600-WATT ALL-BAND AMPLIFIER
Push-pull 813's Ease Your Steps to Higher Power

There's no "easy" way to power—but this amplifier, designed and described by W2OYV, employs tested techniques and standard components to make the road to power as smooth as possible.

—Lighthouse Larry

Deadline for nominations for the Third Annual Edison Radio Amateur Award is January 3, 1955... Pick a candidate and send in your nominating letter... see page 8.

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600-WATT ALL-BAND AMPLIFIER

GENERAL DESCRIPTION

Here's a boldy all-band final that does not utilize any new or trick circuits or any substantially different mechanical layout. It will be recognized from the circuit diagram and photographs as a conventional push-pull amplifier constructed in a straightforward manner. It illustrates the use of modern components and practical design.

In this complicated age, there is much to be said for an occasional attempt at simplification; and those seeking a respectable amount of power may find this amplifier fills their needs without emptying their pocketbooks or fraying their nerves during construction and testing.

The amplifier employs a pair of GL-813 tubes in a stabilized push-pull circuit. A multi-grid tank board allows the input circuits to be permanently shielded and amplifiers band-blocking. The plate circuit uses standard plug-in coils which are easily accessible for band changing through the shielded and RF weather- stripped panel door.

No sharing is provided in the amplifier itself. The incorporation of meters would make shielding and circuit isolation more difficult. It is much simpler and far better to install grid, screen and plate current meters in a standard three-hole panel mounted elsewhere in the rack and connected in the power leads going from the amplifier after all RF has been filtered from them.

A regulated bias supply is included in the unit since the low grid currents encountered it can be a simple affair and is something that would probably be built up on a unit.

All controls, including input and output coupling, are conventionally located on the front panel. Coupling capacitors are used for the RF input and output and HV plug connectors for plate and screen leads. The grid meter and interlock circuit connections are made with two-contact microphone plugs mounted under a small shield on the rear of the chassis—thus making it a short and easy job to remove one or the other and replace the amplifiers from the rack. The AC input—for bias and plate voltage—is brought through a cover or shielded panel to the control unit shown in G-E E-H NEWS 31, March-April, 1954, Volume 9, No. 2.

CIRCUIT DETAILS

The only part of the circuit which may be out of the ordinary is the use of a four-section variable capacitor, C5, in the plate tank. This capacitor is used as an adjustable unit as explained under the constructional details. It may be necessary to adjust C5 to be achieved by plugging in all bands. It also makes tuning less critical on the high frequencies.

The proper sections of the capacitor are selected automatically by jumpers on the coils between the sections.

The plate coils are standard 500-watt units and although only a single set has been used, there is no reason why they cannot run for extended periods at 500 watts without heating the tubes. The usual precautions—jacks 3 and 4 on the coil socket—were not used in this design.

The output is through a shielded link as specified. There links are available in 1, 2, and 3 turns. General practice has shown that a 3-turn link is satisfactory for 10 watts, a 2-turn link at 10 and 25 watts, and a 3-turn link at 75 and 100 watts. However, during tube testing, a 2-turn link was found satisfactory for all bands when working into a 15000 ohm coaxial line. Experimentation is recommend here as each antenna system may be slightly different. What works at one location may not work well at another, even though the same general system is used. The line must be driven as close to the antenna as wave ratio than the other. As any rule, link coupling is the sort is probably the essence of all coupling devices to adjust.

The vacuum capacitors, C5 and C6, are for the purpose of providing a short low-impedance path for the higher harmonic which might excite the amplifier. It should be pointed out that they are not necessary to the normal satura- tion operation of the amplifier and may be omitted if TVI is not a problem.

Don't be misled, however, into thinking that these capacitors themselves will be a complete cure for all TVI. They are an aid in stubborn cases and you may well want to try the amplifier before installing them. However, the vacuum capacitors are part of the total circuit, and shunt condensers added to the coil modifications given in the coil modification list on page 2 will be effective in bringing the output voltages down to the desired level.

The bias supply is conventional. It utilizes a GL-650 variac for regulation and as a source of 75 watts of bias voltage. The remaining bias is developed from the Yoke transformer. This transformer is shown in the photographs on top of the bias supply sub- chassis. The grid and plate voltages are actually not mounted under this sub-chassis. The 75 volts is more than sufficient for the power output, allowing the switch to be keyed for CW work provided the screen is supplied from a fixed supply or from a voltage divider from the RF plate supply. Do not attempt CW operation without supplementary power supply. The dropping resistors.

The use has been made of by-pass capacitors and RF chokes. All of these precautions made for stable, trouble-free operation and a minimum of maintenance.

An interlock switch, B1, is provided to protect the system should the interlock be connected in the power supply in such a manner that the principal series capacitor to the plate supply is removed. A small switch located on the door is open. The interlock switch is used in a SPDT switch and should be connected so that the switch opens the circuit when the switch is open. In addition, provision should be made for shutting the high voltage.
lead to discharge the filter capacitors before changing coils. Make up a shorting stick NOW, AND USE IT! A fellow isn't even allowed one mistake at these voltages!

MECHANICAL DETAILS

Much thought and time was given trying to evolve some novel and suitable mechanical layout—something that would be easy-catching and efficient. In fact, the whole project was delayed several months because of this. Several unique ideas were dreamt up but discarded because they were too expensive, too difficult to construct without much-working facilities or else they just shuddered over-design.

The carer of the chassis and panel construction proved to be not only the easiest to handle with the usual facilities but also promised to fit into most modern station layouts.

The biggest problem (and it was small compared to some of the difficulties we were considering) was that of getting the plate tank capacitor and link controls out of the front door. The solution was found with standard components. The capacitor is driven with a right-angle drive unit, a universal joint, and some 1/4-inch diameter shaft. Panel buildings are used wherever the shaft goes through the chassis or panel. The intake control required only two flexible shafts. The arrangement should be evident by inspecting the photographs.

The parts layout is also clearly shown and no detailed drawings are given. The main tank is mounted on spacers so the tuning and link shafts are centered on the lower section of the front plate.

The bias supply is built on a separate sub-chassis easily shaped and mounted as shown and there is nothing related about the appearance of parts. The sub-chassis is fastened to the side of the main chassis by two screws in front and by the feed-through capacitors, Cm and Cc, on the rear apron of the main chassis. The AC line filter capacitors, C1 and C2, are mounted on the bias chassis and project through the main chassis in close-fitting holes.

Ventilation is provided through the panel door and the rear plate over each tube. Insulated drafts provide sufficient air to prevent overheating of the tubes.

CONSTRUCTIONAL DETAILS

All components are mounted as shown in the photographs on a 12 x 15 x 4-inch aluminum chassis. Aluminum is recommended rather than steel as it is both easier to work and will not rust in damp locations. Even a plated steel chassis will rust around the dielectric holes. No special precautions are necessary in the layout that cannot be obtained in the illustrations.

The front panel calls for special attention. The three-factor shield must be obtained. The panel used here is 1/2 x 12 x 15-inch Porcelain Grill Panel Cover (Cat. No. D41pro-8). In building this, the panel was covered on the right-hand side by taping the holes over, and the right-hand side was covered with black paper, then the panel was copper-plated. While plating is not absolutely essential it will result in a more permanent shielding job.

After plating, a piece of standard brokens screen was carefully soldered to the inside of the grill door.

The next operation was to install the JF weather stripping. The particular material used was made by Instrument Specialties Co., Little Falls, N. J. (Cat. No. 97-112-201). This material is 3/8-inch-wide beryllium copper strip with 1/2-inch wide fingers, 5/32 fingers per inch. Similar stripping of other manufacture could also be used satisfactorily. This strip is held to the panel by a 1/2 x 1/4-inch aluminum angle forming completely around the sides and top of the door opening and secured to the panel with loose machine screws.
PLATE TANK COIL DATA

- All coils B & W TVH, 2"-inch inside diameter
- 20-24 L, No. 14 spaced to 1/4-inch length with 3/16-inch separation in center (Jumpers between pins 1 & 3 and 5 & 7.)
- 20-22 L, No. 12 spaced to 1/4-inch length with 3/16-inch separation in center (TVH with one turn removed from each end.)
- 20-21 L, 1/2-inch d. wire or tubing spaced to 6-inch length with 3/16-inch separation in center. (TVH with one turn removed from each end.)
- 20-4 L, 1/4-inch d. wire or tubing spaced to 3-inch length with 3/16-inch separation in center. (TVH with two turns removed from each end.)
This single serves the dual purpose of providing a support for the cover as well as holding down the RF transfer wire.

The chassis cover is made of 1/16-inch soft aluminum, bent by clamping it over the edge of a work bench, using a piece of angle iron and two "C" clamps. Legs should be bent on the edges of the back to be fastened to the sides after all bending is completed. Self-tapping screws are used to hold the shielding together. Any gaps in the joints should be filled with paste or small brads. The cover should be fastened with several self-tapping screws along each edge rather than with the screws in each corner as provided by the manufacturer.

Two 1/8-inch diameter holes should be drilled in the back opposite the neutralizing wires for later use in adjusting the neutralization.

After the construction and wiring is complete, the outside of the panel and the cover can be painted with a high-temperature enamel. After all mechanical details are complete, the amplifier may be wired. Shielded wire was used exclusively in the input and output leads and ordinary single-conductor shielded wire for the low voltage wiring. The filament leads should be No. 14 shielded wire. Grounding the shielding at both ends of the leads and wherever else it may be convenient.

Leads length on all by-pass condensers should be kept as short as possible. The Sprague H-Pass capacitor used for C9 should be connected so the black lead is connected to the top of the chasis, providing a short shunt across the plate. In other words, it should be connected so the top of the chasis, the RF would have to find its way through the capacitor. If the capacitor is not completely the cutouts and could well result in instability due to the non-uniform distribution of the shunt capacitance. This capacitor is mounted through a snug-fitting hole and held in place by a metal bracket in the top of shielded transformer box. This angle also provides the ground connection for the filament wiring. Neutralizing circuit and grid current meter terminals are protected by an aluminum cover cut from a 3/8-inch sheet aluminum.

MODIFYING THE PLATE CAPACITOR

The modification of the plate capacitor requires no tools or equipment other than a %-inch drill and a %-inch reamer. This capacitor, before modification, consisted of two sections—each with ten paper plates. The seventh plate was removed from each section and was removed by sawing through the support rod. %-inch from each side of the plate. Next, four pieces of %-inch diameter insulating rod (graphite was used) were cut to fit exactly the space left between the sixth and eighth plates. The ends of these insulating spacers were drilled and tapped to the threads of the statior support rods. No changes were made in the rotor. This is a capacitor having two separate section states—the two inside sections consisting of three plates each, and the two outside sections six plates each. Suitable heavy solder lugs, stifll in the photographs, are inserted between both ends of the insulated rod and adjacent plates to allow con- nections to be made to the statior.

The shielded link is plugged into an SO-290 coaxial connector mounted on top of the chassis, to allow the link line to feed through the chassis and connect to the output connector on the rear apron. Both connectors are of the phono type and are insulated from the chassis by means of standard receptacle heads designed for this purpose. The shielded link is supplied with a pair of shielded leads. To use the link with coaxial cir- cuits, solder "back to back" joints on the shield braiding right at the link, leaving a single shielded lead for connection (see circuit diagram). The bases of the GL-315's are grounded to the chassis by small metal clips from a socket for a GL-42-150A. Since these may not be readily available, a suitable clip can be made from spring brass or bronze.

TUNING UP

The first step in getting the amplifier into operation is to set the bias voltage. This can best be done before the supply is fastened in place. After checking to see all wiring is correct, apply power and adjust R4, for a current of 5 milliamperes through the VR tube. The easiest way to check this is to measure the voltage drop across the 10,000-ohm series resistor, R5, using a VOM or high resistance DC voltmeter. This will be 30 volts DC for 5 milliamperes current. Blue resistor R6 should be set at 5000 ohms for a plate supply voltage of approximately 400 volts. If only CW operation is contemplated, set R4 at 2500 ohms. The signal voltage output for the output transformer and CW work it is recommended that slightly lower grid drive be used on CW, approximately 7 milliamperes per tube. It is good practice to use the minimum amount of drive for full output under all conditions as an aid to keeping down harmonic generate.

Neutralizing should be accomplished as explained under "Circuit Details" only if fully adjustable plate and screen voltages are available. Otherwise it should be left out of the circuit. It was found by using a very sensitive RF indicator to plate and adjusting the neutralizing wires for minimum output. It is recommended that all wiring to the power supply be made as short as possible and that the shield be grounded at both ends. screened that both ends of the output screening wire are grounded. A series dripping resistor from the plate supply may be necessary for plate voltages only, or a voltage divider across the plate supply could be used for CW. When possible, place to CW is it only necessary to turn off the power supply and short the secondary of the plate transformer to earth ground. This amplifier has proved itself in all respects. It is easy to build, provides a good deal of gain and power, and offers sufficient power to compete with the best.

PARASITES

In the 200-megacycle range in the September-October 1944 issue of QST, the Harmonics News (Vol. 9, No. 10), there was a treatment of 100 megacycle forms instead of %-inch forms as described in the parts list. Also, RFC's should have 15 turns, instead of 8.
Hey, fellows, don't forget the deadline for entering nominations in the Third Annual Edison Radio Amateur Award. January 2, 1933. Complete rules are on page one of the September and October issues of QST and page one of the September issue of QO. The award means not only acclaim for the winner and recognition for the person responsible for his nomination—but also the Award gives him radio a big boost. Get those nominations in.

CD workers may be interested in the following article by VE-83N in "Sparks," published by the Brandon (Manitoba) Amateur Radio Club.

"During the last war the enemy had a CD communication system—one of the most extensive ever. I had the opportunity to monitor. The number of stations on this net was amazing. The area covered was enormous—from Channel to Baltic in the north, along the Russian front, north to Italy, along the Mediterranean, and all the land between. Guess what band this operation took place on—long-wave. Down around 170 kcs.

"The operators were good, the discipline rigid—and unauthorized transmissions were nil. The activity that took place on this net after an Allied raid on the Reich was inestimable. All traffic was coded, not High-grade cipher, and not for security's sake, either. All traffic was essential. There were requests for medical, fire fighting aid, etc. The transmitters were VFO. The machines could be used at all times by going up or down in frequency, and still be very close to net frequency. This can only be accomplished on long-wave. And guess the mode of operations... CSW.

One letter out of ten—and we get more than a thousand here in the course of a year—asks how to change one of our circuits in order that a slightly different component can be used or so the piece of equipment will do something a little different than what it is designed to do.

These are not easy letters to answer in most cases. We are busy here in New York, as we have written to countless fellows, it simply is not possible for us to enter into a design or re-design project upon individual request. Usually, it's not only that the design or re-design publications take a lot of time (see build each piece of equipment on paper before touching a drill or soldering tool) but also the matter of responsibility.

We simply can't afford to make some calculations and then pass them on to someone else to carry through. For we stand behind every design we publish; and it is our desire that you save yourself plenty of time or equipment—often several models of it—and trend L-12 thoroughly. So we know it works the way we say it does.

Now for us to go back somewhere near the beginning of the job and make some design changes so the equipment will operate a little differently—and still guarantee operation—may not sound like a big project. But sometimes we can't tell you big a project such a change is until we also carry through with perhaps new construction and new conditions and complete a series of tests on the new design. And this, as I said before, we cannot do on an individual request. So, in most cases, we are forced to reply by saying simply that we are sorry but the design has been worked out to do that particular job in that particular way, and with these particular components—and in making changes and substitutions you'll do it on your own.

Good dynamic regulation in a power supply (see G.E. HAM NEWS, Volume 9, No. 1 & 2) is particularly important in an SSB transmitter to obtain the peak output of which the amplifier is capable. And with as many fellows tuning to SSB (over a thousand, according to what we hear), the question continually has come up as to just what practical advantage you get with 100 or so microfarads of capacity in your power supply filter. In other words, a lot of fellows ask if 30 or 50 microfarads won't do just as well in practical operation.

The answer lies in the oscillograms of our issue No. 3. They show the sort of dynamic regulation you get with varying amounts of capacity. They show how performance improves continually as you add capacity. You will note, however, that the performance has improved tremendously by the time the capacitance reaches a value of 6 microfarads. After that, although the improvement continues with additional capacitance, the improvement naturally is smaller.

Now when you get into this latter region—the region where, quantitatively, the improvement is small—the effect on practical operation of your transmitter begins to depend on a larger and larger degree on just how well the rig is working in other respects. In other words, you get to a point where the transmitter is otherwise capable of ideal performance, the best dynamic regulation in the power supply is not necessary to exploit this capability. On the other hand, if the new capacitance is limited, the improvement becomes almost by the last 10 microfarads or so of filter capacity will not make a great difference in practical bench air operation.

We all boil down to this, as we said in Volume 9, No. 3. "It is difficult to see how one can get too many things 'tuned in' to our supply." This means, of course, you should put in all the capacity you can get hold of—and it saves the VLO and Jr. op. in the process of buying filter capacitors.
FOR OUTSTANDING PUBLIC SERVICE

Nominations now are open for the Third Annual
Eddison Radio Amateur Award—to be granted for out-
standing public service by a United States amateur in
1954. The deadline is January 7, 1955.

Any individual or group may nominate a candidate
for this Award. Letters of nomination should include
all details of the public service performed, and should
be mailed to:

Eddison Radio Amateur Award Committee
Tube Department
General Electric Company
Schenectady 5, New York

Judging will take place in mid-January and presenta-
tion of the Award and prize will follow shortly there-
after. Judges for the 1954 Award are:

Val Peterson, Administrator, FCC
E. Roland Harrison, President, Red Cross
Edward M. Webster, Commissioner, FCC
Goodwin L. Detland, President, ARRL

Detailed Award rules are listed on page one of QST
magazine for September and October and CQ magazine
for September. A copy of these rules will be mailed to
anyone upon request.

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