Audio Squelch Circuits

By JOHN L. GERGEN

IN installations where a receiver must remain on for long periods of time even though no signal is present at the antenna, noise and background hiss (present in any receiver no matter how well designed) are amplified through the i.f. and audio stages and cause annoying noises at the loudspeaker. A squelch circuit is a control arrangement, usually operating from the a.v.c. voltage, that silences the receiver when no usable signal is being received.

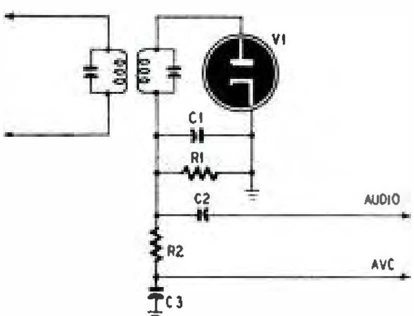


Fig. 1—The sources of a.f. and a.v.c.

Squelch circuits are used frequently in military and police receivers; such equipment must remain on to receive unscheduled broadcasts. However, designers of high-quality receiving equipment can use the squelch circuit to good advantage to silence between-station noises while tuning. A squelch circuit would be impractical for this purpose in a communications receiver when listening to signals which fluctuate rapidly at random due to atmospheric conditions, but it offers improved performance for FM and broadcast reception.

The diode detector V1 of a conventional AM receiver, such as that in Fig. 1, furnishes two output voltages. An a.f. signal, from which r.f. has been removed by C1, appears across R1. This is applied through C2, which blocks the d.c. component, to the volume control (not shown), the arm of which is connected to the grid of the first audio amplifier. The rectified d.c., filtered by R2 and C3, is negative with respect to ground. It is brought back to one or more r.f. and i.f. stages as a.v.c.

Since the a.v.c. voltage is the result of rectifying the r.f. signal, its magnitude depends solely on the signal strength, not at all upon the modulation.

The a.v.c. voltage may also be used to control a squelch circuit, as shown in Fig. 2. Only two additional tubes are required, the most convenient arrangement being to use a dual-triode. The 6SL7-GT was chosen because it has a sharp change in plate current for a change in grid voltage of from 2 to 4 when the plate voltage is 250.

How the squelch works

The circuit of the squelch is very much like that of a direct-coupled amplifier: a voltage divider is placed across the power supply, and the two stages—plates, cathodes, and grids—are placed at various points along it. Fig. 2 is drawn so as to show clearly the voltage-divider effect provided by the three resistors R4, R5, and R9 across the power supply.

The voltage appearing across R9 is applied as plate voltage to V2-b, an ordinary cathode-follower amplifier. The a.f. signal from the detector is applied between grid and ground. Output is taken from across the cathode resistor.

The bias on V2-b, however, is controlled by V2-a, which, in turn, is controlled by the a.v.c. voltage.

When no signal is being received, there is no a.v.c. voltage; therefore there is no voltage between grid and cathode of V2-a, except a small bias furnished by R4. The grid is connected to the negative end of the power supply (through R3, in which there is no current flow and therefore no voltage drop), while the cathode is connected to the top of R4, which is a more positive point on the voltage divider. The grid is slightly negative for that reason, but plate current flows.

The plate current of V2-a flows through its plate-load resistor R6, which has a high resistance. The current flows through R6 from plate to supply, which means that the plate end is negative with respect to the other end. The negative (plate) end of R6 is connected (through R7, in which there is no voltage drop) to the grid of V2-b, and the positive end (through R8, in which there is no drop when V2-b is not conducting) to the cathode of V2-b.

When V2-a is conducting (when there is no a.v.c.), V2-b is biased by the voltage drop across V2-a. This is sufficient to cut V2-b off completely. Therefore, it cannot amplify the audio signal impressed on its grid by the detector, and the loudspeaker is silent.

When a signal appears, it creates a certain amount of negative a.v.c. voltage, which appears across R3. Enough of this is tapped off R3, by the setting of the movable arm, to cut off V2-a. Since there is now no V2-a plate current passing through R6, there is no voltage across it and the cutoff bias it had applied to V2-b is removed. Because the only resistors between the grid of V2-b and the bottom of its cathode resistor are now carrying no current, these two points are at the same potential. The only d.c. voltage appearing between the grid and cathode of V2-b is that caused by the usual voltage drop across the cathode resistor R8, which gives the correct bias for normal operation.

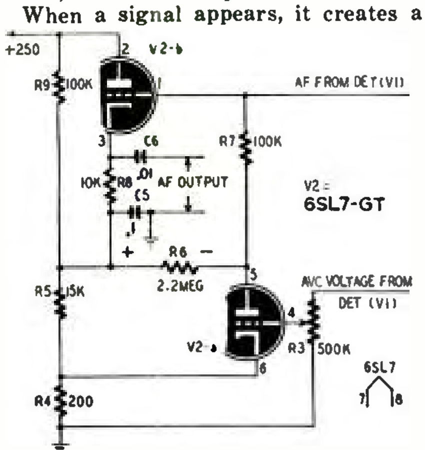


Fig. 2—Where squelch tube is inserted.

The a.f. plate current of V2-b causes a.f. voltage variations across R8. The a.f. voltage is fed out to the following audio stage through C6, which blocks the d.c. component of the cathode voltage. The lower end of R8 is bypassed to ground for a.f. by C5, so that the audio output is effectively 10,000 ohms above ground, while the entire tube is actually far above ground for d.c., a condition necessary for operation of the d.c. circuits just described.

Construction

The squelch circuit can be installed in any receiver which has a.v.c.; the detector need not be a diode. The 6SL7-GT and its resistors and capacitors can usually be installed right on the chassis. Connections are made to the receiver's B-supply, filament supply, and to the detector's audio and a.v.c. outputs.

The only actual change necessary in the receiver circuit is to disconnect the audio output of the detector from the top of the volume control and lead it instead to the grid of V2-b. The a.f. output from the cathode end of R8 is then connected to the top of the volume control. Because V2-b is a cathode follower, it has no gain and the output volume of the receiver will be about the same as before. It may be slightly less because the cathode-follower gain may be slightly less than 1, but there is not enough loss to cause trouble.

Only one adjustment is needed. The magnitude of the a.v.c. voltage developed in the receiver depends on the proximity and power of the stations listened to. The weakest of these should be tuned in and R3 adjusted until V2-a just cuts off—that is, until normal audio is heard. Tuning off the station should silence the speaker. When any other station is tuned in correctly, it should be heard; but, when tuning between stations, all noise, hiss, interference, and so on should be inaudible.

Though the diagrams show the squelch circuit used with an AM receiver, it can be especially valuable with an FM set, particularly to silence the loud hiss heard between stations on sets which use limiter-discriminator combinations. All that is necessary is a negative d.c. voltage which is present when there is a signal and absent when there is none. The grid voltage of the limiter satisfies this requirement and may be connected to the top of R3 to control the squelch. With other types of detectors which do not need limiters there is generally a way of obtaining a d.c. voltage. Sets which have a.v.c. will, of course, present no problem, as R3 is simply connected to the a.v.c. line.

MATERIALS FOR SQUELCH

Resistors: 1—200, 1—10,000, 1—15,000, 1—100,000 ohms, 1—2.2 megohms, 1/2 watt; 1—100,000 ohms, 1 watt; 1—500,000-ohm potentiometer.

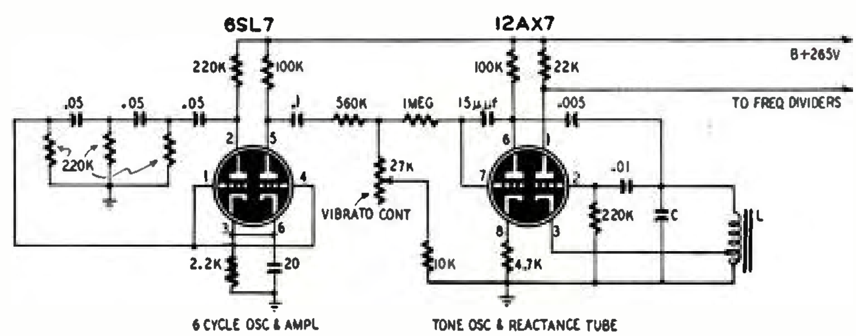
Capacitors: 1—.01, 2—0.1 μf, 600 volts, paper.

Miscellaneous: 1—6SL7-GT; 1—octal tube socket; necessary hardware.

New Electronic Music Vibrato Circuit

A novel electronic musical instrument was described in a recent issue of *Electronics*. The instrument consists of 12 tone-generator channels and an audio amplifier. A switch frame is fastened across the keyboard of a standard piano so its keys close appropriate circuits in the electronic-organ tone generators and both instruments are played at once.

Each tone-generator channel consists of an electron-coupled sawtooth oscillator and a series of four cascade frequency-halving multivibrators. Each of the oscillators can be frequency-modulated to produce a vibrato effect. Frequency modulation is produced by applying a 6-cycle signal to the grid of a reactance tube across the oscillator of each of the tone-generating channels.



The low-frequency oscillator and a single tone-generating oscillator and reactance tube are shown in the diagram.

The vibrato signal is generated in one triode of the 6SL7, which is connected as a phase-shift oscillator whose frequency is controlled by the 220,000-ohm resistors and the .05-uf capacitors. The other section of the 6SL7 is a buffer amplifier.

One section of the 12AX7 is an electron-coupled oscillator whose frequency is controlled by the values of the iron-cored inductor L and the capacitor C shunting it. The signal from the buffer amplifier is applied to the grid of the remaining triode of the 12AX7. The strength of the vibrato signal is controlled by varying the 27,000-ohm resistor. The value of this resistor is altered by switching in parallel resistors in the original circuit.

The signal from the buffer-amplifier could be applied to the suppressor grid of a voltage amplifier in an audio amplifier used with electric guitars and similar instruments to produce a vibrato or tremolo effect.