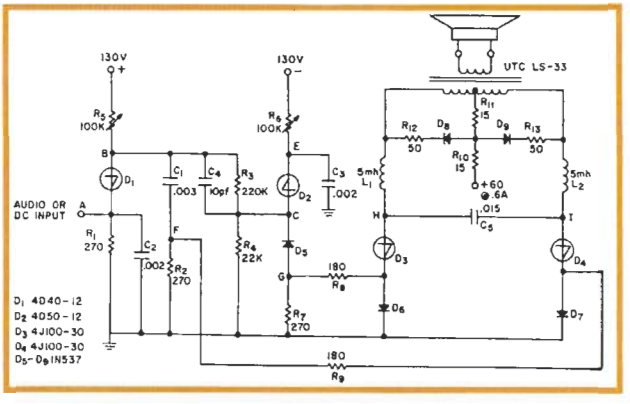
40 years ago

May 10, 1961

Cover Story: *AC regulator holds voltage despite changes in load, line, frequency or phase*

Just Diodes in Hi-Fi Amplifier

Attendees at Dr. William Shockley's lecture on four-layer diodes, given recently at the Eighth Annual Cleveland Electronics Conference, were treated to a demonstration of music played through an amplifier devoid of tubes or transistors—diodes were the only active elements. Response of the amplifier extended from dc to over 15 kc, with average audio power about 2 w. The improved version of the amplifier, shown in the circuit diagram, delivers about 10-w average audio power into a speaker or resistive load.



In basic principle, the device consists of two sections—a pulse-width modulator operating from the input signal, and a bistable multivibrator or flip-flop producing a square wave, which will vary in symmetry in accordance with the applied signal. A transducer, such as a loudspeaker, can be used to sense changes in symmetry and thus reproduce the original signal.

The modulator operates at 37.5 kc, more than double the highest audio frequency to be amplified. The modulator consists of a relaxation oscillator using a four-layer Shockley diode which fires at 40 v. When it fires, it discharges capacitor C_1 through resistor R_2, producing a 40-v negative pulse; a sawtooth waveform is produced at B at the top of C_1-D_1.

The modulator's second section is another four-layer semiconductor relaxation oscillator operating at 37.5 kc with this oscillator operating from a negative supply voltage to produce a negative-going sawtooth waveform at the top of C_3-D_2.

A voltage divider, R_3 and R_4, allows a small portion of the positive-going sawtooth, which appears at the top of C_1-D_1, to be applied to the bottom of D_2; thus, D_2 fires when the combined negative and positive sawtooth signals reach a difference potential equal to the firing voltage of D_2 (in this case 50 v). When D_2 fires , it discharges C_3 through R_7, producing a negative pulse of approximately 40 v.

The two relaxation oscillators operate in synchronism and the phase relation between these oscillators is affected by the sawtooth slope as well as the firing voltage of each diode. A small ac signal applied, as shown, changes the firing point of D_1 and thus phase-modulates the pulses from D_1 and D_2. Symmetry is adjusted with R_5 or R_6.

The output stage is a bistable multivibrator consisting of two Shockley switching devices and is switched from side to side with the pulses supplied by the two relaxation oscillators. When no modulation is present, the speaker sees a square wave of 37.5 kc and a net audio signal of zero. As the symmetry is varied from side to side with an audio input signal, the transducer sees one diode conducting for a longer time than the other one; thus the transducer sees an audio component in the form of a zero-line shift. (ELECTRONIC DESIGN, *May 10, 1961, p. 216)*

Shockley, an expert in the physics of p-n junction and multijunction devices, continued to come up with odd devices that never made it into the mainstream. I'm not sure how practical this circuit was, but it sure is interesting.—Steve Scrupski

Industry Preparing for Push in FM Stereo

Triggered by the FCC's approval of suppressed-carrier-am as the multiplex standard for fm stereo broadcasts, manufacturers are preparing to produce equipment for transmitting and receiving. In the new system, the main carrier is frequency-modulated by the sum of the left and right microphone signals and by the sidebands of a suppressed subcarrier. The subcarrier is amplitude-modulated and suppressed by a left-minus-right difference signal. The suppressed subcarrier is restored at the receiver by a pilot signal transmitted between subcarrier and main carrier.

To receive the broadcasts requires that an adapter be added to a standard fm tuner and dual-channel amplifier. General Electric Co. believes that a one-tube adapter—a double triode—would give satisfactory results, although it says addition of a preamplifier would make possible good reception by a wider variety of amplifiers. The cost of the adapter would be minor compared to that of the complete stereo system.

The system is compatible with existing fm broadcasting standards. Monophonic receivers tuned to stereo transmissions would receive the left-plus-right signal and produce sound only slightly reduced in quality. (ELECTRONIC DESIGN, *May 10, 1961, p. 6)*

FM stereo broadcasting was authorized to begin on June 1, 1961, and regular operations began at WEFM Chicago and WGFM Schenectady. There's a good chronology of FM broadcasting at http://members.aol.com/jeff560/chronofm.html.—Steve Scrupski

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