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(EXPI)

MAGNETIC FIELD SWITCH*

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In the June 21, 1969 issue of Electronic Design, K. L. Siegler presents a method of conserving the energy when reversing the current in an inductor. Here an alternate method that is used at SLAC (Z. D. Farkas, Report No. SLAC-TN-64-33, Stanford Linear Accelerator Center, Stanford University, Stanford, California (1964)) is presented.

The switch is shown in Fig. 1. It is capable of quickly reversing the current through an inductor and maintaining that current for any desired time. It isolates the power supply from the inductor while the energy in the inductor is transferred to a condenser and then again back to the inductor as a current flowing in the opposite direction. At the completion of the energy transfer, the switch automatically connects the power supply across the inductor with a reversed polarity, so as to maintain the current in the reversed direction.

The circuit functions as follows: Transistors Q3 and Q4 are driven fully on and fully off by complementary, and not necessarily symmetric, square wave. When Q3 is on and Q4 is cut off, current flows through Q1-L-R2-R1-D2-Q3. The voltage developed across D2 cuts of Q2. Thus the source voltage appears across terminals A-B. This is a stable condition.

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When the signal to Q2 and Q4 reverses, the current in L has only one open path and that is to charge the capacitor. Thus the parallel LC circuit is isolated from the power source and will start to oscillate. Just prior to the end of a half period when the voltage across C is equal to the P.S. voltage, a stable condition exists again but now the current in L flows in the reverse direction.

Diodes D3 to D6 prevent transistors Q1 and Q2 from becoming forward-biased and thus shorting the tank circuit during switching.

The switching capability of a given circuit is given by

$$\frac{U}{t_0} = \frac{VI}{2\pi}$$

where

U = total energy to be switched

t_0 = switching time

VI = peak, voltage and current, rating, respectively, of switching elements.

The operation of the circuit is illustrated in Figs. 2 to 5.

Figure 2 shows the voltage across A-B. Figure 3 is Fig. 2 magnified. The half-period oscillation during switching and the constant voltage across the inductor resistance are clearly seen. Figures 4 and 5 show the current through R1 and R2 respectively. Both figures also show the voltage at point A. The zero current through R1 shows that the tank circuit is indeed isolated during switching and Fig. 5 shows the half period cosinosoidal current in the inductor. Both figures show the stable constant current in L. If both Q3 and Q4 are cut off, the voltage across A-B is zero. If both Q3 and Q4 are turned on, the voltage across A-B is still zero and the source current is limited by D1 and D2 cutting off Q1 and Q2.

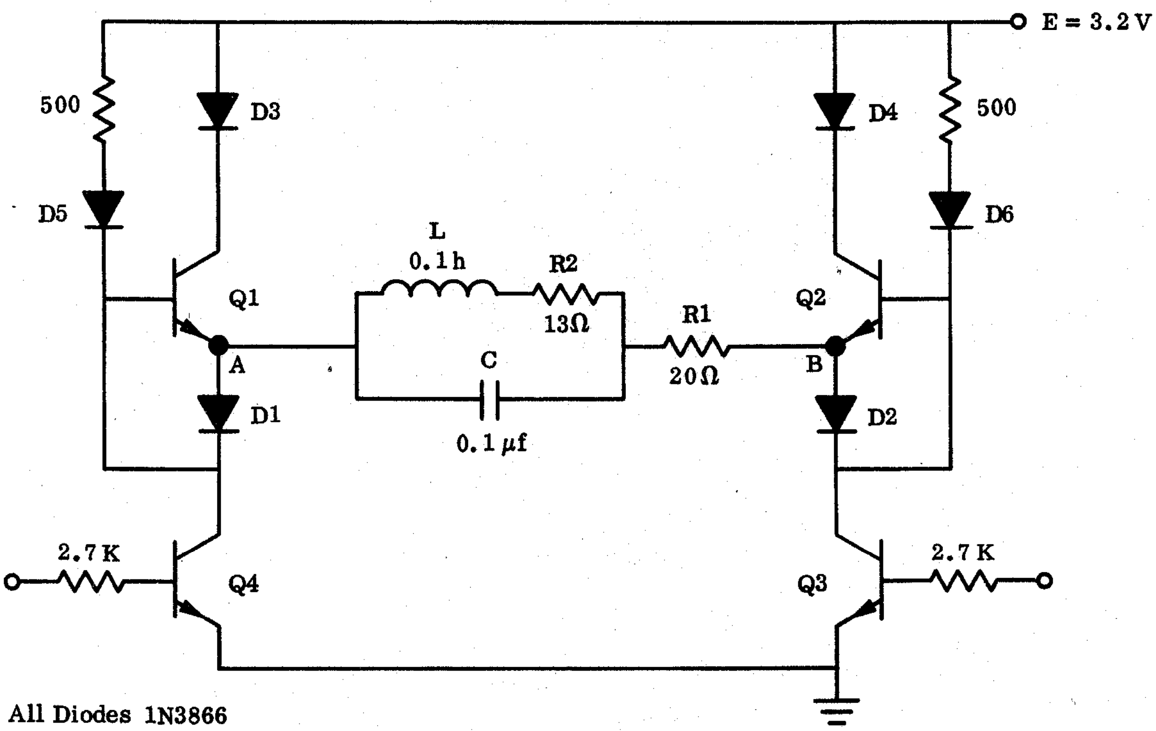
The circuit will also function with a resistive load.

FIGURE CAPTIONS

1. Magnetic field switch schematic.
2. Voltage across A-B

   V: 10 V/div   H: 0.2 msec/div
3. Voltage across A-B magnified.

   V: 0.5 V/div
4. Current through R1 and voltage at A.
5. Current through L and voltage at A.



All Diodes 1N3866

All Transistors 2N3643

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Fig. 1

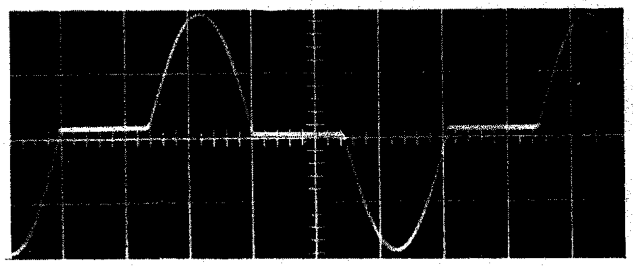

Fig. 2

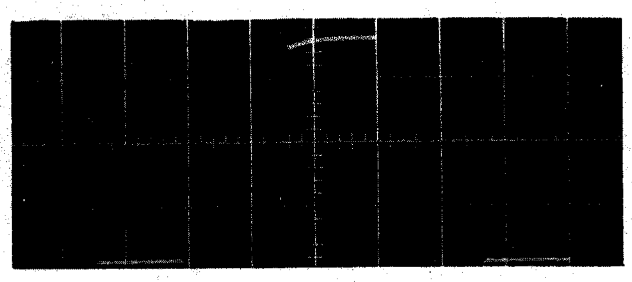

Fig. 3

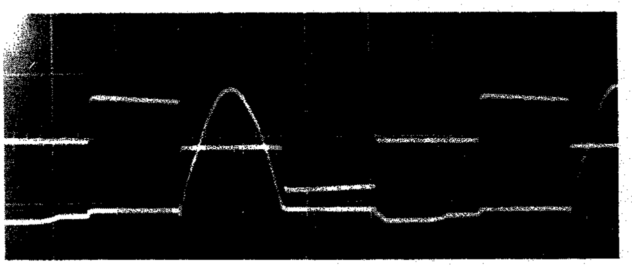

Fig. 4

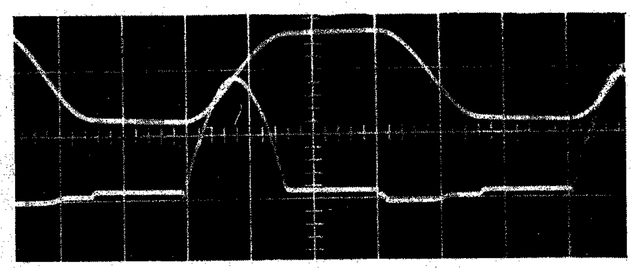

Fig. 5

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