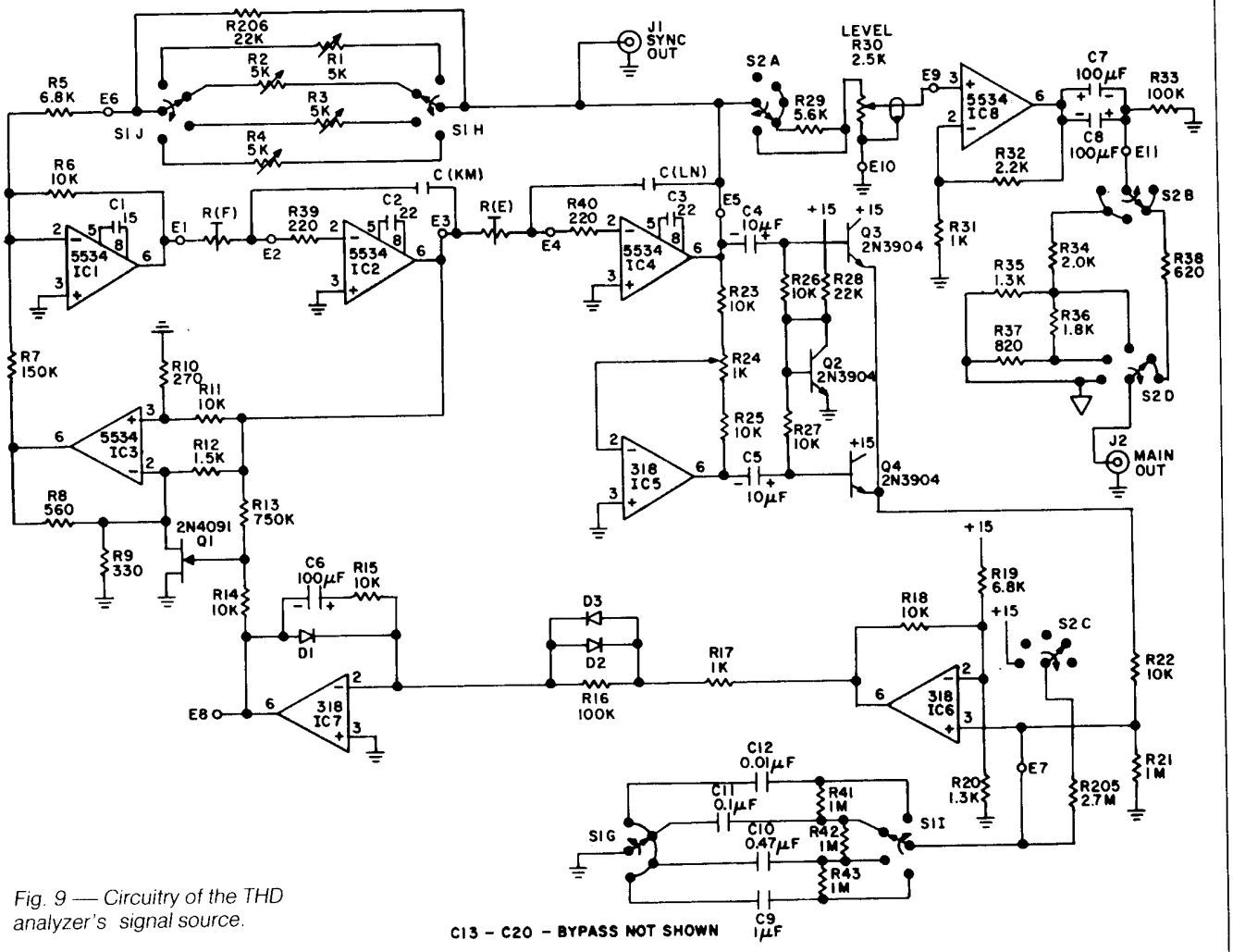

Fig. 9 — Circuitry of the THD analyzer's signal source.

octave low-pass characteristic. Notice that the phase of this output lags that of the bandpass output by 90 degrees at all frequencies. This feature is used to provide the required 90-degree phase-shifted fundamental signal to the frequency detector in the auto-tune circuit.

The Signal Source

With a solid understanding of the state-variable filter, operation of the state-variable oscillator is quite simple. As in the earlier example, we remove R_I and R_B as a start.

As with any linear oscillator, we must provide a means to control the amplitude of the oscillations, i.e., provide a type of a.g.c. circuit. Recognizing that the presence of R_B produced negative feedback around the first integrator which tended to damp out oscillations, we can reason that a feedback circuit around A1 which can provide variable amounts of negative or positive feedback will allow us to control the oscillations. Negative feedback will cause the oscillations to decay, while positive feedback will cause them to grow. This can be accomplished with a multiplier and a resistor in place of R_B. To complete the oscillator, we must add a control circuit to measure the amplitude of the oscillations, then compare it to a fixed reference, and finally deliver a d.c. error signal to the control input of the multiplier.

The complete schematic of the signal source is shown in Fig. 9. First, a word about notation and conventions used on the schematics in this article. For simplicity, power-supply bypass capacitors and power-supply connections to standard pin-out operational amplifiers (+15 V to pin 7, -15 V to pin 4) are not shown. Off-board interconnection terminals are designated with an "E" number. Terminals on different boards which are connected together have the same E designation.

Each pole of a multi-pole rotary switch is designated with a letter, beginning with "A" closest to the front panel. Wafers with two poles have the left-hand pole (as viewed from the front panel) designated with the earlier letter in the alphabet; the letter for the right-hand pole is next in the alphabet. Arrows on switch wipers indicate clockwise rotation