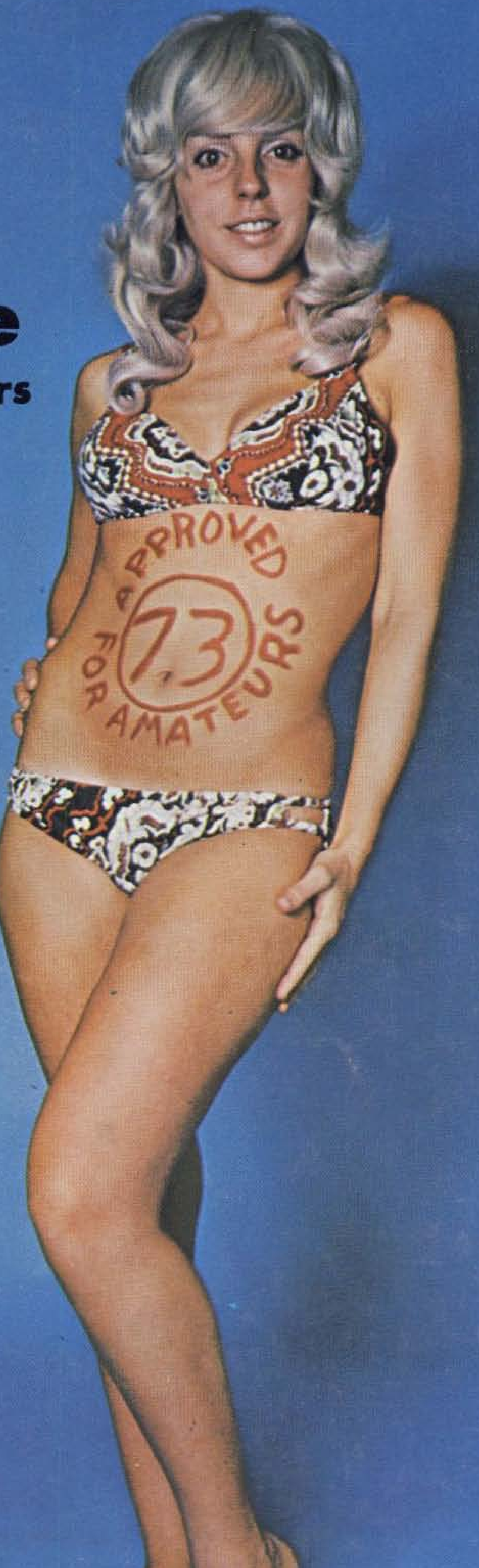
# 73

# magazine

for radio amateurs

$1.00
February 1973
26009



**73 magazine**
**for radio amateurs**

#149 FEBRUARY 1973

## FEATURES







COVER: Apropos of St. Valentine's Day, we have Judi Light encovered — or perhaps uncovered. Repeater Bulletin readers know her as Judi Repeater. The photographer on the "work is fun" project was Charles Webb K0BWR and those of us who appreciate fine construction projects thank him for making the effort. Perhaps some of you budding photographers out there will win your way into the heart of a nice YL and provide us with an amateur radio or 73 slanted picture.

*73 Magazine is published monthly by 73, Inc., Peterborough, New Hampshire 03458. Subscription rates are $6 for one year in North America and U.S. Zip Code areas overseas. $7 per year elsewhere. Two years $11 and $12 overseas. Three years, $15, and $16 overseas. Second class postage paid at Peterborough NH 03458 and at additional mailing offices. Printed at Menasha, Wisconsin 54952 U.S.A.*  *Phone: 603-924-3873.*

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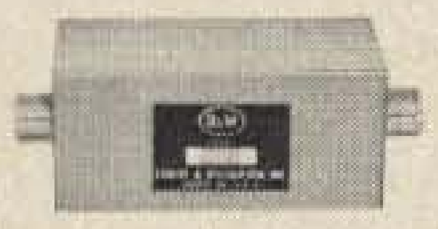

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|---|---|---|---|---|---|---|---|---|---|
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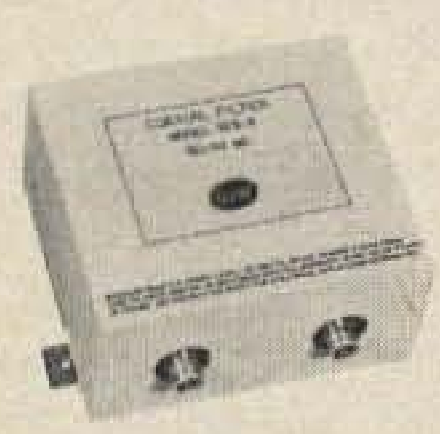

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*EDITORIAL BY WAYNE GREEN*

## ONE MEG THOUGHTS

The new regulations have had quite an impact on repeater operations. The complexity of getting repeater licenses have noticeably slowed down the appearance of new repeaters on the two meter band – as well as on 220 MHz. But most repeater groups are in agreement that this is a temporary slowdown and that there will be a big need for more channels before long.

The opening of the 147 MHz segment made a bunch more channels available, but it also made a one MHz split feasible for the first time, and the benefits of this have caused quite a bit of brow knitting.

If we leave the 146 part of the band as it was we have fourteen repeater channels and six simplex channels, figuring the standard 600 kHz split. There are thirteen repeater channels and seven simplex channels in the 147 MHz segment, a total for the two megs of 27 repeater channels and 13 simplex.

Now, since repeaters have been forbidden to operate in the 144–146 MHz part of the band, it would seem reasonable to try to encourage simplex to use these channels and thus permit repeaters to have all of the channels possible in the band segment to which they are restricted. Since, in most areas of the country, simplex operation accounts for perhaps 5% of the total FM activity, the allocation of one third of the channels for simplex would seem seriously unbalanced. In fact, simplex activity rarely occupies more than one or two channels in any area and the allowance of 13 channels is enormously wasteful as far as repeaters are concerned.

If the simplex channels were all turned into repeater channels, this would add six more repeaters, a total of 33. This should be enough for all but the most urban of areas such as the eastern megalopolis.

While 33 channels may indeed be enough even for New York City, the consequences of there being a need for more than 33 are dire. Before the 147 meg segment opened there were more repeaters than available channels and new groups began filling in between the standard channels, with mixed results. Some receivers are capable of handling the problem of a repeater just 15 kHz away, but not many.

The channel splits in the early FM days were set up as 60 kHz. This permitted six repeaters in the meg. It didn't take long at all for the six channels to fill up and the next step was the logical one of splitting into 30 kHz channels. It was logical, but it was wasteful and set up a problem for those coming along a couple of years later when the only remaining split left was to 15 kHz.

Technically, it is a lot easier to make receivers which will work reasonably well with repeater chanels 20 kHz apart than it is 15 kHz. A whole lot easier.

With this situation in mind, many of the proponents of reestablishing repeater channel standards favor not only a one meg split, but also a change to 20 kHz between channels at the same time. With some repeater groups still struggling into the 600 kHz split standard, it is difficult to engross everyone in the benefits of making such a major change just a year after we all finally accepted 600 kHz. A few of us point out that we tried to sell the one meg idea a year ago when 600 kHz was coming to be accepted, but were shouted down. No matter, this is 1973 and things are different today than they were just a year ago. Crystals are much cheaper – synthesizers are a reality – and we have learned that change is not all that big a deal.

Proponents of one meg splits point out that this would solve several serious problems. First of all it would greatly simplify the construction of repeaters – and would enable most repeaters to work a lot better than they do today. Few repeaters do not suffer from desensitization to some degree. Further, now that mobile and base station rigs are asked to transmit over a two MHz range, the efficiency of most of them drops off seriously on either one end of the band or the other.

Transceivers must transmit from 146.01 to 146.40 in the lower MHz and 147.63 to 147.99 in the upper meg. Not many can handle that. The receiver is not strained as much, having only to cover one meg. In areas where the 147 meg part of the band is set up with input low and output high, like the 146 band, the receiver has to cover 1.5 MHz and so does the transmitter! Add to that almost insurmountable intermod problems which result from this system and you have headaches of major proportions.

If we decide to put all our repeater inputs in the 146 segment we ask our transmitters to cover only 1 MHz – ditto our receivers. It's easier. Intermod is greatly reduced too. It would only take a slight stretch to add some simplex channels below 146 on transmit.

If we also decide to change to 20 kHz spacing we will have a total of 50 repeater channels available. Since this would include all of the original 60 kHz channels, on which most of the larger repeaters are settled, it would not cause serious problems to very many operators. Repeaters would be on every even channel starting at 146.00–146.02, etc.

It may just be time for repeater councils to start talking about this and see what can be done. The one meg split talk is gathering momentum and we all have to face the prospect that it might be with us a lot sooner than seems possible. The fact is that several repeater groups have already announced their intention to go one meg – and if we are all to get in step and arrange for mutually acceptable standards we have to put aside those who oppose change and see what can be done to accommodate it.

If we don't agree, we will be faced with the prospect of some repeaters going 20 kHz channels, some 15 kHz, some input low, others input high. We do need to get together.

What about this business of moving from 30 kHz channels to 20? Some rigs will swing that much on transmit – some may require a padding capacitor. Others may not make it and it may be necessary to send the crystal back for a slight shove. I suggest that we try to always move down as this is where added capacity moves crystals. Thus a repeater input on 146.07 would move 146.06. It apparently is not a big or expensive deal to get crystals moved a few kHz. During a change it would be possible for many repeaters to run two outputs for a month or so while users got new receive crystals. By staggering this operation the spare transmitter could be used for one month with one repeater and then moved to another for the next month – etc.

Needless to say, 73 will welcome any and all ideas on repeater standards. We are not really interested in emotional harangues, but would like to pass along any well reasoned arguments and suggestions.

### REPEATER LICENSES

Firstly, to establish my bona fides – the following is what I managed to glean from an all-day confab with the FCC (amateur division) in Washington. Hopefully I have not screwed it up too much.

The fact emerged that repeater licenses are going to be a lot more difficult to get than most repeater clubs realize – if they insist on going for a license for their complete system right off the bat. As the complexities of providing satisfactory information on the many aspects of the license grew more apparent to me, the direction in which a solution to this maze lay became more obvious.

Let's take the complexities from the top and make you wait, if this problem interests you, for the easy out.

Take docket 18803 firmly in hand and turn your attention to part 97.41(f), the application for a repeater license. You will find this on page 106 of the November 73.

(1) The docket requests that the location of the repeater be drawn upon a 1:250,000 scale topographical map, one with 50 foot contour lines. These maps are available from the U.S. Geological Survey, Washington, DC 20242 for $1.50 each and they are extremely difficult to find anywhere else. You will find an index to some of these maps published in the March 1970 issue of 73 on page 94. The maps use the same numbering system as the three dimensional maps. The FCC wants these particular maps used and *no* others. Yes, they know that the more available 1:62,500 maps give more detail and are "better." They want what they specified.

(2) They would like you to show your computations for determining antenna height above average terrain. See appendix 5 on page 112 of the November 73.

(3) Your effective radiated power will be the transmitter output less the loss in your feedline (see the 73 Coax book for details on coax losses by type of cable, frequency and length) and less any radiation in other than the main lobe. You may find that you will have to consult "Antennas" by Krauss or stick to something simple in an antenna such as a dipole. If you are going to use anything more complicated than a half wave dipole you should show the mathematical derivation of the power in the horizontal plane main lobe and also show evidence that you have confirmed this figure by actual measurement.

(4) The manufacturer's rating of output is not sufficient here – show that you have actually measured it with reasonably precise equipment.

(5) The transmission line loss will be the same as used for your calculations in (3). Give the theoretical loss and show that you have verified this by actual measurement.

(6) The patterns as published by the antenna manufacturers are not sufficient to get you through this part – unless the manufacturer has had the patterns of radiation accepted by the Chief (amateur division) of the FCC. None have as yet. If you do use the manufacturer's patterns you must indicate how they were determined – whether by mathematical derivation or range – whether they were checked on a range and the characteristics of the range used. If you made the patterns yourself you should give data on the methods you used.

(7) More of same.

(8) (9) Forget these for now – they're too much to cover in less than a book.

#### The obvious answer

Since the problem facing most repeater groups is an immediate one: to get licensed as quickly as possible – and with the deadline approaching when repeaters will have to be shut down unless some sort of WR- license is in hand, the path of least resistance would seem to be to simplify the application to the barest bones for a starter and then add complications to it once the license has been obtained. This makes sense, doesn't it?

Since it is possible to get shot down for the whole license on any one of the details, the route of extreme simplification seems best. If you think in those terms the repeater license gets a whole lot easier to work on.

How can you simplify the application? Well, if you get your license first for direct local control, you will avoid a vast number of complications, any of which could bounce your application back. This immediately deletes (8) and (9) as problems. If you put down that you will start with a dipole you avoid all those patterns and the complications of the gain of collinear antennas. The pattern is ultra simple – see page 8 of the VHF Antenna Handbook by 73 Magazine ($3) for the vertical and horizontal pattern of a vertical dipole. For some reason the amateur handbooks do not give these patterns. That's a "tsk" for ARRL and Sams.

If you use foam RG-8/U you have a loss of about 2.3 dB per 100 feet at 146 MHz. The chart on page 13 of the Coax handbook shows that a 2.3 dB loss is equal to a power ratio of 0.588. If you put ten watts in the bottom you will then get 5.9 watts out the top of the feedline. If you are using a dipole (gain of 1) this will give you an effective radiated power of 5.9 watts.

Once you have that elusive WR- call in hand (none have been approved as of this writing) you can go ahead and modify for your big antenna. With that okayed you can go to perhaps a phone line remote control – then on to a 450 link – and work on into proposals for automatic control or whatever turns you (and the repeater) on.

The Repeater Bulletin provides a faster communication medium for repeater news and this situation will be covered at far greater length in that publication – still available for $2 per year from 73. The December issue of the Bulletin carried the latest available FCC helpful hints for getting your repeater license and further editions of that poop sheet will be published in the Bulletin.

#### FCC vs CBer

The report that the FCC monitoring stations had issued more citations to hams last year than to CBers makes it rather obvious that the FCC just isn't even trying to solve the mess on 27 MHz.

Some people are of the opinion that it is the magnitude of the mess that has stopped the FCC from even making a serious attempt at cleaning it up, but that does not make real sense. The fact is that if the FCC had any serious desires to get the CBers into shape they could do it with little effort and expense.

How? There are a hundred thousand or so amateurs who would gladly pitch in and help. With even the slightest hint, amateurs would work up direction-finding teams and hunt down the illegal operators, presenting the FCC with the names, addresses, illegal calls, etc., of the pirates. Amateurs are well aware that the lack of distinction between amateur and CB has caused much trouble for radio amateurs. Few of the newspapers seem to have any idea that a CBer is not a ham, so whenever a CBer does something so raunchy that it makes the papers he is often as not billed as a ham. Hams would be only too delighted to help clean up this cancer.

Why is it that the FCC has made no noticeable effort to clean up this problem? Is it the power of the EIA Washington lobby that has them backed off? Money talks, and it may be speaking loud and clear in this case. How else can we try to understand the present situation wherein there is an obscene mess on eleven meters – little is done about it – and now there is very serious talk of giving this bunch of illegal idiots another 80 channels?

I would like to tender an abject apology to any law abiding CBer who is actually on the air and using the band as it was intended. While I recognize that there is a remote possibility of such a person existing – he is remote enough so I don't know where he is. He is also totally covered up 24 hours a day by Red Apple and his ilk.

### TUNING CB RIGS

The fact is that CB transceivers have a tendency to go out of tune quite a lot with a resultant loss of power on both receive and transmit. This is due to several factors – changes in temperature can have a profound effect on some of the parts such as i-f transformers and can loosen the little screws which hold them together. Once these come loose their operation can be seriously degraded.

Vibration during use and in shipping often loosens these screws, not only on i-f transformers, but also in crystal oscillator circuits.

Though it is not legal for a CBer to mess with his own set, it is not all that difficult for him to get a small screw driver and tighten all of the loose screws and thus bring the set back to the way it was when shipped from the factory.

Once the screws on the i-f's and padders have been tightened, the average CBer will be better able to operate his rig and observe the FCC regulations.

### FM = FUN MAKER?

If it were not for the number of FMers who personally thank me on the air and at conventions for urging them into FM I might just stop poking those of you not yet on FM in the sore spot. But the fact is that there is a lot of fun that is being missed by tens of thousands of ops – inexpensive fun.

The complaint that I hear most from low banders who have not yet tried FM is that it is just another citizens band. I even hear this now and then from someone who has listened to it for a few minutes from a store or from a friend's house. I don't think you'll find any active FMers who will back up that evaluation.

Anyone who checked out FM in Southern California up until recently would have reason to wonder what all the fuss was about. There was a lot of the CB-type stuff going on, with Broderick Crawford ten signals, virtually no rag chewing, and darned little meaningful communications.

There are peculiar problems here and there around the country, to be sure. But in all, if you get more than one or two sets of crystals for your FM rig, you will find as nice a group of people to talk with you as you could possibly ask for.

Up here in New England I can name maybe a half dozen over-inflated ego cases that are a minus quantity on FM – and for every one of these dingalings I can name ten nice decent interesting FMers. For every bad mouther of FM there are a hundred or more fellows who will go way out of their way to be of any help they can.

When the president of a repeater club turns out to be the one jamming the club station, we have some problems. When the editor of a repeater council newsletter goes on the air and expresses disgust with FM, we have problems. But these are the problems of a couple individuals and they are insignificant. They are ego difficulties – and until the FCC decides to include a psychiatric exam with the license test, we must accept the bad apples along with the good – and try to ignore the bad.

My discussion of the bad aspects is all out of proportion to their importance. The average FMer rarely runs into them and FM is for almost everyone a joy. FM provides the truely interference-free contact that we find so rarely on the low bands. It provides you with a small group of not very distant friends with whom you can talk, joke, visit, help, and be with on the air whenever you have a free moment. You can be with them while you are taking your children to school – while driving to work – while driving to a customer – any time. You can have a hand unit and be on call whenever you are awake if that turns you on.

When you travel you have an immediate intro to the FMers anywhere – and you will find them most gracious. W1QXR steered my wife and me to one of the finest restaurants in the country one evening when I was driving through Bangor. Every FMer has had experiences like this – by the dozens.

And what a good feeling it gives you when you are able to provide a public service! The other night I was driving from New York to New Hampshire and the road conditions were execrable. It was snowing and raining, with the rain freezing the road into a sheet of ice and the cars were being frosted over. Cars were sliding off the road everywhere. Whenever I would see one that obviously couldn't get back on the road I would pass the word to the highway patrol via the nearest repeater. I reported six such accidents during my trip. None of those people will know who sent help, but they will appreciate it.

What do we talk about on FM? Anything and everything. Since the contacts are QRM-free, we can get into real conversations and are not limited to name and location as on the low bands. And since we generally get to know most of the regular inhabitants of the repeaters we use, we have more and more to talk about.

Well, enough of the sales talk on FM. Check around and you'll find that there are a number of active FMers in your area – talk with them – and you'll be getting a rig soon.

### SECURITY COLUMN?

Unless I get an awful lot of static, I would like to devote a small space in 73 every now and then to keeping readers up to date on equipment and literature available for security involved amateurs. If there is anyone among our readers who is well versed in the field and would be interested in keeping us all informed, I'd like to hear from him.

While some readers have all the money they need and the price of a Signal One is no problem – the sad fact is that most of us would like to have an extra couple hundred dollars a week coming in. It is just a lot further between times we can buy a new rig or a hand unit that we really like.

### ARTICLE IDEAS

Hundreds of rigs are stolen out of cars every year – and the situation is getting nothing but worse. What can be done about this?

We have already asked for articles on car burglar alarms – and frankly we would like to have a lot more sent in to be published – but we haven't seen much in the way of new ideas.

Now that more and more of us are packing a hand unit when we leave our car we might be able to put it to good use. Suppose we set up a circuit that not only set off an alarm when someone tampered with the car, but also sent out a signal on two meters that we could receive on our pocket unit? Most of the time you are not all that far from the car and would be able to zip out and collar the kid who is busy ripping you off.

This would be valuable even at home – and a lot of gear is swiped out of cars parked in front of the house or even in the garage.

Let's see some articles on this.

The new VWs have a plug built in for hooking into a "computer" at your local friendly Teutonic service center. This plug connects to sensors spread all through the car, keeping touch with each pulse. Some of these might be of interest to us to monitor – like for instance the battery water level. Be assured that the editorial staff of 73 will not look too

*Continued on page 22*

# SSTV SCENE

*Dave Ingram K4TWJ*
*Rte. 11, Box 499, Eastwood Vil. 50N*
*Birmingham AL 35210*

As you know, Slow Scan activity is growing tremendously, and 1973 promises to be the biggest year yet. (Wait 'til you see all the new gear and SSTV info coming out this year!) This is really great; however, we "modern day pioneers" are now realizing "growing pains" similar to the SSB activity in the early 50's. The increasing number of active Slow Scan stations now call for a review of such matters as identification methods and worldwide calling frequencies, for example. Maybe we should consider video and audio ID every three minutes mandatory. Possibly we should move our favorite "hangout" frequency of 14230 kHz to 14250 kHz, and start stacking back toward 14230 kHz as Slow Scan activity increases. This would serve the double purpose of easing some pressures between SSB DXers and Slow Scanners, plus giving us room for future expansion. Cop Macdonald and I feel through a unified effort these issues can easily and quickly be resolved. What's your opinion? If you have any ideas, or suggestions, we would be quite interested in hearing from you – and soon!

*Orbit 418 (11/18/72 GMT)*

Gene W8YEK is up to 64 countries on SSTV now, and W4MS is right behind. Two ET3's just got on SSTV, ditto a DU1. Remember Bill XW8AX? He's now back on Slow Scan as TJ1AX. Look for him around 21340 kHz, about 1900 to 2000 GMT. VU25KV has been running some good pictures out of India lately . . . the usual frequencies, 15 and 20 meters. Two DX "goodies" appeared on Slow Scan for about a week during November, 5W1AT and an HSØ. Both operated on 21340 kHz about 2000 GMT. Hmmm, new trend here . . . or is 20 meters just getting too rough?

The WA9UHV/W9NTP QSO's through Oscar VI continue to grow in success. This month's pictures from WA9UHV should illustrate this. If you hold the photo out at arms length the QSB won't be too noticeable. Although a complete description of these guys' work and rigs would take a full column, I think it would be sufficient for now to say WA9UHV uses a transverter, some beams, all home-brew Slow Scan gear, and a Signal One transceiver. W9NTP's rig is so large – I'll just have a picture or two in next month's column!

*Orbit 418 (11/18/72 GMT)*

Sometime back, Mike Tallent W6MXV and Don Miller W9NTP, came up with the idea of transmitting two regular, 120 line, Slow Scan pictures of an object, and shifting the second picture ever so slightly, so its 120 lines would fill "in between" the previous pictures 120 lines. If the two pictures (or Frames, as they should more properly be termed) were then viewed simultaneously, the result would be a high resolution, 240 line Slow Scan picture. To accomplish this, you simply take a photograph off the screen, and leave the shutter open for both frames, or 16 seconds. The only requirement of your monitor for this "interlaced" system is that focus can be adjusted sharp enough each line, and space between each line is clearly visible. (You can't fill in a space that's not there.) Your Slow Scan generator can probably be modified, inexpensively, to obtain the simple sync generator shift. Robert Suding WØLMD, took the sequential interlaced frames a step further in his sync generator modification and has selectable 120, 240 or 480 line picture capabilities. I found his circuit quite interesting since the cost is very low. W6MXV, W9NTP, and WØLMD will probably hve copies of these circuits at the Dayton Hamfest in April – however, if you can't wait, send WØLMD an SASE and 10 cents (to cover Xerox cost) for a copy.

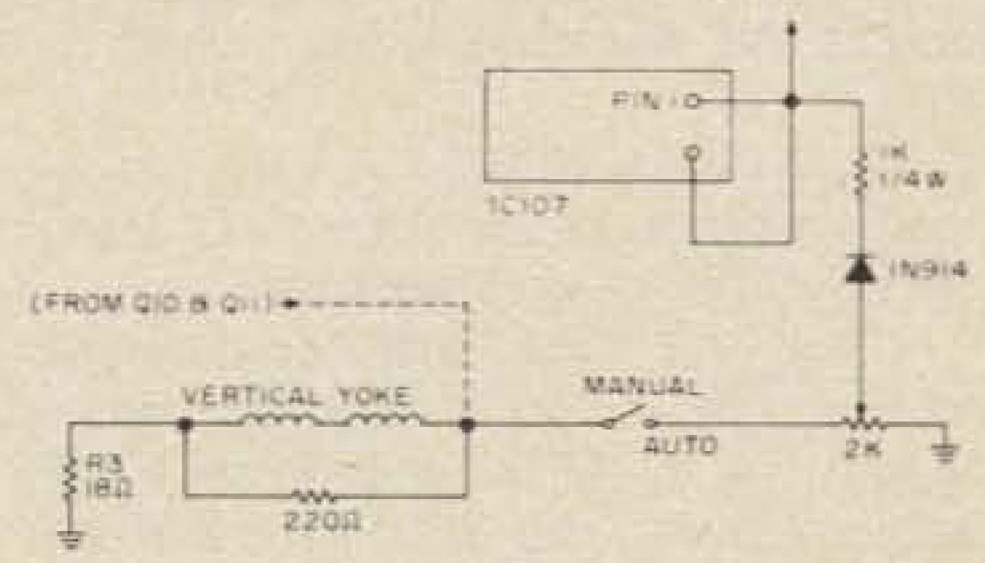


*Fig. 1. Automatic vertical reset modification.*

Those of you with W6MXV monitors might be interested in Fig. 1, a modification for automatic vertical reset (constant running sweep). The switch selects manual vertical trigger, or automatic reset.

You might use Pin 12 (that previously unused pin) on the monitor circuit board to bring out the lead from IC 107. A simple modification to make a great monitor even better!

Don't forget the Slow Scan contest the 10th and 18th of this month. Hope to be "seeing" you then . . .

73 . . . Dave, K4TWJ

# SUMMER E SEASON REPORT

The last half of June along with July and August seem to have been very active with not only aurora and E's, but with continued F2 contacts as well. There seems to have been a lot of activity in the Caribbean area. A number of stations, from all sections of the United States, worked VP5RS, 8P6EN, and a host of KP4's. August seems like an interesting month for Jack K2KDQ. He told of hearing a pair of KH6's in QSO. When Jack tried to break in, one of the stations came back to him and said "K2 . . ." Unfortunately, the band gave out and they were never heard from again.

Meteor scatter DX'ers take note: W2AZL, Holmdel, N.J. and WØLER, Minneapolis, Minn., made the first meteor scatter two-way on 432 on August 12th. It took them over five hours to complete the two-way, proving once again that patience pays off! I thought I might mention this fantastic achievement even though it is not really related to the E season. One of the greatest auroras of all time occurred between August 3–5th, when 50 through 432 were wide open. I had an eyeball with one of the members of the WA1MUG group at the Hudson Division Convention back in October. He told me that if I thought the June contest was bad, I should have operated the September contest. It was completely lacking in E's.

Mel Wilson, W2BOC, a VHF propagation enthusiast for almost 40 years, sent the following comments:

"The only comments I could make at this time is that the summer was a 'good' one in the sense that the MUF was up to at least 180 MHz and the two meter band was open a number of times. From 6 May to 13 August, there were 7 days in which I have no reports of VHF propagation, not counting 3 days of aurora which of course blanks out intense E's. This number of days is about average for each year. However, this year the length of openings was somewhat greater, the geographic area seems to have been greater, and the openings at more northern latitudes were better. The year started earlier, with very unusual intense openings during the first week of March, with the MUF at least to 100 MHz. Beyond that I don't know of anything else very unusual. I have no reports of KH6 being heard east of the Mississippi, which is surprising with so much intense E's. There have been some rather wild reports, but they haven't checked out."

Bob Scupp WA2CXS
*Reprinted from the* **Knight Knews**.

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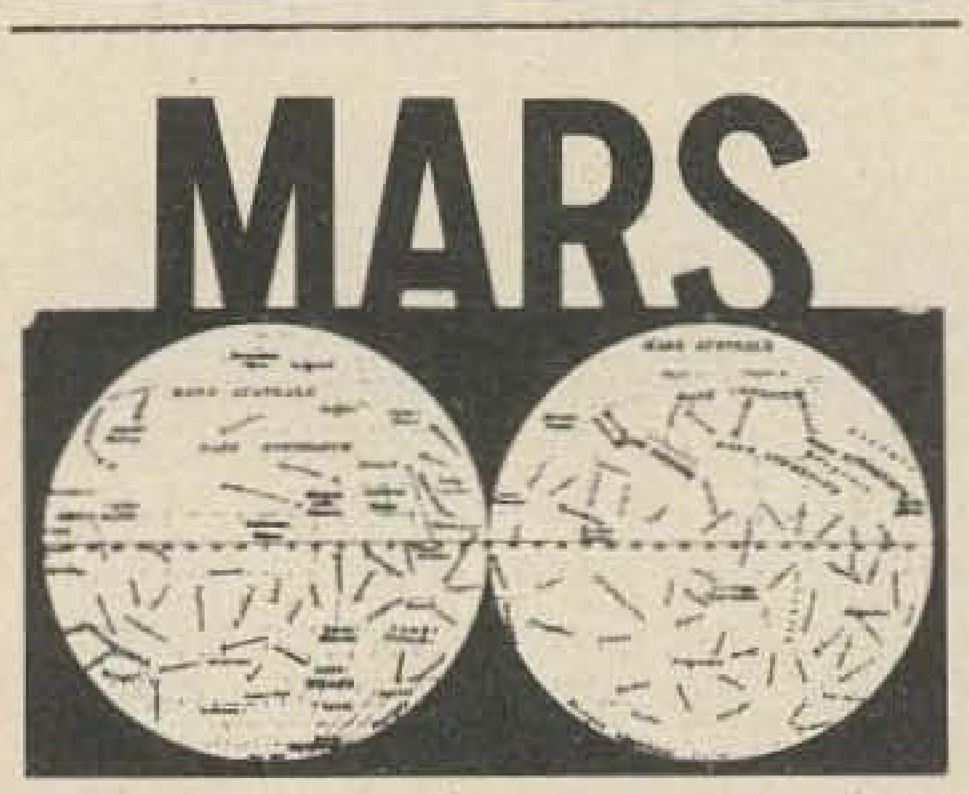


*Harry Simpson A4SCF*
*c/o 73 Magazine*
*Peterborough NH 03458*

Orchids to AFC6YPX, the North American Rockwell Radio Club station located in Anaheim, California, on their fine bulletin written especially for the benefit of their fellow AF MARS operators in Southeast Asia. To quote: "We are located at North American Rockwell's Electronics Group where approximately 12,000 are employed. Our station is at the Employees Recreation Park just outside the main plant premises. The park comprises 20 acres and has a picnic area, a nine hole golf course, exercise room and various club rooms . . . antennas overlook right field on one of the ball diamonds and our log periodic is adjacent to the tennis courts and swimming pool – still it seems that we spend all our time in the Radio Club operating MARS!"

This very fine station, which my informant says handles more Southeastern Asian phone patches than any other known station, is well equipped with the most modern gear – including a wind-sensing circuit which automatically lowers their towers from 75 to 25 feet whenever high winds come up!

A welcome letter from Hugh Dowell NØASG3/NØKXW, Assistant to the Director for Operations, Ninth NAVMARCORMARS District, outlining Navy MARS procedure which, if adopted by the other services, would be a boon to the overall program. He says, ". . . a number of hams join MARS with the idea of getting free equipment. You probably know as well as I do what happens to these would-be members! Navy MARS has changed their policy toward new members recently. We are looking for members who will be active and are trying to weed out the others. When a person joins Navy MARS he is given a four-letter suffix call sign (example – NØBAT) and is considered a temporary member for 90 days. At the end of that period, if he has met the minimum participation requirement of 18 hours per quarter he is recommended by his area coordinator to the District Director to be accepted as a full member. If he has not met the requirements he is terminated. This method allows us to assign new member calls much faster than before, cut down unnecessary paperwork, etc. If the new member is recommended, the "T" in his call sign is dropped and he has a standard call sign." Thanks, Hugh, for your wonderful letter and the information.

Thanks also to Sam Dunn WB4ICF/NØJXG for filling us in on Marine Corps MARS activity in the Okinawa area – there are 5 stations on the island, plus one in Japan. Each station is manned only by qualified MARS operators with a MOS of 8981, and also must be a licensed amateur! A very nice letter from Shorty Sutter AFA9YBM, offering the information that in Air Force MARS a W prefix is changed to AF; K is AFA, WA is AFB and WB is AFC. I would like to acknowledge many, many other nice letters – unfortunately my space is severely limited (we're proud of even the limited space, Wayne!). Suffice it to say that thanks to your response, I can now forward inquiries for a particular MARS service directly to the proper person. To the few who wrote nasty letters about my not mentioning their service – yet who didn't offer one iota of information on same – I can only quote an old friend, "You ain't a solution – you're part of the problem!" Just keep those cards and letters coming in – we'll make a worthwhile column yet!

. . .A4SCF

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# HAMS LOCATE MEDICATION

On August 15, 1972 10 GMT Hildegard I8PLH from Reggio Calabria made a call on 80m for medication (Gamma Globuline). A child in the Clinica pediatrica in Roma was sick and needed it desperately. All commercial ways were exhausted or did not work, since there was a big church holiday in Italy.

Hannes DK1KQ from Lindau/Bodensee picked up the call and said he would be back at 10:30 GMT. Now Traudl DK1AX from Miesbach near Munich called I8PLH asking if she could help and also asking about the Maiory YL RC Italiano Meeting, where she will represent the DL YL's. Since DK1KQ could not come back at the stated time, Traudl called DC2CG, Dr. Friedrich, in Munich. He had the proper medicine. It is very expensive and not common in that area; he had wanted to donate it to a missionary for some time. Traudl made the arrangements with Lufthansa, the German airline, to fly the medication at 13:40 GMT to Roma, while Hildegard contacted the police to have it picked up at the airport by a patrol car. It was all settled at 11:54 GMT.

At this point Hannes DK1KQ came back. He must have had a tough time in between, but he found some of the medicine, too. Since there is no commercial airport in Lindau, the German Air Force flew the medicine to Roma, where another patrol car was waiting for it.

Now the medication for the child was secured for two days. After that, slow (on holidays slower) working commercial channels could take over.

*Traudl DK1AX was instrumental in helping to locate the medication.*

# DX FOOTNOTES

*Gus Browning W4BPD*
*Drawer DX*
*Cordova SC 29039*

Here goes my second month as DX Editor for 73 Magazine. I hope by now that all you DX'ers out there will have the "message" and start sending me (direct if possible) all the DX news you come across. Keep in mind that I have a lead date of 2 months. Of course I can and WILL use the info that would be too late for this magazine in my weekly DX'-ers Magazine. In advance I would like to thank you for your efforts.

As you know those sun spots are getting less and less, so you may as well kiss 10 goodbye, and not expect those "almost" around the clock 15 meter openings. You had better be getting ready for the low bands and a new form of excitement that goes with working DX down there. No big, fancy, high power is needed (or allowed) on 160 meters you know. Nothing fancy in the form of antennas is needed either. I had a picture of a chap in Western Australia who had his "long wire" (?), strung along his wooden fence around his home ! I understand that he has been doing extremely well with it too. I guess you could call it his invisable antenna because when you look at the thing it certainly don't look like any antenna I have even seen - Sort of like an extra clothes line - yes, but not an antenna ! Right about now is a good time to be getting on 160 with QRN way-down, and activity up. Remember this band is at its best when its sunset or sunrise on one end, but you gotta get in there fast, because its short and sweet. The band has some other odd features which you will find out when you get going there. I once made WAS on 160 meters on two weekends. Of course that was when we had the whole band from 1750 to 2000 kc. Maybe if enough fellows get on this band and do a little real complaining to FCC they will get that darn Loran off for sure and start using some of these new DF's I have been reading and hearing about in recent years AND then give us back "our band". Let's us all hope.

It seems that we have at last got some little activity going in the AC Spots (as I used to call them). The Maharaja of Sikkim gets on once in a while signing AC3PT (The PT is a part of his initials), usually on 20 SSB and just occasionaly on 15 SSB. No need to look for him on CW because when I was there he was not copying CW and knowing what a busy man he is I seriously doubt if he has had the time to learn the code since then. At present Bhutan (ex-AC5-land) has two stations that can be worked if you are "persistant", and really "go after them" and have a certain amount of good luck or have someone to "fix you up" with a few firm schedules. At least it seems as if I did leave a small "seed" about ham radio in that area. I did sell the Collins "S" line and a 30L1 and even a Telrex and Ham-M rotar to AC3PT. I understand the Hallicrafters SR150 that I left in Bhutan is the Transceiver they are using now. If it is let me tell you that the "RIT" tuning has been changed so that it will only tune "up", not down from the transmitting frequency, in fact as much as maybe 15 kc as near as I can remember. You might keep this in mind if you hear him working stations off his frequency.

HEY THERE YOU DX CLUBS !!! We want you !!! We would like to "appoint" one DX (or at least DX minded) Club in each of the USA call areas, and one DX Club in each country in the world to act as verification points for our WTW Awards. We do not want any DXer to have to send us his cards to be checked. You run the chance of them getting lost and its that much more "work" for us here ! (we are basically lazy). For the time being we are using the the ARRL Country list, BUT we do have some ideas of some (but only a few) changes in their "official" list. We WANT MORE COUNTRIES, not LESS and we have our ears and eyes open to any and all suggestions from DXers here in the USA or anywhere else in the world. We want DXers to have something to do since this will keep them busy and out of "trouble" and keep the bands busy so that some other "service" wont steal any more of our "living space" !

If you have not as yet received your OJ0 QSL you might try again now because they are being mailed out and you should have received yours by this time. The same goes for cards for those who worked TI9C. (send your cards via TI2GI for TI9C). If you worked HH9DL some months ago you might try W3HIZ (I printed the cards for W3HIZ in early Dec.

In case some of you don't know about our 73 - 73 - 73 DX Award, here is the info again: Work 73 different countries in the first 73 days of 1973, make a list of the stations, giving the dates, times and freqs of each QSO, get a few hams to verify (let 'em look over your cards, or at least your log) and tell us you are OK, then send the whole mess to us (the whole mess being the verified list - YOU KEEP YOUR CARDS (if you have them !). We'll do the rest. In case you don't know it 1973 is 73 Magazine Year. This is a historical fact and cannot be denied by anyone. If you don't believe me just ask Wayne Green and I am sure he will verify this fact.

Ever want to hear about what's new in DX ? Try listening on 14,218 kHz almost any evening between 2300 to 2400 GMT. This is where the INDXA fellows hang out, you might try calling in and if you are lucky (and "skip" is with you) get K3RLY to answer your call. He is a very busy fellow, but will answer you OK if he hears your call. He can usually be counted on to hand out some good DX info, he might even be able to put you on the "list" if one is being made up for some DX station. You know some DX stations are very much afraid of a "pile-up", or maybe they just don't know how to handle a "wolf-pack" of callers and they have asked someone like K3RLY to be an MC for them. Maybe they are stuck with just a transceiver and every-time they show up on the band they get "clobbered" with callers. (yes I believe that some fellows, just call and call - never bothering to listen and hear what the DX station has to say !). Of course there are quite a few other DX Nets in operation, and each of them usually can be counted on to give out some good DX info, or maybe the DX will be in the net ! The SEA (South East Asia) Net usually will have a "goodie" or two calling in. They generally meet above 14300, somewhere around 1230z. Then there is a big DX net with KH6GLU Mc'ing it is called the Pacific (DX ??) Net. Then there is the Arabian Net, in case you want to maybe work The King of Jordan (JY1) or maybe the Queen (JY2). Quite a few "rare ones" call into this net. A few more good nets have sprung to life down in Africa and then there will be found a number of DX Nets being "run" from the USA. ANYONE should be able to work at least 200 countries by checking in just these nets, of course wait until a good chance to "break-in" on them. Back when W1FH, PY2CK, W6AM, W8HGW, W8PQQ, VQ4ERR, VQ4AQ, W4CEN, W4TO, W4TM, W3CRA, myself and many other Ole Timers was battleing it out there was no nets or even DX Magazines (like my DXERS Magazine-a weekly one) to help out DX'ers. You had to just do a lot of "digging, schemeing, writing letters, and most of all "listening".

73 Gus

# REPEATER UPDATE

LISTENING
94 76 88 73 70 64 82. . .

| | | | |
|---|---|---|---|
| CO | WØJGL | Castle Rock | 443.50–448.50 |
| MA | W1BHD | Skunk Hollow | 31–91 |
| NY | Delete | Belfry Mt. | 444.10–446.10 |
| NY | WA2MBT | Delete | |
| NY | WA2UYJ | Delete | |
| NJ | W2BHK | Delete | |
| NJ | W2FLY | Delete | |
| NJ | Delete | Cherry Hill | |
| NJ | Delete | Camden | |
| NJ | WB2ZQG | South Jersey | 22–82 |
| PA | WA3KXI | Lancaster | 01–61 |

# 50 MHz BAND

*Bill Turner WAØABI*
*Five Chestnut Court*
*St. Peters MO 63376*

Early December brought several openings, WA1EXN worked WA5SJM on the 2nd and heard a similar opening to Georgia, Kentucky and Tennessee on the 3rd, this one of 45 minute duration. Also on the 3rd Art worked Dan, WA9UBI, with 5–9 reports both ways. Dan was the only midwestern station heard. WA9YJE was worked under similar circumstances the evening of the 5th; YJE could not hear W1GAO or K1HFK who were in QSO with Art at the time. Art is looking for scatter schedules (random or meteor) in the 20–25 wpm range. Bob, WAØTXV, reports having worked 1's and 2's during the opening of the 2nd. The writer caught openings the 4th and 5th, the first to Florida (W4GDS and WB4OSN) and could hear Jim, WØPFP, slightly on backscatter when he joined in. Bob is already planning another DXpedition for June contest time. The opening of the 5th was mostly 3's working as far West as Oklahoma (WA5RBI) also heard were W5QDB and WB4BBO.

John, WB4RUA, of Calhoun, Georgia writes "re the '50 MHz' column in the December *73*, in answer to Lowell's (WB4WNV) question, yes there is a 6 meter net in North Georgia. The Dixie 6 meter SSB net meets on 50.110 MHz Sunday at 9 AM EST and Wednesday at 9 PM EST. This net is to bring together interested VHF amateurs in the area and provide a clearinghouse for any news and developments concerning VHF. This is a rejuvenation of the same net that sort of died out several months back when the regular NCS had a change in work schedule and could no longer function as NCS. WB4WMT and I are trying to get things back on a regular schedule. We welcome any check-ins and could use more VHF activity in the area."

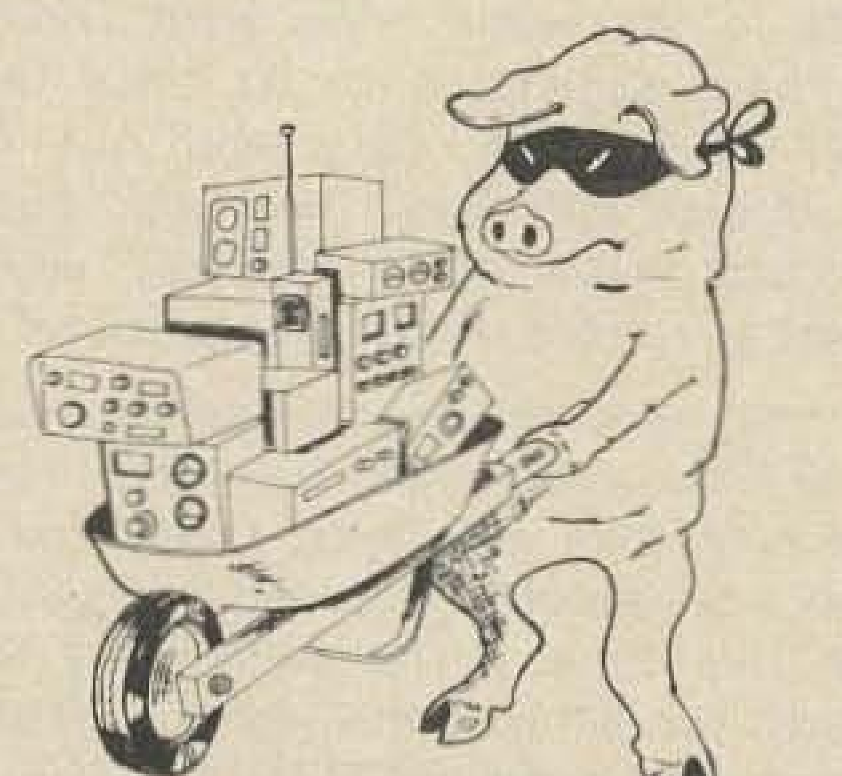
The 19th edition of the Editors and Engineers Radio Handbook is out and while it could use further updating in some areas it does contain much of interest. Much of the construction material is new, several items are must reading for the 6 meter oriented builder. There is a new 2 KW PEP linear featuring the 8877, a solid state exciter by K9HTK/5 covering 6 meters in addition to the HF bands and another in the series of solid state receivers by VE3GFN. (Looks like the perfect i-f for a 6 meter converter.)

A new 6 meter transverter, the CX-6X, has been announced by Signal One. Deliveries are scheduled to begin at about the time this column appears. Preliminary data indicates all mode capability, direct digital frequency readout of both receive and transmit frequencies and compatability with all Signal One transceivers and transmitter/receiver combinations.

Henry Radio has added a new 2 KW PEP linear for 6 and 2 meters to their Tempo line. It is my understanding that this unit is manufactured by E.F. Johnson of 6N2 Thunderbolt fame.

The Annual Conference of the Central States VHF Society for 1973 will be held at the Marriott Inn, Minneapolis the weekend of August 17-18-19. John Fox, WØLER is president of the group, WØMJS is program chairman. Hope to see some of you there.

WAØABI



**The Hamburglar**
*STRIKES AGAIN!*

SNEAK-THIEF STEALS FROM CHURCH – Leaves Town Defenseless!

A Clegg 22'er, ser. no. 1900-578, belonging to the Wallingford, Conn. Civil Defense Group was blasphemously ripped from the dashboard of W1NVR's automobile. The sacrilege occurred while said automobile was parked in the parking lot of the Grace Baptist Church on Nov. 20, 1972. If anyone has information concerning the theft, please contact Mike Saul W1DHP, Communications Director, Wallingford CD, 31 Hanover St., Yalesville CT 06492.

List from Past Issues:

| Mfr., Model, Ser. No. | Owner | Issue |
|---|---|---|
| Yaesu FT-101 No. 107036 | WA2YSW | 4/72 |
| Standard 2m FM No. 102703 | W6NPV | 4/72 |
| Drake ML2 No. 20189 ]3 | WB2LLR | 4/72 |
| Standard SRC-806M No. 009210 | K1TLP | 5/72 |
| Aerotone 6M 355LT, No. 685064 | RR Police Grd.Ctrl.Trml. NYC | 5/72 |
| Standard SRC-806M, No. 102703 | C. Mathias 3234 Coronado Ave Imperial Beach CA | 5/72 |
| Lafayette HA-410 No. 009210 | WA2KDG | 5/72 |
| Coll., 62S1 No. 10728 | MSU ARC E.Lansing MI | 6/72 |
| WRL Duo-Bndr 6010AT302 | WA6FCY | 6/72 |
| HR-2A, 11 chan., 04-07152 | WA1NVC | 9/72 |
| Swan Cygnet 270,No. 313022 | K4ACJ | 9/72 |
| Collins Mic, Mod. MMs, No. 4294 | K4ACJ | 9/72 |
| Heath HW-100 & AC PS | WA2JGP | 10/72 |
| Swan 270B, No. M-395430 | W8HST | 11/72 |
| AF68 No. 10888 PMR8 No. 10918 M1070 pwr supply | K5LKL | 1/73 |
| Trio TR2200 No. 241969 | WA2ZBV | 1/73 |

# AMSAT NEWS

OSCAR

*Mike Frye WB8LBP*
*640 Dauville Dr.*
*Dayton OH 45429*

Latest news on OSCAR 6; Due to a defective solar panel and because of unexpected use of the on-board translator, OSCAR 6 will be turned off during mid-week. The following schedule will hold to allow time for the batteries to recharge. ON TIMES will be Thursday through Sunday evening passes, and Saturday and Sunday morning passes, unless the batteries are low due to extended use.

ARRL's WA1PID has announced that OSCAR 6 contacts will count in the January VHF contest. ARRL also announces a "Satellite DX Achievement Award," one requiring a 1000-point-or-better total. QSO's through the satellite will count for 10 points, each new country will count for 50 points, and each new continent 250 points. Contacts must take place on or after December 15, 1972, with


only one contact per station regardless of mode. This award only applies to the OSCAR 6 satellite.

SSTV: The accompanying pictures were taken from OSCAR 6. All photos were transmitted and received by WA9UHV, except the frame sent by W9NTP.

I noticed the clarity and quality of these photographs. This certainly attests to the performance and stabilization of the satellite. Phil Howlett WA9UHV relates that best pictures are received when overhead passes are used. However, acceptable pictures can also be obtained when maximum elevation is 40°. This would appear to be the minimum orbit required for a full 8 second frame. Of course using 2 second frames, a considerably lower elevation is acceptable. Due to the camera used, he was unable to adequately illustrate the gray scale present in the photographs.

More slow scan tests are scheduled to be held in the near future, operating frequencies have been between 29475–29485 kHz.

Now that OSCAR 6 is a definite success, we are faced with a growing problem – *what next?* AMSAT has the next satellite in line, but what will we do with it? After a while QSO's lose some of their excitement. A few people have written in and suggested ideas, and AMSAT is looking them over. A portion of next month's column will be devoted to what is in the future for amateur satellites. If you have any ideas or suggestions of possible experiments, please drop me a line. Thank you.

. . .WB8LBP


*Joe Kasser G3ZCZ/W3*
*1701 East West Highway, Apt. 205*
*Silver Spring MD 20910.*

Well, the scene in England is really humming. I received a letter from G3ZGO full of goodies which are now to be passed on to you.

An FM group has been formed in London. There are over 74 members, and in charge is G5AGX, none other than W8TIF. There are over 120 people in 144.48 MHz FM simplex at the present time.

The only repeater in England is a specially licensed experimental unit in Cambridge. It has a license for one year and then the whole question of repeaters will be considered by the licensing authorities. It is operating on 145.15–145.75 MHz with tone burst access as reported in previous issues of 73.

Slow scan TV is going strong, even the police force are getting in on the fun. The Sussex County police use slow scan for base to mobile communication for passing pictures of suspects quickly, so as to facilitate and speed up the identification process.

It seems that in view of the replanning of the two meter band there may be changes in the simplex frequencies in the early months of 1973.

In Europe, the VHF bands are voluntary planned so that stations in a region occupy a section of the band. Stations in a neighboring region occupy a different part of the band. In this way when an opening occurs, they know where to tune for the DX.

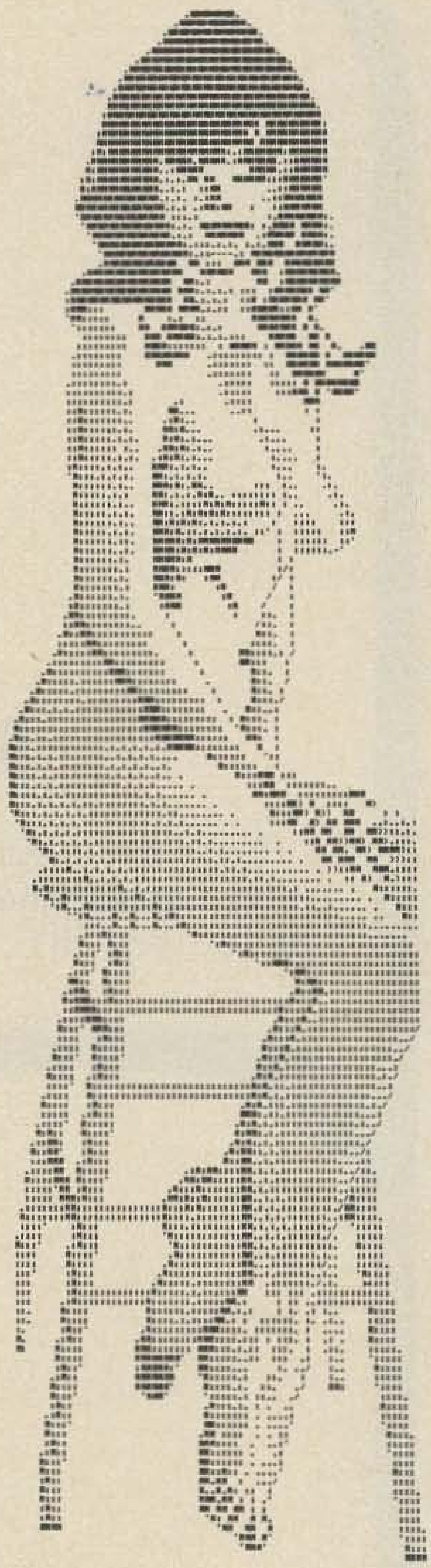
This column has been appearing on and off for a few months now, and I have not had any letters offering ideas. Does that mean that everyone is spending their time at home? If so, then this column will have to cease appearing, so 73 can use the space for something that will be of more interest to the readers. How about a column called "The Homebody Ham?"

What do you do if you need more FM frequencies than your 6 channel rig will allow? Do you put in the most used or wait at each street corner and change continuously? Here in the Washington area we need more than the 6 positions than the usual rig contains, yet a synthesizer is too bulky to carry around. One enterprising fellow carries two rigs.

G3ZCZ/W3

**RTTY PICTURE OF THE MONTH!**

Want to see your artwork here?



### THIRD PARTY REGS EASED DURING HOLIDAYS

Exchanges of third party traffic were temporarily permitted between The Republic of Korea and the United States during the Christmas-New Year Holidays. Phone patches were allowed between HL9 stations in Korea and amateurs in the continental U.S. and its possessions during the period of Dec. 21, 1972 through Jan. 4, 1973. With good results during this period joined with the possibility of easing political tensions, can we expect a more liberal communications agreement with Korea?


# escape from the 2 meter crowd

## The <u>all new</u>

## 220 MHz Clegg FM-21 Transceiver puts you in tomorrow's channels today!

220 MHz FM is *the* early solution to overcrowded 2 meter channels. Here's your chance to get in on the ground floor of the FM future. The new FM-21 all solid-state transceiver is an opportunity to "do it right" this time and start with the leader. The FM-21 uses only 1 crystal in any channel . . . one crystal gives you a separate transmit and receive frequency as well as automatic 1.6 MHz programming in the repeat mode. We call this unique triple-duty crystal feature Clegg Crystal Saver Frequency Control. For the complete story, see your Clegg Dealer or call or write us today for detailed data sheet and avoid the crowd.

**CHECK THESE FEATURES**

- 8-10 watts output (minimum).
- Speech clipping.
- Sensitive receiver—.25 $\mu$v (max.) for 12 db Sinad.
- Selectivity—Adjacent channel (40 KHz) down 50 db.
- Each crystal does triple-duty, providing a transmit and receive frequency (Crystal Saver Frequency Control).
- Monolithic crystal filter.
- Compact, rugged, attractive.

*Amateur Net* **$299.95**

SIGNAL AND CONTROL INTERNATIONAL CORPORATION Clegg DIVISION

3050 Hempland Road, Lancaster, Pennsylvania 17601

Tel: (717) 299-3671 Telex: 84-8438


### MUSKEGON HAMFEST

The 1973 ARRL Great Lakes Division Convention-Hamfest will be held in Muskegon, Michigan on March 23–24. Ham-Hospitality will be offered at the Ramada Inn on Friday evening the 23rd. Saturday, starting at 8:00 AM, technical sessions, swap & shop, commercial exhibitions and net meetings will be held at Muskegon Community College. More fun at the Ramada Inn that night! Tickets are $2.25. Reservations and info may be had by contacting Muskegon Area ARC, PO Box 691, Muskegon MI 49443 (see their ad on page 119). If you attend you will also be able to meet the gang from 73 . . . we'll be there!

### 3RD WORLDWIDE SSTV CONTEST

The third worldwide contest for SSTVers is being sponsored by cq electronoca Magazine. The operating times are 1500–2200 GMT Feb. 10, and 0700–1400 GMT Feb. 18. Plan to use all authorized frequencies on 80 through 10 meters. Each two-way exchange counts one point with a multiplier of 10 for each continent and an additional multiplier of 5 for each official ARRL country. The only exception is that each VE and W call area will count as a separate country.

Logs must contain Time (GMT), Frequencies, Data, Call sign, No. sent and received, Country multipliers, Points and final score. They must be received by Prof. Franco Fanti, via A. Dallolio 19, 40139 Bologna Italy before March 20, 1973.

NOTE: All contacts must be made via SSTV *only*. Use of any other mode of transmission before, during or after the Slow Scan exchange is not permitted, and will cause your log to become invalidated.

### FOOTHILL HAMFEST

The Foothill High Amateur Radio Club is having its first annual Swapmeet and Hamfest Saturday, Feb. 3, 1973, at Foothill High School, 19251 Dodge Ave., on the corner of Dodge and Newport Ave. It begins at 9 AM to 5 PM. Tickets are 35¢ for adults and 25¢ for children under 12. Booths are $5 each. For more information, call 714/838-7385 between 7 AM and 2:30 PM Monday through Friday.

### INTERNATIONAL RECIPROCAL OPERATORS CLUB

A club which supports the establishment of worldwide reciprocal amateur radio privileges has opened its membership to all reciprocal amateurs. Membership is free. Send a copy of your home and foreign reciprocal license with a QSL and two IRC's to IROC, Box 33, Medway, MA USA.

### LA PORTE SWAP-FEST

The La Porte, Indiana, Amateur Radio Club will hold its Annual Swap-fest and Auction on Sunday, February 4th, 1973, beginning at Noon, at the Civic Auditorium. There will be talk-in on 94 and on the La Porte Repeater, 22–82. 3910 will also be monitored.

### VHF CONTEST

Worlwide VHF Activity 1973 – 3PM local March 10 to 10PM local March 11. Purpose: To keep VHF bands active, allow rig testing, allow hams to get acquainted with fellow VHFers. Exchange call letters, county and state. Count contacts with mobiles in each county worked. Mobiles can work a station once from each county of mobile or portable operation. Let's see some mobiles. Scoring: Multiply number of contacts times number of counties worked times number of states worked. Awards: Certificate to each station scoring 100 points on six or 50 points on two meters. Certificate to the top station in each state regardless of score. This applies to each band of operation. Each band is a separate entry and a station can enter one or both bands. Logs should show time band mode and exchange info. Mail logs by April 15 to WA3NUL, Box 1062, Hagerstown MD 21740.

### WHEATON HAMFEST

The Wheaton Community Radio Amateurs will hold their 11th annual Mid-Winter Swap and Shop on Sunday, February 11, 1973 at the DuPage County Fairgrounds, Wheaton, Illinois. Hours: 8:00 AM to 5:00 PM. $1.50 Advance/$2.00 at the door. We are expanding to two buildings this year. Refreshments and unlimited parking. Bring your own tables. Free coffee and donuts 9:00 – 9:30AM Hams, CB'ers, electronic hobbyists, friends and commercial exhibitors are cordially invited. Write W.C.R.A., Bill Rambox, WB9AVD, P.O. Box QSL, Wheaton, Illinois 60187 for information. Please include SASE with ticket requests. NOTE: Ticket prices announced last month in this column were incorrect. The amounts shown above express the actual ticket prices.

### 1973 IARC PROPAGATION RESEARCH CONTEST

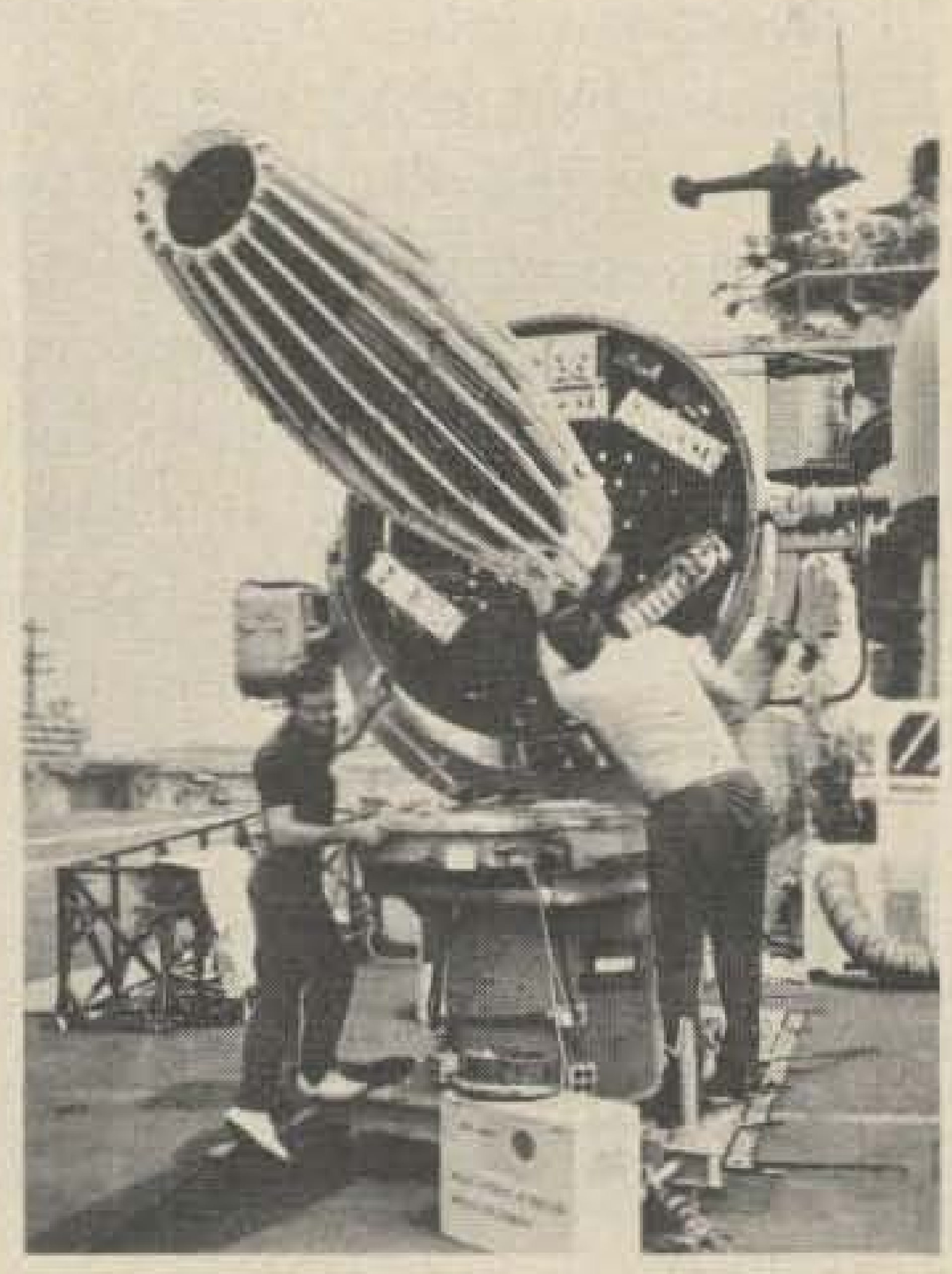
The object of this contest is to work as many CPR ZONES as possible. CW/RTTY dates 0001 GMT Feb. 17 to 2400 GMT Feb. 25; PHONE dates 0001 GMT Mar. 24 to 2400 GMT Apr. 1. Exchange signal report plus zone no. Final score equals no. of zones worked X no. of contacts. Contacts in own zone do not count as contact points. Mail all logs to L.M. Rundlett, 2001 Eye St., N.W., Wash., DC 20006.

### GRANT COUNTY FESTIVITIES

February 18: Grant County Amateur Radio Club Swap and Shop at Jonesboro Park Shelter House, Jonesboro, Indiana – 10 AM to 4 PM.

### LAKE COUNTY HAM BANQUET

The Lake County (Indiana) Amateur Radio Club, Inc., proudly announces its 20th annual Radio Club Banquet to be held at the Scherwood Club, 600 East Joliet St., Schererville, Ind. The date is Saturday, February 10, 1973, and the affair starts promptly at 6:30 PM, CST. Awards, music, speeches, food – all you can eat – entertainment, good fellowship. Bring your wife, family, or girl friend. Tickets are $5 each, and are available from Herbert S. Brier, W9EGQ, 385 Johnson St., Gary, Indiana 46402, or from other club members. Positively no tickets sold at door.



*Technicians prepare Western Union international's transportable satellite ground station, WUI-1, aboard the USS Ticonderoga to transmit live television coverage of the events surrounding Apollo 17 via communications satellite. The 15-foot diameter expandable parabolic antenna is mounted on a gyro-stabilized platform to enable an accurate view of the satellite regardless of the vessel's sea-going maneuvers.*

# NEW PRODUCTS

## HAND TRANSCEIVER

If you were looking for a small 2-meter hand-held transceiver to hang onto your belt not too long ago, your search was probably limited . . . to what you could *find*. Now, with several types available you can afford to shop around a bit before making your decision.

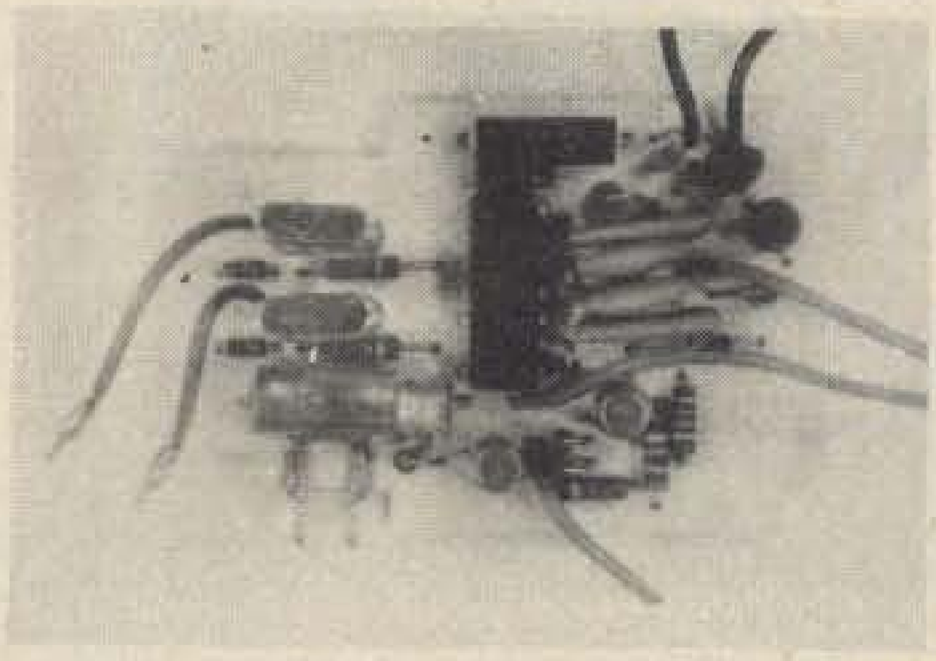
One to consider is the new KP-202, a six channel, 2 Watt unit that is being offered by Grove Electronics. Admittedly, 2W is a bit of a strain on a battery pack composed of 10–250 mAH ni-cads, but Grove works around the problem by using Fast-Charge cells that return to full charge in just 3 hours when connected to their accessory Super Charger. For such a small unit there is always a trade-off between battery life and power. The receiver has better than 0.35 $\mu$V sensitivity and draws about 15 mA on standby. One nice feature of the rig is that it has trimmer capacitors on not only the transmit but the receive crystals as well. These are an extra that is not found on some rigs that have space to spare.

Inside, the first thing you notice is the large amount of shielding that is used. Each section is surrounded by its own little wall of copper. The second thing you notice is, compared to other components, how much space is taken by the transistors. They seem huge next to the other subminiature parts. This is probably due to the super-tight packaging required to get all that circuitry into a hand sized case. The construction in general should stand plenty of hard use.

The controls include on/off volume, squelch and the channel switch. An output/voltage/S-meter is built-in and a telescoping whip is included, along with crystals for 34–94 and 94 simplex. The accessories include the nicad battery pack, their Super Charger, a leather case and a rubber-duckie whip.

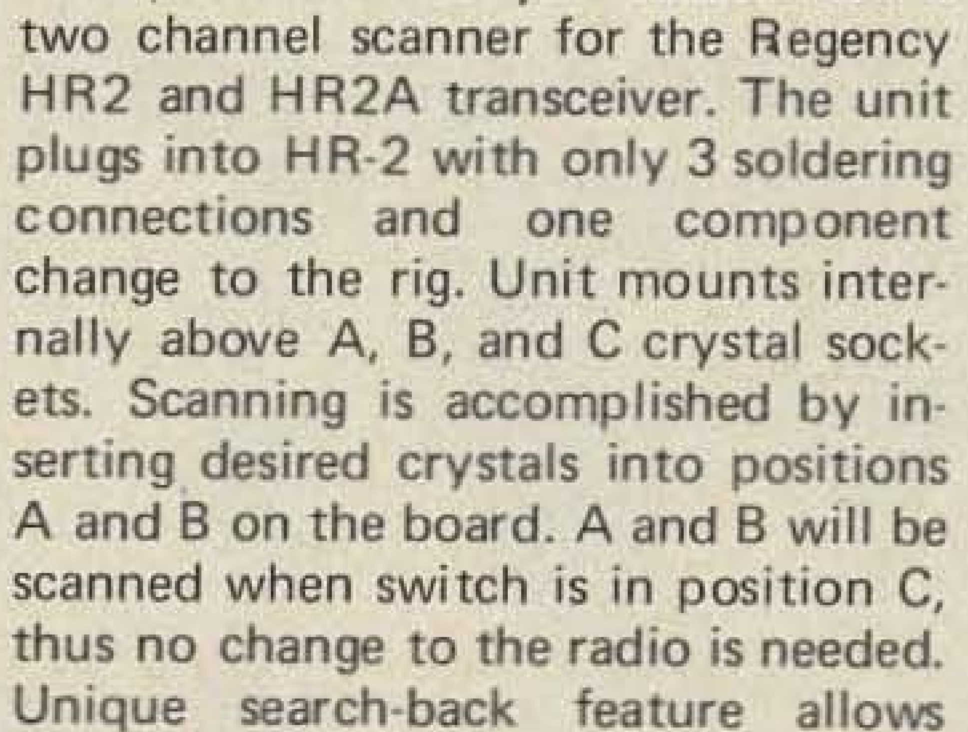
The price of the KP-202 less accessories is $219. Contact *Grove Electronics, Box 565, Roxbury Crossing MA 02120.*

## SCANNER FOR HR-2



Topeka FM has just announced a two channel scanner for the Regency HR2 and HR2A transceiver. The unit plugs into HR-2 with only 3 soldering connections and one component change to the rig. Unit mounts internally above A, B, and C crystal sockets. Scanning is accomplished by inserting desired crystals into positions A and B on the board. A and B will be scanned when switch is in position C, thus no change to the radio is needed. Unique search-back feature allows unit to scan channel not in use every 5 seconds. This may be disabled or switched in and out. Scan rate is 20 times a second when no channel is in use. SCAN 2 is available for $19.95, including shipping, from *Topeka FM Communications and Electronics, 1313 E. 18th Terrace, Topeka KS 66607.*

## ALL BAND LINEAR *(HONEST!)*




A new linear amplifier has been put on the amateur market by Top Band Systems that runs 2000 watts PEP on all *six* bands, 160 through 10 meters. For quite a while manufacturers of amateur equipment took great pride in advetising their all-band sideband rigs and linears. This was nice for them from an advertising proint of view. It gave the impression that the piece of gear they offered was all that was needed for full enjoyment of the HF frequencies. The problem was . . . they weren't exactly telling the truth . . . Lurking near the top end of the BC band, sandwiched in between skull rattling LORAN signals, was band number six. (Or band number ONE, depending on your particular feelings regarding the situation.)

If one wished to operate on 160, what equipment did he have to choose from? His *all-band* 80–10M rig did little to help the situation. Most amateurs had to scrounge around at hamfests for beat up gear that no one else wanted. A well equipped 160 station usually ran a Ranger I or a DX-100. This writer used a Lettine 240 for a long while before he advanced to a 20 year old converted Command Set. (Incidentally, a free 73 book is available to the first person who can send the Technical Editor a description of that old Lettine.)

Sideband was naturally a latecomer to the band. Not that SSB was unwelcome, there just wasn't any gear around. The only hope was to run into a stray 20-A at (again) a hamfest, or homebrew something. Heath offered a modified marine radio for a while, but it was restrictively crystal controlled. The situation was such that active 160 men were restricted from operating SSB because of the lack of equipment; and SSB men were restricted from operating 160 by their equipment's lack of flexibility. Lots of people were secretly angry at manufacturers.

Lately the picture has been changing . . . slowly. Since LORAN is on its way out as a navigation system, (it has been obsolete for a long time) people have started to take 160 seriously for what it always was, a damned good place in the spectrum to operate on. At least one manufacturer has taken the step to add that extra position on the bandswitch of his rig . . . and everyone is giving serious consideration towards doing the same.

Suppose you are in the market for some new gear? Would you rather buy a five band or a six band rig? It makes little sense to spend that wad of cash and get cheated out of a band. And how about a linear? If you are thinking of getting one now, what are you going to do with it once you update your station with a six band exciter? Once LORAN goes, so does the power restrictions. Without that extra switch position you'll be destined to operate barefoot until you trade that amplifier in for something with more capabilities.

The TBL 2000 offers you a choice *now*. For an attractive price of $259 you can purchase a linear that will operate on all six bands whether you

# the proven 'ONE' a transceiver by Tempo


**MORE THAN A YEAR AGO THE TEMPO 'ONE' WAS INTRODUCED TO THE AMATEUR WORLD AS THE NEW 'ONE'. NOW WITH THOUSANDS IN USE IT'S THE PROVEN 'ONE'. LOOK AT ITS PRICE AND THEN LOOK AT ITS SPECIFICATIONS. ADD TO THIS ITS RECORD OF RELIABILITY AND THE RESULT CAN BE SUMMED UP IN ONE WORD . . . VALUE.**

SPECIFICATIONS

**FREQUENCY RANGE:** All amateur bands 80 through 10 meters, in five 500 khz. ranges: 3.5-4 mhz., 7-7.5 mhz., 14-14.5 mhz., 21-21.5 mhz., 28.5-29 mhz. (Crystals optionally available for ranges 28-28.5, 29-29.5, 29.5-30 mhz.)

**SOLID STATE VFO:** Very stable Colpitts circuit with transistor buffer provides linear tuning over the range 5-5.5 mhz. A passband filter at output is tuned to pass the 5-5.5 mhz. range.

**RECEIVER OFFSET TUNING (CLARIFIER):** Provides ±5 khz. variation of receiver tuning when switched ON.

**DIAL CALIBRATION:** Vernier scale marked with one kilohertz divisions. Main tuning dial calibrated 0-500 with 50 khz. points.

**FREQUENCY STABILITY:** Less than 100 cycles after warm-up, and less than 100 cycles for plus or minus 10% line voltage change.

**MODES OF OPERATION:** SSB upper and lower sideband, CW and AM.

**INPUT POWER:** 300 watts PEP, 240 watts CW

**ANTENNA IMPEDANCE:** 50-75 ohms

**CARRIER SUPPRESSION:** -40 dB or better

**SIDEBAND SUPPRESSION:** -50 dB at 1000 CPS

**THIRD ORDER INTERMODULATION PRODUCTS:** -30 dB (PEP)

**AF BANDWIDTH:** 300-2700 cps

**RECEIVER SENSITIVITY:** 1/2 $\mu$v input S/N 10 dB

**AGC:** Fast attack slow decay for SSB and CW.

**SELECTIVITY:** 2.3 khz. (-6 dB), 4 khz. (-60 dB)

**IMAGE REJECTION:** More than 50 dB.

**AUDIO OUTPUT:** 1 watt at 10% distortion.

**AUDIO OUTPUT IMPEDANCE:** 8 ohms and 600 ohms

**POWER SUPPLY:** Separate AC or DC required. See AC "ONE" and DC "ONE" below.

**TUBES AND SEMICONDUCTORS:** 16 tubes, 15 diodes, 7 transistors

| | |
|---|---|
| TEMPO "ONE" TRANSCEIVER | $319.00 |
| AC/ONE POWER SUPPLY 117/230 volt 50/60 cycle . . . | $ 99.00 |
| DC/1-A POWER SUPPLY 12 volts DC | $110.00 |

Prices subject to change without notice.

11240 W. Olympic Blvd., Los Angeles, Calif. 90064 213/477-6701
931 N. Euclid, Anaheim, Calif. 92801 714/772-9200
Butler, Missouri 64730 816/679-3127

**Henry Radio**

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**U.S. AREA REPRESENTATIVES**

New Mexico/West Texas
Ambrose G. Barry, W4GHV/5
1010 Juniper Avenue
Alamogordo, New Mexico

**DX REPRESENTATIVES**

BCN Agencies Pty. Ltd.
178 Collins Street
Melbourne 3000, Victoria
Australia

The Wireless Institute of Australia
478 Victoria Parade
P.O. Box 36
East Melbourne, Victoria
Australia

Carlos Rohden
Caixa Postal 5004
Sao Paulo, S.P.
Brasil

Jul. Gjellerup
87-89 Solvgade
DK-1307 Copenhagen K.
Denmark

Jim Coote
56, Dinsdale Avenue
Kings Estate
Wallsend
Northumberland, England

Radio Society of Great Britain
35 Doughty Street
London WC1N 2AE, England

Short Wave Magazine
55 Victoria Street
London, SW1, England

Rautatiekirjakauppa Oy
Kampinkatu 2
Helsinki 10, Finland

Hans Hartinger Nachf.
Xantener Str. 14
1 Berlin West 15
Germany

Richard Beeck
Bodekerstr. 85
3 Hannover, West Germany

W. E. Saarbach SMBH
P.O. Box 1510
5 Koeln 1, West Germany

Martinus Nijhoff
P.O. Box 269
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The Hague, Holland

Bryan R. Vogerty
Irish Radio Transmitters Society
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Dun Laoine, Ireland

Orion Books
13-19 Akasaka 2-chome
Minato-ku
Tokyo 107, Japan

Gordon and Gotch Ltd.
P.O. Box 584
Auckland, New Zealand

G. H. Gillman
Smarts Road
Waikuku RMD
Rangiora, North Canterbury
New Zealand

New Zealand Assn. of Radio Transmitters
P.O. Box 1459
104 Hereford Street
Christchurch, New Zealand

Harold C. Leon
P.O. Box 61141
Marshalltown, Transvaal
South Africa

South African Radio Publications
P.O. Box 2232
Johannesburg, South Africa

South African Radio League
P.O. Box 3911
Cape Town, South Africa

AB Nordiska Bokhandeln
Post Adress Fack
101 10 Stockholm 1
Sweden

Almqvist & Wiksell
Gamia Brogatan 26
Stockholm, Sweden

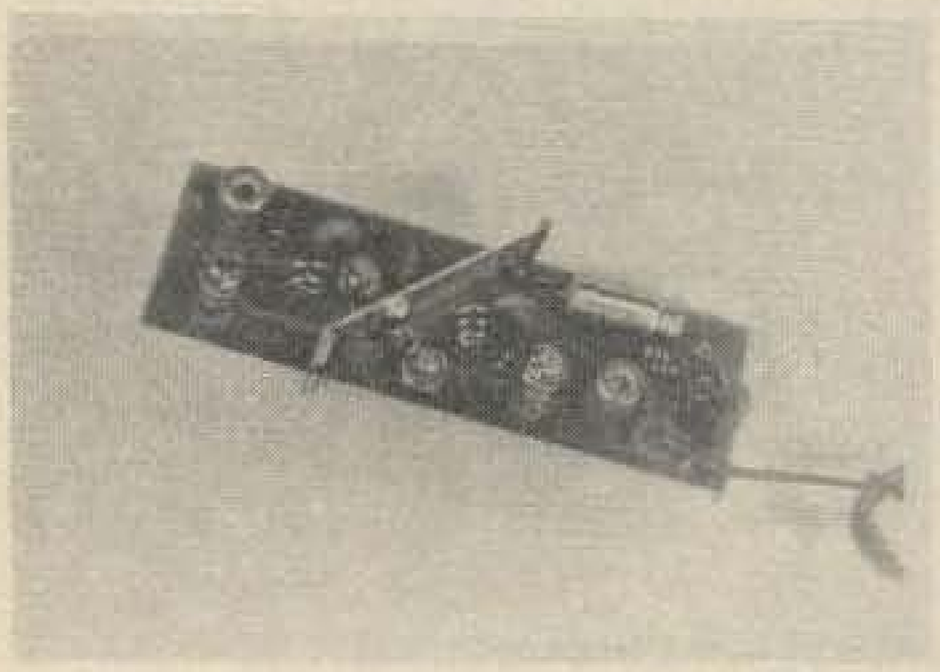
Eskil Persson, SM5CJP
Frotunagrand 1
194 00 Upplands Vasby
Sweden

Buchandlung zum Elsasser
Arnold & Stamm AG
Limmatquai 18
Zurich 1, Switzerland

are ready to or not. As opposed to being obsolete in the future, it is already one step ahead of the rest of your station! It uses five 6LF6 power pentodes in the final compartment which makes it easy when the time comes for replacement. A new set of finals can be ordered for $20. Each tube has its own bias control to make the job simple. The driving power required is between 70 and 150W and an ALC circuit protects the linear from doing what it is not supposed to. The metering system is practically absolute. There are switch positions to monitor the cathode current of each final tube separately, plus total plate, screen and grid currents and high voltage. As a bonus, a forward and reverse reading Wattmeter will measure outputs to 1000 Watts. The power supply is built-in and operates your 220V line. It is desktop and fairly lightweight – 10Kg (22 lbs). A modified version, the TBL 2000X, is available for the 110/220V operation. (15 Amps at the lower voltage.) It has all the same features but weights slightly more because of the extra transformer mass. 1805 kHz, watch out!

For further information contact: *Top Band Systems, 1839 Redondo Ave., Long Beach CA 90804.*

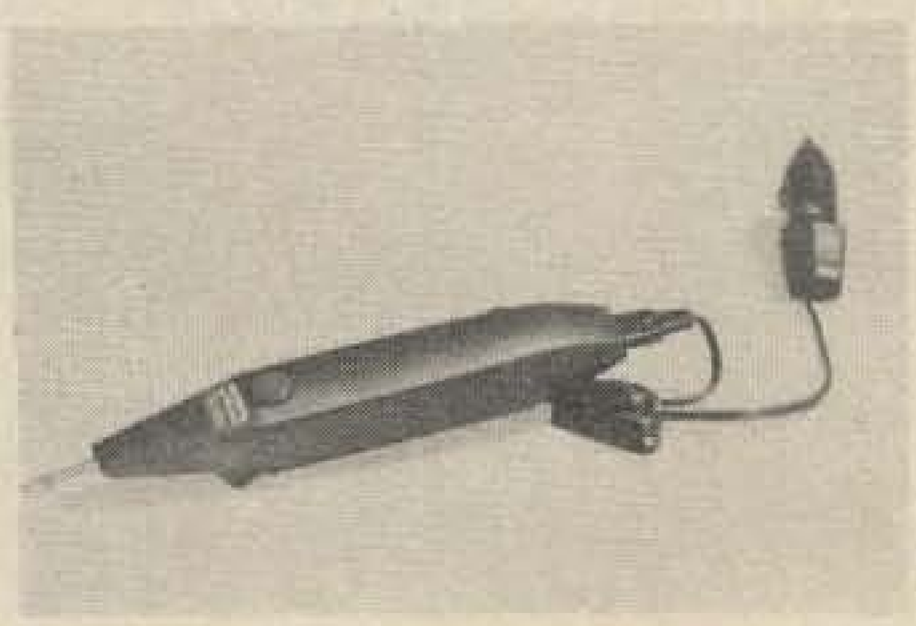
### 450 MHz PREAMP



One of the first things you start looking for once you have gotten over the excitement of completing your first 450 MHz QSO is something to pep up your receiver. Topeka FM has just added a dual-gate MOSFET preamp to their line that could possibly help quench that desire.

Constructed on a G11 low loss epoxy circuit board, the 450M has a voltage gain of 15 dB with a noise figure of typically 4.5 dB. The board is silver plated for maximum efficiency and has a shield on both sides for maximum isolation of the input and output circuits. The MOSFET design insures superior cross-modulation performance and reduced spurious responses. The input and output connectors are mated RCA and the unit comes complete with instructions and all mounting hardware. It is designed to operate from 10–15V but may be fed with higher plate voltages when the accessory HF450PK adaptor ($1.25) is used. Similar models for 406 to 470 MHz are available. $29.95 from *Topeka FM Communications and Electronics, 1313 E. 18th Terrace, Topeka KS 66607.*

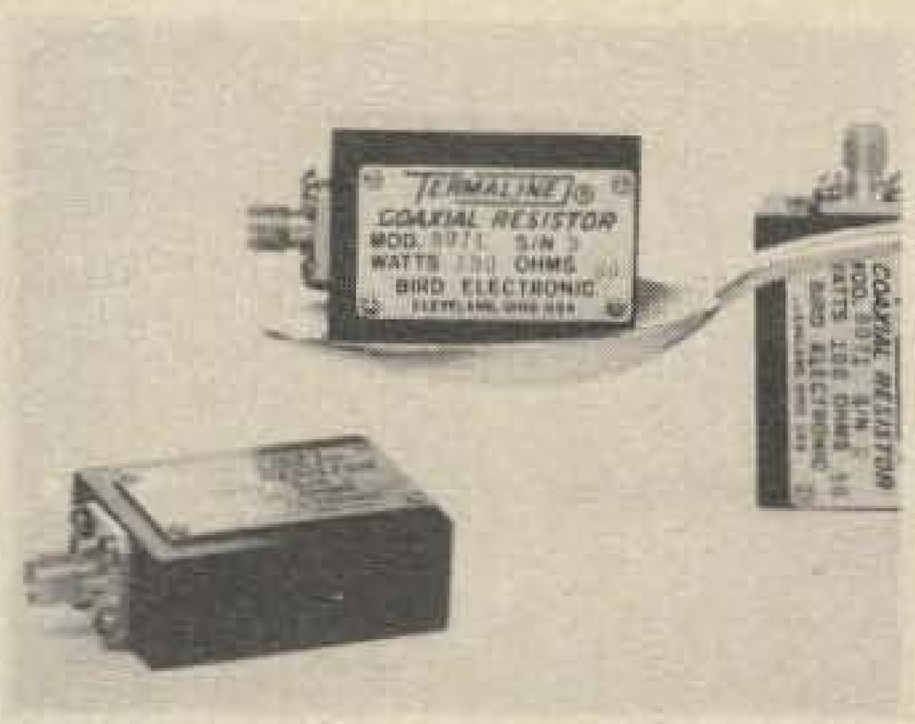
### AUTO CHARGER FOR CORDLESS SOLDERING IRON



A new accessory is available for the Wahl "Iso-Tip" cordless soldering irons that lets you recharge their batteries via an automobile cigarette lighter. With this gadget, the serious mobile enthusiast no longer has *any* reason to leave his car. The last wire connection to the home QTH has been cut!

The increased portability is welcomed. Cordless soldering irons in themselves are great. What else are you going to use when soldering a connection at the top of a tower? Everything has been tried, from a torch to a match, but expectedly a soldering iron works best. The only trouble is when you get to that remote repeater site and you suddenly remember that the iron is still in the shack where you plugged it in the night before so it would get a good charge. For $4.95 you can get this adaptor that will let you keep that iron ready in the car (where it *belongs*, of course). An overnight charge will restore dead batteries to a full charge with negligible drain on the automobile system. The #7585 Auto Charger Plug Assembly is available from *Whal Clipper Corp., 2902 Locust St., Sterling IL 61081.*

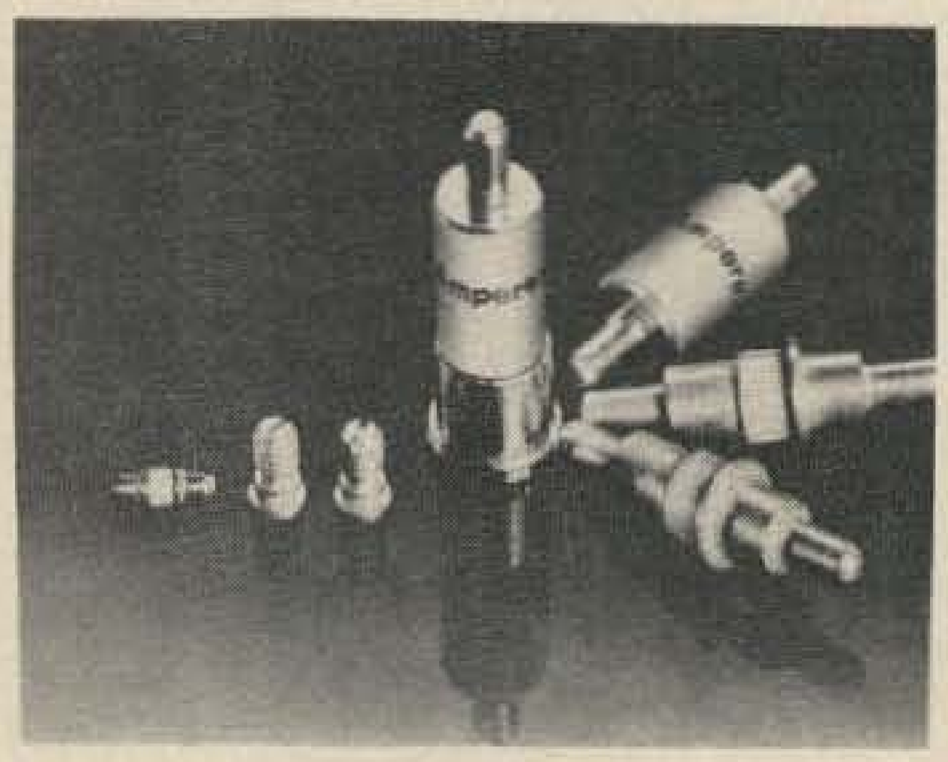
### RF MINILOAD



A new 50Ω rf load resistor has been announced by Bird Electronic Corporation. As you can see from the photograph, it does not have the appearance you would expect of the average 100 watt dummy load. The tremendous reduction in size is accomplished by requiring the Miniload to be mounted to a suitable heatsink while in use. It is designed to allow maximum heat transfer from the resistive element to the case so almost any equipment panel or chassis will serve as the mounting point and heat sink. Just tuck it away in some unused corner and forget it. No need to hunt around for those (usually lost) interconnecting cables next time you want to do some work on your transmitter because the load will be built in.

The Model 8071 features a VSWR below 1.1 from dc to 1000 MHz and a figure below 1.2 up to 2000 MHz with its female SMA connector. The price is $125; from *Bird Electronic Corp., 30303 Aurora Road, Cleveland (Solon) OH 44139.*

### MICROWAVE DIODES



Amperex Electronic Corporation has announced four new lines of microwave diodes for communications and other commercial applications. The four lines include 11 Schottky barrier devices, four tuning varactor diodes, 23 Gunn effect devices, and five IMPATT devices.

The 11 Schottky barrier diodes are intended for low-noise mixer and detector applications up to 18 GHz.

All 11 types in this group are available in matched pairs.

The four tuning varactor diodes are high-Q, GaAs, Schottky barrier devices. Each of these types offers a tuning range of 3:1 with voltage variation from 0 to 12 V and has low series resistance (max. 3.0Ω) for low circuit loss.

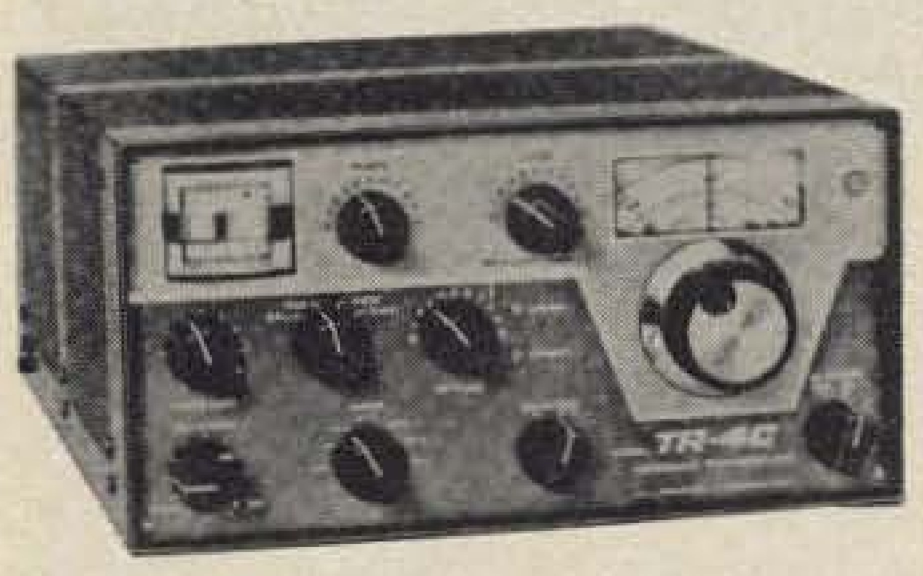
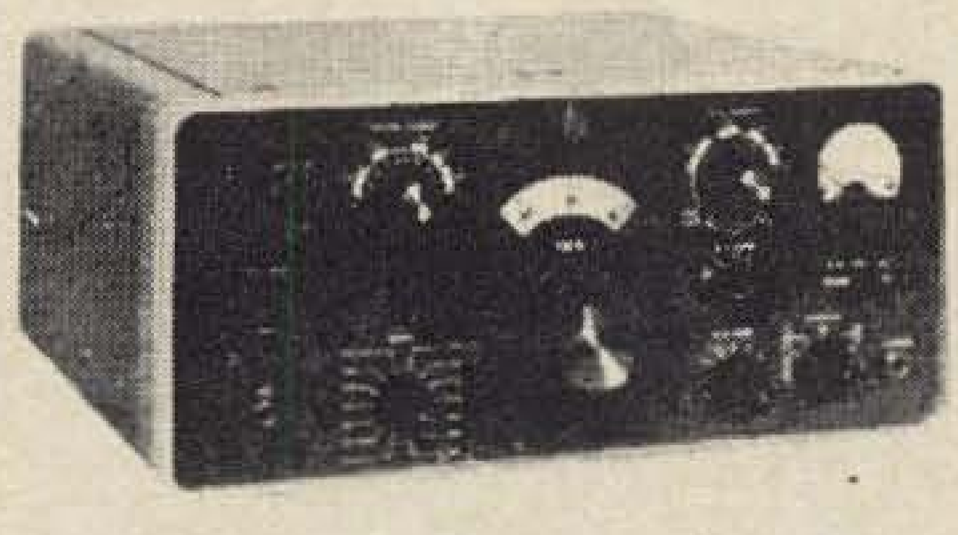
The 23 Gunn effect diodes offer a wide range of power outputs and frequencies for use in local oscillators in radar and communication systems.

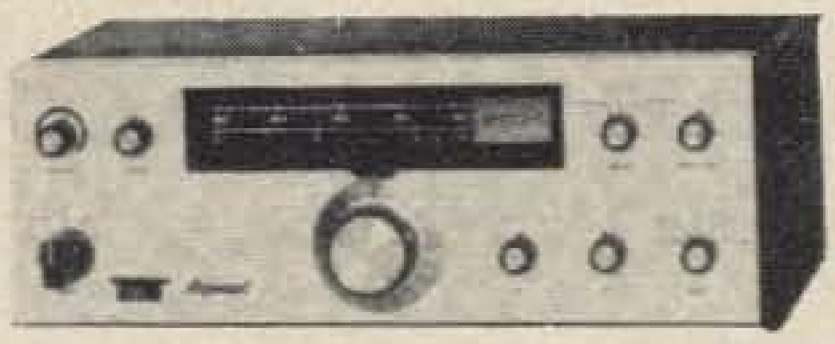
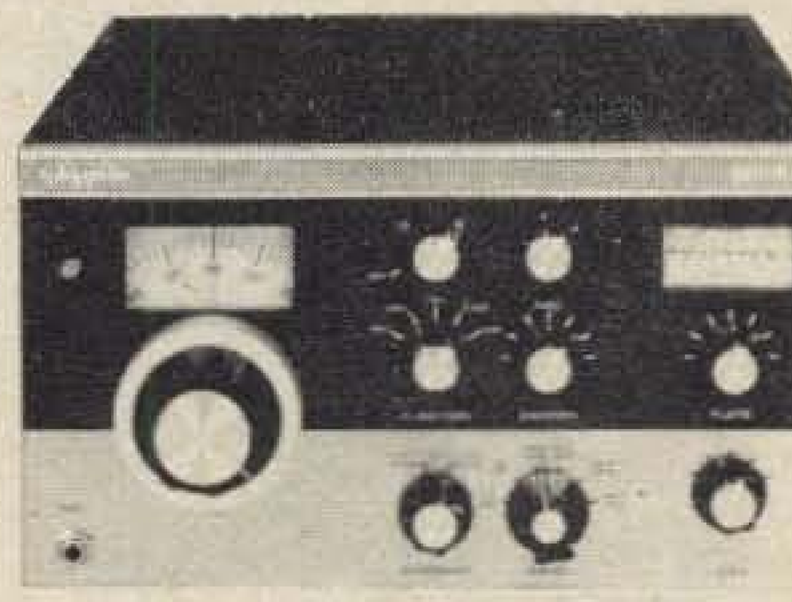
The five silicon IMPATT devices are used as oscillators in telecommunications and radar systems at C, X and Ku band frequencies.

More information may be obtained by writing: *Product Manager, Amperex Electronic Corporation, Hicksville Division, Hicksville, New York 11802.*

# HATRY ELECTRONICS

500 Ledyard St., Hartford, Ct. 06114 • 203-527-1881
See Ward, W1WRQ Take Airport Rd. Exit, Rte. 6, off I-91 or Rte. 15


All accessories for above lines of HF gear.

**ANTENNA WIRE**

Saxton #18 Copperweld 100 ft. Interconnected
Saxton #14 Copperweld 100 ft. Interconnected
Saxton #12 Copperweld 100 ft. Interconnected
Saxton #14 Copper Enameled 100 ft. Interconnected
Saxton #12 Copper Enameled 100 ft. Interconnected
Saxton #14-7/22 Stranded Copper 100 ft. Interconnected

**COAXIAL CABLE**

Times FM-8, 50 ohm RG/U type Low-Loss
Times T5-50, 50 ohm RG58/U type Low-Loss
Belden—All Popular Types of Cable
Belden RG8/U Put-ups — 25-50-75-100 Ft. with PL259 each end (Low-Loss Foam)

**OPEN WIRE FEED LINE**

Saxton 450 ohm #18-1" spaced, 100 ft. spools
Saxton 300 ohm #18-½" spaced, 100 ft. spools

**TWIN LEAD**

Belden 8210-75 ohm H.D. 1 KW
Belden 8235-300 ohm H.D. 1 KW

**NON-METALLIC GUY LINE**

Saxton 1/8" Fibreglass-Plastic Covered 500 lb. Test-100 ft. I.C.
Saxton ¼" Fibreglass-Plastic Covered 1000 lb. Test-50 ft. I.C.

**COAX CONNECTORS**

Amphenol & Gold Line — UHF — "N" BNC and many inter-series adaptors

**INSULATORS**

E.F. Johnson — Ceramic Stand offs and Antenna End and Center Insulators

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Hy-Gain — 50 ohm 1:1
W2AU-50 ohm 1:1 and 4:1

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**TYMETER CLOCKS (24 hr.)**
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## *CONNECTICUT'S OLDEST HAM STORE*

Please include Postage  Canadian Amateurs Send U.S. Funds Only  F.O.B. Hartford

## DIGITAL PANEL METERS


A new line of digital panel meters are available from Weston Instruments. The series 1220 draws only 3/4W of power from a 6V source. They come in five voltage ranges from 0–100 mV to 0–1000V and five current ranges from 0–10$\mu$A to 0–100 mA. Accuracy is claimed to be ±0.1% of the displayed amount. Readout is accomplished by the use of plug-in LED display units and provision is made to incorporate a push-to-read circuit for battery conservation.

Although these meters are relatively expensive for ordinary ham use, just think of the fun you could have being the first one on the block to own a digital Wattmeter! The accuracy would be amazing. One of these meters could give you an unmatched record of your rig's performance by noting the slightest drop in power that would normally go unnoticed while watching a meter needle.

Prices for the Model 1220 digital meters run a bit under $100. For more information contact *D.F. DiCerto, Weston Instruments, 614 Frelinghuysen Ave. Newark NJ.*

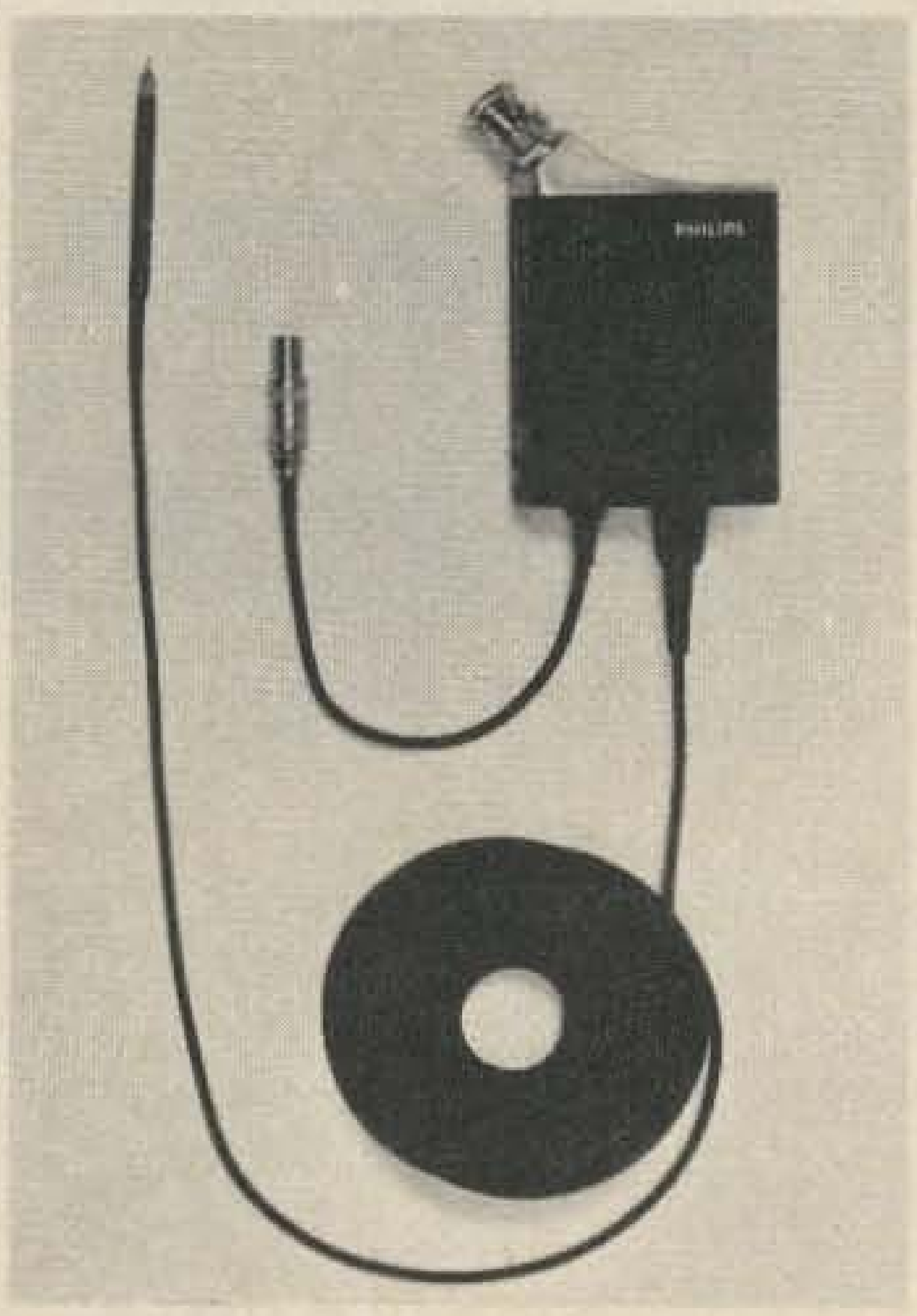
## PORTABLE FIELD STRENGTH METER

Blonder-Tongue Laboratories has just announced the availability of a new, all solid state portable field strength meter.

Features normally associated only with laboratory or bench models include audio output jack (earphone provided), gold-plated, accurately calibrated attenuator switches, and 75Ω type F connector for signal input. Meter is calibrated to read average signal strength and the entire unit operates on four standard 9V batteries with extremely low current consumption for extended life. Its range is from 54 to 890 MHz.

For further information contact *Blonder-Tongue Laboratories, Inc., One Jack Brown Road, Old Bridge, N.J.*

## FET PROBE FOR OSCILLOSCOPE



A new active FET probe for wide-band oscilloscopes has been announced by Test & Measuring Instruments, Inc.

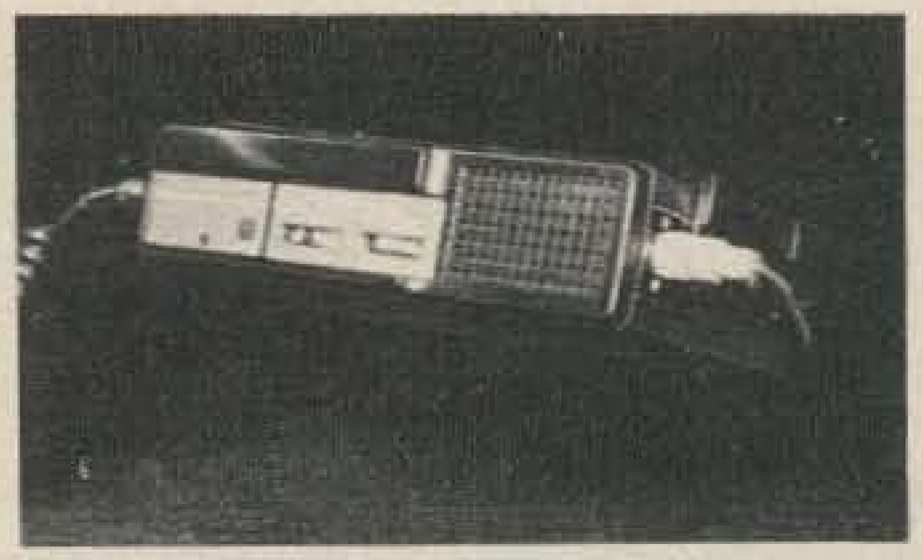
The PM9353 measures low amplitude, high frequency signals without appreciable circuit loading. The probe's bandwidth is 220 MHz, making it suitable for oscilloscopes with intrinsic bandwidths to 150 MHz with no adverse effect on the oscilloscope rise time.

Input impedance of the PM9353 is 3.5 pF in parallel with 1 MΩ; its unity-gain FET amplifier eliminates the 10:1 attenuation on conventional probes without introducing high input capacitance.

For detailed information write: *Test & Measuring Instruments Inc., 224 Duffy Avenue, Hicksville NY 11802.*

## UHF "MOBILE COMMAND"

A two-way mobile radio that is slim, safety styled, has 5 watts of power output with all solid state circuitry and 3-channel capability on transmit and receive with recessed controls, plus optional tone squelch and selective call, the Model MC-405, is being marketed by The Hallicrafters Co.



The Model MC-405 operates in the 450–470 MHz frequency range, delivering 5 watts output. The radio's universal mounting tray permits it to be mounted horizontally or vertically, either on top of a flat surface or overhead, always leaving the controls readily accessible at a touch of the finger.

Tone squelch and selective call options further provide the user with truly personalized communications. The new "Mobile Command" UHF Model MC-405 is in the $600.00 price range. For further data, contact *The Hallicrafters Co., Dept. PR., 600 Hicks Road, Rolling Meadows IL 60008.*

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*W2NSD/1 continued*

askance at articles showing how to build monitors to plug into that service function. Let's get those IC chips flying.

## FAX

Hamfax looks like another fun way to go and 73 most eagerly solicits articles on every aspect of it. Let's see how to get machines on the air – where we can tune for fax signals – converter construction projects – the works.

## MOVIE MONEY NEEDED

One of the more important events in recent history for amateur radio – and for emerging nations – has been the setting up of amateur radio stations in the schools in Jordan. Several of these have been set up and are being enthusiastically operated by a growing number of interested students.

As I have written before, the development of countries hinges today on their ability to communicate. Electronics and communications is the major key to their ability to develop. And without people who know and are interested in electronics a country is seriously hobbled. They need people to build equipment – to install it – to operate it – to service it.

Unfortunately, in virtually every smaller country, the emphasis is on

*Continued on p. 156.*

# LETTERS

Reference certain letters appearing in 73, I suspect that you have now achieved the first genuine breakthrough in ham radio since SSB arrived. I refer to comments on the October and November covers. How much more rewarding than a picture of an IC, or some lad testing his antenna! I hope that most hams (and their XYL's) can take a mature view of the forest, as well as of the trees. Don't retreat.

Al Smith W1GAA/K3ZMS
Temple NH

I have been getting issues of 73, CQ, and QST for one year now. I have dumped my subscription to QST and will no longer purchase CQ at the newstand. They just can't cut it like 73 can. Keep up the good work, Wayne.

The November issue was fantastic. I got more out of it than all my QST's and CQ's put together. If the November issue is anything like what coming issues of 73 are going to be like, I will remain a faithful subscriber.

Dave WB5FWE
Fort Smith AR

After reading the letter on Page 62, Dec. 72 issue, from Mrs. Philip Shera, I could only wonder that if Mr. Shera was so puritanic, why did he not write that letter himself? Ho Ho Ho!

Frankly I love those adulterous thoughts I get after viewing your Oct. and especially Nov. 73 cover! I guess I'm just another dirty ole man ham!

You could send your 73's in a plain brown envelope if you have a second objection to the covers. You probably had only this one.

Clarence Jones
Saint George SC

My wife just saw the front cover of the November issue of 73. She says she don't care – but I can't subscribe to your magazine NO MORE!

Phil WØJHS

I am in total agreement with your November editorial re the new repeater rules. By imposing such unnecessary restrictive regulations on amateurs while at the same time permitting the bedlam that exists on 11 meters, the commission is fostering the same contempt for its authority that made CB what it is today.

I urge all readers to flood Washington with support for your petitions.

John Cable WA4AIZ
Raleigh NC

Wow! I wish to complement you fellers and gals for the best copy of a ham magazine I've ever read. If you keep this up, you are definitely No. 1. The articles on gravity and Tesla were classic. My XYL loved reading them also.

In the way of suggestion, I wish to recommend to you two new departments for classic papers: Entitle them the "Past Classic" (Tesla) and the "Future Classic" (Gravity). Then solicit articles for each department.

Best of luck and boy am I glad I have a life subscription.

Otto Grupp W9LH

The cover of your Nov. issue is stunning; the issue itself is outstanding. Keep up the cover and size of content. It's worth it at a buck and a half. Just great, just great!!!

Miles Cannon K4OLA
Athens GA

The November issue is terrific! Am making note in next "Old Timers Bulletin" about the Tesla article – telling readers to write to 73 if they wish to purchase a copy.

Bruce
The Antique Wireless Association, Inc.
Holcomb NY

Wayne, you didn't have to send me the renewal slip, I wouldn't miss an issue for a million bucks. I've tried all the major mags, and I find yours better than calling CQ or QST in Ham Radio (hi, hi).

I'm trying to get my ham friends to subscribe, and I've about got them, too!

Dave WN5GHN

C'mon, Wayne! How about a centerfold spread? You know – a stripped amplifier . . . a barefoot transmitter . . . a stacked antenna . . .

Michael R. Hanna K8UUO
Parts Hts OH

Please correct the spelling of my last name. I've been called a lot of different names, but your interpretation takes the cake. The address label from 73 reads:

W F SWILL JR
3824 WICKER ST
HIGHLAND IN 46322

W. F. Swiss, Jr. W9HVY

P.S. Keep up the good design on the magazine covers, especially like the October issue.

**Re: Gravity Abecedarium, Nov. 72, Par. 7**

It seems to me that Kepler did a lot more than "obtain excellent observational data," so that "Newton was able to show that his principle of universal gravity did in fact explain beautifully the complex motions of the planet . . ."

According to the Encyclopedia Britannica, (ASTRONOMY), '54, Kepler's 3rd law, " . . . being a necessary *consequence* of the law of gravitation, must prevail in every system under its sway." Also, "The Rudolphine Tables computer by him (Kepler) from elliptic elements, retained authority for a century, and have in principle never been superseded." Furthermore, " . . . the importance of Kepler's generalizations was not fully appreciated until Sir Isaac Newton made them the cornerstone of his cosmic edifice." And finally, "The true foundations of a mechanical theory of the heavens were laid by Kepler's discoveries, and by Galileo's dynamical demonstrations . . ."

Newton's concept of gravity and his concept of point sources for gravitational forces both seem to have been implied in Kepler's laws. And Kepler was the first to " . . . explain beautifully the complex motions of the Planets . . ." 50 years ahead of Newton. K is for Kepler!

George W. Fyler W9JT
Lombard IL

Here is some update information for your Repeater Atlas:

Please delete the following –
Cherry Hill NJ Repeater (22/82)
Camden Repeater (22/82)
W2BHK Repeater (22/82)
W2FLY Repeater (22/82)
Plus whatever reference to a 22/82 repeater in South Jersey.

Now, where all this info came from is confusing – they are all one and the same machine.

Anyhow, a license has been received and we'd like to have it listed as follows:
WB2ZQG – South Jersey – 22/82 – open repeater.

For the record, it is a split-site repeater with an input at WB2EVU's QTH in Erial, N.J. (ground elevation 200 ft). Equipment is a 4-bay J pole on a 60 ft fower, GE Progress Line receiver and a Motorola T44 link transmitter.

The transmitter is located 3 miles away in Blenheim, N.J. at an abandoned commercial site (with permission of the owners, of course!)

Equipment is a T44 Rx and an RCA carphone. Transmitter at 40 watts to an Andrews 3dB antenna at 130 feet, fed with RG18. (Ground elevation ≈ 85 ft).

Control is accomplished with a second T44 receiver on 450 MHz using secode.

Coverage is approximately 30 miles from Exit 3 of N.J. Turnpike.

*Continued on page 156.*

## FCC Report No. 8244, December 21, 1972
## ACTION IN DOCKET CASE RULES FOR REPEATER STATIONS IN AMATEUR RADIO SERVICE AFFIRMED BY FCC


The amendments of Part 97 of the Amateur radio service rules adopted in the Commission's Report and Order in Docket 18803 (FCC 72-757, released September 8, 1972), have been affirmed by the FCC and numerous petitions for reconsideration, stay or changes have been denied. The Report and Order established rules for licensing and operation of repeater stations in the Amateur Radio Service.

(Repeater stations receive and automatically retransmit the radio signals of other amateur radio stations and are used primarily to extend the radiocommunication range of vehicular and hand-held mobile stations.)

The majority of petitioners objected to the rules requiring a control operator to be in attendance at a control point while a repeater station was in operation and to the placement of responsibility for proper operation of the station on the control operator. Seven petitioners requested that the burden for proper use of repeater stations be only on the user station operator transmitting on the input frequency of the repeater station and that the rules "limit the responsibility of a repeater station control operator to properly maintaining the technical operation of the station."

Several petitioners proposed a tone-access system in which the users would activate the repeater station by transmitting a certain combination of tones on the repeater station input communication frequency channel.

Stating that petitions added nothing to the information considered in adopting the Report and Order, the Commission explained that operation of a repeater station in the Amateur Radio Service could present unique problems not comparable to other radio service such as Land Mobile or Citizens Class A where control operators were not required at repeater stations.

In response to the tone-access system proposals, the Commission pointed out that a basic principal of radio control was that there be a reasonable probability the remote station would not be activated by unauthorized persons, and the control operator could indeed effect supervisory control of the station from the remote control point just as well as if the control point was located at the station.

Stating that the ingenuity of amateurs could eventually "develop the techniques, technical and operational," that would permit the adoption of rules for automatically controlled repeater stations and that it was conceivable that automatic and reliable means could be developed to perform "all of the supervisory functions of repeater station control operator under certain specific conditions," the Commission said provisions for automatic control were not warranted at this time.

Action by the Commission December 20, 1972, by Memorandum Opinion and Order. Commissioners Burch (Chairman), Robert E. Lee, H. Rex Lee, Reid, Wiley and Hooks with Commissioner Johnson concurring in the result.

# JUGE

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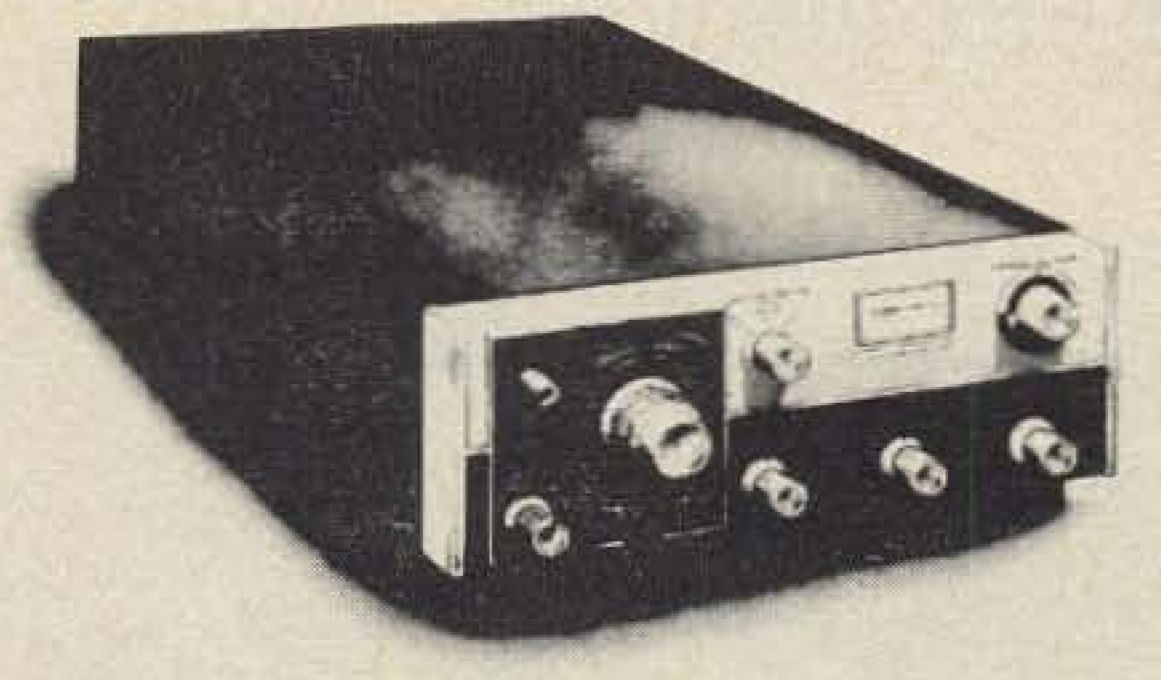

*. . .' See you at SAROC!*

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| **SWAN SS-1200,** 1200 watt P.E.P. Linear Amplifier (tube type) | **$299.00** |
| **SWAN SS-208,** External VFO | **$159.00** |
| **SWAN 610X,** Crystal Controlled Oscillator | **$ 53.95** |
| **SWAN SS-16B,** Super Selective Filter | **$ 79.95** |

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*Peter A. Stark K2OAW*
*196 Forest Drive*
*Mt. Kisco NY 10549*

# A TTL LOGIC CW ID GENERATOR

**A**n ID generator is an important part of any 2-meter repeater, and several designs have appeared in various amateur magazines. There are various ways of doing the job, from code wheels and continuous tape loops to digital integrated circuits. We decided recently to design our own version, based on a digital IC identifier written up by W7PUG in *73* in September 1970.

This design improves on the original W7PUG design in several ways. It uses readily available TTL integrated circuits, instead of the older RTL circuitry. It is built on a single-sided printed circuit board rather than the double-sided one required for the older design. But most important, it uses a simple 32-position diode matrix for storing the call, and does not require the knowledge of Karnaugh maps or any other fancy techniques to decide where to put the diodes. And it is completely compatible with

*The ID generator described in this article is part of a solid state repeater control system, the second half of which will be presented next month.*

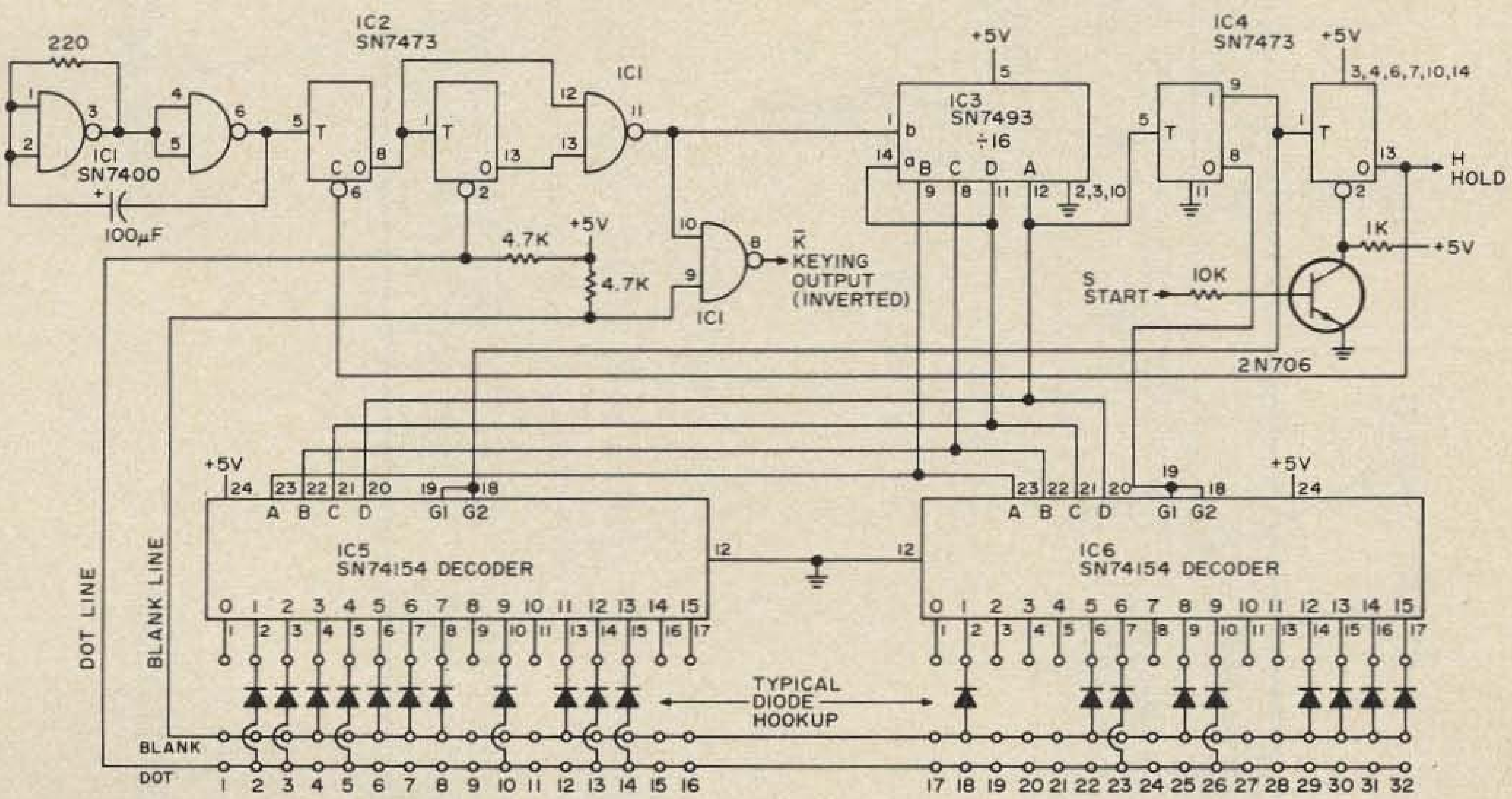



*Fig. 1. CW identifier.*

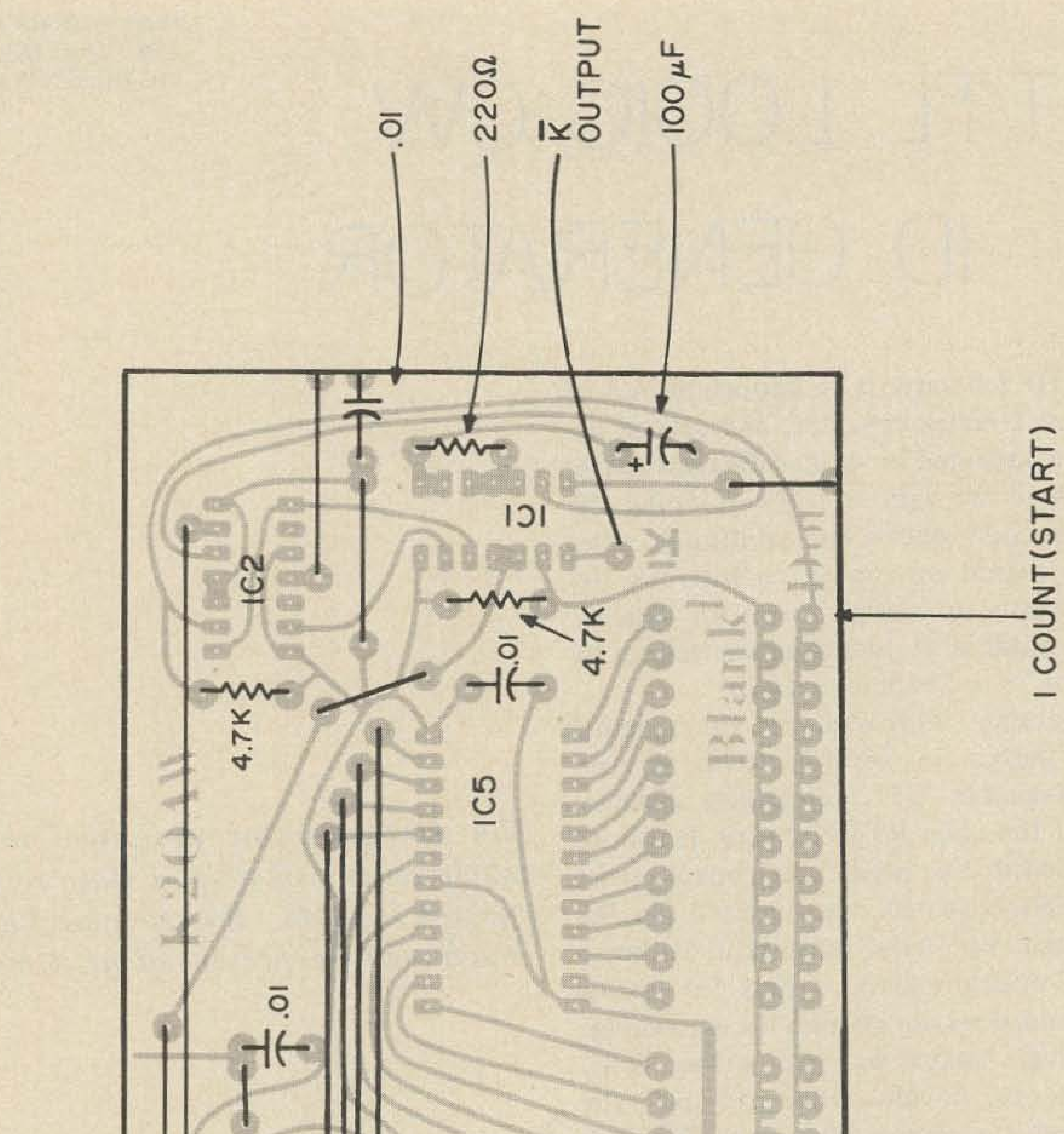
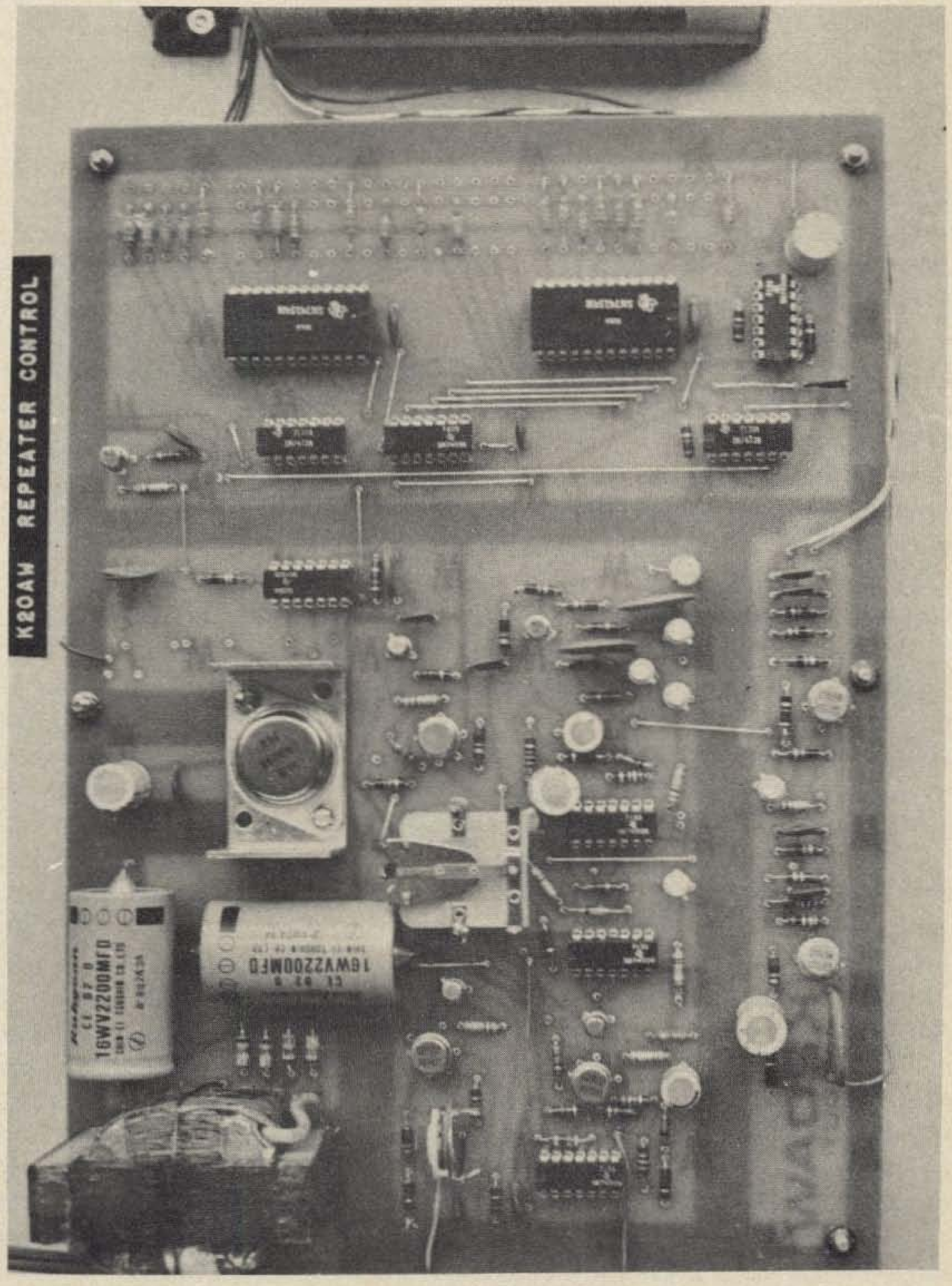



*Fig. 2. I.D. parts layout board shown foil side up (full size). The edge of the board is at ground potential. Pin 1 of each IC is identified with a dot.*

our all-solid-state repeater control, which will appear in an upcoming article.

Figure 1 shows the complete logic diagram of our unit. Two gates in IC1, in the upper left corner, oscillate and provide the clock for the system. IC2 is the character generator which controls the length of dots and dashes. A dot is exactly one clock interval, while a dash (or a blank) is exactly three clock intervals. After each dot, dash, or blank, a pulse is sent to IC3 which, along with a flip-flop in IC4, forms a divide-by-32 counter. The second flip-flop in IC4 is the start-stop flip-flop.

The output of the divide-by-32 counter is sent to two special purpose MSI IC's, IC5 and IC6. These are called four-line-to-sixteen-line decoders. Each of these two IC's gets the four outputs from IC3, and one output from IC4. The two IC's together provide a total of 32 output lines which are used to scan the diode matrix. In normal operation, 31 of these lines are high (near +5 volts) and only one is near ground. When the ID starts to generate the identification, the ground moves from pin to pin, starting with pin 1 of IC5 and moving down the line, finally winding up at pin 17 of IC6.




*The upper third of the circuit board at the right contains the I.D. generator that is described in this article. The lower portion is the power supply and the repeater control circuitry that will be described next month.*

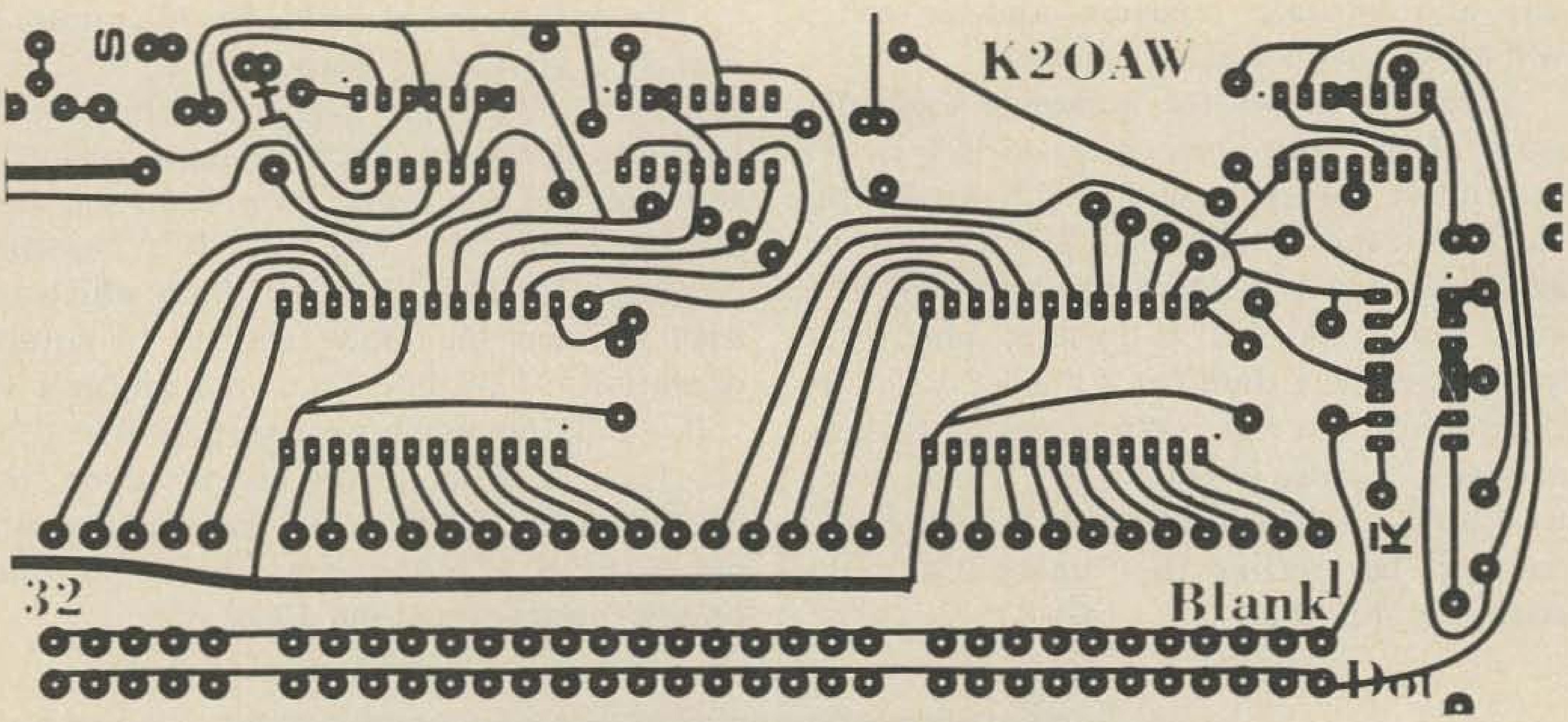



*Fig. 3. Identifier board layout (80% actual size).*

To program the diode matrix for a call, we separate the call into 32 dots, dashes, and letter-spaces (called blanks). With simple calls having K or W prefixes we generally have enough room to include a DE in front of the call; with a WA or WB call you will have to skip the DE. Then we number the dots, dashes, and blanks with numbers from 1 to 32, which assigns them to a specific position on the matrix. For every dot we place a diode from the corresponding IC output to the dot line; for every blank we connect the diode to the blank line; and for a dash we put in no diode. As shown in Fig. 1, the cathode side of the diode goes toward the decoder IC. You should use only germanium diodes here because we need a low voltage drop when the diode is on. Figure 1 shows the typical diode placement for generating DE K2OAW. Incidentally, if the call requires fewer than 32 positions, you will have to add blanks to stretch it out to 32 counts. It's better to add them at the beginning than the end, since this gives the transmitter time to come up before the code starts.

To use the ID you will need to make five external connections. The ID needs +5 volts regulated within 5%, at several hundred milliamperes and a good ground to the rest of your repeater control. To start the ID connect +5 volts (a digital 1 signal) to the start line (labeled S on the board). Output keying appears on the $\overline{K}$ line and is inverted – that is, this line is normally at +5 volts or so and switches down to ground when generating a dot or dash. The H output (hold) is normally grounded, and switches to +5 volts during the generation of the ID. Except for the $\overline{K}$ output, the other control signals operate the same as those in the W7PUG ID mentioned earlier. If you need complete compatibility, it is easy to add a transistor inverter to the $\overline{K}$ line to invert it back.

The entire ID generator fits on a single-sided PC board about 3 x 7 in. The board layout is shown in Fig. 3, and the parts placement is shown in Fig. 2. Speed of the ID is controlled by the 100 $\mu$F capacitor; the value shown generates code at about 5 wpm. To speed up the ID make the capacitor smaller. The five 0.01 $\mu$F capacitors are disk ceramics which bypass the +5V line to ground. Etched boards and parts kits are available from *Circuit Specialists, P.O. Box 3047, Scottsdale, Arizona 85257.*

In an upcoming article (soon!) we will present a complete solid-state repeater control, with ID timer, time-out timer, tone burst or PL latch, COR, and all the other necessities to make a complete package. The control fits on a 7 x 7 in. PC board. Alternatively, the control and ID can be built together as a complete package on one 7 x 10 in. board. . . .K2OAW

*A. Prose Walker, Chief*
*Amateur and Citizens Division*
*Federal Communications Commission*

# THE EVOLUTION Of SPECTRUM MANAGEMENT

*Mr. Walker made the following address at the 63rd Anniversary Banquet of The Radio Club of America, Inc., held in New York City on November 17, 1972:*

Choosing a subject for tonight was not easy, I knew that the total expertise of all of you represents a great amount of knowledge and experience, accumulated over a long time. When one is called upon to speak before his peers, he is usually expected either to entertain or educate them. Those of you who know me, know that I'm not a comedian . . . at least intentionally. Although I have been involved in the allocation of the radio spectrum for more than 25 years, the aggregate of your experience so far outweighs mine that I seriously doubt I shall educate you. If I'm fortunate, many of you will have forgotten some of the details I shall recall to your mind.

> **"The technique utilized to get a clear channel (when diplomacy failed) was merely to lay a book on the telegraph key so that no one else could hear any other signals."**

Evolution, by definition, involves change regardless of what is being considered. Change takes place at some rate, or velocity. Considering the time span from the birth of Christ, knowledge in the world did not double until 1750; the next doubling by 1900; the third by 1950 and the fourth by 1960. I'm not sure whether the fifth has yet occurred but probably so. If one consider man's existence to be 50,000 years, that would represent about 800 average life-spans. That many people could theoretically cover that period; about as many as could have attended this banquet tonight.

Of those 800 people 650 would have spent their lives in caves, or something worse;

Of those 800 people only the last 70 had any effective means of communicating with each other;

Of those 800 people, only the last six ever saw a printed word or could measure heat and cold;

Only the last four were able to measure time with any precision.

Almost everything that makes up our world was invented during the life span of the 800th person;

And more technological progress will be made during the life of the 801st person, than during the entire lifetimes of the previous 800.

Spectrum Management has existed ever since we learned to transmit information by means of electromagnetic waves. In understandable terms, it means reconciling in the best possible way the desired uses of the radio spectrum. Initially it was rather simple, as viewed from our vantage point of hindsight. But most things are that way. The usable radio spectrum has changed over the years from the first transmission across the Atlantic in 1901 on 328 kHz (915 meters), to the present complex of usable radio frequencies now extending up to 275,000 MHz, not including laser optical systems in use, and some other "electric" waves about which we know comparatively little. Consequently, the difficulty of the task of administering the spectrum has increased immensely since men began useing wireless waves.

Probably the very first attempt at spectrum management occurred because the extremely wide bandwidth of early spark transmitters would blanket *everything* on *any* frequency within a hundred miles or more of the transmitter. The technique utilized to get a clear channel (when diplomacy failed) was merely to lay a book on the telegraph key so that no one else could hear any other signals. But a succession of disasters at sea, culminating with the loss of the Titanic in April 1912, brought forcefully to mind that such a technique was not really useful as a spectrum management tool.

It was 1903 when Prince Heinrich of Prussia, enroute home from a visit to America, tried to send a courtesy message to President Theodore Roosevelt. He was refused service because the apparatus on board ship was of a different make than that of the shore station. That incident led to the first real attempt to manage the spectrum at the Berlin Conference of 1906, which was attended by representatives of 29 countries. The principal issues were, understandably,

obligatory communications regardless of the manufacturer of the equipment;

allocation of frequencies for public correspondence and maritime services,

and agreement on the use of "S O S" as the distress signal.

Their discussions must have been totally foreign to the modern concept of spectrum management which is judged by the criteria of bandwidth and signal-to-noise ratio required to transmit information at a given capacity in bits/second.

> **"When nations next met in Washington in 1927 . . . the frequency spectrum had been extended into the short waves above 3000 kHz primarily through the efforts of radio amateurs who had been denied the use of other frequencies."**

By 1912 progress in wireless communication had progressed to 479 coast stations and 2752 ship stations of which 1964 were open to public correspondence. These developments lead to the next radio conference in London in 1912, where three new services came into being; *radio beacons, weather reports,* and *time signals,* with frequency bands allocated to each. Such was the state of affairs in wireless at the beginning of WW-I in 1914. When nations next met in Washington in 1927, three important scientific advances had been made in the field of radio;

broadcasting of radio programs had commenced;

radio sets had been installed in aircraft; and

the frequency spectrum had been extended into the short waves above 3000 kHz primarily through the efforts of radio amateurs who had been denied the use of other frequencies.

Many of you in this room remember the thrills of those days when you finally got a UV200 or 201, a 210 or a

203, to oscillate on roughly 200 or 80 meters, or if you were lucky, on 40 meters; building your own chemical rectifier and filter, and gazing in awe at the Roller Smith hot wire ammeter (Model No. HWA-1041), which was *absolutely necessary* to measure your "radiation."

**By 1932, "broadcasting had expanded into the short waves, as had also commercial interests and government stations which had 'seen the light' uncovered by radio amateurs in their experiences."**

Herbert Hoover was chairman of that 1927 conference, and a most revolutionary procedure was adopted to use the English language as well as French, the traditional language of diplomacy. However, all delegates were cautioned to "use the privilege with discretion!" This was the beginning of the establishment of the official languages of the ITU which now are English, French, and Spanish, with Russian and Chinese also included as working languages. In cases of dispute, the French text is still considered the official version. The work of the 1927 conference was so exhausting (it had nearly 2000 proposals before it) that it took what has proven to be a most important step in establishing a Consultative Committee which has withstood the test of time and is now known as the C.C.I.R. (from the French version of the title).

The usable frequency spectrum as then understood extended from 10 kHz to 60,000 kHz and the real difficulties of spectrum management had begun. After a table of frequency allocation was drawn up,

> how should the rights of conflicting parties be settled? . . .
> . . . if a station changed frequency or a new station started up which caused interference, which station had priority?

After lengthy discussions it was concluded that there was no possible way in practice to make adherence to the table of allocations obligatory. That principle is still true today as evidenced by the numerous reservations taken by many countries in the present International Radio Regulations, and the many transmissions which do not coincide with the Table of Allocations.

The period from 1932 up to the beginning of WW-II, encompassed two international conferences at Madrid and Cairo where additional scientific developments were taken into account.

1) broadcasting had expanded into the short waves, as had also commercial interests and government stations which had "seen the light" uncovered by radio amateurs in their experiences;
2) by 1934 there was a kind of radar in existence, and
3) in 1936 the BBC in London was broadcasting a "high definition" television service using 180 lines, which had been received on this side of the Atlantic.

During these early days after broadcasting became established, the portion of the spectrum which gave most difficulty to allocation people was from 150–1500 kHz. Little did they know what was to be the future of medium frequencies, later known as the standard broadcast band. As stations became more numerous, ways were sought to enable them to operate without causing undue mutual interference. One of the applicable techniques developed was the directional antenna, using vertical radiating elements with spacing, phrasing and current ratios adjusted to produce the desired radiation fields in the wanted directions. The beginning of an era of consulting engineering was introduced by the installation in 1940 of such an antenna at WFLA in Tampa, Florida by the late FCC Commissioner T. A. M. Craven and Raymond Wilmotte. Since that time, the allocation, or assignment, of stations in the standard broadcast band has been on an engineering basis, with complicated directional arrays now in use by roughly 2500 AM broadcasting stations in this country.

Almost as soon as we realized that frequency congestion would become a future problem, we found the world engaged in another World War. In all countries involved in the scene of the struggle, terrible destruction of telecommunication facilities took place. Suffice to say that in France alone:

> 54,000 miles of overhead wires were down;
> 60 relay stations were destroyed;
> 30 cities had their underground cables cut;
> 110 telegraph offices lay in ruins;
> 50 submarine cables had been severed;
> and of the original 42 French national broadcasting transmitters, only four were usable at the end of the war.

Wars are waste, however much they accelerate technological progress. During WW-II more technical developments were made than in the entire previous history of telecommunication . . . which laid the base for everything that has occurred in spectrum management since that time.

Following the war, the Big Five powers met in Moscow to discuss preparation for the next international telecommunication conference which had been recognized as absolutely essential to avoid utter chaos in peaceful applications of war-time developments. Only the United States was relatively unscathed by the war; and characteristically, we desired to use this advantage for the benefit of others. This led to the World Administrative Radio Conference, the Plenipotentiary Conference, and the first of a series of High Frequency Broadcast Conferences in 1947 at Atlantic City. Six hundred delegates from 76 countries attended to the post-war problems of the spectrum, not entirely aware of the tremendous added burdens to come into the scene with post-war developments and applications in the regions of VHF, UHF and SHF. Television was still an experiment on VHF, but wartime radar techniques brought it into clear focus shortly after the end of hostilities. Fortunately for the United States, our government had recognized the impending spectrum utilization, and as early as 1944–45 before the war had ended, called General Allocation hearings on uses of the spectrum. This set the stage for the United States position at the Atlantic City WARC.

**"During WW-II more technical developments were made than in the entire previous history of telecommunication . . . "**

The significant problem of the post-war years, which still has not been solved, relates to international standards for television. At Atlantic City in 1947, delegates were unworried about the allocation of the spectrum from about 30 MHz to 10.5 GHz. They concluded that it could be allocated to radar, television, FM broadcasting and a few other "relatively minor services." What can happen even with considerable international liaison in our present world of telecommunication is typified by present television standards in use throughout the world. In the United Kingdom they use 405 lines on VHF, but on UHF they use the CCIR standard of 625 lines. In the United States we established our system using 525 lines, and the French use 819 lines. This perhaps wasn't so bad, although annoying, until along came color television. No other subject ever elicited such acrimonious debate among I.T.U. delegates as the subject of color television standards at meetings in Vienna in 1965 and Oslo in

1966. We had the NTSC simultaneous color system; the French had their SECAM systems; Germany introduced the PAL system and Austria came up with what was called QUAM.

Some witty delegate coined some humorous descriptions for these systems which you might enjoy:

NTSC – Never Twice the Same Color

SECAM – System Elegante Contre L'Allemagne

PAL – Pay for Additional Luxury

QUAM – Quick Austrian Modification

So we not only have four different line standards but also different systems for encoding and transmitting color pictures. Fortunately the four mentioned (actually there were more) have been pared down to three. Every time you see a satellite picture coming from the European area, remember it had to start out with a different line scanning standard as well as a different color encoding system, and go through a standards converter in order for it to be seen on your color television set. I often marvel at the preservation of quality considering everything that has to be done. We have learned that spectrum management becomes dependent on technical standards. As you look at the various TV systems in use throughout the world we find great variations in such important parameters as channel width, spacing between sound and video carriers, width and attenuation of the vestigial sideband, type and polarity of modulation, ad infinitum. I mention these aspects only as examples of factors taken into account in considering how to use the spectrum. Other examples could practically fill a book, and still relate to only technical aspects.

**"By 1980 it has been predicted that the Amateur population of the world will be between six and eight hundred thousand."**

Probably I should have stated initially that any attempt to comprehensively cover this subject would require much longer than you would like to listen. At this point we have progressed beyond WW-II and the technological revolution has just begun. You realize, I know, that any agency of the government which uses frequencies (and most of them do) has a group of spectrum managers overseeing their requirements. No agency can act alone in this field because of the interaction among the various uses of the spectrum. So there is a group of government spectrum managers called the Interdepartment Radio Advisory Committee (IRAC), which has existed since 1922 by various names. The broad main charter of this group is to take care of the frequency requirements of each agency of the government. The FCC is a liaison member, because its responsibility is to the civilian uses of radio, and therefore close coordination is required.

The IRAC has a membership of 16 departments or agencies, and three permanent subcommittees; Frequency Assignment, Spectrum Planning and Technical. The IRAC and its subcommittees are chaired by officials of the Office of Telecommunications Policy, whose Director is Dr. Clay T. Whitehead. The magnitude of the government's use of the spectrum almost staggers one's imagination. The dollar investment is over $50 billion; millions of transmitters are operating daily; government frequency assignments amount to about 120,000 and the number of governmental missions depending on radio is incalculable. No wonder such a group is required to exercise the President's responsibility in this area of spectrum management.

Although there are thousands of worthy post-war developments, I would choose the satellite as the one which will remain the oustanding example of technology covering a wide variety of fields. Satellite communication became a reality on July 10, 1962, a short ten years ago. TELSTAR I was designed and built by Bell Laboratories and launched by NASA in just 18 months. Its impact is still being felt throughout the world. Congress created the Communications Satellite Corporation three months after TELSTAR, and the international consortium known as INTELSAT now numbers 82 nations as members.

The evolution of international communications has proceeded rapidly through increased utilization of both cables and satellites. The INTELSAT system, now in fourth generation satellites, has increased its technological capacity from 240 voice circuits for INTELSAT I to 9000 such circuits in INTELSAT IV in the spot-beam mode, or 12 TV channels, or various combinations depending on modes, emissions and radiation configurations. In 1965 we had only two point coverage over the Atlantic basin in the northern hemisphere, whereas today several satellites provide practically total coverage in the Atlantic, Pacific and Indian Ocean basins with more than 80 antennas at 64 earth stations in 49 countries. Technological investigations now under way indicate that whenever traffic volume justifies it, a new generation of satellites can be provided during the late 1970's capable of providing 20,000 to 30,000 voice circuits with a maximum degree of redundancy to achieve the highest standards of reliability and useful lifetime. Although evolution of cable capcity is not so dramatic as that of satellites, it has increased from 36 voice channels in the first cable authorized, to current and planned capcities of three thousand such channels or even higher, per cable. We now have cable connections from the United States to Europe via TAT-1 through 5, to Bermuda, Puerto Rico, Virgin Islands, Jamaica, Panama, Cuba, Hawaii, Japan, Hong Kong, Phillippines and southeast Asia on to Australia.

**"Frequencies allocated to Amateurs have been gradually whittled away over the years, rather than increased . . . they will desperately need additional spectrum space in the 3–30 MHz area."**

Every service concerned with long distance and international communication has felt the impact of these achievements. Work in the CCIR, recent ITU conferences, and proceedings before the FCC emphasize that communications handled by the Fixed, Aeronautical and Maritime Services are either in process of transition now or are being planned for satellites in the near future. What happens to the HF spectrum which is currently allocated to these services? Well, obviously it will not mean a complete reduction of their HF spectrum allocation, because there will be a number of countries throughout the world without cable terminals and satellite earth stations. Such a major evolutionary development in communications makes it obvious that we must reexamine the utilization of the high frequency spectrum. The last over-all allocation from 3–30 MHz was in 1959 before we had a satellite system and prior to current cable expansion. Undoubtedly, new services and several old ones will clamor for more spectrum space.

The High Frequency Broadcast Service now assigns stations every 5 kHz, utilizing geographic sharing, time sharing, highly directional antennas, and restriction of maximum modulating frequencies to 6400 Hz. They will want more bands; something like ten, probably 500 kHz wide. By 1980 it has been predicted that the Amateur population of the world will be between six and eight hundred thousand. Frequencies allocated to Amateurs have been gradually whittled away over the years, rather than increased, as with most other services; and if the prediction of their numbers should come even close to being true, they will desperately need additional spectrum space in the 3–30 MHz area. Large areas of the spectrum must not be pre-empted by stations moving into unoccupied regions of the spectrum in a haphazard manner. (Some of this is currently taking place). That will only make the future administration of the spectrum more difficult. In my opinion, a study of the re-allocation of the HF spectrum will be inevitable. Services which have major blocks of HF spectrum allocated to them and which are going to cables and satellites with their traffic, will receive close scrutiny by the world's spectrum managers.

What does this mean to spectrum management? Well, in 1971 it meant a World Administrative Radio Conference specifcally dealing with Space Telecommunication. Allocators now must think in new terms which ten years ago would have been foreign to their vocabulary except in specialized areas of communication. They now must deal with

- progagation effects on earth-space transmissions instead of just the usual phenomena of $F_2$ layer transmission, ducting, sporadic E, etc.;
- the atmosphere "window" through which signals pass without undue absorption;
- Signal levels in terms of $dBW/m^2$ of power flux density instead of signal strength in $\mu v/m$;
- angle of elevation;
- refraction phenomena;
- scintillation and scatter;
- Dopper and Faraday effects;
- station keeping of the satellite;
- interference from the sun, and
- echoes, noise temperature of the receiving system, and a host of others too numerous to list.

All problems of spectrum utilization are certainly not solved because we have a satellite system. The tremendous requirements for mobile communications by the countless users in the various Land-Mobile Services have led to extreme pressures on desirable regions of the VHF and UHF spectrum. Although frequency sharing has existed for years, our parochial system of frequency allocation has been by the block method. Within each allocated block, station assignments in particular services are made. But Land-Mobile needs more spectrum, which has been the subject of numerous papers, hearings, discussions, arguments and controversies over the past several years. Land-Mobile stations are now sharing certain of the UHF television channels under specified conditions. Still the growth continues and the squeeze on the spectrum has resulted in an attempt to bring modern technology into the Land-Mobile frequency management process.

**"Perhaps certain of these unseen radiations will be discovered to be the catalyst which will enable people to communicate reliably by thought transmission."**

No doubt many of you know about the spectrum management project which the Commission is now implementing in Chicago. This probram will require building and maintenace of a complete administratige and technical data base containing the records of all the licenses within a particular area. That data will be used as the FCC's automated record of the licenses, and will provide the engineering environment to enable making more optimum frequency assignments. The data bank will contain not only data from the Application Form 425, but also inputs from monitoring observations. There are differences of opinion as to whether sufficient benefits can be derived from such an endeavor to make the result positive in terms of cost-effectiveness. It requires considerable money to conduct such an operation. No one can predict yet with much reliability just how much more spectrum utilization can be obtained by these methods, nor at what cost per application or channel assignment. Only time will tell. For administrative purposes, plans and budgets are being prepared for extending the project into the other areas of the country. Regardless of which side of the fence one may be inclined respecting this project, it is an attempt to utilize modern techniques involving magnetically stored data and a computer to improve the use which can be obtained from one area of the radio spectrum. It is a step in the right direction toward making a more effective value judgment of spectrum management. Its evaluation is awaited with interest.

There are always competing claims on the spectrum. There are five usually applied criteria in determining priority of use:

1. Inability to use wirelines or other substitutes for radio;
2. Contribution to maintaining safety of life and property;
3. The number of people who would benefit;
4. The demands of the public for the output of the service, and
5. The technical suitability of the spectrum requrested for the requirements of the service.

When all is said and done, and we have every transmitter on the right frequency operating in the best interests of its users, we have a lot of electromagnetic energy wafting around throughout the area here on earth where people live. You can't see it, but do you wonder if there are any effects on humans from all this electromagnetic energy to which we are all subjected? Is there any relationship between the known forms of radiation and those "waves" about which we know so little? There are some measurable side-effects of electromagnetic radiations:

- At 700 Hz we can produce electrical anesthesia;
- Certain components of living cells in people are resonant in the aural and television broadcasting bands;
- We know that ants will align their antennae parallel to an electromagnetic field at 9 MHz;
- Radiation at 21 MHz increases the germination of gladiolus bulbs by 200%;
- Emissions at 27 MHz affect growing cells of garlic plants;
- You can kill bugs in bread with emissions at 29 MHz;
- Short exposure to energy in the 300–3000 MHz region expedites regrowth of severed nerve cells, and
- Radiations at 388 MHz are lethal to monkeys.

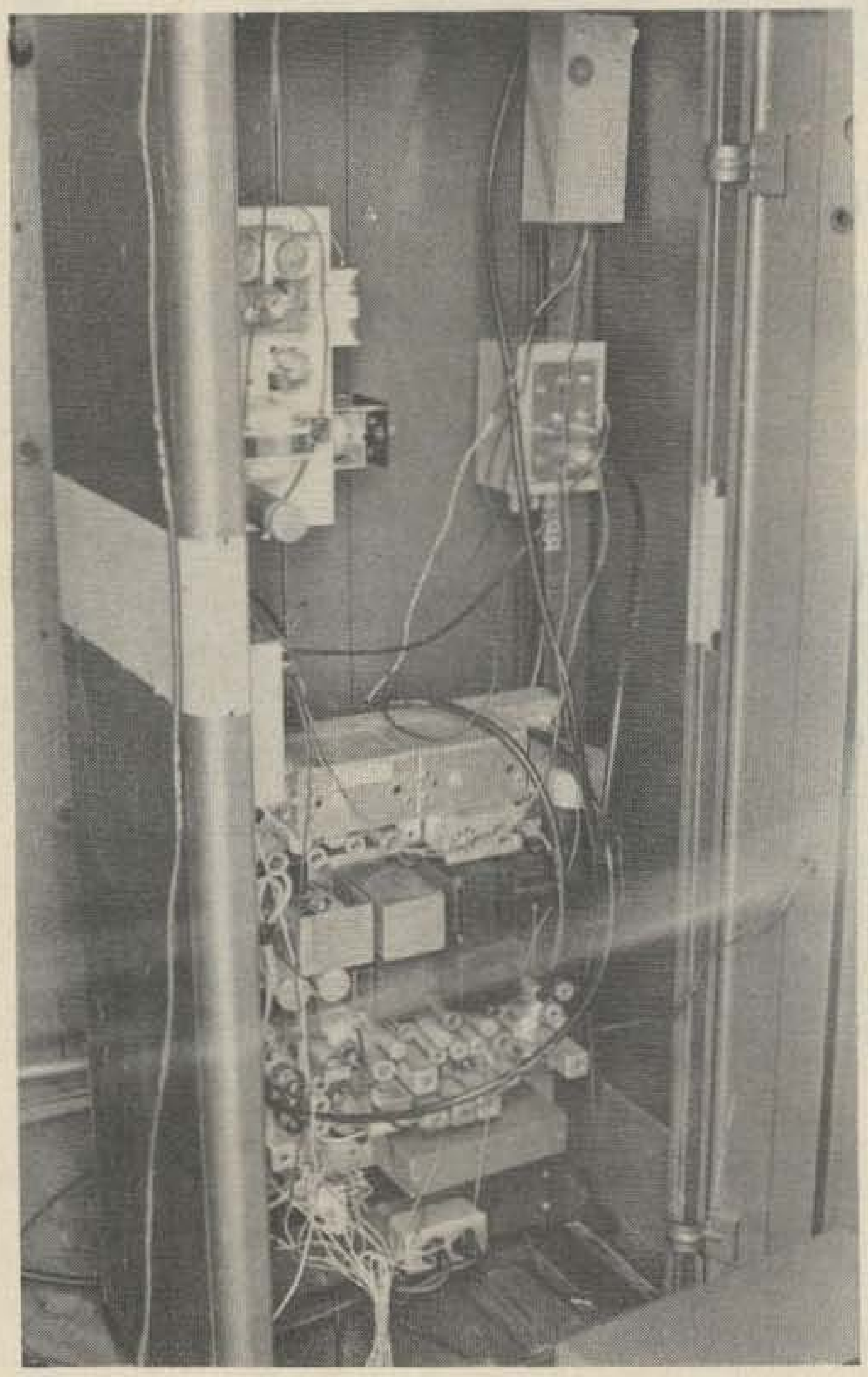
If one had the acumen to evaluate the present with the hindsight of the 802nd or 803rd person, I'm certain we would conclude that the science of communication is still in its infancy, despite the wondrous things that have come about. Perhaps certain of these unseen radiations will be discovered to be the catalyst which will enable people to communicate reliably by *thought transmission.* We know that some people have such limited powers now, although we don't understand yet the details of how it is done. There is much research in progress on the subject throughout the world.

After thousands of years of development in mechanical technology, we are now engaged in extending our thought transference by electromagnetic means throughout our globe. We are even probing outer space, for some sign of life and intelligence there with which to communicate. If we do this, the final phase of the extension of mankind may well be, as Marshall McLuhan puts it,

> ". . . simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and nerves by the various media . . ."

When that time arrives, God help the spectrum managers!

*Clifford Klinert WB6BIH*
*520 Division Street*
*National City CA 92050*



# PHASE LOCKED LOOP DECODER

*A continuous tone operated relay for the repeater or remote*

A continuous tone squelch or relay is used in a repeater or remote base system where it is desirable to restrict use of the machine to only certain individuals, or to select one repeater if there is more than one system sharing the same channels. Commercial names for this system include Private Line, Quiet Channel, and Channel Guard. This is accomplished by transmitting a low frequency, low deviation, continuous tone along with the carrier and other modulation of the accessing transmitter. Only transmitters with the proper tone will activate the tone operated relay in the repeater.

Single tone or "beep tone" is also used for this purpose, and this decoder can also be used as a single tone decoder. However, single tone is an inferior system since it creates an annoying audible tone. Also it defeats the purpose of tone access when an undesirable carrier can hold the repeater on, and anyone can access it by simply whistling.

The continuous tone system is usually inaudible, and cannot be activated by a whistle.

## The System

This article describes a continuous tone squelch decoder–encoder system that is completely solid state with no expensive, unreliable mechanical reeds. The decoder is relatively easy to build, featuring a Signetics phase locked loop decoder integrated circuit. The decoder can operate consistently with a tone that is as much as 6 dB below the wideband noise level. The detection frequency and bandwidth are adjustable by external component selection. In this case

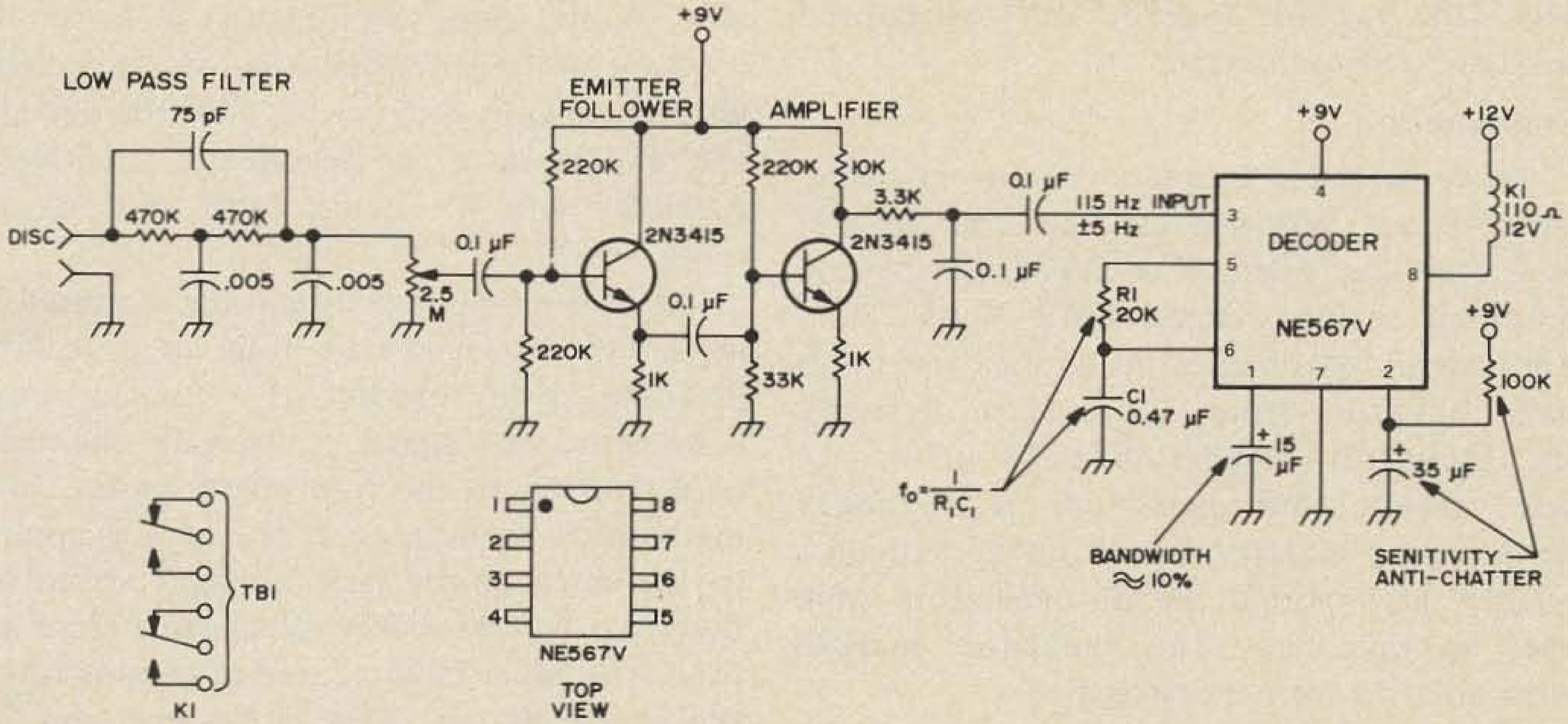



*Fig. 1. Decoder schematic.*

the bandwidth was set relatively wide to allow for frequency instability on the encoder. This allows the simplest possible encoder circuit to be used. This is a good consideration in a large group of repeater users where some members may not have the desire to buy or build an expensive, complicated encoder. The encoder uses a simple phase shift oscillator circuit.

### The Circuit

Figure 1 shows the schematic of the decoder. The signal must be taken directly from the discriminator of the receiver. The low pass filter removes most of the higher frequency signal components that may be at a higher level than the tone signal. The filter prevents strong out of band signals from desensitizing the decoder. The emitter follower provides a high impedance input to minimize loading effects on the discriminator. An amplifier is necessary to bring the signal up to the proper level for the decoder.

Although the decoder has more than fifty transistors in its integrated circuit, only a few external components are necessary to set the desired operating conditions. The detection frequency is: fo = 1/R1Cl. From the values shown in Fig. 1: fo = $1/(20 \times 10^3)(.47 \times 10^{-6})$ = 107 Hz. In actual on the air tests with an audio oscillator and frequency counter, a center frequency of 110 Hz was measured. R1 and C1 can be varied to select the desired frequency, but R1 should be kept between 2000 and 20,000Ω for best stability. The 15μF capacitor affects the bandwidth, which was set at about 10%. Tests again show a frequency response from 105–115 Hz. A smaller value capacitor would narrow the bandwidth. The 35 μF capacitor and the 100 K resistor circuit affect bandwidth, sensitivity, and help prevent chatter. Information on this was obtained from Signetics application notes, and final values were obtained experimentally.

The output of the decoder can sink up to 100 mA, so it is used to drive a relay directly. Nine volts is used to power the decoder and preceeding transistors, but 12 volts is used as a voltage source for the relay. The output of the decoder on pin 8 of the integrated circuit can operate to as high a voltage as 15 volts without damage, but the rest of the IC must be held to less than 10 volts.

The circuit of the encoder is shown in Fig. 2. The circuit shows a phase shift

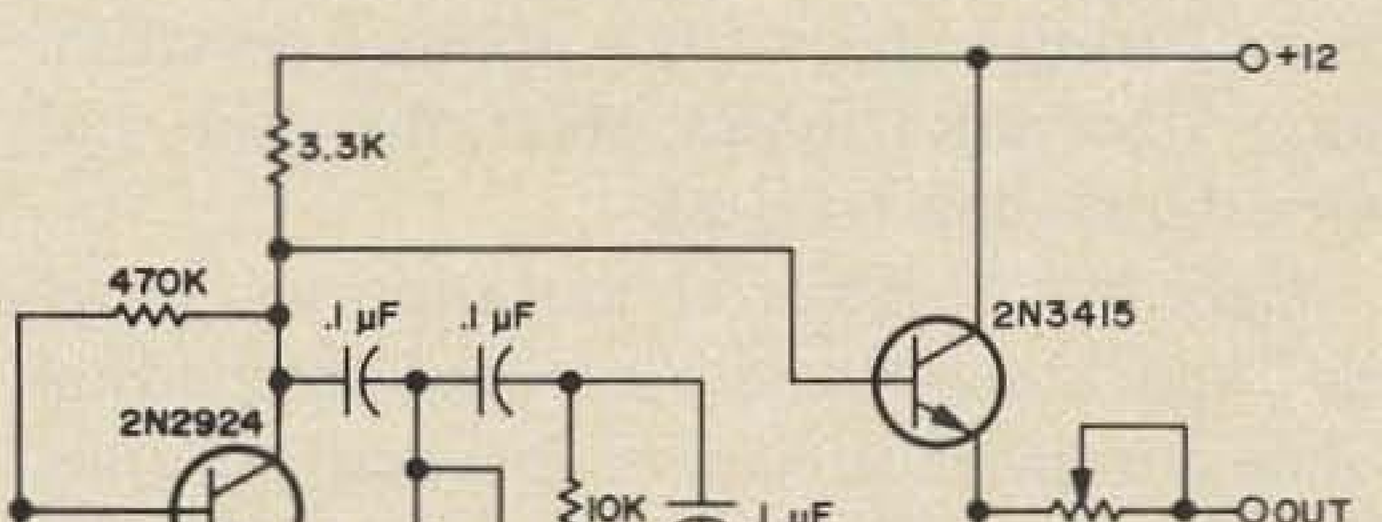



*Fig. 2. Encoder schematic.*

oscillator followed by an emitter follower. The 20K variable resistor sets the desired frequency of oscillation.

**Construction**

Since such low frequencies were involved, parts layout was not critical. The decoder was built on a piece of Vectorboard and mounted inside a small LMB chassis box. The integrated circuit and application notes were obtained from Solid State Systems, Inc. Capacitors smaller than 0.1 $\mu$F can be disc ceramic, but capacitors in frequency determining circuits should be of as high a quality as possible. Mylar capacitors were used in this case. The capacitors marked with polarity were electrolytic.

If the encoder oscillator is put near a strong rf field it may not oscillate. This can be cured by bypassing the power leads with a .01 $\mu$F capacitor, or shielding the entire circuit if necessary.

2N3415's were used for the two transistors in the decoder and for the emitter follower in the encoder. A 2N2924 was used in the oscillator circuit.

**Operation**

The input of the filter circuit in the decoder unit is connected to the discriminator of the receiver. This circuit has been used with RCA CMU15 and Motorola T44 receivers, and should work as well with other similar receivers that have enough discriminator signal.

The encoder in the transmitter should be connected as directly as possible to the phase modulator. It is usually connected to the deviation control.

To adjust the levels, the tone deviation of the transmitter should be set to 500 Hz, and the *combined* tone and voice deviation should be set to a maximum of 5 kHz. Triple these numbers for a 450 wideband system, remembering to keep the combined deviation below maximum limits, since the tone and voice signals add on peaks.

With the transmitter deviation set properly, and a combined voice and tone signal coming from the receiver, increase the level control until the relay holds in without dropping out on voice peaks. If the level is advanced too far, the decoder may give false outputs from the filtered noise sent to it. Setting levels may take considerable trial and error if proper test equipment is not available. In any case, the objective is to set the transmitter tone deviation as low as possible without having voice peaks false the decoder off, and to have the decoder as sensitive as possible without giving false outputs on noise.

After the system is operating, it should be impossible to hear the tone in a receiver listening to the repeater. If a buzzing sound is detected on a signal, it is usually the result of distortion in the transmitter audio, causing audible harmonics. If the tone is applied to the microphone jack of the transmitter, the tone will probably be audible since the tone level must be increased in proportion to the voice signals. This is because the frequency response of most transmitters is limited below 300 Hz. Also, if the tone signal received at the decoder is very distorted, the level may have to be increased to hold in the relay.

At different times the relay may pull in almost instantly or may take as long as a few tenths of a second to activate. This depends upon the phase relationship between the signal from the encoder and the signal of the internal oscillator in the decoder integrated circuit. This effect is unpredictable.

The decoder should make a good single tone decoder also. This might be done by eliminating the low pass filter from the input, and changing R1 and C1 to different values for the desired frequency. The two electrolytic capacitors should be changed from 15 and 35 $\mu$F to 2 and 5 $\mu$F respectively. It would be necessary to provide output latching for the circuit, and unlatching by the COR.

**Conclusion**

This project only took a few days to make operational, and has been operating reliably for about four months now. The integrated circuit was the most expensive item, and it only cost a few dollars. Integrated circuit prices have been getting lower every month. Construction of the encoder is a simple task, and would make an ideal club project. When compared to the price of a tone reed that may have to be replaced in a few years, the solid state system is a real bargain to protect the input of your system.

. . .WB6BIH

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# TOROIDAL QUADRATURE ANTENNA

My work on the "Long Circular Quad," was a needed departure into endfire antenna design which proved ring shaped elements to be superior to discrete directors in – the possibly obsolete – Yagi configuration. Extensive tests on a professional antenna range proved that.

Another, although unproved departure from the norm, was George A. H. Bonadio's *Square / Diagonal Antenna*, commonly thought to be a diversity antenna, when in reality it is quite similar to an '8JK multi-driven element collinear/broadside array.

While these two antennas have nothing in similarity except their novelty, however, it might interest the reader to know that W4KAE spent many hours contemplating just the same arrangement that Mr. Bonadio thought up, except he couldn't stand the idea of using tuned lines – so the project was abandoned. I guess what I had in mind was a point-source with gain. Anyway, after reading W2WLR's article, I knew the principle of operation: Simply use 90 degree physical and electrical phasing on each pair of 4 or 8 wires; place them in the correct plane for the desired radiation; and even semivertical "diversity operation," can be obtained. True diversity would require more than one set of antennas – not simply relays!

These random thoughts and conclusions led W4KAE to test the "Quadrature Approach" in practical form, without tuned lines or relays. Being familiar with the quadrature phasing (90°) concept for winding low-power octave bandwidth receiving networks, I immediately began to wind the coils for the "Toroidal Quadrature Antenna."

### TQA Theory

Reiterating the phasing concept above: The Square/Diagonal Antenna is basically no more than a set of four wires, arranged in phase quadrature. This means there is ninety electrical degrees between each leg, and preferably 90° physical/angular "spacing" between each wire. The length of the elements can be made from either one or two *electrical* wavelengths, the choice depending mostly upon space and gain desired. Optimum design standpoint would utilize a minimum physical wavelength of about 3/8 wavelengths-per-leg. This is doubled to be 3/4 wavelength because of criss-crossed quadrature connections to the transforming coils – and the whole element functions as a full electrical wavelength – with the additional "length" contained in the coils. Obviously whenever a particular design is op-

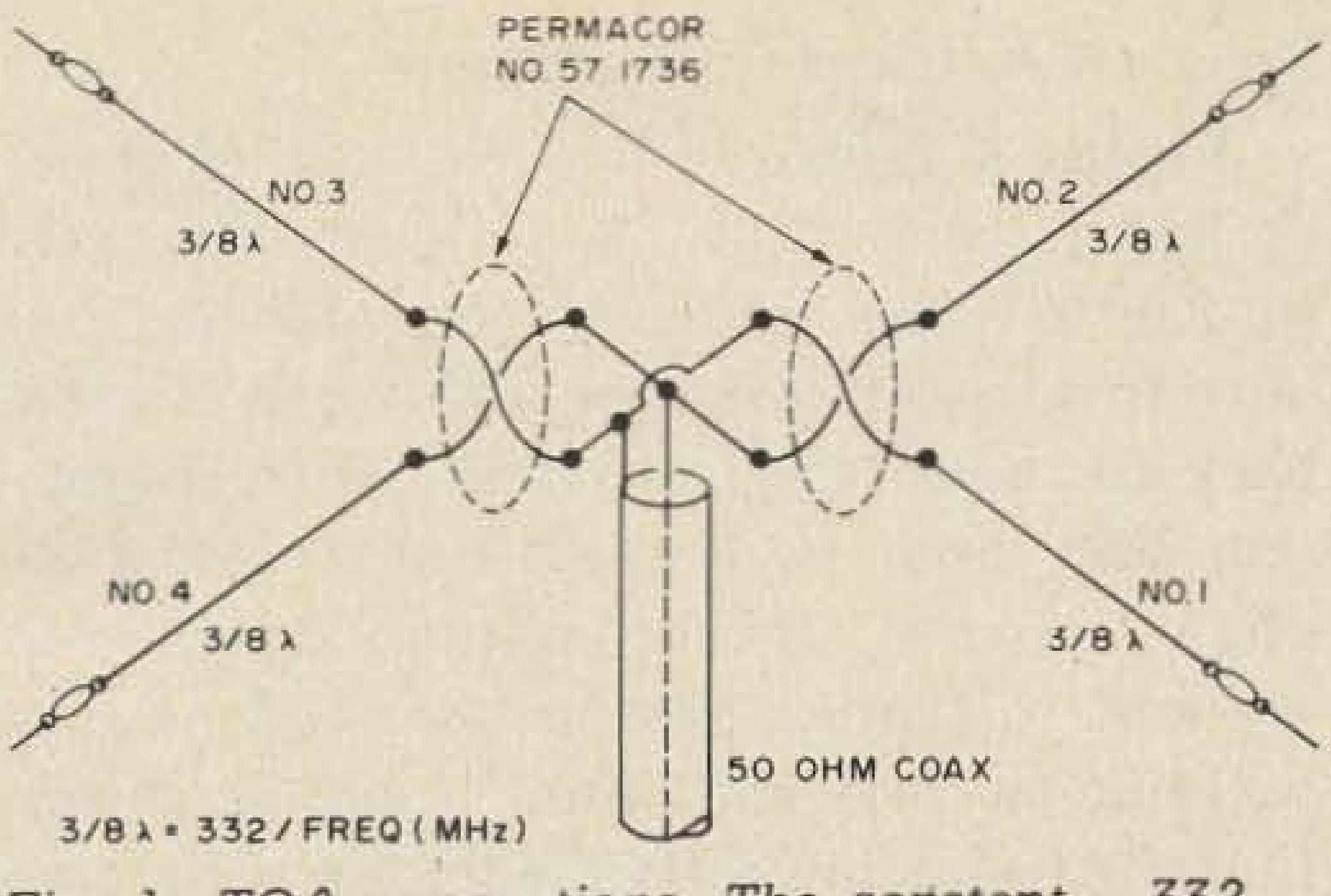


*Fig. 1. TQA connections. The constant – 332 – includes shortening factors and quad-coil loading.*

timized by cut-and-try coil wind and substitution, lowest swr readings are the criterion of proper operation, along with proper continuity tests.

Derivation of element formulas is quite simple – if you don't overlook the ninety degrees in the network! Keep in mind also that since each complementary two-wire element functions as one full wavelength, you must double the usual shortening factor. There is also 2 or 3 per cent compensation present using 10% instead of 5%. We won't go into that, however.

Figure 1 shows the quadrature networks in use by W4KAE. Briefly, to calculate an element length (equal to two "legs") we take 984 minus 246, which leaves a new constant of 738. From this figure, ten per cent is to be taken off, or about 74 from 738, which leaves 664. $664/F_{MHz}$, is for 3/4 physical wavelength. Half of this is $332F_{MHz}$, for each 3/8 wavelength leg. This arithmetic is for the optimum or small-space model. If you want two to four decibels (estimated) additional gain, use the following method:

Take twice 984, or 1968. Take twice 74 or 148 off, for double the 10% shortening factor. Next, take off twice 246 from the number 1968, which leaves 1476. From 1476 subtract the shortening factor (148) found above. This leaves the figure 1328 or $1328/F_{MHz}$ which is for two legs. Half of this becomes $664/F_{MHz}$ which is exactly double the 3/8 wavelength previously. It is also a good check. I have no information about swr in this design.

The TQA connections are made in Fig. 1. Observe that there is dc continuity between elements No. 1,3 and No. 2,4. Similarity to the W2WLR design can be seen where the classical 90 degree phasing, from element to element, is obvious. Dashed-line ellipses are representative of the powdered iron Carbonyl SF cores.

Gain obtained from the TQA should be about the same as from W8JK's two-section flat-top, which appears on page 151 of *The ARRL Antenna Book*, ninth edition, 1960. The spacing between each bay of endfire elements is conveniently eliminated in our version of the Toroidal Quadrature Antenna. Noting the continuity between complementary legs, it is only a short step to place each wire at physical right angles with the other, for overall correct phasor relationships. String the whole array into the same vertical or horizontal plane and you've got an improved quadrature design. With two arrays, in opposing planes, then you have true diversity, not just semi-vertical polarization! Here, a relay and switching networks would be feasible.

Although I do not have facilities to accurately check actual gain readings against a dipole, it should be adequate to figure, by rule of thumb, that 6 dBD is available for the "optimum" design; or 8 dBD for the longer model. Maybe you could expect 10 dBD by combining both collinear and broad-

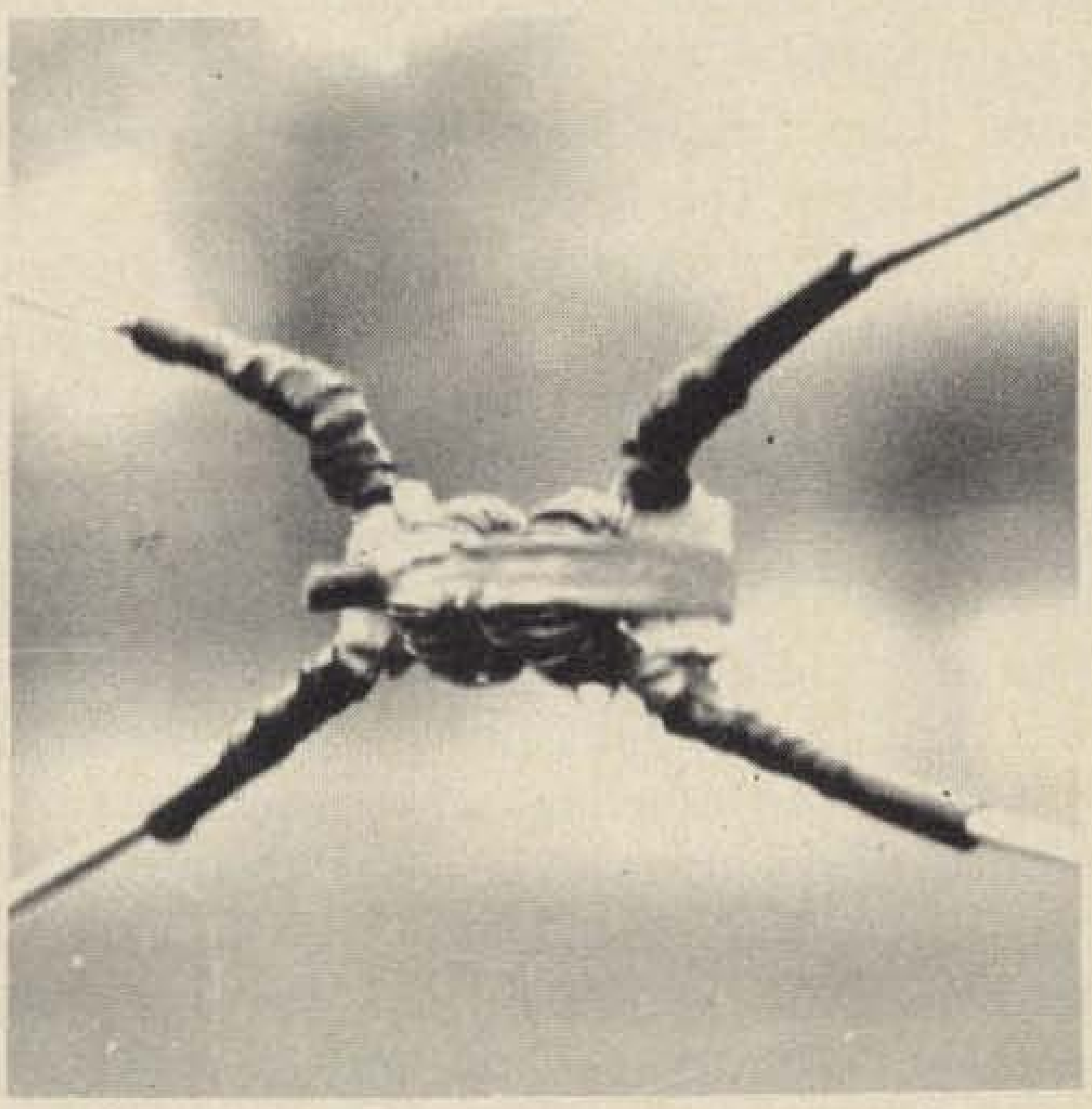

*Fig. 2. TQA receiving coils. With wire of proper size and leg length of about 15 ft, reception for SWL and WWV monitoring is satisfactory. Frequency coverage from an octave below the normalized frequency to an octave above, is feasible.*

*Fig. 3. This shows the quadrature coils before encapsulation. Two No. 57-1736 Permacor cores are wound with No. 16 Beldsol wire, in a bifilar fashion. This pair is for 6 meter sample, sent to Wayne Green for testing on that band.*

side arrays. These conclusions are based upon the reference cited above.

Figure 2(normally I'd have included this photo in the construction section, but it exemplifies proper winding data, here) shows my first torodial coils. This was for general coverage use, with reception coming in on virtually all high frequency bands, and particularly, WWV. My design used No. 24 wire, wound fully in bifilar manner on the toroid cores. This is a 1:1 design ratio.

It was a rainy day when this shot was taken, so it is hard to see the input port cable connection in the middle-left with a cut piece of RG-58/U soldered on. The wire connections have been bared to show cores and the aluminum ground wire connections. The aluminum was swaged and wrapped to the smaller wire ends and held together with a plastic rod, through the cores, and the whole works doused in clear epoxy resin. This receiving design resulted in antenna resonance at 11 MHz; however there was excellent pickup an octave higher at 22 MHz and beyond. Lower-octave reception down to 5.5 MHz was quite good! To the nearest amateur band: 15 meters is recommended, while *reception* of WWV at 10 MHz should be "optimum."

**Practical Antenna Construction**

Figure 3 shows an improved 50 MHz set of quadrature coils. Note that they are similar to a five port circulator, having four output ports in common with earth ground, back to the antenna structure, when connected. The input port doesn't share the same phase of any of the output ports with ground, so there is reasonably good balance without an external balun. It can be shown that the balancing action from the worst two on any pair of wires is +90/Ground Isolated/ -90 basis. You can see the total phase difference is still 180 degrees, but the coaxial cable "ground" is not the same as earth ground.

Figure 4 shows an improved 50 MHz array, as strung up in W4KAE's attic. The elements are mounted in a vertical plane but the reception or transmission is horizontal, as would be expected. This antenna was loaded by my TX-62 on 6 meters giving an swr of 1.5 to 1, in the basement laboratory. By making it "droop" like the drooping ground plane (not illustrated) the swr went down to 1.3 to 1.0. A drooping TQA hanging from a set of square supports should

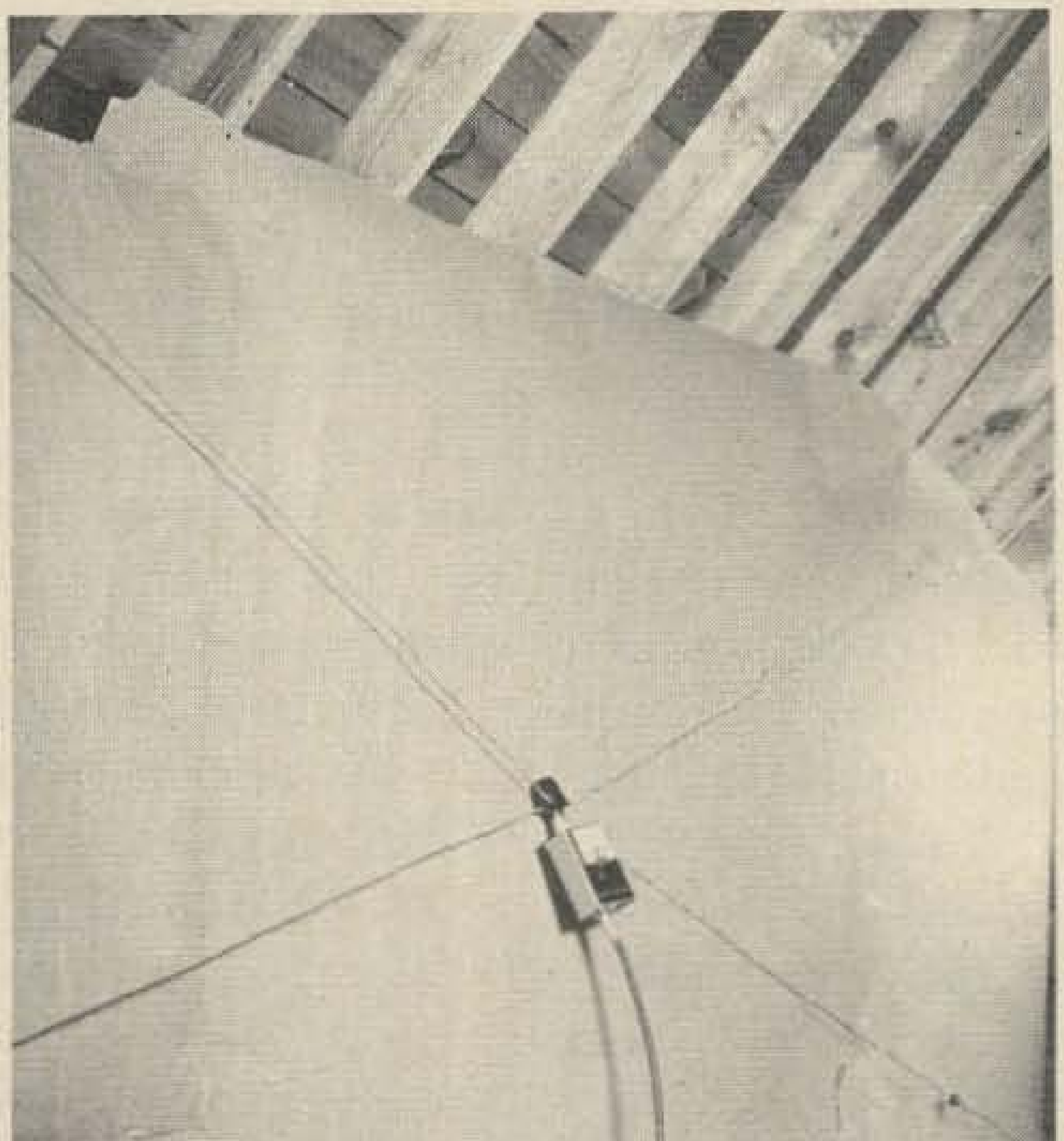

*Fig. 4. The completed 6 meter Toroidal Quadrature Antenna. Individual leg lengths re about 6 2/3 ft. Swr about 2 to 1 with legs not equally angular spaced. (When first tested in my basement lab: swr was only 1.5 to 1. Drooping will improve readings.)*

out-perform a "Halo, Squalo, or even Big Wheels," on VHF.

Figure 5 shows the TQA in packaged form ready to be sent to the editorial research department of *73* Magazine! The toroidal coils are heavily potted in silicon rubber, with an overcoating layer of Valspar No. 8880 glass plastic resin. (This clear resin is no good when in intimate contact with coils, toroid cores or any dielectric use.) In the Valspar resin flat 1/8 in. copper strap is secured, after being soldered. Then the molded network was taped to help secure mechanical strength. Prior to taping, the copper strap was silver-soldered to silver-plate No. 10 ground wire.

### Toroidal Core Materials

The toroidal phasing coils are made with Permacor Material No. 12, Carbonyl SF powdered iron mouldings. The stock number is 57-1736. They are available from *Permacor Division of Radio Cores, 9540 S. Tulley Ave., Oak Lawn, Illinois,* on a $10.00 minimum order basis. It may be possible to get several samples free, by writing on your company letterhead.

With the No. 57-1736, six meter networks can be made by winding bifilar two lengths of No. 16 enamel wire (Formvar preferred), covering all the core space possible. For 10 to 20 MHz, a full bifilar winding of No. 24 enamelled wire is permissible, but the coils will only take 100W PEP or so. For 160 meters and/or 80 meters, Permacor No. 57-1516 is a good choice since it is considerably larger.

If good VHF/UHF networks are desired I must recommend ferrite – not powdered iron – cores. Indiana General makes a very high quality core, size CF-111-$Q_3$ which is almost identical in size to the Permacor 57-1736. I do not know where these can be obtained. In the meantime X-7541 cores are in use at W4KAE (Permacor Iron-9) – but I am anxious to try the $Q_3$ material. For two meters, with the CF-111 size ferrites, wire size should be No. 14.

### Conclusion

At the outset I mentioned the LCQ in opening remarks about the TQA. This is because they are both new departures in contemporary antenna design. The LCQ: A Yagi replacement at least for UHF; and the TQA is a 40 or 80 meter quad or rotary beam replacement. It can also be used on 160 – if you have the room.

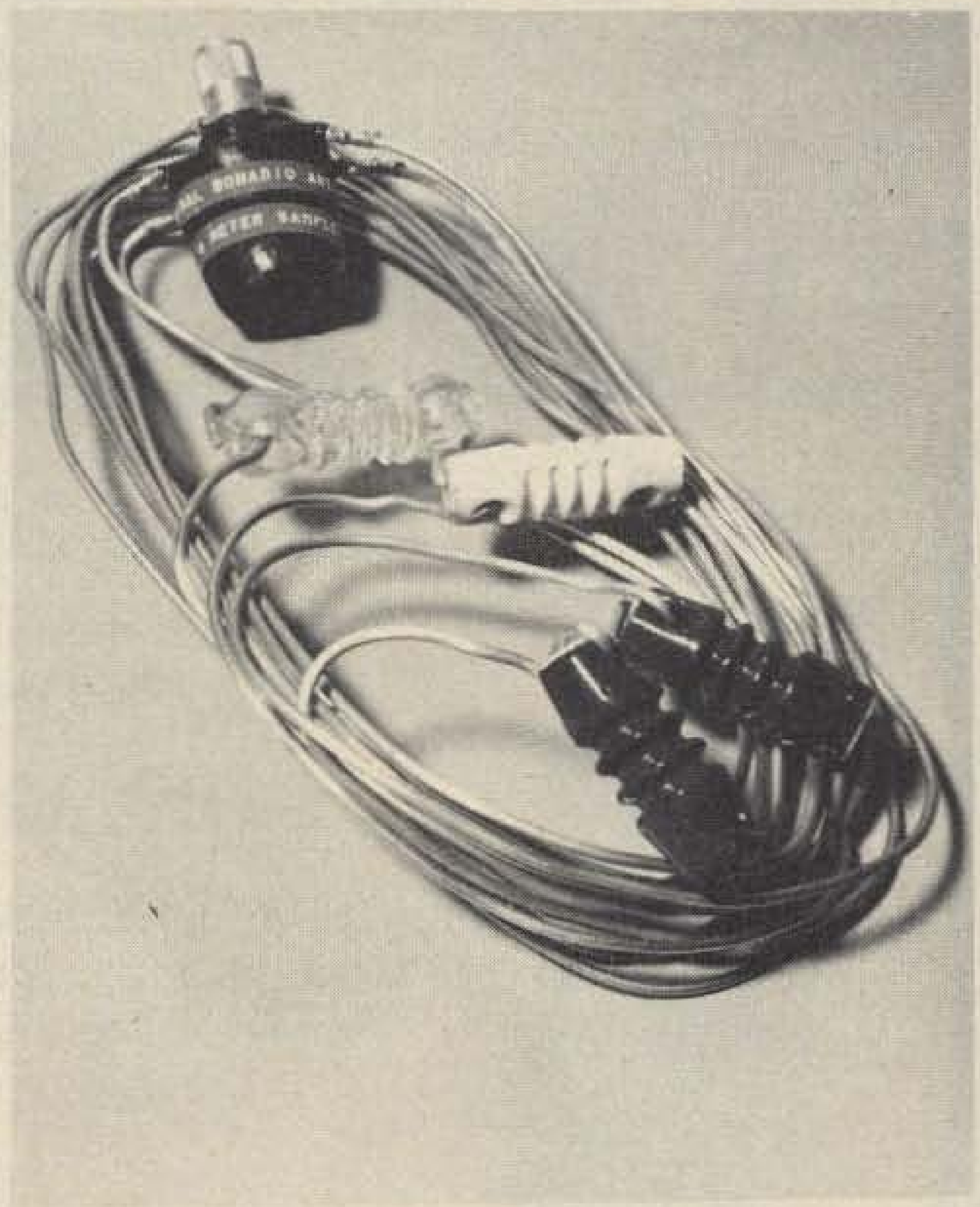

*Fig. 5. The TQA is ready to be shipped. The entire antenna and insulators are easily contained in an old shoe box. With aluminum ground wire elements, the weight was very little.*

It is my opinion that the cubical quad antenna, as already perfected, is ideal for use on 10, 15 and 20 meters – also for 6 or 2 unless you want broad angular coverage. Then the TBA is still practical when wound with good ferrite cores. DXing on 6 meters is still best accomplished using 11 element Yagi designs, I hear; however I'll be glad to recommend my LCQ to home-brewers.

Although the 6 meter design is featured in this article, it is primarily an HF antenna replacement for rotaries when used N/S or E/W in array. With two medium height aluminum masts we can string up a wire element replacement for the Inverted Vee – or – it can be used as a 4 wire Vee that is completely omnidirectional, with only a single set of coils! It will also work on at least one octave of frequencies, on a reciprocal basis, or two octaves in the receiving mode. . . .W4KAE

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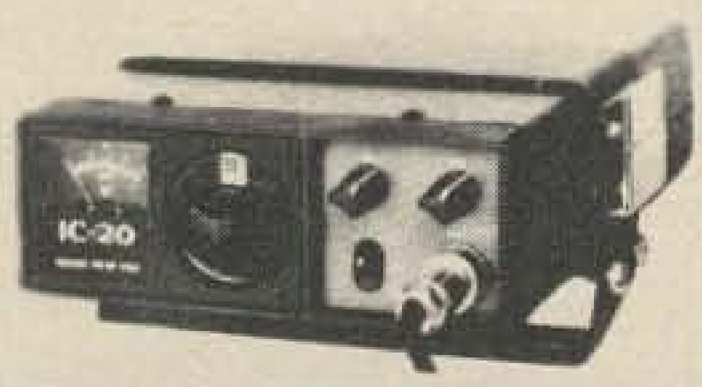


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# APPLICATIONS FOR AN ACTIVE FILTER

Most experimenters are familiar with the effects of cascaded phase shifters applied to the feedback loop of an amplifier. A useful feature which ends up as a very sharp filter can be the result.

In most applications it has been used in audio work as an accessory to a receiver for CW work. I have been able to study further the usefulness of this device at audio and radio frequencies and would like to present the results for what they may be worth to other amateurs.

When the interest in Teletype was at its peak at W1SNN, construction of a converter led to many tries until a satisfactory unit evolved.

The unit was similar to the many published designs with the exception of the filter. Two active filters were constructed which were incorporated in the converter and the improved selectivity made copy considerably more legible. A plot of these filters is shown in Fig. 3a. The circuit of the filter is shown in Fig. 1.

The active filter is not restricted to audio frequencies. During the development of the filters, the center frequencies were extended over a range of 2 kHz to 1 MHz.

A Table, Fig. 2, indicates component values for the individual filter electronics; Figs. 3b and c are presented to show the response of plots for single filters and a cascaded pair stager tuned to produce a symmetrical pass band with a very respectable shape factor at 80 kHz.

An overall gain of 40 dB can be achieved by setting potentiometer Ra to a point well below a level which will make the filter regenerative.

Two potentiometers ganged and connected as part of the network marked Rb and Rc can serve to adjust the center frequency of the filter if an adjustable filter is required. To accomplish good tracking of these two potentiometers, it was necessary for their values to be a very small percentage of the total resistance for Rb and Rc. Therefore it goes without much further discussion that wide frequency excursions are not permissible for a fixed filter.

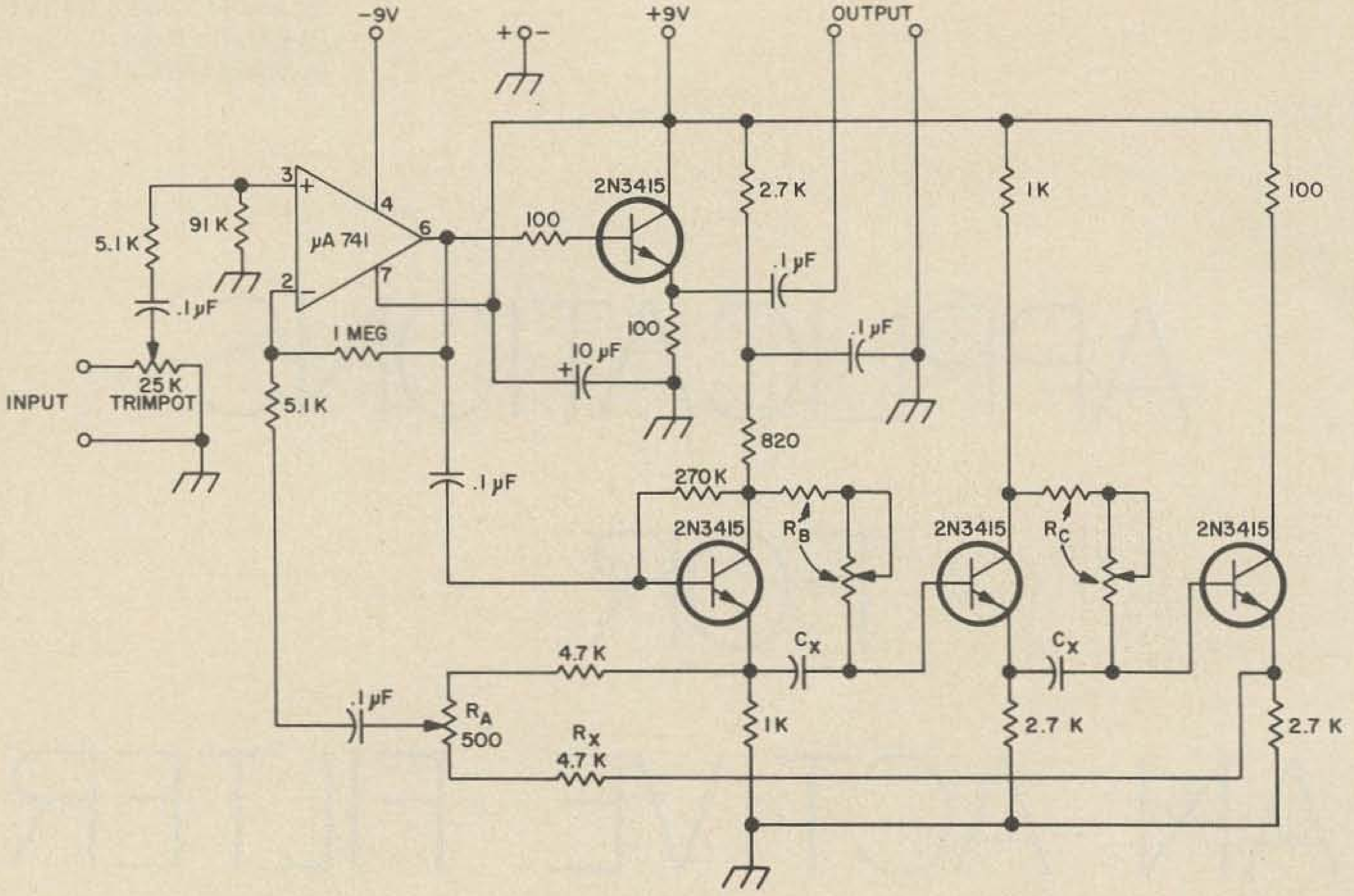


*Fig. 1. Phase shift network active filter.*

The method just described is used in a receiver where the filters are used in a second conversion (i-f) amplifier. The filter is adjusted so that it passes either a lower or an upper side band by simply a turn of the ganged pots. Selectivity can be sharpened by adjusting Ra for narrow or wide band widths. In my application, a range of 200 Hz to 4 kHz was required.

Some care must be used in construction of these filters at frequencies above 30 kHz. Regeneration will occur if the lead lengths are too long for any of the three potentiometers. It is better to group the pots in a row on a small piece of vector board and build all components around the potentiometers than to run wires to them.

The components used are inexpensive plastic transistors. All resistors and by passes are non-critical. If a frequency above 85 kHz is required a 702 operational amplifier should be used in place of the 741.

The overall gain of each filter is very high (40 dB), therefore, very little signal is required and is controlled by the 25K trim pot at the input of the filter. The output of the filter is decoupled through an emitter follower. In our case a 100Ω output impe-

| f, kHz | Rb | Rc | Cx | Gain | 3 dB Bandwidth |
|---|---|---|---|---|---|
| 2.125 | 200K | 200K | 370 pF | 45 dB | 350 Hz |
| 2.975 | 140K | 140K | 370 pF | 44 dB | 380 Hz |
| 10. | 50K | 50K | 330 pF | 44 dB | 1.4 kHz |
| 50. | 10K | 10K | 300 pF | 44 dB | 2.4 kHz |
| 60. | 11K | 11K | 300 pF | 48 dB | 2.0 kHz |
| 85. | 15K | 15K | 100 pF | 44 dB | 2.0 kHz |
| 100 | 15K | 15K | 90 pF | 44 dB | 2.5 kHz |
| 1 MHz | 5K | 5K | 30 pF | 36 dB | 4.5 kHz |
| 5 MHz | 1K | 1K | 30 pF | 27 dB | 8.9 kHz UNSTABLE |

*Fig. 2. Table of values for a phase shift filter.*

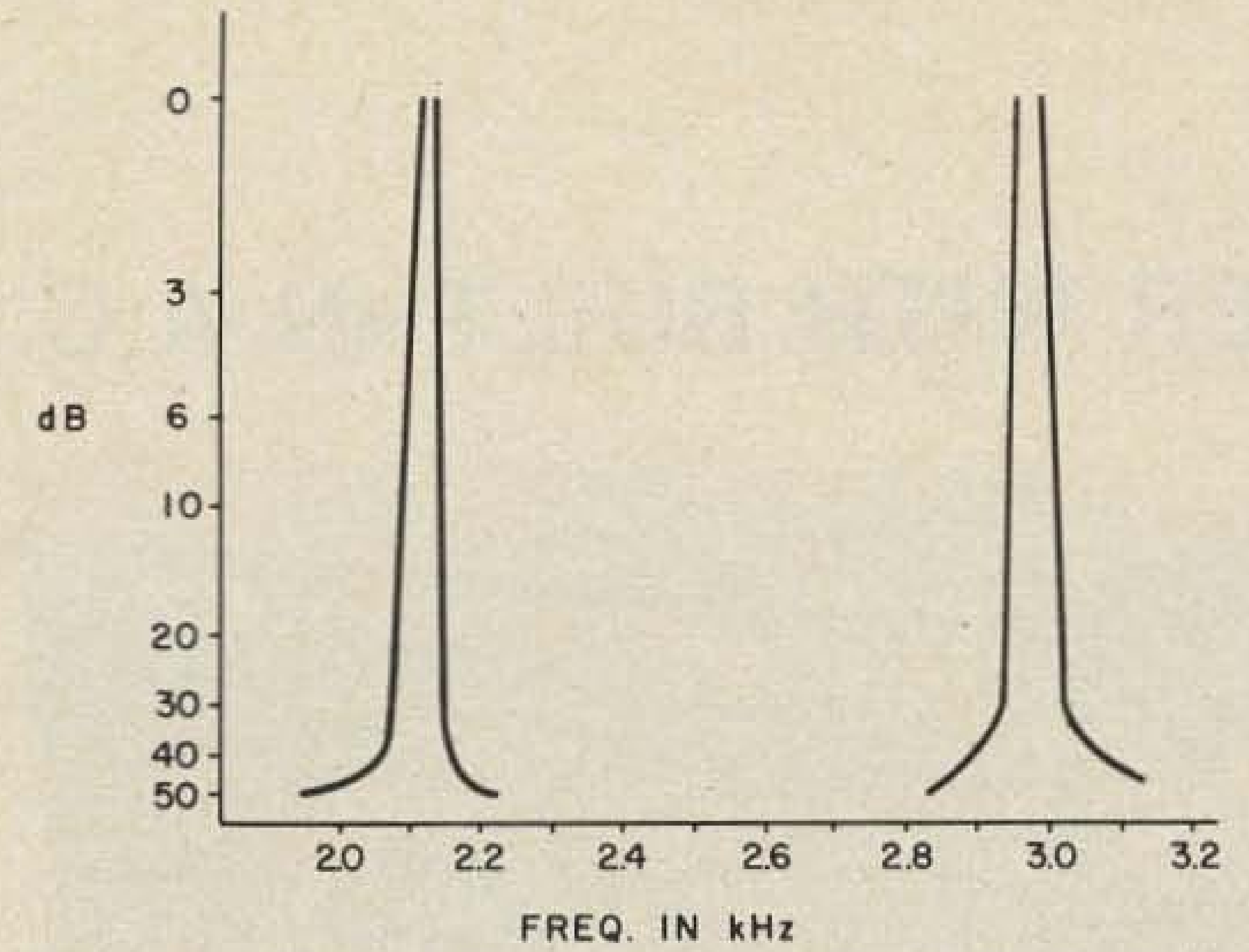


*Fig. 3a. Plot of discriminator filter for W1SNN RATT converter.*

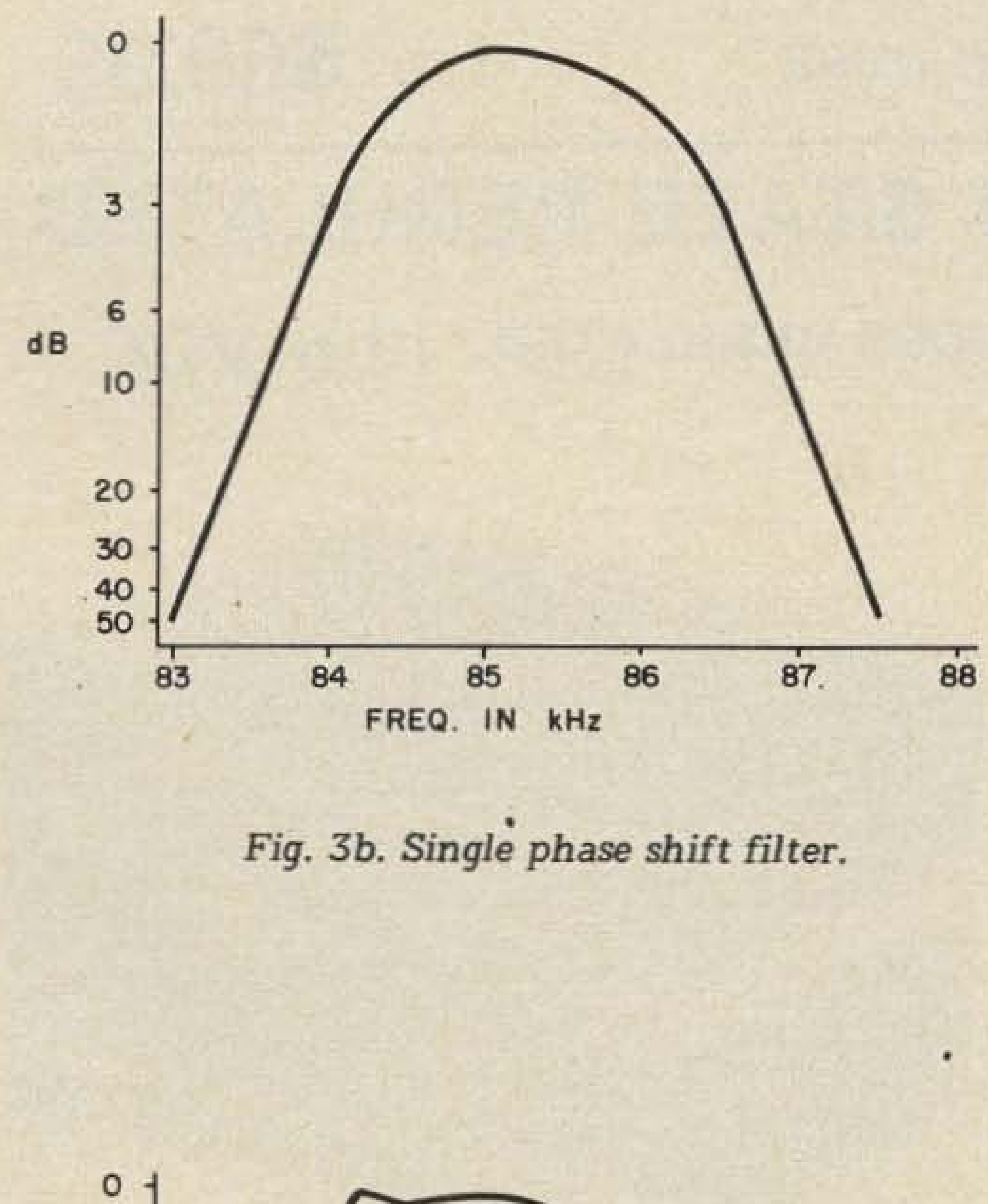


*Fig. 3b. Single phase shift filter.*

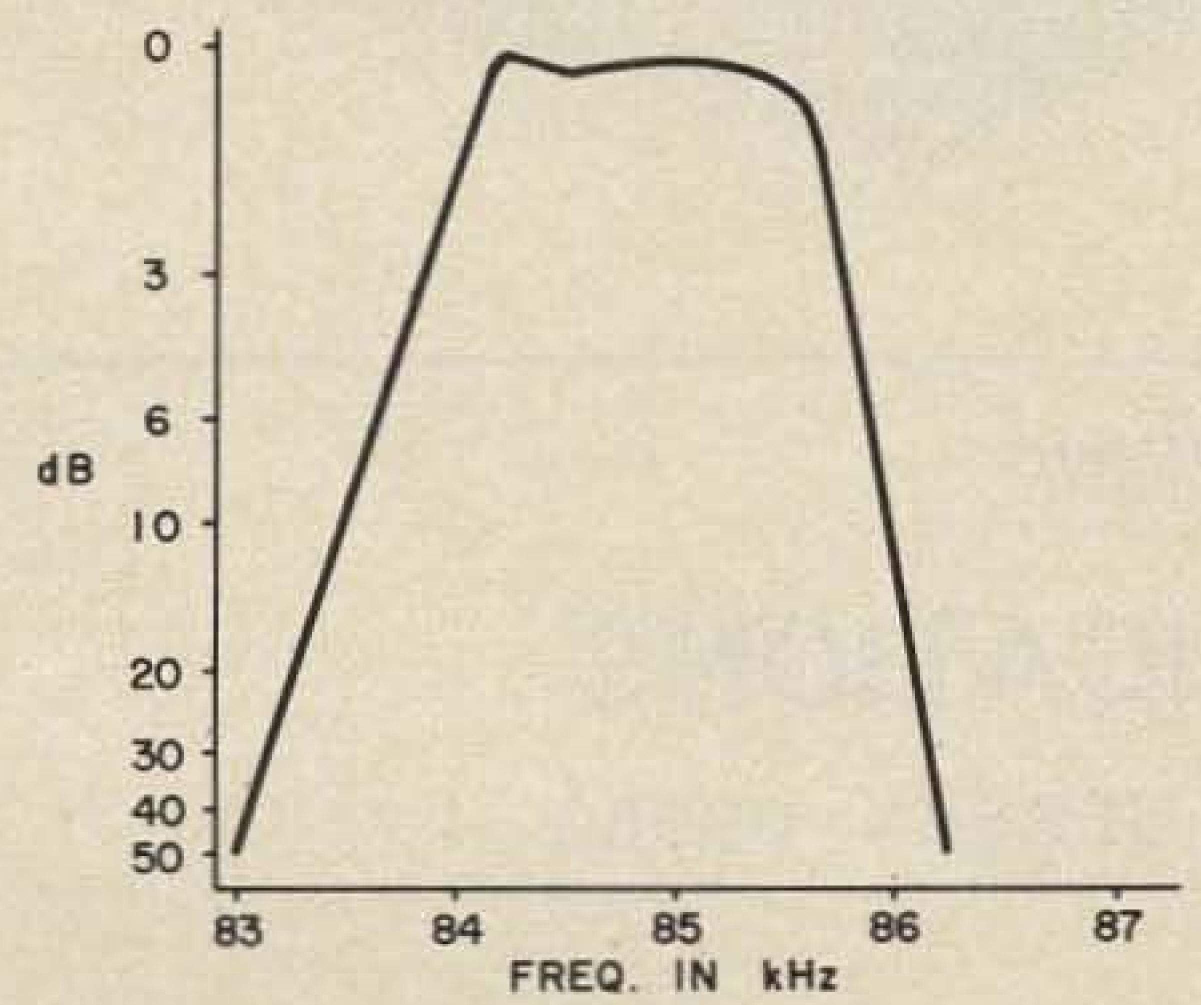


*Fig. 3c. Cascaded pair phase shift filter.*

dance was required, but higher values can be had by simply changing the value of the emitter resistor.

Do not try to drive a high level signal into this filter, 3 mV in produces 0.3V out, which is sufficient to drive any detector.

A maximum of 12 volts should never be exceeded for the supply voltage; 9 volts is best from a battery since current drawn is very low.

To adjust the filter, first connect a VTVM rf probe to the output; adjust the potentiometers R and Rc to the middle of their ranges; set Ra to about one-third open. If the unit has output with no signal in . . . readjust Ra until it just stops oscillating. Now apply a weak signal from a signal source tuned to the desired center frequency. If no indication of a signal is shown on the meter, sweep the generator slowly through the range of frequencies around the desired frequency. Do not increase the generator level. A signal will be indicated by a very pronounced upswing and over a very narrow range. By adjusting Rb and Rc ganged pots you will be able to center the filter on your desired frequency.

If you find Ra will cause oscillation to occur when it approaches its full-on value, change the value of the series resistor Rx to a higher value, probably, not more than 470Ω more. This adjustment allows control on selectivity or the filter bandwidth before oscillation occurs.

So far we have described only one filter. If a wider bandwidth but a sharper roll off is desired, cascading two of these filters in a stagger tuned configuration will produce the effect.

Greater reduction in signal level will be required. The trim pot at the inputs should be barely open to reduce the input signal for each filter. The use of potentiometers to adjust each filter gets very touchy and fixed values are recommended.

Tune up procedure will be the same as for one filter but now each Rb and Rc value will require trimming each resistor by paralleling with other fixed values.

In this application Ra can be a trim pot set to produce the selectivity response required.

. . .W1SNN

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# TIME-FREQUENCY MEASURING SYSTEM PART II DESIGN THEORY AND CLOCK

This is the second of a three-part series describing the design theory of a time/frequency measuring system for a well equipped amateur radio station and workshop. The heart of the time base is the master oscillator. For the expected accuracy and stability, a crystal oscillator, with the crystal in a temperature-controlled oven, is necessary and sufficient. A crystal oscillator not using an oven might be made to hold to within one part in $10^6$ with careful temperature compensation and a bit of experimentation, but remember that that is the very worst stability we can use. A simple crystal oven, and reasonable care in construction of the oscillator, can achieve stabilities better than one in $10^7$, which is consistent with our goals. More exotic techniques, with double ovens (one around the whole oscillator), can yield crystal oscillators with stabilities measured in parts in $10^9$, but these are beyond the needs of most amateurs.

Any oscillator consists of an amplifying element and a feedback element, as shown in Fig. 2. The amplifying element must have a stable gain great enough to provide a usable output power without loading the feedback element, and the feedback element must put just enough of the amplifier's output back to the input to sustain that output, but only at the desired operating frequency. The multiple-amplifier integrated circuit packages provide the most convenient way to get the stable forward gain needed. The RTL and DTL circuits are intended for digital applications, but when biased into their linear operating regions make good high-gain linear amplifiers. The more popular TTL circuits tend to be unstable as amplifiers but work ok as oscillators. I used a quad NOR gate in this application because I happened to have one, but other gates might work.

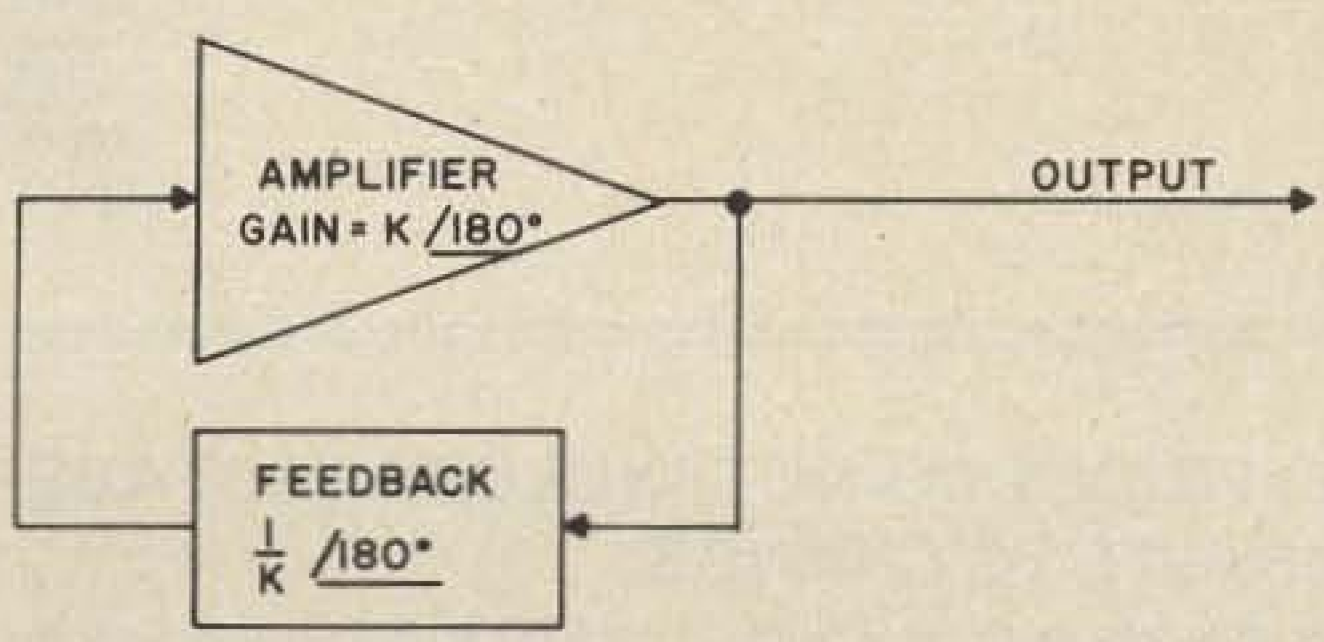


*Fig. 2. Oscillator block diagram.*

The feedback element is, of course, the crystal, operating as a parallel resonant filter. I chose an operating frequency of 1 MHz, because I happened to have a crystal for that, but a crystal on any frequency between 1 and 10 MHz designed for a stability of one part in $10^6$ per week over the temperature range provided in the chosen oven will be adequate. It is difficult to get crystals of the necessary stability lower in frequency than 1 MHz, and the cost is much higher below about 5 MHz. The chosen frequency should be a multiple of only the numbers 2, 5, 6, and 10 (like 4 MHz = $2 \times 2 \times 10^6$, or 5 MHz = $5 \times 10^6$), otherwise the dividers will have to be specially designed.

A fine trimmer adjustment must be provided on the oscillator with a no-backlash calibrated vernier control. Because adjustments will be made to the oscillator that will not show up until a week later, the operator must be able to tell exactly how far and in what direction he is adjusting. The calibrations don't have to be in Hz, but do have to be in linear repeatable units so that if, for

example, a correction of one unit reduces the drift from 0.5 to 0.4 seconds per week, then four units of correction in the same direction should put the oscillator right on. I used a vernier control giving 100 divisions for 1/2 turn of the trimmer capacitor, and about a five-to-one speed reduction from the knob.

**Divider Chain**

The oscillator is tied to the clock through a divider chain, as shown in the time base/clock diagram, Fig. 3. The purpose of this chain, of course, is to divide the oscillator frequency until it has a frequency useful for the devices to be connected to it. Integrated circuits are available for dividing by 2, and multiples of 2, 5, 6, or 10. Other division ratios may be implemented, but not as conveniently. The 7490 decade divider IC chosen for my project has two independent dividers, a by-2 and a by-5. These are normally cascaded, or the signal run through both, to get divide-by-10. If it is being used as a counter, the signal must go thru the by-2 first and then the by-5 to make the numbers run in the right order, but if it is only being used as a divider, the signal may go thru the by-2 last. This has the advantage that the output signal is a symmetrical square wave, which is a little nicer for use as a clock signal.

**Line Drivers**

The output signals from all of the above mentioned divider IC's are zero and four volt logic levels, which may be driven directly into any of the other IC's. If these signals are to be transmitted via coaxial cable outside the unit, however, some buffering must be done. The reason for this is that the low impedance of standard coaxial cables places too heavy a load on the IC circuit. Even if they could drive the load, a four-volt swing on a 50Ω cable is an unecessarily large amount of power to use just to transmit a clock signal. To mitigate these conditions, I use 90Ω RG-62 cable for all interconnects, and extra gates for signal isolation.

**Clock Speed Control**

In order to set the clock to the correct time and synchronize the change of seconds with standard time, some sort of clock control must be provided. The most convenient system to use requires a full set of digit switches and parallel-load button, plus an interrupt control to stop the clock. In use, the operator sets into the digit-switches a time that is coming up, stops the clock, and loads the set time into the clock. At the instant the selected time occurs, he restarts the clock, and it is synchronized. Unfortunately, the digit-switches are bulky and expensive, so I did not use this method.

The system I used is less convenient to use, but then the clock does not need to be set very often. I provided a rotary selector switch which selects clock speeds of Off, Normal, and up to 10,000 times normal speed. This fastest speed will run the clock through its full 24-hour range in 8.6 seconds. In use, I set the clock by running it at high speed until it gets to the time I want, switch to OFF to wait until that time comes up, then switch to NORMAL speed. The switch is controlling the 10 Hz point in the divider chain, so the clock can be synchronized to within 100 milliseconds.

**Clock Counters**

As may be seen in the clock diagram, Fig. 3, a separate counter IC package is used for each digit of the clock, except the tens of hours. A 7490 decade counter is used for the units of seconds, units of minutes, and units of hours digits, all of which count modulo-10 (0 to 9, then back to 0). The leftover divide-by-2 parts of the 8288's are combined to make a 2-bit divide-by-4 for the tens of hours decade. This makes a basic 40-hour clock.

To make the clock recycle at 24 hours, that time is recognized by a detector gate, which then resets (clears) the clock to zero. Actually, most of the clock is already zero, so only the tens-of-hours 2, and the units-of-hours 4 need to be reset. A *nand* gate toggle buffer (simple flip-flop) is used to store the reset signal until it is itself cleared four seconds later. This storage is necessary because the reset signal is removing the signals which cause it by resetting the clock, and a race around the loop would occur without the storage. The four seconds is purely arbitrary. I used the units of seconds 4 line because it was handy; any signal that switched on between midnight

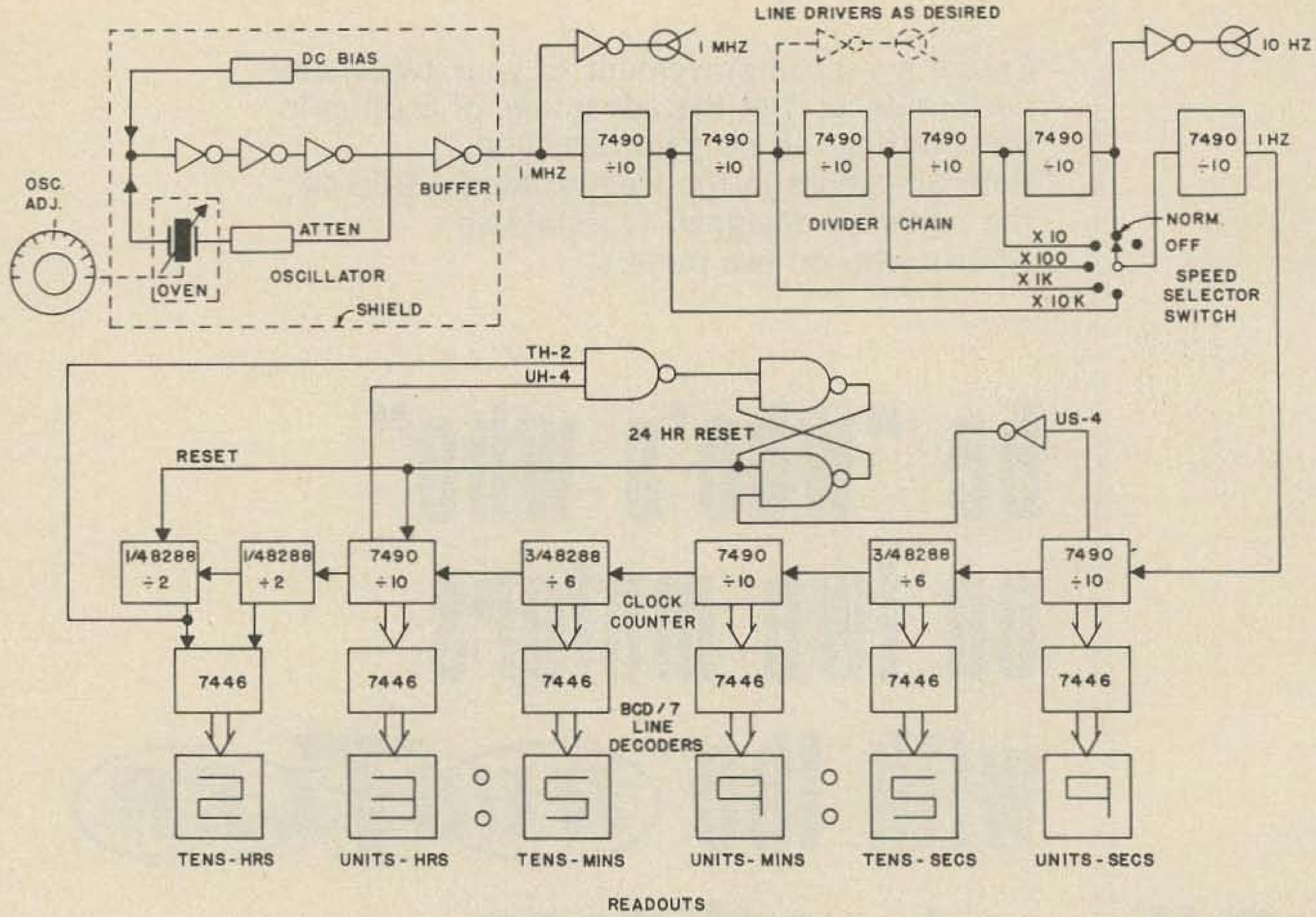


*Fig. 3. Clock/time base block diagram.*

and ten seconds later would have worked. The reset signal must be cleared within ten seconds because the reset for the tens of hours 2-bit is also holding down the tens of seconds digit, which shares the same 8288 IC.

### Decoders and Readouts

The decoders must be chosen to drive whatever readout the builder chooses. Seven-segment readouts such as I chose are the most economical incandescent readouts, but the builder may have other kinds from surplus sources. Nixie tubes are also economical, but require a high voltage power supply.

The 7446 decoders I chose match the seven-segment readouts with 24 volt incandescent bulbs that I used. These decoders will stand 30 volts and switch 40 mA. I run the lamps with 12 volts; they are bright enough to read easily and the life of the bulbs is extended greatly. If the builder used lower voltage bulbs, he may use the 7447 decoder, which has a 15 volt rating. However, if the lamp current will exceed 40 mA per lamp, it will be necessary to use the 7448 decoder (which pulls up instead of down at the output), and a buffer transistor in the line to each lamp. This can be any cheap NPN such as a 2N5129. The connection for this is shown as an alternate on the schematic.

If the builder uses ten-line rear-projection readouts, which are sometimes available as surplus, he will need 7442 decoders. If he uses Nixie tubes, he will need 7441 decoders.

### Power Supply

The circuitry used draws a substantial amount of current at 5 volts dc, plus an even larger amount for the readout lamps, which may also be 5 volts, plus power for the oven heater. All of these loads are varying; each number showing on the display uses a different number of lamps, and the various counts that appear from time to time in the counters draw different currents. A good voltage regulator can eliminate any problems arising from this, and I would not suggest that anyone consider getting by without one. IC regulators are available for a few bucks with all the features one would want (voltage regulation, current limiting, short circuit protection, etc.) from several manufacturers, including National and Fairchild.

The National LM 309K I used, for example, is in the standard diamond power transistor case, takes in 6.5 to 35 volts or wave forms with ripple between those limits, puts out 5 volts at up to 2 amp., is short-circuit-proof, and just bolts directly to any grounded heat sink. All that costs around $4, and no one can affort to design and build a regulator with that kind of thing available.

The rest of the power supply is a transformer-rectifier to supply 12 volts dc for the regulator, a lamp supply, and a shunt regulator for the standby batteries. My lamp supply is very simple, being just another set of rectifiers from the same power transformer, because I used 12V lamps. If other voltage lamps are used, a separate transformer will probably be necessary, but separate rectifiers should be used in any case, to prevent the heavy lamp current from loading the filter capacitor. The lamp power does not need to be filtered.

The standby batteries are connected in parallel to float across the unregulated 12 volt line. This simple connection would be adequate to keep the batteries charged and provide standby power for the 5 volt regulator, except that the voltage can rise high enough to overcharge the batteries. The simple shunt regulator I used limits the peak unregulated voltage to about 14 volts, which a 12 volt storage battery can stand almost indefinitely.

**Batteries**

The floating-battery scheme used here is appropriate for lead-acid type batteries. I use a motorcycle battery, which has the capacity to run the clock for several hours. It has the drawback of having the acid fume and spillage worry of that type of battery. A better choice would be a sealed battery of the type made by Centralab under the name GelCel. The Nicad batteries look very attractive, although high-priced, but they require a different charging scheme than I have provided here, that is, constant current instead of constant voltage.

**RFI Considerations**

Digital circuitry of the type used in this unit generates large amounts of wideband, high-frequency noise. The reason for this is the very thing that makes TTL logic so good: it works very fast. Whenever a gate switches, the resulting square voltage waveform has harmonics spread out well into the VHF region. For this reason, all digital devices to be used near radio equipment should be built in shielded enclosures, at the very least an all-metal cabinet, and all wires leading in or out should be shielded or filtered. Normal techniques for TVI-proofing a transmitter will serve here.

Three of the NOR gates in the LU380A package are connected in cascade to form the amplifier portion of the oscillator, as may be seen in the Time Base Schematic, Fig. 4. The input to this amplifier is pin 10, and the output is pin 2. The last gate is used as an output buffer, from pin 4 to 3. There are two feedback paths, one for dc stabilization, and one for the rf signal. R4 and R3 provide enough negative feedback bias to stabilize the amplifier in its linear region. R3 is to be adjusted to get a symmetrical square wave from pin 3. C8 bypasses the rf to ground so that only dc is fed through this path.

The crystal Y1 and capacitors C3, C4 and C7 are connected to form a 180° phase shift and voltage step-down network, as used in a Colpitts oscillator. C4 is a fine trimmer across the high-impedance side of the network to adjust the frequency, and is the Frequency Adjust Control mentioned in Part I of this series The amplifier output is attenuated by R2 and C6, then lightly coupled to the high-impedance side of the crystal network through C5 to keep the crystal voltage as low as possible. The output from the low impedance side of the crystal network is connected back to the amplifier input to complete the loop. The amplifier output is to be coupled as lightly as possible (smallest value of C5) and still maintain oscillations.

You might get by without shielding the oscillator, but I consider it a worthwhile precaution to isolate the oscillator from outside influences. I enclosed the whole oscillator in a brass strip fence, as can be seen in the photo. All the capacitors associated with the crystal network (C3, 5, 6 & 7) must be high quality stable types such as silver mica. C4 must be a good grade VHF type trimmer.

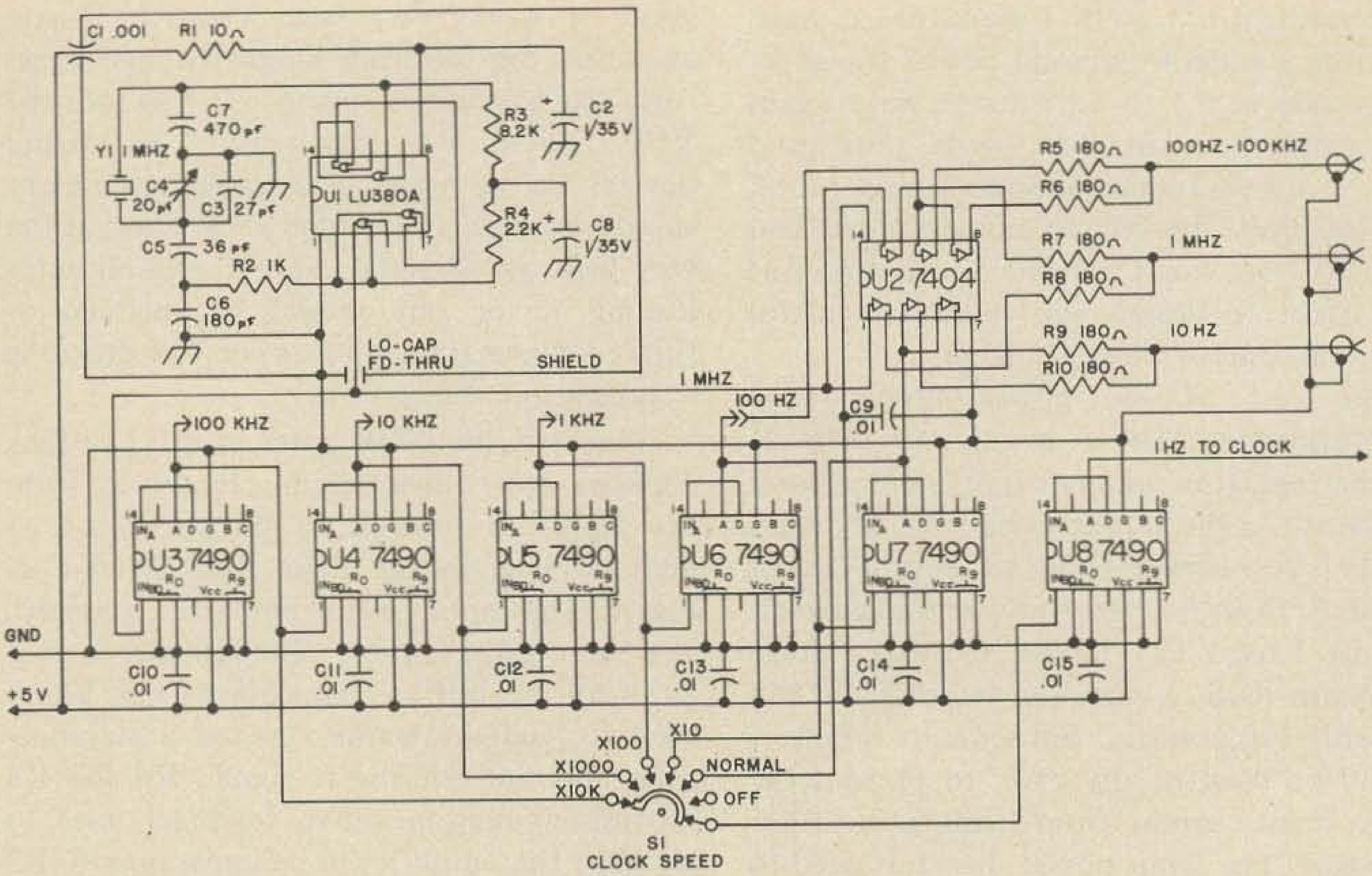


*Fig. 4. Time base schematic diagram.*

### Divider Chain

The divider chain consists of a string of decade dividers, each reducing the operating frequency by a factor of ten. Each is connected with the divide-by-five ahead of the by-two portion to give a square wave output. The input signal enters at the divide-by-five trigger port (labeled $IN_{BD}$). The output of this section (labelled D) is connected to the trigger of the divide-by-two section (labelled $IN_A$). The output labelled A is then the square wave.

The B and C outputs are not used and are left open. The reset-to-0 and reset-to-9 inputs are not used in the divider chain and are grounded. Inputs left open will assume a logic 1 (high) state, which in this case would hold the counters in reset (0) state.

The A output of each divider goes to the $IN_{BD}$ input of the next divider in each case, except the 10 Hz line between U7 and U8. This line goes through the Clock Speed Switch S1 in the NORMAL position. In other positions, the input to U8 is tapped from the output of dividers running at higher frequencies to speed up the clock, as explained previously.

Bypass capacitors C9–15 are required because of a characteristic of the TTL IC's used; these devices draw a large amount of current for a very short period of time while they are changing state, appearing as a current spike on the Vcc line. Due to the inductance in even a short piece of wire feeding the supply voltage to the IC, this current spike can produce bad voltage surges. The cure is simply a small capacitor directly across the supply terminals of each device. This is a small price to pay for the high performance of the TTL logic family.

### Line Drivers

U2 is a hex inverter used as an isolation amplifier for driving coaxial lines. Two amplifier sections are used in parallel to drive a 90Ω coaxial line (RG-62 cable) through isolation resistors. These 180Ω resistors in parallel give an effective 90Ω output impedance and keep the load on each amplifier within its 10 mA rating. One IC provides three output lines. 10 Hz is needed for frequency counter, 1 MHz is a useful output for initial oscillator checks, and the other line may be connected to whatever frequency is desired between 100 Hz and 100 kHz. To bring out all the possible frequencies would require additional hex inverter packages.

## Clock Counters

The clock counters consist of a divider IC for each digit of the clock except the tens of hours, with a 24-hour reset circuit to switch the clock back to zero every midnight, as may be seen in the Clock Schematic Diagram, Fig. 5.

The units of seconds (U14), minutes (U12), and hours (U10) counters are decade dividers connected in the standard manner for this device. That is, the input signal triggers the divide-by-2 A section first, and then the by-5 BCD section to produce the standard binary-coded-decimal (BCD) counting sequence for which the decoders are designed. Therefore, the ABC & D outputs are connected to the ABC & D inputs of the decoders respectively, The D, or last, output drives the input of the following stage.

All the reset inputs on the units digits are unused and grounded, except the reset-to-zero for the units of hours. This is connected to the reset line, as shown in Fig. 3, to clear the four in the twenty-four hours.

The tens of seconds and tens of minutes digits use the divide-by-six BCD sections of U13 and U11 IC's respectively. Because these represent the ABC bits of a modulo-six digit, the BCD outputs of these counters are connected to the ABC inputs respectively of the corresponding decoders, U19 and U17. The reset-to-zero input of U13 is connected to the reset line, all others being grounded.

The leftover divide-by-2 A sections of U13 and U11 are used to make the two-bit tens of hours digit. The U11 A section is the TH1 bit and the U13 A section is the TH2 bit. Therefore, the D output from U10 drives the A input of U11, and the A output of U11 drives the A input of U13. These two A sections are connected to the A & B inputs of the tens of hours decoder U15, representing a two-bit number to that decoder. The other decoder inputs are grounded.

The quad *nand* IC U9 is connected to implement the 24-hour reset logic, which may best be seen on Fig. 3. The number 24:00:00 is recognized by the gate at pins 8, 9 & 10 by the presence of the TH2 and UH4 bits in the high state, which then sets the *nand* toggle made up of the gates at pins 1 through 6. The toggle puts a high state on the reset line from pin 3, which resets to zero U10 and U13. The next US4 bit is inverted by the gate at pins 11–14 of U9 and then used to clear the *nand* toggle.

## Decoders and Readouts

The common terminal of the readouts is connected to the lamp voltage from the

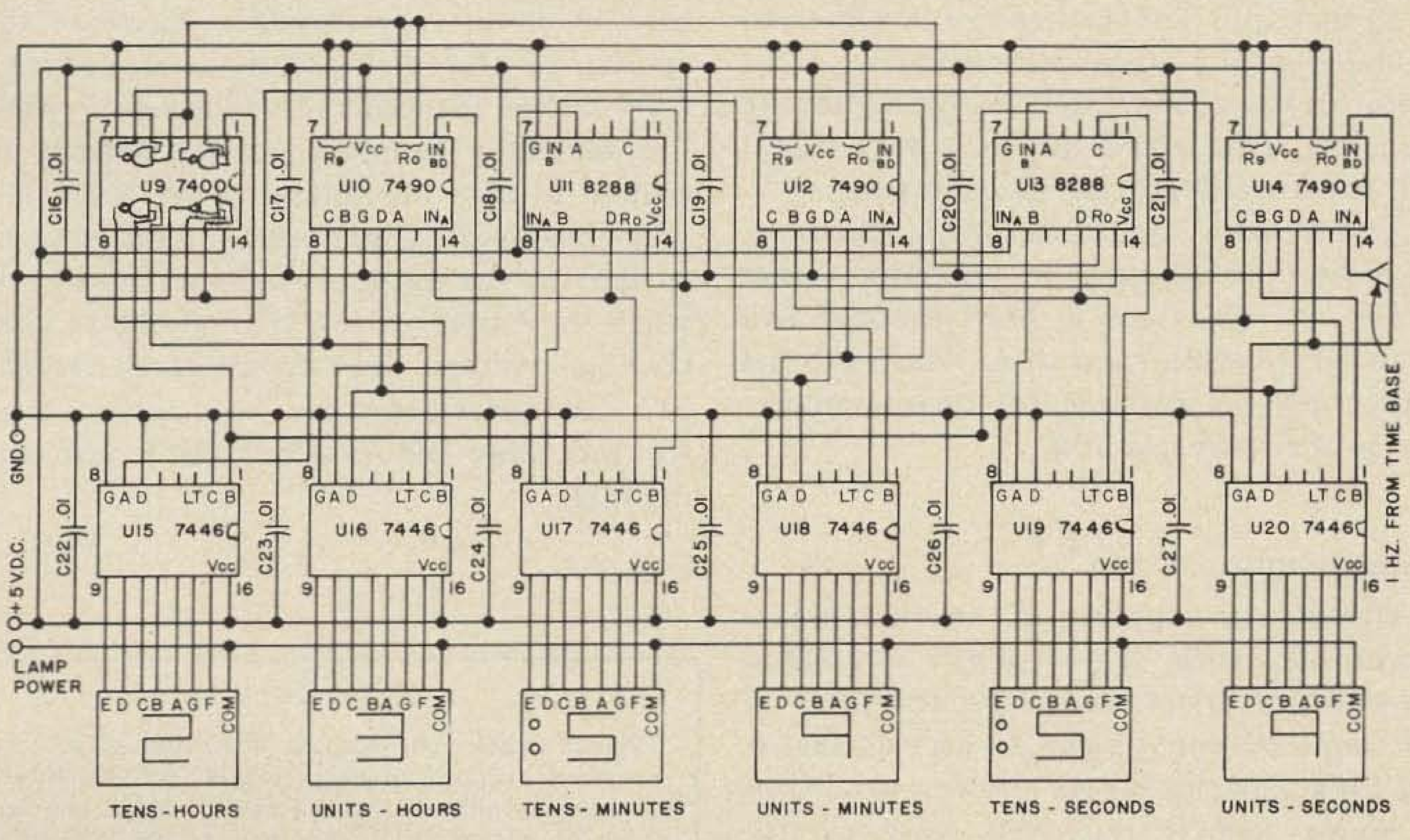


*Fig. 5. Clock schematic diagram.*

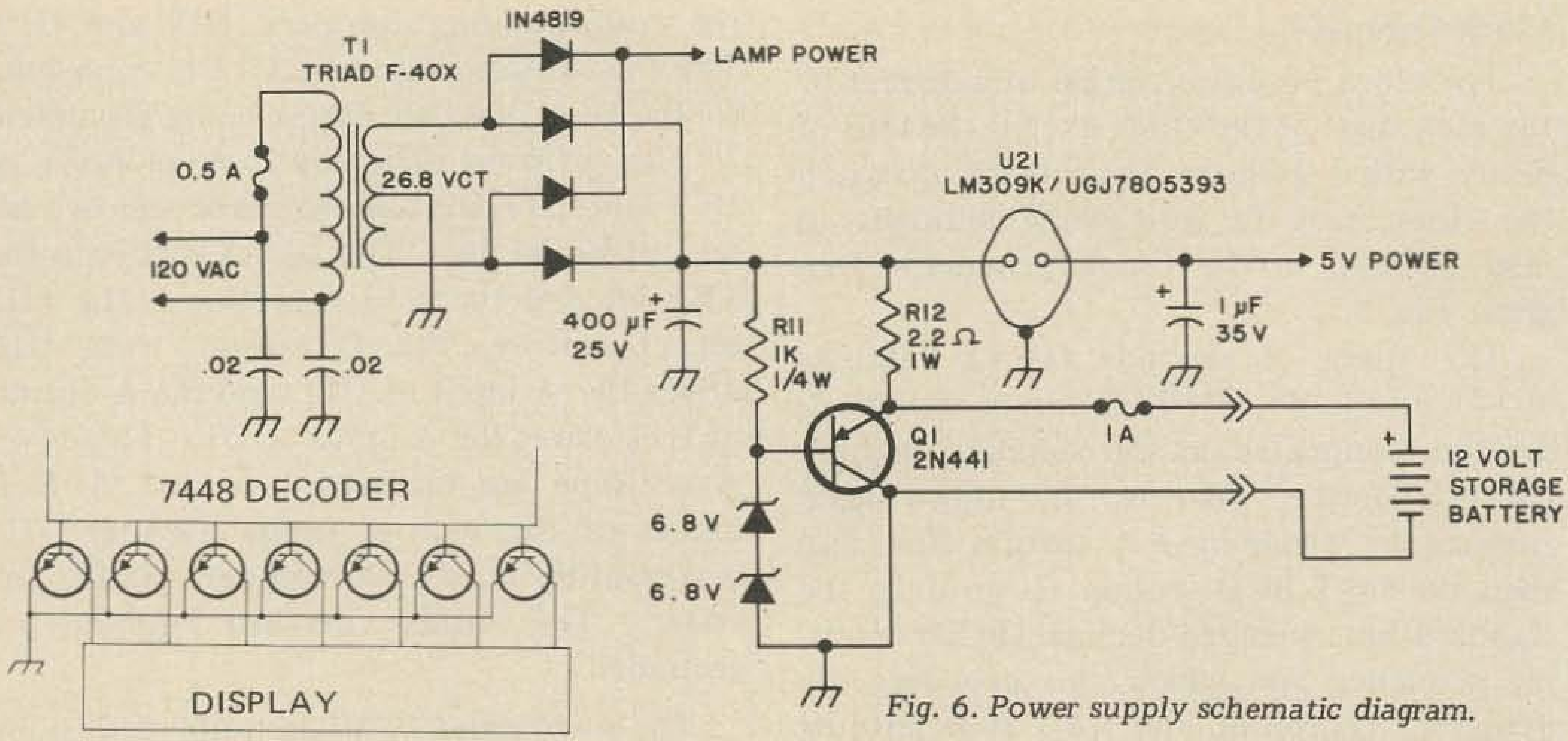


*Fig. 6. Power supply schematic diagram.*

power supply, and the lamp of each segment in the display lights as its line is grounded by the decoder. The decoder lights the combination of lamps making the numeral corresponding to the binary code fed to it from the counter.

The pin 4 & 5 connections to the decoder are for blanking of unused numbers and have no function in a clock. Because they are active in the low state, they may be left open to be inactive (high).

The input at pin 3 of the decoders is for lamp testing. I didn't use this, but one could tie all these pin 3's together to a bus line and ground it with a push-button to make all 8's appear in the display, thus testing all display segments. This would not be a very useful frill, but it wouldn't cost much either.

An alternate connection for lamps drawing more than 40 mA is shown in the corner of Fig. 6. This uses a 7448 decoder and seven NPN switch transistors. The 7448 has output pull-up resistors for direct connection to the transistor base.

### Power Supply

The power supply for the IC's uses a transformer with center-tapped secondary, full-wave rectifiers, and capacitor filter of the simplest type, as can be seen in Fig. 6. The filter capacity shown allows several volts of ripple and is thus very easy on the rectifiers, but the regulator IC U21 changes this to as pure dc at 5 volts as one could desire. About one $\mu$F of filter capacity should be on the output of the regulator, but this can be at the load, or almost anywhere on the 5 volt bus, as it is to bypass low-frequency transients.

The lamp power is derived with a separate set of rectifiers to prevent loading the filter capacitor with the relatively heavy lamp current.

The shunt regulator I used is fairly crude and non-adjustable, but is doing its job quite adequately. The two 6.8 volt zener diodes provide a 13.6 volt reference voltage for the base of shunt regulator Q1. Whenever the emitter of this PNP transistor exceeds 0.3 volts higher than this, or about 13.9 volts, the regulator begins to shunt current to ground to hold the voltage at that level. The 2.2Ω resistor R12 is chosen to limit charging current to the battery to about 1/2 ampere when the battery is low, i.e., about 11 volts terminal voltage. R11 is not at all critical, and only provides some keep-alive current for the zener diodes when Q1 is not conducting.

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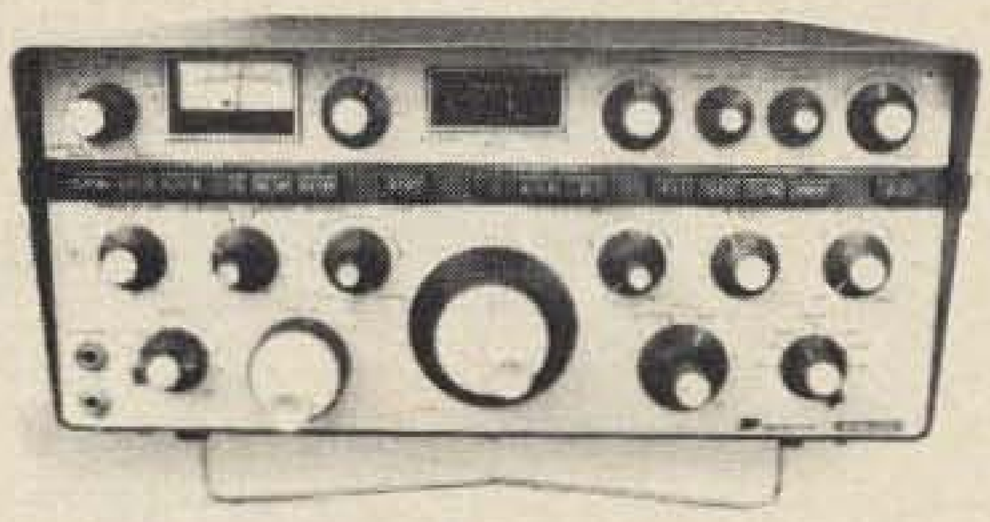

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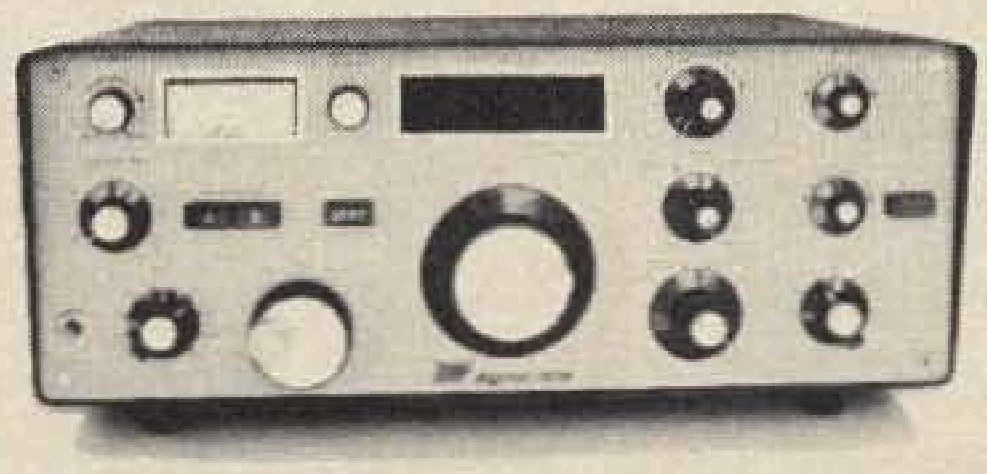

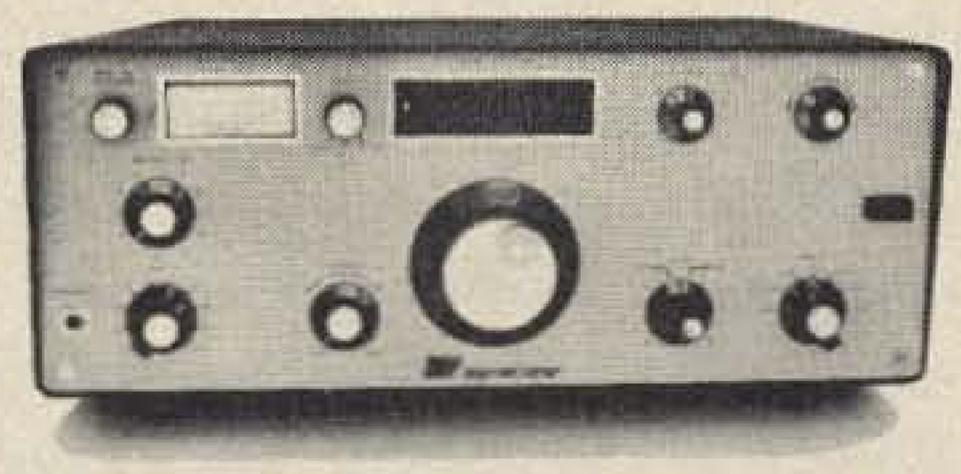

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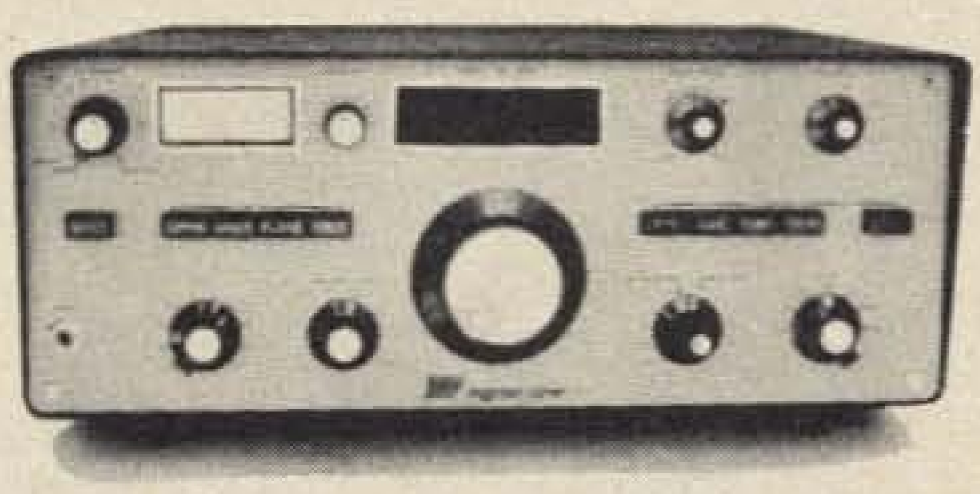

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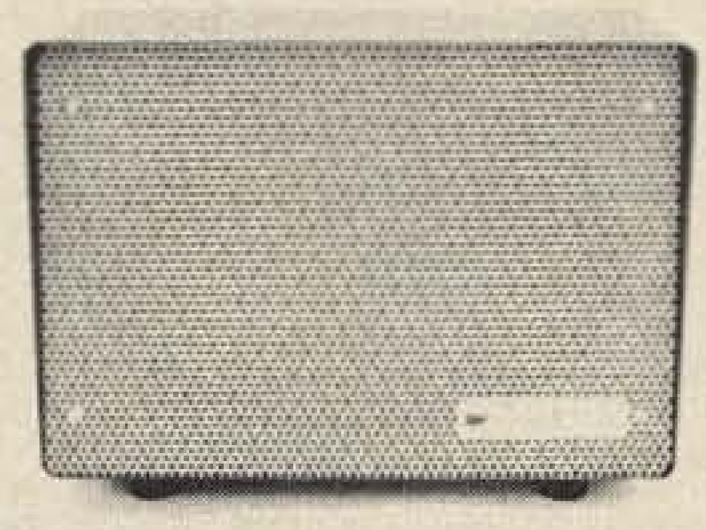

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# REPEATER KEYING LINE CONTROL

*A circuit for controlling timed functions in a repeater. The use of the new Signetics NE555 IC timers eliminates electronic and mechanical complications.*

Every repeater has a need for two basic timing functions. The first is the delayed drop out. A short time delay between the release of the COR and the transmitter drop out is necessary to prevent the transmitter keying relays from chattering on a signal that is fluttering in and out of the repeater receiver. This short delay, usually approximately two seconds, will prevent the annoying chattering noise and prolong the life of the equipment.

The second function is usually called the time-out-timer or transmit-interval-timer. Occasionally someone will accidentally or deliberately leave his transmitter keyed up on the input channel of the repeater. If the transmitter in the repeater is not rated for continuous service, it may overheat or be damaged. If for some reason, the repeater cannot be controlled under these conditions, this can cause severe anxiety for the person who must either wait for it to go away, or drive a hundred miles in the mountains at night to solve the problem.

Many repeater systems use surplus time delay relays, coffee pot trimmers, or other mechanical contrivances. These devices may be either unreliable or expensive.

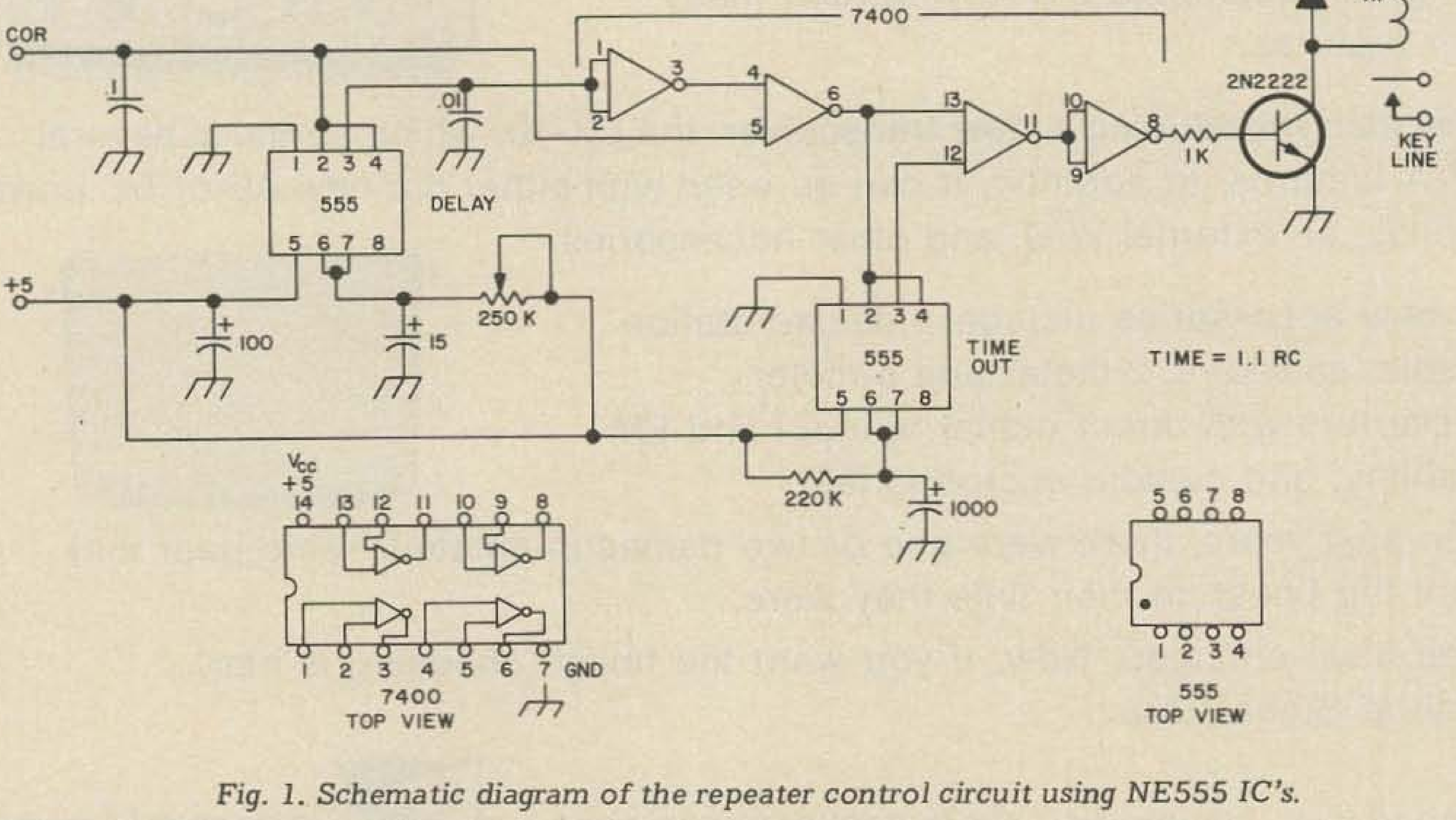


*Fig. 1. Schematic diagram of the repeater control circuit using NE555 IC's.*

**Integrated Circuits**

The device to be described in this article uses three integrated circuits that are reliable and inexpensive. A few resistors and capacitors set the time intervals for the two Signetics 555 timers. A 7400 quad dual input nand gate performs the required logic functions. A transistor is used to drive a relay in the output circuit. The completed unit is connected between the repeater receiver COR contacts and the repeater transmitter keying line.

**Construction Notes**

Any available method of construction can be used since the layout is not critical. A piece of perforated circuit board makes a good chassis for hand wiring. With the pins on the ICs inserted in matching holes in the boards, wires can be stuffed into the same holes alongside the IC pins for soldering. Teflon insulated wire is a must where repeated soldering and unsoldering may be necessary to correct solder bridges between pins. Making a printed circuit board is not recommended since such a one-of-a-kind project usually does not justify the trouble and expense.

The integrated circuits and data sheets for this project were obtained from Solid State Systems, Inc. Capacitors with polarity markings were electrolytic. The .1 and .01 $\mu$F capacitors can by mylar or disc ceramic. These two capacitors were necessary to prevent radiated noise from triggering the timer. Other precautions may become necessary under different conditions.

Note that the top view of the pin connections for the 555 in the schematic are numbered differently from the usual convention. This numbering was given with the application information, but the normal convention was given on the data sheet. The numbering shown in the schematic was used, and the circuit operated this way.

The output circuit shows a transistor driving a relay. A 2N2222 switching transistor can be used to drive a 28 volt crystal can relay coil. The contacts of these relays will typically handle up to two amperes. A silicon power diode must be placed across the relay to protect the transistor. A 28 volt lamp can also be used for this purpose while providing an indicator light, if the transistor can handle the extra current. Other combinations of transistor and relay may be used if the transistor has enough dc gain to be fully turned on by the IC output. The IC should be able to provide more than 10 mA, and as much as 50 mA short circuit current. A resistor is placed in the base of the transistor to limit base current to no more than what is necessary to saturate the transistor.

A plug-in relay can be used to provide for easy repair of the only probably cause of failure in the circuit.

**Setting Up**

Once the circuit is completed, the drop out delay time can be adjusted with the 250K variable resistor. The time-out timer is not made adjustable, but the 220K resistor or the 1000 $\mu$F capacitor can be changed to select different time constants. Longer time constants may be difficult to achieve because of the leakage resistance found in most large electrolytic capacitors. The components used resulted in a time-out delay of almost ten minutes although the theoretical time constant would be only about four minutes. This is because the leakage resistance in the capacitor counteracts the timing resistor. If the leakage is bad enough, the timer will never time out.

No power supply is shown in the schematic, but voltages can be obtained from a dropping resistor and zener diode from the repeater's 28 volt power supply. If a special separate power supply must be built, there are many integrated circuit voltage regulators that can make the project very simple.

**Final Comments**

The integrated circuits cost just over three dollars at the time of this writing, and prices have been decreasing steadily. The circuit gives solid state reliability with the exception of the output relay which can be made easily replaceable. Anyone who is putting up a new repeater should consider making this simple circuit a part of the control system right from the start, but if the machine is already up, its never too late for improvements.

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# POPULAR SLOW-SCAN TELEVISION CIRCUITS

# PART I

This article presents a description and analysis of some of the circuit elements commonly used in slow scan gear. The data presented will be very useful to those wishing to experiment with different circuits but a light reading will provide you with some of the basic circuit functions. A thorough understanding of the material presented here is not essential to build and operate the circuits to be presented later, but it is presented for easy reference if you desire to go a little deeper into the various circuit functions.

**Operational Amplifiers**

If one could pick a single electronic component that was the most valuable to a slow scanner, it would be an operational amplifier. The op-amp is an integrated circuit consisting of many transistors. It has high gain in excess of 100,000. It can be connected to external circuits to perform a wide variety of electronic functions. This discussion will avoid some of the shortcomings of these amplifiers and concentrate on the usefulness of the economical and readily obtainable devices.

In order to simplify the discussion as much as possible, just two types of amplifiers will be discussed. These two types were first introduced by the Fairchild Company, but they are also now being made by a great number of manufacturers. These two op-amps are the 709 and 741. The 709 is the original uncompensated op-amp and, since it has been available the longest, it is the lowest priced. Compensation refers to external capacitors and resistors added externally to control the roll-off of the frequency response. The many uses of the op-amp call for different compensation, so care must be taken to use the correct capacitors and resistors.

The 741 is a universally-compensated amplifier that requires no external resistors or capacitors. It also has some superior breakdown and operational characteristics that make it a bit more reliable than the 709. The designs described in this handbook will use either 709's or 741's.

Op-amps can be purchased in three or four package styles. These are the TO-99,

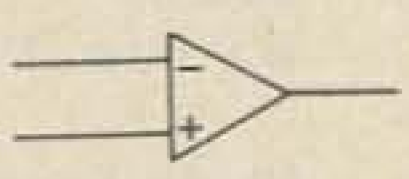


Fig. 2-1. Symbol for op-amp.

flatpack, dual in-line package or DIP, and a shorter DIP called the mini-dip The TO-99 package looks like an ordinary transistor with many leads. The flatpack is very hard to use since its leads are difficult to fasten down unless the designer had developed a special socket PC board mounting. The DIP is our favorite. It lends itself to sockets or to 0.1 mill vector board. They come in a 14-pin or 8-pin package. The 8-pin package is called the mini-dip. The 741 can be purchased from Texas Instruments, T.I., in the mini-dip package. Usually the 14-pin DIP 709 or 741 works out very well either in a breadboard circuit or on a finished PC board layout and is recommended.

Let us now look at the general uses of the op-amp. The op-amp requires an equal positive and negative voltage supply in most applications. The amplifier has two inputs labeled – or + which are called inverting and non-inverting respectively. Either or both can be used for signal inputs. The output terminal of all economically priced op-amps is single ended. The op-amp can be a dc amplifier and can provide outputs referenced to any dc level within the dynamic range of the amplifier. The gain is controlled very accurately to a known quantity by merely choosing the ratio of two resistors. The frequency response is limited to about 1 MHz and below. The usual symbol and the terminal markings for an op-amp are shown in Fig. 2-1.

Again, if it is desired to invert a signal, connect the signal source to the minus (or inverting) terminal. This is shown in Fig. 2-2.

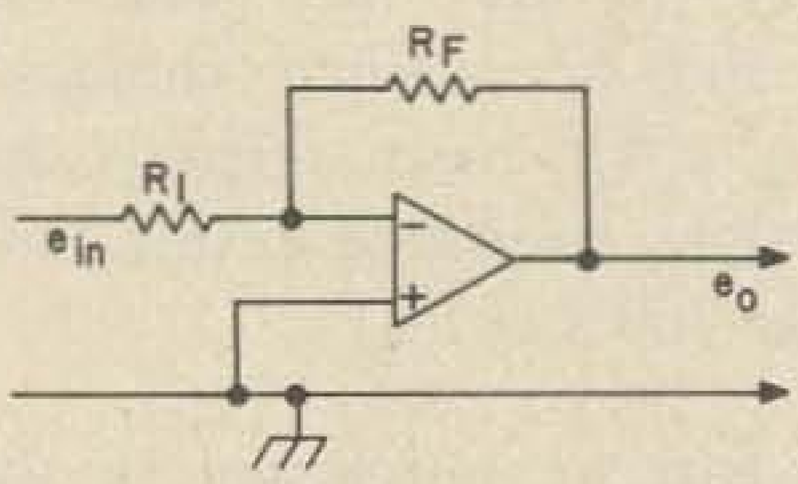



Fig. 2-2. The inverting amplifier.

By algebraic manipulation, it is possible to prove that the gain of this amplifier is the ratio of the values resistor Rf to resistor R1. The gain is independent of any amplifier characteristics as long as the open circuit amplifier gain is high. The gain equation is therefore:

Co = –Rf/R1 Cin

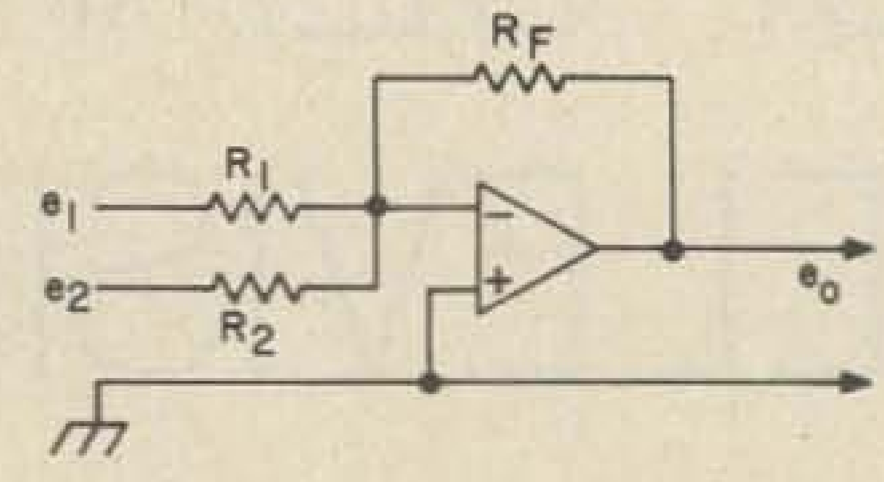



Fig. 2-3. Use of an op-amp in summing.

As was mentioned before, it is necessary to add the compensation resistor capacitor combination if a 709 is used; but if a 741 is used, no compensation is necessary.

The inverting input has other extremely interesting features. This input terminal appears to be near ground potential in its amplifying characteristics. In fact, it is called the virtual ground input. Because of this feature, this input can be used as a summing junction. Let us say that you want to add two signals and have each signal amplified by a different amount. The circuit is shown in Fig. 2-3.

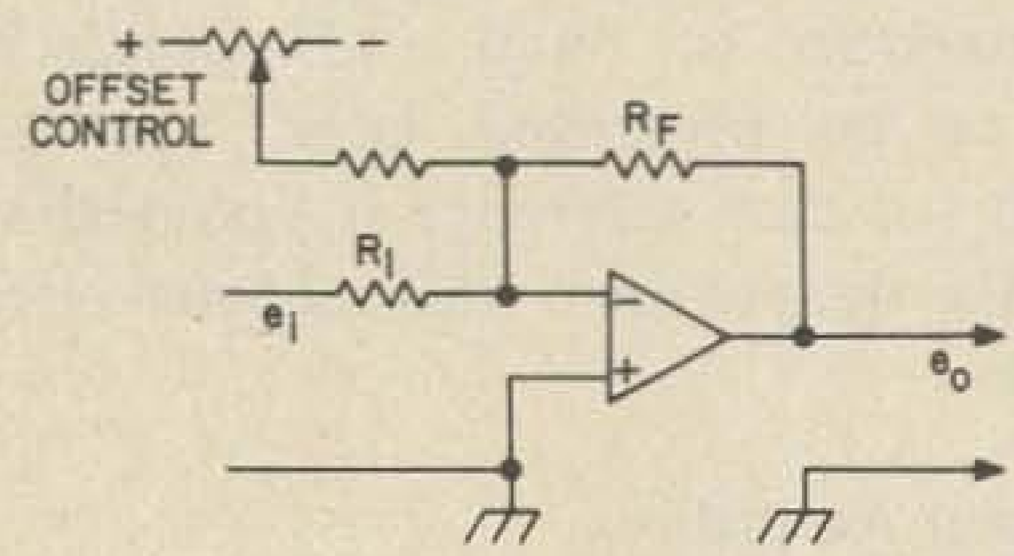



Fig. 2-4. Op-amp with offset control.

The output voltage is given by equation
Co = –C1 R1/R1 –C2 Rf/R2

So far, very little has been said about dc offset. This effect is just the dc output voltage that exists when the inputs are returned to ground. This defect is caused by the IC imperfections and can be easily controlled by adding a dc signal to the input

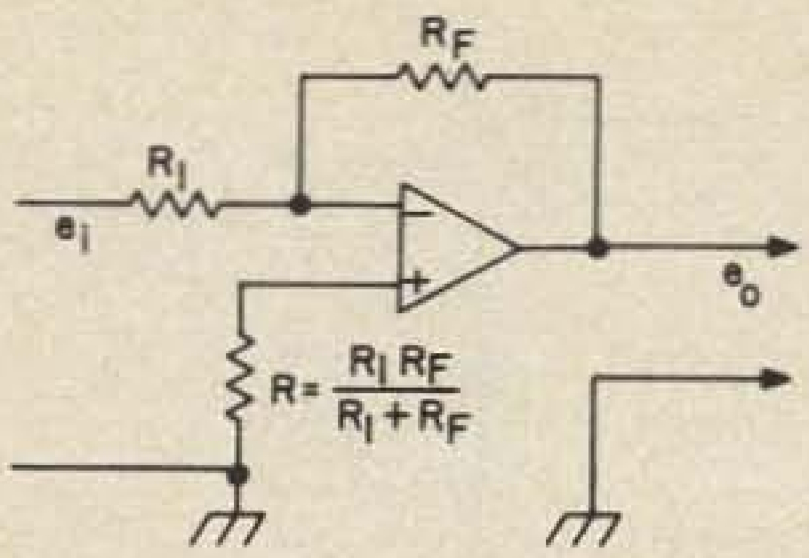



*Fig. 2-5. Offset compensated op-amp.*

to return the output to zero volts. As an example, see the offset control shown in Fig. 2-4. The potentiometer is adjusted so that the output is dc zero with E1 grounded. In order to balance the op-amp as much as possible, many times the need for the offset adjustment is eliminated by putting a resis-

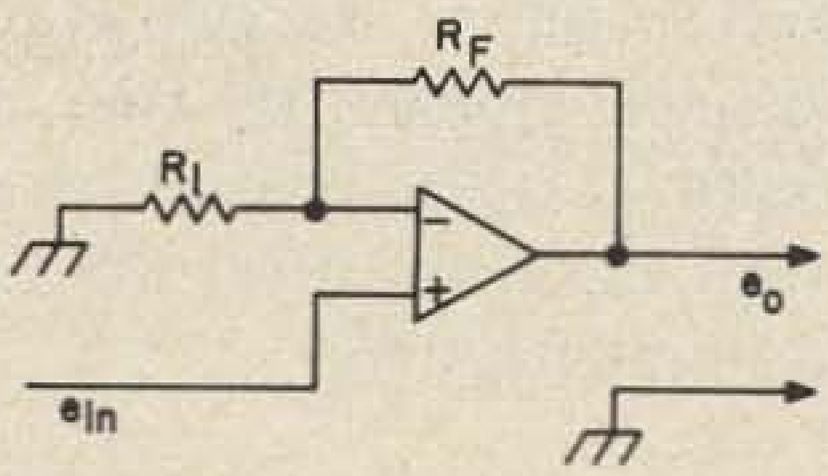



*Fig. 2-6. Non-inverting op-amp.*

tor from the plus (+) or non-inverting input to ground equal to the parallel combination of resistor connected to the minus (−) or inverting input terminal. This is shown in Fig. 2-5.

It is obvious that if it is desired to have the ac signal appearing at the output referenced to A plus or minus dc signal that the potentiometer shown in Fig. 2-6 can be easily adjusted to do this. The usefulness of this adjustment shows up in slow scan when accurate adjustment of the black level is necessary.

Let us look at the plus or non-inverting input. This input can be used simultaneously or alone for op-amp applications. It provides an output that is in phase with the input and

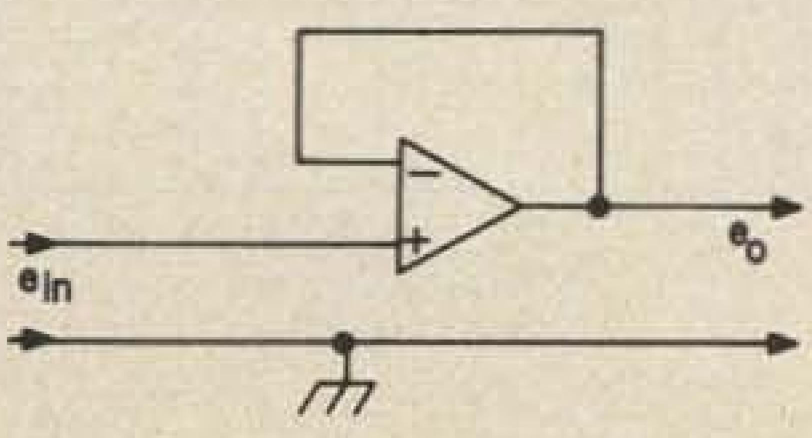



*Fig. 2-7. Voltage follower op-amp.*

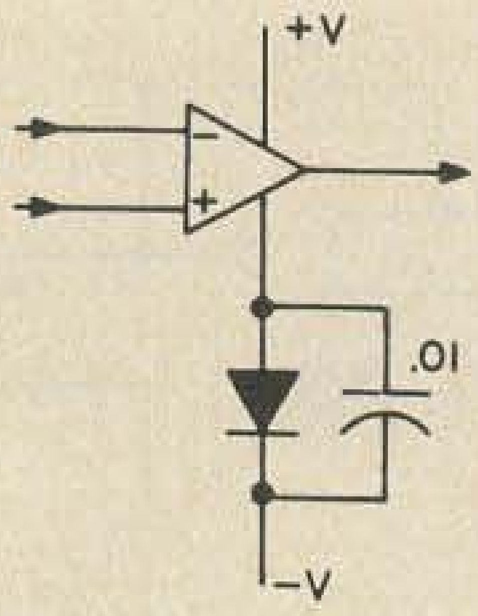


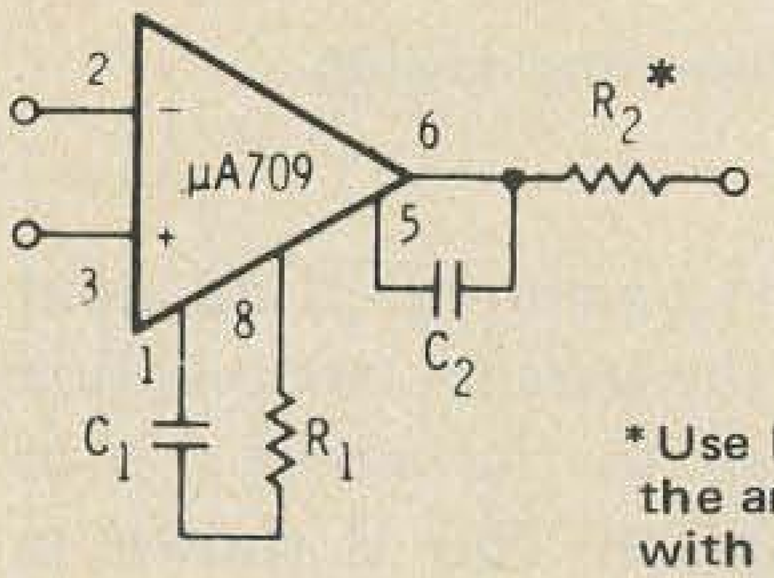

*Fig. 2-8. Power lead reversal protection.*

is referenced to dc similar to inputs applied to the inverting input. The circuit is shown in Fig. 2-6.

It can be shown by analysis that the gain of this configuration is given by

Co = + Cin(Rf/R1) + 1

In other words, besides the output being in phase with the input, the gain is 1 plus the gain for signals applied to the minus or inverting input. It is also possible to apply dc signals at this input to offset the output to the desired reference level.




*Use $R_2$ = 50 ohms when the amplifier is operated with capacitive loading.

**FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS**

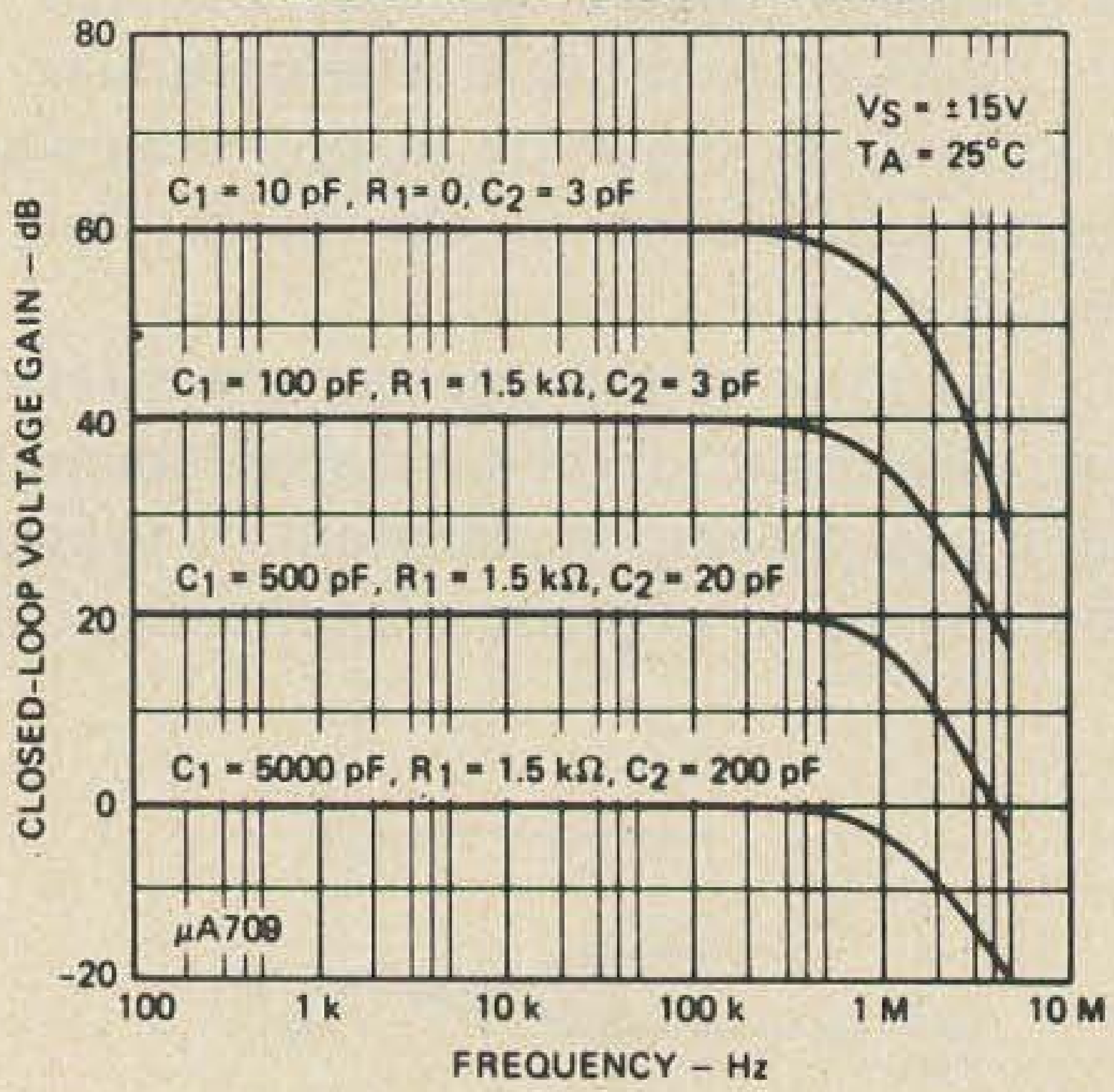
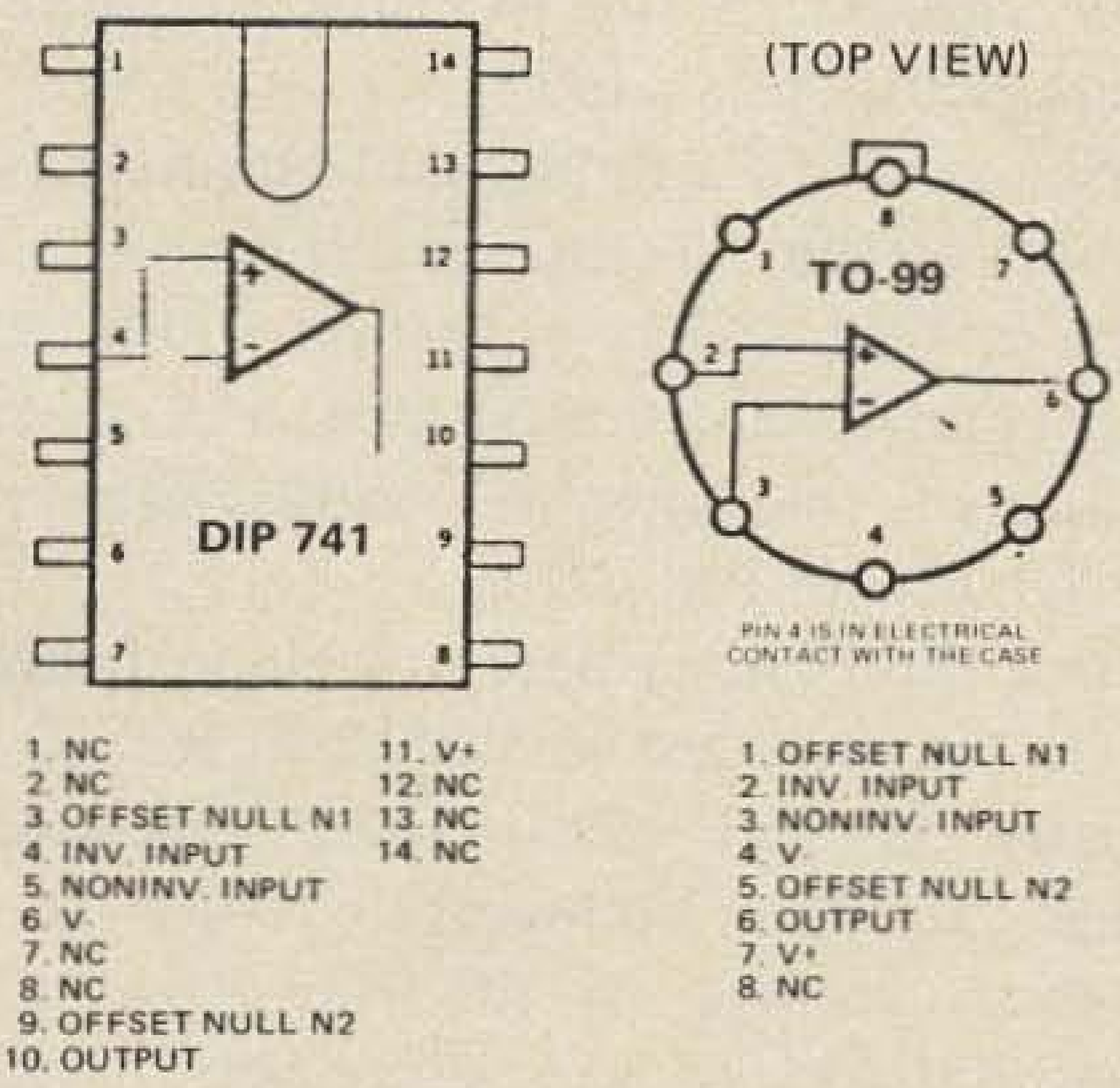



*Fig. 2-9. Compensation information for the 709.*

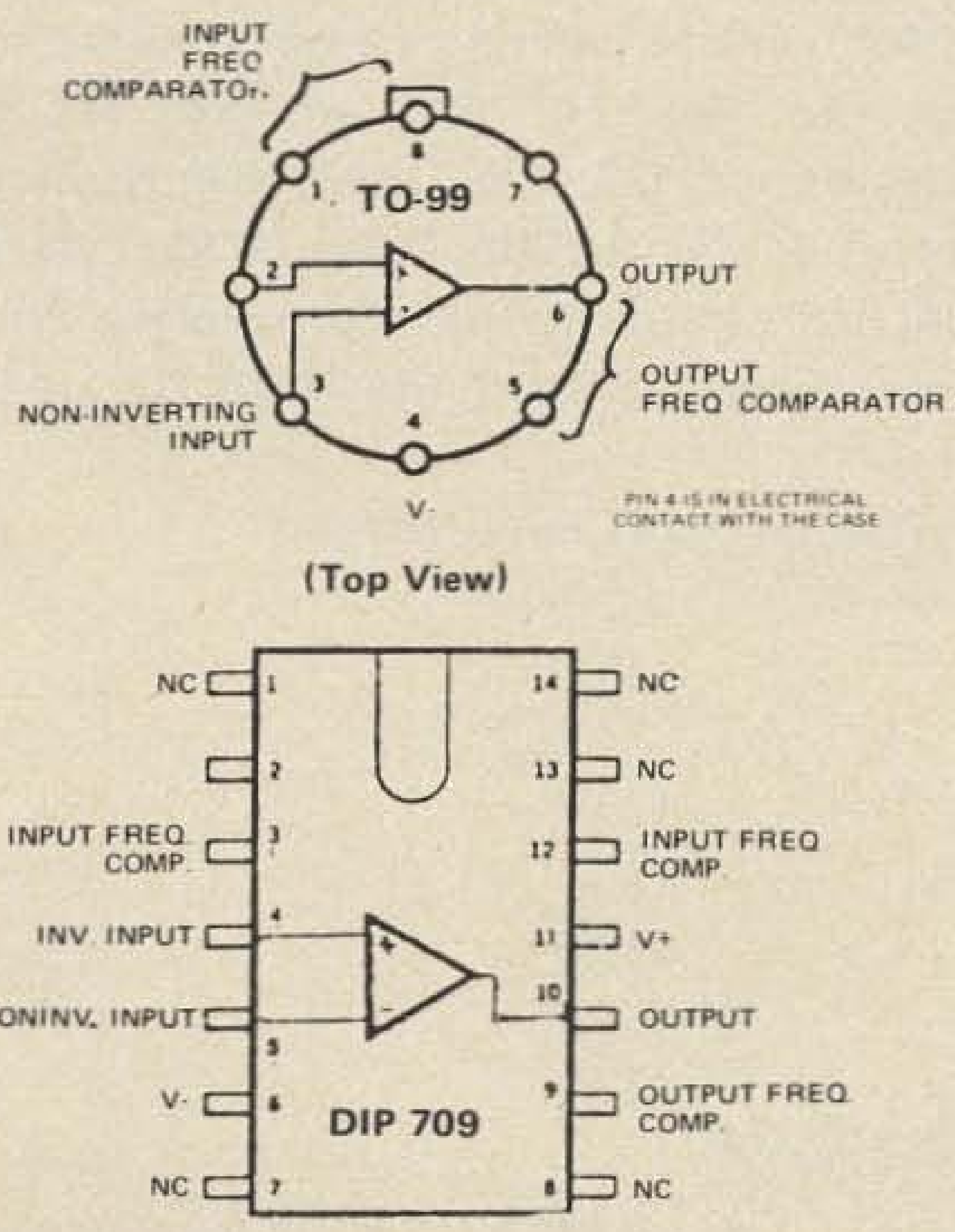
A word should be stated about the realtive size of resistors applied to the op-amp. If all resistors are kept below 1 MΩ no problems will develop. Usually the gains desired can be achieved with this range of resistors without developing any problems.

One final circuit should be shown that is needed by the slow scan active filter designer. This is the voltage follower circuit. It provides very high input impedance and low output impedance. It has a gain of +1. It is shown in Fig. 2-7.

The response of an op-amp to large changes of input signal is not as fast as might




TO-99 and DIP 741 pin connections.




TO-99 and DIP 709 pin connections.

*Fig. 2-10. Note that the 741 can be used as plug-in replacement for the 709 but not vice versa.*

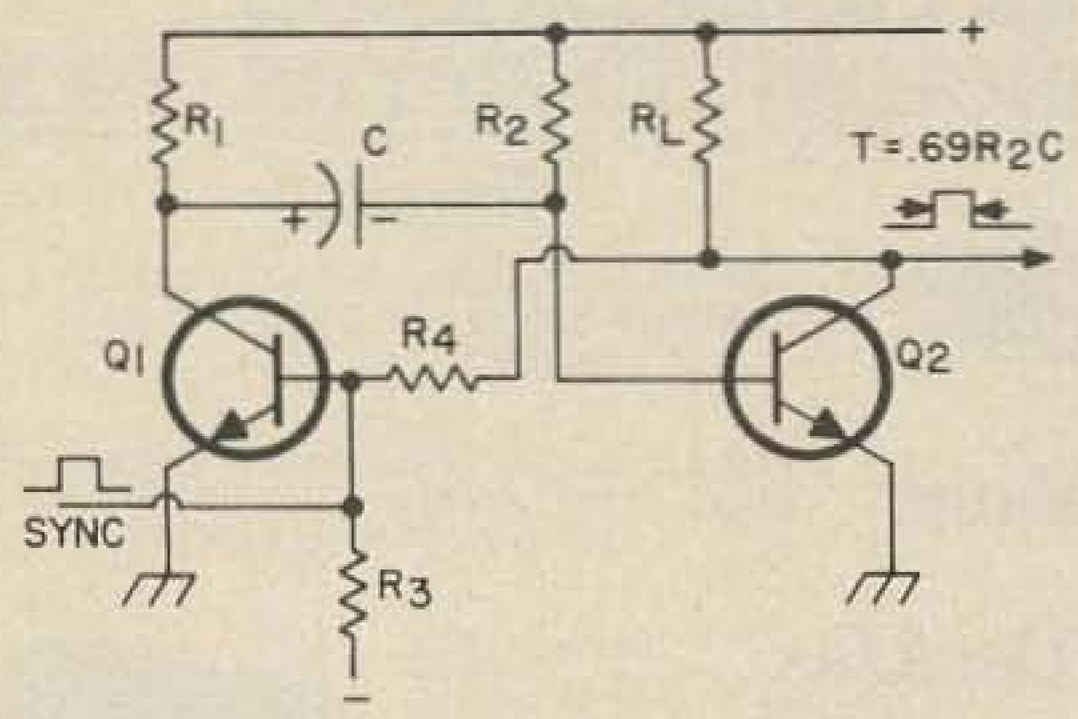



*Fig. 2-11. Collector-coupled monostable multivibrator.*

be expected from circuit considerations. A large change of input causes the feedback to overdrive the input stage as it attempts to correct the slow rise time of the frequency compensated stages. The clipped signal is integrated by the compensation capacitors, resulting in an output voltage that rises at a fixed rate. This rate limit, or slew rate, determines the speed with which the amplifier can respond to large signals. This slew rate becomes important in the slow scan sweep driver circuits shown later.

In order to protect an op-amp on the breadboard from accidental reversal of the power supply leads, a diode can be inserted into the negative power lead. This will assure that the reversal will not damage the internal circuitry of the op-amp. This is shown in Fig. 2-8.

For convenience to the slow scanner some of the specifications of the 709 and 741 are shown in table form below. In addition, a graph of resistor and capacitor combinations is given for the different gains for the compensated 709. The pin connections of each amplifier in its various packages are also shown in Figs. 2-9 and 2-10.

Note in Fig. 2-10 that the 741 can be used as plug-in replacement for the 709 but not vice versa.

### The Monostable Multivibrator

The monostable multivibrator (or "one shot" as it is sometimes called) is used extensively in both slow scan monitors and cameras. The monostable oscillator is able to produce a pulse of the desired width from a noisy pulse recovered from the sync recovery circuits of the monitor or from the timing circuits of a camera.

The circuit of a monostable multivibrator is similar to that of other multivibrators, but differs in that it has only one stable state. The general circuit configuration of a collector-coupled monostable multivibrator is shown below in Fig. 2-11.

Since the emitter base junction of transistor Q2 is forward biased by R2, Q2 is normally in full conduction. The output voltage at the collector of Q2 is the saturation voltage of the transistor Upon the application of a positive sync pulse at the base of Q1, the collector voltage of Q1 drops and, since the voltage across a capacitor cannot change instantaneously, it causes the base of Q2 to cut off the conduction of Q2. The feedback from the collector of Q2 to the base of Q1 via R4 causes the action to be regenerative and a positive pulse occurs at the collector of Q2.

| | 709 Specifications | 741 Specifications |
|---|---|---|
| Maximum power supply voltage | ±22V | ±22V |
| Minimum power supply voltage | + 9V | ± 3V |
| Recommended power supply voltage | ±12V | ±12V |
| Maximum differential voltage swing | ±15V (Rl ⩾ 2,000Ω | ±13V |
| dc current requirements | 3 mA | 3 mA |
| Output current | 5 mA | 5 mA |
| Slew rate | 3V/μsec | 0.5V/μsec |

The 741 is short-circuit protected.

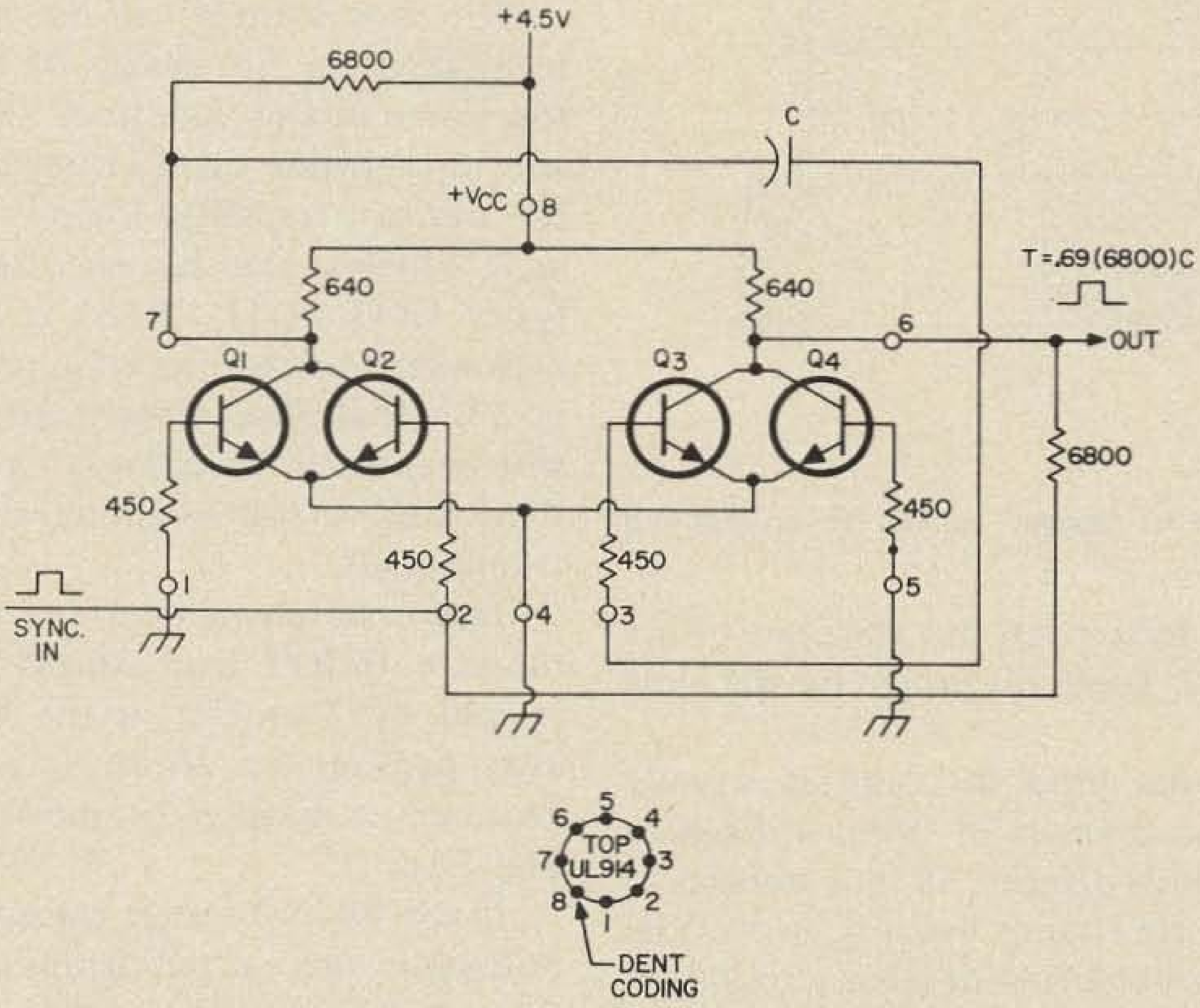



*Fig. 2-12. Hookup of a UL914 as a monostable multivibrator.*

The time constant of R2C determines the approximate width of the output pulse and is given by: T = 0.69R2C.

It is common practice now to utilize integrated circuits for monostable multivibrators. A popular circuit using the UL914 or MC-824F integrated circuit is shown in Fig. 2-12 Note that the 824 is a quad-transistor gate and therefore can be utilized for two monostable multivibrators.

### The Schmitt Trigger Circuit

The Schmitt trigger circuit is shown in Fig. 2-13. It resembles a bistable multivibrator, but it lacks the coupling from the output collector to the input to make it have two stable states without an applied input voltage.

In order to understand the operation, assume that Q2 is conducting by virtue of its base-coupling resistor R2. The input voltage Ein is assumed to be at zero volts. As a result of the conduction of Q2, the emitter of Q1 will be raised in potential by the current flowing in Re. When the input voltage on the Base of Q1 is increased, Q1 eventually begins to conduct. Transistor Q1 will amplify this input signal which will lower the base voltage on Q2. The voltage across Re rises in response to the input voltage and together with the lower base voltage on Q2 causes Q2 to cease conduction. Under this condition, the output voltage is near the B+ voltage. The gain of the amplifier Q1 is made greater than unity so that the action happens very abruptly.

When the input voltage is lowered, it is noted that the return to the original state does not happen at the same input voltage as that required for the original transition because Q1 is cut off by the increased emitter resistor voltage across Re. This result occurs because of the non-unity gain of the amplifiers. Designers use various schemes to

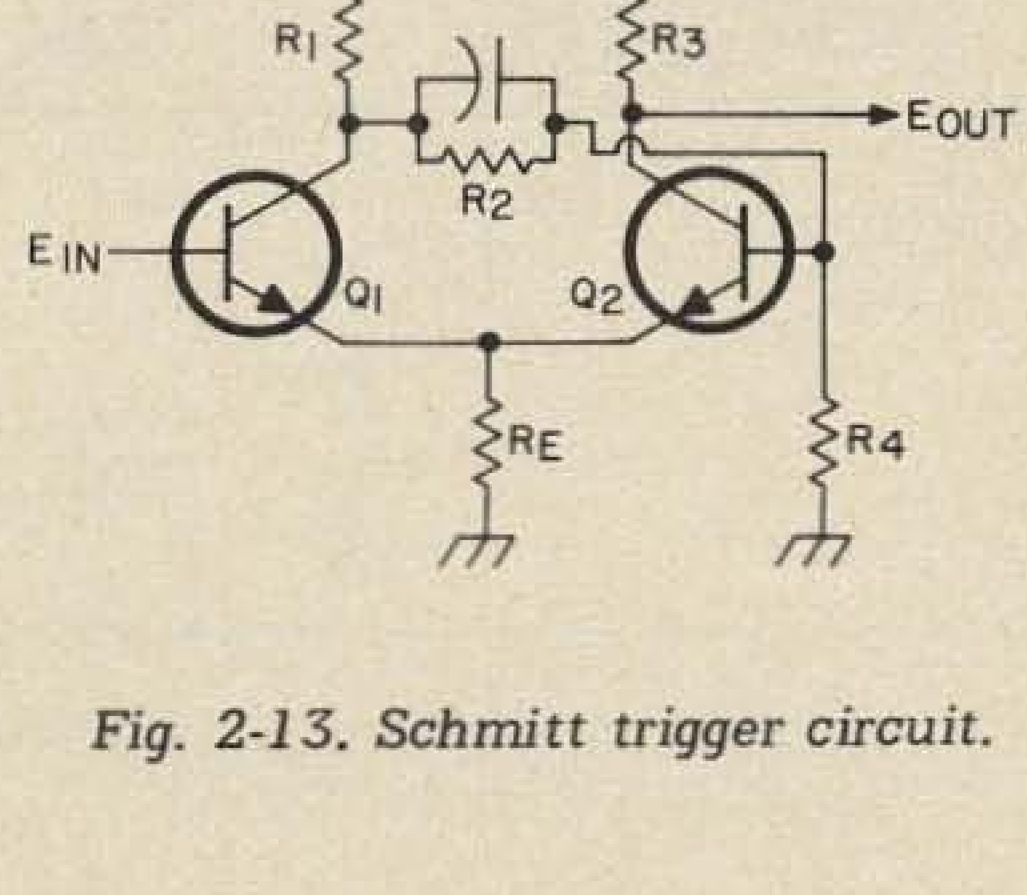



*Fig. 2-13. Schmitt trigger circuit.*

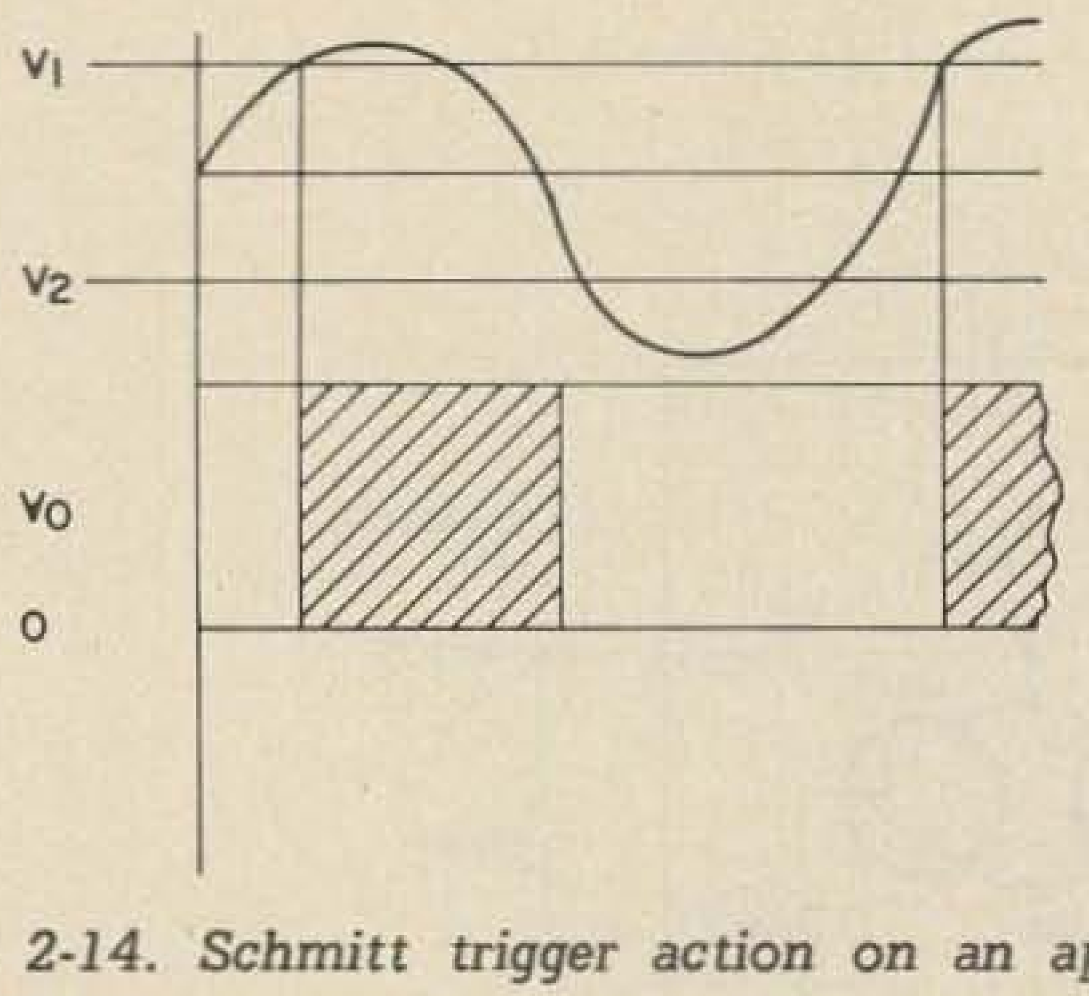



*Fig. 2-14. Schmitt trigger action on an applied sine wave.*

eliminate this hysteresis, but the same effect can be used to good advantage by the slow scanner.

Logic circuits used in counting usually require abrupt changes of input voltage to make the circuits trigger. If it is desired to generate a 15 Hz timing signal from a 60 Hz sine wave, it will be first necessary to distort the sine wave into a sharp-edged square wave. The desired result is shown in Fig. 2-14.

When the E input sine wave reacheds V1 the Schmitt trigger changes its state. At V2 the state changes back to the former condition. The output shows very fast transitions necessary for driving RTL logic circuits. Figure 2-15 shows a Schmitt trigger designed with an UL914 RTL gate. The unused transitors have their bases grounded to eliminate noise pickup. Sometimes a capacitor is used across the collector to base resistor to commutate or speed up the transitions. Its value is small.

### Timing and Gating Circuits

The slow scanner can make use of digital technology in his design of timing circuits for cameras and monitors. This discussion will concentrate on RTL logic which stands for resistor-transistor-logic. This type of logic which is the slowest of the three main types (RTL, DTL, TTL) is also the most reasonably priced. As time passes, it is very possible that TTL (transistor-transistor-logic) will become price competitive. This type is the fastest of the economically priced logic components.

The basic element of any logic system is the gate. In RTL logic, this is the *nor* gate. It is sold by Fairchild as the UL914 or in a dual package by Motorola as the MC824. The circuit diagram of the 914 is shown in Fig. 2-16.

If the base of either transistor is raised in potential, the output drops to a near zero voltage. This positive voltage applied to the base is called a ' high" and the resulting output at near zero volts is called a "low." Note that the application of a high at either base causes the output to go to a low. This is called a nor gate because the output is opposite any input and the same "low" output is obtained regardless of which input is gated into a  high" condition. Note that both inputs can be in a 'high" condition and produce the same "low" output. The symbol for this operation is also shown in Fig. 2-16.

We are now ready to advance to an application of the *nor* gate. Often a multivibrator or switch is needed that has two stable states. A trigger pulse can be used to set the multivibrator in one condition and

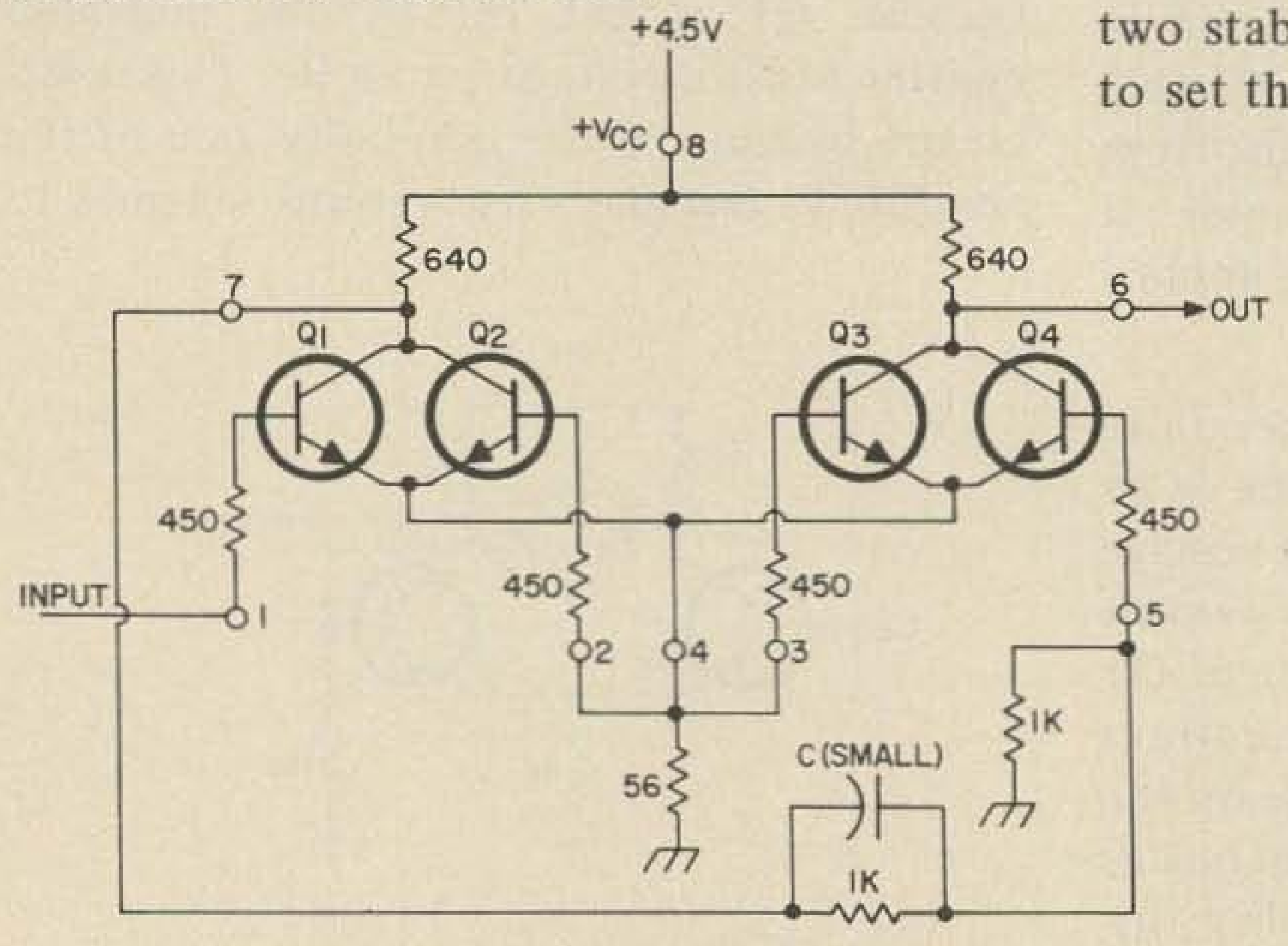



*Fig. 2-15. Timing and gating circuits.*

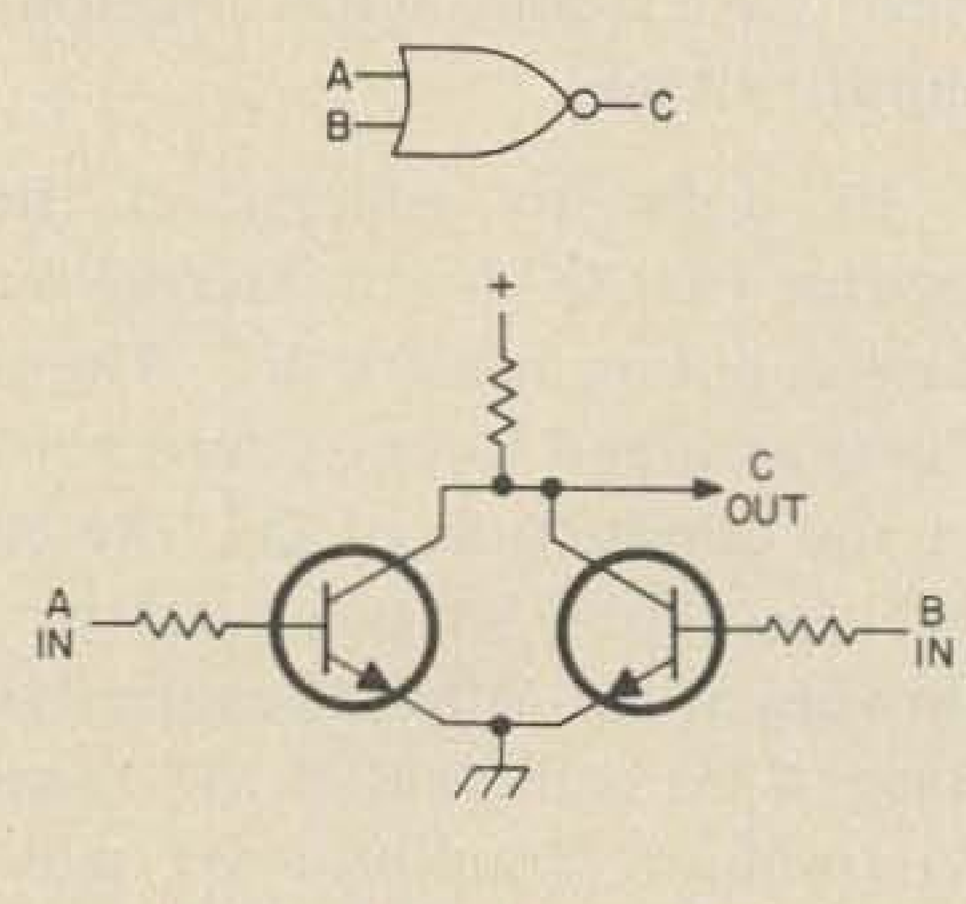



*Fig. 2-16. The nor gate.*

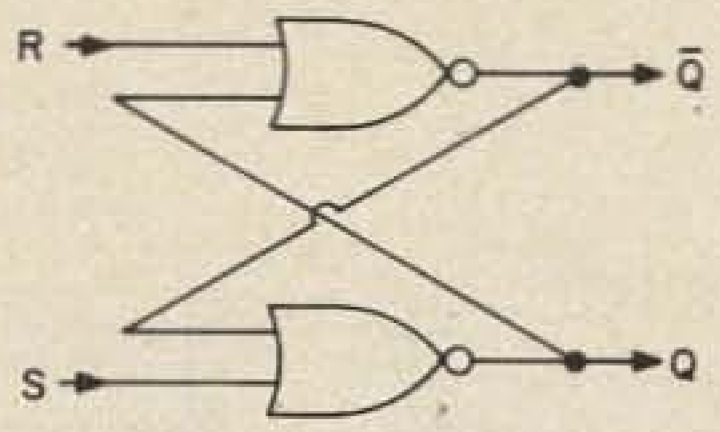



*Fig. 2-17. RS flip-flop made from two nor gates.*

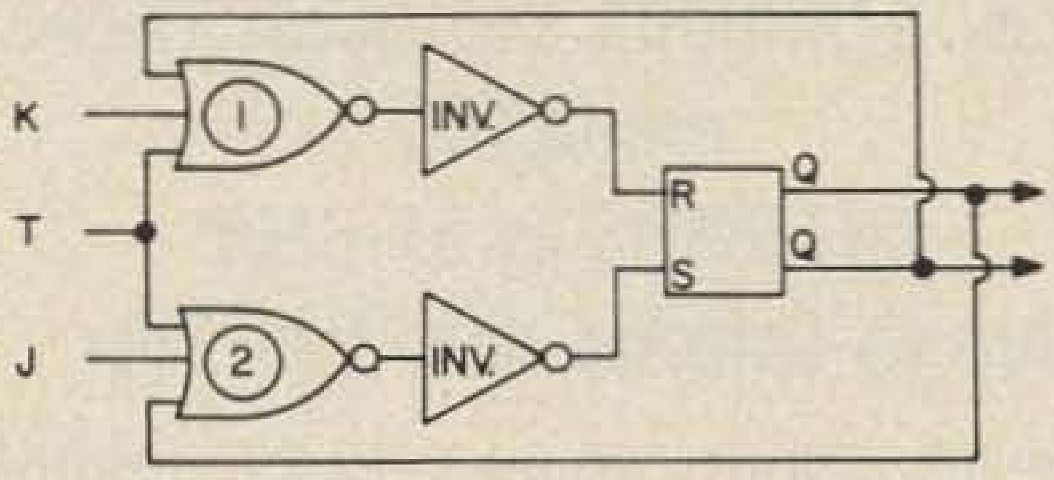



*Fig. 2-18. The JK flip-flop.*

a second trigger can be used to restore the multivibrator to the original condition. This principle is used in the slow scan sampling camera later described.

Connect two *nor* gates in a cross connection as shown in Fig. 2-17.

If a momentary high is put on R, Q goes low. It is assumed that S is low and output Q is high, therefore making the top gate continue to stay low even after the R high is removed. At some later time a momentary high is connected to S. This immediately causes Q to go low, forcing $\overline{Q}$ high and therefore locking the bottom gate in the new condition. Inputs R and S and the outputs Q and Q are universally designated terminals of an RS flip-flop.

Let us now extend the RS flip-flop one more step to design a new kind of device called a JK flip-flop by combining several *nor* gates. The simplified circuit diagram in block form is shown in Fig. 2-18.

To start the operation assume that terminal T is grounded to a low state. A high is temporarily applied to K which causes gate 1 output to go low. This signal is passed through an inverter to make this signal a high. $\overline{Q}$ goes low and does not affect flip-flop 2 so Q remains low.

Now let's assume input J is momentarily raised to a high. This input causes gate 2 output to go low. The inverter changes the signal to a high and causes the RF flip-flop to change state with Q low and Q high. The feedback from Q to K input is low, so it does not affect the operation.

The JK flip-flop has one property that makes it of particular interest to the slow scanner. This is the T (or toggle) input. If both inputs J and K are tied to ground (or "low") and a sequence of high pulses are applied to the T input, the RS flip-flop receives alternative high's on the R and S input to cause the flip-flop output to oscillate back and forth. The simple block diagram of a JK flip-flop shown in Fig. 2-18 is sensitive to pulsewidths. The more complicated correct diagram will show an additional RS flip-flop for holding purposes. The result is that for every two pulses into the T input, the Q or Q output goes through one change of state. This is a frequency divider of 2 which forms perfect square waves at the output. It will be shown later that this signal is quite useful to the slow scanner.

The JK flip-flop is commercially packaged and is sold by Fairchild as the UL923 and by Motorola in a dual package as the MC890.

What does a slow scanner do with JK flip-flops? The most obvious use is the generation of the 15 Hz line rate used in the SS camera. A typical circuit is shown in Fig. 2-19 where two "divide-by-two" JK flip-flops are hooked in cascade.

The 15 Hz square wave must now be used to trigger a monostable multivibrator to set the exact pulse length desired. The design of a monostable oscillator is covered elsewhere in this book.

What about the other frequency divisions other than two? Digital designers are very

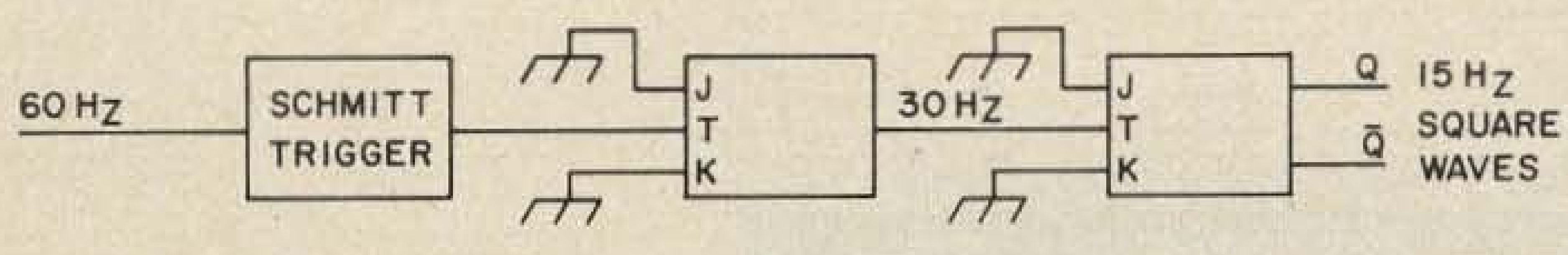



*Fig. 2-19. 15 Hz timing circuit.*

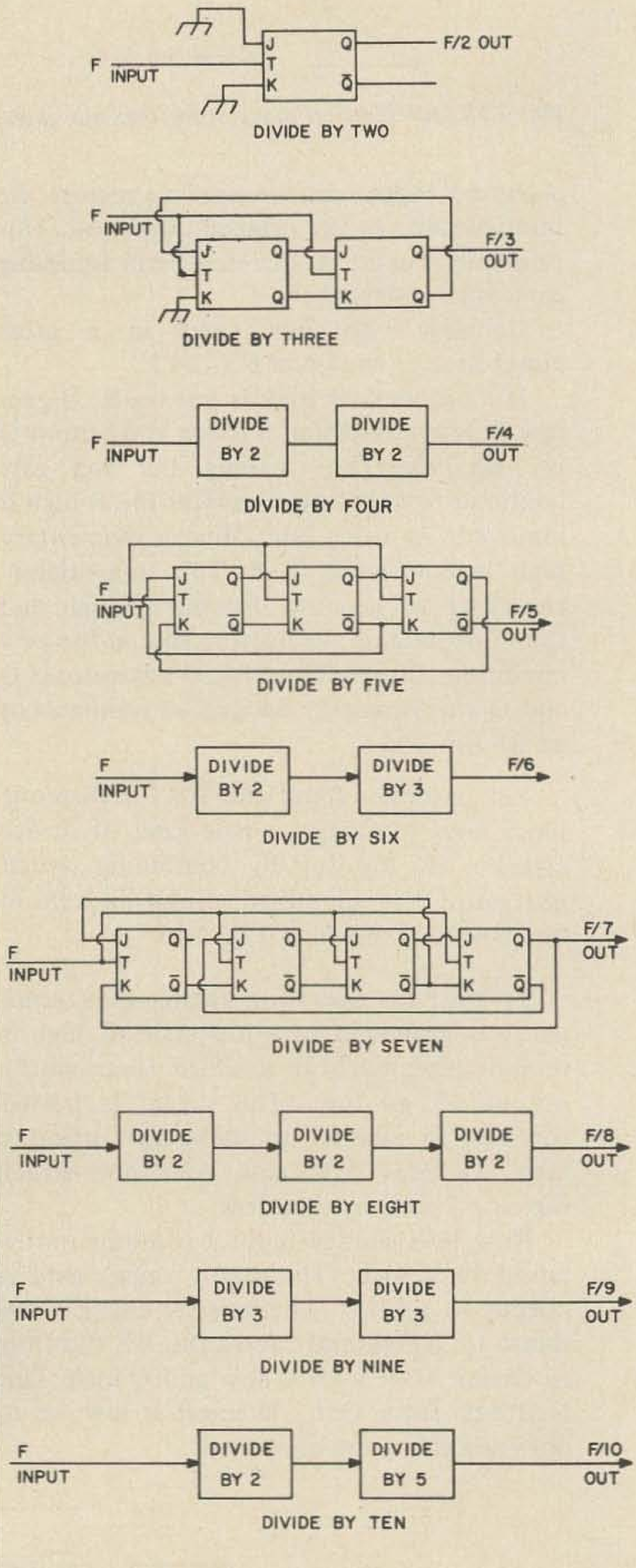

F INPUT
J
T
K
Q
Q̄
F/2 OUT
DIVIDE BY TWO
F/3 OUT
DIVIDE BY THREE
DIVIDE BY 2
F/4 OUT
DIVIDE BY FOUR
F/5 OUT
DIVIDE BY FIVE
DIVIDE BY 3
F/6
DIVIDE BY SIX
F/7 OUT
DIVIDE BY SEVEN
F/8 OUT
DIVIDE BY EIGHT
F/9 OUT
DIVIDE BY NINE
DIVIDE BY 5
F/10 OUT
DIVIDE BY TEN

*Fig. 2-20.*

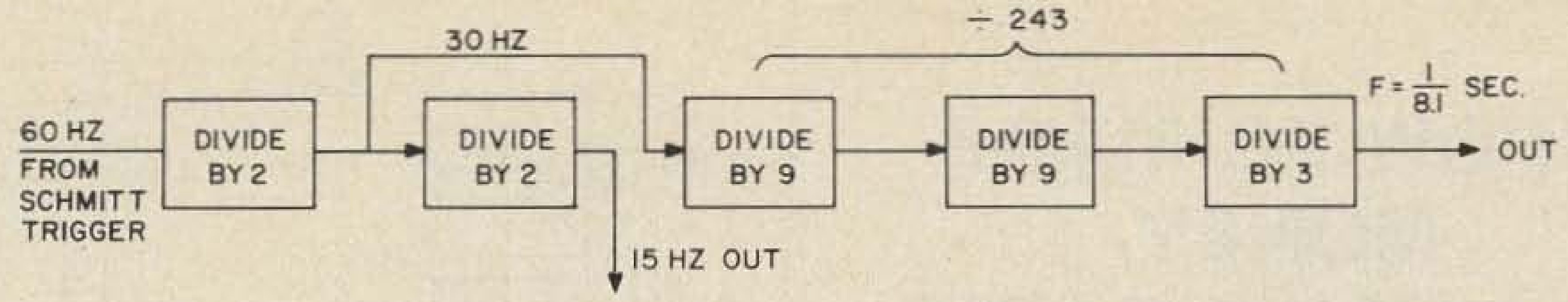



*Fig. 2-21. Complete timing generator for slow scan television.*

clever and have designed every modulus needed up to 10. The circuit hookups shown in Fig. 2-20 are given without derivation or proof. Those of you who are interested can trace the high's around to see the timing sets and resets to provide the indicated frequency division.

It is obvious to a digital designer that some of the divisions can be done with fewer JK flip-flops, but cascading is simpler to the novice.

Finally a block diagram is shown in Fig. 2-21 that produces all the basic timing needed in a slow scan camera. The outputs of 15 Hz and eight seconds are derived for the 60 Hz mains. Later on a more sophisticated timing generator is shown that provides for different scan rates and complete locking of the sampling camera raster to the 60 Hz mains.

The hookup diagram of the UL923 JK flip-flop and the dual MC890P is shown below in Fig. 2-22. We wish to thank W9ZRX for help with logic ideas shown here.

**Phase Lock Loops**

An extremely versatile phase lock loop integrated circuit has recently been developed by the Signetics Corp. Other companies are now producing this type of circuit, but the original package known as the SE565 and NE565 are the most popular and economically priced.

The block diagram of the phase lock loop is illustrated in Fig. 2-23.

The basic parts of the package include a phase detector, amplifier, loop filter, and a voltage-controlled oscillator (VCO). The versatility of this package comes from the fact that each part of the loop can be externally connected to other circuits and their outputs reintroduced back into the loop.

Some of the slow scan applications of the phase lock loop are as follows:

1. Horizontal sync detector in the slow scan monitor.

2. Voltage-controlled oscillator FM generator in the SS camera.

3. Line locked frequency divider in the SS camera.

There are countless other applications of the PLL in other phases of amateur radio. A few of the obvious applications are the RTTY converter, synchronous AM detector, and FM detector. These applications have been well covered in many of the popular amateur radio magazines. The Signetics application notes also carry many interesting applications.

The phase lock loop acts like a very narrow filter. A phase comparison is made between the incoming signal frequency and the frequency of a voltage-controlled oscillator which has been adjusted to operate very close to the frequency being detected. A phase error results in a positive or negative voltage which is filtered by an RC time

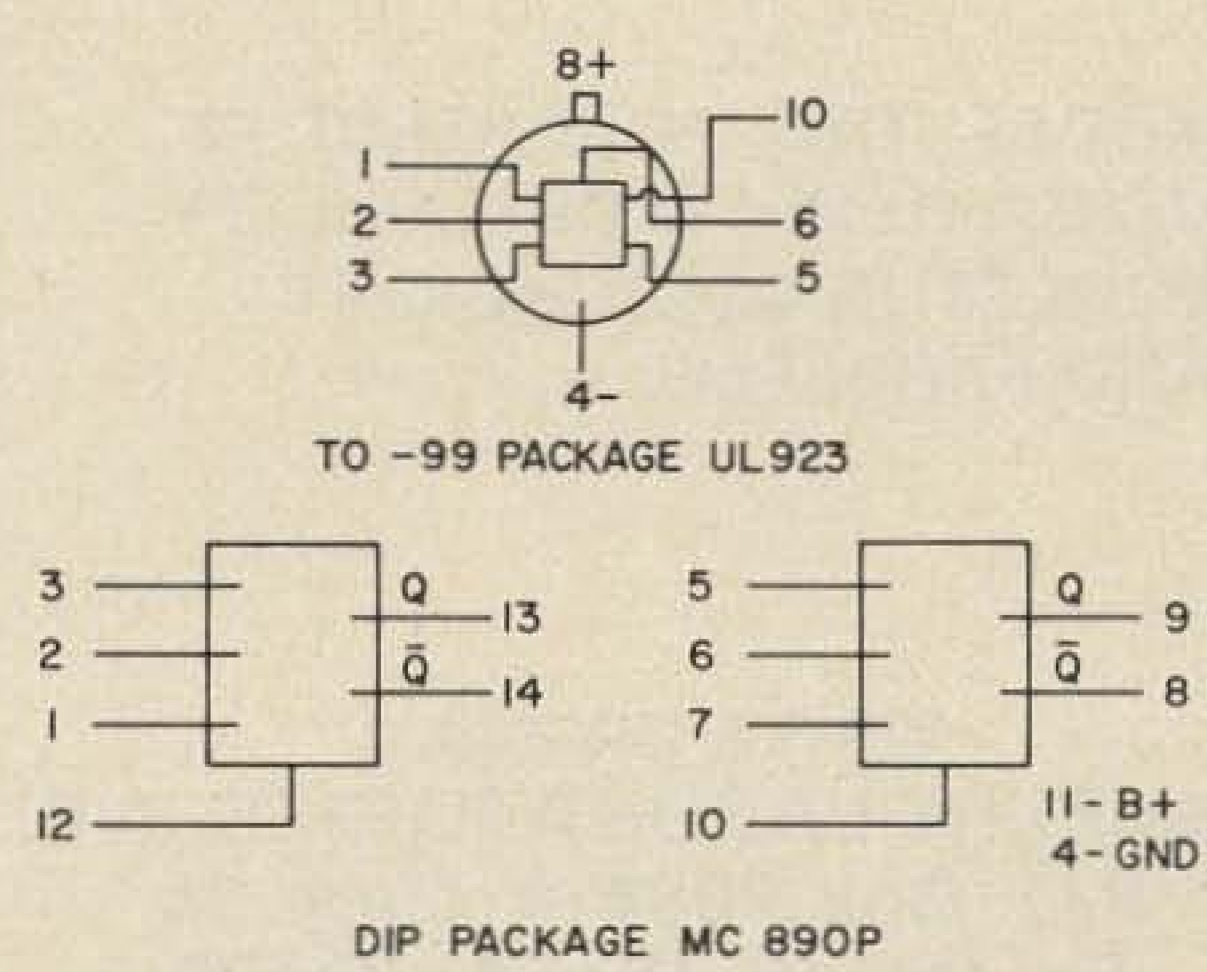



*Fig. 2-22. Connections to popular RTL JK flip-flops.*

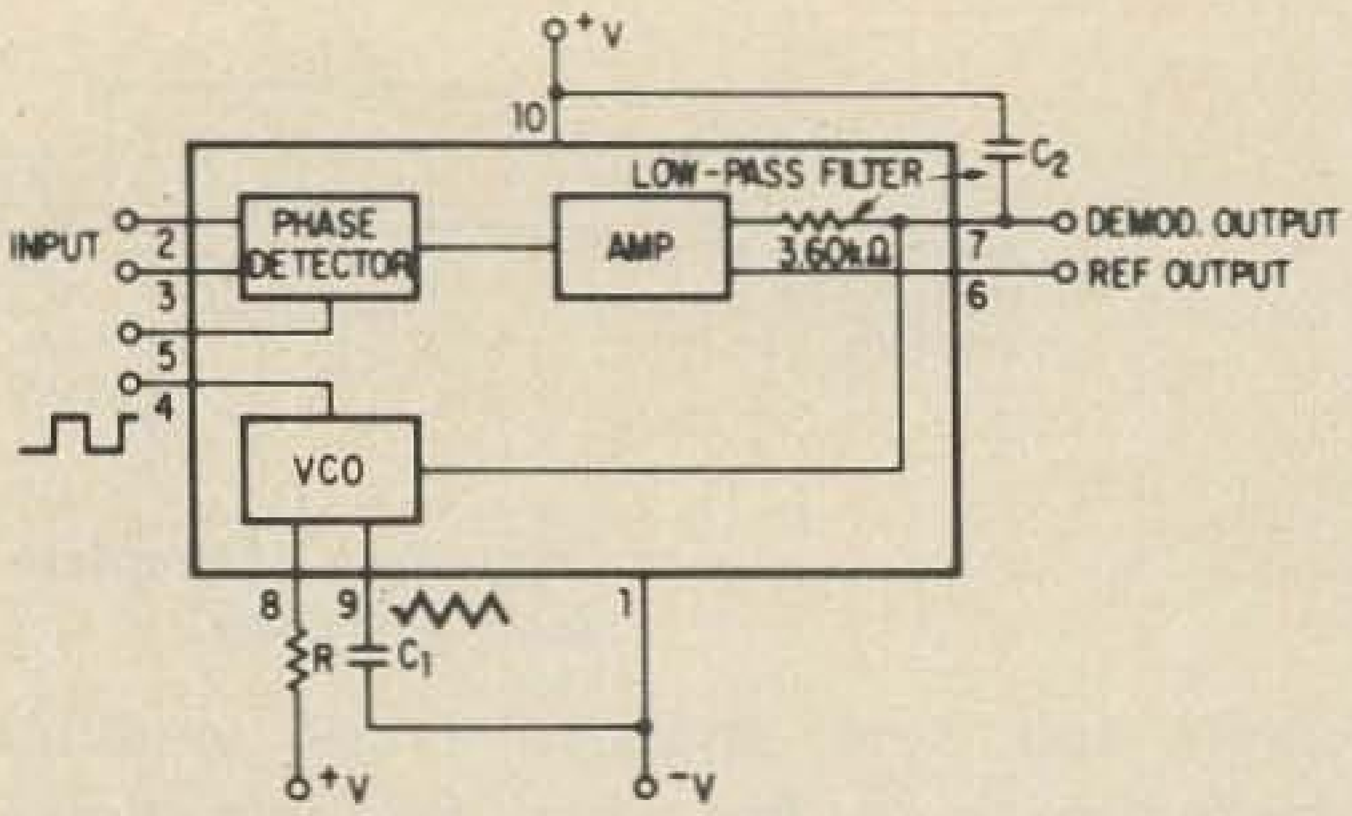



*Fig. 2-23. The phase lock loop.*

constant and is used to drive the VCO closer to the incoming frequency until both are locked together. The secret of the PLL comes from its ability to average several cycles of the incoming frequency to produce a VCO frequency that does not show the short time noise variations of the incoming frequency. This averaging results from having a long loop time constant.

The net result is that the phase lock loop is free running and locks on to a very noisy input signal and has a highly filtered output averaged signal. As an example, if the slow scanner is interested in detecting a 15 Hz horizontal slow scan sync signal, the VCO capacitor is calculated by formula to give a VCO frequency of 15 Hz. The loop capacitor is designed to have a time constant that is 15 to 20 times the period of the 15 Hz input horizontal pulse. The output VCO 15 Hz signal will not be locked to the average period of the 15 or 20 incoming 15 Hz pulses. This circuit is extremely sophisticated inside the integrated circuit package, but it is simple to design and represents an excellent way to recover sync for the slow scanner monitor.

The design formulas for the loop are as follows:

$$f_o = \frac{1}{4R_1C_1}, \text{ let } R_1 = 4000$$

$$C_1 = \frac{1}{4R_1 f_o} = \frac{1}{4(4000)(15)} = 4\ \mu F$$

$$T = 3.6 \times 10^3 C_2 = 15 \left(\frac{1}{15\ Hz}\right)$$

$$C_2 = 277\ \mu F$$

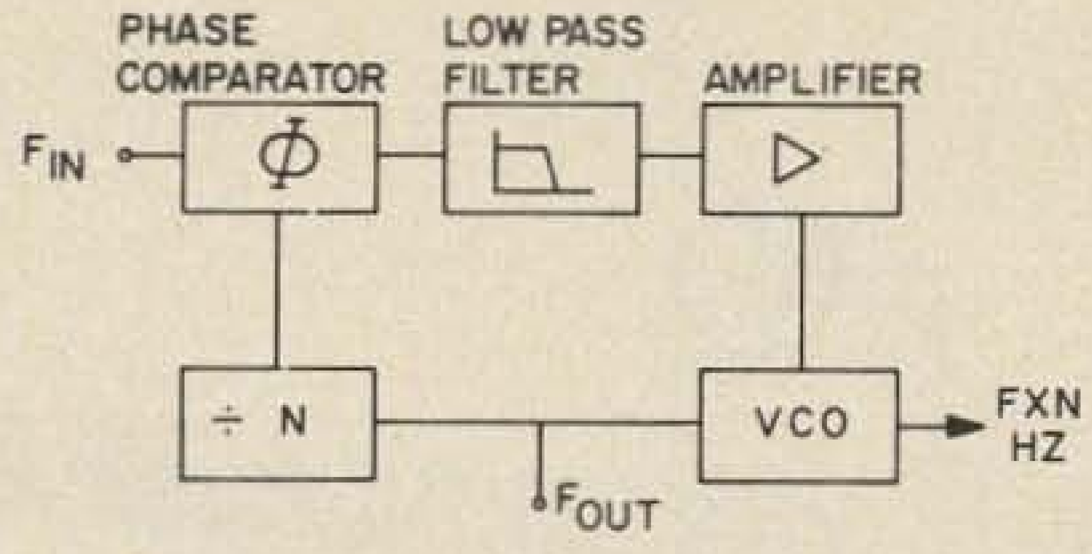



*Fig. 2-24. High frequency phase locking.*

Another application of the PLL is in the generation of the FM video in the SS camera. Here the PLL-VCO is changed in its frequency output by the incoming base band video. Only the VCO part of the PLL package is used here. The formula for calculation of C1 is the same as before. The design should result in a frequency near the 1200 to 2300 Hz FM band of interest. The actual design of this VCO circuit is given in a later discussion of the integrated circuit SS sampling camera. Recently Signetics announced an integrated circuit VCO that is essentially the VCO used in the NE-565 PLL. This new IC VCO is called an SE/NE-566.

Last but not least is another extremely interesting application of the PLL. If it is desired to synchronize a high frequency, i.e., 4800 Hz, with a local standard 60 Hz, the PLL can utilize countdown circuits and generate a host of locked sync signals. As an example, consider Fig. 2-24.

The digital divider circuits shown in the previous discussion of RTL frequency division can be used here to give the desired division. This is an excellent way to lock the sampling camera horizontal sweep frequency to the 60 Hz mains. This complete circuit is shown later in the integrated circuit SS sampling camera design.

This discussion is far too brief to do justice to the PLL circuit. Many more applications of this integrated circuit will be discovered by the slow scanner. It is extremely easy to use in all synchronous generation and detection applications.

The connections and terminals of the SE/NE565 are shown in Fig. 2-25.

**Sweep Generation**

Most monitors and cameras used for slow scan television use a driven sweep circuit to generate the sawtooth voltage or current to produce the raster.

Driven sweep circuits require sync pulse repetition to cycle the sawtooth in contrast to free running sweep generators which require synchronization from a pulse chain. The result on the CRO face is a completely black tube face for driven sweeps without sync pulses and a constantly recurring raster for synchronized sweeps even in the absence of sync pulses. Today it is a matter of opinion which is best, but in the early days of slow scan TV (late 1950's) the drift and synchronizing difficulty of free running sweep circuits resulted in the use of driven sweeps. Today, the free running unijunction oscillators and phase lock loop circuits can produce some very good results with synchronization.

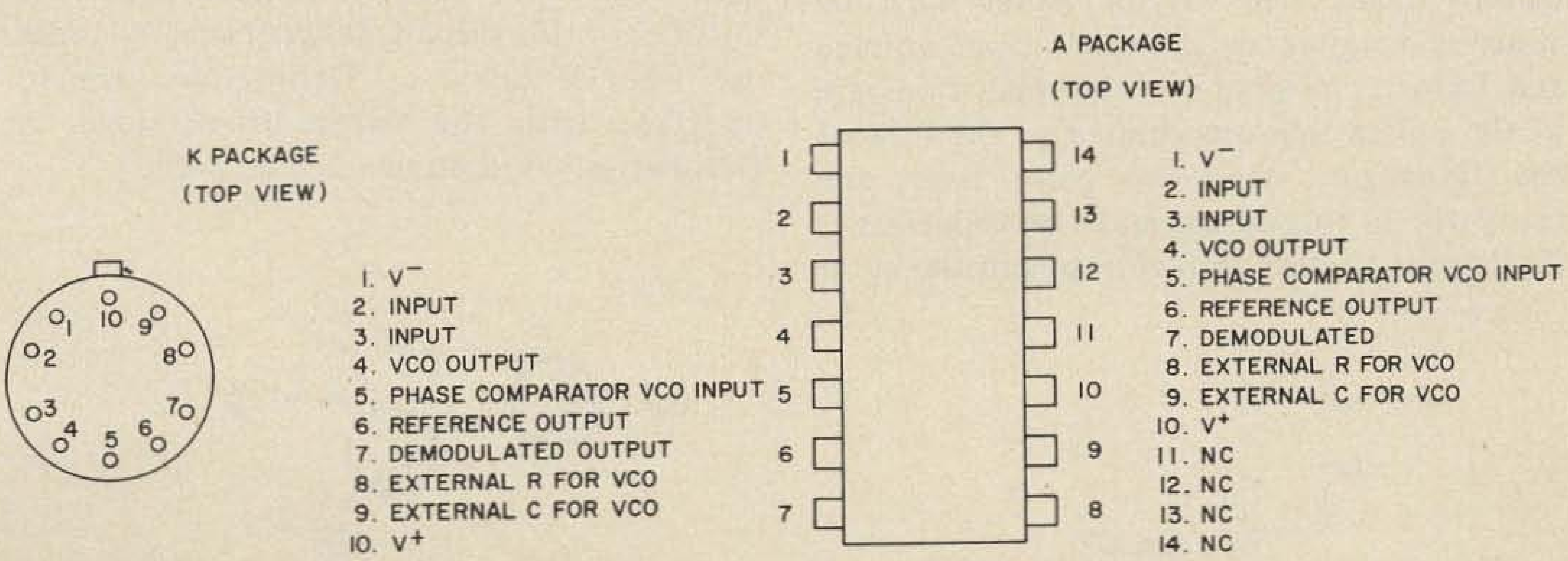



*Fig. 2-25. Connections to the SE/NE 565 PLL.*

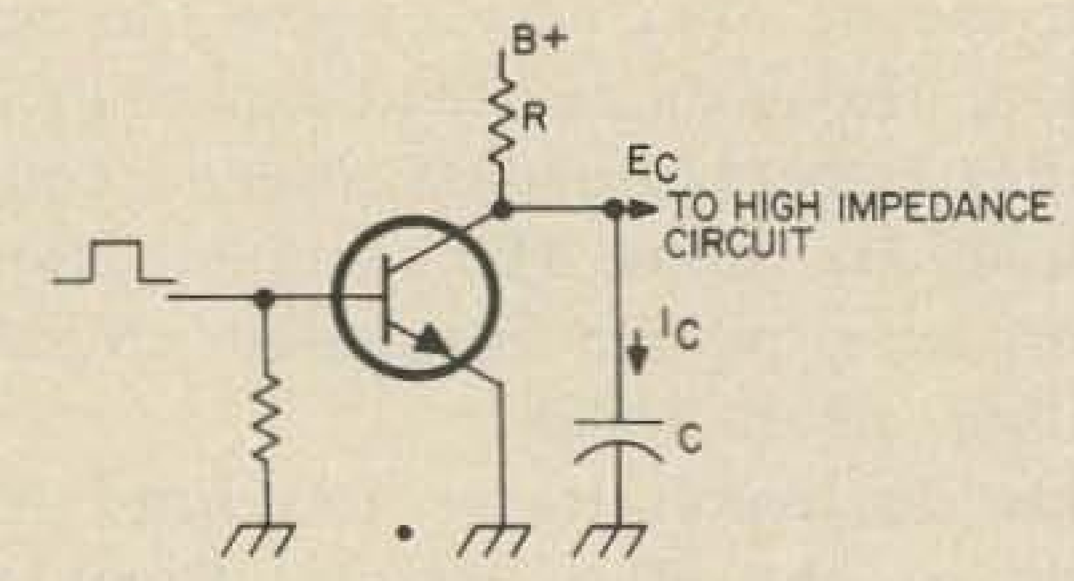



*Fig. 2-26. Capacitor discharge circuit.*

Sweep circuits all have some kind of a capacitor circuit that is charged at a more or less constant current. The simple circuit in Fig. 2-26 shows the principle.

Without the presence of the sync pulse, the transistor is in a non-conductive state. Capacitor "C" is charged from the positive supply voltage through resistor R. The charge of voltage across a capacitor is given by $\Delta E/\Delta T = i_C/C$.

We know that a sawtooth voltage means equal changes of voltage with equal changes of time. Therefore, $i_C/C$ must remain constant throughout the sawtooth. It is obvious that Ic will not remain constant in the above circuit because as the capacitor builds up in voltage, it opposes the flow of current from B+ through R to the capacitor. This decrease of current has a name "exponential" in contrast to the "linear" change desired. There are several ways devised by circuit designers to minimize this deviation from a linear ramp or sawtooth voltage. The easiest way is to utilize only a small fraction of the total Ec variation. This is shown in Fig. 2-27.

If the ramp is restricted from building up to B+, the output voltage will be approximately linear. The circuit values must be adjusted to give the desired output voltage and linearity desired for the repetition rate of the pulses that are applied to the base of the transistor. At every pulse time, the transistor is turned on and the capacitor is discharged to near zero voltage and the cycle then repeats itself. This pulse width must be sufficiently wide to discharge the capacitor through the resistance of the transistor. Some care must be taken to make sure that the transistor does not burn out from the high discharge currents of the capacitor.

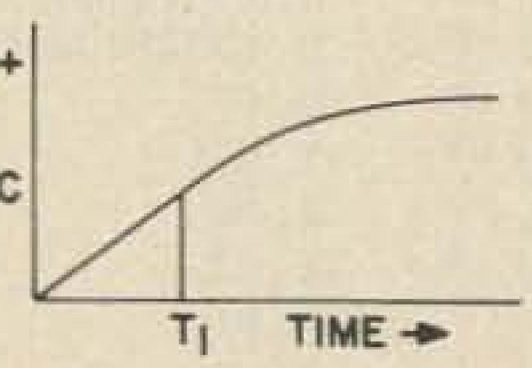



*Fig. 2-27. Simple RC ramp generation.*

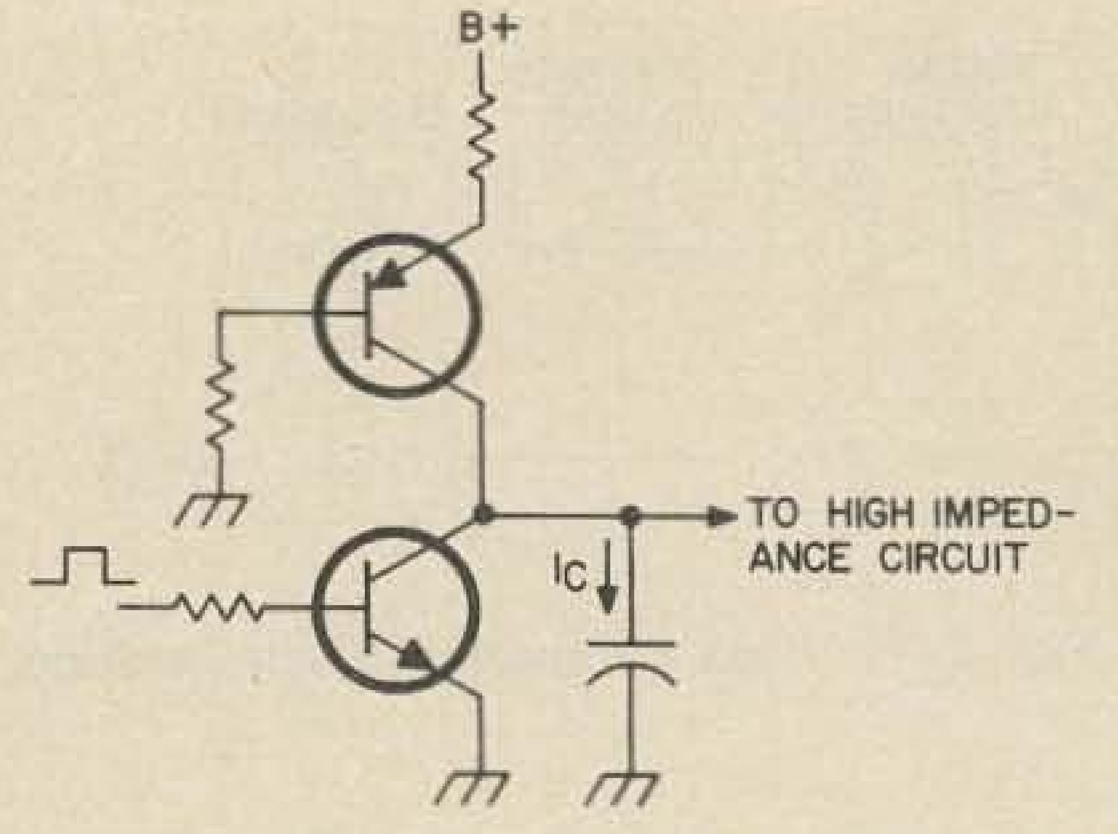



*Fig. 2-28. Current source sweep.*

A better solution to linearity is to use a current source instead of a resistor to supply the current to the capacitor. A current source can be a current from a source of high voltage and high value resistor. The current being supplied should not be affected by the building up of the capacitor voltage. Rather than use a high voltage and resistor combination, active components such as pentodes or transistors can be used for the current source. These devices are distinguished by having "flat" current versus voltage characteristics. The output voltage of the capacitor will be a linear ramp as long as the current source remains constant. Such a circuit is shown in Fig. 2-28.

In the circuits previously reviewed, there still remains a problem of interfacing the high impedance capacitor circuit with the outside world. Circuit designers many times use what is called a "Darlington" pair to interface with the sweep driver stage. A Darlington pair is shown in Fig. 2-29.

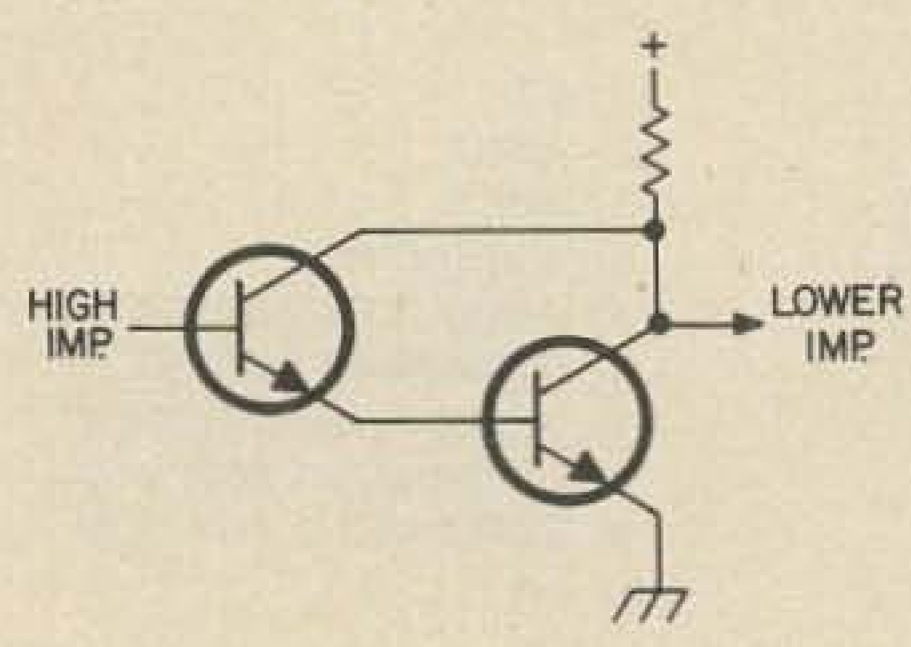



*Fig. 2-29. Darlington pair.*

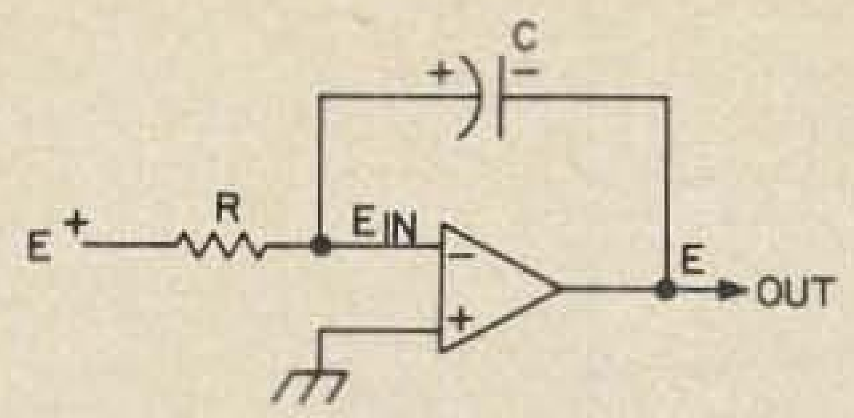



*Fig. 2-30. Operational amplifier with RC integrator.*

Very good sweep generators can be designed today from operational amplifiers. These small amplifiers have very high gain, low drift, and are very low priced. The famous 709 and compensated 741 are amplifiers made by many integrated circuit companies today. These op-amps come in three basic packages – flat pack, DIP, and TO-99. The DIP or dual in-line package and TO-99 are the most attractive from a ham viewpoint. The flat pack is cheaper but difficult to mount in breadboard circuits.

The op-amp is shown in Fig. 2-30 with a capacitor and resistor.

Remember that the amplifier has very high gain, i.e., 100,000. This means at the minus or inverting input of the op-amp that the input voltage is very low for full output. Since the charging circuits can be calculated as $I = (E+ - Ein)/R$ and Ein is very low over the full cycle, the charging current is constant and very nearly equal to $I = E+/R$. The current flowing into the amplifier is very low due to Ein being low and also to the high input impedance of the amplifier. This means that the capacitor receives nearly all of the current through resistor R and the output voltage of the amplifier linearly decreases to the limit of saturation. It is easy to visualize this operation if it is remembered that the plus end of the capacitor is at near ground voltage, therefore the capacitor can be redrawn as going directly across the output to ground. This effect has a name and is called "virtual ground" input. If you doubt this sequence of events, check them with a good grade oscilloscope.

This circuit still must be made to recycle itself so some way must be provided to discharge the capacitor once it has charged up.

Two ways are used to cycle the capacitor. Either way shorts the capacitor by means of an electronic switch. A bipolar transistor (ordinary transistor) can be used, but a much more effective switch is the field effect transistor (FET). The circuit is shown in Fig. 2-31.

Upon the application of the pulse at the sync repetition rate, the FET shorts the capacitor and causes the cycle to repeat.

Another way to generate a sweep is to use a synchronized free running oscillator. There are many ways to design a free running sweep circuit that can be synchronized by the detected transmitted sync pulses. The stability of any sweep generator is basically related to the sharpness and quality of the synchronizing pulse. The ordinary home TV set is an example of a synchronized free running sweep or raster. In the early days of commercial TV, sets different in the quality of sync recovery and their operation became a measure of excellence when considering the purchase of a receiver. All free running sweep circuits must have an oscillator that repeats or cycles near the desired frequency of the sweep. In addition there must be another circuit that sets the exact retrace time and forms the desired blanking and sync pulses if desired. The proper width pulse can now be used to discharge a capacitor in any of the ways discussed in the section on driven sweeps.

Examples of free running sweep generator can be a blocking oscillator, multivibrator, unijunction oscillator, or a VCO in commercially available phase lock loop IC packages. The pulse width shaper can be a monstable multivibrator or a silicon controlled rectifier discharge circuit.

All of the above circuits can be made to work very well and the choice of one or the

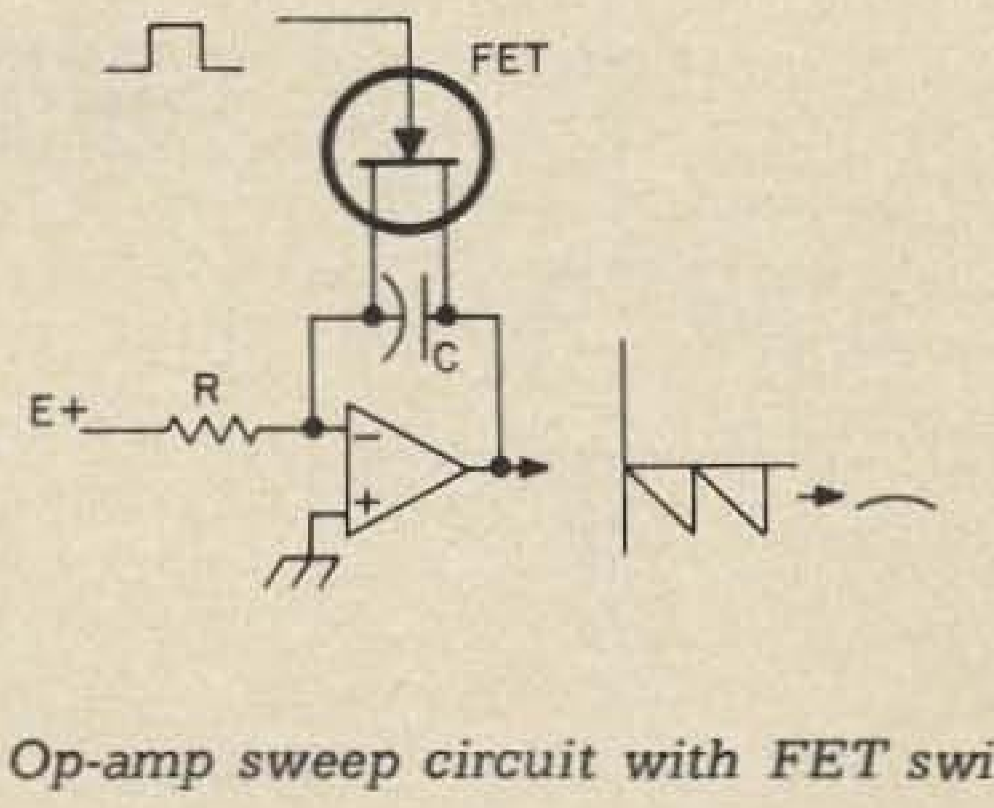



*Fig. 2-31. Op-amp sweep circuit with FET switch.*

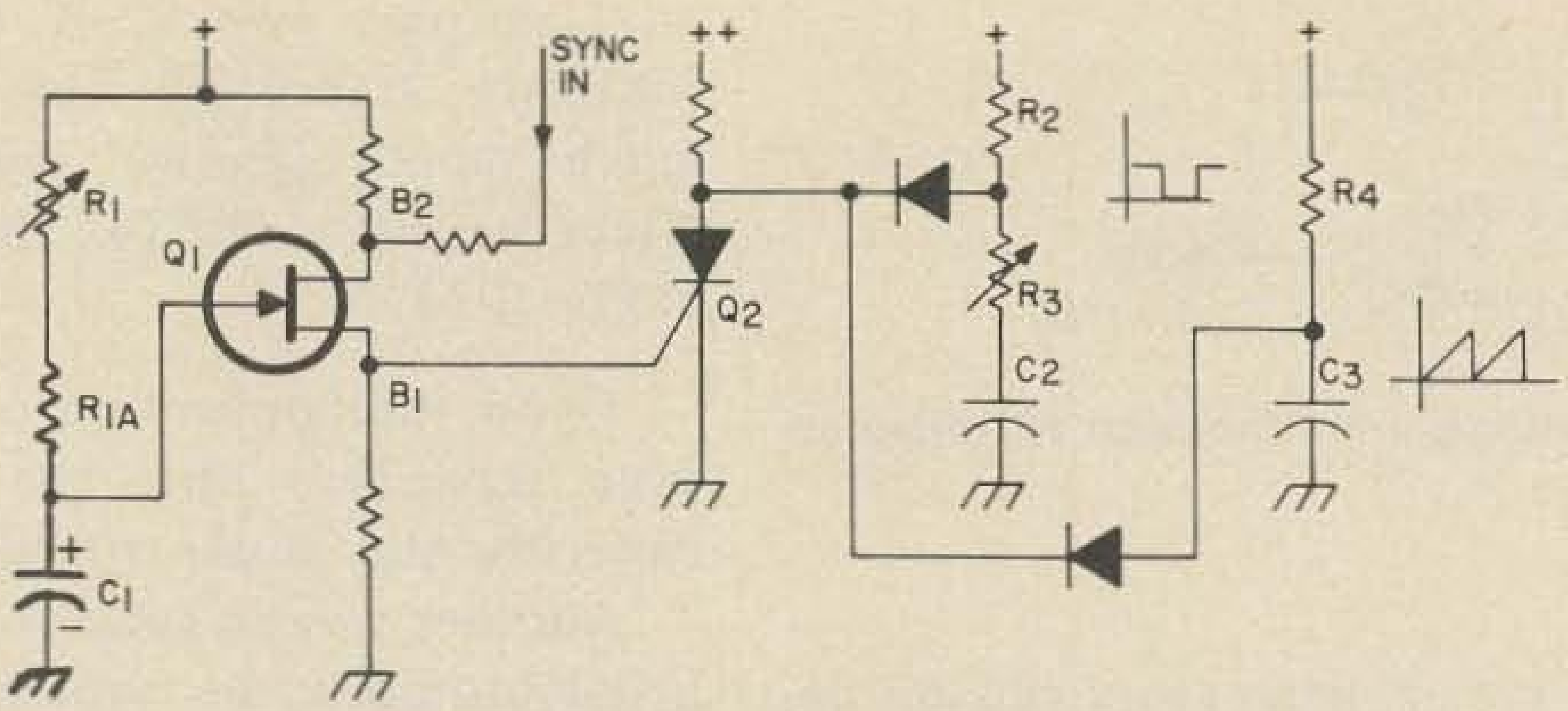



*Fig. 2-32. Unijunction sweep generator.*

other may depend upon the ease of synchronizing the free running oscillator, temperature consideration, or one of economics and availability.

As an example consider a simple unijunction relaxation oscillator. The basic circuit is shown in Fig. 2-32.

Capacitor C1 charges through R1 and R1A until the breakdown of the emitter of Q1 occurs causing the discharge of C1 through the emitter-base 1 junction of Q1. Once this occurs, the potential of C1 drops and eventually the conduction stops and the cycle repeats. Sync pulses are added in at base 2 in order to cause the discharge to occur a fraction of time before the normal discharge cycling.

The output of the unijunction transistor is connected to the base of a silicon controlled rectifier (SCR). This pulse causes the SCR to discharge for a period of time determined by the charge stored in C2 and the discharge time constant. This is adjusted to give the required pulse width.

This pulse is used to discharge a capacitor C3 as discussed earlier to create a sawtooth or ramp voltage.

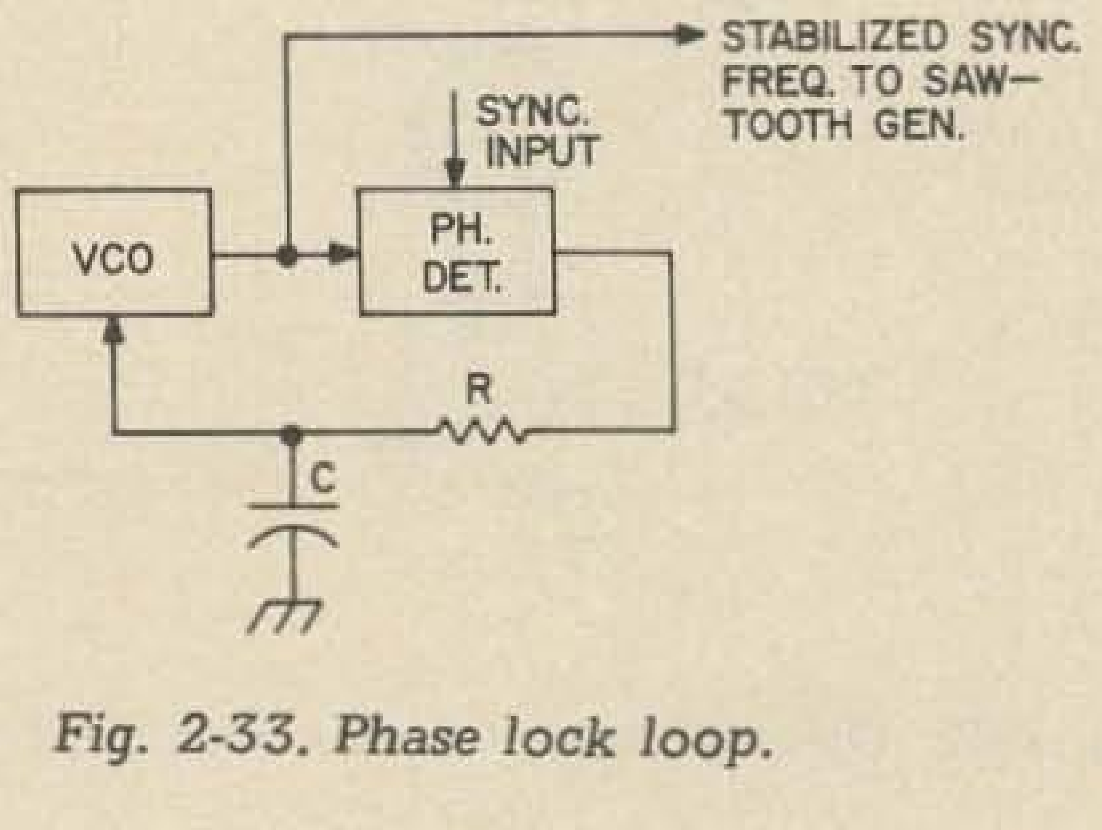



*Fig. 2-33. Phase lock loop.*

A very interesting method of creating a free running raster is the use of a phase lock loop. The basic circuit is shown in Fig. 2-33.

The VCO is a stable oscillator whose frequency can be controlled by means of a dc input voltage. The phase detector is able to compare in phase two signals that are the same frequency but differ in phase. The output of the phase detector is a noisy dc signal that is filtered by an RC time constant in the loop. This time constant is made long enough so the loop exceeds the repetition rate of the sync pulses by 10–25 times. The result is that the loop acts like a very narrow filter and develops a stable signal based on the average of many receiver sync pulses. When no signals are being received, the raster continues to sweep at a frequency very near the sync repetition rate.

Driven sweep oscillators can effectively utilize some kind of lock out monostable oscillator to prevent the main monostable from triggering falsely on noise spikes after the main monostable has recovered. The synchronized free running oscillators have some basic immunity to noise since they can only be synchronized near the normal repetition rate.

This discussion of popular slow scan television circuits will be continued next month. Among the topics to be described are sweep drivers, subcarrier generators, limiters and discriminators. The design of active filters for slow scan use will also be covered and a complete regulated power supply that is suitable for solid state slow scan circuitry will be presented.

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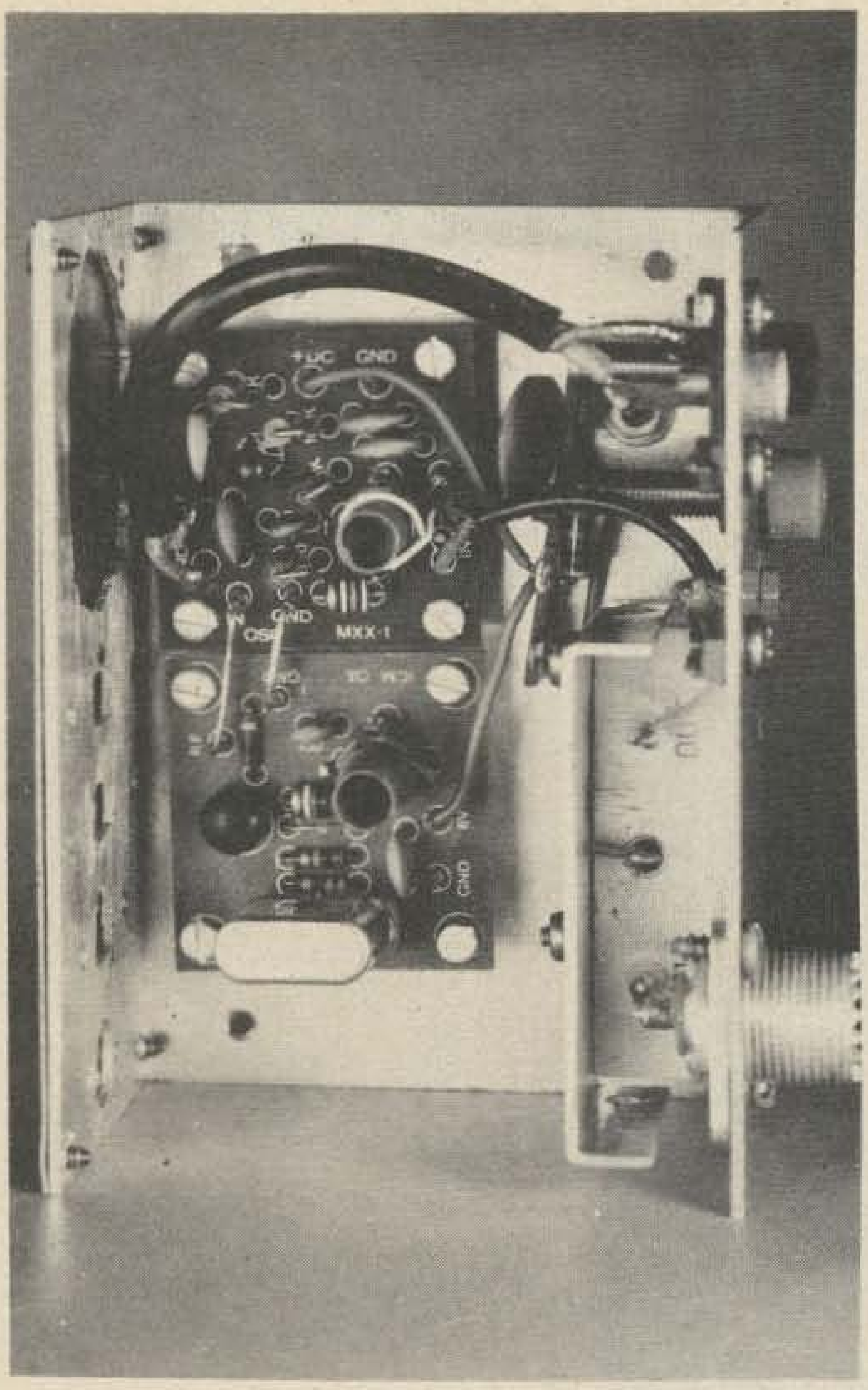


# A 2-METER CONVERTER FOR AN AM-FM BROADCAST RECEIVER

Many articles in the past have been written on converters. But this one is different in that it is designed to use an FM broadcast receiver as the tuneable i-f and preassembled modules as much as possible.

Most two meter converters have had their output on either 10 or 20 meters. For the beginner, this alone could be a drawback in that he may not have a general coverage receiver. This project uses an ordinary FM broadcast band tuner or receiver. Using the tuner has several marked advantages over the conventional AM/SSB receiver. First, since it's FM to begin with, you'll get the added quieting and noise suppression that's lost in an AM/SSB receiver. Second, depending on the complexity of the tuner, it may have muting and afc provisions. The muting can be used as a squelch and the afc keeps those off-frequency stations on your dial without retuning. Third, maybe you're a newcomer to the two meter band and don't know the more popular frequencies that are in use in your area. With this converter you can cover the entire two meter band, MARS frequencies and some of the commercial band from 144 to 164 MHz.

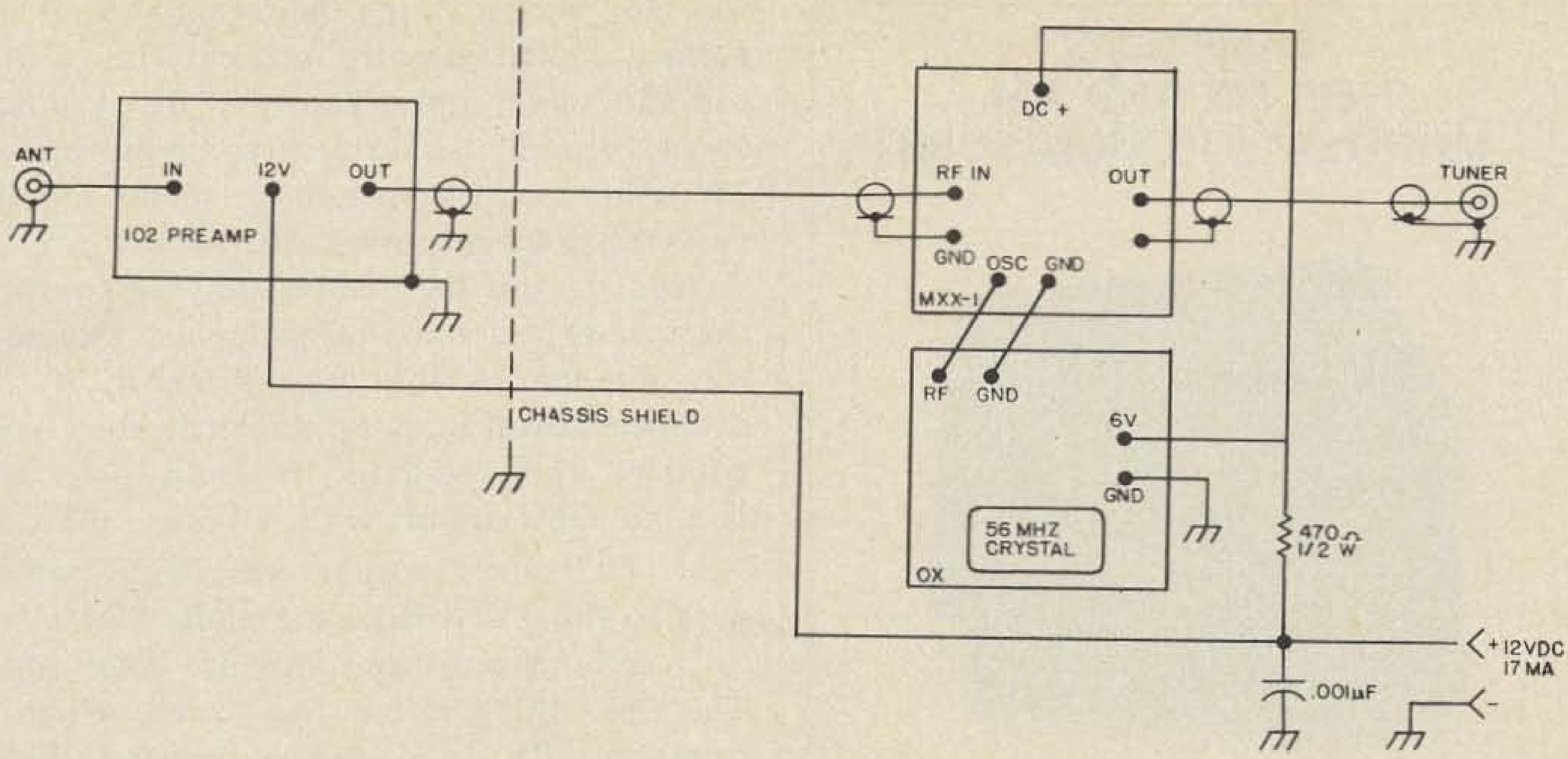


*Fig. 1. Block diagram of the converter showing the method of connecting the modules.*

As was mentioned, modules are used to their fullest extent to simplify construction and to eliminate those hard-to-find parts. The unit is designed into three subassemblies which are placed on a small chassis. An rf amp, mixer and oscillator make up the three modules. The rf amplifier used is manufactured by Vanguard Labs (196–23 Jamaica Ave., Hollis NY 11423). Their 102 preamp has less than a 2 dB noise figure with a power gain of 24 dB at 150 MHz. The preamp comes from the factory tuned to the frequency of your choice with a bandwidth of 2–4 MHz. This particular model uses a neutralized J-FET. From the preamp, the signal is passed to a mixer stage where a 56 MHz signal is injected from the local oscillator. After converting the signal down to the 88–108 MHz band, the signal appears at the tuner output jack. For example, if the input signal is at 144 MHz, then the converter's output will be 88 MHz. The lower part of the FM dial was chosen because of the general lack of stations there. The stations that are present are mostly lower power and educational.

The mixer and oscillator kits are from International Crystal (10 North Lee, Oklahoma City OK 73102). The MXX-1 and OX are the mixer and oscillator kits respectively. Both are the HI kits with a 56.0 MHz EX crystal used in the oscillator.

Construction is simple, straightforward and noncritical. The case used is a small cowl minibox which measured 5 x 10 x 7.5 cm. A shield is mounted across the preamp chassis to suppress any unwanted FM broadcast signals. The modules layout is not particularly critical, although the relative positions should be followed for best results. A SO-239 is used for the antenna input, and a phono connector is used for the converter's output. See the photograph for details.

The kits are easy to assemble and go together without any problems. Entire construction time for the OX and MXX-1 take about thirty-five minutes. On the OX board use the coil with the red dot. The MXX-1 coil and capacitor are the coil with the green dot and the 4.7 pF capacitor. After completing the boards, double check your wiring, especially transistor placement. Make

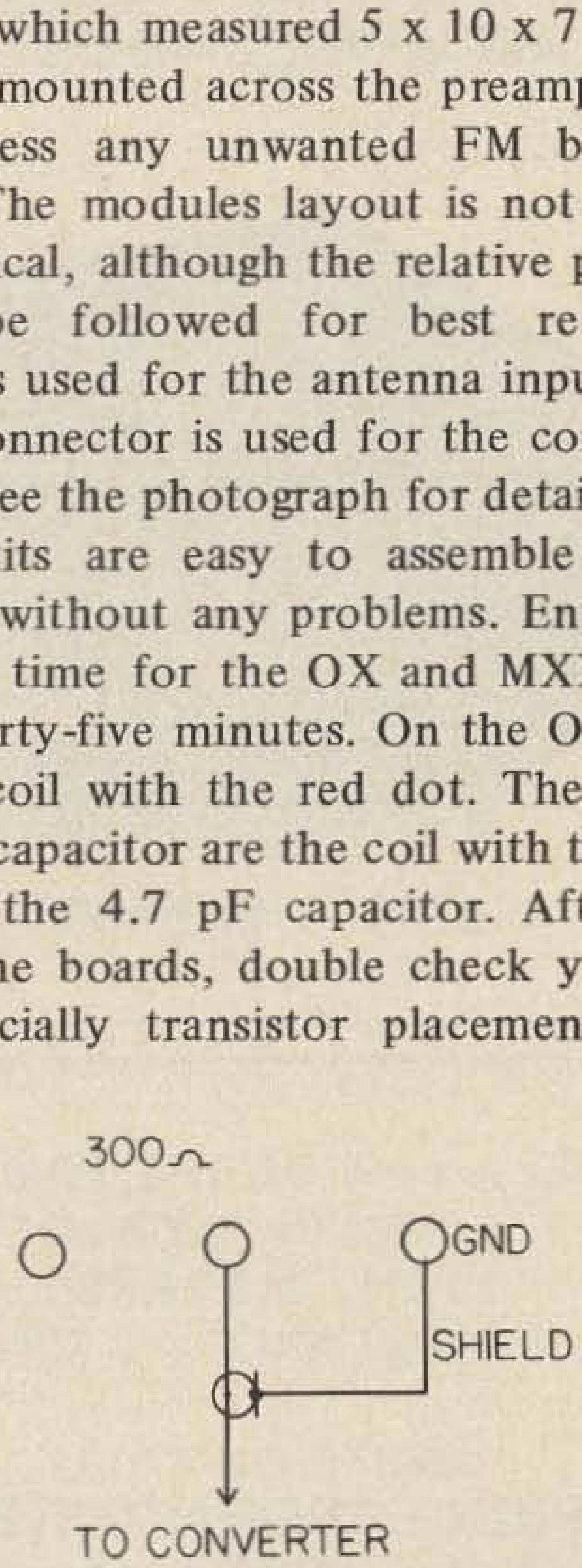


*Fig. 2. To use coax with a 300Ω input, connect the shield to chassis ground and the center conductor to one of the 300Ω inputs.*

sure you have soldered the terminals that are factory staked into the boards. The oscillator and mixer operate on 6V dc. A quick check of oscillator output can be performed by using a field strength meter or by measuring current flow in the collector.

Next mount the boards and preamp using the screws and stand-offs supplied. Connect the antenna to the preamp input. If the distance is over 2 cm use shielded cable. Now connect the oscillator rf output to the mixer's OSC input with a short piece of wire. The mixer output uses RG-58 which goes to the TUNER jack. Preamp "OUT" to "rf" mixer input uses miniature coax cable. The only thing left is for power, which is primarily 12V dc for the preamp and 6V for the mixer and oscillator. The preamp is connected directly to the 12V source while the mixer and oscillator receive their power through a 470Ω resistor.

After all connections are made connect an antenna. Use coax for the converter's output to the tuner.

With a signal present on the tuner, adjust the mixer coil for maximum signal. If the tuner is not equipped with a meter, adjust for maximum quieting. Since the output is untuned, some TV stations may be heard along with the normal two meter activity. This can be eliminated by using an 88–108 MHz bandpass filter. These are available through most parts jobbers. Here in the Los Angeles area, channel 11 is weakly heard around 92 MHz on the FM dial.

Oscillator stability is quite good. A ¼λ whip brings in most of the stations that my commercial unit receives. Coverage of MARS and the commercial band are an added benefit. Mobile telephone, fire and police departments, and the government weather broadcasts, are all received with full quieting signal levels.

The only problem you may encounter is low sensitivity. This happens on some of the older tuners. If your tuner has an input sensitivity of around 2 μV, no added amplification should be necessary. If not, adding another International crystal module, the SAX-1 rf amplifier, between the converter and tuner, should bring the sensitivity up to a respectable level.

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# ALL PURPOSE METERING CIRCUIT

The builder of more complex equipment is often faced with a choice of three evils, whether to meter all circuits which should be metered with individual meters, with a single switched meter or forget the whole thing and trust the equipment to perform in a satisfactory manner after initial adjustment. Individual metering is rather expensive and space-consuming and must in most instances be confined to "price is no object" projects. Obviously, lack of metering is an invitation to trouble, expense, and work, repairing and replacing ruined components. Switched metering too has its shortcomings, but when used in conjunction with full-time metering of the most important circuits it serves well.

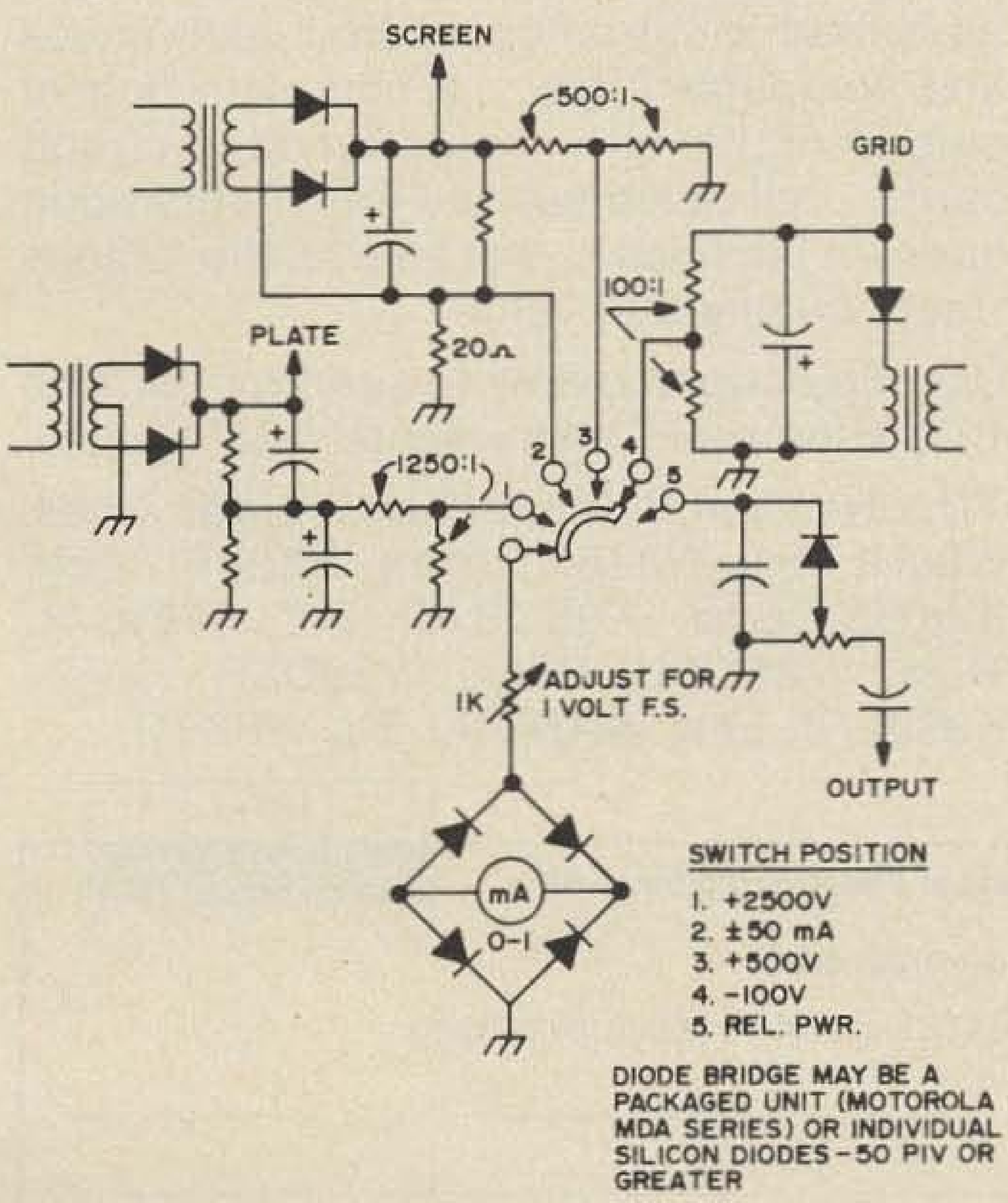


*Fig. 1. Diode bridge may be a packaged unit (Motorola MDS series) or individual silicon diodes of >50 PIV.*

As a typical example, a linear amplifier might well have a plate current meter plus a second switchable meter which could be used to monitor filament, screen, plate, and bias voltage, screen current, relative power or any desired combination. It will be noted that these voltages and currents are of various polarities and magnitudes and may (as in tetrode screen current) be both positive and negative depending upon operating conditions. It would not be easy to design a conventional switching circuit capable of measuring all these parameters.

The easiest method of attacking this problem is to install the meter in a diode bridge in such a way as to cause an upscale deflection no matter which polarity is applied. By proper selection of component values it is possible to use the basic meter scale times a factor for each function. By this I mean the meter/bridge assembly is made to read a set value (one volt is handy) and all inputs to the switch are arranged to produce this voltage under full scale conditions of the range desired. In the example, this system is used in conjunction with a 0–1 mA meter movement to read ± 50 mA screen current, + 500V screen voltage, + 2500 high voltage, and –100V bias, not to mention relative power. The switch is a simple single pole, five-position type. In your design let Ohms Law be your guide and be sure to use a voltage divider where required to keep surges out of the meter. Remember too to use a non-shorting switch to prevent connecting adjacent circuitry together while switching.

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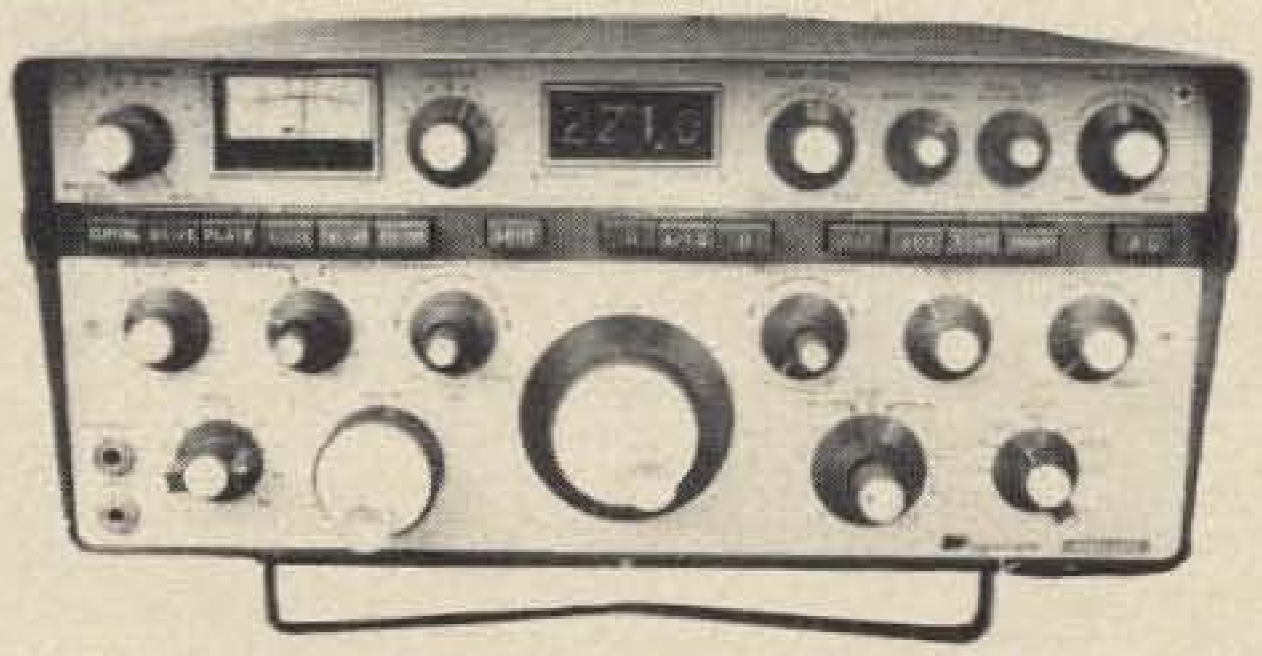

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# ARE FET'S REALLY BIASED?

The field effect transistor, or FET as it is called, has proven to be a very unique device and is now being used quite widely in the electronic industry as well as in amateur radio projects.

The low cost FET is popular with hams because so many things can be done with this electronic marvel. The junction type of FET is extremely rugged, but a few basic facts on these devices should be taken into consideration before your next project with the FET is started. The following points are generally ignored, and as a result many projects do not work out-right, if at all, even though you have followed the schematic and used the same parts. In some cases, the FET has been shunned because it was thought not to be as stable as the transistor. Let s take a look at the important points and how to use them so we can make the FET circuit just as stable, if not more so, as the transistor or the tube.

One of the most important and overlooked parameters of the FET is the $I_{DSS}$ or zero bias drain current of the device. This is always found on the FET spec sheet and is a range of current from 1 mA to as much as 50 mA. Different FET's will have different ranges of current. If one person uses a FET with an $I_{DSS}$ of 2 mA and you use a FET of the same number with an $I_{DSS}$ of 10 mA, you may not be able to get your project to work right, and you will find that the slightest temperature variation will change the circuit conditions. To find out why, let's look at the curve of the drain current of a FET under different temperature conditions to see how they vary. Figure 1 shows this curve with the drain current plotted against

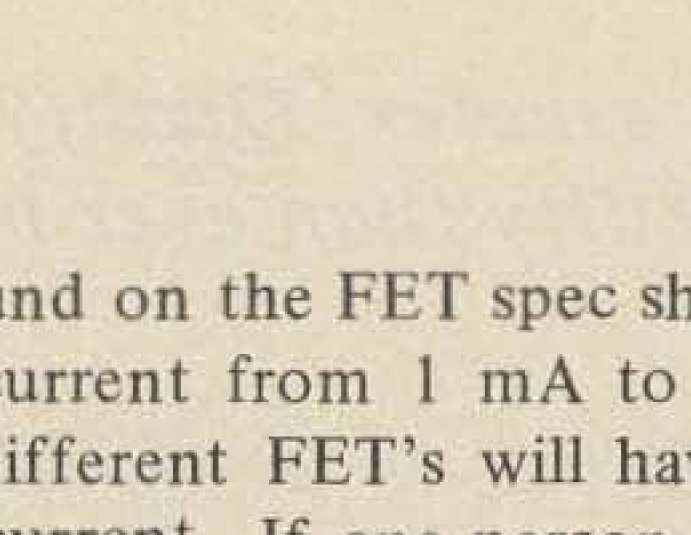


*Fig. 1. Id versus Vgs for 0 temperature shift bias point.*

the gate voltage. As you can see, when the temperature is the coldest, the drain current is the highest at zero bias, and when the temperature goes up, the maximum drain current decreases.

If the FET were biased at zero bias, the maximum amount of gain can be obtained from the circuit, but with the maximum sensitivity to temperature change. The three curves cross at a point with the gate bias negative, causing a low flow of drain current. Beyond that point, the action changes. When designing a circuit for maximum stability, such as an amplifier for mobile operation or an oscillator for a vfo, we would like to bias the FET at the cross-over point or the zero temperature point. This would result in the smallest change in drain current for the maximum temperature variation. To achieve this, you could run a set of curves on the FET's that you are using to find this point, but there is a much simpler method.

Most FET manufacturers have found that the zero temperature point is around .9 to .11 of the $I_{DSS}$ of the FET. We can use this handy information to design our circuits for maximum stability and minimum drift. All we must do is measure the zero bias drain of the FET that we are going to use, and use the average of .10 times the zero bias drain current to find the operating point of the transistor. The $I_{DSS}$ of the FET can be found in two ways: with a commercial FET tester such as the Sencore TF151 that will measure this drain current as well as the Gm or with the circuit of Fig. 2.

The circuit is set up to measure the zero bias drain current for an "N" channel FET. To measure the zero bias drain current of a "P" channel, reverse the meter and battery connections shown. The battery voltage is not critical and any value between six and nine volts can be used with the same figures resulting.

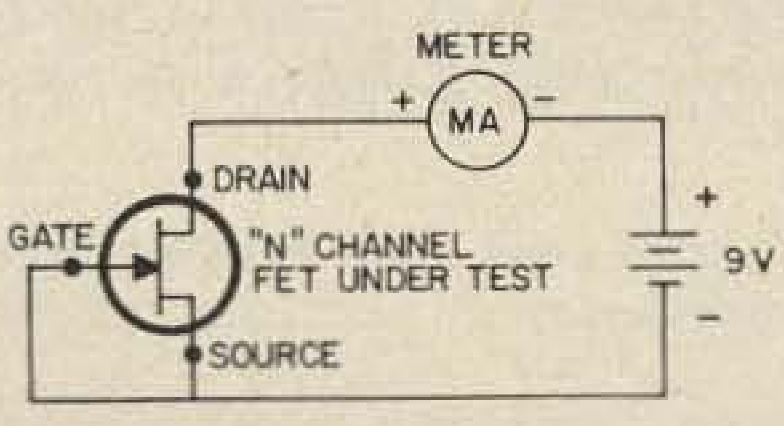


*Fig. 2. Setup for measuring $I_{DSS}$ of a FET reverse meter and battery for "P" channel FET.*

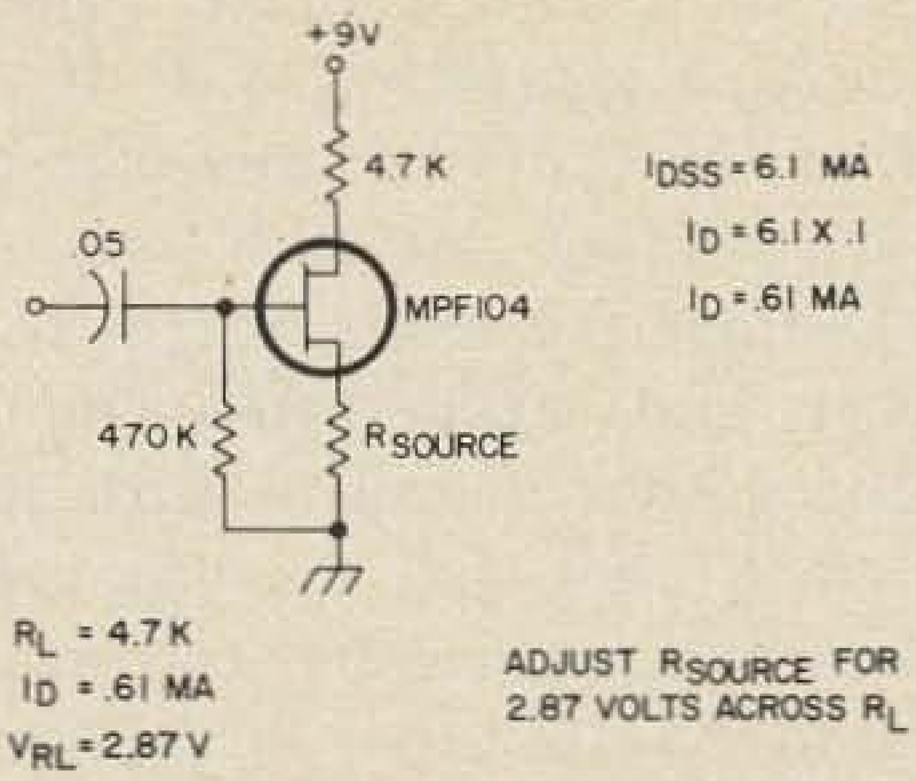


*Fig. 3. Setting up bias point on a FET for 0 temperature shift.*

Here are a few examples of different $I_{DSS}$ currents I measured on several Motorola MPF104 junction FET's. If a pair of FET's were needed, such as in a bridge circuit, numbers 2 and 3 would be the best suited as they are the closest in zero bias drain current measurements.

| FET | $I_{DSS}$ |
|---|---|
| 1 | 4.3 mA |
| 2 | 6.1 mA |
| 3 | 6.9 mA |
| 4 | 7.5 mA |

Numbers 3 and 4 could also be used as a matched pair, but number 1 could not be used with the other three as a matched pair such as in a bridge circuit for a voltmeter. If number 1 was matched with any of the other FET's, the circuit would be unstable and subject to temperature drift. Any of the FET's above could be used as an amplifier for a zero bias stable condition. Let's use the FET with the zero bias drain current of 6.1 mA as an example of how we find the proper operating point of the FET that we are going to use.

The example uses a load resistor of 4.7K and is being used as a low level audio amplifier for a mike stage. If the zero bias drain current is 6.1 mA, then we can use the average of the .08 to .11 figure which is normally .10 as a starting point. Multiply the figure of 6.1 mA times .10 which gives us a figure of .61 mA of drain current for the FET. Using Ohm's Law, this would give us a voltage drop of .61 mA times 4.7K or 2.87V across the load resistor. To achieve this voltage drop, we must now adjust the source resistor in the circuit until the voltage drop across the load resistor is 2.87V. If you have the curves for the FET this can be done simply by finding out how much bias is needed to limit the drain current to around this figure and, again using Ohm's Law, figure out a source resistor with the drain current of .61 mA and the bias voltage. In most cases it is much easier to use a resistor substitution box or a pot in the source and adjust the value until you find the voltage at the drain load resistor to be that which you have calculated.

If a low level signal is to be amplified, a FET with a low $I_{DSS}$ can be used, but if a high level of signal is to be amplified, it is much better to use a FET with a high $I_{DSS}$ so that the resulting drain current will allow a greater swing and still remain in the linear portion of the curve, as you would for a tube circuit. Above all, do not allow the FET to run at a drain current above its normal $I_{DSS}$ or permanent damage to the transistor will result. If you are replacing a FET in an existing circuit, be sure to check to see how much drain current was being drawn by the previous FET. If the circuit draws more drain current than the maximum $I_{DSS}$ of the replacement FET, you will have trouble.

The zero bias drain current or $I_{DSS}$ can be helpful in many ways; for example, to find the best operating point for a vfo, matching a pair of FET's for a bridge circuit, or finding the best operating point for an amplifier for best stability. In rf applications the FET is ideal and in most cases is biased at zero bias to get the maximum gain from the circuit with an agc voltage to control the signal level from the stage. In a cascade amplifier the upper FET must have an $I_{DSS}$ of two to four times that of lower FET.

The FET is the ideal device to be used in rf amplifiers, vfo's, i-f circuits, audio stages, and many others. The high input impedance that can be achieved with the FET also makes it the ideal device to be used in test equipment around the shack. By using Ohm's Law and the zero bias drain current or $I_{DSS}$ of the FET, these circuits can be made to perform with great satisfiaction and very little trouble.

. . .K9VMH

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# FREQUENCY COUNTER INPUT CIRCUIT

Having read with interest all the articles in *73* and elsewhere on digital frequency counters, the bug finally got me about three years ago, and I started to build my own. It was a while before the finished product finally emerged but I was happy with the result, learned a tremendous amount in the process, and couldn't live without a "counter' any longer.

The purpose of this article is to give the solution to a problem I have always had with the counter as originally built. Input impedance was only 10k which made it a bit low and caused an upset to signal generator output and other circuits when the counter was connected to them. Related to input was also the amount of signal required to drive the counter and in a secondary way the problem of always having to set the input level.

I have tried several solutions to the problem but did not really get on the right track until I read the "Digital Instruments" article by Donald L. Steinbach in *Electronics World* January 1971. Mr. Steinbach used a differential voltage comparator as a Schmitt trigger driven by a FET.

The result of my experiments with this circuit are shown in Fig. 1. There is no input level control in this circuit. The sensitivity is 10 dB better than the original circuit using a pair of inverters as a shaping circuit. The input is protected from high level input signals and the input impedance is much higher than the original

The absence of an input level control is attributed to the components associated with the gate circuit of Q1. Resistor R1 and capacitor C1 couple the input signal to the gate of Q1. An input signal of approximately 32 mV is all that is required to drive the trigger circuit in a stable condition all the way up to 10 MHz. If the input signal becomes greater than 2 volts p-p the diodes, D1 and D2, will conduct and clip the input at this level. This protects the gate of the FET, Q1, and also eliminates the need for an input level control.

The IC is a Differential Voltage Comparator. I used one of the '3 for a dollar' Poly Pak 710's. This unit is a 10 lead flat pack so not as easy to work with as the TO-99, but in the end makes a very neat circuit. Figure 2 gives the outline details of the 710 flat pack

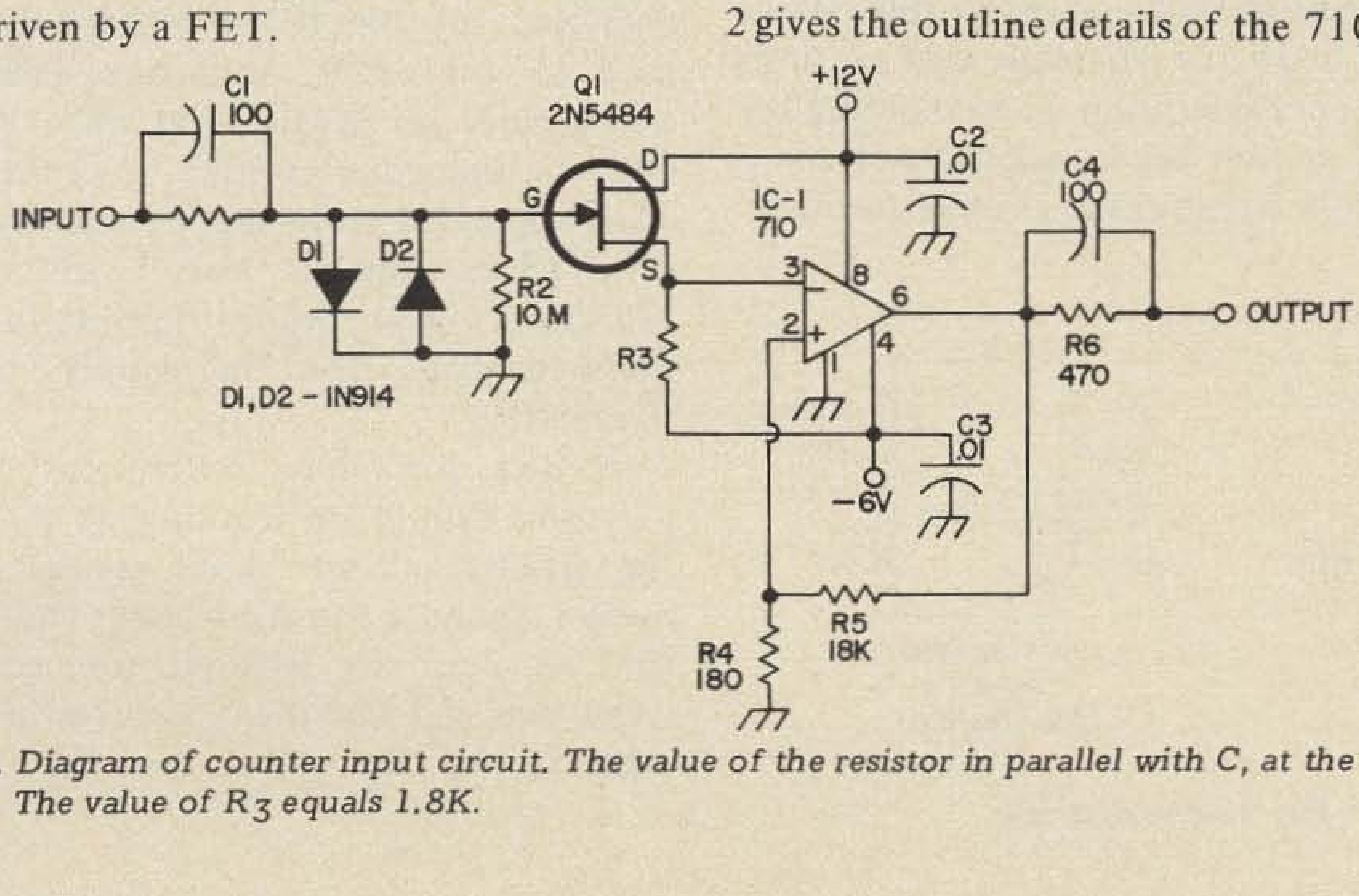


*Fig. 1. Diagram of counter input circuit. The value of the resistor in parallel with C, at the input, is 100K. The value of $R_3$ equals 1.8K.*

and also of the MC170CG which is in a TO-99 package Either will work well in this circuit and specifications are given for both units for reference purposes.

IC-1 is hooked up as a Schmitt trigger. When the voltage on the source of the FET, Q1, reaches the upper trip point of about 7 mV the Schmitt trigger will latch on. The output will be driven negative very quickly by the feedback action to the non-inverting input (marked +).

The way this works is as follows, for those of us who are new at these things. The positive going input signal is applied to the "Inverting" (–) input. That is to say, the positive going signal will be amplified and inverted, thus becoming a negative going signal at the output. This 'Non-inverting' (+) input will amplify whatever signal is applied to it and be in the same phase at the output. Since this is the feedback point in our circuit the original input signal, inverted, is fed to this non-inverting input, amplified and comes from the output even more negative. The result is a very fast switching action and a beautiful square wave, as the IC is driven into saturation in each direction, to apply to our counter circuits.

The reverse action is true also. As the input swings in the negative direction the output will switch into the positive direction. The voltage required to overcome the action in one direction and reverse it into the opposite direction is the hysteresis voltage and determines the minimum signal at the source of the FET which will trigger the IC. The hysteresis voltage in this circuit is about 20 to 30 mV.There are two cautions to take into consideration when building the circuit. One is that the bypass capacitors C2 and C3 should be mounted as close to the IC

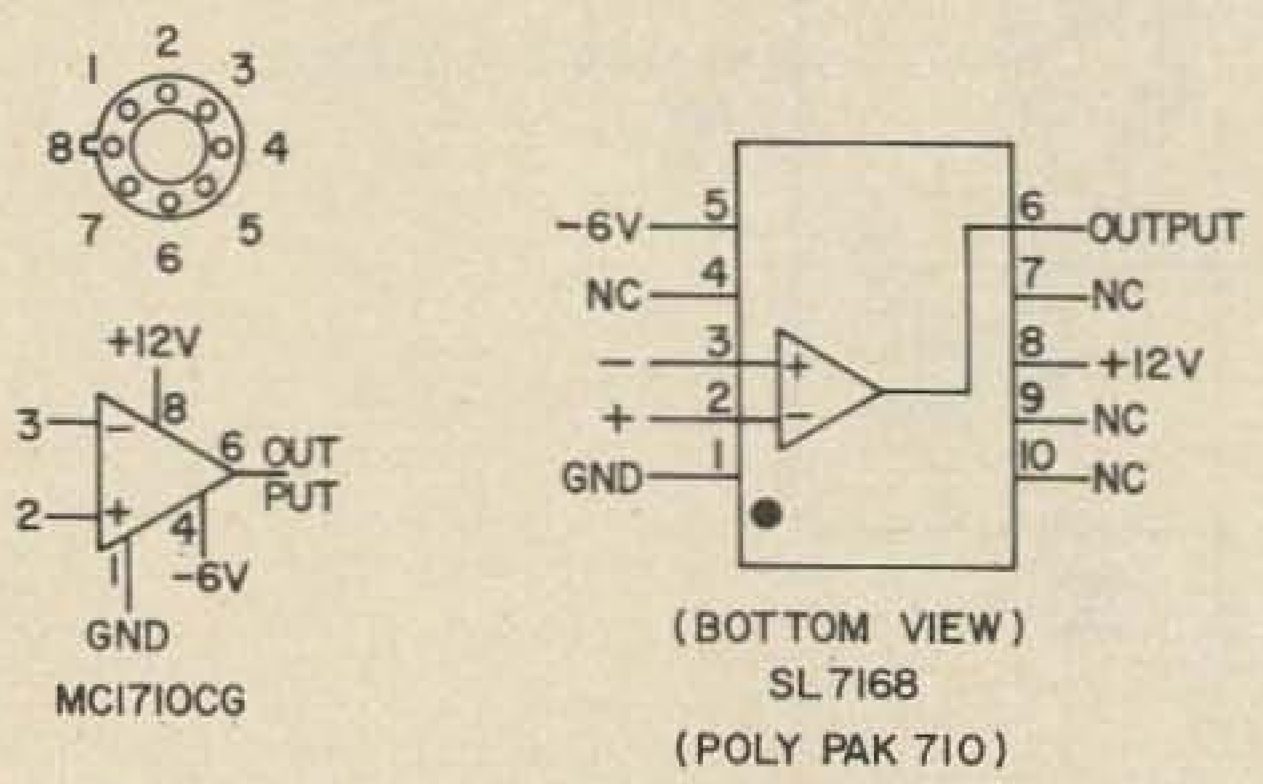


*Fig 2. Base diagrams.*

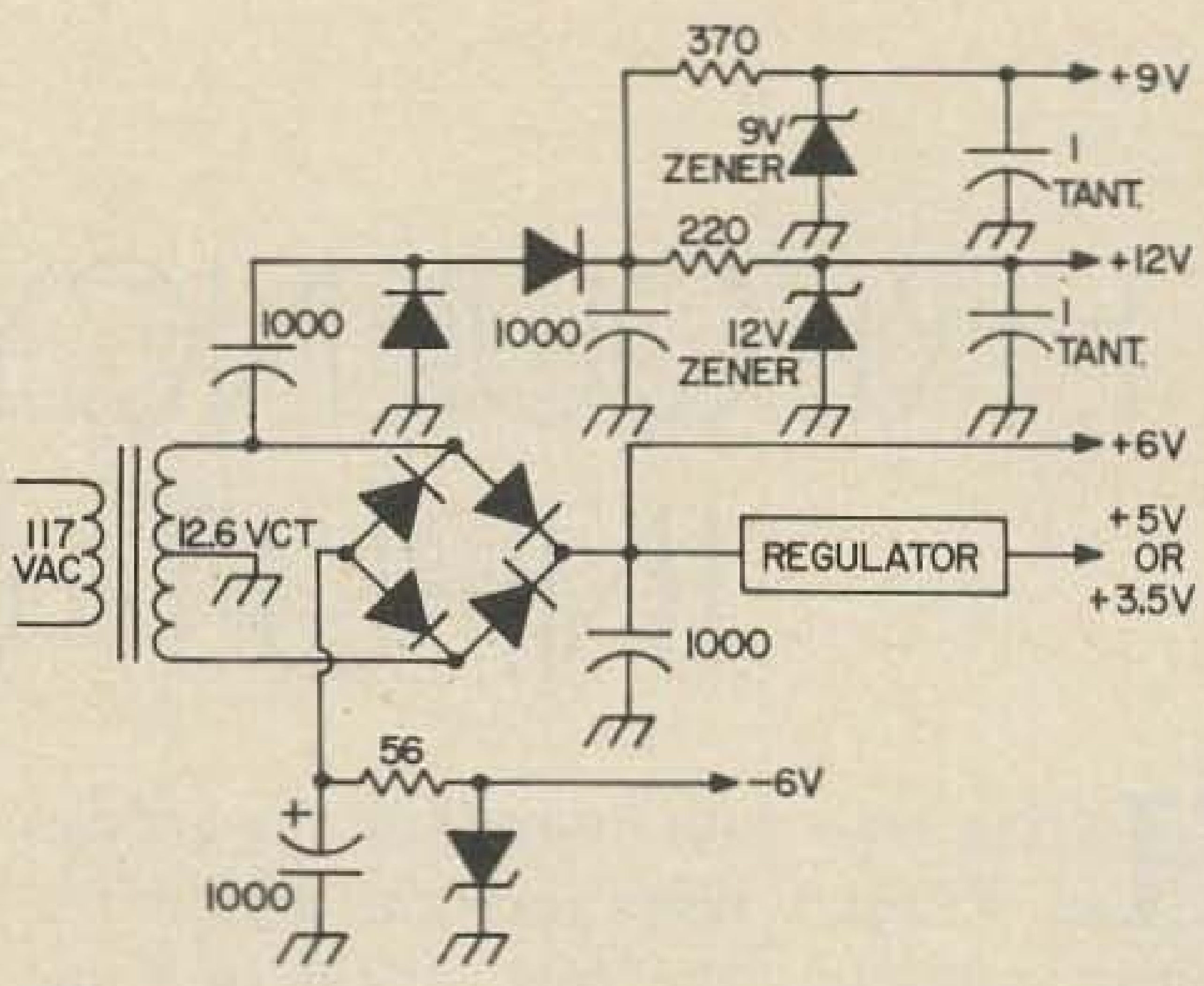


*Fig. 3. Power supply circuit.*

as possible. The other is that the value of R3 should be chosen to give a zero voltage at the source of Q1 with no signal input. This value can be found by experiment or a 1k resistor used with a 1 or 2k trim control in series to set the correct value. The value will be between 1 and 2k and is almost exactly 1.8k on my unit

There is a drawback to building such a circuit unless you already happen to have the voltages required. You need +12V and –6V. In my frequency counter I only had a 6V transformer with a bridge rectifier to supply the +6V and the regulated +3.5V.

The best solution is given in Fig. 3. The transformer is 12.6V center tapped. The bridge rectifier is actually two full wave rectifiers now. One half supplies the +6V as previously required and the other half supplies the –6V which is filtered and zener regulated for the IC. A voltage doubler is used to get +12V from one half of the transformer secondary, and since the oscillator in the counter uses +9V, this is also zener regulated from this doubler output. It is a good thing to use 1 $\mu$F tantalum capacitors on all supply outputs to prevent noise feedback from one supply voltage to the next.

If you don't have a frequency counter yet, you should be working on it. Read all the articles and ads, work up the old gray matter, spend a hundred bucks and have the time of your life without even going FM! (And you will find many uses for it there, as well.)

. . .K4EOE

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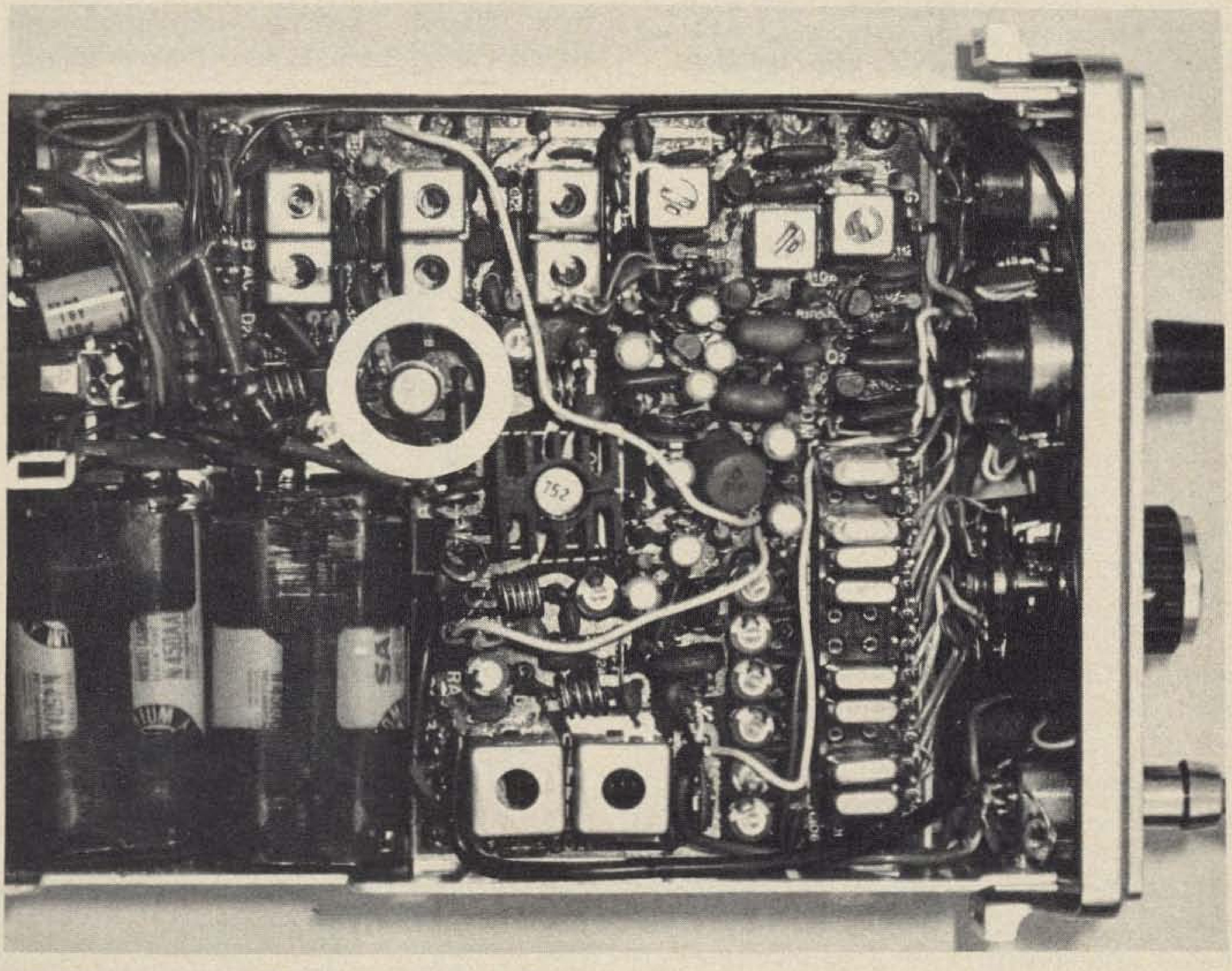
*Warren MI 48093*

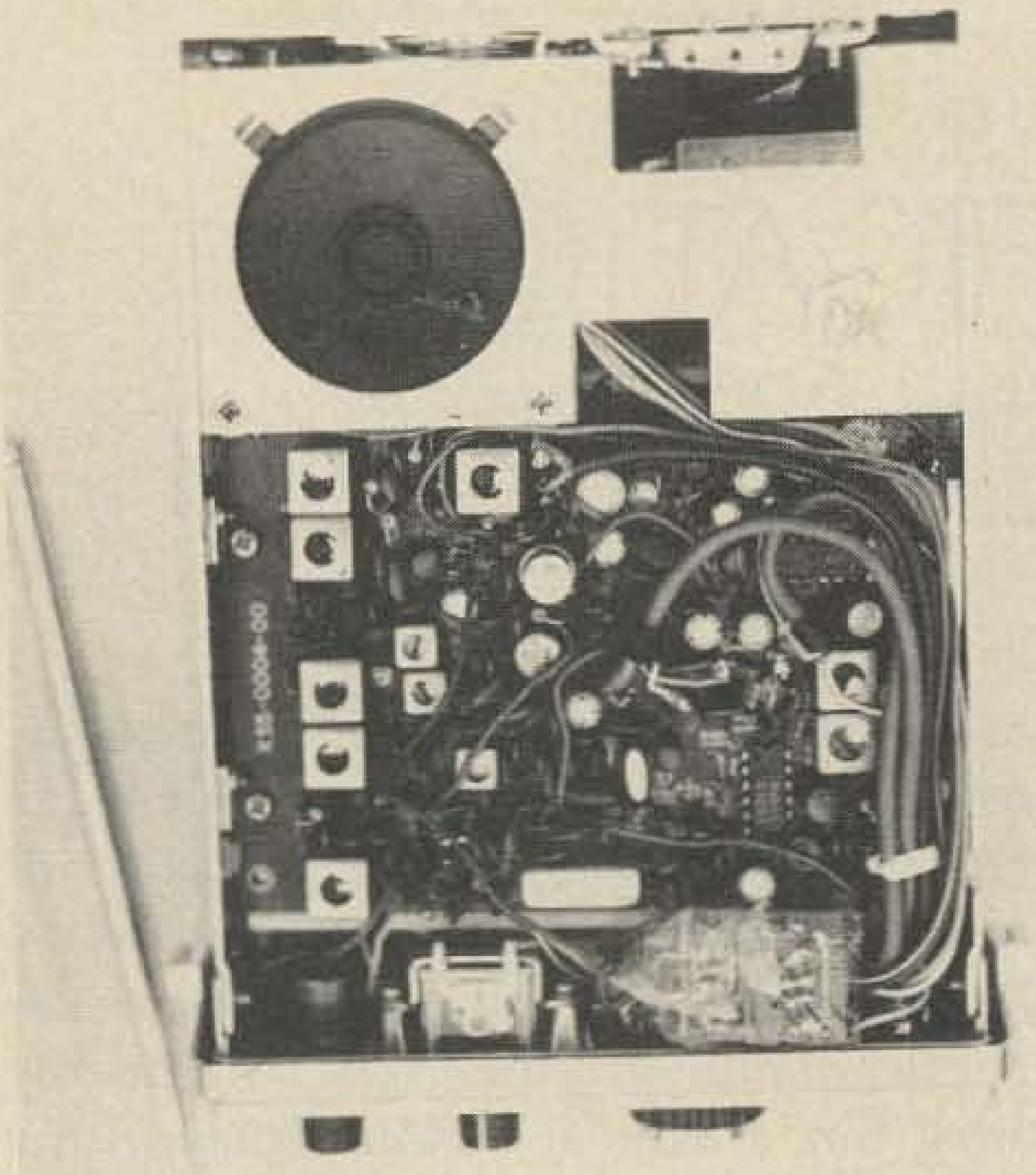
# TR-22 MODIFICATION (HIGHER POWER OUTPUT)

One of the most popular 2 meter FM transceivers in use today is the TR-22 from the R.L. Drake Company. Much of its popularity is due to the established reputation for quality of Drake products, but also the versatility of the unit itself. It can be used effectively as a mobile, a portable, and even a base station.

I have used my simplex as far as ten miles, but find that its very best dependability comes working into the repeaters in the Detroit area where I live. As a mobile, I can operate it on the car battery, and with a 5/8 whip, I have no trouble reaching the DART repeater on 04–64 or the GLRA on 16–76 from anywhere in the city or nearby suburbs. But I have also found that with a very simple modification, I could increase its power enough so that it would also hit the same two repeaters when I'm as far as 25 or 30 miles out.



*The transistor with the ring around it is the driver (Q28) that we are going to change. To gain access to the foil side of the transmitter board, we turn the rig over and remove the receiver board.*



*The side of the unit with the speaker has the receiver board. The self-contained antenna has been removed here along with its insulating sleeve, to disclose two mounting screws underneath it. These two screws are removed, along with two more on the left side which are under the wires.*

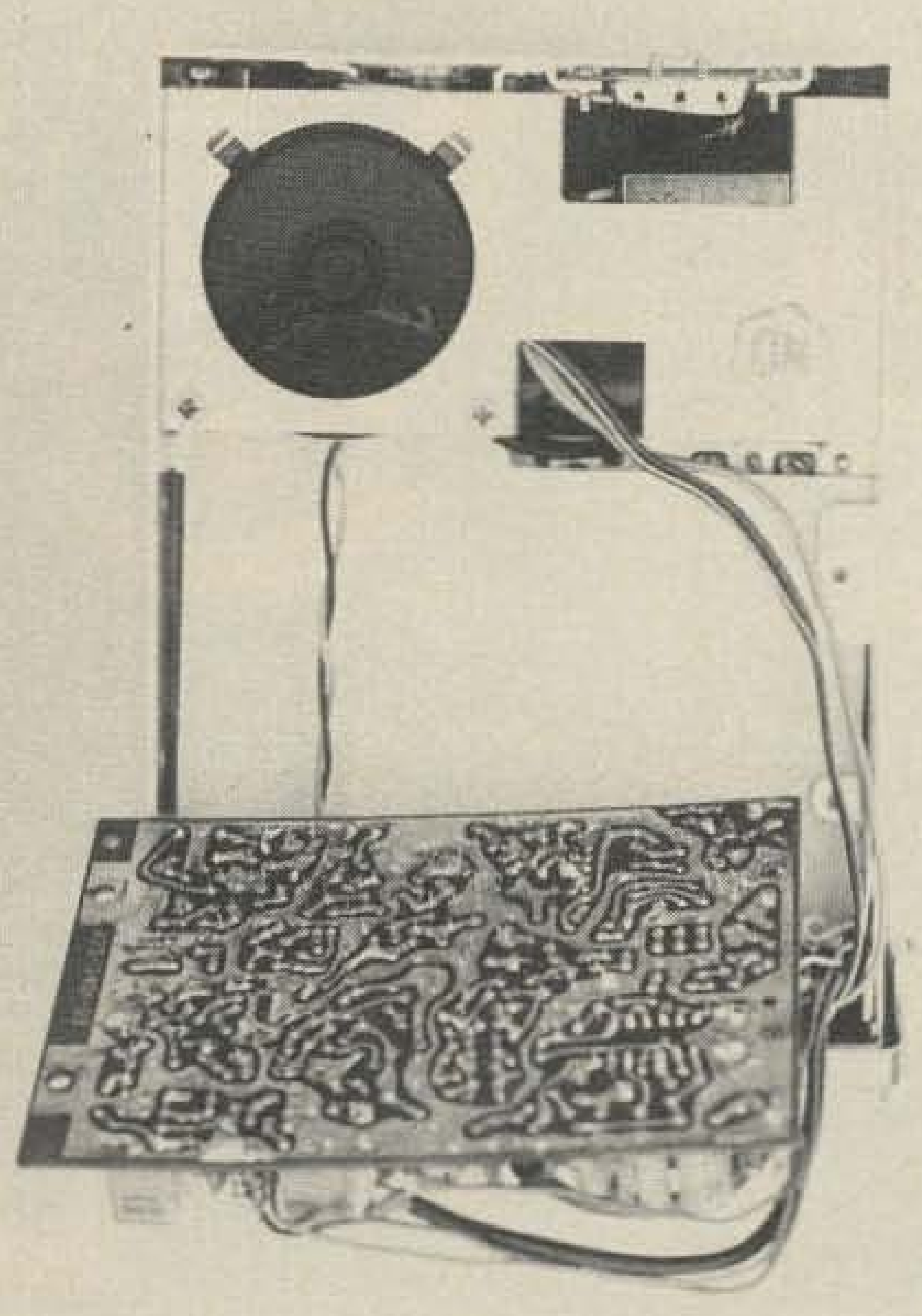
Simple – now, there's a word that I've heard misused quite a bit. I've read some articles where the author used that term with the connotation that meant it was simple if you were an electronic engineer with at least twenty-five years of experience and had $12,000 worth of test equipment at your fingertips to use. But when I define simple, it means that I can do it, and believe me, you can't get any simpler than that. In this case, you replace *one* transistor and peak two coils.

I first heard of the modification from another Detroit area ham, W8FJR (no relation), Roger Moss. He had returned from a vacation trip on the West Coast, and while in the Monterey, California area, he talked with WB6CTA, Jack Lemon, who was using a TR-22 that he had modified to almost double the power output. About two weeks later, I had to make a business trip out there and I talked with Jack a couple of times myself. He reported that he had changed his unit over a year before and had nothing but good luck with it ever since. He convinced me, so like Roger, I changed my own shortly after I got home.

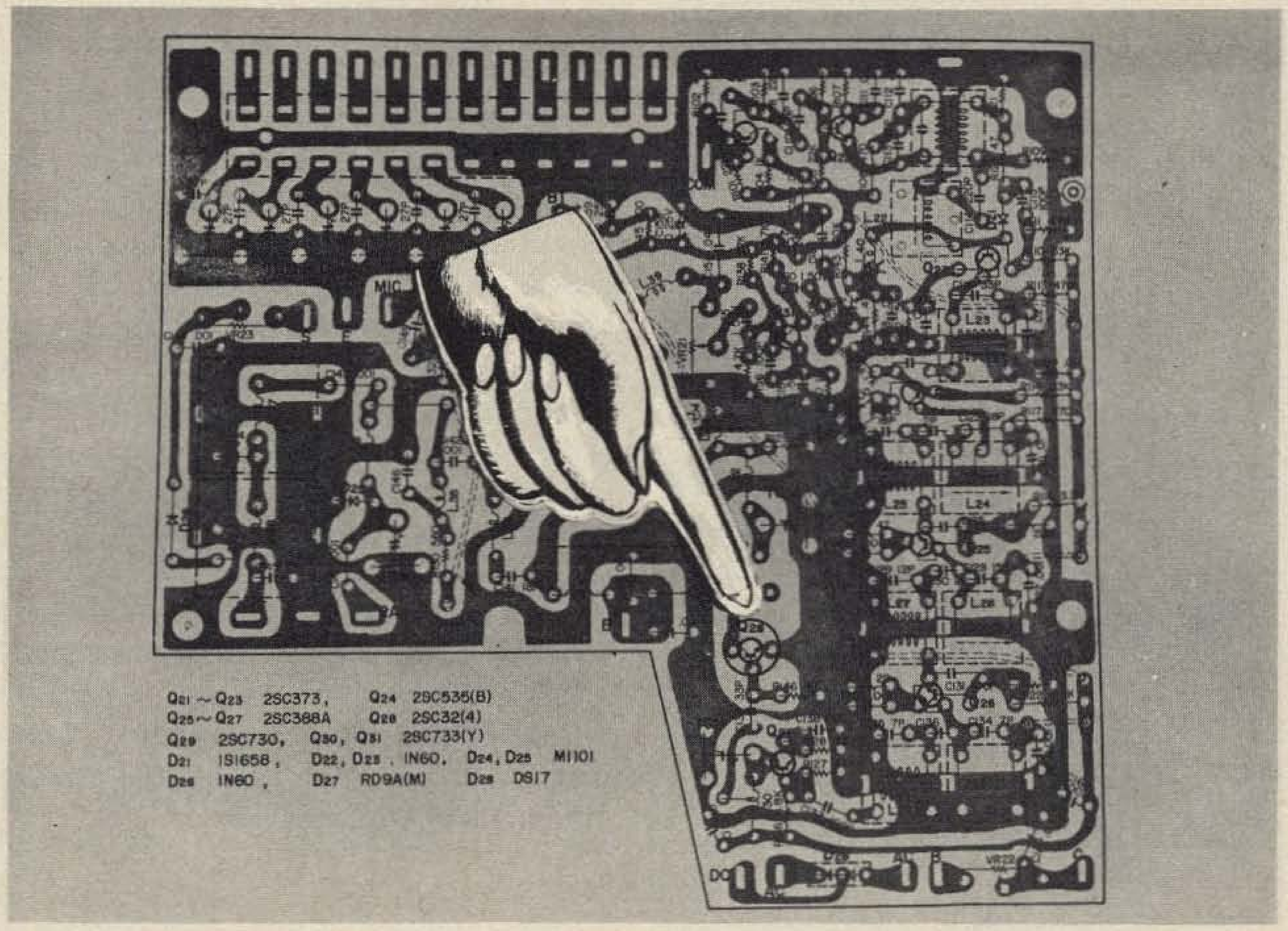
The driver transistor Q28 is replaced with a HEP-75 that is available everywhere, and then the coils on each side of it are peaked with the help of a Bird Wattmeter. With just three solder connections and a little tweaking, you have increased the power out from 1.7 to 2.7W.

I have taken a series of pictures to show how little of the rig must be dismantled to gain access to the board for the actual soldering. In compact rigs like the TR-22, this is an important consideration, as you don't want to put trouble into the rig by messing something up in the process. There are also photos to show the actual differences in output before and after the modification, as well as illustrating how you can gain almost another ten watts when working into an amplifier like the TPL 502B.

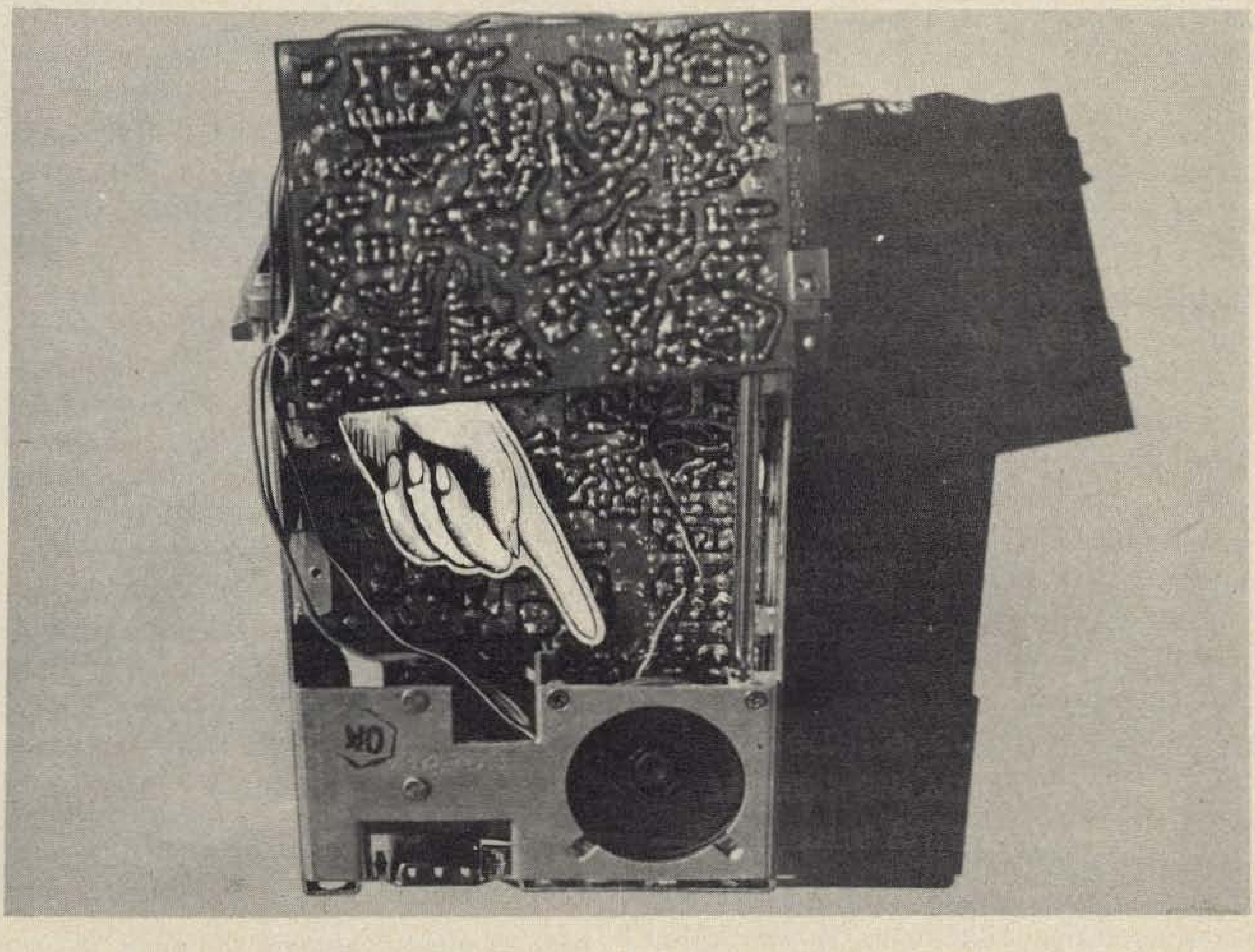
In the photos, my TR-22 will look just a little different than the conventional one which comes from Drake. I have added a



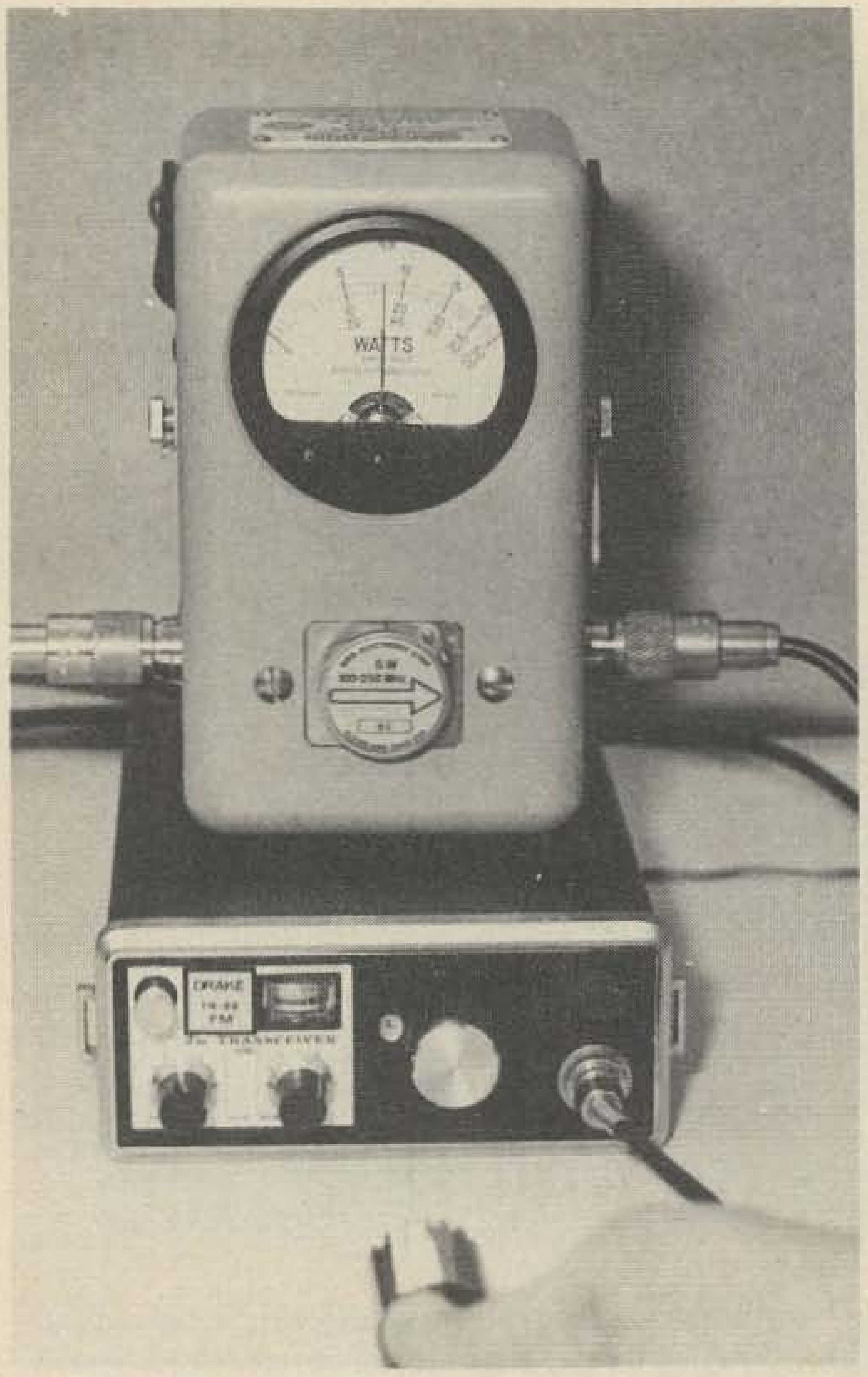
*After removing the four screws, take off two more that hold the small right angle brackets to the right side of the chassis frame. Carefully lift the receiver board to the right and out. You will now see the white fiberglass insulating board and the speaker wires.*




*The transmitter board is illustrated in the owner's manual with the foil side showing how actual connections are made. Here a circle has been drawn around Q28 to show the three connections where the present transistor is removed and the new one substituted.*



*The finger points to the same place on the actual board in the TR-22.*

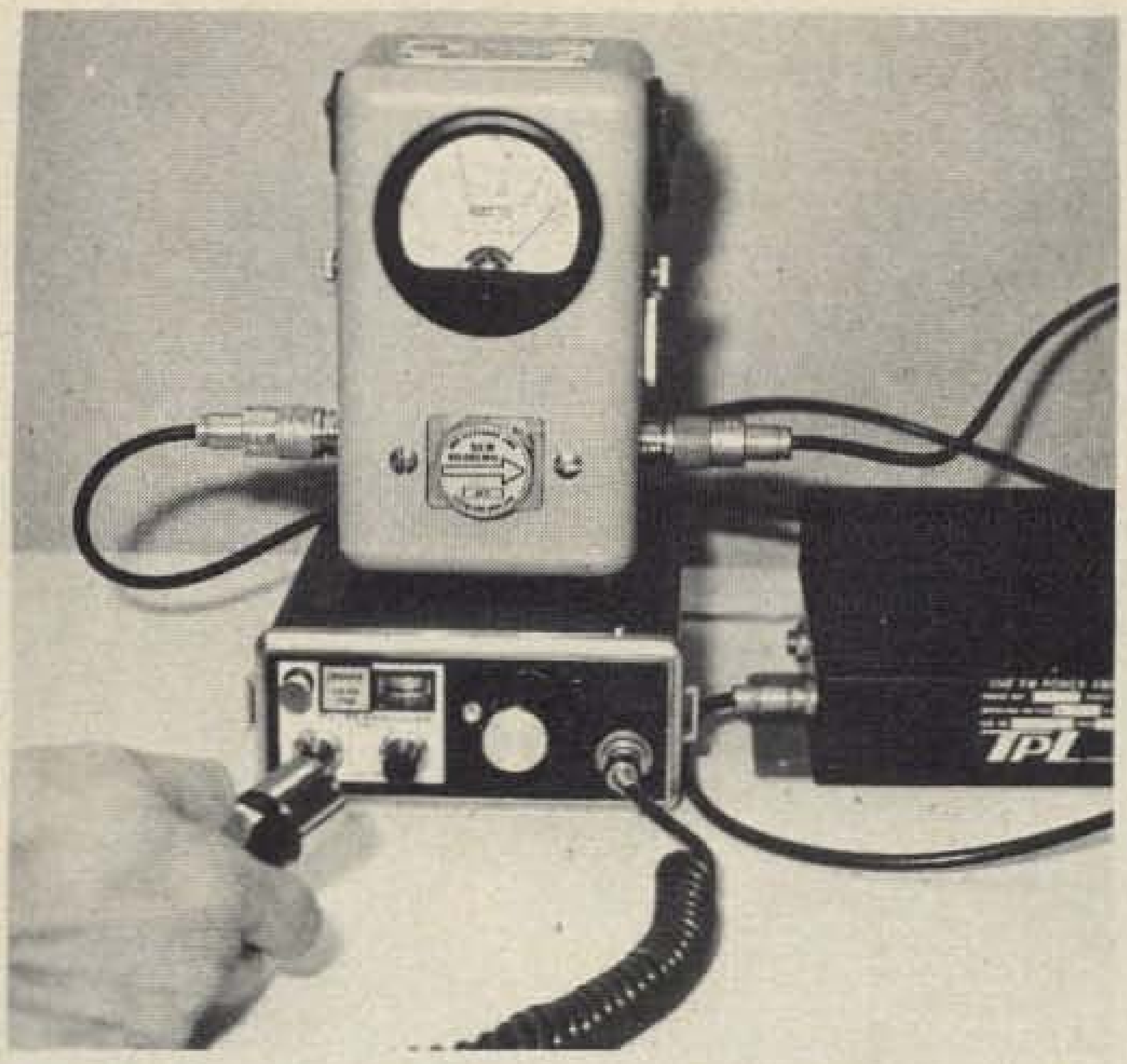



*Here an unmodified TR-22 is operated into a dummy load with a Bird Wattmeter showing actual output of 1.7W.*

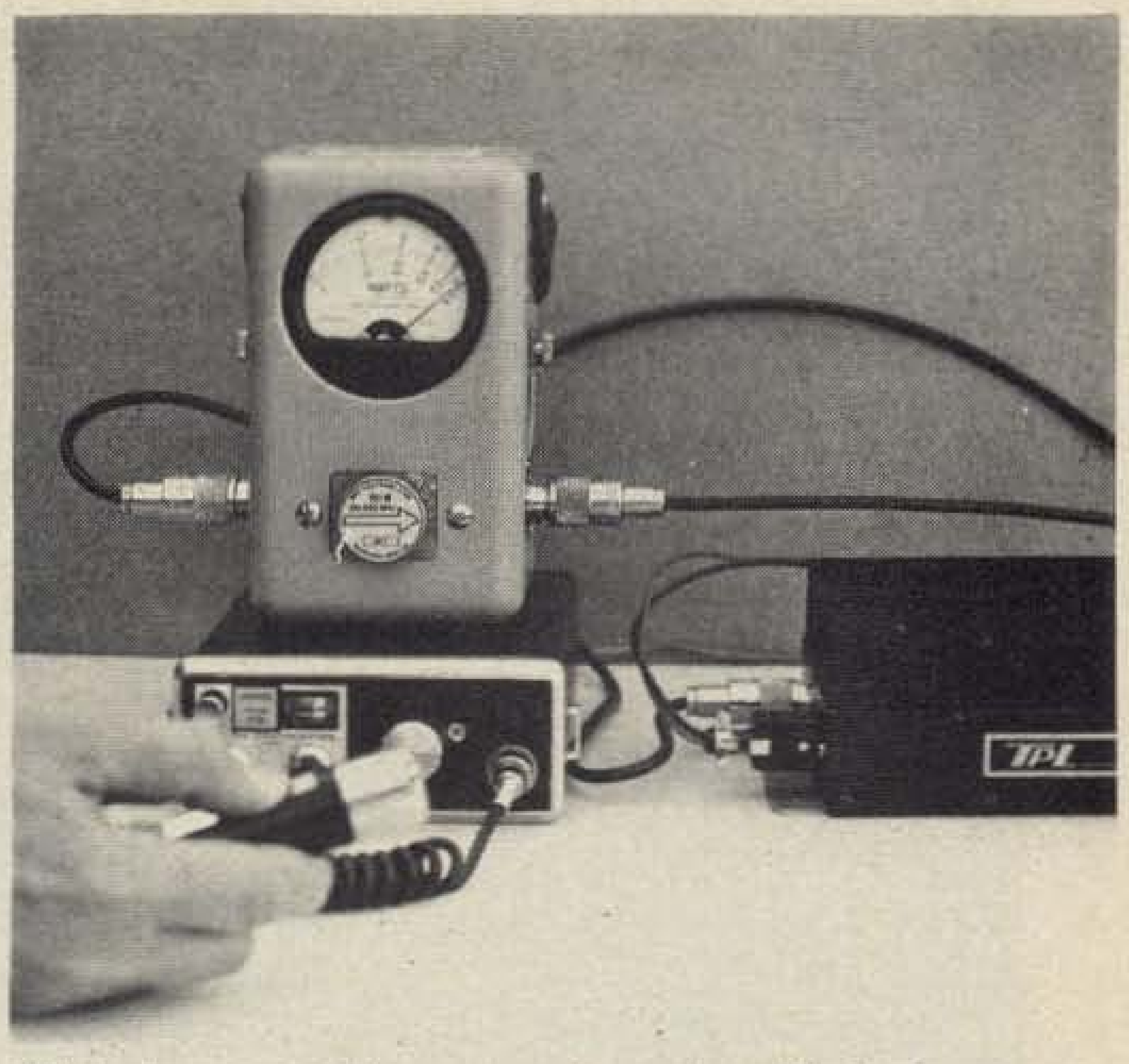
sub-audible tone encoder circuit to it because the two repeaters in the Detroit area require a 100 cycle tone for access. In the plastic bag at the upper right is the miniature circuit board and there are four wires leading from it to the left and down near the speaker to connect to the reed. Part of it can be seen above the ac connector at the bottom of the picture. Those wires also appear in the photo showing the fiberglass insulating board under the receiver board. The only wires seen in a regular set at that point will be the two leading to the speaker.

Even though this is a simple modification to accomplish, some precautions need to be taken to keep from turning it into a very complex project. Extreme care must be taken in the handling and movement of the boards to insure against breaking off any wire connections, and there is one other pitfall to be sure to avoid. Normal time to complete the whole job shouldn't be over 20 to 30 minutes, and the rig does not have to be moved around much in the process. However, if you lose the screw connection for the built-in antenna, you will have a hard time recovering it from under the speaker. It goes through a terminal and then the plastic block which is fastened to the side of the chassis frame with a screw. You can either temporarily remount the antenna after the fiberglass board is removed, or just be careful to not move the rig around so that that darned screw does not slide back. I had no problem with this in making the modification to my unit, but in taking it apart again to take the pictures for this article, it did get away from me. In recovering it, the terminal broke off and I had to replace the miniature coax and terminal. It was an extra task which could have been avoided by merely keeping the screw that holds the antenna from sliding back.


*With all other conditions the same, the modified transceiver output increases to 2.7W.*



*This photo and the next one show that a higher input to an amplifier like the TPL 502B will yield a higher output. Here the TR-22, as it comes from Drake, will have an output of 42W, with the aid of the TPL.*



*With the new driver transistor installed, the power from the amplifier increases to about 49W.*

Removing the old transistor and soldering in the new one are done in the same manner as routine soldering jobs. Since the transistors fit flush to the circuit boards, there is no room for using clamps to heat sink the connections while soldering. You should have no trouble here providing the iron is applied to each terminal only long enough to make the connection.

The two coils to be peaked are TC-27 and TC-28 and are plainly marked on the board. Alternating back and forth between the two as the Bird meter is watched for its highest output reading will complete the job.

For our tests and photos, I used a regular 12V automotive battery for the power source, and had the car engine running at fast idle to insure maximum voltage and current available. While it is best to show examples like this in terms of maximums, it should be remembered that the real benefits to raising power output in small amounts is in the lowest ranges, or when operating portable on the self-contained nicads.

There are several Class C amplifiers available to use with the smaller rigs like the TR-22. Drake offers their own AA-22 for 25W out, and the AA-10 for 10W. If you make this modification, you will *not* be able to use the new amp as it has a fixed input to match the TR-22s as they come from the factory. It should also be borne in mind that if your rig is less than 90 days old and therefore still under warranty, it would not be wise to make this or any other modification. No matter what you buy today, the warranty will be void when any unauthorized repairs or modifications are made to the product.

Battery life of the nicads is shortened by the increased output as it naturally takes more power. While this is difficult to measure, it has been estimated by my use – and some others that I know who have done theirs – to be approximately 25% less. For anyone who would find this to be confining to their operation, the original nicads could be replaced with some 500 mil nicads and this would increase the battery life by about 10%.

If you own a TR-22, the decision to make the modification should be made based on your own particular type of operation. For portable and mobile use barefooted, it almost doubles your effective range. If you work into a variable input amplifier, your increase will be in the vicinity of 16 to 20%. My own experience has proven it to be worthwhile, and in the six months since I have done it, I have found no reason to wish that I had not made the modification.

. . .W8FJA

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PART I

# TRANSISTOR RF POWER AMPLIFIERS

The following discussion of transistor rf power amplifiers assumes the reader knows his *alphas* and *betas* of transistor theory. He may also have had some experience with transistors in audio and small signal applications. The experience will have conditioned him to the importance of protecting transistors from excessive voltage and heat. But transistors perform so much differently as rf power amplifiers than they do in other applications that the previous experience is not essential to understand the discussion.

Figure 1 is the diagram of a typical transistor rf power amplifier. Transistors have largely replaced vacuum tubes in commercial and amateur VHF mobile transmitters at power levels up to 100 watts or so. Their compactness and high overall efficiency more than compensates for their high first cost. But, except in specialized applications, rf transistors quickly price themselves out of the market at power levels above a few watts in equipment operated from the commercial power lines.

As standard automobile and aircraft batteries deliver nominal voltages of 14 and 28 volts, it is hardly coincidental that most rf power transistors are designed to operate at these voltages. Incidentally, the 28 volt

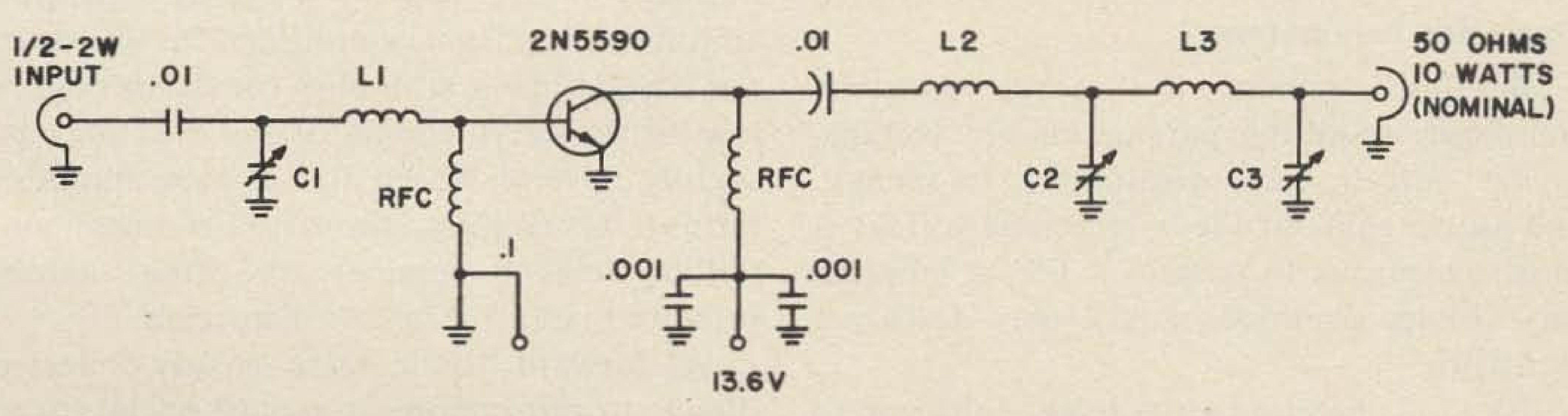


*Fig. 1. Typical transistor rf power amplifier.*

transistors are appreciably more efficent and cost less, watt per watt, than the 14 volt units.

Virtually all modern rf power transistors are silicon NPN's and are usually operated in the common emitter configuration. Early rf power transistors were easily destroyed by momentary overloads, transients, and stresses developed in tuneup operations. Newer units will not take unlimited abuse, but they are more rugged than the older ones; some of them will even survive being operated as rated voltages and rf drive into an open load circuit for at least a short time.

### Operating Parameters

In quick review, the more important transistor operating parameters are voltage, power output, heat dissipation, frequency, and power gain. Of these, excessive voltage is most dangerous to transistor life. A momentary voltage overload of 25% may destroy a transistor.

$BV_{ceo}$ – breakdown voltage, collector to emitter, base open – defines an absolute emitter peak voltage rating established by the transistor manufacturer using pulse techniques. For the user, however, $VCC_{max}$ is usually a more useful figure. $VCC_{max}$ is the maximum safe dc voltage that can be applied between the collector and the emitter of a transistor under any condition of operation.

Typical rated dc $VCC_{max}$ values are 80% of $BV_{ceo}$ for continuous wave (CW) and frequency modulated (FM) services and half that value for high-level amplitude-modulated (AM) service.

Also critical is the transistor base-to-emitter voltage. It has a breakdown rating of three to five volts for virtually all rf power transistors. Fortunately, base voltages are normally quite low in properly operated amplifiers. In class-C amplifiers, for example, the base is often grounded for dc through a low-resistance rf choke, or the base may be slightly reverse biased for highest amplifier output. Conversely, transistor rf linear amplifiers (class-B service) are often slightly forward biased for lowest distortion.

As forward bias increases steady collector direct current rapidly, it may be necessary to reduce the collector dc voltage somewhat to prevent excessive transistor heating, current "run-away," and "second breakdown" when the transistor base is forward biased.

Power input and heat: Each transistor has a maximum dissipation rating; but, in most units, the maximum rating applies only if heat sinks or other precautions keep the transistor case temperature to a maximum of 25 degrees, *centigrade*. Higher case temperatures require reducing the power input, improved case cooling, or greater transistor output efficiency.

In itself, the maximum direct current rating of a transistor is seldom too important, as other maximums are usually reached before maximum current flows. As a matter of interest, however, peak rf collector currents in power amplifiers are normally three to four times the indicated dc value.

Current runaway: All transistors tend to draw increased current as they become hotter. And as the current increases, the transistor gets hotter, and so on. Normally, current and temperature values rapidly stabilize. But if the transistor overheats, current increases so rapidly that the transistor may be destroyed.

Something like current runaway but more rapid is "second breakdown." It results from the emitter current being concentrated in a small area of the emitter to produce a pin-hole short in the emitter junction. Second breakdown problems increase with frequency and seem particularly troublesome in single sideband amplifiers.

One way to control second breakdown in rf power transistors is "balanced-emitter" construction. It consists of dividing the transistor emitter into up to 100 or more segments and connecting the segments together via internal, low-ohmage resistors. As the current in one segment begins to increase beyond the current in the other segments, the corresponding increase in voltage drop across its associated resistance limits the current through that segment.

Besides helping to control second breakdown, balanced emitter construction introduces a small amount of negative feedback into the transistor amplifier. This feedback improves linearity and stability. Power gain is also decreased slightly, but this is of no practical importance in most rf power amplifiers.

Gain, frequency, and stability: The current gain of a transistor is usually measured at a frequency of 1 kHz. As illustrated in Fig. 2, however, the gain varies with frequency. The shape of the gain-frequency curve is similar for all transistors, although the frequencies involved may be different.

Following the curve, the 1 kHz current gain remains essentially constant as the frequency is increased until a knee in the curve is reached. The point in the knee where the transistor current gain has dropped to 70.6% of its 1 kHz value is called the transistor "cut-off frequency." In terms of power, the point represents a 3 dB loss in gain. Beyond the knee of the curve, the transistor current gain decreases at the rate of 50% per octave.

In applications (such as high-fidelity amplifiers) where uniform amplification of frequencies over many octaves is required, a cut-off frequency at least as high as the top frequency to be amplified is required. While many power transistors have low cut-off frequencies, it is not difficult to find audio power transistors with cut-off frequencies of around 20 kHz.

It is difficult, however, to construct transistors that have both high-power capabilities and high cut-off frequencies. Consequently, power transistors with cut-off frequencies are very rare; nevertheless, transistor rf power amplifiers for frequencies up to and above 500 MHz are common. Obviously,

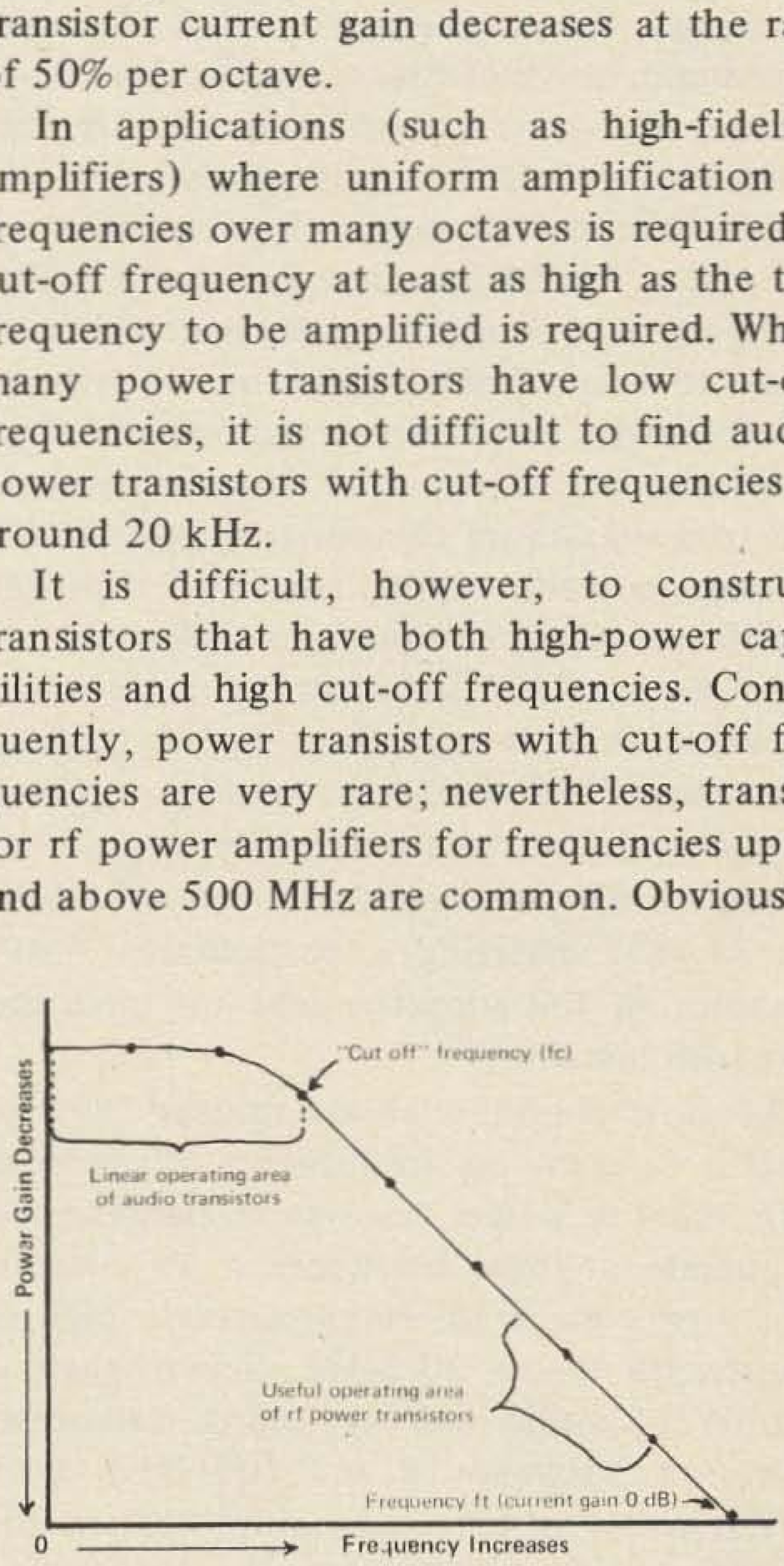


*Fig. 2. Typical gain-frequency curve of all transistors. Their power gain is essentially constant from dc to the transistor cut-off frequency (fc), where it has dropped 3 dB. From fc to frequency ft, the power gain decreases at the rate of 6 dB per octave – equivalent to a 3 dB per octave decrease of current gain.*

transistors are useful far above their cut-off frequencies. The story is this:

Above its cut-off frequency, the current gain of a transistor continues to decrease at the rate of 3 dB per octave (equivalent to a 6 dB decrease in power gain) until the current gain has decreased to unity or 0 dB. The frequency at which the current gain drops to 0 dB is called the "current-gain, bandwidth product," for the reasons illustrated, and is identified by the symbol *Ft*.[1]

Although the transistor gain varies inversely with frequency above its cut-off frequency, a conventional signal is so narrow, compared to an octave, on frequencies above a MHz or so that all components of the signal are amplified equally. On the other hand, the fact that transistor gain does decrease above its cut-off frequency is one reason that rf power amplifiers are practical.

You see, the dynamic characteristics of large-signal transistors change so radically during each operating cycle that neutralization to control self-oscillations in transistor rf power amplifiers is ineffective. But experience has shown that, if power gain is held to a maximum of approximately 15 dB per stage, a well-designed transistor rf power amplifier is stable without neutralization.

Power gain is controlled by selecting a transistor that is operating approximately two octaves below its *Ft* frequency. Commercial practice is to aim for a gain of around 10 dB per stage for a typical transistor; so that inserting a particularly "hot" transistor in the amplifier will not push the stage into instability.

As most commercial and military mobile services operate on frequencies above 100 MHz, most rf power transistors are designed to operate at these frequencies. As a result, their power gains are embarrassingly high at frequencies below 30 MHz. Nevertheless, a number of audio and switching transistors with *Ft's* between 10 and 100 MHz work satisfactorily as rf power amplifiers in the lower-frequency amateur bands.

*1. The transistor still has power gain at frequency ft, even though its current gain is unity there. This follows because the transistor output resistance is greater than its input resistance. This fact is of minor importance, except when an effort is made to make a transistor operate at the highest possible frequency.*

Why the frequency *Ft* is called the "current gain bandwidth product:" Assume that a transistor has a current gain of 1 dB at 400 MHz. One times 400 MHz equals a product of 400 MHz. At 200 MHz (one octave lower in frequency) the transistor current gain is 2. Two times 200 MHz equals 400 MHz. at 100 MHz, the product is 4 X 100 MHz = 400 MHz, etc. As power varies as to the square of the current, the power gain of this hypothetical transistor is 4 (6 dB) at 200 MHz and 16 (12 dB) at 100 MHz.

Coupling circuits: A transistor or tube is useless as an rf amplifier without means of coupling power into and out of it. To do the job efficiently, the coupling devices must match the impedances of the transistor or the tube to its source and load impedances. In the process, the coupling circuits provide selectivity to prevent distortion products generated in the amplifier from reaching its load – especially important when the load is an antenna.

An output circuit Q of 10 to 12 is usually sufficient in vacuum tube rf amplifiers. But rf power transistors normally generate more distortion products than tubes do; therefore higher Q, resulting in greater selectivity, is desirable in transistor coupling circuits.

Simple parallel-resonant or *pi* net coupling circuits normally work well with the high impedances of vacuum tubes. But transistor impedances are so low that other types of coupling circuits are desired in rf power amplifiers. A simple *L* network, for example, can be designed to match virtually any resistance or impedance to virtually any other impedance or resistance. Unfortunately, when the ratio between the two impedances or resistances is low, the resultant Q of the *L* network is low.

Fortunately, two or more networks may be combined to obtain the desired Q and impedance match. In Fig. 1, for example, the input circuit is a simple *L* network, and the output circuit is a combined *L-pi* network.

The second part of this articles continues the discussion of the design of transistor rf power amplifiers. It also contains all component values for practical transistor amplifiers for the amateur frequencies between 3.5 and 148 MHz.

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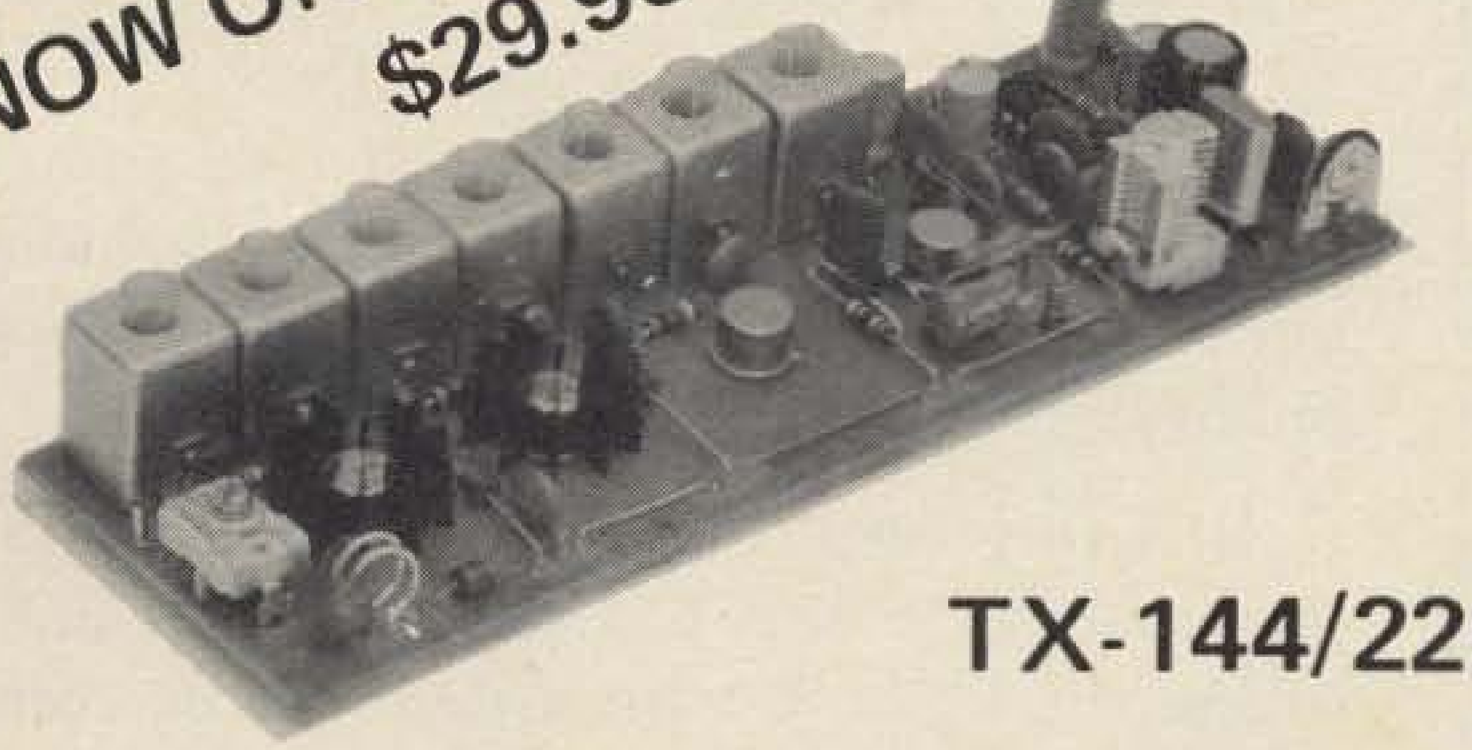

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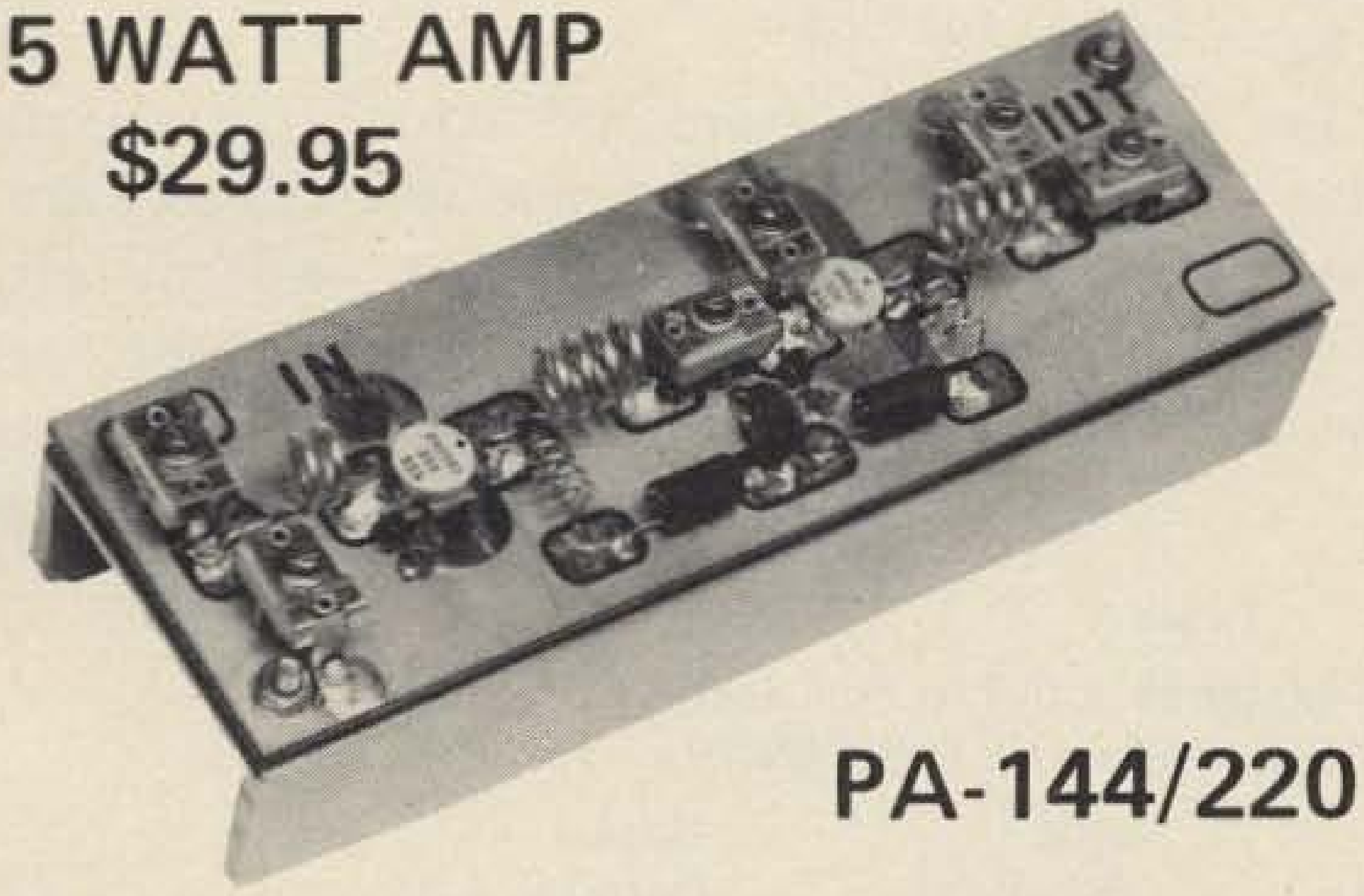

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# LIGHT BULBS AS RF POWER INDICATORS

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The major appeal to the amateur – as well as some commercial applications – of light bulbs as rf power indicators is low cost. To this must be added the universal availability of bulbs and screwbase sockets for pennies.

As low cost is of primary interest to well over 50% of those interested in any project, and as I have always had an insatiable desire to find out the why's and wherefore's of standard light bulbs as rf power indicators, I decided it might be the opportune time to do a resarch project and determine once and for all just which bulbs might be suitable and which might not be, and also to determine whether light bulbs would make *good* rf power indicators, or poor, and to find out what precautions might have to be taken if one decided he was going to take this low-cost path of determining his transmitter output power rather than go for a more expensive power output meter.

Also, power output meters in the higher wattage ranges become quite expensive compared to the $2 to $5 which might be expended in a light bulb indicator. In general, porcelain screw bases are available for from 12¢ to 25¢ each, and bulbs from 15¢ to 65¢ each, and not more than four of each are necessary for up to 3 KW power indication.

Table 1 lists most of the common types of electric light bulbs readily available. One look at this table immediately reveals why such light bulbs might not be such good rf power indicators as some folks may have thought they were in the past. It also reveals that some very special precautions have to be taken in using them, or the user may find he has overloaded his transmitter and burned up a few components which might be expensive to replace.

The extremely high ratio of cold to hot filament resistance in all types of these bulbs immediately struck me as being the most undesirable factor in using them.

It is very easy to see, for instance, that if one wished to use a 250W bulb for indication on a 250W transmitter, and he computed the resistance at 250W to be 53Ω, (which it is, but only when *hot*), he would assume he had just about a perfectly matched indicator to plug in in place of his 52.5Ω feed line.

However, from this table, it is apparent that this 53Ω resistance is attained *only* at full brilliance and wattage, and the actual cold resistance is only 3.5Ω. In other words, if the bulb were connected to the antenna terminals of the transmitter, and the trans-

**Table 1**
**Variation in Resistance, Cold to Hot State, Common Variety of Electric Light Bulbs.**

| Bulb Rating Watts At 115V | Cold Filament Resistance | Hot Filament Resistance | Ratio Cold to Hot Filament Res. (Approx.) |
|---|---|---|---|
| 7.5 | 166 | 1750 | 1 to 10 |
| 25 | 40 | 529 | 1 to 13 |
| 40 | 27 | 331 | 1 to 12 |
| 60 | 20 | 219 | 1 to 11 |
| 100 | 9 | 132 | 1 to 15 |
| 150 | 6 | 83 | 1 to 14 |
| 200 | 4.5 | 65 | 1 to 14 |
| 250 | 3.5 | 53 | 1 to 15 |
| 500 | 2 | 26 | 1 to 13 |
| 750 | 1+ | 17.7 | 1 to 15 |

mitter keyed full power, the transmitter would be looking into *not* 53Ω, but 3.5Ω, which is a lot of difference, and an extremely low value for any pi network to match.

For a few seconds, until the filament attained full brilliance, the transmitter would be subjected to a terrific overload, due to this impedance mismatch.

Therefore the first precaution which might be emphasized in using light bulbs would be *not* to key the transmitter at full power with a cold bulb, but to gradually bring the power from some lower value to full power as the bulb attains full brightness (and hot, matching resistance).

Not until I got into this project did I realize the very high ratio of resistance of these filaments from the cold to hot state; I don't suppose very many people do. It also brings to mind how the house electric meter must jump every time a bulb is snapped on in the house. This is not an ad for those light dimmers being sold at all the electrical stores, but it sure brings to mind that power bills could be cut appreciably through their use, i.e., bringing the bulb gradually to full brilliance instead of just snapping on a switch.

Getting back to the bulbs, Table 2 gives in various configurations series, and/or parallel combinations which would be most likely to give the amateur a load for a particular transmitter power output, in nominal impedances near 52 and 72Ω. If the configuration mentions 200W, this does not mean that it would be suitable for indicating the output of a 100W output transmitter, because at half brightness, the resistance offered by the bulb is not identical to that at full brightness.

While a differance of an ohm or two would not be serious, nor would a difference of as much as five, or even ten watts, at high power levels, at low power levels less than 100W, for instance, such differences would be seen to become increasingly serious from the matched impedance standpoint. The configurations given match quite a variety of standard line impedances and a wide range of power outputs. Matches can be obtained for RG-8, 11, 17, 13, 58 and 59 type cable.[1]

One may not realize without measurement that the lead length of the filament support wires alone inside the 25–150W bulbs is very close to 18 cm. Even though they are coiled on a 2 to 1 ratio, the filament is inductive in every sense of the word. At higher frequencies, the filament support wires would appear inductive, and to these factors must be added the parallel capacity of the screwbase shell and the central base contact wafer. Even though such capacity is small, it would become significant at most amateur frequencies above the 30 MHz range. Though the 22 cm total wire path would perhaps indicate a bulb could be used up to 300 MHz, such is not at all the case.

It is easy to see that the sometimes suggested trick of using a capacitor in series with a light bulb as a load should be approached with caution, for it would be very easy indeed to run into a series resonant circuit which might result in damage to the

**Table 2**

**Possible Configurations for Various Power Outputs at Various Impedance Terminations**

| | | |
|---|---|---|
| A. – Nominal 70 to 73Ω Impedance Loads: | | |
| 175W Load: | 3–60W bulbs in parallel | (73Ω) |
| | OR | |
| | 7–25W bulbs in parallel | (70Ω) |
| 3,000W Load: | | |
| | 4–750W bulbs in series | (71Ω) |
| B. ) Nominal 50 to 55Ω Impedance Loads: | | |
| 250W Load: | 4–60W bulbs in parallel | (54.9Ω) |
| 500W Load: | 2–150W bulbs in series, both paralleled by 1–150W bulb | (55Ω) |
| 1,000W Load: | 2–500W bulbs in series | (53.6Ω) |
| 2,250W load: | 3–750W bulbs in series | (53.1Ω) |

transmitter to which such circuit were connected.

In the course of my preparation of this article, I discussed the ramifications with a number of interested hams. Some of them suggested I extend the research to include the use of the smaller types of indicator (pilot) bulbs as loads for testing out transmitters with power outputs in the 1W to 20W range, not only just for amateur applications, but also with a view to using them as loads in testing FM transmitters.

When one considers that there are well over 100 types of these small bulbs, rated from .001W to 2W, and if all of these were to be considered individually, it could take a vast amount of time – and eventually one would end up with perhaps only five or so of these bulbs that would be at all suitable, so such research was not included in this article. However it did open up a field in which there may be a demand for information and may be the subject of a subsequent article.

**Frequency Ranges**

The use of standard screw-base ceramic or steatite porcelain light bulb sockets is entirely feasible for all of the configurations shown and will handle all amateur bands, 160 through 10. Naturally the leads from socket to socket should be as short as possible in either the series and/or parallel configurations. I found these leads can be kept to approximately 2 cm for such interconnections. Likewise, the coax termination lead should be kept to 2 cm or less.

If extra precautions as to lead lengths are observed, and the bases of the bulbs removed to enable connections directly to the stem wires, it would appear reasonable to suspect that these bulbs might be used for 6, 5, and perhaps 2 meter bands, but it is also quite evident the 2 meter band would be the practical limit.

One should be able to conjecture that light bulbs as power rf indicators are not quite the equal of well-designed power output meters which maintain their rated impedances over a very wide power output range – bulbs do not – but then, they *are* cheap in comparison.

Visual comparison of brightness is completely satisfactory for comparison purposes. For instance, a 500W bulb connected to the 115V mains should show the same brilliance as one of the 500W bulbs as used in the 1 KW load.

Actually a transmitter supposedly putting out 2,000W PEP is putting out something less than 1,000W with average voice modulation; it would be more of the order of 500–750W average power. Remember that the light bulb is only going to show average power output, not peak, and as ham transmitters are limited to 1,000W dc input to the final amplifier, one cannot expect much more than 500–750W output (average) unless the efficiency of the final amplifier stage approaches 85% which is very unusual, although I am hearing lately that certain high-power transistors are in development which will deliver such high efficiency figures; a bit above that which heretofore has been obtainable with tubes. You should be hearing a lot more about these super-efficiency transistors in the near future; and I expect them to be appearing in certain ham transmitters within a year or so.

Naturally a CW transmitter with the final operated Class C may deliver as much as 850W with 1,000W dc input, while a DSB transmitter on phone could not be expected to deliver more than 650W with Class A or B modulation.

The research and conclusions I reached on this project brought to mind the old subject of using light bulbs in series with primaries of transformers to reduce the secondary output voltages, which is a trick which has been used for years by hams and others. The information contained herein indicates they are not only quite suitable for such usage, but in fact make quite ideal voltage regulators of a sort.

In fact, the question immediately arises as to why bulbs would not make rather ideal voltage regulators for high voltage supplies if used as a variable-resistance dc regulator in the dc leg. This again opens up a field which might bear intense investigation.

. . .WB2GQY

[1] Solid Dielectric RF Transmission Lines, W8LUQ, *Radio News* Oct. 1946.
Line Matching: Table of Power and Voltage Loss in DB, *Radio News* Feb. 1947.

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# ECONOMY FILTERS FOR THE COLLINS 75A4

The Collins 75A4 amateur band receiver, although it is over ten years old, is one of the best pieces of amateur equipment available[1]. The selectivity is controlled by mechanical filters. Usually just the 3 kHz mechanical filter is supplied, leaving positions available for two additional filters.

Collins Radio still manufactures mechanical filters specifically for the 75A4 with bandwidths from several hundred Hertz (for CW use) to tens of kilohertz (for AM or other wideband signal use). A worthwhile savings may be obtained by purchasing filters in economy case configurations and making a suitable adapter for the 75A4.

A sharp filter with 500 Hz bandwidth was constructed using a Collins type FA filter mounted in a standard minibox. A broad filter was made using a series of subminiature i-f transformers, again mounted in a standard minibox. The i-f transformers were used because the steep skirts of a mechanical filter were judged an expensive luxury for this application. Broad band mechanical filters are available in economy case configurations.

A savings of at least $15 should be realized by constructing a case for F455FA05 filter. Installing this filter and a plug in a minibox should take a few hours at most. A savings of up to $50 should be realized by constructing a broad filter from

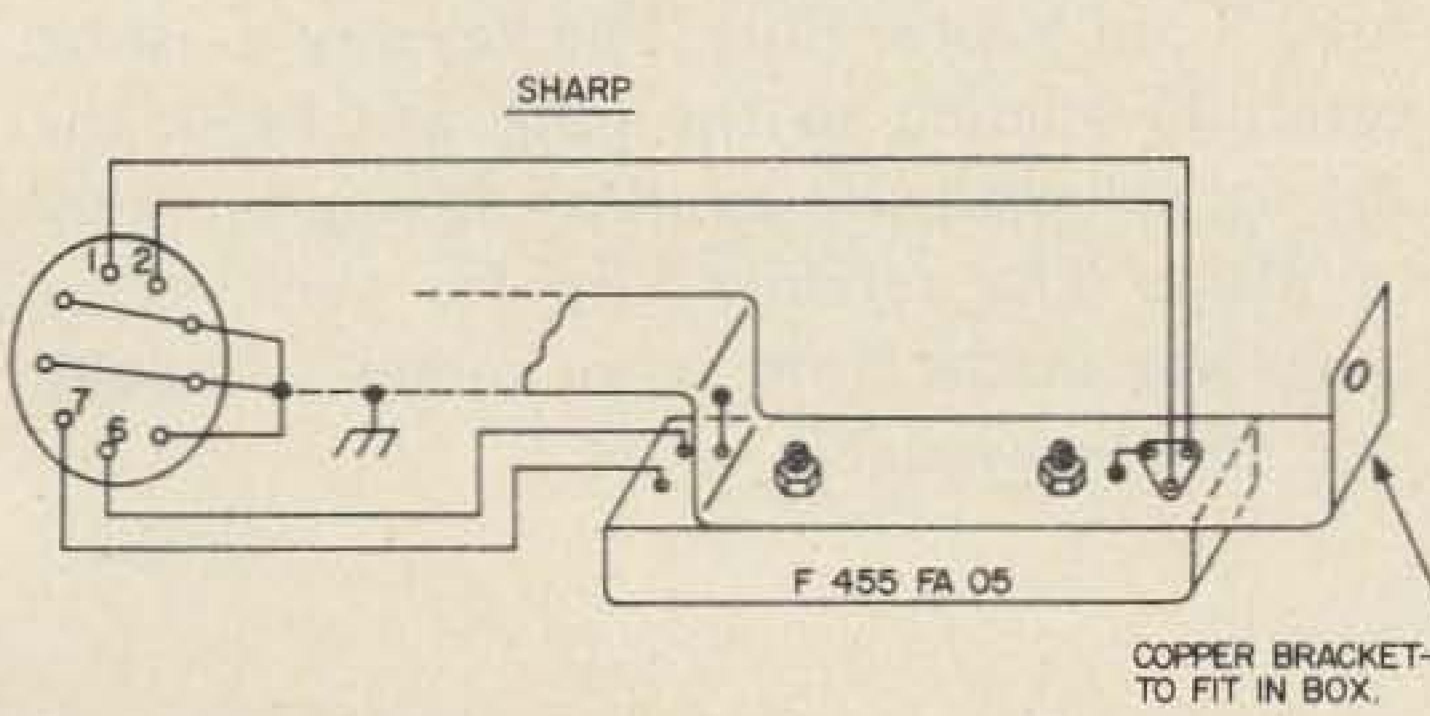


*Fig. 1. Sharp filter with 500 Hz bandwidth.*

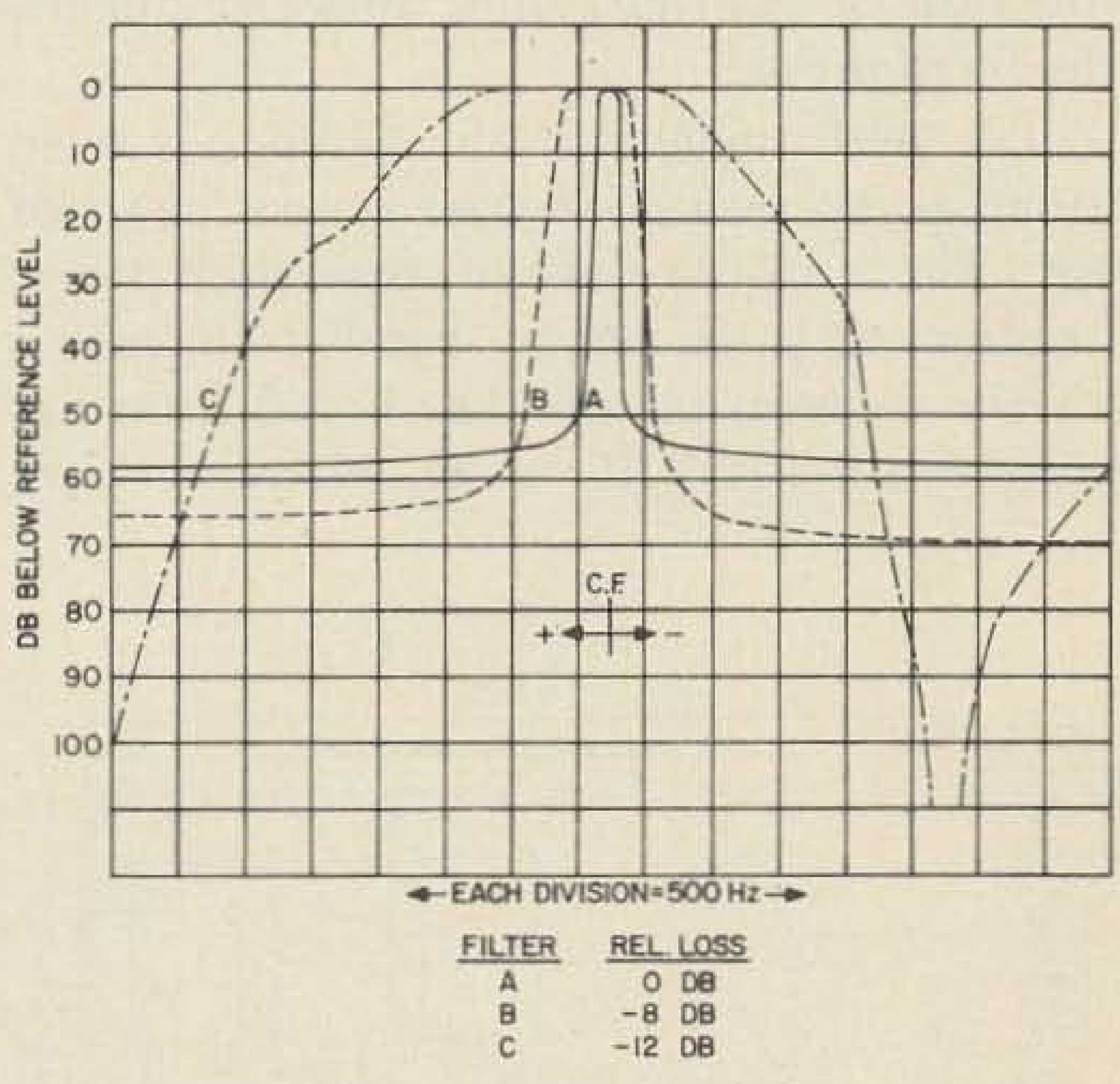


*Fig. 2. Results with different filters. A = 500 Hz bandwidth filter; B = 3.1 Hz bandwidth; C= the broad filter described.*

[1] *QST* Nov. 66, page 53.

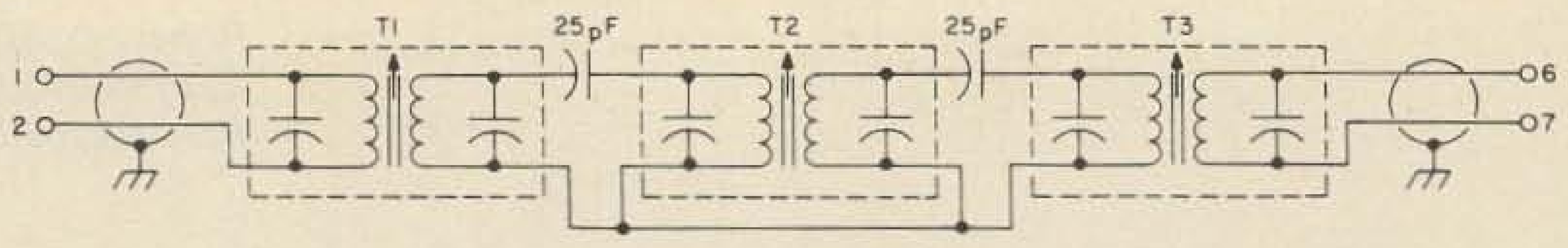


*Fig. 3. Schematic of the broad filter.*

i-f transformers. The construction time is probably double that of the sharp filter.

The results obtained are shown by the accompanying graph. Curve A is the 500 Hz bandwidth filter, Curve B is the standard 3.1 Hz bandwidth Collins filter supplied with the 75A4, and Curve C is the broad filter. Each curve has been shifted vertically so that its peak in output lies on the 0 dB line. With respect to the 3.1 Hz filter, the 500 Hz filter output was 8 dB higher and the broad filter output was 4 dB lower, each having the same input level.

The increased stop-band feedthrough level on the sharp filter may be due to signal leakage around the filter, or it may just be the filter characteristics. Relatively the same construction technique was used in the sharp and broad filters. Note the extreme attenuation achieved at points by the broad filter.

These measurements were made by first calibrating the s-meter of a 75A4 against a set of accurate attenuators. A calibration curve was thus obtained for the s-meter readings. A fixed signal was then tuned in, and the s-meter readings were plotted as a function of receiver tuning above and below the fixed input.

The performance of the filters has been found to be very good over several years of use. The reduced loss of the sharp filter, together with its narrow bandwidth, makes it very pleasant to use. The broad filter has been useful for VHF work, where network stations are not always exactly on frequency. It also makes AM signals more understandable than the 3.1 kHz filter.

The circuitry is quite standard, and is shown in the accompanying figure. There should be no dc current flowing through the mechanical filter input and output windings. It is my understanding that a modification of early 75A4 receivers is necessary to prevent this. The input and output should be well shielded from each other.

The broad filter consists of three Miller 10-C-1 455 kHz i-f transformers series connected. Both the input and output circuits float. There are no chassis ground connections made inside the filter case. The interstage coupling capacitors were selected to give the same output level as the 3.1 kHz mechanical filter. Increasing the capacity will increase the output level (to a point). A broader response may be obtained by using fewer transformers, or by increasing the coupling capacity to get a double-peaked overcoupled response, or both. I have not tried overcoupling the transformers, so their behavior in this respect is unknown. The maximum possible bandwidth may be obtained with a simple R-C-R coupling network.[2]

The cases were made from 1 1/8 x 2 1/8 by 3 1/4 miniboxes. The components were mounted on a copper bracket the width of the minibox (1 1/8) which was then installed in the minibox. A keyway hole was punched for a 9 pin Vector plug. The keyway must be carefully aligned so the plug will fit in the A4 socket with the minibox sitting squarely in place. The retainer clip for the Vector plug was made from scrap metal, although one may be available.

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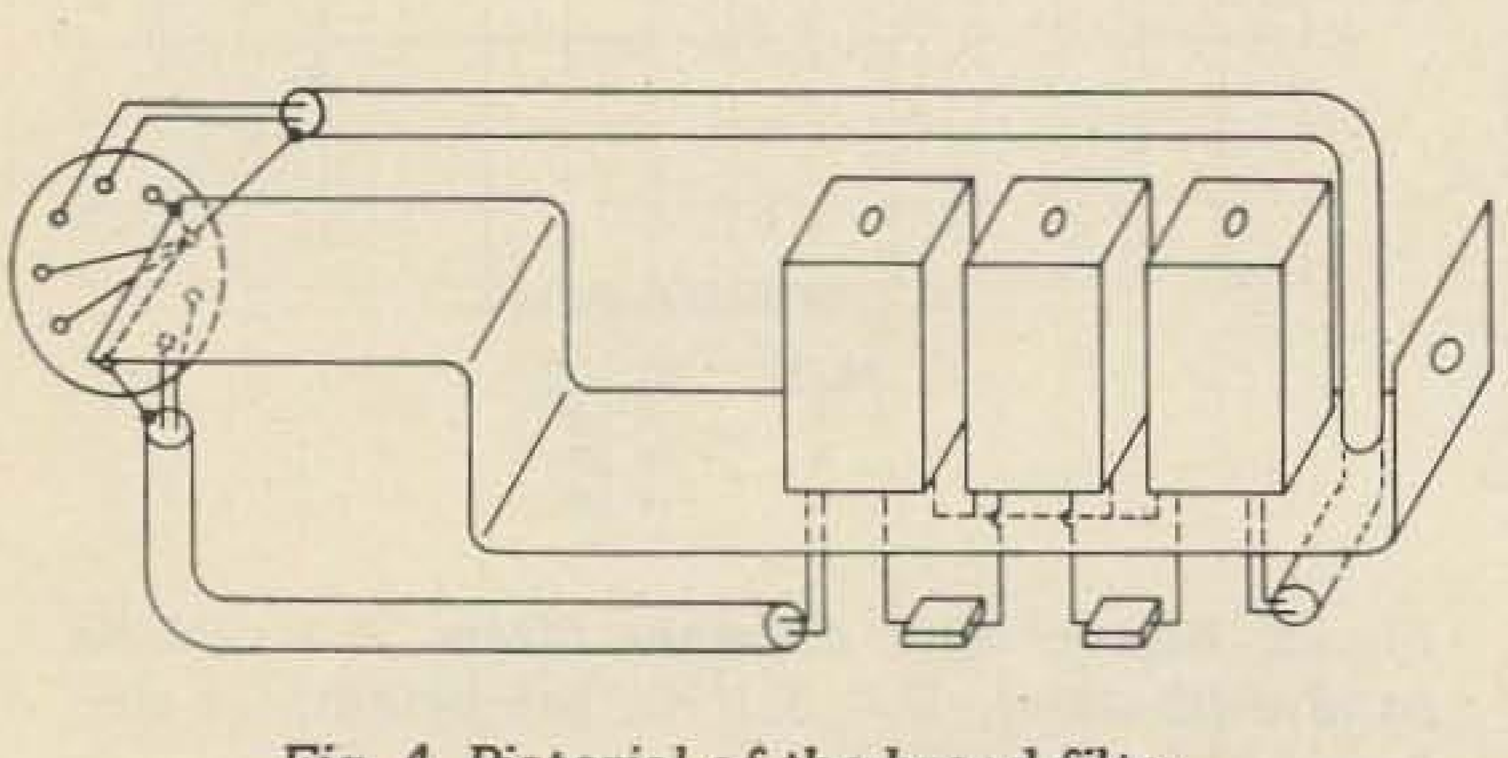

*Fig. 4. Pictorial of the broad filter.*

[2]An extender was made from a 9 pin plug and socket to permit the broad filter to be tuned for peak output conveniently.

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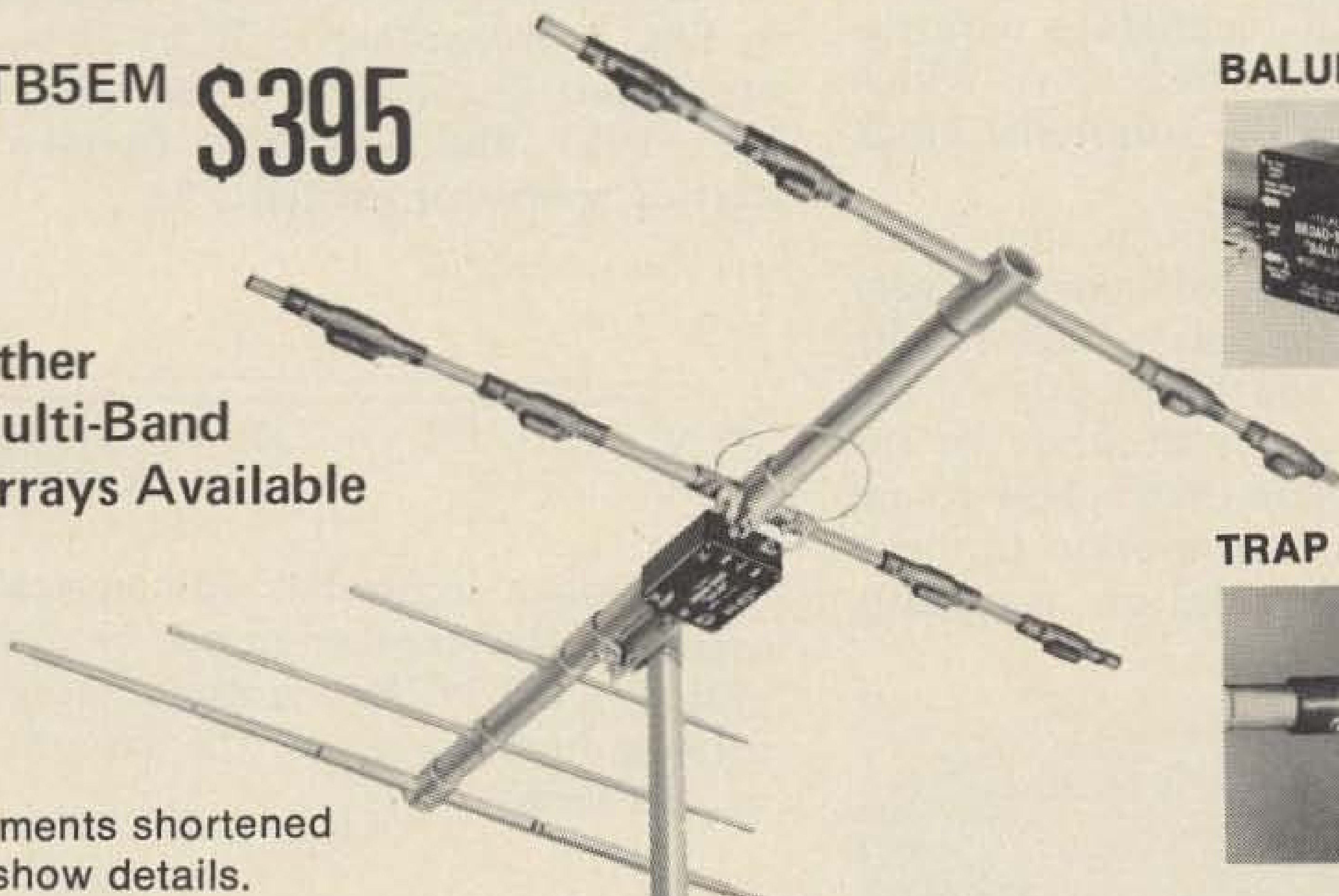

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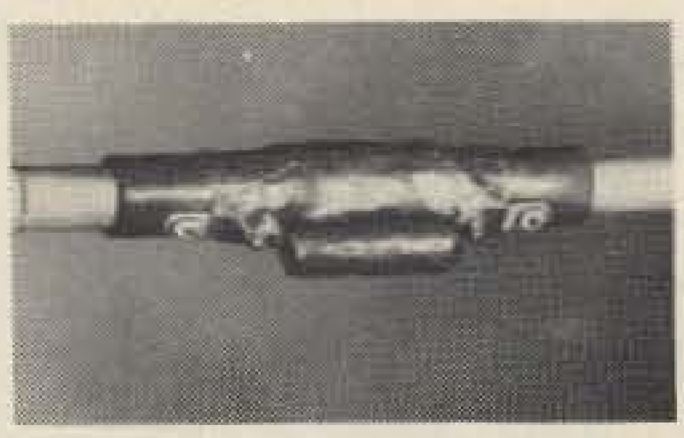

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| 15M317 | - "Monarch", 10 DBD, 3 El., 4 KWP, 2-1/2" O.D, 17' boom | $175.00 |
| 20M326 | - "Monarch", 10 DBD, 3 El., 8 KWP, 3-1/2" O.D, 26' boom | $355.00 |
| 2M609 | - "Monarch", 14 DBD, 6 El., 6 KWP, 1" O.D, 9' boom | $ 39.95 |
| 2M814 | - "Monarch", 16 DBD, 8 El., .8 KWP, 1.375" O.D, 14' boom | $ 59.00 |
| 6M516 | - "Monarch", 13 DBD, 5 El., .8 KWP, 1.5" O.D, 16' boom | $ 63.95 |

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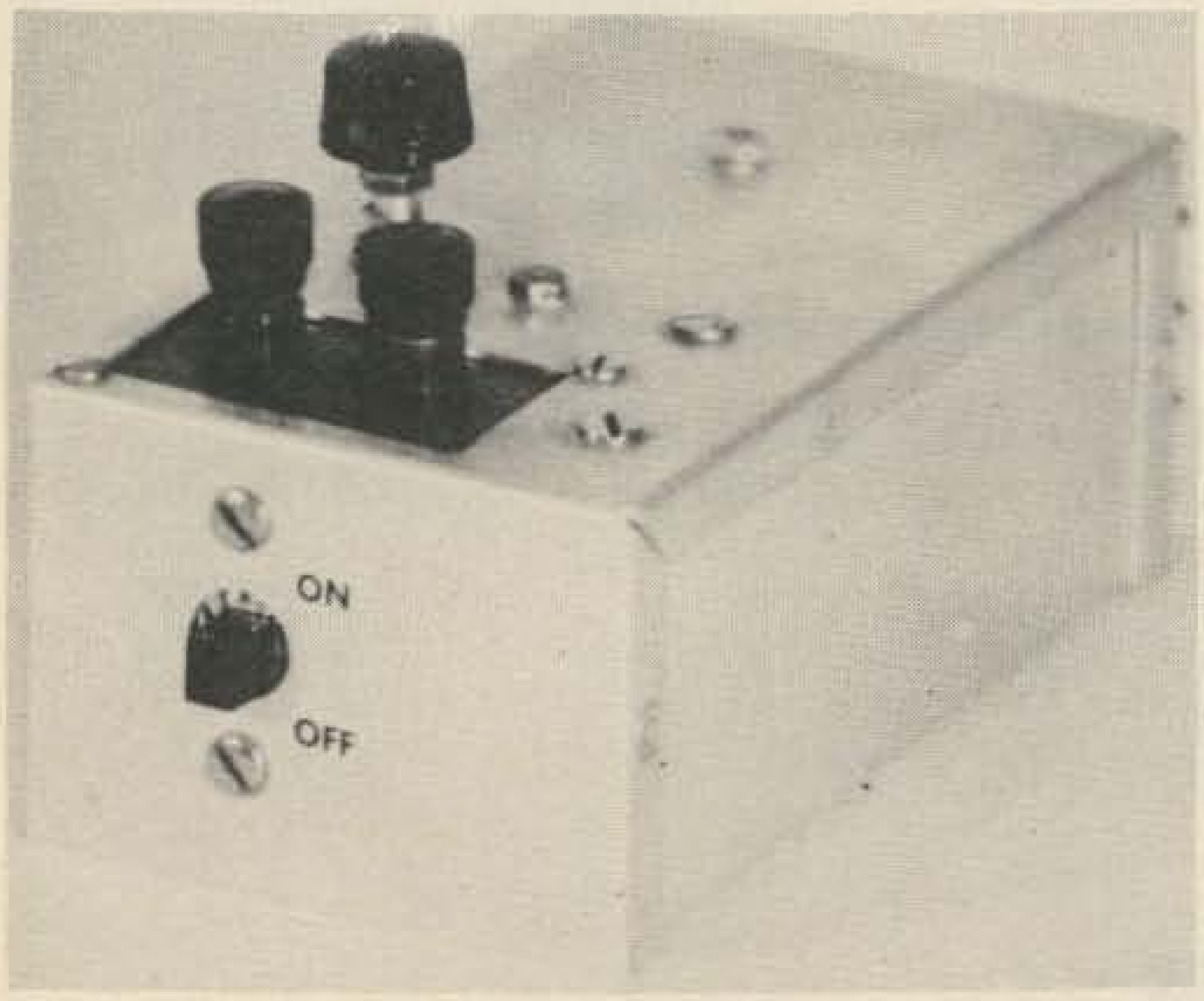
# CMBFS

## *Capacitance Measurement by Frequency Shift*

Why, you might ask, should another article be written concerning capacitance measurement when dozens of articles have appeared on this subject in the past? I have reviewed some of them and find that specialized equipment is generally required that may not be available to the average amateur such as a precision calibrated variable capacitor, a grid dip meter, or a capacitance bridge. All techniques required calibrated standards of some sort which usually turn out to be the stumbling block for the average amateur.

What means of calibration is then available to all? The receiver, of course! Every ham has a receiver these days that is calibrated to within 5, 2 and frequently 1 kHz. Even most transceivers are accurate to the latter figure. The problem then is how to use this accurate frequency calibration to measure capacitance. The solution is readily evident – tune a simple self excited transistor oscillator to the high frequency edge of one of the amateur bands; connect the unknown capacitance across the oscillator circuit and measure the new lower frequency on the receiver. All that remains to be done is to derive the expression for relating the frequency shift to the unknown capacitance.




*Finished unit.*

A basic Hartley oscillator circuit is shown in **Fig. 1**. According to R. F. Shea, *Transistor Circuit Engineering,* John Wiley & Sons, Inc., 1957, the oscillation frequency for a Hartley transistor oscillator is:

$$(1)\ f = \frac{1}{2\pi\sqrt{C\,(L_1 + L_2 + 2M0 - (L_1L_2 - M^2)\,\frac{h22b}{h11b}}}$$

which looks somewhat unmanageable. Fortunately, the expression can be greatly simplified. L1+L2+2M is nothing more than the total inductance L of the circuit. Let the second term:

$$(L_1L_2 - M^2)\,\frac{h22b}{h11b} = A$$

then

$$(2)\ f = \frac{1}{2\pi\sqrt{LC + A}}$$

A is a constant involving the inductive terms L1, L2, & M as well as the transistor parameters h22b and h11b and **Figs. 2 & 1.** If the assumption is made that this term is negligible, then the familiar expression for the resonant frequency of a tuned circuit results.

$$(3)\quad f = \frac{1}{2\pi\sqrt{LC}}$$

Suppose we assume that (3) determines the oscillator frequency for the moment. More will be said about the transistor loading factor "A" later.

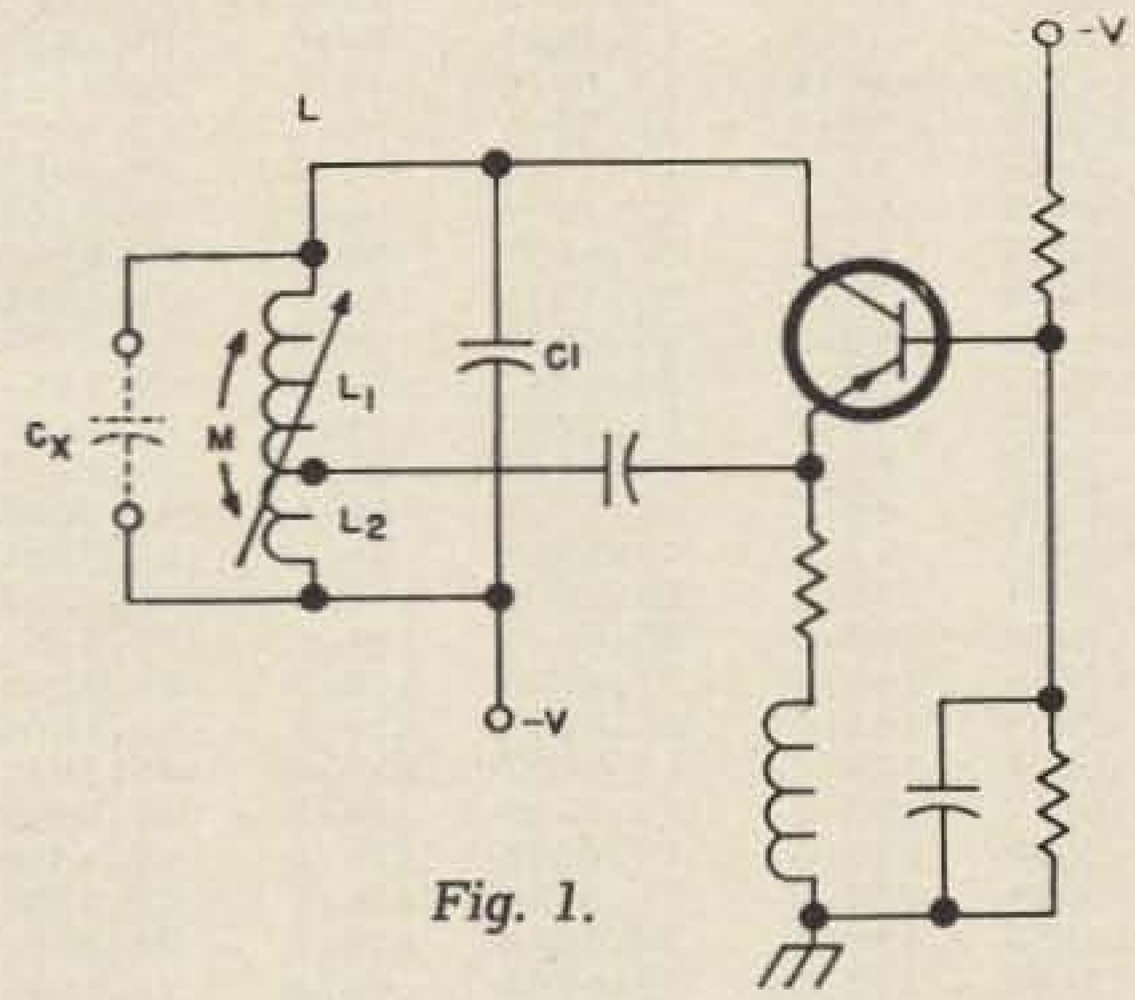



*Fig. 1.*

It can be shown (see Appendix I) that

$$(4)\quad C_x = \left(C_1 \frac{1}{1 - \frac{2\Delta f}{f_1} + \frac{\Delta f^2}{f_1{}^2}} - 1\right)$$

where Cx= unknown capacitance

f1 = basic oscillator frequency in kHz.

Δf= shift in frequency in kHz due to placing unknown capacitor Cx across tuned circuit

C1= fixed, known tank circuit capacitance

The $\Delta f^2/f1^2$ term is very small compared to 2Δf/f1 and can be neglected for the moment. Equation (4) reduces to:

$$(5)\quad C_x = C_1 \left(\frac{1}{1 - \frac{2\Delta f}{f_1}} - 1\right)$$

The significant facts that emerge from this equation are that the unknown capacitance Cx depends only on the shift in frequency Δf, the basic frequency f1 and the tank capacitance C1. Cx is thus independent of L and other factors. To measure large values of Cx, C1 must be large which dictates the use of the lowest frequency amateur band. 80 meters was selected since 160 isn't available on many receivers. Fortunately, 80 meters is also a wide band and contributes to the range of Cx.

Note that the shift in frequency (Δf) is much more important in determining Cx than the basic frequency f1. If f1 is off by 1

| Δf, kHz | $C_x$, pF | Δf, kHz | $C_x$, pF | Δf, kHz | $C_x$, pF | Δf, kHz | $C_x$, pF | Δf, kHz | $C_x$, pF |
|---|---|---|---|---|---|---|---|---|---|
| .0 | .0000 | 1.0 | .5140 | 2.0 | 1.0284 | 3.0 | 1.5432 | 4.0 | 2.0584 |
| 5.0 | 2.5740 | 6.0 | 3.0900 | 7.0 | 3.6063 | 8.0 | 4.1231 | 9.0 | 4.6402 |
| 10.0 | 5.1577 | 11.0 | 5.6756 | 12.0 | 6.1939 | 13.0 | 6.7126 | 14.0 | 7.2317 |
| 15.0 | 7.7512 | 16.0 | 8.2710 | 17.0 | 8.7913 | 18.0 | 9.3119 | 19.0 | 9.8330 |
| 20.0 | 10.3544 | 21.0 | 10.8762 | 22.0 | 11.3984 | 23.0 | 11.9210 | 24.0 | 12.4440 |
| 25.0 | 12.9674 | 26.0 | 13.4912 | 27.0 | 14.0154 | 28.0 | 14.5400 | 29.0 | 15.0650 |
| 30.0 | 15.5904 | 31.0 | 16.1161 | 32.0 | 16.6423 | 33.0 | 17.1689 | 34.0 | 17.6959 |
| 35.0 | 18.2232 | 36.0 | 18.7510 | 37.0 | 19.2791 | 38.0 | 19.8077 | 39.0 | 20.3367 |
| 40.0 | 20.8661 | 41.0 | 21.3958 | 42.0 | 21.9260 | 43.0 | 22.4566 | 44.0 | 22.9875 |
| 45.0 | 23.5189 | 46.0 | 24.0507 | 47.0 | 24.5829 | 48.0 | 25.1155 | 49.0 | 25.6485 |
| 50.0 | 26.1819 | 51.0 | 26.7157 | 52.0 | 27.2499 | 53.0 | 27.7845 | 54.0 | 28.3195 |
| 55.0 | 28.8549 | 56.0 | 29.3908 | 57.0 | 29.9270 | 58.0 | 30.4637 | 59.0 | 31.0007 |
| 60.0 | 31.5382 | 61.0 | 32.0761 | 62.0 | 32.6144 | 63.0 | 33.1531 | 64.0 | 33.6922 |
| 65.0 | 34.2317 | 66.0 | 34.7716 | 67.0 | 35.3120 | 68.0 | 35.8527 | 69.0 | 36.3939 |
| 70.0 | 36.9355 | 71.0 | 37.4775 | 72.0 | 38.0199 | 73.0 | 38.5627 | 74.0 | 39.1059 |
| 75.0 | 39.6496 | 76.0 | 40.1937 | 77.0 | 40.7382 | 78.0 | 41.2831 | 79.0 | 41.8284 |
| 80.0 | 42.3741 | 81.0 | 42.9203 | 82.0 | 43.4669 | 83.0 | 44.0139 | 84.0 | 44.5613 |
| 85.0 | 45.1091 | 86.0 | 45.6573 | 87.0 | 46.2060 | 88.0 | 46.7551 | 89.0 | 47.3046 |
| 90.0 | 47.8546 | 91.0 | 48.4049 | 92.0 | 48.9557 | 93.0 | 49.5069 | 94.0 | 50.0585 |
| 95.0 | 50.6106 | 96.0 | 51.1630 | 97.0 | 51.7159 | 98.0 | 52.2693 | 99.0 | 52.8230 |
| 100.0 | 53.3772 | 101.0 | 53.9318 | 102.0 | 54.4868 | 103.0 | 55.0423 | 104.0 | 55.5982 |
| 105.0 | 56.1545 | 106.0 | 56.7112 | 107.0 | 57.2684 | 108.0 | 57.8260 | 189.0 | 58.3840 |
| 110.0 | 58.9425 | 111.0 | 59.5014 | 112.0 | 60.0607 | 113.0 | 60.6204 | 114.0 | 61.1806 |
| 115.0 | 61.7412 | 116.0 | 62.3023 | 117.0 | 62.8638 | 118.0 | 63.4257 | 119.0 | 63.9880 |
| 120.0 | 64.5508 | 121.0 | 65.1141 | 122.0 | 65.6777 | 123.0 | 66.2418 | 124.0 | 66.8063 |
| 125.0 | 67.3713 | 126.0 | 67.9367 | 127.0 | 68.5025 | 128.0 | 69.0688 | 129.0 | 69.6356 |
| 130.0 | 70.2027 | 131.0 | 70.7703 | 132.0 | 71.3384 | 133.0 | 71.9068 | 134.0 | 72.4758 |
| 135.0 | 73.0451 | 136.0 | 73.6149 | 137.0 | 74.1852 | 138.0 | 74.7559 | 139.0 | 75.3270 |
| 140.0 | 75.8986 | 141.0 | 76.4706 | 142.0 | 77.0431 | 143.0 | 77.6160 | 144.0 | 78.1894 |
| 145.0 | 78.7632 | 146.0 | 79.3374 | 147.0 | 79.9121 | 148.0 | 80.4873 | 149.0 | 81.0629 |
| 150.0 | 81.6389 | 151.0 | 82.2154 | 152.0 | 82.7924 | 153.0 | 83.3697 | 154.0 | 83.9476 |
| 155.0 | 84.5259 | 156.0 | 85.1046 | 157.0 | 85.6838 | 158.0 | 86.2635 | 159.0 | 86.8436 |
| 160.0 | 87.4241 | 161.0 | 88.0052 | 162.0 | 88.5866 | 163.0 | 89.1685 | 164.0 | 89.7509 |
| 165.0 | 90.3338 | 166.0 | 90.9170 | 167.0 | 91.5008 | 168.0 | 92.0850 | 169.0 | 92.6696 |
| 170.0 | 93.2548 | 171.0 | 93.8403 | 172.0 | 94.4264 | 173.0 | 95.0129 | 174.0 | 95.5998 |
| 175.0 | 96.1872 | 176.0 | 96.7751 | 177.0 | 97.3634 | 178.0 | 97.9522 | 179.0 | 98.5415 |
| 180.0 | 99.1312 | 181.0 | 99.7214 | 182.0 | 100.3120 | 183.0 | 100.9031 | 184.0 | 101.4947 |
| 185.0 | 102.0868 | 186.0 | 102.6793 | 187.0 | 103.2723 | 188.0 | 103.8657 | 189.0 | 104.4596 |
| 190.0 | 105.0540 | 191.0 | 105.6488 | 192.0 | 106.2441 | 193.0 | 106.8399 | 194.0 | 107.4362 |
| 195.0 | 108.0329 | 196.0 | 108.6301 | 197.0 | 109.2278 | 198.0 | 109.8259 | 199.0 | 110.4245 |
| 200.0 | 111.0236 | 201.0 | 111.6231 | 202.0 | 112.2232 | 203.0 | 112.8237 | 204.0 | 113.4246 |
| 205.0 | 114.0261 | 206.0 | 114.6280 | 207.0 | 115.2304 | 208.0 | 115.8333 | 209.0 | 116.4367 |
| 210.0 | 117.0405 | 211.0 | 117.6448 | 212.0 | 118.2496 | 213.0 | 118.8549 | 214.0 | 119.4606 |
| 215.0 | 120.0669 | 216.0 | 120.6736 | 217.0 | 121.2808 | 218.0 | 121.8884 | 219.0 | 122.4966 |
| 220.0 | 123.1052 | 221.0 | 123.7144 | 222.0 | 124.3240 | 223.0 | 124.9341 | 224.0 | 125.5446 |
| 225.0 | 126.1557 | 226.0 | 126.7672 | 227.0 | 127.3793 | 228.0 | 127.9918 | 229.0 | 128.6048 |
| 230.0 | 129.2183 | 231.0 | 129.8323 | 232.0 | 130.4467 | 233.0 | 131.0617 | 234.0 | 131.6772 |
| 235.0 | 132.2931 | 236.0 | 132.9095 | 237.0 | 133.5265 | 238.0 | 134.1439 | 239.0 | 134.7618 |
| 240.0 | 135.3802 | 241.0 | 135.9991 | 242.0 | 136.6185 | 243.0 | 137.2384 | 244.0 | 137.8587 |
| 245.0 | 138.4796 | 246.0 | 139.1010 | 247.0 | 139.7229 | 248.0 | 140.3452 | 249.0 | 140.9681 |
| 250.0 | 141.5915 | 251.0 | 142.2153 | 252.0 | 142.8397 | 253.0 | 143.4645 | 254.0 | 144.0899 |
| 255.0 | 144.7157 | 256.0 | 145.3421 | 257.0 | 145.9690 | 258.0 | 146.5963 | 259.0 | 147.2242 |
| 260.0 | 147.8526 | 261.0 | 148.4815 | 262.0 | 149.1109 | 263.0 | 149.7407 | 264.0 | 150.3711 |
| 265.0 | 151.0020 | 266.0 | 151.6334 | 267.0 | 152.2654 | 268.0 | 152.8978 | 269.0 | 153.5307 |
| 270.0 | 154.1642 | 271.0 | 154.7981 | 272.0 | 155.4326 | 273.0 | 156.0676 | 274.0 | 156.7030 |
| 275.0 | 157.3390 | 276.0 | 157.9755 | 277.0 | 158.6126 | 278.0 | 159.2501 | 279.0 | 159.8881 |
| 280.0 | 160.5267 | 281.0 | 161.1658 | 282.0 | 161.8054 | 283.0 | 162.4455 | 284.0 | 163.0861 |
| 285.0 | 163.7273 | 286.0 | 164.3689 | 287.0 | 165.0111 | 288.0 | 165.6538 | 289.0 | 166.2970 |
| 290.0 | 166.9408 | 291.0 | 167.5850 | 292.0 | 168.2298 | 293.0 | 168.8751 | 294.0 | 169.5209 |
| 295.0 | 170.1673 | 296.0 | 170.8142 | 297.0 | 171.4615 | 298.0 | 172.1095 | 299.0 | 172.7579 |
| 300.0 | 173.4069 | 301.0 | 174.0564 | 302.0 | 174.7064 | 303.0 | 175.3570 | 304.0 | 176.0081 |
| 305.0 | 176.6597 | 306.0 | 177.3118 | 307.0 | 177.9645 | 308.0 | 178.6177 | 309.0 | 179.2714 |
| 310.0 | 179.9257 | 311.0 | 180.5805 | 312.0 | 181.2358 | 313.0 | 181.8917 | 314.0 | 182.5481 |
| 315.0 | 183.2050 | 316.0 | 183.8625 | 317.0 | 184.5205 | 318.0 | 185.1790 | 319.0 | 185.8381 |
| 320.0 | 186.4977 | 321.0 | 187.1578 | 322.0 | 187.8185 | 323.0 | 188.4797 | 324.0 | 189.1415 |
| 325.0 | 189.8038 | 326.0 | 190.4666 | 327.0 | 191.1300 | 328.0 | 191.7940 | 329.0 | 192.4584 |
| 330.0 | 193.1234 | 331.0 | 193.7890 | 332.0 | 194.4551 | 333.0 | 195.1218 | 334.0 | 195.7890 |
| 335.0 | 196.4567 | 336.0 | 197.1250 | 337.0 | 197.7938 | 338.0 | 198.4632 | 339.0 | 199.1331 |
| 340.0 | 199.8036 | 341.0 | 200.4747 | 342.0 | 201.1462 | 343.0 | 201.8184 | 344.0 | 202.4911 |
| 345.0 | 203.1643 | 346.0 | 203.8381 | 347.0 | 204.5124 | 348.0 | 205.1873 | 349.0 | 205.8628 |
| 350.0 | 206.5388 | 351.0 | 207.2154 | 352.0 | 207.8924 | 353.0 | 208.5701 | 354.0 | 209.2484 |
| 355.0 | 209.9272 | 356.0 | 210.6065 | 357.0 | 211.2864 | 358.0 | 211.9669 | 359.0 | 212.6479 |
| 360.0 | 213.3295 | 361.0 | 214.0117 | 362.0 | 214.6944 | 363.0 | 215.3777 | 364.0 | 216.0615 |
| 365.0 | 216.7459 | 366.0 | 217.4309 | 367.0 | 218.1164 | 368.0 | 218.8025 | 369.0 | 219.4892 |
| 370.0 | 220.1765 | 371.0 | 220.8643 | 372.0 | 221.5526 | 373.0 | 222.2416 | 374.0 | 222.9311 |
| 375.0 | 223.6212 | 376.0 | 224.3119 | 377.0 | 225.0031 | 378.0 | 225.6949 | 379.0 | 226.3873 |
| 380.0 | 227.0802 | 381.0 | 227.7737 | 382.0 | 228.4678 | 383.0 | 229.1625 | 384.0 | 229.8578 |
| 385.0 | 230.5536 | 386.0 | 231.2500 | 387.0 | 231.9470 | 388.0 | 232.6446 | 389.0 | 233.3427 |
| 390.0 | 234.0414 | 391.0 | 234.7407 | 392.0 | 235.4406 | 393.0 | 236.1411 | 394.0 | 236.8421 |
| 395.0 | 237.5438 | 396.0 | 238.2460 | 397.0 | 238.9488 | 398.0 | 239.6522 | 399.0 | 240.3561 |
| 400.0 | 241.0607 | 401.0 | 241.7659 | 402.0 | 242.4716 | 403.0 | 243.1779 | 404.0 | 243.8849 |
| 405.0 | 244.5924 | 406.0 | 245.3005 | 407.0 | 246.0091 | 408.0 | 246.7184 | 409.0 | 247.4283 |
| 410.0 | 248.1387 | 411.0 | 248.8498 | 412.0 | 249.5615 | 413.0 | 250.2737 | 414.0 | 250.9865 |
| 415.0 | 251.7000 | 416.0 | 252.4141 | 417.0 | 253.1287 | 418.0 | 253.8439 | 419.0 | 254.5597 |
| 420.0 | 255.2762 | 421.0 | 255.9932 | 422.0 | 256.7109 | 423.0 | 257.4291 | 424.0 | 258.1479 |
| 425.0 | 258.8674 | 426.0 | 259.5874 | 427.0 | 260.3081 | 428.0 | 261.0293 | 429.0 | 261.7512 |
| 430.0 | 262.4737 | 431.0 | 263.1968 | 432.0 | 263.9204 | 433.0 | 264.6448 | 434.0 | 265.3697 |
| 435.0 | 266.0952 | 436.0 | 266.8213 | 437.0 | 267.5480 | 438.0 | 268.2754 | 439.0 | 269.0033 |
| 440.0 | 269.7319 | 441.0 | 270.4611 | 442.0 | 271.1909 | 443.0 | 271.9213 | 444.0 | 272.6524 |
| 445.0 | 273.3840 | 446.0 | 274.1163 | 447.0 | 274.8492 | 448.0 | 275.5827 | 449.0 | 276.3168 |
| 450.0 | 277.0516 | 451.0 | 277.7869 | 452.0 | 278.5229 | 453.0 | 279.2595 | 454.0 | 279.9968 |
| 455.0 | 280.7346 | 456.0 | 281.4732 | 457.0 | 282.2122 | 458.0 | 282.9520 | 459.0 | 283.6924 |
| 460.0 | 284.4334 | 461.0 | 285.1750 | 462.0 | 285.9172 | 463.0 | 286.6601 | 464.0 | 287.4036 |
| 465.0 | 288.1478 | 466.0 | 288.8925 | 467.0 | 289.6379 | 468.0 | 290.3840 | 469.0 | 291.1306 |
| 470.0 | 291.8780 | 471.0 | 292.6259 | 472.0 | 293.3745 | 473.0 | 294.1237 | 474.0 | 294.8735 |
| 475.0 | 295.6240 | 476.0 | 296.3752 | 477.0 | 297.1269 | 478.0 | 297.8793 | 479.0 | 298.6324 |
| 480.0 | 299.3861 | 481.0 | 300.1404 | 482.0 | 300.8954 | 483.0 | 301.6510 | 484.0 | 302.4073 |
| 485.0 | 303.1642 | 486.0 | 303.9218 | 487.0 | 304.6800 | 488.0 | 305.4388 | 489.0 | 306.1984 |
| 490.0 | 306.9585 | 491.0 | 307.7193 | 492.0 | 308.4807 | 493.0 | 309.2429 | 494.0 | 310.0056 |
| 495.0 | 310.7690 | 496.0 | 311.5331 | 497.0 | 312.2978 | 498.0 | 313.0632 | 499.0 | 313.8292 |

*Fig. 2. Frequency-shift capacitance equivalents.*

kHz, the effect is only 1 kHz in 4000 kHz whereas a 1 kHz change in $\Delta f$ has a much larger effect since $\Delta f$ can vary between 0 to 500 kHz. What this means is that the linearity of your receiver dial calibration is more important than the absolute accuracy. Setting the basic oscillator frequency to 4001 instead of 4000 isn't much cause for concern. The shift in frequency is the important parameter.

The accuracy of Cx is dependent on the accuracy of C1. If C1 is accurate to 5%, Cx will be accurate to 5%. If C1 is accurate to ½%, Cx will be likewise. You can buy as much accuracy as you are willing to pay for. 5% is sufficient for most amateur applications but great accuracy can be achieved inexpensively in several ways, for example, padding up an undersized C1 if there is precision capacitance measuring equipment available. If not, precision capacitances can be purchased from industrial electronic supply houses. It seems hardly worth buying a 5% unit for 60 cents when a 1% unit can be obtained for $1.37. The Cornell Dubilier type CD19F102F500 capacitor can be obtained from major supply houses. Arco Electronics, Community Drive, Great Neck, N.Y. 11022 is the distributor for El Menco type DM20 capacitors which can be obtained at 1% or better tolerance on special order.

One nice feature of the CMBFS technique is that the oscillator is not critical. There is no precision or long term stability required. Temperature, voltage changes, etc. will have no appreciable effect. The only stability required is that long enough to last for 15 seconds – the length of time it takes to make a measurement. Inaccuracies are balanced out by adjusting the variable inductance L to produce a 4000 kHz oscillation frequency immediately prior to the capacitance measurement.

Returning to an earlier assumption, the next step is to verify the accuracy of equation (4) with regard to omission of the transistor loading factor "A". An oscillator, to be described in the next section, was constructed using a C1 value of 1000 pF accurate to within ¼ of 1% as measured on a precision laboratory bridge. A known Cx of 312.3 pF ± ¼% produced a frequency shift of 497 kHz. If these values are substituted into equation (4), Cx is calculated to be 303.9 pF or 8.4 pF less than it should be. This amounts to an error of 2.7% and is attributed directly to transistor loading shifting the oscillator frequency. Another way of looking at it is that the transistor has added 27.7 pF of capacitance to the tuned circuit. The term "transistor loading factor" is used somewhat loosely. It also includes the circuit stray capacitances. To allow for the loading effect a constant K1 is inserted into equation (4).

$$(6)\quad C_x = K_1 C_1 \left( \frac{1}{1 - \frac{2\Delta f}{f_1} + \frac{\Delta f^2}{f_1^2}} - 1 \right)$$

where $K_1 = 1.02768$

The term A could have been calculated directly from the inductance and transistor parameters but it would have been for an "average" transistor. The question is "What is the variability in this term with different transistors in the circuit?" To answer this question quantities of different transistors were plugged into the circuit and the change in $\Delta f$ was noted. Intermediate frequency type 2N404's produced a variation of ± 6 kHz shift out of 500 kHz. The high frequency type 2N964 produced a negligible variation in shift of ± 1¼ kHz out of 500 kHz and were therefore judged the most satisfactory. The Motorola HEP 1 at 89 cents acts the same as the 2N964 and is recommended.

The average ham would hardly want to solve equation (6) every time he wanted to make a capacitance measurement and therefore a computerized solution was sought. With 1 KC increments in $\Delta f$ being available and covering a 500 kHz range – 500 calculations have to be made. The computer is a natural tool for this job. The problem was programmed for a Univac 1107 and all 500 points were calculated in seven seconds. It would have taken me 41 hours with a desk calculator to get the same answers with many mistakes. The results are photographically reproduced in **Fig. 2**. Don't be fooled by all of the significant digits in the capacitance columns. Although the accuracy is inherently there, your answer is limited by the accuracy of C1 and your receiver calibration.

**Circuit and Construction Details**

TR1, L1, C1 of **Fig. 3** form the Hartley Oscillator circuit. TR2 is a buffer amplifier driven from the emitter tap on L1. Its function is to isolate any loading on the

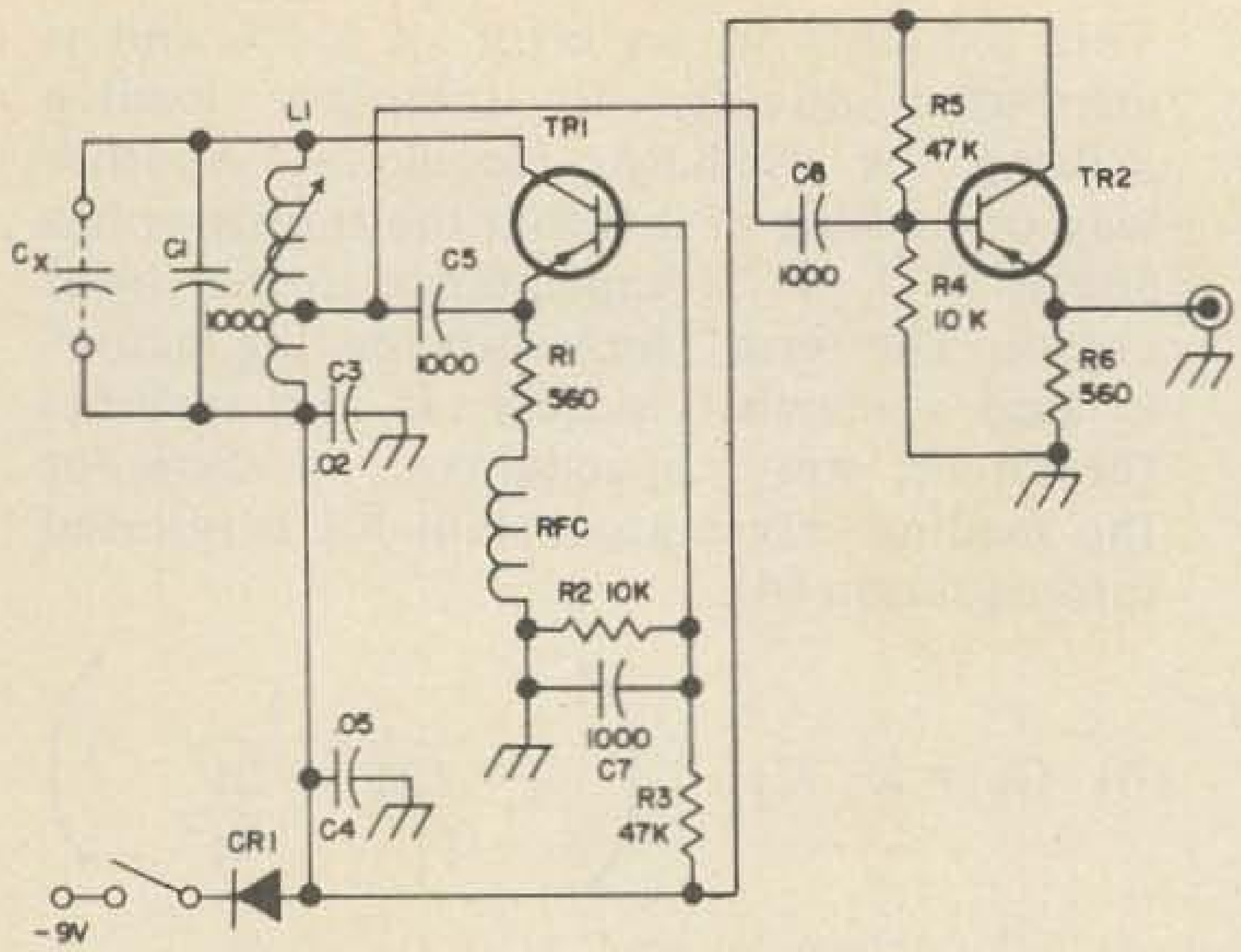
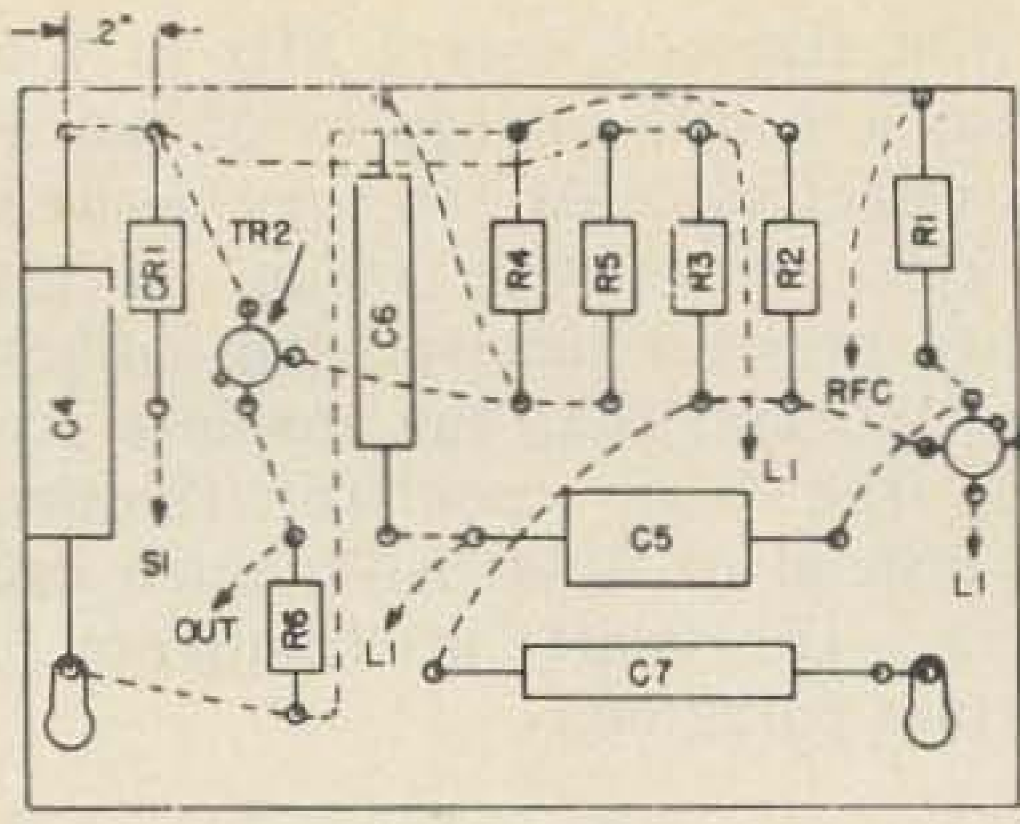
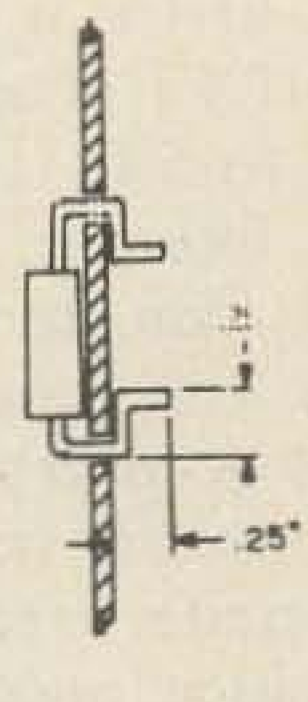



*Fig. 3. Schematic. TR1,TR2: 2N964, HEP1; RFC: 2.5 MH National R100S; L1: 3/8" dia. slug tuned form, J.W.Miller 4400, 12 turns closewound No. 26E, tap 3 turns from the bottom; CR1: 1N34 type germanium diode; C1: 1000 pF precision capacitor (see text); C5: 1000 pF mica; other capacitors can be ceramic or paper. All resistors 1/2W, 10%.*




*Method of crimping component lead.*

*Fig. 4. Component board. Component side solid, wiring side dotted lines.*

output of TR2 from affecting the oscillator frequency. CR1 is a safety diode that prevents the application of reversed voltage from causing any damage. The circuit is conventional in all other aspects.

The complete unit is built into a 5" x 3" x 2" minibox with plenty of space to spare. All components except L1, RFC, C2, C1 and the on-off switch are mounted on a 2-1/4" x 1-7/8" piece of 85G24EP Vectorboard (holes on .1 inch centers staggered) and held onto the chassis by spade lugs. A layout of the board is shown in **Fig. 4**. The components are mounted by inserting the leads through the holes and crimping them as shown in **Fig. 4**. Although the components can wiggle when first installed, the board becomes one solid mass after wiring. Wiring is done on the back side of the board in

*Inside view of device.*

conventional fashion. It is recommended that construction similar to that shown be followed in order to minimize the effect of stray capacitances on accuracy. 1% of 1000 pF is 10 pF which means that the *rf* wiring must be short, direct and kept away from ground. For this latter reason, the hot end of L1 and C1 must be isolated from ground. This is accomplished by mounting the binding posts on a 2-1/8" x 1-5/8" piece of phenolic and inserting behind a 1-13/16" x 1-1/16" cutout on the top front of the aluminum box as shown in the photograph. The terminals are mounted 13/16" apart to conveniently accept the leads of the capacitor to be measured.

C3, the .02 disc ceramic bypass capacitor, mounts between the bottom end of L1 and the spade lug ground. TR2 output feeds to a phono type jack. Although there is sufficient space to include a 9v battery inside the box, I decided to bring power in through a terminal strip instead. The chances are that the CMBFS unit will receive occasional use and that the battery will be dead when you do want to use it. I thought it best to use an external power supply or a battery borrowed from a transistor radio BC set when needed.

**Operation**

Apply voltage to the CMBFS unit. Tune your receiver to 4000 kHz. Connect the output lead to the receiver antenna terminal. Tune L1 until the signal from the oscillator is zero beat with the receiver. It should be a well over S9 stable signal. Now connect the capacitor to be measured to the binding posts. You will note that the signal is no longer at 4000 kHz. Tune your receiver lower in frequency until the new signal is picked up and zero beated. If there is any question about it being the correct signal, bring your finger near the hot binding post and the frequency will shift slightly. Record the new frequency and subtract it from 4000 kHz to get the shift ($\Delta f$) in frequency. Now read the actual value of the capacitor corresponding to $\Delta f$ directly from the chart **(Fig. 2)**. That's about all there is to it.

It may not be necessary to actually connect the CMBFS unit output to the receiver antenna terminal. Radiation from a 2 or 3 foot piece of wire may be sufficient, depending upon the shielding of the receiver. More important is the elimination or reduction of 80 meter signals from other amateur stations that tend to confuse or lose the CMBFS signal. Disconnecting the 80M receiving antenna is desirable. I have found that switching to the 10 or 15 meter antenna or the dummy load is quite effective in reducing extraneous 80M signals.

The battery voltage isn't critical. A 1 volt shift from -9 to -8 volts causes a barely discernible several cycles shift in frequency. Although the oscillator will oscillate down to 2 volts, I don't recommend operating at this point because the loading factor K1 will noticeably increase and cause an inaccuracy in the measurement.

**Summary**

Equations – equations, the proof is in the performance! A number of capacitors were selected from the junk box, measured by this technique and compared to the ¼% precision laboratory bridge. The receiver measurements were made with my old Collins 75A1 and repeated with a Drake TR3 transceiver. The results were as follows.

| Face Value | CMBFS Value | Precision Bridge Value |
|---|---|---|
| 10 pF | 10.35 pF | 10.45 pF |
| 50 pF | 50.8 pF | 51.6 pF |
| 100 pF | 115.2 pF | 115.0 pF |
| 180 pF | 175.0 pF | 174.6 pF |
| 270 pF | 269.36 pF | 268.4 pF |

Not bad, considering that the CMBFS unit costs less than $10 while the precision bridge costs over $1,000.

Although this particular unit has a capacitance range up to 313 pF, there is no reason why a higher C1/L ratio can't be chosen to permit reading higher values of capacitance, that is, if you have a computer handy to give you a new set of computations. Another approach for extending the range is to keep C1 at 1000 pF, but split it into two parts with the unknown capacitor placed across one of the parts in a capacitive divider arrangement. This again requires recomputation. The present range satisfied the majority of my requirements in working with *rf* circuits and provided the excellent definition of .5 pF/kHz at the low end and .75 pF/kHz at the high end of the range. Thus this approach, coupled with the computer printout rather than the usual plotted curve, permits measuring a fraction of a pF difference between 300 pF capacitors.

CMBFS isn't a technique for the production line testing of capacitors but it is well suited for the occasional amateur need and is capable of providing a high degree of accuracy at low cost.

APPENDIX I

$$f1^2 = \frac{1}{4\pi^2 LC1} \qquad L = \frac{1}{4\pi^2 f1^2 C1}$$

with Cx in parallel with C1

$$f2^2 = \frac{1}{4\pi^2 L(C1 + Cx)} \qquad L = \frac{1}{4\pi^2 f2^2 (C1 + Cx)}$$

L is the same in both cases and can be equated

$$f1^2 C1 = f2^2 (C1 + Cx)$$

$$\frac{f1^2 C1}{f2^2} = C1 + Cx$$

$$\left( \frac{f1^2 C1}{f2^2} - C1 \right) = Cx$$

$$\left( \frac{f1^2}{f2^2} - 1 \right) C1 = Cx$$

$f2 = f1 - \Delta f$ where $\Delta f$ = difference in frequency

$$\left( \frac{f1^2}{(f1 - \Delta f)^2} - 1 \right) C1 = Cx$$

$$\left( \frac{f1^2}{f1^2 - 2\Delta f f1 + \Delta f^2} - 1 \right) C1 = Cx$$

$$\left( \frac{1}{1 - 2\Delta f/f1 + \Delta f^2/f1^2} - 1 \right) C1 = Cx$$

. . .W3HTF

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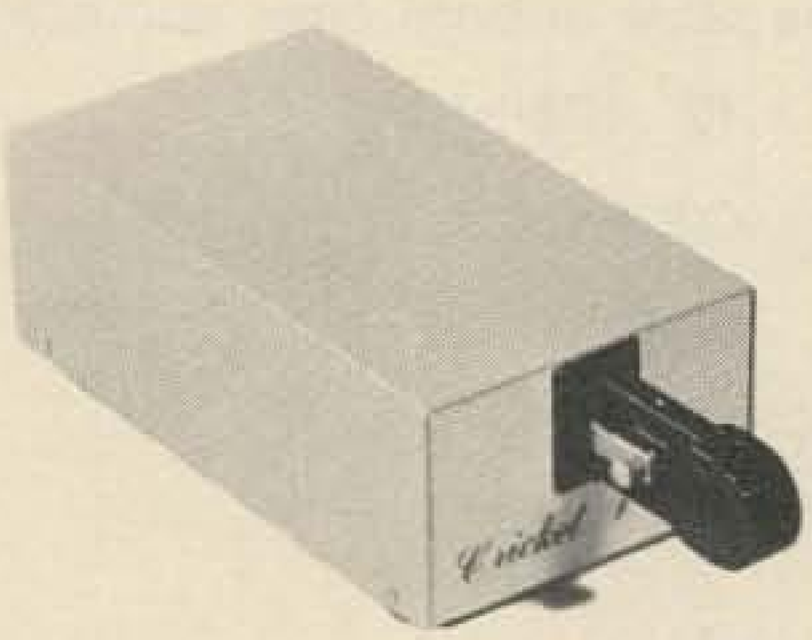

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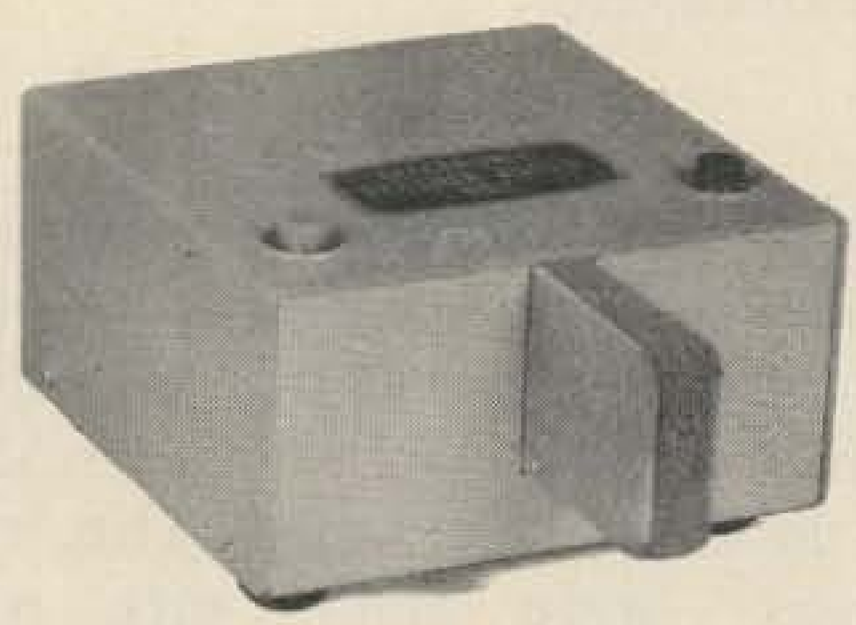

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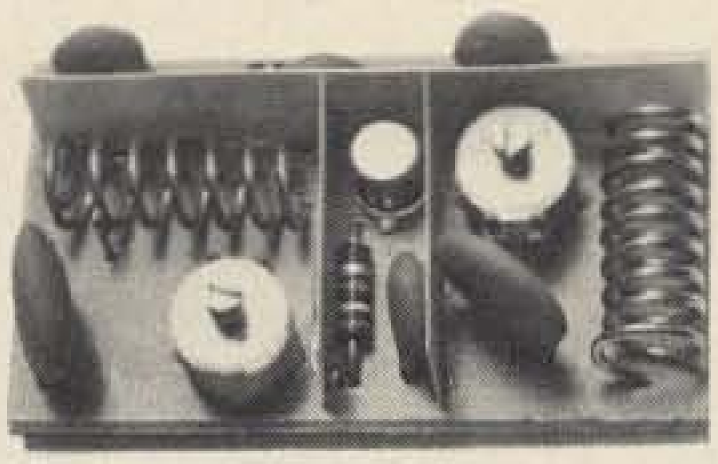

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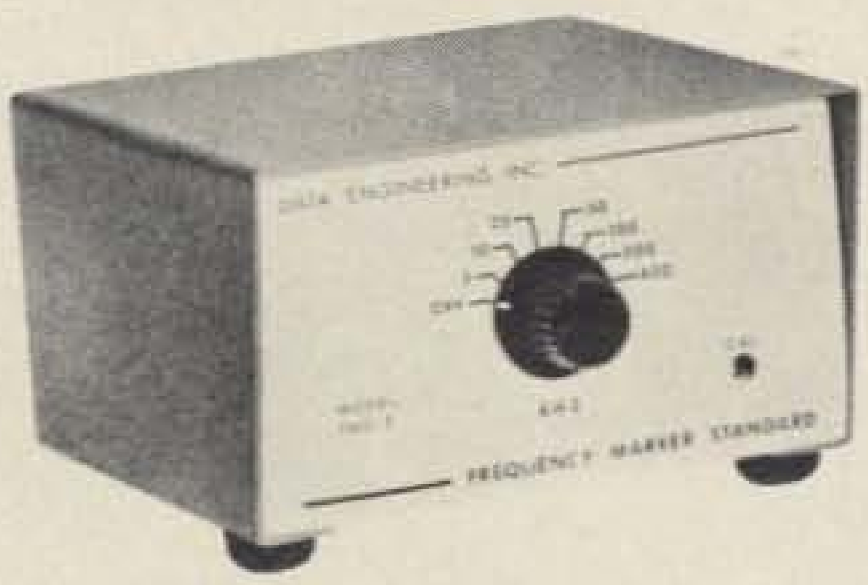


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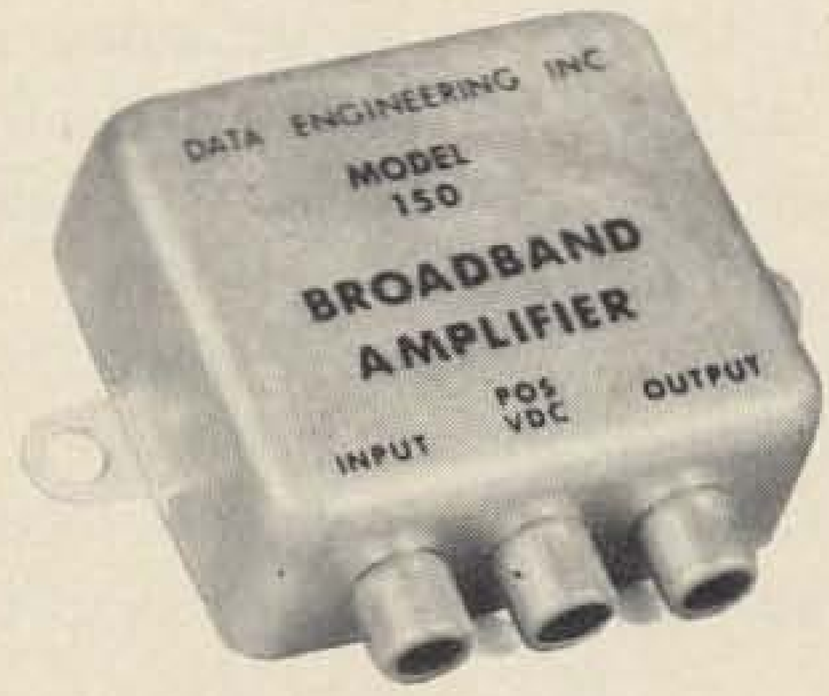


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# ADAPTING ELECTRONIC KEYERS TO OLDER TRANSMITTERS

It all began when a kind good ham friend donated an older type, cathode-keyed transmitter for use at my summer QTH.

It was a Harvey-Wells T-90; immediately appealing for its compactness and lightweight as compared to my burdensome HT-32 when it comes to lugging it back and forth. I eagerly checked out the T-90, bringing it up to specs and found out, rather quickly, that I wouldn't be able to use my electronic keyer (Heath HD-10) with it. The T-90, like any of the older transmitters, calls for grounding the cathodes of the oscillator and/or amplifier tubes for keying. The keyer output transistor will not switch cathode type keying and an attempt to do so can ruin the keyer with too high current.

Operation of the keyer is designed for low negative current as with grid-block keying; this, then, is safely switched through the keyer's output transistor.

Researching the transmitter project indicated an extensive rewiring would be required and a source of large negative voltage necessary to bias the keyed tubes to cut off.

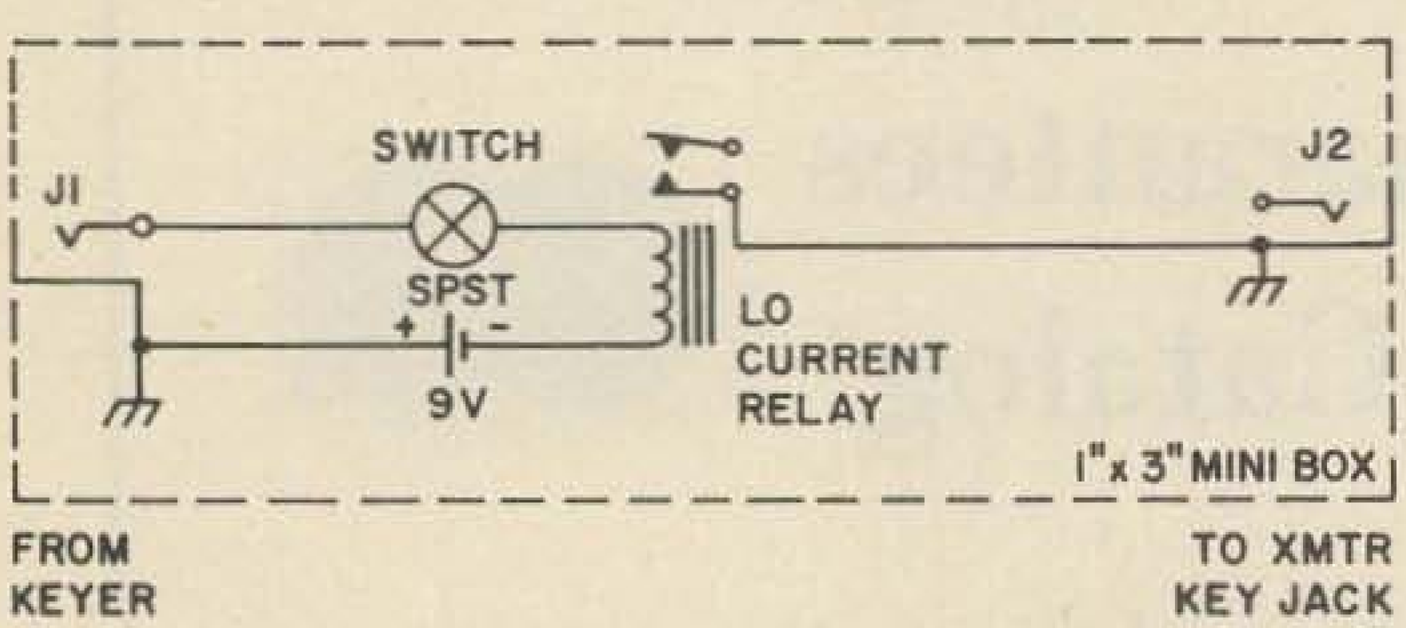
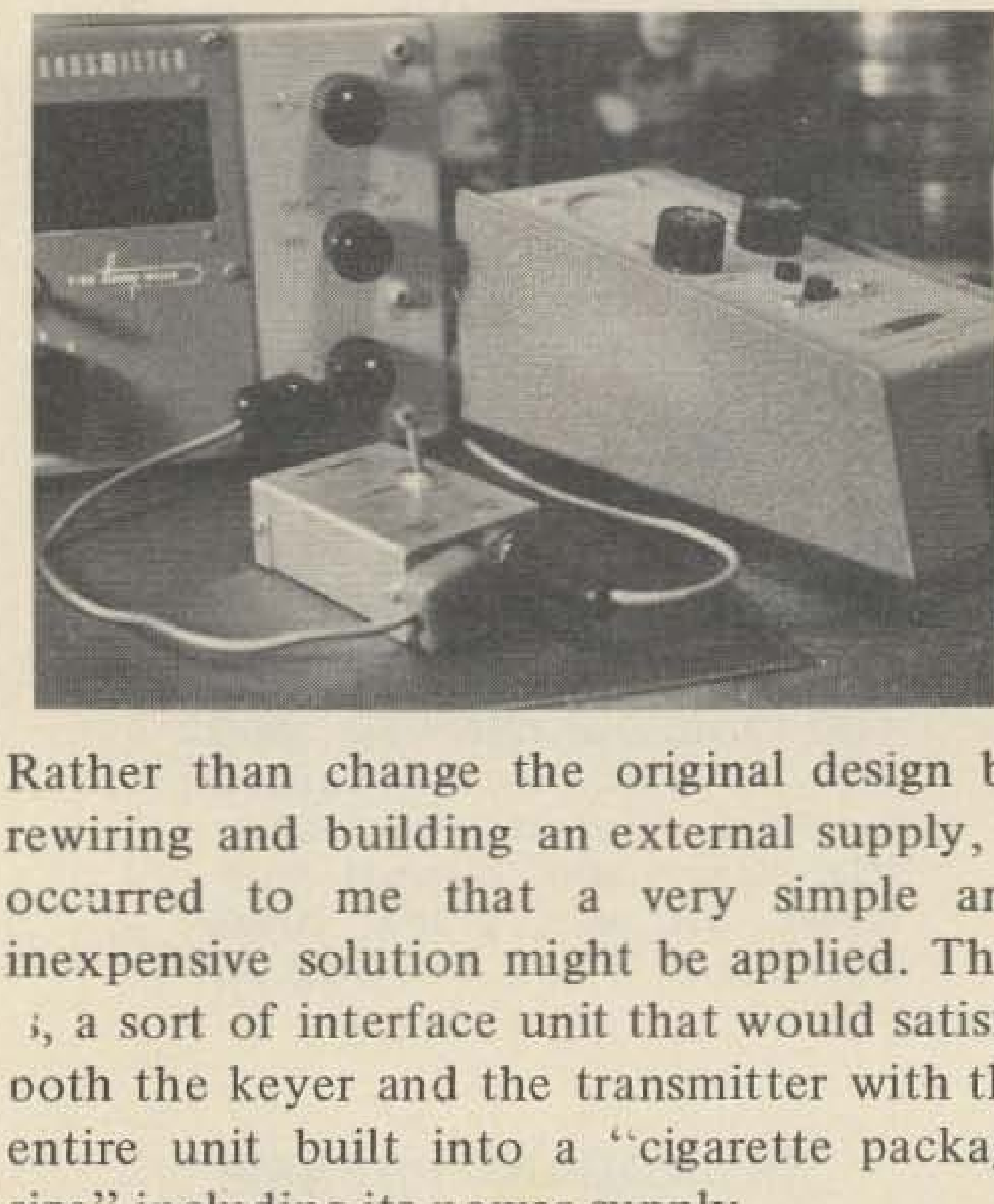



*Fig. 1. Schematic diagram for match-key.*



Rather than change the original design by rewiring and building an external supply, it occurred to me that a very simple and inexpensive solution might be applied. That is, a sort of interface unit that would satisfy both the keyer and the transmitter with the entire unit built into a "cigarette package size" including its power supply.

The electronic keyer requires that no spike voltages exceed 105 volts and that the circuit current be within 35 mA, otherwise the keyer output transistor will be damaged.

The MATCH-KEY unit constructed here is well within the requirements, running at 9 volts at 5 mA. To operate the unit, merely plug the keyer into J1 and a patch cord between J2 and the transmitter key jack.

The switch is optional and the battery should last indefinitely at a 5 mA drain. The combination of the MATCH-KEY and keyer have been used very successfully at slow or high speeds.

. . .W1JSS

# GONSET LINEAR MODIFICATION

W. R. Lingenbrink W6HGX
1809 Hill Ave.
Hayward CA 94541

For those of you who want a good linear at reasonable cost – read on. You will do well to investigate the older models of the Gonset 201 linear amplifier. Not that the new models are not good; but the older models can be had at quite a reduced price.

The main objection to the older models is the action required for the keying of the change-over relay. They were made to be compatible with the Gonset exciter and are not compatible with some of the other types of exciters.

In the case of the Gonset exciter they furnished keyed 115V ac for the change-over relay, while in other exciters this operation is accomplished by furnishing keyed ground. Although that is reason enough for some not to buy the unit, I hold that it does not constitute sufficient reason to reject a fine piece of equipment.

The modification is simple and easy to perform and will not detract from the appearance or the resale of the unit.

The only additional equipment required will be a small plate filament transformer with 125V secondary. Such a transformer is the Stancor PS-8415. The main requirement is that it be small enough to fit under the chassis of the linear. Also needed is the connection jack or terminal to which the control lead is to be connected. The unit used in my modification was the Motorola type or Switchcraft type 3501FP, requiring only a quarter-inch hole to be drilled alongside PL-5 outlet on the rear apron.

The best way for the modification to proceed is to understand what is desired and what is accomplished by the modification: We have a relay in the unit that is looking for dc for operation. We already have this supplied through the rectifier filter network originally installed in the unit. Where this network is looking for ac input, we will supply it with the transformer we are going to install under the output tank coil part of the chassis, as this is the area with the greatest amount of unused space. The mounting of the transformer can be left to your discretion. Suffice it to say, remember the cover has to go on again!

The secondary of the transformer – the 125V side – is to be wired to TS-1 on the linear (in other words, to the underside of the fitting where the cheater-cord formerly plugged in). This socket will now become a terminal strip for connecting purpose only. The primary or 115V side can now be connected to the switched side of the ac line incoming to the unit. The most likely place would be where the fan motor connects to the line. Thus we have the supply connected, and the relay will operate.

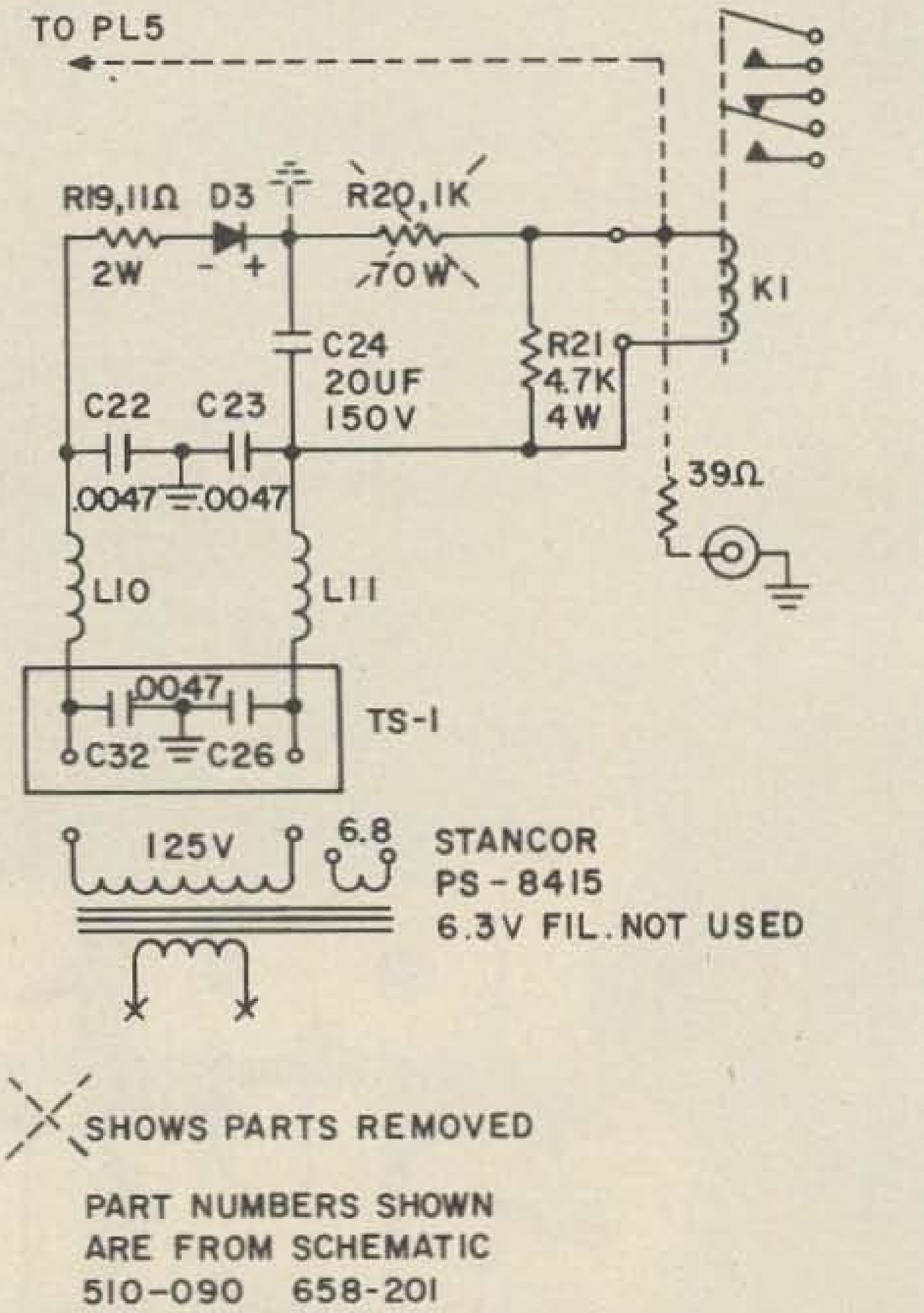



*Fig. 1.*

But let's pause a moment and reflect. We now have 100V dc to operate the relay. The manual states that minus 100V is needed to cut the amplifier off during receiving periods. So let's use this minus 100V to do just that. By grounding the junction of C24, D3 and R20 – this being the positive side of D3 – it will ground the positive side of the supply, leaving us the negative side through the relay and load resistor R21 to run to PL5 where the external bias was to be applied.

Since we now have minus 100V, it would be wise to remove or replace C1 in the grid lead, as this is a 25V condenser and will not be needed, as is the case of D1 diode which formerly supplied the minus 4V of bias. Also remove R20, as we will no longer need this resistor.

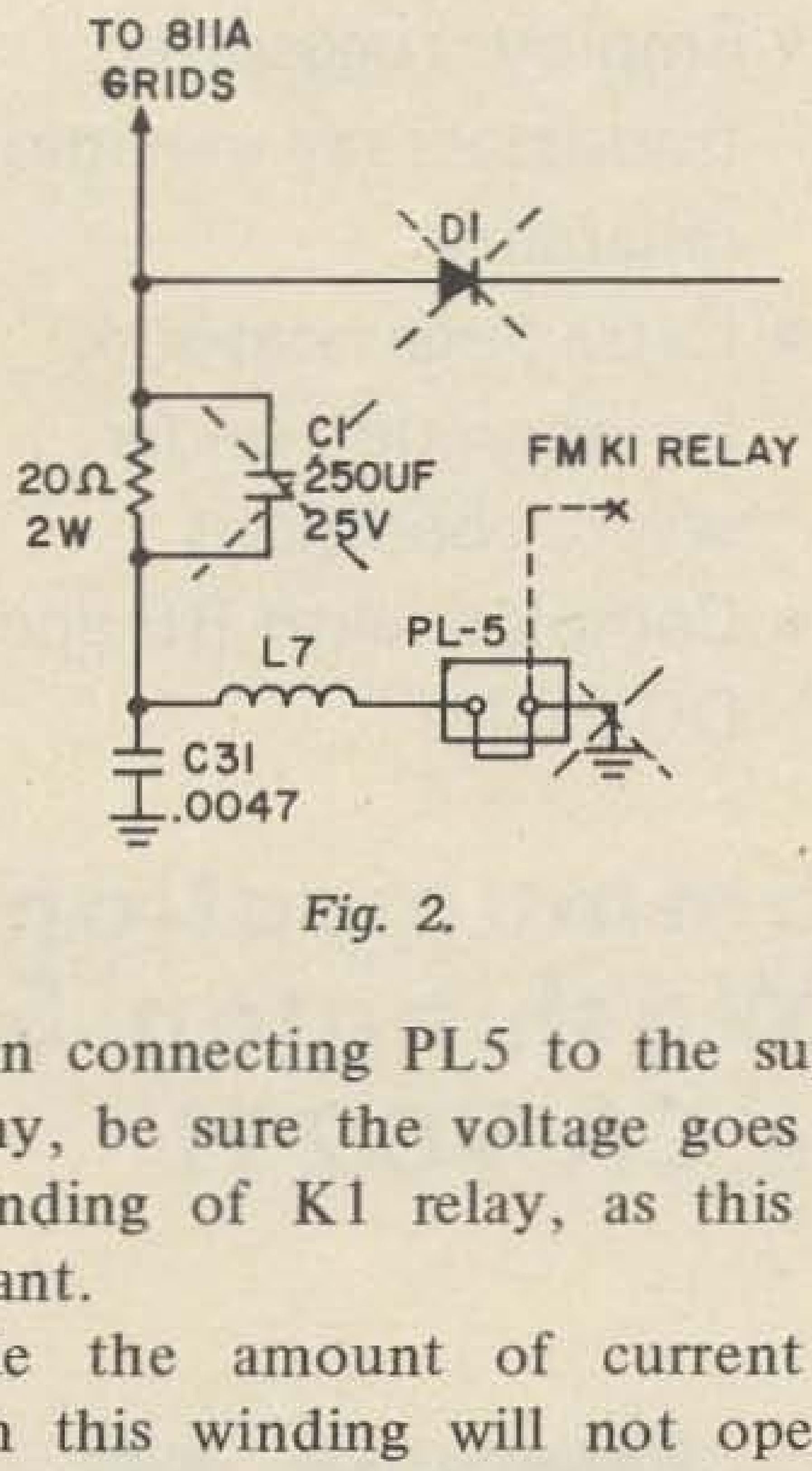



*Fig. 2.*

When connecting PL5 to the supply for K1 relay, be sure the voltage goes through the winding of K1 relay, as this is quite important.

While the amount of current passing through this winding will not operate the relay, it will be enough to bias the grids to cutoff.

To operate the relay with the ground supplied from the exciter, it will be only necessary to ground the grid side of the relay for operation, thus cutting off the bias to the final tubes and operating the change-over relay.

This modification may be applied to several types of linear amplifiers with equal success. The result is a smooth operating unit of equipment with built-in ruggedness.

. . .W6HGX

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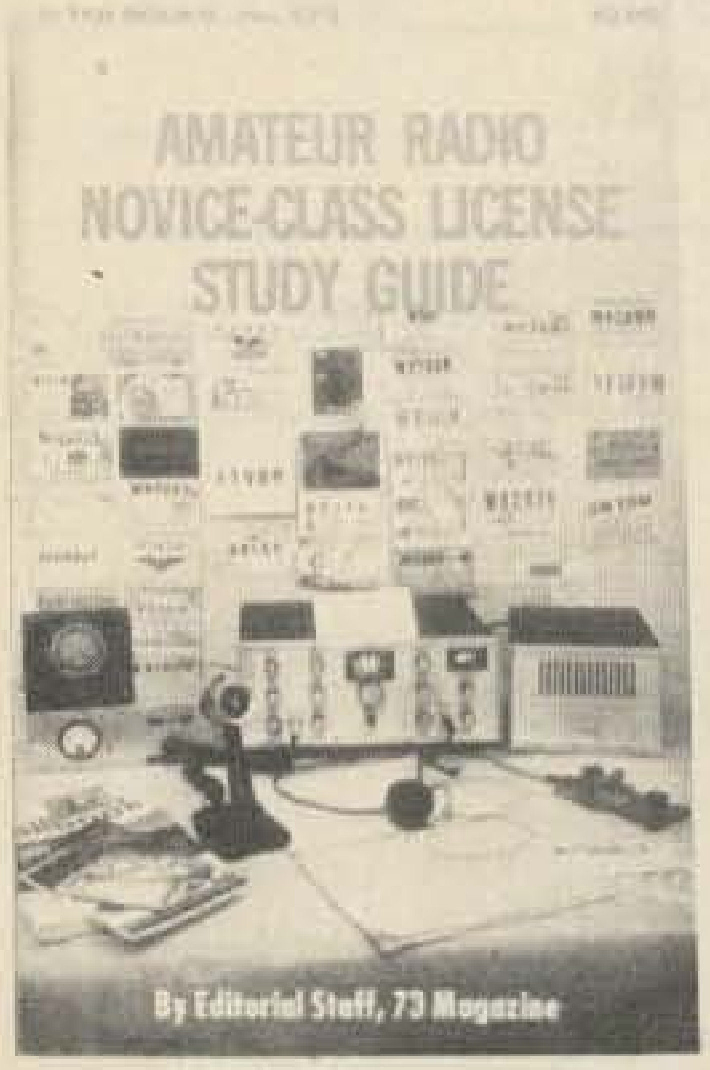


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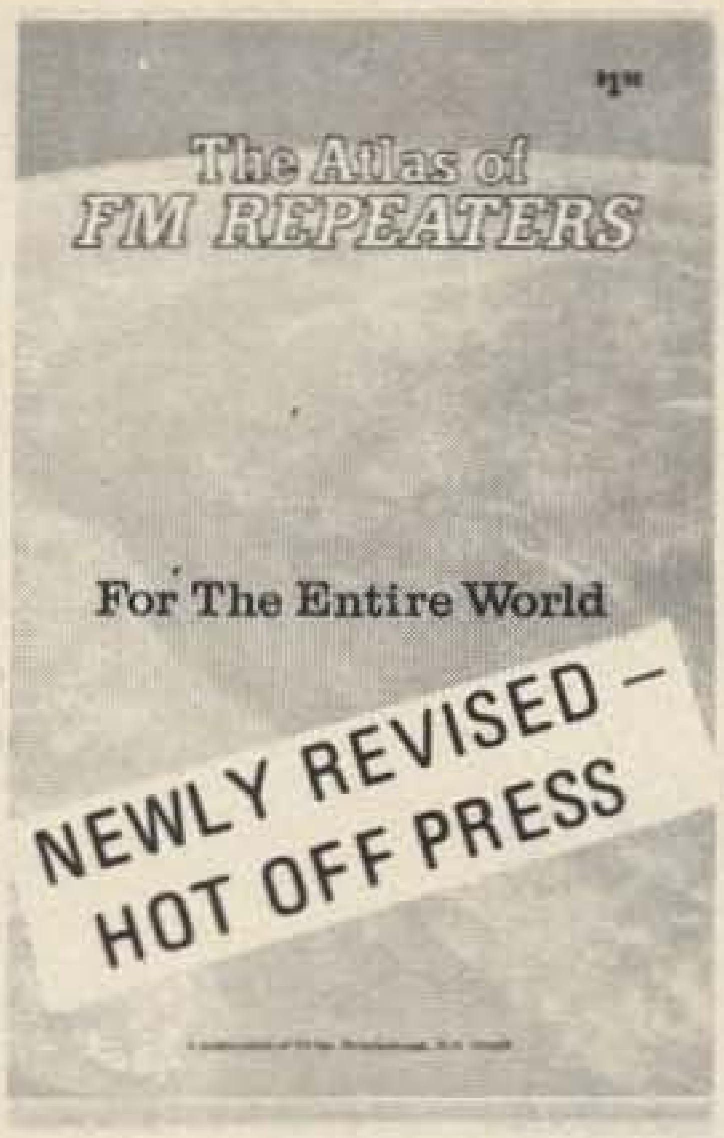



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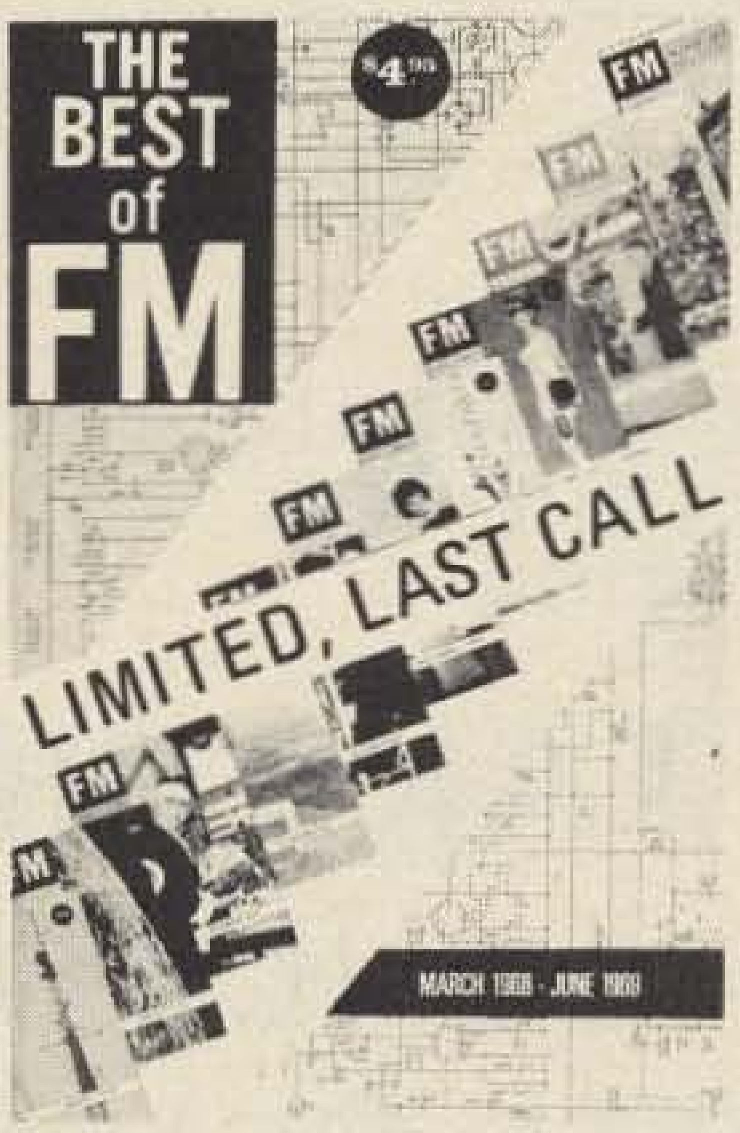



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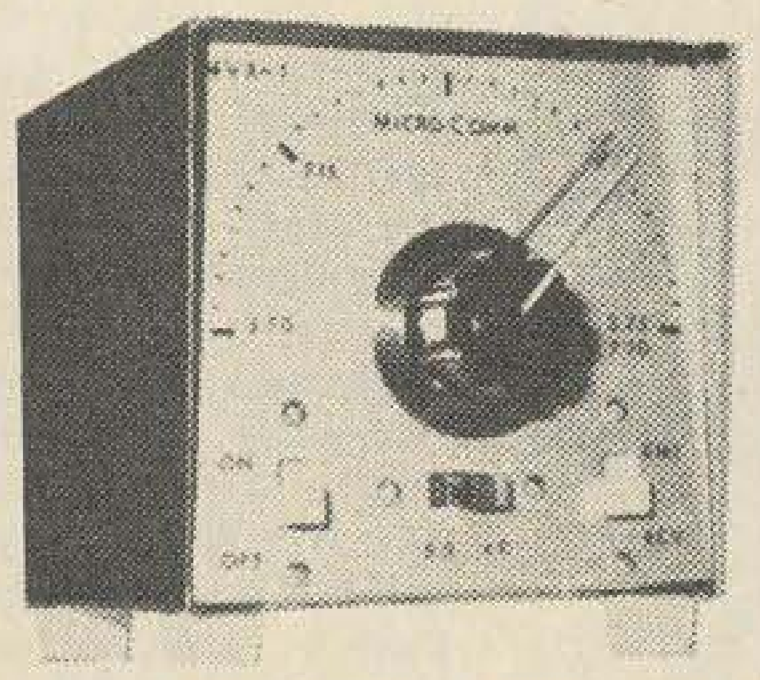


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# A TIME FOR EVERYTHING

Time and tide wait for no man." So runs an old English proverb attributed to Chaucer in the 14th century. As far as time is concerned, this is not surprising – with time moving at the speed of electrons in space, man is ruled by time! Time has influenced all of the actions of mankind since the beginning, when the caveman no doubt planned his life around the rising and setting of the sun. Wars have been won and lost because of time, or the lack of it; and in their everyday actions man and animals base their every move upon time.

Because the time of day varies throughout the world, the zonal time computer that is included in this article can prove valuable to anyone who has occasion to know the time at any point on the earth's surface with respect to his own position.

The map drawn on the face of the computer is known as a "modified polar azimuthal projection." This map presents a view as if you were stationed in space above the North Pole, looking down, but somehow you can view beneath the equatorial line. A map such as this becomes highly distorted when viewed this way, but the shape of the continents, especially in the Northern hemisphere is quite clear. The computer and its operation will be described more fully later, but first, let us examine some interesting background relating to time.

Man probably advanced his timekeeping ability by watching the changing position of shadows cast by trees and other objects as the day progressed. There is evidence to suggest that in very early times, by very complex calculations the priests of Stonehenge (England) were able to increase their power over their people by recognizing that the sun cast the same shadow at the same time in a certain position each year – thus they were able to forecast the occurrence of certain natural phenomena, such as an eclipse.

Later came the sundial, burning candles that had markers on them for keeping time, and finally watches and clocks. The invention of the latter instruments, about 1700, made the use of apparent solar time less than satisfactory, because apparent solar time, which is the time as measured by a cast shadow from the sun, varies east and west of any given point at any moment. In fact, this variance amounts to four minutes for every degree of longitude. So, for a watch to be strictly accurate it would need to be set ahead or back for each degree!

Until quite recently, time measured in minutes and hours was quite sufficient for daily accuracy; and indeed, this is still usually enough for one's purpose. However, advances in all of the sciences, particularly electronics, now require extremely minute measurements or actions to occur in the electronic computer, where functions are measured in picoseconds (one million-millionth of a second!), for such purposes as propagation delays in integrated logic circuits.

Although the methods of measuring time have varied, the measurement is always based upon some recurring phenomenon; the *apparent* motion of the sun around the earth being the most common observation. Time measurement based on this observation is known as *mean solar time*. Time measured by observing the earth's movement in respect to the fixed stars is known as *sidereal* time. You will notice that we emphasized the word "apparent." Obviously, although it appears to us, and it did to ancient man, that the sun and stars are moving across the sky and we are standing still, the motion is actually due to the rotation of the earth upon its axis.

Mean solar time, until 1956, was the scale upon which the arbitrarily selected unit of time – the second – was based. However, because the speed of rotation of the earth is not constant, corrections to solar time are constantly necessary. Due to this, the mean solar second was replaced with "ephemeris" time as the fundamental unit of time interval. Ephemeris time is also determined by astronomical observations of the stars other than the sun.

Nevertheless, mean solar time continues to form the basis for providing time zones around the earth. The circumference of the earth is divided into 360 degrees, and a fixed point on the earth will turn through these 360 degrees in 24 hours. The instant when the sun comes over an observer depends upon his position on the earth – his longitude. Because of the difficulty mentioned previously, that was encountered when watches were first introduced, an hour of time was arbitrarily assigned to an area by local custom. This created another problem which was serious enough while travel was still relatively slow, by foot and by horse and carriage, but with the coming of steam trains the situation became chaotic. Sometimes, a person traveling east and west (or even south and north!) would pass through three different times-of-day in traveling but 50 miles, because of local time differences that were selected by the various towns and villages.

### Standard Time

Primarily, because of the railroad, but also because of this general confusion, "Standard" time was adopted by most of the nations of the day at a conference held in Washington, D.C. in 1884. Standard time, as defined, was to be based on the mean solar day as reckoned by the Royal Observatory, England, and the meridian of longitude at Greenwich, England was accepted as the prime (zero) meridian. This meridian had existed, of course, for centuries but was not acknowledged by every nation as being the prime meridian. At the conference there was a great deal of debate deciding where the prime meridian would, in fact, be located. The meridians of Jerusalem and Rome were advocated for religious reasons; the one passing through the Great Pyramid at El Gizeh was suggested due to the survival of this landmark for centuries; and even one passing through

Hierro in the Canary Islands was recommended because of its location on important sea lanes. Once the decision was reached to designate the meridian at Greenwich, an instrument known as the "Airy transit circle" installed there comprised the primary reference. This device is still at this location, maintained as part of a national museum. By agreement at the conference, the central crosshair of this instrument designates the fundamental reference point for determining longitude. Although the Royal Observatory was moved in 1948 from Greenwich to Herstmonceux Castle in Sussex, no change was made to the prime meridian reference point location.

Having established the zero reference point, the method for calculating the hour of the solar day was determined. The earth's 360-degree circumference is divided into 24 time belts, or zones, of 15 degrees each, with each zone differing in time from Greenwich by an integral number of hours. The center of each zone is on one of the meridians, with the zone itself extending 7½ degrees on each side of the meridian. Interestingly enough, the standards as established at this conference were not ratified by the United States government until March 19, 1918. Although commerce, and the railroads particularly, set their own time zones, usually at divisional points, time from place to place varied widely until this ratification occurred. Today, in the U.S., time zones are established by the Interstate Commerce Commission.

The zones along the meridians are not always exactly parallel. Political boundaries of the various countries and states have caused some modification, so that although the sea and in the air a zone will parallel a meridian, a time zone on land may zig-zag considerably. For instance, in traveling in a straight line north and south in Russia, one may have to change his watch three times between its southern border and the Arctic ocean.

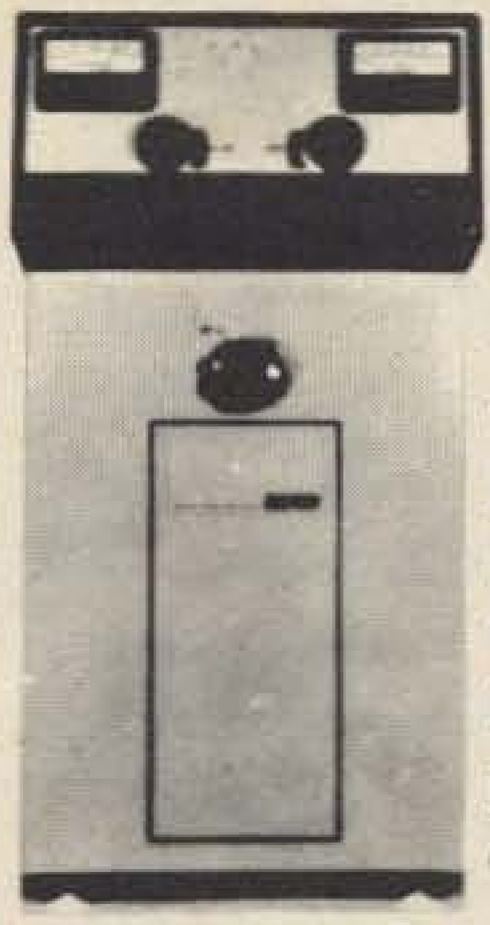
Other countries and places, although having time differences from Greenwich that are fairly close to the nearest meridian zone, have fractional hourly changes. For instance, the Tonga island group, at 175° west longitude in the Pacific, has a time difference from Greenwich of minus 12 hours and 19 minutes; the Cook islands, also in the Pacific, have a difference of minus 10 hours and 38 minutes. A great many places have half-hour differences from the zone hour, as India, with minus 5 hours and 30 minutes from the Greenwich meridian.

**International Date Line**

At some point on the earth's surface a new day must begin for the purpose of determining time. The position for this was arbitrarily adopted by seafarers many years ago, as a place convenient to them but not inconvenient to any populous area. This position was the 180th meridian east and west of Greenwich. (For navigational purposes, the earth's 360 degrees is made up of 180 degrees east, and 180 degrees west, of Greenwich prime or zero meridian.) The International Date Line diverts from the 180th meridian in several places to avoid large land or populated areas, notably the East Cape of the USSR, The Aleutians, and the Fiji island area of the South Pacific. When crossing this line traveling west, one full day is "lost," and when crossing east, a day is "gained." That is, on the east side of the line it may be 0900 on Tuesday, but immediately on the other side although it is also 0900, it is Wednesday. It may be considered the point where the "new day" begins, and, of course, in determining time differences between zones, this day difference must be considered. The International Date Line is not officially recognized by any world agreement at the present time, but is, nevertheless, accepted.

**International Use of Time**

The mean solar time of the Greenwich meridian is used for many commercial, scientific, and technical purposes to avoid problems that would occur by attempting to use conflicting local times. The official name that has been adopted is Universal Time, abbreviated UT, but frequently by long custom it is designated GMT (for Greenwich Mean Time). It is also known as "Z" (Zulu) Time, especially in the military services. The latter designation is also arrived at by international agreement, as is



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the arrangement of all of the other lettered zones described below. Times recorded in the successive 15 degree zones east of Zone Z are designated by the suffixes A through L (omitting J). Time in the eastern half of the zone over the Date Line is suffixed M. Westward from Z zone, the time suffixes are N through X. The letter Y is applied to time in the western half of the date line.

Many other time zones are established locally. Western Europe is on Central European Time (−1 hour, or ahead of Greenwich or Z time), the British Isles and Portugal also recently changed to this time, previously having been on Z time. Mexico, for the most part, follows the same time as United States Central Time (+6 difference from Greenwich), although most of that country is over the 105° W. longitude meridian (+7 hours). Newfoundland and Labrador are 3½ hours (+3.30) behind Z time. New Brunswick, Nova Scotia, and Eastern Quebec are on Atlantic Time, and although Alaska is 10 hours behind GMT, four time zones are actually in use in that state.

For these reasons it has not been possible to show all of the many time zone variances on the map on our computer. In general, the time zone which lies over a country or continent will be correct for that place. However, for specific places, the Index of Locations should be consulted. A few spaces are provided to allow you to enter any places that may not be included and to which you may wish to refer frequently.

### The 24-hour Clock

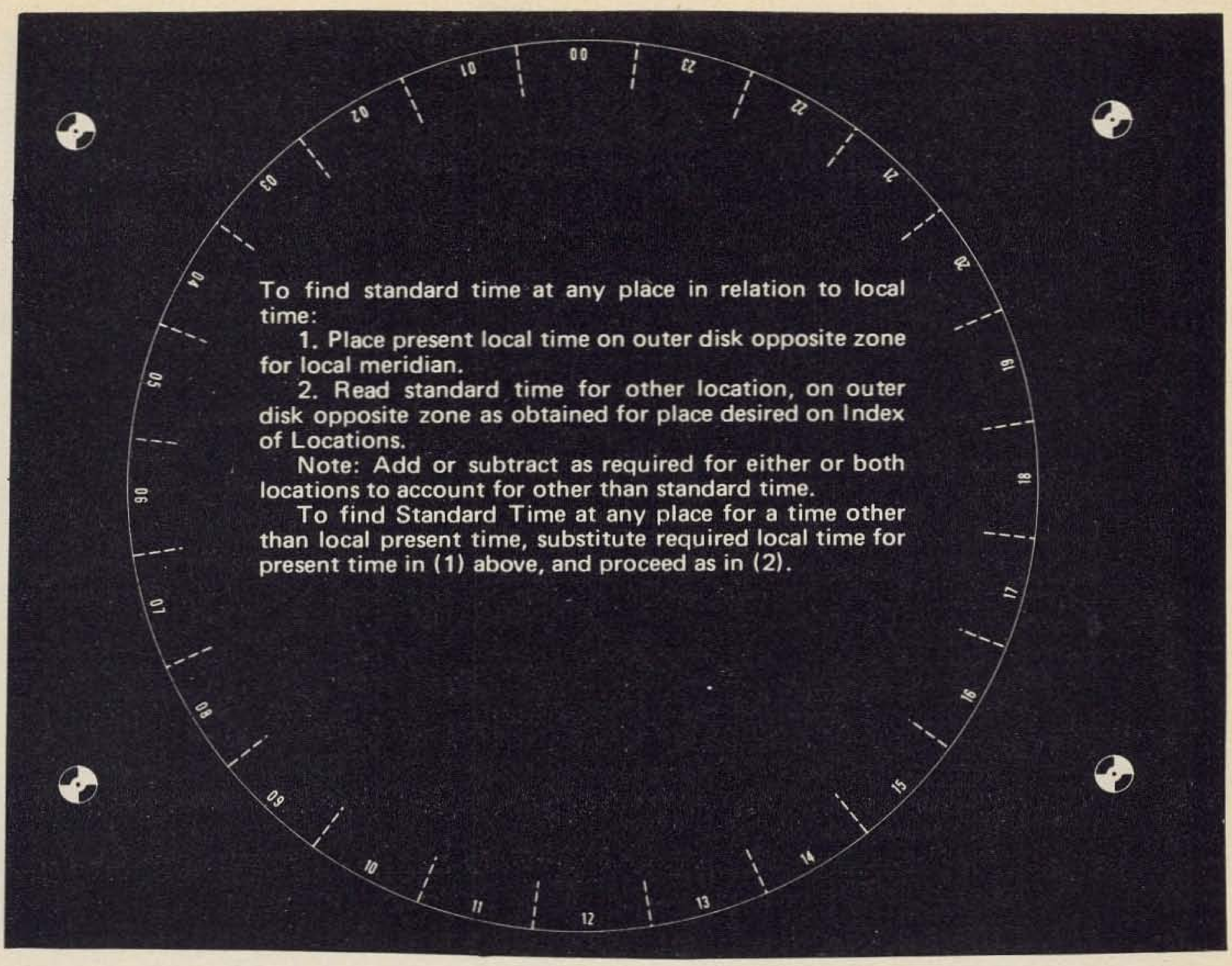
In civil use in the United States and some other countries it is customary to assign a.m. as a suffix to the hours from midnight to noon, and to indicate from noon to midnight by using p.m. There is always the possibility of omitting either suffix, or of erroneously showing noon as either 12 a.m. or midnight as 12 p.m. Such ambiguity is avoided by using a 24-hour system and assigning 24-hour designations to a 12-hour clock, not necessarily on the face of the clock, but by remembering where the differences occur.

You will have noticed that virtually all radio schedules are in the 24-hour system. The hours from midnight to noon are indicated as 0000 to 1200 to the first two digits of the hour two more digits are added to indicate the minutes. The hours from 12 noon until one minute before midnight are referred to as 1200 to 2359. The word "hours" is not added after the four digits. The 24-hour day system, beginning at midnight GMT, was accepted as a standard by world governments on January 1, 1925. On our computer no minutes have been shown, as these will vary according to the moment of use. Unless the place for which the time is being calculated is on a fractional part of an hour difference, the minutes will always be the same at both your location and the other place.

### Time Signals

In an international society there are many phenomena that depend on exact timing and uniform recognition of time. Tide timetables for ships, for instance, must all speak the same time "language" to mean the same for all nationalities. Communications and transportation must also have uniformity in their designation of time. In addition to recognizing a universal system, therefore, the broadcasting of time signals for the accurate adjustment of chronometers for these services must be based upon a standard, and this standard has been accepted as GMT.

Many radio stations transmit time signals for these purposes. Accuracy, to an atomic clock primary standard (wherein time is synchronized to the frequency of oscillation of electrons in certain substances), remains constant over a year to about one part in $10^{10}$. Navigational Loran time pulses of the United States Coast Guard are accurate to one microsecond. Details of the transmission of time signals throughout the world are usually available from the government agency controlling telecommunications for the various countries. In the United States and Canada, the most recognized stations are WWV, National Bureau of Standards at Fort Collins, Colorado, transmitting on 2.5, 5.0, 10.0, 20.0, and 25.0 MHz; and CHU, the Dominion Observatory, Canada, transmitting on 3.33, 7.335, and 14.67 MHz.




**Assembling the Computer**

Cut out the two circles carefully, keeping the cut to just expose the edge line. Paste the circles to any heavy card stock cut to the same dimensions. Using a small pin, make a small hole in the center of each piece, where the dot indicates the center. Place the smaller circle directly over the larger, then fasten them with a small eyelet positioned exactly in the center. If the holes are not exactly centered, the time zones will not align properly. Eyelets may be obtained at most notion counters of five-and-dime or department stores. One package, known as "E-Z No. 720," contains 25 eyelets together with a tool for making the hole, and another for crimping the eyelet, all for 29¢. This package is manufactured by E-Z Buckle, Inc. of New York, N.Y. A snap-fastener, also available in notions departments, may also be used, but may not allow the disks to turn as smoothly. As a last resort a small screw, flat washers, and a nut may be used.

**Using the Computer**

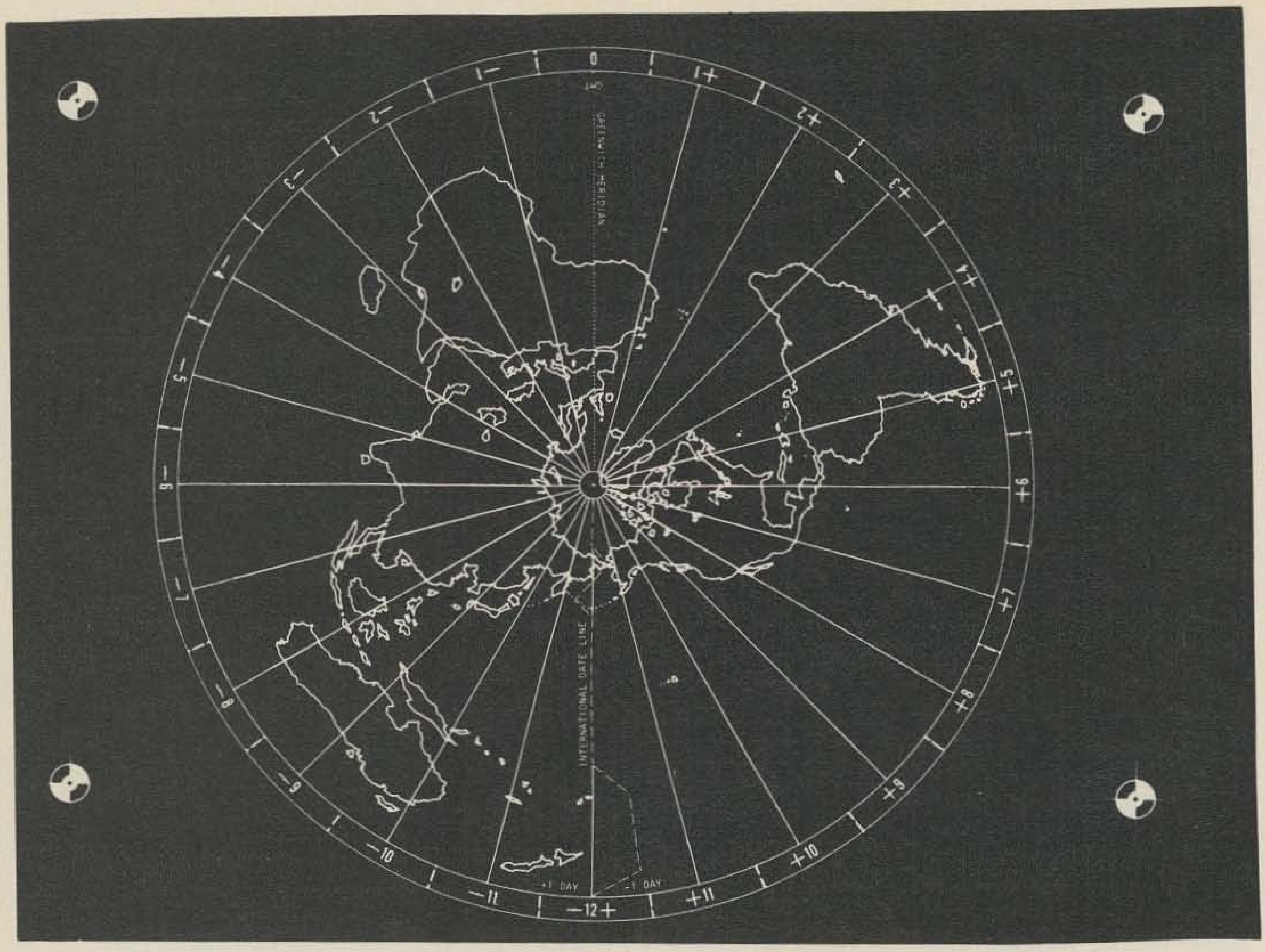
Using the computer is extremely simple. Directions for its use are printed on the lower disk. Just remember to always consider that if the location for which you are calculating the time is west of the International Date Line and you are east of it, it is "tomorrow" there; and "yesterday" if you are located west of the line and the time you are seeking is east of the line.

The positive and negative hours shown on the outer perimeter of the top disk actually represent the time difference in hours from Greenwich Mean Time at a particular meridian. This time difference would be true at any location where political boundaries or local laws are not applicable; for instance, at sea, or where no legal time has been established (parts of Greenland, for example). On the computer the positive and negative hours guide the user to the correct zone as referenced in the Index of Locations.

To find standard time at any place in relation to local time:

1. Place present local time on outer disk opposite zone for local meridian.

2. Read standard time for other loca-




tion, on outer disk opposite zone as obtained for place desired on Index of Locations.

Note: Add or subtract as required for either or both locations to account for other than standard time.

To find Standard Time at any place for a time other than local present time, substitute required local time for present time in (1) above, and proceed as in (2).

**Index of Locations**

List of places with zones to be used as they appear on front of computer. Where entire or nearly entire country is in one zone, cities within that country are not listed.

| | |
|---|---|
| Afghanistan | −4½ |
| Australia – Perth | −8 |
| – Sydney | −10 |
| Alaska – Anchorage | +10 |
| – Juneau | +8 |
| – Nome | +11 |
| Argentina | +4 |
| Bolivia | +4 |
| Brazil | +3 |
| Chile | +4 |
| China | −8 |
| Colombia | +5 |
| Cuba | +5 |
| Ecuador | +5 |
| Ethiopia | −3 |
| Europe | −1 |
| Finland | −2 |
| Formosa | −8 |
| Greece | +2, +3, +4 |
| Guatemala | +6 |
| Haiti | +5 |
| Hawaii | +10 |
| Honduras | +6 |
| Hong Kong | −8 |
| Iceland | +1 |
| India | −5½ |
| Iran | −3½ |
| Israel | −2 |
| Jamaica | +5 |
| Japan | −9 |
| Kiev, USSR | −3 |
| Korea | −9 |
| Latvia | −3 |
| Moscow, USSR | −3 |
| New Zealand | −12 |
| Nicaragua | +6 |
| Paraguay | +4 |
| Peru | +5 |
| Phillipines | −8 |
| Puerto Rico | +4 |
| Rangoon Burma | −5½ |
| Singapore | −7½ |
| South Africa | −2 |
| Surabaja Java | −7 |
| Syria | −2 |
| Thailand | −7 |
| Turkey | −2 |
| United Arab. Rep. | −2 |
| Uruguay | +3 |
| Venezuela | +4 |
| Viet Nam | −8 |
| Vladivostok, USSR | −10 |

. . . WB6KFI

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| | | |
|---|---|---|
| LM370 | AGC/Squelch amp | $4.85 |
| LM373 | AM/FM/SSB strip | $4.85 |

LM309K 5V 1A regulator. If you are using TTL you need this one. .................. $3.00

### POPULAR IC's

| | | |
|---|---|---|
| MC1550 | Motorola RF amp | $1.80 |
| CA3020 | RCA ½ W audio | $3.07 |
| CA3020A | RCA 1 audio | $3.92 |
| CA3028A | RCA RF amp | $1.77 |
| CA3001 | RCA | $6.66 |
| MC1306P | Motorola ½ W audio | $1.10 |
| MC1350P | High gain RF amp/IF amp | $1.15 |
| MC1357P | FM IF amp Quadrature det | $2.25 |
| MC1496 | Hard to find Bal. Mod. | $3.25 |
| MFC9020 | Motorola 2-Watt audio | $2.50 |
| MFC4010 | Multi-purpose wide band amp | $1.25 |
| MFC8040 | Low noise preamp | $1.50 |
| MC1303P | Dual Stereo preamp | $2.75 |
| MC1304P | FM multiplexer stereo demod | $4.95 |

### FETs

| | | |
|---|---|---|
| MPF102 | JFET | $.60 |
| MPF105/2N5459 JFET | | $.96 |
| MPF107/2N5486 JFET VHF/UHF | | $1.26 |
| MPF121 | Low-cost dual gate VHF RF | $.85 |
| MFE3007 | Dual-gate | $1.98 |
| 40673 | Dual-gate | $1.75 |
| 3N140 | Dual-gate | $1.95 |
| 3N141 | Dual-gate | $1.85 |

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| NE562B | Phase Lock Loop | $4.75 |
| N5111A | FM/IF Demodulator | $1.50 |
| NE566V | Function Generator | $4.75 |
| NE567V | Tone Decoder | $4.75 |

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| | |
|---|---|
| T200-2 | $2.00 |
| KW Balun kit only | $3.50 |
| T68-2 3 cores | $1.00 |
| T50-2 3 cores | $1.00 |
| T50-6 3 cores | $1.00 |
| T50-10 3 cores | $1.00 |
| T44-10 3 cores | $1.00 |

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Ferrite Beads 1 doz. .................. $1.00

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### INTRODUCING DEVICES AT NEW LOW PRICES

| | |
|---|---|
| LA3018 (Replaces CA3018 | $1.60 |
| LA3046 (Replaces CA3046) | 1.60 |
| LS370 (Replaces LM370) | 4.00 |
| LS1496 (Improved MC1496) | 2.00 |
| LS3028A (Replaces CA3028) | 1.60 |
| LP1000 (A new fun-type device to make LED flashers, audio osc, timer etc.) | 1.60 |

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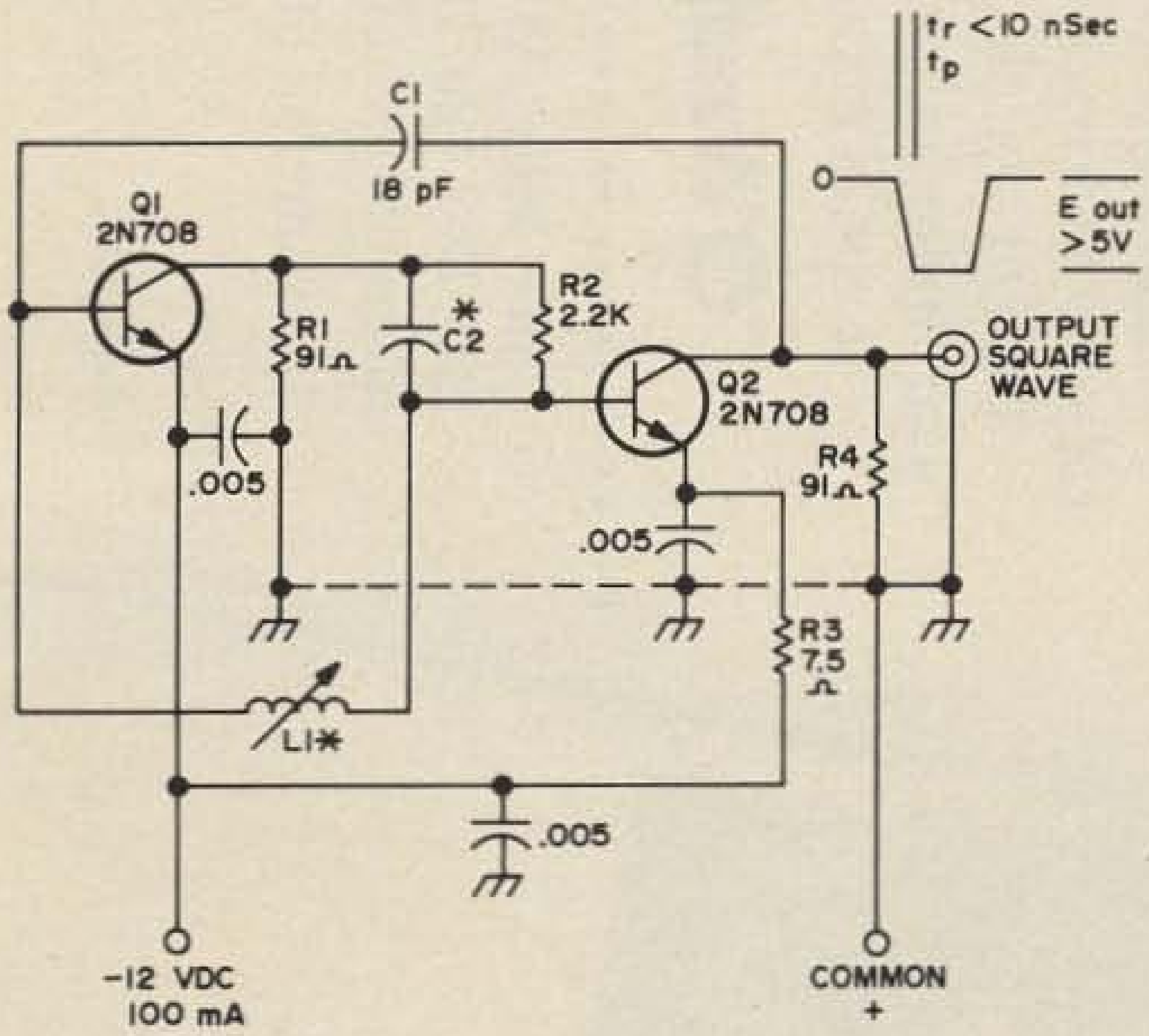
# CIRCUITS, CIRCUITS, CIRCUITS...

*The following circuits have appeared in the referenced books, magazines, application notes, etc. While we try to reproduce all of the information that should be needed by an experienced constructor, readers may want to avail themselves of the original sources for peace of mind.*

*Readers are requested to pass along any interesting circuits that they discover in sources other than U.S. ham magazines. Circuits should be oriented toward amateur radio and experimentation rather than industrial or computer technology. Submit circuit with all parts values on it, a very brief explanation of the circuit and any additional parts information required, give the source and a note of permission to reprint from the copyright holder, if any, and the reward for a published circuit will be a choice of a 73 book. Send your circuits to 73 Circuits Page, 73 Magazine, Peterborough NH 03458.*




## SQUARE WAVE SOURCE

*Trim L1 for best waveshape. An overtone crystal (odd order) can be substituted for C1. For 51 ohm output change R1 and R4, reduce supply to 8 volts. Heat sinks suggested on Q1 and Q2. When cutting and tying, reduce input to about 6 volts.*

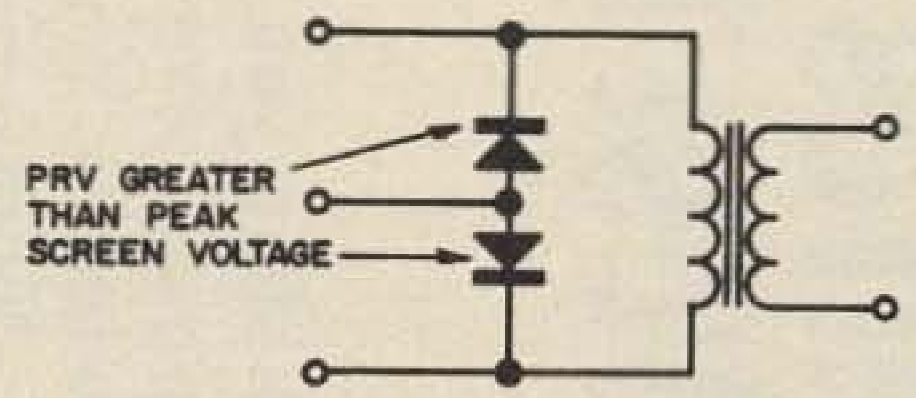
*All resistors are ½W carbon. Capacitors in decimal are disc type (short leads). 2N708's for best performance are Fairchild (other brands work, but do not give clean waveshape).*

*Harmonics observed into microwave region. Symmetrical square wave at output; dc reference to ground. Output at 4 MPS ≈ .5 watt. Short circuit protected.*

Typical Values

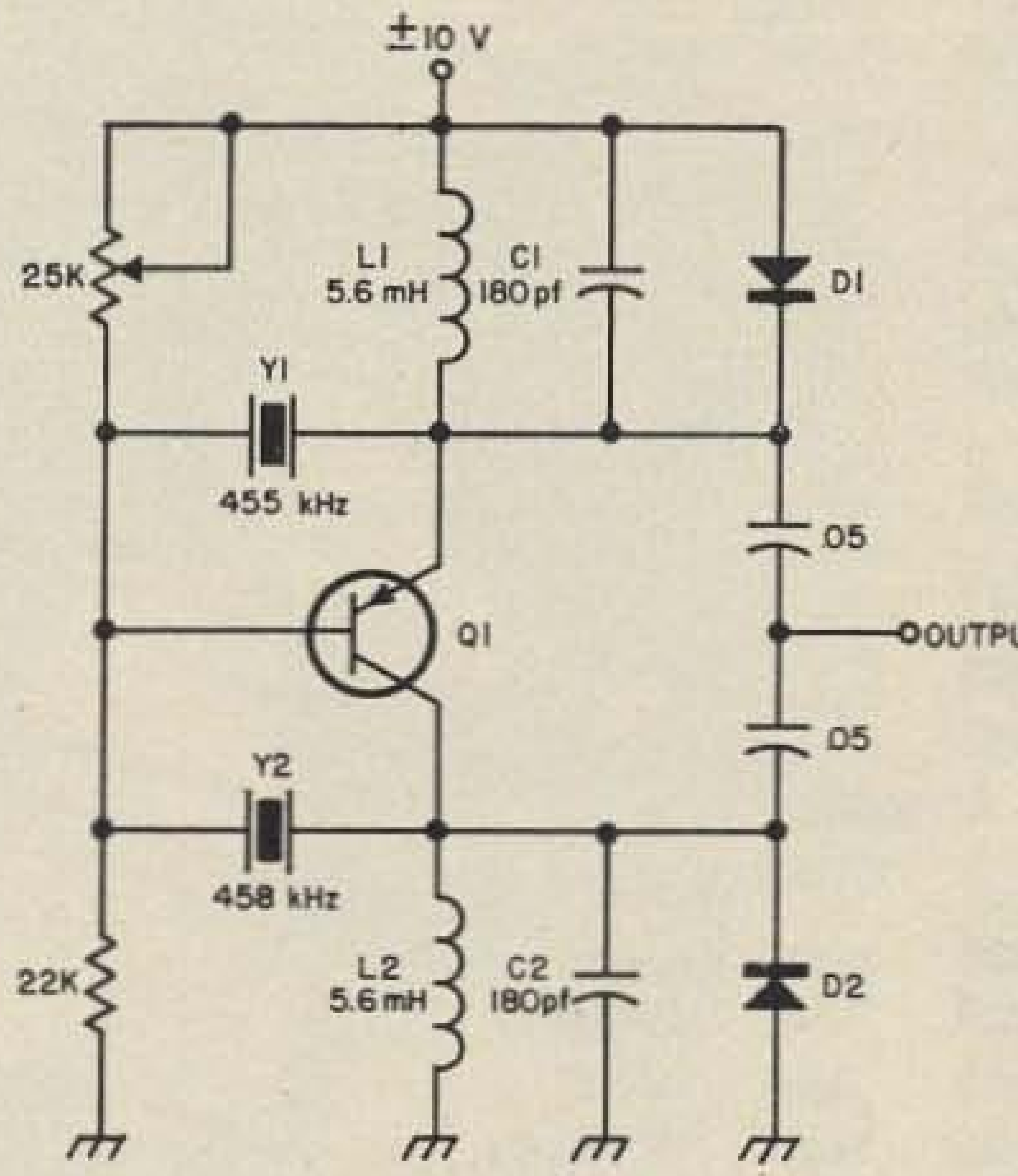
| MPS | C2 pF | L1 |
|---|---|---|
| 4.0 | 100 | 82 µH |
| 10.0 | 47 | 15 |
| 15.0 | 47 | 10 |
| 20.0 | 47 | 4.7 |
| 30.0 | 47 | 2.2 |
| 50.0 | 47 | 2.2 |
| 72.0 | 39 | .22 |

*Thanks to W8MPB.*




*Diode center tap for use with modulation transformers that have no center tap. This circuit was originally designed to modulate a tetrode balanced modulator. Audio is injected into the single end.*

*K5LLI*




*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. Almost any PNP rf transistor will work as Q1. D1 & 2 are general purpose silicon diodes. From 73 Useful Transistor Circuits, available for $1 from 73.*

*Continued on page 143 . . .*

# PROTECTION FOR ICs

*Gene Brizendine W4ATE*
*600 Hummingbird Drive SE*
*Huntsville AL 35803*

This IC-saving circuit is so simple it may appear too obvious to suggest. However, should a regulated power supply pass transistor short-circuit, $100 worth of IC's may easily be destroyed by excessive voltage, for example. The cost of new IC's, plus the often tedious task of troubleshooting and replacement, emphasizes the need for such positive protection.

Essentially, a selected zener diode is wired internally across the regulated power supply output. A typical application for protecting the popular 7400 TTL IC series is outlined in Fig. 1. This particular IC family has a power supply span of negative 0 volts to a positive 7 volts. The device design supply voltage is 5.5 volts, therefore during normal power supply operation the protective circuit draws little current.

With abnormal supply voltage, due to defective regulation or any other cause, the excessive voltage is dissipated in R and the zener diode. The load devices are protected because the applied voltage cannot exceed 7.25 volts. The power supply transformer and rectifier are protected by the combined dissipations of R and CR.

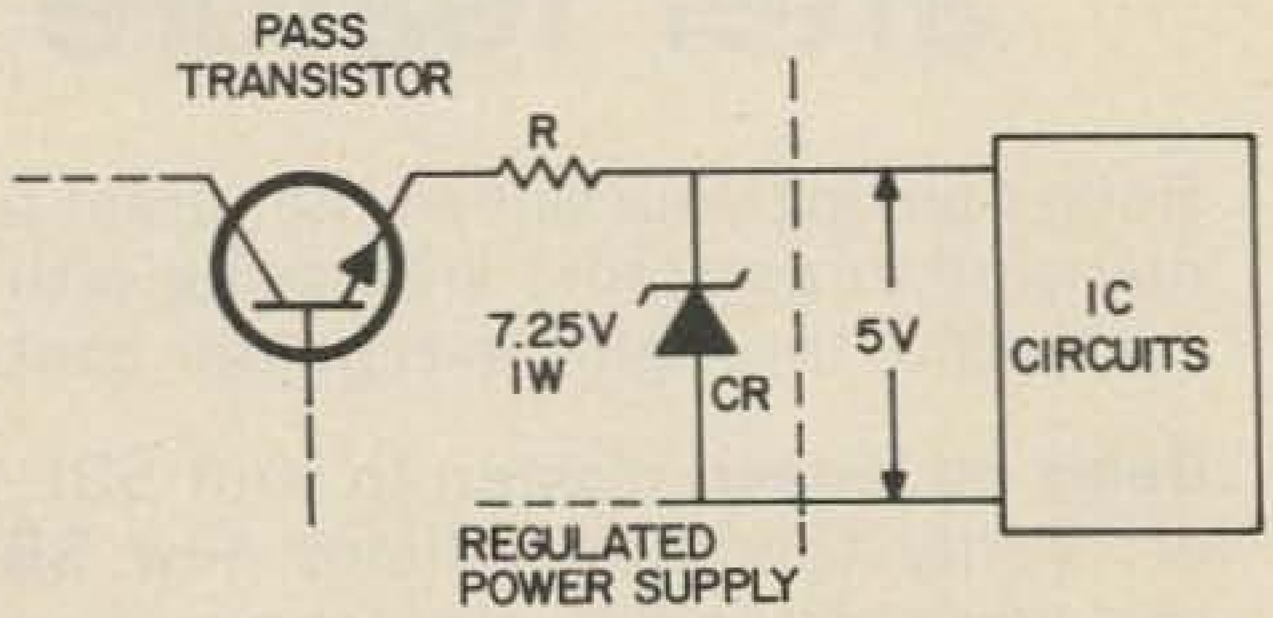
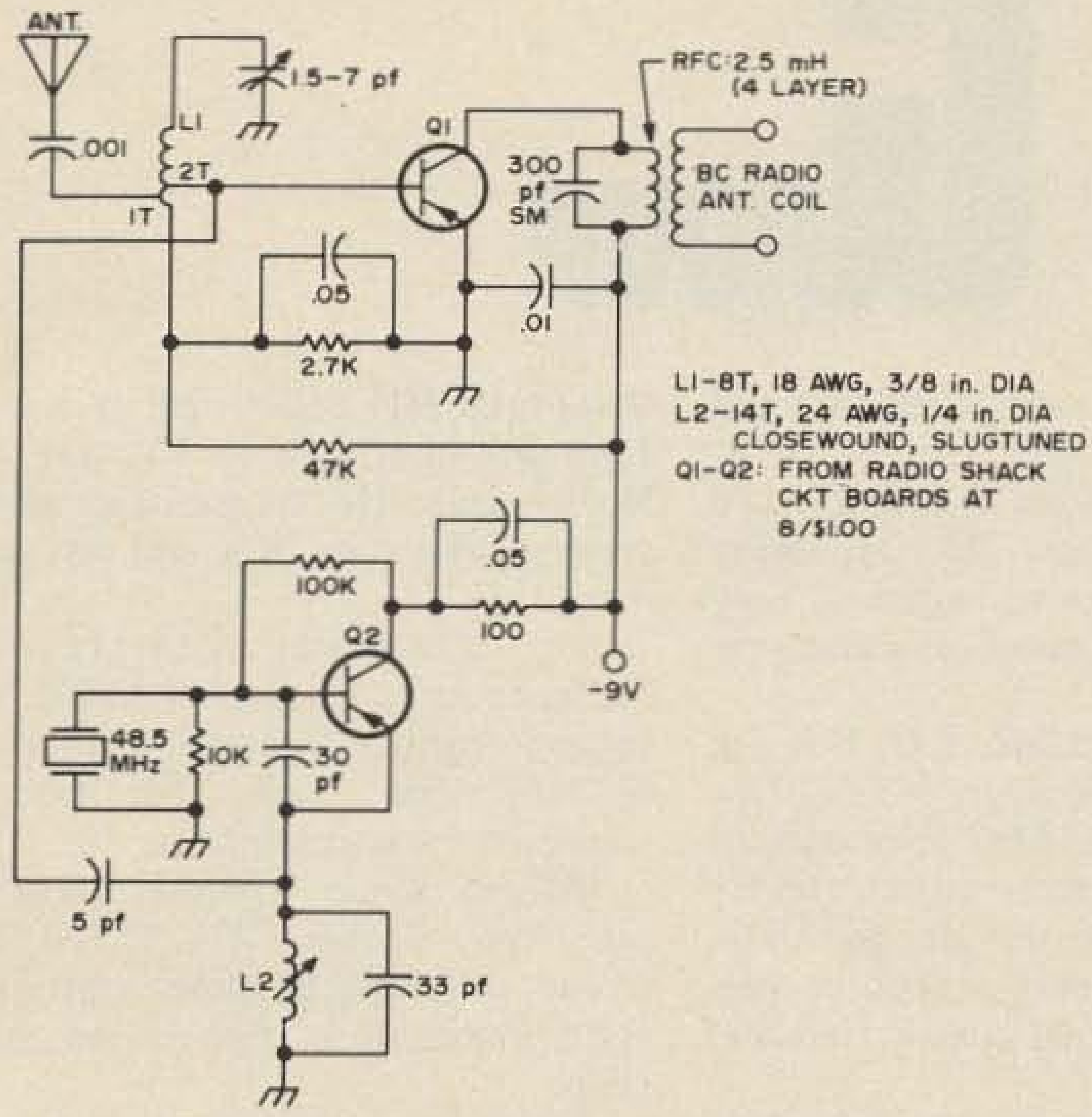



*Fig. 1. IC protective circuit.*

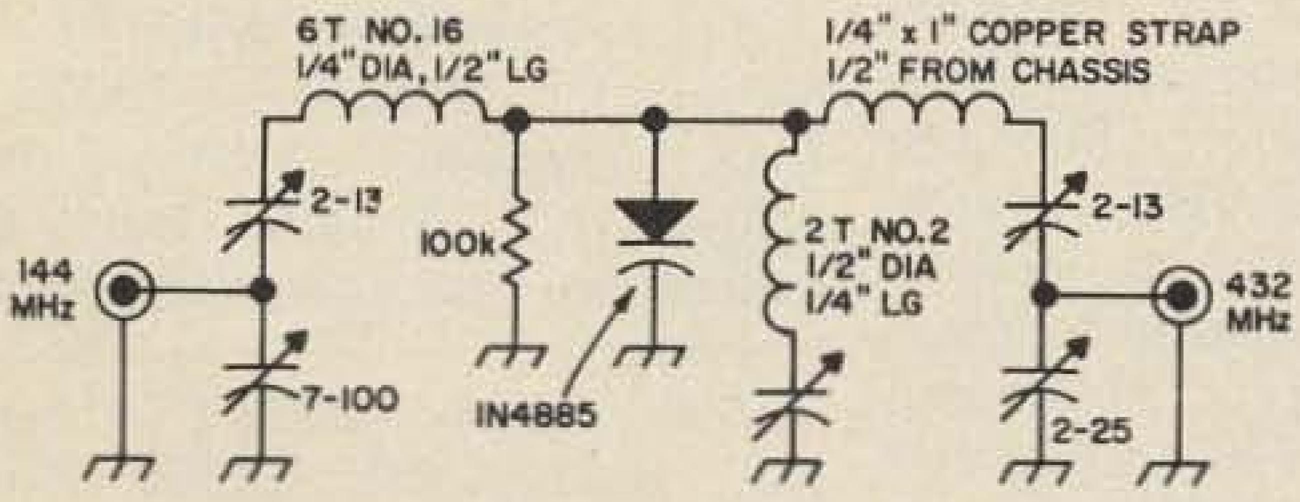
The exact values of R and CR are dependent upon load and power supply characteristics and are easily determined. The cost of a selected zener and resistor is insignificant, compared to the expensive devices they may save.

. . .W4ATE

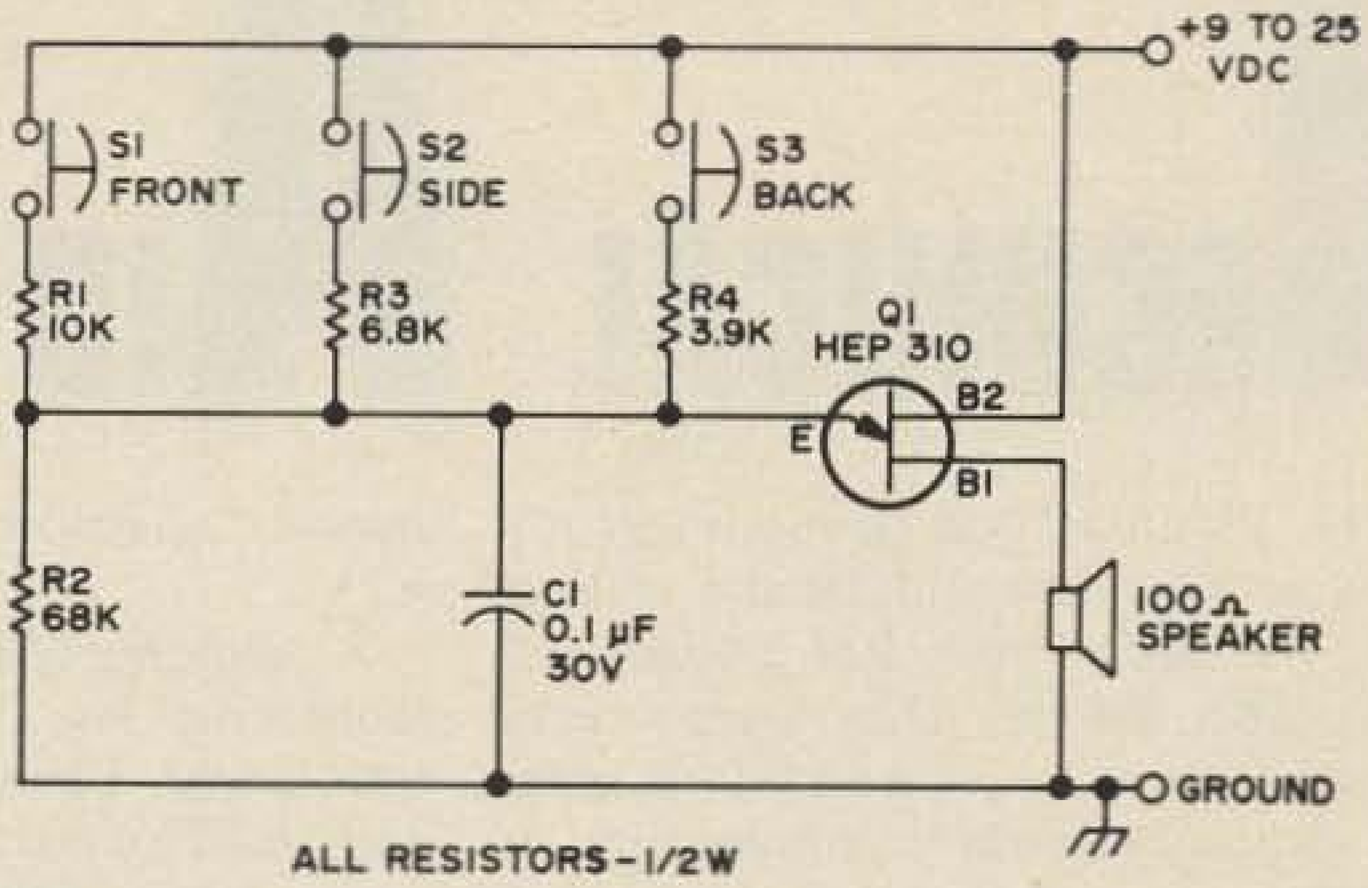
# MORE, MORE, MORE . . . CIRCUITS, CIRCUITS, CIRCUITS . . . . . . .



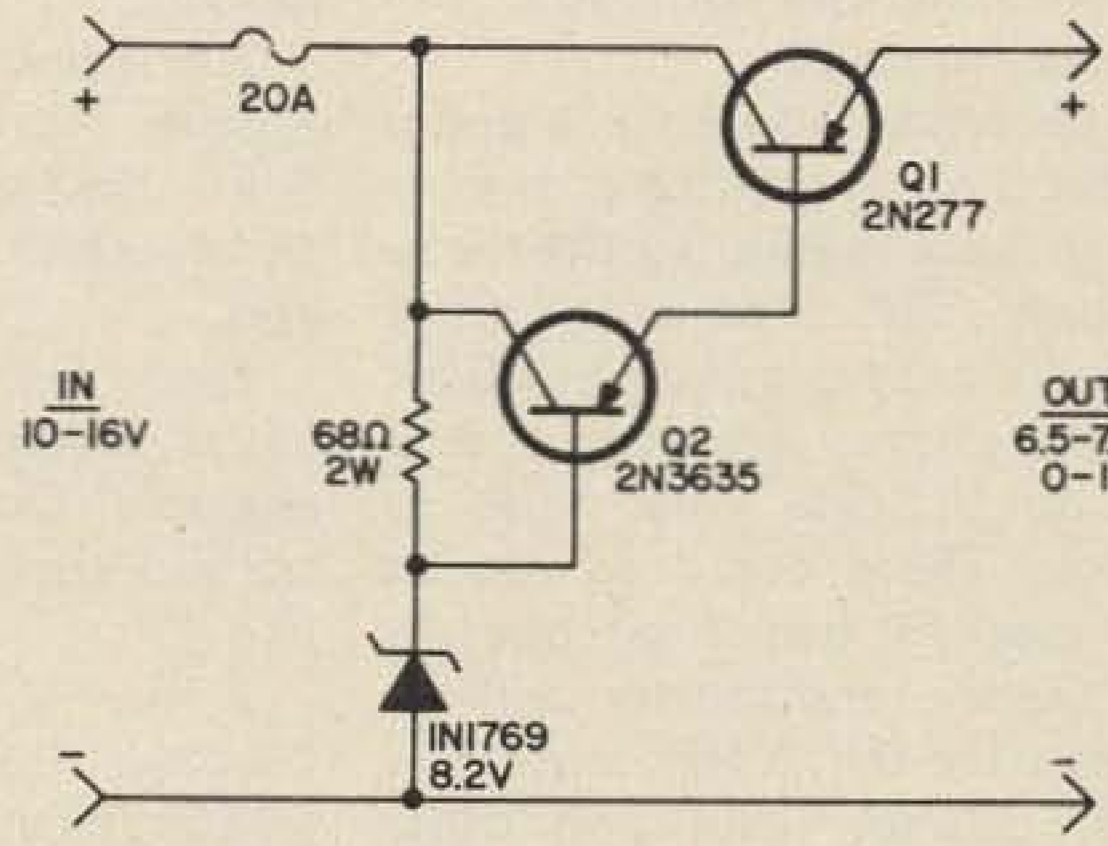

Here is a circuit of a simple 2m converter that works in a pocket AM radio. Since it is crystal controlled, the receiver must tune to a frequency that equals the desired frequency minus 3 x 48.5. Substitute a different frequency crystal if a strong BC station happens to heterodyne with the desired 2m signal. K5IZH




144 to 432 MHz varactor tripler that will give 17W output at 432 when driven by a 25W 2m signal. From the Diode Circuits Handbook, available for $1 from 73

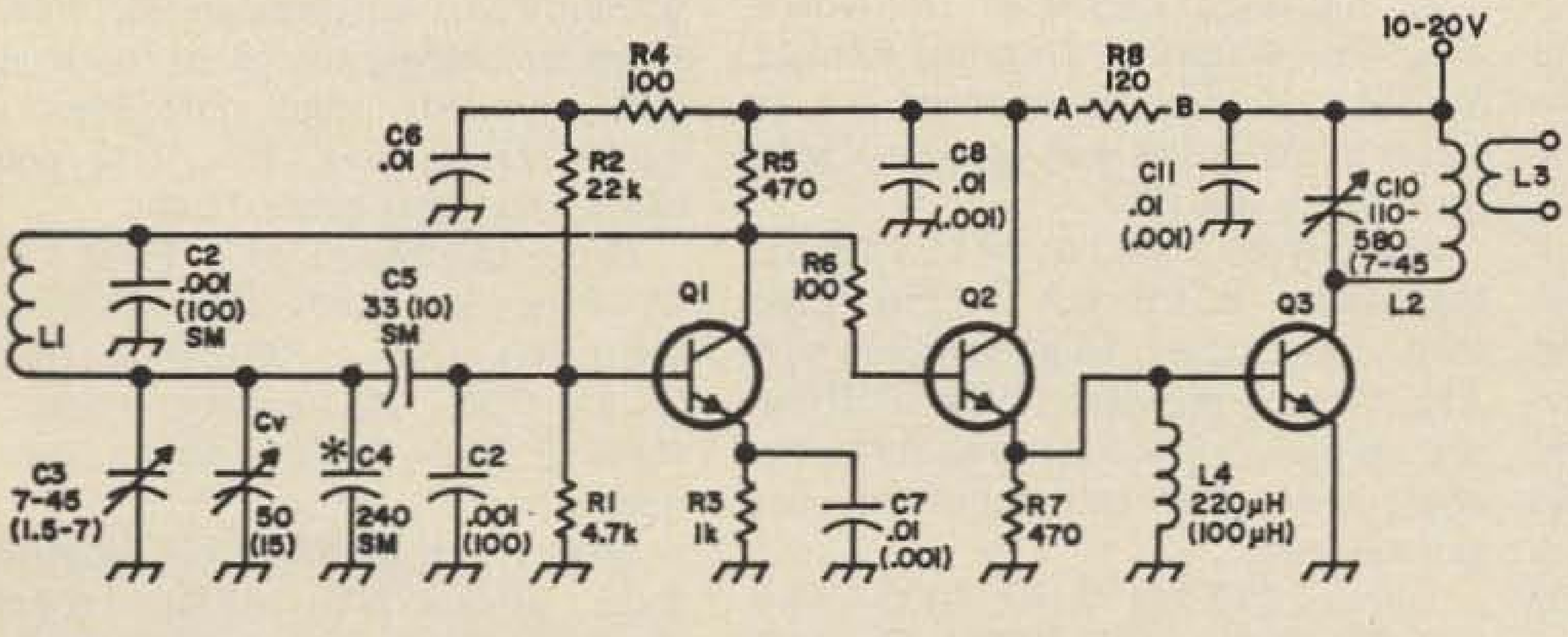



*Electronic door buzzer. This circuit features a different tone for each door. The tones may be varied by experimenting with different resistors at each switch. Courtesy of Motorola Construction Projects HMA 37.*




*6V supply from a 12V source. This is a handy device to use in case your surplus FM rig happens to require 6V. A 2N2147, 2N4314, or 2N3616 can be used in place of the 2N3635 at Q2. Be sure to use a large heat sink for the 2N277 power transistor.*

K3GSY




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

*C4 NOT USED IN 6M VERSION

COIL DATA

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

*Here is a stable VFO that can be assembled in a short time on a piece of Vectorboard. Coil data is supplied for an 80m and 6m version but other bands may be covered with a bit of experimentation. Transistors are all MPS706 but higher output is possible by replacing Q3 with a 2N2270 or 2N3053.*

# Technical Aid Group

The Technical Aid Group is a group of hams who have indicated a willingness to share their knowledge and skills with others. They have volunteered to be of service to fellow hams and do so without compensation. If you have a technical question, look over the list to see who has competency in the area of your question. For many of the TAG members, descriptions of all areas of expertise would be lengthy, so an abbreviated description is given. When stating your problem, give as much information as possible and clearly state the difficulty. Enclose a SASE for reply.

For those hams who have a desire to share, the TAG is the thing for you. Send a brief note requesting the membership form, fill it in and send it back. It asks a few questions about your qualifications, and there is a check-list to indicate your fields of competence. These cover all modes currently used by hams, antenna design and theory, transmitter and receiver design for HF, VHF, and UHF, logic, ICs, general help, and other areas. As more members are added, their names and addresses will be published.

This list is not complete, but represents those former TAG members who have responded to a recent mailing and have expressed a desire to continue in the program. Comments from them indicate that they have enjoyed helping and all have been contacted frequently for advice.

*Robert Perlman WB2VRW*, 3 Josten Place, Hudson NY 12534. Electrical engineering student. Will help with Novice transmitters and receivers, and any help for beginning hams.

*Thomas Laffin W1FJE*, Box 133, Hillsboro NH 03244. Radio communications technician. Special aid to ex-CBers and those who need terms in easily understood terms; aid to Novices and Techs interested in MARS, RACES, CD, and CAP; how to build and scrounge parts; assistance on ham history, ATV, microwave, and general help.

*Theodore Cohen W4UMF*, 8603 Conover Pl., Alexandria VA 22308. Geophysicist. Specially prepared to answer questions about SSTV and ATV.

*J. Bradley Flippin K6HPR*, 116 Montecito Ave., Apt. M., Monterey CA 93940. Electronic engineer. Help with RTTY, data processing and programming, general.

*Ira Kavaler WA2ZIR*, P.O. Box 54, Flatbush Sta., Brooklyn NY 11226. Electrical engineer. Assistance offered in theoretical aspects of electricity and electronics from dc to UHF, design of equipment, computer programming, and signal circuit (failsafe) design.

*Jon Teich WB2JAE*, 22 Olden Rd., Edison NJ 08817. High school student. Novice and others, transmitter and receiver problems, logic, and general.

*David Felt WB6ALF*, P.O. Box 261, Sierra Madre CA 91024. Electronics engineer. Qualified help in logic, digital and analog design, solid state, AM and TV.

*Robert Groh WA2CKY*, 65 Roxborough Rd., Rochester NY 14619. Communications engineer. Bob can lend a hand in HF and VHF transmitter and receiver design as well as solid-state logic and digital techniques.

*Carl Miller WA6ZHT*, 334 Paragon Ave., Stockton CA 95207. Computer technician. Carl's specialty area is solid-state QRP.

*George Daughters WB6AIG*, 1560 Klamath Dr., Sunnyvale CA 94087. Research associate. HF transmitter and receiver, SSB, and solid state, are George's fields.

*D. Hausman VE3BUE*, 267 Northcrest Pl, Waterloo, Ontario, Canada. Student. Novice transmitter and receiver problems as well as logic, digital techniques and ICs.

*Hugh Wells W6WTU*, 1411 18th St., Manhattan Beach CA 90226. Electronics instructor. Hugh can help with AM, Novice problems, VHF-UHF receivers and converters, solid state, test equipment, FM and repeaters, and general help.

*Charles Hill WA7LQO*, 4005 Campbell St., Baker OR 97814. Student. TV, Novice transmitter problems, and logic.

*John Perhay WAØDGW*, Route 4, Owatonna MN 55060. EE technician. John will help with RTTY, AM, SSB, Novice gear, HF transmitters and receivers, solid state, ICs, and test equipment.

*Jim Jindrick WA9QYC*, 801 Florence Ave., Racine WI 53402. Consulting engineer. General help as well as HF, VHF, and UHF antennas, transmitters, and receivers.

*William Welsh W6DDB*, 2814 Empire Ave., Burbank CA 91504. Electronic engineer. Beginner's problems, code instruction, theory and regulations.

*Ken Knecht K8VNT*, Box 39, Clintondale NY 12515. Television engineer. TV, logic, and digital techniques.

*Tom O'Hara W6ORG*, 10253 E. Nadine St., Temple City CA 91780. Communications engineer. RTTY, TV, AM, SSB, VHF antennas, transmitters and receivers for HF through UHF, solid state, and general help.

*Bruce Creighton WA5JVL*, 2517 Metairie Ct., Metairie LA 70002. Electrical engineer. Antennas, Novice problems, solid state, logic, digital techniques, test equipment, and general help.

*Tom Borok WB2PFY* 215-33 23 Rd., Bayside NY 11360. Student. Tom is especially qualified to help Novices with their problems with transmitters and receivers, HF and VHF antennas, HF receivers, test equipment, and surplus, Morse code instruction.

*Roger Taylor K9ALD*, 2811 William St., Champaign IL 61820. Engineer. Roger is adept with AM, SSB, antennas, solid state, logic and digital techniques, ICs, test equipment, and other general help.

*Orris Grefsheim WA6UYD*, 1427 W. Park St., Lodi CA 95240. TV technician. Orris is capable of assisting in all fields of amateur work, DC through UHF, logic as well as Novice help.

*John Allen K1FWF*, 112 Edgemoor Lane, Ithaca NY 14850. Technical director. John's areas of assistance are VHF and UHF antennas, receivers, and transmitters, solid state and digital techniques, ICs, and SSB.

# LETTERS

*Letters continued from page 156*

I have recently acquired an RT-176/PRC-10 RCVR/XTMR and I would like to know if you could tell me how to obtain a schematic diagram for the power and audio connections of this unit.

**David W. Mackeil**
**75 West Main St.**
**Hopkinton MA 01748**

*One easy way is to write to the LETTERS column and hope that someone with the information will read your letter!*

Just a couple of comments on your Editorial Page in the December issue. Namely – "FM – Friendliness Machine." You put it very well but I'm afraid that many FM'ers in the D.C. area will fail to get the point as they are of the opinion that the Repeater Trustee makes the rules, not the FCC.

We of the Capital Area Repeater System (CARS) welcome all amateurs and feel privileged when a newcomer cares to use our facilities. We go out of our way to talk with out-of-towners and to some, are known as WB4QFP, the Quite Friendly People. However, to one of the smaller Repeaters in the area (and I don't mean just in number) we are known as the Garbage Grinder.

It goes without saying that this smaller repeater will remain small until they realize that they are taking up the space, not the users.

Let your readers know that 31–91 and, soon to be, 22–82, are available any time they are in the Washington, D.C. area, and we can hardly wait to talk with them.

Don't forget our convention next September.

**Don WB4QAX**

I just finished the December issue, and I thought it was pretty good. To keep from getting barraged with any more of your "You'd better renew" cards I've sent along $6 for another year of 73, and my free book, of course! (Last year I purposely held out until the last minute before I renewed just so I could read all the different renewal cards that 73 sends. I must admit they are much better than the stuffy cards sent by QST.)

Anyway, I just wanted to say a few things about 73. First, I was wondering what happened to the newspages. Your columns do cover most of what's happening, but I still liked the newspages along with the columns. Also, I wish you would lengthen your editorials and talk about ARRL more than you do, so I know what's really going on.

What's wrong with a regular DX column? Lots of hams like to know what's going on DX-wise, but don't want to spend $12.00 more a year for just DX news.

**Bob Davidson WB8IPB**

*That's what we asked ourselves . . . "What's wrong with a Regular DX column?" So now 73 has one.*

**Re: May 1971 "Transistorized LM Freq Meter" 73 Magazine, page 60**

I have answered sufficient questions about the conversion to warrant a note in 73 Magazine.

TRANSISTOR SUBSTITUTES – Thanks to Bob Bloom W6YUY, the following can be made: MPF - 3004 VFO. MFE - 2095 MIXER. MPF - 107 (2N5486) or 2N4416 XTAL OSC. MFE - 1095 AUDIO. They are made by Motorola.

SCHEMATIC HAS TWO R-106's – My error. The cathode resistor in VFO is R-105. Text did not say shunt R-106 with a 6K resistor. Schematic does show it.

Some FETS IN XTAL OSC. circuit draw more current from battery than the MPF-107. This added drain from the battery can produce small frequency shift in VFO when Xtal is turned off–on. I recommend separate 9 volt battery for the VFO. This can connect to power socket pin 16 provided the filament pins of the 6A7 socket are jumpered 1 to 7. Then 9 volts will appear on pin 6 of the VFO tube socket. The bottom of R-104 can be disconnected and shifted over to his new source of isolated voltage.

LM ACCURACY – doesn't improve with the conversion. It is still the original 0.02% as specified in the manual. The drift, resetability and stability is at least as good as the tube version.

BC-221 – I have not converted a BC-221 mainly because I don't own one.

**Charles Landahl W5SOT**
**Los Alamos NM**

Just a quick note to let you know moounbounce gear is progressing nicely here at W9CGI. Tower house is done, 16-11 EL CushCrafts are together, have Drake receiver-converter lined up in case BC348 mod not done, SSB-CW-AM-FM transmitter runs, transverter in building stages, linear parts acquired, some chassis work done, digital beam steering done – checked out – being modified in some areas, rack being wired, putting insulation and electric heat in top floor now.

Nice opening here to Manitoba last weekend. Worked Len VE4QL and Andy VE4MA both 5-9+ both ways from 23:10 when I turned on rig to 23:45 GMT Sunday. Made it all Provinces for me at last, including a real nice CQZ (VE2) exposition year card for AM contact of a few years back from up on Hudson Bay.

Wayne, could you put this in your letters column for me? Desperately need info, schematic, and manual for Central Electronics 10B. This is rig for moonbounce with transverter and linear added. Seems to run fine but no manual. Will purchase manual reasonable fee, or offer small deposit and mail both ways (please send card or letter first) for manual I can xerox and return to owner. Would be great help to us and "Echo" amateur radio group would certainly be grateful. Know it was built in Chicago territory in 50's or 60's, 5-10W out 80-10M, plug in coils, VOX, xtal control, and this one has homebrew VFO that seems to work. Need manual & info to add metering, tuneup, etc. Many thanks.

Great article by K2OAW on Freq. Counter in May, July and Sept. issue. Like 3-part articles, but would like to see 3 months in a row. Thought the last one with board would never arrive. Caught all omissions before following issue.

**Dave Brown W9CGI**
**Noblesville IN**

*We, too, want the multi-part articles run in sequence – but now and then the drafting screws things up and there we are.*

**KILL THE NOISE!**

Antenna rotator control boxes are generally quite noisy; click-click-click, as they turn. Carefully place thin art foam sponge rubber inside the case as an acoustic absorber. Make sure it clears the moving parts. The loud click-click will now be reduced to a mere peck-peck.

**Richard Mollentine WA0KKC**
**Overland Park KS**

A simple three letter word sums up the November issue.

WOW!

**Richard J. Molby GS9E**
**APO NYC**

As a direct subscriber to 73 magazine I read about what is happening on your side of the pond with interest. I was partiuclarly interested to note that dissatisfied personnel have the same manners and integrity over there as they do in the U.K. (see last paragraph of your editorial, September issue).

As the works manager of an electronics company, I had the task of firing an errant member of the shop floor staff, but made the mistake of allowing him to work out his notice. During that time he sabotaged a number of small pulse transformers, by wiring fuse wire, 5 amp rating, across the primary windings. These windings were connected into the collector circuits of low current transistors. You can imagine the results when the supply was connected. A wonderful mentality!

**Brian Davies G3OUY**

*Continued on page 149........*

# Caveat Emptor?

Price – $2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

For $1 extra we can maintain a reply box for you.

We cannot check into each advertiser, so Caveat Emptor . . .

**WEST ALLIS RAC MIDWINTER SWAPFEST** February 3, 1973 at Hart Park, 7300 Chestnut Street, Wauwatosa, Wisconsin (Milw. suburb). Take 70th Street exit on I-94 North 1.2 miles to Chestnut. Doors open at 8 am. Talk-in on 3985 and 14.964. Food and liquid refreshment available at reasonable prices. One dollar in advance or one dollar fifty at the door. For details write WA9KRF, 4582 South Ahmedi Avenue, Milwaukee, Wisconsin 53207.

**SIGNAL ONE CX7-A** w/spkr and CW filters, amazing deal at $1500. Hallicrafters FPM 300 SSB xcvr $480. Heath IB-101 frequency counter with Vanguard scaler $250. Heath SB200 linear 2 KW PEP $330. Box 230, 73 Magazine.

**22nd ANNUAL DAYTON** Hamvention will be held on April 28, 1973 at Wampler's Dayton Hara Arena. Technical sessions, exhibits, hidden transmitter hunt, flea market, and special program for the XYL. For info write Dayton Hamvention, Dept. M, Box 44, Dayton, Ohio 45401.

**YOUR CALL LETTERS.** Two sets, for windshield and rear glass. Smart white letters with red outline. Easily installed pressure sensitive decals. $1.00, postage paid, anywhere. Satisfaction guaranteed. Lake Jordon Artists, Slapout AL 36092.

**WANTED, OLD RADIO TRANSCRIPTION DISCS.** Any size or speed. Send list and details to Larry Kiner, W7FIZ, 7544 132nd Ave. N.E., Kirkland, Wash. 90833.

**INCOME TAX $$$ NEEDED.** Regency HR-6 $190, HR2MS 8 ch. scanner 15W $255. TME-H-LMU 16 ch. scanning rcvr 6/2/¾m $255. Digital logiclock $75. Tempo CL220 12 ch. $265. Everything brand new. Box 210, 73 Magazine.

**APR-4 RECEIVER**, 39-95 MHz tuner, AM-FM, excellent condition. Swap for 1920's battery radios, early ham gear, Audions, magazines. Alan Douglas, Box 225, Pocasset, Mass., 02559.

**HELP SAVE 220**, and me clean my apartment. 220 FM 5 watt xmtr W/AC supply xtal on 224 MHz TV-10A w/6939 final $30; 2M FM talki W/tuneable rec. 250MW on 146.34 $75; 220 superhet rec on 224 MHz $20; 500w Pwr Amp P.P. 4-125's 2 meters FM W/AC supply $85. Plus odds and ends. S.A.S.E. for list. Want URC-4&11 or other trades. G.W.B. 555 Patten Ave., Apt. 38-B, Long Branch, N.J. 07740, tel. 201-222-4508.

**NEED A/C ADAPTOR** for old STROBONAR V (Gold Model) Electronic Flash – Used in place of 510v battery. Please write WB6AWD/TG9 Les Anderson, ROCAP/Guatemala APO New York 09891.

**TECH MANUALS** – $65.0 each: R-388/URR, R-389/URR, R-390/URR, R-274/FRR, CV-591A/URR, TS-34A/AP, ALR-5, SP-600JX, R-220/URR, SP-600JX-17, RCK, TT-63A/FGC, LM-21, OS-8E/U. W3IHD, 4905 Roanne Drive, Washington, DC 20021.

**FOR SALE KWM-2** with both supplies 30L-1 mint condition. 1200. shipped. First check gets them. Box 69, 73 Pine, Peterborough NH.

**HITACHI DOLBY CASSETTE** deck. Freq. response 20-17,000 Hz., Auto Stop, Walnut Cabinet, etc. ONLY $175. Mountain West Electronics, 23247 Military Rd., Kent, Washington 98031.

**1973 HAMBURG INTERNATIONAL HAMFEST** near Buffalo and Niagara Falls on September 15. Details: Valerie Orgera K2KQC, 187 Main St., Hamburg, N.Y. 14075.

**73 MAG.** January 1961 issue. 2 copies complete. One has loose cover. WB6LLT Jim Mills, 162 S. La Luna Ojai, CA. 93023 (805) 646-6387.

If you are going to buy a new rig, why not at **JOHNSON ELECTRONIC SALES?** Well-stocked and ready to quote on your needs. Featuring Clegg, Regency, Gladding, SBE, Standard, Genave plus CushCraft and Newtronics antennas. Fast, personalized service. Phone or write today. P.O. Box 332, Griffin, Georgia 30223 (404) 228-3831.

**HEATH** SB-300, SB-401, SB-200, SB-620, SB-630, SB-600. Below kit price. Mint condition. All manuals and connecting cables. Five band antenna with 50' aluminum self supporting tower. Will ship. Prices and picture from John G. Mathias, 721 South Meadow Road, Evansville, Indiana 47715. Area code 812-477-2516.

**2 METER FM** – SR-C handie talkie transceiver brand new, complete with carrying case and American instruction booklet $190.00. Joe Gibson 181 So. Orchard St., Wallingford, Conn. 06492.

**WANTED.** Radios, Tubes, Phones, Speakers, Radio Literature from the early 20's. Must be reasonable. My Hobby. Thank You. Bob Hollis, Box 1616, Estes Park, Colorado 80517.

**TECHNICAL MATERIEL CORPORATION** goodies, TRC-500 Antenna Coupler $27.50, FFR Receiver (with all heads) $100.00, AKT-7 100W 220 MHz Amplifier $30.00, TS-497B $150.00, TS-382D $50.00, much more, SASE for 5 page list. Wanted: E and E Radio Handbooks 14th Edition and earlier, 2M walkie, GPR-90/GSB-1 Receiver. Richard Solomon, 5 Cherry St., Lexington, Massachusetts 02173.

**UHF FET PREAMPLIFIER.** 440–470 MHz. Mobile or fixed. At least 6db gain (10db typical). Power source +10V to +15V. 10ma drain or less. RCA phono type jacks. 1½ x 1½ x 1¾ inches, fully shielded. Price includes taxes. $18.00 Prepaid USA. Electronics Enterprises, 6606 Fifth Street, Rio Linda, CA 95673. (916) 991-2010.

**HOOSIER ELECTRONICS** – Your ham headquarters in the heart of the Midwest where only the finest amateur equipment is sold. Individual personal service by experienced and active hams. Factory-authorized dealers for Drake, Regency, Standard, Ten-Tec, Hy-Gain, CushCraft, Mosley, Ham-M, plus many more. Orders for in-stock merchandise shipped the same day. Write today for our low quote and try our personal, friendly Hoosier service. Hoosier Electronics, R.R. 25, Box 403, Terre Haute, Indiana 47802.

**SUPER RIGS . . .** SUPER COUNTER . . . SUPER GAIN ANTENNAS . . . see our ad on page 132, January 73 . . . for the best deal going on the finest quality 2 meter FM gear around today . . . INOUE . . . MIIDA . . . Antenna Engineering. Write for our package deal for a SUPER good buy . . . Bob Brunkow NHE Communications, 15112 SE 44th Bellevue WA 88006 or phone 206-747-8421.

**MODERNIZE FOR PEANUTS!** Frame & display QSL's with 20 pocket plastic holders. Two for $1.00, seven for $3.00. Prepaid, guaranteed. Universally used and approved. Order now. TEPABCO, Box 198S, Gallatin, Tennessee 37066.

**COMPLETE SET:** 73 Magazine. Volume I Number 1 to present. $100 plus postage. Roger Chaffee, 145 Bay Rd., Menlo Park CA 94025.

LETTERS continued from page 147.

As you probably already know, the ARRL has filed a petition for partial reconsideration of FCC actions in docket 19162 to amend that action to allow General and Conditional Class phone operation in the 3825–4000 kHz band as opposed to the 3890–4000 kHz authorized by docket 19162. I feel the League makes some very sound arguments for this reform. I'm sure that many of your readers also support this reform.

I call upon all fellow amateurs to study the League's petition and give it wholehearted support. The paltry additional 10 kHz authorized by docket 19162 borders on insult in view of the fact that incentive licensing has been in effect since Nov. 22, 1968, and its effects on 75 meter phone operation are easily observable. Let's make ourselves heard! Send letters and comments to the League HQ, the ARRL Division Directors and/or direct to the FCC (don't forget the 14 copies if you write to the FCC) . . . but Speak Up Now!!!!

Let's have Seventy Five for Seventy Five!

Dave Stamps W1FUF
Groton CT

May I relate my experience in trying to purchase specific equipment.

After wasting a month, trying to get an Amperex-TAA-300-16, by writing to so-called big transistor distributors and getting, "Sorry, do not carry" and "no got's," I finally wrote the manufacturer. They sent data sheets I requested and forwarded my letter to their local distributor. He had the little gems and at a substantial reduction in price.

So if you have trouble tracking down a certain part, you might try this method.

George Brovet W9TQN
Chicago IL

I still think 73 magazine is the best of the radio publications. I would like to see more articles on RTTY and its application. Also I would like to see articles on new types of high frequency antennas. I am sure there are som e that a lot of us are not aware of and would like to know about. One I have heard of on the air is the Coaxial Dipole. I personally believe the antenna is not stressed enough in our world. The latest interest seems to be how much power a fellow can run and how much compression and processing he can get into the audio and still have it intelligible. These guys apparently have not discovered that it is the radiated power that counts. The old axiom, "If you can't hear them, you can't work them," also applies.

William A. Brink WA6COB
San Jose CA

Your editorial in the first pages of the December issue of 73 hits the nail on the head. Dannals really is a politician; hopefully he will make good on his promise. Further on you say that if each ham put up a buck, we could get a good lobby in D.C. Here's my plan:

Ham radio has often been classified with CB as a nuisance of TVI, Dick Tracy, criminal activity (see events in England and Germany during the past year where crooks used radios, called "ham" by local press), and other nefarious deeds. Perhaps the Institute of Amateur Radio barristered by some good ham attorneys could get some money by suing the TV networks for defamation of character or some such charge. Evidence: On the first episode of *Search* with Hugh O'Brian, there was a reference to crooks using two-way radios, walkie-talkies, and Burgess Meredith was directed to search the ham bands to see if he could detect the criminals in conversation. On *Ironsides*, 11/23/72, the master crook, with a touch of paranoia, communicated with the chief on 3.8 MHz. Since he was a pilot, a quick review of all people with pilot's licenses and ham tickets narrowed the hunt. Upon inspecting the criminal's apartment, wires were found and the detective asked if there had been any complaints of interference to televisions.

These are two most recent events in my mind that tend to blur the positive image of our hobby. What can we do to combine this slur with a positive action that would help us. There must be a few hams in Hollywood that can either write better scripts for the mention of ham radio, and there must be more than a few people in radio-land that would want to help our hobby to the extent of hurting the networks. We all know the ARRL wouldn't make a wave as big as this one could be.

Eric Falkof K1NUN

In the last few years a group of us here at the University of Michigan have attempted to operate a club station (W8PGW), mainly for public service activities such as phone patching. Being located in an area of high population density, we have experienced constant difficulties with TVI and RFI (hi-fi and audio interference). The hassles, legal and otherwise, are truly too numerous to mention, but the result is our belief that TVI-RFI is the most dangerous problem facing amateur radio today.

The amount of ill will generated by even a few incidents of interference is unbelievable, much more than any number of Field Day articles or county fair stations could nullify. Once a person sees interference bars on his TV or hears SSB on his stereo, he may be immune to reason for the rest of his life (we've seen too many demolished antennas and received too many threatening phone calls to expect much rationality or even courtesy from most people!). More and more of the hams we work are facing these same difficulties, and we find the residue of bad feelings among the general public to be of horrifying proportions.

The major source of the problem is the proliferation of junk audio gear on the market today. Shielding, bypassing, and even metal chassis are unheard-of luxuries. Shoddiness is the rule rather than the exception in most audio gear as well as TVs sold today. In the apartment house where I live, at least 75% of the stereo equipment, including some component amplifiers in the $300 plus bracket, were affected by my small transceiver.

All amateurs must assume responsibility for being knowledgeable about the causes and cures of TVI and RFI at the receiving end, as well as the technical standards within the shack that we have always taken for granted. Careful bibliographic research of all ham publications might be in order, as well as concerted effort to gather new ideas and approaches as they come up (could 73 help here?). I'd also like to see appropriate questions on this problem in the General Class exam – it's as relevant a topic today as any. Moreover, hams may well have to accept the cost of shielded speaker cable, high-pass filters, capacitors, and the like to relieve individual problems. Unfair? Very – but a necessary price for our survival. These problems are what give substance to the spectre of dangerous legislation and court action that haunts amateur radio.

The only lasting answer, however, is to get this flood of junk equipment improved or banned from sale. However, if we hams get feisty without national organizations and lobbies to back us up, we can expect the manufacturers and importers of this junk to work that much harder for the elimination of the amateur service. And think how much our PR troubles help their cause! Once again, Wayne, you may be our only hope.

William M. Klykylo WA8FOX
Ann Arbor MI

*If you are depending on me you are rowing with a mighty weak oar . . . Wayne.*

## 73 CRUISE – APRIL 3rd

Several of the titans of the ham industry are planning on making the 73 Caribbean Cruise and for this reason the date was moved up a month. It had been planned for May, but the proximity to the April 28th Dayton convention forced something to give. Dayton didn't want to change.

The 73 Ham Cruise will depart from Antigua on April 3rd and will sail for ten days through the lower Caribbean islands, stopping at one paradise after another. Most of the details of the trip were expounded on page 8 of the December issue of 73. This will not be an Ile de France (sick of France?) luxury cruise, just a fun informal group in bathing suits and simple sportswear.

Read the glowing account of the trip in the December 73 and send your check to *Captain Mike, Windjammer Cruises, Box 120, Miami Beach FL 33139.*

For about $300 you'll have ten days to sun, swim, skin dive, visit very rare countries, perhaps operate some, and talk with Wayne. Except for the last part, it's a very good investment.

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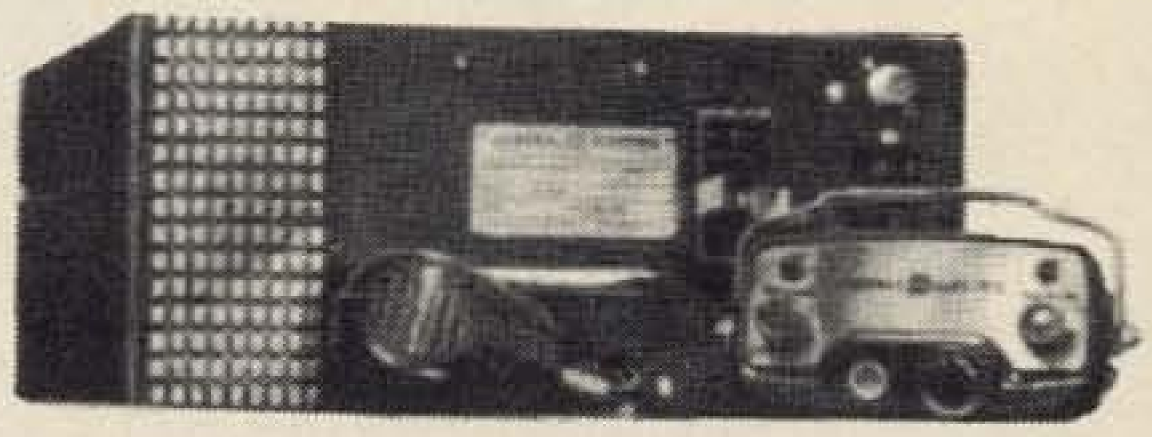
## General Electric Progress Line

450 – 470 MHz Mobile Units

14" case (less accessories & ovens)

**MA/E42** 6/12 volts,
15 watts, vibrator power supply

**$28**



**MT/42** 12 volts,
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*Bill – WB4JFK*

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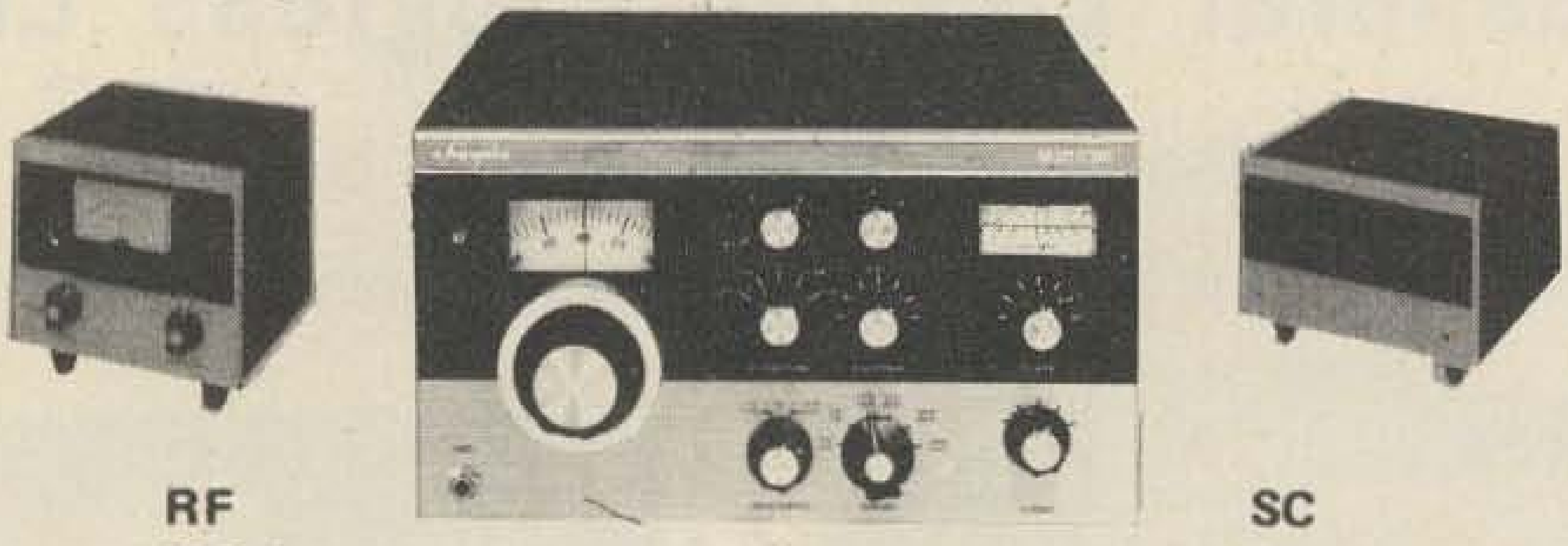

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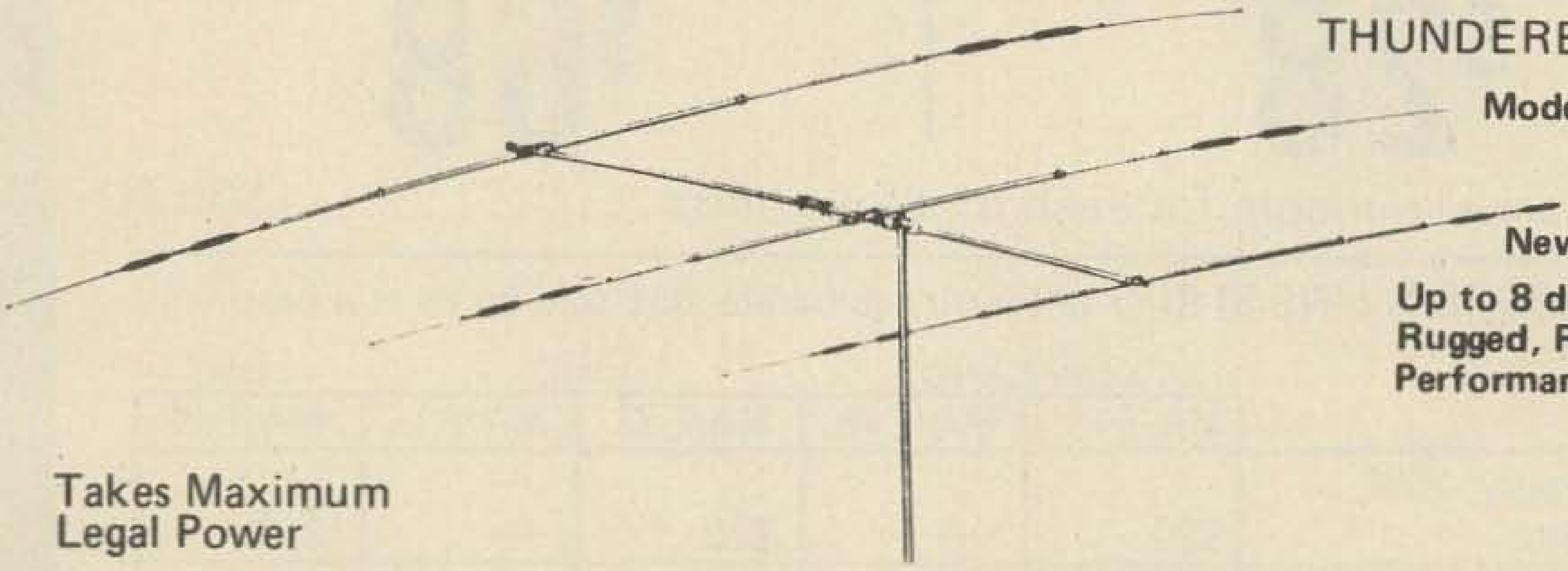

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**Bill – WB4JFK (813) 921-4602**

*Letters cont. from page 23*

Repeater was built and maintained by W2BHK, W2FLY, WB2EVU, WB2PSS, WB2PJS, W2IUI and myself.

Plans are slowly underway for solid state conversion – to run completely off of wet cells in case of emergency.

Any further information can be gotten from me if necessary.

Thank you and – Please!! – delete all those listings for Camden, Cherry Hill, etc.! People swear by your atlas and I've had people tell me that I was wrong about the location of our repeater! All because 73 said it was somewhere else!

**Bruce Tiemann WB2RUH**
**304 Laurel Ave.**
**Woodlynne NJ 08107**

The power supply in the September issue is terrific. Simple, inexpensive, flexible and runs like a thoroughbred.

This is the ideal bench supply for those of us who still like to tinker around and brew something up on our own.

**John A. Scott W5JO**
**Ft. Worth TX**

I read your editorial in the October issue on the never ending question, "Do amateurs build, or buy built?" Well, I thought you might be interested in what info I have on that subject. I have worked 21 States and just recently Puerto Rico and Austria. I have received 22 QSL's confirming QSO's in 10 States, and 14 out of those 22 amateurs were using kits (Heathkits or Knight) or homebrew gear. The HW-16 seems to be the favorite kit, and the HT-40 for the ready made. So, about 2/3 were made by the amateur.

I operate with the reliable HW-16 and a multi-band vertical. One piece of gear I have that I wouldn't be without is my Heath SWR/RF PWR Meter. With my sandy soil so changeable with rainfall and dry spells, a constant check on SWR is important for maximum operation.

I have been on the air since July 20, '72, and my interest has grown greater since that first day on the key when that very first CQ was answered.

**Bill Armstrong WN8NKT/4**
**Sumter SC**

Repeater circuit on P296 (Nov. 72) has no audio connection between receiver and transmitter! Goof?

Article on P37 could get some users in trouble with local board of underwriters. While it seems to be "fail-safe" most power companies would not permit such a device in a service entrance since it is not UL listed.

**Gordy W1JTB**

*Picky, picky.*

Re your editorial July 72 issue of 73 mag, re ham jamming. Good and well, but down in the sunny south (south Mississippi) where I QSO when not out on these rust pots, I note that every morn, sun or rain, some of the older citizens of "up nawth" who have moved down to south Florida, QSO with their "northern brothers" and never give up the freq. they think they own. One old S.O.B. is very nasty and wish old man Fox-Charlie-Charlie would nab this solid citizen and get him off the airways with his nasty ways.

**A.K. Green "Sparks" W5GAJ**
**Newark NJ**

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*. . . . Continued from page 22.*

growing up to work as a lawyer, a government clerk, an accountant. No one even thinks of scientific careers. Enter amateur radio – in the high schools.

As long as the governments of smaller countries and emerging nations are not aware of the importance of amateur radio to their entry into the 20th century, they will be held back. It is difficult to approach the leaders of these countries, particularly without any prior interest on their parts. One way to overcome this would be to have a movie available which would tell the story and demonstrate it.

Dave Bell W6BVN, who made "The Ham's Wide World" and "This is Ham Radio," both shown extensively on television in the U.S., is quite interested in the project of making a film of the extraordinary school radio club program in Jordan – a film which he would distribute all over the world and which could well encourage the beginning of similar club programs in many more countries.

Such a film would not be expensive to produce and Dave is most anxious to get the project going on the basis of doing it on a cost basis as a contribution on his part toward helping the world to move ahead . . . and toward helping amateur radio grow.

Unfortunately the ARRL has shown no interest in the project so far and outside financing is needed. The whole film probably could be done for about $10,000 – about one-fifth the budget for a good one minute television commercial.

Since the school project is a personal one with King Hussein and since such a film obviously would be tremendously good publicity for Jordan, there would be complete cooperation from the government there in making the film.

Fifty amateurs with $200 each could get this started. When you remember that a small group of repeater ops recently came up with an offer of $1200 in reward money for the conviction of the chap who was jamming their repeater, perhaps $10,000 isn't all that much to hope for.

If you would like to pledge some money toward this project, please drop a line with your pledge to 73 and we will see if we are able to make the goal.

### HISTORY TO BE WRITTEN?

One of the phases of amateur radio that has escaped publication in any detail has been the recent history of the hobby on an international scale. Ham radio exists as a hobby because the governments of the world agree during International Telecommunications Union (ITU) meetings that it should.

The more advanced nations of the world have a greater understanding of the importance of amateur radio and have been the ones that have done the most to keep it alive, despite pressures for taking away the amateur bands at each ITU conference.

Until the mid-60's the ITU was run by the U.S. and Europeans and, possibly as a result, these countries fared best in allocations. Then, as African nations proliferated, they joined hands with the Asian countries and swept Europe out of the control of the ITU, replacing American (and an amateur) Gerry Gross as Secretary General with an Ethiopian – then an Indian – etc.

The 1959 Geneva ITU conference had been intended as a time for updating short wave frequency allocations, but this move was stalled off until the next general meeting – which never really happened. Once the Europeans found that they had lost all control of the ITU it became almost impossible to tackle these serious problems.

The recent space conference was an exception. This was the meeting at which virtually all amateur radio satellite channels were lost. I have yet to find anyone with a background in these affairs who does not express resentment at the amateur loss and put it down to a lack of preparation, purely and simply. This is difficult to forgive when you consider that the money had been appropriated by the ARRL precisely for this purpose – but was never really spent.

These are all generalities and it is time that the record be set straight with an article or series of articles giving the inside information on what has happened – and what the future would seem to hold as a result. There are a number of our readers who are involved enough with the international situation to present such a report – how about it?

*Wayne*

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W8IGQ

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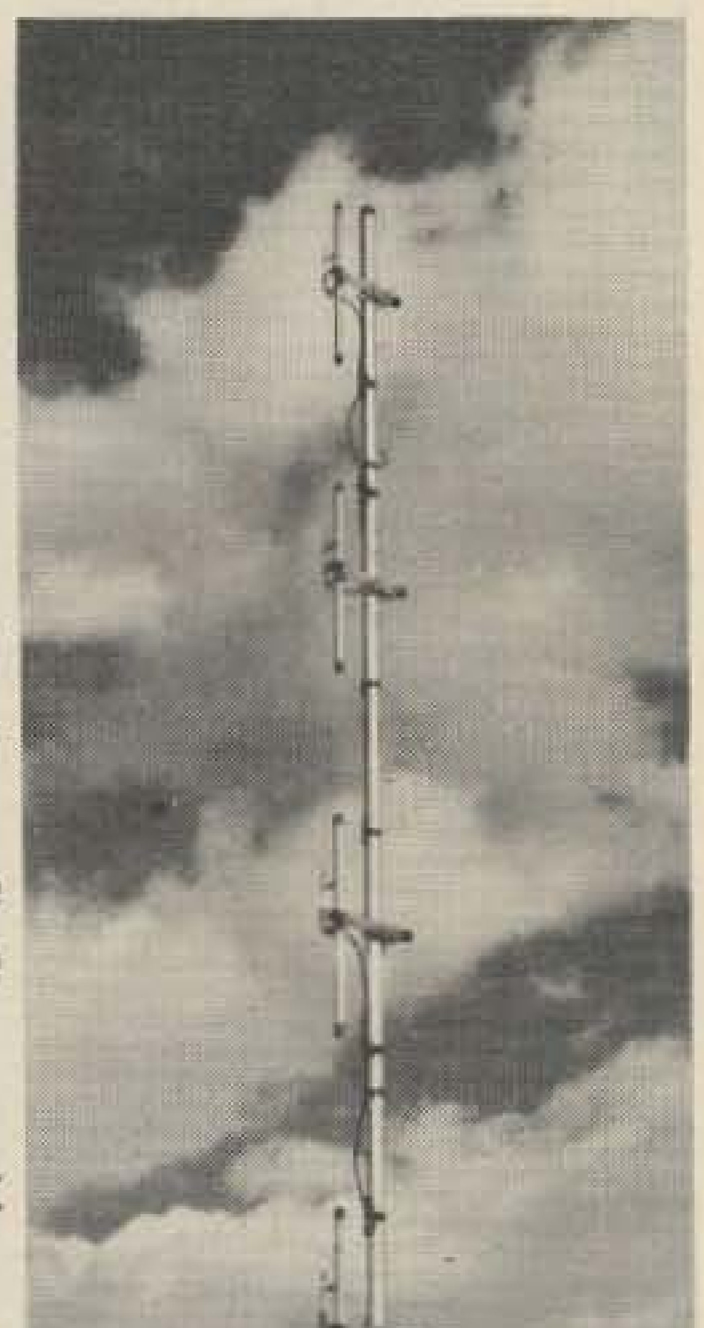

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|---|---|---|---|---|---|---|
| 7400 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7401 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7402 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7403 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7404 | .28 | .27 | .25 | .24 | .22 | .21 |
| 7405 | .28 | .27 | .25 | .24 | .22 | .21 |
| 7406 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7407 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7408 | .32 | .30 | .29 | .27 | .26 | .24 |
| 7409 | .32 | .30 | .29 | .27 | .26 | .24 |
| 7410 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7411 | .28 | .27 | .25 | .24 | .22 | .21 |
| 7413 | .58 | .55 | .52 | .49 | .46 | .44 |
| 7416 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7417 | .52 | .50 | .47 | .44 | .42 | .39 |
| 7418 | .32 | .30 | .29 | .27 | .26 | .24 |
| 7420 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7421 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7423 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7425 | .50 | .48 | .45 | .43 | .40 | .38 |
| 7426 | .34 | .32 | .31 | .29 | .27 | .26 |
| 7430 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7437 | .56 | .53 | .50 | .48 | .45 | .42 |
| 7438 | .56 | .53 | .50 | .48 | .45 | .42 |
| 7440 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7441 | 1.73 | 1.64 | 1.55 | 1.46 | 1.37 | 1.27 |
| 7442 | 1.27 | 1.21 | 1.14 | 1.07 | 1.01 | .94 |
| 7443 | 1.27 | 1.21 | 1.14 | 1.07 | 1.01 | .94 |
| 7444 | 1.27 | 1.21 | 1.14 | 1.07 | 1.01 | .94 |
| 7445 | 1.71 | 1.62 | 1.53 | 1.44 | 1.35 | 1.26 |
| 7446 | 1.24 | 1.17 | 1.11 | 1.04 | .98 | .91 |
| 7447 | 1.16 | 1.10 | 1.04 | .98 | .92 | .85 |
| 7448 | 1.44 | 1.37 | 1.29 | 1.22 | 1.14 | 1.06 |
| 7450 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7451 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7453 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7454 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7459 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7460 | .26 | .25 | .23 | .22 | .21 | .20 |
| 7470 | .42 | .40 | .38 | .36 | .34 | .32 |
| 7472 | .38 | .36 | .34 | .32 | .30 | .29 |
| 7473 | .50 | .48 | .45 | .43 | .40 | .38 |
| 7474 | .50 | .48 | .45 | .43 | .40 | .38 |
| 7475 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7476 | .56 | .53 | .50 | .48 | .45 | .42 |
| 7480 | .76 | .72 | .68 | .65 | .61 | .57 |
| 7482 | .99 | .94 | .88 | .83 | .78 | .73 |
| 7483 | 1.63 | 1.55 | 1.46 | 1.38 | 1.29 | 1.20 |
| 7485 | 1.43 | 1.35 | 1.28 | 1.20 | 1.13 | 1.05 |
| 7486 | .58 | .55 | .52 | .49 | .46 | .44 |
| 7490 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7491 | 1.43 | 1.35 | 1.28 | 1.20 | 1.13 | 1.05 |
| 7492 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7493 | .80 | .76 | .72 | .68 | .64 | .60 |
| 7494 | 1.18 | 1.12 | 1.05 | .99 | .93 | .87 |
| 7495 | 1.18 | 1.12 | 1.05 | .99 | .93 | .87 |
| 7496 | 1.18 | 1.12 | 1.05 | .99 | .93 | .87 |
| 74107 | .52 | .49 | .47 | .44 | .42 | .39 |
| 74121 | .56 | .53 | .50 | .48 | .45 | .42 |
| 74122 | .70 | .67 | .63 | .60 | .56 | .53 |

| Catalog Number | Any Quantity Per Item (Mix) 1-99 | 100-999 | 1000 up | Multiples of 10 Per Item (Mix) 100-990 | 1000-9990 | 10000 up |
|---|---|---|---|---|---|---|
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| 74141 | 1.63 | 1.55 | 1.46 | 1.38 | 1.29 | 1.20 |
| 74145 | 1.41 | 1.33 | 1.26 | 1.18 | 1.11 | 1.04 |
| 74151 | 1.20 | 1.13 | 1.07 | 1.01 | .95 | .88 |
| 74153 | 1.63 | 1.55 | 1.46 | 1.38 | 1.29 | 1.20 |
| 74154 | 2.43 | 2.30 | 2.16 | 2.03 | 1.89 | 1.76 |
| 74155 | 1.46 | 1.39 | 1.31 | 1.23 | 1.16 | 1.08 |
| 74156 | 1.46 | 1.39 | 1.31 | 1.23 | 1.16 | 1.08 |
| 74176 | 1.62 | 1.53 | 1.45 | 1.36 | 1.28 | 1.19 |
| 74177 | 1.62 | 1.53 | 1.45 | 1.36 | 1.28 | 1.19 |
| 74180 | 1.20 | 1.13 | 1.07 | 1.01 | .95 | .88 |
| 74182 | 1.20 | 1.13 | 1.07 | 1.01 | .95 | .88 |
| 74192 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.43 |
| 74193 | 1.98 | 1.87 | 1.76 | 1.65 | 1.54 | 1.43 |
| 74199 | 2.81 | 2.65 | 2.50 | 2.34 | 2.18 | 2.03 |
| **SCHOTTKY TTL** | | | | | | |
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| 74S01 | .88 | .84 | .79 | .75 | .70 | .66 |
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| 74S04 | 1.00 | .95 | .90 | .85 | .80 | .75 |
| 74S05 | 1.00 | .95 | .90 | .85 | .80 | .75 |
| 74S08 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S09 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S10 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S15 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S20 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S22 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S40 | 1.00 | .95 | .90 | .85 | .80 | .75 |
| 74S50 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S51 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S64 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S65 | .88 | .84 | .79 | .75 | .70 | .66 |
| 74S73 | 1.82 | 1.73 | 1.63 | 1.54 | 1.44 | 1.34 |
| 74S74 | 1.82 | 1.73 | 1.63 | 1.54 | 1.44 | 1.34 |
| 74S112 | 1.82 | 1.73 | 1.63 | 1.54 | 1.44 | 1.34 |
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| 74S140 | 1.00 | .95 | .90 | .85 | .80 | .75 |
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| NE526 | 3.59 | 3.38 | 3.17 | 2.95 | 2.74 | 2.53 |
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| NE537 | 7.53 | 7.09 | 6.65 | 6.20 | 5.76 | 5.32 |
| SE540 | 4.48 | 4.20 | 3.92 | 3.64 | 3.36 | 3.08 |
| NE560 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| NE561 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
| NE562 | 3.57 | 3.36 | 3.15 | 2.94 | 2.73 | 2.52 |
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| 709 | .42 | .40 | .38 | .36 | .34 | .32 |
| 710 | .42 | .40 | .38 | .36 | .34 | .32 |
| 711 | .44 | .42 | .40 | .37 | .35 | .33 |
| 723 | 1.00 | .95 | .90 | .85 | .80 | .75 |
| 733 | 1.90 | 1.80 | 1.70 | 1.60 | 1.50 | 1.40 |
| 741 | .44 | .42 | .40 | .37 | .35 | .33 |
| 748 | .48 | .46 | .43 | .41 | .38 | .36 |

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| 1N914 | .10 | .09 | .08 | .07 | .06 | .05 |
| 1N4001 | .10 | .09 | .08 | .07 | .06 | .05 |
| 1N4002 | .11 | .10 | .09 | .08 | .07 | .06 |
| 1N4003 | .13 | .12 | .11 | .10 | .09 | .08 |
| 1N4006 | .15 | .14 | .13 | .12 | .11 | .10 |
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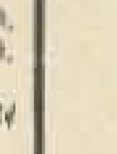

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ALLEN-BRADLEY MIL-GRADE (5-band) RESISTORS. Any of the 84 STANDARD 10% values from 2.7Ω to 22MΩ ¼ or ½ WATT. EACH .......... 5¢

CERAMIC DISC CAPACITORS. Type 5GA-1000WVDC.
5, 7.5, 10, 12, 15, 20, 22, 25, 27, 30, 33, 39, 50, 56, 68, 75, 82, 100, 120, 150, 180, 200, 220, 250, 270, 300, 330, 360, 390, 470, 500, 560, 680, 750, 820, 1000, 1200, 1500, 1800, 2000, 2200, 2500, 2700, 3000, 3300, 3900, 4700, 5000μμF.

EACH .......... 10¢ 0.02μF. EACH .......... 12¢
0.01μF. EACH .......... 11¢

LOW VOLTAGE DISCS, Type UK.

1.0 μF, 3V .......... 25¢ 2.2 μF, 3V .......... 30¢
0.1 μF, 10V .......... 12¢ 0.2 μF, 10V .......... 20¢
0.47μF, 3V .......... 25¢ 0.01μF, 16V .......... 10¢

ELECTROLYTIC CAPACITORS:
All values are available in both, axial or upright (PC Board) mount. PLEASE INDICATE YOUR CHOICE.

| | | | |
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| 10 μF, 15V | 10¢ | 1000 μF, 35V | 50¢ |
| 30 μF, 15V | 10¢ | 1 μF, 50V | 10¢ |
| 50 μF, 15V | 10¢ | 2 μF, 50V | 10¢ |
| 100 μF, 15V | 10¢ | 3 μF, 50V | 10¢ |
| 220 μF, 15V | 15¢ | 5 μF, 50V | 10¢ |
| 500 μF, 15V | 20¢ | 10 μF, 50V | 15¢ |
| 1000 μF, 15V | 30¢ | 20 μF, 50V | 20¢ |
| 20 μF, 25V | 15¢ | 50 μF, 50V | 20¢ |
| 30 μF, 35V | 20¢ | 100 μF, 50V | 20¢ |
| 50 μF, 35V | 20¢ | 200 μF, 50V | 40¢ |
| 100 μF, 35V | 20¢ | 500 μF, 50V | 55¢ |
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STANCOR P-8180, 25.2 VCT, 1-Amp Transformer.
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DUAL–IN–LINE wire wrap type IC sockets. BRAND NEW with gold plated pins.

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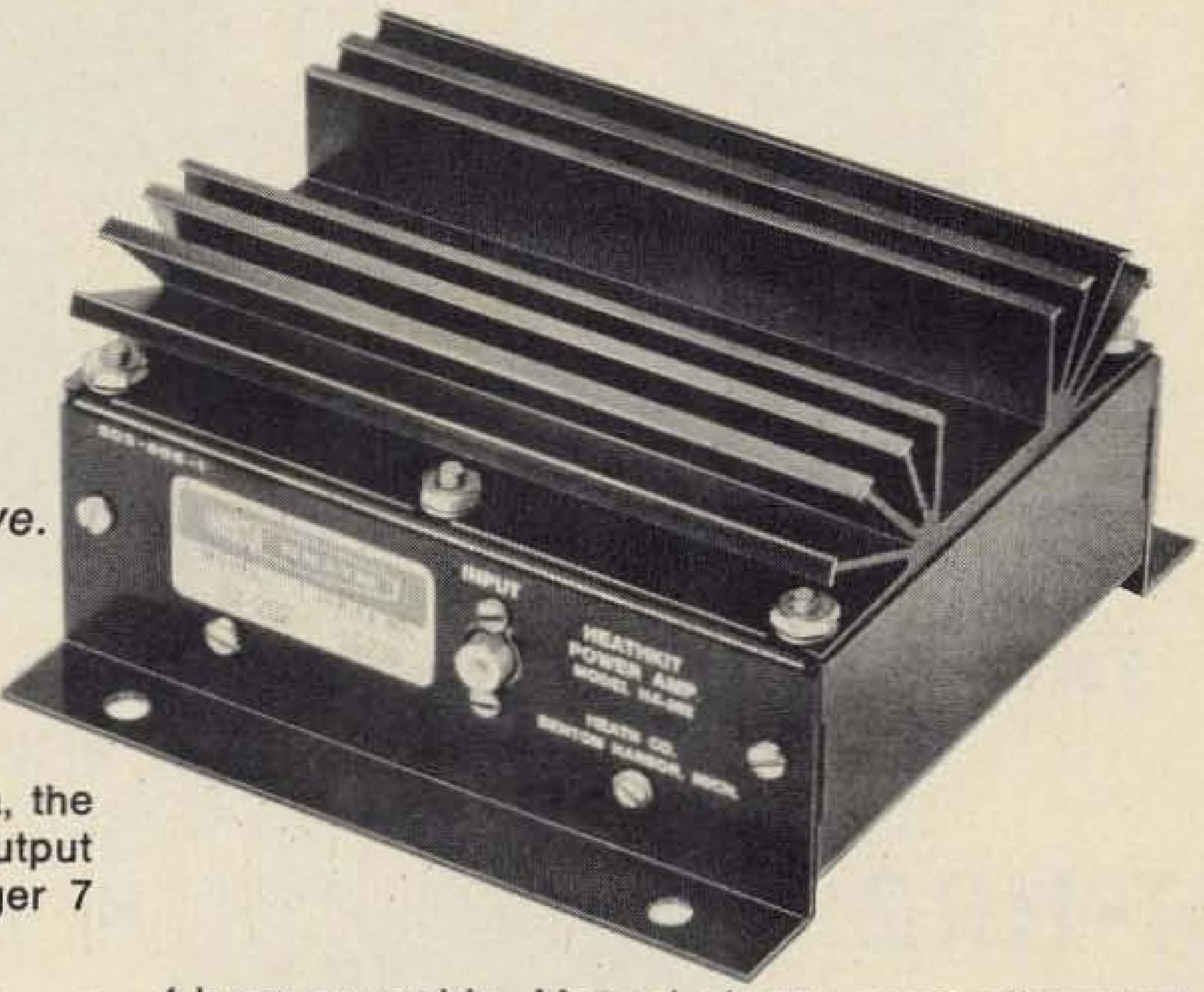
# Introducing Heathkit® 2-Meter Accessories

**NEW Heathkit**
**2-Meter Amplifier for cleaner**
**FM copy on the fringe... 69⁹⁵***



***40 watts nominal out for 10 watts in*** — *requires only 12 VDC supply.*

***Fully automatic operation*** — *with any 2-meter exciter delivering 5-15 watts drive.*

***Solid-state design*** — *all components mount on single board for fast, easy assembly.*

If you're regularly working from a fringe area, the new Heathkit HA-202 can boost your mobile output to 40 watts (nominal), while pulling a meager 7 amps from your car's 12-volt battery.

Install it anywhere...in the trunk, under the hood or dashboard. Use it with any 2-meter exciter delivering 5-15 watts drive. Features fully automatic operation. An internal relay automatically switches the antenna from transmit to receiver mode when you release the mike button.

All solid-state design features rugged, emitter-ballasted transistors, combined with a highly efficient heat sink, permitting high VSWR loads. Tuned input-output circuits offer low spurious output to cover the 1.5 MHz segment of the 2-meter band without periodic readjustment. All components mount on a single printed circuit board for easy, 4-hour assembly. Manual shows exact alignment procedures using either a VOM or VTVM. And installation is just as simple.

Kit includes transceiver connecting cable, antenna connector. Operates from any 12 VDC system — additional power supplies are not required. Add HA-202 power to your mobile 2-meter rig, and boom out of the fringe. **Kit HA-202,** 3 lbs.

**HA-202 SPECIFICATIONS — Frequency range:** 143-149 MHz. **Power output:** 20W @ 5 W in, 30W @ 7.5W in, 40W @ 10 W in, 50W @ 15 W in. **Power input (rf drive):** 5 to 15W. **Input/output impedance:** 50 ohms, nominal. **Input VSWR:** 1.5:1 max. **Load VSWR:** 3:1 max. **Power supply requirements:** 12 to 16 VDC, 7 amps max. **Operating temperature range:** −30° F. to +140° F. **Dimensions:** 3″ H x 4¼″ W x 5½″ D.

## New Heathkit VHF Wattmeter/SWR Bridge... 29⁹⁵*

Perfect tune-up tool for your 2-meter gear. Tests transmitter output in power ranges of 1 to 25 watts and 10 to 250 watts ±10% of full scale. 50 ohm nominal impedance permits placement in transmission line permanently with little or no loss. Built-in SWR bridge for tuning 2-meter antenna for proper match, has less than 10-watt sensitivity. **Kit HM-2102,** 4 lbs.

**HM-2102 SPECIFICATIONS — Frequency range:** 50 MHz to 160 MHz. **Wattmeter accuracy:** ±10% of full-scale reading.* **Power capability:** To 250 W. **SWR sensitivity:** less than 10 W. **Impedance:** 50 ohms nominal. **SWR bridge:** Continuous to 250 W. **Connectors:** UHF type SO-239. **Dimensions:** 5¼″ W, 5¹⁄₁₆″ H and 6½″ D, assembled as one unit.
*Using a 50 Ω noninductive load.

## See them at your Heathkit Electronic Center — or fill out coupon for FREE Heathkit catalog

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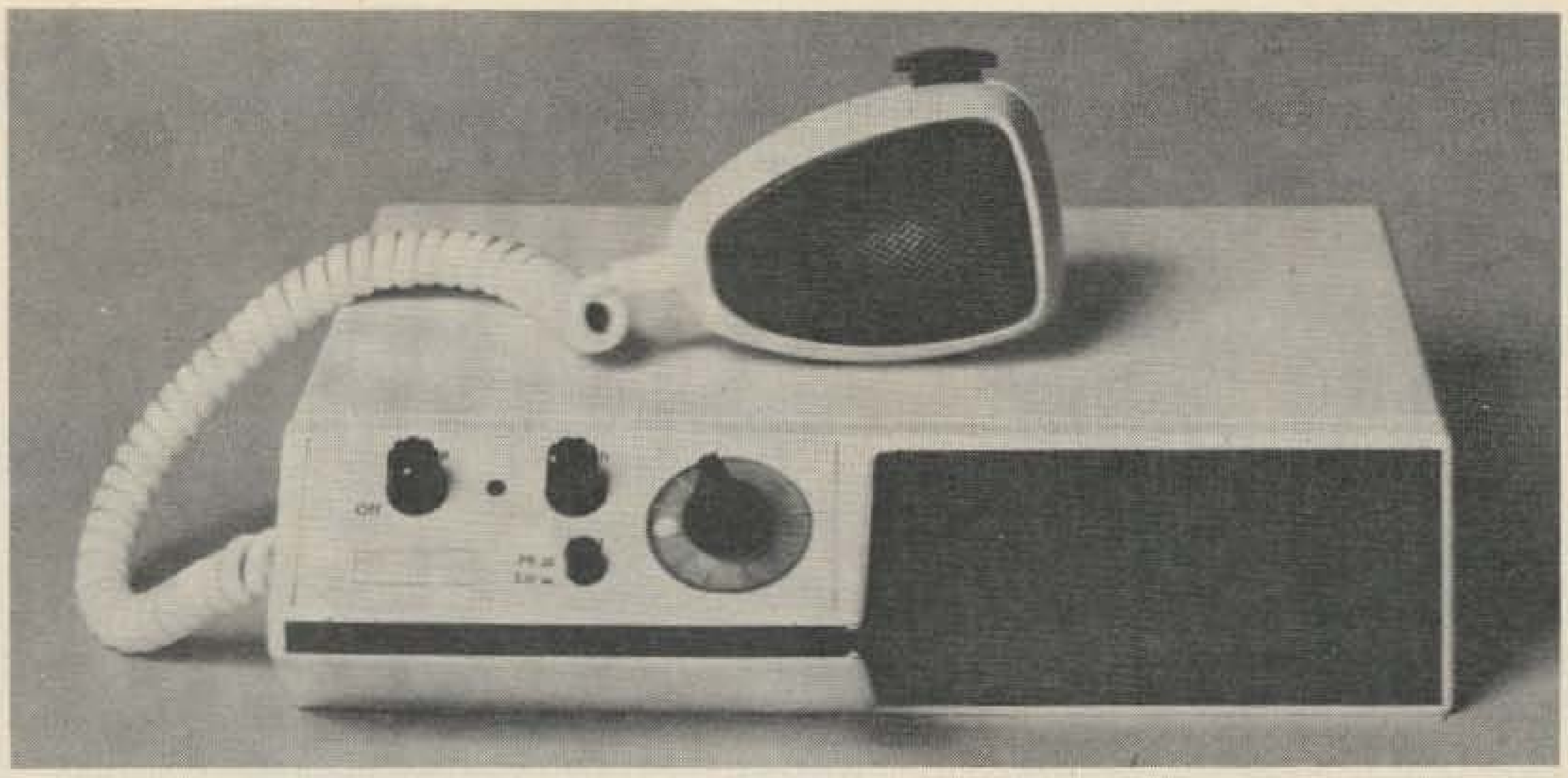
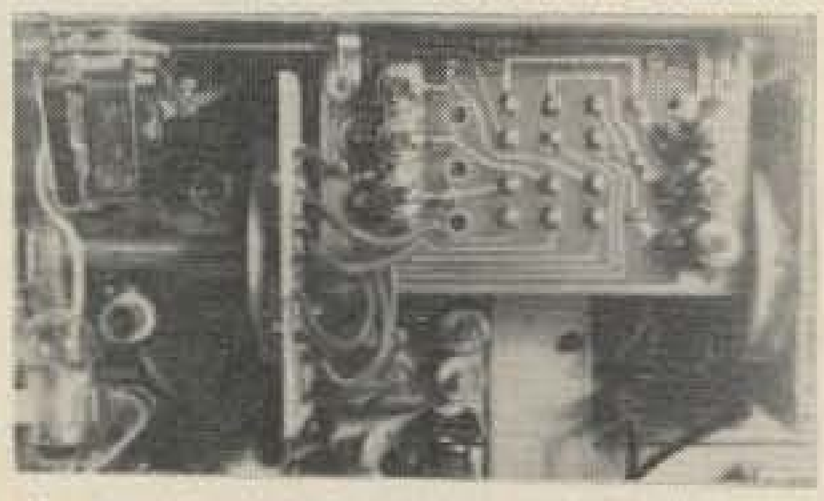


# NEW RADIO FOR THE DISCRIMINATING 2 METER FM'ER FROM TFMC&E

THIS UNIQUE AMERICAN MADE RADIO REQUIRES ONLY ONE RECEIVE CRYSTAL PER CHANNEL TO GIVE YOU TWO TRANSMIT AND ONE RECEIVE FREQUENCY. EXAMPLE: 146.94 RECEIVE CRYSTAL WILL LET YOU SELECT EITHER 146.34 or 146.94 TRANSMIT, SAVING YOU THE EXPENSE OF TWO ADDITIONAL TRANSMIT CRYSTALS. DETAILED INFORMATION AND PRICES AVAILABLE IN OUR 1973 CATALOGUE!

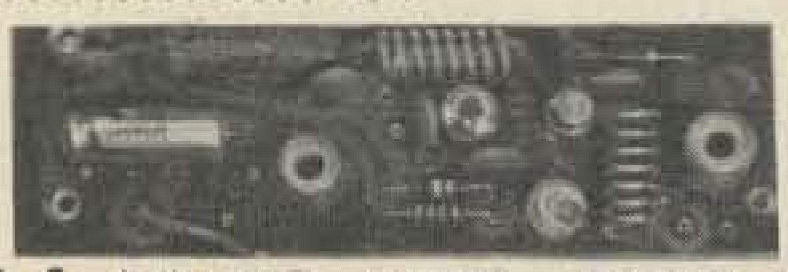
## 6T-HR2

**6 freq. crystal deck**



INCREASES THE REGENCY HR-2 OR HR-2A RADIOS TRANSMIT CAPABILITY TO SIX ADDITIONAL FREQUENCIES. NO MAJOR CHANGE HAS TO BE MADE TO THE RADIO WHEN INSTALLING THE 6T-HR2 DECK

KIT.........................$ 9.95
WIRED.......................$13.95



## HF144 MOS FET PREAMP

OUR FAMOUS 2-METER PRE-AMP STILL OUTSTANDING IN THE HIGH BAND PRE-AMP FIELD GIVES 17db OF AMPLIFICATION WITH ONLY 3db OF NOISE INSERTION.

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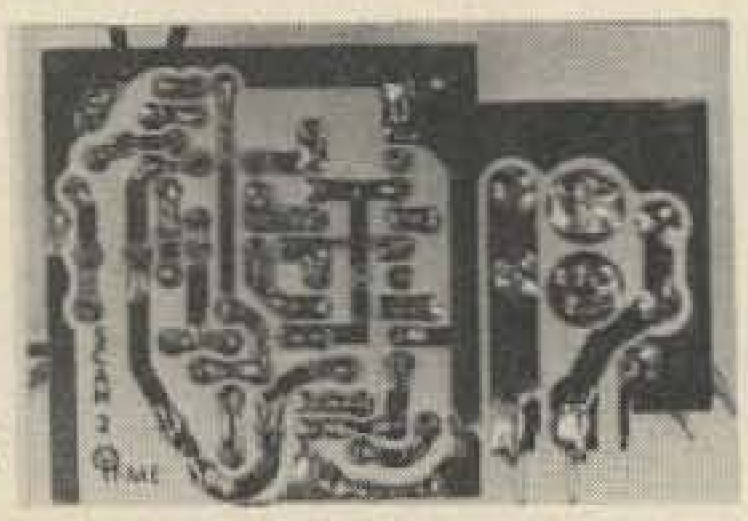
## SCAN-2

**with search back**



DECKS MOUNTS IN HR-2 WITH OUT ANY MAJOR MODICATION TO THE RADIO. GIVES USER A SCANNING TYPE RADIO AT A FRACTION OF THE COST. INCORPORATES "SEARCH BACK" A NEW AND EXCITING FEATURE TO SCANNING TYPE OPERATION.

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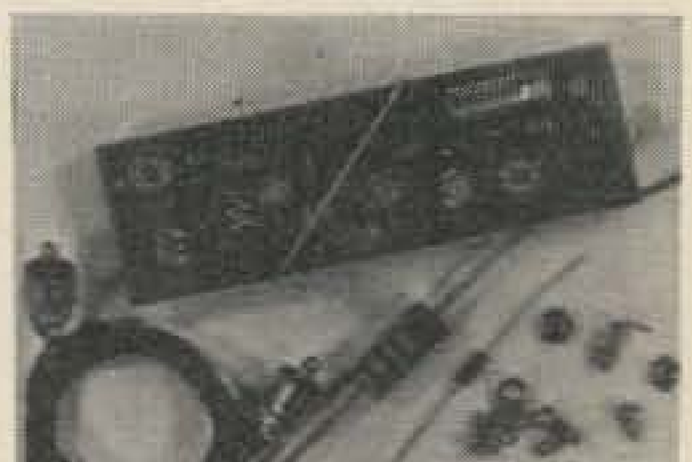
## HF 450 MOS FET PREAMP



NEW FROM "TFMC&E" 406 TO 470MHz PRE-AMP HAS 15db OF GAIN WITH 4.5db NOISE FIGURE. WILL OPERATE FROM 10 TO 15 VDC. TAKES THE SAME AMOUNT OF SPACE AS THE HF-144 PRE-AMP.

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## SPECIALS OF THE MONTH

TFMC&E FOR THE MONTH OF FEBRUARY HAS THIS FANTASTIC OFFER:

WAHL "ISO-TIP" SOLDERING IRON ONLY $17.95, A SAVINGS OF $2.00 OVER REGUALAR PRICE.

BUY A HR-2A OR A HR-212 AND GET A CHOISE OF TWO EACH:
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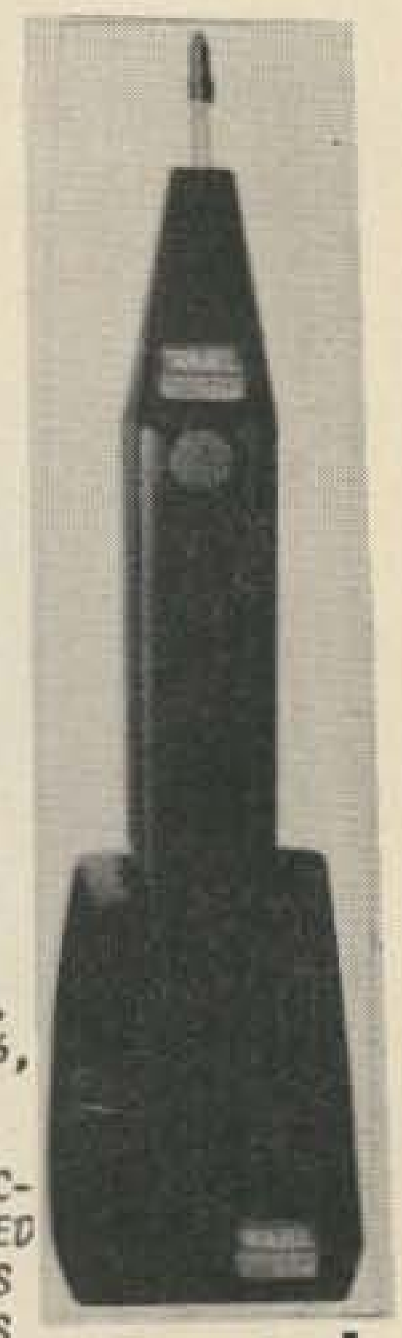
. HF-144 PRE-AMP
. SCAN-2 DECK
. 6T-HR2 DECK
FOR ONLY..95¢
THIS CAN BE A SAVINGS UP TO $38.95 OVER THE INDIVIDUAL PRICES.



"TFMC&E" ALSO CARRIES CUSH CRAFT, A.S.P. AND LARSON ANTENNAS, REGENCY HR-2A, HR-6, HR-212 AND TRANSCAN TRANSCEIVERS AR-2 AMPLIFIERS AND THEIR ACCESSORIES. PLUS SPECIAL ENGINEERED PRODUCTS, ALL AT SPECIAL PRICES. INCLUDED IN ALL MANUFACTURED ITEMS OUR DETAILED COMPLETE INSTRUCTIONS SHOWING FOIL CIRCUIT BOARD LAYOUT, PARTS LIST, SCHMATIC DIAGRAMS AND PHOTOGRAPHS OF THE ACTUAL PRODUCT IN OPERATION.

**special $17^{95}$**

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# COUNT ON TUCKER

## WHEN PRICE *AND* QUALITY ARE IMPORTANT



The Model 60 Frequency Counter (shown with 160 Hetrodyne unit) measures frequency from 1 KHz to 60 MHz with a full 5 digit readout (overranging feature provides an equivalent 8 digit display). With the optional 160 Converter, this tiny (less than 4 pounds) counter will also read 130 to 160 MHz with a sensitivity of 50 MV. With inputs of up to 100 MV, the unit will cover the full range of 110 MHz to 170 MHz. Only three switch controls provide complete operation—just plug in your signal and read the answer. Not a kit and no adjustments to be made!

- 10 MHz Crystal Time Base 1 PPM/Wk
- 1 KHz or 1 Hz resolution
- 115 VAC or 12 VDC operation
- Automatically positioned decimal

Model 60 with Manual and Accessories . . . . . . . . . . . . . **$299.00**

Model 160 Converter. . . . . . . **$ 50.00**

The Tucker Model 5509 Frequency Counter has a full 9 digit readout from 10 Hz to 550 MHz. The Tucker Model 5509 provides the finest resolution, highest accuracy, and highest sensitivity of any counter in this price range. Many features found on the Model 5509 can only be found on a counter costing much more. Like the Model 60, the Model 5509 is simple to operate—just apply the signal (10 MV or less) and select the frequency resolution required (from 1 KHz to 1 Hz) and you have the answer. No where else can you obtain a counter with the sensitivity, readout, and accuracy of the Model 5509.

- 10 MHz Crystal Time Base 1 part in $10^{8}$/per day
- Sensitivity of 10 MV to 550 MHz
- Full 9 digit In-Line Display
- 115 VAC or 12/24 VDC with Option Power Converter available.

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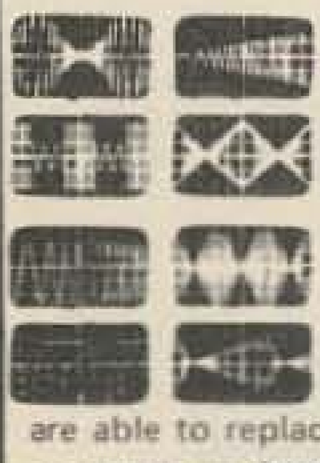

**WAVEFORM GENERATOR, BF-5**
Just one of these BF-5 devices produces sine, square, triangle, ramp and sawtooth waveforms without additional active components. By adding a second BF-5, you can create amplitude, frequency or phase modulated varieties of these waveforms. They are able to replace large discrete waveform generators costing from $200.00 to $1300.00. At the same time, they greatly reduce system weight and power consumption. Full technical data, P.C. layout, assembly, and hook-up instructions included.

BF-5 WAVEFORM GENERATOR................ $9.75

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This amplifier is housed in a plastic dual in-line package with a tab for heat transfer. Has only four active terminals, and requires only one capacitor for stabilization. Compatible with 8, 16, or 22-ohm loads. Applications include P.A. systems, phonos, movie projectors, TV, AM and FM receivers.

**GENERAL ELECTRIC PA-265, 5-WATT VOLTAGE REGULATOR.** Housed in plastic dual in-line package with staggered leads and power tab. Usable over wide range of input and output voltages, input voltages to 37 volts and outputs from 3 to 30 volts. Usable in a wide variety of circuits.

| | |
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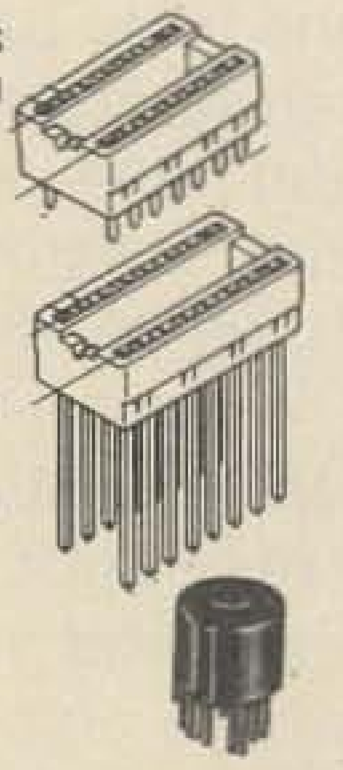
| PA-234 POWER AMPLIFIER | $1.25 |
| PA-256 VOLTAGE REGULATOR | $1.25 |

**SUPER QUALITY I.C. SOCKETS**



Sockets made by T.I. and Cinch. All are low-profile, compact types.
14 Pin Dip Solder Tale Sockets
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16 Pin Dip Solder Tale Sockets
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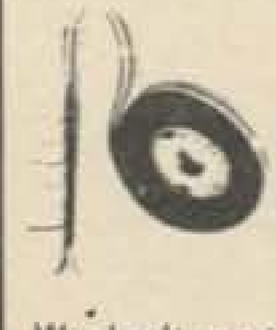
0.27 DLD .................................................. $15.00



**SPECTRA – STRIP FLAT BONDED**
We know this is what everyone wants for their home-brew projects, because they always ask for it. We now have over 5 by $10^6$ feet, but it won't last long, so order now before it's all gone. We don't want any broken hearts. Specs: 20 conductors, 24 AWG, 7 strands, size is .88" x .044". We could give all its virtues, but most people know them or could easily look it up in any industrial electronics house catalogue.

Sh. Wt. 1 lb./10 feet.....Order No. SSFBRC (ft.)
Price: $.35/1 ft. $1.00/3 ft. $5.00/18 ft.
$30.00/100 ft. $55.00/200 ft. $100.00/400 ft.
$200.00/900 ft. $500.00/2000 ft.

**70 WATT RMS AUDIO AMPLIFIER BASIC PACKAGE. STEREO $5.50**
Take advantage of Signetic's NE540 power driver, (class AB amp). Designed for 35 watts RMS per channel. Distortion .5% frequency response, ± .5db 20Hz to 100Hz. NE540 requires two power transistors, a 2N5296 (NPN) and a 2N6109 (PNP), supplied per NE 540. Kit package includes (2) NE540, (2) 2N5296, (2) 2N6109, information on P.C. board layout, parts and circuitry, and a list of miscellaneous small parts required to build the 70 watt amplifier for stereo.

| | | | |
|---|---|---|---|
| ☐ NE540 | | | $2.25/ea. |
| ☐ 2N5296 | 35 watt | NPN | .75/ea. |
| ☐ 2N6109 | 40 watt | PNP | .75/ea. |
| ☐ 70 watt Stereo Kit | | | $5.50/ea. |
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**HARD-TO-GET DIGITAL I.C.'s SALE**

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| ☐ 7447 | BCD To-7 Segment Decoder Driver | $1.06 |
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☐ MUS 4988 Silicon Uni-lateral Switch. Useful for voltage-sensitive switch, sweep generators, etc. $1.00
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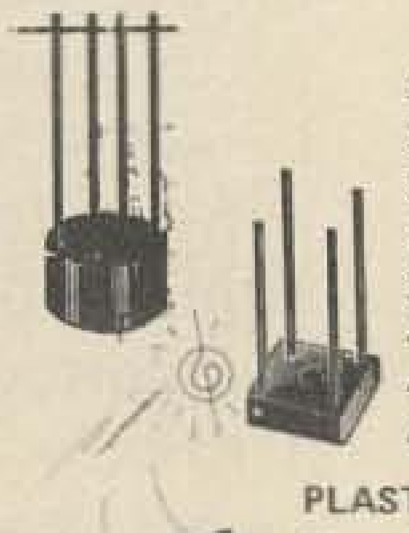

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|---|---|---|
| 2 Amp | 200 Volt | $ .60 |
| 2 Amp | 400 Volt | $1.00 |
| 2 Amp | 600 Volt | $1.50 |
| 2 Amp | 800 Volt | $2.00 |
| 2 Amp | 1000 Volt | $2.50 |
| 4 Amp | 400 Volt | $1.50 |
| 4 Amp | 600 Volt | $2.00 |
| 4 Amp | 800 Volt | $2.50 |


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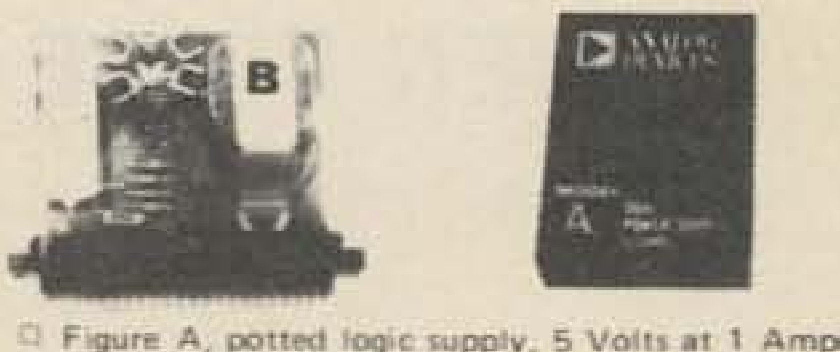
| | 2TGT | $5.00/2 |

**SGS TAA 621 AUDIO AMPLIFIER**
☐ I.C. audio amplifier in 14 pin DIP package, provides up to 4 watts power with proper heat sink, and 28 Volt supply. Can be used at 12 Volts with reduced output power. - $1.95 . . . . . . . . . . . . . . . 6 for $10.00

**LOGIC AND OPERATIONAL AMP' SUPPLIES**



☐ Figure A, potted logic supply, 5 Volts at 1 Ampere, short circuit proof, ultra high regulation, ultra low ripple . . . . . . . . . . . . . . . . . . . . . . . . . . . $16.00
☐ Figure A, potted Op Amp supply, +15 Volts, and -15 Volts at 0.5 Amperes. Mfg. by Analog Devices, similiar to their model 902. Short circuit proof, ultra high performance. . . . . . . . . . . . . . . . . . . . $29.00
☐ Figure B, 5 Volt 1 Amp supply, regulated by Fairchild 9305, short circuit protected. . . . . . . . . . $9.75
☐ Same as above, in kit form . . . . . . . . . . $7.75
☐ Mating connector for above . . . . . . . . . . $1.00
☐ 5 Volt 5 Amp regulated supply, by Blulyne, (not shown). . . . . . . . . . . . . . . . . . . . $29.00

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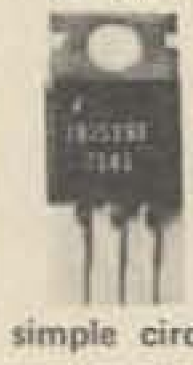
One of the largest manufacturers of MOS Integrated Circuits has discontinued his three-chip set in favor of a single chip. This is the hobbyist's gain, since he can now obtain this fully tested, highly flexible set at a fraction of what even the largest calculator manufacturers pay. Consists of three 24-pin I.C.'s, has debounced input, eight-digit capacity, decoded seven-segment output. Full data included.

8-Digit Floating-Point Calculator Set.............$9.75



**FAIRCHILD VOLTAGE REGULATORS**
**This is the UA 7800 Series. Three terminal regulator, with thermal overload protection and internal current limiting, making it essentially blow-out proof. Because simple circuitry is used with this device, designing regulated power supplies is duck soup. Output is rated at 0 to 1 ampere; maximum input voltage is 35 volts. Choice of voltages: 5,6,8,12,15,18, or 24 Volts. Order as 7805, 7806, 7808, etc.**

**Voltage Regulator (Specify Voltage)................$2.00**

**SHRINK TUBING.** B and F has a truckload of shrink tubing, but we still expect it to go fast. If you have ever used shrink, you know it is indispensable for electronic construction. Made a wire too short? Just splice and shrink tubing over it and it will look like new. Pins too close? Same solution. Excellent results with hot-air gun, soldering iron, or even a match. This is polyolefin type where outer wall shrinks, inner wall melts to encapsulate wire.

SHRINK TUBING ASSORTMENT, 25 feet each, of 1/8, 3/16, 1/4-inch tubing ............................ $5.00

**SPECIAL I.C.'S, PHASE LOCKED LOOPS**
☐ NE560 Phase Locked Loop . . . . . . . . . . . . . $4.65
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☐ NE565 Phase Locked Loop . . . . . . . . . . . . . $4.65
☐ NE566 Function Generator/Tone Encoder. . $4.65
☐ NE567 PLL/Tone Decoder . . . . . . . . . . . . . $4.65
☐ NE595 Four Quadrant Multiplier. . . . . . . . . $3.75
☐ NE555 Timer, 2u Sec to 1 hour, Special . . . $1.25
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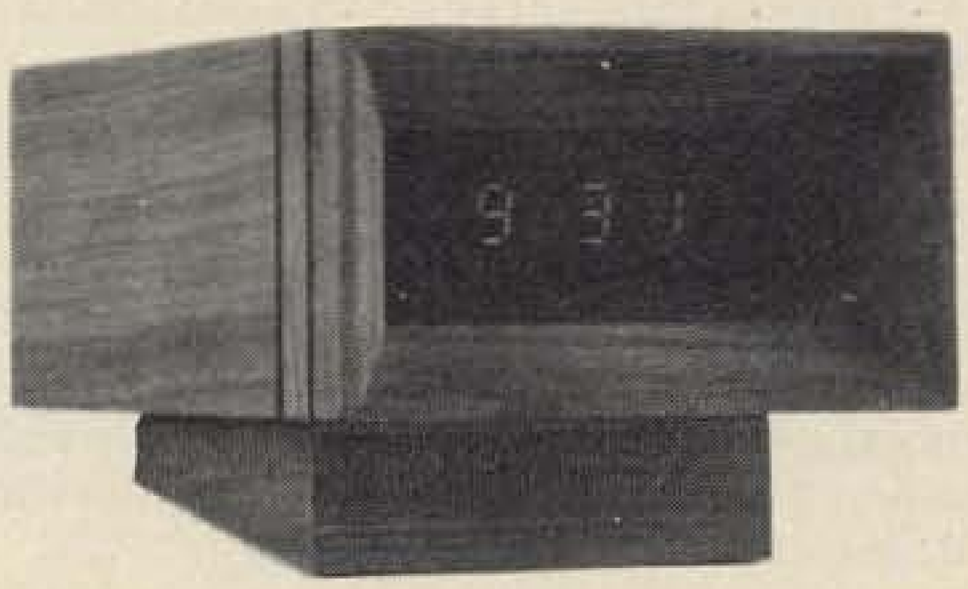
## The Time Machine Electronic Clock Kit

Step Into The Future With
THE TIME MACHINE

Small Size:
2 1/4 X 4 1/2 X 6 3/4



| | |
|---|---|
| BASIC CLOCK ELECTRONICS (KIT) | $45.50 |
| HAND-FINISHED SOLID WALNUT CASE | 8.95 |

Options:

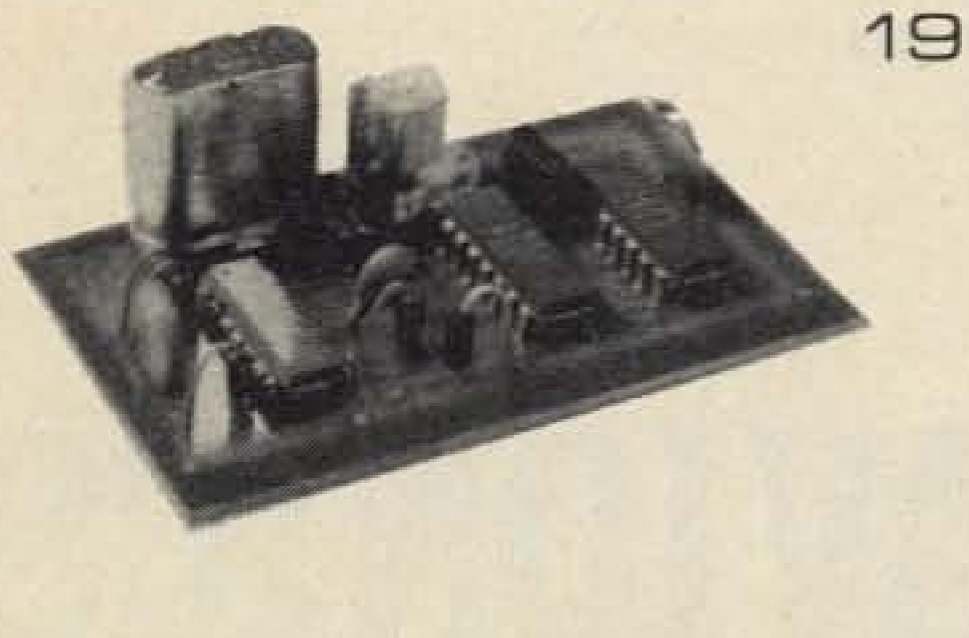
| | |
|---|---|
| ALARM | 6.95 |
| SNOOZE | 2.00 |
| MANUAL RESET | .50 |
| AUTO-POWER RESET | .95 |
| SECONDS DISPLAY | 1.00 |

Introducing the most stylish, compact, state-of-the-art electronic clock kit available anywhere.

THE TIME MACHINE utilizes the latest electronic techniques and advances to provide time information like no clock has before. A Large Scale Integration (LSI) circuit provides the logic to convert the 60 hertz line frequency into a displayable time. Internal options include a presettable alarm circuit, five minute snooze, and 24 hour time.

## 2-METER MARKER GENERATOR KIT

19 95



PROVIDES A MARKER SIGNAL ON ALL STANDARD 2-METER FM CHANNELS. INCLUDING THE REPEATER INPUT AND OUPUT CHANNELS AS WELL AS DIRECT CHANNELS.

## Greatest advance in soldering since electricity...

**COMPLETELY PORTABLE**
**HEATS IN 5 SECONDS**
**SOLDERS UP TO 150 JOINTS OR MORE PER CHARGE**
**RECHARGES AUTOMATICALLY IN ITS OWN STAND**
**NO AC LEAKAGE OR INDUCED CURRENT TO DAMAGE DELICATE ELECTRONIC COMPONENTS.**

**WAHL**

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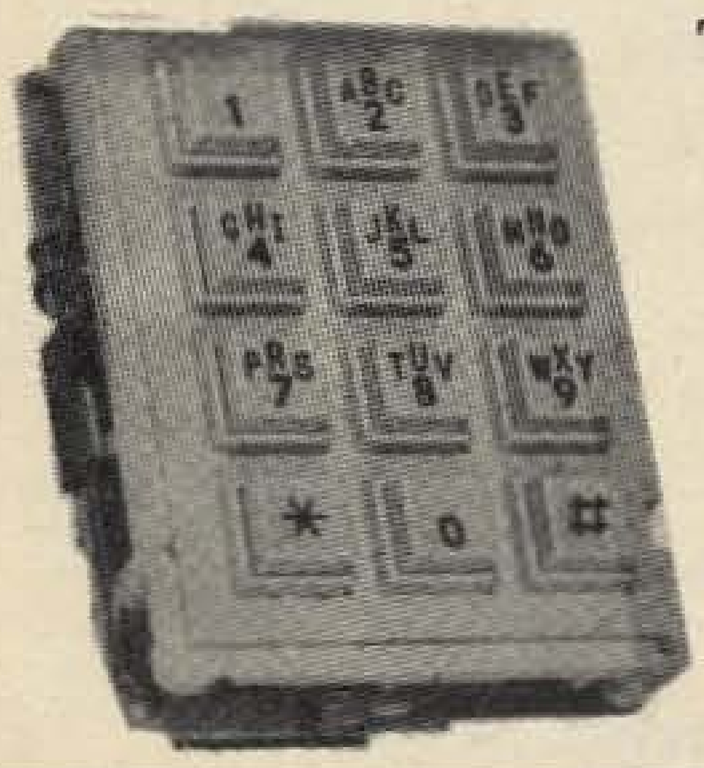
NEW - GUARANTEED

COMPLETE WITH RECHARGING STAND, FINE TIP AND INSTRUCTION BOOKLET

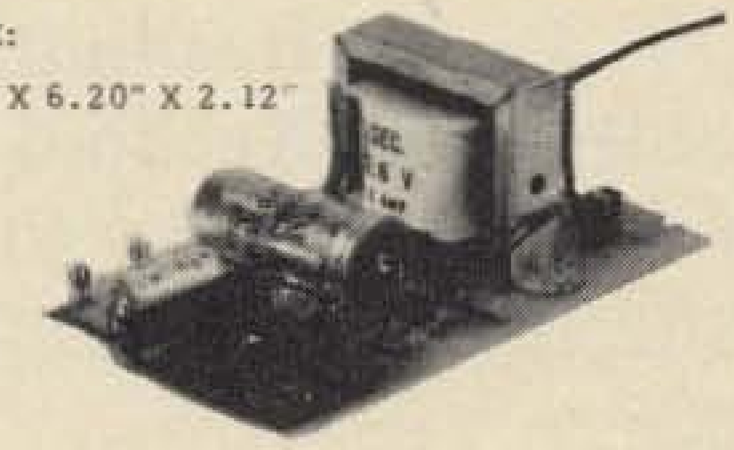


## TOUCH CALLING KEYSET

A 12-button, alpha-numeric keyset equipped with a tone generator; identical to those used in Touch Calling telephones. The tone generator is mounted on a printed circuit card in back of the keyset. All tone frequencies are produced by a one-transistor oscillator.

24 95
**NEW**

SIZE:
3.55" X 6.20" X 2.12"



## 5 VDC 3/4 AMP POWER SUPPLY KIT

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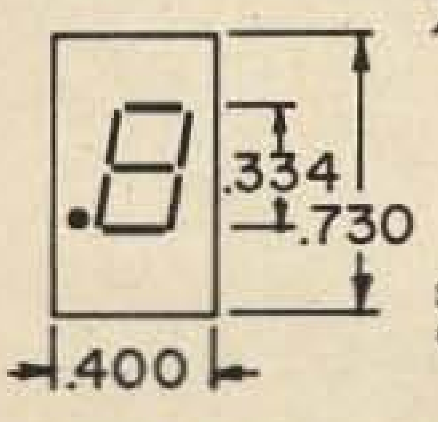
USES THE LATEST STATE-OF-THE-ART THREE TERMINAL REGULATOR CIRCUITRY.

HAS INTERNAL CURRENT LIMIT, THERMAL SHUTDOWN, AND SAFE-AREA COMPENSATION.




## 7 Segment LED Display

3 95 EACH NEW!

SIMILIAR TO MANSANTO MAN-1 AND OPCOA SLA-7. FITS IN 14 PIN DIP SOCKET.

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| DISPLAY KIT 1, INCLUDES: 7 SEGMENT LED, 7447, AND 7490. | $ 5.95 |
| DISPLAY KIT 2, INCLUDES: 7 SEGMENT LED, 7447, 7490, AND 7475. | 6.95 |

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**COMING SOON: TOUCH-TONE DECODER KIT.**

**COMPUTER KEYBOARD W/ENCODER $35**

Another shipment just received. Alpha-numerics keyboard excellent condition. Once again we expect an early sellout. Price of $35 includes prepaid shipment in the US and shipment made within 24 hours of receipt of order.

## AN/URR-13A RECEIVER 220–400 MHz

115 volt AC 60 cycle power, tuneable over the range 220–400 MHz. Govt. cost in excess of $2000. **Yours for only $50.00**

## POWER AMP TRANSFORMER

Brand new compact, regular 115 V 60 cycle input. Output of 40 VCT at 4 amps plus another winding 6V at 2.5 amps. Fine business for Power Amps, Logic or Op Amp supply.

**$5.50 each or 5 for $25.00**

## 12VCT 2A XFMR $1.50

Regular 115 volt 60 cycle input. 12 volt transformers are always in demand, these are brand new. **$1.50 each or 10 for $12.00**

## 60–SECOND TIMER

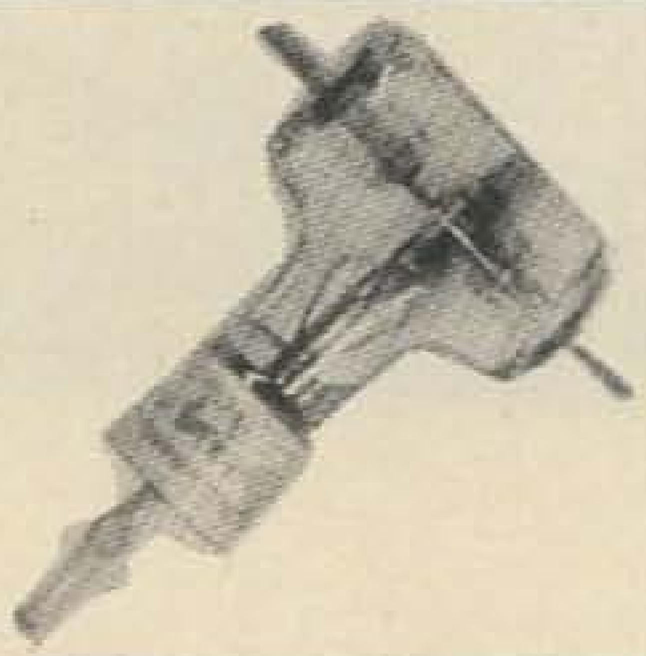
A bonanza for the photo lab or any requirement for a precision spring-wound timer. May be set at any interval 0–60 seconds. Contacts rated at 15 amps. Contacts close while running and open at end of time interval. Brand new.

**$1.50 each, 10 for $12**

## 455 KC IF ASSEMBLY

Complete miniature 455kc IF. amp assembly. 1.5 inches long, little over ½ inch square. Ready to use w/schem. Sim to Miller 8902 ..... 2.50

## RF VACUUM SWITCH



Made for the ART-13 good for 100 watts RF, no doubt handles much more due to being underrated for the military ... #71-17 3/2.00

## 7400 SERIES IC GRAB BAG

Mix of 7400 series DIP, unmarked untested. Some schematics provided ....... 10 for 1.00
100 for 8.00
1000 for 60.00

## IC SPECIAL – ONE MONTH ONLY

Our regular $15 IC board with approx. 140 DIP ICs on them, with ident sheet. For one month only we are pricing them at $6.50 per board to reduce our inventory. **#IC-S $6.50 Or 5 for $25**

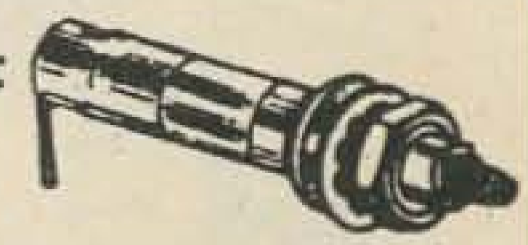
## COPPER CIRCUIT BOARD

Brand new GE 2-sided glass epoxy G-10, the standard of the industry, bright and shiny new. 6 x 12, $1.00. 12 x 12, $1.50. Buy ten pieces and get 2 more free.

## AM-FM RADIO $5.50

Due to the West Coast ship strike they came in too late for the customer. Now it's your bargain. Use it as is or build it into your own cabinet, desk, wall, etc. All built, ready to use, with AC supply. To make it portable all you do is power it with a couple of "D" cells. Fully assembled solid state chassis with AC power supply, less speakers. Covers full AM as well as FM broadcast. The price. . .an astounding meager $5.50 postpaid.

## PISTON CAPS 1–8 μF 3 for $1.00



Unused Military surplus. For hi freq. work. List price over $3.00 each. We have 1 size only, 1–8 μF. No hardware.

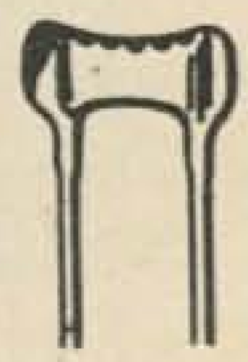
**#73-18 — 3 for $1.00**

## BATTERY ELIMINATOR–CHARGER

Plugs into 115 volt 60 cycle and puts out approx. 12 volts DC 100 mils. Sufficient to power most any small transistor radio and also useful for charging small dry cells and small ni-cad cells. Fully built, ready to use.

**$1.00 each, 6 for $5.00**

## RF FERRITE CORE CHOKE



Hi-permeability, ultra midget style, coated for moisture resistance, color coded. Used in xmtrs, receivers, converters, TV-peaking. Brand new, worth 40¢ each. Assortment of 1.8, 27.0, 330 μH. Pack of 30, $12.00 value.

#A-71 30/$1.00 180/$5.00

## UHF TRANSMITTER

One of the later designs being released. Superb workmanship by HUGHES. Utilizes 3 pencil triodes worth over $46.00. Looks like a "natural" for 220 mc transmitter as it's on 264mc now. Simple to lower freq. W/tubes & schematic. Built-in power supply 400 cycle would have to be changed. Measures only 3x4x8 inches. Nice piece of scarce gear, easy to work on & first class condition.

4 lbs. .................... #TA-401C 15.00

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**TS 323 FREQ. METER**
Similar to the familiar BC 221 except this one covers range of 20–450 mc. Accuracy .005% Used, guaranteed OK, less batteries, with schematic. TS-323 ship wt. 35 lbs. . . . . $50.00

**NOISE ACTUATED SWITCH $1.35**
Solid state noise actuated switch fully wired, includes mike pick-up, amplifier, SCR switch. Actuates by noise or whistle. Useful for burglar alarms, lamp lighter, etc. 15 ft range.

**LIGHT EMITTING DIODES 3/$1.00**
Ruby red, gold plated leads. With mercury cell for instant testing.

Alpha-numeric keyboards. Excellent to new in condition. Styles may vary slightly from picture. Two models available, one with ASCII encoder in base $55.00 postpaid in the U.S. Keyboard with no encoder in base $35.00 postpaid in U.S.

## KEY BOARDS
## $35.00 & $55.00

# 15¢
# IC BONANZA

Brand new DTL dual inline (DIP) package, factory marked ceramic type. The price is too good to be true. Fully guaranteed and with specs.

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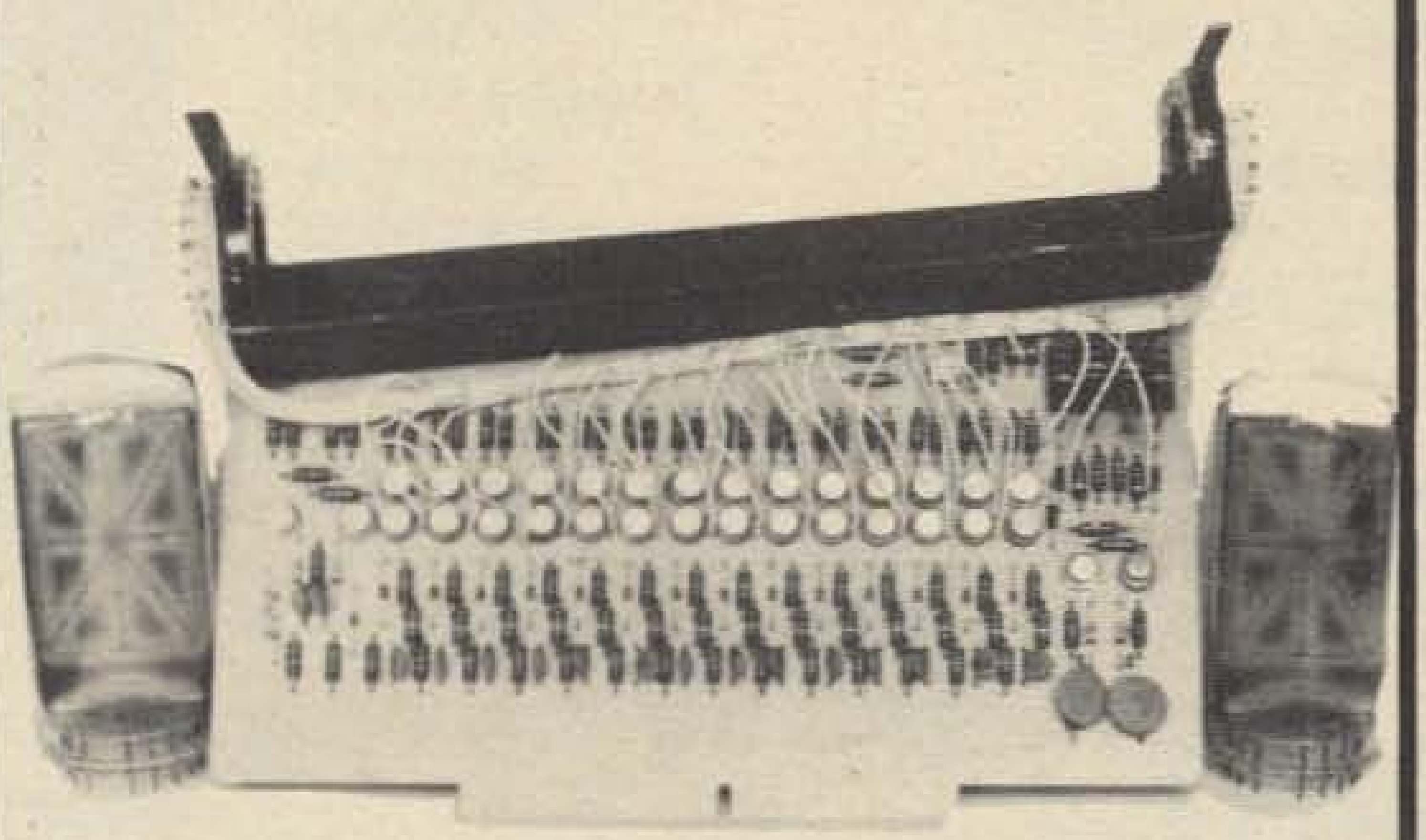
| 930 | Dual 4 input NAND gate similar to | 7420 |
| 931 | Clocked flip flop " | 74110 |
| 932 | Dual 4 input Expand Buff" | 7440 |
| 933 | Dual 4 input expander " | 7460 |
| 936 | Hex Inverter " | 7405 |
| 945 | JK Flip Flop " | 74110 |
| 946 | Quad 2 input gate " | 7400 |
| 962 | Triple 3 input gate " | 7410 |

15¢ each. Buy $100 worth and deduct 10%. 24 hour delivery guaranteed.


**ALPHA-NUMERIC** keyboard removed from unused IBM Selectric machines. Bargain price at only . . . . . . . . . . . . . . . . . . . $8.00



**GIANT B-7971 NIXIES** (2) with 2 sockets and driver board containing hi voltage transistors. Complete plug-in board as removed from operational equipment. Schematics included. Unbelievable but true . . . just $2.50 for the complete package. . . #72S-10 $2.50

Please add postage for above.

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# LINEAR Op Amps

• FACTORY GUARANTEED • FACTORY MARKED • FACTORY TESTED

Buy Any 3 PAKS — Take 10% Discount

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| ☐ 532 | Micro power 741 TO-5 | 2.50 |
| ☐ 533 | Micro power 709 | 2.50 |
| ☐ 536 | FET input op amp | 3.95 |
| ☐ 537 | Precision 741 TO-5 | 2.50 |
| ☐ 540 | 70W pwr driver amp | 2.04 |
| ☐ 550 | Precision 723 voltage reg. | 1.17 |
| ☐ 555 | Timer 2 uSeconds to 1-hour | 1.00 |
| ☐ 556 | 5 Times faster than 741C | 2.50 |
| ☐ 558 | Dual 741 (mini DIP) | .88 |
| ☐ 560 | Phase lock loops | 3.25 |
| ☐ 561 | Phase lock loop DIP | 3.25 |
| ☐ 562 | Phase lock loop DIP | 3.25 |
| ☐ 565 | Phase lock loops (A) | 3.25 |
| ☐ 566 | Function generator (Mini DIP) | 3.25 |
| ☐ 567 | Tone decoder (Mini DIP) | 3.25 |
| ☐ 595 | Four quandrant multiplier | 3.10 |
| ☐ 702C | Hi-gain, DC amp, TO-5 | .44 |
| ☐ 703C | RF-IF, amp, 14 ckts, TO-5 | .69 |
| ☐ 709C | Operational amp (A) | .39 |
| ☐ 710C | Differential amp (A) | .39 |
| ☐ 711C | Dual diff. comp (A) | .39 |
| ☐ 723C | Voltage regulator (A) | .95 |
| ☐ 741C | Frequency compensator 709(A) | .41 |
| ☐ 741CV | Frequency comp 709 (mini DIP) | .49 |
| ☐ 747C | Dual 741C, (A) | 1.25 |
| ☐ 748C | Freq. adj. 741C (A) | .45 |
| ☐ 709-709 | Dual 709C (DIP) | 1.00 |
| ☐ 709CG | Gold, military, DIP | .49 |
| ☐ 739-739 | Dual stereo preamp | 1.98 |
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(G) Military Gold
(A) TO-5 or DIP dual in line pak

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| ☐ SN7438 | .51 | ☐ SN7493 | .71 | ☐ SN74184 | 2.50 |
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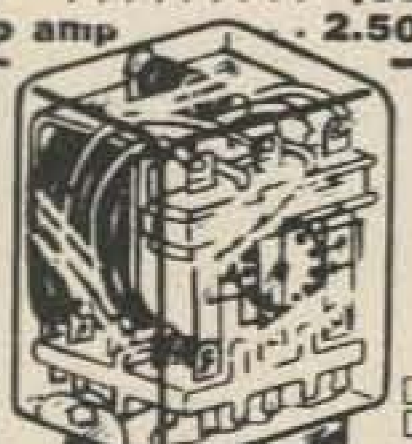
| ☐ SN7442 | 1.12 | ☐ SN7496 | 1.10 | ☐ SN74193 | 1.75 |
| ☐ SN7443 | 1.21 | ☐ SN74100 | 1.41 | ☐ SN74194 | 2.50 |
| ☐ SN7444 | 1.21 | ☐ SN74107 | .49 | ☐ SN74195 | 1.19 |
| ☐ SN7445 | 1.50 | ☐ SN74121 | .49 | ☐ SN74198 | 2.65 |
| ☐ SN7446 | 1.17 | ☐ SN74122 | .67 | ☐ SN74199 | 2.65 |
| ☐ SN7447 | 1.25 | | | | |
| ☐ SN7448 | 1.25 | | | | |

• Factory Marked! Factory Guaranteed!

## NIXIE TUBE SALE $2.50 ☐

Burroughs B7971, 0-to-9, A-to-Z. $2\frac{1}{2}$" high characters, 170V.

## Potter & Brumfield KAP RELAYS



Your choice 3 for $7.50 **$2.98**

☐ 115 VAC 3PDT ........ $2.98
☐ 12 VDC 3PDT ........ 2.98

Excellent for "HAM" use as antenna switching, latching, transmit, receive, etc., and 100's of commercial or industrial uses. Includes plastic dust-cover with diagram and hookup info, 11-pin plug-in base. Contacts movable gold flashed silver, stationary overlay, with silver cadmium oxide movables. All contacts 10 amp 3PDT. Coil data, 115VAC 2250 ohms, 17.5 ma. 12 VDC 21 mils 168 ohms. Size: $2\frac{1}{4}$" x 1 5/16". Wt. 4 ozs. Center pin missing. Comar Mfg. type equal too.

## HI-POWER VARACTOR DIODES

☐ $4.95

Stud mount. Similar to 1N-4886, 60GHZ, 20 watts, capacity 28-32 mmf. Nifty freq. multiplier.

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## PHILCO-FORD DYNAMIC MIKE

☐ **$1.98**

Replacement for tape recorders, PA systems, audio amps. 200 ohms. 6-ft. cord and mini mike plug. 200-5000 Hz. Wt. 6 oz. Fits in "palm of hand." $2\frac{3}{8}$" x $1\frac{5}{8}$" x $\frac{7}{8}$". Impact plastic

## ALLEN BRADLEY'S 'MICRO-POTS'

Type G, 1/2" dia. x 1/2" high. Mounts 1/4" hole, with shaft, linear, immersion-proof high freq.

**2 for $1**

Ohms
☐ 75 ☐ 2.5K ☐ 5.0K ☐ 25.K
☐ 100 ☐ 7.K ☐ 75.K
☐ 500 ☐ 10.K ☐ 100.K
☐ 2.0K ☐ 20.K ☐ 5 Meg

We stock Locknut Bushing & Screwdriver types at same low prices.

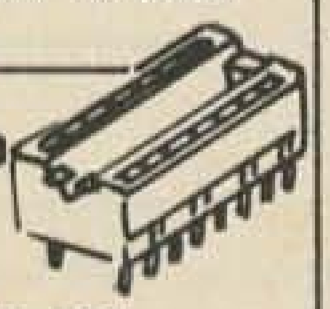
## ALLEN BRADLEY'S 'TRANSISTOR' POTS

Type F. Screwdriver adjust.

Ohms
☐ 75 ☐ 250 ☐ 1.0K ☐ 7.5K ☐ 25.K ☐ 100K ☐ 250K
☐ 100 ☐ 500 ☐ 2.5K ☐ 10.0K ☐ 50.K ☐ 2 Meg
☐ 200 ☐ 750 ☐ 5.0K ☐ 20.0K ☐ 75.K ☐ 5 Meg

**Any 4 for $1**

## INTEGRATED CIRCUIT SOCKETS

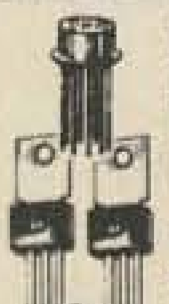


Buy Any 3 - Take 10%

☐ 14-Pin, dual in line ... $.45
☐ 16-Pin, dual in line ... .50
☐ TO-5, 8 or 10 pins ... .29

*Poly Paks Will Never Be Undersold!*

## 35 WATT AUDIO AMPLIFIER BASIC ☐ $3.33 2 FOR STEREO $6



For Class AB use. Basic includes: Signetic 540 30 transistor high power driver TO-5 "IC", with a pair of complimentary 35-watt plastic transistors, i.e. 2N5296 npn and 2N6109 pnp. With schematics, printed circuit and parts board layouts.

## BURROUGHS 5755R

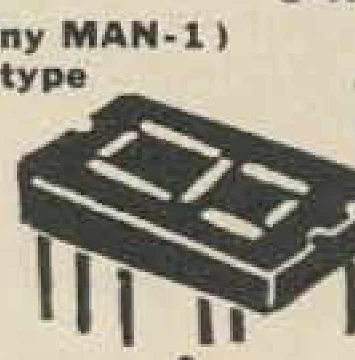
☐ $2.95

0-9, with right and left decimals. Neon red. Requires 175 volts 17 mils. $1\frac{1}{2}$" x 0.5" character size: .51".

## Lowest prices on LED 7-SEGMENT READOUTS

☐ Only **$3.95** 3 for $10.

☐ MAN-4 equal, (skinny MAN-1)
Specs same as MAN-1 type



0-9 plus letters. Snaps in 14-pin DIP socket. $\frac{3}{4}$x$\frac{3}{8}$x$\frac{3}{8}$". characters: $\frac{1}{4}$x$\frac{3}{16}$". 5V, 20-mils per seg. characters: $\frac{1}{4}$x3/16"
☐ Sockets .50 ea.

## 'HAM' UHF 400 MC HIGH POWER TRANSISTORS

☐ Only **$3.95**

3 for $10.

By RCA or equal 2N3632. NPN, 23 watts, 3 amps, TO-60 case, with stud mtg. VCEV max 65.

## ALPHA-NUMERIC 7-SEG. READOUTS 2.50

Flourescent Blue-Green 0-9 numerals, decimals and letters.

| | H. x W. | Characters | Filament V. | |
|---|---|---|---|---|
| ☐ MINI-7* 1.75 | x 1.7" | .360 x .570" | 1.5V AC/DC 42 mils | ☐ Socket — 50c |
| ☐ SLIM-7* 1.6 | x 0.375" | .40 x .20" | 1.5V AC/DC 42 mils | ☐ Socket — 50c |

*Compatible to 7-segment driver IC's.

MINI-7 3 for $6. SLIM-7

## Dollar Stretchers

☐ 3 — "LEDS", visible, micro-miniature, axial leads ........ $1
☐ 2 — "LEDS", infrared, jumbo, TO-18 ........ $1
☐ 2 — "LEDS", visible, jumbo, red, TO-18 ........ $1
☐ 1 — "LED", invisible, parabolic reflector, RCA ........ $1
☐ 1 — PHOTO TRANSISTOR, with darlington amp filter, lens ... $1
☐ 2 — PHOTO TRANSISTORS, with darlington amp, 2N5777, GE $1
☐ 4 — PHOTO CELLS, Clairex, pancake, 30K-70 ohms ........ $1
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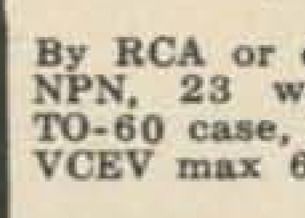

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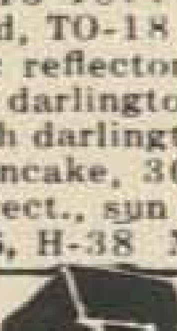

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Code: 2 amp TO-5 case
6 Amp $\frac{1}{2}$ x $\frac{1}{2}$ x 3/16 sq

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# FEBRUARY

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|---|---|---|---|---|---|---|
| | | | | $\boxed{1}$ | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | $\boxed{13}$ | $\boxed{14}$ | $\boxed{15}$ | 16 | 17 |
| 18 | 19 | 20 | 21 | $\boxed{22}$ | $\boxed{23}$ | 24 |
| 25 | $\boxed{26}$ | 27 | 28 | 29 | 30 | |

### EASTERN UNITED STATES TO:

| GMT: | 00 | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALASKA | 14 | 7A | 7 | 3A | 3A | 3A | 3A | 3A | 7 | 14 | 14 | 14A |
| ARGENTINA | 14 | 7 | 7B | 7B | 7 | 7 | 14 | 21 | 21 | 21 | 21 | 21 |
| AUSTRALIA | 14A | 14 | 7B | 7B | 7B | 7 | 7 | 7A | 14 | 14 | 14 | 21 |
| CANAL ZONE | 14 | 7 | 7 | 7 | 7 | 7 | 7A | 14 | 21 | 21 | 21 | 21 |
| ENGLAND | 7 | 7 | 7 | 3A | 7 | 7 | 7A | 14A | 14A | 14 | 14 | 7B |
| HAWAII | 14A | 14 | 7B | 7 | 7 | 7 | 7 | 7 | 7B | 14 | 21 | 21 |
| INDIA | 7 | 7 | 7B | 6B | 7B | 7B | 7B | 14 | 7A | 7B | 7B | 7 |
| JAPAN | 14 | 7B | 7B | 7B | 7 | 3A | 7 | 7 | 7B | 7B | 7B | 7A |
| MEXICO | 14 | 7 | 7 | 7 | 7 | 7 | 7 | 14 | 14A | 21 | 21 | 14A |
| PHILIPPINES | 14 | 7B | 7B | 7B | 7B | 7B | 7 | 7 | 7 | 7B | 7B | 7B |
| PUERTO RICO | 7A | 7 | 7 | 7 | 7 | 7 | 7A | 14A | 14 | 14 | 14 | 14 |
| SOUTH AFRICA | 7 | 7 | 7 | 7 | 7B | 7B | 14 | 21 | 21 | 21 | 21 | 14 |
| U. S. S. R. | 7 | 7 | 3A | 3A | 7 | 7B | 14 | 14 | 14 | 7B | 7B | 7 |
| WEST COAST | 14 | 7A | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 21 | 21 | 21 |

### CENTRAL UNITED STATES TO:

| GMT: | 00 | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALASKA | 14A | 14 | 7 | 3A | 3A | 3A | 3A | 3A | 7 | 14 | 21 | 21 |
| ARGENTINA | 21 | 14 | 7B | 7B | 7 | 7 | 7B | 14 | 21 | 21 | 21 | 21 |
| AUSTRALIA | 21 | 14 | 7B | 7B | 7B | 7 | 7 | 7 | 14 | 14 | 14 | 21 |
| CANAL ZONE | 14 | 14 | 7 | 7 | 7 | 7 | 7 | 14 | 21 | 21 | 21 | 21 |
| ENGLAND | 7 | 7 | 7 | 3A | 3A | 3A | 7B | 14 | 14A | 14 | 7B | 7B |
| HAWAII | 21 | 14 | 7B | 7 | 7 | 7 | 7 | 7 | 7B | 14 | 21 | 21 |
| INDIA | 7 | 7 | 7B | 7B | 7B | 7B | 3B | 7 | 7A | 7B | 7B | 7B |
| JAPAN | 14 | 14 | 7B | 7B | 3A | 3A | 3A | 7 | 7 | 7B | 7B | 14 |
| MEXICO | 14 | 7 | 7 | 3A | 3A | 3A | 3A | 7 | 14 | 14 | 14 | 14 |
| PHILIPPINES | 14 | 14 | 7B | 7B | 7B | 7B | 7 | 7 | 7 | 7 | 7B | 7B |
| PUERTO RICO | 14 | 7 | 7 | 7 | 7 | 7 | 7 | 14A | 21 | 21 | 21 | 14A |
| SOUTH AFRICA | 14 | 7 | 7 | 7 | 7B | 7B | 7B | 14 | 21 | 21 | 21 | 14 |
| U. S. S. R. | 7 | 7 | 3A | 3A | 7 | 7 | 7B | 14 | 14 | 7B | 7B | 7B |

### WESTERN UNITED STATES TO:

| GMT: | 00 | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALASKA | 14 | 14 | 7 | 3A | 3A | 3A | 3A | 3A | 7 | 14 | 14 | 21 |
| ARGENTINA | 21 | 14 | 7B | 7B | 7 | 7 | 7B | 14 | 21 | 21 | 21 | 21 |
| AUSTRALIA | 21 | 21 | 14 | 7B | 7B | 7 | 7B | 7B | 7 | 14 | 14 | 21 |
| CANAL ZONE | 14A | 14 | 7 | 7 | 7 | 7 | 7 | 14 | 21 | 21 | 21 | 21 |
| ENGLAND | 7B | 7 | 7 | 3A | 3A | 3A | 3B | 7B | 14 | 14 | 21 | 21 |
| HAWAII | 21A | 21 | 14 | 7 | 7 | 7 | 7 | 7 | 7 | 14 | 21 | 21 |
| INDIA | 7B | 14 | 7A | 3B | 3B | 3B | 3B | 3B | 7 | 7 | 7B | 7B |
| JAPAN | 21 | 14A | 7B | 7B | 3A | 7 | 7 | 3A | 7 | 7 | 7B | 14 |
| MEXICO | 14 | 7A | 7 | 7 | 7 | 7 | 7 | 7 | 14 | 21 | 21 | 21 |
| PHILIPPINES | 21 | 14A | 14 | 7B | 7B | 7B | 7 | 7 | 7 | 7 | 7B | 14 |
| PUERTO RICO | 14 | 7A | 7 | 7 | 7 | 7 | 7 | 14 | 21 | 21 | 21 | 21 |
| SOUTH AFRICA | 14 | 7 | 7 | 7 | 7B | 7B | 7B | 7B | 14 | 21 | 21 | 14 |
| U. S. S. R. | 7B | 7 | 3A | 3A | 3A | 7 | 7 | 7 | 7 | 7B | 7B | 7B |
| EAST COAST | 14 | 7A | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 21 | 21 | 21 |

A = Next higher frequency may be useful also.
B = Difficult circuit this period.

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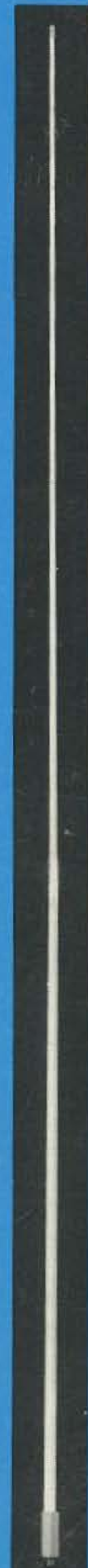

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