CIRCUIT: An electret microphone [1,2] is a capacitor with a permanently charged and polarized membrane attached to one side between the plates. The permanently charged membrane is an "electret", and the permanent charge acts like two additional plates, resulting in the equivalent of two capacitors in series that are permanently charged. Fig. 1 shows the electret capacitor with a diaphragm on one side that moves in and out in response to sound.

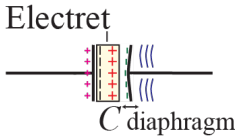

Fig. 1. Electret microphone detailed view.

One plate of the outer capacitor is called the diaphragm and moves in and out in response to sound (air pressure changes). The movement changes the separation between plates and, therefore, changes the capacitance according to the equation for capacitance:

$$C = \varepsilon_0 \frac{A}{d}$$

where $C \equiv$ capacitance, $\varepsilon \equiv$ permittivity of dielectric, $A \equiv$ area of plates, and $d \equiv$ distance between plates.

Since the charge is fixed, the voltage on the capacitor changes according to

$$v = \frac{q}{C}$$

where $q \equiv$ charge and $v \equiv$ voltage. Substituting for C, we see that the voltage is proportional to the distance between the capacitor plates, which in turn is proportional to sound pressure.

$$v = \frac{q}{\varepsilon_0 A} d$$

Fig. 2 shows a typical electret microphone module that includes a JFET (Junction Field-Effect Transistor). The JFET acts like a resistance that is controlled by the voltage at its gate coming from the electret capacitor. Only a minute current flow into the gate of the JFET is needed to change the resistance through the JFET from top to

bottom (or drain to source). The minute voltage changes on the electret capacitor provide the minute currents to drive the gate of the JFET.

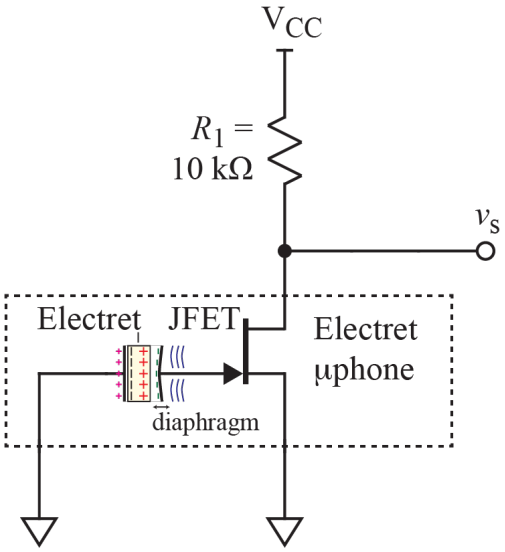

Fig. 2. Electret microphone detailed view.

An external voltage source, V_{CC}, and a current-limiting resistor, typically 10 kΩ, is needed to create proper current flow through the JFET. The output at v_s then varies around a DC offset somewhere between reference and V_{CC}.

It is possible to use v_s as is in a circuit that uses a single polarity of power supply. The amplitude of variation for v_s before clipping occurs is reduced in this case but, for simple sound detection, this approach makes circuit designs simpler.

A capacitor is used to block the DC offset if a sound is to be amplified with high fidelity. Fig. 3 shows an example of the latter type of circuit. Note that the power supplies for the op-amp would have to be positive and negative since the voltage at the + input of the op-amp is now centered at 0V.

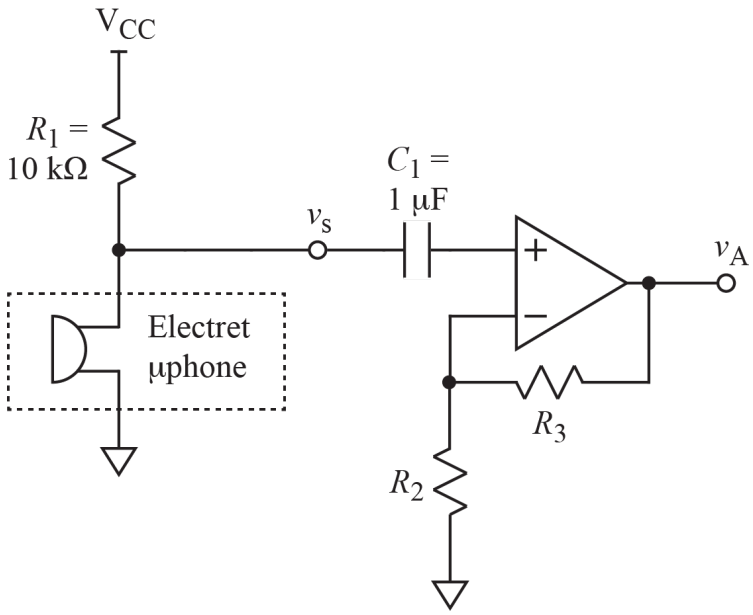

Fig. 3. Electret microphone with amplifier.

REF: [1] https://en.wikipedia.org/wiki/Electret_microphone (accessed 17 July 2020)

[2] https://www.cuidevices.com/product-spotlight/electret-condenser-microphones (accessed 17 July 2020)