Q21. What is a delay-line canceller? Explain its frequency response characteristics with a neat sketch.

Oct./Nov.-17, Set-4, Q4(b)

(or)

Explain in detail the filter characteristics of the delay line canceller.

(or)

What is a delay line canceller? Explain the same with a neat block diagram.

Nov./Dec.-15, Set-1, Q4(b)

Ans:

Delay Line Canceller

A filter which is used to remove the D.C component of fixed targets and to allow the A.C components of moving targets referred as a delay line canceller. The block diagram of delay line canceller is as shown in figure (1).

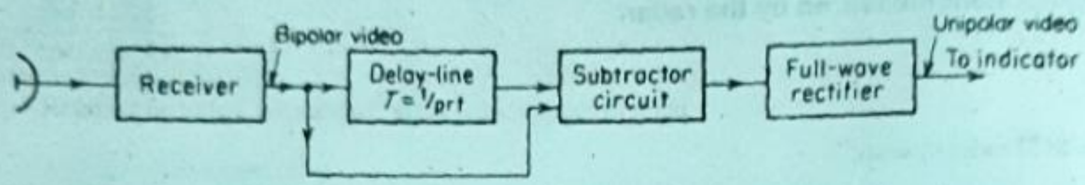

Figure (1)

Necessity of Delay-line Canceller

The velocity of propagation of acoustic waves is about 10^{-5} times that of electromagnetic waves. So to convert the electromagnetic wave into an acoustic signal a delay line of acceptable physical length is established. The delay line injects a time delay equal to the pulse repetition period. After inserting the necessary time delay, the acoustic signal is transformed back into the electromagnetic signal and the processing is continued.

The main advantage of time-domain delay line canceller is that a single filter operates at all frequency ranges. Thus, there is no need to use a separate filter for each frequency range.

Filter Characteristics of the Delay Line Canceller

The main function of delay-line canceller is to act as a filter by rejecting the D.C component of the clutter. The filter also rejects energy in the vicinity of the pulse repetition frequency and its harmonics, because of its periodic nature. The video signal, V_1 received from a particular target at a range R_0 is given by,

$$V_1 = k\sin(2\pi f_d t - \phi_0) \quad \text{... (1)}$$

Where,

k - Amplitude of video signal

ϕ_0 - Phase shift.

The signal which is delayed by a time 'T' from the previous transmission is expressed as,

$$V_2 = k\sin[2\pi f_d (t-T) - \phi_0] \quad \text{... (2)}$$

Where,

T - Pulse repetition interval.

Then, the output of the subractor is obtained by assuming 'k' as same for both pulses as,

$$V = V_1 - V_2$$

$$= 2k\sin \pi f_d T \cos\left[2\pi f_d\left(t - \frac{T}{2}\right) - \phi_0\right] \quad \text{... (3)}$$

It is assumed that the gain through the delay-line Canceller is unity. From equation (3), it is evident that the output of canceller is a cosine wave with a doppler frequency, f_d and an amplitude of $2k \sin \pi f_d T$. Thus, the amplitude of the canceled video output is a function of the doppler frequency shift and pulse repetition frequency. Figure (2) shows the magnitude of the relative frequency response of the delay-line Canceller.

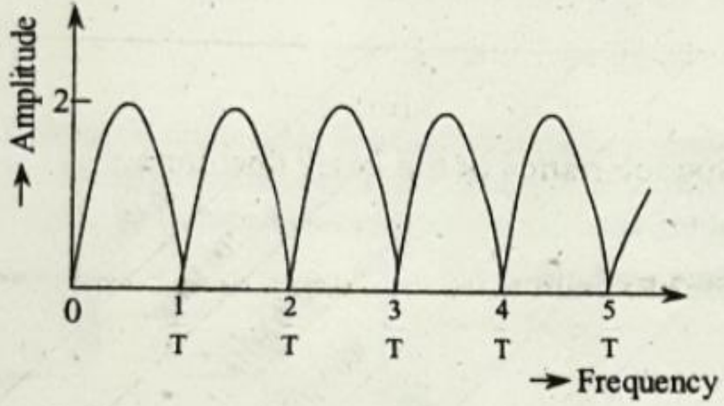

Figure (2)