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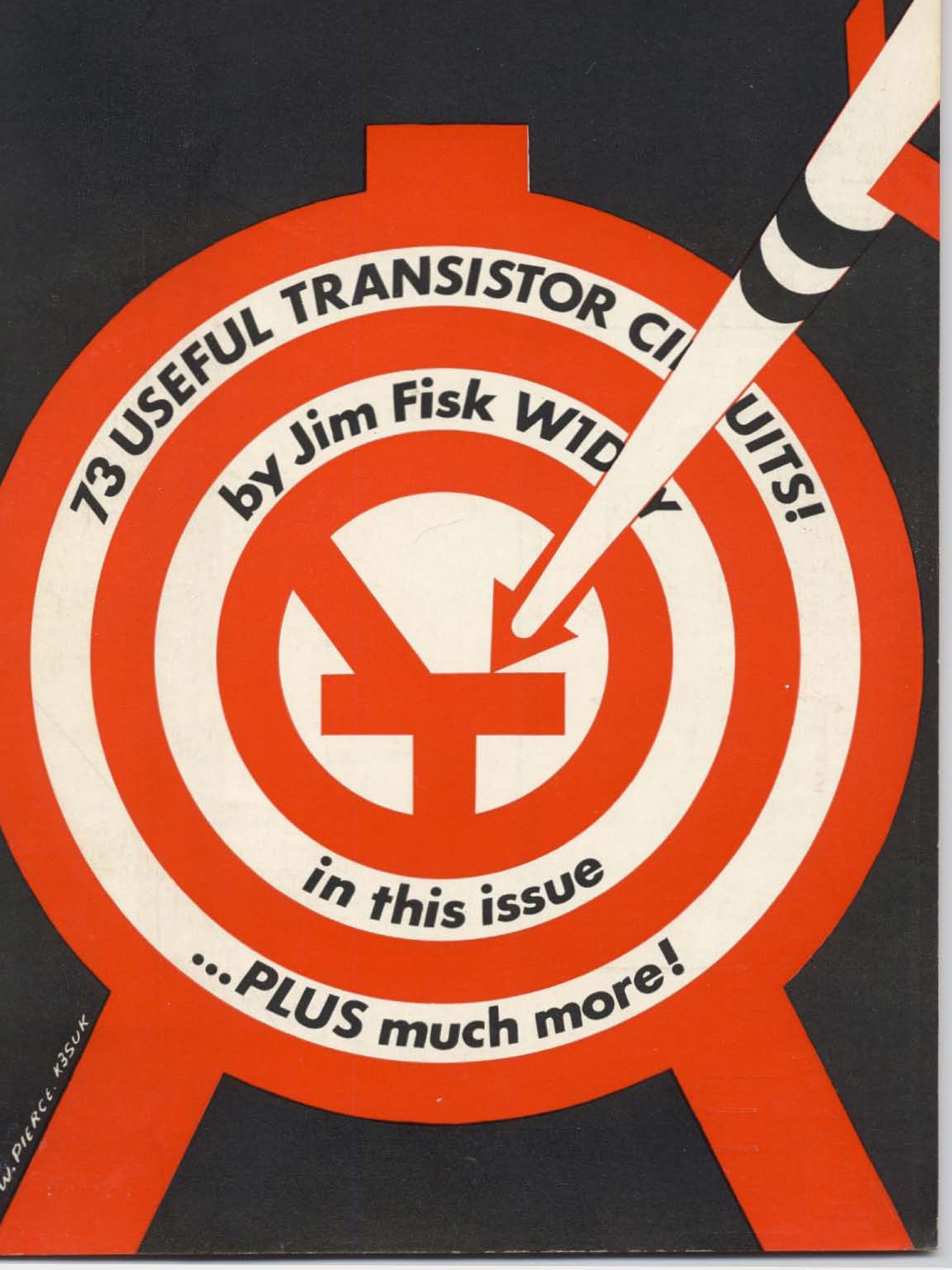

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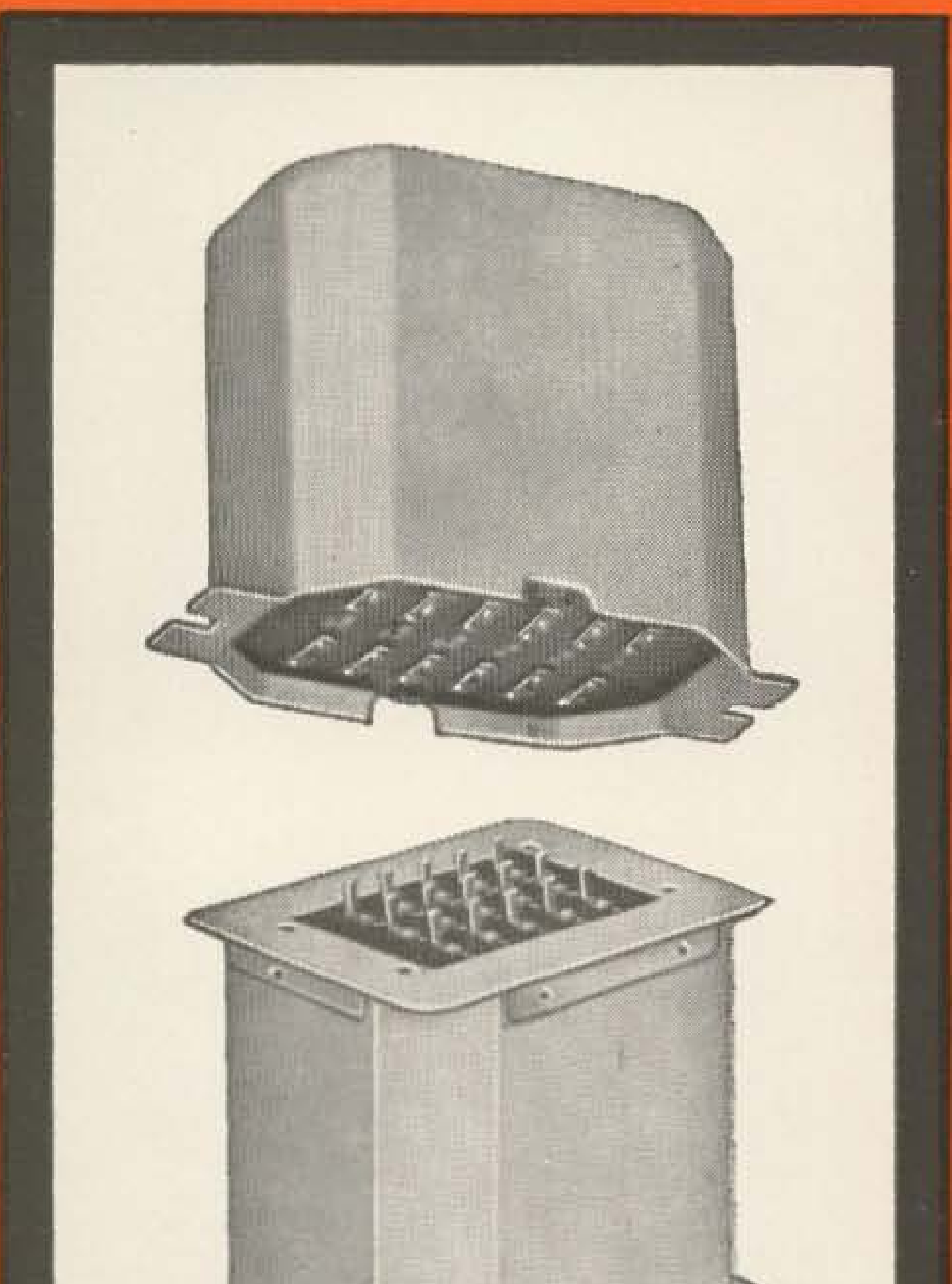

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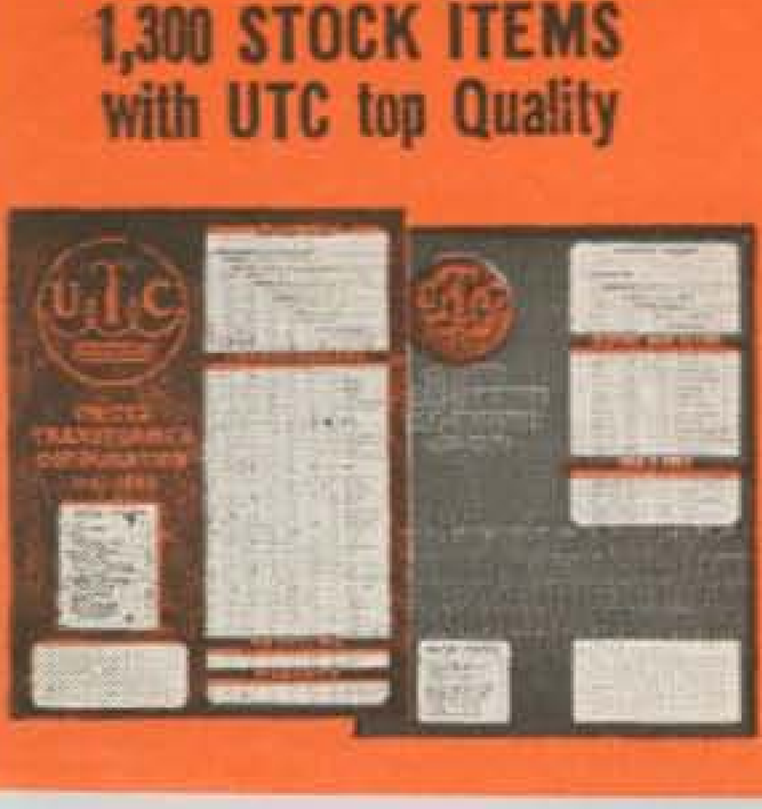

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de W2NSD/1

never say die

I see that ARRL is still leaving no stone unturned to try and kill off the Institute of Amateur Radio. They've done their usual thorough job of making sure that the League is the only national amateur organization. Not that the Institute is dead, by any means, it's just a definite unsuccess.

The responsibility for the failure of the Institute to succeed is largely mine. I know when I started it that it would be fought by every means possible by the ARRL and I was sure that CQ would be as truthful as usual in reporting about it. But I am an incurable idealist and somehow convinced myself that enough amateurs would be interested in helping to keep amateur radio going to overcome the barrage of lies and distortions.

Let me go back and explain. As one of the three officially recognized amateur radio delegates to the 1959 ITU conference I had an opportunity to see at first hand the workings of that organization. I was incredulous that amateur radio went into that conference almost totally unprepared. I felt that we had been deceived and completely failed by the ARRL. I watched the two League representatives living it up in millionaire style . . . they managed to spend over $15,000 of the ARRL funds in just a few weeks. The complete failure of the League to get support for amateur radio, even within the U.S. delegation, was incredible. I talked with the other members of our delegation to find out what had gone wrong and what could be done to see that this didn't happen again.

I'm afraid that they all thought I was very naive . . . and I guess I was. *I had not recognized just how important Washington was until then.* This is where everything comes to a head . . . this is where it happens. Each of these gentlemen explained patiently to me that amateur radio was at the very bottom of their list as far as priority in frequency allocations was concerned and that it would remain that way as long as we did not pressure where it counts: on Congress.

They pointed out that every other major user of radio frequencies maintains a lobby in Washington to look after their interests. They wondered if I thought that all this money would be spent on lobbies if they weren't well worth the investment? Then they brought up the fact that every other major hobby group looks after the interests of their field by having a voice in Washington. I certainly can't argue the effectiveness of the American Rifle Association, the Aircraft Owners and Pilots Association, and many others.

Amateur radio, they laughed, has no voice in Washington. But what about the League counsel in Washington? No, son, this gentleman can only represent the ARRL in dealings before the FCC and cannot, by law, approach any Senators or Congressmen in behalf of the League. No, if the League were to lobby for amateur radio in any way they would have to give up their tax-free setup and operate as a regular business. The law just does not permit tax-free organizations to try to influence legislation.

If a voice in Washington is of such great importance, why is it, I asked, that the ARRL doesn't give up its tax-free situation and do the job that will protect our future? They are the obvious ones to be lobbying for amateur radio. The answer was dollars, of course. Loss of the tax-free government subsidy of the League might cost them well over $100,000 a year, forcing them to either increase the subscription rates to QST or else cut down on the number of high salaries being paid. Neither course is desirable so we have no lobbying permitted by the League.

By 1963, 73 had reached a size where I thought we might be able to get something started to fill in this lobby gap in amateur radio. Time seemed to be growing short too, for in 1959 the USSR came to our rescue and put off the changes in our frequencies until the next ITU conference and this seemed to be headed for us in the late 1960's, leaving not much time for building up support both within the U.S. and internationally. The Institute of Amateur Radio was formed with the major job of lobbying for our hobby in Washington.

It was never the purpose of the Institute to compete with the ARRL as an alternate organization for amateurs to join. The In-

(*Continued on page* 114)

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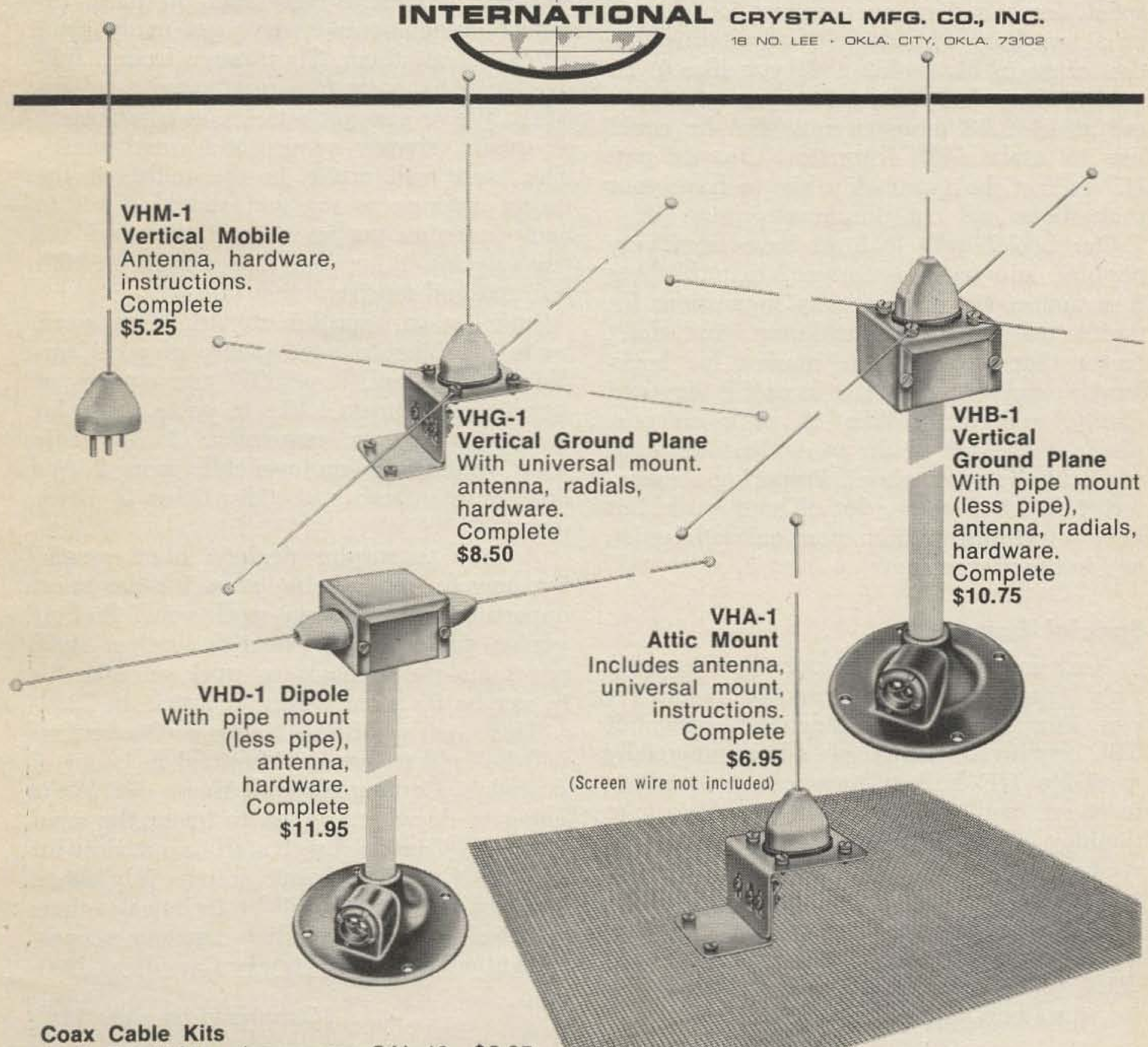

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Editor's Ramblings

Paul Franson WA1CCH

Special features

Have you looked through this 73 yet? If not, thumb through quickly. We've got a special feature for you in this issue. It's the book(let)-length article, "73 Useful transistor Circuits." Jim Fisk W1DTY has spent a lot of time and work on this feature; from the looks of the results, the time was well spent, for he's done an excellent job. It will be a rare ham who doesn't consult this section often in his building. If you like it, be sure to drop Jim a line. I suspect that he's got at least 73 more circuits that he could use to make "73 Transistor Circuits part II." In fact, he'd probably like to have your suggestions and contributions for part II.

Our book-length features have been very popular, and we look forward to publishing many more. If you have any suggestions for topics, be sure to let us know. And don't forget that we're in the market for book-length manuscripts. If you have the time and ability, and would like to work on one, please write me with an outline of what you'd like to write about. Preparing a manuscript of this type is a lot of hard work, but very rewarding in both personal satisfaction and in the payment.

Special issues

Next month's issue is our April special. This April, we've got a double bonus for you. First, we'll have a sideband section. It will contain a listing of all commercially available HF SSB transceivers, transmitter-receivers and linear amplifiers. If you're thinking about buying some sideband gear, reading this section is a must! You'll want to study the specifications, descriptions, photographs and comparisons of all the gear. In fact, you'll have a strong will if you don't rush to your dealer or mail in an order for some new equipment after reading it.

The second special feature in April is too horrible for words and too secret to divulge. We can't let the rat out of the bag yet, but we will warn you: Be Prepared. It's even worse than last April's Playboy spoof. I suspect that 777 people will cancel their subscriptions after seeing it.

Our May issue will be devoted to quads. Amateur interest is very high in these excellent antennas, and we've get many good articles about them. They range from a full-size quad for forty to a quad-quad-quad for VHF. We've also got articles on construction of quads, simple quads, and quad masts. This issue will arrive in the midst of the spring antenna season and should result in many antenna parties around the world as hams decide to improve their signals on both transmit and receive.

June is our surplus month. This year, we're planning to have plenty of good surplus articles and, hopefully, many pages of surplus ads. If you'd like to write a surplus conversion for us, remember: 1. We only want conversions on available gear. 2. We don't want rehashes of old articles. 3. Do it now.

A note to surplus dealers: Start preparing now for our surplus issue. It's the finest opportunity to sell your stock you'll find. If you've got a lot of presently useless stuff, put some clever hams to work on uses for it; maybe it's even worth an article in 73.

This year's ARRL National Convention will be held in July in Montreal in honor of Canada's Centennial and Expo 67. We're going to do what we can to honor the amateurs of Canada by featuring articles for and by Canadian hams in our July issue. Many of the articles will be technical; others will look at the Canadian amateur scene—the ridiculously high prices Canadians have

(*Continued on page* 116)

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A Transistorized Digital Identification Generator

Here is a description of an exotic, yet very desirable, unit that will send your call or other information automatically without any motors or other moving parts. It can be built for about $15.

This is a description of a fully automatic, solid state, no moving parts, digital device for storing and generating upon command, a call sign or other message, in the form of dc to operate a keying relay for telegraphy (cw) or a tone to modulate the carrier for mcw. It contains all standard, commonly used, digital circuits; the flip-flop, multivibrator, and diode "and" and "or" circuits. A rough estimate of cost of parts, if you buy components at surplus and quantity prices as we do, totals $15.

Just what does it do? Briefly, you push the button and it sends your call or any other message that you want to "program" into it. When it has sent the message once, it automatically stops and waits for another command. It is not possible to inadvertantly "erase" the message for it is "built-in" with the wiring of the diode memory. Changing the message is a simple task requiring only: 1) the design of the new diode matrix, and 2) wiring the diodes into their new places. A typical call, such as W6YGZ, takes 47 diodes in the memory.

"Necessity is the mother of invention" and such is the case with the identification generator as we will henceforth call it. We needed a cheap and reliable unit for identifying our transmitters for tests under long periods of unattended operation (within legal limits of course). We had considered the other methods. A tape recorder uses moving parts and the tape wears out rapidly. A code wheel or perforated tape unit also uses moving parts. All require frequent attention to alignment, adjustment, or replacement of worn parts including tape. What we needed had to be reliable for long periods of time, cheap, compact, and capable of changing the call with nominal effort.

The digital computer approach was favored because of the authors' background and familiarity. The unit was designed using "digital sequential circuit design techniques", a specialized branch of digital computer design, which is a carry-over from relay circuits.

It is assumed that the reader is familiar with the basic digital circuits; AND, OR, FLIP-FLOP, MULTIVIBRATOR, INVERTER. Several references cited in the bibliography treat the subject well. The QST, August 1965 article gives a quick review.

A diode matrix was chosen for the memory unit because of the author's immediate familiarity with this type of memory. Different types of memory are presently being contemplated including a fixed magnetic core and a programmable magnetic core type.

A characteristic of this unit which is common to all three types of memory mentioned is that the stored message is changeable; requiring the replacing of diodes in the diode matrix, rerouting sense lines in a fixed magnetic core memory, or simply re-storing a new message in the programmable magnetic core type.

One of the basic questions which arises in the initial design is: in what way should the message be broken down and stored?

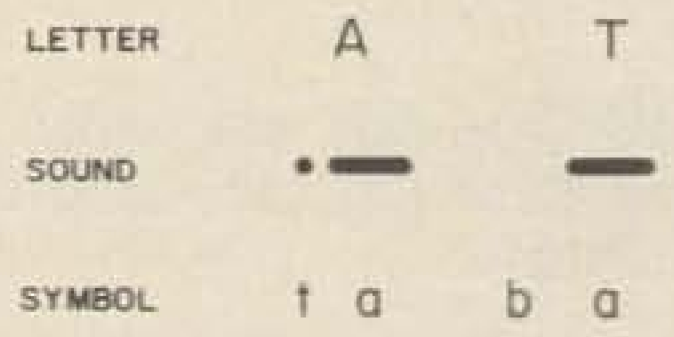
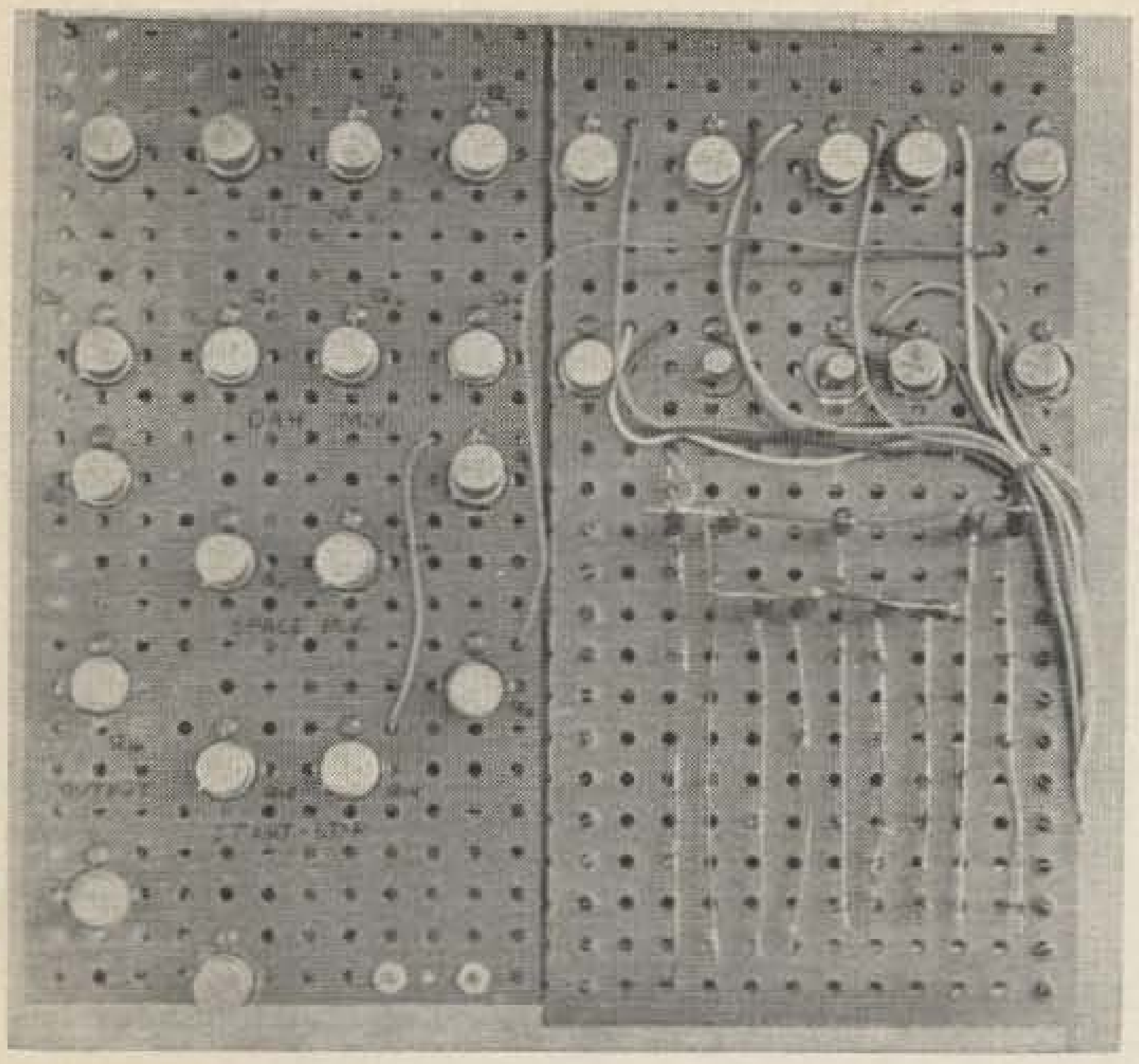


Fig. 1. Graphical representation of the word "at."



Top view of the digital identification generator.

Important criteria in this decision are memory size, circuit complexity, and the ability to store many types of messages. There are three ways in which a message or word can be broken down:

1) By letter. This would require a memory capable of remembering any one of 26 letters, 10 numbers, and certain other characters. It would not require many memory locations. A short message such as a call would only contain 5 or 6 letters and numbers.

2) By character, **i.e.** dot, dash, or blank. This would require a memory capable of storing one of three possible characters. More memory locations would be needed for the same message than for method 1) as each letter would contain from one to six characters (period has 3 dots, 3 dashes). The call W6YGZ contains 23 characters including spaces.

3) By baud. A baud is a telegraphic unit of time, a dot is one baud, a dash is three bauds and a blank is three bauds (the term is more commonly used in teletype). A unit of this type need only remember one of two characters, presence of a baud or no presence. For example, the letter "a" would consist of a single baud followed by a space baud followed by three more bauds for a total of five locations. An advantage to this system is that only one of two characters need be remembered leading to the binary

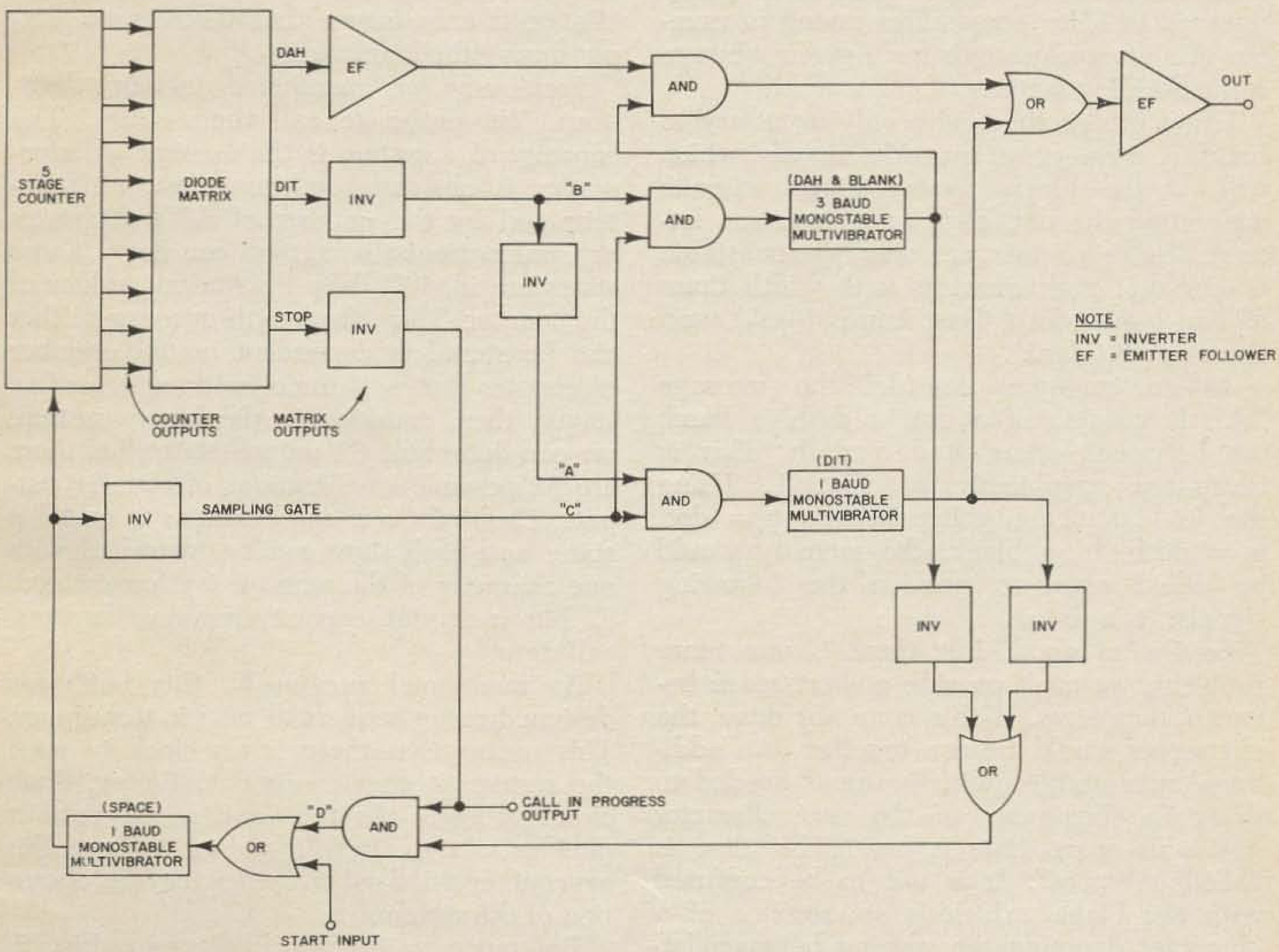


Fig. 2. Block diagram of the automatic code generator.

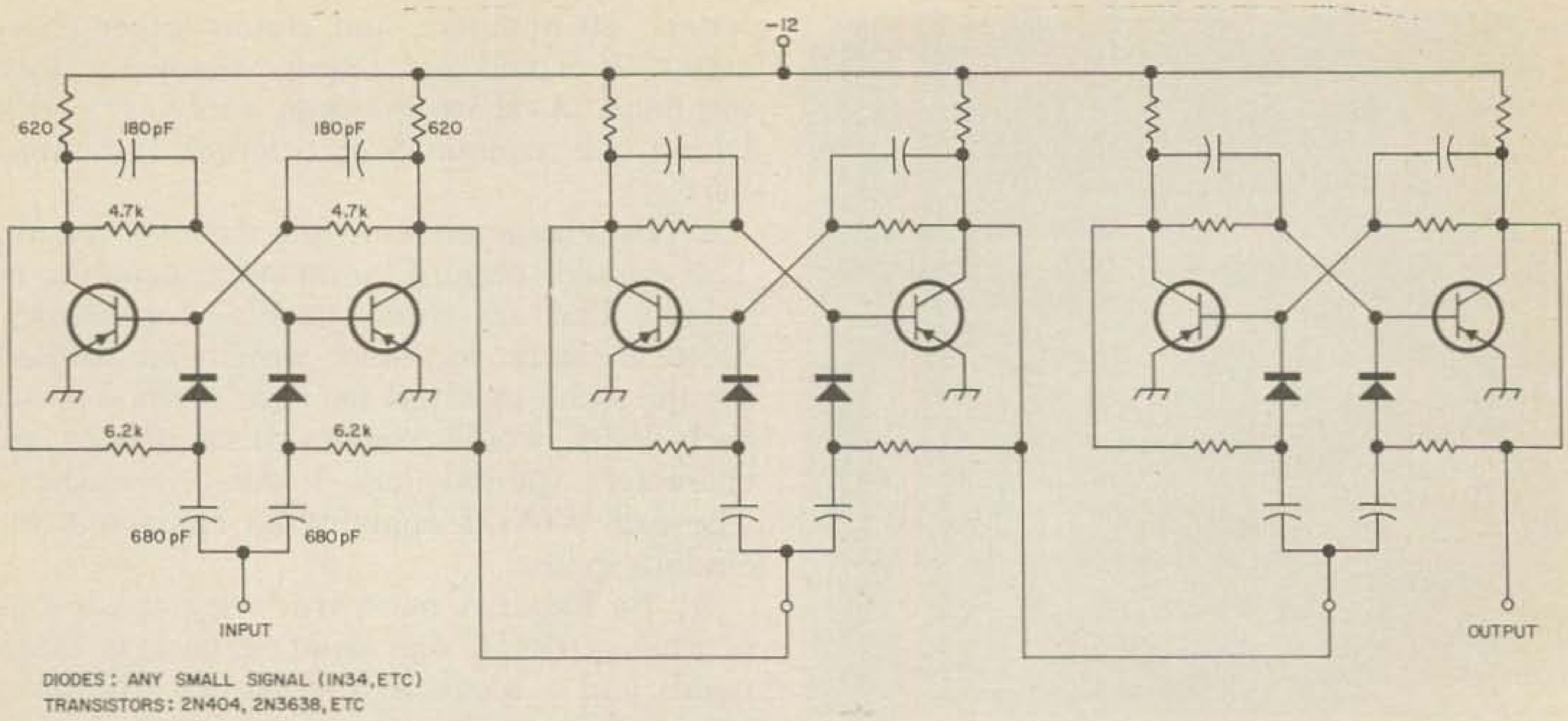


Fig. 3. Typical three stage counter.

system of one, zero, for the memory. The number of locations would be exceedingly large.

Method 2) seemed to be the most practical in light of the criteria involved, so it was chosen for this unit. A memory capable of three characters is only slightly more complex than a two character memory (method 3). The tremendous saving in number of memory locations for a given message is the deciding factor.

Using this method, it is only necessary to build a memory to provide signals which will, at the proper times, trigger circuits generating the dot, dash and blank (no letters). These circuits are simply monostable or one-shot multivibrators with width times of one baud (dot), three bauds (dash), and three bauds (blank).

As an example, consider the message "at". It consists of a dot, a dash, a blank for between letters, and a dash. This is illustrated graphically in **Fig. 1.** Using the following abbreviations; t = dot, a = dash, b = blank, the memory would be called upon to provide the following signals: t a b a.

So far so good, But there is one more problem; we must provide a short space between characters. If this were not done, the characters would be run together. An additional monostable multivibrator is needed to delay the beginning of the next character until this space time is over. This time is called a "space". It is not to be confused with the blank, which is an absence of a character denoting the spacing between letters. The "space" occurs between characters.

We have established that we need four different time segments corresponding to the four parts of the telegraphic code: dot, dash, blank, and space. Since the length of time for the dash is the same as that for blank, it is a simple matter to combine them into one multivibrator; hence, the dash multivibrator doubles as the blank generator. We need only insure that there is no output during the blank time.

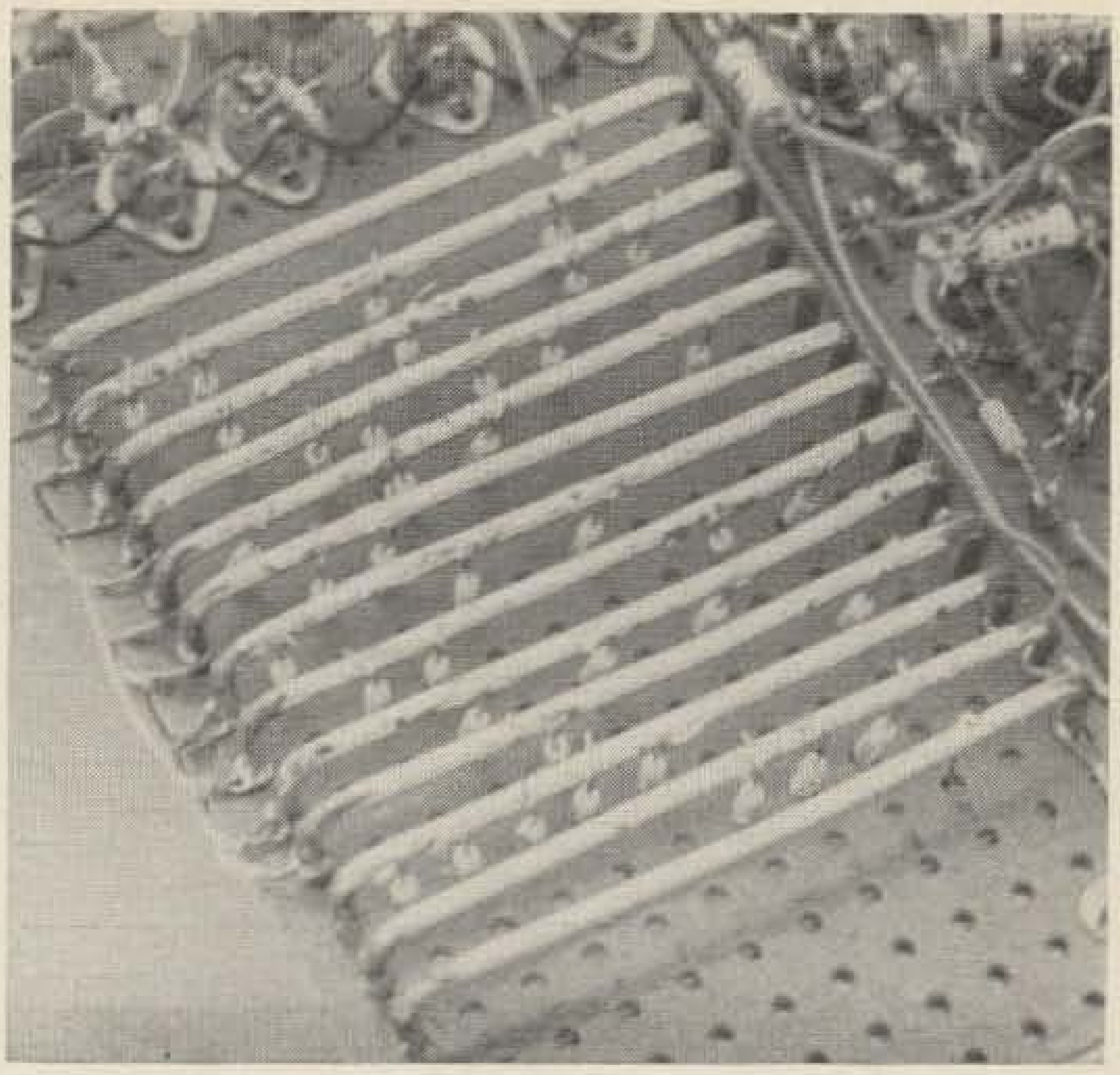
Previously we mentioned memory locations. We prefer to call them states. The capacity of a system is the amount of information it can store and generate and is determined by the number of different states or combinations that system can have. These states are identified by the various values of the counter. Thus, the length of message that can be stored is dependent on the number of counter stages. If the counter contains five stages; then, counting in the binary system, we can determine 32 unique states, i.e. there are 32 possible combinations of counter outputs. Each of these combinations is called a state; and each state can be identified with one character of the message we have stored. 32 bits is enough capacity for most amateur call signs.

As mentioned previously, this unit was designed using sequential circuit techniques. This means that there is no clock to pace the system; it goes on its own timing. Each circuit triggers the next and so on until it decides to stop. It will be best to keep this concept in mind when reviewing the operation of the system.

Reference to the block diagram, **Fig. 2,** will show the main components of the system. They will be discussed in this order; counter, diode matrix, character formation generators (multivibrators), space formation generator, output circuitry.

The counter, a five stage binary counting chain, determines the particular state of the system and hence the next character to be generated. It consists of five bistable circuits or flip-flops which are connected in cascade so as to count input pulses up to 32 then reset. Outputs are taken from each flip-flop and fed to the diode matrix. A diagram of a typical three stage counter with its interconnections is shown in **Fig. 3.**

It is in the diode matrix that the message is stored, hence it is the heart of the system. The matrix intreprets each state of the counter and feeds a signal to one of the character formation generators. "Diode matrix" is just a fancy term meaning a col-



Oblique view of the diode matrix that determines what characters will be generated.

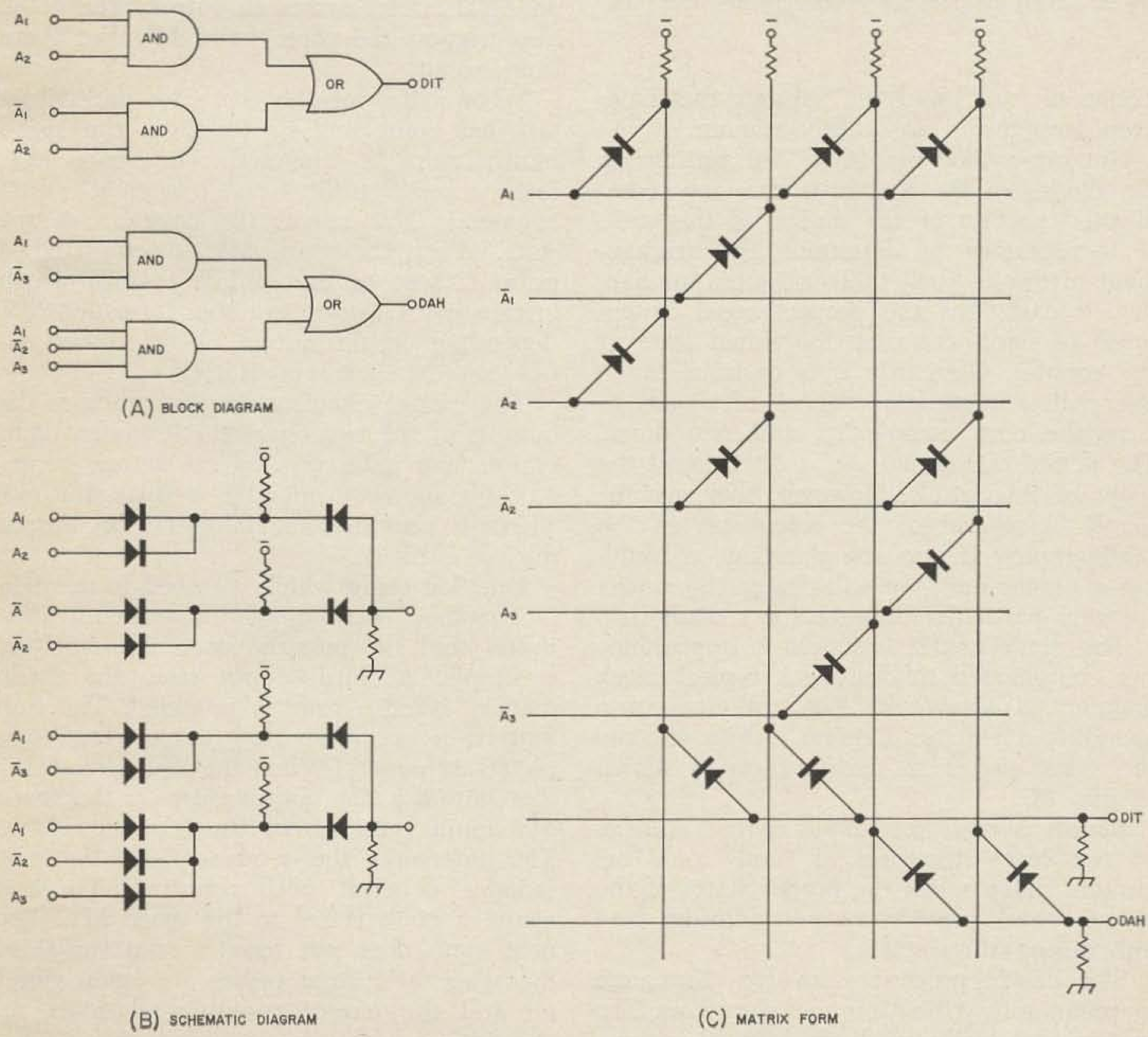


Fig. 4. The diode matrix in three different representations: A. Block diagram. B. Schematic diagram. C. Matrix form.

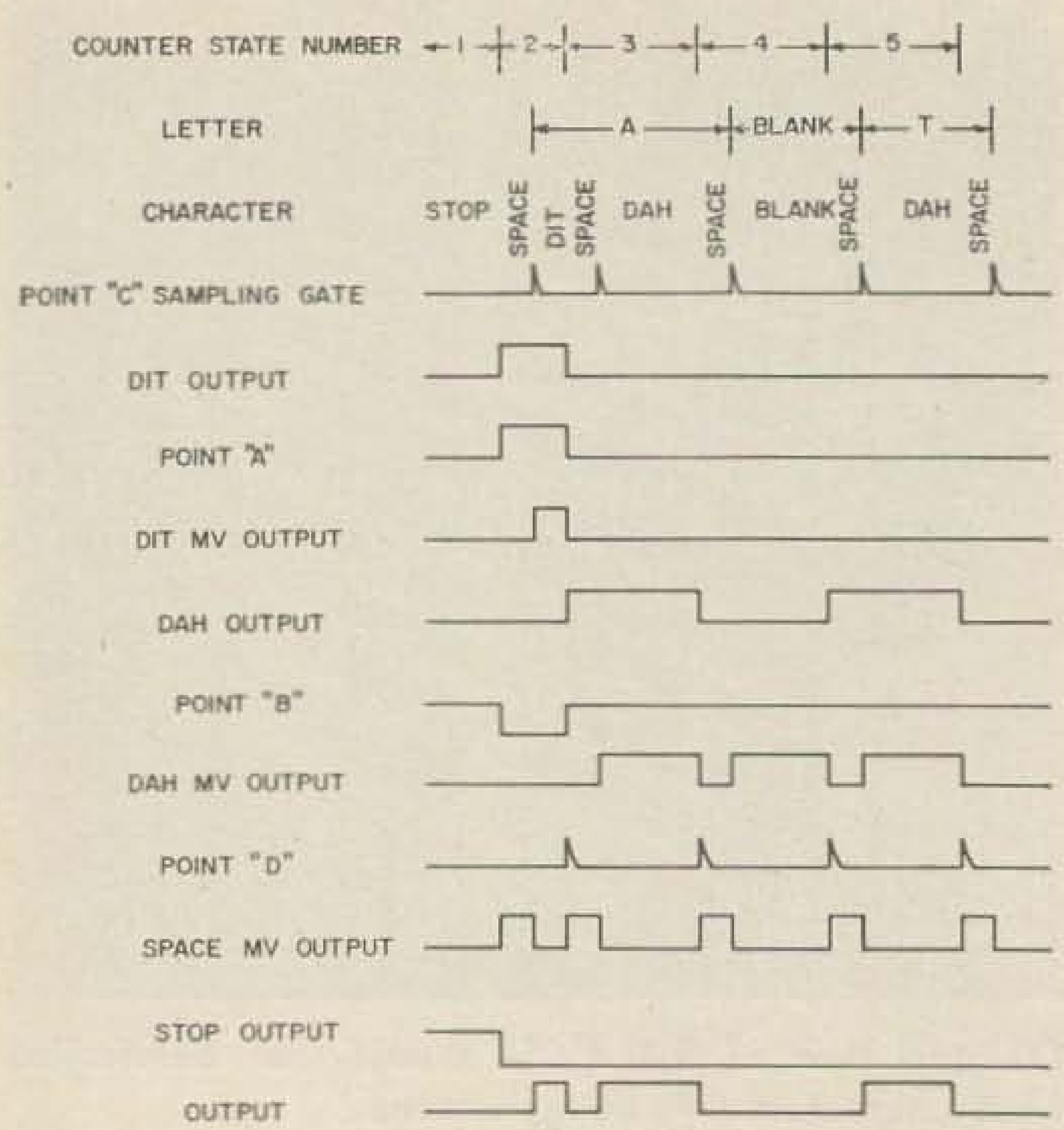


Fig. 5. Timing diagram for generating the word "at."

lection of "and" and "or" circuits that have been arranged in an orderly manner.

Obtaining the "equations" for setting up the diodes in the matrix is the only complicated portion of the design of this unit. It is necessary to determine the arrangement of diodes such that either output line, dot or dash, has the proper signal or absence of signal for each individual state of the counter. Obviously it is desirous to do this with a minimum number of diodes to keep the cost, complexity, and size down. The actual techniques are a bit beyond the scope of this article. However, they may be found in several of the references in the bibliography. If you are planning on building a similar unit, we will design the matrix for your particular message for a small cost.

The diode matrix is simple in appearance but complicated to design. A typical block diagram is shown in **Fig. 4A**, its corresponding schematic diagram in **Fig. 4B**, and the same circuit in matrix form is shown in **Fig. 4C.**

Simply stated, the diode matrix consists of two level structures of "and" and "or" circuits which select the proper states of the counter and provide outputs during (and only during) those states.

The design procedure involves Karnaugh mapping and writing minimal equations. The matrix can easily be built from the equations.

We have not set a definite charge for the service. The time required to develop the equations depends on the nature of the message, the amount of "professionalness" of the code desired and the degree to which the design is minimal (i.e. minimal cost). An estimated typical time for a call would be two hours.

We would like to see our device built by someone else and would probably charge only a nominal fee if the person can show a bona fide interest. The design fee is to discourage non-interested persons from wasting our time.

The character formation generators, as stated previously, are monostable multivibrators. These two circuits are triggered by the outputs of the diode matrix. A dot output triggers the one baud length MV (multivibrator), a dash triggers the three baud MV which together with the dash output in an AND circuit causes an output. The blank also triggers the three baud MV but there is no output.

When either of the character multivibrators has completed its function, the space multivibrator is triggered. The space MV, sends a pulse to the counter when it is first triggered. This moves the counter up one state. When the space MV is completed, a pulse is sent to the sampling gates which in turn gates a pulse to either formation MV depending on the output of the diode matrix. And the cycle repeats itself.

The output circuitry simply combines the outputs of the two character formation generators and gates on and off a tone generator for mcw or operates a relay for cw. There is provision for inhibiting an output during a blank.

One last thing which we need to mention is a method of stopping the generator after it has sent the message once. The method is simple. A third output from the diode matrix, called a stop, is provided. The stop output occurs after the counter has completed 32 counts. When the counter reaches that state the stop output gates off the space MV input pulses from the formation MVs. This interrupts the sequence and the unit remains dormant until restarted. To start again, a pulse is fed to the space MV. The next state does not have a stop signal so the space MV input pulses are again gated on and the circuit continues thru its sequence.

The entire unit timing diagram is shown in **Fig. 5**. A careful study will lead to a

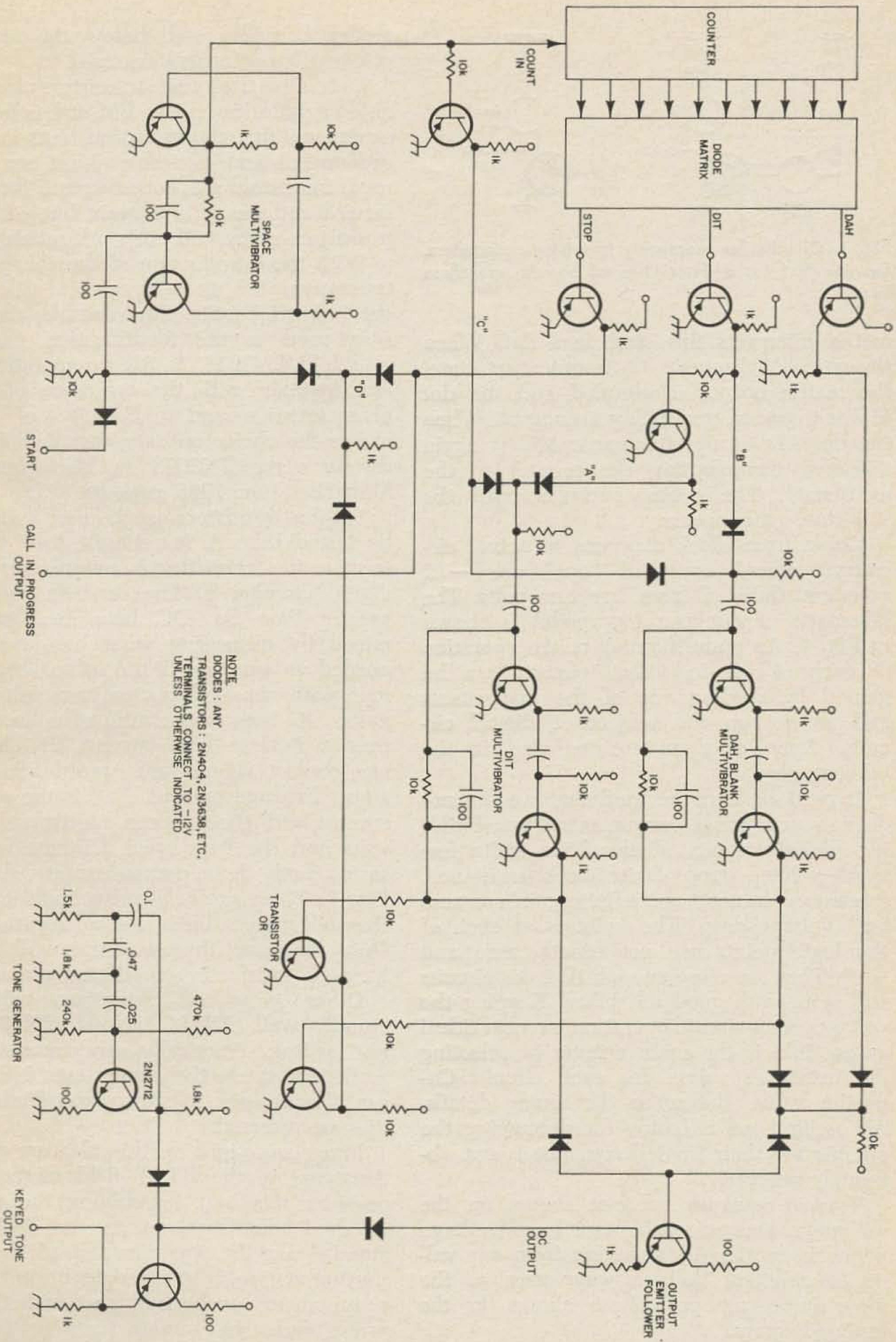


Fig. 6. Schematic of the automatic code generator. If you don't feel up to designing the diode matrix, the authors will do it for you for a small fee.

better understanding of the operation of the generator. The example shown has been selected to show most of the details of operation. The following events happen in sequence: The counter is initially in the stop state (no. 1). A start pulse fed to the space MV input turns it on incrementing the counter to the next state (no. 2). The diode

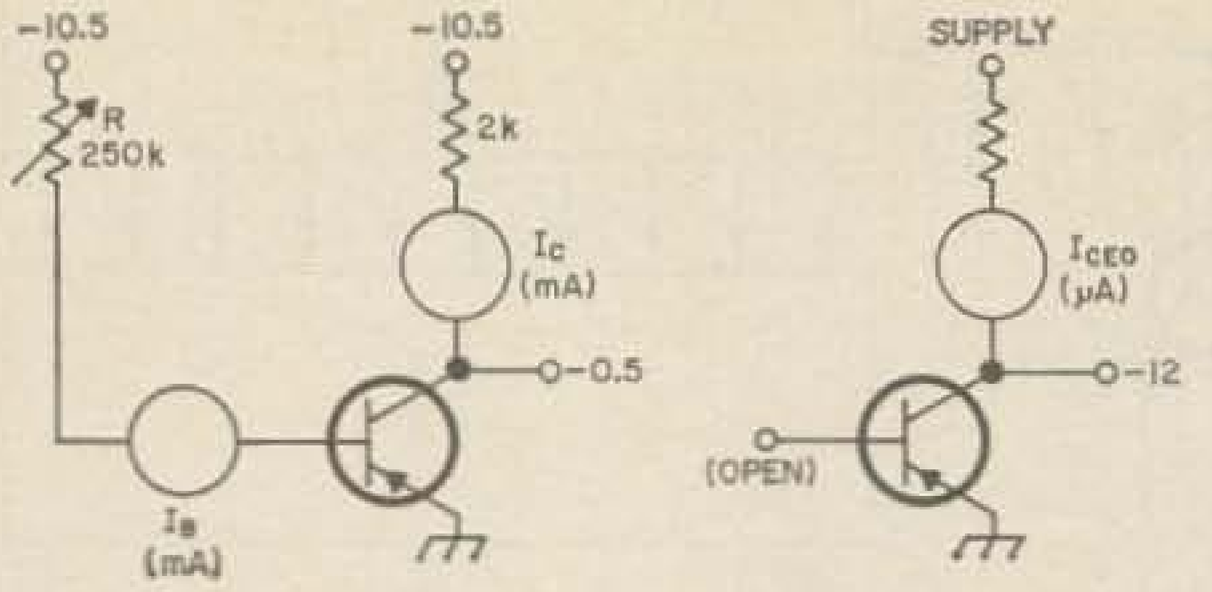


Fig. 7. Circuits for measuring transistor parameters. See the text for a description of how to use these circuits.

matrix interprets this state as a dot. When the space MV returns to its quiescent state, the matrix output is sampled and the dot MV is triggered generating an output. When the dot MV is up, the space MV is again triggered incrementing the counter to the next state. The cycle continues until the stop state again occurs.

Going from block diagrams to actual circuitry; logical levels of "one" are −12 volts and those of "zero" are zero volts. The schematic of our working model is shown in **Fig. 6.** An understanding of the operation of each of the individual circuits can be gained by reading one of the many texts and articles on the subject of digital circuits. Some of them are included in the bibliography.

It must be kept in mind that we are not dealing with ideal components when building digital circuits; diodes have finite forward voltage drop, finite back resistance, transistors do not have infinite gain nor zero "on" voltage drop. The voltages at each of the logic points are not exactly zero and −12. They are close enough that the circuits still work with good reliability. Keeping the voltages and circuit operation as near ideal as possible is the main criteria in selecting the resistance values for each circuit. Capacitor values determine the timing details. An oscilloscope is handy for debugging the circuits for their final design but is not absolutely necessary.

Typical voltages are not shown on the schematic because each point has a voltage which is continually changing from one value to another. Voltage waveforms at the more important points are shown in the timing diagram.

Obtaining parts at a minimum cost has always been a concern for the amateur. The circuit design of this unit was done with low cost in mind. The surplus market is a good source of resistors, capacitors, and diodes at prices well below the industrial prices you pay for new material.

It is also true that transistors are available at quite low prices but, it has been our experience that the industrial units are more economical and desirable. Most surplus or used transistors are not adequate for digital service and out of a bargain bag of surplus transistors many will not work reliably.

With the introduction of the cheap silicon transistors, it is more economical to consider the industrial units. For example, the transistor used in the identification generator, Fairchild 2N3638, is 31c in quantity. This fact together with the assurance of known characteristics and uniformity of quality makes the choice an easy one. Paul Franson discusses the 2N3638 in his column; 73 Magazine, June 1965, page 88.

Surplus transistors can be used but should be tested first. A few simple tests will determine if a transistor is suitable for use in digital circuits: 1) The dc beta should be greater than 30. DC beta, h_{FE}. is determined by measuring what base current is needed to produce 5 mA of collector current with the collector-emitter voltage 0.5 volts. DC beta is the ratio of collector current (5 mA) to base current. 2) The leakage current should not exceed 200 microamps. Leakage current, I_{ceo}, is the collector current with the collector-emitter voltage 12 volts and the base open. Circuits for measuring both these parameters are shown in **Fig. 7.** These are relatively simple tests but they tell quite a bit in comparing transistors. Units that meet these two tests will generally work satisfactory in digital circuits.

Other types of transistors will work equally well. 2N414, 2N404, 2N1305, are just a few. Practically any transistor will work if it meets the above tests. NPN units can also be used if battery and diode polarities are reversed.

Many variations on this idea are possible. Amateurs in the RTTY field might like to consider this unit for solving the problem of dual identification. As the FCC rules stand, only the identification of the transmitting station is required to be in cw. The requirement can be fully met with this generator and a ten minute timer to trigger it.

The ragchewer will find a unit such as this an extension of his "ten minute reminder" (it is suggested that the reader consult the rules and regulations part 97.87 before making final plans).

For the amateur who likes it deluxe, this unit can be the basis for a semi-automated cw station.

With a magnetic core memory many variations of the basic design are possible; for example, several messages can be stored in the memory and called for individually to satisfy various situations. For instance, the following messages could be contained in memory: CQ CQ CQ DE W6YGZ, town, handle, TESTING, 73, and so on. Each could be selected to fit the need. The possibilities are limitless.

For the contest minded (or the novice) a unit with the message: "CQ SS CQ SS CQ SS DE W6YGZ" might be the answer. The message need be stored only once but could be called out three times in a row if a simple three counter is used.

Thanks go to I. S. Reed of the University of Southern California for the idea and background. Photo credit to Rod C Rigg.

Bartee, Lebow, and Reed, **Theory and Design of Digital Machines,** McGraw-Hill, 1962. A more sophisticated approach to the design of digital systems, covers sequential circuits.

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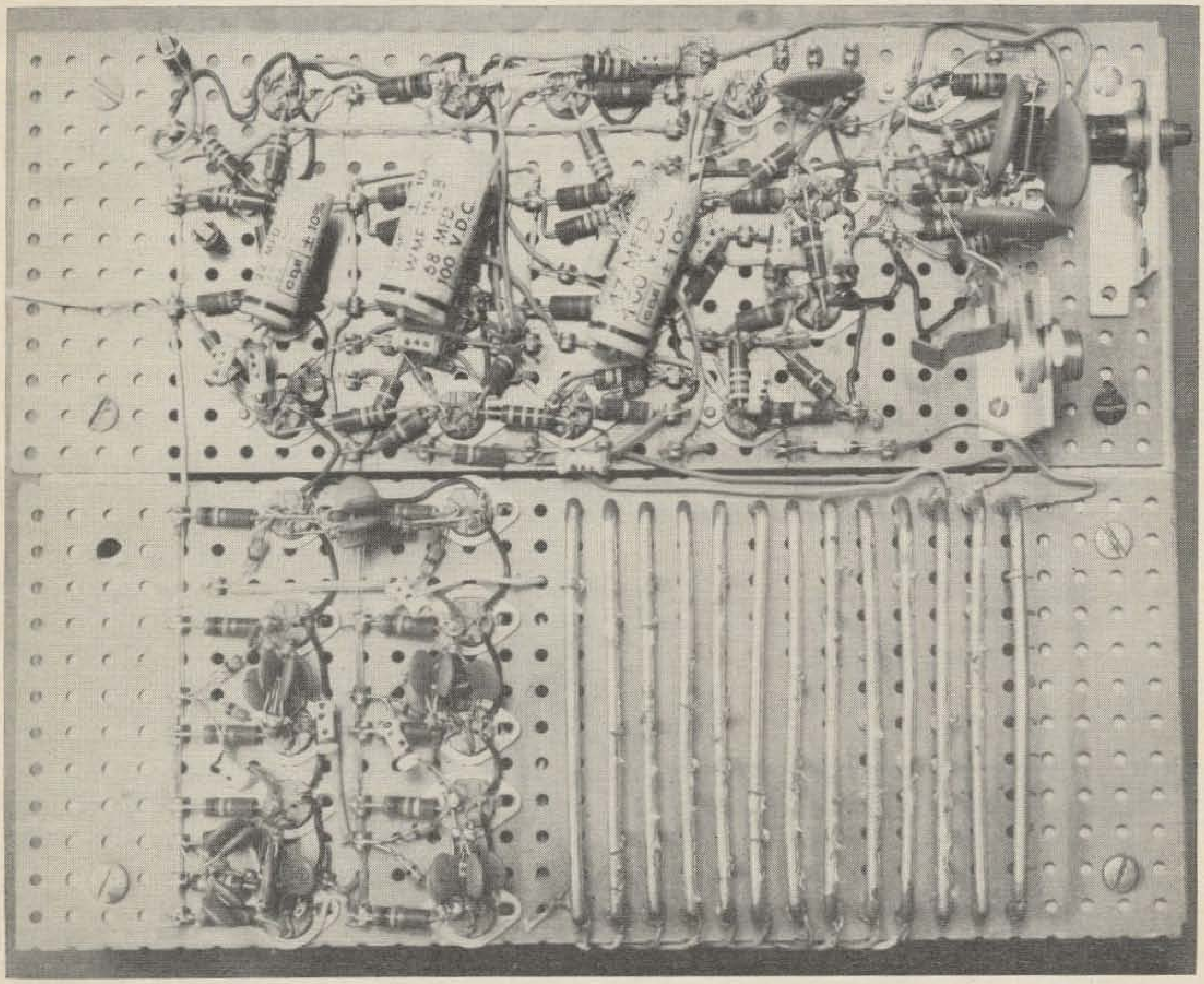
Horowitz, Paul, W2QYM, 'Perfect Code at Your Fingertips'. **QST** 49:9 August 1965, Page 11. Uses diode matrix and magnetic core shift register. Typewriter keyer. Explains digital circuits.

Hurley, Richard B., **Transistor Logic Circuits,** Wiley, 1961. A College level text explaining digital mathematics, design and circuits detail.

Ketchum and Alvarez, **Pulse and Switching Circuits,** McGraw-Hill, 1965. A junior college treatment.

"A Semi-Automatic Keyer", an article in **Electronics Experimenter.** Some issue in 1964 or early 1965. Shows how to build a typewriter-like code generator using relays.



Bottom view of the automatic identification generator described in the text. The diode matrix is in the lower right corner.

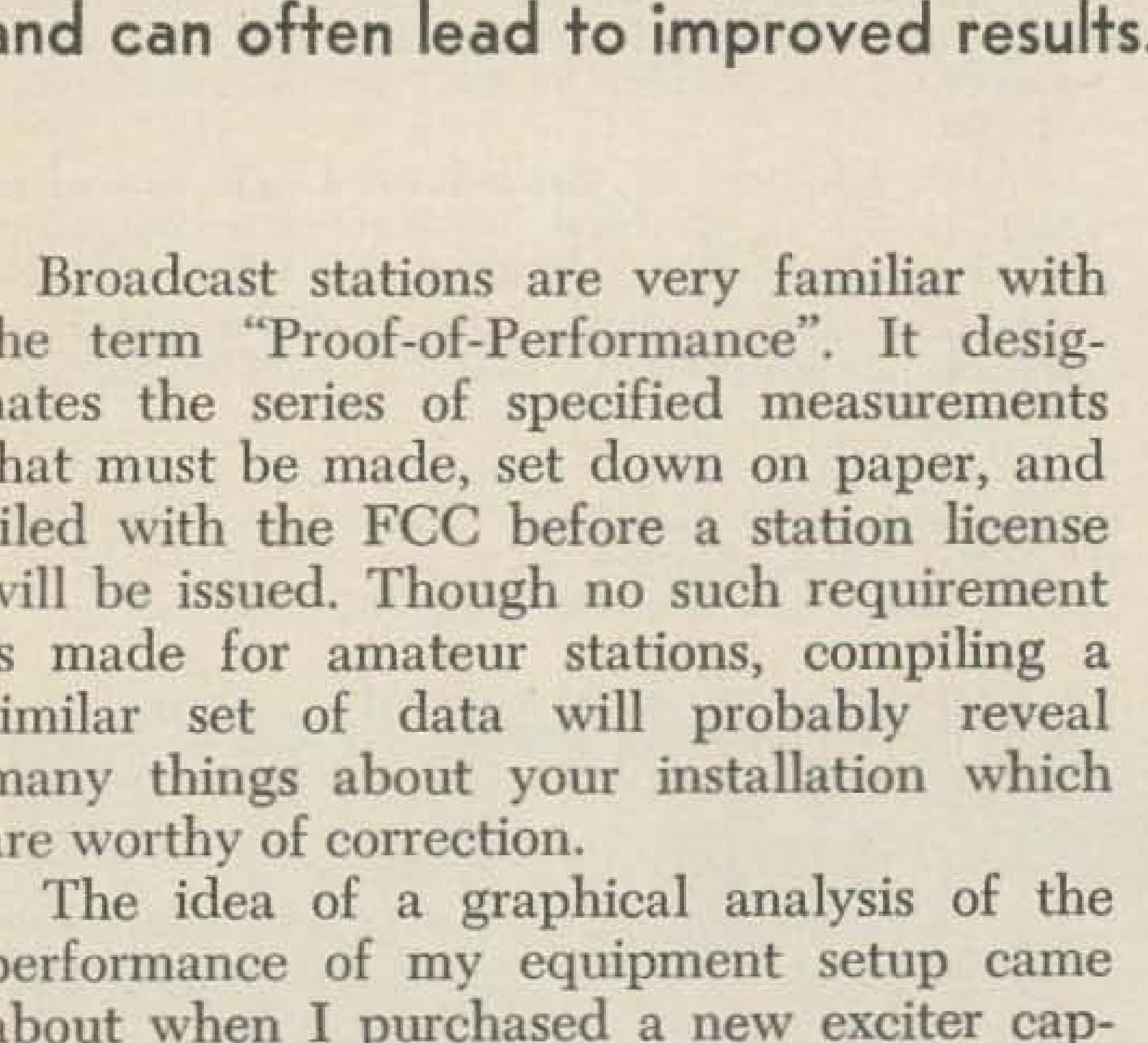
Robert Crotinger K6YKH
4619 Brighton Avenue
San Diego, California

Sideband Proof of Performance

Have you ever checked your gear to see what it can do? It's interesting, and can often lead to improved results.

Broadcast stations are very familiar with the term "Proof-of-Performance". It designates the series of specified measurements that must be made, set down on paper, and filed with the FCC before a station license will be issued. Though no such requirement is made for amateur stations, compiling a similar set of data will probably reveal many things about your installation which are worthy of correction.

The idea of a graphical analysis of the performance of my equipment setup came about when I purchased a new exciter capable of overdriving my linear. It seemed desirable to construct a pad of approximately three decibels attenuation to correct the situation. However, to determine the precise benefits, or obtain a quantitative conception of these benefits required some sort of testing. Graphical plotting of the results was the logical approach.



EQUIPMENT SETTINGS	TR-3		LINEAR	
	PLATE TUNING	7.4	TUNING	1.4
	PLATE LOADING	4.2	LOADING	2.8
	XMTR GAIN	5.5	VSWR	1.7
	RF TUNE	5.9	P-2 SENSITIVITY	2.0
	I_p MAX	.420A	I_p MAX	.620A

Fig. 1. Plate current of the TR-3 and linear versus relative power output.

A graph in two-dimensional form shows the variation of a dependent, plotted vertically, when an independent variable, plotted horizontally, is caused to change through a predetermined series of values. The plotting is done after a series of tests have been made at a relatively large number of values of the independent variable and the values of both variables tabulated.

Carrying out a good test requires: 1. a decision as to what items are to be measured, 2. finding an independent (controllable) variable which will put the dependent variable to the test as much as possible, 3. tabulating the results as accurately as possible while the test is being made, 4. putting the results in a form which will best show the variation taking place, and 5. analysis of the results.

Amateur measurements usually fall into the "comparative" class, as access to precise standards is usually impossible and the results are relative to a given set of conditions. Therefore, it is desirable to plot more than one measureable dependent variable if possible in order that accuracy will not depend on any one measuring instrument. Also, the results of one plotted curve can support the results of another, making the analysis more positive.

The results of the first attempt at measurement are shown in **Fig. 1** and represent

Bob is a technical director at KFMB-AM-TV. He used to be W0GUY and W8DDT.

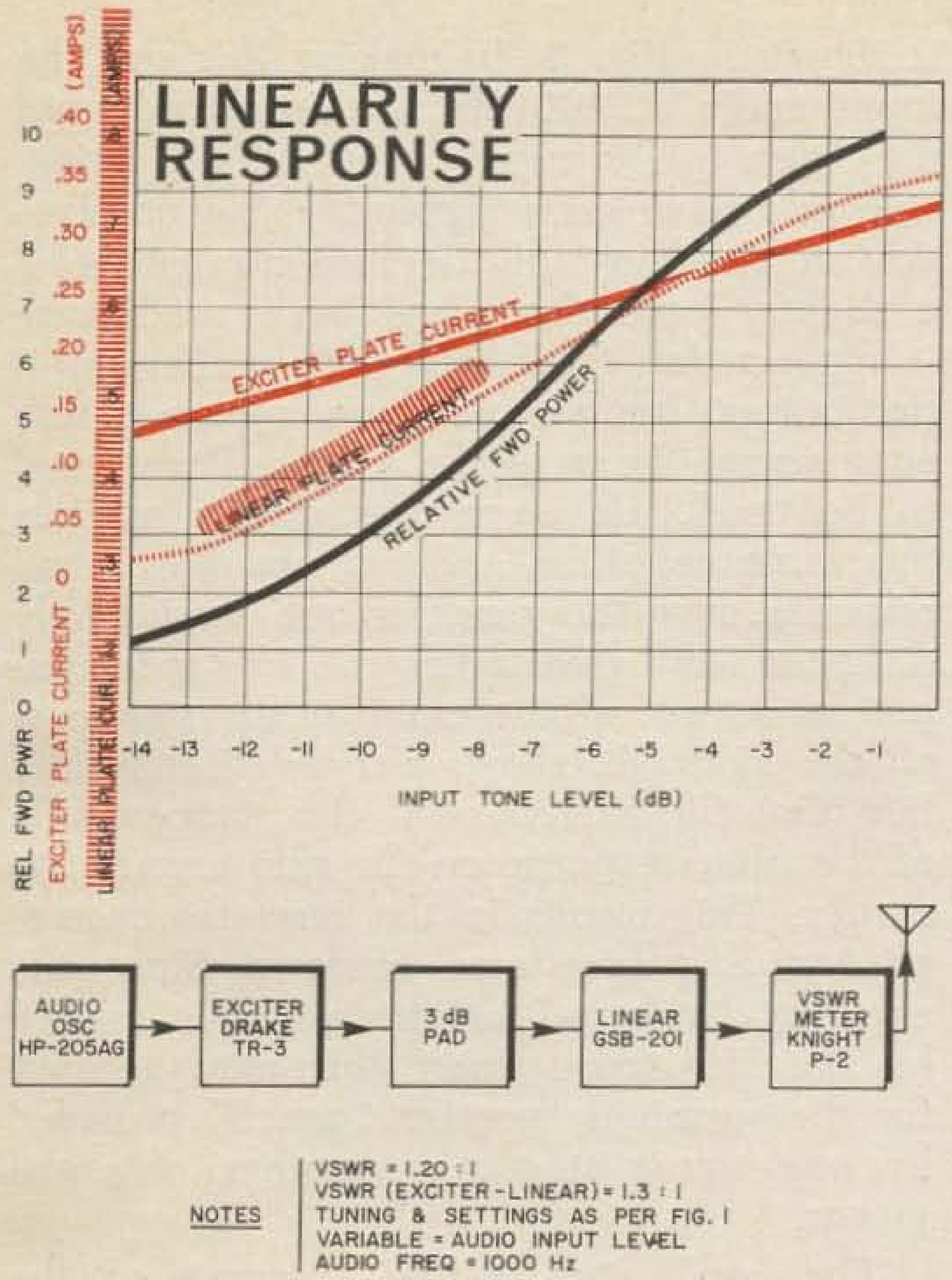


Fig. 2. Linearity response.

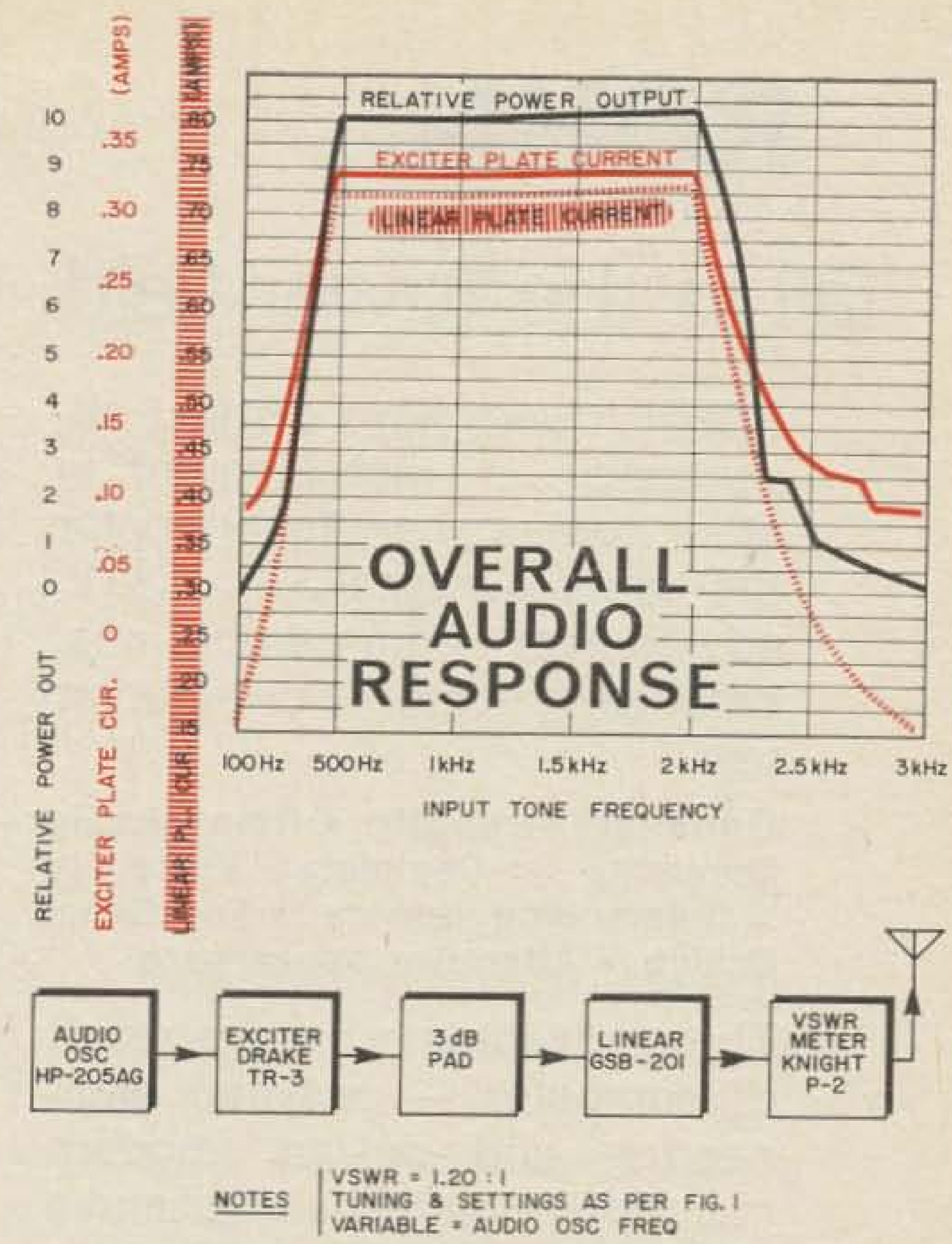


Fig. 3. Overall audio response.

a test which could be made quickly and easily by virtually any station with only a VSWR meter with a relative power scale. Carrier is inserted and the level increased as readings of relative power output are taken, along with exciter plate current and linear plate current. This test is informative, but the fact is that the independent variable is not measureable and the results do not show the most important variation, that of power output with input audio level. However it is a reasonably good indication of the linearity of the two stages with drive. An important conclusion from this graph was the fact that the driver (TR-3) reached 450 mA, its maximum output where flat-topping begins, at the same time that the linear had only reached slightly over 600 mA. The linear was capable of being driven to slightly over 700 mA before flat-topping; therefore it was obvious that on this band (15 meters) the 3 dB pad presented more loss than desirable. The ultimate conditions was that both exciter and linear flat-top at the same point.

A more valuable test was effected when an audio oscillator was used with the output attenuated to mike level and fed into the microphone input, as shown in **Fig. 2.** While a commercial unit was used here with a step attenuator and db level variation read accurately, it is equally as valid to use any audio oscillator in conjunction with a resistor-potentiometer voltage divider to reduce the level and take readings of audio level with a VTVM at the audio oscillator. In many cases. a decibel plot will improve the appearance of a curve over a voltage plot and converting to decibels is not always necessary or even desirable. Use the method of plotting which will emphasize the deficiencies, they are what we are looking for.

In any case, the second set of curves shows that the exciter has become delightfully linear, however on this band (40 meters) it reaches 300 mA plate current when the linear begins to level off. In this case, it would be better to have slightly more padding in order to make the exciter ALC work, thereby raising the average level of rf a few decibels. Another revelation from the curve is the non-linearity in the low plate current region in the linear, a condition which is supported by the relative forward power curve in this region. While non-linearity at this power level is not as serious as at maximum output, it is worthy of some attention in the future.

While the audio oscillator was available it seemed worthwhile to make an overall frequency response run, the result of which is shown in **Fig. 3.** In making this run the input audio at 100 Hz was increased until the linear plate current had ceased rising. It would have been preferable, for observation of the "top" of the response curve, if a slightly lower level had been used since it appears that the leveling-off of the amplifier output has produced an apparent flatness across the response that is "too good to be true". However, the exciter exhibits this same condition and perhaps the actual response over this range is not considerably different from that indicated. The more important aspect of the curve is the steepness of the sides. It shows very definitely the fact that the exciter used the steepest side of the filter response on the side toward the carrier. This results in the response encompassing a greater area of lows. Since the apparent "volume" of the voice is carried by the low frequencies, this may account for the seemingly greater "punch" provided by one transmitter over another of equal power.

The small step is the response of the exciter at 2.7 kHz is interesting but probably rather inconsequential.

I have made no attempt here to "doctor up" any of the results nor to minimize the shortcomings of the test procedures. These are the purpose of testing and it is readily seen how the test procedures can be improved and why. It is also appropriate to remark here that when testing anything it is desirable to write down everything possible pertaining to the conditions of the test, whether it seems pertinent at the time or not. The author keeps index cards in the optimum dial settings and current readings on each band. Also, it is naturally best that tests be made under the same conditions that the equipment is used, and this means into the antenna. This dictates the making of overall tests at a time when the band is dead.

The advent of commercial transmitter manufacture has taken some of the adventure out of ham radio for some of us who used to build such equipment. However, the author is willing to concede that "they can build a better one than he can, and it has better trade-in value". This does not mean that we must be unaware of how it operates or what it is doing, and it is hoped that this article may produce some incentive in that direction. . . . K6YKH

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2-NB NOISE BLANKER: Solid state circuitry is used to provide true noise blanking by quieting the receiver during the interval of the noise pulse.

2-CS MATCHING SPEAKER

2-AC CRYSTAL CALIBRATOR: 100 kHz crystal oscillator corresponding to the numbered dial divisions on the Main Tuning Dial.

SPECIFICATIONS

FREQUENCY COVERAGE: 3.5 to 4.0 mHz, 7.0 to 7.5 mHz, 14.0 to 14.5 mHz, 21.0 to 21.5 mHz and 28.5 to 29.0 mHz with crystals supplied. Accessory crystals provide 500 kHz incremental coverage from 3.0 to 30 mHz.

SELECTIVITY: Selectable Passband Filter provides:
.4 kHz at 6 DB down and 2.7 kHz at 60 DB down.
2.4 kHz at 6 DB down and 9.0 kHz at 60 DB down.
4.8 kHz at 6 DB down and 16.8 kHz at 60 DB down.

DIAL CALIBRATION: Main dial calibrated 0 to 500 kHz in 10 kHz divisions. Vernier dial calibrated in approximately 1 kHz divisions. Main dial and Vernier adjustable for calibration.

STABILITY: Less than 100 Hz after warm up. Less than 100 Hz for 10% line voltage change.

MODES OF OPERATION: USB, LSB, CW, AM, RTTY.

SENSITIVITY: Less than .5 uv for 10 DB signal plus noise to noise on all amateur bands.

AVC: Amplified delayed AVC having slow (.75 sec.) or fast (.025 sec.) discharge and less than 100 microsecond charge. AVC can be switched off. Less than 6 DB change for 100 DB RF input change.

AUDIO OUTPUT: 1.8 watts with less than 5% distortion and .75 watts at AVC threshold.

AUDIO OUTPUT IMPEDANCE: 4 ohms.

ANTENNA INPUT: Nominal 52 ohms.

SPURIOUS RESPONSES: Image rejection greater than 60 DB. IF rejection greater than 60 DB on amateur bands. Internal spurious signals within amateur bands less than the equivalent of a 1 uv signal on the antenna.

CONTROLS AND JACKS:

Front: Main Tuning, Function switch, Band switch, Preselector, RF Gain, Mode, Selectivity switch, AVC, and S-Meter.

Rear: Antenna jack, S-Meter Zero, Mute Jack, Sidetone Jack, and Speaker Jack.

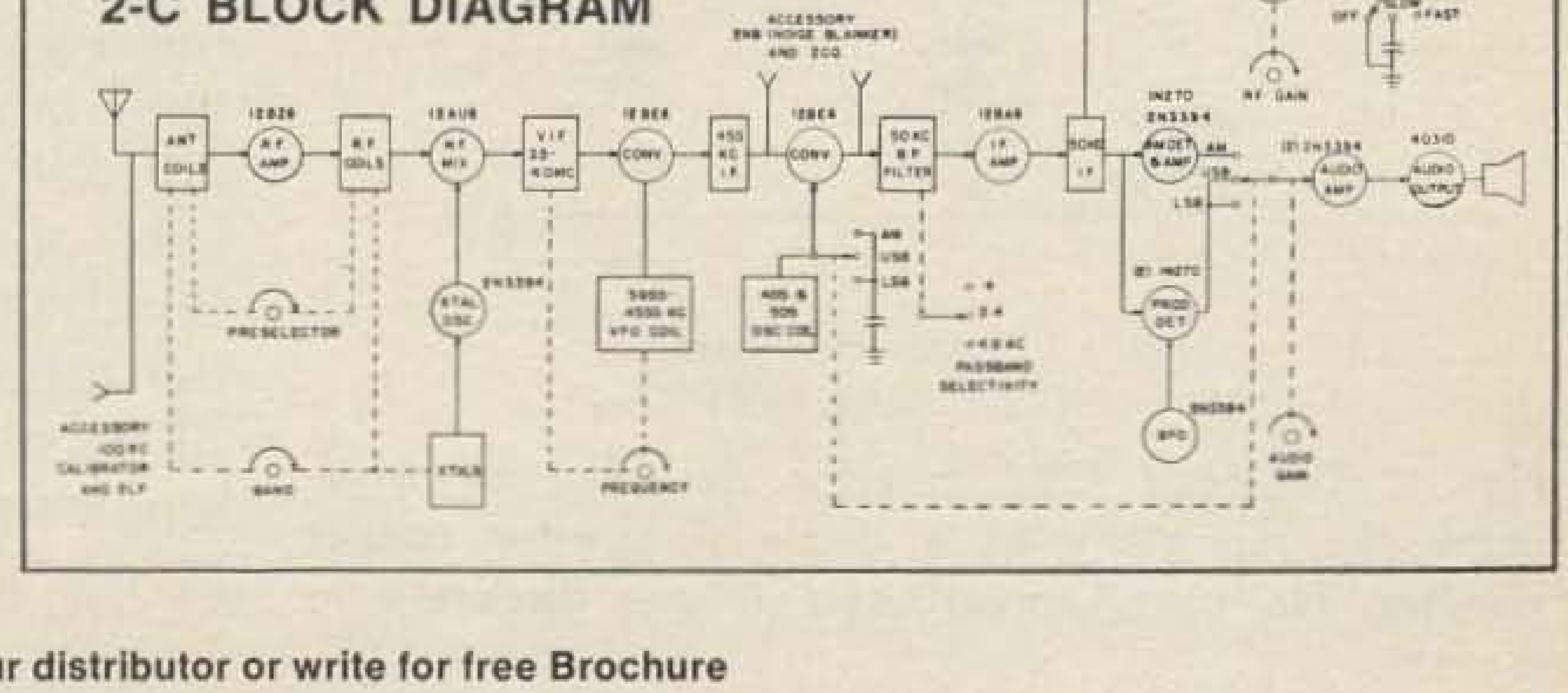
Side: Auxiliary crystal socket, auxiliary crystal — Normal switch, Phones.

Top Chassis: 2-CQ socket, 2-AC socket, and Noise Blanker socket.

POWER CONSUMPTION: 30 watts, 120 VAC, 50/60 kHz.

DIMENSIONS: $11\frac{5}{16}$" wide, $6\frac{9}{32}$" high, $9\frac{3}{32}$" deep, weight $13\frac{1}{2}$ lbs.

2-C BLOCK DIAGRAM



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A Non-Tiring CW Monitor

For anyone who enjoys long periods of CW operation, a good keying monitor is a necessity. Unfortunately, most simple monitors which produce a single tone get awfully hard on the ears after a while and many experienced CW operators still resort to using their receivers as a monitor. They do this because of the pleasing tonal quality of the multi-frequency signal and because one can "play" with the receiver tuning to vary the tone.

It would, of course, be better to have a keying monitor that sounds like the receiver signal and to leave the receiver tuning alone. One can come pretty close to this ideal by use of a dual-tone monitor. Some years ago, I built such a monitor but forgot about it when my interest turned to SSB. Now, with a returning interest to CW, I decided to update the monitor using transistors.

The circuit for the monitor is shown in *Fig.* 1. The circuit is simply two variable tone oscillators with their outputs connected in series to the monitor loudspeaker. The diodes D1 and D2 protect the monitor from the voltage across the transmitter key terminals. These diodes and the battery connection must be slightly changed as shown for use with a cathode-keyed transmitter.

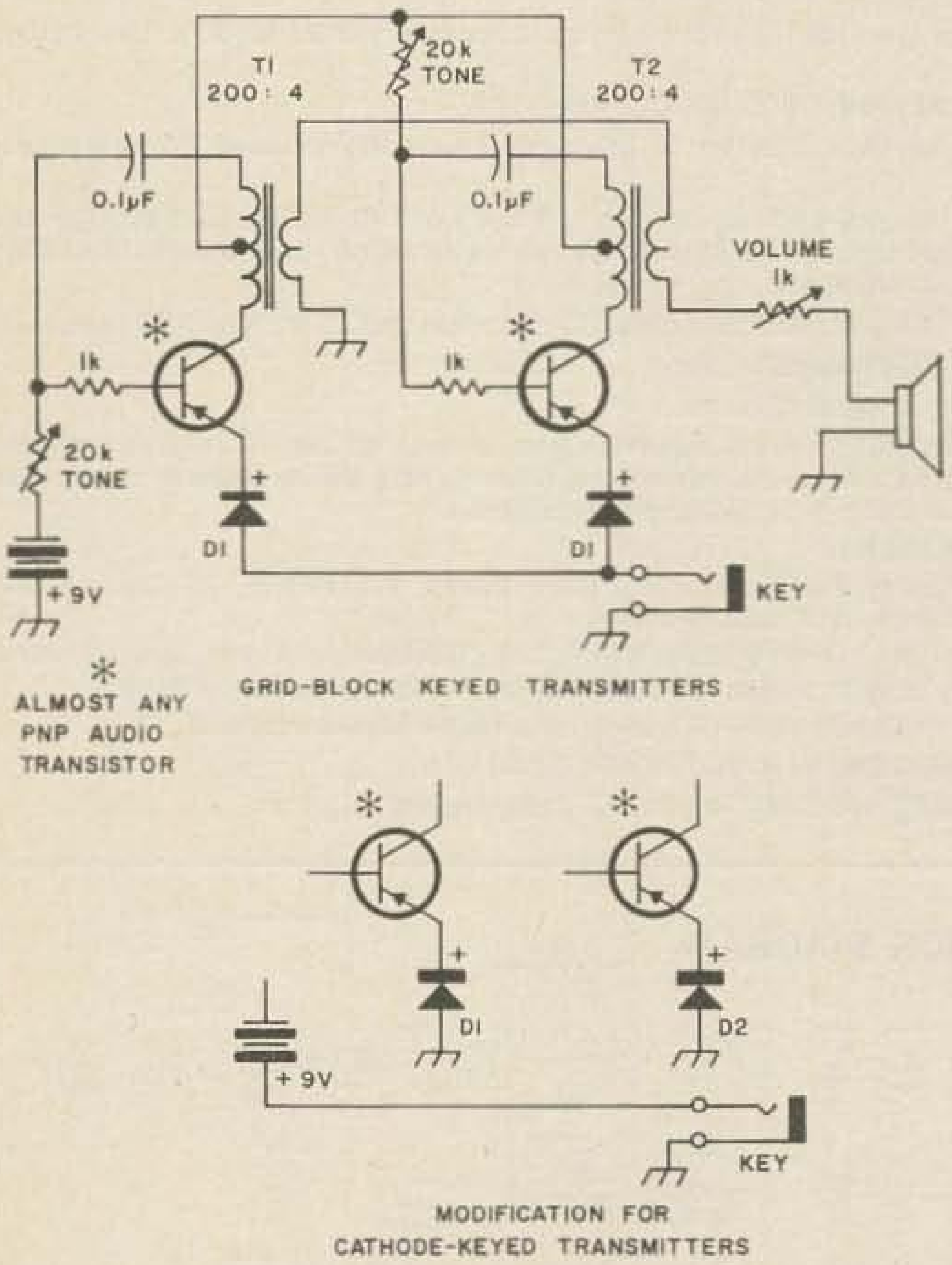


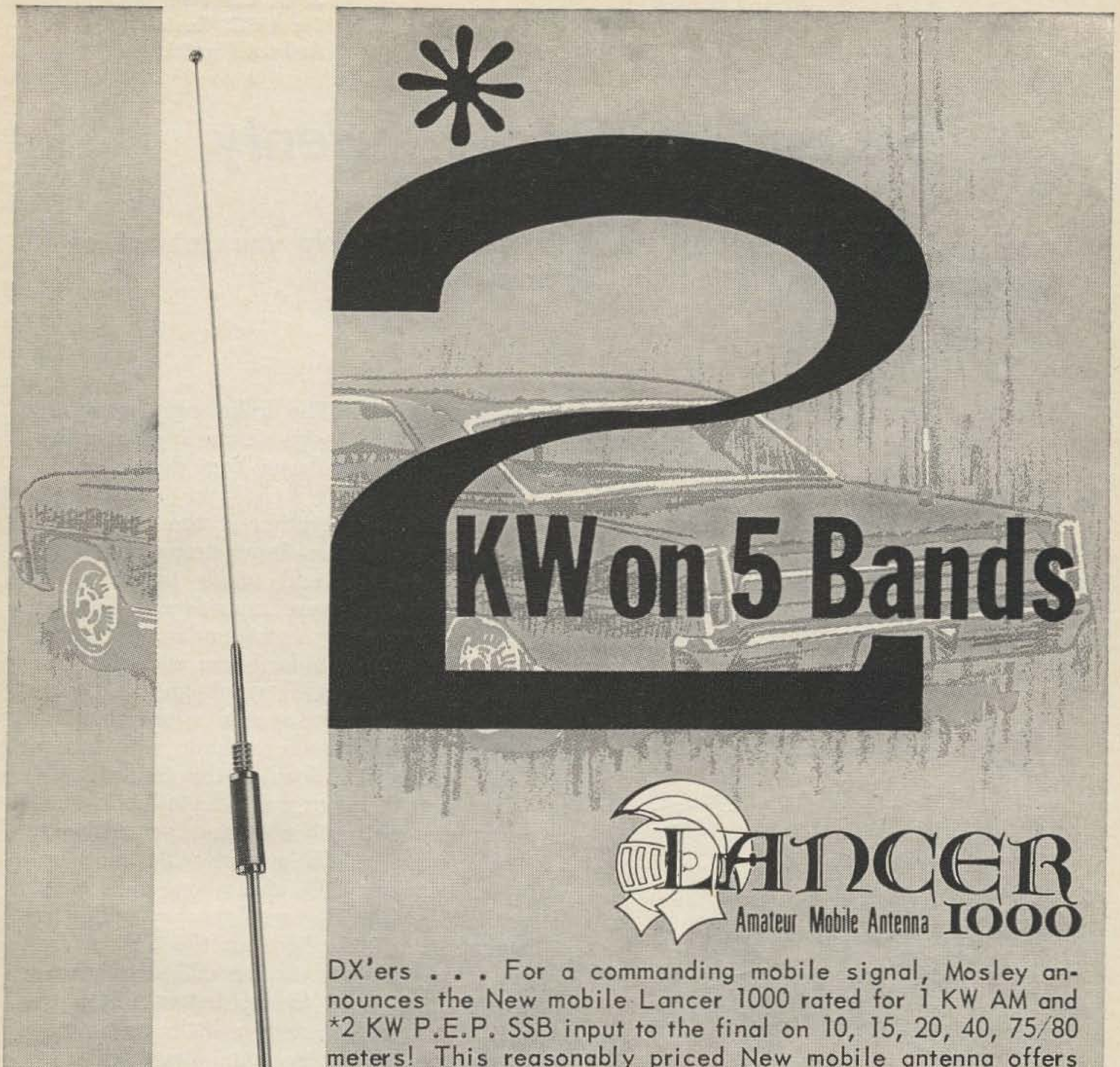
Fig. 1. Two-tone CW monitor designed to overcome the monotony of a single sine wave output monitor. No parts are critical; all are discussed in the text.

I used a Telefunken transistor but practically any low-level audio transistor with a B of 50 or more will work. Some examples: 2N138, 181, 186, 217, 223, 249, 270, etc. The diodes D1 and D2 may be any type—normal power supply silicon diode units work fine—having a PIV greater than the voltage measured across the open key terminals. A battery supply is shown, however, any operating voltage between 6 and 15 volts is satisfactory and this voltage can usually be "borrowed" from some well filtered point in a transmitter or receiver. If a battery supply is used, the resistance across the open transmitter key terminals should be checked. With some transmitters this resistance is only several thousand ohms and an on-off switch must be used in the monitor to prevent a continuous battery drain.

I built the monitor in a small Minibox measuring 3½ x 2½ x 2½ inches so it could be used as a separate unit for portable operation or as a CPO. It could just as easily be constructed on bakelite circuit board and mounted inside a transmitter. The exact frequency range of the oscillators will depend on the manufacture of the components used but should be about 700 to 2000 Hz. The combinations of tones from two oscillators with this range should satisfy anyone's desire to change the monitor tonal quality.

Although conceived only as a keying monitor, some other uses for such an oscillator suggest themselves: a two-tone test oscillator for SSB measurements and as a CW generator/kewer for an SSB transceiver without CW provisions by feeding the output of only one tone oscillator to the microphone input of the transceiver. For these applications, however, it is essential that the output of each oscillator be checked on an oscilloscope to be sure that it is a good sine wave at the tone control setting(s) used.

. . . W1DCG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J. D. Cameron WA4WWM
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Amherst, Virginia

Seven Elements on Twenty

Here's a high gain, low cost beam that will really help you get out on twenty meters. Why not join the big boys?

In antenna design, as in boxing, it is true to say "A good big 'un can beat a good little 'un". Tuning across the favorite DX band, 14MHz, proves this axiom again and again as we hear the choice DX returning to the fellows with the big beams mounted on high towers. However, the bigger they are the more they cost, and even though kind neighbors may not object, the financial strain does not allow the average ham the luxury of a big antenna. The following description of my antenna is to give some idea of a low cost approach to a large Yagi design on 14 MHz.

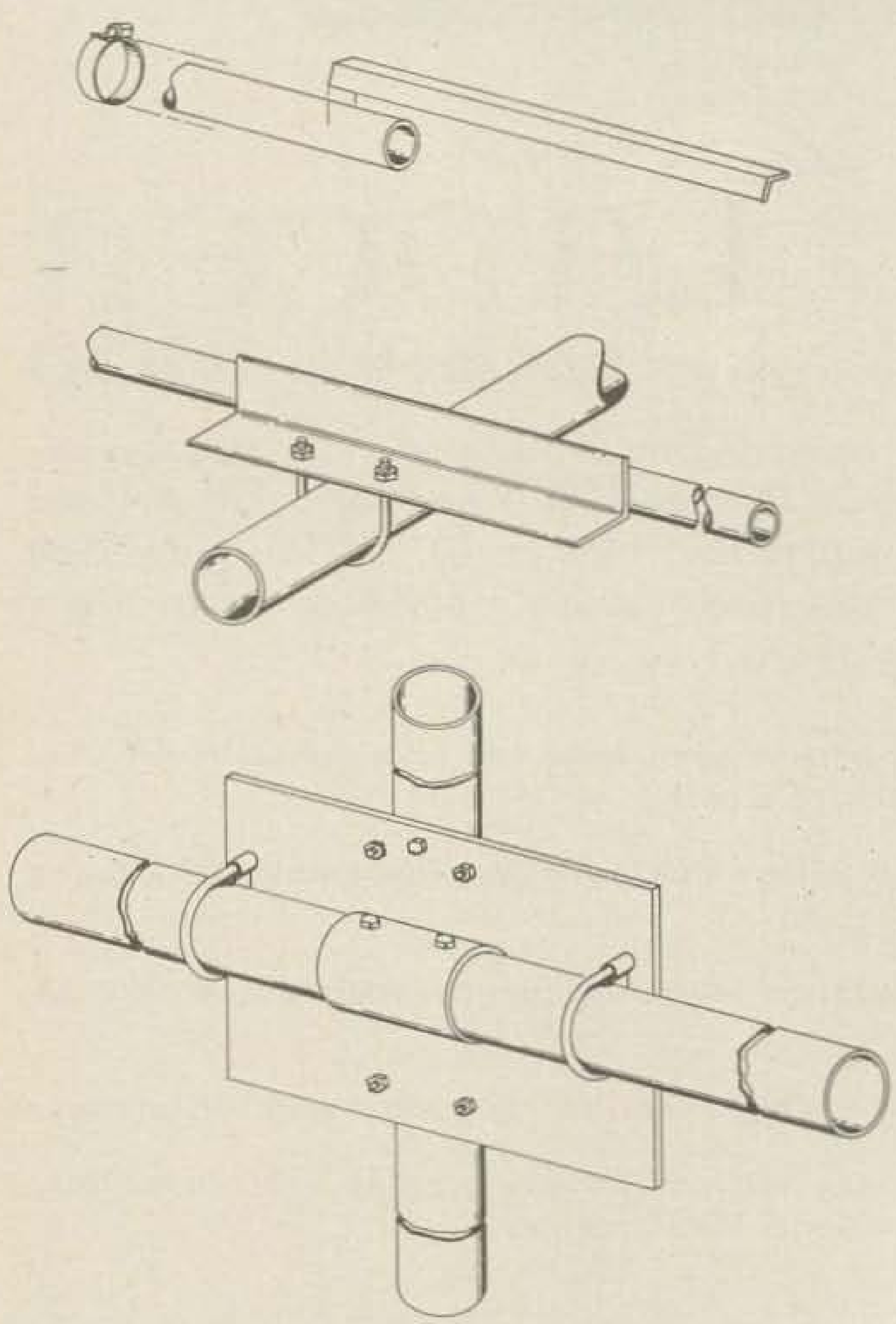


Fig. 1. Details of three parts of the antenna. From the top: Addition of extensions to the ends of the reflector for tuning. Element attachment to the boom. Attachment of the boom to the mast.

The first consideration is the wind load on a large structure–how strong must the beam be to withstand winds to 60 mph? Two approaches were considered. First, a rigid boom using a triangular aluminum tower. Second, a tubular boom with a degree of flexibility to "ride" wind gusts. It was decided to follow the second approach using relatively small diameter tubing, with braces to take the vertical load of the elements.

Sixty feet of boom was selected as a good compromise between cost and performance. For the operator who wishes wide band operation between CW and phone this boom length will allow ¼ wave spacing with five elements. For the phone or the CW enthusiast more elements can be added to give a narrower beam width for better QRM rejection on receive, and a little more gain on transmit. As my antenna was to be used mainly on phone SSB, a center frequency of 14.270 MHz was chosen with seven elements at .15 wave-length, approximately 10 feet spacing.

A visit to the local electrical store produced 2 inch I.D. conduit with .125 inch wall. Two 10 feet lengths were purchased, and a piece cut off each, one foot long, to be used as a coupling between boom sections which are 2 inches O.D. Four lengths of alloy tubing were purchased 2 inch O.D., two at 12 feet, two at 9 feet, wall thickness .065 inches.

Now to assemble the boom on the ground. A screw coupling is supplied with the conduit, so the two 9 feet lengths are coupled together, and two 3 inch, ¼ inch D. bolts fitted through the coupling for added me-

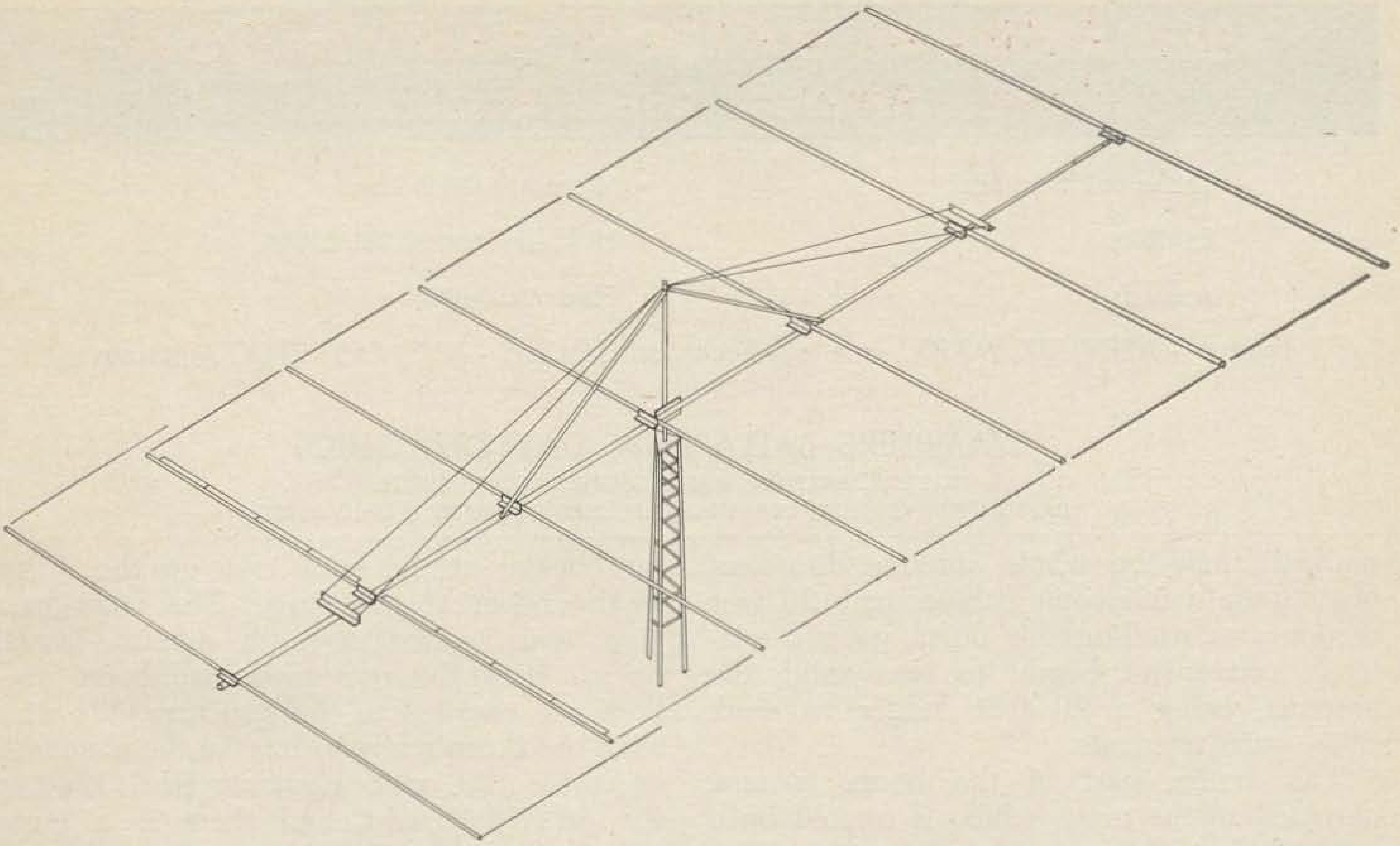


Fig. 2. WA4WWM's seven element twenty-meter beam. Dimensions are given in the text.

chanical security. At either end of the conduit a 3 inch cut is made with a hack saw. Now, a 12 foot length of 2 inch O.D. alloy tubing is inserted in either end of the conduit and a strong joint assured by a 2¼ inch muffler clamp. These muffler clamps are very strong and cost less than 25 cents each. Six at 2 inch and ten at 2¼ inch were bought from the local auto accessory store. The remaining two 9 feet lengths are joined to both ends of the construction using the two one foot sections of conduit which have been previously slotted with the hack saw for 3 inches either side. This coupling is now made tight with two 2¼ inch muffler clamps. We now have a 60 foot boom lying on the ground looking extremely flimsy especially when picked up at the center!

Each element is made from alloy tubing. The center portion is the standard 12 foot of 1 inch O.D., .058 inch wall, with another 12 foot of ⅞ inch O.D. cut into equal parts, inserted at either end, and still another 12 foot length of ¾ inch O.D. tubing cut in half and inserted into the ⅞ inch sections. Now, the beam element is 34 feet long, allowing 6 inches insertion for each joint. Holes were drilled and self-tap screws used to ensure a rigid mechanical coupling. The 34 feet length is sufficient to allow trimming of the driven element and directors, but extra length is required for the reflector, approximately 9 inches at either end. Two strips of aluminum 1 inch x 12 inches were bent to make ½ inch angle and fixed to either end of the reflector with a hose clamp bought from the auto store. This makes an easily adjustable tuning device.

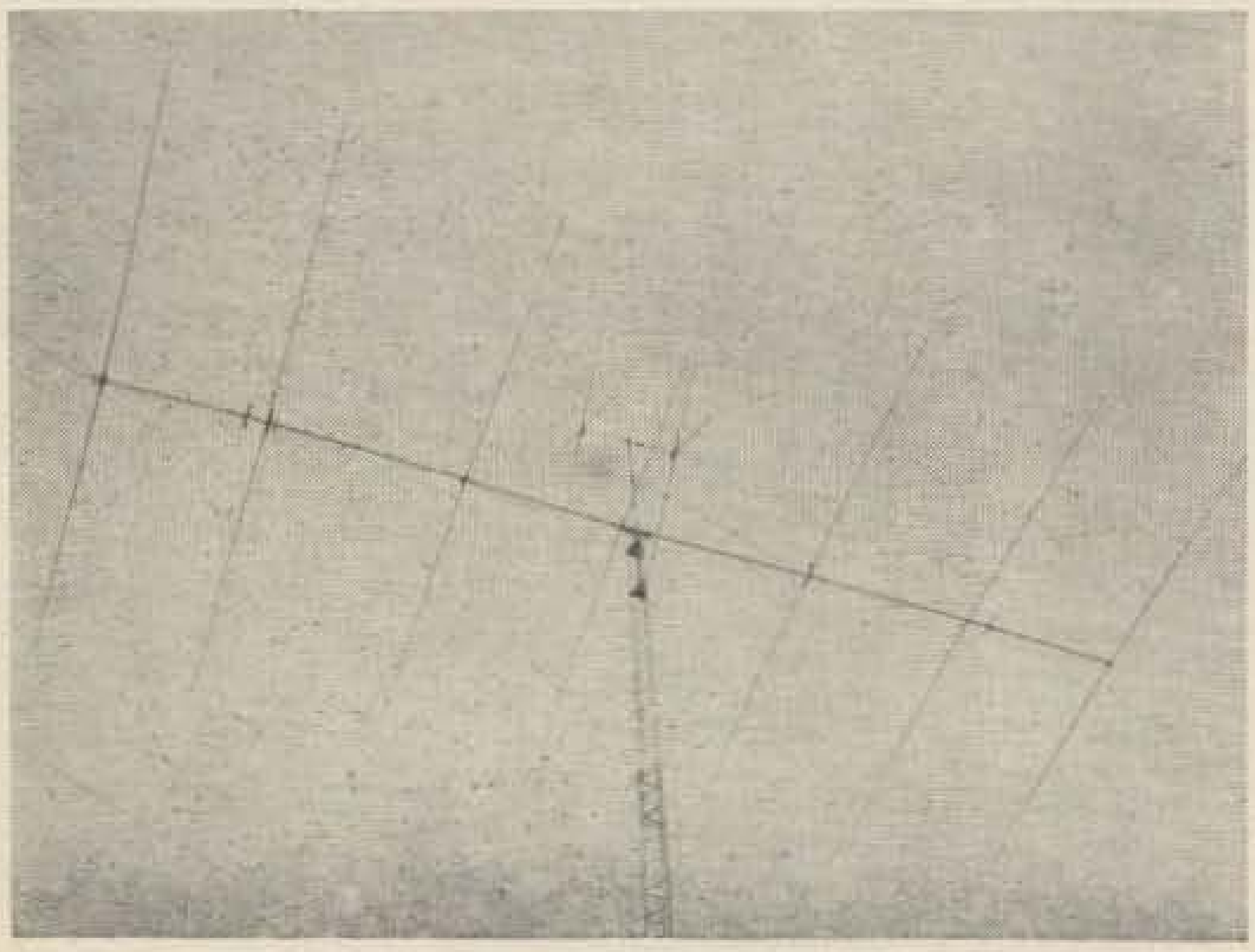
Various methods of feeding the driven element can be used, but, as K200 UHF twin line was available it was decided to try a folded dipole. Aluminum clothes line wire was spaced 4 inches from the driven element and gave a 200 ohm match to the line. A length of 150 feet of line is used at my location, terminating in a ½ wave coax balun to give 50 ohms to the transmitter. The length of the driven element is obtained from the antenna handbook as 465/F in feet when F is in megahertz. Director #1 was found optimum at 445/F, #2, 3, 4, and 5 progressively shorter to make #5 a 430/F. The reflector should be about 490/F but it is highly recommended that this element be tuned for best front to back ratio.

The elements are now attached to the boom by a 12 inch length of 1½ inch alloy angle fixed to the center of the element with two 1½ inch ¼ inch D. bolts, then the angle drilled to take a 2 inch or 2¼ inch muffler clamp to suit the boom, the three inner elements with 2¼ inch clamps, the four outer with 2 inch clamps.

The element positions should now be

marked, then the whole antenna disassembled. I use a telescoping tower with 20 foot sections, so winding this down gave a relatively convenient height to reassemble the antenna, using a 20 foot ladder to work at the outer elements.

The center part of the boom is now mounted to the mast, which is rotated by a rotor 3 feet down inside the tower. The mast is 10 feet long so 7 feet remains above the tower. The boom is mounted to the mast, again with muffler clamps on a ¼ inch steel plate 18 inches by 12 inches. A ⅝ inch hole is drilled through the mast and plate and a bolt used here for added strength. Two 12 feet lengths of ⅞ inch tubing are now used to support the ends of the inner 18 feet from the top of the mast, again using muffler clamps. Next, the two 12 feet lengths of 2 inch tubing are assembled to the conduit as before. The ends of these are now supported by cable from the top of the mast. A 2 foot cross bar of 1½ inch alloy angle was mounted with a muffler clamp and the ends drilled to take the two cables from the mast to either end. Two turnbuckles at the mast take up the droop in the boom at this stage. The cross bars give some added strength against lateral forces. Now the remaining two boom sections are coupled to the structure. We now have the boom ready to receive the elements. Assemble the outer elements first, keeping the array balanced, and there is—a seven element beam on a 60 foot boom.


A shot of the beam with a small quad over it.

Some remarks on tuning are appropriate. The director lengths quoted are close to the optimum but some trimming of the driven element may be necessary to ensure 200 ohms. It is best to measure this with an antennascope and a 4:1 bolun to read 50 ohms. This is a balanced system, hence the balun. The reflector can be adjusted with the aid of a small oscillator located a few hundred yards away, or by getting a local ham a few miles away to give S-meter readings. The antenna handbooks will supply details.

Finally, a beam of this size helps tremendously in reception, as the half-power bandwidth is 45 degrees. The gain in theory is about 12 db, but signal reports would suggest that this figure is low, especially when optimum conditions suit the vertical angle of radiation. It is highly recommended that a height of at least 70 feet should be used with any beam antenna, especially after the expenditure of time and energy on a large array.

The antenna described has been in use for a year and has withstood winds of 60 mph with no sign of damage. The cost is much lower than the commercial versions available. Some of the ideas in this article may also be of some use in the construction of smaller Yagis at a relatively low cost factor.

. . . WA4WWM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Climbing the Novice Ladder

Part IV: The code is almost conquered.

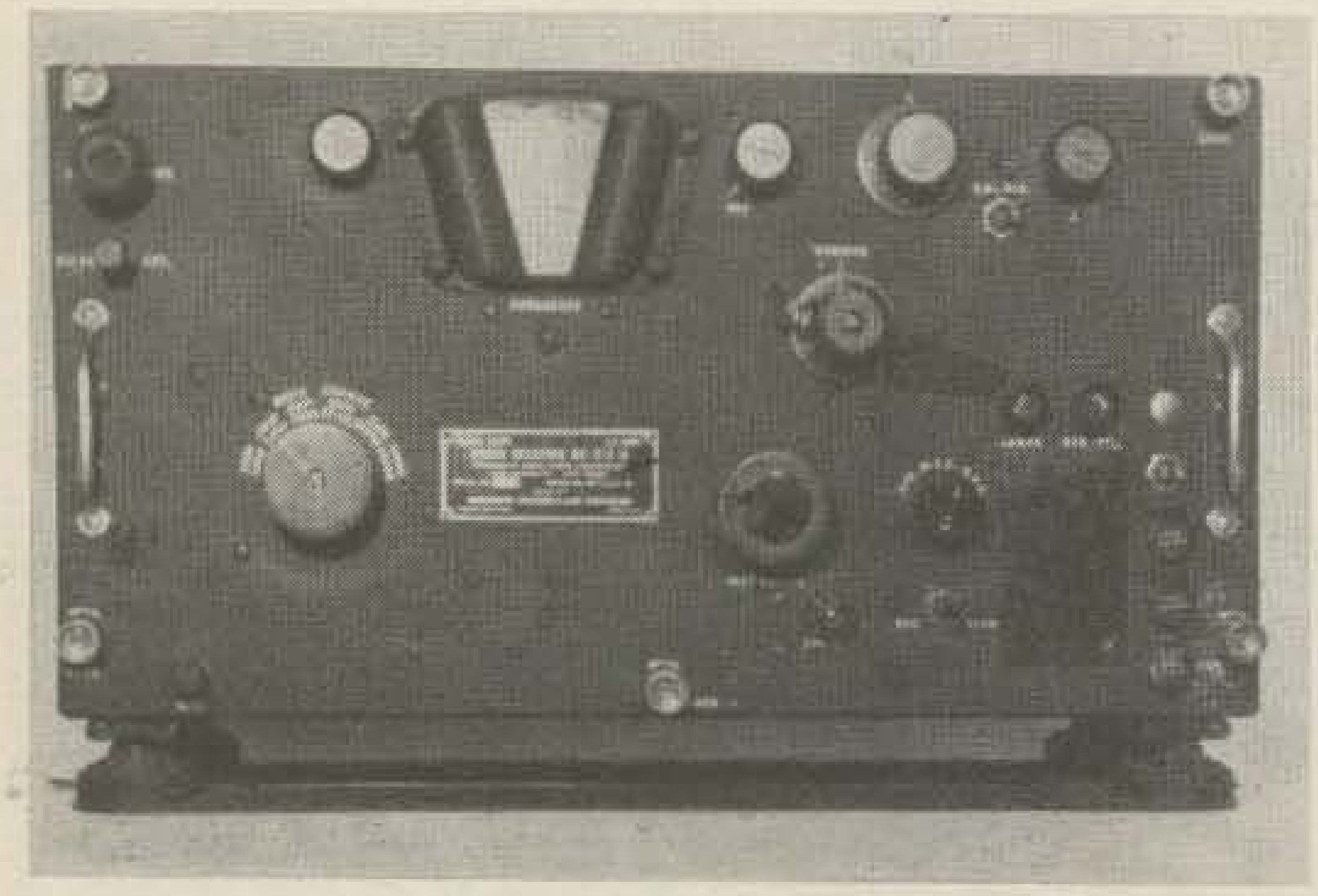
On a Saturday morning just two weeks after their last visit to FN's shack, Judy and Joe wheeled into the yard and were surprised to find Larry leaning against the basement door jamb. "Hi, Larry", said Joe, "what you doin' out here . . . goin' to sit in on a code class with us?"

"That's exactly what I *am* goin to do Joe . . . hello Judy; FN phoned me right after you'd contacted me to be Judy's examiner and suggested that I drop out this morning for an informal session with you kids . . . here I am!"

Just then FN appeared, greeted Judy and Joe cordially and explained, "I asked Larry to come out this morning and we'd put you through a little preliminary examination. Nothing official about it of course; just a run-down to get a double check on your progress. So, if you're all set, let's go inside, set up the CPO and see how your code looks. You bring your headphones this time, Joe?"

"Sure thing" Joe replied, "right here" and he opened the carrier pouch on his Honda and pulled them out along with the license manual. Judy produced the ABC's book which she had picked up and the four of them settled themselves in FN's shop.

"Larry, put on the phones and take a listen to Judy's sending; I'll work Joe over when you're through. Let her send simple English with a few figures and punctuation . . . here, you can take a few lines from one of these books" and so saying FN handed Larry the two little manuals.



Joe chose to use his SWL receiver—a military surplus BC-312-N—for his novice operation.

Picking a short paragraph in Judy's ABC book, Larry donned the headphones and said, "OK Judy; start right here and send me the first three lines in this paragraph."

FN and Joe remained quiet while Larry copied Judy's sending. When she had completed her stint, FN took the phones from Larry and said, "All right Joe, you send these three sentences from the license manual to me while Larry checks Judy's copy".

When Joe finished, Larry looked up saying, "Well, Judy did right well . . . just one mistake girl . . . you sent an 'N' where it should have been an 'A'"

"I knew it" Judy exclaimed, "the minute I did it but Gramps had told me not to go back and correct a mistake like that in an examination but to just keep going, so I did".

"Right, Judy", Larry returned, "you'd correct it if you were actually communicating with another station but in an exam you'd just foul yourself up. Incidentally, both FN and I are checking the time it takes you to send the copy we give you; we can then figure your transmitting speed by counting the characters. You were doing very close to six words a minute Judy; so close we won't split hairs".

By then FN had counted the characters in Joe's copy, checked his stop-watch and announced, "By golly, you kids are running practically neck and neck! Joe hit it right on the button at six wpm and also made but one error . . . the old 'X' for a 'Y' again Joe; give those letters a lot more play next time you practice. Looks like both of you made sufficient solid copy a couple of times to have put you through the formal exam but as far as I'm concerned, I'd like to see you both up to 7 or even 8 words a minute both sending and receiving solid copy before we call the turn formally; what you think Larry?"

"By all means, Larry came back, "if you kids can reach 7 or 8, you'll go through 5 like nothing; give yourselves those extra few words for a bit of leeway".

FN then commented, "You should be able to do that in the next couple of weeks if you keep up your present pace . . . just keep plugging. Let's see now what you *can* do with *receiving*" and both FN and Larry passed the phones to Judy and Joe.

Larry and FN again alternated between sending and checking copy. Again the two youngsters were very close; Judy had a slight edge and Larry gave her 5.5 wpm whereas FN checked Joe out at exactly 5. Judy generously reminded them that she had a bit more time to practice whereas Joe had his paper route obligation every evening. However, both FN and Larry expressed satisfaction and both were confident that in another two weeks, 7 or 8 words a minute could roll out from under both their fists and pencils. It was therefore mutually agreed that if their knowledge of the written portion of the examination proved equally satisfactory, Larry and FN would administer the formal code examination at the next session, two weeks hence. The written portion would necessarily have to await completion of the formal code test and subsequent receipt of the other papers by FN and Larry. In the meantime, both Joe and Judy, independently, were to write to the Federal Communications Commission at Gettysburg, Pa. and request application forms for amateur radio licenses. They were however, *no*t to complete and return them but were to turn them over to their examiners at the time of the code test.

The code tests for this session having been completed, FN suggested, "Suppose we take up the written portion and see what you know about that in a verbal test; you been studying your books?"

"Sure, Gramps", replied Judy, "I've been getting in some time every afternoon and I've been reading myself to sleep at night with one or the other of them . . . Joe and I have been swapping them between us. Kinda rough going in spots but Joe's been able to straighten me out on some of the puzzlers so I figure I'm getting the hang of it".

Judy, FN, Larry and Joe talked about receivers after the code practice session.

"Good" was FN's comment, "now how about you, Joe?"

"Well, FN, I haven't been able to get in as much time as Judy, with my paper route but I think were about even. I've been concentrating on the laws and regulations mostly because a lot of the semi-technical stuff I've had in physics classes and it comes pretty easy".

"OK, then," said FN, "Larry, what say you and I take turns asking them questions at random from the books? You take the license manual and I'll use the ABC's and we'll alternate the questions".

"Fine" replied Larry, you start if off, FN".

"All right; Judy suppose you tell me what the novice frequency bands are." No trouble here . . . Judy rattled them off like she was using them all every day.

Larry came at her then with, "What is

the maximum legal power allowed novice stations?" to which she promptly replied, "75 watts" but Larry wanted more; "Input or output Judy?"

Looking a bit confused Judy countered with, "Input I think, isn't it? Gosh, I guess I didn't pay enough attention to that."

"Yes, Judy" returned Larry, "input it is but remember you may get a question reading just that way" . . . what is the maximum legal *input* power . . "and if you were confused between 'input' and 'output' you could go wrong. Have Joe explain this to you more fully some time."

It again being FN's turn, he asked Joe, "What frequency bands can a novice use for radio telephony?"

Joe immediately replied, "145-147 megacycles, only".

After acknowledging this as correct, FN said, let's divert for a moment here; glad this came up. You're right Joe and the use of the word 'megacycle' may appear in your examination or a new term may appear here. Recently a change was mutually agreed upon by industry, educational institutions and scientific organizations. The word 'hertz' was substituted for 'cycles per second', therefore megacycle has now become 'megahertz', kilocycle is 'kilohertz' and they've made gigacycle 'gigahertz'. Until the changeover is complete, your examination questions may carry either expression; many of the current manuals and handbooks have not as yet been changed . . . this will take a bit of time. The change was made to honor the memory of Prof. Heinrich Hertz who is the acknowledged discoverer of the phenomena known as 'Hertzian waves' or, as we have more commonly referred to them, 'radio waves'. Just remember that if the word 'hertz' appears where you have studied it as 'cycles', they are one and the same. I'll give you each a card before you leave which shows both the old and the new designations and their abbreviations. Now let's get on with the questions".

After about 45 minutes of this it was pretty evident to both FN and Larry that both youngsters had really done a bit of study ing. Several weak points cropped up of course and they were somewhat hesitant and unsure of the correct answer in replying but in the main, Larry and FN were both satisfied that progress had been excellent. The kids were both cautioned not to relax their studies and FN would subject them to another informal verbal exam after they completed the code exam at the next bi-weekly session. Just then FN's XYL made her appearance with a heaping plate of freshly baked doughnuts and a pot of coffee, Joe went to the Honda for a six-pack of Coke and FN declared a recess.

While relaxing with this bit of nourishment, Joe broke out with, "Gee, FN; something Larry and I been wondering about for some time and always forget to ask you. We know what the 'FN' stands for . . your 'sine' or handle . . . but how come FN; why not your initials or some other letters?"

FN laughed and said, "Well it's not much of a story Joe. When I first went to work for Western Union as a student telegrapher, I was told that I must choose a two letter combination as my 'signature' to receipt for messages on the telegraph line. My initials, 'DM' would have been all right except that one of the regular operators already used that sine. So I was told to choose any two letter group not then in use and my supervisor suggested something easily recognized and with good rythm. So, I finally came up with 'FN' which in the Morse telegraph code was easy to send and sounded rythmic . . . dit dah dit . . dah dit . . . that would be 'RN' in the radio code but when I changed over from wire to 'wireless' telegraphy, I was used to the letters FN and it was pretty rythmic in the Continental code as well; just one more dot, like this . . . dit dit dah dit . . dah dit . . . so I just carried it along and I've been FN ever since".

"Should Judy and I have sines too?" Joe inquired.

"You can if you like Joe . . pick your initials or any combination that appeals to you but you'll find most hams and darned few novices will know what you mean when they ask your name and you say 'my sine is YZ' or whatever you have chosen. You'll have to educate 'em to it . . most hams simply use their names. Yours Joe, is hardly longer than a sine would be . . just one more letter and an 'e' at that so you really don't need a sine. On the other hand, Judy's name is kinda long to send though not as bad as many that you'll hear, so if she wants to use a sine, nothing wrong with it. Her initials though are a bit long in code characters . . JM has a dot and five dashes in it . . she may want something shorter

DELUXE ADDITION TO THE SWAN LINE

5 BANDS—480 WATTS
HOME STATION—PORTABLE—MOBILE

It is with great pride that we announce the development and production of the newest addition to the Swan Line. The Swan 500 is a most fitting deluxe companion to the classic model 350. Improved circuit efficiency provides increased power ratings of 480 Watts P.E.P. on sideband; 360 Watts CW input and 125 Watts AM.

At the top of the Swan Line, the 500 offers many extra features: Selectable upper and lower sideband, 100 kc crystal calibrator, automatic noise limiter, provision for installation of an internal speaker (the best solution for the mobile installation), and a factory installed accessory socket for the addition of the model 410 external VFO.

As a receiver, the new 500 will satisfy the most critical operator. Sensitivity is better than .5 uv and the precision tuning mechanism is easily the smoothest you will find on any piece of amateur gear. Improved production techniques result in even better VFO stability. A new product detector circuit provides you with superior audio quality, and a new AGC system responds more smoothly to wide variations in signal strength.

The new 500 is equipped with the finest sideband filter used in any transceiver today. With a shape factor of 1.7, ultimate rejection better than 100 db, and a carefully selected bandwidth of 2.7 kc, this superior crystal filter combines good channel separation with the excellent audio quality for which Swan transceivers are so well known.

Frequency coverage of the five bands is complete: 3.5-4.0 mc, 7.0-7.5 mc, 13.85-14.35 mc, 21-21.5 mc, 28-29.7 mc. (In addition, the 500 covers Mars frequencies with the 405X accessory crystal oscillator.)

Along with higher power, improved styling and many deluxe features, the new 500 has the same high standards of performance, rugged reliability and craftsmanship that have become the trademark of the Swan Line. Backed up by a full year warranty and a service policy second to none, we feel that the Swan 500 will establish a new standard of value for the industry. Our new "Star" is now in production. **$495** amateur net.

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and more rhythmic like DA or BR or something."

"How about BK, Gramps?" Judy broke in.

"No" replied FN, "BK is a radio abbreviation meaning 'break' and it would be confusing; don't use anything which may have a double meaning like BT, AR, SK and such."

Judy pondered a few minutes and then came up with, "I'd like to take the Continental code equivalent of your sine Gramps, making it 'RN' . . how about that?"

Looking smugly pleased FN replied, "Sure . . it's OK with me; I don't think any of the boys will take you for a member of the Royal Navy or think you're a Registered Nurse" he finished with a chuckle. From there on out, Judy became 'RN'!

With the little pick-up snack out of the way, FN reminded them that he had promised to talk about the equipment they'd need for a novice station. "Let's start with the receiver; that's the first thing you should have and it wouldn't hurt a bit to get one right now. You could then listen to the many code practice stations sending slowly on the air and to novice and general class hams talking together. Most of them will be too fast for you but in straining to try and keep up you'll find that your

. . . Judy, Larry and Joe parted . . .

code speed will build up a lot faster from the incentive provided by trying to grasp what they are talking about. Always practice by trying to copy a station sending a little faster than you can receive solid; he'll keep you on your toes".

"Now there's several ways in which you can acquire a receiver" FN continued. "First off, you can build one from a magazine or handbook description. I don't recommend this for a beginner and I think Larry will go along with me on this" and Larry nodded in agreement. "First off, today's ham bands are really crowded with stations. That means that you must have a 'selective' receiver . . . one which will permit you to separate them as much as possible. This calls for what we know as a 'superheterodyne' receiver or, as the hams call it more familiarly, a 'super-het'; a good second bet is a really good tuned radio frequency type, again abbreviated ham-wise to 'TRF'. Building either of these is a pretty tricky procedure and after you have it all assembled and wired, it still must be 'aligned' which, to really do right, calls for several special instruments. In the long run you'll have a somewhat mediocre receiver which will cost you about as much as if you had bought a good, standard make, already built and operating. Then too, you can compromise and buy a 'kit' where all of the so-called 'hard work' has been done for you. Holes are punched and drilled in chassis and panel, coils are wound and roughly aligned etc. It's still quite a job to assemble, wire and complete the alignment. An experienced ham can do a good job with such a kit in a relatively short time but the beginner should be wary of tackling it."

"Buying a good, factory-built receiver has several angles also. A really good new one by a reliable manufacturer is going to cost somewhere in the \$150 to \$250 price range. Even better ones go up in price from several hundred dollars to a few jobs selling at a thousand or more! Don't let it scare you though; you are not about to equip 'Gemini Control' but simply making a start in ham radio. You can do rather well with one of the more modest receivers and if it's a fairly recent model of reliable manufacture, it will bring a good trade-in value if and when you want something better later; home-built jobs are rarely accepted as trade-ins."

"Here's another apprcach . . . the second hand market. Many hams who have started with modest gear eventually trade it in for something more elaborate or sell it at a substantial reduction. If of reliable make and it's appearance indicates that it has received reasonably good care, these can often be had for half or less than their original cost. Don't buy a 'pig in a poke' though; most hams are truthful and trustworthy in deals of this kind but are often prejudiced as they have used the equipment for some time, are used to it's little idiosyncrasies and can handle it; a green buyer however could experience rather unsatisfactory results. By all means arrange to try out a piece of gear like this if you're considering buying it and preferably have a more experienced ham look it over and try it out . . . be guided by his opinion. Larry or I will gladly do this for you . . . many of your fellow club members would also be helpful here too, if you find something you think is a good buy. Some of the mail order houses too, offer used equipment which they have taken on trade-ins and have had re-conditioned by their own technicians. World Radio Laboratories is one who specialize in this; there are a number of other reliable sources and you'll find them advertised in the ham magazines".

"Another good bet in shopping for a receiver is the military surplus offerings. Stores specializing in this as well as many mail order firms who advertise, still have a considerable amount of this kind of gear around at unbelievably low cost when you consider what fine pieces of gear they offer. Again you should rely on an experienced ham in helping you choose something which you won't have to modify extensively for ham band use."

Right here, Joe broke in with, "Say, FN, a couple of years ago when I was doing a lot of short-wave listening, I picked up a surplus BC-312-N receiver down at Jim Turners' for thirty-five bucks. It sure is a well-built deal and really brings in shortwave broadcasts from all over the world. I often hear amateur radio phones at certain places on the dial and the thing is just *loaded* with all kinds of code signals but I don't know who they are. Could I use this receiver for my novice station?"

"You sure can Joe and it's a dandy; I used one for several years before I got this little Davco solid state job I'm using now. The BC-312 is built like a battleship and is plenty sensitive and selective to pull in ham signals from all over the world and you'll find it will fill the bill for you for a long time to come, right on into your general class operation. Only high frequency novice ham band you won't find on it is the 15 meter spread; the BC-312 covers the 20, 40, 80 and even the 160 meter bands in fine shape. When you reach the point where you think you'd like to play around on 15, you can build a simple converter to extend the range of the BC-312 into this band. So, you're all fixed with a receiver for a long time to come . . . how about you Judy?"

"Oh, I'm not so lucky I guess; Dad's got some kind of an FM rig but it's no good for ham bands so I'll have to start from scratch" she replied. "Anyway I've saved a little money this summer from picking berries and a bit of baby-sitting so I guess thats' a good way to spend it".

Larry chimed in with a suggestion that maybe Judy and Joe could take a look down at Jim Turner's and see what he might have in the way of a good surplus military receiver or a second hand ham job.

"If you kids turn up something that looks good, I'll be glad to take a look at it and check it over for you. Jim will let you take it home and try it for a few days Judy, I know." Both kids agreed to do a bit of 'window shopping' at Jim's place and the other two electronic stores in town and made a date for the 'great adventure' for the following week.

With the receiver situation pretty well in hand now, FN suggested, "Let's call it quits for today then . . . it's about lunch time for all hands anyway. You young 'uns be out here two weeks from today, sharp at nine a. m. and we'll put you through your code exam. Don't forget now, write a postcard to the FCC and ask for your amateur radio operator license application forms, soon as you get home. Don't put it off or you may not get 'em in time . . . remember, FCC's mail basket is piled mountain high!"

"OK Gramps" Judy replied, "we'll do it" and at Larrys invitation, they tied her bike on his rear bumper and she climbed in with him for the short ride home while Joe kicked the Honda starter and took off after a friendly wave and an exchange of the now familiar "73" . . BCNU . . "

. . . W7OE

Fred DeMotte W4RWM
Post Office Box 6047
Daytona Beach, Florida

Going RTTY: Part Four

Frequency Shift Keying

The terminal unit is complete with its scope monitor and you have been getting fine copy.

Now you desire to put a RTTY signal on the air and the question is—how?

Let's first take another look at the terminal unit circuit described in December 73 (1964), and add the mercury wetted keying relay.

The addition to the circuit is the dotted lines in **Fig. 1**, and only the section of the original circuit covering the 6AQ5 is shown.

This relay will permit you to key the transmitter through the keyboard of your machine, since depressing the keys on the machine will open the loop current and permit the relay to key the frequency shift keying circuit of the transmitter, and at the same time produce local copy on your machine.

The mercury wetted relay shown is the WE276, although others will work as well, with the required socket changes.

The only word of caution is that the mercury wetted relay must be mounted in a vertical position.

Now that the modification is completed, let's look first to the use of frequency shift keying and a simple way of accomplishing it on the average transmitter.

Let's see what we mean by frequency shift keying, assuming that we will employ the standard shift of 850 Hz.

The terms applied to this difference in frequency are MARK and SPACE, the first being the RF carrier and the difference in this MARK and the capacity introduced into the cathode circuit of the BFO, is called the SPACE signal.

To illustrate, let's take a frequency of 7137 kHz. This would be the MARK signal. Now to shift this signal down 850 Hz would produce a SPACE signal of 7136.150 kHz.

Now how do we accomplish the change in our MARK signal or the fundamental frequency of our transmitter?

Fig. 2 shows a simple circuit which can be used with most transmitters and others with certain modification, but the principle of creating the frequency shift remains the same.

What occurs is that additional capacity is placed across the LC circuit of the oscillator, which lowers the oscillator frequency sufficiently to move the transmitter carrier frequency 850 Hz.

It should be pointed out that the MARK signal is always the higher of the two frequencies, so that the SPACE signal is shifted downward in frequency 850 Hz.

The slug tuned coil (B) is made of 15-20 turns of about 22 wire on a ½ inch form and tuned to an inductance of about 40 mH. If you are unable to reach the 850 Hz between the MARK and SPACE signal, vary the slug in a (B) slightly.

In adjusting the shift pot it must be done slowly, observing the scope monitor for full deflection on both MARK and SPACE. A little experimenting with this adjustment will make for a 850-Hz setting.

. . . W4RWM

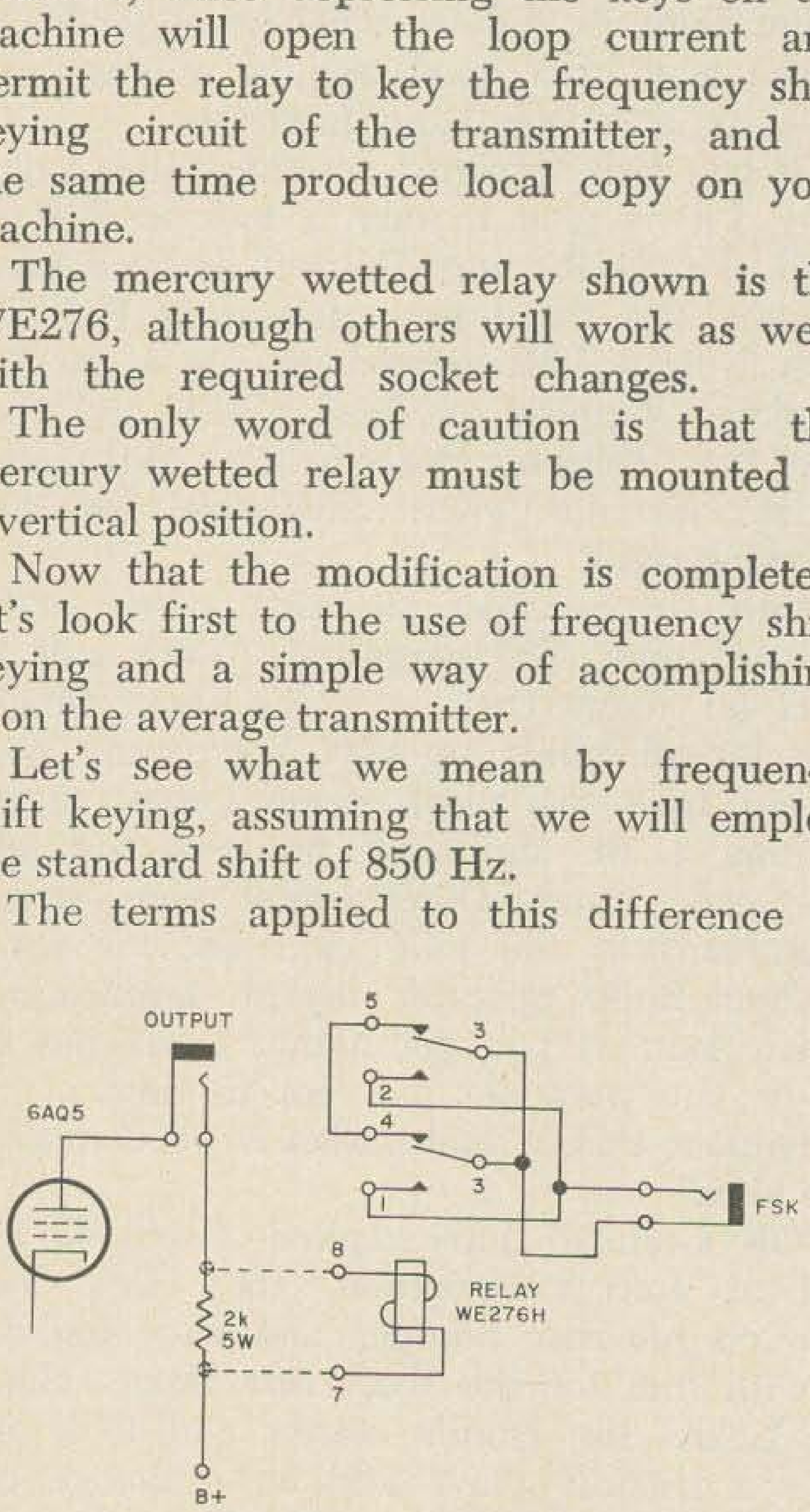


Fig. 1. Adding a keying relay to the terminal unit described in the December 1964 73.

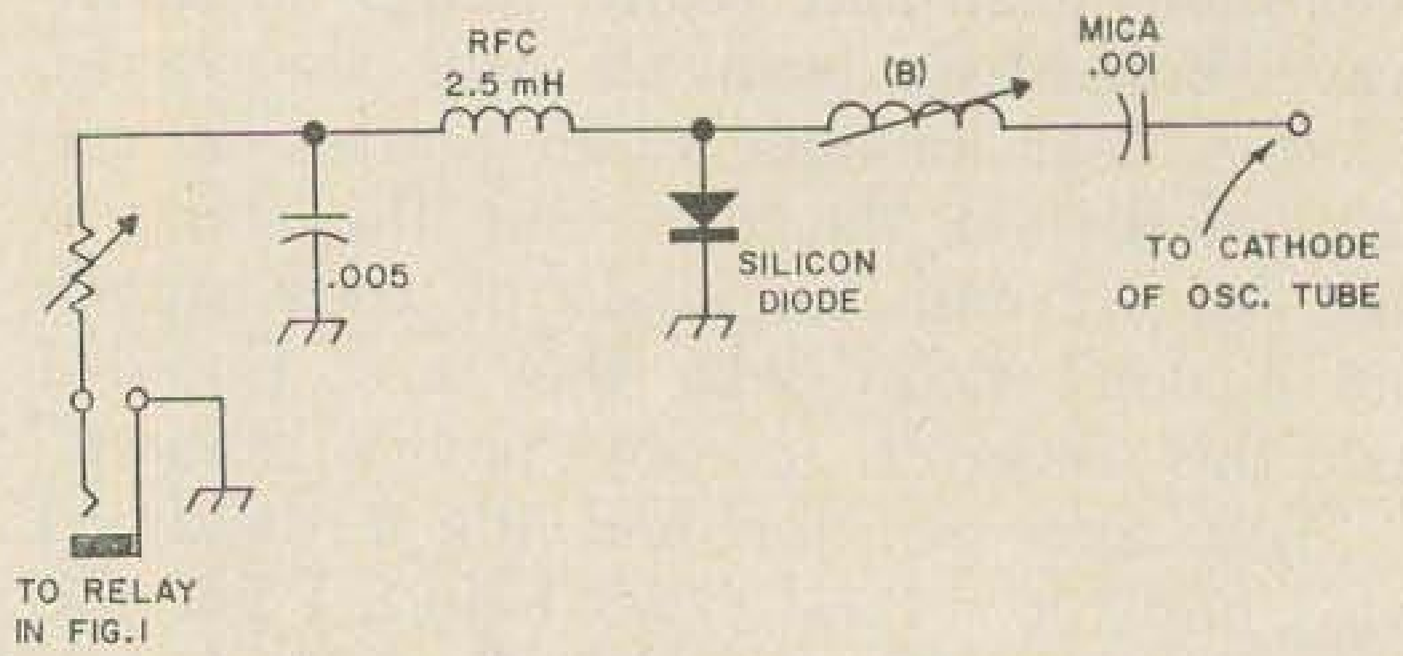


Fig. 2. Simple frequency shift keyer adapter for a VFO.

Robert Sexton WB6CHQ
2806 E. Norwich Avenue
Fresno, California

A Solid-State Product Detector

Improve the performance of your receiver on SSB and CW with this simple transistor product detector.

All receivers not specifically designed for SSB reception suffer, to some extent, in quality and ease of tuning when used for this mode. Distortion of the received signal occurs for a number of reasons. When this includes BFO pulling, reduction of the rf gain may prove necessary. This in turn leads to loss of sensitivity and does not allow the AGC system to operate effectively. This is a less than satisfactory state of affairs.

With the advent of SSB and the almost total disappearance of AM from the HF amateur bands, good SSB reception is mandatory. To date, a combination of hang-AGC and a product detector seems to be the best solution. The product detector is the most important element of this pair and numerous articles have appeared discussing vacuum tube versions of this worthy circuit. There has been very little information dealing with the design of a solid-state version, however.

This article will describe a design which is a transistor equivalent of the popular dual-triode product detector. It will discuss the causes of distortion to SSB signals which include BFO instability as a result of pulling, AGC non-linearity and inter-modulation distortion. As an example of these problems and their cure, it will refer to a product detector built for the Heathkit "Mohican".

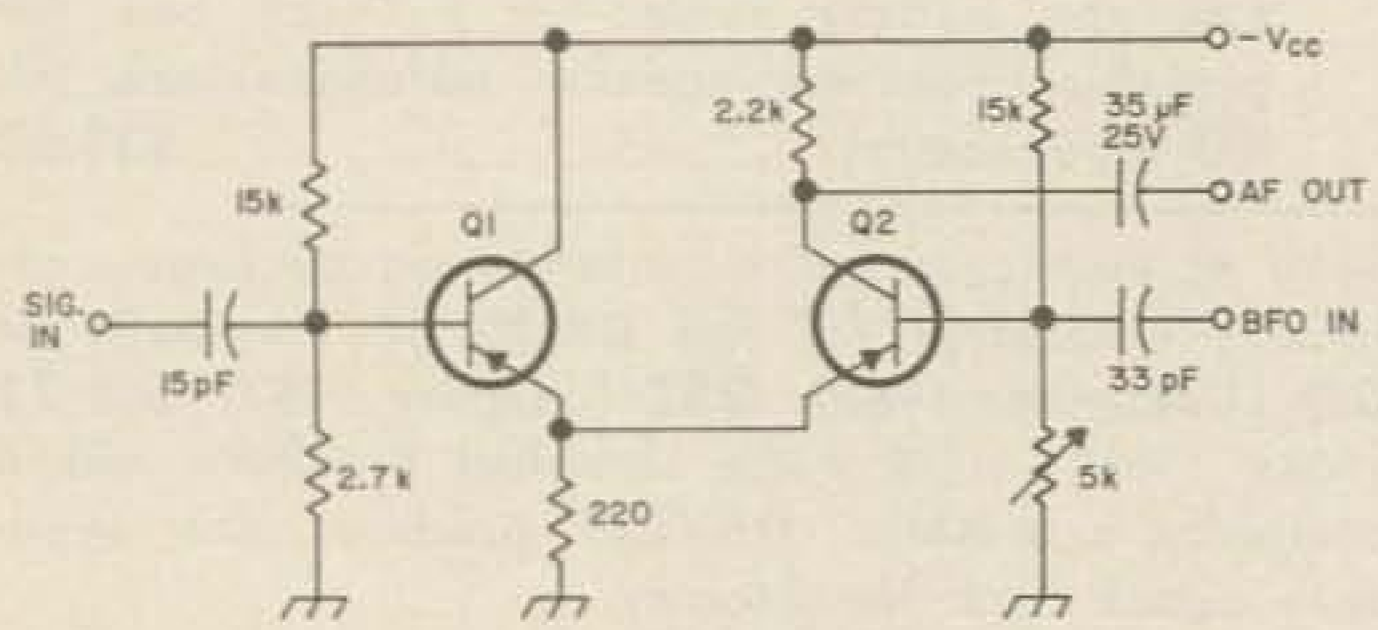


Fig. 1. Schematic of WB6CHQ's simple product detector. The transistors are not critical; IR TR-06's were used in the author's version, which was installed in a Heath Mohican.

In the GC-1A, the primary cause of distortion to SSB signals is BFO pulling. This phenomenon is the direct result of the presence of strong signals in the BFO circuit. In this receiver, the BFO output is injected at the input of the third *if* amplifier. This is done by connecting a 4.7-*pf* capacitor from the collector of the second *if* to a tap on the BFO inductor. Thus, any signal in the *if* strip is also in the tuned circuit of the BFO to some degree.

To understand why this will pull an oscillator, consider The tuned-grid, tuned-plate oscillator. It may be shown that in this oscillator, the tuned circuit with the higher "Q" will control the frequency. This is so because, a low "Q" tuned circuit having a broader frequency response, more feedback will be provided to the high "Q" circuit. Since feedback is the essence of oscillation, the tuned circuit *getting* the most feedback will control the frequency of oscillation.

By applying this logic to the BFO, it is easy to see how pulling occurs. If the BFO is treated as if it were a TGTP oscillator, then the incoming signal can be thought of as a tuned circuit with infinite "Q". With this situation the closer BFO gets to the signal frequency, or vice-versa, than, of the two feedbacks present, that from the signal and that from the BFO itself, the more predominate the signal becomes. At some point in tuning, it becomes the controlling feedback and the BFO shifts abruptly to the signal frequency.

When this occurs, the frequency difference between the signal and BFO is necessarily zero. Since the desired audio output is that frequency difference, there can be no audio output. With an SSB signal, the peaks will be strong enough to pull the BFO leaving only the lower amplitude portions of the signal as output. The result is a highly punctuated garble.

With a diode detector, an output of a different but still useless nature is possible. A diode is a non-linear impedance, that is, the impedance varies as a function of the applied voltage or current. A fundamental principle of electronics states that an AC signal applied to a non-linear impedance will generate harmonics of itself. If two frequencies are applied simultaneously, they will also generate their sum and difference frequencies. When a signal as complex as an SSB signal meets a diode, the result is only slightly less calamitous than the famous meeting of the irresistable force-and the immovable object. In this situation, every audio component present may mix with every other audio component to form still more audio components. The result is the muffled, quacking, semi-speech with which we have become familiar with the rising popularity of SSB.

These components are also the output when the BFO locks onto one of the frequencies of an SSB signal. But even if the BFO stays where it should, these components are still present in the output of the diode mixer, because the diode must mix all frequency components present. This is where the product detector has a distinct advantage. It can mix *only* BFO and signal, rather than BFO and signal, signal and signal, etc. This type of distortion will be recognizable to hi-fi fans as inter-modulation distortion.

The AGC in a receiver can be another source of distortion. In receivers such as the GC-1A, AGC response is fairly fast, capable of following the syllabic rate of an SSB signal or the keying of fast CW. With a perfectly linear AGC, the only effect on an SSB signal will be uniform compression, or overall reduction of the dynamic range. If, however, the AGC response is not linear (which is likely since no tube or transistor has an infinite dynamic range, then the result will be envelope distrotion. This is a rearrangement of the relative amplitudes of the signal components. Normally, this distortion is not too severe as most signals will stay mainly within the most linear portion of the AGC response.

The more important problem with AGC is that, even without modification, it cannot be used effectively. If pulling occurs even with AGC, the AGC is not limiting the signal sufficiently and the only recourse is to reduce the RF gain. When this is done, the AGC begins to lose control and its advantages are gone. It is worth noting that for the GC-1A, Heath recommends that it be turned off for SSB reception.

Theory

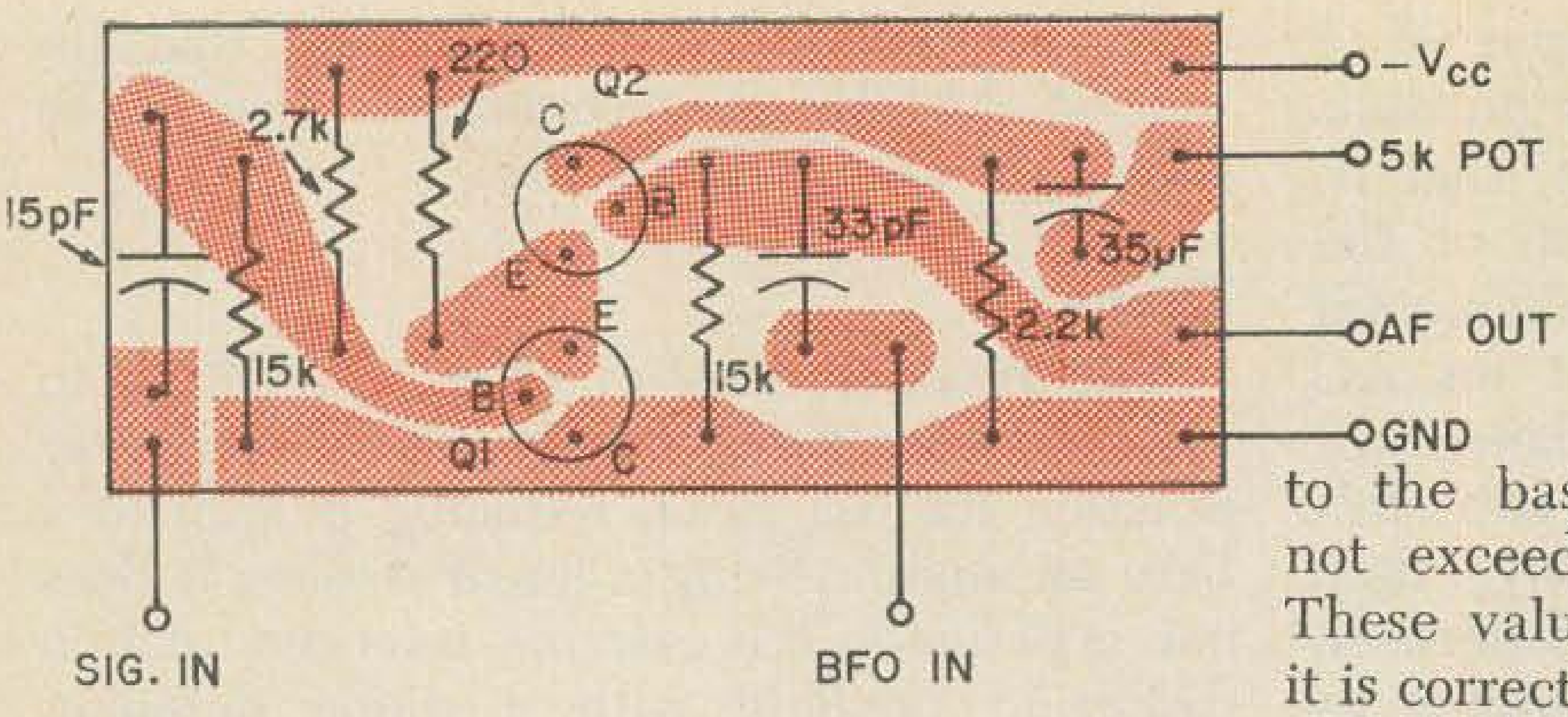
The product detector offers a solution to most of thses problems. It allows far better isolation for the BFO, reducing pulling to a bare minimum. Being a linear device, it does not experience the extreme inter-modulation distortion possible with a diode detetcor. Finally, since pulling is not a problem, it allows operation of the receiver at maximum rf gain and use of the AGC. Thus, neither the convenience of AGC nor the receivers sensitivity are sacrificed to the "new wave".

The product detector is more properly known as a multiplicative mixer, the same circuit as is used for a converter in the front end of most modern receivers. This fact will explain the product detector circuits frequently seen which employ a pentagrid converter tube. Another apt name is "audio converter".

To see why and how a product detector works, refer to the circuit of *Fig.* 1. First, note that the coupling capacitors used have a very high reactance for transistor work, even at 455 kHz. The reactance of the 15-pF capacitor is about 20 kohm and that of the 33 pF is about half that. These high impedances are in series with the low input impedances of the transistors, providing a large voltage division. This insures small signal operation of the transistors guaranteeing their linearity.

This also provides a high degree of isolation for the BFO, which combined with the isolation inherent in the transistor, makes the BFO far more immune to pulling. This immunity is such that in the GC-1A, a local broadcast station about a mile distant, will not pull the oscillator more than about 50 Hz.

In operation, Q1 is an emitter follower, whose vacuum tube corollary is the cathode follower. The same conditions hold true for both. They are capable of power gain, but not voltage gain. Since the emitter resistor is common to the emitter of both transistors, the signal is directly coupled to what is to it, a common-base amplifier. In this amplifier, voltage gain is dependent to a certain extent on the quiescent or operating point of the transistor. This operating point is a function of biasing and the bias may be controlled at the base.



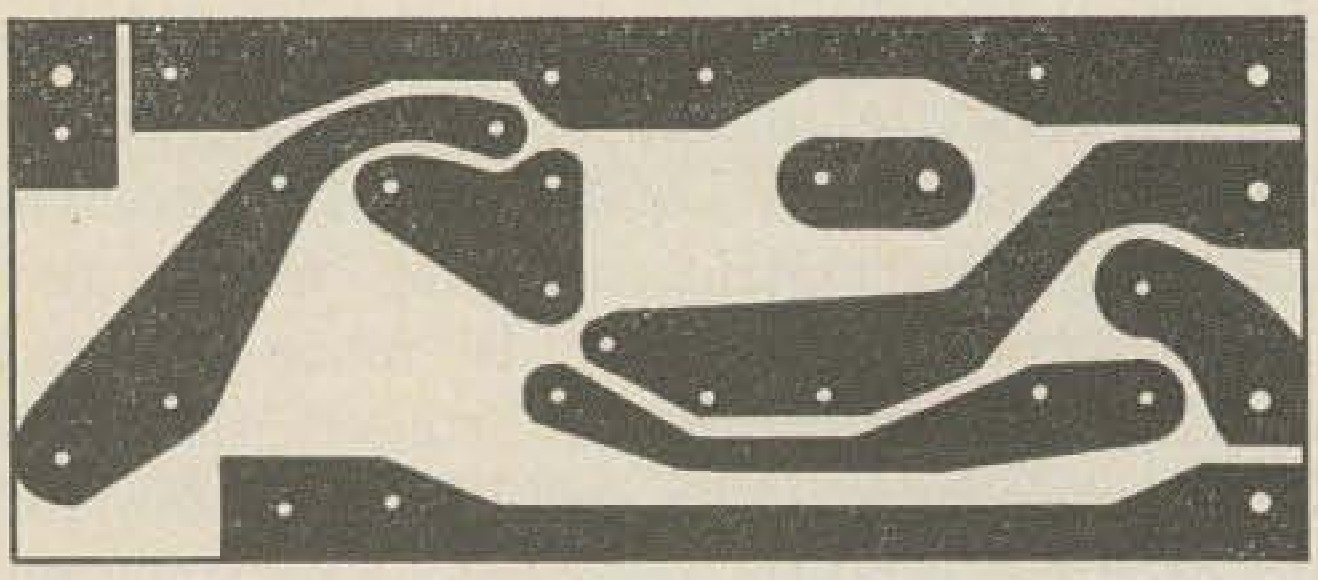


Fig. 2. Layout for the etched circuit board used by WB6CHQ.

Since the BFO is connected to the base of Q2, it is constantly changing the bias and, therefore, the quiescent point at a rate near the frequency of the signal on the emitter. This means that the signal sees a linear input impedance and a rapidly changing voltage gain. This is the reason for the term, 'multiplicative'. Since the output voltage is the input voltage multiplied by the voltage gain, if we must inlcude the BFO frequency to express the voltage gain in the equation, then the effect is literally multiplicative mixing.

Adjustment and operation:

This circuit is sufficiently simple that its construction should provide no obstacle to anyone. I have included the PC board layout (*Fig.* 2) that I used and one can see that I followed the actual appearance of the schematic quite closely. If you wish to make your own layout, this is generally the best method to follow, at least for the smaller projects. I strongly recommend that a PC board be used. They provide the neatest, most compact, best appearing and most durable form of construction available for small circuits such as this. Etching is not difficult and kits are available for it.

Having constructed the circuit, it should be mounted in the receiver and connections made to it. The supply voltage may range from six to twelve volts but be sure that you do not exceed the collector breakdown ratings of the transistor you use. The BFO should be able to supply about .2 volts RMS to the base of Q2 and the signal should not exceed this value at the base of Q1. These values are valid for the circuit when it is correctly adjusted.

To adjust the product detector, first set the linearity pot to zero resistance (so that the base of Q2 is shorted to ground). With the BFO *off*, (making sure that the product detector is on adjust the linearity pot from zero until the signal to which your are tuned becomes slightly audible with the volume control on full. A local broadcast station makes an excellent test signal. When the BFO is turned on the signal should be very loud, though not quite as loud as with the diode detector for an AM signal. This will vary with the type of receiver but will probably hold true in most cases. If one wishes to tinker further, the ultimate desired result is a maximum of signal with the BFO on and minimum with it off. The signal present when the BFO is off is a result of intermodulation distortion and is not desired for best reception.

When all this accomplished, it is possible that the BFO will need adjustment to get a zero-beat at the zero-beat mark on its control. In the GC-1A, this is remedied by tuning an AM signal for maximum on the S-meter, setting the BFO at the zero mark, and adjusting the BFO inductor for a zero-beat. Similar methods may be used for any receiver.

In operation, the product detector is virtually identical to the diode detector with the major difference being the improved reception. The BFO is adjusted to one or the other side of zero-beat depending on which sideband is wanted. The signal should show the most deflection on the S-meter when the voice sounds the best. The receiver may be tuned with the RF gain on full and the AGC on.

The ideal SSB receiver is the one on which the only adjustment required is the tuning and sideband selection. When this product detector is used in the GC-1A or any other receiver, operation begins to approach that ideal.

. . . WB6CHQ

the only "no compromise" six meter SSB transceiver

the Heathkit® SB-110...full features...new lower price—$299.00

• The only truly high-performance SSB transceiver on six meters • Uncompromised engineering — the SB-110 features the same quality crystal filter found on Heathkit 80-10 meter SB-Series rigs • The same Heath LMO (Linear Master Oscillator) found on 80-10 meter SB-Series rigs • Built-in VOX • Built-in Crystal calibrator • Upper & Lower sideband selection • Full CW provisions, including built-in sidetone

You Can Work "Six" With A Truly High-Performance Rig . . . get lowband stability, 1 kHz dial calibration, linear tuning, and a backlash-free dial mechanism, plus all of the other standard "built-in" features found on the Heathkit 80 through 10 meter SB-Series equipment. The SB-110 runs 180 watts P.E.P. SSB input, 150 watts input CW . . . considered the ideal transceiver power level by most ham radio communications engineers. It is one unit of the famous Heath SB-Series, meaning availability of matching low-band transmitters, receivers, and transceivers, plus accessories such as the SB-600 Communications Speaker, SB-630 station console, and SB-610 Signal Monitor. And the SB-110 goes fixed or mobile with the appropriate power supply . . . the same versatility you experience with the famous Heath SB-101. Call it the one "no compromise" six meter SSB transceiver.

Kit SB-110, 23 lbs.	**$299.00**
Kit HP-13, Mobile Power Supply, 7 lbs.	**$64.95**
Kit HP-23, Fixed Station Power Supply, 19 lbs.	**$49.95**
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Kit SB-600, SB Series Speaker, 5 lbs.	**$17.95**
Kit HS-24, Mobile Speaker, 4 lbs.	**$7.00**
HDP-21A, SSB "Ham" Microphone, 4 lbs.	**$29.40**

PARTIAL SB-110 SPECIFICATIONS—RECEIVER SECTION: Sensitivity: 0.1 uv for 10 db signal-plus-noise to noise ratio. **Selectivity:** 2.1 kHz @ 6 db down, 5 kHz max. @ 60 db down. **Image rejection:** 50 db or better. **IF rejection:** 50 db or better. **Audio output power:** 1 watt. **AGC characteristics:** Audio output level varies less than 12 db for 50 db change of input signal level (0.5 uv to 150 uv). **TRANSMITTER SECTION: DC power input:** SSB, 180 watts PEP; CW, 150 watts. **RF power output:** SSB, 100 watts PEP, CW, 90 watts (50 ohm non-reactive load). **Output impedance:** 50 ohm nominal with not more than 2:1 SWR. **Carrier suppression:** 55 db down from rated output. **Unwanted sideband suppression:** 55 db down from rated output @ 1000 Hz & higher. **Distortion products:** 30 db down from rated PEP output. **Hum & noise:** 40 db or better below rated carrier. **Keying characteristics:** VOX operated from keyed tone using grid-block keying. **GENERAL: Frequency coverage:** 49.5 to 54.0 MHz in 500 kHz segments (50.0 to 52.0 MHz with crystals supplied). **Frequency selection:** Built-in LMO or crystal control. **Frequency stability:** Less than 100 Hz drift per hour after 20 minutes warmup under normal ambient conditions. Less than 100 Hz drift for ±10% supply voltage variations. **Dial Accuracy:** Electrical, within 400 Hz on all band segments, after calibration at nearest 100 kHz point. Visual, within 200 Hz. **Dial backlash:** No more than 50 Hz. **Calibration:** Every 100 kHz. **Power requirements:** High voltage, +700 v. DC @ 250 ma with 1% max. ripple. Low voltage, +250 v. DC @ 100 ma with .05% max. ripple. Bias voltage, —115 v. DC @ 10 ma with .5% max. ripple. Filament voltage, 12.6 v. AC/DC @ 4.355 amps. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

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Robert Cox K3CEE
1411 Medford Road
Wynnewood, Pa.

AMCOM—
Amateur Mobile Communications

The Phil-Mont Mobile Radio Club, Inc. of Philadelphia and vicinity is endeavoring to complete the outfitting of what it considers a communications facility second to none in AMCOM, Amateur Mobile COMmunications. This is being accomplished through the equipping of an independently powered mobile communications trailer, W3RQZ/portable, with its own prime mover also fully equipped to operate as an independent mobile relay station, W3RQZ/mobile.

Photo 1 shows the com-truck, a 1949 International Metro, and the com-trailer made by the Schulte Company in 1953. The truck was obtained from the Township of Springfield, Delaware County, Pennsylvania, as a former bookmobile. It is now painted a bright emergency red, and well-marked as W3RQZ, Mobile Communications Center. It is well-known to Phil-Monters as the "Red Truck." The trailer was purchased from a contractor whose use necessitated minor body repair topped off with Rustoleum silver paint.

The emergency Red Truck contains equipment mainly for 10 meter AM operation, a 60-watt unit with VFO and tunable receiver, and a 30-watt fixed frequency unit for operation on the club frequency of 29.493 MHz. This unit can be operated at its position or by the driver of the vehicle. AC power can be supplied by an external generator hauled in the truck. DC power is supplied by a 100-ampere Leece-Neville generating system.

Two other operating positions are available for 2 meter and 6 meter Gonset Communicators, with ac and dc power cords installed. The units are not permanently mounted in the truck, but are available from club members at a moment's notice.

Also included are two telephone line inputs for local and common battery lines; 25 watt public address system which operates on 6 Vdc or 110 Vac; automatic change over for lighting from ac to dc; metering of generator voltage, frequency and running time; handi-talkies on 29.493 MHz; galley supplies; vehicle and other tools; and local area maps. Antennas are available for all equipment, and are mounted in positions for minimum interference between bands.

The communications trailer is Phil-Mont's most refined piece of emergency equipment.

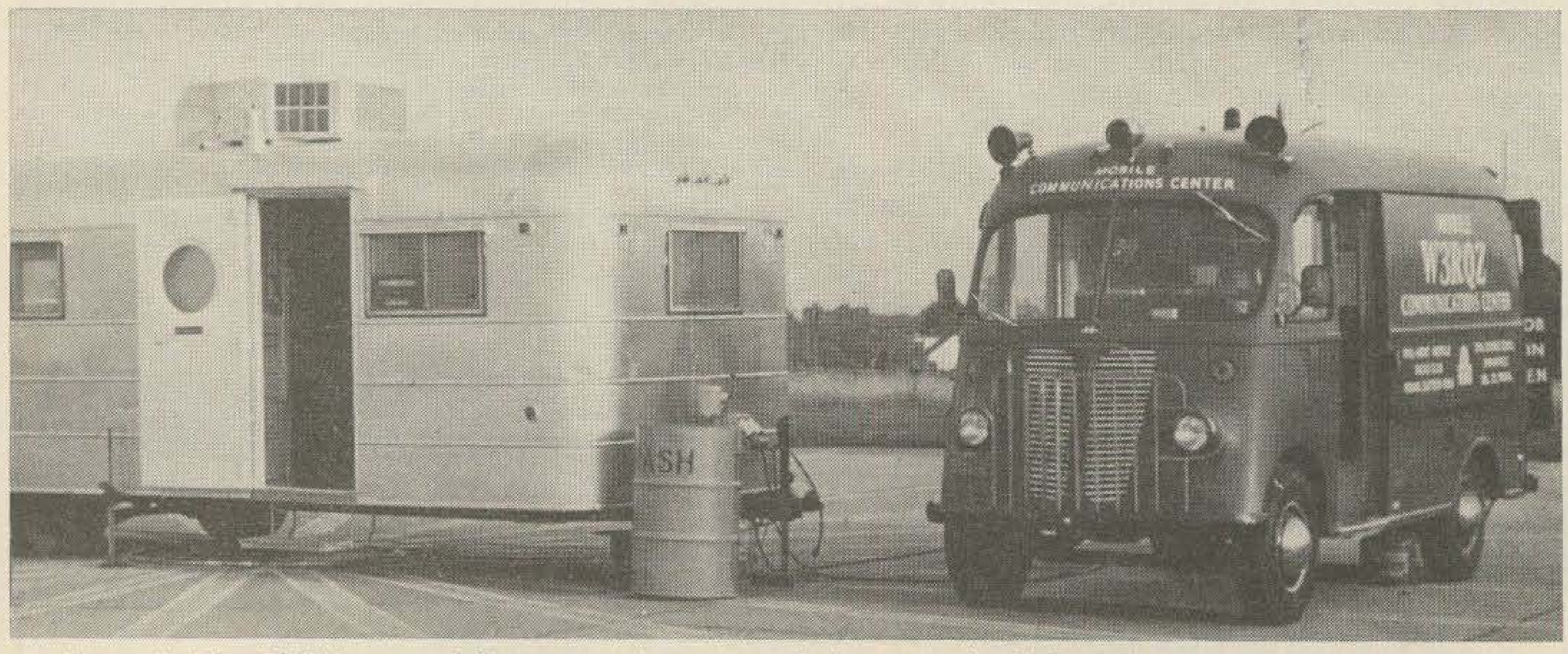


Photo 1. The Phil-Mont mobile communications vehicles. On the left is the communications trailer, and on the right, the Red Truck.

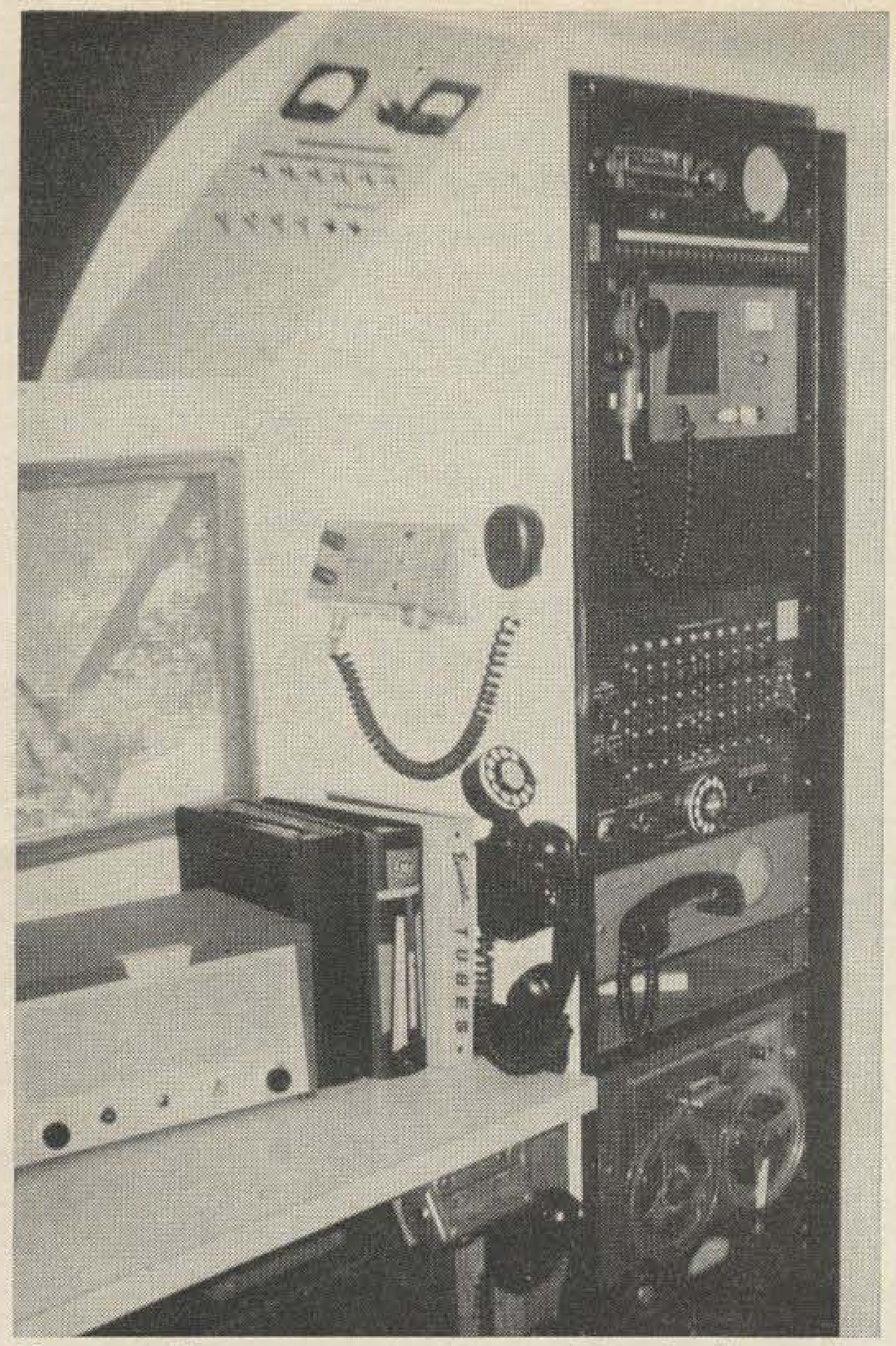


Photo 2. The message center position in the trailer.

Twenty-six feet long, it is divided into an operating area 7′ by 14′ and a lounge area 7′ by 12′.

The operating area walls and ceiling are lined with accoustical tile and are fiber glass insulated. All interiors are white for light reflection, with dark green kick areas. Wall to wall carpeting completes the noise reduction. The lounge area includes a daybed for overnight operators, galley supplies for coffee breaks, and storage cabinets for galley and stationery supplies. The lounge floor is tiled for easy cleaning. Each area has its own door, and eight windows around the trailer provide adequate ventilation when the 1½ ton air-conditioner is not in use.

W3RQZ/portable consists of seven operating positions coordinated by a Message Center Chief. Stationed by the equipment rack at the door between the lounge and operating areas, the Message Center Chief accepts all incoming traffic originating at the portable operating site. He distributes the traffic to the proper operating position for transmission and keeps track of its progress. From his position he has the capability of monitoring, recording or placing on public address both sides of any or all QSO's in progress. He can also patch any receiver to any push-to-talk transmitter.

On the ceiling to the left of the rack is a power panel which distributes the power to the equipment, lights, and fans. It also provides complete instrumentation of the voltage, current, frequency, and running time of the incoming power.

In the rack, from top to bottom, are: broadcast band monitor; NARCO VGTR-2 for use on aircraft frequencies in emergency situations; message center patching and monitoring equipment; tape recorder; and public address amplifier.

On the side of the rack is a control-head for 6 meter FM with an RCA CMV-3 on 52.525 MHz and a telephone instrument for use with two incoming lines. Seen on and under the table are speakers and controls for several safety service receivers on both high and lowband police and fire frequencies. The binders contain complete schematics for all equipment.

Photo 3 is a view from the message center position toward the rear of the trailer. In it can be seen an SB-33 for 75, 40, and 20 meter sideband; a 6 meter AM unit; and at the 10 meter position on the extreme right, an Elmac AF-67 and PMR-6. Either microphones and earphones or operator headsets are used with floor switches for maximum noise reduction and operating ease.

Not shown is a Gonset Communicator II, modified for push-to-talk, and a Model 15 Teletype for future use on 80 meter and 40 meter FSK or 6 meter and 2 meter AFSK.

Vertical antennas are available permanently attached for all frequencies but those below 14 MHz. For such frequencies coil-loaded mobile whips or portable wire-antennas are used.

Before the acquisition of the com-trailer,

Photo 3. View toward trailer rear from the message center position.

Phil-Mont hauled portable power behind the Red Truck in a generator trailer constructed by club members. This trailer houses a 3 kW–110 volt Onan generator, Model W2C, water-cooled, two cylinder–four cycle, with electric start and ignition. The generator trailer is completely enclosed and has louvered access doors; power cords, junction boxes, jacks, wheel chocks, gas cans, and a power distribution panel complete the installation. This unit is up for sale, but is hauled by other vehicles for present communications projects in the absence of a new Onan Model 305CCK, to be purchased by the club when funds permit. The new Onan will use propane as fuel and will be stored in the Red Truck or any other vehicle used to tow the com-trailer.

Phil-Mont is available with its two vehicles to undertake any communications activity, be it an emergency or a routine project. With a force of Phil-Monters active daily in their own mobiles on 29.493 MHz AM, 52.525 MHz FM, and 3.995 MHz SSB, practice in mobile communications is continual, and leads them to say that Phil-Mont in ready "every single minute."

Inquiries on particulars concerning Phil-Mont's vehicles should be addressed to W3QQH, C. R. Spencer, Jr., 124 Central Avenue, North Hills, Pennsylvania 19038.

. . . K3CEE

Improving the Ham M

I am of the firm opinion that the Ham-M is the finest commercial rotator made . . . mechanically. It is very ruggedly built and, when properly installed, will not be the limiting factor, strength-wise, in any reasonable antenna installation.

My complaint is with the direction indicating circuit. The meter in the control box is calibrated in 5° increments. And the signal which the meter measures is the output of a low impedance voltage divider consiting of a wire-wound pot located in the rotor housing. What could be more accurate?

The catch is simply that the bridge is driven by a dc voltage which is rectified from the ac line through a transformer and is directly proportional to it. What this means is that on a cold day when everyone is using their electric heaters, causing the line voltage to drop, my meter says that the antenna is pointed more to the west that on a "warm" day. Or, since I have poor line voltage regulation in the shack, whenever I talk the linear up, the direction meter dips to the west.

A moment of head scratching convinced me that this nasty problem should be solved with only the most advanced techniques: a zener diode was called for, to regulate the indicator supply.

A zener diode, you may recall, is the solid-state design engineer's answer to the VR tube. These little gadgets can regulate a voltage with a dynamic impedance of as low as 1Ω or less, far better than a VR tube. They come in lower voltages and a wider range, too. And this is the turning point of the story.

The cover of the control box was removed, the zener diode and the three new parts shown in **Fig. 1** were installed and the cover was replaced. A word of caution is in order about the installation of the zener diode. It should be connected "backward", that is, with the cathode wired to the positive line. Connecting the diode incorrectly can not harm anything. The only result will be that the output voltage will be less than a volt instead of 16 volts. The usual caution should be exercised with the electrolytic capacitor.

The results have been most satisfactory. During more than eighteen months of operation, the full scale voltage of the bridge has been checked periodically and found to be right on the nose. And even better—when I talk the linear up, the direction meter doesn't budge a bit.

. . . Galen Tustison WB6FGT

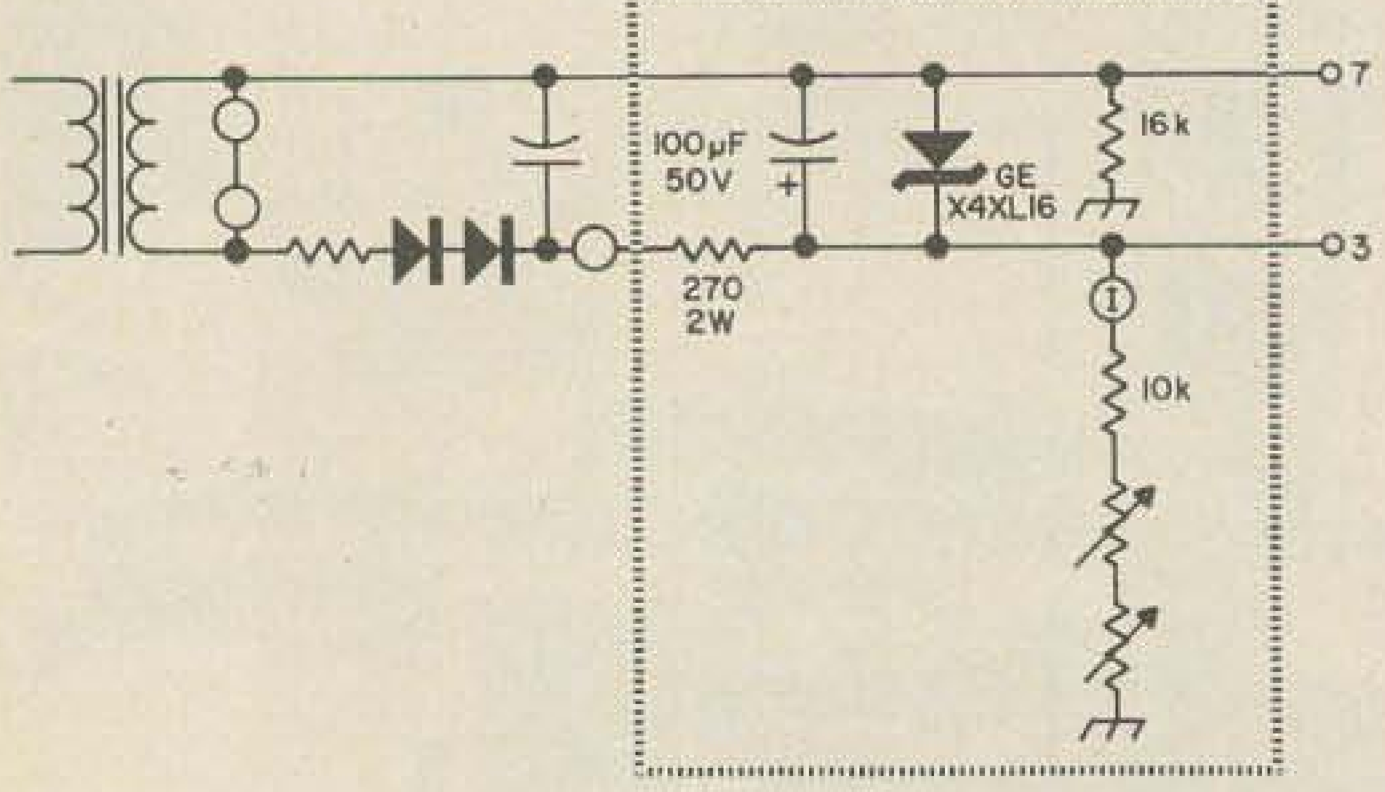


Fig. 1. Circuit of the Ham M control box as modified for consistant directional readings.

The Classic Feed System

By W. E. "BARNEY" ST. VRAIN, WØPXE
DESIGNING ENGINEER - CLASSIC 33 PROJECT
MOSLEY ELECTRONICS, INCORPORATED
4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

Code 107.

SINCE the introduction of multi-frequency beams several years ago, the method of feeding such antennas has been a subject of much disagreement. When these antennas were introduced a few years ago, Mosley Electronics ran a series of advertisements in the technical magazines explaining the method used on our Trap-Master and Power-Master series. Since that time we have tried a wide variety of feed systems endeavoring to improve on the original system.

Testing Other Feed Systems

In testing, we found a three band gamma system ineffective without isolation networks which resulted in the feed system costing about equal to the antenna cost; with a system using hairpins, the cost proved low but did not provide a better match than the original Mosley matching system. It became quite clear to us, the Mosley system was hard to beat, for we had found only one slight disadvantage, the elements needed to be stagger tuned to raise the feed point resistance from about 30 to 50 ohms. This slight detuning, which proved advantageous in increasing the bandwidth, brought about, in turn, a slight gain loss of about 0.5 to 1.0 db. at resonance.

The Classic-33 System

In order to give hams a new choice in beam matching systems and an antenna featuring maximum gain with increased bandwidth, we devised the matching method used on our New Classic 33 antenna, a method which takes advantage of the principle that antenna resistance at the center driving point increases as the antenna length increases. Figure No. 1 shows the radiator element of a three element beam at resonance having an impedance at the driving point (Z_A) of about 30 + J0 ohms. If the element is made longer, Z_A can be raised to about 50 + J50 ohms. (Figure No. 2) Since the reactance is inductive, it can be canceled with a series capacitor of 50 ohms reactance, leaving 50 ohms feed point resistance. (Figure No. 3) Series capacitors used on the Classic 33 are made by inserting a suitable length of heavily insulated wire into each half of the element tube at the center. The wires are terminated in a plastic tube enclosure with a type "N" connector for connection of the coaxial cable. To isolate the outer coax conductor from ground, the coax line is coiled for a few turns near the antenna end. This is designed to prevent the very unlikely affect of "Feed Line Radiation".

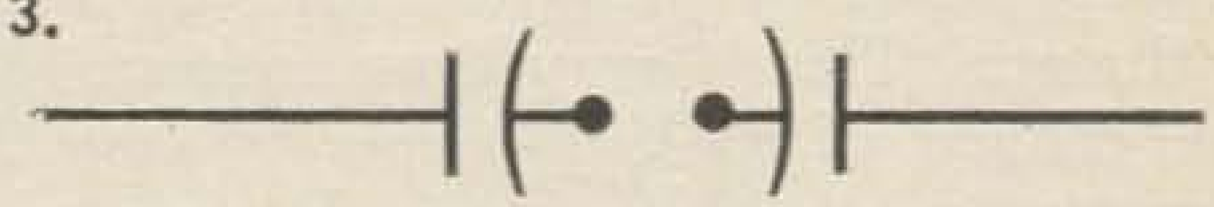
Fig. 1.

$L = \frac{\lambda}{2}$ $\qquad Z_A = 30 + j0$

Fig. 2.

$L = \frac{\lambda}{2} +$ $\qquad Z_A = 50 + j50$

Fig. 3.



$Z_A = 50 + j0$

Converting Other Beams

This feed system could feasibly be used on our other Trap-Master beams, but little would be gained and the antenna would need to be completely rebuilt. The big difference between the new Trap-Master beam and the TA-33 is that the latter has conversion features, while the Classic 33 does not. The engineers at Mosley designed the Classic 33 to give the ham a little extra gain on all bands. It is our conviction that discriminating DX'ers will find this new tri bander specifically suited to their needs, but hams buying the well-known TA-33 will still enjoy a superior quality DX antenna with a gain very close to that of the Classic 33.

Gordon Hopper W1MEG
75 Kendall Avenue
Framingham, Mass.

The Slide Rule Made Easy

The slide rule is a great timesaver for anyone who needs to make a lot of calculations. Here's a simple course in using one.

Are you interested in improving your personal capabilities? Have you given any thought toward mastering the use of a slide rule? Did you, at one time, purchase a slide rule and then fail to follow through on learning how to use it? If the answer to any of these questions is yes, then here is your opportunity to get started on a simple, worthwhile project.

Radio amateurs who are engineering or mathematic students, radio amateurs taking electronic or mechanical refresher courses, and radio amateurs in the electronic, electrical, or mechanical engineering professions readily realize the value of knowing how to use a slide rule. Radio amateurs who design their own equipment will find the slide rule to be an ideal timesaver when they become involved in mathematical processes.

The person who does not use a slide rule for calculations is far less efficient than the person who does use one. For instance, without a slide rule, problems must be written out and the operations performed in lengthy detail by using the rules of ordinary arithmetic. This is very time consuming and the chance of making errors is very high. Sometimes a problem spreads over such a large area that the real point of the problem is lost. Technical people find it to their advantage to be proficient in the use of a slide rule as every practical problem which requires a concrete answer will reduce to a mathematical computation. They find a great deal of time being saved while performing operations in multiplication, division, square roots, etc., on a slide rule and with a fairly high degree of accuracy.

General

What is a slide rule? It is a tool, or an instrument, designed to save time and labor for a person who is performing mathematical calculations. It is the mechanical equivalent of a table of logarithms. It is a ruler, a type of measuring stick which contains a number of graduated scales arranged in such a manner that multiplication, division, squaring, cubing, extracting roots, and other operations may be performed easily by the manipulation of the rule and the reading of the indications obtained on the scales.

There are several types of slide rules available, and before purchasing one, the user should investigate further as to which one is best suited to his needs or purposes. Your technical associates, or instructor, can advise you as to which one will best satisfy your need. It is better to be advised in advance than to find out later that you possess a slide rule not satisfactory for your purposes. If you don't want to take advice, check a catalog and you will find at least five kinds of slide rules available. Your own judgment may lead you to purchase a rule which is used by physicists or someone above the scope of your purpose. There are trig rules and beginners' rules. There are 5-inch rules, 10-inch rules, and circular rules. So, be careful before you decide which rule to purchase. The *vectorlog* rule has 27 scales and is generally used to solve problems in electrical engineering and physics. The *dynamic reactance* rule is used in calculations for decibel, inductive reactance, capacitive reactance, resonant frequency, surge impedance, etc. The *log log dupli-decimal trigonometric* rule has 21 scales including five log log scales and is used extensively when working with logarithms. A trig rule is usually satisfactory for most general amateur calculations, but working with advanced ac theory will require the use of a log log rule.

Complete text books on the use of a slide rule are available and instruction books accompany most new slide rules. This article includes condensed and simplified instructions for the fundamental and basic uses of a

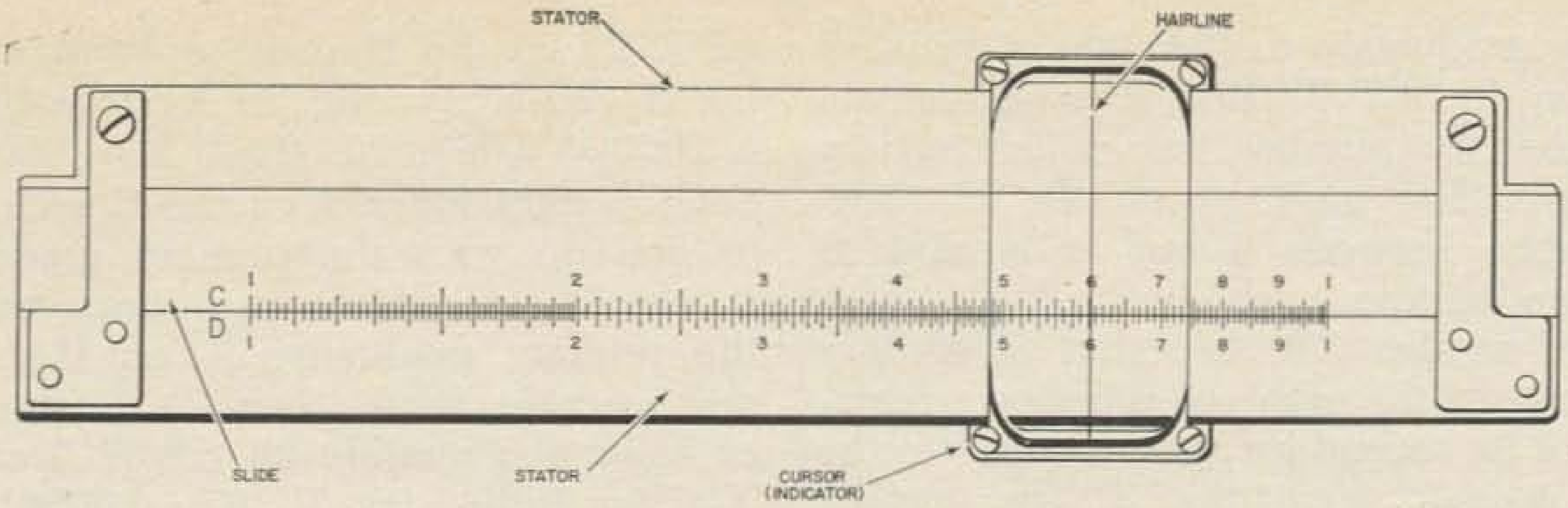


Fig. 1. The major parts of a slide rule with the two most basic scales, the C and D scales.

slide rule and should be beneficial to a beginner.

Slide rule computations for use in electronics are usually more accurate than the tolerances of the circuit components involved. A ten-inch slide rule will give results accurate to within one part in 1000, or one-tenth of one percent when used correctly. As a point of comparison, a good ohmmeter has an accuracy of ± 2 percent and this will lead us to assume that for all practical amateur purposes, numbers used in slide rule calculations may be rounded off to a value which can be easily handled (significant figures).

When working out problems involving ultra-high radio frequencies, the decimal point and powers of ten become involved. A person possessing a good knowledge of working with the powers of ten will have no difficulty in properly placing a decimal point when using a slide rule.

You have now been introduced to the slide rule and it is necessary that you possess a slide rule in order to benefit fully from the remainder of this article, though **Fig. 1** illustrates the most common scales.

Construction of the slide rule

A slide rule has three major parts (see Fig. 1):

(1) the indicator, or cursor
(2) the slide
(3) the stator (upper and lower bars)

Each scale on the slide or stators is identified by a letter (A, B, C, C1, C1F, CF, D, DF, K, L. LLO, LLOO, LL1, LL2 LL3, S, ST, and T). There are two C, C1, and D scales so that the most commonly used scales will be available on either side of the rule. These scales are found on a log log rule and there will be fewer on a trig rule or on a beginners rule.

If the user learns how to read the scales, how to set the slide and the indicator for each operation to be performed, and how to place the decimal point in the answer, it will then be a simple matter to multiply and divide, to square a number or find the square root of a number, to cube a number or find the cube root of a number, to find the logarithm of a number or find a number whose logarithm is known, and to find the sine, cosine, or tangent of an angle or to find an angle whose sine, cosine, or tangent is known.

Interpreting the C and D scales

The C scale on the slide and the D scale on the stator are the scales most frequently used and are exactly alike. They are the fundamental scales of a slide rule and are used for all general fundamental calculations. Examine the D scale (Fig. 1) and you will see lines and large numerals printed on the stator (1, 2, 3, 4, 5, 6, 7, 8, 9). These lines are called primary graduations. The line labeled 1 at the right end of the C scale is called the right index, the line labeled 1 on the left end of the C scale is called the left index. The distance between 1 and 2 on the D scale is divided into 10 parts. These are called the secondary graduations (1, 2, 3, 4, 5, 6, 7, 8, 9). They are located between 1 and the primary graduation 2. To locate the numbers 12 and 8 on the D scale–8 is found at the primary graduation marked 8, 12 is found at the secondary graduation marked 2 (on the left). The number 14 is the secondary graduation marked 4 (on the left) and the number 19 is the secondary graduation marked 9 (on the left). The number 35 is found at the fifth secondary graduation to the right of primary graduation 3 (3.5 X 10). The number 87 is located at tl e seventh secondary graduation to the right of primary graduation 8 (8.7 X 10). The increments of a secondary number are called tertiary graduations. For instance, on the D scale, the distance between 3 and 4 is divided into 50 graduations, each one having a value of 2. The number 3.6 is located 30 tertiary graduations to the right of primary graduation 3, or 6 secondary graduations to the right of primary graduation 3. The number 85,000 is located at the fifth secondary graduation (or the tenth tertiary graduation) to the right of primary graduation 8 (8.5 X 10^4). If you place the cursor hairline at secondary graduation 2 on the D scale, you will be reading the number 12 (.012, 1.2, 120, 1200, etc.). Place the cursor hairline at primary graduation 9 on the D scale, you will be reading the number 9 (.009, .09, .9, 90, 900, etc.).

Use of other scales

The DF and CF scales are the same as the D and C scales except that they are folded at π (3.14). To avoid the necessity of resetting when an answer runs off the scale, they are used with the C and D scales. The C1 scale is an inverted C scale used in reading the reciprocal of a number. The D1 scale is an inverted D scale the same as the C1 scale. The C1F scale is an inverted CF scale used with the DF scale in the same manner as the C1 scale is used with the D scale. The A and B scales are identical and are used with the C and D scales when finding squares and square roots. The K scale is used in finding cubes and cube roots. The S scale is used when working with the sine and cosine of an angle. The T scale is used when working with the tangent of an angle. Trig slide rules may have a T2 scale for working with tangents of angles greater than 45°. The ST scale is used when working with sines and cosines of angles less than 6°. The L scale is used with the D scale for finding the mantissas of the common logarithms.

Simple multiplication exercises

Get familiar with using the slide rule by calculating simple problems first. The easiest function to perform first is the multiplication of two numbers. Set the left index 1 on the C scale (slide) to line up with the primary graduation 2 on the D scale. Move the cursor hairline to the primary graduation 2 on the C scale and read the result (2 X 2) on the D scale as being the number 4 (20 X 2 = 40, 20 X 20 = 400, 2000 X 2000 = 4,000,000, .02 X .2 = .0004, etc.). Set the right index 1 on the C scale (slide) to line up with the primary graduation 8 on the D scale. Move the cursor hairline to the primary graduation 7 on the C scale and read the result (8 X 7) on the D scale as being the number 56 (.8 X .7 = .56, 80 X 70 = 5600, .08 X .07 = .0056, 800 X 700 = 560,000, etc.).

Simple division exercise

Division of numbers on a slide rule is the opposite or inverse operation of multiplication. To divide 8 by 4, move the C scale (slide) until 4 is lined up with 8 on the D scale and read the result (8/4) found at the left index point on the D scale as being 2 (.08/.4 = .2, 800/.004 = 2000,000, etc.)

Multiplication of three numbers

Multiplication of three numbers is a little more involved than with two numbers, but is not complicated. Multiply 28.5 X 4.6 X 6 as follows: make an approximation–30 times 4 times 6 = 720. Set the right index 1 of the C scale to line up with 2.85 on the D scale. Set the cursor hairline at 4.6 on the C scale. Set the left index 1 of the C scale under the hairline. Read the result on the D scale directly below 6 on the C scale as 790. Practice will improve your accuracy.

Multiplication and division combined

Find the product of two numbers and divide the result by another number. *Try* $\frac{24 \times 38}{12.4}$ An approximate answer could be 8. Set 12.4 on the C scale to line up with 2.4 on the D scale. Move the cursor hairline to 3.8 on the C scale and read the result on the D scale as 7.35.

Simple proportion exercises

Here is the easy way to find proportions. Find x if 2/3= 5/x. Place 2 on the C scale directly over 3 on the D scale. Move the cursor hairline to 5 on the C scale and read the result on the D scale as 7.5. Find x if 18/x = 3.5/22. Place 3.5 on the C scale directly over 22 on the D scale. Set the cursor hairline to 18 on the C scale and

read the result on the D scale as 113.

Circular measure exercises

Convert $\pi/2$ radians to degrees. Set 2 on the C scale directly over the π mark on the D scale. Move the cursor hairline over the left index 1 on the C scale and read the answer on the D scale as being 1.57 degrees. Convert 45° to radians. Place R (or P°) on the C scale directly over 4.5 on the D scale. Read the result on the D scale directly below the right index 1 of the C scale as .785. We know it will be less than 1 because 1 radian is equal to 57.3 degrees.

Simple trigonometry exercises

It is very easy to calculate circle circumference and diameter. Here we use the D and DF scales. Find the circumference of a circle having a diameter of 4 cm. Place the cursor hairline at 4 on the D scale and read the result on the DF scale–12.57 cm. Find the diameter of a circle having a circumference of 50 cm. Place the cursor hairline at 5 on the DF scale and read the result on the D scale–15.8 cm.

Squaring and square or cube roots

Likewise, squaring numbers and extracting square roots turns out to be very easy. To square the number 3.3, set the cursor hairline to 3.3 on the D scale and read the result on the A scale–10.9. Find the square root of 40. Set the cursor hairline to 40 on the A scale and read the result on the D scale–6.3. The K scale is set up in three sections. Use the left section for finding the cube root of numbers between 1 and 10, the middle section for finding the cube root of numbers between 10 and 100, and the right section for finding the cube root of numbers between 100 and 1000. Find the cube root of 8. Set the cursor hairline to 8 on the left section of the K scale, read 2 on the D scale. Find the cube root of 80. Set the cursor hairline to 8 on the middle section of the K scale, read 4.3 on the D scale. Find the cube root of 800. Set the cursor hairline to 8 on the right section of the K scale, read 9.3 on the D scale.

Logarithm exercises

A slide rule reads only the mantissa of common logarithms and the characteristic is to be calculated. Find $\log_{10}$ 3.14. Place the cursor hairline at 3.14 on the D scale. Read the result on the L scale directly under the hairline as 0.497. Find $\log_{10}$ 887. Place the cursor hairline at 8.87 on the D scale. Read 0.948 on the L scale. Add the characteristic 2 and the answer is 2.948.

Working with the trigonometric functions

Trigonometric functions are readily determined by the use of a slide rule. Working with these functions involves the use of the C, C1, D, S, T, and ST scales. Examination of the S, T, and ST scales shows each identified graduation as having a double set of numbered graduations. On the S scale, which will be used with the C or D scale, the left hand (black) graduations are angles between 5.7° and 90° to be used with sine value calculations. The right hand (red) graduations are angles between 5.7° and 84° to be used with cosine value calculations. Find the sine of 15°. Set the cursor hairline to the black 15 on the S scale and read 0.259 on the D scale. Find the cosine of 60°. Set the cursor hairline to the red 60 on the S scale and read 0.5 on the D scale. If the sine value is 0.96, what is its angle? Set the cursor hairline to 9.6 on the D scale and read 74° on the S scale. On the T scale, the left hand (black) graduations are angles between 5.7° and 45° to be used with tangent value calculations. The right hand (red) graduations are angles between 45° and 84.3° to be used with cotangent value calculations. The tangents of angles between 5.7° and 45° are read on the C or D scale and those between 45° and 84.3° are read on the C1 scale. Cotangents of angles between 45° and 84.3° are read on the C or D scale and those between 5.7° and 45° are read on the C1 scale. Find the tangent of 31°. Set the cursor hairline to the black 31 on the T scale and read 0.6 on the C or D scale. Find the tangent of 70°. Set the cursor hairline to the red 70 on the T scale and read 2.75 on the C1 scale. The ST scale is used when working with sines and tangents of angles between 0.5° and 5.7°.

The author used a Lafayette 99-7031 10-inch log log dupli trig slide rule in the above trig function manipulations. More detail could be given towards this type of coverage, but since not all slide rules are alike, it would benefit the user more to study the examples given in the book which accompanies each new slide rule.

Log log scales

The LL scales on a log log rule represent a logarithm of a logarithm. The LL1, LL2, and LL3 scales range in values from 1.01 to 20,000, are used with the C and D scales, and give the natural logarithms of numbers greater than unity. The LLO and LLOO scales range in values from 0.0001 to .999, are used with the A and B scales, and give the natural logarithms of numbers less than unity.

Using the c, P°, and π gage marks

Near the left end of one C scale and near the end of one D scale you will note the small letter c. This represents 1.128 and is used when calculating the area of a circle. Find the area of a circle having a diameter of 1.4 cm. Set the cursor hairline to 1.4 on the D scale which does not have the letter c on it. Place the letter c on the C scale under the hairline. Move the cursor hairline to the C scale left index. Turn the slide rule over and read the area on the A scale under the hairline as 1.53. The P° mark found on one of the C scales and on one of the D scales represent 5.72958 and is used when converting an angle from degrees to radians. The π mark found on the C, D, CF, and DF scales represents 3.1416 and is a ratio of the circumference of a circle to its diameter.

Conclusion

Much more could be written about the use of a slide rule but this article is presented with the hope of inducing amateurs to become familiar with the benefits to be gained by using a rule. More difficult exercises and information pertaining to the care and maintenance of a slide rule are usually contained in the book which accompanies a new slide rule. After some concentrated practice, one should be able to multiply, divide, handle square and cube roots, and some of the trig functions very easily. For those who wish to go further, it is recommended that they obtain a textbook covering all of the uses of a slide rule.

. . . W1MEG

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How to Make Better Panels

Do all of your construction projects seem to look horrible? Here are some good hints that will help you make them attractive.

What does your home made gear look like? If your work resembles much of mine, you may not be too eager to show it to the public eye. For some time I've used a simple ink-marking process on bare aluminum which is adequate but harsh and prone to glare. It was passable, but I felt persistently unhappy about its overall appearance. This article describes one of the ways I finally worked out for making more satisfactory panels.

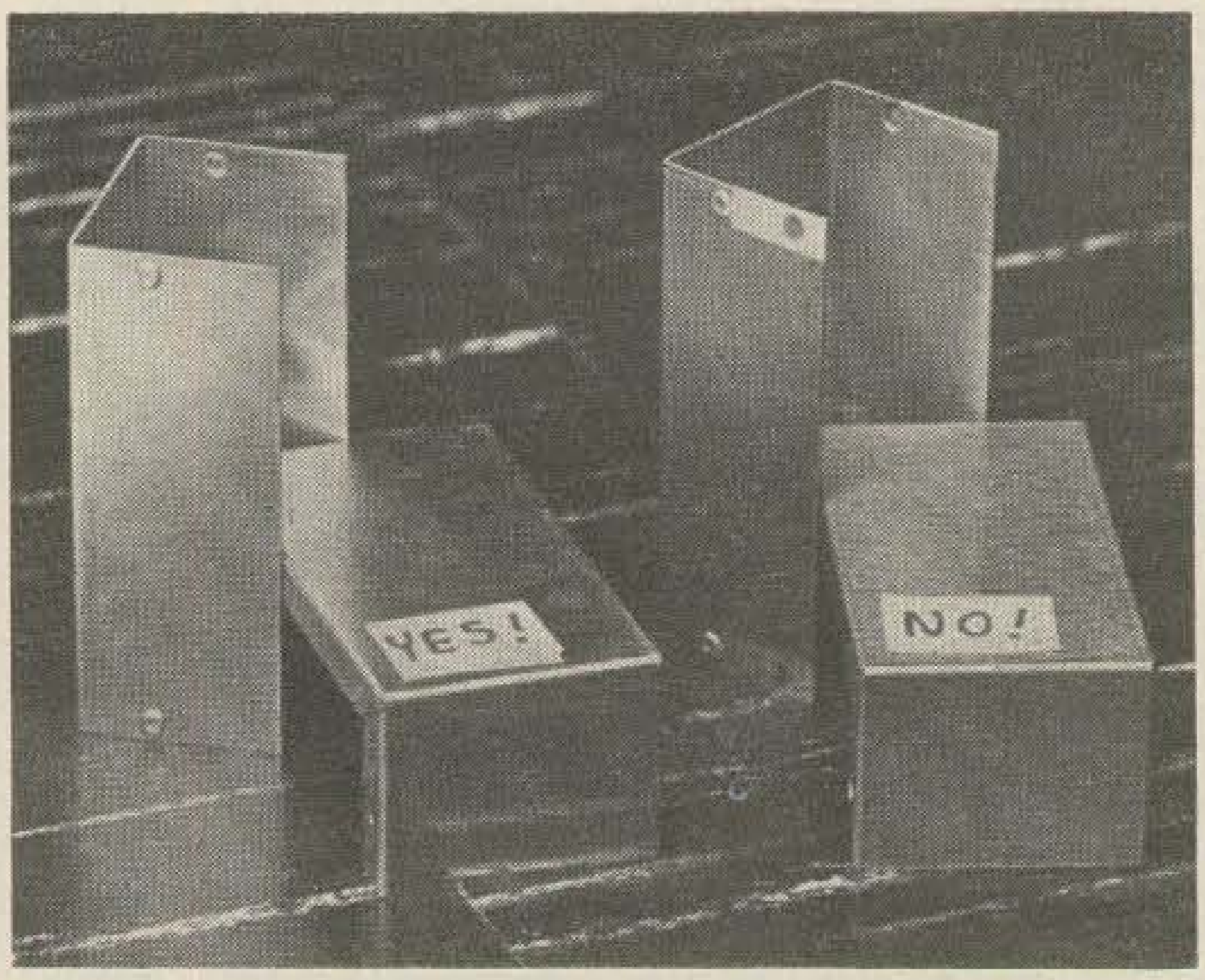
You won't need any special tools or machinery. There are no chemical processes, although some time is required. The finished panels can be very colorful, and a few of mine are. Ten dollars should put you in business for the next two years or more, and the finished panels really do look good!

Materials Required

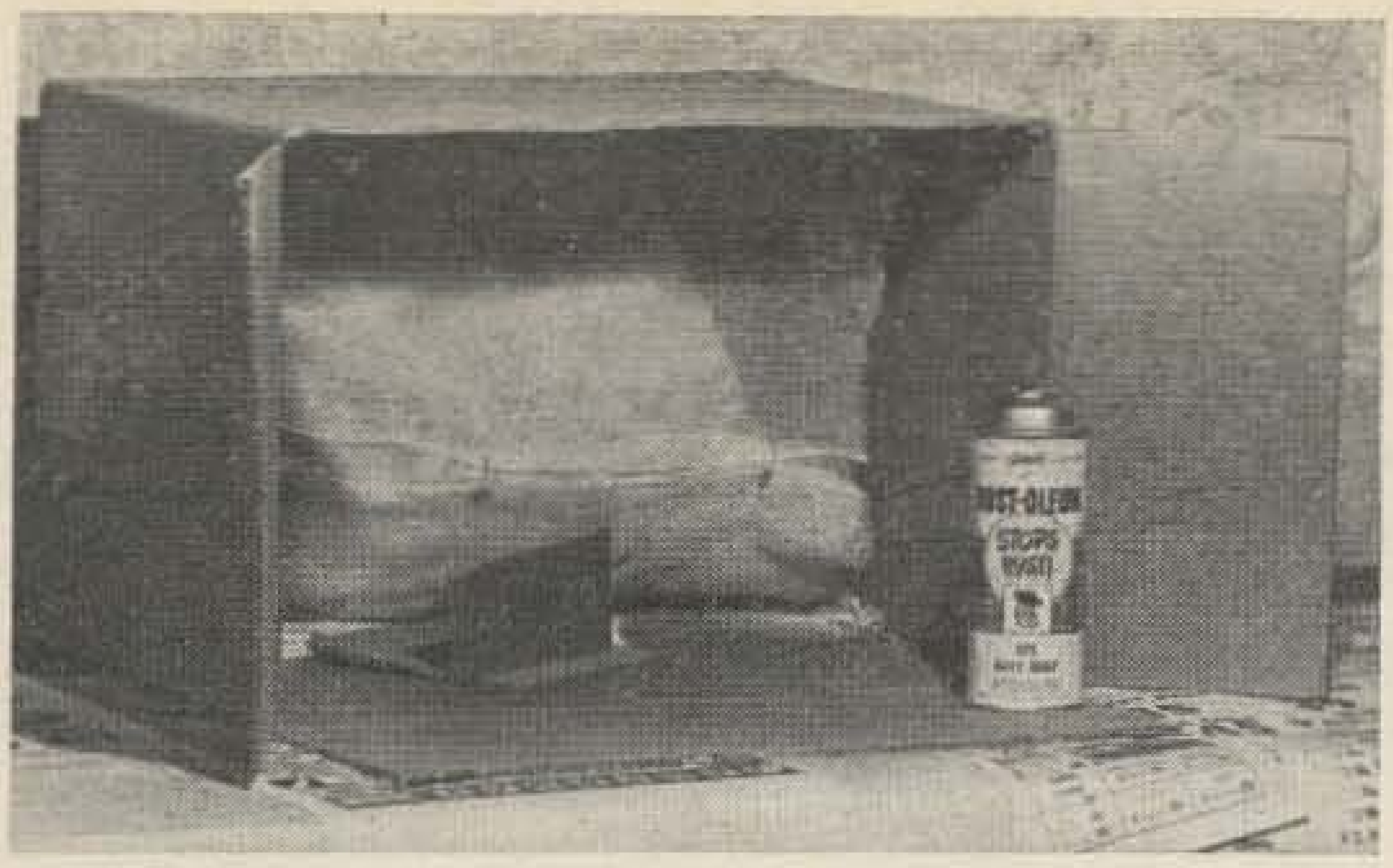
1. A scraping knife, a rather fine file, and some emery cloth.
2. A sheet of fine grade wet sandpaper. A fine-textured abrasive on waterproof backing, used wet. The water prevents removed metal from building up little islands which clog the paper. Try some dry and see.
3. Kitchen detergent, stronger varieties preferred.
4. Denim rag.
5. Large cardboard box and some cheesecloth, scotch tape and safety pins.
6. A few odd pieces of brick, wood, or pipe.
7. Rustoleum spray enamel, about $2.00 per can. Their + 975 gray is good to start, and you might like to purchase other light colors later.
8. Draftsman's lettering supplies: ruler, pens, and waterproof India ink.
9. Rustoleum #717 clear spray enamel.

Purchase emery cloth and wet sandpaper

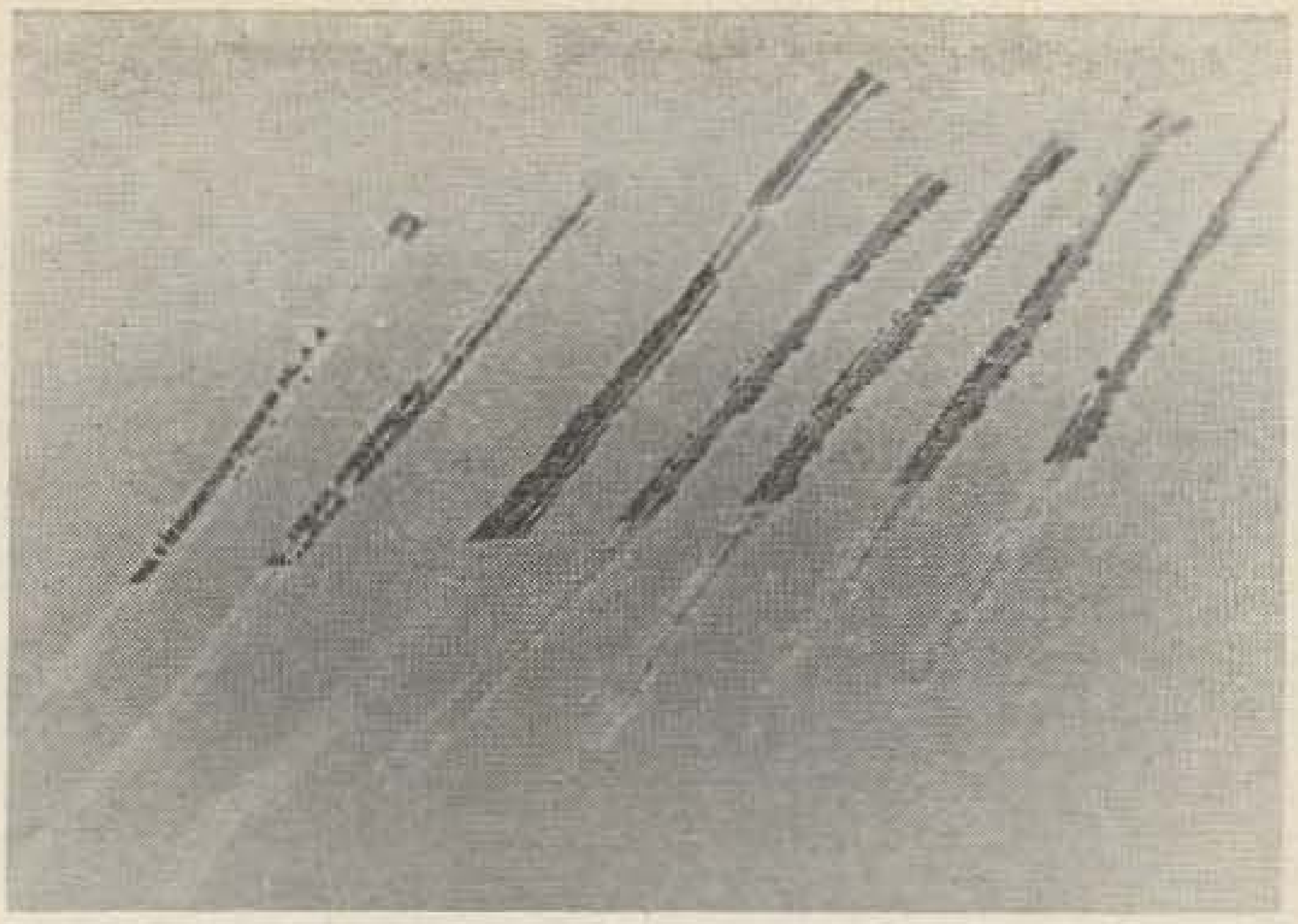
These are the materials used in making panels. Most of them are very easily obtained from local hardware stores, supermarkets, and bookstores.



Choose unpainted metal parts for construction, and save yourself the trouble of cleaning off the manufacturer's inexpensive soft paint.



Simple spray booth. Maybe ten cents in materials. Store it front down to keep dust out.



This piece of scrap metal was cleaned over all and then sanded on the upper portion only, before painting. Test scratches made with the edge of a sharp knife show good adhesion on the sanded part.

which feels abrasive but not toothy to the touch. Different manufacturers use different grading systems so I haven't recommended a particular degree of roughness. Since you're not going to really lean on it, the scratches won't be deep and the grade you use is not critical.

Preparation

If you want a good job, the surface to be painted must be *real* clean. You have two foes: grease and dust. Grease spoils paint adhesion, and dust results in a relatively huge mound in the finish for each tiny particle. I hope you'll begin by practicing on some scrap metal!

Surface preparation starts with the purchase of the chassis or panel that is to be painted. Choose aluminum with a natural or unpainted finish. This saves solvent problems or a trip there and elsewhere for somebody who can get it off for you.

You can make guide scratches on the panel surface during construction. But they mustn't be deep! Although I've never tried it, I suspect a good epoxy auto body filler could fill in some pretty deep gouges. An ordinary nail is hard enough to take a good point for working on soft aluminum, and will not need frequent resharpening.

When the construction work is done, go back over the chassis or panel to clean up the edges, corners and holes. A good knife, used carefully, will pare out the rough edges that usually appear around holes. A fine file can round off sharp corners and feather edges left by dull shearing tools. You may want to give the work a first finishing from a small piece of emery cloth.

Then make up a strong detergent solution and wash the work thoroughly. Use a wad of denim as a washcloth, and scrub all surfaces twice, whether they get paint or not. This removes grease which could be carried around to the painted surface just ahead of the enamel. Rinse thoroughly, and by now your hands should be very clean too.

Still using warm water, have a go with wet sandpaper at the surfaces to be painted. Use only moderate pressure. Rub up and down, diagonally, crosswise, and in circular directions. The surface should take on a dull whitish-metallic sheen with no strongly preferred direction of marking. The enamel sticks very well to metal surfaces treated in this way, so that no primer is required. I've tried it both ways.

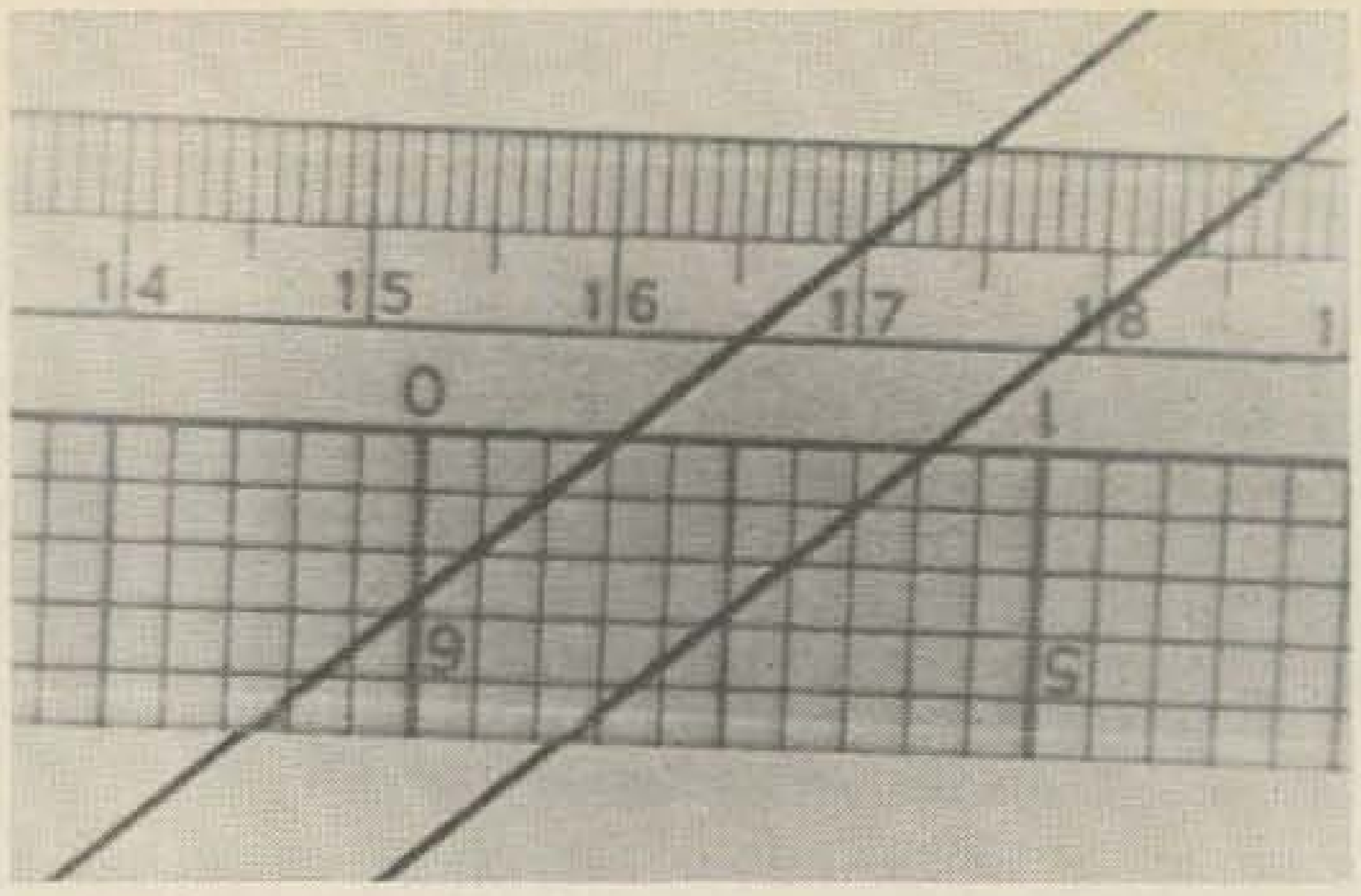
When you're done with this, shake off the excess water, wipe with clean paper towels, and put the work in a warm place to evaporate the last traces of moisture. When dry, wrap it in a clean newspaper and you can store it without deterioration of the surface.

If you're in a hurry, you can shortcut the following process by marking directly on the cleaned surface with India ink. Then spray clear enamel over all. Or you can apply clear fingernail polish over the labels and have your work back on the assembly bench in about a half hour from starting.

Spray Painting

Try to arrange things so you can do the entire job without moving the work. If you're painting a box or other many-sided surface, think about how you will move it when it's wet. You'll soon accumulate a few wood

Take this with you when you go looking for lettering supplies. Here are a pen holder, a Leroy adapter, one of the Leroy lettering tips, and a very convenient ink dispenser.



Closeup of a convenient scale for drawing guidelines. Two parallel guidelines included.

blocks and other objects for propping things in place. A panel or chassis will rest nicely on top of a piece of pipe and can easily be rotated to get at all sides.

The Rustoleum enamels I've been using are well behaved, and flow very nicely a few seconds after going onto the metal. The object is to get just enough everywhere to cover the work. Avoid overdoing by putting on a coat that's visibly too thin. Estimate your progress and then put on a little more. Corners seem to need special attention.

Those handy spray cans will generate an awful mess. I don't think spraying outdoors is practical, so here is a way to keep the stuff under control. Find a cardboard box fifteen inches or more deep and large enough so your work doesn't seem cramped in it. Put in three or four layers of cheesecloth a few inches from the closed back. Scotch tape will do the job and a few safety pins may help. With some newspapers over the adjacent bench, you will have a spray booth that works much better than you'd believe without trying it. The cheesecloth reduces the disturbance of spraying and catches most of the waste spray.

The Rustoleum people suggest spraying from a distance of a foot or so. Start the spray off target, and then swing it across the work. Keep it moving! Spray, check, and spray again. With practice you can learn to paint a vertical surface with little or no bead developing along the bottom edge.

You'll find a little note on the spray can about cleaning the nozzle when you're done spraying. I have a three-year old can of spray which works fine. Another didn't get cleaned properly some time, and it doesn't work so well. Be sure to clean the nozzle as per instructions!

When you're done spraying, get right away from the work. Come back next day. Some heat will help things along if you're in a hurry. But this will increase the chance of dust, dirt or damage. I have done the complete job in one day, but a slower approach will give nicer results.

When the work has dried sufficiently, almost anything that will apply ink to paper will serve for labeling. I generally use a Leroy pen set. Bookstores, paper supply houses, and many other businesses carry drafting supplies which may be usable. Try Speedball products. Lettering jigs and guides that work well on drawing boards are less successful on real panels with their holes, screw heads and other obstacles.

Why not learn draftsman's lettering? Good books on drafting devote a chapter or two to the subject, or little, soft-cover pamphlets come complete with neatly marked practice pages. One of these is well worth 50c or so. Practice a little bit every day . . . you will find yourself using your neat new lettering on schematics, notes, and other applications as well as shiny fresh panels.

Rough out your panel before you mark it up. Almost every time I omit this simple step I regret it. Just make up a freehand sketch about full size and write the lettering on it in pencil. Revise until it looks right to you. Don't get fouled up in rules of proportion and all that.

Then you're ready to put lettering guidelines on the panel. A dull-pointed tool, which will scratch but not penetrate the soft enamel is required. If not overdone, these lines will disappear when you apply the clear finish coat. A nail wili take a good point, use it gently! A transparent five-and-dime ruler with parallel guidelines on it serves to get your parallel lines in place. The lines should be just strong enough to be visible through the ruler. Wash the ruler just before using, and keep fingers and hands off the panel. A handy sheet of paper enables you to rest your hand where convenient.

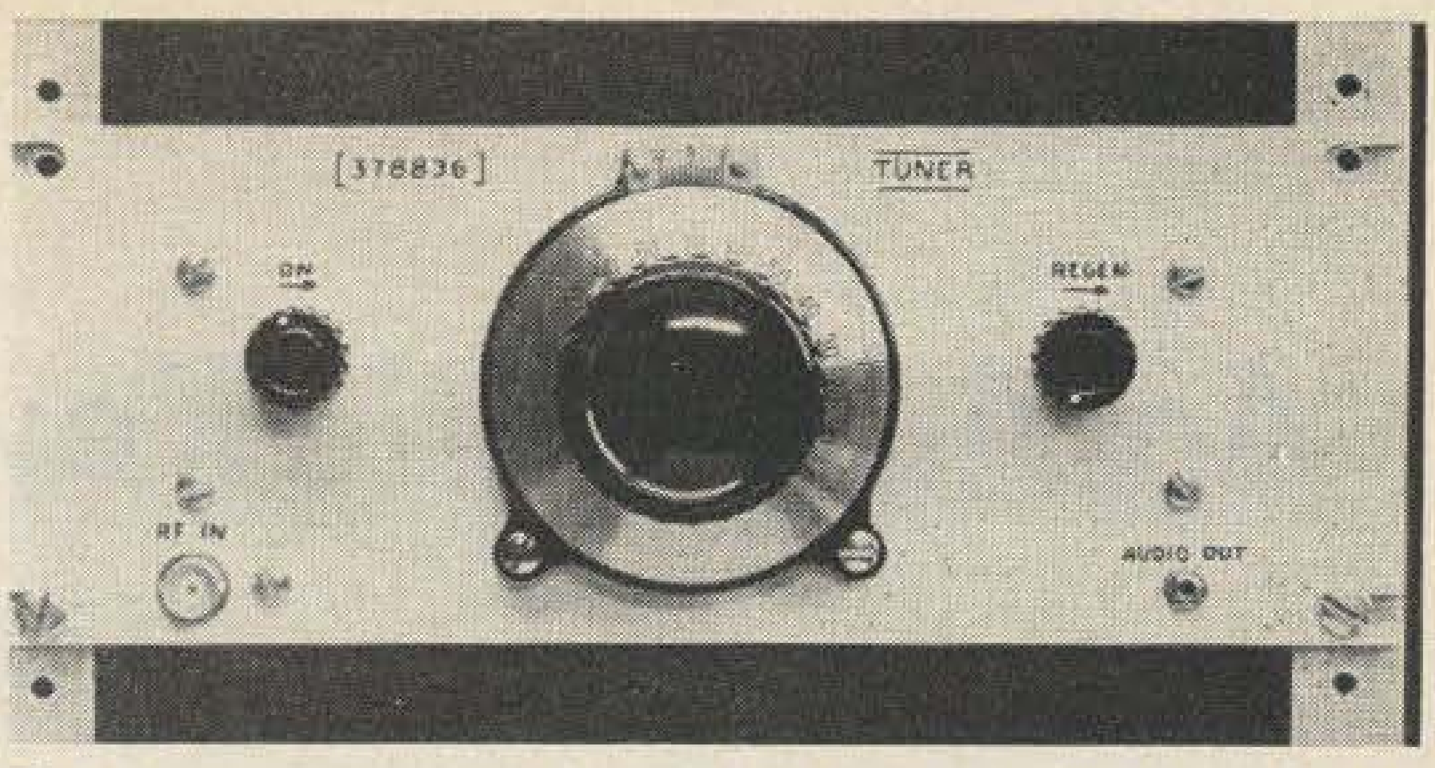
I use a Leroy pen for lettering. You'll probably want to start with a #1 and a #3 point, and pick up a #0 and a #2 later. These odd-looking devices are very good once you get used to the loose piece in the center. This serves to keep the tip from drying rapidly, as it does in a conventional pen. If the tip does seem dry, jiggle and rotate the center piece til the ink flows freely. The flattish working ends are relatively immune to digging into the work.

Choose the larger point for larger lettering to avoid a spidery appearance. Mount the pen in the holder and go at the panel, just as in practice with a pencil. If you can't make out the guidelines, change the lighting a little bit. They should be just visible as white against darker, rather than the usual dark against light seen on paper.

If you make a booboo, and we all do, a handy Kleenex dampened with a little spit will rub out the mistake. Then blow some humid breath on the panel, and wipe off the fogged region with a piece of dry Kleenex. Do this one or twice more. This gets the last traces of spit off, so the new lettering is the same weight as the uncorrected lettering nearby. If you don't do this, it will be heavier.

A grease contamination far too thin to see will spoil the fresh enamel's excellent wetting properties. Have a few pieces of clean paper handy and keep most of the panel covered while lettering. You may get so involved with neat lettering your hand wanders off the protective paper. Sorry about that!

When the lettering is finished, set the panel aside to dry for a few minutes to a half hour before going on to the clear enamel finish coat.



This panel was completely finished in one day. Slight crinkling of the finish at one point probably does not show in magazine copy of photo.

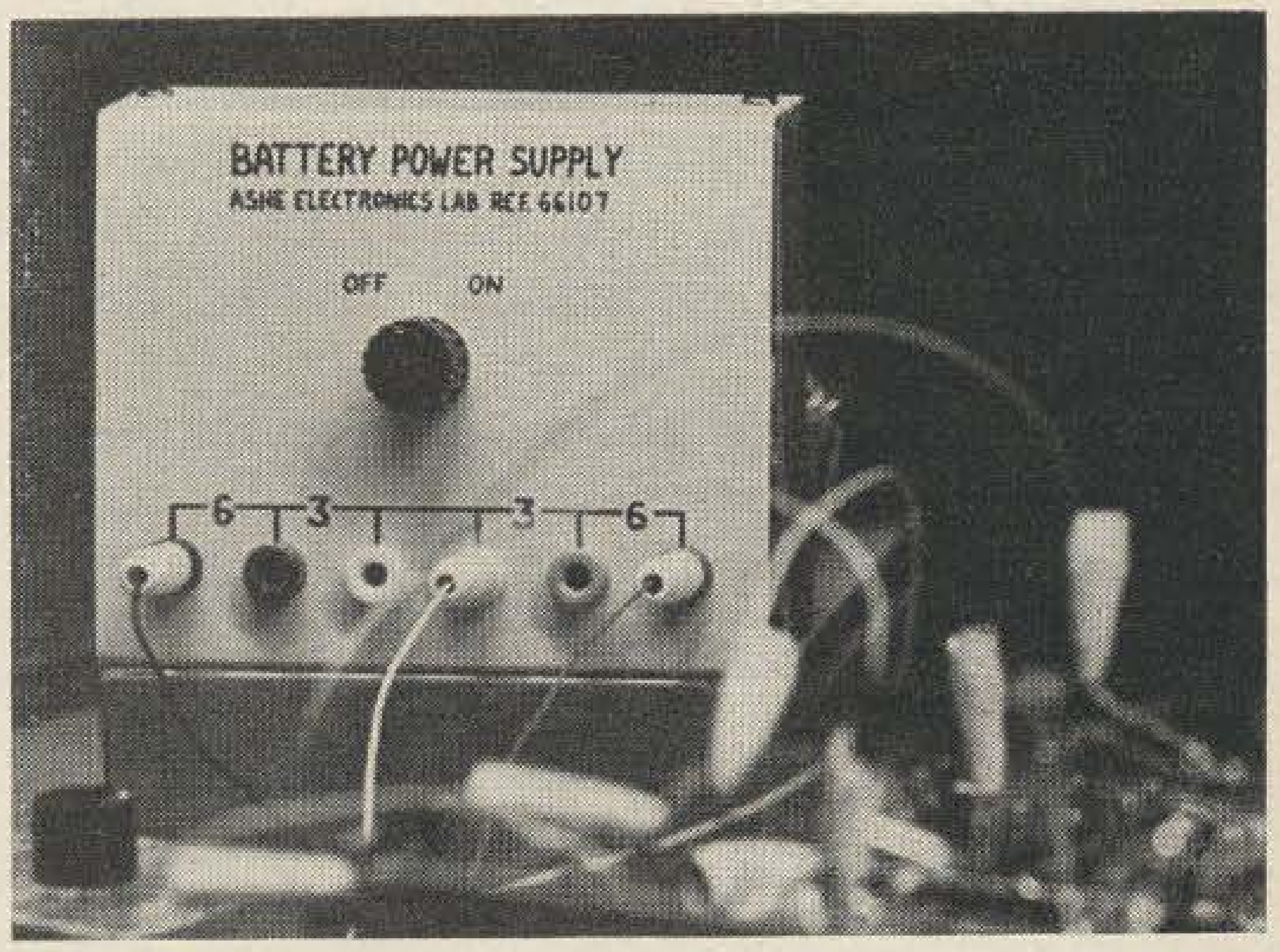
Finishing up

I once applied lettering and finish coat eight hours after enameling, with the help of heat for quick drying. But I recommend a drying period of at least 24 hours in a warm place. Try your luck on some scrap. If the color coat is insufficiently cured, it will wrinkle free of the metal when the finish coat goes on.

After the finish coat has hardened for at least 24 hours, you're ready to go ahead with final assembly of the project. Be nice to the fresh, soft enamel! If you wash your hands and wipe tools with a paper towel just before starting work, the whole project will stay quite surprisingly clean.

As a nice final touch, if you want to wait at least another 24 hours, the enamel will take a coat of auto body wax. Car painters like to have you wait a month or more, and I think they use materials similar to mine. Well, this wax finishing really puts the grand touch on. You'll be very pleasantly surprised at your results, and it really is worth the time it takes!

. . . W2DXH



Another simple panel. Oops, seems to be a breadboard in there.

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An Automatic Keyer Using Intergrated Circuits

Here's a very simple integrated circuit keyer that uses very few parts.

This article describes one of many possible applications of integrated circuits to amateur radio. The keyer described is self completing, completely adjustable from less than one word per minute to sixty words per minute, and could be built in a pocket match-box. The complete keyer can be built for less than thirty dollars ($30.00).

Operation

A clock generator consisting of a unijunction transistor and an R-C combination is used to determine the speed of operation. The basic relation of a space equals a dot, and a dash equals three dots was used and is constant regardless of the speed. The clock pulse is connected to the dot flip flop through the logic built into the flip flop package. The output of the dot flip flop drives the dash flip flop. The output of both flip flops are connected to a gate which has an output if either of the inputs go to zero.

The output of the gate in this keyer is used to drive a transistor to control a relay. It is possible to use a transistor only and build in weighting circuits to give individual desired effects; but, the emphasis of this article is on the application of the integrated circuit.

Texas Instruments integrated circuits were available at reasonable prices and were chosen for this application. The SN7302 package (.125 X .250 X .035 inch) contains two flip flops and all of the necessary logic circuits required for proper gating. (38 transistors total) The SN7360 quadruple two input NAND/NOR gate contains 24 transistors total in the same size package. Only one of the four gates in this package is used.

The integrated circuits operate on 3 to 4 volts dc. The minimum voltage which will operate a unijunction transistor properly is 9 Vdc, therefore, a 5.6-volt zener diode is used to drop from 9 Vdc to 3.4 Vdc. The zener diode was chosen over a divider in order to maintain a low power supply impedance for the integrated circuits.

Circuit description

Refer to the schematic diagram. **Fig. 1,** and the logic chart, **Fig. 2.** The capacitor C3 charges up at a rate determined by the speed control R1 and R3. When the voltage across C3 reaches the intrinsic stand-off ratio of Q1 (firing point) C3 is discharged through R4. This provides a positive pulse several milliseconds long with an exponential decay. The flip flops trigger only on the trailing edge of the clock pulse so this signal is passed through C5 and R5 to provide a fast rise and fall pulse.

The terminals marked on the schematic with an asterisk are the dot flip flop. The flip flop operation is as follows: Q• HAS A 2.5 V. output and $\overline{Q}$• (pronounced not Q) is at zero. If K• is positive when a clock pulse is applied to CP• the flip flop switches and Q• and $\overline{Q}$• switch modes. Since J• is connected to +3 volts the following clock pulse reset the flip flop to its original mode. This action represents a dot and space. If the dot key is held down the next clock pulse simply triggers the flip flop again and if the key is released the next pulse resets the flop flop to a space condition and it remains.

The terminals of the SN7302 without an asterisk are used for the dash flip flop.

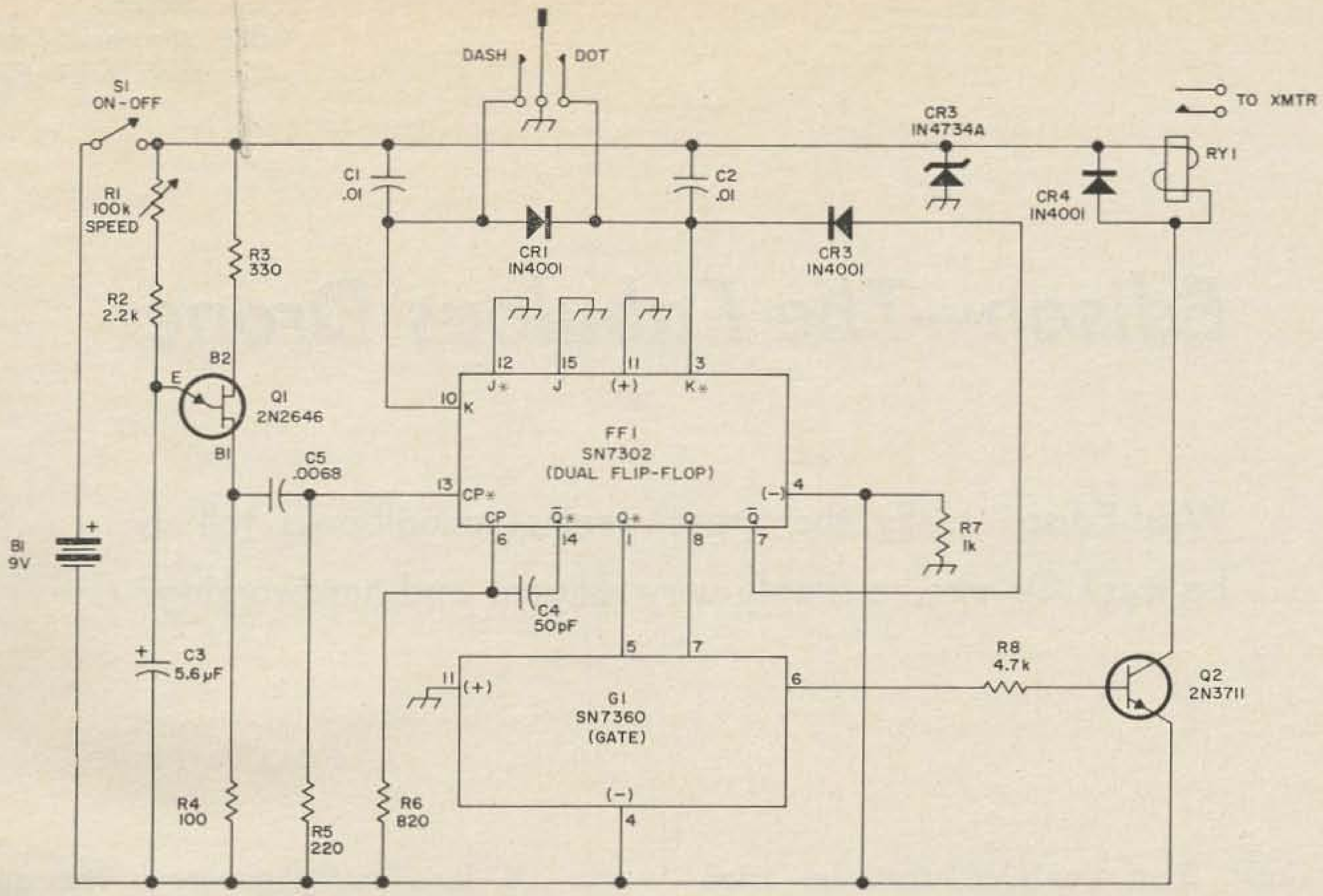

Fig. 1. Schematic of W5FQA's integrated circuit keyer.

The dash operation is as follows: The key is moved to the dash position and a positive voltage is applied to K• through CR1 starting a dot sequence. Q̄• goes positive at the start of the dot. This positive signal is differentiated by C4 and R6 providing a fast rise and fall pulse at CP. (The clock pulse input for the dash flip flop.) The input at CP triggers the dash flip flop causing Q̄ to go positive since K is positive. The next clock pulse triggers the dot flip flop, but it will not trigger the dash flip flop until Q̄• goes positive again which is the following pulse. Then the dash flip flop changes state, but the output of the dot flip flop is still present and will remain for the length of a dot which gives a dash length of 3 dots. If the key is released before a dash is complete a positive voltage is still applied to K• through CR3 which makes the dash self completing.

The operation of the gate SN7360 is as follows: If either and/or both inputs are zero the gate has an output. If both inputs are positive the output is zero.

Information about the integrated circuits used in the keyer is available from Texas Instruments, P.O. Box 5012, Dallas 22, Texas. Request bulletin No. DL-S 657650, July 1965.

Construction

The authors keyer is constructed on a Vero printed board, however, for one who does not have an integrated circuit soldering iron the TI Mech-Pac connectors are ideal. Wiring is not critical and phono wire or #30 to #32 hookup wire is recommended.

The positive 3 volts for the integrated circuits is grounded to prevent floating the common of the key. C1 and C2 shunt any rf to ground. Shielded lead should be used to minimize rf pickup. The battery drain is 30 mA key up and 50 mA key down. A 9 and power obtained from transmitter or receiver B+.
volt zener may be substituted for the battery

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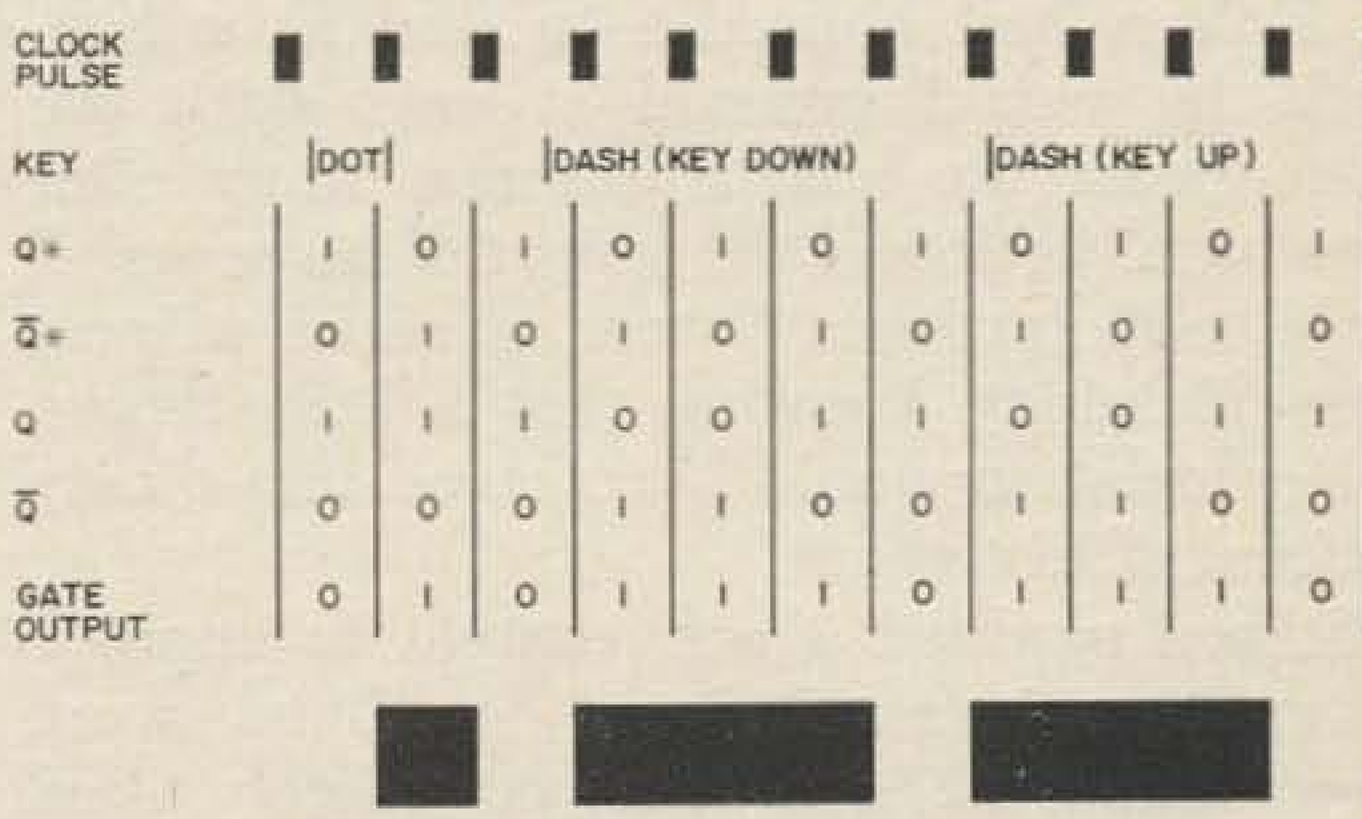

CLOCK PULSE											
KEY	DOT		DASH (KEY DOWN)				DASH (KEY UP)				
Q*	1	0	1	0	1	0	1	0	1	0	1
Q̄*	0	1	0	1	0	1	0	1	0	1	0
Q	1	1	1	0	0	1	1	0	0	1	1
Q̄	0	0	0	1	1	0	0	1	1	0	0
GATE OUTPUT	0	1	0	1	1	1	0	1	1	1	0

Fig. 2. Logic diagram of the keyer.

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Edison—The Fabulous Drone

Was Edison really the great genius schoolbooks tell us he was? Or was he simply very diligent and hardworking?

The Great Man confided that he tried 'everything' while working on inventions. When 10,000 experiments with a storage battery went down to failure, he said: "I have not failed. I have just found 10,000 ways that won't work."

He argued with Nikola Tesla, the brilliant Serbian engineer and scientist, telling him that AC electricity was a "waste of effort and money".

"Looks like a bunch of Chinese laundry markings," he remarked of his hired mathematicians' worksheets.

He said: "Genius is one per cent inspiration and 99 per cent perspiration."

Most people think Thomas Alva Edison was perhaps the world's greatest inventor. But in comparison to his contemporaries, he was an inveterate fiddler, who scorned abstract work to tinker about with one failure after another.

Tesla observed Edison work methods thus: "If Edison had a needle to find in a haystack, he would proceed at once with the diligence of the bee to examine straw after straw until he found the object of his search." Tesla said further: "I was a sorry witness of such doings, knowing that a little theory and calculation would have saved him ninety per cent of his labour."

Edison plodded along, content to improve on existing ideas, insistent on hand work over brain work, and often completely blind to the uses of his own great and original work. Of his first phonograph, he said: "Maybe we could use it for some sort of telephone repeater."

In later years he said of its first successful test: "I was never so taken aback in all my life. Everybody was astonished. *I was always afraid of things that worked the first time.*"

Even after patent rights were issued to manufacturers, Edison claimed it was "just a fad, and would be completely forgotten in five years". As late as 1925 he would not concede that electronic phonographs were superior and maintained that T. A. Edison, Inc. would make an improved mechanical phonograph for long playing records.

Also in 1925 he noted that the 'radio craze' would soon pass. "The present radio . . . is certainly a lemon. It will in time cure the dealer of any desire to handle any kind of radio." He also insisted that the public would not stand still for having to listen to the programming the broadcasters provided.

In 1926, though very hard of hearing, Edison tested an electronic phonograph perfected by Bertil Hauffman, a Swedish engineer, at the Edison Laboratory. Edison found the reproduction 'distorted and terrible' and ordered that Hauffman be fired. Son Theodore, director of the works, arranged for Hauffman to work hence in a part of the laboratory that Edison was not likely to visit.

Edison once said that he enjoyed his deafness because it permitted him to concentrate. Though his progressive deafness made him almost stone deaf in elder years, one wonders if the affliction also allowed him to ignore criticism in earlier times.

Another facet of the Edison myth is the famous story of his sleeping only four hours a night. John J. O'Neill reports in his biography of Tesla: "It was a regular practice with Edison to sit down in his laboratory and doze off into a three-hour nap about twice a day."

Edison was strangely adverse to theoretical work himself; as a thinker, he was second rate—as an administrator, second to none. The 'Wizard of Menlo Park' hired batteries of mathematicians and physicists, laughed at their theoretical approach, but utilised their results.

When the young genius Nikola Tesla came to this country, he had a letter of introduction to Thomas Edison, four cents in his pockets, and the key to alternating current electricity—today's housepower—locked in his mind. Edison offered him a meagre eighteen dollars a week, providing he never spoke of AC.

Tesla proved himself an able engineer and inventor, regularly submitting improvements for Edison equipment. When Tesla suggested research toward improved dynamo manufacture, Edison told him: "There's fifty thousand dollars for you in it—if it works." Inside the week, Tesla presented the design. When he finally had to ask about the money, Edison grinned and said: "I guess you just don't understand our Yankee humor."

Tesla quit. Some months later, he had interested investors in his ideas for AC, constructed working models, and applied for a patent. The U.S. Patent Office responded that the ideas contained in the original patent application were so far-reaching that no less than forty would cover them!

George Westinghouse, industrialist and inventor himself, offered Tesla one million dollars for the rights and the Westinghouse Electric Company was formed. This was prologue to the biggest battle of the 19th century: a technological war in which Thomas Alva Edison was the prime antagonist.

Edison had recently spent $2 million with his DC system in New York City. The financial threat posed by Westinghouse and Tesla could not be ignored. Although Edison had said AC was "a waste of effort and money", he found his system impractical to produce voltages higher than 220, as the dynamo commutators heated badly. Too, line losses necessitated either large, expensive conductors or power stations spaced every mile or so.

DC power left the generating plant at about 120 volts; the users closest to the plant had the brightest lights, sometimes so much so that bulbs burned out frequently. Perversely, those at the end of the line had light hardly better than candlepower, because of the voltage drop along the line. With Tesla's AC system, alternating current could be transmitted equally to home or factory, with negligible power loss in the lines.

Edison wrote: "Just as certain as death Westinghouse will kill a customer within six months after he puts in a system of any size . . . it will never be free from danger."

Westinghouse argued that of thirty deaths by electricity in 'recent' years, sixteen were from 'safe' DC circuits, and none from Westinghouse equipment. During one period Edison lost about a workman a month with safe direct current and almost burned down the fashionable Vanderbilt home on Fifth Ave. A fire started when metallic-threaded draperies shorted out the wiring which had been placed behind it. Mrs. Vanderbilt returned home to find a confusion of firemen, assistants and Edison himself. Learning that there was a generating plant in her cellar, she became 'hysterical' and declared she could not live over a boiler. "We had to take the whole thing out," Edison ruefully remarked.

To sway public opinion in the "battle of the currents", Edison and Charles Batchellor—ironically the man who gave Tesla the letter of introduction to Edison—demonstrated the horrible dangers of alternating currents by electrocuting cats and dogs, using a one kilovolt generator. They paid eager schoolboys twenty-five cents a head for all the animals they could deliver. It is said that the house pet population around West Orange stood in danger of being annihilated. During one of these edifying illustrations for guests, Batchellor lost his hold on the dog he was about to electrify and himself received the shock. As he put it later: "The sensation was of an immense rough file thrust through the quivering fibers of the body."

After this, Edison published an article saying in part: "I have not failed to seek practical demonstration . . . I have taken life—not human life—in the belief that the end justifies the means." Yet in the final battle of this strange war, Edison seemingly reversed his opinions and requested permission to install AC equipment in upstate New York. Westinghouse hastily agreed.

It might be said that the news of the installation came as a shock to Westinghouse—it was the first electric chair. The New York State Legislature had adopted a statute in 1888 to provide for capital punishment by electrocution. H. P. Brown, a former research expert for Edison, supervised the installation of the 'hot squat' for the Edison General Electric Company.

On August 6, 1890, convicted murderer William Kemmler was to be executed. The first attempt at death by legal electrocution was a failure, as the electric force was too weak. The unfortunate man was led away. After quick modification to the chair, "the miserable work was perforce done again, resulting in a spectacle much worse than hanging."

A frantic Westinghouse recouped by obtaining the contract to provide power for the Columbian Exposition of 1893. Tesla had his own exhibit there, where he mystified fairgoers with his scientific marvels. The climax of the many performances was the passing of one million volts of AC through his body to melt a copper plate. It was not high voltage that killed, he maintained, but the destructive heating effect of high currents. High amperage DC could and did kill as readily as AC. While working up his demonstrations, he discovered the medical principle of diathermy.

The public was won over to AC and in 1895, Tesla harnessed Niagara Falls. His powerhouse was completed, providing AC for Buffalo, twenty-two miles away. It was hailed as the greatest engineering achievement in the world to that date.

In 1896, a mysterious cigar-shaped airship was seen by hundreds of people over San Francisco Bay, and subsequently was reported in successive eastward sightings. A New York *Herald* reporter obtained this statement from Edison, who disclaimed any knowledge of the never-identified craft: "I perfer to devote my time to objects of commercial value. At best airships would only be toys." A few years later, he was congratulating Alberto Santos-Dumont for inventing powered flight, not recognising the achievement of the Wright brothers.

The Edison Effect—the expulsion of particles from a heated filament—grew from experiments with the light bulb. Edison found that bulb life was shortened by the deposit of carbon from the filament. He sketched in his notebook the first two-element vacuum tube as a solution to the problem, having found that current would flow into the second element. This forerunner of today's diode was patented but never used, and the patent lapsed.

With the diode, his discovery of the 'etheric force' and a subsequent patent of wireless transmission based on electrostatic induction, he had in his grasp the elements of a complete radio system several years before Hertz demontrated the existence of radio waves. Later in life, he said that it was a pity he had not seen any connection between them.

His first major invention, the carbon but ton microphone, is virtually the same today; it was a symbol of much of his work, since it improved an existing idea, the Bell device. Edison came, as it were, into a technological vacuum, purifying existing and imperfect concepts, and applying much of the random electrical science accumulated over fifty years. He did enough that he could well say in later years his productivity brought him "awards by the quart". He patented over 1,100 inventions and gained a vast reputation while his more brilliant and less understood contemporaries are all but forgotten.

George Westinghouse himself patented over 400 inventions in his lifetime and founded 60 companies.

Charles Proteus Steinmetz, whom Edison liked "because he never spoke of mathematics to me", published the law of hysteresis when he was only 27, went on to produce artificial lightning and delve into higher mysteries. He is little known today.

Nikola Tesla, besides giving the world AC, demonstrated radio control before the turn of the century, developed a working system of broadcast power, lighted his laboratories with wireless fluorescent lights in 1889, and had over 700 patents to his credit when he died in 1943. Yet he is the forgotten man of electrical science.

Edison, the Great Man, reigns supreme.
. . . Elkhorne

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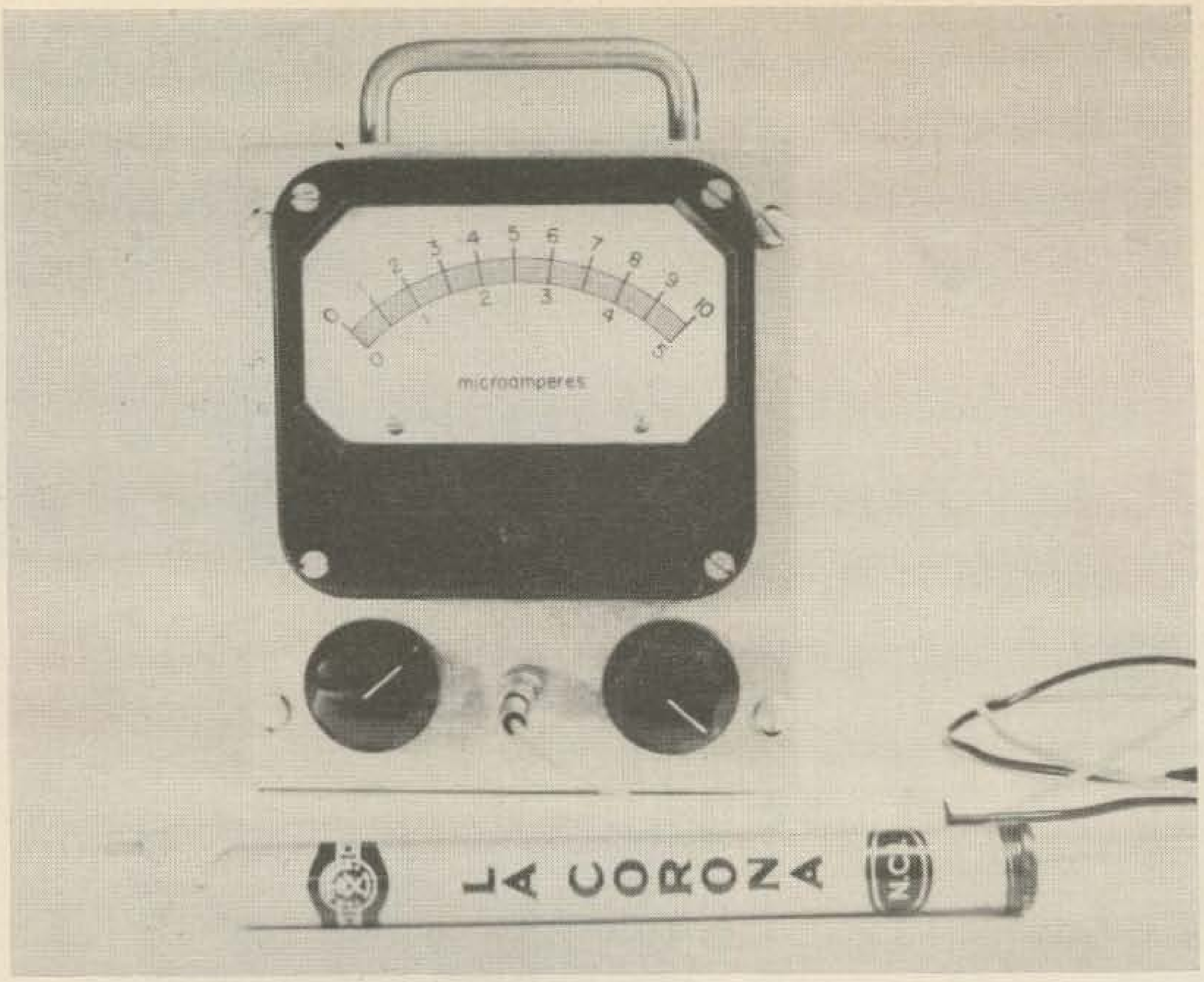


Photos by Jim Harvey, WA6IAK.

Jim Fisk W1DTY
RFD 1, Box 138
Rindge, N.H. 03461

A Sensitive RF Voltmeter

One of the handiest test instruments around the ham shack is the rf probe or rf voltmeter. This almost indispensible unit may be used for neutralizing transmitters, tuning up oscillators and in many other general tasks around the shop. Most hams simply purchase an rf probe to go along with their VTVM, but these probes are usually limited to an upper frequency range of somewhere around 250 MHz. Another serious limitation of the familiar VTVM rf probe is that the lowest voltage range on the VTVM is typically 1.5 volts. Some of the latest models have voltage ranges down to 0.5 volts full scale, but the vast majority are not that sensitive. When working with transistor rf stages, the millivolts (thousandths of a volt) become very important, and a more sensitive rf voltmeter than the common household VTVM must be used.

There are several approaches to this problem, but most of them are not very simple. The commercial instruments that read one millivolt full scale or less are quite complicated; they rectify the rf, chop it up at 1000 Hz, feed it into a very high gain, narrow passband ac amplifier, rectify it at the higher level and drive a meter movement. This is a very effect approach, but instruments using it cost upwards of $500. The rf

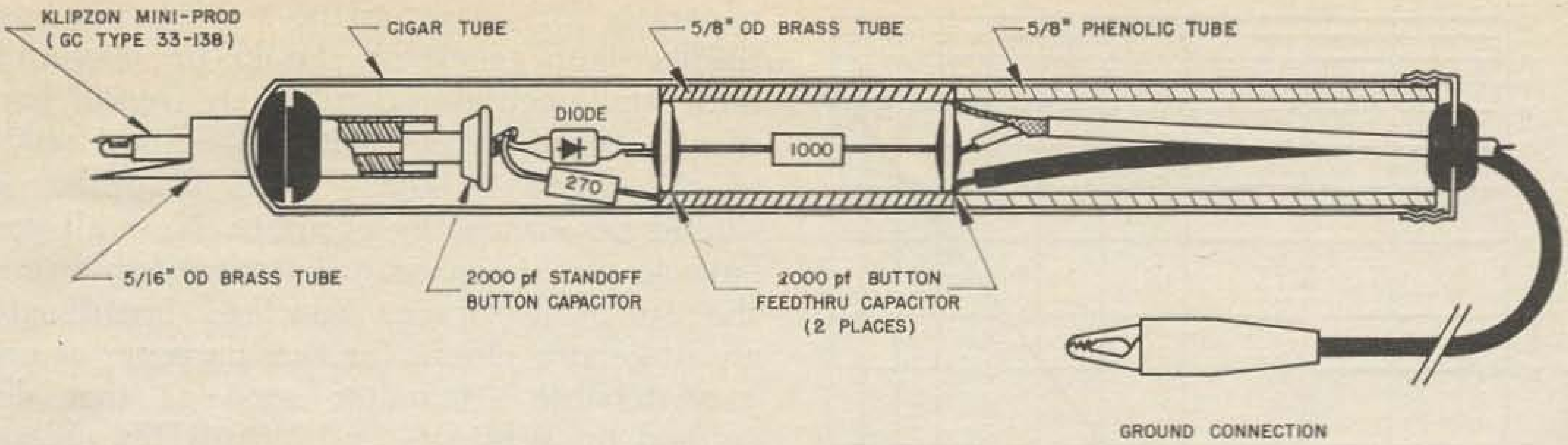


Fig. 1. Cutaway view of the sensitive rf probe. Note that the cigar tube construction results in an essentially coaxial structure; this type of construction ensures relatively flat response up to 500 MHz.

voltmeter I will describe here is not nearly sensitive enough to read 1 millivolt full scale, but with care in construction, you can readily detect 30 or 40 millivolt signals at 500 MHz. This is about 15 times more sensitive than the most sensitive VTVM and about 50 times more sensitive than the average one. Higher sensitivities are obtainable, but noise becomes the limiting factor with the simple construction described here.

With this rf probe, response is relatively flat from about 50 MHz all the way up to 500 MHz. The secret to this unit's wide frequency range lies almost exclusively with its layout and construction. First of all, the probe itself is essentially coaxial in nature, with the filter components mounted in a brass tube. To maintain leakage at an absolute minimum and to minimize series inductance, button mica capacitors are used in conjunction with a coaxial input. The result is a probe that will quite accurately measure small levels of rf voltage up to about 500 MHz. Above 500 MHz you can still get meter deflections with small rf voltages, but the response gradually falls off. This frequency roll off is a result of the parasitic and leakage elements that start to take effect at these higher frequencies. Above 500 MHz for example, it is difficult to predict the dielectric characteristics of molded carbon resistors. In some cases there is sufficient leakage between the two leads of the resistor to completely nullify the resistance.

In addition to the compact and coaxial nature of this probe, the low value of load resistance, 270 ohms, tends to maintain an input-output characteristic which is almost completely independent of frequency from several MHz up to 500 MHz. With the component values shown in the schematic, the response gradually falls off below 50 MHz; at the expense of flat UHF response, the capacitors may be increased for response in the 3 to 30 MHz region. For the high frequency range the input coupling capacitor should have a value of about 500 pF and the filter capacitors should be 2000 pF. For lower frequency use of course, it is not necessary to maintain the coaxial structure of the probe nor to use the more costly button capacitors.

The selection of a diode depends on the frequency range desired. Up to about 100 MHz, almost any germanium diode will work quite well; the 1N34A is an excellent choice for this range. For higher frequencies however, many diodes are constructed in such as way that they exhibit high values of series inductance and leakage capacitance. For this reason, the familiar 1N21 and 1N23 microwave mixer diodes represent excellent choices for a voltmeter of this type which is designed for VHF use. The 1N82A is another diode that works quite well up to 1000 MHz or so. Each of these diodes exhibits different characteristics and even diodes of the same type are not exactly identical.

It is a pretty well known fact that all semiconductor diodes exhibit a square law

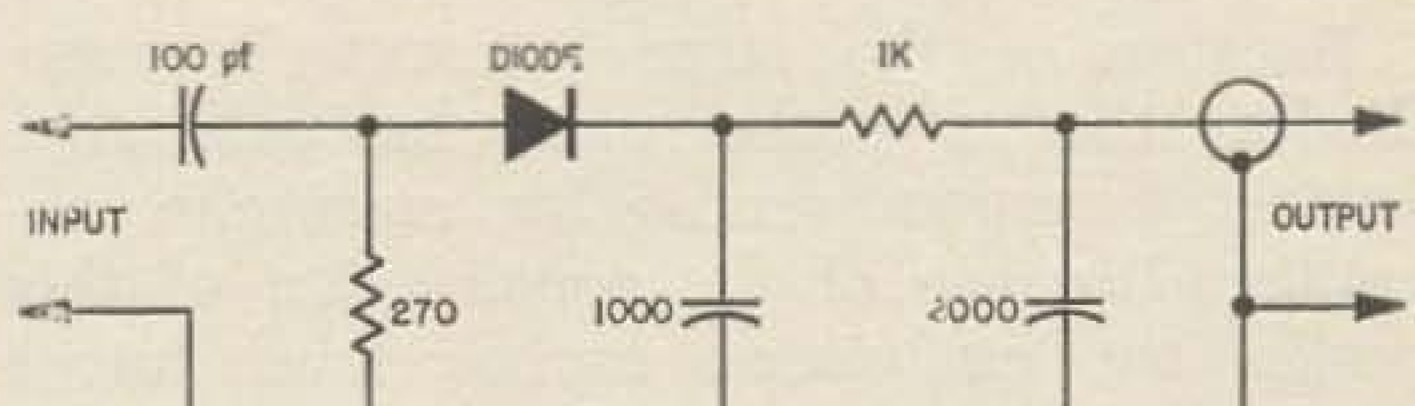


Fig. 2. The sensitive rf probe. For UHF use the capacitors should all be button types to minimize series inductance; for the lower frequencies, conventional types will suffice.

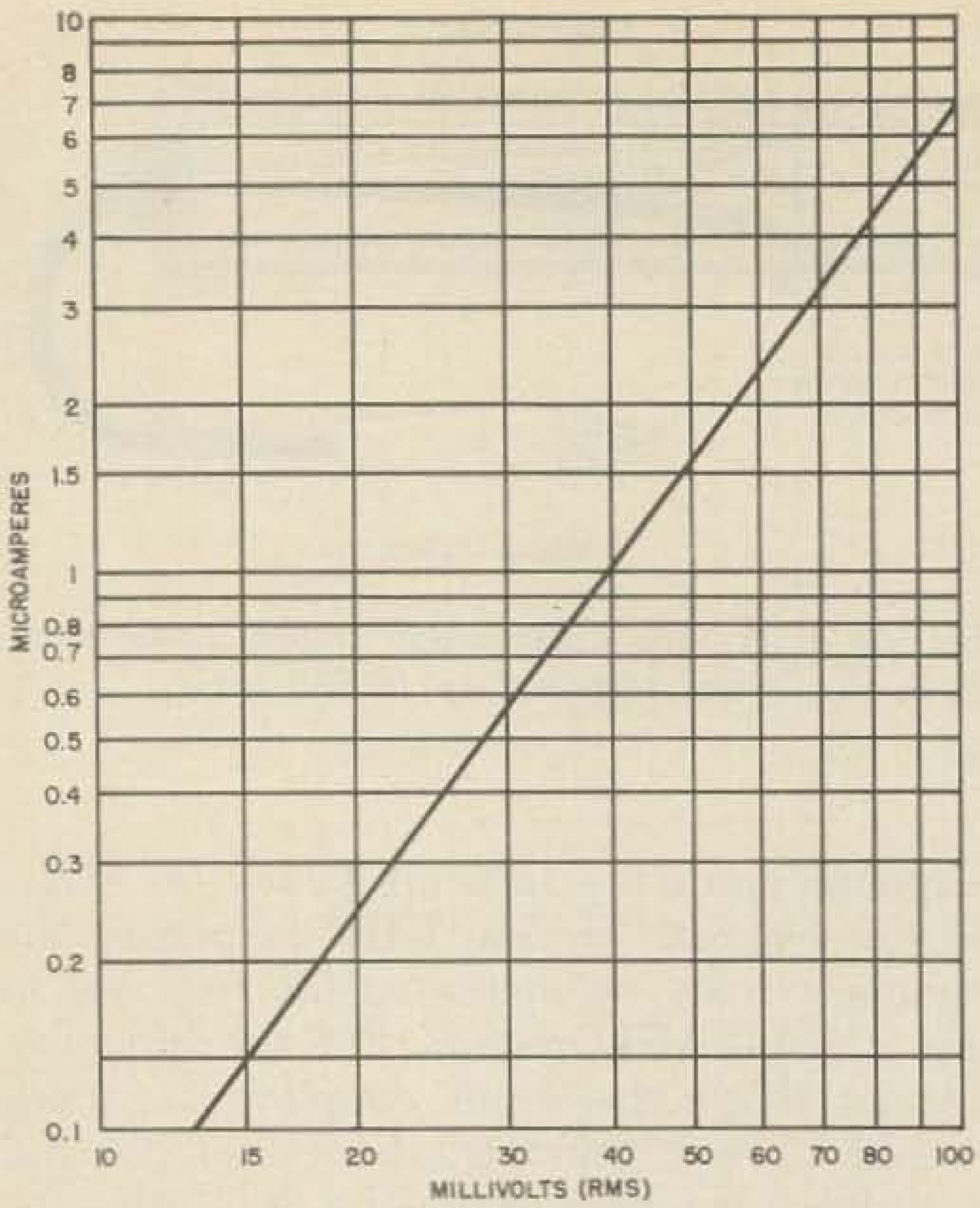


Fig. 3. The microampere per volt characteristic of a 1N34A diode in the square law region. Above 100 millivolts or so, this curve becomes linear.

input-output characteristic up to several hundred millivolts. With germanium diodes the square law region is from zero to about 100 or 200 millivolts; silicon diodes are slightly higher, to 600 or 700 millivolts. The 1N34A diode for example exhibits a sensitivity of 700 to 1200 microamperes per volt squared in this region; a typical 1N34A μA/V curve is plotted in **Fig. 3.** It should be pointed out that this curve varies with temperature, the amount again depending upon the individual diode used. However, in amateur applications this is usually not a problem because the probe will normally be used at room temperature. Above the square law region the sensitivity of semiconductor diodes is essentially linear and typically on the order of 5 milliamperes per volt.

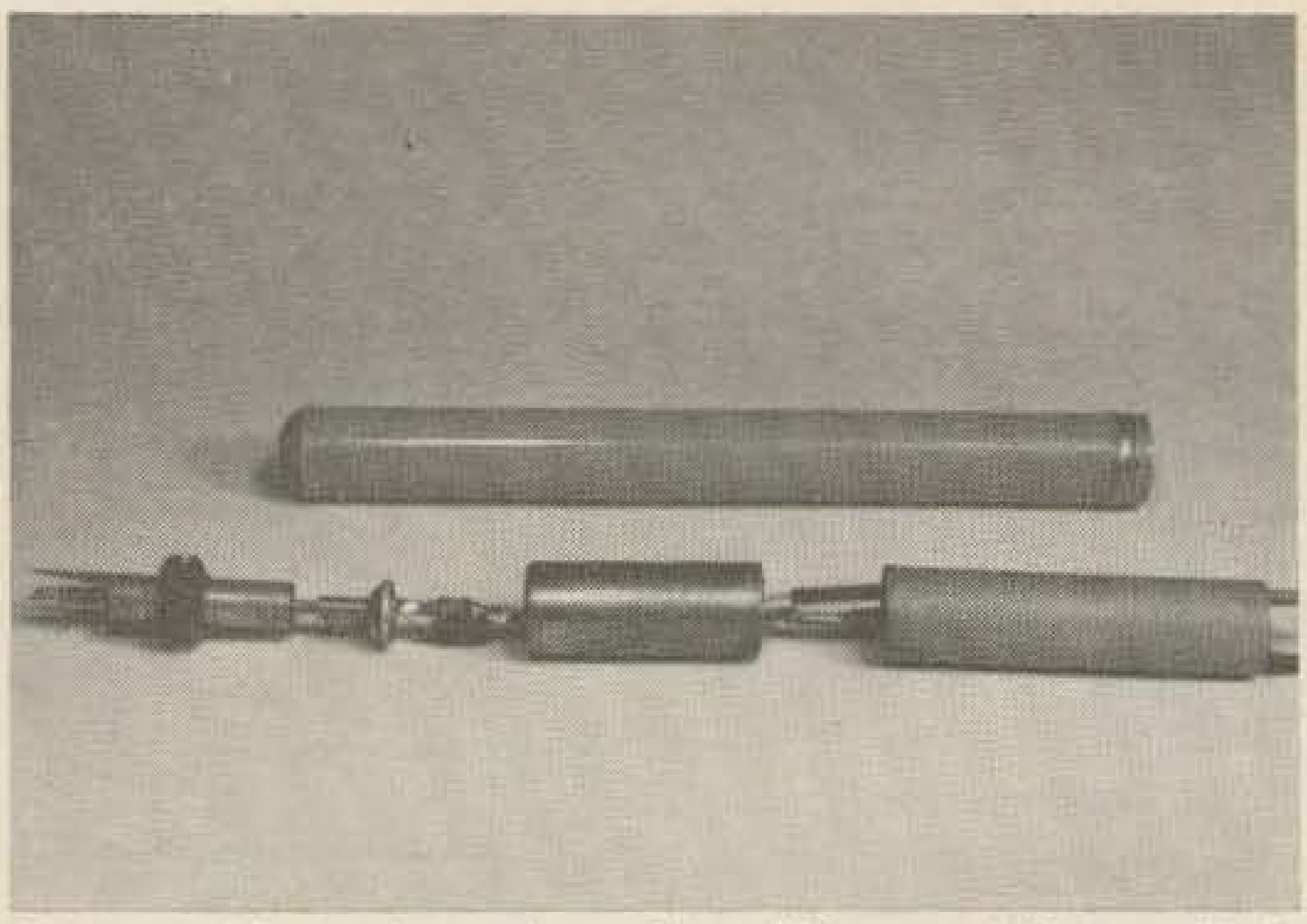
Because of the large variance between diodes, the rf probe must be calibrated against a known source for maximum accuracy. Because of the construction of this probe, the calibration sounds much more complicated that it actually is. Since the probe is essentially flat up to 500 MHz, it may be calibrated at 100 MHz or so; most VTVM's are accurate enough at this frequency for calibration purposes. All you have to do is set the output of your signal generator for 1 volt on the VTVM. For best results your generator should be operating on a fundamental and relatively free of harmonics. Since 1 volt is within the linear range of the diode in the VTVM rf probe, it should be reasonably accurate. Now all you have to do is connect an attenuator between the one volt source. You can breadboard an attenuator circuit for this purpose, or use a switchable attenuator such as that described by WB6AIG and WA6RDZ1. When the input-output characteristics are plotted on graph paper, you should end up with something like the curve of **Fig. 3.**

Construction of the probe is quite simple and is based upon the use of an aluminum cigar tube, the kind those 50c cigars come in. If you can't get one of these or don't smoke, an old pen light or piece of aluminum tubing will work with a little modification. The tip of the probe is made up from a Klipzon Mini-prod (General Cement 33-138) and a piece of 5/16 inch brass tubing from the hobby shop. This tubing is popular with slot car enthusiasts, so it shouldn't pose any procurement problems. One end of the mini-prod has a sharp tip with a small clip that may be clipped unto wires; the other end accepts a pin plug.

Apply a little epoxy cement to the mini-prod and push it into the brass tubing. The mini-prod fits snugly in the tuning and is held firmly in place by the cement. Now place a 5/16 rubber gromment around the tube and push it about half way down; cement it in place with epoxy.

While the epoxy is setting, take a 100 pF standoff button mica capacitor and solder it to a pin jack; this will eventually fit into the end of the mini-prod when the probe is complete. Cut a piece of 5/8 inch brass tubing about an inch and a half long and solder two button capacitors and a 1000 ohm resistor inside as shown in **Fig. 1.** This "filter" assembly should slide easily into the cigar tube. Also drill a 5/16 inch hole in the end of the cigar tube for the mini-prod assembly.

Install the diode and a 270 ohm resistor as shown in **Fig. 1**, using the very shortest leads possible. The cathode of the diode goes to the center pin on C2; the 270 ohm resistor is soldered to the brass tube. On the other end of the tube connect a length of cable; this lead will be connected to the microammeter. Install the complete assembly (mini-prod, C1, CR1, R1 and the filter) into the



Disassembled rf probe. The Klipzon Mini-prod is on the left, the button coupling capacitor, diode and 270 ohm resistor to the right, followed by the filter and phenolic tube. The cigar tube housing is in the background.

cigar tube and cut a length of ⅝ inch phenolic tubing so that it protrudes about ⅛ inch from the end of the cigar tube. When the cover is in place this tube will compress the unit together and ensure a physically strong assembly. The shielded lead is brought out through a small rubber grommet mounted in the cover.

In addition to the rf probe, you will need a very sensitive microammeter for measuring small levels of rf. Occasionally 10 or 20 microampere movements are available at bargain basement prices, but usually another approach is necessary; the sensitive microammeter illustrated in **Fig. 4** is a good example. This meter uses a high gain transistor meter amplifier to obtain full scale readings down to 10 microamperes full scale on a 1 milliampere meter. With a full scale calibration of 10 microamps, it is quite easy to read a half microamp or so; this corresponds to 28 millivolts peak to peak with my probe.

The sensitive microammeter illustrated schematically in **Fig.** 4 consists of a current amplifier with the 1 mA meter in a bridge circuit[2]. This circuit is quite stable with temperature and slight variations in supply voltage may be compensated by the zero control on the front panel. Almost any high gain transistor will work in this circuit, but silicon is preferred because of its better leakage characteristics. The only other requirement is that the transistor must maintain linear current gain and high beta at low collector current levels; the 2N3392 is inexpensive and works very well.

With the switch in the 10 microampere position, the 10k gain control is adjusted to provide 10 microamperes full scale. With a 1 milliampere movement, this corresponds to a current gain of 100. For full scale readings of 50 to 200 microamperes, meter shunts are proved for 5 and 20 mA full scale with the 1 mA movement; the transistor amplifier will maintain a current gain of 100. For meter readings of 1 milliampere, the transistor amplifier is disabled and the meter is operated in the normal manner. The value of the shunts may be calculated by using the formula found in any of the handbooks.

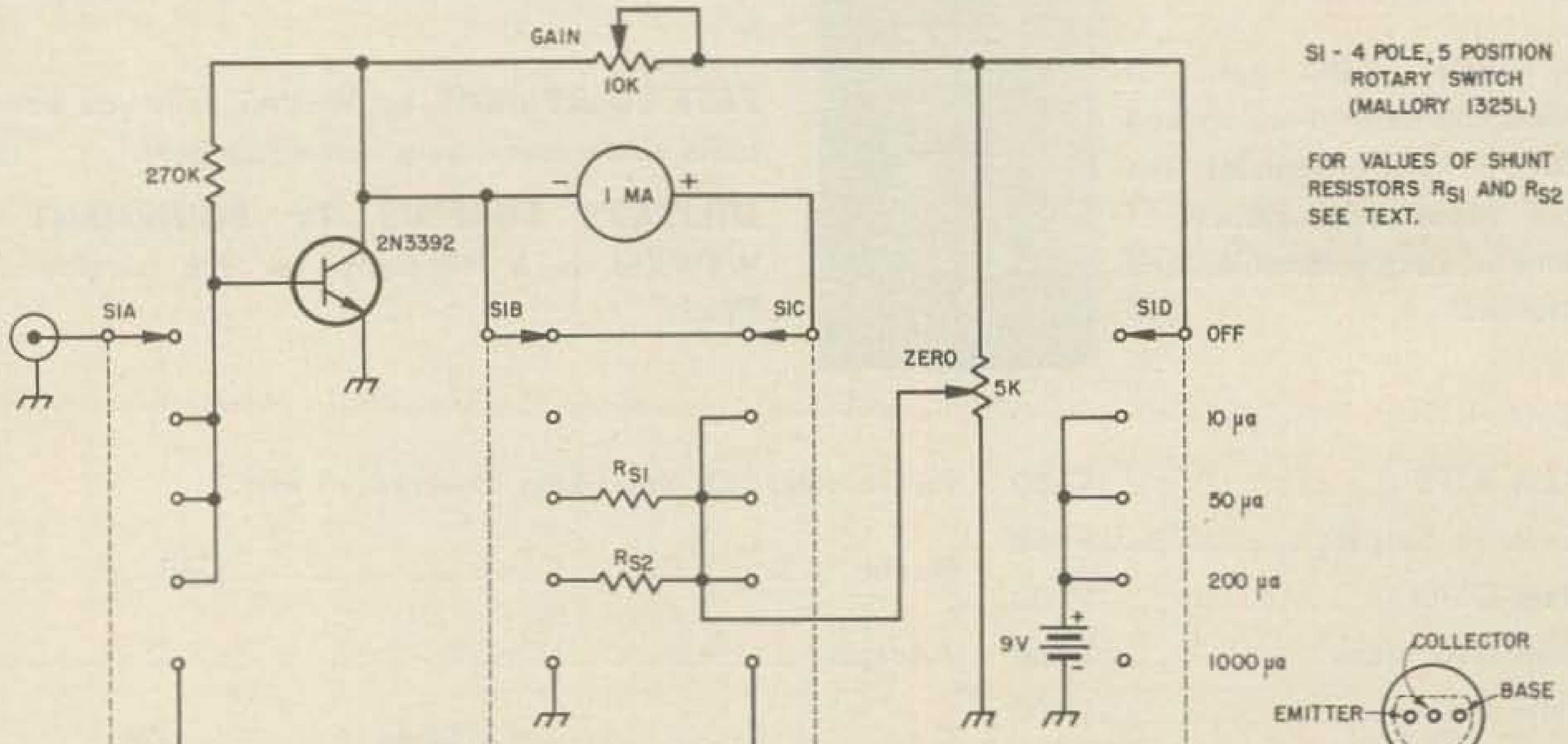


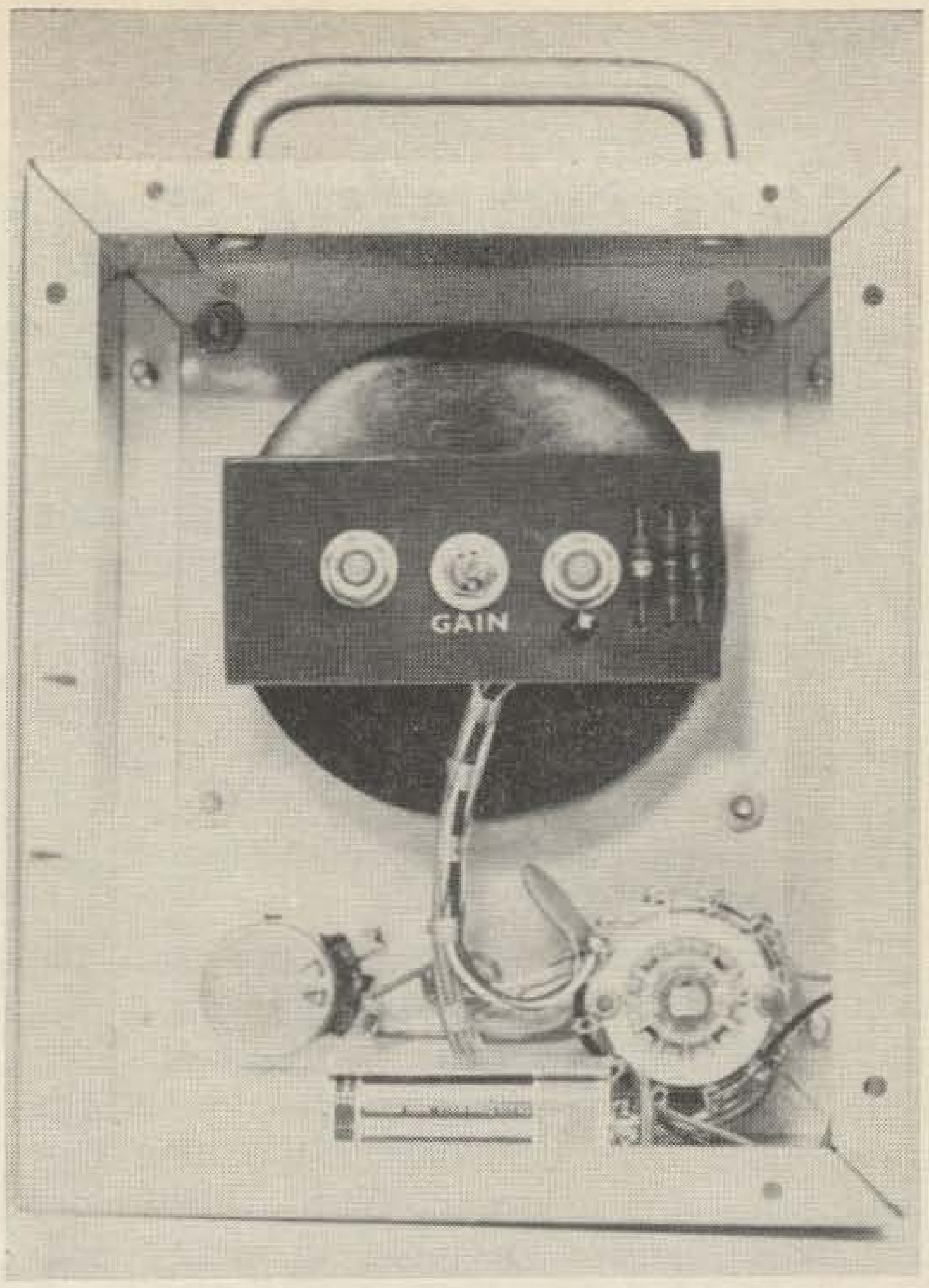
Fig. 4. Transistorized microammeter. This instrument will provide full scale readings down to 10 μA. Although a 2N3392 was used here, any high gain silicon transistor that maintains high current gain at low collector current levels is suitable.

In my transistorized microammeter I mounted the transistor amplifier circuitry and meter shunts on a phenolic strip connected to the meter terminals. The gain potentiometer is also mounted on this strip. With a circuit as sensitive as this, noise can be a very serious problem if the circuit is not properly shielded. In this case a small coaxial cable was used in the input and the amplifier and meter were built into a metal box. In addition, the input was bypassed with a 0.01 μF disc capacitor.

With the sensitive microammeter and calibrated probe, it is quite easy to accurately measure rf voltage down to 30 or 40 millivolts. However, since this is a peak responding instrument, you have to be a little careful or you will obtain some very optimistic readings. If there is any harmonic content in the waveform you are reading, it is apt to be quite a bit higher than predicted, and the rms value will **not** be 0.707 of the peak reading; the 0.707 value applies only when the waveform is sinusoidal. This is not usually the case with rf oscillators and amplifiers, but if the harmonics are suppressed with high Q tuned circuits, the error will be negligible.

In addition to measuring actual rf voltages, this probe has several other uses. It may be used as a very sensitive untuned field strength meter by simply clipping a short length of wire to the tip; in some cases where the rf field is strong and the probe can be placed close enough to the transmitter, this may not be necessary. Hence another precaution: don't use the probe in strong rf fields when measuring small rf voltages; the rf field will negate the voltage reading. This probe may also be used as a demodulator for a VHF sweep generator. Just connect the probe to the circuit being swept and connect the output to your oscilloscope. It may also be used to measure the SWR along a piece of open wire transmission line (or twin lead). When the probe is brought in close proximity to the transmission line, it will provide an upscale reading on the microammeter. The ratio between peaks and valleys as the probe is moved along the line is the voltage standing wave ratio.

In some measurements you may find that the probe will load down low-capacitance high-Q circuits. If you are only interested in peaking the circuit, and many times this is the case, this effect may be minimized by connecting a resistor in series with the probe. The Klipzon Mini-prod is ideal for this purpose because it will securely hold one lead of the resistor; the other lead may be used for probing. If a 5000 ohm resistor is used, it represents less than one pF coupling above 30 MHz; this should eliminate any detuning effect of the probe.



Inside of the meter amplifier. The transistor and gain calibration control are mounted on a piece of bakelite attached to the meter terminals.
The rf probe disassembled. See Fig. 1.

There are many other uses for the sensitive rf probe, limited primarily by the ingenuity of the user. But in it main application, that of measuring very small rf voltages, it is unbeatable for its expense and complexity. Although high rf voltages or mechanical shock may cause permanent damage to the diode, my probe has proven to be particularly resistant to burnout and has accepted peak surges of 500 Vdc and 120 Vac with no apparent effect on calibration.

. . . W1DTY

1. "Low Power Attenuators for the Amateur Bands," WB6AIG and WA6RDZ, 73 Magazine, January 1967.

2. "Transistor Meter Amplifiers," WA6BSO, 73 Magazine, January 1966.

Tom Lally K1UBA
28 Amory Rd.
Waltham, Mass.

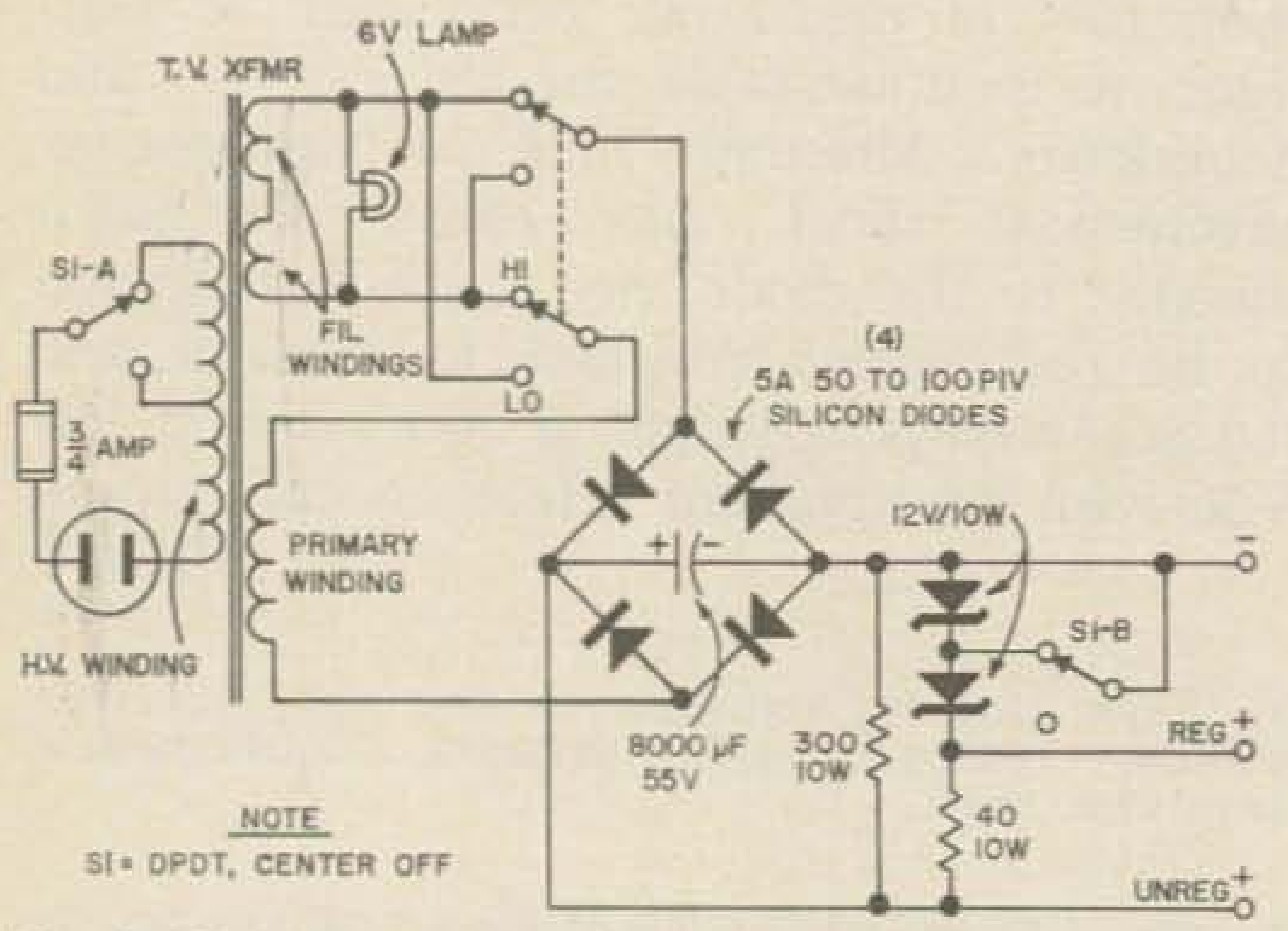
SDRAWKCAB Power Supply

Articles have already been written about building kW supplies with TV power transformers, using voltage doubling and series capacitors. The solid state man, shunning the lethal voltage approach to rf power generation, looks for a way to lower the line voltage. With this in mind, and with a junked TV in the shack, the supply shown here evolved. With 115 V in, the outputs are as follows:

Unregulated 16, 21, 32, 41 Volts
Regulated 12, 24 Volts

The transformer is hooked up with the secondary connected to the line, and the primary as the input to a bridge and filter. Four levels of voltage are available at the unregulated output, which is the next best thing to owning a Variac. With a little more switchcraft, and with more filament windings, more levels can be had. The HV winding center tap provides a choice of high or low outputs, while the filament windings give series aiding or opposing differential adjustment at either level. Stud silicon diodes are used in the bridge. The .008 F capacitor is probably a little fat for the application, and a mere 4,000 μF would still guarantee a T9 report on the air.

The regulated outputs are at the 12 and 24 volt levels for this supply, but depending on your transformer, or your oscillator requirements, these could be modified to 9 and 18 volts, or even lower. For the loads presented by solid state receivers, the stud zener is an adequate regulator, so no series type regulation had been built in. On transmit, a voltage "droop" of over 25% has gone unnoticed on the air, as has a ripple considerably higher than the 0.1 V of this supply. Accordingly, no attempt has been made to regulate anything but the oscillator supply. If too much current is drawn from the unregulated output, however, regulation cannot be maintained.



Here's K1UBA's transistor power supply.

Important criteria for selecting the transformer are:

1. The turns ratio
2. The internal resistance of the windings
3. The number of filament windings.

Transformers which give the highest voltage when normally connected are not necessarily what you want for this supply, since they may give too low an output when connected backwards. Also, their HV windings may exhibit high resistance which reduces the stiffness of the dc output. The author's supply has an internal resistance of 8 ohms, which limits maximum output to 53 watts. More filament windings mean greater range of differential adjustment.

The aluminum chassis acts as a heat sink for the bridge and zener diodes. All diodes are isolated from chassis ground with mica washers to allow a choice of positive or negative grounding. Threaded 6-32 stock holds down the capacitor, but it could have been epoxied to the chassis. The AC line switch is DPDT with center off position to minimize the number of controls, and it also cuts in the second zener when in the "HIGH" position. The pilot light is visibly dimmer in the "LOW" position, but it can still be seen. Grommets protect the transformer leads and the capacitor lugs.

On low voltage, a direct short will not blow the ¾ Amp fuse, but component dissipations are within safe limits. The transformer is not operated anywhere near its allowable power limit for step-up operation, but it exhibits less than 10°C rise at full load, and should be adequate until the advent of the solid state kW.

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A Panadapter Converter

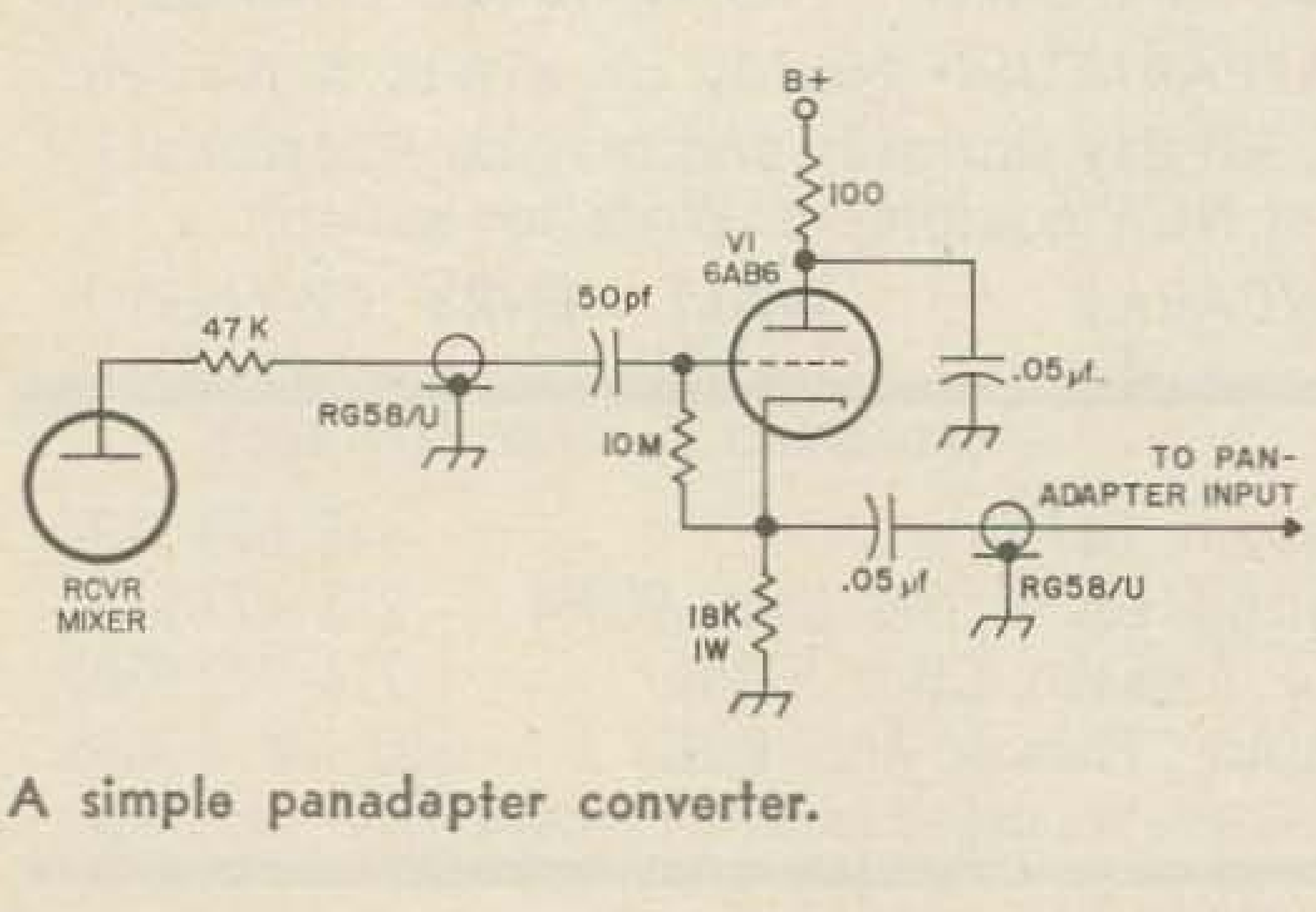
Having trouble getting those pretty pictures with your panadapter? Maybe you need an isolating amplifier.

I recently got a panadapter It worked fine with a signal generator, but gave pretty dismal results when I connected it to my receiver.

A careful search through the literature turned up all sorts of interesting notions on how to connect a panadapter to a receiver. Each was tried without success. Some loaded the mixer too much. Others attenuated the signal too much. Finally a reasonable presentation came on the screen, but only after reducing the length of RG-58/U connecting the adapter to the receiver to a ridiculous length that left the panadapter back to back with the receiver.

Something had to be done. A cathode follower was the obvious approach. One was installed as close as possible to the mixer stage. This gave a very high impedance to the mixer stage, but a low impedance into the coax running to the panadapter input. The results were excellent.

Since most receivers have an accessory socket on the back, this seemed to be an ideal way to get the B+ and filament voltage, and at the same time provide a mounting for the cathode follower circuit. The origonal unit was constructed in a Mini-box 1⅝ x 2⅛ x 2¾, using the piece that has the two ends on it for the chassis.



A simple panadapter converter.

An octal plug is mounted on the long side. This not only makes the necessary electrical connections but also holds the assembly in place on the back of the receiver. The cathode follower circuit is assembled on one end, and an octal socket is mounted in the other end in case any additional accessory is to be connected to the receiver.

A 6AB4 tube was used because it was handy, but any of a number of other tubes might be substituted with only minor changes in the circuit. A more compact unit could probably be built easily by using a triode Nuvistor. Construction is straight-forward but lead lengths should be kept to a minimum, and the length of RG58/U between the mixer and the cathode follower should be kept as short as possible to minimize attenuation. The 47 k resistor should be as close to the plate connection as possible, and likewise the 50 pF capacitor as close to the 6AB4 grid as possible. The 100 ohm resistor in the plate circuit of the 6AB4 provides decoupling and was adequate in this installation, but a different value might be required in other installations.

Using this unit between the receiver and the panadapter, no detuning of the mixer is noted when connecting to it, and enough coax to allow the panadapter to be removed to a respectable distance from the receiver has little effect on the input signal. In fact despite the fact that the gain of a cathode follower is of necessity less than 1., the lowered impedance gives the effect of an actual gain.

. . . WB2CCM

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73 Useful Transistor Circuits

Useful transistor circuits for audio and speech equipment, receivers, transmitters and test equipment.

Circuits for Audio Equipment

Direct coupled amplifiers

The direct coupled amplifier illustrated in Fig. 1 is just about as simple as possible, but provides very usable results. The collectors of the first two transistors operate at about 0.3 volts; this type of operation yields somewhat less than normal gain, but provides considerable reduction in noise produced at the input by the transistor. The biasing of the first stage is controlled by resistor R1 and because of the direct coupling between stages, indirectly controls the bias to the other two stages. Since the gain and leakage varies widely between different transistors, this resistor must be adjusted experimentally to provide optimum bias for the last transistor (Q3). This is easily done by adjusting its value until there is 0.8 volts across the headphones (points A and B in the schematic).

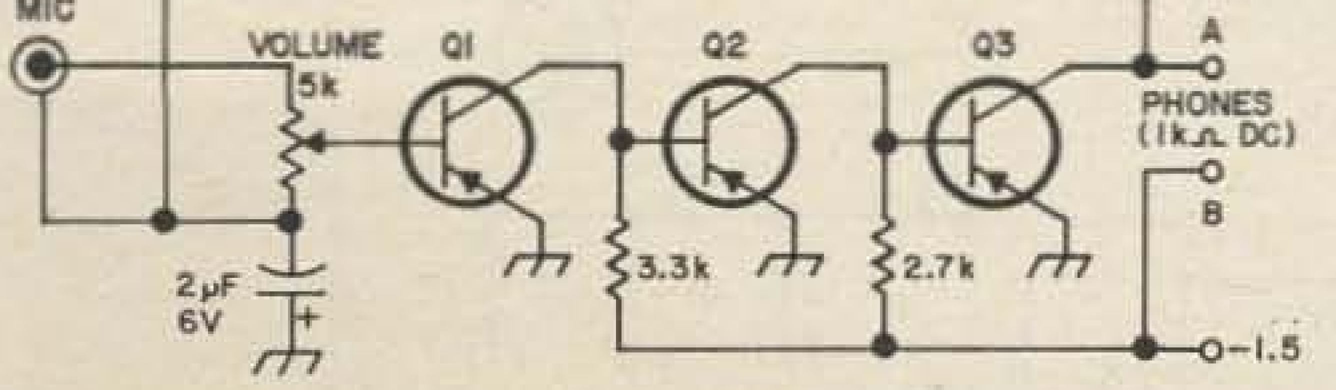


Fig. 1. Simple direct coupled amplifier. Transistors Q1, Q2 and Q3 should be the 2N207, 2N584, 2N1098, SK3003, GE-2 or HEP-254.

Since R1 is connected to the collector of Q3, bias variations caused by changes in temperature are reduced by negative dc feedback introduced by this resistor. For example, as the leakage in Q1 increases with temperature, the collector voltage on Q3 decreases. The increased leakage is partially compensated for because the lower voltage on Q3 causes less current to flow through R1. Generally speaking, this circuit will compensate quite nicely against temperature changes up to about 100°F. Above 100° it is possible that the transistor will be driven into nonlinear operation with resultant distortion and reduced power output.

The dc resistance of the headphones is very important in this circuit because the

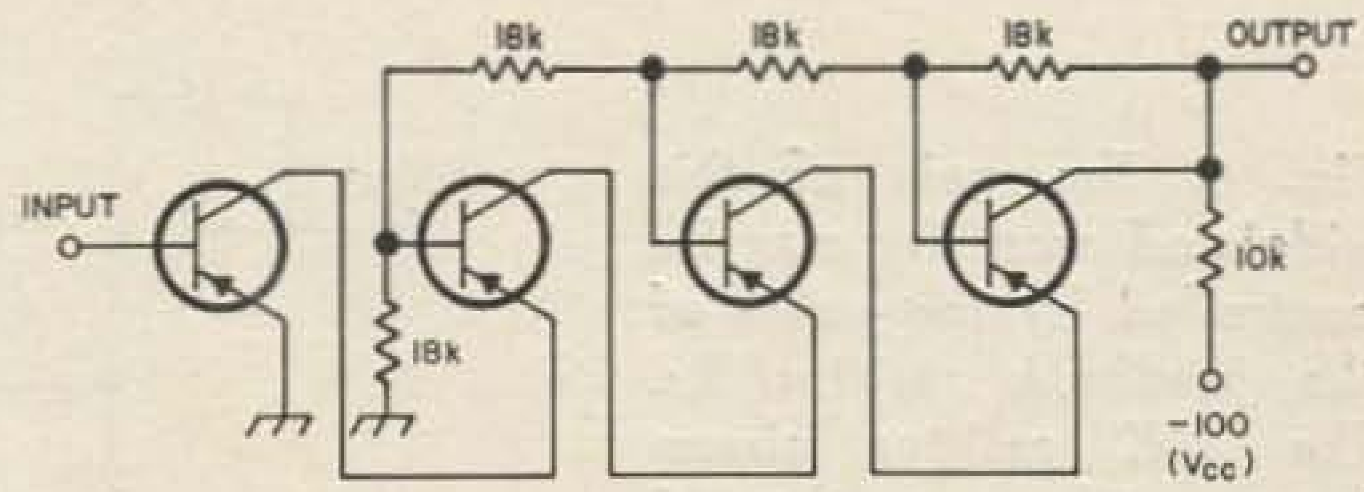


Fig. 2. High voltage direct coupled amplifier. The gain of this amplifier is equivalent to both sections of a 12AU7. All transistors are 2N384, SK3008, GE-9 or HEP-51.

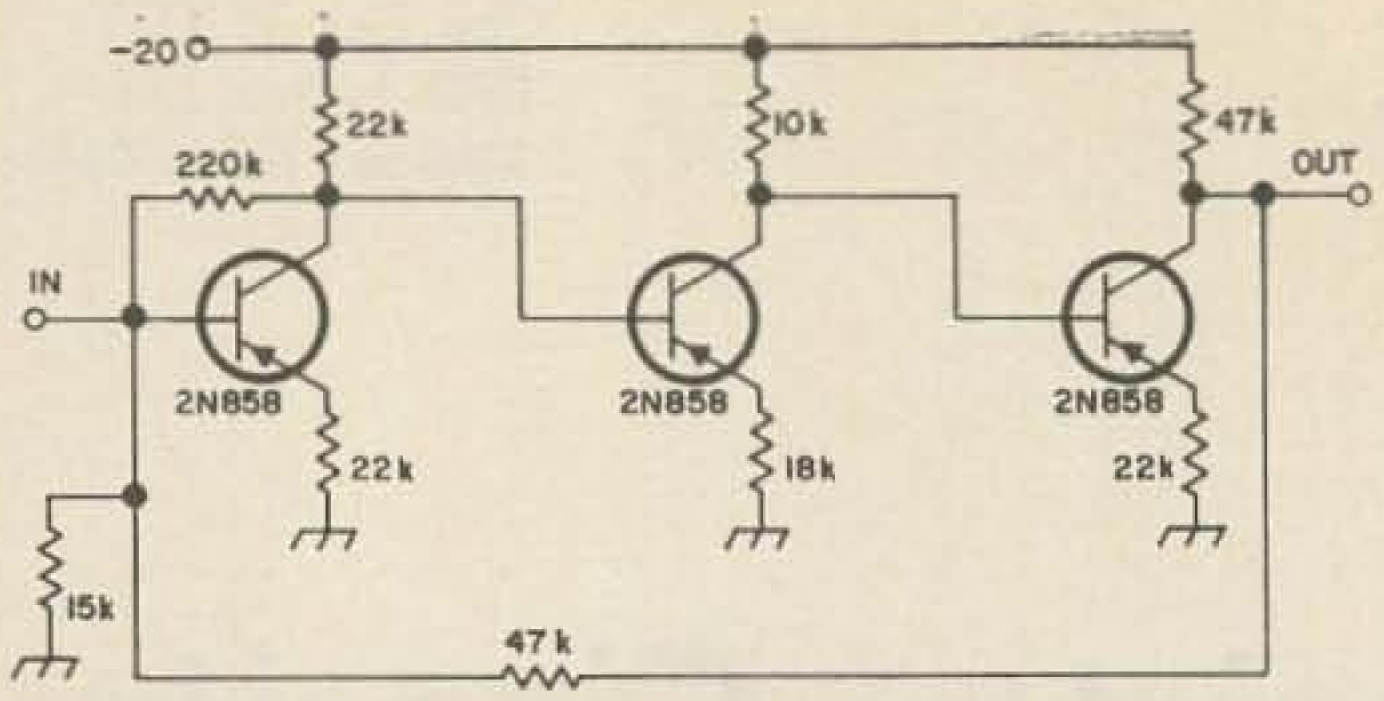


Fig. 3. This simple direct coupled amplifier provides 30 dB gain and identical 1500 ohm input and output impedances. For higher gain, similar units may be cascaded up until 10 volts peak to peak is obtained at the output.

voltage drop across them determines the operating conditions of all three stages. For optimum operation, the dc resistance of the earphones should be in the neighborhood of 1000 ohms. Most phones with an impedance of 2000 ohms have a dc resistance of 1000 ohms, but if you're in doubt, the resistance may be easily measured with an ohmmeter.

The main advantage of the high voltage direct coupled amplifier in **Fig. 2** is that it may be connected directly to a rather high value of B+. Its gain is equivalent to a single 12AU7 (both sections) and because of the direct coupling, provides extremely wide bandwidth. Although the input impedance of this circuit is only 2000 ohms, it is still very useful for many applications where a simple amplifier is required.

Another very simple direct coupled amplifier is illustrated in **Fig. 3.** This amplifier provides almost exactly 30 dB gain and has identical 1500 ohm input and output impedances. For extremely high gain then, similar units can be cascaded up until an output voltage of 10 volts is obtained. This amplifier is also quite wideband, and with the transistors specified, the gain is essentially flat up to about 1 MHz.

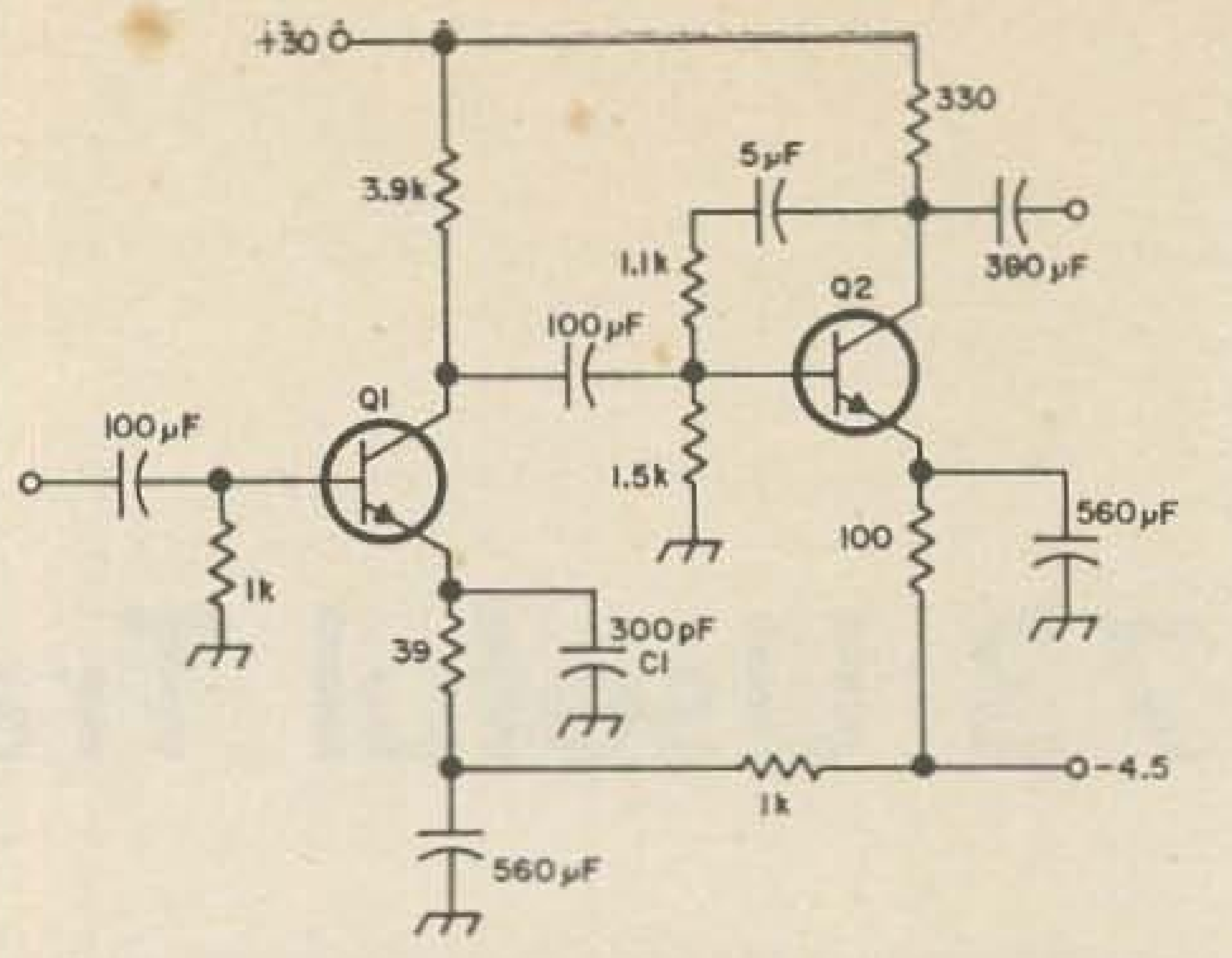


Fig. 5. This wideband amplifier exhibits 26 dB gain from 5 Hz to over 30 MHz and will deliver a 7 volt signal into a 100 ohm load. Transistors Q1 and Q2 are 2N2218.

Wideband amplifiers

In the wideband amplifier shown in **Fig. 4,** the gain is controlled by the feedback resistor R_f. With a 10 kilohm feedback resistor, the gain is greater than 30 dB from 10 Hz to 17 MHz. When the resistor is completely removed from the circuit, the gain is greater than 50 dB up to about MHz, but the biasing of the input transistor becomes very critical to prevent signal distortion. Note that the large electrolytic coupling capacitors should be paralleled with smaller capacitors that have good high frequency characteristics.

Another wideband amplifier is illustrated in **Fig. 5**; this amplifier has a frequency response from 5 Hz to over 30 MHz. The voltage gain over this range is 26 dB and the amplifier will deliver an undistorted 7 volt sine wave into a 100 ohm load. This circuit has excellent stability and linearity, and by adjusting the bias and emitter bypass capacitor C1 experimentally, the frequency response may be increased up to 50 MHz.

Fig. 4. The gain of this wideband amplifier may be controlled by the value of the feedback resistor R_f. The 10K resistor shown here provides more than 30 dB gain from 10 Hz to 17 MHz. Q1 and Q2 are 2N2188, SK3006, GE-9 or HEP-2.

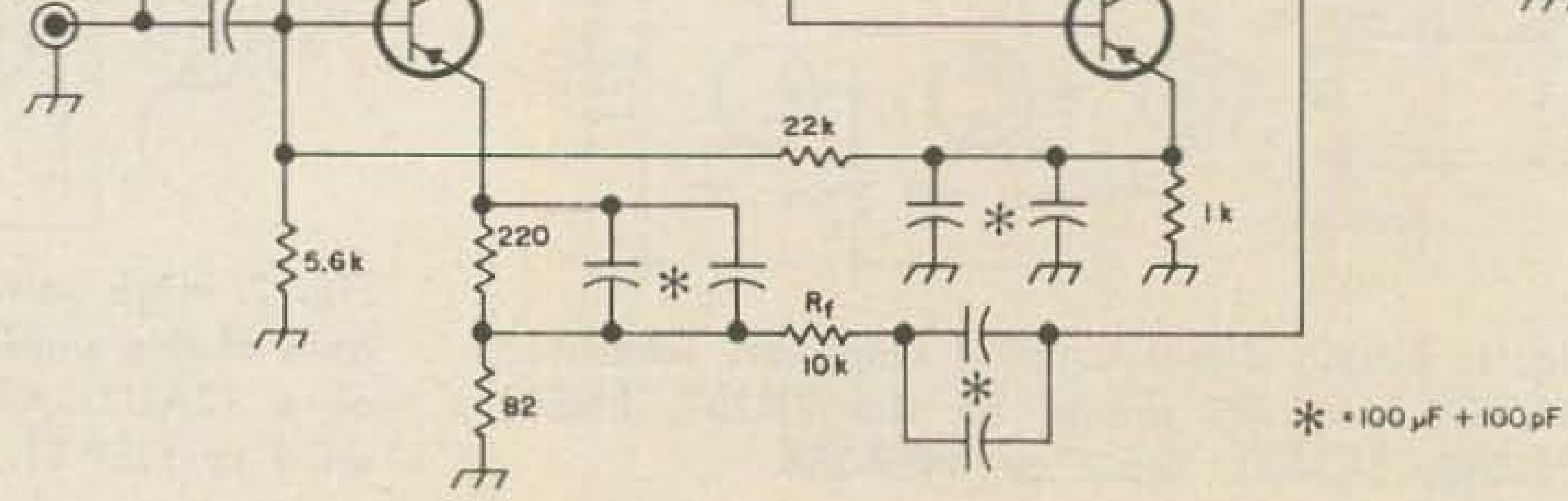
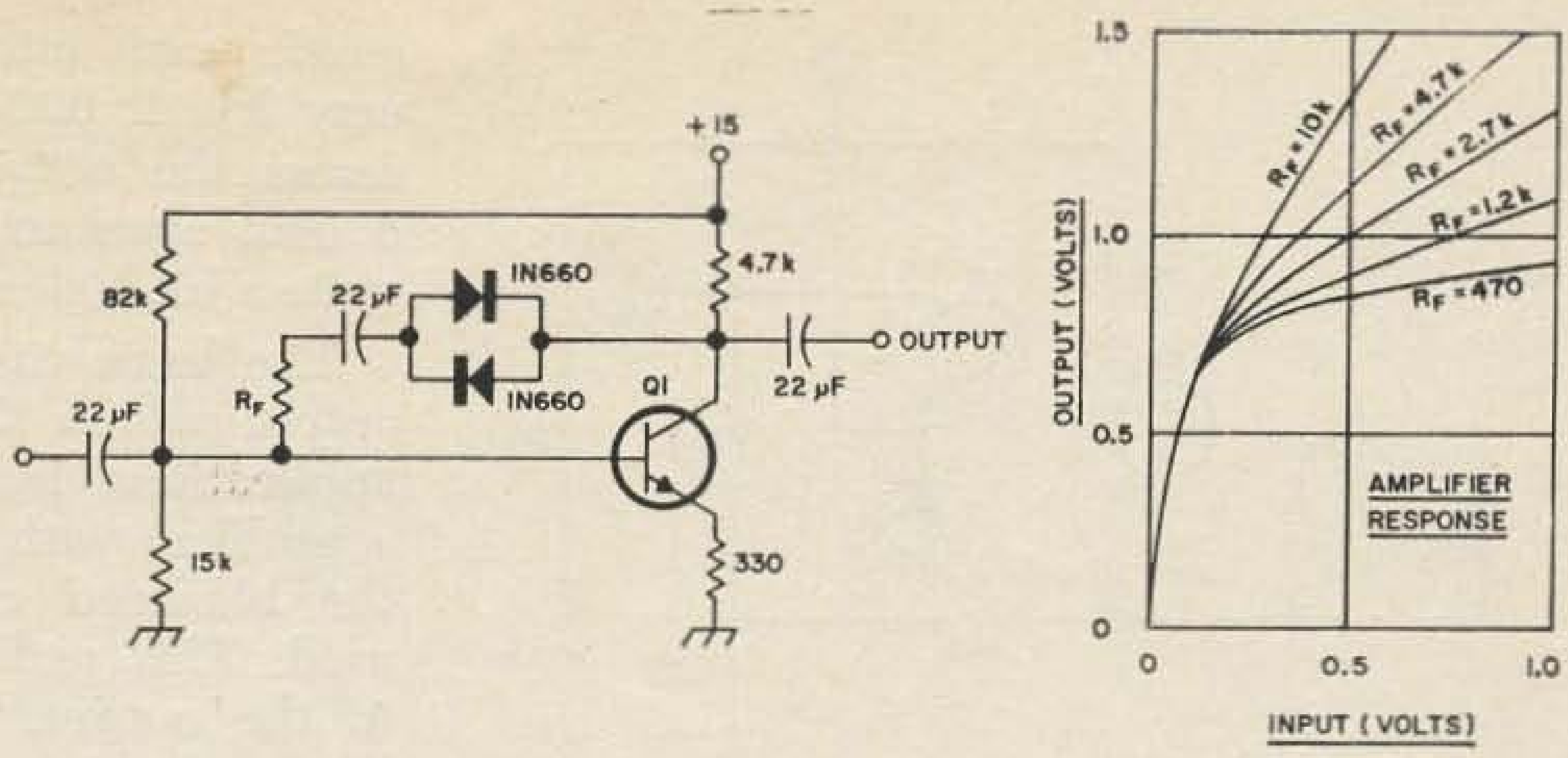


Fig. 6. The gain of this amplifier is controlled by the nonlinear feedback provided by two back to back diodes and the value of the feedback resistor R_f. Q1 is a 2N706, 2N708, 2N3394 or HEP-50.



Gain controlled amplifiers

It is a well known fact that the gain characteristics of an amplifier may be shaped by applying nonlinear feedback. In the amplifier of **Fig. 6**, the nonlinear feedback is furnished by two back to back diodes in the collector to base feedback path. Whenever the signal at the collector is high enough to forward bias the diodes (greater than approximately 0.6 volts peak to peak), negative feedback occurs and the gain of the amplifier is reduced. The gain of the stage may be further controlled by the value of the feedback resistor (R_f) as shown in the amplifier response curve. If it is desirable to have the nonlinearity occur at a higher level (greater than 0.6 volts peak to peak), more than one diode may be added to each leg of the feedback network. For lower levels, germanium diodes may be substituted for the silicon diodes specified in the schematic. With the germanium diodes in the feedback path, nonlinearity will occur when the signal is greater than about 0.1 volts peak to peak.

A voltage controlled, variable gain amplifier has many applications in automatic volume control, amplitude modulation and remote gain adjustment circuits. The only difference between the circuit shown in **Fig. 7** and a standard common emitter amplifier is that a 1N34A diode is used in place of the emitter resistor. In an amplifier of this type, the gain of the stage is critically dependent upon the impedance of the emitter circuit. Since the impedance of the diode varies with the amount of current through it, the gain of the stage depends upon the transistor emitter current. The 1N34A was chosen because it provides an extremely wide impedance variation with a relatively gradual rate of change. This diode typically exhibits an impedance range from 15000 ohms at low levels to 200 ohms or less with high currents. The slow rate of impedance change is required to minimize distortion. This circuit is useful in ALC and AGC circuits, feedback regulation and other cases where wide dynamic range and instant response are required.

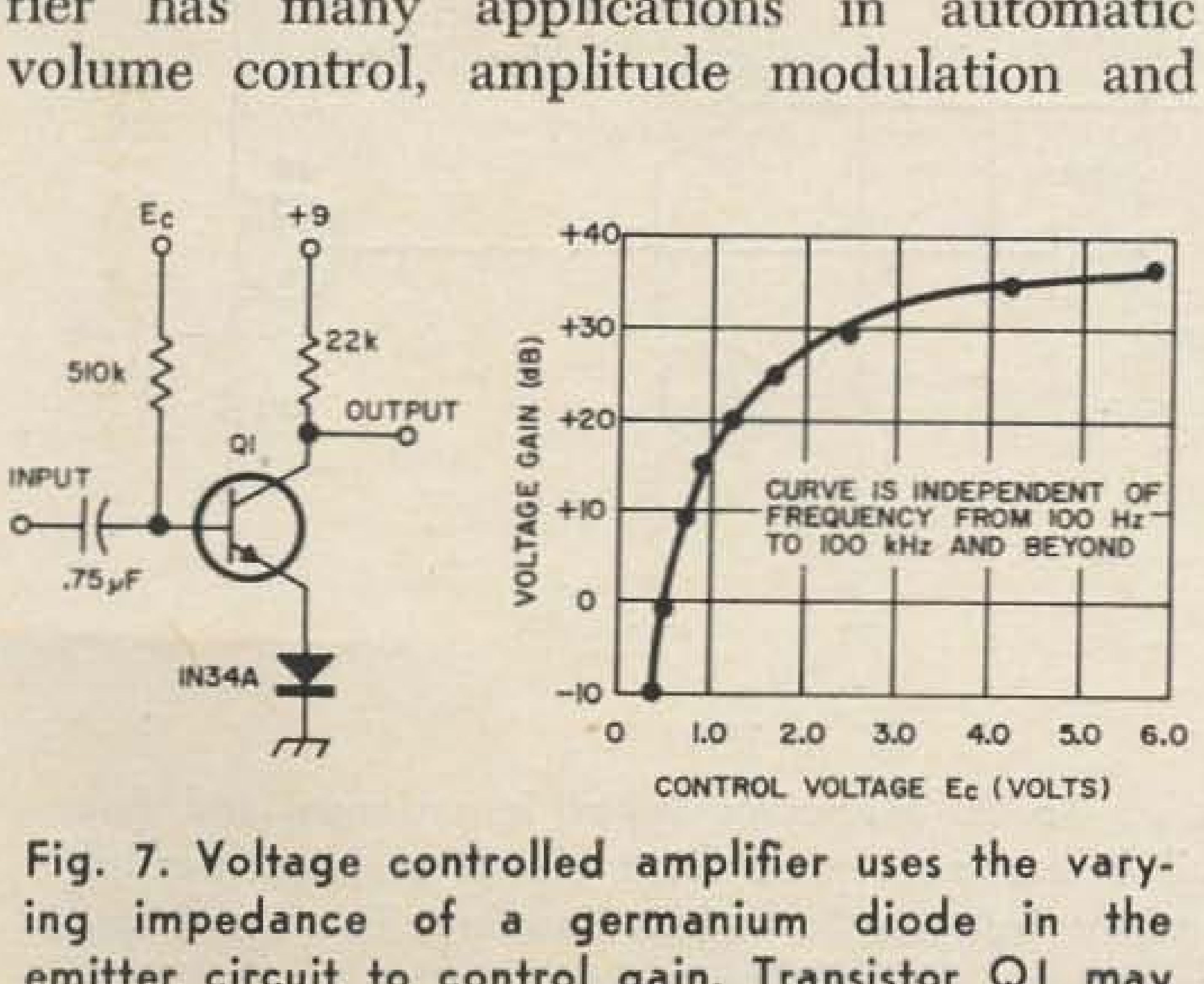


Fig. 7. Voltage controlled amplifier uses the varying impedance of a germanium diode in the emitter circuit to control gain. Transistor Q1 may be a 2N696, 2N3564, SK3019, GE-10 or HEP-54.

Preamplifiers

The simple low cost preamplifier in **Fig. 8** provides extremely flat response from 10

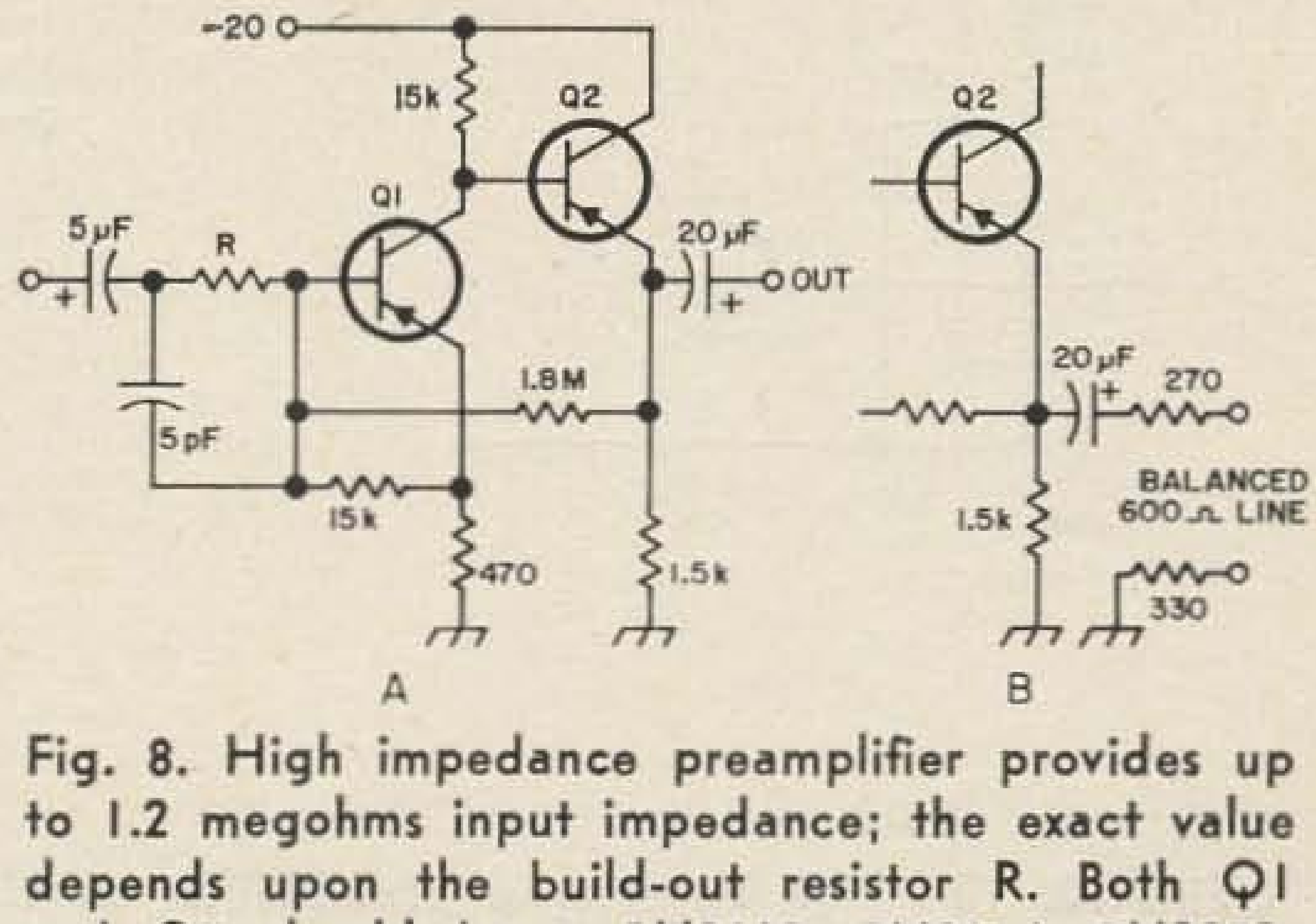


Fig. 8. High impedance preamplifier provides up to 1.2 megohms input impedance; the exact value depends upon the build-out resistor R. Both Q1 and Q2 should be a 2N2613, 2N2614, 2N2953, SK3004, GE-2 or HEP-254. A balanced output for reduced hum and noise may be obtained by using the padded output in B.

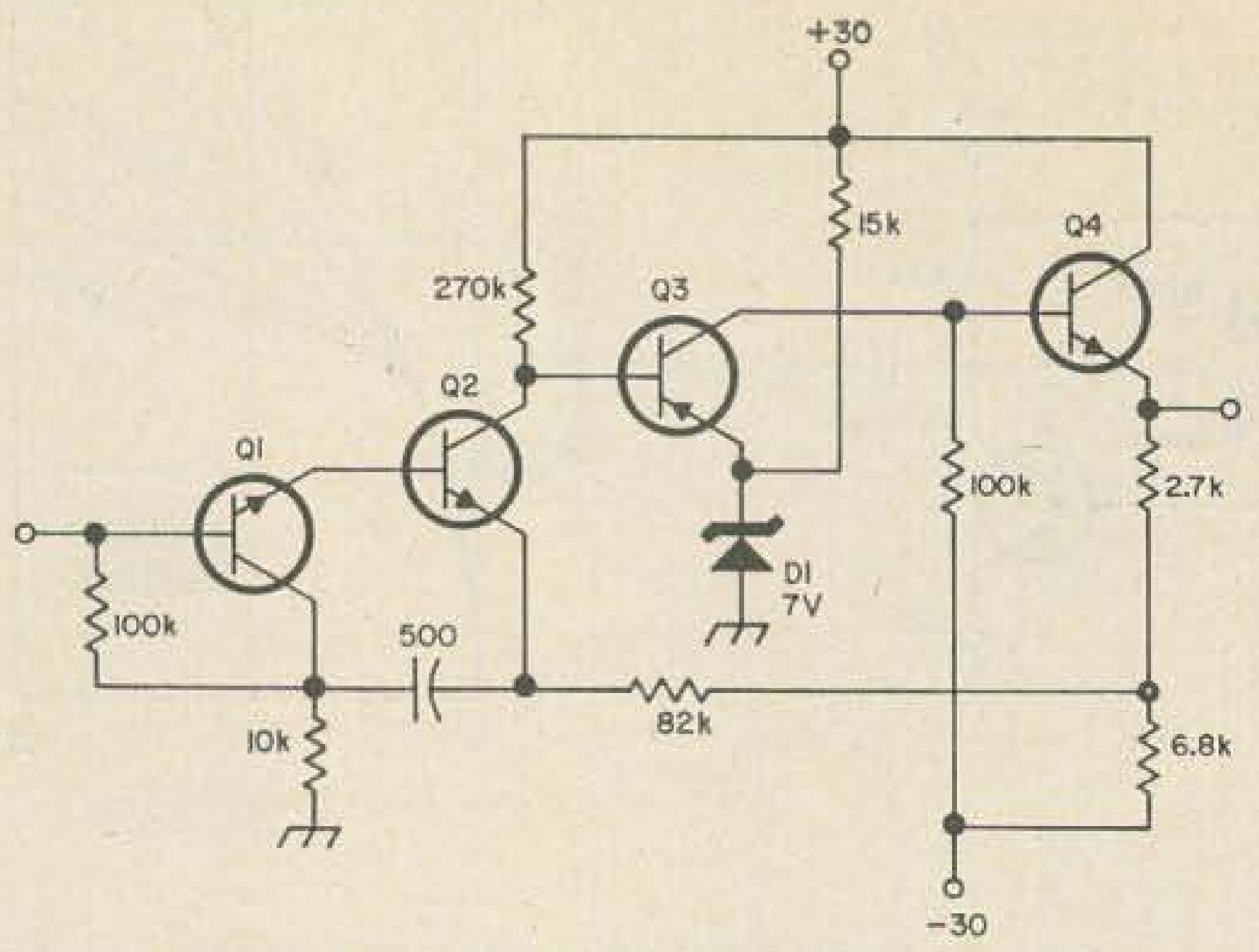


Fig. 9. This preamplifier provides 11 dB gain from 0.5 Hz to 2 MHz and has an input impedance of 32 megohms. Transistors Q1, Q2 and Q4 are 2N338, SK3020, or HEP-53; Q3 is a 2N328, GE-2 or HEP-52.

Hz to 30 kHz and at the same time exhibits an input impedance up to 1.2 megohms. The input impedance of the first transistor with the unbypassed emitter resistor is on the order of 50,000 ohms; by including the build-out resistor R in the circuit, the input impedance may be increased up to 1.2 megohms. Without R in the circuit, the voltage gain is approximately 15. As the value of R is increased, the voltage gain decreases and the entire circuit exhibits unity gain when the value of R is 1.2 megohms.

The output impedance of this simple preamplifier is particularly low, so it may be used for driving all types of circuits. Harmonic and intermodulation distortion are very low if 600 ohm circuits are connected across the output. It will also drive small 8 ohm speakers, but the distortion will be quite a bit higher.

The basic circuit provides an unbalanced output which should be suitable for most applications, but where hum and noise are a problem with balanced 600 ohm systems, the balanced output of **Fig. 8B** may be used. This pad adds a total of 6 dB loss in the output, but it does get rid of the hum and noise.

The four transistor preamplifier illustrated in **Fig. 9** exhibits an input impedance of 32 megohms and provides 11 dB gain from 0.5 Hz to 2 kHz. The high input impedance of this amplifier is a function of the two negative feedback loops; one from the emitter of Q2 to the collector of Q1, the other from the junction of the 2.7k and 6.8k resistors in the emitter of Q4 to the emitter of Q2. The output impedance of this amplifier is 20 ohms so it may be used for driving many types of circuits.

In many cases an amplifier with an input impedance approaching that of a VTVM is required to keep circuit loading to a minimum. The amplifier of **Fig. 10** more than meets these requirements; it provides up to 20 megohms input impedance, develops 1 volt rms across a 3300 ohm load and exhibits a frequency response from 10 Hz to 200 kHz.

The development of this circuit started

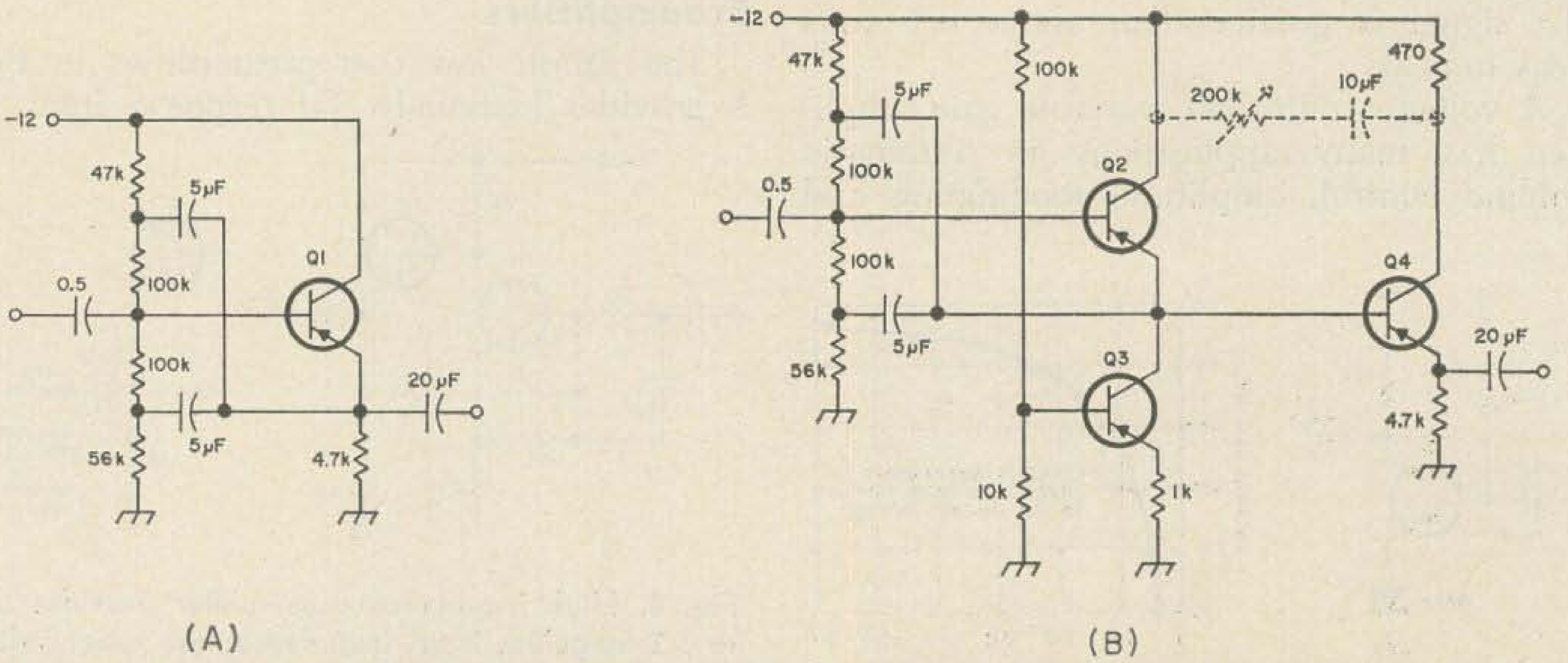


Fig. 10. This high impedance preamplifier provides up to 20 megohms input impedance and has a frequency response from 10 Hz to 200 kHz. Circuit B was developed from circuit A by replacing the emitter resistor in A with Q3 and adding an emitter follower to reduce loading. The input impedance is further increased by the components shown by the dashed line. All transistors are 2N2188, SK3005, GE-9 or HEP-2.

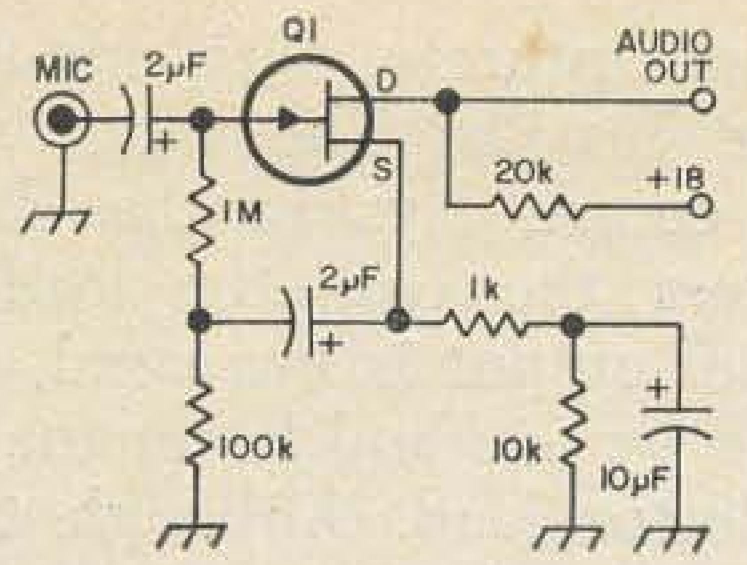


Fig. 11. Microphone amplifier using a field effect transistor has an input impedance of 5 megohms. Q1 is a 2N4360, TIM12, U-112 or U-110. By reversing the polarity of the supply voltage, a 2N3820, MPF-104 or HEP-801 may be used.

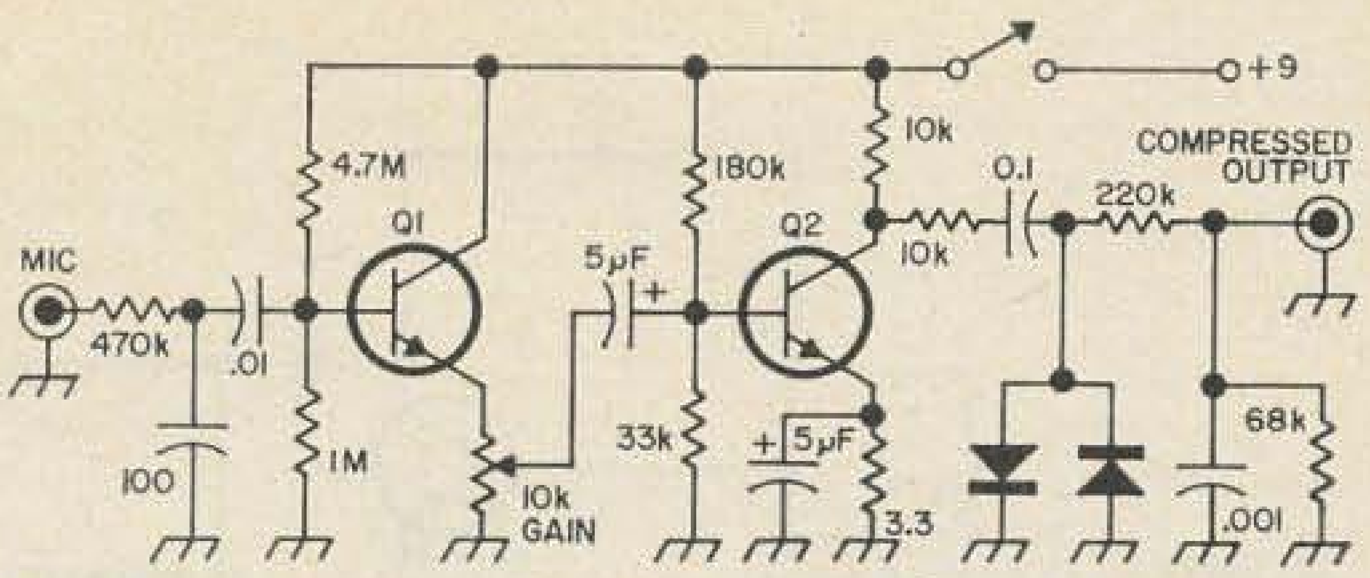


Fig. 12. Two stage clipper/preamp will increase the talk power of your rig. Transistors Q1 and Q2 are 2N1304, 2N2926, 2N3391, SK3011, or HEP 54. The diodes are 1N456 or HEP-158.

with the circuit shown in A. Here conventional bootstrapping was used on a basic emitter follower circuit to eliminate the shunting effect of the base bias resistors. When a transistor with a current gain of 100 was used, the input impedance was measured at 200K with a 3300 ohm load. A significant increase in input impedance may be obtained by replacing the emitter resistor of Q1 with the collector resistance of Q2 as shown in B. To keep the loading as light as possible on the emitter of Q1, an emitter follower (Q3) is used. With this circuit, the input impedance is slightly over 1 megohm with a 3300 ohm load.

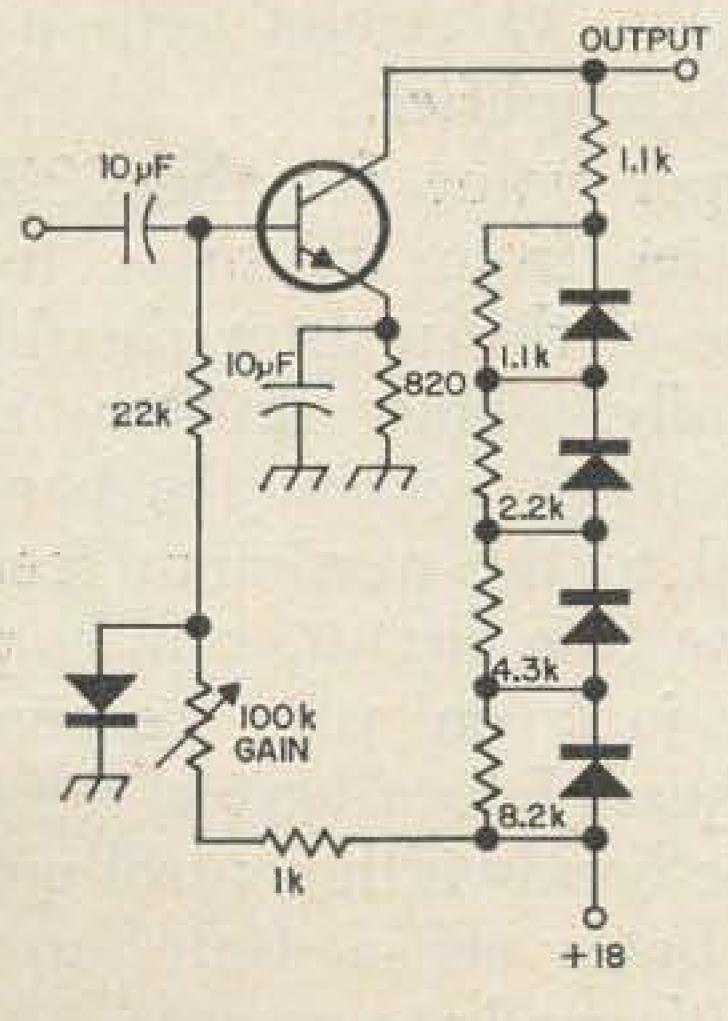
The input impedance of this circuit may be further increased with the addition of the components shown by the dashed lines. However, if this positive feedback is overdone, the circuit will oscillate. If, on the other hand, the 200k feedback pot is carefully adjusted, the input impedance may be raised to 20 megohms or so before instability occurs.

The high impedance microphone preamplifier illustrated in **Fig. 11** makes use of the inherently high input impedance of field effect transistors. This impedance is raised still higher by the use of the 2 µF bootstrap capacitor from source to gate; in this case to about 5 megohms. This circuit's output impedance of 2k is suitable for driving other FET's or conventional junction transistors.

Clipper/preamplifier

The microphone clipper/preamp shown in **Fig. 12** is very simple to construct and allows you to stay as far away from the mike as you like; it does a very good job of beefing up weak audio signals. It was designed primarily for high impedance dynamic microphones, but may be used with other mikes with slightly less gain. It provides up to 10 dB gain on low level audio signals and since it uses a minimum of parts, may be easily constructed in a small minibox.

Although the best way to adjust a clipper such as this is with an oscilloscope, the gain control may be set so that the final



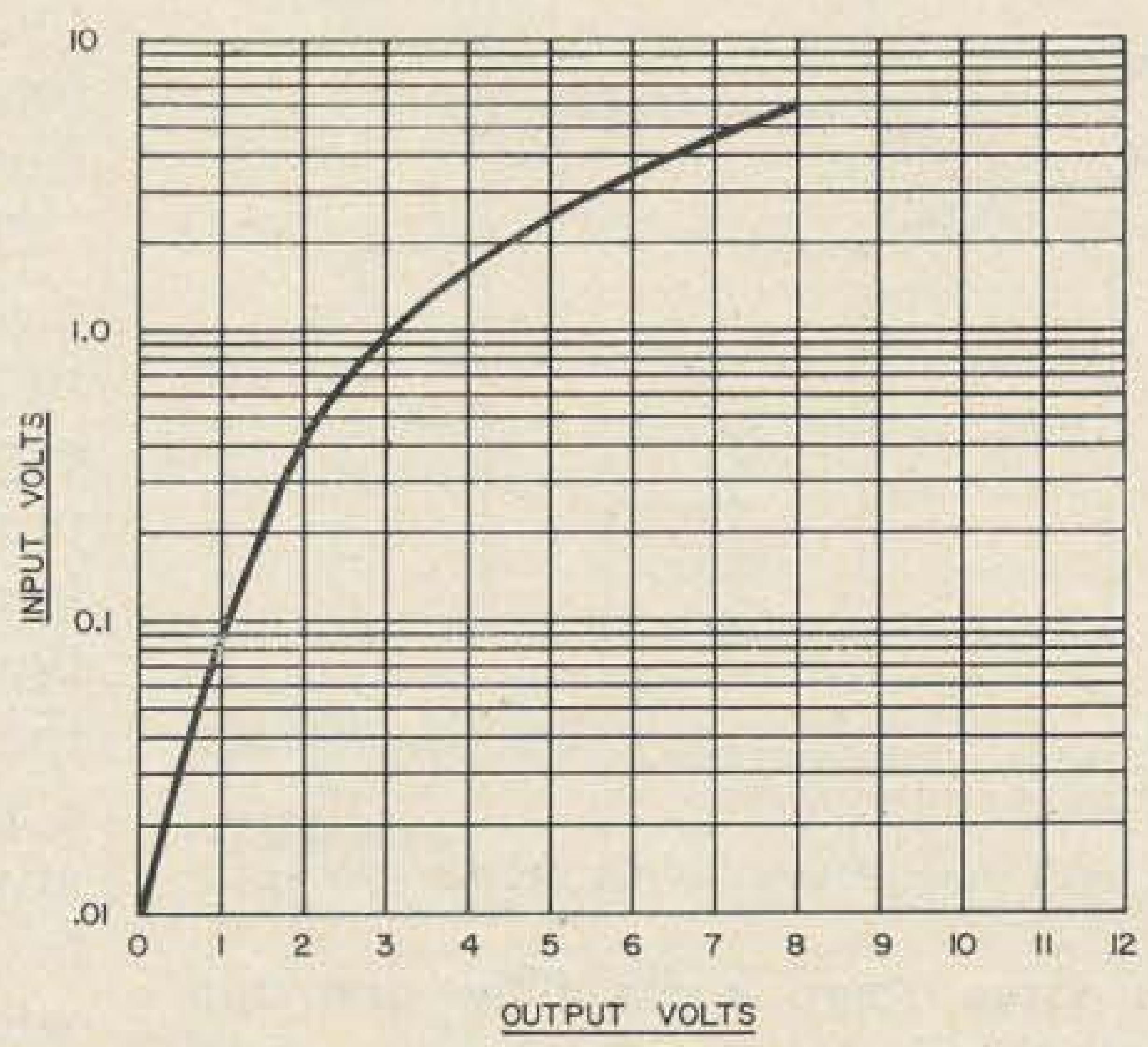
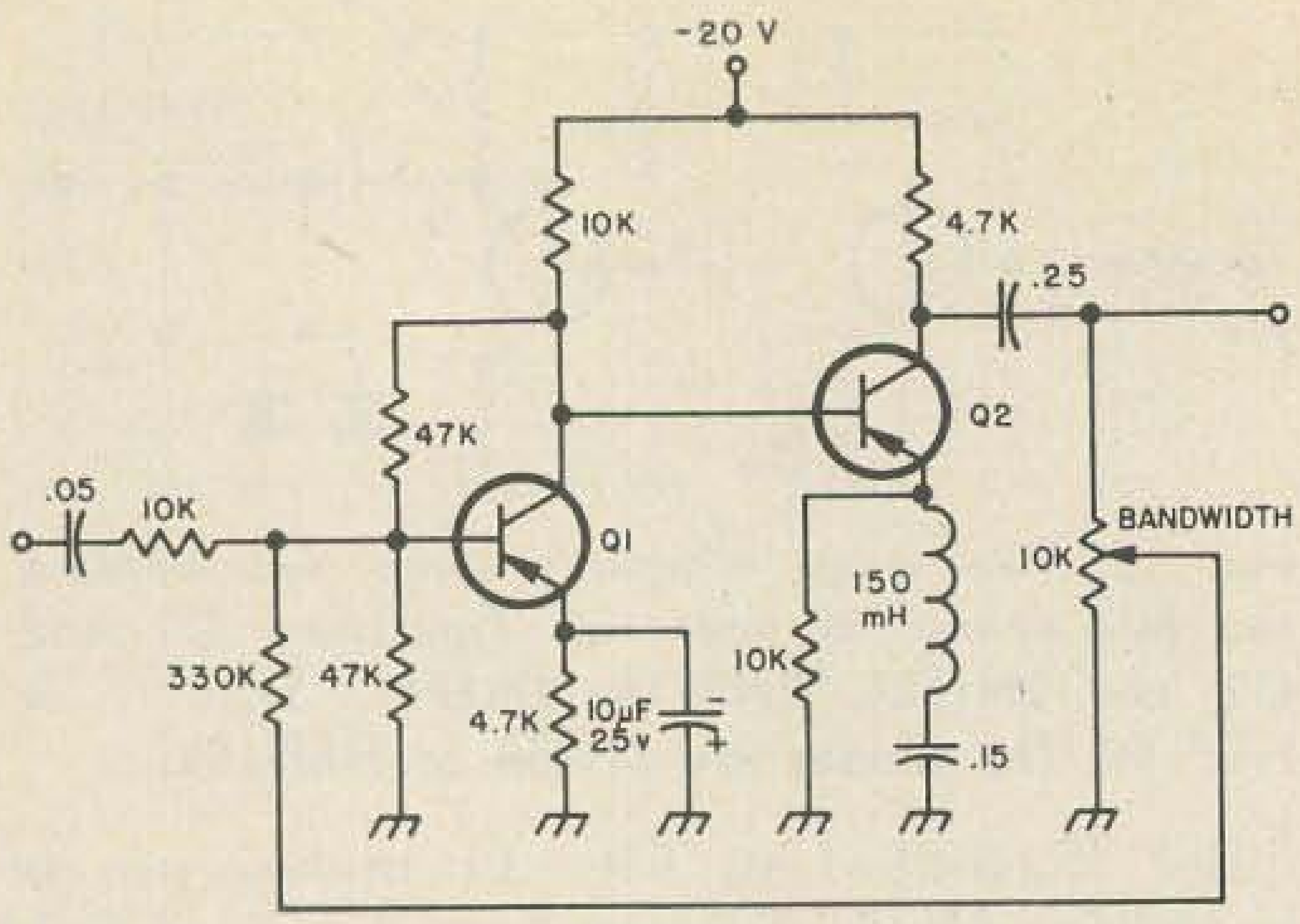


Fig. 13. This simple dynamic range compressor provides more than 50 dB range; it exhibits gain with a 20 millivolt signal but will not saturate with input voltages up to 6 or 7 volts. All the diodes are 1N914; transistor Q1 should be a 2N2926, 2N3391, SK3010, GE-8 or HEP-54.



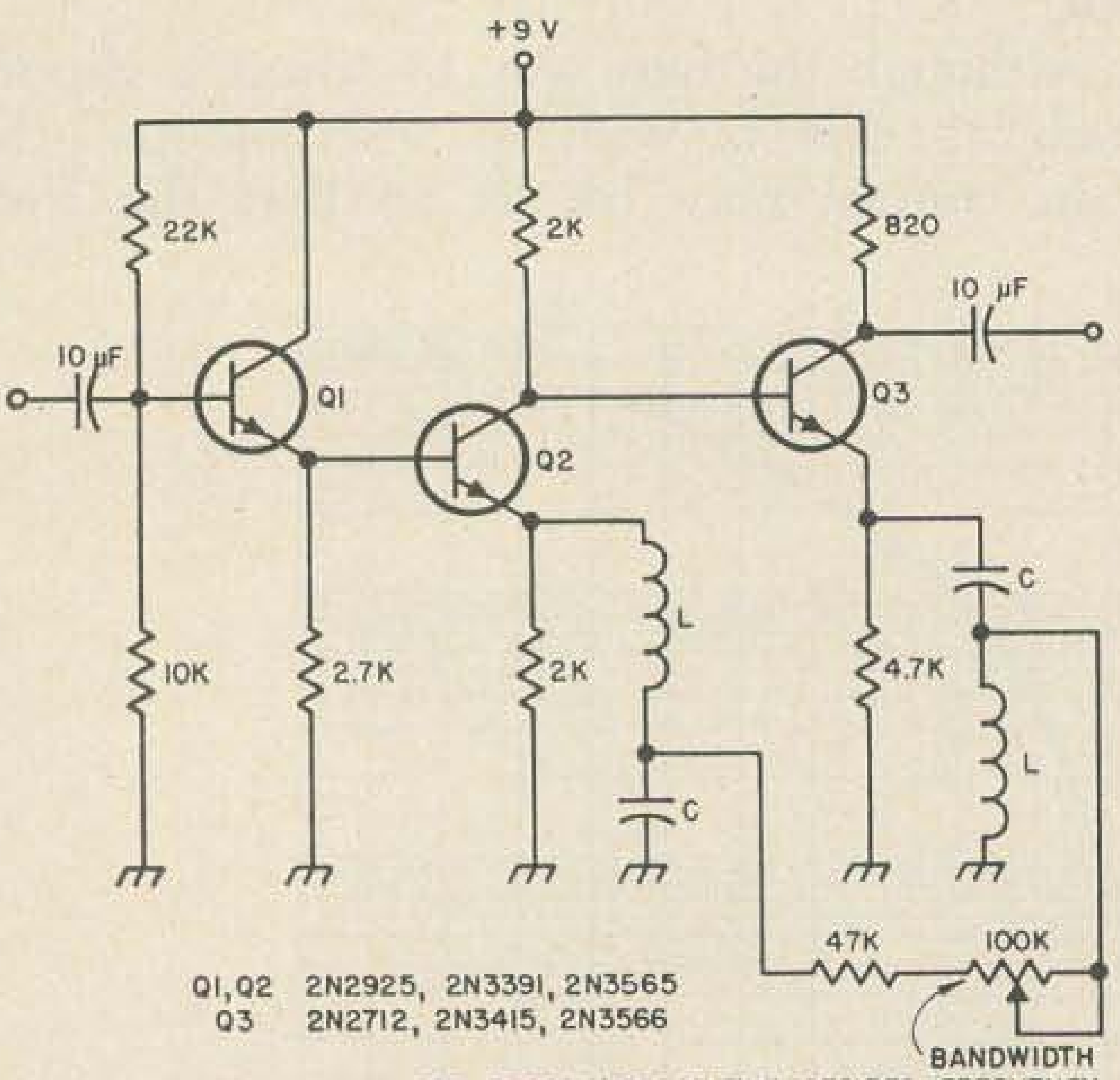
Q1, Q2 - 2N465, 2N2953, SK3004

Fig. 14. This simple audio bandpass filter may be narrowed to the limits of unintelligibility. At a bandwidth of 80 Hz, it provides about 20 dB gain. The input is connected to the phone jack on your receiver while headphones are connected across the output.

audio stage (of your transmitter) approaches saturation on a steady whistle (into a dummy load please); this will approach optimum adjustment. A final check should be an on the air report from a nearby station so you can determine the approximate range settings appropriate for your particular transmitte.

Compression amplifier

The compession amplifier illustrated in **Fig. 13** provides a minimum output signal with only 20 millivolts (0.02 volts) input,



Q1,Q2 2N2925, 2N3391, 2N3565
Q3 2N2712, 2N3415, 2N3566

CHOOSE L AND C FOR RESONANCE AT THE DESIRED FREQUENCY. FOR CENTER FREQUENCY OF 1000 Hz, USE 250 mH AND 0.1 µF

Fig. 15. This three stage audio filter uses two series resonant circuits to provide a very narrow audio passband. The Q of the circuits, and therefore the bandwidth, is controlled by the amount of feedback.

but will not saturate with input voltages up to 6 or 7 volts. The secret to its operation of course lays in the diodes connected across the collector load resistors. As the signal output is increased, the diodes conduct one by one and lower the resistance of the collector load. Although this amplifier has a minimum gain of 1 and a maximum gain of 15 with the components shown in the schematic, the gain characteristics may be made to follow other curves by the proper selection of load resistors and diodes.

Audio filters

The two transistor audio filter in **Fig. 14** uses positive feedback to increase the Q of an inexpensive LC circuit to a very high degree. At a bandwidth of 80 Hz for example, this circuit provides 20 dB gain and furthermore, the bandwidth may be decreased to the limit of intelligibility. The gain stability is increased in this amplifier by the use of negative feedback from collector to base of Q1; this also serves to reduce the output impedance and increase the power transfer to the succeeding stage.

At frequencies far removed from the resonant LC circuit in the emitter of Q2, the emitter impedance is essentially that of the 10k emitter resistor. As resonance however, the low series impedance of the LC network predominates and increases the gain of the stage. Since the output signal is in phase with the input signal, the feedback through the 10k bandwidth pot and 330k resistor is regenerative. As the gain of the amplifier increases near resonance, the output voltage rises sharply and transforms the low Q circuit into a highly selective audio amplifier.

The proper value for the 330k feedback resistor varies from transistor to transistor, so the value of this resistor should be chosen experimentally. This resistor should *just* produce oscillation when the bandwidth pot is advanced to the maximum feedback position. To use this circuit, simply plug it into the phone jack on your receiver, connect a pair of headphones across the output and advance the bandwidth control until a whistle is heard; back off a little on the bandwidth and it's ready to operate.

The audio filter illustrated in **Fig. 15** is somewhat similar to the one in **Fig. 14** except that the passband has a better shape

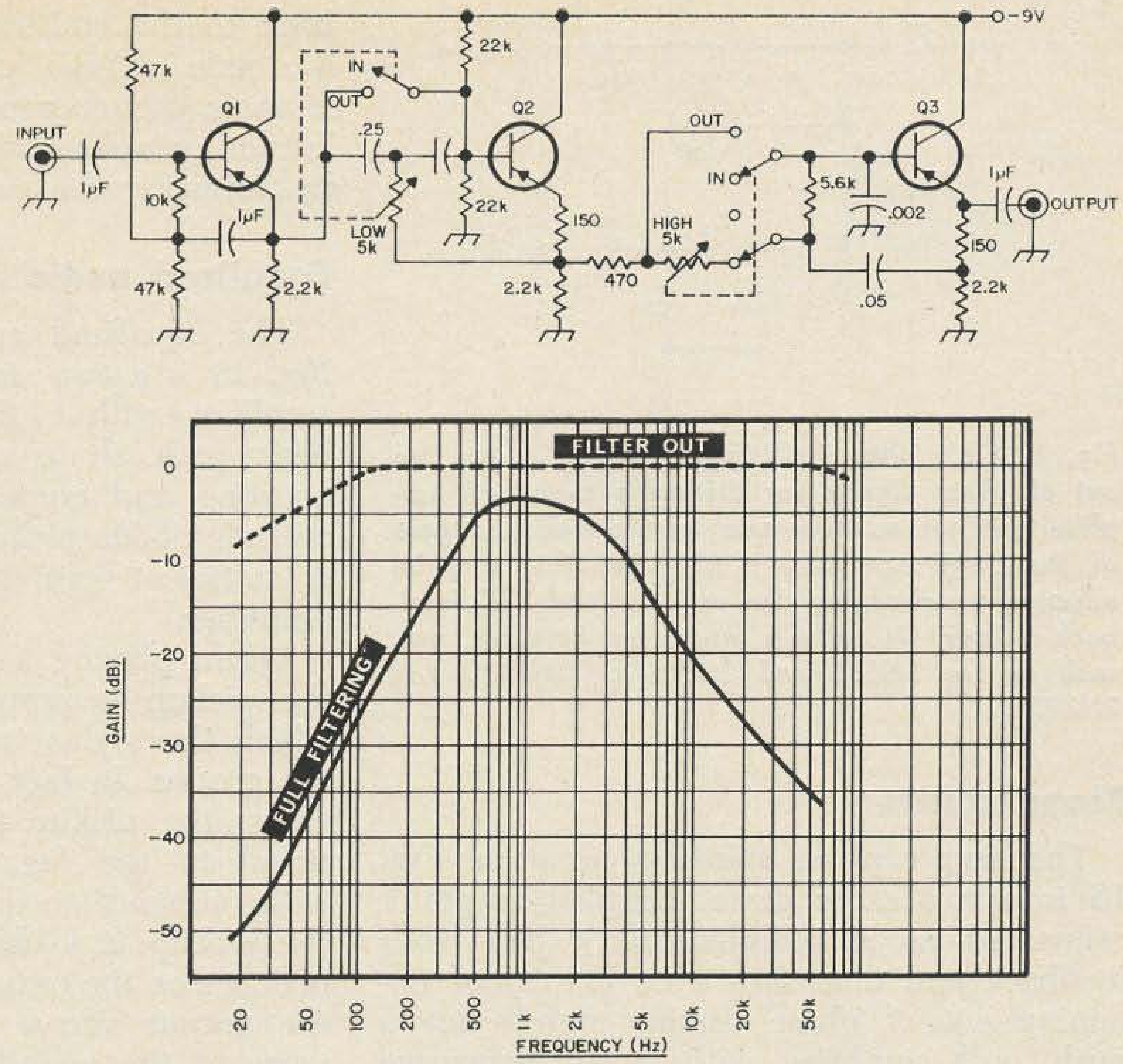


Fig. 16. This highly versatile audio filter may be used to completely shape the audio spectrum of your receiver or transmitter; it may be used with the filters out, or with the variable low- and high-pass filter networks connected. All the transistors are low cost audio types such as the 2N1305, 2N1380, 2N2613, GE-2 or HEP-253.

factor because two series resonant LC circuits are used. Here again feedback is used to raise the Q of the resonant circuits to a very high value. The 47k resistor in the feedback line should be adjusted experimentally so that the circuit will just oscillate when the 100k bandwidth pot is shorted out (maximum clockwise position). Although the LC values shown in the schematic are for a center frequency of approximately 1000 Hz, other values may be used for other center frequencies.

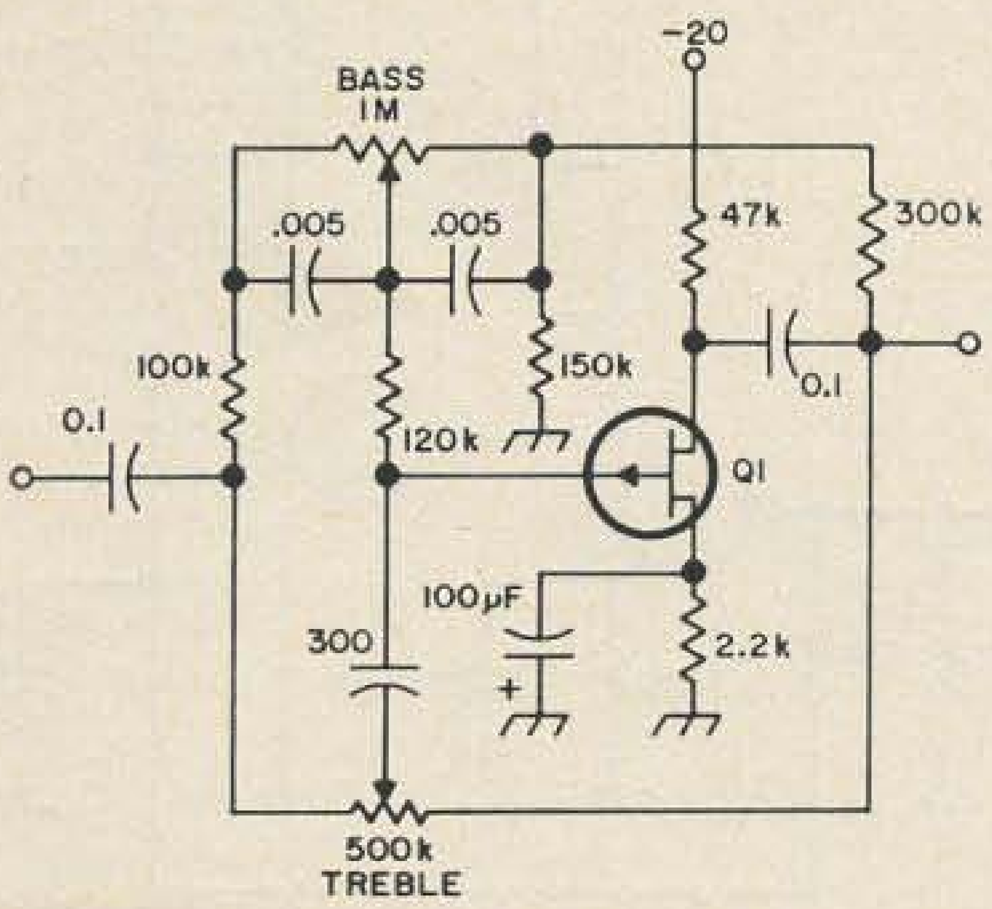


Fig. 17. Resistance-capacitance tone controls are usually not too satisfactory with junction transistors because of heavy loading. The high impedance characteristics of the FET eliminates this problem with no loss in the dynamic range of the tone control. Q1 is a 2N2943, 2N3820, MPF-105 or HEP-801.

One of the problems in amateur SSB communications is that the audio spectrum of the speech amplifier should be shaped so that it amplifies only those signals between about 300 and 3000 Hz. This can be accomplished by high-Q tuned circuits, but the inductors required are quite large and expensive. A simpler approach is to use the adjustable audio bandpass filter shown in **Fig. 16.** When the high- and low-pass filter of this amplifier are out of the circuit, it is flat within 1 dB from 100 Hz to 50 kHz. With the filters in the circuit, the audio may be shaped between the limits shown in **Fig. 16.**

Tone control

Audio tone controls using conventional junction transistors are difficult to build because the low input impedance of these devices seriously limits the tone control's dynamic range. An obvious solution to this problem lies in applying the inherently high input impedance of the field effect transistor. The tone control illustrated in **Fig. 17** should be familiar to old vacuum tube hands; it is a straightforward tone control for both treble and bass using a modern FET in place of a thermionic triode.

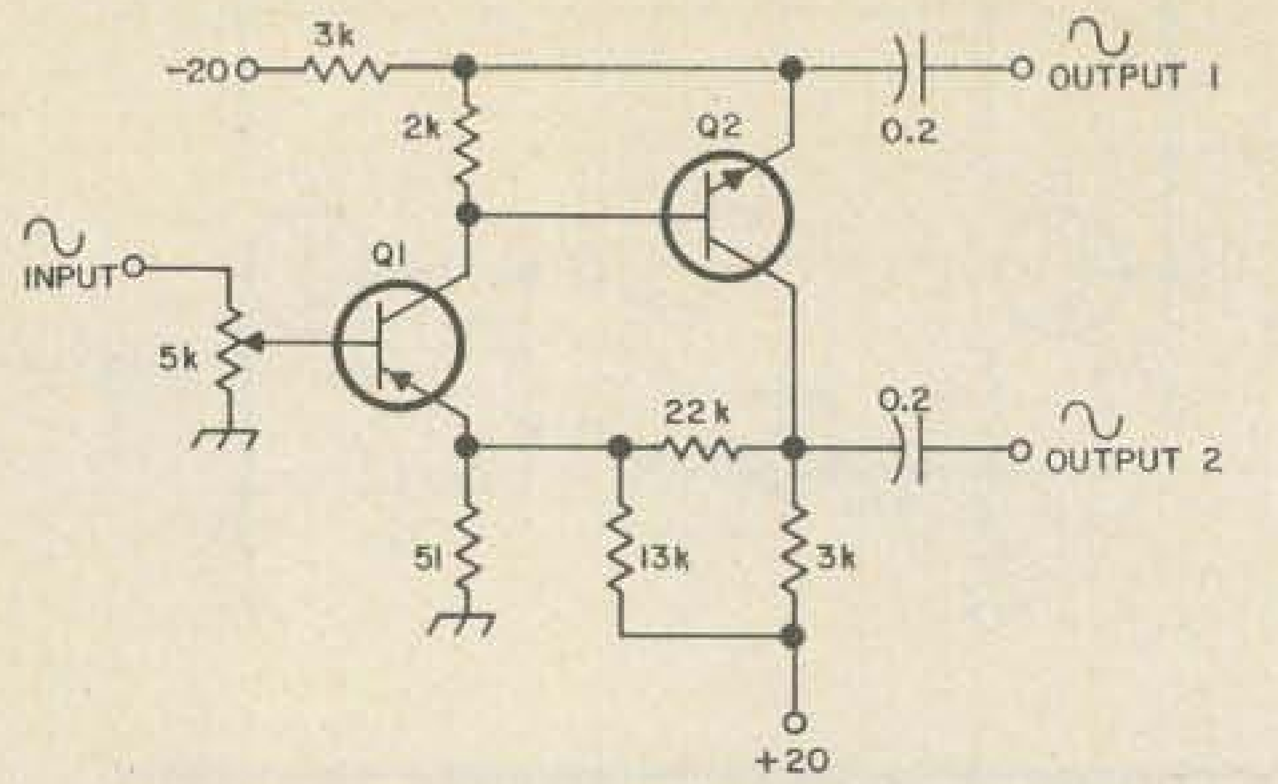


Fig. 18. This phase splitting circuit provides two out of phase signals for driving a push pull amplifier without an expensive transformer. The gain of the stage as shown is 150, but this may be adjusted by changing the value of the 22K feedback resistor. Q1 and Q2 are a complimentary pair such as the 2N652 and 2N388 or 2N2430 and 2N2706.

Phase splitter

The simple phase splitting circuit in **Fig. 18** is a two stage direct coupled amplifier connected as a complementary pair with feedback and illustrates a novel way of obtaining out of phase driving signals for a push pull amplifier without an expensive transformer. The input transistor is a common emitter voltage amplifier with its collector tied directly to the base of Q2. The 3k resistor in the emitter of Q2 provides bias for this transistor but does not cause regeneration because it is common to both the base *and* emitter. The 13k resistor sets the overall circuit bias and its value is chosen so that the collector and emitter of Q2 are at the desired operating level. The 22k feedback resistor provides negative feedback to the emitter of Q1 and determines the gain of the circuit. In this case 22 kilohms was chosen to set the gain at 150, but other values of gain may be obtained by adjusting the value of this resistor.

Equalized audio amplifier

The equalized audio amplifier shown in **Fig. 19** is a two stage direct coupled audio amplifier with a frequency selective feedback path. It is particularly suitable for boosting and equalizing the signal from a ceramic phono pickup to obtain a *flat* output of sufficient level to drive an audio power amplifier.

When playing a record, the output from the pickup is proportional to the force to which the stylus is subjected when tracing the groove. In fact, the open circuit voltage across the pickup is approximately proportional to the logarithm of the frequency with reference to the recorded amplitude. If the pickup is loaded with a very high impedance on the order of one or two megohms, the output versus input is nearly the inverse of the recording characteristic; therefore, the equalization is automatic.

However, it is not always possible to load the pickup with a very high impedance circuit, especially when transistors are used

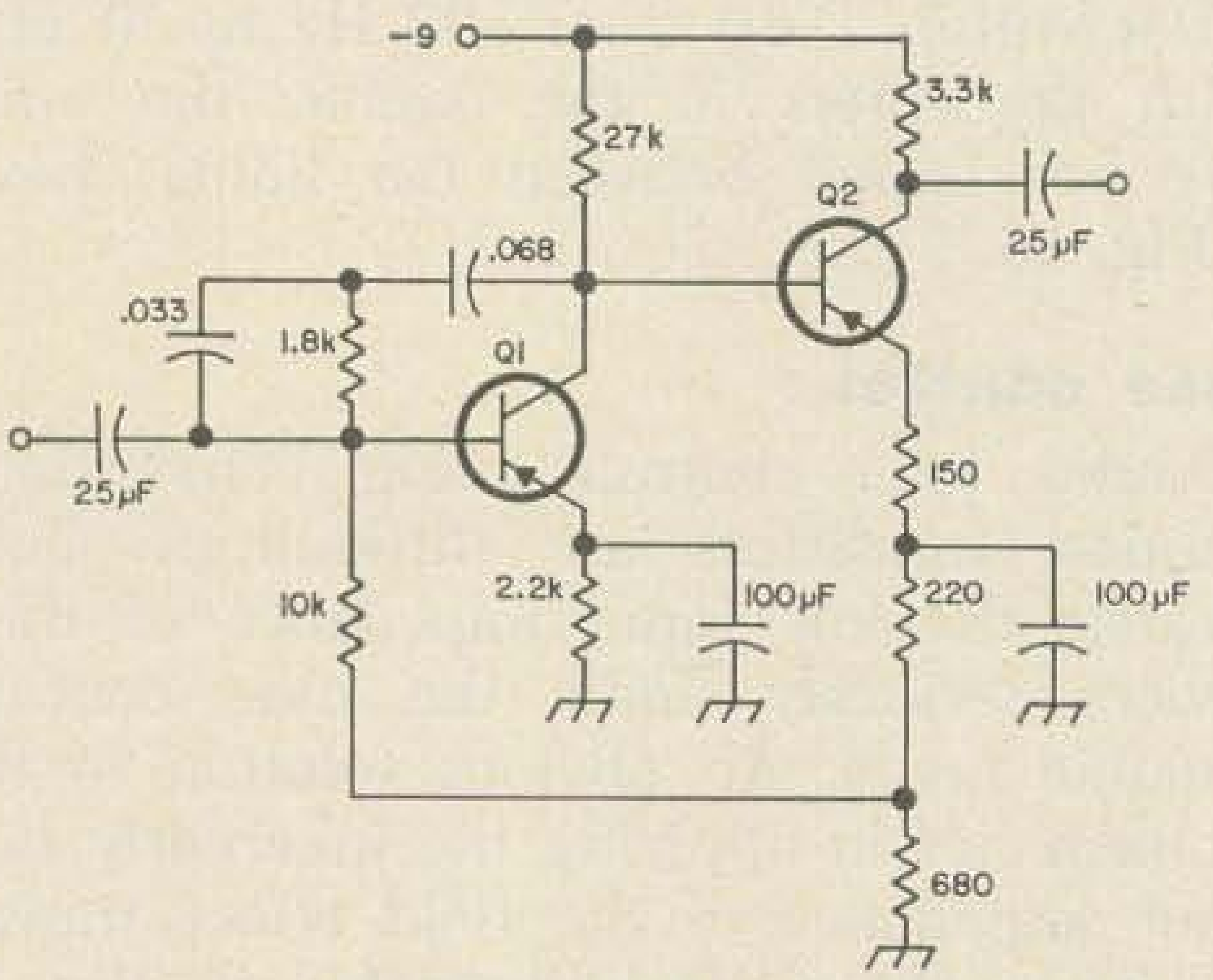
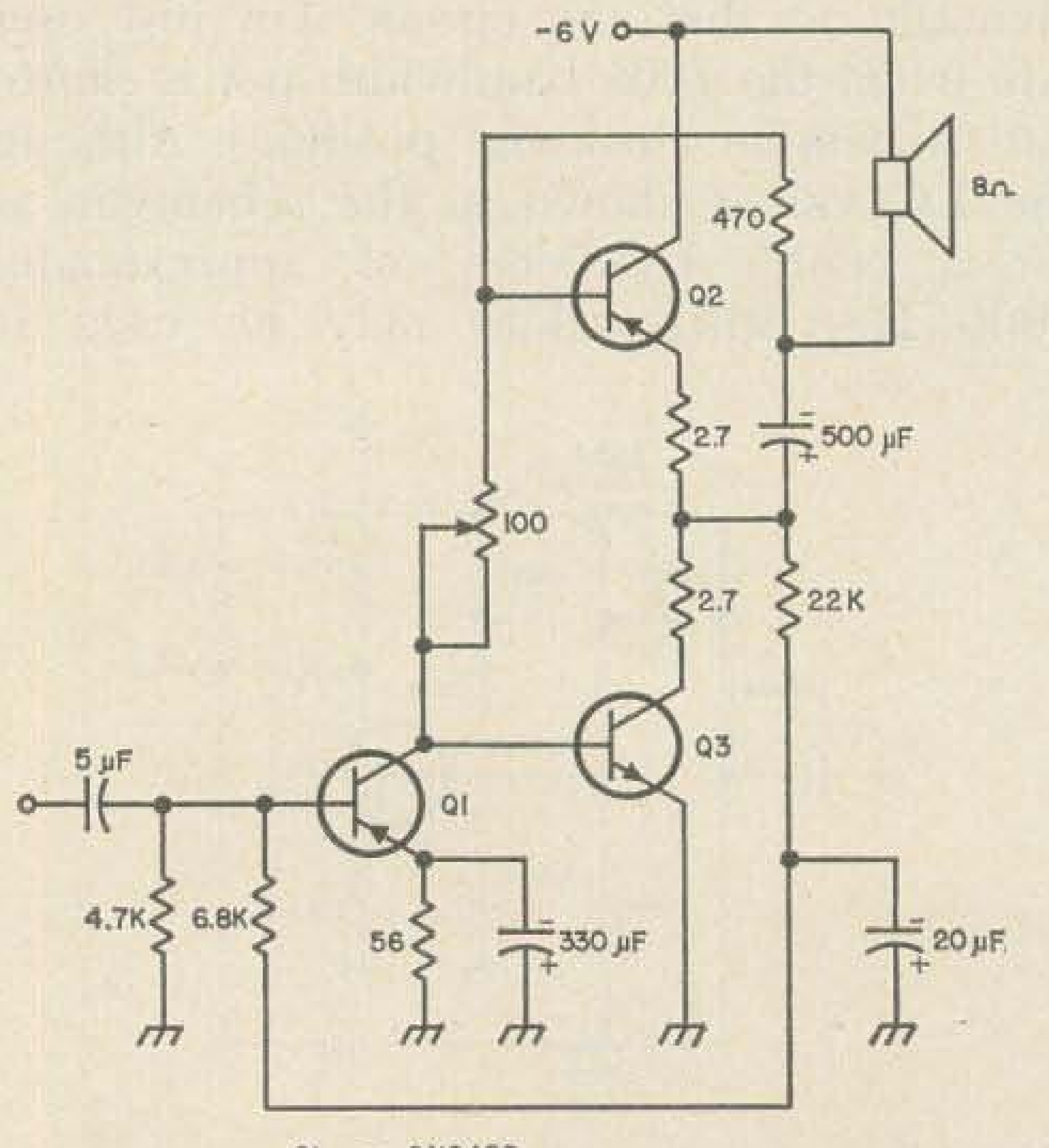


Fig. 19. This phono preamplifier uses frequency selective feedback between the collector and base of Q1 to obtain proper equalization during playback. Transistors Q1 and Q2 are 2N584, SK3003, GE-2 or HEP-254.



Q1 - 2N2429
Q2 - 2N2706
Q3 - 2N2430

Fig. 20. This complimentary amplifier provides up to 220 mW output with a frequency response from 90 Hz to 12.5 kHz. Although matched transistors are not required for Q2 and Q3, they are available as the 2N2707.

in the preamplifier. Resistive pads may be used to increase the input impedance, but they greatly reduce stage gain and increase problems with signal to noise ratios.

In the amplifier of **Fig. 19** equalization is obtained by a frequency selective feedback path between the collector and base of Q1. Stabilization at dc is provided by the direct coupling between Q1 and Q2 and the current feedback path through the 10 ohm resistor in the base of Q1. In addition, more negative feedback is provided by the unbypassed emitter resistor in the second stage.

Complementary power amplifiers

The small transformerless complementary amplifier illustrated in **Fig. 20** provides an output of 220 mW with an input of only 40 microamps. The transistors in the single ended class B output stage are used in the common collector configuration and are biased by a resistive voltage divider and the driver transistor circuit. The emitter resistors in the output stage provide adequate temperature stability and are established by cut and try, but a value of 2.7 ohms seems to offer a good compromise. In adjusting this amplifier, the 100 ohm pot should be adjusted so that the idling current of the output transistor is on the order of 2.5 mA; this will insure a minimum of crossover distortion. When properly adjusted, this amplifier will exhibit a ±3 dB frequency response from 90 Hz to 12.5 kHz and distortion of 4% at 120 mW input and 10% at 220 mW input.

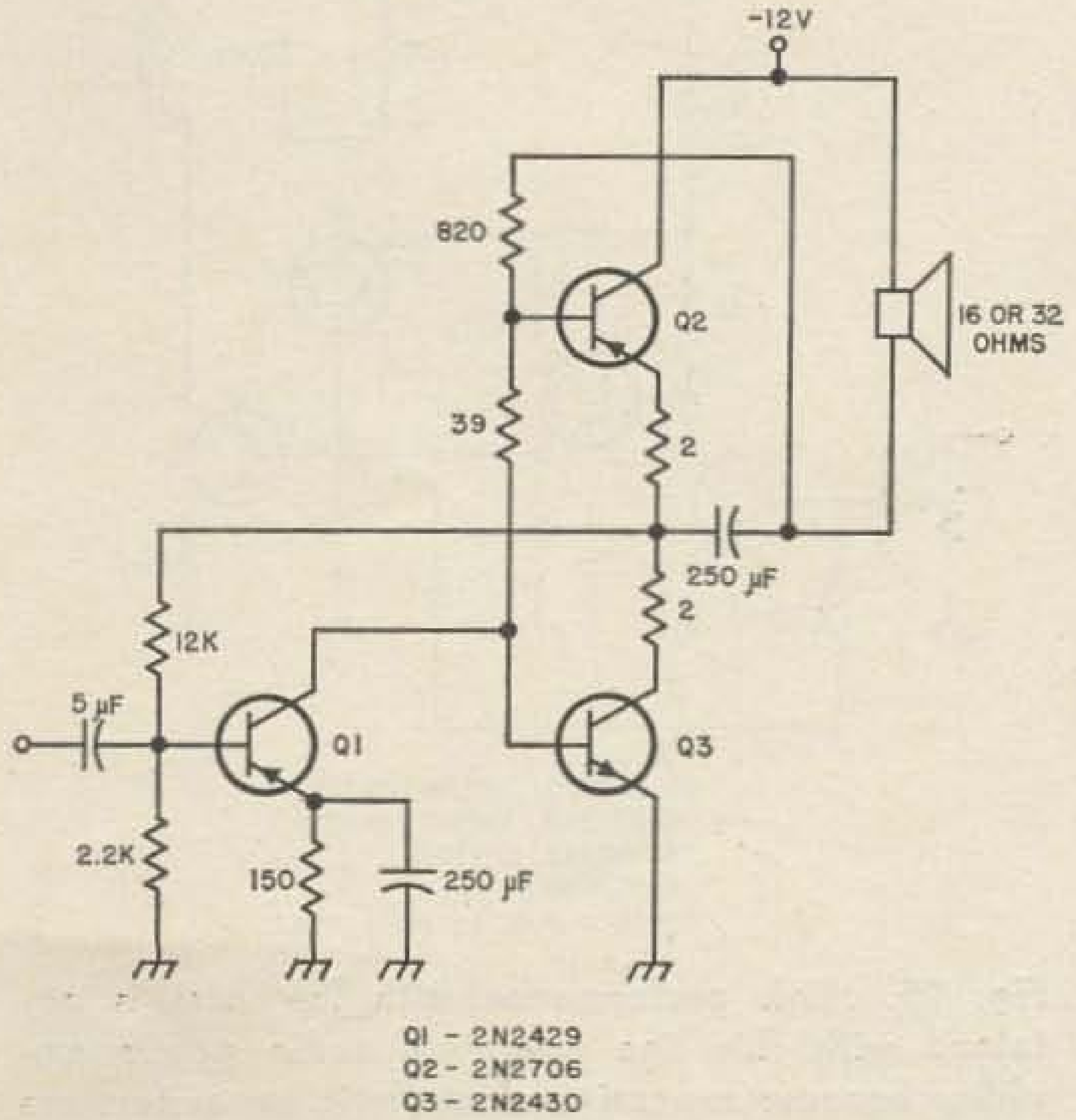


Fig. 21. This 470 mW complementary audio amplifier exhibits less than 2% distortion and is flat within 3 dB from 15 Hz to 130 kHz.

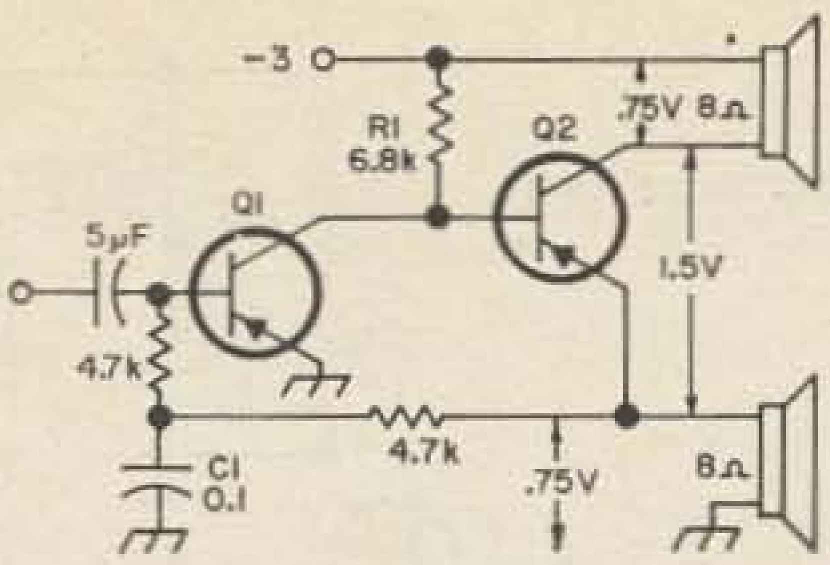


Fig. 22. An audio power amplifier with push pull output using a single transistor in the final stage may be obtained with this simple circuit. Only about 50 mW is available from this amplifier, but the gain is flat up to 30 kHz. Both Q1 and Q2 should be germanium audio transistors such as the 2N215, 2N404, 2N2953, SK3004 or HEP-253.

Another complementary audio amplifier is shown in **Fig. 21.** This power stage provides 470 mW output and utilizes both ac and dc feedback to minimize distortion and extend frequency response. Although unmatched transistors are not required for the proper operation of this amplifier, a set of matched transistors is available as the 2N2707; the cost of the matched pair is only several cents more than the total separate costs of a 2N2706 and 2N2430. This very useful amplifier is flat ±3 dB from 15 Hz to 130 kHz, exhibits an input impedance of 750 ohms and produces less than 2% distortion at 470 mW output.

Single transistor push pull

The amplifiers illustrated in **Figs. 22** and **23** illustrate how a quasi-push-pull output may be taken from a single transistor.

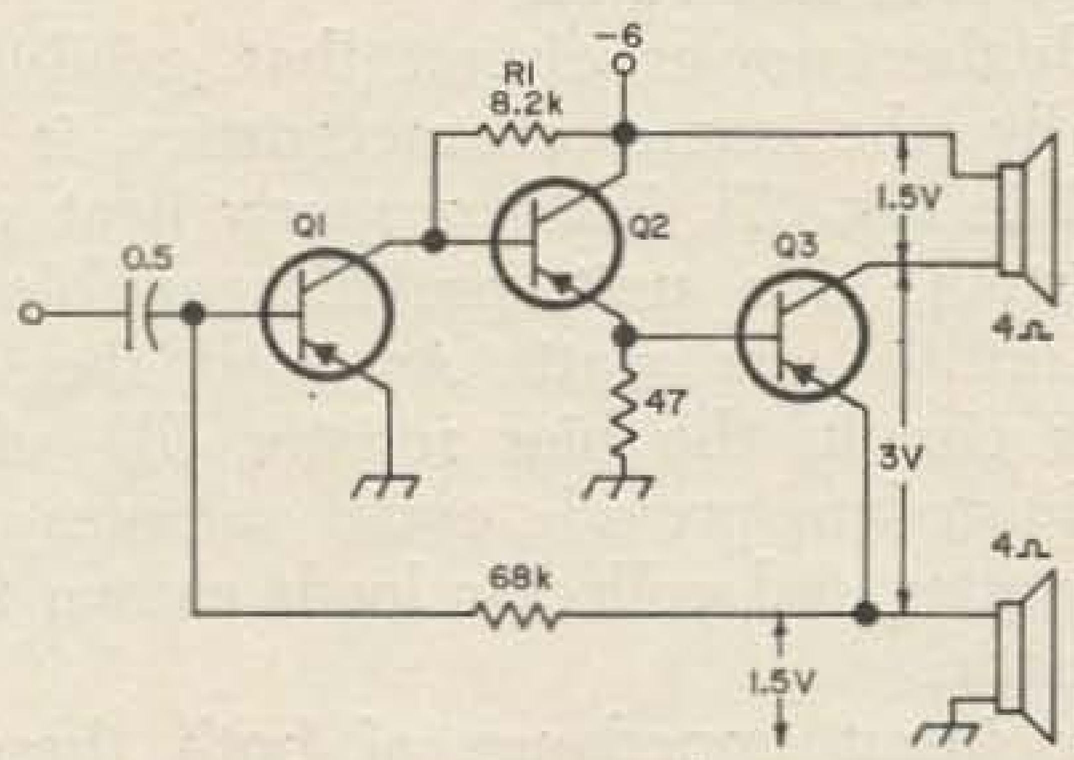


Fig. 23. A larger power version of the single transistor push pull circuit of Fig. 22 is shown here. The operating characteristics are similar to the 50mW circuit except that approximately 1 watt may be obtained. Transistors Q1 and Q2 are 2N215, 2N404, 2N2953, SK3004 or HEP-253; Q3 is a 2N554, 2N1032, 2N1666, SK3009 or HEP-232.

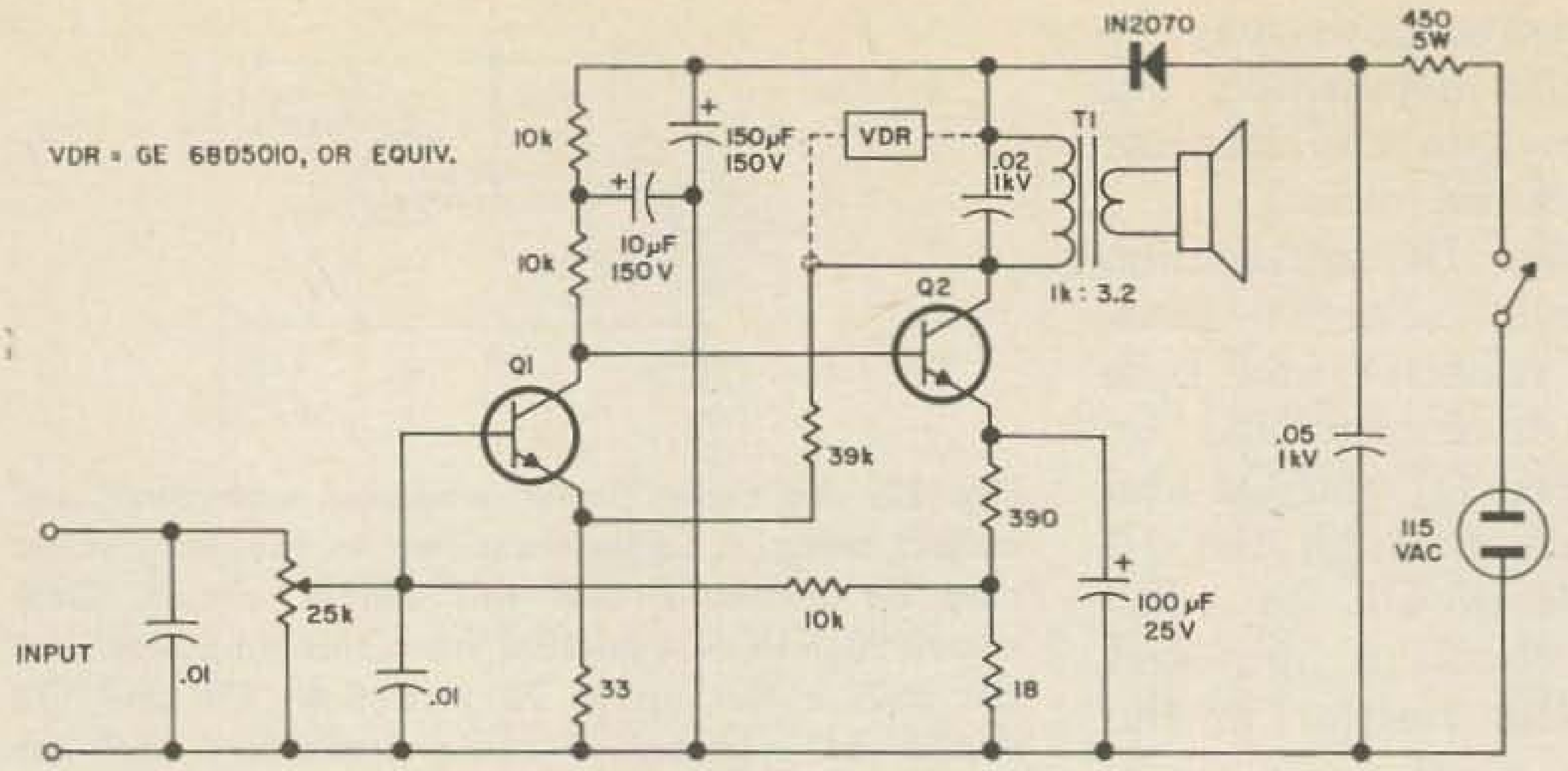


Fig. 24. This line operated audio power amplifier provides about 500 mW output with an 80 millivolt input signal. Q1 is a 2N3565, SE4002, SK3020 or HEP-54; Q2 is a 2N3916 or SE7005.

These amplifiers are dc connected, thereby eliminating many components, while at the same time assuring excellent low frequency response.

In the circuit in **Fig. 22**, the first transistor serves as both an ac driver and part of the dc bias system. Although the values shown in the schematic were selected for optimum results, the 6800 ohm biasing resistor (R1) should be adjusted experimentally to obtain equal voltages across the collector and emitter loads as illustrated in the schematic.

The frequency response of this amplifier may be adjusted by changing the value of the 0.05 µF capacitor (C1). When this capacitor is left completely out of the circuit, the heavy negative feedback around the circuit provides a frequency response that is flat from dc (with the input capacitor shorted) to 30 kHz. However, under these conditions, the gain is only about 35 dB. The maximum power output available from this circuit is on the order of 50 mW; above this level severe clipping occurs with noticeable audible distortion.

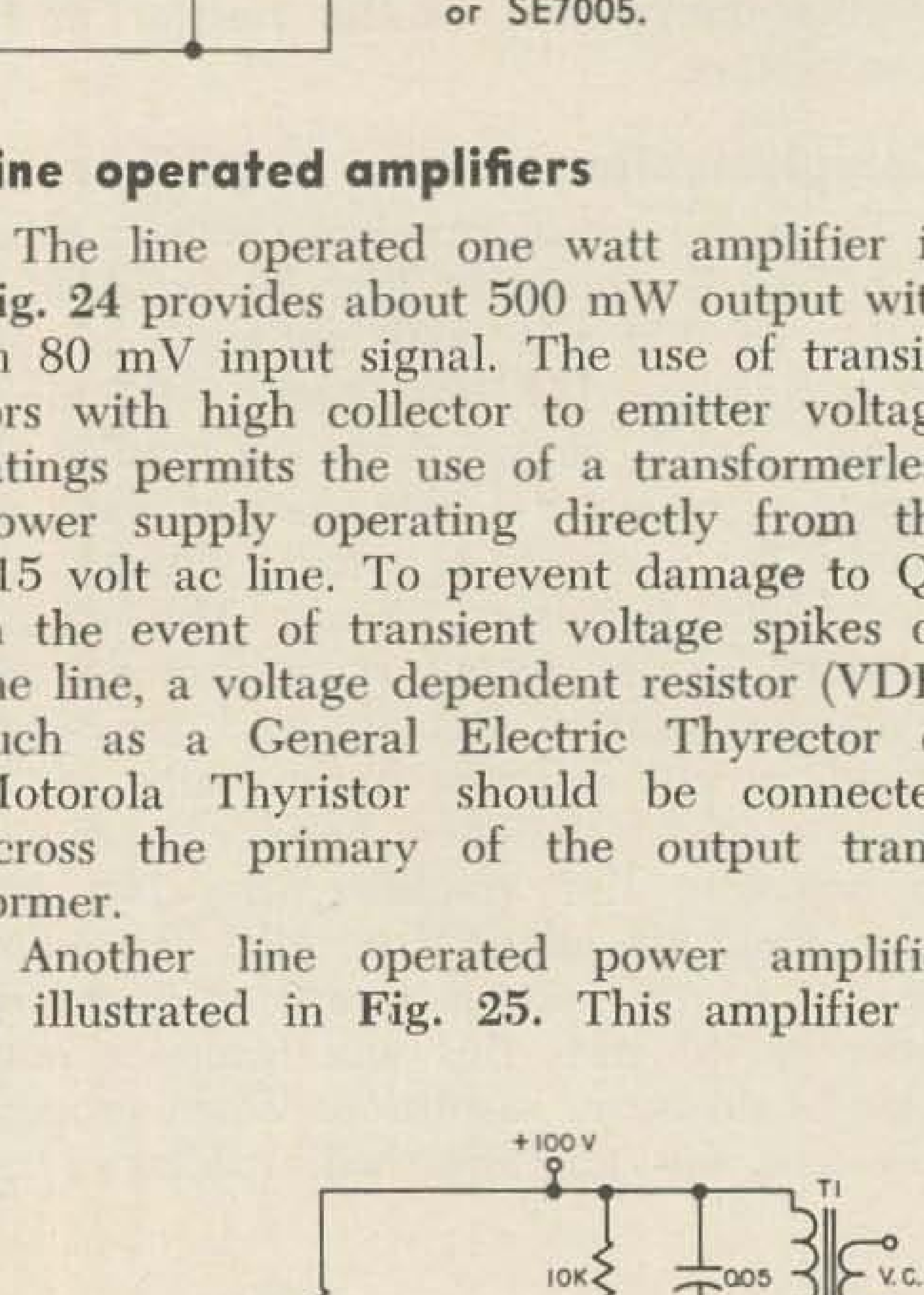
A higher power circuit that exhibits essentially the same characteristics is illustrated in **Fig. 23.** With properly heat sinked transistors, this unit provides usable outputs up to one watt. As with the lower power circuit, the bias resistor (R1) should be adjusted to provide equal voltages across the emitter and collector loads shown in the schematic.

The input impedance of both these circuits is on the order of several thousand ohms, so they may be easily driven by other transistor circuits. Although two separate speakers are shown as the output load, the load could just as easily be two separate transformer windings.

Line operated amplifiers

The line operated one watt amplifier in **Fig. 24** provides about 500 mW output with an 80 mV input signal. The use of transistors with high collector to emitter voltage ratings permits the use of a transformerless power supply operating directly from the 115 volt ac line. To prevent damage to Q2 in the event of transient voltage spikes on the line, a voltage dependent resistor (VDR) such as a General Electric Thyrector or Motorola Thyristor should be connected across the primary of the output transformer.

Another line operated power amplifier is illustrated in **Fig. 25.** This amplifier is



Q1-2N2925, 2N3391, 2N3392
Q2-2N2924, 2N2712, 2N3393
Q3-2N2923, 2N2926
Q4-2N4054
T1-2500 ohms TO VOICE COIL

Fig. 25. High performance with low cost is obtained with this line operated audio power amplifier because expensive electrolytic capacitors are eliminated by direct coupling between stages. This circuit delivers 1 watt to the speaker with 3 mW input.

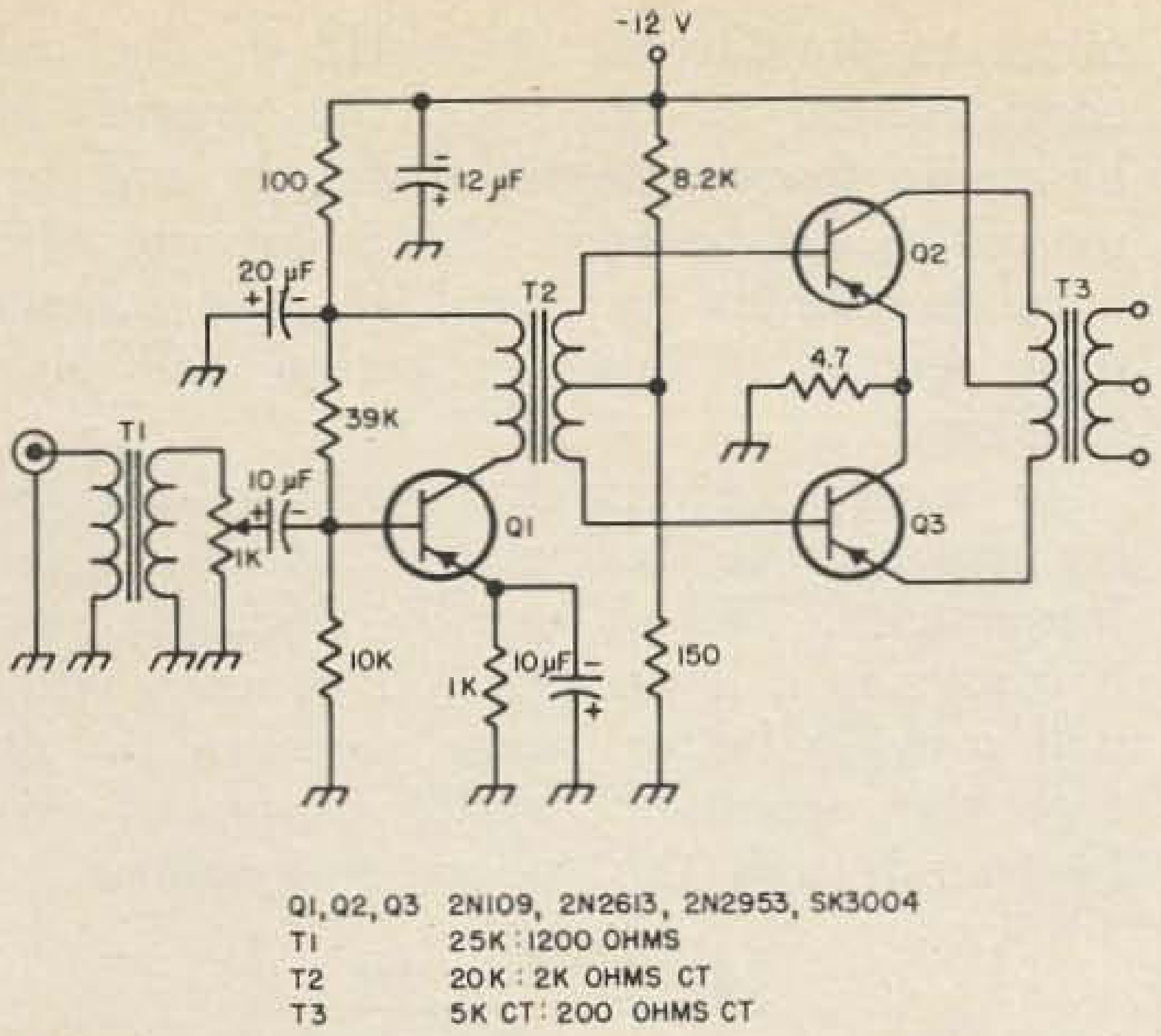


Fig. 26. This 100 mW modulator may be used to collector modulate transmitters up to about 200 mW or to base modulate somewhat larger power amplifiers. Good performance with a minimum of components is obtained by transformer coupling between stages.

based on the use of a high voltage plastic transistor, the 2N4054. The circuit delivers one watt of audio power to a speaker with about 3 millivolts input signal; at this power level the total harmonic distortion at 1 kHz is less than 10%. The key to its low cost performance is the fact that direct coupling is used, thereby eliminating the need for expensive electrolytic capacitors.

Modulators

The 100 milliwatt modulator illustrated in **Fig. 26** is suitable for collector modulating small transistor transmitters up to about 200 milliwatts. It may also be used for base modulating somewhat larger transmitters. The circuit is relatively straight forward, with a single audio amplifier driving the class B push pull power stage through a small transformer. To modulate the collector of a small transmitter, simply run the collector voltage supply through the secondary of the "moduation" transformer, in this case a low cost 5k:200 ohm audio transformer.

The 5 watt modulator shown in **Fig. 27** may be used to modulate transmitters with up to 10 watts input. The use of low cost, high gain silicon transistors and efficient transformer coupling significantly decreases the complexity of the circuit. Usually many more transistors are required to obtain five watts of audio with a microphone input. Although this modulator was designed for a ceramic or crystal microphone, it may be used with dynamic types with slightly less gain. This circuit exhibits extremely low distortion characteristics, and when used to collector modulate a ten watt transistor transmitter, produces extremely clear and crisp audio.

The transistorized 25 watt modulator shown in **Fig. 28** is not much different from other types which have been described, but with three transformers it is somewhat more efficient than most. The transformers are readily available commercial models which may be obtained from most suppliers. However, transformer T2 must have a center tap on the secondary; this is easily accomplished by unwinding 46 turns from the outside winding, bringing out a center tap at this point and rewinding. Impedance matching to the rf amplifier is accomplished by adjusting the rf output loading network.

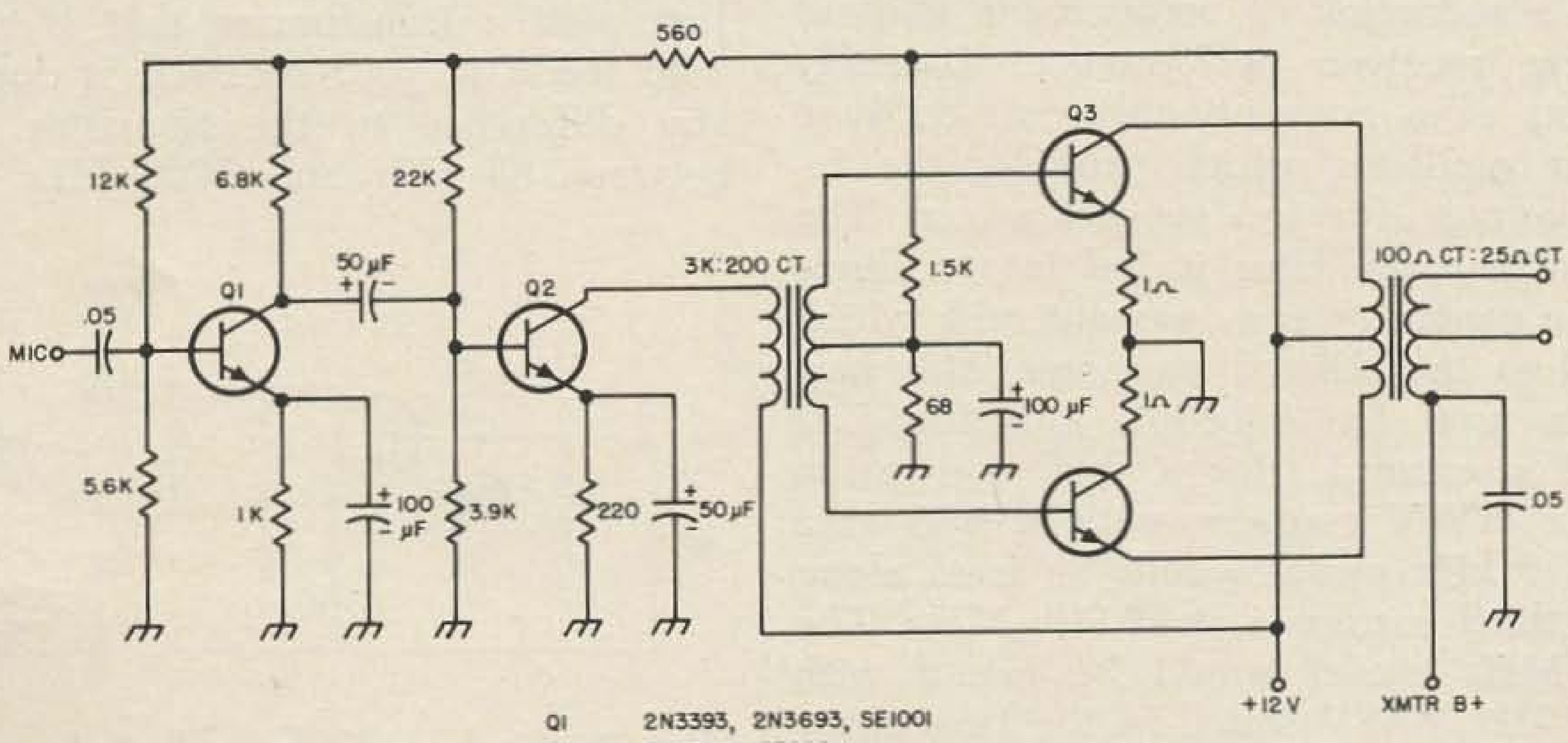


Fig. 27. 5 watt modulator for transmitters up to 10 watts input. High gain silicon transistors and transformer coupling increase performance at decreased circuit complexity.

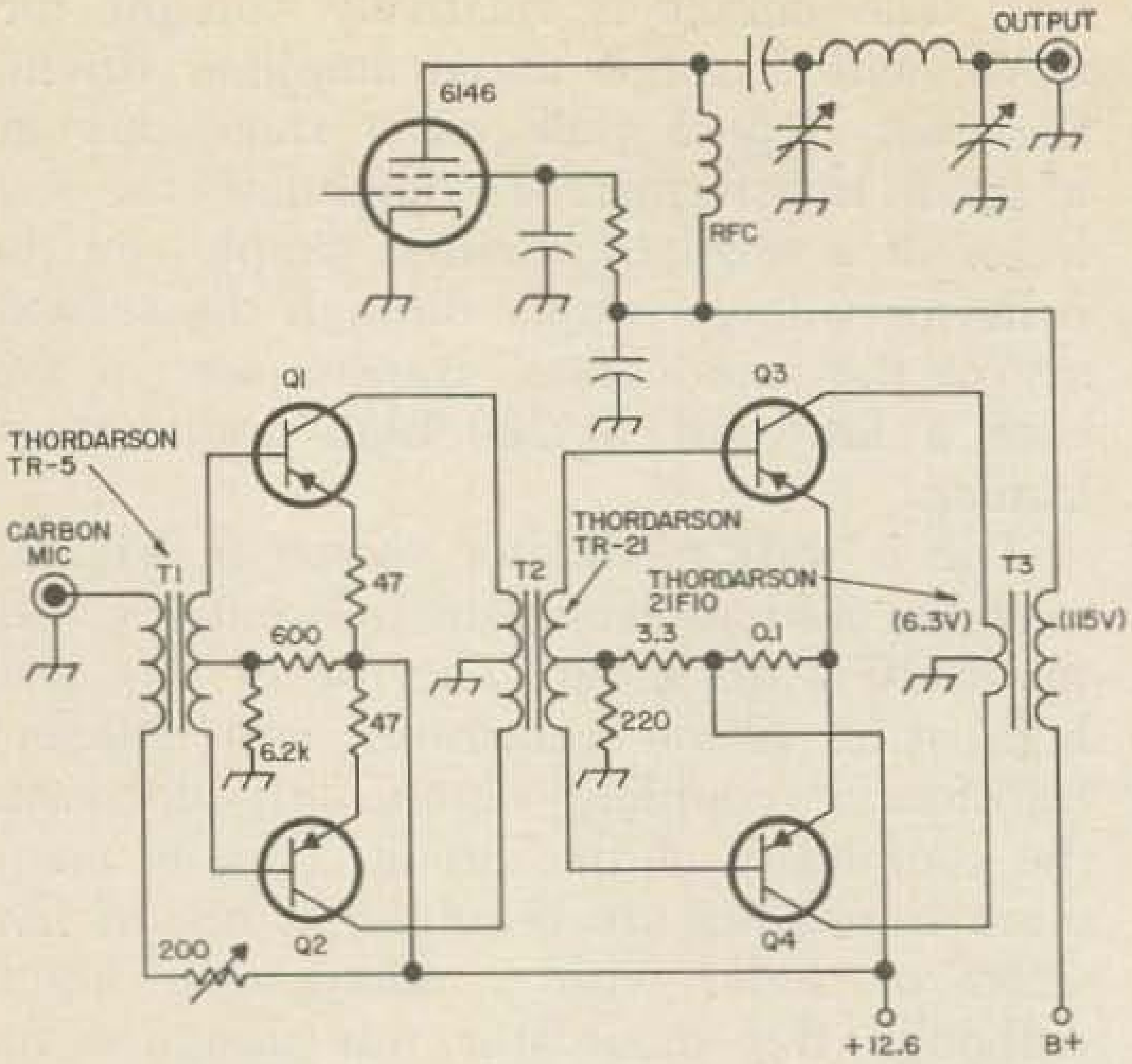


Fig. 28. 25 watt modulator uses readily available commercial transformers. Transistors Q1 and Q2 are 2N1172, 2N301, 2N1560, SK3009, GE-9 or HEP-232; Q3 and Q4 are 2N174, 2N278, SK3012, GE-4 or HEP-233.

The frequency response of this circuit is quite good and is essentially flat from 200 Hz to 7 kHz.

Circuits for Receivers

Injection oscillator

If you are interested in building a dual conversion receiver for single channel operation on MARS, 2 meter FM or WWV, the single oscillator circuit which provides two outputs illustrated in **Fig. 29** should be of interest. This single oscillator circuit results in a reduction of components without sacrificing receiver performance. Basically it consists of a conventional common base transistor oscillator which provides the injection voltage for the second mixer. The output of the oscillator is fed into a diode harmonic generator and resonant tank which is tuned to the desired harmonic; this harmonic is used for injection into the first mixer. For example, for a dual conversion 15 MHz WWV receiver with a 455 kHz if, a 3636 kHz cystal would be used along with its third harmonic at 10.908 MHz. The 10.908 MHz signal would be mixed with the 15 MHz WWV signal in the first mixer to provide an output at 4092 MHz; this signal would in turn be mixed with the 3636 kHz oscillator output in the second mixer to provide the 455 kHz *if*. The only consideration in choosing the crystal and harmonic frequencies is that only *odd* harmonics should be used. This is because when even harmonics are used in this scheme, poor second *if* image rejection will be a problem.

In most receivers the oscillator injection frequencies are below that of the signal frequencies. This is usually desirable since it results in a lower first *if* frequency which will provide better image rejection. In this case the necessary crystal frequency may be found from the following formula:

$$f_o = \frac{f_s - f_{if}}{h + 1}$$

Where: f_o = Crystal frequency

f_s = Signal frequency

f_{if} = *if* frequency

h = Harmonic to which diode tank circuit is tuned.

In those cases where it might be desirable to have the injection frequencies higher than the signal frequencies, the following formula may be used:

$$f_o = \frac{f_s - f_{if}}{h - 1}$$

BFO's

The simple BFO in **Fig. 30** may be added to an existing receiver with a minimum of cost and effort. Essentially it is a tuned collector oscillator with an *if* transformer being used for the tuned circuit inductance. Just pick a transformer that is compatible with the *if* in your receiver; it doesn't make any difference to the transistor. Anything between 85 kHz and 1600 kHz will work

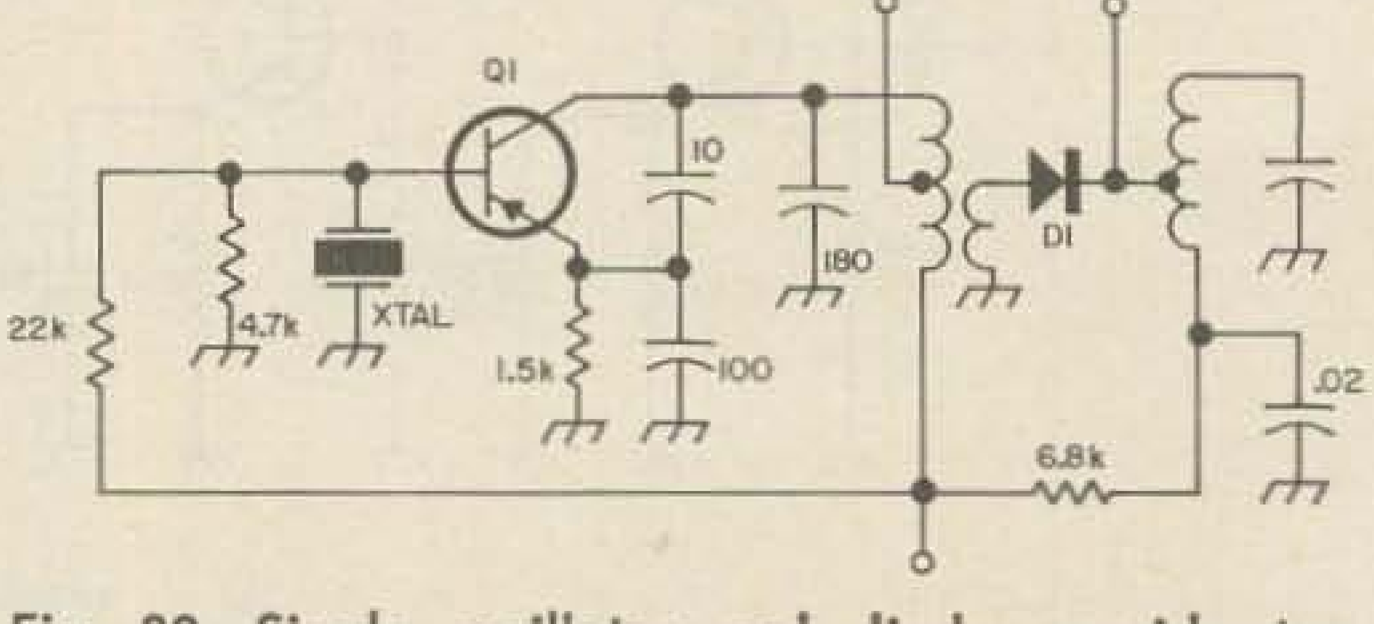


Fig. 29. Single oscillator and diode provide two injection frequencies for dual conversion receivers. Transistor Q1 is a 2N1745, 2N2188, TIM10, GE-9 or HEP-2; the diode should be a 1N82A or similar.

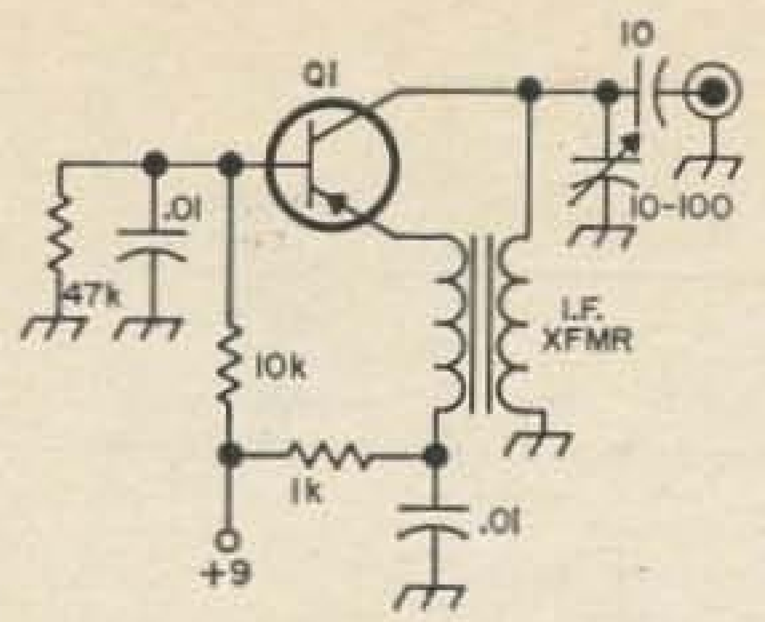
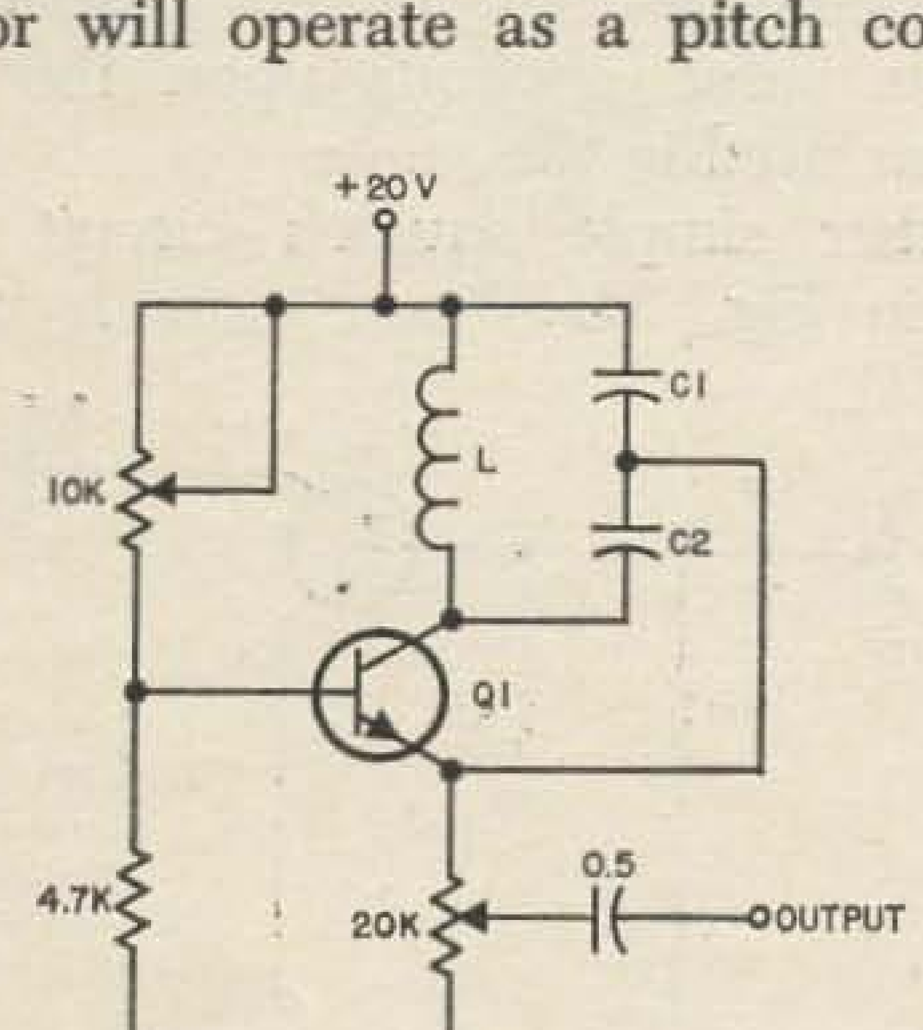


Fig. 30. This beat frequency oscillator may be added to existing receivers with a minimum of difficulty. The BFO frequency is determined by the *if* transformer which provides feedback from collector to emitter. Transistor Q1 should be a 2N384, 2N1749, 2N2362, TIM10, SK3008, GE-9 or HEP-2.

well in this circuit. Before you can use the transformer though, remove all of the fixed tuning capacitors from the unit; usually these are readily available on the bottom of the transformer. If the circuit does not oscillate when voltage is applied, reverse the transformer leads going to the emitter of the transistor. To connect the BFO into the receiver, run a piece of small coaxial cable from the BFO output to the base (or grid) of the detector. In some cases sufficient injection will be obtained by just placing the coax lead in the immediate vicinity of the detector. Adjust the core in the BFO transformer so that the variable tuning capacitor allows the BFO output to swing to either side of the receiver *if*; then the variable capacitor will operate as a pitch control.



Q1 - 2N2925, 2N3392

FREQUENCY	C1	C2	L
50 kHz	3500 pf	1500 pf	10 mH
80 kHz	2200 pf	910 pf	6.2 mH
100 kHz	1800 pf	750 pf	4.7 mH
200 kHz	910 pf	390 pf	2.2 mH
455 kHz	390 pf	160 pf	1 mH
1000 kHz	180 pf	75 pf	0.47 mH

Fig. 31. This simple circuit provides an extremely stable BFO. The frequency of oscillation may be tailored to your needs by simply choosing the proper tank components listed in the table.

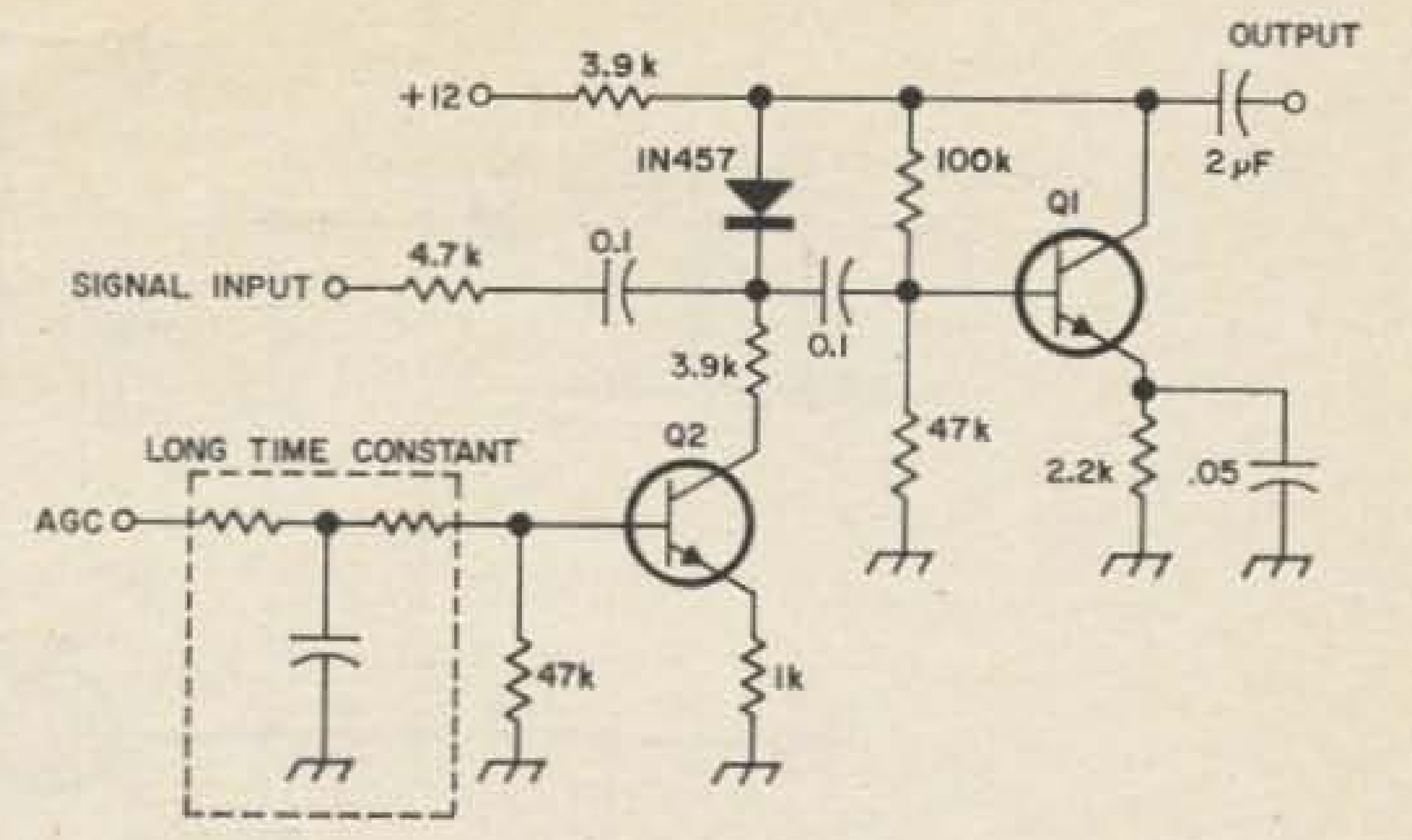


Fig. 32. This super AGC circuit only requires two transistors to obtain up to 60 dB of control. Q1 and Q2 are 2N1613 or HEP-254.

The circuit illustrated in **Fig. 31** represents a temperature stable Colpitts oscillator which is very useful as a BFO. This oscillator utilizes an inexpensive silicon planar transistor and is exceptionally stable over wide ranges in temperature. In addition, it is characterized by a large output amplitude (10 volts peak to peak) and low harmonic distortion. In addition to duties as a beat frequency oscillator, this circuit is useful where a stable signal source is required up to several MHz. The 20k emitter pot is an output level control; the 10k pot in the base bias leg is used to adjust the base bias for maximum amplitude output.

AGC circuit

The super AGC circuit shown in **Fig. 32** requires only two transistors to obtain 60 dB of control, while maintaining low distortion and power requirements. When a signal appears at the input with its corresponding AGC signal on the input of the long time constant circuit, Q1 conducts and causes current to flow through the diode. This current flow lowers the impedance of the diode and provides a low impedance path between the amplified signal at the collector of Q2 and the input signal at its base. When the diode conducts heavily, there is nearly 100% feedback and the gain of this stage is nearly unity. In addition, the input impedance of the stage becomes very low and results in a large voltage drop across the series connected 4700-ohm resistor.

When the collector current of Q1 is reduced to zero, the feedback through the diode is negligible and the gain and input impedance of Q2 is the same as that of a standard common emitter amplifier. With

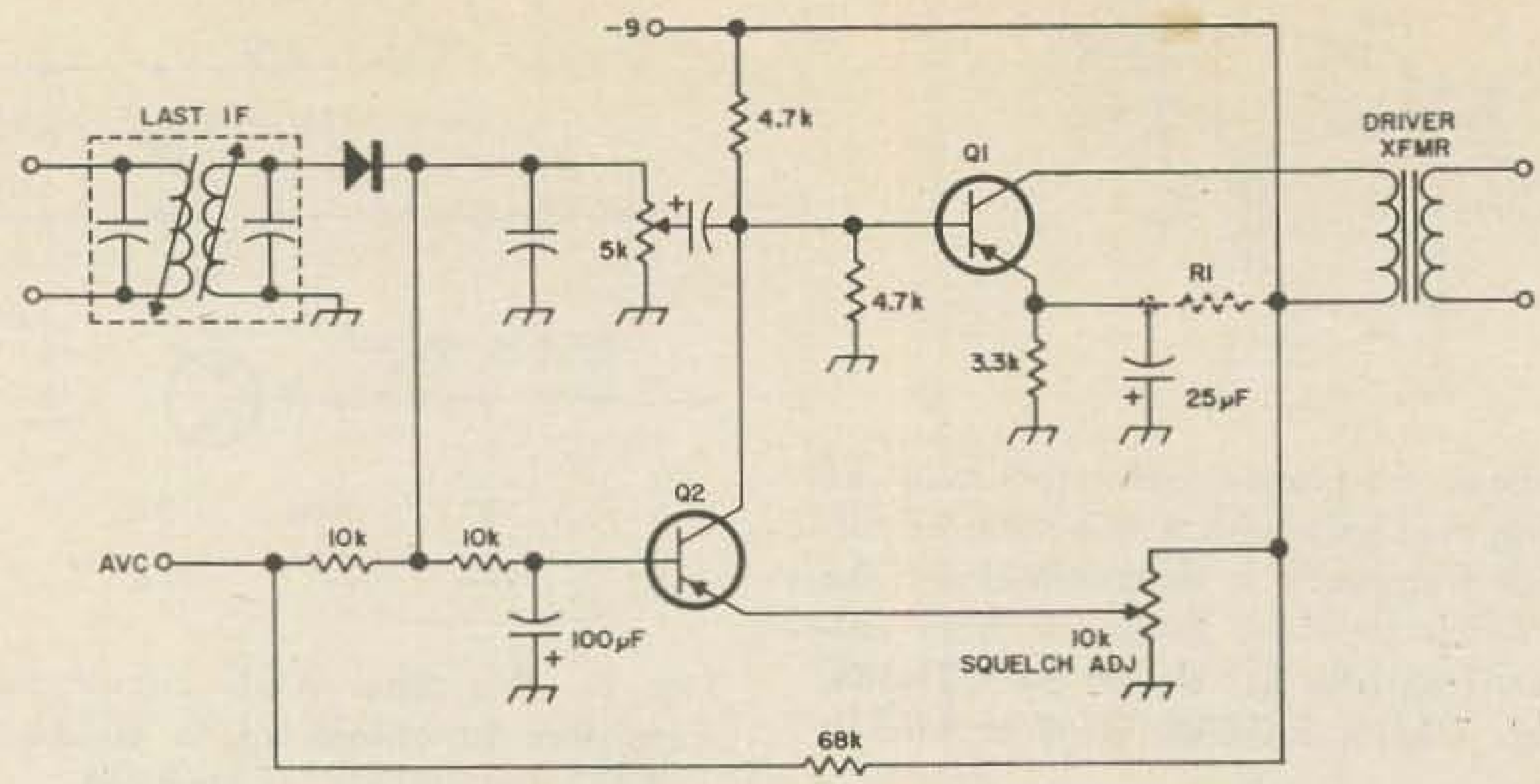


Fig. 33. This simple squelch circuit may be added to any transistorized receiver with only minor changes; in most receivers only four additional components are required, two resistors, a capacitor and a transistor. Q1 is an existing transistor in the receiver; Q2 is a 2N404, 2N2953, SK3004, GE-2 or HEP-254.

the constants shown in the schematic, a 60 dB control range is provided by a 0 to 100 µA AGC input. To increase this range, high gain transistors and a higher voltage power supply must be used.

Squelch circuits

The simple, but positively acting squelch circuit in **Fig. 33** may be added to any transistorized receiver with only minor changes in the audio section and four additional components. Without an input signal, normal forward bias to the *if* amplifier flows in the AGC line. A portion of this bias voltage is applied to the base of Q2 through the 10K ohm squelch adjust. This voltage biases Q2 into full conduction with the squelch control pot determining the degree. When Q2 is saturated, base bias for Q1 is diverted to ground so the driver cannot amplify incoming noise and the speaker is quiet. When a carrier large enough to cut off Q2 is received, Q1 conducts and amplifies normally. The 100 µF filter capacitor in the base of Q2 removes all but the AGC signal coming from the detector.

To make the squelch less sensitive to large noise pulses, resistor R1 will ensure that transistor Q1 will be cut off until rf operates the squelch. The value of this resistor should be determined experimentally, since its value depends upon the type of transistor used in this stage.

Another simple squelch circuit is illustrated in **Fig. 34**. When there is no signal

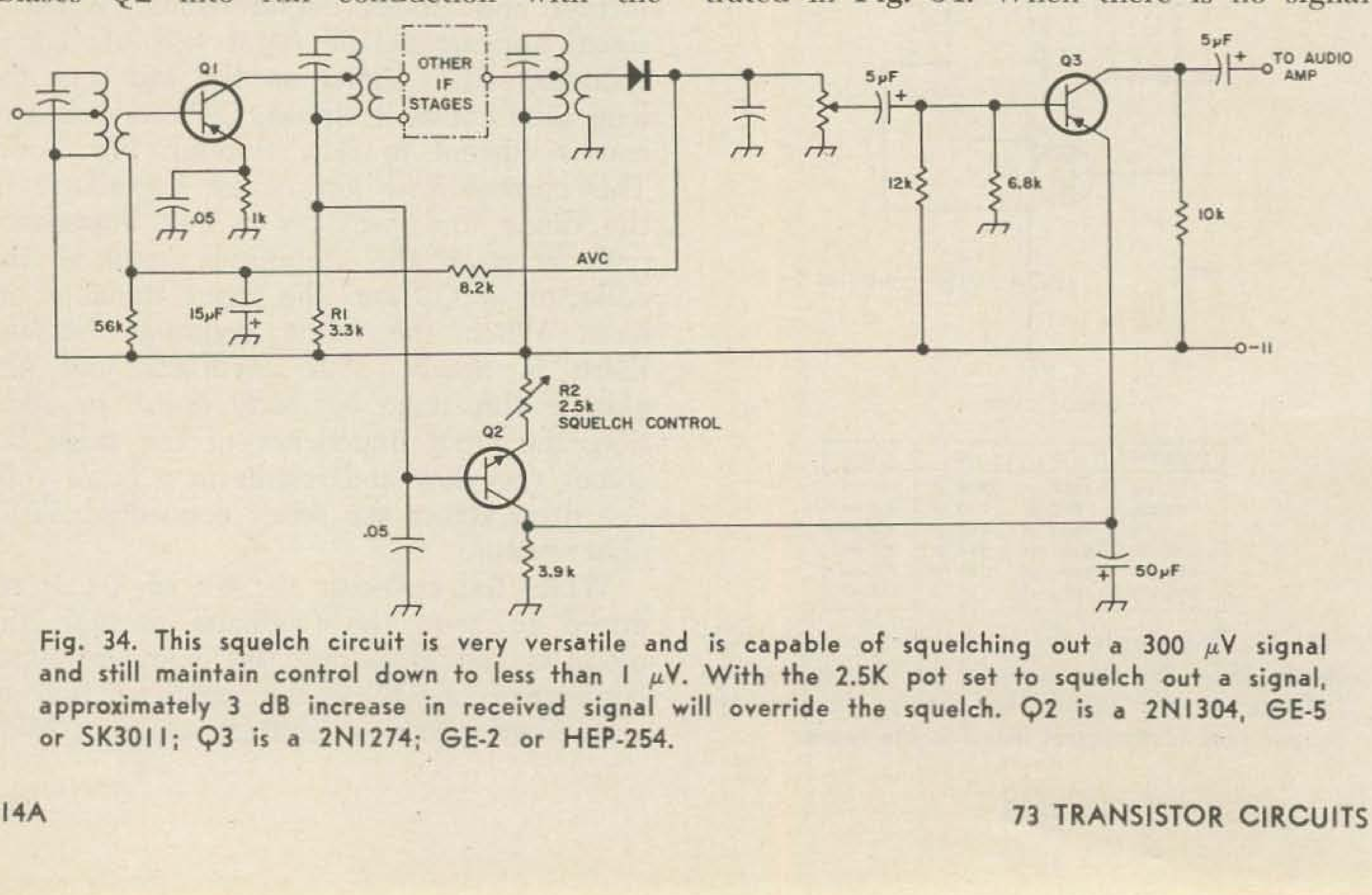


Fig. 34. This squelch circuit is very versatile and is capable of squelching out a 300 µV signal and still maintain control down to less than 1 µV. With the 2.5K pot set to squelch out a signal, approximately 3 dB increase in received signal will override the squelch. Q2 is a 2N1304, GE-5 or SK3011; Q3 is a 2N1274; GE-2 or HEP-254.

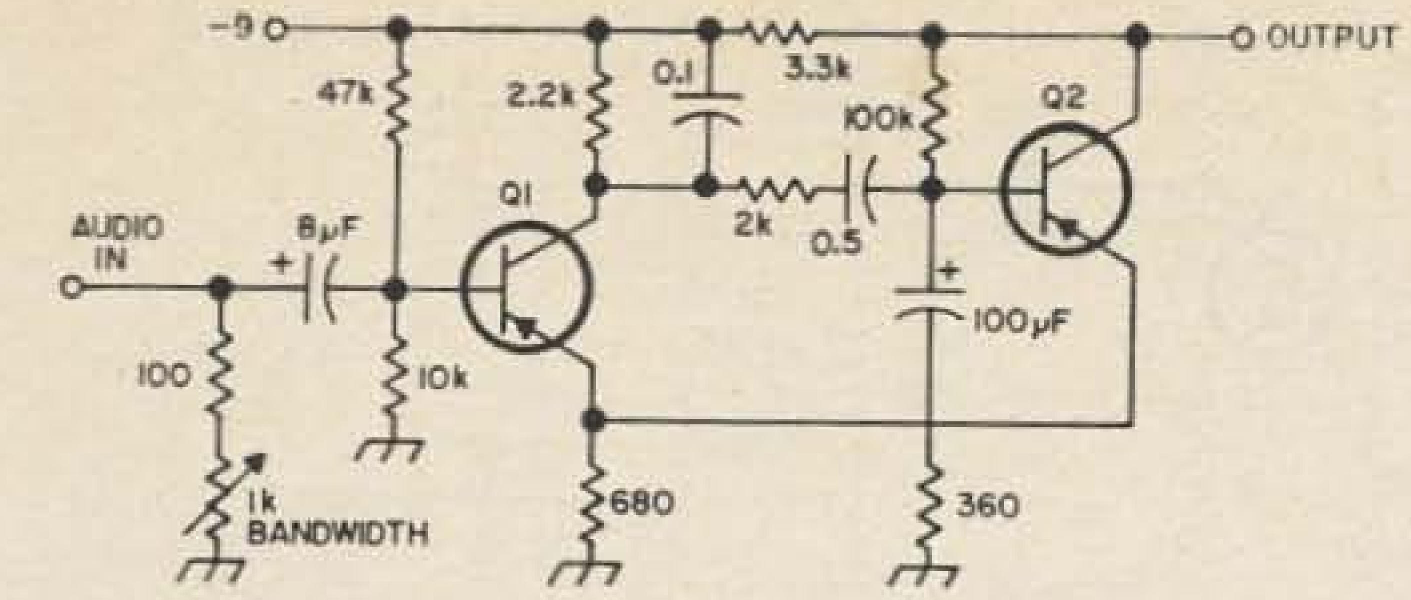


Fig. 35. This audio filter uses a 1000 Hz Wien bridge circuit to provide bandwidths from 70 to 600 Hz wide. Q1 and Q2 are 2N408, 2N2613, SK3004, GE-2 or HEP-254.

coming into the receiver, the AGC controlled *if* amplifier Q1 is operating at maximum gain. Under this condition the voltage drop across R1 is also maximum and is used to turn Q2 on. The current through Q2 is determined by the squelch control, R2. If R2 is set so that the current flow through Q3 causes the voltage drop across the 3.9k emitter resistor to be greater than the base voltage of Q3, it will be turned off. Under these conditions, there will be no output from Q3 and the receiver will be quiet.

When a signal is picked up by the receiver and the AGC is operating, the current through Q1 is reduced according to the signal strength of the received signal. This in turn reduces the voltage across R1, reduces the current through Q2 and lowers the voltage on the emitter of Q3. When the emitter to base junction of Q3 is forward biased, the stage turns on and results in an output to the audio amplifier.

This circuit is very versatile and is capable of squelching out a 300 μV signal into the receiver and still maintain control down to less than 1 μV. In some cases there may be some audio distortion between the on and off conditions of Q3, depending upon the setting of the audio gain control. This distortion is not ordinarily objectionable however and when the signal is several times greater than that required to just trigger the squelch, it is not present.

Selective audio amplifier

Selective transistor amplifiers are very helpful in sorting out stations from the QRM that plagues our HF bands. They are also quite helpful in VHF and UHF work for effectively narrowing the bandwidth of the receiver. This is because as the bandwidth is narrowed, the noise in the receiving bandpass is reduced accordingly.

In the selective transistor amplifier illustrated in **Fig. 35**, the frequency selected is determined by a modified Wien bridge circuit in the collector of the first transistor. Although the constants shown in this circuit are for a center frequency of 1000 Hz, other frequencies may be selected by the proper choice of bridge components. The bandwidth of this circuit is determined

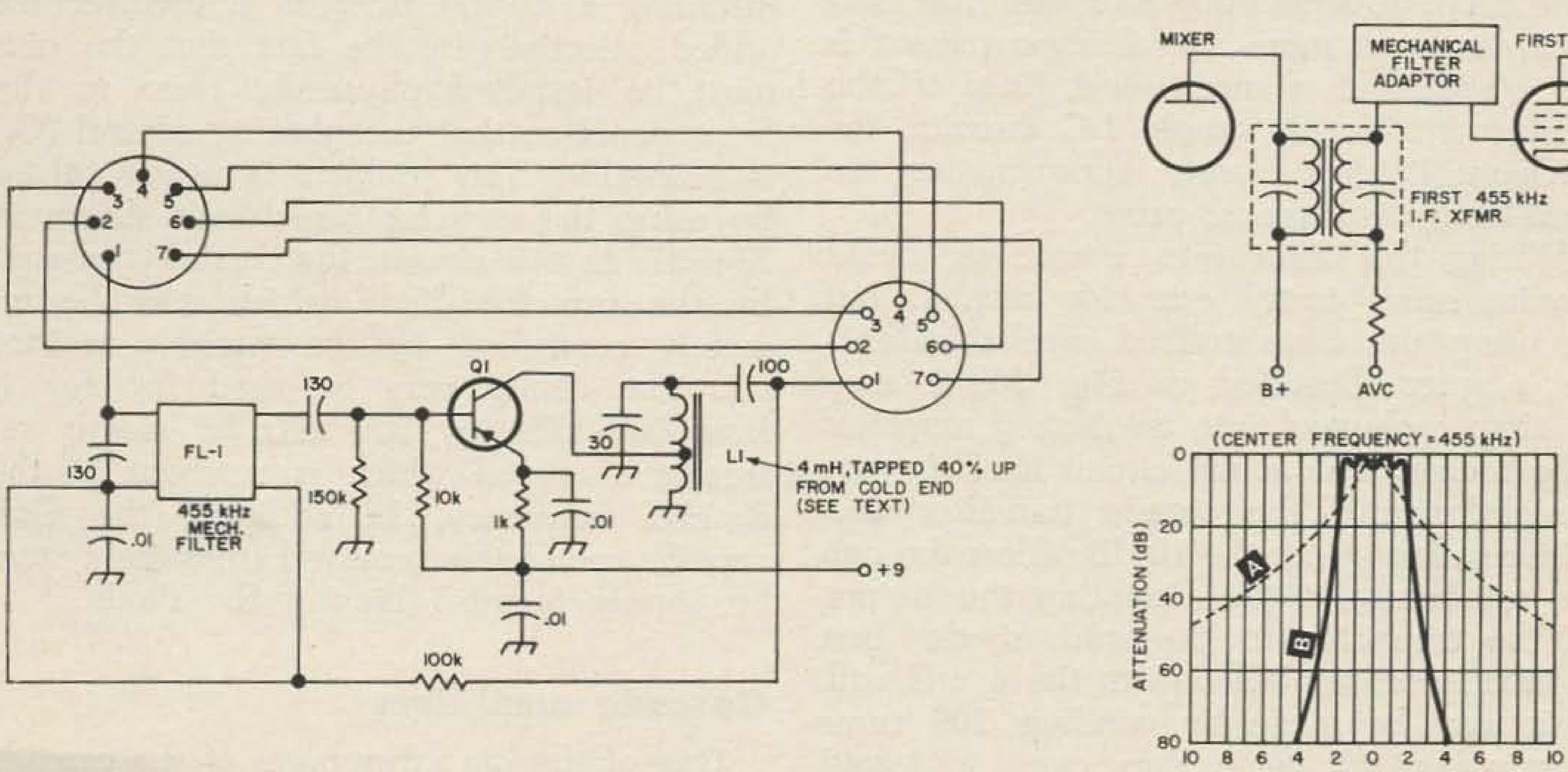


Fig. 36. The selectivity of inexpensive communications receivers may be substantially increased by the addition of this mechanical filter adapter. The transistor is used to make up for the 10 dB loss through the filter. The typical passband of a receiver without the filter is shown by A in the frequency response curve; the mechanical filter adapter results in curve B. Q1 should be a 2N1638, 2N1727, SK3008 or HEP-3.

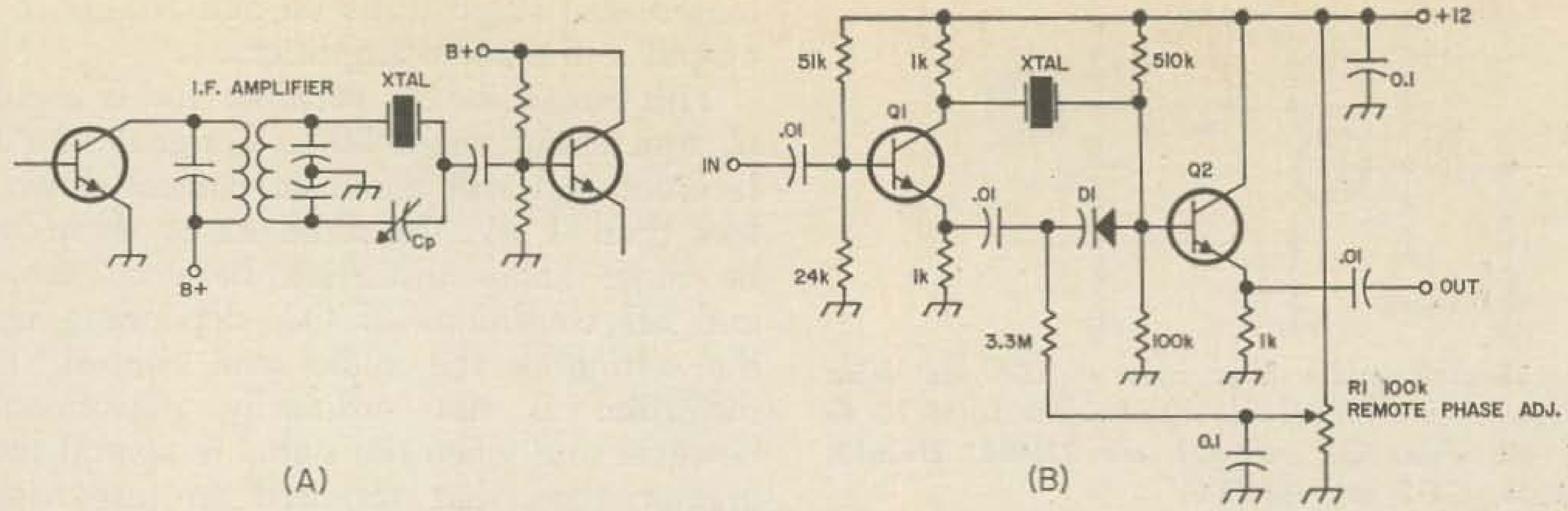


Fig. 37. Usually the crystal filter circuit in a receiver (A) must be physically located so the phasing capacitor (C_P) is accessible to the front panel. By using the varactor phased filter in B, the crystal may be located in any convenient location. Q1 and Q2 are 2N3478, 2N3564, 2N3707, 40236 or HEP-50; D1 is a 20 pF varactor such as the 1N954 or TRW V20.

by the value of the input load resistor, but with the resistors shown, it may be varied between 70 and 600 Hz.

Mechanical filter adapter

With the heavy QRM that is rampant on today's high frequency ham bands, the selectivity of many of the lower cost communications receivers leaves a great deal to be desired. In fact, in many cases the selectivity of these receivers is hopelessly inadequate. Adding a Q multiplier or a simple crystal filter will help to some extent, but these devices simply narrow the peak of the *if* response curve. Although this is quite suitable for CW work, it is of little help in separating SSB and AM stations. A much more useful improvement is the addition of a mechanical filter to the receiver *if*. Unlike simple LC circuits, the mechanical filter closely approximates the ideal bandpass response curve.

Wiring this filter into a receiver could require some pretty extensive rework, but by using the transistorized mechanical filter adapter illustated in **Fig. 36,** it may be simply plugged into the first *if* amplifier tube socket. The actual circuit itself is very straightforward; the simple transistor amplifier makes up for the 10 dB of loss thrugh the mechanical filter. Coupling the output of the transistor to the grid of the first *if* tube is accomplished with the 4 mH coil. This may be made by winding 100 turns of number 36 on a cup core r toroid (tapped at 40 turns) or the primary of an inexpensive 455 kHz if transformer may be used.

Layout of the circuit is not at all critical except that care should be taken to make sure that there is no leakage around the mechanical filter and amplifier. To this end the plate lead of the *if* tube should be shielded. Although the base layout shown in the schematic is for a 6BA6 tube, this adapter may be used with any *if* tube by simply placing the mechanical filter in the grid lead. Packaging this device is quite simple too; just mount an appropriate tube socket on top of a plug-in can (Vector G2.1-8-4), build the circuitry inside, plug it in the receiver tube socket and pick the weak signals out of the QRM.

Tunable crystal filter

One of the problems encountered when installing a crystal filter in a receiver for added selectivity is the fact that the unit must be installed physically close to the front panel so that the phasing control (C_P) is accessible. This problem is neatly solved by using the varactor tuned unit shown in **Fig. 37.** In this circuit, the crystal is phased by the varactor diode which may be remotely controlled by the variable resistor R1. The circuit may be used for any *if* from 100 kHz to 1500 kHz by simply selecting a crystal which is resonant at the desired frequency. In addition, the filter may be completely removed from the system by simply forward biasing the diode.

Cascode amplifiers

One of the big advantages of the cascode rf amplifier is that in the high frequency range it does not require neutralization. In the cascode circuit shown in **Fig. 38,** two transistors are connected so that the mismatch between them reduces internal

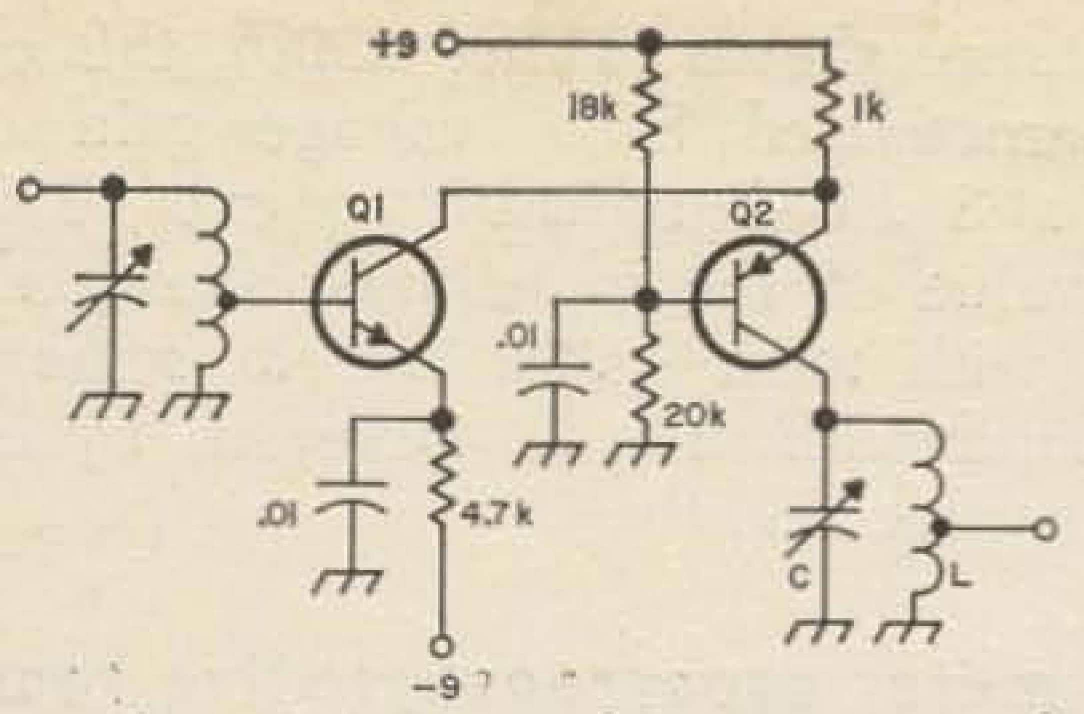


Fig. 38. This cascode amplifier is extremely useful because it provides high gain without the need for neutralization. Q1 is a 2N918, 2N3464, 2N3478, MPS918, 40235 or HEP-56; Q2 is a 2N1742, 2N2398, 2N2894, 2N3399, TIM10 or HEP-2.

feedback; therefore the input and output impedance of the circuit is essentially independent of the source and load.

In single transistor amplifiers the collector to base capacitance causes internal negative feedback that reduces amplifier gain at high frequencies. This feedback also causes the input and output impedances of the transistor to be dependent upon the value of the source and load impedances. Normally this negative feedback is neutralized out with a small amount of positive feedback external to the transistor. Unfortunately however, this process is long and tedious and often requires many adjustments.

The isolation between several similar stages is particularly important where more than one stage is used, because as a multi-

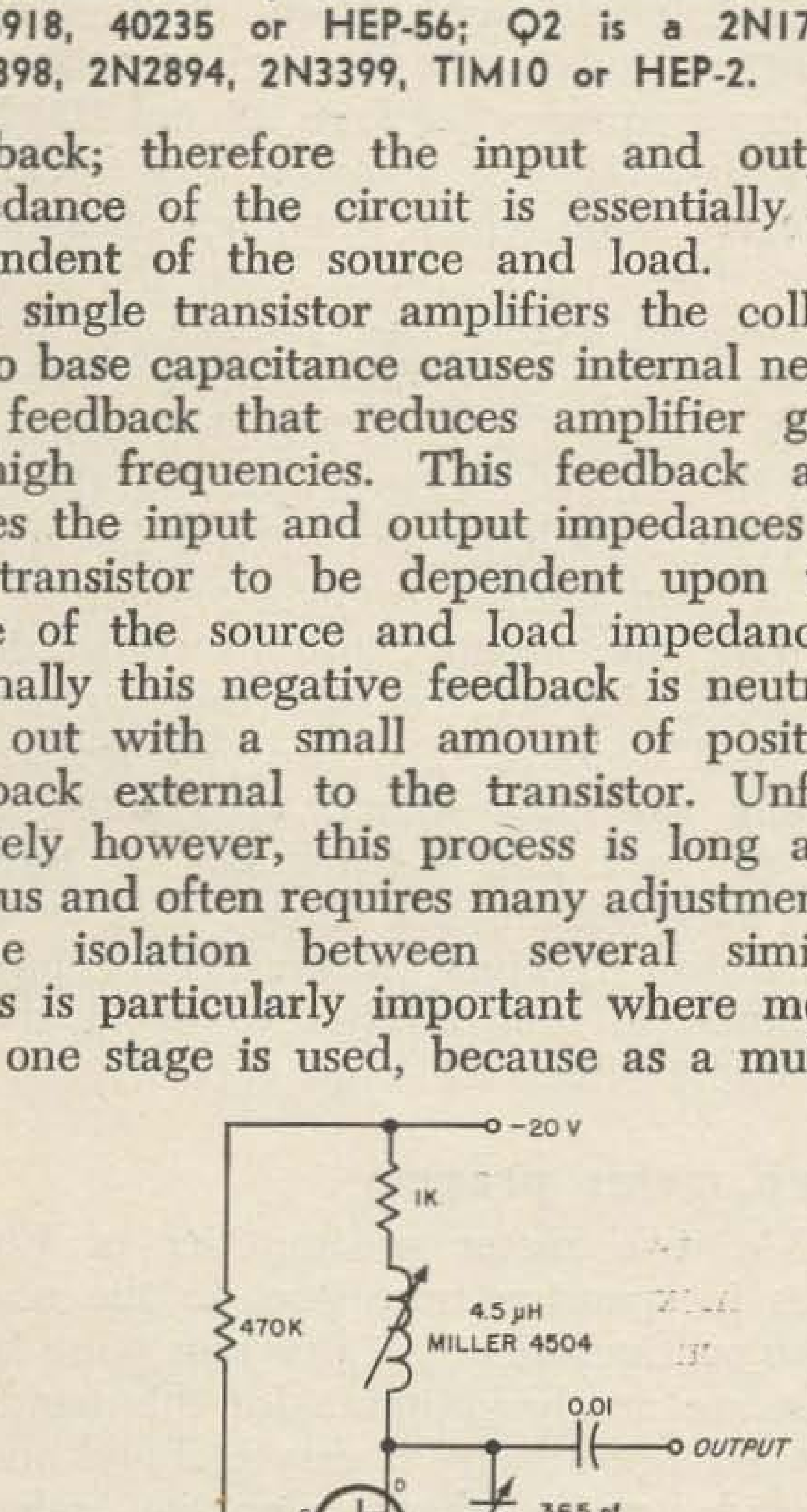


Fig. 39. This 30 MHz *if* stage uses two FET's connected in the cascode arrangement to provide 20 dB gain without neutralization; the bandwidth is 4 MHz. Both FET's in this circuit are 2N3819, MPF105 or TIS34. With a negative supply voltage, the 2N4360 or TIM12 would be suitable.

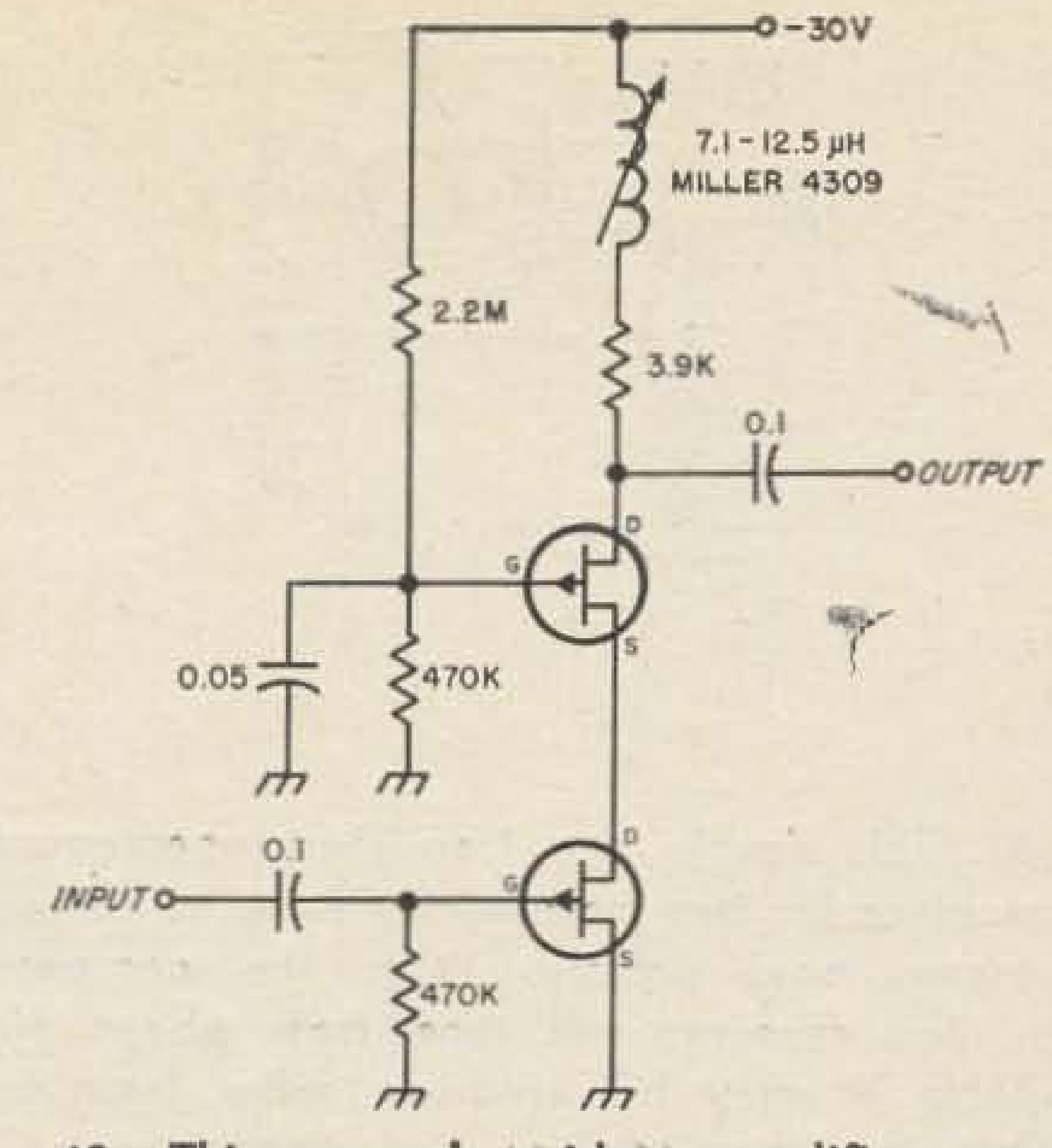


Fig. 40. This cascode video amplifier provides more than 6 MHz bandwidth with a voltage gain of 10. Both FET's are 2N3819, MPF105, TIS34 or HEP-801. A negative supply would permit the use of a 2N4360 or TIM12.

stage amplifier is being aligned, the tuning of one stage effects all the other stages. With the cascode rf amplifier, this shortcoming is overcome. Moreover, the gain of the cascode circuit is greater than the gain of a neutralized common-emitter stage with the same stability.

Since the emitter of Q1 is tied directly to the negative supply, the base can be connected directly to the output of the previous stage which is at ground potential. This eliminates a coupling capacitor and speeds up circuit recovery time after an overload. In addition, the gain of the stage may be controlled by varying the amount of current through Q1 (by adjusting the value of the negative supply).

The high gain cascode circuit shown in **Fig. 38** uses two very inexpensive transistors to obtain 15 dB gain at 100 MHz with no neutralization; at lower frequencies the gain will be somewhat higher. No values are shown for the tuned circuits because they will be different for each application. However, dc biasing is usually the toughest part of any amateur transistor circuit design, and that is already done; all you have to do is put some tuned circuits in. The tap point on the input inductor should be chosen for best noise figure. The tap on the output inductor is chosen for maximum power gain.

Another somewhat different cascode circuit is illustrated in **Fig. 39.** This cascode 30 MHz *if* amplifier uses FET's and is

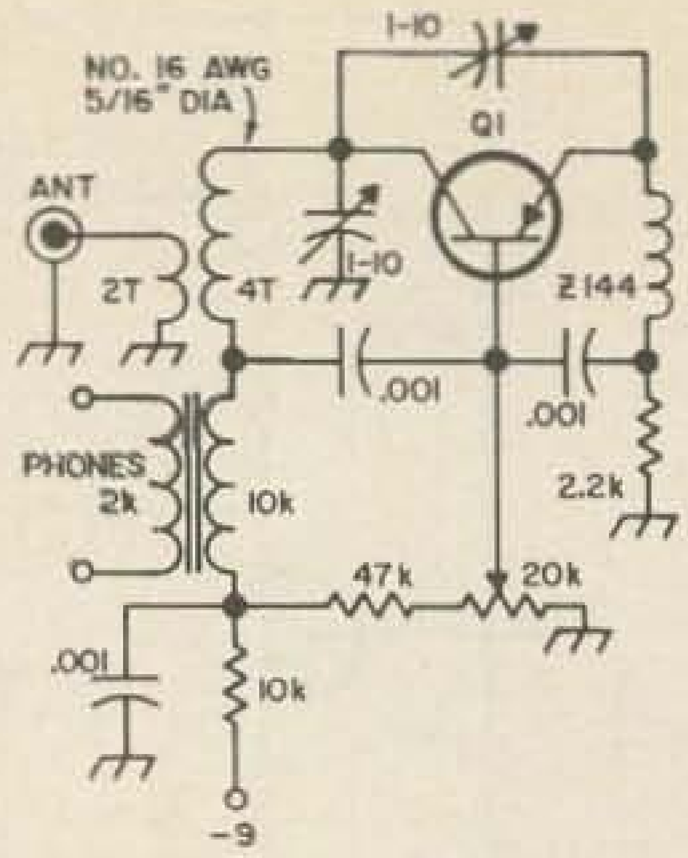


Fig. 41. This simple one transistor superregenerative receiver for two meters may be used for copying many local signals. With the components shown, this receiver will tune from about 90 to 150 MHz. It may be used on other frequencies by changing the inductor and capacitor as described in the text. Q1 is a 2N1742, 2N2398, 2N3399, TIM10, GE-9 or HEP-2.

characterized by a 20 dB power gain, bandwidth greater than 4 MHz, and all without the necessity for neutralization. For even more gain, these stages may be simply cascaded.

The cascode video amplifier shown in **Fig. 40** is almost an exact replica of the vacuum tube circuit that was originally developed in the 1940's. Usually a single triode is avoided in wideband or video amplifiers because the input capacitance and its multiplication by device gain (called Miller effect) seriously loads the input. With the cascode configuration, the input capacitance is no longer multiplied by the gain of the device, but is limited to the input capacitance of the FET. With the shunt peaking

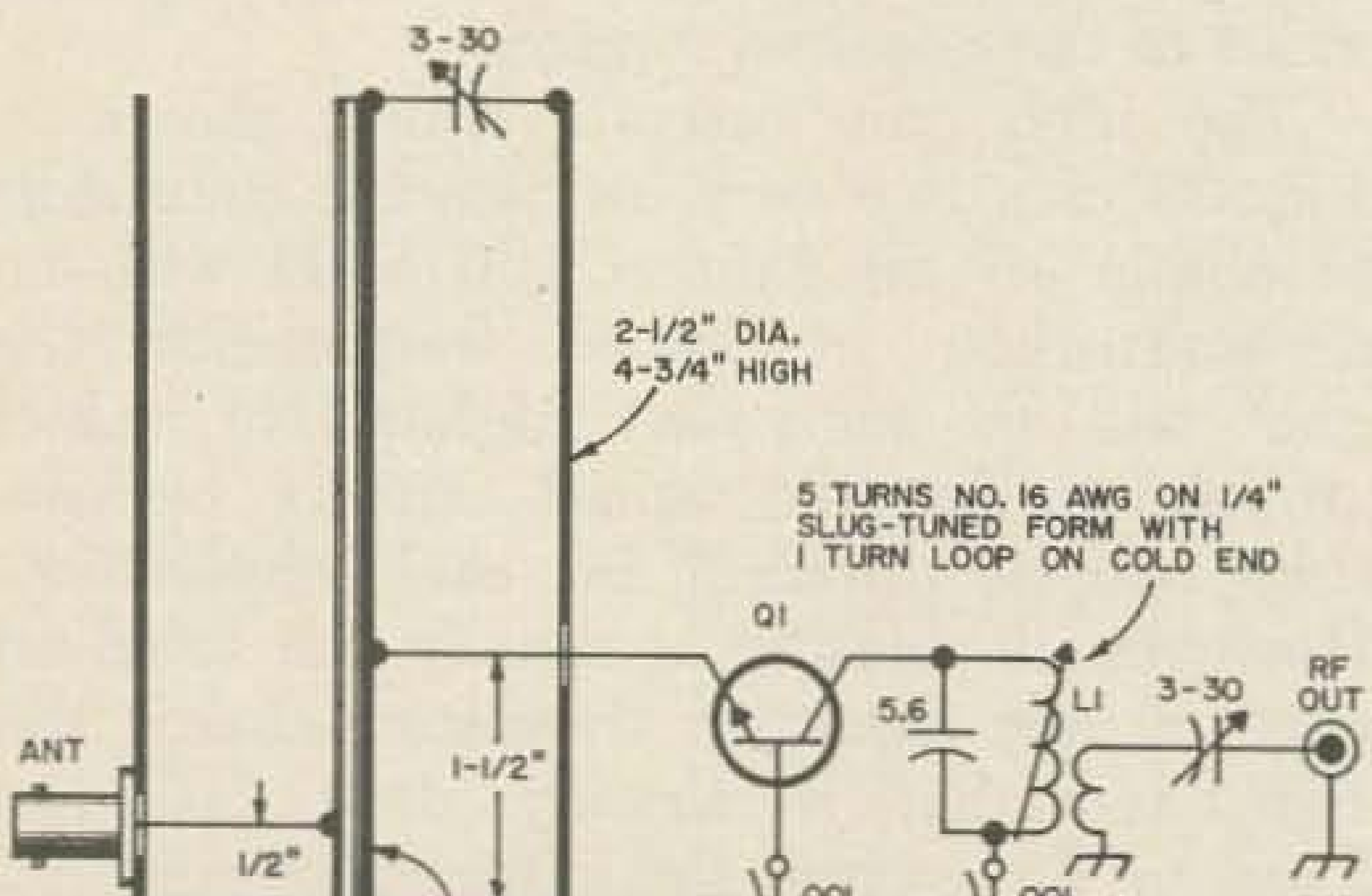


Fig. 42. Low noise two meter preamplifier uses a beer can cavity to provide excellent discriminatoin against nearby kilowatts. Q1 is a 2N3478, 2N3563, 2N3564, 40235 or SK3019

inductance shown (Miller 4309), this circuit is characterized by a voltage gain of 10 with a 3 dB bandwidth of over 6 MHz. The value of the inductance shown should work with most loads, but in some cases the bandwidth may be increased by changing its value slightly.

Two meter superregenerative receiver

The simple little receiver shown in **Fig. 41** was designed primarily for the two meter band, but with appropriate changes in the input rf coils, it will work equally well on any frequency between 28 and 160 MHz. Basically, Q1 is a common base oscillating detector stage which quenches at about 25 kHz. The audio output from the detector is coupled across the transformer to the simple two stage audio amplifier. For more audio output, a 500 to 3.2 ohm transformer may be connected between Q3 and the speaker. The 20 kilohm pot should be adjusted for a total current drain of about 30 mA.

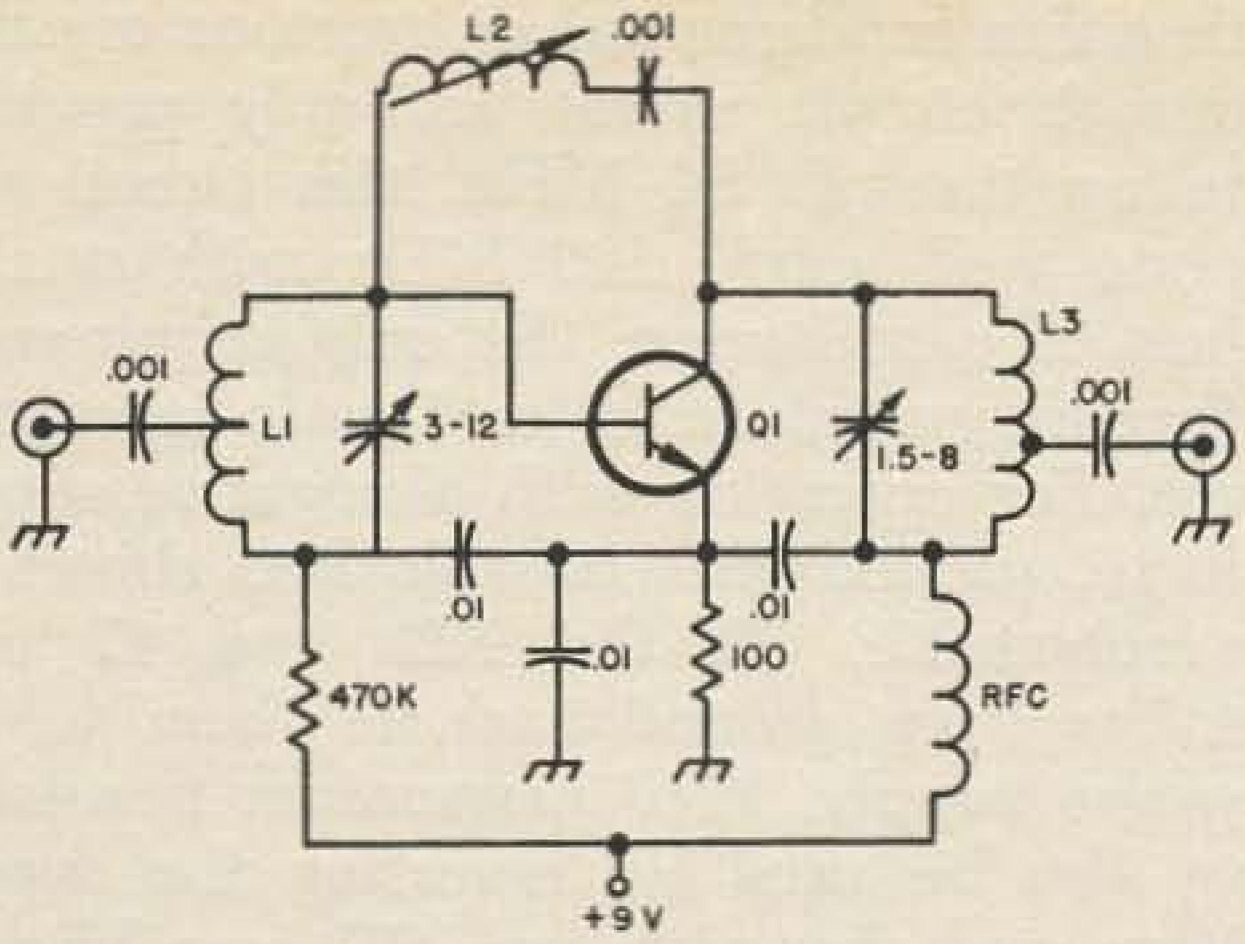
With the circuit constants shown in the diagram, this receiver will tune from about 90 to 150 MHz. To cover six meters, the tuning capacitor should be changed to a 15 pF unit and the number of turns on L2 increased to 6½. Since this is a regenerative receiver, it must be completely enclosed in a metal box to avoid the undesirable effects of hand capacity.

Two meter preamp

The two meter preamplifier of **Fig. 42** uses inexpensive transistors in the common base configuration, yet provides noise figures that are nearly optimum for this band. The coaxial input cavity is easy to build and will provide more than adequate selectivity against your high powered neighbors on two. Although this input cavity may be built from scratch, the easiest approach is to use a spent beer can. Be careful when choosing the can though, some brewers are using aluminum cans wich are pretty difficult to solder. The whole amplifier may be mounted on a small piece of epoxy board and then the entire assembly attached to the outside of the cavity.

220 MHz rf amplifier

The 220 MHz rf amplifier shown in **Fig. 43** exhibits about 17 dB gain, although the exact amount will depend upon the type of transistor used. Optimum operation for low-



L1 3-1/2 TURNS NO. 16, 1/4" DIAM, 1/2" LONG. TAPPED AT CENTER.
L2 8-1/4 TURNS NO. 24 ON 1/4" SLUG-TUNED FORM.
L3 8 TURNS NO. 16, 1/8" DIAM, 7/8" LONG. TAPPED ONE TURN FROM COLD END.
Q1 2N3478, 2N3564, 40235
RFC 0.84 μH (OHMITE Z-220)

Fig. 43. Low noise 220 MHz preamplifier. This circuit will provide extremely high gain with low noise on the 1¼ meter band. Neutralization is controlled by inductor L2.

est noise figure also depends upon the transistor type, but usually will be in the vicinity of 6 volts collector voltage and 1 mA collector current. Unfortunately, this is usually not the same operating condition for maximum gain; maximum gain will occur at somewhat larger values of collector voltage and current. When this amplifier is set up, the 470k base bias resistor should be adjusted for the condition that you are looking for, whether it be minimum noise figure, maximum gain or a compromise between the two. Remember that for most practical receivers the noise figure will be dictated by the noise figure of the first rf stage; more gain can be added by another stage of amplification.

Circuits for Transmitters

Crystal oscillators

A compact untuned crystal oscillator is a very useful unit to have around the shack. The oscillator illustrated in **Fig. 44** does not have any tuned circuits, so almost any crystal from 300 kHz up to 10 MHz will oscillate satisfactorily. It can be used for driving transmitters, as a signal source or for just testing crystals. In this circuit the first transistor is operating as an untuned crystal oscillator with the second transistor connected as an emitter follower. With this arrangement, Q2 acts as a buffer stage and quite effectively isolates the oscillator from the load.

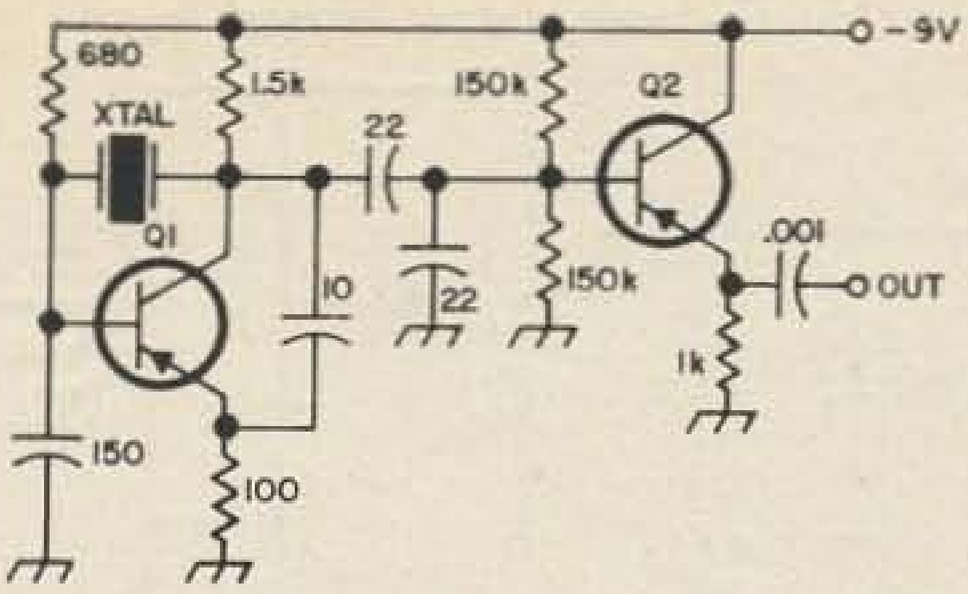


Fig. 44. This untuned crystal oscillator will oscillate with any crystal from 300 kHz to 10 MHz. Frequency stability is very good because the emitter follower buffer amplifier effectively isolates the oscillator from the load. Q1 and Q2 are 2N993, 2N1749, 2N2084, 2N2362, TIM10, GE-9, SK3006 or HEP-2.

Another untuned crystal oscillator stage is shown in **Fig. 45.** This circuit will oscillate with any crystal between 3 and 20 MHz with no tuning whatsoever. If overtone crystals are plugged into the circuit, they will oscillate on their fundamental frequency. For overtone crystals up to about 60 MHz, the fundamental will be *approximately* ⅓ the marked frequency; above 60 MHz the fundamental is normally about ⅕ the marked frequency. For best stability with each of these untuned crystal oscillators, all the capacitors should be high grade silver mica types.

The crystal oscillator shown in **Fig. 46** has proven to be extremely stable and easy to adjust. Basically it is a standard Colpitts circuit with the frequency determined by the crystal. By using the appropriate inductors and capacitors, this circuit will oscillate

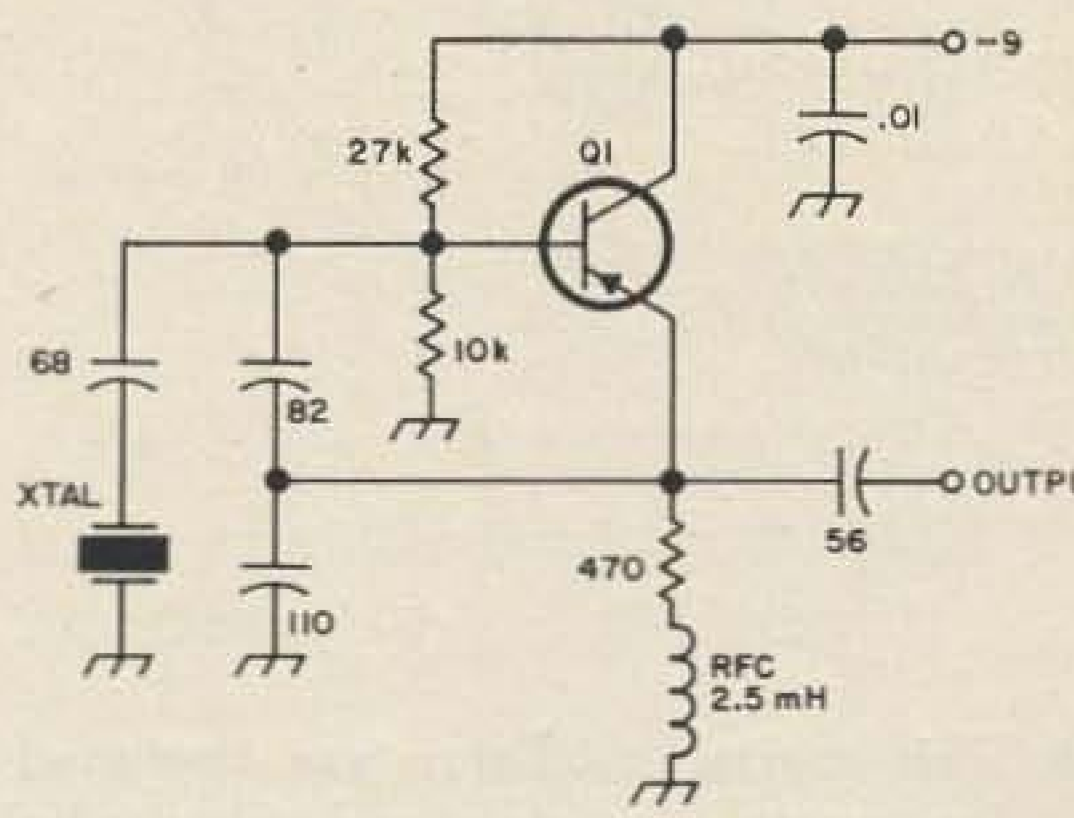
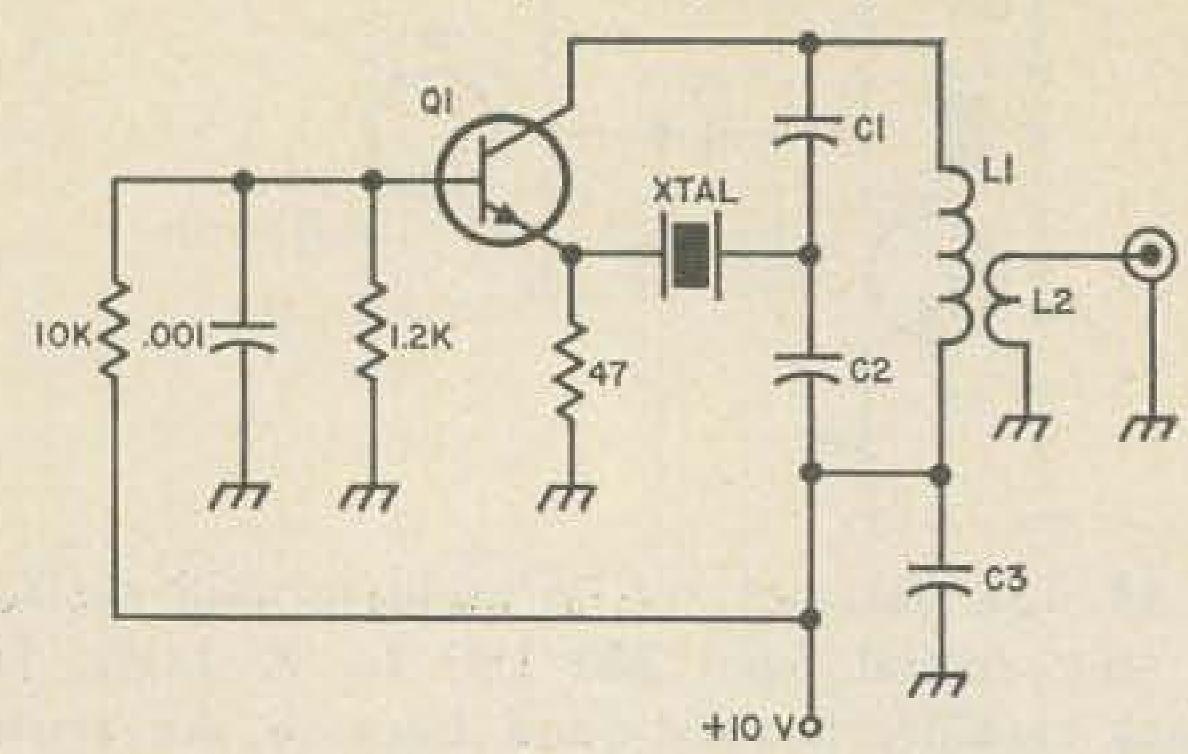


Fig. 45. This crystal oscillator will oscillate with any crystal between 3 and 20 MHz with no tuning whatsoever; overtone crystals will oscillate on their fundamental in this circuit. Q1 is a 2N1177, 2N1180, 2N1742, GE-9, SK3006 or HEP-2.

Q1 - 2N708, 2N3564, 2N3854, 40237



FREQUENCY	C1	C2	C3	L1	MILLER NO.	L2
10 - 13.5 MHz	30pf	300 pf	.01	5.0 - 9.0 μH	4505	4-1/2T
13.5 - 18 MHz	30pf	300 pf	.01	2.8 - 5.0 μH	4504	3T
18 - 24 MHz	30pf	300 pf	.01	1.6 - 2.8 μH	4503	2-1/2T
23.5 - 32 MHz	10pf	100 pf	.01	2.8 - 5.0 μH	4504	3T
32 - 42 MHz	10pf	100 pf	.001	1.6 - 2.8 μH	4503	2-1/2T
42 - 53 MHz	10pf	100 pf	.001	1.0 - 1.6 μH	4502	2T
58 - 84 MHz	10pf	100 pf	.001	0.4 - 0.8 μH	4501	1-1/4T

Fig. 46. This Colpitts type crystal oscillator may be used with either fundamental or overtone crystals from 10 MHz to 84 MHz with the tuned circuit components listed. It oscillates quite readily when adjusted and provides a stable output.

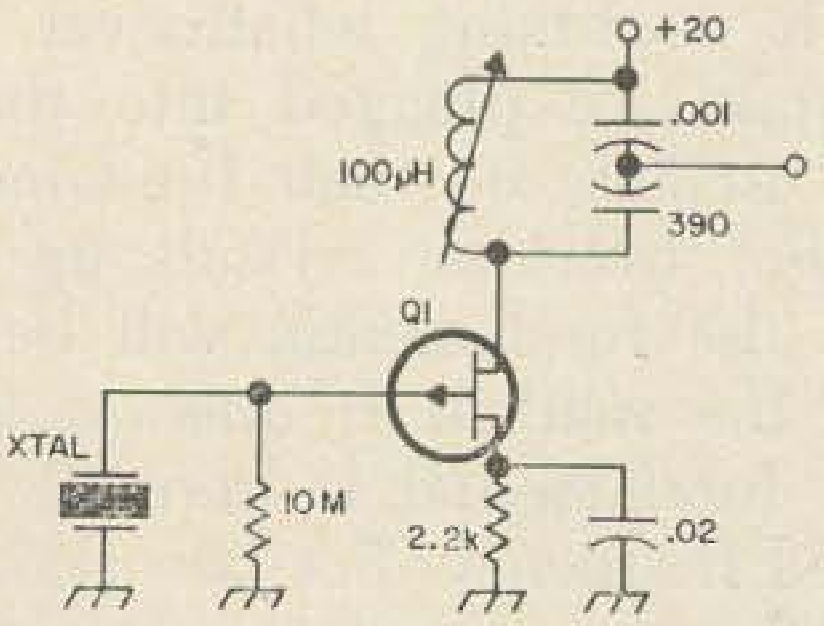
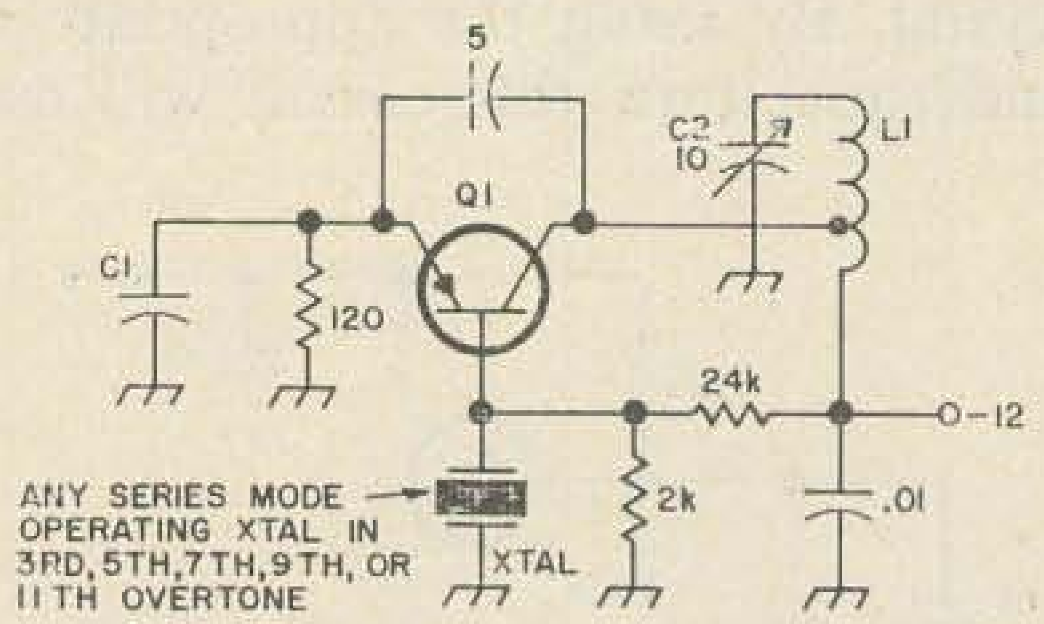


Fig. 47. This is the old familiar vacuum tube Pierce oscillator circuit with a field effect transistor in place of the thermionic triode. Circuit constants shown here are for the 1 MHz region, but the tuned circuit may be adjusted to any frequency desired. Q1 is a 2N4360 or TIM12.



L1 = TUNED TO RESONATE WITH C2 - COLLECTOR TAP 1/3 UP FROM COLD END

C1 = CAPACITIVE REACTANCE OF APPROX. 90Ω AT OPERATING FREQUENCY

FREQ (MHz)	50	144	220	432
C1 (pF)	36	12	8.2	3.3

Fig. 48. This crystal oscillator was designed specifically for overtone crystals and will oscillate up to the 11th overtone in the VHF range. Suitable values for C1 are shown for the VHF bands; for other frequencies, C1 should exhibit approximately 90 ohms capacitive reactance for best results. Q1 is a TIM10, T1400 or HEP-3.

with either fundamental or overtone crystals. Although circuit values are only provided here up through 84 MHz, this circuit will operate well above 100 MHz with smaller values of capacitance; the only requirement is that they retain a 10 to 1 ratio in capacitance. For operation with a negative supply voltage, ground the 10 volt line shown in the schematic, lift the 1.2k and 47 ohm resistors from ground and tie them to the negative supply. PNP germanium transistors may also be used by reversing the supply voltage and changing the 10K base bias resistor to 33k.

The untuned crystal oscillator in **Fig. 47** uses an FET in the familiar Pierce vacuum tube circuit. In this oscillator the drain to source capacitance and gate to source capacitance make up the feedback path with the amount of oscillator excitation determined by their ratio. This circuit cannot be used with conventional junction transistors because their low input impedance severely loads down the crystal.

The crystal oscillator shown in **Fig. 48** is designed specifically for overtone crystals and will work up through the eleventh overtone. The circuit is completely noncritical except for the value of C1 which should exhibit approximately 90 ohms capacitive reactance at the operating frequency. The tuned circuit is tuned to the frequency of interest. The 5 pF capacitor from collector to emitter should be adjusted for maximum rf output; above about 200 MHz it may not be required. The constants shown in the schematic should cause oscillation with any overtone crystal in the VHF range, but in some cases a sluggish crystal may require adjustment of the 24k base bias resistor to take off every time power is applied.

Variable crystal oscillator

The variable crystal oscillator shown in **Fig. 49** is a very useful circuit to the ham who wants a highly stable signal on two meters or 432. Although it will only tune about 50 kHz on two and 150 kHz on 432, it is adequate for many types of operation. On 432 for example, most operation is within a few kHz of 432.00 MHz. The circuit's operation is quite straight forward; the dual 365 pF capacitor pads down the resonant circuit and *pulls* the crystal *down* in frequency. Just how much it is pulled down is determined by the inductor L1. For an

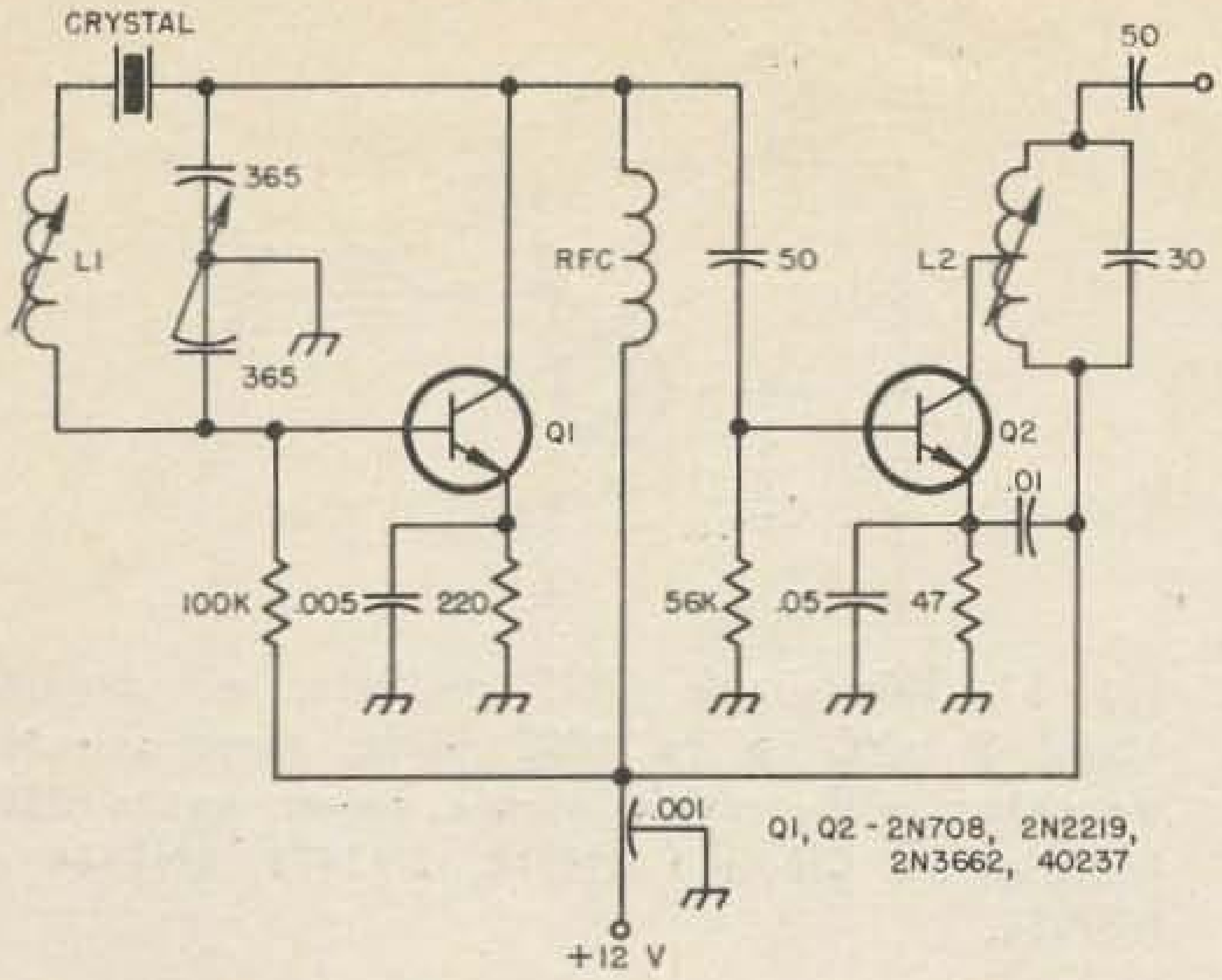


Fig. 49. This variable crystal oscillator (VXO) may be used to vary the frequency of an 8 MHz crystal 4 or 5 kHz when the 365 pF dual variable is tuned through its range. When multiplied to two meters or 432, this provides a very stable variable frequency. For 8 MHz crysals, L1 is a 20-25 uH slug tuned coil; L2 is chosen to resonate at 8 MHz with the 30 pF capacitor.

Table 1

Crystal	L_1		L_2*
3.5 MHz	35-60 μH	Miller 4509	80 turns #36, tapped at 27 turns
5.0 MHz	24-35 μH	Miller 4508	62 turns #36, tapped at 21 turns
8.0 MHz	16-24 μH	Miller 4507	40 turns #36, tapped at 13 turns
9.0 MHz	16-24 μH	Miller 4507	36 turns #36, tapped at 12 turns

*Wound on ¼" slug tuned form.

8 MHz crystal, this inductor should have a center value of about 22 μH; it should exhibit relatively high Q at 8 MHz and be self resonant well above the crystal frequency. As this inductor is increased beyond a certain amount, the crystal will lose control and the circuit becomes a rather inferior VFO. For best results L1 should be adjusted so that the crystal is pulled 4 or 5 kHz when the variable capacitor is tuned through its full range.

The buffer amplifier is coupled to the oscillator through a 50 pF capacitor. For maximum frequency stability, this capacitor should be the minimum value that will provide adequate drive for your transmitter. With the 50 pF capacitor shown, approximately 10 volts of 8 MHz drive should be available with the buffer tank tuned to resonance. Inductor L2 is chosen to resonate at 8 MHz with the 30 pF capacitor; the tap is ⅓ up from the ground end.

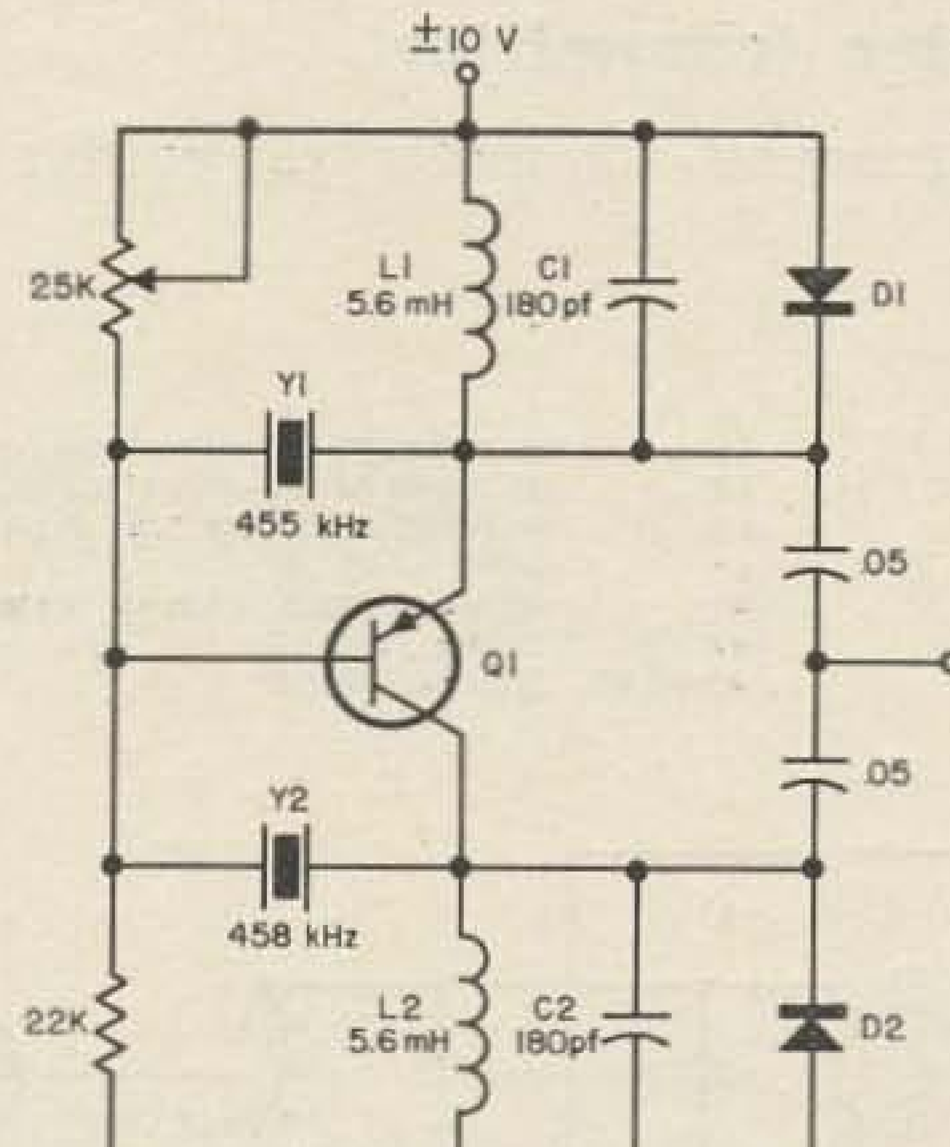
Two frequency crystal oscillator

In the two frequency crystal oscillator illustrated in Fig. 50, the bilateral characteristics of the transistor effectively provide two separate common emitter stages. Either of the two frequencies may be selected by simply applying a positive or negative voltage to the circuit.

When a positive voltage is applied, current flows through D1 to the emitter of the transistor. The tuned circuit consisting of L2, C2 and the crystal Y2 determine the oscillation frequency available at the output. The other tuned circuit consisting of L1 and C1 is shorted out by D1. In addition, since crystal Y1 is connected between the base and emitter, there is no gain to promote oscillation at its frequency.

If a negative voltage is applied to the supply terminal, the transistor "inverts" itself with the collector becoming the emitter and the emitter the collector. In this case L1, C1 and Y1 determine the frequency of oscillation. Diode D2 shorts out the other tuned circuit and the crystal Y2 is connected between the base and emitter of the inverted transistor; therefore, there is no output at Y2's frequency.

Transistors may not normally be used in the inverted mode because rather large



Q1- 2N384, 2N525, SK3004, TI-XM03
D1, D2- GENERAL PURPOSE SILICON DIODES

Fig. 50. This two frequency crystal oscillator changes frequency by simply reversing the supply voltage. When the supply voltage is changed, the transistor inverts itself; usually transistors may not be used in the inverted mode, but in an oscillator a gain of only 1 or 2 is needed and this circuit provides a novel and simple way of obtaining two frequencies from a single stage with a minimum of switching.

amounts of gain are desired. However, as an oscillator, the gain need only be sufficient to produce oscillation; this usually requires a forward current gain of only one or two. For this reason almost any germanium transistor may be used in this application. Silicon NPN transistors will also work, but operation will be just opposite to that described above.

Diodes D1 and D2 limit the output voltage to about 0.7 volts, so for some applications, further amplification may be necessary. The tuned circuit values shown in the schematic are for a resonant frequency of 455 kHz, where this circuit provides an excellent method for upper and lower sideband selection. It may be used on other frequencies by simply changing the values of inductance and capacitance in the tuned circuits.

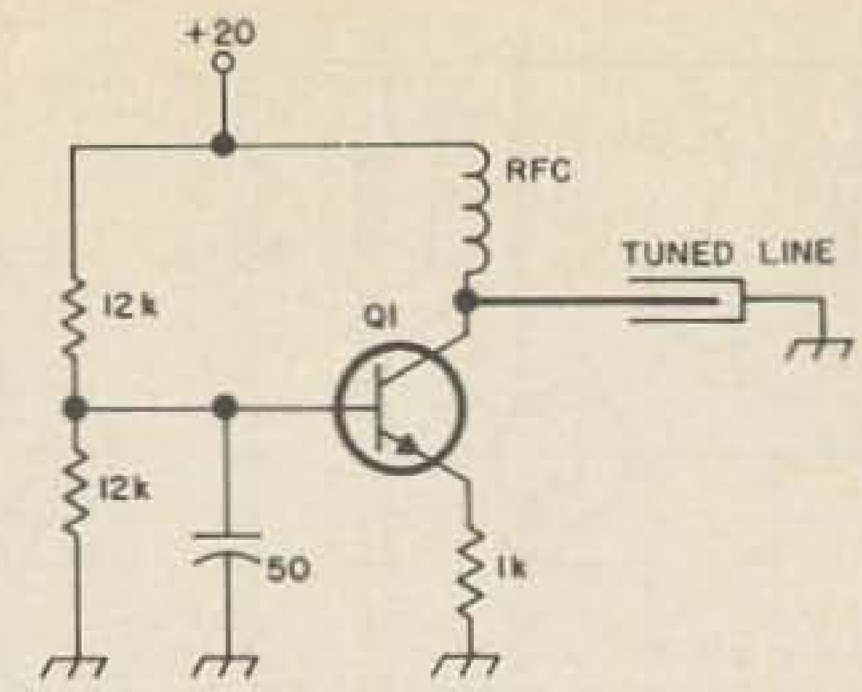


Fig. 51. This simple UHF oscillator will provide about 2 mW up to 1000 MHz; some selected transistors will provide usable power up to 1500 MHz or so. Q1 is a 2N918, 2N3478, 2N3564 or HEP-56.

UHF oscillator

The simple UHF oscillator circuit shown in **Fig. 51** will deliver up to about 2 mW of power at 1000 MHz. Although this amount of power is insufficient for some applications, 2 mW is more than enough for many mixer and converter circuits. Many transistor types, when selected, will oscillate up to 1500 MHz in this simple circuit.

Ten meter transmitter

The three watt ten meter transmitter shown in **Fig. 52** gets over the high rf power/high price hurdle by using three inexpensive transistors in parallel in the final stage. The three paralleled transistors used will produce three watts output with a 15 to 18 volt supply and about 2.25 watts with a 12 volt supply. The rf drive is provided by a 28 MHz crystal oscillator and driver amplifier. For maximum efficiency, modulation is applied to both the final amplifier and driver through the modulation transformer; about 1.5 watts of audio power is required for 100% modulation. Since the transistors used in this transmitter have an f_T of 500 MHz, a similar transmitter could be built for six meters; the only change would be in the resonant circuits.

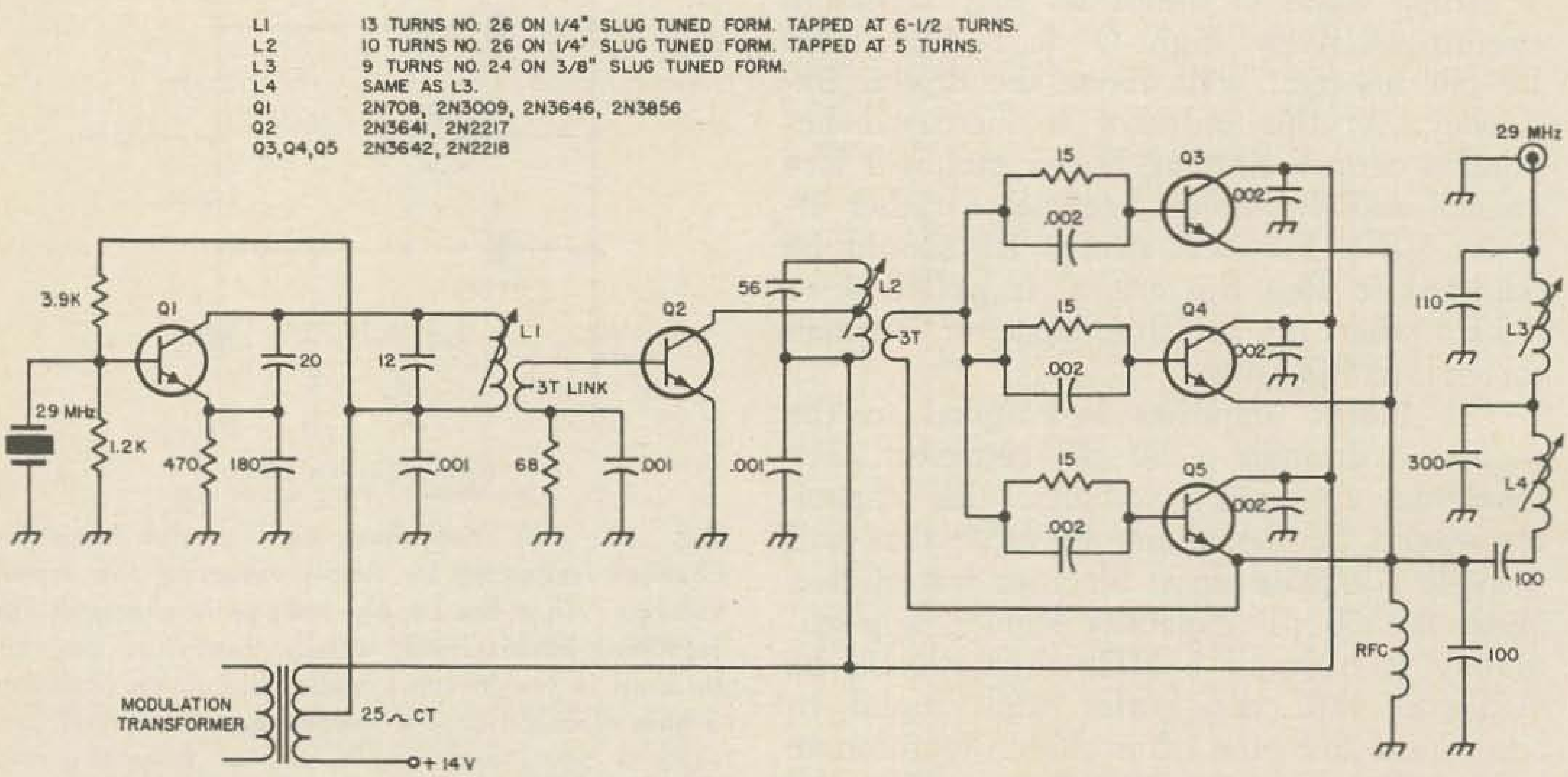


Fig. 52. This three watt ten meter transmitter maintains high efficiency and low cost by paralleling three inexpensive silicon transistors in the final stage.

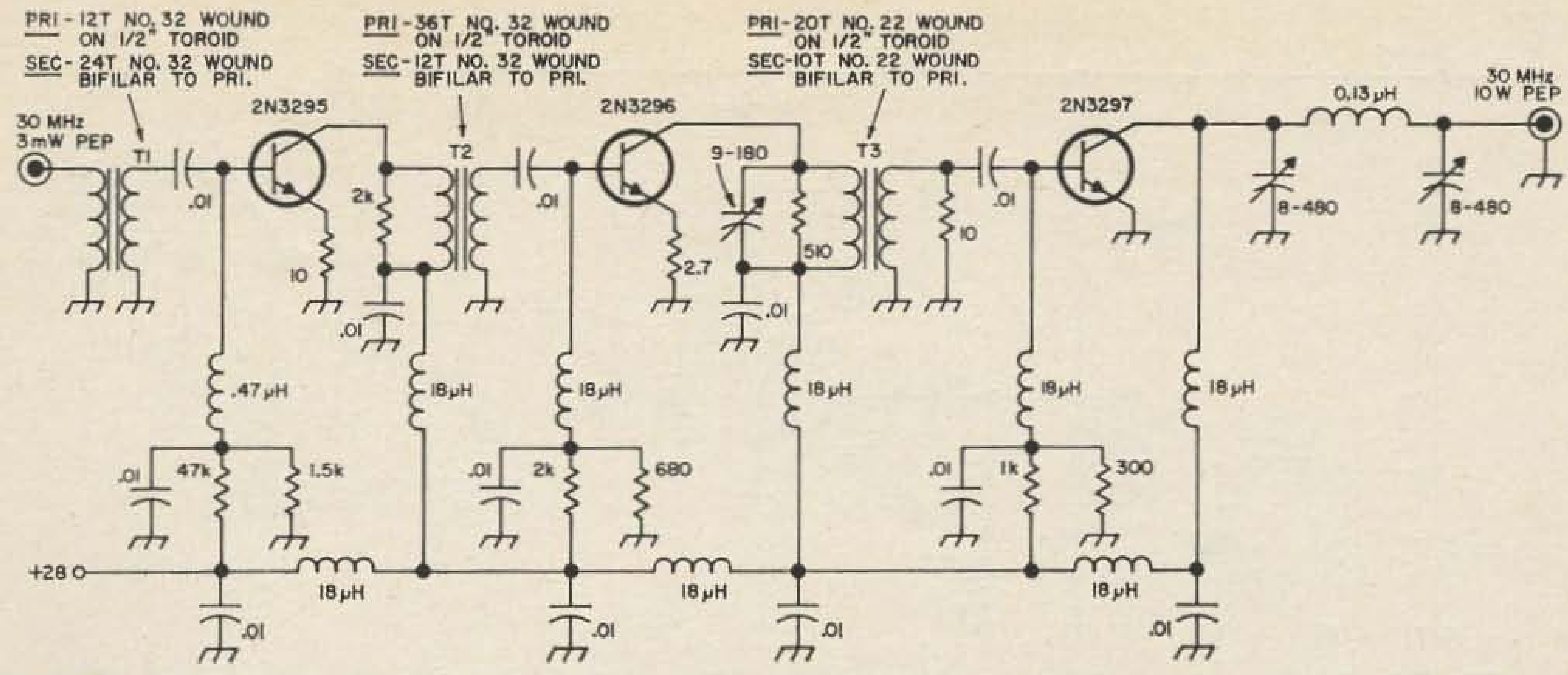


Fig. 53. This ten meter linear amplifier for SSB service uses transistors which were designed specifically for single sideband linear operation. Many junction transistors cannot be used satisfactorily for this application, because linear amplification at low power levels is a serious problem.

Ten meter linear amplifier

Up until the present time transistors haven't been used too much in SSB transmitters because linear amplification at even low signal levels has been a serious problem. However, the transistors in the ten meter SSB power amplifier illustrated in **Fig. 53** were designed specifically for linear amplifier service and perform quite well. The measured distortion of these devices is less than three percent without feedback, which is somewhat better than tubes under the same conditions.

Actually the circuit of this amplifier is quite straight forward. The only critical parts are the coupling transformers between succeeding stages. These are wound on small ½" toroids which are suitable for use at 30 MHz (Ami-tron T-50-2). Coupling between stages must be very tight and the transformers should be bifilar wound. Both the input and output of this unit are designed for 50 ohm coaxial line, so it fits in nicely with other equipment being used on ten meters.

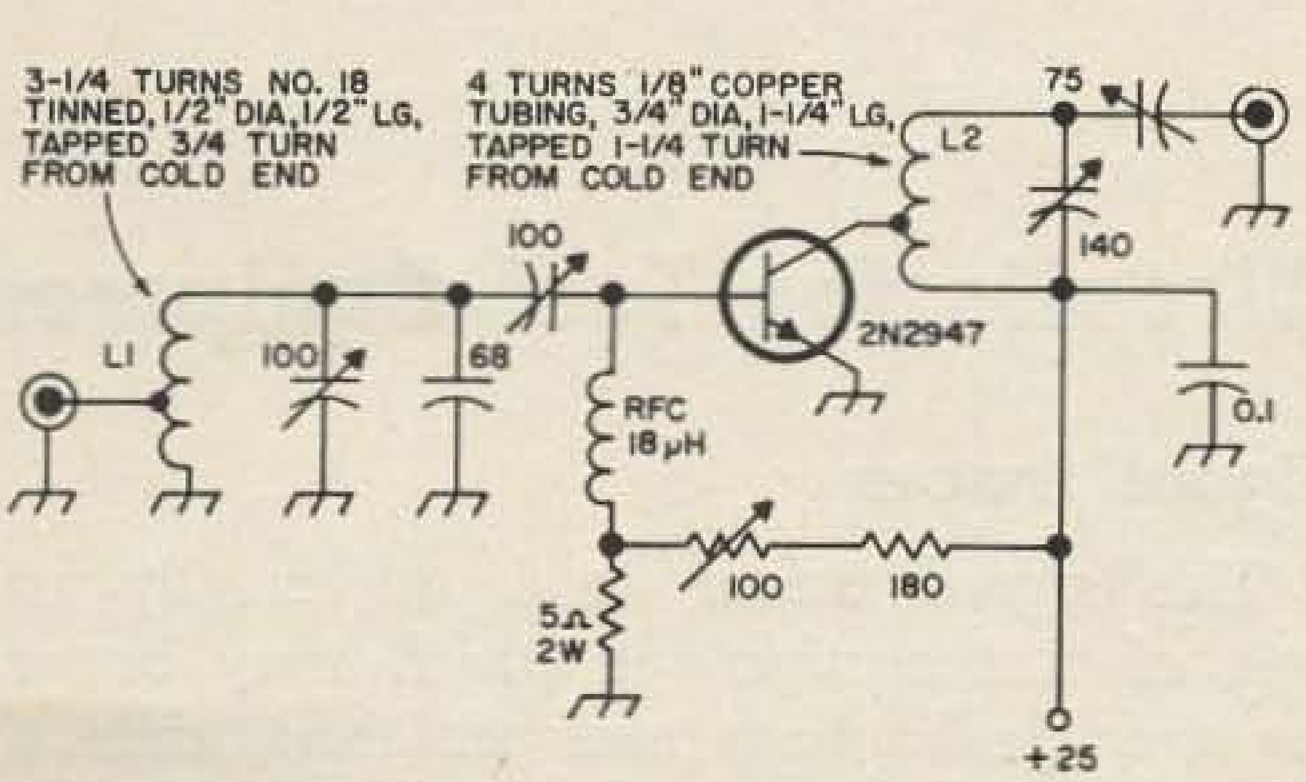


Fig. 54. This ten meter single sideband linear power amplifier will provide up to 8 watts PEP. The power gain of the 2N2947 is 13 dB at this frequency, and the odd order distortion products are at least 30 dB below the desired output.

The ten meter single sideband linear power amplifier shown in **Fig. 54** is capable of delivering an output power of 8 watts PEP. The power gain at this frequency is 13 dB, and all odd-order distortion products are at least 30 dB below the desired output.

The main difference between this amplifier and one designed for class C operation in CW, AM or FM transmitters lies primarily in the dc bias circuit. For class C operation, the only dc bias normally applied is the collector supply voltage. The 18 μH rf choke and resistive divider in the base circuit would be omitted. The transistor is biased *on* by the driving signal on the base. This results in one of the big advantages of the transistor transmitter—if the driving signal is suddenly removed, the power amplifier merely shuts off and sustains no damage.

To obtain linear operation, a small amount of forward bias is applied to the transistor. This is a function of the resistive divider and the isolating choke in the base circuit. The bias is adjusted so that a small collector current flows without any input driving signal; when a driving signal is applied, the transistor is biased on to full operating collector current. In this circuit the 2N2947 draws 20 mA with no drive and 350 mA with full drive.

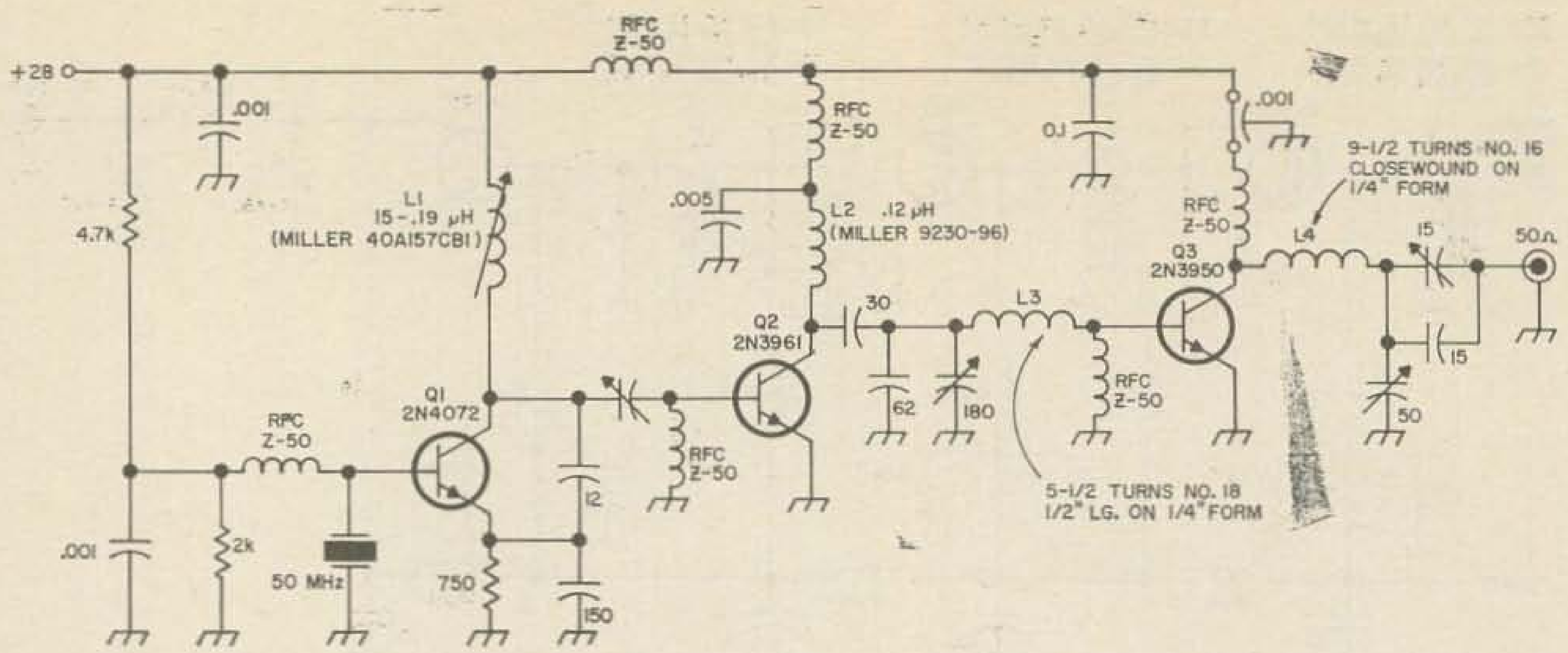


Fig. 55. This 6 meter transmitter provides up to 50 watts of power with very good efficiency and very low harmonics. The 2N3950 in the final provides a minimum power gain of 8 dB on six and is rated at 50 watts continuous service.

Six meter transmitter

The six meter transmitter of **Fig. 55** will provide 50 watts of power into the antenna with very good efficiency and very low harmonics. The second harmonic is suppressed on the order of 28 dB while the third harmonic is more than 34 dB down. The efficiency of the final stage is 69% and the overall efficiency of the entire transmitter is 62%. The bulk of the total current drain of 2.9 A is required by the final amplifier –2.6 A. By choosing each of the circuit components very carefully, a transmitter evolved which uses only three transistors where several more stages are normally required. The mainstay of this transmitter however is the 2N3950 transistor in the power amplifier; this transistor can provide 50 watts of continuous power at 50 MHz with a minimum power gain of 8 dB.

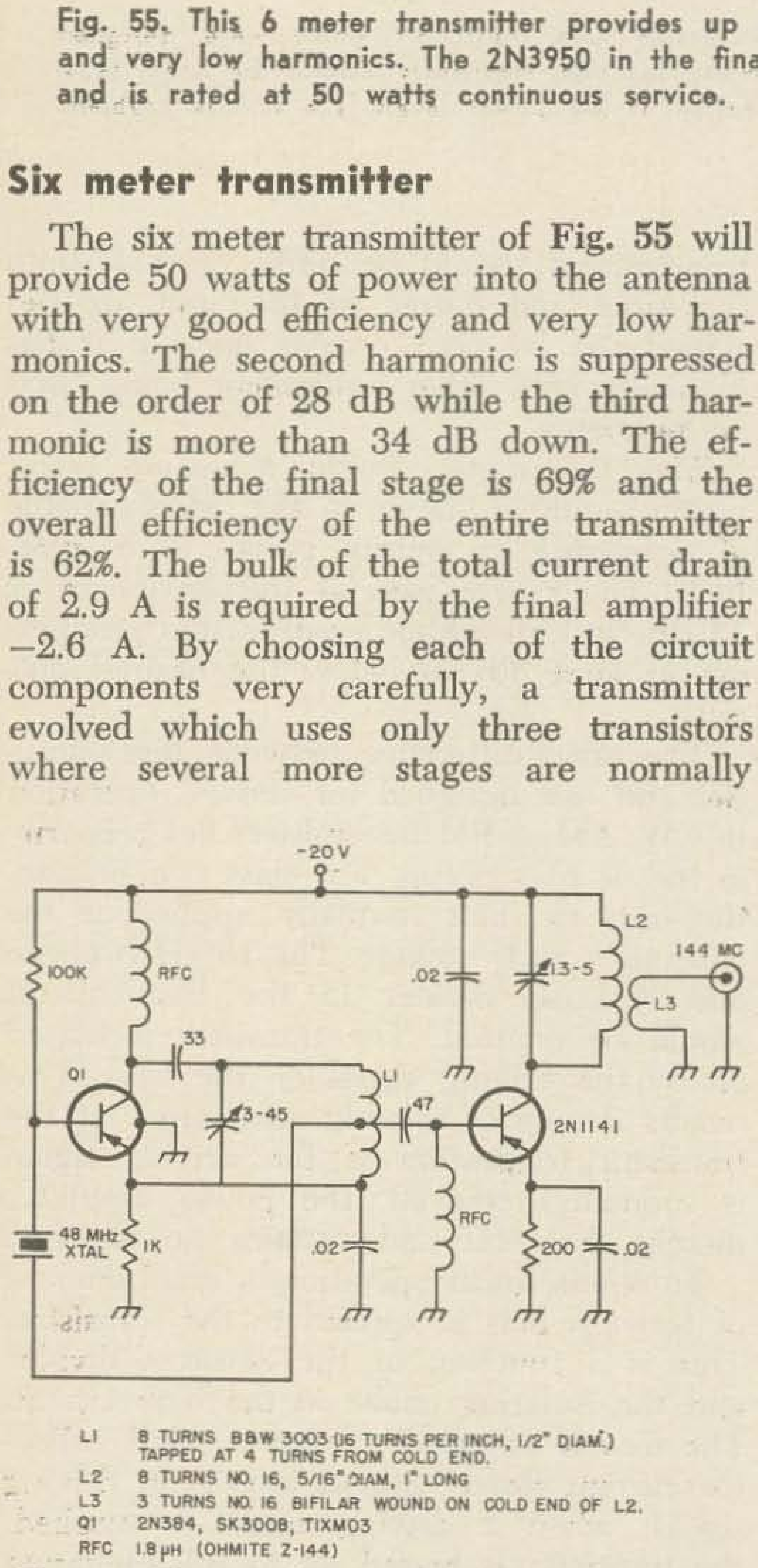


Fig. 56. This simple two meter transmitter may be used as a driver for a larger 144 MHz transmitter or a signal source for testing receivers, converters and antennas.

Two meter driver

The simple two meter driver shown in **Fig. 56** is just about the minimum that is suitable for driving a small 144 MHz transmitter. The first stage of this VHF driver consists of a crystal controlled oscillator operating at 48 MHz; the 48 MHz output from the oscillator is capacitively coupled to the 2N1141 tripler stage tuned to 144 MHz. The two meter output of this circuit is quite low, but sufficient to drive a small power amplifier to a quarter watt or so. This circuit may also be used as a two meter signal source, or as a source for a VHF SSB mixer.

Circuits for Test Equipment

Signal tracer

The signal tracer is a universally used unit of test equipment which may be used for troubleshooting and isolating defective stages in all types of electronic equipment. With a suitable rf probe it may be used to check the operation of rf and *if* amplifiers; with an audio pickup probe it may be used as a straight through audio ampli-

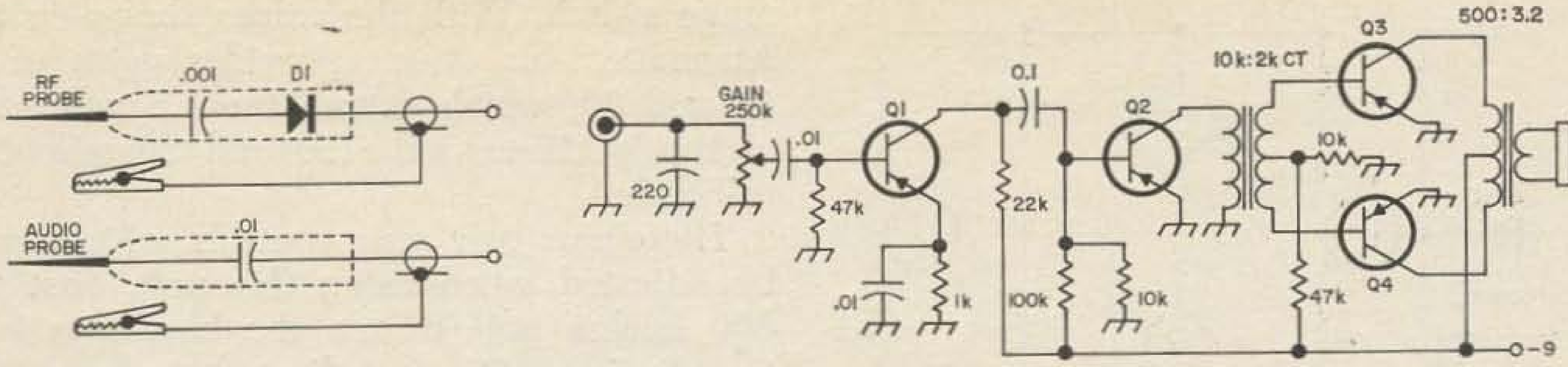


Fig. 57. This signal tracer provides more than adequate audio output with only 100 microvolts of modulated rf at the input. It may also be used for tracing audio circuits, but don't depend on its fidelity. All the transistors are germanium types such as the 2N404, 2N1450, 2N2953, SK3004, GE-2 or HEP-253; the diode in the probe is a IN34A or IN67A or similar.

fier to check microphones and preamps and to detect noise and hum in amplifiers.

The signal tracer shown in **Fig. 57** uses a push pull output stage which produces more than adequate audio output to a miniature speaker with only 100 microvolts input. The output from the probe is applied directly to the 250 kilohm pot, which serves as a gain control and as a diode load when an rf probe is being used. The signal is coupled to the base of the first transistor, amplified, and fed to the driver stage and transformer coupled push pull output.

Only a very small amount of audio signal is necessary to operate the signal tracer as a straight through audio amplifier. However, don't use it to check fidelity because it is designed primarily for maximum sensitivity without regard to frequency response.

When using this signal tracer always start with the audio gain control turned all the way down because it is easy to overload the simple amplifier; the result is a highly distorted output signal. In some receivers the rf probe may load the mixer plate or *if* grid. If this happens, a tone modulated signal should be injected at the antenna terminals of the receiver to obtain a usable output from the signal tracer.

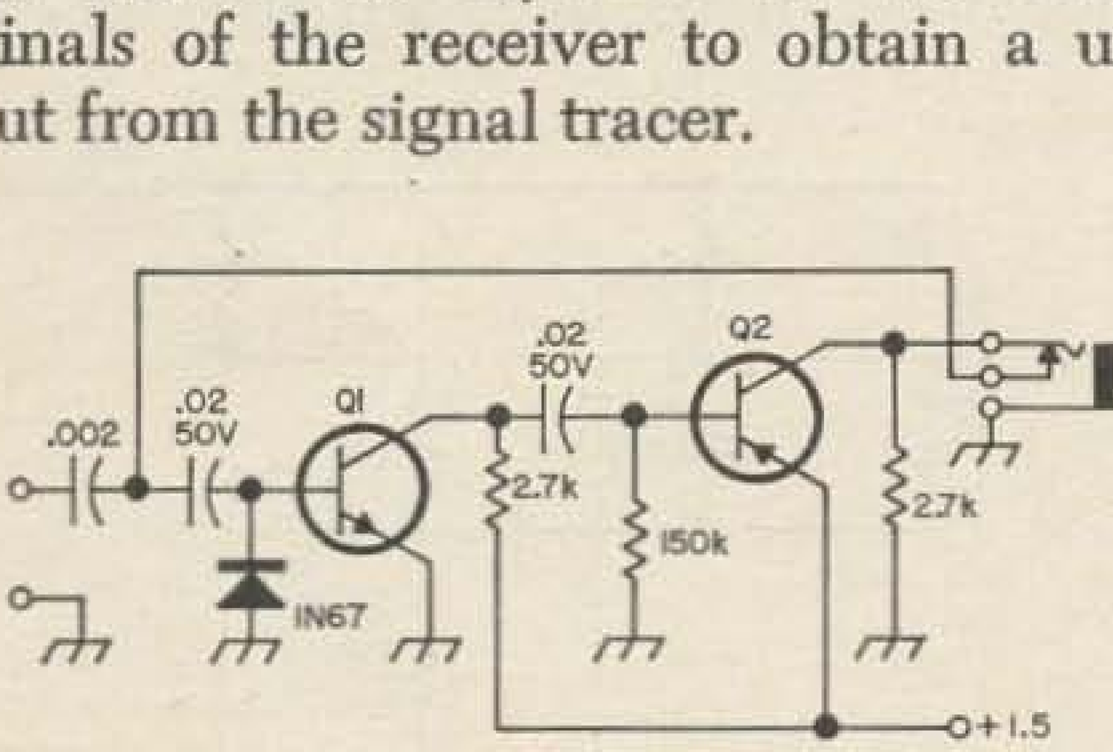


Fig. 58. This signal injector/tracer switches from the injection mode to a signal tracer by simply plugging in a pair of high impedance magnetic earphones. As a tracer is works from audio up to 432 MHz. Transistor Q1 is a 2N170, 2N388A, 2N1605, SK3011 or GE-7; Q2 is a 2N188A, 2N404, 2N2953, SK3004 or HEP-253.

Signal injector/tracer

The circuit illustrated in **Fig. 58** functions as both a signal injector and signal tracer. Furthermore, no switching is required; it's all accomplished automatically when the headphones are plugged in for signal tracing. In the inject mode the circuit is a clamped multivibrator with extremely narrow pulses and high harmonic content. In fact, with this circuit, sufficient output is available for signal tracing from audio (750 Hz) to well above 40 MHz. This frequency range is more than adequate for most requirements.

The unit is switched to the signal tracer mode by simply plugging in a pair of high impedance magnetic headphones. In this mode

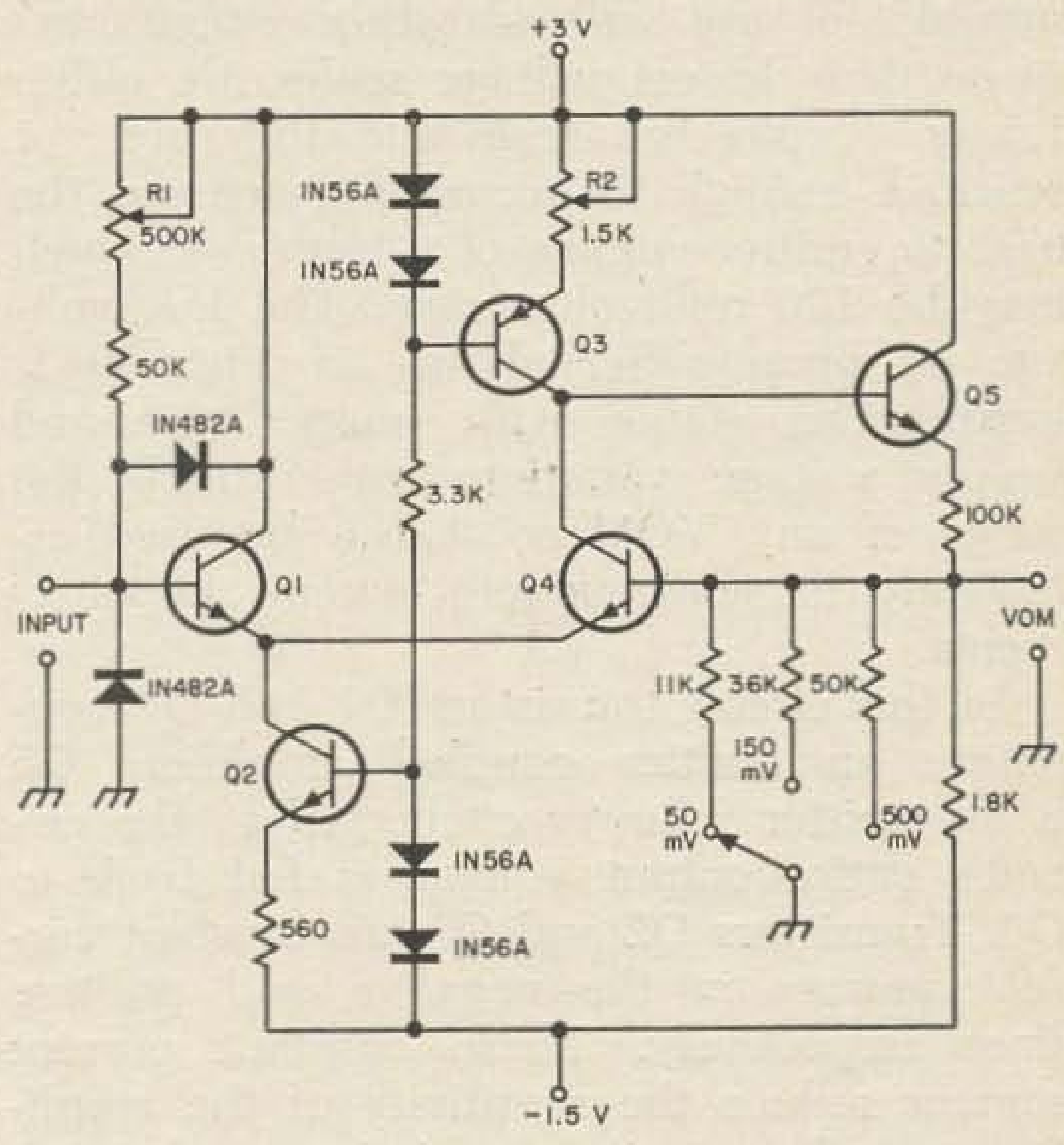


Fig. 59. This VOM range extender increases the sensitivity of your volt-ohm-milliammeter to 50 millivolts full scale; full scale readings of 150 and 500 millivolts are also provided by the range switch.

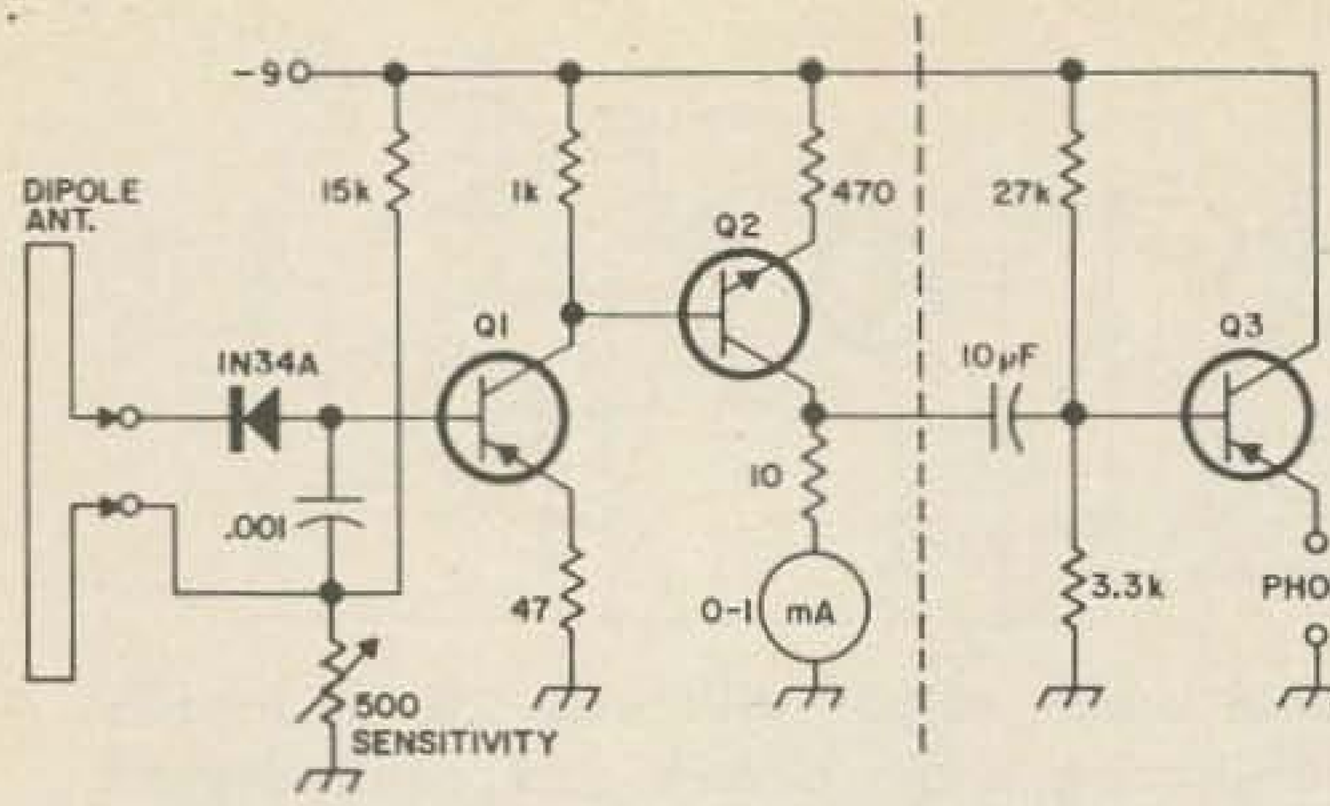


Fig. 60. This monitor/detector may be used for measuring field strength, monitoring modulation or finding hidden transmitters by simply attaching a resonant dipole antenna at the input. Q1 and Q3 are 2N408, 2N2953, SK3004, GE-2 or HEP-253; Q2 is a 2N170, 2N388A, 2N1605, SK3011 or GE-7.

it will detect and amplify signals from 20 Hz to above 432 MHz. Since this circuit only requires about 100 microamperes, no on-off switch is provided. This very small current drain insures that the life of the battery will be nearly that of its shelf life. By using miniature components and a little care in layout, it is possible to mount this complete injector/tracer in an old penlight case or metal cigar tube.

VOM range extender

Most volt-ohm-milliammeters are not too suitable for use with transistor circuits because their lowest voltage scales are either 1.5 or 3 volts full scale and they are not sensitive enough to accurately measure the base to emitter voltage of a transistor which may be 120 millivolts or so. The low voltage dc preamplifier shown in **Fig. 59** is inexpensive, stable with temperature and supply voltage variations yet extends the range of any VOM so it can be used effectively in semiconductor circuit measurements.

In this circuit transistors Q1 and Q4 constitute an emitter coupled amplifier; Q5 is an emitter follower connected so the circuit's entire output voltage is fed back to Q4. Transistors Q2 and Q3 are constant current sources in the negative and positive lines respectively. These constant current sources reduce the sensitivity of the amplifier to voltage supply variations and result in substantially lower drift. To control the gain of the amplifier for different voltage ranges, a portion of the output voltage is fed back to the base of transistor Q4 through the voltage divider selected by the range switch. With the values shown in the schematic, this circuit provides gains of 3, 10 and 30, which extend the 1.5 volt scale of the VOM to 500, 150 and 50 millivolts full scale.

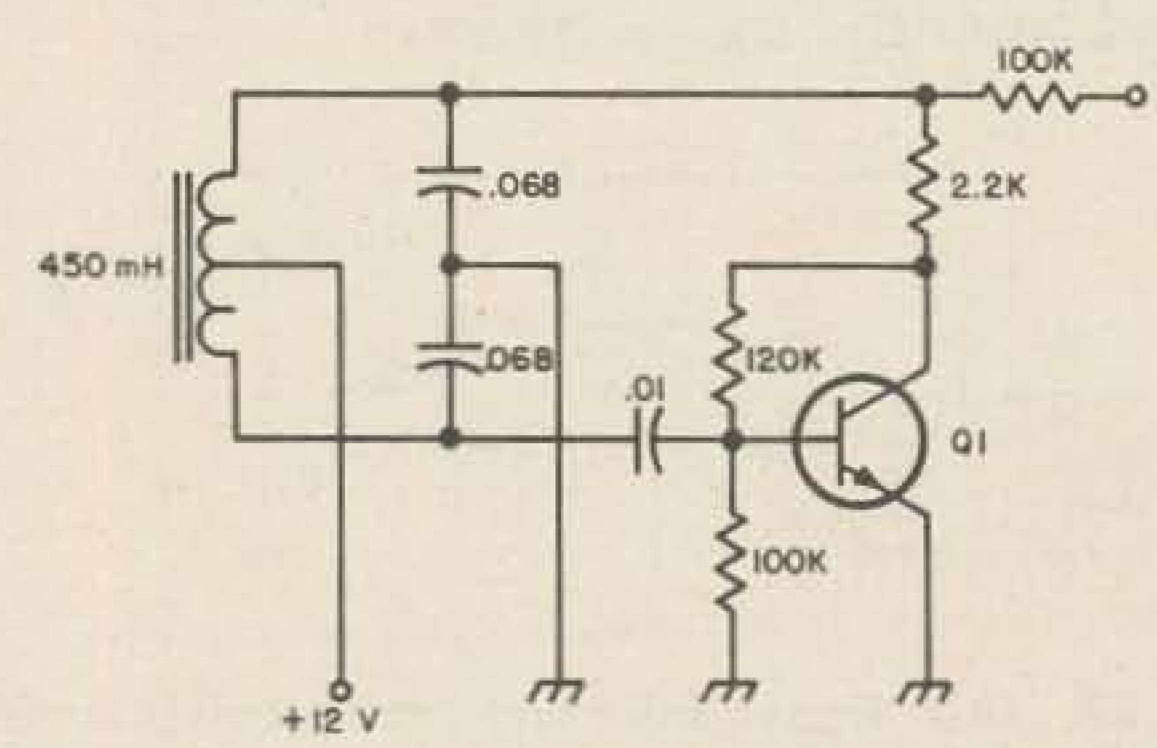
There are two zero controls which must be adjusted when using this unit; first the 500 kilohm pot (R1) in the base bias lead to transistor Q1 is adjusted to zero the output with no input and the base isolated from ground. The 1.5k zero adjust pot (R2) is then adjusted for an output zero with the input leads shorted together.

Monitor/detector

The simple VHF monitor/detector illustrated in **Fig. 60** may be used for measuring field strength, monitoring modulation or even in hidden transmitter hunts. The frequency of use may be simply changed by changing the length of the dipole antenna. In some cases where the rf field is strong enough, a simple vertical pickup antenna will be sufficient for signal monitoring purposes. Furthermore, the use of this monitor/detector is not limited to the VHF bands; the addition of an appropriate antenna will permit its use at any frequency up to about 500 MHz. For lower frequencies where the size of the dipole antenna would be impractical, a simple vertical pickup antenna and tuned resonant circuit may be substituted at the input.

1 kHz oscillator

The simple 1 kHz oscillator shown in **Fig. 61** is very useful for many testing devices around the shop. This circuit is simply a Colpitts oscillator, but the circuit values and feedback have been chosen for maxi-



Q1 - 2N2924, 2N3393, 2N3566

Fig. 61. Simple 1000 Hz oscillator is very useful for testing and measurement around the shack. The Colpitts circuit is used with component values chosen for maximum stability and good waveform.

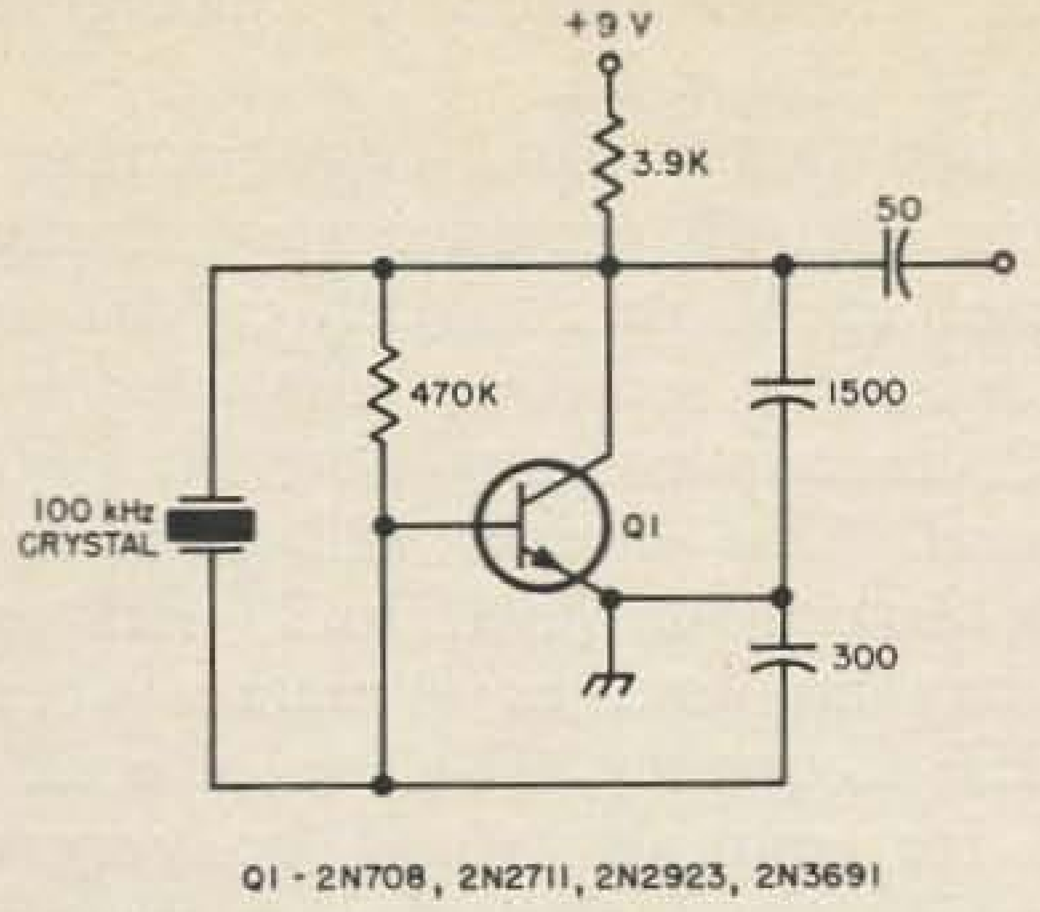


Fig. 62. The 100 kHz calibrator shown here is just about the simplest circuit that will provide usable results. For zeroing in with WWV a small padder capacitor may be added in series with the 100 kHz crystal.

mum stability along with good waveform. It may be used for testing speech and modulation equipment, or even as a driver for a code practice oscillator.

100 kHz crystal calibrators

The 100 kHz crystal oscillator illustrated in **Fig. 62** is just about as simple as you can build and still get a usable output. This circuit will provide usable harmonics up to about 30 MHz but it has no provision for zeroing in with WWV. This feature may be added by simply placing a small variable padder capacitor in series with the 100 kHz crystal.

The calibrator circuit shown in **Fig. 63** is only slightly more complicated than its counterpart in **Fig. 62**, but provides usable harmonics up to 150 MHz and has a built in voltage regulator. In this case the base

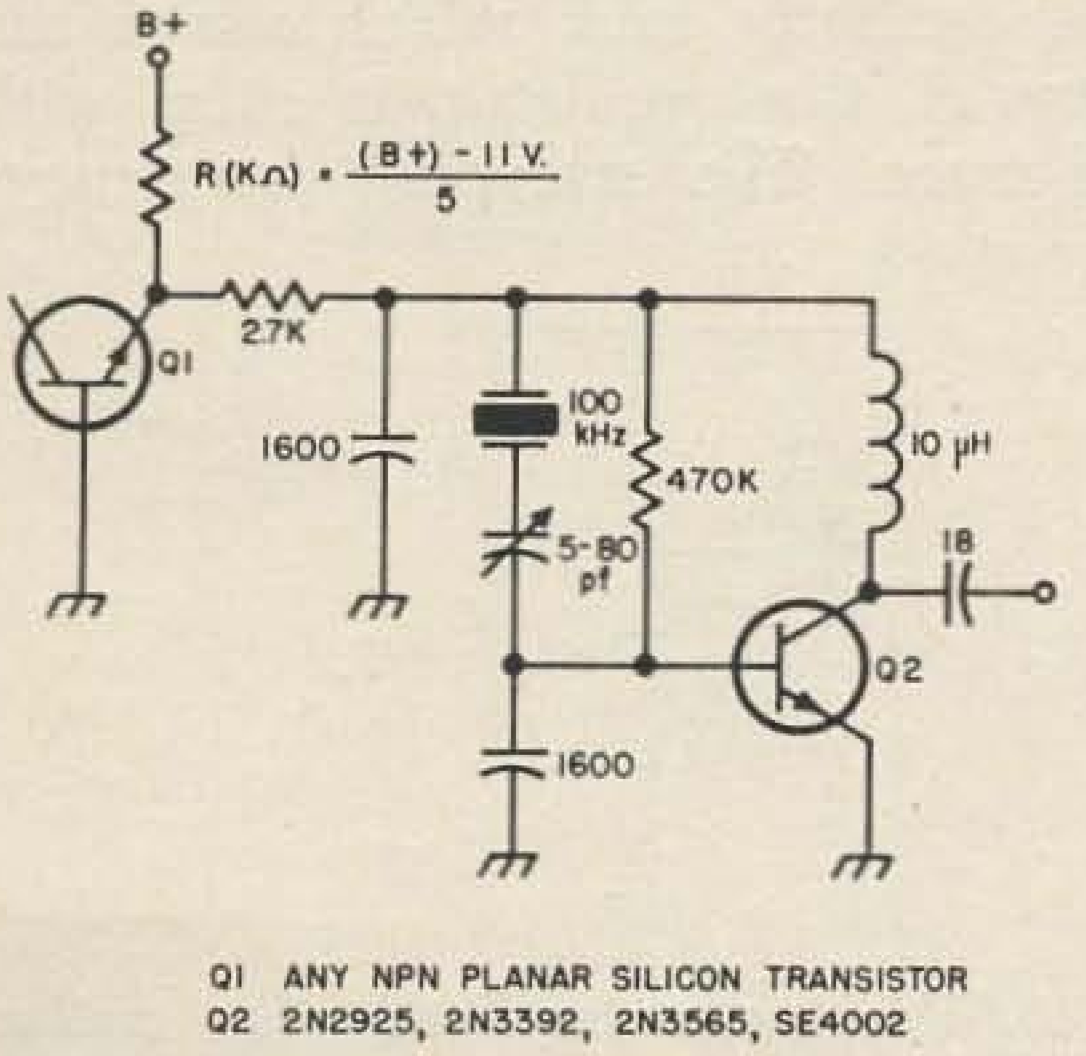


Fig. 63. This 100 kHz crystal calibrator is only slightly more complicated than the one shown in Fig. 62, but has a built in voltage regulator (Q1) and provides usable harmonics up to 150 MHz.

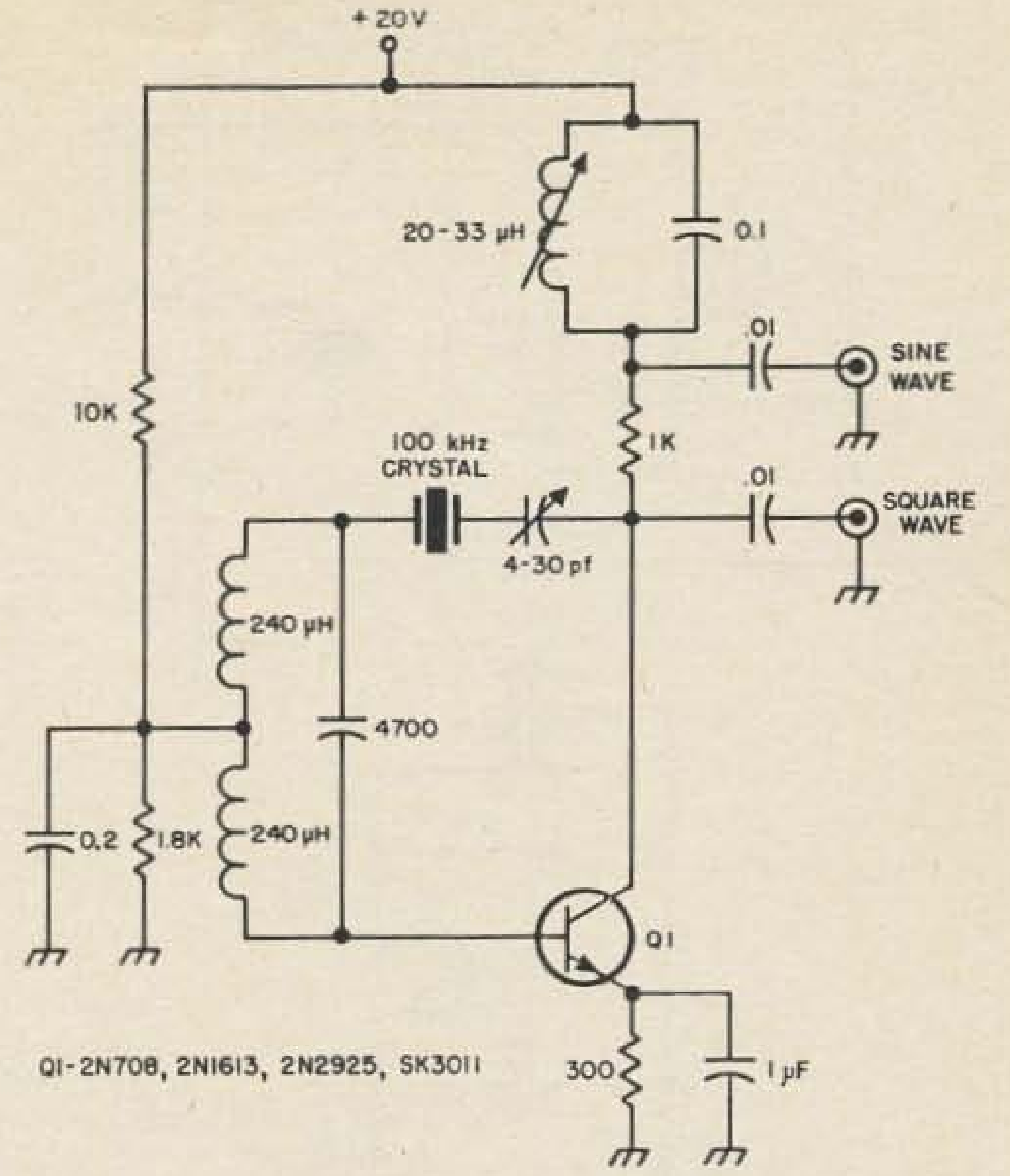


Fig. 64. This 100 kHz crystal calibrator uses a crystal in the parallel mode and provides either a sinusoidal or square wave output. The calibrator may be zeroed to WWV with the 4-30 pF trimmer.

to emitter junction of an NPN silicon planar transistor is connected as a zener diode. When connected in this manner, these transistors provide a regulated voltage of approximately 11 volts. The value of the series dropping resistor may be determined by using the formula shown in the schematic. The 5–80 pF capacitor is for zeroing in with WWV.

The 100 kHz crystal controlled oscillator shown in **Fig. 64** uses a low cost silicon transistor, and provides both a square wave and sine wave output with excellent frequency stability. The oscillator circuit is basically the Hartley type with positive feedback from the collector to base through a phase reversal in the tapped tank circuit, consisting of two 240 µH chokes and a 4700 pF silver mica capacitor. The oscillator frequency is determined by the resonant frequency of the very high Q series LC network in the feedback loop. This network is made up of the 4–30 pF variable capacitor and quartz crystal which operates in the parallel mode. The variable capacitor provides a fine frequency adjustment control. Feedback is sufficiently large to assure normal circuit operation almost completely independent of transistor gain. The large amount of feedback drives the collector from cutoff to saturation, making a square

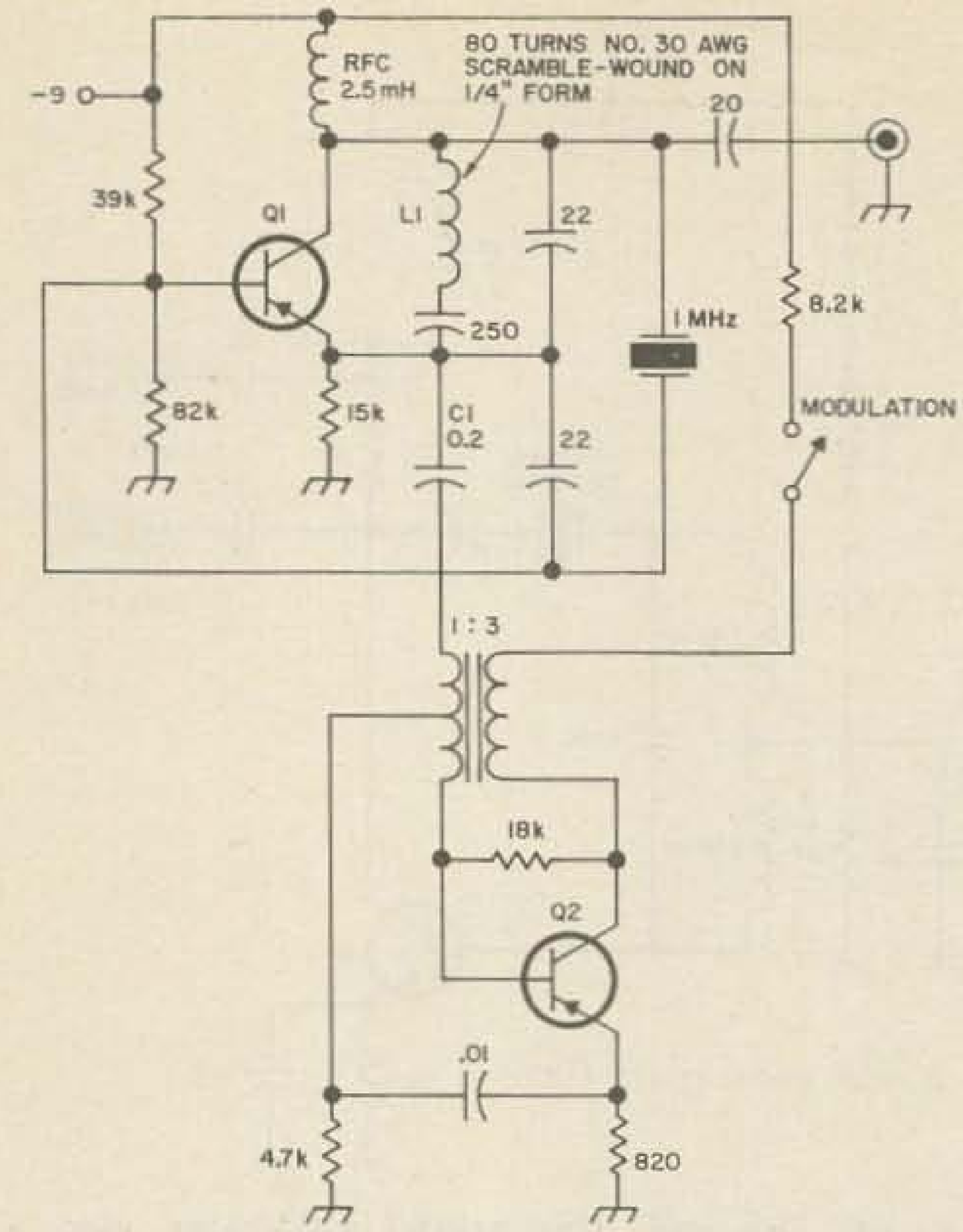


Fig. 65. This crystal controlled oscillator provides very distinctive markers up to 30 MHz. The modulation frequency is approximately 1000 Hz, but by changing the value of C1 it may be changed slightly. Q1 is a 2N384, 2N1742, 2N2362, 2N2084, TIM10, GE-9 or HEP-2; Q2 is a 2N2613, 2N2953, 2N1303, SK3004, GE-2 or HEP-254.

wave available at the output. A sine wave is developed across a tunable high Q tank and is also available at the output.

Modulated band edge marker

The crystal controlled calibration oscillator shown in **Fig. 65** is especially useful for band edge marking and providing distinctive crystal controlled markers up to 30 MHz. To assist in identification of the marker, particularly at the higher frequencies where the harmonics are quite weak, the note may be modulated by simply turning on the audio oscillator. The modulation frequency of this unit is about 1000 Hz, but it may be changed slightly by changing the value of C1. If the oscillator fails to oscillate when power is applied, reverse the connections on one side of the transformer. At the lower frequencies the output of the calibrator may be coupled into the antenna circuit of the receiver by inductive coupling, but on 15 and 10 meters, a direct connection to the antenna terminals may be necessary to obtain sufficient output. Although this circuit is designed for a one MHz crystal, other crystal frequencies may be accommodated by changing the number of turns in L1.

The two meter band edge marker illustrated in **Fig. 66** provides very strong harmonics of an 18 or 24 MHz crystal on 144 MHz; when a sensitive converter is used on 432, harmonics may also be heard on this band. This circuit will oscillate with crystals throughout the 18 to 24 MHz region, so it may be used as a marker at almost any VHF frequency. The use of a 20 MHz crystal for example would be very useful for marking the lower edge of the amateur 220 and 420 MHz bands. If a modulated marker is desired, the audio oscillator (Q2) of Fig. 65 may be coupled into the base of the oscillator through a 0.2 μF capacitor.

Sweep frequency generator

More and more hams are finding out that the sweep generator is one of the most useful test instruments to have around the shack. It may be used to align communications receivers, VHF converters, to plot response curves and to check bandwidth. The circuit illustrated in **Fig. 67** is a very simple unit that may be used at any spot frequency between 100 kHz and 60 MHz. Although a three range bandswitch is shown in the drawing, it may be omitted if only one spot frequency is required (455 kHz for example).

The sweep generator shown here consists of a single unijunction transistor sawtooth generator which provides the sweeping signal for the oscilloscope and the fixed tuned rf oscillator. The output of the sawtooth generator is connected across a 56 pF varicap in the oscillator tank which varies the frequency of the oscillator in step with the scope trace. The sweeping frequency may

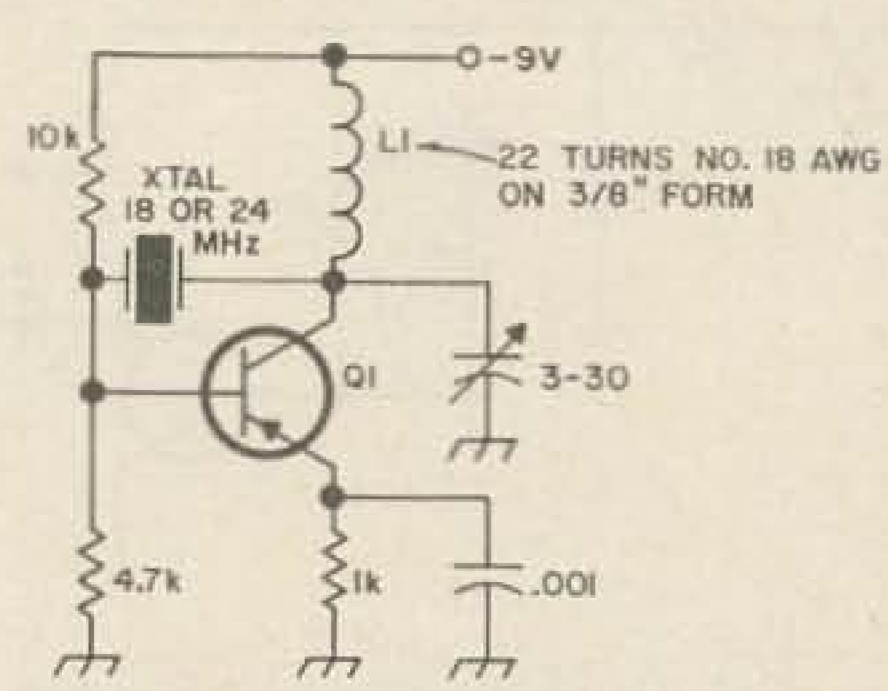


Fig. 66. This two meter band edge marker provides useful harmonics up to several hundred MHz with 18 or 24 MHz crystals. If modulation is desired, the audio oscillator from the circuit of Fig. 65 may be coupled into the base. Q1 is a 2N1745, 2N2362, or HEP-2.

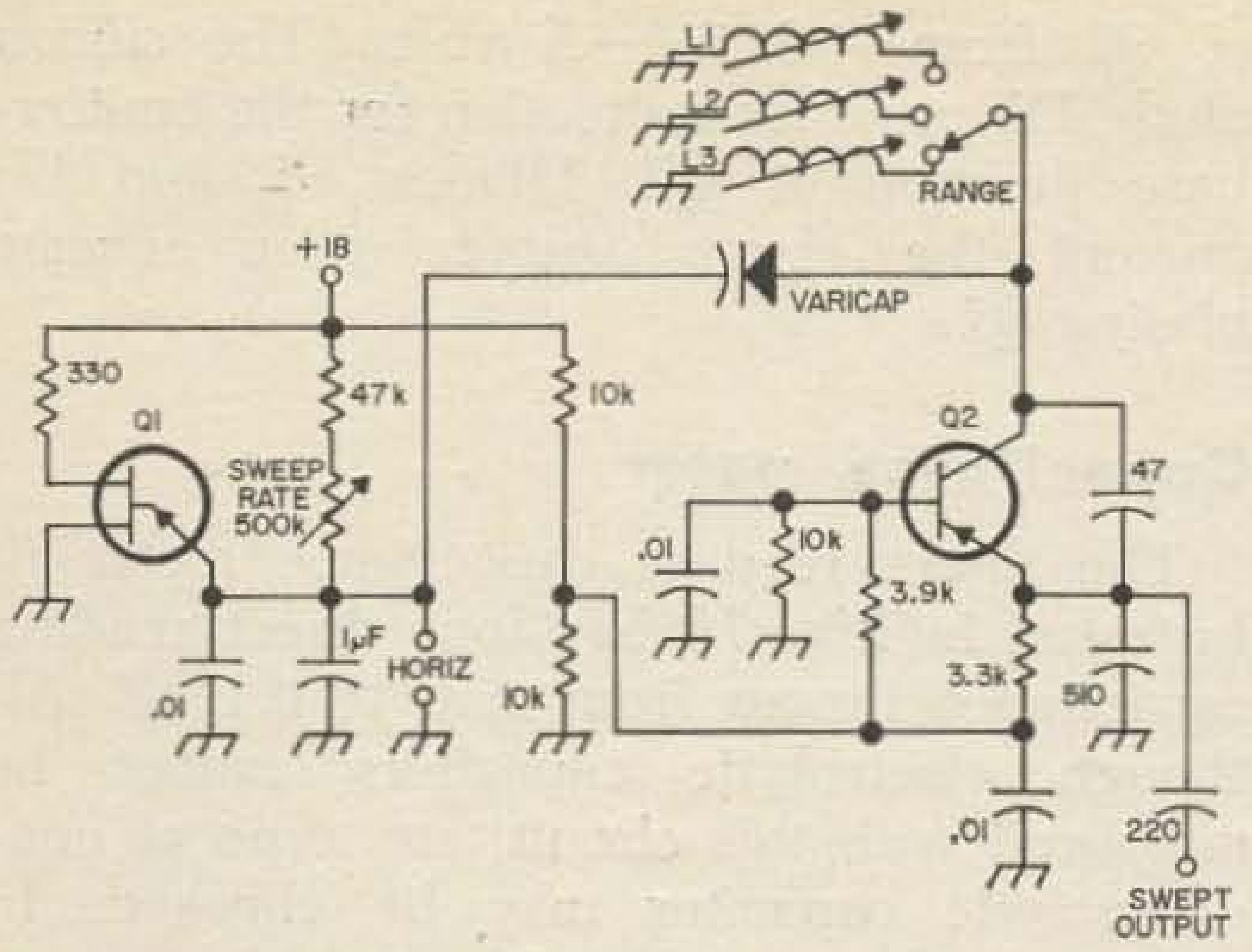


Fig. 67. A sweep frequency generator is a very handy gadget, but many times the commercial units are more complicated than the ham requires. This simple sweeper may be used at any spot frequency between 100 kHz and 60 MHz by simply using the coils listed in Table 2. By using a three position range switch, the three most popular frequencies may be used, such as 455 kHz, 1600 kHz and 10.7 MHz. Q1 is a 2N1671, 2N2160, 2N2646, 2N3480. or HEP-310; Q2 is a 2N741, 2N1747, 2N2188, GE-9 or HEP-2. The varicap is a 56 pF capacitance diode such as the 1N955 or TRW V56.

be varied between 5 and 30 sweeps per second with the 500k sweep rate control.

The center frequency of the swept output is determined by the coils that are connected across the range switch. A listing of coils for all frequencies from 65 kHz to 60 MHz is listed in Table 2. When using this generator, always use the slowest sweep speed that will provide a usable trace on your oscilloscope. The slower the sweep speed, the more accurate the reproduction of the response curve; if the generator is swept at too fast a rate, the resonant circuit being swept may ring and distort the curve.

Table 2
COILS

Frequency	Miller No.
65 kHz—140 kHz	9007
95 kHz—190 kHz	9006
150 kHz—300 kHz	9005
190 kHz—550 kHz	9004
380 kHz—1000 kHz	9003
700 kHz—1.8 MHz	9002
1.4 MHz—3.7 MHz	9001
3.7 MHz—4.7 MHz	4508
4.7 MHz—5.9 MHz	4507
5.9 MHz—7.5 MHz	4506
7.5 MHz—10 MHz	4505
10 MHz—14 MHz	4504
14 MHz—18 MHz	4503
18 MHz—23 MHz	4502
23 MHz—29 MHz	4304
29 MHz—36 MHz	4303
36 MHz—45 MHz	4302
45 MHz—60 MHz	4301

Sawtooth generator

Sawtooth generators are very useful in many measurements and their circuitry may be greatly simplified by the use of field effect transistors. When conventional junction transistors are used for this purpose, complex feedback networks and methods of compensation must be used to generate a linear voltage ramp. The output waveform of the sawtooth generator shown in **Fig. 68** is linear within 2% and may be adjusted from 1 kHz to 3 kHz by the center frequency control. The thermistor R1 provides temperature stability and circuit loading is reduced by the use of a source follower at the output.

Square wave generator

The square waves available from most inexpensive signal generators deteriorate pretty badly at the higher frequencies. In

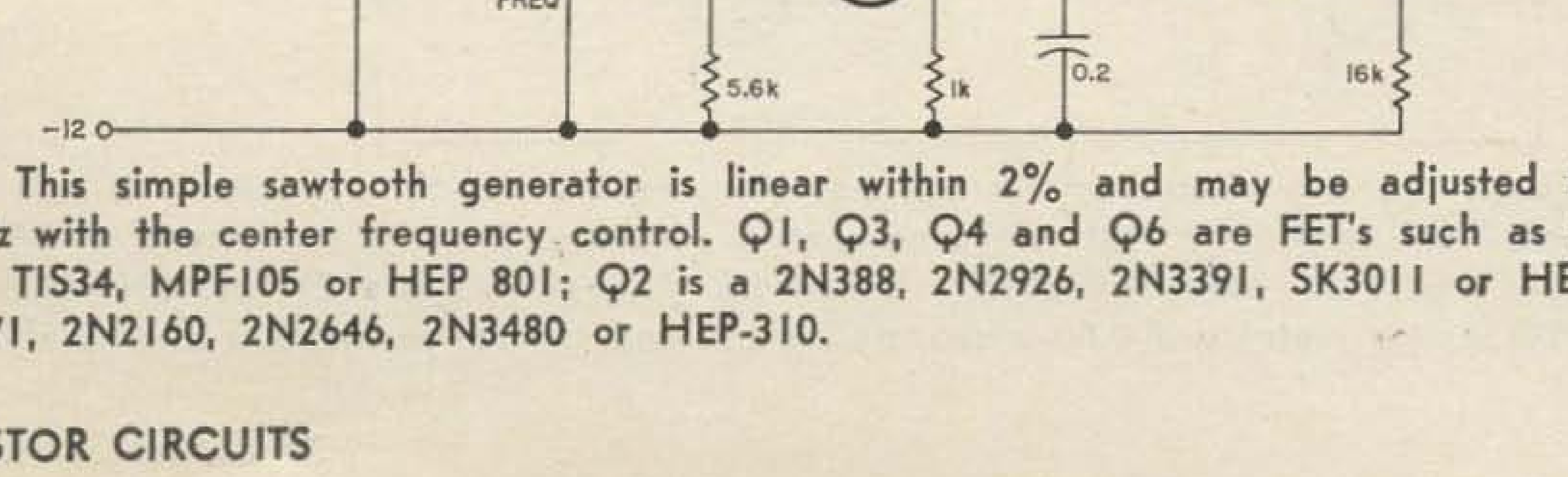
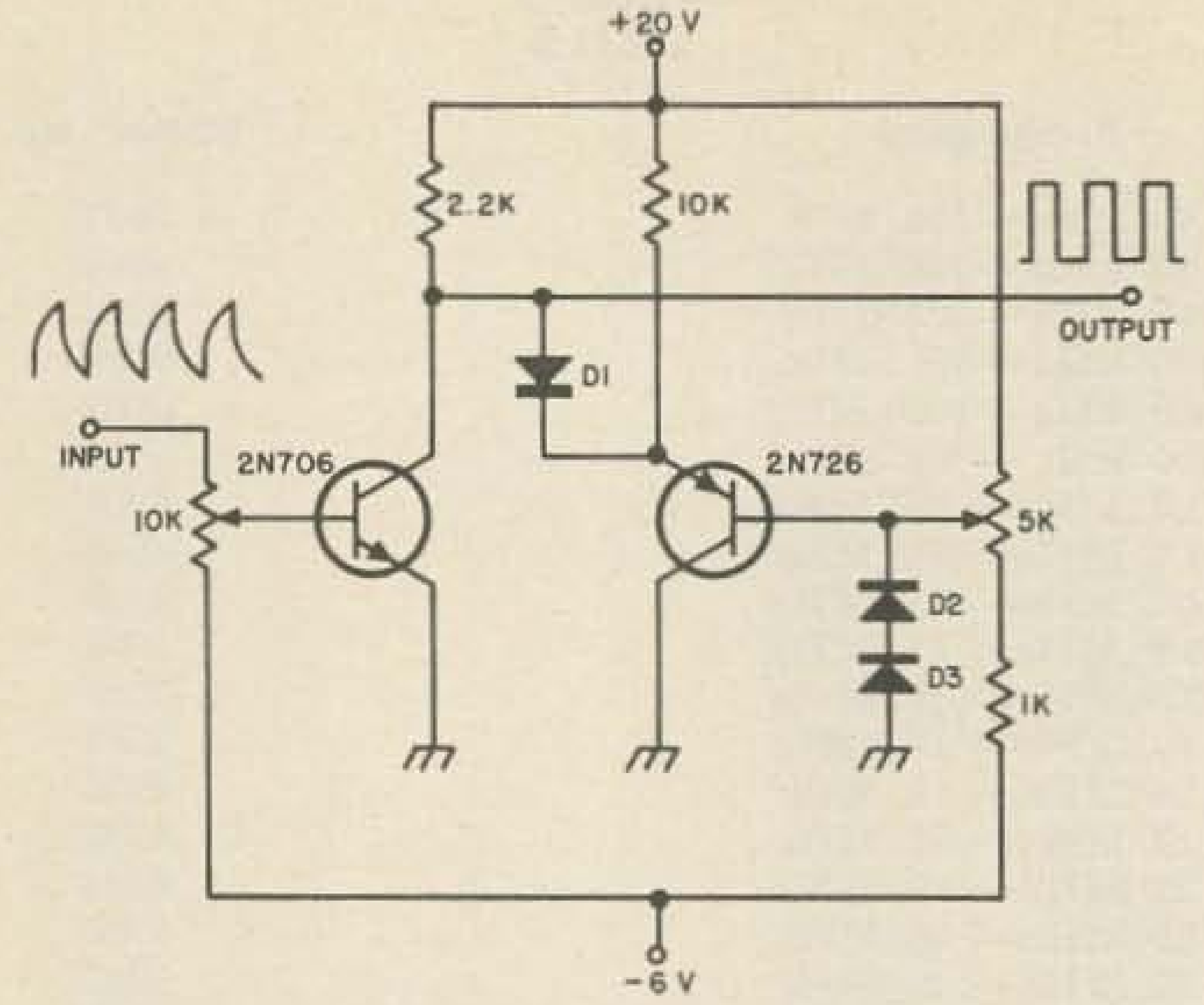


Fig. 68. This simple sawtooth generator is linear within 2% and may be adjusted from 1 kHz to 3 kHz with the center frequency control. Q1, Q3, Q4 and Q6 are FET's such as the 2N3819, 2N3820, TIS34, MPF105 or HEP 801; Q2 is a 2N388, 2N2926, 2N3391, SK3011 or HEP-54; Q5 is a 2N1671, 2N2160, 2N2646, 2N3480 or HEP-310.



ALL DIODES GENERAL PURPOSE SILICON

Fig. 69. The square wave output of many inexpensive signal generators deteriorates quite badly at high frequencies, but this circuit will square them off again. The diodes may be any inexpensive computer type such as the 1N914.

addition, the output amplitude often varies with frequency. The addition of the simple circuit illustrated in **Fig. 69** to the output of the signal generator will provide a good square wave output with an amplitude that does not vary with frequency.

In this circuit, Q1 is an inverter, while Q2 and the 5 kilohm amplitude control pot provide a variable clamp voltage for the output. In most cases, the necessary positive and negative voltages may be obtained from the signal generator's internal supply. The input potentiometer should be adjusted for best output waveform. Once this control is set, it will not change unless the signal generator varies significantly. Ideally, this control should be adjusted so that the input signal provides a voltage swing at the base of Q1 from +3 to −5 volts. The silicon diode D1 provides protection for the emitter-base junction of Q2. Diodes D2 and D3 prevent the clamp voltage from reverse biasing Q1.

Capacitance meter

The direct reading capacitance meter illustrated in **Fig. 70** has four direct reading capacitance ranges from zero to 0.1 μF. Although electrolytic capacitors cannot be measured with this circuit, any type of non-electrolytic capacitor may be checked. In fact, it works as well with variable capacitors as with fixed; the meter deflection will follow the capacitance change as it is tuned. The four direct reading ranges are 0-200 pF, 0-1000 pF, 0-0.01 μF and 0-0.1 μF. The lowest capacitance which may be accurately read is 4 pF, but 2 pF may be estimated quite easily.

In this circuit transistors Q1 and Q2 are connected in a conventional free running multivibrator. The output from the collector of Q2 is a constant amplitude square wave whose frequency is determined by the values of the resistors and capacitors connected across the base circuit of Q1 and Q2. The square wave output from the collector of Q2 is coupled through the unknown capacitor connected across the test terminals to the metering circuit consisting of the 1N34A diode, the potentiometers and the dc microammeter. For any given square wave frequency, the deflection of the meter will be directly proportional to the capacitance across the test terminals. For example, if a precision 100 pF capacitor is connected across the test terminals and the calibration pot is set for full scale deflection, the

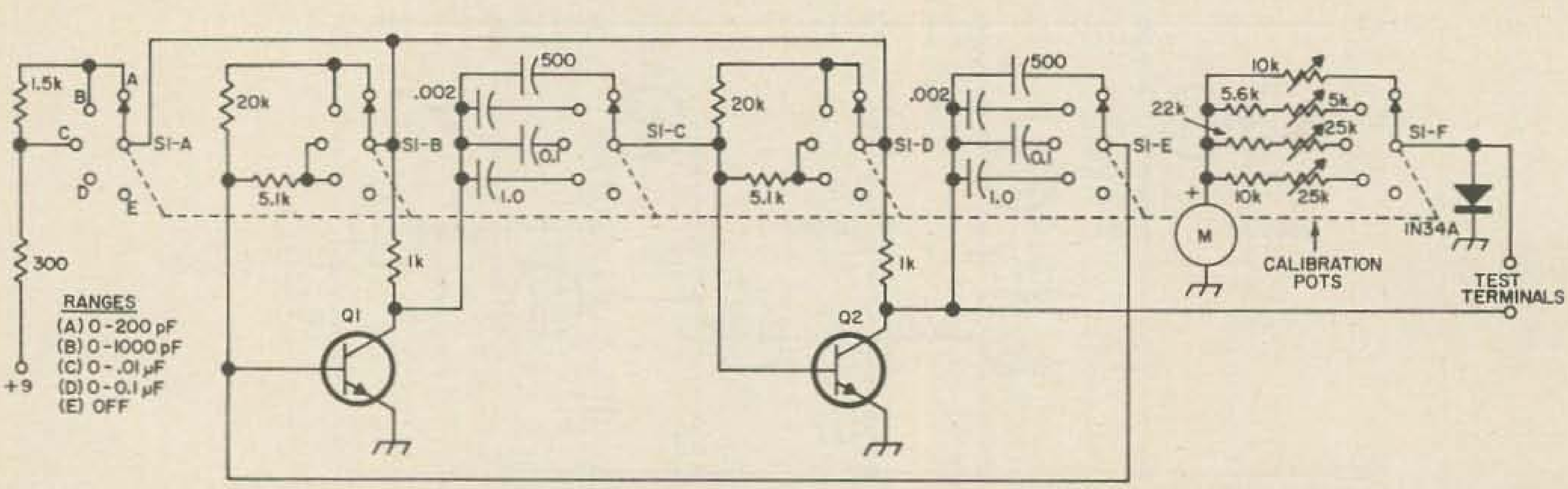


Fig. 70. Although this capacitance meter will not measure electrolytic capacitors, it will measure any other type from zero to 0.1 μF with reasonable accuracy. On the lower end 4 pF can be read accurately and 2 pF easily estimated. Transistors Q1 and Q2 are 2N168, 2N1605, 2N2926, SK3011 or HEP-54; the meter is a 0-50 microampere unit and the range switch a Centralab PA1021.

meter will have a range from zero to 100 pF. The response of this circuit is essentially linear, so 50 pF would provide half-scale deflection, 1/10 scale deflection would indicate 10 pf, etcetera. To change the range, the frequency of the multivibrator is changed by choosing new values of resistance and capacitance in the base circuits of Q1 and Q2.

Calibration of the direct reading capacitance meter requires the use of four accurately known capacitors–0.1 μF, 0.01 μF, 1000 pF and 200 pF. These capacitors should be very carefully chosen because the accuracy of the completed meter depends on the tolerance of the calibration capacitors. In addition, it is essential that they are not leaky; if they are, the calibration will not be accurate. To calibrate the meter, set the range switch in the appropriate position, connect the respective calibrating capacitor across the test terminals, and adjust the calibrating potentiometer for full scale deflection of the meter.

Although electrolytic capacitors cannot be measured on this instrument, it will check all other types. If a capacitor is open, there will be no deflection on any range. If it is leaky or shorted, the meter will deflect below zero. It is imperative that leaky and shorted capacitors be immediately disconnected from the test terminals to prevent damage to the diode and microammeter.

High impedance scope probe

Most oscilloscope probes are unsuitable for use with high impedance circuits because they severely load them down. By using the high input impedance characteristics of the field effect transistor, an extremely high impedance probe may be produced. The circuit shown in **Fig. 71** uses the bootstrap action of the 500 megohm resistor to raise the input impedance of the circuit to 1200 megohms. The 2 kilohm feedback resistor from the collector of Q2 maintains unity gain while the 5k potentiometer provides circuit equalization. The rise time of this circuit is extremely fast, typically less than half a microsecond. In addition, it can handle up to two volt signals (peak to peak) without distortion.

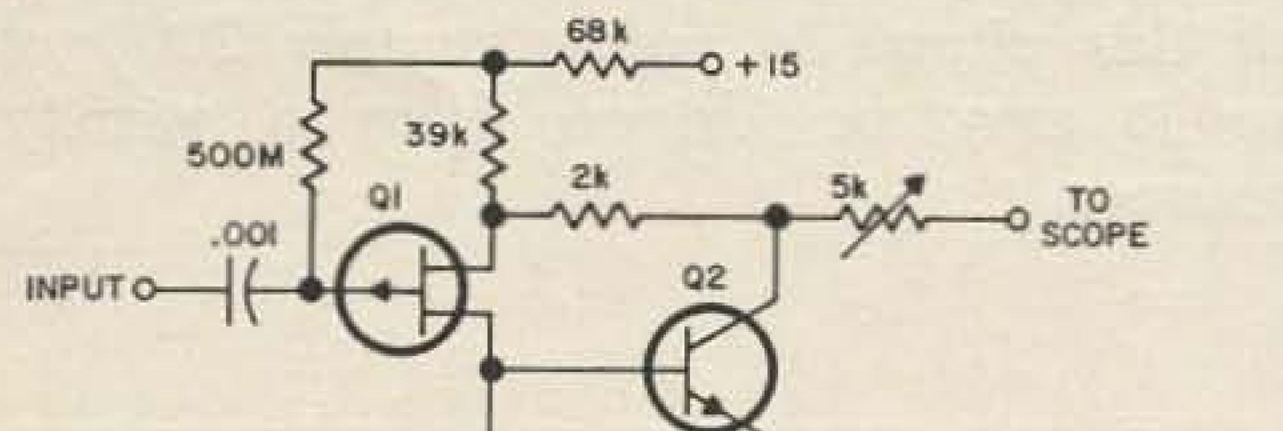


Fig. 71. This high impedance probe provides about 1200 megohms input impedance with unity gain. Upper frequency equalization is provided by the 5K pot. Q1 is a U112, 2N2607, 2N4360 or TIM12; Q2 is a 2N706, 2N708, 2N2926, 2N3394, or HEP-50.

Microammeter amplifier

The sensitive microammeter amplifier illustrated in **Fig. 72** may be adjusted from approximately 2 μA to 100 μA full scale deflection each side of zero. The input impedance of this circuit is 60 kilohms at 2 μA sensitivity and 2.5 kilohms at 100 μA sensitivity; total battery drain is 1.5 mA.

In this circuit a differential amplifier with degenerative biasing and collector meter feed provide a satisfactory compromise between sensitivity and stability. The transistors used in this circuit should be chosen for high current gain throughout the emitter current range; in addition, they should exhibit very low leakage currents. The 50 ohm null potentiometer is used to compensate for any differences in the base-emitter voltage of the two transistors. The balance pot is used to compensate for dif-

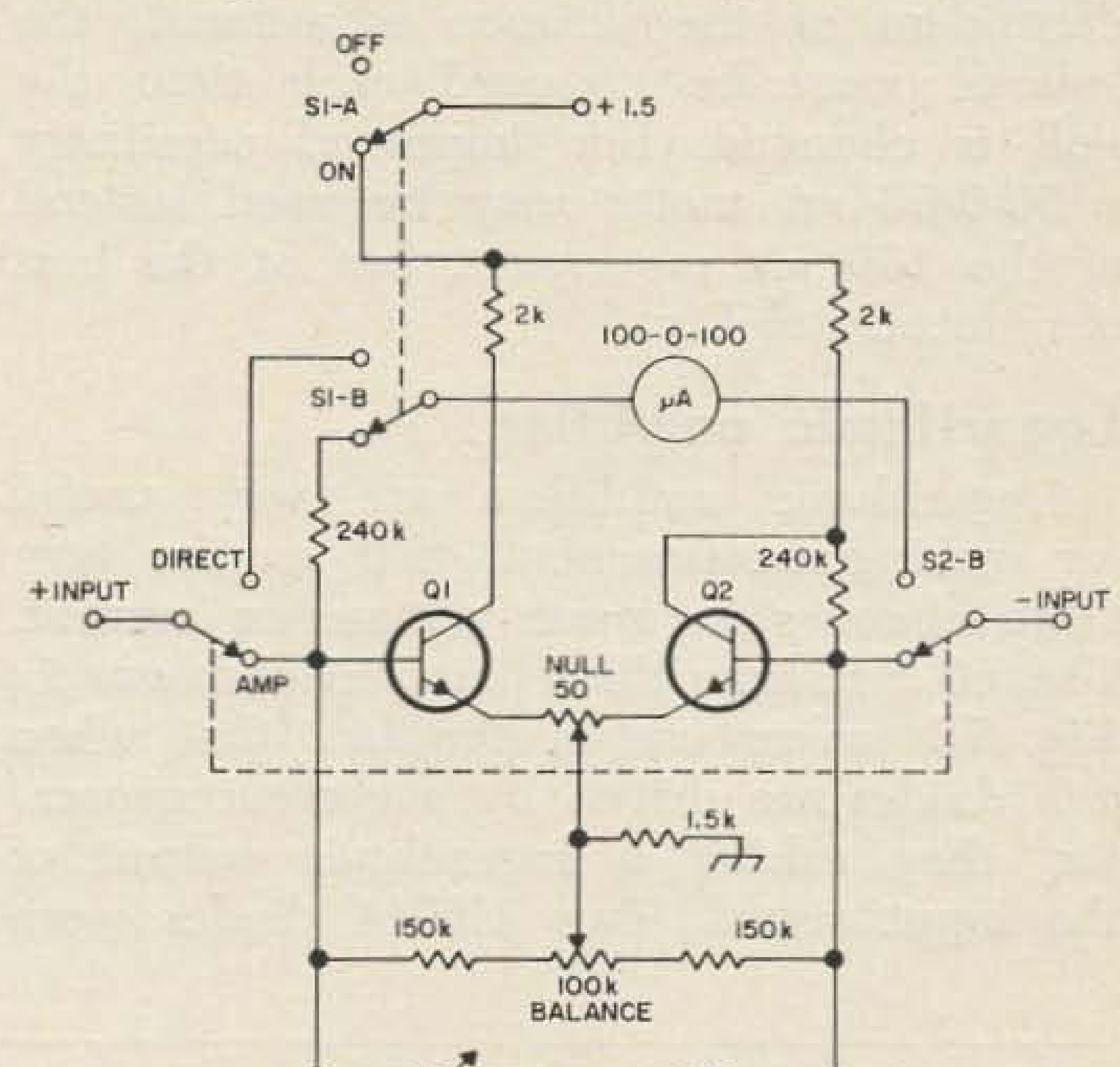


Fig. 72. This very sensitive microammeter amplifier may be adjusted from 2 μA to 100 μA each side of zero; the input impedance varies from 60K at 2 μA to 2.5K at 100 μA. Transistors Q1 and Q2 are 2N930, GE-10 or HEP-50.

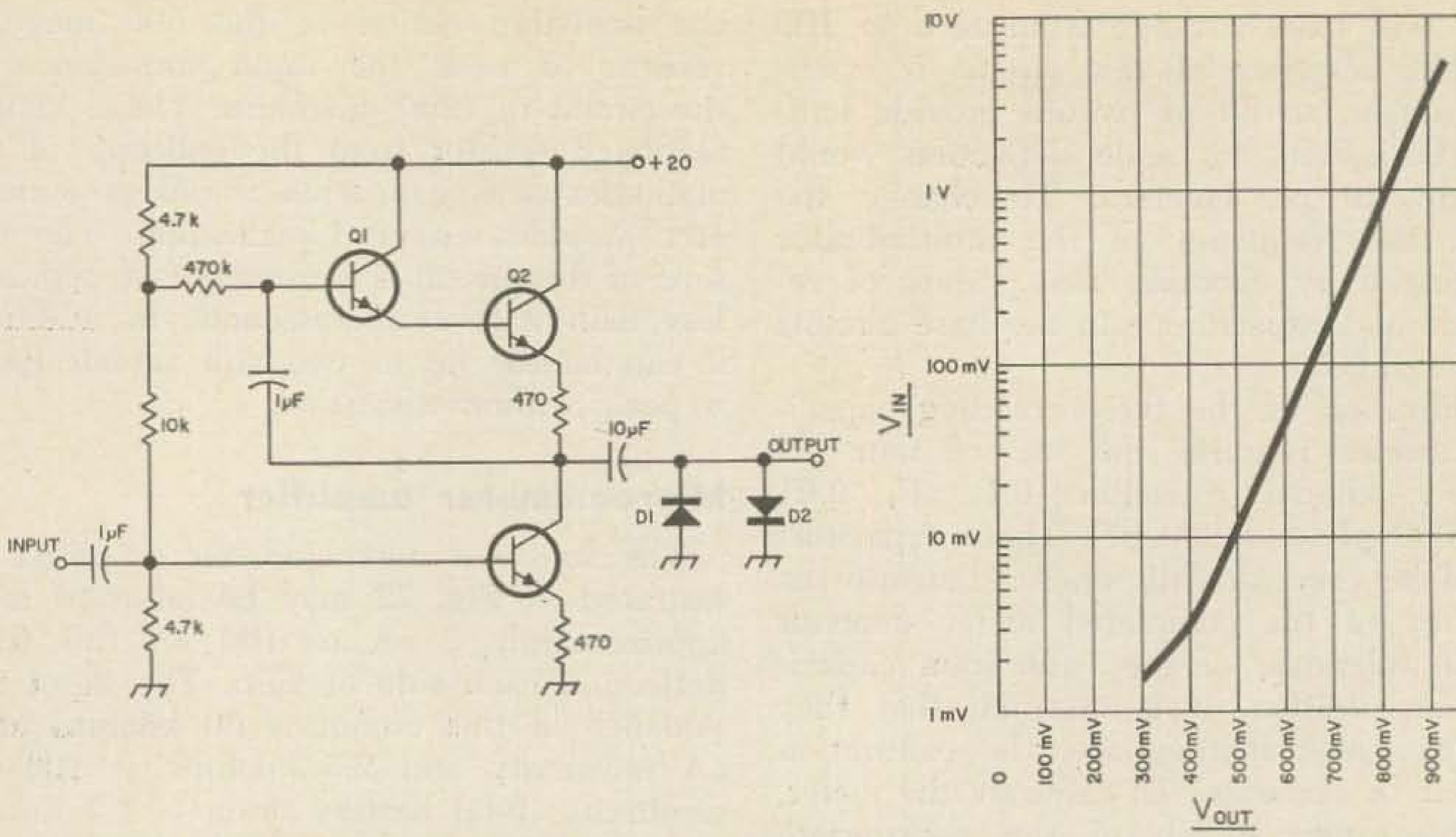


Fig. 73. This logarithmic amplifier makes use of the fact that when two back to back diodes are driven by a current generator, they exhibit a logarithmic output of the input signal. With the circuit constants shown, this amplifier follows a nearly perfect logarithmic curve over a 60 dB range; selected diodes will increase this to 80 dB. Q1, Q2 and Q3 are 2N2924, SK3019, GE-10 or HEP-54; D1 and D2 are 1N914.

ferences in components and transistor current gain.

The null adjustment is made with S3 depressed, S1 on and S2 on "amplifier." The balance is adjusted with S1 on and S2 on "direct." Although the null is completely independent of the balance adjustment, the balance must be changed each time the null is changed. For improved sensitivity a 50-0-50 μA meter may be used instead of the 100 μA movement, but at the cost of reduced stability.

Logarithmic amplifier

Logarithmic amplifiers are very useful for making measurements that require very large changes in input voltage or current. The 60 dB logarithmic amplifier shown in Fig. 73 makes use of the fact that when two diodes are driven by a current generator, they exhibit a logarithmic output of the input signal. Two 1N914 diodes were chosen for this amplifier because they follow an almost perfect logarithmic curve over a 60 dB range; by selecting diodes, it is possible to obtain the same type of curve over an 80 dB spread.

To insure that load changes are not affected by Q1, its output impedance must be extremely high; to cover the 60 dB range for example, the impedance must exceed 100 kilohms. This is accomplished by the Darlington pair, Q1 and Q2 and the 470 ohm resistor in the emitter of Q2. If Q3 is maintained in its linear range, its ac collector current is completely independent of the collector load. Hence, it presents a very high output impedance to the diodes; greater than 100,000 ohms with almost any silicon planar transistor. The input impedance of this circuit is approximately 2000 ohms, so it may be driven from a variety of sources.

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The Importance of Being Grounded

Ground paths and ground connections are important at all frequencies from dc on up. As the frequency increases, however, the ground path becomes trickier and harder to predict. When time is spent making any ground path neat, direct and predictable, a potentially serious source of trouble in the circuit is eliminated.

Have you ever had rf all over the shack or a power amplifier or *if* strip just not act right? The trouble could be lack of a secure, solid, short rf return path to the cathode or emitter of the stage. An example of the need for a good return path is probably a few feet away as you read this. Notice the cord to the lamp you are probably reading by. It contains two wires, one to supply current to the lamp, and the other to allow the current to return thru the transformer. Notice (or be informed!) that both wires are the same size, correctly inferring that both are of equal importance. Remove one of the wires and no light! So watch your grounds and regard them as equal in importance with the coils, capacitors and other components of your rf circuits.

An unpredictable ground on a power amplifier can produce rf all over the shack. To see why, let's remind ourselves of a few things about radio frequency energy. rf current always takes the path of least resistance and inductance. If a less inductive route exists around a long path than thru a shorter path broken by a bolted joint or partition, then the current will go the long way. Partitions are harmful to the return path because when they are tight, rf currents cannot go around them, nor can they penetrate thru to the other side. A phenomenon called skin effect causes rf currents to run only along the surface of a conductor, penetrating less than 10 mils at even the lowest amateur frequency in aluminum, even less in copper.

Additional things to remember are that bolted joints are always lossier than a straight plate, and rf energy does not like to go around sharp corners or around edges of material to get where it's going.

The way some power amplifiers are built, it's a wonder that they are as stable or as interference free as they are. Imagine the rf return current from a high power amplifier having to sneak along the chassis, once it leaves the output connector, going under partitions and across bolted joints to get back to the PA cathode. More than a bare minimum of it is going to go around, travelling along the outer surface of the rig. When this happens, the chassis radiates and sometimes develops an appreciable difference of potential from surrounding and perhaps better grounded metallic objects. Presto—a rig that produces rf in the shack.

What does one do about all of this? Simply provide a neat, direct and predictable ground for the stage. A flat piece of copper or other conductor run directly from the output connector to the cathode is best, a heavy wire can be used to get by on.

If no reasonably thin copper strap is available a favorite (and enjoyable) stunt is to cut a beer can at the seam (must be emptied first) and scrape away the lining where it is desired to solder. The half quart size is (smack) best. Aluminum is less satisfactory to use as all connections are normally only bolted down and a connection to the tube base and the cathode pin directly from the nearest point of the strip is not easy to obtain.

The rf current will flow along one side of this strip as the edge tends to restrict current flow to the surface upon which it was launched. When tying components to the strip, use the same side for best results, particularly at the higher amateur frequencies.

To complete the job, tie all bypasses and tuning capacitors directly to the strip, or run a large lead directly to them. Don't depend on a shaft bushing to provide the return path for these critical rf components as this path may be longer than the one discussed earlier that went from the output connector to the cathode. Most components that are adjusted in operating the gear end up bolted thru the front panel and really deserve a much better return path to the cathode than they usually end up with.

As the frequency of operation increases, the effects discussed will become more pronounced. Currents will travel ever closer to the surface and direct ground paths will become more important. They are already important at even the lowest amateur frequency.

Let's review the important points now that the groundwork (!) has been laid:

1. Use a neat, direct, predictable ground plate from output or load back to the cathode.
2. Avoid bolted joints in the return path.
3. Avoid going under tight partitions.
4. Tie all bypasses and tuning capacitor frames back to the ground plate.

Remember that:

1. rf currents do not penetrate very deep but flow along the surface of a conductor.
2. rf currents will not go thru a plate.
3. rf curents tend to stay on the suface upon which they are launched.

rf power amplifiers are not the only things that require good ground returns. That has been the main topic here, but the ideas are 100% applicable when constructing stable drivers, oscillators, rf and *if* amplifiers, and even audio amplifiers. They all deserve the same treatment: a neat, direct and predictable cathode return path.

The essential thought here is that the builder of any piece of gear should sit down and trace out the ground return path of every stage. Where a direct path from one cathode or emitter to the next is not obvious, continuous and relatively unimpeded—put it in yourself.

The results can be quite dramatic. A thousand watt class C amplifier that was recently designed and put into service here at WA6KLL was constructed using a 3" wide copper strip down the front panel and directly back to the cathodes of the two 813's. All bypasses from the tube socket were tied directly to this strip. The output connector and the tuning capacitors all mount thru the strip and the front panel and are strapped to the strip. The shielding to the compartment consists of aluminum screen with the frame secured by catches spaced at a quite wide 7 inch interval. There is no radiation of energy from the cabinet even with this minimal shielding. A portable TV ten feet away using an indoor antenna in our fringe area is unaffected when the transmitter is keyed, even on channel 2 (50 miles over hills). The ground return may not be the whole answer, but nobody's touching it!

The problem with specifying good return paths on circuits is that the schematic remains the same. If you are homebrewing from someone else's schematic, you had better know at least as much about the ground return problem as the designer or problems may occur. It is the rare construction article that delves far enough into "well-known, fundamental" concepts as grounding. Usually the requirement for considering the returns is your responsibility as the builder. Failure to consider the ground path (since it is not particularly specified on most schematics) may be the cause of a perfect circuit that just doesn't work well for some reason.

If you ever have any doubt about the path return currents must take in any stage, provide one yourself that you can depend on. The results will often be well worth the trouble.

. . . WA6KLL

Gus Browning W4BPD
Cordova, S.C.

Gus: Part 21

The trip to Mombasa was very enjoyable, plenty of good food and plenty of good rest. No/MM this time, the ship had a new wireless operator who knew nothing about ham radio, plus the fact he was new on the job and did not want to "take a chance", even tho I were willing and ready to get going from the ship. The rest did me plenty of good and I had time to get all my logs ready to be mailed to Ack upon my arrival in Mombasa. Good old Leny 5Z4GT and 5Z4AA met me at the docks when the ship arrived. 5Z4AA was way up in the Police Dept. and a nod from him to Customs did the trick, and in a few moments all my equipment was in Leny's car and away to my hotel we went. I spent only one or two days in Mombasa, did a little shopping down at the local market place—where all those carvings are—REMEMBER! I had nothing to trade them this time so I had to do it the hard way—by bargaining a few hours, even though I spent only about maybe $10.00 I got a big armfull of some FB carvings. I had found out how to "bargain" with these people while "drinking their Cokes", and I still think they love it. A few even remembered me being there before—One referred to me as that big business man from America. They never say the U.S.A.—You know they call us Americans, this is true in every country I have ever visited. Not just Kenya. They were referring to my big business deal" that I had with them a few years previously when I traded all that "genuine plastic" jewelry to them. THEY WANTED TO KNOW DID I BRING SOME MORE! ! ! They all thought I was a "Big Deal" fellow.

The evening's train was caught for Nairobi, you know it only makes that trip at night, I guess it's too hot to be made in the daytime, plus the fact at night they sell you a "sleeper coach ticket" and that puts a few more pounds in someone's pocket I suppose. Arriving back in Nairobi was sort of like coming back home, all the sights was familiar to me, even the taxi drivers with those L O N G earlobes with the hole in them and the tall, Fez-sort-of-looking hats they wear. Good old George 5Z4AQ met me at the train and away to his home we went, outside the city limits of Nairobi a few miles. Right besides hole Nr. 5 of a golf course which had that sign near hole Nr. 5, saying, "beware of the lions near hole 5". And don't think this sign is there just to be funny—there are LIONS around there, George said one night he saw five of them walking across his lawn. There are also hyenas there, George put a piece of meat on his front steps one night and about midnight there was that laughing hyena sound out on the FRONT PORCH, and there they were fighting over that chunk of meat. George at that time was working with Kenya Television near Nairobi and he had the usual "understudy" following him all over the place when he was on the job. His

MEAT AND POTATOES AND SOMETHING CALLED VALUE

I am always on the lookout for electronic components or assemblies which possess potential ham value. I have also been interested in any item which makes it possible for more hams to enjoy sideband. You can, therefore, understand how happy I was when on a recent western trip I found one lot of 225 watt core power transformers and in another area a batch of computer grade electrolytic condensers. Immediately, I felt that we could put out a darned good universal transceiver power supply and when I got back, the boys in the shop confirmed this.

I say universal because with two of these power transformers and two 500 mil chokes, 12 diodes, assorted resistors and other components, we were able to make up a supply which met the requirements of the latest Swan, Collins, Drake, Hallicrafters, Heath, and National transceivers. Talk about value! We can offer this complete assortment of parts including a 16 gauge steel chassis and bottom plate, a good PM speaker and mating plugs for your particular transceiver for just \$50. The transformers in this set weigh 17 lbs. and altogether the completed supply will weigh close to 40 lbs. This is what I call meat and potatoes. The filtering is excellent; the regulation is extremely good, and we have schematics and a printed story to be supplied with each kit, giving detailed information as to how to make the connections for your rig. You will have to tell us what model you own.

This is what the power supply will do:
800-1000 V at up to 400 mils on peak
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bias of up to 125V at 100 mils
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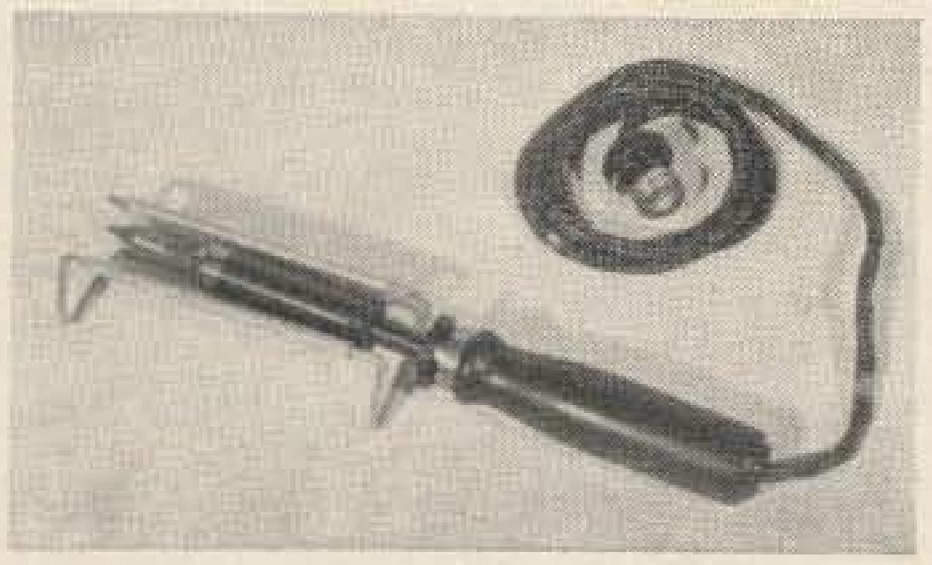
12.6V AC at 6.5 amps
Remember, this is an assembly of parts.

We do not furnish a drilled chassis; we do not furnish the hardware; we do not furnish the solder and the wire but literally everything else is supplied.

Please allow for 45 lbs. shipping weight or otherwise be prepared to accept Railway Express or motor truck shipment.



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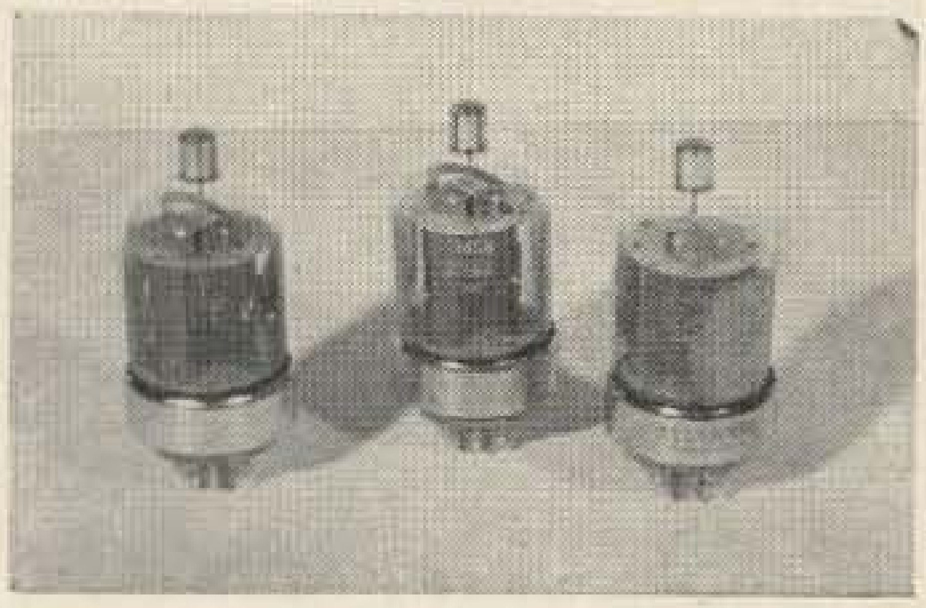

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understudy I think he said was "Kyuku," one of the natives of Kenya. George suddenly has left 5Z4 land you know for ZS6 land so I guess that 5Z4 fellow has stepped into his job. Boy I bet that Nairobi T.V. is not on the air 100% of the time. I guess being from ZS land (that's where George is from you know) is sort of tough on a fellow in 5Z4 land. Must be getting sort of tough all around now because Leny 5Z4GT, I understand will be leaving, I think next year for U.K. Sort of looks like all of them are leaving. Robbie is still there, had a QSO with Wayne Green W2NSD/1 from 5Z4ERR a few weeks ago. I wonder if he will be leaving one of these days? Maybe the day will come when 5Z4 will become a rare one? Maybe someone will have to go there to give the boys a new one some time. George told told me ALL ABOUT the situation when I were there, a very interesting story too. Time to depart for Ruanda and Burundi soon arrived and George took me down to catch the train. George's wife is incidently a good cook, fellows, hunt them up if you happen to get down to ZS6 land sometime. Tell em, "Gus sent me".

The trip to Lake Victoria was only a few hours, I saw the "Great Rift Valley" from the train. In fact the train goes thru the Rift Valley, a sunken portion of the country quite a number of miles across in this portion of Africa. I understand this Rift Valley extends from down near Northern Rhodesia all the way up thru Africa, across Asia Minor across Iran maybe even into Russia. Maybe part of it is in Eastern Turkey where they had the big earthquake a little while back. It could be seen very easily from the train. The land had sunken down some hundreds of feet I would estimate.

Arriving in Kismu on Lake Victoria the weather was extremely hot. Loading the Lake steamer took about four hours it seemed to me. The boat was full mostly of natives, some returning to their homes from working in Nairobi or maybe Nakuru or maybe even Mombasa. Quite a number of Europeans in their White suits also went on board. The steamer headed across the lake for Kampala, Ugunda. Taking about one half the day to get there. The ship was close to the land quite a while and many crocodiles were seen, even a few hippos and even some dozen or so wild water buffalos—thats those "mean ones" that you don't monkey around with at all. Those are the ones you had better "kill" if you shoot at them or you are in for a lots of trouble. I was glad we were on a ship and they some distance away, even then they gave the boat a "mean look". The crocodiles just sank below the water and disappeared from sight. Upon landing in Kampala everyone went ashore and we were taken to a nearby water-front hotel and told to have a drink on the house, some of us wandered out and walked around town. I picked up a few carvings and some native-made items. The weather was too hot for me to walk all over so I headed back to the hotel/restaurant. Stayed there some three or four more hours until we were told to go back to the ship. The little whistle tooted a few times and we were away for the Sourthern part of Lake Victoria. The ship docked at Mwanza which is in Tanganyaki. This was where I was to meet 9U5JH from Ruanda. He was to arrive late that afternoon. I was met at the docks by a VQ3 fellow from either Kanama or Shinyanga where he was managing a diamond or gold mine. He was originally from ZS land so I am quite sure he is not in Tanganyake at this time. He drove me in his car all over the little town and we had a very fine meal at a local hotel-restaurant and chatted until late in the afternoon when John, 9U5JH arrived in his 1959 Chevrolet which he had driven all the way from Burunda. All three of us had a big "eye ball QSO" for an hour or two, the VQ3 chap departed for his home QTH, John gassed up filling a few five gallon cans full of gasoline for the trip back to Burunda across unchartered roads with no filling stations and no signs of civilization at all were seen by us as we drove to 9U5 land that night. All THREE SPARE tires was carefully checked, two spare cans of water was filled, a few extra quarts of oil were bought, and away for 9U5—Burunda we went. Now don't get the idea that there is an "interstate highway between these two places, don't get the idea that it's even a paved road, or you will be completely wrong. This auto trip was nearly what you might call a safari. We were packed for a safari I would say. We had everything a safari has except "guns". Later on I sure wish we had a gun or two with us. This was going to be another of those trips I was to remember all my days. Dirt roads all the way, not one single road sign and many many roads turning off to the right and left. All of them looking right to me. A few times we chose the road by refering to our compass. OH YES we took quite a few wrong roads. John could speak Swahili so we had no trouble getting back on the right road. but if you don't speak Swahili—Brother don't you dare make this trip or you will end up staying there all the rest of your life. No one we met all the way spoke ONE WORD OF ENGLISH, and Brother this can get rough. Most of the natives were more or less friendly, but a number of them looked downright "mean" to me, not a sign of a smile could be seen on their faces. When you leave the town limits of Mwanza and are out on that road a few hours, you know you are in "deep Africa", you smell it, you see it, you hear it, you hear in the distance the beating drums (this trip was an all night affair you know), even the stars sort of have that African look, the trees are a dead give away. You remember seeing those "flat top" trees in African movies? Well they are here, and I mean all over the place. Those darn beating drums are what got to me more than anything else, some sounded like they were saying bong, bong, bong diddy bong, others sounded like bang, bang space bang bang bang, All had a different sound and were beat in a different sounding way. I was thinking to myself something like this—"I wonder what those things are saying to each other". Because some of them were most certainly answering the other drummer's CQ. I wonder when they sign off do they have a certain thing that says 73? Those jungle sounds were sometimes frightening, at times smooth, and sort of soothing. I had been in the African jungle before a number of times between Mombasa and Nairobi, Kenya and twice between Nairobi and Dar es Salaam, Tanganyaki, but I was in a bus along with about 25 or so people all the time and on at least a "marked road". You might say the other roads were roads that were traveled on by a good number of cars every day. But this was now a real "back country" road and lead us straight in the middle of real wild country—a part incidently where Dr. Livingston went for supplies to Dar es Salaam and very definitely a portion was used by Stanley when he was hunting Dr. Livingston. This was an all night trip and half of the next day. You know wild animals are daytime sleepers and roam around at night. So doggoned many different kinds of animals was seen it's hard to remember them all. John (9U5JH) had along in his car a head light sealed beam light mounted on the end of a short handle with the end of its cord a plug that we plugged into the cigarette lighter on the dasboard of his car. When we saw a pair of eyes in the distance I would snap on the light and zero in on them and keep the light in their eyes until they disappeared into the jungle. Most of them did not try to evade staying in the light. Many many lions, big baboons, antelopes, zebras, rhinos, elephants and best of all quite a few big beautiful leopards setting up on rocks beside the road ready to pounce on anything that happened to pass their way. When we passed them you can bet the windows were rolled up. We did not want a leopard jumping in our car. These rascals usually would just set there watching the car as it passed. A few times we pulled up and stopped parallel to them and I kept the light in their eyes and had a good chance to look them all over. Boy, if we only had a gun along with us, Peggy would have had a few leopards skins towards a leapord skin coat. It would have been so easy to shoot them smack between the eyes and not even leave a bullet hole in their skin. But all we could do was just "look" at them from the safety of our car.

Lions: this was their hunting grounds, they were to be seen at least every half hour. We would see from one to three or four, I mean right beside the road. They were like the leopards—not afraid of anything. The most numerous of all animals was those hyenas. Many other animals were seen. Many of them, not even John knew their name, some looked sort of like our American racoons and opossoms. My flash no pictures was taken I am sorry to say. Even a few very large snakes crawled across the road, probably pythons. This was the real African jungle and I was a little bit on the edge everytime we stopped the car, wondering if it would start again O.K. My only regret was that it was a fast trip without many stops along the way. After the all-night trip from Mwanza and driving all the next morning we arrived at Kitega, Burundi and drove a few miles from town to the home QTH of 9U5JH which was at a missionary settlement on top of one of those hundreds of little hills that you see in Burundi. As a rule the Eruopeans build their homes on top of these hills and the natives build theirs down in the valleys between the hills. The natives lived in typical thatched huts with many many banana trees all around their settlements. I asked John why all the banana trees, thinking they exported bananas, and he said they made banana wine from the fruit. He said this banana wine was very powerful stuff and that great quantities of it was consumed by the natives. We also saw quite a few tea plantations here and there usually on the side of the hills. The temperature was not too bad on top of those little hills. Usually a slow breeze blew during the daytime and at night it was very pleasant, late at night getting a little chilly. John had up a real nice 20-meter quad, maybe it was also 10 and 15 because it was of the center spider construction. His equipment was cleared from the operating table and mine was placed there and tuned up. I was on the air as 9U5JH, the band stayed open until about 3 AM and was open to everybody all at the same time. All my "Gus watchers" were in the pile-up and I had a ball with FB signal reports from everywhere. Nearly everyone saying I was a new country for them, which I doubt since John had always been quite active and many other 9U5's from Burundi had been on for many years. I am a firm believer that, "if you are the rarest thing on the air, you automatically become DX to everyone everywhere, and they will join in the pack just to be working DX. Of course this suited me FB because the bigger the pile the better I like it. A DXpedition wants big business, that's the reason there are DXpeditions you know. John filled up the coffee pot and told me how to heat up the coffee. Milk and sugar was on hand and everytime I got a little sleepy, to the coffee pot I went. John had a nice wife and she was a good cook so there was always plenty of good food there. My stay with John was one of those good ones. The kind you are always looking for when you get away from home. John told me many stories about what has happened there since he had arrived, lots of good ones about lions getting into native huts, gobbling up a few of them, then their lion hunt to get the "man eater". You can be sure these things do happen in deep Africa, they right now have lion trouble in some of the out laying places I am sure. That's it for now fellows, MORE NEXT MONTH.

. . . W4BPD

Jim Fisk W1DTY
RFD 1, Box 138
Rindge, N. H. 03461

Waters' Dummy Load and Wattmeter

The new dummy loads from Waters Manufacturing down in Wayland, Massachusetts, nicely fill the amateur need for a dummy load and/or wattmeter that he can depend upon. The two models are basically the same load, but the Model 374 has a built in wattmeter while the Model 384 does not. These loads consists of a structured monolithic 52 ohm non-inductive resistance unit designed to present a constant impedance of 52 ohms over the frequency range from dc to 230 MHz. To provide adequate cooling when large amounts of power are dissipated by the resistor, it is sealed into a steel container filled with oil; a thermostat is also sealed into the container as an indicator of maximum safe operating temperature.

Since the impedance of a load of this type is dictated solely by the physical geometry of the load resistor, once it is sealed into the can, it cannot be adjusted. However, the manufacturer states that the maximum SWR is less than 1.3:1 from dc to 230 MHz, and tests with a commercial SWR bridge bear this out. The load is somewhat flatter (closer to 52 ohms resistive) on the high frequency bands up to 30 MHz than on the VHF bands, but even at 230 MHz the measured SWR was less than 1.3:1.

The two loads appear to be identical except that the 374 Dummy Load—Wattmeter has a built in rf wattmeter. This wattmeter consists of a semiconductor rectifier and filter network which furnishes a dc voltage to the meter movement from the rf voltage across the load. The dc voltage is connected to the meter through four resistive attenuators to provide full scale readings of 15, 50, 300 and 1500 watts. This instrument is calibrated at the factory with a precision low frequency wattmeter and the guaranteed accuracy from 2 to 30 MHz is ± 5% of the full scale reading on each range. This means that on the 1500 watt range the reading is ± 5% of 1500 or ± 75 watts. The accuracy from 30 MHz to 230

MHz is not stated by the manufacturer because the power readings above 30 MHz will be somewhat higher than predicted. However, the 374 may be used as a *relative* power indicator up to 450 MHz; above 230 MHz the power input should not exceed 250 watts.

One very nice feature of the wattmeter is that it is possible to run a quick check on the calibration with normal 120 Vac, 60 Hz, line voltage. Immediately after calibration, the technicians down at Waters make a note of the reading obtained on the 50 watt scale when 120 Vac is applied to the input terminals of the model 374 and record it on the rear panel of the instrument. No attempt should be made to correlate actual power levels at 60 Hz with the wattmeter readings, because the circuit is not compensated for this frequency, but it does give the ham out in the field an opportunity to check the calibration.

These loads are very useful for loading your transmitter without radiating a signal and for measuring the power output of your transmitter. The Model 384 does not have a built in wattmeter, but it may be used with the Waters 369 Reflectometer to provide accurate, direct measurements of rf power. If your antenna is very closely matched to 52 ohms, your transmitter may be loaded into the dummy load and then switched to the antenna with no changes in final amplifier tuning. If a coaxial switch is used to switch the transmission line from load to antenna, make sure you turn off the transmitter when switching.

The wattmeter is also useful to checking the loss of coaxial transmission lines and for checking and adjusting SWR bridges. If you suspect that old World War II coax you're using is lossy, a quick check on the Waters 374 will confirm (or deny) it.

Once you have one of these units in your shack, whether it's the 374 Dummy Load-Wattmeter or the 384 Dummy Load, you'll wonder what you did before you got it. Besides, all your ham buddies in town will be over to borrow it! . . . W1DTY

Waters' Model 384 Dummy Load Specifications

Frequency range:	DC to 230 MHz.
Load impedance:	52 ohms nominal.
Power rating:	1500 watts (intermittent). (Maximum inner case temperature of 220° is reached in 4 to 6 minutes at 1500 watts input).
Input connector:	Hermetically sealed SO-239 UHF mates with standard UHF PL-259 plug.
Power Requirements:	120 Vac, 60 Hz (for over temperature warning light).
Size:	4¾"x9"x10¼".
Weight:	12 pounds.
Price:	$65.00

Model 374 Dummy Load - Wattmeter Specifications

Same as for the Model 384 above except as follows:

Wattmeter ranges:	0-15, 0-50, 0-300, 0-1500 watts.
Accuracy:	± 5% of full scale value from 2 to 30 MHz. May be used as a power indicator from 30 MHz to 230 MHz without statement of accuracy.
Price:	$135.00

WTW News

We've printed up a small WTW countries list which you can use to check off each WTW country as you work it. It has a place for the date of each QSO and a place to check when you receive the QSL. Please send a self-addressed business envelope for your copy.

WTW Awards Issued

SSB WTW-200
1. Bob Wagner W5KUC

SSB WTW-100
1. Gay Milius W4NJF
2. Bob Wagner W5KUC
3. A. A. Hopple W3DJZ
4. Bob Gilson W4CCB
5. Jim Lawson WA2SFP
6. Joe Butler K6CAZ
7. Warren Johnson WØNGF
8. Ted Marks WA2FQG
9. Lew Papp W3MAC
10. George Banta K1SHN
11. Don Redman K8IKB
12. Paul Friebertshauser W6YMV
13. Jay Chesler W1SEB

CW WTW-100
1. Vic Ulrich WA2DIG
2. James Resler W8EVZ
3. Dan Redman K8IKB

Questionnaire

What with new breakthroughs in semiconductors, two meter moonbounce, Don Miller, lasers and incentive licensings, we want to know your interests. Please clip, tear, rend, or in some way remove this questionnaire (or even just copy it) and let us know post haste your interests.

1. Are you licensed? yes____ no____
2. Do you work in electronics? yes____ no____
3. How long have you been licensed? 0-1 year____; 1-5____; 5-up____.
4. Class license? Nov____; Tech____; Gen____; Cond____; Adv____; Extra____.
5. Do you own an SSB transceiver- yes____ no____
6. About how many hours a week do you devote to amateur radio? ____
   Please indicate the approximate percentage of your time you spend on the following:
7. Bands used: 160M____ 80M____ 40M____ 20M____ 15M____ 10M____ 6M____ 2M____ 220MHz____ 432MHz____ other________
8. Modes used: SSB____ AM____ Mobile____ CW____ RTTY____ TV____ FAX____ FM____ NBFM____ other________
9. Ham activity: Rag chewing____; DX____; Traffic____; Construction____; Contests____; other________.
10. Do you belong to an amateur radio club- yes____ no____
11. How much do you expect to spend on amateur radio in the next year?________.
12. What major items are you considering purchasing? ________
13. You like to build, you say? What construction articles would you particularly like to see? ________.

A Hint for the TR-4

Occasionally a TR-4 transceiver owner lives near a high power broadcast station that concentrates an antenna pattern in his direction. The result maybe an annoying signal appearing on one of the ham bands.

To eliminate the trouble it must be determined if the interfering signal is the fundamental or a harmonic of the station. Generally this is very easy to do. If the signal comes in loud and clear with no distortion it can possibly be the fundamental. If there is distortion or garble the signal is a harmonic because every time the frequency doubles, the audio signal components double and the station sounds distroted. The frequency of the incoming signal has to be determined so that a trap can be installed in the transceiver.

In my particular case I was troubled by XERB at 1090 kHz coming in on the twenty-meter ham band. It was found that this signal could be almost eliminated by using a series tuned trap across the neutralizing capacitor in the driver grid circuit to trap out the interfering signal.

For this particular station the fundamental was the culprit and a trap was made by from a 37-250 pF trimmer capacitor and 0.1 mH rf choke in series across a 865 pF capacitor (C-43) located in the grid circuit of the driver.

After the trap is installed, listen to the station and tune the trimmer for a minimum signal. If the trimmer closes without tuning through a minimum connect a 100 pF capacitor across the trimmer. The choke in series with the trimmer resonants at 1090 kHz which does the trick. Frequencies not in the broadcast band will take different values which would have to be calculated for the interfering frequency.

Essentially what we have done is to trap out the interfering signal at the grid of the 6EA8 mixer tube. There is no reason why other transceivers using the final amplifier grid coil as the antenna coil coupled to the mixer, and having similar interference problems, could not be fixed by the same method.

. . . Ed Marriner W6BLZ

PLEASE INCLUDE YOUR ZIP CODE WHEN YOU WRITE 73.

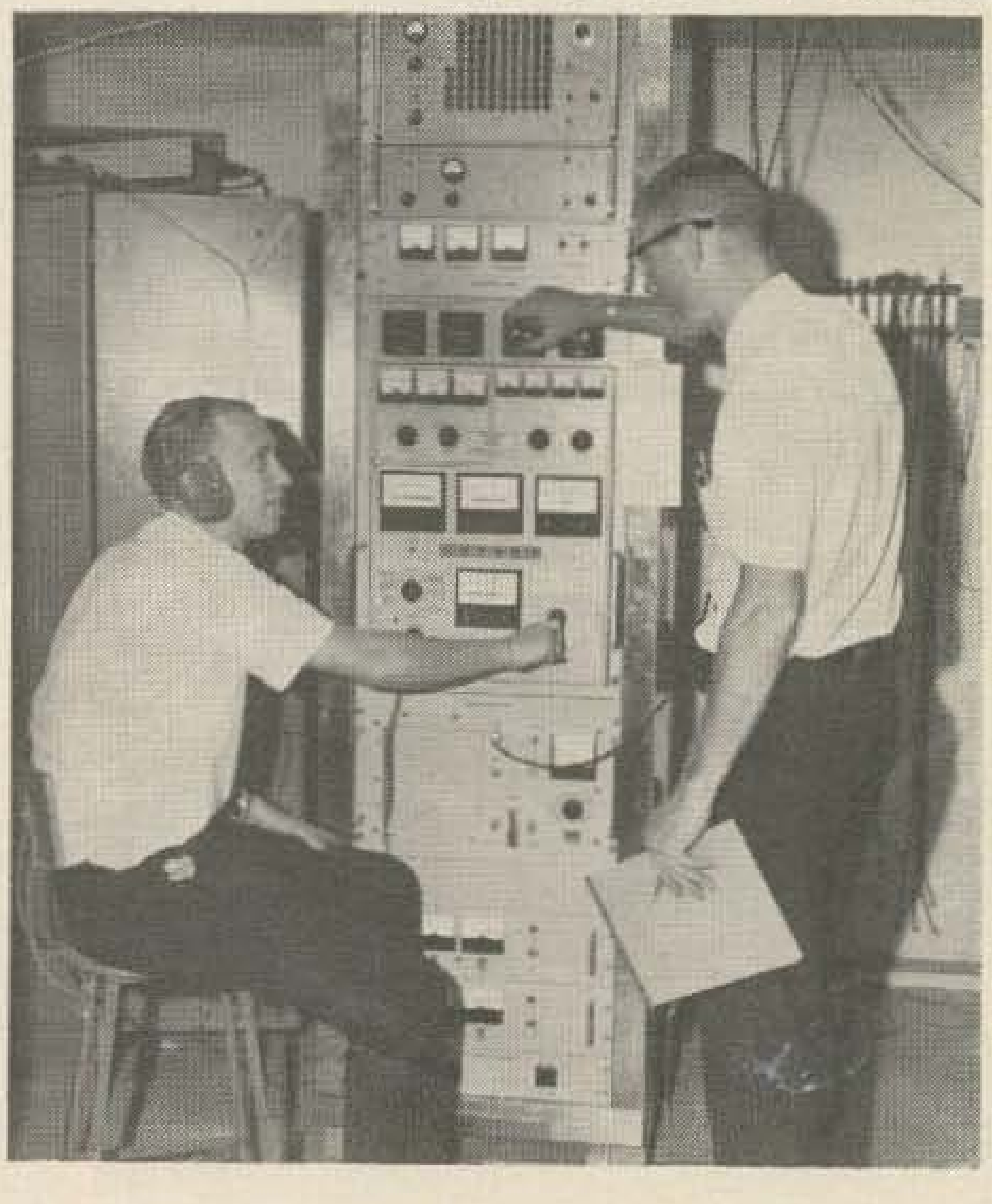
Dear Paul:

In your recent editorial you mentioned trying to create more interest in the 2.4 GHz band. You may be interested in the enclosed photographs showing an amateeur tracking experiment organized at Interstate Electronics by Jim Counter (K6AIP). This group successfully locked on and tracked the Surveyor moon probe. The antenna was a surplus 8 foot dish with a home brew feed mounted on a home made tracking mount. The preamp was borrowed from Mel Labs. The receiver is one which the group in the photograph designed and built for NASA. It is called the "General Concept Receiver" and is extremely flexible. It covers 70 MHz to 10 GHz and is triple conversion. Its main application is for reception of narrow band telemetry and doppler from space craft. Tuning is done by a "push button" frequency synthesizer.

The success of the first experiment has resulted in an organized effort to improve the antenna and mount for further amateur tracking experiments.

As you can see the people at Goldstone were quite surprised at the results of this effort.

Sam Kelly W6JTT
Garden Grove, California



Kc. or kHz.?

Caen Van Necklaan 227,
Rijswijk, Z. H.

Editor, *QST*:

Unnecessary to say, I'm as full of admiration for your fine paper as everybody else, but just this fact urges me the stronger to protest against one inaccuracy. Some time ago you pointed out to all hams that it is much better to speak about frequencies than wavelengths, and the whole world has followed your example. But when speaking about frequencies, we mean the number of cycles per second, in any case the number of cycles *in a certain time*, and therefore it is wrong to speak about frequency of, for instance, 14,300 kilocycles; one should speak about kilocycles *per second*, abbreviated kc/s. Nobody would speak about coulombs instead of amperes, but neither should we speak of kilocycles when we mean kilocycles per second.

Now we have a new name for this unit, the *Hertz*, abbreviated Hz, which was internationally adopted by some congress. As Heinrich Hertz was without doubt an eminent and leading figure in physics, and as it is easier to type and print kHz than kc/s, I think you had better adopt it, too, before you lead all hams in the world astray by the wrong unit, the kilocycle, which you are using to-day.

—*W. Keeman, PAOZK.*

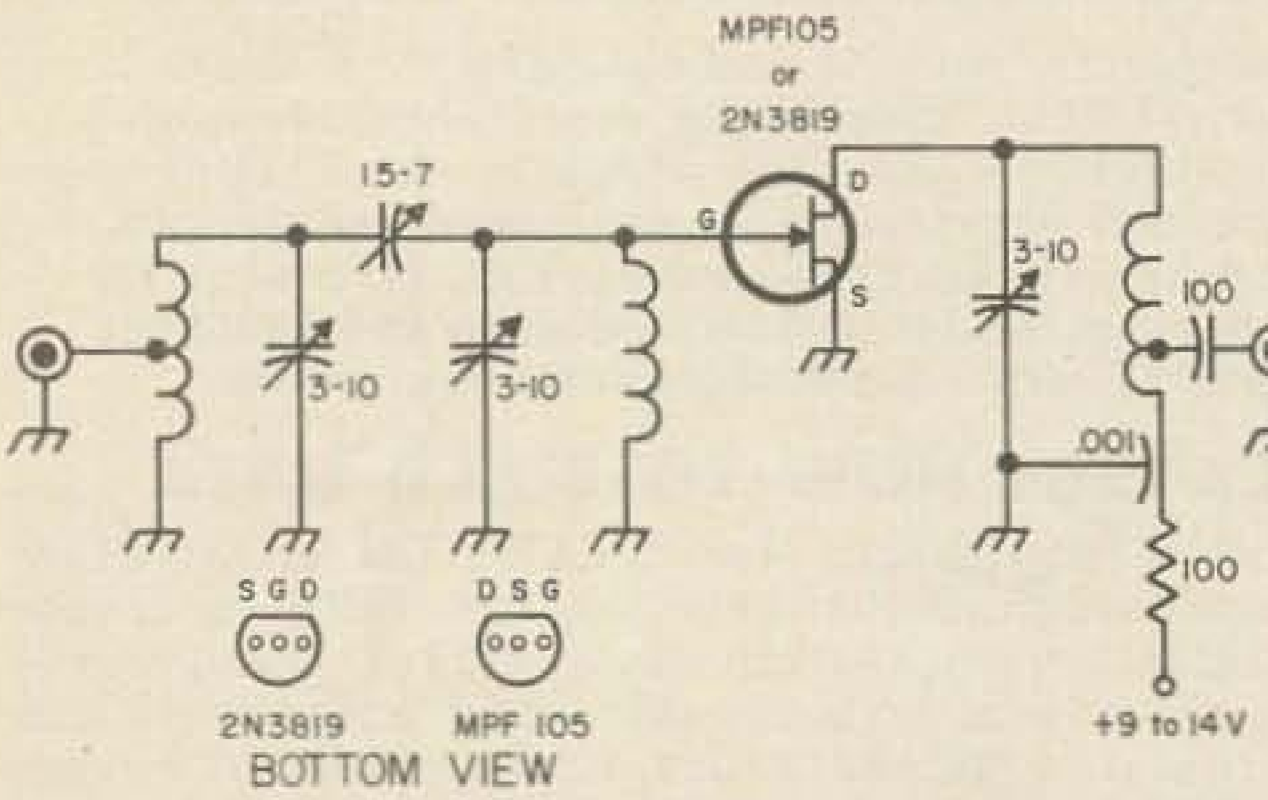
While agreeing with the author of this letter on the merits of the term "kiloHertz" as a unit of frequency, QST is inclined in this respect to follow the recommendations of the *Committee on Standardization of the Institute of Radio Engineers*, which is still at work in collaboration with other agencies in the standardization of radio definitions, nomenclature, measuring practice, etc. The current recommendations of that committee gives the meaning "kilocycles per second" to the abbreviation "kc.", exactly as attaches to the abbreviation "kHz." The "kiloHertz" is not yet a recognized unit of frequency either in this country or in the international literature, and for that reason QST does not use it.—Editor.

From QST, page 58, September, 1930.

What's New for You?

OOP Transistor Notes

$1FET's I tried the inexpensive Motorola FET's in a number of circuits and found them quite satisfactory. I would use them without hesitation in the second stage and mixer of the 2 meter converter described by K6HMO in the October issue, and would use them for all stages on six or below. They are about a decibel noisier at 220 MHz than the TI plastic-cased units (2N3819), but nevertheless quiter than a 417A at that frequency, which is pretty good for a buck. The numbers are MPF103, MPF104 and MPF105. These are N-channel symmetrical FET's similar to the 2N3819, but with a different base. The MPF105 has the highest transconductance and the lowest noise figure. Its best NF is at zero bias, also like the 2N3819. MPF is about a buck; the 3819 is about four. The MPF105 is equal in noise figure to a 6CW4. I got 4.1-db NF at 220 MHz with the best of the Motorola units and 2.5 dB for the best 2N3819.



220 or 144 MHz preamp using $1 Motorola MPF105's or $4 Texas Instruments 2N3819. The $4 one is about a dB better. Dip the coils to frequency. The input tap is about 50% up, output is 20%. Adjust everything for best NF. W1OOP got 1.8 dB.

Fairchild 2N4122: I am really impressed by the Fairchild 2N4122. It isn't more anything than anything, but it is silicon, and it is a *good* replacement for PADT and such germanium transistors where heat turns out a problem. (Note that silicons may not be very good below zero degrees F, though the germanium transistors get better down as low as you are likely to get.) The 220-MHz NF of 4-5 dB of those I measured beats the Philco T2028 and is about even with the 2N2398 and 2N2494-5, considered very good three years ago. Price under a buck. Also good for audio.

GE16K2: GE's 16K2 is a good NPN silicon, cheap, for local oscillator chains and such. NF is 3.5 to 4.8 dB at 220 MHz for 20 units. It's similar to the Fairchild 2N3563.

TI XM101 vs TI XM10: We've run some interesting comparisons of the TI XM101 (about $20) and the TI XM10 (about 94c). 220-MHz NF of the 101's was 1.9 dB. One lot of XM10's ran 2.0 to 2.5 dB. The late, lamented, XM05-6's ran about 30% under 2 dB, with 1.5 and 1.75 measured.

150 *MHz converter*: Last week I made a 150 MHz converter for lab use. With four under $1 types, I had a 3-dB NF. For anything better, another rf amplifier would be needed.

Fairchild 2N4342: I tried out the Fairchild P-channel 2N4342 FET. NF 6 to 7 dB at 220 MHz, which, with a 5 dB second stage, is about even with a short. Don't know if it had any gain or not. I had five, tried only three.

The above notes are all from Hank Cross W100P, who is generally accepted as knowing what he's talking about. The information on prices is approximate and subject to change or error. Get the specifics from your distributor.

Kindly Keyer

Dear Paul,

I have had considerable correspondence considering "The Kindly Keyer" in the July 73". It appears that there were a couple of minor problems in the article as it appeared, which we failed to catch.

First, there are a few discrepancies between the schematic and the p.c. board layout:

Corrections to p.c. layout, page 49

1. Q_5 and Q_6 (labels on same) should be interchanged.
2. A 33K resistor should be shown between base of Q_5 and emitter of Q_6.

These are the only real errors which should be straightened out. However, in the case of Q_1:

3. The 100 k could be changed to a 220 k.
4. The .1μF capacitor could be a .22 F.
4. The .1 F capacitor could be a .22μF. (These only affect the time constant of the blocking oscillator, and any combination would work, with a different setting of the speed pot.).
5. The 82Ω resistor could be attached to +4.5V. (This makes the side tone louder.)

Notice that the order of components in the base of Q_1 is different, but since they are in series, there is no electrical difference. Even a novice should know this, but it seems to bother some!

6. Labels could be affixed to three terminals in Q_1 - Q_2 block as shown.

These changes would result in perfect agreement of p.c. board and schematic, but only 1 and 2 seem worthy of mention.

George Daughters WB6AIG

(W2NSO from page 2)

stitute had plenty to do on its hands just filling in those areas where the League should have been active, but wasn't. Possibly this was a mistake. I suspect now that many more amateurs might have joined the Institute if it had been formed as a direct opponent of the ARRL, complete with hundreds of appointed officials all over the country to spread the gospel from headquarters to the grass roots members, hoked-up elections of cardboard directors with no real say or even awareness of the real forces running things, official bulletins, inconsequential "services" and the whole ball of wax.

No, I goofed it. We set up with minimum of overhead, sent inexpensive letters to Congress, and ran the Institute without all the hoopla and big salaries. We also ran it without very many members for I found, to my intense disappointment, that without the Big Show there were very few dollars . . . or members to speak of. I tried telling the straight facts in my editorials, but found myself being called interesting names for trying to ruin the ARRL. Oh, I've centainly been critical of a couple of the top men running the League, no question of it. Few people have noted that none of these gentlemen will face me in public and answer my criticisms. But I've intentionally kept the Institute completely out of any hassel with the League and kept it on its published aim of speaking up for amateur radio in Washington.

All current members will receive a long and detailed account of the history and philosophy of the Institute, as well as a complete and detailed account of the income and expenses. And there'll be none of this vague coverup you find in the ARRL annual report.

How great is the disaster? In August 1966 there were six new members . . . September five . . . etc. There is no question at all that very few amateurs believe that there is any importance in th goals of the Institute. I suspect that the best plan is to not make any further effort to promote membership. I'll do what I can at my own expense to send information about amateur radio to Congress. Barry Goldwater has made some excellent suggestions for getting the most out of the least effort along this line. I'm going to keep pitching . . . sorry I failed to interest very many of you in the idea.

DX Flash

The DXers may be interested to know that as far as WTW credits for countries are concerned that not only do we accept anything as a country that is accepted by any national amateur radio society, but we feel that if a fellow operates from a country then contacts with him should count for that country. We do not feel that we should try to set ourselves up as official arbiters on exactly how legitimate a license is for any spot.

In the U.S. there is little question about licenses. Either you have one or you don't. But once you get off the beaten path it is difficult to set up firm rules. In Nepal there is, the last I heard, one and one only legitimate licensed amateur and that is Father Moran 9N1MM. But other amateurs can and do operate with the knowledge and unofficial consent of the government. This same situation is true in several other countries I have visited . . . and things are even looser elsewhere. It becomes almost capricious to try to set oneself up as the "official" decider as to what is or is not licensed. Hence our decision that if he is there it counts.

Technical Aid Group

The first 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 concise question that you think can be answered through the mail, why not write to one of the hams on the list? Please type or write legibly, and include a self-addressed stamped envelope. One question to a letter, please.

If you'd like to join the Technical Aid Group and you feel that you are qualified to help other hams, please write us and we'll furnish complete information. It's obvious that we need many helpers in all parts of the country and in all specialties to do the most good. While 73 will try to help with publicity and in other ways, we want the TAG to be a ham-to-ham group helping anyone who needs help, whether they be 73 readers or not.

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

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

Stix Borok WB2PFY, high school student, 209-25 18 Ave., Bayside, N.Y. 11360. Novice help.

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

Roger Taylor K9ALD, BSEE 2811 W. William, Champaign, Ill. 61820. Antennas, semiconductors, general.

Jim Ashe W2DXH, R.D. 1, Freeville, N.Y. Test equipment, general.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont St., Falls Church, Va. 22042. General.

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

Robert Scott, 3147 E. Road, Grand Jct., Colorado 81501. Basic electronics, measurements.

J. J. Marold WB2TZK, OI Div USS Mansfield DD728, FPO San Francisco, Calif. 96601. General.

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

Richard Tashner, WB2TCC, 163-34 21 Road, Whitestone, N. Y. 11357. High school student, general.

Wayne Malone W8JRC/4, BSEE, 3120 Alice St., West Melbourne, Fla. 32901. General.

(Continued from page 4)

to pay for equipment to the movement to form an effective Canadian amateur organization instead of expecting Canadians hams to be a small division of the US ARRL. Incidentally, it sounds like this is an excellent year to visit Canada. From all indications, Expo 67 will be a far more satisfactory world's fair than the one in New York. Maybe we'll see you there.

So there are the special issues of 73 coming up in the next few months. Each issue will also feature the usual selection of what we hope will be interesting, informative and entertaining articles. Be sure to be with us.

Writing for 73

So many people have sent for copies of our booklet, "Writing for 73," that we've had to reprint it. If you've thought at all about writing for publication, why not send us a self-addressed business envelope and we'll mail one out immediately. I have also compiled a list of articles I'd like to have for 73. Please mention if you'd like the list.

TAG

The Technical Aid Group (TAG) is starting to help hams with their technical problems. However, we need many more helpers to be able to work effectively. If you feel that you're competent to help, and have a few extra hours to devote to helping other hams, we'd like to hear from you. Your main reward from this work will be a sense of satisfaction and a little publicity, though there are a few other benefits. Please write for details.

. . . Paul

Propagation Chart

MARCH 1967

J. H. Nelson

EASTERN UNITED STATES TO:

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

CENTRAL UNITED STATES TO:

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

WESTERN UNITED STATES TO:

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

Very difficult circuit this hour.

* Next higher frequency may be useful this hour.

Good: 1-5, 7-17, 19-22, 26-31
Fair: 23, 25
Poor: 6, 18, 24
VHF DX Likely: 6, 13, 14

New Products and Books

Eico 711

Eico's newest communications product is their 711 Space Ranger Short Wave Communications Receiver. It covers .55 to 30 MHz with a BFO, bandspread, S-meter. Its cabinet is attractive enough for the living room. In kit form, the 711 is $49.95; wired, it's $69.95. You can get more information from Eico, 131-01 39th Ave., Flushing, N. Y.

Denson Catalog

A surplus catalog to really make you drool is the new, 160-page catalog from Denson Electronics Corporation. Al Denson, W1BYX has spent a tremendous amount of time photographing, listing and organizing his stock and the results are very impressive. Al specializes in television equipment, but the catalog contains surplus and used equipment of every description. Of special interest to the TV ham is a complete bibliography of articles on ham TV and many reprints of articles on TV in the catalog. The catalog costs 50c; it's worth far more than that for the reference data alone. Denson Electronics, P. O. Box 85, Rockville.

Oscilloscope Measuring Techniques

The serious electronics experimenter knows that an oscilloscope is the most valuable piece of equipment available for testing. However, few hams take full advantage of their scopes. An excellent book about scopes and their uses is Oscilloscope Measuring Technicques by J. Czech. The book is the English edition of a book published in German by Philips, and it is very complete. The first 250 pages of the book are devoted to scope circuits and construction, the next 120 pages to general measuring techniques, the next 170 to specific techniques and the last 50 pages to scope photography and projection. The book costs $15.80 and is available from Springer-Verlag, 175 Fifth Ave., New York, N.Y. 10010.

Low Cost VHF Antennas

A new line of low cost VHF "Space-Saver" antennas for 120-480 is being manufactured by International Crystal Mfg. Co. The antennas feature full performance, solid molded bases, ease of installation. Mobile and fixed base units include a vertical mobile for $5.25, vertical ground plane with universal mount $8.50 or with pipe mount $10.95, dipole with pipe mount $11.95, and the attic or base antenna with universal mount for $6.95. Special coax cable kits for use with antennas are priced at $3.95 and $4.95. For complete information write International Crystal Mfg. Co., Inc., 18 North Lee, Oklahoma City, Oklahoma 73102.

RCA Receiving Tube Manual

The new edition of the RCA Receiving Tube Manual (RC-25) contains over 600 pages of information on electron tubes and their uses. The first 100 pages contains a wealth of data on general characteristics of tubes and how they should be used. The next 400 pages lists all receiving tubes made by RCA—virtually all receiving tubes—with all of their characteristics. The last section of the book contains many applications of tubes, with specific circuits and description of how they work. The book is a tremendous buy at $1.25. Buy at your dealer, or order from RCA Commercial Engineering, Harrison, N. J. 07029.

Hammarlund HQ-205

The new Hammarlund HQ-205 is a general coverage receiver with a built-in 5 watt 10 meter or CB transmitter. Electrical bandspread is on 80-10 meters as well as CB. The receiver tunes .540-30 MHz. It includes a variable BFO, Q multiplier, NL and S meter. Price is $259.00. You can get more information from Hammarlund Amateur Products, 73-88 Hammarlund Drive, Mars Hill, N. C. 28754.

Designs & Construction of Electronic Equipment

In this new book by George Shiers, the author acquaints beginners with the processes and problems of designing and building electronic equipment while at the same time providing experienced technicians and designers with much practical assistance. This text covers chassis design and layout, panel layout, component boards, wires and cables, connection methods, printed circuits, fasteners and finishes. It also provides a great deal of practical information on circuit protection, interference, shielding and grounding and environmental problems such as heating, cooling techniques and corrosion. This book is filled with excellent illustrations and drawings; a number of useful tables are also included for the prospective electronic designer. For the amateur who builds his own equipment, this book provides a wealth of very useful and practical information. $14.00 from your local bookstore or write to Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.

G and G Catalog

A new 24-page Catalog of Communications Electronic Equipment has been published by G & G Radio Supply Company, 75-77 Leonard St., New York, N. Y. 10013. The catalog, which is fully isllustrated and contains complete technical information, covers military surplus receivers, transmitters, power supplies, test sets and associated equipment, including dynamotors, tranmitting crystals, special purpose tubes and headsets. Copies are available from G & G Radio Supply Company for 25c refundable with first order.

Amperex Components Catalog

Amperex makes some very nice electronics components that aren't well known to most readers of 73 because they aren't handled by any of the distributors we usually buy from. However, they've put out a catalog that should be of interest to all designers and buyers for manufacturing companies. The catalog contains condensed listings of electrolytic, foil, ceramic and variable capacitors, linear and non-linear resistors, speakers and knobs. Copies may be obtained by writing on company letterhead to Amperex Component Division, Hicksville, N. Y. 11802.

Directory of Electronic Circuits

In his new book Matthew Mandl presents a unique and valuable took for amateurs, technicians and engineers; a very comprehensive directory of more than 150 circuits used in all fields of electronics. Each of these circuits is completely analyzed in a very readable manner, and typical circuit values are provided along with the equations and formulas that describe their operation. To provide a more useful tool, the author has grouped the circuits into general categories and provided a detailed cross-reference system throughout the book. While the emphasis has been placed on transistorized circuits, vacuum tube circuits are detailed for comparison purposes or where they find a special application. Some of the categories of circuits are amplifiers, modulation and demodulation circuitry, filters, attenuators and pads, oscillators, power control and supplies and pulse circuits. In addition, a handy glossary of the most frequently encountered technical words is provided along with an appendix containing unit values, conversion factors, color codes and other useful electronic information. In all, this book is a very useful text that should be of interest to old timer and novice alike. \$10.00 from your bookstore or write to Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.

FET Projects

The latest book in Motorola's line of HEP publications in Field Effect Transistor Projects. It is a step-by-step instruction manual on projects that can be made with Motorola HEP FET's and other components. The projects are a vibrato for electronic musical instruments, an audio mixer, a timer, a crystal oscillator (such as a 100 kHz calibrator), and hi-fi preamplifier, and a dc voltmeter. The book also includes a short section on FET theory and construction practices. Complete building instructions are given for each project, including layouts.

Quaker Electronics Tech Manuals

Quaker Electronics has published a catalog of technical manuals they have for sale. The catalog also lists a number of very common pieces of surplus for which they have schematics. You can get the catalog for 25c from Quaker Electronics, P. O. Box 215, Hunlock Creek, Pennsylvania.

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $5 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

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

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ALL Makes of new and used amateur equipment. Write OR call Bob Grimes, 89 Aspen Road, Swampscott, Mass. Tel: 617-598-9700 or 617-598-2530.

CONVERTERS. World's largest selection of frequencies. Ham TV vidicon cameras and parts at low factory-direct prices. See them now in our full page ad in this issue. Vanguard Labs, 196-23 Jamaica Ave., Hollis, N.Y., 11423.

WE WILL PAY CASH: Wanted, popular, late model unmodified amateur equipment. Highest prices paid for clean good operating gear. Write Graham Radio, Dept. 100, Reading, Massachusetts.

ARE YOU SINCERE? Are you really looking for the best deal on a new or fully guaranteed used unit? Let us convince you with a specific quote that will really save you money. Graham Radio, Dept. 10, Reading, Massachusetts.

MOTOROLA new miniature seven tube 455 kc if amplifier discriminator with circuit diagram. Complete at $2.50 each plus postage 50c each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

COMPLETE CONVERSION instructions for the AN/VRC-2, just $1 while the supply lasts. 73 Magazine, Peterbirough, N. H. 03458.

WANTED case for Morrow receiver. WA1CCH, c/o 73, Peterborough, N.H. 03458.

SIX ASSORTED ISSUES of ATV Experimenter, circa '64-'65, $1 from 73 Magazine, Peterborough, N.H. 03458.

SCHEMATICS FOR either the ARC-508, or the ARR 15. both described in June '65 issue of 73, only 50c each. 73 Magazine, Peterborough, N.H. 03458.

1963 BOUND VOLUMES OF 73. $15 each from 73, Peterborough, N.H. 03458.

ROCHESTER, N. Y. is headquarters for Western New York Hamfest and East Coast Spring VHF Conference, Saturday, May 13. Top programming plus huge "flea" market. For more information, write: Rochester Amateur Radio Assn., P.O. Box 1388, Rochester, N.Y. 14603.

WANTED: General Radio model 1140A wavemeter. W1DTY, RR #1, Box 138, Rindge, N.H. 03461.

HANDBOOK OF HAM RADIO CIRCUITS by W9CGA. Complete schematics and operation data on many popular ham receivers, transmitters, transceivers and power amplifiers. $2.95 from 73 Magazine, Peterborough, N.H. 03458.

CONVERTERS, three transistor, 50-54 m in, 14-18 mc out. wired, tested, printed circuit. Crystal controlled, $10 ppd. Tuneable, $8 ppd. Syntelex, 39 Lucille, Dumont, N.J. 07628.

25 WORDS FOR $2. Sell or buy through these want ads, a terrific bargain. Caveat Emptor, 73 Magazine, Peterborough, N.H. 03458.

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

RTTY GEAR FOR SALE. List issued monthly. 88 or 44 mH toroids five for $1.75 postpaid. Elliot Buchanan, W6VPC, 1067 Mandana Blvd., Oakland, California 94610.

ESTATE SALE and bargain list. Send for it and include SASE. Write Paradd Sales and Engineering Service, 280 Route 10, Dover, N.J. 07801.

PLASTIC HOLDERS—each display 20 QSL cards. 3 for $1.00 or 10 for $3.00 prepaid and guaranteed. Free brochure of other ham goodies included. Tepabco, Box 198N, Gallatin, Tennessee 37066.

FREE CATALOG—loads of electronic bargains. R. W. Electronics, Inc., 2244 So. Michigan Avenue, Chicago, Illiniis 60616.

DAYTON HAMVENTION April 15, 1967—Dayton Amateur Radio Association's 16th annual Hamvention, Wampler Arena Center, Dayton, Ohio. Participate in the technical sessions, forums, banquet and hidden transmitter hunt. Bring XYL for best in women's activities. For information write Dayton Hamvention, Department C. Box 44, Dayton, Ohio 45401.

CHRISTIAN HAM FELLOWSHIP is now being organized. For free details write Christian Ham Fellowship, Box 218, Holland, Michigan. (Christian Ham Callbook $1).

4-1000A! G-G all band final with spare tubes. 3.5 kW supply, 110-220 input. Both $325. Immaculate SW-140, $125. Will deliver either up to 150 miles from Bakersfield. Mike Gibson WA6MWA, 3917 Reno Lane, Bakersfield, California 93309.

HEATHKIT VHF-1 Seneca transmitter like new, 120 watts. 6 and 2 meters. Will ship prepaid. Certified check, $135. David H. Richardson WA4GNA, P.O. Box 213, Demopolis, Alabama 36732.

COLLINS 75A2 $185. HT-40 $50. SX-140 $50 and SX-100 with speaker $140. All like new. WA7CQX, 808 East 4th Place, Mesa, Arizona 85201.

FERRITE BEADS—Modern Slip-On ferromagnetic VHF chokes for Parasitic Suppression, RF Shielding, RF Decoupling and Radioferric Inductors. Dozen Beads plus Spec Sheet: $2.00. Packaging and Postage: 25¢. AMI-TRON Associates, 12033 Otsego, North Hollywood, Calif. 91607.

DAVCO DR-30 new model including FETs, $350.00; 2M Tecraft xmtr, used, $25.00 and new power supply, $35.00; Knight 4 track stereo tape recorder, used, $75.00: Ed Jurow, 30414 Harding, Olympia Fields, Illinois 60461.

UNIQUE relay to build variety of remote controls, model railroads, liquid level control, weather detector, burglar alarm, games, trick circuits. 20 design ideas included free. 3.95 prepaid. Dept. E., Alco, Lawrence, Mass.

WANTED: Lampkin 105-B, 111 PPM Meter, 205A. John Crosby, K4GBL, 1421 Bell Terrace, Titusville, Florida 32780. Condition, age, and price in first letter please.

RADIO OPERATOR—TECHNICIANS NEEDED: second class radio-telephone license, some typing ability, good character references and diction, high school graduate. Illinois State Police Radio, 777 S. State, Elgin, Ill. 60120.

AUCTIONFEST—Broward ARC—New location this year. Chaminade High School, 500 North 51st Ave., Hollywood, Florida. March 11, doors open 8:00 am, auction begins 10:00 am.

50 FOOT MAST DESIGN. Designed for commercially available materials. Why pay $360 for a 50 foot tower? Send $1. Joe Shaw, 2014 Boston, Irving, Texas.

COLLEGE EXPENSES. EICO 753, 751 p.s., factory aligned, s.s. VFO, $280. SX-140, $65.; HT-40, $55.; HA-5 VFO, 6 mtr. Xtal, $55. All three $165. Webcor "Compact Deluxe" Tape Recorder, $65., with mike, $70. Turner Dynamic Mike, stand, $14. Mosley "El Toro", (80-40-20-), $9. Command T-19/ARC-5 Xmtr. $14. WA5JVL, 8704 Belfast, New Orleans, Louisiana, 70118.

JOHNSON RANGER I with PTT, Johnson Viking 6-2 transmitter, both excellent condition with power cable, $200. WA0AGP, 1139 Crest Drive, Topeka, Kansas 66604.

DUMMY LOAD 50 ohms, flat 80 thru 2 meters, coax connector, power to 1 KW, kit $7.95 wired $11.95 pp HAM KITS, box 175, Cranford, N.J.

NOVICE CRYSTALS, all bands, $1.30 each. Also other freqs. Free list. Dealer and club inquiries invited. Nat Stinnette, Umatilla, Fla. 32784.

HALLICRAFTER SX117 with speaker, like new; DX40 Transmitter, VFO, Astatic mike. All perfect $250.00. Never got General license. Pershan, WB2HPS 142 Brittle Lane, Hicksville, L.I., N.Y. Tel. OV 1-3145.

COAXIAL CONNECTORS. Similar to old Gen'l Radio type 774. Set consists of CBWU 49121-A plug, CANS 62112 cable adapter and CN 49120 jack. If you have any of the older model G-R test equipment, these are the connectors you need. $1.25 each in lots of 10. Large qty avail; dealer inquiries invited. K. Y. Hoo, 3233 Conti St., New Orleans, La. 70119.

WANTED: Copies of 6-UP Magazine. Numbers 5, 6, 7 and 8 to complete personal collection. Also copies of VHFER for 1963 and 1964; April 1965 also needed. W1DTY, RFD 1, Box 138, Rindge, N.H. 03461.

RHODE & SCHWARTZ type KZS—BN5500 limit bridge with all manuals. Like new laboratory equipment. Will sell or swap. Make offer. WA5AWO, Box 79, Port Gibson, Mississippi 39150.

COLLINS, MP-1 and 351D-2 mint condition, $175.00. Also crystal bank, contains 126 crystals in plastic carrying case, 3.4 Mcs to 30.0 Mcs. $175.00. R. C. Canter, Rt. #1, Frederick, Md. 21701.

TOP HATS, EPOXIES, STUDS, SCR'S

800 PIV	1.5 Amp	Epoxy	.69c	5 for	$3.00
800 PIV	1.5 Amp	Tophat	.59c	5 for	2.50
600 PIV	1. Amp	Tophat	.39c	5 for	1.75
400 PIV	1. Amp	Tophat	.29c	4 for	1.00
100 PIV	6. Amp	Tophat	.39c	5 for	1.75
100 PIV	.2 Amp	Tophat	.15c	8 for	1.00
50 PIV	150. Amp	Stud	$2.95	4 for	10.00
50 PIV	6. Amp	Stud	.98c	5 for	4.50
50 PIV	.5 Amp	Tophat	.15c	8 for	1.00

SCR Gen. Elec. C40B (2N685) 200 PIV 25A..........2.95

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BEAMS: new complete with boom and hardware; SWR 1:1; handles 5 KW; adjustable entire band; 7/8" and 1" alum. alloy tubing; single coaxial feedline:

4 EI 20	$32.*	2 EI 15	$12.
3 EI 20	22.*	6 EI 10	28.*
2 EI 20	16.	4 EI 10	18.
5 EI 15	28.*	10 EI 6	32.*
4 EI 15	25.*	4 EI 6	15.
3 EI 15	16.	*Has 20' steel boom	

ALL BAND VERTICAL V80 (6 thru 80) $16.95
ALL BAND VERTICAL V160 (6 thru 160) 18.95
Remit with order; shipped charges collect.
GOTHAM, 1805 Purdy Ave., Dept. 73, Miami Beach, Fla. 33139

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