The Megabooster is a final amplifier designed for operation on the 430 to 450 megacycle band. No driving stages are incorporated, as the Megabooster may be driven by practically any 2 meter transmitter. The power output is sufficient for experimental work on the 2 meter band. The Megabooster is easy to build and it may be modulated with any five to ten watt audio amplifier.

**WHY CRYSTAL CONTROL**

Because the 2 meter band is so wide, it may seem unnecessary to use an MOPA or crystal controlled rig. However, definite advantages come from this type of transmitter. From the transmission standpoint, several watts of output from a modulated oscillator will go as far as the same power from a crystal-controlled rig. The main advantage in using crystal control is to give the receiver at the other end a chance to do a better job. If a relatively narrow signal is transmitted, a 430 megacycle converter can be used with a regular receiver. This setup is much more sensitive than a regenerative or a super-regenerative receiver, which it would be necessary to use if a modulated oscillator were used. Of course, a special receiver, with a very broad i-f system could also be used.

**CONTENTS**

Megabooster [High-Frequency Final Using GL-2C43 Lighthouse Triodes] pages 1, 2, 3

Technical Tidbits [Cautions—Screen Grid at Work; Wiring Techniques] pages 4, 5

Tricks & Topics [Plug-in Variable Link; Noiseless Slip Rings; QSL Card Display; Eyelet Holder] page 6

Questions & Answers [Standby Operation; Storing Spare Tubes; Frequency for Typical Data; VR Tube Jumpers] page 7

Parasitics [Correction for Fig. 4 in the May-June 1948 Ham News] page 4
The circuit of the Megabooster is shown in Fig. 2. A pair of General Electric GL-2C43 light-house tubes is used in a grounded grid tripler circuit. Grid drive is applied to the cathodes of the two tubes. This circuit is similar to the usual grid input circuit except that the center-tap of coil L2 is grounded instead of going to a bias supply. The grids of the tubes are tied together and connected to ground through capacitor C2. The plate tank consists of a parallel line circuit, with a shorting bar for rough frequency adjustment and a tuning capacitor, C3, for fine frequency adjustment. Metering is accomplished by jacks J1 and J2, grid current being read in J1 and plate current being read in J2.

CONSTRUCTIONAL DETAILS

The main chassis (5 X 10 X 3 inches) as shown in Fig. 1 forms the base for the Megabooster, and the smaller 3 X 5 X 4 inch chassis acts as a shield for the plate lines and the output link, L4. The tubes are mounted under the chassis, with just the plate lead extending through the chassis deck. Fig. 6 shows in detail how the tubes are mounted. Two three-quarter inch holes are cut in the chassis to match with the holes in the plate shown in Fig. 7E. A piece of varnished cambric 2 X 4 inches is placed between this plate and the chassis and forms capacitor C2. The grid ring on the GL-2C43 is flush against the plate and is kept from slipping by soldering a wire ring around the hole.

CIRCUIT DETAILS

The circuit diagram of the Megabooster is shown in Fig. 2. A pair of General Electric GL-2C43 Lighthouse tubes is used in a grounded grid tripler circuit. Grid drive is applied to the cathodes of the two tubes. This circuit is similar to the usual grid input circuit except that the center-tap of coil L2 is grounded instead of going to a bias supply. The grids of the tubes are tied together and connected to ground through capacitor C2. The plate tank consists of a parallel line circuit, with a shorting bar for rough frequency adjustment and a tuning capacitor, C3, for fine frequency adjustment. Metering is accomplished by jacks J1 and J2, grid current being read in J1 and plate current being read in J2.

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CLEAR SHAFT

FILE HALF

C3 and are fastened to the to drilled and are drilled of % inch

tion. transformer The plate.

These pieces of poly or pieces

Fig. 5. Under-chassis View of the Megabooster

The top of this piece are two pieces of % inch

% inch wide. on the top of this piece are two pieces of % inch

red, with a rubber grommet. These pieces are adjusted on the 4 inch bar so that

the bottom of the axial connectors and thus hold the tubes up against the grid plate.

The grid resistor (Fig. 5) fastens to the grid plate. the two filament chokes are connected as shown to a terminal strip. Two closed-circuit jacks and the fila-

ment transformers complete the underside wiring.

Fig. 4 shows in detail the above-chassis construc-

tion. The two plate lines (Fig. TD) fastens on the plate caps of the GL-243 tubes. The shorting bar is made of % inch brass, % inches long and % inch wide. Two holes of a diameter to fit the plate lines snugly are drilled on % inch centers, and the bar is then drilled and tapped so that set screws can hold the bar to the plate lines. The fixed plates of C3 (Fig. 7A) are fastened to the bottom of the plate lines with 2-56 machine screws. The slots permit the plates to be moved back and forth for adjustment of capacitance.

Two pieces of poly or bakelite form the bearings for the shaft of C3. These pieces are % inches square and drilled with a hole in the center of a diameter to suit the shaft bushings used. The pieces are also drilled and tapped for mounting to the chassis. The rotor of C3 (Fig. 7B) is mounted on a % inch shaft and placed between these pieces.

Details of the output link are shown in Fig. 5. Condenser C4 is formed of two pieces of flat brass. It will be necessary to experiment with the size of these

plates in order to achieve maximum output. One side of the link soldered directly to the coaxial output con-

nector and the other side of the link supports one condenser plate. The other condenser plate solders to the ground lead of the connector.

In order to mount the 3 x 3 x % inch chassis on top of the main chassis, it is necessary to cut one side of the box off with a hackaw. A knife should also be drilled in the front to pass the shaft of C3.

OPERATING ADJUSTMENTS

An output of 5 to 7 watts or that obtained from an ICB-424 transmitter on 500 megacycles is ade-

quate to drive the GL-243 tubes. Before driving power can be used as long as the coupling is arranged to provide the proper amount of plate current. When the two GL-243 tubes should run from 30 to 40 mils.

When the cathode circuit is properly driven, plate voltage can be applied. No neutralization is necessary because of the grounded grid circuit. With the link side of the small chassis removed, resonance may be indicated by a neon lamp held close to the plate lines. The plate shorting bar is moved up and down until the neon lamp is at maximum brilliance. Condenser C3 is used for fine adjustment.

With the link side of the small chassis replaced, it may be found necessary to re-neutralize the final. This will depend in large part on the antenna used. This latter adjustment may be made with the other side of the chassis removed. It is also convenient to adjust the link condenser, C3 from this side.

Plate current should be approximately 50 mils at resonance. Under these conditions a measured power output of three watts was obtained on the unit pic-

tured. It is very important to match the output link to the antenna in order to get maximum output. It may be necessary to spend more time determining the proper size for the link and for the plates of C3. They will depend on the link used and also the type of antenna used.

It was found that the addition of the shorting plate on the plate lines more than doubled the power output obtainable.
The screen grid is probably the most critical single element in modern high-gain tubes and yet it is un-
doubtedly the least understood. The screen grid is what goes upon the screen grid as an element which is supposed to be fixed in potential; and, therefore, the screen grid seems to go no place in particular in the circuit he completely neglects it. He feels that once he has connected the screen voltage lead that he is through with that part of the circuit until the rig wears out. (The latest census lists 1,269,321 cases of parasitics due to improperly bypassed and stabilized screen cir-
cuits. The adding machine broke down before the number of resultant key clicks was totaled.—
Editor's note.)

If the screen is important, let us use why. The best way to do this is to compare triodes and screen-grid tubes. A comparison on this basis brings us the fol-
lowing points.

(a) In a triode there is a large capacitance be-
tween grid and plate. If this capacitance is not taken care of by neutralization, the resultant feedback volt-
age may cause oscillation. In a screen-grid tube, the screen, if suitably bypassed, acts as an electrostatic shield between grid and plate and therefore materially reduces the feedback.

(b) The plate voltage (and grid voltage) in a triode determines the amount of cathode current that flows. In a screen-grid tube the plate voltage has a negligible effect in determining the amount of cathode current because the screen acts as a shield between plate and cathode. It is the screen voltage (and grid voltage) which controls electron flow in a screen-grid tube, just as the plate voltage controls the electron flow in a triode. Obviously then, if the current flow is to be held constant, the screen voltage must necessarily be held absolutely constant.

Thinking now of an actual circuit using a screen-
grid tube, what do the above points mean? Let us assume a screen-grid tube in the final of our rig. With the antenna tightly coupled to the final tank and the plate current going up to suit us. The link is therefore coupled tighter and tighter as the power output increases. However, the plate current does not increase appreciably. At this point the average harm decides this tube won't work properly. Actually all that happened was to be expected. In point "b" we argued that the current depended upon the screen voltage. Incasmuch as the screen voltage was not affected by increased loading, we found it difficult to change the plate current. All that was accomplished by the increased loading was a decrease in power output, because the plate dissipation went down as the load was increased and the plate dissipation went up.

To this point comes the concept of loading—too little load—we come to the exception in rule 7b. That is, the power output will bring on a condition where the plate voltage will affect the cathode current. Practi-
cally this means that if the final is lightly loaded, the screen current will be high (even over rating), the plate current low, efficiency poor, and output low.

(c) Loading a screen-grid tube will have a large voltage swing, whereas in a normal triode the voltage swing will occur when maximum current should flow. With a low enough plate voltage, the electrons in the tube will not be attracted to the plate as strongly as usual. These electrons will therefore tend to collect on the screen-
grid. This large increase in screen current may harm the screen, as it is a finny element in comparison to the plate, and is not capable of dissipating too much energy.

Many amateurs have found from first-hand experi-
ence that this last point is true. When an ECO is lightly loaded so that this effect takes place, a slight change in loading will change the frequency quite a good deal, whereas the same ECO, when heavily loaded, will be less affected frequency-wise by a load change.

Adding up the information above give us data by which we may formulate four rules for operating screen-grid tubes that will make them do the fine job we were designed to do.

1. Carefully bypass and install the screen circuit so that it acts as a good shielding device. This means that the bypass condenser leads should be short and properly placed. Also, external shielding should be used on the tube if such is recommended.

2. Make certain that the screen voltage is acu-
ately held to the design value. If the circuit is keyed this may require a separate, stable source of voltage. It is also important that an accurate voltmeter be used. The voltmeter part of volt-ohmmeters, espe-
cially home-made units, may easily be off 20-30% if the voltmeter is an old instrument.

3. Make all loading adjustments carefully for maximum power output and maximum circuit effi-
ciency. Loading an amplifier or final too lightly or too heavily will cause poor circuit and tube efficiency. Maximum power output will be obtained when the load is neither too light or too heavy.

4. Install a screen current monitoring position. A screen current meter, connected in the circuit at all times is to be preferred. This will help to avoid acci-
dental damage to the screen due to overload. Also, a screen current meter is an invaluable aid in the tuning-
up process, as this meter is much more sensitive as a tuning indicator than the plate current meter.

When a screen-grid circuit is unloaded, plate current will be very low and the screen-grid current will be high. As the loading is increased the screen current will drop off as the plate current rises. A point will be reached where further loading does not affect the screen current. This is the approximate point of proper loading. A further refinement would be to check power output as the loading was changed, and adjust the loading for maximum output.—Lighthouse Larry.

PARASITICS

Fig. 4, page 3 of the May-June 1948 Ham News is in error. The lead going from the top of R1 to C1 should be removed from C1 and placed instead in the bottom of the secondary of T1. The C1 lead from the bottom of R1 to the top of R2 should be replaced with a direct connection. The lead going from R1 and R2 should be rewired so that it connects R1 to the top of R2.
WIRING TECHNIQUES

How many times have you built a piece of high-frequency ham gear, which had been described in glowing terms in your favorite radio publication, only to come to the conclusion that the author of the article probably never had it working either? You proceed to check and recheck the wiring, closely inspect the photographs to be certain that your layout is identical, measure the values of all components, and still it oscillates when it shouldn't, won't oscillate when it should, or just doesn't have the pep that the article led you to expect it to have.

Before you condemn the gadget and discard it, consider the one remaining factor in the construction, a factor which incidentally is not apparent from the circuit diagram and not apparent from the photographs. That factor is the method of wiring, such as the placement of leads, the points of connection to the various components and the length of leads. Also to be considered is the type and characteristics of the components used. All of these points become increasingly important as higher frequencies are considered.

In a high-frequency circuit composed of resistance, capacitance and inductance, it is important that you use only resistance where such is called for, use capacitance only where a capacitor is specified, etc. This may sound obvious, but a resistor has long leads, and if these are not shortcircuited, they add inductance in series with the resistor and the leads have a capacitance to ground. One example, a one inch length of No. 30 solid wire has an approximate inductance of .02 microhenrys. This means that one inch of this wire will resonate at 146 megacycles when paralleled with 60 mfd. of capacitance. We can control the lead lengths of various component parts, but we cannot control the component themselves, except to select the best.

The small size one-half and one watt composition resistors are generally suitable for high-frequency circuits. In the capacitor line, silvered-mica button capacitors, high-capacity ceramics and regular tubular ceramic Capacitors are fine for bypassing, coupling and coupling applications.

Fig. 8 shows the schematic diagram of a typical mixer circuit using a 6AK5 miniature tube. This type of circuit embodies most of the principles of high-frequency wiring techniques. These same principles are of course applicable to radio-frequency amplifiers and oscillators. Fig. 9 is a photograph of this 6AK5 mixer wired in two different ways. Circuit-wise the two methods are identical, but the layout on the left uses high-frequency components and high-frequency wiring techniques, while the right-hand layout illustrates the more common type of wiring technique which should be avoided at high frequencies.

With reference to Fig. 9, the tuning condenser, Cg, is in the lower left section of both circuits with the grid coil directly above. The i-f transformer is mounted in the upper-right portion, with only the six leads extending below chassis. The similarity in layout stops at this point. In the right-hand unit mica condensers are employed for bypassing. These condensers all go to ground at a common point, and the resistor and coil leads tie in at this common point, and the coil connects the grid circuit of the tube. In the left-hand unit uses silvered-mica button condensers which are mounted around the tube socket so that each condenser is opposite the socket pin to which it connects. One end of the button condenser bolts to the chassis and the other end has a lug which ties directly to the socket lug. There are no leads added to these condensers and hence a minimum lead length is obtained.

Another interesting point is the grid coil and condenser combination. In the right-hand unit the coil leads connect to the condenser and then two long leads of wire go from the condenser, Cg, to pin No. 1 and the other to ground. These long leads have inductance which is in series with the condenser coil combination. Note how this series inductance is eliminated in the left-hand unit. The top coil lead goes directly to pin No. 1 and the condenser is connected to pin No. 1 through a piece of one-eighth inch wide copper strap. This strap has very little inductance. The lead from the grid to the coil has inductance but it forms a part of the coil inductance. The other two leads ground directly to the chassis, the

Fig. 8. Circuit Diagram of Mixer Circuit Described

Fig. 9. Wiring Techniques—High-Frequency Construction on the Left, Usual Construction on the Right
How did you solve that last problem that almost you stupid? Is it about tubas, antennas, circuits, etc... Lightness Barry would like to tell the rest of the bands about it. Send it in! For each "trick" published, he will publish $10 worth of 3.9 Electronic Tubs. He sincerely requests that his letter "Entry for Tricks and Topics" and send it to Lightness Barry, Tube Division, Blvd. 209, General Electric Company, Ltd., Toronto, Ont., Canada.

PIG-IN VARIABLE LINK

For medium and high power transmitters a variable link with plug-in coils is highly desirable to meet a wide variety of impedances, frequencies and loads. Also, for the suppression of harmonics, it is desirable to ground the center of the link.

With these thoughts in mind and with a view to simplicity of construction and availability of materials the plug-in variable link (Fig. 15A) was designed. Some dimensions such as the tank coil diameter, distance from center of tank coil to center of shaft, and width allowed in tank coil for link will be determined by each individual case. Other dimensions as used by the author are suggested.

A piece of mycalex $\frac{1}{2}$ in. thick and 2 in. long was used to mount the coil. Its width depends on the space available in the tank coil. Three holes are drilled and tapped for 6-32 screws. Screw in tightly three small slotted banana plugs. Cut off the two outer screws flush with the top and allow the center one to stick up about $\frac{1}{4}$ in. A small hole just large enough for the wire is drilled near each of the outer plugs. A coil is made up of two, four or six turns so that the center tap can be soldered to the top of the center plug. The ends of the coil were brought through the two holes, bent over and soldered to the base of the plug. The coil will be self-supporting if No. 14 or larger wire is used. Mycalex was used because it is not affected by the heating of the subduing.

The arm is composed of another similar piece of mycalex $\frac{3}{4}$ in. X $\frac{3}{4}$ in. X $\frac{3}{4}$ in., holeed. The mycalex has three holes drilled in it at the same angular distance that the coil supports. The two outer holes are drilled with a $\frac{1}{4}$ in. drill and the center with a $\frac{3}{8}$ in. drill. The two outer holes in the center jack are inserted and the nut run down to within one turn of being tight. The lead wire is then soldered to both the nut and the jack. This allows the $\frac{1}{4}$ in. dia. jacks to fit loosely in the $\frac{3}{8}$ in. hole, to compensate for mechanical errors, and will give good contact when adjusted.

For the center jack a $\frac{3}{8}$ in. X $\frac{1}{4}$ in. copper or brass bushing was used. Larger size power wiring connectors have one in each of them. It is drilled lengthwise to the inside diameter of the banana jack with the head being drilled out further to accommodate the base of the plug. The piece of mycalex is then drilled lengthwise and tapped for the $\frac{1}{4}$ in. machine screw. When this has been screwed down firmly, drill a hole through the side of the bakelite arm passing through the $\frac{1}{4}$ in. screw and tap for 6-32 screw. This provides the ground connection. Lastly drill the hole for the shaft at the desired distance from the center of the tank coil and provide one or two setscrews to hold it firmly in place. W2FEN.

NOISELESS SLIP RINGS

Continuous rotation of large antennas is highly desirable especially in cases where the antenna cannot be viewed from the shack to check "winding" feeders. Coaxial rotary joints are available but open wire or twin-lead type feed lines usually require a difficult slip ring and brush assembly. With reference to Fig. 10B, the rings are $\frac{1}{32}$ in. wide bands saved from large diameter aluminum tubing. They are supported around the mast by polyester squares which also act as guides for the stationary contactors. Three contactors consist of boots of braided copper shielding slightly larger than the rings. The boots are held tight by small springs and make contact over approximately 270° of the ring surface. This unusually large contact area permits absolutely noiseless reception and noiseless power transmission during rotation. With rings $\frac{3}{8}$ in. thick spaced 1 in. between centers and standard $\frac{1}{32}$ in. braided shielding, no mismatch was apparent in a 300 ohm twin-lead feed system. Closer spacing would suit 15 ohm line and wider spacing should be used for open wire lines. W2DWF.

QSL CARD DISPLAY

The usual method of mounting QSL cards on the wall results in a rather messy looking wall, with thumbtacks being used for each card. However, if the QSL cards are connected together (see Fig. 10C) with straps, copies of cards may be made which will require only two thumbtacks for mounting. W5BDG.

EYELET HOLDER

In dismantling war surplus equipment and making changes in existing equipment it sometimes becomes necessary to remove eylets or rivets. The usual procedure is to use a hand drill to loosen the shoulder of the eylet or rivet is removed. This works nicely, except when the rivet is fed lines and the antenna is brought around the drill so that no further drilling can be done. To prevent the rivet moving, the following trick is very useful.

A drill is placed in the vise, point up, and the underside of the eylet or rivet placed on the drill. The eylet is drilled from the top. Enough pressure is exerted so that the underside of the eylet is forced into the drill which is fixed in the vise. This prevents the eylet from turning. It may be necessary to experiment to get the right drill size, and in some rivets it may be necessary to drill a small pilot hole on the underside so that the fixed drill can bite in. W2FEN.

Fig. 10. W2FEN's Variable Link; W4DWF's Slip Rings; W5BDG's QSL Card Display.
General Electric Company, Schenectady, New York, unnecessarily, because, voltage for periods of 100% of normal filament voltage during transmitting hour and operate them. In many cases, the tube cannot be operated at the maximum ratings. For example, if 30 megacycles is the frequency for maximum ratings, two other frequencies such as 60 and 100 megacycles may be used. The maximum permissible percentage of maximum rated plate voltage and plate input for class "B" telegraphy service could be: 70% at 30 megacycles, 50% at 60 megacycles, and 25% at 100 megacycles. The tube data will usually give information of this sort, or, if lower ratings for higher frequencies are not recommended, then the data sheet will give the frequency for maximum ratings. -Lighthouse Larry.

STORING SPARE TUBES Question: What is the purpose of the junper lead (pins 3 and 7) in the VR tube? Answer: The VR tube junper is used to connect the circuit in which it is to be used to the appropriate terminal of the VR tube. The tube data usually gives information of this sort, or, if lower ratings for higher frequencies are not recommended, then the data sheet will give the frequency for maximum ratings. -Lighthouse Larry.

V-R TUBE JUMPERS Question: When is it necessary to provide a jumper lead between the VR tube's pins 3 and 7? Answer: The VR tube junper is used to connect the circuit in which it is to be used to the appropriate terminal of the VR tube. The tube data usually gives information of this sort, or, if lower ratings for higher frequencies are not recommended, then the data sheet will give the frequency for maximum ratings. -Lighthouse Larry.

**Questions and Answers**

Do you have any questions about tubes or tube circuits that are of general interest? For each question published this week, you will receive $10 worth of $0.00 Electronic Tubes. Mark your letter "Sorry for Questions and Answers" and send to Lighthouse Larry, Tube Division, Box 269, General Electric Company, Schenectady, New York, or in Canada, 1000 General Electric Ltd., Toronto, Ontario.

**STAND-BY OPERATION** Question: If a ham transmitter is not used for an hour or so, between contacts, it is better to leave the filament voltage on, or should it be reduced, or should the filament voltage be turned off entirely? -WCKX Answer: High power thoriated-tungsten filament transmitting tubes should be operated at eighty per cent of normal filament voltage during stand-by periods of less than two hours and shut down entirely for longer periods. For transmitting tubes of less than 250 watts plate dissipation the filament may be removed for stand-by periods greater than fifteen minutes. There should be no reduction of filament voltage for periods of less than five minutes. However, the filament voltage may be reduced to eighty per cent during stand-by periods greater than five minutes, if so desired.

Transmitting tube filaments should not be kept on unnecessarily, because, in thoriated-tungsten filament tubes, the rate of deterioration of the filament goes up five to ten times if it is run off as with the plate voltage off as it does with the plate voltage on.

**Typical Data** Question: Voltage regulator tubes are used for what purpose? Answer: Voltage regulator tubes are used to regulate the supply of power to a circuit. When compiling technical information for various types of electronic equipment, it is necessary to have a good understanding of the equipment being tested. The manufacturer's ratings. When compiling technical information for various types of electronic equipment, it is necessary to have a good understanding of the equipment being tested. The manufacturer's ratings. When compiling technical information for various types of electronic equipment, it is necessary to have a good understanding of the equipment being tested.

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TECHNICAL TIDBITS

(Continued from page 8)

condenser being connected through its hug to ground and the coil lead being soldered directly to the metal base of the Miller slug-tuned form.

making all ground leads to one point has long been a favorite wiring trick, but in high-frequency work it is usually far better to ground to chassis at the closest point. Incidentally, make sure that the chassis is clean and bright before tightening the ground lug. In some cases, where grounds are made at random, it may be necessary to shift the grounding point slightly, although usually this will not be necessary.

A solid copper strap as shown will always give a lower inductance lead than a wire lead, and is even preferable over copper braid in cases where the wire may be subject to mechanical strain. A copper strap 1/4 in.wide and 146 mc. on braid and solid copper of the same cross-section showed that the solid strap had a Q two and a half times as high as the Q of the copper braid. This great decrease in FR loss is a definite help at these frequencies.

Another good stunt is to place a portion of the IF transformer tuning capacity at the plate pin of the tube. In the right-hand unit the plate transformer tuning capacity 5) goes directly to the IF transformer. This long lead has inductance and is liable to cause a high-frequency parasitic, even though the IF transformer works at a relatively low frequency. The left-hand unit shows a capacitor from pin No. 5 to ground. (The resistor-like component with the five color bands is this capacitor.) As long as this capacitor is in the order of 15 to 20 mmf, most high-frequency oscillation voltages will be short-circuited. In effect this capacitor (not shown in Fig. 8) is in parallel with C3. It would be even better if the padding capacitor in the IF can were to be removed and wired in right at the socket.

The last point is the proper use of the two cathode connections on the 6AK5 tube. As shown in the circuit diagram, pins 2 and 7 are both bypassed to ground. This gives a lower impedance path to ground and is definitely desirable. If the ultimate in proper grounding is desired, a separate ground lead to each cathode would be even better. Many people say that the resistor used to ground the cathodes would be used differently. The original idea in making two cathode leads available was to prevent a common coupling impedance. This is done by wiring the grid returns to one cathode connection, and the plate and screen returns to the other cathode connection. In this system, only one side of the cathode is bypassed to ground. Incidentally this latter system is not always a convenient method, the wiring as shown in the diagram may be used and will be perfectly satisfactory except for the most critical cases.—Lighthouse Larry.