TWO-TUBE DIFFERENTIAL KEYER

S. E. Johnson, Jr., W2FBS
GE Ham News May-June 1961 Volume 16 Number 3

A GOOD-SOUNDING CW SIGNAL usually results from a transmitter keying system that applies and removes the keying voltages with a smooth waveform, without sharp peaks that can result in key dicks and thumps; or chirps from too-slow application of these keying voltages.

TOP VIEW showing keyer constructed by W2FBS in a Minibox. Heater voltage for the 6BL7GT in this model was obtained from one of two 6.3-volt windings on filament transformer T1, with 6.3 volts fed into other winding. Only 6 terminals were thus needed on strip TS_1 for external connections.

W2FBS describes here a vacuum-tube screen grid keying system that will key tetrode or pentode power amplifier stages in 20 to 300-watt transmitters. It will provide the following functions:

1. Keyed screen grid voltage for a power amplifier, with adjustable keying waveform;
2. Negative screen grid voltage when the key is open to cut off amplifier plate current;
3. Adjustment of screen voltage to the power amplifier to set the RF power output of that stage to the optimum level;
4. Negative blocking bias voltage to cut off an oscillator or mixer when the screen grid keying function is idle;
5. Adjustable negative bias voltage for the RF power amplifier.

This keyer contains a series screen voltage keyer tube, a control triode tube for the keyer tube, a diode-connected tube section to apply the blocking bias, and a 200-volt negative bias power supply.

Function of the keyer on a time wise graph is shown in the waveform chart, Fig. 1.

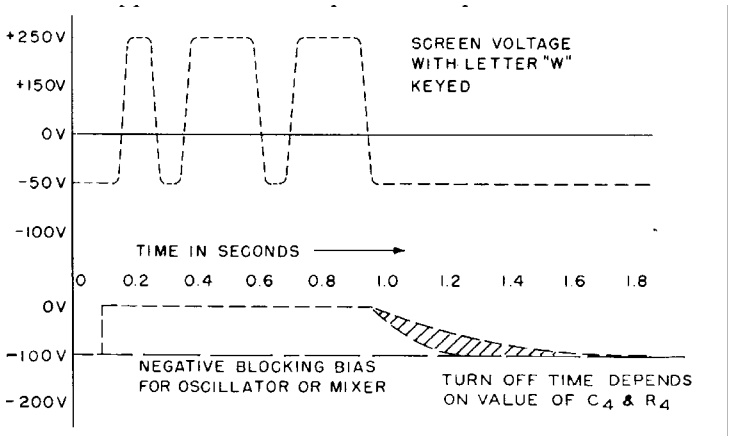
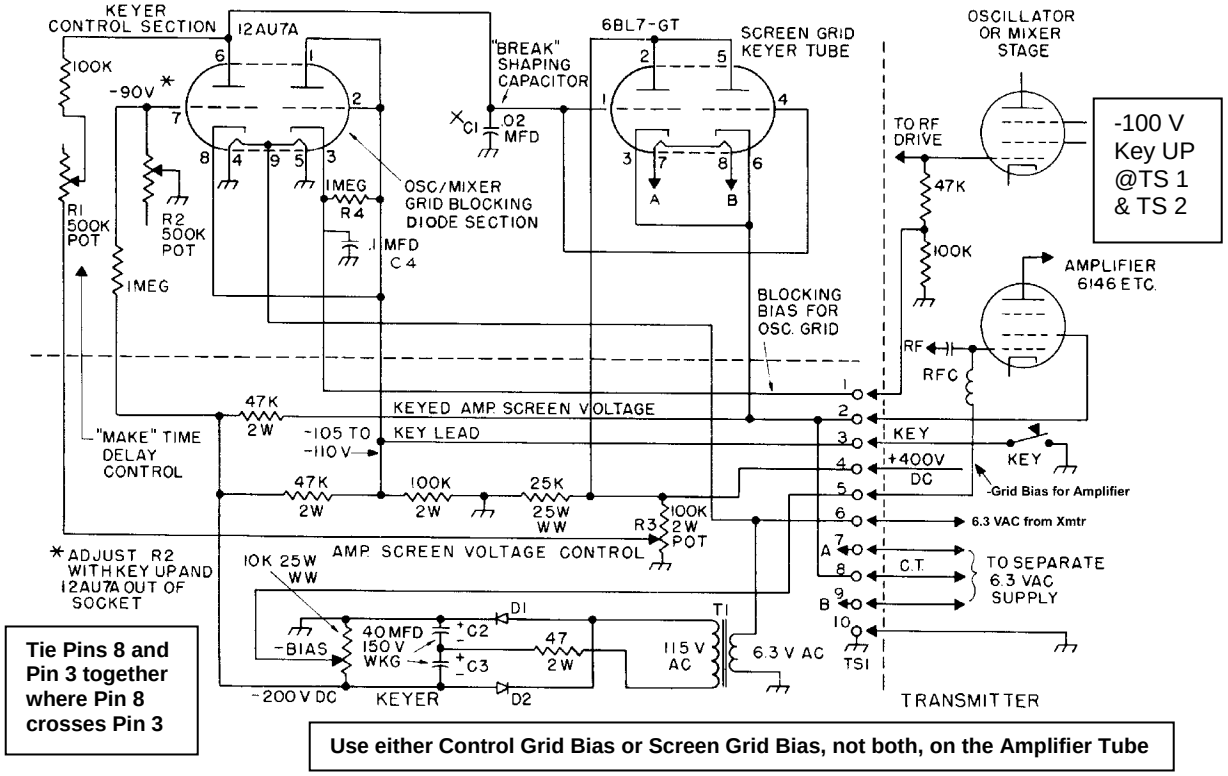


FIG. 1. WAVEFORM GRAPH showing (top) the screen voltage applied to the transmitter power amplifier when the letter "W" is keyed. Peak voltage will be from plus 25 to 300 volts, depending upon setting of R_3. Bottom graph shows sharp rise of negative blocking voltage for oscillator or mixer control grid from minus 100 to 0 volts, and slow decrease back to minus 100 volts after keying is stopped.

- When keying starts, screen voltage rises from a negative value to the operating value for the amplifier tube each time the key is pressed.
- The negative blocking bias on the oscillator or mixer grid is removed at the instant the key is pressed, and remains off until keying stops.
- The blocking bias then returns gradually, cutting off the oscillator or mixer shortly after keying of the amplifier screen grid stops.
- The oscillator or mixer thus will continue to operate during normal sending, but stops when the operator stops sending briefly to listen for incoming signals.

A 6BL7GT TWIN TRIODE is the screen grid keyer tube as shown in the schematic diagram, Fig. 2. Both sections are connected in parallel, thus reducing its internal resistance to less than 1,000 ohms at zero control grid bias. You can also use a 6BX7. Audiophile alert – these tubes have become unreasonably expensive. The screen voltage of one, two or three small transmitting pentode tubes (807, 1625, 6146, 6L6-GC, 7581, GL-829B, etc.) thus can be controlled.

Screen grid current flows from the cathode to screen grid of the transmitter power amplifier tube, then to the cathode of the 6BL7 keyer tube, through this tube to its plate, and then to the high voltage supply of 400 volts.



Section one of a 12AU7A twin triode serves as a control tube for the grid bias voltage applied to the 6BL7GT.

- With the key open, grid pin 7 has minus 90 volts applied while the cathode, pin 8, is at minus 110 volts.
- This 12AU7A section thus draws plate current through the 100 Kohm resistor and potentiometer, R1. This holds the control grid in the 6BL7GT sufficiently negative with respect to its cathode, so that no plate current (and RF amplifier screen grid current) flows.

About minus 100 volts is applied to the transmitter's power amplifier screen grid from the keyer bias supply through the 47Kohm, 2-watt resistor.
At the same time, a minus 100 volts is applied to the transmitter's oscillator or mixer control grid through the diode-connected, second section of the 12AU7A triode. This is developed through the second 47Kohm, 2-watt resistor.

When the key is closed, the cathode, pin 8, of the 12AU7A is grounded, and the minus 90 volts on the control grid at pin 7 cuts off plate current flow through this section.
This causes the plate, pin 6, of this 12AU7A section, and the control grids of the 6BL7GT, pins 1 and 4, to rise to a positive voltage determined by the setting of R3, the "Amplifier Screen Voltage Control."
The 6BL7GT then conducts, and the cathodes, pins 3 and 6, rise to a positive value approaching the positive voltage applied to pins 1 and 4.

Since closing the key also removes the negative voltage from the plate (pin 1) of the diode-

connected 12AU7A section, negative blocking bias no longer is presented to the grid circuit of the oscillator or mixer in the transmitter and it can operate.

Capacitor C4 in the cathode of the 12AU7A diode-connected section prevents this bias from reappearing during the brief intervals the key is open between characters. But C4 charges through R4 and the blocking bias to the grid circuit of the oscillator or mixer returns from 0.5 to 1.5 seconds after keying stops.
The RC time constant is 0.1 MFD x 1 MEG = 0.1 sec. Complete discharge will occur in 5 time constants 0.5 seconds) and it will take 5 more time constants to achieve full recharge. A total cycle requires about 1 second.

The setting of potentiometer R3 adjusts the positive voltage applied to the control grids of the 6BL7GT, and thus the voltage drop through it. This permits setting the screen voltage applied to the RF power amplifier tube (or tubes), when the key is closed, to the positive value which results in the desired RF power output. This feature is most helpful when only a portion of the normal power output of the transmitter or exciter being controlled with this keyer is needed to drive a large RF power amplifier.

The rise of the amplifier screen grid voltage is delayed by C1 charging exponentially through R1 and the 100 Kohm resistor. The sharpness of the keying on the front of the keying characters is thus adjusted by the setting of R1. Increased resistance increases the rise time and softens the keying.

The value of C1 also shapes the tail of each keying character; more capacitance here softens the "break." Several values of capacitance can be cut in by a tap switch at this point to provide easy adjustment of both "make" and "break." Either a set of capacitors ranging from .01 to .05 microfarads, in steps of .005 microfarads; or, several .005 microfarad capacitors can be added to the circuit with a progressive shorting switch.

Negative bias for the Differential Keyer and transmitter’s RF amplifier is provided by connecting a 6.3-volt filament transformer (T1) to a 6.3 volt supply that also supplies the 12AU7A tube, and rectifying the filament transformer’s 115-volt winding output. A voltage doubler provides about minus 200 volts bias.
A lower bias voltage for the RF amplifier can also be obtained from the voltage divider on the 10 Kohm 25-watt bleeder resistor.
The 6BL7GT keyer tube should be run from a separate 6.3-volt AC source, with the center tap connected to the amplifier screen voltage lead to keep the heater-cathode voltage of the 6BL7GT within its rating.

CONSTRUCTION of W2FBS's keyer is in a 4 x 5 x 3-inch Minibox (Bud CU-3005, or Premier MC-1005). All parts except the terminal strip and tubes are inside the box, as shown in the photo. Controls were mounted on one side, and the bias transformer was mounted inside on the opposite wall. This model has the tap switch added to select different values of C1 for soft or sharp "break" characteristics.

W2FBS has constructed another model of this keyer for the heterodyne exciter in his transmitter.

All parts above the horizontal dotted line in the schematic diagram, Fig. 2, are inside a 2.25 x 2.25 x 5-inch Minibox (Bud CU-3004). The box is mounted on the main chassis of the exciter, with the other keyer parts located inside the main chassis below the Minibox. This complete exciter will be described in the July-August, 1961 (Vol. 16, No. 4) issue of G-E HAM NEWS.

ADJUSTMENT, after a check of the wiring, it is simply a matter of applying 6.3 volts AC and measuring the output of the bias supply.

- With the 12AU7A tube out of the socket and the key open, adjust R2 until minus 80 to 90 volts is measured at grid pin 7 of this socket. Use a voltmeter with a resistance of at least 5 Megohm (scale of 250 volts or higher on a 20,000-ohm per volt meter), or a vacuum tube voltmeter.

- Plug in the 12AU7A and 6BL7GT tubes and, with the key still open, minus 105 to 110 volts should be read at the cathode, pin 3, on the 12AU7A socket.

- The screen voltage to the power amplifier should be about minus 50 volts with the key open (Connection #2 on the Terminal Strip).

- With the Differential Keyer connected to the amplifier tube's screen grid circuit in the transmitter (or with a 10,000-ohm, 10-watt resistor from the screen grid voltage terminal to ground), check the screen voltage with key up and key down.

- Adjust R3 over its range with the key closed, and a screen voltage from about plus 25 to 300 volts should be read.

This keyer can be built into an existing exciter if desired. It is ideal for replacing less satisfactory keying systems in transmitters in the 20 to 300-watt power input class. A keyer of this type has been operated *as a replacement*, with excellent results, on the 150-watt SINGLE BANDER transmitter models (See G-E HAM NEWS, November-December, 1957; and January-February, 1958, Volume 12, No. 6, and Volume 13, No. 1 issues).

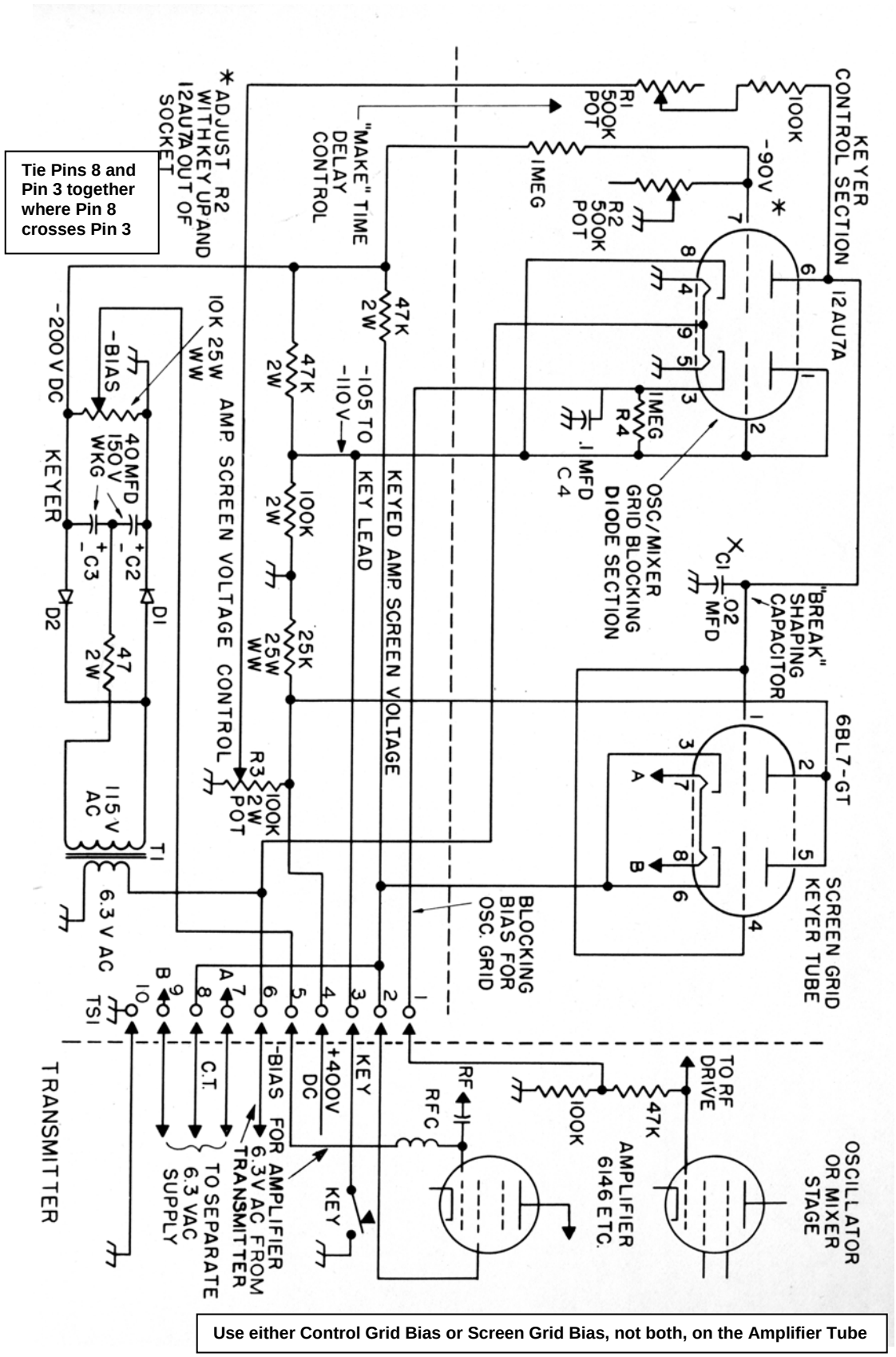
The 6BL7GT twin triode will pass sufficient current to key the screen grid voltage of two, three, or even four transmitter stages which require about the same screen grid voltage.

TABLE I — PARTS LIST DIFFERENTIAL KEYER

C_1.....Paper capacitor, .02 mfd, 400 V. DC working (try values from .01 to .05 mfd for fast or slow "break" in keying).
C_2, C_3....40 mfd, 150-volt working electrolytic capacitors.
C_4.....0.1-mfd, 400-volt paper, see text.
D_1, D_2....Selenium, Germanium or silicon diode recitfiers, 380-volt peak inverse rating, 50 milliampere DC current rating.
R_1, R_2....500,000-ohm, 2-watt potentiometer.
R_3.....100,000 ohm, 2-watt potentiometer.
R_4.....1 megohm, ½ watt, see text.
T_1.....6.3-volt, 1 ampere filament transformer, 115-volt Primary (Thordarson T-21F08 or equivalent).

FIG. 2. SCHEMATIC DIAGRAM of complete keyer. Connections to typical oscillator or mixer control grid, negative bias for power amplifier control grid, and keyed screen grid voltage for power amplifier, are shown at right side of diagram. All resistances are in ohms, ½-watt rating, unless otherwise specified. All capacitances are in microfarads.

NOTE: A tap switch with several positions and a set of paper capacitors from .01 to .05 microfarads, can be inserted at point "X" in place of C_1. This provides adjustable sharpness of "break" characteristic of keyer.


KEYER CONTROL SECTION
100K
-90V *
R1 500K POT
IMEG
R2 500K POT
"MAKE" TIME DELAY CONTROL
* ADJUST R2 WITH KEY UP AND 12AU7A OUT OF SOCKET
Tie Pins 8 and Pin 3 together where Pin 8 crosses Pin 3
12AU7A
47K 2W
-105 TO -110 V
-200 V DC
-BIAS
10K 25W WW
AMP. SCREEN VOLTAGE CONTROL
47K 2W
100K 2W
KEY LEAD
KEYED AMP. SCREEN VOLTAGE
IMEG R4
.1 MFD C4
OSC/MIXER GRID BLOCKING DIODE SECTION
40MFD 150V WKG
KEYER
+C2
+C3
D1
D2
47 2W
25K 25W WW
R3 100K 2W POT
115 V AC
T1
6.3 V AC
TS1
C1
.02 MFD
"BREAK" SHAPING CAPACITOR
6BL7-GT
SCREEN GRID KEYER TUBE
BLOCKING BIAS FOR OSC. GRID
B
A
C.T.
-BIAS FOR AMPLIFIER
6.3V AC FROM TRANSMITTER
TO SEPARATE 6.3 VAC SUPPLY
+400V DC
KEY
RFC
RF
100K
47K
TO RF DRIVE
AMPLIFIER 6146 ETC.
OSCILLATOR OR MIXER STAGE
TRANSMITTER
Use either Control Grid Bias or Screen Grid Bias, not both, on the Amplifier Tube