

## 6.7 A CLASS C LINEAR R-F AMPLIFIER

As soon as the eyebrows stop clicking and the unbridled laughter ceases, clear your mind of all the facts that you have just been reading, about classes of operation. Hold off regarding opinions on my sanity for a few pages; I must warn you, I have a lawyer. Strange as it may seem, I am about to describe an amplifier that uses no grid bias supplies (either regulated or otherwise), obtains its bias by rectifying the driving SSB signal, and does not employ screen regulation! As a matter of fact, the screen voltage is obtained through a huge dropping resistor, and the voltage kicks around wildly!

Possibly some background information will help to soften the blow. Some time ago, the author did a conversion on the Heath DX-100 to double sideband (April 57 CQ Mag.). In this conversion, the grid voltage was not stabilized, the screen voltage was not regulated, and the original clamp tube was left in the screen circuit. Many of the more learned hams scoffed at such an idiotic conversion, but the fact remained that the 6146 final in the DX-100 *did* operate as a linear! The r.f. peaks were extremely sharp and the cross-over "X" was just like the book said it should be. Unfortunately, I did not take the time to investigate *why* the device worked.

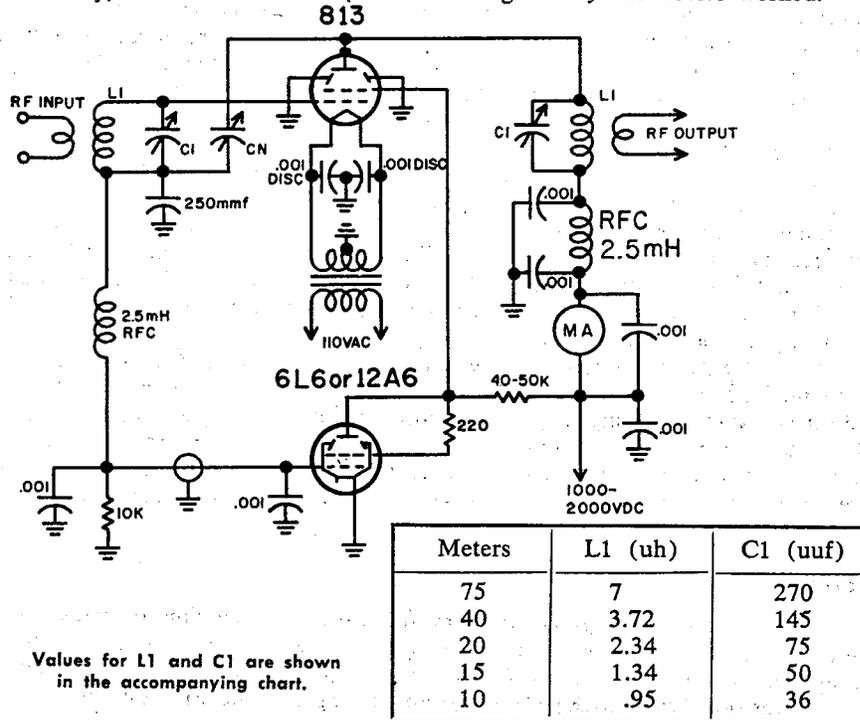


Fig. 6.7A—Schematic for the ZL linear (ZL1AAX). Note that no external bias supply is used and the screen voltage is not regulated. L1 should resonate on the desired band with C1.

Some time before this, Lester A. Earnshaw, ZL1AAX, was conducting experiments along the same line, that is, using a clamp tube in conjunction a class C amplifying stage. Lester perfected the circuit, and it is this design that is presented here (fig. 6.7-A). His design has been duplicated with the same success by hams



The loading effect of the amplifier upon the driver stage is exactly the same as that of a zero bias class B linear. In this class (unlike class AB<sub>2</sub>) grid current is drawn for all amounts of input. Thus, the impedance is normally low, and varies lower. In AB<sub>2</sub>, when grid current is not drawn, the impedance is high until the moment of grid current flow, then the impedance drops considerably. Of the two, zero bias class B offers the least variation in grid impedance and therefore the demand upon the exciter regulation is less stringent. The ZL linear behaves exactly like a zero bias class B linear and the drive requirements are the same.

At this point, a word about tubes is in order. ZL1AAX has experimented with a pair of 6146's and found the combination unsatisfactory when clamped with a 6AQ5. The 6AQ5 appears to have insufficient clamping action, in this application, when connected as a triode. Many have had great success with other tubes; John, ZL2AG has the system working nicely with a 4-125A, several ZL3 chaps have had success with the 807, and an unknown VK is reported to be using a Philips equivalent of the 4-65A. There is no apparent reason why the system cannot be applied to almost any tetrode or pentode.

The choice of clamp tube is somewhat more critical. Earlier it was stated that the increase in the 813 plate current will be in proportion to the input if the clamp begins unclamping the moment bias is applied. Many tubes have this property. The 12A6 and 6F6 are excellent tubes, as is the 6L6 and 5881. The usual 6Y6 is unsatisfactory for the clamping action is far too severe. No doubt there are other tubes that will have the linear action required.

#### Technical Considerations

Excessive grid drive will cause too much grid current and will drive the 813 into the class C region. This should be avoided like the plague for someone (probably another ham) is sure to saw your tower in half. With 1100 volts on the 813, 2.5 mils of grid current, (on a two tone test) seems to be about maximum. As the plate voltage is increased, the grid drive requirement will decrease.

It is quite important that the correct LC ratio be used in the plate tank circuit. There should be more capacity than would be used in a class C stage. If the reader has any doubts about this he should refer to the formulas for L and C given earlier in this chapter. In addition, the amplifier must be completely stable. It must be checked without drive by varying the input and output capacitors, across resonance. The smallest trace of grid current or plate current fluctuation must be eliminated. Neutralization is a necessity.

Rough tests of stage efficiency indicates that the ZL linear has an edge over the zero bias class B linear stage, which is usually thought of as the most efficient type of linear amplifier. The ZL linear should gain wide popularity because of the lack of regulated power sources, ease of adjustment, and high efficiency. The fact that it is so similar to existing transmitter circuits, should make it a natural for converting these transmitters to single sideband.



The Lakeshore P-400-GG uses four 6CN6 tubes in a grounded grid configuration and operates on 80 through 10 meters. With a driving signal of approximately 20 watts, this unit will deliver 400 watts PEP to a 52-300 ohm load.



are used in a grounded grid configuration. The control tube (a 6L6) is connected in series with the screen and the 380 volt power supply. In effect, the 6L6 acts a series gate tube rather than clamping the screen voltage to ground as is the case with the ZL and G2MA linears.

All the advantages of grounded grid operation are retained with this circuit, and far less grid drive is required to "get the show on the road". R-F drive from the exciter is applied to the 6L6 and the heater circuit of the RK-65's. The positive r-f cycles cause the 6L6 to draw more current, thereby increasing the screen voltage. A B&W filament choke eliminates the possibility of r-f getting back into the power line. A standard pi-network output circuit effectively matches the final stage to the antenna. The RK-65's will handle 2 kilowatts PEP input with ease.

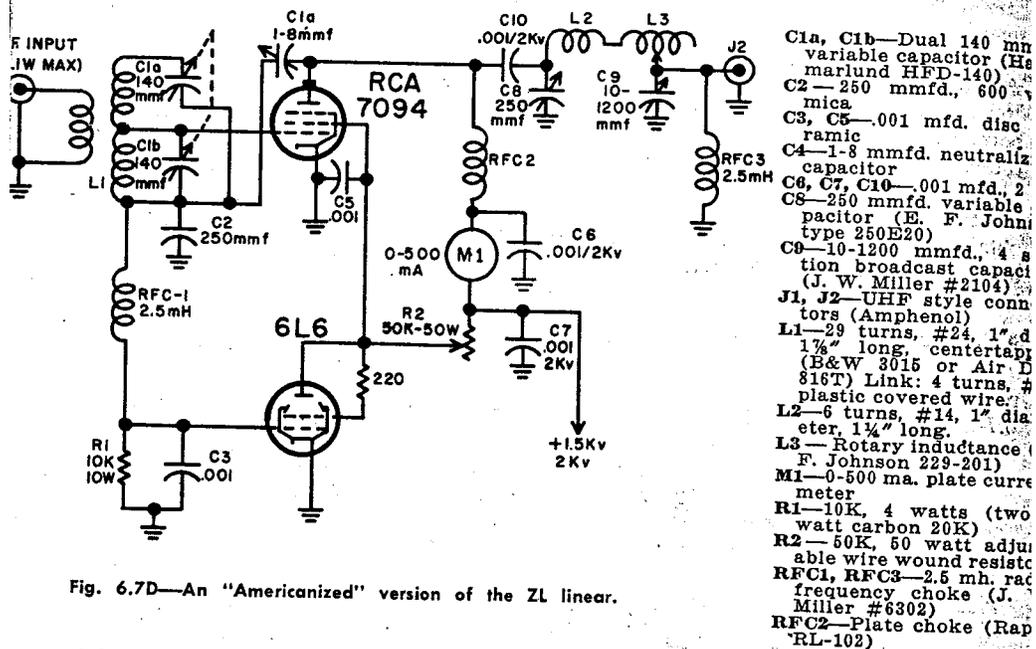


Fig. 6.7D—An "Americanized" version of the ZL linear.

## 6.8 LINEAR AMPLIFIERS USING SURPLUS TUBES

The 304TL and Western Electric 701A are plentiful and inexpensive, on the war surplus market. Unfortunately, both these tubes have extremely high inter-electrode capacities which reduce their usefulness on the 10 and 15 meter band. However, they do represent an inexpensive way to get a kilowatt going on the lower frequency bands.

Two units are described here, one using a single 304TL and the other incorporating a pair of WE-701A's. The 304TL amplifier is shown in fig. 6.8-A and is conventional in most respects. The filament was wired for 10 volt operation because of the availability of 10 volt transformers, and the desire to avoid copper buss for filament wires. The 304TL filament requirements are 10 volts at 12.5 amperes or 5 volts at 25 amperes. The center-tap of the filament is used as the cathode return point. Both sides of the filament voltage line are bypassed to ground (C5-C6) at the tube socket with good quality mica capacitors. The cathode current meter is connected from the filament center-tap to ground, and C7 grounds the meter for r-f. The parasitic resistors R1 and R2 are in the grid circuit and the grid neutralizing