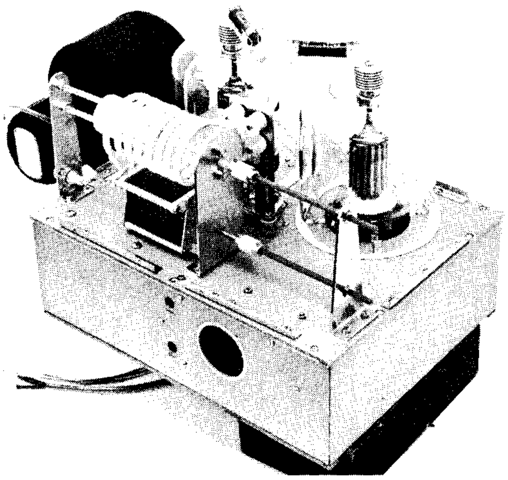
amateur service newsletter
W6SAI



inductively-tuned high-frequency tank circuit

A method for achieving high efficiency in the "shadow region" between 14 and 54 MHz

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Radio frequency amplifiers require a certain critical value of plate circuit impedance and Q for optimum performance at any frequency. Design deviations may lead to higher levels of intermodulation distortion or excessive harmonic radiation. While the design requirement may be quite tolerant in some cases, the mechanical assembly of the components and the choice of proper values become increasingly critical as the operating frequency nears the upper region of the hf spectrum. It is as though a "shadow region" exists that's too high for conventional lumped circuit components, yet is too low for conventional vhf linear and stripline techniques. The "shadow region" extends roughly from 27 through 54 MHz.

Above 27 MHz or so, the construction of a conventional high-power plate-tuning circuit having good Q and good efficiency can be vexing, as residual tube and circuit capacitances combine to assume a major portion of the tank circuit capacitance. It's possible, in fact, for this residual capacitance to be much larger than specified for proper design considerations. The unusually high circuit capacitance may lead to unreasonable Q and high circulating tank current, resulting in poor over-all efficiency and excessive heat loss in the tank circuit.

inductive tuning

To achieve good circuit efficiency and proper Q in the upper portion of the hf spectrum, it is convenient to resort to a different mechanical configuration than is commonly used at lower frequencies. One way to overcome problems of efficiency and Q is to reduce residual circuit capacitance to an absolute minimum by removing the cause of the largest portion of this unwanted capacitance: the tank tuning capacitor. Circuit resonance can then be established by including a fixed capacitance combined with a variable inductor.

The inductor can be a fixed, high-Q coil having a low-loss shorted turn introduced into one end. As the turn is moved within the coil, coil inductance is reduced, and resonance is established by correctly positioning the shorted turn **(fig. 1)**. The rf current in the shorted turn is high compared to the coil current; however, if the turn is of homogeneous structure and low-resistance material, turn losses will be small.

Shown in the photographs is a commercial 5-kW input PEP linear amplifier designed for any 500-kHz range between 27 and 54 MHz. The plate tank is a conventional pi network, inductively tuned by a shorted turn within the plate coil. The turn (or "slug") is moved into and out of the coil by a lead screw driven from a counter dial mounted on the amplifier panel. Tank circuit values were derived from pi network charts.[1]

The amplifier uses a pair of parallel-connected 3-1000Z high-mu triodes in a grounded-grid, cathode-driven circuit with zener diode bias.[2] The combined output capacitance of the tubes is approximately 15 pF. Stray circuit capacitance from plate to ground is less than 10 pF, which provides a minimum input capacitance (C1) for the pi network of about 25pF. Additional capacitance can be added for operation at lower frequencies. Ceramic or vacuum padding capacitors can be used for this purpose.

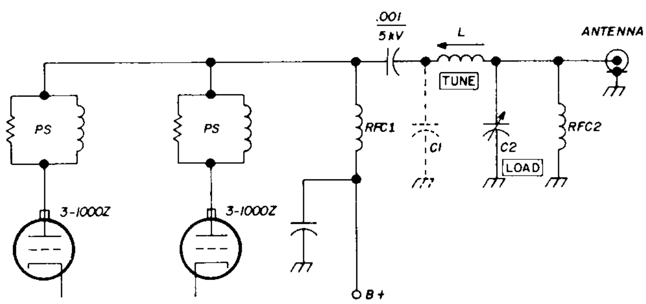


fig. 1. Inductively tuned tank circuit using conventional component values. C1 is the residual circuit capacitance plus tube output capacitance. Resonance is achieved by a variable shorted turn moved inside L.

construction

Tank-circuit inductance is calculated for the low-frequency end of the tuning range in the usual manner. As the shorted turn is driven into the plate inductor, its inductance decreases, and resonant frequency increases. A range of about 500 kHz or so can be obtained with this assembly.

Construction details are shown in **fig. 2.** The shorted turn is a section of seamless copper water pipe 1-¾ inches O.D. by 3 inches long. Discs of insulating material are cut to fit into the ends of the pipe and are held in position with small pins or rivets. A

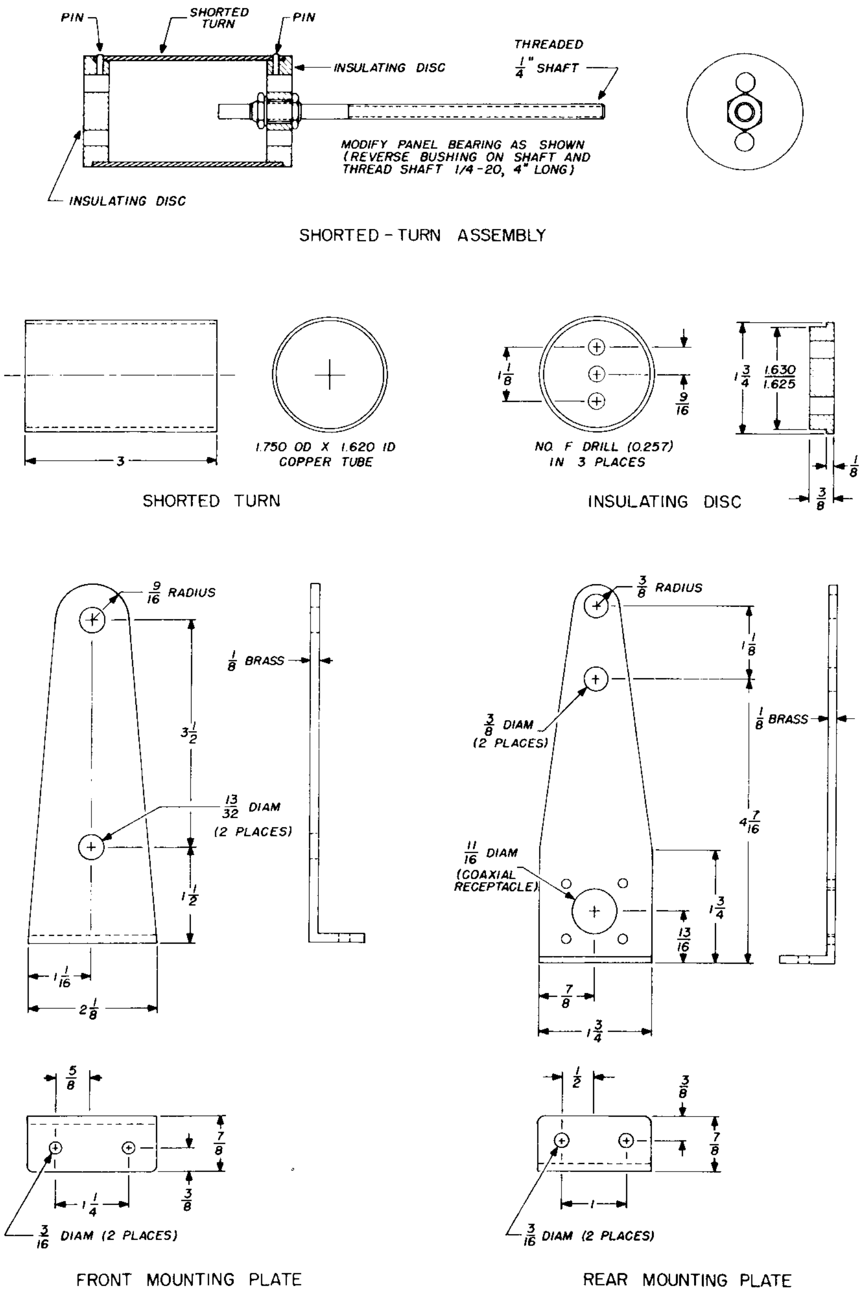


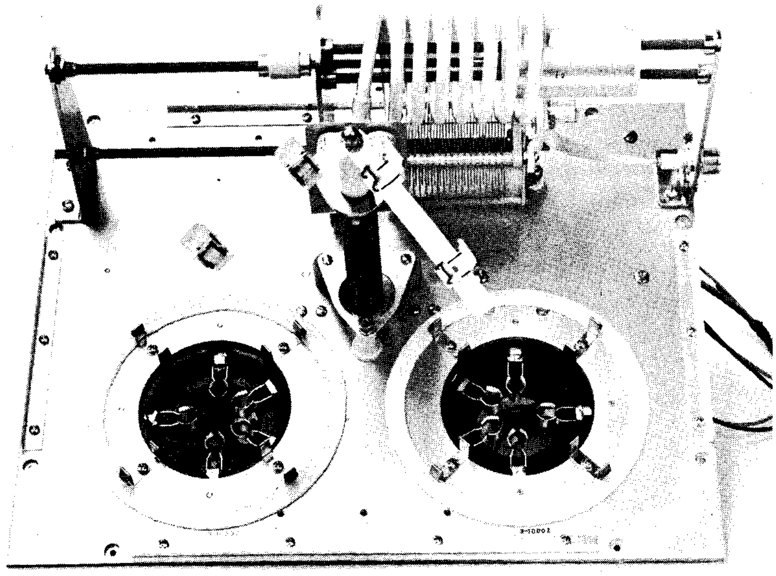
fig. 2. Mechanical details of the shorted-turn assembly.

threaded bushing is attached to one disc, through which the drive shaft extends. The shaft is ¼-inch-diameter copper rod, threaded with a ¼-20 die. Two fiberglass guide rods are mounted between the end support brackets to keep the shorted turn from rotating as it's driven back and forth. The threaded drive shaft is driven from the amplifier panel by an insulated extension shaft and an insulated coupling. The shorted turn is ungrounded at all times, and no moving parts carry rf current.

The plate tank coil is wound with ¼-inch-diameter silver plated copper tubing with an I.D. of 2-¼ inches, providing ample clearance for the shorted turn to move within the coil without danger of arcing. Heavy-duty copper mounting lugs are silver soldered to the coil. Resonance is initially established with a grid-dip oscillator. Indication of resonance is quite broad. Loading is accomplished with the pi network variable output capacitor, C2.

value will cause excessive fundamental rf power to dissipate in the parasitic resistor. The proper value of shunt inductance, while not particularly critical, should be determined for the operational range of the amplifier in each case.

The amplifier shown in the photographs was designed for commercial service and is included in a shielded cabinet as part of a larger package. A similar design using 4-1000A's has been built for commercial ssb service at the 6-kW PEP level—but that's another story. The basic design is



top view of the high-power commercial amplifier. Inductively tuned tank is shown at rear. Tuning is the same as with a variable capacitor, except inductance decreases as shorted turn penetrates coil. Parasitic suppressors have been removed for this photo.

parasitic suppression

An important consideration in plate-circuit design is a parasitic suppressor. In this amplifier parasitic suppressors are included in each plate lead. Each suppressor is a 40-ohm, 16-watt *Glo-bar* resistor shunted across an inductor, which consists of a length of plate lead. The value of the shunt inductance is important. A too-small value won't completely suppress the tendency for vhf parasitics, and a too-large

adaptable to any high-power amplifier operating in the upper region of the hf spectrum.

references

1. William I. Orr, "Pi and Pi-L Networks for Linear Amplifiers," *ham radio,* November, 1968, page 36.
2. William I. Orr, "The 3-500Z in Amateur Service," *ham radio,* March, 1968, page 56.

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