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Scanning Beacon Locator System: A Concept

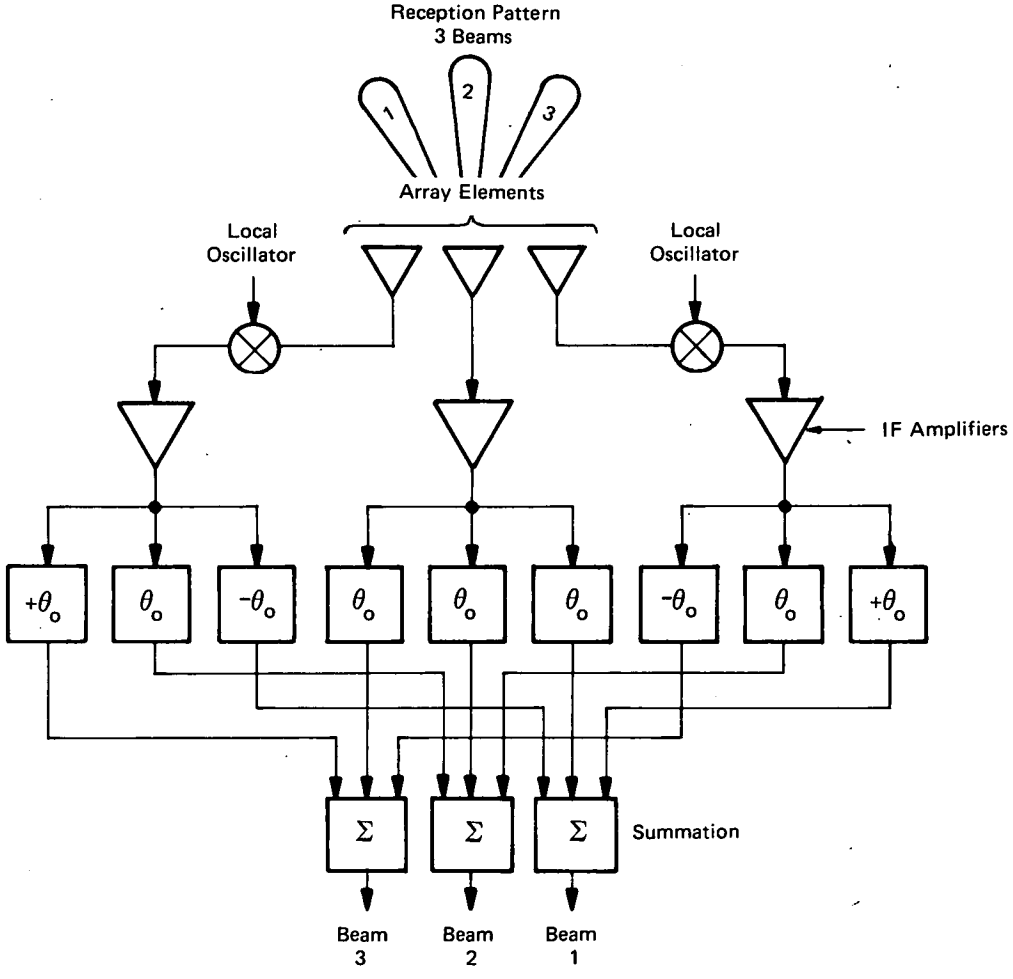

Figure 1. Multiple Beam Array

Aircraft and ship disasters often sustain many casualties because the rescue crews cannot locate and get to them quickly enough. With present communications, the search may continue for hours and sometimes days, particularly in bad weather. In the future, however, rescue efforts may speed up significantly if aircraft and ships are equipped with beacons capable of communicating with satellites. In the event of disaster, these beacons can be activated and transmit a distress message to a satellite which, in turn, will relay the message to the nearest rescue center, indicating the distress location. To be practical, this system must meet at least two

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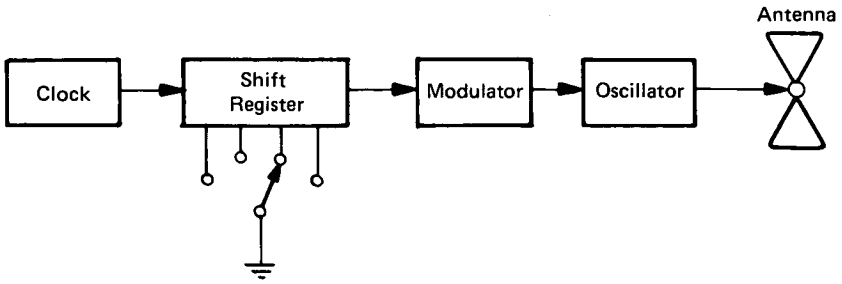

Figure 2. Ground Beacon

requirements. First, the beacons must be relatively inexpensive, and second, satellites must be capable of searching an area as large as the continental United States (approximately 5000 by 3200 km) and locating the distress signal to an accuracy of 2 km.

To cover a large geographical area such as the continental United States, the satellite should orbit above some fixed geographical location (geo-synchronous). In this case, the orbit altitude is about 36,200 km. The antenna must be capable of scanning a 3200- by 5000-km area within 10 seconds and locating the beacon within 2 km. Acquisition time must be no greater than 10 seconds after activation of the beacon.

Various computations were performed to determine if such an antenna was technically feasible. To scan the specified area within 10 seconds, the horizontal scan-line rate was computed at 160 lines/second along a 3200-km front. This rate is possible only with electronically scanned, phased arrays. Resolution as a function of surface was computed as 1.37 S (arc), where S is the surface distance. Antenna aperture as a function of wavelength was calculated to be $16{,}181\lambda$, where λ is the wavelength of operating frequency.

Based on the accuracy goal of 2 km, the operating frequency range for the antenna is between 5 and 30 GHz. Peak pulse powers of 10 watts are generally available throughout these bands and are used as a basis for further calculations.

The RF bandwidth based on non-return-to-zero (NRZ) data of four bits per element was computed at approximately 3.5 MHz. Based on this bandwidth, a signal-to-noise power ratio of 6 dB and transmitter power of 10 watts, the computed antenna diameter is 29.6 m. Using 10,000 elements, the size of the array is 875 m^2; its weight is approximately 62,000 kg (136,000 lb). Both the antenna size and weight can be reduced by a factor of four approximately, by dividing the search area into four sub-areas and using four beams.

Each array element is mixed with a local oscillator signal and amplified in an IF amplifier. The output of each amplifier is subdivided into a number of independent signals, which are summed with other signals as if they were from separate receivers. By varying the amounts of relative phase shifts, multiple beams are formed simultaneously. All beams can be swept in synchronism, using the signal beam steering signals (see Figure 1).

The ground beacon, by definition, must be simple, small, and inexpensive. One concept of such a beacon is shown in Figure 2. The heart of the beacon constitutes either avalanche or bulk devices that essentially oscillate when mounted in an appropriately tuned cavity or stripline and the proper dc voltage is applied.

Modulation of the signal is easily accomplished by interrupting the supply voltage. The coded message amplitude modulates the carrier. The codes are generated from an integrated circuit clock (1 chip) and a four-bit shift register (1 chip); the modulator is the final chip. The antenna is a simple stripline antenna. Based on this design, it is possible to fabricate the entire circuit in a single large-scale integration (LSI) chip, including a microwave-integrated circuit antenna.

Notes:

1. These beacons may also be used in automobiles, boats, and other vehicles, to send distress signals from remote locations.
2. Requests for further information may be directed to:
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Patent status:

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