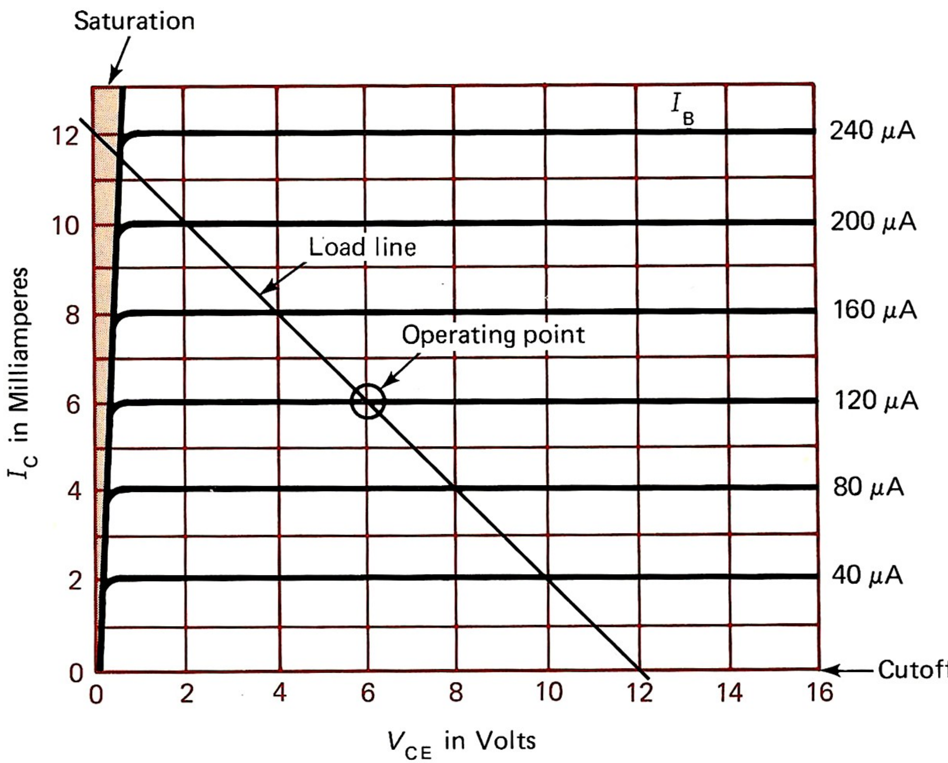
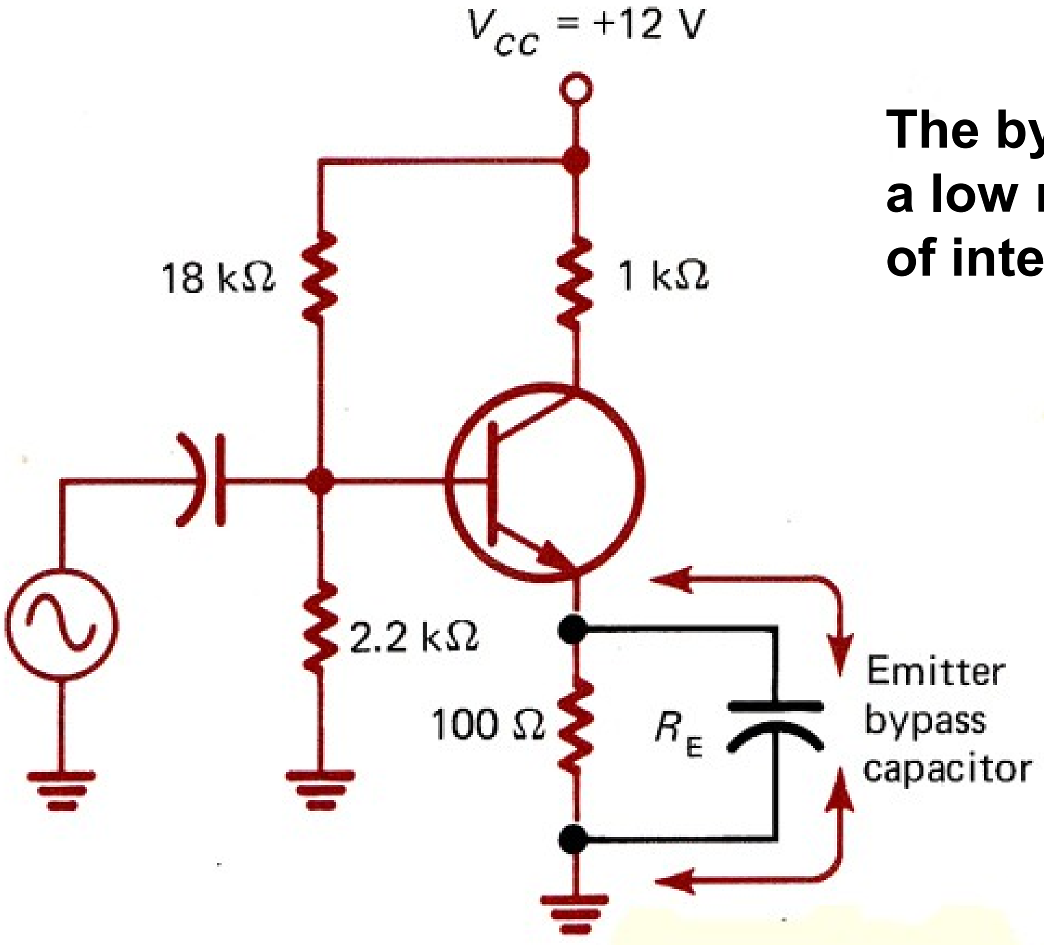
The New England Radio Discussion Society electronics course (Phase 3 cont'd)



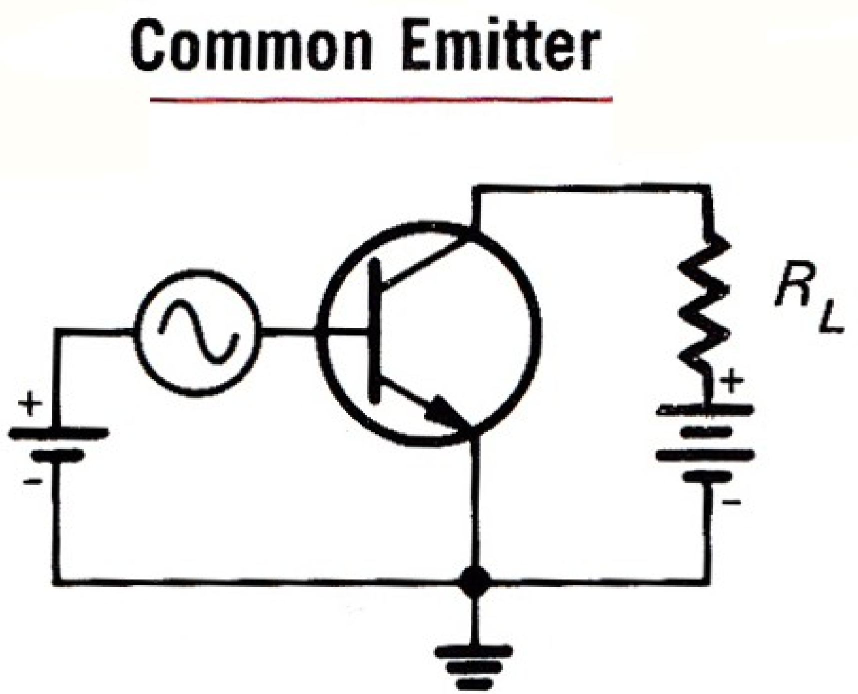
AI2Q – February 2017

We previously looked at achieving higher gain using an *emitter bypass* capacitor in a common-emitter configuration.



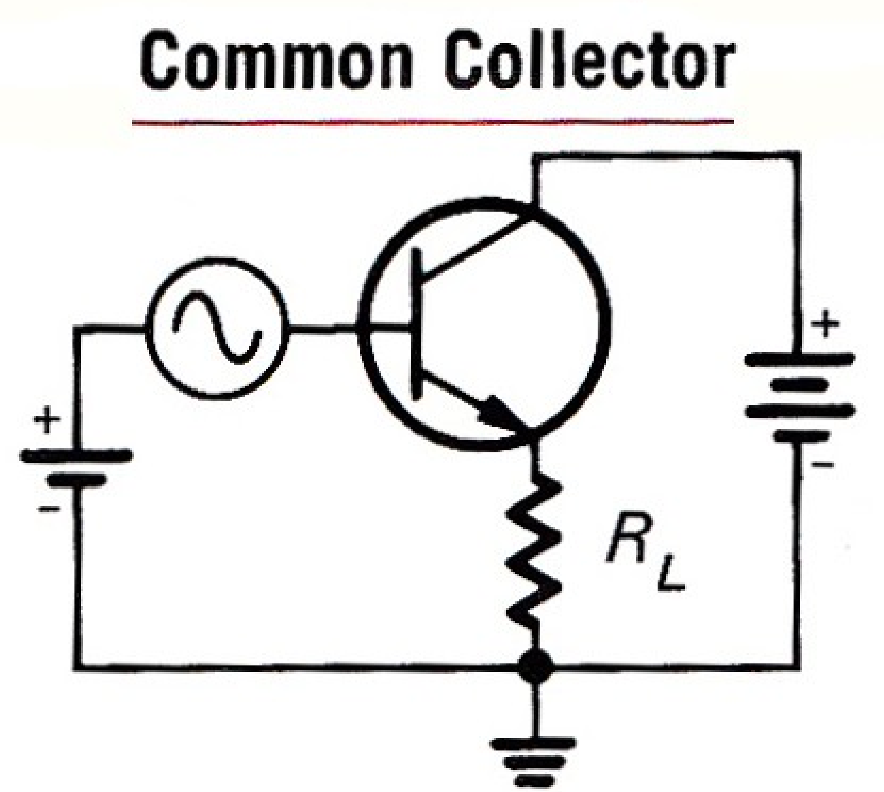
The bypass cap is chosen to have a low reactance at the frequency of interest.

In its most simplified more-or-less theoretical form, the *common-emitter* circuit looks like this. It’s input impedance is moderate, at around 1-kohm, and its output impedance is around 50-kohms. This circuit results in 180-degree phase inversion of input signals.



Another way to connect a BJT is in what's called a *common-collector* configuration. The collector is common to both input and output. This configuration has a very high input-impedance, usually around 300-kohms. More importantly, its output-impedance is very low. It's most often called an ***emitter-follower.***

The output signal is developed across the emitter resistor, R_L.

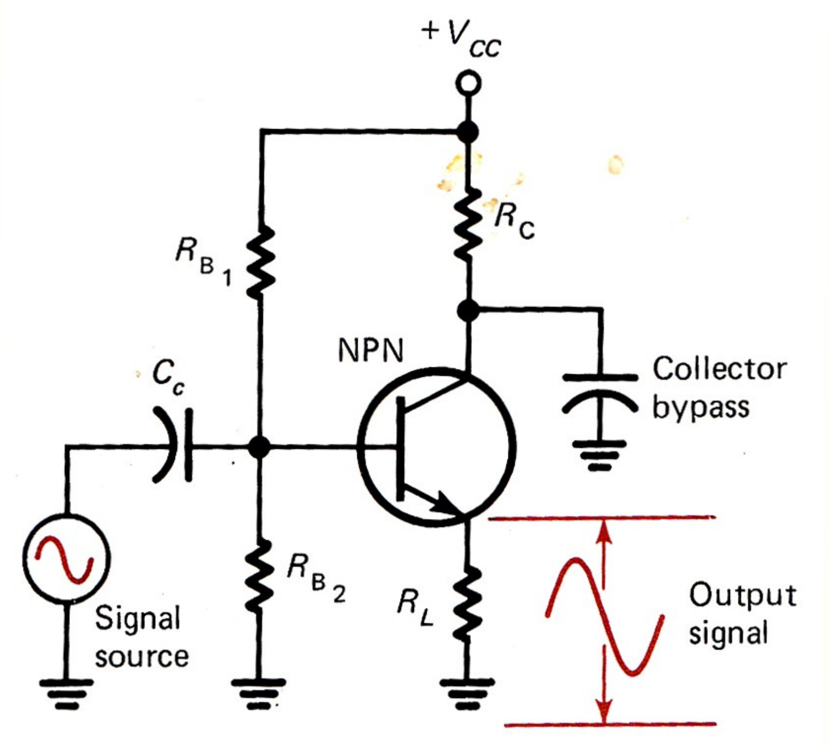


At first glance the common-collector looks like the common-emitter amp. But, notice that the collector is bypassed to ground with a cap that has very low reactance at the frequency of interest.

Also, the emitter is now the output terminal. High input impedance gets transformed to a very low output impedance.

The configuration has a gain of less than one!

The input is also not inverted at the output.

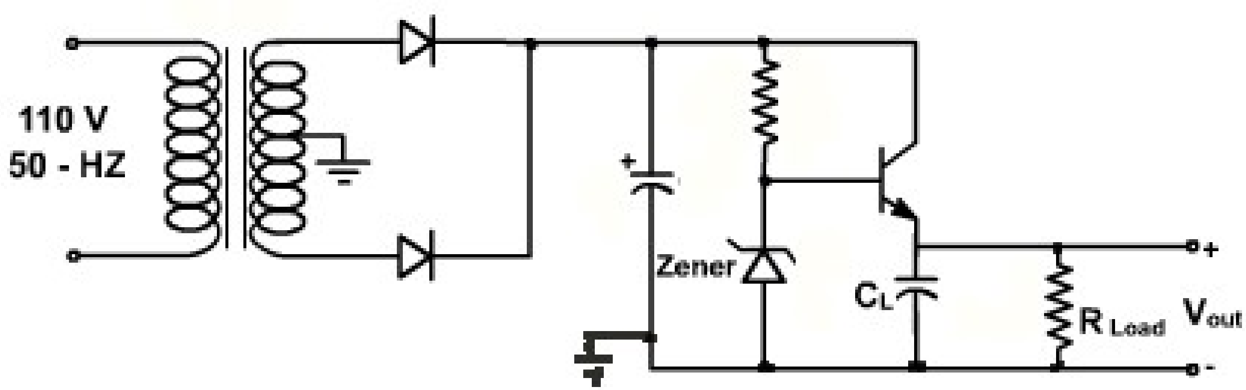


So, of what use is the “no-gain” emitter-follower?

Here’s an example: say a typical 25-watt 2M FM transceiver operates from 13.8 volts, and draws 10 Amperes.

Ohm’s Law reveals that the rig acts like a 1.38-ohm load!

An emitter follower, set up as a voltage regulator, can deliver current into that very low 1.38-ohm impedance.



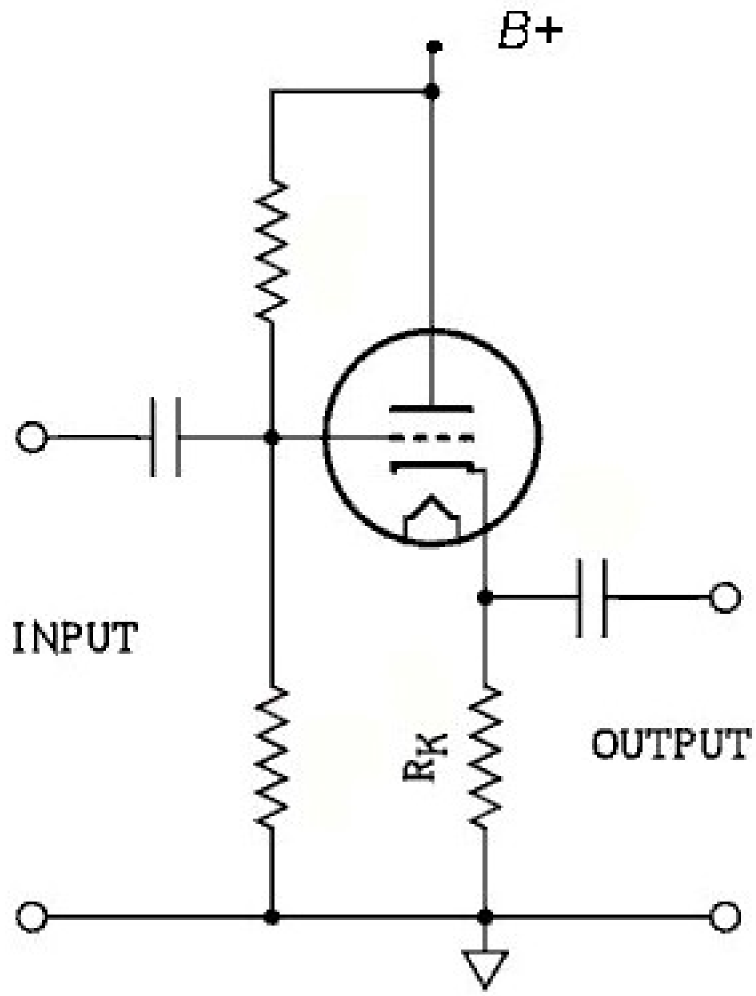
The Zener sets the base voltage.
The emitter voltage is about 0.7 V lower.

A 14.5V Zener would deliver a 13.8V output.

A vacuum tube can also be used as a low output-impedance matching stage.

The grid can present a high input-impedance.

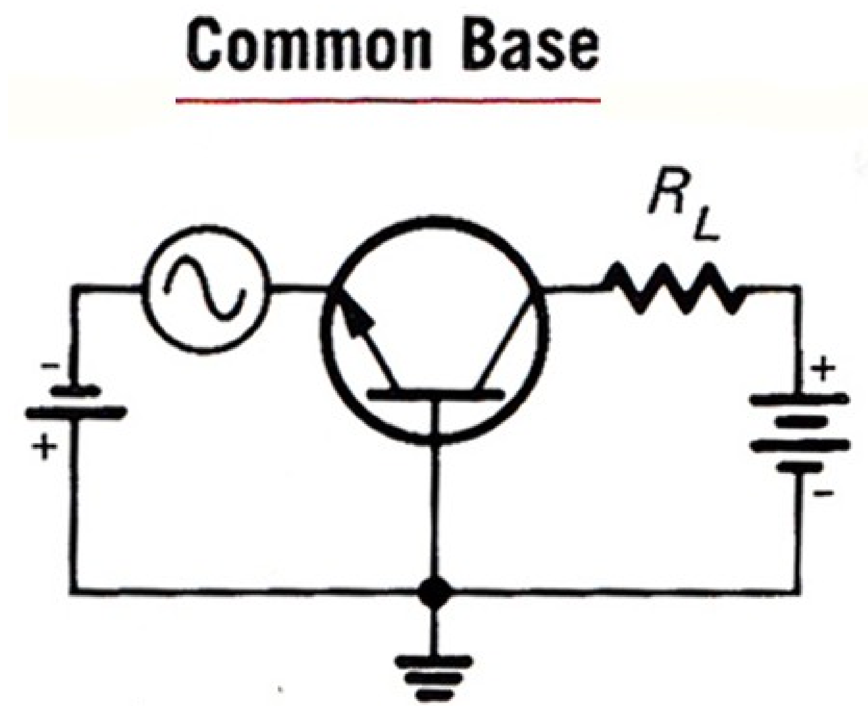
In this case the circuit would be dubbed a *cathode follower* instead of an emitter follower.



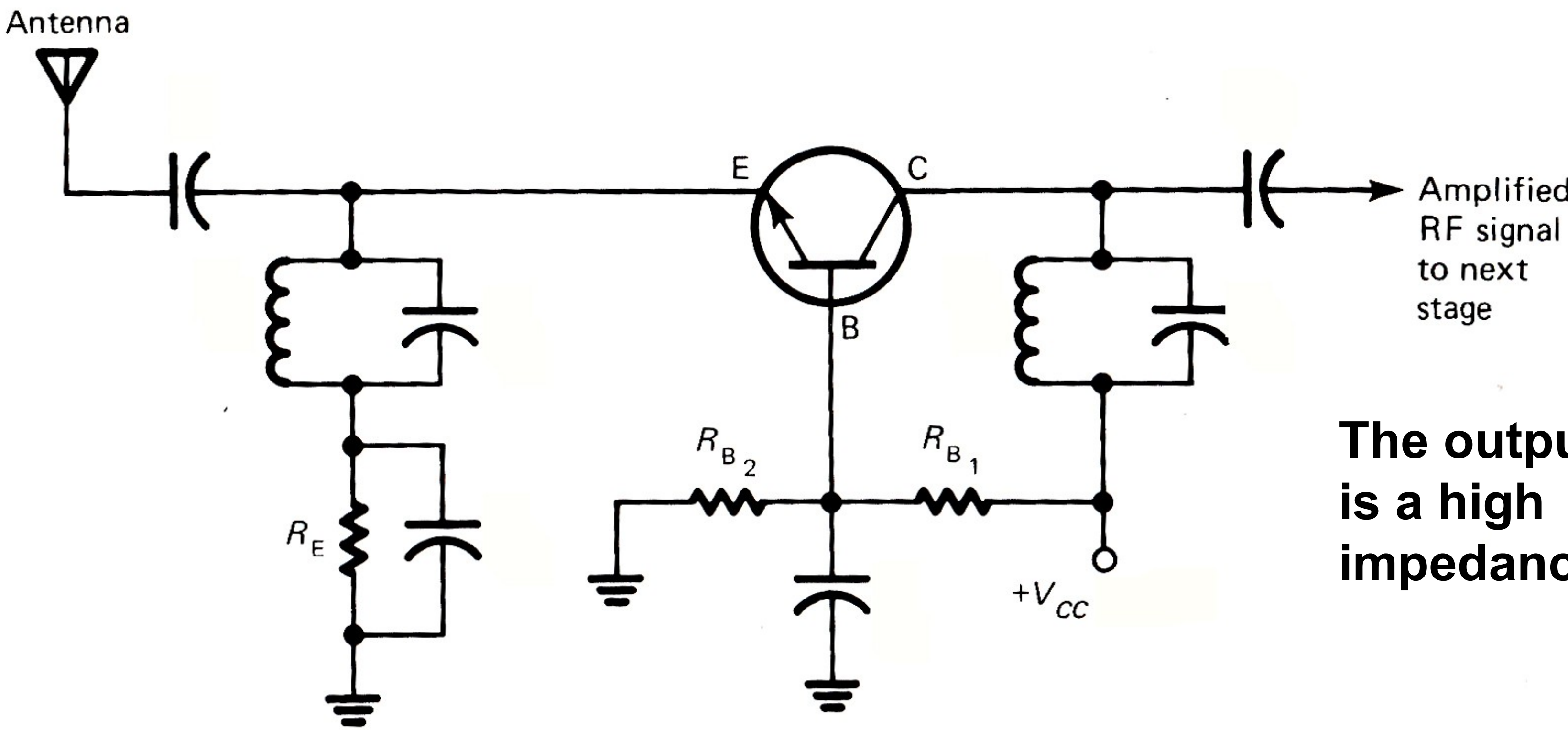
The filament supply wiring is not shown.

The BJT can also be set up as a *common-base* amplifier circuit.

This amplifier configuration has a very, very low input impedance (around 50-ohms) and a very high output impedance (about a Megohm).



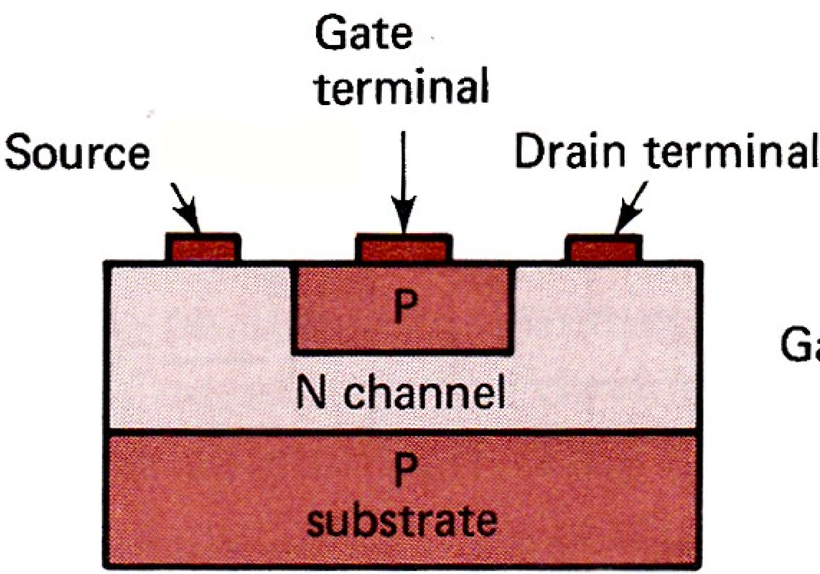
Here's a typical *common-base* RF amplifier used in the "front end" of a ham receiver. It takes the RF signal from a low-Z (*i.e.* 50-ohms) antenna connection and applies the amplified signal to the next block in the receiver architecture.

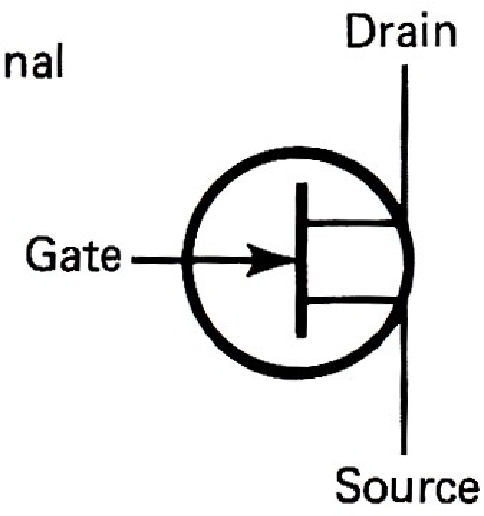


The output is a high impedance.

In addition to current-based junction xstrs, devices can also be controlled with electric fields.

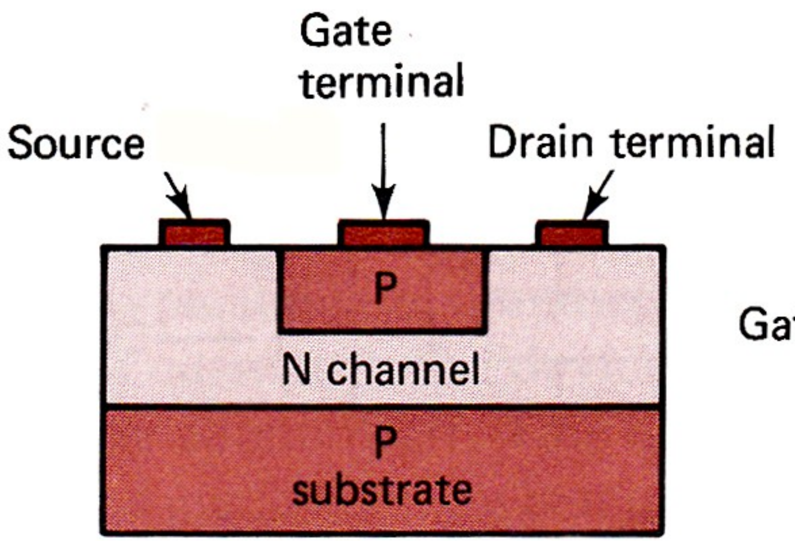
In an N-channel *junction field-effect-transistor*, or JFET, a control <u>voltage</u> on the gate *depletes* electron carriers in the N channel. Current typically flows internally from source to drain, but could just as easily travel from drain to source.

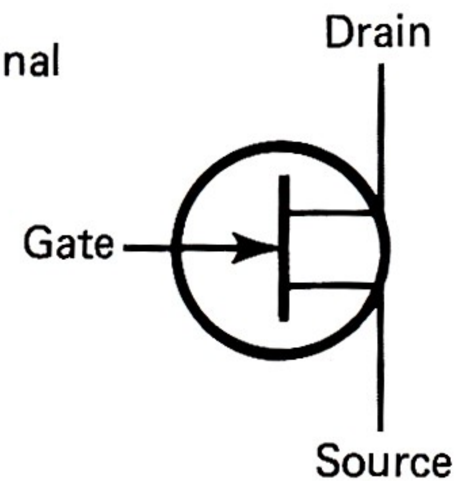




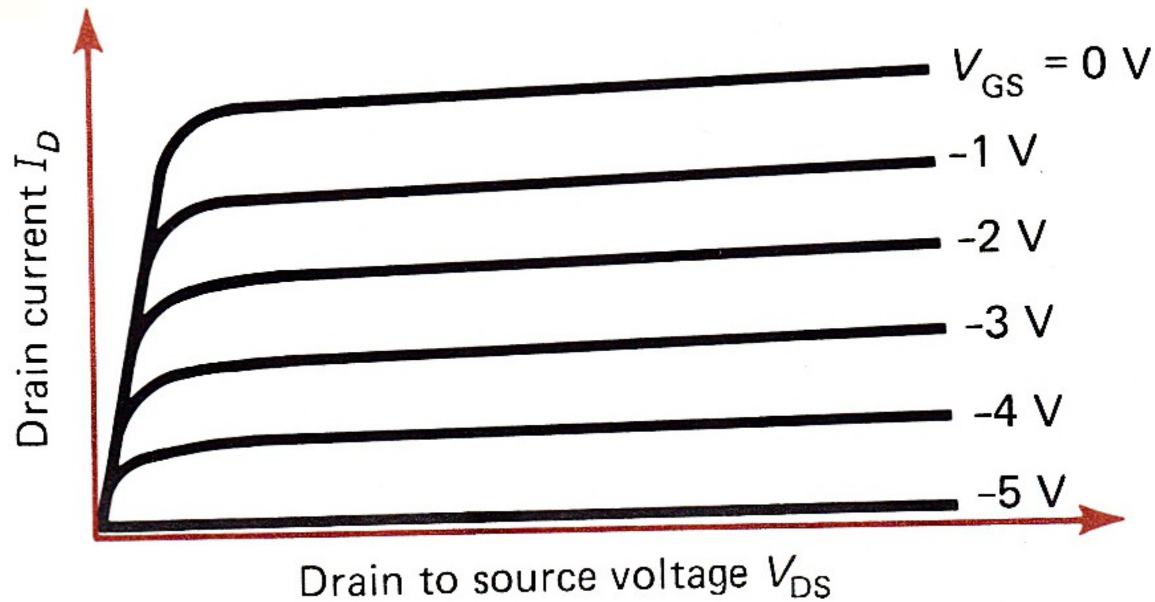
This device operates in the *depletion mode*.

A negative control voltage at the JFET’s gate pushes electrons out of the channel, as like charges repel. In essence, as the negative voltage goes up, the resistance of the channel goes up. If the gate is driven sufficiently negative, the device can be cut off.



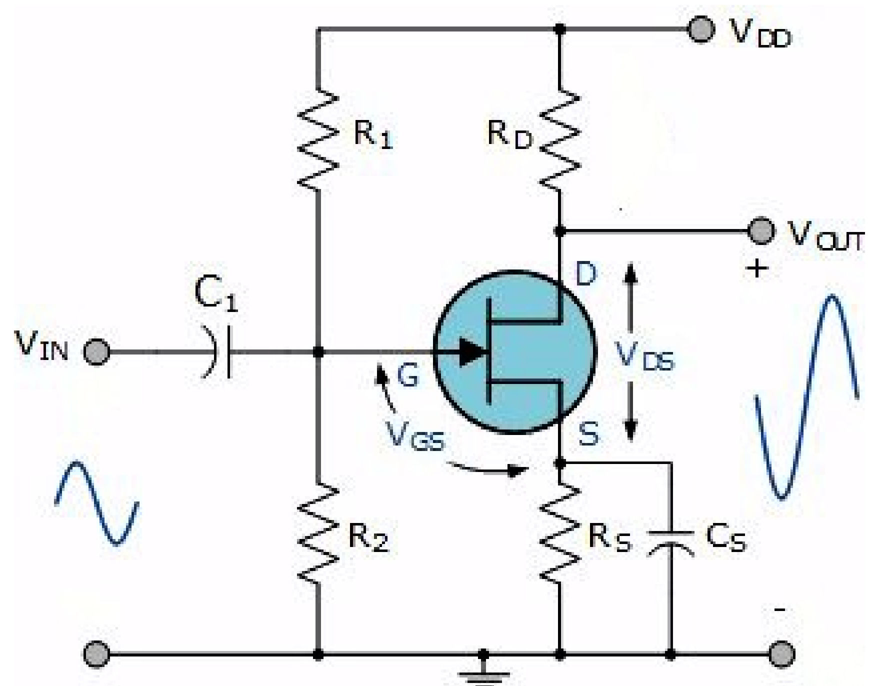


No gate current flows!



Here is a set of typical characteristic curves for an N-channel JFET. As the voltage from gate-to-source increases more negatively, the drain current decreases. At –5V the device is almost at cutoff.

Here's a small-signal JFET amplifier. Note the source bypass capacitor to increase the gain of the circuit. Note, too, the signal phase inversion.



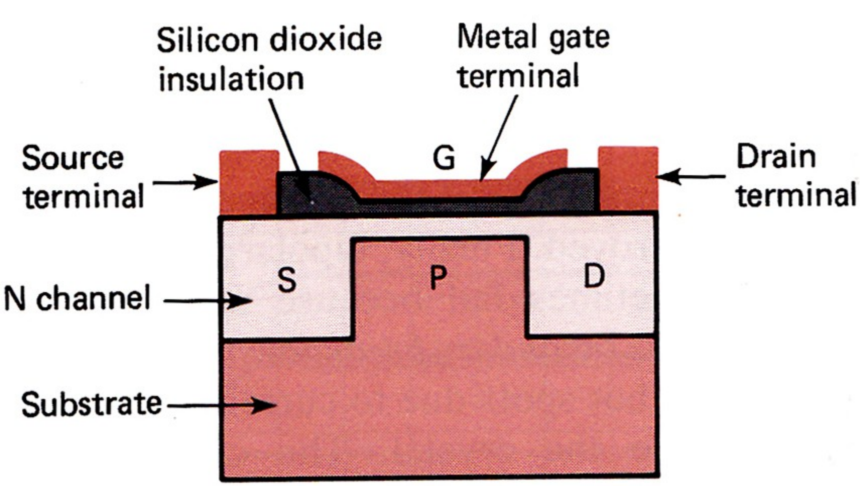
Instead of V_{CE} as in a BJT, the significant signal voltage is V_{DS}.

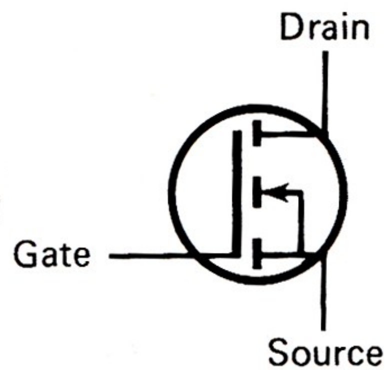
Note that instead of V_{CC} for the supply voltage, it's now referred to as V_{DD}.

No gate current flows.

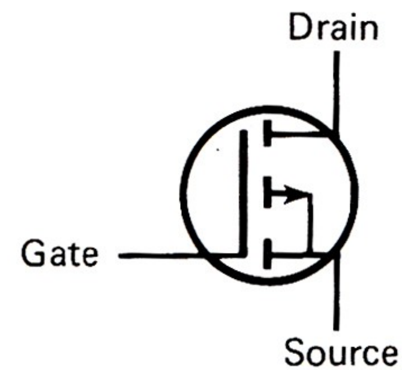
The input impedance is very high.

Gates can also be fabbed from metal. Insulation is then made from an oxide of silicon. This structure is dubbed a ***metal oxide field effect transistor***, or ***MOSFET***. It can be an N-channel or P-channel MOSFET device.



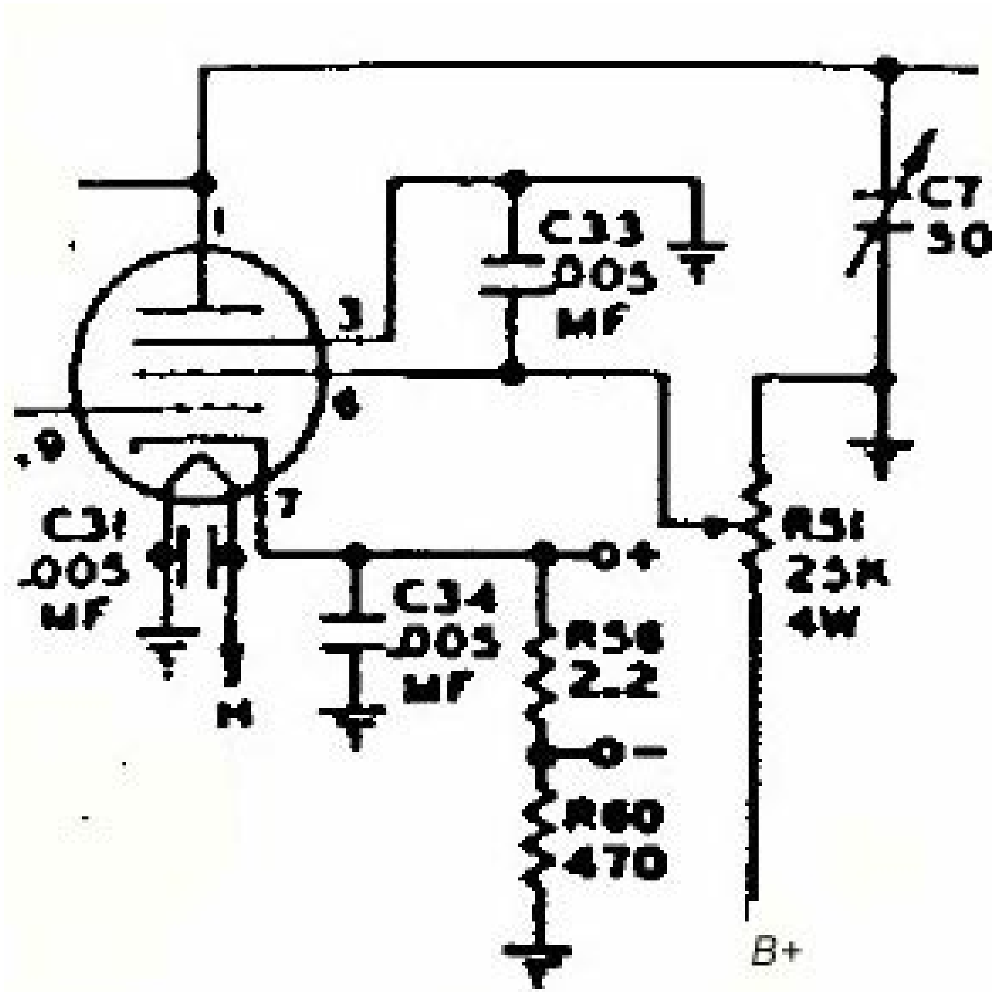


N channel



P channel

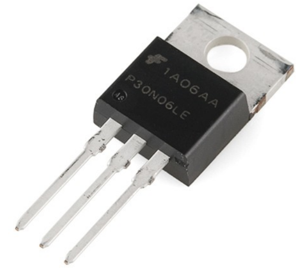
Here's the original drive control circuit in a 1961 E.F. Johnson *Viking Valiant* AM transmitter.



The DRIVE potentiometer R51 is a 25-kohm 4W control. Across a 300V B+ line it dissipates 3.6 watts. Most of these 4W pots therefore burn out prematurely.

The answer to this 1960s problem is to replace the pot with a MOSFET!

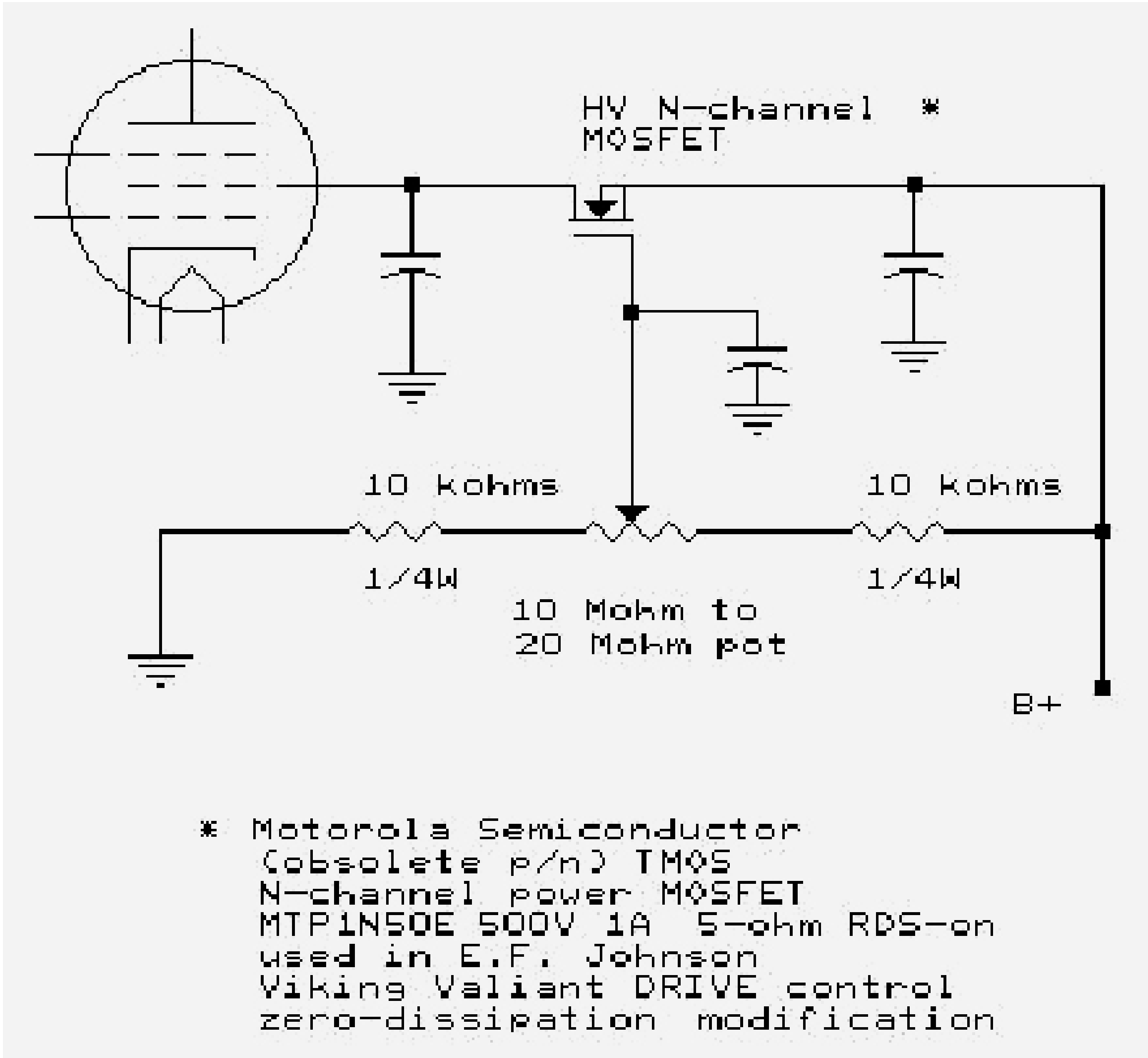
The burned out potentiometer was replaced with a 500V 1A MOSFET.



A low-current voltage divider was rigged, using a junkbox 10-Mohm pot and some small-wattage series resistors.

The wiper on the pot adjusts the voltage on the gate of the MOSFET, thereby varying its source-to-drain resistance.

That “variable resistor” throttles the screen current in the DRIVER circuit.


HV N-channel *
MOSFET
10 kohms
1/4W
10 kohms
1/4W
10 Mohm to
20 Mohm pot
B+
* Motorola Semiconductor
(obsolete p/n) TMOS
N-channel power MOSFET
MTP1N50E 500V 1A 5-ohm RDS-on
used in E.F. Johnson
Viking Valiant DRIVE control
zero-dissipation modification

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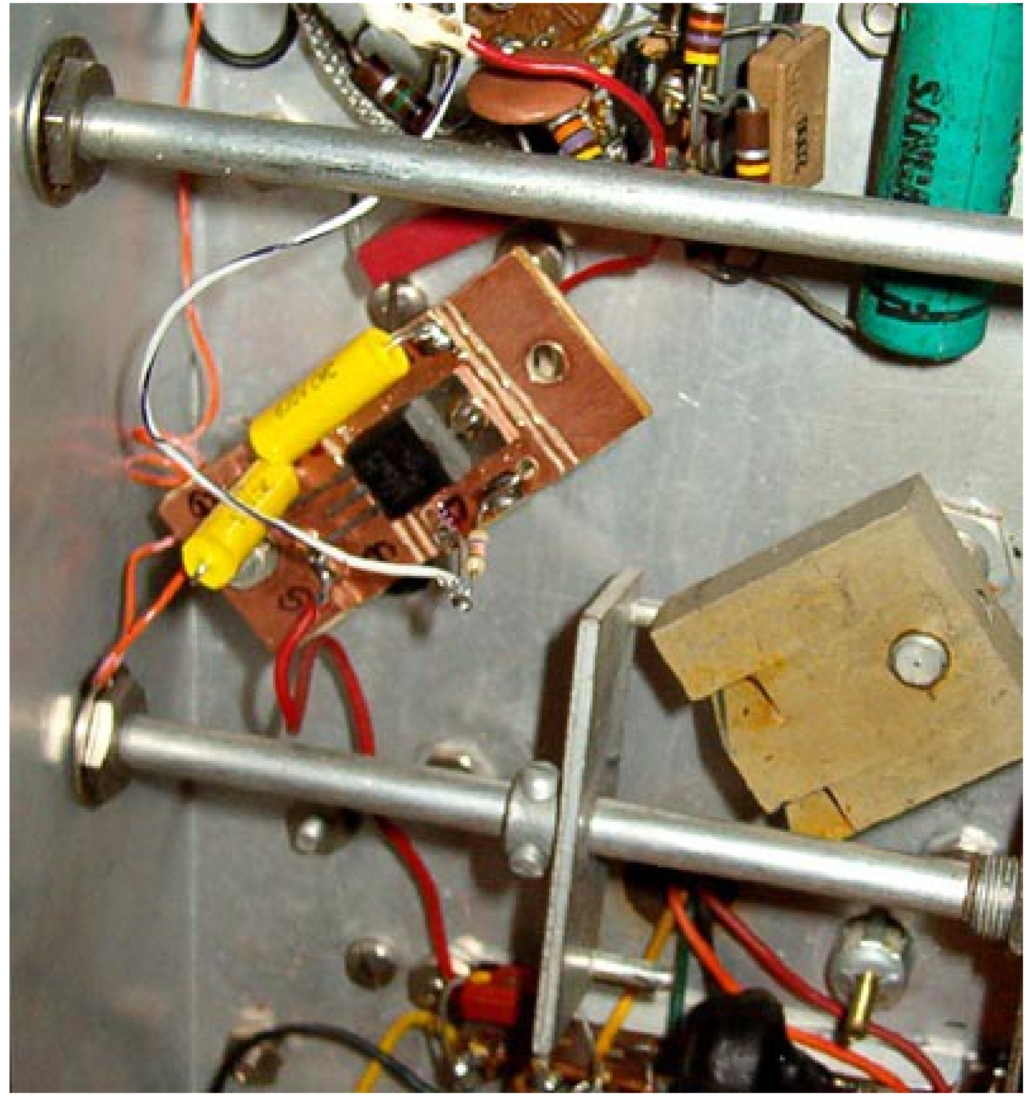
Here's the MOSFET (and two tubular noise-bypass capacitors) attached to a scrap of circuit board material.

It's mounted under the chassis, out of sight. The pot resides on the rig's front panel.

Works FB! It's a solid-state upgrade to the ol' 1961 rig.



Congratulations. You’re almost ready for Phase 4!

Until next time, 73
de AI2Q