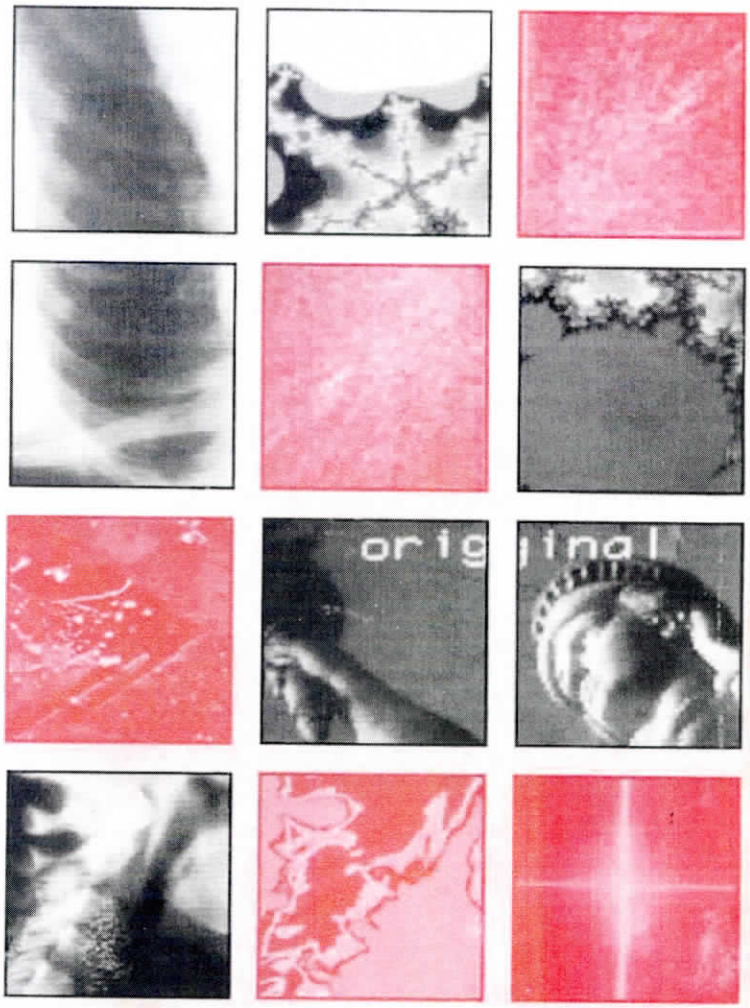
Electronic Imaging '86

International Electronic Imaging Exposition & Conference



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ADVANCED HIGH PERFORMANCE REFLECTIVE INFRARED SCANNING SYSTEM WITH BUILT-IN TEMPERATURE REFERENCES.

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Introduction.

During the last 20 years commercial IR-scanners preceding the System described in this paper, has been using various mechanical scanner systems to provide a real time IR-image. Thermovision® units of the 650 and 660 series used a combined reflective and refractive scanner, models 680, 750, 780 and the current 782, uses a completly refractive system with two 8-sided prisms providing the scan. Refractive scan systems provide a non folding linear scan for the flying spot type scanner and are very reliable and rugged. It is not always practical to further increase the scan efficiency and to incorporate IR-references inside the scanner, using these techniques.

A new Advanced infrared scanner with mainly reflective optics provides higher scan performance, applicability of scanned internal blackbody references, excellent vertical and horizontal scan syncronization for perfect picture element registration and a new detector system using Thermoelectric cooling, with performance equal to the earlier LN_2 cooled units.

Description of hardware.

In an effort to gain a definitive benefit in a new scanning system over earlier systems, many different systems have been studied, conceived and evaluated. Finally a specific system was adapted and eventually provided a world patent protection. This system is now incorporated in the new model 870 by AGEMA Infrared Systems in Sweden. Many a criteria had to be fullfilled. A high efficiency long life, mechanical scan system, rugged and with a precice optical bench, is used. A scan efficiency of 98% is achieved. The scanning optics consists of diamond turned aluminum alloy mirror sections combined with a new rotating octagon reflective prism system. The prism system provides both the scanning of the object in space as well as, through its back facets, the scanning of the new SPRITE Detector (see fig. 1). A new long life brushless DC-motor is employed to run the high speed prism assembly. Calculated life time of this special motor is in excess of 30,000 hours.

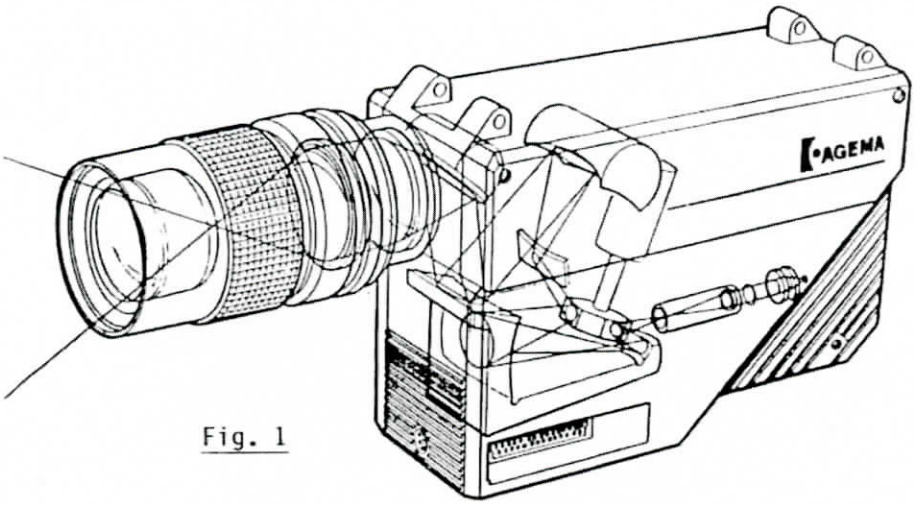


Fig. 1

The vertical scan tilting mirror is running servo-linked with the horizontal scan prism.

As part of the reflective mirror system within the optical bench, two active stabilized micro blackbody temperature references are installed. These references are continuously scanned as part of the regular scan sequence. A microprocessor within the scanner unit senses these referenseses plus internal optics temperature sensors so as to provide a zero drift, long and short time highly stable calibrated output from the scanner. Microprocessor software is contained within the scanner. The Microprocessor is also communicating with the Display Unit via an RS232 link.

Most current and many earlier commercial IR-scanner-imagers are using Liquid Nitrogen as cooling media for their detector systems. Occasionally Joule-Thomson high-pressure gas cryostats are used.

The 870 scanner provides the user with the conveniance of Thermoelectric cooling of the detector assembly. Thus the scanner will provide a continuous image as long as electric current is energizing the T-E cooler.

This major step in the technology of commercial real time IR-scanning imaging radiometers has been possible through the employment of a rather new detector type, developed in England by the Royal Signals and Radar Establishment, and manufactured by MULLARD LTD. This detector is called SPRITE (Signal PRocessing In The Element) or sometimes the "TED" detector (after the inventor Dr. C. Ted Elliott of the Royal Signals and Radar Establishment, Malvern).

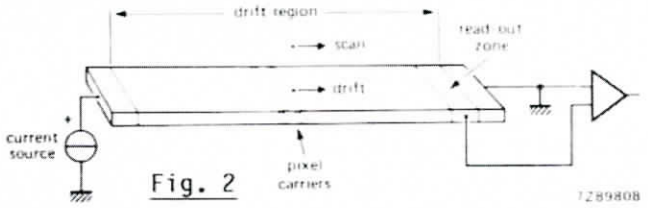


Fig. 2

The SPRITE Detector (see fig. 2) is essentially a strip of MCT, MERCURY CADMIUM TELLURIDE, mounted on a substrate, normally sapphire, and cooled to a low temperature. Cooling by LN_2 at 77°K is an excellent way to get maximum performance out of this detector. However it will also work at warmer temperatures.

In the 870 scanner, a 4-stage thermoelectric cooler is employed to cool a SPRITE Detector to about -80°C (190°K). (See fig. 3)

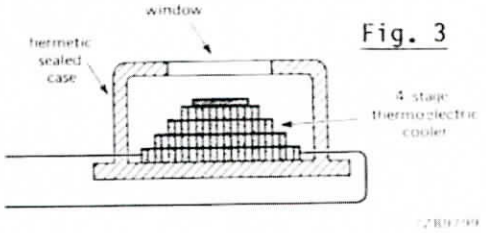


Fig. 3

This detector has optimized sensitivity in the 2 to 5.6 micron band and provides a minimum detectable temperature sensivity of 0.1 degrees Celcius at 30 degrees object temperature for the 870 system.

SPRITE versus linear detector array.

The conventional serial scan system utilizes an array of discrete detector element (see fig. 4) with a mechanical scanner providing the movement of a scanline of the image over the detector elements. The signal from each detector element is amplified separately and then time delayed in an integrating delay line in the appropriate way, depending on the scan system configuration. All the time delay and integration is done outside the detector element.

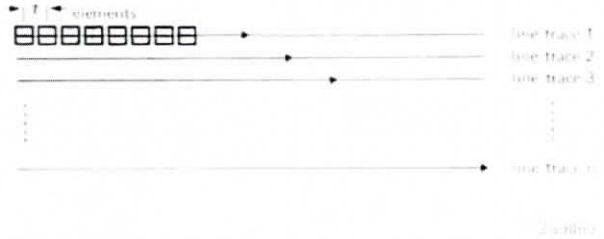
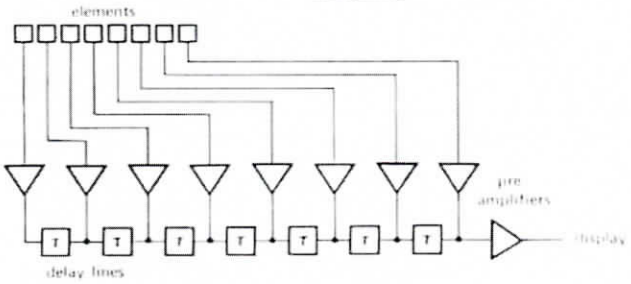


Fig. 4



The SPRITE Detector offers a particular advantage over the conventional linear array in that all the time delay and summation functions are performed at the focal plane by the detector element itself. (See fig. 2)

This detector element has only three electrical connections. Two are utilized to set up a biasing current through the element, and a third is connected to the read out zone, where the integrated picture element signal is read out, amplified and fed to the appropriate processing and display system.

Scanner FOV and other data.

The 870 scanner provides the user the choice of foreoptics. Lenses with bayonet mount and the following field of view are available: 40° - 20° - 12° - 7° plus on special order 2.5° FOV. All lenses are F:1.0 and can be focused manually or via remote focus.

External selection of three apertures is included, and space for 2 spectral filters in an externally selectable filter cartridge is provided.

The temperature measurement range for this new IR-System is -20°C to +500°C in three temperature ranges with option to +1,500°C available.

The scanspeed is 25 Hz with 100 by 100 picture elements resolution. The Scanner weighs 2.5 kg. (5 lbs) with a 20° FOV lens.

Display unit 870.

A Display unit is provided with the 870 scanner. It displays a B/W IR image on a 50 x 50 mm CRT, and has controls for thermal range, thermal level, Isotherm 1 & 2, mode selector, brightness and contrast. It also provides electronic automatic photo reset for Polaroid® or 35 mm camera, and recording and playback functions for a system Video, modified Video tape recorder. (VHS tape)

A remote focus control for lens focusing is part of the front panel. Accessory and RS232 output on the back panel interfaces with the TIC-8000 Thermal image computer with its new high performance real time image presenting and measuring software CATS 1.00. The TRC Temperature Readout Computer can be used in a man portable configuration and also communicates via the RS232 link for level, range, aperture and filter information.

Conclusion.

The innovative use of a diamond turned reflective scan system together with a high technology T-E cooled SPRITE detector and ultra long life scanmotors, has provided the IR-community with a most rugged, application adaptable, economical, lightweight calibrated Infrared Imaging System with real time image presentation and absolute temperature measurement capability. The TIC-8000 Thermal Image Computer with the new CATS 1.00 software accepts Menu or Mnemonic inputs to the IBM XT for measurement and image processing.

References: 1. AGEMA Product Literature for Thermovision® 870.
2. MULLARD Technical Publication M82-0099.
3. Technology Trends, Electronic Product Design, August, 1981.

Acknowledgement: AGEMA Infrared Systems, USA, has been helpful with material for this paper.