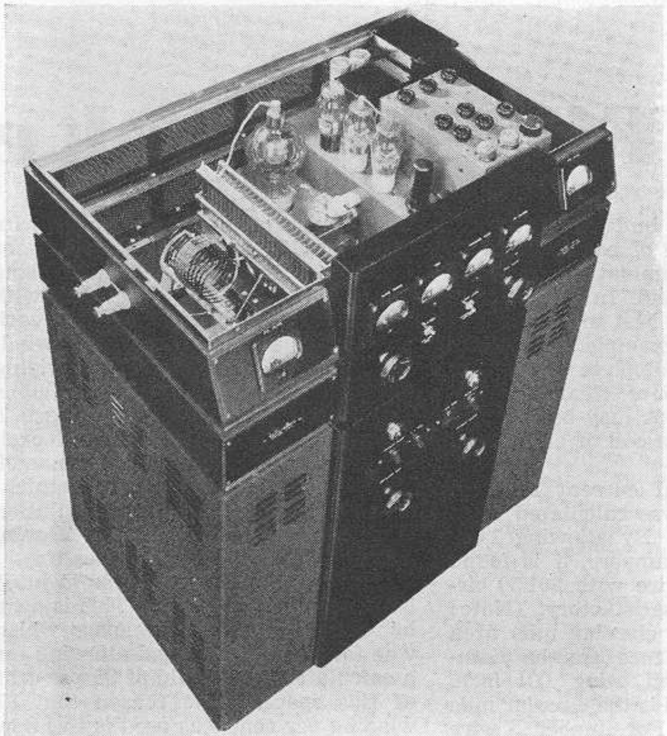
Commercial Ham Transmitter

By ROYAL J. HIGGINS, W9AIO
Engineer, The Hallicrafters, Inc.
Chicago, Illinois

A cleverly designed 325-watt transmitter featuring band-switch and reasonable cost.



The entire bandswitching mechanism is housed on top.

EVERY amateur will agree that 325 watts of carrier power on fone and 450 watts on c.w. represents a signal capable of really going places. While stating the power output, in the design of a transmitter, before first considering the oscillator, doubler and the other stages before the final amplifier, might appear to be putting the cart before the horse, practically it's the most straight forward way to plan a transmitter and what goes into it.

It must be appreciated that if the output power of our transmitter were doubled the effective signal strength at the point of reception would go up only about 3 DB,—1 S unit or so—and when the cost for that slight increase in signal strength is considered, one has to ask, is it really worthwhile? Power goes hand and hand with a loud signal but some middle path has to be chosen or one's desires will run away with his pocketbook. Amateurs know that 300 watts of fone carrier power is a really healthy signal and with 400 watts on c.w. they wouldn't have to take the back seat from any signal on the air.

Large tubes cost money and power supplies to run them are also expensive. Still, to have the output power agreed upon as satisfying the high power desired one of two courses must be followed: use one high voltage tube or two or more low voltage, high current tubes. Considering efficiency and co-ordinating it with the price of both the tubes and power supply the high voltage tube wins out. So the 3000 volt RK63 Raytheon tube for the final stage is chosen. This high mu tube requires only 17 watts of driving power amply provided by the parallel RK39 tubes which act as drivers.

Doing a little juggling of convenience, cost and efficiency, "plug-in" is the answer for the final plate coil. Only in the driver stages, where efficiency can be overlooked at no expense of driving power, inasmuch as the parallel RK39's initially provide more power than is necessary, the convenience of band switching dictates its inclusion in this transmitter.

So many old timers, failing to realize the advantages to be gained with the latest screen grid tubes, doubt that a 6L6 doubling could drive the parallel RK39's to full output. Actually the 39's require considerably less excitation than the amount delivered by the 6L6 doubler. Tests show a marked decrease in output from these tubes if more than ¾ watt of grid drive are fed to them.

A 6F6 very reliably performs the function of crystal oscillator. And, when the transmitter is being worked on the crystal frequency rather than a harmonic, the 6F6 has sufficient output to drive the RK39's direct. The band switch is so wired to jump the 6L6 tube when working straight through on the crystal frequency.

Seldom should it be necessary to band switch more than 3 bands. Rather than limit this high powered transmitter for operation on only three bands, however, the coils of the excitation stages are plug-in. The flexibility of such an arrangement is immediately apparent. One might be interested only in 10, 20, and 40 meters for most of the communications work, but imagine how concerned in the investment one would be if one wanted to work on 80 or 160 meters at odd times and your transmitter was wired only for 10, 20 and 40. Coils for the three bands used most are left in the transmitter and output from these shielded coil combinations, seen at the right of the top view of the transmitter, is available at the flip of the band switch. When a seldom used band is desired, one of the coil boxes is removed and the new band coil box substituted. Briefly, coils boxes for all bands can be kept on hand and those for the 3 most used bands plugged into the transmitter and left there until the need arrives for operation on a seldom used band. The shielded coil boxes represent a very foolproof way of conveniently connecting the proper coil and condenser combinations into the band switch circuit. The only other operation necessary when going from one band to another is plugging in the final plate coil for the band on which operation is desired.

The RK63 is rated at 3,000 volts at 230 milliamperes but, inasmuch as its output is going to be modulated, 2,000 volts will allow the desired carrier power to be obtained and still keep the cost of the high voltage power supply within reason. All transformers in the transmitter under consideration are *Kenyon* and are conservatively designed for their particular job. The 2,000 volt power supply, with 866 tubes as rectifiers, is capable of providing plate power for the push pull class "B" RK38's and also power for the RK63 final r.f. amplifier. The regulation of this power supply is excellent and allows it to properly perform this dual function. When operating the transmitter on c.w. the slight increase in plate voltage on the RK63, due to the modulator being inoperative, is desirable for increased c.w. output.

The RK38 modulators are driven by push pull class "A" 2A3's. A little maneuver in economy at no expense in performance disclosed the possibility of working the 2A3 plates at ground potential which would allow the same power supply to deliver bias for the final r.f. stage as well as the modulator tubes. A separate 5Z3 rectifier takes care of the exciter stages, so the number of power supplies are kept at a minimum consistent with satisfactory performance of the equipment supplied by them.

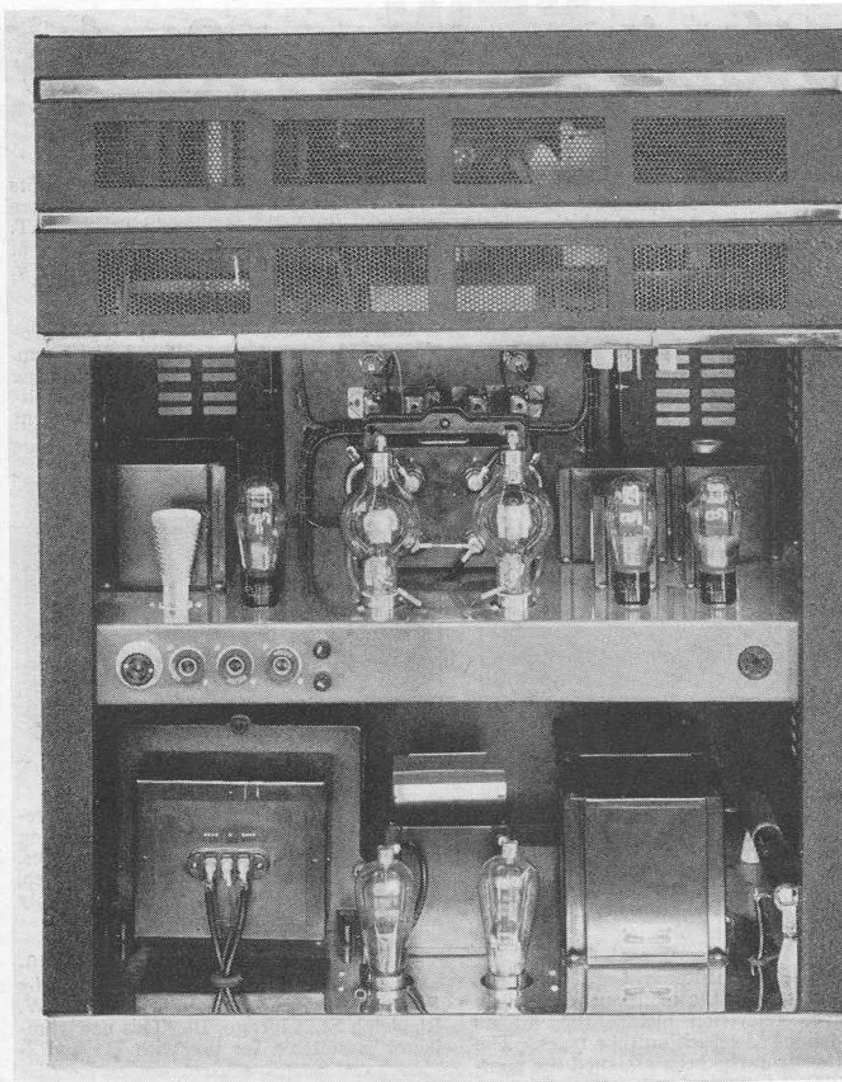
If you have ever been backed against the wall by a high voltage shock you'll agree that some protective measures should be used to remind you of the danger of high voltage. It has been a frequent cause of wonder that each year more amateurs are not killed through carelessness. Two thousand volts can be lethal, so the designed transmitter, when the cover of the r.f. unit is removed to change the final plate coil, an interlock switch is operated which opens the primary of the high voltage power supply. Because of the pains taken to enclose everything but the plate connections to the RK39 tubes, and the fact that tuning adjustments of the exciter stages are made with the top cover removed, plate voltage to the low power tubes remains connected.

Additional protective steps are taken by interlocking the protective perforated back on the transmitter. When the back is removed the high voltage circuit is dead and will remain that way until the back is replaced, which automatically closes the plate interlock switch.

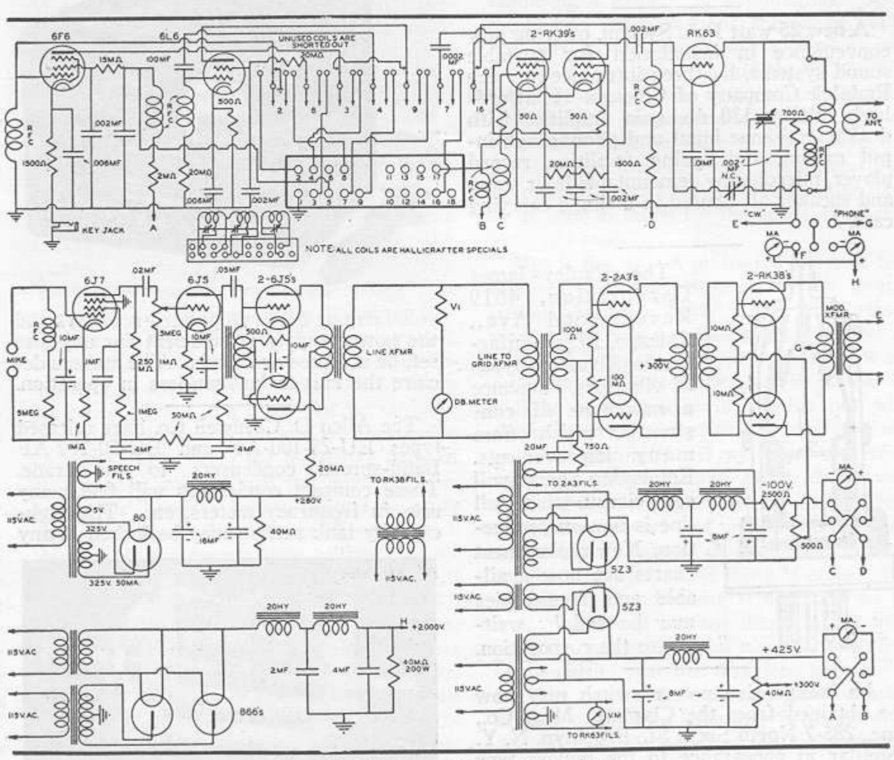
The transmitter is now ready to be placed in operation and the preamplifier, usually set on the operating table next to the receiver, is so arranged to control the unit from the operating position. After the filaments are lighted by closing the switches on the front panel, and the transmitter is resonated to the frequency desired, the whole transmitter can be turned on and off with the standby switch mounted on the front of the preamplifier. On this unit is also provided a jack into which the key is plugged for c.w. operation.

The tube lineup in the preamplifier is a 6J7, 6J5 in cascade, which in turn drives push pull 6J5's. A crystal microphone is connected inside the metal housing around the 6J7, and gain is controlled in the input circuit of the first 6J5. R.f. feedback is eliminated by an ounce of prevention, worth a pound of patience, in first shielding and carefully filtering the high gain amplifier circuit. The output of the push pull 6J5's is transformer coupled

(*Please QSY to page* 53)



Rear view of the 325-watt transmitter.



Circuit diagram of the transmitter.

which is generally used and which has been found guilty of losses even in short lengths of 6″ or so.)

Consider Figure 1d as a typical case. Generally the output of the driver can be measured at point BB although if the coupling coil itself is suspected of losses the output can be measured at point AA as described in previous paragraphs and at point BB after the optimum setting for maximum energy transfer is made. A decrease in indicated power at point BB with the same plate input would mean losses in the coupling system itself. *The plate input would, of course, be referred to again as it may have been reduced through wrong adjustment of the coupling coil and less power at point BB may be due to this reduced plate input rather than losses. The comparison between plate input and power output must always be made before any conclusions can be made as to losses occurring.* Repeating the power measurement at point CC will allow calculation of losses occurring in the line from point BB to point CC, again *referring to the plate input* before definite conclusions are made. The same procedure can be followed for further information in

(e) Determination of the efficiency of the transmission line between the final amplifier and antenna.

After the final stage is adjusted for maximum output (say e.g. on a 73 ohm dummy load) suppose we substitute a 73 ohm concentric line and place the dummy at the far end which would normally attach to the antenna. Without readjustment of the transmitter the r.f. current at the transmitter should be approximately the same as with the dummy. Likewise, the plate current and plate voltage. On a poorly regulated plate supply, in the event of a plate current change, plate voltage will also change.

If there are any appreciable line losses the current will be progressively less out to the end of the line where the dummy is attached. The current measured at this point is the current in the dummy and the power is calculated as before. The difference between this figure and the previous figure determined at the transmitter would be the approximate line losses, providing mismatches have not occurred which may alter the efficiency of the amplifier itself due to several reasons. This loss figure then may not be strictly true since the line losses are in part due to insulation resistance which in effect shunts the dummy and lowers the nominal resistance of the whole system.

If the plate current or voltage changes appreciably, this is due to mismatches and/or appreciable distributed capacity entering into the system. Any change in plate current or voltage means that the efficiency of the final amplifier will alter and the figure for line losses may also include a change in amplifier efficiency as well. As a matter of fact, if the match was poor in the determination of the amplifier efficiency and should happen to be improved upon when the line was brought in to the system, an increase in overall efficiency might be the result. The above possibilities would also apply to previous measurements made on the link coupled stages described in the previous paragraph under (d).

[Next month the author concludes this interesting subject with a complete explanation of different dummy antennas and their application towards improving the radiation efficiency of an antenna. This applies to receiving as well as transmitting antennas. Ed.]

325-Watt Transmitter

(*Continued from page 31*)

into a line of 500 ohms, which is cable-connected to the 2A3 input circuit in the modulator section of the transmitter. The volume indicator on the front of the preamplifier provides a convenient means of checking the level of modulation with a gain control readily available for close, quick adjustment. Examination of the schematics will show how the various units are interconnected.

The pictures show clearly the placement of components and the schematic diagrams how they are connected.