AMATEUR RADIO

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February 1963
The Usual
40¢

73

Magazine

Wayne Grein, W2NSD
Editor, etcetera

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and
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de W2NSD

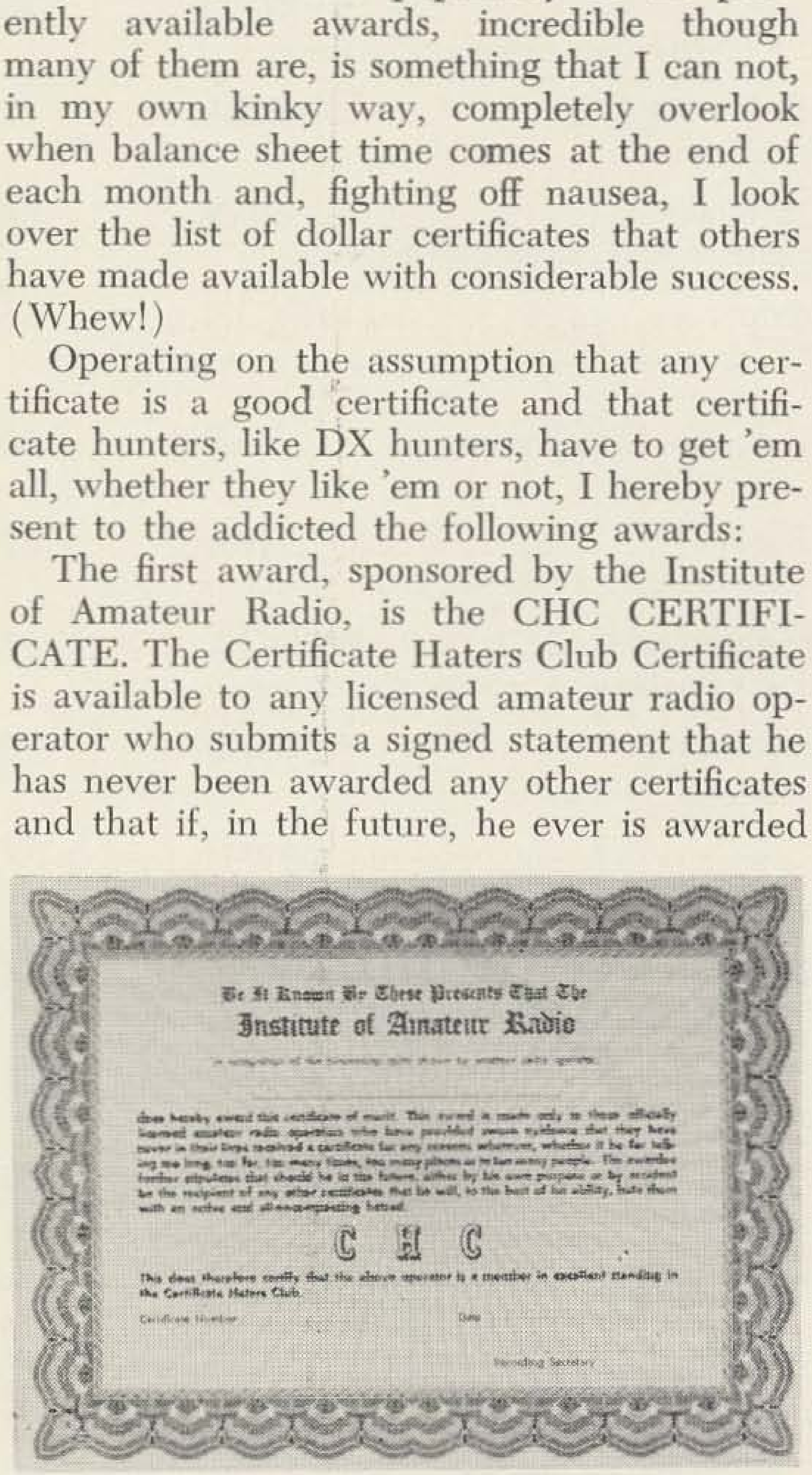
never say die

AWARDS

Though the awarding of certificates is a little out of the line of 73 Magazine, devoted as it is to the technical and constructional side of our hobby, and my own feeling is that there are already several times too many certificates available, still, even to a reactionary like myself, the success and popularity of the presently available awards, incredible though many of them are, is something that I can not, in my own kinky way, completely overlook when balance sheet time comes at the end of each month and, fighting off nausea, I look over the list of dollar certificates that others have made available with considerable success. (Whew!)

Operating on the assumption that any certificate is a good certificate and that certificate hunters, like DX hunters, have to get 'em all, whether they like 'em or not, I hereby present to the addicted the following awards:

The first award, sponsored by the Institute of Amateur Radio, is the CHC CERTIFICATE. The Certificate Haters Club Certificate is available to any licensed amateur radio operator who submits a signed statement that he has never been awarded any other certificates and that if, in the future, he ever is awarded



Be It Known By These Presents That The
Institute of Amateur Radio

[illegible]

C H C

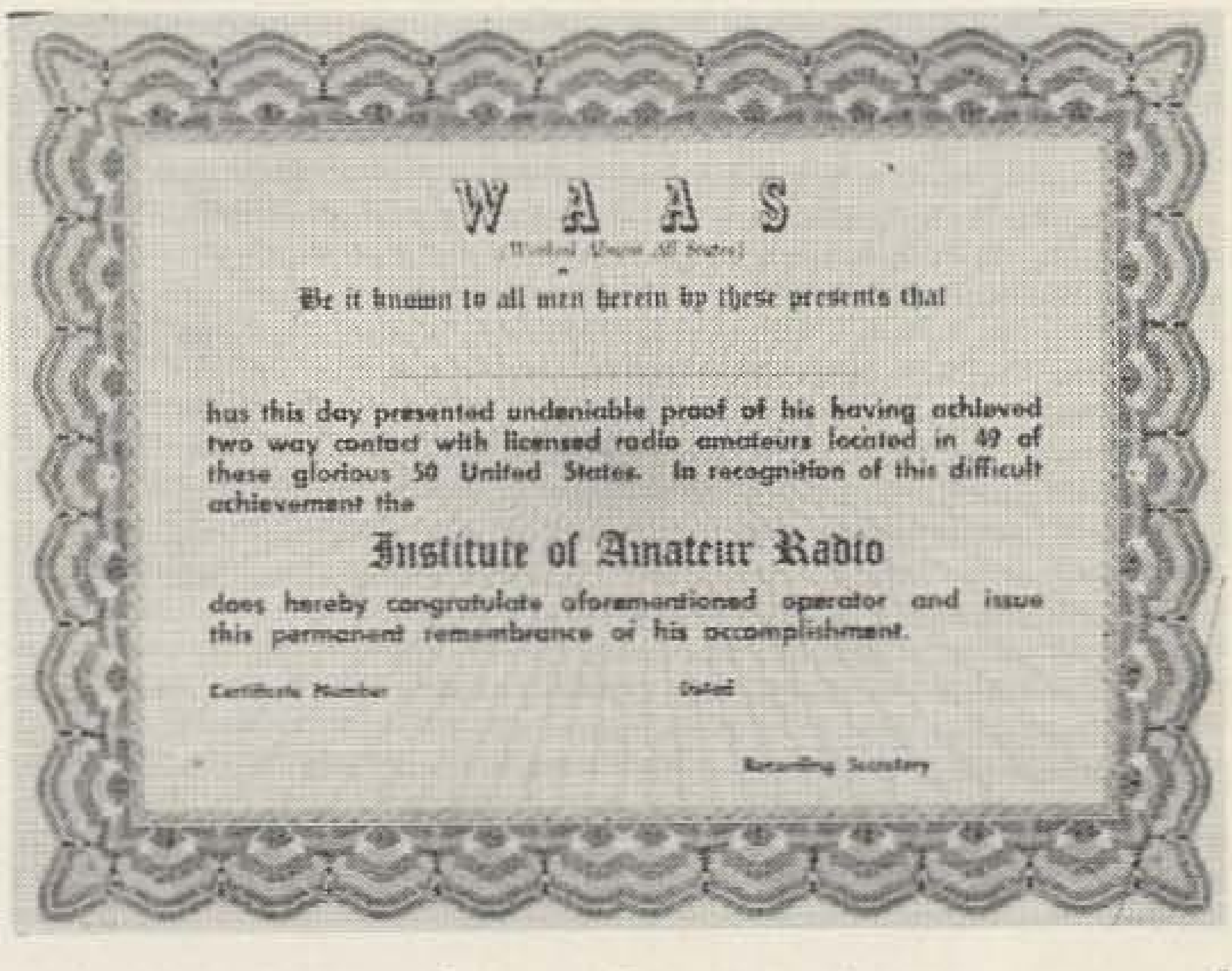
This does therefore certify that the above operator is a member in excellent standing in the Certificate Haters Club.

Certificate Number — Date

Recording Secretary

another certificate that he will hate it. Please include one dollar with the application to help cover the costs of administration of this program.

The second award certificate now available from the Institute is the WAAS CERTIFICATE. This is the Worked Almost All States Certificate and is available only to licensed amateur radio operators who have proof of contact with 49 states, but haven't been able to get that elusive 50th. There is no reason why all this effort should go unrewarded and unacknowledged for it takes almost as much effort to contact 49 states as it does 50. What a shame to get so close and then miss just for the lack of one extra state! Please include the 49 QSL's in alphabetical by state order, a note indicating the missing state and a dollar to help defray the costs of administration of this program. Stickers are available for WAAS made all on one band, all with one mode, or all in one year upon separate application with submitted cards and dollar to help defray the administration costs of this program. Mode stickers are available for CW, AM, SSB, and RTTY.



W A A S
(Worked Almost All States)

Be it known to all men herein by these presents that

has this day presented undeniable proof of his having achieved two way contact with licensed radio amateurs located in 49 of these glorious 50 United States. In recognition of this difficult achievement the

Institute of Amateur Radio

does hereby congratulate aforementioned operator and issue this permanent remembrance of his accomplishment.

Certificate Number — Dated

Recording Secretary

DXDC Certificate. Sure, it is easy to work 100 countries on twenty meters, but how about forty and eighty? This award requires QSL's from ten countries. Special stickers are available for all contacts being on single bands, using a single mode of emission and all being made during any one year. This award naturally brought up the perennial question of what is a country and what is not a country, a little matter that has brought on near revolutions and frequent mass hysteria. What should we do? Should we accept the ARRL list as it is and keep on accepting new countries as they think them up? Or perhaps should we make up our own list, granting new country status here and there as either the demand requires or friendship dictates. There was a strong in-

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(W2NSD from page 2)

clination on our part to accept the ARRL system of designating offshore islands as separate countries, thus establishing such new countries as Long Island, Staten Island, Manhattan Island, Catalina Island, Vashon Island, Block Island, Martha's Vineyard, etc. This could have many beneficial results. It certainly would cut down on the expense of DXpeditions . . . how much can it cost to take a ferry over to Fire Island? And think of all the countries we would have up in the St. Lawrence River . . . WOW! Our imaginations were so staggered by the possibilities that we decided to stick with the official U.N. country list and let them decide what was a country and what wasn't.

The DXDC Certificate applications must include QSL's in proof of the contacts claimed, a list of the countries contacted, and a dollar to help defray the costs of the program. There are no stickers available for more than ten countries contacted, so please do not apply for stickers for 20, 30, etc., countries contacted. Stickers are available, on separate application, for ten countries being contacted all on one band, all contacted with a single mode of emission used by both stations (AM, CW, SSB, RTTY), or all contacted during one calendar year. Each sticker must be applied for individually with corroborative QSL's and a dollar to help cover the costs of administration of the program.

RRCC Certificate. None of this twenty or thirty minute stuff for us. If You are a Real Rag Chewer you should be able to keep it flying for at least six hours. This certificate will be awarded to amateurs who provide a signed statement to the effect that they have completed a two-station (not three or more) contact which has lasted a minimum of six hours, with no time whatsoever out for any interruptions of any kind, even for a half minute. A QSL indicating the length of the contact must accompany the statement, and the times of starting and ending the contact must be stated. Please include one dollar to help cover the administrative costs of this program.

There are a lot more on the drawing boards . . . and we are open to any suggestions that these new awards may bring in from readers. Watch for the announcement and rules for the WAZP Certificate, the WAAC Certificate, the WAP Certificate and others. We're working on some other dandies too . . . the Worked All County Seat Certificate, the Worked American Empire award for contacting all countries con-

(Turn to page 82)

TO MY FRIENDS AND FORMER CUSTOMERS IN AMATEUR RADIO AND COMMUNICATIONS FIELDS.

I am pleased to announce formation of SBE, Sideband Engineers, Inc., a new communications manufacturing company headed by myself and a fine group of former amateur radio associates. As many of you know, I retired from active electronic manufacturing several years ago and since then have been asked continually when I would return to the field. After careful study of potential new items that would meet my requirements of high value and performance, I have formed this group to bring you a new series of dynamic products. All will have outstanding "break-through" features.

Our first product is a new single-sideband transceiver which is described on the adjoining page. It is my personal feeling that this exceptional unit will soon lead the field. It is physically small, outstanding in circuitry, provides 4-band operation with selectable upper and lower sidebands, has built-in power supply. These are truly dynamic new features. There are several other new products in our laboratories that will soon go into production. These will be announced in the near future.

73

SBE

Faust Gonsett, W6VR, Pres.

Sideband Engineers, Inc. Rancho Sante Fe, California

SB 33 ONE OF THE BIGGEST VALUES EVER!

Entirely New! Outstanding! Dynamic!

SB-33 transceiver . . . dynamic product of solid-state electronics and advanced electro-mechanical design! Exceptionally small—less than one-half cubic foot **including built-in AC supply** and weighing only 15 pounds! **Powerful** . . . 135 watts P.E.P. input. **Four-bands,** 80-40-20-15 meters. Upper or lower sideband selectable by panel switch **and without carrier or dial shift!** Collins mechanical filter. Very low frequency drift. Check the specs . . . compare prices. **This has to be one of the biggest values ever! Available at your SBE distributor during February 1963. Write today for complete specifications.**

SIZE: 5½"H, 11¾"W, 10¼"D. Weight 15# (approx.)
FREQUENCY RANGE: Band 1: 3.8-4.0 mc.
Band 2: 7.15-7.35 mc. Band 3: 14.2-14.4 mc.
Band 4: 21.25-21.45 mc.

TRANSMITTER

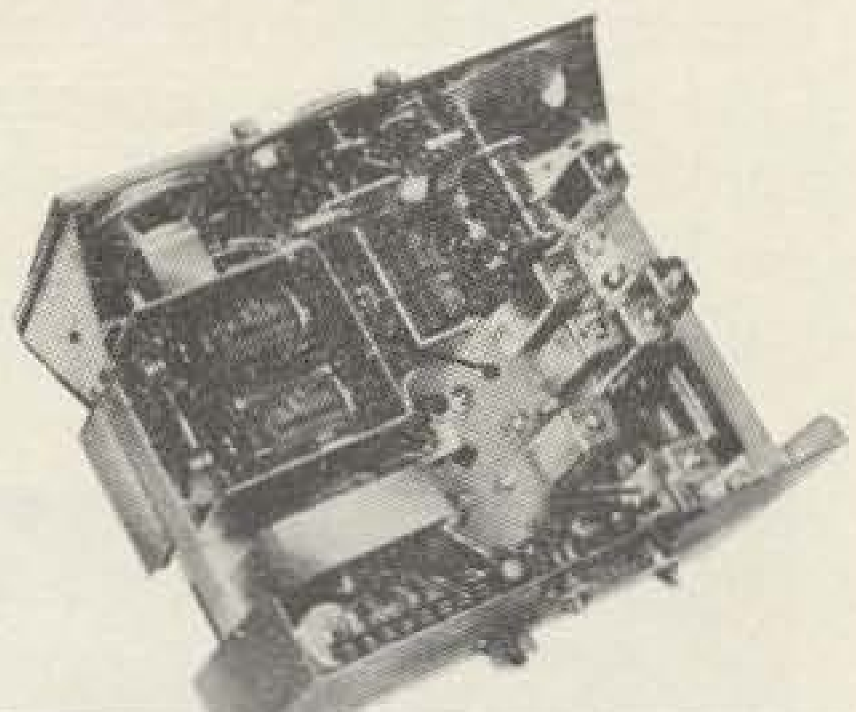
POWER INPUT: 135 watts P.E.P. max. (Speech waveform.)
DISTORTION PRODUCTS: Down at least 25 db.
CARRIER SUPPRESSION: —50 db.
SIDEBAND SELECTION: Upper or lower sideband selectable by panel switch.
UNWANTED SIDEBAND: —40 db.
OUTPUT IMPEDANCE: 40-100 ohms unbalanced.

RECEIVER

SENSITIVITY: Better than 1 uV for 10 db signal/noise ratio.
SELECTIVITY: 2.1 kc @ 6 db. 5.3 kc @ 60 db.
SPURIOUS RESPONSE: Images and I-F response down at least 40 db.
STABILITY: Less than 100 cps drift in any 30 minute period in any normal ambient temp. condition.
AUDIO OUTPUT: 2.0 watts @ 10% distortion.
TUNING RATE: 30 kc per revolution.
POWER SUPPLY: 117VAC POWER SUPPLY IS BUILT IN.
POWER CONSUMPTION: AC operation. Receive 35 watts. Transmit: 165 watts (single tone).
DC operation through vibrator or transistorized inverter.

TUBE AND SEMI-CONDUCTOR COMPLEMENT:
2—PL-500 beam power tetrodes, **PA.** 1—12DQ7 driver.
19—transistors, 13—diodes. 1—zener diode.

OPTIONS: Several options are separately available including VOX and Calibrator unit with provisions for mounting on rear of transceiver. Internal power supply provides operating power. Rear connections are brought out for linear amplifier



389.50

LOCKING-TYPE MOBILE MOUNTING BASE 12.50
SPECIAL INVERTER, 12V DC-115V AC . . . 59.50

SBE

Sideband Engineers, Inc.
Rancho Sante Fe, California.

6M SSB

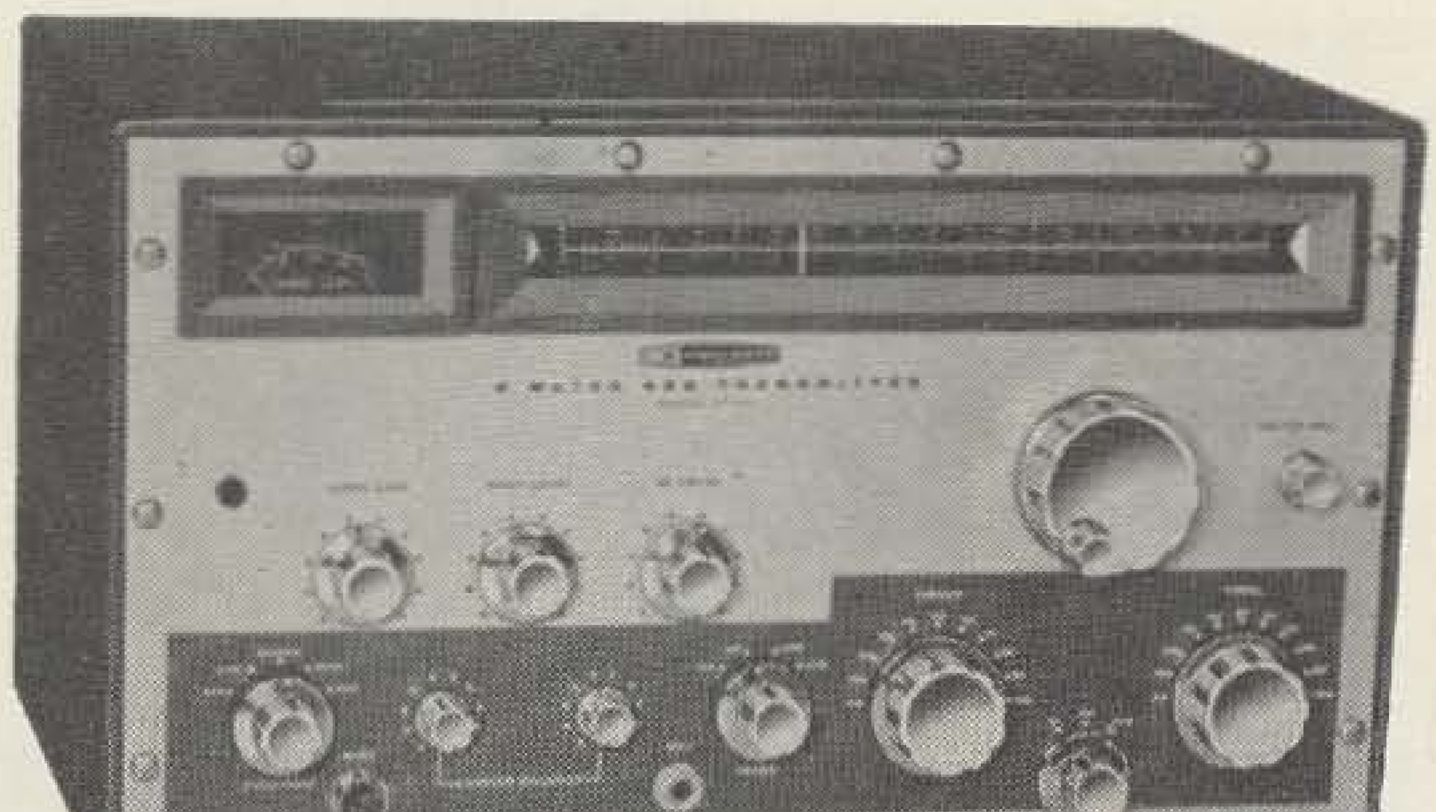
An examination into and some reflections upon the advantages and disadvantages of utilizing single sideband transmission on the six meter band and a brief investigation into the commercial components available for such application.

DENIZENS OF WHAT is probably our most active ham band, six meters, have lately been hearing more and more of that quack-quack-quack on the low end of their band. Will six go the way of twenty meters? Is sideband just a new snobbery for us to resist, or is it perhaps a thing to be reckoned with? Are there enough advantages to sideband to outweigh the considerable extra cost involved?

First, let's get a little perspective on the band. Six meters, though made available to us shortly after WW II, lay almost dormant for many years, mostly due to the lack of commercial equipment for the band. The few pioneers that were interested found that they had to use their own two hands if they wanted to get on six, for the few receivers or converters that covered the band were so insensitive that they were of little value and virtually none of the surplus gear hit the band. There would be a flurry of activity when the band opened up for a few hours, but the rest of the time you could listen for days without hearing even a heterodyne . . . even in New York City!

The big change came when the FCC, bowing to pressure from the ARRL and Technician licensees, opened the band to the Techs. This little rule change brought on a stampede of applications for this class of license and today we have in the neighborhood of 25,000 Technicians, with the bulk of the active Techs operating on six meters. This also brought on the instant commercialization of the band so that today we find a wide variety of gear available for six and the band is so active that it is difficult to find a place in this country so remote that you can't hear six meter stations.

Hallicrafters HA6



Heath HX-30

Where does sideband fit in the picture? It fits here just as it did on the lower frequencies. The DX man finds that he is able to extend the range of his station considerably by changing to sideband. The increase in effective radiated power not only makes for longer ground wave reception, but increases the sock of the signal when the band is open. The rag chewer finds that QSO's are more fun when everyone is on the same channel and they are using VOX. Since sideband so far has been used by just a few of the more adventurous operators there is naturally an increase in the interest of the contacts that result.

There is one important benefit of sideband that is peculiar to the VHF bands: greatly improved aurora communications. Those of you who have experienced the peculiar transmission distortion resulting from aurora know that normally phone is completely unable to get through and CW must be used, though it sounds like a rushing noise in the receiver instead of a tone. Sideband will get through too, with the voice coming through as a whisper as a result of the multi-path reflections.

From the equipment point of view it takes quite a bit more exciter to generate an SSB

COMPARISON CHART — SIX METER SIDEBAND

Manutacturer & Model	Kit Price	Assembled Price	Final	PEP Watts	Drive	Power Supply	Notes
Telco SB-50		$85.00	6146	50	20M	Heath HP20	($29.95)
Continental SSB-6		$99.95	2E26	50	20M	HP20	
Irving Hiverter	$59.95	$99.50	6146	50	20M	HP20	
P & H 6-150		$299.95	8117's	175	20M	Included	
Hallicrafters HA6		$349.50	5894	120	10M	$99.50	Includes rec. conv.
Collins 62S-1		$895.00		160	20M	Included	6&2M, incl. conv.
L-W Labs		$100 ±	6146	50	xtal	HP20	Complete exciter
Supreme SSB-6	$180 ±	$229 ±	6146	50	xtal	HP20	Complete exciter
Supreme SSB-6VFO		$279 ±	6146	50	VFO	HP20	Complete exciter
Heath HX-30	$189.95		6360	10	VFO	Included	Complete exciter
Telco SSB-50		$250 ±	6146	50	VXO	HP20	Complete exciter
Clegg Venus		$450 ±	6883	85	VFO	Included	Complete transceiver
Heath HA-20 Linear	$99.95		6146's	125	HX30	Included	Linear amplifier
J & D Labs Linear		$199.95	7034	1000	5 watts	$119.95	Linear amplifier
Johnson 6N2 Thunderbolt		$549.50	7034's	1200	6W	Included	Linear amplifier

signal, but once you have it the amplification is a lot simpler and less expensive than high power AM. Since the great bulk of six meter ops are Technicians it is not likely that many of them will have a sideband exciter sitting around. This not too difficult to figure out fact probably has been responsible for the recent announcement of some complete sideband transmitters for six meters in addition to the earlier advertised converters which change a 20 meter sideband signal to six meter output.

There is much to be said for either system. Older sideband exciters are not very expensive these days . . . many of them are sitting up on dusty shelves, displaced by newer equipment, and a bit of asking around is likely to uncover at least one of these that is quite reasonably priced. Even an old Central 10A

P & H 6-150

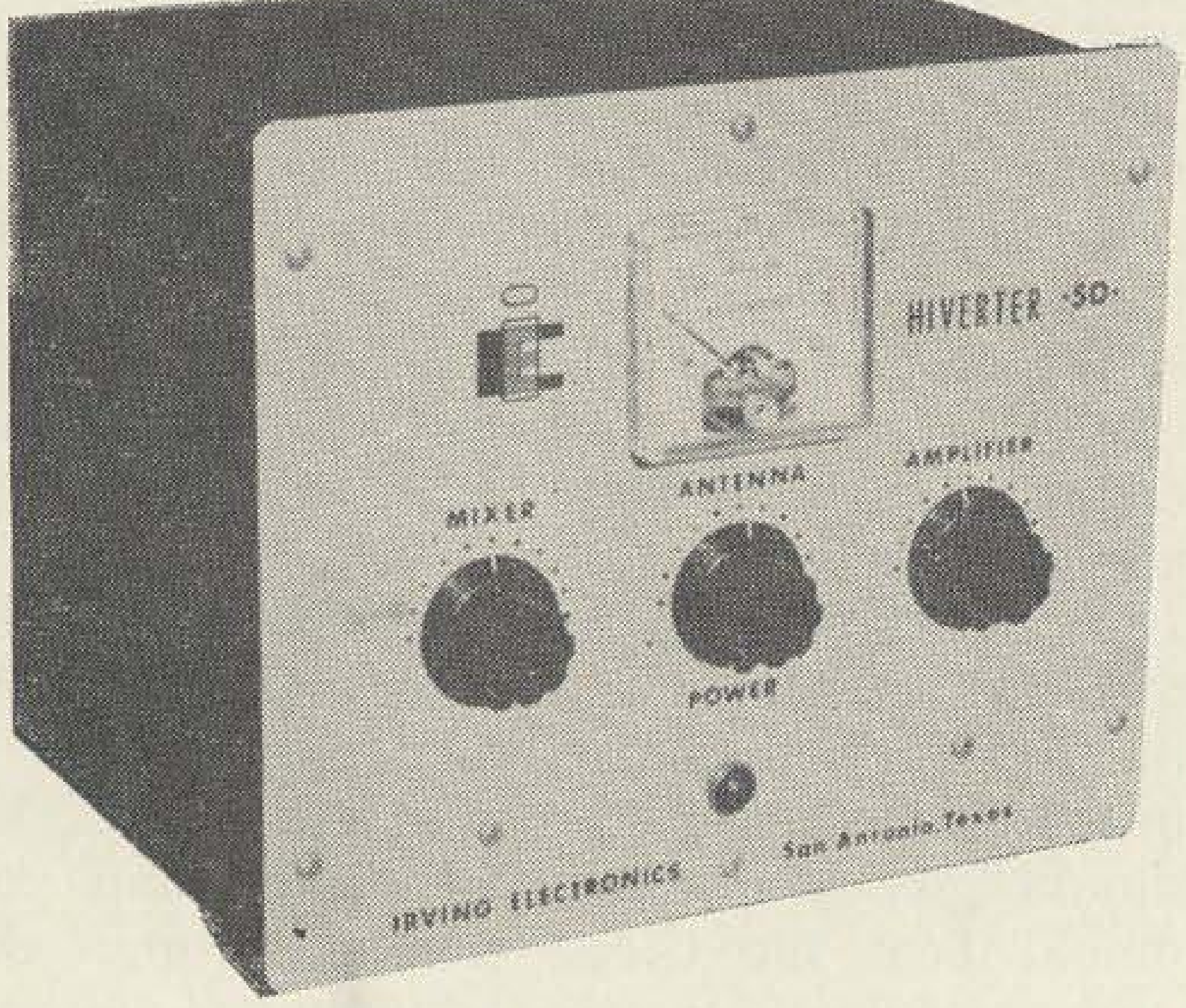
will do the job just fine. The complete sideband six meter exciter way of doing things does generally cost more, but you don't have to fuss around with a lot of separate units, power supplies, and controls. It will no doubt have a higher resale value if you consider such matters.

Perhaps you have heard the quack-quack of sideband on your six meter transceiver and wondered whether there was any way to receive this since you don't have a BFO built in. Yes, if you have an all-band station receiver around . . . and you certainly should have. You can tune into the *if* of the transceiver and use the receiver BFO for demodulating the sideband. The Clegg first *if* is at 10.7 mc so you can tune to 10.7 mc on the receiver and run a short piece of wire from the receiver antenna terminal up and stick it in the top of the first *if* can in the Clegg. This should give you plenty of pickup and you should hear the Clegg coming through the station receiver. On other equipments you can check the manual and see what the *if* is and tune it in the same way.

We've run test articles on the Continental sideband converter (November 73, p. 18) and the Irving Hiverter (December 73, p. 12). Both of these were tested here at HQ and worked out fine. They require a separate power supply (Heath HP20), and a sideband exciter with 20 meter output. The Telco SB-50, which is quite similar, has not been reviewed since Telco is about to release a complete sideband six meter transmitter. We've heard nothing but good about the SB-50 though. The

J & D Labs Linear

Clegg Venus



Irving Hiverter

Supreme SSB-6

Continental SSB-6

P & H Model 6-150 transmitting converter does much the same as the others, but has a built in power supply and linear which runs considerably higher power (175 watts PEP). The Hallicrafters HA-6 gives 120 watts PEP and converts from ten meters instead of 20. This unit also contains a nuvister converter which brings the received signal down to ten meters for use with any of the popular transceivers that cover ten meters and have an output of from 10 to 100 watts.

The Collins 62S-1 is designed to convert the signal of the S-line or KWM-2 up to both six and two meters, giving 160 watts PEP input. It also has a converter to bring the signals back down to the transceiver or station receiver.

One of the most interesting new rigs for the Tech is the Supreme SSB transmitter. This rig runs 75 watts PEP and doesn't require the usual low band sideband exciter, being a complete transmitter in itself. A separate power supply is required for this rig and almost full power can be run with the usual Heath HP20 supply. The Supreme SSB-6 operates from a crystal or from an external 5 mc VFO.

Another sideband exciter which will be on the market soon is from L-W Labs. This crystal controlled rig will have the usual 6146 final with about 50 watts PEP input, be very small, and sell in the neighborhood of $100 less power supply! Clegg has recently announced the imminence of a six meter sideband transceiver which will cost about $450, run about 85 watts PEP, and have a built in stable VFO.

Heath has recently announced their HX-30 six meter sideband exciter kit which has a built in power supply, VFO, VOX, etc. The power input is 10 watts PEP. They have a linear available for this, the HA-20, which boosts it up to 125 watts PEP with a built in power supply.

Since linears have been mentioned, it is only fair to point out the J & D Labs linear which runs 1000 watts input PEP on six or two meters to a 7034. They have a power supply available if you are short on 2000 volt sources. Needs only five watts drive, so any of the transmitting converters or exciters will drive it quite adequately on SSB. The Johnson 6N2 Thunderbolt covers both six and two meters, uses two 7034's requires only 5-6 watts drive, and runs 1200 Watts input PEP with built in power supply.

The Future?

The many advantages of sideband over AM for six meters should eventually make that mode even more popular that it has become

on the lower frequencies. I expect sideband to slowly creep up from the low end of the band until most of the active segment of six is quack-quacking. We'll probably always hear a few remnants of the low powered transceivers here and there, mostly toward the hjgh end of the band.

It seems logical that once the conversion is made to sideband that a great many operators will want to increase their ground wave coverage even more and we will see more and more linears on the market. We shall see . . . maybe I'm wrong and all we will see are more AM transceivers.

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432 mc Gallon

The increasing of the legal power input for the 432 mc amateur band to one kilowatt in most sections of the country, effective in January, means that TV and other experimenters using this band will be wanting to build a little amplifier for their present rigs. K2TKN here gives us the details on such an amplifier. Note that he does not use old fashioned construction techniques and thus does not suffer old fashioned losses of efficiency. We assume that the constructor of this unit will have been around 432 enough so he doesn't have to have detailed drawings and layouts in order to reproduce the rig.

Bill Ashby K2TKN
Box 97
Pluckemin, N. J.

MOST VHF POWER amplifier design has been a natural extrapolation from low frequency circuits. This has lead to some rather fixed views by many as to the relative merits of various designs—but the writer has found that D.C. band circuits and techniques usually result in very inefficient VHF devices. In recent years, a number of VHF tubes have been produced that are within reach of the serious amateur. These allow design of VHF amplifiers that use some rather new concepts and give excellent efficiency. One of the better examples of this break-thru in tube design is the RCA-7650. The ceramic construction allows high-temperature, efficient operation thru 1296 mc. The original cost is high, but the rugged construction and ratings indicate long years of operation, so that cost per year should be within reason.

First, you have to make up your mind that it is going to be necessary to build the socket for this tube. These VHF tubes that have their elements brought out in a series of graduated diameter rings keep this job from being too difficult, but necessary. After getting over this mental block you will be prepared for the rest of the good news, that is you are going to build all the other components too, if reasonable efficiency is to be expected. At 432 mc, this does not come out too badly—the normal assortment of hand tools, a drill-press and several gallons of elbow-grease will overcome the mechanical details.

This amplifier is grounded-grid with a shorted half-wave cathode circuit and a high efficiency half-wave plate tank. The grid is bypassed to ground on the cathode side of the socket partition and the screen is bypassed to ground on the side of the socket partition toward the plate circuit.

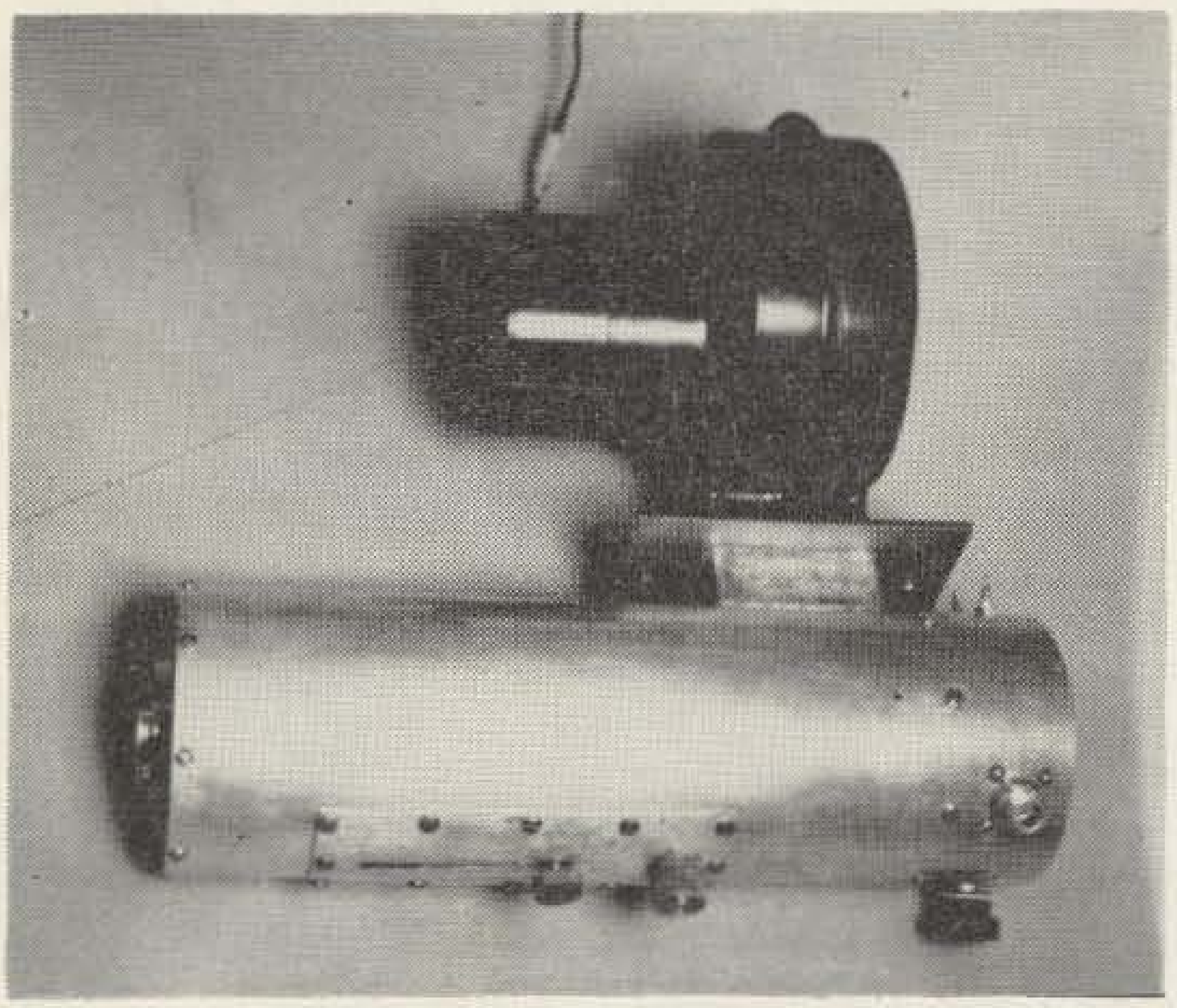
I have hated grounded-grid amplifiers with a vengence for years, for they usually would work half-heartedly only after much coaxing. In the usual configuration, the cathode to grid circuit acts like a high impedance diode with low plate current and drive, and a very low Z, high current rectifier with high drive and plate current. All in all, a very peculiar device. Working with 2C39's at 1296, I found a circuit for the cathodes that reduces this problem to a minimum. By placing the cathode at one end of a half-wave line and grounding the other end, the cathode is forced to operate in the fundamental high current mode even with no plate current or voltage applied to the tube. The cathode circuit cannot jump up to a highly reactive reactive impedance and cause instability at any condition of the plate circuit, which is a welcome change! The drive, output of a 4 X 150 operating straight thru, is tapped up on the cathode line a short way from the grounded end, at a point that gives a reasonable match under operating conditions. The ½ wave line is tuned to 432 mc at the center with the smallest Johnson variable available. This could well be a 1-10 mmfd glass piston trimmer, instead.

Other than a series 100 ohm carbon resistor to discourage H.F. parasitics, the grid and screen are operated by the book.

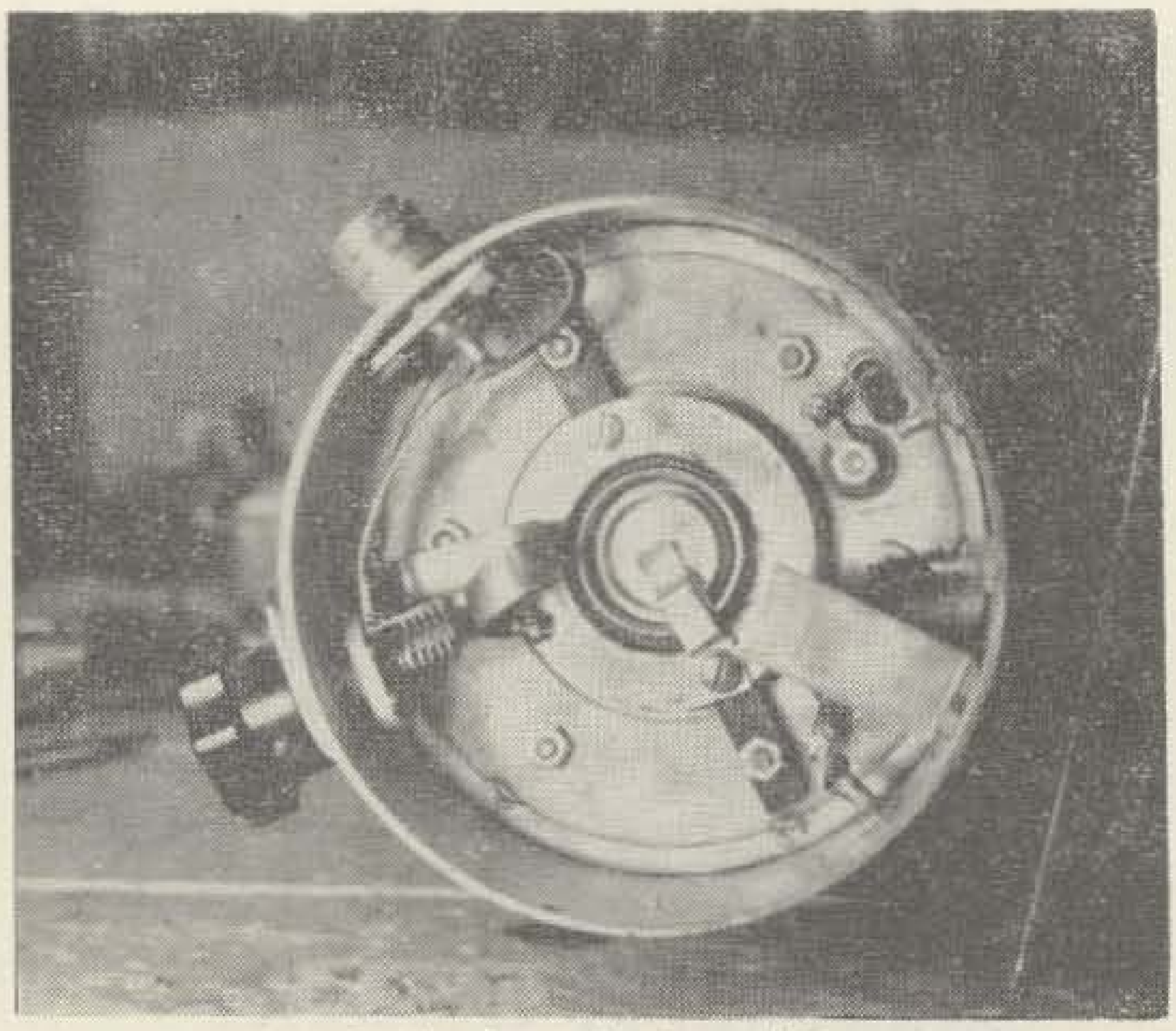
The plate circuit is a ½ wavelength of 2 1/16 inch dia. thin walled copper tubing that matches the diameter of the 7650 plate. After several years of work at 1296 mc, I have slowly realized that any high-power resonant circuit that requires a bypass capacitor at a high-current point is going to be inefficient. A ¼ or ¾ wave plate circuit that utilizes a high capacity mica, mylar, teflon, or you name it dielectric capacitor that must isolate the HV and bypass very high rf current, is going to have a poor rf power factor. This loss shows up as heat and causes a deterioration of the dielectric that can be fairly spectacular. This also appears to be where the 20 to 40 percent tank circuit losses, shown at these frequencies on all commercial data sheets, comes into effect. Lack of necessity to bypass the plate tank is very likely why most old-timey circuits for 2 meters that worked well at all were push-pull!

But while an efficient, low loss bypass capacitor for high-current operation is practically impossible to come by, a dead short for rf that will carry almost any practical amount of rf current is simply another quarter wave of tank circuit. Most attempts in the past by Amateurs to use ½ wave plate lines in single-ended amplifiers have ended up pretty bad. But how do you expect a tank circuit, 4 inch OD with a 2 inch center conductor, with a Q of several thousand to act when some idiot tries to tune it with a surplus neutralizing capacitor or worse, with a penny on the end of an 8-32 screw!

In this amplifier the ½ wave plate tank is naturally resonant when installed normally on the 7650 tube at approximately 450 mc. Then



432 mc KW amplifier



Cathode-end of amplifier

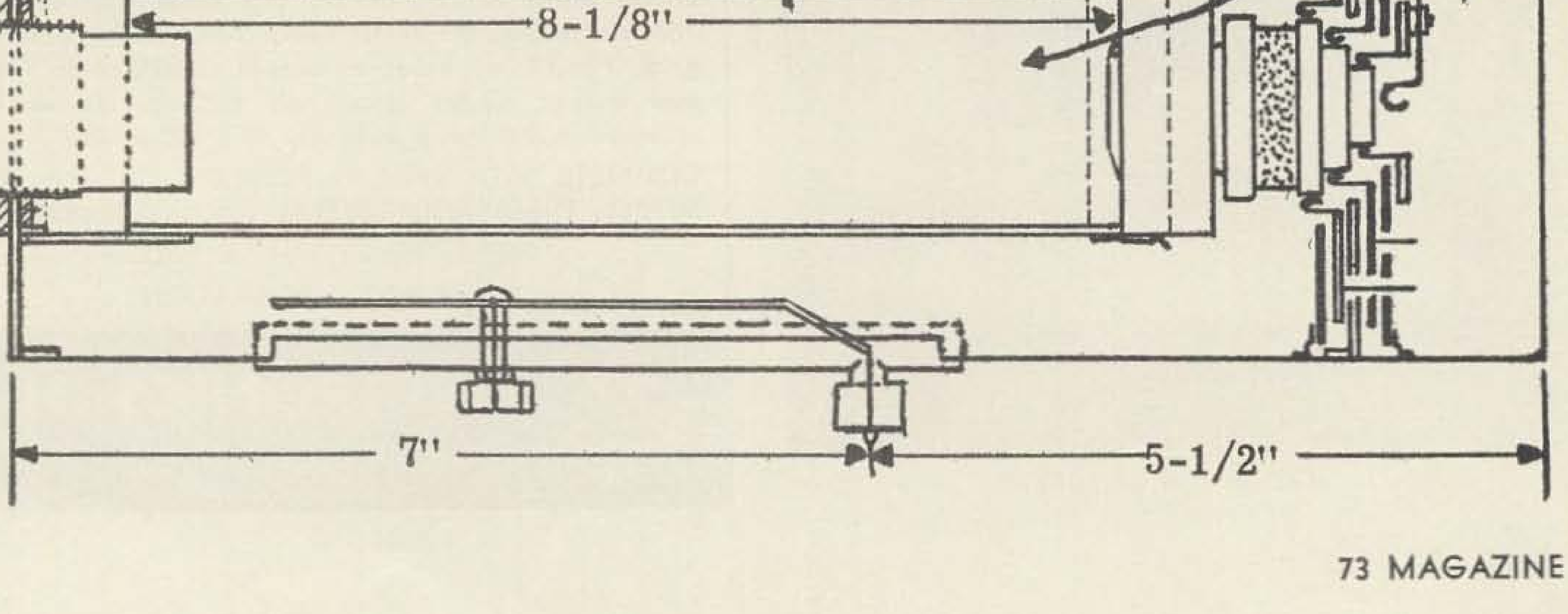
it is trimmed lower in frequency by means of the threaded 1½ inch OD air exhaust tube. This is in close proximity to the free end of the plate line, and forms a trimmer capacitor that is able to carry the full circulating tank current with low losses, and cannot possibly be self-resonant at the operating frequency. The large area of conducting surface of the inner conductor and outer shell of the entire plate circuit so distribute the rf current that silver plating becomes a luxury. HV is bypassed to the wall of the plate cavity by a brass plate 3 inches square which is insulated by teflon sheet. An rf choke connects the dead spot on the inner conductor to the bypass for HV.

The antenna coupling circuit took a while to straighten out. Handling over 600 watts of 432 mc power can get a little sticky, even at 50 ohms. The slotted bar type of semi-fixed coupling loop works fine and allows adaquate variation. To co-ax fitting is a teflon male type N to match the antenna transfer device. A 50 ohm load must be connected during any power operation or this fitting will go up in smoke.

Air is provided by a blower rated at 100 c.f.m. in free air. The 7650 has over one-half inch of back pressure thru the plate, and a blower of this size is needed to supply enough air at this pressure. A small amount of air is bypassed around the socket partition to cool the cathode. Do not attempt even short periods of operation of the filament without air flow, for solder melts on the cathode surface in less than one minute. Air flows into the main plate cavity thru the tube and out the plate line thru the trimmer pipe.

Construction

The main cavity tube is brass, 4 inch OD by 12½ inches long. The wall is just over 1/16" thick and it is silver-plated, having been salvaged from a surplus wave-meter. The plate end cap and the socket partition are of 1/16" brass plate, cut to the proper diameter and soldered to short rings of the 4 inch pipe that were cut and formed down to make a sliding inside fit. The blower mounting is formed from 1/16" brass and soldered to the main cavity. The pipe that carries air to the cathode is square channel formed from brass and soldered in place. Rather than cut a hole in the main cavity for air intake, the proper area is drilled with many ⅜ inch holes. These allow free passage of air but do not lower the Q of the cavity as a large hole would. The HV bypass is made of a 3 inch square of a scrap of the main cavity



material. The plate is secured and the HV brought out by a 10-32 bolt thru a ¾ inch hole and teflon insulation. A short length of ¼ inch tubing is soldered inside this plate so that an appropriate jack on the end of the rf choke plugs in when the plate line is installed. The plate circuit tuner and air exhaust tube is 1½ inch diameter with a fine thread cut over a portion of the outer wall—salvaged along with a thick nut that was hack-sawed into two thin ones, one soldered to the end plate, and the other acts as a lock-nut after tuning is completed. The teflon tubing that supports the plate line at the trimmer end was fabricated out of a 1/16" thick flat piece lapped over ⅜ inch and sewn with a needle and cotton thread by hand. It is a force-fit over the plate line and a sliding fit over a ¼ inch length of 2 1/16 inch tubing soldered inside the end cap. The plate line is held in good thermal and rf contact with the 7650 plate cooler by a strip of very stiff finger-stock that is soldered to the end of the line. Use of regular soft-solder here and in fabrication of the socket as a safety measure, for it will soften and let go before the tube temperature gets dangerous, yet allows normal operation.

Close overload protection in all element power supplies is cheap insurance when using hard-to-get tubes.

The output coupling circuit cover plate is made of another scrap of the 4 inch tubing, 5½ by 2 inches. A square hole, 5 by 1½ inches is cut in the wall of the main cavity with holes drilled and tapped around the edge to secure the plate. A 3 inch slot, wide enough to pass an 8-32 screw is drilled and filed for the sliding short. A similar slot is sweated out of a brass plate, ¾ by 5 inches—1/16" thick—one end of which bent and tapered down to form a smooth junction where it connects to the center conductor of the rf connector. This male type N fitting is soldered thru at the proper place in the coupling cover.

Socket Construction

Full size templates and exact dimensions of each piece of material are not of much value unless a precision machine shop is available. A very efficient, if not pretty, set of bypasses can be made by any experienced ham if common sense and plenty of patience is available. The finger-stock is Instrument Specialty, as specified in RCA's 7650 tube data sheets. This material could be scrounged from surplus, I am sure, but some fresh new strips will make you feel better, if poorer. All other material used is 1/16 inch brass plate and the thinnest teflon sheet you can obtain. Starting at the shield partition, going toward the plate circuit,

Various sub-assemblies

there is a 3½" disk of teflon, then a 3¼" disk of brass, then another 3½" circle of teflon, and finally another brass disk that is 3½" OD. This top plate has a hole in the center large enough to clear the screen and its fingerstock that is soldered to the middle brass plate. In other words, the 3¼" disk has a hole cut in it's center just large enough to slide over the finger-stock that contacts the screen and is soldered to this finger-stock. It is insulated from the partition and the grounded cover disk by disks of teflon. The complete bypass assembly is secured by six 6-32 bolts around the edge. These bolts contact all grounded disks and the holes in the partition are threaded so these thru-bolts make good contact. These holes in the screen and grid disk are enlarged to ⅜" to provide clearance. Filling of these ⅜" holes with hand-made teflon washers 1/16 thick will make assembly much easier. A 6-32 bolt soldered to the screen disk brings the screen voltage thru ⅜" holes in the partition plate and all other parts of the bypass. The grid finger-stock and bypass is made in exactly the same manner on the cathode side of the partition. The same bolts secure it as the screen assembly. Another 6-32 bolt is brought out in a manner similar to the screen to supply grid bias. The finger-stock that contacts the cathode ring is soldered to a disk of brass that is 2" in dia. This is supported above the grid bypass on two squares of formica. Two very short 4-40 screws secure the cathode disk to these insulators. They are held by two of the thru-bolts. Filament power is brought in thru a ¼ inch strip of spring brass insulated by teflon.

Use of the grounded disks over each rf bypass disk are well worth the extra effort. After final assembly, the edges of these outer disks are soldered to the partition in six spots using a very hot large soldering iron. This latter refinement might not be necessary on 432, but was helpful on 1296. Before final put-together, wash and dry all parts carefully, then assemble well away from the construction area, for a single filing of silver or brass between the plates means complete dis-assembly and rebuild. After completion, this makes a rugged, extremely efficient UHF socket.

Cathode Circuit

Locate two holes ¾" from the edge of the main cavity, 2¼" from each other. Mount a type N fitting in one, and the cathode tuning capacitor in the other. Solder a 3¼" by ¼" strip of flashing copper to the capacitor stator and bring straight over and solder to center conductor of type N then form half circle and secure under one of the mounting screws of the rf fitting. Form a 2½" by ¼" strip of the same material into a single turn coil and solder to stator of capacitor and the other end to the cathode disk at a point nearest the capacitor. A 10 turn, ¼" dia., #18 wire, rf choke is soldered to the filament contact strip and brought out thru the wall of the cavity by means of a feed-thru capacitor. The screen and grid ring studs go to 100 ohm 2 watt carbon resistors and out thru feed-thru capacitors. The feed-thru for the screen must be rated for 1000 volts.

Operation

Power supplies are necessarily interlocked and time-sequenced, and overload protection is furnished for both plate and screen. One-half second delay after antenna transfer is completed is mandatory before HV comes on, and HV is removed one second before antenna can be transferred back to rcvr. It happens that the power supplies used for this amplifier are variable from zero up, so that a variety of operating conditions have been tried. I have yet to find a really accurate means of measuring large amounts of power at these frequencies. Every serious 432 nut that I know of has a 4X150 running straight thru, so there is no drive problem with this amplifier. I have found, as always, higher plate voltages result in more actual power out for a given input. With just under 3 KV on the plate at 350 mils, loaded heavily (abt 420 volts on screen to control input) for max rf out—there is more than 600 watts heading for the antenna. If this rf affects receivers the way it does rf line and hardware, I am going to have some fun. Every dummy load and half the feedline, relays, etc., have gone up in smoke during the few short hours of operation since this beast got up to full power.

Conclusion

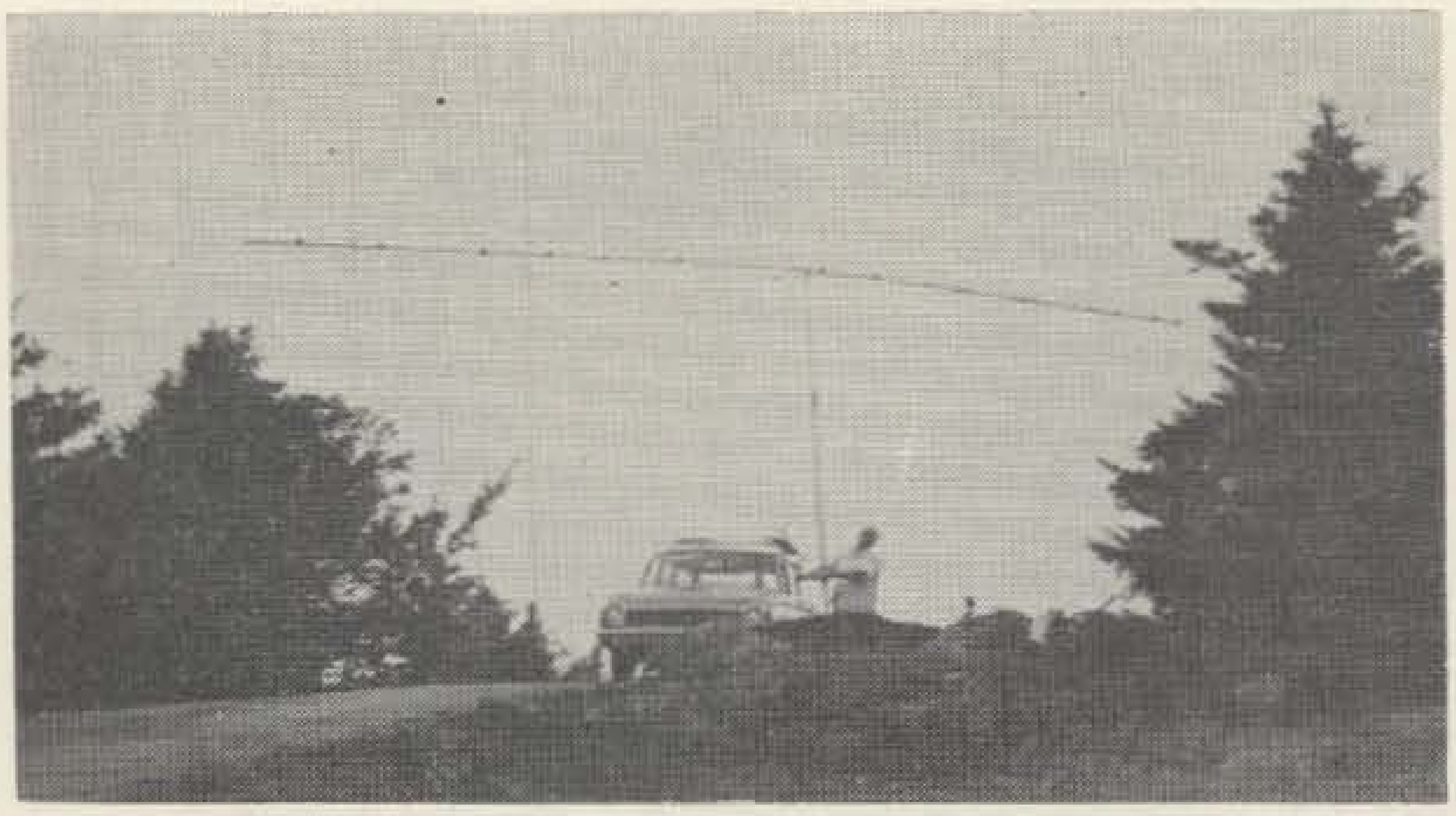
The number one deterrent to reasonable results by a state-of-the-art 432 mc station is the extremely narrow patterns of even modest sized arrays at this frequency. With 10 degree beamwidth patterns, it is necessary to make schedules to even call CQ when you have low power. With modern tubes, such as the RCA 7650, high power can be efficiently generated, and you can talk a long way off the back or sides of your beam with this power—and if someone happens to be in front—that is his problem! This kind of a signal can be heard way off the peak of the beam! The next time WWV is sending W-4 or worse, listen with the beam somewhere toward North, for I will be illuminating the whole curtain with 432.000 mc pwr. After you have peaked your beam, I might even be able to hear your low power—build this rig and we won't have to wait for aurora! . . . K2TKN

Book Reviews

USING THE SLIDE RULE IN ELECTRONIC TECHNOLOGY, a RIDER (#253) book by Charles Alvarez is an excellent text for the engineer, radio amateur or technician who wants to learn to solve problems rapidly. It examines the application of the different scales of the slide rule to typical problems. Practice problems with answers are included. Soft-cover, 109 pages, $2.50.

Are you wondering how to interpret schematic diagrams or trace a signal path through a complex circuit? **HOW TO READ SCHEMATIC DIAGRAMS** by Donald Herrington, a HOWARD SAMS publication will help answer these questions. It describes and illustrates various components and their schematic symbols. This book shows the step by step procedure for tracing a signal through a typical circuit. Soft-cover, 128 pages, $1.50.

Alan Lytel has written a **TRANSISTOR CIRCUIT MANUAL** (HOWARD SAMS TCM-1) which is a collection of the current applications of semiconductors. It includes a general discussion of each type of application and then a specific circuit giving the component values. This book would be a valuable addition to the library of anyone interested in transistors. Soft-cover, 255 pages, $4.95.
. . . KIAPA



Mountain-Topping for BLOOD

or

How to Work 49 W2's (and a couple of 3's) in One Evening, on 2 Meter Phone from the State of Maine

A DETAILED list of the 6 "MUST" items follows. *If* you *do* operate with *all* of them we guarantee that *you too* can fill pages of your log in *one day*, with nothing but stations *over 200 miles!* On 2 meter phone!

No. 1

A good transmitter of some power. After many years (first call 2BAV, Rye, N. Y., 1923) of more or less "amateur" hill-topping on 5, 2½, then 2, ending with a Gonset III which is still a great rig for my money, I decided to shoot-the-works. More or less careful calculations, and many talks with good 2 meter stations led to the purchase of a Johnson 6 & 2; an Eico modulator, 50 watts; and the Heath-Kit 600 volt power supply; as written up in 73, November 1960. I have never had a moment of regret. Input has been kept at 90 watts to avoid buying another 5894, and the 3 units mounted in a carrying rack as shown in the pix. Don't forget that this type of operation calls for the complete station *in your car*.

An important part of the rig is an ac generator. Keeping away from "bargains," I chose a Sears-Roebuck 750 watt ac job. This weighs some 80 lbs., but with two baby-buggy wheels and the "antenna plank," it goes in and out of the Falcon wagon with ease. (By the way, *don't* do serious mountain topping without a stick-shift). Some 100 feet of ac cable keeps the somewhat noisy putt-putt away from the car on mountain locations, and, *very important*, allows it to be trundled down into the bushes where it does not bother the many sight-seers who may be found up there during the day. Rangers and wardens take a dim view of complaints of noise. At night there is a different class on hand who are not so fussy!

No. 2

A good receiver. This means selectivity and a low noise figure. Calibration must be fair to good also, as you will always hear, "please look for my friend WA2 so & so across town. He has never worked Maine yet. He is on 145.426!" Having a Morrow 13 tube amateur band receiver with 6 tuned circuits on 200 kc settled the tunable *if* portion of the unit. An Ameco xtal converter with added Nuvistor pre-amp takes care of front end requirements for now. These units, with power supply, are also mounted in a carrying rack. This "carrying" business is strictly limited to in and out of the car, piece by piece. The entire set-up cannot be moved any distance out of the car, short of by some half dozen *young* amateurs.

No. 3

A *powerful* beam. This means as near to 20 db gain as possible. It does *not* mean stacked halos, home-made 3 elements, etc. I will admit, being an "antenna man" has its advantages here, but this item of portable beams will be taken up soon. I used a 24 ft. Yagi (2 twelve foot sections) wide-spaced, high gain, up to 2 years ago, at which time a 36 footer was tuned up (more of that further down the log). This is in three twelve foot sections, with a clip-on top guy of poly-propalene (transparent to radio waves) "Float-Rope," and weighs less than 10 lbs. The gain is somewhere between

17 and 19 db. This *actually* means that *both received and transmitted* energy are amplified some 60 to 70 times, over operation with a tuned ½ wave dipole. Don't forget though, GAIN IS EQUAL TO DIRECTIVITY! The fact remains that when you are in Maine and you *do* point it on New York, your 90 watt signal there is the same as though you were using a 6 kw transmitter and a dipole. There are other advantages too, concerning ground effects (Again, further down the log).

The mount and rotator used for the beam is shown also, although it is not too good in a high wind. At least 2" masting should be used to counter the 36 ft. torque. Care should be taken with all small db items as regards rf. Don't let anyone sway you with "that's only ½ db and you can't *see* that!" These *all add up*, and when a TWO-ER (Benton Harbor 1 watter) is trying to get his call through to you from Hoboken, N. J. with a busted coat-hanger antenna indoors (he did, too!) you'll be sorry! Examples, 36 footer instead of 24; 15 feet of mast instead of car top; Times Wire & Cable coax., T-4-50 (½ db less attenuation than RG-8/U); operation on favorable edge of mountain top instead of back from the edge (more on this drop-off later); *if's* all peaked; power indicator on transmitter; and, well, you get the point.

No. 4

Elevation. Again, we don't mean 2 or 3 hundred feet. Let the West Coast boys snicker, but we have to do with what we have, so here goes. In Maine, the top of Mt. Agementicus is only 692 ft. above sea level but

it sticks up all by itself above the New Hampshire and Maine coastal flats, with a lot of the highly desirable drop-off. This does marvelous things on DX for a vertically sharp beam.

In New Hampshire, Mt. Pack Monadnock is 2280 ft., and in Vermont Mt. Equinox is 3800 ft. above sea level. Note that these are all *drive-ups,* remember the 6 man team? From any one of these, using 5 of the six "MUSTS" (leave out No. 5 "small band openings") good QSO's can be had with Charlie W3IBH in Philadelphia, Pa., on a flat band. This is some 300 to 350 miles *airline.* (And no QRM)!

No. 5

Medium to Small Band Opening, A "flat" band will in general let only the 300 watters or elevated W2's through to Maine, even with all of the other 4 previous items on hand.

A real, "wide" opening will clutter up the band too much, with W4's in there shouting, etc. What is needed for pages of continuous W2's in the log is a sort of "limited type" of opening.

This condition can be predicted with reasonable success by following the high pressure areas over the region, in a newspaper which shows them (N. Y. Tribune, Times, etc.). The *trailing* edge brings good conditions, in the summer time. The isobars (equal pressure lines) must however, run *parallel* with the desired path.

No. 6

A Hard-Hearted Operator. Under no conditions must a call from a WI be answered! This would immediately break up the string of W2's going into the log! They will wait in line to work Maine, but *not* if you "waste your time" with "locals!" This leads to plenty of "misunderstandings" (a slight understatement) in WI land, but, as they say Down East, "You can't make an omelette without breaking eggs!" Getting down to the facts of life, some "little guy" (one who does *not* have any of the 6 items listed) will be listening with a Communicator II, a 5 element beam on the roof of his "Ranch," down on the flats in some river valley (an awful lot of new homes are built on this kind of land. The old Indians wouldn't even live there!) All of a sudden he hears Maine coming through nice and loud! WOW-EE, he starts calling, no answer. He listens to the deal and hears the Maine station coming back to Gonsets on Long Island. Of all things! "He *must* be hearing me!" (You're right, I did!) But, what can you do? You didn't build all those racks, cables, masts, planks, beams, etc., put them all in the car, drive an hour and a half, set them all up on a mountain top, (you even have to *locate* these drive-up mountains by trial and error over *years*) sit cramped up in the car for eight hours fighting off all kinds of ravenous flying mountain-top bugs, and then pack the stuff in the car at 2:00 A.M. and drive home again, *just to work WI's!*

Also, many operators are born rag chewers, local operators, etc. They *like* long QSO's! They just *cannot* understand the 1½ minute contact limited to antenna, power, & signal. Occasionally I relax and have a long QSO. Once even for over an hour but *this* was talking about coming 1296 mc work. So, on reading these notes maybe some of the W1's will understand the Hard-Hearted Operator deal.

That ends the list of items. The log for one of those evenings, Mt. Agementicus, near York, Maine, August 4th, 1961 follows.

I started at 9 o'clock (P.M.) at the low end of the band. You will see how long it took to get up to WA territory. 9:00 P.M.

W2DHB; 9:22 K2ATA; 9:32 W2IZA; 9:35 W2NCF; 9:45 K2RTH; 9:55 K2LCU/2; 10:00 K2LIO; 10:05 KINPE (Norwalk, Conn. is very near W2 land!); 10:10 K2BNK; 10:12 W1IBU (I must have been getting soft-hearted!); 10:15 W2CDO; 10:21 W2IGX; 10:33 K2UAF; 10:35 W2WIY; 10:40 W2UVU/2; 10:45 W2LJF; 10:50 W2COT; 10:55 W2YPM; 11:05 W2BAH/2; 11:10 W1JZA (Conn.); 11:15 W3DJJ; 11:20 W3LHF; 11:21 K2SJN; 11:25 WA2HFI; 11:26 (real short contacts!) WA2NMX; 11:30 K1RBS; 11:31 K1IED; 11:35 WA2FBA; 11:43 WA2DRK; 11:45 WA2GRE; 11:50 WA2QEG, (you can see that by now I had gotten up into the technicians band!); 12:01 WA2OLC; 12:08 WA2NUQ; 12:10 WA2MDT; 12:14 W2EEW; 12:22 WA2DPN; 12:25 W2AMQ; 12:30 WA2CHN; 12:35 WA2OSY; 12:40 WA2MOY; 12:45 WA2HVV; 12:46 K2HHS; 12:50 W2IMG; 12:52 K1GSD; 12:53 K2RRZ; 12:54 WA2LPJ; 1:00 W2QCR; 1:02 K1DDY; 1:04 K1DIH (see what happens when you answer a WI call!); 1:05 WA2NOF; 1.07 KINUM; 1:09 K2KME; (must be back at the low end again); 1:12 K1NMO; 1:15 K2EAF; 1:20 W2JJI; 1:22 W3SFY; 1:50 W2AMJ; 2:00 K2DDE; 2:02 K2KRJ; 2:21 WIUVZ; 2:25 K2ORA; 2:29 WA2BAH; 2:35 WV2SPG.

So then I packed up antenna, putt-putt, mast, etc., and drove home. . . . K1CLL

Simplified 8JK Beams

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Los Angeles 46, Calif.

ONE OF THE SIMPLEST directive antenna arrays for 7 through 50 mc is the "flat-top," or 8JK beam. Since 1945 several versions of the 8JK have been employed at W6WAW with exceedingly good results, especially in DX work. The antenna is characterized by a bi-directional gain falling between 4 and 6 db, plus the fact that it produces the low-angle of radiation required to obtain maximum skip on multi-hop DX, even at fairly low heights above ground (approximately one-half wavelength).

The original 8JK design employing two single wire dipoles fed 180° out-of-phase was somewhat difficult to match properly, due to the low impedance viewed at the feed point. However, the famiiar "twinplex" configuration, employing a 3-wire folded dipole effectively raised the center impedance to around 275 ohms, providing a fairly good match to a 300-ohm twinlead phasing section and transmission line. This antenna is a bit cumbersome how-

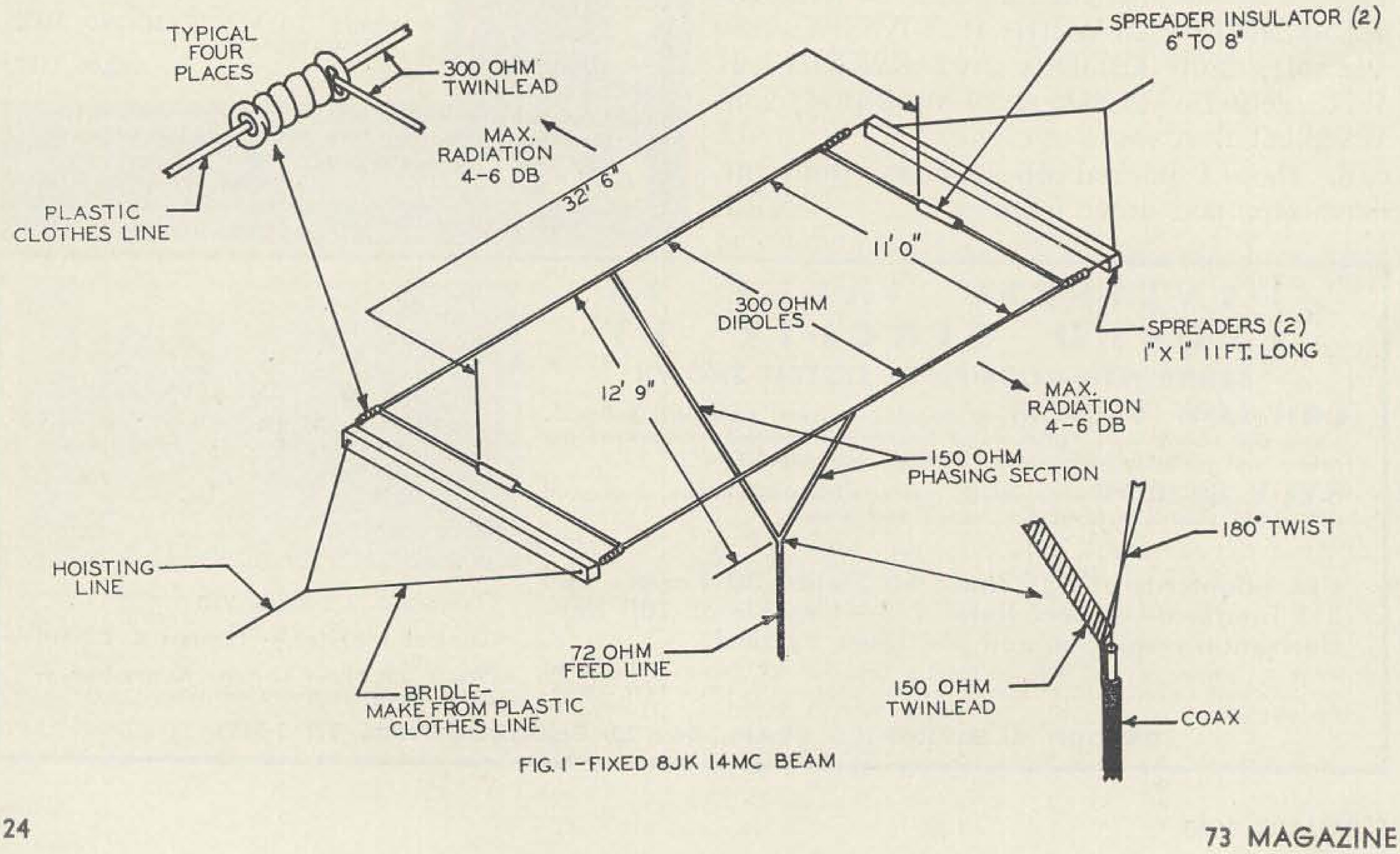
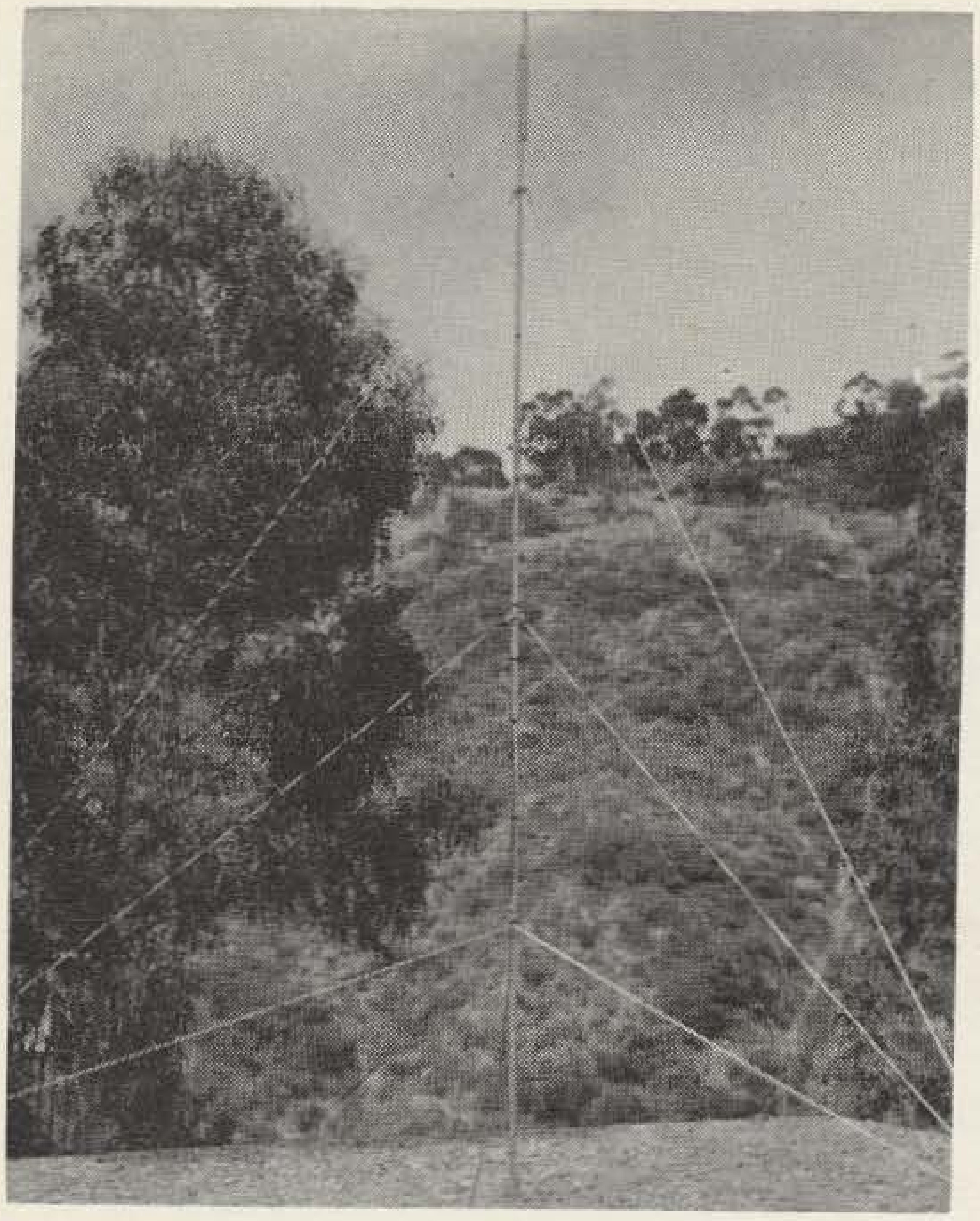


FIG. 1 -FIXED 8JK 14MC BEAM



ever when cut for 7 or 14 mc. A simpler configuration is to make the folded dipoles from 300-ohm twinlead. This produces a center impedance of approximately 150 ohms, in turn permitting the phasing sections to be cut from 150-ohm twinlead.

This all twinlead version may then be fed with a 72-ohm transmission line. Tests at W6WAW have shown little difference between feeding with 72-ohm twinlead, or using a 72-ohm coaxial line. However, it is simpler to match the coaxial line to the pi-network output of most transmitters.

The 8JK antenna can be shortened approximately 30% by folding the ends inward without degrading performance of the array. This permits erection of an antenna for 14 mc having a horizontal space requirement of 26 by 11 feet. At this size an 8JK is very easily constructed as a rotable array, requiring a maximum of 13 feet turning radius. As the antenna is bi-directional this also permits use of a simple method of rotation, as only 180° is required.

Construction of both a fixed, and a rotary version of the 8JK are covered in the following details. The antenna measurements are given for 14 mc operation, however if it is desired to build the antenna for any other frequency between 7 and 50 mc, the proper dimensions may be found in Table 1.

Fixed Array

First cut two dipoles from 300-ohm twinlead. These should be 32′ 6″ in length, with

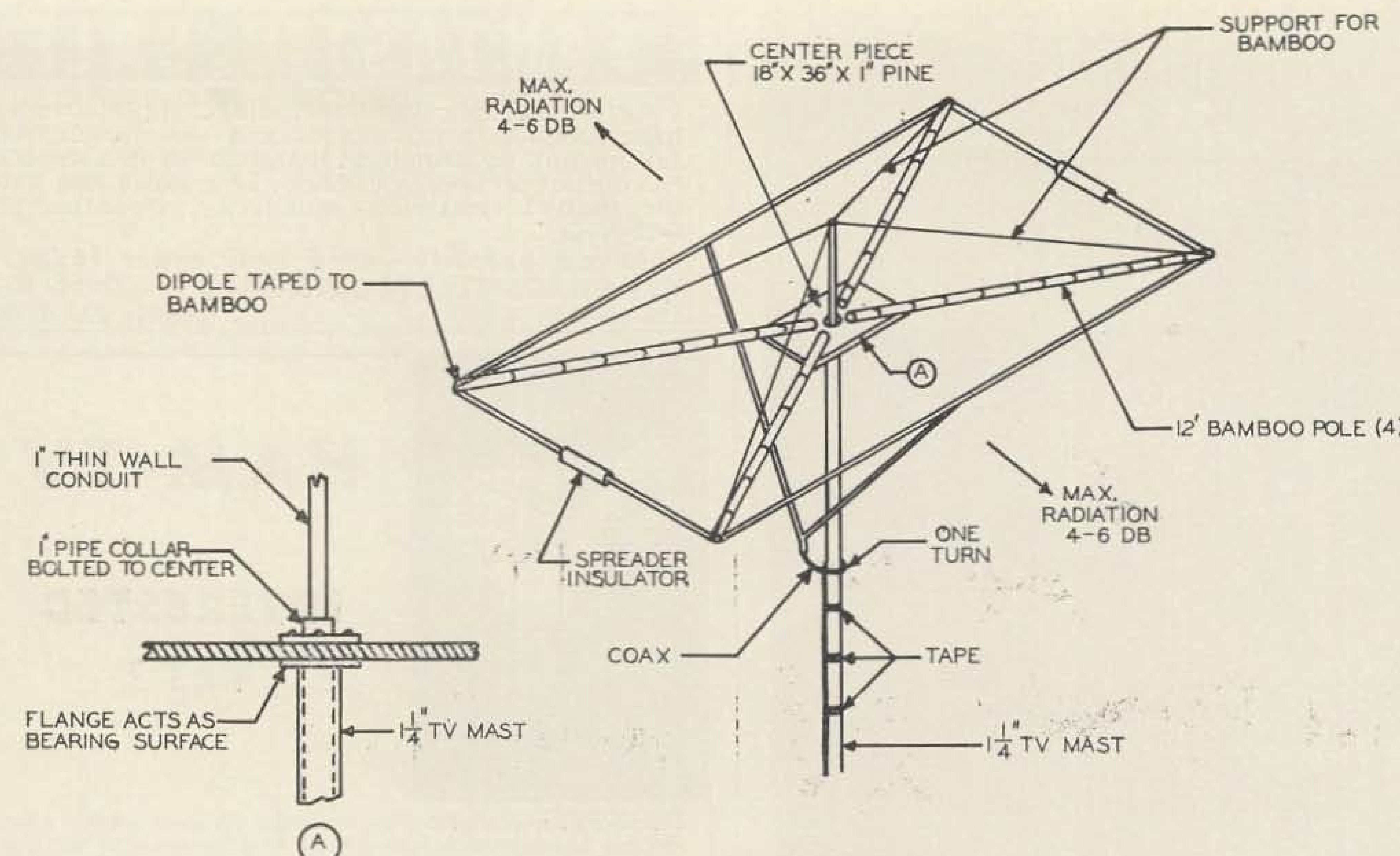


FIG. 2-ROTARY 8JK 14 MC BEAM

about 6 to 8 inches of excess wire left on each end. Next, cut the two phasing sections from 150-ohm twinlead. These should be 12′ 9″ in length. Open one side on each of the dipoles at the exact center and connect the phasing sections. These connections should be soldered, and some surplus insulation melted around the joint for protection.

Twist one of the phasing sections 180° with regard to the other as shown in Fig. 1 and connect the free ends of the two phasing sections together. Connect the 72-ohm transmission line (twinlead or coax) between this junction and solder. Wrap this connection well with tape to prevent entrance of moisture, which will damage the coax.

The next step is to construct the spreader arms and antenna bridle as shown in Fig. 1. Attach a glass or ceramic insulator to each end of the two 11 foot spreaders. An easy way to do this is to drill a hole through each end of the spreader. Pass the end of the bridle line through the hole and secure to the insulator. Measure off sufficient line for the complete bridle and connect the other insulator in the same manner. Fabricate the second spreader the same way.

TABLE I

FREQUENCY	LENGTH OF DIPOLE	LENGTH OF PHASING SECTION	DISTANCE BETWEEN DIPOLES
7.0	66′ 9″	25′ 8″	22′ 0″
7.2	65′ 0″	25′ 0″	22′ 0″
14.0	33′ 4″	12′ 10″	11′ 0″
14.2	32′ 6″	12′ 9″	11′ 0″
21.0	22′ 3″	8′ 6″	8′ 3″
21.3	21′ 11″	8′ 5″	8′ 3″
28.5	16′ 5″	6′ 4″	5′ 6″
29.0	16′ 0″	6′ 3″	5′ 6″
50.0	9′ 4″	3′ 7″	3′ 0″
52.0	9′ 0″	3′ 6″	3′ 0″

Insert one end of a folded dipole section through the remaining eye on each of the four insulators. Twist the two wires together at each end of the folded dipoles and connect the spreader insulators at each end as shown in Fig. 1. As the rf voltage at the end of each dipole section is quite high the spreader insulators should be at least 6 inches in length.

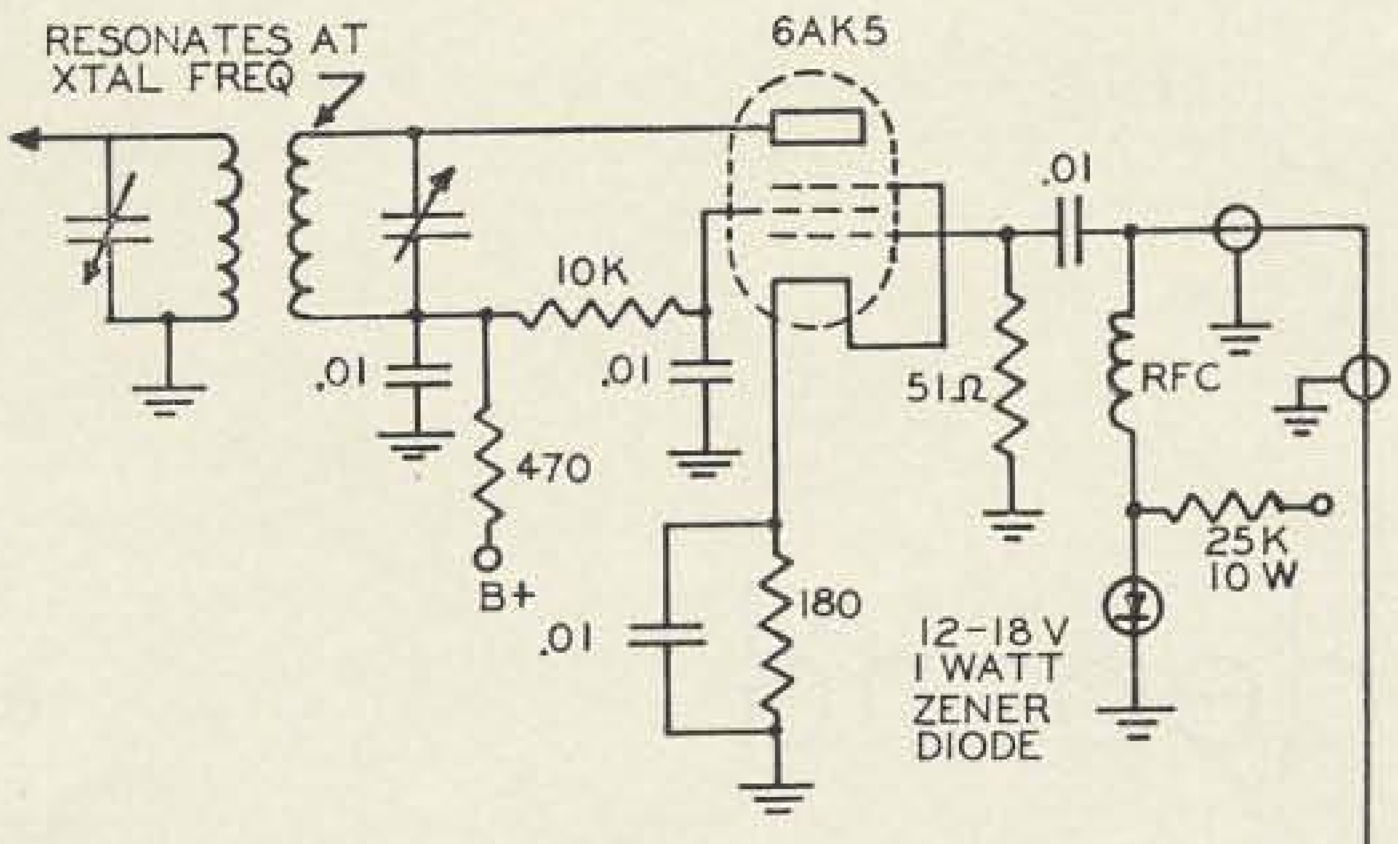
Attach a hoisting line to the apex of each bridle and raise the antenna into position. For best results the array should be at least 35 to 40 feet above ground for operation at 14 mc.

Rotable Array

The rotable 8JK is constructed exactly the same as the fixed version, except no spreader arms are employed. Instead, 4 bamboo poles, 12 feet in length are used to support the ends of the antenna. A simple center construction is shown in Fig. 2. If trouble is experienced with "droop," the ends may be guyed to an extension of the mast, approximately 36 inches above the array.

Lead the phasing sections off to the mast and tape the coax, allowing enough slack for 180° rotation. No attempt will be made here to describe the various methods of rotation, as this will depend upon the individual installation. However, even the lightest duty TV type rotators will prove sufficient for this type of array at 14 mc. In the past at W6WAW most beams of this type have been hand rotated due to close proximity of the beam mounting to a window by the operating desk.

. . . W6WAW

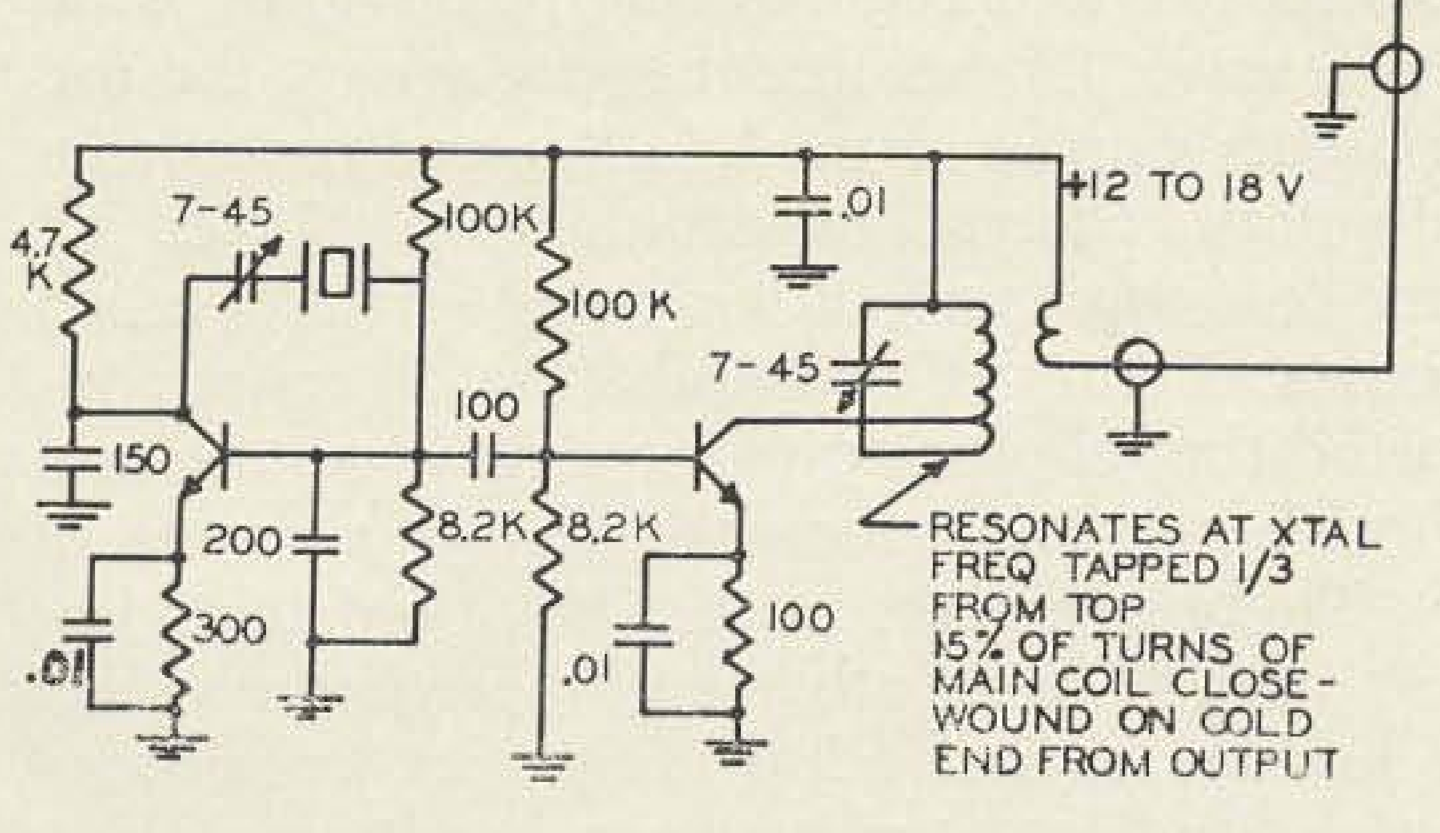


Ultra-Stable Xtal Oscillator

This unit is being used extensively for generation of stable frequencies for UHF. The osc. unit should be constructed on a small phenolic board and placed in a vacuum bottle, which may be buried in the ground. The plus 12 to 18 volts is carried on the center conductor of the co-ax so only one cable goes to the osc. Any good NPN rf transistors suitable for the xtal frequency used will give excellent results. This osc. will permit multiplication of a 7.814mc xtal times 162 up to 1266 mcs by means of a tube multiplier string and the results will be stable within cycles and give pure dc beat notes.

The 6AK5 buffer stage raises the 3 to 5 volts of rf at 51 ohms up to 50 to 60 volts at the Xtal frequency suitable for driving a string of tube multipliers. The Zener diode is a handy way to get regulated low dc for the oscillator from available B plus.

. . . K2TKN



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Double Sideband

FOR MANY YEARS there have appeared articles in amateur radio magazines which have compared two modes of radio telephony, namely amplitude modulation and single sideband. Most of these comparisons have been on the "equal" basis of the most simple and straightforward operation of each mode. Almost without exception, these articles treated each system with the same conditions, but neglected to say that when this is done, AM could be at its minimum effectiveness whereas SSB could be at its maximum effectivness. A common approach, has been to examine the ability of a given final rf amplifier stage by first assuming maximum operation of that stage in the AM mode and then using the same stage for SSB. Another approach has been to assume equal power *outputs* when the powers were considered to be the unmodulated AM carrier and the SSB output with tone input. In almost all such comparisons the voice modulating signal has been assumed to be identical for both modes ignoring the fact that certain types of voice processing are advantageous with one mode but not with the other. If two modes of voice transmission are to be compared, each mode should be treated wholly to itself, and not be limited by restrictions inherent in the other.

There are many amateurs who feel that the operation of the most effective mode is paramount and that the so-called savings such as total power consumed from the power line, overall size of equipment, possible higher packing density on the bands, high trade-in value when selling out, etc., are insignificant to them when compared to this goal. Therefore, the comparisons, which follow will consider three three modes of radio telephony from *only one view*. They will be compared only on the basis of the maximum effectiveness possible within the limitations of the amateur regulations, with optimum conditions available at both transmitter and the receiver. One of these limitations concerns the power that may be used by the amateur. This discussion will consider a maximum power station and the utilization of that power in the most effective manner. What then, is the maximum power that may be used? The definition of the maximum power limitation varies according to the mode of operation being considered. Since all three systems involve the use of audio signals, sine wave tone signals will be assumed unless otherwise noted. It will also be assumed that only the final rf stage supplies power to the antenna.

Power

AM

Conventional AM, double sideband with carrier is limited to 1000 watts dc input (the carrier) plus the power needed for 100% modulation. The *total* power input to a 1 kw AM station is therefore somewhat vague because the average amount of power needed for 100% modulation varies over a wide range. Because of differing voice characteristics, use of clipping or compression, etc., the average audio power might vary from 200 watts to well over 500 watts. Clipping has been used extensively in radio communications systems because clippers reduce and regulate the peak value of an audio wave. Therefore, clipping allows the use of higher depths of modulation and provides a safeguard against overmodulation. Voice of America engineers, after conducting detailed studies of means of combating jamming, reported that clippers provide signal-to-noise and interference improvements of approximately 9 db. These engineers further point out that clippers offer a basic advantage over compressors or limiters in that clippers operate instantaneously. Studies of many speech patterns show that high-frequency sounds, necessary for good intelligibility, normally occur immediately after low-frequency, high amplitude sounds. Compressors, which are quick to reduce gain and slow to restore gain, effectively reduce the amplitude of these high intelligibility, high-frequency sounds. Clippers, being instantaneous in operation, do not suffer from this limitation.

It is possible to find a reasonable maximum average audio power figure for 100% modulated AM by assuming tone moduation instead of voice. A pure sine wave modulating signal would require 500 watts average power output from the modulator going into the final. Clipping and filtering of this sine wave would change its shape and significantly increase the amount of average power needed for 100% modulation. It does not seem unreasonable that with clipping, the average audio power in this example could be increased from 500 watts up to 800 watts or more. Therefore, the legal total power input to the final rf stage of an AM transmitter might well be 1 kw of dc power (for the carrier) plus 800 watts of audio or a total of 1800 watts. The dc power input to the final stage of an AM transmitter is determined by metering the plate voltage and the plate current and by using Ohm's Law that $P = E \times I$. An oscilloscope can provide a means to determine when the degree of 100% modulation occurs, but will not indicate the average power of the audio needed to attain this point. However an audio average power indicating device is not required. Thus, the only power determining devices needed to meet requirements are a dc plate meter and a dc ammeter. It should be noted that dc devices read average and that the average of an ac signal amplitude is zero, so that both instruments remain at the same reading with or without modulation. It should also be noted that the peak envelope power of a 1 kw AM transmitter modulated 100% is equal to 4 kw.

SSB

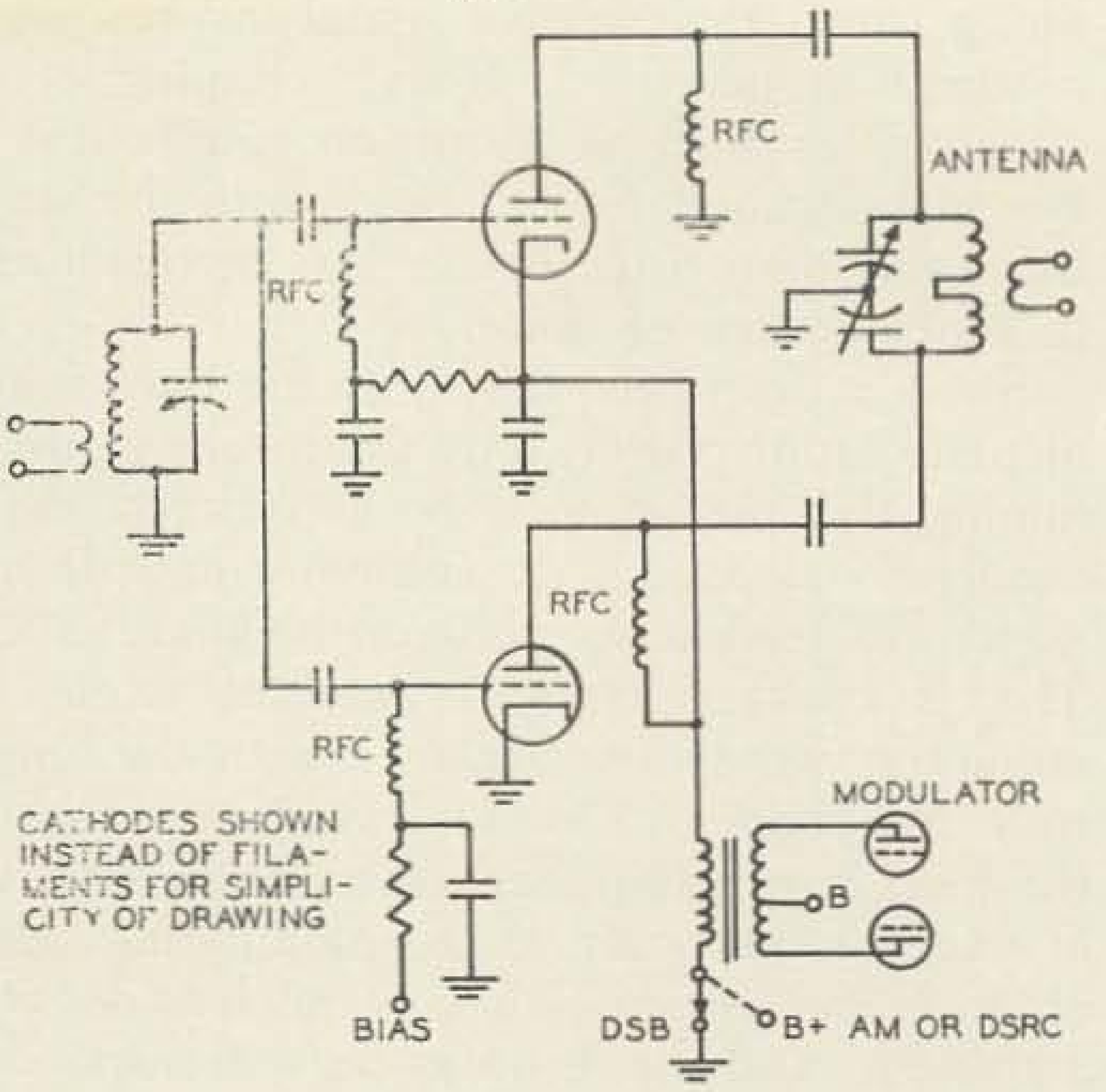
Single sideband suppressed carrier has a power limitation of 1 kw average dc input to the final rf amplifier stage. With an average voice as the program source and proper metering, this results in an actual peak envelope input of 2 kilowatts. Speech has occasional high power low-frequency (say 200 cycle) components which if clipped become nearly square waves. When a square wave is sent through a typical low-pass filter which may pass up to the 11th harmonic, and then used to modulate an SSB transmitter, the peak rf power is increased three times over what it would be in AM modulation. To avoid exceeding the peak power limitation of the law (or of the tubes being used) the average signal level must be reduced to one-third. Heavy clipping is not effective for SSB as distortion results due to the inability of a linear response to the waveform and there is a further loss of readability in the presence of noise.

Since a dc power supply is the only source of plate input power, only the means of determining this power need be considered. As in conventional AM, a dc voltmeter and dc ammeter are used at the plate of the final rf stage. The dc voltage remains constant while the ammeter varies in accordance with the amplitude and shape of the low level input signal to the final linear amplifier. Here, as in AM, the average of the peaks of the modulating signal controls the average power as much as does the amplitude, and the dc ammeter will respond to changes in either. This means, that with a fixed maximum reading on a dc ammeter as a guide, that audio with occasional high peaks and a low average will achieve a high peak input power on those peaks. Audio having little difference between occasional peaks and the average will have a lower peak input power on those peaks, but have a higher average peak input. The average input power is the same in both of these cases, for the dc ammeter was used to equate the powers and it is an average reading device when in the presence of a varying signal. Because of the character of the current flowing in the plate circuit, a specific degree of damping of the meter movement is required. This is reasonable because it can be seen that a meter having a very high degree of damping would result in a much higher input power for a given meter reading than a meter having a low damping figure. The meter used by amateurs transmitting SSB is required to be quarter second damped. Using Ohm's law, that $P = E \times I$, the reading on such a meter while the operator is talking is used with the known dc voltage to determine the power input, the maximum being 1 kw.

DSB

Double sideband with no carrier is usually thought of as being similar to SSB in a general sense, both systems being low level modulation systems having the ability to cancel out the carrier. However, the double sideband system described in this article is a high level modulation system which also has the facility of reducing or even eliminating the carrier.[1] The important difference, as far as power is concerned, is that the former requires a final amplifier of relatively low efficiency whereas the latter uses a high efficiency amplifier. As shown

FIG. 1



in Fig. 1, a pair of tubes are used in an rf amplifier in such as fashion that they are connected back-to-back as far as the plate power source is concerned. Such a device properly operated will pass electron current in either direction equally well. Properly connecting grid and plate rf circuits and applying an ac voltage of audio frequencies to the plate input results in a double sideband, no carrier, output signal. Since modulation takes place in the plate-cathode circuit of both tubes, both tubes may be operated at Class C efficiency. It can be seen that since there is no dc voltage involved, that a dc ammeter placed in the transformer secondary circuit would read zero. The average of an ac voltage is zero, and in varying about ground the average voltage on the final is zero. Thus, dc instruments for voltage and current would result in apparently zero power regardless of the amount of ac or audio power used. It seems reasonable that ac rms meters may be used to measure the power input in this circuit. Since both plate voltage and plate current vary with the speech, then *both* meters would be quarter-second damped. It should be pointed out that an rms reading meter reads .707 of the actual peak value of voltage or current. The voice controlled metering is utilized for both current and voltage and at the same time, the values read rms. In SSB operation, using a fixed dc voltage, the peak envelope power is twice the metered average power, that is, 2 kw PEP for 1 kw average input. The quarter second damped meter affords this advantage. In this DSB transmitter, *if* the two quarter second damped meters were *peak* reading, then a 1 kw average input would result in 4 kw peak envelope power, the same as the AM transmitter. However, to measure average power, rms reading meters are used. Thus when 1 kw average power would be indicated by the two rms reading meters during speech, each reading would be multiplied by $\sqrt{2}$ to calculate peak values.

$\sqrt{2} \times E \times \sqrt{2} \times I = 2 \times P$. The peak envelope power would then approach 8 kw. It should be noted that the circuit shown in Fig. 1 can be used as a straight AM transmitter simply by returning the modulation transformer to a power supply instead of ground. Suppose then that a dc power supply is connected to the modulation transformer of sufficient voltage such that the final amplifier may be loaded to 1 kw of dc power and afford a match to the modulation transformer. Assume that the transmitter is modulated 100% with a clipped and filtered sine wave tone causing a total average input power of 1800 watts. If the voltage from the power supply were gradually reduced and the audio power gradually increased until the dc input was 900 watts and the audio power 900 watts, the total average power would still be 1800 watts. At this point the carrier would be modulated in excess of 100%. The waveform of the rf envelope would not however contain any distortion because the DSB circuit provides a continuous response of the proper rf phase to the entire applied audio signal regardless of the polarity. Thus although the applied dc voltage was over-modulated there are no spurious sidebands created. The 900 watt carrier and 900 watts of audio add up to the same 1800 watts as our sample optimized AM case. Suppose now that the carrier is further reduced by lowering the dc voltage and the audio power increased. At almost zero dc voltage the carrier could be reduced to 1 watt and the average audio power could be increased to 1799 watts, still the same total average input power as the optimized AM station. Of course this 1800 watts average input power would be, for practical purposes, all in sideband power.

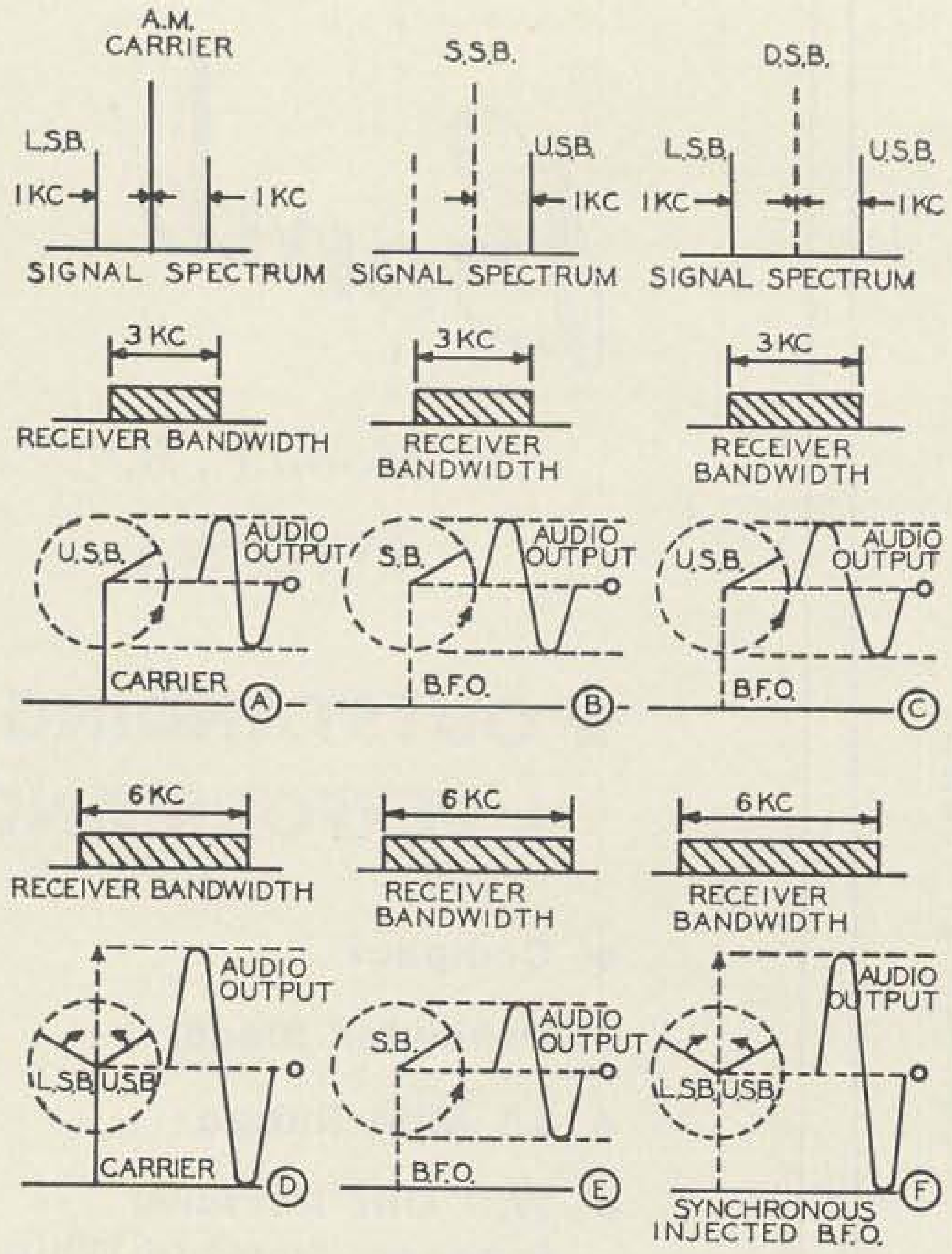
Efficiency of the Final Stage

It should be noted that the selection of certain voltage to current ratios can improve the efficiency of either a linear amplifier or Class C amplifier. It will be assumed that any comparison of efficiency between the two has been equalized by treating each under the same conditions.

AM

Conventional high level modulated AM can be operated at the efficiency afforded by Class C operation. This will be considered here as

FIG. 2



75%. At this efficiency, out of the total of 1800 watts average input power in the optimized AM case, the total average power output will be 1350 watts. Of this, 750 watts will be in the carrier. The average sideband power output will be 600 watts split into two sidebands of 300 watts each.

SSB

The efficiency of a single sideband suppressed carrier linear amplifier will be considered here as 60%. At this efficiency, out of the total of 1000 watts average input, the average sideband power output will be 600 watts in one sideband.

DSB

The double sideband amplifier herein described can be operated at the same efficiency as the AM station. With the same total average input power as the AM station the average power output will be 1350 watts. This is the same as the output power of the AM transmitter except that all the power is in the sidebands, each sideband containing 675 watts.

Reception Capabilities

For the purpose of this discussion, it will be assumed that the signal to be received contains information up to 3 kc.

AM

The most common method of detection of conventional AM is through the use of a linear detector. Assuming the bandwidth of a receiver accepts both sidebands and the carrier, the detector uses the carrier to demodulate the sidebands. The carrier, being of proper phase, the two sidebands add together to form the audio output from the detector. By having such a receiving bandwidth, in this case 6 kc, the AM signal is more susceptible to interference than a mode of reception which is more narrow. AM can be detected by the single sideband method. However, in this case fully half of the sideband power is discarded. Although only half the sideband power is used, it is very important to remember that the other sideband is immediately available. Thus, the sideband experiencing the least interference can be continually selected under varying conditions of interference.

A third method of reception would be the use of a synchronous detector as proposed by W2CRR.[2] This method ignores the presence of the carrier and uses the synchronous information appearing in the two sidebands to control a product detector. The system adds the two sidebands of a double sideband signal and allows the operator to select the interference to be rejected, which might be present in one of either of the two sidebands. It accepts the desired signal appearing in 6 kc of the spectrum, yet affords an effective 3 kc bandwidth in regard to interference and noise.

SSB

Normal single sideband reception can be accomplished by carrier insertion using a 6 kc or a 3kc bandwidth. Naturally, since all the transmitted signal is in one sideband the 6 kc system does not warrant attention. In the 3 kc bandwidth position all of the transmitted signal is received as in contrast to single sideband receiving AM. The facility of changing sidebands is of course available, but the need to change sidebands is not immediately apparent to the transmitting operator.

DSB

In double sideband no carrier reception, we take advantage of having all the transmitted power in the sidebands as in SSB and by using the system of synchronous reception also take advantage of the effective 3 kc bandwidth. In addition, we can immediately select either one of two adjacent 3 kc portions of the spectrum at the discretion of the receiving operator.

System Performance

AM, SSB and DSB will be compared under

a condition where sine wave tone modulation is used and the 9 db reception improvement possible with clipping for AM and DSB transmission is ignored.

Assume that reception with 3 kc bandwidth for AM, SSB and DSB is to be considered. The left-hand group of drawings in Fig. 2 shows what takes place in receiving the AM signal. The spectrum of the signal consists of the carrier and upper and lower sidebands, spaced 1 kc either side of the carrier. Since 100 per cent modulation is assumed, each sideband has exactly one-half the carrier amplitude. The signal is tuned in so that the carrier is placed at the low frequency edge of the 3 kc bandwidth for reception of the upper sideband only. The signal arriving at the second detector consists of the carrier and the upper sideband. The resultant audio signal in this case is the beat between the two, and it is generated in the second detector by the vector process shown at (A). The instantaneous amplitude is equal to the vector sum of the carrier and the sideband, but since the two are on different frequencies this sum varies at a rate equal to their difference. This is represented by the circular path followed by the extreme end of the sideband vector, and in this example the sideband vector would rotate 1000 times a second with respect to the carrier vector. As the total amplitude varies from the carrier level to maximum and to minimum and back, it generates the audio signal.

In the single sideband case, shown at center, only the upper sideband is transmitted. The upper sideband is inside the 3 kc bandwidth of the receiver, and at the second detector the BFO is used to supply the missing carrier. At (B), the BFO amplitude is shown the same as that of the carrier in the AM case. The sideband is shown with the same amplitude as in the AM case; the process of generating the audio output is the same, so the audio signal at the second detector is exactly the same as in the AM case.

The double sideband case is shown at the right. It can be seen that only one of the two sidebands will be accepted by the 3 kc bandwidth; that the BFO injection will be necessary for detection, and that with an upper sideband amplitude equal to the AM and SSB cases the output audio signal (C) will be equal in amplitude.

Assume that the upper sideband power *output* in each case is 100 watts. An AM transmitter running 533 watts carrier input at 75% efficiency with 1 kc tone modulation at 100% would have 100 watts output in the upper sideband. A SSB transmitter running 166 watts input at 60% efficiency with 1 kc tone modulation would have 100 watts output in the upper sideband. A DSB transmitter running 266 watts input at 75% efficiency with 1 kc tone modulation would have 100 watts output in the upper sideband. Using a 3 kc bandwidth for receiving, and assuming tone modulation with no audio processing, it can be seen that an SSB signal having an input equal to the carrier of an AM signal would have a detected output 3.2 times (5 db) the output of the detected AM signal (assuming 533 watts input at 60% eff. = 320 W). Likewise, an SSB of 266 watts input would have a detected output 1.6 times (2 db) the detected output of the DSB signal.

The comparison just conducted was favorable to the SSB signal because of the bandwidth of the receiver. Consider the use of synchronous detection for receiving signals having double sidebands. In the lower section of Fig. 2 the AM carrier and its sidebands are drawn to the same scale as above for easy comparison. However, the receiver bandwidth for the AM signal is now 6 kc and both sidebands contribute to the audio output. While each sideband traces a circle, in the vector diagram, they rotate in opposite directions and at the same rate, so that the vector sum is not traced by the circle but moves up and down along the same line on which the carrier lies. When both sideband vectors are along the same line as the carrier and are pointing upward, their sum is equal to the carrier amplitude and the total amplitude, carrier plus sidebands, is equal to twice the carrier amplitude. When both lie on the carrier line pointing downward, their sum is again equal to the carrier amplitude but the direction is opposite, so the total amplitude is zero. Thus, the instantaneous amplitude varies between zero and twice the carrier amplitude and the audio output (D) is equal to these variations.

In the center, for SSB, the same sideband amplitude has been retained; that is, the amplitude is the same as that of one sideband of the AM signal. In fact, everything at (E) is identical with (B). The audio output has exactly half the amplitude of the output from the AM signal and so has only one-fourth the power of the detected AM signal. On the right side at (F), for DSB, the same amplitude sidebands appear as at (C), and here, with synchronous detection, the audio output amplitude is equal to the vector sum of both sidebands. This is possible because synchronous detection provides an automatic system which controls the frequency *and* the *phase* of the BFO and exactly replaces the missing carrier which is needed.

Assume 100 watts *output* for the upper sideband, and the same efficiencies and modulation as before. It will still require an AM transmitter of 533 watts input, an SSB transmitter of 166 watts input, and a DSB transmitter of 266 watts input. The audio output amplitude for both the AM case and the DSB is twice that of the SSB and thusly is four times the power. Equating the output of the detected audio amplitudes by adjusting the power inputs at the transmitters, the AM and DSB inputs must be divided by four. The power inputs for equal detected audio outputs are 133 watts input on AM, 166 watts on SSB, and 67 watts on DSB.

As a function of the method of reception, DSB has gone from second place to first place in the power input comparison. As before, if equal power inputs are assumed, 166 watts input on DSB would have a detected audio output 2.5 times (4 db) that of the detected output of a SSB signal having an input of 166 watts. An input of 133 watts on DSB would afford a gain of 2 times (3 db) over AM. An input of 166 watts on AM would afford a gain of 1.25 times (1 db) over SSB. It should be remembered that synchronous detection permits the ability to receive the 6 kc of the DSB signal and at the same time offers an effective 3 kc bandwidth as regards interference and noise. It should also be noted that the power comparisons were for steady *tone* modulation. The Voice of America engineers found that 9 db gain in signal to noise ratio can be obtained by proper voice processing and if a change from *tone* modulation to voice is made, the advantages of DSB are great indeed. Assume that the three systems are to be compared on a voice basis, that *optimum* conditions exist for each mode at both the receiver and the transmitter cases (B), (D) and (F), and that the instantaneous peak envelope input power for each mode does not exceed that of the previous comparison using tone modulation. It is possible for DSB using voice processing, under these conditions, to afford a gain of 10 db over SSB.

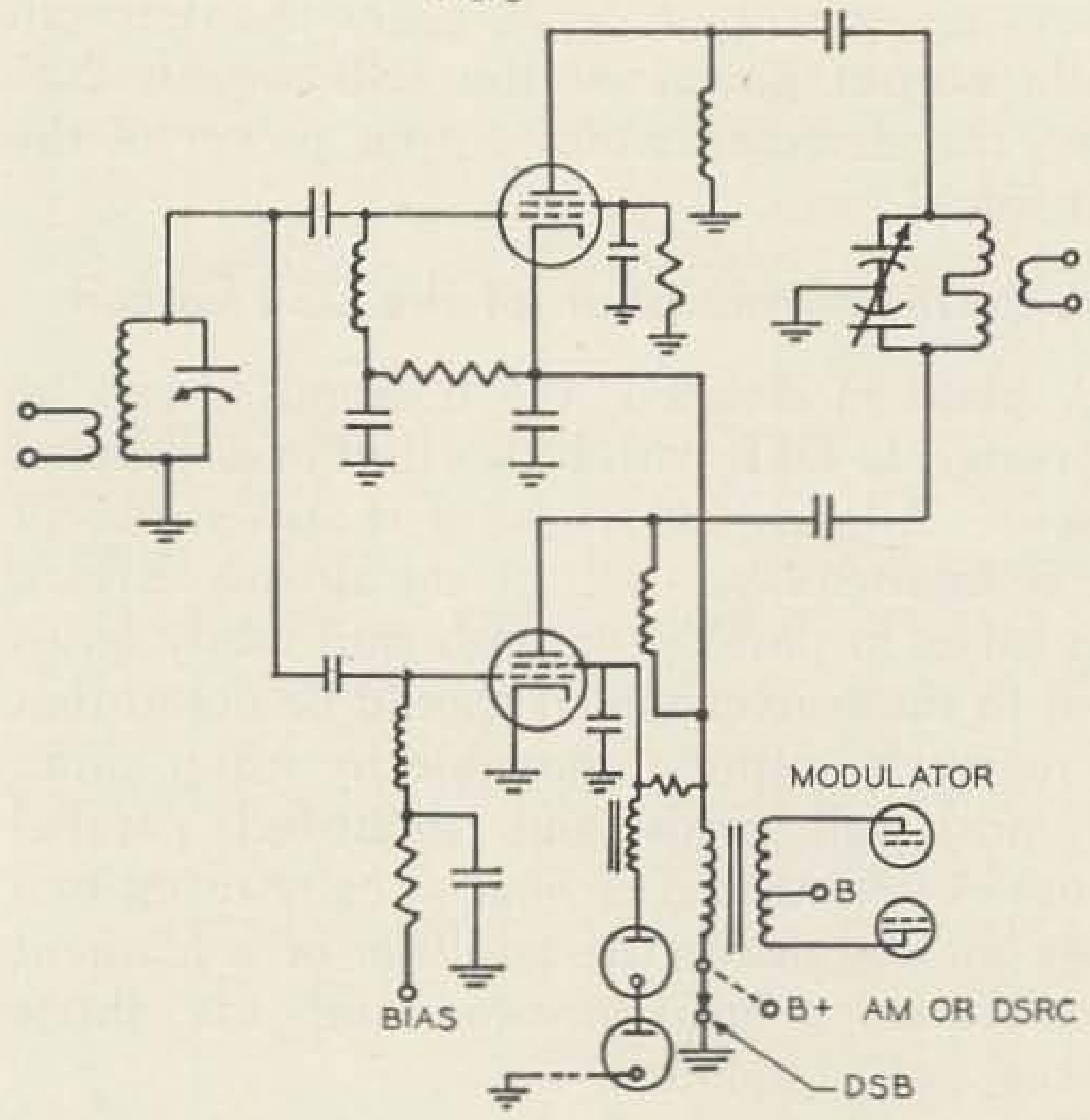
Now, setting aside the comparisons based on output power or peak power and assuming each transmitter to be operated at the amateur legal limit of average input power as measured according to the methods previously discussed, DSB gains an additional advantage over SSB. The total average output power in the sidebands of the AM signal was 600 watts; in the sidebands of the DSB was 1350 watts; and in the sideband of the SSB was 600 watts. Assume the use of synchronous detection for the AM and DSB signals and normal BFO injection for SSB. It can readily be seen that DSB enjoys an advantage of 4½ times the detected audio output power of the SSB signal; 2.25 times the detected audio output power of the AM signal.

A Further Description of the DSB Circuit

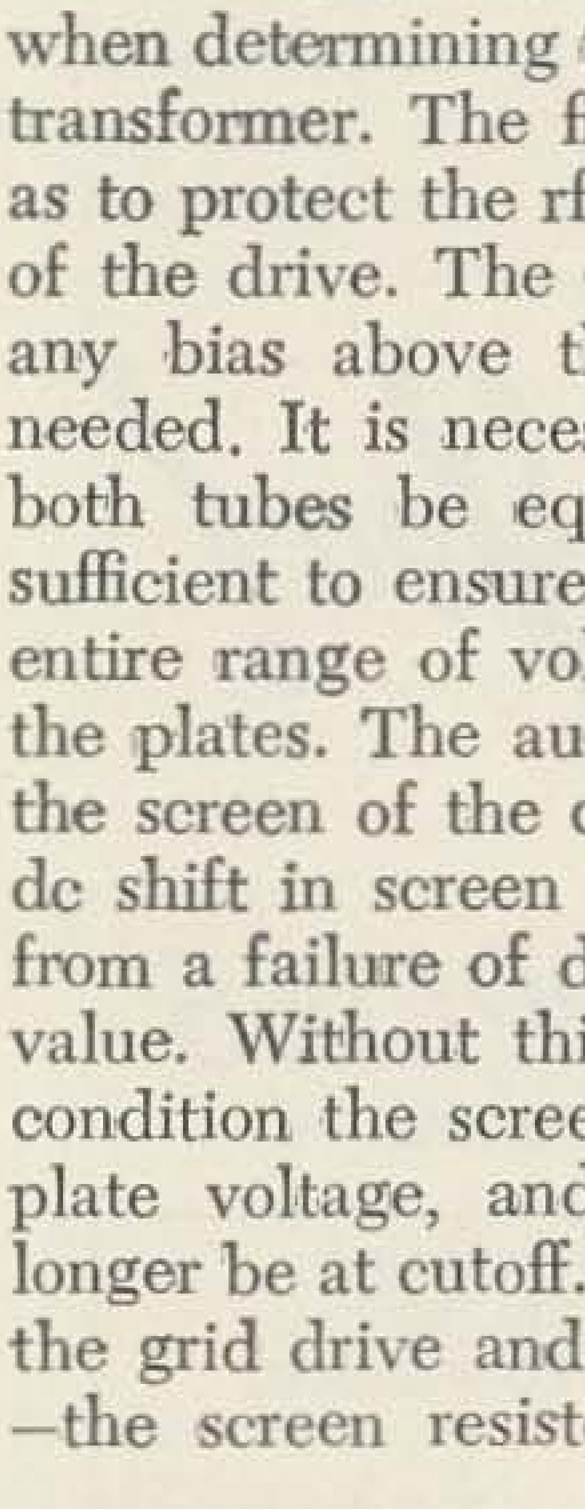
A plate modulated AM transmitter can be converted to DSB with little effort or additional expense. All existing stages of rf and af except the rf final can be used. A rig already having two tubes in parallel or push pull easily lends itself to the conversion. It should be noted that PI network output is possible by using shunt fed push-pull grids and shunt-fed parallel plates. A neutralized rf final already using two tubes merely needs the addition of a filament transformer, a grid resistor and the shunt chokes and capacitors.

The circuit shown in Fig. 1 is not confined to the use of triodes. Tetrodes, which require much less drive, can be used. No additional supply is needed. Each screen should have the proper screen resistor returned to the same source as its respective plate. This is shown in Fig. 3. When using either circuit, initial tune-up must be done in the AM position, that is, by applying a known dc voltage to the modulation transformer. Application of rf drive will

FIG. 3



cause the carrier tube to respond in a normal manner and the grid current should be maximized and the plate current dipped to resonance. If tetrodes are used, the plate and screen current will indicated on a common meter and this total current should be used when determining the match to the modulation transformer. The fixed bias supply is used so as to protect the rf final in the event of failure of the drive. The series grid resistor provides any bias above the minimum fixed voltage needed. It is necessary that the total bias on both tubes be equal and that the value is sufficient to ensure Class C operation over the entire range of voltage which may appear on the plates. The audio choke and VR tubes at the screen of the carrier tube ensure that any dc shift in screen voltage, which could result from a failure of drive, is restricted to a small value. Without this circuit, under a no drive condition the screen voltage would rise to the plate voltage, and the fixed bias would no longer be at cutoff. If it can be determined that the grid drive and grid bias (and for tetrodes —the screen resistor) are the same for both



A—100% Modulation

B—200% Modulation

C—300% Modulation

D—400% Modulation

tubes and that both tubes are treated identically, in an rf sense, then there is good assurance that the two tubes will respond equally. Of course, an oscilloscope can be used to ensure this. Application of a tone input while in the DSB position will provide the classic DSB envelope pattern. If there is a difference in adjacent peaks of the DSB envelope pattern, the series grid resistors can be changed, one at a time, until a classic pattern is obtained. Since the rf circuit is a balanced modulator, there should be *no* need for neutralization. With no modulation, any rf appearing in the plate circuit while the modulation transformer is returned to ground, will probably be due to poor engineering layout and should be corrected by changing the layout.

Conclusion

The circuit of Fig. 1 has been in use by the author for two years and has proved to be very effective. The transmitter is operated as a double sideband reduced carrier rig, running 600 watts dc input and 1200 watts peak audio input (See Fig. 4B). The carrier (600 W) permits detection of the signal with an AM receiver with some accompanying distortion. Although very few synchronous receivers are in use today, the DSB signal does well with ordinary SSB receiving techniques. The synchronous detector was built as an adapter to an existing receiver, being connected to the output of the last if amplifier. It seems that when double sideband is transmitted and received in an efficient manner it has a considerable advantage over the other modes. The simplicity of the circuit and the possible conversion of an existing rig should appeal to the home brew addict. The use of an SSB receiver to receive DSB, selecting the sideband most clear of QRM, should prove an intermediate step to synchronous detection.

In conclusion, it is intuitive that the concentration of all the sideband power in one sideband results in an advantage, however, it is equally intuitive that the more narrow a signal becomes the more susceptible to interference it becomes, or, the more difficult it is to tune out interference. Of course, only the receiving operator is able to choose which sideband about a given frequency is most clear of interference at any given instant and this choice is continuously available with double sideband.

. . . W3PHL

[1] **Over Modulation Without Splatter,** O. G. Villard, June 1947, QST; Jan. 1947, ELECTRONICS.
[2] **Synchronous Communications,** *(Costas, p. 1713, Dec. 1956, IRE)*

Some Double Sideband Reference Material

1. **Synchronous Detection of AM Signals**
   Proc. NEC pp 121-129, Oct. 1951
2. **Synchronous Communications**
   Proc. IRE, Dec. 1956
   "If equal average powers are assumed for SSB and synchronous AM it can easily be shown that identical S/N ratios will result at the receiver. The additional noise involved from the reception of two sidebands is exactly compensated for by the coherent addition of these sidebands. The 9 db advantage often quoted for SSB is based on a full AM carrier and a peak power comparison. If intelligent jamming rather than noise is considered there exists a clear advantage of two-to-one in average power in favor of synchronous AM."
3. **DSB vs. SSB Systems**
   Proc. IRE, April 1957, pp 534-538
   ". . . AM, if brought up to date by giving it the same advantages (carrier suppression, improved frequency stability, and improved receiving techniques) proposed for SSB, would be by far the more desirable system." "For a good many years now various groups have been attempting to convert the radio amateur to SSB and to date these groups have enjoyed some measure of success.. Recently a small number of amateurs have been told about DSB and have been using the modulation method. Some of these people have employed clipping and filtering in their equipment and their experiences to date seem to bear out the claim that there is a sizable power gain over SSB to be had. Thus, we may be facing an actual battle between DSB and SSB for survival under conditions that in many respects are not unlike the conditions to be found in a military combat area. Although any amateur operating experience must be interpreted very carefully when applied to areas outside this field, the results of the DSB-SSB battle on the amateur bands bears some watching. This situation will be altered, of course, by any amateur regulations which discriminate against DSB either on an input power basis or by giving SSB exclusive use of certain frequency assignments."
4. **The Use of Speech Clipping in SSB Communications Systems**
   Proc. IRE, Aug. 1957, p. 1148
   ". . . It would appear that the important advantages obtainable by the use of simple clipping systems may not be fully enjoyed by conventional reduced or suppressed carrier SSB systems."
5. **Selection of Modulation for Speech Communication**
   ELECTRONICS°, March 1958, p. 56
   An analysis of AM, DSB, SSB, and FM, showing DSB to be the best overall system of communication.
6. **AM Transmitters as SSB Jammers**
   Proc. IRE, Dec. 1958, p. 1960
   A properly placed 125 watt output AM signal with speech clipping effecively jams a 1 kw output SSB.
7. **Poisson, Shannon and the Radio Amateur**
   Proc. IRE, Dec. 1959, p. 2058
   "Congested band operation as found in the amateur service presents an interesting problem in analysis which can only be solved by statistical methods. Consideration is given to the relative merits of two currently popular modulation techniques, SSB and DSB. It is found that in spite of the bandwidth economy of SSB this system can claim no overall advantage with respect to DSB for this service. It is further shown that there are definite advantages to the use of very broadband techniques in the amateur service."
8. **Poisson, Shannon and the Radio Amateur**
   Proc. IRE, Aug. 1960, p. 1495
   DSB vs. SSB in the presence of jamming.
9. **Traffic Efficiencies in Congested Band Radio Systems**
   Proc. IRE, Nov. 1960, p. 1910
   DSB vs. SSB
10. **Suppressed-Carrier AM**
    QST, March 1957, p. 19
11. **The AM Equivalent of SSB**
    QST, Jan. 1954, p. 19
12. **DSB vs. SSB**
    QST, May 1957, p. 42
13. **High-Level Balanced Modulator for DSB**
    QST, April 1960, p. 22
14. **Single Sideband Communication**
    Proc. IRE, March 1961, p. 632
    "SSB's principle "advantage" is its spectrum conservation . . . examining Shannon's equation for channel capacity
    $c \quad w \log_2 ((11 + P/N)$ .....
    it can be readily seen that the required receiver signal-to-noise ratio goes up exponentially as the channel bandwidth is reduced."
15. **Double Sideband**
    CQ, Jan. 1957, p. 26

Stutterless Vox

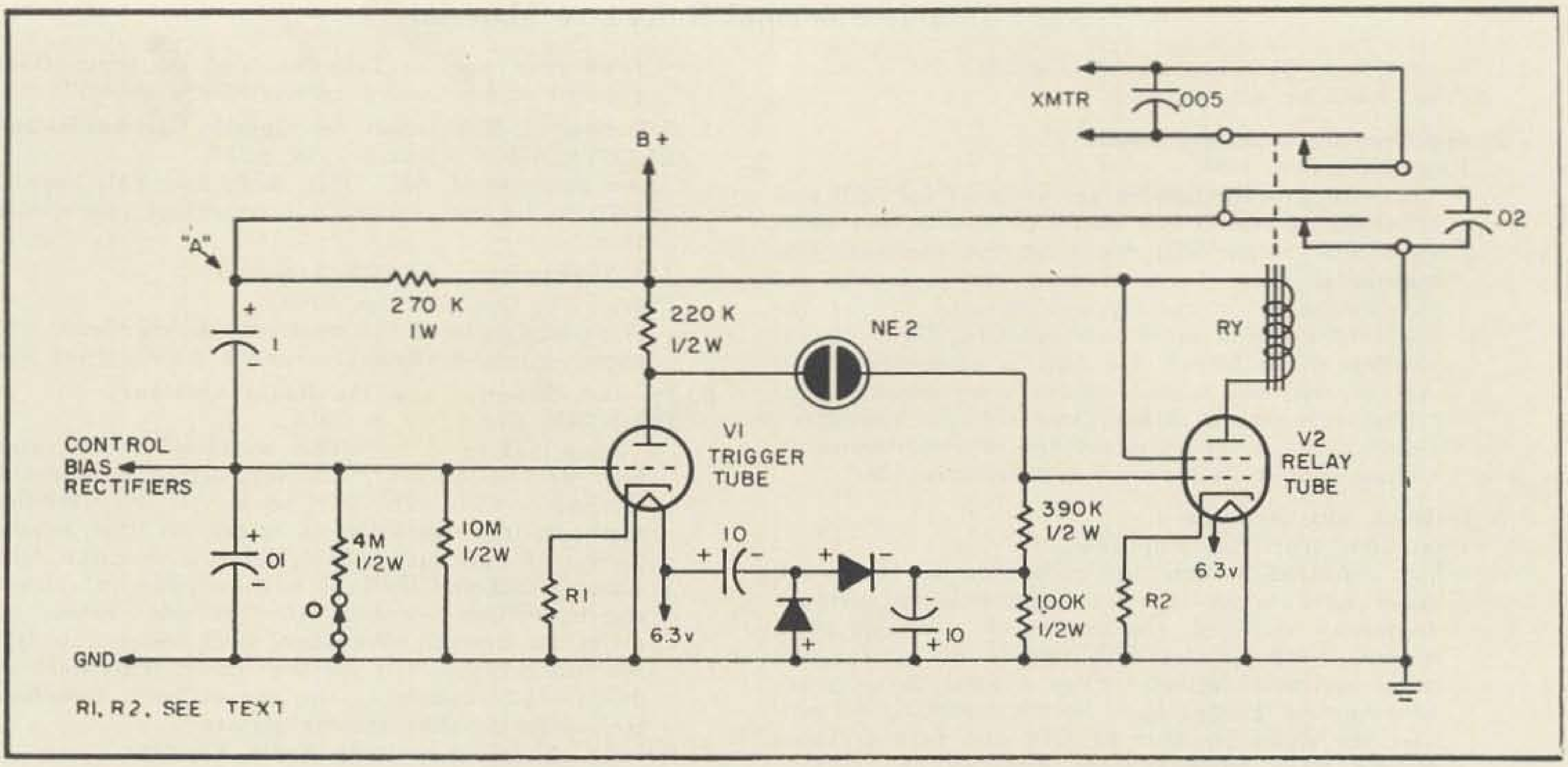
Harvey Pierce WØOPA

IN an ordinary VOX circuit, there is sometimes the problem of relay stutter at marginal levels of voice input. There is also the problem of quick pull-in and proper delay. If the bias rectifier capacity is small enough to charge fast, it is too small to give adequate delay.

In the circuit shown VI is the trigger tube (almost any triode will do) with its cathode resistor R1 adjusted so it draws enough current to keep the NE2 bulb from firing. As soon as some negative voltage from the control rectifiers appears on its grid, the NE2 fires, applying a positive voltage on the grid of the relay tube, cancelling its cutoff bias from the bias supply (a voltage doubler from the heater circuit).

As V2 conducts, the relay closes, with one set of contacts turning on the transmitter, while the other set grounds point "A." This puts the .1 mfd capacitor in parallel with the .01 capacitor in the grid circuit of the trigger tube. And, as the .1 capacitor has been charged from the plate supply in the polarity shown, the trigger tube acquires a substantial charge that keeps the transmitter from immediately going off the air or chattering, and the added capacity increases the delay time for talking.

As the operator stops talking, and the NE2 goes out, bias is restored to V2. The relay opens, and the .1 capacitor charges. During this charge time the trigger tube grid is held positive, holding the transmitter off the air for



a short time, again preventing stutter.

The cathode resistor of V2, R2, is selected to limit the current thru the tube to that recommended for the relay. V2 is shown as a beam tetrode, but a pentode or triode can be used instead, depending on the current required for the relay used. Other resistors are of typical values. Switching in a 4 meg resistor in parallel with the 10 meg gives a choice of long or short delay, but a 10-meg variable resistance could be used instead. Plate supply voltage should be over 150 volts.

The .1 mfd capacitor must be of high quality, with over 1,000 megohms leakage resistance. The capacity may be increased or decreased, if desired, to increase or decrease the hold time.

For those who have been bothered in the past by having their home-made VOX re-cycle or motorboat, this is a cure. The real cause is switching transients, however, and a cure can be had without building this circuit by carefully "de-sparking" each and every contact in the transmitter-receiver control circuits. Personally, I prefer this circuit. . . . WØOPA

Ballast Replacement for the NC-300

Robert Hall K6GVB
Post Office Box 24
Talmage, California

SHORTLY after purchasing my National NC-300 receiver, the 4H4C ballast burned out. At that time I ordered a replacement and a spare. Since then, the spare has been used and replaced. The receiver has been very satisfactory except for these frequent ballast replacements.

Other NC-300 owners have voiced the same complaint, so it seemed logical to look for a solution. One ham replaced the ballast with a 6V6-GT. He sacrificed stability for reliability, as this ballast is used to stabilize the first oscillator heater current.

The following solution should be quite reliable and offers improved heater voltage regulation. A transistorized voltage regulator was built which plugs into the 4H4C socket. The only modification to the receiver consists of soldering ground leads to pins 1 and 8 of the 4H4C socket.

The first oscillator heater circuit is shown in Fig. 1.

The circuit in Fig. 2, replaces the 4H4C ballast.

This regulator-rectifier supplies 6.2 VDC with less than $\mp$.1 volt variation over an AC input range of 105 to 130 volts. Resistor R_2 is necessary if the output voltage is high. In my case, the output was 6.4 volts. A .47 ohm resistor was added to bring the output down to 6.2 volts. The value of this resistor is determined by Ohm's Law. (6.4-6.2) divided by .45 (heater current) equals .44 ohms. I used the nearest available value.

My unit was built on a 2¼" x 4⅜" aluminum plate. This plate was soldered to the metal base of a discarded 2E26 tube. The aluminum to brass soldering job is easy if SAL-MET flux is available. If not, the plate can be bolted to the socket. The plate should be oriented as shown in the drawings (Fig. 3). The 2N257 transistor was mounted in a Motorola MK-15 mica insulated socket. The 2N270 was mounted by its leads. None of the wiring is critical and the transistor types were chosen because they were available. Almost any diamond shaped power transistor will replace the 2N257. The 2N270 can be replaced by a PNP, audio type, transistor having a collector dissipation of 150 mw or better.

. . . K6GVB

—Parts List—

Q1 Sylvania 2N270 transistor, or equiv.
Q2 Sylvania 2N257 transistor, or equiv.
CR1 Motorola ¼M6.8Z10 zener diode, or equiv.
CR2 Diodes Inc. DI-56 silicon rectifier, or any .75 amp, 50 piv Diode.
C1 Sprague TVA-1162, 500 mfd. @ 15 v.
TRANSISTOR SOCKET Motorola MK-15.

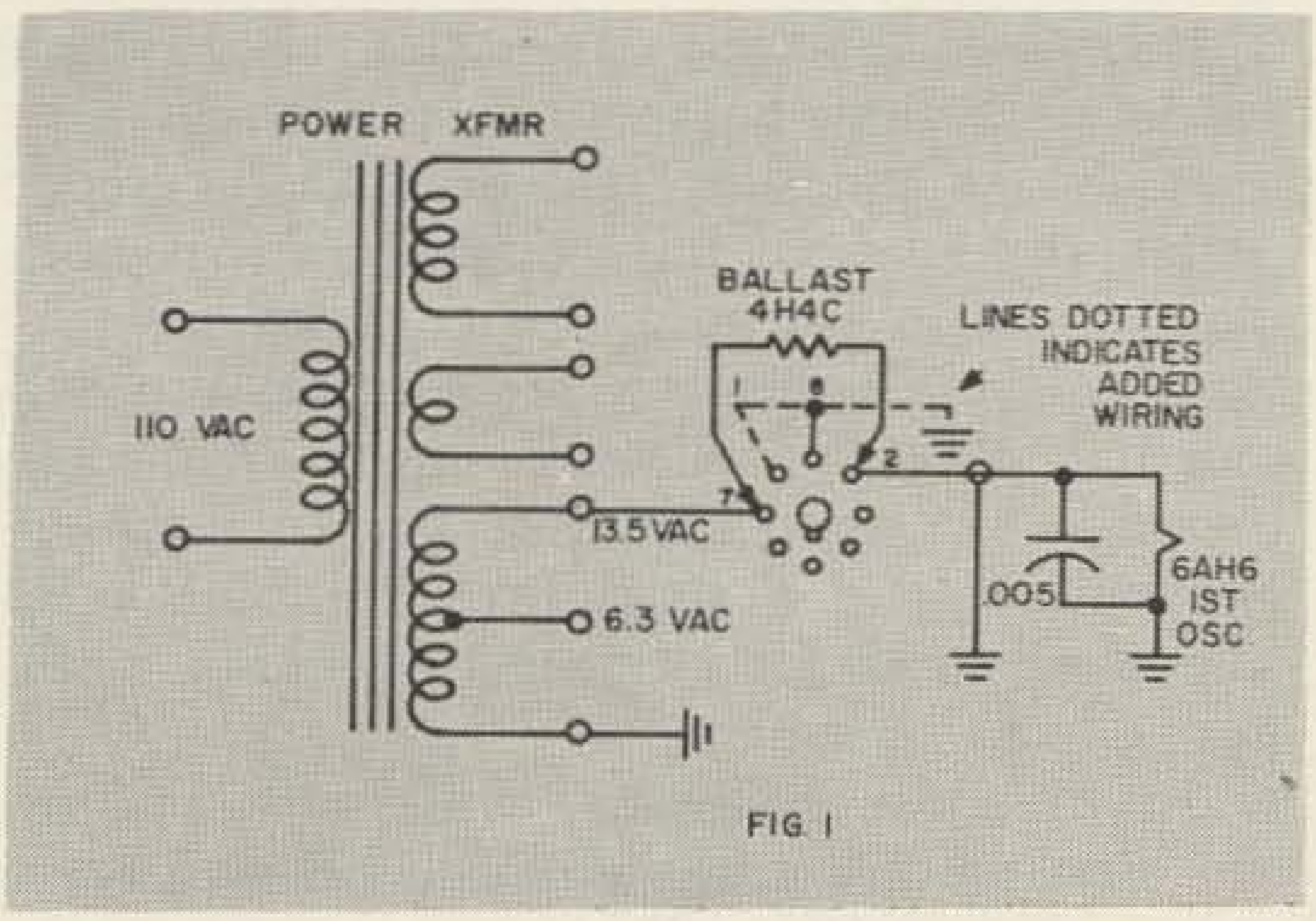


FIG. I

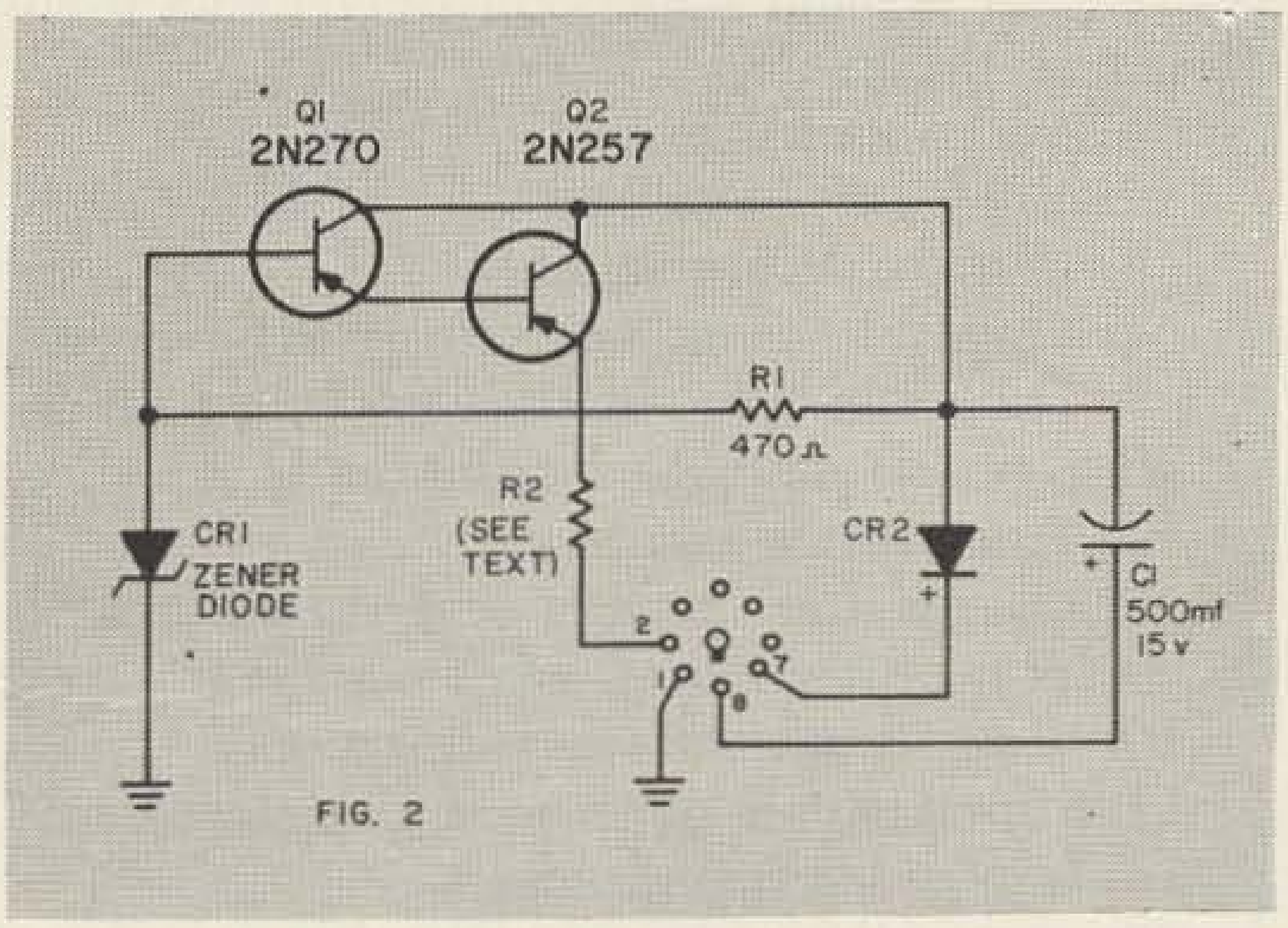


FIG. 2

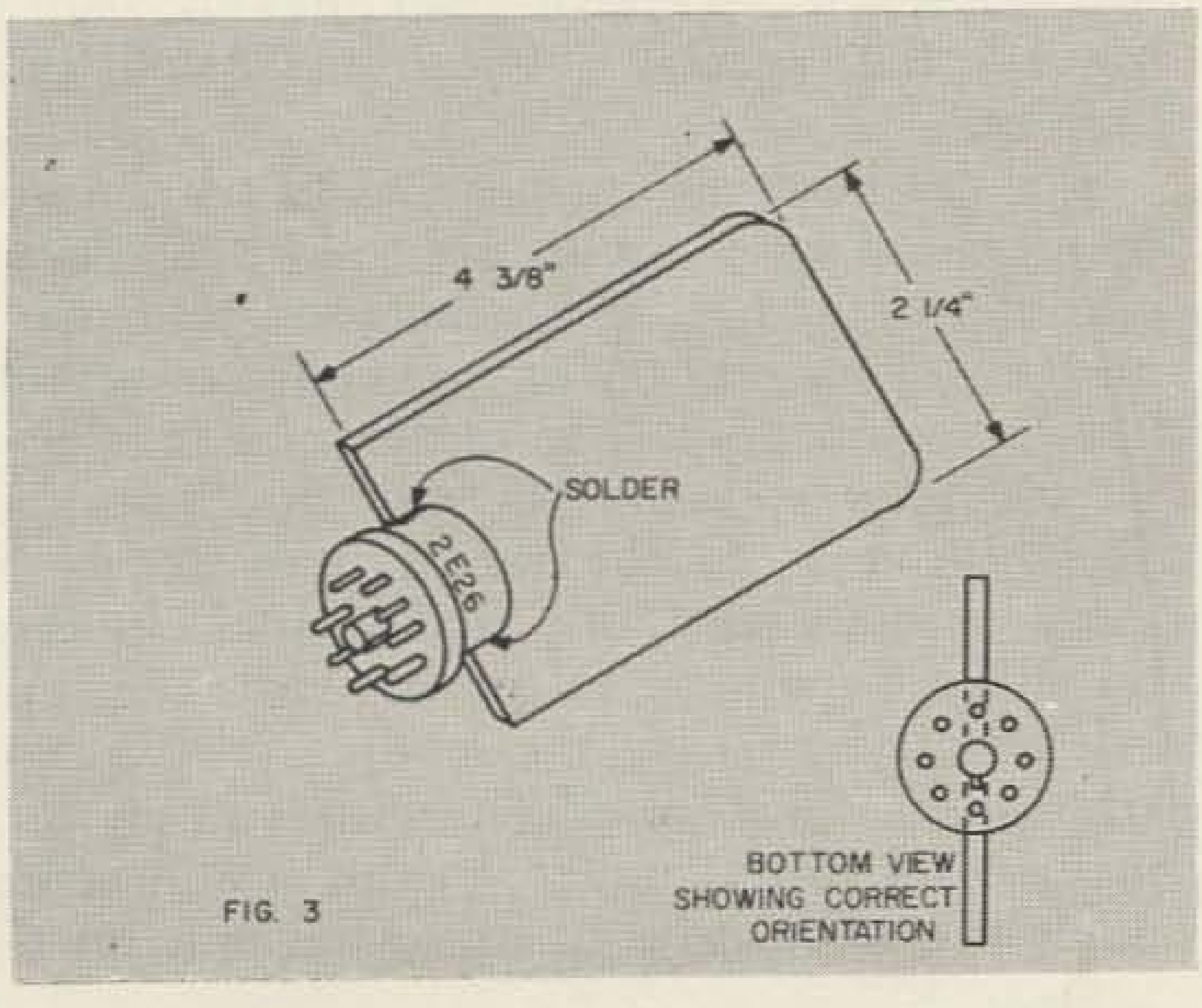
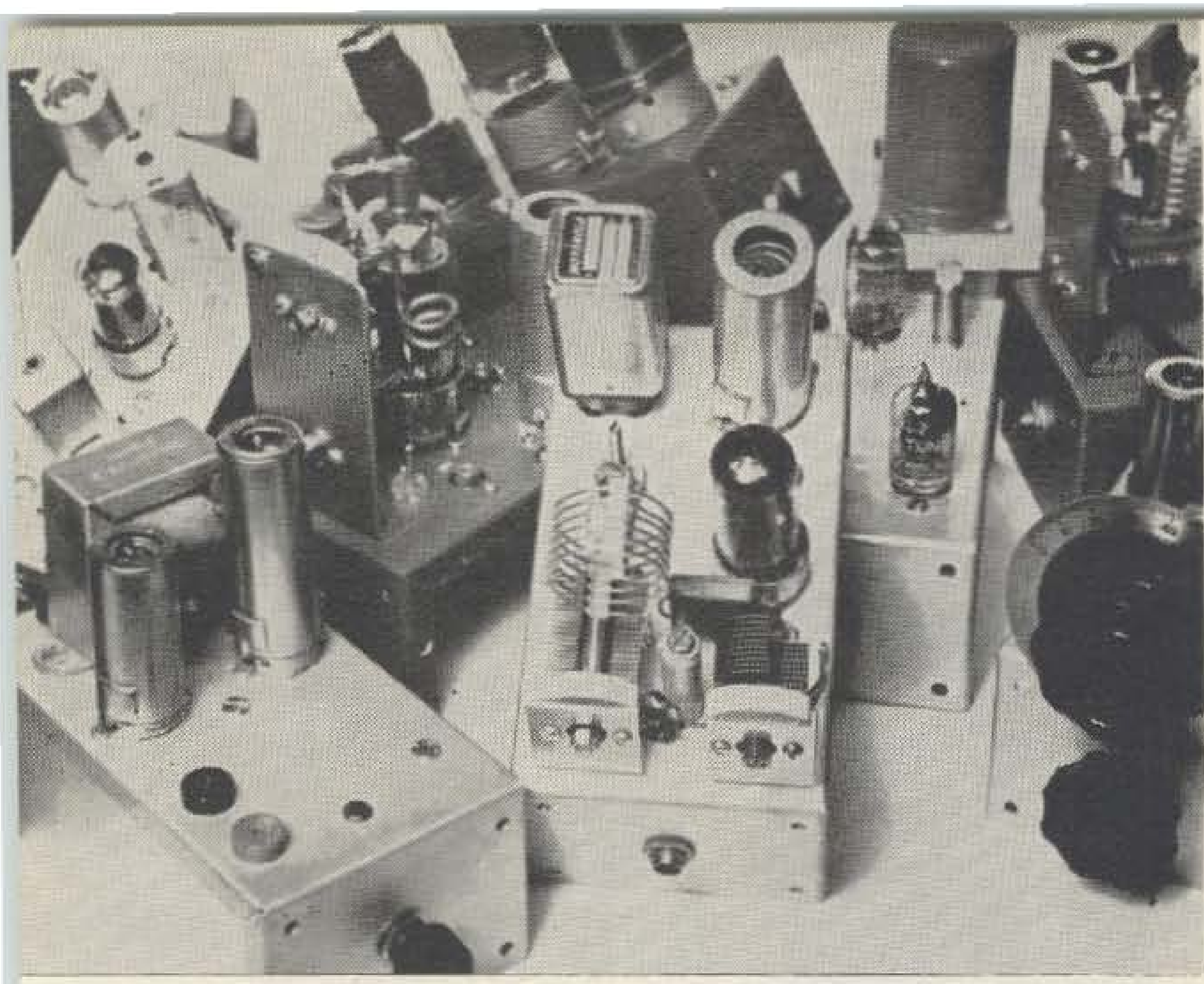


FIG. 3



Modules

Howard Burgess W5WGF
1801 Dorothy Street, NE
Albuquerque, New Mexico

THE OLD SAYING "If it works it is obsolete" pretty well sums up why hams who like to try new circuits and build new gear just keep right on trying and building. This sort of philosophy is good for the progress of the art, but it usually results in a chassis that looks as though it had taken a charge of buckshot at twenty paces.

After several modifications to modifications, what started as a super het may end up as a transmitter. Or, it may never end up. Not only is the chassis lost but most important is the time lost in duplication between projects.

There may be several answers to the problem but one is as simple as a set of A B C building blocks. It is the use of modules. Perhaps the first attempt at a module system *was* a set of A B C blocks. In the A B C system the same units can be used over and over again to build many words. A similar system used for communications and electronics circuits can work equally well to build many combinations.

Nearly all circuits break down into natural blocks. We all use the block diagram every day. If each of the individual blocks is constructed as a separate physical unit, its use is multiplied many times. Nearly all of the blocks can be used over and over again in many circuits. Commercial builders are using the system to save time and money; amateurs can do the same. In addition the ham builder will get more enjoyment from the hobby.

If an item such as a receiver is constructed in modules, each block of the diagram can be completed one at a time. Each can be tested and made operational before proceeding to the next. It is not necessary to wire completely a large chassis before any circuit can be tested. The same applies to transmitters. If somewhere along the line a buffer turned out to be a duffer, just pull out that section and try again.

In ham fashion, each builder may want to develop his own system, but in any case several basic rules should be followed. To be successful, all units should be the same general size and shape. They should require as little sheet metal work as possible. The basic chassis that is chosen should be inexpensive and one that is available at almost any parts house. After many false starts, the 2¼ x 3 x 5¼ inch aluminum box was found to be a good answer. Almost any basic circuit can be put on one of these when used as a chassis, and this chassis also meets the other requirements.

As each new home project is tried, a new module (or modules) is assembled as needed. After the project has "cooled" down and it has served its purpose, the modules are added to the shelf collection for further use when needed. As the collection grows it becomes possible to assemble almost any circuit merely by pulling the desired building blocks from the shelf and inter-connecting them with a few pieces of wire.

In time the collection will grow and even the first module built will still be giving good service. A typical collection may include such items as these:

1. Audio amplifiers.
2. 455 kc *if* amplifiers
3. 10.7 mc *if* amplifiers
4. Tuneable front ends for VHF receivers
5. Tuneable front ends for HF receivers
6. Crystal controlled front ends
7. Transmitter exciters
8. Transmitter buffers and amplifiers
9. Transmitter finals up to over 100 watts
10. Regenerative second detectors
11. Superregenerative second detectors
12. Low power modulators

The list will also have items that are slanted toward the special interest fields of each builder.

For the ham who would like to try the system, several sample units are shown. The modules shown in Fig. 1 can be used to make a low power transmitter or exciter for either the 6 or 2 meter band. The center unit is a crystal oscillator and one stage of multiplication. The output is in the range from 28 to 54 megacycles. Almost any fundamental cut crystal above 6 megacycles can be used. This unit can be used to drive the module on the right which is a 2E26 amplifier with output on 6 meters. Or, for 2 meter operation the center module can be used to drive the unit on the

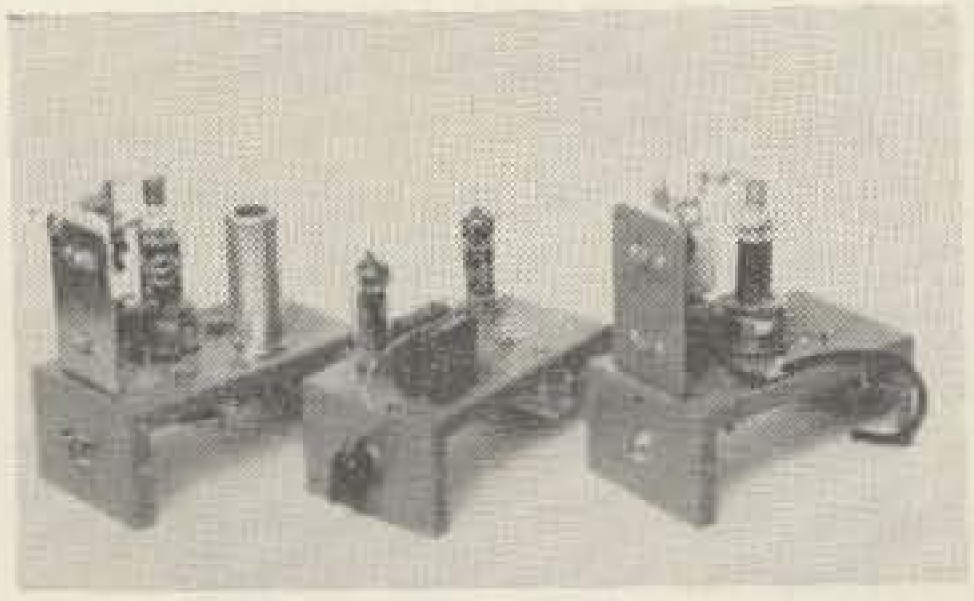
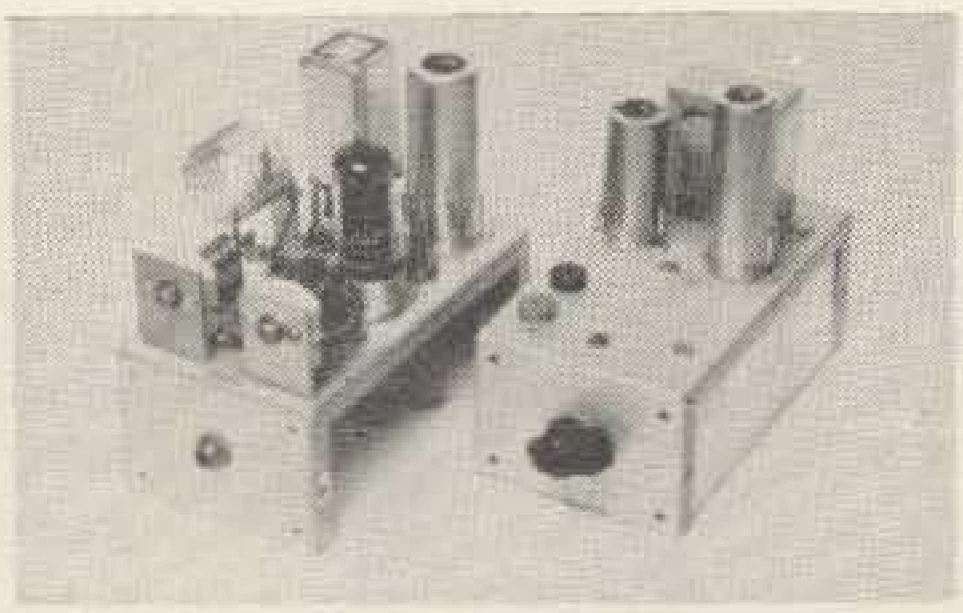
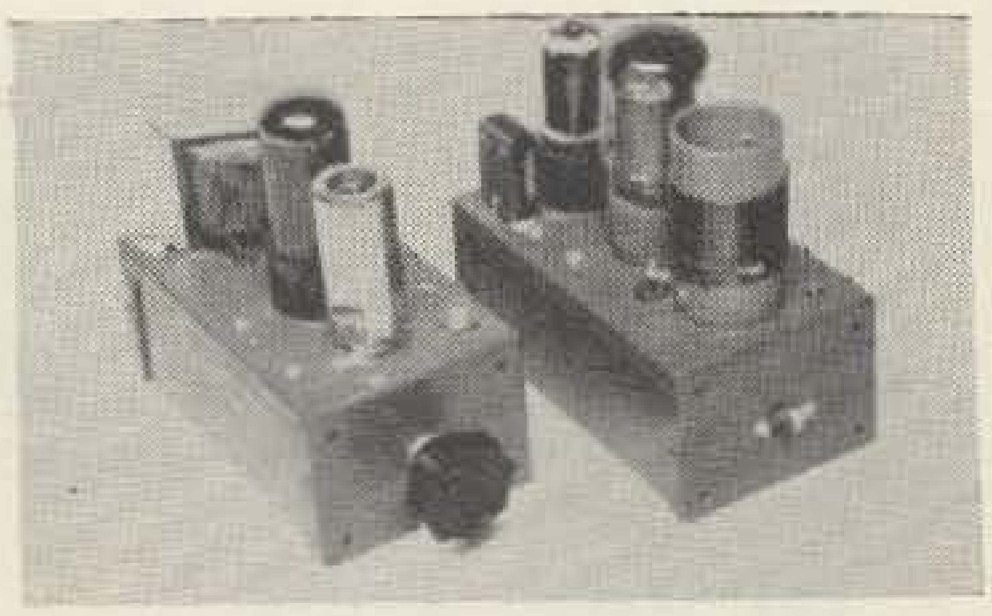




Fig. 1. Three modules can make either a 6 or 2 meter transmitter. The center chassis is an oscillator and multiplier. Two meter final is on the left and the six meter final on the right. Fig. 8 shows an underside view.

Fig. 2. A complete 10 meter phone transmitter, or a driver for a higher powered final.

Fig. 3. A low frequency phone or CW transmitter. A single channel transmitter that will handle up to about 30 watts on CW. It will also serve as the driver for a larger final.

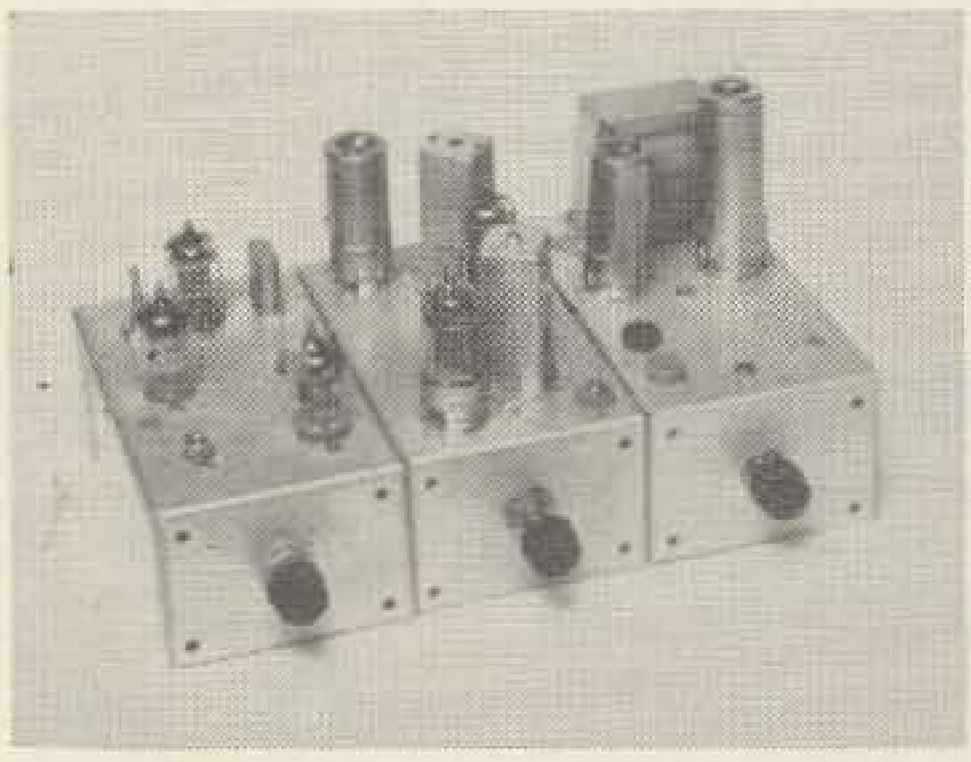
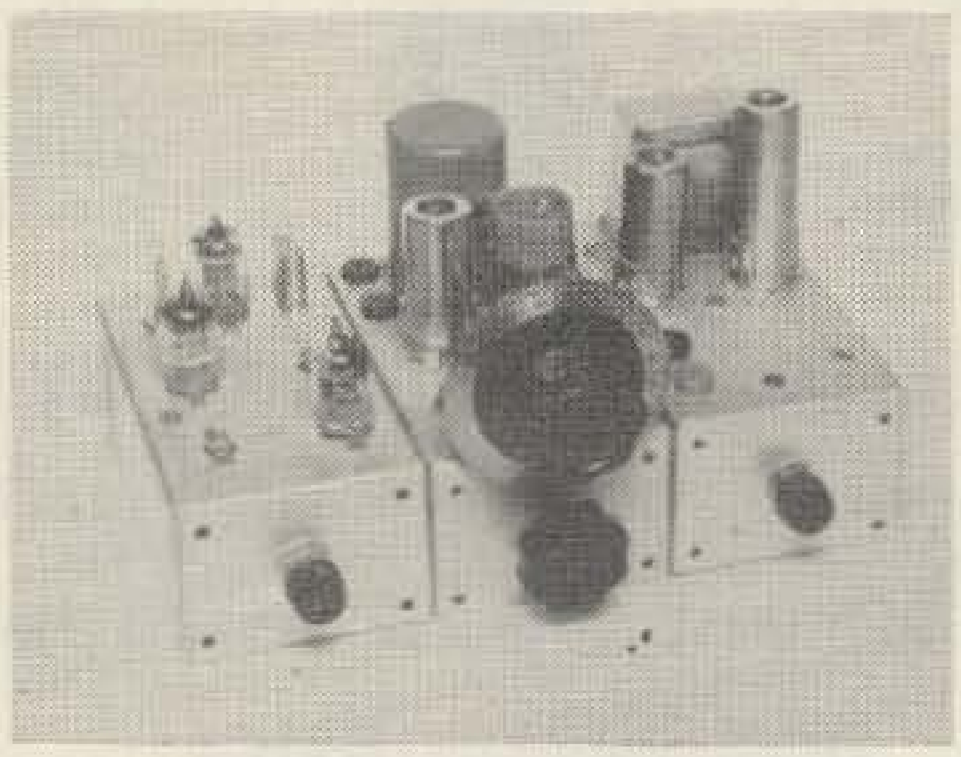
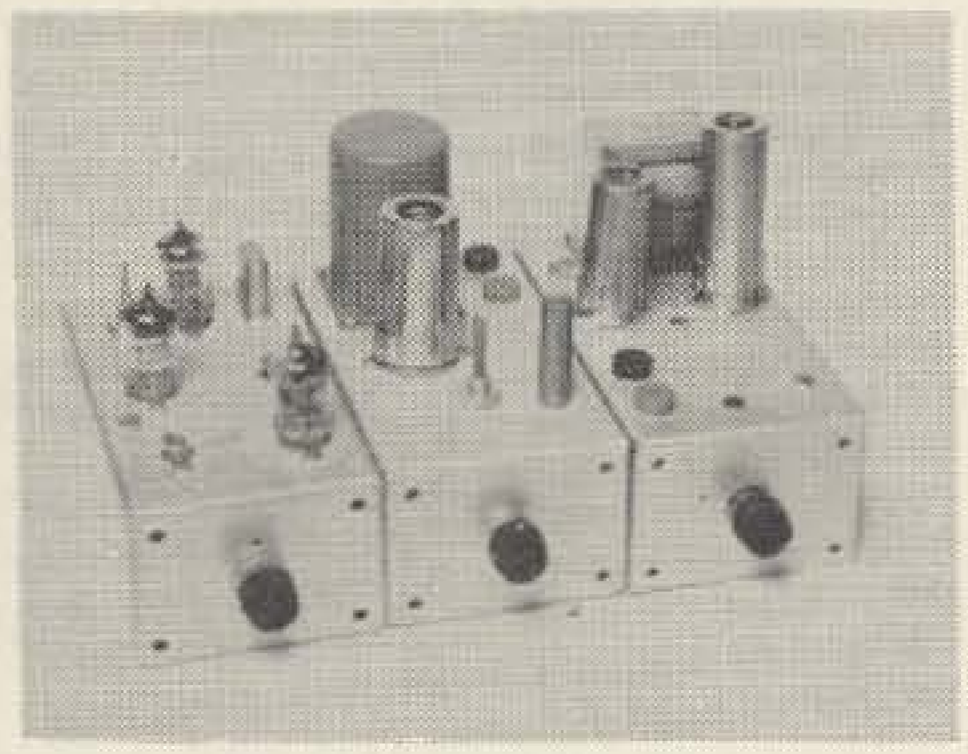




Fig. 4. Three modules will form a crystal controlled receiver. The audio module is the modulator used in the 10 meter rig shown in Fig. 2.

Fig. 5. A variation of the receiver of Fig. 4 using a tuneable regenerative *if* system.

Fig. 6. For those who like to try super-regen circuits, the same receiver now uses a super-regen *if* module.

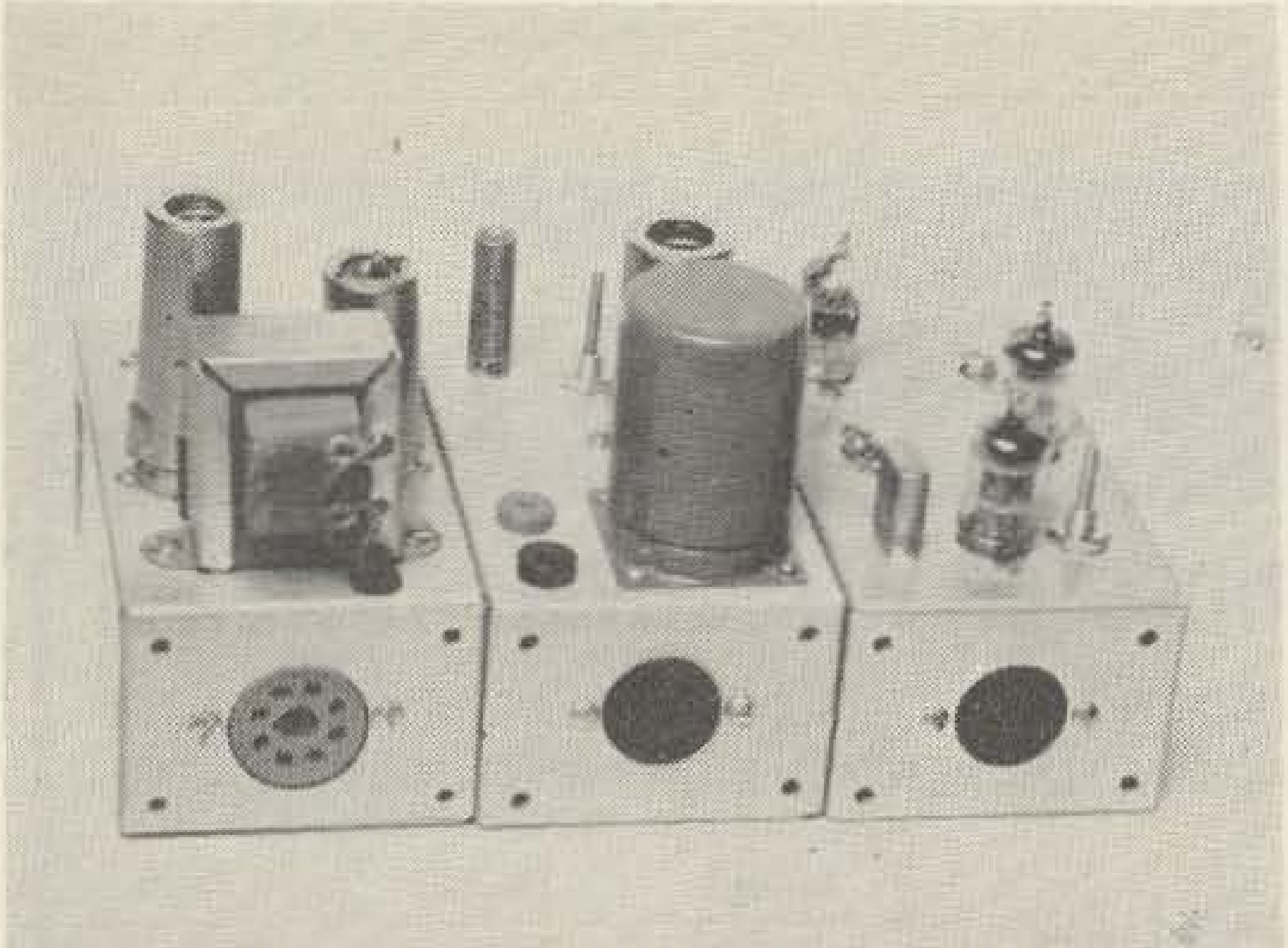
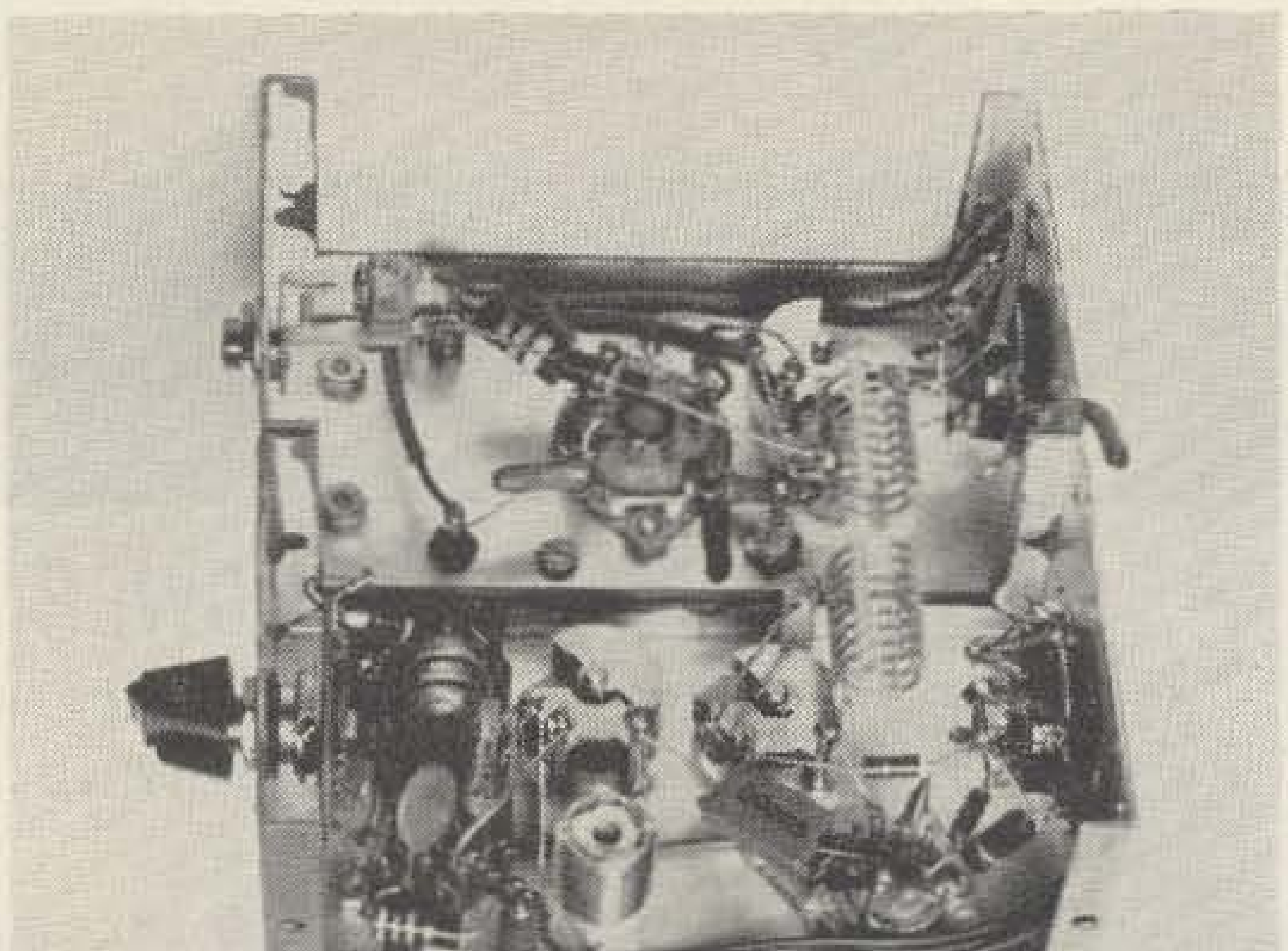



Fig. 7. In many of the modules the power is brought in at the rear of the chassis. An octal socket is used for power and interchassis connections.

Fig. 8. This view shows the underside of two modules. These are two of the units shown in Fig. 1. Inductive coupling between units eliminates the need for interconnecting rf links and the like.

left which is another stage of multiplication driving a 2E26 final amplifier on 2 meters.

The unit shown in Fig. 2 can be used as a low power transmitter on ten meters, or it can be used as a driver for a more powerful final amplifier. This model even has room for a temperature-controlled crystal oven. Shown with this module is a low power modulator. This audio module is wired to accept either microphone input or input from a receiver detector. In this way it can be plugged in as either a low power modulator or the audio section of a receiver.

The pieces shown in Fig. 3 make up a low frequency phone or CW transmitter. This one is suitable for the beginner or as a standby unit. It can also be used as the basis for a mobile installation.

Thus far we have shown only transmitter combinations. For those who build receivers the system works even better. Fig. 4 illustrates how the modules fit in for this use. From left to right is a crystal controlled front end, next is the *if* system and to the right is the audio output. The audio unit is the same one used as a modulator in Fig. 3.

In the combination shown in Fig. 5, the fixed tuned *if* system has been replaced with a tuneable, regenerative *if* unit. The advantages of a superregenerative *if* system can be investigated with the combination shown in Fig. 6, or a VHF front end is fed into a 10.7 mc *if* amplifier.

A few details on the mechanics of the system may be of help. The illustrations all show four holes in each end of each chassis (near the corners). These holes are used to mount the units to a rack panel if one is used or to a small panel if the units are kept single or in twos or threes. They also help to make the units interchangeable. If one "beneath the chassis" control is to be used it is placed in the center front of the modules. If two controls are needed they are spaced evenly in the front. To assure that all chassis are drilled symmetrically, a template was made from a piece of sheet metal. The pattern of holes is drilled in both ends before any layout work is done. The hole in the center of the rear of the chassis can be used for power or signal connections as desired. Of course for some units additional holes will be required for connectors in the rear.

In addition to panel mounting, the small chassis can be bolted together through the small flange along the sides to form a larger chassis base. This method of attaching the units together forms a very rigid type of construction.

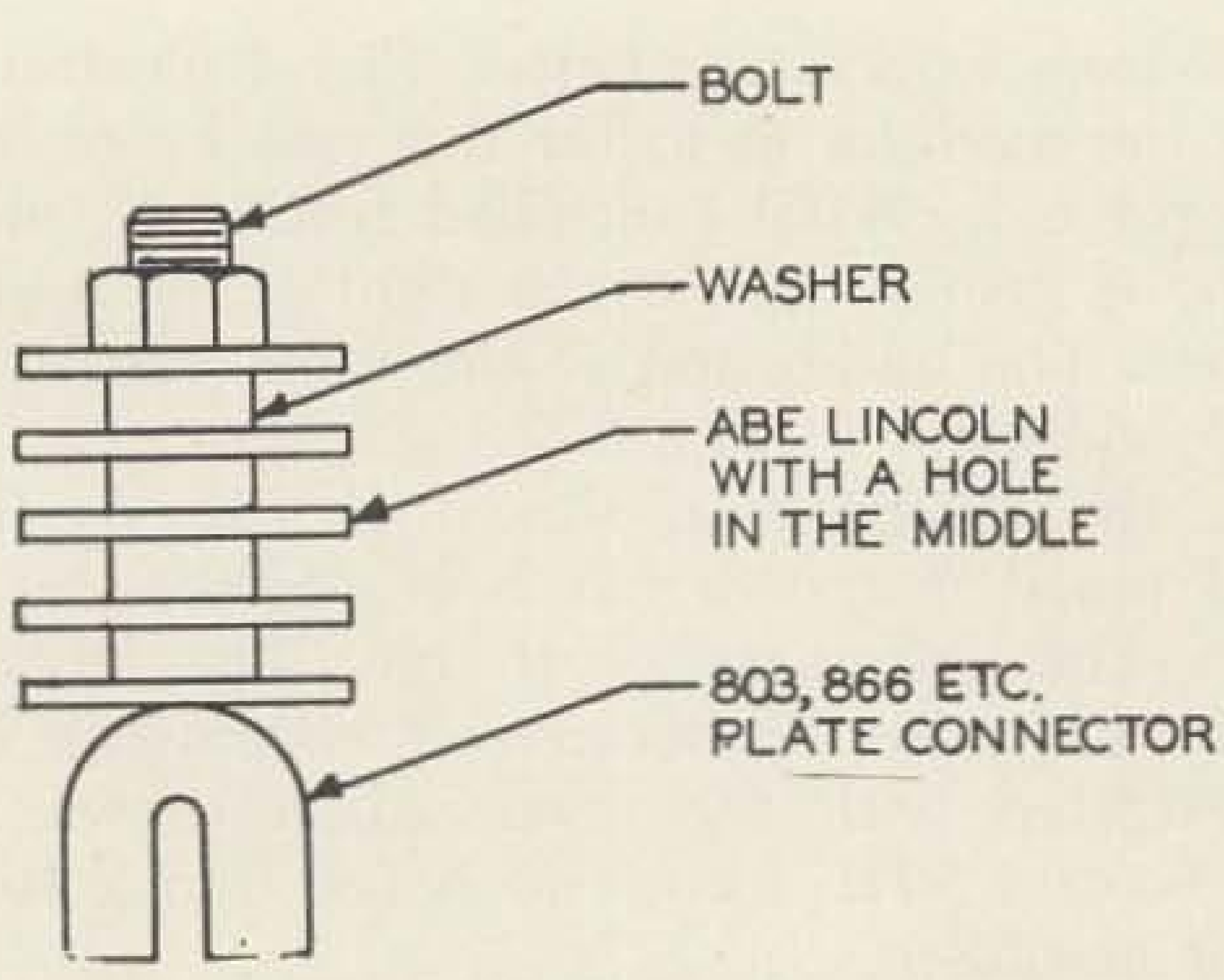
In circuits where it is likely that the units may be changed quite often, the power connections are brought out to a plug in the rear. Octal sockets have been used as the power connector. These are just about as universal and inexpensive as any connector tried. The base removed from an old metal tube makes a very good mating plug and conserves room at the end of the chassis because of its shallow construction. However many circuits will not be changed often and can use a small terminal board as tie points for power and input and output connections.

If you have imagination, like to build things the easy way, and in the process save time and money, we think that you will find the module system a useful approach at least for your experimental building. Whether you work phone, CW, or just listen, you can still MODULE-ATE. . . . W5WGF

K6BIJ
Box 143
Weimar, Cal.

The RK 715-B

a neglected tube



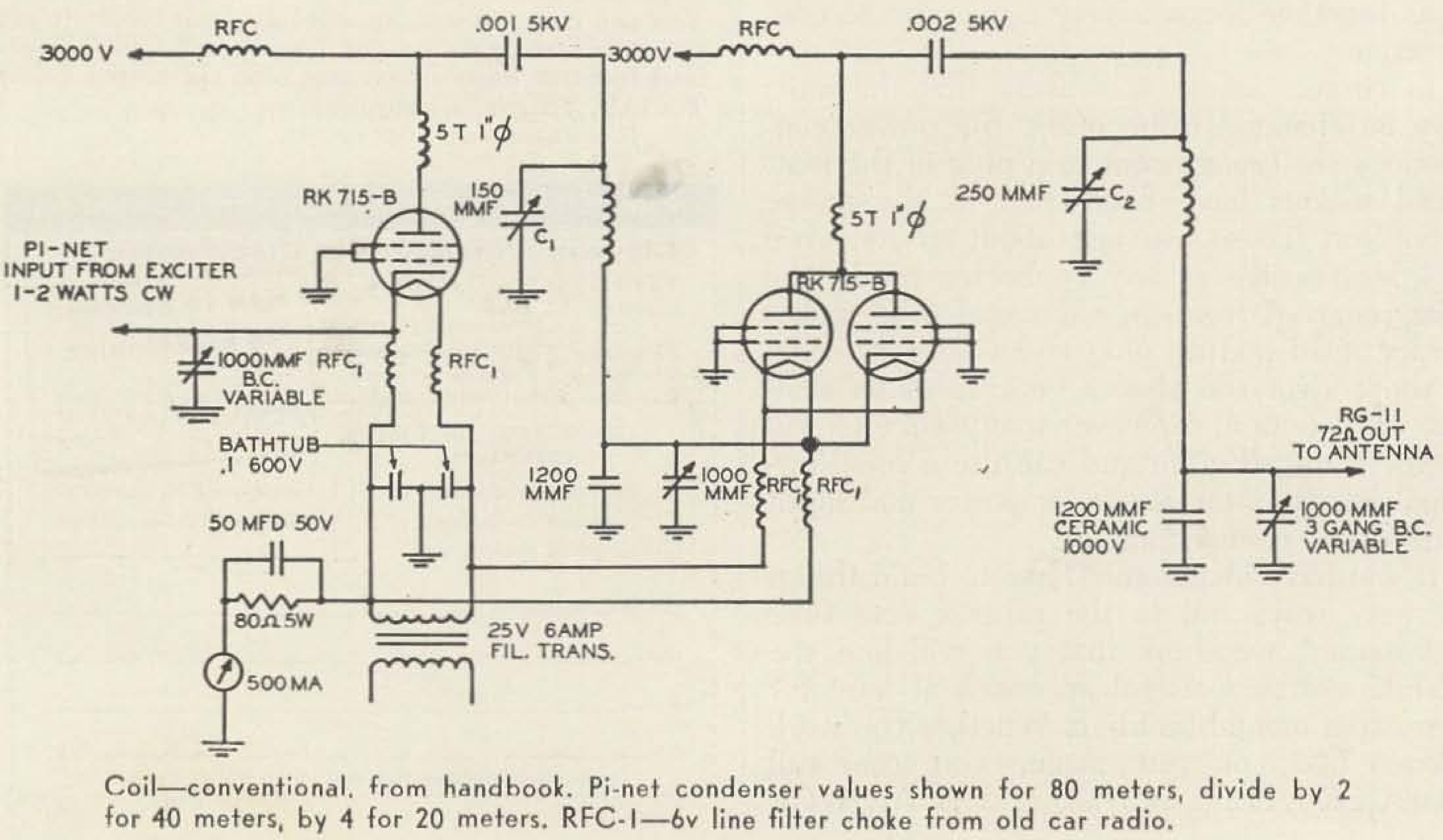
Heat dissipating connector for 715-B.

IT LOOKS LIKE 813, same size and shape, but has an indirectly heated cathode and four pins at the bottom going through a ceramic disc acting as a base. It is a tetrode, and an old Handbook (1949) says that its plate dissipation is 50 watts, filament voltage is 26-28 volts and you are supposed to run it with 1500 volts on plate at 125 ma and use 300 volts on screen. Sockets are readily available, and before surplus dealers see this article, the 715-B sells for about 50 cents.

The Handbook information looked fishy to me, so the following experimental data was obtained:

1. Three RK 715-B tubes in grounded grid (and screen grid) circuit can give you a legal limit on SSB or CW with 3000 volts on the plate and driven by Central Electronics 10-A exciter (its output tank changed to pi-network).
2. With sufficient convection–no cooling is necessary. Tubes will operate with dull red plates (when an Abe Lincoln heat dissipating plate connector is used).
3. Tubes operate normally on 25 volts (two 12v transformers in series). Raising the voltage to 28 volts did not improve matters. Filament current at 25 volts is under 2 amperes, which makes it easy to make filament rf chokes.
4. With grounded grids and pi-network used throughout (and all normal precautions like using a common grounding point), the rig is very stable on 80-40-20. It was not tried on 10-15 meters.
5. The amplifier is essentially a two stage affair, but if you do not hang any 6x4's or other unnecessary gadgets on it, the first tube will provide a considerable feed-through power to the antenna, making it actually a three tube final.

. . . K6BIJ



Coil—conventional, from handbook. Pi-net condenser values shown for 80 meters, divide by 2 for 40 meters, by 4 for 20 meters. RFC-1—6v line filter choke from old car radio.

Report from the 73 Mobile

Jim Morissett WA6EXU

CONSIDERING THE NUMBER of mountain-tops and wide open spaces available here in the wild, wooly west, I decided to make use of the top of the 73-mobile for a roving antenna farm.

First a 6-element beam was tried from such peaks as Idylwild, Mt. Soledad in La Jolla, and various peaks around Los Angeles. With good results. The Heath Pawnee was used at all times.

But the real fun began when I discovered it was actually possible to mount a Master Mobile Twin-6 on top of the VW without exceeding the width of the rear vision mirrors, or a height of about 12 feet. That's when we started getting those "stoned" looks from passers-by. The same thing happened when the Space Raider P. D. Beam (16 elements) was tried, and when I later put both of them on at the same time—well, we developed something like prestige. Even the State police steered clear of us. I think they thought the white VW was from the AEC, or FBI.

(Turn page)

A total of 4000 miles was spent on west coast highways, startling the citizenry and racking up fabulous signal reports from various hilltops, using the gasoline-driven rotator shown in the photo. This climaxed with a trip to the Portland ARRL Convention, where we caused quite a stir, and the Seattle World's Fair, which was the only place we sort of fitted in with the scenery without causing undue comment.

Usually, in California, the reports on the Twin-6 were 5 to 10 db. above the P. D. Beam. This seemed about right, since all stations worked were using vertical polarization, the Twin-6 vertical, and only 8 of the 16 elements of the P. D. being vertical.

However, around Portland, those other 8 elements came in right handy, since I couldn't raise anyone at all on my two verticals (Twin-6 and Maynard "Kluge") but worked out just fine with the P. D.—Oregon & Washington being almost exclusively horizontal on 2.

The real corker came when I worked the San Diego net from about 60 miles out, about 200' above sea level. The Twin-6 was getting reports of about 1 and as high as 2 S-units over the P. D. Suddenly one station called and gave me a report of 35 over 9 on the P. D., and only 9 plus 20 on the Twin-6! Why? Instead of the usual vertical, this chap had a Spiral-Ray—nominally mounted in the vertical plane, but with elements skewed toward the horizontal on both ends. This did the trick, picking up on the diversity polarization effect from the P. D. Later another Spiral-Ray gave us a similar report. Since the P. D. is very new on 2 meters, no other stations were worked using P. D., but I expect this would have been more startling than the P. D.-to-Spiral-Ray effects. No "corkscrew" beams (helical) were found, either, but results should be similar.

We concluded from these tests that you sure do have to watch out for those trees, boy.

. . . WA6EXU

Book Reviews

KIAPA

HOW TO BUILD ELECTRONIC EQUIPMENT, a recent RIDER (#286) publication, is aimed at the ham who gains satisfaction from "rolling his own" gear. It begins with a chapter on tools and follows proper construction procedure of a typical project from chassis preparation to completion. The suggestions included in this book help avoid many of the pitfalls found in building your own equipment. Hardbound, 290 pages, $6.95.

HOWARD SAMS, HANDBOOK OF ELECTRONIC TABLES & FORMULAS would be a valuable reference book in any hamshack. Its 192 pages contain information that is usually found scattered throughout many texts. Some of the material included is not found in the more common electronic handbooks. Even a chart of the radio spectrum with FCC allocations is included. Hardbound, Catalog no. HTF-2, $3.95.

BASIC TRANSISTORS, by A. Schure, is another in the series of "picture-text" courses by RIDER. Starting with a description of the atomic structure of semiconductor material, it presents the theory of transistors and their fundamental circuits in an easy to understand sequence. Soft-cover, 146 pages, $3.95.

DESIGN AND OPERATION OF REGULATED POWER SUPPLIES is another well-written book by Irving M. Gottlieb. Typical open and closed-loop regulator circuits are examined. This text covers the use of both tubes and solid-state devices in regulated power supplies. HOWARD SAMS (RPS-1), soft-cover, 111 pages, $2.95.

Did you ever look at that piece of test equipment on your bench and wonder just what makes it tick? Are you trying to decide what test instruments would be the most valuable to you? **IT'S EASY TO USE ELECTRONIC TEST EQUIPMENT,** a new RIDER (#308) text by Larry Klein and Ken Gilmore will help solve this problem. This book not only answers these questions, but it shows some of the ways the equipment can be used. Soft-cover, 186 pages, $4.00.

A recent HOWARD SAMS publication, **GENERAL CLASS AMATEUR LICENSE HANDBOOK,** is primarily a book for the Novice who is "sweating" the theory for his General, Technician or Conditional ticket. Its object is to give the newcomer to ham radio enough knowledge to pass the requirements for a higher grade license, without becoming too involved in mathematics or complicated discussions of radio theory. Soft-cover, 128 pages, $2.50.

GERNSBACK LIBRARY has printed a revised and enlarged edition of John T. Frye's **BASIC RADIO COURSE.** The popular first edition has been brought up to date by including material on transistors and other new devices. It presents a clear and concise picture of radio theory and is a good stepping-stone for anyone wanting a firm background in electronics. Soft-cover, 224 pages, $4.10.

HOWARD SAMS has just printed the fifth edition of their **TUBE SUBSTITUTION HANDBOOK.** This edition contains substitution information on American receiving tubes, including subminiature, industrial and picture tubes. A foreign to American and an American to foreign substitution section is also contained in this very handy text. Soft-cover, 127 pages, $1.50.

A B C's OF ELECTRONICS by Farl J. Waters, a HOWARD SAMS publication, takes a rather different approach to explaining the subject of electronic theory. The fundamentals are taught by analogies. Each new concept is related to something which is familiar to everyone. Soft-cover, 96 pages, $1.95.

QUESTIONAIRE

The below questions are arranged so you can cut out this part of the magazine. If you prefer your magazine uncut then just give your answers and the question numbers on a postcard or separate letter. Your expression of your interests will help us in the selection of articles for 73.

1) It is likely that I will be trying out six meter sideband during the next year. yes—— no——

2) It is likely that I will be going sideband mobile during the next year. yes—— no——

3) It is likely that I will be going to Europe with the Institute of Amateur Radio Ham Flight next fall. yes—— no——

4) I would like to see more emphasis on VHF in 73. yes—— no——

5) It is likely that I will be buying a tower this coming year. yes—— no——

6) I have purchased some surplus equipment during the last year. yes—— no——

Call —————— (not required)

Send this questionnaire or facsimile to
73, Peterborough, N. H.

Announcing a THREE BAND SSB TRANSCEIVER from SWAN

SWAN SW-240 THREE BAND SSB TRANSCEIVER FOR 20-40-75 METERS $320

Now on display at your nearest Swan dealer!

(SW-240 SPECIFICATIONS)

Frequency Range: 3780-4020 Kc, 7050-7320 Kc, 14,130-14,370 Kc.

Power Rating: 240 Watts PEP Input on SSB, 200 Watts Input on CW, 60 Watts Carrier Input on AM. 6DQ5 P.A. Tube.

Emission: Lower Sideband on 75 and 40 Meters, Upper Sideband on 20 Meters. (Opposite Sideband Available as Accessory Kit.)

Swan Bandpass Filter: High Freq. Crystal Lattice, 3 Kc bandwidth at 6 Db Down.

Output Impedance: Pi Coupler, Approx. Range: 20-200 Ohms.

Suppression: −40 Db Unwanted Sideband, −50 Db Carrier.

Frequency Stability: Fully Compensated for Wide Variation in Temperature, Supply Voltage, and Mechanical Shock or Vibration.

Tuning System: Precision Capacitor and Friction Drive Assembly, 25:1 Ratio.

AGC: Adjustable, with Controlled Delay and Release Time, Provides an Extremely Smooth, Wide Range, automatic gain control System.

Separate audio & R.F. gain controls

Receiver Sensitivity: Less than 1 UV for 10 Db S/N Ratio.

Total of 15 Tubes, including 6DQ5 P.A., 12BY7A Driver, 12BE6 Trans. Mixer, 12AU6 VFO, 6BA6 Rec. R.F., 12BE6 Rec. Mixer, 6BZ6 1st I.F., 6BA6 2nd I.F., 7360 Bal. Mod., 12AX7 Prod. Det.-1st Rec. A.F., 6V6GTA Output A.F., 6U8A Carrier Osc., 12AU7 Mic. Gain, 6AL5 AGC Rect., OD3 Volt. Reg.

Meter: 0-400 MA., Illuminated.

Mechanical: All Aluminum Construction. 5½ In. High, 13 In. Wide, 11 In. Deep. Weight: 11¾ Lbs.

Shipping Weight: 13½ Lbs., including Mobile Mounting Bracket and Hardware. Each Set is Shipped in a Specially Designed Polystyrene Container.

Power Requirements: 800 Volts D.C. at 300 MA., 275 Volts D.C. at 110 MA. −100 Volts DC at 5 MA., 12.6 Volts AC or DC at 3.5 Amps.

MATCHING POWER SUPPLIES!

Model SW-12DC (transistorized) **$115**

Model SW-117AC, with matching cabinet and speaker **$95**

SWAN ENGINEERING CO.
Oceanside, California

The DX-40 with an SB-10

William Hall K1RPB
250 Mountain Road
North Wilbraham, Mass.

"Gee whiz, you must be kidding, Bill. I've never heard that combination used before. Whatever you did there, you've certainly got a clean, walloping signal here. Give me some of the lowdown. I've got a buddy next door with a DX-40; he'd like to get on sideband but says he can't afford it, hi!" This represents some of the enthusiastic, gratifying comments that have been received in contacts made on 75 thru 10 meters during the past year. To those wanting over-the-air circuit details, the basic conversation data supplied by the Heath Company is usually recommended. Unfortunately, this information does not include means of optimizing the compatability of these units into an integrated transmitting package. The interest expressed by many amateurs and the superb performance that is being displayed by the DX-40/SB-10 combination has prompted the author to write the following article.

Analysis of the project indicates that five basic steps are necessary to provide the operation suitable to most stations.

1) Construction of a good outboard power supply for the SB-10.

2) Placing the 6146 into class AB_1 amplifier service.

3) Installation of a switching arrangement to allow either sideband or normal CW/carrier control phone operation with the DX-40.

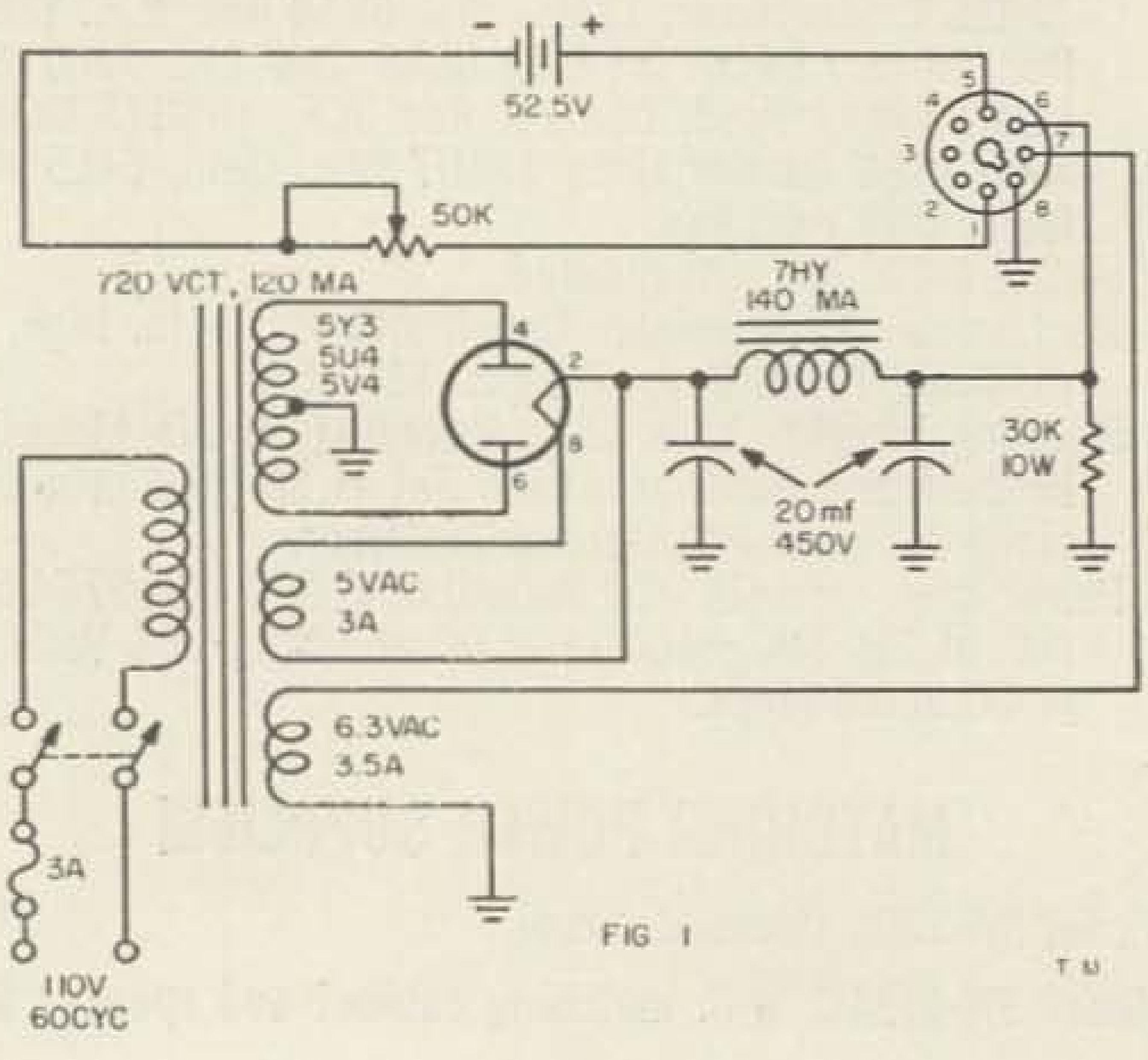


FIG 1

4) Routing excitation from the 6CL6 buffer in the DX-40 to the SB-10 and from the SB-10 to the 6146 grid in the DX-40.

5) Stabilizing the VF-1 VFO.

Power Supply

The circuit illustrated in Fig. 1 provides the necessary power requirements for the SB-10. It is relatively straightforward and will not be discussed in detail in order to save space. In addition, a -52 volt dc grid bias supply is required for the 6146 when it operates as class AB_1 amplifier. This is best obtained by connecting a 30 volt and a 22½ volt hearing aid battery in series and strapping these to the power supply chassis. A 50K potentiometer is series connected with the bias supply to allow a controlled amount of grid current to be drawn during tuneup. Since the grid does not draw current during actual operation, no power is consumed from the batteries and they will last approximately their rated shelf life.

Conversion of the DX-40

Two changes are made in the DX-40 circuitry. First, the RF excitation to the grid of the 6146 is broken at the output side of the buffer coils. This signal is routed through the switching arrangement to the SB-10 input. Signals from the SB-10 are then fed directly to the grid of the 6146 amplifier. Secondly, the 6146 is placed in class AB_1 operation for sideband service only. This is simply accomplished by the fixed -52½ volt bias battery pack and a regulated 210 volt potential on the amplifier screens. Again, these changes are routed through the same switching system. Now, the lowdown.

1) Mount two RCA type phono jacks on the rear chassis apron. If these are installed close together a small shield between the jacks is recommended to prevent undesirable coupling.

2) Install two OB2 voltage regulator tubes horizontally on the left side of the 6146 shield bracket located under the main chassis.

3) Install a three position, 2 wafer, 6 pole

rotary switch on the front panel between the bandswitch and pilot lamp. Do not tighten mounting nut. It may be necessary to move some of the power supply components in that area to make room for the switch and to prevent accidental contact after installation is complete.

4) Mount a 25K 10 watt wirewound resistor on a terminal strip fastened to the top of the chassis. This can be located in any convenient spot where heat dissipation will be good.

5) Remove the 110 volt antenna relay wire from pin 5 on the accessory socket and solder to pin 7 of same. Connect a wire from pin 6 on the AM-CW/SSB switch (deck 2) to pin 5 on the accessory socket. Similarly connect a wire from pin 9 (deck 2) of the switch to pin 7 of the accessory socket. This wiring change will allow the DX-40 to control the antenna relay for CW and AM and allow the DX-40 and SB-10 to control the same relay during SSB operation.

6) Remove the 27K 1 watt gril leak resistor between the rear deck of the bandswitch and the 20 ohm precision meter resistor. Remove the wire between pin 5 of the 6146 and the rear deck of the bandswitch. Install a 1.1 mh rf choke between pin 5 of the 6146 and the ungrounded side of the 20 ohm precision resistor. Loosen the front panel of the DX-40 and replace the ground wire at pin 6 of the grid/plate meter switch with a .001 mfd ceramic bypass capacitor. Now run a wire between pin 6 of this switch to pin 10, deck 2 of the AM-CW/SSB switch. Secure the front panel to the main chassis. Disconnect the grounded end of the 20 ohm precision resistor and connect it to pin 10 on the AM-CW/SSB switch (deck 2). Connect the 27K 1 watt grid leak resistor to pin 1 of the switch (deck 2) and the other end to the nearest ground point. Now run a wire to pin 12 deck 2 of the switch to pin 3 on the accessory socket. It is a good idea to bypass both ends of this wire to ground with .001 mfd ceramic capacitor. This completes the wiring of the grid bias circuits in the DX-40.

7) Connect a wire from pin 7 of the existing function switch to the 25 K 10 watt resistor previously mounted on the chassis. From the remaining end of this resistor, run a wire to pin 8, deck 1 of the AM-CW/SSB switch. Remove the wire between pin 3 of the function switch and pin 3 of the 6146. Install a wire between pin 3 of the function switch and pin 9, deck 1 of the AM-CW/SSB switch. Bypass pin 3 of the function switch to ground with a .001 mfd ceramic capacitor. Ground pin 7 of one of the OB2 voltage regulator tubes. Connect pin 1 of this tube to pin 7 of the second OB2. Bypass pin 1 of the second OB2 to ground with a .001 mfd capacitor and run a wire from pin 1 of this tube directly to pin 3 of the 6146. Connect a wire from pin 1 of the second OB2, around the front of the shield compartment to pin 6, deck 1 of the AM-CW/SSB switch. This completes the wiring of the screen voltage supply.

8) Disconnect the wire between the rear deck of the bandswitch and pin 5 of the 6146. Also remove the 47 mmfd capacitor between pin 5 and ground. Run a piece of RG58/U from the rear deck of the bandswitch to pin 2, deck 1 of the AM-CW/SSB switch. Similarly connect a piece of coax from pin 5 of the 6146 to pin 2 deck 2 of the switch. Ground the coax shield braid at both ends of both pieces. Connect a bare wire between pin 5 deck 1 and pin 5 deck 2 of the AM-CW/SSB switch. Connect a 62 mmfd silver mica capacitor between this wire and ground. Now connect a piece of RG58/U between pin 4 deck 1 of the switch to one of the phono jacks mounted at the rear chassis apron, grounding the braid at both ends. Mark this jack "out." Similarly run a piece of RG58/U between pin 4, deck 2 of the switch to the other jack and mark it "in." This completes the rerouting of the rf signal for the SB-

10 exciter. The use of a jumper cable to return the DX-40 to its normal AM/CW service is not required.

9) The following comes purely as a bonus. The author had made provisions several years ago to neutralize the 6146 final. Since this system robs drive and may have other deleterious effects in AB_1 operation, neutralization is switched in only during AM-CW operation. The neutralization "capacitor" is installed as follows. A feed-through insulator is mounted behind and to the right of the 6146, approximately one-inch distant. A stiff, 1½ to 2 inch wire is attached to the insulator above the chassis next to the tube. The wire is bent 90 degrees approximately ½ inch from its insulator end so that its main length is vertical to the chassis and so that it may be rotated about the insulator nut to vary its distance from the tube. On the underside of the chassis, connect a length of RG62/U (low capacitance coax) between the 20 mmfd drive control capacitor (hot side) to pin 1, deck 1 of the AM-CW/SSB switch. Similarly connect a piece of RG62/U between pin 10 of this switch and the under-the-chassis terminal of the neutralization probe feed-through insulator. It is only necessary to ground the switch ends of the coax braid. This essentially completes the conversion wiring of the DX-40 transmitter.

Adjustments

The length and type of coax (RG58/U) combined with the 62 mmfd capacitor at pin 3 on the AM-CW/SSB is found to give the best all around results after a great deal of experimentation. The addition of the cabling materially changes the resonance point of the buffer tank circuits, however. These must of necessity be retuned. After checking to make sure all the wiring is correct, plug in the DX-40, place the new switch in the AM-CW position, the function switch to tune and the bandswitch at ten meters. Pick a mid-range frequency on the band and adjust the drive control at half mesh. There may be very little grid current indicated on the meter. *With the power off* begin to remove one to two turns from the ten meter buffer coil at a time. A marked increase in grid current will be observed when the power is turned on. Continue to remove turns until grid current is maximized. Repeat this procedure for the 15, 20, 40 and 80 meter buffer coils. More turns may be removed at a time at the lower frequency bands. When this is completed, return the bandswitch to the 10 meter position and check the grid drive through the entire range of the band. If it is found to be less than the required 2 ma, replace the 27K 1 watt screen dropping on the two 6CL6 tubes with

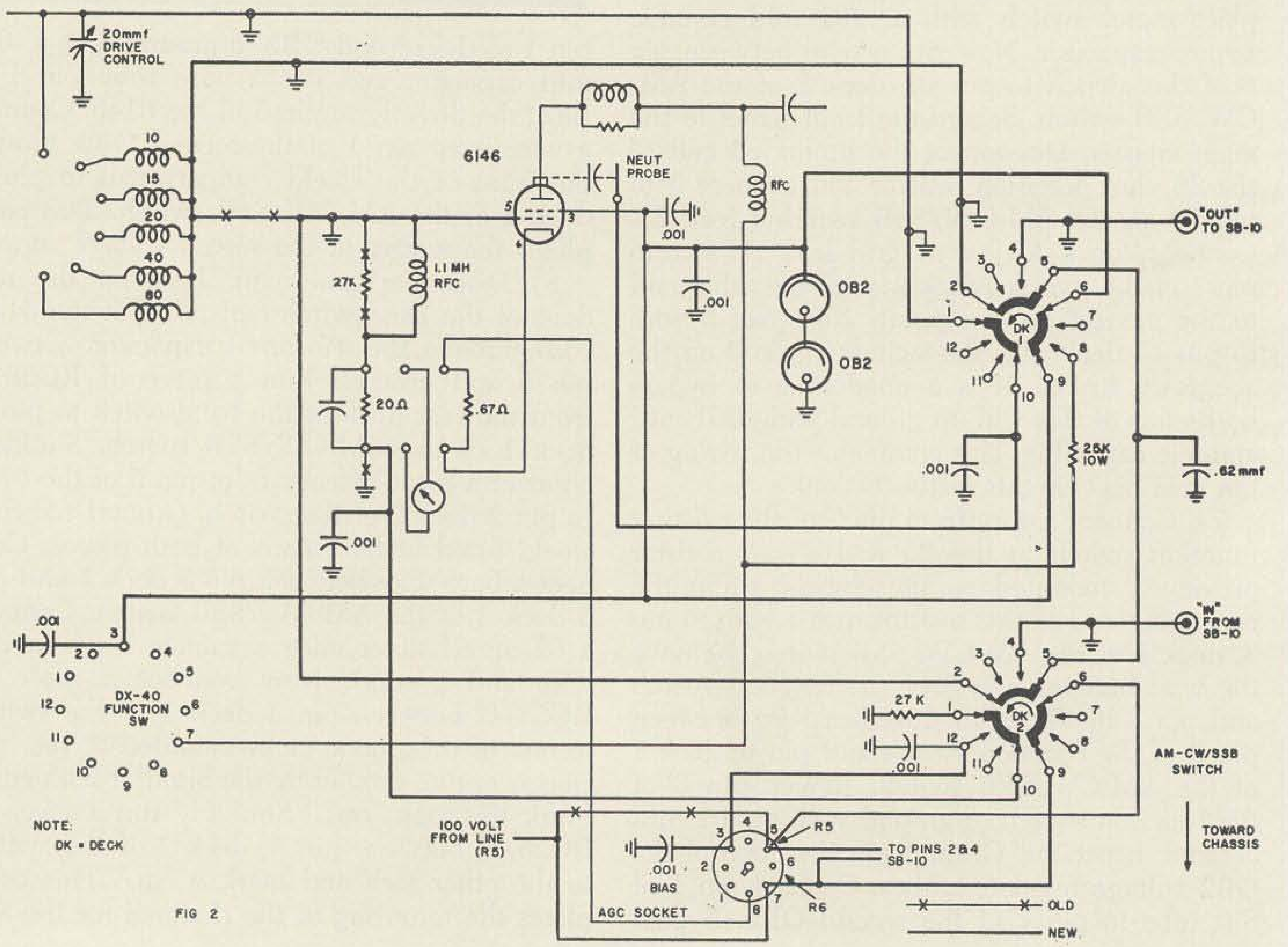


FIG 2

17 or 10K resistors. This should result in sufficient drive. 10K resistors are being used at the K1RPB installation without any apparent deleterious effects. With the grid drive set for maximum and the DX-40 in the tune, AM-CW, and ten meter position, slowly sweep the final tuning capacitor through its range. With the 6146 not neutralized properly, a dip in grid current will be observed. Turn the transmitter off or better, unplug it and loosen the neutralizing probe. Using an insulating object, vary the distance between the probe and the tube, repeating the "dip test" until the dip is minimized or completely eliminated. In carrying out this adjustment, "Danger-High Voltage" should be assumed. With the DX-40 unplugged, tighten the probe in its desired position. This completes the adjustment of the DX-40.

The SB-10 Hookup

The SB-10 is connected to the DX-40 in the following manner: 1) The antenna relay control wiring was removed from terminals 5 and 6 on the rear panel of the SB-10 and connected to pins 2 and 4 of its accessory socket. A three wire cable is run between the SB-10 and DX-40 accessory sockets. Wires are connected from pins 3, 5 and 7 of the DX-40 to pins 1, 2 and 4 at the SB-10 socket respectively. Pin 1 at the SB-10 has no internal connection and serves merely as a fastening point. Connect a five wire cable between pins 1, 5, 6, 7 and 8 of the SB-10 accessory socket and pins 1, 5, 6, 7 and 8 of the power supply socket (see Fig. 1).

2) A 14 inch length of RG58/U is connected between the "out" phono jack at the rear of the DX-40 and the input coaxial receptacle of the SB-10.

3) A 31 inch length of RG58/U is connected between the "in" phono jack and the output receptacle on the SB-10. These coax cable lengths are fairly critical for optimum operation.

4) The 47 mmfd silver mica capacitor removed from the DX-40 is now connected between the rf input receptacle inside the SB-10 and the coax leading toward the front panel of the adapter.

In many cases, the SB-10 is found to be unstable on 15 and 10 meters. This is easily cured by replacing the 2.2K 1 watt resistor between L_1 and pin 6 of the 6CL6 driver in the SB-10 with a 1.5K 1 watt resistor.

Stabilizing the VFO

For those using the VF-1 VFO with the DX-40 (as at K1RBP) the following steps are recommended to simplify operation and increase stability. First, rewire the power cable to the station receiver instead of the DX-40. (Be sure to check if the receiver power supply is capable of handling this additional load). This results in the greatest stability improvement, as well as allowing the VFO to warm up in conjunction with the receiver prior to operation. The VFO is keyed by the transmitting relay external contacts to allow the oscillator to run continuously during CW operation, thus eliminating chirps. In order to do this, the white wire in the VF-1 cable is cut short and taped out of the way. Then a jumper wire is soldered between pins 1 & 2 on the VFO keying jack. It is now possible to spot the frequency by turning the operation switch to "on" (manipulation of the DX-40 function switch is now not necessary for spotting purposes). To complete the wiring changes, a piece of coax is run from the transmitting relay to the keying jack on the VF-1. Connect the VF-1 output to the DX-40 and place the transmitter in the "tune"–"10 meter"–"AM-CW" positions. The VF-1 will be in the 40-20-15-10 and "on" positions. Insert a key in the DX-40 and obtain maximum grid drive. Tune in the signal with the BFO on. Key the transmitter. If there is any frequency shift, detune the VF-1 output coil until there is no difference between the key up and key down notes. Repeat this procedure on 40 meters using the 160-80-40 position on the VF-1. After a ½ hour warm up period, place the VF-1 in the 40-20-15-10 position and turn the switch between standby and on. If there is a short but rapid drift observed, replacement of the 6AU6 is recommended.

Testing

With the DX-40, SB-10 and VFO properly cabled together, the following procedure for testing is suggested.

a) Connect a 60 watt dummy antenna to the DX-40.

b) Turn the AM-CW/SSB switch to the AM-CW position and test these functions as outlined in the instruction booklet.

c) Switch the DX-40 to standby, the AM-CW/SSB switch to SSB and plug in the keying cable from the SB-10. Turn the SB-10 power on, and match the bandswitch positions on both units.

d) Disconnect the output cable from the SB-10 to the DX-40 and switch the SB-10 to "manual" and the DX-40 to "CW" on the function switch. Plate current should read approximately 25 ma.

e) Place the DX-40 and SB-10 on "standby" and reconnect the output cable of the latter to the transmitter. Now turn the DX-40 to "tune" with the meter switched to the "grid" position. With the series variable resistor in the bias battery string set for maximum resistance turn the SB-10 to "manual." Tune the DX-40 drive control and SB-10 tuning controls for maximum SB-10 output. There should be next to no grid current indicated at the DX-40. Carefully decrease the bias series resistance until about ½ ma grid current (never more!) is drawn by the 6146. Switch the DX-40 to the "CW" position on the function switch, and the meter switch to read plate current. Quickly resonate the final to 125 ma. Turn the adapter output control counterclockwise until plate current just starts to drop off. Grid current should now be zero with full loading on the amplifier. Null the carrier. Speed is of essence in the tuneup of the final since the tube is operating past its maximum plate dissipation rating. With modulation the plate current "kicks" must never exceed 100 ma.

Sideband is loads of fun. There's little reason why it can't be enjoyed by every fone man who is contemplating permanent QRT due to heavy AM QRM. Even the dyed in the wool CW man is becoming fascinated by this effective mode. The proof of the pudding is in operating the DX-40/SB-10 on 75 meters on Sunday nights and getting the following comment: "Gee whiz, OM, you must be kidding . . ."

. . . K1RPB

How to Build a Junk box

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Newcomers to the amateur fold with limited resources overlook a lot of good bets in getting 'goodies'. A few examples. Older auto radios of 8 to 10 years age have very little resale value. Radio shops, used car lots and junk lots will usually give these away or ask very little.

The speakers with a six volt field coil (not a PM) yield lots of wire (around #22 to #26). Even the hash chokes (#14 to #18) make good coil wire.

Audio output transformers designed for 6V6's or 7C5's will work with 6AQ5's. A push pull output transformer will make a good modulation transformer, using the *ct* for B+, one plate lead to a 6AQ5 (6V6) modulator and the

other plate lead to the rf load. The speaker leads would not be used. The primary of audio output transformers with a dc resistance of 200 to 500 ohms can be used as filter chokes in small power supplies running around 50 ma. or less.

Don't overlook the fact that by stripping the power supply from a good auto radio, adding a small ac supply and using a mobile converter, a good home SW receiver can be had.

Old TV sets are a mint of supplies. Power transformers with a husky current output, filter chokes, audio sections, a good supply of resistors, tube sockets, slug tuned coil forms, wire from width and liniasity coils, rf chokes, to mention a few, plus oodles of tubes. There has been several articles on making good front ends from a turret tuner for your homebrew communications receiver. A uhf converter usually can be made to tune the 420 mc ham band.

If there are any electronic plants in your area, don't overlook the local junk yards. They buy the junk from the plants and there oodles of electronic parts may be had for as low as five cents a pound.

Get acquainted with the maintenance men of hospitals, office buildings and big concerns. Old intercoms and many other goodies may be laying around, many times yours for the asking. Motor rewinding shops are a source of cheap wire of all sizes to wind your coils.

Make the rounds of radio-TV shops. Some will give you old sets to 'clean house' and others will sell you bargains.

Don't overlook any business in your town that takes 'trade ins.' Some radios and TV's are not worth the repair in order to resell them and they must get rid of them. I have seen many an old TV set that could be bought for one to three dollars.

Used car dealers (auto junk yards also) are good bets for used car radios.

There are many sources not mentioned that may exist in some parts of the country and not other parts. It doesn't take long for word to get around among hams that so and so's salvage has got some good stuff in. Just look and listen. Don't go overboard and pay too much for used units. Mentally think what can be salvaged and what the same items would cost you new and come up with an idea of what it's worth to you.

Don't ever forget that 'dealers' are out for a buck. If they see you want something badly they may ask five dollars for it. Someone else not so anxious gets it for fifty cents to a dollar. I have seen this work many a time. Don't overlook the idea of club auction and 'buy, sell or swap' in club papers.

This has been written for the novice or beginner who is starting to build up a 'stock.' A ham can usually fill a garage or basement with 'junk' for the same price that a novice can fill a cigar box with parts. Get going and good luck.

Mobile Alternators and Alternator Conversions

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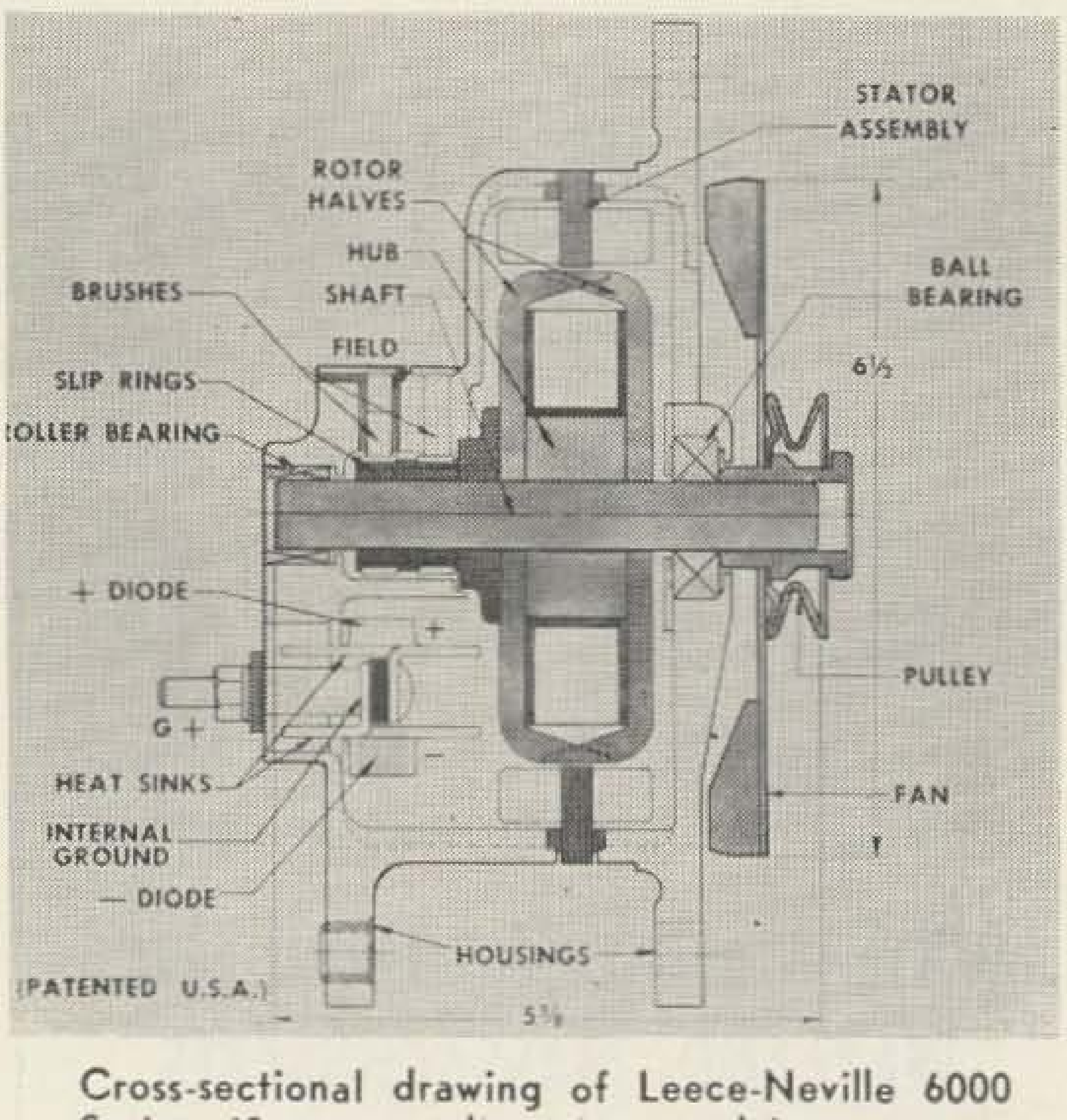
WITH THE INTRODUCTION of more and more high powered AM and single sideband mobile transmitters and transceivers, the strain on the factory-installed electrical system of the average automobile has almost reached the saturation point. Even the highly efficient transistor power supplies require more power input than is realized in the output. We are reminded of the old adage, "You can't get something for nothing."

Mobile alternators have provided a convenient way to increase power and eliminate the problems of battery failures and poor operations resulting from low battery voltage. So let's examine the alternator from two angles—first the alternator itself, its function and operation; second, its conversion from six volt to twelve volt operation.

Mobile alternators produce low voltage, high current, three phase ac power. This power is rectified, regulated and used to charge the battery and supply power to operate the electrical components installed in the automobile. From the standpoint of efficiency, this



Cross-sectional drawing of Leece-Neville 6000 Series, 40-ampere alternator, used in most passenger cars.

system beats a generator, hands-down. At engine idle (about 500 rpm), output of a small (40 amp rated) automotive alternator is about 10 amperes. A comparable generator has not even cut-in at this speed. The vehicle must be traveling 15 to 20 mph in order to charge the battery. The output of an alternator rises much more rapidly with the engine speed than does the generator.

In terms of performance, an alternator can produce more electrical power over a wider engine speed range than a generator. In most cases, more electricity to power all of the normal vehicle's lights, accessories, and mobile equipment is delivered at engine idle.

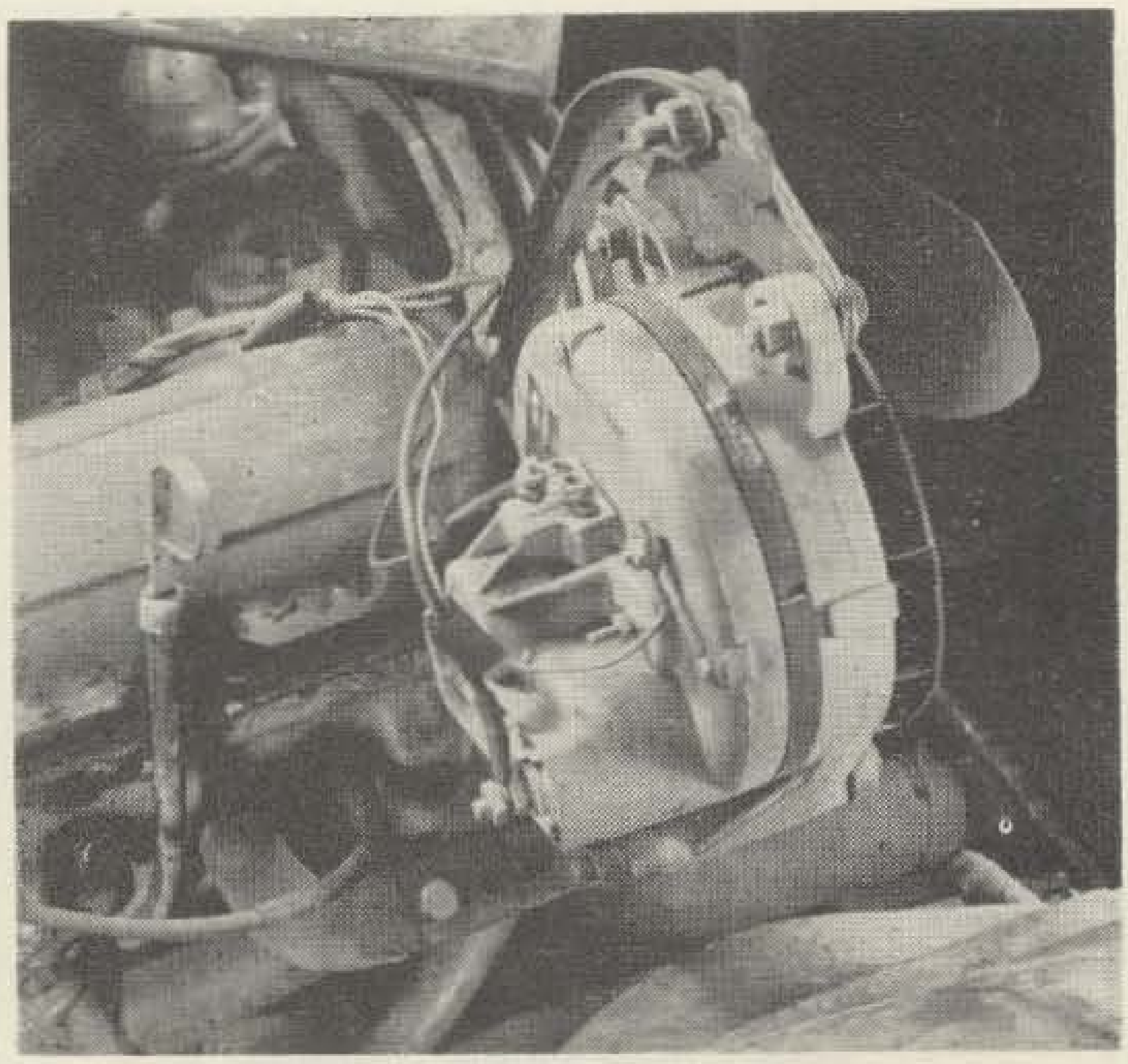
Now that we have examined a few of the alternator's advantages, let's take a peek at the innards of this mysterious package and see what makes it percolate. Most of us are familiar with the conventional generator's function, so let's use a comparative analysis between the generator and the alternator. The main functional parts of a generator are the armature, field coils and pole pieces, commutator and heavy current-carrying brushes. The field coils and pole pieces produce lines of force, known as the "field." The armature, which is the rotating member, cuts lines of force, thereby inducing an ac voltage in the armature windings. The commutator and brushes mechanically rectify this ac voltage into dc required by the vehicle's electrical system.

The main functional parts of an alternator are the stator (this compares functionally with the generator's armature); the rotor (functioning as the field coils and pole pieces); and the rectifier (which performs the same duty as the commutator and brushes). The stator, from which the electrical current is picked up is stationary; the field revolves within it. Or, stated another way: the stator is the stationary member of the alternator, just as it is in a conventional ac motor—but, its function is different. In an alternator, the *rotor* produces the lines of force. As these lines of force cut the stator windings, a three-phase ac voltage is generated. This voltage is conducted to the rectifier unit, which electrically changes the ac to usable dc. An alternator can be thought of as an "insideout" generator that produces three-phase alternating current.

If you ain't "seen the light" yet, let me throw a few more alternator advantages at ye: since the stator conducts the high output current, it is not necessary to use large brushes; more windings can be inserted in the stator slots to give a greater electrical output than from a dc generator of comparable frame size; also because the stator is stationary, the windings are not subjected to centrifugal force as in a generator; the rectifier unit changes the ac to dc *electrically,* so does not encounter mechanical wear as do the generator's commutator and heavy brushes; maintenance is much lower on alternators than on generators (for one thing, the alternator has no commutator or cumbersome brush system—slip rings and bearings are the only wearing parts. The slip ring brushes seldom need attention since they only carry the 2.5 amps required for field excitation). The heavy current load common to brushes and commutators of ordinary generators is taken directly from the stationary member of the alternator.

The Leece-Neville Company of Cleveland pioneered automotive type alternators for the armed forces during World War II. They released them to police, fire and governmental vehicles as soon as wartime production ceased. Most FBI, state and local law enforcement agencies, and fire departments now use alternators to the total exclusion of generators. You may recall first reading about alternators back in August 1945, when a B-25 crashed into the 83rd floor of the Empire State Building. A New York City police cruiser, with its engine idling, was used as an emergency communications relay station until more elaborate facilities could be set up. With a Leece-Neville alternator supplying all the electrical power for its radio, lights and other accessories, the cruiser stayed on the scene in continuous operation for 36 hours after the tragedy.

Alternators are now priced competitively with comparable generators. When first introduced, they cost $20 to $100 more than generators of comparable ratings. But, even at that price, they reduced associated costs such as battery replacement and ignition system maintenance so much they have proven to be actually less expensive than ordinary generators in the long run and so have even more to offer the average car owner—especially the ham operator with a mobile rig. For instance,



Typical installation of Leece-Neville 40-ampere, 6000 Series alternator with built-in silicon rectifier diodes.

reports retained by Leece-Neville show that battery life has increased anywhere from 30% to 100% as a direct result of installing alternators to replace generators. Even without preventive maintenance or extensive repairs, the average alternator system can be expected to give three times the service life of conventional dc generators.

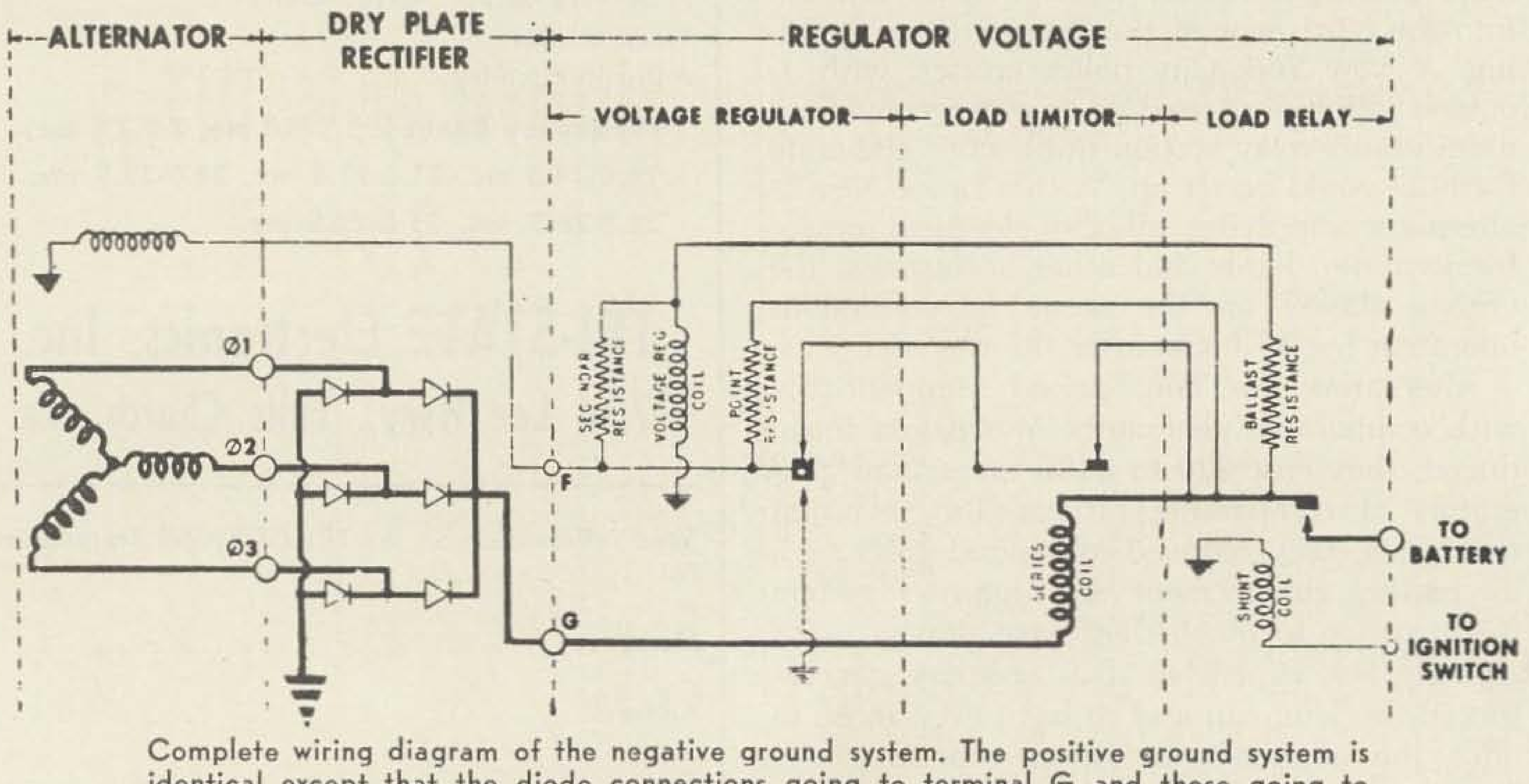
If you are contemplating the purchase of a new family 'bus,' you should consider either placing an alternator system under the hood yourself or checking with your dealer and have the system factory installed in place of the conventional generator.

Unfortunately there are a few of us that can't quite swing the price of a new unit and must resort to the timely art of conversion. With the influx of twelve volt systems on almost all of the new cars there are many six volt alternator systems being placed on the shelf. The price of these units usually depends on the power rating and of course on its condition. One of the most popular six volt alternators and the one that will probably be found by most of us scroungers is the Leece-Neville 5058-G Series, rated at 95 amps. So for the sake of an example, we will refer to this series in our conversion discussion. All parts mentioned may be purchased from your nearest Leece-Neville sales center, or ordered through the Leece-Neville dealer in your community.

Let's assume that we are going to convert the 5058-G series alternator to a 12-volt, 50 to 60 amp unit and require a high (20 to 30 amp) output at engine idle. The first step is to remove the rotor assembly from the alternator. Second, install a new rotor coil No. 28459 and a two turn stator No. 32641. If a high output at engine idle speed is not required, you can convert the alternator simply by changing only the rotor coil. Another alternate is to completely replace the rotor assembly (Leece-Neville No. 29802). This will increase the overall conversion expense and will probably not be considered unless the original rotor assembly is damaged. You do not have to touch the stator in this method of conversion.

Unfortunately the alternator is only a portion of a system that also contains a regulator and a rectifier. At present there is no method of converting them. However, the required regulator and rectifier may be obtained from any Leece-Neville distributor.

Another option on the conversion process is to install silicon diode rectifiers in the alterna-

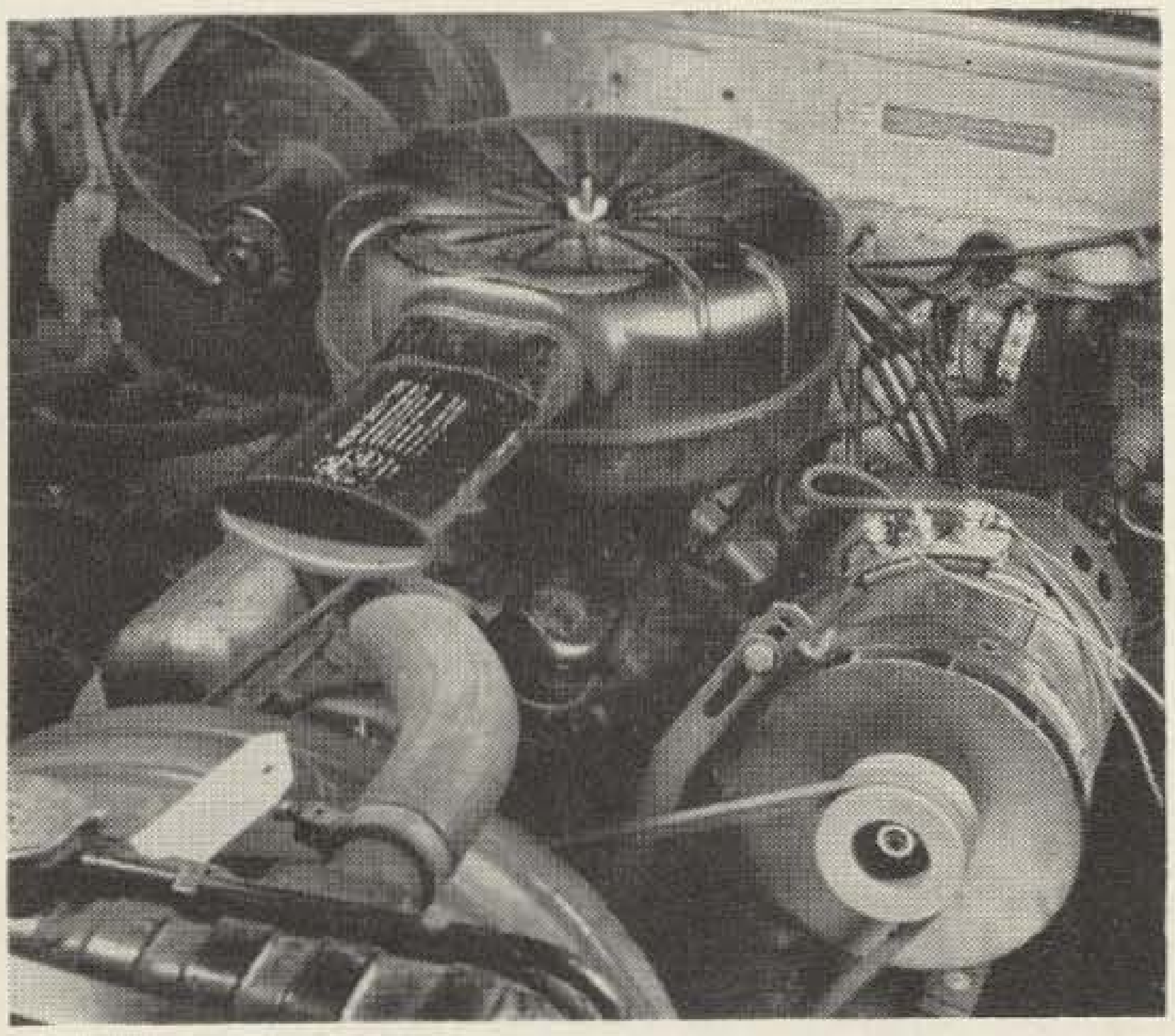


Complete wiring diagram of the negative ground system. The positive ground system is identical except that the diode connections going to terminal G and those going to ground are reversed.

tor. This may be accomplished by using the Leece-Neville rectifier kit number 57254. The kit consists of a new alternator end housing with built-in silicon diode cells, heat sinks, housing cover, and connection cables. You merely take off the old end housing and replace it with the new silicon rectifier end housing unit, using the original through bolts and ac stator terminal nuts and washers.

If I have sold you on the alternator and you are ready to have one installed or install one yourself (either from preference or because you happen to be as broke as I am) you may be interested in a few notes on installation and trouble shooting.

When installing an alternator system disconnect the battery first and do not reconnect until you are ready to check the installed system. Be sure to check the ground polarity and see that your rectifier and regulator system are corresponding polarized. If you hook up the battery or rectifier backwards, you'll be causing a short circuit across the battery, to say nothing of ruining those gold plated diodes.



Typical installation of Leece-Neville 60-ampere heavy-duty alternator equipped with silicon rectifier diodes.

It would be impossible to be specific on the physical installation because of the many different makes and models of cars. However, there are available complete mounting kits for your automobile from the Leece-Neville Company that furnishes just about everything except the fan belt. Just use your hat rack coupled to some common sense.

After the installation a few simple checks can be made to determine if the alternator is functioning properly; with the engine at idle speed, remove the "F" (field) lead from the regulator, and touch it against the "G" (ground) terminal. This will allow the alternator to operate "Full Field."

If the alternator shows a high rate of charge when running full field, the alternator is functioning properly. If the alternator shows a very low or no rate of charge when running full field, the alternator will have to be removed and checked on the bench. Remove the rotor from the housing and check with an ohmeter to determine if it is open or shorted by placing the meter's leads on the slip rings to measure the resistance of the coil. The meter should read between 4.3 to 4.6 ohms on a 12 volt, or 2.3 to 2.5 ohms on a 6 volt system. If very little resistance is read, it indicates a possible shorted coil. Check for loose or broken wires at the slip rings. If infinity is read on the meter, the coil is open. If the rotor checks good, it should be cleaned by washing with a brush dipped in a cleaning solvent or paint thinner. Rinse with another brush dipped in unleaded gasoline or kerosene and wipe dry with a cloth.

While the unit is on the bench, check the stator sections for continuity between each section and ground (these leads should be disconnected from the rectifiers). Next check for continuity between each stator phase, then check for ground between the stator leads and the stator. Continuity should be found in each combination.

Many amateurs will discover the advantages that the alternator system has to offer and will probably bend your ear about them every time a discussion starts on mobile operations. Two important features that have not been discussed are: 1. The noticeable absence of generator noise that is usually so aggravating on the higher frequencies; 2. The alternator produces a three phase ac voltage that can be utilized directly into a transformer system to supply just about any voltage that you might need. Three phase power supplies offer better transformer utilization, less ripple output and better power factor in the load placed upon the ac line. Only a small amount of filtering is required on such a power supply and the battery is not overloaded.

So the next time the snow is near the sensitive area of a tall giraffe and your car won't start, or your transmitter starts "FM-ing" because of a low charged battery you will be only one step away from becoming a proud owner of an alternator. . . . W5VOH

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73 trys out the Viking Personal Messenger

WHILE I FIND the doings on the Citizen's Band as annoying as any other amateur, this in no way interferes with my using the band for its intended purposes. I don't believe in letting a little emotion stop me from being practical.

The 11 meter band comes in handy for ham use every now and then, though not for hamming. For instance, the Porsche Club was putting on an acceleration test and needed communications between the start and finish to time the runs. We could have done it by ham radio to be sure, but by using a couple of CB handitalkies we were able to let anyone available operate the rigs and the event went off very smoothly.

Speaking commercially, there is a wide choice of pocket sized CB gear and nothing much for the ham bands. Sure, I could retune the gear to ten or six meters without much difficulty, but this would lower the utility because then I could only use it with licensed operators at both ends and though most of my friends are hams, I do have a slight circle of acquaintances in other fields. Why restrict their use when there is little to be served by doing this?

We keep a pair of handitalkies around here ready to use and find them invaluable. When someone is making the trip up one of the 100 foot towers it is a lot easier to have him clip a rig on his safety belt and keep in touch with him instead of trying to holler over the wind and traffic noises.

The units also come into play when we have some antenna tuning or evaluation. We park someone on a neighboring hill with a field strength meter and the CB unit and tune away. It also is dandy for investigating TVI complaints, greatly speeding the process of trying all bands and beam directions while maintaining constant communications during the process.

We have a friend (non-ham) who goes hunting a lot and he has found the units a great help for keeping in touch with fellow hunters and keeping them from shooting each other.

When we decided to invest in a pair of CB handitalkies we looked over the market very carefully. The final choice was a pair of the Johnson Viking Personal Messengers. This decision was dictated by the high power that they put out (one watt) and the available rechargable battery assembly. The extra range made possible by the one watt unit over the more usual 100 milliwatt or less frequently is important. The lower power transceivers are less expensive and don't require the formality of even a CB license, but the higher power, when you need it, is worth all the extra effort and expense.

. . . W2NSD

Station Time Panel

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BACK IN THE "good old days," when exact timing was not too important, the "station chronometer" was a 98-cent alarm clock, which was wound daily (if we didn't forget); and set, every now and then, by the NAA time signal. This gave us a time standard of sorts, which was usually within five minutes, plus or minus, of "train time."

With the passage of years, time became more important, and now, in many instances, time accurate to about the nearest second is very desirable. RTTY transmissions start exactly on schedule, and are not repeated. If you tune in late, you lose the first part of the transmission.

With the increasing importance of accurate time, the 98-cent alarm clock was replaced by a better mechanical clock, and later by an electric clock, which kept "perfect" time between the almost-daily power failures. For this electric clock, an "automatic" WWV setter was developed, as well as a power failure indicator. Eventually, the electric and mechanical clocks, and all the various adjunct "black boxes," took up too much desk space, and the desirable and tested elements of the assemblage were integrated into a single time panel, appearing as in Fig. 1.

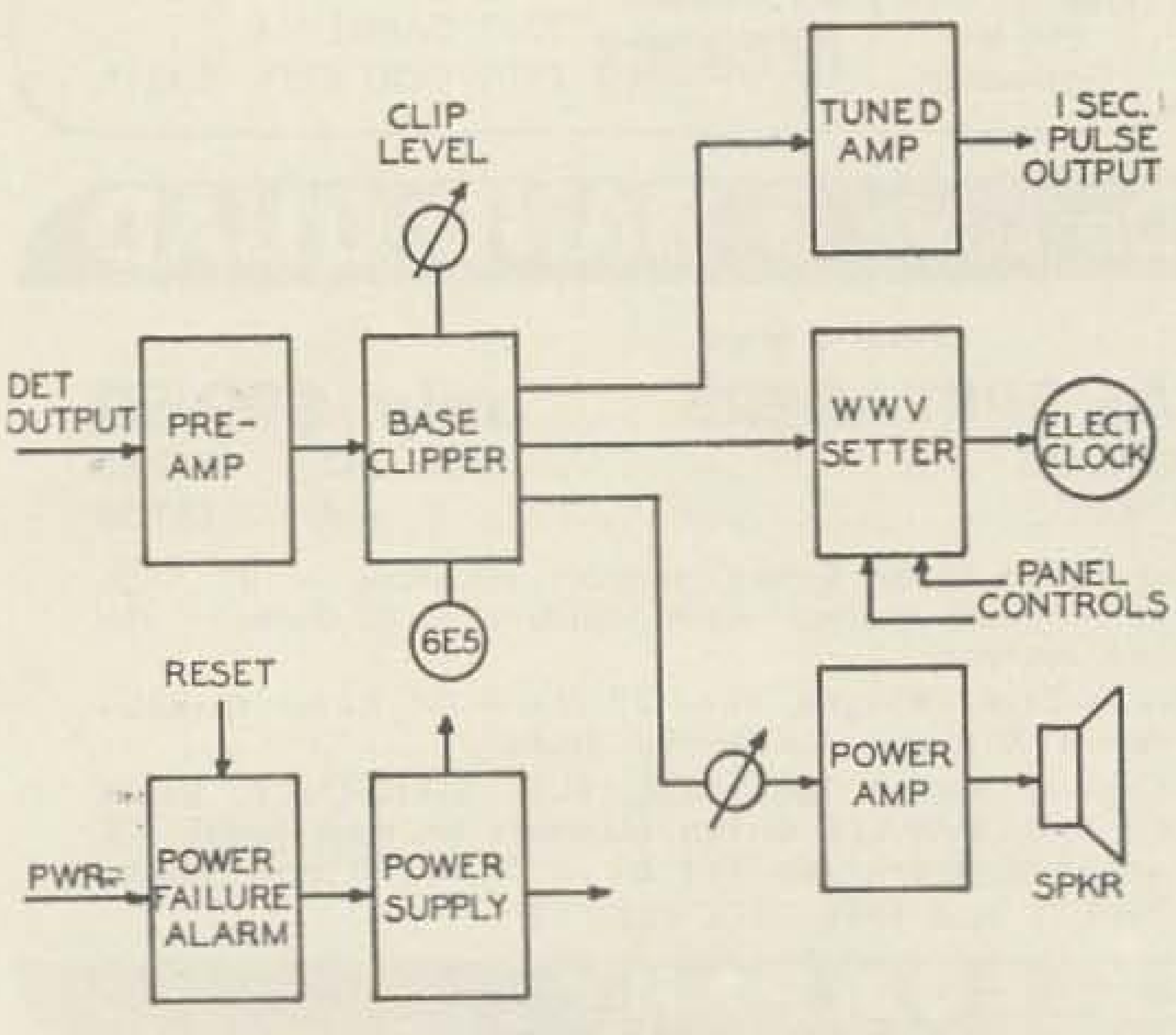


Fig. 2

For operating convenience, the mechanical clock (right) is kept on Greenwich Meridian Time ("Universal Time"), and the electric clock, (left), which is periodically checked against WWV or WWVH, and reset when necessary, is kept on local time. This procedure eliminates mental calisthenics in converting from one time to another, yet makes possible immediate recovery of local time should the power fail (as it too frequently does).

Block diagram of the time panel comprises Fig. 2. Circuit of the "ordinary audio" portion, which is largely conventional in design and use, is shown in Fig. 3. The detector output of the receiver is fed into a pre-amplifier, which is one half of a 12AT7, conventionally connected and operated. Pre-amplifier output goes to a base clipper, which is adjustable to eliminate background noise. Signal and background levels, at the output of this, are monitored by use of a 6E5 "Magic Eye" tube. Base clipper output also goes to a 12AT7 cathode follower.

From an adjustable tap on the load resistor of this cathode follower, a signal is fed to a 6AQ5 power amplifier, and thence to a small speaker on the panel. Speaker output is the input signal, amplified and stripped of all, or any desired part, of the background noise.

Fixed output of the cathode follower goes

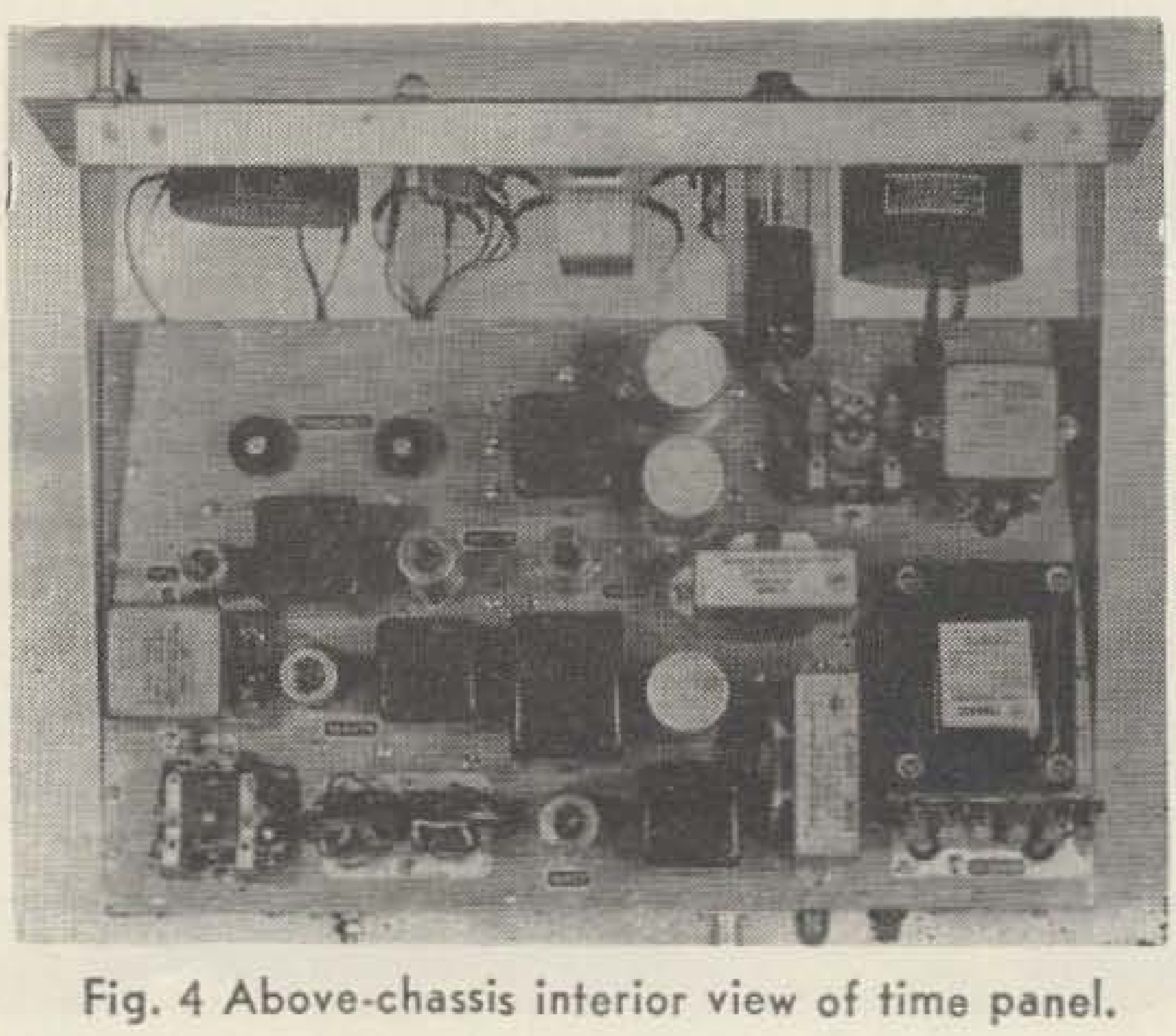


Fig. 4 Above-chassis interior view of time panel.

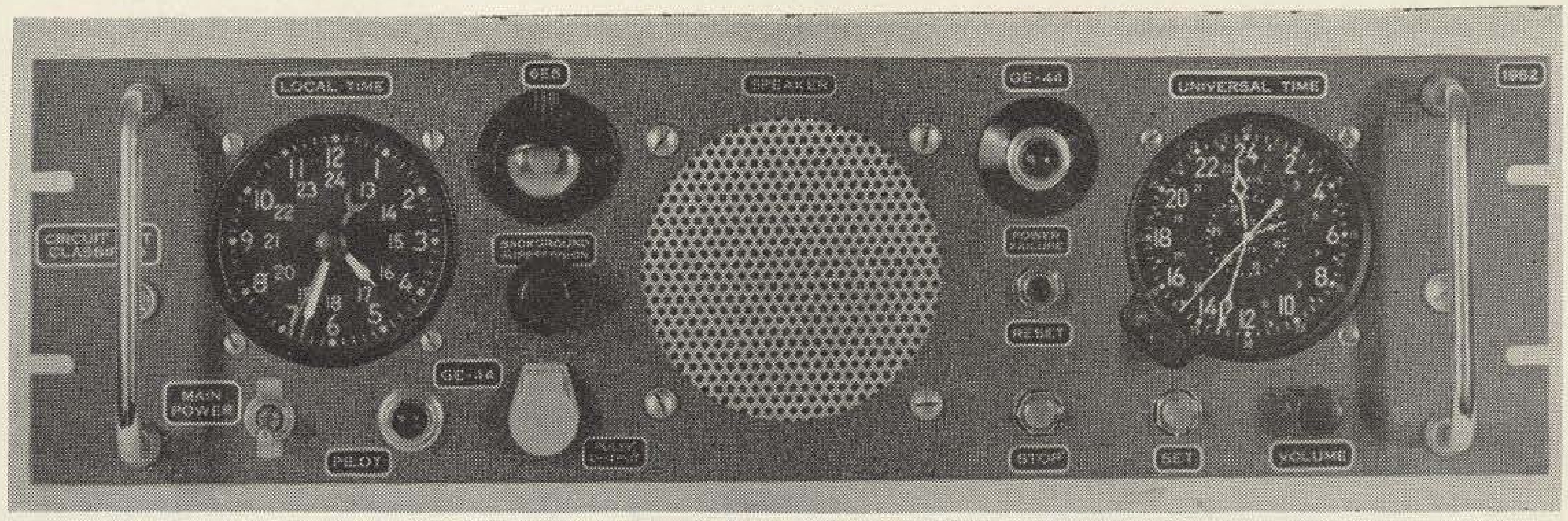


Fig. I Station time panel.

to the "automatic" setter for the electric clock, and to a selective amplifier, whose output is the "seconds pips" of the WWV signal. Major components of this audio channel are visible near center of Fig. 4.

The selective amplifier, which isolates the seconds pulses from the composite WWV signal, is an "MIT" design[1], using the two halves of a 12AU7A in cascode as the amplifier, and a twin-T network as the frequency-selective feedback element. A 6C4 cathode follower isolates the feedback network from the amplifier, and also provides an isolated output.

Circuit of this amplifier, with constants, constitutes Fig. 5. To eliminate the use of costly precision components, the resistive elements of the filter are made adjustable. Exact values of these components can be computed from standard handbook formalae, or scaled from the Carter Nomograph[2].

After construction, the filter is set to approximately 1,000 cycles, and then trimmed to exact setting using the WWV signal as a standard. The adjustments are the two "Frequency" controls visible in Fig. 4. Almost any symmetrical dual triode will perform well in this circuit.

The clock setter is a signal-actuated switch, and is an improvement of an older model which performed well. Circuit of this comprises Fig. 6. Under normal conditions, the armature of the set coil of the symmetrical latching relay is up, the clock is connected to line, and keeps as good time as the local frequency stability permits.

When clock time differs from WWV time, the second hand is stopped at 60 by pressing the STOP pushbutton, and the minute and hour hands are manually set to the next WWV announcement period. Pressing the STOP pushbutton energizes the set coil of the latching relay, which disconnects the clock from the line (stopping it); shunts the power switch of the entire panel, and closes the contacts

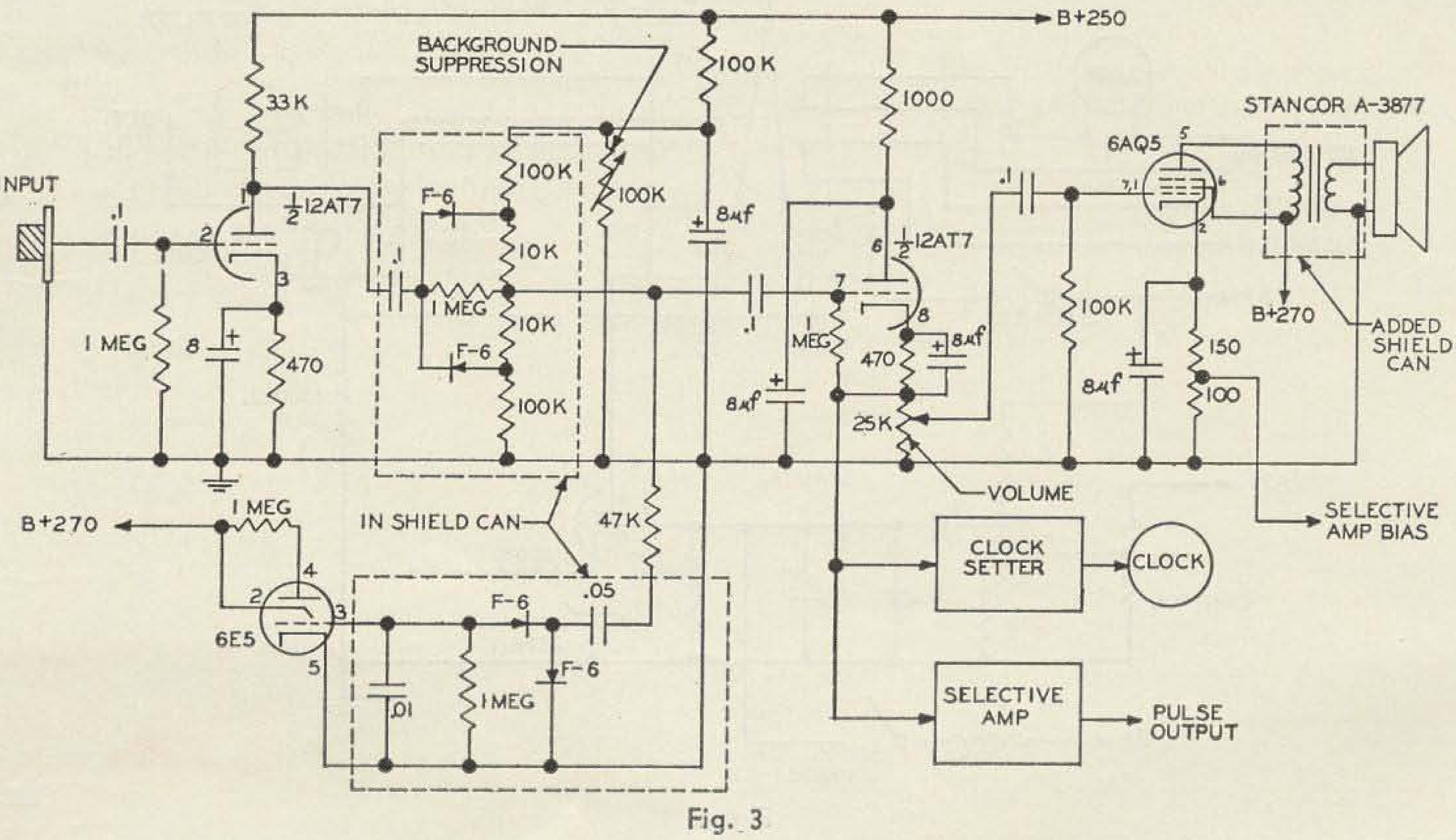


Fig. 3

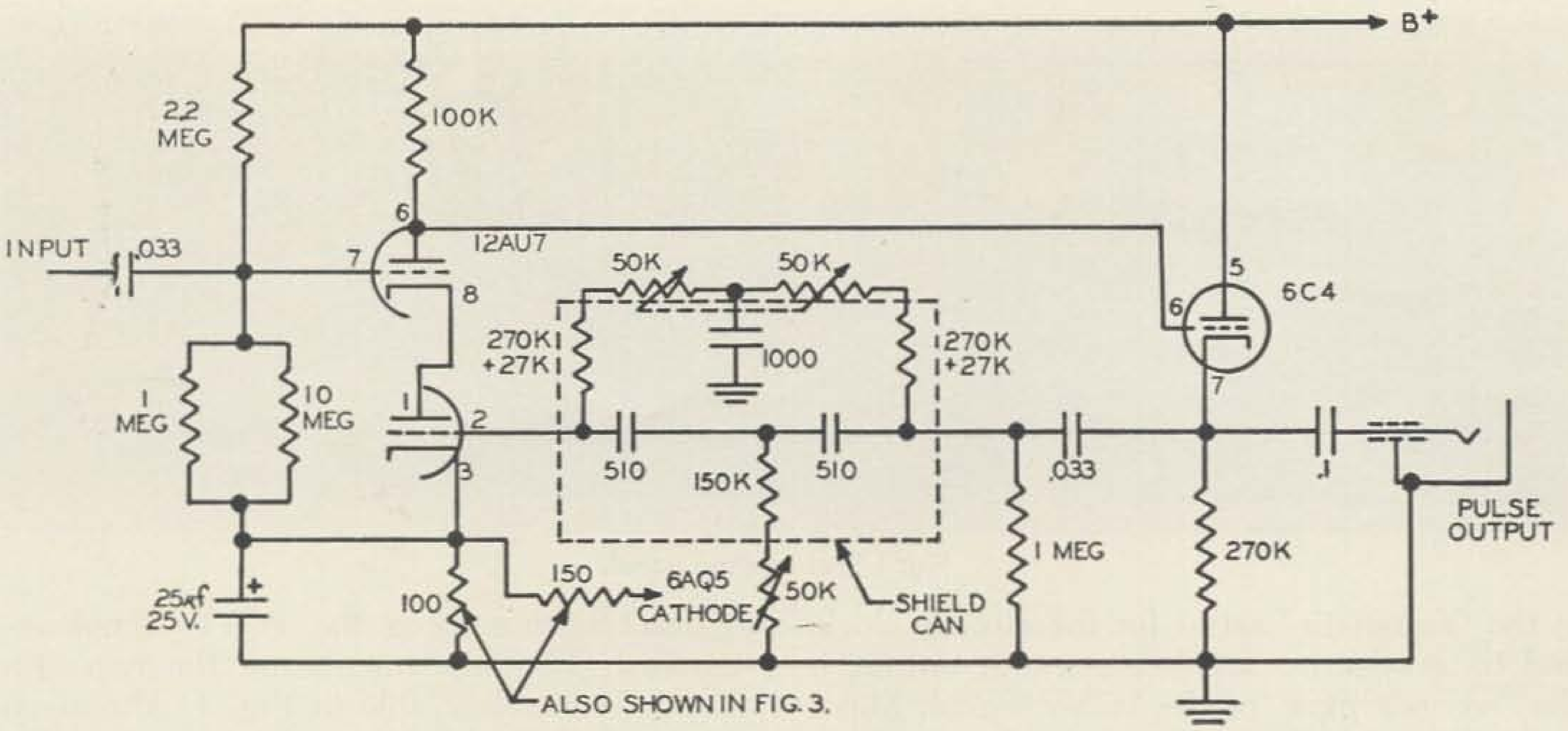


FIG. 5

associated with the reset coil of the same relay. As this is a latching relay, the coils only draw current when energized, but the contacts "stay put" until the opposite coil is energized. The F-6 diodes across the relay coils, "connected backwards," are flyback absorbers.

After the second WWV time announcement of the next period, the SET pushbutton is depressed. This readies the circuit for the commencement of the tone signals. Pressing the SET button energizes the DPST relay (extreme right, Fig. 6), which is wired for self-holding (lower armature contacts), and which also energizes the reset coil of the latching relay. This relay, however, cannot function, as no signal is incoming, and the right half of the 12AU7A is held to nonconduction by the Zener voltage on its cathode.

Recommencement of the WWV tone signal applies an af voltage to the system. This is amplified in the left half of the 12AU7A, rectified in the doubler circuit between halves of the tube, and the rectified output applied to the right grid. This drives the tube into conduction, so that the reset coil is energized, and its armature pulls down. This releases the previously locked-down armature of the set coil, so that the clock starts, and the shunt is removed from the panel power switch. At the same time, the contacts controlled by the reset coil armature are opened, removing energization from the DPST relay. After a short time

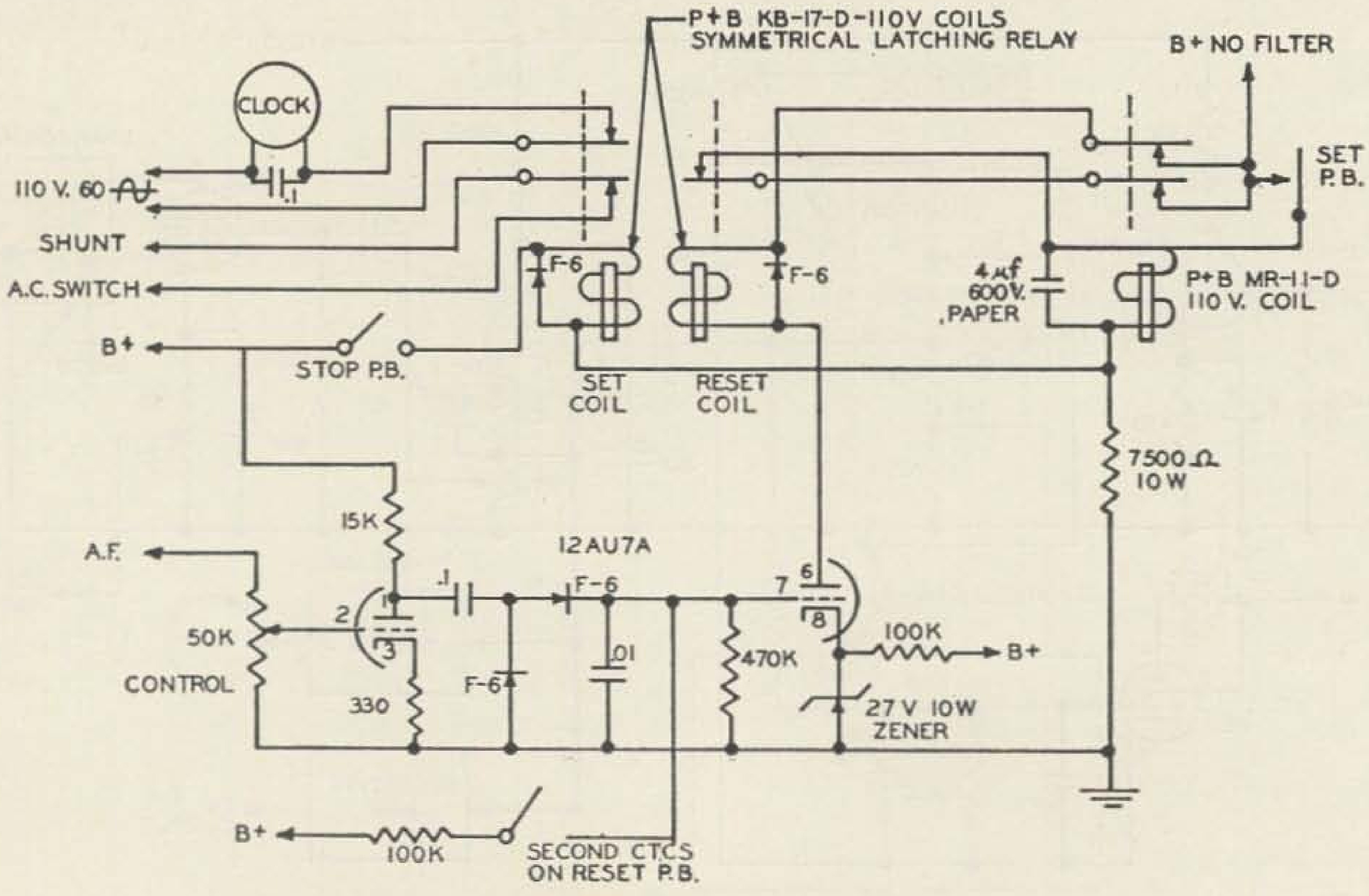


Fig. 6

delay, caused by the 4 mfd shunt capacitor, the armature rises, de-energizing the reset coil of the latching relay. This time delay is inserted here so that the armature of the reset coil will surely pull down and latch in place before the coil is de-energized.

If desired, the amplifiers and reset mechanism of this time panel can be made to shut itself off automatically once the clock is set. This is made possible by the contacts on the set coil that are shunted across the ac switch. For automatic shutoff, snap the main power switch to OFF position any time after the STOP pushbutton is depressed.

If there is a fumble or snafu anywhere in the setting process, press the SET button and then the RESET button, and everything is ready for a new start.

Components of the clock setter are visible in lower left of Fig. 4, and in lower right of Fig. 7. Note the copper disks which form the heat sink for the Zener diode.

Power supply used is somewhat more than adequate, with an ample margin of safety built in, to avoid trouble as components age. Circuit of power supply and power failure alarm comprises Fig. 8. The power failure alarm is a self-holding relay, which releases when the power is interrupted, and must be manually reset (RESET pushbutton). In its de-energized position, the relay switches an alarm light on. This is a GE-44 bulb, operated from the line in series with 5 mfd of capacitance.

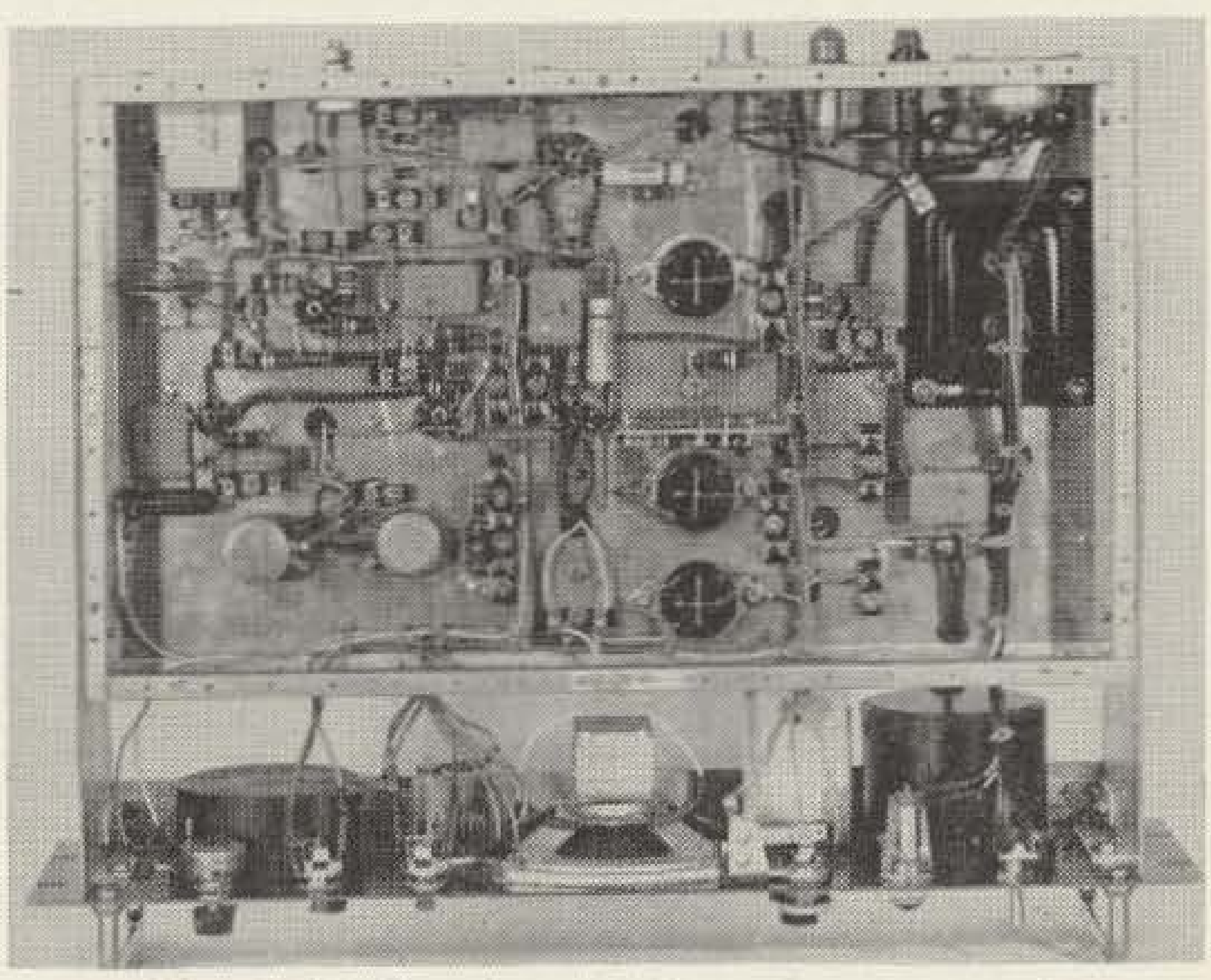


Fig. 7 Under-chassis view of time panel.

Layout and construction are not at all critical. Components that must be seen regularly, or operated regularly, are placed on the front panel. Adjustments of the "set and forget" type are mounted on the chassis top and skirt. Permanent connections—ac and audio input—are made at the rear; the temporary connection—Pulse Output—is made by means of a jack on the front panel.

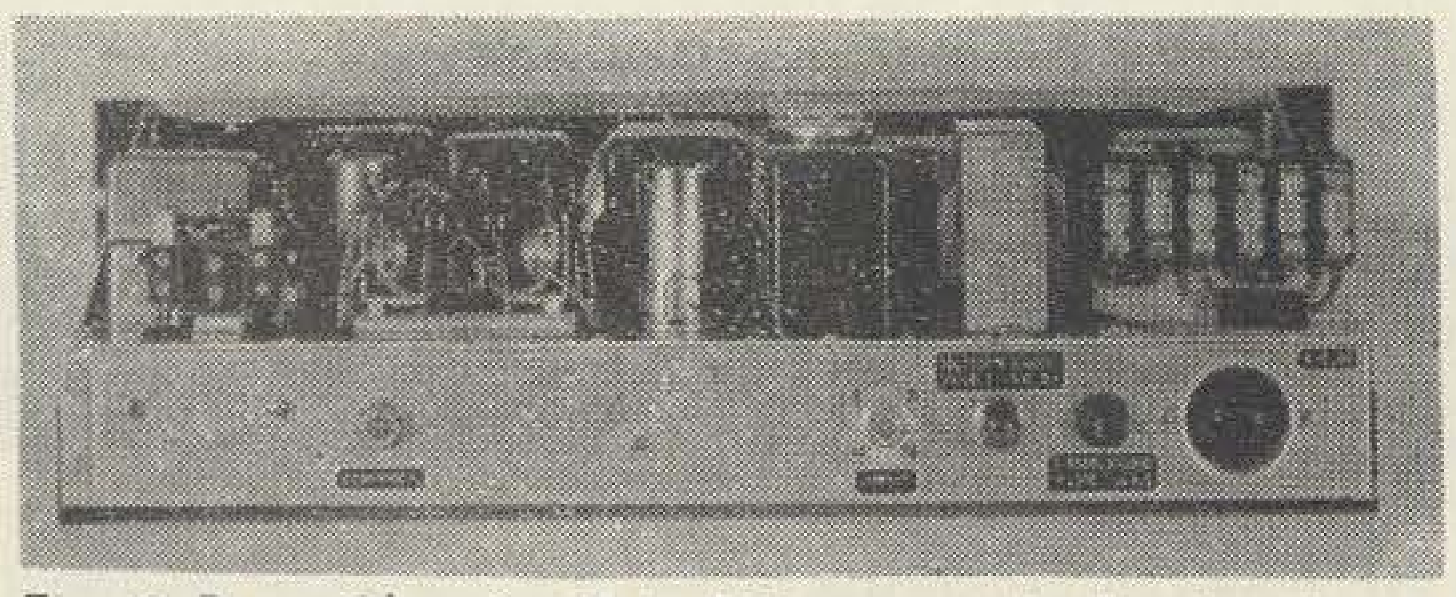


Fig. 9 Rear Chassis skirt of time panel, showing inputs and "set and forget" control.

Workmanlike construction is most desirable, as a time panel of this type is designed for regular use, not as a repair and trouble–shooting exercise. Liberal use of tie points (Fig. 7) not only firms up component mounting, but also provides convenient test points, so that a component failure, if one occurs, can be localized promptly, and corrected without performing major surgery on the assemblage.

Mounting of the various networks, most of them in shield cans, is simplified by use of punched epoxy board and push-in terminals (Vector 82G24WE and T-28, for example). Cabling here is done by use of G-C cable ties.

Initial adjustments are few and relatively simple. After a thorough circuit check, feed a WWV signal into the input. In the writer's receiver, this is taken from the detector output through a cathode follower. Set background suppression to zero, and adjust speaker volume to suit your taste. Slowly advance the background suppression control until the signal has optimum intelligibility. This will be at approximately the point where the 6E5 is wide open on no signal, and closed, or slightly overlapping on receipt of an audio signal. Readjust the volume if necessary.

Set the CONTROL (rear chassis skirt, Fig. 9) at about mid range, and go through the clock setting procedure, readjusting, if necessary, to secure certain operation of the relays. None of these adjustments are critical. Lock the CONTROL when operation is satisfactory.

Adjustment of the selective filter for the pulse output is done as follows:—Feed a signal of as near 1,000 cycles as possible into the time panel input, and adjust the frequency controls (upper left, Fig. 4) for maximum output. Then, replace the 1,000 cycle source with a WWV signal, and gently re-adjust these same controls for maximum pulse output. When this is attained, lock the controls.

Performance of this time panel has been entirely satisfactory, with maintenance needs confined to replacement of one pilot lamp in six months. The predecessor of this device, using the same general principles, but somewhat cruder circuitry, became obsolete after five years of service with no need for any major repairs.

A considerable number of alternative circuits and layouts, performing the same functions, are possible, and should perform well. The only precautions to be followed, and these are for operating and maintenance convenience only, are to make components possibly needing attention accessible—the silicon rectifiers should be near the back of the chassis and exposed, so that they can be tested and replaced easily. The filter capacitors are best

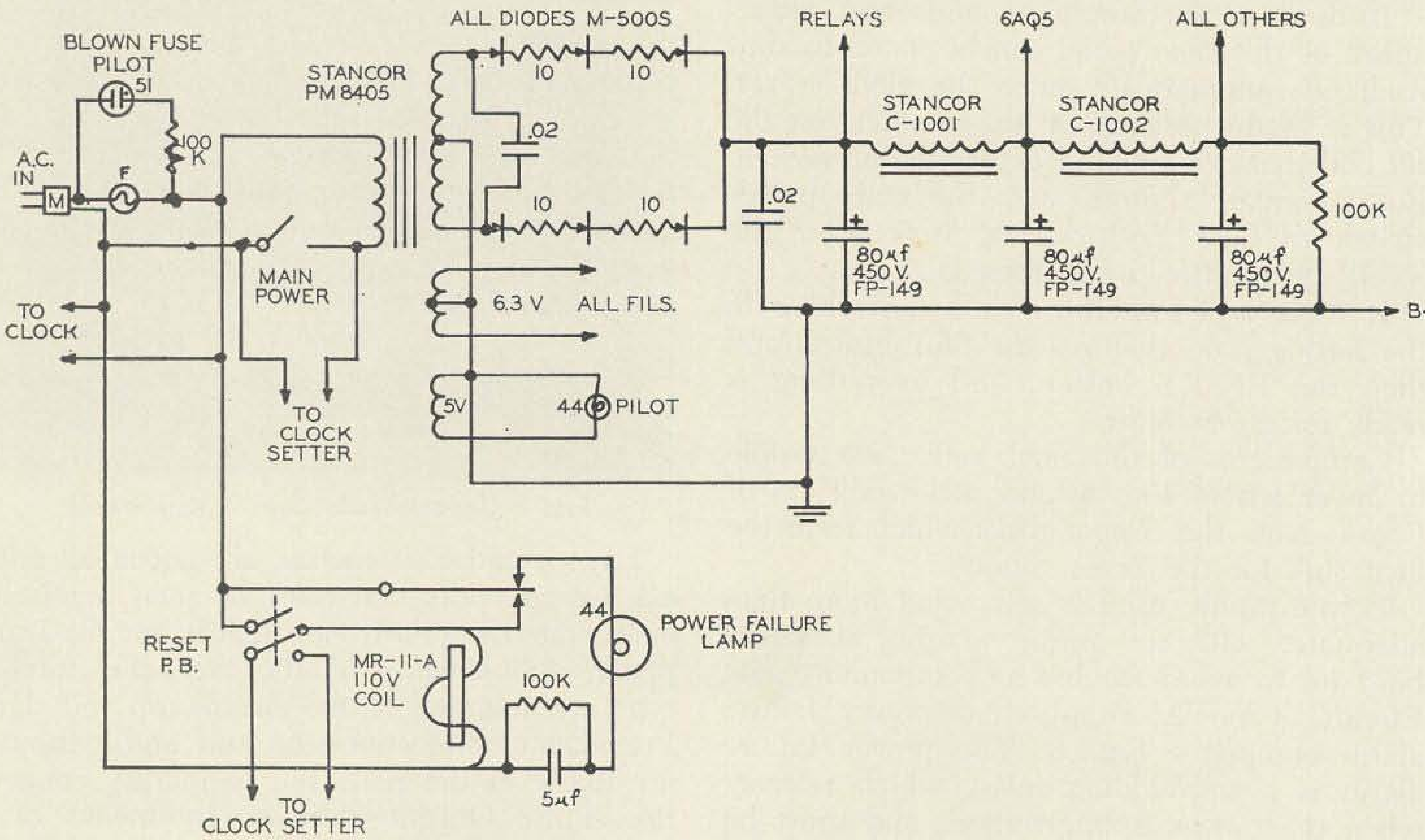


Fig. 8

socket-mounted (Cinch 2-C-7), for easy replacement. The relays should not be "buried," as the contacts may need cleaning after several years of service.

Although almost any electric clock, and almost any mechanical clock, can be used on this panel, fairly rugged equipment is most desirable, so that indicated time will mean something. The electric clock used is a Navy type, with cut gears and heavy plate construction, suggesting long trouble-free life. The mechanical clock is a Waltham Aircraft Chronometer. This is available surplus, in running condition, for about $20.00 (C and H Sales); used, but reworked and with an FAA certificate, for about $85.00; and new for about $125.00. This clock, in station service, can be regulated to hold within about one second a week; and its service life, if annually overhauled by a skilled watchmaker, is considerably in excess of 20 years.

GMT, for chronometer setting, can be computed from local time by methods outlined in your son's geography book; or determined from tabulations in the *Nautical Almanac* (p. 262-265, 1963 edition). Both local and GMT are regularly announced by your local Aeronautical Range Station.

Labels used on this equipment are Metalphoto, made and applied by the Kohler techniques[3]. Decals can also be used effectively, if they are applied carefully, and protected by a coat of clear lacquer.

With a time panel of this sort, the busy operator is never at a loss for the correct time, either local or GMT, and this time can be checked as often as desired against WWV or WWVH. With careful checking, station time errors in excess of 1/20th second should never occur.

. . . IVES

[1]Valley, G. E. and Wallman, Henry, "Vacuum Tube Amplifiers," New York (McGraw-Hill), 1948, 401-403.
[2]Carter, D. F., "Parallel-T Nomograph," Electronics Vol. 30, No. 11, Nov. 1957, 192.
[3]Kohler, G. M. "Photography Produces Custom Labels," Electronics, Vol. 33, No. 1, Jan. 1, 1960, 100 et seq.

Oiler

Doctors are now using throw-away needles for penicillin on home calls. The thing consists of a glass tube with a needle at the end. All one has to do is to grind the sharp end flat, pull out the rubber plunger which is left at the bottom, and by attaching something to the plunger one has a very fine oiler. My doctor gave me a half dozen to experiment with when I mentioned that I thought I could use them.

. . . . KφHVK

These are not good playthings for the kids.

THIRD PARTY TRAFFIC

A reminder . . . Bolivia and the United States now have an agreement permitting the exchange of third party traffic by amateurs. Third party traffic may presently be handled with the following countries: Bolivia, Canada, Chile, Costa Rica, Cuba, Ecuador, Haiti, Honduras, Liberia, Mexico, Nicaragua, Panama, Paraguay, Peru and Venezuela.

A Remote Antenna Tuning Unit

Earl Murphy
8891 Olentangy River Rd.
Powell, Ohio

ANTENNAS IN GENERAL and mobile antennas in particular perform best at a single frequency and if operation over a band of frequencies is contemplated, as with a VFO, a means of tuning the antenna must be employed. This tuning can be accomplished at either the transmitter end of the transmission line or at the antenna terminals. In the first instance the transmitter output circuit or an antenna coupler at the transmitter can be adjusted so as to deliver most of the available power to the antenna. However at frequencies

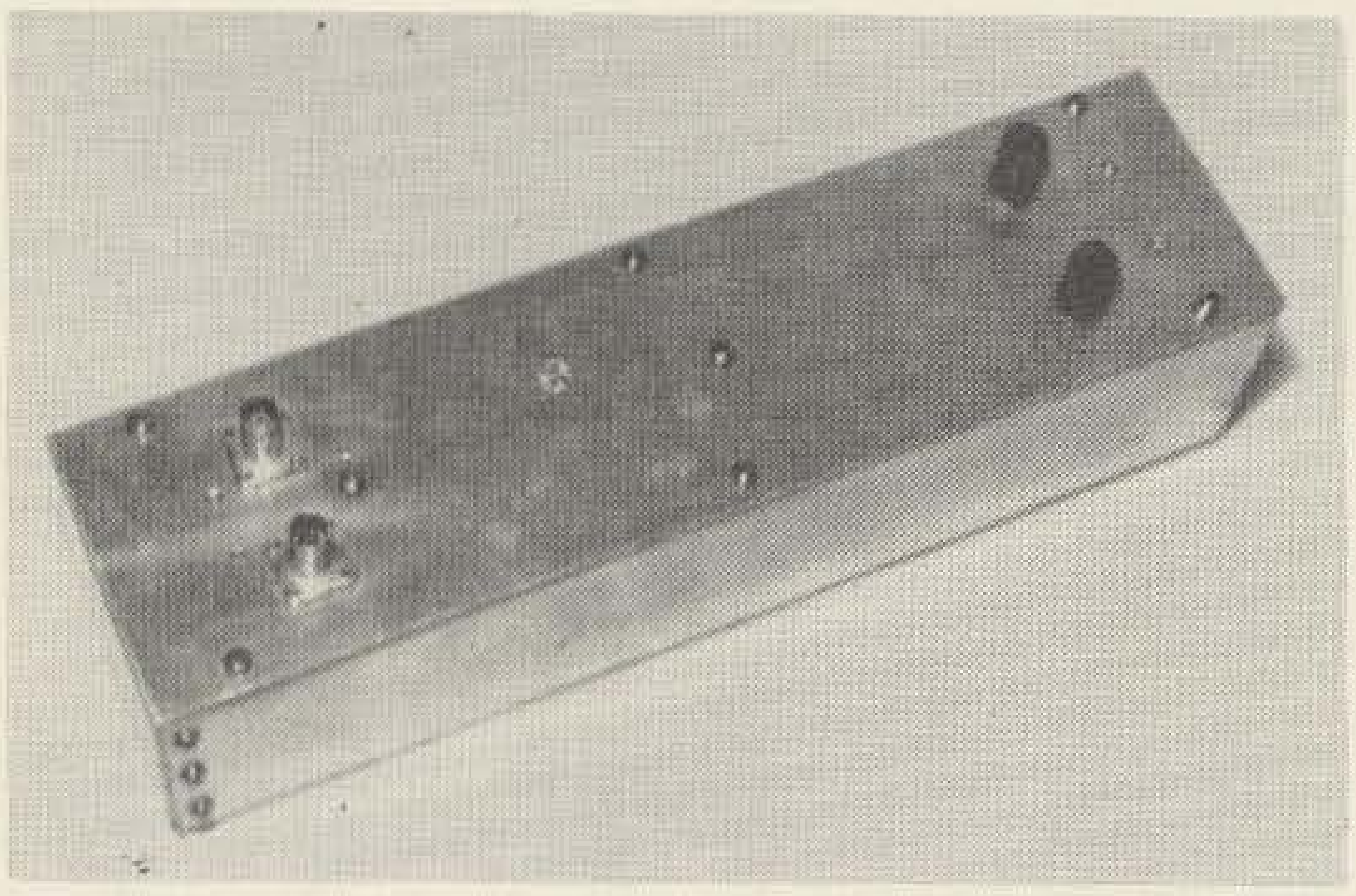


Fig. 1

where the antenna is no longer matched to the transmission line, usually away from the antenna resonant frequency, a standing wave will appear on the line. In many instances, particularly mobile installations where the antenna Q is high, the standing wave ratio can be quite large away from the resonant frequency of the antenna and in many cases these high standing waves cannot be tolerated. Also, the transmission line absorbs more and more of the power going to the antenna as the standing wave ratio is increased, lowering the overall efficiency. On the other hand, if the tuning is accomplished at the antenna terminals, the antenna will remain matched, or nearly so, to the transmission line over a band of frequencies. As a result of this the standing wave ratio will remain near unity over the frequency band thus maintaining good efficiency and avoiding the problems associated with a high standing wave ratio. What is needed then is a method of remotely tuning the antenna to keep it matched, or nearly so, to the transmission line. Many schemes have been tried with varying degrees of success and currently the most popular centers around either a tapped or continuously variable rotary inductor. This article offers a different solution to this problem in the form of a remote tuning unit that uses a variable capacitor for the tuning element. This technique, in general, is more economical in that the rotary variable inductors are expensive whereas a variable capacitor can usually be salvaged from the junk box. If the power is low, that is, less than about 15 watts, a receiving type capacitor can be used. It also appears that there is less contact loss in the capacitor than in the inductor. For what it is worth, it is also noted that the electrostatic field of the capacitor is much easier to shield than the electromagnetic field of the inductor. Also a more compact unit can be made using a variable capacitor. Fig. 1 shows a completed unit that measures only 12" x 3" x 2¾". The two binding posts are connections to the drive motor. All the components are mounted on the top panel as shown in Fig. 2. All of the parts were salvaged from the junk box except the aluminum box which

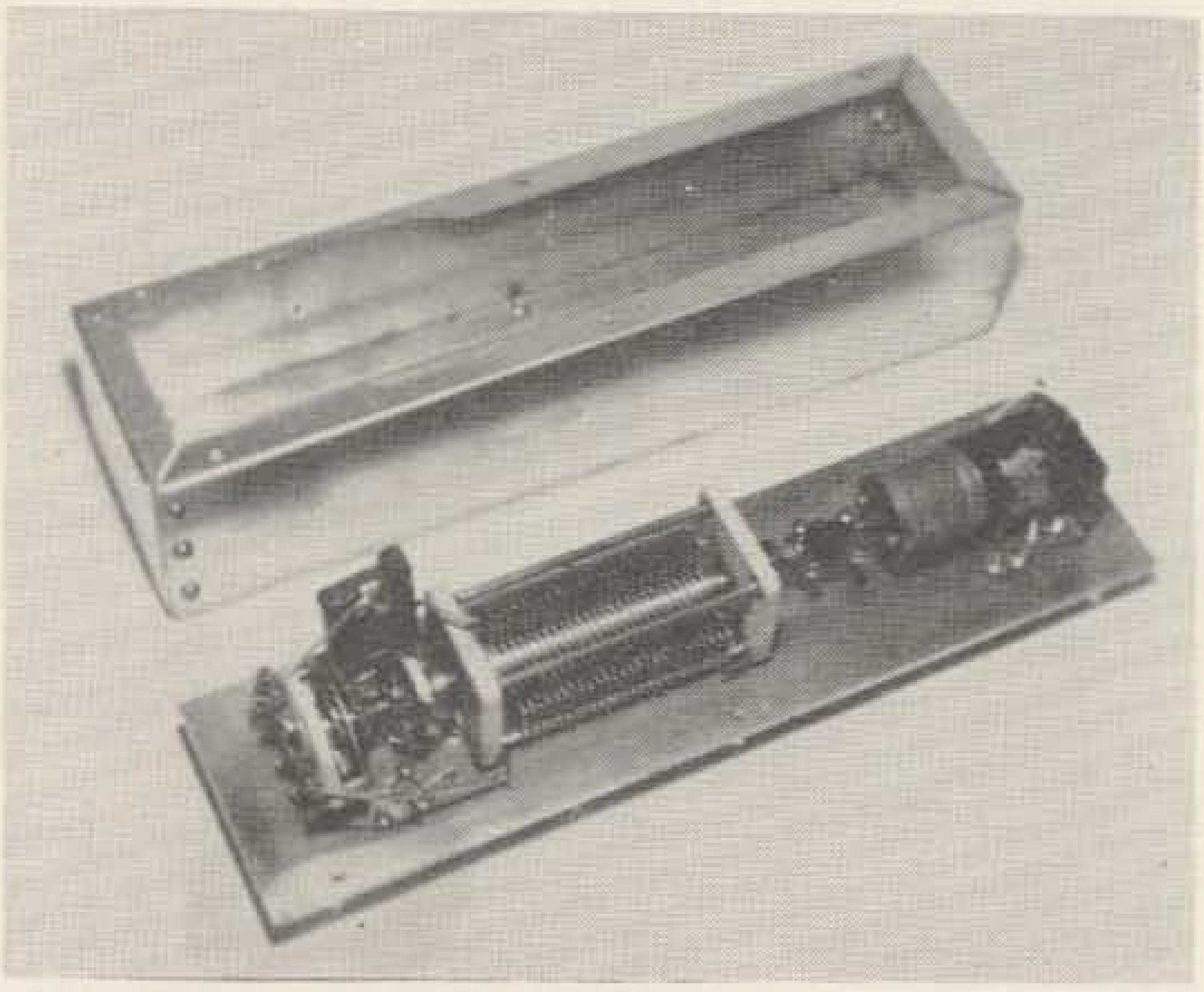
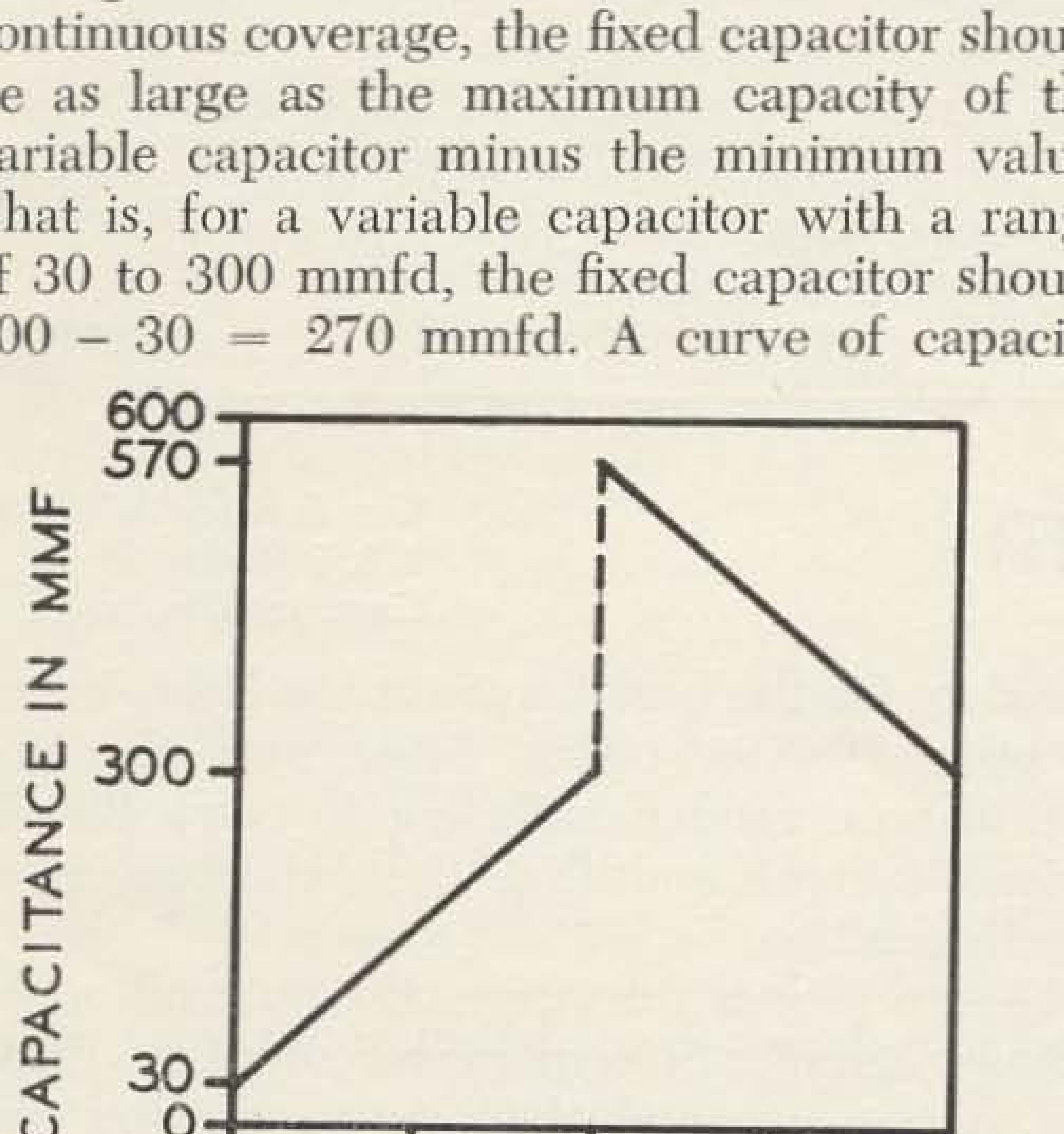
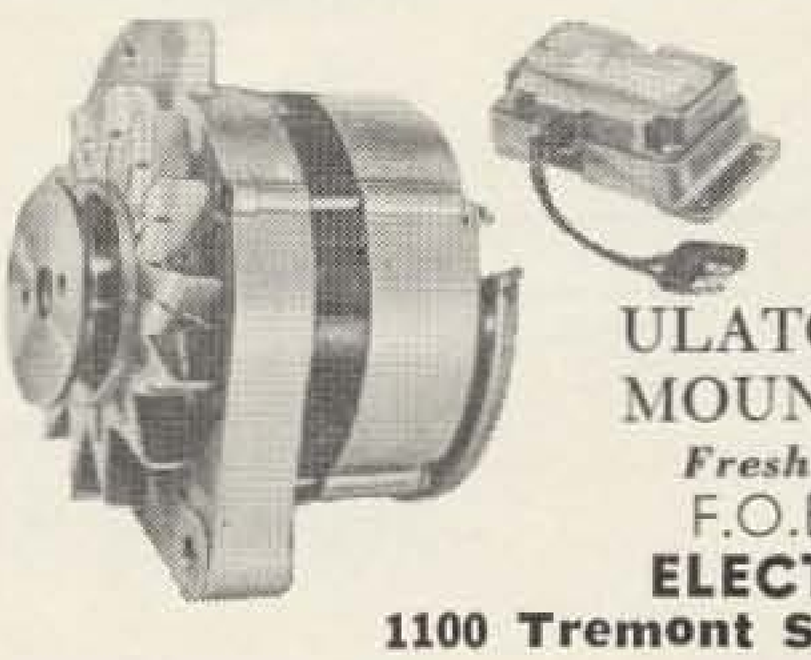


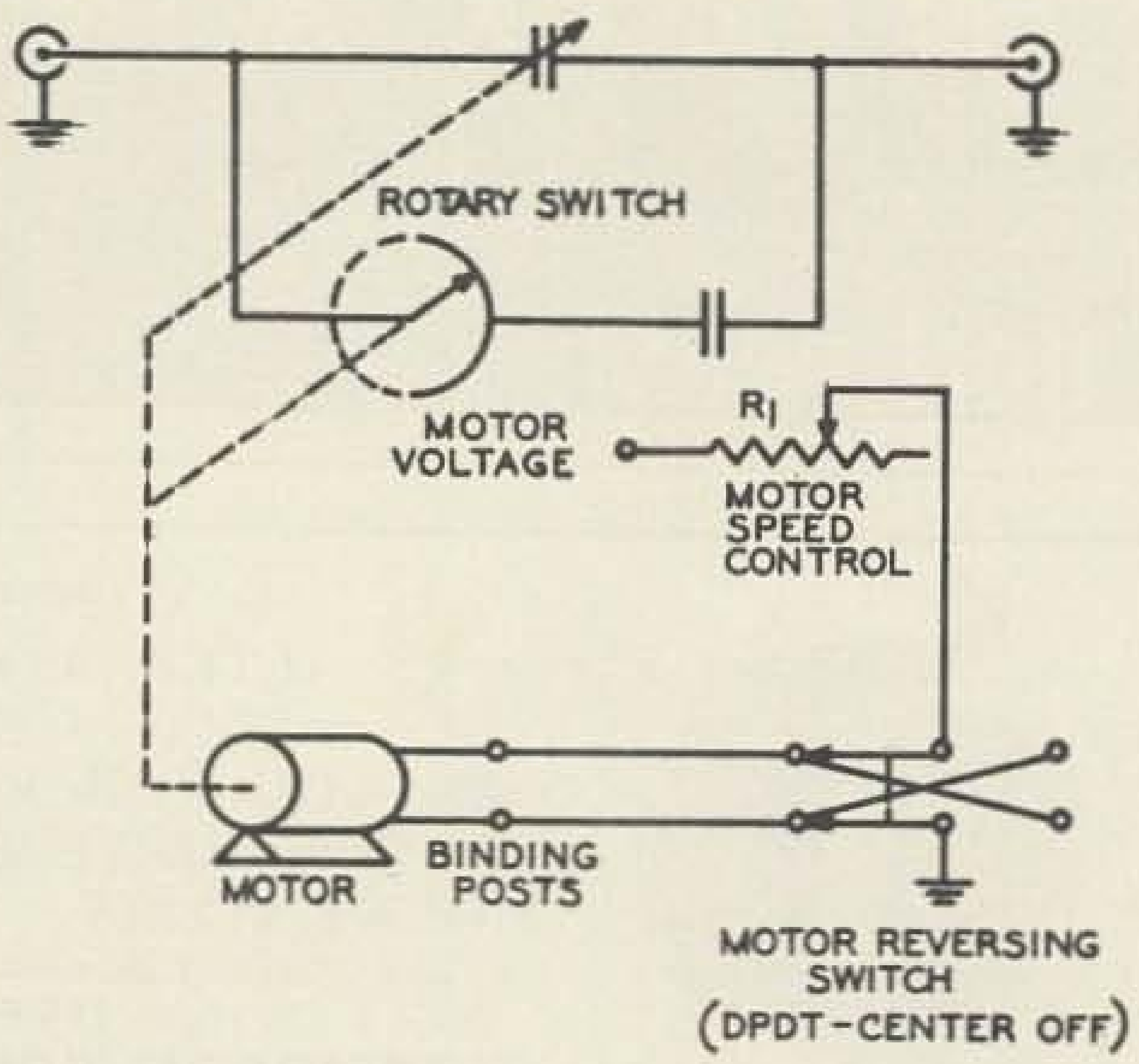
Fig. 2

I made. The motor has a reduction gear drive and was designed for 28 volts dc. The 12 volt system in the automobile made it run at about 4 or 5 rpm which is a comfortable tuning speed. If desired, a speed control potentiometer (R_1 in Fig. 4) can be added to the motor control circuit. The size of R_1 for best results for a particular motor can readily be determined by experiment. It is necessary to obtain a similar motor regardless whether a capacitor or rotary inductor is used for the tuning element so the requirement for a motor is not a disadvantage for this unit. Similar motors with satisfactory performance can be purchased at many surplus stores. The rotary switch shown in Fig. 2 inserts a fixed capacitor in parallel with the variable capacitor for half the tuning range to double the capacity range. The switch is of the shorting type with half the contacts bussed together and adjusted so it inserts the fixed capacitor into the circuit as the variable capacitor is passing through maximum and removes it as the variable capacitor passes through its minimum. To assure maximum continuous coverage, the fixed capacitor should be as large as the maximum capacity of the variable capacitor minus the minimum value. That is, for a variable capacitor with a range of 30 to 300 mmfd, the fixed capacitor should $300 - 30 = 270$ mmfd. A curve of capacity



versus rotation for this unit is shown in Fig. 3. As a further refinement, the switch could have been a double gang type and the second section could be used to light indicator lamps or drive a meter through different sizes of resistors to indicate the position of the drive shaft and hence, by experience, the antenna could be nearly tuned before applying transmitter power. A slightly more elaborate though more precise arrangement would involve coupling a continuously rotatable potentiometer to the drive shaft to drive a position indicating meter. Both sides of the capacitor are "hot" so it must be insulated from the box





and the motor and switch coupled to it by flexible insulated couplings. A circuit diagram is given in Fig. 4 where the dashed lines indicate mechanical coupling. A speed control potentiometer, R_1, and a motor reversing switch are shown at the remote control site.

In operation the tuning unit is inserted in the transmission line as near to the antenna terminals as possible. With the tuning unit in its maximum capacity position (just past 180° in Fig. 3) the antenna and capacitor combination is resonated at the low edge of the band of interest. The resonant frequency is then raised up through the band by decreasing the capacity of the tuning unit. By good antenna design and a judicious choice of tuning unit capacity the resistice component of antenna impedance can be made to stay near the characteristic impedance of the transmission line resulting in a low standing wave ratio across the band. While this unit was primarily designed for application in mobile installations, it can be used with any antenna that can be tuned by a single element at its terminals such as dipole, long wire, and vertical antennas. The unit pictured above was used successfully for two years in the author's 60 watt, 80 through 10 meter mobile station. Tuning was accomplished by operating the unit until the plate current meter indicated the antenna was loading. Crude but effective. Obviously for high power levels the antenna should be at least approximately tuned before applying transmitter power.

The almost endless combination of motors, capacitors, switches, potentiometers, and the like permit the unit to be built according to the designers partictular requirements, desires, finances and/or size of junk box, and is limited only by his imagination.

. . . W8HOA

Recipe for Cooked Ham

Ken Johnson W6NKE
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Canoga Park, Calif.

TAKE ONE LARGE MEASURE of high voltage. Add to this various tubes, transformers and wire. Stir in some poor insulation and a bit of carelessness. Add a few unfused circuits, a couple of poor grounds and a spoonful of thoughtlessness. Throw in a ham and mix well.

It's quite possible that the ham may end up well cooked, although the time element varies with luck and the quality of the ingredients. This type of ham could be served up with all the trimmings, not in the gourmet atmosphere of a fine restaurant, but as the main course at the local morgue. Let's make it a point to avoid being on the menu at the latter establishment.

As a well known advertisement says, "don't be half safe." Take a good look around your ham shack and ask yourself, "how safe am I?" If you make a close check, chances are that you'll find some questionable wiring or a high resistance ground lead lurking in some corner.

Whether you run high power or low, the potential hazards are still there. Wherever electricity is found, so are the possibilities of fire and lethal shock.

Safety for the ham begins at the light socket, or power service outlet. Make sure that the size of wire used is sufficient to carry the required current and that the insulation is in good condition.

Design proper fuse protection into all of the primary circuits in your power supplies. Fuses are inexpensive and they may save you and your gear from disaster at some future date. Don't wrap lead foil around burned out fuses or use solder in the fuse clips as a temporary measure. Find out what blew the fuse and fix it before turning the power on again.

Select wire of the proper size and with adequate insulation when doing your circuit wiring. If you plan on harnessing your wiring into a cable, pay particular attention to the latter. The difference in potential between two adjacent wires may be very high and an insulation breakdown can cause no end of trouble, expense and danger.

Make sure you have good, low resistance grounds wherever they are required. The ground leads should be kept as short as possible to provide maximum effectiveness. Once your transmitter or receiver is completed, use great care in giving it its operational checks. Keep your hands in front of the panel, away from high voltages while the power is on. If adjustments are necessary, make them with the power off. If this is impossible, keep one hand clear of the chassis and make the adjustments with the other. This may seem rather awkward but you will avoid making a complete circuit through your body if you should accidentally touch a hot spot.

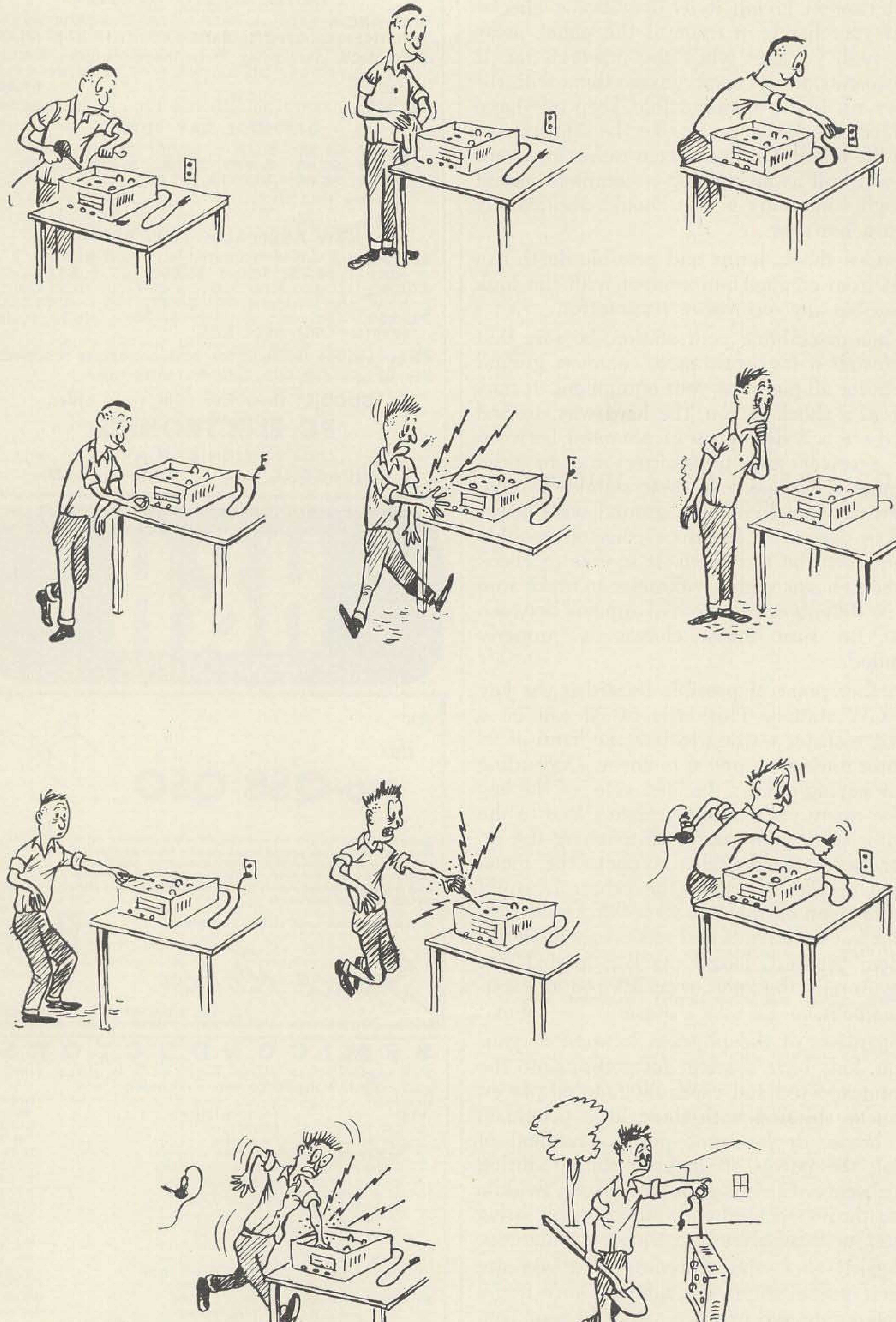
Serious shock, burns and possible death can result from coming into contact with the high voltages in any receiver or transmitter.

When assembling your station, be sure that you install a low resistance, common ground system for all pieces of your equipment. It may come as a shock to you, the hard way, to find that there is a difference of potential between your receiver and transmitter due to poor grounds. Each piece of gear should be connected to a good common ground with heavy braid or wire using lengths as short as possible to minimize the resistance. It is wise to check between chassis with a voltmeter to make sure that no difference of potential appears between them. Be sure every chassis is properly grounded.

Another point of possible hazard is the key in a CW station. This little rascal can be a lurking monster waiting to bite the hand of its operator during a careless moment. Depending on the keying circuit, the "hot side" of the key can be many volts above ground. Woe to the operator who, with one hand touching the receiver panel accidentally contacts the metal surface of the key with the other. It could bring his ham carrier to a screeching halt. Low voltage keying circuits and relays can solve this problem. At best, locate the key so that you can grab only the knob or paddles in an exciting moment.

Regardless of the physical location of your station, kids have a talent for getting into the most unexpected and carefully guarded places. If you are blessed with these little people in your home, devise some positive method of locking the power off in your station during your absence. Curious little fingers can twiddle knobs, throw switches and quite possibly bring disaster to themselves and their surroundings.

Regardless of who, where or what you are, there is no substitute for safety. Don't forget to incorporate and practice safety in your ham shack. If you must, go out and get "boiled" at your favorite tavern on a Saturday night, but don't take the chance of becoming a "cooked ham" in your ham shack. . . . W6NKE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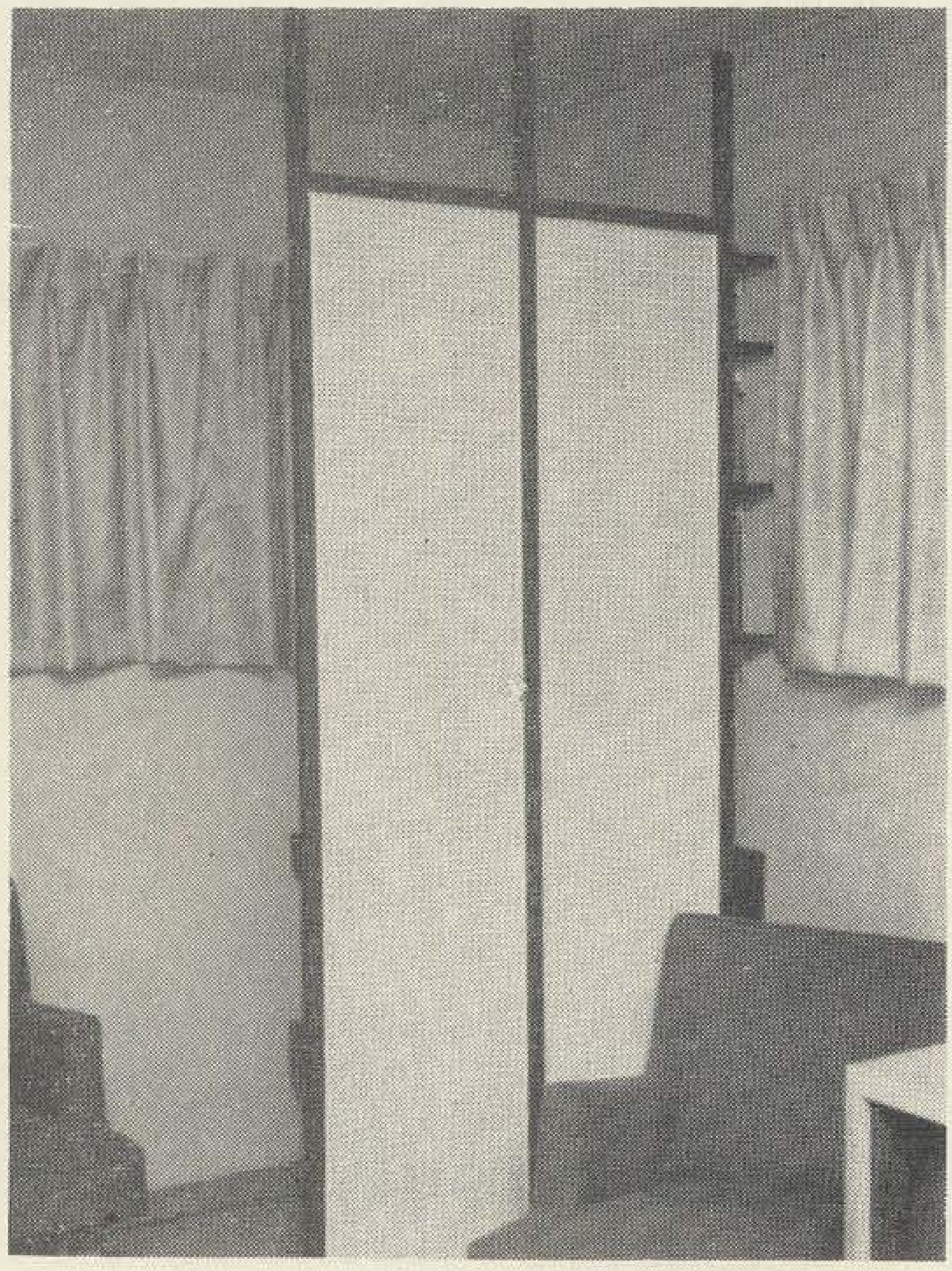
THE CURRENT PUBLISHING of many fine construction articles on electronic equipment and the appearance of a multitude of electronic kits on the market, by a host of manufacturers, covering just about every electronic component imaginable, would indicate that a large amount of home construction is being undertaken. On the other hand, the ever increasing presence of ready-made commercial amateur equipment on the air would indicate that a great number of hams are missing out on a very interesting and vital aspect of our hobby.

Among the reasons for this can be listed a very important one that usually escapes notice: the non-construction ham may simply not have a convenient place to work. At the very best, the usual workbench is an eyesore that is relegated to the basement or the garage, along with its owner. Even when a workshop is installed in such a location, the time spent at it can become a problem.

Fortunately, modern styling of amateur equipment has allowed the emergence of the amateur station from the attic or basement to the family room or den, placing ham radio operating on a more acceptable social level with other hobbies, such as collecting stamps or tropical fish. If the humble workbench could be given a similar face lifting, its stature could also be brought to a point where it too could be accepted into the habitable sections of the home.



Such an undertaking recently became a necessity for me since at this QTH there is no basement. In addition, the attic is unfinished, making the temperature unbearable except for a few days each spring and fall. As a result, for a period of time, construction projects had fallen to zero, and it was a rare instance when all the ham gear, hi-fi, TV's, etc., were all in working order due to the difficulty encountered because of the lack of a suitable place to work on them.

For the ham construction type of work to be undertaken, two places were actually needed:

1) A location with a good solid bench for metal and wood working—a place where the chips can fall as they may.
2) A well lighted, comfortable spot where assembly, wiring, and testing can be done.

The former may never achieve respectability. Fortunately, the heavier work occupies the smaller amount of time and the location can be remote. The old 200 pound monster made from 2 x 6's that had been used in previous QTH's was set up in the garage supporting a drill press, grinder and heavy vise. The car has to be backed out to use it, but that is not a real problem.

The latter activity is the part of home construction that consumes the majority of time and provides the most fun. Convenience would be achieved if it could be worked into the family room without ruining the appearance. Flushed with confidence from the success of not only installing the station in the spare bedroom used as a family room, but in having the XYL and Junior Ops pointing it out to their friends with pride ("Daddy talks to people all over the world on that"), I undertook to gain similar acceptance for a small workshop.

In considering possible solutions to the problem, the closet idea was judged impractical because there are no spare closets in this house. The folding-workbench-that-converts-into-a-beautiful-piece-of-furniture idea was likewise discarded because of the woodworking skill required. The answer was to locate it in the far corner of the room and hide it with a disguise.

A lightweight 2'x3'x30" bench was made from ½" plywood and 1"x3"'s. This size was selected for several reasons. First of all it has casters and will pass through the doorways, making it very handy to wheel about when working on heavy components such as the final amplifier or TV. Secondly, the work surface is the height I prefer. Finally, the work area is the largest that was practical after the other considerations. A full size bottom shelf adds structural rigidity and serves as the location for the tool boxes.

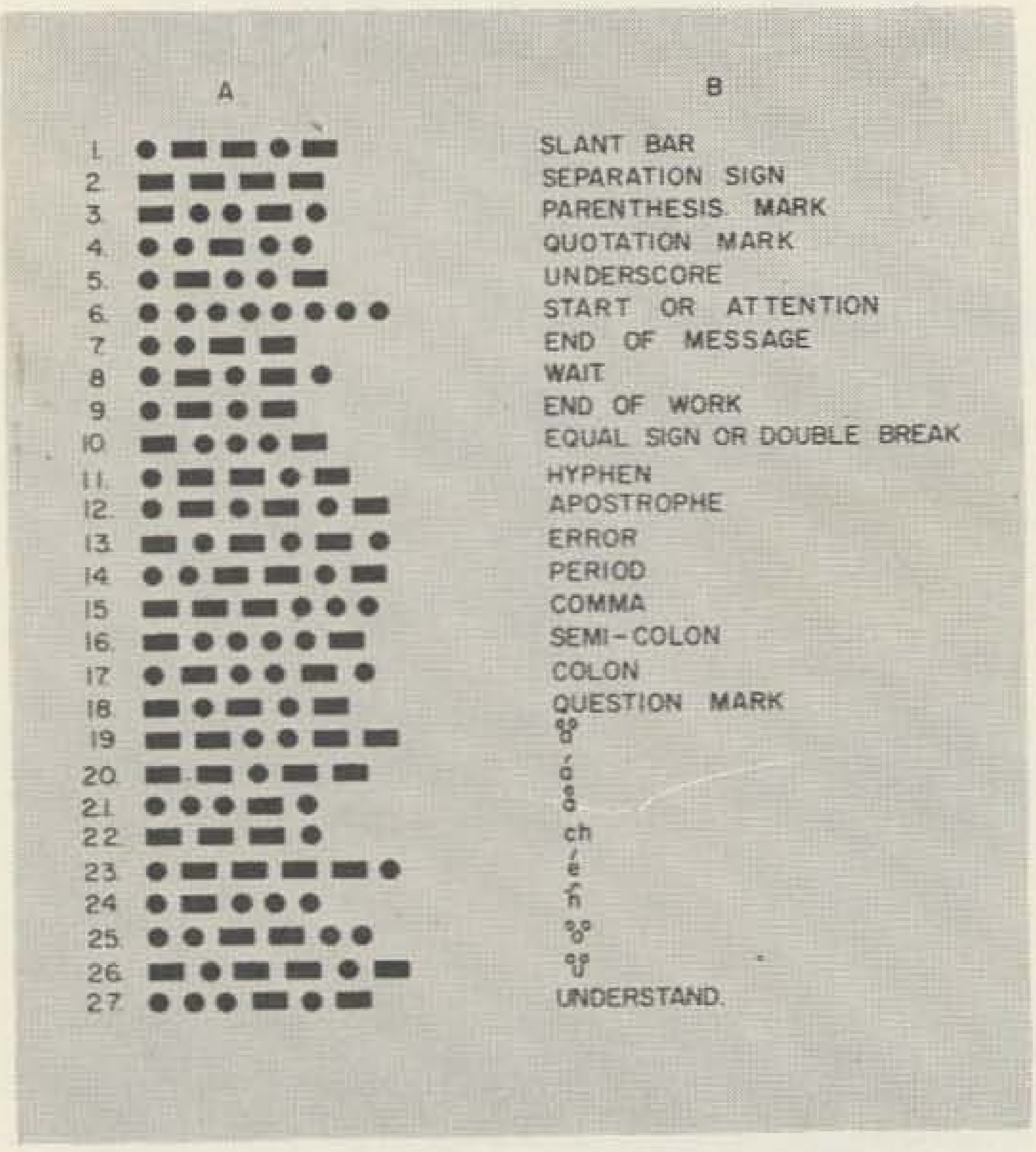
Four adjustable shelves, utilizing a clever bracket assembly obtained at the hardware store, were mounted on the wall above the bench to hold the smaller test equipments and parts. Electrical outlets were mounted on the workbench for convenience.

The disguise is a combination of a magician's illusion and a current decorator fad. The bench and shelves were painted flat black and located in the corner. A 3'x6' perforated decorator screen was placed at the side and the lighting in the room arranged so that the work area is not illuminated, except for work lights, of course, and the light that filters through the screen. When viewed from the sitting area of the room, the screen hides the workbench yet does not give the impression of reducing the size of the room. The black painted wood blends into the perforated pattern of the screen and cannot be seen.

The screen was constructed from a kit purchased from the local hardware store and cost about $15.00 for everything, including paint. The hardest part is the tongue and groove arrangement suggested by the manufacturer. Simple angle brackets were used instead, making the entire assembly much easier. After painting, the angles were not visible.

The scheme had worked perfectly. Not only is it very convenient and pleasurable to use, but the time available to use it has been more than any other previous arrangement, since it is in the room where leisure time is spent. The TV stays in operating condition and construction projects are completed without my disappearance into the basement.

A final word of advice; since it is rather radical to bring a workbench into the living area, it is essential to its acceptance that it never be called a workbench. Always refer to it as something more glamorous, such as the "Electronic Laboratory" or "Development Center."



Do you really know the code?

Carl Drumeller W5EHC

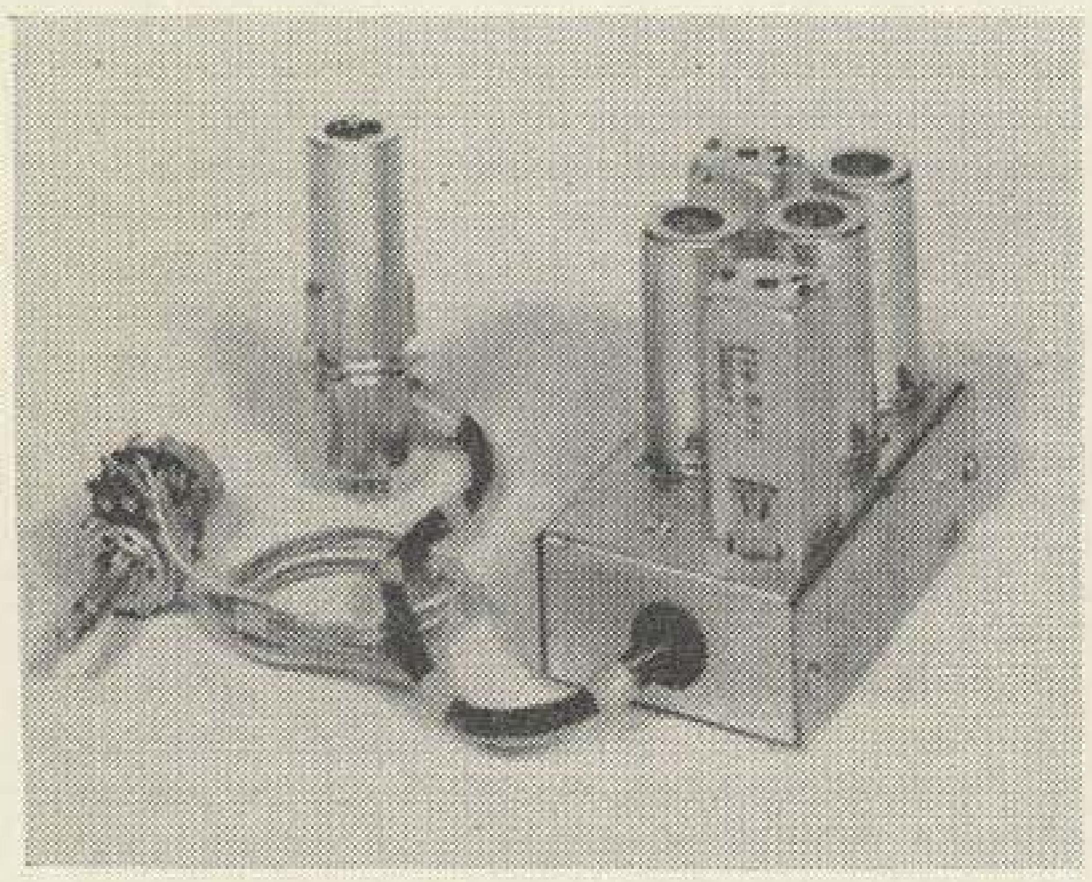
Every person holding a FCC-issued amateur radio operator license can, unless he is a liar, copy the International Morse Code at a speed of five words a minute or greater. Ah, yes? Do you think you know the code well enough to recognize the written symbols (dots and dashes) when you see them? Then try your hand at matching the dots-and-dashes in column A with the meanings given in column B. They're all from the International Morse Code!

For the answers, turn to page 87.

Coming Articles

General Coverage with S-line, K1DBR
Sixer & Twoer Modifications, K1GHO
Rotten CW Circa 1963, W1GQJ
Transistorized RTTY Converter, W1JJL
Putting Up a Quad, K2AAC
HE-45 Modifications, K2GOI
6DJ8 Converter for 6M, WA2HVK
Dual Mobile Antenna System, W2IAZ
Case for Balanced Pi-Net, W2LHB
Effective Filter Design, W2OZY
HE-35 Portabilized, W3IKH
Compact Full Size 20M Beam, W3PMV
Minute Motor, W3WPV
Last Word RTTY Converter, W3TUZ
Bandswitching Relays at VHF, K4GRY
Twin-City TU (RTTY) Mod., K4GRY
Tuned Feeders Forever, W4RGR
ARR-15 Conversion, W4WKM
RT-45/ARQ-1, W4WKM
ARC-5 Receivers, more, W4WKM
BC-230 Conversion, W5EHC
Bandspreading the BC-348, W5EUL
Product Detector with One Tube, K5JKX
Simple AC Current Adapter, W5KKB
Power Xfmr to Fil. Xfmr conversion, W5VOH
12 Volts from 6, K6BIJ
Not Generating TVI, K6BIJ
Full-Wave Tripler Myth, W6LWE
Push-pull 5763's on 144 mc, WA6SIZ
VHF Yagi's from TV Antenna, W6TKA
Two Meter DSB Adapter, W6TKA
Two Meter Coupler/SWR Bridge, W6TKA
Electronic Genius Confessions, K6UGT
Code Monitor for CW Man, WA6UVS
Panadaptor Converter ($10), K6VNT
Operating Table, WV6WAV
ARC-5 Modications, W7ATK
DX-60 Vector VFO, W7IDF
Bandswitch Swan 175 to 20M, W8DHZ
UB5UG's 5 Band Vertical, W8FAZ
Using the SWR Meter, W8JWP
Compact 40/80M Antenna, W8MPD
The Value of Two Meters, W8VVD
Preparing to be a Silent Key, K9AMD
Nu Nuvistor Approach, W9DUT
Vertical Antennas, W9EGQ
Mobile Field Strength Beefing, W9NTP
Noise Generator, K9ONT
98¢ Surplus Pre-Amp, W9SLM
VHF Tunable Oscillators, KΦCZD
Automated CW, DJφHZ
European Mobile DX, G3BID
Directional Coupler Indicator, VE2HE
How to Beat High SWR, VE3AZX
Novel Ground Plane Antenna, VE7BBM
DXpedition to Aldabra, VQ9HB
Video Modulation, W8VCO
R-48/TRC-8 220 mc Bargain, K3IUV
End of Line Indicator, K8IQY/K8TAC
Kitchen Heat Sink, WφCGQ
Antenna Fact & Fiction, K6CTV
The Trouble With Fred, XYL G3MRN
Cheap Phone Patch, K5HPT
Remote Antenna Tuning, WN2CQM
Radio Astronomy, WA2BWQ
Practical V Beam, K1MRK
SWR Meters, W2KPE
Amateur Radio in Britain, G3FPK
Further on the Windom, W3AFM
Diode Frequency Doubler, K6AI
Conquering Fading RTTY Signals, W5KEK
Rig Here is Homebrew, W5HJV
6/10 Meter Mobile Antenna, W3GSC
High Capacitance VFO, YU1FR
Constant Gain Audio System
Selective Audio Bandpass Filter
Transistorized AM/SSB rig
The VR Tube
Compact Transistor Circuits
ZL Special for 40 Meters
Diode Noise Generator

New Products



Noise Silencer

Owners of Hammarlund HQ-170 and 180 receivers should get in touch with Hammarlund immediately about adding a heavy ignition or pulse type noise silencer which has been announced. This accessory sells for $33.50, uses three tubes, and works on all modes of reception. Hammarlund, 460 West 34th Street, N.Y. 1.

SSB Power Tube

Home constructors and engineers may well be interested in the new Amperex 8300, a twin tetrode with instant heating filament for mobile SSB rigs in the 200 watt input range. 73 would look favorably on an article on a rig using one. Write Amperex, 230 Duffy, Hicksville, L.I., N.Y. for specs. Mention 73.

New-Tronics

has one of the most complete lines of mobile antennas and accessories we've seen. You'll certainly want their new catalog 68NC. Write New-Tronics, 3455 Vega Avenue, Cleveland 13, Ohio.

Waters Coupler

Owners of a Waters Universal Hybrid Coupler that haven't sent in their warrantee postcards (about 80% of the owners, unfortunately) will have to write for the modification sheet on this unit which tells how to get even better operation with tape recorders. If you have one of these couplers you'd do well to get on their list. If you don't have one then rush out and buy one and get on the list. Don't miss this list. Waters Manufacturing, Wayland, Massachusetts.

Six & Two Meter Converters

Lafayette now has a six meter converter (Model HE-56, $29.95) and a two meter converter (HE-71, $31.95) available. The outputs are 7-11 mc for both and they have built in power supplies so you don't have to sap your receiver. Questions? Write Lafayette, 111 Jericho Tpk., Syosset, L.I., N.Y.

RTTY Award

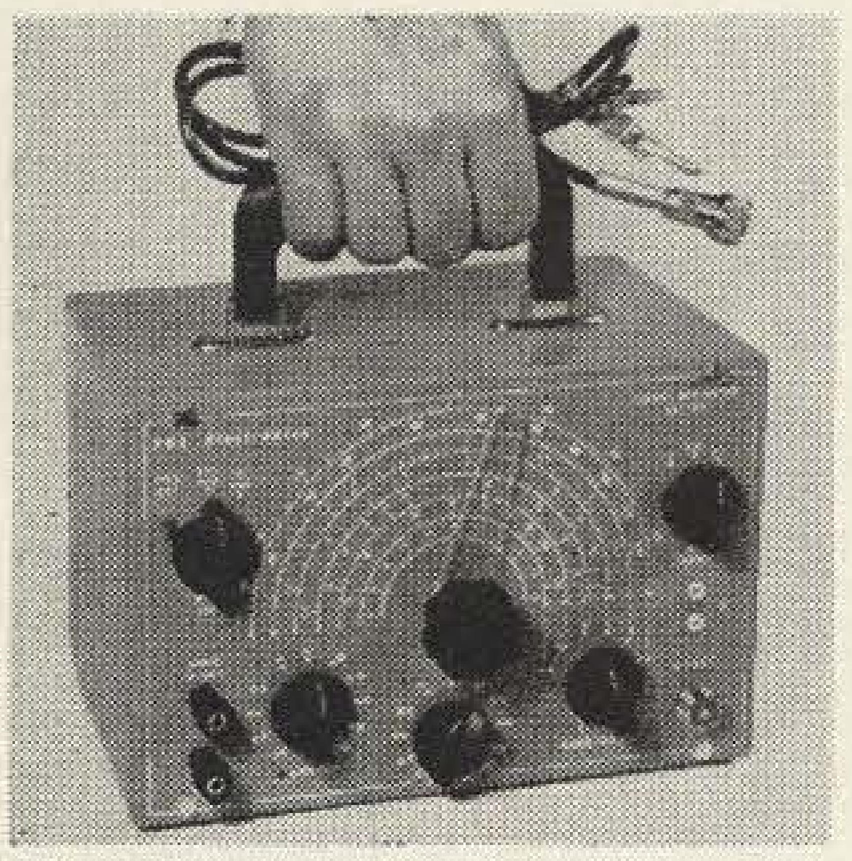
The RTTY Bulletin, Box 6047, Daytona Beach, Florida has a nice certificate available for RTTYers who can produce QSLs showing two way RTTY contacts with all 50 states. Send cards, get back cards plus certificates.

Catalog

The 1963 model International Crystal catalog is now out and you'll be sorry if you don't have one. They have quite a collection of small circuits and power supplies available in addition to crystals for any application you can imagine. 18 North Lee, Oklahoma City, Oklahoma.

40 & 75 Meter Dipoles

New-Tronics Corporation has announced their new rotatable remotely tuned dipoles which are available for 40 and 75 meters or a combination of both frequencies. They tune across the entire band from inside the shack, are fed with 52 ohm coax and use no traps, baluns or matching devices. Will handle a full kw. The largest model is only 31 feet long. Maybe you'd better write for full specifications on this one, eh? It can probably do a lot for your signal on the lower frequencies, particularly if you are a bit short of antenna space.



Transistorized Signal Generator

Quite a package. 135 kc to 120 mc on fundamental and up to 240 mc on harmonics; battery powered; 3 lbs.; internal or external modulation; crystal test oscillator; $34.90 in kit form. Write Pel Electronics, 214 Main Street, Hackensack, N.J.

Globe and Subscription: $16.95

If you shop around carefully in other ham magazines you may be able to find this very same globe with no subscription bonus being sold for a paltry $19.95. When you think it over carefully I am sure that you will see their point and order a globe from them for it certainly is worth that three dollars extra not to have another year of 73 to worry about.

In case I have not been as persuasive as usual and you still insist on ordering this terrific 18" diameter (nearly five feet around the equator) world globe and the one year subscription or renewal that goes with it whether you like it or not (unless you are a life subscriber in which case drop us a line for your special deal which I daren't publish for fear of starting a rush for life subscriptions). These plastic balloons are guaranteed, so don't grumble about what happens when it gets old. I have two of them that have been kicking around for over seven years now and they are still going strong. Use them all the time. Deflate 'em when going to hamfests or moving. Just jot your name, address, call, new or renewal sub (give expiration date if you know it), and bundle this up with cash, check or money order (U. S. or Canadian) and send it to us: 73, Peterborough, N. H.

Speech Clipping

THE ARTICLES IN amateur magazines extolling the advantages of speech clipping have apparently not all been in vain for we find that some commercial units are now appearing to accomplish this function. In addition to the C-Y Electronics "Chatterbox" which we reviewed in the December issue of 73 (page 19), there is the Speak-Easy, being manufactured by Instruments and Communications, Inc., down in Wilton, Connecticut.

Rather than have you flounder back through your magazine library or pull a strain lifting down the new Editors & Engineers Handbook to find out about speech clipping, we'll indulge in a short non-technical discussion.

First let me explain, no doubt to the horror of the manufacturers who are intensely emotionally involved with this, that a signal with the speech well clipped sounds lousy. It sounds loud, distorted, and unnatural. It is.

Under normal conditions, if you ever happen to run across normal conditions, it is very annoying to sit and listen to all the racket put out by a speech clipped rig. The difference comes when you are trying to eke a weak signal through the noise, at which time the clipping makes a world of difference and you bless every db of clipping and the redundancy of our English language. That noise, incidentally, can be from Papa Thor, ten W9's on the same frequency, the razor next door, or from your first rf stage. Clipping helps.

Someone always wants to know how things work, so I suppose we should at least give a hint, or maybe pile confusion upon confusion. It's like this. Our voice is made up of a bunch of sine waves of many frequencies. Some of these are high (loud) and many are wee. The result of this is that when we set the gain control of the transmitter so that the peaks of the voice reach 100% modulation, the average modulation is quite low. If we put the voice sine waves through a clipper, we shave off the tops of the higher sine waves until we are down to the lower ones, making our speech into more like a series of square waves, all reaching to the 100% level. Our average percentage of modulation can thus be increased tremendously. You can go too far with this, of course, and end up with something that is hard to recognize. Oh, you have to put a little filter in there to smooth the sharp corners of those square waves elsewise you will have a very broad spattering signal, for these little square edges are actually high audio frequency harmonics which make your signal occupy more than the regulation 3 kc sideband.

If your ham operating is of the rag-chew-with-local-station variety then you will have little need for a clipper. CW-only operators may also feel that this is of little moment for them. But if you occasionally attempt to get in over your head and wrest a QSL from one of the choicer DX stations, or try to work out a little on the VHF's, or attempt anything at all on 20 meter phone, then you might well consider building in a bit of clipping or buying one of the commercial units.

The C-Y Chatterbox ($24.95) connects between your mike and the speech amplifier and is transistorized and self-powered. The I & C Speak-Easy is a small console job, complete with modulation percentage meter, which connects into your transmitter or transceiver. We found the connections to the Clegg 99'er to take only a few minutes and that the Speakeasy not only was a help with its clipped and filtered audio when things got tough during band openings, but that the modulation meter on the front panel was edifying and assuring to watch as we talked. It eliminates any guessing about how well you are filling out the carrier and you can back off from the mike as much as you want, correcting for the distance with the gain control and know how you are doing without having to ask.

The Speakeasy comes in kit form for $24.95 and gives you quite a lot for that price. The kit goes together easily, being mostly a printed circuit board. You can spend $34.75 and get the unit ready to connect to your rig. The Speakeasy is available at most radio parts distributors or from Instruments & Communications, Inc., 33 Danbury Road, Wilton, Connecticut.

. . . WAYNE

Letter

Dear Wayne,

I have always been particularly impressed by your magazine's articles on the modification of ham gear, but your January cover has out done them all! Imagine! A modification of the U, S & A!

A moment's thought on this momentous undertaking leaves me with a few doubts. How are your Brooklyn offices managing now that Long Island has apparently sunk into the sea? And don't you think the self-styled anti-communists of California will be enraged to find that the Florida Keys have been ceded to Cuba? Personally, I am delighted to find myself living in a new state made up of what was formerly Illinois, Wisconsin, and Michigan's upper peninsula. But I wonder how the boys on the upper peninsula will now sign their calls. W8XYZ/9? W8/9XYZ? W9/8XYZ? Well I'm sure something can be worked out.

I'm certain North Dakota will be happy with its acquisition of half of South Dakota. South Dakotans need not worry, for their state has absorbed all of what used to be Nebraska. Not to be out done in this coup d'etat, Nebraska has retained its original shape and devoured Kansas, which no longer exists, except for the members of a provisional government who are being sheltered, I understand, by some subversive Oklahomans. Our friends in Nebraska have really done it up well. They've put a big chunk of Colorado out of business too.

Perhaps in the near future you'll run an article explaining how this conversion was accomplished. Oh well, it probably starts out "First remove all wiring and components except the fuse holder in the upper left. . . ."

Seriously, Wayne, I enjoyed the January issue as thoroughly as I did all the others. 73 continues to be my favorite of the big three.

In reply to your editorial inquiry, the best way to get me to subscribe instead of buying from the newsstands would be to make sure that new subscribers start getting their copies within a reasonable time. I have a few friends who sent their money in October, have received cancelled checks, and have just bought the January issue at the newsstand.

Usually I find my head bobbing up and down as I read your column each month, but this time I found it swaying from side to side as you suggested that it was my duty to keep the ham magazines in business. I've always thought that it was a businessman's duty to keep his product worthy of continued consumption. QST is an

SSB Dinner March 26th

The Twelfth annual SSB Dinner will be held at the Statler-Hilton in New York with displays opening at 10 AM (73 will probably be there) and dinner at 7:30 PM. Steak dinner is $12.50 if you pay in advance: SSBARA, Buddy Robins W2JKN, 4665 Iselin Ave., New York 71, N. Y.

Mobile Rally in Belgium

Word from the Amateur Radio Mobile Society (G3BID, 5 Ferncroft Avenue, London NW3) tells of an international mobile rally to be held April 28th (Sunday) in Verviers (Eastern Belgium). If you are going to be driving around Europe at this time make it a point to be there.

excellent example of this. I haven't bought one copy of that rag since they began insulting my intelligence by begging for contributions to their ridiculous building fund. What is the ARRL becoming anyway, a church? At any rate Wayne, keep up the good work and I'll keep on buying. And if it appears that I can expect prompt delivery on a subscription one of these days, I'll send you a check.

If you've managed to get this far, thanks for listening. One day soon I'll re-do a map of the Soviet Union, and perhaps you can use that on your cover.

Dale Ulmer, WA9CZQ

All 73 readers except Dale get two demerits for missing the map that I hid on the cover last month. Heh, heh! And I even gave you a broad hint on page one too. Tsk. Now, about those subscriptions; whooey . . . what a problem. Just a little over a year ago the cutting and filing of subscription stencils began to be too much for us to handle by ourselves without quite an investment in larger machinery. I spent weeks trying to solve the problem. Finally I farmed the job out to a commercial firm that specialized in this and everything ran fairly smoothly until last September. Our first issue was in October 1960, so everyone who had a subscription from that first issue came up for renewal in one big lump. During September and October we had well over 10,000 renewals in addition to the usual number of new subscriptions. This did it. I began to suspect that all was not well by late November when the complaints started coming in. By mid-December I was ready to commit mayhem if an ulcer didn't finish me off first. I called and called, getting the same message each time, "We'll have everything caught up in a few days, don't worry. Send us the complaints and we'll check them for you and print the stencil on it to prove everything is OK." By Christmas (Merry Christmas!) the complaints were outnumbering the subscriptions and some of the more sour dispositioned of our readers were accusing us of fraud, Better Business Bureau, post office violations, and so forth. We may be TARFU, but we're not crooked, so the few who got definitely unpleasant received refunds of their subscriptions and a note saying that no further subs would be accepted from them, ever. The only solution to this whole miserable problem was to buy the machinery, hire the help, and move the stencil department up here with everything else. The machine cost well over $1000, counting the needed accessories. Special typewriters ran up the bill even more, plus the time and phone calls to locate all this. We've hired two new girls to handle the stencils and subscriptions. And we had to cut down to 80 pages with the January issue to help get us through the unexpected financial drain. We'll have everything moved up to New Hampshire by the time you read this and I think we'll be able to keep things running smoothly this way. My apologies to everyone who suffered with us through this growing pain. Now, the last item Dale, and I came close to editing this out of your letter, being held back by some vestiginal shreds of journalistic honesty which whispered to me that, right or wrong, you have a right to say your piece. Is it really fair to pass moral judgment on the League as you have done without knowing all the facts? After all, the decision to finance the new headquarters building (did you see the picture of it in the January QST on page 62? It is immense!) by donations from League Members was made by the Board of Directors. I am sure that the Directors of the League must have had adequate and good reasons for this move and that, if we knew them, we would understand and approve. . . . wayne.

(W2NSD from page 6)

quered by the U. S. at any time in history . . . etc. Permission is hereby specifically denied for any of these awards to be listed in the Directory of Certificates and Awards or in CQ Magazine. These are our awards and *only* 73 readers should know about them.

IoAR

The deadline is drawing near for anyone who is considering going along on our tour of Europe next fall to join the Institute. The rules for a charter flight specify that everyone must have belonged to the chartering organization for at least six months before the flight. When you consider that the normal fare for a round trip economy (the cheapest fare) to Rome is $630, you can see that our group fare of $500 round trip, including London, Paris, Geneva, Rome and Berlin plus accommodations and breakfasts in these cities qualifies as quite a bargain.

If enough west coasters are interested we can arrange for a second group to leave from Los Angeles, but this will up the cost a bit, naturally. Even so this is probably one of the most economical ways to make the trip and it will be with a group of fellow hams, which will make it a lot more fun than such a trip would be if you were all alone.

We are making arrangements for hospitality during our visits to the five cities. Between the RSGB, the REF, the International Ham Hop Club, The DARC and other clubs we may be able to meet local hams and get a nice personal welcome to each city. Those of you who are planning on making the trip might start looking for DX hams near or in these cities and finding out what points of interest they recommend.

In order to keep the total cost of the trip down to ham level, I wil make reservations at second class hotels. Those of you who have traveled to Europe or who have read "Europe on $5 a Day" (excellent book), will know that this is the best bargain in such travel for the hotels are spotless and are different from the first run expensive hotels in that they are usually smaller, located around the corner on a smaller street, and are more friendly. These are the hotels that the Europeans use and they are a lot different from the expensive American type hotels. The trip will be one you will never forget and one you will want to make over and over, once you have tasted the delights of Europe.

The enthusiasm for our European trip has brought in several suggestions for further trips and we have tentatively started planning for a 1964 spring trip through Mexico, Central America, across northern South America, up the Leeward and Windward Islands and back. In the fall of 1964 we figure on running a flight to Oslo, Stockholm, Copenhagen, Helsinki and Berlin. If you have any other suggestions let us know and we'll see what reaction we get from the IoAR members. Obviously I cannot be a tour director on so many trips, so were open for any volunteers that have the know how to set up the plans and who would like to work on this. This might be something ideal for one of our retired hams to get his teeth into. We'd like to have all trips be made for the lowest possible cost per person, with just a small profit left for the Institute to help it grow and be able to thus finance further trips.

Charter members of the Institute (those who joined before Dec. 31, 1962) will have first choice of seats on all flights. On many planes charter groups have a number of first class accommodations available and it is a lot more comfortable to fly in these. Charter members will also, in effect, get their membership donation of one dollar back if they mention Charter membership to the IoAR on their next subscription renewal to 73 and send us one dollar less than the regular subscription fee for the magazine.

Vitriol

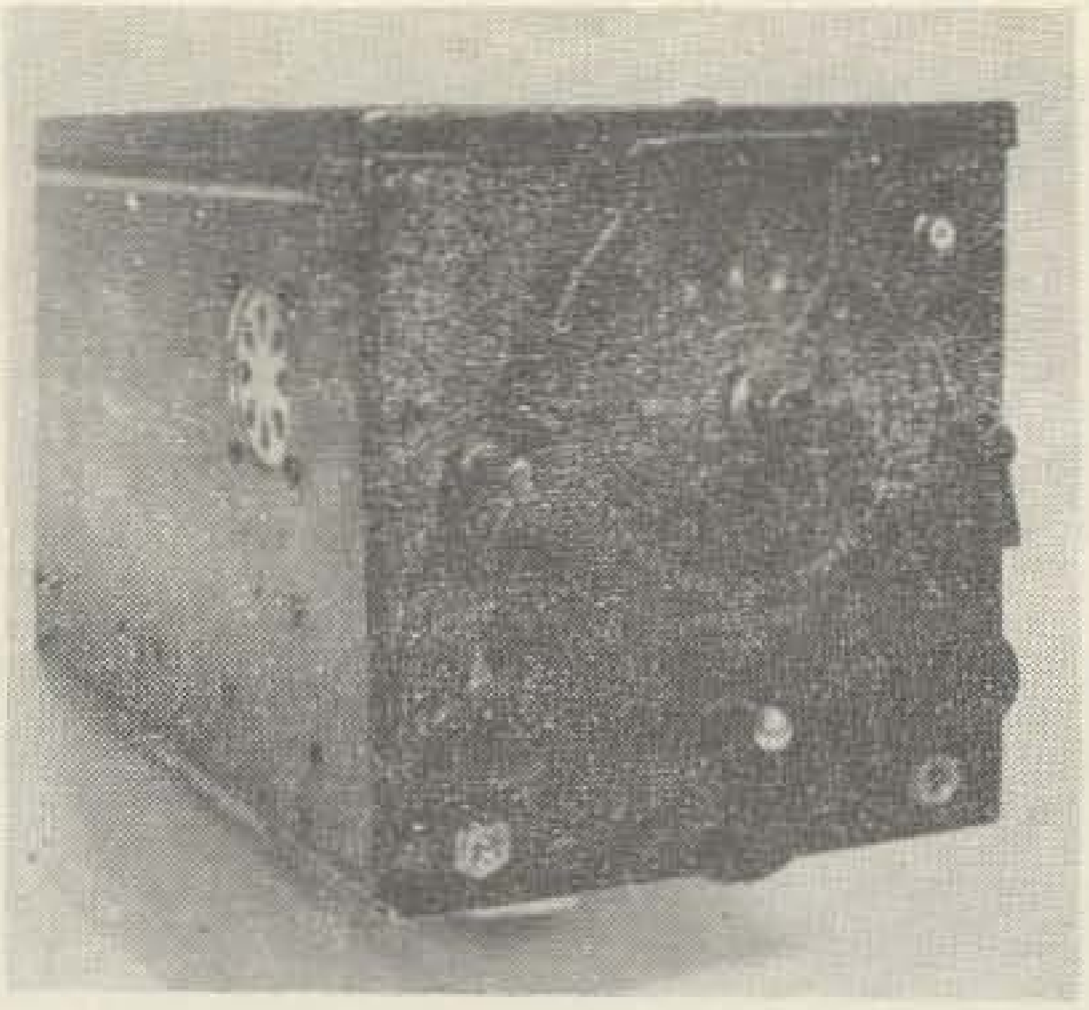
It is annoying to see the ARRL being so viciously attacked by CQ's OLD MAN, particularly when he is so completely off base in his criticism. While most of the ham publications, club bulletins and such are doing yeoman work in building up our hobby, it is painful to see a couple of mimeographing Californians swinging an axe at our underpinnings with such bitter determination. Those of you who are on the mailing list for this trash would do everyone a favor if you would protest this destructiveness and/or ask that you be removed from the mailing list.

CB or Not CB

The FCC has proposed some new regulations for the CB'ers. These rules are obviously aimed at eliminating the ham type of operation from the Citizen's Band and, if they are adopted, there may be several thousand displaced CB'ers working for their Tech tickets. I suspect that along this Spring some time there may be a great demand for articles on converting CB gear for six meters. This may have a temporarily depressing effect on the CB manufacturers, but perhaps we will find them following their market to the ham bands.

On the other hand it is entirely possible that carelessness of the FCC, in their original writing of the regulations and their subsequent lack of clarification or enforcement may come back to haunt them. Tens of thousands of fellows have invested in CB equipment to pursue the hobby of CB chit-chat and they may be a force to be reckoned with.

. . . WAYNE



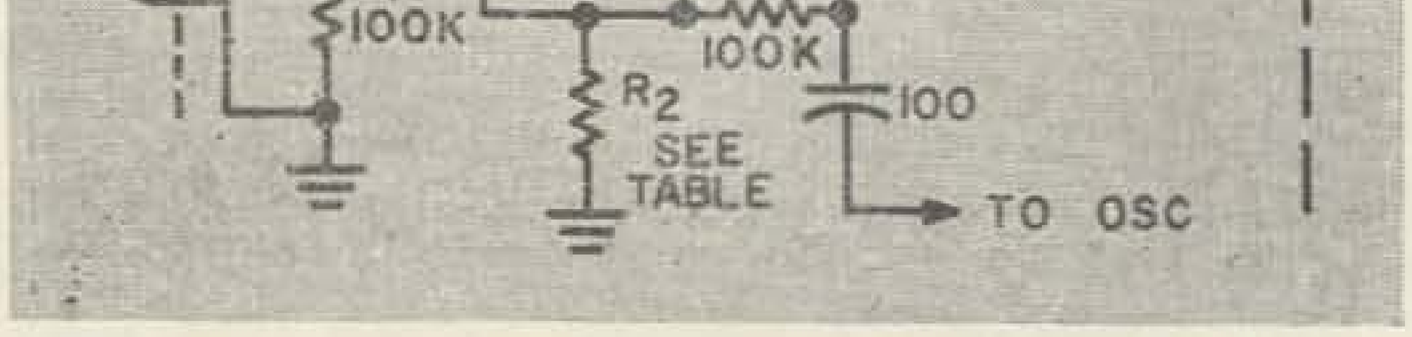
Like New RAX

Edwin Cole W7IDF
P. O. Box 3,
Vashon, Wash.

JUST WHEN I THINK OUR World War II surplus has been thinned out somebody comes up with a new idea that makes working the old diggings profitable again. Green's Impartial Statistics Agency regularly proves with sly pride that 73 is the best source of such fresh thinking on the technical front. And sure enough, look at page 32 of the October 1961 issue, and the letter from K6BHN on page 39, May, 1962.

The "Like New Mixer" plus one RAX-1 (more about this later) can provide a receiver with superior signal-to-noise ratio and more than adequate stability for sideband service. For a very few bucks you can supply drift-meter readings to your friends on the round table. They like to know when they slide around and will compliment you on your accuracy, honesty and gall.

My first thought was to turn the mixer circuit into a converter type front end as simply as possible. My second thought was to buy an RAX-1 for the tuneable intermediate frequency section. Two thoughts per project is my normal workload. A nine turn length of 3011 Miniductor with a three turn link and a broadcast variable were added where "existing circuit" is indicated in the "Like New" circuit. This junk-box expedient tunes forty and twenty. The coil is ¾ inch diameter, sixteen turns per inch. A 12AT7 was used for the mixer, and half of another one for a Pierce oscillator to take care of the beat generation. Despite the socio-economic pun this combination works well enough that ideas of an rf stage and a more sophisticated oscillator were abandoned. I suspected that with the feeble input voltage from the antenna the signal-to-noise potential of the mixer circuit would not be fully exploited. This was confirmed by an annoying comparison with a more elaborate unit built by W7ATK; nevertheless simplicity is a vanishing virtue I cherish, and with the added leverage of a well-fed doublet cut to 7050 the performance on forty is good.



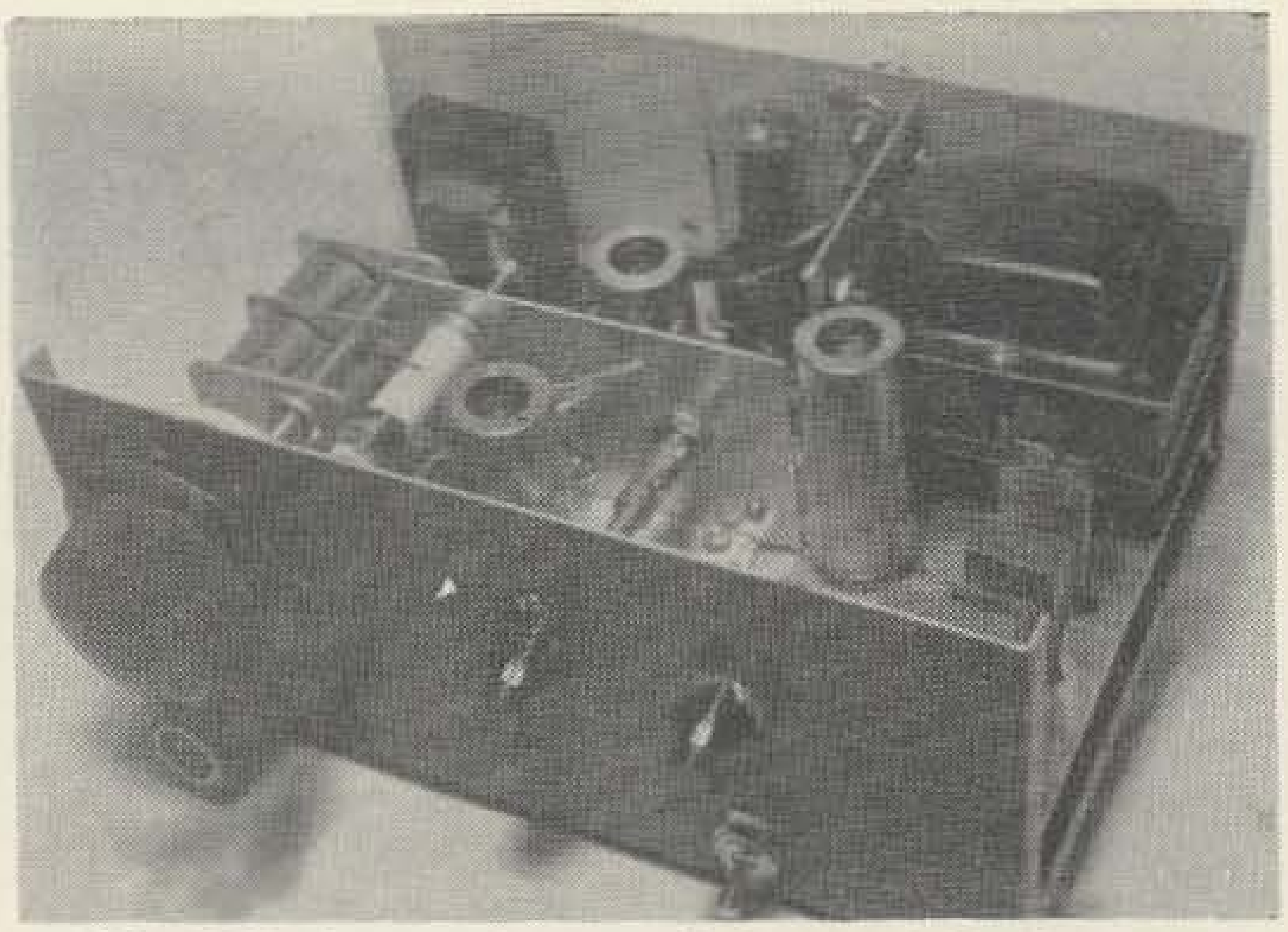
The 73 mixer circuit using a 12AT7 plus half of another 12AT7 as a Pierce oscillator. A 7 mc doublet and the coil-condenser combination in the upper left corner replace the normal IF transformer input. The four crystals permit tuning forty meters on any of the RAX-1 band positions, and certain commercial stations (crystal on the high side by tuning backwards—which is good enough for them.

The simplest application of the 73 mixer and the RAX-1 is worth trying if you want a receiver of moderate sensitivity and exceptional stability and calibration utility (this last means the dial is readable to a fine point and stays put). As it happened I thought the sensitivity was very good until I heard what resulted when W7ATK's rf stage boosted the signal and gave the mixer something to work with. But even without the rf stage the performance left me with this conclusion: I could buy a better receiver but I wouldn't dare bring it home. What began as a tentative experiment jelled as the station receiver and no elaboration is contemplated until solar storms or bigger test shots bring ten meters back. That occasion will be celebrated with an rf stage and an overtone oscillator. The harmonic of crystals used for forty meter reception works fine on twenty but to go any higher with a receiving crystal in the 6 mc range means a ubiquity of beats. That last phrase belongs in the mode configuration, dial excursion type of magazine, but you know what I mean. Harmonic mischief.

The RAX series has been around for twenty years or so, but it was new to me and maybe it is to you. The RAX-1 circuit and tube lineup are much like the BC-453, but it is twice the size, strictly front panel local control, covers 200 kc to 1500 kc in four bands and has a lovely big dial. The intermediate frequency is 160 kc. It's a beautifully built receiver and very easy to work on. My first one I used without much modification until W7ATK talked me out of it, to my lasting regret. A second was on order and when it arrived I sawed off the dynamotor apron, removed two low frequency series traps (the cans marked Z-101 and Z-102), paralleled the filaments and found room inside for a transformer power supply and a speaker. A VR tube was added too, and taken out again when a check of the designed-in stability proved regulation was superfluous.

Two admonitions are relevant here. I bought my RAX's from Columbia Electronics and I'm a satisfied customer, but I achieved this status the hard way. When the first RAX arrived I opened the sturdy carton, removed quantities of padding and gently lifted out a receiver tightly wrapped in heavy brown paper. Gee, new or reconditioned? The evidence of extra care in packing didn't prepare me for the outcome. Tearing away the paper released a small flood of fine, brown sand, and the implication in this was soon confirmed. The tuning knob couldn't be budged. Efforts to turn the band switch resulted in a horrid grating and more sand. Much of the paint was worn from the front panel and the pressures of wartime communication had left several dents in the thin aluminum dial cover. Depressing. But as I said before these receivers are easy to work on and it wasn't really much of a job to get the front end cleaned up and the gears greased. The wiring is unusually accessible under the roomy chassis and tracing is simple. As it turned out all three receivers (and presumably the fourth, due soon) worked fine as soon as power was applied, and I accept the near cupful of sand in each one as the price of dry storage over the years. Real dry.

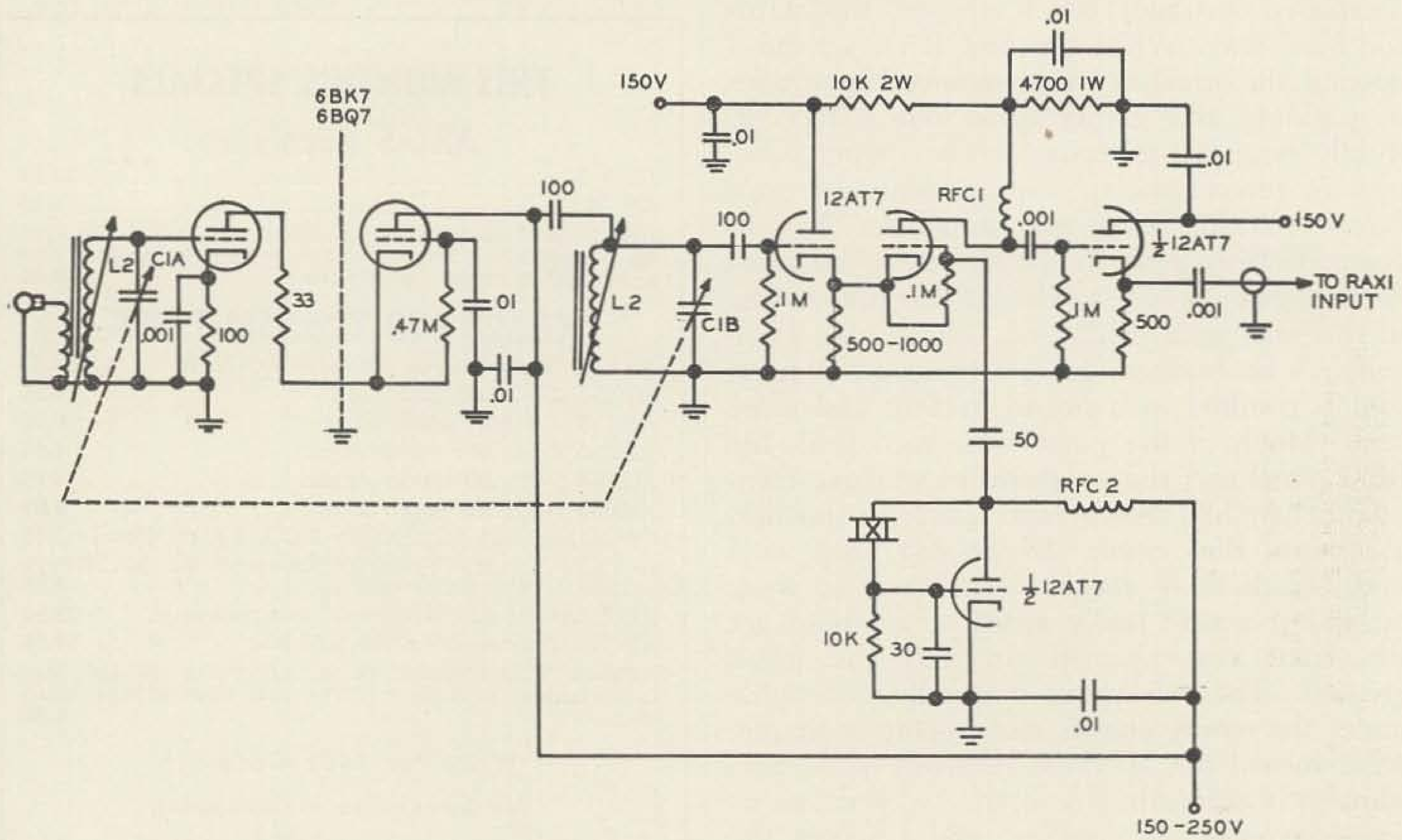
With my second order to Columbia I had enclosed a note reporting the condition of the first shipment and offered to pay a reasonable



W7ATK's heavy duty model. Rear left rf stage; front left mixer with tapped slug-tuned coil covering 80, 40 and 20; front right 12AT7 oscillator—if cathode follower. Photographed under conditions of constant bragging.

premium for an RAX in better shape. They replied that my description probably could apply to the balance of these receivers on hand, and that I should expect additional units to be in comparable condition. I did, and they were. So if you get sand in your shoes think nothing of it. Just dismantle, clean and lubricate. It's a lot better than rust and corrosion, and in the past year my receivers have been used a lot with no component failures. Fifteen dollars isn't much to pay for a reliable broadcast and beacon band receiver with excellent stability, good selectivity and low noise contribution.

The other qualifying note, referred to earlier, is in reference to the expedient of simply hooking an antenna and coil to the "Like Newer." As you would guess, skipping pre-selection can pay off in images. I attacked this situation slantwise by using three surplus crystals for forty meter reception. Normally I use 6000 kc and tune forty from 1000 kc to 1300 kc on the RAX-1. This gives the advantages of direct calibration and best image ratio for the circuit. If a troublesome image does pop up I switch to 6500 kc and tune from 500 kc to 800 kc. With a 6800 kc crystal and tuning from 300 kc cranking in the sidebanders on the high end is good fun. You don't need a steady hand. In fact the receiver seems broad until you count the kilocycles on the dial. The fact that the best image rejection is on the top band and the best bandspread on the lowest band you can call flexibility or natural contrariness. Of course if you do the job right and use W7ATK's circuit you can forget about images. The coil and condenser combination he gives covers eighty and forty, and a 3000 kc crystal can be used for both bands. The circuit for the RAX-1 is in Kenneth Grayson's "Surplus Schematics Handbook." . . . W7IDF



Value of R2	100	500	1000
Input—Voltage (Signal)	1.4	7.0	14.0
Input—Voltage (Osc.)	1.6	7.0	13.1
Conversion—Gain if IF Xfmr Impedance Is 50K ohms (For Comparison)	100	150	160

Answers to Code Quiz

(from page 76)

1.	.--.-	á OR å
2.	----	ch
3.	-..-.	SLANT BAR
4.	..-..	é
5.	.-..-	SEPARATION SIGN
6.	....	ERROR
7.	..--	ü
8.	.-.-.	END OF MESSAGE
9.	.-.-	ä
10.	-...-	EQUAL OR DOUBLE BREAK
11.	.--.-	å OR á
12.	.-.-.-	PERIOD
13.	-.-.-.	SEMI-COLON
14.	..--.-	UNDERSCORE
15.	---...	COLON
16.	-....-	HYPHEN
17.	.-..-.	QUOTATION MARK
18.	-.-.-	START OR ATTENTION
19.	--..--	COMMA
20.	--.--	ñ
21.	...-.	UNDERSTAND
22.	---.	ö
23.	.----.	APOSTROPHE
24.	.-...	WAIT
25.	..--..	QUESTION MARK
26.	-.--.-	PARENTHESIS MARK
27.	...-.-	END OF WORK

A Precision Frequency Standard

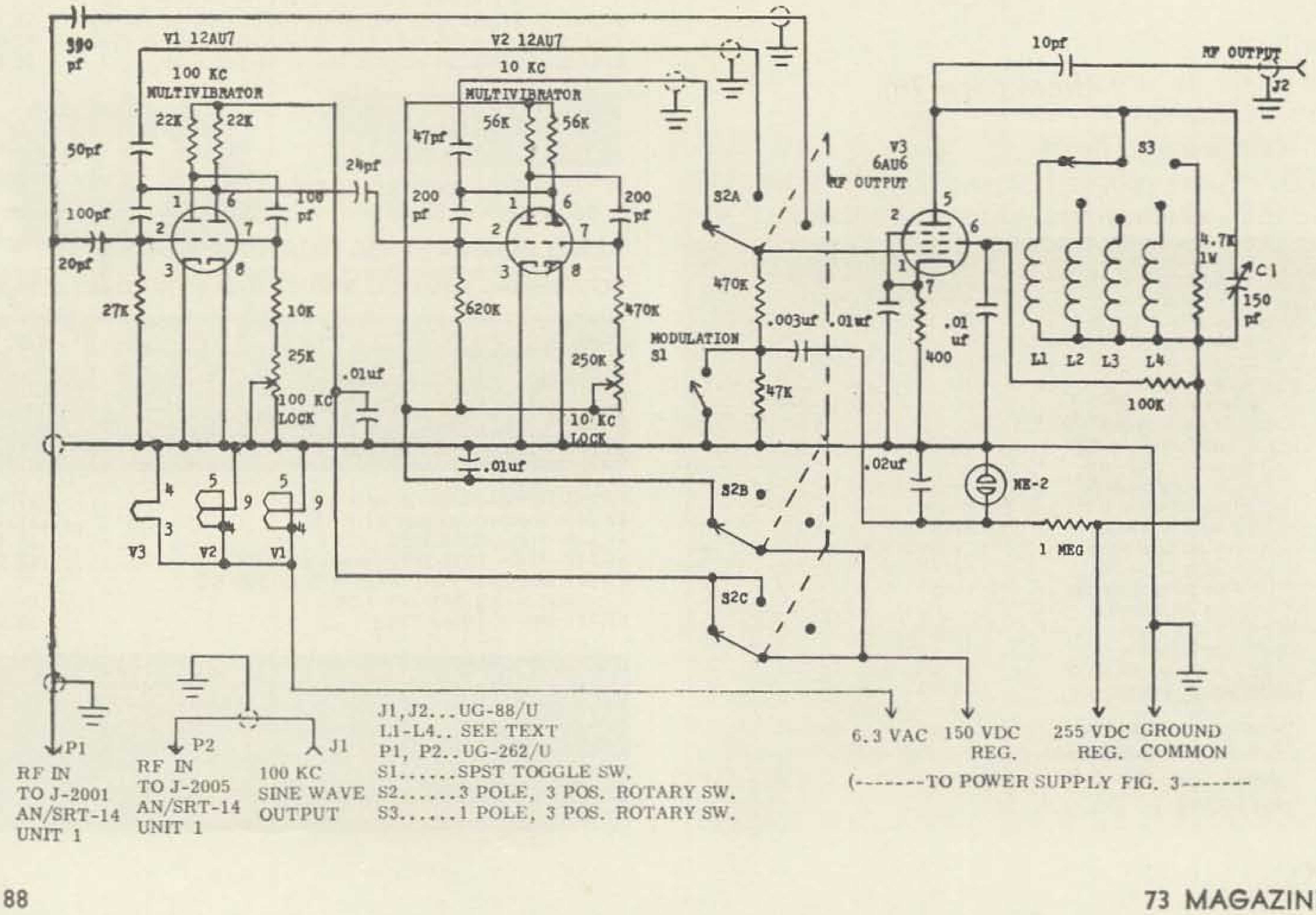
Using the AN/SRT-14

Roy Pafenberg W4WKM
316 Stratford Avenue
Fairfax, Virginia
Photography by Morgan S. Gassman, Jr.

THE SUBJECT OF PRECISE frequency control and measurement is becoming of increasing interest to a growing number of amateur operators. The general use of receivers with calibration accuracy approaching that of some frequency meters has pointed up the unmistakable operating advantages that are obtained with precise frequency calibration. This is aside from the personal satisfaction of knowing precisely where you are in the band.

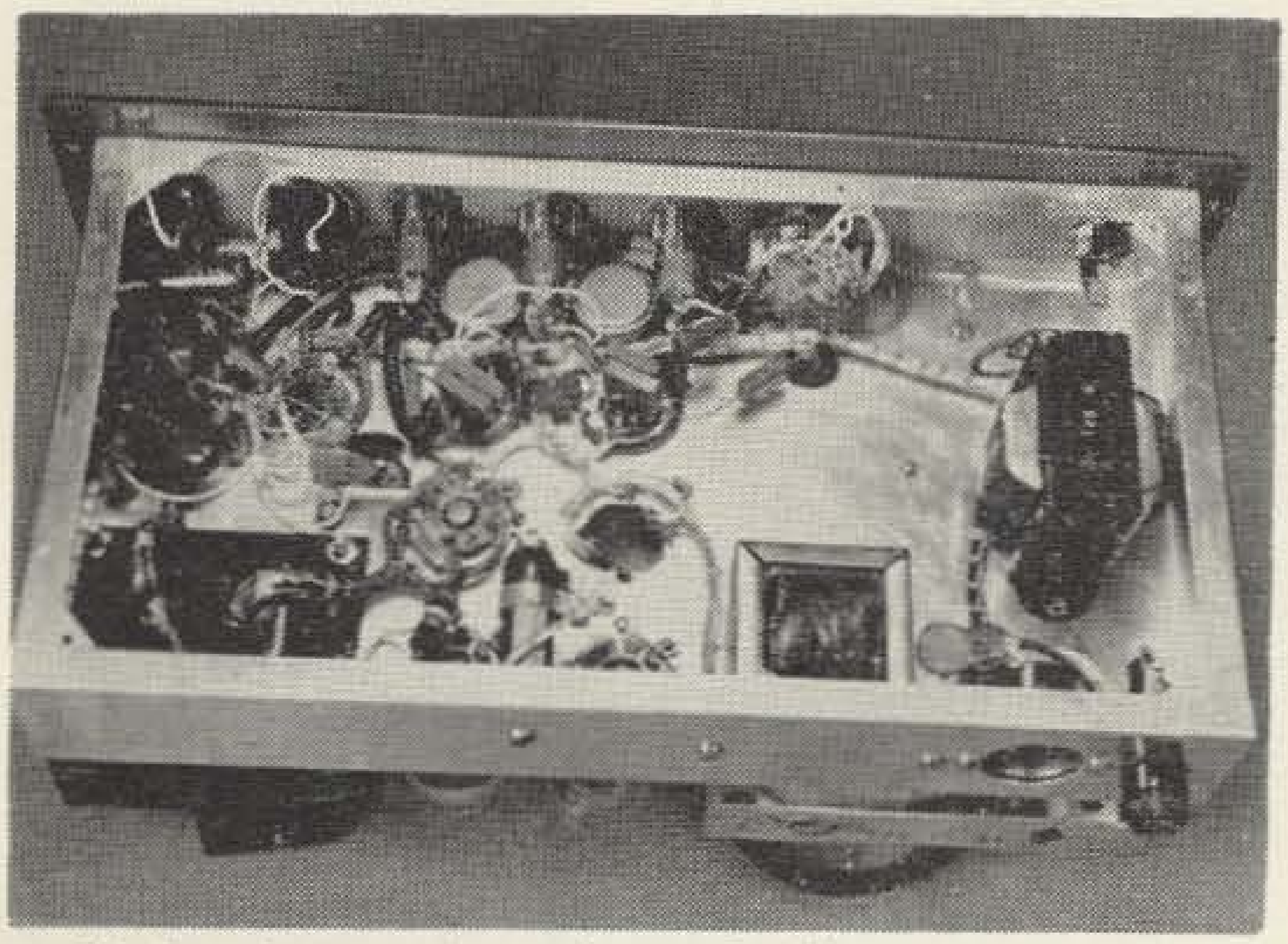
Many amateurs with older or less expensive modern receivers have updated them by installing 100 kc crystal calibrators. While this is all for the good, it is a long way between those 100 kc check points and the existing dial calibration is rarely good enough for accurate interpolation. With most receivers, more closely spaced, readily identifiable check points are desirable. A further point, worthy of consideration, is that many of the available 100 kc calibrators leave something to be desired in stability. While a drift of 10 cps seems inconsequential, it becomes significant when we are using the 300th harmonic to check a 30 mc signal. This 10 cps drift then becomes a 3 kc measurement error.

Two things are then required to insure accurate higher frequency calibration and frequency measurement. The stability of the standard should be as great as possible and identifiable calibration frequencies should be generated at closer spacing than the usual 100



kc. Both objectives are achieved in the unit shown in the photographs.

The heart of this frequency standard is a surplus, high stability 100 kc oscillator unit. This oscillator is Unit 1, Z-2001, of the AN/SRT-14 Radio Transmitter. Other components of this surplus dream were described in the article, "A Surplus Frequency Synthesizer," which appeared in the February, 1962 issue of 73 Magazine. The oscillator unit is a real gem. The crystal proper is a Bliley Type BH8, 100 kc unit which is housed in a 3¾" diameter, 4½" high plug-in oven. The oven is a Bliley Type TC922 which operates from 6.3 volts ac and maintains a constant 70° temperature.



Under-chassis view shows further construction details. The detector-audio amplifier circuit shown on the left side of the chassis is not described in this article.

The circuit of the oscillator unit is shown in Fig. 2. A 5654 (6AK5) oscillator stage drives an isolation cathode follower stage which, in turn, drives 3 separate cathode follower output stages. All cathode followers use a single triode section of the dual-triode 5814 (12AU7). Isolation resistors are used to provide five independent, low impedance outputs which are terminated in BNC coaxial fittings mounted on the top of the chassis. The Unit 1, AN/SRT-14

The frequency standard is housed in a stock Par-Metal cabinet.

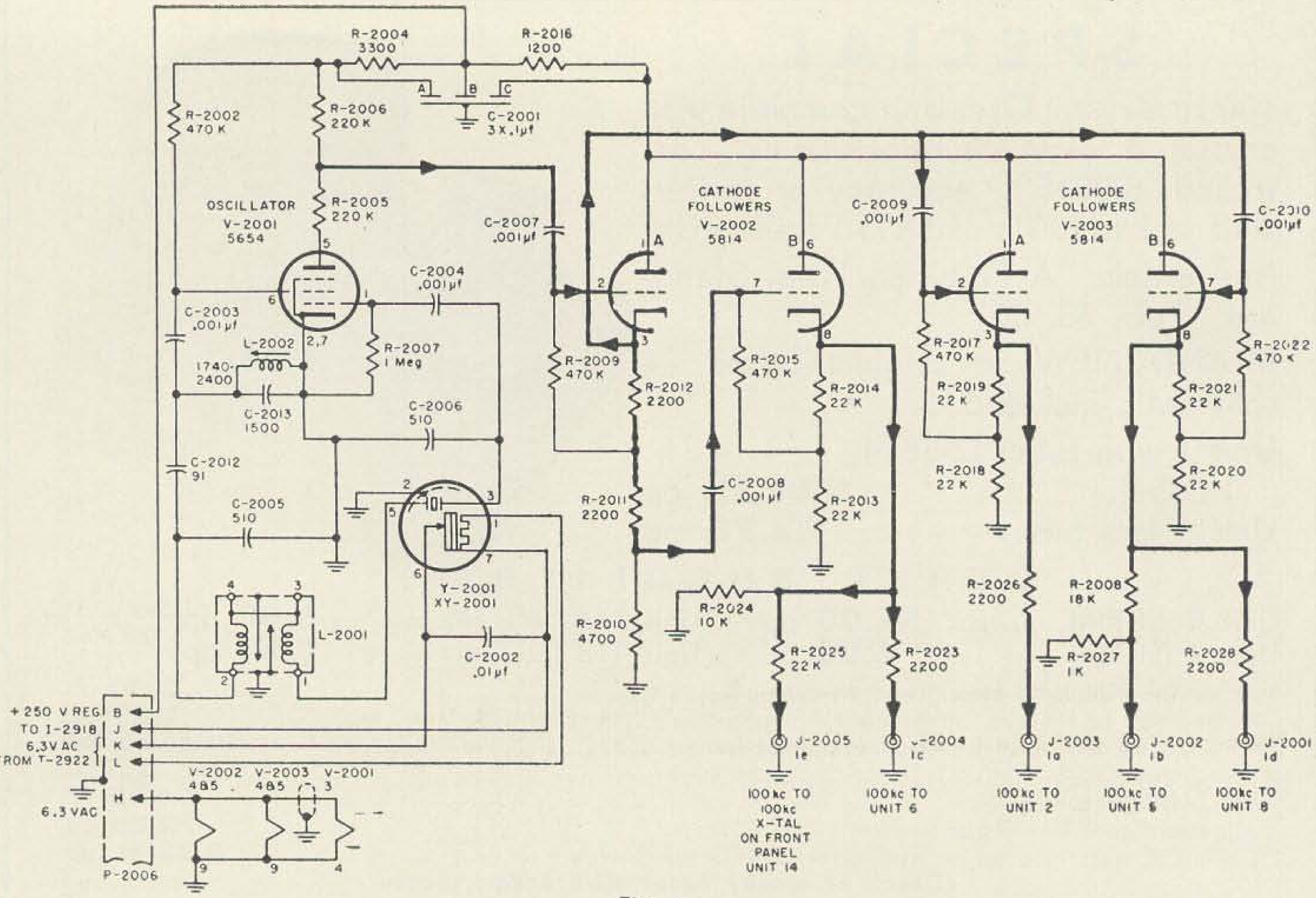
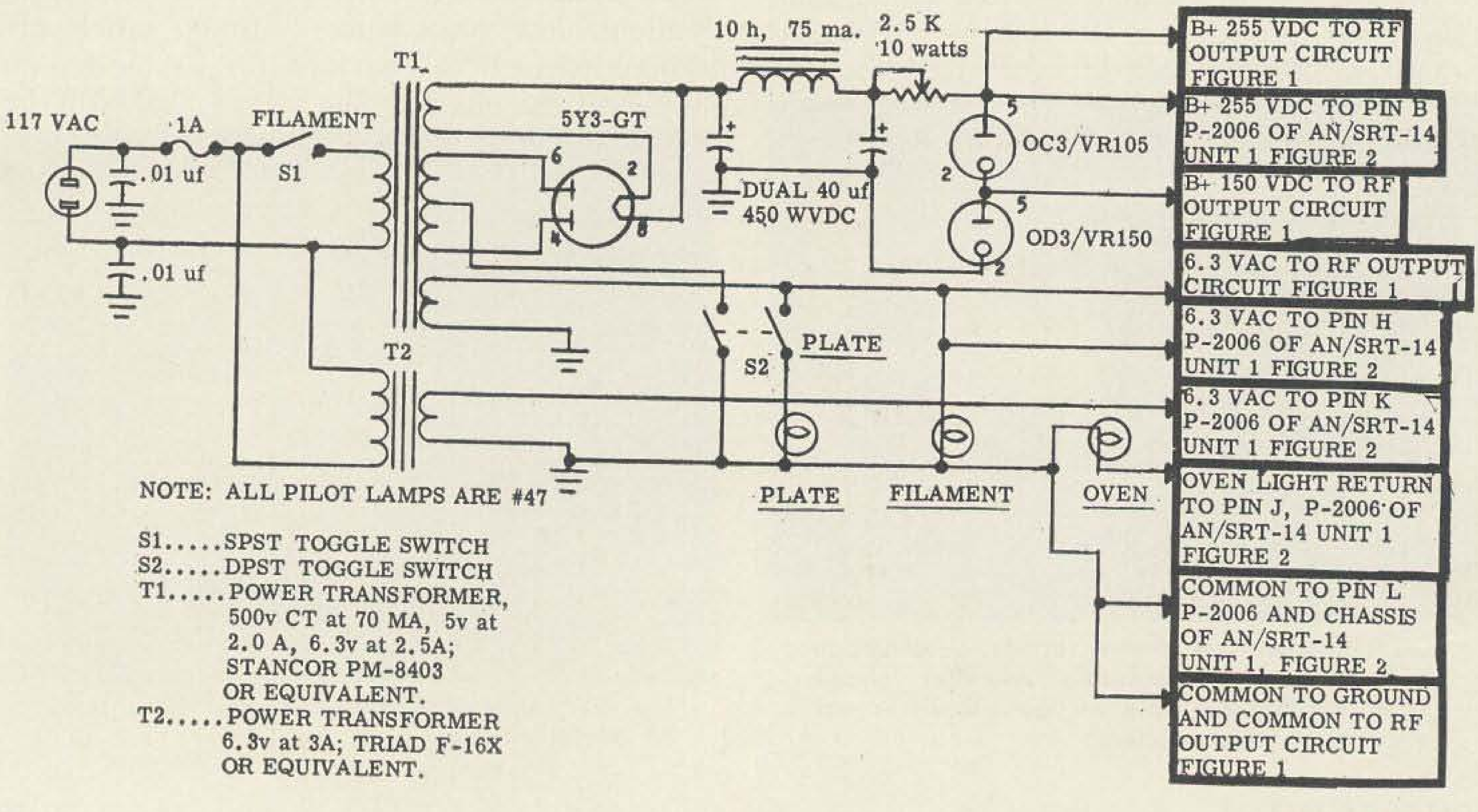


Fig. 2

Oscillator Unit has been widely distributed in MARS channels. These units have recently become available on the surplus market. RITCO Electronics of Annandale, Virginia has a very substantial stock of these units which are priced at under $25.00 Incidentally, some of the units on hand at RITCO use a James Knight crystal comparable to the Bliley unit described above.

The AN/SRT-14 Oscillator Unit requires a power source of 250 volts dc, a 6.3 volt filament supply and, preferably, a separate 6.3 volt crystal oven supply. Apply power, allow time for the crystal oven to stabilize and you have a 100 kc frequency standard with accuracy of 1.5 parts per million. However, those 100 kc harmonics become progressively weaker at the higher frequencies and are soon unusable.

The circuit shown in Fig. 1 solves the problem of high frequency attenuation and in addition provides 10 kc check points. The 10 kc



crystal standard is used to synchronize a dual-triode (V1), 100 kc multivibrator. The output of the 100 kc multivibrator is then used to synchronize a dual-triode (V2), 10 kc multivibrator. The output waveform of these stages has high harmonic content. A 6AU6 tuned rf output stage completes the circuitry of the rf unit. Switch S2 is provided to allow selection of 100 kc sine wave, 100 kc square wave or 10 kc square wave output. This switch also removes B+ voltage from the multivibrator stage or stages that are not used for any given output.

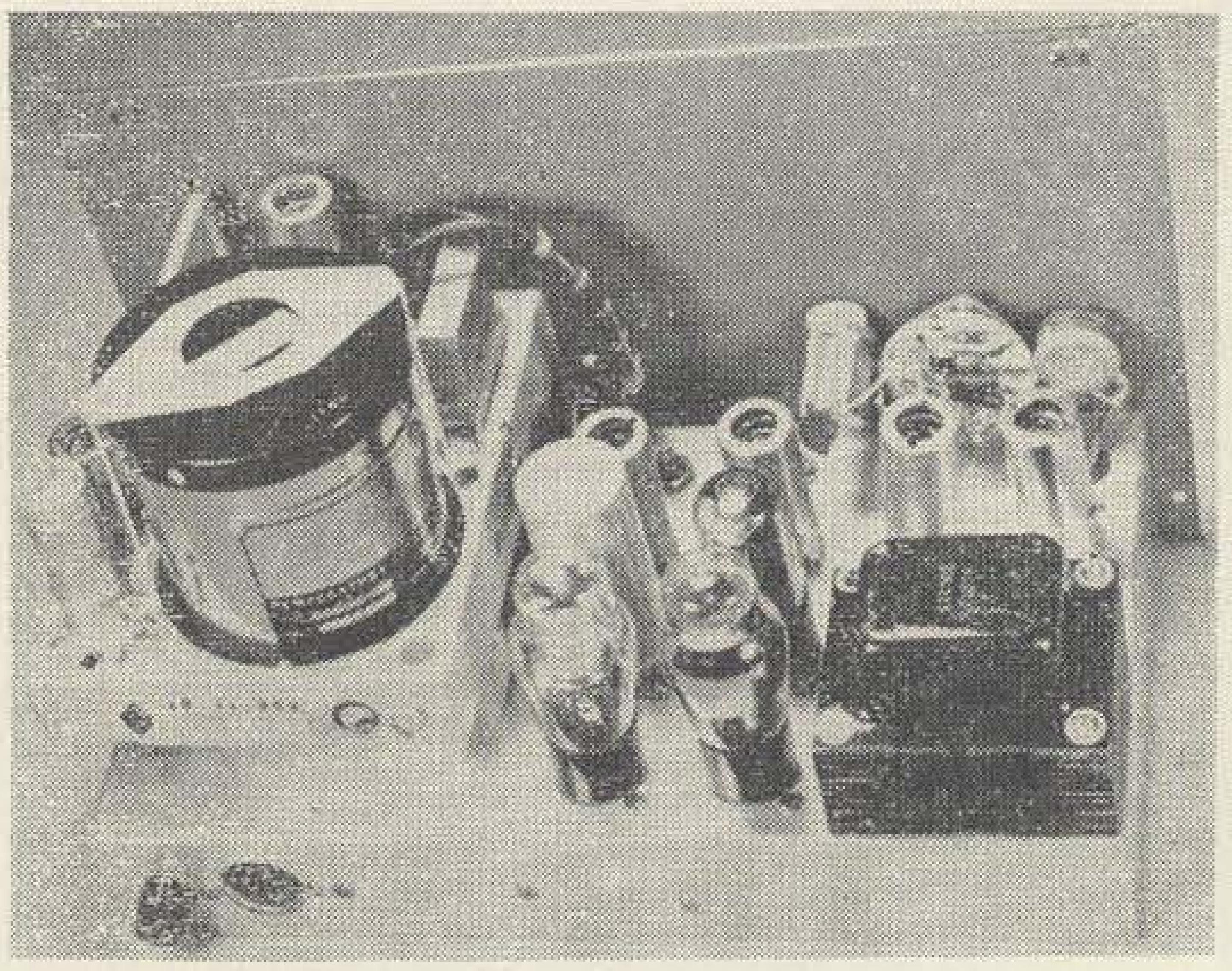
The output tuned circuit requires a few words of explanation. L1 through L4 provide continuous coverage from 3.3 to 60 mc. The 4,700 ohm resistor position is used for lower frequency output and C1 then serves as an attenuator. The coils used in the unit shown were tailored from surplus rf chokes with the aid of a grid dip meter. The 39th Edition of the ARRL Handbook, page 521, lists readily available commercial chokes which may be used unchanged to obtain similar coverage. This ARRL Handbook coil data is as follows:

L1..3.5-7 mc..10 uh National R-33 rf Choke
L2..6.5-14 mc.. 4.7 uh IRC CL-rf Choke
L3..15-30 mc..1.0 uh IRC CL-1 rf Choke
L4..30-60 mc..4 turns No. 20 Plastic Insulated Wire ⅜" Diameter.

Under certain conditions of measurement, it is difficult to pick out the frequency standard signal in a welter of heterodynes. This problem is minimized by tone modulating the output of the frequency standard. A relaxation oscillator using an NE-2 neon lamp generates an audio tone which is used to grid modulate the rf output stage. The sawtooth wave form of the modulating signal and the "dirty" modulation method provides unmistakable identification of the standard signal. Switch S1 disables the modulator after the signal is identified.

The power supply, shown in Fig. 3, is conventional. Power requirements are nominal and the seriesed voltage regulator tubes provide acceptable regulation. A separate filament type transformer is strongly recommended to provide oven heater current. Note that this transfrmer is connected between the ac line switch and the fuse. This permits the oven to run continuously which is essential if maximum stability is desired.

While any method of construction may be used, the unit shown in the photographs is a very convenient package. The cabinet is a Par-Metal CA-301 unit which is designed for use with a 7" x 13" x 2" chassis. This chassis size permits all components and the AN/SRT-14 oscillator unit to be mounted without undue crowding. It will be noted that an extra tube, coaxial input jack and phone jack appear on the unit shown in the photographs. These components are used in a mixer/detector and audio amplifier which is not described in this article. Since practically all use of the standard is with the station receiver as the detector, description of this feature was not considered warranted.



The AN/SRT-14 oscillator unit is mounted on the top of the chassis and further secured to the front panel. Note the plug-in crystal oven which insures stability of the precision crystal unit.

The photographs show construction details. The pilot lights and switches secure the chassis to the front panel. The oscillator unit is then positioned with the crystal to the rear, flush against the panel. The four screws which hold a shield plate to the bottom of the crystal socket well are used to secure the unit to the chassis. Two screws are then used to secure the front lip of the assembly to the front panel. The BNC rf connectors shown in Fig. 3 are of the panel jack type which permit complete shielding of the output cables. Power connections to the AN/SRT-14 oscillator unit may be soldered directly to the existing connector pins or a mating connector, Winchester Electronics part MSE-14S-G, may be used.

After construction is completed, check your work. If all looks safe, throw the output selector switch, S2, to the 10 kc position and set the 2500 ohm voltage regulator dropping resistor to maximum resistance. Open the connection between pin 2 of the OD3 VN tube and ground and connect a 0-100 ma. meter to these points. Apply power and adjust the resistor for a reading of 20 ma. on the meter. Remove the meter and restore the connection.

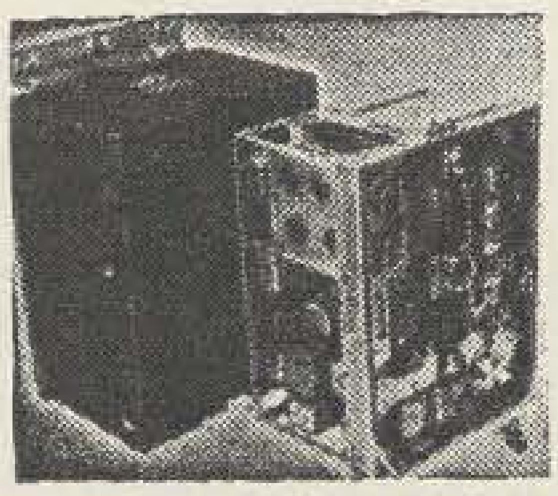
Connect the 100 kc sine wave output, J1, of the standard to a receiver, using coaxial cable to avoid pickup of other signals. Switch the receiver to the lowest frequency band and tune the receiver, with the BFO on. Signals should be picked up at 100 kc intervals. Make certain that the modulation switch, S1, is closed; throw the output selector switch, S2, to the 100 kc sine wave position and transfer the output cable from J1 to J2. Signals should still be heard at 100 kc intervals.

Leaving the receiver tuned to one of the 100 kc harmonics, switch the standard to the 100 kc square wave position. Now adjust the 100 kc LOCK control across its range. Unstable hash should be heard across most of the range but a clean, stable signal should be heard at one or more points. Leave the resistor adjusted to the center of one of these points and tune the receiver across the band. Signals should be observed only at the 100 kc points. If other signals are noted, readjust the control to another "clean" signal point and try again. When the multivibrator is correctly adjusted to 100 kc, switch the standard to 10 kc and go through the same procedure using the 10 kc LOCK resistor. The objective this time is to obtain exactly nine clean signal points between each pair of 100 kc points. When this is obtained, switch S2 through the three positions to insure that the multivibrators reliably lock in at the correct frequencies. If not, readjust slightly the appropriate lock resistor.

Tune in a signal from the standard and open the modulation switch, S1. Strong audio tone modulation should be heard. If the relaxation oscillator is not functioning or if a different modulating frequency is desired, adjust the value of the 1 megohm dropping resistor for the desired results. There is quite a wide variation in lamp characteristics so if you run into trouble, try changing the lamp. If desired, an NE-51 lamp may be used and a pilot lamp socket installed.

For the final test, switch the standard through the various output bands and tune in the signal on the receiver. It should be possible to peak the output signal by tuning the output tuning capacitor. After the unit is checked out, install in the cabinet. It will be necessary to remove the plug-in crystal oven to fit the unit in the Par-Metal cabinet shown. After the chassis is installed, open the top door of the cabinet and reinstall the crystal oven.

The completed frequency standard is an extremely worth-while addition to any station. Stability of the surplus oscillator unit is outstanding. Cost, using the AN/SRT-14 unit, is quite low and, for the laboratory quality involved, a real bargain. . . . W4WKM



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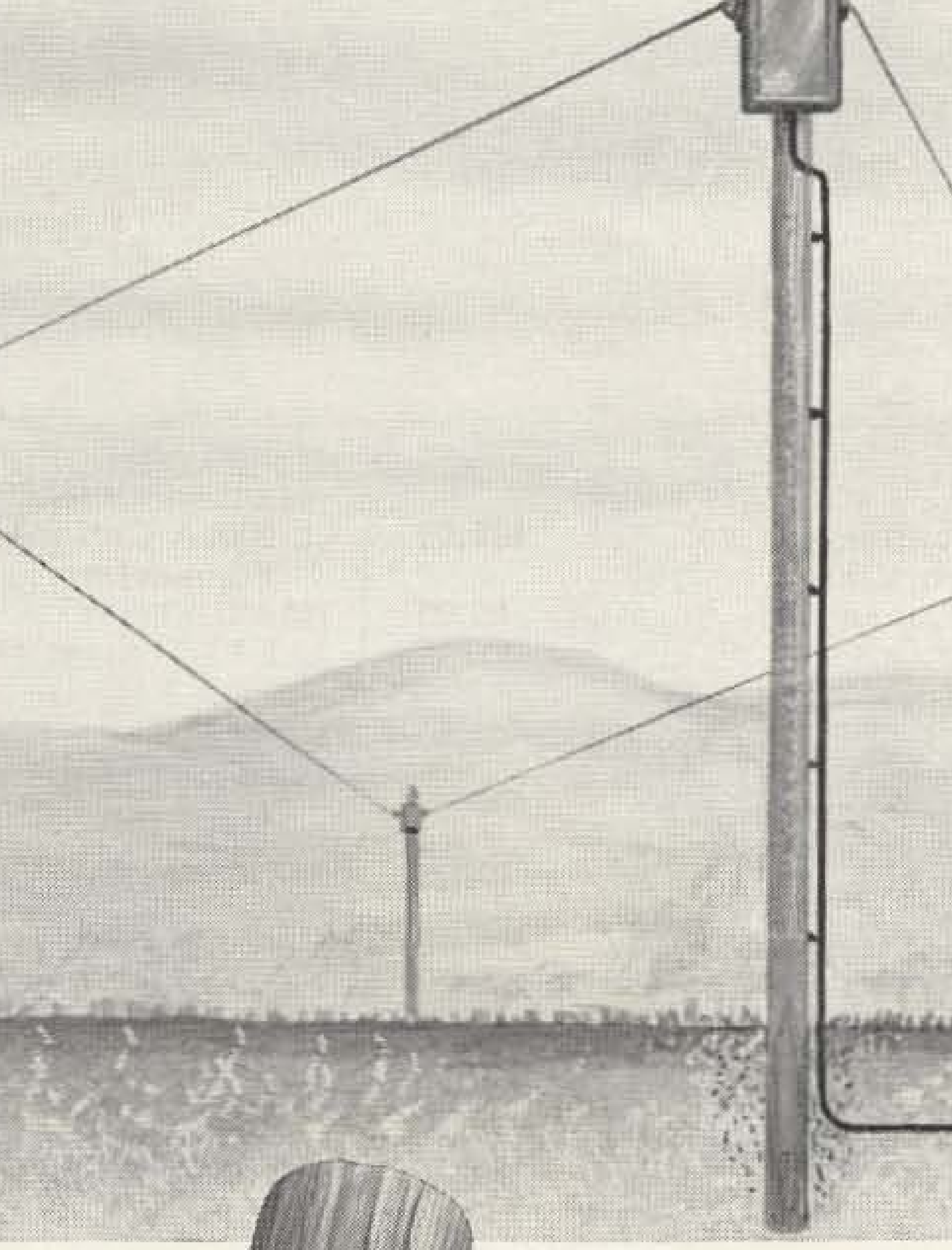

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