Electronic TUBE

# Ham News

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# S/N-6 CASCODE 2 METER PRE-AMPLIFIER

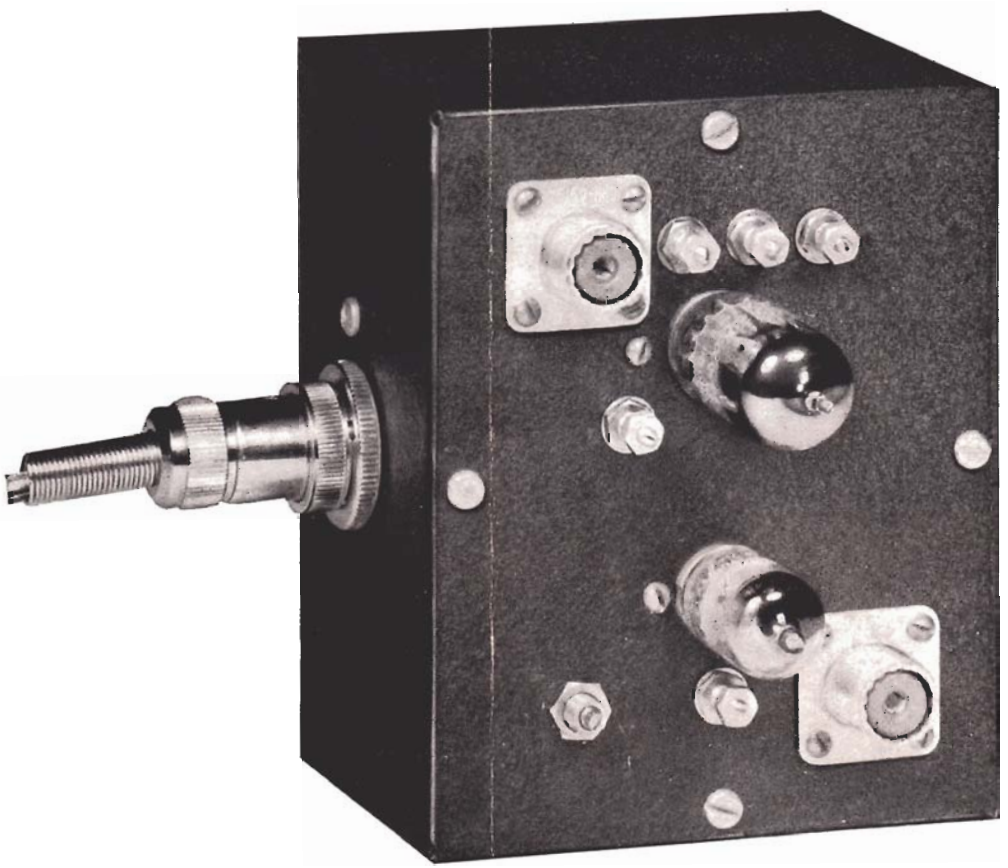


*Fig. 1. Front view of the S/N-6 Cascode 2 Meter Pre-amplifier.*

**CQ — CQ — CQ**

**THE EDISON RADIO AMATEUR AWARD—SEE PAGE 6.**

*—Lighthouse Larry*

## Contents

# THE S/N-6 CASCODE 2 METER PRE-AMPLIFIER

*Here it is fellows! Another pre-amplifier from the shack of W2RDL, designer of the popular R-9'ER, which appeared in HAM NEWS Vol. 1 No. 4. This 2 meter cascode pre-amplifier utilizes the recently announced 6BK7 in a neutralized circuit which matches the output to the receiver.*

*This is W2RDL's answer to those many requests for a cascode amplifier using this new tube. It is relatively simple to construct and the average amateur should have no trouble in making it work properly. One word of caution—the circuit constants and layout must be followed faithfully.*

*The newcomer and the oldtimer will find that the S/N-6 will improve the signal-to-noise ratio—6 DB noise figure—give added gain—18 to 24 DB—and pull in what used to be weak stations.*

*—Lighthouse Larry*

## GENERAL DESCRIPTION

The S/N-6 cascode 2 meter pre-amplifier is entirely self contained (except power supply) in a 3 x 4 x 5 inch metal box. All parts mount directly on the rear of the front panel so that construction is easy and straightforward. The 6BK7 and 6AK5 r-f tubes are mounted horizontally on the front panel. Coaxial fittings are used for the r-f input and output connections. All tuning adjustments of the coils are made from the front of the panel.

The plate voltage required for the two tubes is low —150 volts d-c—and can be taken off the communications receiver. Filament voltage required is 6.3 volts a-c or d-c at 0.625 amperes.

## DESIGN CONSIDERATIONS

Many 2 meter converters and receivers, today, lack two important features which are necessary for DX work at this frequency. These two features are (1) high signal-to-noise ratio (low noise figure) (2) gain. Of these two, high signal-to-noise ratio is the most important. An amplifier could increase the gain but if it did not improve the signal-to-noise ratio nothing would be achieved—that is, you would notice an increase in signal level but at the same time the noise level would be increased proportionally.

The opposite case would be an amplifier with a high signal-to-noise ratio with no increase in gain. This would be a decided advantage over the first amplifier in that the signal would appear louder to the ear, however, the S meter would show no increase in signal level. These two amplifiers are exaggerated cases, since fortunately practically all r-f amplifiers improve the signal-to-noise ratio to a certain extent and give an increase in gain.

In the design of the S/N-6, the above two features were deemed to be of utmost importance. Since the first stage of any r-f amplifier, receiver, or converter is the most important from a signal-to-noise ratio standpoint, it was given careful design consideration. The cascode circuit was chosen because if properly designed it will produce a high signal-to-noise ratio. A pentode could be used in this circuit for high gain, however, it would produce more noise because of the current division at the screen grid. Therefore, the low-noise twin triode type 6BK7, particularly designed for cascode circuits, was chosen.

The selection of a triode was not too difficult. At first a pentode connected 6AK5 feeding a pentode connected 6AK5 in a cascade circuit was calculated for signal-to-noise ratio. Under optimum conditions this calculated to be approximately 9 DB (noise figure)

# Electrical Circuit

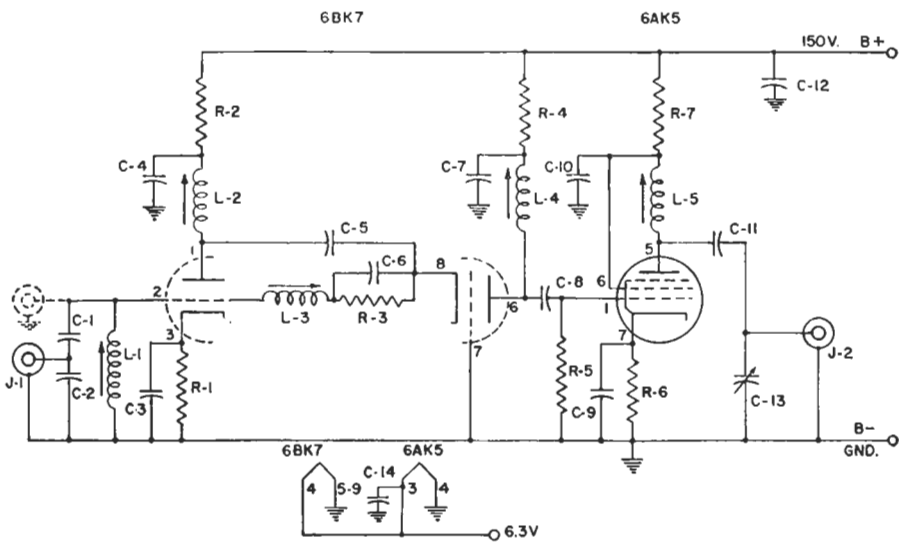



*Fig. 2. Circuit diagram of the S/N-6 pre-amplifier.*

which was good but still too high. Then a type 6BK7 cascode feeding another 6BK7 cascode was calculated and the over-all signal-to-noise ratio was approximately 5 DB (noise figure). This was considered to be very good so the original design was started. After the circuit was designed on paper a laboratory model was constructed. This model had a tendency to break into oscillation. Therefore, two other models were constructed with different layouts to overcome this condition. Each of these models still showed the tendency to break into oscillation. Methods were devised to eliminate the oscillations, but it was felt they were too difficult for the average amateur to duplicate and achieve a stable unit. A pentode connected 6AK5 was then considered for the second stage to replace the second 6BK7. This combination, 6BK7-6AK5, calculated to 6 DB (noise figure) under optimum conditions. Three models were constructed each with a slightly different layout. None of the layouts were unstable, however, the one illustrated in Fig. 3 was considered the best and simplest for construction.

Another feature considered and incorporated was to make the front end broadband. This is very desirable for this band, since it eliminates the necessity for retuning when going from one end of the 2 meter band to the other. Also the output impedance was made adjustable so that a proper match could be made to the receiver. This is important since any mismatch to the receiver may tend to decrease the signal-to-noise ratio.

## CIRCUIT DETAILS

Refer to the schematic circuit diagram shown in Fig. 2. The cascode section of the unit, which consists of both triode sections of the 6BK7, is of the parallel d-c type. This type of circuit has the advantage over the series-type circuit, in that a lower plate supply voltage is required and the heater-cathode voltage is lower.

The input circuit has been designed to accommodate either a 70 ohm or 300 ohm unbalanced line. For 70 ohm input, jack J1 is connected as shown. For 300 ohm input, the center pin of J1 is connected to the junction of C1 and L1 as indicated by the dotted lines. Capacitors C1, and C2 and inductance L1 together with the attached antenna form a broadband input network to cover the entire two meter band. Once L1 is adjusted for the center of the band no further adjustments are necessary.

The plate circuit of the first triode section of the 6BK7 consists of L2, C4, C5, and R2. Capacitor C4 and Resistor R2 form a decoupling network for the supply voltage. The inductance L2, is of primary importance in that it has a decided bearing on the signal-to-noise ratio. If it is replaced by an r-f choke, the signal-to-noise ratio may be very low. Inductance L2 tunes fairly broad but it should be adjusted for the center of the band by the brass slug.

Capacitor C5 feeds the signal into the cathode of the second triode section of the 6BK7. Part of this signal is fed through L3, the neutralizing inductance, which forms a parallel resonant circuit with the grid-to-plate capacitance of the first triode section. This effectively tunes out the grid-to-plate capacitance which is necessary for high signal-to-noise ratio and good stability.

The second triode section of the 6BK7 is operated as a grounded grid stage. Bias voltage for this section is obtained by the cathode current flowing through R3. Capacitor C6 effectively by-passes the r-f around this bias resistor. The plate circuit of this section incorporates another decoupling network R4 and C7. It is also tuned to resonance at the center of the band by the brass slug of inductance L4.

### CIRCUIT CONSTANTS

(All resistors and capacitors ±20% tolerance unless specified otherwise)

| | |
|---|---|
| C1, C2 | 15 mmf, zero-temperature, tubular ceramic (Centralab TCZ-15) |
| C3, C4, C5, C6, C7, C8, C12 | 1000 mmf, high-K tubular ceramic (Centralab D6-102) |
| C9, C10, C14 | 1000 mmf, high-K disc ceramic (Centralab DD-102 or Sprague 5HK-D1) (See text) |
| C11 | 25 mmf, zero temperature, tubular ceramic (Erie NPOL-25, ±10%) |
| C13 | 12-120 mmf, mica compression padder (EL-MENCO 612) |
| R1, R3 | 56 ohms, ½ watt |
| R2, R4 | 220 ohms, 1 watt |
| R5 | 2400 ohms, ½ watt |
| R6 | 180 ohms, ½ watt |
| R7 | 2700, 1 watt |
| L1, L2, L4 | 3 turns No. 24 enamel wire, spaced diameter of wire, wound on Millen type 69047 coil form, brass slug. |
| L3 | 6 turns No. 24 enamel wire, spaced diameter of wire, wound on Millen type 69047 coil form, brass slug. |
| L5 | 2 turns No. 24 enamel wire, spaced diameter of wire, wound on Millen type 69047 coil form, brass slug. |
| J1, J2 | coax jacks |
| 6BK7 socket | 9-pin miniature (vector type 8-N-9T) |
| 6AK5 socket | 7-pin miniature (Cinch-Erie, 1000 mmf capacitors built in) (See text) |

The final stage consists of a type 6AK5 operating as a pentode. The input to this stage is conventional. The plate circuit utilizes another decoupling network formed by resistor R7 and capacitor C10. Incorporated, also, is an impedance matching network formed by inductance L5, capacitors C11 and C13. Inductance L5 is adjusted by the brass slug to resonance at the center of the band, then with the receiver connected to J2, variable capacitor C13 is adjusted for the loudest signal.

## COMPONENT PARTS

Particular attention should be given to Figs. 3 and 4 which show clearly the 6BK7 socket and the 6AK5 socket. The 6BK7 socket is manufactured by Vector, type 8-N-9T. It is recommended this type be used as it permits easy mounting of the components and short leads. The 6AK5 socket is manufactured by Cinch-Erie and is of a special type. This particular socket has 1000 mmf by-pass capacitors built in on all pins except pins 1 and 5. No information was available on the type number during the construction of this model, therefore, another was constructed using a standard National type XOA-C-7 ceramic socket and by-passing pins 3, 6 and 7 with 1000 mmf disc type capacitors (C9, C10, C14) to ground with shortest leads possible. No difference was noted between the two models, therefore, the builder can use whichever is available.

Capacitors C1, C2, C11, and C13 should be of the value and type specified. The other condensers specified can either be of the tubular type or disc type. It is highly recommended the tubular type be used, with the exception of those used in by-passing the 6AK5 mentioned above, to facilitate short and direct connections.

The coil forms used are type 69047 manufactured by the James E. Millen Manufacturing Co. This type of coil form has an adjustable brass slug. It is very important that brass or copper slugs be used as iron slugs will ruin the Q at this frequency. It is recommended the coil forms specified be used.

All of the resistors specified are of standard composition type with tolerances of $\pm 20\%$.

## CONSTRUCTION DETAILS

It is recommended that the mechanical layout shown in Figs. 3, 4 and 5 be followed faithfully. This layout was found to be the best from an electrical and mechanical standpoint.

The S/N-6 is constructed on a 3 x 4 x 5 inch box with removable front and back panels. All of the components are mounted on the back of the front panel as illustrated in Figs. 3 and 4. Before mounting the components all of the black crackle paint should be removed. This is very important to insure good ground connections. Also the lip on the box, to which the front panel attaches, should be cleaned of all paint to further insure a good ground connection.

Dimensions are given in Fig. 5 for locating the various holes. No dimensions are given for the socket holes or input and output jack. These will depend on the type the builder uses.

As will be noted in Figs. 3 and 5, coils L1, L2, and L3 are in line with the input jack J1 and are mounted close to the Vector socket. Coil L4 is mounted above and to the right of the 6BK7 socket with coil L5 mounted to the right of the 6AK5 socket. If the dimensions outlined in Fig. 5 are followed, the coils will mount close to the sockets permitting short and direct connections. In winding the coils, leave approximately one inch of wire at the ends for soldering.

The power plug, which is clearly seen in Fig. 1, can either be mounted on the side of the box or on the rear panel. This is left up to the discretion of the builder as its location is not critical.

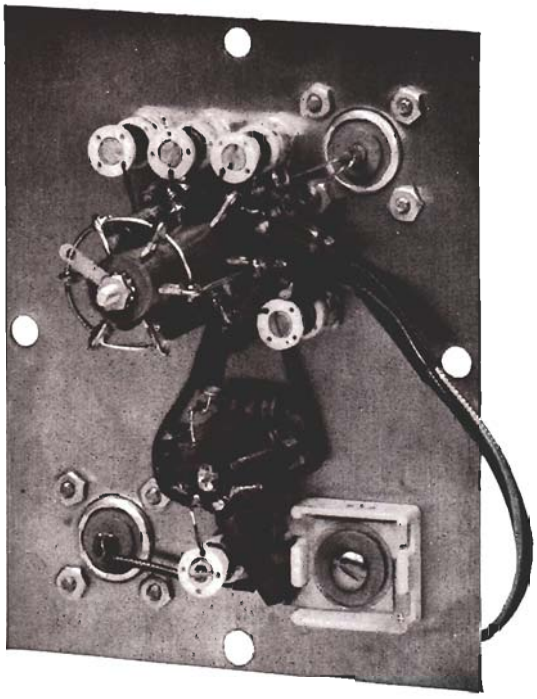


*Fig. 3. Rear view of front panel illustrating layout.*

## WIRING DETAILS

In wiring the S/N-6, the work will be much easier if a small-tip soldering iron is used. As will be noted from the photographs, the capacitors and resistors are compactly grouped around the Vector socket which makes the soldering operation a little difficult if a large-tip iron is used.

In wiring the 6BK7 stage, use is made of the lugs on the Vector socket as tie points. The lug above pin number 1 is used as a tie-point for C4, L2, and R2. The lug above pin 6 is used as the tie-point for C7, L4, and R4. The lug above pin 9 is the tie-point for C6, R3 and L3. The lugs at the top of the form are all tied together. This is used as the B plus tie-point. Resistors R2 and R4 and capacitor C12 are placed between the two sets of lugs on the form with one end tied to the B plus tie-point. This results in a neat and workmanlike appearance. Use is also made of the four lugs on the socket mounting ring. These are used as ground tie-points for C2, C3, C4, C7, R1, and L1 and also for pin 7.

The 6AK5 socket is wired in the conventional manner using short direct connections. Soldering lugs placed at the socket mounting holes are used as ground tie-points.

## ALIGNMENT

The alignment procedure is straightforward and simple to perform. The output of the pre-amplifier should be connected to the antenna terminals of the receiver by a short piece of cable. The cable should not be over twelve inches long and must be shielded to avoid picking up extraneous signals.

With the receiver tuned to 146 megacycles, a signal of this frequency should be fed into the antenna input (either 70 ohm or 300 ohm input). This signal can be obtained from a signal generator, transmitter, or a

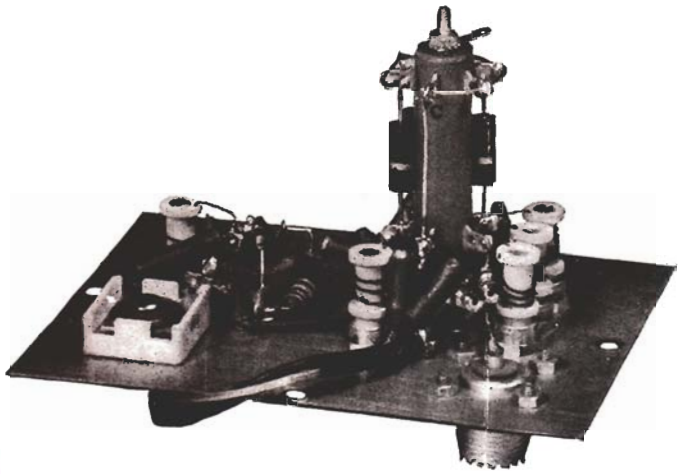


*Fig. 4. Side view of front panel illustrating layout.*

fairly loud signal from another amateur station can be used. If the last two methods are used, the signal should be close to the center of the band.

With the signal fed into the input, capacitor C13 and the brass slug of inductance L5 should be adjusted for maximum signal. Next the brass slug of inductance L4 should be adjusted for maximum signal. The brass slug of L2 is adjusted next in the same manner followed by the adjustment of L1. In adjusting L1 and L2, it will be found that they tune quite broad. Next, the neutralizing inductance, L3, should be adjusted for maximum signal. This may be tricky if the inductance of L3 is too high. In this case there will be a tendency to oscillate, with a large increase in signal just before oscillation starts. This condition will also cause the amplifier to have a rather narrow bandwidth. So check the bandwidth if you suspect L3 is wrong.

After the above procedure has been followed, it should be repeated and the inductances realigned if necessary.

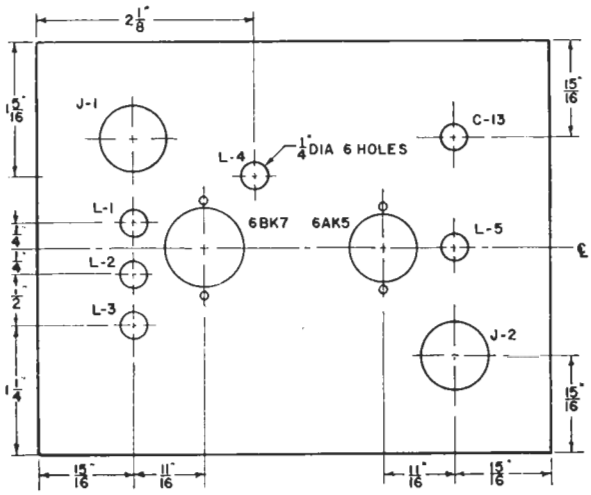
Once the above alignment procedure has been completed, no further adjustments are necessary while operating your receiver.

## OPERATING INFORMATION

To coin an old expression, "the receiver is no better than the antenna," applies equally well here. Use a good antenna, and one with the proper impedance—either 52 ohms or 300 ohms unbalanced. If you do this and the pre-amplifier is properly constructed, you can expect a noise figure of 6 DB and a signal gain of 18-24 DB.

On-the-air tests were conducted at W2RMA's shack over a period of a month. During this time the S/N-6 was put through various tests and suffice to say it proved its value. Signals were heard which could not be detected without the S/N-6. Also, a *definite* improvement in signal-to-noise was noted on weak stations which could be detected without the pre-amplifier. This was to be expected, however, since any pre-amplifier, or receiver with a noise figure of 6 DB is an exceptionally good one. (Compare this with the average communication receiver which is liable to have a noise figure of 30 DB!)

To those of you who build this 2 meter pre-amplifier, be sure to use good quality parts, good workmanship and above all follow the article faithfully and you'll enjoy lots of DX.




MOUNTING HOLE DIMENSIONS OF COAX CONNECTORS & TUBE SOCKETS NOT SHOWN

*Fig. 5. Panel layout of the S/N-6 (Back elevation).*

*Announcing*

# THE EDISON RADIO AMATEUR AWARD

**To gain greater recognition for the many vital and humane public services performed by radio amateurs, G. E. offers the Edison Radio Amateur Award for 1952**

**Who is eligible for the Edison Radio Amateur Award:** Radio amateurs eligible for nomination will be those men and women who, during 1952, have performed a meritorious public service on behalf of an individual or a group, in a disaster area, in civil defense, or in similar situations.

Nominations may be made by any amateur, club, association, or individual familiar with the service performed.

Winner of the award will receive the Edison Radio Amateur trophy in a public ceremony in a centrally located metropolitan city. National recognition will be accorded the winner of the award, and as a token of appreciation for his service, General Electric will present him with a 24-hour watch to clock DX accurately.

**How to nominate a candidate:** To nominate a candidate for the award, you need only submit his name, address, call letters, and a description of the service performed.

Entries will be reviewed by a distinguished group of impartial judges, and the decisions of the judges will be based on (1) the greatest benefit to the individual or group (2) the greatest amount of ingenuity and sacrifice displayed in performance of the service.

Your candidate must hold a radio amateur's license issued by the F. C. C., Washington, D. C., and the service must have been performed while he was pursuing his hobby as an amateur within the continental limits of the United States.

**Your letter must be postmarked** not later than December 31, 1952.

**Judges who will decide** which candidate's achievement is most worthy of the award, are:

Mr. E. R. Harriman, President, The American Red Cross.

Mr. G. E. Sterling, Commissioner, Federal Communications Commission.

Mr. G. L. Dosland, President, American Radio Relay League.

**Winner will be announced** on or before March 1, 1953, and the award will be publicly bestowed soon thereafter.

Employees of the General Electric Company may nominate candidates for the Edison Radio Amateur Award, but are not permitted to receive the award.

**Choose your candidate . . . prepare your letter of nomination . . . and mail to Edison Award Committee, Tube Dept., General Electric Co., Schenectady 5, N. Y.**

**GENERAL ELECTRIC**

166-1B10

# SWEEPING *the* SPECTRUM

Have you nominated your candidate for the Edison Radio Amateur Award sponsored by the G-E Tube Department? I hope all of you readers saw our October ad in CQ and QST announcing this award. For those who may have overlooked it we have reprinted the ad on the preceding page.

I hope you readers will take time out and nominate an amateur who you feel is worthy of this award. We want to find the amateur who has performed a meritorious public service and inform Mr. and Mrs. John Q. Public of his deed so that they will realize that amateurs *can* and *will* perform such services whenever they are called upon. We want the public to know that amateurs of today are always ready to give unselfishly of their time to help in any emergency whether it be floods, tornadoes, snow storms or relaying medical information to save a person's life; also they are doing valuable work in Civil Defense and other similar public services. We want the public to look upon the amateur not as the one who causes Tennessee Valley Indians but a person whom they can call upon for help.

This is another step forward in promoting better understanding and goodwill between Mr. and Mrs. John Q. Public and the amateur.

So how about it fellows! Let's find this amateur. Send your nominating letter in as soon as possible. Remember all letters must be postmarked not later than December 31, 1952.

* * *

Would you like to see an issue of HAM NEWS devoted to the calculation of signal-to-noise ratio? This would be a mathematical treatise on the subject by W2RDL and would entail the design and calculations of typical r-f amplifiers. No calculus or higher mathematics would be used—only simple algebra which I am sure most of you readers know. If you would like to see such an article appear in this publication, drop me a line. If enough votes are received, it will appear in a future issue.

* * *

Here is a very interesting definition of "flea power." It is that power generated by a flea weighing one milligram and jumping 20 inches high every 5 seconds—a microwatt. Just think, it would take one million fleas jumping in harmony to produce one watt!

* * *

A news release that passed over my desk recently told of the demonstration of a "transistorized" megaphone which amplified the normal speaking voice to a volume comparable to a cheerleader's most strident yell. The article goes on to say "The transistors in the megaphone operate from tiny batteries, the size of a miniature cigarette lighter, eliminating the use of bulky, high-voltage batteries and the need for an external power supply. The little batteries are enclosed with the transistors in the amplification unit. The new unit has a volume control which permits the adjustment of the normal speaking voice from a raucous shout to an inaudible whisper." Can you just picture the vest-pocket transistorized modulator of nineteen umpteen modulating that KW! What about the modulation transformer? I dunno———.

Another news release told of experimental transistors operating at temperatures well above the boiling point of water—270 degrees. That's pretty hot! And a recent article mentioned that some transistors can operate up in the megacycles. This new field of electronics is certainly developing at a fast pace.

Would you like to see an article in HAM NEWS on a "transistorized" receiver or transmitter? It is hoped that not too far in the distant future we may have such an article.

* * *

Here's another newsy item. The G.E. Company will supply electronic signalling equipment for automatic and simultaneous control of civil air raid warning instruments throughout the state of Delaware. The equipment produces electronic tones, which when broadcast over the State Police radio system, are useful only to special civil defense radio receivers. The receivers are connected to air raid warning devices and on receiving the tones, activate the device so as to produce the standard civil air raid warning signals.

It's comforting to know that some people in the United States are not just sitting around and glibly saying "it can't happen here." This brings up a mighty interesting question—What are you as an amateur doing for Civil Defense? Have you joined your local Civil Defense organization?

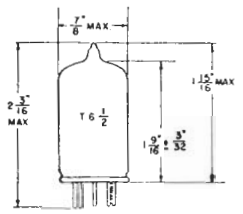
—*Lighthouse Larry*

## GENERAL DESCRIPTION

Principal Application: The 6BK7 is a miniature twin triode designed primarily for use as a cascode amplifier at frequencies below approximately 300 megacycles. The electrical characteristics of the 6BK7 are similar to those of the 12AV7; however, the 6BK7 incorporates an internal shield which reduces the feed-through capacitance between sections and thus makes the 6BK7 especially suited for use in cascode amplifiers and other applications in which a minimum of coupling between the two sections is required.

| | |
|---|---|
| Cathodes: | Coated Unipotential |
| Heater Voltage (A-C or D-C) | 6.3 Volts |
| Heater Current | 0.45 Ampere |
| Envelope: | T-6½, Glass |
| Base: | E9-1, Small Button 9-Pin |
| Mounting Position: | Any |

## PHYSICAL DIMENSIONS

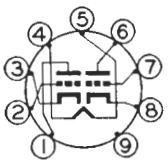



RTMA 6-2

## TERMINAL CONNECTIONS

Pin 1 – Plate (Section 2)
Pin 2 – Grid (Section 2)
Pin 3 – Cathode (Section 2)
Pin 4 – Heater
Pin 5 – Heater
Pin 6 – Plate (Section 1)
Pin 7 – Grid (Section 1)
Pin 8 – Cathode (Section 1)
Pin 9 – Internal Shield*

## BASING DIAGRAM




RTMA 9AJ
BOTTOM VIEW

## MAXIMUM RATINGS

DESIGN CENTER VALUES: (EACH SECTION)

| | | | | | |
|---|---|---|---|---|---|
| Plate Voltage | 300 | Volts | Plate Dissipation | 2.7 | Watts |
| Negative D-C Grid Voltage | 50 | Volts | Heater-Cathode Voltage** | 90 | Volts |

* It is recommended that pin 9 be grounded.
** When the 6BK7 is used as a cascode amplifier and the two sections are connected in series, the heater-cathode voltage of the grounded-grid stage may be as high as 250 volts maximum with the heater negative with respect to the cathode.



FROM: