73

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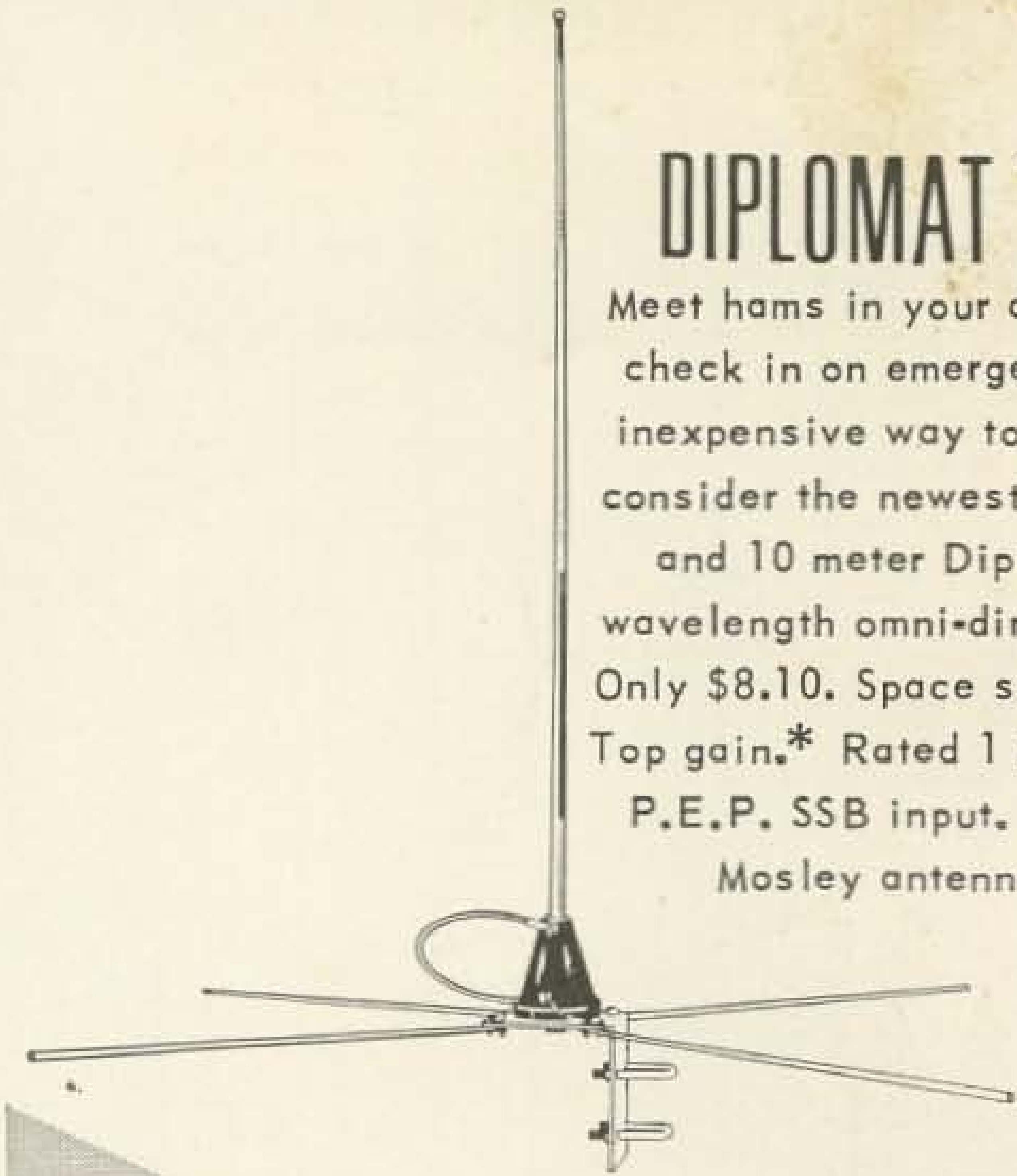

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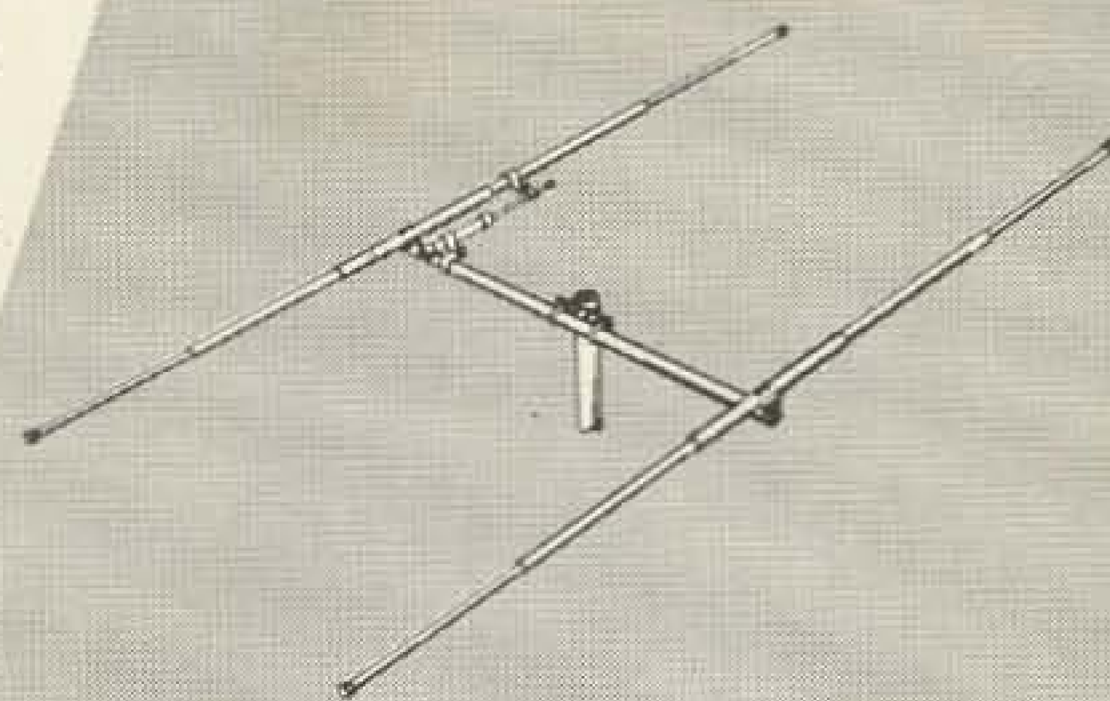

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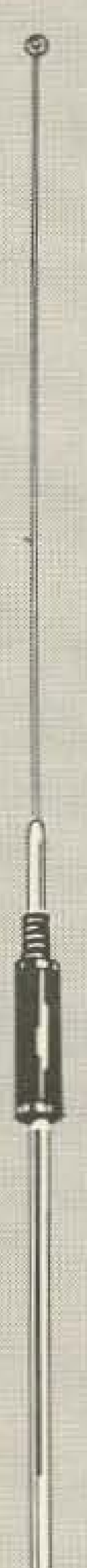

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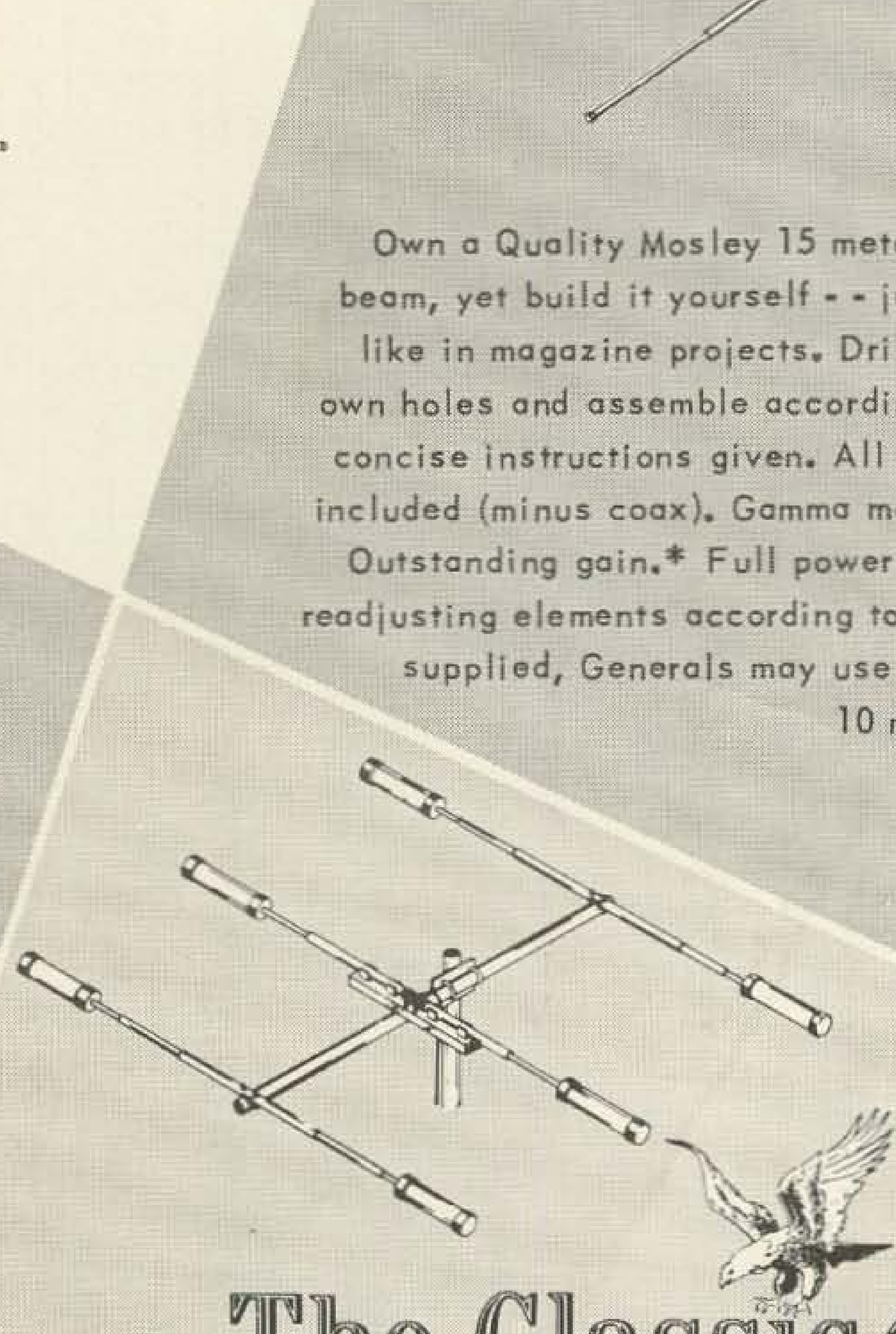

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73 Magazine

August 1967

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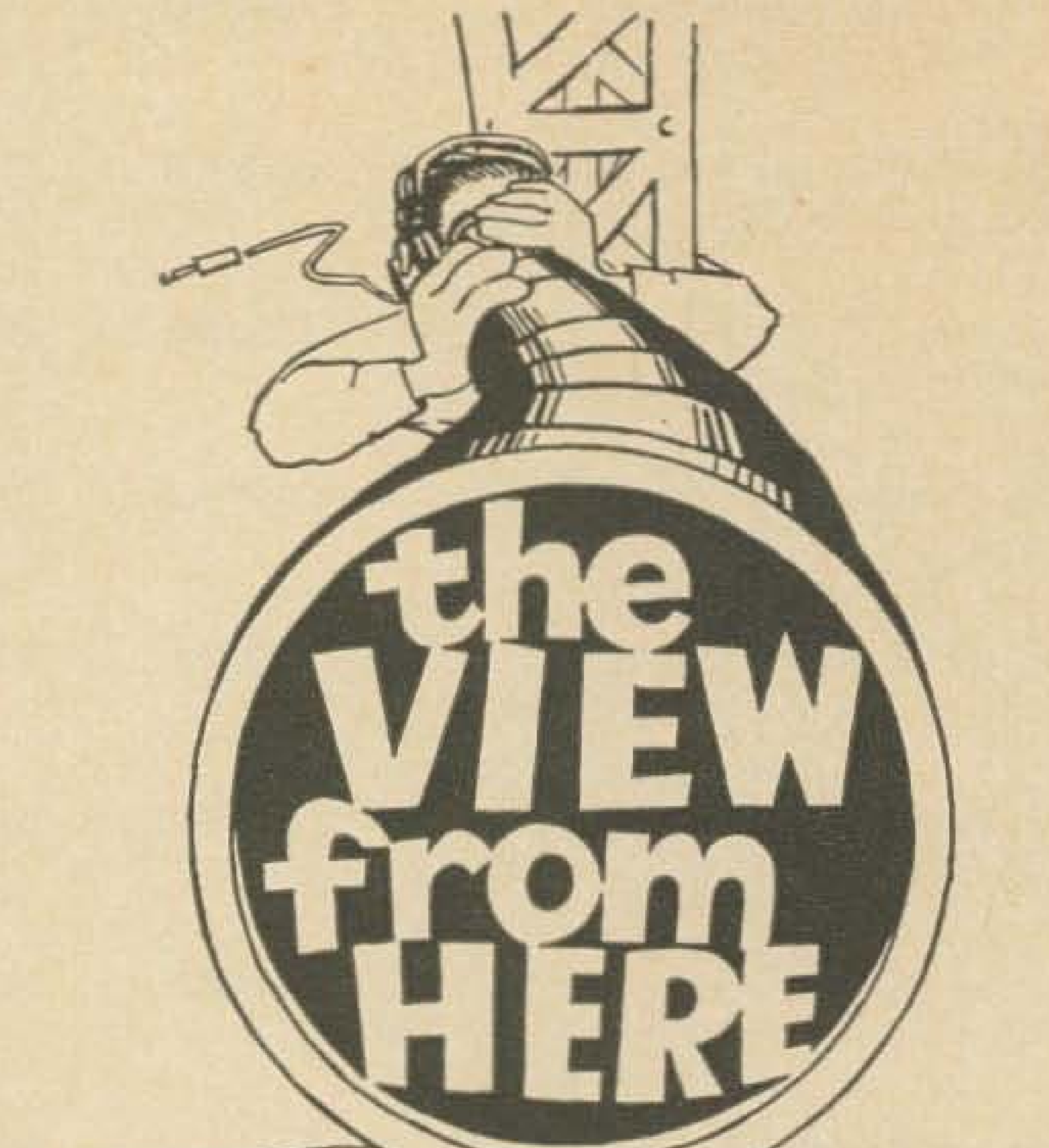
SPECIAL FEATURE ARTICLE



With the slackening growth of ham radio, a number of proposals have been made, and perhaps the most interesting and promising of these is an idea I first heard from Bob Waters, W1PRI. He, and some of the other ham manufacturers, are advocating several modifications to the current Novice regulations which they think would attract more youngsters to our hobby.

Although a great number of Novices go on to the General and higher class licenses, many sell their gear after their twelve months is up and try another hobby. The manufacturers feel that if the period of the license was extended to two years, if a small Novice phone segment on ten meters was available, and, if the name of the Novice class was changed, we would see an increase in Novice licensees, and subsequently, higher-class licenses.

The current twelve-month limitation on Novices is a serious problem to many young hams. Many of them are high-school students, and in addition to their chosen hobby, they have homework, sports, probably a part-time job and all kinds of other activities to take up their time. With only so many hours in the week, there's just not much time left to devote to ham radio. The fact that many of them are able to upgrade themselves to the General license in the limited time available is a credit to their ability. I wonder how many adults would be able to do as well under the same circumstances?

If the license period were extended to two years or even longer, a great many more Novices would be able to qualify for a higher class license. There doesn't appear to be any good reason why the Novice license should not be issued for a two- or five-year period. Some Novices graduate to the General class in a year, but how many more would make it if they had more time?

In addition, limited phone privileges on ten meters would serve to introduce the Novice to the *true* picture of ham radio. The two-meter allocation they presently enjoy does this in some part of the country, but, in many areas there is almost no activity on 144 MHz. Up here in New Hampshire, for example, except on VHF Contest weekends, two-meter activity is nil. With a low-noise converter and a high-gain antenna, I hear a few DX stations, but with the equipment the average Novice is apt to have, he wouldn't hear anything except noise! I'm sure the same thing is true in other parts of the country too.

If you have a receiver that covers the top 1 MHz of the ten-meter band, you'll find it to be a veritable wasteland. In some areas there are a few FM repeaters and channelized CB-style stations, but the unused spectrum between them is going to waste. And of the upper 1 MHz, who is operating on the top 200 kHz? Thus far I haven't heard a signal up there.

Even the best of the five-band transceivers does not cover the entire 28 MHz band. Most of them provide one 500 kHz segment, while a few give a full 1000 kHz, usually 28 to 29 MHz. Unless you have a general coverage receiver, or have gone to the trouble to buy an extra crystal, chances are you have never even listened above 29.0 MHz. I have, and I can tell you, except for sporadic activity on a few net frequencies, the band is empty even when the skip is in.

The allocation of 29.5 to 29.7 MHz phone privileges to the Novice would give him a chance to get his feet wet and see what amateur radio is really like. If you had to operate CW in the congested Novice portions of our lower-frequency bands when you started out, I wonder how many of you would still be licensed and active?

The manufacturers would also like to change the name of the Novice license to

(Turn to page 103)

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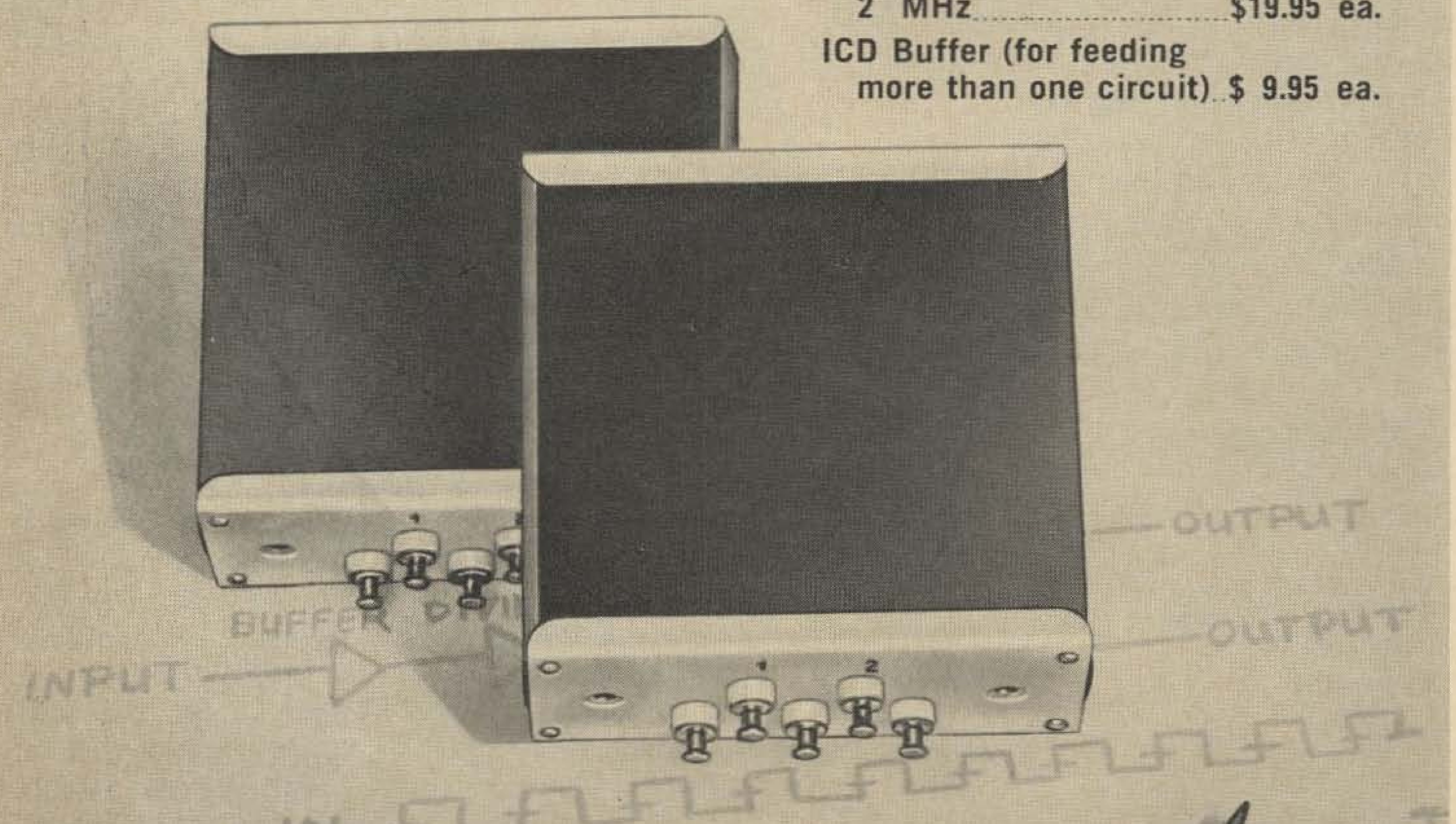

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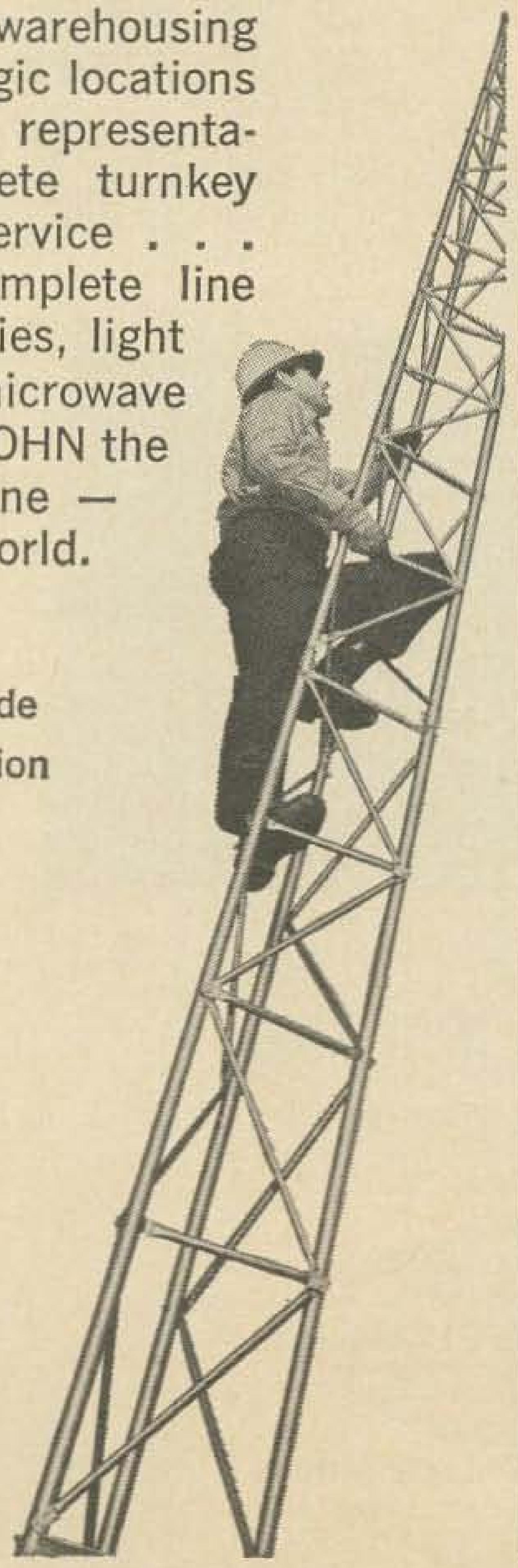

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never say die

After the big party of EP hams the night before, I felt sorry for Gerry EP2GF as we headed for the airport at 4:00 in the morning with very little sleep under our belts. What a ridiculous time of the morning to fly. The plane actually got off about 6 and, after four hours of flying across desert and treeless mountains, we dropped into Kabul.

I'd worked one YA from home before the trip, but didn't get more than a signal report through all the QRM, so I didn't have much of an idea what was waiting for me. I'd talked briefly to Ed YA1DAN from EP2GF and knew that he would be meeting me at the airport and would put me up during my two day stay.

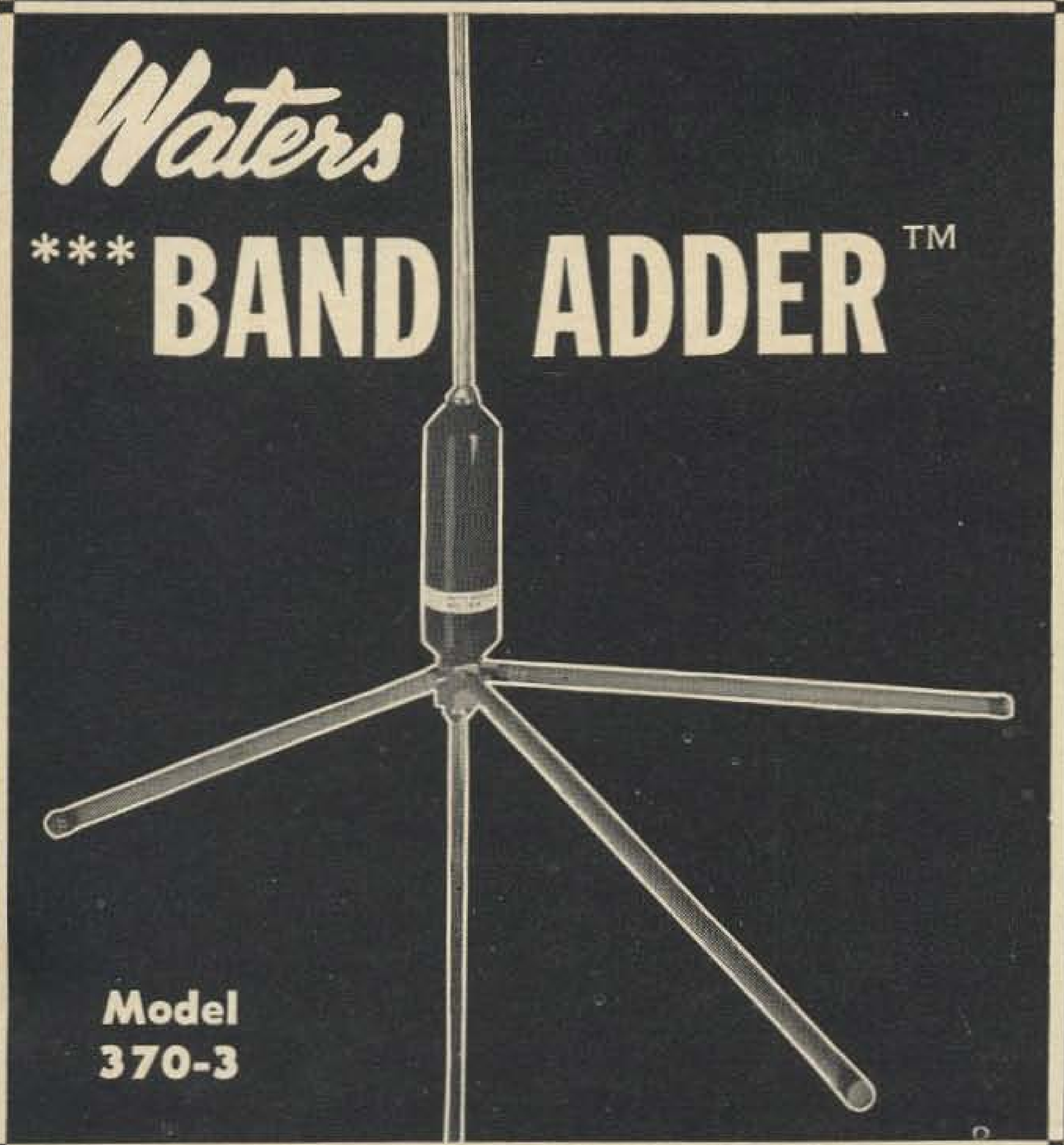
Sure enough, there was Ed, waving to me from the gallery as we landed, QSL card in hand for identification. He came down and put in a good word with the airport manager and I was rushed through the formalities of customs and immigration and on my way to town. After a stop to say hello to YA1FV and some of the other fellows, we went on to Ed's house, which turned out to be a veritable palace.

Ed, a maintenance man with the FAA in Kabul, lives with his family in a house that would run easily $100,000 over here, complete with two servants to keep the place clean, cook the meals, serve and keep the clothes washed and ironed, a not unsubstantial job for a family with four small boys. Things are not expensive in Afghanistan, obviously.

Ed drove me to downtown Kabul and we walked through the small stalls that serve for stores there. Ed haggled with dealers here and there for old Afghan coins to add to his collection, which is probably already one of the finest in the world. He explained that the ice for the cold-drink stands around town was brought down from the 17,000 foot high mountains just out of town which have snow on them all year around. Kabul is at about 7000 feet altitude. We watched them bake bread by sticking the flat loaves to the side of the ovens for a minute or so and then prying it off with long sticks working through the fire in the middle of the oven.

Ed explained that the white community has to be ever on the watch against sickness. I watched the Afghans bathe in the

(Turn to page 75)



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A Push-Pull Class B-Linear

A 1 kW push-pull grounded-grid linear amplifier using 3-400Z's.

It is one of those minor ironies that during the past ten or fifteen years, while the single-ended audio amplifier has almost completely given way to push-pull, exactly the reverse has occurred in respect to rf amplifiers. This is even more surprising when one remarks that rf amplifiers nowadays are seldom called upon to perform a modulating function and so are, like their audio counterparts, devices for raising the power level.

The faculty of even harmonic distortion cancellation attributed to push-pull circuits depends upon tight coupling between the two halves of the output circuit—this is very much more easily realized at audio than at radio frequencies. Nevertheless, there is a basic symmetry in the push-pull circuit that can hardly do anything but help to produce a symmetrical output which in turn is likely to possess fewer spurious components.

The case for the grounded-grid amplifier has been competently and extensively made and does not need elaboration here. It seems then that a push-pull grounded-grid amplifier would be an especially attractive proposition. Before launching into a description of one such amplifier, I should like to identify some of the other assumptions (perhaps they should be called prejudices) that underlay the project:

1. Bandswitching is not necessary or even desirable if it must be bought at the price of tapped coils or huge voltages across unused coil segments.

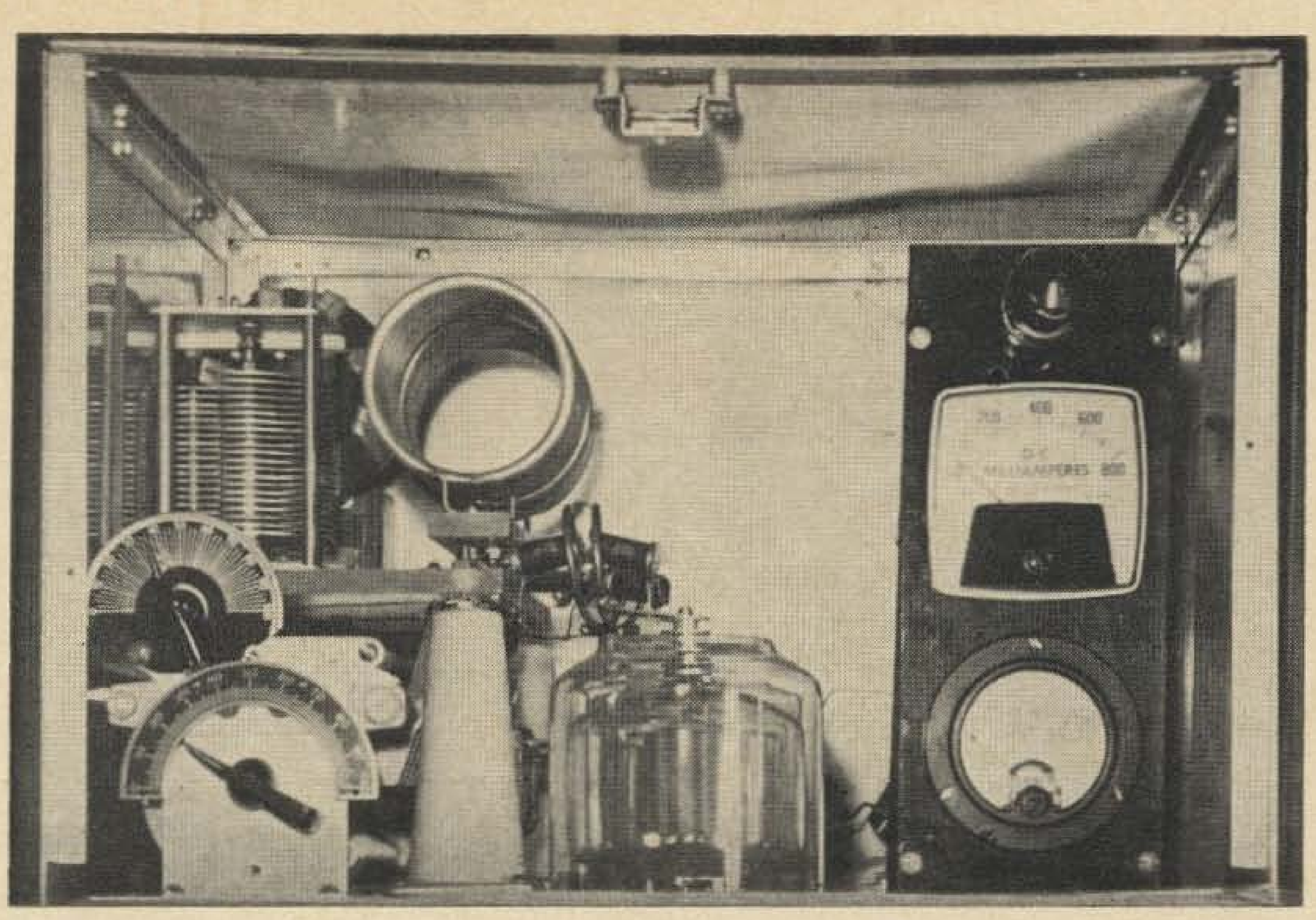
2. The desired frequency range is 3.5-29.7 MHz, CW and SSB, and power input capability up to the legal limit. Both plate voltage and current must be continuously monitored at such power levels to satisfy Canadian government regulations.

3. Shunt feed is only acceptable as a last resort.

4. Voltage-doubling circuits, choke-less filters, series-string rectifiers and filter capacitors and such artful dodges are to be avoided.

5. The driver is a B & W 6100 and the load will be a 50 ohm (nominal) unbalanced antenna.

Fig. 1 is the schematic of the completed amplifier. To sum it up, it consists of two Eimac 3-400Z zero bias triodes with 3000 volts on the plate in a push-pull grounded-grid connection. RF drive is series fed to the cathodes (heated by two separate filament transformers—872 type filament transformers have sufficiently low capacitance for this application) from a transformer whose primary is connected to a pi network of reactances affording impedance matching to the driver



The interior of the push-pull grounded-grid amplifier. The 3-400Z's are located in the center, the plate current and voltage meters to the right and the output circuitry to the left. The toroidal rf power transformer is hidden by the vertically mounted variable capacitor to the left.

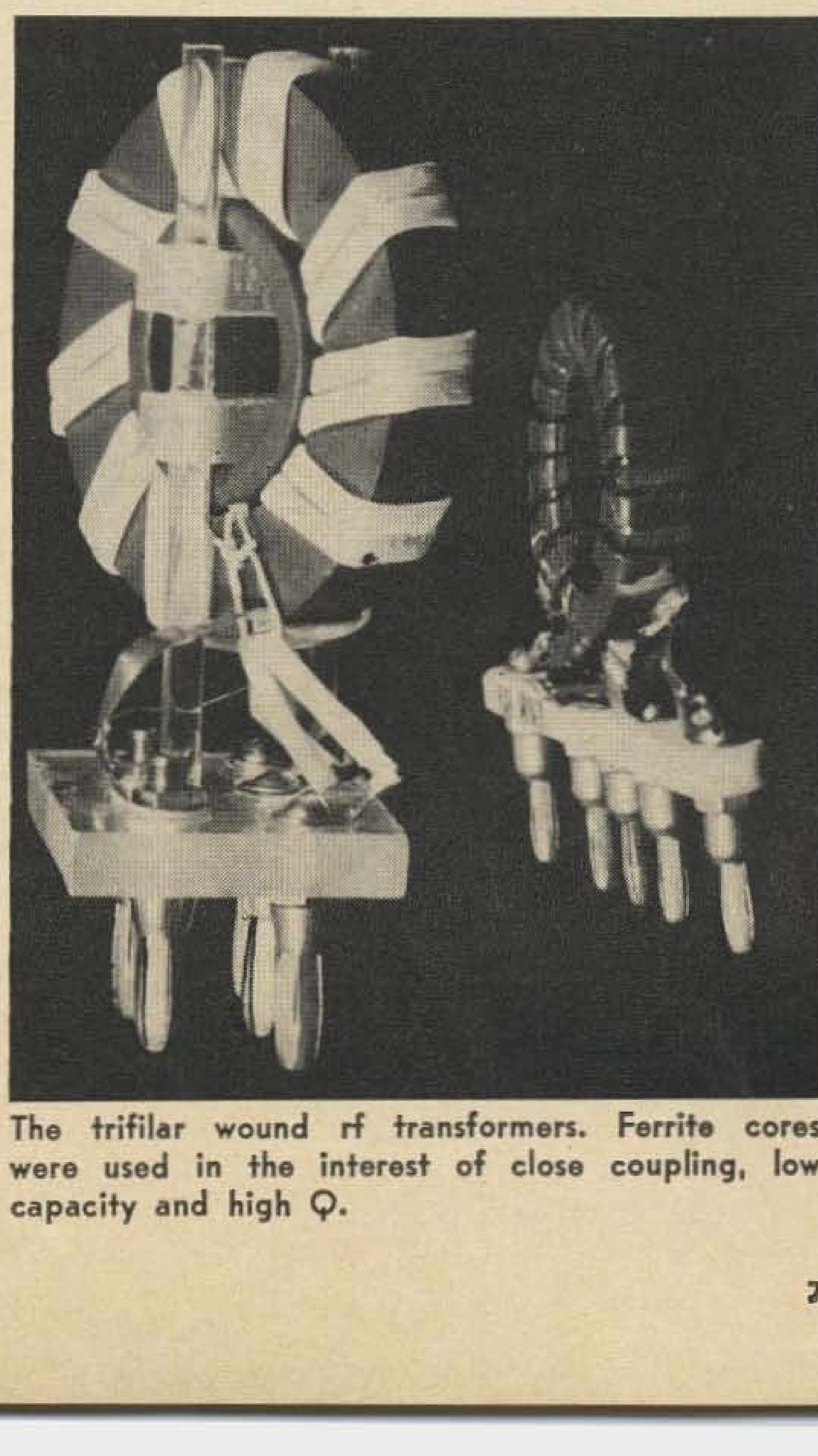
output. The output circuit is series fed with a split tank coil. The loading of the stage is controlled by the variable capacitor across the output transformer primary. The power supply (full wave 872's; single section L/C filter; 24 μF total capacitance) is of standard design. As for housing the linear, quite conventional construction practices were employed—the underside of the chassis is kept air tight so that a single fan (Ripley SK-4125) can handle both tubes which are mounted in Eimac air system sockets and chimneys.

The rf transformers

The central features of this linear are the *trifilar* input and output transformers pictured in **Fig. 2** and detailed in **Fig. 3.** "Trifilar" means that three conductors are grouped and wound onto the core as a single turn. Ferrite core material is employed because of its admirable magnetic properties at radio frequencies. This mode of winding on this type of core seems to produce the tightest possible coupling consistent with low losses and reasonable distributed capacitance. In both cases the transformers are used with two windings connected in series and one winding by itself. The input transformer is, therefore, 1:2 step up in turns. However, since only one tube is operating at any one instant, it may be viewed as simply 1:1 in terms of impedance. The output transformer has part of the tank circuit circulating current in its primary and sees the antenna as its load, so it is 2:1 step down in turns and 4:1 step down in impedance. The transformers provide good performance on three adjacent ham bands so there is an overlap on 14 MHz.

The pi input network

In spite of the additional coil which requires band switching, this network more than pays its way for several reasons. First,



The trifilar wound rf transformers. Ferrite cores were used in the interest of close coupling, low capacity and high Q.

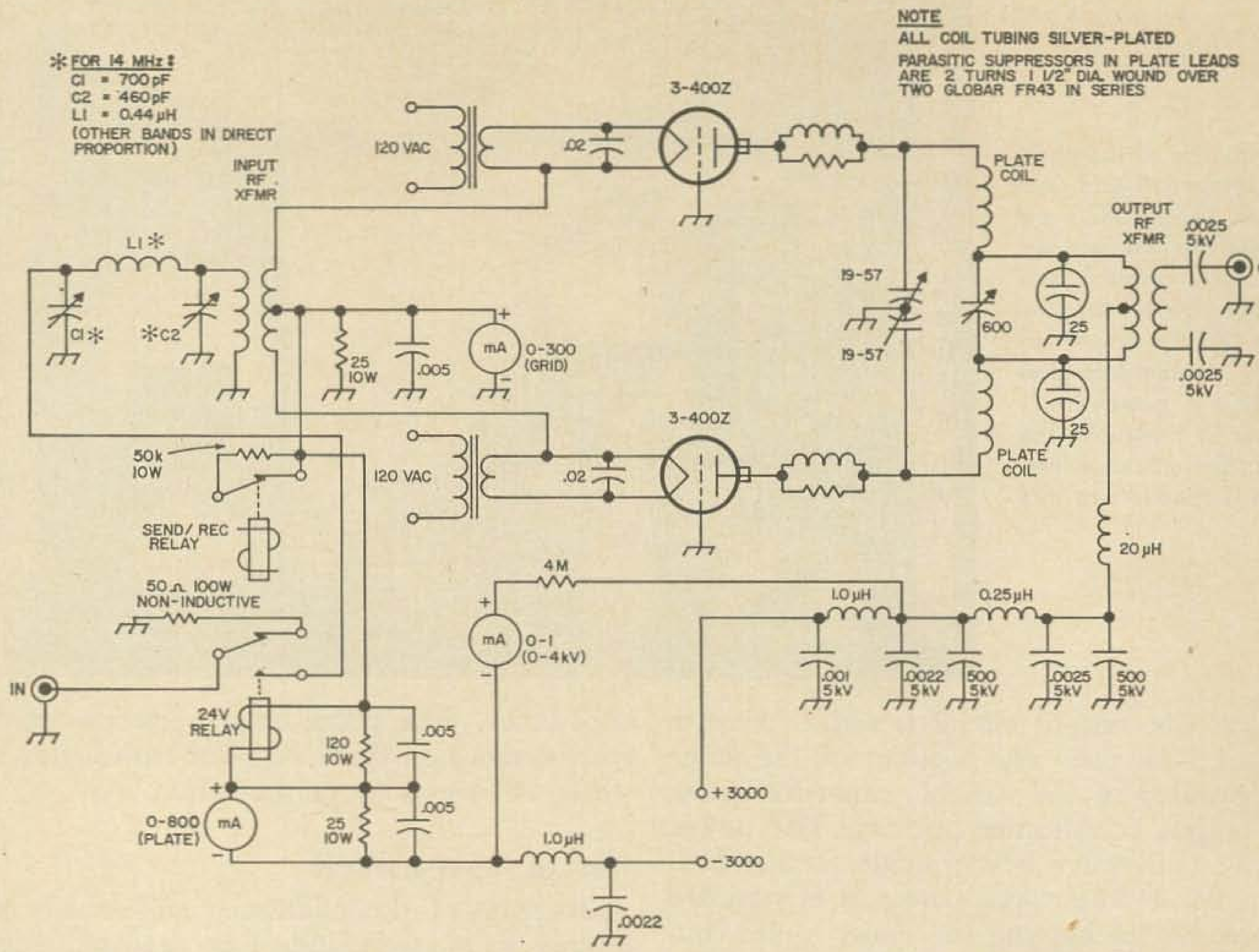


Fig. 1. Schematic of the push-pull grounded-grid class-B linear amplifier. The dual 19-57 pF capacitor in the plate circuit was made from a surplus unit, 0.25 spacing, by removing all but four stator plates per section.

it serves as a reservoir of stored energy whose flywheel action serves both to couple the tubes together and to stabilize their waveform. Secondly, it provides almost complete isolation betwen the linear and its driver, thus making it possible to make the SWR presented to the driver very close to 1:1.

Since the definitive article on *all* phases of grounded-grid power amplifier operation apparently has yet to be written, it is, perhaps, appropriate to summarize the problem of driving such an amplifier. Four impedances are of concern:

1. The impedance looking toward the amplifier—analytically, this represents the *fed-through* power plus the grid losses.

2. The impedance seen by the cathodes of the linear stage looking back toward the driver. Theoretically this may be zero—practically it must be finite. Furthermore, if there is to be any stored energy, reactances must be involved and resonance must be achieved so that the cathode-ground voltage will be in phase with the plate current.

3. The desired impedance seen looking forward from the exciter. This is almost always 50-52 ohms (unbalanced).

4. The impedance seen looking back into the exciter output terminals. This may be nearly any small resistance, often accompanied by a larger reactive component.

Suppose that, on the basis of reasonable capacitor sizes and modest Q, we aim to make the cathode to ground impedance (2) equal to the impedance looking toward the amplifier (1). Since impedance is equal to Q times capacitive reactance ($Z = Q X_c$), high Q's call for low X_c's and therefore, large capacitors. The basis of this design was $Q = 5$; therefore, the capacitive reactance (X_c) is about 25 ohms since (1) is approximately 125 ohms for the 3-400Z in this circuit. A nameless but very useful theorem* states that in any circuit containing loss-less elements (L, C, and perfect transformers), if a conjugate impedance match occurs at one junction then it must exist at every other junction and conversely. Such a state of affairs would mean that the conjugate of (4) would be the load to the driver and this is nowhere near the value of (3). To be blunt, there would be a very high SWR on the driver-to-linear transmission line with consequent difficulty in getting power out of the driver. As an additional complication, unless the exciter and linear are bolted together, these various impedances are transformed differently depending on whether one is considering the direction — exciter to linear or linear to exciter. Not only that, these transformations will be different on different bands unless the length of coaxial line is changed when changing bands. The only straightforward way out of this dilemma is to swamp out the impedance irregularities by imposing the greatest power loss that can be tolerated between the exciter and the linear. Consequently a 3 dB pad (see **Fig. 4**) is placed between the linear and the exciter. Since the greater the loss in the pad the greater isolation it affords, and since there is a considerable surplus of drive from the B & W 6100, the pad could have been raised to 4 dB or so in my case to some advantage.

Drive interlock

Most articles on grounded-grid amplifiers view the possibility of drive being present with no plate current with alarm—an eventuality that has been rendered almost impossible by the drive interlock relay whose resistor terminates the driver when the relay is not actuated.

Trials and tribulations

Perhaps a paragraph or so on the unsuccessful experiments and assorted disappointments would be appropriate here. The feasibility of the cathode drive transformer idea was established at the outset in a series of experiments involving 809's and 811's (*not* 811A's). Cross neutralization of these tubes is easily achieved by bringing a lead up through the chassis from a cathode to a copper bracket and facing it toward the opposite plate through the glass envelope—less than 1 pF is required. However, on 21 and 28 MHz the parasitics took over in a spectacular fashion. The only way they could be tamed was by using resistive stoppers between grid and ground. However, a little circuit analysis shows that this makes the neutralizing null and void with resultant operating-frequency instability. No such problem was ever encountered with the 3-400Z's.

**Communications Engineering*, third edition, Everitt and Anner, McGraw-Hill, page 407.

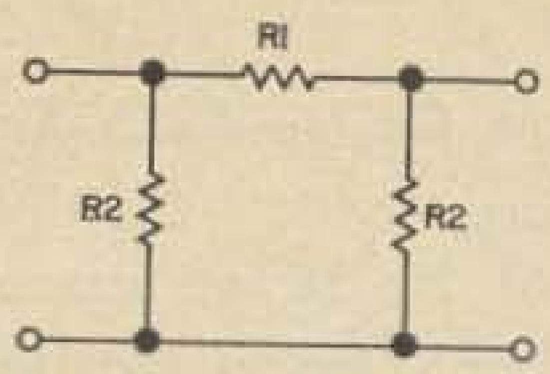


Fig. 2. 3-dB isolating pad. R1 consists of twenty 360-ohm, 1-watt composition resistors in parallel—total resistance 18 ohms. Each of the pad resistors labeled R2 consist of thirteen 3900-ohm, 2-watt resistors in parallel—total resistance 300 ohms.*

Right up until nearly the end of the experiments, it had been hoped that a shielded link coupling could be used between the tank and the antenna. Unfortunately, the coupling obtained with the link proved to be quite insufficient on 21 and 28 MHz and the output transformer had to be introduced. It was also necessary to come to terms with the fact that the load impedance seen by each tube for the target outputs is in the vicinity of 5500 ohms. Using the old rule of thumb that a Q of 6 is adequate with push pull, the capacitance required works out to about 6 pF on 28 MHz, 8 pF on 21 MHz, 12 pF on 14 MHz and so on. Since the output capacitance of the 3-400Z is 4 pF and strays will

*For construction hints, see K. Glanzer, "T-Pads for RF Circuits," *CQ*, July 1964.

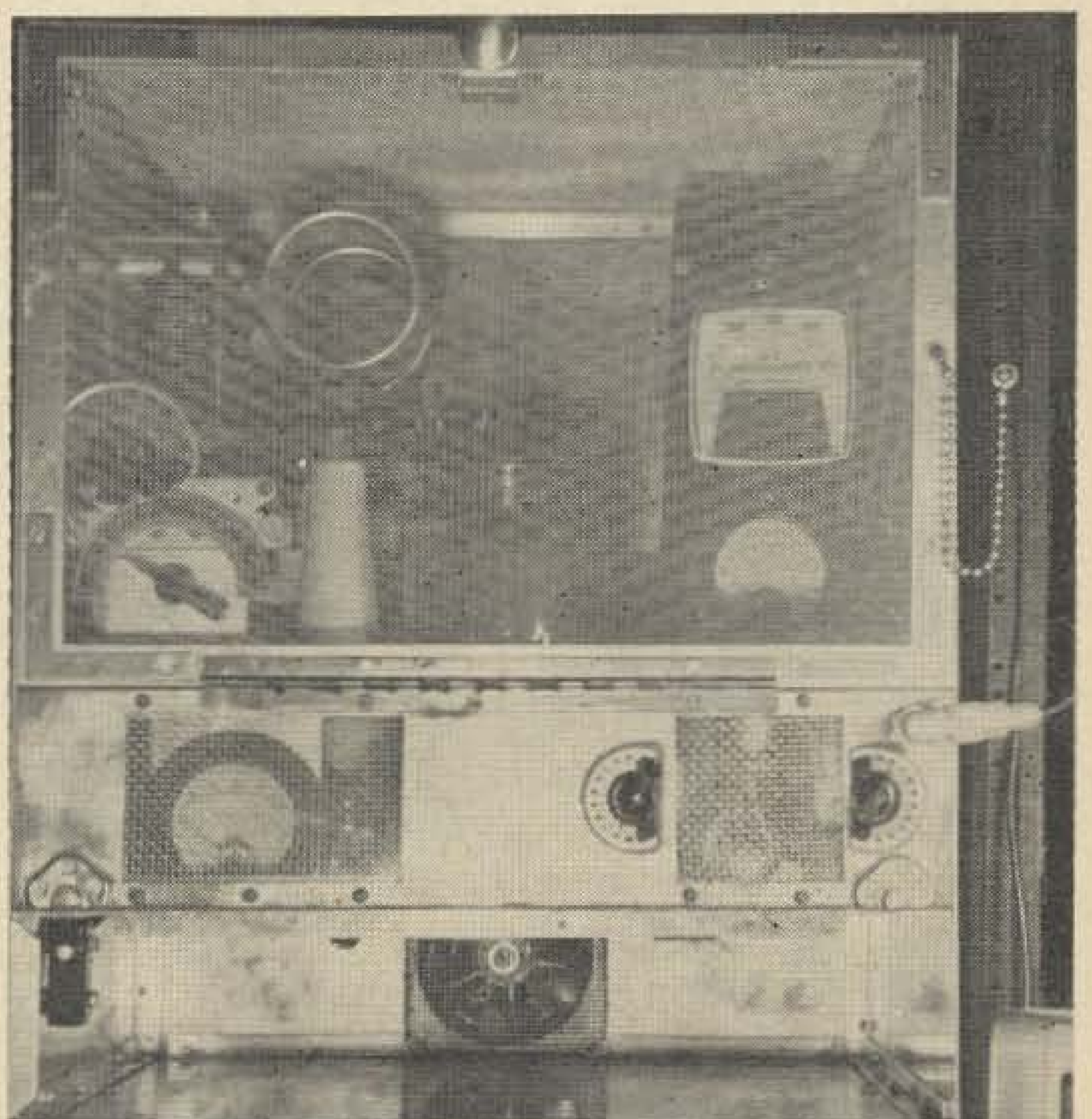

VE3AAZ's push-pull grounded-grid linear amplifier. In this view the underside of the chassis is opened up to show the blower. The screen door across the rf compartment permits changing the final plug-in coil.

Table I. Coils

	Plate Coils—Both Sides
3.5 MHz	18 turns #14, 2¼" long, 2⅜" ID, shunted by 25 pF vacuum capacitor at high end of band; shunted by 35 pF vacuum capacitor at low end.
7 MHz	12 turns #12, 2¼" long, 2⅜" ID, shunted by 10 pF vacuum capacitor.
14 MHz	8 turns ¼" silver-plated copper tubing, 2¼" long, 2¾" ID.
21 MHz	6 turns ¼" silver-plated copper tubing, 2¼" long, 2⅜" ID.
28 MHz	4 turns ⅜" silver-plated copper tubing, 2¼" long, 2⅝" ID.
	L1—Input Pi Network
3.5 MHz	8 turns #14, 2" long, 1½" ID.
7 MHz	5 turns #14, 1¾" long, 1½" ID.
14 MHz	3 turns ⅛" silver-plated tubing, close wound, 1¼" ID.
21 MHz	2 turns ⅛" silver-plated tubing, close wound, 1½" ID.
28 MHz	2 turns ⅛" silver-plated tubing, close wound, ⅞" ID.

Coil Construction

The input rf transformer is wound on an Indiana General CF-117* toroid ⅜" thick 1⅞" OD., 1⅜" ID. The primary consists of a 0.010 copper strip, 3/16" wide, placed next to the core. The pushpull secondary winding consists of 150-ohm twin lead wound over the primary strip; 14 turns for 80, 40 and 20 meters, 12 turns for 20, 15 and 10.

The output transformer is wound on an Indiana General CF-124 form ½" thick, 2" ID and 3½" OD. The primary consists of a 0.010 copper strip, ¼" wide placed next to the core. The push-pull secondary winding is made from two ⅛" wide 0.010 copper strips; insulated by #9 Teflon tubing and wound over the primary strip; 9 turns for 80, 40 and 20, 7 turns for 20, 15 and 10. Two CF-117 cores are mounted in the center of the larger core as shown in photographs.

These cores from Indiana General are available in two different materials designated Q1 and Q2. Material Q1 has a nominal relative permeability of 125, while Q2 has a nominal relative permeability of 40. In the both the input and output cores used in this linear, Q1 cores were used for 80–20 meters, and Q2 cores were on 20, 15 and 10.

*Indiana General cores may be purchased from Permag Corporation, 88-06 Van Wyck Expressway, Jamaica 18, New York.

account for an additional 10 pF or so, we are just not going to be able to meet our specification. *It is only a slight comfort to know that parallel connection and a Q of 12 would call for 12 pF on 28 MHz–8 pF being contributed by the tubes.* Nor can we evade the issue by dropping the plate voltage and then calling for lower load impedances to give the rated power. When the "C" is too large and the "L" is too small we lose power in the tank circuit; if we drop plate voltages, we sacrifice plate efficiency and lose power at the plate. The only way out seems to be to use as large a coil as possible and keep its losses low—silver plated copper tubing was used here for the coils with jumbo banana plugs and jacks. In any case, be prepared to accept the drop in power as frequency rises with good grace. For these reasons no L/C values are shown in **Fig. 1**—anyone wishing to copy the design will have his own approach to this matter—he might even have a split-stator vacuum variable in the junk box! I didn't.

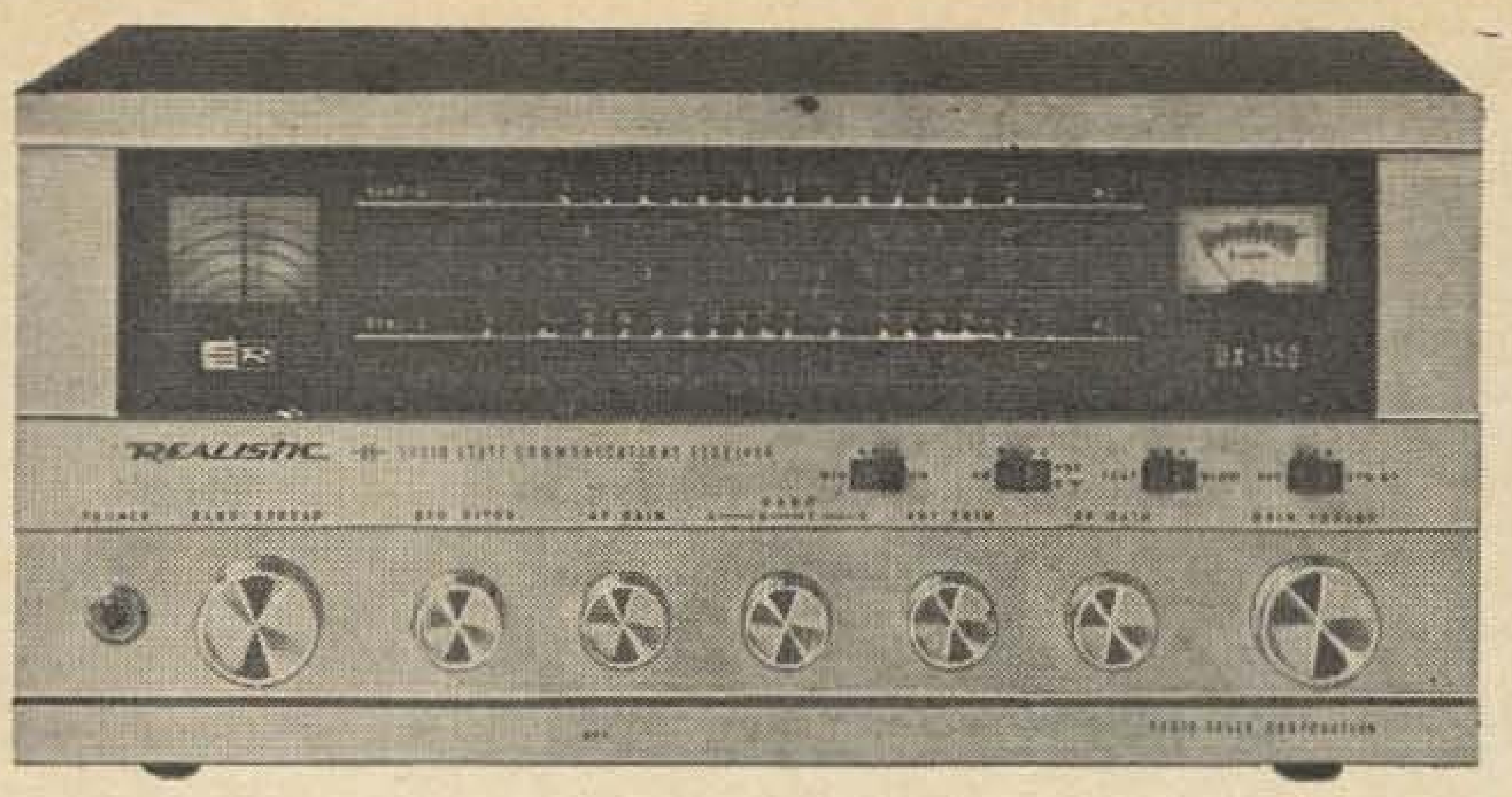
Power and distortion

It has become fashionable to rate linear amplifiers at so many watts PEP input. Aside from the rather impressive numbers generated, there seems to be little to recommend the practice. It is far more meaningful to quote the CW output and the PEP output consistent with good linearity—and with due respect to legal restrictions on power input.

With a 1 kW dc input, this amplifier yields at least 600 watts output on the 3.5, 7, and 14 MHz bands, shading off to 550 watts on 21 MHz and 500 watts on 28 MHz. The PEP output with good linearity is at least 1 kW on the low bands tapering off to about 800 watts on 28 MHz. The drive powers range from 20-40 watts, but the driver has to deliver twice this power since one-half is lost in the 3 dB pad. The power gain in the linear itself then is at least 20.

Distortion figures must of necessity describe all of the system up to the point of measurement. The published specifications for the B & W 6100 are: harmonics—50 dB or more down; intermodulation products—35 dB or more down. These figures can be met at the output of this linear driven by this exciter. Without becoming involved, therefore, in any attribution of distortion components, this amplifier does not measurably degrade the signal.

. . . VE3AAZ



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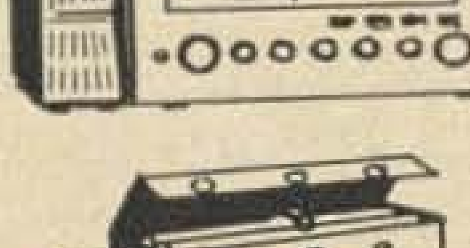

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A Frequency Calibrator for the VHF Man

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If You've ever listened to the "VHF Nut Net" on 3815 kHz, Mondays at 0500 GMT, you've heard the elaborate scheduling between stations for long-haul VHF QSO's. The current schedules are mostly on two meters, near the bottom end of the band, via meteor-bursts. The frequencies quoted are usually given in kHz above 144 MHz, and these serious VHF'ers *mean* it when they say 144.013 MHz.

While most serious VHF'ers *can* be on at least one two-meter frequency to a tolerance of ± 100 Hz, there are occasional apparent errors. These show up in the comments on the "VHF Nut Net" like: "I listened for you on 144.006 MHz last Wednesday, but didn't copy. I did hear a few 'pings' up at 144.008 MHz, though. That couldn't have been you, could it?"

To assure oneself of being on some arbitrary VHF frequency to within 100 Hz is no easy task. If we could operate "right on" 144.000 MHz, it wouldn't be so hard to check; but that isn't the usual case. Rather,

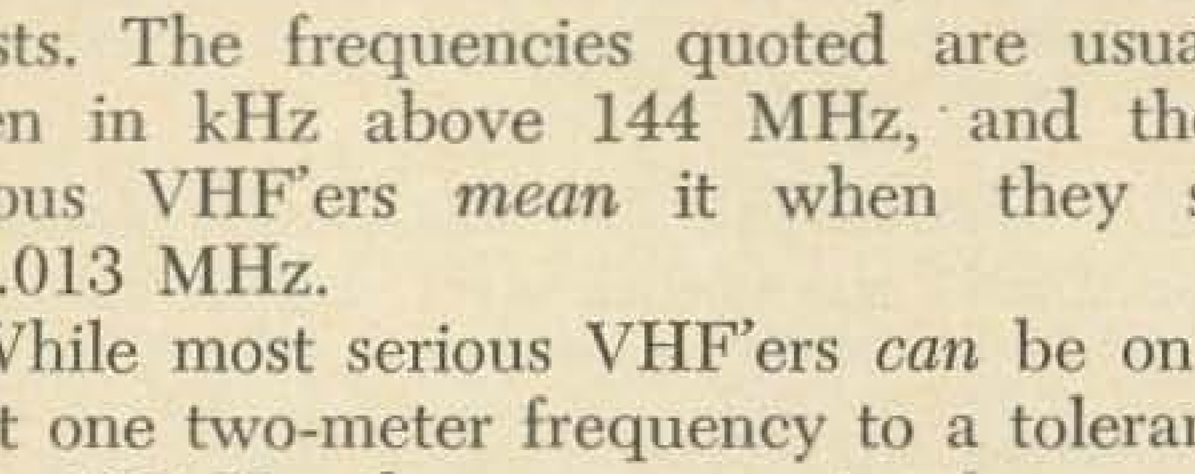

Fig. 1. Typical temperature curve of an 8 MHz AT-cut crystal. Note that the crystal frequency varies up to 0.0015% from 10° C to 40° C, a normal shack temperature range.

we are usually required to use a VHF frequency that isn't the harmonic of any of the usual standard frequency sources.

There are a number of ways of making frequency measurements of VHF signals, and they all have limitations. Basically, the problem is that we are trying to make a very precise measurement; 100 Hz in 144,000,000 is better than one part in a million. To see why stations are not always on frequency, see the frequency versus temperature curve of a typical 8 MHz AT cut crystal in **Fig. 1.** Notice that over the range from 10° C to 40° C, a reasonable "shack" temperature range, the frequency of the crystal can vary about .0015%. This much variation is over 2 kHz, when multiplied up to 144 MHz.

A logical extension of the principles used to calibrate high-frequency receivers has been used on 144, 220, and 432 MHz[1]. This is simply the use of a very fast switch in the harmonic generator section of a 1 MHz calibrator. With a tunnel diode, or snap diode, doing the switching, useful harmonics spaced 1 MHz apart can indeed be generated through 432 MHz.[2] This method is really the brute-force approach, since the harmonics we are interested in, in this case, are the 431st, 432nd, and 433rd. Harmonics spaced at 100 kHz intervals could, also, be generated in the same way, but then the harmonics of interest would be the 4310th through the 4330th!

As most hams know from experience, harmonic amplitude decreases as we look for successively higher ones. This is predicted in detail by Fourier Analysis* of nonsinusoidal waveforms. Several nonsinusoidal waveforms are shown in **Fig. 2**, with their Fourier series to illustrate this. Note that the harmonics of these two different waveforms drop off at different rates with frequency. However, both do drop off as 1/n or faster (where n is the harmonic number). Therefore, in a 100 kHz interval calibrator for two-meter use, we can expect to have *less than* 1/1440th of the signal for calibration at 144 MHz if the rate of fall off of the Fourier series is 1/n. If the fall off rate were $1/n^2$, we would have only $1/(1440)^2$th. A one volt 100 kHz signal, then, can theoretically produce a 1440th harmonic of about 0.5 μv, if the series falls off as $1/n^2$. Extension to 10 kHz-spaced marks will further reduce harmonic levels by a factor of between 10 and 100 (depending on whether the fall off rate is 1/n or $1/n^2$ respectively). To top all this off, it can be rather interesting to determine "which picket is which" in this "picket-fence" of harmonics that we've succeeded in generating.

The VHF calibrator presented here attempts to solve the fundamental problems of the brute force approach by applying techniques that are used in modern frequency-synthesis. The circuitry is admittedly more complex, but the use of integrated circuits helps considerably to ease the con-

*Fourier analysis is a mathematical method whereby a series of sine and cosine terms of the integral multiples of frequency are used in evaluating the harmonics of complex waveforms.

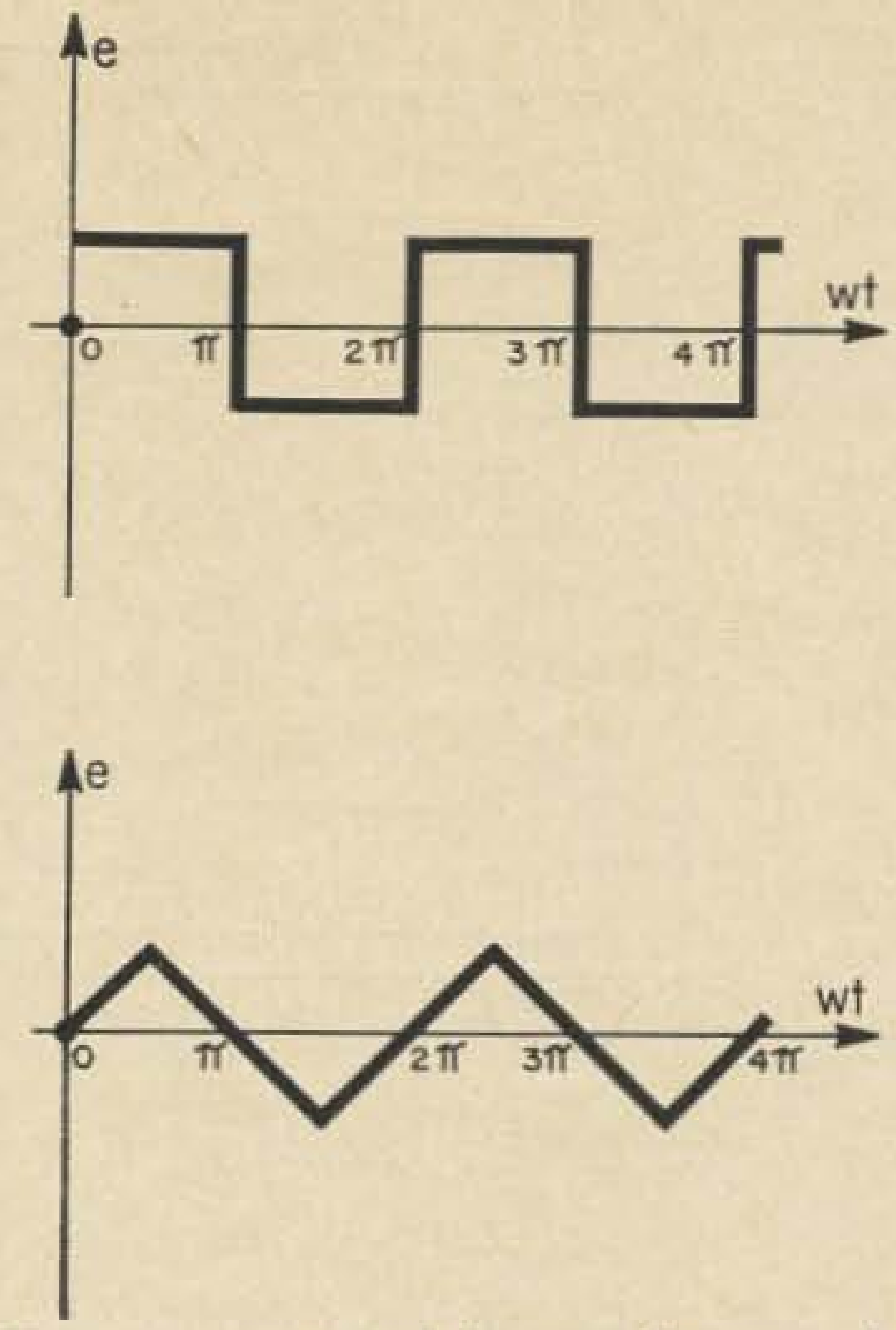

Fig. 2. Two nonsinusoidal waveforms which may be used for harmonic generation. The Fourier series of the square wave indicates that harmonics fall off at the rate of 1/n, where n is the harmonic number. The harmonics of the triangular wave fall off at the rate of $1/n^2$.*

*For those of you are so inclined, the Fourier series for the square wave in Fig. 2 is $e = A_1 [\sin(\omega t) + 1/3 \sin(3\omega t) + 1/5 \sin(5\omega t) + 1/7 \sin(7\omega t + \ldots.\ 1/n \sin(n\omega t)]$. The Fourier series of the triangular wave in Fig 2 is $e = A_2 [\sin(\omega t) - 1/9 \sin(3\omega t) + 1/25 \sin(5\omega t) - 1/49 \sin(7\omega t) + \ldots. - 1/n^2 \sin(n\omega t)]$. From the last term in these equations it can be seen that the harmonics of the square wave fall off at the rate of 1/n, while the triangular wave harmonics fall of at $1/n^2$.

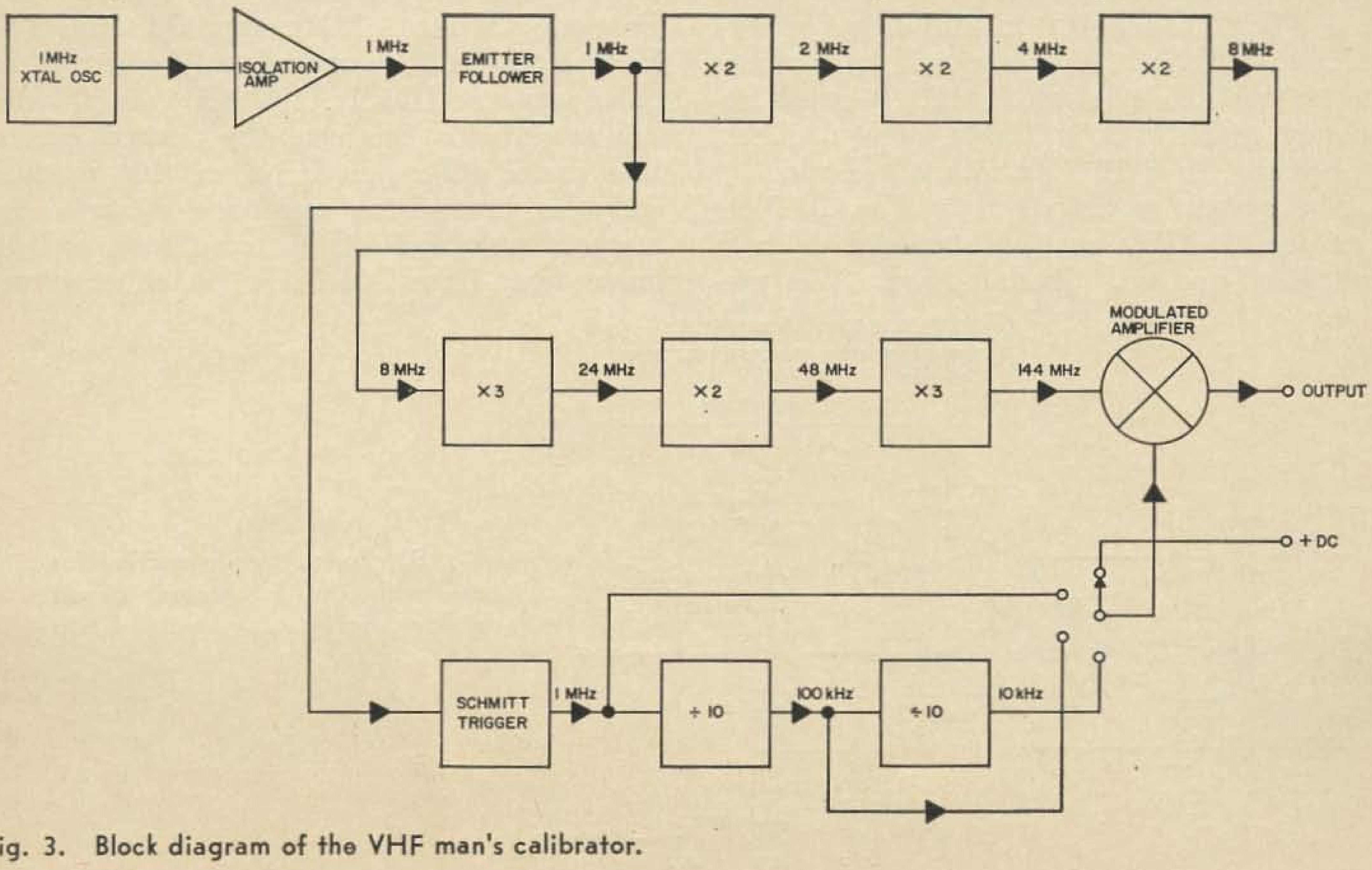

Fig. 3. Block diagram of the VHF man's calibrator.

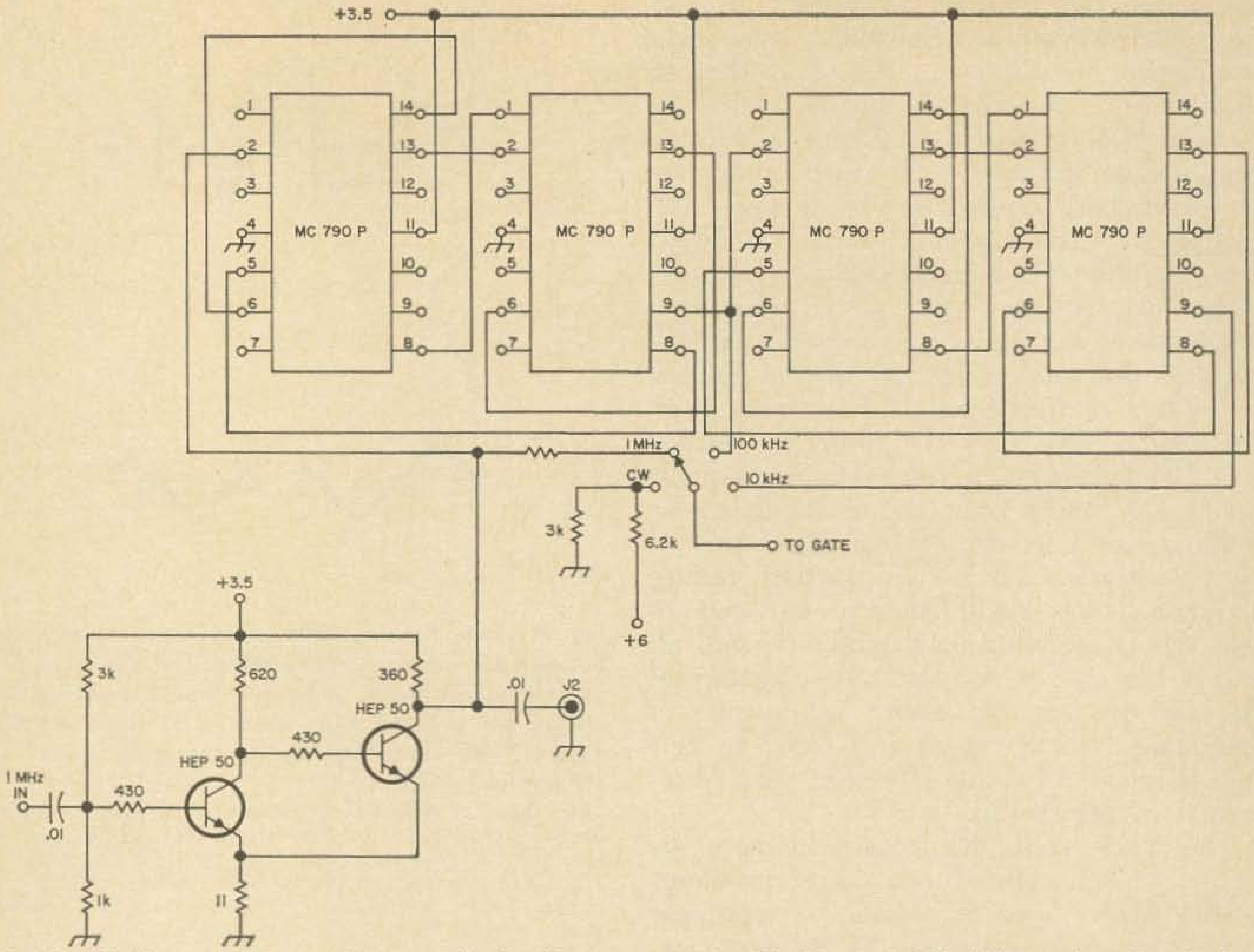

Fig. 4. Divider section uses integrated circuits to generate 10 kHz and 100 kHz marker signals from a 1 MHz crystal. The unmarked resistor in the 1 MHz should not be there—short it out.

struction job as well as to reduce the cost. This two-meter calibrator offers a choice of calibration modes: 144 MHz alone, 144 MHz ± 1 MHz, 144 MHz ± 100 kHz, or 144 MHz ± 10 kHz. The mode-switching allows one to go from a rough 1 MHz interval frequency check to a 100 kHz interval check, and finally, to a 10 kHz interval check.

The system is described in **Fig. 3.** Note that the 1 MHz crystal standard is both multiplied-up *and* divided-down. We produce, by means of a rather ordinary frequency multiplier chain, a clean 144 MHz CW signal that is exactly 144 times the frequency of the 1 MHz standard. This 144 MHz signal is then modulated by a rectangular wave at 1 MHz, 100 kHz, or 10 kHz; this modulation produces the desired marks. The main difference between this method and the brute-force approach is that our markers now fall off in amplitude as we move away from 144 MHz (in either direc-

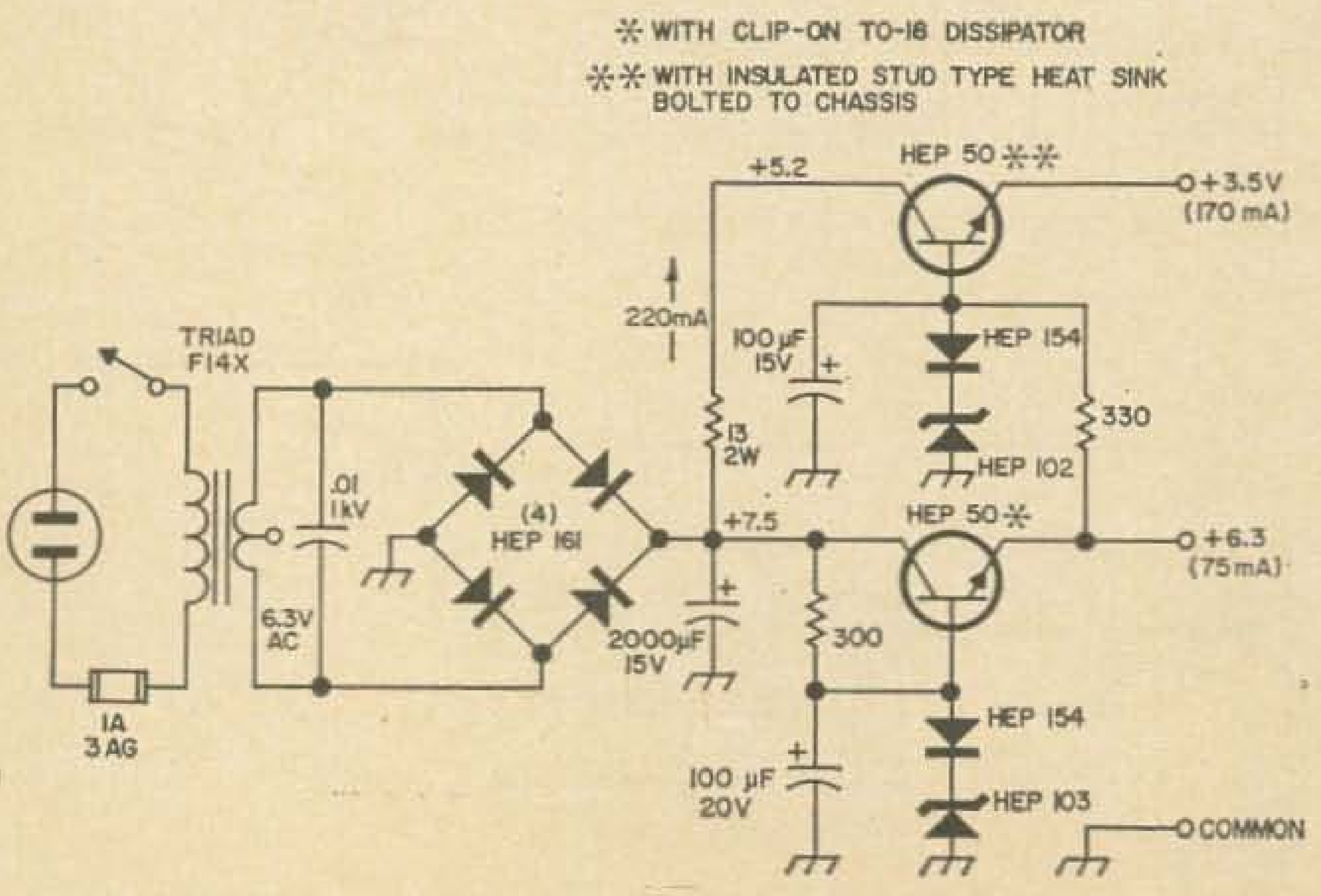

Fig. 5. Power supply section for use with the integrated circuit divider of Fig. 4.

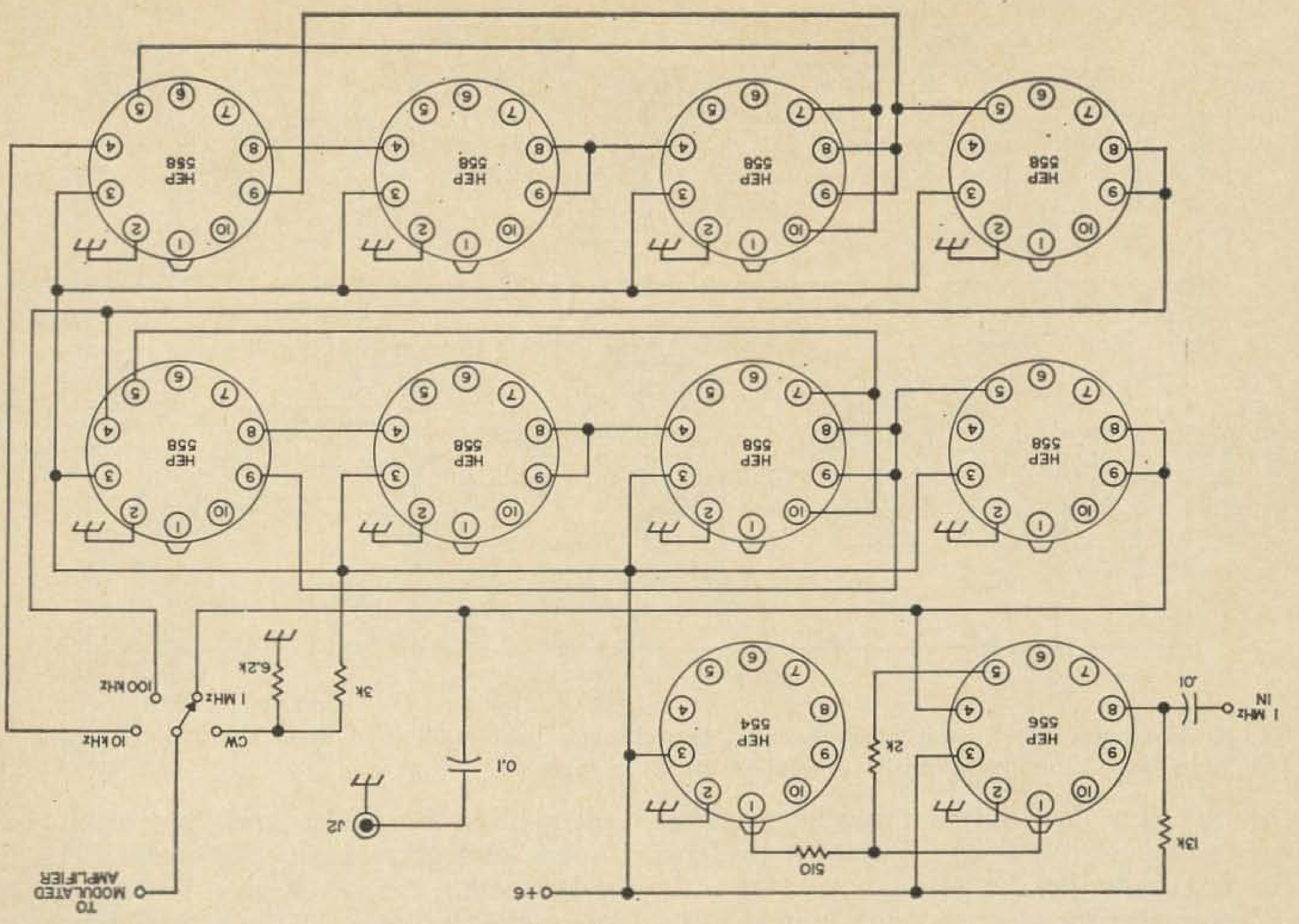

Fig. 6. Divider circuitry using HEP 558 J-K flip-flops to replace the MC790P RTL IC's which are inherently slower.

tion in frequency). Because we are now only interested in harmonics of the modulation frequency that are of relatively low order, the rectangular wave does not have to have a nanosecond rise or fall time. The "modulation" is not of the linear sort that hams usually encounter, since the rectangular wave essentially turns the signal off and on.

The circuit diagram is shown in **Fig. 4.** Note the use of digital integrated circuits. The internal circuitry of the individual IC's isn't shown since it would make **Fig. 4** vastly more complex. The Motorola HEP line of semiconductors is used for the most part, except for the four dual J-K flip flops. These J-K flip-flops are wired to divide 1 MHz by two decades. The MC790P flip-flops (Motorola) are members of a logic family called RTL (Resistor-Transistor-Logic) which is inherently slower than MECL (Emitter-Coupled Logic), to which the HEP digital integrated circuits belong.

If you wish to use HEP 558 J-K flip-flops to replace the MC790P's, the circuit changes of **Fig. 6** should be used. Since the HEP digital IC's are designed for +6 volts, a much simpler power-supply and regulator are used. The IC Schmitt trigger is of a somewhat different design than one in a previous article by the author, and follows a technique outlined in a recent Motorola application note.[3,4]

The crystal oscillator sections, in both versions, use an FET as a Miller oscillator. The Miller oscillator was used here because the DC9AJ crystal (1 MHz) was designed for that type of circuit, and has one side of the crystal grounded to the crystal can. Following the crystal oscillator is another FET, operating as a Class-A isolation stage. The isolation amplifier feeds an emitter-follower that in turn drives both the "count-down" and the "multiply-up" portions of the

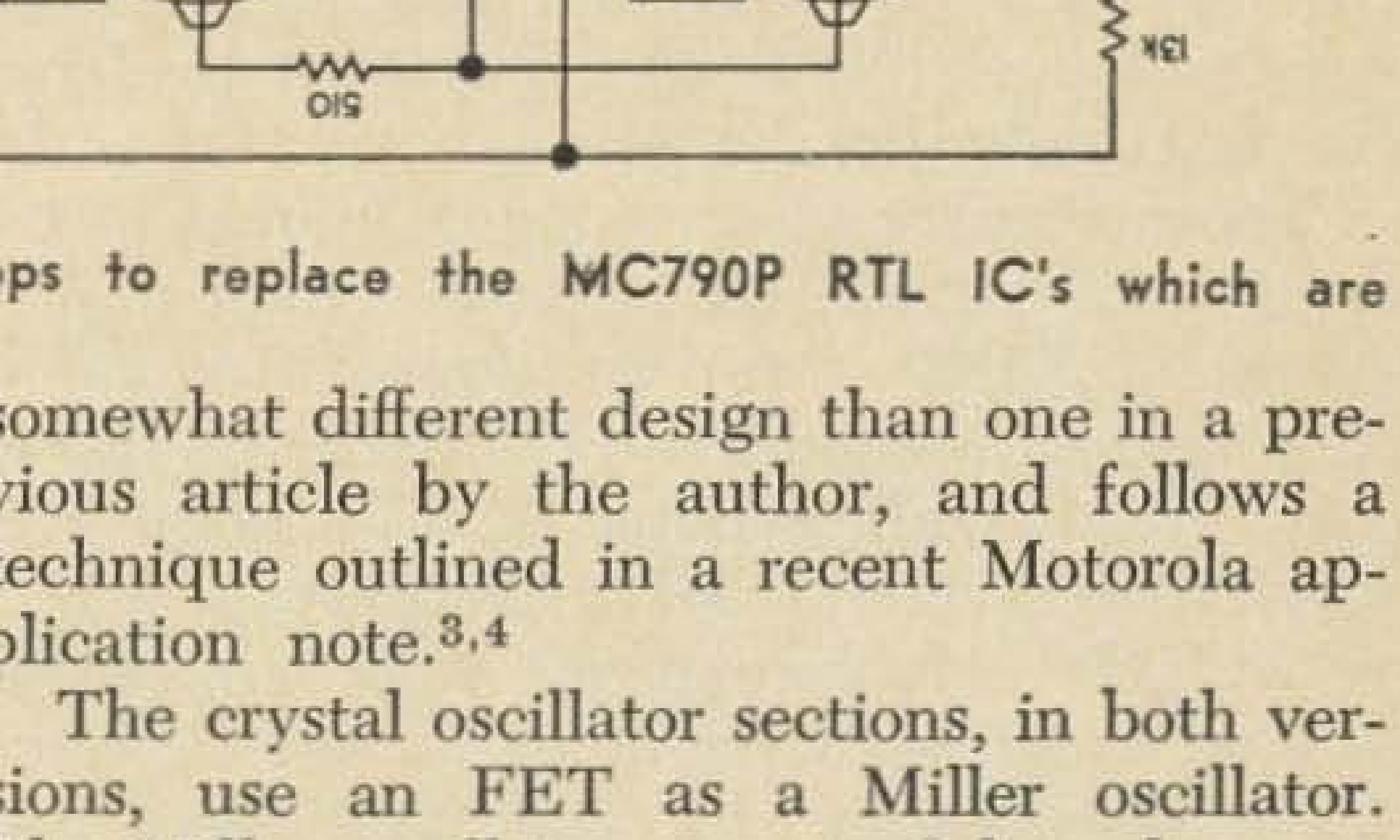

Fig. 7. Power supply for the HEP integrated circuit divider of Fig. 6.

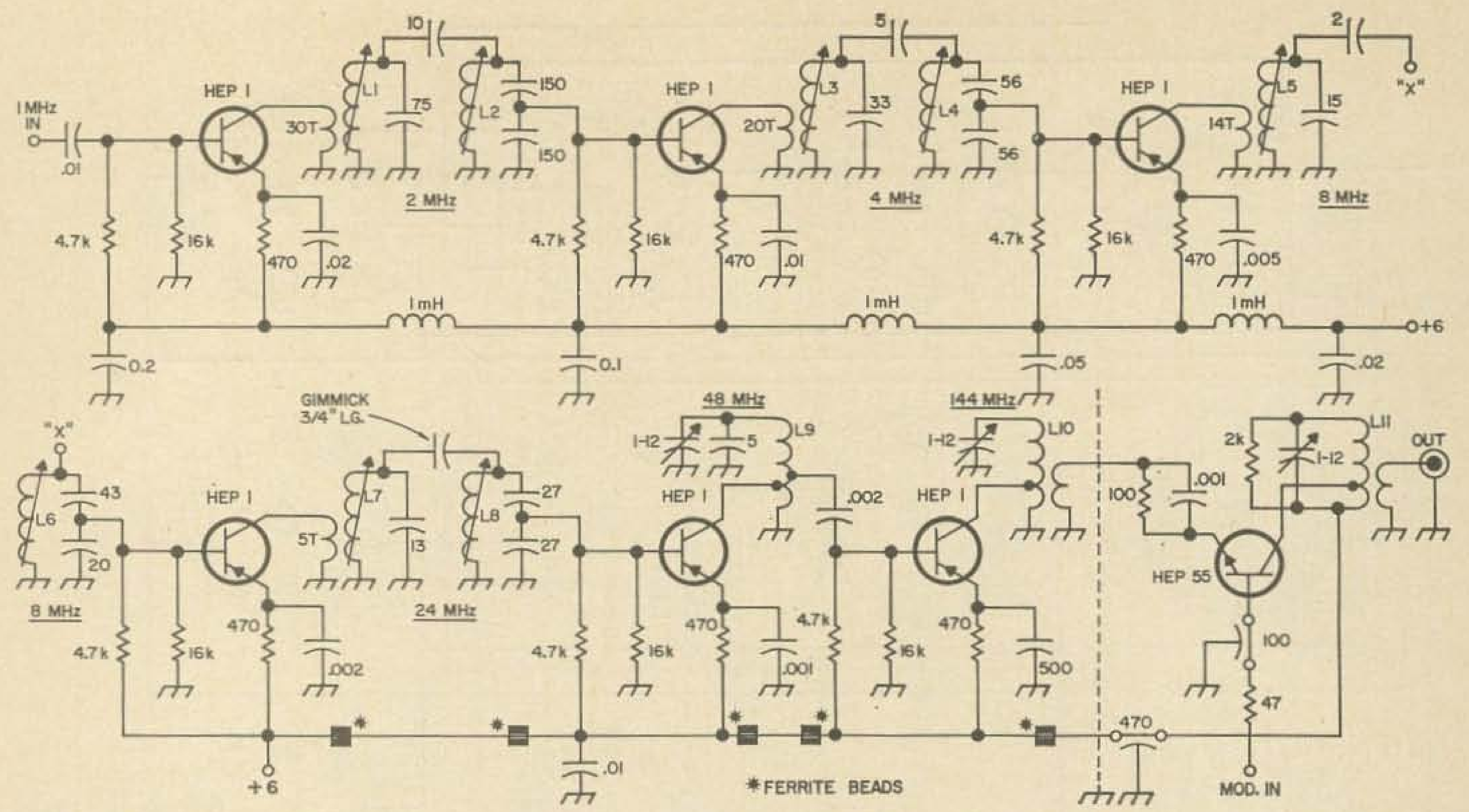

Fig. 8. The times 144 frequency multipler. A crystal controlled input at 1 MHz provides an output at 144 MHz. Coil information for this circuit is given in Table 1.

circuitry. The low output impedance of the emitter follower is needed primarily to drive the first multiplier.

The multiplier chain is conventional in its design–x2, x2, x2, x3, x2, x3–a total multiplication of 144. In the four lowest frequency stages, double-tuned interstage coupling is used. This double-tuning is to prevent the possibility of any 1 MHz, 2 MHz, 4 MHz, or 8 MHz side-frequencies from appearing around our 144 MHz signal when S_2 is in the CW position. All the multipliers are PNP mesa transistors, operated "up-side-down" so that the +6 volt supply feeds their emitters. The modulated amplifier is a grounded-base stage, with the base as the modulation-control element.

Tuning of the multiplier section is easily accomplished with a grid-dip meter used as an absorption frequency meter. The divider section can be checked by loosely coupling the output of S_2 to a high-frequency receiver and listening for the various harmonics, say at 80 meters. If the divider section is wired correctly, it will put out the right frequencies.

Checking the divider section with a high-frequency receiver, points out a potential problem. If the frequencies generated by the divider section are allowed to get into the receiver that is used as an *if* for your VHF converter, confusion will reign. The overall shielding of the calibrator, the general supply lead decoupling, and the VHF bandpass nature of the modulated amplifier are adequate to prevent such a problem in the units

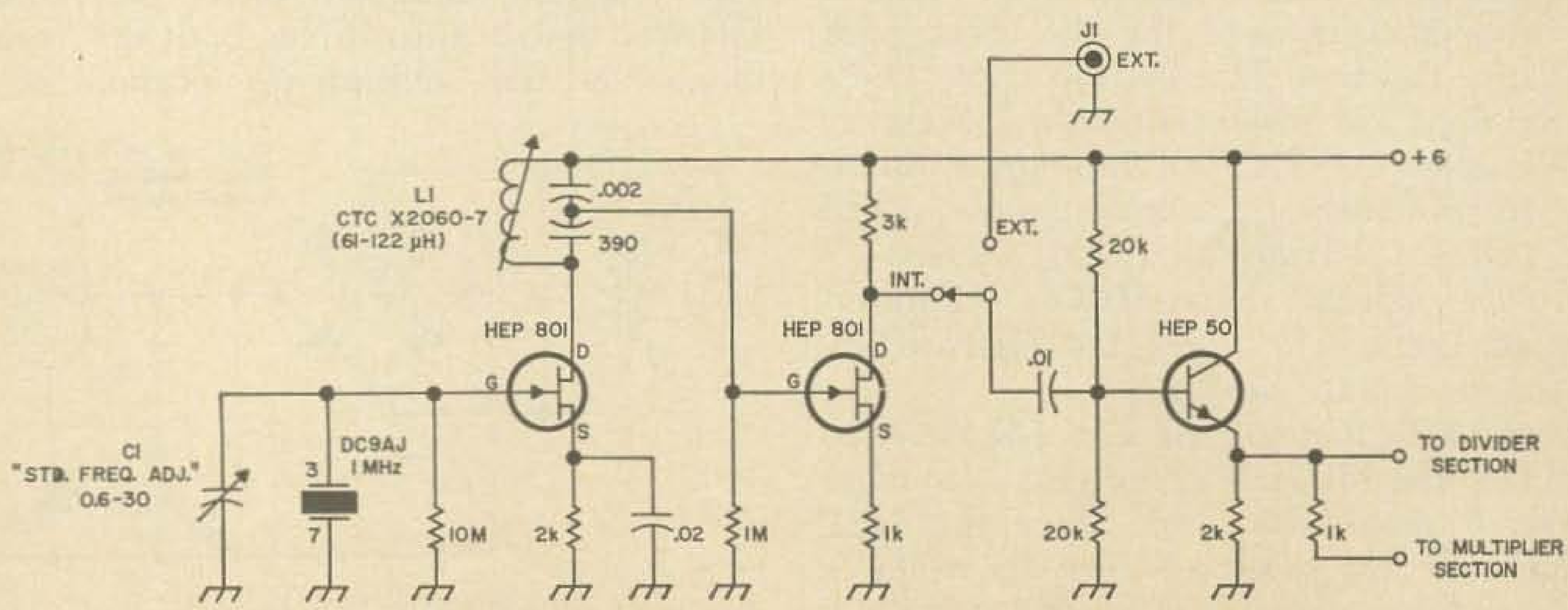

Fig. 9. One MHz oscillator-buffer section.

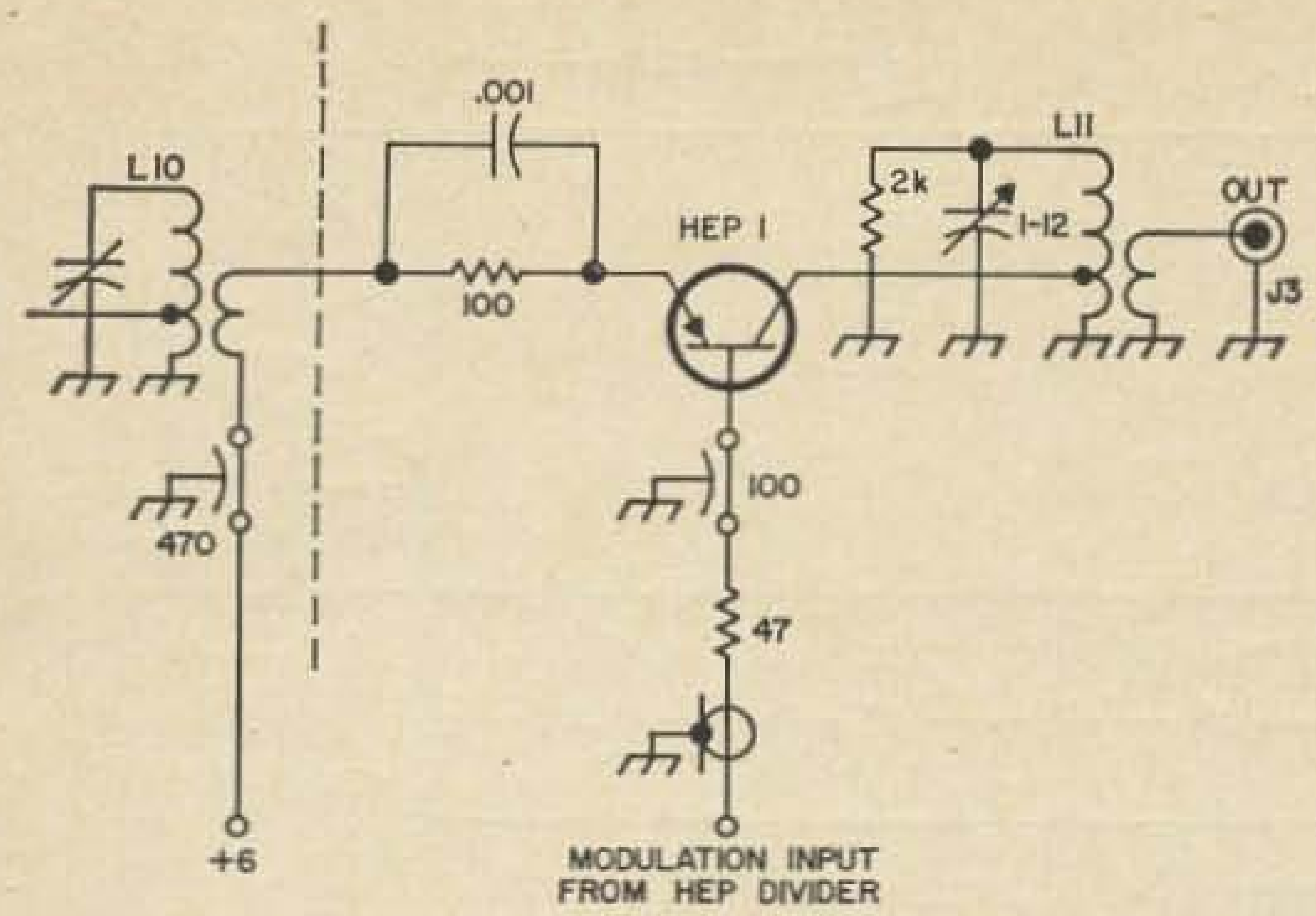

Fig. 10. Modulated amplifier for use with the HEP divider section. This circuit replaces the last HEP 55 stage in Fig. 9. when HEP IC's are used.

shown.

However, 1 MHz harmonics *can be* purposely coupled out (from the Schmitt Trigger) via J_2. These 1 MHz harmonics are used to beat with WWV on 5, 10, 15, or 20 MHz (in a high frequency receiver), for calibrating the 1 MHz crystal oscillator.

Operation of the calibrator would then be as follows. Couple the 1 MHz harmonic output (J_2) to the receiver with a small (5 pF) capacitor. Tune in WWV on the *highest* frequency that provides satisfactory reception. Adjust C_1 (the 1 MHz crystal oscillator frequency control) for zero beat. Zero beat is best observed on the "S" meter of the receiver. This is because the low-cutoff frequency of the receiver audio amplifier won't pass near-zero beat notes for aural monitoring. Disconnecting the cable from J_2,

Table 1. Coils used in the times 144 frequency multiplier

- L1 = CTC (Cambion Thermionic Corporation) X2060-7 with 30 turns #28 on primary winding.
- L2 = CTC X2060-7
- L3 = CTC X2060-6 with 20 turns #28 on primary winding.
- L4 = CTC X2060-6
- L5 = CTC X2060-5 with 14 turns #28 on primary winding.
- L6 = CTC X2060-5
- L7 = CTC X2060-1 with 5 turns #28 on primary winding.
- L8. = CTC X2060-1
- L9 = 10 turns Airdux 416, collector tap at 2½ turns, base tap at 3 turns.
- L10 = 7½ turns #12, ¼" inside diameter. Collector tap at 3 turns. Secondary is 2 turns #20 solid insulated hookup wire.
- L11 = 7 turns #12, ¼" inside diameter. Collector tap at 2 turns. Secondary is 1½ turns #20 solid insulated hookup wire.

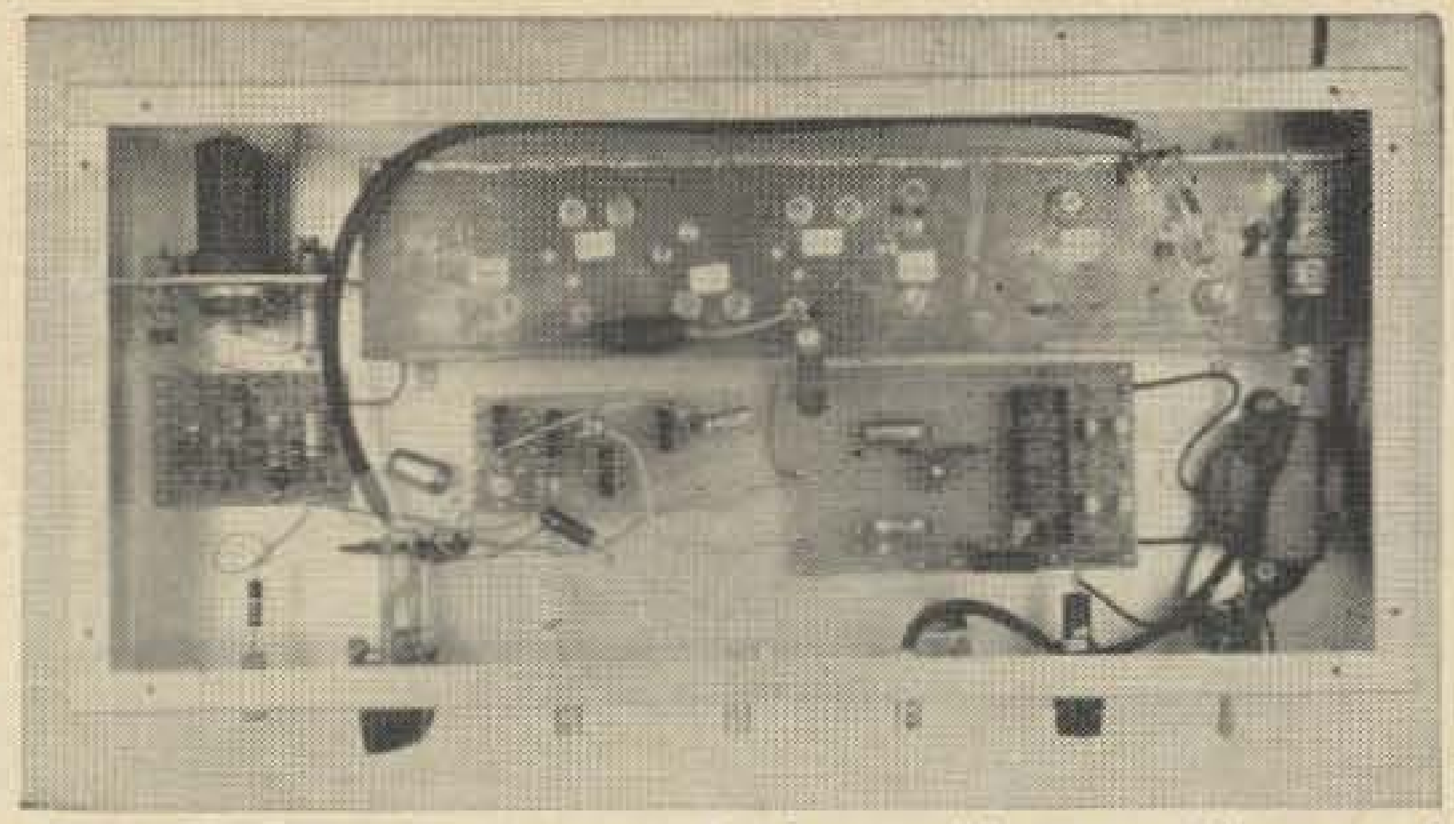

Fig. 11. Construction of the calibrator illustrated schematically in Fig. 4. Motorola MC790P dual RTL J-K flip-flops are used in the divider section.

the VHF output of the calibrator (J_3) is coupled to the VHF converter by means of a directional coupler and attenuator. The total decoupling between the calibrator and receiver should be about 50 dB. A temporary expedient for coupling the receiver to the calibrator may be used: a 6 to 12 inch piece of wire is simply connected to J_3 to radiate the calibrator output into a nearby antenna.

S_2 is first put in the "CW" position and 144 MHz found on the receiver. Then the switch is set to "1 MHz" and 144, 145, 146, 147, or 148 MHz found (which ever is closest to the desired operating frequency). Then we switch to "100 kHz", and finally to "10 kHz", selectively pinning down our frequency.

If desired, another decade could be added to the count-down circuits to give 1 kHz intervals. Also, another tripler could be added to the multiplier chain, making the calibrator useful at 432 MHz.

Another intriguing possibility is the use of WWVB (60 kHz) or WWVL (20 kHz) as a calibration signal. By using a divide-by-five circuit on the 100 kHz output of the first decade divider, a 20 kHz signal for

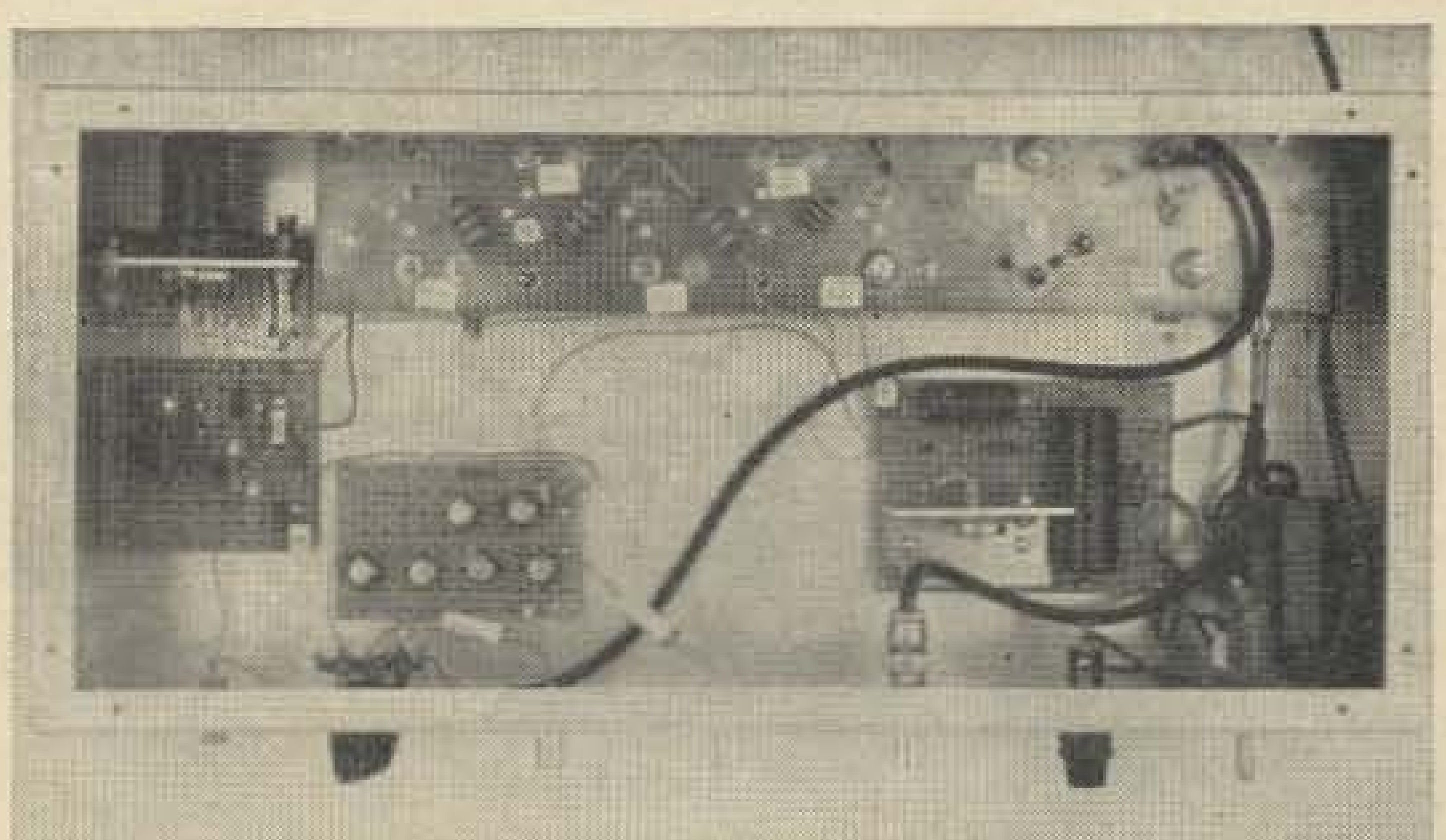

Fig. 12. VHF calibrator built with HEP 558 J-K flip-flops in the divider section. This photograph shows the unit in early stages of construction, with only one decade of dividers in use. Later four more HEP 558's were added to provide a second decade.

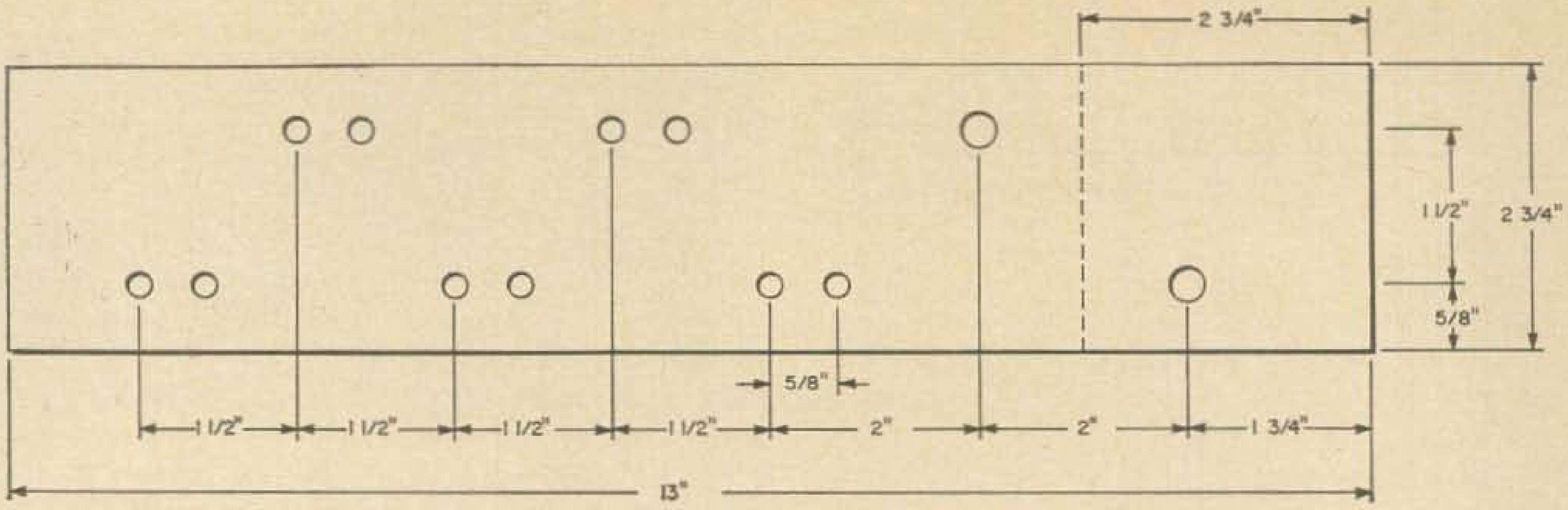

Fig.14. Template for the top plate of the multiplier assembly.

comparison with WWVL is produced. By simply putting this 20 kHz rectangular wave (which is rich in third harmonic power) into a 60 kHz tuned amplifier, a 60 kHz signal is produced for WWVB comparison.

You might ask why we didn't divide 100 kHz by five and then 2 to obtain 10 kHz, allowing a 20 kHz pick-off after the divide-by-five section. That was not done because it produces a *symmetrical* 10 kHz square wave for calibrator use. This type of waveform has very small even-harmonic power.

Construction of both units was in modular form, with the individual modules enclosed in a 8 x 17 x 3 inch aluminum chassis which serves as a cabinet. **Fig. 11** and **12** show the two calibrators built by the author.

The multiplier chain assembly (which also contains the 144 MHz modulated amplifier stage) is built from copper laminated board which is used in making etched circuits. This material is easily sheared, drilled, punched, reamed, and soldered. The bottom view of one of the multiplier chains is shown in **Fig. 13** and its top-plate template is shown in **Fig. 14.** Note in **Fig. 13** that alternate multiplier stages have their transistor cans inverted; this was necessary because of the coil-mounting positions. The coils were mounted on alternating sides of the "strip" to assure stability since there is no shielding between multipliers. There *is* a shield between the 48 MHz to 144 MHz tripler

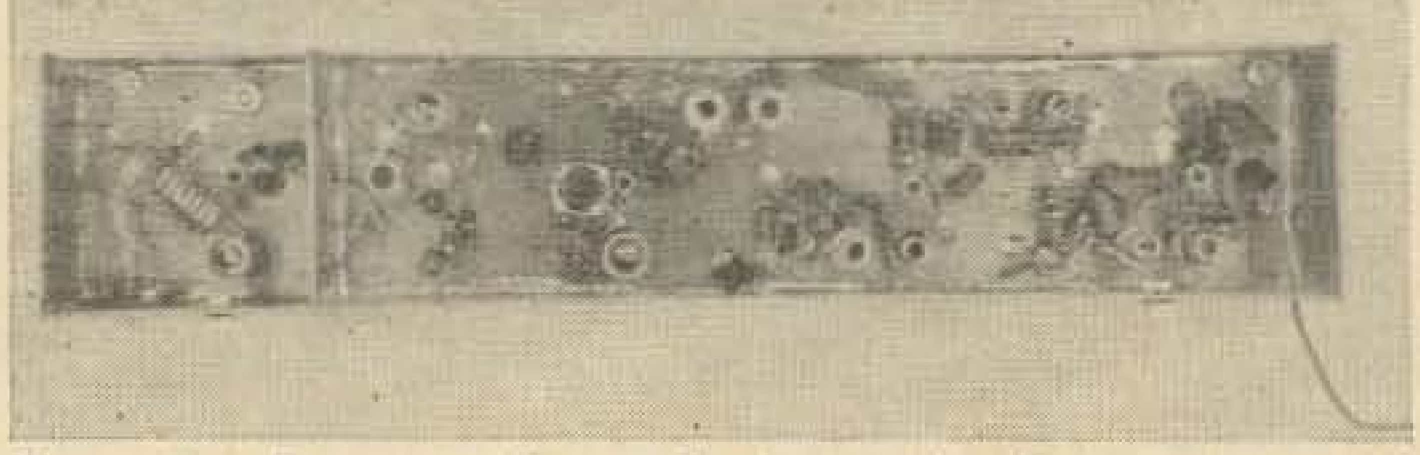

Fig. 13. Bottom view of the multiplier section of the VHF calibrator. A second tripler section could be added for use on 432 MHz.

and the 144 MHz modulated amplifier stage, of course.

Except for the crystal oscillator, capacitor C, and inductor L_1, the crystal oscillator circuitry is built on a piece of Vector board (64AA18). The crystal, C_1 and L_1, are mounted next to the oscillator board on a metal bracket. The metal bracket is positioned so that L_1 and C_1 may be adjusted through two holes in the rear of the cabinet.

The power supply is also built on Vector board except for the transformer and one of the regulator transistors in the dual-voltage version.

The divider units are also built on Vector board. Vector 64AA18 is used in the unit with the HEP IC's with holes in the board in which to mount epoxy HEP 451 sockets. The divider unit that uses MC790P type IC's is constructed from Vector 85G24EP because the hole-spacing is adaptable to the IC pin-spacing. Vector pins (T28) are used for this 85G24EP board, whereas Alden 651T terminals are used for the 64AA18 board.

The calibrators described above have proved very useful in two-meter frequency measurement, both in measuring meteor-scatter stations' frequencies and in accurately measuring MARS frequencies at 143.950 and 148.010 MHz. Though somewhat more complicated than most calibrators, either can be built in a few evenings of persistent fabrication.

. . . W6GXN

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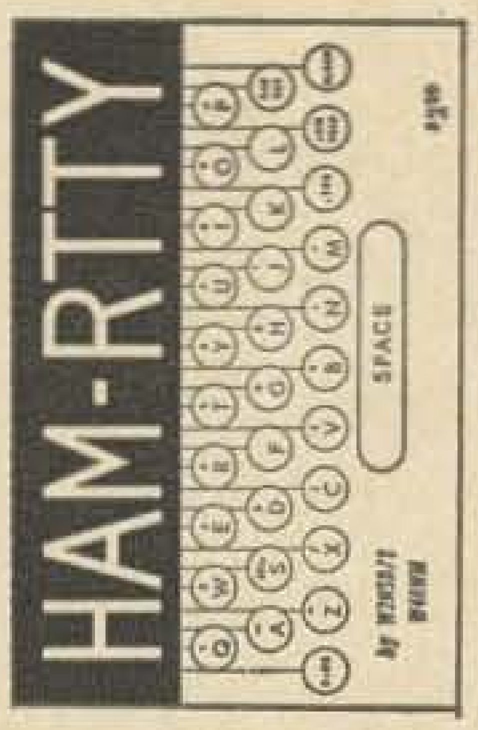

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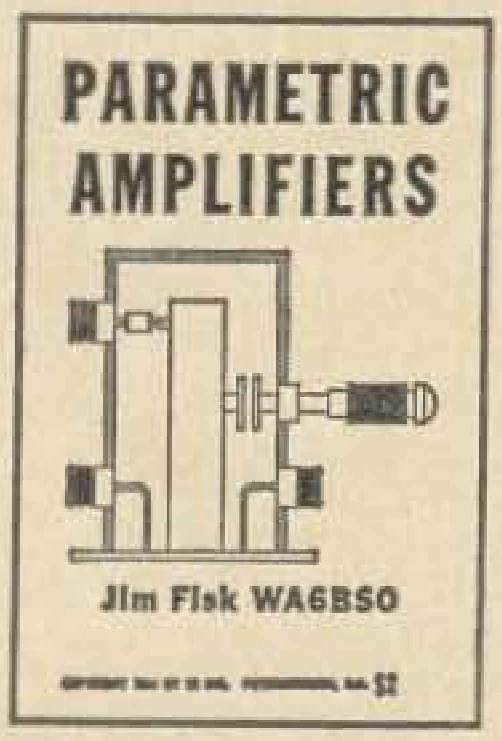

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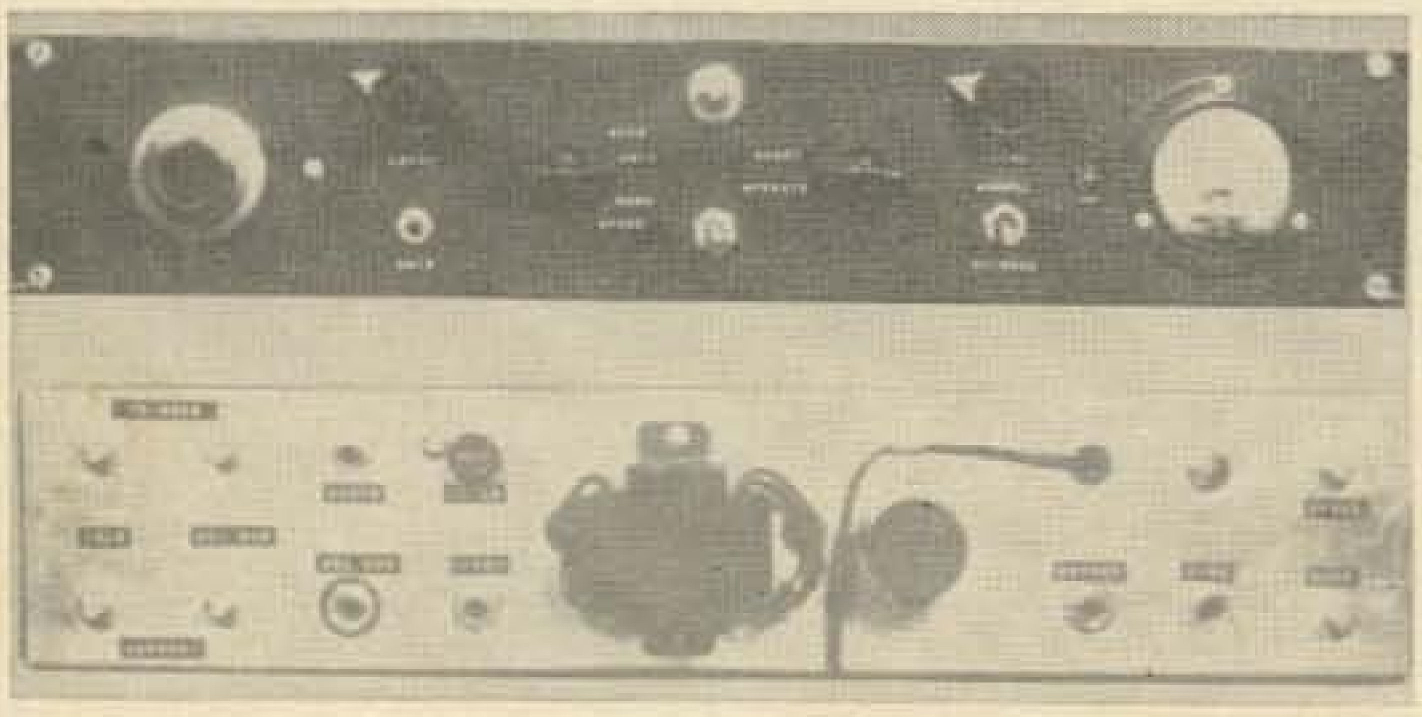
The Semi-RTTY System

A high performance solid-state AFSK oscillator and tuning unit for the RTTY man. Silicon controlled rectifiers are used to drive the printer magnet.

Early in 1966 I acquired an RTTY printer-keyboard and started building gear to get it on the air. I'm strictly a six-meter man, so it had to be AFSK. Two articles had appeared in ham magazines which caught my fancy and I decided to use their ideas for my system.

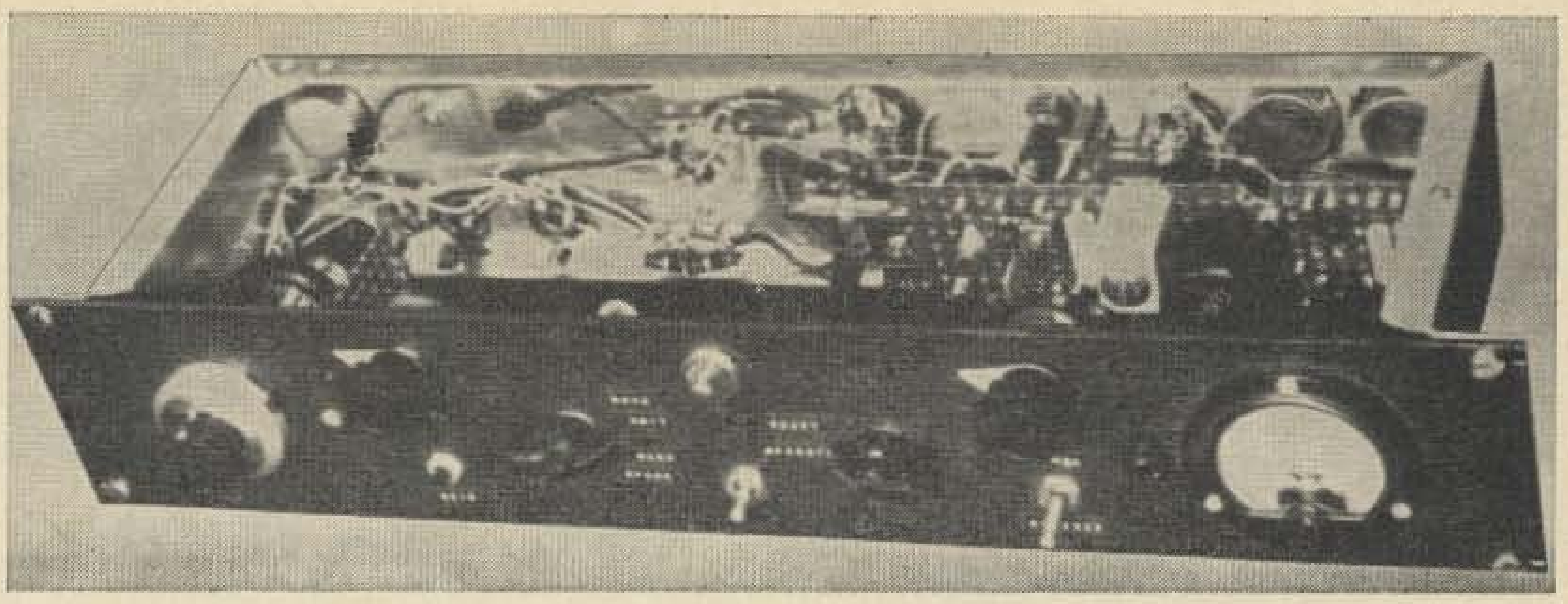


Front and back view of the Semi-RTTY unit. On the front panel, top, the AFSK is to the left, the TU on the right. The ten turn pot on the extreme left is not used. In the back view, bottom, the TU controls are on the left, AFSK on the right. The power transformer and filter capacitor are mounted in the center.

The first was by a friend in Nebraska, Gene Austin, WØLZL, on a thyratron tuning unit.[1] I wanted my system to be all solid state, so I started adapting Gene's ideas to a silicon controlled rectifier (SCR). To cut a long story short, Gene's system of feeding the output of each filter to a thyratron did not work for me—both SCR's turned on at the same time from noise pulses, etc. About this time I ran across a discriminator circuit which I thought would be ideal to prevent the above situation if a suitable triggering circuit could be devised for the SCR's.

The second article was by Tom Lamb, K8ERV.[3] I built his circuit as described, but never used it on the air; I was dissatisfied with the shape of the signals generated by it. I'm sure this could have been cured by more carefully selecting filter components. However, being basically lazy, I decided to concoct something simpler and more straightforward. The upshot is a simple phase shift oscillator with a variable shift network.

Top view of the Semi-RTTY system. The tuning-unit circuit board is on the right. The FET in the AFSK oscillator is soldered to the pot in the upper left hand corner of the chassis.



As I built the AFSK unit described by K8ERV I was disturbed by the idea of generating a non-sinusoidal signal and then filtering out all but the fundamental component. It seemed that too much care had been devoted to selecting components for the filter. Also, his system involved some 45 components excluding the power supply—my junkbox wouldn't stretch that far.

The phase-shift oscillator which replaced K8ERV's circuit has the good points he required in his article—equal mark and space output levels, no switching transients, isolation from the keyboard, a simple shift system—plus the advantages of lower cost and simple adjustment and operation.

The phase-shift oscillator is the simplest circuit I could find in common transistor circuit handbooks.[5] Two basic changes were made to this circuit. First, R_1 was made adjustable to set the mark frequency (2125 Hz). Secondly, R_2 is tapped and an FET placed between the tap and ground.

An FET will conduct as long as the gate-source and gate-drain junctions are not reverse biased.[2] With the gate grounded, the U112 FET exhibits about 500 ohms between source and drain. However, when a positive voltage (greater than 6 volts for the U112) is applied from gate to source, the U112 is "pinched-off". In the pinched-off state the resistance from source to drain is extremely high and can be considered to be infinite for our purposes.

With positive voltage on the gate of the U112, the phase-shift circuit is unaffected and the mark frequency can be set with R_1. When the gate is grounded (positive signal removed) the U112 conducts, placing 500 ohms across a portion of R_2, lowering the resistance of this arm of the phase-shift network, and raising the frequency of the oscillator. In this state, the space frequency (2975 Hz), can be set with R_2.

As long as a voltage greater than six volts is applied to its gate, the U112 will be pinched-off. This gives complete isolation from any resistance changes in the keyboard—if the divider network is properly designed. The circuit values shown draw a little less than 10 mA through the keyboard contacts to keep them clean, and any changes in keyboard contact resistance are small compared to 3k ohms.

The positive signal for the gate can be derived as shown, or from the printer local loop. In either case be sure to have a small resistor from gate to ground. The input resistance of these devices is so high that a charge on the 10 pF gate-source capacitance will take a *long* time to decay (the better part of a second!) unless shunted by a much smaller resistance. The decay has the effect of slurring the markspace transition, and is slow enough to be easily heard. Also, be sure not to exceed the gate-source breakdown voltage, listed as 20 volts maximum for the U112.

Output of the oscillator is several volts peak-to-peak. The fixed resistor in the collector circuit isolates the output load from the phase-shift network. Without this, set-

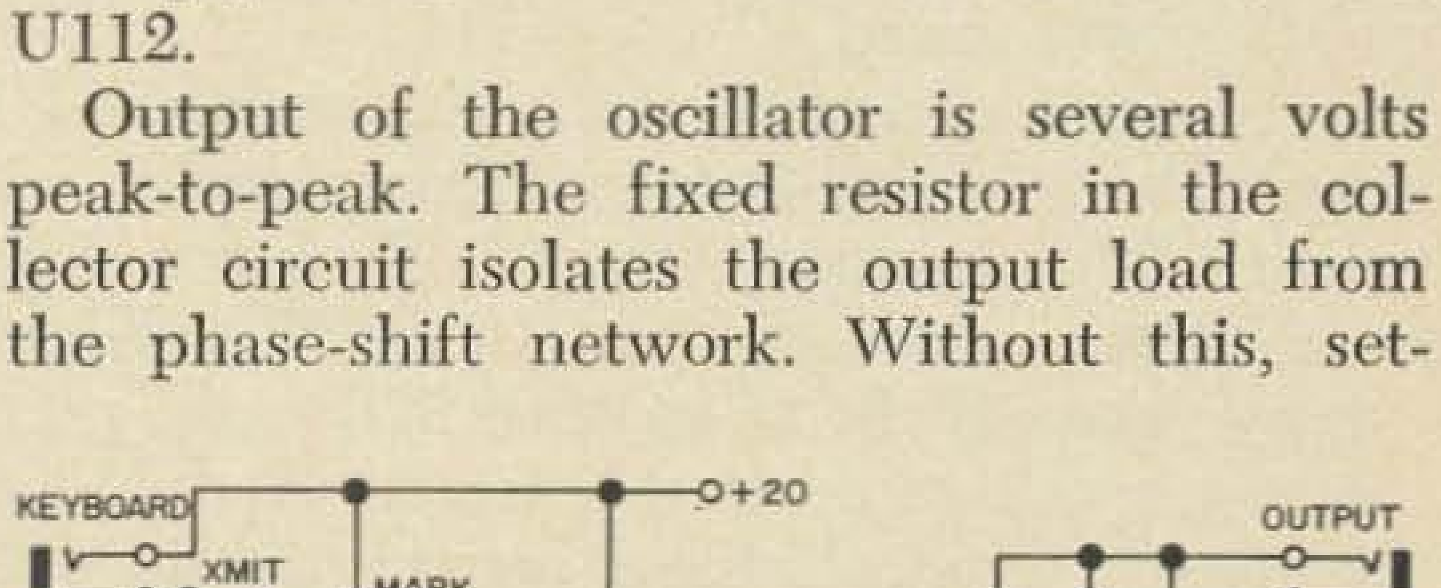


Fig. 1. The AFSK phase-shift oscillator used in the Semi-RTTY system. This circuit features equal mark and space output levels, no switching transients, isolation from the keyboard and a simple shift system—an FET used as a resistor.

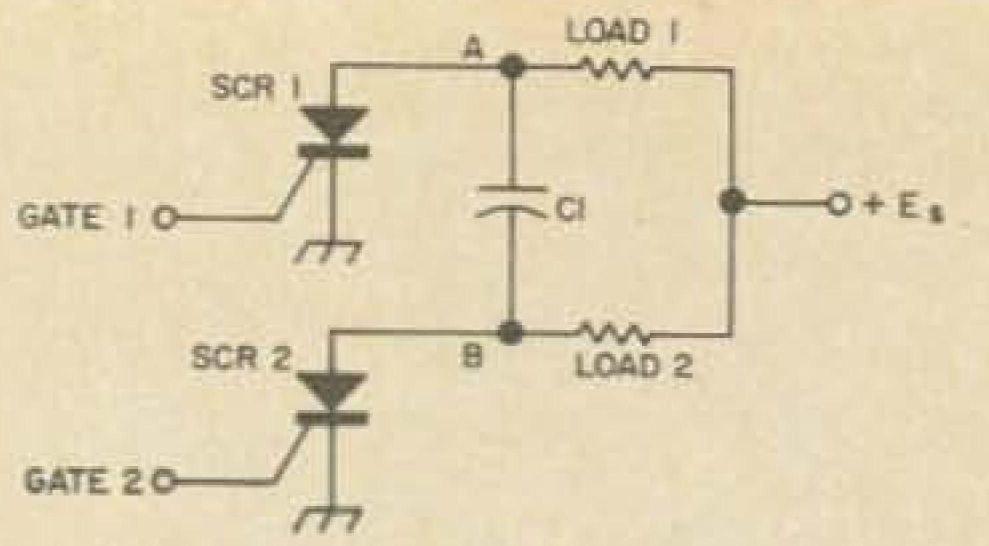


Fig. 2. Basic SCR circuit which is used to drive the printer magnet.

ting the output pot to the collector end loads the network and reduces the frequency of oscillation. The oscillator as shown is sensitive to supply voltage changes so a regulated supply is necessary. In its simplest form the AFSK oscillator can be built into a small minibox for around $10.

The terminal unit posed more of a problem. There are several good transistorized circuits available, but they all use 30 volts or less to drive the selector magnet. When I was having trouble with my original converter, a friend pointed out that the selector magnet would not pick up properly unless the change of current versus time were large; this requires a large voltage driving the magnet. My printer would not print properly with a 20 volt supply, but with a 100 volt supply it would (both at 60 mA, of course). A solution to this problem might be to purchase some of the high-voltage transistors available. However, the ham fund was low and the SCR's were on hand, so they were used.

As mentioned in the introduction, the SCR equivalent of the thyratron commutator was used.[7] This is simply a method of switching a dc load on or off using two SCR's. Essentially, when SCR_1 is on, and SCR_2 off, point A is grounded and load 1 is activated. When a positive control signal arrives at the gate os SCR_2, it turns on, grounding point B. Capacitor C_1 has been charged to the supply

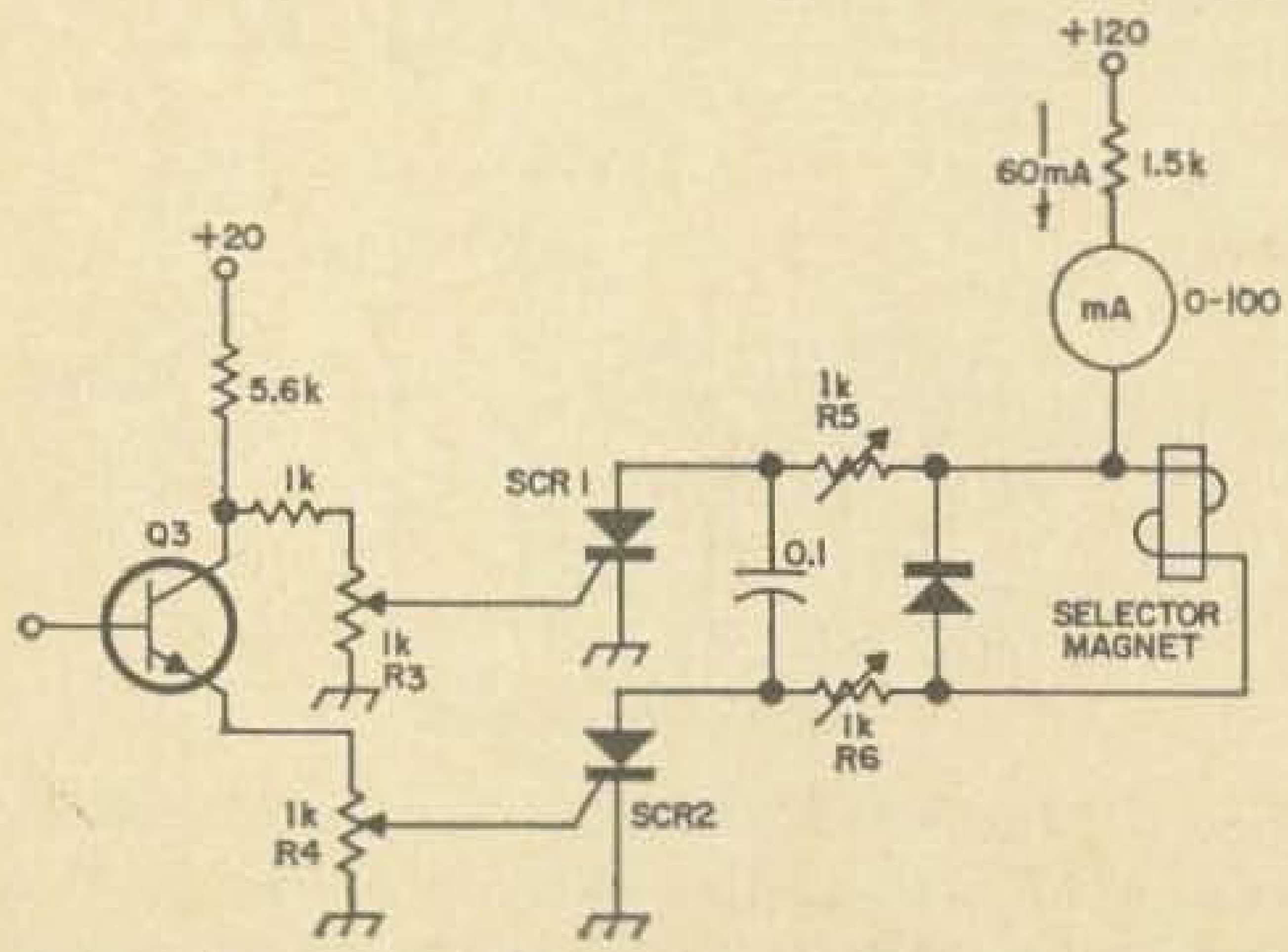


Fig. 3. The complete SCR printer-magnet driver circuit with the trigger, Q3.

voltage and grounding point B applies a negative voltage to point A, the anode of SCR_1, turning it off. SCR_1 will stay off if its gate is less positive than the necessary trigger signal. A signal at the gate of SCR_1 will reverse the action. With this commutator to carry the current for the selector magnet (at any voltage up to several hundred), the only requisite was to find a suitable triggering circuit.

Fig. 3 shows the triggering circuit, along with the actual SCR circuit in use with my printer. With Q_3 off, there is no voltage across R_4 and about 3 volts across R_3, which can be set so that SCR_1 fires. When a positive voltage is applied to the base of Q_3, turning it on, about 3 volts appears across R_4, which can be set so that SCR_2 fires. The voltage across R_3 drops when Q conducts, removing the gating signal from SCR_1. When Q_3 is turned off the action reverses again.

With this circuit in hand it is a simple matter to adapt one of the discriminators to drive the switch. **Fig. 4** shows the whole circuit. Diodes 1 and 2 provide simple limiting This is adequate for strong signals. For weaker signals, a bandpass amplifier with AGC might be added ahead of this circuit. The rest of the circuit is self-explanatory except for R_2. This provides no-signal bias to Q_3.

Tunable inductors were used for two reasons. First and foremost, they were in the junk-box. However, with tunable inductors, adjustment of the discriminator is very easy.

Tuning the system is very easy. Place the *reversing switch* to "normal" and the *standby switch* to "standby". Apply a mark signal (2125 Hz) to the input and a VTVM to the test point (TP). Tune the mark filter for maximum voltage at TP. Switch the input to a space signal and tune the space filter for minimum voltage at TP. With a large enough signal, this voltage should go negative.

Remove the signal and vary R_2 through its range. The voltage at TP should go from zero to some maximum, with a sharp knee around 3 volts. This knee marks saturation of Q_3 and should be noted. R_2 is set so that the no-signal voltage at TP is midway between zero and the saturation point.

Now apply a mark signal again and adjust the gain so that Q_3 saturates. Switch to a space signal and the voltage at TP should go negative. If the voltages from the discriminator are not symmetrical, adjust R_2

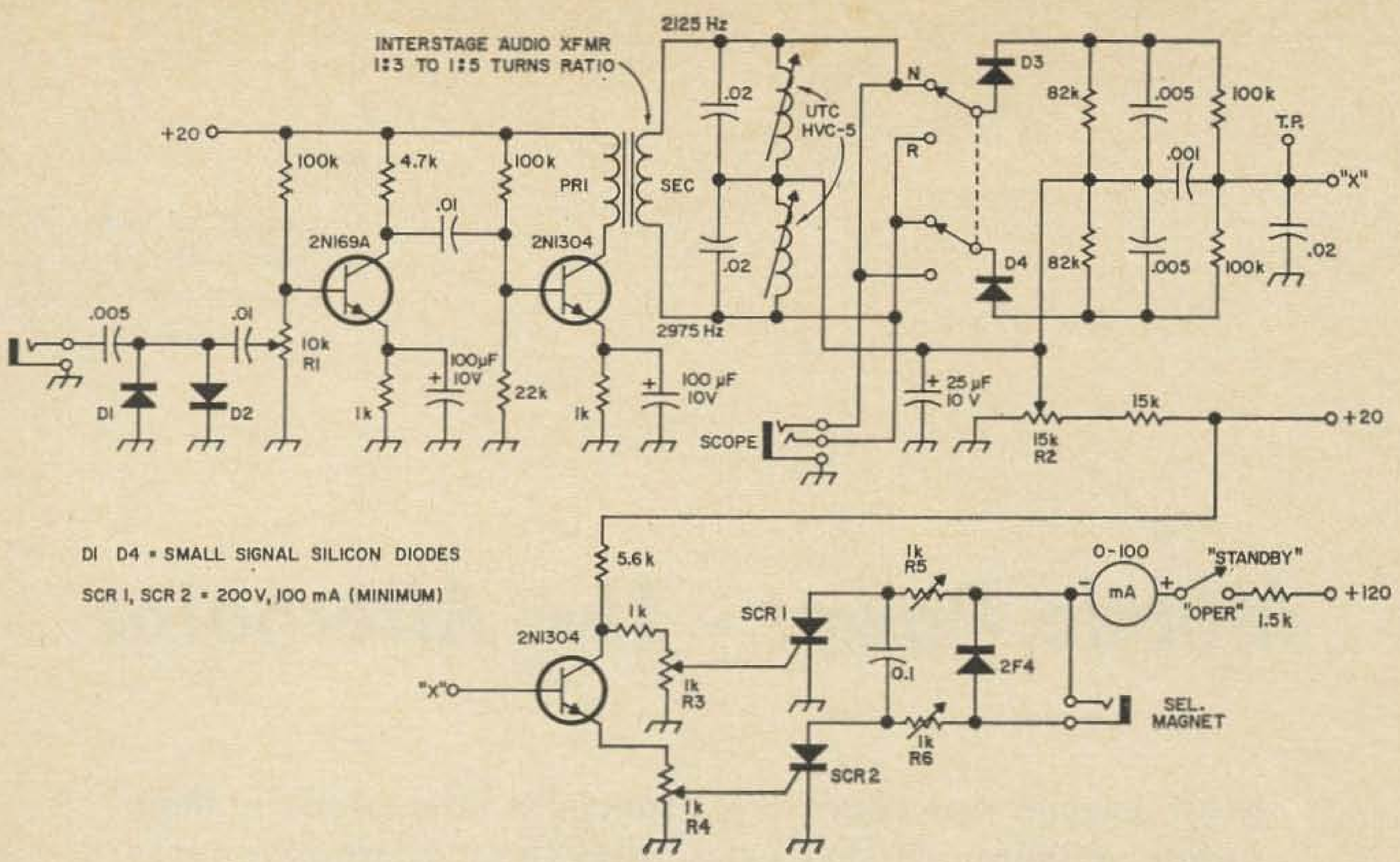


Fig. 4. Circuit of the complete semi-RTTY tuning unit.

slightly so that a reasonable signal will saturate Q_3 on mark and cut it off on space.

Set R_3 and R_4 to ground and R_6 and R_5 to their midpoint. Apply a mark signal and switch the *standby switch* to "operate". Increase R_4 slowly until SCR_2 fires. This is noted by the jump in current and by the selector magnet pulling in. Adjust R_6 for the desired 60 mA. Now switch the input to a space signal. Increase R_3 slowly until SCR_1 fires. This should be noted both by a change in the current and by the selector magnet dropping out. Adjust R_5 for the same current as drawn by the selector magnet. A little playing around with R_3 and R_4 may be necessary to get the proper switching action from a weak signal. Now tune in a station and listen.

The power supply I built is not shown because it uses a special transformer I salvaged from an old pin-ball machine. Besides, no ham builds power supplies exactly as they are published. As mentioned above, a zener regulated supply is necessary. The high voltage supply uses a simple half-wave rectifier with RC filtering, the 1500 ohm current limiting resistor is included as part of the power supply. The regulation on this supply is not too important, as long as it will supply the 60 mA and maintain 100 volts or more.

Both the AFSK oscillator and the tuning unit are built into a 3½ inch relay rack panel and recessed channel as shown in the photographs. Operating controls are on the front panel. Frequency and current adjustments are on the back, along with all jacks, the fuse, and power supply components. The AFSK oscillator is built onto a small circuit board attached to the front panel. The tuning unit is built on a similar board mounted parallel to the panel. The photographs show a ten-turn pot on the left. This is not used and the space may be large enough to mount a 1" scope for tuning, if the desire and funds so prescribe. The transistorized scope by K8ERV should be ideal.

This unit has been giving good copy on 40 meters and 6 meters, new services, several Spanish stations and lots of garble. All signals are obtained with my BC-455 Command set (6-9.1 MHz). On the weaker stations, garbled copy from fading is annoying and the bandpass filter with AGC as mentioned above would be valuable.

I would like to thank my friend Bill Perkins for help with the photography.

. . . KØJXO

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Mobile Power - The Alternator

Most mobile operators are especially interested in their power system — W9NLT describes the modern alternator system and how it works.

Hams who are enthusiastic mobile operators have learned how important it is to have a power source that is reliable and stable. A poor power system can result in erratic operation and a high trouble rate in mobile equipment. It can also cause missed contacts, frustration and deep-seated feelings of inferiority in the operator. A lot of this kind of grief can be avoided by understanding and making design allowances in mobile gear for that most common source of mobile power—the alternator.

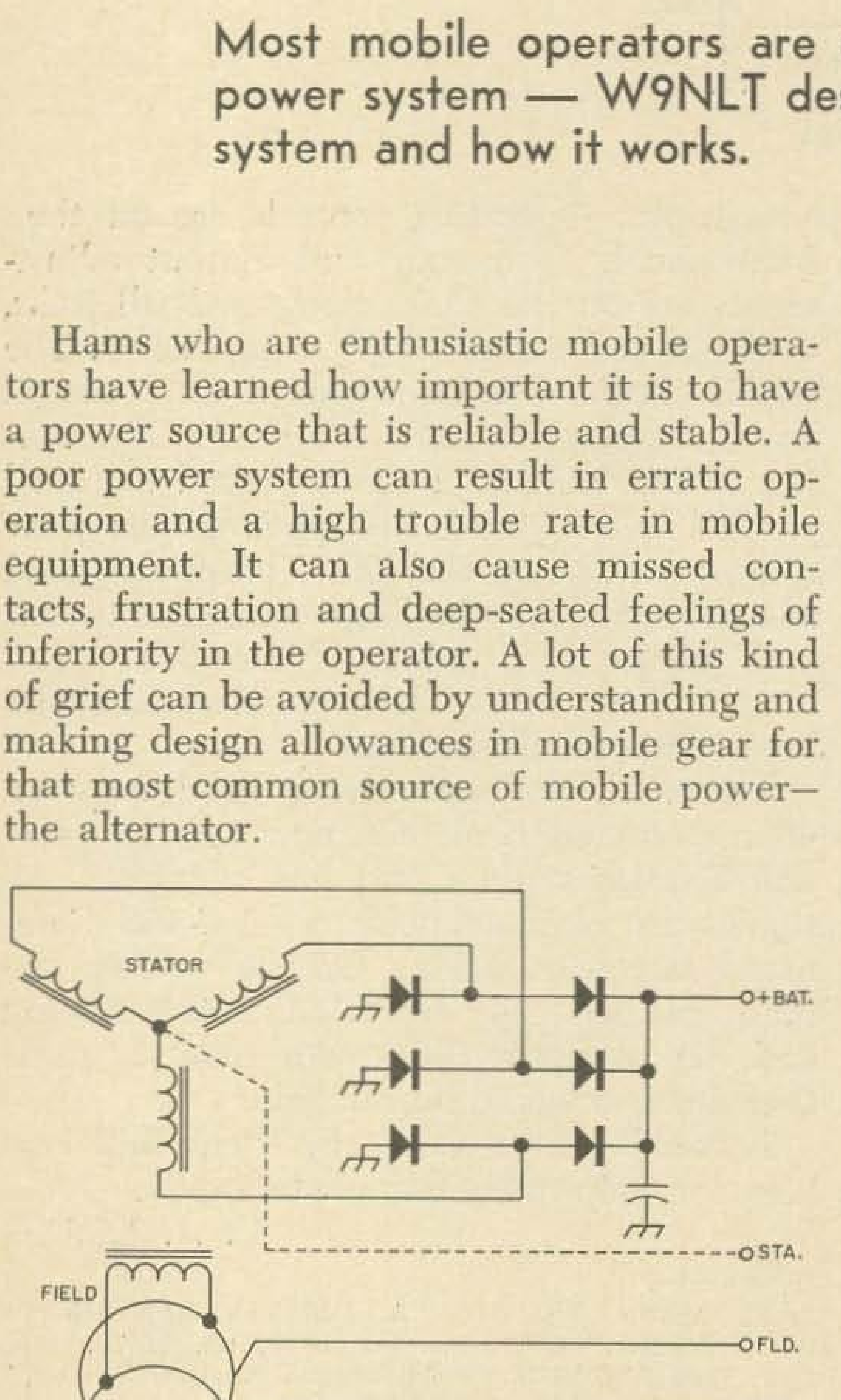

Fig. 1. Typical alternator schematic showing wye-connected stator windings: the stator midpoint is brought out to a terminal only on Ford (Autolite) units.

While there are a number of alternator/regulator systems, some characteristics are common to all of the recent models. To begin with, all of the alternators are designed to be mounted on the engine block; they are belt driven. The alternator pulley is about 3 inches in diameter while the driving (crankshaft) pulley is not less than 6 inches in diameter. As a result, the alternator shaft will turn at a speed that is at least twice the speed of the engine; a commonly found ratio is 2½:1. Rotation is normally clockwise as viewed from the front (pulley end) of the alternator. It is important that the alternator be rotated in the proper direction; reverse rotation will cause the integral fan to move less air and the alternator may overheat if it is run at full load.

Alternators use a rotating field to which dc current is supplied through a pair of slip rings and carbon brushes. This arrangement permits the high output currents to be supplied directly from the stator windings without going through brushes or sliding contacts. Field current is usually less than 3 amperes for alternators that are rated at less than 50 amperes output. The rotating field is built with 6 pair of poles and so the output of any one stator winding goes through 6 electrical cycles with each revolution of the alternator shaft. The output frequency in hertz is equal to one tenth of the shaft speed expressed in revolutions per minute. For example, if the alternator shaft is turning at 4000 rpm, the output frequency will be 400 Hz. Exception: the Delco-Remy alternators used in G. M. cars generally have 7 pairs of poles and produce 7 cycles per revolution.

The stator has three windings and it supplies 3-phase power; the windings may be connected in either the delta or wye configuration, the wye connection being the most common. The stator leads are connected directly to the internal rectifier which is made up of six silicon diodes. The diodes are mounted in the alternator and are arranged to provide full-wave rectification. The ripple frequency is six times the frequency developed in any one winding. At a shaft speed of 4000 rpm the ripple on the dc output will have a frequency of 2400 Hz (2800 Hz in G. M. cars). The rectifier diodes may be mounted on the rear end-bell of the alternator or on 2 separate plates (or a printed circuit board) mounted inside of the rear end-bell. Three of the diodes are built with their cathodes connected to their cases; the structure that they are mounted on is connected to the positive output (BAT) terminal. The other 3 diodes have their anodes connected to their cases which in turn are grounded to the alternator frame. Several makes provide a capacitor that is connected between the output terminal and the frame to protect the diodes from voltage surges; it also acts to suppress radio noise. A typical alternator schematic is shown in **Fig. 1.**

The dc output is a function of the shaft speed and the field current; an increase in either one will raise the output voltage. The alternator is self-limiting, however, in that when the shaft speed exceeds about 5000 rpm, the output does not continue to rise in proportion to increased speed. This effect is mainly due to the fact that the flux created by currents induced in the stator windings opposes the flux created by the rotating field. Designers call the phenomenon "armature reaction". Hysterisis losses in the stator also contribute to self-limitation. In all current models, the alternator output is regulated by changing the current in the winding of the rotating field.

The alternator output terminal is directly connected to the battery in all cases. Direct connection is possible because the reverse leakage through the diodes in the rectifier (less than 1 milliampere) is so small as to be insignificant. This arrangement eliminates the necessity to provide a relay having heavy contacts capable of disconnecting the alternator from the battery when the engine is not running as is done with dc generators.

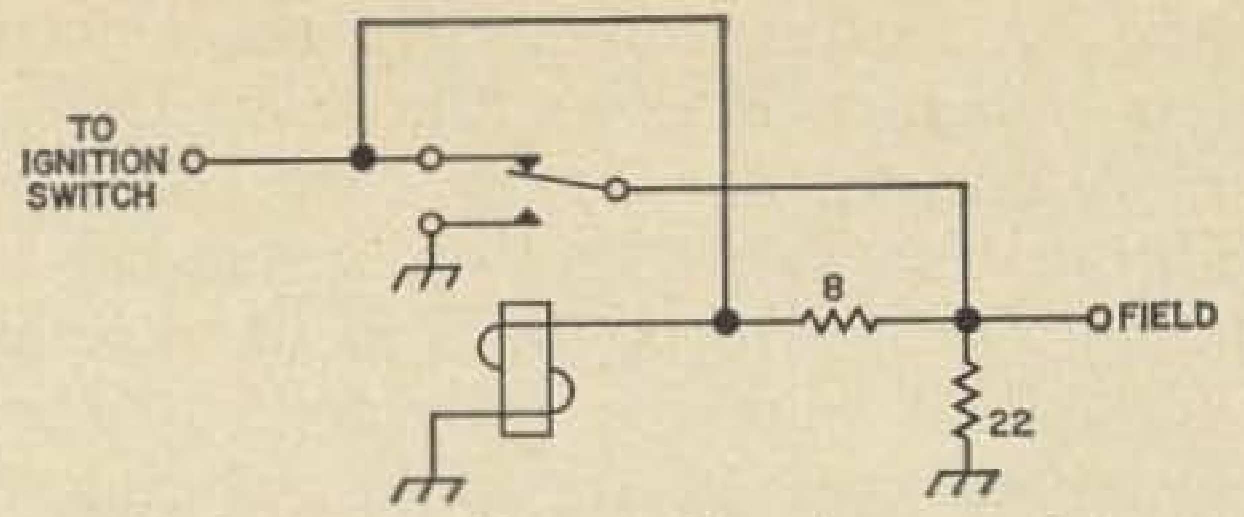

Fig. 2. Schematic of a single-relay regulator.

Regulating systems

The regulator is made sensitive to the voltage of the auto's electrical system. To a lesser extent it also reacts to the ambient temperature, with slightly higher voltages being maintained at low ambient temperatures. The relationship of temperature to voltage is shown in **Table 1.**

Regulating systems fall into three groups. Some operate with relays alone, some with a combination of relays and transistors and some regulators are wholly solid-state. The simplest form of regulator consists of a single relay and two resistors as shown in **Fig. 2.** This arrangement is typical of the regulators used in cars built by the Chrysler Corporation. Battery power is picked up through the ignition switch. It is applied to the alternator field through the upper contact and the armature of the relay. The relay coil is connected between the ignition system terminal and ground. The action of the relay can be compared with that of a voltmeter, the armature acting like the indicating pointer of the meter. The voltage required to just pull the armature away from the upper contact would be the nominal voltage listed in **Table 1.** The additional voltage necessary to pull the armature to the lower contact would be from 0.2 to 0.6 volt greater than the voltage required to pull the armature away from the upper contact. When the electrical system voltage is low, the relay armature rests against the upper contact and the full system voltage is applied to the field winding.

As the battery becomes charged, the system voltage increases and the relay armature is pulled into a position between the upper and lower contacts. The opening of the upper contact places a resistance of about 8 ohms in series with the field, causing the field current to drop from some 2½ amps to about 1 ampere. A further increase in the electrical system voltage will cause the relay armature to close against the lower contact. In this condition the field lead is grounded and field current will drop to zero. A resistance of about 20 ohms is provided to absorb surges generated in the field winding and thus protect the relay contacts. In normal operation the armature will first rest against the upper contact for a short time after the engine is started. At moderate speeds it will vibrate against the upper contact and at road speeds it will vibrate against the lower contact (assuming the battery condition to be normal). The vibrating relay switches the alternator condition rapidly between full output and partial output or between partial output and no output. The rate at which the vibrations occur and the length of time that the relay armature rests against either contact is determined by the system voltage and the alternator response characteristic for the speed at which it is turning. While the average system voltage should be within the limits given in **Table 1**, the instantaneous dc voltage (other than ripple) measureable in the electrical system will vary between 11.5 and 15 volts. It will change with each vibration of the relay armature, which might be as high as 100 Hz or so. Single-relay regulators provide no means of operating a charge indicator or "idiot light"; an ammeter must be used to show whether the battery is charging or discharging.

Some G. M. and Ford automobiles employ a two-relay regulator system. The two relays function in a way that permits the use of either an ammeter or a charge indicator lamp. A typical two-relay regulator is shown in **Fig. 3.** Some early Chevrolets employ a third relay, separately mounted, to operate the charge indicator lamp. In later models the relay was made an integral part of a three-relay regulator. Some G. M. autos are equipped with a relay-type of regulator that contains a power transistor which isolates the field coil from the relay. This arrangement contributes to longer relay contact

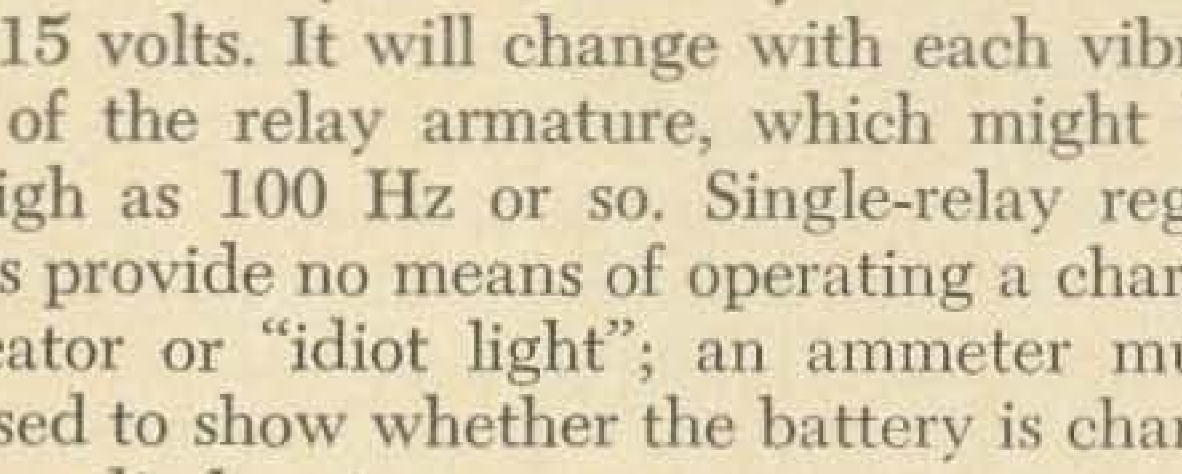

Fig. 3. Schematic of the two-relay regulator with a terminal for operating a charge-indicator lamp.

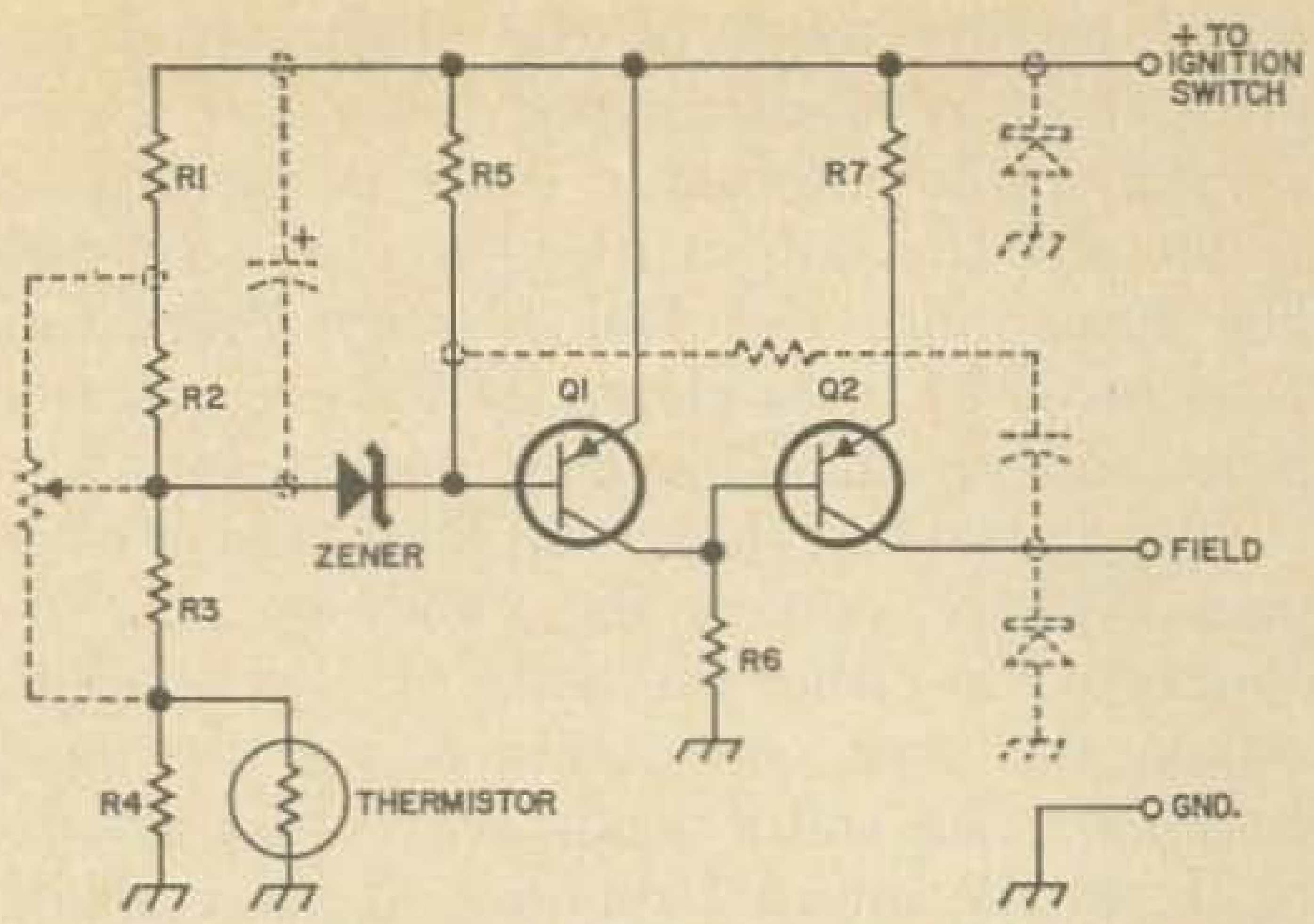

Fig. 4. Schematic of a typical solid-state regulator. Components shown connected by dashed lines are used by some manuafacturers, but not all of them.

life, making a more reliable regulator. One of Ford's arrangements uses a connection to the wye-connected stator neutral to operate a separately mounted field relay; the balance of the regulator is transistorized and contains a variable potentiometer for voltage adjustment. A significant characteristic of relay control is that there is a level of generator output between zero and full output, with the charging rate controlled by switching the generator rapidly between two of the three conditions.

Several auto manufacturers are now using solid-state electronic regulators. Included are American Motors, Checker, Ford, G. M. and several truck makers. The solid-state regulator offers a more stable and reliable control of the alternator output. It is free of the maintenance problems that arise from the aging of relays, pitting or wear of contacts and the effects of dirt accumulation. A schematic of a typical transistorized regulator is shown in **Fig. 4.** The regulator consists of two PNP transistors, a zener diode and an assortment of resistors. The regulator circuit is a two-state, high-speed switching network. The values of the components are chosen so that at voltages below the selected operating potential, the zener diode is non-conducting. The resulting positive potential that is applied through R_5 to the base of driver transistor Q_1 biases it to cutoff. With Q_1 cut

Table 1

Charging voltage related to ambient temperature

Temp. °F	Chrysler	Ford	G.M.	Motorola
0	—	—		14.6-15.4
25	—	—	Range	14.4-15.2
50	13.6-14.6	14.3-15.1	is 13.5	14.2-15.0
75	13.5-14.5	14.1-14.9	to 15.2	14.0-14.8
100	13.4-14.4	13.9-14.7	for all	13.8-14.6
125	13.3-14.3	13.8-14.6	temper-	13.6-14.4
150	13.2-14.2	—	atures.	13.4-14.2

off, only a minute amount of current flows through R_6 and the base of Q_2 will be nearly at ground potential, biasing it to full conduction. In this condition the positive potential of the electrical system is applied to the alternator field through R_7.

As the electrical system voltage increases, there is an increase in the potential that appears between the base of Q_1 and the junction of R_2 and R_3. A zener diode having a reverse breakdown or zener voltage of from 8 to 10 volts (depending on the manufacturer) is connected between these two points. When the zener breakdown voltage is reached, the diode conducts and the positive potential on the base of Q_1 is reduced. Q_1 then conducts, raising the voltage developed across R_6 and biasing Q_2 to cutoff. This interrupts the flow of current in the alternator field, causing the alternator to stop developing power. As the system voltage drops, the zener diode stops conducting, Q_1 is again biased to cutoff, Q_2 conducts and current flows to the alternator field. The switching action takes place so rapidly that it can go through as many as 2000 switching cycles per second. The key to transistorized regulator operation is the zener diode which acts both as a voltage reference and as a voltage actuated switch which initiates regulator action.

It is possible to add temperature correction to the regulator by using a thermistor. A thermistor is a special kind of resistor with a very pronounced negative temperature characteristic. Its cold resistance can be several times its hot resistance. The zener diode senses system voltage through the network of resistors R_1 through R_4. The thermistor is connected across R_4. As the temperature rises, the resistance across R_4 becomes less and a greater proportion of system voltage appears across the zener diode. The net result is that the system voltage will be regulated at a slightly lower voltage when the ambient temperature is raised.

A few components are shown in the schematic that should be discussed. Ford and G. M. regulators are equipped with a potentiometer in place of resistors R_2 and R_3 to permit a small range of regulator voltage adjustment. They also use a feedback circuit from the collector of Q_2 to the base of Q_1 to speed up the switching action, together wih diodes intended to protect the regulator from surges appearing on the field or ignition leads. G. M. also places a capacitor across the combination of R_5 and the zener diode to smooth out the voltage surges in the diode circuit. **Fig. 5** shows the delta connected stator used in the Motorola 55 ampere alternator. It also shows the isolation diode used in all of the Motorola alternators. Use of the isolation diode makes the operation of a charge indicator lamp possible and it further reduces the small battery leakage through the rectifier diodes. Since there is a small voltage drop across the isolation diode, the alternator is designed to produce a slightly higher voltage than others. This voltage is present at the "AUX" terminal and is used for the regulator and field supply.

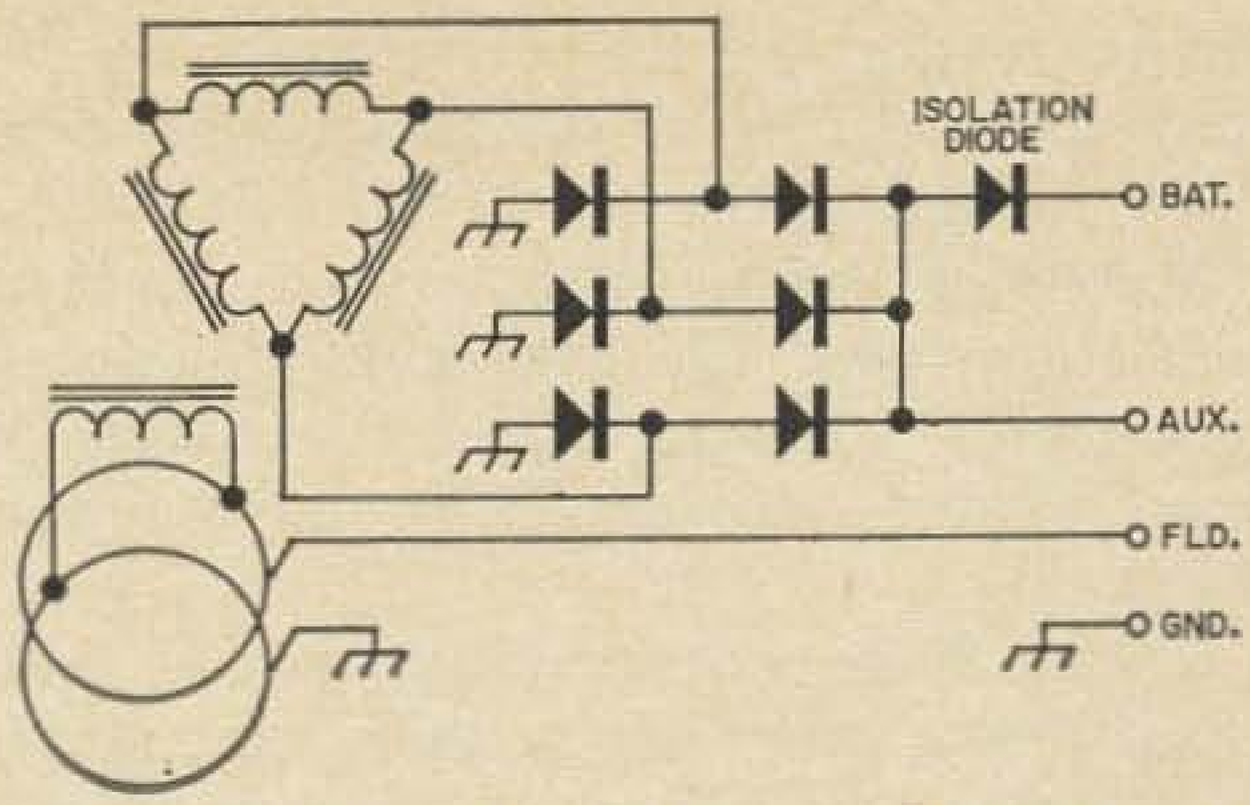

Fig. 5. Schematic of a Motorola alternator showing the delta-connected stator used in the 55-ampere model. Also shown is the isolation diode and auxiliary terminal connection.

Hints for happy mobiling

One way of assuring yourself reliable mobiling—and motoring—is to *know* that your battery and its charging system are in good condition. Here are a few suggestions that you may find helpful:

1. Use only distilled water in the battery; keep it properly filled. Check the electrolyte level at regular intervals and after periods of heavy charging.

2. Measure the specific gravity of the electrolyte occasionally; when fully charged it will measure 1.265 ± 0.01 at 80°F. Correct for temperature by adding 0.004 to the measured value for each 10° that the electrolyte temperature is above 80°; subtract the same amount for each 10° that the electrolyte temperature is below 80°.

3. Provide a means of giving the battery a supplemental charge when it is needed[1]; such occasions include periods after extensive winter night driving, when mobile activity (es-

1. Schleicher, "A 12-Volt Battery Charger", *CQ*, May 1966.

pecially testing in the driveway) has been heavy and whenever the generating system is not in top form.

4. Regulators sense system voltage; if possible, equip your car with a good voltmeter. War-surplus aircraft style voltmeters and ammeters are still available at reasonable prices.

5. If you have equipped your car with a voltmeter, an ammeter or both, consult them often enough to know which conditions are normal and which are abnormal.

6. Make this simple test occasionally to verify that your charging system is in good shape: with the engine running at the speed it would attain at the road speed of 30 mph, turn on the headlights (high beam), electric windshield wipers and heater fan. That will place a load on the electrical system of about 25 amperes. (If you don't have electric wipers, use the cigar lighter; it draws about 10 amps.) Under these conditions the charging system should maintain 13.5 to 14 volts at the battery terminals.

7. If your alternator system will not put out its rated current, look for such troubles as a loose fan belt, defective contacts or blown fuse wires in the regulator; test the voltage applied to the field terminal. If the above items are ok, then investigate the brushes for wear. The alternator bearing lubrication and diodes should be checked last since testing the diodes requires that the alternator be disassembled and the diode leads be unsoldered.

Some tips for experimenters

Automotive alternators can be arranged to supply 6 or 12 V dc, 60-Hertz or 400-Hertz power to mobile, emergency, or Field Day rigs. A gasoline engine rated at 2 or 3 horsepower makes an ideal prime mover—keep your eyes open for discarded power lawn mowers if you want a cheap engine. Used alternators are easy to find at most auto wrecker's yards for a few dollars. Both can be mounted on a piece of 1" lumber, leaving room for the regulator or field supply arrangement. The engine speed and alternator shaft speed can easily be optimized by using pulleys of the proper sizes and a V-belt. The alternator will be most efficient when operating at speeds in the range of 4500 to 5500 rpm. Small gasoline engines will develop their rated power at some speed between 2000 and 3000 rpm; this speed is often listed on the name plate or in the instruction manual.

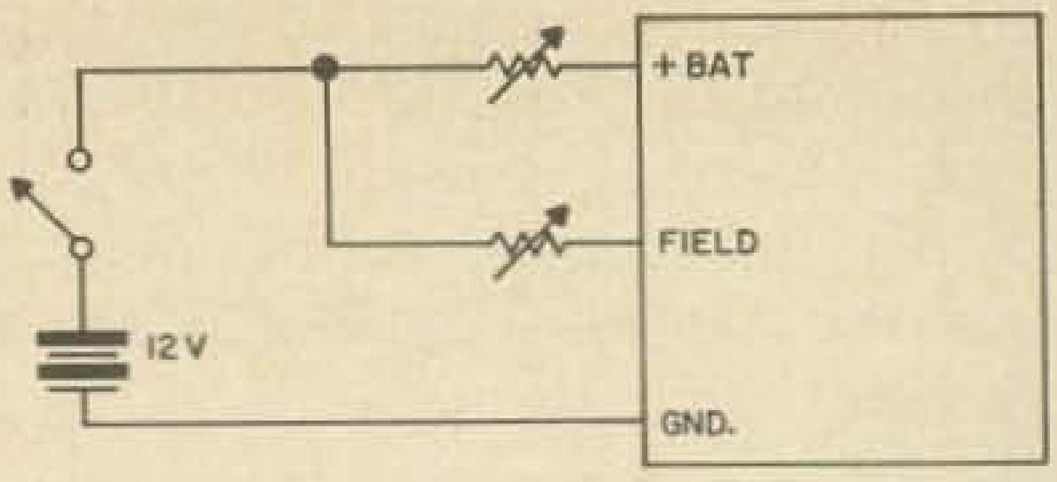

Fig. 6. Arrangement for adjusting the field current to a constant value when the alternator is used to supply ac.

Even the smallest alternator made should be able to develop at least 350 watts of electrical power. Most alternators are wye connected and will furnish two dc voltages simultaneously if the common connection or neutral is brought out. (Ford Autolite alternators bring this point out to a terminal designated "STA".) The voltage across the arms of a wye connected three-phase generator or transformer is 1.73 times the voltage developed in one winding. The dc at the stator common is produced by three-phase, *half-wave* rectification, however, and so its ripple frequency will be only half that present on the regular dc output (BAT) terminal. Losses in the diodes, added to the above conditions, result in a dc voltage at the stator neutral that is approximately half that at the BAT terminal.

Residual magnetism in the alternator field is often so low that the output voltage will not "build up" until the field is excited by an external 12-volt source. Once the alternator is running and developing power it can be kept self exciting. If the alternator is to supply dc to the radio equipment, it is a good idea to leave the storage battery connected to smooth the ripple in the alternator output. With such an arrangement, any type of automotive alternator regulator should work satisfactorily. If the alternator is used to supply ac, it is better to use a rheostat for excitation control to avoid the on-off operation of the regulator. One such arrangement is shown in **Fig. 6.** The two rheostats are 10-ohm, 50-watt units and are adjusted to produce the proper field current while limiting the battery charging current to about 1 ampere. The lightest possible dc load is recommended to avoid excessive flattening of the output waveform. The alternator output is a fairly good approximation of a sine wave unless it is supplying a heavy dc load. A heavy dc load will cause the output waveform to be severely clipped. When the alternator is self excited it is in a positive feedback situation, i.e. as the field current goes up, the output voltage goes up, which in turn results in more field current. Under no-load conditions the alternator voltage could get high enough to damage the rectifier diodes, so when experimenting, bring the field current up from a low value rather than down from a high value.

Alternators can be used to supply 60-Hertz equipment. When turning slowly enough to develop 60-Hertz power, the alternator will be pretty inefficient and will require more field current than is normal. It is best to push the speed (and frequency) as high as the radio equipment will allow. Most radio equipment of good design will operate well on frequencies around 100 Hz if the power is supplied in the manner shown in **Fig. 7.** This kind of connection can be easily made to any receiver that is equipped with a socket for the supply of external power. Notice that filament power is supplied directly from the alternator; the filament winding becoming the transformer primary. In this condition the transformer is called on to supply only that amount of power that is required for B+ and for the rectifier tube filament. The reduction in total power transferred by the power transformer is one of the reasons that the equipment tolerates the higher frequency so well.

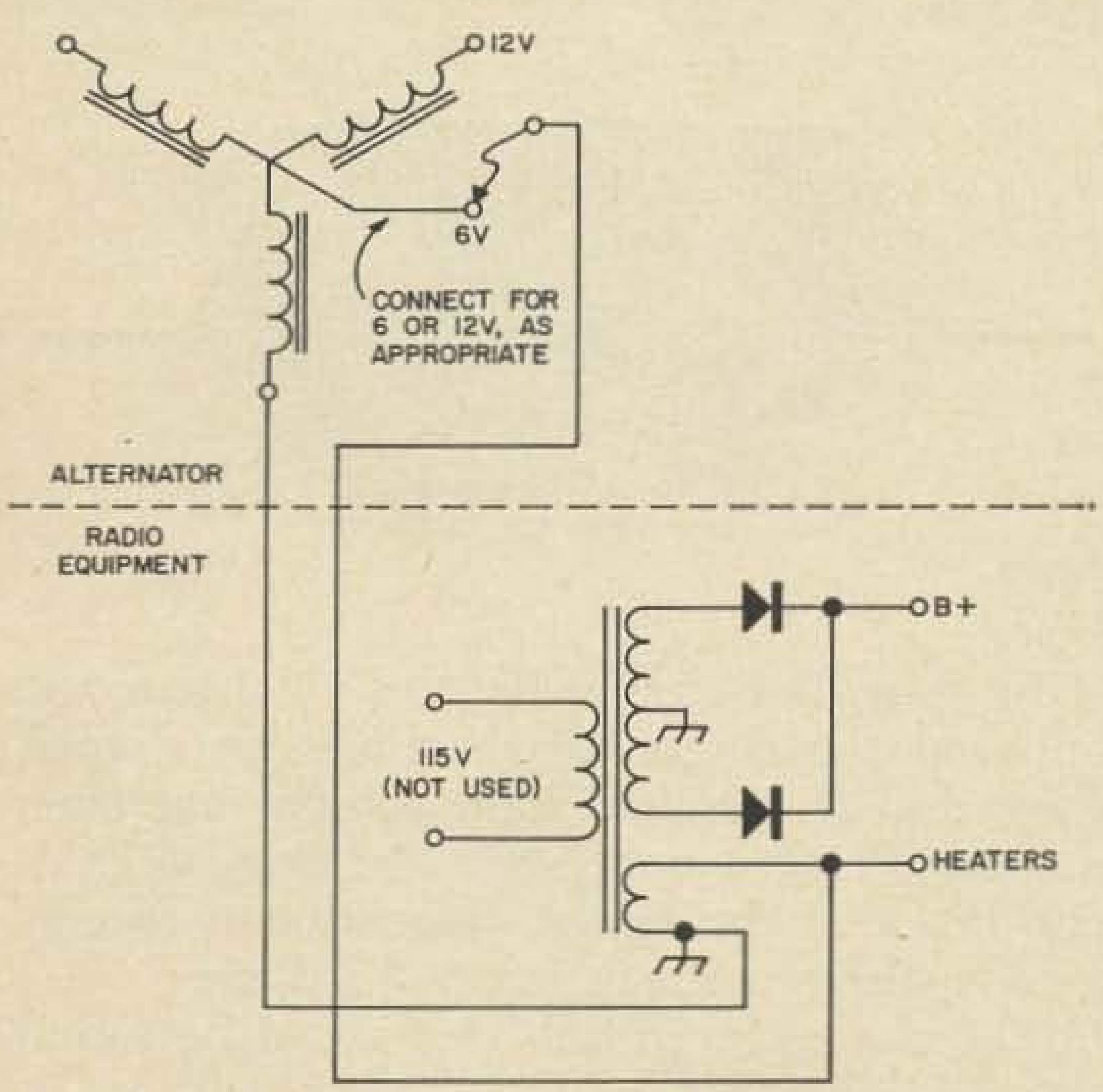

Fig. 7. A simple way to operate radio equipment from low-voltage alternator ac.

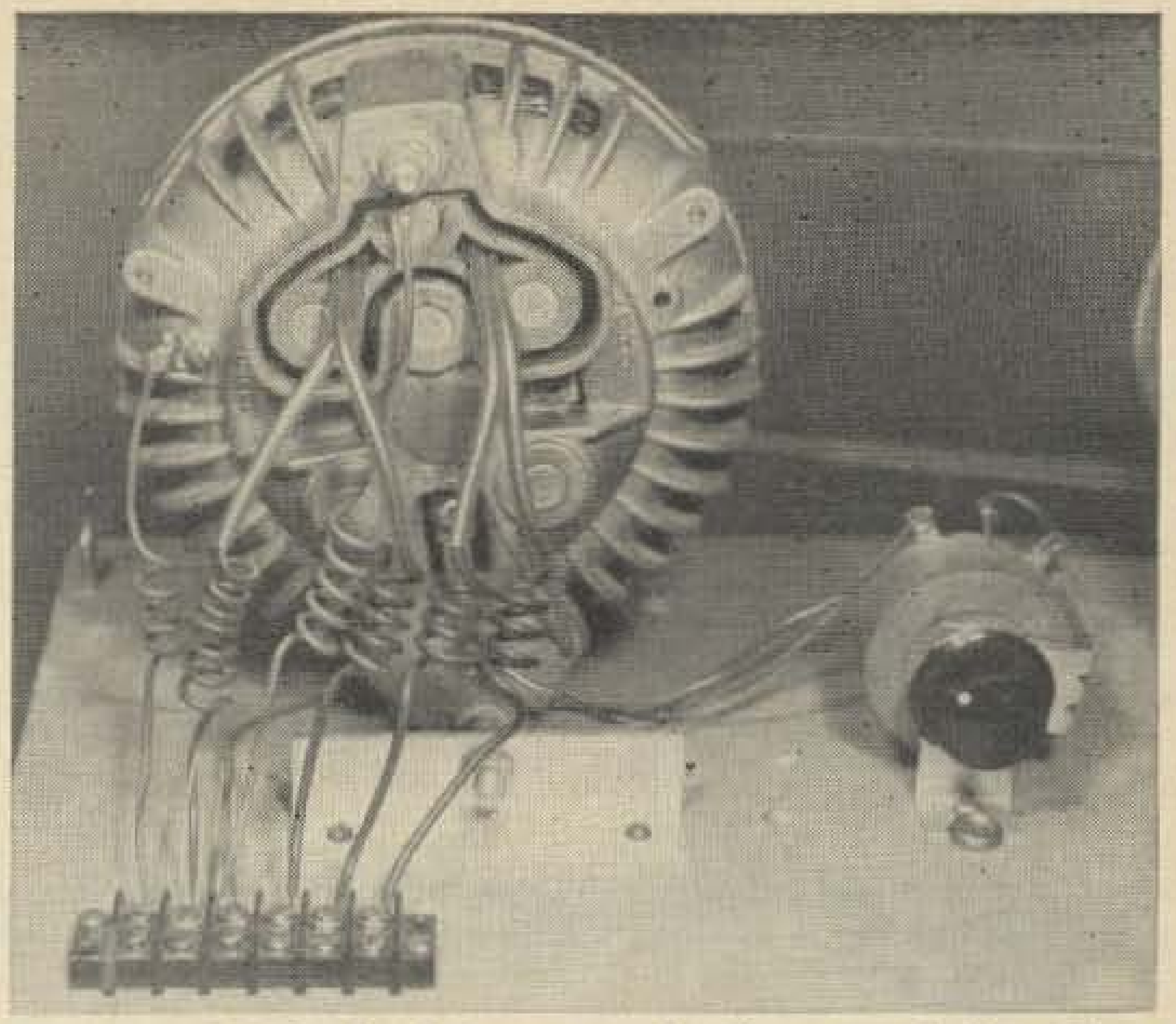

Fig. 8. Method of bringing leads out of the alternator housing without drilling holes in it.

The arrangement shown in **Fig. 7** can also be used well with 400-Hertz equipment. This is a particularly promising field for experiment since 400-Hertz power transformers of the highest (Military Spec.) quality are available at rock-bottom prices. They are a lot lighter than 60-Hertz transformers, too. When using the arrangement in **Fig. 7**, be sure to isolate the alternator frame electrically from the radio equipment. The more ambitious experimenter may want to isolate one alternator winding for use with the rectifier for field supply and use the other two for ac supply. **Fig. 8** is a photograph showing how leads from the neutral and the three phases can be brought out of an alternator without drilling the case or mounting any additional terminals on it. While much of the foregoing presumes that the alternator will be driven by a small engine, it can also be mounted on an engine block as a special supply for mobile operation. Watch for wide voltage swings if this is done, and provide for protection of 400-Hertz equipment against excessive currents that can flow if the frequency drops radically.

. . . W9NLT

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Frank Case W3RMI
2000 Kernan Drive
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Visual Monitoring of Remote Carriers

What does your CW signal look like?

If I make it known during a QSO that I have a panadaptor (Heath Ham-Scan HO-13), I am nearly always asked to check keying characteristics; or if on phone, which I use on occasion, I am asked to check modulation. The Ham-Scan can do neither of these things. However, the thought occurred that keying and modulation could be checked if one could take a look at the other's carrier, and a handy place to look at an incoming carrier is at the last *if* stage before detection—so that's where we look.

Modulation checks are easy to make and I oblige. Inasmuch as hams are human and they want only compliments, I suppose this is a mistake. If you want a fast "73 es cul", tell him that he is splattering all over the place. On the other hand, why not let him earn a pink ticket on his own?

However, the main discourse here is CW keying characteristics. Keyed carriers can be studied at leisure—you needn't be in QSO with anyone. Just turn on your receiver and scope, tune around the CW portions of the band and watch. I'll describe the circuitry to accomplish this a little later.

There are almost as many different signals on the air as there are stations. I would suggest that whenever Official Observers send their friendly QSL's, they would include a sketch of the offender's signal. This would present more fact than opinion. The picture might suggest a fault to the signal's owner that he had been suspecting, but not worrying about because all his reports were T9.

There seems to be an ideal keyed form listed in the *ARRL Handbook*, and it looks like this:

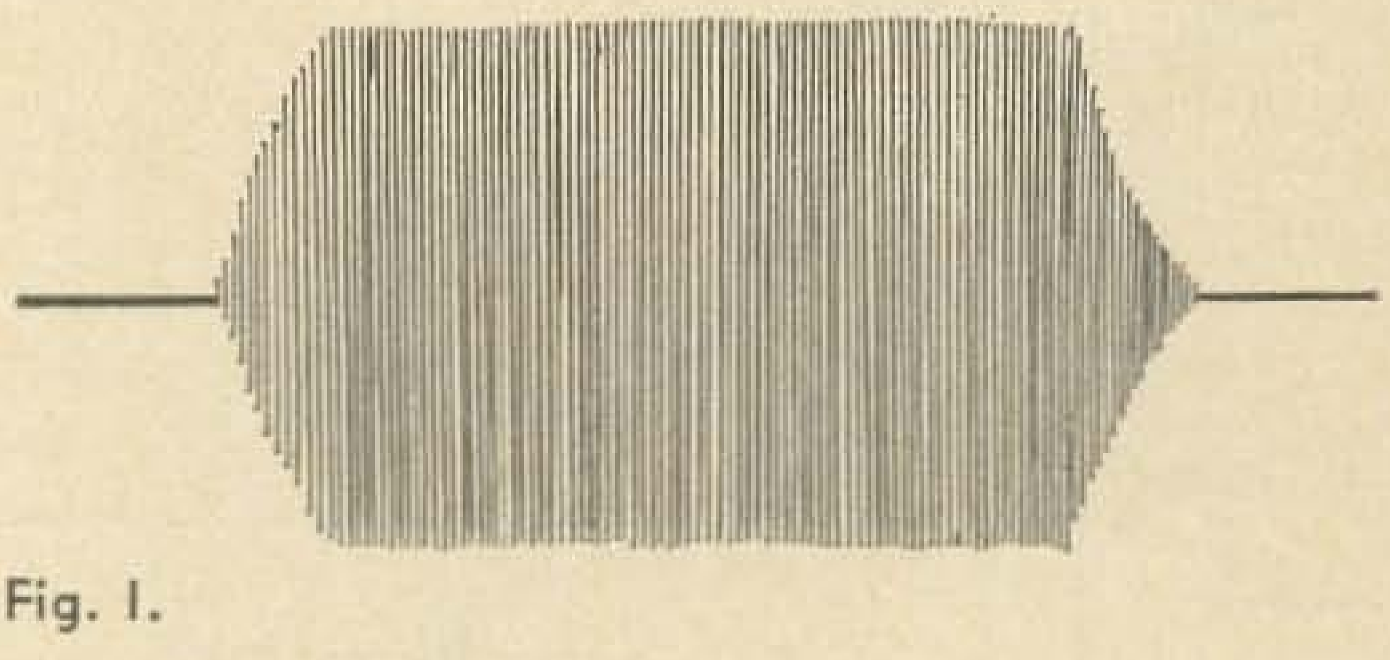

Fig. 1.

In searching around for this ideal shaping, only one signal was found which was shaped thus, and it wasn't a ham station, not even a commercial, it was NSS. Not even W1AW can boast of the signal shape that it recommends; there is much left to be desired.

The nearest approach that could be found to the ideal looks like this:

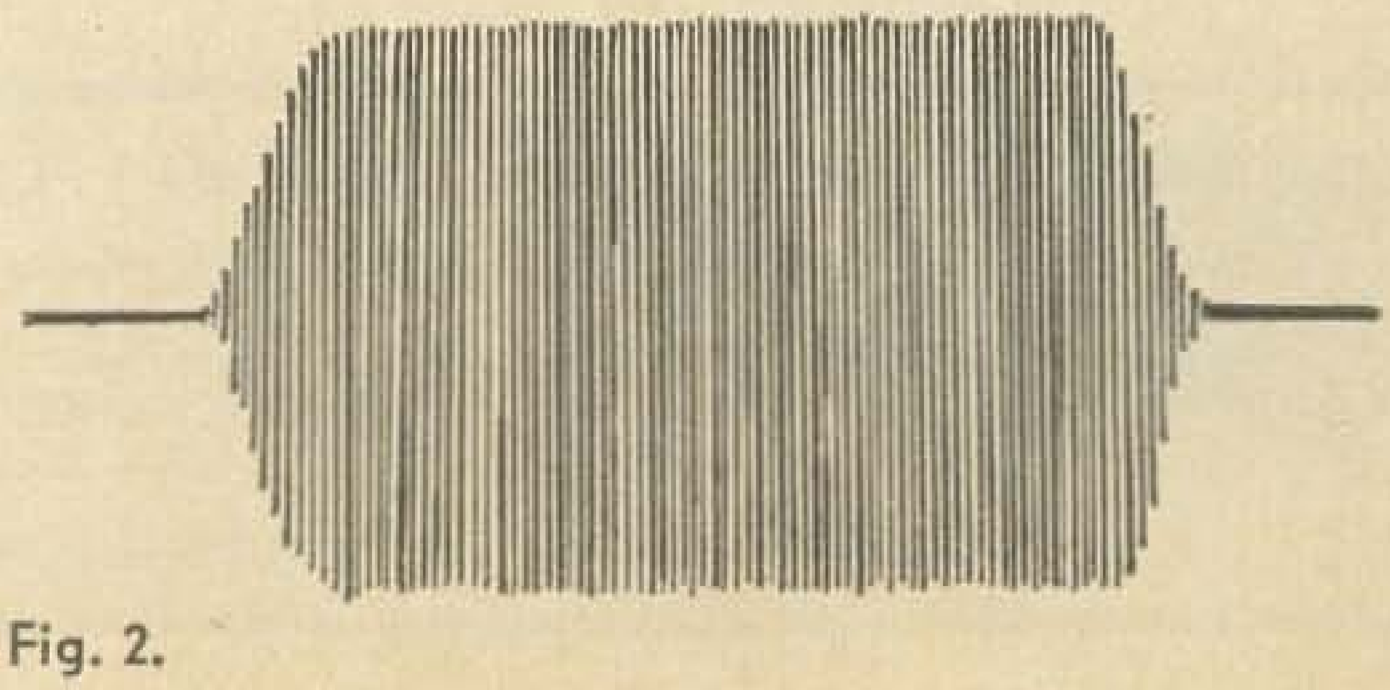

Fig. 2.

The slope of the leading and trailing edges suggests an absence of clicks. The carrier is smooth with no hum modulation. It is crisp and clean, and easy and pleasant to copy—assuming, of course, that the paddle manipulator is doing a good job. There are quite a few of these signals around I am happy to report, but percentage-wise they are far too few. There is one thing the form will not reveal—a chirpy signal. It can have good form and still sound poorly.

Another signal appears thus:

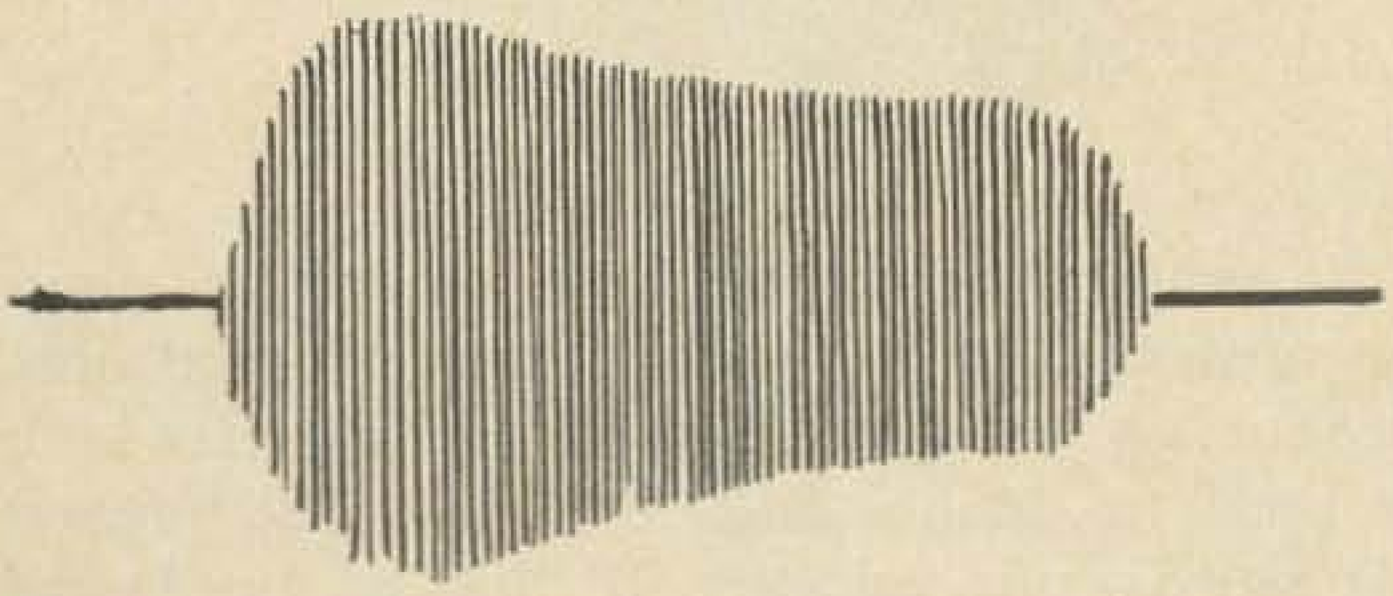

Fig. 3.

This signal sounds good. Matter of fact, it is hard to tell it from the previous signal. It suggests, however, that the power amplifier power supply regulation leaves something to be desired. There are quite a few of these signals on the air.

Here's one that probably does not generate broadband clicks, but does tend to sound clicky-thumpy.

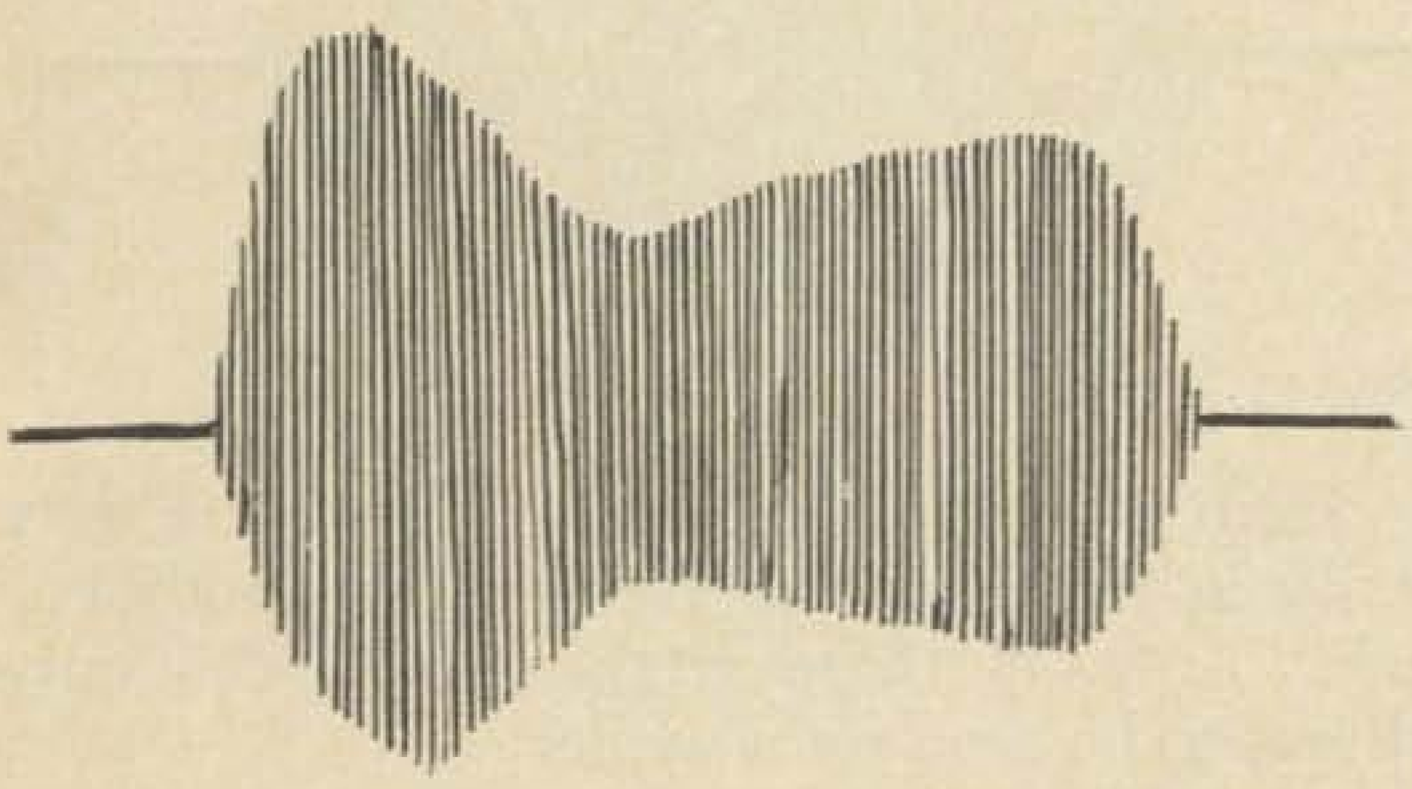

Fig. 4.

It's hard to describe, it seems overly crisp. However, for a QRQ hound, I think I would prefer it to some of the softer signals. The leading edge hits you with a loud bang and assists in resolving the characters at high speeds. I am unable to diagnose the reason for this particular shape except perhaps that somewhere in the transmitter there is a regulated power supply which loses control when the key is depressed, then begins to recover about the time the key is let up.

Though this may not look it, it has a pleasant and crisp sound, and is free of clicks.

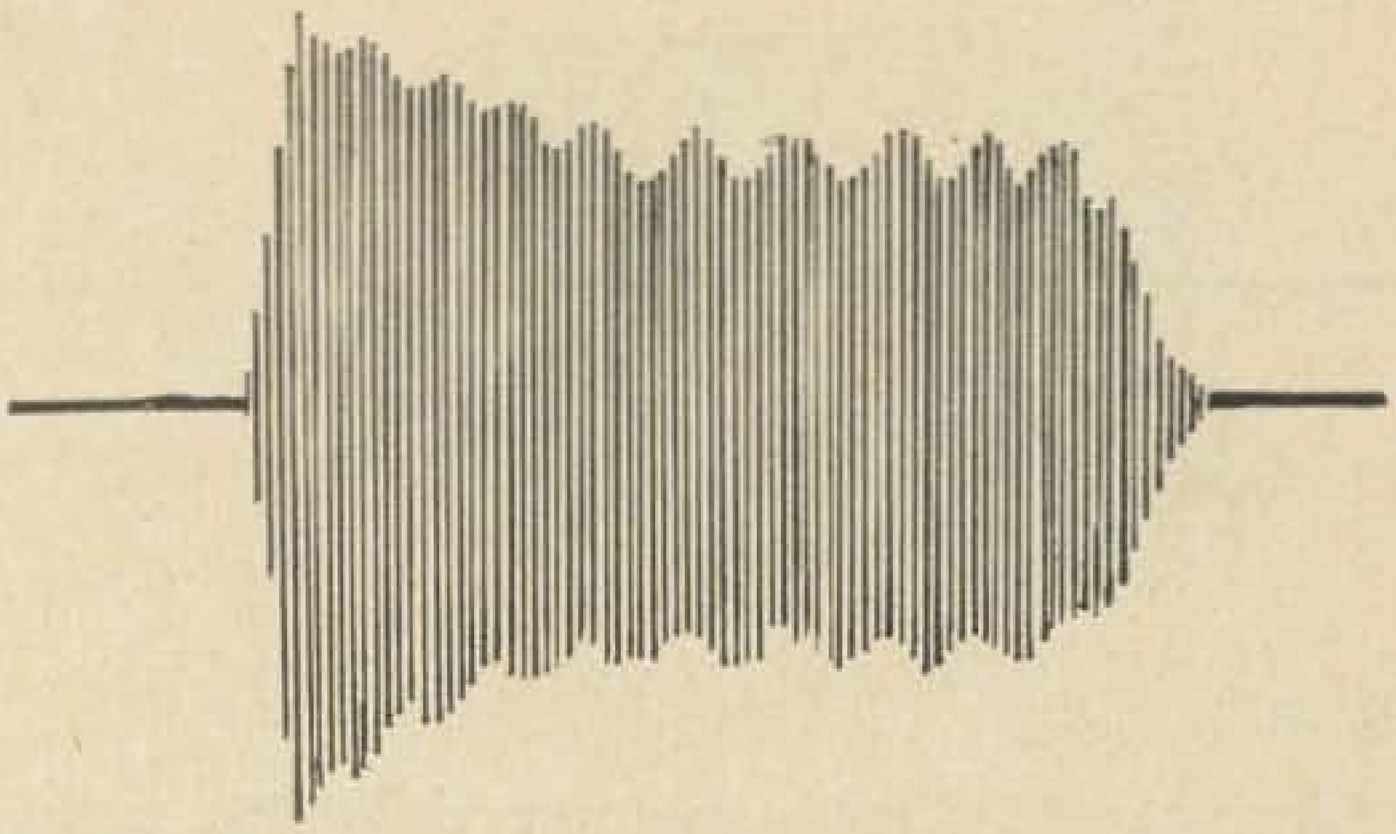

Fig. 5.

It is very similar to *Fig.* 3 except it is modulated by a test pest who has his key down for a long period. The scalloped edges produce the audible beat which adds to the pleasant sound (to me).

Here is one that's hard to figure. No clicks, no thumps—sounds clean and crisp.

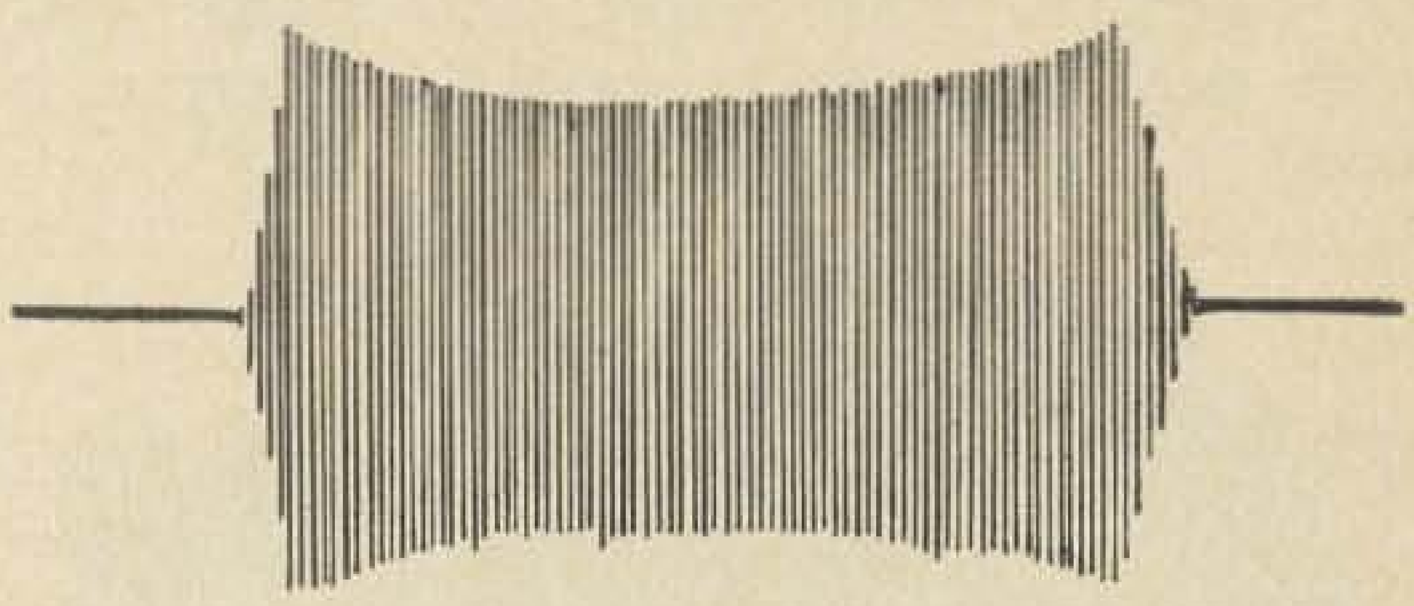

Fig. 6.

Fig. 7 will drive you frantic. This really should not be permitted on the air. The clicks were heard 15 kHz each side of the center frequency—in spite of a 500 Hz filter.

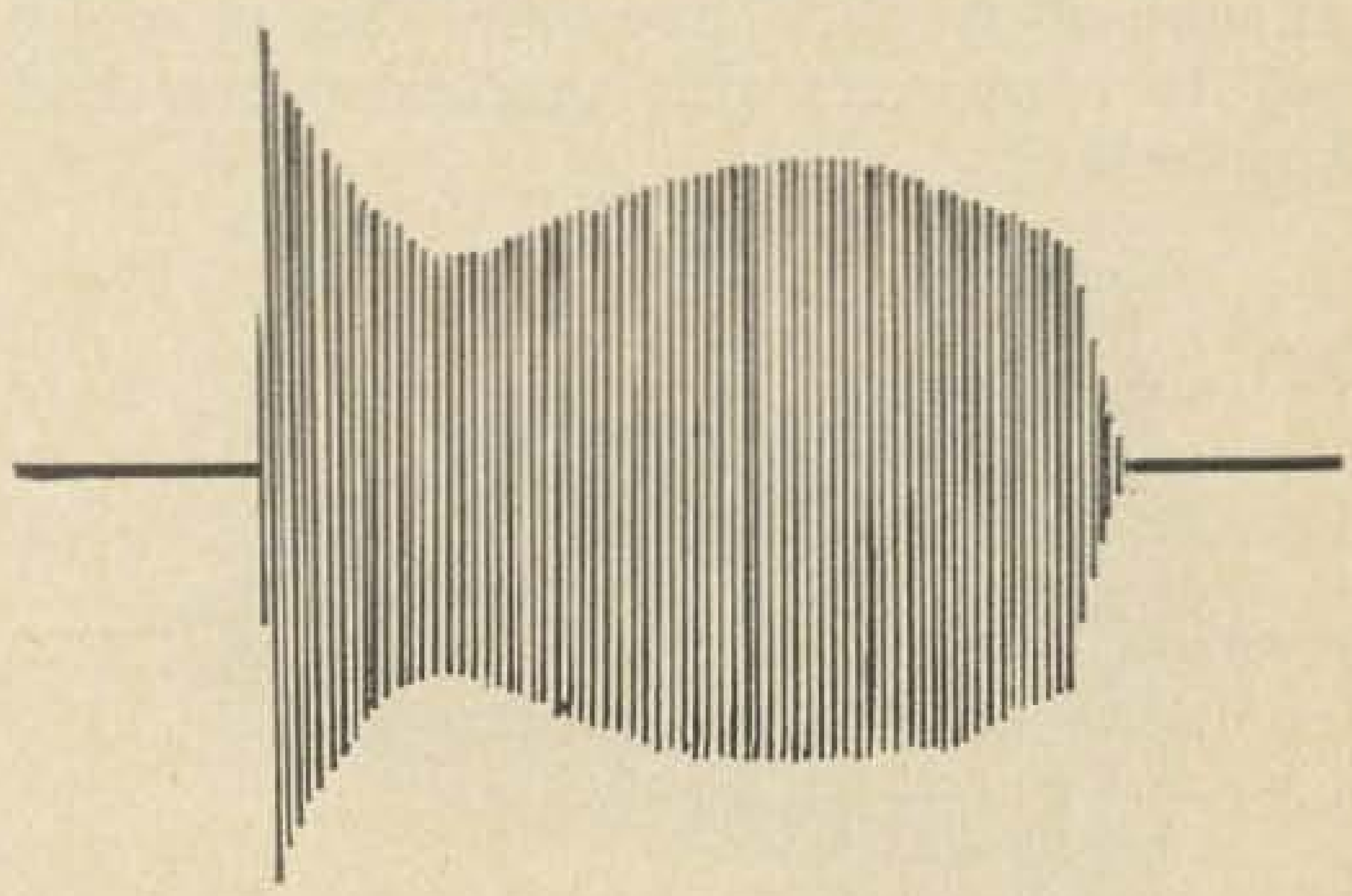

Fig. 7.

Here's a real shame. The main body of this pulse looks like the ideal. However, parasitics are probably messing the front of the pulse, then stopping until after the pulse is terminated. But what are those blobs trailing the main body?

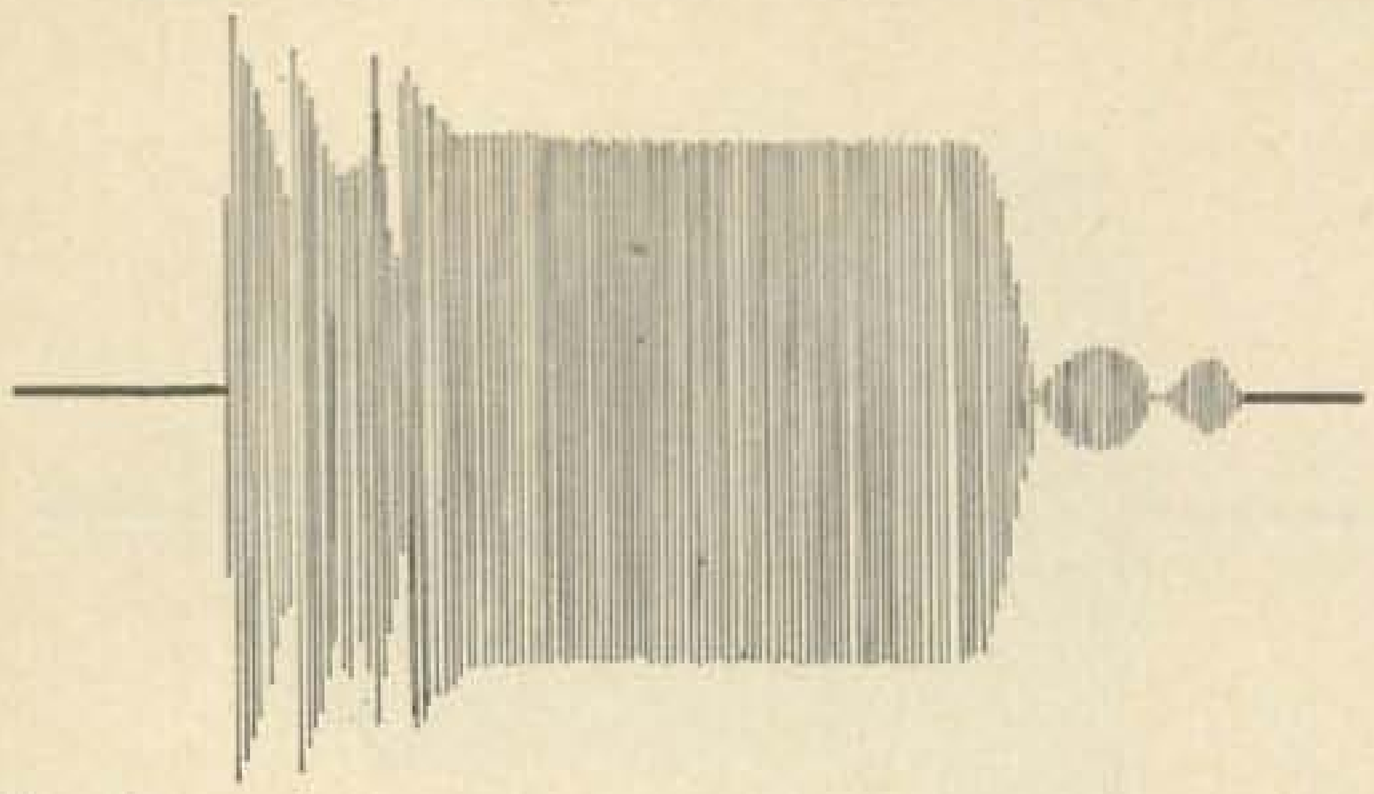

Fig. 8.

Perhaps it is relay bounce if keying relay is used. I seem to recall that this particular operator said something about time sequence keying which might rule out the keying relay in the amplifiers. Whatever it is, it sure messes up another fellow's QSO even 15 kHz away.

What's this mess? Actually, it is a noisy signal, probably with excellent keying characteristics, riding on the QRN—deep grass for sure, but surprisingly, this signal was very easy to copy. I would have given it a 539.

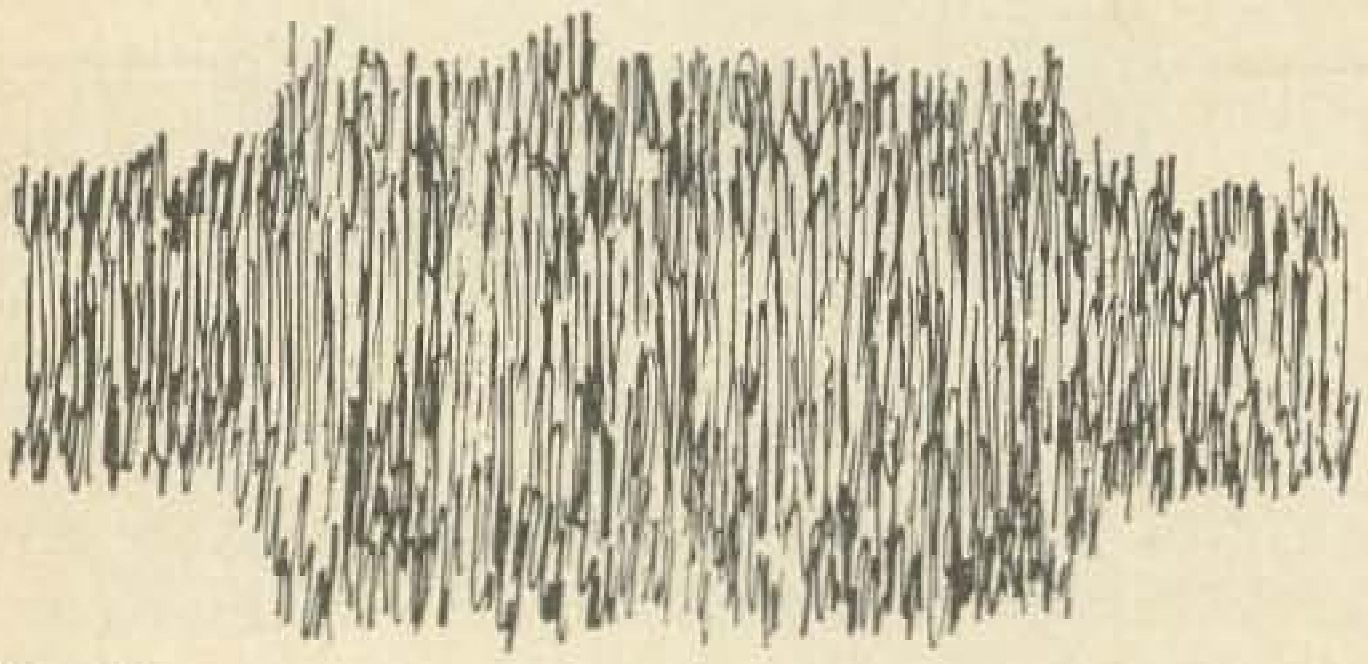

Fig. 9.

Fig. 10 shows a thumpy and mushy signal. I'm sure it is click free, but this is really hard to copy, and this particular one had chirp to boot.

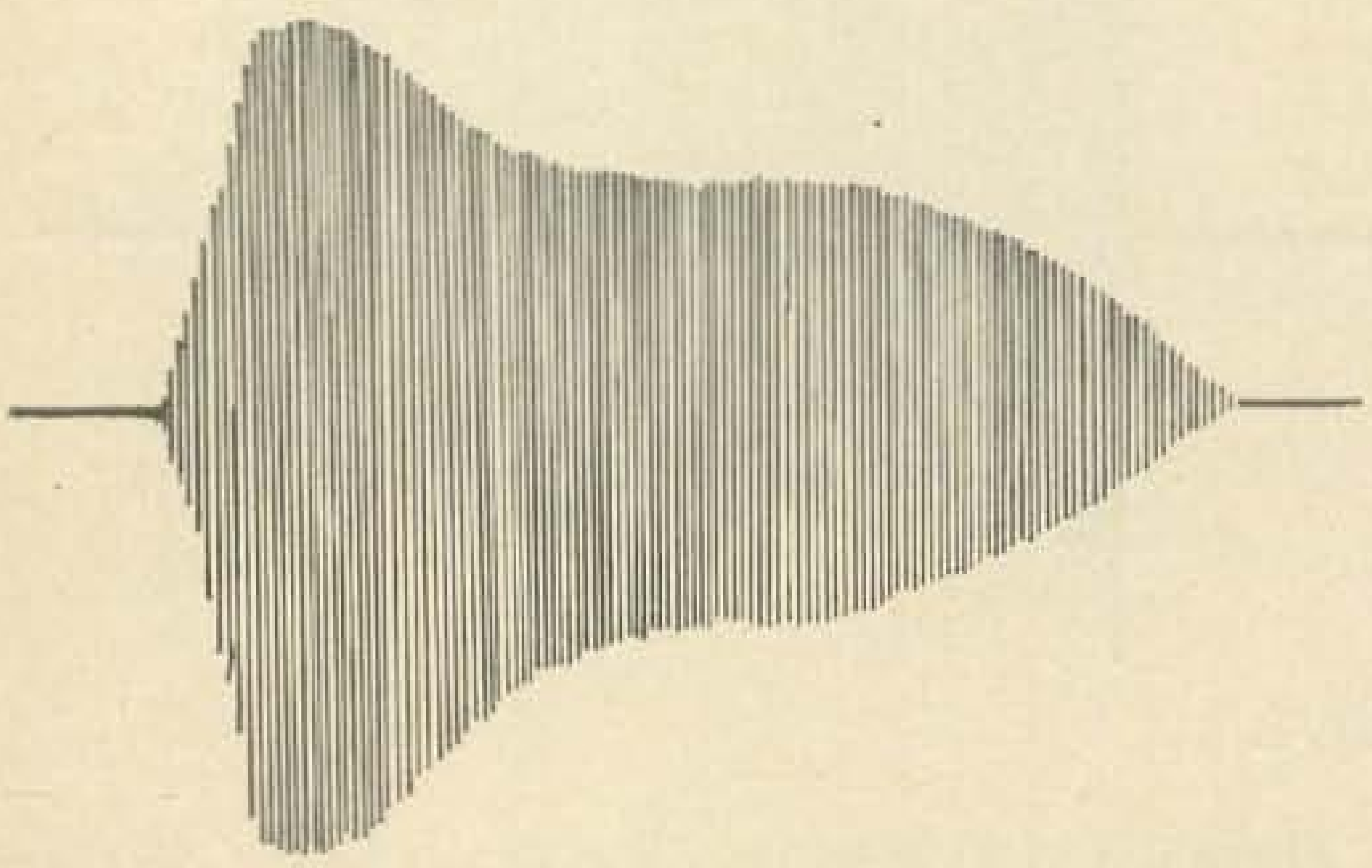

Fig. 10.

If the owner of this form could see his own signal (*ARRL Handbook* shows how), I'm sure he would try to do something about it. However, the listener to whom this signal was directed gave the owner a 589. Like Linus' blanket, indiscriminate 589's make for false security.

Here's one that can boast of a good regulated power supply and plenty of key click filtering—as a matter of fact, the owner seems to have gone overboard in trying to eliminate key clicks.

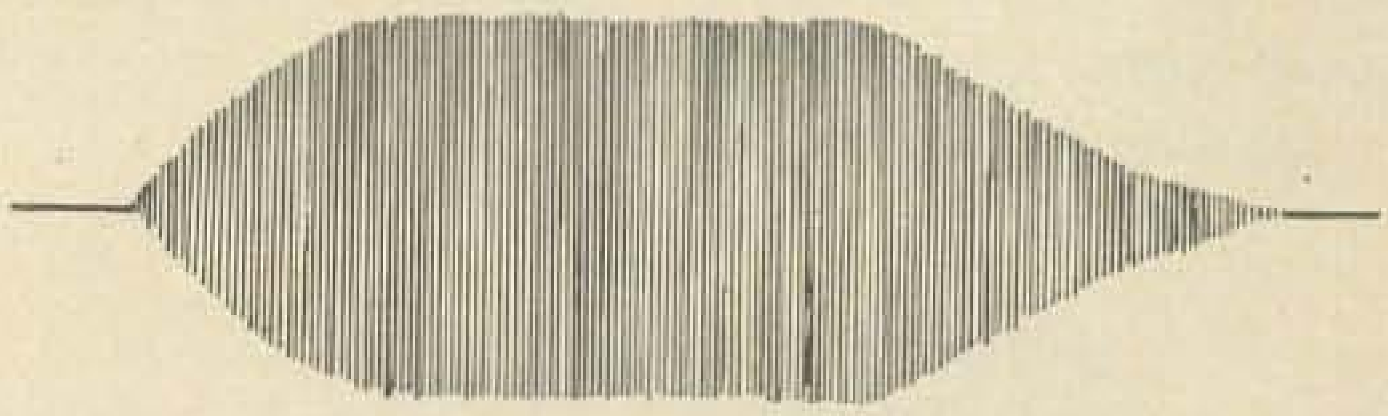

Fig. 11.

It is too mushy and very hard to copy because one pulse trails off into the next one, producing an undulating sort of sound which is hard to define, and hard to copy beyond 10 words per minute. It has to be heard while seen.

Fig. 12 shows the same pulse as in **Fig. 2**, The difference is that for **Fig. 12**, the AVC was turned on. It can be seen that the AVC action has reduced the gain. The point is, when looking at CW signals, keep the AVC off. Otherwise, you will be adding characteristics to the signal that do not exist.

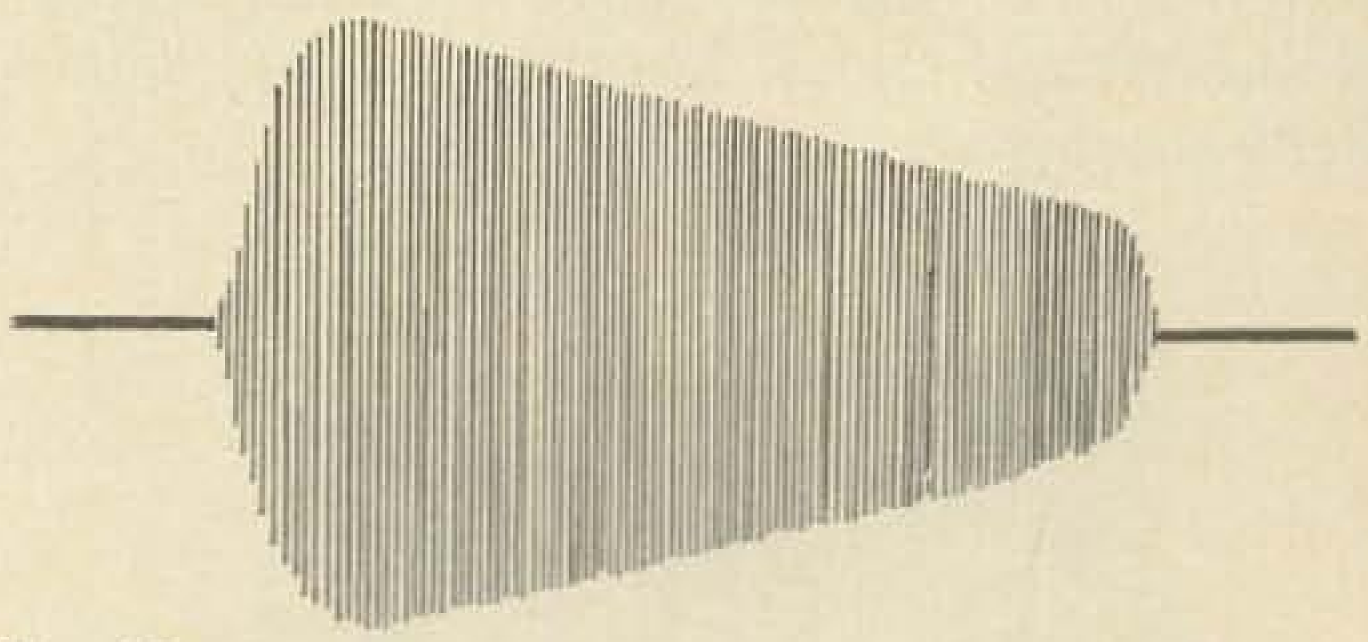

Fig. 12.

Here is a dandy. **Fig. 13** developed very early in the design of the receiver modification. Actually these wiggles were the only things to be seen for a while.

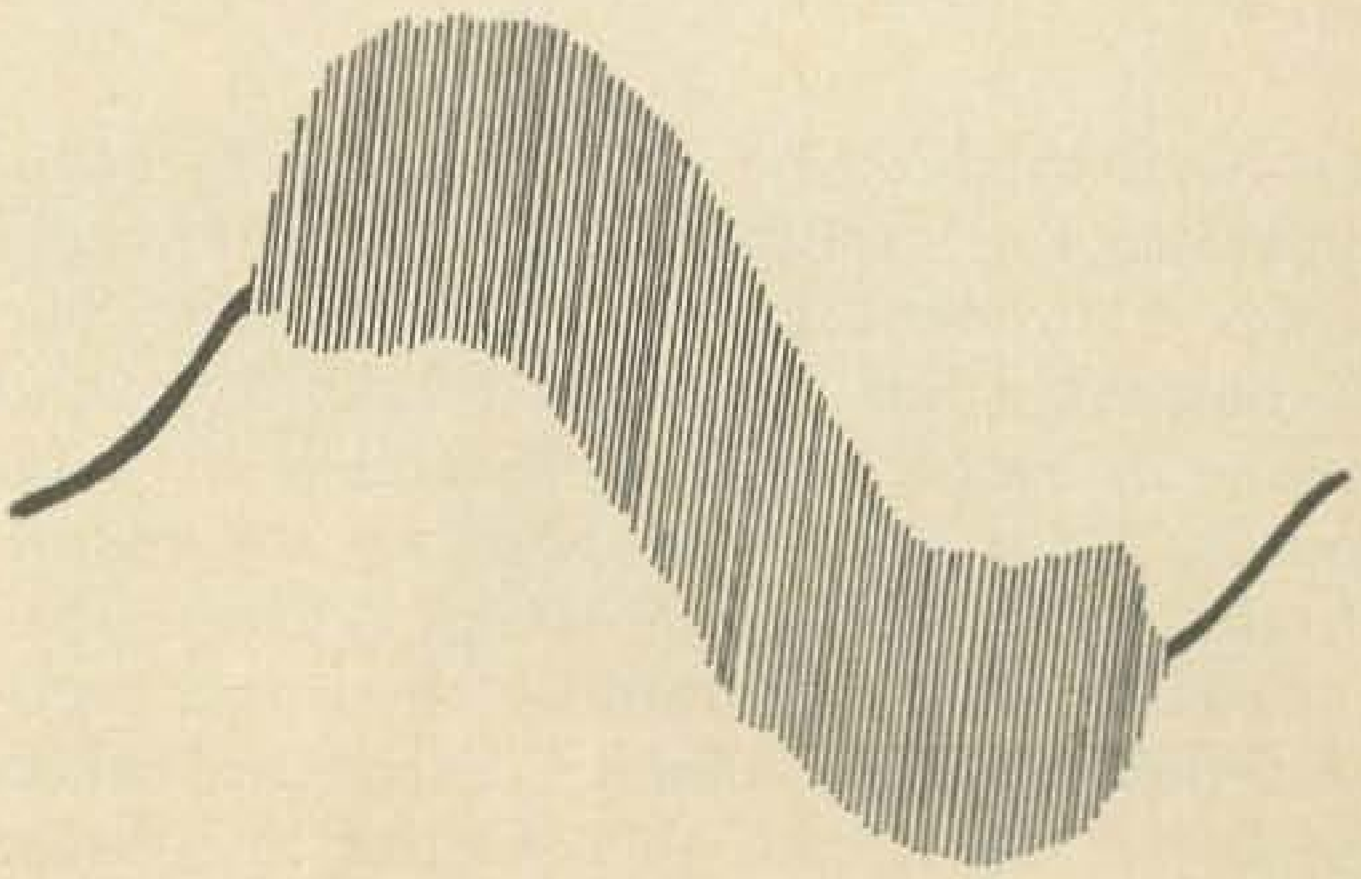

Fig. 13.

While trying to figure out this sausage pattern, the answer came unexpectedly. My wife had come into the shack to make some comment about chores still waiting to be done. I turned down the audio to hear what she had to say. Later, as I looked back at the scope to continue my observations, the sweep had straightened out. This was pretty frustrating because it sure looked like something intermittent had developed. I turned the volume back up to listen to the signal, and there was the sausage again. The crookedness was proportional to the volume. Volume down, straight sweep; volume up, baloney. Poor regulation in the B+ line of my receiver was the cause.

May I suggest that you keep these pictures handy and if we ever bump into each other (low end of 80 early evenings), I will be happy to tell you what kind of signal you have by saying that it is similar to, or exactly like figure so and so. If you bump into someone else who has made this modification, let him tell you what you look like. It's fun watching the characters as you listen to them.

So far all the discussion has been on CW characters, mainly because there is such a variety, and it is my prime interest. However, don't discount the AM aspect. The modulated carrier envelope is a pleasure to watch—you can tell your QSO exactly how he is modulating, and on AM you can leave your AVC on, or off, as you wish. SSB signals are easy to monitor. Flat topping is very apparent. You can do all the monitoring as shown in the *Handbook*. In addition, you can monitor the other guy's carriers where the *Handbook* indicates only how to monitor your own. Do you like trapezoid patterns? Just plug the audio into the horizontal amplifier.

Now for the technical details. I said earlier that a good place to look at a carrier was at the last *if* stage before detection.

A cathode follower is added to the receiver. Inasmuch as this circuit presents about a 30-megohm load, the loading of the *if* is negligible. As a result of this connection, no trimming or touching up of the last *if* is necessary. The output of the cathode follower is brought out to a phone jack installed in a convenient place. Because the output impedance of this follower is approximately 180 ohms, plain unshielded wire was used between the cathode-follower output and the phone jack, keeping the wire close to the chassis, and not over a foot long.

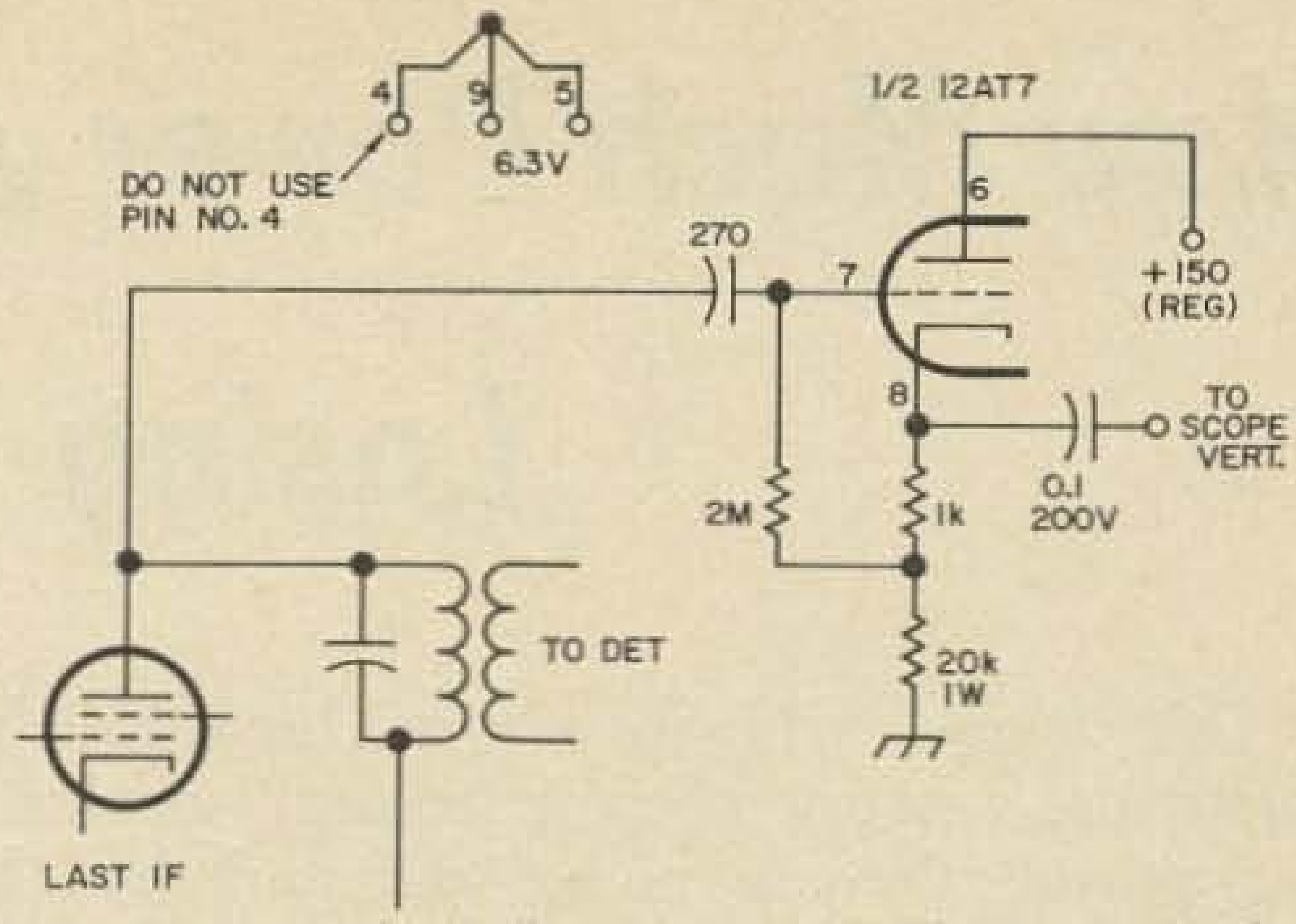

Fig. 14. Cathode follower circuit which is used to isolate the last *if* stage from the oscilloscope.

Between the phone jack and the vertical input of your scope, use a piece of RG-58. Plain shielded wire will work fine if your second *if* is 50 kHz as are most double conversion jobs. Assuming that you use as much as six feet of plain shielded wire to connect your scope, about 300 pF of shunt capacity will be added across the cathode follower output. Sounds like a lot, but 300 pF at 50 kHz provides a reactance of about 10,000 ohms. When shunted across the 180 ohm output of the cathode follower, this will not produce any noticeable attenuation. At 455 kHz, the reactance of 300 pF would be about 120 ohms. When shunted across the follower output, the attenuation would be quite noticeable, but it will still work. However, if your scope has lots of gain at 455 kHz, it's still ok. The choice is up to you.

Your scope may need a small modification to produce a slower sweep than you normally have. I found that as low as two sweeps per second is very useful. The scope on the W3RMI operating console is a three-inch Heath Model 10-21 with a bandwidth of 200 kHz, more than adequate to handle 50 kHz signals. A capacitor and switch were added to produce the slow rate, as shown in Fig. 15.

. . . W3RMI

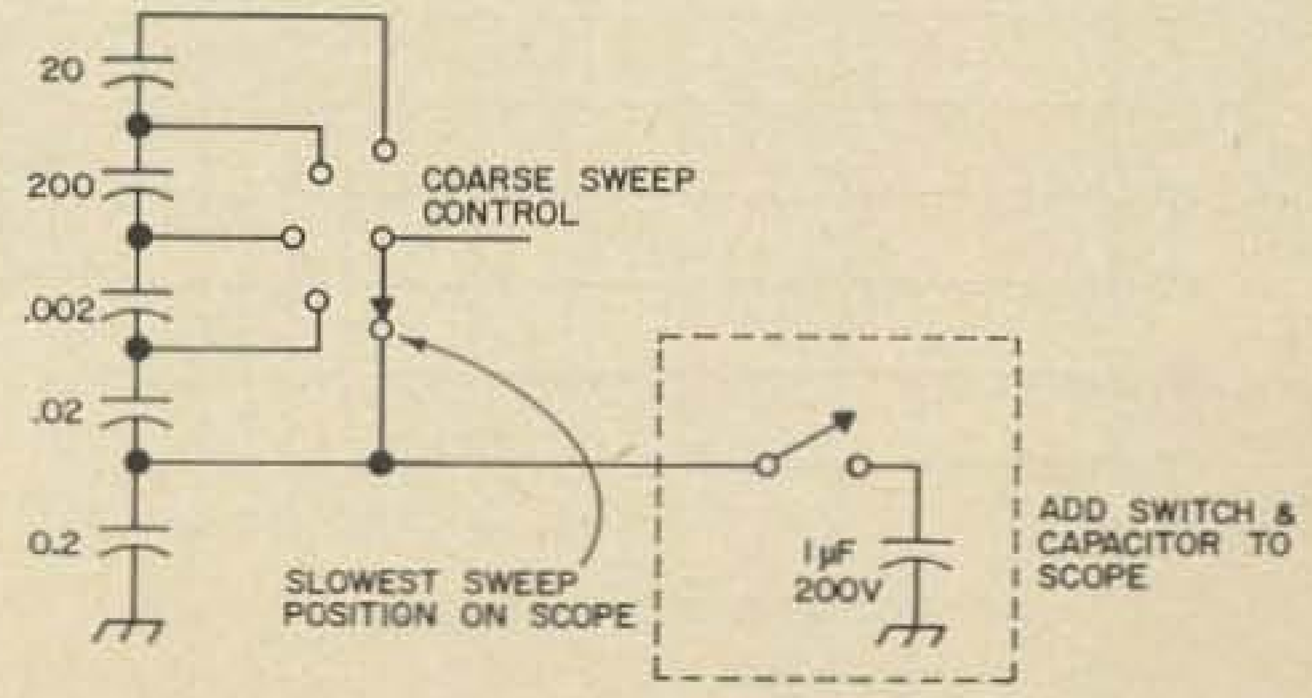

Fig. 15. Adding a capacitor to the scope's sweep circuitry to slow down the trace for CW monitoring.

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How Much Power Are You Losing Through High SWR?

This article will show you how to calculate the amount of your transmitter's output power that is being radiated by the antenna and the amount being lost in the feedline.

To perform this very important calculation, all you need to know is the SWR and the type of coax you have (the number is printed on the insulation).

Before we go into more detail, let's consider why this is important. First of all, it tells you how high an SWR you can tolerate without wasting most of your power melting ice off the coax. You may find that this SWR is considerably higher, or lower, than you thought; this depends on the frequency and the type of coax you use. Secondly, you can assume the superior attitude of an antenna expert toward any kid on 75 meters who doesn't show the proper respect for your two letter call.

Now, how do you measure SWR? Well, the easiest way is to buy an SWR bridge such as those distributed by Heathkit, Knight, Laffeyette, etc. These bridges are all essentially the same; they provide continuous monitoring of tne SWR and relative power output.

To apply the following analysis to your antenna system, first compute the attenuation of your transmission line at the frequencies of interest when properly matched. This is done by looking up the attenuation per 100 feet of coax in **Table 1** or in the Radio Amateur's Handbook under Transmission Lines. Then:

$$\text{A (Attenuation in db of line when properly matched)} = \frac{\text{attenuation per 100 ft X Length of coax in feet}}{100}$$

With this information the % of the input power delivered to the antenna for a given SWR can be read directly from **Fig. 1**, for most antenna systems.

If a more exact answer is desired, use the formula

$$\frac{\text{Power to Antenna}}{\text{Power Output of Transmitter}} = \frac{(S+1)^2 - K^2\,(S-1)^2}{4KS}$$

Where S is the SWR indicated by the bridge and K is found by referring to **Fig. 2.**

The SWR should be measured close to the transmitter output connector for this analysis to be valid.

As a brief example, consider a station that has an 80 meter dipole fed with 50 feet of RG-58/U. Consulting **Table 1**, we find the attenuation at 80 meters to be 0.8 dB per hundred feet and $A = \frac{.8 \times 50}{100} = .4$ dB. If the SWR is 4:1, **Fig. 1** shows that 81% of the transmitter output power is delivered to the antenna; that is, about 1 dB of power is lost in the feedline.

Consider a second example where the station is using the same feedline as above to feed a two meter beam. Let's say that the SWR measured on this band is only 2:1; this sounds like a more favorable situation than the one postulated in the first example. Once again, we refer to **Table 1** and calculate A = 3.5 db. **Fig. 1** shows that only 22% of the power is delivered to the antenna.

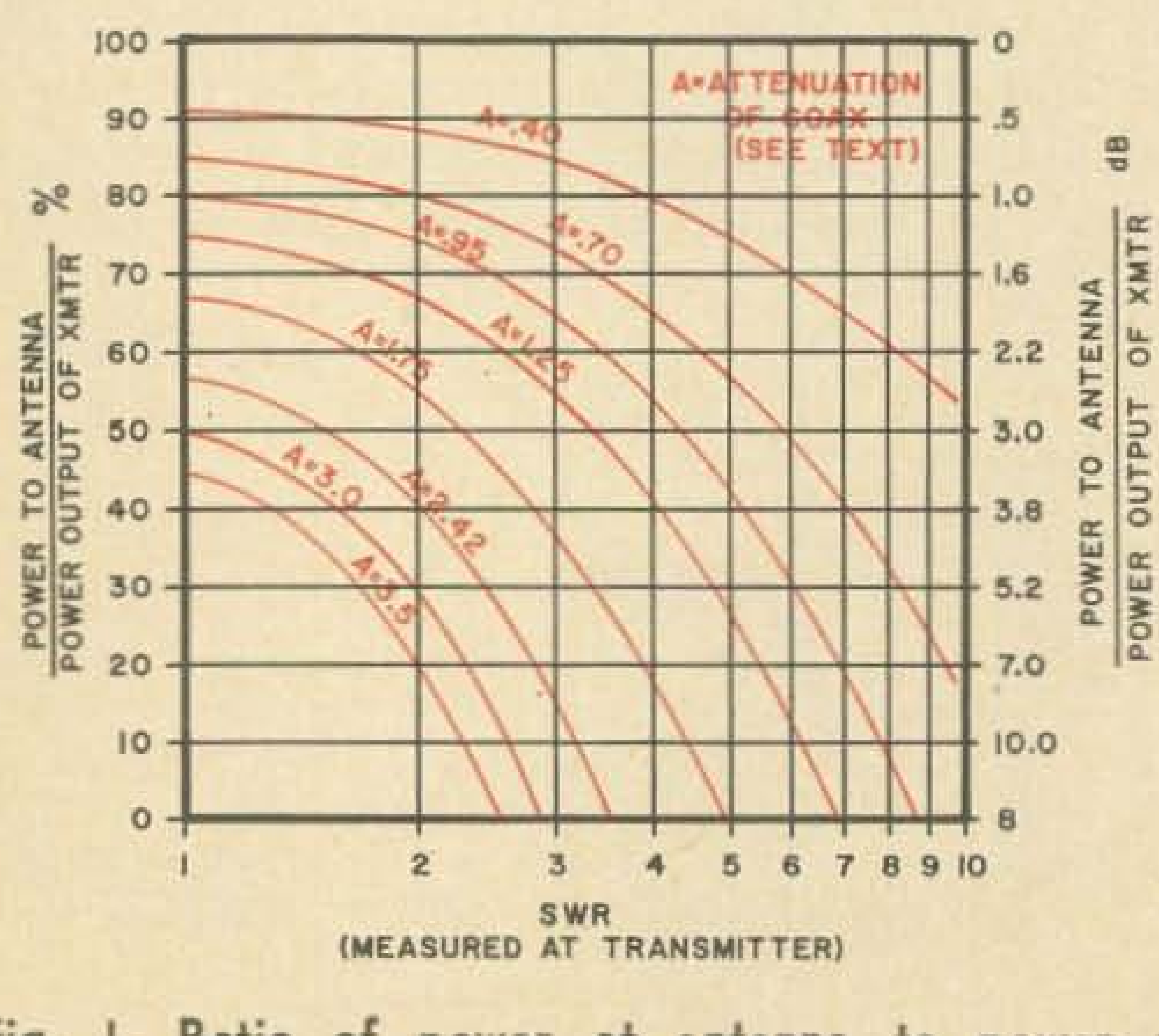

Fig. 1. Ratio of power at antenna to power at transmitter versus SWR.

Type of Coax	Attenuation per 100 ft. in dB						
	3.5 MHz	7.0 MHz	14 MHz	21 MHz	28 MHz	50 MHz	144 MHz
RG-8/U, RG-9/U RG-10/U, RG-11/U	.38	.53	.75	.92	1.1	1.5	2.6
RG-58/U	.8	1.2	1.75	2.2	2.6	3.6	7.0

Table I—Attenuation of coax lines per hundred feet

If we use the equation given to do the same problem, we have

$$\frac{\text{Power to Antenna}}{\text{Power Output of Transmitter}} = \frac{(3)^2 - (2.25)^2\,(1)^2}{4(2)\ (2.25)} =$$

$$\frac{9-5.06}{18} = .22$$

The value K = 2.25 was read from **Fig. 2.**

These examples show that there is no guesswork or magic associated with SWR, and much of the confusion on the subject is unwarranted.

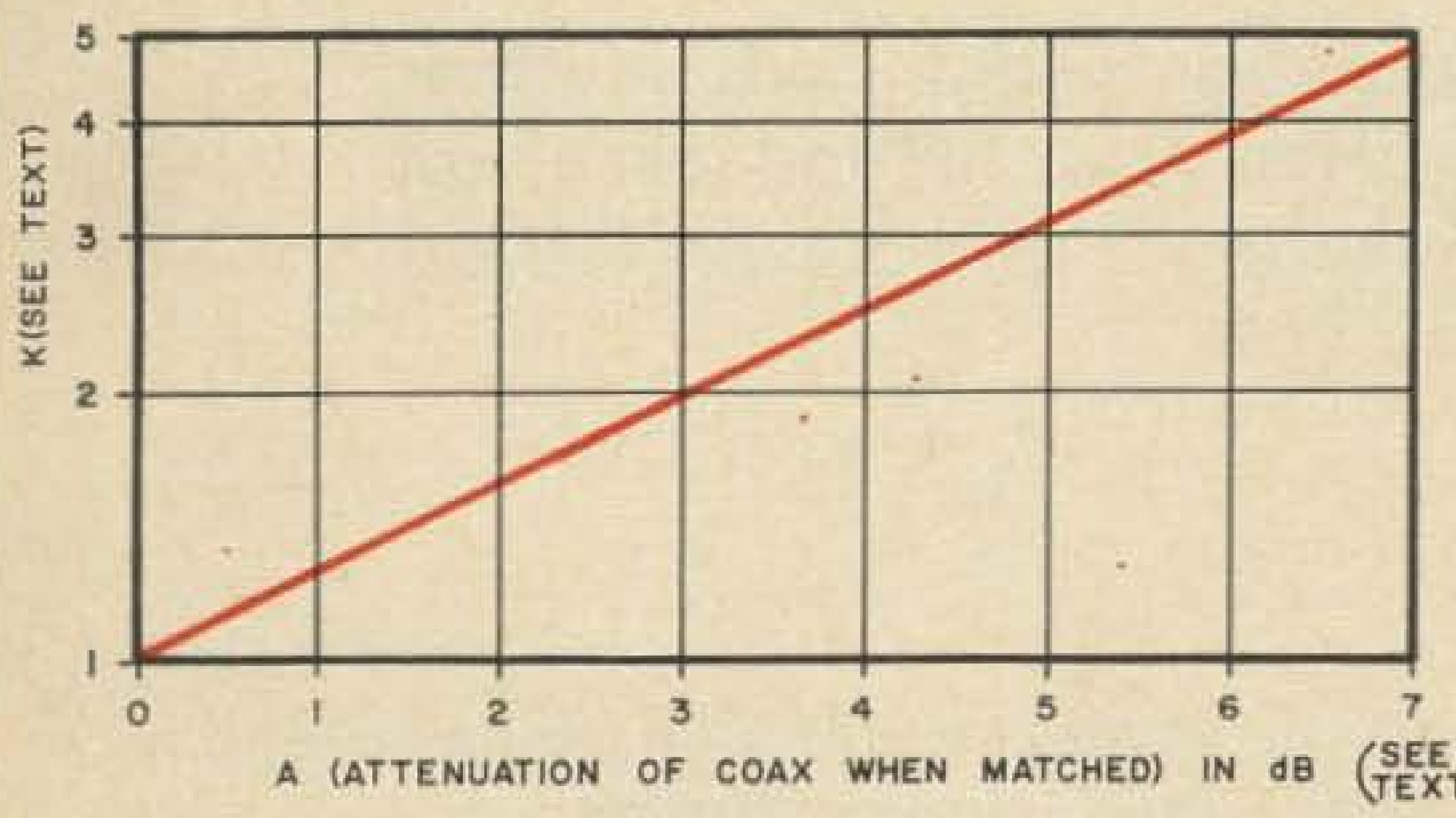

Fig. 2. Attenuation of coax versus factor K.

This analysis has some interesting results. For instance, if the antenna were disconnected from the feedline of example two, **Fig. 1** shows that the SWR bridge would read an SWR of only 2.6; a deceptively low reading considering that all the power is being lost in the feedline.

On the other hand, the operator of the station postulated in example one would lose less than 3 dB of power with an SWR of 10:1!

The moral is, don't be fooled by guesswork and generalizations; compute the power you are losing at your installation on your favorite frequencies, and decide if you have an SWR problem.

One note of caution; high SWR's often make the transmitter difficult to load and excessive rf voltages may be created at high power levels. . . . K2DXO

1. Stewart, John L., "Circuit Analysis of Transmission Lines," John Wiley and Sons, Inc., New York.
2. Everett and Anner, "Communications Engineering," 3rd Edition, McGraw-Hill, New York.
3. The Radio Amateur's Handbook, ARRL.
4. Reference Data for Radio Engineers, 4th Edition, ITT Corp.

Break-In for the HX-20

The VOX function for the Heathkit HX-20 transmitter may be used for CW break-in without making any changes in the transmitter's wiring. All that is needed is an audio signal from a CW monitor common to every CW man's shack. There are two simple ways that this may be accomplished. In the first method the microphone is simply hung beside the speaker of the monitor, the transmitter's *audio gain* control is set to the "CW" position, and the *mode* switch placed in either the "upper" or "lower" sideband position. For this the microphone element must remain open when the push-to-talk switch is released. The author found it necessary to open his microphone and spring open the part of the push-to-talk switch that normally shorts the microphone element when the button is released.

An alternate method is similar except that a part of the audio signal from the monitor is fed through a .01 μF. capacitor and shielded cable to the microphone input (pin no. 1). A small outboard aluminum box equipped with a DPDT toggle switch and appropriate microphone fittings can be used to switch from c.w. to phone. No microphone tampering is necessary with this method.

As long as the transmitter's *audio gain* control remains in the "CW" position there is no signal distortion or 1000 Hz shift in frequency. The audio signal should not be taken from the receiver speaker since the transmitter anti-trip function will not allow the receiver audio to operate the VOX. The audio monitor must be one actuated by the station key rather than by the transmitter's rf output. (There will be no output until the vox has operated and turned on the transmitter).

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Using Toroids In Ham Gear

More and more amateurs are using toroid coils in their construction projects — they offer high Q and excellent performance in a compact package. If you haven't tried toroids yet, VE1ADH shows you how.

During the past few years, use of the toroid core in winding inductors and transformers has become increasingly popular. Once used primarily in telephone and teletype equipment, and some dc-dc converters, the toroid core can now be found in a great deal of contemporary solid-state electronics.

The advantages of using toroid cores are: high Q in a small size, a winding scarcely affected by external fields, and tight coupling of transformer windings. The disadvantages are that the ferrite cores are subject to temperature changes (more on this later) and a little inconvenient to mount on a chassis.

Since coils wound on toroid cores are insensitive to external fields (compare the permeability of ferrite with that of air!), it seems that the coil must be measured on an inductance bridge, since coupling to a grid-dip meter is not practical.

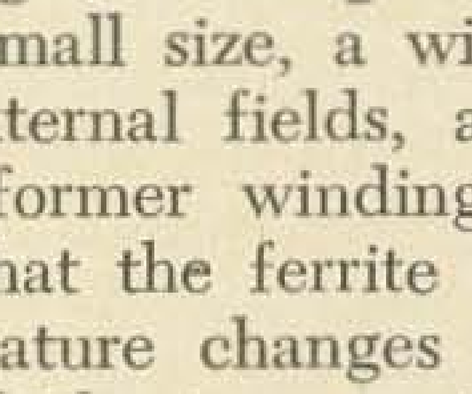

Fig. 1. A toroidal-core of six turns. When using toroids, there is no such thing as half a turn—if the wire goes through the center of the core, the turn counts as one full turn.

Toroid cores are available in sizes ranging from at least a foot to less than ¼ inch in diameter. The basic material of the core is ferrite, a high-permeability material made up from several magnetic materials and a binder. It is important to note that there are many different grades of ferrite used in these cores, all with different electrical characteristics. To design around these cores, one *must* obtain manufacturers' data on the type of core at hand. If the cores obtained are unknown, (scrounged components don't always come with spec sheets!), grab some wire and head for the nearest inductance bridge. Some cores are good to 100 kHz, while others are used up to 50 MHz, so assume nothing.

There are several things one should keep in mind when using toroid cores:

1. For a loop of wire to be counted as a turn on a toroid core, the wire need only pass through the center of the core. Therefore, there is no such thing as a half-turn on a toroid core. Each time the wire passes through the core, a complete turn has been wound. If we remember that magnetic lines

of force tend to be self-completing, this is easily understood. **Fig. 1** illustrates this concept of turns through the center. The coil shown in **Fig. 1** is a six-turn coil, not a five-turn coil as it first appears to be.

2. Ferrite cores have a tendency to change their electrical characteristics with changes in temperature. One manufacturer states that for a selection of toroid cores popular in industrial rf work, the percent change in permeability per degree Centigrade varied from .01% to 0.5%, depending on core material. While this variation does not appear extreme, it means that oscillators using toroids in the frequency-determining circuits will drift, and sharp tuned circuits will drift out of resonance*.

If it is necessary (or desirable) to use toroid cores as the core of a high-Q coil, and drift must be considered, one can use varactor diodes and/or temperature compensating capacitors to correct for drift. A much simpler solution is to use a much higher Q coil than is actually required, then pad the coil with resistance to decrease the Q to a desired value. The drift tendencies are padded by the resistance as well. The resistance may be put in series with the coil or in parallel with it. If I may delve into higher mathematics for a moment, the exact method of calculating the needed resistance will become clear. Considering the case of the series resistor first, let's assume that we require a 10 μH inductance with a Q of 10. As long as the coil we intend to pad has a much higher Q than the desired Q, we can ignore the coil resistance. Assume we measured our coil, and it measured 10 μH inductance with a Q of 50. What resistance do we put in series with the coil to decrease the Q to 10?

$$R_{series} = \frac{6.28\ fL}{Q}$$

where f = Operating frequency of coil in MHz.
L = Coil inductance in H.
Q = Desired Q of the finished coil

Substitute the proper values into the equation, grind out the answer and you have

*For the temperature range normally encountered in amateur equipment, particularly solid-state units, the drift contributed by the toroid core will usually be insignificant when compared to the other devices in the circuit. ed.

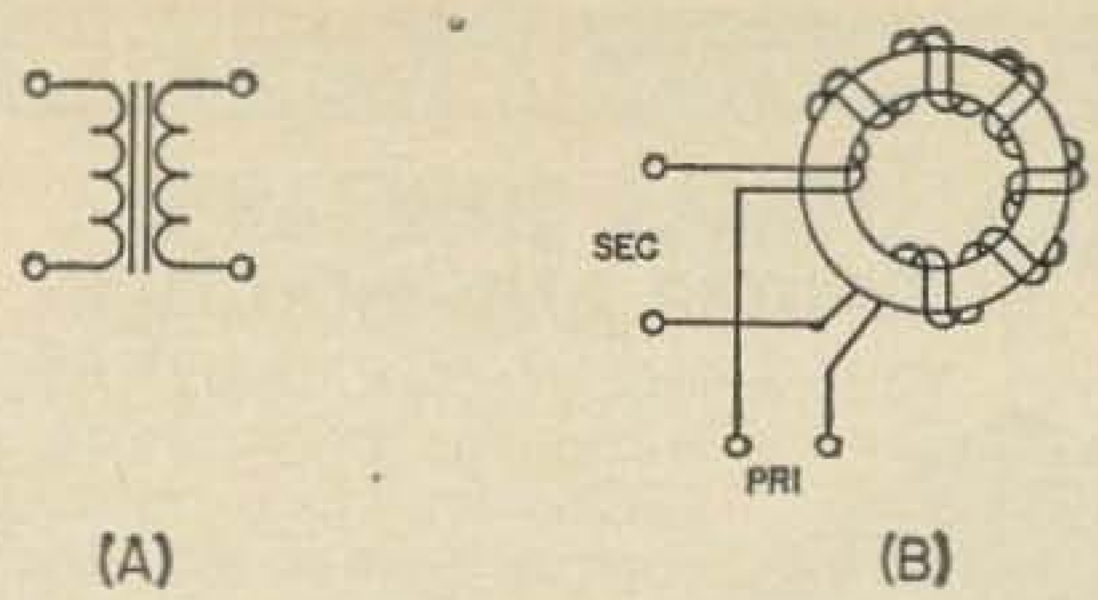

Fig. 2. Winding a high-frequency transformer on a toroid core.

the required value of series resistance.

Now, let's consider the case of a resistor in parallel with the coil. This will probably be the most popular case, as putting a resistor in series with a coil usually fouls up some dc circuit in the process. This might be a good place to mention that these parallel-tuned/padded circuits are dandy for broadband untuned circuits in transmitters, receivers, and converters. To design such a circuit, first determine the values of capacitance and inductance that resonate at the *center* of the band to be tuned. Then determine the necessary Q of the circuit:

$$Q = \frac{f}{B_w}$$

where f = Center frequency of desired band in MHz.
B_w = Width of the desired band in MHz.

Having found our desired Q, we need to know the parallel resistance across the coil to provide the desired Q.

$$R_{parallel} = 6.28\ fLQ$$

where f, L, and Q have the same values as the series resistance equation.

Perhaps I should point out that *unpadded* toroid-core circuits are dandy for high-Q, sharply tuned high-frequency circuits in receivers. Toroid cores are also very useful in constructing transformers for other high-frequency uses and for dc-dc converters.

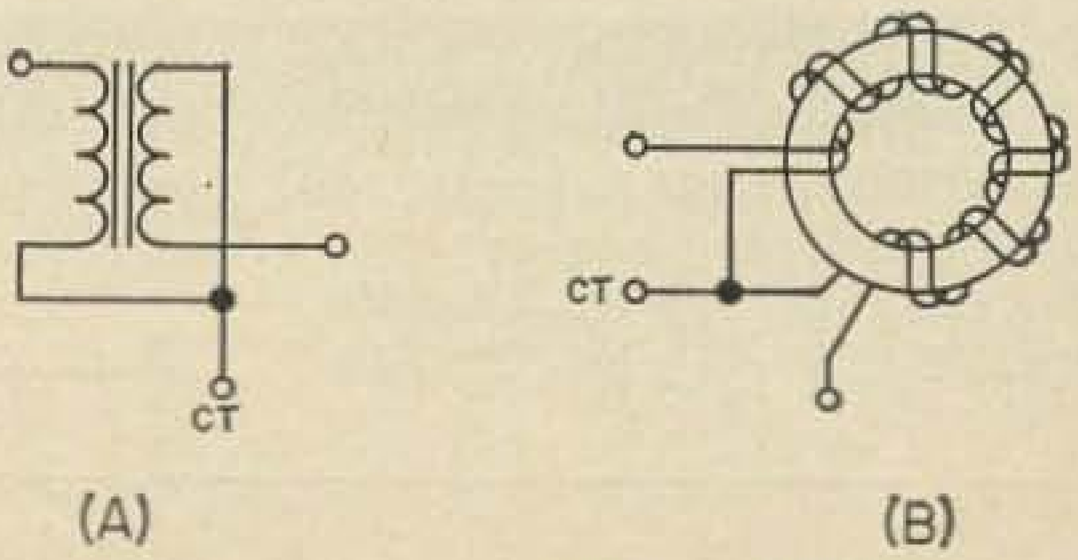

Fig. 3. A balanced, center-tapped inductor wound on a toroid core.

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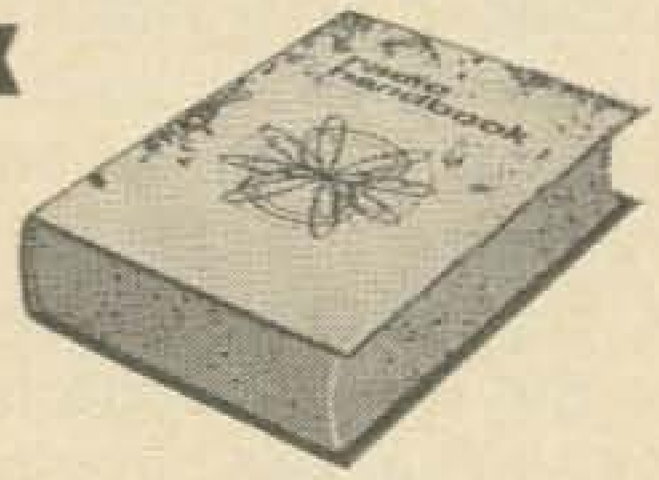

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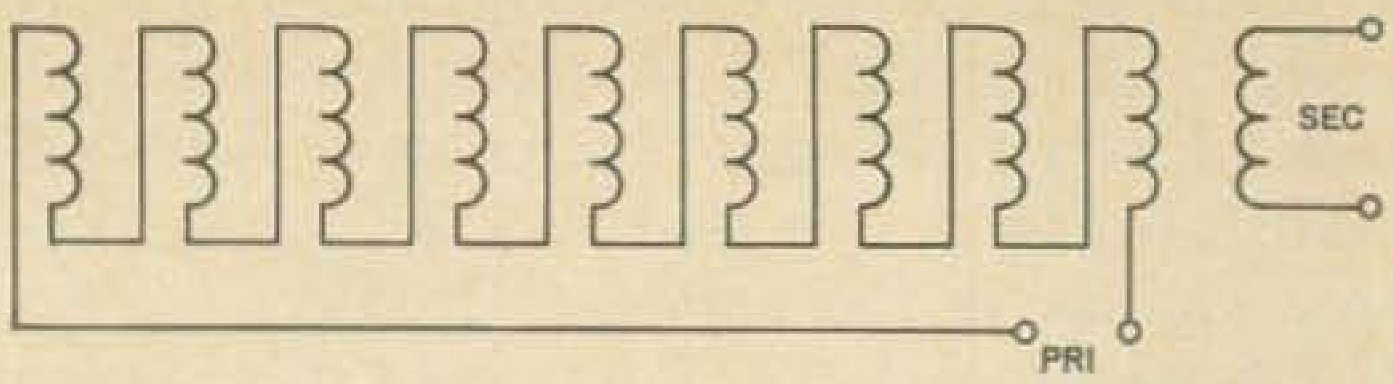

Fig. 4. Method of connecting several windings in series to obtain higher turns ratios. When doing this however, the proper phase relationships between windings must be observed.

The toroid core provides a means of obtaining a highly efficient, easily wound transformer.

They are efficient because of the very tight coupling between windings obtained by interwinding the transformer windings. For example, suppose we need a 1:1 transformer, with ten turns on the primary and secondary, for use at high frequencies. Choose a toroid core useable at the desired frequency. Parallel two wires long enough to wind ten turns on the core. Wind the ten turns and separate the leads. Secure the windings with some Q dope and *voila*—high-frequency transformer. The finished product is illustrated in **Fig. 2.**

If a balanced, center-tapped inductor is needed, wind it on a toroid exactly as the transformer of **Fig. 2** was wound. After separating the leads, join the proper two leads to obtain the desired center-tapped inductor. See **Fig. 3.** Be careful to connect the proper leads (one from each end of the coil) to obtain the proper phase.

The method of winding shown in **Fig. 2** and **3** is particularly useful if a multi-turn inductance or transformer is required. For example, suppose we require a transformer with ninety turns on the primary and ten turns on the secondary. Choose ten lengths of suitable wire long enough to wind ten turns on the core, and wind the ten turns as before. Separate one of the windings and call it the secondary. Now, separate the remaining windings and connect them all in series to obtain the ninety-turn primary. Be sure to observe the proper phase relationships when connecting the primary windings in series. See **Fig. 4.**

I am sure that many other uses will be dreamed up by amateurs for these cores, but these are a few of the more obvious ones. Most manufacturers will readily supply information for their products upon request. The cores may be cemented to a chassis with one of the epoxy cements.

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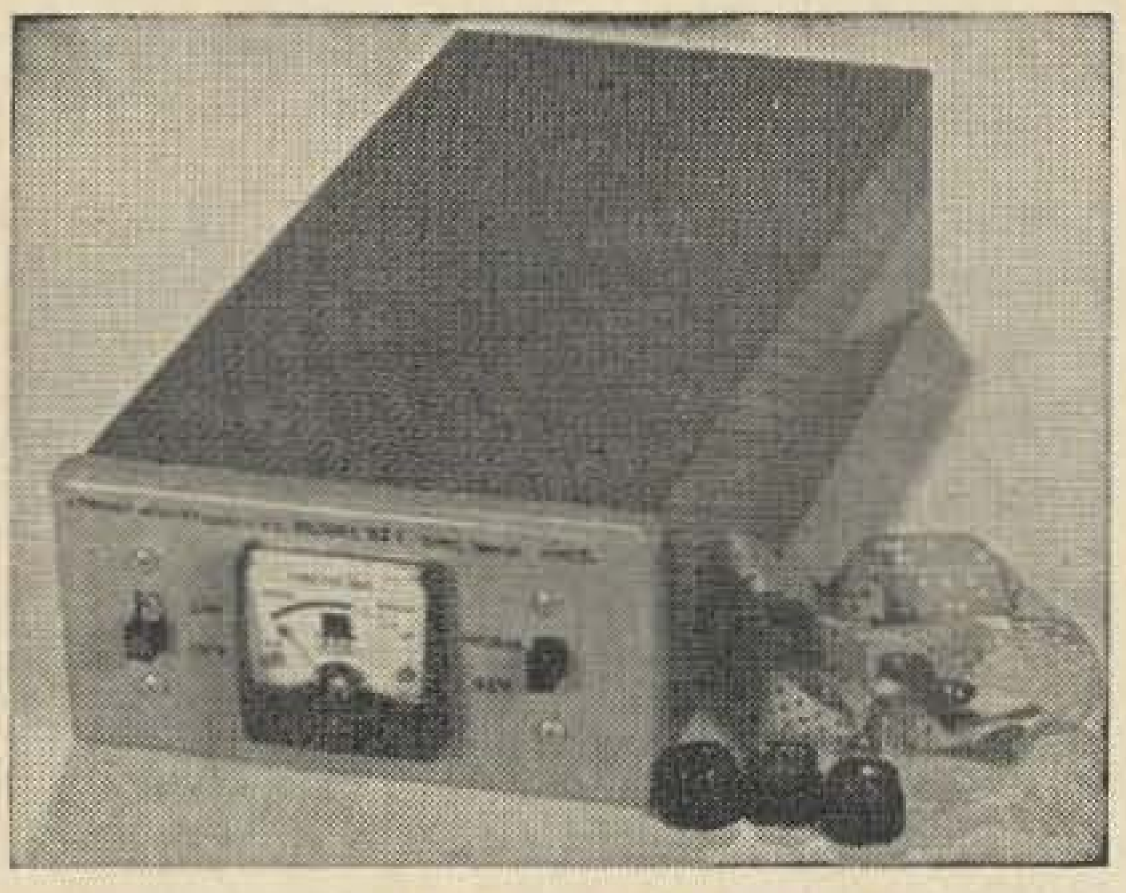

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Solid—State Alternator Regulator

An excellent regulator for the mobile operator. It will maintain the system voltage within 1/3 volt even when drawing 150 amps — provided your alternator can take it!

The regulator described here was designed mainly for use with a 40- or 100-amp Leece-Neville alternator, but the circuit is compatible with just about any alternator made. If you are using the 100 amp unit, omit the current limiting pot and connect your bias wiring directly to the output of the regulator. (The 100-amp jobs have a tremendously low source resistance and current limiting protection is never required. However, fuses are advisable.) If you have a mechanical regulator, the best place for it is the round file. These gadgets offer poor regulation and always choose to fail when you're in Timbuktu.

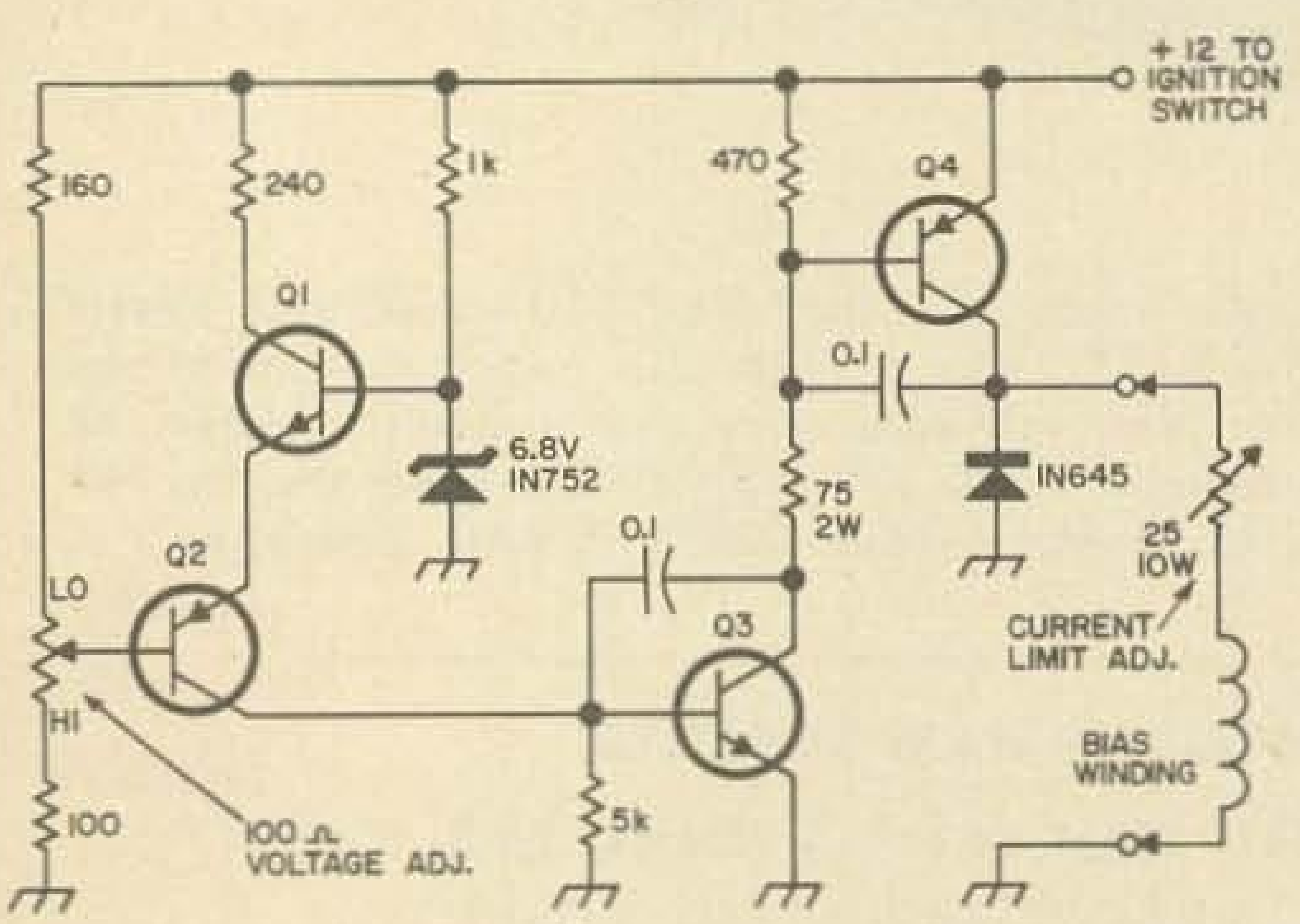


Fig. 1. Circuit diagram of the solid-state automotive voltage regulator. This circuit will provide excellent regulation to over 100 amperes. Although it was designed for use with Leece-Neville alternators, it will work with just about any alternator made. Transistor types may be chosen by referring to Table 1.

Moreover, it would cost twice as much for a mechanical unit which would do the same job as this transistorized unit.

In my car the regulator performs as follows: the system voltage from the alternator does not vary more than 1/10 volt from 0 to 70 amps. From 70 to 120 amps the voltage drops a total of ¼ volt. At 150 amps out, the voltage is down only ⅓ volt from the nominal setting. Running the alternator over 100 amps for a period exceeding 5 seconds is not recommended. The alternator will take it, but the rectifiers are not only expensive, they are cumbersome to replace!

Construction

I built my regulator on a sheet of fiberglass breadboard material. However, construction is not critical, so build it in or on anything you like. Make sure to heat sink Q_3 and Q_4. Be sure the heatsinks are exposed to free air. Heat sink Q_3 as though it were to radiate 2 or 3 watts, and Q_4 10 to 20 watts, and you will be in good shape.

The circuit is designed so that you can use either germanium or silicon transistors anywhere in the circuit. **Table 1** shows recommended transistors of both types. Transistors Q_3 and Q_4 will no doubt be the most expensive, so use germanium if the cost of silicon is prohibitive. Under no circumstances use germanium transistors, however, if you drive in an extremely hot climate or through deserts. Silicon transistors can withstand 2 to 4 times the temperature of a comparable germanium type.

Installation

Once constructed, install the regulator under the hood, preferably in front of the radiator so that it is cooled by virgin air rather than warmed air. On a hot day the temperature under the hood of a car is typically 200°F. Connect the output of the regulator (ground and the collector of Q_4) to the bias winding of your alternator. This winding is sometimes referred to as the "excitation coil". Time to connect 12 volts! Select a point that is turned on and off by the ignition switch, fused and easily capable of delivering 3 amps. Such a point is obtainable at the main fuse block in your car. Be sure to provide a good ground for the regulator.

Adjustment

Connect an accurate voltmeter across the battery. Throttle the engine up to about 1200 rpm and adjust the regulator for a system voltage of about 13.5 volts. If you are using the current limiter pot, be sure it is in the "shorted position" before making the above adjustment. There is nothing magic about the number 13.5; in fact, you should use the lowest value that will still maintain a good charged condition on your battery. After establishing the above potential, it is time to adjust the current limiter pot if you are using it. Turn on everything you normally use in the car: lights, ham rigs, etc., but do not exceed the maximum current you feel your particular alternator can safely deliver. Now, with the current limiter pot, adjust for a system potential of about 12.4 volts. Further current will now be drawn from the battery instead of the alternator.

Circuit Analysis

All high quality voltage regulators depend on a difference amplifier of some sort. In this case Q_1 and Q_2 serve the same purpose but are complementary; Q_3 and Q_4 further amplify and increase the open-loop gain of the regulator to an extremely high value. The alternator in the feedback path feeds back a value of E_{dc} to the voltage divider in the regulator. **Fig. 2** demonstrates how this system resembles a dc feedback amplifier. An ordinary feedback amplifier is also shown.

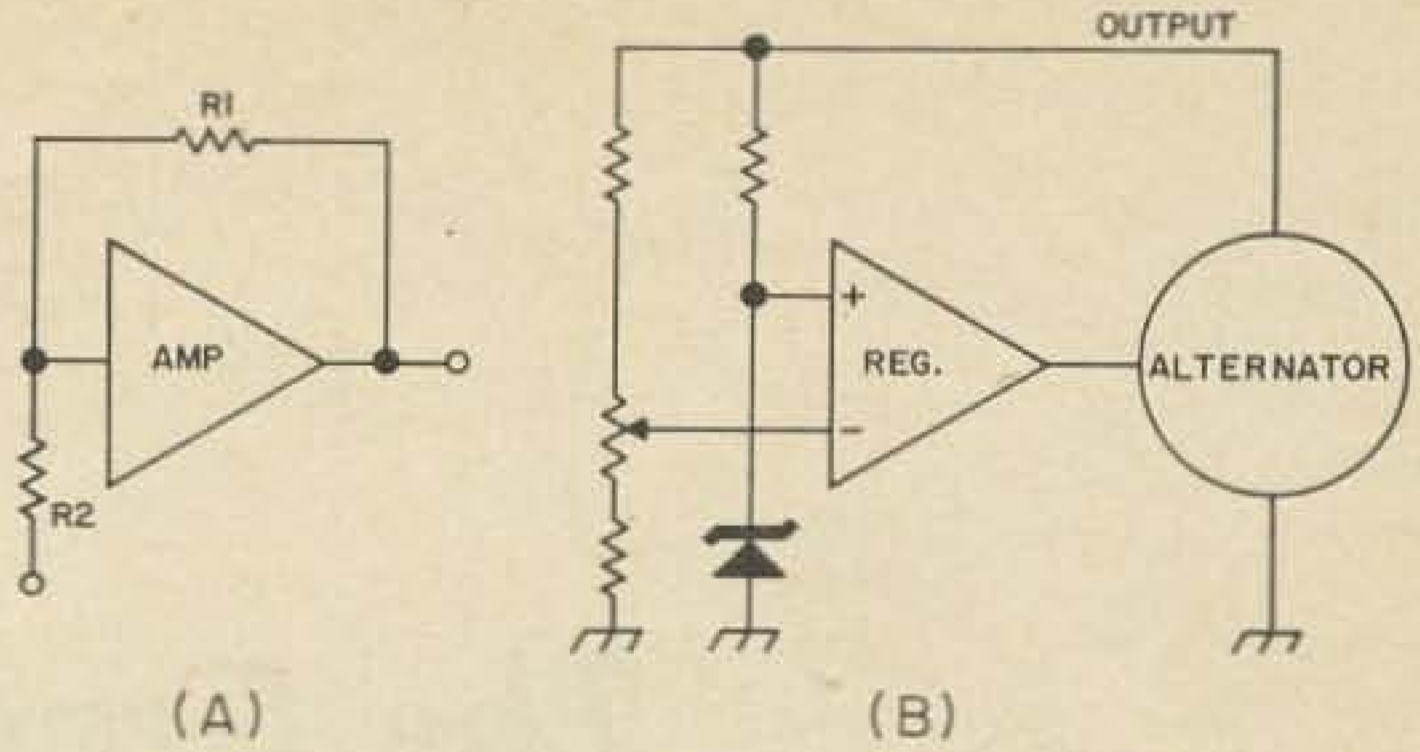


Fig. 2. Block diagram of the solid-state alternator. The system used closely resembles the simple dc feedback amplifier in A. In this type of amplifier, the gain closely approaches R_1/R_2. If the gain is very high, the regulator in B will not allow the preset voltage to change until the alternator is no longer capable of delivering the required current.

If the ratio of R_1 to R_2 is quite small compared to the open-loop gain of the amplifier (amplifier gain without feedback), then the gain will, in fact, nearly approach the ratio R_1/R_2. At this time one can appreciate the illustration in **Fig. 2** and it should be evident that if the open-loop gain is tremendously high, the regulator (amplifier if you like) will not allow the preset voltage to change until such time that the alternator is no longer capable of delivering the required current. The .1 μF capacitors provide regulator stability since they apply local degeneration at a relatively high frequency. The 1N645 diode protects the output transistor when you shut off your ignition. This stops the large negative inductive surge which might conceivably achieve a value of 600 volts open-circuited. Any rectifier you have on hand that can handle an amp should do the job.

. . . K6UAW

Table I

Transistor	Type	Silicon	Germanium
Q_1	NPN	2N1711	None recommended*
Q_2	PNP	2N1132	None recommended*
Q_3	NPN	2N657 2N3738 2N3739	None recommended*
Q_4	PNP	2N3790 2N3789	2N174, 2N1537, 2N3611, 2N3612

*No germanium transistors are suggested for Q_1, Q_2 and Q_3 because excellent silicon units should cost less than $6.00. If you use silicon all the way through, the cost should be less than $13.00 total.

John E. Boyd WAØAYP
RFD I
Egan, South Dakota 57024

The Great Dipper

A versatile transistor emitter-dipper for the VHF man.

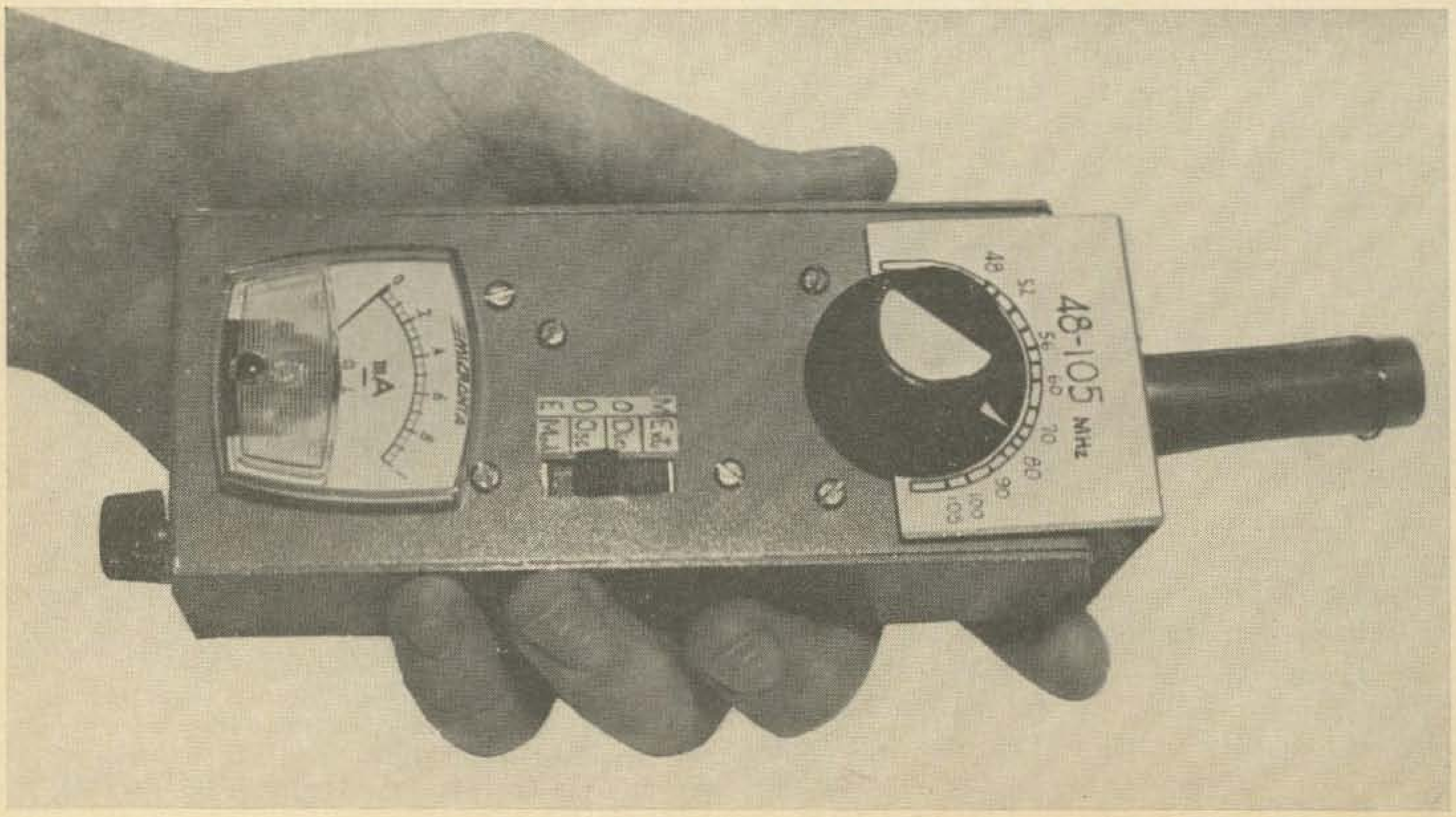
Test equipment is essential in the hamshack, as those of us have found when we attempted to get that new piece of homebrew perking for the first time. One of the most useful pieces of test equipment is the grid dip oscillator or simply, the GDO; besides being relatively inexpensive, it is particularly versatile. Need an indicating absorption wave meter? The GDO will do that. How about a modulated signal source? It handles that too. If you are interested in discovering its whole variety of uses, why not purchase one of several books on the subject.[1]

Every item used in this GDO was selected with an eye toward the average home builder. There are no parts which must be specially purchased from the West Indies Export Company or similar outfit. Nearly all the parts, except for the meter, miniature pot, and mode switch, were obtained from the junkbox, or rather, from several junkboxes. If you insist on buying all new parts, total cost of the project will be about $20.

Circuit description

The grid-dip oscillator, in this case more properly termed an emitter-dip oscillator, gets its name from the fact that emitter current in transistor Q_1 decreases when the tuned circuit C_1-L_1 is in resonance with a nearby circuit. This decrease is easily seen by the dip of the meter indicating pointer.

When switched to the diode position, B+ is removed from the oscillator and the incoming rf is rectified by diode D_x; the voltage developed across the 2k resistor is amplified by the meter amplifier and monitored by the 0-1 mA meter. In switching to the



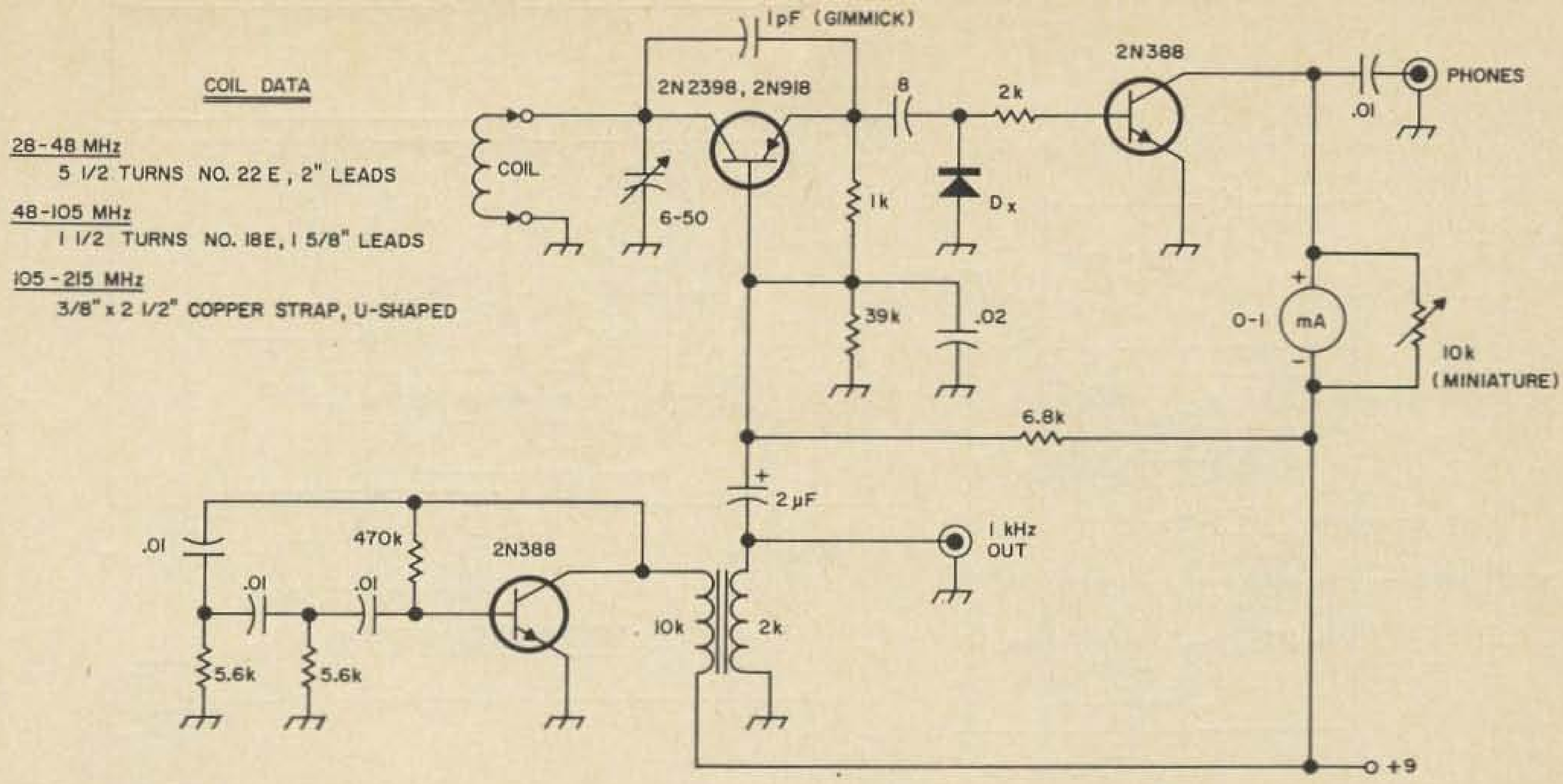


Fig. 1. Circuit diagram of the great dipper. Note that although the 2N2398 is a PNP transistor, the 2N918 is NPN, and if used as the oscillator transistor, problems would arise with voltage polarity. The diode D_x may be almost anything that you have available. The 1 pF gimmick capacitor consists of 1½" of twisted wire.

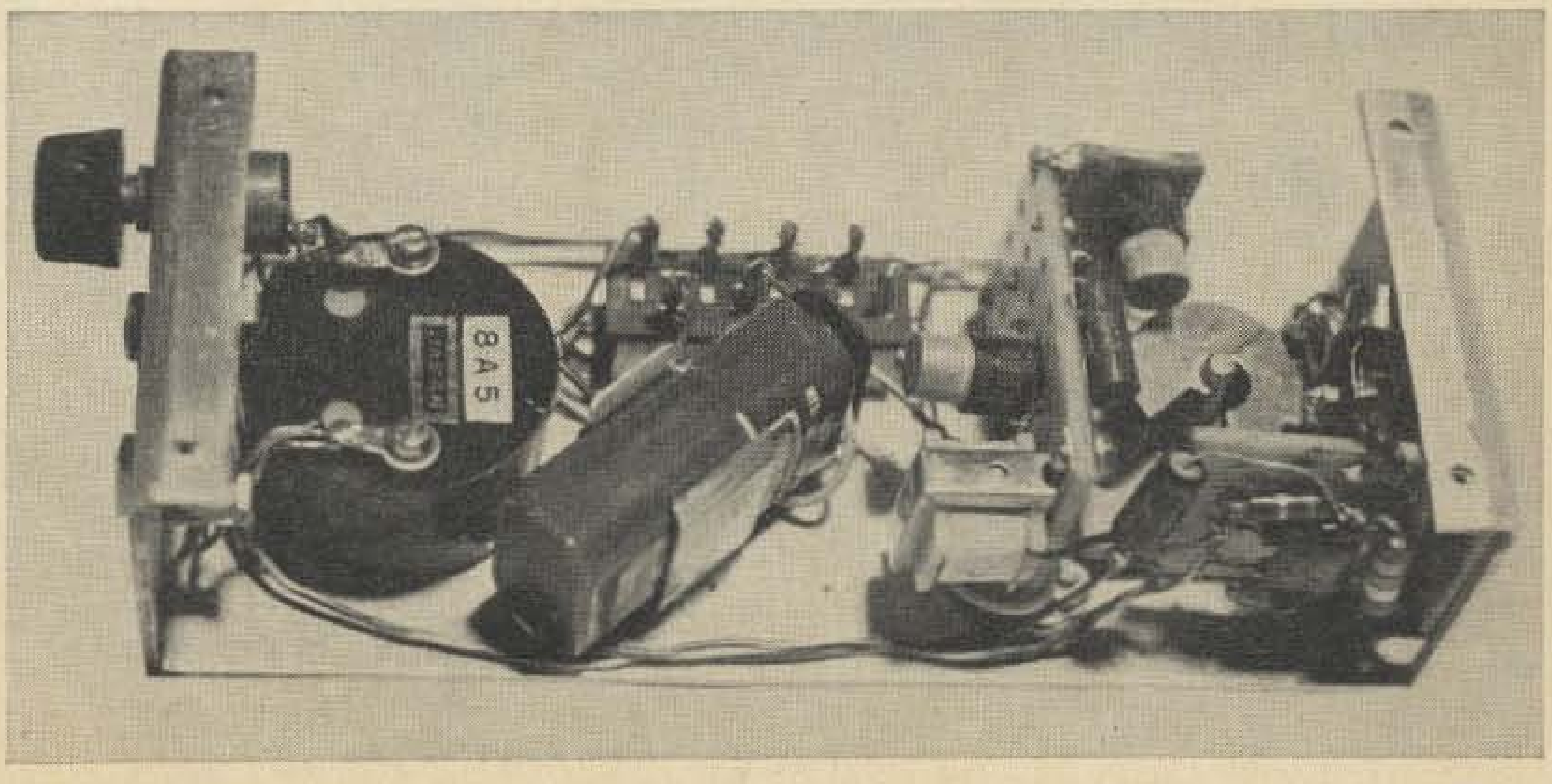
signal position, B+ is removed from the meter amplifier but applied to the modulator, and a 1 kHz tone is available from one of the output jacks. In the modulated oscillator position, B+ is reapplied to the oscillator, and the oscillator is modulated by the 1 kHz tone.

Like a patch-work quilt, this GDO was built using circuits from already published articles or books and modified where necessary. The whole circuit is composed of three separate entities–oscillator, meter amplifier, and audio tone generator. The circuit is not particularly critical, but lead lengths and dress in the oscillator must follow good VHF practice, if stable VHF oscillation is to be maintained.

My operating time is spent on the various bands from 28 mHz to 432 mHz. Quite naturally, when I discovered that the GDO would not oscillate satisfactorily over the entire range from 2 mHz to 200 mHz, I juggled values so that it would oscillate well at 216 mHz (for tuning frequency doublers to 432 mHz); then I tried to get as low in frequency as possible. Oscillation was vigorous to about 20 mHz. Coils and scales were then made to cover the respective ranges. It you don't do any homebrewing on the VHF bands perhaps you will find it necessary to change the value of the emitter-collector feedback capacitor, and to juggle the emitter and base resistor values in order to sustain oscillation at your desired frequencies.

Construction

Vector board was used, mainly because I wanted to experiment with component values; however, a printed circuit would be just as good, especially for something such as a



Internal construction of the great dipper. The modulator and oscillator boards are to the right—the oscillator transistor is mounted right next to the coil jacks.

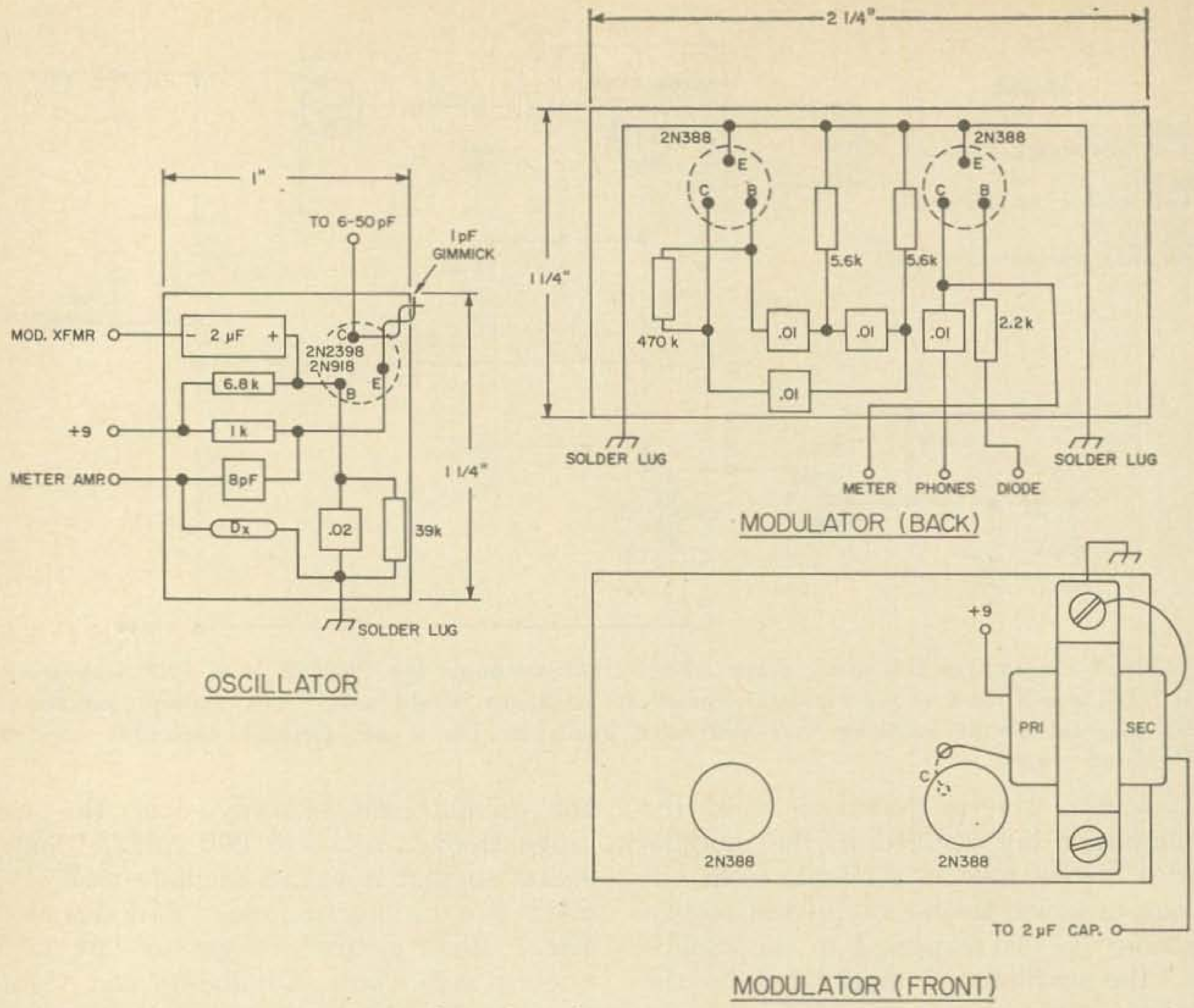


Fig. 2. Layout of the two circuit boards used in the great dipper. Although two boards were used in this case, the circuit could be easily adapted to one board, and even to printed circuitry.

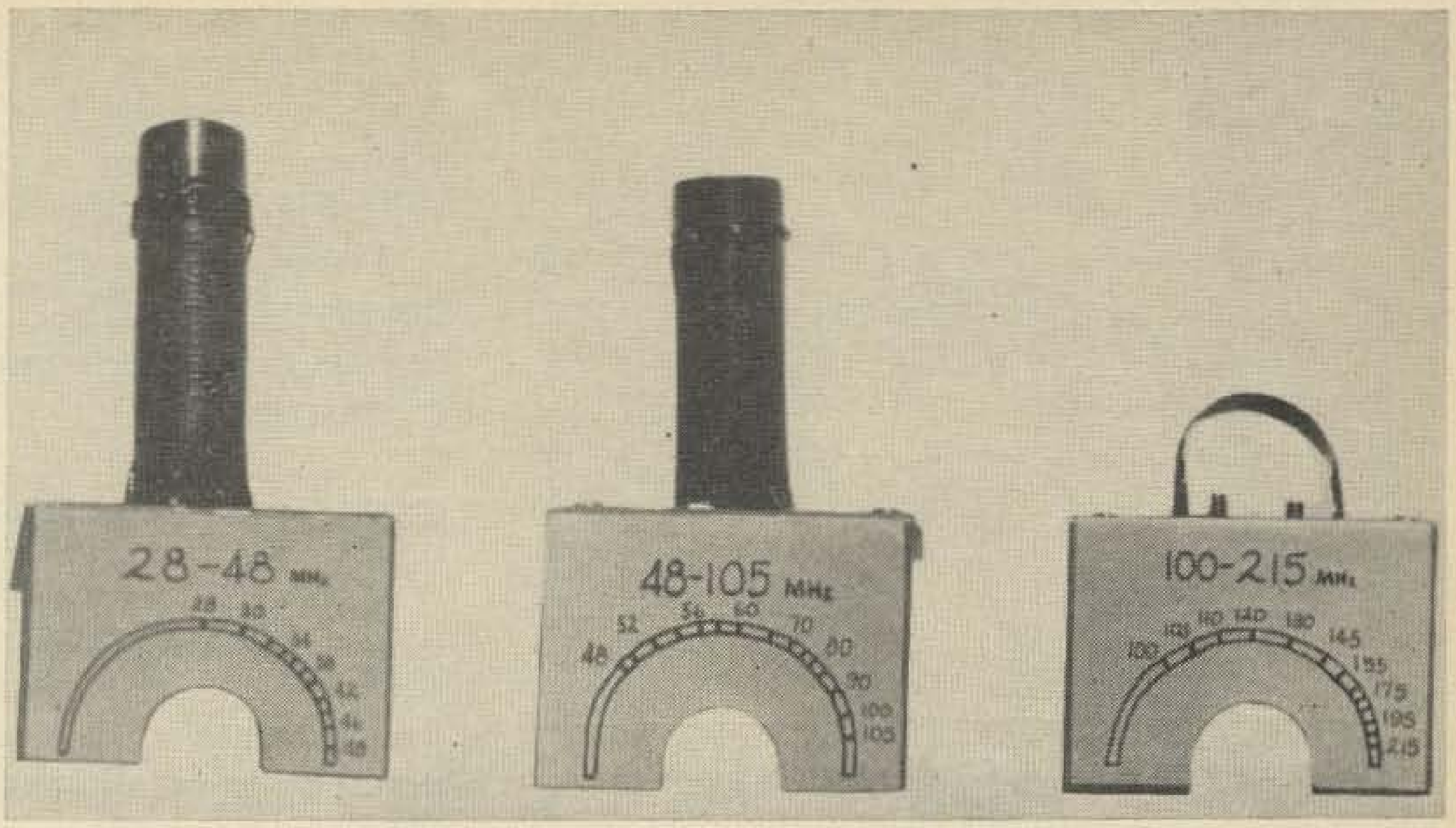
club project. It can be seen from the photograph that the meter amplifier and audio oscillator are built on separate boards. This is due to the fact that I built several different amplifiers; the layout would look neater if they were on the same board. Positioning of the rf oscillator and capacitor C_1 as shown in the photograph is recommended, but the placement of other parts is not critical.

Fiberglass board is used as an insulator for mounting the banana jacks and plugs. It cuts and drills easily and appears to work fine. Three banana jacks were used, the third jack being used merely to provide mechanical rigidity. It could also be used, if necessary, to shunt additional capacitance across the emitter and collector on the lower frequencies.

Because a shear and a brake were available, I constructed my own chassis, consisting of two U-shaped pieces of 1⁄16" aluminum. Using the GDO is a breeze, for it fits the hand very comfortably; if placed on the workbench, it doesn't roll off each time it is bumped. The completed case (1¾" H x 2½" W x 6¼" L) is exceptionally rigid and imparts a reassuringly solid feel when handled. Commercially available miniboxes could be used if you don't have facilities available for rolling your own.

In building the rf oscillator, keep all the rf leads as short as possible; especially the short lead from C_1 to Q_1 and from circuit ground to chassis ground. It was found that false dips could be completely eliminated if a copper strap ¼" wide was added from the capacitor ground lug directly to chassis ground. Apparently the ground on the variable capacitor C_1 is not quite good enough at frequencies above 100 mHz. Various transistors were tried in the oscillator; the PNP type 2N2398 was found to be a good performer, as was the NPN type 2N918. However, the use of the NPN type could lead to problems with battery polarity. Capacitor C_2 is a 1½" length of twisted wire positioned near the collector lead of Q_1. This slightly modified oscillator circuit is from a book describing, among other things, a transistorized GDO which you may wish to use as a reference.[2]

The three plug-in coils for the Great Dipper. Three ranges cover from 28 to 216 MHz. The second harmonic of 216 MHz may be used for tuning up 432 MHz converters and such.



To keep cost low, a 0-1 mA meter was used in conjunction with a simple meter amplifier. If you happen to have a 0-50 μA meter lying in the junkbox, that would work equally well, and the circuit could be simplified accordingly. Several circuits were built for the meter amplifier; the one chosen was a compromise between cost and performance. A germanium transistor was used because it requires less voltage to turn it on. Leakage is low, the pointer of the meter resting just off zero when no coil is in place. Further information can be obtained from January 1966 *73 Magazine*, which was the source for this circuit.[3]

A transistorized audio tone generator is coupled by a 2 μF capacitor to the base of the oscillator transistor for modulation. This modulated oscillator allows the GDO to be used as a versatile signal source. An output jack is included on the panel to allow the 1 kHz tone to be used without turning on the oscillator. The deceivingly simple circuit was taken from June 1966 *73 Magazine*.[4]

There are a couple of components which not everyone will want to duplicate. One, the sub-miniature 10k pot with SPST switch, was chosen because a very limited amount of space was available; if the unit is built on a larger chassis, the more commonly available *Midgetrol* could be used. The other, a four position switch used to select the desired mode, is a 29c variety available from Lafayette or Radio Shack. It has a peculiar switching arrangement and if you duplicate this project, several hours of experimenting could be eliminated by following the pictorial diagram included in this article. A disadvantage of this particular switch is that

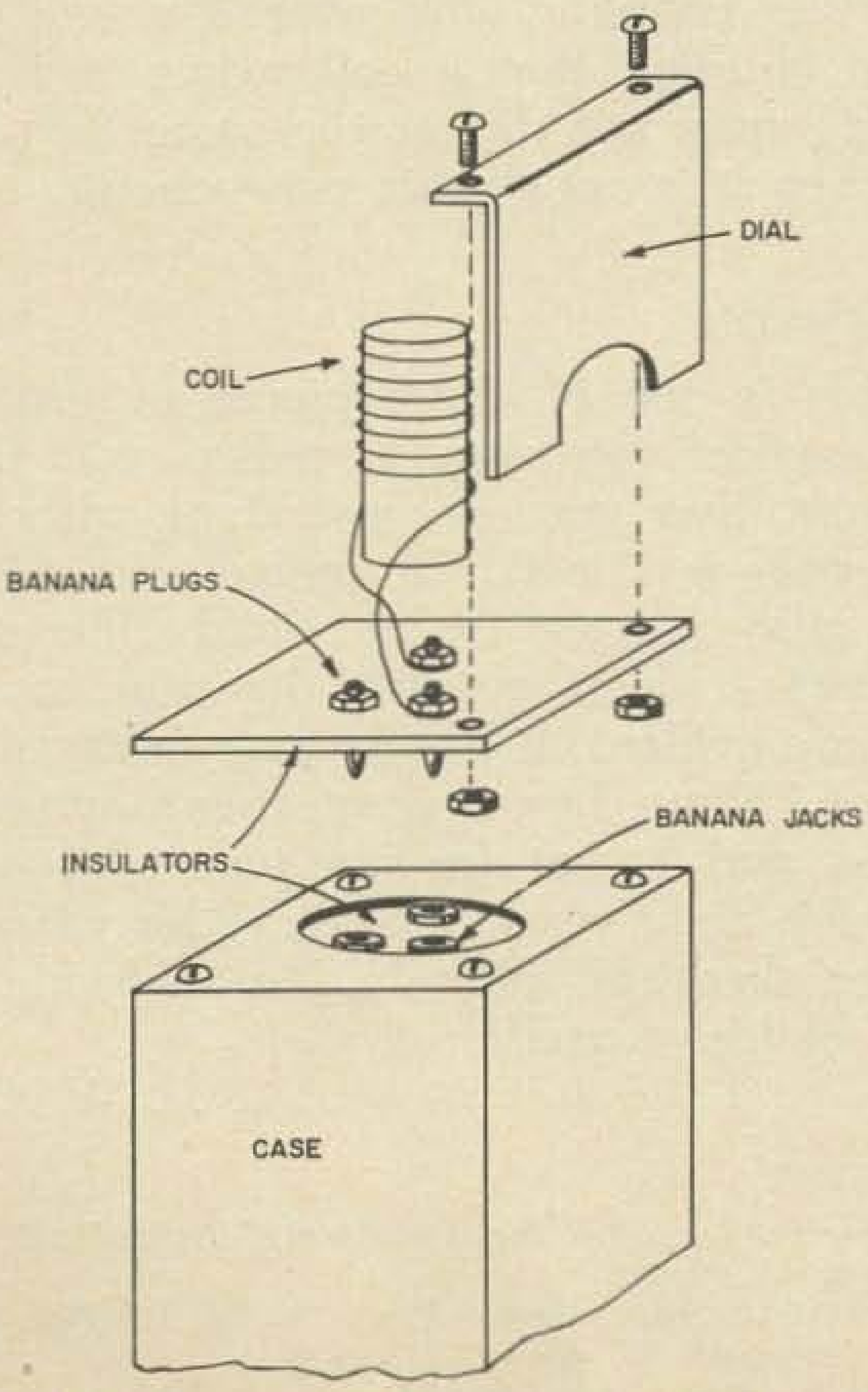


Fig. 3. Construction of the plug-in coil assemblies. The coil forms were made from the plastic containers which hold Polaroid print coater.

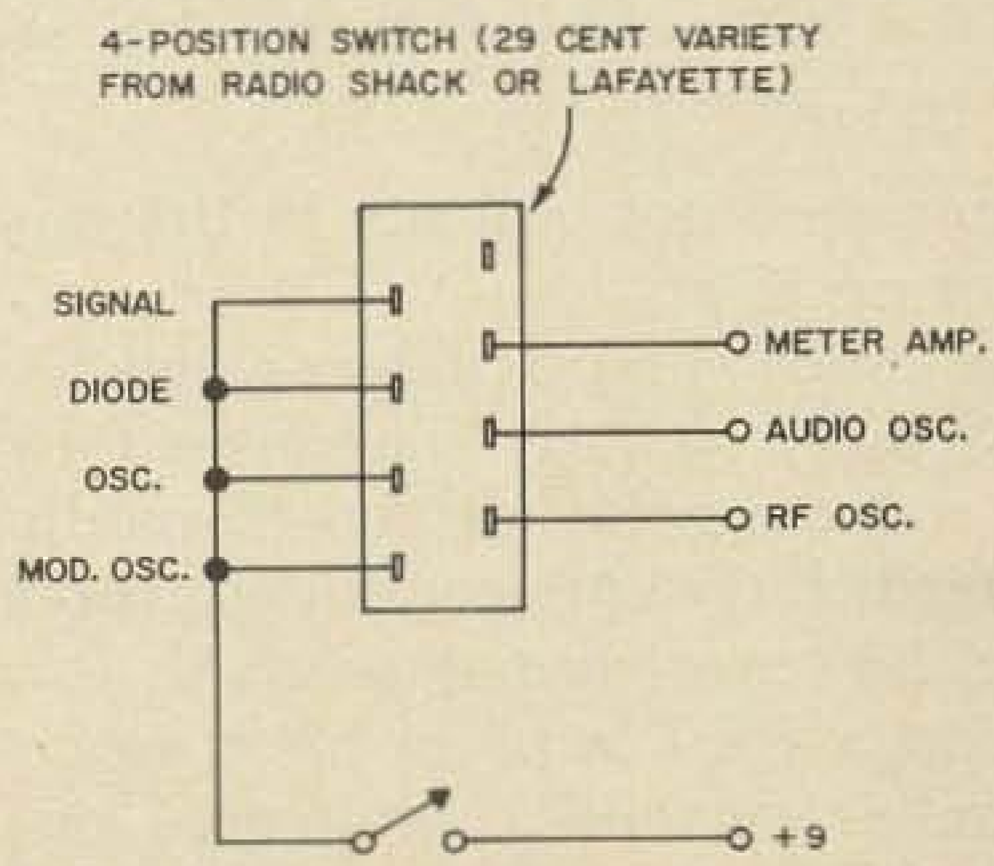


Fig. 4. Wiring the four-position slide switch for the great dipper.

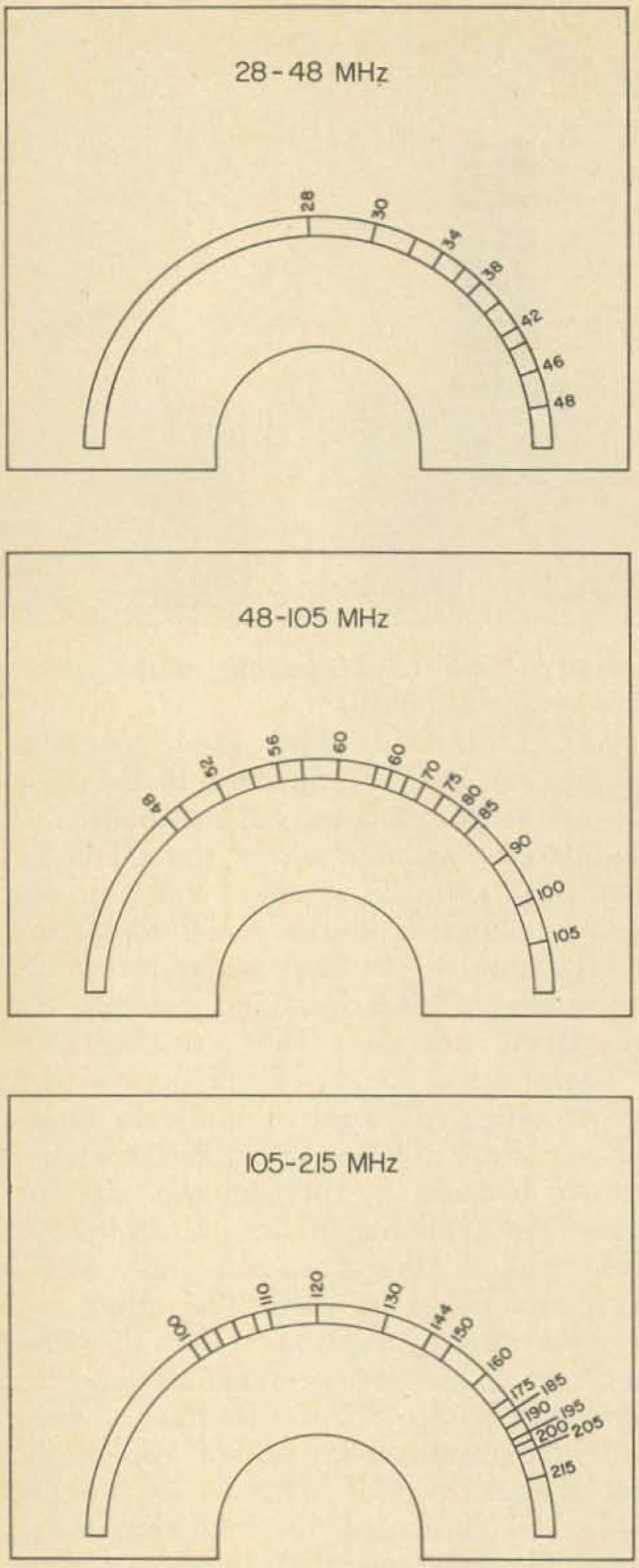


Fig. 5. Full-scale dials for the great dipper. If the construction shown in the photographs is followed closely, the calibration of these dials should be within several percent.

the meter does not indicate in the modulated oscillator position.

Using individual scales on each plug-in coil assembly greatly enhances scale legibility, reducing the chance of reading error and speeding frequency identification. This scheme, however, is not original. It was described in a 1957 issue of *Short-wave Magazine*, and is currently being used on a commercial GDO. It requires little additional effort to build the coil assembly in this manner and is, to me, well worth that extra effort. For want of anything else, the coil forms were made from the plastic tubes which contain the film coater supplied with each roll of Polaroid film.

Lastly, ease of tuning is accomplished largely through the use of a 1" skirted knob. Small knobs are simply too difficult to use comfortably.

Calibration and operation

It is best to calibrate this GDO by listening for the oscillator, modulated by the 1 kHz tone, on a general coverage receiver. An alternate method is to use another GDO, placing one in oscillate and the other in diode, tuning for either peak or dip. The scales which were used on this GDO will serve if parts and layout are followed closely.

To use this unit as a dipper, place the mode switch in oscillate, and place the dipper coil next to the coil under test. The turns of both coils should be parallel, and not at right angles to each other. To keep from pulling the oscillator frequency, keep the two coils separated as much as possible, while still maintaining a meter dip. This assures that dial accuracy will be kept high. If a coil is inaccessable, twist a pair of wires together, forming a two turn coil on each end; slip this coupling link over the two coils. Keep in mind that a coil, when it is in a circuit, may not dip at the same frequency as when it is out of this same circuit.

Conclusion

This is one of those pieces of test gear that makes you wonder, when you finally get one, how you ever got along without it. Not only is this GDO rugged and reliable, it is also inexpensive to build. The meter exhibits a deep positive dip and no false dips are evident. It has become indispensable to me. Some hours were spent optimizing values and layout for my particular needs, but the final result justified this effort. If you're skeptical, plug in the soldering iron and see for yourself!

. . . WAØAYP

References

1. *How to Use Grid Dip Oscillators*, by Rufus Turner, Howard W. Sams.

2. *Practical Ham Radio Projects*, by Charles Caringella, Howard W. Sams.

3. "Transistor Meter Amplifiers," WA6BSO, *73 Magazine*, January 1966, p. 44.

4. "A Simple Two-Tone Test Generator," WA6BSO, *73 Magazine*, June 1966, p. 42.

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28 Durant Ave. **L. E. BABCOCK & CO.** **Maynard, Mass., 01754**

John Crawford WA4SAM
Box 13
Berryville, Virginia 22611

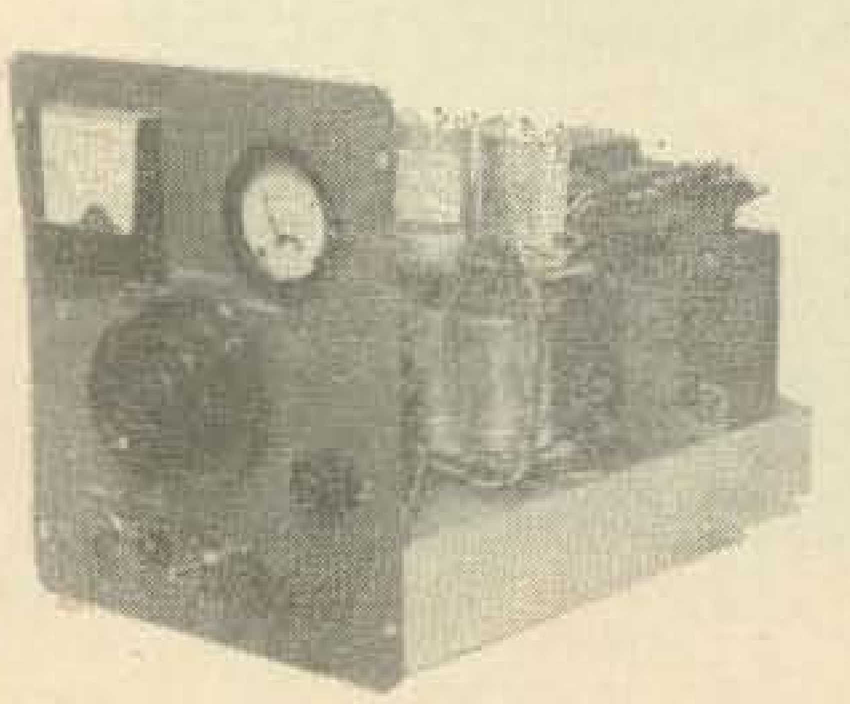
A 20—Amp Power Supply

Service your mobile gear with this inexpensive 20 amp supply built from surplus parts.

When I needed an inexpensive variable power supply for my mobile gear, I built this one with excellent results. I had previously found that commercially built supplies were either too costly or did not have the current requirements I needed. Construction of this supply centered around two ideas; keep it as simple and as inexpensive as possible while obtaining the highest power (my ARC-1 draws 15 amps *without* the autotune running). After looking around a little, I was able to get some high quality surplus parts very reasonably and this is the circuit I finally ended up with. While looking in the various electronic catalogues I found several components which would have been just as good except for price.

Because of the very nature of surplus—here today, gone tomorrow—I doubt if the same parts I used can be easily obtained. They are included in the parts list merely as a guide. I have presented some alternatives here to save trouble for anyone wanting to build a similar unit.

Basically, the circuit consists of a high current, low voltage transformer with solid-state rectifiers and an inductive-capacitance "L" filter. Several refinements were added later to give the circuit shown in **Fig. 1.** A switch on the front panel (S1) provides up to 16 volts or up to 30 volts at 20 amps through a relay which changes the



The 20-amp power supply without its cover. In the photo the capacitors and two chokes can be seen in the rear.

windings on the secondary of the power transformer. Meters showing voltage and current are provided and the voltage is varied by means of a small variable transformer mounted on the front panel.

The main component of this type of power supply is, of course, the power transformer. I obtained mine from John Meshna[1] for $4.50. The secondary consists of four 9-volt windings at ten amps each. Filter chokes T2 and T3 are both ten amps, also from Meshna for about a dollar each; or, a 50-amp monster weighing 22 pounds is available from Barry's[2] for $22.00. I used the others mainly because I had them in my junk box.

If you can't get a transformer like mine, the companion to the above choke is listed in Barry's catalogue at $27.00. It has only one winding and is rated at 24 Vac, 50 amps. This would be an excellent choice if you are willing to spend the extra money. You could almost arc weld with it! If you don't need that much power and want to spend less, Barry's has several different high current transformers and chokes listed from five to ten dollars.

The diodes, meters, switches and output connectors can be found almost anywhere. I had mine just lying around. The 0-30 ampere meter is for a car and was purchased for a dollar from the Surplus Center in Lincoln, Nebraska. The variable transformer is a small two-amp unit which came out of a piece of fire-control equipment and varies the voltage on the primary of the power transformer. I already had the cabinet.

I used two 1000 μF, 25 volt capacitors in series at first, hoping they would work, but found my ripple was too high with T2 and T3 at .037 henries. I had several of these capacitors on hand and proceeded to stuff them in the cabinet wired in series-parallel until I had sixteen totalling 8000

[1]Meshna, 19 Allerton Street, Lynn, Mass. 01904.

[2]Barry Electronics, 512 Broadway, New York, New York 10012.

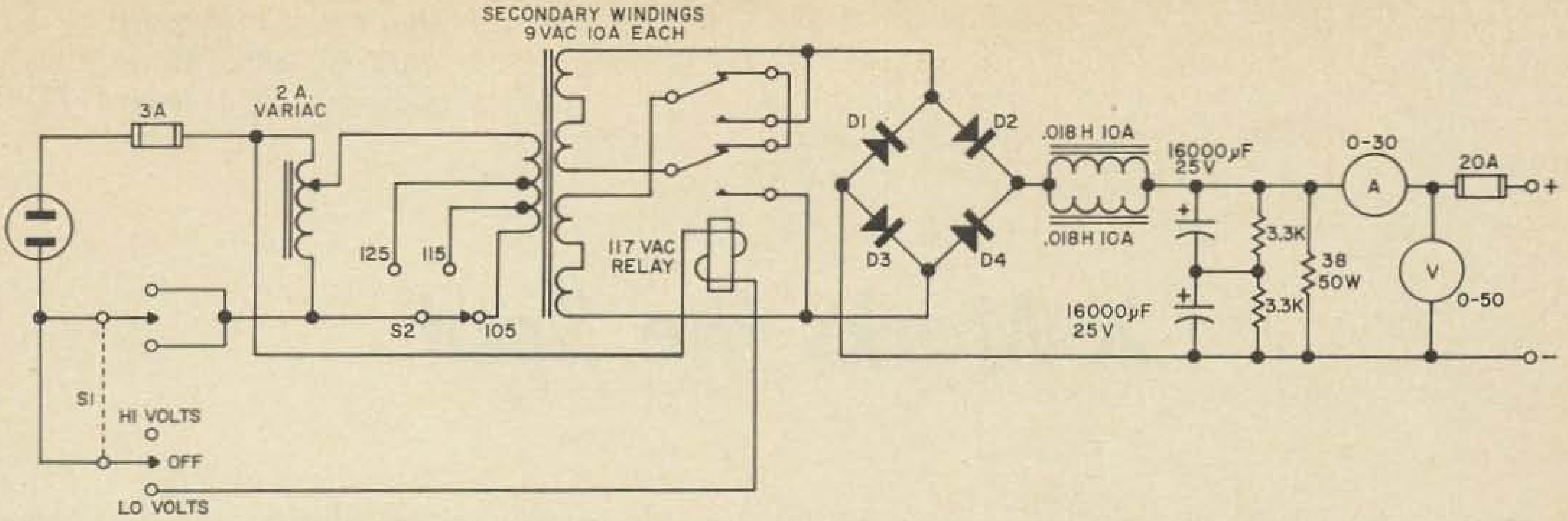
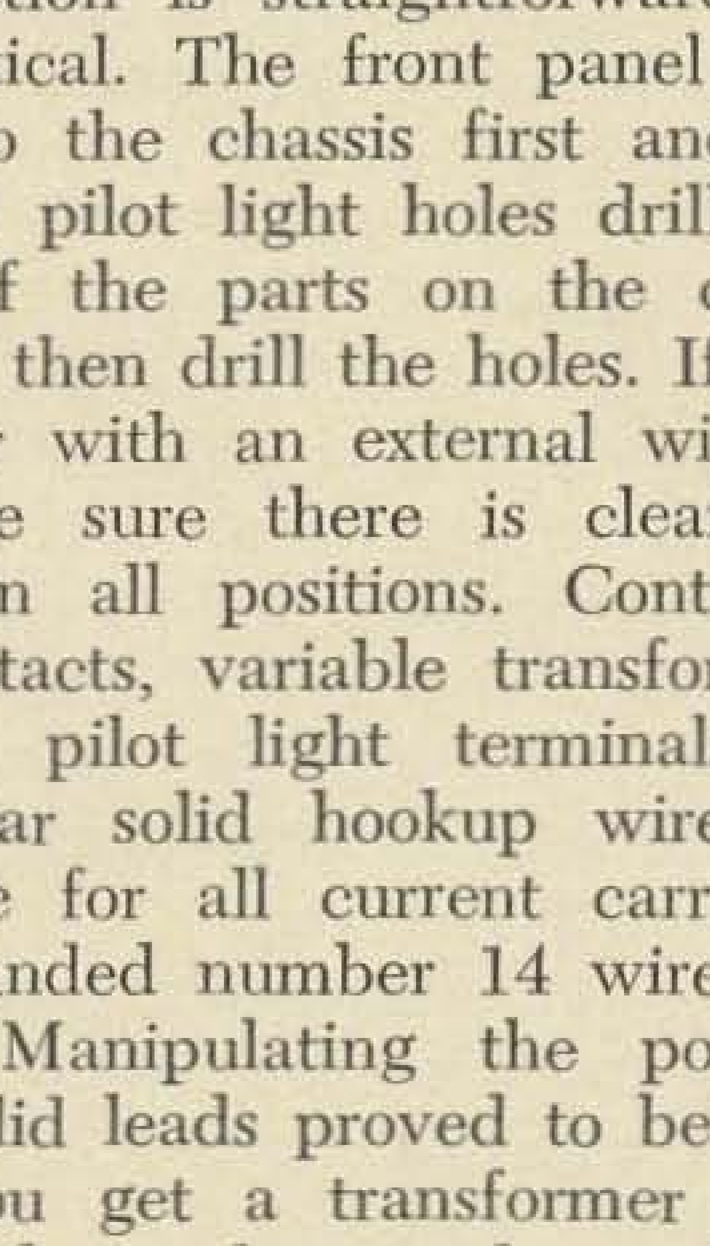


Fig. 1. Schematic of the 20-amp power supply. The 1600 μF filter capacitors consist of sixteen 1000 μF units wired in parallel. A minimum of 8000 μF should be used. The diodes are 100 PIV, 20-amp units available from Meshna.

μF. Not very professional, but quite effective. Two 8000 μF units at 55 volts each from Barry's for $2.50 apiece would work even better in parallel. If you use odd values in series be sure to shunt them with a 3.3k, ½ watt, resistor or at least 100 ohms per volt of supply voltage to equalize the voltage drop across the capacitors.

Construction is straightforward and wiring noncritical. The front panel should be attached to the chassis first and then the switch and pilot light holes drilled. Locate the rest of the parts on the chassis and "fit" them, then drill the holes. If a variable transformer with an external wiper arm is used, make sure there is clearance with the arm in all positions. Control wiring-switch contacts, variable transformer winding leads, pilot light terminals—is made with regular solid hookup wire, but use heavy wire for all current carrying leads. I used stranded number 14 wire for easier handling. Manipulating the power transformer's solid leads proved to be very difficult. If you get a transformer like mine, any heavy duty relay can be used to switch the secondaries. A pilot light enables me to tell when I am in the low-range position. It is connected across K1 and lights when



Bottom view of the 20-amp power supply showing the layout of the bottom bank of capacitors and 20-amp diodes. Since no heat sink was available at the time of construction, rubber grommets were used to insulate the diodes from the home-made bracket.

the relay is energized. The diodes run cool mounted to the chassis with no heat sink.

The diodes are rated at 20 amps each, although I seldom have more than ten-amp loads on the supply. A circuit breaker should be included in series with the output to prevent damage to the diodes and other components because the fuse in the primary of the transformer will not act fast enough.

With the power supply in operation, regulation is poor because of the charge of the capacitors. However, the variable transformer can be adjusted to compensate for different loads. On-off switch S1 is a DPDT type with a center off position. In the low-range position, with the toggle pointing downward, the relay kicks in to place the transformer windings in parallel. In the high-range position, the toggle is up and the relay is not energized. Because of the instant on feature, the switch should be wired this way to prevent accidentally placing a higher voltage on units under test. To turn on a piece of equipment, the operator will instinctively push the switch down to get a low range voltage.

I have been using this supply for servicing transistor radios and running my mobile equipment and unconverted 28-volt surplus gear for over a year with no trouble. I even charge batteries with it at times. Surplus parts are used throughout except for the two pilot lights, and from the use I get out of it, the parts have proved to be the best deals I ever made. This under-twenty-dollar 20 amp supply would probably sell for well over a hundred dollars retail! So, if you are short on cash and high on amps, try this one. It's a shame to let all those high quality parts go to waste.

. . . WA4SAM

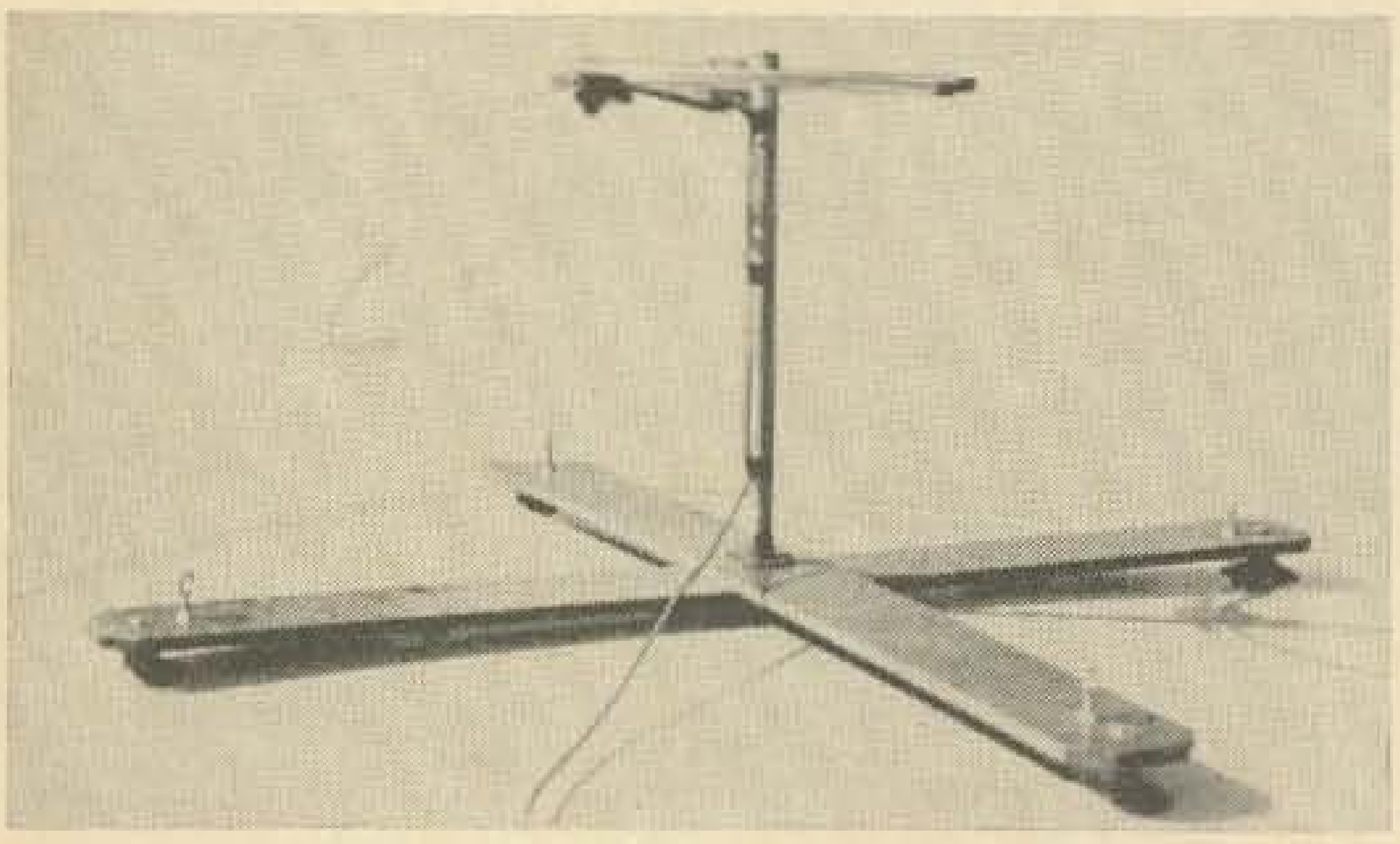
Jim Fellows WA3AJD
7517 Creighton Drive
College Park, Maryland 20741

X Marks the Spot

Did you ever consider trying some mobile operation, only to drop the idea like a hot 813 for fear of marring your car with a permanent antenna installation? Worry no longer, for here is a temporary antenna mount which in no way harms the vehicle it is fastened to, and yet is as strong as any bumper-mount.

The X-mount was born of necessity; I wanted to share in the fun of mobile operation, and yet, there were orders that no holes of any type could be drilled in the family car. A search for a commercial bumper-mount revealed the recessed bumper on the 1961 Valiant to be a tough customer. I only found one mount which would hold the mast clear of the over-hanging rear, and it was so flimsy that it couldn't be considered. I really didn't want to use a bumper-mount anyway, because they are too permanent. This is a distinct advantage when Friday night comes. Women, young and old, share an aversion to being seen in an automobile that looks like it belonged on the set for "Highway Patrol."

Several tests of gutter-mounted verticals were made, but they were so susceptible to ignition interference from other vehicles that they were ruled out. Also, the majority of the 2-meter stations in the Washington, D.C. area are horizontally polarized. A halo or big wheel seemed to be the best antenna for my purpose, but how to mount it?



The X-mount is slid around on the roof of the car until it is centered, then the straps are put in place. In this picture the mount is being used to support a commercial two-meter halo antenna.

Just when I thought that I was destined to drive around holding a halo out the window, the great antenna search was ended. Dad, WA3DRI, had designed an antenna mount that seemed to have everything that was required. It was sturdy yet easily installed, and did not harm the car. Besides, this was the only antenna which WA3DRI would allow to be used on his car—the one he designed of course. The X-mount, so named because of its shape, provides a solid mount for VHF antennas.

The cross-pieces of the original were cut from ½ inch plywood. They were 4½ inches wide by 48 inches long, but could be made smaller. The prototype turned out to be much stronger than we had thought it would be. Three good coats of varnish sealed the plywood from the weather, but those who worry about such things might paint the mount to match their car.

The suction cups are replacements for car-top carriers and are easily obtained through the popular mail-order stores. We mounted ours by simply screwing them to a jam-fit with machine screws.

Due to a lack of originality and a surplus of screw-eyes, we secured our mount to the car with webbed straps and gutter-clips. The straps, with the clips attached, are simply looped over the screw-eyes.

Four bolts hold the cross-arms at their intersection. At this point a faceplate pipe fitting was mounted. The antenna mast consists of a length of pipe which is threaded so that it screws into the flange.

Although the X-mount was designed as a mount for VHF antennas, there is no reason why it couldn't be adapted to support high-frequency verticals, particularly those shortened by a loading coil. There is no limit to the length of mast which could be tolerated on a parked car during portable operations.

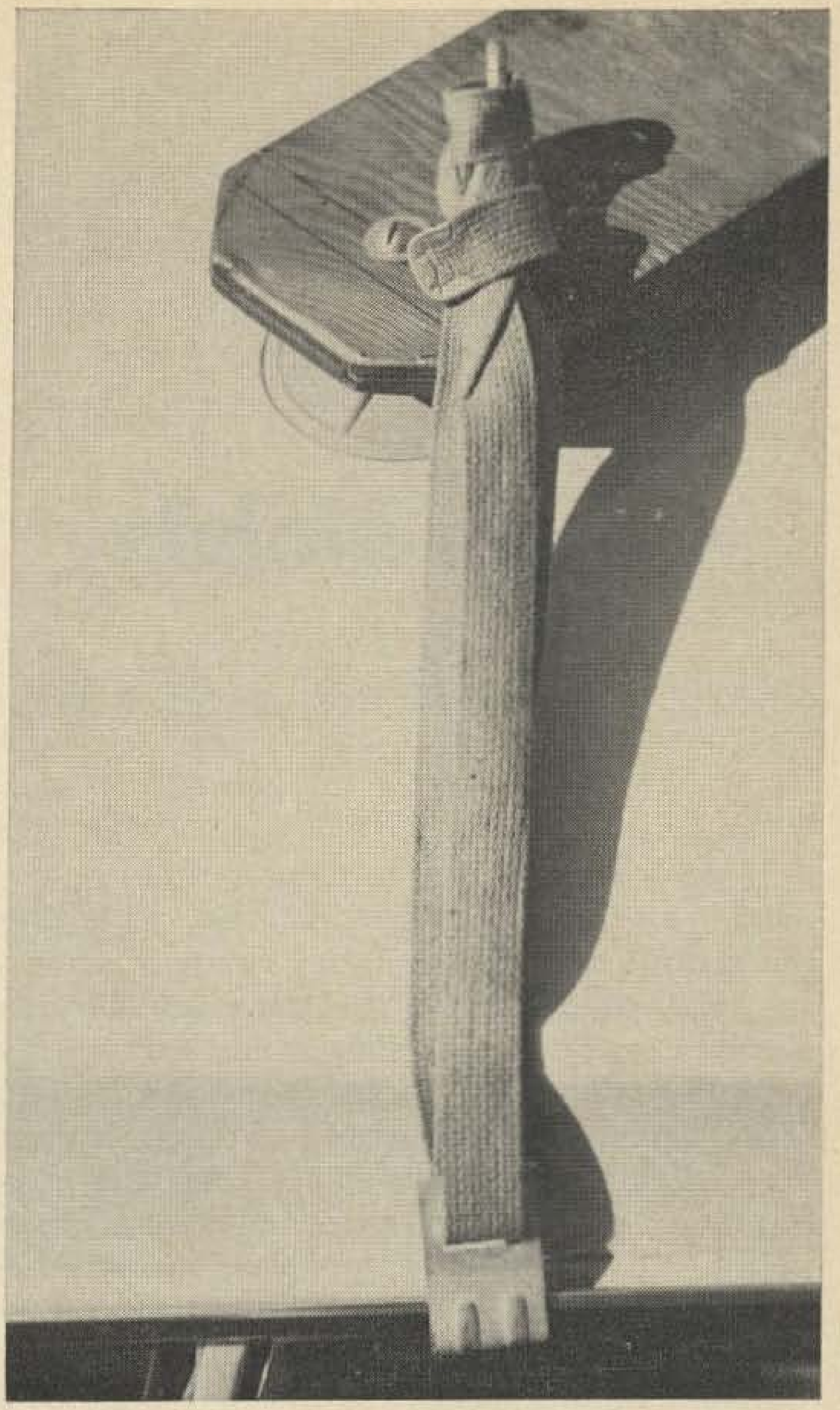
Much discussion developed concerning the height above the car roof at which the two-meter halo should be mounted. Some books said ¼ wave length, and some hams said that this would make a good vertical beam with the car's roof acting as a reflector. Nice for talking to aircraft, but not too practical for conventional use.

Accepting no one's word, we tested different heights from one inch to four feet above the roof. The antenna was observed to radiate the strongest field when it was 19 inches or ¼ wave length above the roof. Adding extra height up to four feet did not improve the signal.

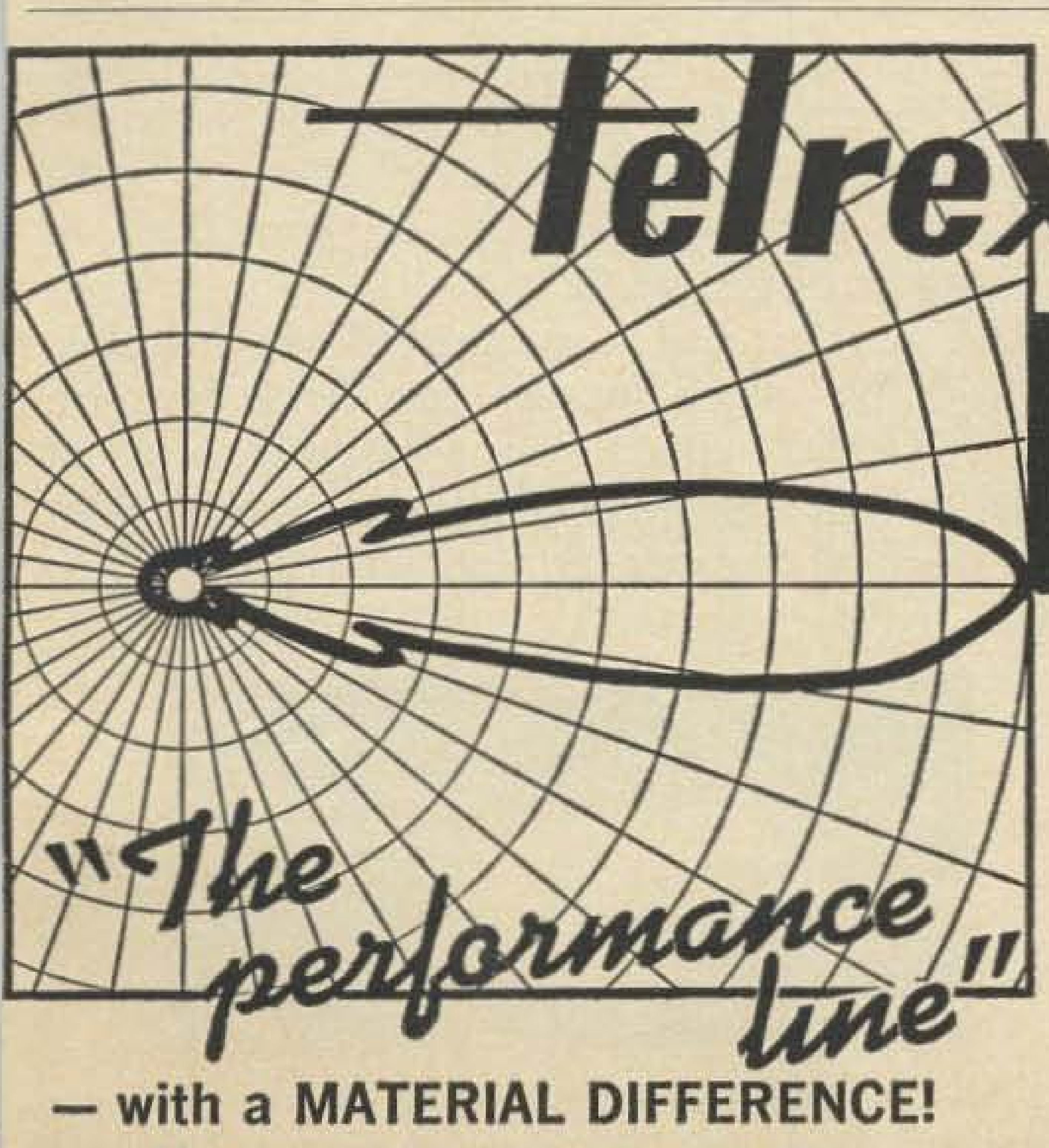
This would indicate that a six-meter halo should be mounted 52 inches above the roof, a little high for a rigidly mounted antenna. The antenna would probably load satisfactorily even if it were lower. After all, how many bumper-mounted six-meter halos are 52 inches above the trunk?

Hopefully, we have given you some ideas for a quick and dirty mobile set-up. Don't miss out on the fun of mobiling because you think that your car must be torn up to mount the antenna. By the way, if you do build a mount similar to ours, be prepared for such comments as: "Doesn't watching television interfere with your driving?" and "Where's the moose that rack came from?"

. . . WA3AJD



The X-mount is secured to the car with suction cups, gutter clips and straps as shown here.



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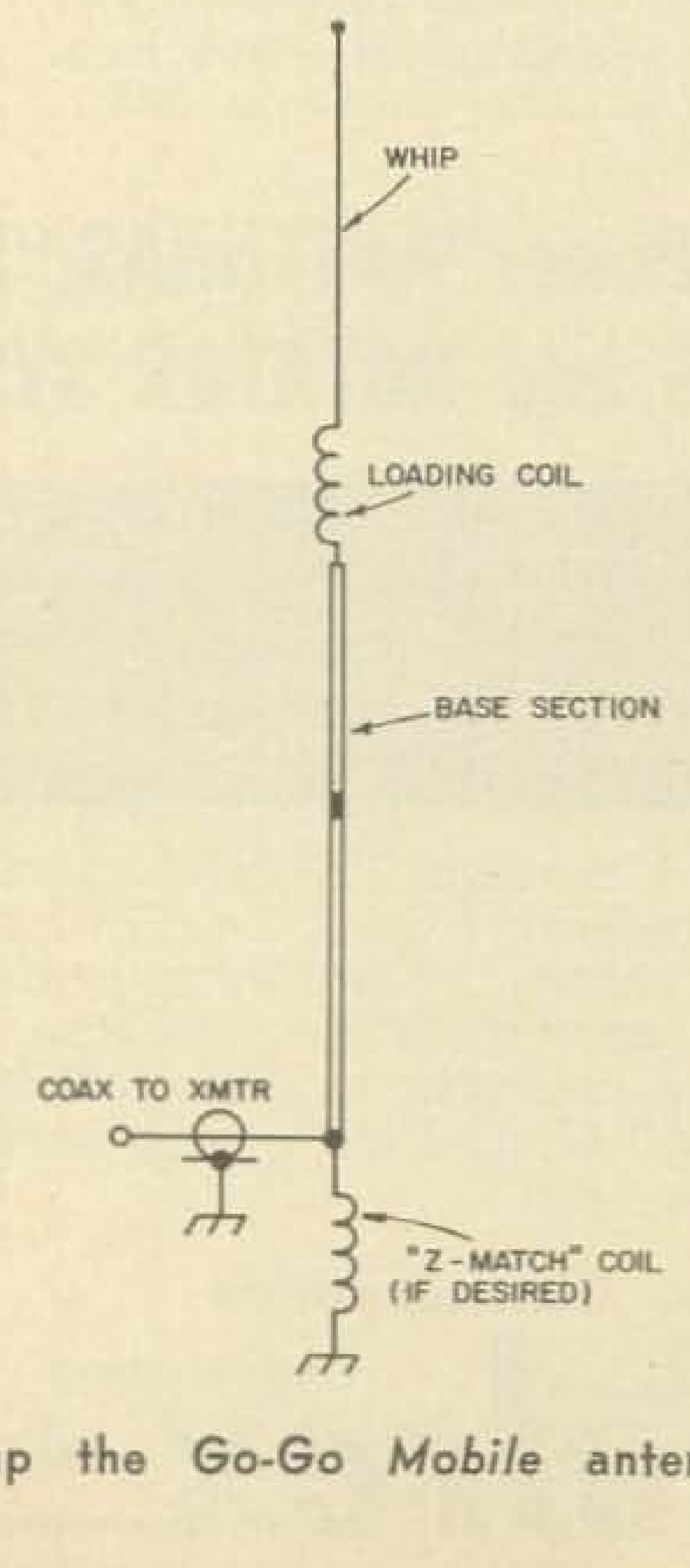
If you've had the urge to go mobile at the least possible cost—particularly regarding the mobile antenna—here's a good, inexpensive way to do it. All the parts are easy to obtain, construction is simple and quick, and a highly effective antenna is the result. The "Hi-Q" coil arrangement has been found very effective, and on field tests, the performance of this unit exceeded that of two popular commercial antennas. Comparative S-meter reports at several hundred miles' distance showed one full S-unit higher, and local field strength measurements showed appreciable gain over the commercial units.



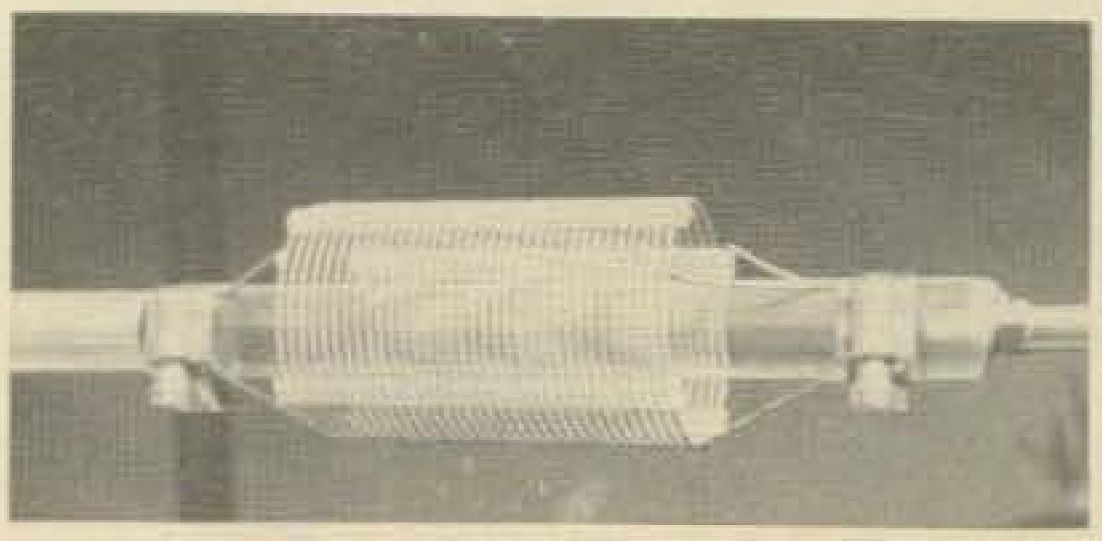
Hooking up the Go-Go *Mobile* antenna with a Z-match.

The base section is electrical-mechanical tubing (EMT, which is light, strong, and attractive). The top whip is a walkie-talkie, CB replacement unit, or a standard auto radio item—whichever is preferred. With their sliding sections, these units give smooth and rapid adjustment to your exact transmitting frequency.

The unit illustrated here covers 40, 20, 15 and 10 meters by tapping the coil and adjusting the height of the top whip section.

Construction is begun fitting a plastic or maple rod into the EMT base section tubing and securing it with a self-tapping screw through the tubing into the plastic rod. The next step is to mount the whip by tapping into the top of the plastic rod with the same screw-thread size as provided on the bottom of the whip.

The loading coil is supported on the plastic rod by three wires, top and bottom, soldered 120° apart, on the coil turns at each end of the coil. These wires are then bent toward the plastic rod and clamped in place by the worm-drive hose clamps. One



The loading coil. Note the support wires, which are connected from the first and last turns of the air-wound coil.

Table I.

Contacts made during final test of mobile antenna project.

Band	Call	QTH	Signal Report
40	W6VX	Brentwood, California	10 over S-9
40	WA6FQI	Fullerton, California	Wants antenna data
40	WB6SEC	Bakersfield, California	Q5-S-15
20	WA7BKW	Billings, Montana	Plus S-12
15	W5PLE	Houston, Texas	"Exceptional Mobile Signal"
10	W6NRV	Fullerton, California	Q-5
10	WB6HVS	Garden Grove, California	Excellent Signal for "Ground Wave"
10	KH6EEM	Honolulu, Hawaii	Q5-S8
10	W4QKK	Winter Park, Florida	Q5-S10 plus
10	WA4WFE	Winter Park, Florida	Q5-S-10
10	W9ELG	Chicago, Illinois	"Terrific Signal"

Note: These contacts were made from the driveway at my home with a Drake TR-4 Transceiver. The SWR was less than 1.5:1 on all bands.

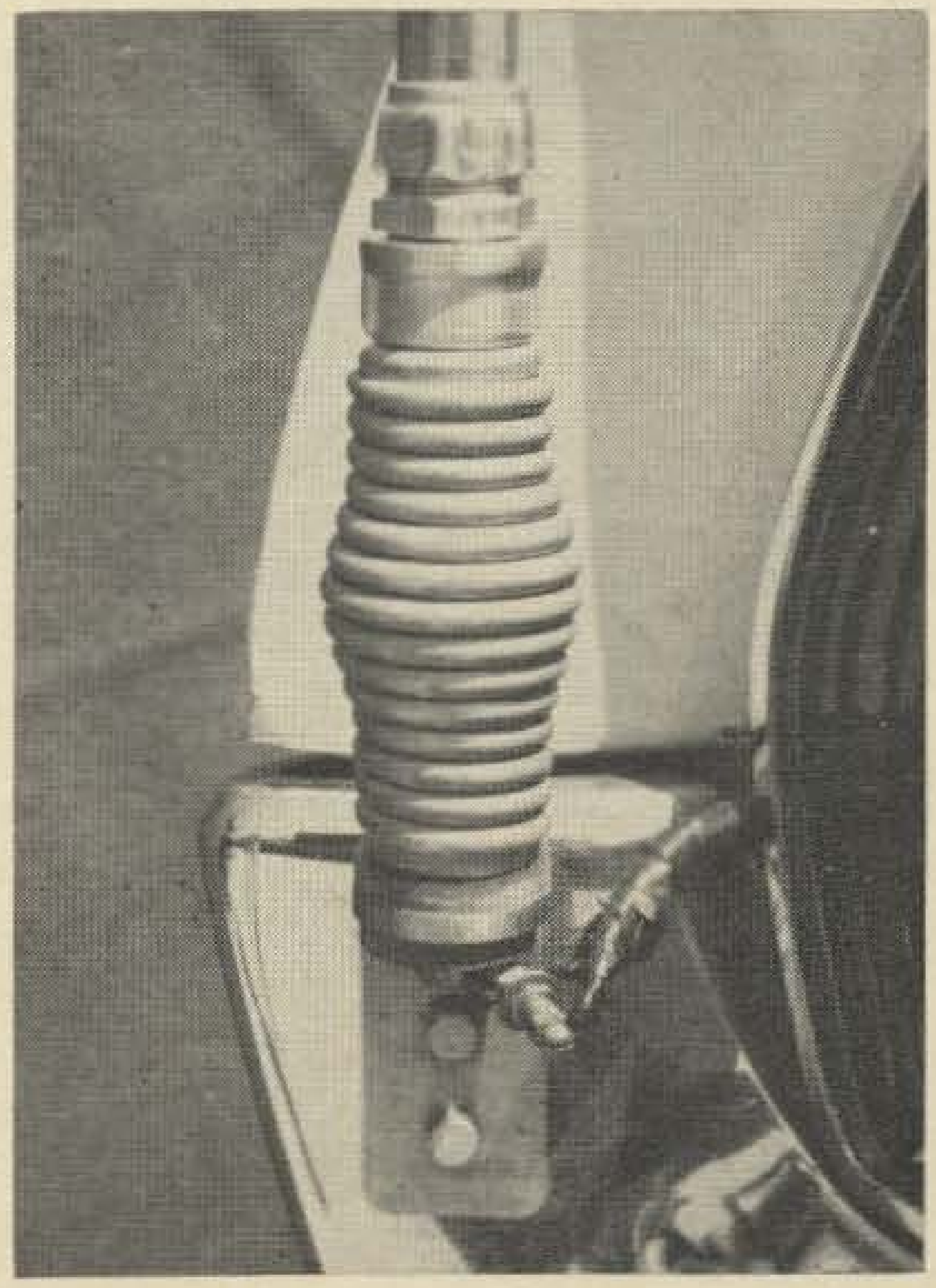
of the three wires on each end of the coil should be extended to provide electrical connection to the base section on the bottom and to the whip section on the top.

The pipe cap on the base section is drilled with a ⅜" hole and a ⅜"-24 threaded cap screw is inserted and soldered in place. This is best done over a gas flame, flooding plenty of solder over and around the head of the previously well-cleaned cap screw. Then the EMT base section is fitted with an EMT compression fitting, which is then screwed tightly into the ¾" pipe cap.

The antenna is now ready for installation —run 52-ohm coax between the transmitter and the antenna base, making certain that the coax braid is well grounded. The antenna must now be tuned to your operating frequency; this is best done with an SWR meter and test clips, tapping down a turn at a time until the lowest SWR is obtained. Coarse adjustment may be made with a GDO, if available, followed up with fine adjustments obtained by changing the length of the top whip in increments of ½" or so. The overall length of the top whip should then be measured for future reference when making an appreciable frequency change within the band in use. After setting the top whip for the correct length for the operating frequency, the sliding section can be easily locked in place with a single wrapping of transparent Scotch tape.

On the antenna illustrated, the 40-meter phone band required all but two of the coil turns, and the top whip was extended to 47½ inches; on the 20-meter band, the coil was tapped down to 10 turns; for 15-meters, 5 turns. For operation on 10 meters, the coil is completely shunted and resonant frequency adjustments are made entirely by adjusting the top whip section. In order to minimize the amount of dielectric in the field of the coil, no cover was used, thereby retaining the highest "Q" and efficiency.

If a spring mount is used with this antenna, a fish line is used to stabilize it and to minimize swaying while under way. Tie the line between the car and the underside of



Construction of the base section of the W6IEL mobile antenna.

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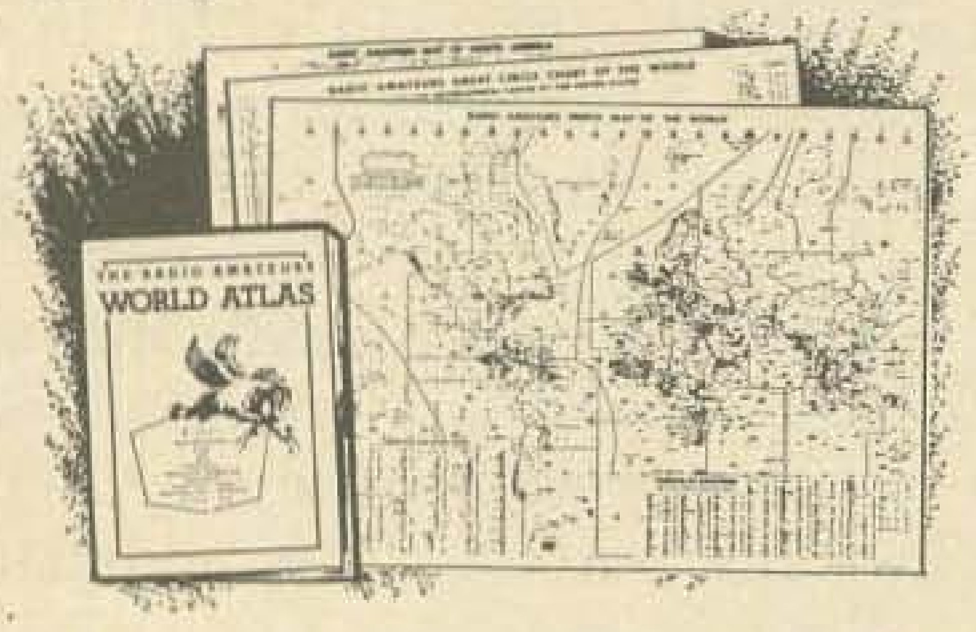

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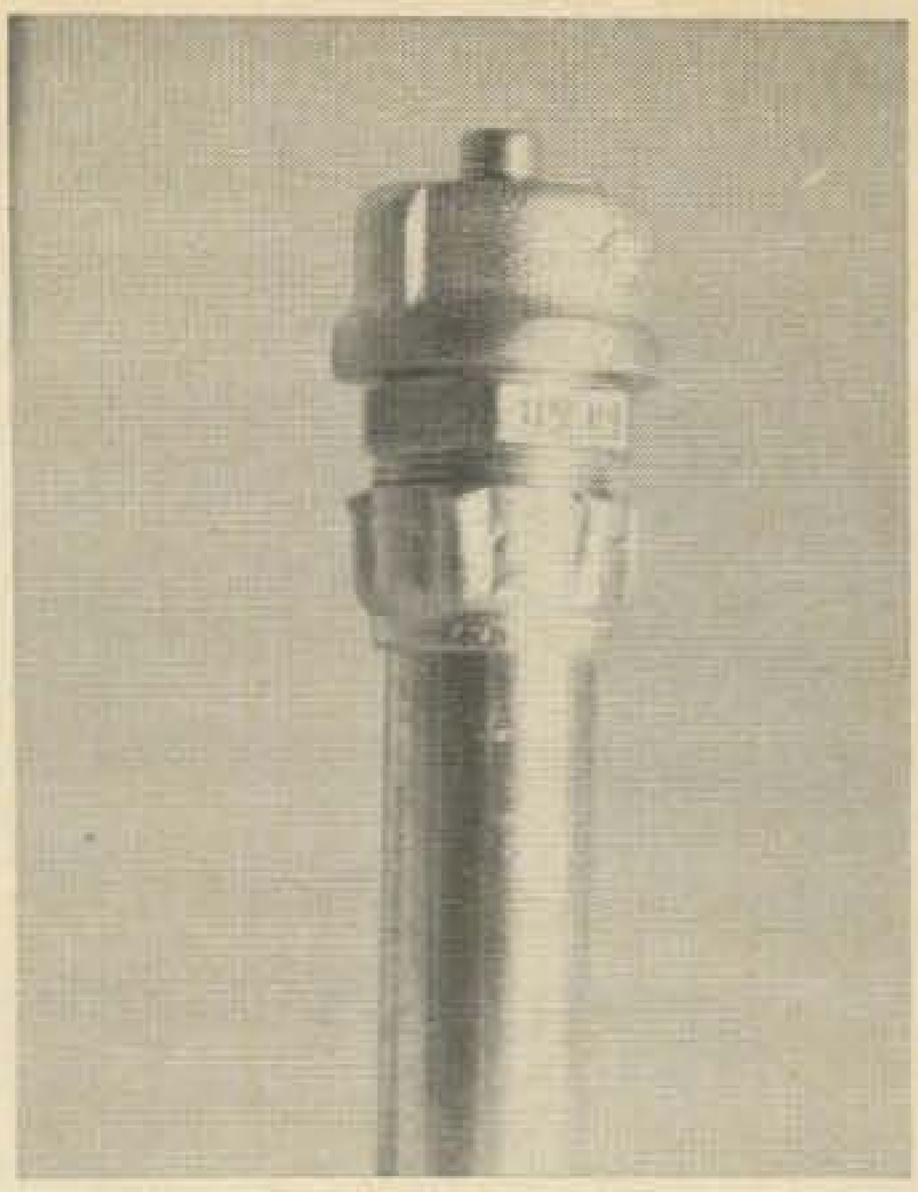

Base mounting of the mobile antenna, showing the use of a threaded pipe cap.

Mobile Antenna Parts List

Loading Coil—	34 turns, 2½" diameter, 8 turns per inch, Air Dux #2008T. Illumitronic Engineering, Sunnyvale, California.
Coil Support—	10" x 1" diameter solid polystyrene or lucite rod. If plastic is not available use hard maple dowel; wax thoroughly before mounting.
	Two worm-drive hose clamps.
Top Whip—	CB replacement antenna or replacement auto whip, 50" extended, 11 section, Olson #AA-148, Olson Electronics, 260 Forge Street, Akron, Ohio, 44308.
Base Section—	52" of ¾" diameter electrical metallic tubing (Thinwall conduit—EMT)
	1—¾" EMPT connector—Compression type (T & B #5221 or Appleton #96T075)
	1—¾" Brass pipe cap
	1—⅜" x 24 THD cap screw
	1 Bumper mount, Allied #86U606

the coil support.

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. . . W6IEL

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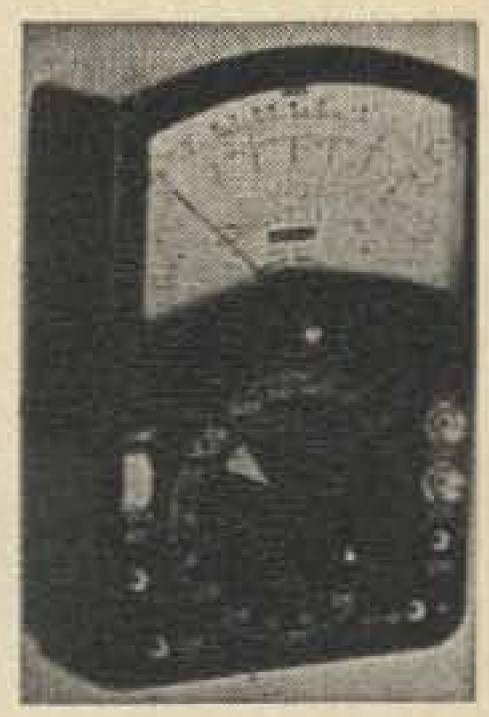

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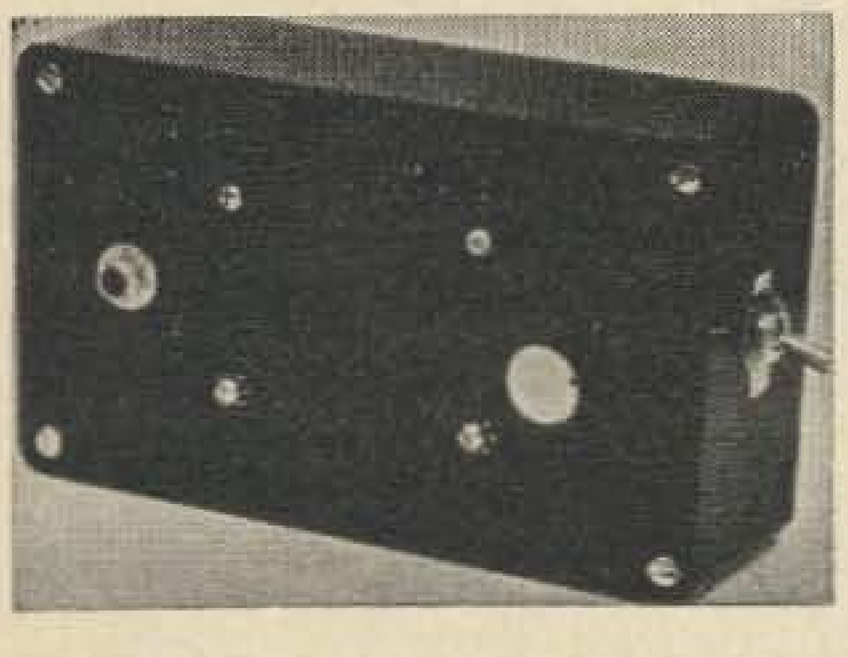

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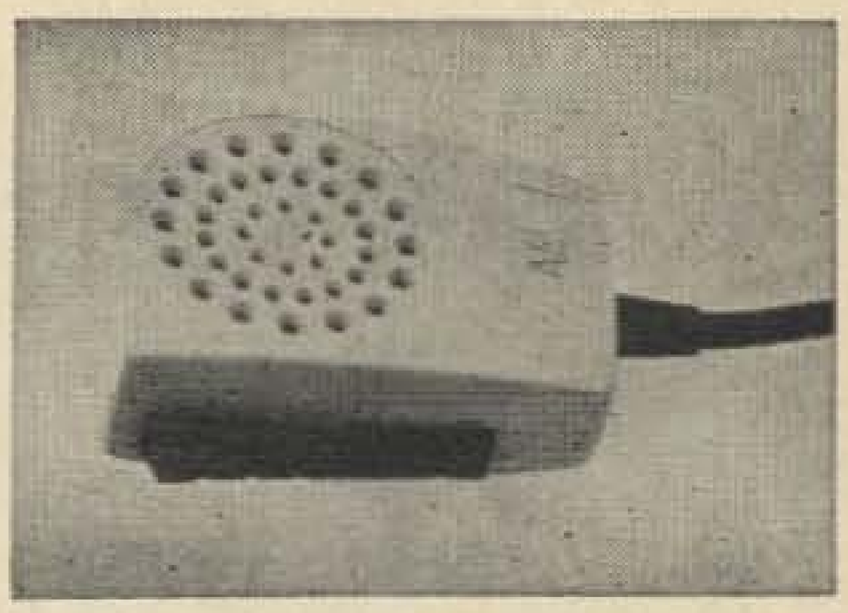

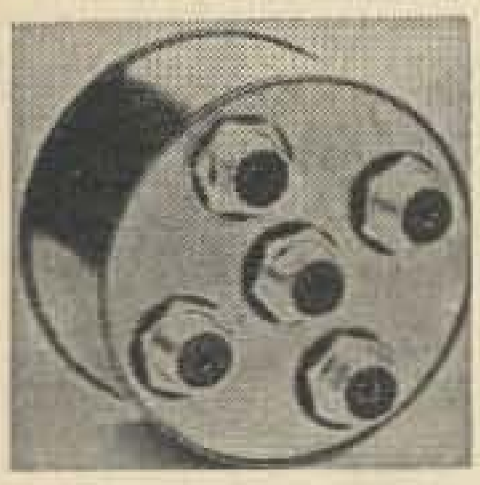

CO-4 4 Position Coaxial Antenna Switch. Uses low loss connectors and a ceramic switch. Complete with knob. Regular price **$9.95.**

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CO-2 2 Position Coaxial Antenna Switch. Same construction as the CO-4 switch to the left. Used for switching linear amplifier in and out of the antenna line. Regular price **$8.95.**

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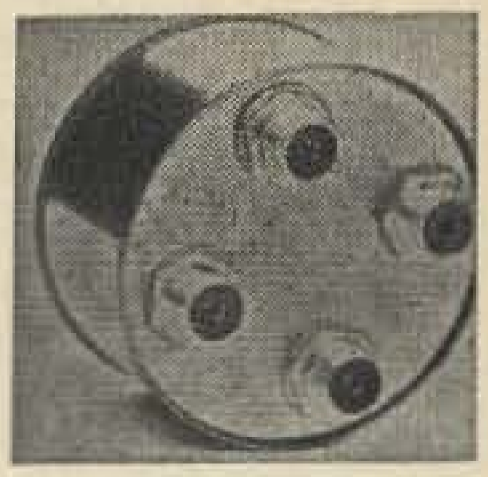

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The Front-to-Back Ratio of an Automobile

Have you ever checked the antenna pattern of your mobile antenna?

We are, of course, accustomed to thinking in terms of the back-to-front ratio of beams, but how about the directional properties of the automobile in mobile operation?

Some time ago I did some work on this subject with a view to learning something about the effect of different positions for an antenna on a car.

My first experiments were carried out on a station wagon with a nearly flat metal roof. I deliberately placed the antenna base on a bracket mounted at the left hand rear corner of the roof.

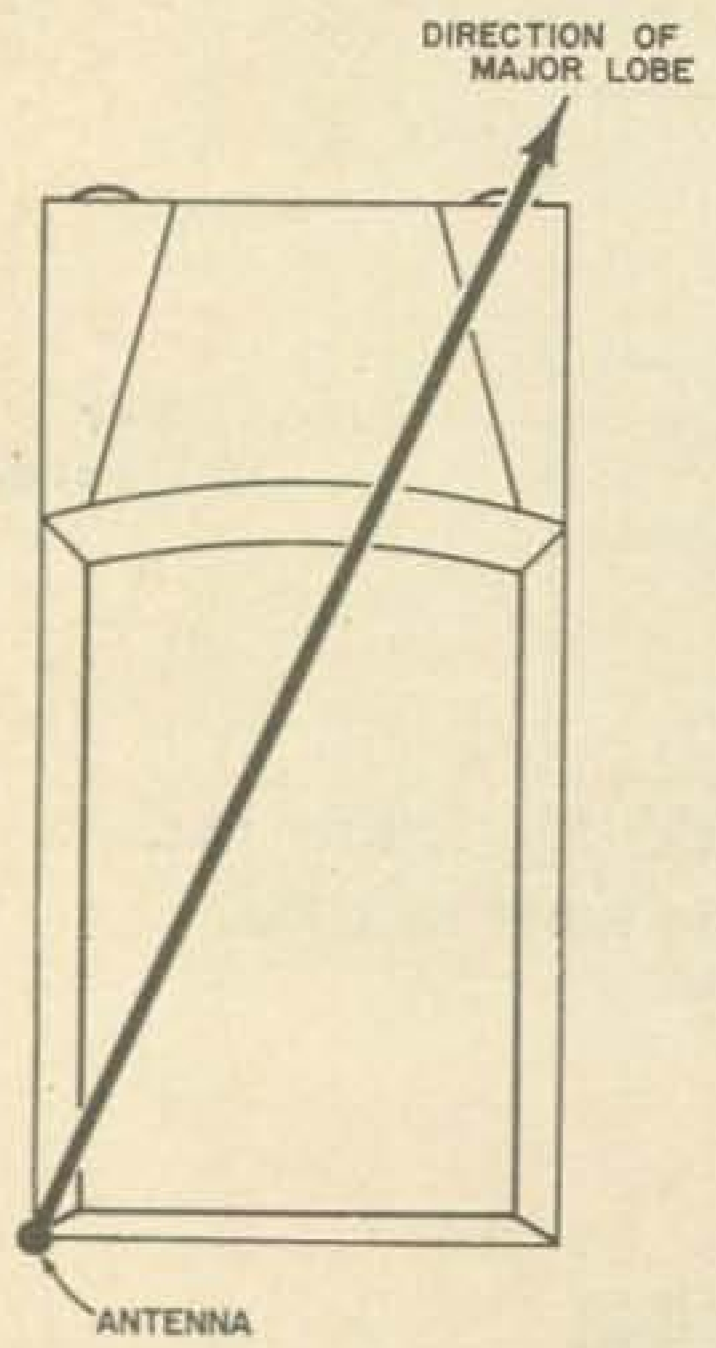


Fig. 1. Directional pattern of a vertical mounted in the rear left corner of a station wagon.

I soon found that the major lobe was in the direction diagonally across the roof of the car as shown in **Fig. 1.** Thus it appeared that the roof was acting as one part of a dipole (see **Fig. 2**) rather than as a ground plane.

On 10 metres this was very logical since the diagonal length of the roof of the car was roughly ¼ wave length on 10 metres.

On 15 and 20 metres a similar radiation pattern was found although, of course, the roof of the car was too short for ¼ wave length on 20 metres. Probably the SWR was quite high but I never measured this, because owing to the very short feeder used in mobile installations I do not regard the SWR as very important. Provided the SWR is not so bad as to prevent the antenna loading, the actual SWR is felt to be of little importance. The losses on that length of feeder are small.

For some time I continued to use my mobile installation with the antenna placed unsymmetrically in this way and found a back to front ratio of about 3 dB on 10, 15 and 20 metres. This small beam effect was at first welcomed as it facilitated mak-

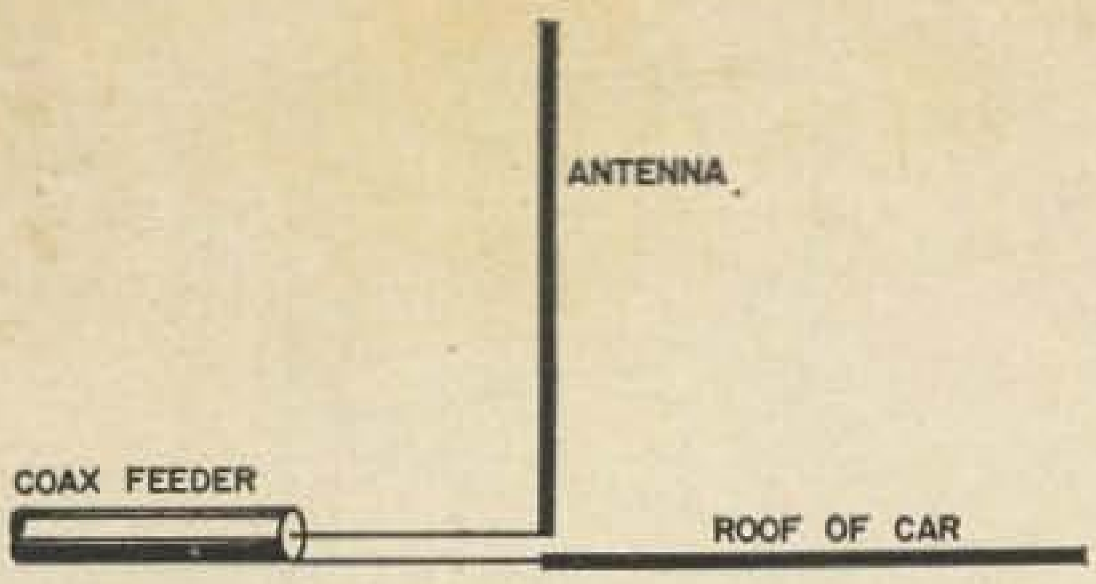


Fig. 2. Apparent effective antenna on 10 meters with the arrangement in Fig. 1.

ing contacts when the car was stationary.

Soon, however, the disadvantages became apparent. When in motion, particularly when driving in towns where frequent turns are necessary, this beam effect tended to increase the QSB always present in mobile operation. This was a distinct disadvantage.

So a second bracket was fitted in the centre of one side of the roof. See **Fig. 3.**

It may be asked why I did not mount the antenna in the middle of the roof. There were two reasons.

(1) I felt that to pierce the roof might lead to rain coming through the roof. It would need a good professional job to do this effectively.
(2) It would be difficult to reach the antenna to adjust it to take it down.

Thus I tried it in the two positions shown in **Fig. 3.**

The effect of position two was about as expected—a somewhat cardoid pattern developed, as in **Fig. 4.**

In other words the antenna radiated best in those directions in which there was longest line of roof and least well where there was no roof at all. For operation in motion there was an advantage, though to some extent I lost the beam effect when stationary, that is I could no longer get as much advantage from aiming the car towards the other station as I could before.

Recently I fitted a mobile rig into another car. This is a convertible and so no metal roof was available. I decided to mount the antenna as symmetrically as possible and chose the centre of the panel between the back of the roof and the hinge of the trunk, as in **Fig. 5.** Here I got a professional body builder to seal the hole against rain, etc.

I took great trouble also on this occasion to bond all parts of the metalwork of the car together. I bonded the trunk lid to the body, the doors to the body (I do not regard the

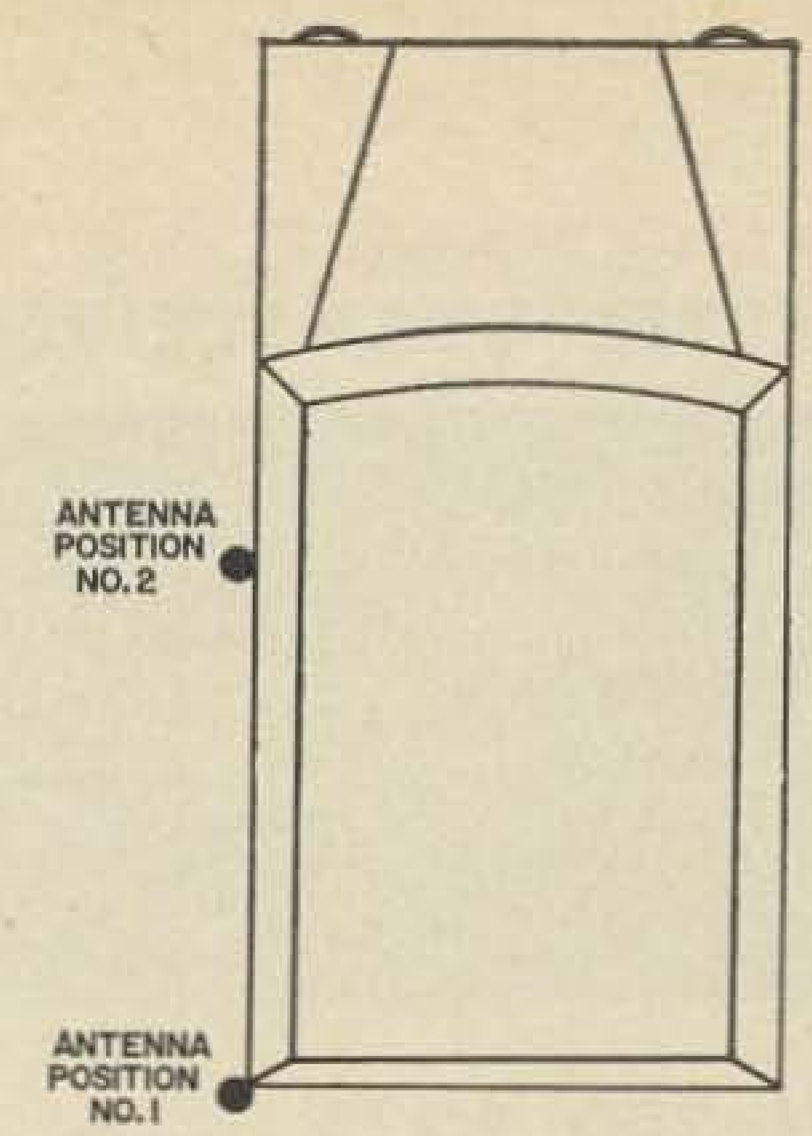


Fig. 3. The second location for the antenna is shown above.

door hinges as adequate contact) the body to the chassis, the engine to the chassis, the hood lid to the body, etc. etc.

The results on the new car have been very satisfactory, much DX has been worked, all continents and a number of new countries added to my MCA award (Mobile Century Award) including BV1US.

Recently I was able to take a polar diagram (**Fig. 6**) by rotating the car while getting readings from a station about 60 miles away on 15 metres (presumably ground wave).

I was quite surprised to see how directional the car still was despite my efforts to put the antenna as nearly centrally as possible in a convertible.

I have not mentioned the vertical posi-

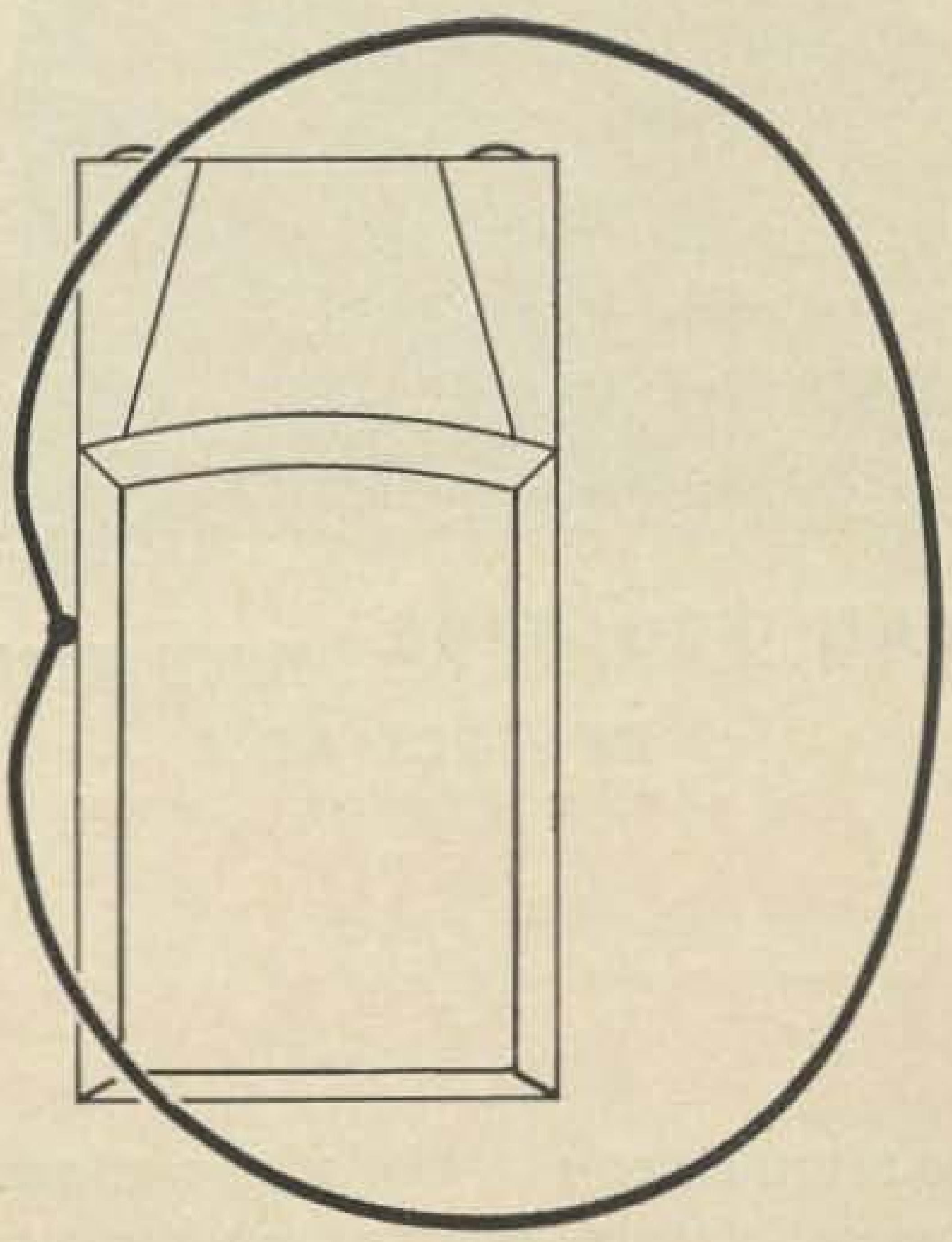
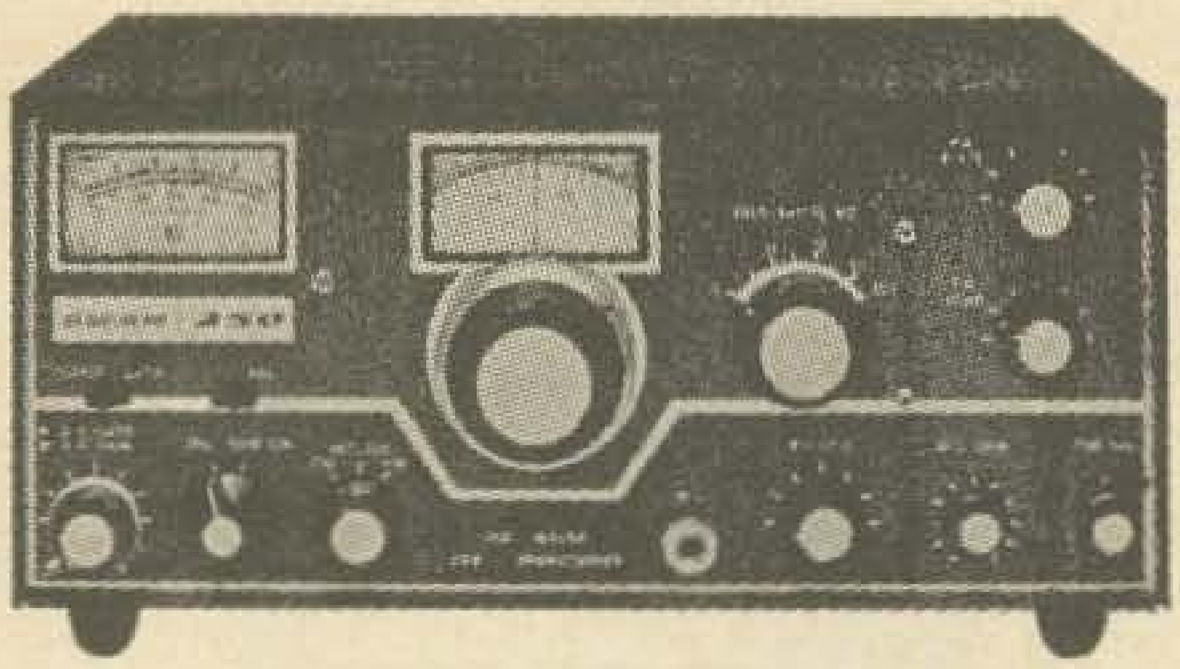


Fig. 4. Pattern of the antenna in position two in Fig. 3.

6 METER TRANSCEIVER



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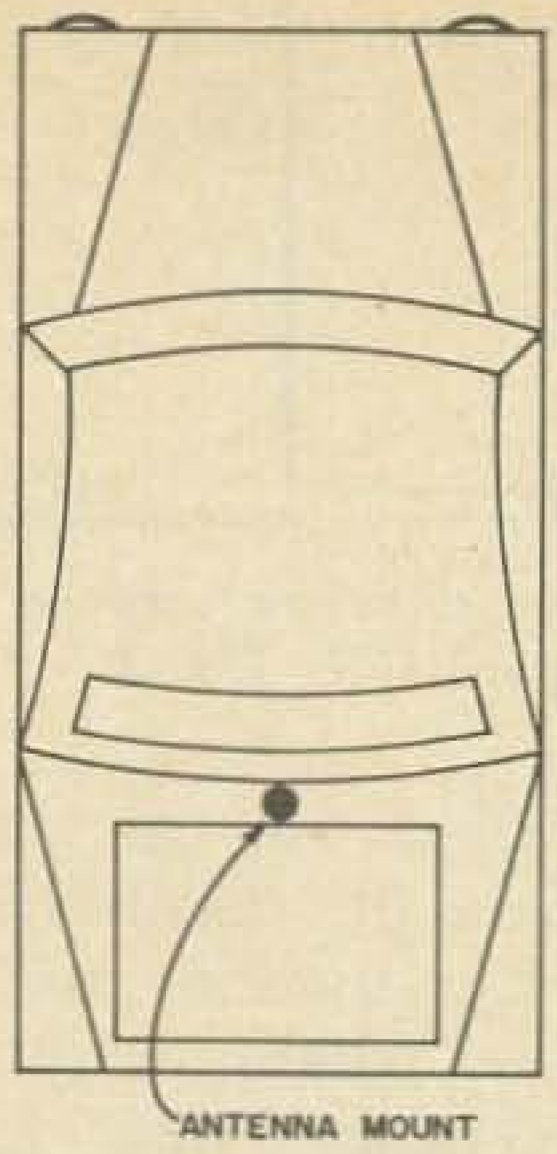

Fig. 5. Antenna mounted in the convertible.

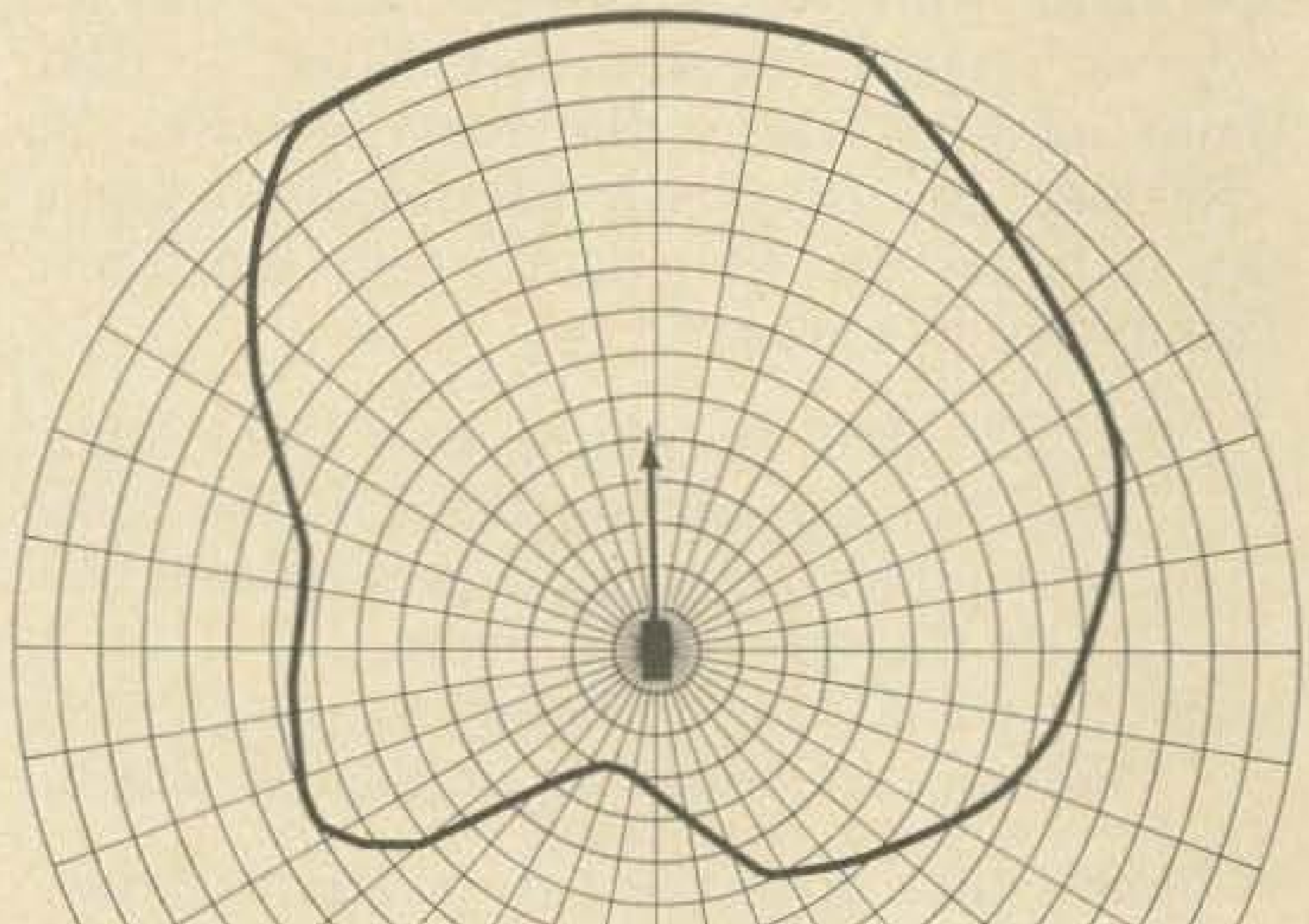

Fig. 6. Directional pattern of the antenna as mounted in Fig. 5.

tion of the antenna so far. In the first two examples, the antenna was mounted at roof level and in the second case as high as possible bearing in mind that there is no fixed roof.

Many people fix their antennas to the bumper. But I believe that the higher the antenna is placed, provided a good massive metal base is under it, the better.

No claim is made that this polar diagram is conclusive, since, in my opinion, far more experimentation is needed and this polar diagram is based on one test only.

I hope that this discussion will stimulate interest in mobile antennas and their positioning from the efficiency rather than the aesthetic point of view.

. . . G3BID

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George Cousins VEITG
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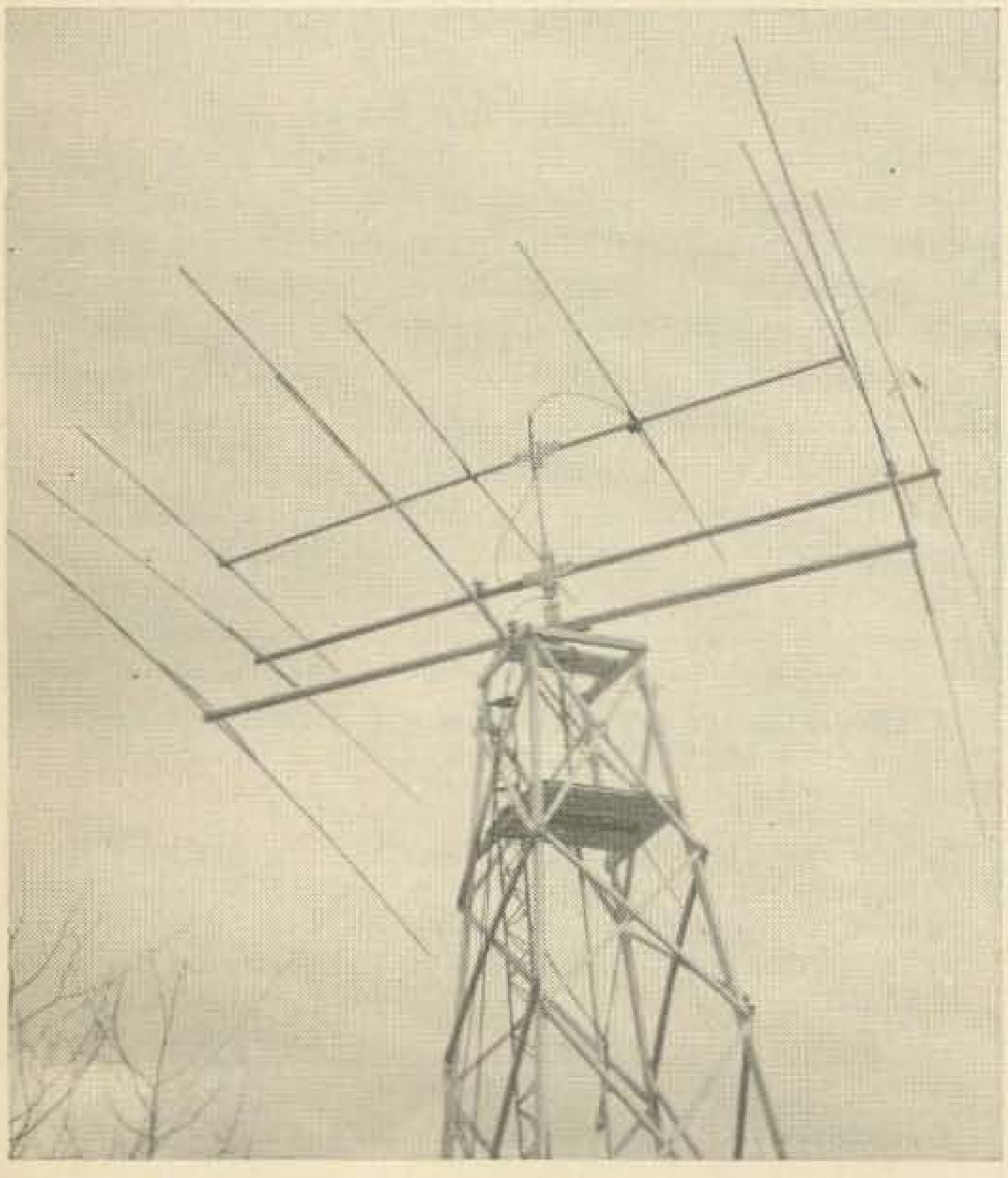
Beginner's Beam for 10 Meters

The ten meter openings are going to be better this winter than they were last—this simple, low-cost four element beam will increase the effectiveness of your signal.

With the steady improvement in 10 meter propagation conditions, it looks like DX prospects will be pretty bright by the winter of 1967/68, and many old-timers will be dusting off their beams and looking forward to a return of the "good old days". However, there are a great many newcomers to the ranks of ham radio who are inexperienced on this band, and this article is really intended for them.

Most people will argue that the power output of the rig is the least important factor in 10 meter DX operation. Naturally a kilowatt will make a big noise, but a 100-200 watt rig will make just as much noise if it's hooked onto a good antenna. The size and weight of 10 meter beams are well within reason for even the most crowded back yard or roof-top.



The antennas at VEITG—the four-element ten-meter beam is on top with homebrew 15 and 20 meter beams on the bottom. The tower is also home built.

The beam described here is ideal, especially for the newcomer, as it combines light weight, standard components, very simple construction, and of course, low cost. Despite the simplicity, the gain will be 7 to 8 dB for the three-element version, and around 9 or 10 dB for the four element one. For the small extra cost and work involved, the four element version is much to be preferred. The front-to-back ratio will also be better, and the extra gain is worthwhile.

Depending upon your operating preferences, the length of the elements should be decided by reference to the standard formulae:

$$\text{Driven element length} = \frac{473}{\text{Freq MHz}}$$

$$\text{Reflector length} = \frac{501}{\text{Freq. MHz}}$$

$$\text{Director length (both)} = \frac{450}{\text{Freq. MHz}}$$

Since the elements are adjustable, the exact lengths are easy to come by. If the

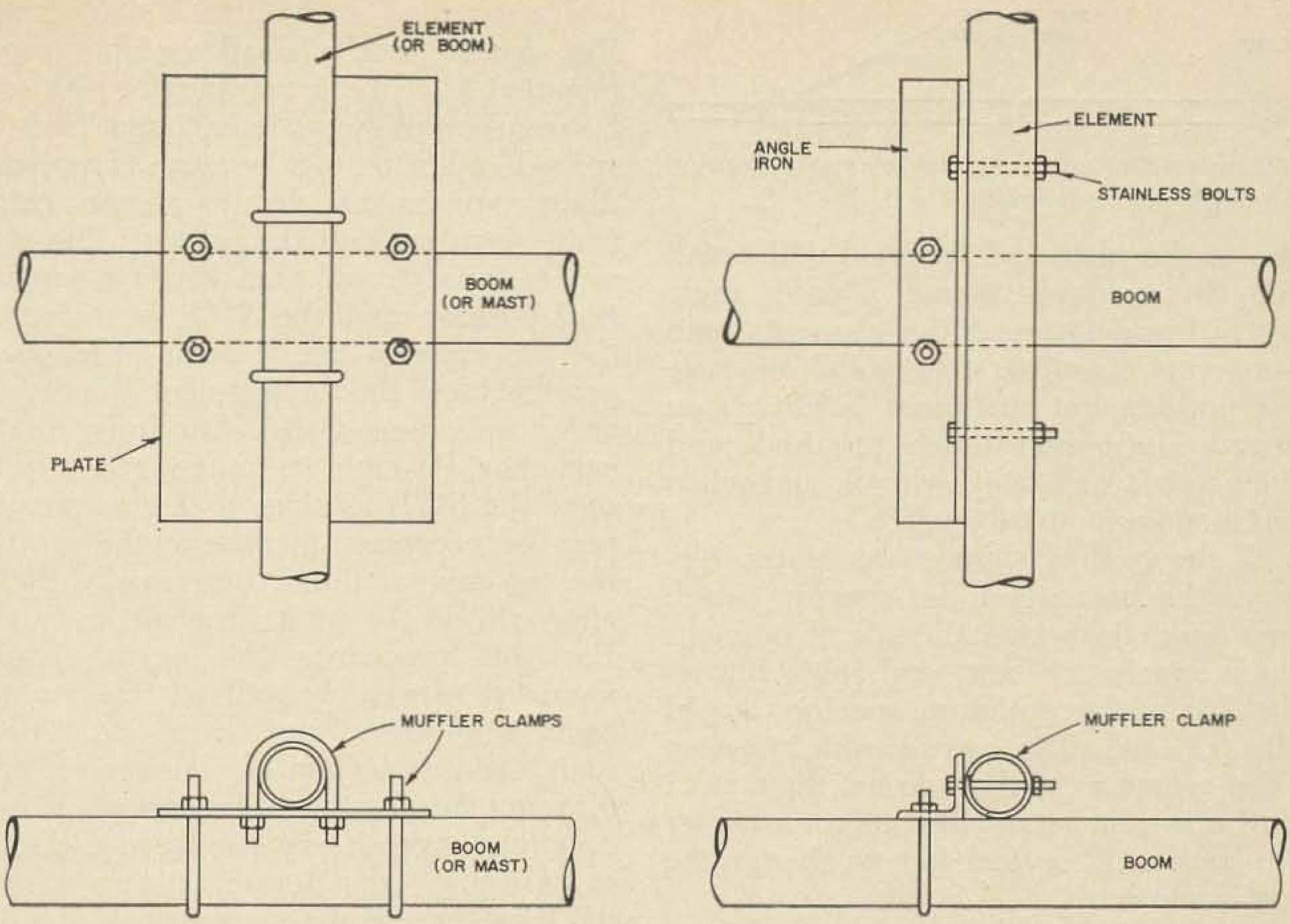


Fig. 1. Alternate methods for mounting the beam elements on the boom.

material is purchased new, choose rigid aluminum tubing 1" and ⅞" in diameter (or similar relationships in size) so that the center sections can be made of the larger tubing with the smaller tubing inserted into the ends to form the adjustable sections. For a 4-element beam, you'll need four lengths of the larger size, and three lengths of the smaller. This is assuming you get 12-13 foot lengths which are pretty well standard. The three lengths of smaller tubing can be cut into four foot pieces for the end sections, with a little left over. If cost is a prime factor, you can use old booms from defunct TV antennae as I did. I scrounged a bunch of these from a local service shop, took off all the elements and assorted junk, and ended up with excellent material for the beam elements.

Without doubt, the best material for the boom is old reliable irrigation tubing. The 2" diameter stuff is fine, in a 20 foot length. This gives reasonably wide element spacing. As a matter of fact, a 5-element beam can be mounted on such a boom if you wish, but I happen to prefer the wider spacing. Steel TV masting is another common material which can be used for the boom, but it is quite a bit heavier and you may have to couple sections together to make up the required length.

Several methods can be used to mount the elements on the boom, as shown in Fig. 1. In both cases, standard automobile muffler clamps are used to fasten the element support plates to the boom. Make sure the clamps are given a couple of coats of rust-proofing first. By using the flat plates, the elements can be laid across the long di-

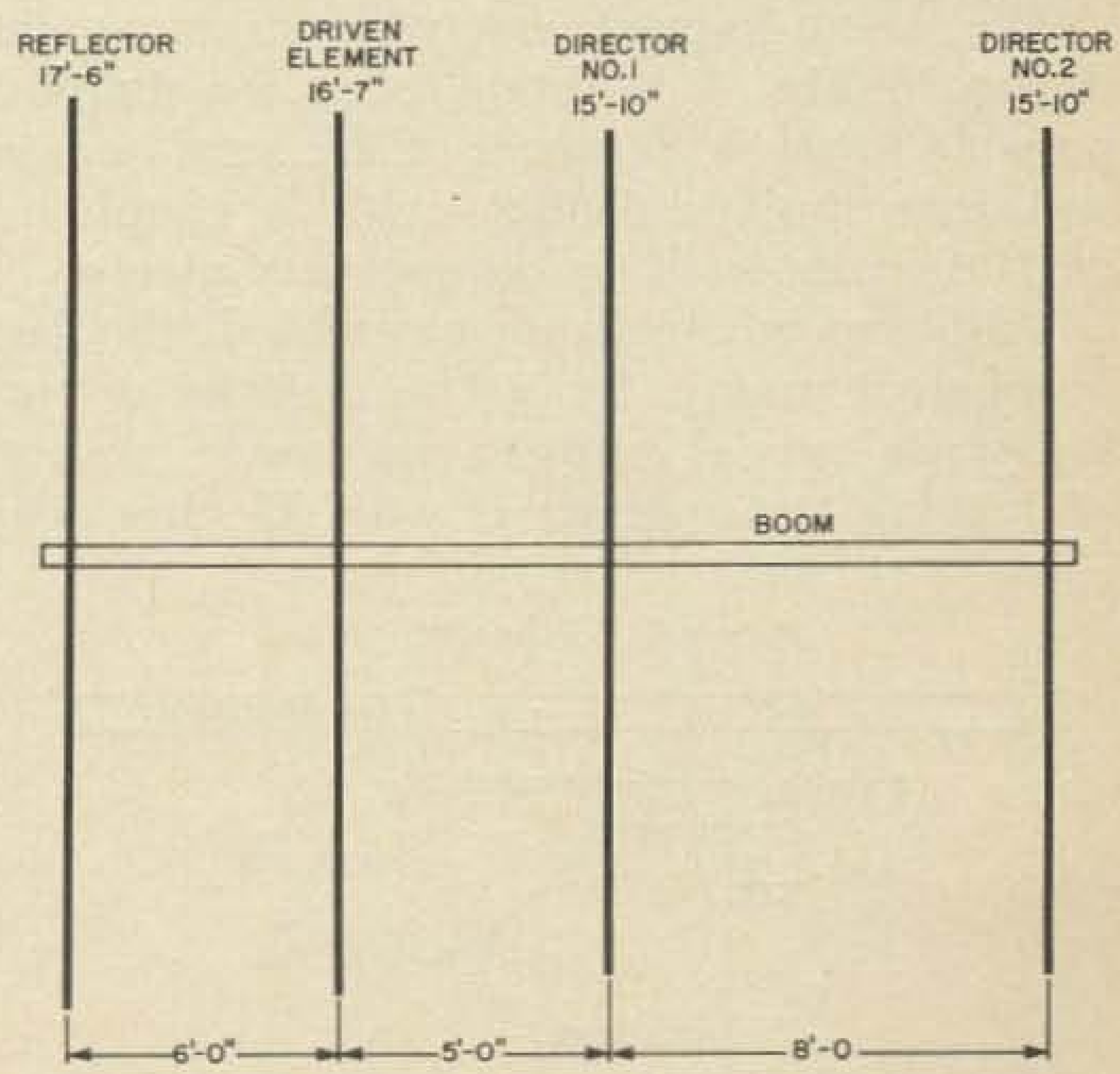


Fig. 2. Physical layout of the four-element ten-meter beam. Dimensions given are for approximately 28.4 MHz.

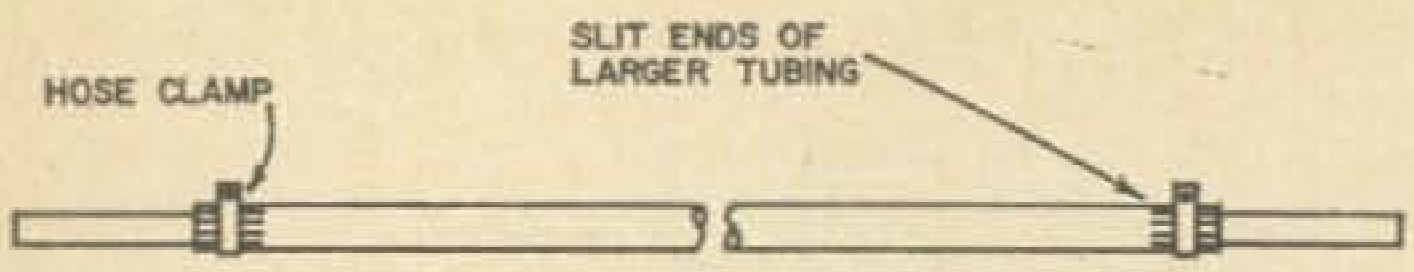


Fig. 3. Construction of a typical element, showing the adjustable end sections.

mension of the plate and fastened with small U-bolts. On my own model I used angle iron instead and fastened the elements onto the iron with *stainless* steel bolts. Be sure you use nothing but rust-proof hardware on the beam. There isn't much required, and the small cost is well worthwhile if and when you try to take it apart again.

Fig. 2 shows the arrangement of the elements on the boom and the spacings used. Antenna handbooks give all sorts of opinions on which spacing is best, and why, but as a general rule the optimum spacing should be 0.2, 0.2 and 0.25 wavelength, reading from the reflector to the second director. I modified this a bit in an effort to get a higher front-to-back ratio, so feel free to change the spacing if you wish.

Fig. 3 shows a typical element and how it is put together. Simple. All you need is a hacksaw, a screwdriver and two hose clamps per element. Depending upon how the tubing fits, you may need small shims to tighten up the joints. Incidentally, if aluminum tubing is not readily available, look up the nearest electrical contractor and his stock of thin-wall conduit, either steel or aluminum. This comes in all diameters, but unfortunately the standard length is only 10 feet, so your total requirements will be a little different.

The boom-to-mast clamping arrangement shown in **Fig. 4** is probably in its simplest possible form. Two pieces of flat steel or iron and four muffler clamps—with a couple of coats of paint—will do the job very nicely.

With the whole beam assembled, the last problem is tuning. Since the majority of rigs today use coaxial outputs, the easiest method of feeding the antenna is with 52 ohm coax

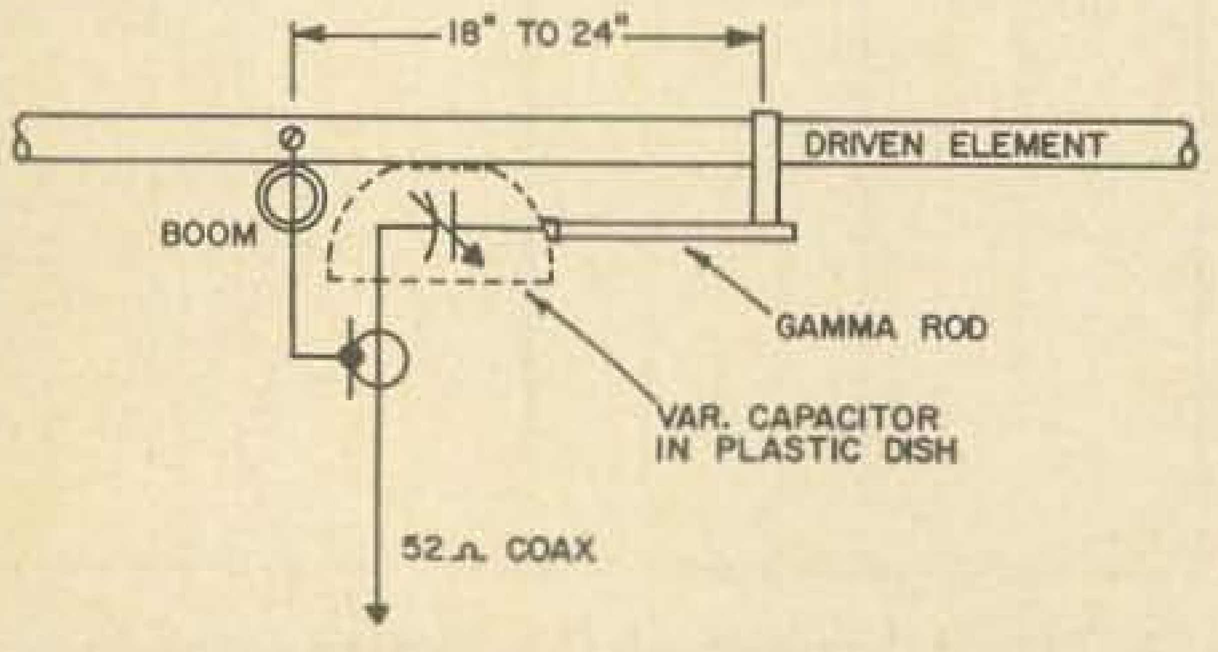


Fig. 4. Gamma match details for the four-element ten-meter beam.

and a gamma match. This is diagrammed in **Fig. 5** and uses a small variable capacitor mounted in a plastic refrigerator dish or similar weatherproof container. Use a fairly wide-spaced capacitor, not because of power handling requirements, but to prevent oxidation from shorting out the plates. The gamma rod is tapped onto the driven element at a trial position and the SWR is measured on the transmission line. Use as little power as possible for this adjustment procedure in order to reduce QRM. Carefully rotate the capacitor through its range and try to reduce the SWR as close to 1:1 as possible. It may be necessary to change the position of the tap several times, but usually the capacitor will do the trick after one or two trials. For this procedure the beam should be mounted reasonably well off the ground and away from trees, guy wires, etc. The ideal place for it is on top of your tower, but this may not be possible. The procedure will be infinitely easier if you can persuade someone to turn the capacitor while you watch the SWR meter *and* the resonance of the final in the rig. It changes considerably while all this is going on, so make sure you check it often. Actually, if you get the SWR down under 1.5 you can be pretty happy with it. It is debatable whether or not the extra effort of getting down to 1:1 is worthwhile.

The last problem is tuning the elements for best forward gain-or best F/B ratio. The two factors don't go hand-in-hand. Several methods can be used, all of which involve test dipoles, field strength meters, signals which stay steady enough to make adjustments and of course, the "friendly amateur" "a few miles away" who will dutifully do just what you want him to—baloney! If you figure out your dimensions properly by formulae, measure the lengths exactly, and get the gamma match adjusted, you are very likely going to get just as much out of the antenna as if you spend a month fooling with it. It's your choice—the methods are detailed in the various handbooks. Personally I don't think it's worth the effort.

The tower and rotating system are up to the individual. However, the light weight construction should allow the use of a TV type tower and rotator. This beam will give the low or medium power operator many hours of fine contacts and provides a *kilowatt* type signal at a small fraction of the cost. Welcome to 10 meters.

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Simplified Printed Circuits

Current interest in transistorized construction projects is high; prices of many types of transistors are much lower than equivalent tubes. Many of the current construction articles include a printed circuit layout and this makes things more interesting and much easier.

I have etched several of these circuits with success and have even done the layout myself on a few of them. I use the photographic method, as it is much easier and one can produce several circuits from one negative if necessary (for club projects and such).

First, you need the photo-sensitive (presensitized) copper-clad boards. I use one-sided glass base, obtained from B-A* for about 75c each in the 3" x 6" size. They come in light-tight packages, so don't expose them to flourescent lights or direct sunlight; low wattage incandescent bulbs can be used to work by. You will also need a contact-printing frame, which is nothing more than a sheet of glass placed over a flat sheet of foam rubber and can be as fancy or plain as you wish. Just be sure the negative is absolutely flat when put it in the frame; use clamps or weight on edges of glass. The board to be etched is placed face up on the foam rubber, the negative is placed on top of the board, and the whole works is exposed. For exposure lamps I use a couple of R40 sun lamps in a Kodak bracket and expose for 16 minutes.

The negatives I use are paper negatives produced on a Verifax copying machine. These are the *Fine Line* one time matrices; use a soft, damp sponge to remove any color from the white areas. Careful, don't scratch! If you know of a printing shop using offset printing you can probably get them to shoot a whole batch for a couple of bucks or so. These will be film negatives and will require about a third less exposure than the Verifax Negatives.

*Burstein-Appleby, 1012 McGee Street, Kansas City, Missouri 64106.

After the exposure, the board is placed face up in an aluminum pan or dish and trichlorethylene is *gently* poured into the container so as to cover the board. Do not disturb the copper surface; at this stage it is very soft. Rock the container gently for a minute or so, then carefully remove and let dry. Drying only takes about 30 seconds, so don't blow or heat, just let it air dry. When completely dry, place the board face up in a plastic container, such as the larger ones that disc capacitors come in. Gently flow ferrous chloride solution into the container and start etching. This takes from 20 minutes to an hour, depending upon the temperature of the solution. I use an old hair dryer a couple of inches above the surface of the solution to speed things up a bit. Check on the etching frequently and when the unwanted parts of the copper are completely etched away, drain and wash in running water for a couple of minutes.

These chemicals are perfactly safe, just don't spill any ferrous chloride because it stains quite badly. Dump it carefully and flush with plenty of water. Trichlorethylene was obtained from a local chemical company ($1.00 a gallon) and the ferrous chloride was scrounged from a local photo-engraver.

In making the originals I use pen and ink and *Chart-Pak* tapes. The Chart-Pak tapes are rolls of black paper tape in various widths and are available from most office supply houses. The dots and connectors are usually furnished with the board kits. These are gummed on the reverse side and save a lot of time-consuming hand-drawn circuits.

To date, I have etched the *Multical* (five at a time), the *Two-Tone Test Oscillator, Regulated Power Supply, Grid Dip Oscillator, FET Voltmeter,* 6 *Meter Converter* and several others in fine shape. Why not get a fist full of inexpensive transistors and have a ball with etched circuitry?

. . . K5IRP

Jim Fisk WIDTY
RFD 1, Box 138
Rindge, New Hampshire 03461

Designing Transistor Oscillators

If you have been having trouble with transistor oscillators, this article will show you how to design them to meet your requirements. Five brand new nomographs eliminate most of the math.

Of all the electronic circuits that the ham must analyze, design, construct and use, oscillators are apt to give him the most trouble. Although oscillators are basic requirements for any radio communications, they are probably cussed at more and understood less than any other singular circuit. Actually, vacuum tube (and FET) oscillators are relatively easy to get going, and except for some thermal drift problems, are fairly simple to tame down. In vacuum tube circuits, you can hang *just* about any tuned circuit across the output, feed a little of the output energy back to the grid, and the thing will take off. It really doesn't *seem* to matter a great deal what the tuned circuit values are so long as they are resonant at the desired frequency. It's this last statement that gets most oscillator builders into trouble. Even though in many cases it doesn't *seem* to matter what the tuned-circuit values are, in almost every instance it *does,* and frequency stability, amplitude stability, and power output can be improved by pursuing proper design.

With the transistor oscillator, it's a little different story; this is because the low value of input impedance associated with a transistor may seriously load the oscillator circuit if it is not properly designed. In fact, if the tuned circuit is not properly designed, chances are the circuit won't oscillate at all. It is the purpose of this article to describe some of the more common transistor oscillator circuits and to present a simplified method for their design.

Although all oscillator circuits consist of an active device such as a transistor, and some passive elements like capacitors and coils to store energy, there are actually two basic categories of oscillators, *harmonic* and *relaxation.*

In the harmonic oscillator, energy always flows in one direction from the transistor to the tuned circuit, and the frequency of oscillation is determined by the frequency characteristics of the feedback path. In the relaxation oscillator the transistor acts like a large-signal switch which periodically turns on and cuts off the flow of dc power to the passive storage elements in the circuit; its frequency is determined by the charge and discharge time during the exchange of energy. This type of oscillator is normally characterized by a nonsinusoidal output, while the harmonic oscillator primarily produces a sine wave and is of major importance in all radio equipment. Only the harmonic oscillator will be discussed in this article.

Depending upon what frequency selection components are used in the circuit, the output waveform may or may not show in what way it was generated. One important characteristic of the harmonic oscillator is that the transistor is continually applying power to the tuned circuit; in the relaxation oscillator there is an interchange of energy in a discontinuous manner.

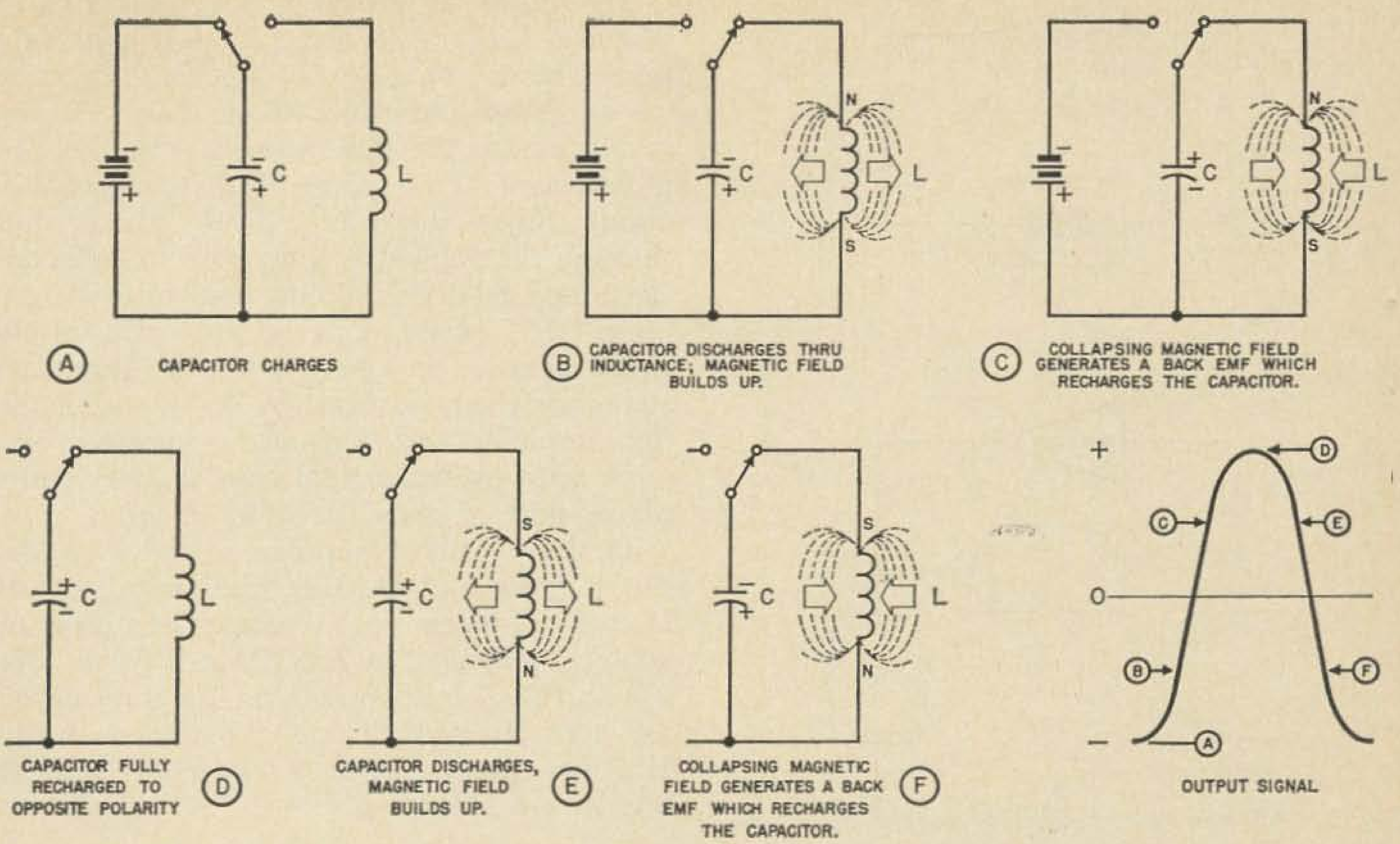


Fig. 1. Oscillatory action in a simple resonant LC circuit.

Basic oscillator circuit

Before we discuss transistor harmonic oscillators in detail, let's talk a little about the most simple oscillatory circuit of all, the straight-forward L-C circuit illustrated in **Fig. 1**. If the capacitor in the tank circuit is initially charged with a battery (**Fig. 1A**), and then switched in parallel with an inductor (**Fig. 1B**), it will discharge through the inductor. The capacitor doesn't discharge in a single blue flash, but discharges quite slowly because the inductor tends to oppose any change in current through it. As the capacitor starts to discharge, the current in the inductor slowly increases and a magnetic field builds up around the coil. When the capacitor is fully discharged, the magnetic field surrounding the inductor starts to collapse and as it collapses, it generates a current equal in magnitude to the original discharge current, but of opposite polarity (**Fig. 1C**); when the field around the coil is completely collapsed, the capacitor is recharged to the opposite polarity (**Fig. 1D**). However, as soon as the capacitor is recharged, it again seeks equilibrium and discharges through the inductor (**Fig. 1E**); the magnetic field builds up, and when the capacitor is completely discharged, the field collapses, recharging the capacitor to its original polarity (**Fig. 1G**).

This action happens over and over again, with the capacitor and inductor exchanging electrical energy. If there were no losses, this circuit would continue to oscillate back and forth as long as the coil and capacitor were connected in parallel. However, in practical circuits, the coil exhibits a certain amount of resistance and the capacitor doesn't quite regain a complete recharge on each succeeding cycle. The result is that the oscil-

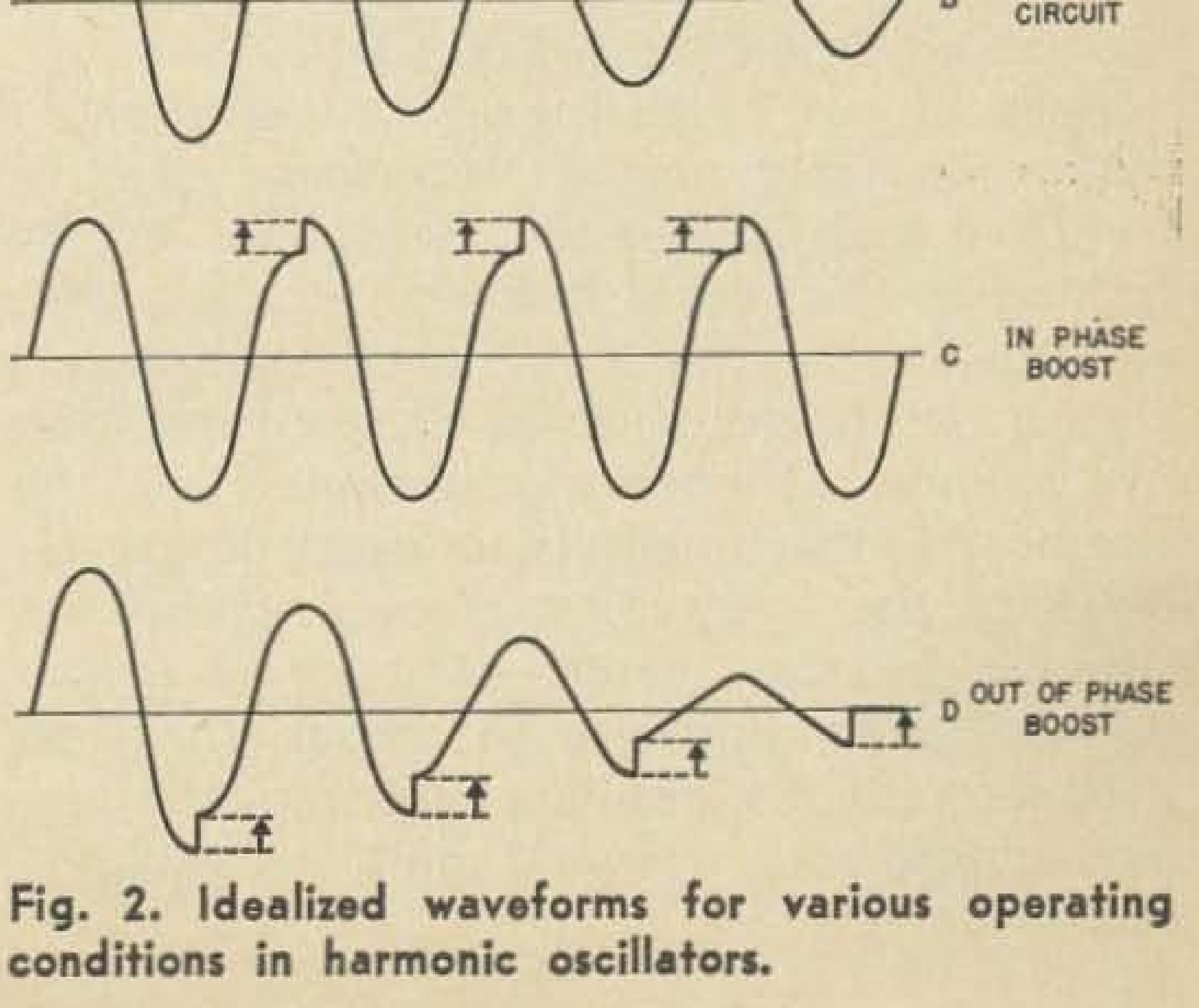


Fig. 2. Idealized waveforms for various operating conditions in harmonic oscillators.

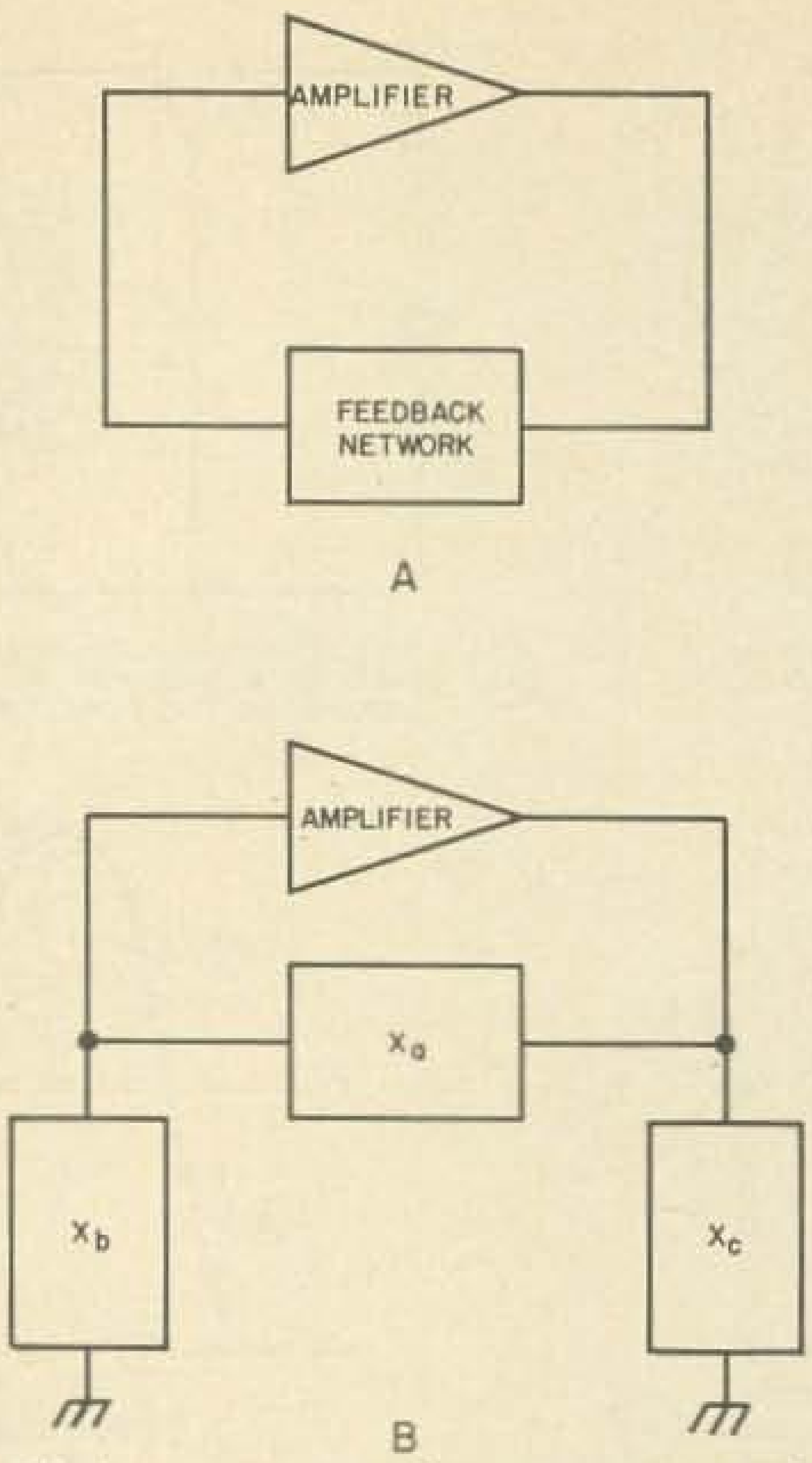


Fig. 3. All harmonic oscillators consist of an amplifier and a frequency-selective feedback network as shown in A. In the popular Colpitts and Hartley circuits, the feedback network consists of three reactances, X_a, X_b, and X_c as shown in B.

lations slowly decline in magnitude as illustrated in **Fig. 2B.** To maintain oscillations, a small amount of energy must be added to the circuit once each cycle as illustrated in **Fig. 2C.** It is here that the transistor or vacuum tube must be used, to provide the little kick of energy once each cycle.

This little kick of energy is a lot more complex than it would appear at first glance. First of all, it must be just large enough to overcome the inherent losses of the circuit; and second, it must occur at just the right time. If the boost does not occur at precisely the right time, it will either do nothing at all, or it will result in the rapid demise of oscillations as shown in **Fig. 2D.**

Actually, any oscillator may be represented by an amplifier and a frequency selective feedback path similar to that of **Fig. 3A;** by looking at this block diagram for a moment, we can see exactly what the requirements are for oscillation. First of all, we know that the amount of energy contributed by the amplifier to the tuned circuit must be exactly equal to the energy lost through circuit resistance. In other words, we want an output that is exactly equal to the input; the total gain through the amplifier and frequency selective feedback network must be equal to one or unity.

The other requirement for oscillation is that the kick must occur at just the right time. This is not really so difficult to do once we sit down and think about it—all we are saying is that the kick furnished by the amplifier must be in phase with the oscillator ouput. Since there is a 180° phase shift through the transistor from base to collector, the tuned feedback circuit must provide another 180° phase shift so that the output signal appears in phase with the input. In summary then, to function as an oscillator, the amplifier and frequency selective network must exhibit a total gain of unity and a phase shift of zero (or 360) degrees.

In the two most popular oscillator crcuits, the Colpitts and Hartley, the frequency selective feedback path consists of three reactances denoted as Xa, Xb and Xc in **Fig. 3B.** In the Colpitts oscillator, Xa is an inductor and Xb and Xc are capacitors. In the Hartley circuit, Xa is a capacitor and Xb and Xc are inductors.

Colpitts oscillator

In the transistor version of the popular Colpitts oscillator in **Fig. 4** and **5,** capacitors C_1 and C_2 form a resonant tank circuit with the inductance L. A small fraction of the current flowing in the tank circuit is fed back to the base of the transistor through C_3. Although the oscillation frequency is determined primarily by the tank components C_1, C_2, and L, the transistor input impedance (h_{ib}) and output impedance (h_{ob}) affect it

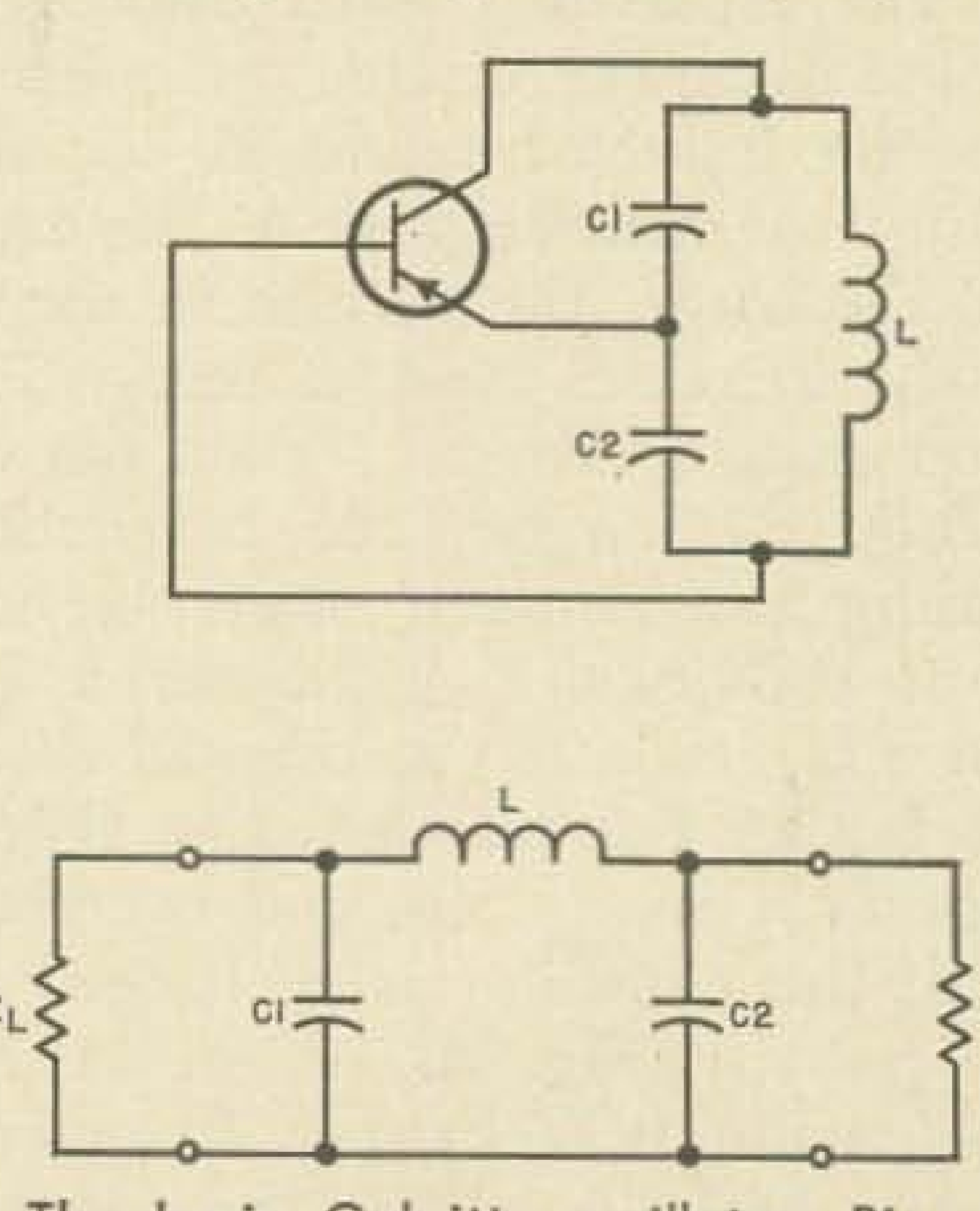


Fig. 4. The basic Colpitts oscillator. Bias resistors and power supplies have been left out for clarity. Since the input and output impedances of the transistor (Z_i and Z_L respectively) load the tuned circuit, the circuit may be further simplified by replacing the transistor with two resistors representing the loading.

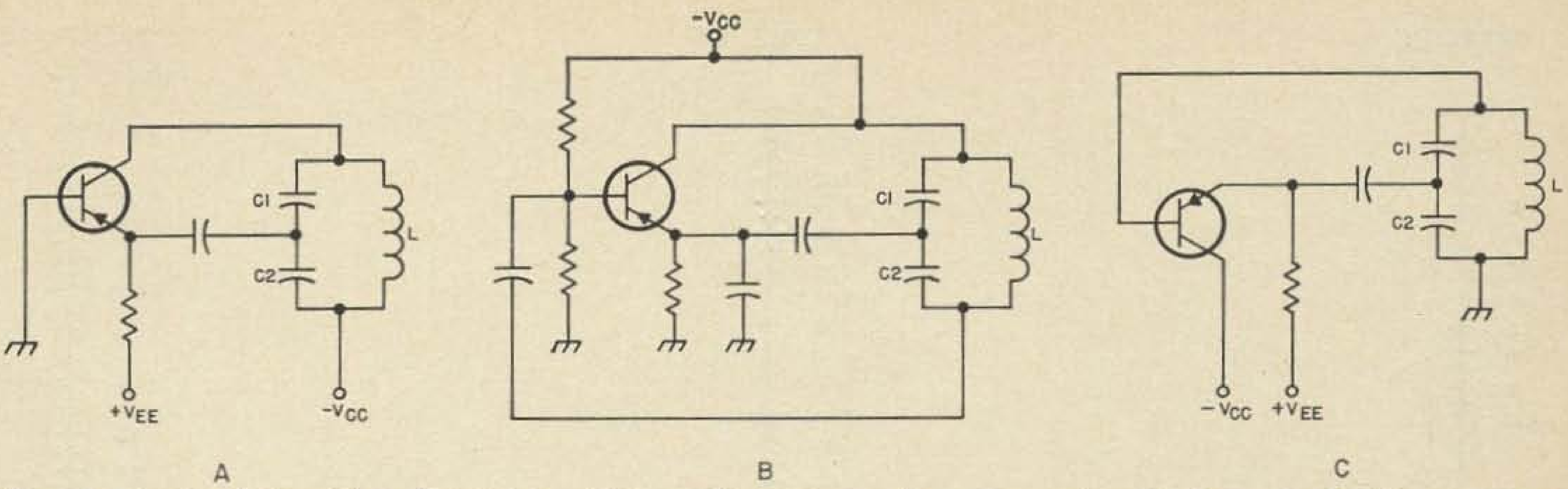


Fig. 5. Practical transistor Colpitts oscillators. The common-base connection is shown in A, the common-emitter in B and the common-collector in C. C3 is the unmarked capacitor connected to the junction of C1 and C2.

slightly. The frequency of oscillation is given by

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC_T} + \frac{h_{ob}}{h_{ib}C_1C_2}}$$

where C_T is the equivalent capacitance of C_1 and C_2 in series:

$$C_T = \frac{C_1C_2}{C_1 + C_2}$$

Fortunately, the term $(h_{ob}/h_{ib}C_1C_2)$ is usually quite small, and the frequency of oscillation may be simplified to

$$f = \frac{1}{2\pi\sqrt{LC_T}} = \frac{0.157}{\sqrt{LC_T}}$$

This formula is not difficult to work if you're familiar with the slide rule, but its solution can be quite tedious if done by hand. The nomograph of **Fig. 6** does all this work for you. In fact, **Fig. 6** may be used in any case where the resonant frequency of a tuned LC circuit must be determined.

For more accurate results, the more complex equation including the term $(h_{ob}/h_{ib}C_1C_2)$ must be used. In solving this formula, the nomograph will not work. However, usually a slug-tuned coil is used in a practical circuit, so the oscillator may be adjusted to the correct frequency after the oscillator is constructed.

Although predicting the frequency of oscillation is important, it has been previously noted that just any combination of inductance and capacitance that is resonant at the desired frequency will not necessarily cause the circuit to act like an oscillator. From the diagram of **Fig. 4** it can be seen that the portion of energy circulating in the tank circuit which is fed back depends upon the size of C_1 and C_2. To ensure that the oscillator will start and sustain oscillations when voltage is applied to the circuit, the common-emitter current gain (h_{fe}) must be greater than the ratio of C_2 to C_1.

$$h_{fe} > \frac{C_2}{C_1}$$

where h_{fe} is the value of forward current gain at the frequency of interest.

Frequency stability

In addition to these two requirements, there is one other important consideration when designing an oscillator—that of frequency stability. Frequency stability is extremely complex because it varies with changes in temperature, power supplies, external circuit components and circuit Q. In addition, frequency drift is a function of amplification, and through amplification, of the collector voltage and emitter or base current. It is also a function of the effective impedance of the tuned circuit, and that impedance is a function of the coupled loads reflected from the input and output loads of the transistor—complex, to say the least. If frequency stability is of paramount importance, the first thing to do is to insure that only a small amount of power is taken from the tank circuit. In most cases a good buffer amplifier will effectively isolate the oscillator from loading and load variations and eliminate many problems with drift.

Theoretically, the frequency stability of an oscillator is independent of the configuration in which the transistor is used. However, degradation of circuit Q by transistor loading and amplification variations must be identical; in practice this is difficult to achieve. This being the case, the best stability can be expected for the circuit arrangement which provides the smallest load-

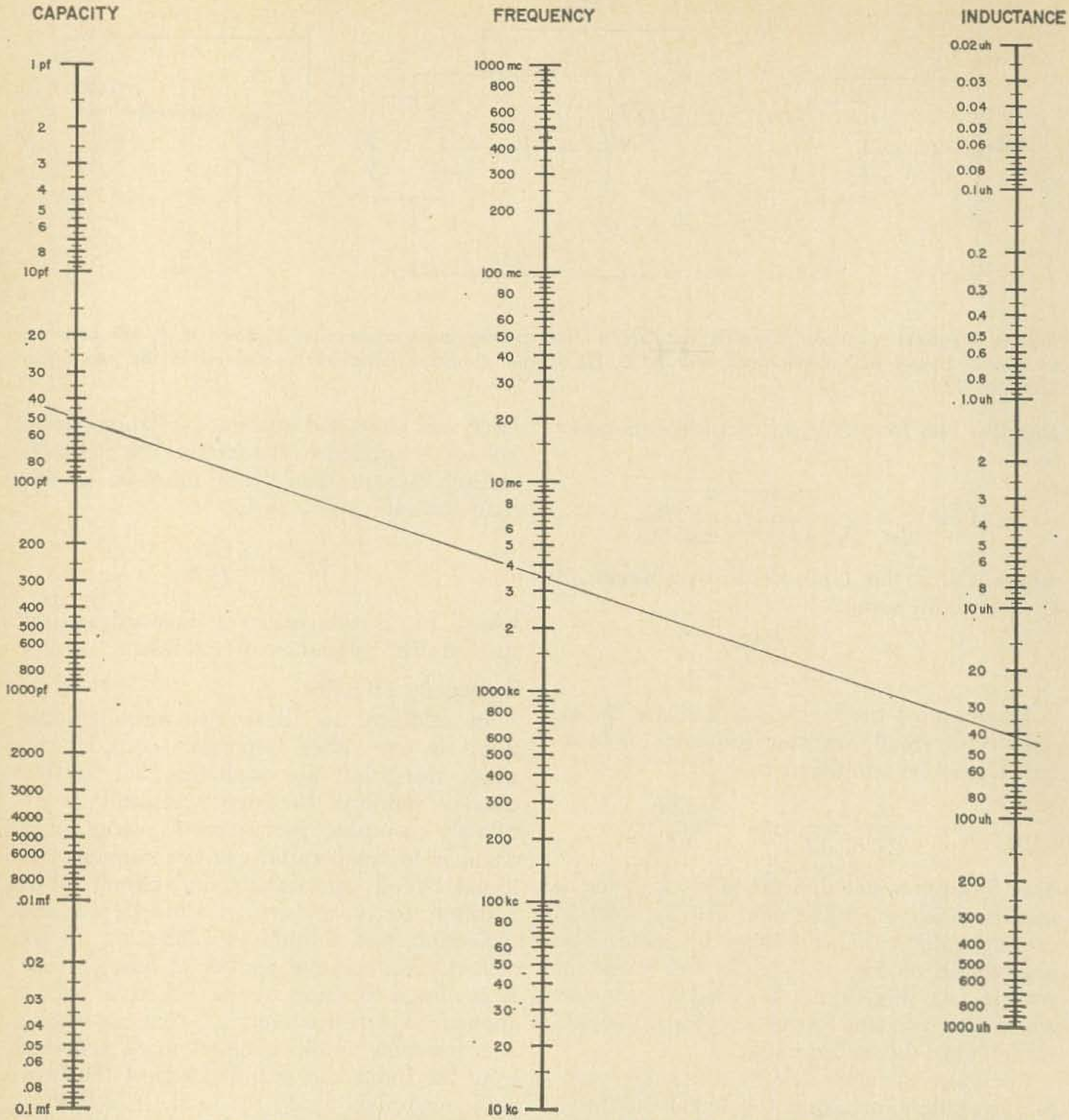


Fig. 6. Nomograph for determining the resonant frequency of tuned circuits. It may also be used to find the value of capacitance which will resonate at a given frequency with a given coil, or vise versa. A ruler is laid across the two known quantities and the third may be easily found. In the case illustrated, 42 μH resonates at 3.5 MHz with a 50 pF capacitor.

ing and the smallest variation in gain. The common-base circuit has reduced stability because of the large input signal power required by the emitter and because of the transistor's reduced power gain when compared to the common-emitter configuration.

The selection of a configuration between the common-emitter (CE) form and the common-collector (CC) or emitter-follower configuration is much more difficult. The power gain of a CC amplifier is much smaller than the CE, but the uniformity of both in loading and gain are much better; consequently, selection between the two can be rather difficult. If the common-emitter circuit is properly designed, it can provide an excellent high stability oscillator; otherwise, the emitter-follower circuit often gives the most stable arrangement. This is borne out by the large number of Clapp and Q-multiplier type emitter-follower oscillators. The improved drift characteristics in both cases is a result of the reduced and uniform loading of the transistor on the tuned circuit and more uniform gain.

Temperature variations which result in frequency drift may be largely neutralized by proper biasing techniques or by using temperature sensitive capacitors in the tank circuit. Although the design of bias networks is beyond scope of this article, there have been several excellent articles and books written on the subject.[1,2] Essentially, the bias resistors must be chosen so that the operating point remains relatively fixed with changes in the outside environment. This may often be done economically by using temperature-sensitive resistors; the temperature dependence necessary to stabilize the frequency may be determined quite easily.

A variable resistance is simply inserted into the circuit in place of the temperature-sensitive element. Then the circuit is exposed to the projected temperature range and this resistance is varied to keep the frequency constant. The temperature dependence of the temperature-sensitive resistor is then selected to match the measured temperature curve. This resistance may not necessarily keep the bias point constant, but it will change in such a way that it maintains a constant frequency of oscillation, compensating for more than one fluctuation in the circuit as a function of temperature.

A temperature sensitive capacitor in the tank circuit may be selected by the same technique—a variable capacitor is placed across the tank and adjusted for constant frequency output at the temperature extremes. The compensating capacitor should be chosen to follow the same curve.

Although temperature considerations and circuit loading are both very important to frequency stability, low drift is primarily dependent upon the Q of the tank circuit. All other things being equal, the higher Q circuit always results in lower drift. When the effects of temperature and circuit loading are neglected, the percent of drift is a direct function of Q as shown in **Fig. 7**. With proper temperature compensation and very light loading, the frequency stability obtained in a practical circuit will very closely approach this curve.

In addition, the tank L/C ratio should be low; this results in a larger value of capacitance in the tank circuit to filter out harmonics which tend toward frequency instability. Also, the self-resonant frequency of the inductors and capacitors in the tank circuit should be at least ten times the operating frequency of the oscillator, and where possible, even larger. Otherwise, the internal parasitic parameters of these tank components will seriously degrade oscillator performance to the point that stability will be unsatisfactory.

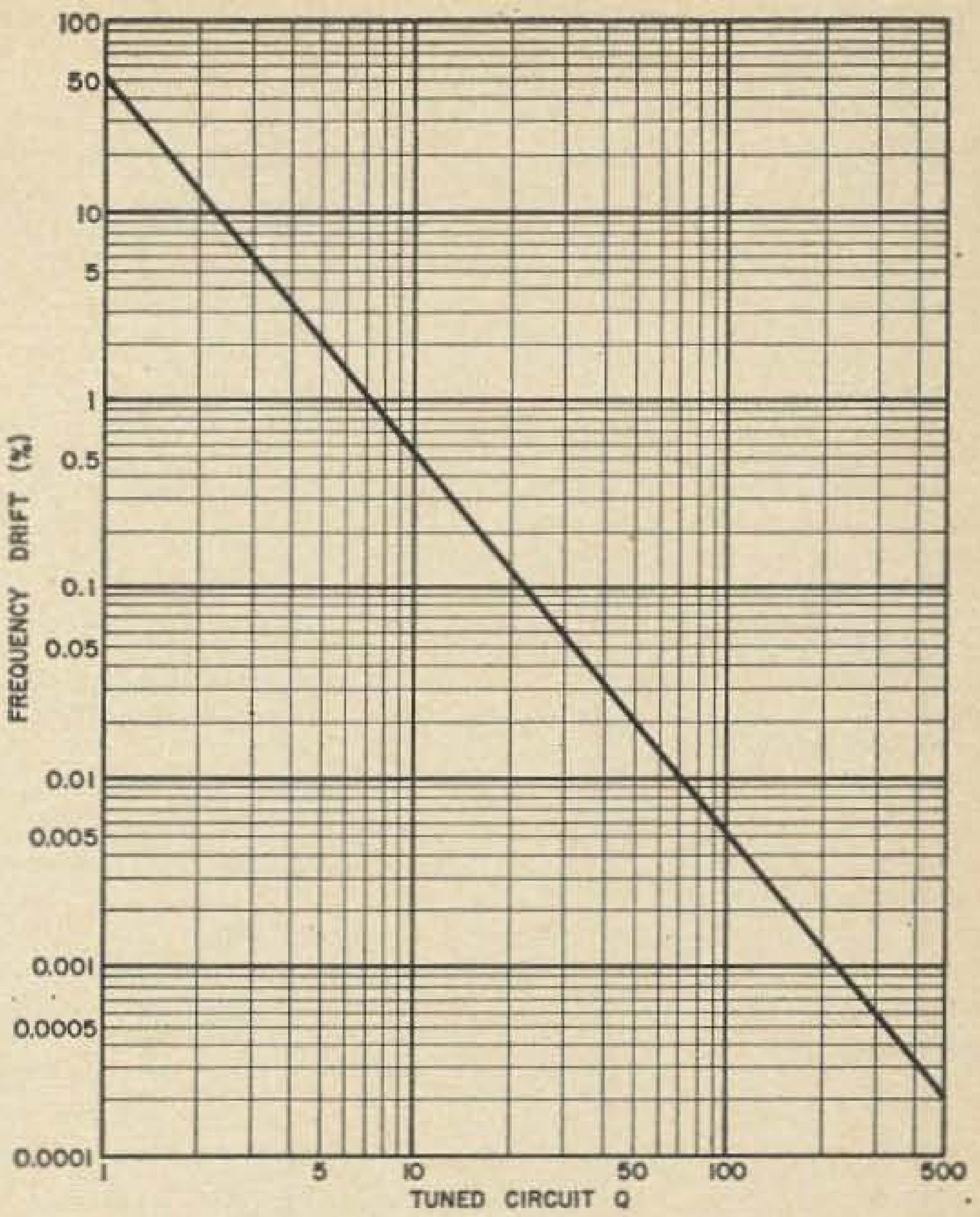


Fig. 7. The affect of tuned-circuit Q on frequency drift in an oscillator. For maximum frequency stability in a practical circuit, the Q should be as high as possible.

Colpitts oscillator design

Since frequency stability is usually the first consideration, circuit Q is a good place to start the design of a transistor oscillator. From the graph of **Fig. 7**, you can choose a value of Q that is compatible with practical components and will provide the frequency stability required. With this value of Q in mind, the frequency of operation and the desired impedance of the tuned circuit at resonance, the correct value of tank capacitance may be found from

$$C = \frac{Q}{2\pi f Z}$$

Again, the math in this formula, although not completely formidable, is inconvenient, so the nomograph of **Fig. 8** was prepared to give you an almost instant answer; the nomograph has the added advantage that you can quickly check the effect of various values

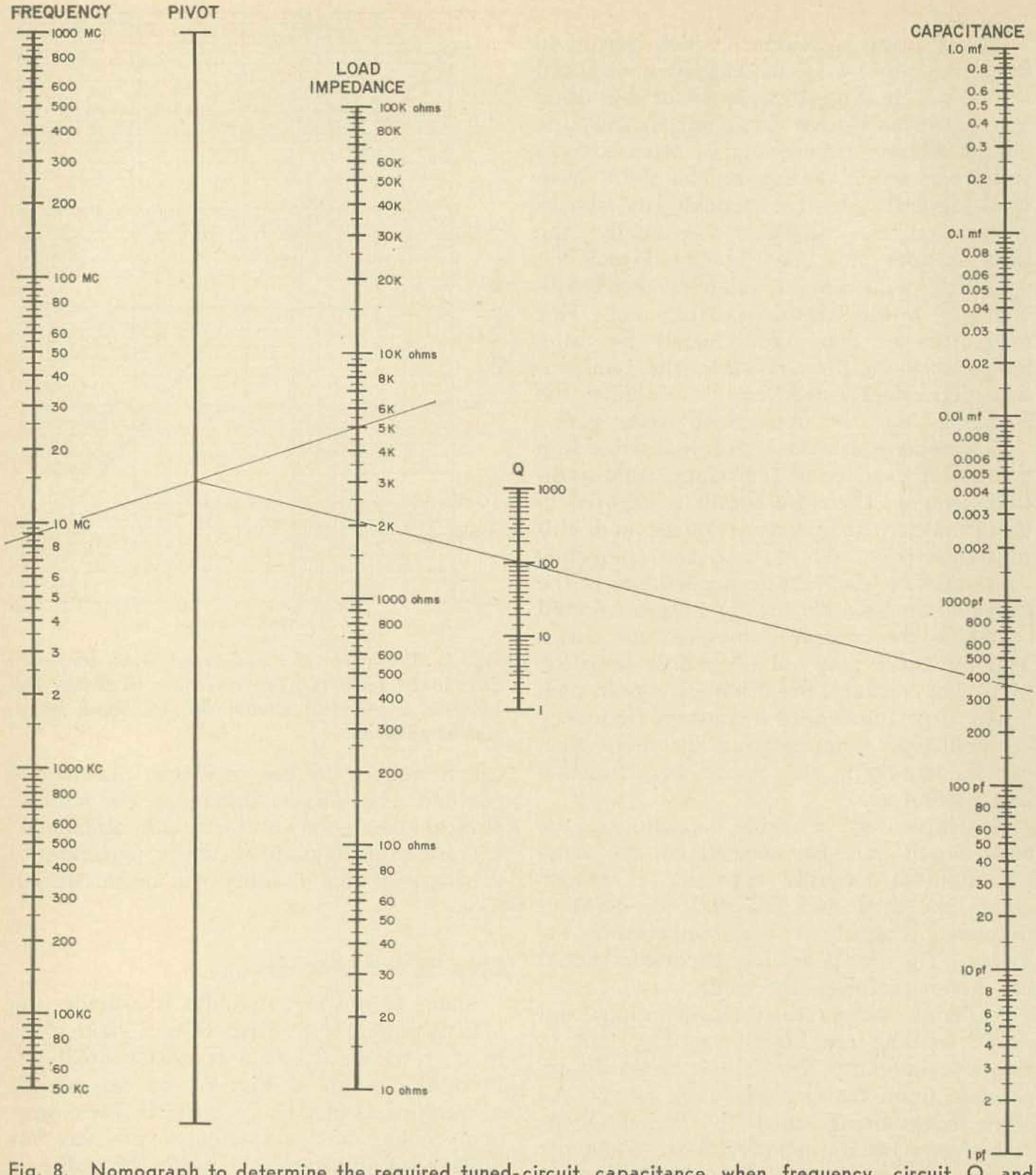


Fig. 8. Nomograph to determine the required tuned-circuit capacitance when frequency, circuit Q and load impedance are known. First the frequency of operation and load impedance are plotted. A straight line is then drawn from the cross-over point on the pivot line through the required value of circuit Q to find the necessary tuned-circuit capacitance. In the example illustrated, a 9 MHz oscillator with a 5000-ohm load impedance and circuit Q of 100 requires a 355 pF capacitor. In addition to its use in oscillator design, this nomograph may also be used when designing rf and *if* amplifiers, transistor or vacuum tube.

of tank capacitance.

For example, let's assume that you want to build an oscillator at 9 MHz with a circuit Q of 100; the load impedance is chosen to be 5000 ohms. From the nomograph, plot a straight line between 9 MHz on the frequency scale and 5k on the load impedance scale; note where this plot crosses the pivot line. Now plot a line between the cross-over point on the pivot line and 100 on the Q scale to find the required value of capacitance; in this case about 355 pF. To find the value of inductance that resonates with 355 pF at 9 MHz, use the nomograph of **Fig. 6.**

Before we can go any further, we must

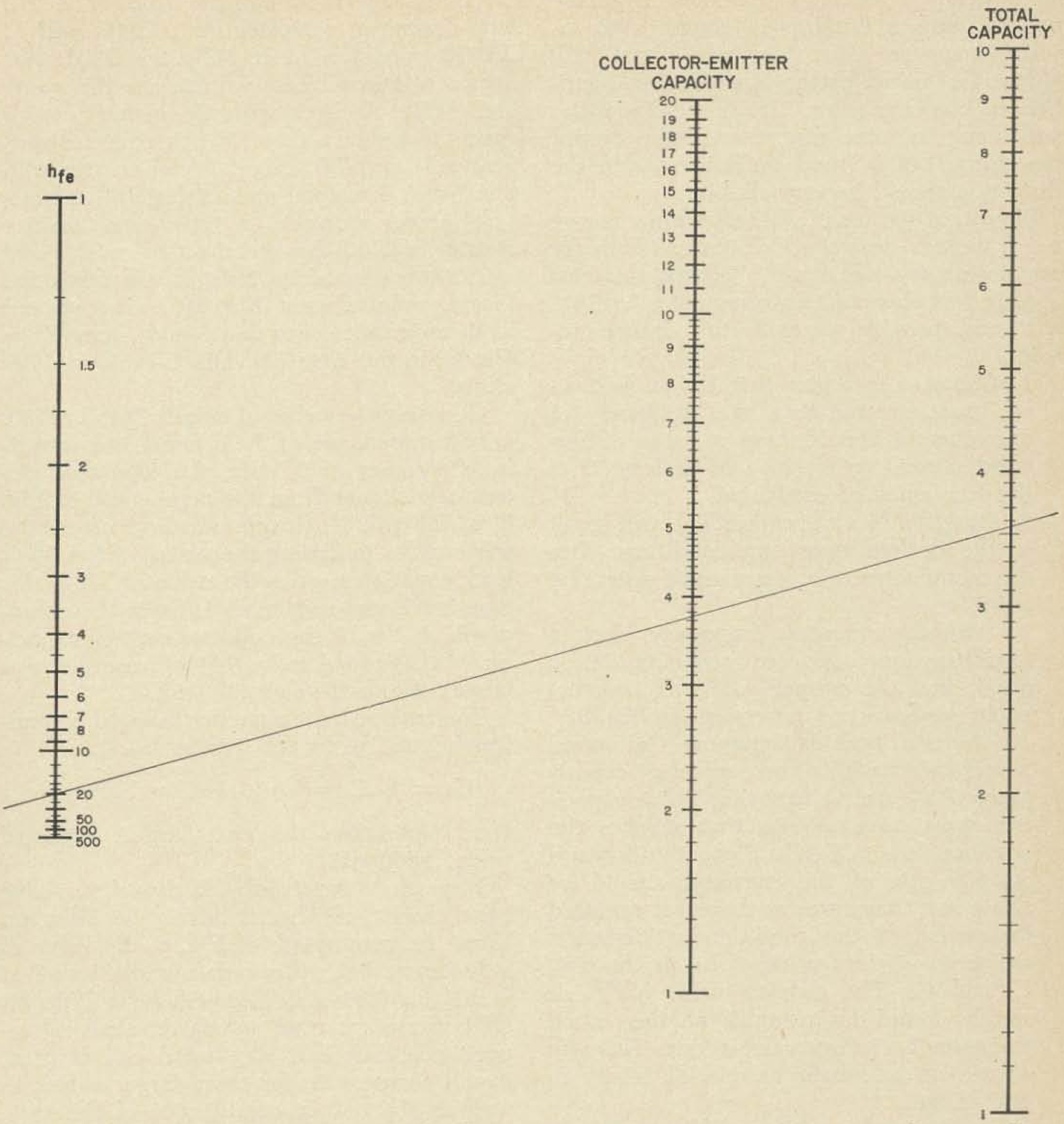


Fig. 9. Nomograph to find the required collector-emitter capacitor in a transistor Colpitts oscillator when the forward current gain (h_{fe}) and total tuned-circuit capacitance (C_T) is known. In this case, forward current gain of 20 and total tuned-circuit capacitance of 355 pF requires a collector-emitter capacitor of 375 pF.

determine the impedance of the tuned circuit at resonance. For maximum power again, the tank impedance should be equal to the transistor output impedance; this may be found from

$$Z = \frac{V_{CE}^2}{2P_o} \text{ or } \frac{V_{CE}^2}{I_C}$$

where P_o is the output power, V_{CE} is the voltage between collector and emitter, and I_C is the collector current. In practice a value in the range from 1500 to 5000 ohms is usually used.

The only other consideration is what transistor to use. Theoretically, the oscillator transistor only requires a gain of one or unity, but in practical circuits the gain must be greater than unity because if it were not, aging of the components would eventually result in discontinuance of the desired waveform because of gain reduction. The minimum excess gain that will assure starting is usually about 50 to 100 percent for ordinary circuits. When the gain is greater than one, more signal is fed back than was originally present, and a buildup in signal level results; however, this increased signal will always be limited by the inherent nonlinearities in the transistor. These nonlinearities will result in some distortion of the output waveform, but in good oscillator design the distortion should be very slight.

Now that we have all the information we need, we can design a Colpitts oscillator for any frequency we desire. Perhaps the best approach at this point is to lay out a "recipe" that will provide us with the desired results:

1. Choose a transistor that has an f_T several times greater than the frequency of operation; it should have a value of forward current gain (h_{fe}) of at least 5 at the frequency of oscillation.

2. Design a bias network which will result in the desired operating conditions. Use the manufacturers recommended operating point.

3. With the operating frequency, desired load impedance and required circuit Q in mind, find the proper value of tank capacitance from the nomograph in **Fig. 8.**

4. The total tank capacitance (C_T) found in step 3 is equal to the equivalent capacitance of C_1 and C_2 in series. These capacitors must have a ratio that satisfies the equation $h_{fe} > C_2/C_1$. Since the forward current gain of the transistor should be about five times greater than that required for oscillation, this condition is satisfied if we use a *starting* value of h_{fe} in choosing C_1 and C_2. The *starting* value of h_{fe} is simply found by using ⅕ of the actual transistor h_{fe} in our calculations. This will ensure an adequate margin of safety in our design.

   When the total capacitance (C_T) and *starting* h_{fe} are known, the value of the collector-emitter capacitor (C_1) may be found from the nomograph of **Fig. 9.** Then the required value of emitter-base capacitance (C_2) may be calculated by multiplying C_1 by the *starting* h_{fe}.

5. From the nomograph of **Fig. 6** choose a value of inductance that will resonate with the total capacitance at the desired operating frequency.

This recipe may seem to be a little complex at first, but as soon as you use it, you will find that it is really pretty simple; all the drudgery is removed by the three nomographs.

To illustrate the use of the Colpitts' recipe, let's design an oscillator for 9 MHz with a 2N918 transistor. At 10 MHz the 2N918 has a gain of about 20, so we can use this value at 9 MHz. A check with the manufacturer's spec sheet shows that 1.5 mA collector current (I_C) and 7.5 volts collector-emitter voltage (V_{CE}) is a good operating point. A nine-volt power supply, a 1000-ohm emitter resistor, a 2200-ohm stabilization resistor and a 6800-ohm base-bias resistor will satisfy the biasing requirements (**Fig. 10**). The required load impedance can be found from $Z = V_{CE}/I_C$; in this case 7.5 volts/1.5 mA = 5000 ohms.

Choosing the value of circuit Q to be 100, a load impedance of 5000 ohms and operating frequency of 9 MHz, the total tank circuit capacitance from the nomograph of **Fig. 8** is 355 pF. To insure starting, use ⅕ the value of h_{fe} in finding the values of the feedback capacitors; since the value of h_{fe} in this case is 20, use a value of 4. From the nomograph of **Fig. 9** the collector-emitter capacitor (C_1) is found to be 444 pF; use the next largest standard value, 470 pF.

The emitter-base capacitor is found by multiplying 444 pf by the *starting* h_{fe}, 4:

$$C_2 = h_{fe}C_1 = 4 \times 444 = 1756 \text{ pF}$$

Here again use the next largest standard value, 1800 pF.

Now that the feedback capacitors have been chosen, all that is left is the inductor. From the nomograph of **Fig. 6**, the value of inductance that will resonate with 355 pF at 9 MHz is 0.84 μH. This will be a little bit off because we used standard values of capacitance, but if a slug-tuned coil is used, it will compensate for these larger values as well as the output capacitance of the transistor and any stray capacitance introduced

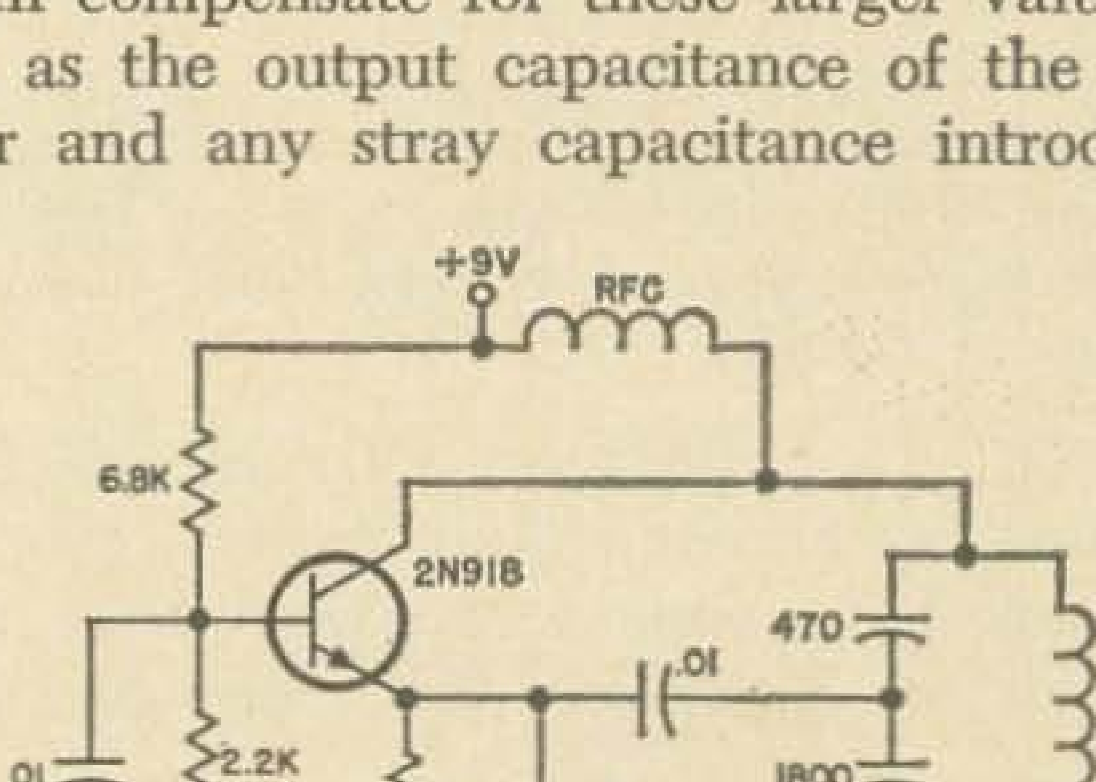


Fig. 10. Practical 9 MHz Colpitts oscillator designed with the procedure outlined in the text.

by wiring.

The completed circuit is shown in **Fig. 10.** When this circuit was constructed on the bench, it started oscillating as soon as power was applied. The collector current was 2 mA and the collector to emitter voltage was 7 volts—very close to the desired operating condition. The frequency could be tuned from 8.7 to 11.6 MHz by tuning the slug-tuned coil. The output voltage, measured at the collector with a VTVM and rf probe, was 4.4 volts peak to peak.

Hartley oscillator

The Hartley oscillator in **Fig. 11** and **12** differs from the Colpitts in that the capacitors in the Colpitts circuit are replaced by two magnetic-coupled inductors in the Hartley configuration, and the inductor is replaced by a capacitor. The behavior of the Hartley circuit differs in one significant way from that of the Colpitts; if the magnetic coupling between the two sections of the inductor is relatively high (it usually is),

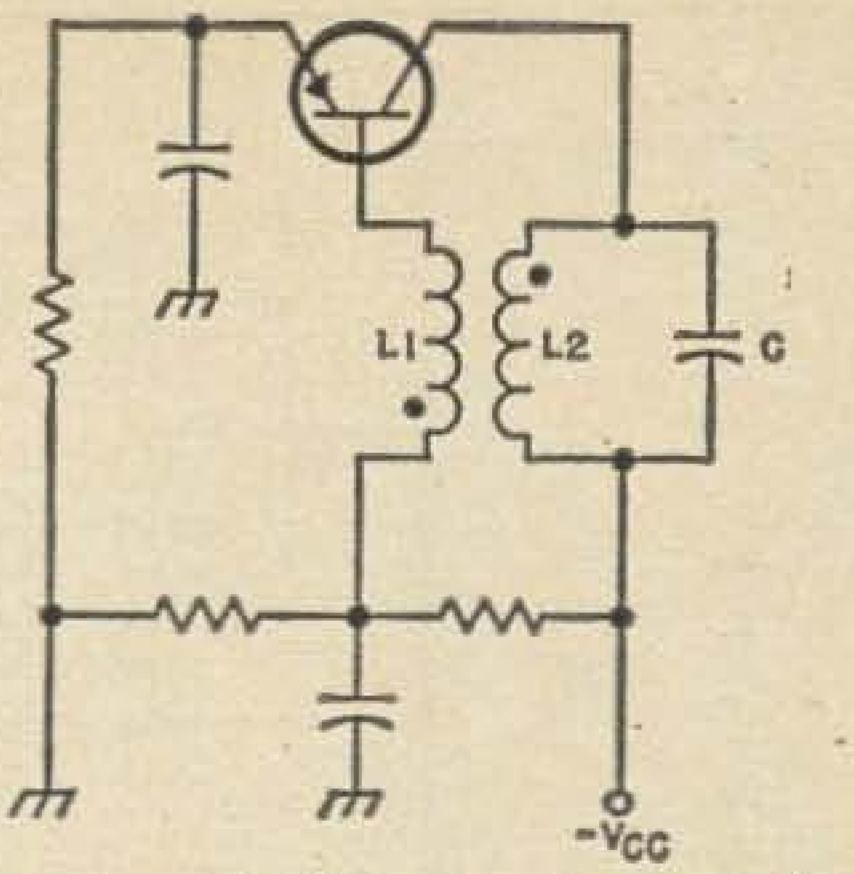


Fig. 13. The two-winding version of the Hartley oscillator. In this circuit the necessary phase reversal is obtained by connecting the transformer as shown by the dots.

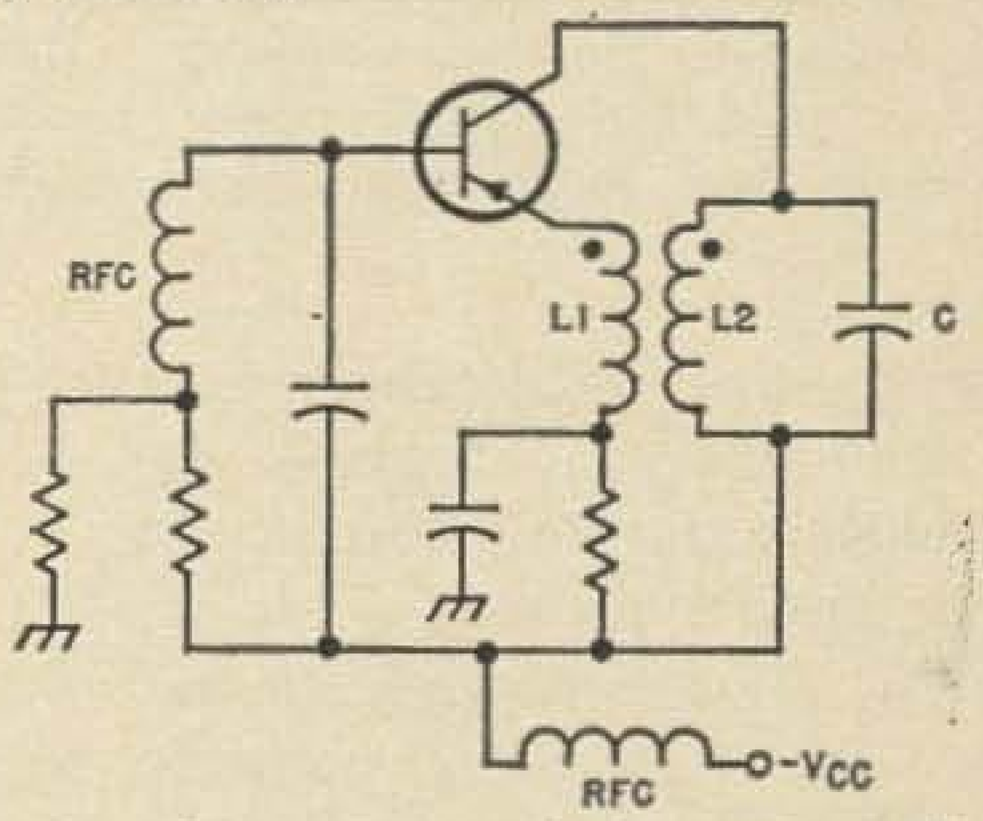


Fig. 14. Another version of the two-winding Hartley oscillator. In this case, since the drive is applied to the emitter, no phase reversal is required and the transformer is connected as shown.

then transformer action can be utilized to obtain the required current gain to the output of the circuit. Consequently, smaller values of Q-factor can be used for the tuned circuit without loss in circuit efficiency.

In most cases the loading of the Hartley circuit is relatively unimportant as long as the coupling coefficient between the two windings on the inductor is high. If the coupling coefficient is small, then the circulating current in the tank must be large compared to the load current (implying light loading) as is the case with the Colpitts

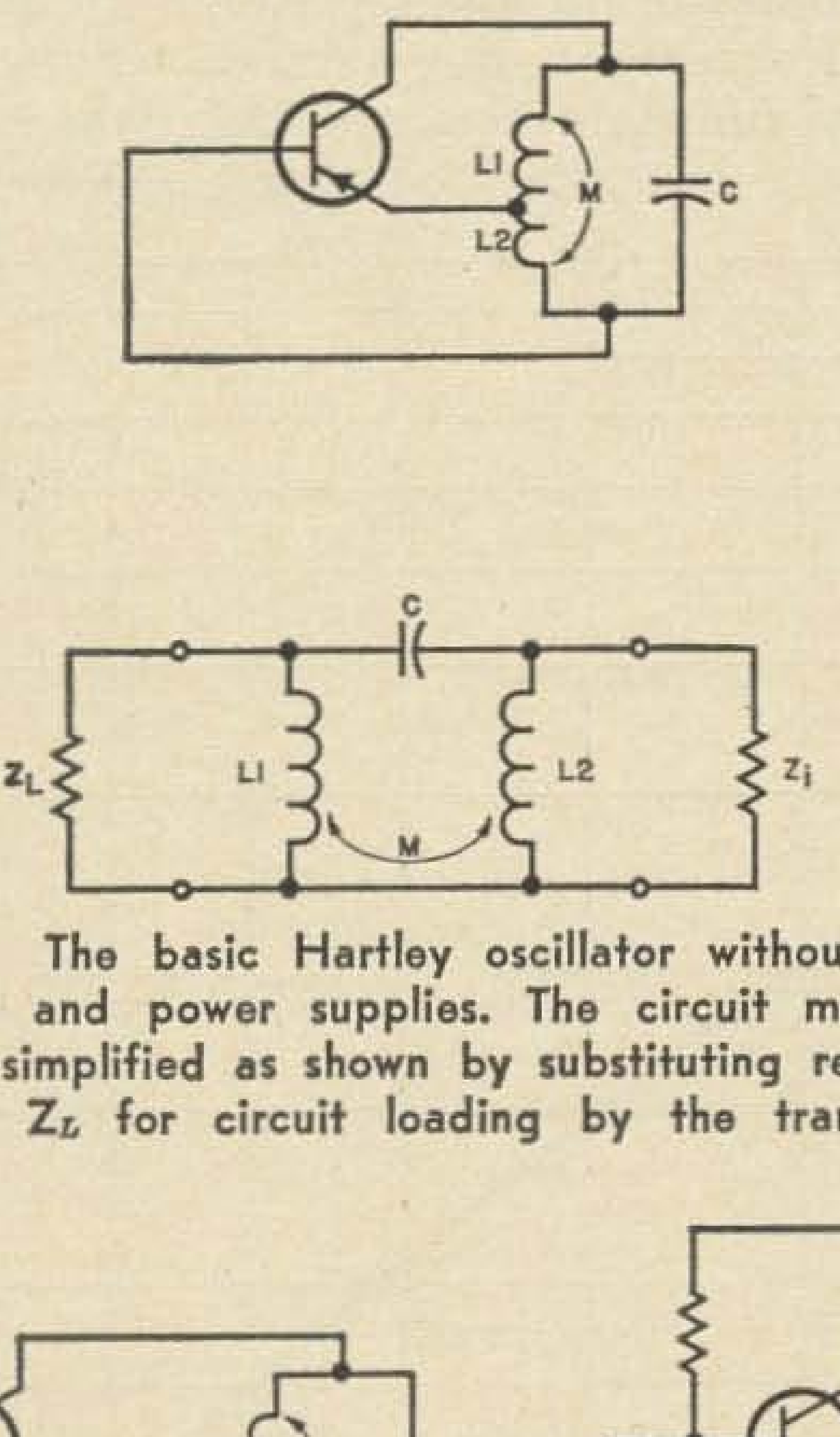


Fig. 11. The basic Hartley oscillator without bias resistors and power supplies. The circuit may be further simplified as shown by substituting resistors Z_i and Z_L for circuit loading by the transistor.

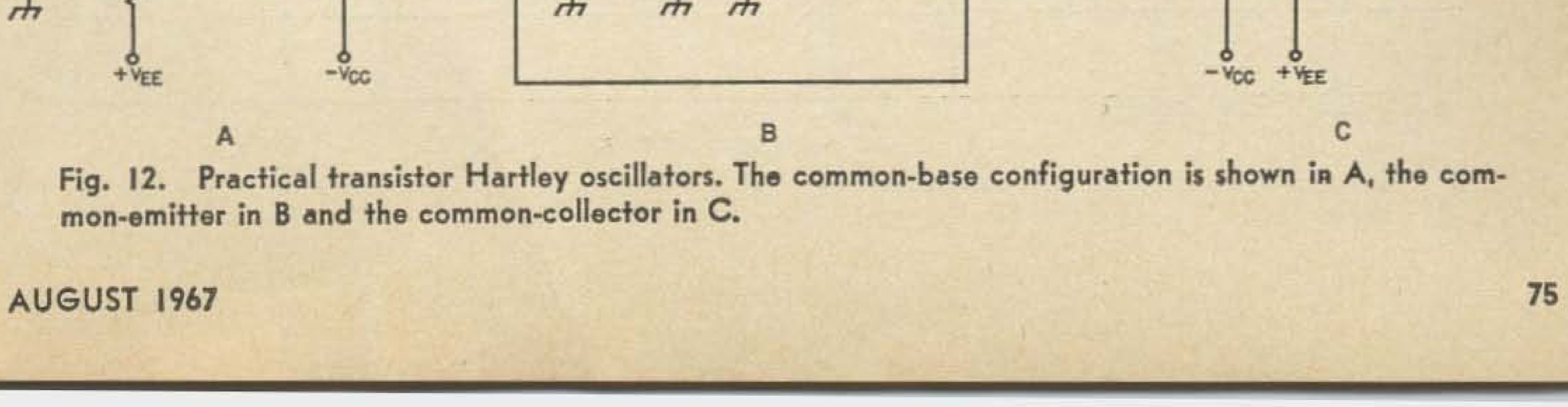


Fig. 12. Practical transistor Hartley oscillators. The common-base configuration is shown in A, the common-emitter in B and the common-collector in C.

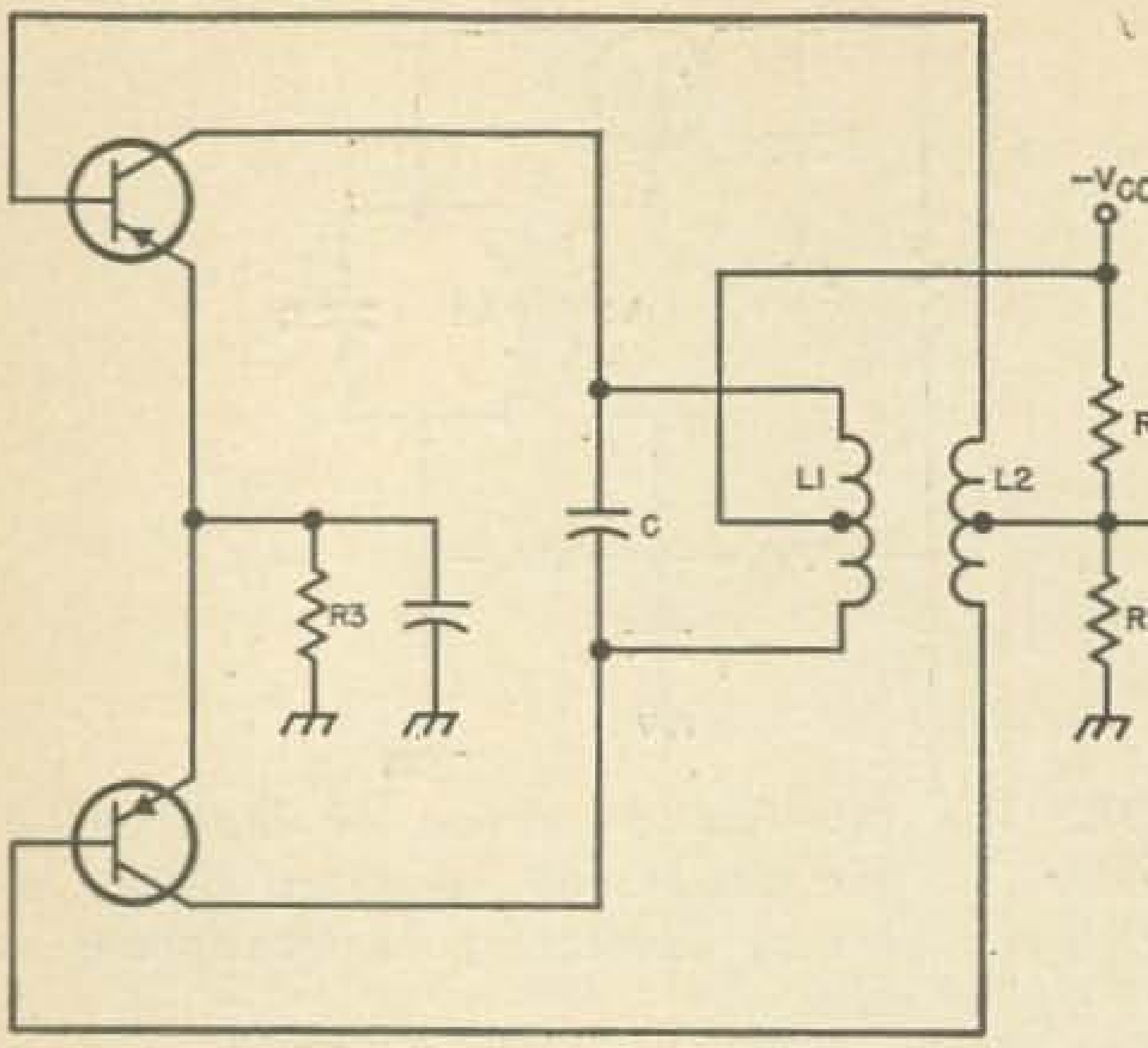


Fig. 15. Push-pull Hartley oscillator. This circuit may be designed for greater power and less harmonic output than single transistor circuits.

oscillator.

Although the inductance in the Hartley circuit is usually a tapped coil, a transformer with separate primary and feedback windings may be used. This particular arrangement allows an additional degree of flexibility in that it is possible to obtain the dc bias from the collector supply *or* from a separate dc source. For higher power output and greater efficiency, the Hartley circuit may be readily modified for push-pull operation by providing center-tapped primary and feedback windings on the transformer. In **Fig. 15** oscillating currents flow in the tank circuit formed by the winding L_1 and the capacitor C_1. Winding L_2 feeds back sufficient energy to the bases of the transistors to maintain oscillation. If the transistors are operated in class B or C, substantially greater efficiency and output power may be obtained than from the single transistor version.

In some respects the design of a Hartley oscillator closely follows that of the Colpitts, but as you might expect, the tap point on the inductor is found in a somewhat different manner. To insure that the Hartley oscillator will start, the value of h_{fe} must be

$$h_{fe} > \frac{L_1 + M}{L_2 + M}$$

In this case, like the Colpitts, the value of h_{fe} used will be about ⅕ the actual h_{fe} of the transistor at the operating frequency.

Unfortunately, this formula contains the mutual inductance factor (M) which is dependent upon the coupling coefficient. And

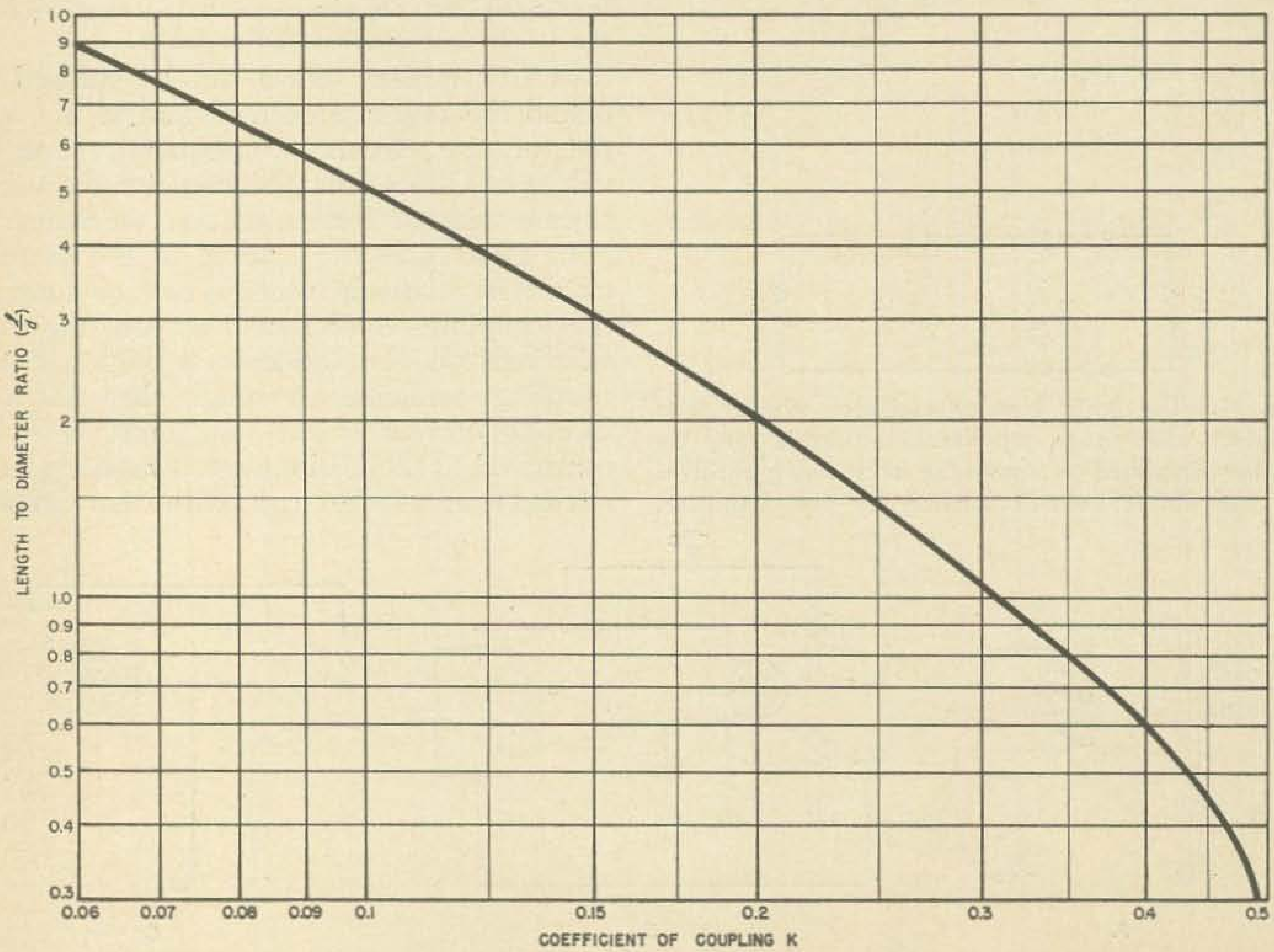


Fig. 16. The approximate coupling coefficient (k) of a single wound tapped coil as a function of the coil size.

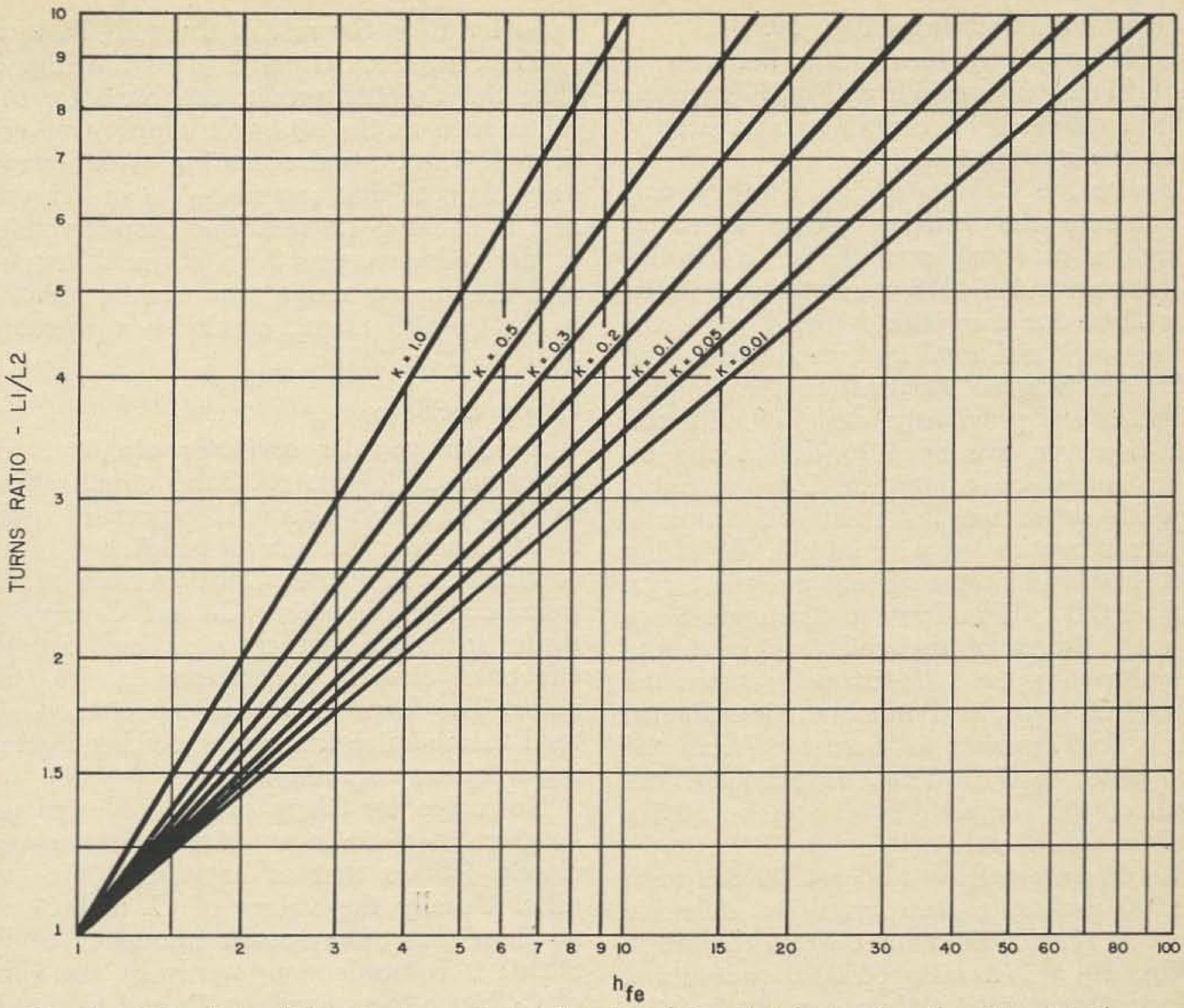


Fig. 17. Graph for determining the tap point on the tuned-circuit inductor in a transistor Hartley oscillator when the forward current gain (h_{fe}) and coupling coefficient (k) of the coil are known.

—the coupling coefficient is dependent upon the size of the coil and the tap point. Because of all the inter-related dependencies, it's a little tough to come up with the proper tap point on the first try, but by approaching the middle from both ends, the graphs of **Fig. 16** and **17** will simplify things.

Once the total inductance is decided upon, the coil can be designed using conventional techniques. When the length and diameter of the coil are determined, the coefficient of coupling can be *approximated* from **Fig. 16.** With this value of coupling coefficient (k) and the *starting* value of h_{fe}, the necessary turns ratio can be found from **Fig. 17.** Although both of these curves are approximations, they will get you into the ball park with an operating unit; the oscillator can then be optimized for maximum efficiency and power output.

With these points in mind, we can come up with recipe for the transistorized Hartley oscillator:

1. Choose a transistor that has an f_T several times greater than the frequency of operation; it should have a value of forward current gain (h_{fe}) of at least 5 at the frequency of oscillation.

2. Design a bias network which will result in the desired operating conditions. Use the manufacturers recommended operating point.

3. With the operating frequency, desired load impedance and required circuit Q in mind, find the proper value of tank capacitance from the nomograph in **Fig. 8.**

4. From the nomograph of **Fig. 6** choose a value of inductance that will resonate with the tank capacitance found in step 3 at the desired operating frequency.

5. Design an inductor that will fit the requirements of step 4; the inductance curves in the ARRL Handbook and the inductance nomograph in the Radio Handbook[3] will eliminate some tedium here.

6. When the length and diameter of the inductor are known, the length to diameter ratio may be calculated and the coupling coefficient found from **Fig. 16.**

7. The required turns ratio between L_1 and L_2 may be found from **Fig. 17** by using the coefficient of coupling from step **6** and the *starting* h_{fe}.

As with the Colpitts design, the best way to illustrate the Hartley recipe is to go through a practical example for a Hartley oscillator with a 2N918 transistor at 9 MHz. Since the same transistor is being used, the bias network and total tank capacitance and inductance will be identical to the Colpitts oscillator we previously designed. In this case, however, we have to design the inductor before we can proceed. By scanning the data sheet, we find that 10½ turns of number 26 enameled wire on a J. W. Miller 4500 form will pretty closely put the target value of 0.84 µH midway in its range. Since the total length of the coil may be found by multiplying the wire diameter times the number of turns, and number 26 enameled wire is 0.017 inches in diameter (from the wire table in the ARRL Handbook), the length of the completed coil will be 10.5 x 0.017 = 0.170 inches.

The diameter of the Miller 4500 coil form is 0.260 inches, so the length to diameter ratio is 0.179/0.260 or 0.69. From the graph of **Fig. 16** a l/d ratio of 0.69 provides a coefficient of coupling of approximately 0.35. From **Fig. 17** a 0.35 coefficient of coupling and *starting* h_{fe} of 4 indicate a turns ratio between L_1 and L_2 of 2.6.

This turns ratio and the total number of turns may be used to find the tap point on the inductor. To find the number of turns in L_2, simply add one to the turns ratio (which gives 3.6 in this case) and divide this factor into the total number of turns. In this example L_2 = 10.5/3.6 = 2¾ turns. Inductor L_1 is the rest of the coil—7¾ turns.

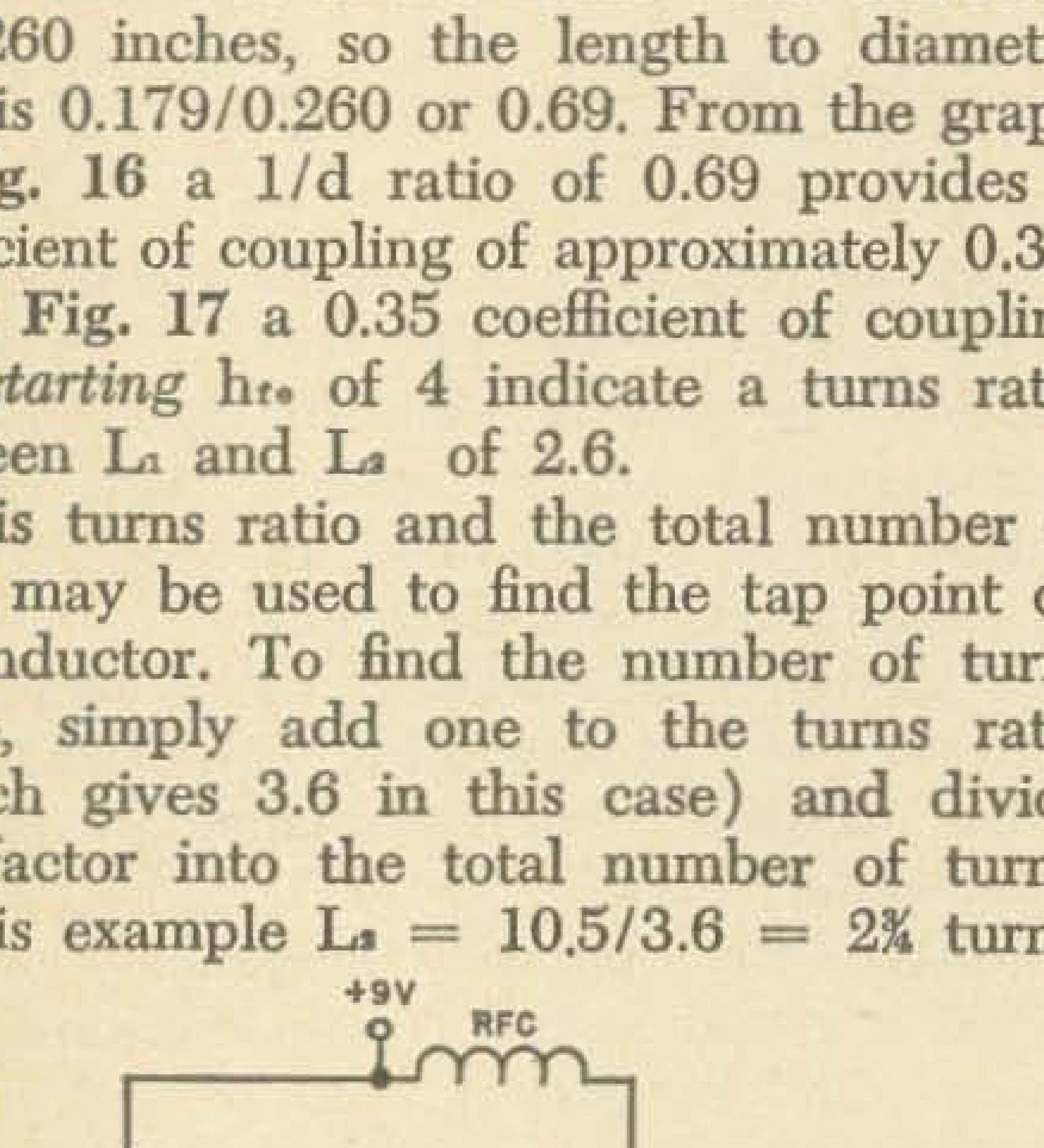
The completed circuit is shown in **Fig. 18.** Like the Colpitts circuit, this oscillator took off as soon as the nine-volt supply was connected. The desired operating condition was very close to that required—V_{CE} of 7.2 volts and I_C equaled 1.8 mA. The output voltage, at the collector, was 3.8 volts peak to peak and the tuning range was almost identical to the Colpitts circuit previously constructed —8.6 to 11.5 MHz.

Clapp oscillator

Another popular oscillator circuit is the series-tuned Colpitts or Clapp circuit shown in **Fig. 19.** This circuit is especially useful to the amateur because in practice it is susceptible to less drift. This is because the tuned-circuit capacitors C_1 and C_2 may be made so large that they swamp out the effects of element capacitance in the transistor. The large values of capacitance also tend to minimize harmonics, further increasing frequency stability.

No recipe for Clapp oscillator design will be given, because in practice the design very closely follows that of its parent, the Colpitts. Usually the values of C_1 and C_2 are so large that the resonant frequency of the circuit is determined primarily by the value of C_3. Since the capacitors C_1 and C_2 govern the amount of feedback, their ratio may be found by using the procedure outlined in step **4** of the Colpitts recipe. The value of C_3 may be found from the nomograph in **Fig. 8,** and the inductance, from **Fig. 6.**

Since the Clapp oscillator is usually used in a VFO, capacitor C_3 is a variable. This is the tough part—to choose a combination of inductance and capacitance (C_3) that will cover the desired range. Although this can



L = 10-1/2 TURNS NO. 26 ON J.W.MILLER 4500 SLUG-TUNED FORM. TAP 2-3/4 TURNS FROM BOTTOM.

Fig. 18. Practical 9 MHz transistor Hartley oscillator designed with the procedure described in the text.

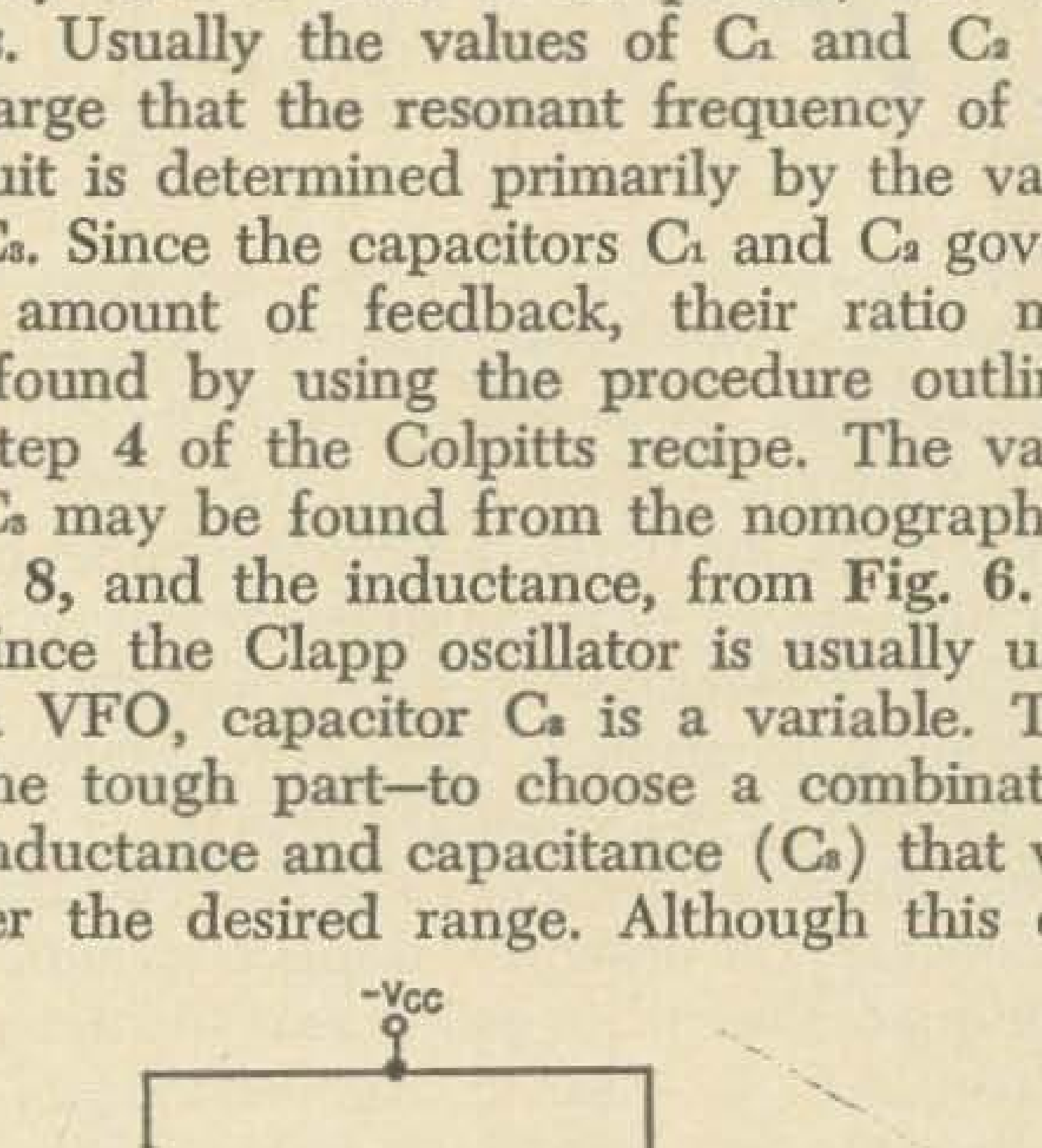


Fig. 19. The transistor Clapp oscillator. Excellent frequency stability can be obtained with this circuit because the capacitors C_1 and C_2 may be made large enough to swamp out any capacitive effects of the transistor.

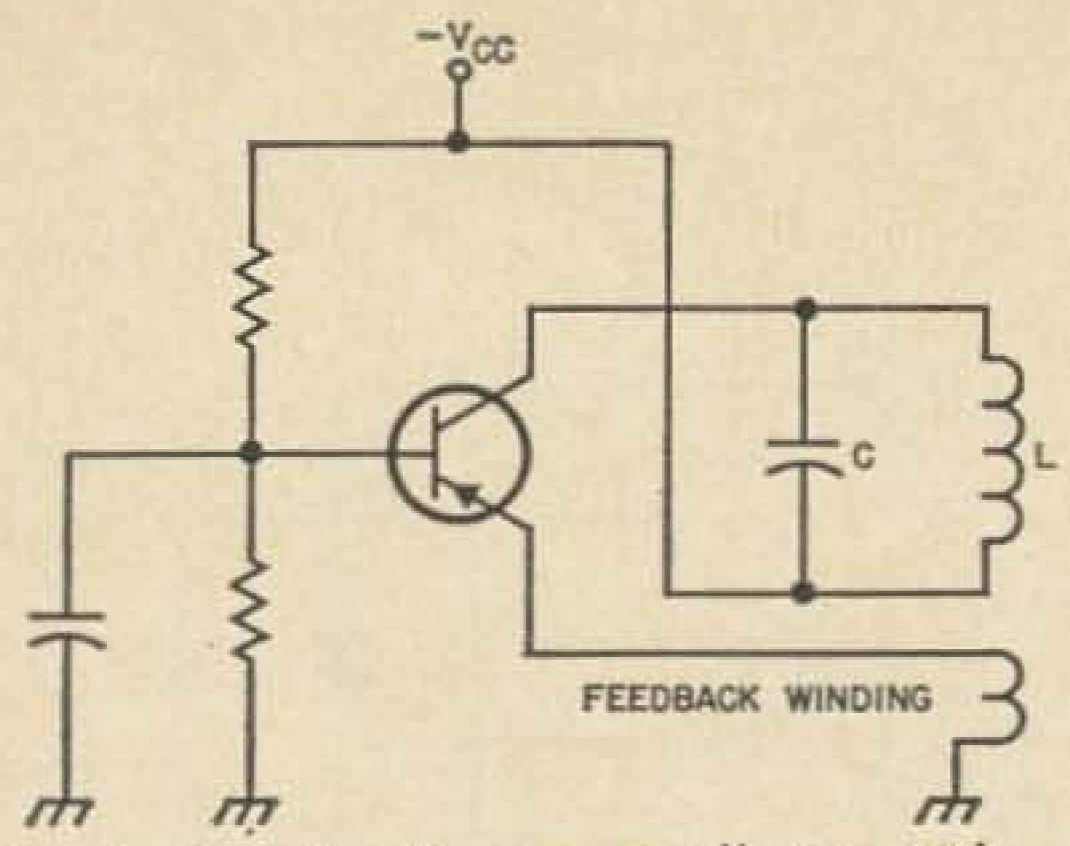


Fig. 20. A tuned-collector oscillator with a feedback winding to the emitter.

be given mathematically, the resulting formula is long and drawn out.[4] The best approach is to design for the center of the required frequency range, and then juggle the values of L and C_3 to exactly what you want. If you use a value of C_3 which is slightly smaller than what your calculations call for, a padding capacitor can be placed in parallel with it to provide the necessary capacitance adjustments.

Other oscillator circuits

In addition to the Hartley and Colpitts circuits, there are obviously many different ways to satisfy the condition for oscillation. In the tuned-base tuned-collector oscillator

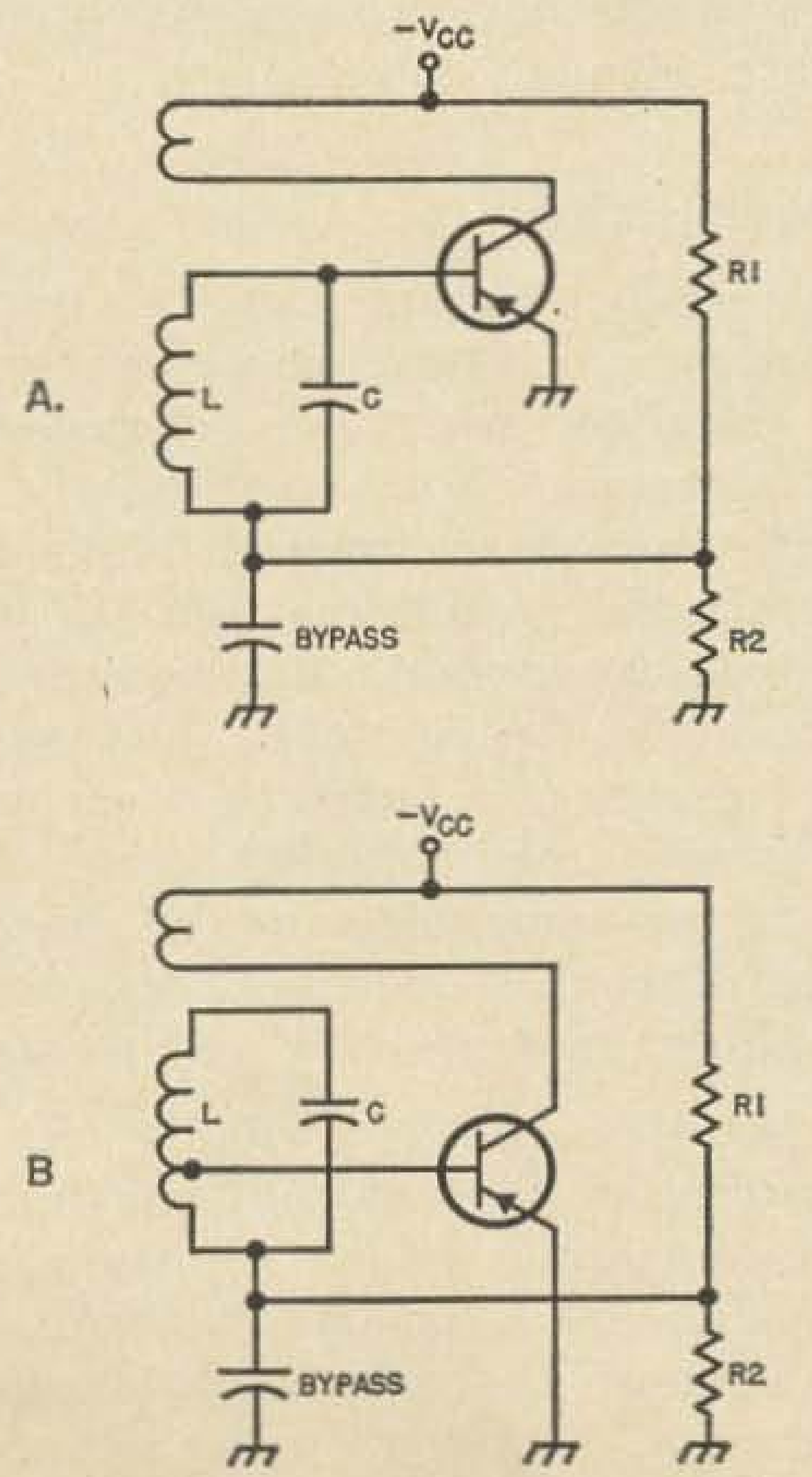


Fig. 21. A tuned-base oscillator with feedback from the collector winding. A better impedance match to the base of the transistor may be obtained by using the tapped inductor as shown in B.

for example, a series LC combination is inserted in both the base and collector leads, which together form the necessary resonant circuit. **Fig. 20** shows an oscillator with the tank circuit connected between the collector and base with feedback taken off the tank circuit by the in-phase feedback winding and applied to the emitter.

In the circuit in **Fig. 21**, the tuned tank circuit is placed between the base and emitter (through ac ground) and out of phase feedback picked up from the collector winding. In **Fig. 21B** a better impedance match to the base of the transistor is obtained by tapping down on the tuned-circuit inductance.

Most of these simple circuits have one very serious disadvantage—the frequency of oscillation is very dependent upon the collector resistance of the transistor. There is some dependence on the transistor characteristics in all oscillator circuits, but in the circuits of **Fig. 20** and **21**, the influence of the transistor predominates.

Colpitts or Hartley?

One of the big questions that invariably arises is what circuit to use in a specific application. In many cases the Clapp oscillator is chosen, particularly for VFO's, because in practice stability is somewhat easier to obtain. For other applications though, both the Hartley and Colpitts find favor. Between these two the choice is more difficult. However, as a rule of thumb, the Hartley is more satisfactory at the lower frequencies, while the Colpitts works best in the high-frequency and VHF range. The reasons for this are quite complex, but they can be explained fairly simply with a couple of block diagrams.

In all transistor oscillators where the tuned circuit is connected between the collector and emitter, the feedback network may be represented by X_a, X_b and X_c as shown in **Fig. 22.** Neglecting circuit losses, the only way that the voltage across Z_i (the base input impedance) can be precisely 180° out of phase with Z_L (collector impedance) is for the reactance X_a to be opposite from the reactances X_b and X_c *and* for X_a to be equal to the sum of X_b and X_c. In the Colpitts oscillator X_b and X_c are inductors and X_a is a capacitor. When the circuit losses are neglected, at resonance the input impedance of the feedback network in **Fig. 22A** appears as an infinitely large resistance.

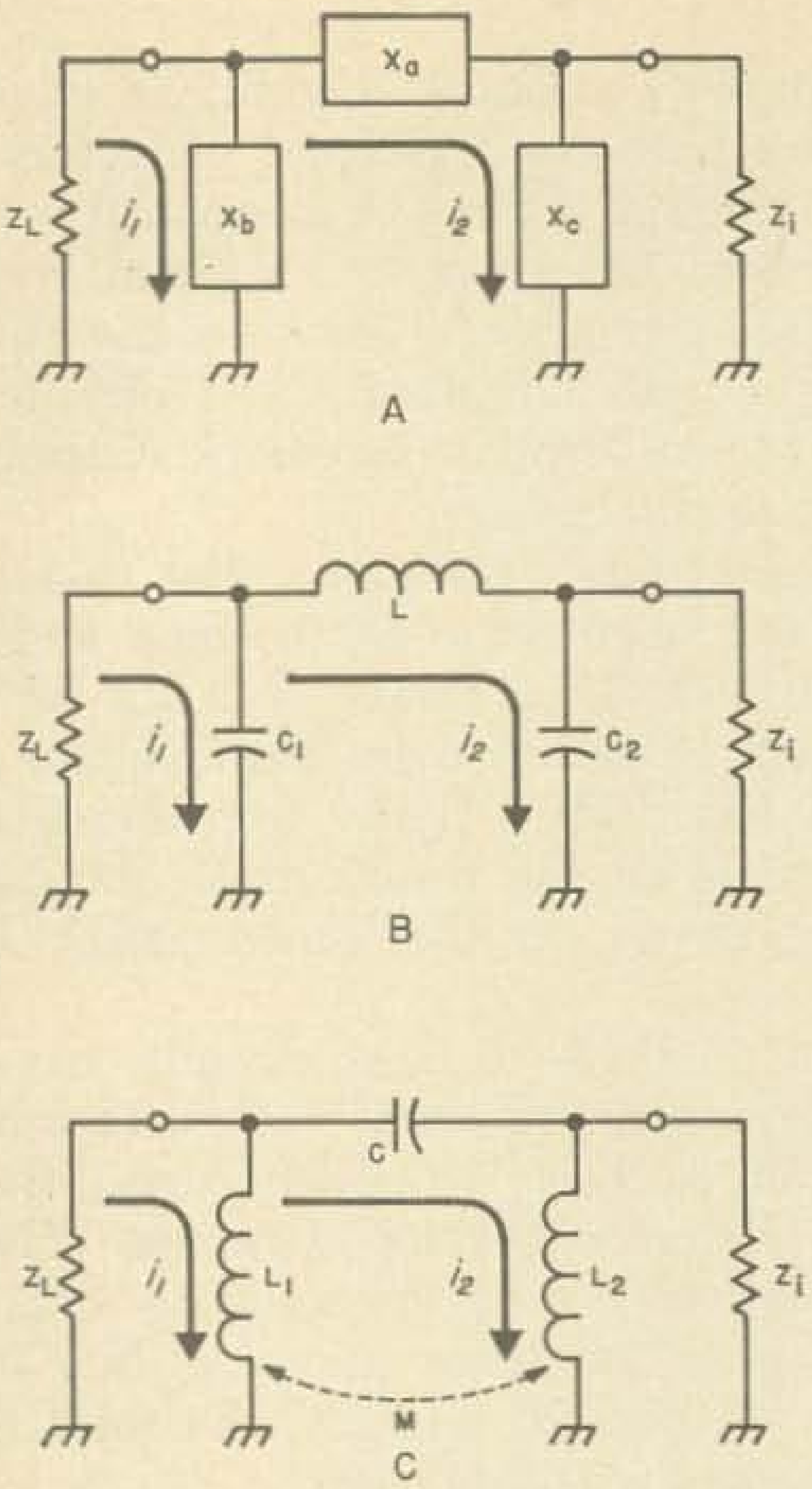


Fig. 22. The current flow in the feedback paths of the Colpitts and Hartley oscillators is shown in B and C. The general case is illustrated in A.

However, in a practical circuit there is base loading, series resistance in the tank coil, loading due to power being coupled from the circuit and the impedance is *not* purely resistive. In a practical Colpitts oscillator for example, the feedback circuit would be represented as shown in **Fig. 22B**; Z_L is the output impedance of the transistor, while Z_i is the input impedance. In this circuit currents i_1 and i_2 are not exactly the same magnitude or of opposite phase as in the ideal lossless circuit. The loading of the base circuit (Z_i) causes the current i_2 to *lag* the collector driving voltage across Z_L by less than 90°; hence the base driving voltage *lags* the collector driving voltage by something less than 180°.

On the other hand, in the Hartley circuit represented in **Fig. 22C**, the base loading causes the current i_2 to *lead* the base driving current by less than 90° and therefore the base driving voltage *leads* the collector voltage by less than 180°.

In the Hartley oscillator the effect of circuit losses and transit times are accumulative, but in the Colpitts circuit these effects tend to offset one another. The fact that the base driving voltage through the Colpitts feedback circuit lags the collector voltage partially compensates for the effects of transit time. For this reason the Colpitts oscillator is somewhat superior to the Hartley circuit at the high and very high frequencies.

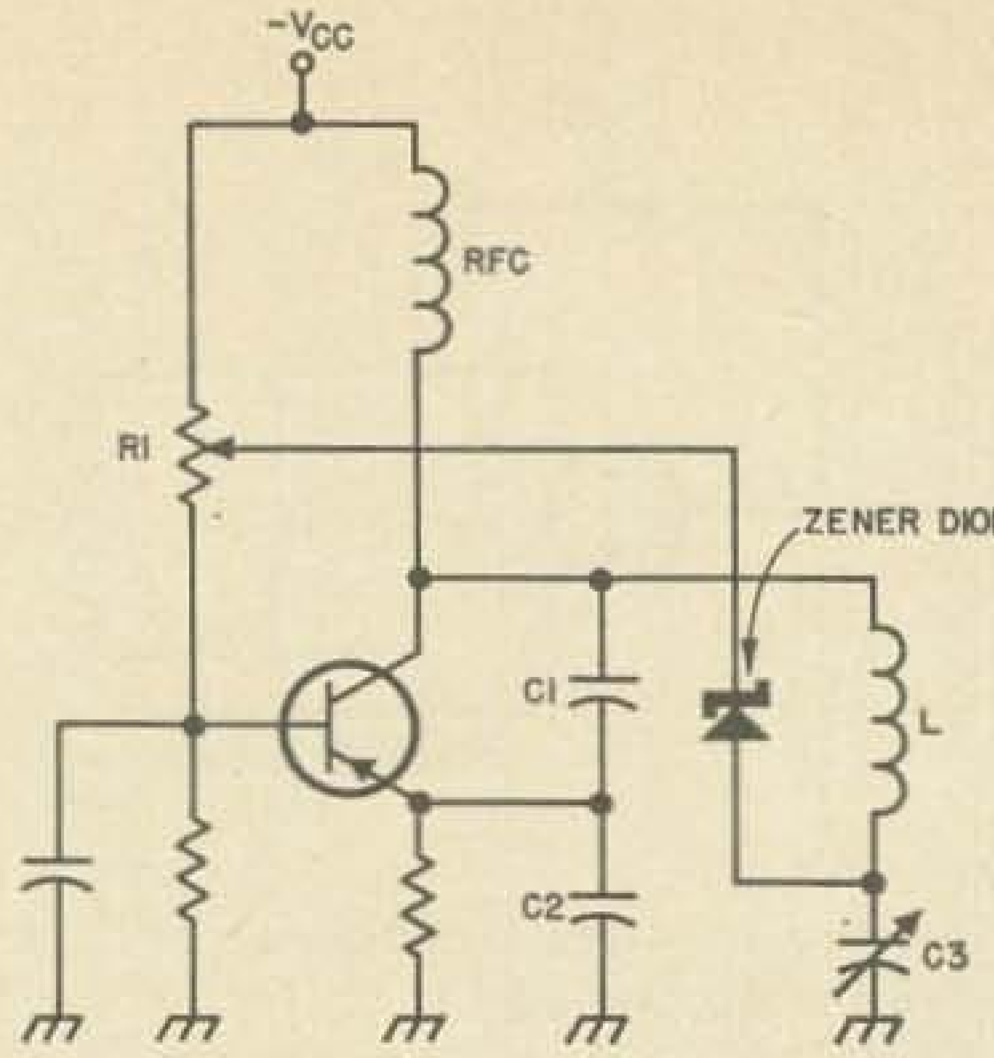


Fig. 23. Connecting a zener diode across the tank circuit of a Clapp oscillator to obtain output stability.

Oscillator requirements

The requirements on any oscillator circuit are varied, but in addition to frequency stability, there are several important characteristics which serve to specify the performance of any particular circuit. Perhaps most important of these are amplitude stability, harmonic content, output power level, efficiency and noise output.

Amplitude stability

It is usually desirable for the output signal to remain constant within certain limits as the transistor and other components age during operation. This is particularly a problem with variable frequency oscillators, but fortunately the output may be stabilized in most cases by one of the techniques described below. Theoretically, the amplitude of the voltages and currents in an oscillator will become infinite unless some limiting action occurs somewhere in the circuit. The nonlinearities which will limit the amplitude of the output in a practical circuit are:

1. Limitation of the available dc voltage or current by the capability of the supply.
2. Nonlinearities in the transistor.
3. Nonlinearities in external loads. This is true because the external loads are often a function of voltage and current; above a certain amplitude their values change so that the condition for oscillation is no longer satisfied.

In any case, the amplitude of oscillation will build up until it is limited by one of these three basic limiting mechanisms.

When the oscillator is designed for high efficiency and the output voltage nearly equals the supply voltage, variations in the supply will cause fluctuations in output power. These fluctuations may be eliminated by stabilizing the supply voltage with a zener diode.

Another technique which is slightly more sophisticated has been successfully applied to variable frequency oscillators (**Fig. 23**). Here the output is compared to a reference diode and the difference fed back to the transistor. Whenever the ac voltage across the capacitor in this Clapp oscillator exceeds a value determined by the variable resistor R3, the diode conducts a compensating base current and reduces the output amplitude.

Harmonic content

In many applications it is desirable to restrict the output power of the oscillator to one single frequency. In other cases harmonics are desirable for frequency multiplying. There are always certain nonlinearities in an oscillator circuit which give rise to signals as multiples of the fundamental. The harmonic content depends on many factors and is as difficult to control as is stability, but primarily it is dependent upon the nonlinearities in the circuit and the filtering action of the tank capacitance. If very low distortion is desired, push-pull operation in a two-transistor oscillator may be advised. On the other hand, nonlinearities may be deliberately used to produce frequency multiplication. This is done by incorporating another tank circuit into the oscillator which is tuned to the desired harmonic.

Output power level

The maximum power output from an oscillator is important in many cases, as well as the maximum voltages and currents available within the limitations of stability and harmonic content. The requirements for frequency stability and harmonic content are closely connected with the power, voltage and current-handling characteristics of the transistor used in the circuit.

The conversion efficiency of the transistor oscillator depends primarily on the class of operation and increases as you go from class A to B to C. However, the circuit must be initially biased somewhere in the active region to insure that the oscillator will be self-starting. With most transistors, efficiencies of about 50% in class A, 78% in class B and 80-90% in class C may be expected.

A bypassed emitter resistor permits class C operation in a manner somewhat similar to the grid-leak method used with vacuum-tube oscillators. An average voltage builds up across the emitter RC combination that provides reverse bias for the emitter diode. With an initial operating point near cutoff, rising oscillations will first result in clipping at the low-current end of the load line, and eventually the buildup will be limited by the nonlinearities at the high current end; the operating point will eventually lie in the cutoff region.

The efficiency of an oscillator is reduced by the dc losses in the resistors of the bias circuit and is tied in very closely with the required operating point stability and ease in getting the oscillator started. AC losses in the resonant tank also reduce efficiency, and a high *unloaded Q* in the tank circuit is desirable. To obtain high efficiency it is necessary in all classes of operation to utilize as much of the available dc supply voltage as possible, with the peak ac collector voltage being equal to approximately 90% of the supply voltage.

In addition, the output power delivered by the transistor to the tank and load must be high. This means that the load impedance seen by the transistor must be designed to be as close as possible to the matching impedance for the transistor. If the output power from the oscillator is specified, then the supply voltage should be only a few percent higher than the ac voltage swing necessary to deliver the required power into this approximately matched load impedance.

Unfortunately, the requirement for high efficiency will lead to low Q of the *loaded* tank circuit. This may cause poor frequency stability and a compromise must be found.

Noise output

In many applications it is very important to keep the noise power from the oscillator at a minimum. This is particularly true in VHF converters where a minimum of noise should be injected into the mixer.

Noise in the transistor also effects frequency stability—the initiation of oscillation is a result of thermal and other forms of noise shock-exciting the oscillator circuit,

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changing the over-all amplification and affecting the phase stability at the same time. Consequently, in oscillators that must meet extreme frequency stability requirements, the transistor must be very quiet at the operating frequency. In addition, the operating conditions should be selected to introduce a minimum amount of noise.

The design of transistor oscillators is not particularly amenable to a paperwork design, followed by building an optimum circuit on the very first try; in all cases the design must be accompanied by some experimental cut and try. The frequency of oscillation, the desired power output, and other requirements, such as frequency and amplitude stability are required with fluctuations in supply voltage and transistor perameters over certain temperature ranges. However, experience has shown that the following general procedure provides best results:

1. Select a transistor capable of the desired power output and exhibiting sufficient gain at the frequency of oscillation.
2. Select the type of oscillator circuit to use.
3. Establish the bias point and design a bias network with the necessary degree of stability. The bias point may be subject to change later to improve efficiency by shifting operation into class B or C.
4. Design the tank circuit using the given formula and design nomographs.
5. Try varying amounts of feedback to optimize efficiency; vary the operating point to achieve class B or even class C operation without sacrificing ease in getting the oscillator started (the emitter junction must not lock in the reverse-biased condition).
6. Use a slug-tuned coil or trimming capacitor to make final adjustment, if necessary, of the frequency of oscillation.

. . . W1DTY

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Gus: Part 26

Tristan de Cunha

When last month's episode ended, I was on board the South African ice breaker, departing Capetown for the first scheduled stop at Tristan da Cunha. Jack (ZS1OU) and I had gone aboard the ship a few days earlier. We had installed the gear in my little stateroom and it was ready to go. I watched the city of Capetown slipping away in the distance as we headed in a general Northwesterly direction.

After about an hour or so, the Captain said it was OK to use the radio gear, so I headed back to my little room, turned on the rig, re-calibrated the receiver and transmitter at 14100 kHz, then checked the SWR. It read almost 1:1 so I was all set. Out went the first CQ signing W4BPD/MM and I was back in business again. The boys were all there, no East Coast fellows to be sure, because the band wasn't open to them, but a goodly number of W6's and some W7's called. They all wanted to know when I expected to arrive at the island. I could only make an educated guess at this time, so I told them the approximate time. Then the Europeans began calling and all the info had to be given out again. This kept up for a few hours and since I was in no hurry, I took it easy and gave them all the answers they requested.

When the little pile-up died down somewhat, I decided to take a walk around the ship and meet all the crew again. I wanted to get to know them better and to see what kind of work each fellow was doing. The last one was the wireless operator. He was all shut off by himself in his little poop-deck. We had a long eye-ball QSO and I had a good chance to look over his Japanese built radio gear. It was beautifully built and seemed to work very FB. The nicest part was that I had no interference from him on the ham bands, and I didn't cause him any QRM either. This meant we could both operate at any time without bothering each other. Later I found that this is not usually the case when you set up a ham rig on a ship.

The ship had been built in Japan about five years before, so as far as ships go, it was practically a new one. The old diesels ran as smooth as a new Swiss watch. While on board the ship, I used to hang around the engine room looking at those two big diesels. Each one was about the size of an automobile and they purred like kittens. As near as I can remember, their cruising speed was about 300 RPM and I was told they usually last a lifetime.

It was always interesting for me to sit and look at the Radar on board the ship. It would even spot whales and waves in the distance if the gain were turned up. Then the depth finder was another item I found interesting. It would show every hill and vale down below the ship and it would even spot a school of fish now and then. Large fish could be easily seen and I believe if one were to study it for a while, he could tell the size of some of the larger fish.

Listening to the sounds from that depth finder made my flesh crawl. They were some of the wierdest sounds I've ever heard. You could hear the reflected echo from each of the objects shown on the CRT screen. This was something I had never observed before in my life and it always attracted me when I had nothing to do, especially late at night after the last cup of coffee. I had brought about five cases of Cokes along with me and I always kept a few of them in the ship's "Fridge", as they called it. Some nights it was coffee, other nights Coke—sort of depended on the mood I was in.

I spent many hours of the night sitting up on the top deck looking at the strange arrangement of stars overhead in the Southern Hemisphere, with the Southern Cross about 45 degrees above the horizon. During the early morning hours quite a few whales were spotted and each of them took a nose dive, straight down, as the ship approached. They were really some "whoppers" too.

Listening across the bands, when there was nothing else to do, was always interesting, especially if someone was talking about me. It did sort of shake them when I would break in and say, "Hey, Ole Buddy, you had better be careful, I am a lissenin' to what you say".

I had plenty of time to just sit and reflect and ask myself why I was down here, away from all the comforts of home and my nice family . . . especially sweet Peggy. The more a DXpeditioner thinks about it, the more he is convinced that the fellows back home in the air conditioned houses or apartments are actually getting more enjoyment out of the DXpedition than he is. It's like I have always said, the fun is in the chase, getting in the pile-ups, working that elusive and rare DX, then going in and telling the XYL about it . . . and she sometimes saying, "So what?". I am sure the only one who can appreciate the thrill of working a new one is a real DXer. The 75 meter rag chewers cannot understand all this, and you are wasting your time trying to explain to one of them how it is with you. But, you know, if every ham was a real DXer, the bands would be absolutely unusable. Can you picture the mess if the pile-ups were about 10-15 times as high as they are? The poor DXpeditioner would go stone crazy and would not make as many QSOs as he does at each stop.

Every chance I got, I would go on the air and sort of keep a running account of how we were approaching our goal—Tristan da Cunha. The South Atlantic seemed, on the entire trip, to be in a mean mood. There were never any of those near calms you sometimes see around the Seychelles in the Indian Ocean. Mind you, this was Summertime, so I can just picture what it must be like during the winter season down there. They tell me it gets pretty rough during those months.

One nice thing about being at sea is the superb conditions and the late hours the bands stay open. I had observed how early the bands closed when I was operating from ZS1RM. They closed just about the way they do in the USA, but it was a completely different story at sea. I hoped the bands would be like this when I finally got ashore at the places I was heading for.

I noticed that when the wind blew from the Southwest at night it got downright chilly. Even during the daytime, it was too cool and too windy to enjoy yourself on the deck chairs. I suppose that cold air over Antartica must have had it's effect even at this distance from it.

Big schools of fish could be seen at all times, and I was amazed at the number of birds which could be seen from the ship all day long. Many of them seemed to be following the ship. Maybe they were lost and figured we would sooner or later bring them to land.

Food was no problem on the boat. There was plenty of good eating at every meal. Occasionally the crew had some beer. The Captain and First Mate treated me royally and I got almost everything I asked for. I was their guest and they really knew how to treat a guest. Maybe one of these days I will get a chance to go with them again. I would take them up on it tomorrow . . . maybe I should get a letter off to them one of these days, eh?

I have found that if you are friendly when you are away from the USA, everyone is then your friend. If you act "snooty" (like some people still do) then they know how to treat you. You can get "red taped" to death when you are at their mercy overseas, you know. So, Ole Buddy, take it easy over there. Be friendly to everyone and everyone will be friendly to you. Things will go much more smoothly for you. I think most people in the world want to be friendly and if you act right and say the right things, they will go all out for you when you need them.

This really pays off aboard a ship. If you like to eat, always make it a point to be on friendly terms with the head cook. Then you can always visit the galley at any old hour and get a real good handout, or a fresh cup of coffee, and you can get him to cook little things especially for you.

I got to know the three men who were going to Tristan da Cunha. They were part of the island's population which was forced to leave when the volcano exploded a year or two before. They spoke a very odd type of English, but were very friendly. They told me about someone else who had operated a ham station from the island some years earlier. The trip to the island took about 4 or 5 days. The days seemed short to me, since something was going on every day. It seems like yesterday to me, sitting here writing all this some years after it happened. Right now, I can almost hear those wierd sounds of the depth sounder going on all day and all night. I wonder how many of the old crew are still with the ship . . .or even if they are still using the same ship.

One morning the birds became more numerous than usual, and the ship's intercom announced that Tristan was being approached. In another hour, what appeared as a few mountains sticking up out of the water was seen on the horizon. There was a little smoke coming from one of them. The men from Tristan da Cunha became nervous and big smiles came over their faces. They began shaking hands with everyone. They were coming home after being away for a long time. As we came nearer, I could not understand how anyone would be anxious to get back to such a dismal looking spot. But it was home to them, I suppose, since each of them had been born there and had lived most of his life on those rocks. As for me, I sure would hate to know I had to spend the rest of my life on such a miserable island as this.

The ship anchored about half a mile off shore and a few small boats were placed in the water for some of the crew to go fishing for rock lobsters. Rock lobsters are very numerous in that part of the South Atlantic. The large landing boat was lowered and the three islanders, the first mate, three of the ship's crew, and I boarded the craft. We were lowered to the water and then headed for the island.

As we approached, I could see that it was even more desolate than it looked from the ship in the harbor. The color of the soil was almost black as coal and the spots where the lava had streamed from the volcano looked like frozen liquid coal. There were three or four streams of this lava which had flowed down to the sea from the volcano. I'll bet this was a sight to behold when it was actually taking place.

When we landed, the three men headed for their homes which were still standing. They went all over the place looking into the other houses. While this was going on, I was trying to figure out the best spot to put my antenna and which house to use as my ham shack. I discussed this with the First Mate, and that's when he told me they were planning to leave there the next morning, at the latest! The Tristaners decided they would stay, so when we got back to the ship, all their posessions, even a few goats and sheep, were loaded into the landing craft and they went back to the island after shaking hands with everybody. I stayed on board the ship and went on the air to tell the fellows where I was and what we were going to do.

The fellows who had been fishing came back with a few rock lobsters and some nice looking fish. In the distance, we saw a ship approaching us. The fellows with the signal light got busy and had a QSO with them as they neared our boat. They pulled up alongside us and their Captain and First Mate, along with a few members of their crew, came over to our ship. We all went into the dining salon for a few cups of tea. They were in need of a few items in the food line, and a few drums of some kind of oil. In exchange for this, they gave us between 500 and 1000 pounds of rock lobster.

Their ship was one of two which stay in the waters around Tristan da Cunha many months of the year to fish for rock lobster. They had had a good catch, they said. They were practically a floating refrigerator and, when they were fully loaded, could carry many tons of lobsters. They take their boats back to Capetown when full, and most of these lobsters are then shipped by air to the USA. Their crew was a very rough looking bunch and hard as nails. These fellows had been following this business a long time, I was told.

We departed for Gough Island at about sundown. Everyone had a big plateful of rock lobster for dinner that night. Needless to say, they were delicious.

Just before darkness set in was the last view I had of Tristan da Cunha with the little stream of smoke still coming from the smoldering remains of their volcano. I seriously doubt if I will ever again see this island.

Later, I read in the newspapers that all the inhabitants who fled the island during the eruption had returned there. Then sometime last year I read that many of them wanted to leave again. I suppose their sample of modern civilization had spoiled them. As for myself, I don't see how anyone would ever want to live on that cold, damp, bleak patch of rocks sticking up out of the cold South Atlantic in the first place. I don't think the wind ever stops blowing, and it seems cold all the time, even in their summertime.

. . . W4BPD

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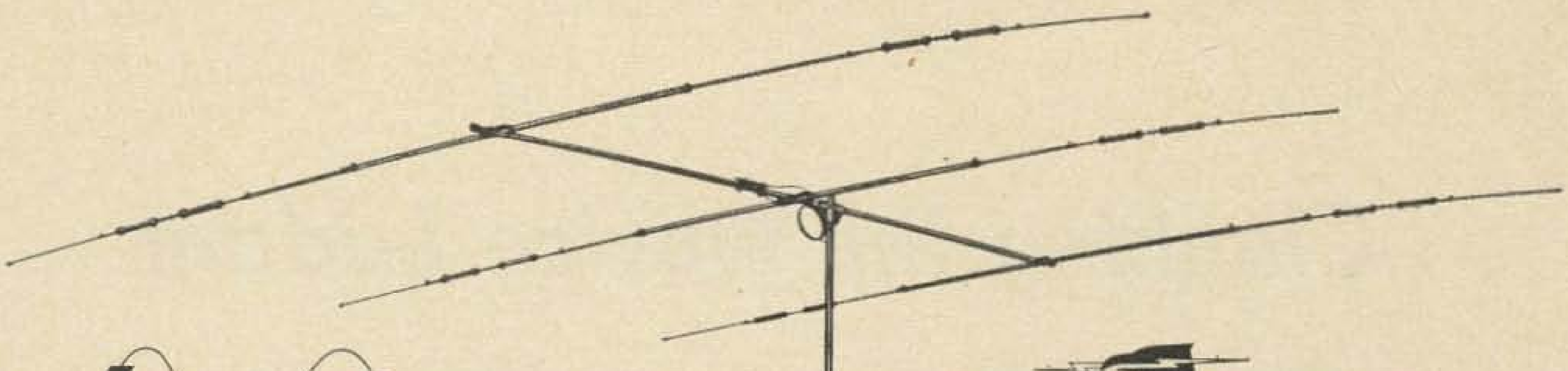

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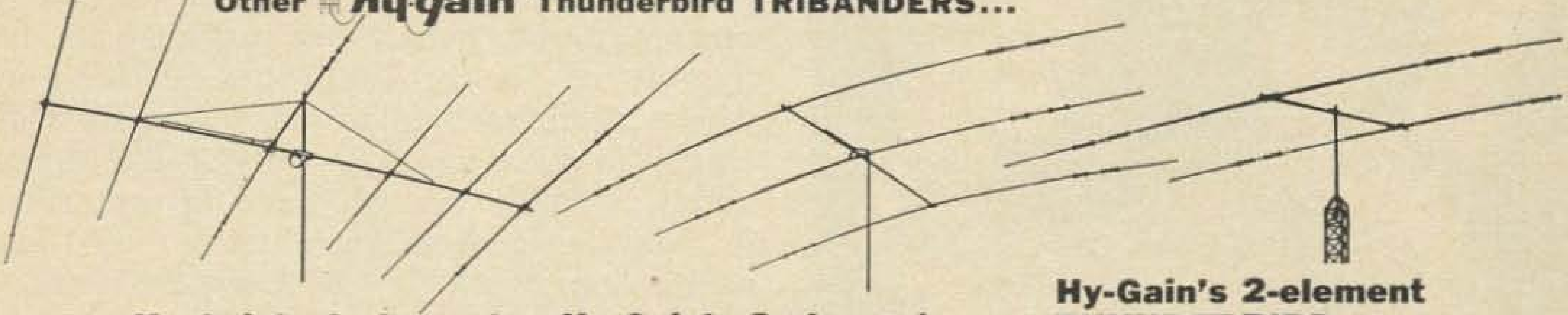

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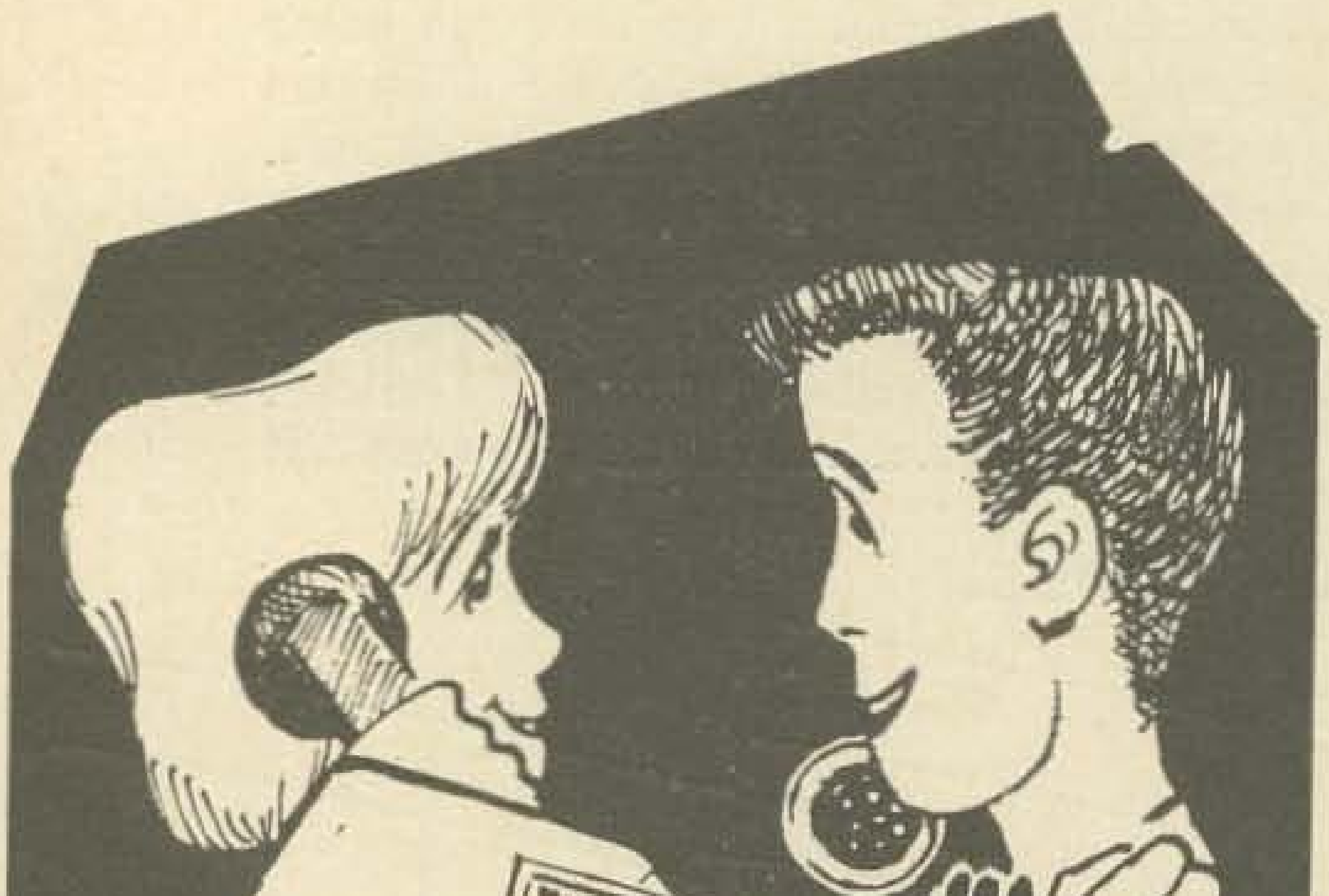
Climbing the Novice Ladder

Part IX: Happy day! Joe and Judy are licensed!

The month just passed had been full of activity for Judy and Joe. School had commenced for both and Joe had begun his employment at the supermarket on Saturdays. Judy's evenings had been spent mostly between school homework and familiarizing herself with the ham bands through listening on her little CONAR receiver. She had experienced greatly improved reception on all bands since hanging a good 80 meter dipole. As she gained experience in tuning adjustments, her code ability gradually improved through her many hours of listening. She began to pull in some real DX stations occasionally . . . VK's, JA's, ZL's and a few G and D stations she was able to identify. Judy was already on her way to becoming an accomplished novice operator even before she could legally put her transmitter on the air.



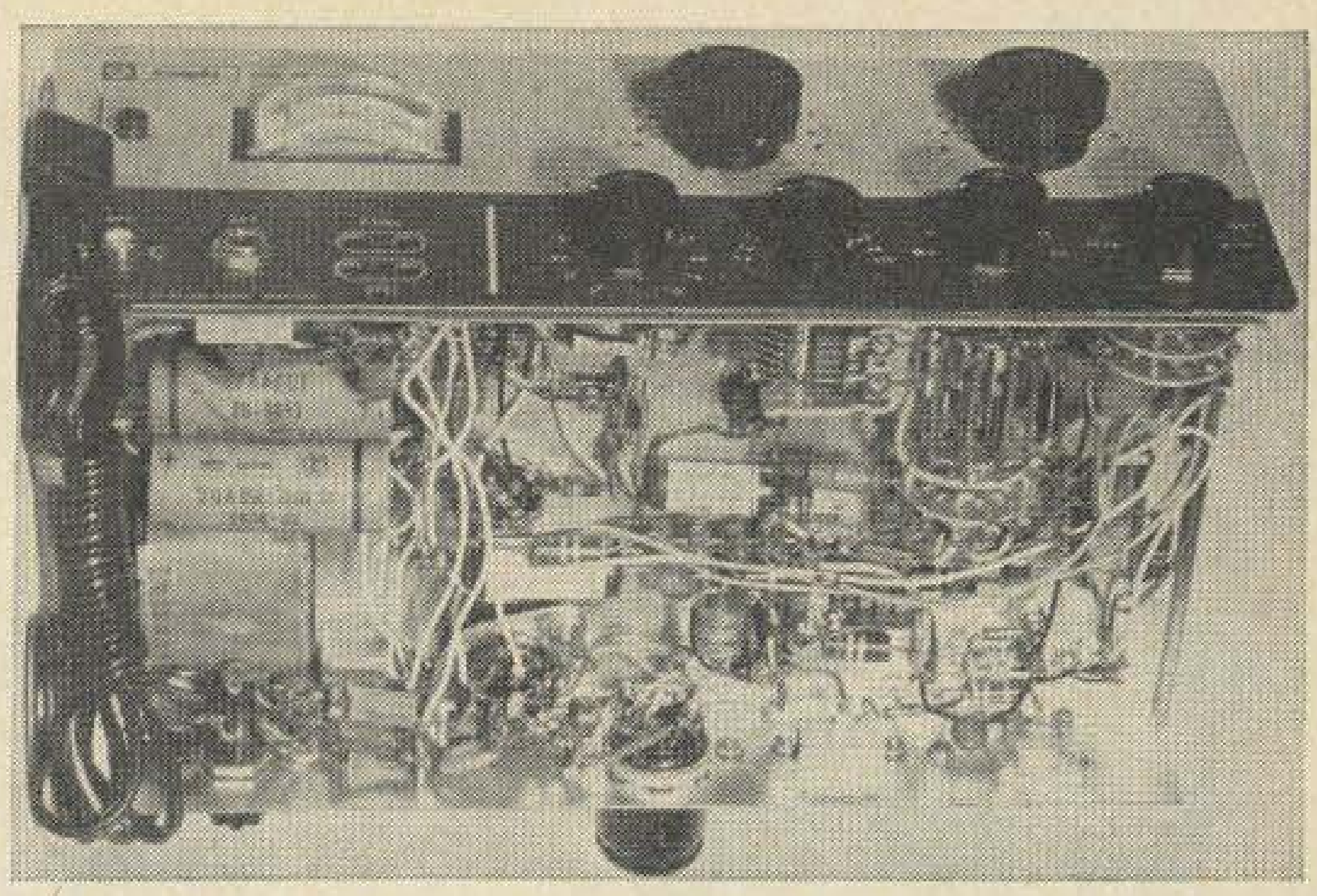
Their novice licenses arrived simultaneously!

Joe too, had not been idle. He had given up his evening paper route when his new job at the market had materialized. Rushing home from school each day he would first accomplish his home work assignment and then make for his little basement corner where his father had installed a small work bench. Progress on his Knight-Kit T-60 transmitter assembly was good and he was but a few days away from an initial test by Larry with a final check by FN. Larry had been a frequent drop-in visitor while Joe was working on the rig and had given him a number of hints and tips which helped ease the construction path. Larry's college would not commence for three more weeks, so he wasn't yet burdened with studies and could devote considerable time to Joe.

And then, to climax the month's activities, both Judy and Joes' formal official licenses as novice class amateurs, complete with call letters, arrived simultaneously! Excited rejoicing and an overwhelming eagerness to get on the air electrified the atmosphere at both of their homes. As the licenses had arrived on a Thursday, Judy was forced to wait until Saturday when FN had promised to come over and help her get set up to transmit. As much of the initial installation, tune-up and adjustment procedures would necessarily be repeated by Joe when he finished his transmitter, he was invited to Judy's place to participate in her inauguration into the realm of transmitting hams. Completion of Joe's rig had been delayed because, in his haste to complete it, he had made a couple of significant wiring errors which Larry had caught and pointed out to him. The instruction book had been perfectly clear, but in his eager haste, Joe had been a bit careless; he was now engaged in rectifying the errors.

On the appointed Saturday morning FN, Judy and Joe gathered in Judy's shack. This had originally been just a 'catch-all' storage closet on the second floor near her bedroom. Her mother had been cooperative in removing such odds and ends as had been stored there, relegating them to the attic. Judy's Dad, Tom, had done a bit of patch-work on the closet walls and built a neat little operating desk at one end and Judy had painted the interior. Fortunately the closet contained a good sized window and Tom had provided additional lights and electrical outlets; Judy came up with a real neat shack . . . really 'groovy' as Joe termed it.

FN opened the session with, "Well, kids, there isn't much to do in here now. Your Dad has the coax feeder to the antenna run in and you've already got a ground wire to the cold water pipe in the bathroom. Tom, I'm glad to see that you provided a couple of outlets right here at the back of the operating table; won't have to drape straggling lamp cord about the room. You have your transmitter sitting in just about the right spot for you Judy; you're right handed so the transmitter should be at the right as you have it. This will leave your other hand free to manipulate the receiver for minor adjustments when you're copying someone. You won't need to touch the transmitter ordinarily while you're working another station, so your right hand will be free for keying." "OK Gramps . . . here's the coax feeder . . . I already have it skinned . . . let's get going, shall we?" Judy cut in. Both Tom and FN laughed and FN said, "Goodness girl, don't rush me; let me get my trusty briar fired up first; never could make a good connection without a nicely drawing pipe". Filling and lighting his pipe took but seconds and then FN removed the



Joe's little T-60 rig in the final wiring stages. Later FN showed him how to lace and cable the loose wiring into a neat harness.

coax from its' connection to the receiver and said, "Now where's the little knife switch I told you to get for the antenna change-over Judy?". "Right here Gramps," she replied, opening a drawer which Tom had thoughtfully built in to the desk. "And now Tom, a couple of round-head wood screws . . . about #6, half inch long will do." "Yep, got lots of 'em in the shop Dad; I'll grab a couple . . . anything else we'll need?". "Yeah, bring a screw-driver too unless your thumb-nail is that good," FN chuckled. "I brought my little pocket tool kit but I left the screw driver on my bench for some reason".

Tom returned in a few minutes and FN then proceeded to fasten the little single pole, double throw porcelain base knife switch to the table about midway between the transmitter and receiver. He connected the coax from the antenna to the center blade of the switch and the pigtailed braid to Judy's ground wire. "Now", he said, "we had several feet of coax left from the antenna installation didn't we?" Again Judy pulled open the drawer and said, "About six feet Gramps; I coiled it up and saved it to start my 'junk box'." "Good girl Judy, that's plenty. Now suppose you kids cut a couple of pieces of coax to reach from the transmitter and receiver to the switch, skin both ends and connect them up. While you're about it, better move your key over closer to the transmitter Judy . . . you've mounted it for code practice so that the switch now crowds it . . . about six inches to the right will be better. Meanwhile, Tom and I will go down and see if we can wheedle a cup of coffee from your ma."

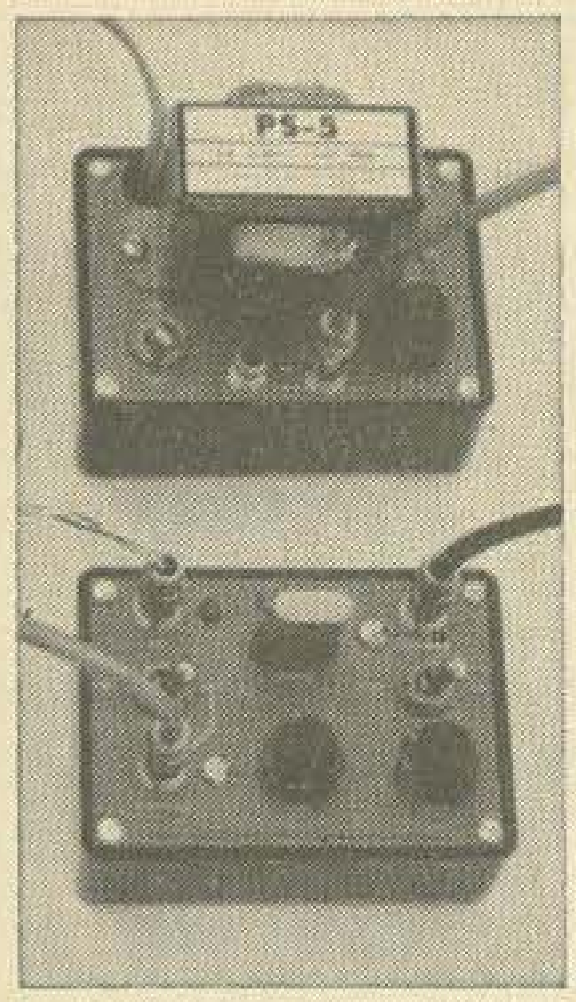
When FN and Tom returned to the shack, the coax lines were in and FN complimented the youngsters for remembering to connect

. . . You can't drive a car with an empty gas tank . . .

the coax shield braid to the ground screws on the equipment and to the ground wire at the switch. Judy was making up a cord and plug for the key jack on the transmitter. This finished, she handed it to Joe who connected the open ends to the key, then plugged the cord into the jack. "That does it, kids," FN announced, "we're ready for the first blast. Plug in the transmitter power cord Judy . . . good; I'm glad to see you checked the panel switch first to be sure it was in the 'off' position; thats' one little lesson that got through to you, eh?". "Yes Gramps, I've been doing that with my receiver since you told us about playing it safe so it's just about a habit now." "All right", said FN, throw your antenna switch to the 'transmit' side now and turn on the power at the transmitter switch. Give the tubes a minute to warm up . . . that should do it. Now with the meter switch on 'plate' press the key Judy and watch the meter. If the needle hits the pin at miximum, and no doubt it will, quickly turn the final amplifier dial to find the 'dip' spot; you've left the load control at minimum which is correct at this time. Remember to tune the final quickly to save the meter and maybe a tube. Ready? Go to it!" This wasn't too difficult; Judy had been industriously reading the adjustment procedure section of her instruction book ever since her license came but to her surprise, the meter showed *no* reading! "Gramps, what did I do wrong?" she anxiously inquired. FN chuckled as he said, "It's not what you did *wrong*, Judy, it's what you *didn't* do that made the difference! I wondered if either of you would catch it but guess you're too excited. How about plugging a crystal into its' socket so the final amplifier gets something to work with; you can't drive a car with an empty gas tank you know . . . you *did* pick up a crystal didn't you?" "Yep, got one at Jim Turners . . . 3720 kilohertz . . . that OK?" and again she dipped into the drawer and brought forth a conventional mounted crystal in a standard amateur holder. "That's fine Judy, it's almost the center of the band and a safe distance from either edge; anybody else in town with the same frequency?" "Only one FN," Joe chimed in, "we checked at the club and one of the fellows over on the west side has 3720, but he's taken his General class exam and hopes to have his license soon and then he says he'll sell me his novice crystal and Judy and I can work together on the same frequency. I'm going to buy another crystal too so I won't bother Judy when she's working other stations". "OK" said FN, "you youngsters seem to have things pretty much under control then. Now Judy, plug in the crystal and hit the key and lets' see what happens. Now you get a full scale reading . . . that's it, dip the final and you get 40 milliamps. Move your loading adjustment up a couple of points then dip your final again . . . there, you get 70 mils now . . . give it a couple more points and do again. Whoops . . . that hits 115 at the dip; better keep it at about 100 to prevent overload. Go back one point on the loading knob and dip the final once again; thats' better . . . just a hair over 100 . . . leave it at that. Now flip your meter switch to 'grid'; press your key now; what have we got? Three mils . . . you can use a bit more drive so tune your oscillator dial a bit . . . let's see if we can bring the meter to about 4. Now it peaks at a little over 4. Put the meter switch back on 'plate' and hit the key again. Now you get about 108 on the dip; go back just a bit on the loading dial and dip the final again . . . that's good . . . 102 now and you're all set to pound out a 'CQ' . . . feel up to it?" "Oh, gosh Gramps, do I have to? I'm kinda shaky and maybe I can't make it". "You're the operator Judy, you might as well get used to it . . . you don't want Joe to make the first call do you?" "Hey FN, not *me*," Joe broke in, "I think I'm even shakier than she is". Both FN and Tom gave out with hearty laughs following which FN said, "All right, don't start out with a 'CQ' call then Judy; simply make a few 'V's', send the word 'test' a couple of times, follow it with a single 'de' and your call letters about twice, then an AR to finish off. Want to write that down so you can follow it? Nobody should call you after that and it will give you a chance to get the feel of putting your signal on the air." Judy wrote it down as FN dictated and then, not exactly in fear and trembling, but with plenty of misgiving, she rather haltingly made the suggested sequence of characters, stumbling a bit on one or two but reasonably readable. "Joe" said FN, "you want to try the same thing?" "Not this time FN," replied Joe, "I think I'll wait till I get my own rig on the air . . . then I won't have to sweat it out twice!" "OK son," laughed FN, "as you like. Judy, go ahead and repeat your test call once more . . . fine . . .you're better already. *Now* make the 'CQ' call . . . I've written the letters down here for you so you won't have to hesitate. You'll get used to the conventional method for such calls after a few trials then you'll find it automatic". "Well" shrugged Judy, "no time like the present I guess so . . . here goes!" Rather haltingly at the start, she gained confidence as she proceeded and wound up with her call and a 'K' in pretty good style. "Throw your antenna switch to the left Judy and do a little tuning on your receiver. There's a signal . . . hold it; no, he's already working someone. Try another CQ". Again there was no reply. As Judy appeared a bit crestfallen, FN reassured her with, "You won't get an answer every time you call CQ Judy . . . sometimes it takes a number of calls before someone runs across you. Let's try a different approach; tune slowly around your own frequency on your receiver and see if you can find someone who is *sending* a CQ; maybe you can raise him". Sure enough, about 3 kHz removed from her own frequency, Judy tuned in a reasonably strong signal, slowly sent as befitted a novice and making rather good character formation. Concentrating with furrowed brow, she copied his call correctly after two false starts; fortunately he repeated it several more times then signed off with AR and 'K'.

"Go ahead Judy, give him a call" Joe broke in; gosh, I hope my first chance will be with a guy sending as good as that; I can read every letter he makes". Judy looked grim but determined and threw her antenna switch to the 'transmit' side and carefully spelled out the other stations' call several times, 'de' once and followed with her own call a number of times ending with 'K'. Back came the antenna switch and her hand automatically reached for the receiver dial knob; she might need to trim his signal slightly *if* he came back! And . . . he did! Gripping her pencil tightly Judy carefully wrote, letter for letter as the other

"Go ahead Judy, give him a call."



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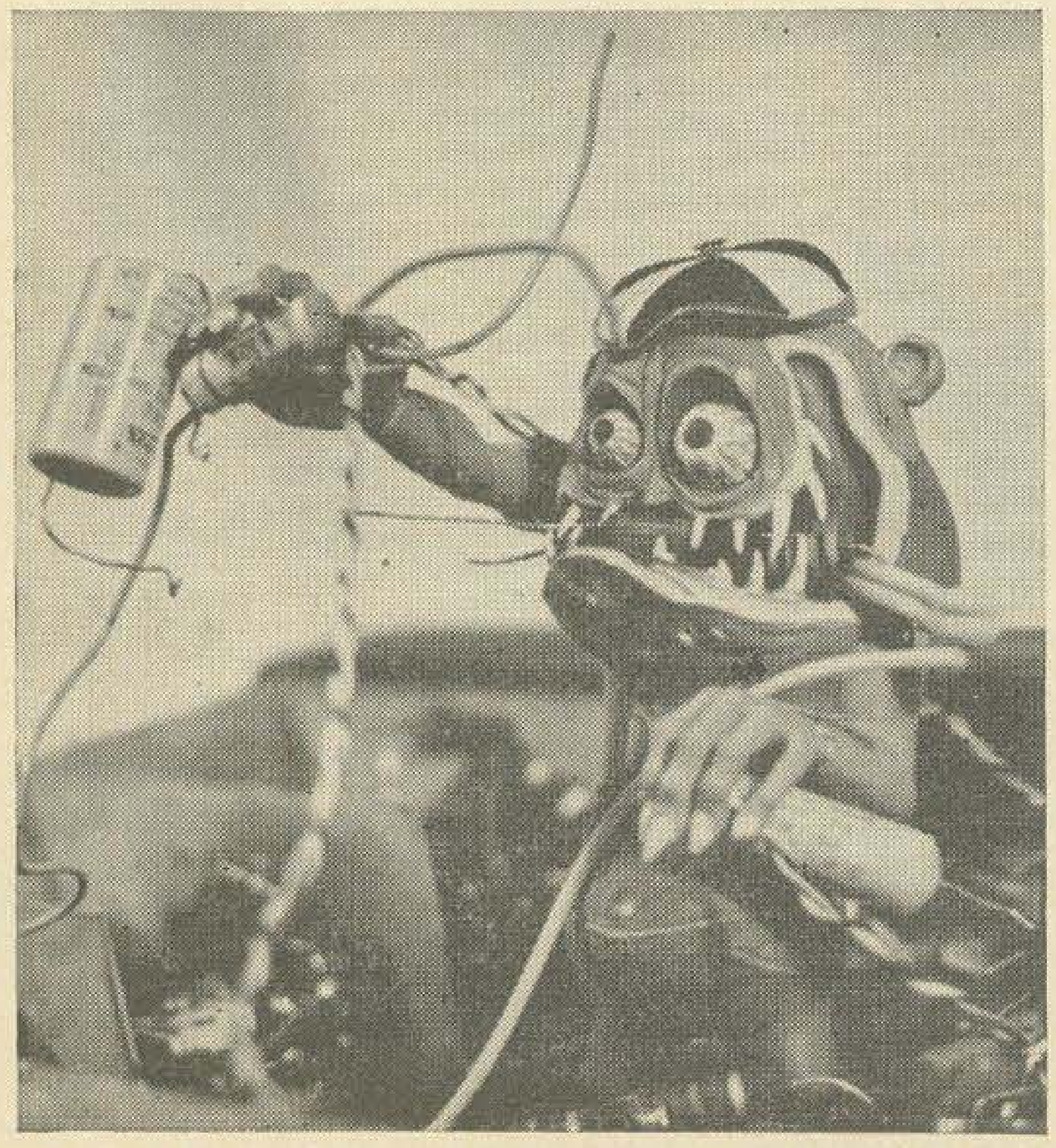
station gave her the conventional signal report, his location and his name. FN copied with her and filled her in on two of the signal report figures; she was still a bit timid on the numerals. Reminding her to acknowledge, FN said, "Give him a couple of R's, tell him his signal is RST579, that your QTH is Columbus, Ohio and your name is Judy, then let him take it". Judys' confidence increased as she continued her QSO and she managed nearly ten minutes with him with Joe avidly listening to the speaker while Tom and FN went downstairs for another cup of coffee. "Better to let them wrestle it out now Tom; Judy has caught on and they won't feel so nervous if we're not standing over them." "Right you are Dad," said Tom with a laugh, "Judy has been fit to be tied the last couple of days.



"They don't make receivers as good as they used to."

She was *so* anxious to start going the day her license came but we put our foot down and told her that her school work came first and that she would have to wait until Saturday, so this has been a really gala occasion for her". "Yeah", FN replied, "I've seen a lot of beginners and her reactions are comletely normal . . . they all run in the same pattern; kinda like taking the wheel of the family car for the first time I 'spose".

When the men returned upstairs, FN was a bit surprised to find Judy entering all details of the contact in the little log book she had provided for herself. "Well Judy," said FN, "I was about to remind you that you had to make log entries for every transmission but I see you didn't need reminding . . . good for you." "Sure thing Gramps . . . I'm all set up now but I'm sorry to say that Joe had to give me a nudge on the logging. I was full of the other guy's chatter and would have forgotten if Joe hadn't brought it up. That fellow was in Cleveland Gramps, and I guess my signal was as good there as his was here; at least he said 'solid cpy' which I think means 'solid copy'. His name was Fred and his weather is about the same as ours. Thats' not really 'DX' but it's a start; I'm going to go right after a WAS certificate . . . you think I can work all states with this rig Gramps?". "Sure thing, Judy; pick the right band at the right time of day and go to it . . . you'll make it in time. States close by you'll work on 80, those several hundred miles from here will be better on 40 and the most distant states will probably come through on 15. We'll all get together on some of the finesse of working out next time we have a session. Anyway, you're on the air now Judy . . . congratulations."

Turning to Joe, FN inquired, "Well son,

you see how its' done now; when do you think you'll finish that T-60 kit you're working on so you too can get on the air and work Judy and others?" "I'll bet it won't take me more than a couple of days now FN; I'm supposed to go on some kind of picnic tomorrow but I'm not going; I'd rather spend Sunday working on the rig and then Larry can check it for me and maybe I can even get on the air Sunday evening. The club gang and Larry helped me get up a good antenna a couple of weeks ago and it sure made a difference in my received signals. I've got the crystal, key, antenna switch and everything for the transmitter now so you can bet I'll get that finished in short order". "Tell you what we'll do kids, if its' OK all around" FN replied, "suppose you come out to my place next Saturday and we'll have a nice talk about clubs and organizations to which you can now belong, magazines and books most suitable for the novice and we can also discuss proper operating procedures to get you the best results and put you on the road toward your General class ticket. As you know, you can be a novice for only a year, and then you must pass the General class exam or give up ham radio until you do, so you'll have to keep right on with your code practice and book learnin'. The code will not be too bad as you'll be using it every day on the air but don't neglect your books because the theory exam for General is considerably broader in scope than was your novice. So, how about it . . . want to come out next Saturday?" "You bet," they chorused, "we'll need all that kind of help we can get".

Before the gathering broke up, Tom chimed in with, "Remember Dad, I'm coming out with them; this doggone stuff has gotten under my hide and I can't let these kids beat me out. I'm reading both the books and Judy has been giving me a lot of code practice so I'm getting there". "Fine Tom," returned FN, "come on out . . we'll make a ham of you yet".

. . . W7OE

Next Month: A discussion of proper operating techniques and related tricks of the trade, recommendations for suitable magazines and other literature, and a general summing up, embarking Judy and Joe on the road to the General Class and firing Tom with increased enthusiasm to become a novice and catch up with the kids.

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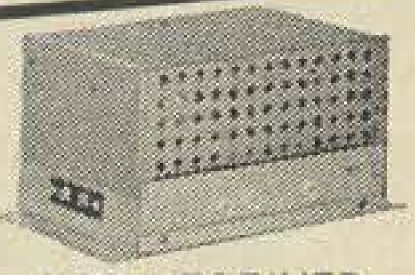
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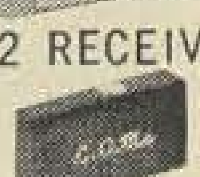
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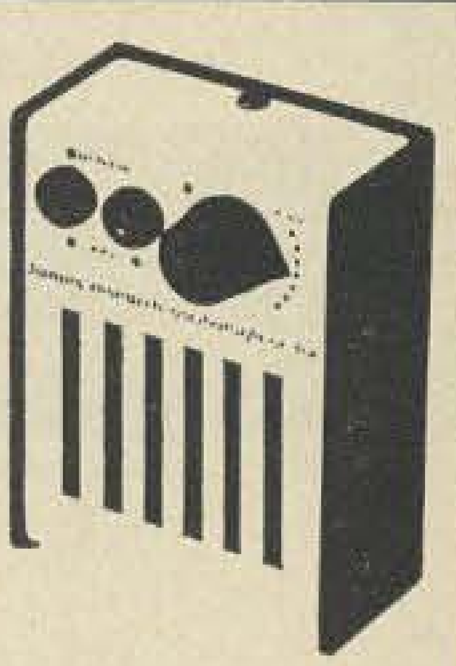

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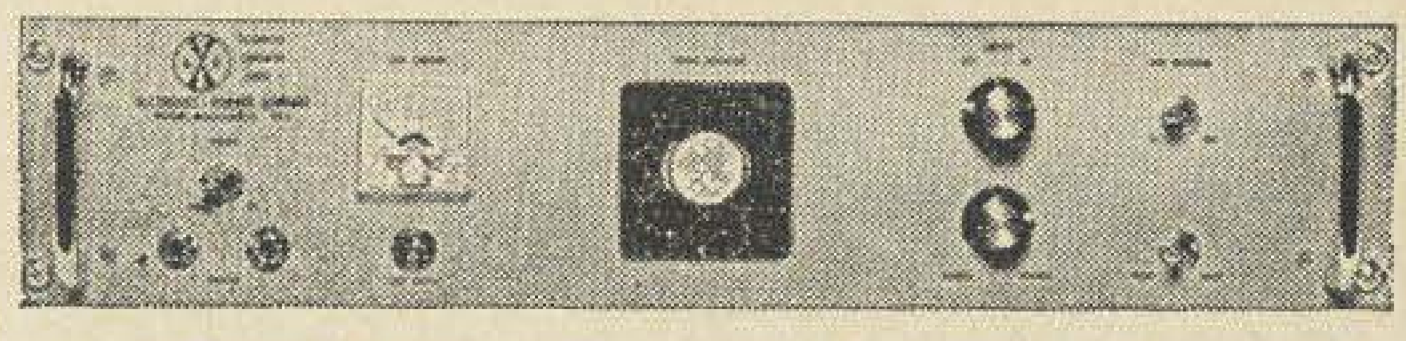

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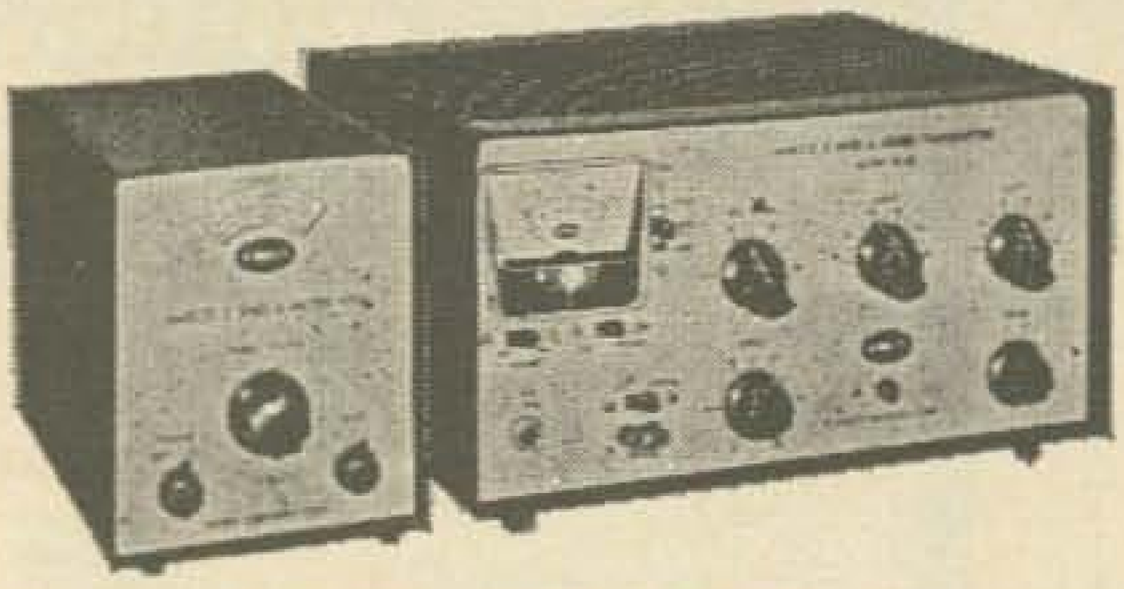

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73 Magazine **Peterborough, N.H. 03458**

(Continued from page 4)
river that goes through the center of town and then take out water down river for drinking. I saw cows dropping in a small stream and people washing clothes and drinking just below. Oh well, they haven't invented backhouses here yet, much less indoor plumbing. Ed gets his water from the U.S. Embassy.

I watched the streetside merchants weigh out fruit and vegetables on scales with stones for the balance. Everything is basic and primitive here. I was amazed to find that a nice sheep lined coat cost only about $6. The wages are low, with a policeman making about $20 a month and an airline pilot about $80 a month. No wonder I was able to find a beautiful wolf rug made up of six fine pelts for only $30!


In Kabul. Prices are really low—this sheep-lined coat was only $6.

There was a note at the hotel from Jim W5PYI, who had gone on ahead of me to Kabul a couple days earlier. He'd found the place dull and gone on to New Delhi.

Back at Ed's home we went almost immediately to the ham shack, a small building out in back of the house. Ed had a Swan 350 and a Swiss Quad up about 20 feet. He claimed it worked just fine. He explained that since there is no licensing authority set up in Afghanistan that I could go ahead and use YA1NSD, or any other call I liked. I sat there the rest of the afternoon and evening filling my log with contacts and talking to friends.

Although there is much to be said for the fun of working out with low power,


Ed Daniels, YAIDAN.

I can't help but notice that the further I get from the U.S. the more a few strong signals really stand out. Over here in Kabul there would be few U.S. stations to talk with if it were not for the fellows with the kilowatts and big beams. They are the only ones you hear except when conditions are just right. Chaps like W2ONV and WA2SFP come through no matter what the conditions are. I had great trouble in getting their attention with my low power, which was frustrating. I'm used to the way it is back home at W2NSD/1 where I know that my signal is getting through and will be heard.

We had dinner out that night with Fred Vogel YA1FV and his family at the king's summer palace, which has been converted into a night club. The tab came to about a dollar per person.

After dinner I went back on the air again and finally hooked WA6BSO (now W1DTY) operating my home station. We talked for a good half hour with good signals both ways.

The next day Ed piled his family, me and Mrs. Vogel and daughter Kathi into his


YAIDAN's palacial home in Kabul.

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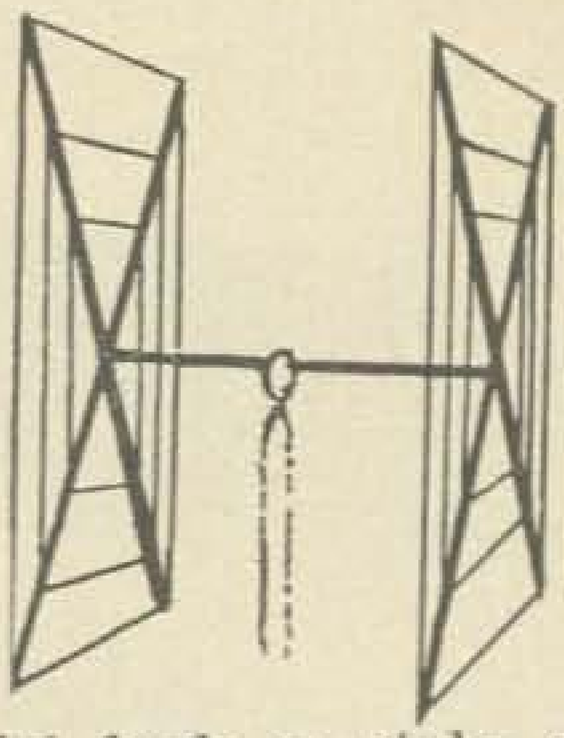

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Fred Vogel, YA1FV.

microbus and we were off to a small mountaintop village a few miles away. The houses are made of mud bricks, as they are in all of Afghanistan. The most amazing thing was the town water supply. They've dug a tunnel from a nearby mountain which feeds a stream through the valley and up into a reservoir on the top of the hill with the town on it. The water is fed to the town through ditches for a few hours a day, a couple hours through one ditch and then a couple hours through another, etc.

Afghanistan is right next to Russia and you can see the influence everywhere. All of the taxis in Kabul are the Russian "Moscow" car and all are, as far as I could see, in the last stages of disrepair. The roads were built by Russians with Afghan slave labor, as were many of the buildings. Right then they were working on a Russian college which will be staffed with Russian teachers. The Americans, on the other hand, get all

Left to right, front row: Pit YA1BW, Ed YA1DAN, Wolf YA5RG, Charlie YA1EXZ. Back row: Ken YA1KC, Helmut YA1HC, Ali YA1AN and Fred YA1FV.

their workers on the open market and pay them well. USAID is here and doing well, as is the Peace Corps. The Americans live in their own section of town in houses built out of mud bricks, but over the mud is a layer of plaster and paint and they look very nice indeed.

In the evening we visited YA1FV and I met just about the entire ham population of Afghanistan. They talked over the local situation, which is delicate. The government will not license anyone and they are all afraid that something will come up which will put a lid on their operation, which is done with tacit consent. You can be sure that they police themselves very carefully.

The airline schedules were all mixed up and my plane had been delayed a day, so I had one more day in Kabul than I expected. I spent most of it on the air working as many stations as I could. My short visit netted me 46 countries and I surely could have made it a hundred if I had tried at all. Ed and I went downtown and I bought another jacket, fox lined and a fox rug. These things are so reasonable that it is hard to pass them up, even for a stinge like me.

When I arrived at Kabul someone said, "Welcome to the land of the soft stool." He was right. Ed and I both picked up a mild case of dysentery. The Americans living there have a difficult time. They have to watch out for the water, fruit, vegetables and almost everything else. Even with the utmost care they have a bout every now and then, never seeming to get immune to it. Funny, but when you travel, particularly in Asia, your digestion becomes a major topic of interest and discussion.

If I thought I had troubles in Kabul, I should have known what was going to hit me in Delhi. The plane left for New Delhi the next morning, only one day and a half hour late, carrying me to my meeting with Raju and Karnik. And I only had to bribe the chap at the airport 100 Afs to get my cameras out of the country.

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the town, visit the churches and museums, or hit the nightclubs; whatever spirit moves you. The cost of the tour will pay for all jet flights, ground transportation, hotels, breakfasts, tips, and like that.

In addition to having the fun of traveling with fellow amateurs, we will be visiting the amateurs in the European countries. We'll arrange to have them there to meet us, explain about their countries for us, perhaps take some of us to their homes for a visit and dinner, and we may even be able to arrange a big hamfest type dinner in most of the cities we visit.

The itinerary is not firm yet, but it looks as if we will be stopping first at Paris. After five days we will then be on to Vienna. Next famous Berlin, and then Frankfort and back to Boston. We plan to leave about mid-May and return three weeks later in early June. We'll arrange to be in Paris on Sunday for the fabulous Flea Market. One guided tour . . . East Berlin.

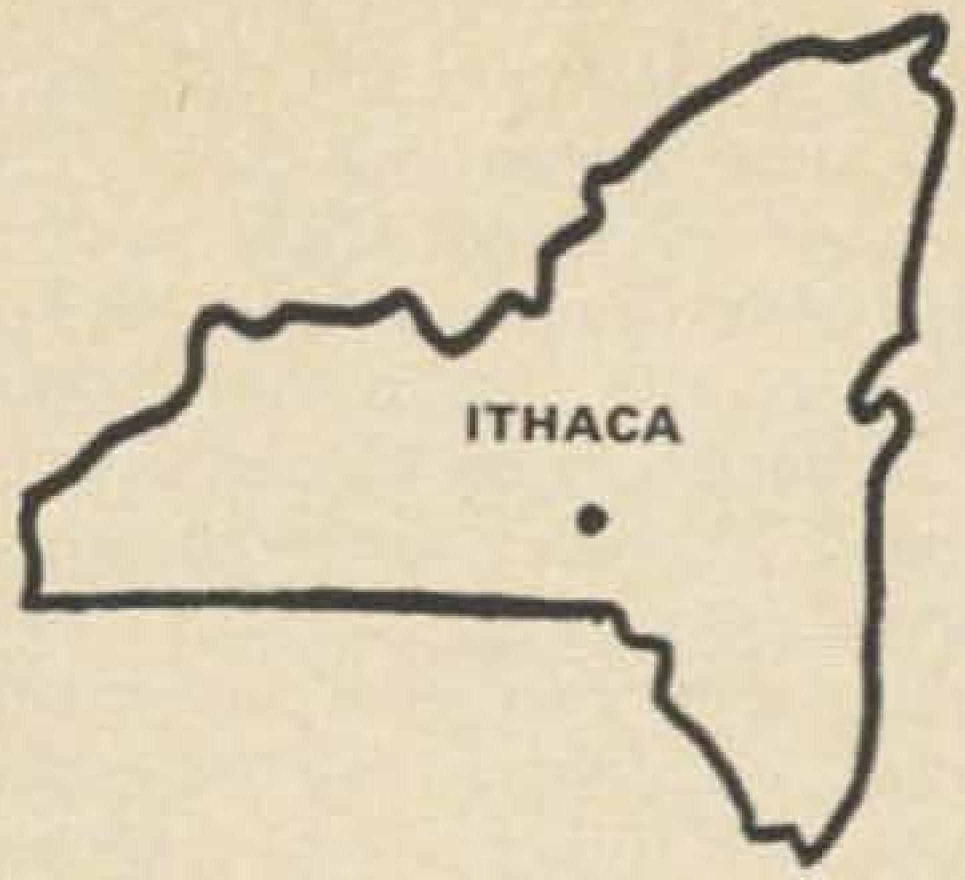
Most of the tours like this run about $1000. We're interested in promoting international amateur friendship, not running tours, so we've set a ridiculous price tag for the whole works. $990 per couple, or $520 for a single person. We'll be staying at the good reasonable hotels instead of the Hiltons, but you'll find that these are a lot more fun. You don't find a hand out in front of you at every turn expecting a tip. We'll stay where charm and good food abound rather than plastic and aloof waiters.

We can only handle just so many on these tours, naturally, so if you are interested, please send in a $100 deposit now to hold a space. Make your check payable to *73 Magazine*. If your plans change, this deposit will be returned up to 60 days before departure. My wife and I will be personally leading the tour . . . and I know all of these cities and the wonderful amateurs in them very well.

Viet Nam

Last year Fortune magazine did some cost accounting on the war in Viet Nam. I remember when there was considerable worry in the press, a few years back, because the U.S. was spending $1,000,000 a day there. Last year we were spending about $60,000,000 a day. It's probably up around $75 million by now, reaching for $100 million a day.

The U. S. economic aid to Viet Nam this



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year is just under $2 million a day.

I've been mulling this thing over.

Back during WWII, I read the figures on the cost of the war and wondered what the world might be like if we could put all that investment into the building of countries instead of tearing them apart. We poured millions of dollars of bombs and equipment, not to mention lives, into dozens of Pacific islands. With this investment we could have built whole cities . . . whole countries.

Further thought . . . if we had been investing in building cities and countries perhaps the war would never have happened?

Now, to get back to the present, or close to it. Last year I made a little trip through Asia, visiting Burma, Thailand, Singapore, Australia, and the Pacific islands. I talked a great deal with friends in these places about our Viet Nam war. I found the people rather better informed than most Americans, and, in general, in support of our goals.

The situation is serious when you get out your map of Asia and take a thoughtful look at it. Right there in the middle is China. If China is going to open up its central and western areas, it must have access to the south. And they are getting it. In the west they have done a fine job of opening things up for themselves in Pakistan. This country is now very pro-Chinese and anti-U.S.A. They tried to open things up into India, but the U.S. threatened to come in and help and they gave up. They did take over Tibet.

Central China is ready to open up now too. In case you didn't know, Burma is a communist country today. I'll tell you more about my visit there in due time, but Burma is one of the great untold stories in the world today. I read a lot and I have seen nothing about the fantastic situation there. Burma is open to the Chinese right now.

Thailand is in a fighting war against the communists . . . Cambodia has been largely taken over . . . so what is left? Mainly our little holding action in Viet Nam. If we pull out that will be the end of southeast Asia . . . and probably India too. How can they hold out when they are surrounded? The Indian government is weak and disorganized. It would not be difficult for the communists to push in and take over there.

So what's wrong with letting them have Asia?

Well, when would you try to stop them? It is like the situation we had with Hitler.

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He took a little bit here and a little bit there, gradually ending up with everything. The communists are doing a fine job of getting little wars started here and there. They are hard at work in Africa. Right now they've got a nice little thing going in Somalia and upper Kenya, with Sudan and Ethiopia all tied up trying to keep things from getting out of hand. Supplies are pouring in from China and Russia to the Shifta in Somalia.

Once they win southeast Asia completely, then India, Afghanistan will be a pushover, as will be the other Arab countries . . . Iran, Iraq, Syria, etc., where they already have a heavy foothold. Then comes Africa . . . and they have a good foothold in there too now. They're working industrially in Central America, South America . . . when do we worry?

Now let me tie my ideas together for you. We are, as far as I can see, faced with expanding communism in many areas. Right now the area that is critical is Viet Nam. The war we are fighting there is miserable and expensive. I just wonder if there isn't a way that we could pursue peace in Viet Nam instead of war.

It is difficult to escape noticing that the U.S. military has some rather inflexible ideas on how to win a war. This is not strange, when you consider the whole system that provides our military leaders. The development of officers in our armed forces is a weeding-out process. Those officers that are trouble-makers don't get promoted and eventually drop out for something more rewarding. As a general rule then we find our generals and admirals are made up of men who have spent a lifetime not causing trouble. They usually live by the book. Few men can go through the years of indoctrination and then change when they come out on top. This is why, to my mind, we have found the navy sticking by their battleships and fighting carriers and why the army generals fought off air power for so many years.

Right now this means that the military who are running our war are working in deeply dredged channels of thought on how wars are to be fought and won. They have been changing slowly and meeting the situations in Viet Nam with new solutions, but I suspect that many of these new solutions were brought into play only after repeated disasters with the old ways of doing things. Certainly a close reading of the war reports

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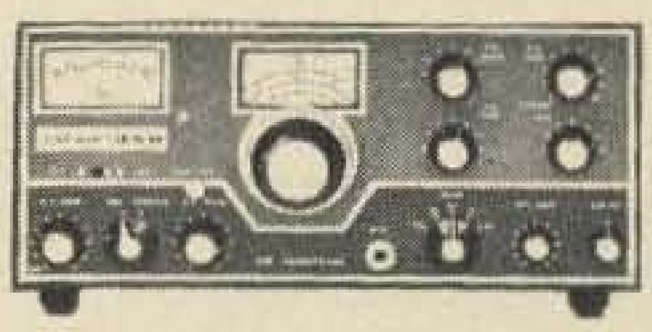

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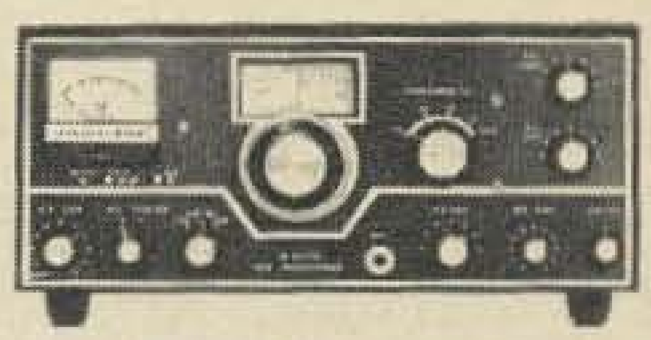

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are full of this sort of thing.

I just wonder how much brainstorming has gone into the whole overall idea of trying to achieve our ends in Viet Nam? From the figures I've given, we can see that our present course is largely a military solution . . . $75 million a day for the war and $2 million a day for economic aid.

What would be the result if we took a few of those $75 million spent every day and used them a little differently? Like for building instead of destruction? Suppose we shipped over a $2 million dollar factory to make prefab native houses. Suppose we sent over the sawmills to make the lumber for the prefab factory? And how about a factory for furniture to furnish these houses? Then we might put in a factory to make simple tractors for working the land. And even more important, a factory to make small cars, possibly something like an overgrown go-kart, which could sell for a very low price.

And what would we do with all this stuff pouring out of the factories? How about giving a house and furnishings plus a job to everyone who asks for it? The houses could be set up in Levittown-like groups. Tractors could be available for each so many houses to farm nearby lands. From there on they would have to work to buy food and buy cars and other goodies. With something like this going on I wonder how long it would take before we would have to set up a toll booth on the Ho Chi Minh trail to register the flood of communists coming down from the north to get in on the good life?

It looks to me as if we might be able to build a new country over there along the lines that have worked here, for a fraction of the money we are now pouring into it. Plus we would save a lot of lives and produce a strong new country. Not to mention the effect this would have on all of the other countries that are falling into the communist camp. This should solve the pacification of villages problem, and probably even the political problems would solve themselves.

The U.S. would retain ownership of the industries at first, then set the larger ones up with stock which could be bought by the people. The stockholders could then insist on their own management of the companies, if they thought this would bring them more returns.

The future of any country depends heavily on the schools it has. We would do well to build schools into each of our new communities and staff them with American teachers. Scholarships for brighter students to come to U.S. colleges would cost us little, comparatively. We need to aim for Viet Namese teachers for the next generation . . . as well as Viet Namese engineers, artists, and businessmen.

There you have it, the Green solution to the war. This should be acceptable to those who think we must win in Viet Nam and also to those who think we shouldn't be fighting there. It should be of interest to those who don't like the idea of throwing away $75 million every day, including Sunday. And that is what it is, throwing it away.

No doubt you've thought of several reasons why my program would get into trouble. I wonder if there are really any unsolvable problems involved? . . . Wayne

The View From Here

(Continued from page 2)

the "Basic" license because they feel the word "novice" has some bad connotations. I can't see why. After all, isn't the General class license the basic license? If it isn't now, it certainly will be if and when incentive licensing goes through. Right now it appears that incentive licensing isn't an *if* anymore, but a *when*.

The Novice licensee is a novice, or a beginner, and the name of the license seems most appropriate. In some respects the title novice is better than the beginner class issued in some countries. The word beginner seems to indicate that the individual is just beginning. Although the Novice is a beginner in many respects, he has to have a rudimentary knowledge of radio theory and Morse code, so he is slightly beyond the beginner stage.

Although it doesn't appear to me that the name of the license would have very much effect on the number of new Novice licensees and the number that go on to higher class licenses, a longer license period and phone privileges on ten meters would offer a great deal. The Novice license was intended as an introduction to ham radio, but it doesn't seem to me that that is what the present Novice class offers. An extended license period and limited high-frequency phone privileges would give these new amateurs a chance to see what ham radio is really like. Hopefully, more of them would go on to obtain full operating privileges.

. . . Jim Fisk W1DTY

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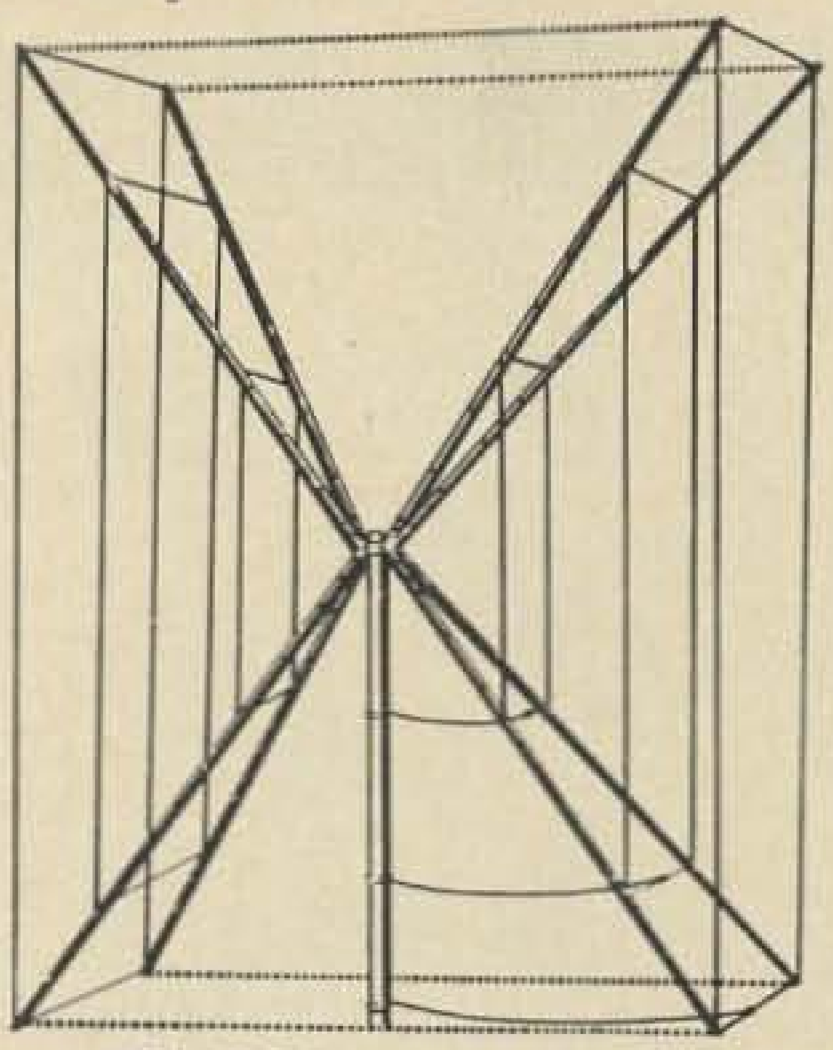

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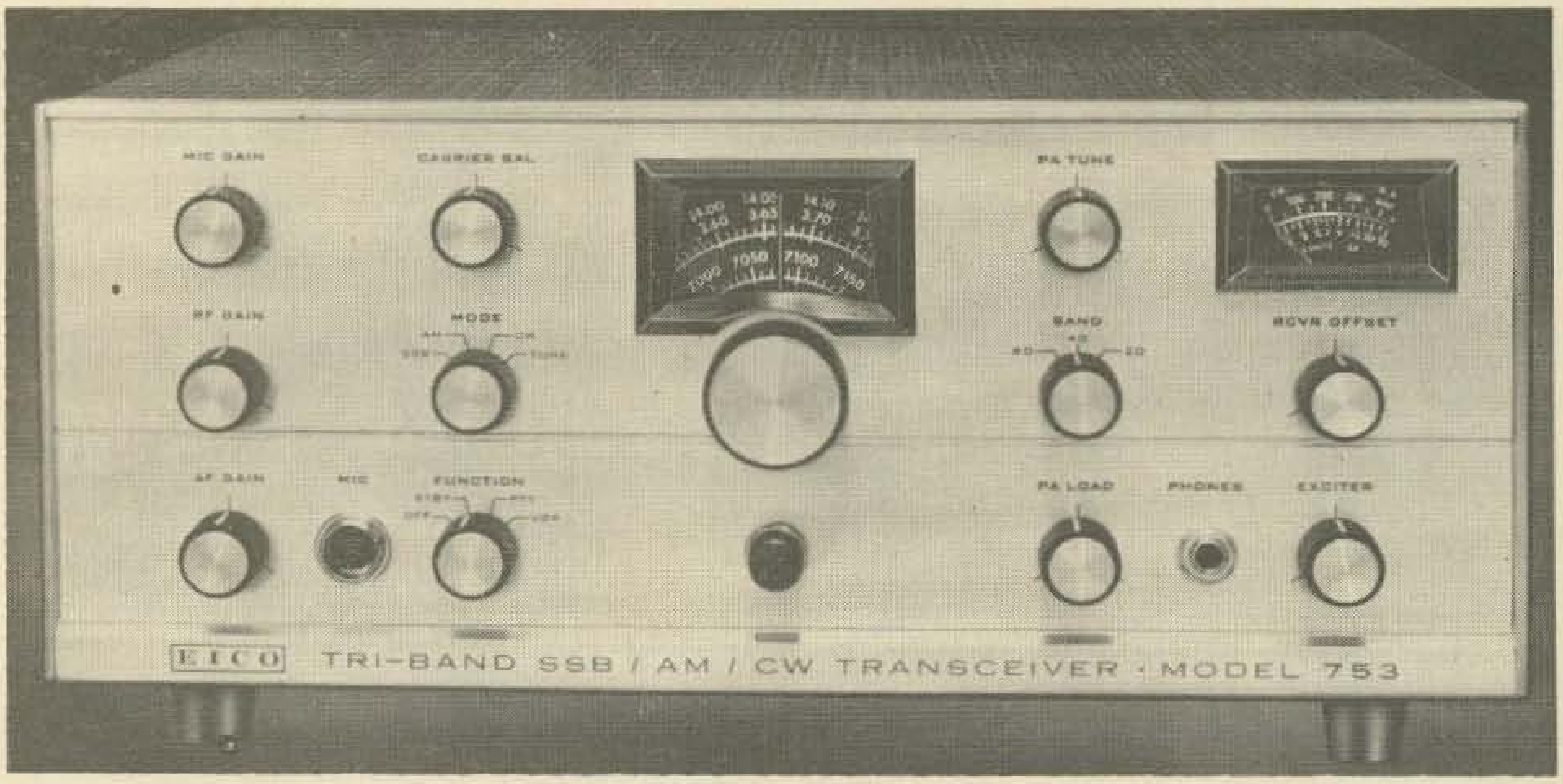

One thing I hate is the use of super $64 words as a means of attracting attention. When you have used up all of the extravagant phrases, what is left to describe a truly good deal? Once in a long while, however, a value does come along which is relatively outstanding and which causes me some concern because I don't want to turn my principles around in the enthusiasm which I rarely feel. I am talking, of course, about the 753 Eico kit. First, it is good looking. The gals will appreciate that. Second, it is not exactly a naked transceiver. It has incremental tuning, enabling you to listen up to 5 kc either side of your signal, and it has vox, and built-in high level ALC. It has two speed tuning, either 6 to 1 or 30 to 1 and this is nice when you are trying to make the other fellow sound just perfect. It has a triode detector for AM. It gives you full band coverage on 80, 40 and 20 and it provides grid block break-in CW keying. These are the kinds of features found normally on the highest priced transceivers. The 753 has a normal power input of 200 watts PEP; of 100 watts AM. Its output is a pi and will match 40 to 80 ohms. Its thermal shift is less than 400 cycles after a 10 minute warm-up, and its sensitivity is better than 1 mv for 10db signal-to-noise. In short, this is a darn good design, especially since the factory has improved the VFO and made it Solid State.

Our "Meat and Potatoes" power supply kit, described in recent ads, has been going over real big. There is really no comparison. This kit weighs 45 pounds and will make any standard transceiver sound better with its superior regulation and higher dynamic range. The MP supply is a kit of our own development and we have been selling lots of them. While our stocks last we will provide the Eico 753 and our MP supply for only $189.95, F.O.B. Harvard. We will ship via Railway Express or truck. The Eico will weigh about 30 pounds and the MP supply 45, so you can figure your transportation costs from this. Remember that this unit will drive any standard linear and that by itself, with the addition only of an antenna, a mike or key, you will have a complete station, suitable for AM, CW or Sideband. For those interested in the original Eico power supply kits, we have these too, either the DC or the AC. By themselves they sell for $59.95. If you want the Eico 753 by itself, the price on this is $149.95. The best value, of course, is the combination we spoke of first.

With the continuing shrinkage of the dollar ever present, where and when can you expect to find this kind of a deal again? This would be fine for mobile operation if you already have a rig and don't forget that this set makes an excellent beginner's station. If you are prone to want to break into this ham radio game, here is sound value.

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What's New for You?

Have you found a simple new circuit, or new semiconductor or other component, that has been useful in your building? There are plenty of hams who would like to find out about it. Why not send in a short note for this column and we'll publicize it and make it available to all the other experimenters who read *73*. We're also looking for technical comments on *73* articles—corrections, modifications, or compliments—and newly available surplus, technical nets and meetings, new records and other information that's likely to be interesting to the technically-minded ham. Please keep the comments short, and send them soon before someone beats you. Send to Paul Franson WA1CCH, 38 Heritage Road, Acton, Massachusetts 01720.

Cheap VHF FET

The 2N3819 FET has been used in many projects in *73*. It's an excellent general purpose N-channel FET made by Texas Instruments. It can be used from dc to 300 MHz. The former price was $3.75—now it's 90c, from Allied as well as many others. Here's the perfect FET to transistorize all those old tube projects. We've heard of people converting command sets to use FET's by simply replacing the tubes and a few resistors, but have no details yet.

Tunnel Diode for $1

General Electric (and others) have recently developed new techniques for mass-producing tunnel diodes at low cost. TD's have been around for a long time, but haven't been used too much because of the former high prices and the peculiarities of the devices. Now TD's are being used more and more. They are used in a number of UHF-TV converters (incidentally, the Japanese call tunnel diodes Esaki diodes, after the Japanese who invented them), and in many computer applications. Tunnel diodes use little power, can furnish high gain and low noise, and are very small. One TD can act as an rf amplifier, an oscillator, and a mixer at once, but you have to make sure that the proper function is happening at the proper frequency. TD's overload easily and can't furnish much power. They also are difficult to cascade and tend to take off at unsuspected frequencies. Nevertheless, they are interesting devices with many uses and more ham experimenting and articles on tunnel diodes are needed. Both GE and RCA publish inexpensive books on TD's and in addition, GE has many excellent TD application notes. If you want to experiment, the GE TD710-719 are $1.05 to $1.62.

Laboratory Power Supply Questions

Hank Olson W6GXN always writes interesting articles, but perhaps his Laboratory Power Supply on page 38 in last December's *73* turned out to be a little too challenging—through no fault of his. The two zener diodes (CR7) are shown correctly on the schematic, but they're reversed on the parts layout. Likewise, the 560 kΩ resistor next to them on the layout should be 560 Ω. There seems to be a little confusion about the diodes mentioned for CR5 and CR6. The Hoffman HB5 is no longer available and the Fairchild FD135 (not FD1135 as stated) is also rare. It doesn't matter too much since almost any silicon junction diode (1N457, for example) will do.

Finding Your Two-Meter Frequency

Bill Richerson WA6VGR has come up with a simple way to multiply 8-MHz crystal frequencies by 18 to get the two-meter frequency they'll produce. Simply double the frequency in kilohertz on the crystal, then subtract that number from double the frequency plus a zero. For example, to find the 18th harmonic of 8127 kHz, double 8127,

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giving 16254. Then add a zero to 16254 (162540). Subtract 16254 from 162540, leaving 146.186 MHz. Very quick.

Free 88-mH Toroids

You can't beat this offer: Art Brothers W7NVY, president of the Silver Beehive Telephone Company in Grouse Creek, Utah 84313, has offered two 88-mH toroid telephone loading coils of the type used in many RTTY converters and audio filters free to those who write him and request them. Include 25c for postage and handling, and your QSL card. Though he has a pretty good stock available, the offer is limited, of course. Send now before he runs out.

Transistor circuits - again

Watch out for those complimentary circuits in Fig. 20 and 21 of the 73 *Transistor Circuits* in the March issue. In both cases the collector and emitter of Q3 are reversed; The collector should be grounded—not the emitter.

Teletype Flip

Frank Dick WA9JWL has suggested a small change in W6AYZ's AFSK converter in the January issue that helps make it more useful for FSK on the high frequency bands. It allows the received signal to be turned upside down at the receiving end. All that is necessary is a DPDT polarity-reversing switch added between the 0.02 μF capacitors connected to the hot ends of L1 and L2, and the diode multipliers. Frank also mentions that he is very happy with the way the unit performs.

1 Watt IC

Packaged audio amplifiers available from Lafayette and others are very popular for many ham projects. They provide high gain, are small, and take little power. They are also available in many varieties with power output from 100 mW to 5 or 10 watts, and cost only $3 to $10. I've used a number of them as modulators for small transmitters, audio amplifiers for simple transceivers or receivers, and most of all, for testing. However, new developments in integrated circuits have just about made them obsolete. For example, the new General Electric PA222 integrated circuit audio amplifier ($3.70 for one), is a tiny (less than 1 inch by ¼ inch) device that will put out 1 watt of audio at 24 V. Its frequency response is within ±3 dB from 55 to 15,000 Hz with 1 watt

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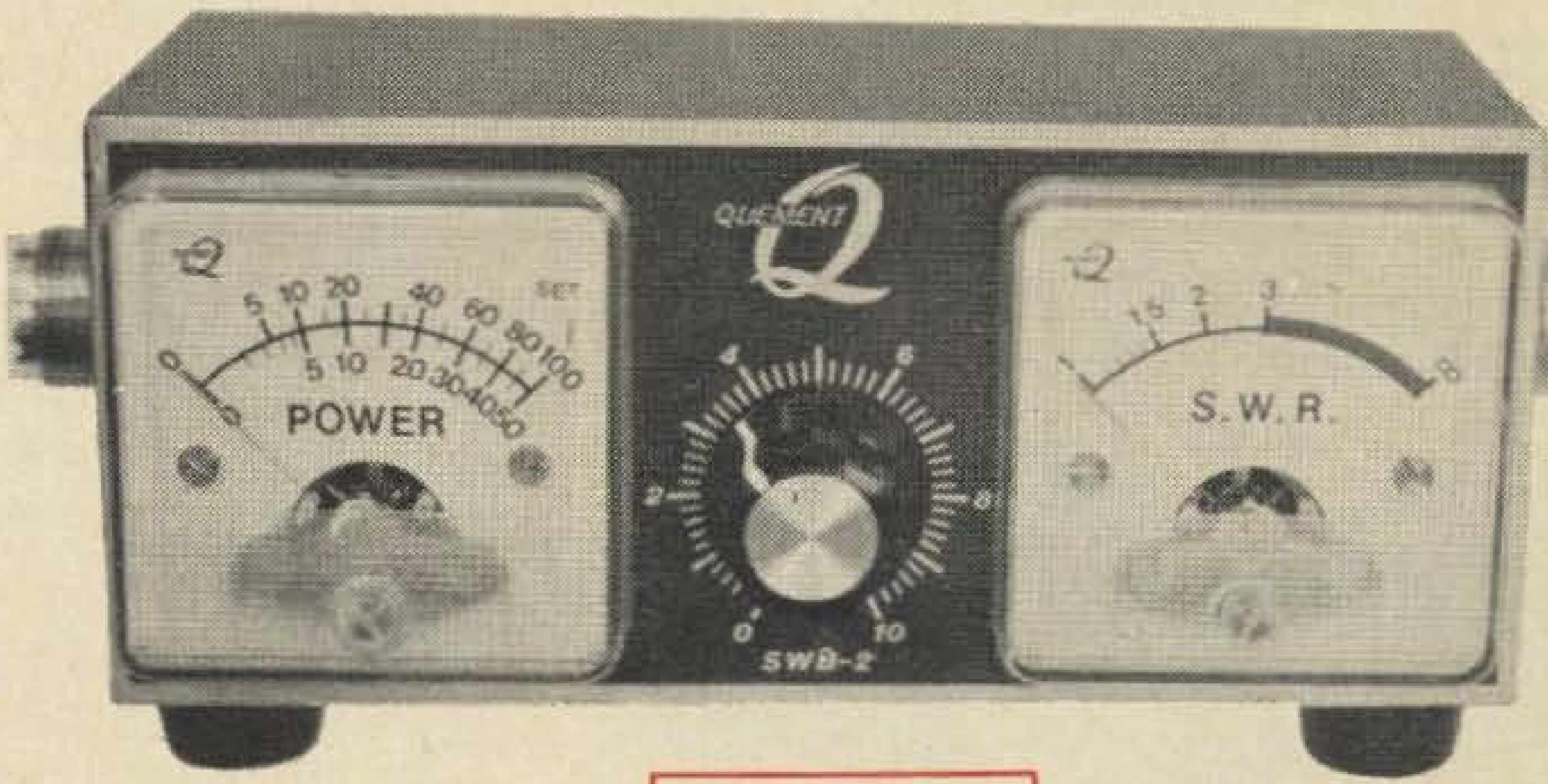

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of output, distortion is low, sensitivity for 1 W output is only 75 mV, gain is 72 dB, input impedance 40 kΩ and efficiency is about 50%. It requires a heat sink, which is attached to a small tab sticking out of the end of the device. External circuitry isn't very complicated, either. Now, about that miniature receiver you were going to build . . .

Is Aries Dead?

The death of Ewell Carter WA6ZAIJ, originator and director of Aries, has caused severe problems for the group. Ewell had done much of the work and kept a record of it in a form that isn't very useful to others. It now appears that the satellite project may have to be shelved. If anyone might be interested in helping out, please contact Bob Kolb WA6SXC, 1300 W. Oak, Fullerton, California.

Keeping Kids off Your Tower

A ham can be sued for liability if a child climbs his tower and falls off or is otherwise hurt. This is true even if the child is trespassing on the ham's property. Bob Sull WB2ZQI has suggested a simple way to discourage unwanted climbing. He wraps the lower part of his tower with chicken wire and fastens it in place with wire. This prevents the kids from climbing, yet is easy to remove when necessary.

What Transistor to Use?

An unidentified author is *Static*, the bulletin of the North Penn ARC in Philadelphia mentions that he has just about solved the question of what transistor to use by standardizing on the 2N706 NPN transistor (available in surplus for almost nothing or new as the plastic-cased Motorola MPS706 for 45c) and the PNP 2N3638 (Fairchild) or MPS3638 (Motorola) for 46c. Both are excellent silicon transistors with a dissipation of about 200 mW. The 706 is useful to at least 100 MHz and the 3638 to about 10. The *Static* author mentions that he has built a complete 10-meter superhet including audio output with 2N706's and that almost all of the transistor circuits in the April 73 circuits book can be built with these two transistors.

. . . Paul WA1CCH

NEW PRODUCTS

Knight-Kit Solid-State RF Signal Generator Kit

If you have been struggling with an old tube-type signal generator or using a unit that is poorly calibrated, you can step up to an excellent solid-state unit with the new Knight-Kit KG-686. This generator covers from 100 kHz to 54 MHz with an accuracy of ± 1.5% on all bands. When the built-in 100 kHz/1 MHz crystal calibrator is used, usable calibration within 0.1% can be easily obtained. A built-in detector-amplifier-speaker gives zero beats from the crystal calibrator.

The built-in meter shows either rf carrier or modulation level and the individually shielded attenuator switches provide 21 output levels to −96 dB. 0 dB equals 100,000 μV into 50 ohms and calibrated outputs as low as −106 dB (0.5 μV) may be obtained. Fine control with the meter covers −10 to +2 dB calibrated on the meter. The maximum calibrated output into a 50-ohm load up to 30 MHz is 120,000 μV, ±2 dB. The internal modulation is 400 Hz with metered depth of 50% up to 30 MHz. Provisions are made for external modulation—1 Vrms will provide 50% modulation at 400 Hz.

The KG-686 features a solid-state floating-type chassis-isolated oscillator with tunable L and C on every band for accurate tracking. The 4" metal dial has two alternating colors for easy reading and the 6:1 vernier drive with anti-backlash permits you to set it right on the money. The chassis has been carefully layed out and generous copper shielding assures minimum radiated leakage. The power supply is regulated for maximum output stability.

The KG-686 kit is furnished with a BNC output jack, mated terminated cable, solder, detailed assembly manual and operators manual—everything you need. Available for $95.00 from Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680.

Ameco Preamplifier

The new Ameco **PT** preamplifier is a continuously tuning unit that is specifically designed for use with a transceiver. It improves sensitivity and signal-to-noise ratio while receiving and bypasses itself while the transceiver is transmitting. In addition, it may be used to feed a second receiver and automatically mutes it when transmitting. It also improves immunity to transceiver front-end overload by use of its built-in attenuator. All of this *without* any modifications to the transceiver.

The **PT** preamplifier has been found to be especially effective on 10 and 15 meters when used with transceivers using a pi network in the output. Most receivers of this type begin to suffer a noticeable decrease in sensitivity on 15 meters and especially on ten. In addition, the inclusion of 6 meters in its tuning range makes it usable with those second receivers having a 6-meter range. $49.95 from Ameco Equipment Corporation, U. S. Highway 1, North, P.O. Box 6527, Raleigh, North Carolina 27608.

Gonset Two-Meter Linear

A new linear amplifier with a built-in solid-state power supply for mobile use with a GSB-2 SSB Communicator or similar exciter has been announced by Gonset. Ruggedized for mobile use, it is completely self-contained, and derives all operating voltages from the 12 Vdc primary electrical system of the vehicle.

The Gonset "Comtron" mobile linear covers the entire two-meter band including MARS and CAP frequencies and may be operated in any mode, AM, CW, FM or SSB. A blower provides ample cooling for the heat sink in the solid-state supply and the cooling required by the 4X150A used in the amplifier. The high-voltage supply provides 1000 volts from a dc to dc converter and the bias supply is self adjusting.

The "Comtron" may be driven to 180 watts PEP by an exciter in the 5 to 30 watt range. It is compatible in appearance to the Gonset fixed-station linears, but is styled to the requirements of mobile operation. $299.00 amateur net. For further details, write to Don Ward, Sales Manager, Gonset, Inc., 1515 S. Manchester Avenue, Anaheim, California 92803.

Skylane Quad Antennas

Skylane Products, manufacturers of multiple element quads, is introducing quad kits at greatly reduced prices. Two, three and four element quads may now be purchased in kit form, with either bamboo or fiberglass spreaders. These new kits are economically priced, yet easy to assemble. For more information, write to Skylane Products, 406 Bon Air Drive, Temple Terrance, Florida 33617.

High-Frequency RF Amplifier

A significant improvement in the design and performance of broadband, high dynamic range rf amplifiers has been announced by Comdel. The power gain of their new unit is 9 dB from 0.5 to 50 MHz and when installed in a 50 ohm system, the noise figure is less than 3 dB. The typical dynamic range of more than 140 dB insures freedom from cross modulation and makes gain control unnecessary. Typical applications for these new amplifiers include low power linear amplifiers (0.2 watts peak output), antenna amplifiers, broadband multicouplers, and broadband instrument amplifiers. Input power requirements are 18 to 22 Vdc at 40 mA–a 110 Vac self-contained power supply is available with the amplifiers. For more information on the HDR 10 series amplifiers, write to Comdel Inc., Beverly Airport, Beverly, Massachusetts 01915.

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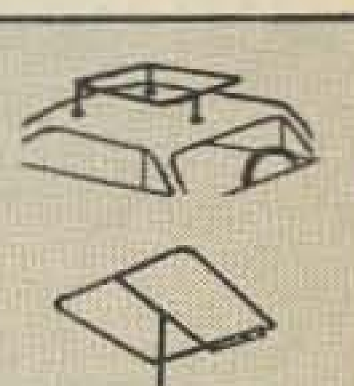

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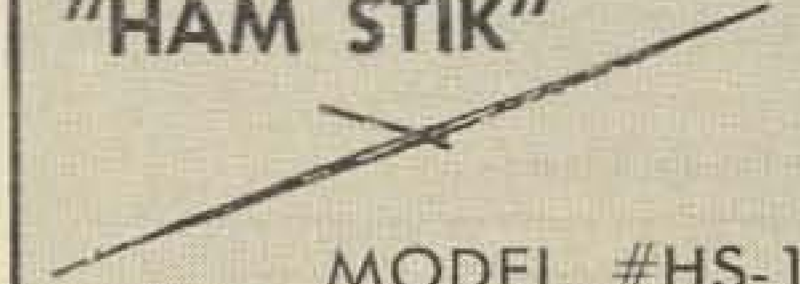

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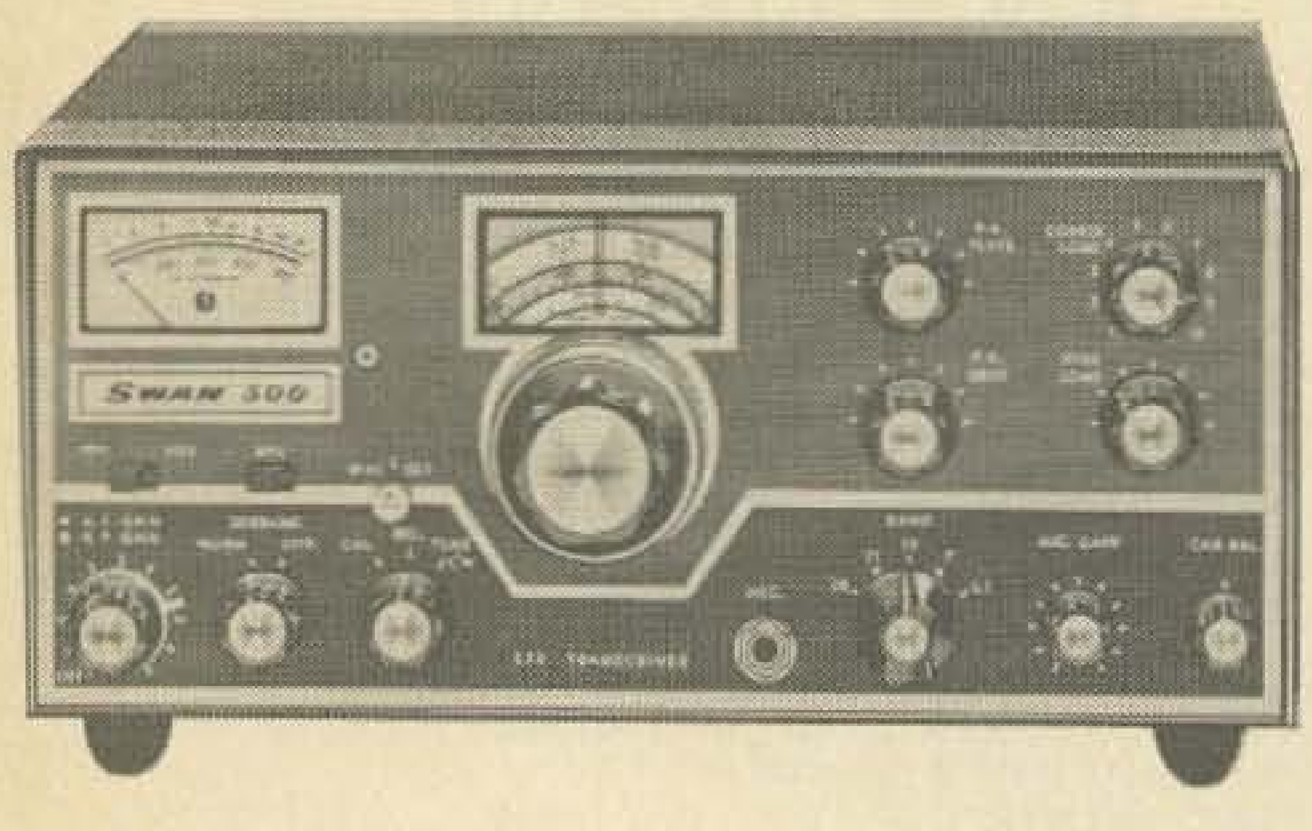

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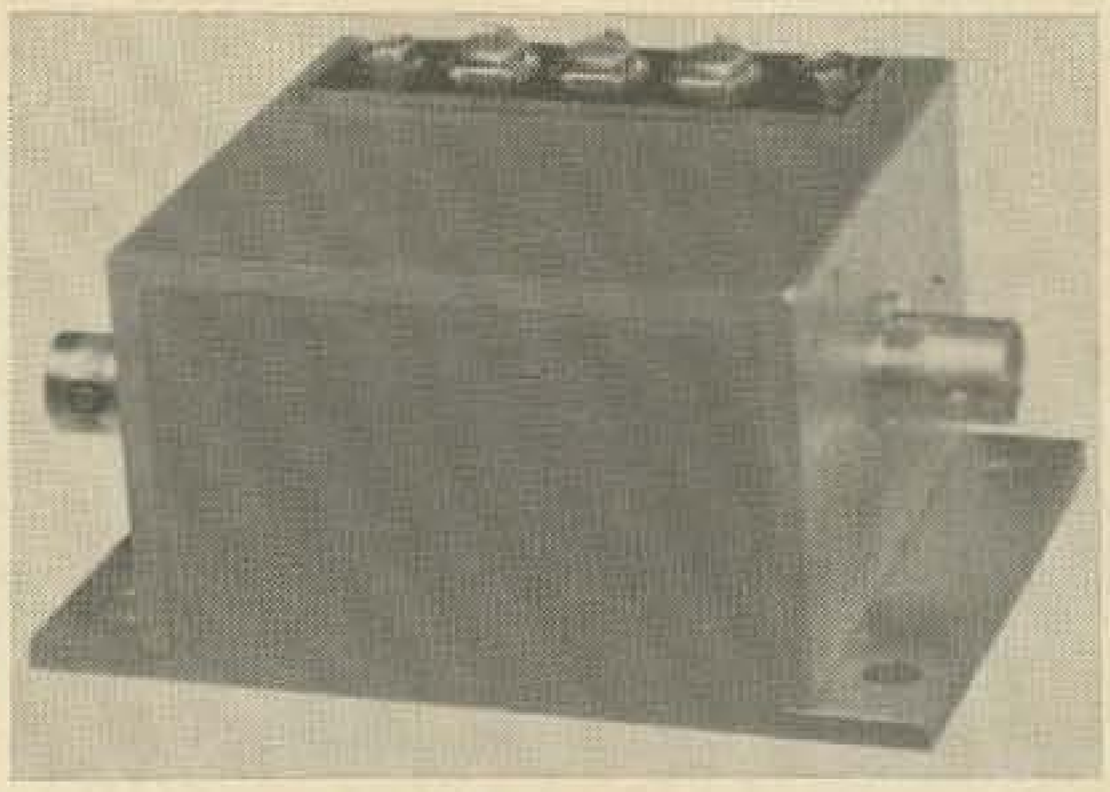

A significant improvement in the design and performance of broadband, high dynamic range rf amplifiers has been announced by Comdel. The power gain of their new unit is 9 dB from 0.5 to 50 MHz and when installed in a 50 ohm system, the noise figure is less than 3 dB. The typical dynamic range of more than 140 dB insures freedom from cross modulation and makes gain control unnecessary. Typically applications for these new amplifiers include low power linear amplifiers (0.2 watts peak output), antenna amplifiers, broadband multicouplers, and broadband instrument amplifiers. Input power requirements are 18 to 22 Vdc at 40 mA–a 110 Vac self-contained power supply is available with the amplifiers. For more information on the HDR 10 series amplifiers, write to Comdel Inc., Beverly Airport, Beverly, Massachusetts 01915.

Automatic Voltage Regulator

The Perma-Power company has just announced a line-voltage regulator for electronic equipment up to 400 watts. Although designed primarily for color television sets in areas where line voltage regulation is poor, there are many applications in the amateur station.

The regulator automatically boosts line voltage 10 volts when the line drops below

110 volts. When voltage is normal, the unit cuts out. It also shuts off when the equipment it is powering is shut off. Complete information is available from the Perma-Power Company, 5740 North Tripp Avenue, Chicago, Illinois 60646.

CB Matcher

Although designed primarily for CB operation, the new Gold Line CB Matcher should be useful for low-power operation on the ten-meter band. The CB matcher is an antenna matching network which can provide an SWR of 1.1:1 on the transmission line at all times. It is inserted between the transmitter and antenna and can be calibrated with an SWR bridge. For further information, write to Gold Line Connector, Inc., Muller Avenue, Norwalk, Conn. 06852.

IC Audio Power Amplifier

A high performance integrated circuit audio power amplifier is now available from Motorola. The MC1554G offers an audio output of one watt with total harmonic distortion of less than 0.4% from 20 to 20,000 Hz. The 1-watt output may be delivered to either direct coupled or capacitively coupled loads.

The input impedance of the MC1554G is 10k ohms and the output impedance is a low 0.2 ohms. This low output impedance is optimized for driving a 16-ohm load—commonly encountered in audio and servo applications. The voltage gain of the unit is adjustable by means of external connections to three gain-adjust pins. Through these external connections, nominal voltage gains of 9, 18 or 36 may be selected. For zero signal input, the current drain is only 11 mA with a 16 V power supply. Price is $15.00 each in quantities of 100. For more information, write to Technical Information Center, Motorola Semiconductor Products, Inc., Box 955, Phoenix, Arizona 85001.

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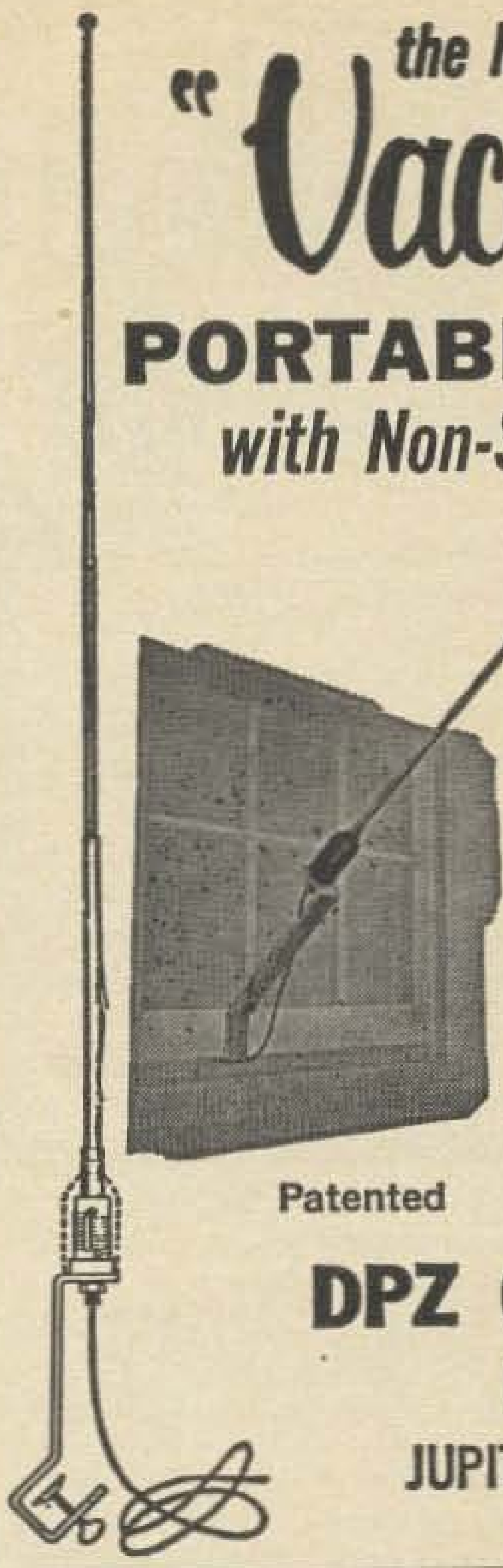

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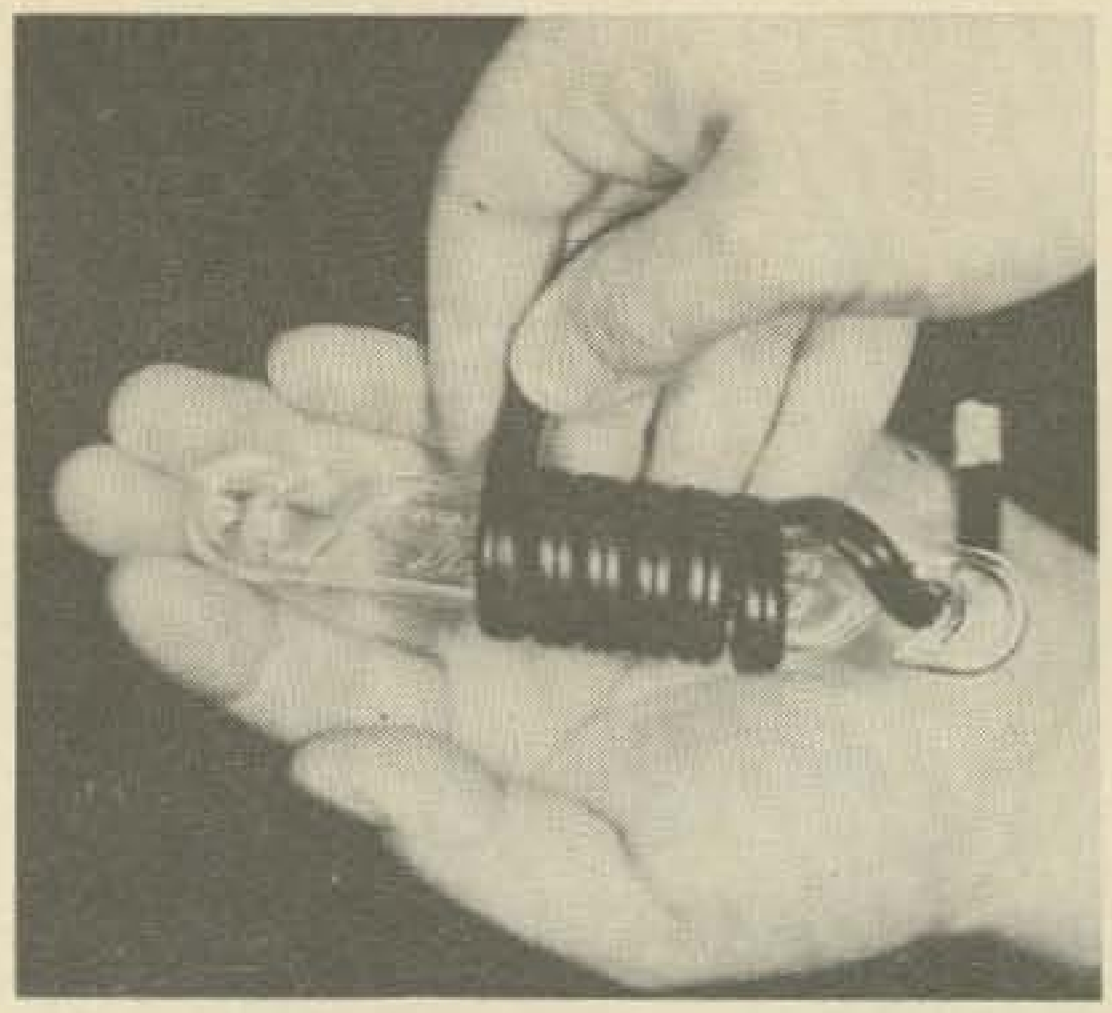


Well OM, you say that you really have your shack cleaned up . . . after all these years! Yes, I suppose it does look pretty good from the operating position, but how neat are things behind the scene? I mean, when the time arrives for some changes or repairs, does the wiring behind your rig appear to be the remains of an explosion at the spaghetti factory? Well, with the help of a new item on the market, you will now be able to at least get a head start at straightening out that tangle of wires.

The General Electric Company now produces a handy and inexpensive item, available at most hardware and department stores, which provides a neat method of shortening those excess ac power cords dangling from your equipment. The excess cord is simply wound around the plastic cord shortener and secured at each end in slots. Priced at 7 to 10 cents, the GE "Coilzit" goes a long way toward improving the appearance of the shack. Ask for GE catalog number GE-2550-0.

Kent A. Mitchell, W3WTO

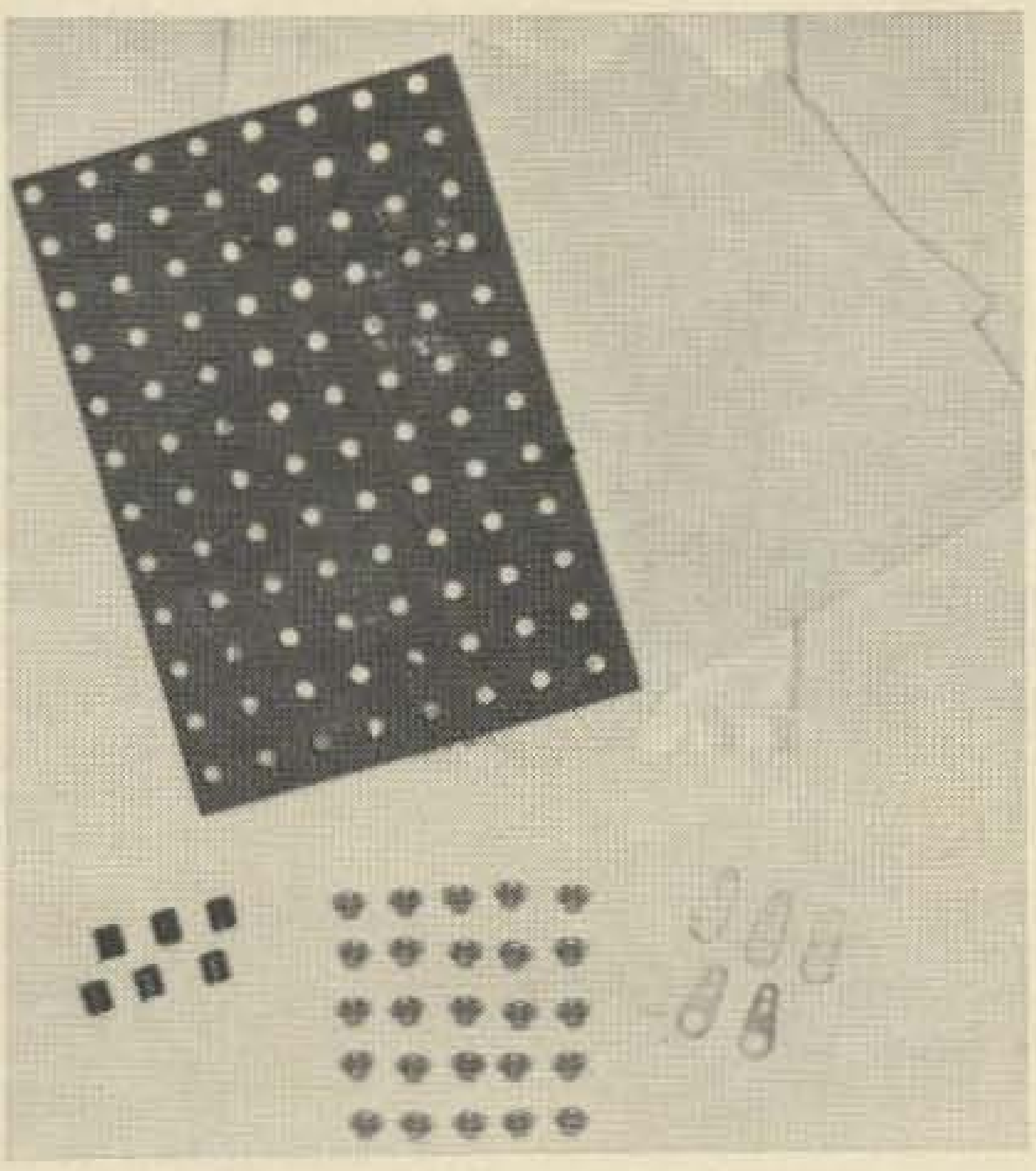
Semitron Zener Diodes

The Semitronics Corporation has just announced a new series of low-cost, heavy-duty zener diodes. These zeners are noted for their maximum surge capacity and stability. Rated at one watt, these Semitron zeners are encapsulated in an alkyd resin case and feature an inner epoxy seal, long leakage paths and low dynamic impedance. Zener voltages available are from 2.4 to 16.0 volts, ±10%, Price is 99¢, with lower prices for quantity purchases. For a copy of the SZ Zener Diode Data Sheet, write to Semitronics Corporation, 265 Canal Street, New York, New York 10013.

Remote Isolation Relay

Alco Electronic Products has just announced a new relay which should be very useful in many remote control and similar applications. This unit combines an isolated step-down transformer and a sensitive low-voltage relay into a single, trouble-free design. Although 110 Vac is required, the relay is activated by shorting the safe, isolated low-voltage circuit which can be run through ordinary surface wiring. Operates from 95 to 125 Vac with low current drain. Two basic models are available: the model FR-101, SPST, $3.85 and the model FR-102, SPDT, $3.95. For more information, write to Alco Electronic Products, Inc., Lawrence, Massachusetts.

Semitron Experimental Chassis Kit



For the home experimenter who does a lot of breadboarding, the new Semitron Experimenters' Perf-Board Kit looks ideal. It consists of a sturdy ⅛" tempered board with holes on ½" centers to prevent component crowding. Solid brass eyelets are supplied for easy soldering and insertion of a number of components leads through a single eyelet. If solderless connections and maximum construction speed is desired, the spring connectors supplied with the kit can be used for making rapid and mechanically secure connections.

The extremely low price of 89¢ for the kit makes it available to all—even beginners. For further information, contact Larry Rivman, Sales Manager, Semitronics Corporation, 265 Canal Street, New York, New York 10013.

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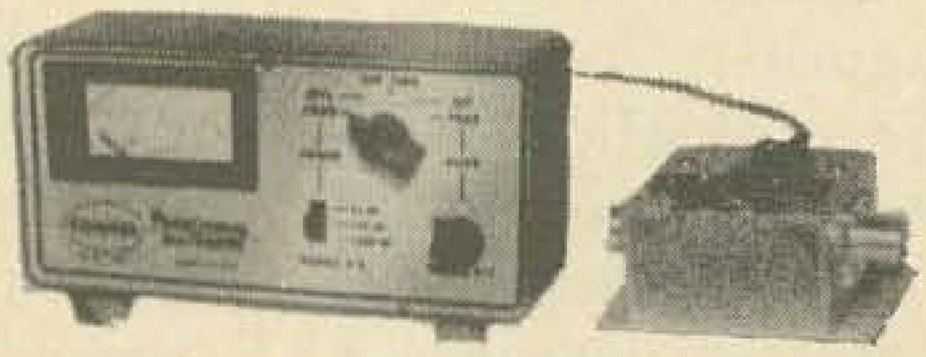

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Letters

INTOLERANCE

Dear 73:

Would it be wrong to say that some of the complaints in amateur radio represent intolerance—a mild form of the same disease in religion, race and politics? This shows up in discussions of GMT, Hertz, license classes, operating modes, activities . .

What amateur has earned the authority to tell all others they must use GMT in log-keeping if they want to be good operators? DX'ers are able to think in terms of DX, but casual operators cannot and need not. But, it is incumbent on the casual man to transpose to GMT in any and all DX QSL matters.

Those in favor of Hertz and those in favor of cycles/second are antagonists. But really, practically, if one talks in Hertz and the other in cycles, they will understand each other.

How about the AM-SSB feud? Mechanically, these modes are somewhat antagonist. But the AM'er is intolerant when he puts carrier deliberately on a SSB QSO. And, the SSB'er is intolerant when he refers disparagingly to Ancient Modulation.

Dick Ellers K8JLK
Warren, Ohio

SSB vs AM

Dear 73:

I didn't think much of your editorial this month—kind of stinks! I believe it is a ham's privilege to choose which mode of operation he desires, whether it is CW, SSB or Advanced Modulation. When are you SSB'ers going to give up trying to cram that "squawkin stuff" down everyone else's throats—don't you think it is their own decision?

J. C. Evans WØGSW
Pittsburg, Kansas

Dear 73:

Agree with you on SSB only for the phone bands. AM is dead. Let's bury it.

D. G. Thibault WØNLH
Chesterfield, Missouri

Dear 73:

Isn't it time u wr eliminated? DSB would defeat ur narrow bandwidth. I prefer AM for audio quality. SSB has no base power. It sounds rotten and I've listened on a lot of new rcvrs too. Splatter is terrible. SSB commercial fad—I don't want a xcvr.. Even if you can make 1 kc precision gear—but u will never hve perfect operators!! It isn't the gear so much as these sloppy unrespectful operators on the air, particularly SSBers. What about static on SSB—ha ha. Wipes out SSB. SSB—Scientific Step Backward.

John Fickeisen WB2IQE
Moravia, New York

Punctuation ours—grammar his!

Dear 73:

Fine business on your June editorial . . .

Ralph Campbell W4KAE
Lexington, Kentucky

Dear 73:

Sideband is on the way out just a matter of a few more years like the FM fad in the 1950's.

R. Homrighausen WØUBI
Paloa, Kansas

Ferrite Beads

Dear 73:

In connection with the **Ferrite Bead** article (*73*, April, 1967), I seem to have made an oversight.

Although the photo shows the bead on a dime, it is not necessary that a dime be incoroprated into the circuit. In the event that a dime is used as a pallet for the bead, it is not necessary that the dime be grounded.

The bead people say that they used the dime to show the relative size of the component, but I suspect that they did this to confound any oriental imitators.

Joe Williams W6SFM
North Hollywood, Calif.

Happiness

Dear 73:

Happiness is receiving the June issue of 73 Magazine on May 31. Your new circulation manager is OK!

R. F. Herbig W6MCS
Arroyo Grande, Calif.

Dear 73:

. . . You really surpass QST and CQ. Keep up those great articles.

Bob WN3FNT

Phone Patching

Dear 73:

The article on phone patches by K8BLL was very good and covered the aspects of patching well. There is one point, however, he has overlooked.

As an ex-Ohio-Bell man, I have delved into company tariff regulations. There is a tariff for all telephone companies allowing for customer owned and maintained equipment. This allows large concerns to attach their own radio equipment to telephone company lines. The tariff requires that the equipment be maintained, and to be removed in case of difficulty with the lines until the trouble is located. There is no rate for this tariff. The tariff books are available at the telephone company office and can be examined upon demand.

If large companies can attach **their** radio equipment to telephone company lines, there should be no reason an amateur can not. Also, to keep cross-talk down, do not let voice peaks from the receiver hit the telephone line at more than +3 dBm.

Jan Underdown K8LUR
Napoleon, Ohio

Youth in Ham Radio

Dear 73:

I have just finished reading your editorial in the May 73 **Magazine** and would like to inform you that some of us are doing something to interest youth in amateur radio. Perhaps I can pass along a suggestion which may well help other groups in getting an organization started for this purpose.

The exploring program of the Boy Scouts of America offers a perfect opportunity for any amateur radio club or organized group of interested persons to sponsor a program for boys specializing in any of the hobby interests.

The Toledo Mobile Radio Association Incorporated has just finished organizing an Explorer Post for boys of high school age in the Toledo area. The specialty of this post is, of course, amateur radio. Starting with eight boys two months ago, the number attending meetings is already up to fifteen and expected by the end of the first year are between thirty and fifty boys in the program. The sponsoring organization provides its name, leadership, and a meeting place. TMRA has provided twelve adults for the Explorer Post Com-

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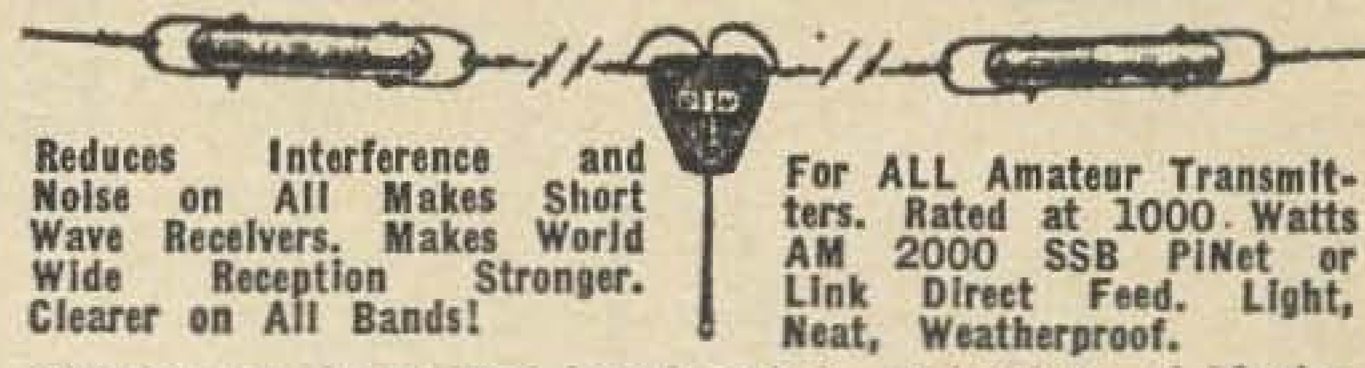

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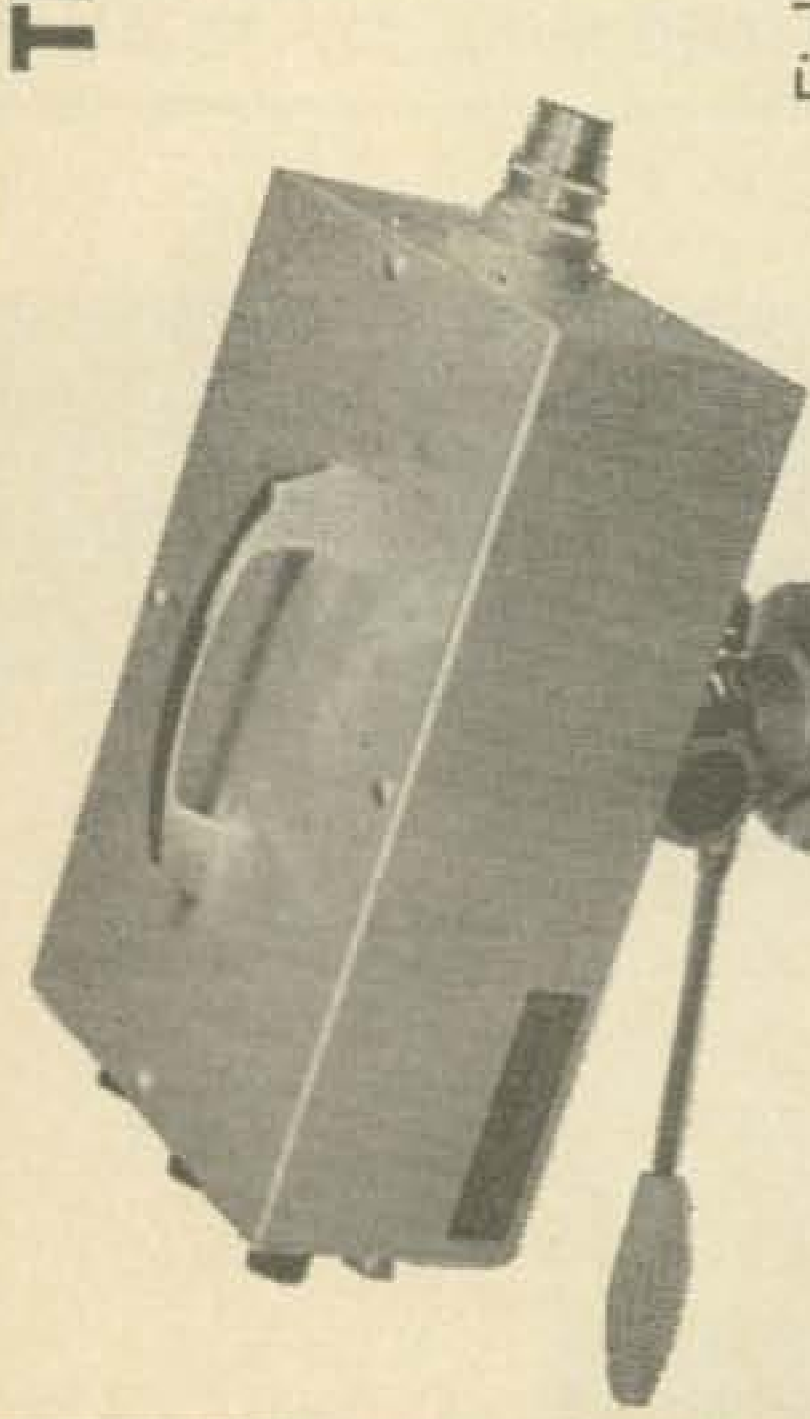

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ATV RESEARCH

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mittee and made arrangements for using Start High School in Toledo as a meeting place for the boys. Classes in code and theory are provided by the post leaders, while lectures and demonstrations by specialists within the club are put on a volunteer basis. Club members are also opening up their junk boxes and unused rigs for the boys as they become licensed. Plans are under way to have the entire post participate with the club on field day.

Any amateur radio club or organization interested in public service needs only to contact their local Boy Scout Service Center to get full information on the organization and operation of such a unit.

Bill Smith K8LFI
Explorer Post 73
Toledo, Ohio

Break-in

Dear 73:

The influx of "Break — Break," "10-4," "Charlie — Charlie," "Roger," "Over," "Go-ahead" boys is maddening. Nothing is more obnoxious to me than to hear "Break — Break" when I'm right in the middle of a good conversation.

Most of these "Break — Break" boys, so I'm told come from the military, but I bet some are converted CB'ers, and still others fresh from fillibustering ancient modulators. Regardless of origin—is not good English the better way? Why not join in a QSO, rather than "Break" it. Say "This is W5XXX — may I join you?" or maybe even, "Hello Bill," if you know someone in the QSO.

Another thing, why fillibuster on SSB? Use VOX for realistic type conversations. You sound better and get more out of it. Push-to-talk is quick enough too. If a question is asked, you can answer it immediately. If the signal fades momentarily, you can repeat. What could be more natural?

Just listening to an old AM type fillibuster is boring. They sound like they are settling down for the night sometimes. There are long periods of silence (key still down), heavy breathing or chewing, and many yawns and repeats of what was said ten minutes ago. As far as I'm concerned, there was only one advantage to fillibustering; it gave the guy on the other end a chance to read the newspaper.

Well of course, all of this is my opinion. Is it fact? You be the judge. Amateurs are an independent lot, and everyone has his own ideas of what's best for him and the fraternity. And of course, he can do what he pleases—within bounds. But, I'm asking for help. Let's campaign for better English. Let's have names—not handles.

John Gee K5AMF
Dallas, Texas 75228

Help Needed

Dear 73:

Our Red Shield Youth Center is in the process of organizing a radio club, and we have already secured our ham radio license. We are now in the process of securing the proper equipment, but we are still in need of one or two men who would be qualified to head up this club. I thought that perhaps your organization would be able to put me in touch with someone who might be interested in being the leader of our club. We serve children from ages six to eighteen who come from a financially deprived neighborhood, and so volunteer help is necessary for us to carry out many of our activities; therefore, we need a man or two who would be willing to donate a few hours once a week or so as a leader of our amateur radio club.

G. P. Alexander, Director
The Salvation Army
Red Shield Youth Center
711 N. E. Dekum Street
Portland, Oregon

Are there any Portland hams who can aid in this worthy cause?

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Technical Aid Group

The members of *73's* Technical Aid Group are listed below. They are willing to help other hams with their technical problems. If you have a question about ham radio which can be answered adequately through the mail, write to one of the Volunteer TAG members whose specialty encompasses your query. Please write legibly and include a self-addressed stamped envelope with your request.

If you feel you are qualified to help other hams and would like to join the Technical Aid Group, write for complete details. To do the most good and to provide the best coverage, we need TAG members in all parts of the country. Right now all US call areas except W1 are represented as well as Europe and South America.

Although 73 will help the Technical Aid Group with organizational help and publicity, we want it to be a ham-to-ham group helping anyone who needs help, whether they are 73 readers or not.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on *any* subject.

Jim Ashe W2DXH, R.D. 1, Freeville, New York. Test equipment, general.

G. H. Krauss WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Don Nelson WB2EGZ, EE, 9 Greenridge Road, Ashland, New Jersey 08034. VHF antennas and converters, semiconductors, selection and application of vacuum tubes.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD728, FPO San Francisco, California 96601. General.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611. TV, AM, SSB, receivers, VHF converters, semiconductors, test, general, product data.

Theodore Cohen W9VZL/3, BS, MS, PhD, 261 Congressional Lane, Apartment 407, Rockville, Maryland 20852. Amateur TV, both conventional and slow-scan.

James Venable K4YZE, MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042. General.

Wayne Malone W8JRC/4, BSEE, 3120 Alice Street, West Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's, commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Tom O'Hara W6ORG, 10253 East Nadine, Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters, receivers, semiconductors, and general questions.

Hugh Wells W6WTU, BA, 1411 18th Street, Manhattan Beach, California 90266. AM, receivers, mobile, test equipment, surplus repeaters.

Howard Krawetz WA6WUI, BS, 654 Barnsley Way, Sunnyvale, California 94087. HF antennas, AM, general.

Howard Pyle W7OE, 3434–74th Avenue, S.E., Mercer Island, Woshington 98040. Novice help.

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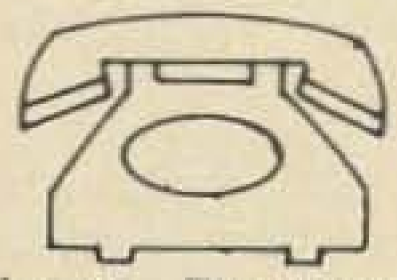

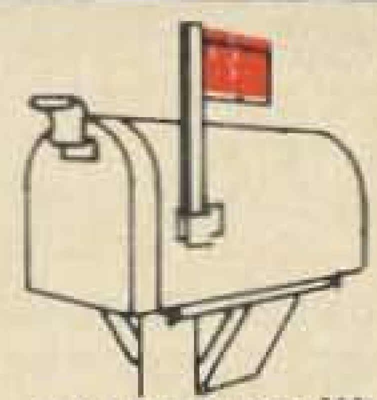

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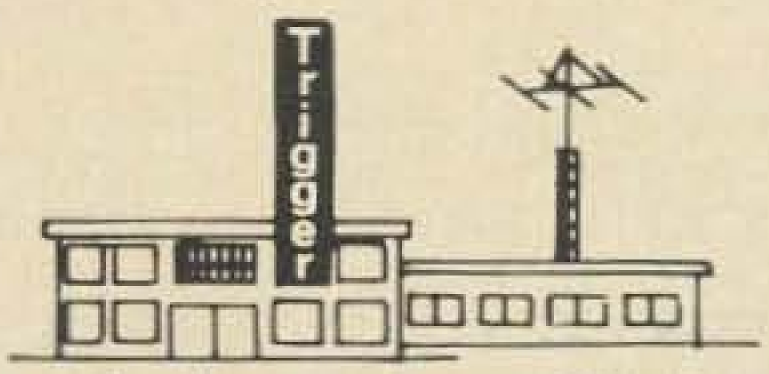

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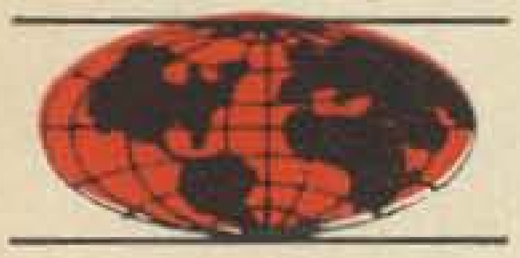

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CE-100V serial 790. Mint condition, little used. Original carton, manual and pair of spare 6550's. $400.00, W3NKS, 312 West Timonium Road, Timonium, MD 21093.

TEKTRONIX 511AD scope, 10 MHz bandwidth, good shape with instruction book. $150. Paul Franson, WA1CCH, 38 Heritage Rd., Acton, Mass. 01720.

SOUTH HILLS BRASS POUNDERS & MODULATORS 27th annual hamfest will be held August 6th at St. Clair Beach, 5 miles south of Pittsburgh, Penna., on route 19. For further information write W3WFR, 1500 Tretter Drive, Pittsburgh, Pa.

QUAD CITY AMATEUR RADIO CLUB, of Moline, Illinois, and the Davenport Amateur Radio Club, of Davenport, Iowa, will hold a hamfest Sunday, August 20th, at Fairy Land Park, route 61, 12 miles north of Davenport, beginning at 8 A.M. Trunk sales, prizes, hidden xmtr hunt (6 meter and CB). Advance ticket donations: $1.40 or 3/$4. Contact Wayne Youngberg, WA9RDG, 2308 Stadium Dr., Rock Island, Illinois.

WANTED: Instruction manual for the Hallicrafters S-27 UHF receiver or copy. I will make copies if there is a manual available for loan. W1DTY, RFD 1, Box 138, Rindge, N.H. 03461.

SOUTHWESTERN/PACIFIC DIVISIONS ARRL CONVENTION September 8-10, Ambassador Hotel, Los Angeles. Registration $2 (with banquet $10) until Aug. 15; thereafter $3 and $12. Checks to "ARRL Convention", and send to Box 3151, Van Nuys, Calif. 91405.

SIX METER CLUB OF CHICAGO, Tenth annual picnic and mobile meet, Sunday, August 6th, at Picnic Grove, on Route 45 one mile north of Route 30, Frankfort, Illinois. For further information write Alfred Bagdon, K9YJQ, Chairman, 7804 W. 66th Place, Bedford Park (Argo P.O.), Illinois 60501.

INTERNATIONAL CHC/FHC CONVENTION: Third annual convention, at Stouffer's Inn, 120 W. Broadway, Louisville, Ky., August 3, 4 and 5, 1967. For further information write Fred Gleeson, WA4LMD, Box 20114, Louisville, Ky. 40220.

ALBERTA CENTENNIAL Amateur Radio Convention. Calgary, Alberta, Canada, July 8-9, 1967. Write to VE6NQ, Box 592, Calgary, Alberta, for full information.

ST. LOUIS COUNTY, MISSOURI: Second annual hamfest of the Suburban Radio Club, Sunday, July 30th, 1967, at Creve Coeur Lake Memorial Park, St. Louis County. For further information write Joe Owings, KØAHD, Suburban Radio Club, 10217 St. Daniel Lane, St. Ann, Mo. 63074.

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IOWA 75 METER PHONE NET will hold its annual picnic on Sunday, August 13th at McHose Park, Boone, Iowa. Hams and their families are invited; please bring a covered dish and your own table service. Soft drinks will be available. Prizes and guest speaker. For more information, write to Ray Pollock WAØFFN, Mt. Auburn, Iowa.

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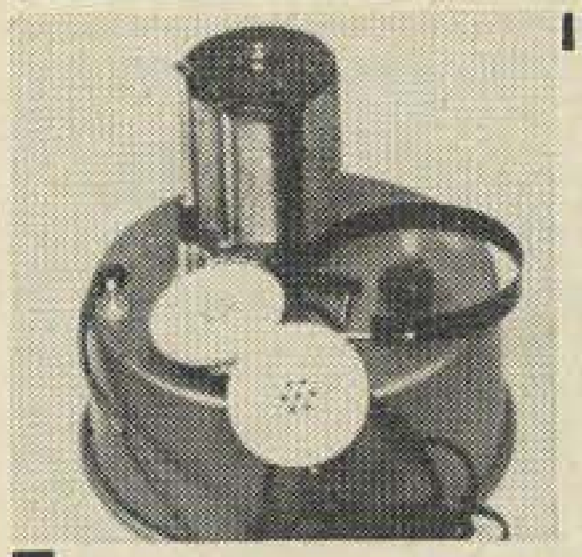

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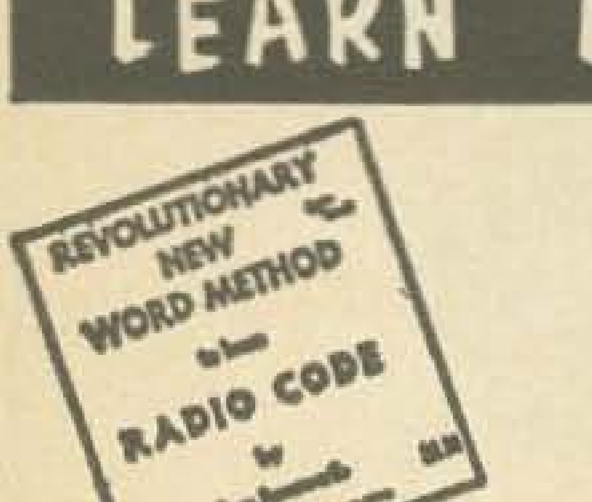

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SB-300 with SSB, AM and CW filters plus 2 M converter, $275; HO-10 monitor scope, $50; HO-13 Ham Scan, $70; like new with manuals. Ed Jurow, 20314 Harding, Olympia Fields, Illinois, 60461.

CUYAHOGA COUNTY, Ohio, call book with cross index, zones and radio clubs, $1.50. H. Bormann, W8CZM, 3671 W 129 St., Cleveland, Ohio.

JOHNSON INVADER 2000 new, $1000; Tapetone receiver with 2 M converter, $225; Valiant, Harvey-Wells TBS-50D; Send for list. Thomas, 11 Sussex North, Lindsay, Ontario, Canada.

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HEATH HW-12, $90. HW-32, $85. Or both for $160. Excellent condition and clean. Robert Shaw, W9EII, Box 154, Rankin, Illinois, phone 217-397-6211.

NEW JERSEY, Southern Counties A.R.A., Hamfest and picnic, Sunday, August 27. Egg Harbor Lake, Egg Harbor City, N.J. Off route 50, 3 miles north of route 30. Family affair, lake bathing, children's events, shaded picnic area, in addition to swapshop, auction and door prizes. $1 single registration or $1.50 for family. Talk-in 50.2 and 147 mcs. Other details, C. J. Hobart, Jr., 313 Shore Road, Northfield, N.J. 08225.

TELREX tri-band model TB7E, exellent condition with spec sheets, priced to sell. 100 ft. CPH Amphenol RG8/U, $8. Jack R. Hildreth, 1 Stonehill Dr., Apt. 3K, Stoneham, Mass. 02180, phone 617-438-0755.

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HAMMARLUND HQ-110A communications receiver, mint condition, $150. Heath Seneca 2&6 meter transmitter late model, $100, excellent condition. Heath 2 meter converter model XC-2, best offer. Lafayette HE-45B 6 meter transceiver, $50. Karl O. Anderson, 36 Elm St., Mayville, NY 14757.

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NOVICE AND TECHNICIAN HANDBOOK by W6SAI and W6TNS. Limited quantity for only $2.50 each. 73 Magazine, Peterborough, N.H. 03458.

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"SAROC" Sahara Amateur Radio Operators Convention 4-7 January, third annual fun convention hosted by the Southern Nevada Amateur Radio Club. Designed for exhibitors and participants at Hotel Sahara, Las Vegas, Nevada. MARS seminar, Army, Airforce and Navy representatives. Ladies luncheon with crazy hat contest, hat should convey amateur radio theme. Plus fabulous entertainment as only Las Vegas can present, Registration fee includes three cocktail parties, Hotel Sahara show, hunt breakfast, technical sessions, admission to leading manufacturers and sales exhibits. Advance registration closes one January, QSP, QSL with ZIP and telephone number for details to Southern Nevada Amateur Radio Club, Box 73, Boulder City, Nevada 89005.

MONCTON AREA AMATEUR RADIO CLUB, is sponsoring Atlantic Centennial Amateur Radio Convention, at the Brunswick Hotel, Moncton, New Brunswick, September 2-4. Contact Mrs. Audrey Hughes, Chairman of the Registration Committee, at P. O. Box 115, Moncton, New Brunswick, Canada. U.S. Hams planning to attend this should waste no time writing the Department of Transport, Ottawa, Canada, to arrange a permit to operate when there.

LANIERLAND AMATEUR RADIO CLUB of Gainesville, Georgia, will hold its annual Hamnic on August 6th, to help support its great work of providing radio equipment for disabled amateurs in the North Georgia area. Contact the club at P. O. Box 150, Gainesville, Georgia, 30501, for information as to location and time of this meeting.

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W9 DX CENTURY CLUB will hold this year's meeting on September 16 at Holiday Inn of Chicago—O'Hare, Schiller Park, Illinois. G2MI, RSGB QSL Bureau, will be guest DX personality.

INTERNATIONAL FIELD DAY 9 A.M., August 13th, at Cliffside Country Club, Burlington, Vermont, sponsored by Burlington Amateur Radio Club, Inc. Busy day for OM, XYL and JRs. Contests, Bingo, Chicken barbecue at noon, Special Trio for the teenagers. Swap-shop and auction, Net meetings, Swimming, Boating, Eye-ball QSO's. Talk-in freqs. 3909 SSB, 3855 AM, 146.94 FM-146.34 FM (Rep.). Door prizes, Raffles, $3.00 at the gate, $2.50. Early Bird registration. Send early registrations to W1OKH, Lloyd Tucker, Box 16, Essex Center, Vt.

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FAIRBANKS ALASKA CENTENNIAL EXPOSITION, KL7ACS is official exposition station. Visitors call in on 3866 or 145.35. Informal get-togethers, Kings Kup, Noble Street, noon Saturdays. Commemorative QSLs sent. Exposition runs May 27 through September 21st.

SELECTRONIX AUDIO FILTER, use between receiver and speaker or phones, cuts monkey chatter and narrows band pass to about 1000 Hz. Some QSO's possible only with this in circuit. $24.95 pp. WØRA/1, Box 115, Greenfield, N.H. 03047.

THE LONG ISLAND HAMFEST will be held at Hempstead Town Park, Point Lookout, Long Island, N.Y., on Sunday, July 16th beginning at 9:00 A.M. Bring your family and enjoy the fun. For further information write Federation of L. I. Radio Clubs, Box 304, Long Beach, N.Y.

CAPE KENNEDY HAMFEST, sponsored by Platinum Coast Amateur Radio Society. Second annual hamfest, at the civic auditorium, Melbourne, Florida, August 26 and 27. Home-making and flower shows. Swap tables and equipment auction the hit of the 1966 hamfest. Give-away every hour, and of course BIG, BIG door prizes. Fun for the XYL, the kiddies and the OM himself. For information write Box 1004, Melbourne, Florida.

DELAWARE HAMFEST will be held August 27 at Banning Park, Wilmington, Delaware. Rain date: September 3. For more information, contact Bill Robinson, 204 W. Delaware Ave., Wilmington 19809.

DONATE YOUR EYES SO THAT ANOTHER MAY SEE

Great advances have been made over the past 25 years in the repair of damaged corneas, the clear substance that covers the pupils of your eyes. The only material that can be used to make these repairs comes from other eyes—those WILLED by their owners for removal within 4 hours after death, and the degree of success in these operations is astonishingly high.

Hundreds of people every year are able to see again because of these donations, but even so the availability of eye material is so limited that the majority of the over 75,000 who should have this surgery will not live long enough.

The need now is for hundreds of thousands of additional pledges to produce an ever increasing availability. A thousand pledges today may produce no material for many years, so the greater the pledge group, especially among the upper age levels, the greater the chance that many of those who need this transplantation will indeed live to see again.

Obtaining these pledges has been a project of Lions Clubs in many cities, and their members, or Doctors and Hospital Administrators, can direct you to a source of pledge cards which you and your family must complete to make an eye donation valid. Here is a project for entire families. What greater gift could you give to a fellow man!

Amateur Radio's participation in this work can be heard every day of the year on 3970 kHz, currently at 7 A.M. and 8 P.M. EST, as the Eyebank Network locates the availability of and/or the need for corneal transplant material among the nations 57 Eye-Banks.

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400	.12
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800	.25
1000	.50
1200	.65
1400	.85
1600	1.00
1800	1.20

Silicon Control Rectifier

PRV	3A	7A	20A
50	.35	.50	.80
100	.50	.70	1.35
200	.75	1.05	1.90
300	1.25	1.60	2.45
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200	☐ 80	☐ 1.05	☐ 1.30	☐ 1.70
300	☐ 1.05	☐ 1.60	☐ 1.90	☐ 2.20
400	☐ 1.60	☐ 2.10	☐ 2.30	☐ 2.70
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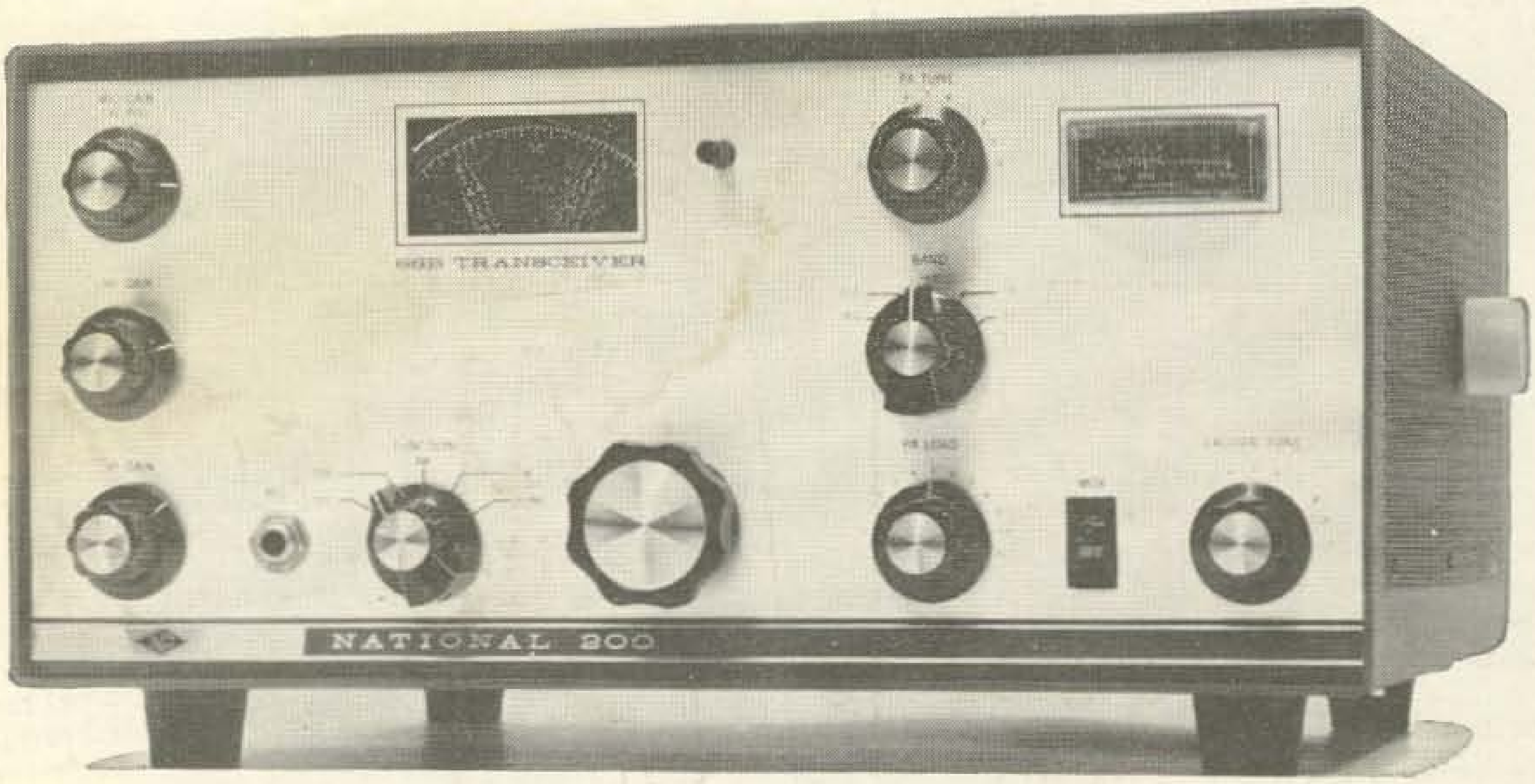

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