ADITYA ENGINEERING COLLEGE (A)

Radar Systems

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Course Outcomes

At the end of the Course, Student will be able to:

CO 1 : Model the radar range equation.
CO 2 : Make use of the range equation in analytical problems.
CO 3 : Explain the different types of radars and its applications.
CO 4 : Classify the different tracking techniques.
CO 5 : Explain the performance of radar receiver systems.

Course Contents

UNIT I : Basics of radar & radar equation
UNIT II : CW & FM radar
UNIT III: MTI& Pulse doppler radar
UNIT IV: Tracking radar
UNIT V : Detection of Radar Signals in Noise & Radar receivers

Text Books

Introduction to Radar Systems, Merrill I. Skolnik, TMH Special Indian Edition, 2nd Edition, 2007.

ADITYA ENGINEERING COLLEGE (A)

Radar Systems
(UNIT-IV)
Tracking radar

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Unit-1 Outcomes

At the end of the unit, Student will be able to:

CO 4 : Classify the different tracking techniques.

Contents

Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two-coordinates), Phase Comparison Mono pulse, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers.

Learning Outcomes

At the end of this lecture, Student will be able to:

LO1: get an idea of Tracking Radar

It is the method by which angle tracking is accomplished that distinguishes what is normally considered a tracking radar from any other radar.

Continuous tracking radar and track-while-scan (TWS)radar

The antenna beam in the continuous tracking radar is positioned in angle by a servomechanism actuated by an error signal. The various methods for generating the error signal may be classified as sequential lobing, conical scan, and simultaneous lobing or monopulse.

The information available from a tracking radar may be presented on a cathode-ray-tube (CRT) display.

Some radars operate in a search, or acquisition, mode in order to find the target before switching to a tracking mode.

Search radar and tracking radars

acquisition radar

If the change in target coordinates from scan to scan is not too large, it is possible to reconstruct the track of the target from the sampled data from search radar.
ADT (automatic detection and track).
When the outputs from more than one radar are automatically combined to provide target tracks, it is called ADIT (automatic detection and integrated track) or IADT (integrated ADT).

A surveillance radar that provides target tracks is sometimes called a track-while-scan radar.

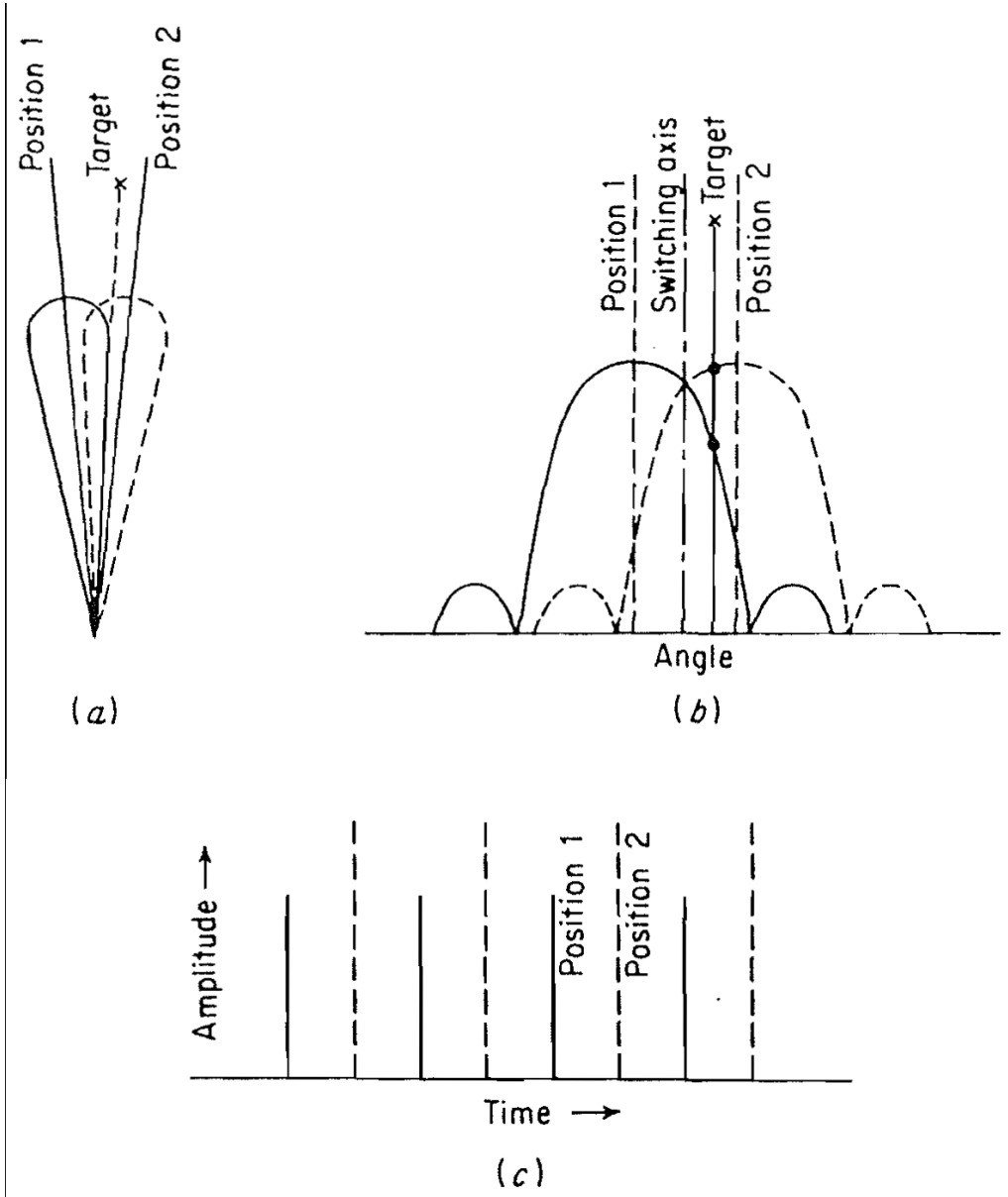
SEQUENTIAL LOBING

The antenna pattern commonly employed with tracking radars is the symmetrical pencil beam in which the, elevation and azimuth beamwidths are approximately equal.

Angular error

lobe switching, sequential switching, or sequential lobing

a two-dimensional sequentially lobing radar might consist of a cluster of four feed horns illuminating a single antenna, arranged so that the right-left, up-down sectors are covered by successive antenna positions. Both transmission and reception are accomplished at each position. A cluster of five feeds might also be employed, with the central feed used for transmission while the outer four feeds are used for receiving.



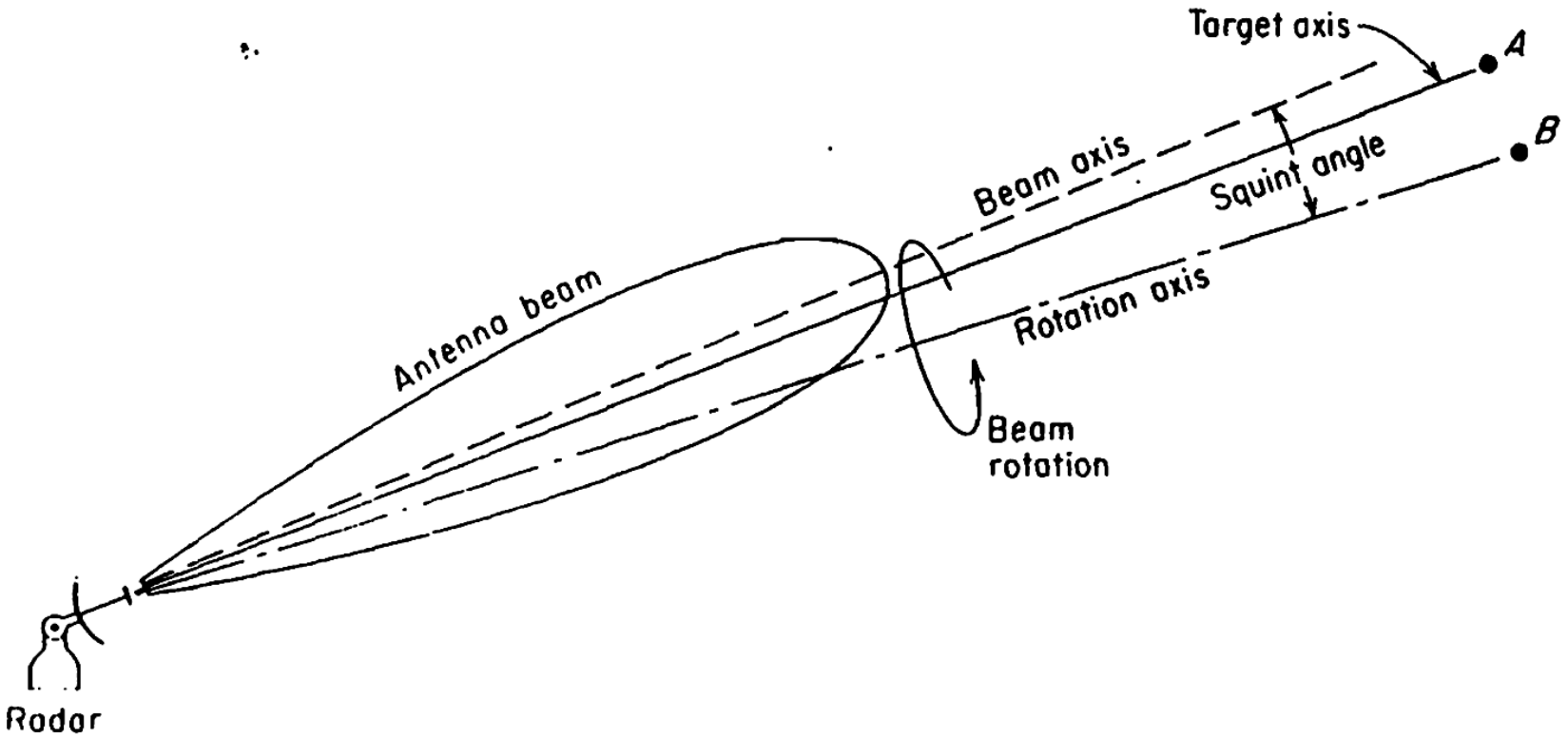
Summary

Tracking radar is introduced, and sequential lobing is discussed.

One of the limitations of a simple unswitched nonscanning pencil-beam antenna is that the angle accuracy can be no better than the size of the antenna beamwidth. An important feature of sequential lobing (as well as the other tracking techniques to be discussed) is that the target-position accuracy can be far better than that given by the antenna beamwidth

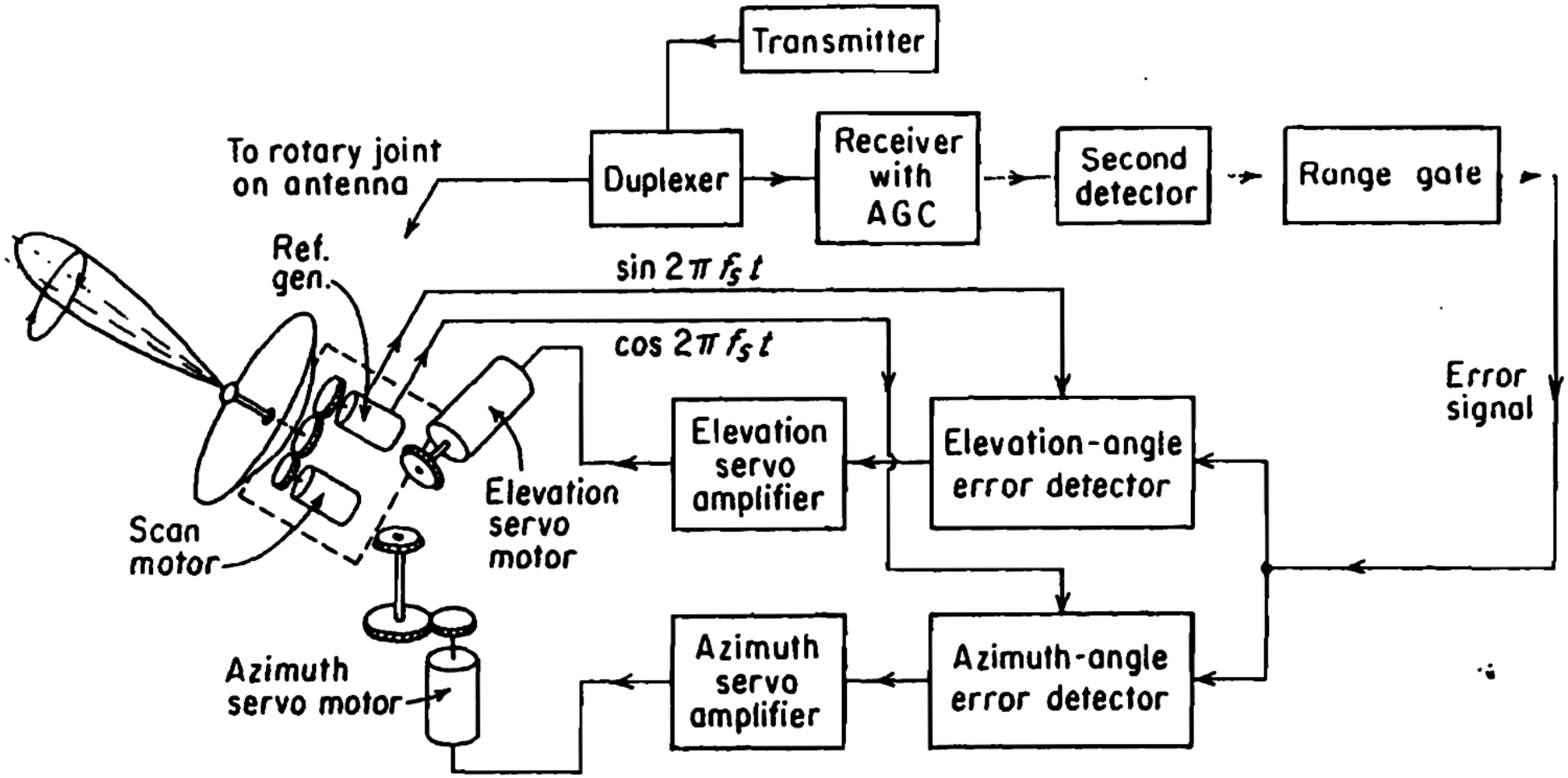
Conical-scan tracking.

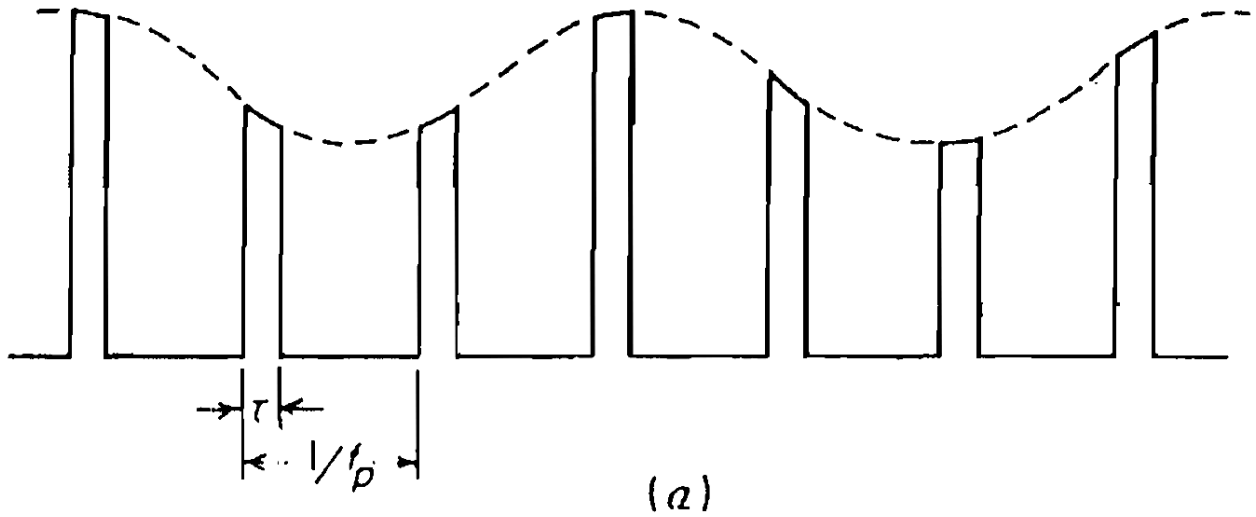
Squint angle
Nutating and rotating feeds--------polarisation



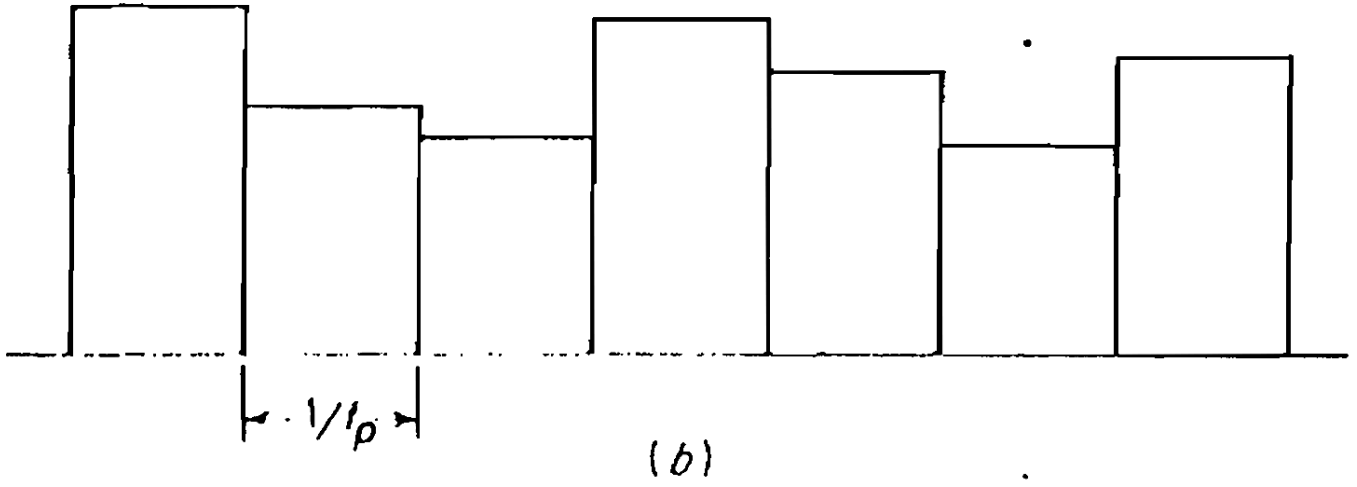
One of the simplest conical-scan antennas is a parabola with an offset rear feed rotated about the axis of tlie reflector. If the feed maintains the plane of polarization fixed as it rotates, i t is called a nutating feed. A rotating feed causes the polarization to rotate. The latter type of feed requires a rotary joint. The nutating feed requires a flexible joint.

Block diagram of conical-scan tracking radar





Boxcar generator

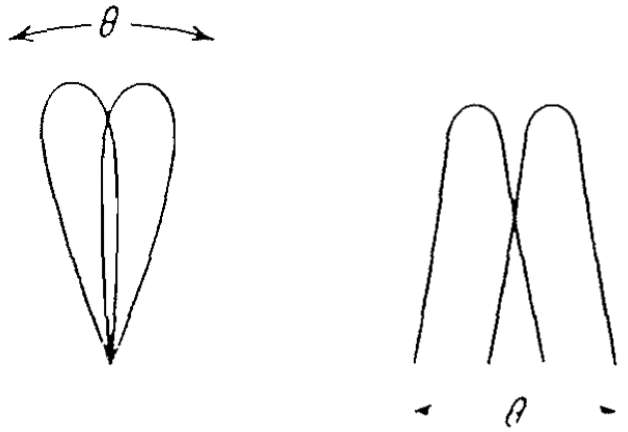


Automatic gain control: The three major causes of variation in amplitude are (1) the inverse-fourth-power relationship between the echo signal and range, (2) the conicalscan modulation (angle-error signal), and **(3)** amplitude fluctuations in the target cross section

MONOPULSE TRACKING RADAR

In the time interval during which a measurement is made with either sequential lobing or conical scan, the train of echo pulses must contain no amplitude-modulation components other than the modulation produced by "scanning".

The two adjacent antenna feeds are connected to the two arms of a hybrid junction such as a "magic T," a " rat race," or a short-slot coupler. The sum and difference signals appear at the two other arms of the hybrid.



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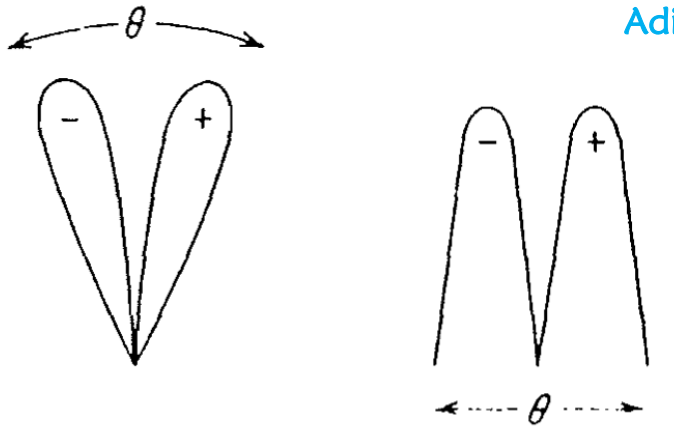

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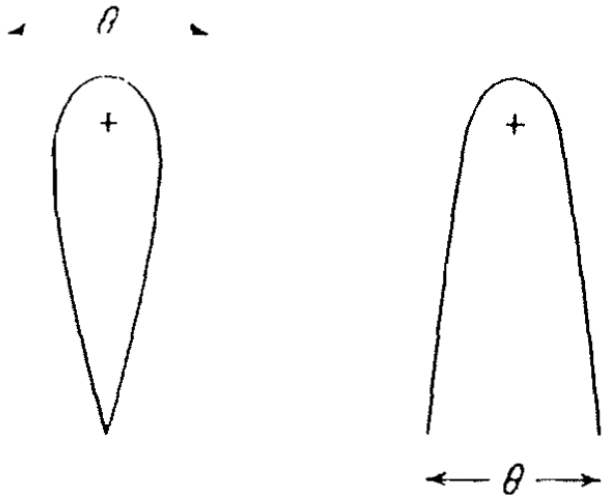

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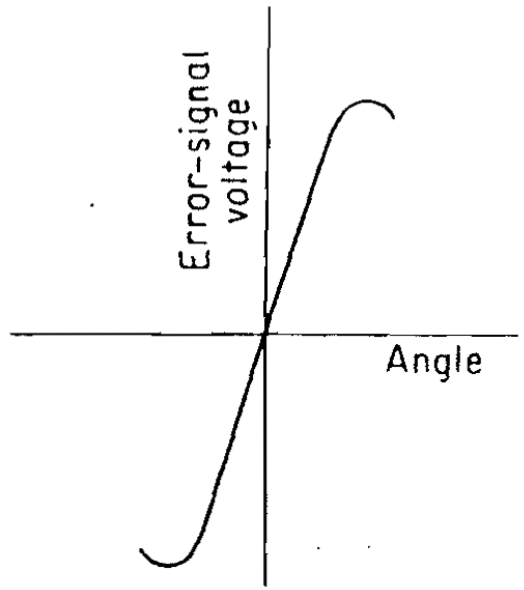

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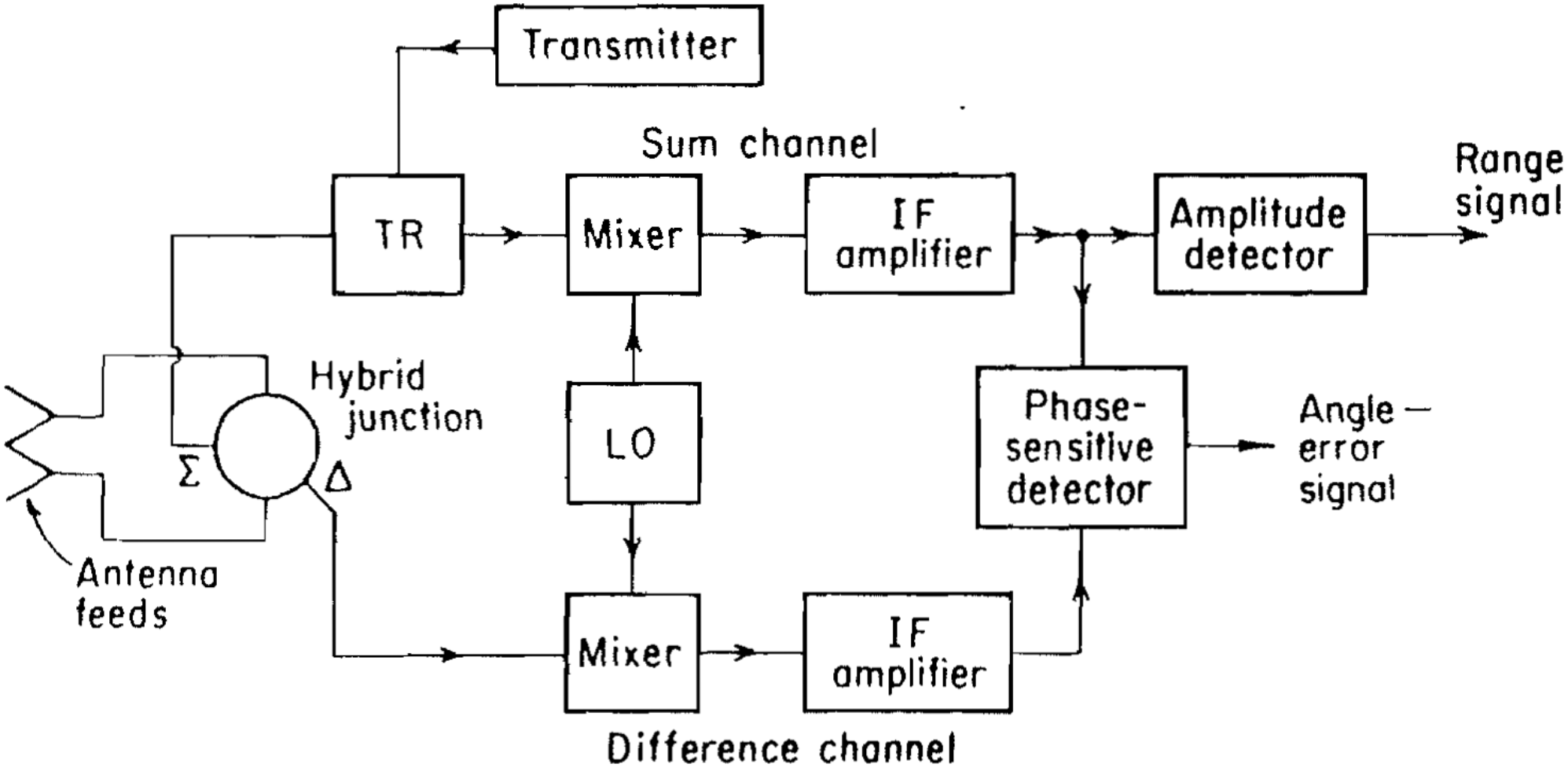
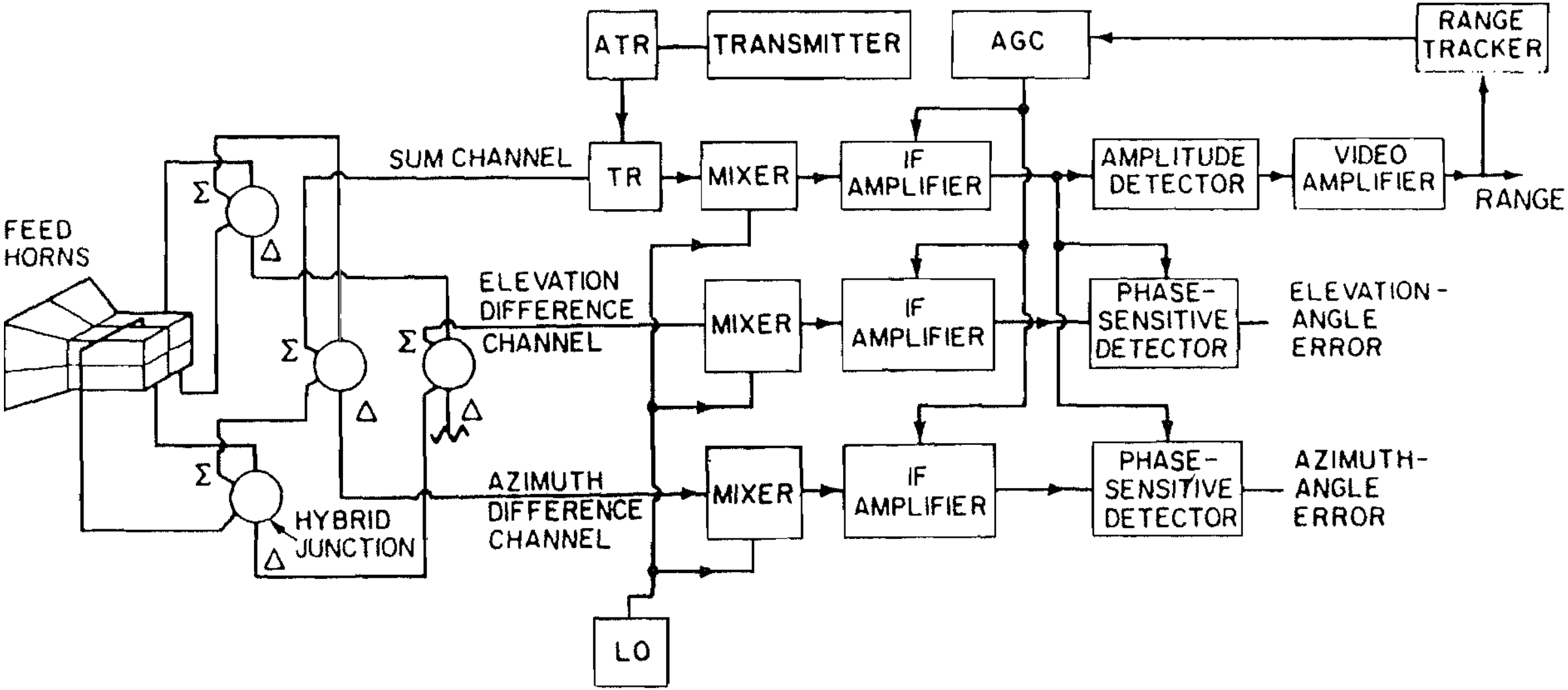

Transmitter
Sum channel
TR
Mixer
IF amplifier
Amplitude detector
Range signal
Hybrid junction
Σ
Δ
LO
Phase-sensitive detector
Angle — error signal
Antenna feeds
Mixer
IF amplifier
Difference channel

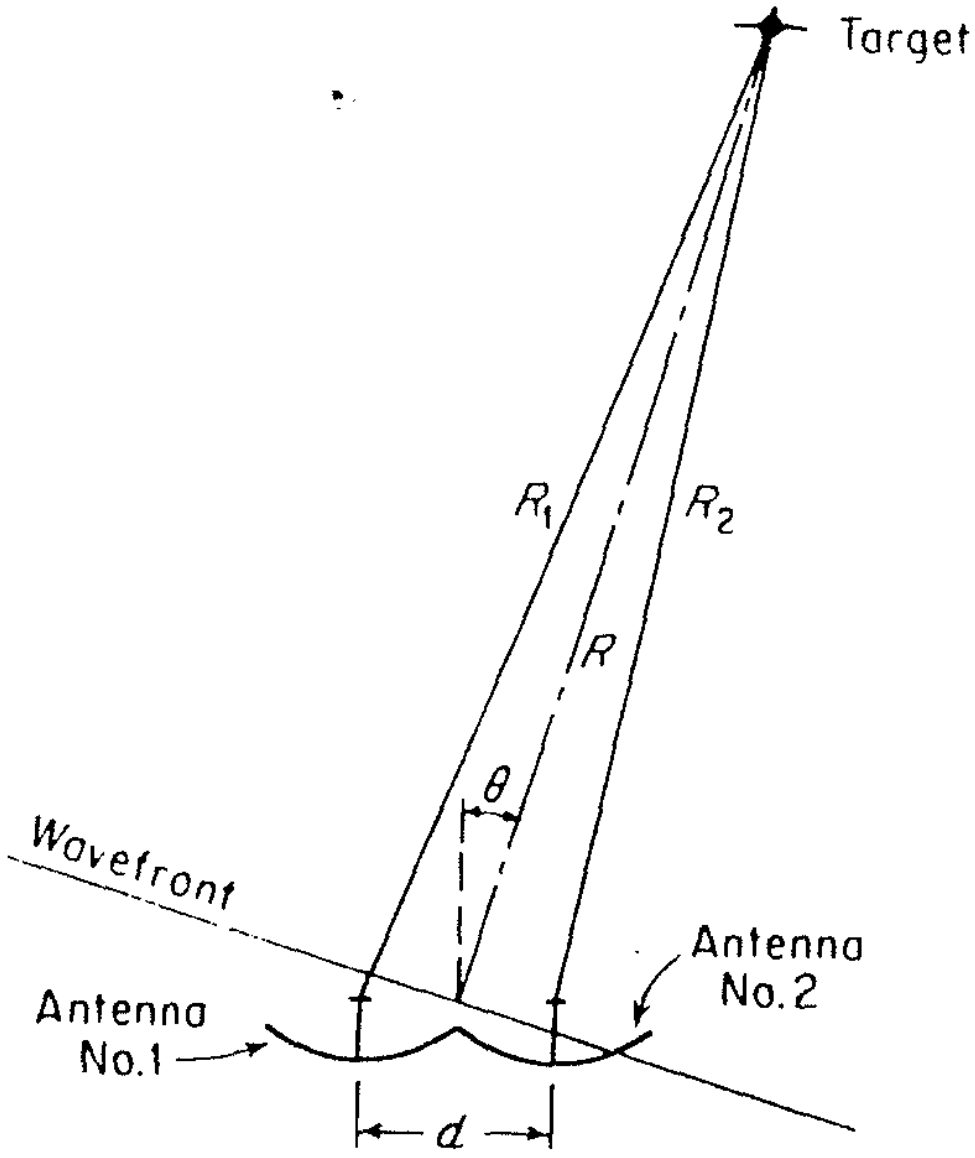

ATR
TRANSMITTER
AGC
RANGE TRACKER
SUM CHANNEL
TR
MIXER
IF AMPLIFIER
AMPLITUDE DETECTOR
VIDEO AMPLIFIER
RANGE
FEED HORNS
Σ
Δ
ELEVATION DIFFERENCE CHANNEL
MIXER
IF AMPLIFIER
PHASE-SENSITIVE DETECTOR
ELEVATION-ANGLE ERROR
HYBRID JUNCTION
AZIMUTH DIFFERENCE CHANNEL
MIXER
IF AMPLIFIER
PHASE-SENSITIVE DETECTOR
AZIMUTH-ANGLE ERROR
LO

Phase comparison monopulse:

$$R_1 = R + \frac{d}{2}\sin\theta$$

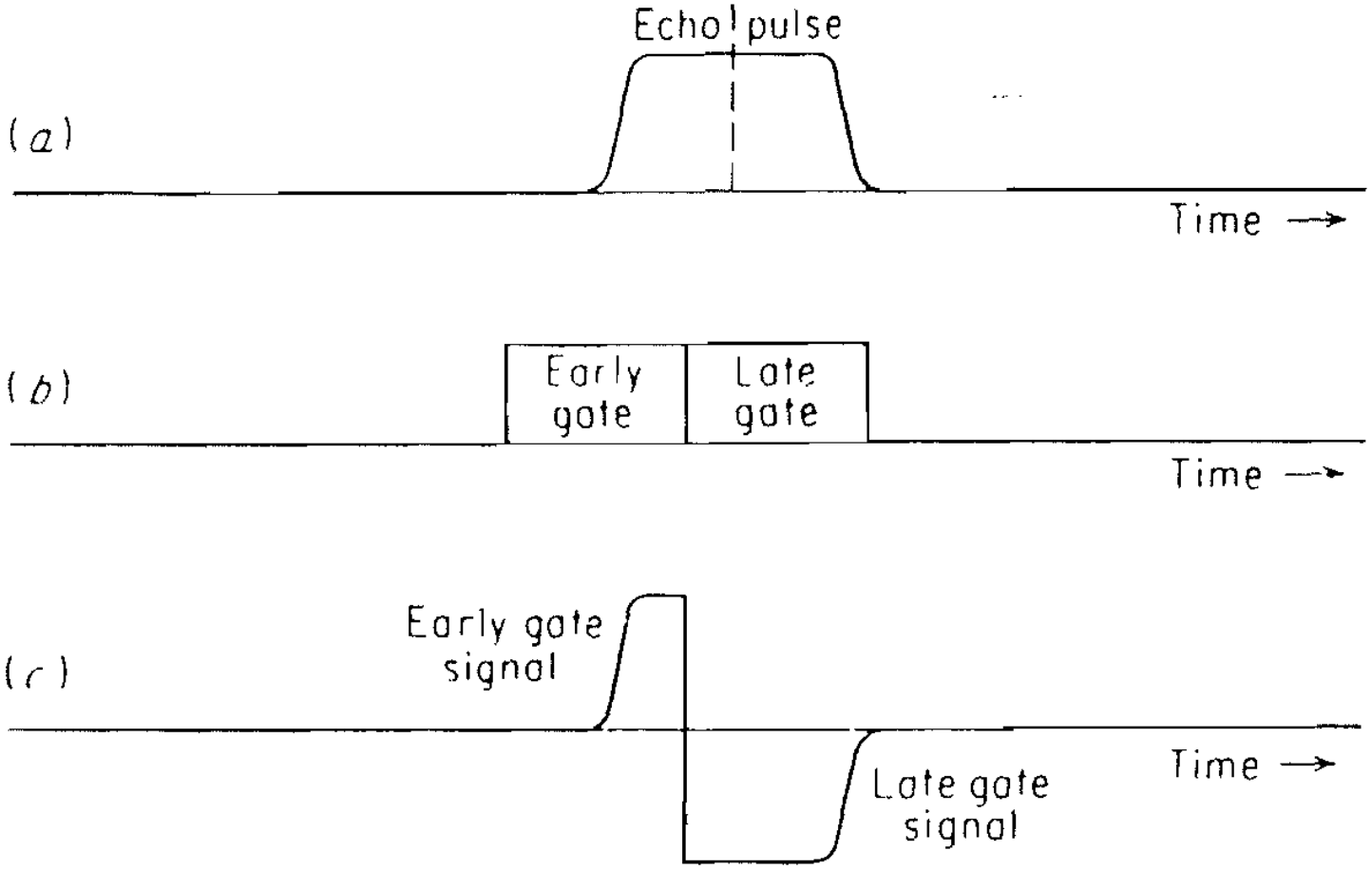
$$R_2 = R - \frac{d}{2}\sin\theta$$

$$\Delta\phi = \frac{2\pi}{\lambda} d \sin\theta$$



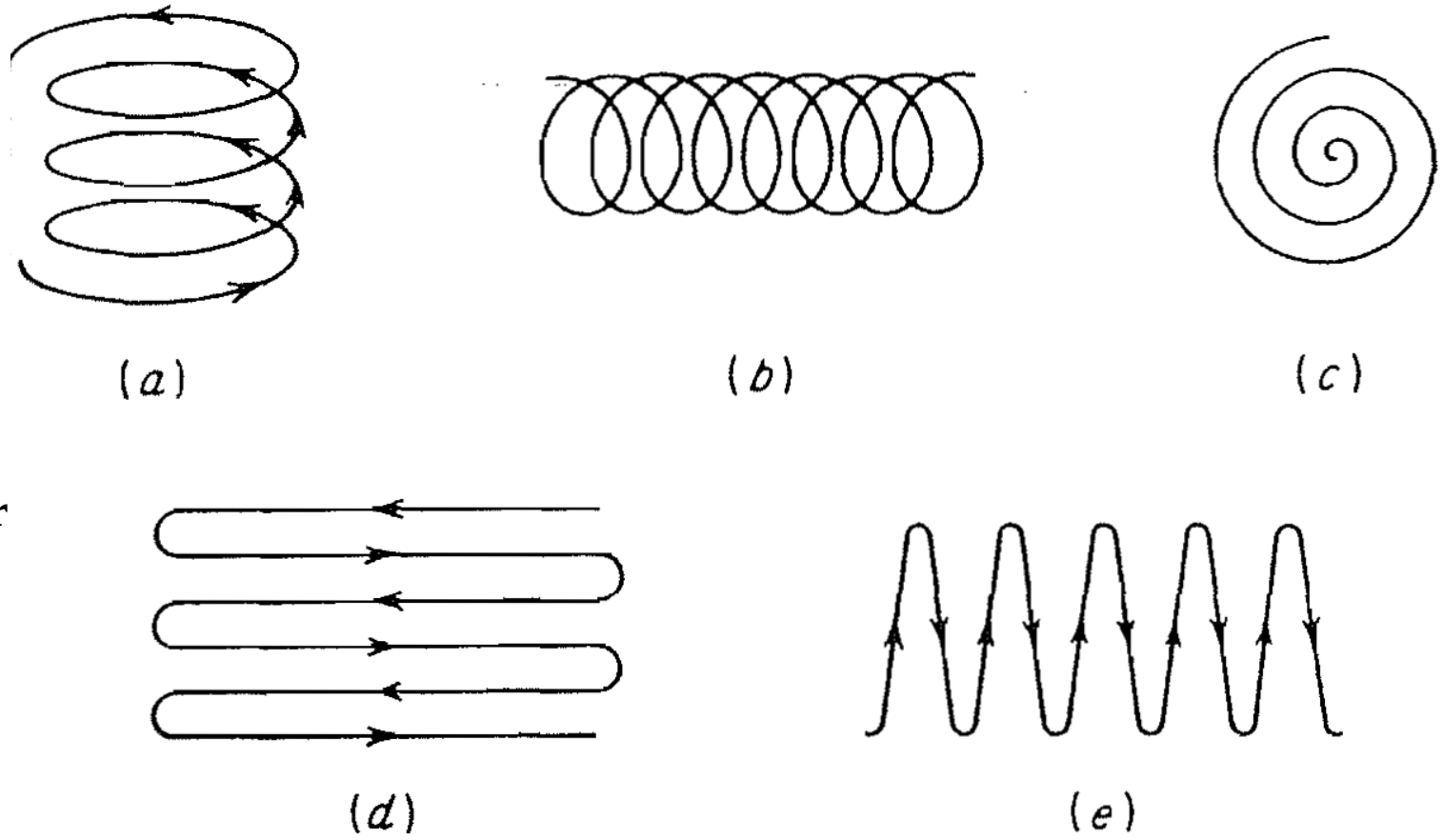
TRACKING IN RANGE

Split-range-gate tracking. (a) Echo pulse (b) early-late range gates; (c) difference signal between early and late range gates



ACQUISITION

**Examples of acquisition search patterns.(a)Trace of helical scanning beam; (b)Palmer scan; (c) spiral scan; *(d)* raster, or TV, scan;
(e) nodding scan. The raster scan is sometimes called an n-bar scan, where *n* is the number of horizontal rows.**



COMPARISON OF TRACKERS

When the target is being tracked, the signal-to-noise ratio available from the monopulse radar is greater than that of conical scan radar, all other things being equal, since the monopulse radar views the target at'the' peak of its sum pattern while the conical-scan radar views the target at an angle off the peak of the antenna beam.

The monopulse radar is the rnore complex of the two.

Since the monopulse radar compares the amplitudes of signals received in three separate channels, it is important that the gain and phase shift through these channels be identical.

With the monopulse tracker it is possible to obtain a measure of the angular error in two Coordinates on the basis of a single pulse. A minimum of four pulses are usually necessary with the conical-scan radar.

The monopulse radar first makes its angle measurement and then integrates a number of pulses to obtain the required signal-to-noise ratio and to smooth the error. The conical-scan radar, on the other hand, integrates a number of pulses first and then extracts the angle measurement.

Because a monopulse radar is not degraded by amplitude fluctuations, it is less susceptible to hostile electronic countermeasures than is conical scan.

The monopulse radar is the better tracking technique; but in many applications where the ultimate in performance is not needed, the conical-scan radar is used because it is less costly and less complex.

Summary

Conclude Course (unit)Outcomes at the end of each unit

Summary

CO 1 : Modelled the radar range equation.

Summary

Conclude Course Outcomes at the end of course