

REFERENCES

1. "Application of Accutronics' Reverberation Devices," Technical paper available from Accutronics, Geneva, Ill.
2. "What Is Reverberation?," Technical paper available from Accutronics, Geneva, Ill.

5.4 PHASE SHIFTER

A popular musical instrument special effect circuit called a "phase shifter" can be designed with minimum parts by using two quad op amps, two quad JFET devices and one LM741 op amp (Figure 5.4.1). The sound effect produced is similar to a rotating speaker, or Doppler phase shift characteristic, giving a whirling, ethereal, "inside out" type of sound. The method used by recording studios is called "flanging," where two tape recorders playing the same material are summed together while varying the speed of one by pressing on the tape reel "flange." The time delay introduced will cause some signals to be summed out of phase and cancellation will occur. This phase cancellation produces the special effect and when viewed in the frequency domain is akin to a comb filter with variable rejection frequencies.¹ The phase shift stage used (Figure 5.4.1) is a standard configuration² displaying constant

magnitude and a varying phase shift of 0-180° as a function of the resistance between the positive input and ground. Each stage shifts 90° at the frequency given by $1/(2\pi RC)$, where C is the positive input capacitor and R is the resistance to ground. Six phase shift stages are used, each spaced one octave apart, distributed about the center of the audio spectrum (160 Hz-3.2 kHz). JFETs are used to shift the frequency at which there is 90° delay by using them as voltage adjustable resistors. As shown, the resistance varies from 100Ω (FET full ON) to 10kΩ (FET full OFF), allowing a wide variation of frequency shift (relative to the 90° phase shift point). The gate voltage is adjusted from 5V to 8V (optimum for the AM9709CN), either manually (via foot operated rheostat) or automatically by the LM741 triangle wave generator. Rate is adjustable from as slow as 0.05 Hz to a maximum of 5 Hz. The output of the phase shift stages is proportionally summed back with the input in the output summing stage.

REFERENCES

1. Bartlett, B., "A Scientific Explanation of Phasing (Flanging)," *Jour. Aud. Eng. Soc.*, vol. 18, no. 6, December 1970, pp. 674-675.
2. Graeme, J. G., *Applications of Operational Amplifiers*, McGraw-Hill, New York, 1973, pp. 102-104.

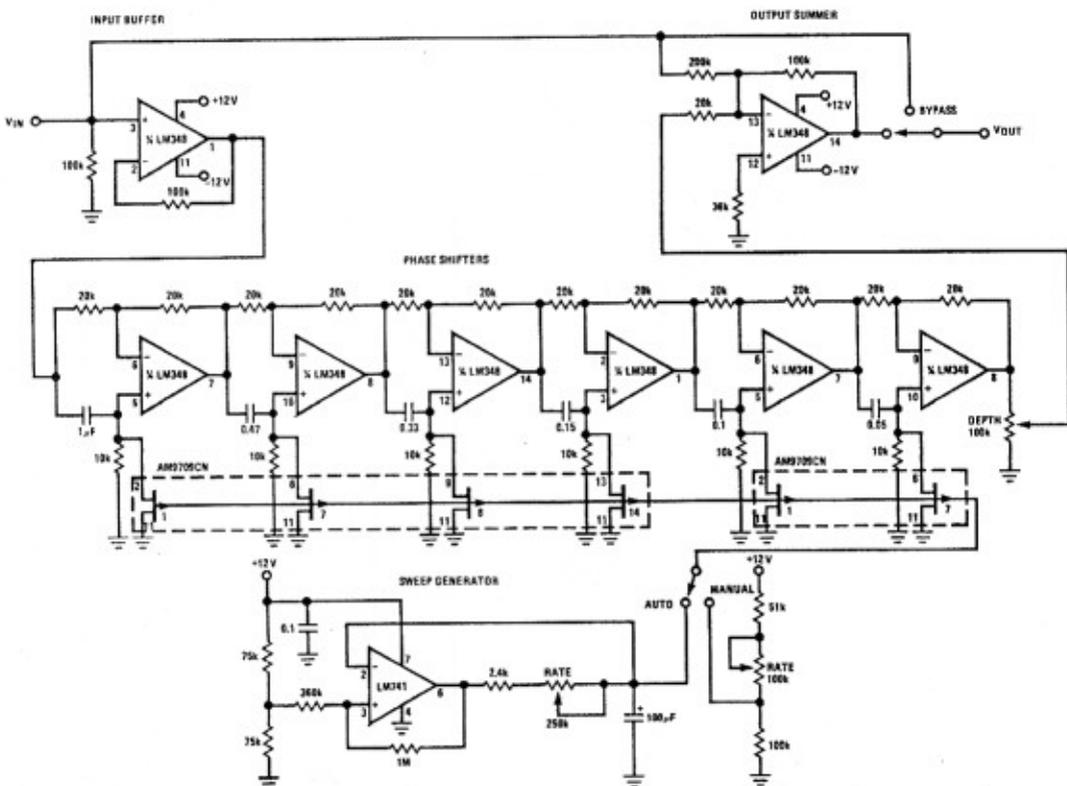


FIGURE 5.4.1 Phase Shifter