coupling capacitor is increased in small steps until the required loading of the final amplifier is obtained. However, each time the coupling capacitor is changed, the final amplifier and the antenna tuning must be resonated.

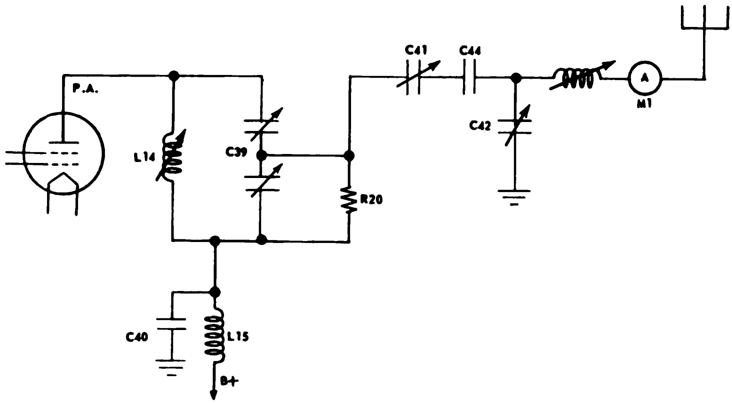

Figure 4–16.—TBK–13 antenna tuning using current feed.

Care must be taken not to overcouple with capacitor C41. After the final amplifier and the antenna circuit are resonated, the final amplifier sees a pure resistive load and the best transfer of energy from the final amplifier to the antenna is obtained.

FSB FREQUENCY-SHIFT KEYER

The FSB frequency-shift keyer is designed to key a transmitter by the frequency-shift method. A photograph of the FSB is shown in figure 4–17. It consists of a 13-tube, 2-watt exciter which produces a carrier capable of being shifted between two distinct frequencies in accordance with the output of a teletypewriter.

The frequency-shift keyer is connected to an associated transmitter. The output of the master oscillator of the transmitter is fed into the FSB. A low-frequency oscillator in the keyer has a reactance tube connected across its tank circuit. The keying pulses from the teletypewriter change the current through the reactance tube and cause the frequency of the low-frequency oscillator to change. The output of the low-frequency oscillator is mixed with

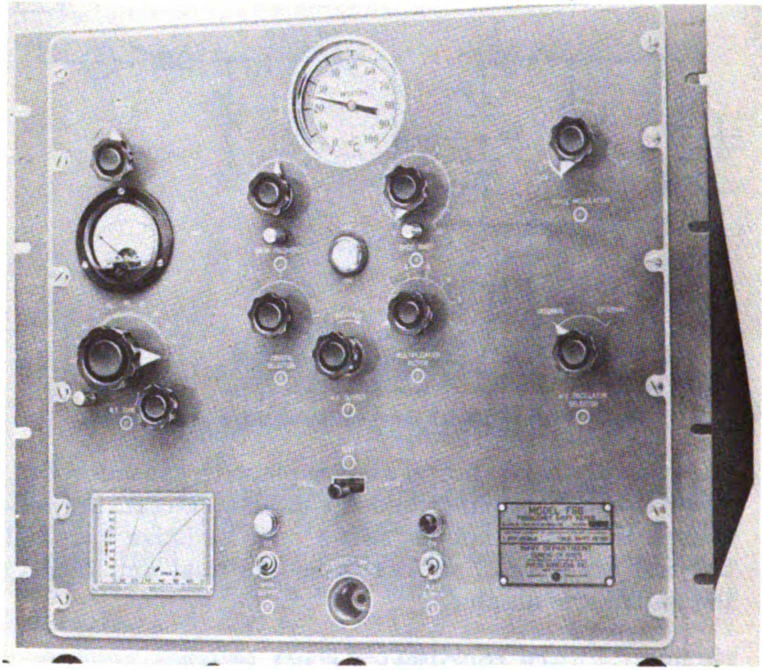

Figure 4–17.—FSB frequency-shift keyer.

the input from the master oscillator of the transmitter. The sum frequency is amplified and supplied back to the stages following the master oscillator in the transmitter.

The frequency shift is usually 425 cycles below the assigned carrier frequency for a space and 425 cycles above the assigned carrier frequency for a mark. A polar keying signal from the teletypewriter must be positive for a space and negative for a mark.

A simplified schematic diagram of the keying-pulse limiter, keyer, and reactance tube is shown in figure 4–18. The keying-pulse limiter tube has a positive bias on its cathode and it conducts only if a negative mark signal is applied to the cathode. When a steady space signal is present, the keying limiter does not conduct.

A positive bias obtained from a voltage divider in the keyer plate circuit is connected to the grid of the keyer causing it to conduct heavily. The cathode current of the keyer flows through the BASIC SHIFT control and also through a voltage divider in the grid circuit of the reactance tube. The voltage developed across the voltage divider is positive with respect to ground and, since it is applied to the grid of the reactance tube, the tube conducts heavily. The amount of current through the reactance tube determines the frequency shift of the low-frequency oscillator. The frequency output of the low-frequency oscillator is 199.150 kc for a space.

A mark signal of at least −50 volts placed on the cathode of the keying-pulse-limiter cathode causes this tube to conduct and bias the keyer to cut-off. If the keyer is cut off, the positive bias on the grid of the reactance tube is removed and the plate current of the reactance tube decreases. This lowers the capacity reflected into the low-frequency oscillator tank circuit and increases its frequency to 200 kc. Thus the frequency of the low-frequency oscillator is shifted a total of 850 cycles from a space to a mark.

A phase modulator incorporated in the FSB may be used to phase modulate the signal from the low-frequency oscillator with a 200-cycle signal. This is sometimes done to improve the signal-to-noise ratio at the receiving station under conditions of multipath propagation.

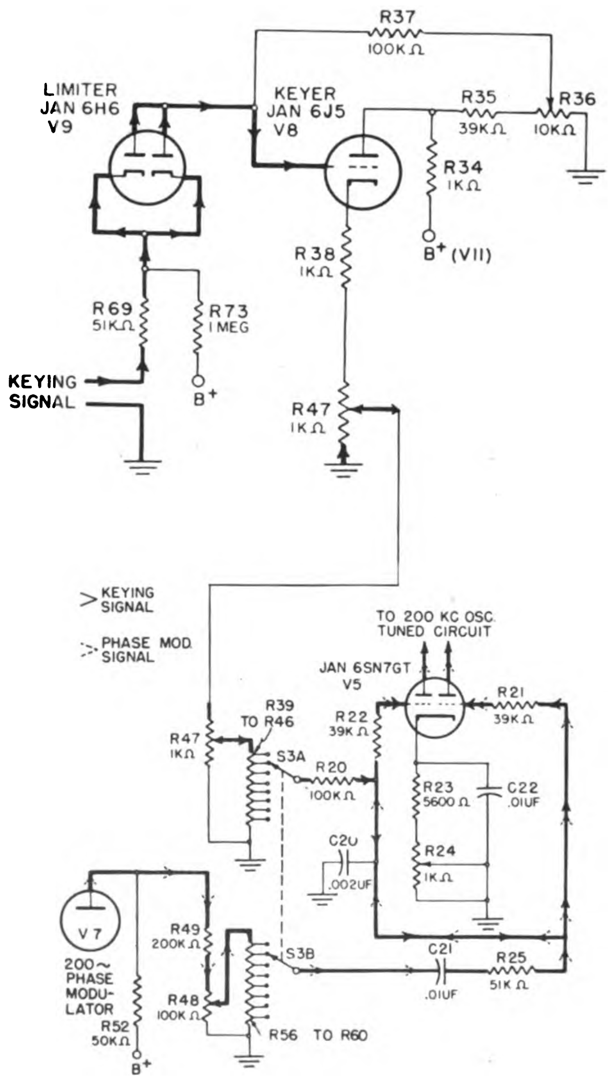

Figure 4-18.—Simplified schematic diagram of the keying-pulse limiter, keyer, and reactance tube.

200-Kc Oscillator and Balanced Mixer Amplifier

Figure 4–19 is a simplified schematic diagram of the 200-kc oscillator and the balanced mixer amplifier. The output of the 200-kc oscillator is used as a push-pull input to the balanced mixer amplifier. The input from the transmitter master oscillator also is coupled into this stage and is placed on a pair of grids connected in parallel.

The signal from the 200-kc oscillator will not appear in the output of the balanced mixer amplifier because of the push-pull arrangement. However, three different frequencies appear in the plate circuit: (1) The signal from the master oscillator, (2) the difference frequency of the master oscillator and the 200-kc oscillator, and (3) the sum frequency of the master oscillator and the 200-kc oscillator. The plate-tank circuit of the balanced mixer amplifier is tuned to the sum frequency. The sum frequency is coupled to the grid of the r-f amplifier.

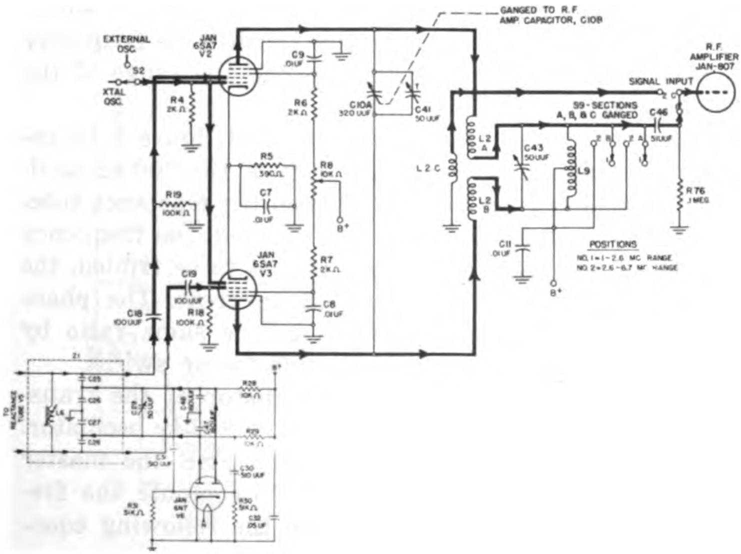

Figure 4–19.—Simplified schematic diagram of the 200-kc oscillator and the balanced mixer amplifier.

With switch S9 in the number 1 position the tuned grid circuit is tuned from 1.0 to 2.6 Mc. In the number 2 position it tunes from 2.6 to 6.7 Mc.

A schematic diagram of the r-f amplifier is shown in figure 4–20. This stage amplifies the output of the balanced mixer amplifier to about two watts. The output is supplied back to the transmitter. The RANGE SWITCH S9 selects the required coupling circuit to the r-f amplifier and also the tank circuit for the r-f amplifier. The output of the FSB is taken from jack J3. Part of the output may be coupled to a frequency meter through jack J2.

Provisions for Frequency Multiplication

It has been assumed in the foregoing explanation that no frequency multiplication follows the output of the FSB. However, provisions have been made so that the output can be multiplied. If the output of the FSB were multiplied, the frequency shift of the carrier also would be multiplied. This is not desirable because the frequency of the carrier would be shifted beyond the range of the receiving equipment.

The MULTIPLICATION-FACTOR switch S3, figure 4–18, reduces the amount of frequency shift of the 200-kc oscillator by reducing the positive bias on the reactance tube. If the output of the FSB is to be doubled, the frequency shift must be one-half as great. If it is to be tripled, the frequency shift must be one-third as great. The phase modulation frequency is reduced in the same ratio by another section of the multiplication-factor switch.

The frequency of the master oscillator of the transmitter is added to the frequency of the 200-kc oscillator. For a given output frequency of the FSB the master oscillator frequency must be less. To compute the frequency of the master oscillator use the following equation:

$$\text{carrier freq.} + 0.425 \text{ kc} - 200 \text{ kc} = \text{master oscillator freq.}$$

If the output is to be multiplied, the multiplication-factor switch must be placed in the position corresponding to the number of times the output is to be multiplied and the master oscillator frequency may be computed by using the following equation:

$$\frac{\text{carrier freq.} + 0.425\ \text{kc} - 200\ \text{kc}}{\text{freq. multiplication factor}} = \text{master oscillator freq.}$$

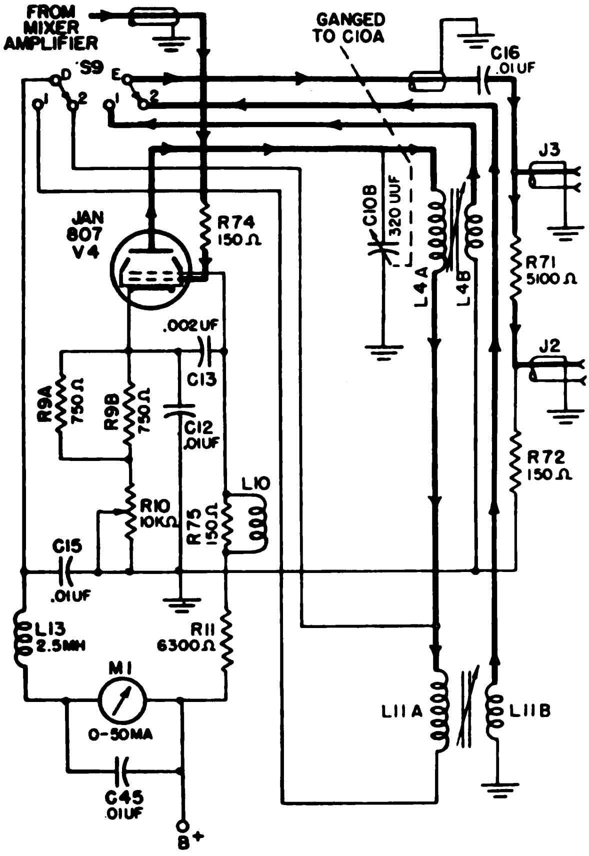

Figure 4-20.—Schematic diagram of the r-f amplifier.

In practice the master oscillator frequency need be only within one kilocycle of the frequency computed from the equation because the frequency of the 200-kc oscillator can be varied a small amount with capacitor C29.

Adjustments

The basic shift control is used to adjust the frequency of the 200-kc oscillator to 199.150 kc for a steady space signal. The MARK FREQUENCY control C29 is used to adjust the 200-kc oscillator until the output frequency of the FSB is 425 cps above the input frequency of the master oscillator for a steady mark (figure 4–19).

A test key is provided so that the FSB can be placed in a steady mark or a steady space condition in order to measure the frequency of its output when keying signals from the teletypewriter are not present. When the test key is in the SPACE position, a high positive bias is placed on the cathode of the keying-pulse limiter to be sure that no negative mark signals cause this tube to conduct. In the mark position the voltage divider in the grid circuit of the reactance tube is shorted to ground and no bias is placed on the grid. A crystal oscillator is incorporated in the FSB. It may be used in place of the transmitter master oscillator.

QUIZ

1. What is continuous wave (c-w) transmission?
2. What is modulated continuous wave (m-c-w) transmission?
3. What is teletype transmission?
4. What is on-off keying as used with teletype transmission?
5. What is frequency shift keying as used with teletype transmission?
6. What is two-tone keying as used in teletype transmission?
7. How is transmitter frequency drift in the variable master oscillator minimized?