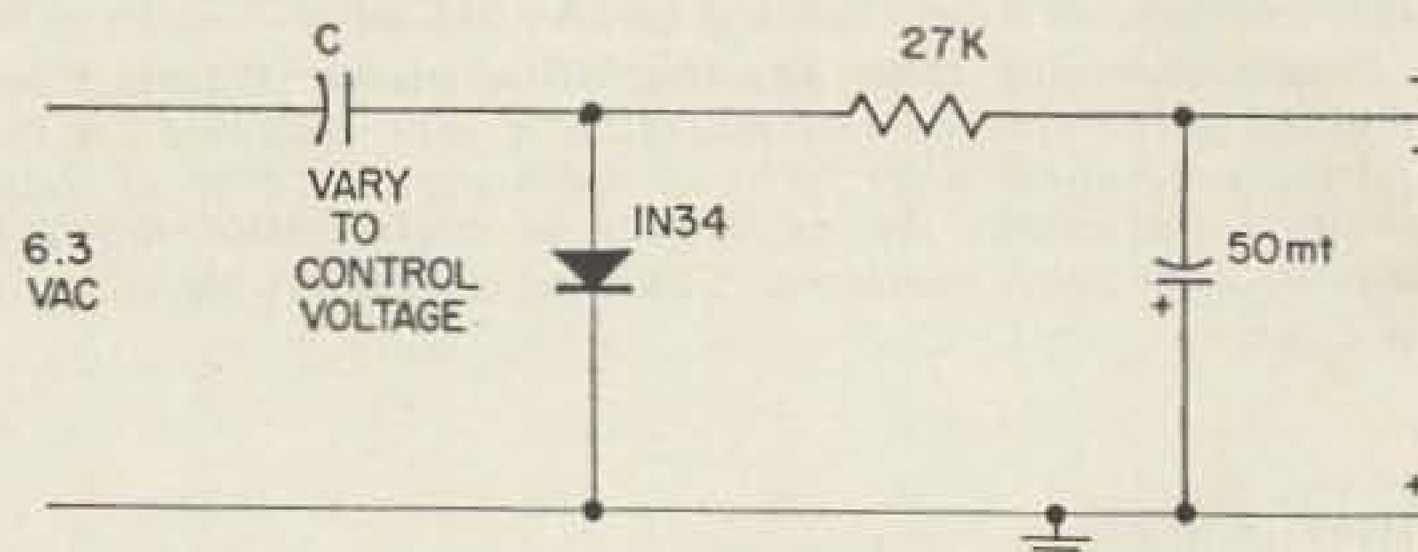


Fig. 12

Especially for experimentation, it's frequently nice to have a power supply on the bench which has continuously variable output. While this can be achieved either by using a hefty rheostat in a conventional voltage divider or by using an active-regulator circuit, an English circuit developed by A. H. B. Walker and described eight years ago by William Creviston in Radio & Television News offers a simpler approach.

The basic circuit uses audio power output

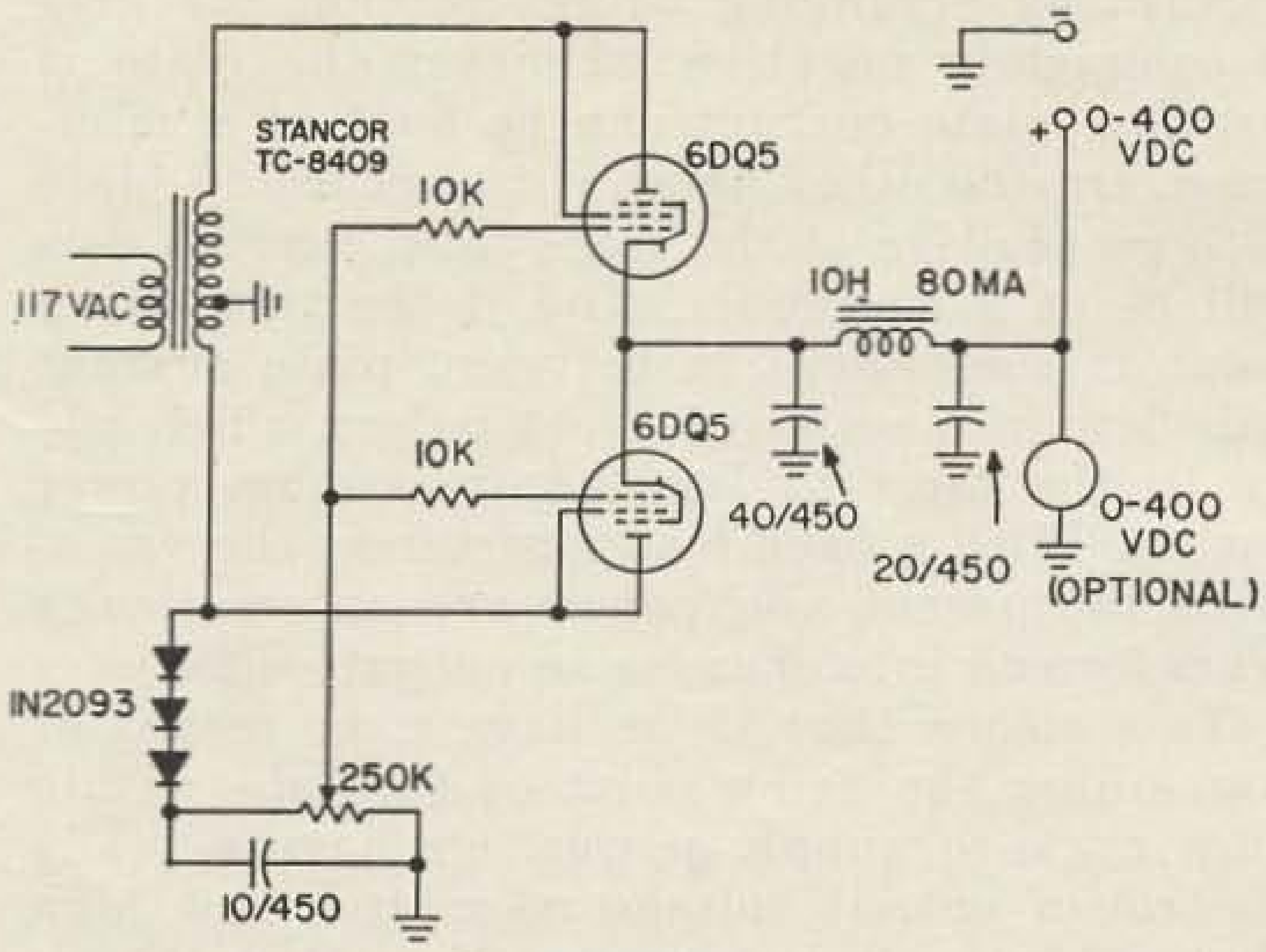


Fig. 13

type as rectifiers in a conventional center-tapped full-wave circuit. However, the grids of these tubes are returned to a variable bias source which is controlled from the front panel. Output voltage cannot be greater than grid voltage, and as a result the low-power bias supply controls the much greater output power of the main unit.

As shown in Fig. 13, the circuit has been adapted to use the high-perveance TV horizontal-output tubes which didn't exist when the circuit was developed. With constants as shown, output ranges from 0 to 300 volts at up to 250 ma. All parts values are uncritical, as are tube types.

A similar type of variable-voltage power supply, widely described, makes use of a type of rectifier we haven't yet discussed—the gas diode. Actually, in the variable-voltage design, a gas triode is used instead of the diode, but before we examine the circuit, let's detour a bit and compare gas rectifiers to the more-ordinary type.

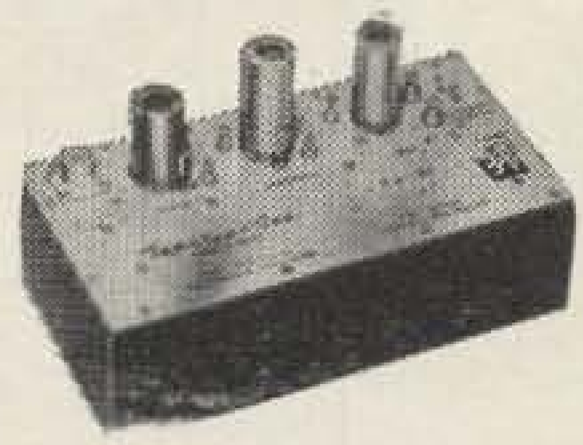
The most common type of gas diode is the familiar mercury-vapor tube, such as the 866 for high voltage or the old type 83 for lower-power applications. They're distinguished in operation by a fluorescent blue glow inside the tube.

Principles of operation of the mercury-vapor tube are similar to those of a vacuum diode in many ways; electrons are emitted from the hot cathode, and are attracted to the plate only when the plate is positive. However, the M-V tube is filled with gas, and as the electrons move through the gas they ionize it.

The positive ions produced as a result nullify all space-charge effects, which in a vacuum diode limit the amount of current available. The "plasma" in a M-V tube or other gas diode is actually a near-perfect conductor so long as the gas is ionized.

Because of this near-perfect conduction, the voltage drop in an M-V tube is much lower than that in a comparable vacuum diode. However, this advantage carries a built-in disad-

(Turn to page 54)



(Power from page 53)

vantage, similar to one requirement for semiconductor rectifiers: a current-limiting resistor is a must when using an M-V rectifier. Otherwise, the tube may run away with itself and be destroyed.

In addition, operating temperatures are more critical, since both the ionization and the allowable reverse voltage are determined by gas pressure within the tube, which in turn is determined by the tube's temperature.

In summary, the M-V diode offers lower voltage drop and higher current capacity than does a comparable vacuum diode. It can also be built with higher reverse-voltage ratings, and for this reason is popular in high-power circuitry.

With the gas diode sketched in, let's look at the gas triode—or to give it its more common name, the thyratron.

A few paragraphs back we mentioned that the gas in an M-V tube is ionized by motion of electrons through it. It follows naturally that if no electrons are allowed to flow, no ionization can occur, and the conducting "plasma" won't be formed.

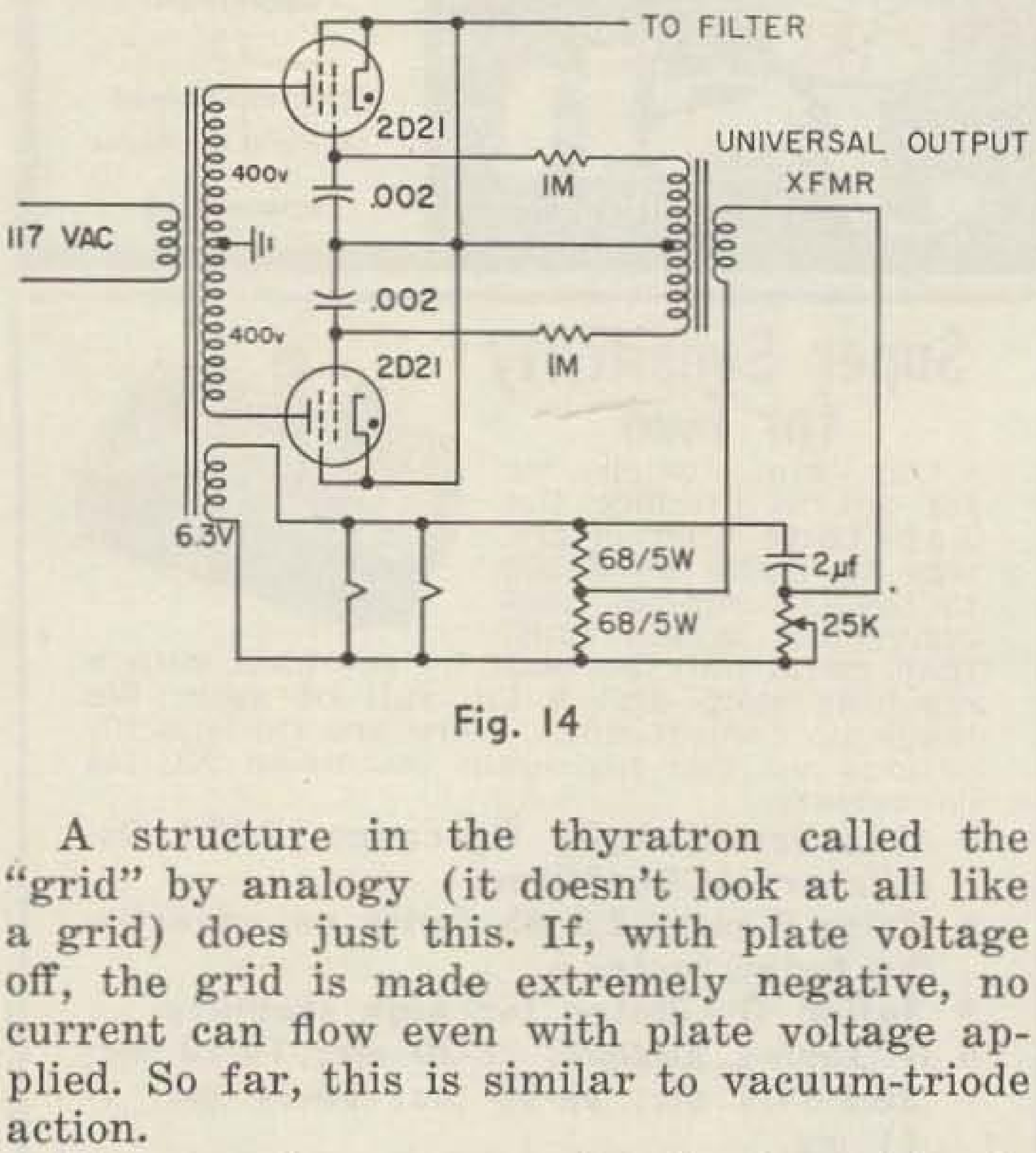


Fig. 14

A structure in the thyratron called the "grid" by analogy (it doesn't look at all like a grid) does just this. If, with plate voltage off, the grid is made extremely negative, no current can flow even with plate voltage applied. So far, this is similar to vacuum-triode action.

However, in a vacuum triode, the grid acts something like the handle on a valve; plate current can be turned on, then can be controlled in intensity, and finally can even be turned off again, all by the grid's action.

In a thyratron, the grid is more like an explosive charge. It can be fired to "blast loose" ions and initiate an avalanche of plate current, but once it has been fired it loses all control until plate current is once again turned off externally.

This might seem useless were it not that plate current in a rectifier tube is turned off externally at least 60 times every second, whenever the ac supply goes negative. This restores control to the grid at the same rate.

Now, by arranging things so that the grid is completely negative whenever the plate is positive, plate current can be kept at a minimum. On the other hand, if the grid and plate both go positive at the same time, current flow will be at a maximum. And if the tube firing point is somewhere in between, plate current will flow in a series of short pulses which add up in the filter to less-than-maximum power output. With a fixed load resistance, the variations in current and power are automatically transformed into changes in output voltage.

This means that if we have some means of controlling the firing point of the tube within each cycle of supply power, we have a ready control of output voltage no matter how high that output voltage may be. Note that there's no regulation; simple control is the only thing we're gaining here.

One way to accomplish our end is to vary the relative phase of grid and plate voltages by an adjustable phase-shift network supplying the grid voltage. That's the way it's usually done. The phase-shift network is composed of the capacitor and variable resistor in the primary of the grid-power transformer, T2, in the circuit of Fig. 14.

If you like to experiment, you might blend this circuit and the active regulator of Fig. 3 together by using the DC amplifier output of the regulator to control resistance of a vacuum tube, which would in turn replace the variable resistor of Fig. 14. Such a circuit might extend regulated-supply operation into the high-power classification at minimum expenses—and it might cost you a power supply. It hasn't been tried to our knowledge, and is mentioned here only as a suggestion to the experimenter.

So far, we've talked only of power supplies which convert electrical input power into electrical output power having different characteristics. Naturally, batteries, solar cells, and the like can also be considered as "power supplies" but have been deliberately omitted from the discussion. However, before closing we want to describe a unique power supply which might be classed as a "vacuum thermocouple," a special form of vacuum rectifier, or maybe just a useful oddity.

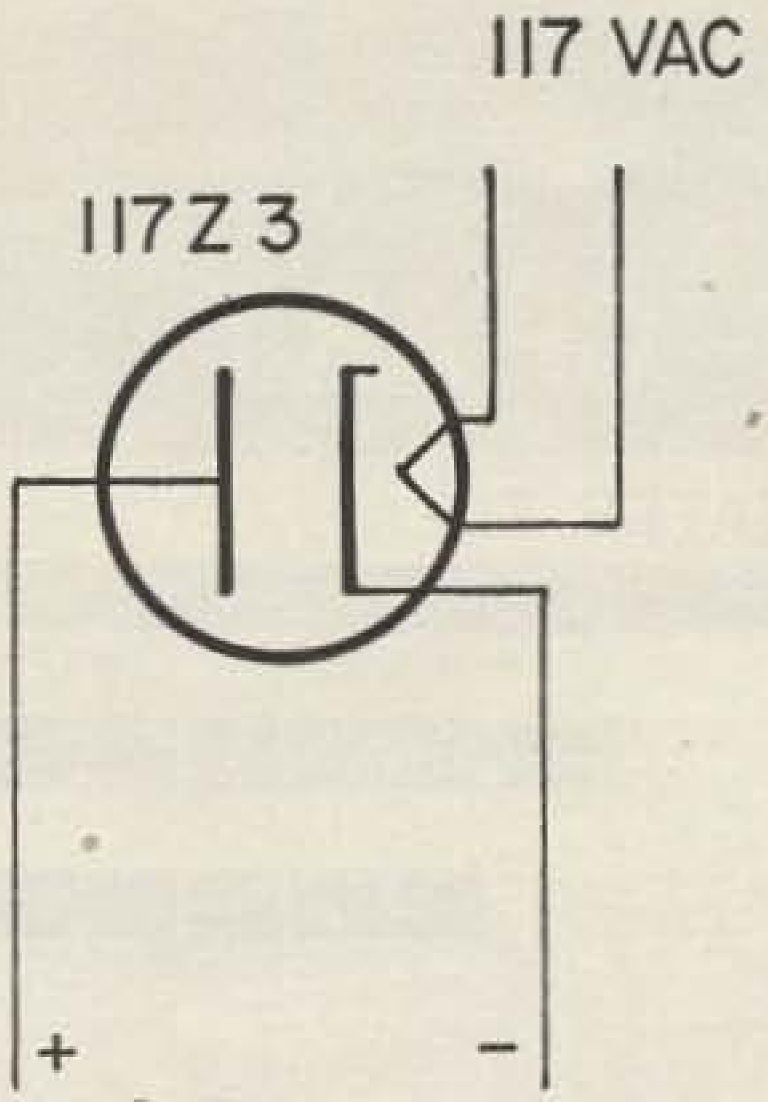
This is the contact-potential supply developed and described by Hubbard in several articles over the years. A typical circuit for such a supply is shown in Fig. 15.

This may look a bit odd to anyone familiar with conventional power supply circuits, but we can verify that it works. Here's what happens:

When the rectifier cathode is heated, electrons boil off and form a space charge surrounding the cathode. Even with no potential applied to the plate originally, a few of the electrons punch through the space charge and reach the plate.

With the plate open-circuited, the few elec-

Fig. 15



trons which punch through have no place to go and the plate is almost immediately made too negative to accept more. However, if a high-resistance load is connected from plate to cathode, the high-pressure electrons can flow through the load back to the cathode.

Output is as close to pure dc as you can get, since it is unaffected by power-supply frequency. While it's true that power is almost microscopic (less than a volt at one ma for most tubes) it's plenty to operate transistors, and will even power a vacuum-tube oscillator to several microwatts output at audio and low radio frequencies. Certainly no simpler supply for low-voltage transistor projects can be made; using a 117-volt tube means that all you need is the tube, a socket, and a line cord; no filter or other circuitry is required.

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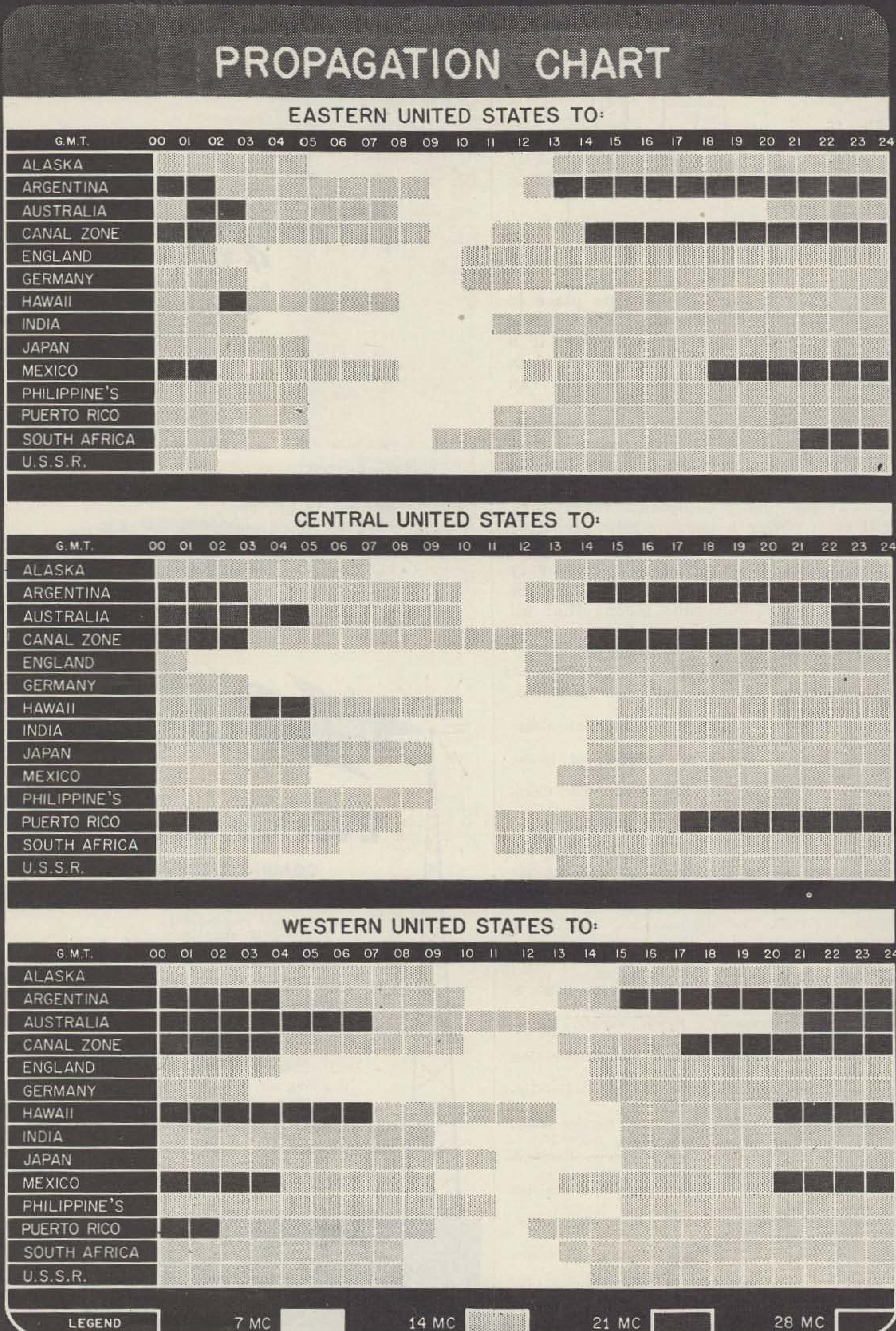

PROPAGATION CHART
EASTERN UNITED STATES TO:
CENTRAL UNITED STATES TO:
WESTERN UNITED STATES TO:
G.M.T.
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
ALASKA
ARGENTINA
AUSTRALIA
CANAL ZONE
ENGLAND
GERMANY
HAWAII
INDIA
JAPAN
MEXICO
PHILIPPINE'S
PUERTO RICO
SOUTH AFRICA
U.S.S.R.
LEGEND
7 MC
14 MC
21 MC
28 MC

Propagation Charts

David A. Brown K2IGY
30 Lambert Avenue
Farmingdale, N. Y.

The bands listed are MUF's and a higher band will not work for the time period listed. Lower bands will work, but not nearly as well. Times are GMT, not local time.

These charts are to be used as a guide to ham band openings for the month of July, 1961 to the various countries listed. I will be interested to hear of your results in using these charts and to know what other areas you might wish included in future charts.

Advanced Forecast: July 1961

Good 1-3, 7-19, 26-31

Fair 4-6, 20-25

Bad None

Zero Center Meter For RTTY

Most ham junk boxes contain a few meters, but if you are a newcomer to RTTY they are not likely to have a zero center. Before you rush out and "pay the shot," or look for one in surplus, do a little reconnaissance inside those that you have and you may discover that you can adjust one to have a zero center.

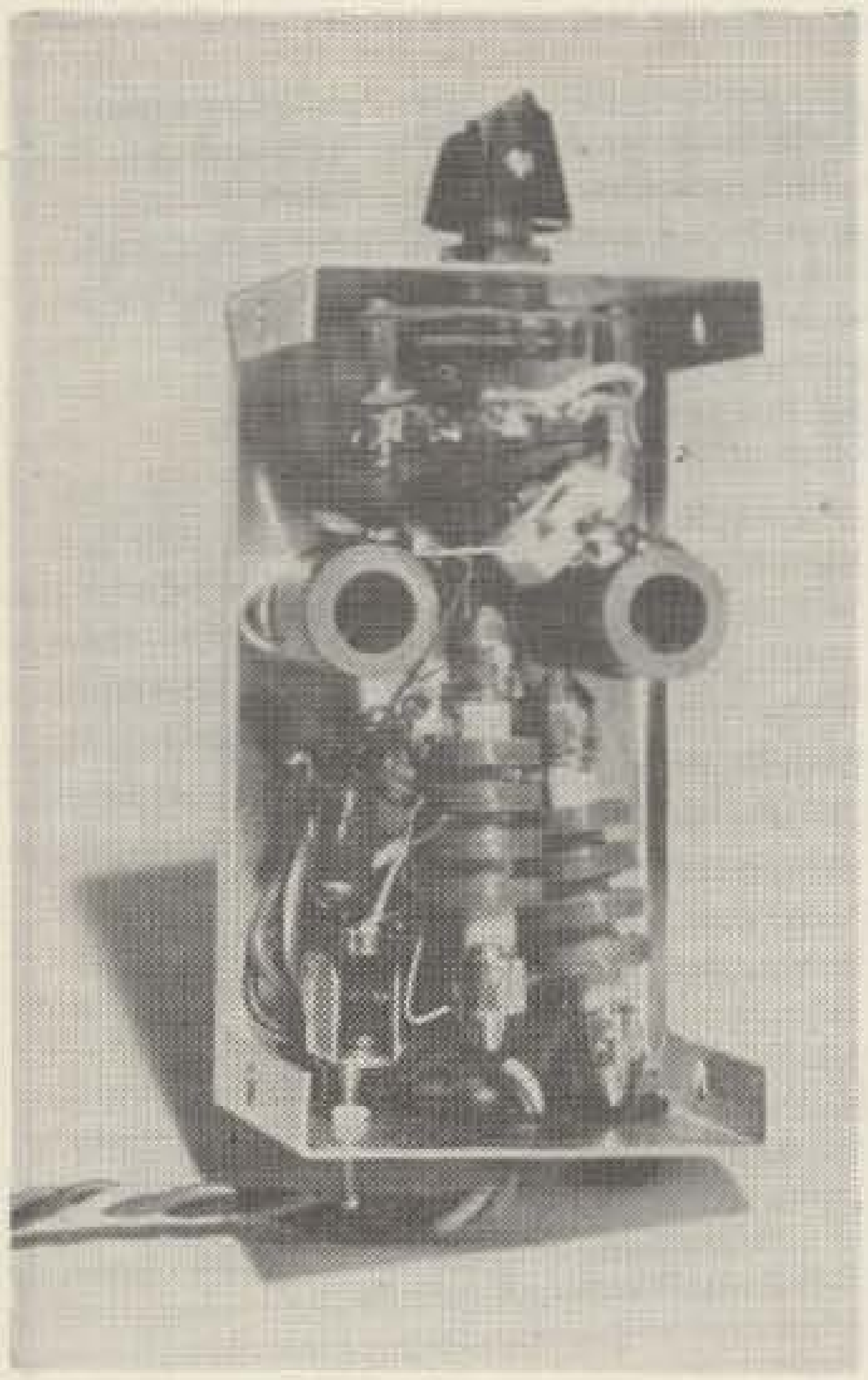
Meters usually have a lever, actuated by a screw on the face of the meter, to set the needle to its usual spot at zero. This lever does not have enough range to put the needle up to center scale. However on the opposite end of the needle shaft there is another lever, the one to which the needle return coil spring is attached. If this lever can be moved carefully to the left without interfering with the rest of the works, the needle will move upscale to the desired center spot.

Remove the scale, turn it over and spray with several coats of white lacquer, and let it dry thoroughly. Now with a drafting compass and India ink, draw a heavy arc which is the same length as the original meter scale. At the center of the arc draw a short vertical line to represent the meter zero.

The meter may now be reassembled, and the regular zero adjusting screw used to put the needle right on center. The meter action may be checked by setting up a series circuit with a rheostat and a flashlight battery. The needle should deflect an equal amount in each direction when the polarity is reversed.

An old Jewell meter as well as a surplus British O-.5 amp thermocouple meter (basic O-5 ma movement) responded to this treatment. Remember that most meters, despite what it says on their scales, are basically milliameters and are fair game. Several Weston meters that we looked into defied adjustment, but then, one really shouldn't tamper with the family heirlooms.

For use with an RTTY converter, it is not necessary to calibrate the scale, however the meter should be properly shunted to read full scale in either direction when the desired current is flowing. . . . W2BZN



Band Edge Marker

A. DePascale KINFE
125 Queen Street
Bristol, Connecticut

How many times have you said, "I think I'll save this piece of junk; some day I may have use for it!" I certainly have and I've got a cellar full of stuff to prove it!

Several weeks ago, in the box marked miscellaneous, I found an old 3500 kc crystal which had been removed from a BC-696 Command transmitter. The crystal is housed in a tube-like enclosure, and is mounted on a standard octal plug base. Then it hit me! Why not use this crystal for a simple band-edge marker. Harmonics of a 3.5 mc crystal are conveniently located at 7, 14, 21, and 28 mc—how nice!

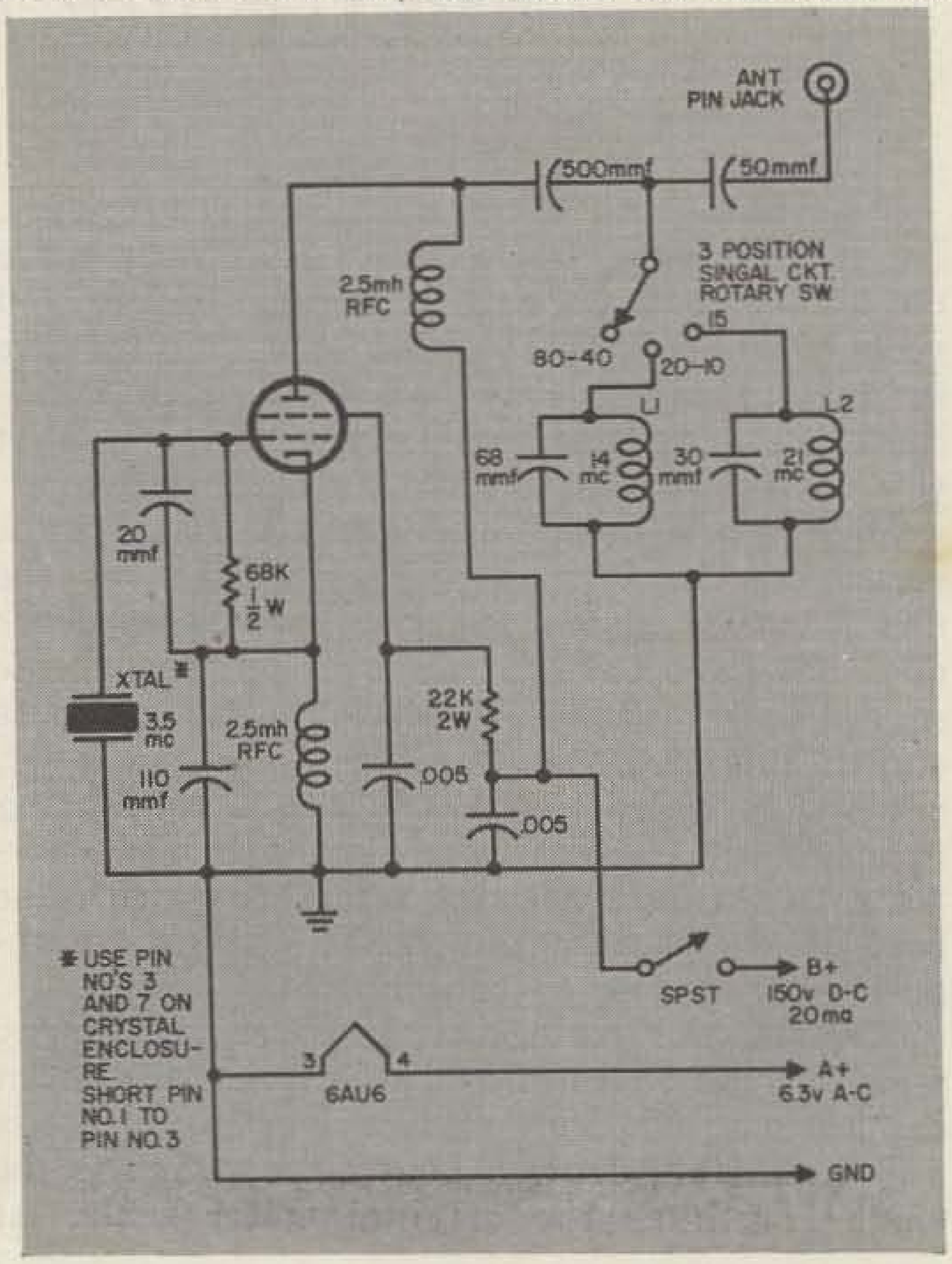
Now, refer to the circuit diagram, the photographs, and the parts list. A 6AU6 was used as the oscillator tube in my particular unit, but almost any screen-grid pentode of this type should work satisfactorily. A Mini-Box was used to house the components, and the parts layout is not critical. The slug-tuned coil forms were stolen from an old TV set and rewound for 14 and 21 mc with the help of a grid-dipper. The fundamental frequency and the second harmonic of the oscillator are strong enough so that tuned plate circuits are not necessary on 80 and 40 meters. LI is tuned for 14 mc, and the band switch should be in this position when using the unit on 20 and 10 meters. L2 is tuned for 21 mc, and the band switch should be in this position when using the unit on 15 meters. With the band switch in the first position (80 and 40 meters), harmonics of the fundamental frequency *will* be heard on all bands, but they are rather weak on 20, 15, and 10 meters. For this reason, tuned plate circuits are switched in for operation on the higher frequencies.

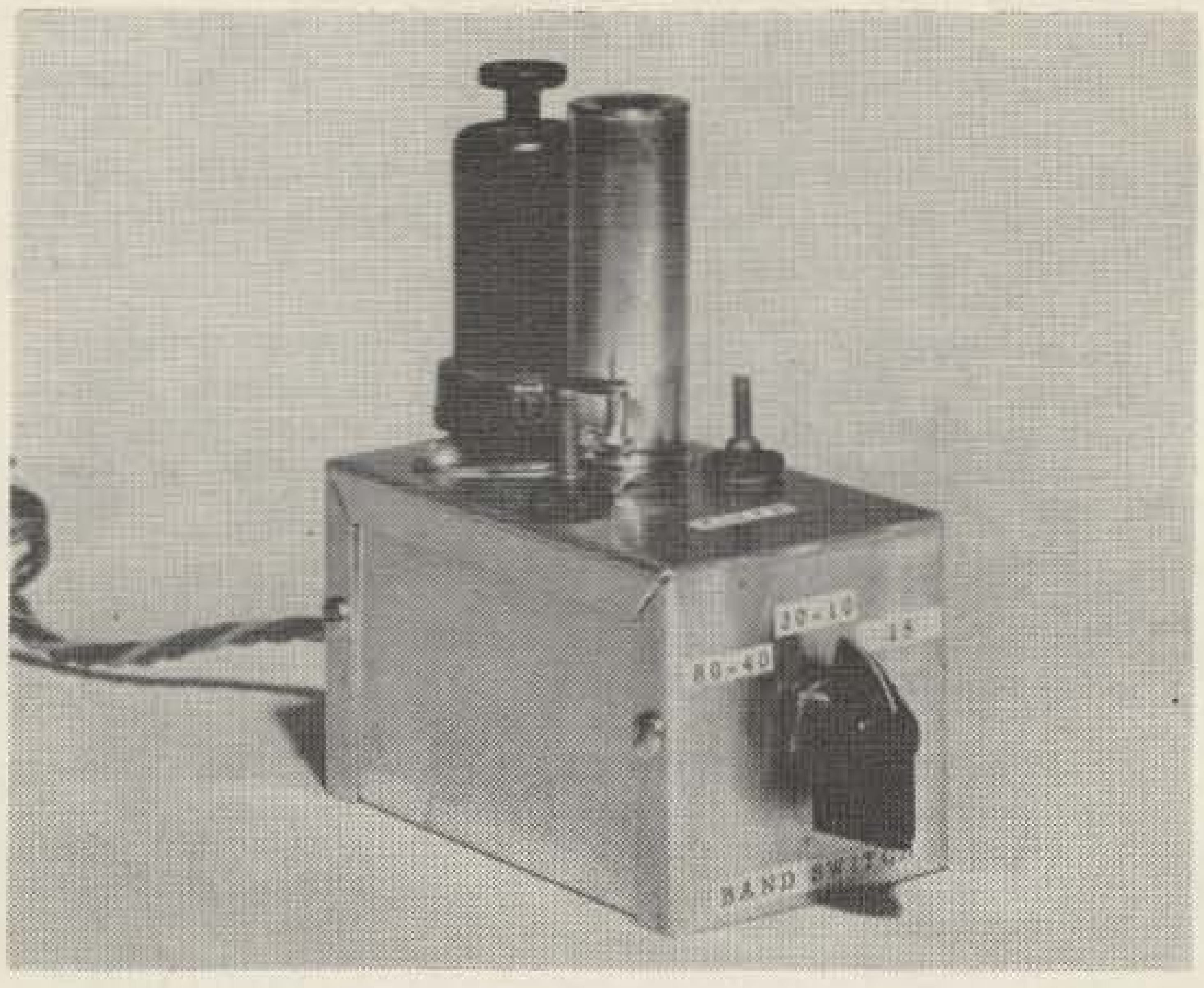
During the construction of the unit be sure to short pins 1 and 3 on the octal crystal socket. This will allow the unit to be used for testing crystals that have a standard FT-243 base.

Operation

The unit requires about 150 v dc at 20 ma, and 6.3 v ac at 300 ma. Most communications receivers will supply the necessary additional power for the unit. Many of the receivers on the market have an accessory socket to which the unit can be connected.

With power applied to the unit, and a piece of wire in the antenna pin jack, set the receiver dial to 3.5 mc, and move the band switch





to the 80-40 meter position. The oscillator signal should be heard in the receiver (don't forget to turn on the BFO). Tune the receiver to 14 mc, move the band switch to the 20-10 meter position, and adjust L1 for the loudest beat note in the receiver, or turn the BFO off and use the receiver S-meter and tune L1 for maximum deflection. Tune the receiver to 21 mc, move the band switch to the 15 meter position, and adjust L2 for maximum S-meter deflection (or loudest beat note). If the oscillator signal appears to be weak, add a few inches to the oscillator antenna, or wrap the oscillator antenna around the receiver antenna lead (use insulated wire).

Of course, you dont' have to use a Command set crystal in this unit. Any 3.5 mc crystal will work just as well. With a collection of parts on the table it only took me one evening to build this unit, and it certainly is a worthwhile (and inexpensive) addition to any amateur station.

Parts List

- 1—Mini Box, 2¼"x2¼"x4"
- 1—Octal Socket
- 1—7 Pin Min. Socket (Shielded)
- 1—3 Term. Mounting Strip
- 1—Pin Jack
- 1—½" Rubber Grommet
- 1—SPST Toggle Switch
- 1—3 Pos. Single Pole Rotary
- 1—20 mmfd 100 v dc
- 1—110 mmfd 100 v dc
- 2—.005 mfd 300 v dc
- 1—50 mmfd 300 v dc
- 1—500 mmfd 300 v dc
- 1—68 mmfd 300 v dc
- 1—25 mmfd 300 v dc
- 1—68K, ½ Watt
- 1—22K, 2 Watt
- 2—2.5 mh rf Choke
- 1—6AU6 Tube
- 2—½" Slug Tuned Coil Form
- 1—3500 kc Crystal
- 1'—#16 Enamel Covered Wire
- L1—12T #16 enam. close wound
- L2—7T #16 enam. close wound

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Few DX operators can afford to buy a Callbook. If you have one that is less than three years old that you would like to send to a DX ham then drop a card to Cliff Evans K6BX and he will send you a letter from a DX ham that would like to have your Callbook. K6BX, Box 385, Bonita, California. We think this is a wonderful service and extend our best regards to Cliff for his work.

Radio Bookshop

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If you don't order at least one of these specially selected books this month you are going to feel awful. This will be the combined result of your realizing that you've let another month of your life go by without improving your reference shelf and the guilt, shared with all other 73 readers, for reducing the Bookshop personnel to near starvation. This is such a humanitarian gesture all the way round that it should be tax deductible.

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86—

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(W2NSD from page 6)

If you are much of a short-wave listener you have a rough idea of what the results of this program would probably be: an exposure of the shameful waste of frequencies that is the result of our present allocation system. There are thousands of transmitters on the air day after day just holding down channels or running up log time to prove the need for the frequency. There are hundreds more devoted to jamming attempts at international broadcasting. The wastage is incredible. Can anyone say with a straight face that the solution to this is to take frequencies away from the amateur and turn them over to commercial or government use? Bah!

With some facts and figures we might be able to bring some sanity into this jumble. If you don't like this suggestion, then how about you're thinking up something better? I recognize that many government groups will be against this idea . . . they are in the middle of a terrible situation and are trying to live with it on the present system of allocation . . . ditto commercial groups. Though everyone would gain in the long run from an investigation of the actual traffic use of the short waves, everyone but the amateurs would be faced with the facts and figures on their folly and the pressure would be on to solve this enormous waste. It is always easier to take temporary expedients than to make overall changes, so we can expect vigorous resistance to anything we propose from many quarters.

If nothing else, this is something to think about and maybe give an airing on a roundtable. Give the weather a rest.

Pay Our Way?

The WA2 calls have been unwinding at quite a rate as ham radio expands into every corner of New York and New Jersey. The FCC must indeed be working full time to take care of this flood of new licensees. As the calls unwound I got to thinking more and more how desirable one of those WA2 calls would be. As a matter of fact there is one that I would trade in my well worn W2NSD to get . . . heh, heh!

So I called them just to make sure that there was no hope of getting the coveted call. There wasn't. As a matter of fact they go out of their way to make sure that fellows won't get a call that might look like favoritism. So died my hope of getting WA2YNE (the two is silent). Sigh.

While talking with them I asked about some other problems that had been bugging me . . . such as allowing fellows to take the Tech exam under FCC supervision, etc. The difficulty with this is the personnel that it would take and the costs. Which brought up the subject of our footing the bill for our own licenses. This makes sense to me, but then I would probably be a Goldwater Republican if I were interested much in politics. The present governmental system irritates me . . . too damned big with department built on department. Undoubtedly I am naive, but I firmly believe that they could send 50-75% of Washington home to honest work and maybe even get more done than they do now.

Now, while the D. C. hams are out forming a lynching party, let's mull over this fee business. As a matter of principle I believe that we should not ask non-hams to pay the costs of administration of our hobby. With a quarter of a million hams we can pay our own way. A flat fee of, say, \$3 for each application, whether it be for a new license or for renewal, should cover everything quite well.

This could be carried one step further, as with auto licenses, and a special application fee established for specially requested call letters. Many of us would like to get our initials or something like that. The fee would have to be pretty high to keep the percentage of those requesting the special licenses down to reasonable numbers. Perhaps this could be restricted to the Extra Class licensees. What do you think?

Rats, Rats, Rats, Rats

Just as my arm was tiring from patting myself on the back that the June issue came out so well in came a little note from Dave Brown saying that we had mixed the two propagation charts Ugh. Rats! I've been so busy with my head in the clouds trying to plan a super First Anniversary October Issue that I forgot to watch those printers every minute. If you look at the charts at all it is obvious that they are reversed.

Speaking of the future, I've got another little surprise up my sleeve. This is a bonus book which we are planning to send out in November. This will be an Almanac-Yearbook-Buyers' Guide. We will encourage as many manufacturers as possible to run as much information as possible on their products in order to make this a really complete Guide. We're going to try to get the cooperation of as many parts manufacturers as possible too. If you have any suggestions as to material that you think would be appropriate for this book drop me a note. . . . Wayne

Transformer Action Demonstrator

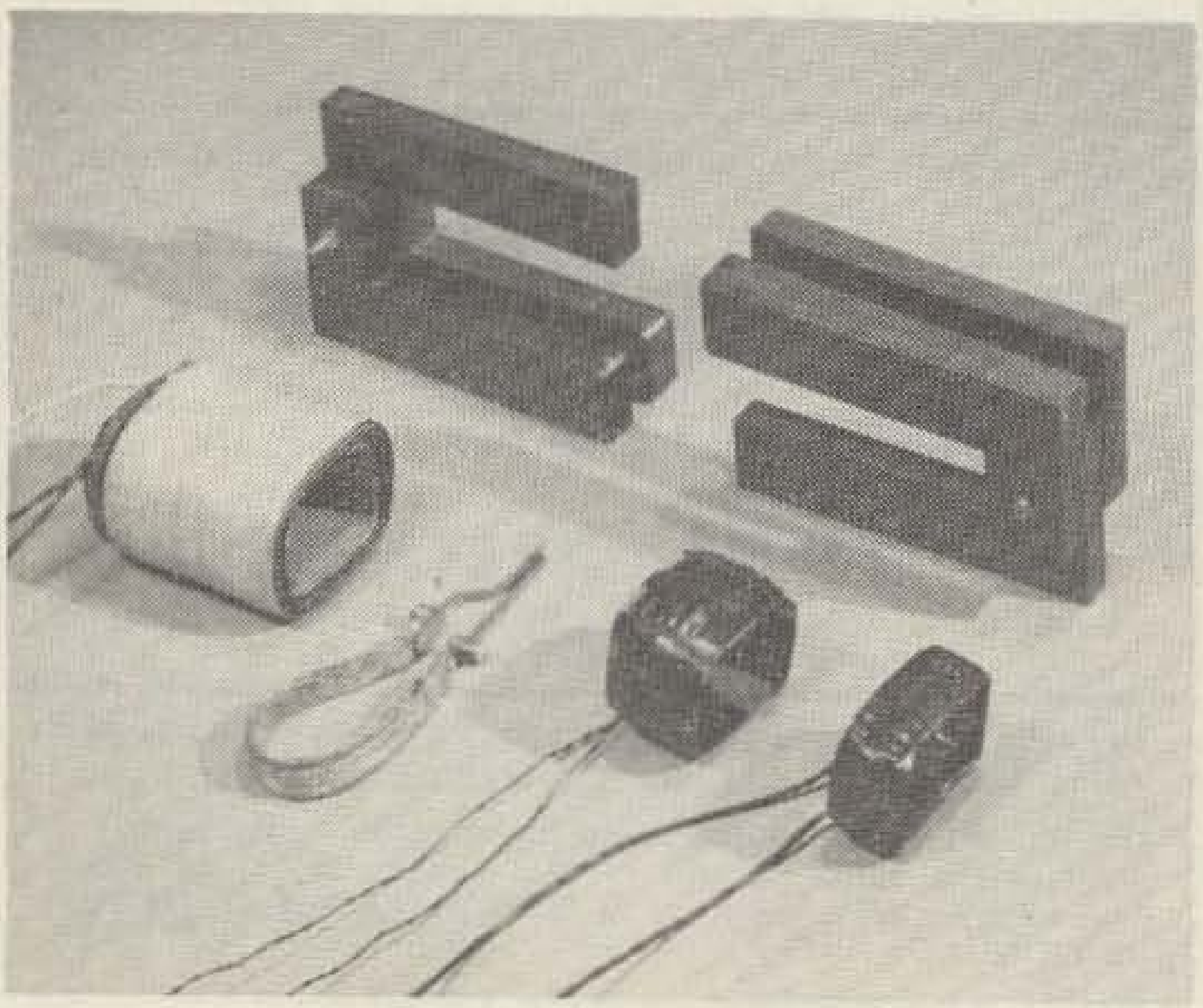
Mike Barlow W8KTJ
2827 Whitehall Road
Muskegon, Michigan

Photos were taken by K8SAF.

OUR local Radio Club, "The Muskegon Area Amateur Radio Council", has been operating a school for Novice and General class hams for a few years and we have been constantly improving our methods of instruction.

This year I came up with an idea for a physical demonstration of transformer action to give the students an idea of the parts of a transformer in operation.

As illustrated, I used the core taken from an old filament transformer. By rearranging the laminations, I was able to bolt them together in such a way as to allow quick stacking, unstacking and changing windings.



I wanted to use one turn per volt for the primary (for ease of calculation), but due to the core being inefficient with this kind of assembly I had to use two turns per volt.

I put a tap at 115 turns to demonstrate auto transformer action using only the primary.

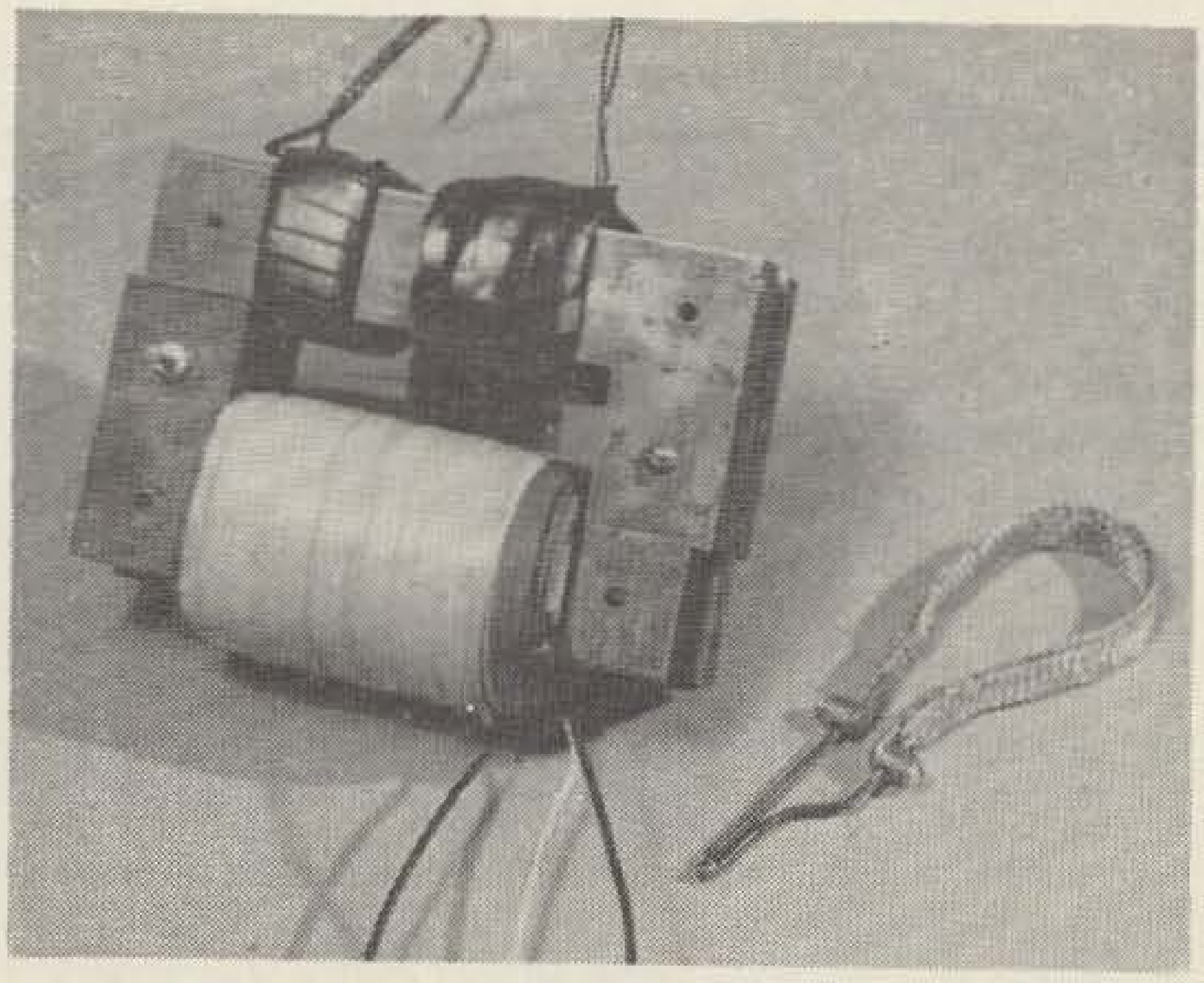
I wound two secondaries, one with 10 turns for 5 volts, and one with 20 turns for 10 volts. Then, to demonstrate the action of the transformer in a soldering gun, I took two pieces of ⅝" wide copper braid and put them in parallel across a soldering gun tip as shown in the photo. When the primary is energized, the tip actually heats quicker than a soldering gun.

I can demonstrate excess current drawn by the primary due to the core being too small, by not having the demonstration core fully meshed, turning up the Powerstat and watching the primary amps increase until the primary fuse blows.

The unit is built in a TV serviceman's tube caddy.

I used a Powerstat to control the primary voltage, which is indicated by a 0-150 volt ac meter.

In the lid of the case I mounted a 7" x 7" x 2" chassis which serves as a panel for the 3 meters. The 150 volt meter is for primary voltage, a 10 amp meter is for primary current and a 0-25 volt meter is connected across two binding posts in the control panel to which the various secondaries are connected during the demonstration.



I also use a single turn of #6 solid wire with a 15 amp fuse link inserted to demonstrate the currents which can circulate in a shorted turn.

After the demonstration and talk are given I ask one of the students to come up and make a winding from a spool of #20 wire which I carry in the case, calculating beforehand what voltage it will produce.

All of the windings are made of #20 enameled wire, wound on a wood block of a size which will enable them to slip easily on the core.

Just so the photo won't confuse you I will add that there are 3 extra binding posts on the panel for future uses. There is also a receptacle in the panel which is controlled by the Powerstat for the control of future demonstrations which might be plugged into it.

The photos are self explanatory and I hope some other club will be able to make use of this idea as it has been a great help in teaching transformer theory for us. . . . W8KTJ

(Frequency from page 43)

to one ratio is obtained with the beat difference at 5 kc, the final possible error, assuming again the oscillator error does not exceed 0.5%, will be 0.0007%, or 25 cycles. This is close enough for almost all purposes, and well within the specified FCC tolerances.

If higher accuracy is desired, a calibrator using multivibrators for a beat of 5 kc or less can be built. An internal mixer and audio amplifier allows accurate interpolation, and the total accuracy is increased to a minimum of 0.0007%. Usually the error will be much less than this, especially since the audio oscillator can be calibrated to better than 0.1% for this purpose.

Other Ham Publications

In lieu of half of the magazine being filled with specialized departments, we recommend that you subscribe to the bulletin of your special interest. You get a lot more news and get it faster this way . . . and you encourage the fellows who are putting out these bulletins.

WESTERN RADIO AMATEUR. Don Williamson W6JRE, 10517 Haverly Street, El Monte, California. Monthly. Subs are $2 per year, $3.50 for two years, $5 for three years. Operating news of west coast activity, columns on DX, SSB, YL, and some articles. 48 pages.

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HAM-SWAP. Published by Ham-Swap, Inc., 35 East Wacker Drive, Chicago 1, Illinois. Editor is Ed Shuey, K9BDK. Subs are $1 per year by 3rd class mail, $3 for 1st class, $5 airmail, and $7.20 special delivery. Published once a month. Contains classified ads entirely. This is your best bet for an inexpensive way to sell or swap some gear in a hurry. Within two weeks people are answering your ad.

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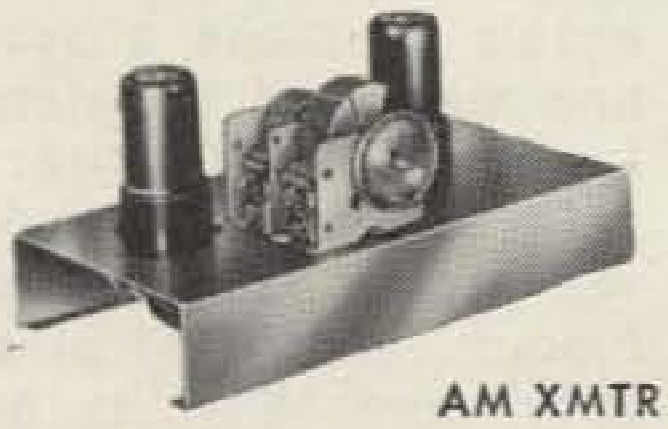

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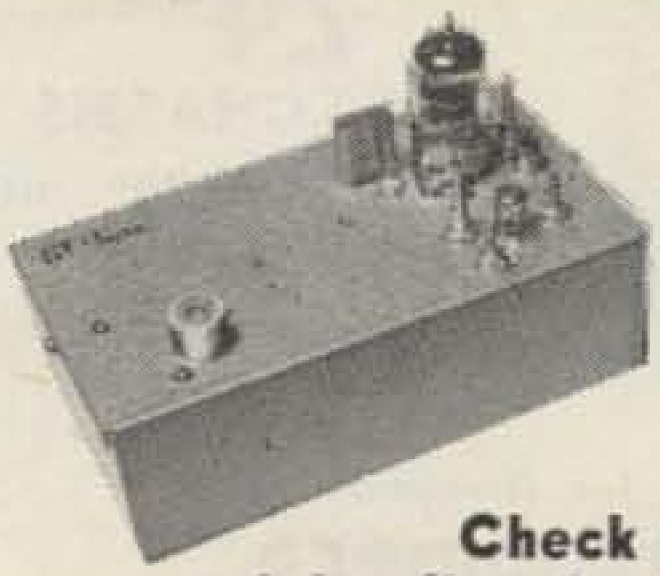

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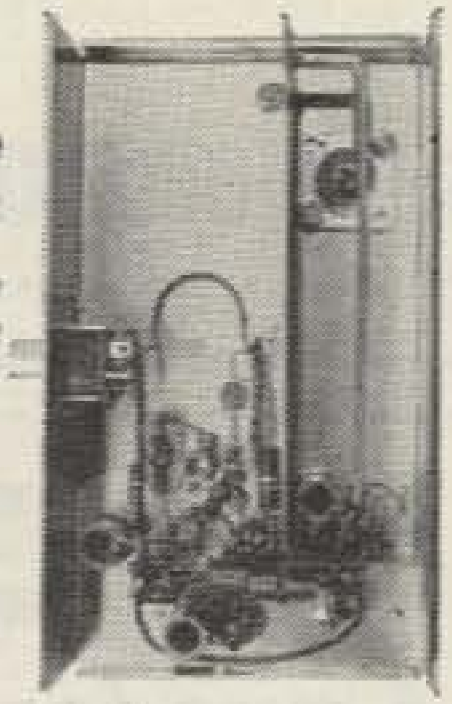

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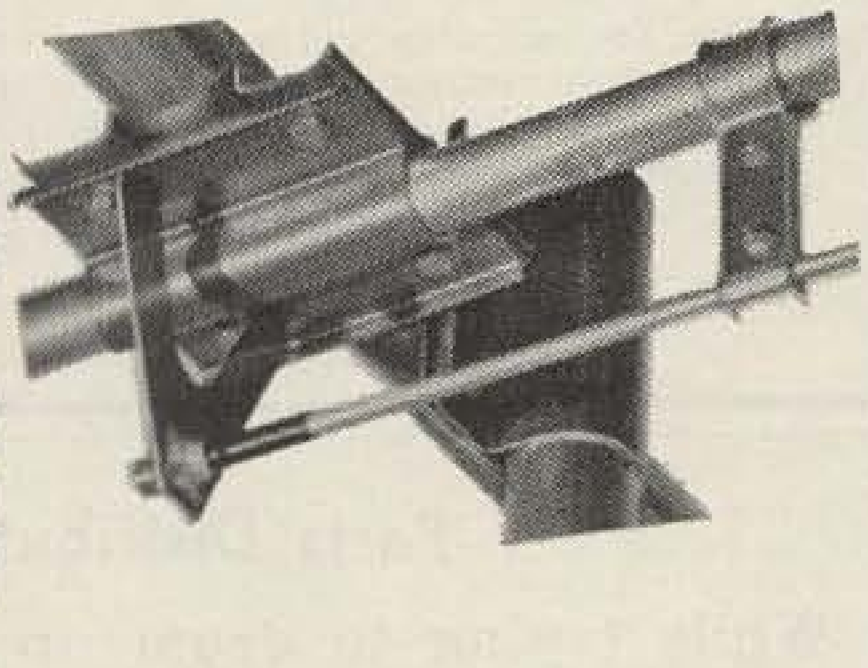

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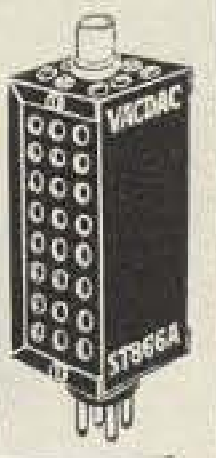
Even so there are hundreds of parts distributors who are not yet handling 73. You can add your 2¢ to the cause by letting me know the name and address of any such delinquent distributor and perhaps needling him a bit so he will be receptive when I send him the details. Look for 73 the next time you are out buying parts.

I'm particularly anxious to keep our circulation increasing as fast as possible so we can pass the 50,000 mark this fall and swing into second place in circulation. . . . Wayne

Advertisers Index

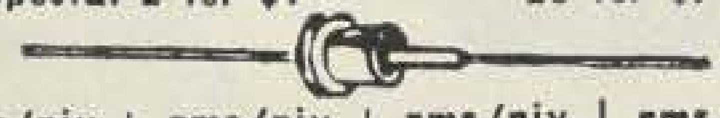
NEW "VACDAC"® SILICON TUBE REPLACEMENTS WITH BUILT IN RF SURGE & SERIES BALANCING PROTECTION



TYPE	VRMS/PIV	AMPS	PRICE
ST866	5000/10400	0.3	$20.00
ST816	5000/7000	0.3	$16.00
ST5R4	1900/2800	0.5	$15.00
ST5U4	1120/1600	0.6	$ 8.00

SILICON DIODES 750MA* TOP HATS

General Purpose Special 2 for $1 — 400 PIV at 300 MA 20 for $7



rms/piv 17/25 14¢	rms/piv 35/50 19¢	rms/piv 70/100 29¢	rms/piv 140/200 34¢
rms/piv 210/300 43¢	rms/piv 280/400 55¢	rms/piv 350/500 70¢	rms/piv 420/600 $1.00
rms/piv 490/700 $1.25	rms/piv 560/800 $1.50	rms/piv 630/900 $1.70	rms/piv 700/1000 $2.00

Low Priced ★ T200 SILICON DIODES rated 380piv/266rms @ 200Ma @ 100°C 36¢ each; 10 for $3.25; 100 for $27;

*CAPACITOR INPUT DERATE 20%:
($5 or more this item we pay P.P./U.S.A.)

SPECIAL! TRANSISTORS & DIODES!!!

Factory Tested & Guaranteed!
FULL LENGTH LEADS

2N123 PNP 45¢, 12 for $5, 100/$37
2N292 NPN 45¢, 12 for $5, 100/$37
2N293 NPN 45¢, 12 for $5, 100/$37
2N223 PNP 80¢ ....100/$65
2N597 PNP $1.90 ....6/$10
2N598 PNP $1.90 ....6/$10
2N599 PNP $3.50 ....3/$10

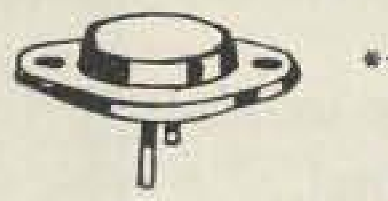
"SUNTAB"® SELENIUM PHOTOCELL

2BP 75μa ¾x⅝" ¢40@, 11 for $4
5AP 1" Dia., 5BP/Sq & Rect 220μa, ¢55
15AP 750μa, 1¾" Dia. $1.45@, 4 for $5
10BP 350μa, 1-11/16" Rect. ¢75@, 10 for $7
10CP 750μa. 1⅞x1⅜" ¢1.45@, 4 for $5

Each "TAB" Kit Contains The Finest Selection!!!!

- Kit 35 Precision Resistors
- Kit 10 Switches
- Kit 75 Resistors ½/1&2W
- Kit 12 Electrolytic Cond's
- Kit 15 Volume Controls
- Kit 56 Tube Sockets
- Kit 65 Tubular Condensers
- Kit 500 Lugs & Eyelets
- Kit 10 Bathtub Oil Cond's
- Kit 5 lbs. Surprise Package
- Kit 10 Transmit Mica Cond's
- Kit Glyptal & Cement
- Kit 3 Phone/Patch Xfmrs
- Kit 4 AN/Reflector Lites
- Kit 6 Insltd Tuning Tools
- Kit 4 "Suncells" Asstd.
- Kit 5 Sub-Min Tubes
- Kit 75 Mica Condensers
- Kit 8 Crystal Diodes
- Kit 200ft Hook Up Wire
- 4 Rolls, 50ft/ea. Asstd. Color
- Kit 100 Ceramic Condensers
- Kit 5 FT243 Xtal Holders
- Kit 5 Microswitches
- Kit 8 Xtal Osc-Blanks
- Kit 4 Asstd Rectifiers
- Kit 5 UG/Connectors
- Kit 100 Self/Tap Screws
- Kit 4 Selenium "Suncells"
- Kit Adj Wire Striper & Cut
- Kit Hi Gain Xtal Mike
- Kit 6 ea Phonoplugs & Jacks
- Kit 2 pair S0239 & PL59
- Kit 12 Binding Posts Asstd

Order Ten Kits—We Ship Eleven!!!
ONE EACH ABOVE KIT ONLY...... **99¢**



GTD! POWER-DIAMOND-TRANSISTORS

Factory Tested
***MFGRD in U.S.A.
Replaces Medium & HiWattage Types
2N155, 2N156, 2N234, 2N256, 2N307, 2N554

GENERAL TO 3GP 80¢ @, ...20 for $15
PURPOSE ....100/$65
($10 or more this item we pay P.P./U.S.A.)

8 TOPHAT SILICON DIODES $1 EXPERIMENTERS KIT, USE AS STABISTORS, ZENOR DIODES METER PROTECTION CLIPPER & RECTIFIERS! $10 VALUE.

DIAMOND BASE MICA MTG KIT..$ .30
ROUND BASE MICA MTG KIT....$ .30
DELCO POWER HEAT SINK WITH FINS 80 SQ"......................$1.25
KIT DIODES COMPUTER......20¢, 8/$1
KIT TRNSTR NPN or PNP. 39¢ @, 3 for $1
IN34A DIODES 23¢ @, 10 for $2, 100/$18
($10 or more this item we pay P.P./U.S.A.)

Send 25¢ for Catalog

"TAB" THAT'S A BUY

"TAB" Tubes Factory Tested, Inspctd, Six Months Guaranteed! No Rejects! Boxed!

GOVT & MFGRS Surplus! New & Used

0A2	.89	6BZ7	1.25	*We Buy & Sell*	
0A3	.80	6C4	.45	43	.75
0B2	.65	6C5	.69	45	.49
0C3	.70	6C6	1.08	50L6	.69
0D3	.50	6C8	1.08	RK59	1.39
0Z4	.79	*We Trade!*		RK60	1.17
1A7	.90	6CB6	.89	HY69	2.20
1B3	.99	6CD6	1.49	75	.81
1L4	.82	6CF6	.85	HY75	5.00
1R4	5/$1	6CL6	1.40	83V	.95

We Swap Tubes! What Do/U Have?

1R5	.78	6CB6	.89	4PR60A	37.50
1S4	.78	6CG8	1.12	4-125A	27.50
1S5	.68	6CM6	.79	4X150G	15.00
1T4	.85	6CS6	.70	4X250B	41.00
1T5	.95	6CU6	1.29	4-400A	41.75
1U4	6/$1	6D6	.99	4E27A	39.00
1U5	.75	6E5	.79	250TL	19.45
1X2	.99	6F4	2.49	307A	2/$1
2C39A	Q	6F5	.63	316A	5/$1
2C40	5.50	6F6	.99	VR92	5/$1

Send 25¢ for Catalog!

2C43	6.50	6F7	.99	388A	3/$1
2C51	2.00	6F8	1.39	350A	2.45
2D21	.65	6H6	.59	350B	1.75
2E22	1.75	6J4	1.72	371B	.95
2E24	1.90	6J5	.59	5146	3.90
2E25	2.50	6J6	.59	416B	16.00
2E26	2.75	6J7	.99	450TH	43.00
2E30	Q	6J8	1.39	450TL	43.00
2E35	1.60	6K6	.59	460	11.50
2K25	9.75	6K7	.79		

All Tubes Stocked at Low Prices!

2K26	34.00	6K8	.99	703A	Q
2K28	30.00	6L6	1.19	707B	3.50
2V3	2/$1	6SN7	.72	715C	10.90
2X2	.48	6T8	.98	717A	5/$1
3A4	.70	6V6GT	.90	723AB	5.00
3A5	1.00	6X5	.49	725A	2.75
3AP1	5.95	12AT6	.59	803	3.50
3BP1	3.99	12AT7	.89	804	8.85
3C24	3.50	12AU6	.63	805	6.00
3D23	3.95	12AU7	.69	*We Trade!*	
We Buy!		*We Sell!*			
3E29	6:00	12AX7	.79	807	1.10
3Q4	.68	12AY7	1.29	5/$5, 10/$12	
3Q5	.86	12B4	.95		
4-65A	13.50	12BA6	.65	811	3.45
4-125A	27.50	12BA7	.99	811A	4.41
4-250A	34.00	12BD6	.59	812	3.30
4X150A	Q	12BE6	.59	813	9.95
4X250	36.00	12BH6	.79	815	1.75
4X500	37.00	12BH7	.99	826	.99
5AP1	2.95	12BY7	1.00		

Wanted Test Sets and Equipment

5BP1	7.95	12BZ7	.99	828	9.00
5BP4	7.95	12H6	.75	829B	8.00
5CP1	4.99	12J5	.69	832A	6.00
5CP7	9.00	12J7	.69	833A	36.00
5R4	1.00	12J8	1.35	837	2/$2
5T4	.90	12K8	.89	866A	2.45
5U4	.99	12SA7	.69	954	10/$1
5V4	.89	12SC7	.89	955	3/$1
5Y3	.60	12SF5	.69	957	3/$1
5Z3	.89	12SG7	.89	958A	2/$1

Send 25¢ for Catalog!

15GP22	89.00	12SH7	.89	991	5/$1
6A7	1.00	12SJ7	.75	1614	2.75
6A8	.99	12SK7	.75	1619	5/$1
6AB4	.59	12SL7	.79	1620	2.00
6AC7	.72	12SN7	.69	1625	3/$1
6AG5	.65	12SQ7	.69	1626	5/$1
6AG7	.75	12SR7	.69	1629	4/$1
6AK5	.69	15E	1.19	2050	1.25
6AL5	.59	15R	4/$1	5517	1.25
6AQ5	.66	FG17	Q	5608	3.95

Top $$$ Paid for 304TL, 813, 811A, 812A Tubes

6AR6	1.95	19T8	1.16	5618	3.25
6AS7	3.49	24G	3.50	5651	1.35
6AT6	2/$1	25A6	1.19	5654	1.20
6AU6	.79	25A7	2.19	5656	4.25
6B8	1.35	25C5	.81	5663	1.15
6BA6	.59	25L6	.72	5670	.90
6BE6	.59	25T	4.00	5686	1.75
6BG6	1.49	25Z5	.72	5687	1.15
6BH6	.79	25Z6	.75	5691	4.70
6BJ6	.72	26A7	3.69	5725	1.95

Top $$$ Paid for XMTTR Tubes!

6BK7	.99	FG27	8.28	5732	2.00
6BL7	1.35	HV27	19.39	5736	85.00
6BN4	.69	28D7	.89	5749	1.95
6BN6	1.08	FG33	15.00	5750	2.75
6BN7	1.99	EL34	3.49	5751	1.25
6BQ6	1.19	35A5	.69	5814	1.20
6BQ7	.99	35L6	.59	5879	1.20
6BX7	1.11	35T	4.49	5894	$12.00
6BY5	1.19	35Z5	1.25		
6BZ6	.91	RK39	2.99	No See—Write!	

"TAB" TERMS: Min Order $3—25% with order F.O.B. New York. Ten day guarantee, price of mdse. only. Our 17th year.

Prices shown are subject to change.

111G5 Liberty St., N. Y. 6, N. Y. • RE 2-6245

"TAB" FOR THE BEST KITS!

GENERAL PURPOSE—PNP—COMPUTER GRADE!
Use as Amplifier—Oscillator—HiFi Logic—Servoamp—Power Supply Pulse Amplifier or High Current Switch
Veb. Vce. Veb Approx 40V
GP3C rated 300 Milliwatts 65¢, @ 10 for $5, 100 for $39
GP10C Rated 1 watt 90¢, 6 $5, 100 $63

2N155 $1.39, 2N176 $1.80, 2N177 $1, 2N178 $1.75, 2N247 $1.50, 2N255 $1.20, 2N270 $.95, 2N274 $1.25, 2N408 $.80, 2N544 $1.20, 2N578 $1.80, 2N579 $2.20, 2N581 $1.25, 2N582 $2.10, 2N174 $8.50, 2N443 $.650, 2N670 $1.60, 2N671 $2.

NEW BATTERY CHARGER BC6-12V FOR 6V OR 12 VOLT BATTERIES, TRICKLE & FULL CHARGE up to 4 AMP

Charges 6 & 12 volt batteries
Built BC6-12VB.....$10.00
BC6-12VK preassembled Kit 7.50
Same except rated 2.5A BC612AB 8.00
BC6-12AK Presassembled Kit 6.00

! ! ! TUBE SPECIAL ! ! !
4X150D—Removed from Govt. equipment. Tested. $3 ea., 2 for $5. Filament Xfmr. $2. First come, first served.

"TAB"—THAT'S A BUY. BARGAINS

New Variacs/or equiv 0-135V/7.5A.$15.30
New Variacs/or equiv 0-135V/3 Amp $10.65
New Variacs/or equiv 0-132V/1.25A. $7.25
RF-MTG GE/475 Ma & 5 Amp $4@, 2/$7
DC-METER Dejur 800 Ma/2½" $3@, 2/$5
DC MTR 100Ma/2½" ....$3@, 2/$5
RF-HTR Weston 750Ma/TC....$4@, 2/$6
DC-METER One Ma/4" Rd. $5@, 2/$8
TRS PWR DIODES* up to 3amp..4 for $1
TRS PWR DIODES* up to 5amp..4 for $1
*Heat sink mounted.
SNOOPERSCOPE TUBE 2"...$5@, 2/$9
MINI-FAN 6 or 12VAC/60 Cys $2@, 3/$5
NEW PRINT CKT-PANEL, 11x12x.062" $2
1N34A 45¢@, 15/$5; 1N35 $1; 1N38 70¢@;
XTAL OVEN—115V&Thermostat.....$2
Blower 24VDC/100CFM..............$3.98
Xmitting Mica's .006 @ 2500V, 5 for $1.00
4-1000A Air Socket, less chimney....$9.95
829B Socket 85¢, 183 Socket.............$1
4x150 Ceramic/LOKTAL.......2 for $1.00

GTD! HIPOWER-ROUND-TRNSISTRS Factory Tested

***MFG in U.S.A.
2N277 or 2N441 @ $2.25,
2N278 or 2N442 @ $3.75,
2N173 or 2N443 $5.00 @ 4/$16
($10 or more this item we pay P.P./U.S.A.)

NEW POWER CONVERTER

12VDC to 500VDC up to 200MA
100 Watts; Tap at 250VDC
*Type C1250E $35

TYPE C650E FOR 6VDC INPUT $35
12VDC to 250VDC up to 150MA
Type C1225E $30
C625E for 6VDC input $30

"TAB" TOROID XFMRS for TRANSISTOR POWER CONVERTERS!

T6-500E/6VDC Inpt. 500VDC & Tap. Max 200Ma $15. T12-500E/12VDC Inpt, 500VDC & Tap, Max 200Ma $15. T6-250E/6VDC inpt. 250VDC, Max 150Ma $14. T12-250E/12VDC Inpt, 250VDC, Max 150Ma $14.

Leece Neville Charger Systems "SILTAB" Silicon Rectifier Replacement Non-Aging Hermetically Sealed
FOR 6 or 12VDC @ 100A, Type YJ9 $24

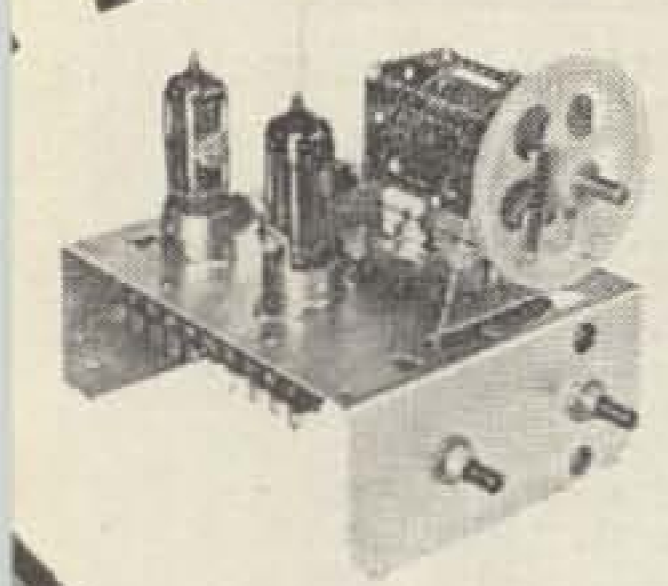
SELENIUM F.W. BRIDGE RECTIFIERS

One Year Gtd!

DC AMP	18VAC 14VDC	36VAC 28VDC	72VAC 54VDC	130VAC 100VDC
½	$1.00	$1.90	$3.85	$5.00
1	1.30	2.00	4.90	8.15
2	2.15	3.00	6.25	11.10
3	2.90	4.00	8.60	13.45
6	4.15	8.00	18.75	31.90
10	6.10	12.15	26.30	41.60
12	7.75	14.90	30.95	43.45
20	12.85	24.60	*Write For*	
24	15.00	29.45	*Rectifier Catalog*	

BULLSEYE BUYS at ARROW!

AMERICAN GELOSO V.F.O.'s



Wired, tested, calibrated, ready for use. Mod. 4/104 for driving one 807 or 6146 final in AM or CW under Class "C" conditions.

Mod. 4/102 for driving two 807's or 6146's final. Has 5 bands. Supplied with Mod. 1640 dial ass'y.

Mod. 4/103 for 144-148 mc bands. Combines VFO primary freq. of 18 mc with xtal fundamental freq. of 12 mc. Supplied with Mod. 1647 dial ass'y.

Mod. 4/104, 4/102 or 4/103 less tubes and xtal, each $29.95

AGS—RT—101 CITIZENS BAND TWO WAY RADIO

No license required. Complies with part 15 of FCC rules on low power units. 1.5 mi. average range on land, up to 5 mi. on water. Xtal controlled XMTR, Rec. Sens. 1 µv. Each unit complete with transmitter-receiver, AM radio, leather carrying case, ear-phones, antenna, 6 penlight batteries.

$70.00 ea. 2 for **$139.50**

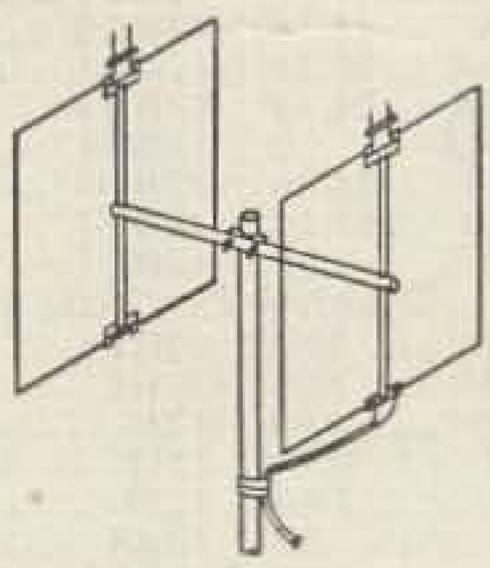
PRECISION PLANETARY-VERNIER
for exceptionally fine tuning

Superb craftsmanship by Jackson Bros. of England. Ball bearing drive, 1/4" dia. shaft, 1⅛" long, 6:1 ratio, vy FB for fine tuning. Easily adaptable to any shaft. Comparable value — $5.95.

Amateur Net $1.50 ea.
10 for $13.50

Shown approximately actual size

THE COR-MAC 2 METER CUBICAL QUAD ANTENNA



Complete 2 meter quad antenna kit, machined from the finest alloys of aluminum . . . assemble it yourself with only pliers and a screwdriver. This 2 meter cubical quad was derived from the basic design concept proved so successfully for the 10 and 20 meter beams.

2 meter Kit **$12.50**

"Wonder Bar" 10 Meter Antenna

As featured in Nov. 1956 QST. Complete with B & W 3013 Miniductor. Only 8 ft. long for 10 meters. Wt. 5 lbs.

Amateur Net $7.85

24 HOUR CLOCK

24 hr. chrome plated 8" metal wall clock. Inner dial with south polar projection map of world indicates time around world. Polar projection dial adjustable for various time zones. Shpg. wt. 2 lbs.

110 v. 60 cycle model
$8.47 tax incl.

Versatile Miniature Transformer

Same as used in W2EWL SSB Rig — March 1956 QST. Three sets of CT windings for a combination of impedances: 600 ohms, 5200 ohms, 22000 ohms. (By using center-taps the impedances are quartered.) The ideal transformer for a SSB transmitter. Other uses: interstage, transistor, high impedance choke, line to grid or plate, etc. Size only 2" h. x 3/4" w. x 3/4" d. New and fully shielded.

Amateur Net $1.39
3 for $3.49 10 for $10.75

ARROW Authorized distributor of HEATHKIT equipment

MAIL ORDERS PROMPTLY PROCESSED
SAME DAY SHIPMENT FROM STOCK

TO SAVE C.O.D. CHARGES, PLEASE INCLUDE SUFFICIENT POSTAGE WITH YOUR ORDER. ANY EXTRA MONEY WILL BE RETURNED.

ALL PRICES F.O.B. N. Y. C.
Arrow's Export Dept. Ships To All Parts Of The World!
Prices Subject To Change Without Notice.

ARROW ELECTRONICS, INC.

65 Cortlandt Street, New York 7, N. Y. • DIgby 9-4730
525 Jericho Turnpike, Mineola, N. Y. • Pioneer 6-8686

SAY YOU SAW IT IN 73

It pays to insist on

PR *crystals*

STANDARD OF EXCELLENCE SINCE 1934

Z-2

Z-9A
Z-9R

Z-1

2XP

AMATEUR TYPES

Fundamental, PR Type Z-2

Frequency Ranges in Kcs.: 3,500 to 4,000 (80M); 7,000 to 7,425 (40M); 8,000 to 8,222 (2M); 8,334 to 9,000 (6M).

Rugged. Low drift, fundamental oscillators. High activity and power output. Stands up under maximum crystal currents. Stable, long-lasting; ±500 cycles.................. **$2.95 Net**
(All Z-2 Crystals calibrated with a load of 32 mmfd.)

Third Overtone, PR Type Z-9A

Hermetically sealed; calibrated 24,000 to 24,666 and 25,000 to 27,000 Kc., ±3 Kc.; .050" pins.................. **$3.95 Net**

6 Meters, PR Type Z-9A

Fifth overtone; for operating directly in 6-meter band; hermetically sealed; calibrated 50 to 54 Mc., ±15 Kc.; .050" pins. **$4.95 Net**

CITIZENS BAND CLASS "D"
Type Z-9R, Transmitter

FCC assigned frequencies in megacycles: 26.965, 26.975, 26.985, 27.005, 27.015, 27.025, 27.035, 27.055, 27.065, 27.075, 27.085, 27.105, 27.115, 27.125, 27.135, 27.155, 27.165, 27.175, 27.185, 27.205, 27.215, 27.225, 27.255, calibrated to .005%. (Be sure to specify manufacturer and model number of equipment) **$2.95 Net**

CITIZENS BAND CLASS "D"
Type Z-9R, Receiver

Specify I.F. frequency, also whether receiver oscillator is above or below transmitter frequency. Calibrated to .005%. (Be sure to specify manufacturer and model number of equipment.).................. **$2.95 Net**

Type Z-9R, Radio Control

FCC assigned frequencies in megacycles: 26.995, 27.045, 27.095, 27.145, 27.195, 27.255; calibrated to .005%. (Be sure to specify manufacturer and model number of equipment.).................. **$2.95 Net**

Type 2XP

Suitable for converters, experimental, etc. Same holder dimensions as Type Z-2.

1600 to 12000 Kc., (Fund.) ±5 Kc.................. **$3.45 Net**

12001 to 25000 Kc. (3rd Overtone) ±10 Kc.................. **$4.45 Net**

COMMERCIAL TYPES

Commercial Crystals available from 100 Kc. to 70 Mc. Prices on request.

Type Z-1, MARS and CAP

Official assigned frequencies in the range. Calibrated to .005%.
1600 to 10000 Kc.................. **$3.45 Net**

Type Z 1, TV Marker

Channels 2 thru 13.......... **$6.45 Net**

4.5 Mc. Intercarrier, .01%.................. **$2.95 Net**

5.0 Mc. Signal Generator, .01%.................. **$2.95 Net**

10.7 Mc. FM, IF, .01%.................. **$2.95 Net**

Type Z-6A, Frequency Standard

To determine band edge. To keep the VFO and receiver properly calibrated.
100 Kc. .... **$6.95 Net**

Z-6A

**ALL PR CRYSTALS ARE UNCONDITIONALLY GUARANTEED.
ORDER FROM YOUR JOBBER.**

PETERSEN RADIO CO., *Inc.* 2800 W. Broadway
COUNCIL BLUFFS, IOWA

EXPORT SALES: Royal National Corporation, 250 W. 57th Street, New York 19, N. Y., U. S. A.

TWO SET PERFORMANCE FOR THE PRICE OF ONE

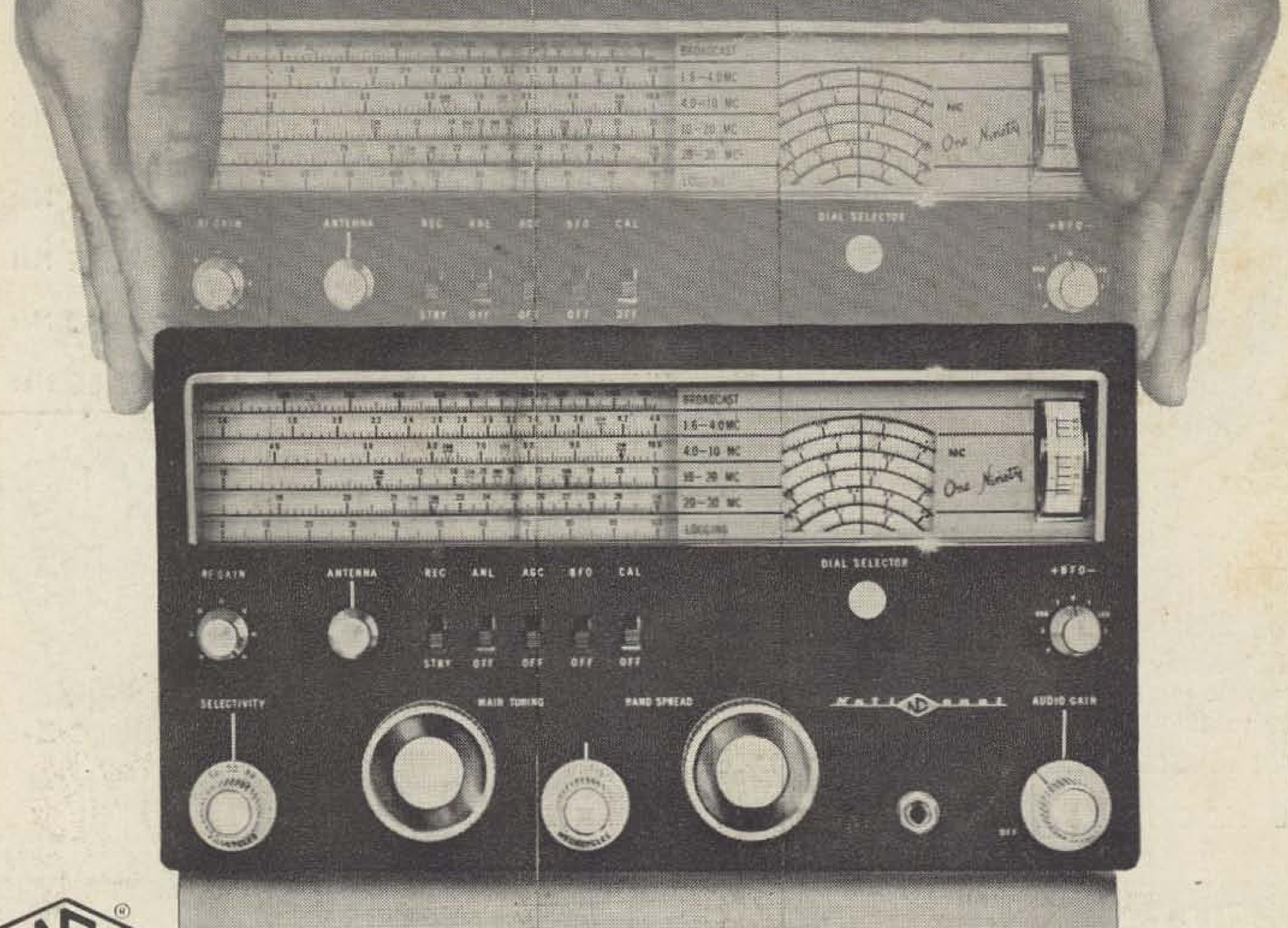
- **Exclusive Dial Selector** instantly converts the finest amateur receiver for the money into the receiver for the SWL by providing calibrated amateur or foreign broadcast bandspreads at the flip of a knob.
- **Double Conversion** for maximum image rejection.
- **Variable IF Selectivity** with ferrite filter for 600 cycle CW, 3 kc SSB and 5 kc AM bandwidths.
- **Five Main Tuning Ranges** for uncrowded calibration from 540 kc to 30 mc.
- **Built in 60 to 1 Bandspread Vernier** for maximum tuning ease.
- **Separate Product Detector and Full SSB/CW AGC**
- **Sensitivity** better than one microvolt for 10db S/N.
- **Voltage Regulated** oscillators and ceramic coil forms for maximum stability.
- **Flip Foot** for maximum operating convenience.

NATIONAL'S NEW NC-190

Only $19.95 down*

Suggested cash price: $199.50.
NTS-3 Matching Speaker: $19.95

(slightly higher west of the Rockies and outside the U. S. A.).
*Most National Distributors offer budget terms and trade-in allowances.



NATIONAL RADIO COMPANY, INC. MELROSE 76, MASS.

A WHOLLY OWNED SUBSIDIARY OF NATIONAL CO., INC.

Export: AD AURIEMA, INC. 85 Broad St., New York, N.Y. **Canada:** CANADIAN MARCONI CO., 830 Bayview Ave., Toronto 17, Ont

Specifications Subject To Change Without Notice